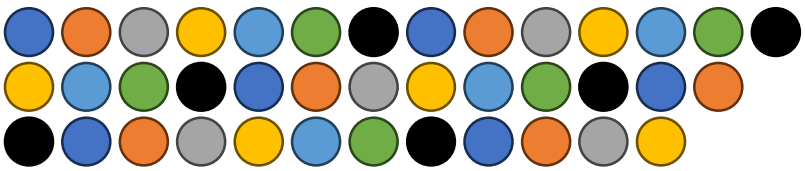
MDOT Research Priorities

Fiscal Years 2027-2029



Michigan Department of Transportation
RESEARCH
Administration

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Research Strategic Priorities and the Program Development Process

In a world of rapid technological advances, evolving infrastructure and emerging modes of transportation, the Michigan Department of Transportation (MDOT) remains steadfast in its commitment to progress. Every two years, MDOT refines its research priorities, ensuring they align with both the present challenges and the bold aspirations of the future. This process is guided by the *Michigan Mobility 2045 Plan* (MM2045), a roadmap to a more connected, resilient and forward-thinking transportation system. At the heart of this effort is a vision that propels MDOT forward:

> *To provide people with a safe, future-driven, interconnected multimodal transportation network that ensures equitable options.*

To bring this vision to life, MDOT Research Administration (RAd) plays a crucial role in defining research priorities that meet the evolving needs of the state. MDOT also embraces national research initiatives to strengthen its approach. The *TRB Critical Issues in Transportation for 2024 and Beyond* outlines key challenges and policy directions shaping the future of mobility. Furthermore, the *USDOT Research, Development and Technology (RD&T) Strategic Plan Fiscal Year 2022-2026*, alongside the *RD&T Annual Modal Research Plans*, provide essential guidance in adapting research priorities across various transportation sectors. Through collaboration, innovation and a commitment to continuous improvement, MDOT is shaping the transportation network of tomorrow, one that is safer, smarter and built for all.

With this clear vision, RAd leads a planning process every two years throughout the department to develop and approve their upcoming three-year candidate program of research projects. This three-phase process ensures that strategic priorities are directly linked to project selection and ultimately to the implementation of research results. RAd leads this entire process to ensure that it is timely and effective, and that it conforms to all state and federal requirements.

The first phase in the three-year planning process is research idea development. During this phase, the Research Advisory Chairs (RAC) and Research Executive Committee (REC) identify priorities with focus area managers (FAM) and technical experts within the Research Committee Structure. These priorities assist internal and external stakeholders in submitting research ideas that address these areas of focus during the call for research. Submitted research ideas are reviewed for consideration, selected and amended as needed.

In the second phase of planning, project managers (PMs) take the lead, transforming selected research ideas into well-defined problem statements. These statements undergo refinement through program development meetings, where internal and external stakeholders collaborate to enhance their clarity and effectiveness. RAd then compiles these problem statements into three-year planning documents, ensuring they align with strategic priorities before being submitted for RAC and REC approval. A problem statement serves as the foundation of a research project, providing a clear roadmap that outlines its objectives, tasks, schedule and budget, setting the stage for impactful and results-driven research.

In the final phase of the planning and approval process, RAd obtains annual program approval and issues requests for proposals for the problem statements. Each summer, RAd submits the upcoming fiscal year program for approval and provides a list of projects for which proposals will be requested.

The following pages provide the identified MDOT Research Priorities for the 2027, 2028 and 2029 fiscal years. The priorities are listed by focus area and grouped according to our research committee structure. A list of projects that resulted from the last call for research and other resources can be found on the RAd website. A description of what is eligible for SPR II Research funds is available in section 5.1 of the Research and Implementation Manual.

Michael Townley
MDOT Engineer of Research

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Research Advisory Committees (RACs) and Research Focus Areas

RACs and Research Focus Areas (continued)

Highways Development RAC

RAC Chair: Demetrius Parker and member Kristin Schuster

"We will be a knowledge-based, service-oriented organization providing high-quality transportation project development services in support of the department's strategic goals."

- **Bureau of Development Mission**

Environment and Water Resources — Hal Zweng

Goal No. 1: Develop an assessment framework and potential integrated processes while increasing understanding of stream grade control for Michigan.

Research Needs for Goal No. 1

Understanding stream grade control in Michigan is crucial to preventing infrastructure damage, erosion, sediment transport, flooding and other risks. This research will identify, assess countermeasures, mitigate, support and monitor stream degradation to enhance resilience and sustainability. Set up a risk framework and countermeasures for stream grade control inside or outside of structures. Gain an understanding of cross-agency policies and mitigation practices of stream grade control in Michigan. Provide guidance for implementation, ensuring positive outcomes and broader acceptance across agencies.

Goal No. 2: Develop a risk matrix for prioritization of bridge scour action plans.

Research Needs for Goal No. 2

There are many scour-critical structures across Michigan that would require action during a flood event. Large events require a guide to assess the priority of structures to initiate monitoring and/or closure to ensure the integrity of our infrastructure and the safety of our customers. Consider and address the findings from the recent Federal Highway Administration assessment for Michigan. Collaborating with the MDOT Bureau of Bridges and Structures to research best practices and policies is required.

Goal No. 3: Develop a better understanding of wildlife safe erosion control blankets.

Research Needs for Goal No. 3

Conduct a synthesis or scan to determine how wildlife-safe erosion control blankets are being deployed in other transportation agencies.

Real Estate, Utilities and Permits — Larry Doyle

No Research Priorities Identified

Innovative Contracting and Major Projects — Ryan Mitchell

Goal No. 1: Increase certainty for unfunded needs to allow for long-term planning of major projects.

Research Needs for Goal No. 1

Identify best practices for long-range funding, financing and programming/investment (project identification and selection) strategy.

Goal No. 2: Identify emerging trends in collaborative contracting (i.e., construction manager/general contractor (CM/GC), progressive design-build (DB), progressive public-private partnerships (P3)).

Research Needs for Goal No. 2

Research collaborative cost estimating best practices (MDOT is a national leader in this competence); independent cost estimating, schedule and risk analysis; progressive scope/risk/price reconciliation.

Goal No. 3: Improve public and stakeholder engagement and strategic communications.

Research Needs for Goal No. 3

Identify the best practices for managing and adapting to the emerging trend of increased public and stakeholder involvement and influence on project development decision-making. This increased involvement has led to a tendency for scope changes and increased controversy and increased scrutiny, indicating a need for increased transparency and more effective messaging and communications on major projects.

Project Development — Nathan Miller

Goal No. 1: Utilize data from existing MDOT systems and programs to aid the department's development scheduling software by enhancing data integrity, streamlining processes and improving overall scheduling efficiency.

Research Needs for Goal No. 1

1. Identify all current MDOT data systems and programs (e.g., asset management, geographic information system (GIS), computer-aided process planning (CAPP), etc.) that produce or store data relevant to development scheduling.
2. Analyze and provide recommendations on how integrated data can optimize scheduling workflows and reduce manual entry or redundant processes.
3. Evaluate the technical feasibility of integrating data from various MDOT systems into the scheduling software.
4. Assess the quality, accuracy, completeness and timeliness of data within existing systems.
5. Examine other state DOTs or agencies that have successfully integrated data systems with scheduling tools.
6. Provide alternative scheduling software that meets the department's goals.

Goal No. 2: Develop a barrier system consisting of traditional beam guardrail, cable barrier or a combination of the two that is capable of withstanding low-speed transverse impacts that is capable of Manual on Assessing Safety Hardware (MASH) compliance.

Research Needs for Goal No. 2

Depressed freeways with service drives along the freeway have a need for barriers placed alongside a service drive to not only redirect impacting vehicles traveling along the service drive but also capture any vehicles traveling on intersecting side streets that may errantly drive through the intersection and potentially enter the freeway. Traditional guardrail and different types of cable barrier systems have been used in an attempt to capture side street vehicles impacting the barrier transversely. However, these designs have either proven to be ineffective or have not been subjected to successful crash testing. Analyze and provide recommendations on how integrated data can optimize scheduling workflows and reduce manual entry or redundant processes.

Goal No. 3: Achieve full MASH compliance within MDOT for all applicable hardware.

Research Needs for Goal No. 3

The department is committed to achieving full MASH compliance for all roadside safety hardware categories. There are national roadside safety pooled fund groups that have generated beneficial research, but this has not resulted in full MASH compliance for the department. There are certain areas where additional research is needed (e.g., sign supports, work zone devices, luminaires, etc.). Some of these devices are proprietary and manufacturers may not possess the expertise, resources or incentive to develop MASH-compliant options. However, MDOT cannot do research on patented devices, so the alternatives would be to wait until manufacturers develop MASH-compliant alternatives, or for the department to explore development of non-proprietary substitutes. In summary, additional research is necessary in device categories that are not fully MASH-compliant.

Goal No. 4: Refine the Michigan Highway Construction Cost Index (MHCCI) methodology to include lump-sum items in index calculations and development of real-time data integration systems.

Research Needs for Goal No. 4

Current index calculations include pricing for standard items only. Previous research focused primarily on non-lump-sum items for cost estimation, potentially overlooking a significant portion of project costs. Non-standard and lump-sum items often involve complex or unique aspects of a project and may not be easily estimated through index-based methods. Future research could develop methodologies for accurately estimating lump-sum and unique items of work. Incorporating these items into the model could provide a more comprehensive cost estimate, especially for large-scale or complex projects. Future research should also explore the development of real-time data integration systems that can continuously update construction cost index predictions using live data feeds from market sources (Department of Labor Statistics/economic data providers). This would allow for more timely and dynamic adjustments to cost estimation, providing MDOT with the ability to respond to real-time economic fluctuations.

Surveys and Automated Design — Brian Fish and Andrew Block

Goal No. 1: Define organizational information requirements relating to survey, design, construction and asset management for building information modeling (BIM).

Research Needs for Goal No. 1

ISO 19650 has set standards for developing the information management requirements for managing assets throughout their lifecycle to facilitate the transfer of information and information needs in different phases of a project. Identify, define and evaluate MDOT organizational information requirements relating to digital workflows for survey, design and asset management.

Goal No. 2: Evaluation of level of detail requirements and modeling guidelines for digital transfer of design information to construction.

Research Needs for Goal No. 2

Traditional plan set development guidelines focus on a portable document format (PDF) deliverable that is human consumable, requiring visual line styles, patterns and other differentiators to optimize how people understand the plans. As the industry is moving forward with more digital workflows and using equipment that can consume digital information in the field, research is needed to understand how this information is actually translated into field operations, specifically staking and layout for the project. This includes investigating the key layout points and parameters needed for construction staking, the level of detail required for these elements if provided in a digital format, and creation of modeling guidelines for designers.

Goal No. 3: Seamless transition of information from survey and design to construction, operations and maintenance, and asset management.

Research Needs for Goal No. 3

1) Identify systems and processes to transition information developed in survey and design to construction contractors for project delivery as well as for MDOT inspection and installation activities. Removing duplicative efforts in the development, collection and utilization of this information is a key factor in creating efficiencies for this information transfer.
2) Identify systems and processes to pass information developed in survey and design to asset management databases.
3) Identify how separate systems utilized for survey, design, construction and asset management can be utilized based on a single source of truth to streamline processes and information transfers. Develop exchange information requirements per ISO 19650.

Goal No. 4: Software that automatically recognizes mapping features in light detection and ranging (LiDAR) data to create CAD drawings.

Research Needs for Goal No. 4

Investigate and test existing software that automatically recognizes mapping features in LiDAR point data to create topographic maps in CAD.

Goal No. 5: Determine unmanned aircraft systems (UAS) LiDAR use cases for hydraulic surveys.

Research Needs for Goal No. 5

Observe the difference between conventionally mapped hydraulic sections (that are outside the water measurements) against terrain measurements using UAS LiDAR. Testing different UAS LiDAR for measuring the depth of water, accuracy and affordability are the main goals.

Goal No. 6: Investigate survey mapping equipment that will efficiently and easily measure construction quantities.

Research Needs for Goal No. 6

Test different hardware and software that would be easy for construction technicians to measure quantities accurately in the field.

Goal No. 7: Find better ways to locate subsurface utility engineering (SUE) features.

Research Needs for Goal No. 7

Test the latest technology for accurate location of subsurface utility features that can be done at a reasonable cost.

Highways Bridges and Structures RAC

RAC Chair: Rebecca Curtis

"We are devoted to the efficient and innovative design, construction and active preservation of Michigan's transportation structural assets."

- **Bureau of Bridges and Structures Mission**

Bridge and Structure Design and Construction — Brad Wagner

Goal No. 1: Ultra high-performance concrete (UHPC) uses for Michigan.

Research Needs for Goal No. 1

Develop a better understanding of UHPC use cases and limitations for Michigan applications. Create greater awareness among bridge designers and bridge owners of potential use cases and applicability of fix types. Consider a technology transfer to learn from Michigan local agencies, academia and Midwest bridge owners.

Bridge and Structure Preservation and Inspection — Mike Halloran

Goal No. 1: Remediating bridge deck cracking in Michigan.

Research Needs for Goal No. 1

Evaluate recent national research on this topic, particularly TR-782 Guide to Remediate Bridge Deck Cracking initiated by Iowa DOT and perform a similar analysis for the Michigan network of structures. This includes:

- Analyzing crack development and crack type/depth based on Michigan climate and design details, deck reinforcement protective coatings, and life cycle cost analysis comparing various crack remediations.
- Develop recommendations for future actions, including intervention timing, product and application methods.

Goal No. 2: Evaluate the feasibility of implementing a Michigan bridge washing/flushing program.

Research Needs for Goal No. 2

Determine what information may be applicable to Michigan, identify existing evidence using a comparative analysis, and/or perform laboratory tests to quantify the long-term benefits of bridge washing, determine the resource needs for MDOT to implement such a program, and make a recommendation based on the findings.

Goal No. 3: Prioritizing scour plan of action (POA).

Research Needs for Goal No. 3

Improve POA development and implementation by determining high, medium and low risk based on structures' scour vulnerability and criticality. Determine the impact (if any) of weighing specific data points to more accurately assign risk and prioritize in-person monitoring.

Goal No. 4: Improve predictive needs to most efficiently use resources in pursuit of bridge state of good repair

Research Needs for Goal No. 4

Identify a condition-based service life of the historical bridge inventory. Build upon existing decommissioning research as well as major changes to bridge design and construction practices. Create a process to forecast remaining bridge service life in a reliable manner. Identify costs to extend the service life of existing bridges.

Geotechnical and Foundation Design — Ryan Snook

Goal No. 1: Improve MDOT's ability to obtain geologic information while drilling cores.

Research Needs for Goal No. 1

Determine the applicability/correlations of measurement while drilling (MWD) in Michigan

Goal No. 2: Development of a corroded and distressed culverts assessment method.

Research Needs for Goal No. 2

The development of a finite element model (FEM) for assessing corroded and/or distressed culverts can be driven by several key needs that could address more than just technical and operational challenges. An accurate FEM would provide insight into the structural performance of culverts under various deterioration scenarios, allowing staff to identify areas before failure occurs. This would assist in ensuring safe public use of infrastructure, while protecting maintenance and construction staff. The development would enhance the understanding of forecasting, prioritization and efficient use of funds for culverts.

Goal No. 3: Development of temporary casing designs in very soft clay.

Research Needs for Goal No. 3

The development of an FEM to assist in determining the minimum thickness of temporary casing in very soft clay has been a technical challenge, but also touches on safety, efficiency, innovation and risk management. An FEM designed to predict the behaviors of temporary casings in very soft clay would help ensure that these casings perform reliably during installation and excavation. This also would allow MDOT and potentially other agencies to optimize design parameters, such as the casing's thickness by simulating real-world conditions and soil-structure interactions. Having an FEM would empower engineers to conduct parametric studies and develop performance-based design approaches, leading to more accurate predictions of casing behavior.

Highways Delivery and Operations RAC

RAC Chairs: Jason Gutting and members Kim Zimmer and Lindsey Renner

"We provide leading edge services and solutions."

- **Bureau of Field Services Mission**

Construction — Ken Koepke

Goal No. 1: Quantify the benefits of implementing connected and smart work zones (SWZ).

Research Needs for Goal No. 1

Identify the metrics and methodologies to monitor and quantify the benefits, in real time, of implementing SWZ. A synthesis or survey of SWZ tool usage, practices and implementation guidance or specifications should also be included in the project.

Goal No. 2: Optimize queue warning systems.

Research Needs for Goal No. 2

Review current slow/stopped messaging, speed ranges, board and sensor placement, and alternate signs to more effectively warn motorists of queued traffic ahead.

Goal No. 3: Understand the validity of autogenous healing.

Research Needs for Goal No. 3

Evaluate any known effects of autogenous healing of various cracking in concrete pipe in a humid, caustic and pressure flow environment.

Goal No. 4: Understand intelligent compaction efforts through data.

Research Needs for Goal No. 4

Evaluate any efficiencies, analyze long-term performance based on known density data and consistency of compaction efforts.

Goal No. 5: Understand long-term effects of geopolymer concrete pipelining techniques.

Research Needs for Goal No. 5

Evaluate the life span of geopolymer concrete pipelining techniques. Compare life spans and costs against different pipelining techniques such as epoxy impregnation and acrylamide grouting.

Goal No. 6: Understand long-term effects of polymer-coated steel drainage pipe.

Research Needs for Goal No. 6

Evaluate life spans of polymer-coated and uncoated steel pipes. Compare life spans and costs of coated versus uncoated steel pipe.

Signals — Hilary Owen and Jason Bodell

No Research Priorities Identified

Facility Management and Operations — Diane Sevigny

Goal No. 1: Preparing future facility designs to meet operational/equipment needs (i.e., zero emission initiatives, fleet/operational equipment storage, maintenance and service needs).

Research Needs for Goal No. 1

- Strategic planning focuses on understanding how/where MDOT needs to prioritize resources and plan/prepare to support the future operations and equipment MDOT incorporates, including utility supply infrastructure and changing fire codes/building construction codes.
- Options, innovations for the construction of salt storage buildings to include any new anti-corrosive coatings/materials in the construction of the facility for overall savings on total cost of ownership (less maintenance, longevity of building to prevail over the corrosive environment).

Roadway and Roadside Maintenance — Justin Droste

Goal No. 1: Leverage data from existing MDOT systems and/or programs that are applicable to maintenance operations to improve operations, increase effectiveness, develop performance metrics, etc.

Research Needs for Goal No. 1

- Evaluate mineral well brine sources and use considerations, including testing and regulation standards, for winter operations at MDOT.
- Evaluate the current pump station facilities, weather data and supervisory control and data acquisition (SCADA) data to determine base flow rates in comparison to rainfall intensity. Furthermore, include the use of predictive analytics to determine a risk level for flooding at certain pump station locations based on forecasted rain fall and or other data.
- Develop sustainable weed management techniques to maintain long-term ornamental plantings along urban highways and rest areas, enhancing aesthetics, ecosystem services and biodiversity.

Intelligent Transportation Systems and Connected and Automated Vehicles

Jason Firman and Jason Bodell

Goal No. 1: Leverage data from existing intelligent transportation systems (ITS) to improve operations, increase effectiveness, develop performance metrics, etc.

Research Needs for Goal No. 1

1. Leverage connected vehicle and third-party probe data to assess real-time traffic conditions, validate sensor accuracy and inform dynamic traffic control strategies such as flex routes and ramp metering.
2. Integrate ITS data into operations planning by utilizing traffic signal performance metrics, detection systems, automated traffic signal performance measures (ATSPMs), and connected vehicle data to optimize signal timing and corridor coordination.
3. Utilize advanced data analytics and machine learning on ITS data sources, such as closed-circuit television (CCTV) feeds, detection loops, weather sensors, and weigh-in-motion (WIM) systems, to proactively identify bottlenecks, recurring congestion points and potential safety concerns.
4. Support work zone management by analyzing ITS data to evaluate traffic impacts, optimize lane closure times and enhance traveler information strategies (e.g., digital message sign (DMS) messaging effectiveness).
5. Evaluate the effectiveness of traffic management center (TMC) operations by correlating incident data, road weather data and response times to develop KPIs for incident detection, clearance, and communications efficiency.
6. Identify opportunities for data fusion and predictive analytics across ITS systems (e.g., SCADA, road weather information systems (RWIS), advanced traffic management system (ATMS), connected vehicle (CV) data) to forecast traffic conditions and anticipate weather-related delays.

Goal No. 2: Explore how traffic signals and other ITS assets can communicate with connected and automated vehicles (CAVs) to enhance safety and flow.

Research Needs for Goal No. 2

1. Study vehicle-to-infrastructure (V2I) communication standards and protocols.
2. Identify required hardware and software upgrades to existing traffic signals to support CAV interactions.
3. Examine how traffic signals can send/receive real-time information (e.g., Signal and Phase Timing messages (SPaT), MAP messages (as defined by SAE J2735), and basic safety messages (BSM)) to and from CAVs.
4. Assess signal priority or preemption strategies for CAVs and emergency vehicles.
5. Evaluate field tests or pilot deployments of smart intersections.
6. Assess how integrated ITS/CAV systems can reduce crashes and improve intersection safety.
7. Understand regulatory barriers and needs for integrated ITS and CAV systems.

Goal No. 3: Establish standards and policies for vehicle-to-everything (V2X) deployment.

Research Needs for Goal No. 3

1. Align technical, legal and operational standards for large-scale V2X rollout (i.e., How do we promote interoperability and ensure safe, regulated adoption?).
2. Evaluate cybersecurity and data privacy for V2X systems (i.e., How do we protect users from spoofing, eavesdropping and system manipulation while preserving data privacy?).

Goal No. 4: Identify the best practices to implement real-time signal timing changes due to incidents.

Research Needs for Goal No. 4

1. Define benefits, best practices and lessons learned on signal timing changes due to incidents.
2. How do other states implement incident corridor management and how do they operate signals of other owning agencies during incidents?

3. Identify corridors and develop an MDOT plan for implementation. MDOT potentially has a couple corridors for use cases.
4. Develop guidance documents for traffic operations center (TOC) implementation.

Pavements and Materials — Chris Byrum

Goal No. 1: Benchmarking of asphalt mixtures for balanced mix design (BMD) program.

Research Needs for Goal No. 1

The BMD methodology aims to move asphalt mix design away from volumetric-based design and acceptance measures and to mixture performance-based testing to achieve an optimization of pavement performance, cost and sustainability. There is a need to evaluate the currently approved asphalt mixtures used and set realistic criteria for performance specifications. The research will use the reimagined BMD framework (2025) to determine the critical performance characteristics and mechanical tests to be evaluated across a variety of mixture and material types. The research will assess both laboratory-produced mixtures for design and plant-produced mixture for acceptance. The research will validate the performance indicators from mechanical tests using field performance data. The study will provide recommendations on which mechanical tests are most implementable for design as well as acceptance, assess the limitations of current mixtures' performance and develop the targets for performance improvement.

Goal No. 2: Incorporation of non-condition factors into MDOT's pavement prioritization and optimization tool.

Research Needs for Goal No. 2

MDOT has been working on a tool that would help with the selection of the most appropriate and cost-effective projects to optimize its transportation dollars. To date, scoring projects is based on the current condition of the pavement and the projected improvement to that condition from various fix types. However, there are factors that affect where and when pavement projects are selected besides the condition. Things such as traffic levels, impacts on the local economy, performance of previous projects, impact on emergency responders, resiliency, safety improvements, improvements for vulnerable road users, etc. These other factors need to be evaluated to determine which should be incorporated into MDOT's project selection methods. The chosen factors would then need to be quantified in a way to be useable within MDOT's project identification tool, including the improvement of the factor due to various fix-types. This work would build on current research regarding the project identification tool and multi-objective decision analysis.

Goal No. 3: Investigate potential uses of artificial intelligence (AI) methods to help manage Michigan's pavements.

Research Needs for Goal No. 3

Use of AI methods (i.e., machine learning, neural networks, etc.) are beginning to be explored for pavement management uses. MDOT would like to understand the different types of AI that could be utilized for pavement management predictive models, where the state of the art or state of the practice with AI is nationally, and potential areas within MDOT's pavement management system where it could be beneficial to utilize AI. One goal of this study would be to train a team of MDOT staff on how to generate predictive models using readily available codes for model development. MDOT has databases that were used to make traditional linear and non-linear regression models and would like to use these databases as the basis of AI-type methods for predictive models for comparisons.

Goal No. 4: Continue the ongoing state-specific calibrations to the mechanistic-empirical pavement design (MEPD) performance prediction models.

Research Needs for Goal No. 4

Establish and monitor a cluster of well-documented Michigan pavement sections, with detailed tracking of their performance measures over time. These sections will serve as the basis for calibration of the MEPD performance prediction regression model coefficients. Calibrating MEPD coefficients for Michigan will provide design outcomes that more accurately reflect state-specific climate, materials and pavement performance rather than relying on the national default (i.e., global) coefficients. As part of this effort, the study may include a review and refinement of Michigan input data related to climate, traffic and materials. Furthermore, advanced data collection technologies may be considered and utilized to enhance monitoring of existing or new pavement sections. It is important to note that ongoing local calibration studies are a common practice among other state agencies, particularly as the design software continues to improve with new models, data inputs and other enhancements. This study will support MDOT's implementation of MEPD and commitment to improved pavement design, ensuring that Michigan pavement designs remain reliable, optimized and aligned with modern best practices.

Goal No. 5: Assess the potential of dielectric profiling system (DPS) technology to support asphalt pavement quality assurance and acceptance practices.

Research Needs for Goal No. 5

DPS offers a non-destructive means of measuring asphalt pavement density, providing continuous profiles that may improve construction quality and uniformity. However, there is a critical need to evaluate the accuracy and variability of DPS measurements compared to traditional core sampling and to validate DPS data using field data across diverse conditions. This research will also examine the implications of adopting DPS for quality assurance, including its effect on pay factor calculations, percent within limits (PWL) specifications and the distribution of incentives and disincentives. The research will assess the practical limitations and potential risks of using DPS as a standalone acceptance tool and will provide recommendations on whether the technology has the potential to support implementation. If supported by the findings, the research team will recommend and outline the necessary steps for possible integration into existing specification and quality assurance frameworks. The study will also evaluate the cost-effectiveness of DPS testing compared to traditional coring methods, considering both short- and long-term impacts on pavement performance.

Goal No. 6: Evaluate the effect of concrete sand 2NS gradation and minerology on shrinkage potential for highway concrete.

Research Needs for Goal No. 6

California was the first state to attempt jointed concrete pavement construction in dry desert environments. Their early concrete pavement experienced extreme upward warping and related poor ride quality and faulting performance in some cases. The California Department of Transportation (CalTrans) then developed ways (Hveem et al, 1940s and 1950s) of reducing warping of concrete panels, including evaluating concrete sand sources for shrinkage potential using tests like the sand equivalency test and others. MDOT is interested in a concrete mixture study using a standard highway paving mixture design but varying the sand properties, using different sources/minerology from across the state and different gradations within the allowable 2NS sand size band and correlating sand variability to shrinkage potential. Michigan's natural sands range from younger high-carbonate content sands near Traverse City and southward, to very low carbonate older harder sands in areas such as the Huron Mountains and the western Upper Peninsula. The overall goals are to assess the effects of sand source type and gradation on shrinkage potential for pavement mixtures using the latest procedures and to capture a test procedure or index value for a sand source that can quantify the effect and be used as a rating scale or specification scheme for shrinkage potential.

Transportation Safety — Garrett Dawe

Goal No. 1: Seek alternative approaches to maintaining pavement marking presence and retro reflectivity.

Research Needs for Goal No. 1

A study to assess:

1. The best practices used in other state DOTs,
2. Retro reflectivity degradation of various marking strategies,
3. Retaining marking quality,
4. Available contracting methods,
5. Various funding sources and budget recommendations including inflation impacts, and
6. Other pertinent factors.

Goal No. 2: Seek alternative approaches in maintaining sign retroreflectivity and sign support conditions on freeways and non-freeways.

Research Needs for Goal No. 2

Best practices of other state DOTs, contracting methods, funding sources, maintenance best practices, investigations and recommendations for sign support types (up to and including sign trusses) and sign substrate materials, process improvements for no passing zone and curve warning sign layouts/installations, budget recommendations accounting for future inflation, and others.

Goal No. 3: Leveraging AI in traffic and safety.

Research Needs for Goal No. 3

Cataloging and inventorying roadway safety features, designing complex sign and pavement marking layouts, interpreting traffic crash reports, identifying detailed crash trends, translating GIS layers and others.

Goal No. 4: To determine the benefits and return on investments of diverging diamond interchange (DDI) deployments at freeway interchanges in Michigan.

Research Needs for Goal No. 4

Safety and operational performance of DDIs installed in Michigan.

Worker and Facility Safety and Security Emergency Management — Todd Bechler

Goal No. 1: Large-scale debris management

Research Needs for Goal No. 1

Understand the debris management approach for other states such as Florida, California and North Carolina. Technological enhancements (i.e., GPS and video) in response vehicles for assessment.

Goal No. 2: Nighttime illumination at construction sites

Research Needs for Goal No. 2

Understand the best practices from other states on their approaches and requirements for nighttime illumination at construction sites and technologies available.

Fleet Management and Operations — Colby Page and Tim Croze

Goal No. 1: Optimize replacement/retention criteria for MDOT's fleet assets.

Research Needs for Goal No. 1

- Evaluate cost/benefit of replacement versus increased maintenance costs of fleet assets near or past retention.
- Determine ideal retention schedules for various types of equipment.
- Determine current state of practice for government agency investment strategies to meet retention schedules.

Goal No. 2: Preventive maintenance schedules for all equipment/fleet.

Research Needs for Goal No. 2

Review state of the practice for maintaining government fleets and create a project management (PM) model for MDOT, including tracking PMs, notifying appropriate staff of units requiring PM and maintaining appropriate records.

Goal No. 3: Identify what the optimum fleet size is for the department and individual business. Monitor/track existing utilization of fleet.

Research Needs for Goal No. 3

- Review available asset tracking technology to monitor, driver, location, hours and miles of fleet vehicles for the purposes of tracking and reporting utilization.
- Review state of practice for government fleet optimization and provide recommendations to decision makers on fleet purchase versus rent versus lease.

Goal No. 4: Practical implementation of a zero emission MDOT fleet.

Research Needs for Goal No. 4

Research the feasibility and practical implementation of a zero emission MDOT fleet.

Multimodal Transportation and Finance RAC

RAC Chairs: Jean Ruestman, Bryan Budds, Peter Anastor and Patrick McCarthy

"To develop and preserve a safe, high-quality statewide air transportation system."

- **Office of Aeronautics Mission**

Aviation — Alicia Morrison

Goal No. 1: Provide additional weather-related safety critical data to Michigan pilots in close to real time.

Research Needs for Goal No. 1

Michigan is home to a robust system of automated weather observation stations that provide high-quality weather data to Michigan pilots through existing state and federal processes. Recently, additional capability has entered the market that would supplement existing weather station capability with near real-time video feeds. Explore the deployment of this technology in coordination with our existing systems for both traditional airports and emerging vertiport locations in Michigan. Additionally, explore MDOT's existing roadside weather capabilities to explore potential applications for emerging aviation technologies.

Goal No. 2: Utilize emerging aviation technology to bolster MDOT's roadside safety projects.

Research Needs for Goal No. 2

New tools are emerging within the drone space to provide improved illumination, driver safety and worker safety in roadside construction projects. Research is being sought to explore the safety and efficiency of employing drones to support roadside emergency response, active construction site management and persistent aerial lighting.

Goal No. 3: Continue to explore the implementation of advanced communication networks to support the integration of ground-based and aerial autonomous vehicles.

Research Needs for Goal No. 3

Initial work has occurred with MDOT to advance the exploration of connected vehicle technologies that can support both ground and aerial vehicles via dedicated short-range communications (DSRC) connection. Early testing showed promise in utilizing the technology to form a connected vehicle mesh communication network. Additional research in a real work environment could bolster the progression of technology that can improve transportation safety and vehicle connection.

Goal No. 4: Examine the intermodal connectedness of novel transportation hubs serving multiple modes of transportation.

Research Needs for Goal No. 4

New forms of transportation continue to evolve both in terms of planning requirements, vehicles servicing communities and technology needed to support wider intermodal connectedness. Additional research is suggested to explore the planning and design of a multimodal hub servicing potentially highway users, public transit riders, aerial logistics customers and others. This research should also include a wider perspective of where such hubs could be placed for the highest and best use of limited real estate across Michigan with its diverse user base.

"Through strategic planning, monitoring freight, maintaining data, supporting legislative and policy development, providing technical assistance to stakeholders, and ensuring compliance, we strive to advance efficient, sustainable freight transportation."

- **Intermodal Policy Section Mission**

Freight Logistics and Maritime — Elisha Wulff

Goal No. 1: Examine the needs of the freight and maritime transportation systems, identify critical infrastructure gaps and evaluate strategies to strengthen intermodal connectivity and improve overall system performance.

Research Needs for Goal No. 1

Support research that advances an efficient, resilient and integrated freight and maritime transportation system by addressing key challenges in infrastructure planning, intermodal coordination and freight/maritime operations.

"To ensure that Michigan's rail system meets the economic needs of the state and is safe for the motoring public, rail passengers and railroad employees."

- **Office of Rail Mission**

Passenger and Freight Rail — Sara Moore

Goal No. 1: Evaluate the safety of and identify best practices for rails-with-trails.

Research Needs for Goal No. 1

1. Rails-with-trails are multi-use trails that run alongside active rail lines.
2. MDOT's current rails-with-trails along state-owned rail corridors policy was established in 2017.
3. As trails have become more prevalent along the railroad corridors, in addition to national data and incident reports being limited, research is needed to determine the design aspects necessary to enhance the safety of such trails while providing answers to the following questions:
   a. Does safety data currently exist?
   b. What levels of incidents and fatalities have been recorded on rails-with-trails?
   c. How does this data compare to trails along roadways?
   d. Is the risk of train derailment a safety concern for rails-with-trails?
   e. How does the risk of train derailment compare to the risk of a vehicle crashing along a roadway when a trail is adjacent to the rail or road corridor?
   f. Is there a design standard distance from the rail line to locate a multi-use trail to enhance safety?

"Providing Michigan citizens with the best passenger transportation services through quality customer assistance. We move people."

- **Office of Passenger Transportation Mission**

Local Transit — Janet Geissler

Goal No. 1: Preparing for the future of public transportation.

Research Needs for Goal No. 1

1. Determine how technological changes have evolved the way transit is implemented as a service and determine the state's role in mobility as a service and mobility on demand, considering all the services that encompasses (i.e., cell phones, computerized mapping and scheduling, Google, social platforms).
2. Develop strategies for future local and long-distance passenger transportation systems that account for changing demographics, changing customer needs/preferences, emerging vehicle technologies (including automated vehicles), emerging private sector passenger transportation services (i.e., Uber, Lyft, etc.) and shared-use mobility services.
3. Develop future federal and state funding strategies, related to technical assistance and regulatory programs, that will account for future passenger transportation changes.

Goal No. 2: Improving equity and access to mobility services.

Research Needs for Goal No. 2

1. Identify barriers to accessing mobility services and strategies to mitigate them.
2. Determine the state's role in equity as it relates to private transportation services that are offered to the general public.

Intercity Bus and Private For-Hire Passenger Carriers — Rob Pearson

Goal No. 1: Identify funding strategies to improve sustainability and flexibility of intercity bus services.

Research Needs for Goal No. 1

Evaluate blended funding models, including local matching funds, federal discretional grants, private partnerships and cost-sharing with health and human service agencies.

Goal No. 2: Leverage emerging technology and data systems to improve route performance evaluation.

Research Needs for Goal No. 2

Explore the integration of mobile ticketing, real-time ridership analytics and customer feedback systems to collect and assess data on route performance and user experience. Identify best practices from other DOTs. Look to partner with the Council on Future Mobility and Electrification (CFME) team, MaaS platform team, etc.

Goal No. 3: Evaluate the effectiveness of contracted intercity bus routes beyond cost per rider.

Research Needs for Goal No. 3

Investigate additional performance indicators such as economic impact, access to essential services, rider demographics and social equity. This research would help identify the overall public value the routes provide and develop a decision-making framework for future investment based on a more holistic set of metrics.

Goal No. 4: Explore alternative mobility models to replace or supplement low-performing routes.

Research Needs for Goal No. 4

Analyze the feasibility of implementing demand response, micro transit, shared mobility and public-private partnerships in rural or underserved areas. Identify cost-effective approaches to meet travel demand without sacrificing access.

Goal No. 5: Develop improved methods for assessing the return on investment of the intercity bus services.

Research Needs for Goal No. 5

Create a framework that incorporates broader benefits such as economic development in rural towns, healthcare access, reduced car dependency and environmental impact. Compare return on investment of intercity bus service with alternative transit modes.

"To provide quality financial and administrative services to optimize the accomplishments of MDOT's mission."

- **Bureau of Finance and Administration Mission**

Contract Administration — Mike Meddaugh

No Research Priorities Identified

Finance — Adam Feldpausch

No Research Priorities Identified

Planning and Organizational Development RAC

RAC Chairs: Todd White and Amber Thelen

"Planning today for a successful tomorrow."

- **Statewide Transportation Planning Mission**

Data Inventory and Integration — Wendi Burton

Goal No. 1: Improve the safety, efficiency and cost-effectiveness of data collection and the integration of geospatial solution and services required to meet reporting and operational functions.

Research Needs for Goal No. 1

Identify the best practices and lessons learned of moving data to the cloud via a literature review of other DOTs.

Goal No. 2: Improve trunkline and non-trunkline travel monitoring program.

Research Needs for Goal No. 2

1. Study options for usage of passively collected traffic data in travel monitoring programs. Survey other state DOTs to understand if and how they make use of passively collected traffic data in their programs.
2. Research the best practices for developing and maintaining continuous count stations on non-state-owned roads and assess considerations unique to Michigan.
3. Update previous research on the feasibility of using ITS data to enhance MDOT's travel monitoring program and research the feasibility of using data from traffic signals as part of MDOT's travel monitoring program.

Goal No. 3: Improve downstream applications for GIS and Advanced Linear Reference System (ALRS) data.

Research Needs for Goal No. 3

The Roads and Highways ALRS is normalized data that does not output multiple data events aligned in segments (such as intersection-to-intersection records) without a large resource commitment each year from Data Oversight and Geospatial Management Section staff. The process of converting data to be consumed by Roadsoft is stable. However, long-term, we see risk for MDOT, Roadsoft, and the State of Michigan Transportation Asset Management Council (TAMC) based on changing technology (process more than 20 years old) and single-source dependencies. The alignment process across data events is half the battle and already being addressed for Highway Performance Monitoring System (HPMS) needs. This research looks after the data is internally aligned and how aligned data would be consumed by downstream applications. The level of effort and resources would be included in the findings. These results could also be useful for MDOT's Data Integration and Data Warehouse Design (DIWD) effort.

a. Research into what efficient integration options are available for downstream applications, such as Roadsoft, to consume our normalized GIS ALRS edits and be able to migrate information to segment-based GIS and non-GIS databases on different platforms.
b. Research into how efficient integration options can be developed for downstream applications, such as Roadsoft, to consume our normalized GIS ALRS data/edits and be able to migrate information to segment-based GIS and non-GIS databases on different platforms.

Active Transportation (Nonmotorized) Planning and Development — Deb Alfonso

Goal No. 1: Develop tools and methods that enable active transportation needs and facilities to be mainstreamed into transportation decision-making processes.

Research Needs for Goal No. 1

1. Develop a model for the inventory of bicycle and pedestrian facilities that encompass both on- and off-road locations. Recommend the best options for incorporating related data collection into existing business processes, both MDOT and local, to assist with future planning in support of Complete Streets, current initiatives and long-range or strategic planning documents.
2. Explore the best practice methodology for assessing the needs of pedestrian and bicycle networks in all infrastructure plans and projects.
   a. Identify strategies to eliminate gaps or address barriers in each system.
   b. Develop tools appropriate to Michigan for incorporating improvements.

Program Development — Craig Newell

No Research Priorities Identified

Asset Management and Policy — Eric Mullen

Goal No. 1: Local asset management scanning.

Research Needs for Goal No. 1

A research project may be appropriate to scan local agencies for the appropriate level of local asset management activities. The number and differing natures (i.e., rural versus urban) of local agencies with jurisdiction of road assets of local agencies make it difficult to determine effective ways to collect asset data and develop asset management strategies. Research might help identify common needs and themes for asset management plans from different sized agencies. Difficulties may arise in that there are independent boards such as the TAMC, Michigan Infrastructure Council (MIC), and the Michigan Infrastructure Office (MIO) that all have some standing in this issue. We have many thoughts that these entities should fund or be involved in developing any research for local asset management activities.

Goal No. 1: Enhancing state metropolitan planning organization (MPO) collaboration for travel demand forecasting.

Research Needs for Goal No. 1

In order to identify and implement best practices for coordination between MDOT and transportation management areas to meet the federal requirements of 23 CFR 450.324 as they pertain to long-range travel demand forecasting given ongoing constraints in staffing, expertise and financial resources, the following are needed:

1. Literature review of existing travel demand forecasting collaboration models among state DOTs and MPOs.
2. Inventory of available pooled resources (i.e., data repositories, modeling platforms, training, consulting, etc.).
3. Evaluation of alternative forecasting methods (i.e., compared to traditional travel demand models).
4. Recommendation for best practices and developing practical implementation frameworks.

"Attract, develop and engage MDOT's workforce now and into the future."

- **Organizational Development Mission**

Workforce Development and Organizational Effectiveness James Fults and Debra Ulbrich

Goal No. 1: Understand retention strategies for DOT employees.

Research Needs for Goal No. 1

Research comprehensive and data-driven strategies to increase retention within DOT organizations.

Goal No. 2: Identify best practices for organizational leadership training.

Research Needs for Goal No. 2

Research into best practices for leadership training both in private and public sector settings.

Goal No. 3: Identify employer branding best practices.

Research Needs for Goal No. 3

Research into best practices surrounding employer branding from early ages and adults focused on areas of need for state DOTs.

Goal No. 4: Identify change management best practices.

Research Needs for Goal No. 4

Research into best practices for managing ongoing change in multiple business areas, procedures, personnel, other.