NDOT STATEWIDE TSMO PROGRAM

TSMO
Performance Management Program Plan

NEVADA DOT SAFE AND CONNECTED

ATKINS
Member of the SNC-Lavalin Group

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CONTENTS

FIGURES

LIST OF TABLES

ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ATCMTD	Advanced Transportation and Congestion Management Technology Deployment
ATM	Active Traffic Management
CAV	Connected and Automated Vehicle
CCTV	Closed-Circuit Television
CMM	Capability Maturity Model
DMS	Dynamic Message Sign
DOT	Department of Transportation
FHWA	Federal Highway Administration
HAR	Highway Advisory Radio
HOV	High Occupancy Vehicle
IPT	Investment Prioritization Tool
ITS	Intelligent Transportation System
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MAP-21	Moving Ahead for Progress in the 21st Century
NDOT	Nevada Department of Transportation
NHS	National Highway System
PDC	Project Development Committee
RACI	Responsible, Accountable, Consulted, and Informed
RCM	Reliability-Centered Maintenance
RWIS	Road Weather Information System
SOV	Single Occupancy Vehicle
TAMP	Transportation Asset Management Plan
TCT	TSMO Champion Team
TIM	Traffic Incident Management
TPM	Transportation Performance Management
TSMO	Transportation Systems Management and Operations
VMT	Vehicle Miles Traveled
WPS	Work Performance Standard

HOW TO USE THIS PLAN

Start

1 Align with NDOT Vision, Goals, Statewide Plans, Strategy

The TSMO Performance Management Program Plan aligns with NDOT goals and objectives agreed and approved in:

- The One Nevada Transportation Plan
- The 2020 Statewide TSMO Program Plan
- The TSMO Program goals

2 Direct and Monitor TSMO Program Performance Measures

The TSMO Performance Management Program Plan serves NDOT's vision through the adoption of three performance measures classifications:

- **TSMO Program Performance**: Best direction of TSMO Program to help NDOT meet key goals
- **TSMO Program Delivery Performance**: Optimal functioning of the TSMO Program
- **Asset Performance**: Optimal performance of TSMO - related assets (i.e., condition, resilience, availability)

3 Engage with Internal and External Stakeholders and Utilize the RACI Matrix

The implementation actions generated by this plan will need internal and external support to be executed.

- **Internal:** formalize NDOT TSMO roles and responsibilities to provide cross - department alignment through:
  - ☐ RACI Matrix
  - ☐ Training Delivery
- **External:** Communicate and formalize performance expectations to external stakeholders via:
  - ☐ Agreements
  - ☐ Detailed contract performance requirements

4 Deep - Dive into Device - Level Performance History USE RCM for ITS Assets

Conduct a detailed RCM-focused study of recent TSMO asset performance, maintenance history, and other related factors to examine performance and failure rates of TSMO assets.

This will clarify the factors necessary to make RCM-aimed maintenance decisions and alter the maintenance scheme for ITS assets to better align with the demands of new ITS performance measures.

5 Involve TSMO Program in "Acquisition" Stage of ITS Asset Lifecycles

Integrate the TSMO Program in the design, procurement, and commissioning phases of TSMO assets. This involvement will help ensure that such capital expenditure investments are appropriate for the intended purpose of those assets from a TSMO perspective.

6 Update Cycle

Update the elements of this plan as follows:

- TSMO Performance Management Program Plan ➤ 5 years
- TSMO Program Performance Measures ➤ Annually
- TSMO Program Delivery Performance ➤ Biannually (including RACI)
- Asset Performance ➤ Annually

1 Introduction

The Transportation Systems Management and Operations (TSMO) Performance Management Program Plan advances NDOT's performance measures to help ensure that TSMO objectives are being methodically integrated into the management and operations of NDOT's transportation system, and that TSMO-related assets are performing in accordance with TSMO goals. This TSMO Performance Management Program Plan builds on the decisions and implementation recommendations set forth in recently completed Nevada Department of Transportation (NDOT) strategic planning documents. These documents include the Statewide TSMO Program Plan, Intelligent Transportation Systems (ITS) Asset Management Business Plan, TSMO Program Capability Maturity Model Workshops action items, and department-wide plans such as the Smart Mobility Initiative and the Transportation Asset Management Plan (TAMP) that was certified in 2019 and was updated in 2022.

Establishing a performance management program supports the goals and objectives of the TSMO Program in several ways. It provides transparency, identifies problems, provides means of evaluating past investments, and guides future investments based on data. Applying performance management principles to TSMO will help improve the effectiveness of operations' programs. Traditionally, planning and analysis occur at the front-end of projects. Once projects are underway, ongoing analysis to measure their performance is critical to regularly evaluate how well services are being delivered and to systematically devise methods for improvement. A performance management approach enables NDOT to demonstrate progress, detect issues, and learn from both successes and challenges. It also provides an early warning as issues arise. Making effective, data-driven, and performance-based investment decisions is especially important today because of the strained financial environment transportation agencies face.

The TSMO Program Plan establishes both programmatic and asset-level performance measures. Programmatic performance measures established in this plan address and add accountability for organizational processes needed to optimize TSMO activities and ensure that they are aligned with NDOT goals. Programmatic performance measures are divided into two categories: (1) measures that track the execution of TSMO activities, and (2) measures that quantify the achievement of NDOT goals. The establishment of programmatic performance measures formally institutionalizes TSMO efforts and associated activities within the organization. Asset-level performance measures focus exclusively on the degree to which individual and collections of assets perform in relationship to precise and specific performance targets. Asset-level and programmatic performance measures have a reciprocal relationship, whereas asset-level performance informs program-level decisions – e.g., are the TSMO activities that will most improve poor asset-level performance being implemented? Equally, programmatic measures inform asset-level measures – e.g., have departmental objectives shifted so that asset-level targets need to change? Or are TSMO activities improving asset performance?

As established in the Statewide TSMO Program Plan, performance measurement is a key component for maturing into a fully performance and outcome-based program. Furthermore, the Federal Highway Administration (FHWA) is increasingly focused on improved planning for operations utilizing objectives-driven, performance-based planning. By implementing this TSMO Performance Management Program Plan, NDOT is demonstrating its commitment to this FHWA objective.

2 Goals and Objectives

This TSMO Performance Management Program Plan uses the goals and objectives created and approved in the One Nevada Transportation Plan. The One Nevada department-wide goals are:

- **Enhance Safety:** Continuously improve and promote safety on our transportation system for all modes.
- **Preserve Infrastructure:** Maintain the state's transportation assets to preserve investments.
- **Optimize Mobility:** Make strategic investments that enhance mobility opportunities, better connections, and transportation reliability expectations.
- **Transform Economies:** Improve the contribution of the transportation system to Nevada's economic competitiveness through a supportive and innovative transportation framework.
- **Foster Sustainability:** Develop a transportation network that reduces emissions while being environmentally, historically, culturally, and financially sustainable.
- **Connect Communities:** Enhance opportunity, livability, and quality of life through better connections, increased transportation choice, and supportive infrastructure for all modes.

The complementary 2020 Statewide TSMO Program Plan and the TSMO Program goals are:

- **Enhance Safety:** Reduce crashes, injuries, fatalities, and achieve the Vision Zero Initiative.
- **Preserve Infrastructure:** Maintain transportation assets to preserve investments.
- **Optimize Mobility:** Maximize system efficiency by reducing congestion and/or promoting multimodal transportation.
- **Foster Sustainability:** Develop a sustainable transportation system through sustainable and balanced design, operations, and maintenance.
- **Enhance Reliability:** Improve economic competitiveness and enhance quality of life through reliable travel times.
- **Optimize Customer Service:** Provide timely and accurate travel information to internal and external customers to enable informed decision-making.
- **Enhance Collaboration:** Maximize coordination and cooperation between NDOT divisions and partnering agencies to proactively manage and operate an integrated transportation system.
- **Strengthen TSMO Integration:** Incorporate and prioritize TSMO as a core objective in NDOT's planning, design, construction, operations, and maintenance activities.

3 State of the Practice

NDOT's 2020 Statewide TSMO Program Plan identifies transportation performance management as a tactical element to be implemented over subsequent years. The element is predicated on FHWA's description of performance management (FHWA's "What is TPM?" Webpage. Access June 23, 2022):

"FHWA defines Transportation Performance Management (TPM) as a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals. In short, Transportation Performance Management:

- Is systematically applied, a regular ongoing process
- Provides key information to help decision makers to understand the consequences of investment decisions across transportation assets or modes
- Improves communications between decision makers, stakeholders, and the traveling public
- Ensures targets and measures are developed in cooperative partnerships and based on data and objective information"

NDOT's Statewide TSMO Program Plan serves as a road map to guide the agency as it continues to integrate operations, asset management, and preservation into the organization. The Statewide TSMO Program Plan is the basis for statewide policy and improvements aimed at transportation operations. The extent to which these TSMO activities benefit the NDOT transportation system is not currently measured in a formalized and systematic way. This TSMO Performance Management Program Plan aims to fill that gap.

To develop the Plan, NDOT conducted a focused state-of-the-practice review of policies and procedures used internally and those applied at other transportation organizations across the country. As part of this plan, NDOT reviewed readily available publications and plans (Appendix A) to gain insight into other potentially applicable TSMO performance management practices.

Transportation agencies across the U.S. are taking steps to harness the benefits of performance management principals and data-driven decision making to manage TSMO programs. While there is no uniformly accepted approach to TSMO performance management, many transportation agencies are moving forward with TSMO performance management schemes tailored to their needs and scale. Relevant findings from the literature review include:

- Both Oregon and Ohio Departments of Transportation (DOT) measure TSMO performance at the program level, but not at the asset level. NDOT is adopting a hybrid version of this philosophy, as described in Section 4.1.2 and Section 4.1.3.

- Ohio DOT has created formal linkages from select asset-level key performance indicators (KPI) to TSMO, but asset owners (e.g., ITS, traffic signal, branches) continue to be accountable for asset-level performance. In these cases, TSMO programs are viewed as a tool for improving performance, but not as the subject of performance targets. NDOT uses a hybrid version of this approach; however, performance targets are also applied to TSMO Program. Section 4.1 explains this approach.
- Where TSMO is a supporting office to ITS and Traffic Signal KPIs, it is in charge of project prioritization decisions. NDOT's TSMO Program will influence project prioritization processes when it concerns projects that affect TSMO performance (see Section 5.5).
- Colorado, Louisiana, and Pennsylvania DOTs reversed decisions and removed ITS and other TSMO-related assets from their transportation asset management plans when those assets were part of earlier versions of the plans. Conversely, NDOT included ITS assets in its plan and will do so in the future to a an even greater extent.
- TSMO and TSMO-related performance measures are being used elsewhere (Appendix B).
- ITS and traffic signal condition/performance is frequently measured by "useful life," which is defined by manufacturer's specification, maintenance personnel experience, changing technologies/obsolescence; general maintenance costs; and geographic locations of devices.
- The American Association of State Highway and Transportation Officials (AASHTO) and FHWA cite interval-based maintenance practices and the appropriate practice for maintaining and improving ITS asset condition performance. NDOT is already following interval-based maintenance practices for its ITS assets.

4 Implementation

This section establishes the actions necessary to implement TSMO performance management program goals. Each subsection addresses key TSMO performance management areas and explains why it is important to program success, what needs to be accomplished, and how proposed actions will achieve those needs. The subsections include:

- **Performance Measures:** Establishment of the performance measures and targets used on behalf of the TSMO Program.
- **Plan Integration:** Description of how the TSMO Performance Management Program Plan builds on and adds to NDOT plans and strategy documents that collectively direct NDOT transportation systems management and operations.
- **Stakeholder Engagement Plan:** Documentation of the internal and external engagement initiatives necessary to ensure successful plan implementation.
- **Training Program:** Description of the training necessary to ensure that the decisions and recommendations initiated by the TSMO Performance Management Program Plan are most effectively implemented and institutionalized throughout NDOT.
- **Update Cycle:** Identification of the frequency in which elements within this plan will be updated.

4.1 Performance Measures

Performance measures and targets used on behalf of the TSMO Program and linkages between TSMO goals and performance measures are documented. Because TSMO Program performance ultimately is connected to the performance of a diverse set of assets, the relationships between TSMO performance measures and related NDOT divisions, sections, asset types, and responsibility are discussed.

The TSMO Program is uniquely positioned to implement actions that have meaningful impact because it is focused on strategic and transportation system-wide solutions that can improve the conditions surrounding key performance areas noted in the TSMO Program Performance level of measures. These determinations then cascade down to the lower levels of the TSMO Program performance measure hierarchy since the measures and TSMO tactical elements tied to those levels are capable of improving performance in targeted ways.

Programmatic and asset-level performance measures are structured in a four-level hierarchy, as illustrated in Figure 1. The hierarchy is necessary to capture the multiple objectives of the TSMO Performance Management Plan in order to maintain alignment of TSMO activities with NDOT organizational goals, perform activities that best achieve TSMO objectives, and ensure that TSMO-related assets perform optimally and in alignment with TSMO goals. These levels of performance measurement are defined as "**TSMO Program Performance**," "**TSMO Program Delivery Performance**," and "**Asset Performance**." Ultimately, all performance measures serve NDOT's vision and mission, as represented through its department-wide goal statements, and are depicted as the top-most "NDOT Goals" level in Figure 1.

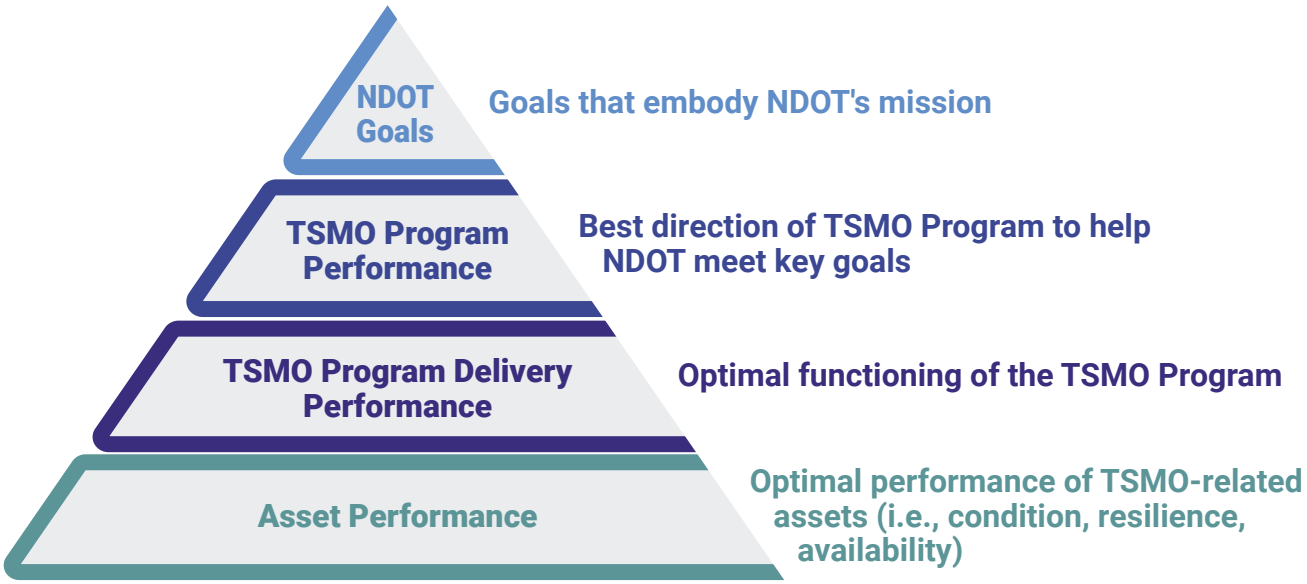

Figure 1: Levels of TSMO Performance Measures—What's Being Measured?

4.1.1 NDOT Goals

The top level of the hierarchy serves as the definitive goalpost for all subsequent levels and performance measures that fall below it in the hierarchy. NDOT's department-wide goals define the value that all performance measures ultimately are trying to bring about. These six goals are (NDOT's "About NDOT" webpage):

1. Safety first
2. Cultivate environmental stewardship
3. Efficiently operate and maintain the transportation system in Nevada
4. Promote internal and external customer service
5. Enhance organizational and workforce development

4.1.2 TSMO Program Performance

To measure the degree to which NDOT is meeting its six goals, the Department tracks 16 performance goals and measures, reporting on their status in its annual Performance Management Report. Several of these performance measures can be directly influenced by TSMO. These performance measures are noted in Table 1. TSMO Program performance measures help answer the question: "**Where can the TSMO Program best direct its support to help NDOT meet key goals?**"

TSMO Program performance measures are used by the TSMO Program to better understand where NDOT is and is not meeting its department-wide performance targets. Performance measures located lower in the hierarchy can be adjusted for improvement, and connected tactics can be pursued with greater urgency. TSMO Program performance measures also ensure that measures lower in the hierarchy align with NDOT goals in the quantifiable and measurable ways that are set and monitored at the top-most levels. These targets are extracted from the 2022 Annual Performance Measurement Report and may need to be adjusted annually. For accuracy in measurement, please refer to the most recent performance measure reports.

Table 1: TSMO Program Performance Measures and Targets by NDOT Strategic Goals

Performance Measures	*Targets*
Enhance Safety*	
A. Decrease the projected 5-year rolling average of traffic fatalities	**≥ 1**
B. Decrease the projected 5-year rolling average of serious traffic injuries	**≥ 1**
C. Decrease the projected 5-year rolling average of traffic fatalities per 100 million vehicle miles traveled (VMT)	**≥ 0.5**
D. Decrease the projected 5-year rolling average of non-motorized fatalities and serious injuries	**≥ 1**
Preserve Infrastructure**	
E. Closed-Circuit Television (CCTV) assets in Low Risk or better condition	**75%**
F. Dynamic Message Sign (DMS) assets in Low Risk or better condition	**65%**
G. Flow Detectors assets in Low Risk or better condition	**65%**
H. Highway Advisory Radio (HAR) assets in Low Risk or better condition	**50%**
I. Ramp Meter assets in Low Risk or better condition	**90%**
J. Road Weather Information System (RWIS) assets in Low Risk or better condition	**20%**
Optimize Mobility	
K. Annual hours of peak hour excessive delay per capita *	**Reno: ≤ 12.0** **Las Vegas: ≤ 10.0**
L. Non-injury related incidents removed from the travel lane***	**< 30 mins.**
M. Injury related incidents removed from the travel lane***	**< 60 mins.**
N. Fatal incidents cleared from the travel lane***	**< 120 mins.**
O. Percent of person-miles traveled on the interstate system that are reliable*	**≥ 87%**
P. Percent of person-miles traveled on the non-interstate National Highway System (NHS) that are reliable*	**≥ 87%**
Q. Percent of Non-single Occupancy Vehicle Travel in Nevada urbanized areas*	**Reno: ≥ 23** **Las Vegas: ≥ 21.6**
R. Truck travel time reliability index on the Nevada interstate system*	**≤ 1.26**
Connect Communities	
S. Positive satisfaction level (annual customer service survey)	**≥ 75%**

** Performance measures also in the 2022 Annual Performance Management Report.*

*** Performance measure also in the 2022 Transportation Asset Management Plan as an aspiration, but not a formal performance measure. "Current levels" is the target set in the Plan.*

**** Performance measures also in the TSMO Program Plan.*

For example, TSMO Program performance measures could indicate that conditions affecting a certain goal need to be more aggressively improved, prompting TSMO Program tactical elements that best address this performance driver to be deployed. TSMO Program performance measures also are a guide to ensure that the tactical elements and asset-level measures lower in the hierarchy produce the best value possible for NDOT. This is achieved by first verifying that the performance measures or tactical elements in the TSMO Program Delivery Performance or Asset Performance level of the hierarchy would benefit a TSMO Program Performance measure. Tactical elements that would benefit TSMO Program Performance provide value and may be further evaluated to gauge their value. Further evaluation tools include analyses like cost benefit analysis, Investment Prioritization Tool (IPT), etc.

4.1.3 TSMO Program Delivery Performance

TSMO Program delivery performance measures answer the question: "How well is the TSMO Program functioning?" These performance measures also could be viewed as "progress measures" since they measure the degree to which the TSMO Program is completing the activities and implementing the tactical elements that have been identified in previous plans such as the Statewide TSMO Program Plan, ITS Asset Management Business Plan, Smart Mobility Initiative, and TAMP. These measures are necessary for tracking where the program is in terms of furthering proposed solutions and progressing program maturity. Figure 2 below illustrates the suggested process for TSMO Program Delivery Performance Measure Evaluation.

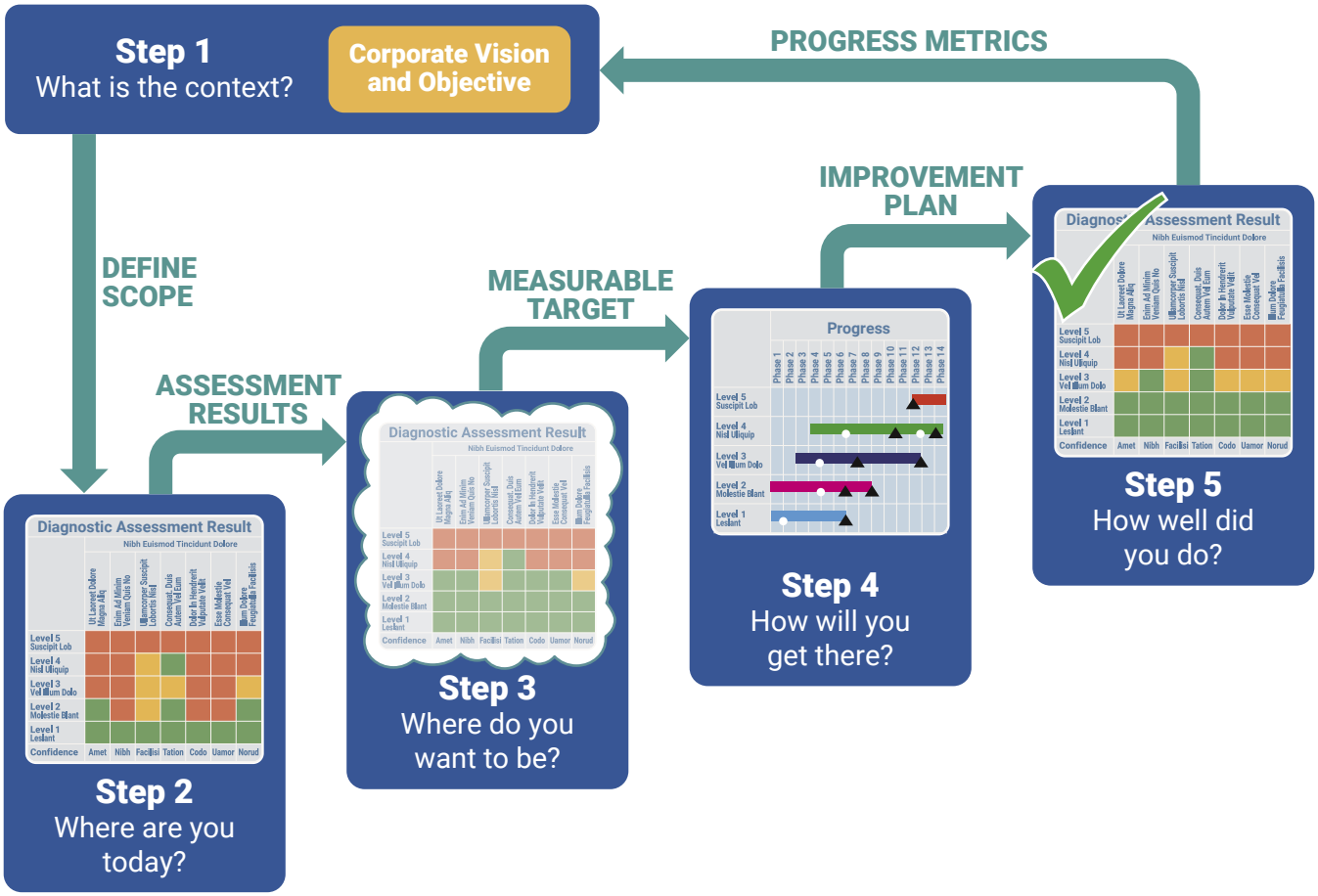

Figure 2: TSMO Program Delivery Performance Measures Concept

- **Step 1** Review latest corporate mission and goals and identify the context, as NDOT mission and goals are the basis for all subsequent steps. Step 1 should be re-visited upon completion of Step 5 to adjust if there have been updates.

- **Step 2** Evaluate current conditions, such as current performance, current ITS asset conditions, and TSMO Program maturity.

- **Step 3** Define the aspirational goals and objectives set in these same plans, which describe how the Program will progress in the future.

- **Step 4** Develop the specific sets of recommendations, actions, and tactical steps to move from current conditions to the desired state.

- **Step 5** Identify the TSMO Program Delivery Performance Measures, which serve to monitor progress in accomplishing commitments identified in Step 4. While Step 1 through Step 4 are largely established in previously completed plans, the TSMO Program Delivery Performance Measures identified in Step 5 were established as part of this TSMO Performance Management Plan.

- The linkage from Step 5 back to Step 1 represents the hierarchical nature of TSMO Program performance management. This linkage represents the methodical check to ensure that the progress made in Steps 1 through 5 indeed benefits the preceding performance measures in the TSMO Program Performance level of the hierarchy, and thus NDOT's mission and goals.

TSMO Program Delivery Performance Measures:

1. Delivery of TSMO Statewide Program Plan tactical elements

2. Delivery of TSMO Statewide Program Plan programmatic elements and Capability Maturity Model (CMM) workshop action items

3. TSMO Performance Management Program Plan recommendations

TSMO Program Delivery Performance Measures are based on the milestones identified in Table 2. Achievement of these milestones is complex and has many organizational dependences and assumptions. Therefore, tracking responsibilities and accountability is critical to the successful completion of these activities. As a result, the TSMO Program Responsible, Accountable, Consulted, and Informed (RACI) Matrix has been developed as a tool for facilitating the tracking and monitoring of TSMO Program Delivery Performance Measures. The RACI matrix is discussed further in Section 4.3.1 of this plan.

While success in meeting TSMO Program Delivery Performance targets relies on successful completion of TSMO Program commitments (Figure 2), timeframes and sequencing are subject to change due to the dynamic nature of the TSMO Program. As departmental needs change and performance at the TSMO Program Performance level of the hierarchy changes, TSMO Program Delivery Performance Measures will allow NDOT to respond and adapt. Completion dates will be updated in accordance with the update cycle.

Table 2: TSMO Program Delivery Performance Measures

Performance Measures ("Progress Measures")	Targets*	Status
1. Delivery of 2020 TSMO Statewide Program Plan Tactical Elements		
A. Real-time traveler information	**2025**	**In Progress**
B. Connected and automated vehicles	**2025**	**Planned**
C. Active traffic management	**2025**	**In Progress**
D. Traffic incident management	**2025**	**In Progress**
E. Transportation asset management	**2025**	**In Progress**
F. Transportation performance management	**2025**	**In Progress**
G. ITS database and communications	**2025**	**In Progress**
2. Delivery of 2020 TSMO Statewide Program Plan Programmatic Elements Action Items		
Organizational Structure		
A. Work with TSMO Champion Team (TCT) to identify TSMO integration opportunities	**2022**	**Completed**
B. Approve and fill TSMO Program Manager position	**2024**	**In Progress**
C. Develop additional TSMO positions under TSMO Program Manager	**2025**	**Completed**
Business Process		
A. Develop processes to obtain new data identified for traffic operations performance management	**2022**	**Completed**
B. Define process to develop actions based on performance	**2022**	**Completed**
C. Develop process to efficiently evaluate, select, and prioritize new technology and pilot projects	**2022**	**Completed**
D. Identify procurement and contract processes to be modified to accommodate TSMO	**2023**	**Completed**
E. Develop and document a performance management program	**2023**	**Completed**
F. Develop processes to identify the required TSMO positions within Traffic Operations	**2022**	**Completed**
G. Perform CMM assessment for Implementation Planning Phase	**2020**	**Completed**
H. Review NDOT manuals and guidance documents to include TSMO-related activities	**2025**	**Planned**
I. Benchmarking of TSMO action items	**2020**	**Completed**
J. Perform CMM assessment or Implementation Phase	**2024**	**Planned**

Performance Measures ("Progress Measures")	*Targets**	*Status*
Staffing and Workforce Development		
A. Identify the required skillsets and capabilities to implement TSMO	**2022**	**Completed**
B. Develop TSMO training program for NDOT staff	**2022**	**Completed**
C. Develop TSMO training program plan for both existing and new employees	**2022**	**Completed**
D. Evaluate Phase 1 implementation of the organizational chart transition and revise the Work Performance Standards (WPS) in preparation for transition to Phase 2	**2022**	**Completed**
E. Implement Phase 2 of the organizational chart transition	**2023**	**Completed**
F. Identify required TSMO training opportunities for staff	**2023**	**Completed**
G. Evaluate Phase 2 implementation and begin the TSMO Program Workforce Development Plan	**2023**	**Completed**
H. Develop and implement Phase 3 of the organizational chart transition with TSMO positions as defined in the TSMO Workforce Development Plan	**2025**	**In Progress**
Financial Resources Management		
A. Apply the TSMO IPT for project selection on annual basis	**2022**	**Completed**
B. Work with planning division to develop TSMO-specific inputs into the statewide planning process	**2025**	**In Progress**
C. Include TSMO consideration in update to TAMP	**2022**	**Completed**
D. Develop a TSMO 5-year plan	**2022**	**Completed**
E. Develop funding guidance tool for TSMO funding, including basic descriptions of funding requirements and application processes	**2023**	**Completed**
F. Develop regularly scheduled meetings to ensure financial plans are aligned with TSMO funding	**2025**	**Planned**
Communication and Collaboration		
A. Identify existing means of internal communication and collaboration and the missing links for effective coordination	**2022**	**Completed**
B. Develop communication processes to identify and document TSMO issues prior to Project Development Committee (PDC) meetings	**2025**	**In Progress**
C. Develop training program for internal and external user education of performance measures	**2022**	**Completed**
D. Develop TSMO training program for internal and external agencies	**2022**	**Completed**
E. Develop quarterly TSMO newsletter and circulate it internally and externally	**2025**	**Planned**
F. Identify and develop required interagency processes and protocols	**2022**	**Completed**
G. Develop interagency agreements to enhance collaboration with external agencies	**2025**	**Planned**

Performance Measures ("Progress Measures")	*Targets**	*Status*
3. Formal review of TSMO Statewide Program Plan Performance Measures		
A. Enhance Safety measures: number of incidents, number of incidents with injuries, number of fatalities, rate of fatalities for 100 million VMT, number of non-motorized fatalities, number of non-motorized injuries, number of secondary incidents, incident density, number of incidents in work zones	**Annually**	**In Progress**
B. Preserve Infrastructure measures: TAMP measures, identification of NDOT ITS assets, condition of NDOT assets, age of NDOT assets, status of assets	**Annually**	**In Progress**
C. Optimize Mobility measures: average travel time by mode (urban and rural), travel time reliability, buffer index	**Annually**	**In Progress**
D. Foster Sustainability measures: Percent of non-single occupancy vehicle (SOV) travel in Nevada urbanized areas, CMAQ performance measures	**Annually**	**In Progress**
E. Enhance Reliability measures: MAP-21 measures, peak hour excessive delay in urban areas, average incident-related delay, average duration of impact from weather-related events, average delay related to special events, roadway and incidents clearance time	**Annually**	**In Progress**
F. Optimize Customer Service measures: Near real-time updates to 511, near real-time updates to website, near real-time updates to DMS, number of visits to Travel Information webpage on the NDOT website ,Twitter alert, weather alert construction, special event, etc. (as applicable)	**Annually**	**In Progress**
G. Enhance Collaboration measures: Additional scheduled TCT meetings annually, increased participation with TSMO coalitions, additional relevant agreements with partners and neighboring states, use of collaboration tools, results from surveys and questionnaires, participation in Traffic Incident Management (TIM) coalition meetings	**Annually**	**In Progress**
H. Strengthen TSMO Integration measures: Executed policies, plans, and procedures that reference TSMO strategies; and executed multi-agency activities and agreements to promote TSMO	**Annually**	**In Progress**
4. Implement TSMO Performance Management Program Plan Recommendations (see Section 5)		
A. Review TSMO Performance Measures	**Annually**	**In Progress**
B. Use TSMO Program RACI Matrix	**Annually**	**In Progress**
C. Deep-Dive into Device-Level Performance History	**2025**	**In Progress**
D. Use Reliability-Centered Maintenance (RCM) for ITS Assets, and update asset-level performance measures accordingly (i.e., different targets for high and normal priority assets)	**2025**	**In Progress**
E. Involve TSMO Program in "Acquisition" Stage of ITS Asset Lifecycles	**2025**	**In Progress**

Performance Measures ("Progress Measures")	*Targets**	*Status*
5. Actions from 2020 TSMO Program Capability Maturity Model		
Business Process Actions		
A. Communicate TSMO Business Case at state legislative level	**2025**	**Planned**
B. Implement mitigation plan, document successes and challenges; continuous improvement	**2025**	**Planned**
C. Integrate the Regional ITS Architecture and Systems Engineering Process with the TSMO Project Evaluation Tool	**2025**	**Planned**
D. Document before/after lessons learned from Project Evaluation Tool deployment	**2025**	**Planned**
Systems and Technology Actions		
A. Track performance of ITS projects	**2024**	**Planned**
B. Implement privacy policies and security requirements	**2024**	**Planned**
C. Define access, roles, and responsibilities and perform monitoring	**2024**	**Planned**
D. Implement functional performance-based criteria for deployed TSMO systems	**2024**	**Planned**
E. Document and distribute infrastructure procurement process	**2024**	**Planned**
F. Track asset uptime, monitor and report performance regionally, and ensure assets are placed based on Life-Cycle Assessment (LCA) and performance	**2024**	**In Progress**
Performance Measurement Actions		
A. Gain consensus on regional TSMO performance measures and document performance metric criteria	**2024**	**In Progress**
B. Document region-wide TSMO performance-based project deployment processes and procedures	**2024**	**In Progress**
C. Establish funding for TSMO deployment	**2024**	**Planned**
D. Coordinate with regional partners on performance measure data	**2024**	**In Progress**
E. Gain senior executive support for revising processes to support performance measure needs	**2024**	**In Progress**
F. Document regional performance measures as they relate to Moving Ahead for Progress in the 21st Century (MAP-21) and TSMO alignment	**2024**	**Completed**

Performance Measures ("Progress Measures")	*Targets**	*Status*
Collaboration		
A. Planning group: collaborate with Traffic Operations when planning projects for the future	**2024**	**In Progress**
B. Planning group staff members: incorporate TSMO strategies into traffic modeling and other corridor study activities	**2024**	**Planned**
C. Document roles and responsibilities for TSMO implementation to be carried out by other NDOT Divisions in collaboration with the Traffic Operations Division	**2024**	**Planned**
D. Regional committee: meet on a recurring basis	**2024**	**In Progress**
E. Document established roles and responsibilities among partners and track performance	**2024**	**Planned**
F. Establish working group that is responsible for mitigating issues that may arise from private partnerships	**2024**	**Planned**
G. Engage regional partners in discussions with private industries	**2024**	**Planned**
Organization and Workforce Actions		
A. Allocate funding to develop and implement new TSMO positions or roles to support ongoing and new TSMO efforts	**2024**	**In Progress**
B. Gain senior leadership buy-in for new TSMO roles within the agency	**2024**	**Completed**
C. Develop and share benefit/cost scenarios of new and existing TSMO roles	**2024**	**Planned**
D. Continuously update TSMO training with new initiatives or deployed strategies	**Ongoing**	**N/A**
E. Document performance and progress in completing specific activities; include these measures of effectiveness with annual performance development reviews	**Ongoing**	**N/A**
F. Track performance and continuously work to reduce barriers for sharing resources with partner agencies (on-going)	**Ongoing**	**N/A**
Culture Actions		
A. Share successes in the TSMO Program agency-wide	**Ongoing**	**N/A**
B. Share successes in the TSMO Program with regional partners	**Ongoing**	**N/A**
C. Share successes in the TSMO Program with the public	**Ongoing**	**N/A**

** Targets are subject to change based on TSMO Program and NDOT department wide priorities. Dates may be accelerated or pushed-back based on the Program's continuous assessment of needs and NDOT priorities.*

4.1.4 Asset Performance

TSMO Asset Performance measures answer the question: "How well are TSMO-related assets performing?" The TSMO Program adds a level of strategic management concerning assets owned by others. The TSMO Program focuses on collections of assets that, when managed in a coordinated and methodical fashion, provide high-value performance benefits which ultimately serve critical NDOT goals (see Section 4.1.1 and Section 4.1.2). This includes features that extend beyond traditional physical assets to include systems (such as data management systems) that exist to improve the coordinated performance of assets and, to benefit the overall performance of transportation systems. Assets relevant to TSMO strategies include, but are not limited to:

- Active Traffic Management (ATM)
- Connected and Automated Vehicle (CAV) Systems
- Data Collection, Storage, Utilization, Analytics, and Decision Support Systems
- Flow Detectors
- HAR Systems
- ITS Database and Communications
- Ramp Meters
- Real-Time Traveler Information
- RWIS
- Smart Work Zone Management
- Transportation Asset Management System
- Wrong Way Driver Detection
- High Occupancy Vehicle (HOV) Detection

Strategic management provided by the TSMO Program concerning assets owned by others includes defining asset criticality (which collections of assets are most important to achieve NDOT objectives), informing operation and maintenance decisions for NDOT, and evaluating lifecycle performance.

NDOT recognizes the importance of integrating TSMO with transportation asset management to better coordinate and leverage data, allocate resources, and manage risks. This integration allows NDOT to effectively manage assets through lifecycle planning, monitor asset condition trends, and identify assets critical to sustained performance.

The associated performance measures will not only assist NDOT in prioritizing maintenance and resources but will also make the business case for the funds to keep TSMO assets in an acceptable condition, while focusing on engineering and economic analysis based on quality information.

As shown in Table 3, TSMO assets include not only physical assets, but also digital assets that support implementation of TSMO and the associated strategies. These include assets and critical components such as ITS and associated elements, communications infrastructure, physical elements, and associated infrastructure, etc. As NDOT advances in TSMO and implementation of associated strategies, the following categories and performance measures should be reviewed and updated to ensure they remain inclusive and up to date.

Currently, key asset-level performance measures (i.e., ITS assets) focus on condition, as documented in the TAMP. From these measures, indicators drive maintenance-related activities, including inspection, minor repairs, major repairs, and replacement. Indicators based on the assets' manufacturer-recommended service life are used as a proxy measure of condition. This process is thoroughly documented in NDOT's 2019 TAMP, Appendix B. For the plan, ITS asset condition ratings were based on the manufacturer's recommended service life and grouped into four categories: "good," "low risk," "medium risk," and "high risk." Table 4, below, shows the classification for each condition. Table 5 shows the correlation between the current condition of the device and the resulting condition after each maintenance activity.

Table 3: Current ITS Asset Condition Definition

Condition Rating	Condition Definition
Good	< 80% of manufacturer's recommended service life
Low Risk	> 80% of manufacturer's recommended service life < 100%
Medium Risk	> 100% of manufacturer's recommended service life < 125%
High Risk	> 125% of manufacturer's recommended service life

Table 4: Maintenance Activity Impact Matrix

Condition Rating	Condition Definition			
	Inspection	Minor Repair	Major Repair	Replacement
Good	Good			
Low Risk	Low Risk	Good		
Medium Risk	Medium Risk	Medium Risk	Low Risk	
High Risk	High Risk	High Risk	Medium Risk	Good

As noted in Table 2 (see the table's Section 4, "Implement TSMO Program Plan Recommendations", row "D") this TSMO Performance Management Program Plan recommends adding new indicators that are responsive to the asset-level performance measures. The new measures move beyond the current state of condition-based measures for ITS assets to include criticality as a factor. In a related step, this TSMO Performance Management Program Plan recommends continued movement toward having an RCM program that is informed by the data systems that are currently being enhanced throughout NDOT. The approach recognizes that maintenance activities ultimately are designed to address failure modes, yet they are currently being planned based on time and conditions because not enough is known about the detailed set of circumstances that lead to asset failures nor which sets of assets are more critical than others. The new asset-level performance measures are designed to help align maintenance activities with TSMO aims—that is, prioritizing collections of high-priority assets over others, and making wise investments to maintain their operation.

Reliability-Centered Maintenance

RCM is a technique for systematically identifying appropriate maintenance tasks and frequencies from an understanding of failure risks. RCM systematically identifies failure modes and effective mitigations, including design and operation modifications, and condition-based and time-based maintenance.

RCM:

- Identifies the ways that assets fail
- Quantifies the probability of failure
- Identifies if the probability of failure is acceptable or unacceptable
- Devises maintenance regimes that will eliminate or reduce unacceptable failures

An RCM maintenance regime puts together groups of maintenance tasks so that they can be optimally planned. To do this requires an understanding of (1) the required performance of the asset, (2) the capability of the asset and how it degrades in time/use, (3) credible failure modes and the consequences of those failures, (4) the operational context or how long the asset's function is required, and (5) resources and costs associated with carrying out planned maintenance activities.

NDOT has made significant progress towards practicing RCM for TSMO assets. The condition categories and risk-based maintenance activities summarized in Table 4 and Table 5 are important first steps in this progress. To continue this progress, this plan recommends conducting a detailed RCM-focused study of recent TSMO asset performance, maintenance history, and other related factors. The study should examine performance and failure rates concerning TSMO assets against factors that might possibly influence them, such as manufacturer, elevation, climate, etc. The outcome of the study would clarify the factors noted in the sidebar. The study would supplement NDOT's existing interval-based maintenance program with insights gained through hotspot analysis to find locations of higher-than-average failure, then perform root cause-type analysis to understand why and provide lessons learned for management strategies and what indicators may be used to foresee failures. Ultimately, the study would define the optimal level of maintenance needed to achieve high-priority and normal-priority performance targets described in Asset Performance Measures and Targets for immediate-term and mid-term asset-level TSMO performance measures.

Criticality and Priority. A TSMO approach to managing and operating transportation assets recognizes that focusing efforts on the most important collections of assets in key locations has the greatest ability to improve overall transportation system performance and to further the programmatic goals and targets discussed in Section 4.1.1 and Section 4.1.2. For the purposes of this plan, criticality is represented in performance measures (Table 5, below) through the categories of "high priority" and "normal priority." High-priority assets are those located in Critical Corridors, whereas normal-priority assets are all other. Critical Corridors are being defined through the NDOT ITS and ATM Master Plan.

Performance. As previously described, TSMO asset-level performance measures answer the question: "How well are TSMO-related assets performing?" Given its role as the base of the TSMO performance hierarchy, the function of TSMO assets has tremendous ability to improve performance measures embodied at the Program Performance level of the performance hierarchy depicted in Figure 1.

The immediate-term TSMO Asset performance measures and targets formally adopt the base assumption targets used in NDOT's TAMP to calculate average annual investment needs and budget to maintain current conditions of ITS assets. This TSMO Performance Management Program Plan does not supplant these performance measures; rather, this plan is used to harmonize performance measures spanning Divisions for the purposes of holistically improving transportation system performance as an interconnected network, rather than by individual assets.

The strategic nature of the immediate-term performance measures will be expanded by prioritizing assets with higher criticality and demanding higher performance from these assets, while also allowing less-critical assets to have more relaxed targets. However, overall device-specific performance targets will not fall below the conditions first established in the immediate-term measures, thus preserving the base assumptions and forecasts made in the TAMP for ITS assets. TSMO asset performance measures and targets focus more on the performance and less on the assets' operational condition. These are represented in Table 5 as Mid-Term ITS Performance Measures and Targets.

Table 5: Asset Performance Measures and Targets

1. Immediate-Term Asset Performance Measures and Targets

ITS Asset	Target Low Risk or Better Target	ITS Asset	Target Low Risk or Better Target
CCTV	75%	HAR	50%
DMS	65%	Ramp Meter	90%
Flow Detectors	65%	RWIS	20%

2. Long-Term ITS Performance Measures and Targets

Asset	Criticality	% Uptime	Asset	Criticality	% Uptime
CCTV	High Priority	99%	**HAR**	High Priority	99%
	Normal Priority	95%		Normal Priority	95%
DMS	High Priority	99%	**Ramp Meter**	High Priority	99%
	Normal Priority	95%		Normal Priority	95%
Flow Detectors	High Priority	99%	**RWIS**	High Priority	99%
	Normal Priority	95%		Normal Priority	95%

Lifecycle Performance. Ultimately, the value of an asset is provided through its proper function over time. As established in the RCM and other preceding discussions, NDOT strives to keep TSMO assets functioning as intended. The Department has taken concrete steps (such as the interval-based maintenance program for ITS assets) to ensure timely maintenance happens when assets are installed and operating. Yet the TSMO Program can provide additional strategic value to the activities across the entire lifecycle of an asset, not just the operational and maintenance stage. An individual asset's lifecycle can be summarized as four key stages:

1. **Acquisition:** Identify the needs correctly and select the right solution (design, procurement, construction, and commissioning).
2. **Operate and Maintain:** Achieve the optimal mix of asset utilization and asset care, including managing the tensions between these competing requirements; the primary focus of Section 4.1.4 is on this operations and maintenance stage, as well as the modify and improve stage, which comes next.
3. **Modify or Improve:** Continually seek cost, risk, performance improvement, and life extension opportunities.
4. **Dispose or Replace:** Manage aging and obsolescence, which involves repair versus replace decisions, decommissioning, disposal, and management of residual risks.

The value impact of decisions will differ across asset lifecycle stages, as illustrated in Figure 3. This graph shows how costs (in red) and benefits (in green) typically vary over the stages of an asset's lifecycle. The steps that NDOT is taking to optimize value in the operation and maintenance stage are described in Section 4.1.1. There are additional opportunities that exist within the Acquisition stage (or capital expenditure). Decisions in the design or asset selection stage have the greatest opportunity to improve or damage value over the whole lifecycle. Up to 30 percent of total lifecycle costs can sometimes be eliminated by good decisions at this stage. In the aging assets and end-of-life stage, where obsolescence, deterioration, or changing functional needs are encountered, it is important to consider life extension options, new investments, and critical intervention timing decisions. This stage also can benefit from TSMO approaches where high-priority assets are replaced to maintain continuity, whereas normal-priority assets are maintained with life extension in mind but replaced on less aggressive timescales or only after failure.

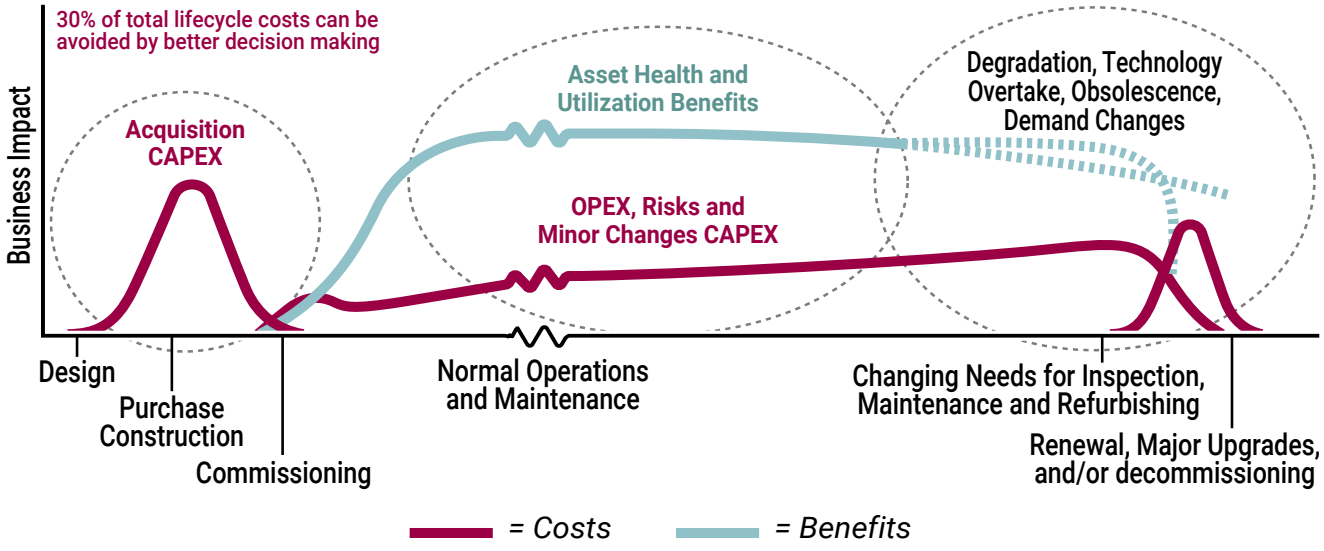

Figure 3: Asset Lifecycle Stages

TSMO Program involvement is recommended in the design, purchase, and commissioning phases of TSMO assets. This involvement will help ensure that such capital expenditure investments are appropriate for the intended purpose of those assets from a TSMO perspective. The TSMO Program, for example, could help influence procurement decisions effecting critical corridors by focusing on performance objectives, but also help find savings for procurements facing non-critical areas.

4.1.5 Data and Sources

To support TSMO Program performance measures, data is used to determine:

- What assets exist in the Inventory
- Where the assets are located
- What condition the assets are in
- How the assets are performing
- What needs to be done to the assets
- What has been done to the assets in the past

Data used by the TSMO Program to understand and manage comprehensively the assets performance are listed in Appendix C. Additional data-driven recommendations are connected to the RCM-focused study, which will generate data to assist with developing asset lifecycle strategies that define inspection, maintenance frequencies and activities, and criteria for asset refurbishment and/or asset overhaul or replacement. Asset data will help to better understand:

- The causes of asset degradation
- How asset degradation affects the asset's performance
- Maintenance and other actions to address asset degradation and the likely costs
- If an asset has reached the end of its working life and requires replacing
- The assessment of the costs and value delivered over the life of an asset for a range of inspection and maintenance options

4.2 Plan Integration

The TSMO Program Plan builds on and adds to plans and strategy documents that collectively direct NDOT transportation system management and operations in ways that best achieve department-wide goals in the most efficient manner possible. Through this TSMO Performance Management Program Plan, NDOT adds to this body of work and existing plans by advancing performance measures to help ensure that TSMO capabilities are integrated methodically into the management and operations of NDOT's transportation system, and that TSMO-related assets are performing in step with TSMO goals. The most notable connections to other NDOT planning documents are described below.

4.2.1 Transportation Asset Management Plan

The TSMO Program Plan helps to address the TAMP's "asset management improvement initiatives" (Table 7-1 in the plan), which will produce "… improved financial assessment of the ITS needs and maintenance strategies," describing how maintenance and management of ITS assets needs a more-structured approach. The conclusions and recommendations set forth in this TSMO Performance Management Program Plan support the TAMP's commitment that, "NDOT will provide the Districts with more autonomy in managing the ITS assets within their jurisdiction. To help support the process, NDOT will provide maintenance agreements and funding for Districts I, II, and III." The asset-level recommendations generated through this TSMO Performance Management Program Plan set a base level of expectations for performance and maintenance targets for Districts and elsewhere across the state. Also, the RACI matrix formalizes roles and responsibilities to ensure seamless and dependable ITS management across the state.

Furthermore, recommendations from this TSMO Program Plan are consistent with TAMP commitments for performance and lifecycle planning. Performance targets cited in Table 2 were created to meet TAMP goals to maintain current levels of ITS asset service over the next 10 years (proposed). These TSMO Performance Management Program Plan recommendations that add tiered levels of asset criticality and new key performance indicators will be noted in the next update of the TAMP.

The TSMO Program Plan directly supports the TAMP's charge to assess trade-offs between different asset classes and programs and improve processes to determine cross-asset funding allocation priorities. This plan supports the TSMO Program's aim to determine funding allocation priorities across various asset classes and programs using a data-driven approach.

4.2.2 ITS Asset Management Business Plan

The ITS Asset Management Business Plan is directly supported by the TSMO Program Plan by formally binding the recommendations of the 2020 TSMO Statewide Program Plan Tactical Elements, the 2020 TSMO Statewide Program Plan Programmatic Elements Action Items, and the 2020 TSMO Program Capability Maturity Model Workshops to TSMO Program goals. This increases accountability for delivering key elements to the Business Plan. This is further bolstered by the creation of the RACI matrix, to ensure recommendations are implemented.

4.2.3 Performance Dashboards

It is recommended that the dashboarding task be performed in two phases. During phase 1, TSMO team members will meet to discuss the performance metrics to be tracked along with data required to evaluate these metrics. An evaluation of technical constrains to setup the dashboard (wireframing, hosting, and maintenance) shall also be discussed and documented. Phase 2 will entail the actual development of dashboards and reporting to help monitor and document the metrics shortlisted during Phase 1.

4.3 Stakeholder Engagement Plan

The implementation actions generated by this plan will need internal and external support to be executed. This section documents the internal and external engagement initiatives necessary to ensure plan implementation.

4.3.1 Internal

This plan recognizes that the assets and activities that influence performance are owned and are the responsibility of different NDOT Divisions and subdivisions. A holistic TSMO approach to managing and improving performance requires cross-department coordination and decision-making. The RACI matrix, shown in Table 6, is a tool for facilitating this endeavor. Defining roles and responsibilities through a RACI matrix provides clarity, alignment, and transparency to those involved in activities related to the TSMO Program by formally documenting who does what for the following roles:

Responsible (R) parties are those who do the work to complete the task.

Accountable (A) individuals or groups ultimately must answer for the completion of the deliverable or task. They make the final decision when one is needed. There should be only one "A" specified for each line item.

Consulted (C) parties are involved in making the decision or completing the task (e.g., Subject Matter Experts) and are crucial to two-way communication.

Informed (I) individuals are kept up to date on progress (e.g., copied on email), often only on completion of the activity or decision; communication with Informed groups or individuals may be only one-way.

Currently, the RACI matrix only defines roles and responsibilities within the Traffic Operations Division. As the performance management program matures and in alignment with NDOT's Maintenance and Asset Management Program, the matrix should be expanded to include roles and responsibilities for all NDOT Divisions.

Table 6: TSMO Program RACI Matrix

(R) Responsible: Owns completing the task (A) Accountable: Approves or is ultimately accountable for the task (C) Consulted: Involved in completing the task (e.g., Subject Matter Expert) (I) Informed: Notified about the task (e.g., copied on email) N/A: Not Applicable	Operations				
	Traffic Operations				
	ITS Programs	TOTS	SLI	SSTC	Network Analysis
Processes					
New ITS device selection and purchase	I	R	A	C	C
ITS device maintenance decisions	C	R	A	I	I
1. Delivery of 2020 TSMO Statewide Program Plan Tactical Elements					
Tactical projects documented in TSMO Statewide Program Plan. Tactical elements:					
A. Real-time traveler information (for the process)	A	R	R	R	C
B. Connected and automated vehicles (CAV) (policies, coordination with NV2X)	R	C	C	C	C
C. Active traffic management (ATM)	C	R	A	R	R
D. Traffic incident management (TIM)	A	N/A	N/A	C	N/A
E. Transportation asset management (specific to ITS devices)	A	R	R	R	C
F. Transportation performance management	R	C	C	C	R
G. ITS database and communications	C	A	R	N/A	N/A
2. Delivery of 2020 TSMO Statewide Program Plan Programmatic Elements Action Items					
Organizational Structure					
A. Work with TCT to identify TSMO integration opportunities	A	C	C	C	C
B. Approve and fill the TSMO Program Manager position	R	C	C	C	C
C. Develop additional TSMO positions under TSMO Program Manager	R	C	C	C	C
Business Process					
A. Develop processes to obtain identified new data for traffic operations performance management	A	R	R	R	R
B. Define process to develop actions based on performance	A	C	C	C	C
C. Develop a process to efficiently evaluate, select, and prioritize new technology and pilot projects	A	R	R	R	R
D. Identify procurement and contract processes to be modified to accommodate TSMO	R	C	C	C	C
E. Develop and document a performance management program	R	C	C	C	C
F. Develop processes to identify the required TSMO positions within Traffic Operations	A	R	R	R	R
G. Perform CMM assessment	R	C	C	C	C
H. Review NDOT manuals and guidance documents to include TSMO-related activities	A	R	R	R	R
I. Benchmarking of TSMO action items	A	R	R	R	R
Staffing and Workforce Development					
A. Identify the required skillsets and capabilities to implement TSMO	A	C	C	C	C
B. Develop a TSMO training program for NDOT staff	A	C	C	C	C
C. Develop a TSMO training program plan for both existing and new employees	A	C	C	C	C
D. Evaluate Phase 1 implementation and revise the WPSs in preparation for the transition to Phase 2	R	C	C	C	C
E. Implement Phase 2	R	C	C	C	C
F. Identify required TSMO training opportunities for staff	A	C	C	C	C
G. Evaluate Phase 2 implementation and begin the TSMO Program Workforce Development Plan (WDP)	A	C	C	C	C
H. Develop and implement Phase 3 with TSMO positions as defined in the TSMO WDP	R	C	C	C	C
Financial Resources Management					
A. Apply the TSMO IPT for project selection on an annual basis	A	I	R	I	C
B. Work with the planning division to develop TSMO-specific inputs into the statewide planning process	A	C	C	C	C
C. Include TSMO consideration for the TAMP update	R	C	A	C	C
D. Develop a TSMO 5-year plan	A	C	R	C	C
E. Develop funding guidance tool for TSMO funding, including basic descriptions of funding requirements and application processes	A	I	R	I	I
F. Develop regularly scheduled meetings to ensure financial plans are aligned with TSMO funding	A	I	C	I	I
Communication and Collaboration					
A. Identify existing means of internal communication and collaboration and the missing links for effective coordination	A	C	C	C	C
B. Develop communication processes to identify and document TSMO issues prior to Project Development Committee (PDC) meetings	A	I	I	I	I
C. Develop training program for internal and external user education of performance measures	A	I	I	I	I

	ITS Programs	TOTS	SLI	SSTC	Network Analysis
D. Develop TSMO training program for internal and external agencies	A	I	I	I	I
E. Develop quarterly TSMO newsletter and circulate it internally and externally	A	I	I	I	I
F. Identify and develop required interagency processes and protocols	A	C	C	C	C
G. Develop interagency agreements to enhance collaboration with external agencies	A	I	I	I	I
3. Reference to all TSMO Program Plan Recommendations					
A. Monitor TSMO Performance Measures	A	R	R	R	R
B. TSMO Program Responsible, Accountable, Consulted, and Informed (RACI) Matrix	A	C	C	C	C
C. Deep-Dive into Devise-Level Performance History	A	R	C	I	I
D. Use Reliability-Centered Maintenance (RCM) for ITS Assets	A	R	R	I	I
C. Involve the TSMO Program in the "Aquire" Stage of the ITS Asset Lifecycle Lifecycels	A	C	R	I	I
4. Actions from the 2020 TSMO Program CMM Workshop					
Business Process Actions					
A. Communicate TSMO Business Case at the state legislative level	R	I	I	I	I
B. Implement mitigation plan, document successes and challenges; continuous improvement	R	C	C	C	C
C. Integrate the Regional ITS Architecture and Systems Engineering Process with the TSMO Project Evaluation Tool	A	I	I	I	I
D. Document before/after lessons learned from Project Evaluation Tool deployment.	A	C	C	C	C
Systems and Technology Actions					
A. Track the performance of ITS projects	A	C	R	I	C
B. Implement privacy policies and security requirements	C	A	I	N/A	N/A
C. Define access, roles, and responsibilities and perform monitoring	C	A	I	N/A	N/A
D. Implement functional performance-based criteria for deployed TSMO systems	A	R	I	N/A	N/A
E. Document and distribute infrastructure procurement process	A	C	R	N/A	N/A
F. Track asset uptime, monitor and report performance regionally, and ensure assets are placed based on LCA and performance	A	R	R	N/A	N/A
Performance Measurement Actions					
A. Gain consensus on regional TSMO performance measures and document performance metric criteria					
B. Document region-wide TSMO performance-based project deployment processes and procedures	R	R	A	A	R
C. Establish funding for TSMO deployment	R	I	I	I	I
D. Coordinate with regional partners on performance measure data	R	R	I	I	A
E. Gain senior executive support for revising processes to support performance measure needs					
F. Document regional performance measures as they relate to MAP-21 and TSMO alignment	R	I	I	I	A
Collaboration					
A. Planning group: collaborate with Traffic Operations when planning projects for the future	C	I	I	I	I
B. Planning group staff members: incorporate TSMO strategies into traffic modeling and other corridor study activities	C	I	I	I	I
C. Document roles and responsibilities for TSMO implementation to be carried out by other NDOT Divisions in collaboration with the Traffic Operations Division	A	I	I	I	I
D. Regional committee: meet on a recurring basis	R	I	I	I	I
E. Document established roles and responsibilities among partners and track performance	R	C	C	C	C
F. Establish a working group that is responsible for mitigating issues that may arise from private partnerships	R	A	A	A	A
G. Engage regional partners in discussions with private industries	C	I	I	I	I
Organization and Workforce Actions					
A. Allocate funding to develop and implement new TSMO positions or roles to support ongoing and new TSMO efforts	C	I	I	I	I
B. Gain senior leadership buy-in for new TSMO roles within the agency	R	I	R	I	R
C. Develop and share benefit/cost scenarios of new and existing TSMO roles	A	R	R	R	R
D. Continuously update TSMO training with new initiatives or deployed strategies	R	R	R	R	R
E. Document performance and progress to completing specific activities; include these measures of effectiveness with annual performance development reviews	A	A	A	A	A
F. Track performance and continuously work to reduce barriers for sharing resources with partner agencies (on-going)	R	R	R	R	R
Culture Actions					
A. Share successes in the TSMO Program agency-wide	R	R	R	R	R
B. Share successes in the TSMO Program with regional partners	R	R	R	R	R
C. Share successes in the TSMO Program with the public	R	R	R	R	R

4.3.2 External

External stakeholders contribute to TSMO Program performance. In some instances, NDOT is reliant on local agencies and contractors for operation and maintenance of local devices. Because of this, it is imperative that performance requirements not only be communicated to these external stakeholders, but formally built into expectations where new assets are being planned or currently are operating on NDOT facilities. Tools for ensuring compliance include memoranda of understanding and, in the case of third-party maintenance contracts (such as ITS devices), detailed contract performance requirements.

4.4 Training Program

Training is necessary to ensure that the decisions and recommendations initiated by this TSMO Performance Management Program Plan are implemented most effectively and become institutionalized throughout NDOT offices. The topics and components described in Table 7 represent training initiatives that support effective TSMO Performance Management Program Plan implementation.

Table 7: TSMO Performance Management Program Plan Related Training

Training Topic	Components	Audience
TSMO Assets	Prioritization Acquisition Management and Performance	TSMO asset owners TSMO Program staff Asset management program staff
TSMO Performance Management Plan	Goals/Objectives State of practice Implementation	Staff responsible for reporting performance Asset management program staff
Engagement	General overview	Anyone, internal and external
RACI	General briefing	Organizational groups cited in the RACI

4.5 Update Cycle

The elements within this plan will be updated according to the cycle shown in Table 8.

Table 8: TSMO Performance Management Program Plan Update Cycle

Plan Element	Frequency
TSMO Performance Management Program Plan	5 years
TSMO Program Performance Measures	Annually*
TSMO Program Delivery Performance (including RACI)	Annually
Asset Performance	Annually**

** Already being updated annually in NDOT's Performance Management Report*

*** As use of dashboards matures, asset-level performance measures will be updated more frequently than once a year.*

5 Recommendations

5.1 Monitor TSMO Performance Measures

With the publication of this plan, NDOT's TSMO Program formally adopts the program, delivery, and asset-level performance measures detailed in Section 4.1. Achieving the performance targets set in this section is a complex endeavor. Those involved in the decisions, actions, and coordination necessary to reach these targets will be assisted by having a keen awareness of current performance levels. To that end, this plan recommends regular meetings of the TSMO Program to monitor performance and progress on the measures noted in Section 4.1. This recommendation is linked to the use of a TSMO Program RACI Matrix—the subject of Recommendation 2, below.

5.2 Use TSMO Program RACI Matrix

In Section 4.3, this plan recommends formalizing TSMO roles and responsibilities to provide clarity, alignment, and transparency to those involved in activities related to the Program. Clearly outlined roles and responsibilities enable effective communication between all NDOT Divisions and teams. The tool recommended for this is a RACI matrix, which documents "who does what" for TSMO Program activities. Use of the matrix includes updating it when needed to account for new activities, roles, responsibilities, etc.

5.3 Deep-Dive into Device-Level Performance History

This plan recommends conducting a detailed RCM-focused study of recent TSMO asset performance, maintenance history, and other related factors. The study should examine performance and failure rates concerning TSMO assets against factors that might possibly influence them, such as manufacturer, elevation, climate, etc. The outcome of the study would clarify the factors necessary to make RCM-aimed maintenance decisions. The study would supplement NDOT's existing interval-based maintenance program with insights gained through hotspot analysis to find locations of higher-than-average failure, then perform root cause-type analysis to understand why and provide lessons learned for management strategies as well as what indicators may be used to foresee failures. Ultimately, the study would define the optimal level of maintenance needed to achieve high-priority and normal-priority performance targets described in Table 6, for TSMO asset-level performance measures.

5.4 Use RCM for ITS Assets

As detailed in Section 4.1.4, this TSMO Program Plan recommends altering the maintenance scheme for ITS assets to better align with the demands of new ITS performance measures documented in Table 6. The new measures consider asset criticality (i.e., normal versus high priority), as well as redefine performance (i.e., failure rate). As a result, modifying the current NDOT ITS asset program, which focuses on manufacturer's recommended service life, is needed to better understand failure modes and adjust the maintenance scheme accordingly.

As part of this RCM recommendation, 2022 NDOT TAMP development should consider the changes described in this TSMO Performance Management Program Plan regarding the evolution of ITS asset performance measures and the related changes made in how maintenance resources are directed to those assets to maintain performance. This may impact TAMP ITS base assumption targets used in the plan to calculate average annual investment needs and budget to maintain ITS assets.

5.5 Involve TSMO Program in "Acquisition" Stage of ITS Asset Lifecycles

This TSMO Performance Management Program Plan recommends TSMO Program involvement in the design, purchase, and commissioning phases of TSMO assets. This involvement will help ensure that such capital expenditure investments are appropriate for the intended purpose of those assets from a TSMO perspective. The TSMO Program, for example, could help influence procurement decisions affecting critical corridors by focusing on performance objectives, but could also help find savings for procurements facing non-critical areas.

APPENDICES

Appendix A. Literature Review Sources

Sources evaluated for the literature review process in determining the state of the practice nationwide included:

AASHTO Transportation Asset Management Guide

ADOT Transportation Asset Management Plan

Autroads Reliability-Centered Maintenance Strategy and Framework for Management of ITS Assets

Caltrans 2019 State Highway System Management Plan

Caltrans Asset Management Performance Report

Caltrans TAMP

Colorado DOT Transportation Asset Management Plan and CDOT Asset/Fund Management Guidebook—ITS Technical Plan

FHWA Handbook for Including Ancillary Assets in Transportation Asset Management Programs

Florida DOT ITSFM

Georgia DOT Transportation Asset Management Plan

Louisiana DOT Comprehensive Asset Management Plan

Ohio DOT TSMO Performance Management Brief

Oregon DOT Transportation Information Gateway

Oregon DOT TSMO Program Performance Plan

Pennsylvania DOT Transportation Asset Management Plan

Seattle DOT Asset Management Status and Condition Report

Utah DOT Transportation Asset Management Plan

Appendix B.
New Candidate Performance Measures

Potential New Performance Measures

Program Objectives	Performance Measure	Target
Reduce secondary crashes caused by traffic incidents.	Percentage of secondary crashes to primary crashes on monitored freeways	< 15% of all TMC-verified crashes
Reduce work zone-related crashes.	Frequency of work zone crashes	Reduce by 1% over a 5-year moving average
Reduce roadside “struck by” incidents.	Frequency	Zero
Maximize free flow travel time on Nevada’s freeway system.	Percent of time motorists experience free flow travel time (TTRI)	> 88%
Increase resilience of the transportation system to winter weather events.	Percent of routes that recover speeds within 10 miles per hour (mph) of the expected speeds within 2 hours of a snow event ending	> 96%
Reduce incident clearance time.	Duration	To be determined
Reduce roadway clearance time.	Duration	To be determined
Optimize signalized corridors.	Percentage of corridors retimed per year	25% of Tier 1 and Tier 2 Corridors
	Percent arrival on green	> 97%
Reduce work zone traffic delays.	Number of hours the operating speed is less than 35 mph per monitored work zone	Increase no more than 25% over preconstruction
Provide consistent incident response and management across the state	Percentage of traffic incident management (TIM)-trained emergency responders in state (DOT/Public Works, Fire, Police, Towing, EMS)	Increase by 5% per year over 5 years
Optimize travel time reliability on major freight corridors.	Percent of time freight operators experience free flow travel time (TTRI)	> 94%

Program Objectives	Performance Measure	Target
Maximize equipment and communications reliability.	Percent asset uptime	97%
	Communications network uptime	97%
	Percent asset beyond service life	Less than 10%
Respond to and clear heavy vehicle incidents as quickly as possible.	Response < 45 minutes; Clearance < 90 minutes	Informational only
Expand TMC surveillance and management capabilities.	Percent of congested corridors (based on TTRI and Level of Service [LOS] analysis) with fixed ITS	Informational only
	Number of mobile data collection devices (automatic vehicle location/ global positioning system [AVL/ GPS], cameras, weather sensors)	Informational only
Manage TMC staff workload.	Number of incidents logged	Informational only
Provide timely, accurate, and comprehensive information to customers.	Increase number of pushed incident notifications—average number of notifications opened per incident	Increase year to year
	Usage of pushed data service data—number of personalized routes created	Informational only
	Incident verification (incident occurrence to time public is notified)	90% of incidents posted within 10 minutes
Hold after-action review (AAR) meetings for 100% of incidents that exceed clearance goals.	Percentage of meetings that occur within 30 days	100%
Monitor key transportation assets/ events to prevent harmful acts.	Number of assets/events monitored.	Informational only
Promote TSMO tools to improve emergency management.	Number of agencies with CCTV and NDOT data access.	Informational only

Appendix C.
TSMO Physical and Digital Assets

NDOT has developed the following TSMO asset categories and performance measures to lead the agency toward comprehensive and proactive asset management through TSMO in the future.

Physical Assets	Digital Assets
Cabinets and traffic signal controllers	ATIS system(s) (511, HAR, etc.)
Closed-circuit television (CCTV)	ATMS software
Cellular routers	Asset management systems (NDEX, AMP, PowerBI, etc.)
Dynamic Message Sign (DMS) type 1 & 2	Central software system(s)
Fiber optic cable	Incident management software
Flashing beacons	Servers (software/Operating Systems)
Flow detectors	Video distribution software
HAR	AI and Data Dashboards / Traffic Incident Management Dashboards
Illumination (highway tunnel and lighting)	
Ramp Meters	
Routers	
RWIS	
Signs	
Striping	
Switches	
Traffic signals	
Traffic structure (such as ATM gantries)	
Wireless ethernet radio	
Wrong way driver detection	
Servers	
Fiber communications	
ATM type 1, 2 & 3	
HOV Occupancy Detections	


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