Enterprise Transportation Asset Management

Synthesis and Work Plan Final Report

Prepared for
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Executive summary

Transportation Asset Management (TAM) is a strategic and systematic process of maintaining and managing infrastructure assets throughout their life cycle, focusing on business and engineering practices for resource allocation and utilization. It uses data and analysis to improve decision making, with the objective of providing the required level of service in the most cost effective manner.

The Alaska Department of Transportation and Public Facilities (DOT&PF) desires to improve its asset management practices, as a means to improve the life cycle cost effectiveness and performance of its physical infrastructure. The Department is in the Awakening stage of asset management maturity, where a basic set of capabilities are in place for a few types of assets, but these are not yet integrated into Department-level decision making. There is considerable room for enhancement through a variety of initiatives involving data, research, procedures, tools, and culture.

This document provides a comprehensive synthesis and gap analysis to describe the state of the practice and the Department's position within it, for all infrastructure assets across the agency, including highways, aviation, ferries, public facilities, and equipment. In most cases there is wide variation in best practices across the industry, so the focus is on levels of maturity that the Department can reasonably attain over the next few years.

Currently the Department has a considerable amount of data on certain assets and certain performance concerns, particularly pavement roughness and rutting, bridge condition and geometrics, geotechnical material sites, unstable slopes, and rolling stock. To date, these data resources are not yet used to their full potential to maximize the performance of the network. Routine processes for monitoring conditions and performance, and for updating a central asset performance database, are missing for important parts of the inventory. Given the complexity of the raw engineering data, there is a strong need for simple means of summarizing performance, forecasting future performance, and predicting the likely outcomes of alternative preservation decisions to keep the infrastructure in service reliably and at minimum cost.

This report provides a specific work plan with planning-level estimates of cost, resource requirements, and time allowances; and suggests relative priorities based on the inter-relationships among tasks, current Department readiness, and likelihood of success. The work plan is designed for a time frame of 2013-2014, an ambitious but not unusual period in which a significant step in maturity can be achieved. Each task in this work plan is conceived as a self-contained project, usually small, capable of being managed with a defined scope, cost, schedule, and deliverables. Each can stand on its own and has benefits in its own right. Most importantly, the tasks all contribute to an integrated vision of asset management that moves the Department forward in maturity, that responds effectively to Federal requirements, and that contributes to delivery of more cost-effective transportation service.

1 Introduction

Transportation Asset Management (TAM) is a strategic and systematic process of maintaining and managing infrastructure assets throughout their life cycle, focusing on business and engineering practices for resource allocation and utilization. It uses data and analysis to improve decision making, with the objective of providing the required level of service in the most cost effective manner.

Alaska DOT&PF desires to improve its asset management practices, as a means to improve the life cycle cost effectiveness and performance of its physical infrastructure. Progress can be achieved through a variety of means, involving data, research, procedures, tools, and culture. This study represents a first step, to identify and prioritize near-term initiatives that can make a difference quickly and within available resource constraints.

A key theme of TAM is performance management. Highway users wish to travel from point A to point B as quickly, safely, and reliably as possible. Speed, safety, and reliability are measurable aspects of performance of the state's transportation network. These attributes can be measured and tracked over time. With scientific forecasting methods, the future performance outcomes, as a result of agency action (or inaction) can be estimated. This information can be used to set performance targets, to determine how much performance is possible with available resources, and to prioritize investments.

Similarly, taxpayers are concerned that the travel and freight movement needs of the state's economy are served at the lowest possible cost over the long term. This means keeping the state's transportation infrastructure in suitable condition where ongoing maintenance costs and service disruptions are kept to a minimum. Condition and life cycle cost are also measurable aspects of performance, which can be tracked and forecast with the right data and tools.

Customers, taxpayers, businesses — everyone in the state — rely on the highway network to keep the economy moving, and live with the consequences when the system breaks down or when it adversely affects communities and the natural environment. Risk and externalities are also measurable aspects of performance.

In Alaska, transportation asset management is multi-modal. In addition to its 5,619 centerline miles of highway and 805 bridges[1], the Department owns 254 airports, of which 172 have gravel surfaces, 48 are paved, 33 are provided for seaplanes, and one is a heliport[2]. Two of these

[1] http://www.dot.state.ak.us/stwddes/asset_mgmt/assets/tam_handout.pdf

[2] http://www.alaskaasp.com/admin/Docs/47034%20Final.pdf

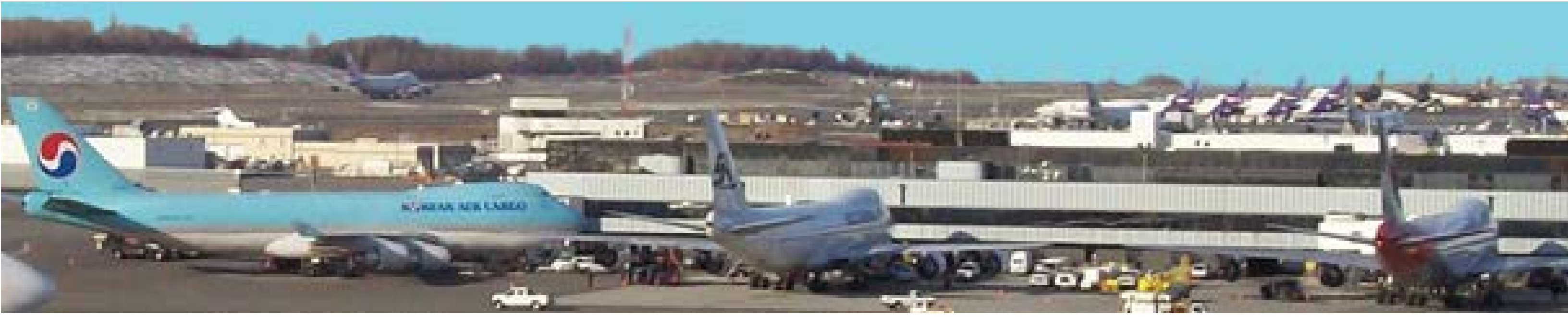
airports serve significant volumes of international traffic, including one of the world's most important freight hubs. The Department owns 11 ferry vessels, 25 harbor facilities, and 33 marine highway terminals. It manages at least 720 owned or leased buildings and 3,500 vehicles and pieces of support equipment, many of which serve agencies far beyond transportation.

Alaska's highway network is sparse and fragile, vulnerable to a variety of natural hazards, especially adverse weather, permafrost melting, and earthquakes. Many communities, including the State Capital, have no highway links to the continent at all. Air and marine infrastructure often provide lifeline service to these communities.

Within the state, the Department is one of the few public agencies with a comprehensive engineering and project administration capability. As a result, it is often called upon to construct new public buildings for other agencies. It may initially own the building, but later turn ownership over to another agency. Sometimes it keeps ownership but allows partial or complete occupancy by other agencies. Even for buildings it does not own, it may retain responsibilities for property management or for funding, design, or administration of improvements.

The Department often serves a similar role for public transit properties within the state, for construction of maintenance and administrative facilities, and for rolling stock procurement. In addition, the Department built most of the ports and harbors in the state, but over time has turned most of these over to local communities. Yet, it often retains responsibilities for engineering and administration of improvements, and may partner with the local community and/or the Army Corps of Engineers to fund improvements. These purchases and projects are typically included in the STIP, even when the Department does not take ownership.

Asset management is a process by which the Department is smart and strategic about investing its scarce resources in the right facilities at the right times to help performance the most. In the past, many agencies have used guesswork and politics to allocate resources for preserving the transportation network. This is no longer sufficient, either professionally or politically, when better data and tools are readily available. This study is a roadmap to better practices that can ensure that the state's infrastructure makes its maximum positive contribution to the state's economy and livability.



1.1 Objectives

The Department seeks to improve its capability to use data and analysis to support decision-making, which will have the effect of increasing the cost-effectiveness of Department assets. This entails a coordinated and managed set of initiatives to modify existing business processes with the aid of some additional data and tools. The objectives of these combined initiatives are:

- Maintain or improve the performance of assets in the highway network.
- Reduce and optimize life cycle costs, first by knowing what these costs are, then understanding and controlling the drivers of these costs.
- Achieve the full potential return on infrastructure investment, by planning and undertaking life extension opportunities at strategic times, and by increasing the Department's ability to optimize preservation activity.
- Increase the Department's ability to manage risk, which is especially important given the sensitivity of the network to service disruption due to natural and man-made hazards, or due to the programmatic risk that funding deficiencies or lack of staffing or project readiness could prevent the Department from responding effectively and timely to infrastructure needs (Exhibit 1).
- Communicate more clearly with stakeholders and customers, so they understand the Department's decision-making process and trust Department personnel to do the right things at the right times to keep the network in service.

Achieving these significant objectives involves a managed program of steps to improve data and analysis resources, and to integrate decision support tools across the various classes of assets and categories of performance concerns. A systems approach is essential.

Exhibit 1. The ability to manage risk is a significant benefit of asset management

1.2 Approach

The ability to measure performance systematically and reliably across an asset inventory, is an important milestone in asset management. The ability to store and track this information over time (i.e. a periodic data collection program with objective, repeatable results) is a further advancement in maturity. Further advancement provides the ability to forecast future performance, which is a necessary step in developing credible performance objectives for the future. These developments follow a natural sequence. For example, credible forecasting is impossible unless the agency already has the ability to track performance over time; without that, there is no way to know if the forecasts are accurate.

All state DOTs have some experience in trying to improve their asset management capabilities. AASHTO has published the AASHTO Transportation Asset Management Guide, Volume 2: A Focus on Implementation (Gordon 2011) as an authoritative source for describing the state of the practice and as a guide for efforts to improve. Airport Cooperative Research Program (ACRP) Report 69 (GHD 2012) has relevant general information for airports. Like the AASHTO Guide, ACRP 69 builds on two earlier, more generic documents: Britain's Publicly Available Specification 55 (PAS-55, BSI 2008) and New Zealand's International Infrastructure Management Manual (IIMM, NAMS 2006). Together, these documents can offer sufficient guidance when adapted to the needs of Alaska infrastructure.

PAS-55 presents a holistic integration of processes and systems that make up asset management (Exhibit 2). In this framework, the agency strategic plan drives asset management strategies, objectives, and plans. These then drive decisions about standards and processes for acquiring, maintaining, and replacing assets. By monitoring the performance outcomes of this process, the agency is able to improve continuously over time.

The AASHTO Guide builds on this framework, primarily by adapting to US practice, by strengthening the tools for performance measurement and management, and by addressing the technical methods for using historical and forecast quantitative performance data to support decision-making. While PAS-55 and ACRP 69 focus on *what* management activities have to be done, the AASHTO Guide goes further in describing *how* these activities can be accomplished. Thus the frameworks are complementary and readily adaptable to all types of infrastructure.

All of the capabilities that make up asset management have identifiable stages of maturity, with inter-dependencies from one stage to the next. Recognizing this fact, the AASHTO Guide defines a maturity scale, as follows:

1. Initial: No effective support from strategy, processes, or tools. Minimal internal use of quantitative performance information. There can be lack of motivation to improve.

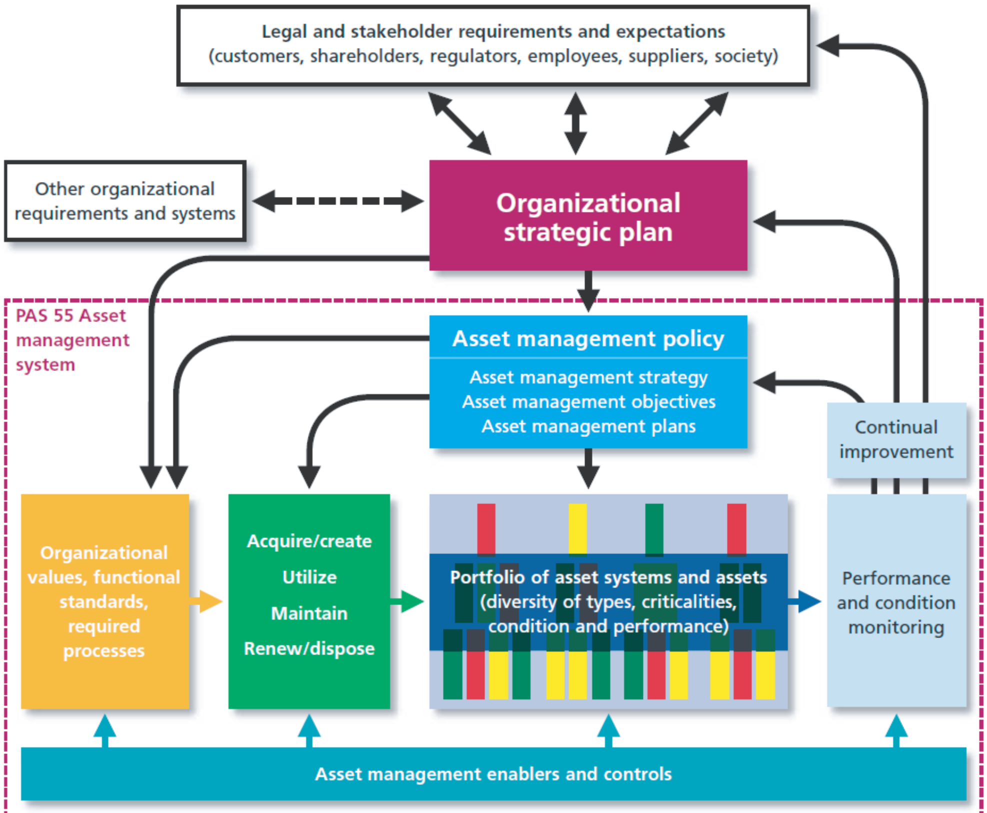


Exhibit 2. ACRP 69 framework for asset management
(GHD 2012, adapted from BSI 2008)

2. Awakening: Recognition of a need, and basic data collection. There is often reliance on heroic effort of individuals. Asset inventory and performance information is used by individuals but rarely shared.

3. Structured: Shared understanding, motivation, and coordination. Development of processes and tools. Performance information is tracked and used for internal vertical communication and decision-making, but silos still inhibit horizontal communication.

4. Proficient: Expectations and accountability drawn from asset management strategy, processes, and tools. Performance information, forecast as a function of decision-making, is used for setting objectives and measuring accomplishments. Communication of performance is both horizontal and vertical.

5. Best Practice: Asset management strategies, processes, and tools are routinely evaluated and improved. Performance information is used to optimize decision making.

Maturity levels can vary by business process, by type of asset, by capabilities and their ingredients. The AASHTO Guide provides a method for boiling these variations down into a maturity index. An example of quantifying an airport gap analysis can be found in ACRP 69 (page 39). This can be useful for tracking the maturation process over time.

Because of the interdependencies among maturity levels of the various asset management capabilities, it is not possible for most agencies to jump from their current maturity to best-practice maturity in any short time period. Maturation happens in phases. For the present study, the first phase is envisioned as 2012-2014. The key is to identify the critical gaps that inhibit progress at any given time, build support and determination to improve, and implement a plan to overcome those gaps.

1.3 Framework

Exhibit 3 shows the framework to organize the synthesis. At the center is a set of key capabilities that make up an agency's asset management abilities. These are the focus of the synthesis because they are easy to recognize, can often be measured, and can often form the subject matter of manageable tasks having tangible deliverables.

With the TAM definition given above, decision support capabilities are especially important as indicators of progress. They are the means by which data and analysis can be put to work to improve decision-making.

Each of the capabilities is made up of ingredients which together make each capability possible. Typically a capability will fail if any of the ingredients is missing. For example, the assessment of performance, no matter how comprehensive or sophisticated, is sterile if it is not communicated to all the stakeholders who can use the information. Similarly, the assessment is not credible if quality assurance procedures are absent.

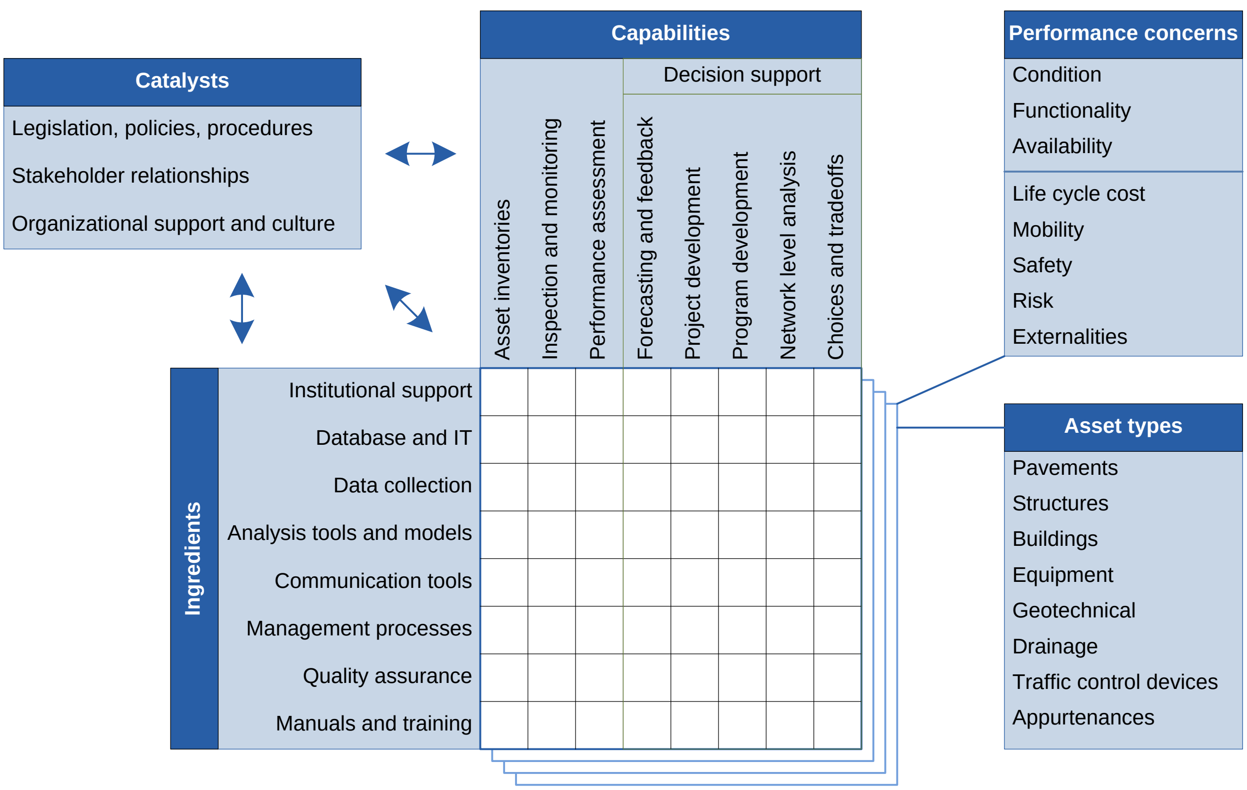


Exhibit 3. Synthesis framework

Asset management is meant to be an improvement — a positive change — in the way the Department operates. An object at rest tends to stay at rest unless acted upon by an outside force, which is usually the initiative taken by champions within or close to the agency. Champions are typically a small number of people with limited power by themselves to affect change. Thus change tends not to happen unless a catalyst is also supplied. In asset management, several catalysts are available, and typically act in combination to facilitate progress.

A few catalysts are listed in Exhibit 3, but one more is not listed: crisis. Asset management progress has often been propelled by crises, but presumably a goal is to avoid this particular catalyst if possible. Risk management is a key part of the decision support capability, which can help the agency avoid or manage crises.

The relationship among catalysts and capabilities is two-directional. Catalysts enable development of capabilities, but capabilities also inspire catalysts. For example:

- The ability of the Department to assess its performance reliably, may inspire a stronger and more positive relationship with stakeholders, who then help to spur further progress.
- An agency that gains confidence in its performance measurement and forecasting is in a better position to build a culture that values better agency performance.
- When senior management comes to understand that all the necessary ingredients are in place for effective decision support, it is more likely to be pro-active in supporting and promoting further progress in asset management.

Agencies that have been successful in asset management often pay special attention to this ability to fortify catalysts.

Historically, asset management capabilities have been built with a narrow focus on just one type of performance and one type of asset. Early pavement management systems, for example, focused just on condition of pavements. By listing a broader range of performance concerns and asset types in Exhibit 3, the diagram emphasizes that there is much more to asset management than pavement condition.

Certain aspects of asset management, especially data collection processes, will always be limited to their silos of technical expertise in specific performance concerns and asset types. Moreover, the level of detail, technology, and investment will vary across these dimensions. For example, the level of resources applied to measuring performance of roadside appurtenances will never match the resources necessary for structures. Resource commitments have to fit the level of performance benefits that are at stake.

1.4 Organization of this report

After a preliminary review of the context for asset management in the Alaska DOT&PF, this chapter has two main sections:

- Synthesis and gap analysis. For each of the catalysts and capabilities shown in Exhibit 3, the general state of the practice is described, including best practices. In most cases there is wide variation in best practices across the industry, so the focus is on levels of maturity that the Department can reasonably attain over the next few years. The gap to be identified is the near-term improvement that is believed to be feasible for the Department.
- Work plan. A set of work tasks is defined, in order to close the identified gaps. Some of the tasks are best done internally, and some by stakeholders or consultants. In each case a recommended approach, planning-level resource estimates, and calendar time requirements are estimated.

The work plan listing closes with a presentation of the author's sense of relative priorities. Naturally it is up to Department management to set priorities, but some guidance can still be developed from task interrelationships and the assessment of Department readiness and likelihood of success.

2 Synthesis and gap analysis

It is important to recognize that the Department already has in place a number of business processes and tools for asset management. The essence of the present study is the belief that these existing processes can be improved by a set of specific initiatives in a specific time frame, namely 2013-2014.

Many state DOTs are more advanced, and many are less advanced. It isn't useful to make general comparisons of the Alaska DOT&PF with other specific agencies, but much can still be learned by examining how agencies typically advance in maturity over time. Such an analysis can help define the near-term feasible range of improvement, and the logical sequence of new investments in asset management.

AASHTO has published an Asset Management Guide (Gordon et al 2011) which summarizes the state of the practice at all maturity levels. A structured analysis, presented in this report, can locate the DOT&PF on the typical nationwide (in fact, worldwide) maturity scale in order to identify the logical next steps with greatest likelihood of success. That is the goal of this chapter.

2.1 Legislation, codes, and policies

In agencies which successfully implement asset management, written rules are a necessary catalyst. Having a solid basis in law or policy can help the Department in its implementation decision making, as well as help to forestall potential barriers. It is not uncommon for organizational change to meet resistance, and sometimes this resistance is abetted by a lack of statutory or policy support.

2.1.1 MAP-21

Federal legislation has specified certain principles of asset management, starting with the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Although the management system requirements of ISTEA were subsequently made optional, many states, including Alaska, proceeded with some of the initiatives called for in the legislation, on the basis that these represented good management practice.

MAP-21, the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141), was signed into law on July 6, 2012. The bill provides funds for surface transportation investments in fiscal years 2013-14, and also establishes a new performance-based management framework[3].

Many aspects of MAP-21 related to asset management echo and refine provisions of the ISTEA. MAP-21 is less technically prescriptive than ISTEA, in an acknowledgement of state-level objections to ISTEA's very specific management system mandates. Yet, the emphasis on quantifying a return on Federal investment still remains.

MAP-21's performance management framework draws on the AASHTO Transportation Asset Management Guide (Gordon 2011). It uses a very similar definition:

> *The term 'asset management' means a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.*

As the following sections show, MAP-21 leaves many important decisions up to the states. Compared to ISTEA, it covers more of the broad characteristics of performance management with a focus on outcomes, while having less depth in its mandates for specific tools or

[3] http://www.fhwa.dot.gov/map21/summaryinfo.cfm

procedures. A rule-making process over the next year will undoubtedly fill in a few of the details, but it should not be expected to cover as much ground as the rules that followed ISTEA.

As of this writing, it does not appear that MAP-21 will mandate reporting of any additional asset management data to the Federal government, other than the enhancement of bridge inspection data that the Department was already planning to implement. However, the expansion of the National Highway System and the requirements for certain financial data could peripherally affect certain asset management processes. FHWA is developing guidance on this topic.

MAP-21 reinforces the existing industry direction on asset management, rather than breaking any new ground. Nonetheless MAP-21 is a strong statement in favor of measuring and managing performance, something that has already become a professional imperative but now is a legal imperative as well.

2.1.1.1 National Highway System

Most of the MAP-21 requirements regarding asset management apply only to the National Highway System (NHS)[4]. However, Section 1104 of the Act expands the definition of the NHS, in particular including all urban and principal arterials. States continue to be free to implement asset management on roads not on the NHS. It is very common in current practice to include all roads on the state highway system. It should be noted that locally-owned roads on the NHS are now included in the requirement for asset management plans.

Exhibit 4 shows the new NHS map for Alaska, as prepared by the Federal Highway Administration and released on September 28, 2012. A larger, more legible presentation, as well as details for the Anchorage and Fairbanks areas, can be obtained online[5].

2.1.1.2 Funding authority for asset management

Section 1106 of the Act establishes a national highway performance program, with the following purposes:

> *(1) to provide support for the condition and performance of the National Highway System;*
>
> *(2) to provide support for the construction of new facilities on the National Highway System; and*
>
> *(3) to ensure that investments of Federal-aid funds in highway construction are directed to support progress toward the achievement of performance targets established in an asset management plan of a State for the National Highway System.*

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[4] Major exceptions are bridge inspection and certain bridge management issues.

[5] http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/alaska/index.cfm

Exhibit 4. National Highway System in Alaska

Funds that are apportioned to a State to carry out the national highway performance program can be used for a variety of purposes, including[6]:

> …
>
> *(D) Inspection and evaluation, as described in section 144, of bridges and tunnels on the National Highway System, and inspection and evaluation of other highway infrastructure assets on the National Highway System, including signs and sign structures, earth retaining walls, and drainage structures.*
>
> *(E) Training of bridge and tunnel inspectors, as described in section 144.*
>
> …
>
> *(K) Development and implementation of a State asset management plan for the National Highway System in accordance with this section, including data collection, maintenance, and integration and the cost associated with obtaining, updating, and licensing software and equipment required for risk-based asset management and performance-based management.*
>
> …

[6] http://www.fhwa.dot.gov/map21/nhpp.cfm

Section 1108 of the Act authorizes the use of Surface Transportation Program funds for these purposes. State Planning and Research funds can also be used for many aspects of asset management implementation[7][8].

2.1.1.3 Asset management plans

An asset management plan is mandated and defined in Section 1106 as follows:

> *(e) STATE PERFORMANCE MANAGEMENT. –*
>
> > *(1) IN GENERAL. – A State shall develop a risk-based asset management plan for the National Highway System to improve or preserve the condition of the assets and the performance of the system.*
> >
> > *(2) PERFORMANCE DRIVEN PLAN. – A State asset management plan shall include strategies leading to a program of projects that would make progress toward achievement of the State targets for asset condition and performance of the National Highway System in accordance with section 150(d) and supporting the progress toward the achievement of the national goals identified in section 150(b).*
> >
> > *(3) SCOPE. – In developing a risk-based asset management plan, the Secretary shall encourage States to include all infrastructure assets within the right-of-way corridor in such plan.*
> >
> > *(4) PLAN CONTENTS. – A State asset management plan shall, at a minimum, be in a form that the Secretary determines to be appropriate and include –*
> >
> > > *(A) a summary listing of the pavement and bridge assets on the National Highway System in the State, including a description of the condition of those assets;*
> > >
> > > *(B) asset management objectives and measures;*
> > >
> > > *(C) performance gap identification;*
> > >
> > > *(D) lifecycle cost and risk management analysis;*
> > >
> > > *(E) a financial plan; and*
> > >
> > > *(F) investment strategies.*

While the language mandates an inventory of pavement and bridge assets on the NHS, it also encourages States to include all infrastructure assets within the right-of-way corridor. Subsection (e) goes on to specify certification requirements for an asset management plan development process; requires the US Secretary of Transportation to issue rules for plan development (by April 1, 2014); requires States to achieve or make significant progress toward achieving its performance targets; and establishes penalties for non-compliance.

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[7] http://www.fhwa.dot.gov/map21/spr.cfm
[8] http://www.fhwa.dot.gov/map21/snmp.cfm

Under MAP-21 the Secretary does not approve or certify a State's asset management plans, but only certifies the process used in developing such plans[9].

2.1.1.4 Bridges and tunnels

Section 1111 of the Act updates the title 23, section 144 requirements that specifically apply to inspections of bridges and tunnels:

> *(2) DECLARATIONS. – Congress declares that it is in the vital interest of the United States –*
>
> > *(A) to inventory, inspect, and improve the condition of the highway bridges and tunnels of the United States;*
> >
> > *(B) to use a data-driven, risk-based approach and cost-effective strategy for systematic preventative maintenance, replacement, and rehabilitation of highway bridges and tunnels to ensure safety and extended service life;*
> >
> > *(C) to use performance-based bridge management systems to assist States in making timely investments;*
> >
> > *(D) to ensure accountability and link performance outcomes to investment decisions; and*
> >
> > *(E) to ensure connectivity and access for residents of rural areas of the United States through strategic investments in National Highway System bridges and bridges on all public roads.*

In addition to this general statement regarding bridge management systems, Section 1111 mandates that a risk-based priority be assigned for systematic preventive maintenance, replacement, or rehabilitation of all highway bridges on public roads, on and off Federal-aid highways; and extends the bridge inspection standards to include element-level data, at least for NHS bridges (with a feasibility study for later element-level inspection of non-NHS bridges)[10].

The expansion of the NHS will make it necessary for the Department to review National Bridge Inventory item 104 to ensure that bridges newly added to the NHS are properly identified. This review must be completed by April 2013 in time for this year's submittal of bridge data to the FHWA[11].

One of the possible side effects of expansion of the NHS, is that the percent of the inventory classified as structurally deficient may increase. MAP-21 provides added flexibility to use surface transportation funds for bridge work to reduce this percentage. However, section 1106 of the Act provides that after October 1, 2016 a set-aside for NHS bridge work will be mandatory if a specific condition target is not satisfied in each State.

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[9] http://www.fhwa.dot.gov/map21/qandas/qaassetmgmt.cfm
[10] http://www.fhwa.dot.gov/map21/bti.cfm
[11] http://www.fhwa.dot.gov/map21/qandas/qabridges.cfm

2.1.1.5 Performance management

MAP-21 provides a vision of performance management in Section 1203, which overhauls title 23, section 150 of the United States Code. It begins with the following sections:

> *§ 150. National goals and performance management measures*
>
> > *(a) DECLARATION OF POLICY. – Performance management will transform the Federal-aid highway program and provide a means to the most efficient investment of Federal transportation funds by refocusing on national transportation goals, increasing the accountability and transparency of the Federal-aid highway program, and improving project decision making through performance based planning and programming.*
> >
> > *(b) NATIONAL GOALS. – It is in the interest of the United States to focus the Federal-aid highway program on the following national goals:*
> >
> > > *(1) SAFETY. – To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.*
> > >
> > > *(2) INFRASTRUCTURE CONDITION. – To maintain the highway infrastructure asset system in a state of good repair.*
> > >
> > > *(3) CONGESTION REDUCTION. – To achieve a significant reduction in congestion on the National Highway System.*
> > >
> > > *(4) SYSTEM RELIABILITY. – To improve the efficiency of the surface transportation system.*
> > >
> > > *(5) FREIGHT MOVEMENT AND ECONOMIC VITALITY. – To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.*
> > >
> > > *(6) ENVIRONMENTAL SUSTAINABILITY. – To enhance the performance of the transportation system while protecting and enhancing the natural environment.*
> > >
> > > *(7) REDUCED PROJECT DELIVERY DELAYS. – To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.*

These goals should be understood as measures of the return Congress would like to receive on its investment in the Federal-aid highway system. While Alaska is likely to include these among its own goals for all transportation assets, the Department is not limited to the list of goals or the definitions given here, when implementing a broader statewide enterprise asset management framework.

Often in discussions of asset management, a distinction is made between "condition" and "performance" when describing the asset characteristics to be managed. This is often seen when a modern asset management framework is contrasted with a legacy approach to pavement and bridge management, which may focus only on condition. Section 1203 makes it clear that, in Federal policy, condition is included as one element of a broader list of performance goals. Even though condition of assets may not affect road users directly, it does affect the broader community of stakeholders (including taxpayers) due to its impact on the long-term cost of maintaining the desired performance of the transportation system.

The Act does not go any further in defining these goals quantitatively, but calls on the Secretary of Transportation to engage in a rule-making process to produce further guidance. The deadline established for this process is April 1, 2014 (18 months after date of enactment)[12].

There is only a short time allowance, just one year, after the release of rules on performance measures, before states are required to submit their quantitative targets[13]. For asset management implementation, this may be one of the most significant areas of concern. It is not likely that Alaska DOT&PF (or most other states) will have in place the data and analysis tools that are necessary to ensure that published targets are in fact achievable with available funding.

It will be important to closely monitor the rule-making process on this point, to ensure that the Department will be able to comply. At the same time, this short deadline increases the urgency of completing the near-term implementation tasks defined in this report. FHWA has provided the following listing of planning documents which are expected to contain performance targets:

- Metropolitan transportation plans. [§1201; 23 USC 134(i)(2)(B)]
- Metropolitan Transportation Improvement Program (TIP). [§1201; 23 USC 134(j)(2)(D)]
- Statewide Transportation Improvement Program (STIP). [§1202; 23 USC 135(g)(4)]
- State asset management plans under the National Highway Performance Program (NHPP). [§1106; 23 USC 119(e)]
- State performance plans under the Congestion Mitigation and Air Quality Improvement program. [§1113(b)(6); 23 USC 149(l)]
- Additionally, State and MPO targets should be included in Statewide transportation plans. [§1202; 23 USC 135(f)(7)]

To assist states in communicating with a variety of stakeholders about the new performance management requirements, FHWA has made available a Powerpoint slide presentation[14].

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[12] http://www.fhwa.dot.gov/map21/qandas/qapm.cfm
[13] http://www.fhwa.dot.gov/map21/pm.cfm
[14] http://www.fhwa.dot.gov/map21/docs/11sep_perf_mgt.pdf. This presentation can be obtained in Powerpoint format by contacting Francine Shaw Whitson by phone at (202) 366-8028, by email at FSWhitson@dot.gov, or mail at Federal Highway Administration, 1200 New Jersey Ave., SE, Washington, D.C. 20590.

2.1.1.6 Updating schedule

Even though MAP-21 mandates the development of an asset management plan by each State for the NHS, it does not specify a schedule for keeping the plan up-to-date. However, the end of Section 1203 does have the following language:

> *(e) REPORTING ON PERFORMANCE TARGETS. – Not later than 4 years after the date of enactment of the MAP–21 [October 2016] and biennially thereafter, a State shall submit to the Secretary a report that describes –*
>
> > *(1) the condition and performance of the National Highway System in the State;*
> >
> > *(2) the effectiveness of the investment strategy document in the State asset management plan for the National Highway System;*
> >
> > *(3) progress in achieving performance targets identified under subsection (d); and*
> >
> > *(4) the ways in which the State is addressing congestion at freight bottlenecks, including those identified in the National Freight Strategic Plan, within the State.*

It would not be unreasonable to infer from this passage that a biennial updating cycle for the asset management plan would be appropriate.

2.1.1.7 Risk

The term "risk-based" is used in several places in the Act: to describe the required asset management plan for the NHS; to describe the prioritization approach for systematic preventative maintenance, replacement, and rehabilitation of all highway bridges and tunnels; and to determine the required frequency of bridge inspections. However, risk is not mentioned among the national performance goals in Section 1203. The Federal rule-making process will need to address this discrepancy, as will the Department's Enterprise Asset Management Plan. FHWA has provided the following discussion of risk, which at this point can be taken as general information and not specific guidance[15]:

> *In general, risk is the positive or negative effects of uncertainty or variability upon agency objectives. Risk management generally consists of the cultures, processes and structures that are directed towards the effective management of potential opportunities and threats. However, different agencies can use different definitions. Transportation agencies should consider risk as part of the strategic and systematic process of operating, maintaining, and improving physical assets and managing their highway network with a focus on the program and agency level. In addition, risk should be considered at the project level to control cost, scope, and schedule.*

It may be that risk is one aspect of all of the national goals. Certainly in Alaska, risk is a significant concern in relation to highway network access and reliability. Geotechnical assets in many cases are constructed specifically to reduce risk of performance degradation or service interruption due to earth movement. In addition, the speed with which the Department can

[15] http://www.fhwa.dot.gov/map21/qandas/qaassetmgmt.cfm, question 7.

respond to service disruptions is a matter of significant concern and investment in asset management.

2.1.1.8 Analysis methods

The concepts of establishing and meeting performance targets, implies a reliance on forecasting methods to estimate future performance. Even if a State wishes to maintain performance at current levels, it must have a way of establishing that this objective is possible with available funding. However, the Act is silent on any aspect of forecasting except for demand forecasting.

Similarly, the definition given for asset management, which includes the phrase "achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost" implies several analytical methods or tools, such as cost estimation, life cycle cost analysis, and optimization. Again, the Act is silent on how these activities should be performed, and is also silent on the definition of "state of good repair." FHWA has defined "state of good repair" as[16]:

> *A condition in which the existing physical assets, both individually and as a system (a) are functioning as designed within their useful service life, (b) are sustained through regular maintenance and replacement programs. SGR represents just one element of a comprehensive capital investment program that also addresses system capacity and performance.*

It is possible that the Federal rule-making process could offer some amount of guidance on analysis methods, but it is more likely that the Act's silence on these topics is intentional, meant to leave these decisions up to the States.

2.1.2 Federal aviation legislation

The provisions of the 1991 ISTEA and 2012 MAP-21 bills, which established asset management policies and requirements for surface transportation modes, are not generally applicable to airports. FAA legislation has relatively little to say on the topic. Section 47105(e) of 41 USC requires an airport pavement maintenance management program as a funding condition:

> *(e) PREVENTIVE MAINTENANCE. – After January 1, 1995, the Secretary may approve an application under this subchapter for the replacement or reconstruction of pavement at an airport only if the sponsor has provided such assurances or certifications as the Secretary may determine appropriate that such airport has implemented an effective airport pavement maintenance-management program. The Secretary may require such reports on pavement condition and pavement management programs as the Secretary deter- mines may be useful.*

FAA staff have been generally supportive of asset management efforts, particularly to the extent that these efforts support compliance with the grant assurances required of each Federal airport grant recipient. Some of the relevant grant assurances[17][18] include:

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[16] http://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf, page 10.
[17] http://www.faa.gov/airports/aip/grant_assurances/media/airport_sponsor_assurances_2012.pdf
[18] Selected by Jessica Dellacroce

3. Sponsor Fund Availability. It [sponsor or recipient] has sufficient funds available for that portion of the project costs which are not to be paid by the United States. It has sufficient funds available to assure operation and maintenance of items funded under this grant agreement which it will own or control.

11. Pavement Preventive Maintenance. With respect to a project approved after January 1, 1995, for the replacement or reconstruction of pavement at the airport, it assures or certifies that it has implemented an effective airport pavement maintenance-management program and it assures that it will use such program for the useful life of any pavement constructed, reconstructed or repaired with Federal financial assistance at the airport. It will provide such reports on pavement condition and pavement management programs as the Secretary determines may be useful.

19(a). The airport and all facilities which are necessary to serve the aeronautical users of the airport, other than facilities owned or controlled by the United States, shall be operated at all times in a safe and serviceable condition and in accordance with the minimum standards as may be required or prescribed by applicable Federal, state and local agencies for maintenance and operation. …

2.1.3 State legislation

As is the case in other states, Alaska does not have any specific provisions in state statutes related to transportation asset management. Under Title 44, Chapter 42, Section 20, "Powers and Duties" of the Department of Transportation and Public Facilities, the following sub-sections are relevant:

(a) The department shall

(1) plan, design, construct, and maintain all state modes of transportation and transportation facilities and all docks, floats, breakwaters, buildings, and similar facilities;

(2) study existing transportation modes and facilities in the state to determine how they might be improved or whether they should continue to be maintained;

(3) study alternative means of improving transportation in the state with regard to the economic costs of each alternative and its environmental and social effects;
…

(10) develop facility program plans for transportation and state buildings, docks, and breakwaters required to implement the duties set out in this section, including but not limited to functional performance criteria and schedules for completion;

(11) supervise and maintain all state automotive and mechanical equipment, aircraft, and vessels, except vessels and aircraft used by the Department of Fish and Game or the Department of Public Safety
…

(15) at least every four years, study alternatives available to finance transportation systems in order to provide an adequate level of funding to sustain and improve the state's transportation system.

The key points in the Statute are the responsibility to maintain transportation facilities in sub-section (a)(1); the duty to study existing facilities and to evaluate economic costs and environmental and social effects in (a)(2) and (3); the responsibility for facility program plans in (a)(10); and the emphasis on studying alternatives, which appears in several sections especially (a)(3) and (15).

For more specificity on "*economic costs of each alternative and its environmental and social effects*", the Alaska Administrative Code provides the following guidance in 17 AAC 05.125:

(a) In the statewide transportation planning process, the department will consider goals and objectives that will further

(1) the economic vitality of the state;

(2) the safety and security of users of the state's transportation system;

(3) accessibility and mobility options available to people and for freight;

(4) the integration and connectivity of various modes of the state's transportation system;

(5) the preservation of existing transportation systems; and

(6) any metropolitan area plan developed under 23 U.S.C. 134 and 49 U.S.C. 5303-5306.

(b) When formulating its goals and objectives in the statewide transportation plan, and the strategies to implement those goals and objectives, the department will consider the concerns of interested persons and minimize any adverse environmental, economic, or social impact of those goals and objectives upon any segment of the population.

Some fairly specific language related to performance management occurs in the Alaska Statutes in AS 37.07.014, which says:

(a) To carry out its legislative power under art. II, sec. 1, Constitution of the State of Alaska, and to promote results-based government, the legislature shall issue a mission statement for each agency and the desired results the agency should achieve. The legislature may issue a separate mission statement for a subunit of an agency. A mission statement and desired results should promote the efficient, measured use of the state's resources. A mission statement and desired results constitute policy under which an agency shall operate, and, where appropriate, the mission statement may be implemented by statute.

(b) The legislature shall provide for a budget review function that promotes results-based government. The legislature shall adopt a method of measuring results for each agency, and measurements shall be reported semi-annually by each agency to the legislature. The reports shall be used by the legislature to evaluate whether the mission and desired results for that agency or subunit of the agency are being achieved.

…

> *(f) To help fulfill the legislature's responsibilities under this section and achieve results-based government, each agency shall*
>
> > *(1) allocate resources to achieve the mission and desired results established by the legislature;*
> >
> > *(2) express desired results established by the legislature and other program results in measurable terms;*
> >
> > *(3) measure progress towards mission statements and desired results established by the legislature and other results;*
> >
> > *(4) promote activities consistent with mission statements and desired results established by the legislature that reduce or avoid future costs;*
> >
> > *(5) plan for the short-term and the long-term using consistent assumptions for major demographic and other trends; and*
> >
> > *(6) require accountability at all levels for meeting program mission statements and desired results established by the legislature.*

It is not clear that the Legislature ever acted on sections (a) and (b) above, and so section (f) has not become active. A related reference to performance management appears in AS 37.07.040, Office of Management and Budget (OMB), which is directed to:

> *(10) establish and administer a state agency program performance management system involving planning, performance budgeting, performance measurement, and program evaluation; the office shall ensure that information generated under this system is useful for managing and improving the efficiency and effectiveness of agency operations.*

This provision motivates the OMB Key Performance Indicators, where the Alaska DOT & PF is characterized using the performance measures shown in Exhibit 5. This set of indicators addresses, some, but not all, of the objectives mentioned in 17 AAC 05.125. More to the point, it is a responsibility assigned to the Office of Management and Budget, and not to the Department of Transportation and Public Facilities. Therefore, these sections of the Statutes and Administrative Code do not provide a means of improving the types of performance that they measure, nor any effective linkage to decision making.

Portions of the State Statutes and Administrative Code that might potentially address asset management for specific transportation modes, do not have applicable language in Alaska. For example, Title 2, "Aeronautics," does not have any provisions about aviation asset management, preservation of airport infrastructure, or even specific requirements for airfield maintenance.

Exhibit 5. OMB Key Performance Indicators[19]

End result	Strategies to achieve end result
A. Provide a safe transportation system; eliminate injuries, fatalities and property damage.	A1: Build and improve state-owned roads and highways to appropriate department standards. A2: Preserve or improve condition of highway infrastructure.
B: Provide a transportation infrastructure that supports and promotes economic growth.	B1: Enhance economic activities through key transportation services. B2: Enhance economic activities through increased State revenue. B3: Improve efficiency.
C: Carry out safe operations.	C1: Improve employees' awareness of workplace safety requirements.
D: Reduce the risk of accidents or road damage from unsafe commercial vehicles and/or loads.	D1: Reduce number of illegal oversize/overweight Commercial Motor Vehicles (CMVs) on highways.
E: Reduce design and construction project management costs.	E1: Minimize administrative and engineering costs associated with projects.

2.1.4 Public policy

The Department does not have public policy documents that refer specifically to asset management. The Department's Strategic Plan (Exhibit 6, as revised in April 2013) also doesn't directly address the topic, although its vision statement does make reference to the main goals to which asset management can respond. The Statewide Policy Plan[20] (Alaska DOT&PF 2008) also refers to these same goals:

> *Policy 3: Apply the best management practices to preserve the existing transportation system.*
>
> *Policy 4: Increase understanding of and communicate ADOT&PF's responsibilities for system preservation as the owner of highways, airports, harbors, and vessels.*
>
> *Policy 5: Ensure the efficient management and operation of the transportation system.*

Additional policies refer to specific aspects of performance to be managed, including cost-effectiveness, mobility (encompassing travel time, access, and reliability), safety, security (encompassing facility risk and emergency preparedness), energy efficiency, economic development, and other positive social attributes (environmental, social, economic, human health, local community concerns, and quality of life). Policy 14 is the most specific about decision support for asset management:

> *Policy 14: The statewide plan will provide the analytical framework from which ADOT&PF sets investment priorities.*
>
> - *We will monitor, forecast, and report transportation system performance through data-driven management systems.*
> - *We will provide information for performance-based planning and budgeting.*
> - *We will promote and work to improve coordination between public transportation and human services transportation.*

[19] http://omb.alaska.gov/html/performance/details.html?p=157
[20] http://www.dot.alaska.gov/stwdplng/areaplans/2030/index.shtml

- *We will use best practice techniques and technology for involving the public in the transportation planning process.*

DOT&PF Strategic Plan

Purpose

Keep Alaska Moving through service and infrastructure.

To do this we:

- Provide for the safe and efficient movement of people and goods
- Provide statewide access and connectivity
- Provide access for exploration and development of Alaska's resources

Core Values

- ***Integrity:*** Ensure honesty, dependability, loyalty and a high ethical standard
- ***Excellence:*** Personal and department commitment to continually improve individual, team, and organizational knowledge, performance, and methods to provide quality service and products
- ***Respect:*** Positive regard for colleagues and customers

DOT&PF Vision Statement

- We will strengthen our efficiencies and effectiveness at planning, designing, constructing, operating and maintaining all modes of transportation.
- We will strengthen our transparency, accountability, innovation and quality of service.
- We will work as a team, maintaining strong, healthy communications internally and externally.
- We will promote service based management of state-owned transportation assets and facilities.
- We will expand the reach of the transportation system to serve the needs of all Alaskans

Strengths

- Strong work ethic
- Experience, expertise, knowledge
- Dedicated workforce
- Reasonable, responsible problem-solvers
- Quantity and quality of assets
- Interesting challenges
- Opportunity for growth
- Pride of accomplishment
- Good people
- Willing to lead

Exhibit 6. Alaska DOT&PF Strategic Plan[21]

As the Statewide Policy Plan proceeds to describe strategies and actions, it sets a very positive direction for asset management while also demonstrating the limits of the Department's current capabilities. In strategy 1, the need is expressed for a system perspective:

> *Because our transportation system is a network of different modes of transportation, and within modes different facilities, we can make better use of funds by starting from a system-level perspective. This is especially important in a fiscally constrained environment because this level of analysis enables consideration of how best to provide the infrastructure to meet the state's diverse travel demands.*

Action 1.1 starts to express one of the key institutional needs, in order for asset management to take root in the Department:

> *The plan distinguishes between routine maintenance, life cycle management, and system development. Going forward we will use planning analysis to support this decision making.*

[21] http://dot.alaska.gov/comm/strategic_plan.shtml

The current report will have much more to say on the topic of "*planning analysis to support this decision making*". It is evident that the planning analysis is not yet fully established. Action 1.1 goes on to say that the Department plans to fund routine maintenance, preservation, and life cycle management "at current levels." It does not provide any quantitative indication of the performance that can be achieved at current levels of funding, nor at alternative funding levels. It states that

> *If the total budget increases, we will increase preservation and life cycle management funds at a level proportionate to the current allocation.*

As the maturity level of asset management increases, agencies typically are able to offer plans that are much more quantitative and specific. It is not self-evident to policy makers that the best level of investment in preservation and life cycle management should be a constant fraction of total funding.

With improved decision support tools, the Department should be able to quantify an optimal level of preservation and life cycle funding, sensitive to performance objectives. This information would enable decision makers to drive funding based on desired level of service, without appealing to historical funding levels that may no longer be relevant. Some of the early steps to accomplish this, are called for in the Statewide Policy Plan:

> *Action 2.2. Establish a core set of performance measures to monitor performance against plan goals.*
>
> *Action 2.3. Apply life cycle management best practices to the selection of pavement treatments – avoid "worst first."*
>
> *Action 2.4. Implement pavement management system analytical capabilities.*
>
> *Action 2.6. Establish a level of service based approach to maintenance and operations planning and budgeting.*

These are not the only necessary steps. Progress can be made for all types of assets, not limited to pavements. Levels of service are very important for improved planning and budgeting, but other methods and tools will also be needed in order for implementation to be successful. Later sections of this report will address this in much more detail.

A key implication of Action 1.1 is that an objective, fact-based planning analysis can and should be performed for routine maintenance and life cycle management. With a sufficiently mature asset management capability, the cost of effective preservation is directly tied to the level of performance desired (Exhibit 7). When given this information, decision makers will have powerful new tools to set and implement public policy. They will be able to:

- Select performance targets, and determine the cost of those targets;
- Determine the gain or loss in performance that will result if funding does not arrive in the amounts forecast;

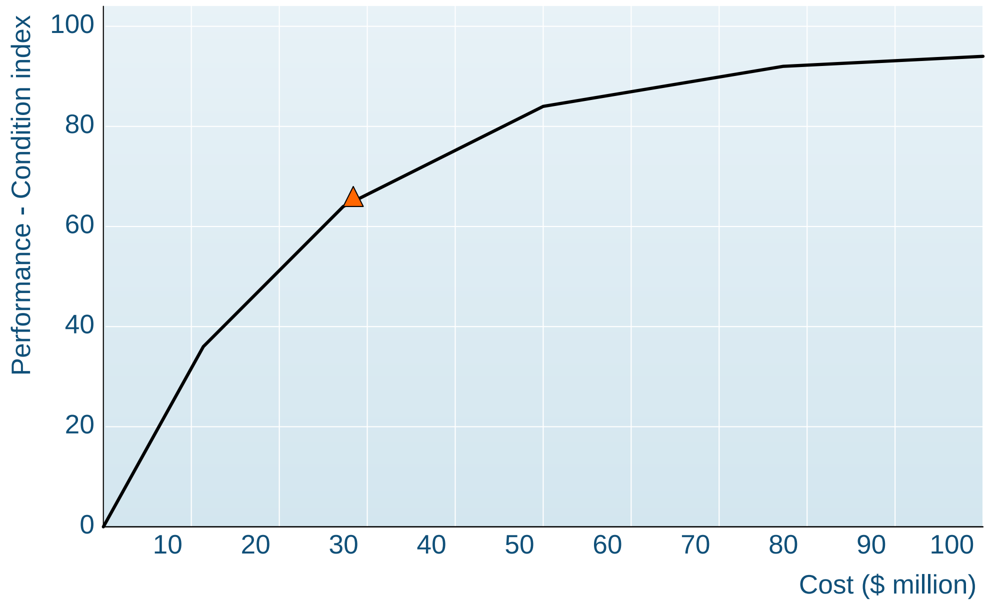

Exhibit 7. Performance as a function of investment

- Separate network growth decisions (which by nature have significant political and economic development implications) from preservation decisions (which by nature are more dependent on weather, age, and traffic);
- Determine the optimal level of preservation funding to maintain desired service levels;
- Determine the additional preservation cost that comes with decisions to expand the transportation network;
- Establish a process for making agency policy sensitive to resource availability.

None of these tools are likely to be available by 2014. They rely on several preparatory steps, including having a reliable inventory of assets needing to be maintained; a systematic process for monitoring conditions and performance; analytical tools for predicting future performance, sensitive to agency actions; and tradeoff analysis tools to connect estimates of funding with estimates of future performance. Many of those tools are feasible to place into service (at least, pilot testing) in the next two years, to make progress in the desired direction.

2.1.5 Alaska Aviation System Plan

Contributing to the Statewide Policy Plan is the Statewide Alaska Aviation System Plan[22]. This plan describes the statewide framework for the air transportation network of some 700 airports, most of which are not state-owned. The plan provides a set of performance measures, focusing on the levels of service required from specific airports and from the network as a whole, in five broad areas: safety, service, fiscal responsibility, communication, and management. Most of these objectives are concerned with decisions about purchase or construction of specific types of assets, or selection of appropriate performance objectives.

These System Plan objectives are outside the scope of asset management, but in many cases they establish the context for asset management: once an appropriate set of objectives is chosen, and corresponding assets are constructed, then asset management principles are necessary in order to ensure that the required performance continues to be provided, at minimum cost, over the life cycle of each facility.

This aspect of the Aviation System Plan is the focus of the Fiscal Responsibility Goal, described as follows[23]:

> *Provide responsible asset management and efficient allocation of limited resources.*
>
> *Objectives:*
>
> - *Ensure that the process of establishing project priorities incorporates appropriate criteria to address funding allocation and asset management policies.*
> - *Conduct regular retrospective review of the Airport Improvement Program (AIP) spending plan in order to determine whether actual project funding is in concert with established priorities.*
> - *Improve accounting mechanisms to assign expenses to airports better.*
> - *Consider the formulation of a policy concerning project add-ons and their effect on funding allocation priorities.*
> - *Improve the use of pavement management information in formulating the spending plan.*
>
> *Measures for Planning Process Fiscal Responsibility Goal*
>
> - *Have the project scoring criteria been reviewed to determine whether criteria are adequate to ensure funding allocation and asset management policies are met?*
> - *Has the AIP spending plan been reviewed in the last year in order to determine whether actual project funding is in concert with established priorities?*

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22 http://www.alaskaasp.com/

23 http://www.alaskaasp.com/admin/Docs/AASP%20Mission%20Goals%20Measures%20Classifications%20-%20for%20website.pdf, page 102.

- *Has the APEB established a policy concerning project add-ons and their effect on funding allocation priorities? If so, has the spending plan been reviewed to determine whether the policy's implementation has improved the allocation of resources?*
- *Have priorities for paving projects become more coherent through the use of pavement management information in the formulation of the spending plan?*

Asset management implementation can be seen as a way of ensuring that these fiscal responsibility goals are accomplished on a routine and continuing basis.

2.1.6 Internal policy

Internal to the Department, there is a process for developing and publishing policies and standard operating procedures. These policies are posted on the Department web site (Exhibit 8), along with a process (P&P 02.01.010) for developing new policies.

Exhibit 8. Policy and Procedures web page[24]

[24] http://www.dot.alaska.gov/admsvc/pnp/policy_and_procedures.shtml

2.1.6.1 Relevant policy and procedure documents

The most relevant documents are[25]:

- The Performance Electronic Tracking System (PETS) will be used to record, track, monitor, and report on both external and internal performance measures (P&P 02.01.017).
- An Information Management Plan will be updated annually by the Statewide Information Systems Division and each Region and System (DPOL and DPDR 02.03.020).
- The department will utilize value engineering techniques in the pre-construction, construction, and operations of selected facilities which will provide the necessary function, safety, and maintenance of the facility at the lowest life-cycle cost (DPOL 05.01.030).
- The department will utilize the Pavement Management System (PMS) to develop a pavement maintenance and rehabilitation program. The intent of PMS is to maintain the network at a desirable performance level at a minimum cost (DPOL 07.05.020). This policy specifically excludes Anchorage and Fairbanks International Airports.
- Procedure 07.05.020 describes the leadership structure and staff positions responsible for highway pavement management in the Department.
- The department will provide immediate corrective or protective action to safeguard the traveling public when a bridge is determined to be critically deficient (DPOL and DPDR 07.05.060)
- Preventative maintenance will be performed by department M&O forces when it is determined to be cost effective and in the best interest of the state (P&P 07.05.080).
- Policy and procedure 07.06.030 specifically assigns maintenance responsibility for windsocks at state-operated rural airports. Similarly, policy 03.03.010 assigns responsibilities for stormwater inlet controls (such as oil/water separators). No other airport assets are addressed in similar policies, although P&P 07.06.040 specifically disavows responsibility for slope indicator devices and automated weather stations (which are typically owned and maintained by FAA).
- A procedure for procurement and control of property owned by, or in the custody of, the Department. This is a broadly-worded policy and a detailed set of procedures covering all "controlled property" with value over $1000, including buildings, vehicles, equipment, computers, etc. The broad wording may be interpreted as including also real property, highways, bridges, appurtenances, and all other valuable assets; however, the topics addressed in the procedure only specifically refer to buildings and smaller assets. In some cases (especially vehicles and pavements) this 1992 policy has been superseded by more recent policies and procedures. P&P 10.03.030 (2006) describes bridges, docks, other improvements to real property (but not the real estate itself), and marine vessels as "controlled property". The policy requires a computerized inventory of all controlled

[25] Based on a summary provided by Victor Winters in 2012.

property, but does not name or describe this inventory. It also covers procurement, decals, reporting, disposition, and audit. (DPDR 10.03.010)

- A policy and procedure for salvaging and destroying Department-owned structures, including bridges, docks, other improvements to real property (possibly including buildings and pavements), and marine vessels, but not real estate or land vehicles. (P&P 10.03.030)

2.1.6.2 State equipment fleet policies and procedures

An extensive set of policies has been prepared on the management of vehicle and equipment assets. These include:

- A policy on establishing and maintaining standard vehicle files for all state-owned vehicles and equipment under the management of the State Equipment Fleet (SEF) unit. This includes ownership documents, work orders, accident reports, and maintenance reports. (P&P 11.01.020)
- A policy to provide for accurate inventory data in the Equipment Management System, which includes cost and depreciation data, historical maintenance and repairs, and cost data for all vehicles managed by SEF. (P&P 11.01.050)
- The department will manage the Highway Equipment Working Capital Fund (HEWCF) in accordance with procedures established by state statutes and regulations, the Office of Management and Budget (OMB), the Federal Office of Management and Budget Circular A-87, and in accordance with Generally Accepted Accounting Principles (GAAP) (P&P 11.02.001).
- A procedure to calculate vehicle rental rates such that the replacement cost of each vehicle is recovered in proportion to utilization. (P&P 11.02.002)
- A procedure for preparation of financial statements for SEF, which includes recognition of straight-line depreciation of vehicles and equipment. (P&P 11.02.010)
- A policy that provides that all state owned equipment under the purview of the State Equipment Fleet, be maintained in accordance with Original Equipment Manufacturer (OEM) recommendations, generally accepted standard industry practices, and in a manner that will be consistent with safe, reliable, and cost effective operation. (P&P 11.04.004)
- A procedure for reporting the custody of each piece of equipment, and for reporting mileage and hours of usage. The procedure also provides for tracking of unreported or lost equipment. (P&P 11.04.009)
- A procedure to define and compute vehicle and equipment Reliability Ratio, which is based on defined levels of service in terms of recorded equipment downtime (time when the equipment is unavailable for service). This is primarily used as a means of tracking warranty performance. (P&P 11.04.012)

- A procedure to distinguish between capital and non-capital costs of repairs and improvements to equipment. (P&P 11.04.019)
- A procedure for periodic inspections and preventive maintenance on vehicles and equipment, following manufacturer recommendations. (P&P 11.04.031)
- A policy that vehicles and equipment be replaced when they are at the end of their economic life, or are no longer safe or reliable to perform their intended function. Defines the concept of "economic life" and assigns responsibility for determining guidelines and criteria. (P&P 11.05.001)
- A policy and procedure defining the allocation of vehicle and equipment costs. This includes an allocation of costs for record-keeping and asset management activities. (P&P 11.05.013)
- A procedure that implements P&P 11.05.001 by setting the criteria for defining "economic life" of vehicles and equipment. The procedure includes quantitative targets for hours or miles of usage, and lifespan in years. It describes the procedure for documenting replacement needs, and also includes a condition rating sheet which is used in making replacement decisions. (P&P 11.05.020)
- A procedure for determining residual or salvage value of vehicles or equipment that are no longer needed by a custodian agency, but may have remaining service life for a different agency. (P&P 11.05.022)

The policies and procedures related to asset management of the State Equipment Fleet are considerably more developed than those for any other type of asset managed by the Department. The policies reinforce each other and are also supported by information systems. The procedures describe in actionable detail how inventory and maintenance information are used in decision making for maintenance, repair, and replacement actions. Methods for cost tracking and cost allocation are specifically spelled out. Levels of service and performance measures are defined.

If there is any room for improvement in the policies and procedures for fleet asset management, it would be in making more formal use of vehicle condition and performance data, for evaluating the benefits of life extension, and for setting priorities for fleet replacement.

2.1.6.3 Relating internal TAM policies to business processes

It can be seen that the policy support for management of all other asset types is spotty. The pavement management policy is fairly detailed, but it is not supported by policies related to inventory, condition assessment, maintenance work accomplishment tracking, project and program development, or priority setting in general. The public policies described in the Statewide Policy Plan are not supported by internal policies and procedures that specify how preservation needs are identified, prioritized, and funded.

Connecting TAM to an agency's business processes requires agreement on common principles and goals, with clear definitions of how each process contributes to overall objectives. TAM activity can be related to general business processes by:

- Formalizing desired outcomes so that specific asset management programs, actions, and budgets can be related back to an agency's strategic objectives;
- Identifying strategic outcomes that the Transportation Asset Management Plan specifically supports and focusing asset management performance measures on these results;
- Developing a performance measure hierarchy that flows downward from strategic planning objectives to operational goals, to support decision-making at every level. This will require asset managers to link their annual work programs back to specific outcomes.

Creation of policies, by itself, does not automatically make the desired outcomes happen. It is very helpful if policies reference and support each other: for example, a policy about project evaluation and priority-setting would be supported by policies that govern the supply of performance data, and the usage of priority criteria in programming and STIP development.

In addition, the successful implementation of new policies relies on several contributing factors:

- Gaining the input and buy-in of stakeholders, including the staff whose activities are driven or constrained by the policy.
- Clear linkage of new policies to existing policies, processes, and deliverables that are already required by external laws and commitments: for example the STIP and the Statewide Transportation Policy Plan.
- Making a specific individual (identified by title) responsible for the implementation of the policy.
- Making a specific individual responsible for identifying events that make all or part of a policy obsolete, or in need of updating. This person then is responsible for making sure the policy is updated or removed via the policy development process.
- Providing incentives for adherence and improvement of existing policies and procedures.
- Providing tools that help to implement the policies and procedures. These include manuals, training, information systems, spreadsheets and other analysis tools.
- Communicating the policies and their outputs to relevant stakeholders inside and outside of the agency. Examples include reports, web pages, the Annual Report, and meetings and conversations with the stakeholders.

In the last category, the Transportation Asset Management Plan is a particularly important communication tool, which will be described in more detail later in this report.

2.1.6.4 GASB Statement 34

The Alaska Administrative Code and some of the internal policies make reference to "Generally Accepted Accounting Principles." These principles are documented, in part, by statements promulgated by the Government Accounting Standards Board (GASB) and posted at http://www.gasb.org.

A particularly relevant GASB statement is Statement 34, "Basic Financial Statements—and Management's Discussion and Analysis—for State and Local Governments." This statement has a section that specifies the means of accounting for the value of infrastructure assets owned by government agencies. The US Department of Transportation has published a helpful primer on GASB 34 (USDOT 2000).

A significant feature of GASB 34 is the ability to define asset valuation using the "Modified Approach," using the information developed in asset management systems. [26]

> *Infrastructure assets that are part of a network or subsystem of a network (hereafter, eligible infrastructure assets) are not required to be depreciated as long as two requirements are met. First, the government manages the eligible infrastructure assets using an asset management system that has the characteristics set forth below; second, the government documents that the eligible infrastructure assets are being preserved approximately at (or above) a condition level established and disclosed by the government. To meet the first requirement, the asset management system should:*
>
> > *a. Have an up-to-date inventory of eligible infrastructure assets*
> >
> > *b. Perform condition assessments of the eligible infrastructure assets and summarize the results using a measurement scale*
> >
> > *c. Estimate each year the annual amount to maintain and preserve the eligible infrastructure assets at the condition level established and disclosed by the government.*

While this has been discussed largely in connection with literal transportation networks, a footnote in Statement 34 makes it clear that any set of assets meant to act together as a system could use the Modified Approach. In the years immediately following the 1999 adoption of GASB 34, this was often viewed as a potential driver for asset management implementation. With some experience, it is now recognized that GASB 34 is not as much a driver as a catalyst and resource for policy development.

Many agencies that have pursued serious asset management implementation have adopted policies that endorse the Modified Approach. With this in place, additional policies can describe the essential elements of asset management (e.g. inventory data, condition and performance assessment, forecasting, and quantitative processes for project and program development) as a means of supporting the Modified Approach. By making this linkage, the policy legitimacy of asset management is strengthened.

[26] http://www.gasb.org, Statement 34, page 12.

MAP-21 is consistent with the GASB 34 Modified Approach. Upcoming Federal rulemaking could end up requiring the same data and tools, thus making the GASB 34 Modified Approach a *de facto* standard that all of the states will need to satisfy, at least for pavement and bridge assets.

2.1.7 Findings: Legislation, codes, and policies

Finding 1.1. The Alaska Statutes have sufficient direction to reasonably infer the necessity of asset management as a Department responsibility. In particular, the Statutes specify the responsibility to cost-effectively maintain transportation facilities; the duty to study existing facilities and to evaluate economic costs and environmental and social effects; the responsibility for facility program plans; and the emphasis on studying alternatives.

Finding 1.2. The Alaska Administrative Code provides a very important element of support by listing performance objectives for asset management, and by referencing Generally-Accepted Accounting Principles. The Code could be further strengthened if it specifically referenced the "Modified Approach" of GASB Statement 34.

Finding 1.3. The Statewide Transportation Policy Plan further strengthens the mandate for asset management. It has been observed that much remains to be done to accomplish the vision described in the plan. Statements about funding requirements are not tied to any corresponding levels of service or performance. However, the Plan does set the stage for data-driven decision making and the development of decision support analysis capabilities.

Finding 1.4. The Statewide Transportation Policy Plan could have much more to say about fiscally-sensitive levels of service and performance targets. However, the Department currently does not have a way of developing such information.

Finding 1.5. A reasonable process is in place for developing and publishing internal policies. However, these policies offer very little support for asset management, aside from the extensive policy support for the State Equipment Fleet. Internal policies to support the public policy statements in the Statewide Transportation Policy Plan, are incomplete or absent. There is no reference to the Modified Approach to GASB Statement 34.

Finding 1.6. Successful implementation of a more complete set of internal policies will depend on the development of data, analysis, and communication tools that do not currently exist in the department, and integration of such tools to support a comprehensive asset management vision.

Finding 1.7. Many of the key concepts described in this report are now codified in Federal legislation in the form of MAP-21. The requirement of a Transportation Asset Management Plan for the expanded National Highway System, as well as a few additional requirements for bridges, will be a valuable catalyst for near-term progress.

2.2 Organization and culture

Teamwork and culture are integral to asset management. TAM provides the information and objectives that enable a team to communicate and work together toward shared, measurable ends. A culture that values high performance motivates the efforts to create better processes of asset management. Several factors are necessary for team-building:

- Awareness across the Department, in the management team and at all levels, of the goals of asset management and the benefits that are expected;
- An understanding and agreement that current processes aren't producing the desired result, and thus better processes are needed;
- Involvement of key players at the appropriate level of time commitment;
- Concrete objectives and deliverables for which each player and the group as a whole is responsible, with a suitable time-frame, usually 2-4 years;
- Agreement, documented in writing, of the measures of success;
- Appropriate resources commensurate with the objectives and time frame;
- Training targeted to the needs of each participant;
- A continual process of progress tracking, performance review, and rewards/celebrations for success.

Agencies committed to positive change don't rely on crises as a rationale for change. Rather they challenge the day-to-day process of the organization through a systematic analysis of what is working well, what needs improvement, and how these areas relate to the agency's mission and goals.

Rather than focusing on the concept of what the agency is doing wrong, the process should ask, "What possibilities exist that we haven't thought about yet?" and "what's the smallest change we could make that would generate the biggest impact?" This process helps define what is possible for an agency's future and the rationale for undertaking the changes required to achieve that future vision.

2.2.1 Leadership

Asset management does not require a formal organizational structure of its own, apart from the existing structure of the Department. More accurately, asset management provides a rationale and structure for certain workflows, meetings, and working relationships that may or may not already exist, but are necessary for the agency to accomplish its mission more effectively. Therefore, the leadership structure for TAM is less formal, more ad hoc than the normal organization chart. The Department has assembled its own TAM leadership structure, depicted in Exhibit 9. It consists of the following teams:

- Executive Leadership Team, including the Commissioner, Deputy Commissioners, and Regional Directors.
- Steering Committee, whose members are division directors and senior managers representing Design & Engineering, Marine Highways, Aviation, Public Facilities, Program Development, Administrative Services, Maintenance & Operations, Commercial Weights and Measures, Public Information, Northern Region, Central Region, and Southeast Region.
- TAM Development Team, consisting of a group of senior professionals from several units of the Department, who will make a considerable time commitment to TAM implementation.
- Data Integration Team, including professionals specializing in database management, geographic information systems, maintenance data, and technology. The team also has representation from key user groups (Highways, Aviation, Marine, and Fleet).
- Communications/Marketing Team, including communications professionals as well as customer representatives from all three Regions, Aviation, and Marine.

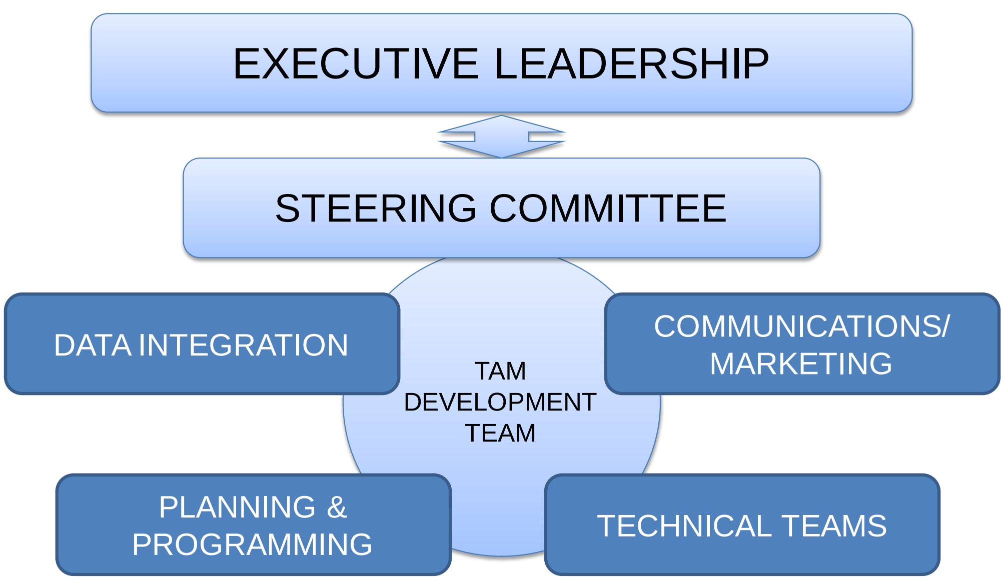


Exhibit 9. TAM Leadership Structure

- Planning and Programming Team, including professionals concerned with planning, budgeting, and programming; regional representatives; and Aviation.
- Technical Teams:
  - Highways Technical Team, consisting of a variety of technical staff, , who contribute their expertise on an as-needed basis in areas such as materials, structures, maintenance, geology, environmental, right-of-way, hydraulics, weights & measures, budgeting, and programming.
  - Aviation Technical Team, with airport professionals in the Alaska International Airport System (Anchorage and Fairbanks), the statewide rural aviation system, and regional offices.
  - Marine Highways Technical Team, with professionals and regional representatives in the Alaska Marine Highway System.
  - Public Facilities Technical Team, with professionals from each Region focused on buildings and other fixed assets, as well as aviation, ferry terminals, ports, and harbors.
  - State Equipment Fleet Technical Team, with professionals and regional representatives who manage the state's vehicle fleets.

Overseeing and guiding the teams is the group of senior managers who form the Steering Committee, which first met on September 17, 2012. The Steering Committee serves the following important functions:

- They provide the necessary breadth of perspective, expertise, experience, and influence.
- They provide staff support.
- They ensure that the asset management process is responsive to the objectives of each agency unit.
- They transmit to their subordinates the purpose and importance of each element of the asset management plan.
- They ensure that the work of the Development Team is a shared endeavor of the whole Department and not a creation of any one unit by itself.
- As a management team, their working relationship builds a shared sense of commitment as well as a shared sense of accomplishment.

Most importantly, Steering Committees like this don't get formed and continue to function without top management support; thus, they are a symbol of that support, that everyone in the organization can see and understand.

2.2.2 Leverage

The members of the Steering Committee are senior managers, who routinely manage to meet their responsibilities by means of assistance from the professional and support staff as well as outside partners. They require leverage to be successful.

The same is true of the professional staff leaders. Much of the activity of asset management is off-line but with time-critical communications and decision points. This means the data collection and analysis activities occur on a continuous or seasonal basis over an extended period of time, but decisions usually have to be made within a narrow time window and a premium is placed on communications among the technical leadership team.

With this decision making structure, it is important that the Department's professional staff leaders be leveraged with technical staff, in both professional and technician roles, especially for field work. An issue observed in Department operations is that professional staff leaders are in the field for extended time periods, and unable to participate in key decision points or team activities. As a result, key decisions might be delayed, or key stakeholders left out of decision making.

These informal observations may warrant an investigation to determine if changes in staff complement or deployment might be warranted in certain cases to remove a potential barrier to asset management team-building.

2.2.3 Communication

Successful asset management requires a communication plan and a means of ensuring consistent, reliable, and accurate messaging. When forming a communication plan, change leaders should keep in mind that communication is a two-way street. It involves both the broadcast of a message and the receipt of that message. Listening is as important as speaking. Important considerations when communicating change include:

- The message must be created clearly and with sufficient detail, and must convey integrity and commitment.
- The message recipient must be willing to listen, ask questions, and trust the sender.
- The message must be delivered in a format that is accessible and acceptable for both sender and recipient.
- The message content has to be relevant to the recipient and must connect with the recipient's emotions or beliefs in order to have lasting value.

The communication plan should include approaches to communicating all that is known about the changes as quickly as possible, indicating that information may change as circumstances evolve. The alternative is to withhold communications until all decisions are made; however silence is one of the primary reasons for failure in change initiatives.

The plan should provide time for people to request clarification and provide input, ensuring understanding of the change as well as enrolling employees in the process of creating it. Clarify that everyone is expected to be on board with the change, along with an understanding that this process takes time and effort. Finally the plan should be proactive to avoid rumors, include opportunities for networking, and indicate the timing and process for reviewing progress toward goals.

Currently the Department does not have a communications plan for asset management. Many agencies lack such a plan, but this raises the risk of implementation failure. This is one of the duties of the Communications Team described earlier in this chapter.

2.2.4 Stakeholder relationships

A key strategy of asset management implementation is the idea of managing upward and outward. This is a method of building support from higher levels of the organization and from external stakeholders and partners, by demonstrating the ways in which asset management will directly benefit them in meeting their own responsibilities.

Given that a main benefit of TAM to these stakeholders is the provision of better information for decision making, a valuable strategy is to provide such information as soon as possible. Early successes tend to result in stronger support, which enables the development of better tools. Change agents in the Department should not hesitate to demonstrate partial results, if they are sufficiently accurate and useful, and even if not yet polished. This is the same strategy used by any entrepreneur when seeking investors to develop a new product or service. In fact, the activity is frequently called “intrapreneuring” (Pinchot and Pellman 1999).

Quick prototypes and demonstrations are good for transparency as well as for building support. This kind of activity is very common in innovative organizations of all types, and is a common phenomenon in transportation agencies that have implemented asset management successfully.

The Department is already broadening its asset management effort by developing the draft 2012 Alaska Pavement Report to complement its existing series of Alaska Bridge Reports. Although this study has many specific ideas to improve these reports (by broadening them into a Transportation Asset Management Plan), the existing reports are very well done, forming a solid foundation for positive stakeholder relationships.

Another Department initiative that will help is the development of a GIS-based Data Integration Page (Exhibit 10), a performance viewer for the state highway system, which could be expanded to cover any or all of the Department’s assets. This new prototype tool will help stakeholders inside and outside the Department to visualize what can be accomplished with better asset management, including better shared knowledge of the infrastructure, better communication, and better decision making.

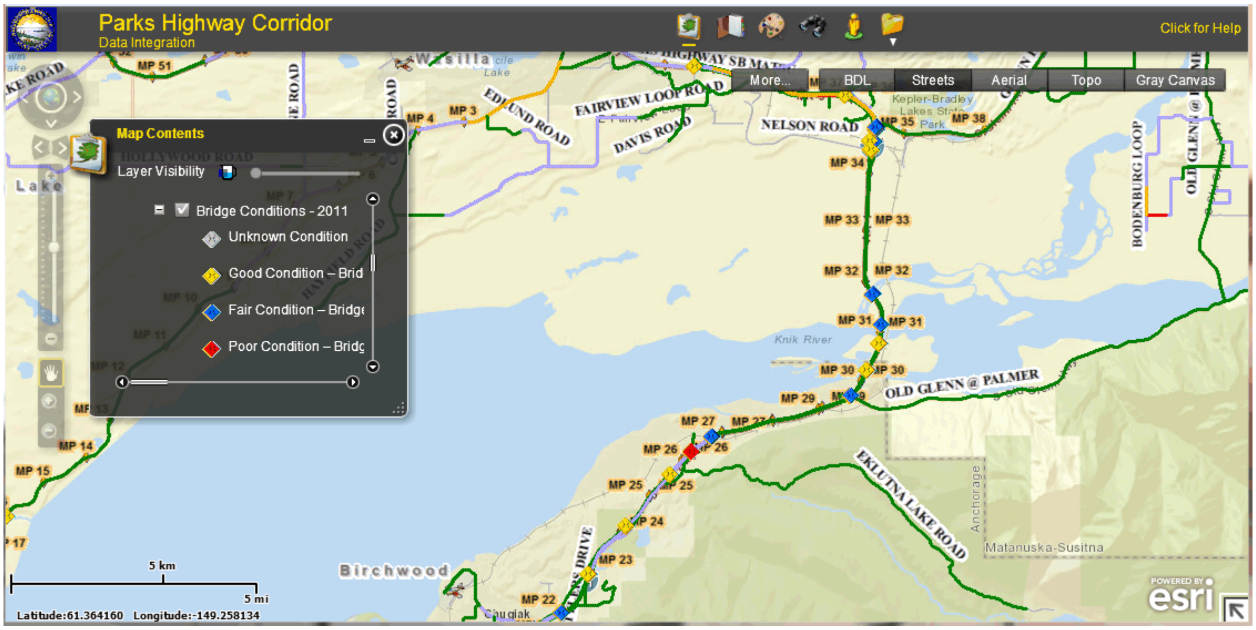


Exhibit 10. Data Integration page

Building on these recent new initiatives and the recent MAP-21 legislation, it is timely to revisit the concept of performance management, to see if an improved process based more broadly on asset management may serve decision maker needs more effectively. Several elements can help to advance this strategy:

- Treat the earlier performance based budgeting initiative as a first draft of an important, transformative work, since that is exactly what it was. Consult the stakeholders who were initially resistant, to ask for feedback on how to make it more useful and relevant.
- Improve the foundation for performance measurement and performance-based decision making, using the various recommendations made in this Synthesis and Work Plan. This report builds on the excellent work already done, filling in some of the gaps and increasing the Department's ability to reliably measure and forecast performance. Most importantly, the recommendations here will help the Department to link performance with funding, and to answer stakeholder questions and scenarios quantitatively.
- Use the Data Integration Page, now under development, to help stakeholders visualize the use of performance information to improve decision making.
- Continue to involve internal Department personnel in developing better asset management capabilities, as a means of building a team that can, together, overcome the barriers to improvement.
- Bring outside stakeholders into this team, making them responsible for continuing to improve the Department's capabilities.
- Involve new stakeholders who might not be aware of the Department's asset management efforts. Examples include a broader set of legislators, the state Office of Management and

Budget, and user groups such as the Alaska Trucking Association, Association of General Contractors, and the oil and gas industries.

- Continue to publish significant asset management accomplishments, such as the Pavement and Bridge Reports, and the Data Integration Page. This will build public expectations of transparency. Over time, the existence of this critical public information will increase Department confidence that it can stand up under scrutiny.
- In internal and external communications, start framing agency performance as though it is the most important measure of success and the most important determinant of future decisions, at least regarding the preservation of existing infrastructure.

These actions work together as an integrated package. Increased expectations, internally and externally, are essential for motivating progress; while at the same time tangible progress makes it possible to turn the expectations into reality.

2.2.5 Findings: Organization and culture

Finding 2.1. Currently asset management is widely visible within the Department but has not been integrated into organizational culture. The most advanced accomplishments in asset management so far can be characterized as heroic efforts of individuals, rather than a routine team effort. However, there appears to be a growing sense that the Department is ready to engage in team efforts on upcoming initiatives. Asset management teams have been formed and are beginning to spur progress and cooperation.

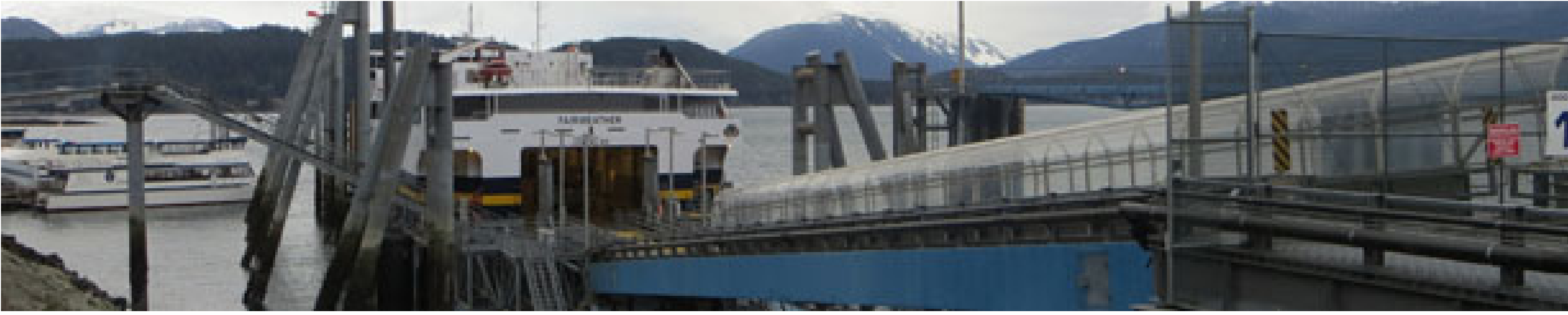
Finding 2.2. While there have been a few initiatives to increase the use of performance measurement, Department personnel and stakeholders do not yet see this as essential to their sense of mission or feeling of accomplishment. No evidence was found of any sort of accountability for quantitative performance within the agency or in relationships with outside stakeholders.

Finding 2.3. Recent efforts toward performance-based management can be treated as a first draft of a broader asset management initiative. The Department has already taken steps to significantly improve its capabilities in this area, and much more can be done in the near-term.

Finding 2.4. The Department has sufficient core staffing to make excellent strides in asset management. It was noted, however, that the Department does not use technicians and interns to the extent common in other agencies for certain tasks such as data collection. As a result, more senior professional staff time is used in performing these roles than is typical in other state DOTs. This is not uniformly reported across the Department, but has been reported in certain areas. It may be possible to leverage these senior staff better, thus allowing them to be more engaged in asset management.

Finding 2.5. The creation of a Steering Committee and TAM Technical Teams has been an important step toward making this implementation plan a reality. The Department now has the internal leadership structure necessary to advance.

Finding 2.6. Communications with external stakeholders (e.g. legislators, executive branch officials, and interest groups) on asset management issues are currently inconsistent, and do not give prominence to performance measurement as a critical issue. A formal communications plan may help the various participants within the Department to hone their message and work together more consistently on this matter.



2.3 Asset inventories

An inventory of assets is the foundation on which asset management decision support is built. Every state DOT has at least a partial inventory of its assets, with significant differences among agencies. Alaska DOT&PF has a few inventories in place, but with important gaps in coverage.

2.3.1 Background

The most complete and uniform transportation asset inventory across the nation is the National Bridge Inventory (NBI), mandated by Federal legislation. Each state DOT is required to submit an update of this inventory to the Federal Highway Administration (FHWA) each year, for nearly all bridges of at least 20 feet in span that are open to the public, regardless of ownership. The contents of this inventory are specified by the NBI Coding Guide (FHWA 1995).

All state DOTs also have a pavement management inventory (Flintsch et al 2004), although this does not have the uniform nationwide coverage and is not compiled in a centralized database as is done with the NBI. Other types of assets have less coverage in asset inventories. Exhibit 11 summarizes the number of states found to have inventories and condition data for several types of assets, according to two recent surveys.

Exhibit 11. Percent of agencies having inventory and condition of each asset type

	% with asset inventory		% with condition survey	
Asset type	2007	2012	2007	2012
Signs	56	91	28	86
Guardrail		81		72
Traffic signals	78		35	
Drainage culverts	70	72	50	67
Roadway lighting	69	70	22	65
Pavement markings	61	60	42	63
Retaining walls		49		47
Sidewalks	31		18	

2007 is from (Markow 2007), 38 responses
2012 is from (Hawkins and Smadi 2013), 43 responses
Blank indicates results were not reported.

The table shows that sign inventories have become nearly universal in recent years, and other types of asset inventories are very common. The use of condition surveys has increased dramatically in the past five years for the asset classes surveyed.

These are not necessarily complete statewide inventories. In most cases, inventories are limited to assets owned and/or maintained by the state DOT. They often are further limited to the state highway network or to particular corridors, districts, or functional classes. In most cases they are updated each year, but in some cases they are updated more often (especially for roadway lighting) or less (especially for sidewalks), or on a random schedule. Some have never been updated.

Most airport owners nationwide have some sort of pavement management program, which contains an inventory of airfield pavements. Very often these systems are site-specific, so it is unusual for them to have statewide coverage. All states have an inventory of airports as required by FAA, and some of these have pavement characteristics, although not generally enough to support pavement management applications[27].

A recent survey of state DOT asset management databases found only one (Vermont) that includes aviation assets along with highways in its general transportation asset management inventory (Hawkins and Smadi 2013).

2.3.1.1 Alaska inventory resources

Alaska DOT&PF, like most state DOTs, uses AASHTO's Pontis bridge management system to house its bridge database and to meet the NBI requirements. The Pontis inventory includes structures satisfying the National Bridge Inventory criteria on airport property (Exhibit 12), and also includes ferry ramps meeting these criteria. The Department also maintains inventories of highway and airfield pavements, and a few partial inventories of other assets discussed in the following sections.

Exhibit 12. Bridge on airport property at ANC

Most of the existing inventories can be accessed by means of a geographic data integration page that is under development (Exhibit 13). This intranet web page features a layered presentation of the state highway network, with the ability to select asset types and data items to be displayed. Although its scope is nominally limited to the Parks Highway, it contains several statewide data resources.

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[27] http://www.alaskaasp.com/admin/Docs/09%20-%20Appendix%20H%20-%20Inventory%20and%20Database%20Documentation.pdf

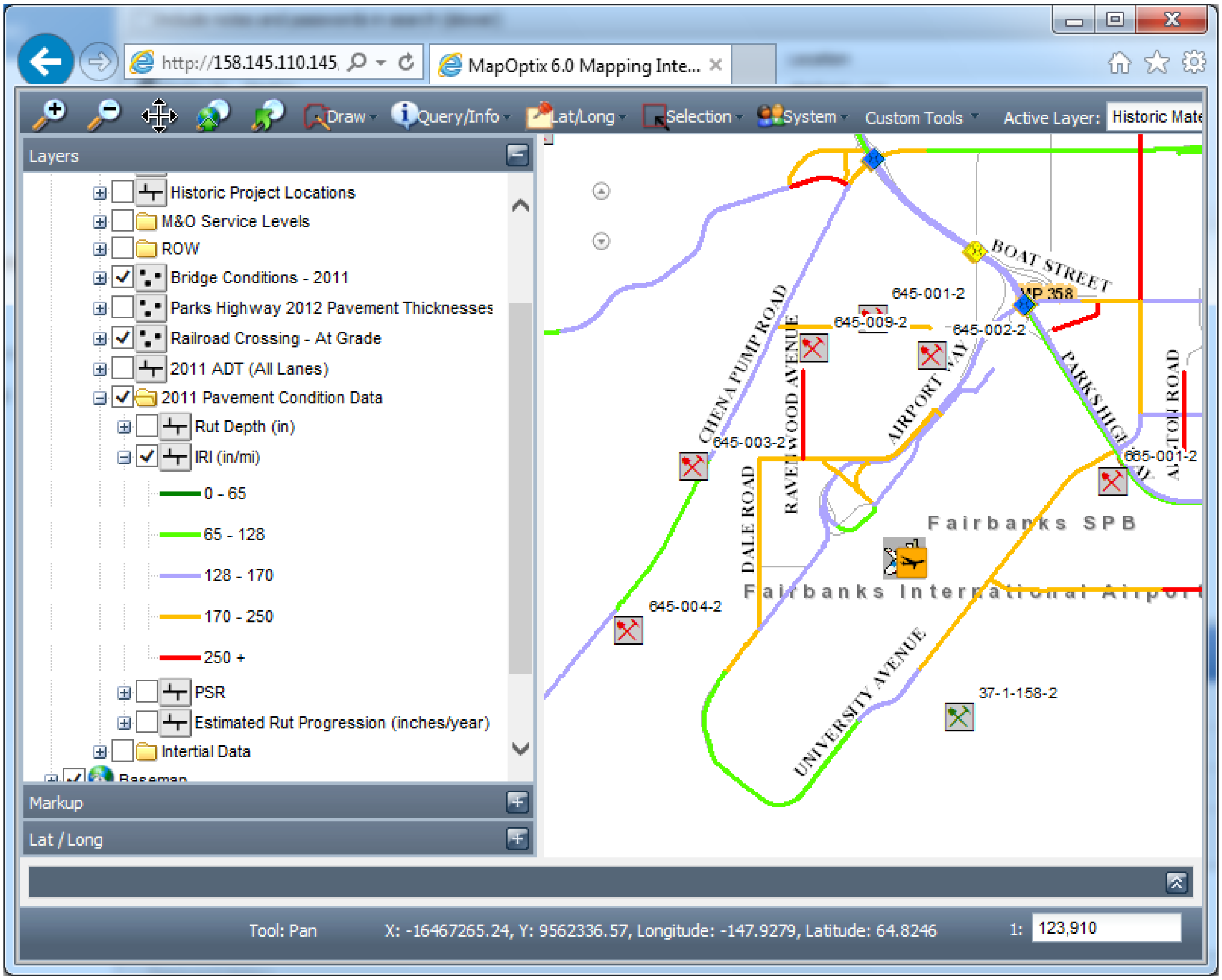

Exhibit 13. Parks Highway Data Integration Page

The Department does not have a comprehensive asset inventory for airports, but the Department web site has a statewide compendium of layout plans (Exhibit 14), which are suitable for deriving major portions of a statewide asset inventory[28]. This information was updated in 2012 and is believed to be quite accurate and complete. However, it is not stored in a relational database format that could be used for asset management purposes at the statewide level, and lacks coverage of some asset types that might be significant for asset management.

A more comprehensive inventory and condition survey has recently been completed for an FAA-funded pilot study of 20 Alaska airports. This was able to identify certain inventory assets, such as state-owned buildings, visual aids, vehicles, and drainage features that are not obvious in the layout plans. It is the intent of the Department to extend this inventory and condition survey to additional airports, the timing and number of which are dependent on funding available. The survey provides valuable experience and metrics that can be used in designing a more comprehensive and repeatable survey.

[28] http://www.dot.state.ak.us/stwdav/index.shtml

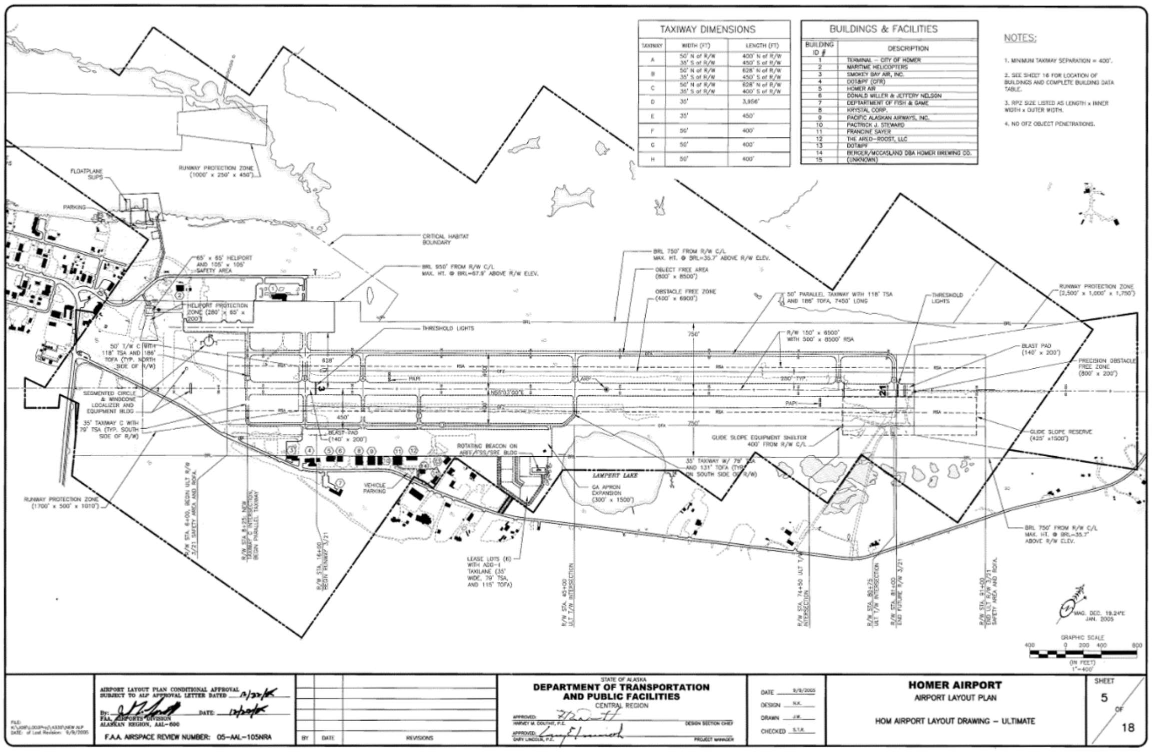

Exhibit 14. Example airport layout plan

2.3.1.2 Types of data

Later in this report is a Work Plan which envisions several tasks to fill gaps and make more progress in developing a complete asset inventory. While the technical requirements of each asset class may be somewhat unique, a few general categories of data are necessary for every type of facility:

- Identification: Road and/or facility name, route number, and enough information to clearly identify and delineate the asset for inspection, maintenance, and evaluation purposes.
- Location: Latitude/longitude and linear referencing.
- Description: Including physical classifications, number of lanes, dimensions, manufacturer (when applicable), age, and other data useful for condition/performance forecasting and cost estimation.
- Network: National Highway System, Strategic Highway Network, freight networks, school or transit bus routes.
- Jurisdiction: District, maintenance area, functional class, city, county/borough, legislative district, owner agency, maintenance responsibility, delivery responsibility.
- Utilization: Traffic volume; truck, aircraft, and vessel types; pedestrians.

- Physiography: geographic features such as rivers, climate zone, presence of permafrost, geology, hydrology.
- Cross-references: Linkages to other assets which are adjacent or related.

Inventories are most often managed in relational databases organized according to a linear referencing system. Each asset is located on the linear referencing system, and is related to other assets through that system. The linear referencing system is used to define road sections, which then may contain a list or count of assets in categories.

2.3.1.3 Level of detail

Constraints on staffing and funding typically limit each agency's ability to create and update asset inventories. Most often, the work is performed by consultants or interns. To save money, it is not uncommon for some of the updates to be performed on a sampled basis, especially for small signs and pavement markings.

Also, the inventory unit of analysis is not necessarily the individual asset. For example, traffic signal data may be gathered by mast arm or intersection rather than by individual display head or component. Roadway lighting and pavement markings are often inventoried by roadway segment, with instances of the asset merely counted and classified.

An inventory does not have to be very detailed in order to be useful for asset management purposes. Combining the insights of ACRP 69 and the AASHTO Asset Management Guide, the following considerations may be used in order to determine an appropriate level of detail:

- Assets should be divided and classified in a way that aligns with the major business functions of the owner. For example, separate airport pavements from terminals, or traffic signals from street lighting, when each of these asset classes is managed by a separate set of business processes or agency units.
- Divide assets that have independent lifespans and are typically replaced or rehabilitated separately. For example, an airport jetway will often be added or replaced as a unit separately from its terminal, but the major components of a jetway typically have the same expected lifespan as the jetway itself (Exhibit 15).
- Ensure that each asset is of sufficient economic and functional value that a periodic inspection (of a year or more in interval) is justifiable. In other words, the inspection must be worth its expense, and must produce actionable information for multi-year programming purposes.
- Ensure that typical rehabilitation or replacement projects are of sufficient size and importance that they would be reasonable line items in a multi-year capital program, AIP spending plan, or STIP.
- Define assets in a manner that has unique traceable impacts on performance measures as perceived by stakeholders. Will customers or regulators notice, in a measurable way, if the

item is taken out of service or replaced? Will the quality of transportation service break down if the item is missing or non-functional?

- Can the condition and performance of the asset be much different from other related or nearby assets, at any given time?
- Ensure that each asset can be uniquely and reliably identified, and that its data can be standardized and stored in a relational database holding all similar assets statewide.

Examples of reasonable-size assets already included in Alaska DOT&PF inventories are:

- Bridge elements, such as expansion joints and railings, which can range in value from $10,000 to over $1 million.
- Passenger cars in the state fleet, which range in value from $10,000 to $50,000.
- Segments of pavement on the highway network and in the airfield pavement management system.
- Material sites (e.g. gravel pits) used in construction.

Exhibit 15. Terminal and jetways

2.3.2 Pavements

In its Pavement Management Systems, the Department maintains a statewide inventory of state-owned pavements, for highways and airfields. Road sections of typically one mile in length form the basis of the highway pavement inventory, and have a variety of attributes associated with them (Exhibit 16). In addition to the general inventory items listed above, the pavement inventory includes:

- Pavement type
- Equivalent axle loadings
- Materials and thicknesses of pavement layers
- Design parameters
- Past construction and maintenance data
- Pavement condition data

Exhibit 16. Road section data displayed in Google Earth

A Pavement Management Engineer is responsible for keeping the inventory up-to-date as changes occur, as the result of new construction, widening, and closing of sections. The linear referencing system used in the Pavement Management System is believed to be suitable for long-term data management and is being used for location referencing of other data stores within the Department. The system itself is owned and hosted by Dynatest, which also gathers the necessary data using a specialized survey vehicle.

The Department has an aviation pavement management program, Micro PAVER, that enables airfield pavement inspections at about 17 airports per year, capturing all paved airports once every three years[29]. This provides pavement condition surveys, pavement condition indexes,

[29] http://www.dot.state.ak.us/stwdmno/pvmtmgt/pop_airports.shtml

maintenance recommendation maps, and reports summarizing airport pavement condition. Paved areas are mapped and divided into sections, based structure characteristics, utilization, and age for data management purposes.

A similar process could be applied to other paved areas such as ferry terminals, maintenance bases, and parking lots, but this is not currently done by the Department.

2.3.3 Structures

As required by Federal legislation, the Department maintains an inventory of all bridges open to the public, of at least 20 feet in span, regardless of ownership. In addition, certain bridges and culverts with span lengths of 10-20 feet are included. A few structures associated with airports and ferry terminals satisfy these criteria and are included in the Department bridge inventory (Exhibit 17).

Exhibit 17. Ferry ramp at Whittier

The inventory has all data items required by the Federal National Bridge Inventory Coding Guide (FHWA 1995), and also all structural elements described in the AASHTO CoRe Element Guide (AASHTO 2002, Exhibit 18). While the AASHTO Guide is not legally mandated, nearly all of the states use it voluntarily as an authoritative framework for performing maintenance inspections of transportation structures.

Exhibit 18. AASHTO Commonly-Recognized (CoRe) Bridge Elements
(AASHTO 2002)

Deck elements		Superstructure elements (continued)		Culverts	
12	Concrete Deck - Bare	126	Painted Steel Thru Truss	240	Unpainted Steel Culvert
13	Concrete Deck - Unprotected w/ AC Overlay	130	Unpainted Steel Deck Truss	241	Reinforced Concrete Culvert
14	Concrete Deck - Protected w/ AC Overlay	131	Painted Steel Deck Truss	242	Timber Culvert
18	Concrete Deck - Protected w/ Thin Overlay	135	Timber Truss/Arch	243	Other Culvert
22	Concrete Deck - Protected w/ Rigid Overlay	140	Unpainted Steel Arch	Expansion joints	
26	Concrete Deck - Protected w/ Coated Bars	141	Painted Steel Arch	300	Strip Seal Expansion Joint
27	Concrete Deck - Protected w/ Cathodic System	143	P/S Conc Arch	301	Pourable Joint Seal
28	Steel Deck - Open Grid	144	Reinforced Conc Arch	302	Compression Joint Seal
29	Steel Deck - Concrete Filled Grid	145	Other Arch	303	Assembly Joint/Seal (modular)
30	Steel Deck - Corrugated/Orthotropic/Etc.	146	Cable - Uncoated (not embedded in concrete)	304	Open Expansion Joint
31	Timber Deck - Bare	147	Cable - Coated (not embedded in concrete)	Bearings	
32	Timber Deck - w/ AC Overlay	151	Unpainted Steel Floor Beam	310	Elastomeric Bearing
38	Concrete Slab - Bare	152	Painted Steel Floor Beam	311	Moveable Bearing (roller, sliding, etc.)
39	Concrete Slab - Unprotected w/ AC Overlay	154	P/S Conc Floor Beam	312	Enclosed/Concealed Bearing
40	Concrete Slab - Protected w/ AC Overlay	155	Reinforced Conc Floor Beam	313	Fixed Bearing
44	Concrete Slab - Protected w/ Thin Overlay	156	Timber Floor Beam	314	Pot Bearing
48	Concrete Slab - Protected w/ Rigid Overlay	160	Unpainted Steel Pin and Hanger Assembly	315	Disk Bearing
52	Concrete Slab - Protected w/ Coated Bars	161	Painted Steel Pin and Hanger Assembly	Approach slabs	
53	Concrete Slab - Protected w/ Cathodic System	Substructure elements		320	P/S Concrete Approach Slab
54	Timber Slab	201	Unpainted Steel Column or Pile Extension	321	Reinforced Conc Approach Slab
55	Timber Slab - w/ AC Overlay	202	Painted Steel Column or Pile Extension	Railings	
Superstructure elements		204	P/S Conc Column or Pile Extension	330	Metal Bridge Railing - Uncoated
101	Unpainted Steel Closed Web/Box Girder	205	Reinforced Conc Column or Pile Extension	331	Reinforced Conc Bridge Railing
102	Painted Steel Closed Web/Box Girder	206	Timber Column or Pile Extension	332	Timber Bridge Railing
104	P/S Conc Closed Web/Box Girder	210	Reinforced Conc Pier Wall	333	Other Bridge Railing
105	Reinforced Concrete Closed Webs/Box Girder	211	Other Material Pier Wall	334	Metal Bridge Railing - Coated
106	Unpainted Steel Open Girder/Beam	215	Reinforced Conc Abutment	Smart flags	
107	Painted Steel Open Girder/Beam	216	Timber Abutment	356	Steel Fatigue
109	P/S Conc Open Girder/Beam	217	Other Material Abutment	357	Pack Rust
110	Reinforced Conc Open Girder/Beam	220	Reinforced Conc Submerged Pile Cap/Footing	358	Deck Cracking
111	Timber Open Girder/Beam	225	Unpainted Steel Submerged Pile	359	Soffit of Concrete Deck or Slab
112	Unpainted Steel Stringer	226	P/S Conc Submerged Pile	360	Settlement
113	Painted Steel Stringer	227	Reinforced Conc Submerged Pile	361	Scour
115	P/S Conc Stringer	228	Timber Submerged Pile	362	Traffic Impact
116	Reinforced Conc Stringer	230	Unpainted Steel Cap	363	Section Loss
117	Timber Stringer	231	Painted Steel Cap		
120	Unpainted Steel Bottom Chord Thru Truss	233	P/S Conc Cap		
121	Painted Steel Bottom Chord Thru Truss	234	Reinforced Conc Cap		
125	Unpainted Steel Thru Truss	235	Timber Cap		

The FHWA Coding Guide incorporates many of the inventory data items listed above, including identification, location, description, networks, jurisdiction, and utilization data. It has fields for linear referencing of roadways on and under each bridge, enabling a linkage with the pavement linear referencing system. Physiographic and asset cross-references are not included in the Coding Guide, although many states have extended their bridge inventories to include this information.

Alaska's bridge inventory is maintained in Alaska's implementation of the AASHTO Pontis Bridge Management System. Pontis was developed with FHWA funding starting in 1989, and was turned over to the state governments via AASHTO in 1994. Since then, AASHTO has kept it up-to-date through its AASHTOWare software development program. More than 40 state governments, as well as several municipal and international agencies, use Pontis. Thus there is a high degree of standardization of inventory and inspection practice, enabling the private sector and national research agencies to provide cost-effective products, research, and training centered on Pontis. Alaska has been able to obtain software, updates, and training at very low cost by means of this AASHTO mechanism.

AASHTO has recently published a new update of its element inspection guide (AASHTO 2010), which takes into account a modern understanding of bridge deterioration processes and protective systems such as paint and bridge deck wearing surfaces. It is anticipated that a portion of this guide, called the National Bridge Elements, may become part of the Federal National Bridge Inventory, and become a part of the mandated bridge inspection program. The MAP-21 legislation will enable this change. Regardless of the mandate, the Department has determined that the new standard will improve maintenance decision making within the Department, and has expressed an intention to adopt the new AASHTO Guide. AASHTO is updating the Pontis software to facilitate the implementation of the new inspection guide as well.

An implementation date for the new AASHTO Element Inspection Manual has not been set by the Department, but it is believed to be after 2014. This is because there are still a number of steps to be taken to facilitate implementation, including Federal regulatory changes, AASHTO software development, and FHWA/National Highway Institute development of manuals and training classes. To save money and insure against wasted effort, it is advantageous for the Department to continue to follow the FHWA and AASHTO schedule for this upgrade.

Given the existence of a stable and full-featured inventory and inspection system within Pontis, many states have extended Pontis to include other types of structural assets. Common examples are tunnels, drainage culverts, sign structures, traffic signal mast arms, high-mast light poles, marine piers, and retaining walls. Aviation and marine structures can readily be included. Usually the factor that motivates state DOTs to add these structures to Pontis is the desire to perform periodic inspections for deterioration, fatigue, and damage.

2.3.4 Buildings

The building inventory available to the Department includes all 2269 state-owned enclosed structures in which workers or the public might enter. This ranges from storage sheds and pump houses to employee housing and office buildings. It includes airport and ferry terminals (Exhibit 19). The inventory, a simple spreadsheet file, is maintained by the Department of Administration for risk management purposes. Most of the buildings are not primarily concerned with transportation service and are occupied by agencies other than the DOT&PF. It is not clear how many of these buildings would be subject to DOT&PF asset management responsibilities.

Exhibit 19. Utility building and Ketchikan Ferry Terminal building

Columns in the building spreadsheet include:

- Identification and classification data, including identification of the owner or tenant agency;
- An address, providing at least the city and sometimes a street address. The data are not geocoded, and fewer than one-third of the records have addresses that can be geolocated.
- Square footage and occupancy rate;
- Original and replacement value;
- Acquisition date, which is not necessarily the date the structure was built (if it was purchased from another owner).

The building inventory does not have any information about building systems. However, it is common in building management to inventory and inspect the major systems of buildings, which may include:

Substructure
Shell
Interior construction
Finishes
Electrical and lighting
Plumbing
Fire protection
Communication
Security
Heating
Ventilation
Air conditioning
Elevators
Escalators
Other conveyances and equipment
Site development
Utilities

The recently-completed 20-airport pilot study is evaluating the condition of airport buildings using a taxonomy like this one. Of course, only the systems that actually exist in each building would be inventoried. It is possible to define levels of service for each possible system, as described in the Inspection section below, and avoid the need to inventory building systems. The levels of service together comprise an inspection checklist for each building.

In general, the buildings in the inventory are managed by the regional offices or by tenant agencies, which each have their own procedures and systems for maintenance. This could present a barrier to implementation for a more comprehensive building inventory and inspection process.

2.3.5 Equipment

The state's Equipment Management System (EMS) manages "anything with a license plate," including maintenance vehicles (Exhibit 20), state police cruisers and motorcycles, snow removal equipment, and construction equipment. It does not include boats, aircraft, snow machines, or any other equipment that is not meant to operate on the highway[30]. Many of these state-owned vehicles are used by agencies other than the DOT&PF. The database contains more than 13,000 asset records.

Exhibit 20. Front loader managed in the State Equipment Management System

Since the EMS is the Department's primary system for managing its fleet, it has an extensive set of data for tracking vehicle assignments, scheduling maintenance, handling warranty service, billing costs to appropriate agencies, managing fuel and parts, and maintaining a detailed history for each vehicle. For asset management purposes, the inventory has useful data such as:

- Identification and classification data (VIN, make/model, class);
- Model year and acquisition date;
- Availability;
- Odometer mileage;
- Cost and replacement value (which appears to be incomplete);

The database contains past and future scheduled maintenance data, and inspection history. It is able to forecast future replacement needs based on equipment age (but not based on condition). It does not have features to forecast future equipment maintenance based on predictions of future condition, utilization, or age. However, equipment managers have the ability to access maintenance history locally to plan local maintenance needs.

[30] Conversation with Brad Bylsma.

2.3.6 Other assets

The four major asset categories covered in the preceding sections — pavements, structures, buildings, and equipment — represent the most visible and costly infrastructure managed by the Department. All are multi-modal, in that they serve highways, aviation, and marine transportation of people and freight. Behind the scenes are some additional asset types, perhaps less visible but still essential to the provision of transportation service. Many of these are multi-modal as well, and some encompass additional transportation modes such as pedestrian and bicycle travel, and public transit.

2.3.6.1 Airport-specific assets

Many types of airport facilities can readily be included — and many are already included — in the inventories discussed above. These include airfield and ground-side pavements, unpaved or gravel-surfaced landing strips, airport bridges, terminal and utility buildings, and certain airport service vehicles. In a future Alaska statewide airport asset database, the following additional items also serve essential purposes for many of the 254 state-owned airports where they exist:

- Jet bridges
- Lighting systems
- Groups of pavement markings (distinguished in the same way as pavement sections)
- Groups of signs and other visual aids
- Windcones and related equipment (e.g. segmented circles)
- Fencing and barriers
- Tie-downs (if significant enough in cost individually, or in groups)
- Docks, float slips, and access bridges for seaplane bases
- Washing, fueling, and deicing stations and tanks if significant in cost
- Vehicles, if not already included in the State Equipment Fleet inventory – may include snow removal, graders, loaders, friction measuring devices, SSO vehicles, emergency equipment, etc. (Exhibit 21)
- Geotechnical assets (embankments, retaining walls)
- Major drainage assets and systems

Exhibit 21. Airport snow removal equipment

On the ground side, assets would logically be divided and classified in the same manner as similar highway assets, for pavements, bridges, signs, etc. Also, while some of the assets listed above are unique to aviation, others are very similar to assets that occur in highways or public facilities. There may be economies of scale in working with other divisions within the Department rather than creating new databases for some of these assets.

2.3.6.2 Marine-specific assets

The eleven ferry vessels can be found in a sort of inventory on the AMHS web site[31] (Exhibit 22). This has basic information about the size and capacity of each ship for public information purposes. Each vessel is custom-built and unique, and each already has a system of maintenance procedures and tools associated with it. Since vessel acquisition and rehabilitation can appear in the STIP, and have a significant impact on statewide transportation system performance, it would make sense to have the vessels included in the statewide asset management process. This would be relatively easy to do since the assets are well known, and the amount of data is small compared to the data already used in maintaining and operating the vessels.

Currently there is no inventory of docks, piers, breakwaters, and other assets typically found in ports and harbors. For the most significant of these assets, it may be cost-effective to cover them as part of the bridge management system.

[31] http://www.dot.state.ak.us/amhs/vessel_profiles.shtml

Exhibit 22. MV Kennicott

2.3.6.3 Transit

Approximately 50 agencies provide transit service in Alaska. Fifteen are Public Transit Systems, while most of the remainder are human services agencies. The Department itself does not operate any transit service and does not maintain any transit assets, but it acts as the local recipient of all Federal funding for transit.

The state is the lienholder on transit equipment purchases until they complete their expected useful life, and then full ownership passes to the operator, which may subsequently keep the equipment in service if necessary and feasible until it must be replaced. All transit purchases are included in the STIP, and any state expenditures on matching funds must go through the Department's programming process.

Generally when an agency buys vehicles or any other capital assets, it prepares a grant application for Federal funding, and also provides the local match (typically 20% for human services and 10% for Public Transit agencies). Recently the state has also provided some matching funds ($1 million in 2012 and $2 million in 2013), but it is not clear whether this will continue in the future. The State has the right to approve or deny these applications, but generally accepts them as long as they adhere to the Federal rules.

Many of these agencies perform their own maintenance, and others contract it out. Some of them have maintenance facilities for this purpose. Agencies also own park-n-ride lots, bus stop shelters, and at least two intermodal buildings. Anchorage has two transit centers, while Fairbanks and Juneau each have one (Exhibit 23).

Exhibit 23. Max C. Lyon, Jr. Transit Center in Fairbanks

The Department has been actively facilitating the adoption of asset management methods in the transit agencies, and has been training the transit properties on the development of transportation asset management plans.

Since transit assets participate in some aspects of statewide programming and STIP development, it may be useful to have a statewide Transit Improvement Program similar to the Airport Improvement Program. It would list the individual projects to make them visible at the statewide level. (Currently, all transit projects are folded into one line item in the STIP.) This would be a 15-year plan that enables the Department to plan all upcoming vehicle replacement projects and anticipate the ups and downs of capital needs. The Department TAMP would include a transit component with all of the relevant ingredients, but focused on just the Department's capital procurement role rather than on preservation.

2.3.6.4 Geotechnical

Because of the climate and topography of Alaska, the state's roads are especially vulnerable to damage from natural hazards such as floods, storm surge, landslides, rockfall, frost heave, permafrost melting, and earthquakes (Connor and Harper 2013). Moreover, the sparse highway network raises the impact of roadway damage, since alternate routes may be very long or non-existent.

Many of the geotechnical features of the transportation system are, or include, constructed facilities that would benefit from being managed as assets. Such management would include:

- Developing a comprehensive inventory of the facilities or features;
- Creating a survey of the hazards that threaten each facility, with quantitative estimates of the likelihood, consequences, and impacts of extreme events and failures;
- Periodic measurement of the condition and performance of geotechnical facilities and features;
- Gathering data to support the development of cost-effective mitigation actions;

- Developing objective procedures for project selection, priority-setting, and programming of preservation and mitigation actions;
- Collection of data on the cost and effect of preservation and mitigation actions after they are taken.

Examples of geotechnical features that would benefit from asset risk management include soil and rock slopes (especially slopes believed to be unstable), rockfall protection systems (Exhibit 24), embankments, materials sites, retaining walls, and foundation elements.

Exhibit 24. Rockfall protection system

Currently none of the states has a comprehensive inventory of geotechnical assets, but several states have started work on them, and the National Cooperative Highway Research Program has begun to fund research in the area. Of all the states, Alaska is the most vulnerable, and would benefit most from leading this movement.

Currently, the Department has a statewide inventory of materials sites; a partial statewide inventory of the "Top 200" unstable slopes rated for hazard and risk; and a retaining wall management program is underway with an inventory, but is not fully developed. An ongoing study considering the Parks Highway as a future gas pipeline corridor could provide a basis for development of concepts for inventories of geotechnical and other corridor assets. To capture the value of these inventory efforts over the long term, a process of periodic inspection of these assets; development of condition indices, service levels and performance measures; development of methods to aggregate condition indices for corridor assets; and research on preservation and mitigation actions are needed.

2.3.6.5 Drainage

Alaska's Pontis bridge inventory already contains all culverts of over 20 feet in diameter, as well as many smaller culverts of at least 10 feet. In other states, it is becoming common to inventory all culverts of at least 4-6 feet, for inclusion in a periodic inspection process of 2-4 years' interval.

Blockage of any culvert, and deterioration of larger culverts, can result in sudden unexpected erosion and road damage, which often interrupts the flow of traffic until the damage is repaired. Other drainage facilities such as ditches, swales, catch basins, detention ponds, and dikes/levees offer this potential as well. The risk of traffic disruption can be reduced if all of these assets are inventoried, and checked periodically for problems. Assets that prove to have recurring problems can then be discovered and replaced with less vulnerable facilities or outfitted with protection systems (Exhibit 25).

In a recent pavement condition survey on the Parks Highway, a photo-logging process was used to identify locations where culverts may be present. This could help to jump-start the development of an inventory of all culverts, which could then form the basis of an inspection process. Maintenance crews currently check culverts on a non-scheduled basis, as a part of their other duties. So a more formal process would not necessarily add to their workload, as long as the means of recording the assessment is quick and reliable. This would provide a basis for an "institutional memory," that would enable the discovery of patterns, to help the Department reduce the risk of drainage-related road failures.

Exhibit 25. Culverts with heating systems

2.3.6.6 Traffic control

As described in Markow (2007), most of the states now have inventories of significant traffic control devices, such as signs, signals, and pavement markings. In a minority of cases these may take the form of a dedicated information system such as a Sign Management System. More often, these assets are merely added to existing management systems such as those for pavements and bridges, or stored in ad hoc databases or spreadsheets.

Alaska's DOT&PF is nearing completion of a statewide sign inventory (Alaska DOT&PF 2011). The Northern Region completed its inventory of some 25,000 signs in 2010, and the Southeast Region inventory is also complete. The Central Region is due to be complete in 2013. The inventory lists each sign individually, describes the location and physical characteristics of each sign, includes an assessment of physical condition and measured retroreflectivity, and has photographs. Signs of all sizes down to mileposts and markers are included.

Ten years ago the Department created an inventory of cantilever structures such as sign structures (Exhibit 26), traffic signal mast arms, and railroad crossing signal supports. An Excel file of passing lanes also exists. The Department would benefit from a more comprehensive effort to develop an inventory of all its traffic control devices and, most importantly, to update the inventory and condition data periodically. The following types of assets could be included:

- Signs (sheeting, posts, sign structures, delineators, mileposts, snow poles).
- Signals (displays, controllers, poles, mast arms).
- ITS equipment (sensors, counters, variable-message signs, weigh-in-motion, cameras).
- Pavement markings (striping, markings, markers, rumble strips).
- Railroad crossings (displays, bells, gates, signal support structures, controllers, crossing surface/flangeway).

An inventory of all of these assets could be built first for a portion of the state highway network, such as the Parks Highway. The effort would be used to develop, document, and test the data collection processes and information systems. The inventory could then be extended to other types of assets and other corridors.

Exhibit 26. Cantilever traffic signal mast arms

2.3.6.7 Appurtenances

A majority of states have inventories of roadside features (Markow 2007, Exhibit 27), but this inventory is often ad hoc in nature and not routinely updated. High-mast light poles are frequently inventoried because of fatigue concerns that necessitate periodic inspections. As a result, these are often included in bridge management system databases. Certain roadside features such as guardrails and barriers are often inventoried as part of a photo-logging process, using pavement survey equipment. However, this process seldom provides the performance and condition data necessary for asset management.

It is likely that these assets will be considered to be of lower priority than traffic control or geotechnical assets, yet they do have an identifiable effect on transportation system performance measures such as life cycle cost, safety, and externalities. If the Department proceeds to develop an inventory system for its more significant assets, it may later want to extend the same inventory to roadside features. The types of assets that could be included are:

- Lighting (luminaires, poles, hi-mast light poles, transformers, controllers), including parking lot, ferry terminal, and bikeway lighting.
- Sidewalks, curbs, gutters, medians, bicycle lanes/paths, manholes, drop inlets.
- Guardrails, barriers, impact attenuators, and vehicular gates.
- Sound walls and fences.
- Landscaping.

These could be added in priority order at any time in the future. To preserve the value of the data collected, it is important to also have an efficient means of updating the inventory, condition, and performance of these assets periodically in the future.

Exhibit 27. Guardrail and bike path

2.3.7 Data governance and life cycle

Recent Department efforts in the area of data governance are very relevant to the development and maintenance of asset inventories (Cambridge 2009). Information systems for asset management do not have to be highly technological or complex. However, over time as the systems become populated and used, they do tend to expand to more users and more applications. This natural evolution tends to increase technological requirements and the potential for conflicts over data ownership, quality, and maintenance responsibility.

Because of this natural growth, it is useful to make a few early decisions about the architecture and responsibilities of asset inventory and condition data. Within the specific environment of the Alaska DOT&PF, several factors influence the ideal approach:

- The pavement and bridge management systems within the Department have their own unique development life cycles, influenced by industry standards, ongoing research, and pooled funding. The Department achieves significant benefits from continuing to use these systems, including significant cost savings.
- For other types of assets, the Department does not have information systems in place. Some development options include: developing a new centralized asset management database to accommodate all assets other than pavements and bridges; developing separate information systems for each type of asset; adding more asset types to the existing pavement, bridge, or maintenance management systems; or a mixture of these approaches. This might or might not involve an integrating data warehouse or ERP software framework (such as Cognos).
- Given constraints on staffing and funding, an incremental approach may be necessary for adding new asset types. Even if funding can be identified for system development by consultants, the Department may not have sufficient staffing to supervise the effort and launch all the necessary data collection and quality assurance processes all at once.
- Current business processes within the Department do not feature a significant degree of integrated data collection across asset types. However, such integration is a potential way of improving communication and cooperation in asset management activities, as well as a way to save money and increase quality.
- For assets not currently served by Department information systems, many of the necessary inventory and condition data requirements are very similar in structure to the existing data stores for pavements and bridges. For example, condition data for many asset types readily fit into the element and condition state framework already used for bridges. Inventory and performance data for many asset types may fit the geographic referencing system used in the pavement database.

Given this background, one promising way to proceed is to first investigate the suitability of the existing pavement, bridge, and MMS databases to be linked and expanded to incorporate new asset types. Many state DOTs have been able to do this at low cost. Aside from cost savings, a key benefit is the ability to take advantage of existing software and linkages for geographic referencing, reporting, and possibly certain decision support functions. In addition, this commonality of systems may help to reduce data collection and training costs.

The data governance issues surveyed in the Cambridge (2009) report are highly relevant to this investigation, and may take some time to resolve. Fortunately, it is possible to pursue the matter incrementally, using the existing pavement and bridge databases, or copies of those databases, to provide interim models or scaffolding for systems to support new asset types. This would be one approach that would enable relatively rapid progress and early success. It has frequently been noted in asset management applications that the existence of a working prototype helps to encourage cooperation and reduce risk in cooperative efforts.

2.3.8 Findings: Inventories

Finding 3.1. Currently the Department has up-to-date inventories for pavements, bridges, large culverts, material sites, unstable slopes (partial, not fully deployed), signs, and transit assets. It has some pieces of other inventories, but these have not been kept up-to-date. The Department has a considerable amount of data on its state-owned airports, but not in a form that is readily usable for asset management. The airport pavement management system covers paved airfields, but not gravel or unpaved runways.

Finding 3.2. A study is underway to investigate the Parks Highway corridor as a possible location for a new gas pipeline. Potentially this study might be used as a means of expanding the asset inventory in the corridor.

Finding 3.3. Most of the existing inventories can be accessed by means of a geographic data integration page that is under development. This intranet web page features a layered presentation of the state highway network, with the ability to select asset types and data items to be displayed. Although its scope is nominally limited to the Parks Highway, it contains several statewide data resources.

Finding 3.4. A pilot study of 20 airports, recently completed, will fill in many of the important data gaps for those airports. This will provide important experience and metrics for designing a more complete and repeatable statewide program.

Finding 3.5. Many of the most significant assets of the AMHS are included in existing inventories of buildings, vehicles, pavements, and structures. Ferry vessels are the major exception. Many additional assets associated with ferry terminals could be included in existing or planned asset inventories associated with highways. These would include marine structures, geotechnical and drainage features, traffic control devices, and roadside features.

Finding 3.6. Currently the Department has good coverage of inventory data on its buildings and rolling stock. A few types of assets are not covered, but these may be considered to be of lower priority for asset management. Building inventory data do not include information about building systems that might require programmed rehabilitation or replacement.

Finding 3.7. The Equipment Management System has a relatively mature process for asset management, and contains sufficient asset inventory data to serve this purpose well.

Finding 3.8. The existing pavement and bridge management systems appear to provide the necessary storage and data management for inventories of those assets. These same databases use relatively generic schemes for structural elements and roadway segments that may be adaptable to additional types of assets. In fact, it is at least within the realm of technical possibility that inventories of all significant asset types could be housed by extending these existing systems. However, many administrative and technical questions would still require exploration in order to select the best approach. DOT&PF has contracted for the development of a Transportation Asset Management Information System Plan to address these questions.

Finding 3.9. It is unknown, but could be investigated, whether any of the existing functionality of the pavement, bridge, and maintenance management systems, or the DOT&PF's existing Cognos system, could be extended for inventory data management for assets other than pavements and bridges. Additional software and tools could be added if found to be necessary for additional asset types.

Finding 3.10. The data governance issues identified in the Cambridge (2009) reports are important and will need to be addressed. In particular, it is important that issues of data ownership and maintenance responsibility be clear, and that all data users be assured of a process to satisfy their needs. The Data Integration Team is developing a Department-wide policy for data governance.

2.4 Inspection and monitoring

Typically the highest priority data collection task in asset management is the establishment of an inventory. After all, an agency has to know what assets it owns, before it can manage them. Once an inventory is established, the next priority is to have a systematic process for tracking condition and performance over time. With this information, it can accomplish several useful objectives:

- Readily identify the assets that are most in need of repair or replacement at any given time, without missing any;
- Apply decision criteria consistently across the entire network;
- Identify systematic problems requiring research, changes in procedures, or management focus;
- Allocate resources fairly;
- Ensure that preventive maintenance is applied in the places and at the times where it is most cost-effective;
- Optimize the performance of the network as a whole;
- Anticipate future replacement and funding requirements;
- Minimize asset failures, service disruptions, and liability;
- Minimize life cycle costs.

Usually the first complete survey of asset condition and performance is performed at the same time as the field work to establish the inventory. However, it is necessary to return to each asset periodically to record changes in condition and performance. This is done most efficiently by means of an inspection or monitoring program. The things that can change between inspections include the following:

- All construction materials and devices deteriorate under the influence of weather, age, and traffic. Once deterioration has proceeded far enough, an asset may stop functioning, or function at reduced effectiveness. This could disrupt service or compromise safety.
- In many cases, an asset will exhibit symptoms indicating prime opportunities for inexpensive preventive maintenance (Exhibit 28). If these opportunities are missed, the agency may be forced to undertake much more expensive actions to maintain service or safety.

Exhibit 28. Preventive maintenance opportunity

- Traffic growth may cause problems to arise where they had not been observed previously. This is especially the case with bridge decks and joints, weak pavement subgrades, and pavement markings.
- General warming of the climate, or shorter-term weather events, may cause problems to arise where they had not been observed previously (for example, permafrost melting).
- Roadway features are occasionally damaged by collisions, storms, earthquakes, or passage of heavy loads.
- Agency standards change over time as more is learned about the effectiveness of system components, or as public expectations change.

Usually the periodic inspection is also the time to record the effects of agency actions that have taken place since the previous inspection. This may include improvements in condition or function; additions or deletions from the asset inventory; replacement of assets; or changes in asset characteristics. Important decisions, affecting large financial investments, are made based on inventory and performance data. Therefore it is important to ensure that this information remains accurate.

2.4.1 Inspection interval

Pavement condition surveys on the state highway network are repeated on each road section annually, and once every 3 years on each of the 55 paved airfields[32] (Exhibit 29). Bridges and other long-span structures are inspected typically on a 2-year interval. These intervals are appropriate given the lifespans and risk exposures of these assets. As a general rule of thumb, most types of assets should be inspected at least 5 times during their typical life, and more often for risk-sensitive assets such as bridges, or timing-sensitive conditions such as pavement cracking.

In most cases it is not necessary to inspect an asset more than once a year, with the exceptions being safety-critical assets such as traffic signals and certain street lighting. Exceptions are also typically made when as asset is seen to have special safety or risk concerns: for example, a fracture-critical bridge where steel cracking has been found, or an unstable slope that is saturated with water and/or showing unusual movement.

Exhibit 29. Airfield pavement condition

[32] http://www.dot.state.ak.us/stwdmno/pvmtmgt/pop_airports.shtml

2.4.2 Condition and performance monitoring program

The main elements of an effective asset condition monitoring program are:

- A predictable schedule of visits to every asset in the inventory. This entails a network-wide planning activity that fits with other responsibilities of agency personnel, and that is suitable for asset lifespans and risk exposure.
- Allocation of necessary resources to ensure that all assets are visited by personnel at the right skill level, with the right equipment. In most cases, inspections are performed by trained technicians with occasional engineering supervision, in most transportation agencies. In some cases (such as automated pavement surveys and complex bridge inspections) specialized consultants are used. Often for low-risk assets, the technicians are engineering students working on summer internships.
- Documentation and training for inspection personnel so they can reliably identify the conditions they are expected to record. Often national and state research programs, and AASHTO manuals, can be relied upon for standardized documentation that can be adapted to Alaska conditions.
- An efficient means/logistics of transporting personnel and/or equipment to each inspection site. Usually the travel route of the inspection team is carefully planned, and the team addresses multiple asset types in the same trip.
- An efficient method of capturing the necessary data. The inspectors must be properly trained and equipped for each asset they are expected to inspect. Electronic data capture is becoming increasingly common (Exhibit 30). Photographs should also be captured.

Exhibit 30. Sign retroreflectivity declines with age[33]

[33] http://safety.fhwa.dot.gov/roadway_dept/night_visib/policy_guide/fhwasa08001

- A quality assurance program. Acceptable levels of accuracy, precision, coverage, and other relevant attributes must be defined. Inspection personnel must be trained and refreshed to ensure they can satisfy the requirements. Independent audits, by random sampling, ensure that the collected data meet the requirements. A process must be established to correct unacceptable inspections as well as to ensure that the inspector's procedure is corrected.
- An information system for storing inspection results, linked with the asset inventory.
- Systems for using the inspection results for a variety of purposes, such as performance tracking, public information, stakeholder communications, project scoping, priority setting, and programming.

These characteristics are typically spelled out in agency policy documents and manuals.

2.4.3 What to inspect

Inspections focus on the performance attributes and asset components that are most important for decision making. In general, a performance measurement or condition state should be monitored only if it has some effect on the actions the agency may take. It may affect the type of action (for example, preventive maintenance or replacement), timing, cost, future deterioration rates, or priority. Data items should be added sparingly after due consideration of the incremental cost and benefit of each item, and only when there is a specific plan for how the data will be put to use by decision makers or researchers.

Exhibit 31 lists the asset types and performance characteristics typically inspected by a transportation agency. The table lists the type of data item, the agency performance concerns that each item addresses, the relative priority, and the implementation readiness within the Alaska DOT&PF.

Pavement and bridge conditions are gathered by all state DOTs at the current state of the practice, due to the large investment each agency makes in these assets (Hawkins and Smadi 2013). Other asset types are less commonly surveyed.

After the first two groups, the remaining rows of Exhibit 31 are performance indicators where changes over time can affect agency actions. Even without systematic performance monitoring, most transportation agencies drive maintenance and replacement actions based on these types of performance. A systematic monitoring program makes maintenance activities more predictable and efficient, and can form the basis for reliable budgeting and funding for asset preservation and management. The result is lower life cycle cost, lower risk, and better performance.

Exhibit 31. Data for condition and performance monitoring

		Performance concerns								Priority[7]		
Asset class and measure	Description	Condition	Function	Availability	Life cycle cost	Mobility	Safety	Risk	Externality	Comply with MAP-21	Internal manage-ment	Readi-ness
Pavement[1]												
Roughness (IRI)	Short-wave due to wear, potholes	x	x		x		x		x	1	1	1
Rutting	Studded tires or weak structure	x			x		x			1	1	1
Frost heave	Long-wave due to freeze/thaw	x			x		x		x	2	1	2
Cracking	Alligator, longitudinal, or transverse	x			x					2	1	2
Surface distress	Raveling, skid, other surface defects	x					x			2	2	2
Spring bearing capacity	Ability to carry heavy wheel loads	x	x		x	x				3	2	3
Bridges												
Bridge condition	Element inspections	x			x			x		1	1	2
Load rating	Strength to carry heavy vehicles		x			x		x		1	1	1
Clearances - vert, horiz	Limits use by trucks		x			x		x		1	2	1
Geometry	Narrowness or alignment		x				x			1	2	1
Scour	Loss of foundation support	x						x		2	1	3
Ice or debris buildup	Damaging pressure on structure	x						x	x	2	2	2
Fatigue	Cracking due to repetitive loading	x			x			x		2	2	2
Buildings												
Condition assessment	Level of service by building system	x			x		x	x		2	1	2
Functional adequacy	Meeting the needs of building users		x	x			x	x		3	2	2
Vehicles and equipment												
Reliability ratio	Defined in P&P 11.04.012	x		x		x				3	1	1
Condition assessment	For replacement, P&P 11.05.020	x								2	1	2
Maintenance schedule	Compliance mfr. recommendations				x		x	x	x	3	1	1
Utilization	Miles and hours used		x		x	x		x		3	2	1
Life cycle cost	Economic life per P&P 11.05.001				x					2	2	2
Mode-specific assets												
Airport-specific assets[2]	Condition, availability, function	x	x	x	x	x	x	x	x	2	2-3	2
Marine-specific assets[3]	Condition, availability, function	x	x	x	x	x	x	x	x	2	2-3	2
Transit-specific assets[4]	Condition, utilization, age	x				x			x	2	2-3	2
Other assets												
Slope stability	Movement that could accelerate	x			x		x	x		2	1	1
Embankment movement	Freeze/thaw or water movement	x			x	x		x		2	1	1
Retaining walls	Element condition	x	x		x			x		2	1	2
Scour	Due to water or ice flow	x						x		2	1	3
Device visibility[5]	Retroreflectivity	x					x			2	1-2	1-2
Material sites	Availability and condition	x		x	x					3	2	1
Rockfall protection	Element condition		x				x	x		2	2	2
Culverts, drainage	Element condition, blockage	x	x					x		2	2	2
Presence where required	Mainly safety equipment		x				x			2	2	2
Standards adherence	Mainly safety equipment		x				x			2	2	2
Electrical function	Reliability of traffic signals, lighting		x				x			2	2	3
Non-bridge structures[6]	Element condition	x			x	x	x	x	x	3	2-3	2
Collision damage	To roadside features	x	x				x			3	3	2
Fences, landscaping	Element condition	x	x				x		x	3	3	3

Notes:
1. Federal rule-making may specify pavement condition indicators for MAP-21 compliance
2. Airport assets not otherwise listed: especially jetways, windcones, tie-downs, deicing stations, off-road equipment
3. Marine, seaplane, and harbor assets not otherwise listed: especially ferry vessels, docks, float slips, and breakwaters
4. Related to asset funding and procurement of buses, maintenance facilities, transit centers, etc.
5. Signs, pavement markings, traffic signals. Sign inventory nearly complete statewide.
6. Barriers, guiderails, sign supports, mast arms, high-mast light poles, sidewalks, curbs, sound walls
7. Priority and readiness: 1=highest, 2=medium, 3=lower

For most asset classes beyond pavements (including aviation and marine assets), a set of levels of service are defined. Typically each asset has up to 5 levels of service, which can be thought of as excellent/good/fair/poor/failed, or A/B/C/D/F. Exhibit 32 shows some typical examples from Alaska bridge inspection practice, and the following section on Performance Assessment provides some more examples. It is important that each level of service be clearly identifiable by visual observation or the use of quick, inexpensive testing protocols (for example, operating a jetway through one cycle).

Exhibit 32. Examples of AASHTO CoRe elements and condition states
(AASHTO 2002)

13 - Concrete Deck - Unprotected w/ AC Overlay	107 - Painted Steel Open Girder/Beam
1. The surfacing on the deck has no patched areas and there are no potholes in the surfacing.	1. There is no evidence of active corrosion, and the paint system is sound and functioning as intended to protect the metal surface.
2. Patched areas and/or potholes or impending potholes exist. Their combined area is 10% or less of the total deck area.	2. There is little or no active corrosion. Surface or freckled rust has formed or is forming. The paint system may be chalking, peeling, curling, or showing other early evidence of paint system distress, but there is no exposure of metal.
3. Patched areas and/or potholes or impending potholes exist. Their combined area is more than 10% but 25% or less of the total deck area.	3. Surface or freckled rust is prevalent. There may be exposed metal, but there is no active corrosion which is causing loss of section.
4. Patched areas and/or potholes or impending potholes exist. Their combined area is more than 25% but less than 50% of the total deck area.	4. Corrosion may be present but any section loss due to active corrosion does not yet warrant structural analysis of either the element or the bridge.
5. Patched areas and/or potholes or impending potholes exist. Their combined area is 50% or more of the total deck area.	5. Corrosion has caused section loss and is sufficient to warrant structural analysis to ascertain the impact on the ultimate strength and/or serviceability of either the element or the bridge.
300 - Strip Seal Expansion Joint	**311 - Moveable Bearing (roller, sliding, etc.)**
1. The element shows minimal deterioration. There is no leakage at any point along the joint. Gland is secure and has no defects. Debris in joint is not causing any problems. The adjacent deck and/or header are sound.	1. The element shows little or no deterioration. The paint system, if present, is sound and functioning as intended to protect the metal. The bearing has minimal debris and corrosion. Vertical and horizontal alignments are within limits. Bearing support member is sound. Any lubrication system is functioning properly.
2. Signs of seepage along the joint may be present. The gland may be punctured, ripped, or partially pulled out of the extrusion. Significant debris is in all or part of the joint. Minor spalls in the deck and/or header may be present, adjacent to the joint.	2. The paint system, if present, may show moderate to heavy corrosion with some pitting but still functions as intended. The assemblies may have moved enough to cause minor cracking in the supporting concrete. Debris buildup is affecting bearing movement. Bearing alignment is still tolerable.
3. Signs or observance of leakage along the joint may be present. The gland may have failed from abrasion or tearing. The gland has pulled out of the extrusion. Major spalls may be present in the deck and/or header adjacent to the joint.	3. There is advanced corrosion with section loss. There may be loss of section of the supporting member sufficient to warrant supplemental supports or load restrictions. Bearing alignment may be beyond tolerable limits. Shear keys may have failed. The lubrication system, if any, may have failed.

Airfield pavements in Alaska are rated according to the US Army Corps of Engineers Pavement Condition Index (PCI) methods as described in FAA Advisory Circular, AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements[34]. This document, in turn, references ASTM D 5340, Standard Test Method for Airport Pavement Condition Index Surveys[35]. The method assesses and combines ratings for 15 distress types including cracking, joint seal damage, disintegration, distortion, and loss of skid resistance. The severity and extent of these distresses is rated and scored using a system of deduct points. The result is a Pavement Condition Index (PCI), ranging from 100 for a perfect, new pavement to 0 for a completely failed pavement.

Highway pavements, including ground-side pavements on airport access roads, are surveyed using the Dynatest vehicle when possible. In remote locations, a manual Present Serviceability Rating (PSR) assessment may be used instead. Parking lots are not currently surveyed. If needed for asset management, it may be possible to use the airfield pavement survey methods (possibly in a simplified form) to assess parking lot conditions.

Any asset can have more than one set of levels of service, representing different performance objectives, or different deterioration paths (as is the case for pavements). For example, a building may have separate sets of levels of service for each of its systems (exterior finish, plumbing, security, etc.). The 20-airport pilot study has its inspection checklist organized in this way. Airfield fencing might have one set of levels of service for physical condition/ corrosion/ damage, and another set for the quality of security that it affords. A jetway might have separate sets of levels of service for interior condition, mechanical operation, and weather protection. The Department's sign inventory has condition states of acceptable, marginal, and unacceptable for surface condition, retroreflectivity, and color (Exhibit 33).

Exhibit 33 Examples of unacceptable signs
(Alaska DOT&PF 2011)

[34] http://www.faa.gov/documentLibrary/media/advisory_circular/150-5380-6B/150_5380_6b.pdf
[35] http://www.astm.org/Standards/D5340.htm

The most useful system for visual inspection of assets separates the severity of deterioration from its extent. Severity of deterioration is useful for deciding what action to take: for example, minor corrosion might be arrested with repainting, but section loss due to corrosion might necessitate replacement. Usually the levels of service are carefully defined to distinguish levels of deterioration severity. For physical condition, these levels of service are called condition states. When the inspector examines a facility, the total quantity of an asset is allocated on a percentage basis among the condition states: for example, 30% excellent, 50% good, and 20% fair. This information is useful for accurate cost estimation, and for forecasting of further deterioration.

2.4.4 Maintenance Quality Assurance Program

Since 2005, the Department has conducted an annual survey for its Maintenance Quality Assurance Program (Alaska DOT&PF 2013). Unlike the inspection programs discussed in earlier sections, the MMS QA Program is run on a sampled basis. Out of roughly 5,700 centerline miles of state highway, currently 1,000 segments, of 0.1 mile each, are randomly selected for the survey each year, for a sampling rate of 1.75 percent. For each segment, the following data are gathered:

- Identification of the segment
- Width and mowing area measurements
- Assessments of the following conditions, based on visual inspection, evaluated according to criteria defined in the QA Program Manual:

  Depth of gravel surfacing material (if applicable)
  Transverse and longitudinal cracks, measured in linear feet
  Alligator cracking, percent of surface area
  Potholes, count of potholes at two severity levels
  Culverts, total count, and count of blocked culverts
  Ditches, total linear feet and linear feet of blocked ditches
  Guardrail panels, total count of panels, and number of functionally impaired panels
  Guardrail ends, total count of ends, and number of impaired guardrail ends
  Traffic signs, total count of signs, and number of deficient signs
  Pavement striping, total count, and count of deficient stripes
  Pavement markings, total count, and count of deficient markings
  Photos

A sample-based QA program has specific purposes for which it is well-suited. It can provide an accurate low-cost global picture of statewide performance, and under certain conditions can accurately represent region-wide conditions as well. With a sample size of 1000 segments, it will have a fairly wide margin of error at the region level, so care must be taken in reading too much into changes from year to year. Nonetheless, even with this small sample, long-term trend information from the survey will be very useful. Exhibit 34 shows the survey results for state fiscal year 2011, converted to a report card format.

Exhibit 34. MMS Quality Assurance Report Card

ALASKA DEPT. OF TRANSPORTATION & PUBLIC FACILITIES
MAINTENANCE MANAGEMENT SYSTEM

Quality Assurance Report Card
Fiscal Year: JULY10-JUNE11

	Condition A				Condition B				Condition C				Condition D				Condition F			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
ROAD SURFACE																				
GRAVEL SURFACE MATERIAL														N						
CRACKS										N										
ALLIGATOR CRACKING									N											
POTHOLES									N											
PAVEMENT STRIPING															N					
PAVEMENT MARKINGS																		N		
PAVEMENT RUTTING																	A			
PAVEMENT IRI											A									
ROAD SIDE																				
CULVERTS													N							
DITCHES					N															
GUARDRAIL PANELS (12' 6")						N														
GUARDRAIL ENDS										N										
GUARDRAIL HEIGHT									N											
TRAFFIC SIGNS															N					
VEG - HYDRO AXE					N															
VEG - SIDE ARM MOW								N												
VEG - STD MOWING										N										

Key

A = Actual
P = Planned
N = No Change (Planned and Actual the same)

The small sample size is a source of advantages and limitations. Many asset management functions such as project selection, forecasting of performance, and programming cannot be served by this approach. It would have to be supplemented with before-and-after evaluations to provide valid information on the effectiveness of preservation actions. Nonetheless, it is a valuable tool to supplement other asset management functions, especially those for which a more comprehensive data collection program is not yet feasible.

2.4.5 Assessing risk

One of the themes in the MAP-21 legislation, and in all types of asset management, is the assessment and management of risk. While the expression "risk-based" appears multiple times in the MAP-21 legislation, it is not explained, and FHWA has not yet defined it. However, the states have begun to establish definitions and measures, especially in connection with bridges.

In common asset management practice today, risk is recognized as the effect of some type of natural or man-made hazard, which is uncommon and difficult to predict for any one facility. If the hazard occurs, it may cause a disruption in transportation service, perhaps a discontinuity, or restriction, or delay. This is different from other types of risk that can be considered, such as project management risk (e.g. unexpected geological conditions during construction), crime risk (e.g. theft of copper wire from a construction site), design risk (that the designer might make a mistake in the computations), work zone risk (that a worker might be injured), or fiscal risk (that expected funding is not available to complete a project). Usually in asset management, risk is recognized if there is an unknown probability that normal transportation service might be disrupted by an unforeseen event.

With its sparse highway network and extreme natural conditions, Alaska's transportation system is subject to a variety of hazards:

- Earthquake
- Landslide and rockfall
- Tsunami
- Wildfire
- Avalanche
- High winds or extreme cold
- Floods and scour
- Frost heave
- Collision of vehicles or vessels with infrastructure assets
- Overloads of bridges
- Advanced deterioration of assets
- Steel fatigue

Risks tend to compound on each other. For example, when an earthquake strikes, the bridges that are already experiencing advanced deterioration or active scour are the most likely to be damaged.

Risk factors can be site-specific (such as a bridge pier located in a river subject to flooding), or more general. Examples of general risk factors are:

- Traffic growth increases the exposure of assets to heavy trucks and hazardous or flammable cargoes;
- Climate change increases the number of facilities operating outside their design parameters or historical site characteristics;
- Funding scarcity increases the possibility of assets experiencing advanced deterioration or metal fatigue.

In general, risk for a given asset can be characterized in three parts:

- Likelihood, or probability, that a hazard or extreme event will take place;
- Consequence of the hazard in terms of damage or loss of function, if the hazard occurs;
- Impact on the public if an asset is damaged by a hazard.

Then risk = likelihood × consequence × impact.

In some cases research can quantify all three of these factors. For example, Florida DOT has a fatigue risk model that can quantify all three parts, for steel bridges. It also has risk models that can quantify some of the parts for nine additional hazards (Sobanjo and Thompson 2013). Alaska may be able to quantify the likelihoods of many of the natural hazards based on geographically-referenced historical records maintained by Federal and state agencies.

It is often difficult to quantify parts of the risk equation because of the rarity of the hazards and the diversity of consequences. Nonetheless, a quantitative risk analysis is still feasible. A common way to do this is by using a method called risk allocation. Risk allocation starts with a broad estimate of total damage or impacts from risks in a given category over a long period of time; for example, the total dollar value of all earthquake damage over the past 50 years, adjusted for inflation and inventory growth. This number is annualized and then divided among all assets in the inventory, according to the relative vulnerability, recovery cost, and public exposure.

Once a risk assessment and/or risk allocation have been performed, the Department can prioritize investments using risk, to ensure that the highest risks are addressed first. Risks can be addressed using mitigation actions (e.g. placing rip rap to prevent scour damage) or by replacing assets with more resilient designs. Minnesota DOT uses this methodology explicitly when programming many types of infrastructure investments.

To maintain a routine risk management process, the asset inventory should include a capability to update hazard vulnerability data, usually as a part of routine inspections. The inspections would note data items relevant to risk analysis, such as evidence of over-height truck collisions or overloads, development of scour holes or river bank erosion, cracking in steel superstructures, progression of frost heave in pavements, and section loss due to corrosion.

It is possible to characterize the assets in an inventory according to their inherent risk, and to track this quantity over time. Since performance measures are usually expressed in a positive direction (a higher number being better), risk can be characterized in the form of resilience. An asset that is not particularly vulnerable to any hazard might have a resilience score of 100; observed vulnerabilities would then deduct points from this perfect score. This is similar to the way pavements are rated for routine deterioration in the Pavement Condition Index.

2.4.6 Findings: Inspection and monitoring

Finding 4.1. The Department has a recurring program of highway pavement condition surveys for roughness and rutting, but lacks this information for other important conditions such as surface texture and bearing capacity. The first survey of pavement cracking began in 2012. There is also a recurring program of pavement condition surveys for airfield pavements.

Finding 4.2. The Department has implemented the National Bridge Inspection Standards and the AASHTO CoRe Elements. This provides enough data for many common asset management needs. There is no routine monitoring for bridge fatigue, scour, or buildup of ice or debris, which would be necessary for a reliable risk management program.

Finding 4.3. Other than pavements and bridges, there are no other recurring inspection programs on the state highway network, nor in the state's airports and marine highway system.

Finding 4.4. The 20-airport pilot study represents a first step in designing a regular inventory and inspection process for non-highway assets. Much will be learned from the pilot study about the cost and effectiveness of visual inspection of these assets in Alaska. The ongoing TAM Information Systems (TAMIS) study will be able to provide a database to store this information.

Finding 4.5. A sample-based Maintenance Quality Assurance Program is in place to provide a global view of statewide performance. This is especially useful for assets that are not inspected in any other way, but the asset management applications are limited.

2.5 Performance assessment

Condition and performance data are used for many different purposes in asset management. As Exhibit 31 indicated, the list of performance data items can be too long and complex for many purposes, even though this level of detail is important for engineering tasks such as treatment selection and cost estimation. Once outside the engineering domains (or "silos") of specific asset types, it is necessary to digest the raw performance data into measures that are more descriptive of the transportation system as a whole, and indicative of the effect on stakeholders.

Historically, this additional step of digesting condition and performance information has been difficult. When agencies first begin to report on their performance, they often rely on measures already in use for silo-specific programs. This is convenient for the organizational units producing the information, but very inconvenient — and often confusing and counter-productive — for stakeholders and the public at large.

Exhibit 35. I-35W bridge collapse in Minnesota

An example of this problem became widely visible after the 2007 collapse of the I-35W bridge in Minnesota (Exhibit 35[36]). The term "structurally deficient" appeared in media reports about the event, but few journalists could explain what it meant, and transportation agencies found themselves on the defensive in trying to explain the structurally deficient bridges in their own inventories. Many are still stinging from the experience. However, to this day structural deficiency is one of the only asset performance indicators used in the Department's Performance Electronic Tracking System (Exhibit 36).

Similar problems occur with other measures that are well understood by professionals but not by the public. Is an International Roughness Index (IRI) of 50 better or worse than a Bridge Sufficiency Rating (BSR) of 50? Would a 10-point increase in IRI or BSR be a good thing, and how difficult would it be to accomplish? (That's a trick question, but few in the public would know it.) What does the Bridge Sufficiency Rating measure, anyway? Why are so few functionally obsolete bridges programmed for replacement? How do you know if a sidewalk's condition is acceptable: how is this measured? These are very good questions for stakeholders to ask and very difficult for agencies to answer.

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[36] http://www.fhwa.dot.gov/programadmin/contracts/sep14mn2011.cfm

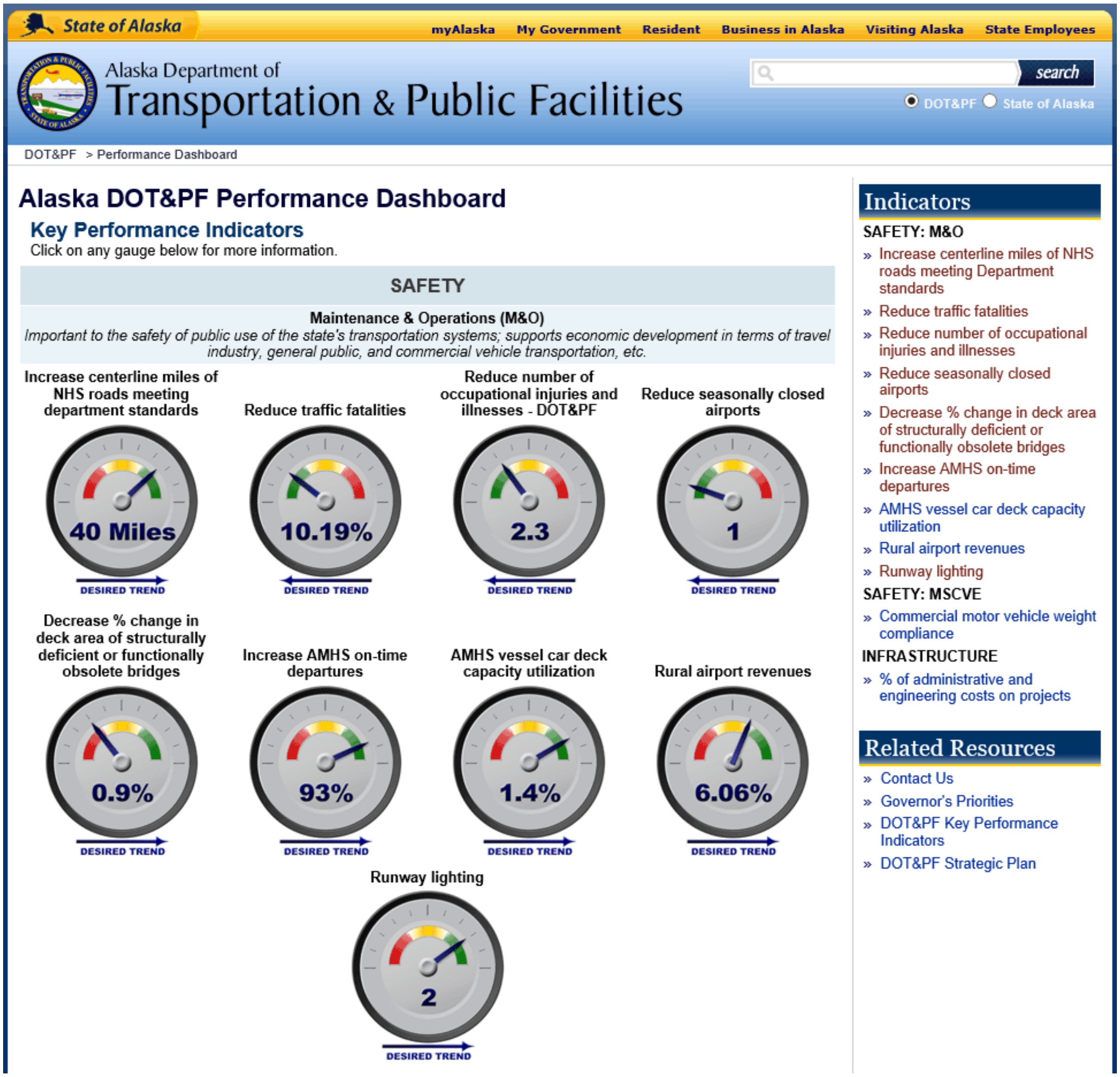

Exhibit 36. Performance Electronic Tracking System[37]

If asset management is to become a basis for better communication with stakeholders, it is critical that a common language of performance assessment be developed. Fortunately, some good models exist, and the Department is starting to use them. Much more can fruitfully be done. The key tools for improving communications about performance are:

- Levels of service, which separate acceptable from unacceptable conditions, and provide warrants for action.

[37] http://dot.alaska.gov/performance-dash/index.shtml

- Condition and performance indexes, providing a uniform scale of best to worst, with meaningful correspondence among asset types, and relevance to all asset types.
- Asset valuation models, which are similar to condition and performance indexes but put assets in a context of financial commitment.
- Tracking tools to draw attention to the magnitude and direction of changes in performance over time.

All of these tools have important uses and interpretations at the levels of individual assets, corridors, projects, and networks.

2.5.1 Levels of service

Levels of service are classifications or standards that describe the quality of service offered to road users, usually by specific facilities or services. All services delivered by the network should be covered by agreed levels of service, although it may take some time to achieve this goal. Achievement of levels of service is quantified by performance measures. Fully-developed level of service statements adopt two perspectives:

- Customer levels of service relate to how the customer receives the service in terms of tangible and intangible measures or criteria. They are expressed in terms that customers can understand. Tangibles include the appearance of facilities, frequency of service disruptions, availability of service, frequency of crashes etc. Examples of intangibles include responsiveness to problems, staff attitude, and ease of dealing with the agency.
- Technical levels of service support both the customer levels of service and the agency's strategic objectives. They are usually expressed in technical terms and will relate to service criteria, e.g. quality, capacity, availability or safety. They are recognizable by inspection processes, and are used as drivers for agency actions.

Because levels of service are developed from the mission and goals of an agency (Exhibit 37), they should cover all of the asset groups that contribute to the delivery of the service. These include the visible assets, such as pavements, bridges, lighting and signs as well as those which might be less visible or less apparent in terms of being important to users, but are vital in providing service. For example, effective drainage minimizes the risk of flooding and guardrails provide an important safety function.

Level of service can include any aspect of asset performance affecting any stakeholder. So it can be used very broadly to include service to stakeholders in their roles as users, taxpayers, partners, elected officials, and community residents.

Condition is somewhat distinct from other performance measures because it often does not directly affect road users except through its effect on other performance measures. However, condition can be the basis for both level of service standards and performance measures. For example, bridge conditions are expressed as condition states of bridge elements, where the condition state definitions are in the same form as levels of service. (See Exhibit 32 earlier in this report.) As another example, pavement skid resistance is a measure of physical condition, and can be the basis for a level of service standard. Agencies often use it as a performance measure, as a proxy for accident risk. Accident risk would be a more direct measure of performance, but it is difficult to measure on a facility-specific basis.

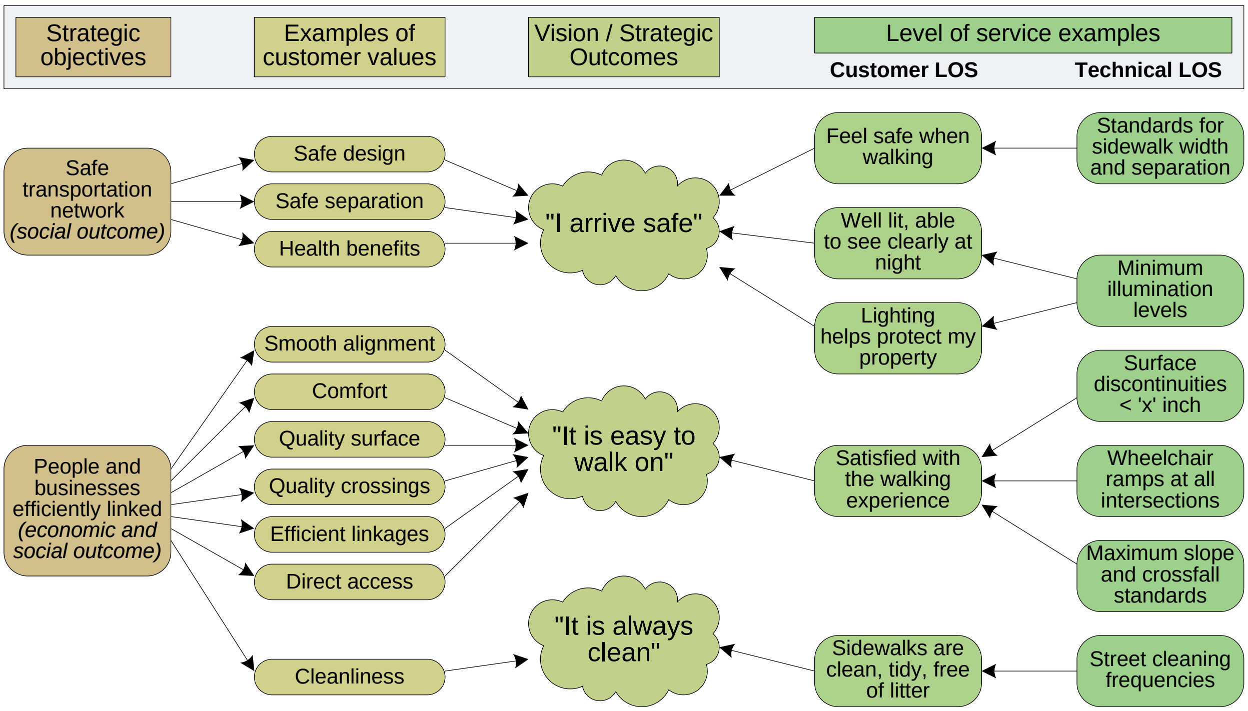

Exhibit 37. Linking strategic objectives to levels of service
(Gordon et al 2011)

Level of service definitions are extremely useful as convenient, standardized descriptions of services provided by the agency. As a result, most agencies have them. Moreover, industry guide books such as the Manual on Uniform Traffic Control Devices and the Highway Capacity Manual provide definitions that are nearly universal. However, agencies may wish to develop their own levels of service for specific applications or to address specific strategic concerns. A way to approach this is as follows (Gordon 2011):

- Start by documenting what services the agency is delivering. Check on corporate levels of service that may already be in place.
- Verify this list against existing reporting procedures.
- Do not include aspirational or proposed changes to level of service unless they have been agreed and adopted at the corporate level.
- Write levels of service which represent current practice and which are SMART:

  Specific: Do they adequately reflect specific strategic goals?

Measurable: Can they be measured?

Achievable: Are they realistic and affordable?

Relevant: Do they adequately reflect agency actions and user expectations?

Timebound: Has a timeframe for delivery of each level of service been stated?

The Department has made considerable progress in developing level of service descriptions for many of its assets and services. Exhibit 38 shows an example of language developed for pavement markings. Similar work has been done for drainage assets, gravel roads, guardrails, pavement surface, and signage. Work is underway in developing levels of service for slopes.

Levels of service are useful for many different functions in asset management, including performance management. The work completed thus far is excellent, and deserves to be extended to all types of assets. It is on the critical path for asset management maturity, so further development is considered to be of high priority.

The best way to gain insight about customer expectations is to ask them. Transportation agencies very often perform marketing research for this purpose. The research may take the form of approve/disapprove surveys, tradeoff scenarios, or other types of survey questions that are geared toward quantifying consumer preferences. These help to establish meaningful level of service definitions as well as to determine the relative importance of different services.

Level of service is, by nature, an asset level concept. It answers questions such as: Is this asset performing at an acceptable level? or Does this asset need repairs? For use at the corridor or network level, the level of service concept is usually converted to an aggregate measure, such as "percent of sidewalks in acceptable condition" or "number of bridge decks requiring overlays." If levels of service can be reliably determined at the asset level for a known population or random sample of assets, then the aggregate measures are easy to compute.

2.5.2 Performance indexes

Levels of service are often developed for individual asset types, or even for separate parts of an asset's performance. They are often closely related to the characteristics of those assets. For communicating with the public, it is useful to combine the various facets of each asset's performance into larger concepts that relate to the overall quality of the asset, or even more broadly to the characteristics of a corridor or network. This is done by a process of amalgamation.

One common example of amalgamation is the bridge health index. During bridge inspections, a bridge is decomposed into a number of elements, typically 5 to 10 of them, such as the deck, expansion joints, railings, girders, bearings, and abutments. Each element is classified by assigning a condition state (an integer from 1 to 5), or by distributing the total quantity of the element among the five possible condition states. The overall condition of the bridge is then computed as a weighted average of all the element condition states.

Exhibit 38. Levels of service for pavement markings[38]

Performance Target	Description	Illustration
A (Excellent Markings)	Pavement striping and other marking are in generally excellent condition. They have high visibility and reflectivity in daytime and nighttime. There is little or no wearing. Up to 5% missing sections of markings.	
B (Very Good Markings)	Pavement striping and other markings are in generally good condition. Markings have good visibility during daytime and night time. Markings are showing minor wearing with 10% of sections missing.	
C (Fair Markings)	Pavement striping and other markings are in fair condition. Generally visible in daytime and nighttime. Noticeable wearing or loss of retro reflectivity and 20% of markings missing.	
D (Poor Markings)	Pavement striping and other markings are in marginal condition. Extreme wearing or no reflectivity during daytime or night time and 50% of markings missing.	
F (Failing Markings)	Pavement striping and markings are essentially worn or missing. Markings that are still present are not easily visible.	

[38] Compiled by Ocie Adams

The weights used in this computation reflect the relative contribution of each element to the bridge's function, and the relative "goodness" or "badness" of each possible condition state.

As another example, the pavement management system in use by the Department computes a Pavement Serviceability Rating (PSR) as a weighted combination of roughness and rutting, intended to represent an indication of overall condition. If the Department were to start gathering data on additional defects such as cracking or surface texture defects, these could be added to the PSR calculation.

Across all asset classes, it is useful to convert all of the performance indexes onto a uniform scale so meaningful comparisons can be made. For example, a score of 100 could always be perfect condition, and a score of 0 always the worst possible condition. If these scales are calibrated to be uniform along their length, then an improvement from (for example) 10 to 15 would have the same value as an improvement from 70 to 75. Some methods for doing this are described in NCHRP Report 590 (Patidar et al 2007). When this is done, the uniform scale can be interpreted in the same way across all types of assets. This makes the scale easier to understand and use (Exhibit 39).

Condition and performance indexes are a common and useful way of establishing minimum standards for different classes of assets. For example, the FAA has a minimum PCI standard of 70 for runways and 60 for taxiways and aprons. The AASP envisions that the Department will eventually be able to develop fiscally-sensitive condition and performance standards using asset management techniques[39].

Exhibit 39. Scaling of performance measures

[39] http://www.alaskaasp.com/admin/Docs/AASP%20Mission%20Goals%20Measures%20Classifications%20-%20for%20website.pdf, page 50.

2.5.3 Asset value

Performance indexes can be aggregated across a corridor or network merely by computing an average over all the individual assets in the group. This might be misleading, however, if the assets are of different sizes. For example, intuitively an individual traffic signal might not have the same importance as a large bridge or a mile of pavement.

A way to make this aggregation more acceptable is to weight each asset according to its value, usually using an estimate of its replacement cost. With this refinement, a condition index of 50 might indicate that the asset has 50% of its original value, or is 50% depreciated (Shepard and Johnson 2001). This perspective is useful for accounting purposes under GASB Statement 34, and also useful as a reliable way to track changes in performance over time, and differences in performance among dissimilar parts of the transportation network.

2.5.4 Tracking tools

The processed condition and performance data described here are valuable for decision making because they remove the focus from the technical details of pavements, bridges, or other asset types, and focus more on the service provided to the public. They help bring non-engineers into a more understandable conversation about performance, making it possible finally to have productive tradeoff and budgeting discussions with elected officials and other stakeholders.

These performance measures are most useful if decision makers can start to gain an intuitive feel for the manner in which performance can change over time, due to deterioration, aging, traffic, and agency actions. A simple tool for imparting this intuitive feel is the basic trendline (Exhibit 40). Once an agency has developed the ability to compute levels of service, performance indices, and asset values, it must go through a period where it consistently computes and tracks these indicators, to see how they change. This is a natural breakpoint in the advancement of asset management maturity, because stakeholders need time to watch performance measures develop, and see how much influence they may have in changing them.

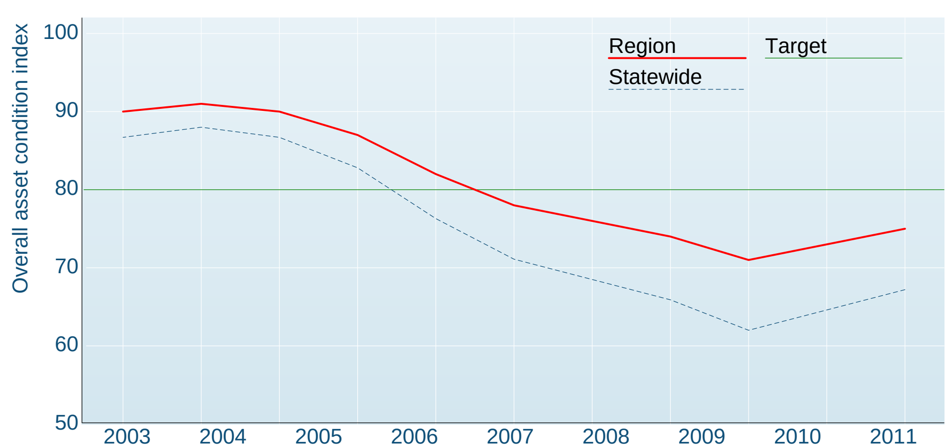

Exhibit 40. Example of a trendline

2.5.5 AASHTO work on performance measures

AASHTO's Standing Committee on Performance Management (SCOPM) has been a forum "to provide State DOTs the expertise and resources to support performance based management and to create a results-driven environment to maximize the performance of both transportation systems and organizations[40]." Anticipating the rule-making process that would result from the MAP-21 legislation, SCOPM formed a Task Force to develop a statement of its own input to the rule-making process. It has published a 34-page report of its findings[41].

Since the purpose of this report is to provide input on *national-level* performance measures in response to MAP-21, it is important to distinguish the findings from *state-level* measures that are useful for day-to-day asset management in the Department. In some important ways, these are entirely separate purposes and would likely justify or compel separate sets of performance measures. Nonetheless the discussion of performance measures in the report is succinct and informative. The national measures recommended in the report are as follows:

SAFETY

- *Number of Fatalities – Five-year moving average of the count of the number of fatalities on all public roads for a calendar year.*
- *Fatality Rate – Five-year moving average of the Number of Fatalities divided by the Vehicle Miles Traveled (VMT) for a calendar year.*
- *Number of Serious Injuries – Five-year moving average of the count of the number of serious injuries on all public roads for a calendar year.*
- *Serious Injury Rate – Five-year moving average of the Number of Serious Injuries divided by the Vehicle Miles Traveled (VMT) for a calendar year.*

PAVEMENT CONDITION

- *Interstate Pavement in Good, Fair and Poor Condition based on the International Roughness Index (IRI) – Percentage of 0.1 mile segments of Interstate pavement mileage in good, fair and poor condition based on the following criteria: good if IRI<95, fair if IRI is between 95 and 170, and poor if IRI is greater than 170.*
- *Non-Interstate NHS Pavement in Good, Fair and Poor Condition based on the International Roughness Index (IRI) – Percentage of .1 mile segments of non- Interstate NHS pavement mileage in good, fair and poor condition based on the following criteria: good if IRI<95, fair if IRI is between 95 and 170, and poor if IRI is greater than 170.*
- *Pavement Structural Heath Index – Percentage of pavement which meet minimum criteria for pavement faulting, rutting and cracking.*

[40] http://scopm.transportation.org/Pages/default.aspx

[41] http://scopm.transportation.org/Documents/SCOPM%20Task%20Force%20Findings%20on%20National%20Level%20Measures%20FINAL%20(11-9-2012).pdf

BRIDGES

- *Percent of Deck Area on Structurally Deficient Bridges – NHS bridge deck area on structurally deficient bridges as a percentage of total NHS bridge deck area.*
- *NHS Bridges in Good, Fair and Poor Condition based on Deck Area – Percentage of National Highway System bridges in good, fair and poor condition, weighted by deck area.*

FREIGHT

- *Annual Hours of Truck Delay (AHTD) – Travel time above the congestion threshold in units of vehicle-hours for Trucks on the Interstate Highway System.*
- *Truck Reliability Index (RI80) – The RI is defined as the ratio of the total truck travel time needed to ensure on-time arrival to the agency-determined threshold travel time (e.g., observed travel time or preferred travel time).*

SYSTEM PERFORMANCE

- *Annual Hours of Delay (AHD) – Travel time above a congestion threshold (defined by State DOTs and MPOs) in units of vehicle -hours of delay on Interstate and NHS corridors.*
- *Reliability Index (RI80) – The Reliability Index is defined as the ratio of the 80th percentile travel time to the agency-determined threshold travel time.*

CONGESTION MITIGATION AND AIR QUALITY (CMAQ)

- *Criteria Pollutant Emissions – Daily kilograms of on-road, mobile source criteria air pollutants (VOC, NOx, PM, CO) reduced by the latest annual program of CMAQ projects.*
- *Annual Hours of Delay (AHD)-Travel time above a congestion threshold (defined by State DOTs and MPOs) in units of vehicle -hours of delay reduced by the latest annual program of CMAQ projects.*

A useful perspective in these measures is that asset condition is only one part of the spectrum, which also includes safety, mobility, reliability, and externalities. Many of the measures are defined in terms of levels of service or acceptable/unacceptable thresholds. A listing of useful state-level performance measures would be considerably longer and more detailed.

The same AASHTO Task Force has also developed a report on methods for setting performance targets, which is highly relevant to the MAP-21 requirements which must be met in the Transportation Asset Management Plan[42].

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42 http://scopm.transportation.org/Documents/SCOPM%20Task%20Force%20Findings%20on%20Performance%20Measure%20Target-Setting%20FINAL%20v2%20(3-25-2013).pdf

2.5.6 Findings: Performance assessment

Finding 5.1. The Department has developed level of service descriptions and photos for several asset types including pavement markings, drainage assets, gravel roads, guardrails, pavement surface, and signage. These are excellent and could be extended to cover all other asset types. They could even extend to the various systems within buildings (shell, electrical, plumbing etc.) and on ferry vessels.

Finding 5.2. The Performance Electronic Tracking System (PETS) was meant to be a central repository for performance reporting, but would require considerably more development in order to accomplish this goal. Currently it has only one measure related to asset performance, and does not have a facility to track changes in performance over time.

Finding 5.3. The Department does not have tools or documents that measure the degree of adherence to level of service standards, nor methods to develop performance indexes, asset values, or other performance measures. The key exceptions are the Pavement Serviceability Rating, Pavement Condition Index (for airfields), and the Bridge Health Index.

2.6 Decision support capabilities

Quantitative, proactive decision making is a major step forward in asset management maturity. Rather than relying entirely on measurements of current and past performance, proactive decision making relies in part on forecasts of the outcomes of current decisions on future performance. Without decision support tools, proactive decisions are a matter of educated guesswork, a judgment about the conditions and performance that could occur in the future.

Proactive asset management decision making addresses important questions on the minds of decision makers and stakeholders:

- If funding is cut, how much performance would be sacrificed?
- How much would it cost to keep performance from declining further?
- How much would it cost to improve performance to a desired level?
- Can we get more life out of our assets, and how best to do this?
- What policies would minimize life cycle costs?
- Is a given preventive maintenance program worth the expense, in terms of reducing life cycle costs?
- What is the best long-term preservation program for a given asset, in terms of the scope and timing of future interventions?

These are difficult questions that are notoriously resistant to judgment or experience. Large businesses typically answer such questions using engineering studies, market research, and financial analysis. Transportation agencies are increasingly doing the same thing using the decision support tools of asset management.

ACRP 69 describes a “10-step” asset management planning process, where most of the steps involve analysis, decision support, and communication methods. These ten steps are somewhat idealized and are also based on business processes in the United Kingdom, so they need to be adapted to fit the business needs and capabilities of the Department. The steps can be summarized as follows:

1. Develop asset registry. This is described in the Asset Inventory section, above.
2. Assess performance and failure modes. In US practice this encompasses two separate business processes described in earlier sections: inspection, which is done in the field, and performance assessment, which is done later in the office.

3. Determine residual life. This terminology encompasses a number of forecasting methods which help to predict future conditions and performance. By extension, they can also be used to predict how long it might take for different aspects of condition or performance to reach unacceptable levels. For assets where preventive and life extension activities are feasible (including most constructed facilities such as pavements, bridges, and buildings), it is typical in US practice to use deterioration models. These models, described below, forecast the likelihood of being ready for a repair or rehabilitation action within a given time frame on a given asset. By extension, they forecast the quantity of work needed in a statewide family of similar assets in a given time frame. For assets that are merely replaced at the end of their life or when they fail, a forecast of remaining life is often used. Since most such assets are manufactured, the life estimates are typically obtained from the manufacturers.
4. Determine life cycle and replacement costs. Cost estimation methods are reasonably well developed in the Department for the design of projects. Cost estimation for program development is not as mature, because it has not been applied yet in an asset management framework. This is an important aspect of forecasting that is discussed below. Tools for estimating life cycle cost already exist in the pavement and bridge management systems, but they first require the development of credible deterioration and cost models as input data. Life cycle cost models for other asset types can readily be developed as spreadsheet tools when the necessary forecasting models are ready.
5. Set target levels of service. One of the first important products of asset management is a fiscally-constrained set of target condition and performance levels. The fiscal constraint is important: if more money goes in, then better performance comes out. Since there are several important aspects of performance (condition, life cycle cost, safety, etc.), there is an implicit tradeoff in resource allocation: if money within a constrained budget is moved to safety projects, then safety targets should improve, but other performance objectives may suffer. The basic analysis method behind target-setting is therefore called a tradeoff analysis. Tradeoff analysis deals with future performance and therefore requires forecasting models. At the Department's current asset management maturity level, forecasting models are not yet available for most assets. Target-setting is therefore out of reach at present, but will become possible as soon as the inventory, inspection, and forecasting tools are ready.
6. Determine business risk. Risk analysis is currently a very active research topic for pavements, bridges, and geotechnical assets (where Alaska is a national leader with work that is underway). The products of this research can feed into the tradeoff analysis as a type of performance measure.
7. Optimize operations and maintenance investment. Optimization is a process of generating and evaluating a large number of preservation and improvement alternatives of scope and timing for each project, and selecting among them to maximize network performance subject to funding constraints. This technique builds on all of the tools discussed in the earlier steps. It is therefore a fairly advanced method. It is not discussed in this synthesis since it is currently out of reach in the 2012-2014 time frame. It is, however, a worthy goal for the longer term.

8. Optimize capital investment. Similar to the previous step, this level of optimization goes further to consider the construction of new facilities and provision of new services to satisfy growth and economic development objectives. Again, this is quite advanced and is not further discussed in the current report. Many US agencies would consider this to be beyond the scope of asset management since a mature long-range planning process already exists.
9. Determine the best funding strategy. This business process can build on any of the preceding steps which happen to be in place at a given time. However, most agencies do not consider this to be a part of asset management, or may regard it as an advanced use of asset management tools.
10. Document the asset management plan. This process can build on any of the preceding steps that happen to be in place at a given time. It is a very important part of asset management and is addressed in detail below.

2.6.1 Basic analysis framework

Support for proactive decision making requires an inter-related set of models that are sensitive to the types of asset management decisions commonly made in the agency, at the asset, project, program, and network levels. These models can obtain their data from existing management systems (such as the pavement and bridge management systems) and from new inventory and condition assessment systems for other types of assets. A key ingredient that is necessary for an integrated system is a file of investment candidates presented in a format that is the same for all asset types. Exhibit 41 shows how this key element supports decision-making across all types of assets.

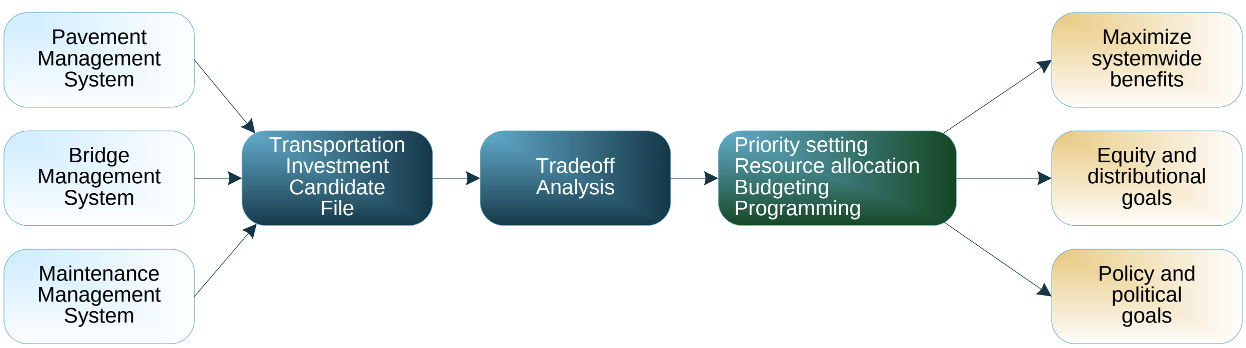

Exhibit 41. Analysis framework for decision support
(Gordon et al 2011)

Investment candidates may include new construction, replacement of existing assets, rehabilitation, repairs, functional improvements, or policy changes. They may involve any asset type, or groups of assets in a corridor or project. The investment candidate file (Exhibit 42) identifies each potential investment and summarizes its cost, resource requirements, and effects on transportation system performance. It is most often prepared as an Excel spreadsheet file, which is simple, flexible, and entails minimal system development costs.

Exhibit 42. Typical contents of the investment candidate file
(Gordon et al 2011)

Type of information		Data items	Description	Purpose
Identification		Project or work order ID Responsibility (organization or unit) Means of execution (contract, in-house, etc.) Desired/planned year Planning/delivery/workflow status	Identifiers here would feed into project tracking or enterprise resource planning systems where applicable.	Uniquely identify projects. Interface with related information systems. Support project development workflow.
Assets	For each cost object:	Identification Geographic location Jurisdiction Value Utilization	List the assets and/or policy concerns that are affected by the action.	Support mapping and reporting by geography and jurisdiction. Provide planned work status to asset management systems. Provide asset weighting in the computation of benefits.
Activity Drivers	For each activity driver:	Performance measure or deficiency Threshold level Actual level	Includes action warrants, level of service standards, vulnerability conditions, damage, or defects. Existing or forecast.	Document the direct justification of projects.
Activities	For each activity:	Classification Quantity (of output) Cost	Includes any type of activity within the scope of asset management: capital, maintenance, preservation, functional improvement, expansion, etc. Also includes engineering, mobilization, traffic control.	Describe the work to be performed and build up the cost estimate.
Resources	For each resource:	Classification Quantity (of input) Cost	Includes labor, materials, equipment, or contract pay items.	Interface with resource management to forecast staffing, stockpiles, and other resource needs.
Forecast Outcomes	For each performance measure:	Forecast change in performance Scaled change in performance Effect of advancement or delay	Includes measures of condition, life cycle cost, user cost, mobility, safety, reliability, comfort/convenience, externalities, risk, etc.	Forecast the performance resulting from the work, and compare with performance targets. Support performance based management.
Project Inter-Relationships		Projects that must be completed first Projects that can't be programmed together Projects that must be programmed together Projects that are mutually exclusive	Constraints on the scheduling and funding of work.	Ensure that traffic control plans are valid, that projects are compatible, and costs are fully recognized.
Evaluation		Total and incremental cost Total and incremental benefit Total and incremental benefit/cost ratio	Priority setting and budgeting criteria.	Set priorities, manage funding limitations.

The data may be entered into the spreadsheet manually, or by means of an automated procedure such as a Visual Basic macro that accesses a pavement management system.

Each investment candidate may have effects on any of the major performance measures, such as condition, life cycle cost, safety, mobility, and risk. Forecasting models (such as the ones found in the Department's pavement and bridge management systems) provide the estimates of these effects. The separate performance forecasts are then combined into a single indicator of priority. State DOTs have historically used some form of priority formula to rank investments. More objective methods include social cost calculations and utility functions, as described in NCHRP Report 590 (Patidar et al 2007). All of the priority setting methods in common use are implementable as spreadsheet formulas.

A tradeoff analysis is the engine that supports the business processes of priority setting, resource allocation, budgeting, and programming across all asset types. In its simplest form, the tradeoff analysis is merely a feature that allows decision makers to change the relative weighting given to different program objectives. For example, if the forecast of systemwide performance does not satisfy safety goals, the decision maker can give safety more weight, causing projects with safety benefits to have higher priority, and be scheduled for implementation sooner. This would come at the expense of other performance objectives, which would then have lower relative priority.

Using this basic priority-setting analysis, agencies can establish performance targets for all or portions of the transportation network, decide on the allocation of resources, and track actual performance against the targets. While the diagnostic and forecasting methods of pavement and bridge management systems are often scientifically based and may be complex or proprietary, the cross-asset tradeoff analysis is most successful if it is relatively simple and open. Agencies typically modify these tools frequently as their understanding improves, as policy issues and priorities evolve, and as leadership changes take place.

By varying funding levels and relative weights of performance objectives, decision makers and stakeholders can perform "what if" analysis, gain a deeper understanding of the relationship between funding and performance, and appreciate the tradeoffs among different aspects of performance. The tradeoff analysis then acts as a valuable tool for communication and collaboration, helping to build a constructive relationship with stakeholders.

2.6.2 Elements of forecasting

The evolution of asset management from guesswork to analysis, is analogous to many other advances in civil engineering, when design methods based on subjective experience were replaced by detailed structural analyses and specifications. In order for this leap to occur, it was necessary to develop and validate analytical models; to use them alongside expert judgment to ensure a safe and smooth transition; to develop a language and written specifications that are widely understood; and to continuously monitor and improve the methods as experience is gained and more research is completed.

For certain types of assets, this evolution has already made considerable progress. Forecasting of pavement deterioration was largely guesswork until the 1980s, when products of the AASHO Road Test became widely utilized. Since then, researchers have developed more refined forms of deterioration models, and have learned to customize these models to fit specific conditions of traffic, materials, soils, and other factors. Once the forecasting of pavement condition became reliable, agencies were able to build on these models to improve decision making in maintenance and design, thus increasing pavement life and reducing life cycle costs.

In bridge management, the industry went through an experimental stage with National Bridge Inventory data in the 1980s, but validation efforts failed. Many different model forms were tried, but their forecasts did not sufficiently match actual conditions that were later observed. It was determined that the condition data gathered in NBI bridge inspections did not provide sufficient detail on the type, severity, and extent of distress, to support reliable forecasting.

As a result of this experience, in the 1990s AASHTO developed a more detailed guide for maintenance inspections, which most of the states, including Alaska, have implemented. Initially it was necessary to develop forecasting models using a quantified form of expert judgment. However, as agencies have passed the 10-year milestone with the new inspections, they have started developing models using the more detailed data. These new models have successfully stood up to validation tests. With improved confidence in bridge condition forecasting, it is now possible to use these tools to improve the scoping and timing of bridge preservation, with confidence that life cycle costs can be reduced.

The lessons learned in forecasting of condition of pavements and bridges, have been applied to many other asset types and other aspects of performance in NCHRP Report 713 (Thompson et al 2012). Forecasting is also a mature discipline in the travel demand models used in planning and designing new roads.

AASHTO's Asset Management Guide (Gordon et al 2011) offers a broad overview of forecasting methods in common use. To begin implementing proactive decision support, the following are especially important:

Base case (also known as "do nothing"). The base case scenario in asset management is typically defined as a project or policy alternative where no initial expenditure is made. Instead, the assets in question are merely allowed to deteriorate under expected weather and traffic (Exhibit 43). Normal physical deterioration may cause condition to decline, and risk of natural (e.g. scour or earth movement) or man-made (e.g. fatigue) hazards to increase. Traffic growth and land use changes may lead to congestion, loss of mobility, and increased accident rates. Forecasting models attempt to quantify these changes in performance.

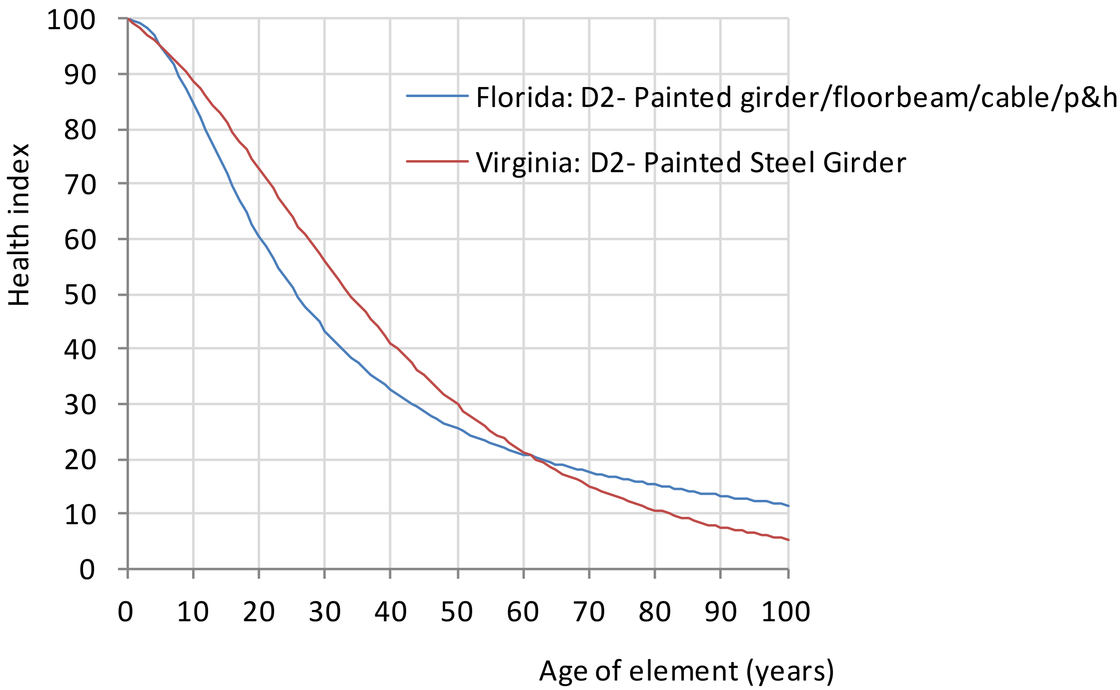

Exhibit 43. Examples of bridge deterioration models

In some cases the designation of "do nothing" as a base case may be misleading or may conceal certain alternatives. For example, assets may undergo routine maintenance work such as bridge washing and pavement crack sealing which affect the rates of future deterioration. If it is desired to evaluate the benefits of these activities, then careful refinement is needed in the definitions of the alternatives to be considered.

Choices of actions. At any given point in time, the Department may intervene in the life cycle of an asset by performing some type of routine or programmed action. Asset characteristics and conditions may determine whether a given action is feasible, or if feasible, whether it is warranted. Pavement management systems often contain "decision trees" to simulate a typical agency decision making process to determine which actions are feasible, warranted, or required for a given asset at a given time.

Simpler rules are also necessary for bridges and all other types of assets when forecasting future expenditures in an asset's life cycle. In addition, special rules may apply to certain types of assets, such as the "10-year rule" for Federally-funded bridge rehabilitation (recently rescinded[43]).

[43] http://www.fhwa.dot.gov/map21/qandas/qabridges.cfm

In a life cycle cost analysis, it is often necessary to identify future actions even in a "do nothing" scenario where no work is to be done in the near-term. For assets in deteriorated condition, the lack of a near-term maintenance action may increase the likelihood or cost of future work that becomes necessary to keep an asset in service.

Cost of actions. Asset management analysis includes a prominent role for cost estimation, which has the same importance as in any planning or programming process. Since asset management analyses are typically conducted prior to any design work, the cost estimates cannot rely on much precision. Typically the available inventory and inspection data are the only basis for the estimate. Cost models often distinguish two general categories:

- Direct costs include labor, materials, and equipment usage which vary smoothly with the quantity of work to be done, which in turn often depends on the extent of deterioration or the magnitude of improvement required.
- Indirect costs include mobilization, land acquisition, maintenance of traffic, demolition, and sometimes engineering costs that are insensitive to the quantity of work but more dependent on the type of work, location, and the characteristics of the affected roadways.

Indirect costs are especially difficult to estimate without a substantial amount of site-specific design data (Exhibit 44). Agencies often use a simple multiplier to represent these costs if better data are not available. The best way to estimate cost models is to perform a statistical analysis of maintenance and contract data. The methodology should ensure that all important cost factors are included in the calculation.

Effect of actions. After an action is performed, the result should be an improvement in condition or performance. This may take effect immediately, or may have its impact over time by reducing the rate of deterioration.

Exhibit 44. Indirect costs include mobilizing equipment to the site

User costs. Certain aspects of condition and performance may increase the costs borne by road users for fuel, vehicle maintenance, or travel time. In addition, a risk analysis on many Alaska highway links would need to include the costs of fares for marine or air modes of transportation.

Externalities. A complete asset management analysis should consider the environmental and external impacts of transportation decisions, such as air and water emissions, noise, greenhouse gases, and impacts on property values and regional economic development. The Statewide Policy Plan places some emphasis on these impacts, but currently they are very difficult to quantify and manage.

The Department has not made very much progress thus far in the development of forecasting capabilities, but such capabilities are necessary before progress can be made on more advanced decision support models. The agency has a pavement management capability to extrapolate past condition trends, and has an expert judgment-based model of bridge deterioration. It has no forecasting models for any other types of assets, and no validation history even for the pavement and bridge models. Maintenance history data are available but it is unknown whether the data are suitable for estimation of cost or effectiveness models. This makes forecasting a relatively high priority for future work. However, forecasting depends on inventory, condition, and performance data which are lacking or incomplete for most types of assets. This logical dependency implies a necessary ordering of tasks for near-term development.

2.6.3 Credibility and the feedback loop

When engineers design new types of bridges, they rely on the credibility of their structural analysis models and specifications to ensure that the structure, once built, will provide the desired level of service safely for its design life. The confidence they have in their models is not given quickly or lightly. The models are constantly tested and validated. The models start simple, and are refined incrementally over time. Expert judgment is always a backup.

All of these statements are also true for asset management forecasting models. Agency commitments to performance targets are difficult to take seriously unless the forecasting models, on which they are based, are proven reliable. When moving from pure judgment and guesswork to a more quantitative, objectively sound method of managing assets, it is advisable to start simple and ensure that judgment is still available as a backup. It will take time to validate and refine the models, and build confidence in them.

To minimize the amount of time this takes, it is important to ensure, early in asset management implementation, that forecasting models for performance and costs are periodically held up to scrutiny. For this to be possible, a feedback loop is required (Exhibit 45). The feedback loop consists of records of actual conditions and project costs, expressed in the same units and form as the planning models used in planning the projects. Comparisons of actual vs. predicted outcomes, help to set priorities for further research and improvement.

When new asset management models are first developed, usually the inventory and inspection processes are new, and historical data are scarce. The initial models frequently rely on expert judgment as data for developing forecasting models. These models are often inaccurate. For example, Florida DOT developed its first bridge deterioration models in 2001 using expert judgment, and then replaced these with more scientific models, using inspection data, in 2010. It found that the expert judgment models estimated bridge element lifespans that were, on average, only half the median lifespans found in real inspection data (Sobanjo and Thompson 2011). This was not regarded as a failure of the old models, but merely a natural result of improved bridge inspection, maintenance management, and analysis methods, which are now producing very credible models. Asset management is a learning process.

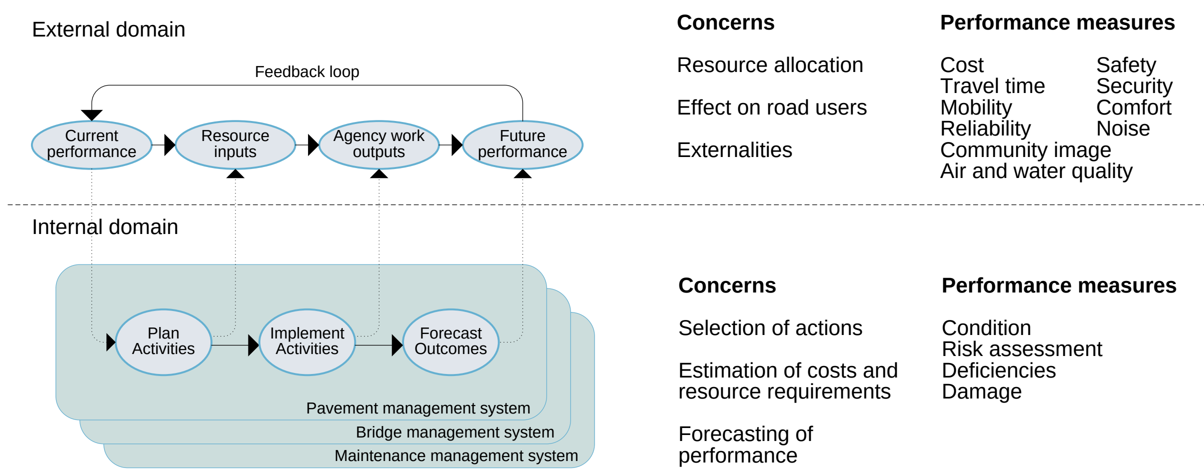

Exhibit 45. Feedback loop to ensure planning inputs correspond to reality
(Gordon et al 2011)

2.6.4 Tradeoff analysis and decision support tools

Given the steps that must be completed first — such as inventory, condition assessment, and forecasting — it is unrealistic to expect a complete decision support capability to be operational in just two years. However, there is nothing to stop the Department from proceeding to develop a prototype of the Transportation Investment Candidate File, even if the data to populate that file are initially developed from judgment. After all, the Department already updates its Statewide Transportation Improvement Program (STIP) each year, with processes that are already in place.

An initial prototype of the Investment Candidate File could be developed to follow the AIP/STIP[44] development process and interface with the prototype Data Integration Page which is already under development. It would be logical to develop this as an Excel spreadsheet, with a list of initial capabilities similar to the following:

[44] AIP projects are typically included in the STIP in Alaska.

- Ability to store and report on all the data items listed in Exhibit 42 for all investment candidates. This would include investments listed in the STIP as well as alternatives that might become attractive at different funding levels.
- Ability to access the pavement and bridge management systems for investment candidates and inventory data for those asset types.
- Geographic referencing to enable graphical display on the maps developed for the Data Integration Page.
- Ability to compute utility functions and benefit/cost ratios for priority setting, using the methods described in NCHRP Report 590 (Patidar 2007).
- Ability to summarize changes in network level performance at any given funding level for any given set of performance weights. This could include graphs of performance vs funding based on the investment candidates provided in the file (Exhibit 46).
- Ability to determine the cost to achieve a given performance target, using the investment candidates in the file.

This analysis would be rough at first, since it must rely on existing STIP projects and existing pavement and bridge management capabilities, as well as some manual data entry. Even so, it would be a useful tool for preparing STIP reports and for presenting the STIP and its consequences to the public.

Most importantly, the initial prototype would be designed to be expanded and improved over time as more of the essential asset management capabilities come online. This would entail adding new asset types, such as culverts and geotechnical assets; adding new performance impacts as forecasting models of condition, life cycle cost, safety, mobility, and risk are developed; and adding more investment candidates as improvements are made in existing management systems to generate such candidates.

Developed in this way, the decision support tool would start small and simple, and would build incrementally. This philosophy means the Department does not have to wait for a large, expensive project with a risky schedule and uncertain results. Early results would help the Department to educate its stakeholders and control the pace of development, while at the same time keeping the flexibility to adapt to future policy issues and stakeholder needs.

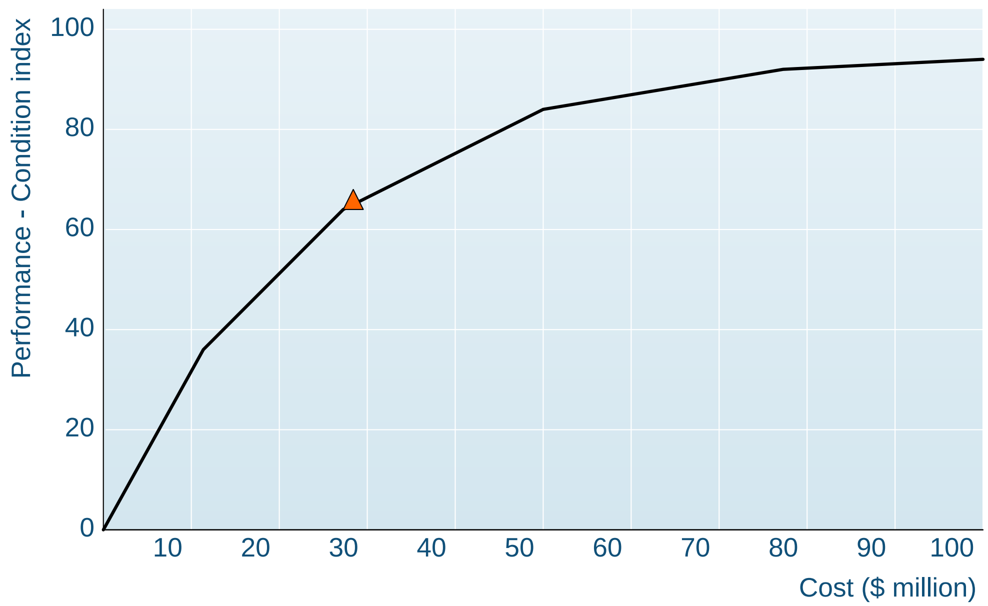

Exhibit 46. Example of performance vs cost graph

2.6.5 Findings: Decision support capabilities

Finding 6.1. The Department has a pavement management capability to extrapolate past condition trends, and has an expert judgment-based model of bridge deterioration. It has no forecasting models for any other types of assets, and no validation history even for the pavement and bridge models.

Finding 6.2. Because of a lack of inventory and condition/performance history, development of forecasting models for any additional asset types would need to be performed using expert judgment. Some work accomplishment data are available, but it is unknown at this time whether the data are suitable for estimation of models of cost or action effectiveness.

Finding 6.3. Currently the Department does not have any other decision support tools for asset management. In particular it does not have a reliable way to estimate life cycle costs or to forecast future preservation needs. It does not have a means of relating funding to performance or of investigating tradeoffs.

2.7 Transportation Asset Management Plan

It is apparent in this synthesis that asset management is made up of a rather large set of policies, relationships, procedures, data, and tools, all working together to maximize performance and minimize life cycle cost of the transportation system. These capabilities and ingredients all share a common focus on physical assets, but are otherwise as widely dispersed as the state transportation network itself.

The Work Plan in the next chapter will show that asset management is also a locus of investment in staff resources, operating and planning funds, consulting services, data, and equipment, which is just a small part of the larger investment the state has made in its physical infrastructure. Given the magnitude of the investment and stakeholder expectations for its performance, it is appropriate that the Department establish a locus of documentation to show how the state's valuable assets are being managed for the public good.

AASHTO's Asset Management Guide (Gordon et al 2011) suggests that a best-practice approach to this documentation would take the form of a Transportation Asset Management Plan (TAMP, Lindquist 2012). The new MAP-21 legislation now makes the TAMP a requirement for the National Highway System. A TAMP answers a variety of important questions that stakeholders and senior managers often have:

- Do we have an accurate picture of the scope of ALL assets that we manage, their financial value, their position in their lifecycle, the risks faced by the assets?
- Have we documented the levels of service or performance of the assets that we are providing, and researched what our customers value?
- How do we know whether the agency's mission is being accomplished with maximum effectiveness and efficiency? Do we have the evidence to convince stakeholders of this?
- Have we considered all the options in developing upgrade and preservation programs?
- How have we optimized our planned expenditure in asset preservation?
- Do we understand growth and demand for the services provided through transportation infrastructure?
- As the asset base grows due to system expansion, is there sufficient information to ensure that maintenance and operations budgets grow accordingly?

- How do we report on performance to our regulators, stakeholders, management and staff?

The TAMP will typically span an implementation period of 2 years, sometimes ranging from 1 to 4 years (Exhibit 47[45]), and address close to one increment on the asset management maturity scale. The initial self-assessment, as presented in this Synthesis, can be the baseline against which the desired improvements are compared. For each dimension of maturity, the plan must establish achievable objectives in the agreed time frame, and a step-by-step plan to reach the objectives. The steps are expressed as the Improvement Plan, a work plan with specific responsibilities, assumptions, and timelines.

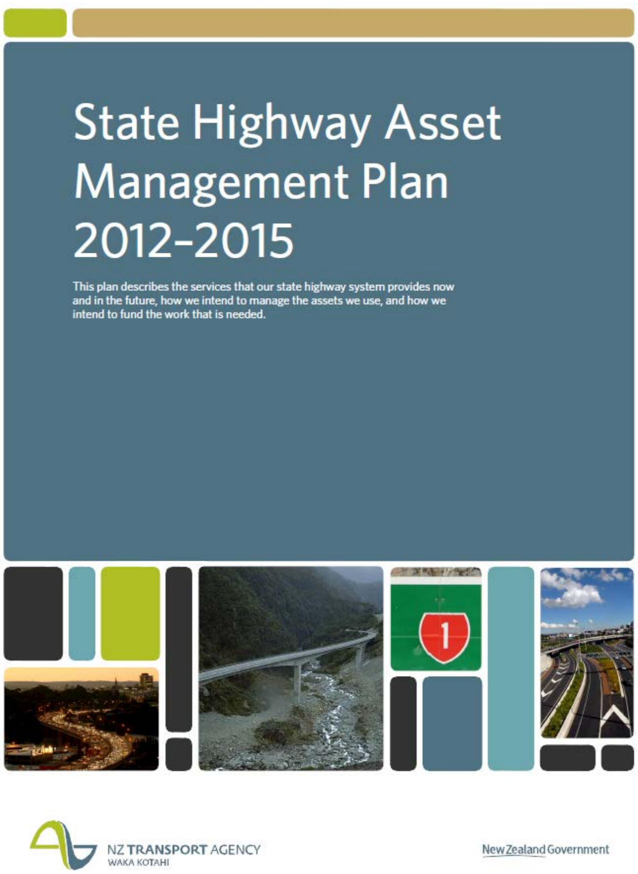

Exhibit 47. Example TAMP

The level of advancement of the TAMP can be an indicator of where the agency lies on the TAM maturity scale. Typically, the first TAMP can be developed at the Awakening stage when an agency has recognized the need, has some data and is able to document its current practices and improvement intentions. As the maturity level improves through Structured and Proficient towards Best Practice the TAMP should become more and more advanced reflecting higher levels of knowledge and analysis. In fact, the practice of writing and updating the TAMP also helps an agency to step up the maturity scale, as the process highlights the data needed, the decisions that need to be made, and the practices that need to be improved in order to make better decisions (Oregon 2011).

In terms of existing documents produced by the Department, the TAMP can be a complement to the STIP and the Statewide Policy Plan, providing more detail on the status of the transportation infrastructure, the near-term outlook in performance, and near-term plans for improving performance and life cycle cost. The TAMP can be a successor to the existing Pavement and Bridge Reports, having a more comprehensive treatment of Department assets.

A TAMP can be a single document, a collection of documents, and/or a collection of online resources. For the DOT&PF, a likely format for the state transportation network as a whole

[45] http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf

would be a PDF document of around 100-150 pages, accompanied by linkages to other data and resources provided on the Department's web site. The main document could contain the following sections:

1. Introduction: Background on the Alaska DOT&PF, and its infrastructure. General data and maps of the network focused on utilization, expected growth, recent history, and established plans.

2. Goals and objectives for asset management: Discussion of the legal and policy background in the Statutes, Administrative Code, and Statewide Policy Plan.

3. Asset inventory: Detailed tables and graphs on all types of assets (for which data are available) in the network, including types, magnitude, replacement value. Statistics on recent and future growth, including demand growth and industrial requirements.

4. Performance management framework: Background on levels of service, performance measurement methods, and data collection methods. General discussion (to aid a layman's understanding) on the specific types of performance to be managed, including condition, life cycle cost, mobility, safety, risk, and externalities. Discussion of how the Department determines preservation needs and how it sets performance targets.

5. Current performance and past trends: In the first iteration of the TAMP, the historical data and trendlines may be limited to pavements and bridges. Future iterations will be able to broaden the perspective as more data are gathered.

6. Future performance: Exploration of alternative futures for the state's infrastructure, sensitive to funding levels. In the first iteration this would be very rough, perhaps based on the first draft of the Investment Candidate File. This section would be intended to become much more authoritative in future iterations as the Department's data and analysis capabilities improve.

7. Processes: Current business processes of asset management, and proposed improvements. This chapter includes a discussion of the barriers to improvements (staffing, funding, legislative cooperation, etc.) and proposals/plans for overcoming the barriers.

8. Work plan: A specific list of tasks, similar to the one in this document, for improvements to asset management capabilities in the following two-year period (e.g. 2014-2016).

9. Financial plan: Includes a summary of the most recent STIP as well as operating funds necessary to achieve the process improvements and the desired performance improvements for the assets.

The MAP-21 legislation lists some general requirements of the TAMP as it applies to the National Highway System. It is likely that these requirements will be spelled out in more detail by upcoming rule-making.

The report would be supplemented with tables, graphics, and maps published on the Department web site. These more detailed presentations could focus on specific segments of the network, functional classes, or other relevant subdivisions of the network. Typically an automated process is required for generating the more detailed presentations, so the timing of such enhancements would depend on the availability of new information systems which can produce them.

The authors of NCHRP Synthesis 439 (Hawkins and Smadi 2013) found that none of the states currently have a complete TAMP that they are willing to share as exemplary of what is required in MAP-21[46]. They indicated that Georgia and Nevada have products that are close to the MAP-21 vision, but neither of these state DOTs has a TAMP publicly available on its web site. FHWA also does not list any domestic plans among the examples given on its own web site[47]. Nonetheless, a considerable amount of work is already underway, including an FHWA pilot project with three states (Louisiana, Minnesota, and New York), for which Alaska is an observer state[48]. Minnesota has retained a consulting team to assist in the development of its first TAMP, and Nevada is also in the process of doing so.

[46] Based on a presentation by the NCHRP Synthesis 439 authors at the 2013 Transportation Research Board Annual Meeting.
[47] http://www.fhwa.dot.gov/asset/plans.cfm
[48] http://www.fhwa.dot.gov/asset/tamp/

3 Work plan

This chapter lists the actions recommended for development of the Department's first Transportation Asset Management Plan (TAMP). It then provides more detail on the recommended new policy statements, and the TAMP development process.

As part of the preparation of this final draft of the Work Plan, the time and resource estimates from the Draft Synthesis and Work Plan were merged, eliminating overlaps and accounting for economies of scale. As a result, the estimates given here are often more than the Highway estimates given earlier, but much less than the sum of earlier Highway, Aviation, Marine, and Public Facilities estimates.

3.1 Recommended actions

The following sections list the specific work plan tasks envisioned in order to advance by one step in asset management maturity. They are conceptualized to be feasible within the time frame of 2013 to 2014. However, it is important to set priorities among this large number of tasks, and it is very likely that some of them will need to be outside the 2013-14 time frame, or may be only partially completed in that time frame. Many of these tasks have economies of scale, such that they may be completed faster and less expensively if combined into projects.

The task descriptions are based on a relatively limited review over four non-consecutive months that included a tour of the Parks and Richardson Highway Corridors, meetings in the headquarters and regional offices, and quick review of a few relevant documents and systems. A more thorough review might result in a more refined work plan. In many cases, the recommended near-term action is a feasibility or pilot study that can more deliberately review all relevant documents, involve all relevant Department staff and stakeholders, and provide more detailed design guidance. Exhibit 49 at the end of this section summarizes the actions and estimated resource requirements.

3.1.1. Organizational structures

Action 1.1. Staff deployment and leverage. DOT&PF is resource-limited. Improved staff efficiency and effectiveness in asset management processes may be possible with certain adjustments in staffing and deployment, with the goal of providing better leverage for key senior professionals. This could entail assistance from technicians, interns, consultants, local agencies, or others. For example, there are instances where the use of consultants, technicians, or interns for inspection tasks could free up time for technical leaders to use for quality assurance and management activities. This would be a promising topic for discussion with the Steering Committee and other senior management.

Action 1.2. Communication plan. Successful management of organizational change depends on clear, consistent communication within the Department and with stakeholders. There is also a need for clear two-way communication with the public regarding asset management. As asset management capabilities develop, there will be considerably more hard information available for public consumption, as well as an improved ability to gather and use public opinion data. The internal and external plans are closely related and need to be consistent with each other. Cambridge Systematics has been tasked with this activity for their TAM Information Systems study. The TAM Communication Team's initial task is to develop both internal and external communications plans.

3.1.2. Public and stakeholder initiatives

Action 2.1. Constituency-building. A major goal of the Communication Plan is to build public awareness and support of the idea that the Department is managing its assets for the public benefit, that performance and funding are linked by predictable forces, and that the Department is doing everything possible to maximize the value of the investment the state has made in its transportation assets. An additional goal is to keep the public informed of specific conditions, decisions, and plans, including corridor performance, STIP plans, and near-term work zone plans. An indirect goal, and a measure of success, would be for stakeholders to hear from their own constituents that the Department is doing a good job of keeping them informed and preserving the public's investment. This action involves maintenance of the web site as well as communication through other media according to the Communication Plan. This action would not necessarily increase the resources already devoted to communications, but the Communications Plan would have more to say about whether any additional resources are required. The TAM Communication Team initial task is to develop both internal and external communications plans.

Action 2.2. Stakeholder consultation. Expand formal and informal contacts with stakeholders. One specific topic to be addressed early, is to obtain feedback on the performance based budgeting exercise that was recently attempted. A more general topic is to discuss the ways in which the Department's performance is measured, and the ways that stakeholders can use the information. Demonstrations of the Geographic Data Integration Page would be helpful. The existing Performance Electronic Tracking System could be a focal point for a discussion of increasing the scope of performance monitoring and tracking in the Department. Stakeholders should be made to feel they are part of the team, attempting to improve life cycle costs and performance of Alaska's transportation system. The TAM Communication Team initial task is to develop both internal and external communications plans.

3.1.3. Policy documents

Action 3.1. Official adoption of the "Modified Approach" of GASB Statement 34. This accounting convention effectively uses the information from asset management systems to determine asset service lives and depreciation. If possible, this would most effectively be done by means of the Alaska Administrative Code, but should also be reinforced via an internal policy document. A Department expert has indicated that this may be difficult to accomplish as an internal policy-making activity, so it may await further guidance from FHWA regarding MAP-21 requirements.

Action 3.2. Amendments to Statewide Policy Plan. The Statewide Long-Range Transportation Plan is being updated using Parsons Brinckerhoff and managed by the same individual who serves as TAM Planning and Programming Team facilitator. In this update, references to pavement management should be expanded to include at first bridges and eventually all types of assets having significant cost or significant impact on Department performance (for example, buildings, equipment, geotechnical assets, etc.) This would help to support the integration of asset management into public policy, and provide a basis for public expectations for performance management. Additional changes could be made to reflect the work plan described here.

Action 3.3. A focused push on internal policy. A concentrated effort is needed to develop a set of internal policies to guide and support further asset management development. These policies should support (and be supported by) the other actions described here, should apply to all types of assets and all aspects of performance identified in the Statewide Policy Plan, and should identify the means of implementation and the individual (by title) responsible for implementation. This action and the related policy development and review process is estimated to require 4-6 person-months of effort over 12-18 months. The TAM Teams affected by new or revised policies will draft some initial policy language for approval by the TAM Steering Committee. Some policy drafting may need to be contracted out based on current DOT&PF staff knowledge and availability.

Action 3.4. Policy follow-up. A policy coordinator will need to be appointed to ensure that the new asset management policies remain current and relevant. This will be the responsibility of the TAM Manager. The same person could be responsible for follow-up on existing policies, some of which appear to be outdated or obsolete. Over the long-term this may require only 5% of a person's time, but the initial cleanup may require 1-2 months of concentrated effort over a 12-month period. Three divisions will be reviewing their current policies and procedures, and removing or updating them as needed.

3.1.4. Asset inventories and condition assessment

Action 4.1. Inventory and condition database study. A feasibility study should be undertaken to prepare a conceptual design for management of inventory and condition data for asset management. The study would prepare a logical database design, and determine whether the data models of the existing pavement, bridge, or maintenance management systems might contribute to the new design for other types of assets. Other development models, such as the use of COGNOS or development of an entirely new system, would also be investigated. It is appropriate in this study to investigate also whether the existing PETS system can be expanded to address all asset management needs for performance assessment and tracking, or whether an alternative approach is required. Methods for data capture and reporting would be investigated, for all relevant types of assets. The ongoing TAMIS study will satisfy the needs of this action.

Action 4.2. Statewide GIS server. Funding has already been identified to expand and permanently host the Geographic Data Integration Page, to enable scaling to a statewide system for visualizing infrastructure conditions and performance. This work would be performed in-house, possibly with consultant assistance. DOT&PF has formed an in-house GIS Work Group with some members of some of the TAM Data Integration Group.

Action 4.3. Levels of service. Existing level of service documentation should be adapted and expanded to cover at least the priority 1 and priority 2 condition data items identified in Exhibit

31. These primarily technical definitions would form the basis for visual condition and performance assessment for all asset types that are not inspected by existing procedures. This could be done in-house using the same process as has been followed thus far. However, since the relevant staff are extremely busy, consultant or university assistance is advisable to help accelerate the process. This may require an effort of $70-100,000 over 6-9 months, with 3-5 weeks of staff support and review. Department staff participation is especially important to verify level of service and condition state language, and to supply photographs.

Action 4.4. Inventory/condition information system. The conceptual design from Action 4.1 and the level of service language from Action 4.3 should be implemented in the form of a database and information system, which may be created as an extension of existing systems, or as an entirely new system. With help from the TAM Technical Teams, asset classes will be prioritized and implemented in phases. The level of effort will need to be refined based on Action 4.1, and could range from $250,000 to $1.5 million, with the higher amount applying to an entirely new information system for inventory and inspection management if that is found to be necessary. The implementation time period would range from 1 to 3 years. The current TAMIS planning contract is due to be completed by August 2014, after which the system can be built.

Action 4.5. Pavement condition survey enhancements. In the current state of the practice, pavement condition surveys typically cover additional defect types which aid in asset management. An investigation should be conducted to determine the cost and work plan to bring such measures into Alaska practice. The most important defects are: long-wavelength unevenness caused by frost heave and permafrost melting (Exhibit 48); alligator, transverse, and longitudinal cracking; surface texture defects and skid resistance; and spring bearing capacity. Such data are likely to be necessary for advancement in the life cycle management of Alaska pavements, given the state's unique exposure to freeze/thaw and permafrost. In addition, the study should address the work plan and cost to extend existing data collection processes to parking lots (aviation, marine, and other public facilities), gravel and unpaved runways, and any other paved areas not currently surveyed. A cooperative effort with other northern transportation agencies (such as in Canada, Scandinavia, or Russia) may help with development of suitable equipment and methods. An initial research study may cost in the $150-200,000 range. Additional costs for pilot testing in the Parks Highway corridor (or elsewhere) and for full implementation would need to be determined. These activities are highly suitable for university research.

Action 4.6. Structure inspection enhancements. The Department is planning to update its bridge inspection process soon in order to implement the new AASHTO Guide Manual for Bridge Element Inspection. This would be an opportune time to extend the inspection process to additional structural assets, including sign structures, mast arms, high-mast light poles, retaining walls, marine structures (such as piers, floats, and breakwaters), and any other engineering structures that are to be included in the asset management process. This would entail the development of documentation and policy statements governing the inspection process and interval (including inspection responsibility and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; a quality assurance process; and any necessary software to be added to the Action 4.4 information system. A pilot study for the Parks Highway corridor would take about one year and would cost $70-150,000. This would develop metrics that would enable a more precise estimate for full statewide implementation, which may occur in phases.

Exhibit 48. Long-wave unevenness caused by permafrost and freeze/thaw

Action 4.7. Development of a building inventory and inspection process. This task would build on Public Facilities work already done in the three regions and in headquarters, as well as the 20-airport pilot study. The first stage of populating the asset inventory can be performed largely in the office, by examination of existing databases, plans, and records for maintenance bases, public facilities, airports, marine terminals, ports, and harbors. Certain asset types will not be covered well from this exercise, but the activity will still help to organize the field data collection process and to test and validate the inventory software. The biggest challenge will be to determine, for each asset, the nature and extent of the Department's asset management responsibility. Many buildings and port facilities might be excluded if the Department has no specific responsibility for them. It may make sense to include ferry vessels and certain aviation and marine equipment in this effort in order to have a comprehensive inventory of high-value assets. Lower-value assets might be saved for later phases. This task may require $100-$200,000 in consultant assistance along with 3-5 weeks of staff supervision and assistance over about twelve months.

A process will need to be created to periodically update the inventory, condition, and performance data on buildings. This would entail the development of documentation and policy statements governing the inspection process and interval (including inspection responsibility and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; and a quality assurance process. This effort may be implemented in phases, with the highest-priority assets addressed first. An initial phase might cost in the $200-250,000 range.

There is a separate 2013 STIP project to support the Alaska Marine Highway System in its implementation of Transportation Asset Management. AMHS will be hiring a consultant to assist in the inventory, condition survey, and development of levels of service.

Action 4.8. Geotechnical assessment process. An inventory and condition assessment process should be established for materials sites, slopes, retaining walls and embankments. This would entail the development of documentation and policy statements governing the inspection process and interval (including condition states and levels of service, inspection responsibility, and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; a quality assurance process; and initial applications, especially deterioration forecasting. This effort may be implemented in phases, with the highest-priority geotechnical assets addressed first. This task is funded and currently underway.

Action 4.9. Drainage assessment process. An inventory and condition assessment process should be established for all culverts not already included in the Pontis bridge inventory. Certain additional drainage structures (swales, levees, etc.) may be included. This would entail the development of documentation and policy statements governing the inspection process and interval (including inspection responsibility and training requirements); identification and procurement (when necessary) of necessary personnel and equipment; a quality assurance process; and any necessary software to be added to the Action 1.4.4 information system. A pilot study for the Parks Highway corridor would take about one year and would cost $40-80,000. This would develop metrics that would enable a more precise estimate for full statewide implementation. This activity is potentially suitable for university research. It will take place after the highest-priority pavement and bridge management work are completed.

Action 4.10. Appurtenance and roadside feature assessment process. A feasibility study should be prepared for the requirements of asset management for barriers, guardrails, traffic control devices (signs, signals, flashers, delineators, etc.), lighting, and roadside safety features. This would then be implemented with the development of any necessary inventory and condition assessment processes, policies, and documentation. A phased implementation over many years may be appropriate. The initial study would cost $50-100,000 and take about one year. It is suitable for university research.

3.1.5. Levels of service and performance assessment

Action 5.1. Prioritization methods. Expand and refine the levels of service from Action 4.3 to ensure that the customer perspective is represented. Develop a set of performance indexes with appropriate scaling and weighting functions. This task will require a survey of stakeholders and customers in order to quantify the scaling functions and weights. This work would typically cost $120-200,000 and take about one year, possibly including the services of a marketing research firm for survey execution. Pavements and bridges would receive the initial focus, with later work on other asset classes.

Action 5.2. Asset-level analysis. For all types of assets addressed by the inventory and performance processes put into place, develop software to estimate asset value, and to perform the scaling, weighting, and asset valuation computations. Develop reports to support trendline analysis for these performance indicators. The effort required for this work would depend in part on the results of the inventory and condition assessment tasks described previously. Ideally the simplest approach would be a spreadsheet model that accesses the relevant databases. Graphics extracted from the model could be posted to the Department web site and used in reports. This type of work would typically cost $100-150,000. More elaborate systems could be developed to present trendlines and indicators in real time in web pages, at a higher cost in the range of $200-300,000.

Action 5.3. Geotechnical performance management tools and asset management plan. This task would develop for geotechnical assets some of the basic tools that already exist for pavement and bridge management, building on the inventory and assessment processes already described. It includes development of a performance management framework, policy and procedure documents specifically concerned with geotechnical assets, communication methods and plans, and a Geotechnical Asset Management Plan. This is intended to bring geotechnical assets to a level where they can play a full role in the Department's risk management and Enterprise Asset Management plans and actions going forward. This task is funded and underway.

3.1.6. Decision support capabilities

Action 6.1. Investment candidate file. Develop a first draft of the Investment Candidate File as an Excel spreadsheet using as data sources the STIP, pavement and bridge management systems, and manual data entry. Subsequently this file can be expanded to include automated generation of needs for other kinds of assets. The capabilities would be as described earlier in this report. This would most efficiently be developed as a joint exercise where Department staff populate the spreadsheet with STIP and management data, while a consultant develops the automated capabilities such as system interfaces, prioritization methods, and reports. This type of work is likely to take about $70-120,000 in consulting fees plus 1-2 person-months of Department staff time over a period of about 1 year. This activity will be sent to the TAM Planning and Programming Team for action. There is an electronic STIP pilot project that could be built upon.

Action 6.2. Capture of maintenance work accomplishment data. A feasibility study would investigate existing and potential methods of capturing work accomplishment data for use in development of planning models and for tracking of program implementation. The study would address information systems, work classification schemes, data collection devices, linkages to inventory and condition assessment systems, policies and procedures, crew reporting procedures, and contractual provisions. It would produce a work plan for maintenance management system improvements. As a stand-alone study this would cost in the $150-250,000 range, but might be less expensive as part of a larger effort to redesign or upgrade the Department's existing maintenance management system. This action will be referred to the TAM Data Integration Team and the TAMIS study.

Action 6.3. Models of highway and airfield pavement deterioration, actions, costs, and effects. This study would analyze existing data on pavement conditions and work accomplishments to develop quantitative forecasting models. The new models would be compared to the existing models in use in the pavement management system, and would be used to improve the forecasting capabilities of the PMS. The study would identify weaknesses in current data resources, and recommend improvements to procedures and systems to enable better planning models in the future. This type of work is typically in the $150-250,000 range and would take 12-24 months. This work is suitable for university research. This is an important project to begin as soon as possible.

Action 6.4. Models of bridge deterioration, actions, costs, and effects. This study would analyze existing data on bridge conditions and work accomplishments to develop quantitative forecasting models. The new models would be compared to the existing models in use in the Pontis bridge management system, and would be used to improve the forecasting capabilities of Pontis. The study would identify weaknesses in current data resources, and recommend improvements to procedures and systems to enable better planning models in the future. This type of work is typically in the $120-200,000 range and would take 12-18 months. Portions of this work, especially the cost model development, may be suitable for university research. This is an important project to begin as soon as possible.

Action 6.5. Models of geotechnical asset deterioration, actions, costs, and effects. This study would use an expert judgment elicitation process to develop a first draft of forecasting models, for use while inventory, condition, and work accomplishment data collection processes are put into place. This type of work is typically in the $20-50,000 range and would take 2-4 months. This action item will be sent to the Geotechnical Asset Management (GAM) Project Manager.

Action 6.6. Models of other asset deterioration, actions, costs, and effects. This study would use an expert judgment elicitation process to develop a first draft of forecasting models, for use while inventory, condition, and work accomplishment data collection processes are put into place. This type of work is typically in the $60-100,000 range and would take 4-8 months. This project will begin as soon as important other assets are identified, inventoried with condition and acceptable LOS.

3.1.7. Transportation asset management plan

Action 7.1. Develop a transportation asset management plan to follow MAP-21 requirements as well as to serve the asset management needs of the Department. The contents would be as described earlier in this report, subject to pending FHWA rulemaking. Alaska DOT&PF is an observer state to the FHWA TAMP development pilot project, in which three states are developing portions of their TAMPs with FHWA and consultant assistance. From this experience, Alaska will be able to learn the process and pitfalls. The TAMP would likely be developed as a joint effort between Department staff and a consultant, with staff time requirements in the 3-6 month range and consulting costs in the $150-200,000 range. The effort would be spread over the entire period from 2013 to 2014 but more concentrated toward the end of the period, especially in the last 6 months. In the initial version a considerable amount of manual data processing may be necessary while supporting systems are developed. The TAMP is the responsibility of the TAM Manager.

Exhibit 49. Estimated resource requirements

	Action	Typical cost	Typical staff time
1.1	Staff deployment and leverage	--	--
1.2	Communication plan	TBD	TBD
2.1	Constituency building	TBD	TBD
2.2	Stakeholder consultation	--	underw ay
3.1	GASB 34 Modified Approach	--	--
3.2	Amend Statew ide Policy Plan	underw ay	underw ay
3.3	Internal policy	--	4-6 mos
3.4	Policy follow -up	--	1-2 mos
4.1	Inventory/condition database study	underw ay	underw ay
4.2	Statew ide GIS server	--	underw ay
4.3	Levels of service	$70-100k	3-5 w ks
4.4	Inventory/condition information system	$250-1500k	3-4 mos
4.5	Enhance pavement condition survey	$150-200k+	2-3 mos+
4.6	Enhance structure inspection	$70-150k+	2-3 mos+
4.7	Building inventory and inspection	$100-200k+	2-3 mos+
4.8	Geotechnical assessment process	underw ay	underw ay
4.9	Drainage assessment process	$40-80k+	1-2 mos+
4.10	Appurtenance assessment process	$50-100k+	2-3 mos+
5.1	Prioritization methods	$120-200k	1-2 mos
5.2	Asset-level analysis	$100-300k	1-2 mos
5.3	Geotechnical TAM Plan	underw ay	underw ay
6.1	Investment candidate file	$70-120k	1-2 mos
6.2	Capture of w ork accomplishment data	$150-250k	2-3 mos
6.3	Pavement deterioration, cost models	$150-250k	2-5 w ks
6.4	Bridge deterioration, cost models	$120-200k	2-5 w ks
6.5	Geotechnical deterioration, cost models	$20-50k	2-4 w ks
6.6	Other deterioration, cost models	$60-100k	3-5 w ks
7.1	Develop TAM plan	$150-200k	3-6 mos

-- = Minimal time in addition to w hat is already being done
TBD = An effort is underw ay to determine resource requirements
underw ay = Work already in progress
\+ = Pilot study w ill determine additional resource requirements

3.2 Draft outline of internal policy statements

All policy statements would be developed using the process and outline described in P&P 02.01.010. In most cases the documents described here would be both "Policy" and "Procedure" as described in P&P 02.01.010. All would be publicly-available documents posted on the Department web page[49]. When the policies reference outside documents, these would also be made publicly available to the greatest extent possible.

P&P 02.01.010 provides guidance on the content of these documents, the level of detail, and the process for developing them. All of these are appropriate for the policy documents described here.

Inventory and condition assessment policies

This policy builds on and updates DPDR 10.03.010 by listing the asset classes of significant asset management concern for the Department. For each asset class, it specifies:

- The master repository system for inventory and condition data (as is done in DPOL 07.05.020 for pavements and P&P 11.01.050 for the equipment fleet).
- The responsible Department unit for keeping the data up-to-date.
- Department unit responsibility for developing supporting policies.
- Inventory and condition data updating interval.
- Reference to another policy document with more specific information about each of the above topics.

This policy would describe general requirements applicable to all inventories, such as relational database structure, quality assurance process requirements, documentation and training requirements, and accessibility to the people who are to collect and use the data. The references to additional policy documents would provide detail specific to each asset class.

Supporting inventory and condition assessment policy documents should provide more detail for each asset class, which would include:

- Listing of essential data items in the inventory.

[49] http://www.dot.alaska.gov/admsvc/pnp/policy_and_procedures.shtml

- Standards for gathering specific items, where such standards exist. For example, standards for linear referencing, geographic location, measurement conventions, classification systems, etc. These may refer to industry standards documents (e.g. AASHTO Guide for Bridge Element Inspection), specific vendor equipment or methods, or to other internal policy documents.
- How to determine inclusion of an asset in the inventory, and how to determine the inspection interval. This would be especially important if there are risk-based criteria, as for bridges.
- Interfaces with other related business processes and systems, some of which may also be addressed by policies. For example, bridge load rating, document management, geographic information systems, maintenance management.
- Broad outline and requirements of the inspection program, including the scheduling of visits to specific facilities (and coordination among asset classes); allocation of resources; documentation, training and certification requirements; and quality assurance processes.

It is important to note that the separate project on Transportation Asset Management Information Systems (TAMIS) will have relevant policy recommendations governing information technology support for the inventory and inspection processes.

Maintenance work accomplishment tracking policies

One or more policies are needed in order to provide the feedback loop, where information about the accomplishment of preservation and improvement activities is fed back to the units responsible for planning future work. This may be done through the maintenance management system or separately, but the means must be specified. Procedures (for data capture, quality control, etc.) and criteria (accuracy, precision, coverage, timeliness, etc.) will need to be established. This policy development would have to occur in conjunction with planning for the information technology support of this capability. The separate project on Transportation Asset Management Information Systems (TAMIS) may have recommendations on this.

Performance assessment policies

This would consist of a group of policies governing performance assessment. The most important is the designation of levels of service for routine condition and performance assessment. One policy would specify the format for level of service definitions, and then there would be a set of policies for major asset classes (pavement, structures, geotechnical, etc.), describing the level of service definitions for asset types, subsystems, and elements within that class. This would be meant to guide field assessment of condition and performance. Some of these policies might reference internal manuals or industry publications.

Building on the levels of service, there is a need for a general policy on how to compute condition and performance indexes. This would specify a general method and conventions (for example, the general convention that 100 is perfect condition, 0 is worst condition, with a uniform value scale in between), then for each asset class would describe the method for computing this index. This may refer to specific software or documents describing the methods (for example, P&P 11.04.012 for equipment).

A policy should be developed to adopt the modified approach to GASB Statement 34. This would specify the method for computing asset value and depreciation, building on the level of service policy. It would also clarify how the requirements of the modified approach are to be satisfied, such as the designation of management systems to be used in maintaining desired condition and performance. Financial statements will need to reference this policy when they address infrastructure asset valuation. (P&P 11.02.010 addresses this topic for equipment.) DOT&PF will consider this as MAP-21 rulemaking progresses.

An update to P&P 02.01.017 will be needed, to provide some additional detail about the types of condition and performance indicators to be presented in the Performance Electronic Tracking System (PETS). It is recommended that the system be enhanced to provide summary output by region, corridor, and major asset class (which would be pavements, structures, geotechnical, drainage, traffic control devices, roadside features, buildings, and equipment), as well as overall indicators for the highway, aviation, marine, public facilities, and equipment components of the state infrastructure. A breakdown of performance should be provided for the following major performance concerns: condition, life cycle cost, mobility, safety, risk, and externalities, to the extent that each one is relevant and measurable. Both current performance and past trends should be available. Once it becomes possible to forecast future performance and set performance targets, these should be made available in PETS.

Decision support policies

One or more policy documents would address a set of topics about the use of asset management data and tools in the Department's decision-making processes. These would cover:

- Project needs identification criteria specific to each asset type. These may include "must levels" for pavement condition, bridge action feasibility criteria, desired and unacceptable levels of service, etc. Some of these criteria can be quite detailed, so the policy document may merely describe a separate system where these criteria are maintained. P&P 11.04.004, 11.05.001 and 11.05.020 address this for the state equipment fleet.

- The Investment Candidate File, including its contents, how it is maintained, the process for adding investment candidates to it, and its role in the preparation of the STIP and other decision documents.

- The method of setting priorities among investment candidates and for establishing performance targets. This can reference asset-specific systems where necessary (for example, in DPOL 07.05.020 for pavements), but should also describe a statewide process that is not specific to asset classes, especially in the context of developing the fiscally-constrained program.

- The method of implementing the GASB Statement 34 requirement to "*Estimate each year the annual amount to maintain and preserve the eligible infrastructure assets at the condition level established and disclosed by the government*".

At this point in time some of these policies may be aspirational, since they can't be implemented without first completing many of the Work Plan tasks. They may be short and vague at first, and then refined later as Department capabilities are developed.

Transportation Asset Management Plan (TAMP) Policy

This policy would establish the TAMP as a routine product of the Department. It would describe the contents, responsibilities for updating the document, the update interval, and (at a high level) the development process.

3.3 TAMP development plan

This Synthesis and Work Plan envisions a Transportation Asset Management Plan (TAMP) for all of the Department's infrastructure assets, extending well beyond the specific requirements of MAP-21. This is based on the belief that the process will be valuable to the Department and is motivated by an internal desire to improve the asset management process.

Nonetheless, one objective of the TAMP development process is to satisfy MAP-21 requirements, which means that the process (although not the product) will need to be reviewed and certified by FHWA. It is anticipated that FHWA will issue guidance on its certification process and requirements.

The TAMP development process should be designed to help the Department accomplish a number of goals it has for this process:

- To gain a better understanding of the Department's assets and their performance, and to communicate this understanding to a wide audience.
- To take a pro-active stance toward future performance, and to align business strategies toward accomplishment of forward-looking objectives.
- To bring together the key decision makers from different parts of the agency, who share common goals and concerns.
- To align expectations of the Department, external stakeholders, and the public with the realities of funding, economic growth, and deterioration.
- To document mutual agreement among the internal and external stakeholders for future objectives, to help reinforce cooperative problem solving, and build a culture that is concerned about agency performance.
- To provide a way of discovering problems with the asset management process, which is the first step in improving it further.

Preparation of the TAMP is an iterative process taking place over multiple TAMP development cycles[50]. Initially each stakeholder will focus on what he or she hopes to achieve from the process, and what information or resources are needed in order to achieve it. On the second cycle there will need to be a stronger effort to provide the needed information and resources. In a sense it is a process of finding equilibrium between supply and demand. It is very important to have strong leadership and a cooperative work atmosphere to conduct this negotiation.

[50] This discussion is adapted from Gordon et al 2011.

Establishing the target level of TAM maturity for a TAMP cycle is an effective way of managing the resources and effort that is put into writing the TAMP. This first cut document is likely to be based on existing information and data, such as service levels, life cycle management strategies, and asset condition. This first TAMP will likely contain many gaps – a complete TAMP is unlikely at the first attempt – with many improvement tasks identified for future implementation.

The TAMP writing tasks would typically be assigned to members of the TAM Development Team, and may also include external resources (e.g. consultants). This can be of benefit in facilitating specific writing tasks, guiding and mentoring in-house staff members, and applying experience from other agencies. The TAM Steering Committee is the "internal customer" for the writing task.

Exhibit 50 outlines the processes involved in writing a TAMP. It also clearly shows that this is a cyclic process that never ends; the plan should be continuously updated and refined to keep up with and ahead of, changes in demographics, demand, materials, methods and legislation and to give effect to its improvement program.

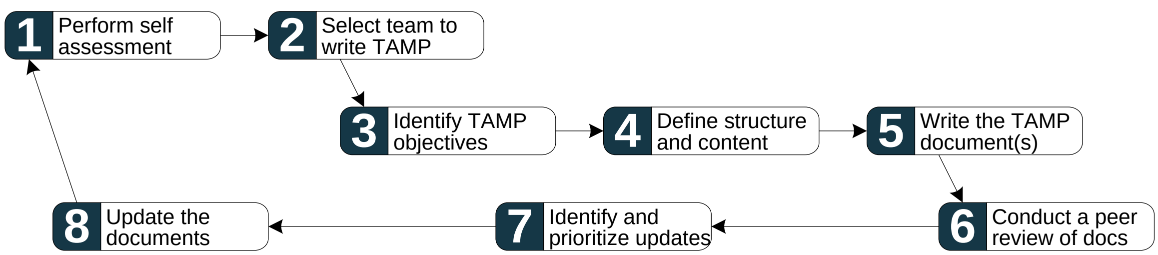

Exhibit 50. Stages in writing and updating the TAMP
(Gordon et al 2011)

The TAMP will typically span an implementation period of 2 years, sometimes ranging from 1 to 4 years, and address close to one increment on the asset management maturity scale. The initial self-assessment is the baseline against which the desired improvements are compared. For each dimension of maturity, the plan must establish achievable objectives in the agreed time frame, and a step-by-step plan to reach the objectives. The steps are expressed as the Improvement Plan, a work plan with specific responsibilities, assumptions, and timelines. The initial Work Plan, laying out the steps to reach the first TAMP, are described in the earlier sections of this chapter.

The International Infrastructure Management Manual (IIMM, NAMS 2006) has words of advice for agencies preparing their first TAMP, reproduced below:

> *The option of preparing, as a first step, an initial AM plan using readily available information is frequently taken as an alternative to the more structured approach of AM improvement planning. There are benefits in accepting limited objectives for the first plan. The first plan may be an internal document produced to understand the strengths and weaknesses of current AM practices and to identify priorities for future AM plan development.*

> *The approach involves using the first plan to record current policies, standards, lifecycle tactics, levels of service, information systems, critical assets, knowledge of assets, and work programs. To be successful, shortcomings need to be accepted and the temptation resisted to initiate AM improvements at this stage. The focus should be on current expenditure on asset development, renewal, maintenance and operations and the associated issues and actions, rather than on the text.*

A TAMP draws upon databases and information sources across the Department. The readiness of each unit of the agency to deliver the necessary information varies considerably. For example, there are basic inventories and inspection processes for pavements and bridges, but not drainage assets or most marine structures. A comprehensive effort is underway to develop the missing ingredients for geotechnical assets, but it will take a few years to build up the necessary databases. A pilot condition assessment has been recently completed for airport assets, but only at 20 sites. In contrast, inventory and performance data have been available for a considerable length of time for the statewide equipment fleet. None of the asset types in the Department have mature forecasting or decision support capabilities.

In preparing for the first TAMP, the various divisions of the Department have different work plans reflecting the gaps that have been found in this synthesis. The general logic for all of these work plans follows the stages shown in Exhibit 51. This diagram shows all the major tasks that feed into the preparation of the Department's first asset management plan. Some of these items will be only partially complete by 2014: for example, asset inventory systems might not be complete for all relevant assets. This should not stop or delay the preparation of a TAMP. The document should merely document the Department's capability at that time, and describe the plan to further improve its capabilities for the next iteration of the development cycle.

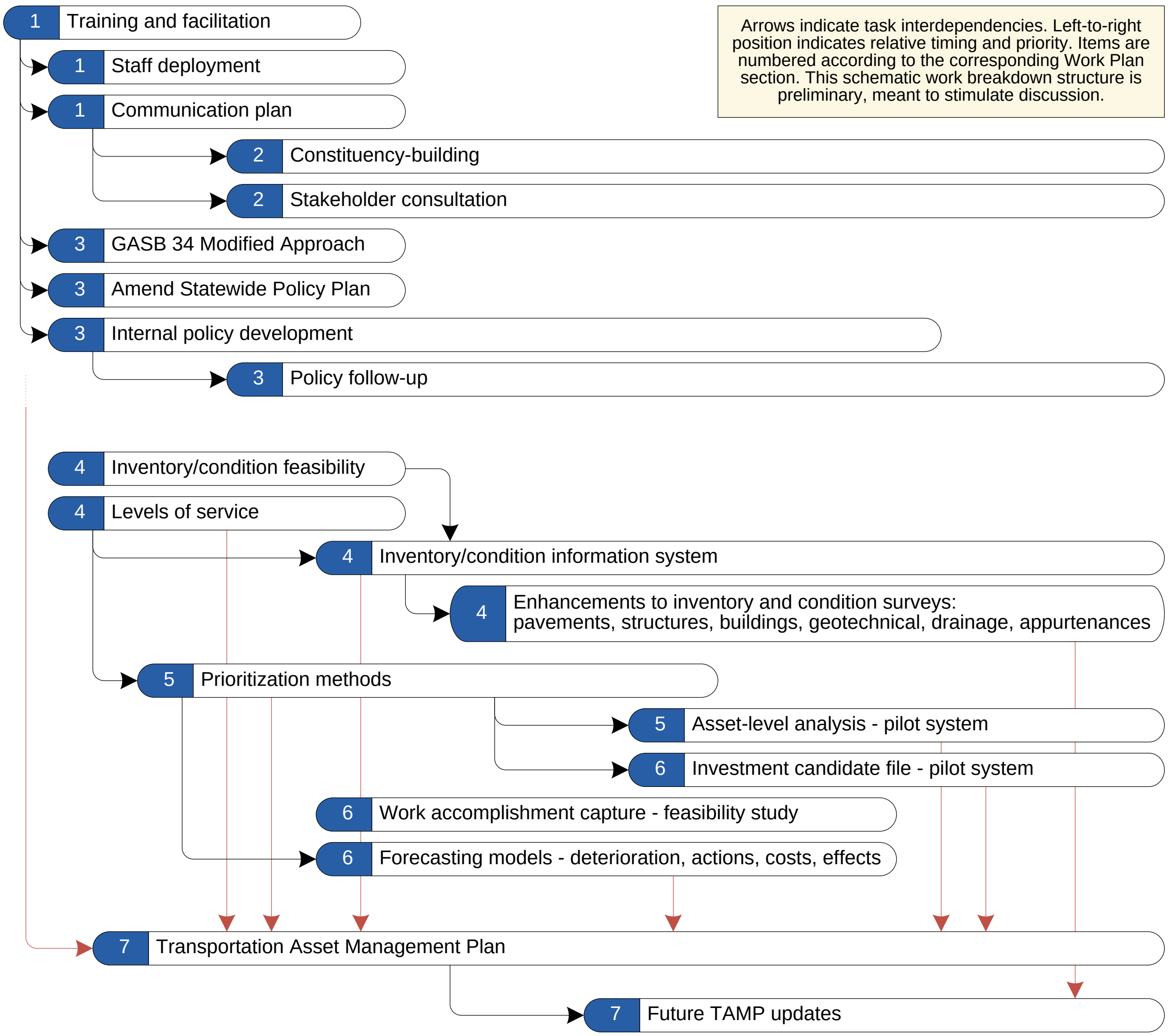

Exhibit 51. General work breakdown structure for developing the first TAMP

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