NCHRP 08-115
Guidebook for Data and Information Systems for Transportation Asset Management

Final Research Implementation Report

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Executive Summary

NCHRP Report 956: Guidebook for Data and Information Systems for Transportation Asset Management provides an assessment framework, guidance, and step-by-step techniques to assist state departments of transportation (DOTs) and other transportation agencies in advancing use of data and information systems for transportation asset management. This guidebook is intended to be used in conjunction with a companion digital tool – the TAM Data Assistant – providing a comprehensive approach to benchmark agency practices and identify and evaluate improvements.

Purpose and Scope

The purpose of this research implementation project was to encourage dissemination and application of the principles, practices, and tools presented in NCHRP Report 956: Guidebook for Data and Information Systems for Transportation Asset Management.

This was completed through the application of the NCHRP Report 956 TAM Data Assessment at four (4) participating DOTs. A total of five (5) assessments were conducted – across a range of agency-specific contexts and objectives. From this collective experience, the research team collected practical implementation experience, lessons learned, and participant feedback which was incorporated into a set of supplemental guidance and communication materials providing effective, transferable practices to support future TAM data assessment and improvement applications. This report presents the key findings, recommendations, implementation experiences, and implementation support materials developed through these assessment experiences.

The implementation experience summary (Sections 1 and 2 of this report) documents the research implementation process, covering what was done and what was learned through the research implementation project. The developed supplemental implementation support materials are described and referenced in Section 3 of this report.

Key Research Products

The supplemental implementation support materials (described and referenced in Section 3 of this report) are the key products of this research implementation project.

Designed to help agencies make effective use of the NCHRP Report 956 assessment guidance and tools, these supplemental materials are intended for use by future assessment facilitators. The developed materials include:

- **Spreadsheet Tools** – useful to target the assessment and consolidate outcomes.
- **Presentation Templates** – designed to support assessment kickoff, summary, and closeout meetings and present assessment context that will be valuable in future implementation actions.
- **Step-Specific Implementation Tips** – organized by the phases of the assessment process.
- **Implementation Experience Summaries** – sharing key assessment context and outcomes from four (4) unique applications of the NCHRP Report 956 assessment methodology and tools.
- **A Strategic Framework for TAM Data and Information System Investments** – which refines and refocuses the broader NCHRP Report 956 framework to show how potential data and

information system capabilities do, or do not, align with three different asset management approaches: (1) a reactive management approach, (2) a cycle-based management approach, or (3) a condition or performance-based management approach.

This framework can be used to provide a structured approach to identify:

- What management approach is intended for your asset?
- What data is required, optional, or not needed for the approach?
- What data informed decisions are intended to be supported?
- What analytical methodologies should be in place?
- What data access and reporting capabilities are expected?
- How should data be stored and integrated?
- What data collection methodologies may be appropriate?

Section 1. Background

1.1 Research Objective

NCHRP Report 956: Guidebook for Data and Information Systems for Transportation Asset Management provides an assessment framework, guidance, and step-by-step techniques to assist state departments of transportation (DOTs) and other transportation agencies in advancing use of data and information systems for transportation asset management. This guidebook is intended to be used in conjunction with a companion digital tool – the TAM Data Assistant – providing a comprehensive approach to benchmark agency practices and identify and evaluate improvements.

The purpose of this research implementation project was to encourage dissemination and application of the principles, practices, and tools presented in NCHRP Report 956: Guidebook for Data and Information Systems for Transportation Asset Management.

1.2 Research Approach

The project was completed through the application of the NCHRP Report 956 TAM data assessment guidance, methodology, and tools at four (4) participating agencies:

- Iowa Department of Transportation (IADOT)
- New Hampshire Department of Transportation (NHDOT)
- New Mexico Department of Transportation (NMDOT)
- Virginia Department of Transportation (VDOT)

The research team worked with agency leads to target five (5) individual assessments – as described in Table 1-1 on the following page. Each assessment was completed following the NCHRP Report 956 Guidebook recommended approach, with the notable adjustment to include implementation action planning in place of detailed improvement evaluations.

The research team also conducted an online survey of all registered TAM Data Assistant users to gather information about broader user experiences, successes, and challenges.

Table 1-1. Agency-Specific Assessment Scopes and Approaches

Agency	Assessment	Scope	Approach
IADOT	**TAM Management Approach Assessment**	Identify data and information systems and capabilities necessary to support three different levels of asset decision-making: 1) Reactive Management, 2) Lifecycle Based Management, and 3) Condition-Based Management. The objective was to align data and information systems to identified management approaches, allowing IADOT to be more strategic in TAM related data collection and IT investments. The effort was structured as three (3) separate assessments (one for each management approach), consisting of offline, individual assessments, followed by group consensus building. Outcomes from the three assessments were reconciled through cross assessment discussions to develop a consolidated framework and action plan. The assessment framework was adapted to utilize the "current state" to represent the minimum needs and the "desired state" to represent more advanced capabilities aligned with a given management approach.	**General Action Plan** • Included all Assessment Elements • Began with Individual Assessments • Followed by Group Consensus Discussion • No Improvement Evaluation • Included Action Plan Development
NHDOT	**Bridge Preservation Program Assessment**	Evaluate data and information system usage in the NHDOT Bridge Preservation Program to identify potential improvements that would bring data-informed decision-making processes more in line with bridge rehabilitation and replacement decision-making, including considerations for project design and asset management system integration. This covered all 51 assessment elements, and included offline, individual assessments prior to targeted group consensus building discussions. It also included development of an implementation action plan.	**General Action Plan** • Included all Assessment Elements • Began with Individual Assessments • Followed by Group Consensus Discussion • No Improvement Evaluation • Included Action Plan Development

Agency	Assessment	Scope	Approach
NMDOT	**TAM Project Evaluation Program Assessment**	Assess a newly implemented TAM Project Evaluation Program established to prioritize TAM related project investments with the objective of identifying where the new program may benefit from data and system improvements. This was a group assessment of targeted assessment elements, focusing on development of a general action plan for future implementation.	**General Action Plan** • Targeted Elements (in reverse order) • Conducted as a Group Assessment • No Improvement Evaluation • Included Action Plan Development
VDOT	**Highway Maintenance Management System (HMMS) Assessment**	Examine VDOT's maintenance management system to identify how current functionality can be expanded to support broader asset management of roadside assets. Structured as a group assessment approach of targeted assessment elements to produce an action plan that would support future, expanded use of the system to new asset programs and use cases.	**General Action Plan** • Targeted Elements (in reverse order) • Conducted as a Group Assessment • No Improvement Evaluation • Included Action Plan Development
	Pavement Management Program Assessment	Evaluate data and information usage in VDOT's pavement management program to identify opportunities for advancement, with no specific concerns or focus for improvement. This covered all 51 assessment elements, and included offline, individual assessment prior to group consensus building discussions. It also included development of an implementation action plan.	**General Action Plan** • Included all Assessment Elements • Began with Individual Assessments • Followed by Group Consensus Discussion • No Improvement Evaluation • Included Action Plan Development

Section 2. Agency Engagement Summary

The research team developed detailed agency assessment targets and work plans in coordination with leads from each of the four (4) participating agencies. The research team lead, agency core team, and agency assessment participants then executed planned assessments per the NCHRP Report 956 guidebook recommendations. Throughout implementation, the research team developed materials and captured lessons learned and adjusted the assessment approach as needed to support practical implementation to the agency-specific assessment motivation and context. General implementation experiences, lessons learned, and supporting materials are described below, organized by NCHRP 956 assessment process step:

1. Selecting a Focus
2. Assessment Planning
3. Benchmarking and Improvement Selection
4. Improvement Evaluation
5. Assessment Summary and Communication
6. Closeout and Post-Pilot De-briefs (conducted for this implementation project)

2.1 Selecting a Focus

This first step of the TAM Data Assessment involves scoping the effort to establish a clear focus and objectives for the assessment. Initial scoping meetings were held with leads in each of the four (4) agencies. These meetings were used to identify specific targets for assessment. In subsequent meetings, the research team engaged representatives from the targeted areas to discuss specific assessment contexts and objectives, as well as identify targeted agency participants. Through this process, the research team established agency-specific assessment targets.

Table 2-1 details key activities, materials developed and lessons learned in this step of the assessment process.

Table 2-1: "Selecting a Focus" Key Activities, Materials and Lessons Learned

Item	Description
Assessment Context, Objectives, Team Members and Approach Documentation	**Activities and Observations:** Facilitators first met with core team members to walk through the process of describing the context within which the assessment is being conducted, establishing objectives, identifying team members, and selecting an overall approach. This helped to set common expectations prior to identifying and engaging assessment participants. A standard presentation template was developed for this step and used in subsequent activities. **Lesson:** Because the assessment tool can be used in many different ways, it is important to clarify the agency's objectives up front. Key questions include: (1) are there specific issues or problems you'd like to see addressed through this effort? (2) are there future initiatives being planned (e.g., new IT projects) that you want this effort to support? (3) do you want to get a general idea of your gaps or do you want a specific action plan to follow over the next few years? (4) do you have resources and organizational support in place to implement recommendations that come out of this process? Clarified objectives and desired outcomes should be shared with assessment team participants to set appropriate expectations and motivate their substantive engagement. **Key Materials:** A TAM Data Assessment Kickoff Presentation Template was created with slides that can be used to document and share assessment-specific context, objectives, team-members, and high-level approaches.
Element-Level Assessment Scoping	**Activities and Observations:** Facilitators worked with core team members to scope the assessment. While the existing Guidebook provides clear instructions to select an asset-specific or area-specific focus, the implementation experience identified the need for further guidance and support for selecting a subset of assessment elements to be included. This is particularly relevant when the agency is targeting a specific system (as was the case for the VDOT HMMS Assessment) or process (in the case of the NMDOT TAM Project Evaluation Assessment). **Lesson:** The current Guidebook and TAM Data Assistant tool do not provide a methodology to support element-specific assessment targeting. Simple spreadsheet tools would be useful to assist assessment facilitators with this process.

2.2 Assessment Planning

The Assessment Planning step involves activities conducted by the assessment sponsor and facilitator to schedule and deliver an assessment kickoff meeting. NCHRP Report 956 provides clear facilitator instructions, as well as a supporting invitation email template, agenda, as well as materials helping to describe the assessment framework and participant roles.

To support meeting execution, the research team developed kickoff meeting presentation materials. A slide deck was designed to assist the facilitator in communicating the targeted assessment areas, sections, and elements as well as share key user guidance relating to use of the AASHTO TAM Data Assistant. It describes the NCHRP Report 956 methodology and tools, summarizes the agency-specific assessment motivation and context, and describes high-level assessment approaches, timelines, and next steps. It also includes links to web-based versions of the research report, AASHTO TAM Data Guide and AASHTO TAM Data Assistant, as well as other available guidance and implementation support materials.

Table 2-2 details key activities, materials developed and lessons learned during this step in the assessment process.

Table 2-2: "Initial Preparation" Key Activities, Materials and Lessons Learned

Item	Description
Assessment Framework and Tool Presentation Materials	**Activities and Observations:** Standard kickoff presentation materials were produced and used to ensure a common understanding of the assessment elements and expectations of participants. These materials were shared at the end of the kickoff meeting for ongoing reference by assessment participants. **Lesson:** It is important for all assessment participants to be briefed on the meaning of the assessment elements, and to have reference materials available as they fill out the assessment. **Key Materials:** The TAM Data Assessment Kickoff Presentation Template (described in Section 3.3).
TAM Data Assistant Tutorial Videos	**Activities and Observations:** The assessment facilitator was often required to assist users in navigating the basic functions of the tool. **Lesson:** To avoid additional burden on the assessment facilitator, short tutorial videos addressing key TAM Data Assistant features and functions were useful. **Key Materials:** Four videos were uploaded to the AASHTO TAM Data Guide, for easy reference by assessment participants and for easy sharing as part of the assessment kickoff meeting.

Item	Description
Subject Matter Expert Involvement in Assessment Kickoff	**Activities and Observations:** During the assessment kickoff, subject matter experts were engaged to share background on the targeted asset programs, systems, or processes as part of the kickoff meeting. This included context specific explanations of the assessment elements as well as general overviews of the agency's existing programs, processes, or tools. **Lesson:** Engage subject matter experts to talk about the agency's current programs, processes, or tools during the assessment kickoff. At this stage in the kickoff meeting, participants can raise any questions and provide background information to inform subsequent assessment activities. **Key Materials:** The TAM Data Assessment Kickoff Presentation Template includes a placeholder slide that can be tailored by subject matter experts to provide their general overview.
Assessment Meeting Scheduling	**Activities and Observations:** Facilitators worked with core team members to schedule the assessment meetings to involve the identified participants. In some cases, scheduling and participant engagement proved challenging and there were significant gaps in time between meetings. **Lesson:** For optimal assessment outcomes, plan on a weekly meeting cadence. Longer gaps between assessment activities will create disruptions in the process and will also lead to assessment participants forgetting previously discussed assessment context, objectives, and instructions.

2.3 Benchmarking and Improvement Selection

This step in the TAM data assessment involves completing the self-assessment activities for the selected focus, including both benchmarking of current and desired state of practice, as well as the identification of potential improvements to close gaps.

During research implementation, these activities were completed as described by the guidebook. Some assessments were scoped to include offline, individual assessments prior to group assessment meetings, while others began as group assessments from the start. In two of the assessments, the research team adapted the assessment approach to conduct the assessment in reverse order, beginning in Area E: Act on Data and progressing backwards towards Area A: Specify and Standardize Data. Additionally, for assessments targeting general action plans over development of detailed improvement lists, documentation of general improvement notes was emphasized over detailed improvement selection.

Table 2-3 details key activities, materials and lessons learned during this step in the agency assessments.

Table 1-3: "Benchmarking and Improvement Selection" Key Activities, Materials and Lessons Learned

Item	Description
Time Required for Individual Assessments	**Activities and Observations:** Agencies choosing to complete the full TAM Data Assessment (all 51 elements) found that it required individual participants 4-8 hours to complete. **Lesson:** Avoid participant burn-out by either eliminating the offline, individual assessments from the group assessment process, or use element-level assessment selections to focus the assessment on a limited set of assessment elements. Offline assessments can also be broken up so that participants are asked to complete only those elements targeted for discussion in the upcoming weekly meeting.
Assessment Order	**Activities and Observations:** In some of the assessments, the facilitator and core team decided to reverse the order of completing the assessment, starting with discussing how the agency would act on the data. This proved to be a more compelling way to conduct an assessment than following the normal sequential approach. **Lesson:** To maximize participant engagement and help focus assessment outcomes, begin the assessment with Area E, discussing the current and desired data-driven decision-making capabilities within the assessment focus and then work backwards through the remaining areas (D through A).
Value of Benchmarking and Improvement Notes	**Activities and Observations:** The facilitator captured detailed notes on the rationale for different benchmark ratings and improvement selections to help guide group consensus discussions. **Lesson:** The default improvements offered by the tool can be very helpful to guide assessment discussions and as a starting point for specific improvement actions. However, in many cases agencies will want to create different actions to reflect their specific context. In these cases, notes should be captured to document the discussions of improvements to be pursued. This will improve the efficiency of the later action planning process.

2.4 Improvement Evaluation

This step in the TAM data assessment guides the facilitator to complete evaluations for potential improvements identified through the benchmarking and improvement selection step.

Table 2-4 details key activities, materials and lessons learned during this step in the agency assessments.

Table 2-4: "Improvement Evaluation" Key Materials and Lessons Learned

Item	Description
Skipping Improvement Evaluation	**Activities and Observations:** The participating agencies elected to skip this step, preferring to focus on action planning. **Lesson:** The detailed improvement evaluation step may not add sufficient value to be worth the time needed and should be considered optional. The facilitator should be offered guidance to support the decision to include or exclude these activities as part of any given assessment.

2.5 Assessment Summary and Communication

This step in the TAM data assessment involves the development of clear, effective communication materials to support executive engagement and implementation action.

As part of the research implementation, this step was expanded to include action planning activities. To support action planning, the research team developed standalone spreadsheet materials and presentation templates.

Table 2-5 details key activities, materials and lessons learned from this step in the agency assessment processes.

Table 2-5: Assessment Summary and Communication Key Activities, Materials and Lessons

Item	Description
Assessment Results Presentation	**Activities and Observations:** Facilitators prepared supplemental presentation materials to summarize and communicate assessment outcomes and to support action planning. These materials were useful to • Provide an overview of the assessment methodology and approach • Share Area-specific themes and benchmark ratings • Communicate proposed action plans, supporting concepts, and share supporting action details. **Lesson:** Assessment summary materials were very consistent in format across the different research implementation experiences. An Assessment Results and Action Plan Presentation Template should be developed. **Key Materials:** A TAM Data Assessment Results and Action Plan Presentation Template was created (see Section 3.4).

Item	Description
Action Planning Tools	**Activities and Observations:** The implementation efforts focused on developing specific action plans for each agency based on the assessment results. NCHRP Report 956 and the TAM Data Assistant do not provide action planning tools, so simple spreadsheet tools were developed to support the research implementation. **Lesson:** Action plans are highly valued assessment products. Supporting tools and guidance are needed to support the action planning process. **Key Materials:** TAM Data Assistant Results and Action Plan Spreadsheet Tool (see Section 3.5). This tool includes spreadsheet templates for action planning that build from data exportable from the TAM Data Assistant, providing capabilities to: • Communicate group consensus current and desired state ratings, benchmark notes, and improvement notes on an element-by-element basis. • Summarize individual benchmark rating counts (for both current and desired state ratings). • Identify, consolidate, and describe specific actions across assessment elements. • Capture and detail consolidated actions on a separable action planning worksheet. • Record and maintain detailed implementation priorities, assignments, target dates, status, dependencies, and comments over the course of implementation.

2.6 Closeout and Post-Pilot Debriefs

This final step of the process, conducted as part of the implementation project served three purposes: (1) to review next steps to be taken by the agency to move forward with the results of the effort, (2) to generate materials summarizing the individual assessment and overall agency implementation effort and (3) to gather feedback from agency participants to support future application of the NCHRP Report 814 data self-assessments. These activities included a participant survey and a close out meeting involving the research team, agency core team, and (in some cases) other assessment team participants.

As a final product of the assessment support, the research team developed a closeout presentation outlining the assessment context, motivation, participants, process, outcomes, and detailed action plan. These presentations were supplemented with detailed assessment summary spreadsheets, which captured individual assessment input, group consensus gathering outcomes, assessment summary and proposed improvements, and final action plans.

Table 4 details key activities, materials and lessons learned from the agency support provided in this phase of the assessments.

Table 2-6: Evaluation and Close Out Phase Key Activities, Materials and Lessons

Item	Description
Research Implementation Experience Summaries	**Activities and Observations:** Throughout the assessment process, agency participants requested information and examples from previous assessment experiences. Lessons learned from some of the pilot assessments were also successfully applied during the NMDOT assessment process (which was conducted last). **Lesson:** Concrete examples of prior assessments are helpful for providing agencies with an understanding of products and outcomes – particularly during the scoping phase. **Key Materials:** Summaries of the NHDOT, NMDOT, and VDOT research implementation experiences are provided in Appendix B of this report. The IADOT assessment experience was somewhat unique; the framework that was created through that pilot is documented separately in Appendix C.
IADOT Framework	**Activities and Observations:** The IADOT assessment experience was a non-standard application of the tool, but provided an assessment framework that may be of interest to other agencies seeking to become more strategic in their TAM data and information system investments. **Lesson:** The process used to develop the IADOT framework is not a standard use of the NCHRP 956 research, however the results are directly useful by other agencies. **Key Materials:** A Strategic Framework for TAM Data and Information System Investments was developed from the IADOT materials and is documented in Appendix C. A supporting presentation was also created.
Assessment Summary / Close Out Presentations	**Activities and Observations:** The research team, in coordination with agency core team members, developed assessment summary presentations to communicate assessment results and support agency next steps. These materials were designed to be used for executive communication, stakeholder engagement, and detailed action plan implementation activities. **Lesson:** Assessment summary materials were very consistent in format across the different research implementation experiences. **Key Materials:** The TAM Data Assessment Results and Action Plan Presentation Template.

Item	Description
Detailed Assessment Spreadsheets	**Activities and Observations:** The research team documented the detailed information collected through each phase of the assessment process, including individual assessment results, group consensus building outcomes, and finalized action plans. Standardized assessment summary spreadsheet materials were developed to meet each agency's needs. **Lesson:** Supplemental templates for documenting research results should be made available to future users of the tool. **Key Materials:** The TAM Data Assessment Results and Action Planning Tools for documenting the assessment results and action planning.
Participant Feedback	Through the survey and the closeout meeting feedback sessions, participants suggested the following improvements: • Make sure participants understand the purpose and likely outcomes of the assessment. In particular, clarify whether the action plan is simply a list of improvement ideas or whether there is some level of commitment to implementation (or a process that will lead to implementation). • Target assessments and find ways to streamline the assessment process, particularly if offline, individual assessment input is desired. • Make sure to involve the right people to have a productive discussion – including the right mix of central office, district, and support staff in the assessment discussion. • Participants also noted the value of facilitation, setting expectations, and ensuring resources to deliver on outcomes.

2.7 TAM Data Assistant User Survey

A TAM Data Assistant User Survey was created and sent to the 116 registered users of the TAM Data Assistant; 14 responses were received. While responses were limited and not necessarily representative of all users, overall, the survey showed very strong support for the TAM Data Assessment methodology and tools, with almost 80% of respondents saying that they would recommend their agency conduct similar assessments in the future.

Half of the survey respondents also believed that their agencies had the capacity to carry out this type of assessment without outside support, with another 35% unsure, and only 15% believing the assessment would require outside support.

Additionally, the survey showed that participants are learning about the assessment organically, with 35% learning about the tool from a colleague, and another 15% through the AASHTO TAM Portal or an AASHTO or TRB webinar.

Section 3. Implementation Support Material

The key products of this research are the supplemental implementation support materials to help agencies make effective use of the assessment guidance and tools. These materials build from the lessons learned throughout the research implementation experience. The products include a range of sample templates, presentations, and other communication and guidance materials as well as spreadsheet tools intended to support assessment results summary and action planning. Each product is described below.

3.1 TAM Data Assessment Element Selection Matrix

The TAM Data Assessment Element Selection Matrix is a spreadsheet tool that can be used by the assessment facilitator to consider and document individual assessment elements for inclusion within their specific assessment. The spreadsheet presents each individual assessment element and element description, organized by assessment area, with additional fields where the facilitator can select assessment elements they intend to include in their assessment. To support this decision, the tool presents recommendations of required, recommended, optional, or not recommended elements, based on general contexts explored through the research implementation experiences.

The guidance relating to the assessment element selection matrix is available in the step-specific practical implementation tips provided in Appendix A of this report, while the tool itself is available for download through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

Figure 3-1. TAM Data Assessment Element Selection Matrix

TAM Data and Information Assessment Elements			Your Assessment		General Recommendations (by Asset Management Approach or other Piloted Assessment Types)				
Label	Element Name	Element Description	*Identify Targeted Elements Below.*	*Provide Additonal Support (as desired).*	Reactive Management Program Assessment	Cycle-Based Management Program Assessment	Condition-Based Management Program Assessment	Investment Prioritization Program Assessment	General Asset Management System Assessment
A.1.a	Asset Inventory Data Model	Standardized asset categories, component breakdowns and core attributes, providing the foundation for asset inventory information tracking, integration, summary, and reporting.			Required	Required	Required	Recommended	Recommended
A.1.b	Asset Condition and/or Performance Data Model	Standardized asset condition and performance data types, detailed attributes, and summary indices, ratings, or scores that are useful in asset related decision-making and			Required (asset issue data)	Optional	Required	Recommended	Recommended
A.1.c	Design Model Standards	CADD standards consistent with asset inventory standards (asset categories and component breakdowns) to support linkage and data exchange with project information with asset inventory and management systems.			Optional	Optional	Optional	Not Recommended	Optional
A.1.d	Location Referencing	Standardized location referencing for asset inventory and condition data to enable mapping and integration with other agency data for analysis.			Required	Required	Required	Recommended	Required
A.2.a	Treatment and Work Data Model	Standardized asset treatment/work categories and attribution to enable information collection, integration, and consistent reporting.			Required (evaluate models to capture work on issues)	Required	Required	Optional (if planned/accomplished work will be used in prioritization)	Required
A.2.b	Treatment and Work Location Referencing	Standardized location referencing for planned and completed work to enable accurate collection, mapping, and integration with other agency data for analysis.			Optional	Optional	Optional	Optional (if planned/accomplished work will be used in prioritization)	Required
A.2.c	Process Documentation and Management	Established and documented responsibilities and business processes for updating asset information as assets are installed, maintained, upgraded, and replaced or			Optional	Recommended	Required	Not Recommended	Optional
A.3.a	Prioritization Factors	Use of asset tiers, condition or performance levels, work types or other prioritization factors to support high-level decision-making.			Recommended (issue prioritization)	Recommended (prioritization of cycle-based activities to resources)	Recommended	Required	Recommended (if prioritization is an current/intended function)
A.3.b	Analysis Parameters	Established analysis parameters (e.g. asset deterioration and treatment benefit models, treatment unit costs, analysis time horizons) supporting			Optional	Optional	Recommended	Required	Recommended

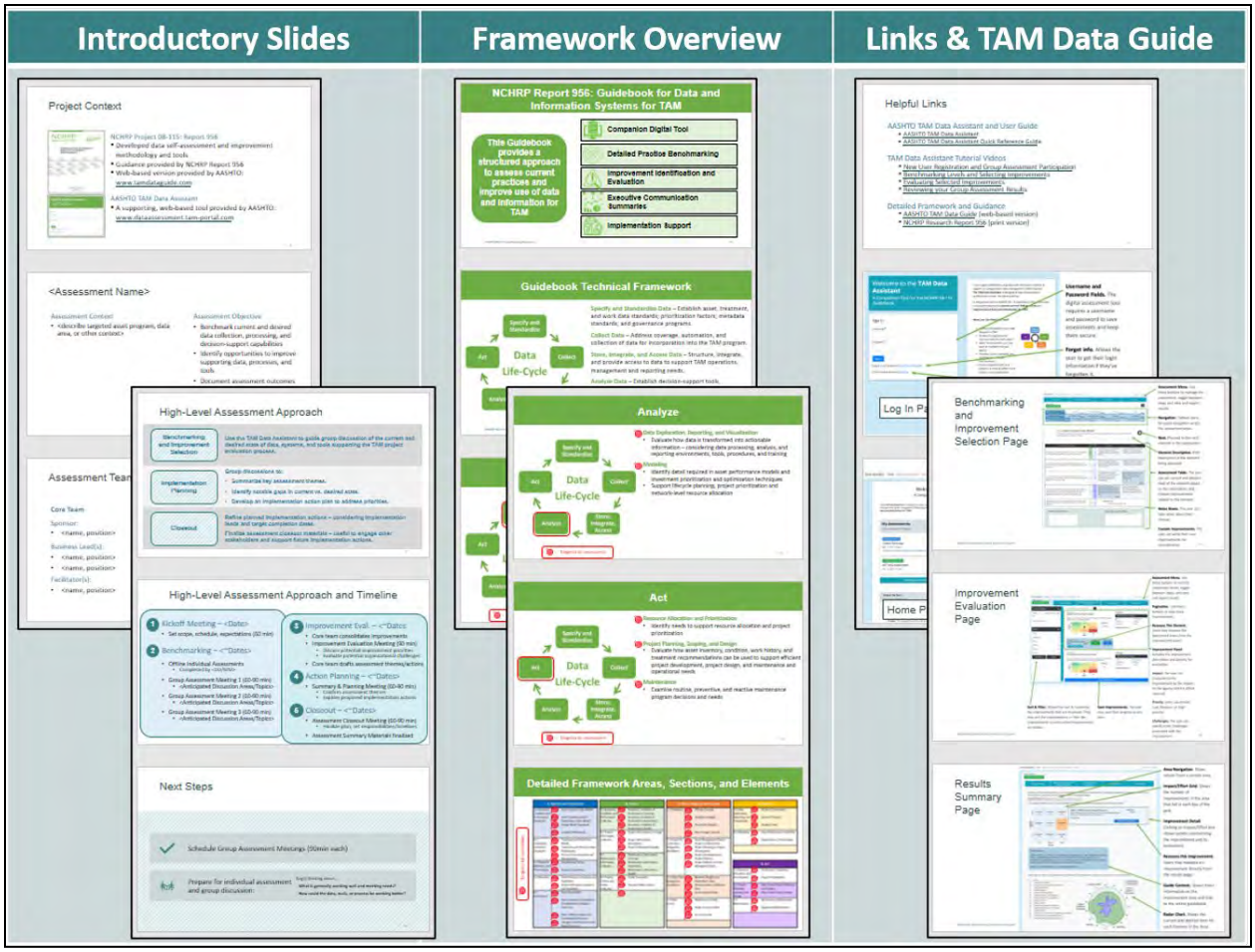
3.2 TAM Data Assistant Tutorial Videos

Short instructional videos assist TAM data assessment participants with navigating the basic functions of the AASHTO TAM Data Assistant. Supplementing the AASHTO TAM Data Assistant User Guide, these four tutorial videos address: 1) New User Registration and Group Assessment Participation, 2) Benchmarking and Improvement Selection, 3) Evaluating Selected Improvements, and 4) Reviewing Your Group Assessment Results. Ranging between approximate 2-3:30 minutes in total length, these videos are made available for download through the NCHRP Project 08-115 website and AASHTO TAM Data Guide.

3.3 TAM Data Assessment Kickoff Meeting Presentation Template

NCHRP Report 956 recommends the assessment process begin with a kickoff meeting to share context, establish a meeting schedule, and ensure participants are prepared for the upcoming assessment activities. The report provides clear facilitator instructions, a supporting invitation email template, agenda, as well as materials describing the assessment framework and participant roles. The TAM Data Assessment Kickoff Meeting Presentation Template was developed to assist the assessment facilitator with this critical meeting. The template provides slides to introduce the assessment methodology and tools, explain the agency-specific context, motivation and targeted assessment elements, set assessment timelines and next steps, as well as share links to web-based versions of the research report, AASHTO TAM Data Guide and TAM Data Assistant, and other supporting materials.

Figure 3-2. TAM Data Assessment Kickoff Meeting Presentation Template

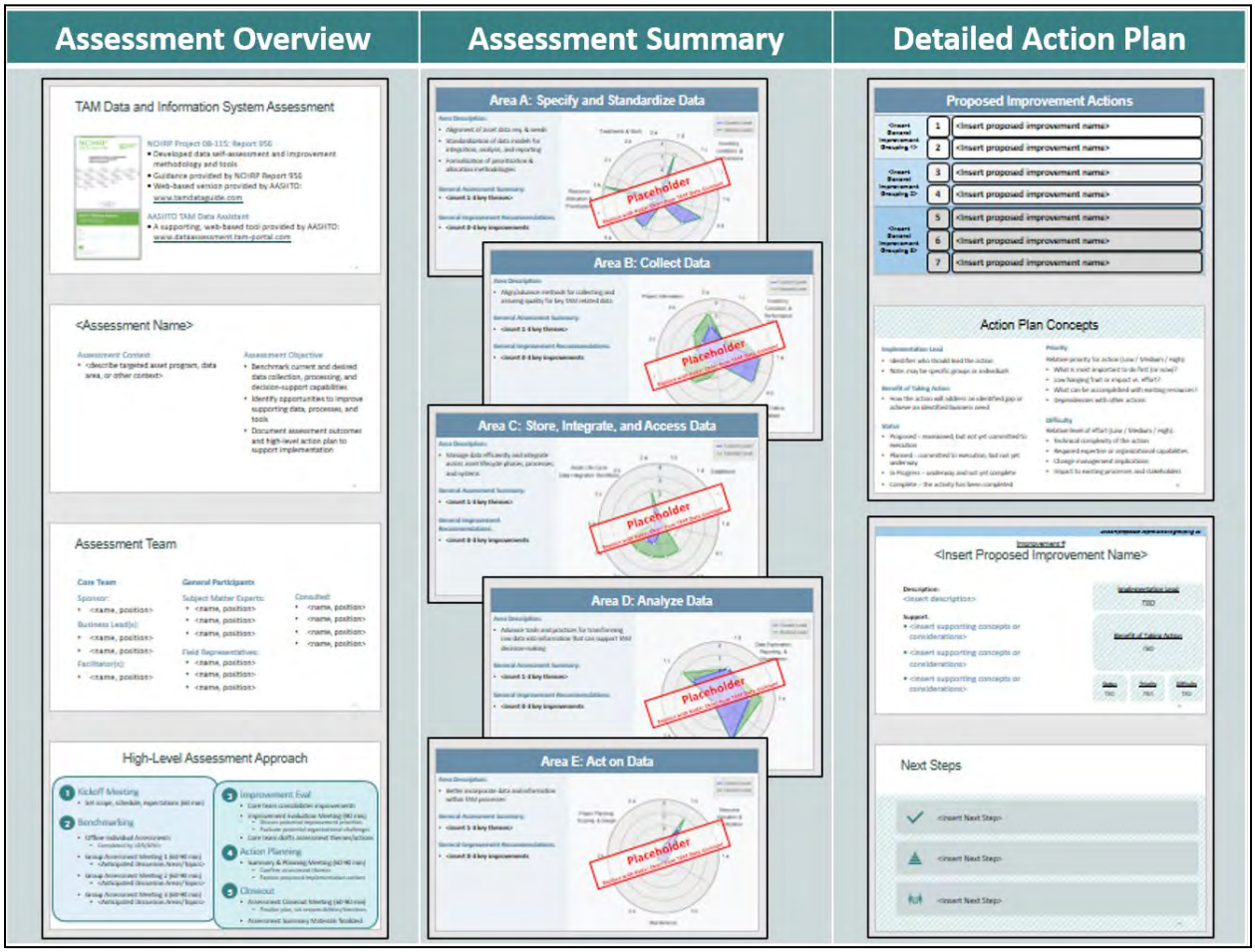


Practical implementation tips supporting use of the template are available in Appendix A of this report and the AASHTO TAM Data Guide, while the TAM Data Assessment Kickoff Meeting Presentation Template is available for download through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

3.4 TAM Data Assessment Results and Action Plan Presentation Template

NCHRP Report 956 recommends that summary and communication materials be developed to communicate assessment outcomes to agency decision-makers and assessment stakeholders and participants. The TAM Data Assessment Results and Action Plan Presentation Template was developed to communicate assessment themes, outcomes, and proposed action plans for confirmation by assessment participants as well as for communication to key agency decision-makers and assessment stakeholders. The template includes slides that provide a general overview of the assessment context, objectives, participants, and approach, summarize area-specific current and desired state benchmarks and proposed improvements, as well as share proposed improvement action plans, action planning concepts, and improvement action-specific details.

Figure 3-3. TAM Data Assessment Results and Action Plan Presentation Template



Practical implementation tips supporting use of the template are available in Appendix A of this report and the AASHTO TAM Data Guide, while the TAM Data Assessment Results and Action Plan Presentation

The template is available for download through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

3.5 TAM Data Assessment Results and Action Plan Spreadsheet Tool

This spreadsheet tool supports development of assessment summaries and action plans and is provided for download through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide. This spreadsheet tool includes two worksheets: a group consensus worksheet and an action planning worksheet.

Group Consensus Worksheet

The group consensus worksheet provides each assessment element, in a format easily populated by data exported from the TAM Data Assistant, to present element-specific group consensus current and desired state ratings and expose benchmark and improvement notes, as well as summarized individual assessment benchmark rating counts. This worksheet also includes element-specific fields where the facilitator can identify, consolidate and describe proposed improvement actions.

Figure 3-4. Group Consensus Worksheet

TAM Data Assessment Assessment Group Consensus Worksheet																			
			Group Consensus				Individual Rating Counts										Consolidated Actions for Action Planning	
							Current State					Desired State						
Status	Label	Element Name	Current	Desired	Benchmark Notes	Improvement Notes	0	1	2	3	4	0	1	2	3	4	Potential Actions	Specific Action Descriptions
	A.1.a	Asset Inventory Data Model																
	A.1.b	Asset Condition and/or Performance Data Model																
	A.1.c	Design Model Standards																
	A.1.d	Location Referencing																
	A.2.a	Treatment and Work Data Model																
	A.2.b	Treatment and Work Location Referencing																
	A.2.c	Process Documentation and Management																
	A.3.a	Prioritization Factors																
	A.3.b	Analysis Parameters																
	A.4.a	Data Dictionary Standards and Guidelines																
	A.4.b	Dataset Metadata Standards and Guidelines																
	A.5.a	Data Stewardship																
	A.5.b	Data Standards and Guidelines Development Adoption Processes																
	A.5.c	Data Collection Approval/Coordination Practices																
	A.5.d	Change Control (Systems and Data) Processes																
	B.1.a	Inventory, Condition, and Performance Coverage																
	B.1.b	Inventory, Condition, and																

Action Planning Worksheet

The action planning worksheet provides a tool to list consolidated actions, related action descriptions, associated elements, and track action specific benefits, relative implementation priority and challenges, proposed or assigned implementation leads, current status, target completion dates, any dependencies or blockers, as well as other comments or notes. This worksheet supports action planning as well as eventual implementation tracking and monitoring.

Figure 3-5. Action Planning Worksheet

ID	Action	Related Elements	Business Need	Description	Benefit of Taking Action	Priority (High/Med/Low)	Implementation Difficulty (High/Med/Low)	Implementation Lead	Status (Proposed, Planned, In Progress, Complete)	Target Completion	Dependencies or Blockers	Comments
1												
2												
3												
4												
5												
6												

3.6 Step-Specific Practical Implementation Tips

The NCHRP 956 Report already provides a wealth of detailed facilitator instructions and assessment guidance, however the research implementation experiences did uncover lessons supporting a more effective, streamlined assessment experience. These lessons are cataloged and supported in succinct, practical implementation tips, which are organized by process step and address the following topics.

Assessment Step	Topics Addressed by the Practical Implementation Tips
Selecting a Focus	• Alignment of the assessment with anticipated implementation next steps • Element-specific assessment targeting • The value of a practical, common assessment context
Assessment Planning	• Assessment streamlining and scheduling considerations • Supplemental kickoff meeting resources • Subject matter expert involvement in assessment kickoff
Benchmarking and Improvement Selection	• Reversing the assessment order • Use of improvement notes vs. detailed improvement selection
Improvement Evaluation	• Considerations for skipping the improvement evaluation step
Summarizing and Communicating Results	• Supplemental assessment summary and action planning resources

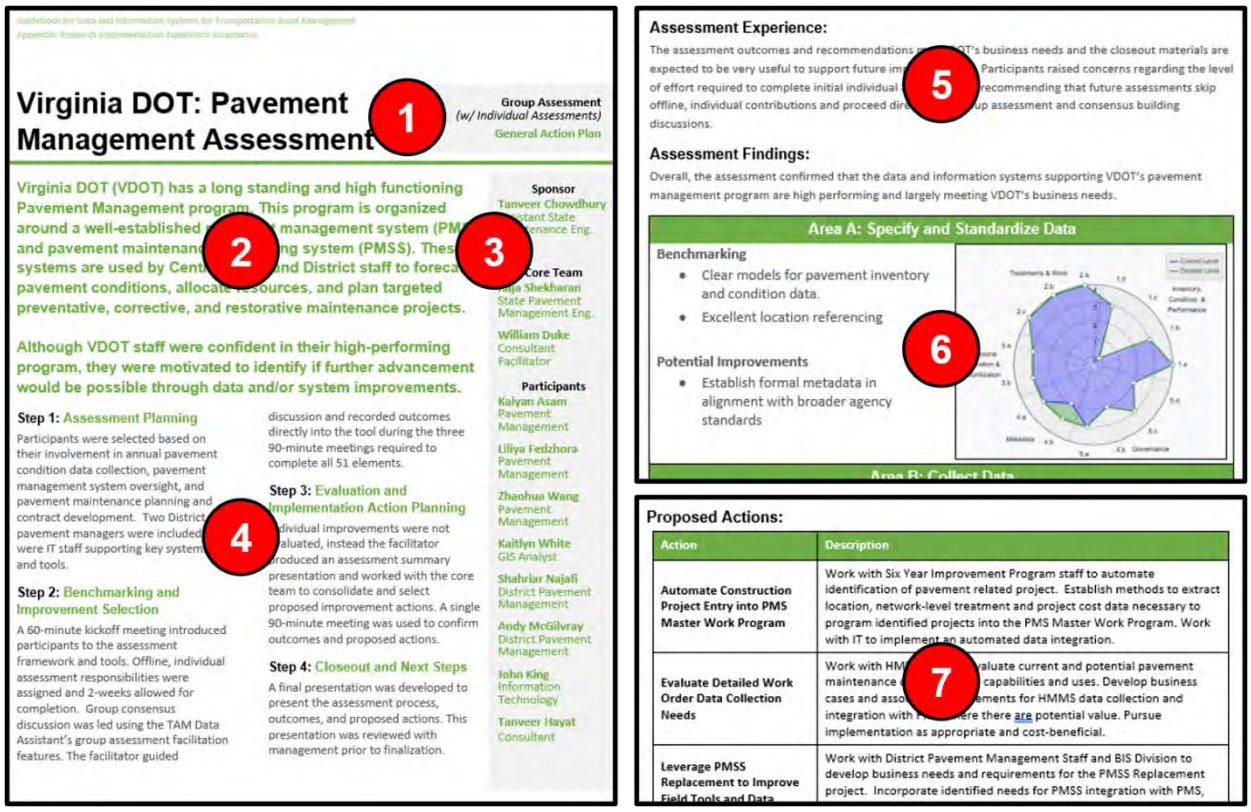
These implementation tips are available in Appendix A of this report as well as through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

3.7 Implementation Experience Summaries

Four of TAM Data Assessments completed through this research implementation project are documented for future research implementors. These research experience summaries document:

1. **An assessment header** – including the agency, assessment name, as well as a general characterization of the assessment scope.
2. **An assessment description** – useful for understanding the high-level assessment focus, motivation, and context.
3. **The assessment team** – identifying the sponsor, core team members, and participants, assisting future implementors in selecting their assessment teams.
4. **The assessment approach** – succinct descriptions of the steps taken to complete the assessment and develop the implementation action plan and assessment summary materials.
5. **The assessment experience** – a high-level description of how the assessment experience was received by the agency participants, including considerations for how the assessment outcomes will be incorporated into future improvement activities.
6. **The assessment findings** – presenting area specific benchmarking and proposed improvements
7. **The proposed actions** – cataloging and describing key improvement actions, providing insight into the varied nature of improvement actions that can be identified through an assessment.

Figure 3-6. TAM Data Assessment Research Implementation Experience Summary Example



These implementation experience summaries are available in Appendix B of this report as well as through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

Strategic Framework for TAM Data and Information System Investments

The IADOT assessment resulted in the creation of a Strategic Framework for TAM Data and Information System Investments. This framework refines and refocuses the broader NCHRP Report 956 framework to show how potential data and information system capabilities do, or do not, align with three different asset

management approaches: (1) a reactive management approach, (2) a cycle-based management approach, or (3) a condition or performance-based management approach.

The framework consists of a series of matrices, organized by tiered management approaches, linked to potential data and information system capabilities, which can be used to provide a structured approach to identify:

- What management approach is intended for your asset?
- What data is required, optional, or not needed for the approach?
- What data informed decisions are intended to be supported?
- What analytical methodologies should be in place?
- What data access and reporting capabilities are expected?
- How should data be stored and integrated?
- What data collection methodologies may be appropriate?

The developed framework materials are provided in Appendix C of this report and are also available for download through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

A supporting presentation provides a helpful introduction to the framework materials, describing the intended application of the framework, as well as recommending implementation steps for future users. The presentation also shares a hypothetical application of the framework to help illustrate the framework's intended use. This presentation is also available through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

Appendix A. Practical Implementation Tips

NCHRP 956 Report provides a wealth of detailed facilitator instructions and assessment guidance, however the research implementation experiences did uncover lessons supporting a more effective, streamlined assessment experience. These lessons are cataloged and supported in succinct, practical implementation tips, which are organized by process step and address the following topics.

Assessment Step	Topics Addressed by the Practical Implementation Tips
Selecting a Focus	• Alignment of the assessment with anticipated implementation next steps • Element-specific assessment targeting • The value of a practical, common assessment context
Assessment Planning	• Assessment streamlining and scheduling considerations • Supplemental kickoff meeting resources • Subject matter expert involvement in assessment kickoff
Benchmarking and Improvement Selection	• Reversing the assessment order • Use of improvement notes vs. detailed improvement selection
Improvement Evaluation	• Considerations for skipping the improvement evaluation step
Summarizing and Communicating Results	• Supplemental assessment summary and action planning resources

These implementation tips are provided below and are also available through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

Practical Implementation Tips

Selecting a Focus

Select an Outcome Aligned with Anticipated Implementation

Ask yourself, the assessment sponsor, and/or the core team membership:

1. Are there specific issues you'd like to address through this effort?
2. Are there initiatives (e.g., new IT projects) you want this effort to support?
3. Do you want a general idea of your gaps or a specific action plan to follow?
4. Do you have resources and support to implement assessment outcomes?

Then, consider and select an appropriate assessment outcome:

Assessment Outcome	Anticipated Implementation
Detailed Action Plan Establish a prioritized improvement action plan, with clear responsibilities and anticipated timelines for action.	Use this approach if you want to identify and carry out specific actions to advance maturity – and key decision-makers are willing to commit resources and take immediate actions to advance priority recommendations.
General Action Plan Establish a prioritized improvement action plan, without delegating responsibilities and timelines for action.	Use this approach to provide clear improvement recommendations for decision-makers – this is recommended when dedicated resources are not yet available, but there is a desire to motivate investment and action in the near term.
Detailed Improvement List Identify and evaluate specific improvement activities to produce a detailed list of needs.	Use this approach if your goal is to produce a very specific set of improvement actions necessary to advance specific data and information system capabilities. This will follow the base NCHRP Report 956 assessment approach and is recommended when a specific set of working actions is intended for implementation within a narrow focus area (e.g., a specific system, data capability, or business area).
Gap Analysis Identify and summarize general gap areas and potential improvement actions.	Use this approach if your main goal is to benchmark current program performance and identify areas for possible advancement. This approach can be used to raise awareness and create discussion even if you are not ready or able to commit to taking immediate action.

Practical Implementation Tips

Selecting a Focus

Limit the Assessments to Selected Elements

- **Be mindful of participant time and avoid participant burnout** by targeting the assessment on a limited set of key assessment elements.
- **Use the TAM Data Assessment Element Selection Matrix spreadsheet tool** to help select elements to include.
- **Share the targeted assessment elements** - selections you make in the spreadsheet tool are easily copied to the assessment kickoff presentation materials and assessment results summary presentation and tools.

Get a Common Understanding of the Scope

- **Be clear about what should be considered in the assessment and improvement planning conversations.** Clarify:
    - Which specific assets are we talking about?
    - Which business processes?
    - Which systems/tools?
    - What time frame?
- **Interpret the assessment elements with the scope in mind –** for example, for the purposes of the assessment, how should participants differentiate:
    - Area A & B: “Projects” from “Maintenance”.
    - Area C: “Project Planning”, “Project Development”, and “Project Delivery”.
    - Note: consider highlighting specific business processes, products, systems, or data to help bring home these concepts.
- **Understand current processes, data and tools –** have subject matter experts share basic information as background to future group assessment discussion.

Practical Implementation Tips

Assessment Planning

Align the Assessment Approach with Selected Outcomes

Outcome	Key Activities	Other Considerations
Detailed Action Plan Establish a prioritized improvement action plan, with clear responsibilities and anticipated timelines for action.	• Benchmarking and Improvement Selection • Assessment Summary • Improvement Evaluation • Action Planning	• Maximize likelihood of post-assessment action by involving executive management and other key stakeholders in assessment summary and closeout meetings. • Engage assessment participants who can take ownership of actions in the plan and make sure they understand this expectation. • Create a "parking lot" of actions that can't yet be resourced so that they don't get lost.
General Action Plan Establish a prioritized improvement action plan, without delegating responsibilities and timelines for action.	• Benchmarking and Improvement Selection • Assessment Summary • Action Planning	• Target participants with decision-authority within specific program or technical areas, who may independently pursue low-hanging fruit or other identified improvement opportunities.
Detailed Improvement List Identify and evaluate specific improvement activities to produce a detailed list of needs.	• Benchmarking and Improvement Selection • Assessment Summary • Improvement Evaluation	• Target subject matter experts, system owners, and working staff or first line management in the selected area. • Be sure participants understand that they are expected to act on improvement recommendations within their areas of responsibility
Gap Analysis Identify and summarize general gap areas and potential improvement actions.	• Benchmarking and Improvement Selection • Assessment Summary	• Ensure participants' expectations are managed – this will be a high-level, awareness building exercise with limited subsequent action anticipated.

Practical Implementation Tips

Assessment Planning

Other Assessment Streamlining and Scheduling Considerations

- **Plan for a weekly meeting cadence** – longer gaps between assessment activities can create disruptions in the process and lead to assessment participants forgetting previous assessment discussions and context.
- **Break up (or skip) offline, individual benchmarking assessments** – individual assessments require 4-8 hours to complete if all of the assessment elements are included. Consider asking participants to complete one area of the assessment each week (immediately prior to planned group discussions) or skipping individual assessments, proceeding directly to group benchmarking discussions.

Supplemental Kickoff Meeting Resources

- **TAM Data Assistant Tutorial Videos** – these are short instructional videos that walk through how to navigate basic functions of the assessment tool:
    - New User Registration and Group Assessment Participation
    - Benchmarking and Improvement Selection
    - Evaluating Selected Improvements
    - Reviewing Your Group Assessment Results
- **TAM Data Assessment Kickoff Meeting Presentation Template** – this is a PowerPoint template that can be customized to:
    - Introduce the assessment methodology and tools
    - Explain agency-specific context, motivation, and targeted elements
    - Set assessment timelines and next steps
    - Share links to web-based assessment resources

Practical Implementation Tips

Assessment Planning

Subject Matter Expert Involvement in Assessment Kickoff

Line up and work with subject matter experts (SMEs) to:

- **Provide a general overview of the targeted business areas** and related processes, systems, and data.
- **Create supporting presentation materials** to replace placeholder slides in the kickoff presentation template.
- **Address participant questions** during the assessment kickoff meeting.

Practical Implementation Tips

Benchmarking & Improvement Selection

Consider Reversing the Assessment Order

Maximize participant engagement and help focus assessment discussions and outcomes by beginning with Area E (Act on Data) and working backwards through the remaining areas. This approach will:

- **Encourage participants to "keep the end in mind"** when discussing data and system gaps and improvements.
- **Establish a common picture of current and desired data-driven decision-making capabilities** before working through progressively more detailed, specific discussions.
- **Build from context gathered through discussions of the preceding assessment areas** to support more informed, streamlined discussion of subsequent, more detailed assessment areas.

Defining Improvements to Close Gaps

- **Use the default improvements lists provided as part of the assessment as a starting point** to help the group identify more specific improvement actions. Note: The default improvements are also useful for helping participants to understand the different benchmark practice levels because they indicate what needs to be done to move to a higher level.
- **Use the Improvement Notes Field to record more specific improvement actions** – these might be more detailed or granular than the default improvements or they might combine multiple default improvements together.
- **Capture nuances of group improvement discussion** to avoid future misinterpretations of the suggested improvements and prevent the need to revisit what was already discussed at future meetings.

Practical Implementation Tips

Improvement Evaluation

Should We Do Improvement Evaluations?

Include the Improvement Evaluation step if:

- ✓ **You intend to produce a detailed action plan** based on your assessment results.
- ✓ **You are seeking a structured methodology** for narrowing down a long list of candidate improvements them down to a shorter list.
- ✓ **You want to tap in to the experience of your assessment team members** to consider potential impacts versus level of effort and anticipated challenges for the improvements you have identified.

Consider skipping this step if:

- **You do <u>not</u> intend to produce a detailed action plan** or specific list of improvements for implementation.
- **The improvements you have identified are <u>not</u> specified in enough detail** to enable an evaluation.
- **You anticipate that resources needed for implementation will <u>not</u> be available** for several years – and detailed improvement evaluation considerations may change before implementation is possible.
- **Participant fatigue is building during benchmarking and improvement selection discussions** – for example, due to unforeseen assessment complexities or scheduling challenges.

Practical Implementation Tips

Summarizing & Communicating Results

Supplemental Assessment Summary and Action Planning Resources

- **TAM Data Assessment Results and Action Plan Spreadsheet Tool** – use this during the group assessment and action planning meetings.

  1) Group Consensus

  The Group Consensus worksheet allows you to export, consolidate and present group assessment outcomes, including:
  - Current and desired state for each of the assessment elements – both individual ratings and group consensus ratings.
  - Proposed improvement actions.
  - Notes taken on the ratings and improvement ideas.

  2) Action Planning

  The Action Planning worksheet allows you to capture suggested actions and associated implementation details, including:
  - Action descriptions and the assessment gaps they are intended to address.
  - Anticipated benefits, implementation priorities, and challenges.
  - Designated implementation leads, targeted completion dates, current status and any dependencies or blockers, or other notes.

- **TAM Data Assessment Results and Action Plan Presentation Template**– use this for final assessment team meeting(s) and follow-up communication to agency leadership to:
  - Provide an overview of the assessment context, objectives, participants and approach.
  - Communicate assessment themes, outcomes, and proposed actions.
  - Share detailed implementation plans.

Appendix B. Research Implementation Experience Summaries

Four of TAM Data Assessments completed through this research implementation project are documented for future research implementors. These research experience summaries document the following assessment experiences.

Agency	Assessment	Scope	General Approach
NHDOT	**Bridge Preservation Program Assessment**	Evaluate data and information system usage in the NHDOT Bridge Preservation Program to identify potential improvements that would bring data-informed decision-making processes more in line with bridge rehabilitation and replacement decision-making, including considerations for project design and asset management system integration. This was a full assessment of all 51 assessment elements, including offline, individual assessment prior to targeted group consensus building discussions and included development of an implementation action plan.	• Included all Assessment Elements • Began with Individual Assessments • Followed by Group Consensus Discussion • No Improvement Evaluation • Included Action Plan Development
NMDOT	**TAM Project Evaluation Program Assessment**	Assess a newly implemented TAM Project Evaluation Program established to prioritize TAM related project investments with the objective of identifying where the new program may benefit from data and system improvement. This was a group assessment of targeted assessment elements, focusing on development of a general action plan for future implementation.	• Targeted Elements (in reverse order) • Conducted as a Group Assessment • No Improvement Evaluation • Included Action Plan Development

Agency	Assessment	Scope	General Approach
VDOT	**Highway Maintenance Management System (HMMS) Assessment**	Examine VDOT's maintenance management system to identify how current functionality can be expanded to support broader asset management of roadside assets. Structured as a group assessment approach of targeted assessment elements to produce an action plan that would support future, expanded use of the system to new asset programs and use cases.	• Targeted Elements (in reverse order) • Conducted as a Group Assessment • No Improvement Evaluation • Included Action Plan Development
	Pavement Management Program Assessment	Evaluate data and information usage in VDOT's pavement management program to identify opportunities for advancement, with no specific concerns or focus for improvement. This was a full assessment of all 51 assessment elements, including offline, individual assessment prior to group consensus building discussions and included development of an implementation action plan.	• Included all Assessment Elements • Began with Individual Assessments • Followed by Group Consensus Discussion • No Improvement Evaluation • Included Action Plan Development

These research implementation experience summaries are provided below and are also available through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

New Hampshire DOT: Bridge Preservation Assessment

Group Assessment
(w/ Individual Assessments)
General Action Plan

The New Hampshire DOT (NHDOT) was interested in improving their data and information systems to enable better alignment between bridge preservation decision-making approaches with those used for bridge rehabilitation and replacement.

This assessment was conducted in anticipation of advancements in data and modeling detail and better integration of bridge asset management and bridge design systems and models. At the time of the assessment, a new bridge management system was being implemented, presenting a unique opportunity to advance data and information system practices.

Step 1: Assessment Planning

NHDOT's bridge functions are executed from the Central Office, with primary bridge preservation program responsibilities split between the Bridge Design and Bridge Maintenance Bureaus. The leadership of these bureaus formed the assessment core team, and they selected key staff from their respective units to participate in the assessment.

Step 2: Benchmarking and Improvement Selection

A 60-minute kickoff meeting introduced participants to the assessment context, framework and approach. All 51 elements were included in the assessment and participants completed individual assessments prior to group consensus building.

The time and effort required to complete individual assessments did not allow for full group discussion of each element. Instead, only elements with significant disparity of opinion or need for improvement were discussed. Three, 90 minute benchmarking meetings were required.

Step 3: Evaluation and Implementation Action Planning

Individual improvements were not evaluated. A single 90-minute meeting was used to confirm assessment outcomes and proposed actions.

Step 4: Closeout and Next Steps

A summary presentation captured the assessment context, process, outcomes and a general action plan. These materials were finalized with offline review by the assessment sponsor.

Sponsor

Nicholas Alexander
Asset Management Administrator

Core Team

Loretta Doughty
Bridge Design Lead

Steve Johnson
Bridge Maintenance Lead

William Duke
Consultant Facilitator

Participants

David Scott
In-House Design

Aaron Janssen
In-House Design (Data & Systems)

Nicholas Goulas
Existing Bridge Section

Tim Boodey
Bridge Maintenance (Annual Scheduling)

Dave Gaylord
Bridge Asset Eng.

Sue Guptill
CADD Design

Angela Hubbard
Bridge Design Manual

Ken Morrison
Bridge Inspection

Assessment Experience:

The assessment was complicated by scheduling challenges, stemming from the higher-than-anticipated level of effort required to complete the individual offline assessments and subsequent group discussions. As a result, there were significant delays between meetings, which resulted in participant fatigue and some inefficiencies due to need to revisit previous group discussion outcomes.

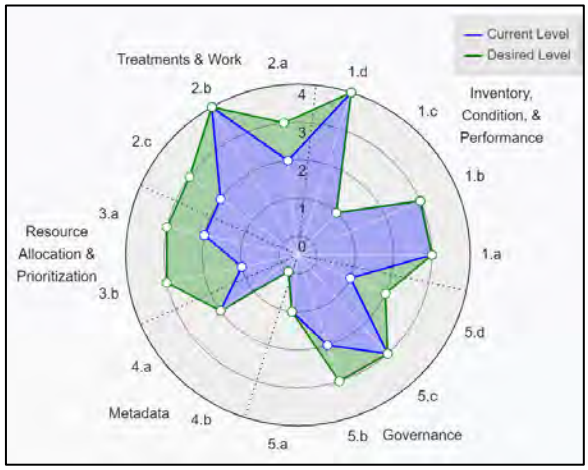
Assessment Findings:

The assessment produced meaningful benchmark ratings, improvement recommendations, and an improvement plan that can be used to guide future actions. Assessment benchmark ratings and identified potential improvements are summarized by area.

Area A: Specify and Standardize Data

Benchmarking

- Clear bridge inventory and condition data models
- Excellent location referencing
- Lack of alignment between work and treatment data models
- No standard methodology to identify preservation investment candidates



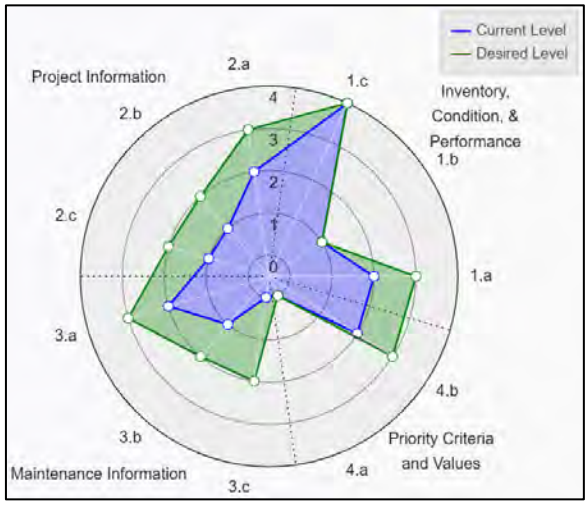
Potential Improvements

- Align bridge data models with data collection
- Document lifecycle planning methodologies

Area B: Collect Data

Benchmarking

- NBI data collection meets base needs
- Project and maintenance data collection needs improvement
- Lack of clear roles and standard activities for data quality management



Potential Improvements

- Consider additional element-level data collection (for additional use cases)
- Align work accomplishment and treatment history in various systems
- Define data quality management roles, activities, and expectations

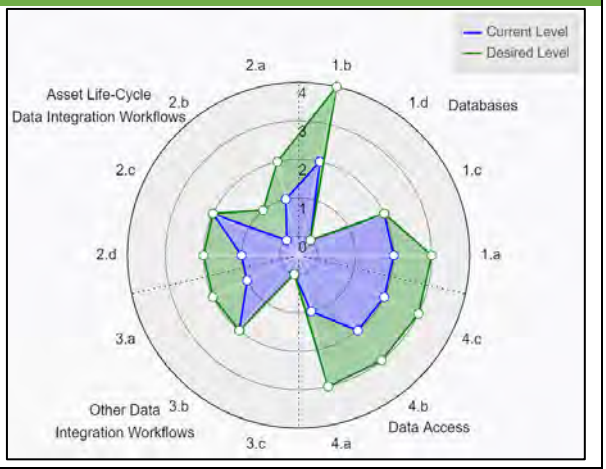
Area C: Store, Integrate, and Access Data

Benchmarking

- Barriers to access of asset databases, tools, and reporting
- Significant data integration needs across asset management and design systems
- Lack of mobile tools for field staff

Potential Improvements

- Integrate systems and data
- Provide training to stakeholders



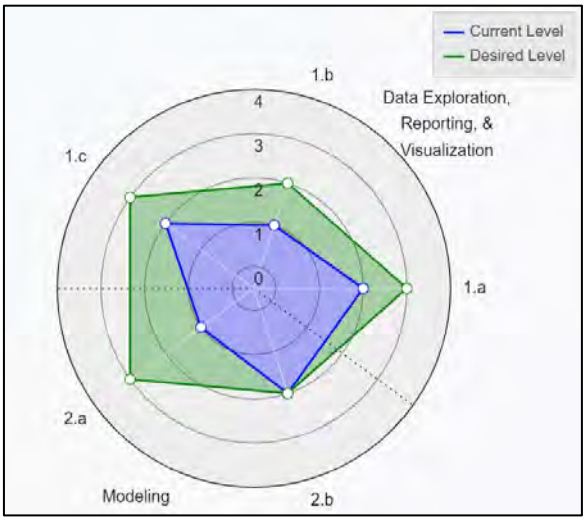
Area D: Analyze Data

Benchmarking

- Lots of data, but not in a single, easy-to-access location for analysis
- Planned and completed work is not incorporated into maintenance and preservation analysis
- Lack of trust in modeling outcomes

Potential Improvements

- Provide authoritative data for reporting and standard BI tools
- Document performance-based bridge modeling and analysis methodologies
- Provide training to stakeholders



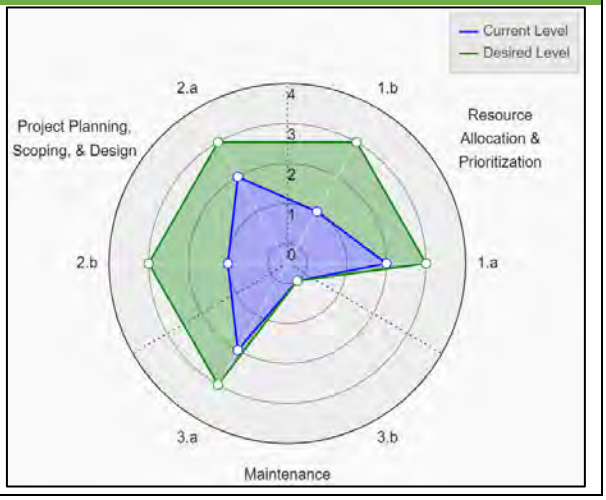
Area E: Act on Data

Benchmarking

- Lack of performance-based decision approaches accounting for work history and plans
- Desire for real-time monitoring

Potential Improvements

- Document performance-based bridge modeling and analysis methodologies
- Implement a performance-based preservation program
- Provide training to stakeholders



Proposed Actions:

Proposed Action	Description
Document Current Inventory and Inspection Processes	Engage subject matter experts to create mid-level process documentation describing current bridge inventory and inspection practice. Identify key roles and responsibilities, as well as systems, tools, and data sources used in each step. Reference detailed policy, practice, and guidance documentation (e.g., Bridge inspection manual, BMS standard operating procedures) as appropriate. Flag gaps in formal documentation.
Document Current Maintenance and Preservation Accomplishment Tracking Processes	Engage subject matter experts to create mid-level process documentation describing current practices relating to bridge maintenance and preservation work accomplishment tracking. Identify key roles and responsibilities, as well as systems, tools, and data sources used in each step. Reference detailed policy, practice, and guidance documentation (e.g., Bridge Activity Log user guidance or BMS standard operating procedures) as appropriate. Flag gaps in formal documentation.
Document Current Maintenance and Preservation Planning Processes	Engage subject matter experts to create mid-level process documentation describing current practices relating to bridge maintenance and preservation work planning. Identify key roles and responsibilities, as well as systems, tools, and data sources used in each step. Reference detailed policy, practice, and guidance documentation (e.g., BMS standard operating procedures) as appropriate. Flag gaps in formal documentation.
Catalog Current Bridge Systems and Data Sources	Create a consolidated catalog of bridge systems, tools, and data sources. Identify what data is collected, integrated, and used in each system or data source. Identify authoritative source systems of record and authoritative sources for reporting or analysis of key data. As appropriate, share the catalog(s) or other documentation to improve awareness and access to bridge systems and data.

Proposed Action	Description
Map Data Flow and Identify Integration Recommendations	Build from process documentation and the bridge system and tool catalog to map how key data flow from initial collection through various systems, access points, analysis tools, and reports. Identify opportunities to standardize and integrate data across these systems, tools, and data collections, with particular consideration of potential integrations to: - Streamline manual business processes to update asset inventory and condition data based on project and maintenance work accomplishments (e.g. BMS and Bridge Activity Log integration) - Capture bridge related work/treatment history, project costs and bridge IDs on multi-bridge projects - Ensure data is available in key analytical systems (e.g. DTIMS, WOFI, BMS) to support expert analysis and reporting - Streamline maintenance treatment and preservation project candidate selection and prioritization
Align Bridge Data Models and Collection	Update asset inventory, condition, and work/treatment data models in key systems to ensure alignment and support integration. Update or create data dictionary and/or glossary documentation necessary to support understanding and use. Adjust data collection practices accordingly. Inventory and Condition Data Models: Consider detailed element-level data needs (e.g., on joints, bearings, criticality of certain defects). Evaluate opportunities to incorporate conditions captured as part of Bureau of Bridge Maintenance studies (e.g., deck evaluations). Consider dTIMS / WOFI implementation needs. Work and Treatment Data Model: Ensure alignment of work history / treatment data models between ProMIS, BMS and Bridge Activity Log to support consistent capture of key treatment and work history related data elements (e.g., capture bridge related project costs and accurately associate bridge IDs and work accomplished on multi-bridge projects). Consider dTIMS / WOFI implementation needs.
Integrate Project and Maintenance Treatment Data Across Systems	Create business requirements and supporting IT requests for integration of project and maintenance treatment data and systems, including: - ProMIS with Bridge Activity Log: improve capture of work/treatment history - Bridge Activity Log with BMS: incorporate key work history data into BMS - WOFI with BMS: incorporate maintenance work into work/treatment history - DTIMS: integrate systems necessary to support expert analysis and reporting

Proposed Action	Description
Master Bridge Data of Enterprise Interest	Document enterprise use cases for critical bridge data, including high-level Bridge Preservation program reporting or analysis. Establish easy to understand and analyze data formats meeting key enterprise use cases. Work to extract, transform, and load data from authoritative sources into to the enterprise data warehouse for enterprise access and use. Document as appropriate per broader agency policy and practice.
Develop Performance-Based Bridge Deterioration Models	Utilize available data, internal subject matter experts, available research, and case studies/examples from other dTIMS implementations to develop NHDOT bridge deterioration models suitable to available tools and identified needs. Ensure alignment of deterioration model with Bridge Inventory and Condition Data Models (and associated asset breakdown structure). Document analysis and decision-making related to model development.
Develop Performance-Based Bridge Treatment Models	Utilize available data, internal subject matter experts, available research, and case studies/examples from other dTIMS implementations to develop NHDOT bridge treatment cost/benefit and treatment selection models suitable to available tools and identified needs. Ensure alignment with Bridge Treatment and Work Data Models as well as Bridge Inventory and Condition Data Models (and associated asset breakdown structure). Document analysis and decision-making related to model development.
Implement Bridge Performance Models in dTIMs	Configure DTIMS to incorporate developed models. Test modeling and performance prediction outcomes for validity and reasonableness. Adjust models as appropriate or necessary, incorporate changes into modeling development documentation and update system configuration documentation.
Document Lifecycle Planning Analysis Methodology	Document how DTIMS can be used to conduct network-level lifecycle planning analysis, compliant with key state, federal, or other needs. Establish approach where key analysis parameters and factors are applied to develop meaningful outcomes. Document sources for analysis parameters and factors (e.g., performance constraints, financial constraints, planned/completed work). Ensure outcomes are useful to identify optimal bridge maintenance and preservation investments.
Plan Implementation with Stakeholder Engagement	Develop an implementation plan, which will progressively incorporate and formalize a performance-based, lifecycle planning approach to the Bridge Preservation program. This may include a pilot implementation to generate lessons learned and develop practical experience to support stakeholder engagement.
Implement a Full-Scale, Performance-Based Preservation Program	Execute the develop plan to progressively incorporate and formalize the lifecycle planning and performance-based decision-making into the Bridge Preservation program.

Optional Actions:

Optional Action	Description
Close Current Documentation Gaps	Engage subject matter experts to create detailed documentation necessary to close documentation gaps identified through the inventory, inspection, and maintenance and preservation planning and accomplishment tracking process documentation activities. As detailed documentation is developed, adjust process documentation to reference the new materials.
Develop Bridge Preservation Data Mart	Create a Bridge Preservation Data Mart to serve as a "one-stop-shop" for enterprise reporting and/or analysis of the Bridge Preservation program (e.g., summary of needs, performance measures and targets, and accomplishments as well as other identified use cases). Implement necessary data transformation, aggregation, summary, etc. and provide standard reporting. Support with necessary training materials to raise awareness and understanding of the Data Mart's use.
Develop a Public Facing Website or Dashboard	Develop a consolidated, public, bridge program website that meets program needs for public data access. Incorporate preservation program as appropriate.
Align Project-Level Preservation Decisions with Lifecycle Planning	Establish standard approach and expectations for application of network-level DTIMS lifecycle planning analysis to project level decision-making. Consider future target setting and monitoring needs as part of initial implementation.
Pilot the Performance-Based Preservation Approach	Apply DTIMS tools and the identified methodologies to pilot practical application of bridge lifecycle planning analysis in bridge preservation resource allocation, project-level investment decisions and program performance targeting. Adjust methodologies to support practical applications, document lessons learned, create supporting training and communication materials leveraging lessons from the pilot.

New Mexico DOT: Project Evaluation Assessment

Targeted Group Assessment
(no Individual Assessments)
General Action Plan

New Mexico DOT (NMDOT) had recently implemented a new data-driven methodology to prioritize proposed capital projects.

They wanted to use the assessment to identify data and information system improvements to advance and sustain District implementation of the new approach and prioritization outcomes.

Step 1: Assessment Planning

TAM program leaders and staff in the NMDOT General Office formed the core team members involved in the assessment.

District leaders were engaged to identify assessment participants representing each District.

The core team also identified support staff (for example, in IT) to be consulted (as needed) during the assessment.

Step 2: Benchmarking and Improvement Selection

A 60-minute kickoff meeting introduced participants to the assessment context, framework and approach.

Targeted assessment elements were confirmed, and two, 90-minute group benchmarking meetings were scheduled and held over the next two weeks.

The group assessment began with selected elements in Area E (Act on Data) and proceeded in reverse order to Area A (Specify and Standardize Data).

Benchmark ratings and supporting notes were emphasized over element-specific detail improvement selections.

Step 3: Evaluation and Implementation Action Planning

The Improvement Evaluation step was not included. Instead, the facilitator produced an assessment summary presentation and worked with the core team to consolidate and select proposed improvement actions. A single 90-minute meeting was used to confirm outcomes and proposed action plans.

Step 4: Closeout and Next Steps

A summary presentation captured the assessment context, process, outcomes and proposed actions. This presentation finalized with a final review by the assessment sponsor.

Sponsor

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Assessment Experience:

The assessment was significantly streamlined by incorporating lessons learned from previous research implementation and TAM data assessment experiences. Key adjustments included:

- Use of a group assessment and discussion approach, dramatically reducing time and effort required by participants to complete initial, offline, individual assessments.
- Targeting of assessment elements – focusing only on elements directly aligned with the assessment objective and context.
- A weekly meeting cadence – from kickoff through assessment closeout.

The assessment could have been further improved by having core team members provide a comprehensive overview of the current TAM project evaluation program, processes, and tools. This would have provided a common baseline understanding across all participants prior to the assessment and action planning discussions.

Assessment Findings:

The assessment results were positively received by the participants. NMDOT staff appreciated that the assessment inspired big picture discussions among participants and that it yielded improvement recommendations that would not have originally be considered by the group. Assessment participants were also pleased that the process allowed for detailed technical needs to be identified and discussed.

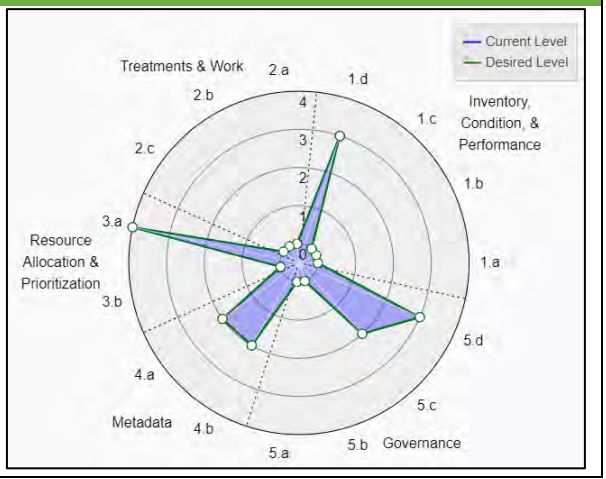
Area A: Specify and Standardize Data

Benchmarking

- Clear data models
- Excellent location referencing
- Formal metadata
- Established governance processes

Potential Improvements

- No significant needs



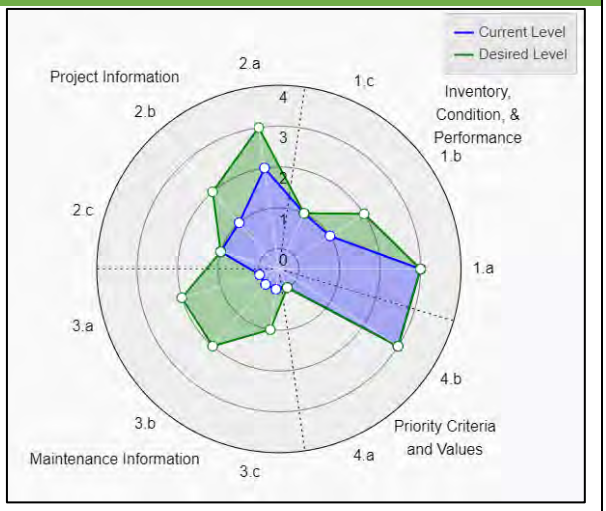
Area B: Collect Data

Benchmarking

- Clear, but manual data collection processes
- Current tools would be difficult to scale for network-wide data collection

Potential Improvements

- Automate and integrate processes to reduce effort
- Shift to network-level collection and analysis



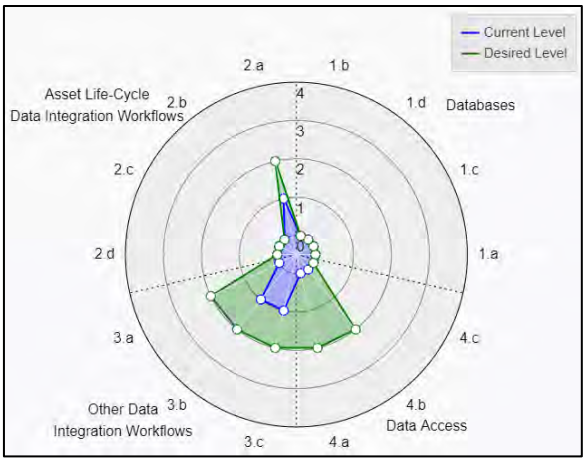
Area C: Store, Integrate, and Access Data

Benchmarking

- Manual data integration processes
- Need better tools to communicate priorities to stakeholders
- Desire to expand prioritization input

Potential Improvements

- Automate eGIS data integration
- Evaluate targeted data for inclusion in prioritization approach
- Provide map-based summaries and a website to share outcomes



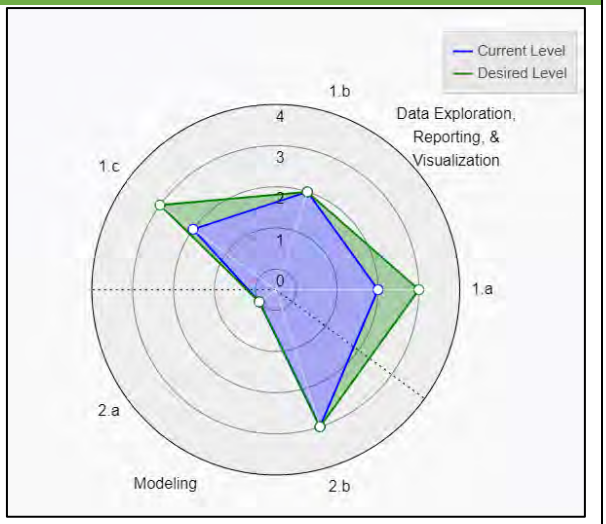
Area D: Analyze Data

Benchmarking

- Manual data analysis process supported by spreadsheet tools
- Lack clarity on the effective dates for individual data involved in the analysis

Potential Improvements

- Provide map-based summary and reporting to improve visualization
- Automate analysis to reduce effort and support scaling
- Document input data effective dates



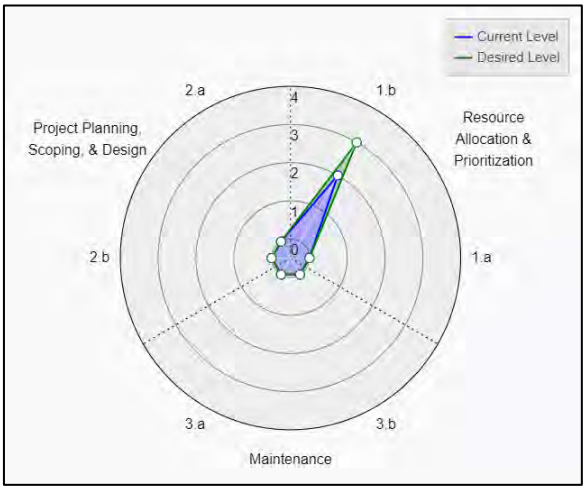
Area E: Analyze Data

Benchmarking

- Inconsistent understanding of process across stakeholders
- Inconsistent implementation across Districts

Potential Improvements

- Dedicate resources for District training and change management
- Provide context to support understanding of prioritization results
- Integrate results into statewide resource allocations



Proposed Actions:

Action	Description
Resource District Training and Change Management	Establish a clear, common vision and motivation for CAR Form application. Provide resources to support District training and implementation. Encourage adoption of the CAR Form and prioritization outcomes into District business. Ensure understanding of the overall process, methodology and tools. Document District roles in intended applications of the CAR Form to the District business process. Support change management, including improvement of statewide resource allocation and project prioritization methods. Provide practical use case examples or success stories from various applications or user contexts (e.g., distributing funds to Districts (regular and special funds), prioritizing the "shelf" projects, supporting public engagement meetings, evaluating the full STIP). Get District Engineer buy in to proposed roles before broader engagement.
Implement a Continuous Improvement Process	Establish responsibilities to gather information regarding statewide use of the prioritization outcomes and supporting tools and business processes. Capture lessons learned and implement prioritized improvement recommendations. Include regular evaluation available/desired data and data collection, analysis, and reporting processes, as well as regularly engage District stakeholders, key system owners and data stewards to identify issues, lessons learned, best practices, and improvement opportunities.

Action	Description
Develop Integrated, Web-Based Project Data Collection Form	Engage District stakeholders to implement CAR form as a web-based electronic form, with direct integration into central data/form repository. Design form to simply project identification by District staff and include features for Central Office update/population of supporting data and prioritization outcomes.
Develop Map-Based Webpage and/or App	Create map identifying relative priorities of various project and/or network locations evaluated through CAR Form process. Include views useful for field and/or public access. Share supporting materials (e.g., process overview or policy) for public reference.
Evaluate Prioritization Methodology	Engage stakeholders to evaluate current prioritization methodology and outcomes for potential improvement considering current data quality and timeliness, potential to expand the prioritization to provide network-level coverage, new or improved data sources, and a sensitivity analysis of theoretical and actual prioritization outcomes.
Integrate and Adjust Prioritization Methodology	Make technical improvements to incorporate additional data sources and to support streamlined data integration, analysis, and reporting - including changes necessary to make data available in eGIS for reference in the CAR Form. Incorporate any adjustments into regular District outreach and communication. Ensure appropriate training prior to implementation.
Automate Data Integration, Analysis and Summary	Integrate CAR form and supporting tools (e.g., web maps, electronic formwork, prioritization analysis tools) with eGIS to automate collection and summary of project-specific prioritization input and to streamline and automate analysis process and outcomes. Incorporate any adjustments into regular District outreach and communication. Ensure appropriate training prior to implementation.

Virginia DOT: HMMS System Assessment

Targeted Group Assessment
(no Individual Assessments)
General Action Plan

Virginia DOT (VDOT) implemented a new maintenance management system (HMMS) The system is currently used primarily for work order management. VDOT management were interested in exploring potential extensions to HMMS to support additional asset management functions. They used the assessment process to identify gaps in system capabilities, standards, or governance that could be addressed to support expanded future HMMS functionality and use.

Step 1: Assessment Planning

Participants were selected based on their current level of HMMS use and involvement. Three Districts were represented, including both urban and rural perspectives. District HMMS power users were involved, as was one additional user per District, selected for their unique and informed perspective.

Based on input from the assessment sponsor and HMMS business lead, the assessment was targeted to a subset of elements that were of greatest importance to the current and anticipated functions and applications of the system.

Step 2: Benchmarking and Improvement Selection

A 60-minute kickoff meeting introduced participants to the assessment context, framework and approach. The targeted assessment elements were confirmed, and two, 90-minute group benchmarking meetings were scheduled. The assessment was completed beginning with selected elements in Area E (Act on Data) and working backwards to Area A (Specify and Standardize Data).

Step 3: Evaluation and Implementation Action Planning

Potential improvement actions were identified but not formally evaluated using the TAM Data Assistant. The facilitator produced an assessment summary presentation and worked with the core team to consolidate and select proposed improvement actions. A single 90-minute meeting was used to confirm outcomes and proposed actions.

Step 4: Closeout and Next Steps

A summary presentation captured the assessment context, process, outcomes and proposed actions. This presentation was finalized with management input.

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District Project Mgmt. Engineer

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Information Technology

Assessment Experience:

The assessment was complicated both by the broad context of the assessment and by the fact that the HMMS was a relatively new system, used in business areas and processes that are still evolving at VDOT. For many assessment elements, this made specific technical improvement actions difficult to identify. Instead, the assessment identified general functionality areas to be explored through future efforts scoped to take a deeper dive into both user requirements and HMMS customization/configuration capabilities and limitations.

Assessment Findings:

Overall, the assessment confirmed that there were significant opportunities to both build knowledge and awareness of current capabilities as well as explore new system enhancements. Current and desired state practice benchmarks, as well as key themes and potential improvement actions are summarized by area.

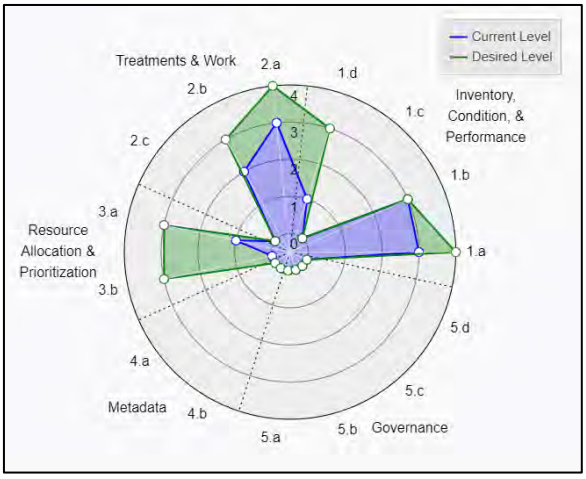
Area A: Specify and Standardize Data

Benchmarking

- Data models for inventory, condition, and work data are not standardized
- Limited capabilities to track linear assets and associated asset data
- Inconsistent understanding of analysis methodologies deployable within the system

Potential Improvements

- Establish formal standards and document supported methodologies
- Provide expanded capability to track linear assets and associated asset data



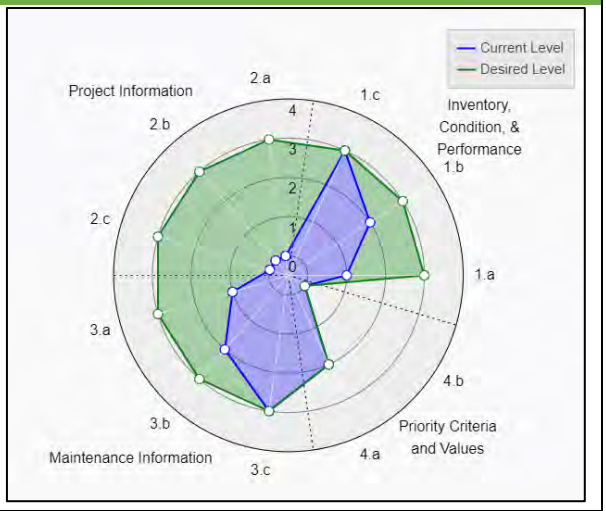
Area B: Collect Data

Benchmarking

- Standard QC/QA capabilities of the system are unclear
- Challenges with field connectivity

Potential Improvements

- Document asset data tracking and entry control capabilities
- Document asset data quality management capabilities (e.g., automated issue flagging and reporting, quality review workflows)



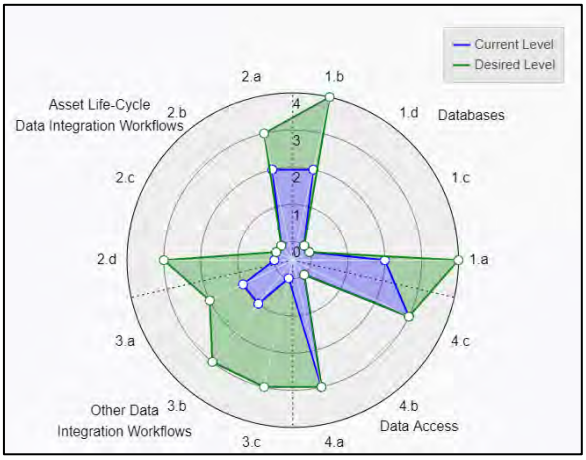
Area C: Store, Integrate, and Access Data

Benchmarking

- Barriers to enterprise access to HMMS data for reporting and analysis
- Inconsistencies with other system and contract data
- Gaps in supporting data

Potential Improvements

- Document existing integrations and data integration capabilities
- Integrate prioritized external datasets
- Add HMMS data to data warehouse



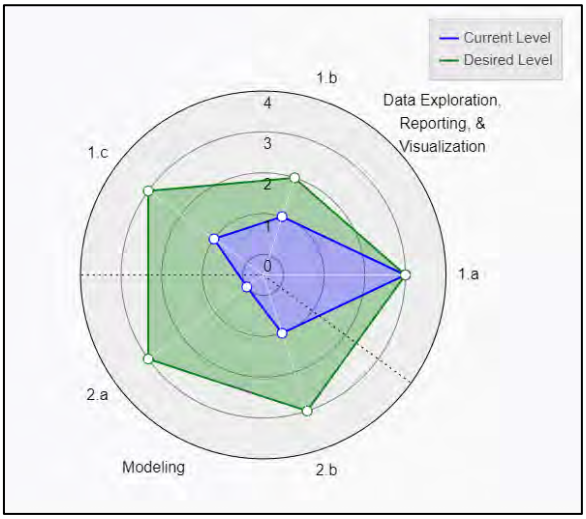
Area D: Analyze Data

Benchmarking

- Performance analysis capabilities are not fully aligned with desired decisions
- Need more user-friendly, accessible reporting
- Lack of understanding of and trust in analysis outcomes

Potential Improvements

- Document asset needs analysis and work prioritization capabilities
- Support standard reporting and analysis configuration and update



Area E: Act on Data

Benchmarking

- System not currently supporting full range of asset maintenance decisions.
- Lack of understanding of the systems decision-support tools and capabilities

Potential Improvements

- Improve alignment of analysis results with desired decisions
- Document and share decision-making best practices

Proposed Actions:

Action	Description
Document HMMS Inventory Tracking Capabilities	Document current HMMS capabilities and limitations for inventory data tracking, specifically addressing both "spot assets" (single point location) and "non-spot assets" (linear or area-based locations), addressing known needs, including: 1) spatial location referencing capabilities and data model requirements 2) LRS location referencing capabilities and data model requirements 3) multi-component asset modeling capabilities and limitations 4) inventory data processing/summary capabilities (e.g. roll up of data across components or elements into general asset classifications) 5) automated updates to inventory based on treatment/work history 6) office and field-based asset inventory management capabilities and limitations (create, read, update, and delete) Define process to create/update asset data model, define any automated processing/calculations and associated HMMS configuration steps. Provide templates and other standard documentation to support established processes.
Document HMMS Condition Tracking Capabilities	Document current HMMS capabilities and limitations for condition data tracking, addressing known needs for: 1) observations where asset inventory is not currently available 2) detailed, multi-component condition assessment limitations 3) condition data processing/summary capabilities (e.g. process detailed assessment information into summary measures (G/F/P, deficient/non-deficient) based on pre-defined rules) 4) combining observation capabilities (e.g. combining multiple assessments over time based on pre-defined rules) 5) segmentation of "non-spot" assets (e.g. assessment of a particular stretch of road but not a single point) 6) automate updates to condition data based on treatment/work history 7) office and field-based asset condition management capabilities and limitations (create, read, update, and delete)

Action	Description
Document HMMS Asset Treatment and Work Tracking Capabilities	Document current capabilities and limitations for treatment and work tracking, addressing known needs for: 1) standardizing asset activities and associated data collection 2) relating work to financials, equipment, employee, and organization 3) capturing work order relationships to one or more assets or locations 4) quantifying work on assets that are not inventoried 5) updating inventory or condition information based on work data 6) work summary capabilities (e.g. statewide performance measures, roll up detailed assessment information based on pre-defined rules) 7) defining default or recurring work schedules 8) identifying treatment recommendations based on inventory or condition data 9) office and field-based asset condition management capabilities and limitations (create, read, update, and delete)
Document HMMS Data Quality Management Capabilities	Document current capabilities and limitations to support standardized data quality management approaches, addressing known needs for: 1) Data validation and controls on initial data entry 2) QA/QC Analysis, Flagging, Updates through: - simple data quality rules - relational data quality rules - dataset level validations - location validation rules (spatial or location referencing-based) - workflow/timeliness rules 3) Regular data quality review and acceptance business processes
Identify HMMS Data Integration Capabilities	Document current capabilities and limitations for data integration, addressing known needs for: 1) non-HMMS asset inventory or condition data sources (e.g. ArcGIS Online/Portal apps, other systems, Interstate MRP) 2) non-HMMS planned work (e.g. paving schedules, SYIP, on-call contracts) 3) budget/allocation/expenditure data and chart of accounts (e.g. financial master data, Cardinal) 4) customer service center requests 5) other data (e.g. traffic, crash, functional classification)
Document HMMS Data Reporting Capabilities	Document current capabilities and limitations for data integration and reporting. Address known needs, such as internal user and enterprise data consumer reporting of: 1) inventory and/or component detail data 2) condition summary and/or detail condition data 3) work summary and/or detail work data 4) combined reporting of HMMS inventory, condition, and work history 5) quality management related data 6) data accessibility for enterprise reporting

Action	Description
Identify HMMS Analysis and Prioritization Support Capabilities	Document current capabilities and limitations to support asset needs analysis and work prioritization. Specifically address current applications and known needs, including: 1) using inventory and condition data to calculate relative priority (e.g., Low/Medium/High/Critical priorities) 2) incorporating past work accomplishments and planned work to adjust priorities 3) apply external data (e.g., network, traffic, crash data) to establish asset priorities 4) creating and applying lifecycle or condition/performance forecasting models to identify needs 5) comparing condition or work against established performance targets (by asset, by work type, by District or system, etc.) 6) leveraging external data analysis and business intelligence tools
Identify HMMS Decision-Support Support Capabilities	Document current capabilities and limitations to support asset or work prioritization. Specifically address current applications and known needs, including: 1) connecting decisions to maintenance performance measures 2) aligning HMMS decisions to available funding 3) identifying meaningful work priorities 4) monitoring asset lifecycle 5) estimating network-level needs (statewide, District-specific)
Develop HMMS Stakeholder Engagement Materials	Consolidate current capabilities documentation, related process documentation and supporting templates, examples, and instructions to support future asset data modeling by asset data stewards or similar business staff. Develop user engagement materials (e.g., HMMS use case vignettes/case studies, presentations, checklists, SharePoint sites) to support information sharing and access to support materials. Engage asset stewards and other motivated stakeholders to explore application of engagement material application to identify and develop specific system use cases. Work with these stakeholders to ensure and expand the usefulness of the materials and understand typical next steps (e.g., system configuration, IT support requests) and expand these materials as necessary to support anticipated activities.
Provide Stakeholder Engagement and Training	Leverage engagement materials to provide stakeholder training (through workshops, virtual meetings, etc.) necessary to raise awareness of HMMS capabilities and use expectations. Share current system capabilities, encourage active use and self-service (as applicable), and highlight opportunities and processes to expand system capabilities towards additional use cases.

Action	Description
Resource and Support Ongoing Use Improvement	Dedicate staff time and additional resources necessary to support requests for HMMS configuration and/or additional information sharing generated through stakeholder engagement. Regularly check in with asset stewards, system users, and district management to proactively identify user needs.

Virginia DOT: Pavement Management Assessment

Group Assessment
(w/ Individual Assessments)
General Action Plan

Virginia DOT (VDOT) has a long standing and high functioning Pavement Management program. This program is organized around a well-established pavement management system (PMS) and pavement maintenance scheduling system (PMSS). These systems are used by Central Office and District staff to forecast pavement conditions, allocate resources, and plan targeted preventative, corrective, and restorative maintenance projects.

Although VDOT staff were confident in their high-performing program, they were motivated to identify if further advancement would be possible through data and/or system improvements.

Step 1: Assessment Planning

Participants were selected based on their involvement in annual pavement condition data collection, pavement management system oversight, and pavement maintenance planning and contract development. Two District pavement managers were included, as were IT staff supporting key systems and tools.

Step 2: Benchmarking and Improvement Selection

A 60-minute kickoff meeting introduced participants to the assessment framework and tools. Offline, individual assessment responsibilities were assigned and 2-weeks allowed for completion. Group consensus discussion was led using the TAM Data Assistant's group assessment facilitation features. The facilitator guided discussion and recorded outcomes directly into the tool during the three 90-minute meetings required to complete all 51 elements.

Step 3: Evaluation and Implementation Action Planning

Individual improvements were not evaluated, instead the facilitator produced an assessment summary presentation and worked with the core team to consolidate and select proposed improvement actions. A single 90-minute meeting was used to confirm outcomes and proposed actions.

Step 4: Closeout and Next Steps

A final presentation was developed to present the assessment process, outcomes, and proposed actions. This presentation was reviewed with management prior to finalization.

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Assessment Experience:

The assessment outcomes and recommendations met VDOT's business needs and the closeout materials are expected to be very useful to support future implementation. Participants raised concerns regarding the level of effort required to complete initial individual assessments – recommending that future assessments skip offline, individual contributions and proceed directly into group assessment and consensus building discussions.

Assessment Findings:

Overall, the assessment confirmed that the data and information systems supporting VDOT's pavement management program are high performing and largely meeting VDOT's business needs.

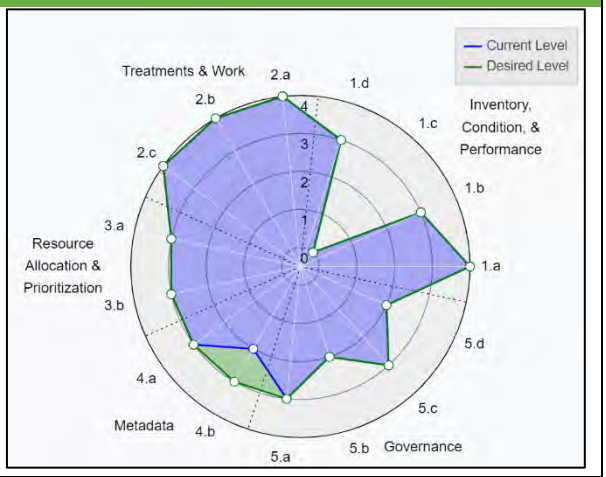
Area A: Specify and Standardize Data

Benchmarking

- Clear models for pavement inventory and condition data.
- Excellent location referencing

Potential Improvements

- Establish formal metadata in alignment with broader agency standards



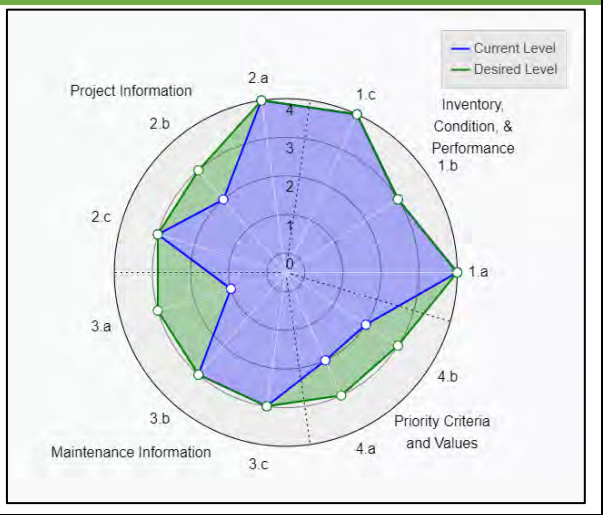
Area B: Collect Data

Benchmarking

- PMS data collection aligns with needs

Potential Improvements

- Improve project data collection for work accomplished on construction projects
- Evaluate detailed maintenance work order data needs and examine the feasibility to capture this data through the HMMS (VDOT's maintenance management system)



Area C: Store, Integrate, and Access Data

Benchmarking

- Barriers to field access of PMS and PMSS data
- Limited business data integration

Potential Improvements

- Improve PMS-PMSS data exchanges
- Integrate other project related systems into pavement management tools (e.g., Project Pool, Transport)

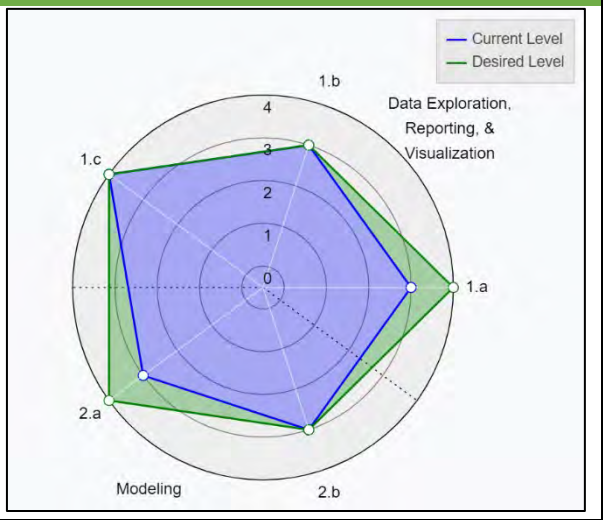
Area D: Analyze Data

Benchmarking

- PMS is a centralized tool that has standard and ad-hoc reporting features

Potential Improvements

- Develop master pavement data and make it available for access and analysis through agency business intelligence tools
- Incorporate pavement friction and network-level structure data into pavement deterioration modeling



Area E: Act on Data

Benchmarking

- High functioning, data-driven decision-making processes

Potential Improvements

- Incorporate new pavement management techniques into PMS and performance targeting (e.g., pavement recycling – FDR, CCPR, CIR, HIR)
- Consolidate various design models for easier reference during project-level pavement design

Proposed Actions:

Action	Description
Automate Construction Project Entry into PMS Master Work Program	Work with Six Year Improvement Program staff to automate identification of pavement related project. Establish methods to extract location, network-level treatment and project cost data necessary to program identified projects into the PMS Master Work Program. Work with IT to implement an automated data integration.
Evaluate Detailed Work Order Data Collection Needs	Work with HMMS staff to evaluate current and potential pavement maintenance data collection capabilities and uses. Develop business cases and associated requirements for HMMS data collection and integration with PMS where there are potential value. Pursue implementation as appropriate and cost-beneficial.
Leverage PMSS Replacement to Improve Field Tools and Data Integrations	Work with District Pavement Management Staff and BIS Division to develop business needs and requirements for the PMSS Replacement project. Incorporate identified needs for PMSS integration with PMS, Transport, and Project Pool. Also incorporate needs for improved field data access and collection tools.
Create and Support Master Data Management Solutions	Build from OIPI data request to identify critical agency use cases and requirements for reporting and analysis of pavement data. Propose a pavement management master data management solution which will meet enterprise needs. Work to master data based on developed requirements. Appoint a pavement management data steward support implementation and to lead data stewardship activities once the data is made available.
Evaluate Network-Level Friction and Structure Data Collection and Use	Build upon ongoing research to evaluate feasibility and use cases for network-level friction data and pavement structure data collections. Where feasible, initiate data collection, and configure PMS for data storage, reporting, and integration into available decision-support analysis and tools. Develop supporting training materials and engage District staff as part of implementation.
Incorporate Recycling Treatments into PMS Modeling and Targets	Incorporate new pavement recycling practices - such as FDR, CCPR, CIR, and HIR - into PMS treatment models and performance targeting and monitoring processes. Modify existing performance targeting processes to promote appropriate application of these treatments by District pavement management staff. Develop supporting training materials and engage District staff as part of implementation.
Continue to Maintain the Paving Schedule Development Process Documentation	Continue to support cyclical review and improvement of paving schedule development process documentation. Engage District stakeholders to identify pain points and work with VDOT subject matter experts to address process documentation needs as VDOT's systems, tools, and overarching contract development requirements continue to evolve. Provide recurring training to District staff.

Appendix C. Strategic Framework for TAM Data and Information Systems

The IADOT assessment resulted in the creation of a Strategic Framework for TAM Data and Information System Investments. This framework refines and refocuses the broader NCHRP Report 956 framework to show how potential data and information system capabilities do, or do not, align with three different asset management approaches: (1) a reactive management approach, (2) a cycle-based management approach, or (3) a condition or performance-based management approach.

The framework consists of a series of matrices, organized by tiered management approaches, linked to potential data and information system capabilities, which can be used to provide a structured approach to identify:

- What management approach is intended for your asset?
- What data is required, optional, or not needed for the approach?
- What data informed decisions are intended to be supported?
- What analytical methodologies should be in place?
- What data access and reporting capabilities are expected?
- How should data be stored and integrated?
- What data collection methodologies may be appropriate?

The developed framework materials are provided below and are also available for download through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

A supporting presentation was created to introduce the framework materials, describe the intended application and suggest implementation steps for future users. The presentation also includes an illustrative example application of the framework. This presentation is available through the NCHRP Project 08-115 website and the AASHTO TAM Data Guide.

Asset Management Approach Descriptions and General Asset Data Requirements

Approach		General Description of the Asset Management Apprach	Required Data		
			Inventory	Condition	Work
Condition-Based	**Advanced**	Condition is routinely monitored *and modeled*. Lifecycle planning is used to *forecast and optimize network-level condition* (e.g. min. cost, max. benefit or performance). Project-level performance-based treatments are recommended and *integrated with lifecycle planning analysis* to provide *District performance and investment targets*.	Network-wide, Asset-specific Inventory	Network-wide, Asset-specific Condition	Network-wide, Asset-specific Work History
	Minimum	Condition is routinely monitored. Lifecycle needs are identified based on current conditions. Project-level performance-based treatments are recommended and incorporated into District project selection processes.	Network-wide, Asset-specific Inventory	Network-wide, Asset-specific Condition	*Optional*
Lifecycle-Based	**Advanced**	An asset inventory and treatment histories are maintained. *Treatment history- or age-based approach to estimate network-level needs*. Track and *address issues arising outside lifecycle*. An asset *lifecycle strategies offer asset-specific treatment recommendations* aligned with current resource levels. *District investment targets are monitored*.	Network-wide, Asset-specific Inventory	*Optional*	Network-wide Asset-specific
	Minimum	A one time inventory extraction, sampling, or model is collected. Inventory-based approach to estimate network-level needs. An asset lifecycle model offers general treatment recommendations for consideration in project-level decisions.	One-Time Extraction or Sample	*Optional*	*Optional*
Reactive	**Advanced**	Methods in place to *screen network* and to *track and report critical issues and issue resolution*. *Issue backlog and/or observation rates inform resource allocation*. Annual work is planned at the aggregate level. District accomplishments are reported.	*Optional*	Network Screening for Critical Issues	Issue Resolution Tracked
	Minimum	No asset inventory or condition data is collected or maintained. Historical expenditures or similar means are used for resource allocation. Maintenance is performed when assets are identified as having an unacceptable defect.	*Optional*	*Optional*	*Optional*

Inventory Data Modeling and Specification Requirements (by Asset Management Approach)

Data Model Type		General Description of Key Capabilities	Reactive (minimum)	Reactive (advanced)	Lifecycle-Based (minimum)	Lifecycle-Based (advanced)	Condition-Based (minimum)	Condition-Based (advanced)
Inventory Data Models / Specifications	Asset Definition	Define the "asset" and determine if/how asset inventory data should be collected to support asset management practice.	**Required**	**Required**	**Required**	**Required**	**Required**	**Required**
	Asset Breakdown Structure	Identify specific asset "sub-types" or "components" useful in asset inventory and condition data collection and reporting, performance modeling and treatment selection, and other critical asset management functions.	*Optional*	*Optional*	**Required**	**Required**	**Required**	**Required**
	Base Inventory Data Model	Specify detailed inventory data elements for each asset, sub-type and component. Identify required, recommended, and optional data elements, as well as specific data types and formats.	*n/a*	*n/a*	**Required**	**Required**	**Required**	**Required**
	Detailed Information Model	Document a detailed asset information model facilitating direct integration of asset inventory with maintenance work orders and/or project files.	*n/a*	*n/a*	*n/a*	*Optional*	*n/a*	*Optional*

Condition Data Modeling and Specification Requirements (by Asset Management Approach)

Data Model Type		General Description of Key Capabilities	Reactive		Lifecycle-Based		Condition-Based	
			(minimum)	(advanced)	(minimum)	(advanced)	(minimum)	(advanced)
Condition Data Models / Specifications	Condition Data Definitions	Define various condition and performance data types applicable to the asset. Determine which data should be collected and their associated or anticipated collection methodologies.	*n/a*	**Required** (critical issues only)	*Optional*	**Required** (critical issues only)	**Required**	**Required**
	General Condition Categorization	Document general condition or performance groupings to support reporting and decision making. Set general criteria (e.g. condition ranges) for each grouping.	*n/a*	*Optional*	*Optional*	*Optional*	**Required**	**Required**
	Base Condition Data Model	Specify detailed data elements for each condition or performance data type. Identify required, recommended, and optional data elements, as well as specific data types and formats.	*n/a*	**Required** (critical issues only)	*Optional*	**Required** (critical issues only)	**Required**	**Required**
	Condition Evaluation Methodology	Establish detailed methodologies to evaluate asset condition or performance and its contribution to overarching agency strategic priorities.	*n/a*	*n/a*	*n/a*	*Optional*	*n/a*	*Optional*

Treatment and Work Data Modeling and Specification Requirements (by Asset Management Approach)

Data Model Type		General Description of Key Capabilities	Reactive (minimum)	Reactive (advanced)	Lifecycle-Based (minimum)	Lifecycle-Based (advanced)	Condition-Based (minimum)	Condition-Based (advanced)
Treatment and Work Data Models / Specifications	Work Definitions	Define what are considered "work accomplishments" for the asset. Determine what accomplishments should be tracked and their associated or anticipated collection methodologies.	*n/a*	**Required** (work on critical issues only)	*Optional*	**Required**	*Optional*	**Required**
	Work Activity / Project Categorization	Develop lists of standard activities and project types, providing criteria for grouping specific work into these activity and project types.	*n/a*	*Optional*	*Optional*	**Required**	*Optional*	**Required**
	Base Work / Treatment Data Model	Specify detailed data elements for the standard activities and project types. Identify required, recommended, and optional data elements, as well as specific data types and formats.	*n/a*	**Required** (work on critical issues only)	*Optional*	**Required**	*Optional*	**Required**
	Integrated Treatment Data Models	Evaluate other assets and project types which impact the asset. Update those assets and project work or treatment data models to capture information needed for the assessed asset.	*n/a*	*n/a*	*n/a*	*Optional*	*n/a*	*Optional*

Data Informed Decision-Making (by Asset Management Approach)

	General Description of Key Capabilities	Reactive (minimum)	Reactive (advanced)	Lifecycle-Based (minimum)	Lifecycle-Based (advanced)	Condition-Based (minimum)	Condition-Based (advanced)
Target Setting	Asset data considered in resource allocation decisions.	*n/a*	**Required** (issue backlog)	**Required** (inventory-based needs estimate)	**Required** (treatment history or age-based)	**Required** (current condition / trends)	**Required** (lifecycle planning analysis)
	Asset program performance / investment targets are set based on available resources.	*n/a*	*Optional* (issue resolution targets)	*n/a*	**Required** (based on lifecycle strategies)	*n/a*	**Required** (based on lifecycle planning analysis)
	Asset program performance / investment targets are set based on forecasted needs.	*n/a*	*n/a*	*n/a*	**Required** (District investment targets based on lifecycle strategy)	*n/a*	**Required** (lifecycle planning analysis)
	Target monitoring and adjustment processes keep resources aligned with performance.	*n/a*	*n/a*	*n/a*	*Optional* (as strategies are updated)	*n/a*	**Required** (performance monitoring)
Project Planning	Project plans and scopes are based on asset data available within business systems.	*n/a*	*Optional* (issue data)	*n/a*	**Required** (treatment history and issues)	**Required** (condition-based)	**Required** (lifecycle planning & conditions)
	Project plans and scopes incorporate project-level treatment recs (e.g. unconstrained needs analysis based on site-specific data).	*n/a*	*n/a*	*n/a*	**Required** (lifecycle strategies)	**Required** (condition-based)	**Required** (condition-based)
	Project plans and scopes incorporate network-level treatment recommendations (e.g. constrained investment optimizations).	*n/a*	*n/a*	*n/a*	**Required** (lifecycle strategies & targets)	*n/a*	**Required** (lifecycle planning analysis & targets)
	Regular maintenance/preservation programs funded based on lifecycle costs and benefits.	*n/a*	*n/a*	*n/a*	**Required** (lifecycle strategies & targets)	*Optional*	**Required** (lifecycle planning analysis & targets)

Asset Modeling and Investment Optimization Methodology Requirements (by Asset Management Approach)

	Models / Methodologies	General Description of Key Capabilities	Reactive		Lifecycle-Based		Condition-Based	
			(minimum)	(advanced)	(minimum)	(advanced)	(minimum)	(advanced)
Modeling and Prioritization Requirements	Asset Lifecycle Models	Formal models of the lifecycle of an asset, from initial installation through removal, replacement or reconstruction. Includes ideal timing and/or triggers for treatments.	*n/a*	*n/a*	**Required**	**Required**	*Optional*	*Optional*
	Resource-Constrained Lifecycles	Formal lifecycle investment models for an asset, adjusted to align with available resources and agency investment priorities.	*n/a*	*n/a*	*Optional*	**Required**	*Optional*	*Optional*
	Treatment Models	Treatment-specific cost, benefit, and selection criteria and models. May be based historical data, research, or expert opinion, and may be refined with other data.	*n/a*	*Optional* (treatment cost only)	**Required** (treatment cost only)	**Required**	**Required**	**Required**
	Predictive Condition Models	Predictive models for key condition and performance data. May be based on historical data, external research or models or expert opinion. May incorporate of other data (e.g. utilization or environmental factors).	*n/a*	*n/a*	*n/a*	*n/a*	**Required**	**Required**
	Investment Prioritization Methods	Established approach for prioritizing network-level resource allocations and investment priorities. Methods may range in complexity based on asset-specific context and need.	*n/a*	*Optional* (critical issues only)	*n/a*	*Optional* (critical issues only)	**Required**	**Required**
	Lifecycle Planning Approach	Formal approach to leverage current and predicted conditions, treatment models, and investment prioritization methodologies to connect network-level investment optimizations with project-level decisions.	*n/a*	**Required** (aggregated targets)	**Required** (lifecycle options)	**Required**	**Required** (condition-based recs)	**Required**

Data Access and Reporting (by Asset Management Approach)

	General Description of Key Capabilities	Reactive (minimum)	Reactive (advanced)	Lifecycle-Based (minimum)	Lifecycle-Based (advanced)	Condition-Based (minimum)	Condition-Based (advanced)
Field Access	Hard copy reports and formwork support field data collection, review, and decision-making.	*n/a*	**Required** (issue/resolution)	**Required** (inventory)	**Required** (inventory & issues)	**Required**	**Required**
	Field staff have laptops/devices but no field connectivity (office download/upload).	*n/a*	*Optional* (issue/resolution)	*n/a*	*Optional* (inventory & issues)	*n/a*	*Optional* (inv. & condition)
	Field staff are equipped with mobile devices with two-way system connectivity in the field.	*n/a*	*Optional* (issue/resolution)	*n/a*	*Optional* (inventory & issues)	*n/a*	*Optional* (inv. & condition)
Public Access	A public website provides a program description, key contacts and select materials.	**Required**	**Required**	**Required**	**Required**	**Required**	**Required**
	A public website provides summary data and reports, and downloadable datasets.	*n/a*	*Optional* (accomplishments)	*Optional* (inventory & needs)	*Optional* (inventory & needs)	*Optional* (condition & needs)	**Required** (condition & needs)
	A public website provides a performance dashboard (objectives, targets, and metrics).	*n/a*	*n/a*	*n/a*	*Optional* (investment target)	*Optional* (condition trends)	**Required** (trends and targets)
Reporting and Targeting	Asset data/program summaries and trends.	*Optional* (expenditures)	**Required** (issue/resolution)	**Required** (inventory & needs)	**Required** (inv., issues, needs)	**Required** (condition & needs)	**Required** (condition & needs)
	Aggregated work and/or investment targets.	*n/a*	**Required**	*Optional* (investment target)	**Required** (investment target)	*Optional* (investment target)	**Required**
	District performance forecasts and targets.	*n/a*	*n/a*	*n/a*	*n/a*	*Optional*	**Required**
	District investment/performance monitoring.	*n/a*	*n/a*	*n/a*	**Required** (investment target)	*n/a*	**Required** (investment target)
	Project-level treatment recommendations.	*n/a*	*n/a*	**Required** (lifecycle model)	**Required** (lifecycle strategies)	**Required** (condition-based)	**Required** (lifecycle planning)
	Prioritized, project-level investment priorities.	*n/a*	**Required** (issue backlog)	*n/a*	**Required** (lifecycle strategies)	*Optional* (condition-based)	**Required** (lifecycle planning)

Data Storage and Integration Requirements (by Asset Management Approach)

Area	General Description of Key Capabilities	Reactive (minimum)	Reactive (advanced)	Lifecycle-Based (minimum)	Lifecycle-Based (advanced)	Condition-Based (minimum)	Condition-Based (advanced)
Inventory & Condition Data Storage	Stored electronically, in a centralized location, accessible to field and office staff.	*n/a*	**Required** (critical issues)	**Required** (inventory)	**Required** (inv. & issues)	**Required**	**Required**
	Data is stored in systems supporting two-way data access and update in the field.	*n/a*	*Optional (critical issues)*	*n/a*	*Optional (inv. & issues)*	*n/a*	*Optional (inv. & cond.)*
	Data is formatted for easy linkage and integration using shared IDs, or common location referencing.	*n/a*	*Optional (critical issues)*	*n/a*	*Optional (inv. & issues)*	*n/a*	*Optional (inv. & cond.)*
Work Order & Work History Data Storage	Stored electronically, in a centralized location, accessible to field and office staff.	*n/a*	**Required** (issue resolution)	*n/a*	**Required**	*Optional*	**Required**
	Data is stored in systems supporting two-way data access and update in the field.	*n/a*	*Optional* (issue resolution)	*n/a*	*Optional*	*n/a*	*Optional*
	Data is formatted for easy linkage and integration using shared IDs, or common location referencing.	*n/a*	*Optional* (work & issues)	*n/a*	**Required** (work & inv.)	*n/a*	**Required** (work & inv.)
Asset Data System Integrations	Data views provide access to data for priority use cases (e.g. issue prioritization, inventory update).	*n/a*	**Required** (critical issues)	*n/a*	**Required** (work & inv.)	*n/a*	**Required** (analysis & work)
	Asset data and work order systems are integrated to automate asset data updates / use cases.	*n/a*	*Optional (critical issues)*	*n/a*	*Optional* (work & inv.)	*n/a*	**Required** (analysis & work)
Other Data Integrations	Data views offer access to data for key uses (e.g. historical expenditure view for resource allocation).	*Optional (expenditures)*	*Optional (allocations, expenditures, data for issue prioritization)*	*Optional*	*Optional (support lifecycle strategy development & District work planning)*	*Optional*	**Required** (support lifecycle planning analysis & District work planning)
	Data flows are in place to import external data for use in asset management systems decision-making.	*n/a*		*n/a*		*n/a*	
	Highly integrated and automated data exchange.	*n/a*		*n/a*		*n/a*	*Optional*

Supplemental Data and Information System Capability Summary

Asset Inventory and Condition Data Collection Capabilities

General Description of Supplemental Capabilities		Applicable Asset Data Collection Types			
		Inventory	**Condition**	**Work**	**Other**
Field Inspection	Capture data with field forces. Best when detailed, high precision data are needed or for incremental data collections. Can be paper-based, or by electronic form, mobile apps (e.g. ESRI Field Maps or Pink Tag System) or dedicated IT systems.	Detailed or Component-Level Survey	Detailed Asset-Specific Conditions	Detailed Asset-Specific Work History	Detailed Site-Specific Context
Imagery-Based Extraction	Extract asset data through review of collected imagery. May be collected as standalone effort, or through office based tools referencing available imagery.	High-Level Visual Survey	High-Level Observable Conditions	n/a	High-Level Site-Specific Context
Vehicle-Based Collection	Use vehicle-based based technologies to collected detailed data and imagery at highway speeds. Examples include Windshield Surveys (manual or imagery based), LiDAR Surveys, Roadway Profilers, Skid Testers, Ground Penetrating Radar, etc.	Detailed Network-Level Survey	Detailed Network-Level Conditions	n/a	High-Level Site-Specific Context
Asset Sensors	Gather data from asset-based sensors, which may already exist for the asset function (e.g. traffic signal detectors and controllers) or are instrumented to support specialized data collection needs.	n/a	Detailed Asset-Specific Conditions	n/a	Operational Performance
Project Data Integration	Integrate planned and/or as-built project data to automatically update or pre-populate asset inventory, condition, work orders, or work history. Collection detail is limited by the level of asset and project data model standardization and alignment.	Incremental Inventory Update	Incremental Condition Update	Incremental Work History Update	n/a
Issue Reporting Systems	Provide tools to report issues identified during routine work or by general public. Can be paper-based, by electronic form, mobile apps, or dedicated IT systems (e.g. CRM System). Detail is limited by what can be reliably captured in a standard format.	General Presence, Location or Asset Type	High-Level Issues	Generate Work Orders or Requests	Public Perception or Priorities

Supplemental Data and Information System Capability Summary

Asset Treatment and Work Data Collection Capabilities

	General Description of Supplemental Capabilities	Applicable Asset Data Collection Types			
		Inventory	**Condition**	**Work**	**Other**
Field Inspection	Capture data with field forces. Best when detailed, high precision data are needed or for incremental data collections. Can be paper-based, or by electronic form, mobile apps (e.g. ESRI Field Maps or Pink Tag System) or dedicated IT systems.	Detailed or Component-Level Survey	Detailed Asset-Specific Conditions	Detailed Asset-Specific Work History	Detailed Site-Specific Context
Project Data Views	Create data views and/or document management solutions to facilitate access to project data, plans, as-builts, or inspection information in formats supporting asset work history updates.	Incremental Inventory Update	Incremental Condition Update	Incremental Work History Update	n/a
Project Data Integration	Integrate planned and/or as-built project data to automatically update or pre-populate asset inventory, condition, work orders, or work history. Collection detail is limited by the level of asset and project data model standardization and alignment.	Incremental Inventory Update	Incremental Condition Update	Incremental Work History Update	n/a
Automate Change Detection	Utilize change detection to automate and/or focus collection of work order, maintenance, and project accomplishment data.	n/a	n/a	Incremental Work History Update	n/a
Issue Reporting Systems	Provide tools to report issues identified during routine work or by general public. Can be paper-based, by electronic form, mobile apps, or dedicated IT systems (e.g. CRM System). Detail is limited by what can be reliably captured in a standard format.	General Presence, Location or Asset Type	High-Level Issues	Generate Work Orders or Requests	Public Perception or Priorities