ASSET MANAGEMENT OF ENVIRONMENTAL MITIGATION FEATURES

Requested by:

American Association of State Highway
and Transportation Officials (AASHTO)
Standing Committee on the Environment

Prepared by:

Marie Venner, Michael DeWit, and Chris Paulsen
Venner Consulting and ICF International
9300 Lee Highway, Fairfax, VA 22031

June, 2009

The information contained in this report was prepared as part of NCHRP Project 25-25, Task 51, National Cooperative Highway Research Program, Transportation Research Board.

Acknowledgements

This study was requested by the American Association of State Highway and Transportation Officials (AASHTO), and conducted as part of the National Cooperative Highway Research Program (NCHRP) Project 25-25. The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation. Project 25-25 is intended to fund quick response studies on behalf of the AASHTO Standing Committee on the Environment. The report was prepared by Marie Venner, Venner Consulting and Michael DeWit and Chris Paulsen, ICF International. The work was guided by a task group chaired by Mr. Brent Jensen which included, Mark Hemmerlein, John Mettille, and David Carlson.

CONTENTS

Acronyms

BMP	Best Management Practice
CAD	Computer-aided Design
CED	Chronic Environmental Deficiencies
CEDAR	Comprehensive Environmental Data and Reporting
CNHP	Colorado Natural Heritage Program
CPD	Coordination and Permits Division
CTS	Commitment Tracking System
DENR	Department of Environment and Natural Resources
DNR	Department of Natural Resources
DOT	Department of Transportation
EAMS	Environmental Asset Management System
EEP	Ecosystem Enhancement Program
EIP	Environmental Information Program
EM	Environmental Management
EMS	Environmental Management System
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ETDM	Efficient Transportation Decision Making
FGDL	Florida Geographic Data Library
FHWA	Federal Highway Administration
GCR	General Condition Rating
GIS	Geographic Information System
GPS	Global Positioning System
IT	Information Technology
MMS	Maintenance Management System
MOU	Memorandum of Understanding
MQS	Maintenance Quality Surveys
MRP	Maintenance Rating Program
NEPA	National Environmental Policy Act
NGO	Non-governmental Agency
NHP	Natural Heritage Program
NHS	National Highway System

NPDES	National Pollutant Discharge Elimination System
PRISM	Partners for Regional Invasive Species Management
PS&E	Plans, Specs & Estimates
ROW	Right of Way
SMA	Special Management Area
TNC	The Nature Conservancy
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VE	Value Engineering
WDFW	Washington Department of Fish and Wildlife

1. Introduction

1.1. Asset Management at DOTs, Application to Environmental Assets

State departments of transportation (DOTs) make a significant investment in the construction of environmental mitigation features and those investments need proper care and upkeep to conserve that investment. Asset management represents a strategic approach to managing transportation infrastructure that takes a long-term view and is comprehensive and proactive. Asset management approaches aim to improve the cost-effectiveness of DOT investments, deliver the best value for the dollar spent, and thus enhance a DOT's accountability and credibility in its stewardship of transportation assets.[1]

Since asset management deals with resource allocation and utilization, ideally asset management systems are linked to a number of DOT management systems, from financial ones, to those used to manage environmental commitments and activities, to maintenance management systems (MMS) and budgeting scenarios. Asset management promotes application of information from these data and management systems throughout the infrastructure management cycle, to evaluate condition status and performance results from maintenance investment strategies, driven by agency policies and priorities.

Asset management can be used to set and meet performance targets and agency goals, through measurable results; however, such agency goals and performance targets are not in existence for most classes of environmental assets. DOT efforts in this relatively new field have been focused on "hard" infrastructure assets.

Agency goals and performance targets are not in existence for most classes of environmental assets. DOT efforts in this relatively new field have been focused on "hard" infrastructure assets, particularly hydraulic infrastructure such as culverts. Environmental aspects including degree of maintenance and functionality for fish passage are starting to be assessed.

Ideally, in asset management, the analysis of options and tradeoffs is strategic, interdisciplinary, and integrated. System performance monitoring quantifies the results of past investment selection criteria. Random or system evaluation surveys update information on current decisions. The DOT establishes baselines for future decisions and identifies updates needed in project asset inventory, condition, and performance, and the cost and effectiveness of project treatments, as well as service delivery methods for use in future analyses. Meanwhile, system performance monitoring provides the information basis for future policy formulation and needed updates to goals and objectives.

Too often, asset management systems are described as having these qualities, when analysis is inevitably limited by the nearly complete lack of information regarding certain asset classes, to even enter the discussion regarding budgeting priorities, needs, and trade-offs. In particular, data on environmental features and conditions is rarely available.

1.2. What Environmental Assets Do DOTs Maintain?

DOTs own or are responsible for thousands of valuable, unique, and sensitive environmental features. DOTs construct and maintain environmental mitigation projects to comply with the Clean

Water Act, Endangered Species Act, the National Environmental Policy Act (NEPA) and many other environmental regulations. Often mitigation projects offset or replace certain environmental functions lost as a result of construction of the transportation project. In order for the environmental mitigation projects to continue to provide the long term functionality intended when they were first constructed, the mitigation feature must be properly maintained, and when necessary, rehabilitated or reconstructed. Examples include stormwater management facilities, wetland replacement projects, stream restoration projects, reforestation projects, construction of sound walls, wildlife crossing structures, and replacement of parklands.

Other environmental assets may already be in the DOTs' hands, so to speak. Examples include nests of ground-nesting migratory birds in grasses in the rights-of-way; New York State DOT is one that has altered mowing practices to help steward these resources. A further example is control of invasive species on government property. Considered together, DOTs maintain many environmental assets, whether they are complying with their own stewardship objectives and those of sister state agencies, or to comply with federal and state laws or policies. These environmental mitigation projects may be considered as assets and, in an ideal world, maintained to certain standards similar to other transportation features.

1.3. Background

The topic of maintenance of environmental features has received little study and attention to date. Resource agencies sometimes contend that DOTs fail to follow through on their commitments and that once constructed, mitigation features receive little if any attention. At the same time, DOT maintenance staff are already overburdened with a set of very diverse tasks and expectations that sometimes appear to be rising as fast as staff numbers are declining. Responsibilities may be increasing but too often DOTs lack systems for meeting them. Forced to prioritize, needs related to infrastructure preservation often come out on top. Still, maintenance staff will add further responsibilities if it is incorporated into their jobs and they are provided resources and training to do the job.

Efficient information and decision support systems for environmental asset management are needed for DOTs and maintenance staff to support their work, especially at existing staffing levels.

1.4. Research Objective

The objective of NCHRP 25-25/51 is to discover what DOTs are doing in the field to maintain environmental assets and to identify models where DOTs are performing condition assessments, setting thresholds and performance measures, and implementing asset management systems. Findings, considerations, and practices are presented in this report as a potential addition to AASHTO's Compendium of Environmental Stewardship practices.

1.5. Methodology

The panel and research team were very aware of the pressures state employees face and the fact that surveys are often a low priority; DOTs remarked and the research team was aware that staff are facing "survey overload" from a variety of AASHTO, Federal Highway Administration (FHWA), and NCHRP research efforts.

Given this context, the team devoted significant attention in the first few months to honing the questions the research really needed to answer, and refining a strategy to approach the DOTs to minimize inconvenience and maximize effective information gathering and screening for deeper interviews and questioning. We primarily pursued appropriate contacts at DOTs via the phone, for verbal interviews. DOT contacts with knowledge in this area were still very difficult to find.

Process for Developing the Survey Instrument

The project kick off call occurred the first week of July 2008. The research team developed a set of initial questions for the panel's consideration during and following the project kick off call. Initial guidance from the panel was that primary contacts at the DOTs were to be the DOT environmental managers.

The research team solicited feedback from the panel on potential survey questions in several rounds. When little input was received on the proposed question set, the research team decided to redesign the inquiry so it was more limited and accessible, with more checkboxes and multiple choice answers. In October 2008, the research team solicited feedback on the revised draft survey instrument from individual panel members. Panelists were presented with two options for approaching the DOTs: a one-page checkbox matrix to assess DOT action along a gradient for a range of target environmental features, and the other a combination of the matrix with the longer set of questions. Panelists overwhelmingly indicated that DOT managers would prefer the one-page checkbox matrix. In addition to utilizing this format, our revisions also incorporated specific suggestions by panelists, such as adding columns to the checkbox matrix to provide DOTs more opportunity to depict earlier stages they might be at (merely maintaining lists of environmental assets and/or identifying global positioning system (GPS) locations of environmental assets), preceding condition assessment. The more extensive question list was reduced further and was used as follow up questions for those states that completed the matrix. Copies of the NCHRP 25-25/51 surveys are in Appendix A.

Survey Administration

In late October and early November, the research team began individual email contacts to environmental managers at each state DOT, plus the District of Columbia DOT and Puerto Rico DOT, describing the research effort and requesting initial screening information via the matrix and appropriate contacts in their agency. This method was relatively successful in terms of generating contacts though completed matrices were slow to filter in. The research team devoted significant effort to follow up calls with both the initial contact list and secondarily generated contacts, often 3 to 5 other individuals at the same agencies, with up to eight or more individuals involved to some degree at a single agency. Initial contacts that responded to the survey and provided information are listed in Appendix B.

In most cases, our follow up inquiries were tailored to initial information received from the DOT or our initial knowledge of states' systems. We responded personally to each replying DOT, to the environmental manager and the contact(s) to whom they directed us, with in-depth questions following up on the DOT's initial responses in the matrix, if one was returned. We followed up with personal phone calls, to offer DOT contacts the option to discuss responses in an interview format or to answer questions if they preferred to reply by email.

With considerable follow-up effort, 48% of the DOTs participated in the research with several indicating they do not have any asset management system, per se. States that responded include:

Alaska	**New Jersey**
California	New Mexico
Colorado	New York
Connecticut	North Carolina

Florida	Ohio
Georgia	Oklahoma
Iowa	Oregon
Indiana	Utah
Kansas	Tennessee
Maine	Virginia
Maryland	Washington DC
Minnesota	Washington State

1.6. Summary of Findings

Our principal finding was that DOTs largely lack systems for long-term maintenance of environmental assets. Project re-evaluations and notice of environmental aspects and commitments occurs at phase transitions, such as from project development, to right-of-way, to construction, and to maintenance. Re-evaluation requirements generally include a look at the commitments made, their status, and implementation.

Currently, almost all of DOTs' environmental commitment tracking is focused on ensuring the transition from project development to construction. These tools have yet to be extended to track monitoring in Maintenance, after resource agencies have accepted or signed off on a mitigation project or permit.

Currently, almost all of DOTs' environmental commitment tracking is focused on ensuring the transition from project development to construction. Importantly for this research effort, tracking tools have yet to be extended to track monitoring in Maintenance, after resource agencies have accepted or signed off on a mitigation project or permit. Many DOTs' stressed that once they go through these rigorous, multi-year development and monitoring processes for mitigation sites, "all are assuming" that the site is stable and will continue to function as intended without intervention, and that indeed, that was the purpose of the monitoring period. This is particularly applicable to wetlands construction and revegetation of disturbed areas.

DOTs are taking a variety of approaches to those environmental assets they retain. Where there is pressure or other need to maintain or retrofit system components, such as culverts for fish passage, or permanent water quality and quantity control structures in the right-of-way (ROW), to ensure functioning, compliance with the National Pollutant Discharge Elimination System (NPDES) MS4 programs and permits[1], and to protect the roadway structure itself from flooding, due to clogged drainage structures — DOTs have begun to develop systems to rate conditions and make

[1] National Pollutant Discharge Elimination System, Municipal Separate Storm Sewer programs and permits under the Clean Water Act regulate runoff from highways and the runoff highways receive from other developments. One NPDES MS4 requirement is for DOTs to locate all outfalls and monitor them to ensure there are no illicit discharges (connections into the system such that toxic pollutants are entering and exiting DOT culverts). DOTs are also required to maintain "good housekeeping" of water quality control features, emptying sediment basins in a timely way and maintaining other DOT facilities to prevent pollution of runoff.

improvements, a step up from an emergency response approach in maintenance, when flooding occurs. Naturally, DOTs are sensitive to flooding, as it impacts public safety and undermines the transportation investment. However, they are often less tuned into indicators from the natural environment. Interagency discussions about indicators that could be used are in their infancy, and have yet to reach most DOTs. Fish passage is an area where considerable initial progress has been made, bolstered by Endangered Species Act compliance requirements in some cases and recognition of the need to assess the whole system to discern where retrofit resources can be directed to greatest effect. In this case, a highly effective environmental outcome indicator is available as well: stream miles opened up to various species of concern, by removal of the barrier through appropriate retrofits.

Ongoing maintenance tends to remain unaddressed. DOTs said again and again that they simply lack the resources to do more. Additional allocations pull from keeping roads open in the winter, pothole repair, and timely road maintenance, without which road degradation would accelerate, necessitating even more expensive action.

Both maintenance and environmental staff at DOTs communicated that it is largely up to environmental staff to try to ensure that appropriate maintenance of environmental features occurs. Many DOTs these days are decentralized, with construction and maintenance work occurring out of a District or Regional office in the state, with its own environmental staff to serve each. These environmental staff members, who often take the lead in negotiating permit provisions, are then relied upon to help ensure that Maintenance is notified. However, in some cases, it is a more distant headquarters specialist who negotiated the permit. In either case, responsibilities may fall through the cracks when turnover occurs; to date, most systems for accomplishing this are informal and in computer parlance “ad hoc,” developed locally in the District or by individuals, often as reminder lists maintained on individual computers, even in states with otherwise advanced systems. States are still working on getting comprehensive lists of resources in various categories developed in many cases. Systems which go beyond this to include condition ratings, regular and repeatable condition surveys, and incorporation of this data in an asset management system that supports decision making to develop a program of investment are rare.

One of the biggest developments of the last decade is the growth in partnerships with resource agencies and conservation organizations, to assume ownership and responsibility for conservation sites, so that the environmental asset resides with an entity equipped to provide needed oversight and management.

1.7. Report Capsule

This document reports the findings from our research and discussions with the DOTs, including considerations with regard to the maintenance of environmental features, and presents a compendium of the best practices identified, along with solutions and recommendations for improved management.

2. Practice Findings & Considerations in Maintenance of Environmental Assets

As elevated to the introductory section and research summary, one of the most important considerations in environmental asset management is the impact on the relationships and negotiations with other resource agencies.

2.1. Why is Maintenance of Environmental Assets So Important?

The importance of environmental asset management to DOTs' ongoing work and ability to gain project approvals is especially evident to DOT environmental managers and specialists. When environmental staff sit down to discuss or negotiate mitigation with a resource or regulatory agency, the content and timing of what occurs is greatly affected by the resource agency's confidence in the DOT-- that the mitigation they are discussing and what the DOT agrees to do *will actually occur and that the features will be maintained as intended.*

Without systems to support management of environmental mitigation features and interagency confidence from a demonstrated performance history, a DOT's work and interaction with partner agencies becomes much harder, more contentious, and subject to delay. DOTs risk legal violations, loss of public trust, and—for the DOT environmental specialists negotiating with other agencies—a loss of professional credibility.

The scope of the environmental asset management issue is large. A state DOT may manage in excess of a hundred thousand mitigation features, when all are tallied. A large number of these are culverts and other drainage or water quality features, for which some DOTs are beginning to develop condition assessment ratings and systems for prioritizing improvements. Other elements are newer to tracking or were tracked more informally, if at all, through their life history. Life cycle costs are rarely assessed and in many cases, plans for long-term management are simply non-existent. For environmental mitigation projects to continue to provide the long-term functionality that was intended when they were first constructed, features must be properly maintained and rehabilitated or reconstructed when necessary.

2.2. Long-Term Stewardship of Property & Mitigation Features is a Challenge

Often neither the DOT nor the resource/regulatory agency feel that the agency has the skill set and structure to accomplish long-term maintenance or management of environmental features. In some cases, the DOT may be legally unable to assume such responsibilities; for example, Caltrans environmental staff noted their legal inability to obligate departmental action in the future.

In New Jersey, once a wetland is successfully established and the monitoring has been completed, the DOT attempts to find a public agency or non-profit to take ownership and responsibility for long-term maintenance. Increasingly, as wetland mitigation occurs in a watershed context to address the highest needs in the watershed, DOTs are identifying long-term managers or recipients, (typically state Departments of Natural Resources (DNR), conservation non-governmental organizations (NGOs), or local governments) in the course of early planning for the mitigation. In other cases, mitigation features that are constructed by the DOT such as fish passages, bike trails, fishing piers, landscaping, pocket parks or aesthetic lighting, that often occur on public lands or local jurisdictions, are thereafter maintained by another agency, per agreement.

DOTs often have little recourse if the other agency is not able to maintain the feature, forgets it, or budgetary or other priorities change. For some DOTs and resource agencies, this has presented an argument to ensure long-term conservation or management with a reputable, long-standing conservation organization.

North Carolina is attempting a similar service, on a state level. In North Carolina, the Department of Environment and Natural Resources (DENR) set up a stewardship program that is endowment driven to manage environmental assets, including those funded by the DOT through the state's Ecosystem Enhancement Program (EEP). Each project using the EEP pays into the endowment. The concept is, once a project is done and through success monitoring and regulatory agencies have signed off in terms of the credits generated, it is transferred to the state stewardship program with a payment, for management in perpetuity. That stewardship program is dedicated to easement integrity. The agency takes on invasive species management and any other particular management issues, but not ongoing functional criteria, in order to minimize the long-term burden. State staff said, "If (the site) meets regulatory success criteria, all (parties) are assuming the project will continue to function."

The issue of long-term, "in perpetuity" management of conservation areas is becoming an issue in finding capable and appropriate long-term managers and enrolling them in the responsibility. Such long-term conservation is a primary role of many land trusts and conservation science and implementation organizations such as The Nature Conservancy (TNC). Oregon DOT's mitigation program manager reported that TNC would not assume sites with long-term management obligations outlined specifically, arguing that it imposed unnecessary and unworkable constraints on the organization.[2] TNC maintained that such management was their primary mission and they would maintain sites responsibly.

Once Washington State DOT (WSDOT) wetland mitigation sites have been closed-out ownership of some sites is transferred to another agency or non-profit group, such as TNC. This has been most effective when the initial mitigation effort was a partnership, or based on watershed needs identified by area stakeholders. However, for sites without any connection to natural areas or sites that are unlikely to be attractive to other groups, WSDOT provides long-term management of established mitigation sites through the Maintenance Program. This management includes control of noxious weeds, fence repair, removal of dumped material, and other actions to protect the public safety.[3]

2.3. More Information on Management of Environmental Assets Would Be Helpful

Ideally, environmental staff and management levels of the organization would have information on DOT maintenance of environmental assets available for discussions with decision makers in other agencies and interested stakeholders during permitting. In the absence of information, regulatory staff in other agencies often suspect and sometimes allege that maintenance of environmental features does not occur. Resource agency staff are not usually involved in maintenance activities, but they are familiar with the occasional mistakes that occur and the holes in systems to prevent them; regulatory agencies are called on the scene during emergencies or severe failures, such as pollution of a stream or mowing of a wetland or ROW habitat preserved for an endangered species, in the course of maintenance work.

Maryland State Highway Administration (MDSHA) is one that has developed an excellent system to assist in this area, though it is focused on construction sites. Designed by one of MDSHA's environmental monitors (MDSHA is unique in having such a system), resource agencies are instantly notified of MDSHA findings of an action on environmental violations. According to one

MDSHA environmental manager, the system has dramatically improved resource agency confidence in MDSHA, as the agency is constantly illustrating its vigilance, responsibility, and responsiveness, when something does go wrong. With the ability to see how the "checking" and "action" components of the Plan-Do/Implement-Check-Act/Review continuous improvement cycle are in place, resource agencies' comfort and cooperativeness increase, with results for the permitting process, project approvals, and timelines.

2.4. Great Needs, Few Resources

The task of maintaining our transportation system and the associated environmental infrastructure is a complex and challenging job, made more so by staff cutbacks, shrinking budgets, and increased deterioration of many of the physical structures DOTs maintain, coupled with increasing expectations and accountability. Complicating the issue for environmental assets, maintenance backlog is considered most urgent in areas where public safety is at stake.

In some cases, environmental infrastructure elements such as culverts are reaching the end of their service lives. In most states, if anything is occurring, specified maintenance procedures are just beginning to be developed. DOTs are beginning to identify and record locations of their drainage system elements using GPS and the more advanced DOTs have designed and are implementing regular surveys and condition assessments.

DOTs have limited funding for more data intensive activities and planning, such as Integrated Roadside Vegetation Management and Environmental Management Systems. Long term maintenance requirements for environmental features are rarely, if ever accounted for in long range planning or project budgets, and there is no federal participation in this end of transportation, which can otherwise prompt such planning. Condition rating and asset management systems have been developed for few resources, in similarly few states.

DOTs Asset Management Capabilities Are Concentrated on Components of the Transportation System

While DOTs now have excellent asset management systems for pavement, DOTs are at an earlier stage of system development for assets beyond roads and bridges. Environmental assets are particularly challenging; while signs, bridges, and pavements are supposed to look pretty similar across the country and may be evaluated to common measures; environmental assets have a much broader range of variability.

Environmental Assets Are Off the Asset Management Radar

Often, environmental assets are not on the radar at DOTs unless mandated by permitting requirements or engineering necessity. Asset management consultants have often advocated creating tiers of assets to help "organize resource allocation priorities and tradeoffs, propose meaningful target values of level of service, and provide a context for tracking expenditures, benefits, and other consequences of investments."[4] These tiers have primarily focused on highways; level of use in terms of traffic and freight are often determined to be the priorities. Cambridge Systematics mentions the breakdown provided by Federal-Aid functional classes as one such example, Interstate highways, non-Interstate National Highway System (NHS) highways, and Other highways; environmental assets are left out of the equation.[5] For CDOT, Cambridge Systematics proposed additional tiers to build on existing functional class, evaluating connectivity role: Intraregional, interregional, or both; level of use in terms of intervals of traffic volume; role in freight carriage: classification or level of truck usage; and role in transit use.

As pointed out by a Transportation Commissioner at TRB's 2006 Programming conference, DOTs seek to target limited resources toward strategic investments and environmental assets will have to rise to that level if they are to be funded. "In a time of limited resources, not all projects can be funded. Strategic investments focus on projects that add value across jurisdictions and across modes. Strategic investments make a real difference in the everyday lives of citizens in terms of providing mobility services."[6] In this context, environmental assets often do not make it on the radar. However, "if strategic investments are (going to be) targeted toward projects that make a difference and will continue to make a difference in the future" as Achterman said, the business case for maintaining these features may need to tie into the larger societal contributions that occur with these environmental investments.

Designing to Minimize Maintenance Costs of Environmental Features

Realizing that pots of money are rarely available for specialized, long-term maintenance, many DOTs have "pushed back" on resource agency requests for "ultra-urban" best management practices (BMPs) with more complex and expensive maintenance regimes. Multiple DOTs stressed they attempt to design environmental features that are self-sustaining and virtually maintenance free. DOTs are putting their research dollars there as well; from Washington State to Maryland, DOTs have been funding research on the runoff pollutant filtration effectiveness solutions that are much cheaper to maintain, such as vegetated swales. NJDOT noted that though the agency has purchased vactor trucks for vacuuming out some ultra-urban BMPs, they attempt to utilize low cost, low maintenance items in construction so that they do not need to expend dollars for expensive filters.

Design to minimize maintenance costs extends beyond water quality features. While constructed or restored wetlands require a monitoring and evaluation period of several years prior to acceptance, DOTs design wetlands to be hydrologically self-sustaining, without human management of complicated water delivery systems. Wildlife crossings are designed for minimal or no management, outside of maintenance of "lead-up" fencing or instructions to maintenance staff not to inadvertently bury entrances in snow removal operations. Cultural resource markers are designed to withstand the elements and graffiti, and maintenance checks are often folded into maintenance of rest stops, picnic areas, and highway pull-offs.

Value Engineering for Environmental Mitigation Features

Value engineering isn't just for transportation elements any more. WSDOT received an award for "Most Value Added Proposal in Pre-Construction Engineering for a $25 - $75 Million project" for its evaluation of the best ways to control and treat stormwater runoff from Interstate 405 that connects Washington's largest cities. Much of the original design relied on the use of traditional ultra-urban stormwater treatment structures – massive vaults and treatment systems. The Value Engineering (VE) team explored more environmentally sustainable solutions to eliminate hard structures. The VE team's most value added proposal involved the replacement of these vaults with a number of alternative treatment options, offering additional accepted cost advantages exceeding $62 million in maintenance savings over the life cycle of the project.

In 2003, WSDOT received the National Award for Outstanding Innovative Value Engineering Achievements for the SR 509/I-5 Corridor Completion Project. The VE study reviewed the stormwater and staging aspects of the project and included neighborhood representatives, local government, transit and community colleges, in addition to WSDOT design and environmental staff. The project involved 16 drainage basins and fish habitat, at an initially projected cost of $102 million. Value Engineering saved the project 38% of that cost, resulting in fewer stormwater facilities to maintain and an 11 month reduction in the schedule.[7]

In the process of identifying opportunities, the VE team used some traditional CSS methods and design visualization, along with a scale model of the project, including contours. An interdisciplinary, interagency Design Advisory Group was formed, with representation from local neighborhoods and stakeholders. The group provided input from stakeholders and various sources of expertise over an extended period during the development of the conceptual design alternatives and increased overall public acceptance of the project. Other project design changes were suggested, resulting in an improved level of service and safety, utilization of existing interchange ramp structures, and increased pedestrian safety.[8]

Recognition of the Issue is Growing

Many DOTs have only recently arrived at the point of recognizing the lack of information on environmental mitigation features as a problem. NPDES Phase II raised much consciousness with its requirement to map outfalls. Other mitigation features are just now being recognized as an issue; for example, New Mexico DOT discovered "an inability to meet accountability standards" in 2006 "because there have been no assessments of the wetland enhancement/mitigation efforts and there is no database showing the sites and potential enhancement parcels."[9] NMDOT subsequently began to research historical data, develop a database, assess past wetland mitigation projects and Geographic Information System (GIS) information on the sites, and inventory potential mitigation sites. Even relatively advanced states in terms of GIS, environmental mitigation, planning, and management such as North Carolina, have just begun to inventory and map mitigation sites in the past couple years, an early step in the AASHTO's asset management process.

DOTs are evolving increased capability to identify and manage individual areas in the ROW, such as populations of rare plants, infestations of invasive species, and mitigation areas, as a subset or special category of other maintenance activities, such as vegetation management.

DOT Maintenance Staff Are Over-Stretched and Typically Are Not Funded for Additional Environmental Maintenance Tasks

As a New York State DOT (NYSDOT) environmental manager recently noted, maintenance staff (those that remain after years of staff reductions) are spread so thin it is often difficult and unrealistic to add to their set of responsibilities.[10]

Maintenance staff at state DOTs cover an incredibly broad range of services for the agency and essentially must become specialists in many areas. In addition to their other areas of technical knowledge and experience, DOT maintenance staff are now expected to increase their environmental knowledge as well, to better manage the resources the DOT oversees. Operations and maintenance are often the most resource-constrained parts of a DOT, and maintenance needs typically overwhelm available resources.

Environmental managers who work with maintenance staff are among the first to point out that Operations and Maintenance lack funds to address environmental needs in the field, much less to employ environmental staff to support them in identifying what needs to be done.[11] Caltrans staff noted that work is proceeding in a few resource areas, such as fish passage improvements, driven by state and federal regulations addressing the needs of anadromous fish species. NJDOT echoed the problem: there are no special pots of money for maintenance of specific features; maintenance for all DOT-owned features is in competition for limited funds. Other than vacuuming for sediment traps, no funding is allocated to long-term maintenance of other mitigation features.

Creative Funding and Organization to Address Environmental Maintenance Needs

A small number of DOTs have centralized pots of funding that can be tapped to accomplish through contract labor what maintenance forces cannot get to. For example, to address this mitigation need for environmental features when they are identified, NJDOT has developed a funding source to implement immediate corrective actions. When mitigation monitoring, as required by permit, indicates there is a problem, the DOT has a contract through the Treasury Department that allows for one contractor to be on-call and to drawdown from one contract, similar to a Term Agreement with the varying draw-downs emanating from task orders.[12]

Several years ago CDOT attempted to set up a separate revolving account fund (outside of a project budget) to monitor and repair environmental mitigation features. CDOT proposed the legislature fund an initial pool of money, e.g., $5,000, for maintenance or restoration of environmental features, as needed, after a project was closed. Subsequent projects would then reimburse the account. The proposal was never implemented due to the lack of funding and lack of management support. Currently, CDOT does not have a system for maintaining environmental assets post-construction.[13]

As Charlie Howard, Director of the Puget Sound Regional Council and a Strategic Highway Research Program Technical Coordinating Committee member, noted at TRB's 2006 meeting on issues in transportation programming, "When financial resources are reduced or limited, operations, rather than capital projects, tend to be the first place budget cuts are made by the legislature or agency administrators. We need to think differently if we are really going to focus on operations as a customer service. The activities that focus on customer service need to be separated to allow for programming funds to these efforts."[14] Maintenance of environmental assets tends to serve larger public interest goals, beyond transportation.

Improve Environmental Cost Estimating to Include Maintenance

Capital cost estimates for environmental mitigation features generally do not extend past construction to long term monitoring or maintenance, beyond what may be specified in a permit and included in contracts. However, there are many reasons why good estimates are critical to sound project and program management, as noted in NCHRP 25-25/39 on environmental cost estimating. Among them are:

- Ability to track, manage, and correct performance during the development of a project
- Ability to identify process problem areas, and to measure the effectiveness of corrections
- Ability to value-engineer solutions to environmental mitigation
- Ability to determine cost effectiveness of environmental programs, processes, and solutions after construction
- Ability to improve agency responsibility and credibility
- Program and process assessment
- Workload projection, workload leveling, and to support requests for additional labor, or redeployment of labor

Elements of Oregon DOT's cost tracking methodology include planning costs, preliminary engineering/environmental costs, right-of-way costs, design costs, construction costs and maintenance costs for environmental features. However, NCHRP 25-25/39 revealed that few

DOTs track environmental cost information, especially in coordinated fashion, a situation which asset management systems for environmental mitigation features would greatly improve. Several DOTs are beginning to track mitigation costs, but typically, such efforts do not extend to maintenance.[15] A few DOT's, such as Colorado, have initiated efforts to account for the costs of maintaining environmental mitigation features in maintenance, but other pressing priorities has made it difficult to make much progress.

Enable Cost Benefit Analysis

With better environmental cost information, DOTs and resource agencies are also in an improved position to make tradeoffs on where investments make the most sense, over the long term, what will most benefit the resources in question, and what will be likely to be adequately maintained.

2.5. What are the Priorities?

Goals and Policies are related to problem recognition and whether management and maintenance of environmental mitigation features rises to a priority level where it fits in people's schedules. For example, MDSHA has a policy goal in their environmental strategic plan which calls for gradual achievement of functional adequacy for 95% of stormwater management facilities by 2010. Organizational goals are reflected in business plans down through all levels of the organization. Through annual goal-setting (percent attainment of "A" or "B" rating on the state's 5-point evaluation system) and resource allocation, MDSHA has met and exceeded their objectives to raise the maintenance standards of the state's hydraulic infrastructure.

Historically, the most common area for DOTs to have agency policy dealing with environmental asset management is in appearance or other standards for maintenance of roadside vegetation. Of environmental aspects of roadside vegetation management (and of environmental resources and mitigation features overall) DOTs were most likely to have set performance measures for management of invasive species. This is consistent with the findings in a 2002 TRB paper on environmental performance measurement at DOTs, based on a 2001 and 2002 census of over 360 DOT best practices.[16] At that point, tracking the amount or ratio of wetlands created vs. impacted per year and invasive species areas were some of the most readily measurable areas of environmental performance, and when DOT environmental branches were asked to identify a couple of environmental measures for the agency, often across 10 program areas, they frequently chose these. Twenty-two percent of responding states had established performance measures for wetlands and 17% had performance measurements for landscaping. Those for wetlands were almost always driven by section 404 permit requirements and no known instances were found of tracking of wetland standards after the monitoring and approval period. Landscaping was typically measured as whether trees, shrubs or other plantings were dead or alive following the one or two year warranty period.

Performance measures for culverts and water quality control features have been a particularly fast-growing area of performance monitoring and standards. Six states responded that they have developed performance standards in this area; California, Florida, Maine, North Carolina, Ohio, and Maryland. Once again, monitoring and maintenance are driven by permit requirements. More importantly, maintenance of these features is necessary to prevent erosion of roadways and bridges or other costly infrastructure.

In recent years, several states have begun publishing agency performance to standards and objectives in highly visible locations, even providing press releases or reports. For example, WSDOT produces a quarterly performance report called the Gray Book, published on the agency's website.[17] Although most objectives are related to project delivery, the agency maintains some

statewide environmental objectives related to environmental asset management, primarily related to management of roadside vegetation.

Triggers for Maintenance Action Are Often Lacking

MDSHA's culvert and hydraulic feature asset management system offers an outstanding example of "triggers" for maintenance action. MDSHA uses a database to track their inventory of stormwater management facilities and track performance. Based on 40 inspection parameters related to structural integrity and functionality, each facility is rated on a five-part A - F scale that determines maintenance priorities ranging from "A" or "no maintenance needed" to "immediate response is mandatory" to "abandonment of the facility" when it can no longer provide a sufficient benefit.

Most states indicated a need and a desire to do post-construction monitoring but few have a mechanism in place, such as routine surveys, to trigger repairs, particularly in the absence of permit requirements such as wetland monitoring or erosion control. For example, New Jersey indicated that the permitting agencies determine the standards and performance thresholds for water quality, fish passages, stream corridor restorations, wildlife crossings, noxious weed control, and sensitive plant protection *when they are involved due to permitting issues*. NJDOT noted, however, that the DOT does not use discrete standards or performance measures when a permit does not require it. Maintenance may occur only when an environmental staff person in the field notices that something needs to be handled or is not functioning as intended, and notifies maintenance management at that time.

Requirements "very much depend on what is written into the agreement."

Maintenance requirements are usually negotiated at the time of permitting. Maintenance requirements for wetland mitigation range from three to ten years, and standards can be quite stringent. For example, maintenance of no more than 10 percent invasive/weed species has been a common requirement that has been particularly difficult for DOTs to achieve and requires significant annual work. The situation outlined by Connecticut DOT is typical:

"Most environmental assets are installed/constructed during project construction and inspected upon completion. Some assets are required to be monitored for a set number of years following construction as defined in the permit or construction specifications. After this (monitoring) period, many of these assets are not maintained unless there is a problem."[18]

Maintenance requirements are usually negotiated at the time of permitting… Most environmental assets are installed/constructed during projects and inspected upon completion. After the monitoring period, many of these assets are not maintained unless there is a problem.

Even in California with greater than average number of environmental staff, systems for ongoing tracking of environmental commitments and conditions are lacking. In the absence of permit requirements, most states do not have an action forcing mechanism to monitor or maintain environmental assets. This combined with resource constraints means that little follow up occurs.

WSDOT may be considered a DOT industry leader with respect to environmental stewardship; the agency has the most comprehensive environmental commitment tracking system in the country, with commitment lists frequently running 80 pages on average projects. Yet WSDOT still lacks a formal mechanism to hand-off maintenance needs at the close of construction. For example,

landscaping maintenance activities may be entered in the maintenance tracking system or it may be a verbal hand-off depending on the activity. Additionally, there is no requirement for contacting or working with the environmental specialists when something is identified in the field as needing maintenance.

Virginia DOT has developed a system centered on environmental activity tracking and has built in the ability for maintenance to send requests for activity reviews to environmental staff. Commitment tracking elements are incorporated into the system, but thus far focus on tracking environmental commitments through construction only.

Requirements for Maintenance over the Long-Term or In Perpetuity Are Uncommon and DOTs Design for Low Maintenance

While maintenance requirements for wetlands are specified for the permit and inspection period, long-term maintenance responsibilities in perpetuity usually are not. Instead, DOTs make great effort to design such features to avoid maintenance requirements. If significant land management and off-ROW mitigation are involved, state DNRs, a U.S. Fish and Wildlife (USFWS) National Wildlife Reserve, or NGO often assume management responsibilities. The latter constitutes an important trend in long-term maintenance of environmental mitigation features.

Treatment/Integration of Commitments from Programmatic Agreements

Programmatic agreements between DOTs and resource agencies are the source of large sets of DOT commitments relative to a DOT's environmental assets and the functions those assets are intended to maintain. Asset management of environmental mitigation often includes management of/to functions outlined in programmatic agreements between agencies.

Sometimes maintenance of existing environmental features or assets becomes a negotiating point in a permit or new programmatic approach. For example, in CDOT's Shortgrass Prairie Initiative, an advance mitigation project for construction projects in the 20-year transportation plan in the eastern third of the state involving investment in off-site conservation areas to be managed by TNC, CDOT also agreed to implement a similar set of BMPs for state maintenance activities that would not normally be subject to ESA section 7 consultation, since such actions occurred with state funds. CDOT agreed to cover maintenance actions in response to a key interest by USFWS and the state implemented protective BMPs for water quality and approximately 35 species, in maintenance, in an area which had previously received little consideration in this regard.

2.6. Inventories: Knowing What the DOT Has

Systems for Tracking Environmental Features Tend to Be Ad Hoc

Environmental specialists in headquarters, Regions, or Districts often maintain lists of resources related to permits they have negotiated, so they can check on these resources when in the area. To date, most systems for accomplishing this are informal and in computer parlance "ad hoc," developed locally in the District or by individuals, often as reminder lists maintained on individual computers, even in states with otherwise advanced systems.

As highlighted in Chapter 1, in all but a few states, communication of commitments through project development, construction, and all the way to maintenance is still a challenge and adequate systems are lacking.[19] DOTs generally lack reliable systems for ensuring interagency commitments and mitigation facility requirements are conveyed to maintenance, budgeted such that Maintenance can manage the necessary work and additional burden, and receive the appropriate follow up, for adaptive management.

For many DOTs that don't have a formal maintenance management system for environmental resources, individual environmental resource specialists try to pick up the slack—tracking and field checking the mitigation features or protected resources and working with maintenance staff to repair or restore them, when needed. In Washington State, maintenance staff map their activities using PDAs to "document what they see in the field but currently it is only for wetlands and Endangered Species Act (ESA) protected areas" and this is not connected with the state's commitment tracking system, which applies to project development and construction only.

States are still working on getting comprehensive lists of resources in various categories developed in many cases. Systems which go beyond this to include condition ratings, regular and repeatable condition surveys, and incorporation of this data in an asset management system that supports decision making to develop a program of investment are rare.

One exception is Oregon DOT. ODOT is developing a global Asset Management system that will track performance measures of all the agency's assets, help decision makers prioritize needs, and monitor and evaluate the effectiveness of implemented strategies and actions. Inventories and systems to manage condition assessment information are currently underway for assets including culverts, stormwater control facilities, unstable slopes, material sources, retaining walls, sound barriers, mitigation sites, fish passage features, and tide gates. Information on hazardous material disposal sites, environmental documents, geotechnical reports, hydraulics reports, and environmentally sensitive roadside habitat and features are being incorporated, as well as information from current stand-alone tracking systems for archaeological sites, wetland mitigation areas, and material sources. ODOT inventoried sensitive resources and erosion control problem areas along nearly 6,000 miles of state highway for its Salmon Resources & Sensitive Area Mapping Project plus an inventory of the state's estimated 20,000 culverts as part of the integrated system.

Lists of Environmental Assets, Maintained by Individual Environmental Staff

DOTs have used a wide variety of methods to keep track of their environmental assets, ranging from the memory of environmental specialists and informal unwritten understandings between agencies, to lists and Excel spreadsheets on individual specialists' desktops and to web-based comprehensive environmental information and decision support systems. Most agencies, at a minimum, keep lists of environmental assets. Headquarters environmental specialists frequently develop stand-alone tracking systems for archaeological sites, wetland mitigation areas, and other mitigation areas focused on ensuring environmental commitments and mitigation features are tracked, at least through the permit, consultation, or Memorandum of Understanding (MOU) terms. In other cases, DOTs may have developed a state or system-wide effort to begin identifying and recording locations, getting GIS location information recorded with GPS. Listings of individual states in each of the following categories are recorded in the Appendix C.

	Listing		**GPS location**	
	No.	**%**	No.	%
Wetlands	12	52%	8	35%
Sound walls/noise barriers	11	48%	7	30%
Culvert maintenance	11	48%	8	35%
Permanent water quality management facilities (e.g. sediment basins)	10	43%	9	39%

	Listing		GPS location	
	No.	%	No.	%
Bicycle/pedestrian trails	9	39%	4	17%
Landscaping	9	39%	2	9%
Wildlife crossing structures	8	35%	5	26%
Sensitive plant communities and animal habitat in ROW	7	30%	5	22%
Stream restoration	7	30%	6	26%
Fish passage remediation	7	30%	4	13%
Control of noxious weeds / invasive species infestations	6	26%	5	22%
No mow areas	6	22%	3	13%
Cultural resources (e.g. markers, fishing access, etc)	5	22%	2	9%
Erosion problem area	5	22%	1	4%
Conservation areas, parklands, and/or forest	4	17%	6	26%
ESA Mitigation Sites	1	4%	1	4%
Archeological Sites	1	4%	1	4%
Dams	1	4%	0	0%
Boat launches under DOT bridges	1	4%	0	0%

As indicated in the table above, DOTs are most frequently tracking (at least via lists): wetlands, sound walls/noise barriers, culvert maintenance, and permanent water quality features. Around 50% of responding states are tracking these areas with lists, and a smaller number in each case have GPS'd the locations. Thirty-nine percent of responding states are keeping lists of landscaping and bicycle/pedestrian trails. Wetland mitigation has a strong regulatory component and tracking may be required for 3-10 years before release of the mitigation credits or acceptance of the mitigation project. In addition, special care must be taken with existing wetlands in the ROW; maintenance needs to know where they are, so it is not surprising that wetlands are the resource for which locations are most often recorded with GPS too. Recording of fish passage remediation is a top area of tracking in the states where these issues occur, especially Maine, California, Oregon, and Washington State.

DOTs have made special efforts to GPS the locations of some resources, or when they started formal tracking efforts they made sure that GPS locations were a constituent element of the program. These are:

- Permanent water quality management facilities (e.g. sediment basins)
- Wetlands
- Culverts

- Sound walls
- Sensitive plant communities and animal habitat in ROW
- Stream restoration
- Fish passage remediation
- Control of noxious weeds / invasive species infestations
- Conservation areas, parklands, and/or forest
- ESA mitigation sites
- Archeological sites

Only 39% or fewer of the responding DOTs were even keeping lists of the following resources (fish passage remediation is not on this list due to the smaller number of states where this is an issue and the relatively high degree of attention in the states where it is an issue):

- Bicycle/Pedestrian Facilities
- Control of noxious weeds / invasive species infestations
- Cultural resources (e.g. markers, fishing access, etc)
- No mow areas
- Erosion problem areas
- Conservation areas, parklands, and/or forest
- ESA Mitigation Sites
- Archeological Sites
- Dams
- Boat launches under DOT bridges

Still, it is more important to note what *is* occurring here than is not, and the progress entailed. The above lists include tracking of some relatively new areas (boat launches and dams) that were not included in the survey. No mow areas are receiving increasing attention and are being recorded in GPS as well. Erosion problem areas are at least more commonly listed and addressed now.

Some Problems with Lists

As the most commonly used mechanism for tracking environmental mitigation features, there is a concern that lists maintained by individual

> Few DOTs have mechanisms in place, such as routine surveys, to trigger repairs, particularly in the absence of permit requirements such as wetland monitoring or erosion control…the DOT only uses discrete standards or performance measures if permits require it. Maintenance may occur only when an environmental staff person in the field notices that something needs to be handled or is not functioning as intended, and notify maintenance management at that time.

resource specialists can easily be lost when there is a turnover in staff. However, since only about half of state DOTs report they are keeping lists (it is possible that not all environmental specialists were consulted), some individual list keeping and assumption of responsibility is a big step "better than nothing."

Lists also tend to rely on the user's memory; lists are not interactive and hence lack "alert" elements, as are available in many email calendaring systems today. Such records or existing DOT commitment tracking forms typically lack details regarding timelines and maintenance. For example, Caltrans' Environmental Commitment Record spreadsheet notes that a project biologist will follow up quarterly (this is for construction sites, which receive more attention), but it is unclear how Caltrans will have a quarterly follow up by a project biologist, if there is a change of employees this information will be revisited, when and how the project biologist receives and tracks this responsibility, etc. Thus, the University of Wisconsin's review of commitment tracking systems concluded that:

> *Caltrans' electronic Environmental Commitment Record has little functionality beyond a paper file. Reports, notifications, and extension to maintenance are a next logical step in the development of any of these relatively static programs. In lieu of a notification system the user could sort the data by due date, corridor, or systematically search for "due dates" or actions required. File updating and staff turnover risks may remain, but such spreadsheet data could be exported into an expanded Environmental Management System, potentially a Maintenance Management System, or integrated into a GIS application.*[20]

Increasingly, many agencies also use GPS to geographically locate environmental features, instead of just relying on physical descriptive information and a linear referencing system. Even when GIS is used to capture, store and manage the data, the DOT may lack a formal, integrated process to ensure all information is entered into the system and ensure maintenance staff have access to the information. Often, individual departments keep their own system management databases, e.g., bridge, hydraulics, design, and they are not integrated with an agency-wide system accessible to everyone.

Developing Inventory and Inspection Systems – Surveys & Frequency

Maryland has the most rigorous system we found. To comply with NPDES permit requirements, MDSHA performs routine maintenance within one year of construction to identify and perform any necessary repairs and each facility is inspected at least once every year thereafter. MDSHA uses a database to track their inventory of stormwater management facilities and track performance and trains and tests evaluators to produce duplicable ratings.

On the cultural resources side, Maine DOT has a model program. Maine's Bridge Maintenance program works closely with the Coordination and Permits Division (CPD) staff and the Maine State Historical Society to develop specific components of bridge structures that should be inspected and damage corrected on National Register eligible bridges and stone arch culverts. The inspection frequency was reduced from every two years to annually. CPD works to craft specific Maine DOT Special Provisions which are included in the project contract documents and process legal documents when ensuring long-term capital investments for historic enhancement projects. Maine DOT is also working on a Historic Bridge inventory study that includes language on preserving National Register eligible bridges.

Maine, Oregon, Washington, and California are developing inventory and inspection systems for fish passage.

Condition Assessments: Measuring Function, Indicating Progress or When Action is Needed

Few agencies monitor environmental functions beyond that required in a particular permit and measure performance to environmental objectives set by the state. WSDOT has committed to improve the level of functioning between removed/impacted wetlands and those constructed to replace them, and this state commitment has become a programmatic element of wetland permits and the monitoring period. WSDOT staff measure the wetland area on mitigation sites twice during the monitoring period and do a final measurement at the end of the monitoring period to determine the actual acreage achieved and ensure no net loss. WSDOT tries to replace lower functioning wetlands with high quality wetlands. To ensure they are meeting their goal of improvement of wetland functions, both the wetlands removed and those that are replaced are scored using the State Department of Ecology's rating scores as an indication of overall function.[21]

Sometimes a larger environmental objective will guide program choices, or may have been chosen to serve as an indicator for multiple goals and objectives. The goal of WSDOT's Integrated Vegetation Management program is to provide roadside plant communities that benefit the environment, provide for safe highway operations, and reduce maintenance costs. To achieve this, the DOT emphasizes soil conservation and vegetation restoration during construction to reduce roadside maintenance requirements post-construction. As a primary measure for these goals, WSDOT uses the pounds of herbicide used. Between 2003 and 2007, herbicide use decreased by 86%. Healthier, native ecosystems reduce both maintenance (mowing and herbicide application) and costs.[22]

Survey Data

In response to the short survey, few states indicated they use condition ratings to assess the need for maintenance, primarily for culverts. None of the respondents provided specific condition measures and a literature review revealed little information, again mostly related to culvert maintenance (Appendix C).

Environmental Feature	Condition Rating	
	No.	%
Culvert maintenance	8	35
Permanent water quality management facilities (e.g. sediment basins)	6	26
Erosion problem areas	4	17
Wildlife crossings	4	17
Landscaping	6	26
Sensitive plant communities and animal habitat in the ROW	3	13
Fish passage remediation	3	13
Wetlands	4	17
Stream restoration	3	13
Sound walls/noise barriers	2	9

Environmental Feature	Condition Rating	
	No.	%
Bicycle/pedestrian trails	3	13
Control of noxious weeds / invasive species infestations	3	13
No mow areas	2	9
ESA Mitigation Sites	1	4
Cultural resources (e.g. markers)	1	4
Living snow fence	1	4
Structured snow fence	1	4
Safety Rest Area and Welcome Center	1	1
Conservation areas, parklands, and/or forestlands	0	0
Archeological Sites	1	4
Dams	0	0
Boat launches under DOT bridges	0	0

According to the Caltrans Maintenance Manual, each District has a culvert inspection program that maintains a database that includes an inventory, condition, and recommended repair strategies for any deficiencies. After major storm events, the more important culverts are inspected for abrasion pitting, rust, rivets, spalling, exposed reinforcing, cracks, joint openings, drift and detritus in the barrel, and erosion of channel banks.[23]

Virginia DOT inventories and inspects all bridges and culverts I accordance with the National Bridge Inspection Standards. Culverts having an opening of 36 square feet or greater are inventoried and inspected on a regular basis. Inspections provide information for the General Condition Rating (GCR) for each structure as compared to the as-built condition. The GRC is a numerical system that ranges from zero (worst condition) to nine (excellent condition). A rating of less than “six” qualifies a structure as a candidate for repair or rehabilitation.[24]

Ohio DOT has a detailed rating system for evaluating the condition of culverts. Culverts are inspected, in general, every five years and are rated on a scale of 0 to 9. Culverts are rated on the general condition, culvert alignment, shape, seams and joints, slab, abutment, headwalls, end structure, channel alignment, culvert waterway blockage, scour, the pavement, guardrail and embankment leading to the culvert. The rating scale is as follows:[25]

Code	Description
9	As built condition
8	Very good condition – no problems noted
7	Good condition – minor problems
6	Satisfactory condition – structural elements show some deterioration
5	Fair condition – all primary structural elements are sound, but may have minor section loss
4	Poor condition – loss of section, deterioration, or spalling
3	Serious condition – loss of section, deterioration, or spalling seriously affected primary structural components
2	Critical condition – advanced deterioration of primary structural elements. Culvert should be closed or closely monitored until corrective action is taken.
1	Immanent failure condition – major deterioration or section loss present on structural components. Culvert is closed to traffic
0	Failed condition – out of service – beyond corrective action

The Connecticut DOT uses a very similar rating system They rate the culverts on a typical 24 month inspection cycle using the FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nations Bridges as-well-as CTDOT's Bridge Inspection Manual. If a culvert is rated 4 or less using the standard bridge rating system, a maintenance memo is issued triggering a maintenance action.

With regard to other environmental features, the Connecticut DOT is representative of many states. "Most Environmental Assets are installed/constructed during projects and inspected upon completion. Some assets are required to be monitored for a set number of years following construction as defined in the permit or construction specifications. After this period, many of these assets are not maintained unless there is a problem."[26]

Random Condition Assessment

When statewide inventories and annual inspections cannot be performed, random condition assessments, as performed for some assets in Virginia and North Carolina, provides an option.

Analysis of the data collected is linked to repair/cost strategies that will then be converted into network-level information required to determine an unconstrained statewide needs-based budget. Specific needs, as determined by the collection activities, can then be categorized into repair strategies. Each strategy requires a dollar investment to return a distressed asset to the specific service level or to maintain the asset at a current acceptable service level. The program is not intended to define a "pass/fail" condition for each asset. Instead, the software program determines a set of values expressed as a percentage or a number, for the asset being evaluated. This allows threshold values to be built into the business models for each asset (in much the same way as

pavements are evaluated) that can then be used to calculate repair or replacement costs for specific asset types and conditions. This modeling allows VDOT to determine the level of activity and cost that will likely be needed to return an asset to a serviceable condition or to optimize its life-cycle. In terms of asset modeling, this approach means categorizing assets by the "opportune time to invest" or "less costly to repair" or "more costly to repair" (VDOT's prevent, repair/restore or replace options).[27]

VDOT includes only a very limited selection of environmental assets in their Random Condition Assessment:

- Cross Pipes (No part of a bridge or culvert with a cross-sectional area equal to or greater than 36 SF is to be included.) Exclude 6'square box culverts unless they have a structure number.
- Unpaved Ditches/Swales
- Unpaved Shoulders

For Quality Assurance and Quality Control (QA/QC), a QA/QC inspector spends some time each week with survey crews to insure that the crews are gathering information in accordance with the intent of VDOT. Each week project administrators randomly select several segments from those that were completed in the previous week. These segments are assigned to the QA/QC Inspectors to independently survey. The Inspectors, working in pairs, gather and record information in a format identical to that used by the Survey Crews. This activity is classified as Quality Assurance. Project administrators array the work of the survey crew against those of the QA/QC Inspector and determine which attributes, if any, differ more than that which would be statistically predictable. This information is distributed to all parties. Where there are significant differences, an effort is made in the field to identify the causes for differences.

The Florida DOT Asset Management System uses a Maintenance Rating Program (MRP) to evaluate highway maintenance conditions for several environmental features among many other transportation related features. Each District is evaluated 3 times per year via pedestrian surveys. Randomly generated sample points are 1/10th mile. Each sample point is evaluated against established standards and given a pass or fail rating for each characteristic. The pass/fail ratings entered into the mainframe MRP computer for tracking.

Of the 79 features that the Office of Maintenance tracks, the following standards relate to environmental features:

- Inlets – 85% of the opening is not obstructed
- Side/Cross Drain – 60% of the cross sectional area of each pipe is free of obstructions and functions as intended
- Litter Removal – the volume of litter does not exceed 3 cubic feet per 1 acre, excluding all travel way pavement
- Turf Condition – turf in the mowing area is 75% free of undesired vegetation
- Landscaping – vegetation is maintained in a healthy, attractive condition

The MRP scores provide management information used to schedule and prioritize maintenance activities and the statewide cumulative MRP scores are reported to the Executive Committee as Florida's "Report Card". By Statute, 100% of roads on the State Highway System must achieve MRP score of 80 or above. For fiscal year 2006/2007, the statewide MRP achieved a score of 82.

To accomplish the intensive surveys, Florida uses an Asset Maintenance Contract and contractors must maintain the road system according to specified performance measures and according to established Department policies, procedures, and guidelines.[28]

The Paucity of "As Built" or Environmental Data

Interviewed DOTs noted that they have inherited many mitigation sites with no digital mapping. Recording may be in paper files in ROW offices (requiring digitization) or may be entirely inaccessible or unavailable. Often, mitigation sites that are past the five-year monitoring period only appear in the ROW database and little information on environmental attributes/features may be attached, outside of easements or deed restrictions that must be conveyed if the property is sold. DOTs reported that beyond the initially agreed monitoring period, environmental features are generally not tracked as assets unless there is a problem.

To date few DOTs have supported construction and maintenance of large, statewide environmental datasets for environmental decision making, much less for ongoing monitoring of environmental conditions, a topic that will be explored in concept in the final chapter of this report. Florida DOT has contributed to the development of the university-maintained Florida Geographic Data Library (FGDL), starting with contributions from the state's NPDES program and efforts to locate outfalls. Now FGDL supports Florida's Efficient Transportation Decision Making Process and Environmental Screening Tool, with over 400 data layers and many pre-programmed environmental analyses. Participating agencies were asked/required to share the information that they use in reviewing and making decisions on FDOT projects, so that all could be aware of these environmental constraints, for better avoidance, minimization, and mitigation discussion.

The Washington State Department of Transportation developed an in-house Environmental GIS Program and "Environmental Workbench" with over 125 GIS data layers crossing a wide range of environmental topics, with tools and resources to help staff use that data to scope projects at a high level and manipulate the data for consideration in project planning and delivery. The tool allows users to locate and buffer proposed projects and view environmental layers, with tools linking the maps to state highway video log images. The workbench retrieves data from three WSDOT servers: the GIS server, the DOT applications server which converts milepost values, and the state route view/image server. Unlike Florida DOT, WSDOT's Environmental Information Program (EIP) has taken on data update responsibility themselves, managing a total of 700 data layers in all and coordinating with many Federal, state, and local agencies to ensure that datasets are continuously updated.[29] Both Florida and Washington State DOTs found that the increased availability of information has reduced decision review time and that centralized control of the system (by EIP in Washington and the FGDL in Florida) has helped maintain and improve data accuracy. WSDOT's GeoData Catalog allows the public to view GIS metadata, example maps and download agency GIS data. Much of the FGDL is publicly available. Neither is used in maintenance.

Whereas the FGDL is used in a structured process by interagency Environmental Technical Advisory Teams for Florida's Efficient Transportation Decision Making (ETDM), WSDOT's Environmental Work Bench is used on a more limited basis to identify and detect environmental issues early in the planning process, to "red flag" environmental concerns at the statewide highway systems level. The analyses performed by this system also provide important information to MPOs and regional transportation planners for environmental assessment of regional plans as required by state law and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (Public Law 109-59) requirements.

For CDOT's Shortgrass Prairie Initiative, the agency contracted with the Colorado Natural Heritage Program (CNHP) to help fill data gaps. CNHP helped map infestations of invasive species in the right-of-way and provide training to maintenance forces. CNHP also performed the GIS analyses and participated in an efficient set of meetings with experts by taxonomic group, to construct range maps and identify where agreed upon BMPs would be in force. Like many DOTs though, CDOT sought a general group of agreeable BMPs that could/should be applied programmatically, on broad scale, so that different sets of requirements were not occurring in different spots along the roadway, greatly increasing management complexity and reducing the likelihood of compliance among maintenance forces.

Condition Data on Environmental Features is Rarely Available

In most cases resource agencies as well as DOTs lack a base of information on the condition of environmental features and the agency lacks performance or condition objectives for environmental assets. The Environmental Protection Agency's (EPA's) national database of impaired waters (waters impaired by various pollutants of concern) and ambient monitoring is a rare exception. The long-term nature of environmental programs means that data needed to illustrate effectiveness or for annual performance goals and measures is often not available. As noted in the April 2000 Government Accounting Office Report on *Managing for Results: EPA Faces Challenges in Developing Results-Oriented Performance Goals and Measures*, the limited availability of data on environmental conditions is a major challenge in establishing a relationship between a program's activities and resulting changes in the environment.[30] The John C. Heinz Center has been working on a partnership to develop a common set of indicators among federal agencies and gear data to speak to common environmental indicators.[31] In 2008, the Center issued a comprehensive update on the health of U.S. ecosystems--along with a plea for the U.S. government to coordinate and fund future assessments. [32]

More Data is Available on Hard Features Such as Outfalls and Where Regulations Require Tracking

Up until the last few years, the most developed models of environmental asset systems were those relating to "hard" features such as stormwater facilities. Maintenance of hydraulic features is also important for the long-term protection of roadways and bridges. As engineering features and due to the large investment in the infrastructure, these facilities may receive more attention from DOTs. Also, they are more likely to face regulatory requirements.

For example, in 1993, WSDOT initiated a Stormwater Outfall Inventory and Field Screening Project to meet federal, state, and local regulations related to controlling contaminated stormwater runoff and reducing peak stormwater flows. The inventory was designed to meet permitting requirements of the NPDES and to assist WSDOT in complying with the Puget Sound Highway Runoff Rule [Washington Administrative Code 173-270], which rule requires WSDOT to identify sources of stormwater runoff and develop a program of best management practices (BMPs) to treat or manage stormwater pollution sources. An overview of WSDOT's outfall inventory process is provided in their Stormwater Inventory and Retrofit Program Stormwater Facility Inventory Training Manual. Florida DOT leveraged their own early investments in outfall inventories and data collection for MS4 compliance into substantial start-up funds for Florida's Geographic Data Library, which now supports the state's Efficient Transportation Decision Making (ETDM) system.

Though DOTs have made the most progress in inventorying culvert and drainage system elements, at many state DOTs even required outfall inventories remain incomplete. States are now using GPS equipment to obtain precise latitude, longitude, and elevation coordinates for the outfalls in their inventories.

A further step is condition assessment and asset management of this hard, environmentally related infrastructure. Of those in existence, MDSHA's hydraulic system inventory is a national model. MDSHA's system includes field evaluations of all stormwater management elements in the SHA's right-of-way, including photos, reproducible evaluations, as-built plans, maintenance schedules, and forecasts of projected water quality improvements from potential changes to investment and management strategies.

Although most states lack a formal process for tracking and maintaining environmental assets that do not require a permit, there are a number of instances where DOTs still attempt some level of post-construction monitoring and maintenance. The most common of these are vegetation management and the management of permanent water quality features and culverts, which also help aquatic and small terrestrial species cross roads.

Lack of Data on Environmental Attributes to Guide Appropriate Maintenance or Retrofit – A Case Study on Partnering with Others to Gain Information

As previously noted, DOTs generally lack information on environmental attributes of mitigation features or environmental components of assets under their management; however, a look at a particular resource which is receiving attention, and the issues the DOT is encountering, sheds light on DOTs' larger situation with regard to asset management. The information in this section is adapted from a paper by Caltrans Natural Resources Program Manager, Gregg Erickson, whom we also interviewed.[33]

Anadromous fisheries such as salmon are a concern for highway agencies because the fish move between cool inland streams and coastal waters, movement which involves multiple road crossings where blockage at one site can effectively exclude salmon from using all upstream habitats and negate the benefits of any blockage removals in those disconnected reaches of stream. Highway crossings can be particularly problematic because they are often the first crossing low in the watershed and cross tributaries as roads follow major river courses.

Careful consultation determined that the removal or modification of barriers to allow steelhead and salmon access to historical habitat is the most cost-effective and successful method to achieve recovery of salmon and steelhead, however:

- The current status of passages and the (specifics or) proportion of road-stream crossings that represent barriers to fish passage is not readily available.
- The lack of blockage information, multiple landownership and limited survey/analysis funding complicates the development of statewide priorities for stream restoration and determining the relative importance of specific crossings.
- A lack of agreed-upon priorities also increases the difficulty in determining where very limited remediation grant funding can be applied most effectively and increases the need for detailed regulatory review of projects and onerous permit requirements.

In Caltrans case, the agency and the resource benefitted from a primary driver outside of environmental stewardship and improving environmental practices or maintenance. By addressing this issue on a broad scale, and indeed because spot improvements on a project basis had the potential not to deliver benefits if a blockage occurred further downstream, Caltrans sought to reduce potential strategic project delivery issues. Often funding capital that could be used to restore sites is associated with projects that are located on low priority streams that highlights the opportunistic nature of funding and priorities. This is complicated by the potential for increased

permitting time and construction costs that discourages engineers from including crossings in projects if cost and schedules are constrained.

Caltrans provided significant funding for better information, to make progress on the agency's streamlining priorities and stewardship commitments, and to improve stakeholder understanding of the issue and options.

Geographic Information System analysis early in the situational analysis stage indicated a large number of potential crossings based upon the intersection of the United States Geological Survey (USGS) waterways and roadway alignments. However, this level of analysis did not identify every location and did not provide an indicator of the likelihood that individual sites may have fisheries or blockages. Background searches of culvert and fishery inventories likewise only provided partial data.

Caltrans decided to have a pilot study of culvert sites in a North Coast Region District by Humboldt State University under a federal research grant. The University developed survey procedures and protocols tailored to the State Highway System needs, forming the basis for statewide assessments. Additional State Planning and Research grants funded scoping and prioritization of assessment work throughout the remaining coastal watersheds. Assessment work conducted in the southern and central coastal regions and the San Francisco bay area allowed refinement of the assessment procedure and an increase in production, but has also showed that Caltrans had more culverts to assess than previously recognized and that regional survey procedures were needed, especially for the dryer southern California region. Further study will complete the assessments in the coastal areas, and will begin the preliminary inventory and prioritization for the Great Central Valley and Sierra Nevada regions. Completion of these studies will involve the development of partnerships and working agreements with multiple agencies including the California State University System Department of Water Resources as well as private sector experts to increase the availability of field crews to complete surveys. Funding has run short, to accomplish all this.

Close coordination with other partners was identified as key elements of the foundational phase of the program. Caltrans began reaching out and participating in the California Fish Passage Forum (includes California Department of Fish and Game, National Marine Fisheries Service, US Fish and Wildlife Service, US Forest Service and others) and sharing data via the CalFish MOU partnership (includes California Department of Fish and Game, California Department of Water Resources and others) to share insights, priorities and data with other agencies and organizations involved in inventorying, assessing, and remediating fish passage. A critical goal of this effort is to prioritize which sites are in greatest need of rehabilitation or replacement for meeting fish passage requirements, to help guide Caltrans in future development of maintenance and capitol construction projects that can then implement corrections. Additional participation on Coho recovery teams provided species-specific coordination and opportunities to share economic information. These partnerships also provide a forum for consideration of stakeholder concerns such as discussion of legislation.

Related stakeholders with interest in fisheries and water issues include the State Legislature, Caltrans Districts, Federal Highway Administration, regulatory agencies including US Fish and Wildlife Service, National Oceanic and Atmospheric Agency, US Army Corps of Engineers, California Department of Fish and Game, US Forest Service, National Park Service, Bureau of Reclamation, Native American Tribal Governments, California Resources Agency, California State Parks, California Department of Water Resources, California Department of Forestry and Fire Protection, California Energy Commission, California Coastal Commission, California Coastal Conservancy, Pacific States Marine Fisheries Commission, the nationally recognized California Fish Passage Forum, local governments including counties and cities and their special interest

organizations such as FishNet 4C (Mendocino, Sonoma, Marin, San Mateo, Santa Cruz and Monterey Counties) and the Five Counties Salmonid Conservation Program, the Tri-County F.I.S.H. Team, local public works agencies, resource conservation districts, farm-oriented groups such as the Northern California Water Association or the Association of California Water Agencies, commercial interests such as the Pacific Coast Federation of Fishermen's Associations, private citizen groups including fishermen, recreationalists, environmentalists, and local watershed councils and groups, specifically California Trout, Inc., Friends of the River, Defenders of Wildlife, Southern California Steelhead Recovery Coalition, various professional groups such as the American Fisheries Society, species or region specific Technical Recovery Teams with interests in the Southern Oregon/Northern California Coast, North-Central California Coast, California Central Valley, South- Central California Coast recovery domains, and others such as the Coho Recovery Planning and Implementation Team, the California State University System, the University of California System, various private educational institutions as well as various grade and high school environmental education programs and groups, and employers needing to provide a quality environmental setting to attract top employees.

Caltrans found that partnerships and the inclusion of multidisciplinary teams were essential to overcome limitations caused by a lack of information and apparently conflicting missions. Caltrans also discovered the level of effort needed to educate stakeholders and develop the institutional support for success. Caltrans sought a number of changes out of their efforts, including policy changes to implement requirements to inventory, assessment and planning for remediation during project delivery; development of an engineering manual; integration of new design standards; progress tracking; outreach to stakeholders; and to continue pursue of grant funds to complete surveys. Caltrans has gone much further with regard to environmental asset mapping and management in this area than any other, though the state has also made progress with regard to mapping and providing environmental support to maintenance with regard to locations of rare plant species in the ROW.

Caltrans is making great progress in statewide evaluation of structural elements, mapping and assessing condition, and prioritizing repairs — far surpassing asset management tools and resources for other environmental infrastructure. Nevertheless, "the agency is (naturally) more concerned about the 5000 culverts that need to be replaced" than the many that are functioning to remove water from the road, but could use upgrades for fish or wildlife passage. An additional problem is that to address environmental deficiencies, additional hydraulic analysis is needed before repairs can be ascertained and prioritized among other work. In almost every case, DOTs lack mechanisms to pay for or perform environmental work in maintenance, making such work more difficult to program and execute.

Data Sharing and Transfer: Compatibility Can Be a Problem without Planning or Conversion

Site data comes in many formats, ranging from hand-drawn maps in project files to computer–aided design (CAD) drawings to an occasional shape file. Much data is now received from consultants in the form of CAD drawings, from construction plans. State staff then often must pull out important features from the CAD drawings, import them into a geodatabase and attribute them, if they want to begin tracking environmental features. Implementing CAD standards that include standards for line attribution can help reduce the amount of time staff devote to manipulating CAD data to convert it to GIS layers. For example, NCDOT has tried to streamline time spent in this area by distributing a paper on "Creating Compatible CAD Data for ArcGIS software" to consultants.

Increasing Systems for Collating and Distributing Project Data and As-Built Drawings

Most agencies still have to refer to the as-built plans for detailed information, though DOTs are developing systems to make that as-built information more accessible. For example, Caltrans' Project Development Procedures Manual Appendix QQ and CAD User Manual are being updated to improve Survey File delivery and the quality of the plans, specifications, and estimates (PS&E).[34] The Survey File is a compilation of electronic design data generated during the development of the PS&E, and it must be accurate, complete and timely to minimize costly delays, claims, contract change orders, and re-staking charges during construction, as well as to ensure that developed mitigation features are maintained appropriately into construction. Electronic Survey Files have the potential to facilitate the use of automated machine guidance technology in construction and maintenance.

Reasonable Monitoring and Adaptive Management

Reasonable monitoring and adaptive management requirements over the long-term are a key consideration for DOTs in executing asset management (or adaptive management by a third party) for environmental mitigation features. The risks managers are reluctant to assume can be mitigated somewhat by diligent effort to make the requirements reasonable. For example, Colorado DOT's Shortgrass prairie initiative did manage to negotiate a simple set of annual site assessment requirements, that met USFWS's desires for management in perpetuity and that The Nature Conservancy agreed were manageable. Nevertheless, this portion of the arrangement took the longest to negotiate, as the management actions had to be "do-able," meaningful, and efficient for the entity assuming the responsibility, in line with existing objectives, and USFWS had to be able to count on the monitoring and adaptive management occurring for many years into the future.

Since, in the course of DOT interviews, multiple DOT environmental managers have asked what combination of monitoring and adaptive management met all the parties' needs, the set CDOT negotiated is briefly summarized here. The agencies (FHWA, USFWS, and CDOT primarily), TNC, and the state Natural Heritage Program agreed to an annual review of the best available information on type of plant communities/habitats present in the conservation reserve areas, including the estimated acreage, general condition of each (including weed infestations, relative abundance), description of plant communities' present and geographical relationship of communities, and the estimated percent cover of each community. Land use changes would also be briefly reviewed, along with success of recommendations from the previous year, and suggested modifications to management plans, with use of coarse measures to start. A management plan will be developed in the first year after acquisition of the real estate interest and updated at least every five years. General observations on wildlife diversity, activity, and general trends, noting presence or absence of targeted species are to be recorded and photo points at established permanent locations according to protocols to be developed in the management plan. The agencies agreed that this reporting could consist of field notes; surveys and quantitative data are not required. The management entity is asked to acquire new or existing aerial photos as they become available, as applicable and appropriate, and label habitats on existing aerial photos and USGS topographical quadrangles. Finally, the partners agreed this work must be performed by a qualified person.

Partner with Resource Agencies and Organizations to Take Long Term Custody and Maintenance of Wetlands and Off-System Conservation Areas

Over the past decade, DOTs have pioneered partnerships with watershed and conservation organizations and state resource agencies to target DOT mitigation investments to help these agencies achieve their conservation priorities. State and regional conservation funds financed

through in lieu fees helped achieve objectives identified by watershed plans to improve water quality and restore wetlands where they fulfill multiple filtration and wildlife functions in the watershed. In many cases, species and habitat conservation investments have been likewise directed where they can protect viable populations and where better, long-term management is more likely. Such partnerships offer excellent examples of interagency cooperation for the public good and efficient use of public resources, by leveraging what each entity can do best.

This early coordination and careful targeting of mitigation investments also helps ensure that the mitigation that is produced is desirable to resource agencies already strapped for funds, so that such resource agencies are more likely to agree to assume mitigation responsibilities. DOTs from New Jersey to California report increasing awareness of the costs of such long-term mitigation responsibilities, and the need for endowments. While Caltrans said the need for long-term management and building an endowment for maintenance of mitigation sites, especially conservation habitat, is well-established now, the state faces administrative limitations in what it can commit to do. The DOT can't promise the credit of the state. If the agency decides they aren't doing it next year, they aren't doing it. Staff members say the better they are at estimating environmental costs, the more likely they are to be able to figure out a way to address the needs.

In Florida, DOT wetland mitigation is essentially outsourced to water management districts. NCDOT has outsourced its mitigation program and long-term management to DENR, where a new section manages long-term stewardship responsibilities and relationships with land trusts that do some of the work. In North Carolina and Colorado, the DOTs have entered into partnerships with non-governmental conservation organizations to manage conservation areas or easements in perpetuity. Colorado DOT has utilized TNC. NCDOT has utilized a consortium of organizations.

Meanwhile, DOTs have encountered difficulties in extending the "adopt a highway" model, even when "free labor" has been volunteered. For example, New Jersey DOT tried but was not able to begin an "Adopt-a-Wetland" program, whereby people could clean out the wetlands and help do more plantings by dividing existing plants etc. Agency staff were told that there would be liability issues. Similarly, a deer club in Colorado indicated an interest in helping to maintain deer fencing along a highway was turned down for similar reasons. Even existing programs can be difficult to continue, without strong connections to DOT goals and priorities. In one state, even the Adopt-a-Highway program was terminated due to lack of DOT staff interest in managing it.

In contrast, New York DOT developed an "Adopt-A-Bird Box" program to elicit help from volunteer organizations to monitor and maintain bird nest boxes along a segment of highway. Maintenance of boxes has been a consistent problem since 2000. In the past environmental staff did a drive by of all boxes to assess their condition and then provided a list of required repairs to Operations, but Operations forces had little to no time to help. The DOT provides the volunteers with a helmet, manual with useful information, a safety training session and a car tag with the permit number. The DOT requires the volunteer organization to sign an agreement to acknowledge the hazardous nature of the activity and their agreement to a number of terms and conditions imposed by the DOT. A copy of NYDOT's agreement is provided in Appendix D.[35]

NYSDOT is also a participating partner in the Adirondack Park Partners for Regional Invasive Species Management (PRISM). Every year or so, invasive species field data collected by NYSDOT staff, interns and other PRISM partners is compiled by the DOT Modeling/Technology staff into one GIS dataset. The dataset is shared with the Adirondack Park PRISM and posted on their website. There will be a more efficient means of disseminating invasive species data in the near future. IMapInvasives is set to become the central database for invasive species field data for all statewide PRISMs, not just Adirondack Park PRISM. There is no funding required for NYSDOT staff to provide collection/inventory support; it is part of their job duties.[36]

In Maintenance, invasive species control is included in the vegetation program, not as a stand-alone program itself. Invasive species control is not budgeted separately. For Capital Projects that include invasive species control, (where and when appropriate), the control is included as specification item(s) in the contracts. NYDOT's focus is on preventing and minimizing spread of invasive species since eradication efforts are more costly.

2.7. DOT Commitment Tracking Systems

Development of commitment tracking systems largely stem from commitments to environmental stewardship, improving compliance reliability, and demonstrating performance. As MDSHA noted, reporting and tracking systems are also a tool to build comfort levels within and across agencies and to operate within more efficient, trusting relationships.

While DOTs have begun to develop systems to track commitments developed in planning and particularly in project development, permits, and NEPA documents so that those commitments are addressed in Design and Construction, the states with the most advanced commitment tracking systems (Virginia and Washington State) are just beginning to develop communication abilities with maintenance staff. Commitment tracking and tracking of environmental assets, to the extent they occur, take place in separate systems. Inter-system communication abilities are minimal at this point.

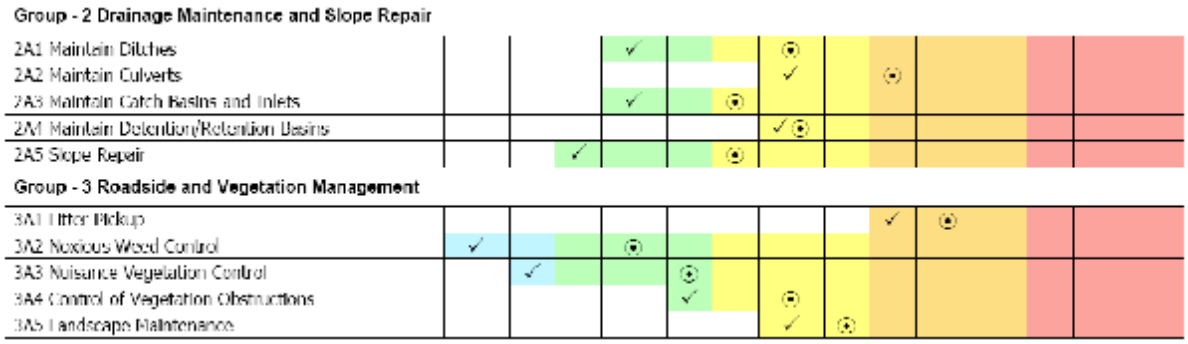
In general, the handful of more formal systems that state DOTs have developed still fall short of following commitments to Maintenance and facilitating management of commitments by DOT maintenance staff, with or without support from environmental specialists. If a DOT has a commitment tracking system, it often only extends to "the point where project delivery ends," as in Caltrans' case; they "don't typically do hand-offs to maintenance. This is true in Virginia and Washington State's commitment tracking systems, the most sophisticated systems in use in 2006 and 2008, at the time of national studies by ICF International.[37] Kentucky and Texas' systems, the most sophisticated in use at the time of the 2003 Volpe study, did not extend to maintenance either and they still did not several years later. Caltrans' emerging system didn't either; the agency added by way of explanation: "Operations doesn't have a plentiful supply of funds" to accomplish the commitments should they identify them and pass them along.[38] The greatest hope Caltrans held out was beginning to cost and incorporate maintenance costs for environmental features at the project outset; even though maintenance and transportation development are from two different pots of funds; the needs generated by one could inform the other and would be taken seriously at that stage.

Washington State DOT's Commitment Tracking System[2] is one of the most comprehensive systems tracking environmental commitments and has future plans for GIS locations; at this time, the system does not contain a mapping element, but plans are in the works for GIS and automated common data references. Wetlands are included in the database and WSDOT is just beginning to develop a system for stormwater management.

WSDOT has also developed a Maintenance Accountability Process (MAP) tool and field manual to measure and communicate the outcomes of maintenance activities and to link strategic planning, the budget, and maintenance service delivery. Twice a year, field inspections are made of

[2] WSDOT tracks environmental commitments made during the NEPA/SEPA and permitting process that results in very comprehensive list of commitments made from planning through project development. The Environmental Commitment Tracking system (CTS) is a custom designed ASP.net web based program that is used to track commitments after permitting is completed.

randomly selected sections of highway. The results are measured, recorded and compared to the MAP criteria to determine the level of service delivered. Results are summarized annually, with A (blue) through F (red, none) grades for drainage maintenance and slope repair and roadside vegetation management, as shown for one year, below:



WSDOT is working on developing a feedback loop to confirm follow through on environmental commitments; however, this does not extend to maintenance. Maintenance activities are on yet another system and are not linked to the environmental commitment system.

The DOTs that have chosen to develop their own commitment and mitigation tracking mechanisms have largely done so in house, rather than with more comprehensive off-the-shelf systems. DOT staff frequently use Excel and Access; the latter is more common if computer support is provided. More sophisticated systems may be programmed by the DOT's Information Technology (IT) staff.

Utah DOT's Oracle-based environmental commitment system was designed in-house and combined 10 stand alone programs into a single system to cover all project management activities from creation of the Statewide Transportation Improvement Program, obligation of funds, funding for consulting services and the amount of funds used, individual project management activities on a two-week schedule by project and task, and finally it links staff working on a project to the payroll system. The electronic project management system includes a description of mitigation commitments made in the NEPA process.

The system has helped UDOT ensure they are fulfilling their commitments; helps keep track of what has and has not been done with regard to completing the commitments through construction. However, as with WSDOT, the system is not linked to maintenance activities.

Corrective Action Tracking is Still Emerging as a System Function

Maryland SHA and Virginia DOT have fully fleshed out corrective action identification, tracking, notification, and follow-up as part of their environmental commitment tracking systems. WSDOT's tool offers "open, closed, or on hold" status for a commitment and MDSHA's Environmental Toolkit for the agency's independent environmental monitors also has "issues and status" related to the commitment that includes documenting what happened or what was encountered in an inspection, who was there, and how MDSHA responded. This information is reported instantly and raises credibility with the public and resource agencies, as it is available to anyone who wants information on a potential non-compliance event. However, this functionality extends to monitoring on construction sites and does not extend to maintenance (though MDSHA maintains another system entirely dedicated to hydraulic system inspection and maintenance).

MDSHA utilizes on-site Independent Environmental Monitors to perform daily inspections as a matter of course on all projects requiring individual wetland permits; inspections drop off in maintenance.

Virginia develops a site risk assessment and decides upon an inspection schedule for every project, but inspections beyond the permit period are also not continued in maintenance. VDOT's Comprehensive Environmental Data and Reporting System (CEDAR) system does facilitate environmental review of maintenance actions when they occur in environmentally sensitive areas, such as wetlands. VDOT's asset management system is moving toward integration with VDOT's system for tracking environmental workflow and permitting (CEDAR) and also the agency's database for hydraulic features and monitoring. Currently all maintenance activities with environmental aspects are reviewed through CEDAR; however mitigation features such as wetlands are tracked by the natural resources group and through the agency's GIS. After regulatory monitoring obligations are complete, wetland/habitat mitigation parcels are only tracked in the state's ROW & Utility Management System.

No state fully tracks all commitments from inception to maintenance, documents that they have been met, and reports on agency performance and opportunity areas for improvement, but VDOT and WSDOT's increasingly comprehensive systems are closing in on this objective. Several others have limited scopes of commitments tracked but know they want to do more, while others have no plans to do so; their systems are providing the functionality they sought and/or the obstacles to do more are too high.

The scope and reliability of commitment tracking is a special concern as the most functional and comprehensive commitment tracking will have commitments enter a standard process that ensures they are tracked and considered at all appropriate points in the life cycle of the roadway and ensures that checks and balances are in place to prompt or guarantee that right steps are taken at the right times. Tracking well in one part of the life cycle and then not in another falls short of the ultimate objective.

Becoming More Systematic and Accountable in How Environmental Work and Commitments Are Executed

DOTs are using these systems—commitment tracking systems and systems (often the same) for tracking their work and increasing communication — to become more systematic and accountable in how work is performed. Taking a more complete, encompassing view of commitments, to ensure that all are tracked, WSDOT's permit conditions commonly run up to 80 pages per project.

WSDOT is using their Commitment Tracking System (CTS) to make sure that every commitment is recorded, and now the agency is using the system to inform and bolster discussions with resource agencies on exactly what the DOT is being asked to do. Existing environmental assets (e.g. wildlife crossings, sediment ponds, culverts) that may have particular environmental commitments or maintenance responsibilities are not managed through WSDOT's CTS.

Likewise, TxDOT's system lacks feedback functions to review and ensure that commitments are retired in design, construction, and maintenance, as noted above.

The tracking systems are often intended to contribute to Environmental Management Systems, as in Texas, Virginia, and Washington. Maryland, Virginia, Texas and Washington are leveraging their systems to a degree, to develop a common way and a standard specification for work requirements or inspections, enabling fewer provisions and better training/enforcement around standards for staff, contractors, inspectors, though such aspects have yet to extend to maintenance of environmental assets.

Systems Have Improved Communications across Silos, Awareness of Costs

DOTs with commitment tracking systems report that designing, developing, implementing, and using the systems have improved communications among the sections. The greater the interaction across silos during each step in the life cycle of these systems results in benefits that go beyond the systems themselves as the needs and issues of the broader organization are addressed and incorporated. DOTs and their environmental departments are learning that an ongoing and sustained effort is needed and is rewarded with success in the form of greater effectiveness and functionality in the resulting systems. Greater attention has also been generated for the costs of maintaining environmental features.

To Maximize Effectiveness, Use of the System Should Be Mandatory

DOTs that allow optional usage of their systems or widely varying levels of use lack a complete set of commitments to monitor. To maximize system effectiveness, use of the system should be mandatory and training should be provided regarding expected level of use (i.e. which commitments or all commitments to be recorded, rather than project managers use to record just those commitments they think they might forget.)

DOTs see the systems as supporting internal management and technical work tracking functions more than serving external purposes. Conversely, when external access is granted and others start to rely upon it, the quality and completeness of that data become more important than ever. In general, DOTs' plans for external accessibility are limited.

Virginia and WSDOT are fostering a culture of publicly reporting performance, WSDOT through the agency's Gray Notebook. WSDOT is also trying to add more performance reporting functionality to its system. Virginia reports instances of construction environmental non-compliance on its public on-line performance Dashboards. If a problem is noted twice and has not been fixed, it is recorded as a noncompliance.

To date, Maryland is the only state to have made their system accessible to resource agencies. MDSHA's Environmental Management (EM) Toolkit was built in part to communicate directly with resource agencies, and the arrangement has greatly increased the U.S. Army Corps of Engineers (USACE) and the State Department of Environment's comfort level with MDSHA's responsiveness about and seriousness in tracking environmental non-compliance. MDSHA reports there is almost no response from the resource agencies when they can see/monitor with their own eyes, via the system, that MDSHA is handling its situations itself. At MDSHA, resource agency requests USACE and the Maryland Department of the Environment, comments, and/or questions can be made through the EM Toolkit. This allows MDSHA the ability to immediately respond to their needs and ensure all parties involved are up-to-date on agency coordination. MDSHA is considering providing access to other agencies, consultants, contractors, and other project stakeholders as needed and limited by project; however, the EM toolkit has not been extended to maintenance monitoring of environmental features.

At MDSHA, a number of systems—the Hydraulic features database and the EM Toolkit among others— have moved forward on different timetables. The Environmental Design division has a workload tracking system already in place, and is accomplishing their goal of entering data only once into a single system that tracks permits, conditions, and workload. The commitment tracking system developed by Planning and GIS is coming on-line as a separate system that does not tackle workload management for every office. Resolution of the different divisions' preferences has required higher levels of management involvement and leadership in some cases.

Facilitating Maintenance Identification Where Special Action is Needed

Once permit requirements are satisfied, maintenance has responsibility for what is on DOT property; however, maintenance staff have little training on management of environmental assets, which may require more specialized knowledge or information. Typical training classes on environmental matters pertain to herbicide application, mowing, salt application and equipment calibration, and in-stream work.

The most sophisticated DOT systems automate more of the decision making or reminders regarding special action that needs to be taken in certain areas or develop handy color-coded guides for what maintenance staff members need to do. For example, Oregon DOT has remotely surveyed and field checked roadside corridors for special management areas, which are color-coded for different maintenance treatments. PennDOT has linked maintenance equipment to a web-based GIS application to assist PennDOT's district roadside specialists in managing and coordinating herbicide spray activities along state highways throughout the state of Pennsylvania. RoSA, a web-based spatial application built using Microsoft's .NET development technology, provides a centralized database for the maintenance and operations of the roadside integrated vegetation management (IVM) program. RoSA (roadside spray application) produces the maps and reports while handling various spraying operations (tank mix, injection, and end result) and providing additional layers of information (water features, guide rail, government properties, and boundaries, etc.) for managing the roadside IVM program.[39]

NCDOT Maintenance has set up a performance based condition assessment system that encompasses hard environmental assets and sensitive vegetation areas, with statewide tiers, regional tier, and sub-regional tiers, and different levels of service. Each division sets goals and performance is tracked in a database. In 2006, EEP began to design a geodatabase (based in ArcHydro) to hold important GIS features for all its sites. GPS units running ArcPad network with the database to locate site features that are obscured by vegetation, mark easement boundaries, and record monitoring information. In 2007, DENR developed a new section and information system for long-term stewardship of natural resources mitigation assets. NCDOT still maintains many mitigation sites within its ROW.

2.8. Incorporate Environmental Asset Management in Maintenance Management Systems

Maintenance Management Systems (MMS) and related systems are increasingly addressing and incorporating environmental components. Some states are incorporating environmental elements in their asset management systems for the other physical features they maintain. For example, a culvert management system may incorporate tracking of debris removal and fish passage, as well as maintenance and the life cycle of the physical infrastructure asset.

In the late 1990s WSDOT and FDOT developed systems for categorizing and improving outfalls.[40] WSDOT began to assess which mitigation projects provide the best return on investment in terms of environmental effectiveness and pollution reduction; their system included a condition indexing methodology and support program that enables users to quickly evaluate and compare projects and generate benefit-cost ratios for projects.[41]

Ohio DOT Central Office of Maintenance conducts regular visual Maintenance Quality Surveys. One quarter of each county is inspected every three months and data is recorded via a touch screen laptop, utilizing GPS technology to record maintenance deficiencies in 8 inspection categories, including drainage obstruction, vegetation obstruction, litter in the ROW. Maintenance action is triggered for any drainage ditch where 50 percent of the cross section is obstructed;

vegetation growth obstructs signage, guardrail or sight distance; or any tenth mile segment with more than 10 litter items or large objects 8 inches in height and 3 feet by 3 feet or greater in area. An Organization Performance Index tracks the overall performance for each District and each District's performance is compared to one another and the overall State average. As of January 2008, Ohio DOT was meeting 100% of the measures.[42]

DOT staff sometimes indicated that environmental features are part of their maintenance management systems; however, on further investigation, this can mean that the department maintains herbicide application data sheets, rather than any particular electronic work scheduling or tracking system for an environmental feature.

Maps of Flagged Features or Areas for Restricted Activities

Maps of "flagged" or "watch out" areas are among the simplest ways that staff can be made aware of how regular activities need to be altered to attend to environmental features. Inclusion of "special management areas" in MMS is one way DOTs have begun to incorporate maintenance of environmental assets into MMS and more effectively address environmental aspects of vegetation maintenance.

Special Management Areas in MMS

Special management areas in a DOT's MMS or GIS can identify the need for more specific and environmentally beneficial maintenance action. Caltrans' Integrated Maintenance Management System has all known locations and maintenance requirements for sensitive areas in the ROW. Electronic Survey Files have the potential to facilitate the use of automated machine guidance technology in maintenance.

Streamline Data Collection through Remote Sensing, Combined with Ground Checks

Practical and economic considerations and technological advances necessitate ongoing exploration of what portion of asset management can be accomplished through remote sensing and automated monitoring. Oregon DOT's system addresses 6000 miles of ROW near salmon streams, with environmental data largely collected through remote sensing.

Oregon DOT's Designation of Special Management Areas

Oregon DOT's Directive MA01-131 provides guidance to staff for designating and managing Special Management Areas (SMA). SMAs are areas within ODOT's right-of-way where there are sensitive natural or cultural resources. SMAs are typically identified in coordination with resource agencies during project development and may require a modification to routine maintenance activities to protect the resource. The directive outlines the roles and responsibilities for designating and managing SMAs. Region environmental staff, the Region Environmental Manager, District Manager, the Central Geo/Environmental Section and the Office of Maintenance work together through a step-by-step process to develop methods to minimize impacts to the resource.

When a potential SMA is identified, the nature of the resource is verified and a determination is made whether maintenance activities negatively impact the site, and methods are developed to temporarily minimize impacts until further investigation is completed. Environmental staff gather the following information and submit it to the Region Environmental Manager.

- Third party verification of the nature of the resource
- Description of resource sustainability needs

- Citation of relevant laws for protection of the resource
- Maps or surveys to confirm the resource is in the ROW
- Confirmation that management of the resource isn't already included in other documents
- Description of the detrimental effects by routine maintenance
- Description of reasonable and safe BMPs and process for implementation
- Input from the resource agencies, where appropriate

Once the Region Environmental Manager and the District Manager agree the site should be designated as an SMA, they work with all stakeholders to develop a site management plan including monitoring and reporting requirements, a draft budget, and the necessary BMPs or modifications to maintenance activities.

The Region Environmental Management and the District Manager make the determination on the suitability of the site for SMA status based on the following criteria:

- Maintenance activities do not adversely affect the site - no SMA designation.
- Routine maintenance activities can be modified without compromising public safety and health - SMA designation.
- Routing maintenance activities negatively affect the site but cannot be modified without compromising public health and safety - no SMA designation.

The Region Environmental Manager documents the decision and, if the site is designated as an SMA, the District Manager works with the Environmental Staff to implement the required mitigation. The Central Geo/Environmental Section reviews known resource sites to ensure the SMA designation remains appropriate. They also maintain the statewide database of review decisions and agreements, monitoring reports and other related documentation. In addition, they prepare statewide summary reports and serve as a contact for regulatory agencies. Finally, the Office of Maintenance ensures the SMAs are adaptively managed and works with the Central Geo/Environmental section to facilitate annual reviews of the SMA program.

If a site is not designated an SMA, the Region Environmental Staff coordinate with the appropriate resource agencies and prepare the required documentation and coordinate with the District Manager for any required mitigation. The Central GEO/Environmental Section provides funding to Regions for monitoring SMAs, and for monitoring resources not associated with SMAs but that have regulatory monitoring requirements.

Add Instrumentation to Permanent BMPs, Where Possible, to Automate Data Collection and Facilitate Condition Assessment

Several DOTs are looking at adding monitoring instrumentation to permanent BMPs. DOTs have used instruments for a number of years to help monitor bridge conditions, and sometimes to automatically spray anti-icing compounds under specific weather conditions. Connecticut DOT has been using electronic monitoring systems to keep tabs on the condition of some of its bridges for years. Systems of linked sensors provide data on structural integrity and wear, and contribute to bridge life and stress assessment data, allowing for early repair of sites that need it, and saving an estimated $2.7 million.[43] Likewise, high-tech optical sensors embedded in concrete beams in a bridge in Las Cruces, N.M. relay information to New Mexico State University researchers about the

performance of the bridge's design and materials, letting them track structural soundness as the bridge ages.[44]

In the Charlotte area, North Carolina DOT has tested a system of water sensors combined with statewide weather information systems to time sampling with runoff from storm events. In Colorado, CDOT used an automated system to monitor water quality during storm events and periods of snowmelt runoff. Monitoring stations at culverts measured the water quality of highway runoff including the effects of winter maintenance activities such as the application of sand and deicers that contribute pollutants to adjacent streams. The system also measured water quality changes in relation to sediment control measures implemented along the highway. CDOT used this information to design unique sediment traps in specific locations that were easy to maintain using existing equipment.

DOTs have also used cameras at wildlife crossings to monitor use and effectiveness. Typically, monitoring data is collected by a university or wildlife organization and is not used to identify the need for maintenance of the crossing. Ideally, electronic sensors convey data back to a uniform database that can be used between agencies, which can also share management responsibilities. Under these circumstances, sensors can result in a cost savings to the DOT because they provide information without requiring field visits in most cases, and data can be reviewed and analyzed to support decision making on needed action in maintenance.

Examples of instrumentation that is now available include the following:

- **Terrestrial Laser Scanning.** Caltrans has completed research with the Advanced Highway Maintenance and Construction Technology at the University of California at Davis and is implementing land-based laser scanning technology to measure and model bridges, structures, roadways, slide areas, accidents, and archeological sites. This technology was successfully used to accelerate the reconstruction of the MacArthur Maze collapse in May 2007.[45]
- **Mobile Laser Scanning**. Mobile laser scanning is another technology that shows great promise for collecting engineering and asset management data on and adjacent to highways, roads and bridges. A laser scanner is mounted on a vehicle and data is collected at highway speeds without lane closures. Caltrans is currently conducting research with the Advanced Highway Maintenance and Construction Technology at the University of California at Davis to investigate mobile scanning applications on Caltrans projects.[46]

2.9. Systems Integration

Systems integration issues are also becoming top priorities for DOTs, with the proliferation of databases and tracking systems. Considerations include providing one central location for storing GIS project data and a common format for GIS project data to promote program analysis; ensuring that data can be easily used with GPS for field verification; storing in format that will allow for web mapping applications and data sharing with consultants; and reducing the time project managers and others need to spend in/manipulating GIS data.

Reducing the Number of Independent and Uncoordinated Tracking Systems

Each DOT that has developed a statewide commitment tracking system has reduced the number of informal, independent, and uncoordinated tracking systems in the agency, on various desktops within a single section in headquarters and among Districts/Regions around the state. To date, VDOT's system has replaced over 73 discrete tracking tools. In addition to offering greater organizational consistency and compatibility, what was previously disconnected is now available

more broadly. Environmental staff in particular save time by not having to develop and maintain their own systems.

DOTs are Increasingly Investing in Workflow Management, Document Management, and Reporting and Accountability Systems

In their environmental CTS, DOTs are increasingly investing in workflow management, document management, and reporting and accountability systems, with a Premium on Integration in their environmental commitment tracking systems.

- Workload and workflow management is a viewed as a highly linked, equally important task with environmental commitment tracking.
- Lead states are using an Oracle/SQL Server platform. Oracle provides a way to link multiple databases and systems in many states, often including an underlying document management system shared across systems. WSDOT's CTS uses SQL and .NET.
- Most of the leading systems are web-based or moving towards it. This is particularly true if the system is not static and has continued to evolve.
- While almost all states host their systems internally, MDSHA has branched out and is experimenting with external hosting.
- Lead states are seeking to link their systems to GIS, which is also seen as a way to link multiple information systems. Over half of the lead states examined here have built in the capacity (location identifiers) to ease that transition.
- Integration with other information systems, and especially the DOT's project management system, is a major trend. All systems are integrated or have plans to integrate.
- DOTs are increasingly sharing their information and accountability systems with other agencies. Maryland and Virginia have gone the farthest. Texas and Washington are on their heels. Caltrans is discussing "instrumenting" environmental mitigation features with sensors and cameras, and making this information accessible to other agencies, to assist with monitoring and management.

Currently, WisDOT is undertaking a review of existing studies and asset management systems for environmental features, with particular focus on Section 106 compliance for cultural resources, (historic properties & archaeology sites), wetlands, hazardous materials, and wildlife accommodations commitments. Wisconsin Transportation Center researchers are meeting with WisDOT staff in Regions, and central office and WDNR "Liaisons" as identified by WisDOT environmental staff to review existing procedures for collecting and tracking environmental commitments and develop a list of recommendations of priority environmental features for further exploration. These may include noise barriers, retaining walls, air quality, and culverts or crossings. The research team will develop and test tools and recommend processes to inventory and track past, current, and future projects. The research team will review plans at WisDOT archives, as-builts and thoroughly document current conditions of three case studies and discuss barriers to implementation and describe opportunities for further development, including implementation strategies.

Data Integration

Some of the most extensive information management and decision support systems at state DOTs are used in maintenance for condition tracking, work planning, budget estimation, and quality assurance. DOTs are confronted with the challenge of managing these and emerging

environmental information and decision support needs in integrated systems that incorporate transportation and environmental assets and quality, and the activities, materials, labor, budget, and tools needed to assess and manage them. System integration remains an elusive goal.[47]

FHWA's Office of Asset Management has produced a variety of practical publications that address data integration and access issues for states. These **National Resources** include case studies that discuss how DOTs in five states (Arizona, Colorado, Michigan, Pennsylvania and Virginia) are successfully integrating their data. FHWA's resources are available at http://www.fhwa.dot.gov/infrastructure/asstmgmt/diindex.htm.

FHWA's Office of Asset Management has embarked on a major research initiative to assess the data integration needs of transportation agencies and to provide technical assistance to address those needs. This assistance includes identification of compatible data referencing methods; evaluation and selection of appropriate software, hardware and data communications tools; and standardization of data collection and data processing procedures. The Office of Asset Management has published a number of practical documents on data integration, including:

- Fact Sheet—Managing Infrastructure Data (http://www.fhwa.dot.gov/infrastructure/asstmgmt/difact.htm).
- Data Integration Primer (http://isddc.dot.gov/OLPFiles/FHWA/010393.pdf). Intended to help state and local transportation agencies understand the importance of integrated databases and to provide options for developing or expanding existing data integration initiatives. Cites recent experiences of state DOTs that have integrated some or all of their transportation data.
- Review of Data Integration Practices and Their Applications to Transportation Asset Management (http://isddc.dot.gov/OLPFiles/FHWA/010939.pdf). Contains a review and synthesis of data integration practices among transportation agencies at the state and local levels.
- Data Integration Glossary (http://isddc.dot.gov/OLPFiles/FHWA/010394.pdf). Defines in simple and understandable language a broad set of terminologies used in information management, particularly in regard to database management and integration. Objective is to provide convenient reference material that can be used by individuals involved in data integration activities.

The Office of Asset Management is also assembling best practices from states that have integrated their databases, and has published case studies of practices in the following states:

- **Arizona** http://www.fhwa.dot.gov/infrastructure/asstmgmt/diaztoc.cfm ADOT is integrating data from existing systems into a data warehouse using an incremental approach that produces results and benefits quickly and often.
- **Colorado** http://www.fhwa.dot.gov/infrastructure/asstmgmt/dicotoc.cfm CDOT is moving quickly toward a completely integrated data system, supported by the rapid development of its geographic information system services, the implementation of the Strategic IT plan, and the migration of stovepipe/desktop applications to an enterprise environment.
- **Michigan** http://www.fhwa.dot.gov/infrastructure/asstmgmt/dimitoc.cfm MDOT began its data integration effort by building a transportation management system, migrating key planning, programming and project delivery data from the mainframe to a user-friendly environment. MDOT also engaged its partners in the cities, counties, metropolitan planning

organizations, FHWA division office and transit properties in the prototype development, setting the groundwork for extending the capabilities and benefits of the asset management data integration effort beyond the MDOT environment.

- **Pennsylvania** http://www.fhwa.dot.gov/infrastructure/asstmgmt/dipatoc.cfm PennDOT's approach to data integration combines strategic business process improvements with information technology enhancements.
- **Virginia** http://www.fhwa.dot.gov/infrastructure/asstmgmt/divatoc.cfm A linear referencing system provides the foundation for VDOT's data integration efforts and has three functions: defining location in space and on the network (spatial referencing), defining connectivity of assets to the network and of parts of the network to itself (establishing topology), and defining temporal versions of the spatial and attribute data to support planning scenario evaluations.
- **Florida DOT** "Development of GIS-Based Conflation Tools for Data Integration and Matching," Final Report, 2002. http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PL/FDOT_BC353_21_rpt.pdf This research began development of a comprehensive set of conflation tools that allow the matching, merging and integration of data and networks across disparate data sources. The research provides several key deliverables of potential interest to state and local agencies considering the conflation of networks and databases. The conflation tools developed are GIS-based and operate on standard database formats so that they are applicable across a wide variety of contexts and applications. The outcomes of this project include:
    - Researchers developed a comprehensive algorithm for network matching. The algorithm is capable of providing a correspondence between networks so that attributes can be matched as well.
    - Researchers developed a prototype conflation software program that implements the algorithm. A three-page summary of this report is available at http://www.dot.state.fl.us/research-Center/Completed_Proj/Summary_PL/FDOT_BC353_21.pdf.
- **Iowa** "Addressing Integration Issues and Developing a Protocol for Integration Issues and Developing a Protocol for Integration of GPS Data with Linear Referenced Data," Midwest Transportation Center, ongoing research. http://rip.trb.org/browse/dproject.asp?n=6126

2.10. Using Maintenance QA Mechanisms

NCHRP Report 422 on Maintenance Program Quality Assurance (QA) Implementation described a Maintenance QA program as "planned and systematic actions needed to provide adequate confidence that highway facilities meet specified requirements."[48]

QA information management and decision support systems support analysis of trade-offs and scenarios, including costs and benefits. Benefits are reflected by the predicted change in highway and environmental conditions that will result from performing maintenance activities to the specified levels of service. Goals or levels of service targets relative to current performance can be used in a feedback loop to assess how the maintenance program has performed and to adjust the program and funding accordingly. Environmental or service level goals thus facilitate management

accountability and provide a means of communicating program accomplishments and value provided.

This approach is in keeping with international standards for monitoring and measurement set out by ISO 14001, which call for:

- The organization to establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of its operations and activities that can have a significant impact on the environment.
- Record the information to track performance relevant operational controls and conformance with the organization's environmental objectives and targets.
- Calibrate monitoring equipment and maintain records according to the organization's procedures.
- Establish and maintain a documented procedure for periodically evaluating compliance with relevant environmental legislation and regulations. Conformity to a DOT's established environmental objectives and targets also indicate that monitoring, measurement, and feedback (the system) is working.

Few DOTs are undertaking complete surveys of classes of assets within their systems outside of bridges and pavement. More often, the current condition of maintained items in the highway system is tracked through periodic inspection surveys and estimates of environmental deficiencies. Since complete surveys encompassing all highway features are difficult and expensive to conduct, DOTs often employ statistical sampling, as in the case of NCDOT and WSDOT. Even when legacy maintenance management systems have an inventory of maintained highway features, they often lack provisions to record feature condition over time or to incorporate environmental data that can be used to create baselines and track progress to targets in level of service or environmental condition.

2.11. Adaptive Management and Continuous Improvement

Adaptive Management is frequently a critical component of environmental mitigation monitoring and site management, a process including four iterative steps: 1) standards or performance measures to describe the desired condition, 2) implementation of management action to achieve desired condition, 3) monitoring to determine achievement and 4) initiation of alternate management plan if the desired condition is not achieved.

The steps shown below are very familiar to anyone who has worked in continuous quality improvement processes or environmental management systems, including ISO 14001.

Continuous Improvement/EMS	Adaptive Management
PLAN	Define the problem to be analyzed and set performance measures
DO	Develop a solution(s) and implement the solution(s)
CHECK	Evaluate the results and analyze whether the goal has been me. If not, go back to step one.
ACT	Adopt the solution and continue monitoring

Monitoring is integral to the success of an effective adaptive management or quality improvement strategy; without valid monitoring data, management actions may or may not result in improved environmental conditions or compliance.

For DOTs, the practicality and feasibility of the performance measures and the adaptive management scheme is key. A balance must be achieved between performance measures resource agencies may desire (e.g. return of absent species, reattainment of gold medal trout stream status) and what DOTs control or can do (e.g. clean out adjacent sediment basins annually).

In 2002, WSDOT entered into Memorandum of Agreement with the Washington Department of Fish & Wildlife (WDFW) to move away from the repetitive repair of WSDOT roads and concentrate on long-term solutions to optimize improvements for fish and fish habitat, while also addressing transportation needs. Chronic environmental deficiencies (CED) are locations along the state highway system where recent, frequent, and chronic maintenance repairs to the state transportation system are causing impacts to fish and fish habitat.

CED projects have to meet two qualifiers:

- Maintenance has been conducted on the site 3 times in the previous 10 years.
- The maintenance being conducted has a negative impact on aquatic fish habitat.

Potential CED's can be nominated by WSDOT, WDFW, Tribes or other concerned parties. If the location meets the CED criteria, the project is added to the list of CED sites. For each site, WSDOT conducts a site evaluation to identify the hydrologic mechanisms for failure and develops a conceptual design solution. In 2005, WDFW developed a prioritization methodology that provides a scientifically based priority to the order of CED correction.

Since 2004, 6 high priority sites have gone through the process of reach assessments/analysis, design, and construction to correct the deficiencies. There are currently 20 CED projects funded for $50 million to design and construct by 2010. The CED program has saved maintenance costs, reduced the loss of commerce due to road closures, removed or reused riprap and other material damaging aquatic habitat and replaced with rough woody structures designed to add salmonid habitat. The CED program is currently working to develop a monitoring plan to monitor 3 major aspects of the Hoh River project; structural integrity, geomorphic changes and biological success of the project.

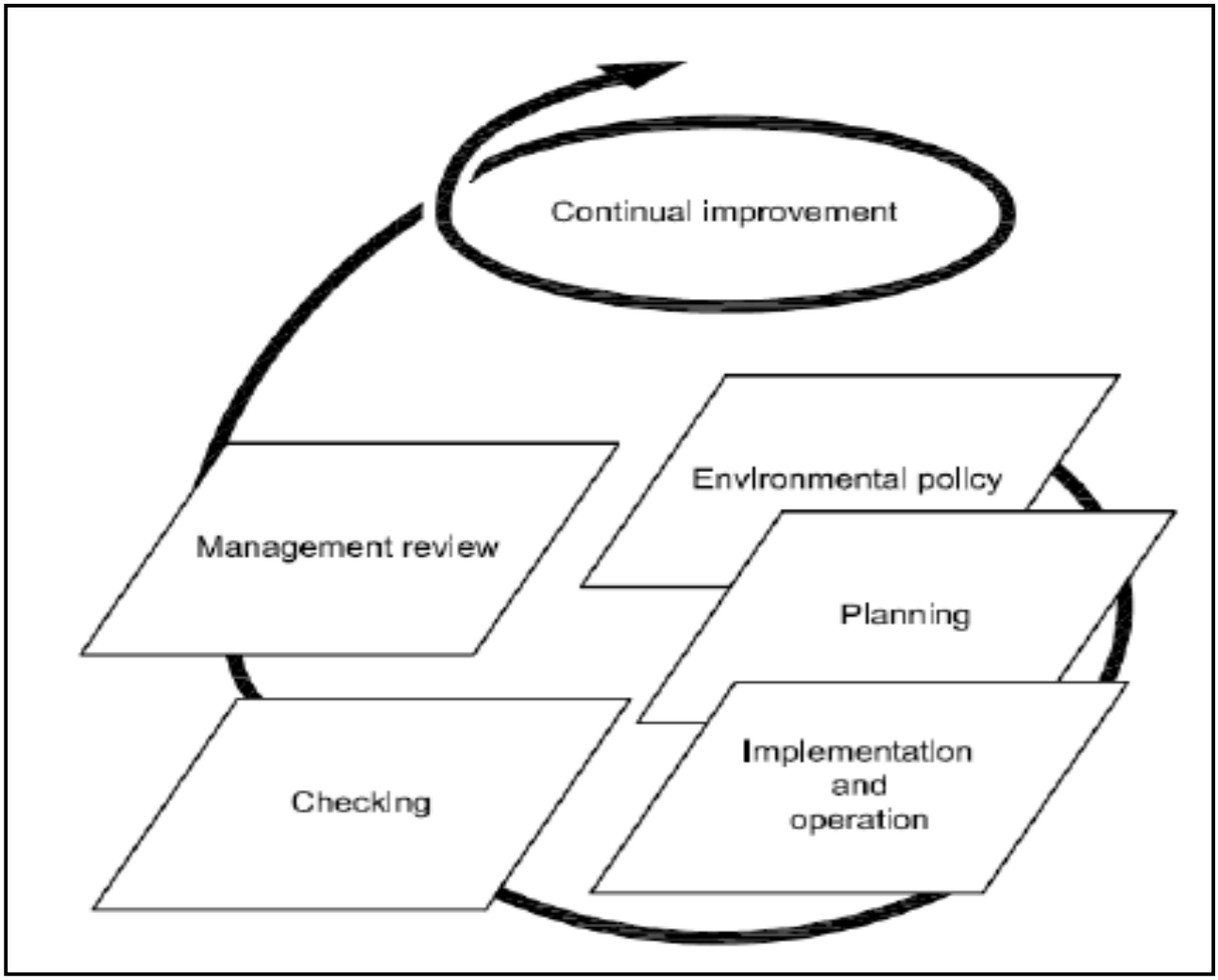
2.12. Environmental Management Systems Relating to Asset Management

Environmental management systems (EMS), known in the International Organization for Standardization lexicon as ISO 14001, offer DOTs a model for systematization of roles and responsibilities, execution of procedures, then checking or monitoring performance to policy expectations and re-planning and implementation, to effect continual improvement.

ISO defines EMS as “that part of the overall management system which includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining environmental policy.”[49] The EMS provides the structure by which specific activities related to environmental protection and compliance can be efficiently and effectively carried out.

Generally, the EMSs that have delivered benefits have had successful mechanisms for monitoring effectiveness, incorporating lessons learned, and managing continual improvement. DOTs in the vanguard have focused on increased compliance assurance and cost effectiveness, adoption and

development of BMPs and sustainability practices, enhanced land and resource use planning and management, accelerating and streamlining the project delivery processes, and improved intergovernmental relationships and stakeholder confidence. Challenges commonly include coping with the demands of intensive up-front effort with only limited staff time, realistically quantifying resource requirements and establishing straightforward metrics for monitoring. Effective management has been enhanced in some cases by information IT tools, which facilitate the flow of environmental information; tracking of metrics; tracking projects schedules, budgets, and personnel; communication of corporate knowledge; analysis of impacts; the availability of geo-referenced data for planning stage decision-making.



ISO Process Approach (source: ISO 14001-2004: Environmental Management Systems-Requirements with Guidance. Standards Australia 2004).

EMSs Address Key Interdisciplinary Communications, Roles and Responsibilities Needs

Achieving a department-wide understanding of asset management and enabling the interdisciplinary approaches needed also requires strengthened communication – vertically within core competencies and to executive levels, and horizontally across the department's organizational

units and disciplines. DOTs frequently lack staff to deal with the junction between environmental and maintenance matters, and so it wasn't uncommon for us to talk with five people in the agency before tracking down someone who might be able to answer, incompletely, the questions we had. Most often, if staff were aware of systems or efforts to begin to manage environmental assets, they were partial or in process efforts for one or two resources, in a single District or Region.

Without clarity of responsibility, it is easy for confusion to arise or maintenance needs to fall through the cracks. For example, at one DOT attempting to locate all outfalls and permanent stormwater facilities, maintenance staff told the DOT environmental contact that "we were told not to touch these things." In our contacts with DOTs, many have noted that for features such as wetlands, especially beyond the monitoring period required in the permit, "it is really up to the personal commitment of the environmental staff." Environmental staff members often keep their own lists and check on features as time permits. Many DOTs noted that longer term maintenance planning for environmental features simply didn't exist. Where it exists, it is always limited. In New Jersey, for example, beyond the regulated monitoring time, maintenance is limited to vacuuming sediment traps, cutting grasses, and any "roadside rehabilitation" of plant material in wetlands and stormwater features. Environmental specialists periodically point out needs and let maintenance know.

D.C. DOT Plans to Track Environmental Commitments in Maintenance

The District of Columbia DOT is among the most recent to design a plan for an Environmental Management System and the agency has distinctive plans to track performance of environmental commitments in maintenance. Overall, the agency has set a target of a 95% completion rate for environmental commitments and features as planned. To check, the agency plans semi-annual reviews during construction, scoring a checklist of environmental commitments. The agency aims for a score of at least 95% on routine evaluations performed by PM/site staff and at least 90% on spot checks performed by EP Staff. As a follow up where corrective action is needed, the agency set a target of 95% for follow through on corrective actions and 90% for preventive actions, to be reviewed quarterly. Finally and notably, environmental commitments on maintenance activities will also be evaluated, comparing those performed to those planned/ scheduled, with a target of completing 95% of that which is scheduled.[50]

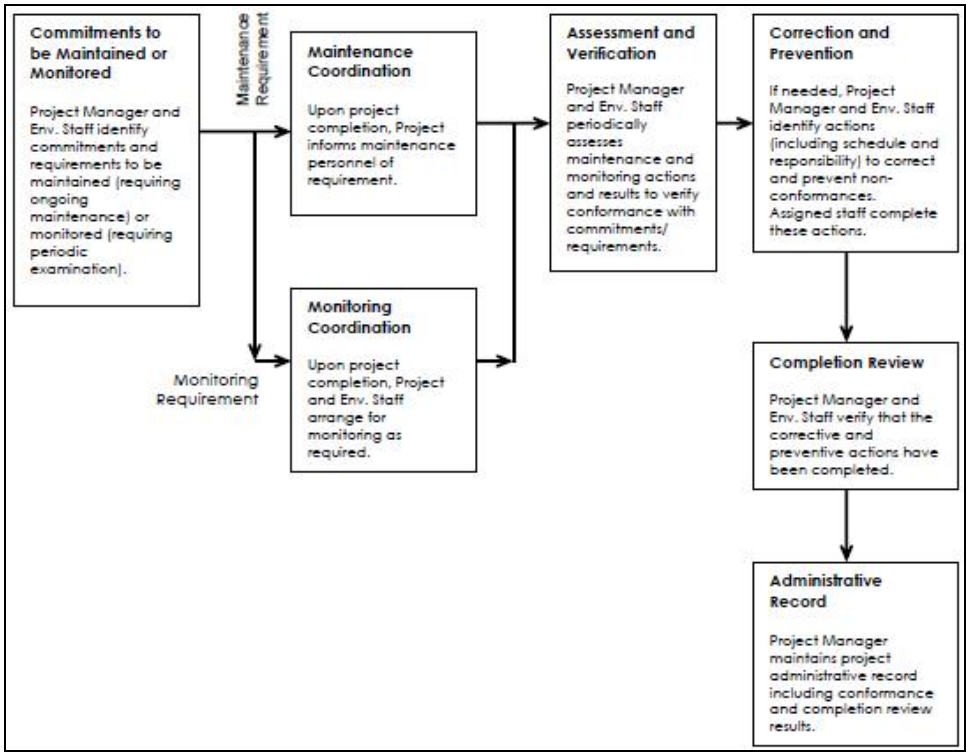
How needed maintenance is to be identified, programmed, and scheduled is not addressed in the plan, though the plan lists as "Key Elements of Operation and Maintenance"[51]

- Develop maintenance plans and budgets that reflect environmental commitments and requirements;
- Maintain and monitor, as applicable, environmental features and requirements; • Verify conformance;
- Take actions, as needed, to ensure conformance; and
- Provide environmental assistance and support.

As in many other DOTs, compliance will rely on "spot checks" performed by EP Staff, presumably as they are available. The project manager and environmental staff are supposed to identify commitments and requirements to be monitored – requiring periodic examination or sampling (e.g., assessment of vegetation); or maintained – features (e.g., catch basins or sediment control ponds) that require ongoing maintenance to function as intended. Determine associated actions and schedules. However, the "when" and "how" are more vague: "as identified during the course of a project" and "capture information as commitments are agreed upon." Then "assigned staff" are to

"fulfill requirements as identified in preceding action in accordance with schedule and assessment needs."

"Staff identified as responsible in preceding actions" will in turn "review practices and measures to ensure conformance" and "provide assessment results to the Project Manager." The Project Manager and Environmental staff will conduct periodic assessments to evaluate and ensure day-to-day conformance and if needed, identify corrective and preventive actions to address findings and assign responsibility and schedule for action/s. Assigned staff will implement corrective and preventive actions in accordance with an action schedule shown below.



Source: District of Columbia DOT Environmental System Management Plan, Oct. 2008.

Implementation tools include an Environmental Evaluation Form, Sample Commitments and Requirements Summary, and Sample Commitments and Requirements Fulfillment Checklists. The Commitments and Requirements summary sheet includes the following maintenance stage actions:

- Description of maintenance required for the commitment
- Maintenance unit informed of requirement
- Maintenance unit acknowledgement of receipt

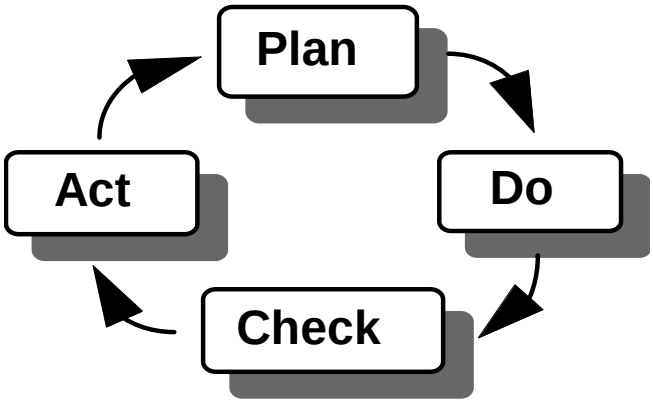
With regard to monitoring, DDOT intends to track:

- Description of monitoring required for the commitment
- Designated unit/individual informed of commitment
- Designated unit or individual acknowledges receipt of commitment

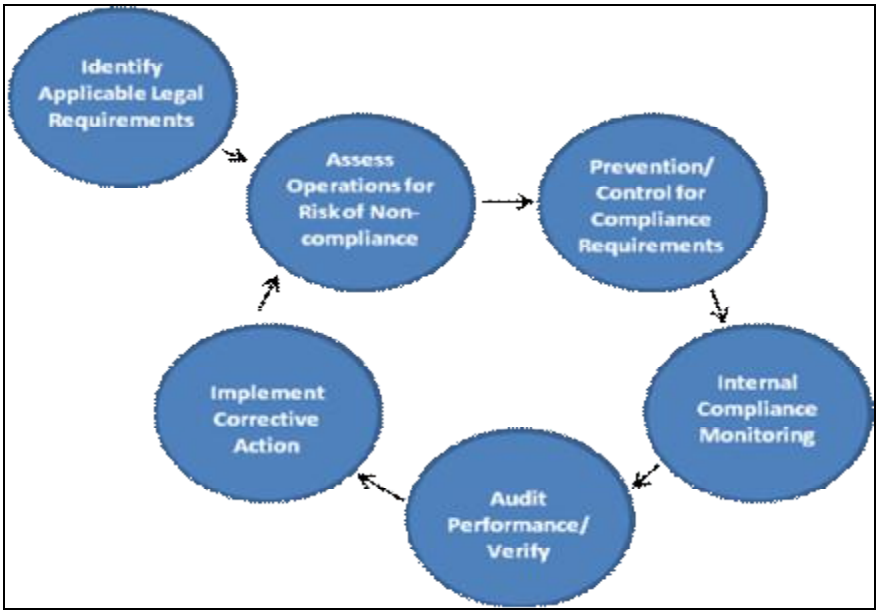
With regard to agency coordination, DDOT will track the extent to which the regulatory agency is informed of a commitment as it is incorporated into Design/Construction documents and agency acknowledgement of completion of commitment as described.[52]

3. Proposed Steps in Developing Environmental Asset Management Systems

Steps in developing an asset management system for environmental features can be considered under the PLAN – DO – CHECK – REVIEW/ACT framework of any quality improvement initiative. The steps are linked together and require ongoing monitoring.

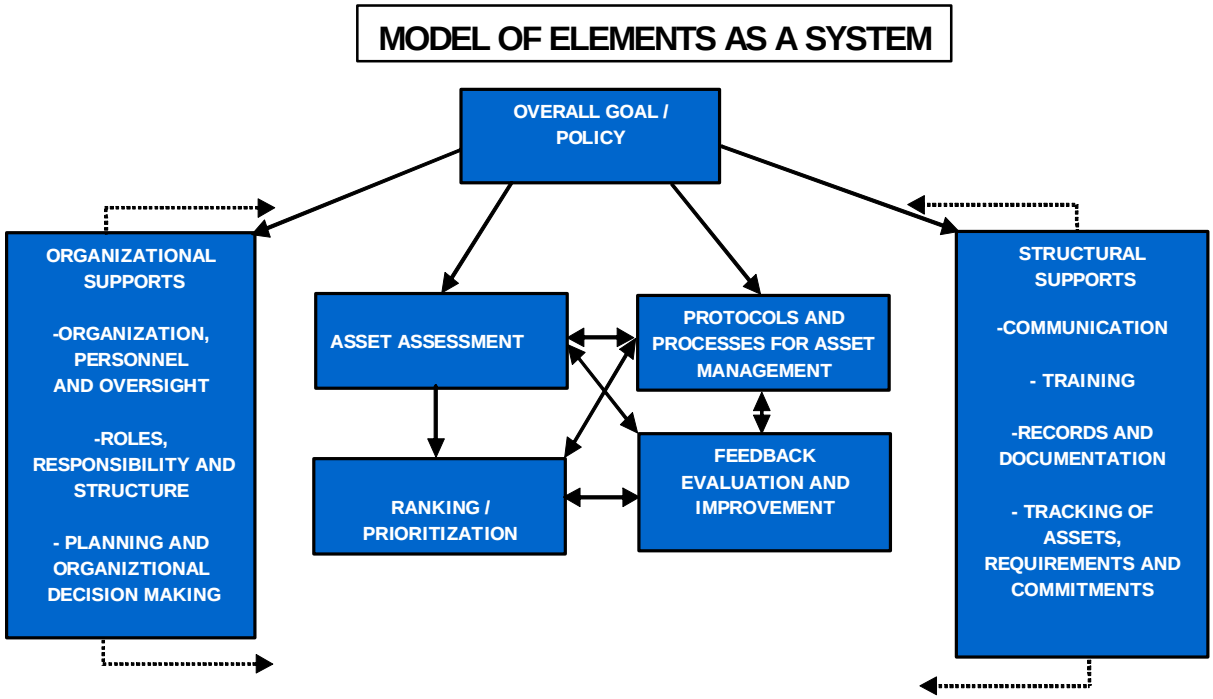


As depicted in the figure below, the PLAN – DO – CHECK – REVIEW/ACT cycle applies within processes of a broader system, in this case managing compliance requirements. The basic approach still applies here as the cycle ensures there is evaluation and feedback, after implementation, to re-consider the resources, objectives, and process, so that refinements in design can occur to improve implementation, accountability, and results.



The management system for environmental features should include the basic elements that are found in most management systems:

- A clearly defined overall goal/ policy for the system from which the system flows
- Driven by this overarching driver, clear definition of what the system is designed to manage, and the drivers that influence management (assets and factors that influence ranking of assets)
- Asset assesment and ranking of asset classes and individual assets
- Protocols and processes approprite for managing classes of assets
- Defined management roles, responsibility and structure
- Communication processes
- Training
- Asset management activities
- Feedback on effectiveness of protocol and process activities
- Feedback on system elements
- Action to improve system and components



A key part of a successful environmental asset management system (EAMS) is to ensure that each element and process in the system is integrated with asset management and general operational management processes in every way possible.

The PLAN – DO – CHECK – REVIEW/ACT cycle applies to both the development and implementation of an EAMS as well as the long term operation and continual improvement of the

system. Steps for system development and implementation are described below. They are suggestions to help lead to the presence of a system with continual improvement by design.

The many possible procedures and practices and techniques for asset management noted in Section 2 above are not repeated in this section. As part of development and operation of a DOT EAMS, a DOT will need to determine what techniques and practices will allow it to meet its goals in this area.

Continual improvement by design does not come easy to most DOTs as most are a project based culture, and do not tend to apply significant resources to the CHECK – REVIEW/ACT activities which are required for a systematic approach.

Overall Goal / Policy

For a DOT EAMS, the overall goal of the system should be expressed in terms of what the DOT aspires to achieve by managing the assets and the overall related commitments to the public, and provide a framework within which environmental asset management activities are expected to perform. Possible content includes:

- DOT's environmental assets include all features already present, required or implemented in the interest of environmental stewardship - which reduce impacts on, sustain or enhance environmental resources within the DOT's sphere of influence.
- DOT is commited to recognizing the investments made in environmental assets, and the intrinsic value of these assets.
- DOT will satisfy all commitments and requirements related to environmental assets and will consider these assets as an integral part of its operations.

It defining its overall goals and policy for an asset management system, each DOT must ensure that they are appropriate for the DOT and are supported by senior management.

The commitment and support of top management is critical to the success of the implementation of an asset management system. Ultimately, it is top management that will provide adequate resources, make management of environmental resources a priority, and ensure the system is integrated with other phases of project delivery throughout the organization.

3.1. Plan

Planning for initial development of an EAMS is needed for projects in a DOT culture. For an EAMS, planning is a repeated function. The planning process needs to be regularly revisited to ensure that as part of continual improvement of the EAMS that appropriate refinements to the system are identified.

What is the Scope of Asset Management Responsibilities?

A starting point for the DOT and those who might take the lead in examining the DOT's long-term environmental asset management responsibilities is: what mitigation features does the DOT have and what environmental resources does the DOT manage? What classes / types, of environmental assets are there?

Environmental resources and mitigation features include many of concern to maintenance forces and other stakeholders. A few examples include:

- Fish habitat

- Wildlife habitat
- Roadside vegetation management, including sensitive areas of rare plants
- Constructed mitigation areas
- Adjacent streams, wetlands, and conservation areas
- Wildlife crossings
- Cultural resources such as historic markers
- Archaeological resources

A DOT's environmental specialists can help answer these questions. Maintenance staff members should be consulted as well. Collectively, headquarters and regional staff can identify key sources of information in this regard.

Build Awareness of the Issue & Recruit Champions and Partners

DOT staff who plan to engage these questions and potentially develop asset management approaches for environmental features will want/need to build awareness of the issue and recruit champions and partners. Partners can help assemble the information management will need to consider priorities and where the agency could most benefit or reduce risks by implementation of an asset management approach for environmental mitigation features and other environmental resources managed by the DOT.

What Environmental Features Do We Have to Maintain in Relation to These?

Some environmental features exist in relation to the items above. For example, fishing access points may exist in relation to streams. Nests of ground-nesting migratory birds may exist in relation to roadside vegetation. Culverts, outfalls, and sediment basins may need to be maintained and checked regularly, to ensure that pollution of streams is not occurring. All of these contribute to the list of environmental features DOTs maintain and manage.

What Should We Be Managing?

As a starting place, the DOT may want to:

- Systematically identify commitments made in terms of maintenance of the environmental features in question that can be found in permits or other regulatory vehicles such as NEPA documents, FHWA's section 4(f) analysis, environmental permits such as section 404 permits and water quality permits, resource specific regulatory protection requirements for such things as threatened or endangered species and historical resources, and agency wide or project specific programmatic agreements. The environmental specialists who negotiate these provisions as part of permits and interagency agreements are likely leads in identifying applicable resources. Specialists can also help identify commitments based on their historical work with resource agencies, individual tracking lists, maintenance records or GIS information, and construction as-built plans. This is not an all-inclusive list and the environmental specialists should be consulted to identify all applicable sources of information.
- Identify the regular gaps or downfalls that occur in meeting those commitments. Gaps can be identified through interviews or in a workshop setting with those most familiar with "how things really work on a daily basis." Some gaps can be identified from field experience. For

example, one DOT maintenance environmental specialist, identifying locations of culverts in the field, was told by maintenance forces, "we were told to leave those alone." Dialogue between environmental staff and maintenance about the commitments and desired conditions will surface many gaps, allowing exploration and discovery of why desired conditions do not occur, haven't been occurring, or can't occur.

- A DOT's credibility and the resource agency's faith that features and functions will be maintained as committed is key to "good deal" negotiating the next time around. Thus, the relationship itself may be considered an asset that is as important as the physical assets.

The question of what the DOT should be managing is likely to be revisited in multiple rounds of the improvement process. Given that it is necessary to start somewhere, DOTs often start with a few resources they find they really need to do a better job of managing. For some, this has been water quality control BMPs. For others, immediate improvement opportunities have risen in the ROW, as DOTs see they could both save costs and enhance the environment by reducing the area they mow. In other cases, ameliorating fish passages is a priority, driven by the ESA, the concerns of state agencies, or local communities.

Ultimately, decisions about what the DOT will manage come back to the highest levels of management. Staff receive instructions about what their priorities should be in the limited time they have available each day. When there are too many things to do, these priorities prevail. For environmental asset management to occur at DOTs, it must begin to be a priority in someone's job and likely the jobs of many people. For this to occur, management support and a degree of organizational change (job descriptions and/or understandings thereof, middle management support, funding, appropriate incentives or consideration of the factors in job evaluations) are likely to be needed, if the work is not managed by contract.

Individual Assets

Asset management processes and procedures often are geared towards identification of and tracking to completion of actions required to assure that each individual asset has and continues to be appropriately managed.

The premise of asset management coupled with a systems approach is based on the ability to ensure that for each asset, required activity is understood, conducted and tracked.

What Are the Environmental Aspects of Maintenance Work?

As the asset management system looks at the classes of assets / individual assets, it is important to consider what specific protocols and processes (activities) are engaged in / required as a part of operation and maintenance of those assets.

An environmental aspect is an element of a DOT's activities (or products or services) that can interact with the environment (can cause or contribute to a positive or negative change to the environment [impact]).

For DOT environmental assets, aspects are often activities that are conducted to enhance or diminish the impacts associated with environmental features. Maintenance staff engage in a wide variety of activities out in the field, with a variety of environmental aspects and potential impacts to the environment from how that work is done. For the inquiry with regard to maintenance of environmental features, questions on the environmental aspects of maintenance work center around the scope of environmental resources identified in the preceding step. For example:

- **Materials management and disposal** have environmental aspects to how this work is performed:
    - With implications for runoff and the health and functioning of nearby streams, wetlands, and fish reproduction in streams.
    - Salt or sediment-laden runoff is an aspect of various maintenance activities, and can impact nearby streams and wetlands if not adequately controlled.
- **Snowplowing has environmental aspects such as:**
    - The potential to bury wildlife crossings under the road, and thus, to maintain functioning of such passages throughout the winter, plow operators should be made aware not to pile snow in such areas.
- **Control of invasive species**
    - Management of invasive species with herbicides can runoff and affect water quality and fisheries

A more expansive investigation of the environmental aspects of maintenance work is a key step toward development of an asset management system.

What Are the Desired Conditions to Maintain Environmental Features & Function? Develop Definitions for Ranking / Prioritization of Environmental Assets

On a general or high level, desired conditions can be simplified to maxims such as:

- Don't mow the birds!
- Don't block the wildlife passage with a big pile of snow!
- Don't smother the fish spawn by getting sediment in the stream!
- Don't poison the fish or contaminate the well water by using more herbicide or salt than you need or leaving it unprotected in storage. Be aware of where salt or herbicides could run into streams or wetlands.

Environmental staff at the DOT usually know what the resource agencies are seeking with regard to satisfactory maintenance, to protect the environmental resources in DOT custody or affected by DOT maintenance activities. Designers and resource agencies may provide supplementary input.

The reality of asset management is that, resources are limited and as such choices have to be made as to the degree of resources to be applied to the management of any class of assets / individual assets. In order to make rational, objective and consistent choices as to where limited resources are applied, a DOT needs a process to prioritize its choices. The factors used to prioritize should be based on drivers that fit the DOT.

When determining what resources to apply, the current state and the desired state have to be assessed. Condition assessments are a way to accomplish this.

Define Characteristics or Indicators of Proper Functioning and Sketch Out a Range of Functionality in a Condition Assessment

Desired or required conditions should be described in detail and translated to a gradation of function for each resource and/or feature (asset) to be managed. A general model for setting up a condition rating scheme will describe what constitutes the following level of function, for each resource the DOT seeks to manage:

A. Good/very good condition or functioning

B. Adequate condition or functioning

C. Moderate condition - Some maintenance action needed to restore to proper functioning

D. Poor condition - substantial maintenance needed

F. Not functioning: rebuild or replace

This step can require many rounds of review to get it right, so that:

- Condition levels are meaningful and accurate
- Achievement of "A" or "B" level condition ratings achieves a level of function that satisfies all environmental regulations and stewardship commitments the agency may have
- Condition levels can be understood by anyone
- Staff or interns can be trained to evaluate the condition of the feature and reliably produce the same rating, from the same conditions, when encountered.

Condition ratings should be defined for each environmental (mitigation) feature the DOT plans to manage as an asset. Having the ratings is one means of leading to prioritization of asset management activity.

What Would It Take to Comprehensively Assess This Resource?

Once a condition rating system has been developed, it is time to consider how it can be efficiently implemented. The following questions may help DOTs go through this thought process:

- Are particular skill sets needed, for example rare plant identification?
- Can it be accomplished by interns or in conjunction with universities?
- In what timeframe could the survey be accomplished with maintenance and/or environmental staff in the course of their normal work? Can other internal staff resources be marshaled?
- How much would it cost to contract out the work?
- Is a census (complete survey) necessary or would a sample be sufficient for estimating the need, for programming and budgeting purposes?

Condition assessment rating systems have been developed that cannot be implemented, due to limited staff resources. What could be accomplished with existing resources, on "rounds" when staff are already in the field? What could be accomplished with devoted resources? What could be accomplished with additional devoted resources?

- Identify what data is readily available.

- Identify what data is needed and what tools and skills will be needed to collect it; e.g. GPS receivers, pen computers, digital cameras, etc. and how this might be obtained.
- Identify what portion of the data collection and data assessment responsibility might be efficiently shared with others, especially sister agencies.
- Identify data collection that might potentially be automated
- Identify where the information would go when it is collected
    - Who will identify and structure the information to be collected?
    - Who will design the database for data storage?
    - Where will the data be stored, who will manage it, and who will have what levels of access?
- How will the information be accessed and feed into decision making?
- How will the information connect to maintenance and the capital program?

Without these final linkages, investment of effort in the program is futile.

Risk Assessment & Investment Rationale

Asset risk ranking and prioritization can drive decision making that leads to greater management attention and action, with the degree of added management driven by the degree of risk. Increased management attention and action results in changes and implementation of asset management techniques like those described in Section 2.

DOTs manage a large amount of land. As AASHTO's Center for Environmental Excellence notes, "The rights-of-way that border the nation's roads include more than 12 million acres of land, and road maintenance crews are on the front line"[53] in managing these environments. What are the risks of failing to manage these lands and the constructed as well as naturally occurring features as the assets they are? Left untreated, invasive species tend to spread rapidly, and cost more to control. Non-compliance with regard to regulated resources can lead to fines and legal sanctions. Cite pertinent regulations or components of the agency's agreements or permits. Typically the cost of violations are a consideration in assessing risks. Costs may include not only fines, but potential jail time under some environmental laws.

DOTs have tended to address environmental features where the risks of inaction are apparent. This step identifies those environmental features that would benefit most from improved maintenance and what resources would benefit most from increased attention.

A variety of risk assessment techniques can be used, from informal lists to more involved evaluation. Risks can be ranked by probability and impact and evaluation of threats to operability, maintainability, or long-term budget, including required reconstruction. In general, project risk management techniques, such as those outlined Caltrans' Risk Management Manual (2007)[54] or Washington State DOT's risk assessment technique can be adapted to program purposes as well.[55]

In sum, management will want to have a sense of the risks and opportunities, as they factor into cost-benefit calculations, in deciding where to invest in asset management and which resources to prioritize first.

Decide Which Environmental Features Will Be Evaluated and Tracked

Regardless of how well constructed, all mitigation features will need to be monitored and maintained; some more frequently than others. However, the tradeoffs between management of environmental assets and infrastructure preservation must be weighed against the reality of limited staff and funds. For many DOTs, priorities are determined on a district by district basis. Some factors that should be considered when determining priorities include:

- Public safety
- Permit conditions(e.g., section 404 permit) and regulatory requirements (e.g., protection of sensitive species)
- Amount of investment in the mitigation feature
- Funding availability
- Protection of infrastructure

Communicate Roles and Responsibilities

When the work is done in-house, as a matter of practicality, responsibilities for asset management may be divided between maintenance, environmental and design staff. For example, environmental staff most knowledgeable about an individual resource, e.g., wetlands or cultural resources, may assess the condition of a particular feature and then communicate needed repairs to Maintenance. Other features are almost universally monitored and maintained by Maintenance such as permanent water quality facilities. Still other features such as culverts may require a team effort; the environmental specialist to identify sufficiency of fish passages, an engineer to assess structural integrity, and maintenance to do the actual repairs. Once the agency has determined which environmental features will be tracked, responsibility for the monitoring, assessment and maintenance of each feature must be assigned to a specific individual or individuals. Without clear assignment it is easy for management of environmental features to fall through the cracks.

Regardless of the division of labor, practical communication and systems for feedback between planning/ environment/design and maintenance should be integrated and not only facilitate communication and tracking of requirements and assets, but necessary budget, requiring cost estimation and tracking.

Communicate

Communication needs to occur across all segments of an organization and from management to front line staff.

Develop formal mechanisms to hand-off asset related procedures, programs, requirements and processes that creates a paper trail so they are not subject to staff turnover

Involve maintenance in development of design of features to ensure they are part of the solution.

Finalize Plan Details for Condition Assessment Implementation

Create a more detailed plan for implementation of the condition assessment. Identify necessary staff, roles, procedures, and training. Identify what resources will be assessed by when, given the allocated budget, and when/how feedback points will work for planning remediation or retrofits. One of the key purposes of an asset management system is to catch and improve elements of a system before they start to fail. Feedback systems should be designed to utilize the information

collected in the condition assessments and plan appropriate maintenance action in a timely fashion.

Identify how regularly surveys are needed for the mitigation feature in question. Environmental specialists and maintenance staff can help identify how frequently is sufficient and practical. Once you "plan the work," it is necessary to "work the plan."

Design Protocols and Training

To hone meanings, understandings, and people's ability to use the system, it is necessary to design and perform training on the rating system and related protocols, from safe conduct on the roadside to equipment use and data entry.

The training provides a standardized curriculum to ensure minimum levels of core competency for new hires, existing maintenance workers and supervisors in environmental stewardship. Training programs include water quality and illicit discharges, stormwater management, control of noxious weeds and the use of pesticides, erosion control and stormwater management, basic wetland recognition, sensitive habitat and many others.

Identify How Observational Data Will Be Incorporated Into Maintenance Plans and Programs

Practical and economic considerations necessitate ensuring that resource data and maintenance requirements can be easily collected in the field and stored in a common format that will allow data sharing between environmental, design and maintenance personnel and contractors who perform maintenance activities. With easily accessible information, maintenance managers are increasingly addressing and incorporating environmental components into staff responsibilities and budgets.

3.2. Implement

The planning elements of a management system can require considerable effort when a system is first being designed. Do not expect to get it perfect the first time through.

The continual improvement PLAN – DO – CHECK – REVIEW/ACT cycle is not a linear process. As elements of the system are ready to be implemented, work to put them into use and once the system (or parts of it) is operational expect to periodically revisit the planning decisions made and refine the implementation of the system.

The implementation elements described below highlight considerations for building a systematic approach to asset management.

Conduct Training

All employees involved in the asset management system should receive appropriate training. Training should include the asset management system process, the agency's environmental policies, the environmental aspects of their daily work and the environmental impacts, and their roles and responsibilities in meeting the agency's objectives of regulatory compliance and environmental asset management.

Data collectors should be trained on the necessary equipment and protocols, incorporating field tests and QA/QC to ensure duplicable ratings, evaluate patterns and where improvement is necessary, including further training.

Execute Desired Condition Assessment Plan and Data Upload

In this step employees or the consultant conduct the preliminary assessment and collect the necessary data to rate the level of function for each environmental feature according to the condition rating scheme developed in the planning process. Data will undoubtedly be collected in much different electronic and hard copy formats. Regardless of the format the data needs to be recorded in a systematic, readily accessible, single location. Storing information electronically can provide the easiest means for retrieval of data as well as controlled access to sensitive data, if necessary.

Analyze and Report on the Results of the Condition Assessment

In analyzing and reporting on the results of the condition assessment, overall performance indicators or maintenance adequacy should be conveyed. In addition, summary condition information for each feature should be designed and presented, if a complete survey or census of features is being conducted.

The analysis should generate scenarios illustrating the options and implications of different investment levels, including timeframes for attainment of different condition levels.

Maintaining the DOT's Credibility and Effective Negotiating Position: Relationships as Assets

DOT environmental staff are highly cognizant of and devote much attention to their relationships with resource agencies and other stakeholders – a key asset that cannot be overlooked. The specialist's effectiveness in their position often depends upon it. DOT environmental specialists are typically in touch with their permitting or consultation counterpart specialists at other agencies on a daily basis. Maintenance of effective and cooperative working relationships is absolutely essential to keep environmental consultations, permits, and thus projects moving forward and especially moving forward on time and on budget. NCHRP 25-25/51 focuses on the physical environmental assets, but the relationship assets with resource agencies, DOT environmental specialists' maintenance of those, and reliability are related and at least as important. DOT specialists have a strong incentive to maintain these relationships.

Maryland State Highway Administration is unique in having developed a system to strengthen the DOT's relationship assets with other agencies, a process which has borne noticeable fruit. MDSHA funds independent environmental monitors, as part of an arrangement with the U.S. Army Corps of Engineers and the state environmental agency. One of MDSHA's environmental monitors conceptualized and helped build MDSHA's EM Toolkit to help track and communicate their inspection work. The system was also designed to facilitate a very high degree of transparency with resource agencies; the Corps and the State Department of Environment can see the monitoring that is occurring and rapid remedial action, where necessary. The system has greatly elevated regulatory agencies' comfort level with MDSHA's responsiveness as well as the agency's seriousness about tracking environmental non-compliance. According to MDSHA's former environmental manager, resource agencies have often felt no need to get involved or have a site visit when problems occur; they can see for themselves, with a log and photos, what is occurring on-site and that MDSHA is handling what is needed. The Corps and the Maryland Department of Environment can pose questions or comments through the EM Toolkit, and the system allows SHA staff to respond promptly. SHA is considering providing access to other agencies, consultants, contractors, and other project stakeholders as needed and limited by project; however, the EM toolkit has not been extended to maintenance monitoring of environmental features.

3.3. Check/Review - Act

Continual improvement of the EAMS needs to be designed into the system and it has to be an ongoing effort. The nature of a systematic management approach is that the system not only provides structure and process for management, but the system itself has defined points where the overall system and each element are as needed and regularly reviewed to identify ways to improve.

To ACT, means to have processes in place to ensure that as required or desirable changes are identified, they are implemented. These improvements may require use of the Planning and Implementation elements of the system, or may change or add to those elements.

Another key part of improvement is how the EAMS identifies the externally driven change and overall how "management of change" is addressed. Change management should be a part of all good management processes at a DOT and the EAMS should start by using existing processes at the DOT.

Discuss Results with Decision-makers and Stakeholders and Refine the Plan

Discuss the results of the condition ratings with management and interested stakeholders. A comparison of the results with the desired condition is a check on how well the system is meeting the stated objectives. This assessment can help management identify deficiencies and gaps, and identify what adjustments may be needed to the program and ideas for further efficiencies. The plan is then refined to take the needed corrective actions. The information can also help determine the priorities for use of limited resources.

Evaluate the Process

Once the condition assessment system has been identified, it is necessary to assure the system is reliably duplicable, that raters will reliably produce the same rankings when they are looking at the same thing. This requires testing and remedial action both with regard to the test or ranking system and with the raters themselves.

Decide Additional Data to Incorporate in the System and Finalize Tools and Equipment and Integrated Functioning

Asset management systems include a substantial amount of additional data, besides the condition rating itself. DOTs must decide how classes of features are named, located, and characterized and what additional information might be helpful and desirable in interpreting records in the future. For example, GPS locations and digital photos can be very helpful. Pull down menus on PEN computers in the field help standardize responses and prevent errors in the database.

Identify Program Adjustments and Lessons Learned

As part of the system design, look for where in the system opportunities for improvement would be identified. Who and What are the sources of opportunities for improvement that can be anticipated in association with each element of the system that has been developed:

- Maintenance staff can identify ways to improve procedures and processes as they are often the most frequent users.
- Managers can note where intended results do not appear to be occurring.

As part of the EAMS there should be a regular review of the system, in order to assess if the system is achieving its goals.

For all areas where problems or areas of concern are identified, the root cause(s) of the problem need to be understood, so that when a corrective action is identified and implemented, the cause and not just the symptoms are remedied.

4. Conclusion

The objective of NCHRP 25-25/51 was to identify successful practices DOTs use to manage environmental assets post-construction. The methods used by industry leaders to track environmental assets, determine when an asset needs maintenance and how that information is transferred to the agency's maintenance management system for follow-through could provide a framework for developing an asset management strategy for other DOTs to adapt to their individual needs and establish their own management system.

Environmental asset management responsibilities may cross several divisions of the DOT, therefore, both environmental and maintenance managers from across the country were asked to provide information on the processes used within their own agency. Nearly 50% of the state DOTs responded to a check-box type electronic survey but far fewer responded to the more detailed survey or requests for telephone interviews. Of the DOTs that responded, there are a few that have developed relatively advanced systems although even the best systems have some shortcomings. Industry leaders in management of environmental assets include VDOT and WSDOT. WSDOT's automated Commitment Tracking System is intended to be comprehensive, enabling WSDOT personnel to track all environmental commitments of any kind in a single on-line database through design, construction, and maintenance. VDOT's Comprehensive Environmental Data and Reporting gives environmental staff a single, centralized data repository that is integrated with GIS databases, offers full integration with VDOT's project management system, and provides improved accountability, and improves the documentation and communication of environmental decisions and commitments.

Many DOTs only track environmental assets that have a legal nexus or where maintenance is necessary to protect the larger transportation infrastructure. Environmental specialists have a strong desire for and a vested interest in a long-term environmental asset management system. Not only is it important because of the amount of time and money that goes into designing and constructing many of the mitigation features, but in many cases their professional reputation with the resource agencies depends on how well the DOT maintains the asset so it continues to meet its intended purpose into perpetuity. However, most respondents said they simply do not have the resources to monitor or maintain environmental assets beyond construction and project closeout.

Most DOTs keep a list or lists of the environmental mitigation assets they own - either formally or informally. Lists can range from an individual specialist's institutional memory or paper trails that are easily lost with staff turnover, to somewhat more reliable Excel spread sheets, to the more sophisticated, centralized data bases that can be accessed by staff across the agency such as WSDOT's CTS and VDOT's CEDAR systems. Increasingly, DOTs are using GIS to track and retain a more permanent record of the location of environmental assets that can be quickly compared to planned maintenance activities to either avoid impacts or to schedule maintenance to coincide with other planned activities in the corridor.

Maintenance of culverts and permanent water quality management facilities along with control of invasive species in the DOT ROW and care of DOT installed landscaping is routine for most DOTs. Keeping culverts open and water quality features clean is a necessity to prevent flooding and protect the investments in roadways and bridges and reduce hazards to the traveling public. Maintenance of landscaping, once it is established, typically is limited to pruning or removal of vegetation to maintain driver sight distance.

Many respondents indicated the DOT had condition ratings and/or performance measures to trigger the need for maintenance. Once again, these were primarily related to culverts or permanent water quality features. Condition ratings and the trigger threshold for maintenance of these features is often done in accordance with the National Bridge Inspection Standards or a comparable rating system. Inspections are done as a matter of routine and provide information on the general condition of each structure as compared to the as-built condition. Typically, the rating system is a numerical system that ranges from zero (worst condition) to nine (as-built). A rating below a given number triggers immediate maintenance action. Permit requirements, e.g., for section 404 permits, were identified as condition ratings and/or performance measures for other assets. Once permit obligations are met and the resource agency has signed off, monitoring and maintenance of the asset often falls off the radar.

One of the more poignant findings of this study was the disconnect across the organization as to roles and responsibilities for tracking, monitoring and maintaining the various assets. Beyond the maintenance of culverts and control of invasive species, there was uncertainty about who was responsible for what. Those DOTs that have developed a centralized database system are able to overcome this issue because the responsibilities and schedules are included with the other project information and accessible to everyone.

A standardized process could help DOTs get a better handle on environmental asset management. The PLAN – DO – CHECK – REVIEW/ACT system described in Section 3 provides such a framework. The environmental asset management system is a cyclical ongoing process for continual improvement. To be effective, management support is necessary to make environmental asset management a priority, devote the necessary resources, and get staff buy-in.

The management system for environmental features should include the basic elements that are found in most management systems:

- A clearly defined overall goal/ policy for the system from which the system flows
- Driven by this overarching driver, clear definition of what the system is designed to manage, and the drivers that influence management (assets and factors that influence ranking of assets)
- Asset assessment and ranking of asset classes and individual assets
- Protocols and processes appropriate for managing classes of assets
- Defined management roles, responsibility and structure
- Communication processes
- Training
- Asset management activities
- Feedback on effectiveness of protocol and process activities
- Feedback on system elements
- Action to improve system and components

These elements are interrelated and necessary for the asset management system to be effective but it will take time and an investment of resources up front to realize the benefits for the long-term. Benefits from the implementation of such a system include protection of the DOT's investment in the environmental mitigation feature, reduced non-compliance violations, increased interagency

confidence that mitigation features will meet the intended purpose into perpetuity and make future agency clearances or permits easier to obtain, and meet the DOT's environmental stewardship objectives. Finally, management will have more accurate information on the most cost effective mitigation features when making decisions on future projects.

APPENDIX A

NCHRP 25-25(51) Surveys

Name and Title:

Agency:

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Permanent water quality management facilities (e.g. sediment basins)	☐	☐	☐	☐	☐	☐
Culvert maintenance	☐	☐	☐	☐	☐	☐
Fish passage remediation	☐	☐	☐	☐	☐	☐
Wetlands	☐	☐	☐	☐	☐	☐
Stream restoration	☐	☐	☐	☐	☐	☐
Wildlife crossing structures	☐	☐	☐	☐	☐	☐
Control of noxious weeds / invasive species infestations	☐	☐	☐	☐	☐	☐
Sensitive plant communities and animal habitat in ROW	☐	☐	☐	☐	☐	☐
Conservation areas, parklands, and/or forest	☐	☐	☐	☐	☐	☐
Landscaping	☐	☐	☐	☐	☐	☐
Cultural resources (e.g. markers, fishing access, etc)	☐	☐	☐	☐	☐	☐
Sound walls/noise barriers	☐	☐	☐	☐	☐	☐

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Bicycle/pedestrian trails	☐	☐	☐	☐	☐	☐
Erosion problem areas	☐	☐	☐	☐	☐	☐
No mow areas *Please list any others:*	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐

Dear SCOE member:

NCHRP 25-25(51) is examining **systems for managing environmental mitigation features after construction**. As a quick start (and perhaps a quick end), can you send me an email if your state **does have** a system or method for managing any of the following? (Condition assessments or sampling for maintenance management would count). Please indicate yes where applicable and a contact in your agency (environmental specialist/manager, Maintenance or Asset Management contact, position, email and phone number) for each "yes":

- Storm water management facilities
- Culvert fish passage and/or debris removal
- Wetlands/riparian
- Stream restoration
- Reforestation
- Historic bridges
- Cultural resources
- Sound walls
- Others
- Landscaping
- Parklands
- Bicycle/pedestrian trails
- Hazardous materials monitoring/control
- Control of invasive species
- Protection of endangered/threatened species habitat
- Wildlife crossing structures

If your agency has a unified method/system for tracking many of these categories, please indicate the method and contact for that.

Please contact us no later than November 15. Lack of a response will indicate that your agency does not have systems in any of these areas.

Even if you do not have practices to share, if you or others at your agency are interested in this topic area and staying abreast of discussion about environmental measures, thresholds, and asset management, please let me know. We may form email lists or other DOT discussion groups in the above sub-areas (by asset class as well as environmental asset management and performance measurement as whole areas) depending on interest.

Thank you for your assistance,

Marie Venner

For those who are interested in the data we will be collecting in this project (or who already know they will be participating and are willing to forward the following to the relevant people in their organizations), we have 20 questions in the attachment.

1. What **condition assessment and sampling** does your agency do for environmental assets managed by your DOT? Please describe the **function or condition measures that have been used for each mitigation feature/environmental asset**. Such condition measures often function as performance standards, with thresholds for action. **Please detail (or provide a copy of or link to) the standards or thresholds for action that** your agency uses to determine the need for maintenance of each type of asset/environmental mitigation feature.
2. **Is achievement of these standards part of your agency's goals or business planning**? Y/N. If yes, please describe. For example, MDSHA has a policy goal in their environmental strategic plan which calls for gradual achievement of functional adequacy for 95% of stormwater management facilities by 2010. Organizational goals are reflected in business plans down through all levels of the organization.

The following provides a general structure for information collection, if it is useful for you:

Features/Assets – High Level Categories	**Standards for Condition/Maint. for these are part of DOT Goals/ Business Planning**	**Performance Measures and Thresholds**	**Asset Management System or Practices**
Storm water management facilities			
Culverts – fish passage and/or debris removal			
Wetlands/riparian			
Stream restoration			
Reforestation			
Historic bridges			
Cultural resources			
Sound walls			
Landscaping			
Parklands			

Bicycle/pedestrian trails

Hazardous materials monitoring/control

Control of invasive species

Protection of endangered/threatened species habitat

Wildlife crossing structures

Other, please list…

We will develop a more inclusive list of resources and send out sample/compiled measures for each, to those who indicate an interest or want to be part of discussions on the pros and cons of different condition measures and asset management approaches.

3. Do you track any **other environmental assets or mitigation features**? If so, please add to the above.
4. Does your agency do **performance modeling for decision support re: maintenance or capital improvements** of environmental assets or mitigation features?
5. **What ideas or thoughts do you have about monitoring and reporting** on constructed or managed environmental mitigation features? Please note particular feasibility or practicability considerations you may have.
6. Please describe **feedback systems** in place for:

- **Corrective action** with regard to mitigation features (work identification and planning, setting periods for required action, work evaluation)
- **Adaptive management**
- **Continuous improvement**; i.e., ensuring larger processes/system improve as needed

7. **How is the above being implemented with regard to maintenance work that is contracted out**?
8. Are any **incentive systems in place for proper management of environmental assets/features**, either within your agency or with contractors (e.g., linkage to performance evaluation or rewards for attainment of certain standards).
9. **How do needs** for maintenance of environmental assets/mitigation features **enter the estimating and budgeting process**?

Please describe your system:

10. What **software** do you use?
11. Does your system offer/dynamically generate **maps or a geo-referenced display**?
12. How does that system (or those systems) **link to other databases and systems**?
13. Is there **linkage to a workflow management system**, such as a maintenance management system or an environmental workflow, permit, or commitment tracking system? Please describe.
14. **Who uses** the system?
15. Please comment on the **more subtle dynamics in your organization**, regarding how information is entered in the system and used or not.
16. Does your agency **report to other agencies on the condition of environmental assets or mitigation features**? If so, how does the system support this?
17. **What works well** with your system, in your opinion?
18. **What doesn't work well or tends to fall through the cracks**?
19. **How is your agency dealing with the lack of data** on many environmental/mitigation features? For example, DOTs and/or current DOT staff inherit many mitigation sites with no digital mapping. Recording may be in paper files in ROW offices (requiring digitization) or may be entirely inaccessible or unavailable. Often, mitigation sites that are past the 5 year monitoring period only appear in the ROW database and little information on environmental attributes/features may be attached, outside of easements or deed restrictions that must be conveyed if the property is sold. DOTs often report that assets past the initially agreed monitoring period are "not tracked as assets unless there is a problem."

How is your agency using asset management systems for environmental features to avoid/minimize the **loss of knowledge (and sometimes the loss of tracking of post-construction environmental commitments) with staff turnover**?

APPENDIX B

NCHRP 25-25(51) Contacts

Contacts that Provided Information for NCHRP 25-25 (51), Environmental Asset Management at DOTs

Alaska

Gary Eddy
Standard Specifications Engineer
gary.eddy@alaska.gov

California

Jay Norvelle
Chief, Division of Environmental Analysis
jay_norvell@dot.ca.gov

Andrea N. Williams, PMP
Senior Mitigation Coordinator & Wetlands Biologist
Division of Environmental Analysis
Biological Studies and Technical Assistance Office
andrea_williams@dot.ca.gov

Glen Moser
glenn_gmoser@dot.ca.gov

Colorado

Yates Opperman
Planning and Environmental
Francis.Oppermann@dot.state.co.us

Connecticut

Craig Babowicz
Transportation Engineer 3
Division of Infrastructure Performance Management
Bureau of Policy and Planning
Craig.Babowicz@po.state.ct.us

Florida

Tim Allen

Office of Maintenance

tim.allen@dot.state.fl.us

Georgia

Gail D'Avino

Office of Environment/Location

d'avino@dot.ga.gov

Iowa

Jim Rost

Director, Office of Location and Environment

Jim.Rost@dot.iowa.gov

Will Zitterich

Office of Maintenance

William.Zitterich@dot.iowa.gov

Indiana

Michelle Allen

Manager, Office of Environmental Services

mballen@indot.in.gov

Kansas

Scott Vogel,

Chief, Environmental Services

Vogel@ksdot.org

Maine

Matt Steele

Coordination & Permits Manager
Environmental Office
matt.steele@maine.gov

Maryland

Sonal Sanghavi, PE

Director, Office of Environmental Design

SSanghavi@sha.state.md.us

Minnesota

Jennie Ross

Chief, Environmental Assessment Unit Chief

Jennie.Ross@dot.state.mn.us

Bonnie Peterson

HYDINFRA Coordinator

Mn/DOT Bridge Hydraulics

bonnie.peterson@dot.state.mn.us

New Jersey

Janet Fittipaldi

Principal Environmental Specialist, Archeology

janet.fittipaldi@dot.state.nj.us

New Mexico

Steve Reed

Environmental Program Manager

Steve.reed@nmshtd.state.nm.us

New York

Kyle Williams

Environmental Analysis Bureau

KWILLIAMS@dot.state.ny.us

Scott Kappeller

Main Office Operations Environmental Coordinator

SKappeller@dot.state.ny.us

John Rowen
Main Office Operations Environmental Coordinator
jrowen@dot.state.ny.us

North Carolina
Greg Thorpe
Branch Manager
Project Development and Environment
gthorpe@ncdot.gov

Ohio
Tim Hill
Administrator
tim.hill@dot.state.oh.us

Oklahoma
Dawn Sullivan
Planning and Research Division Engineer
dsullivan@ODOT.ORG

Oregon
Ken Franklin
Environmental Quality Improvement Program Coordinator
Geo-Environmental Section, ODOT
Ken.FRANKLIN@odot.state.or.us

Utah
Rebecka Stromness, P.E.
Environmental Program Manager
Utah Department of Transportation
RSTROMNESS@UTAH.GOV

Paul West
Wildlife/Wetlands Biologist
paulwest@utah.gov

Tennessee

Greg Duncan
TDOT, Director of Maintenance
Greg.Duncan@state.tn.us

Virginia

Bob Kardian

Special Studies Manager

Bob.Kardian@VDOT.Virginia.gov

Washington DC

Faisal Hameed

Chief, Project Development & Environmental Branch

faisal.hameed@dc.gov

Washington State

Carol Lee G. Roalkvam

Policy Branch Manager

Environmental Services Office

Roalkvc@wsdot.wa.gov

APPENDIX C

Summary of Survey Responses

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Permanent water quality management facilities (e.g. sediment basins)	AK CA FL MD ME NC NJ OR VA WA	AK MD ME MN NC NJ OH OR VA	CA MD MN NC OH VA	CA FL MD NN NC VA WA	CA DC FL MD ME NC OH	CA FL MD ME MN NC NM OH WA
Percent of Respondents	43%	39%	26%	30%	30%	39%
Culvert maintenance	AK CA CT FL ME NC NJ NY OR VA WA	AK CA ME MN NY OH NC OR	AK CA CT FL ME MN OH VA	CA ME MN UT VA WA	DC FL ME OH UT VA	CA FL IN KS ME MN NJ NM OH UT VA
Percent of Respondents	48%	35%	35%	26%	26%	48%
Fish passage remediation	AK MD ME OR CA OH WA	AK ME OR CA	AK OR CA	ME CA	OR	AK ME OR CA
Percent of Respondents	30%	17%	13%	9%	4%	17%

1

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Wetlands	AK CA CT FL IN KS ME MN NC OH OR WA	AK CA IN ME MN NC OH OR UT WA	CT FL MN OR	CA CT KS ME MN NC NJ OR UT WA	CA FL MN OR UT	FL MN
Percent of Respondents	52%	43%	17%	43%	22%	9%
Stream restoration	AK IN KS ME NC OH WA	AK IN ME NC OR OH	ME NC OR	KS ME NC OR WA	ME CA	OR WA
Percent of Respondents	30%	26%	13%	22%	9%	9%
Wildlife crossing structures	AK CA CT FL IN KS ME OH	AK CA FL ME OH	FL ME OH UT	CA FL ME NY	FL ME OH	FL ME NJ NY OH UT
Percent of Respondents	35%	22%	17%	17%	13%	22%

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Control of noxious weeds / invasive species infestations	AK FL ME OH VA WA	AK CA ME MN NY	FL NJ ME	FL ME MN NY UT	FL ME UT VA	AK CA FL IN KS ME MN NM NY OR VA WA
Percent of Respondents	26%	22%	13%	22%	17%	52%
Sensitive plant communities and animal habitat in ROW	AK FL ME NC NM OH OR	AK CA FL ME NC	NC NJ OR	NC NJ OR	XX	AK CA FL IN OR VA
Percent of Respondents	30%	22%	13%	13%	0%	26%

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Conservation areas, parklands, and/or forest	AK ME NC OH	AK CA IN ME NC OR	XX	NC OH	XX	CA OR
Percent of Respondents	17%	28%	0%	9%	0%	9%
Landscaping	AK CA FL ME MN NC OH VA WA	AK MN	FL ME MN NC NJ VA	FL KS ME MN NC VA	FL ME NC VA	AK CA FL IN ME NC UT VA WA
Percent of Respondents	39%	9%	26%	26%	17%	39%
Cultural resources (e.g. markers, fishing access, etc)	AK IN KS ME OH	AK ME	ME	CA ME	ME	AK ME
Percent of Respondents	22%	9%	4%	9%	4%	9%

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Sound walls/noise barriers	AK CA CT FL IN KS ME MN OH OR VA	AK CA ME MN OH OR VA	FL OH	FL	FL ME OH	AK FL ME OH UT
Percent of Respondents	48%	30%	9%	4%	13%	22%
Bicycle/pedestrian trails	AK CA CT FL KS IN ME OH OR	AK ME OH OR	FL OH OR	OR	FL ME OH OR VA	AK CA FL OH UT
Percent of Respondents	39%	17%	13%	4%	22%	22%
Erosion problem areas	AK CA FL ME WA	AK	CA FL ME VA	CA ME NJ VA	CA FL ME OR VA	AK CA FL KS ME NM VA WA
	22%	4%	17%	17%	22%	35%

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
No mow areas	AK FL ME MN NC OH	AK CA NC	FL VA	NC NJ	FL ME VA	AK CA FL IN ME NC NM UT
Percent of Respondents	22%	13%	9%	9%	13%	35%
Please list any others:						
Safety Rest Area & Welcome Centers	VA	VA	VA	VA	VA	XX
Percent of Respondents	4%	4%	4%	4%	4%	0%
ESA Mitigation Sites	OR	OR	OR	OR	XX	OR
Percent of Respondents	4%	4%	4%	4%	0%	4%
Archeological Sites	OR	OR	OR	OR	XX	OR
Percent of Respondents	4%	4%	4%	4%	0%	4%
Dams	CT	XX	XX	XX	XX	XX
Percent of Respondents	4%	0%	0%	0%	0%	0%
Boat launches under DOT bridges	CT	XX	XX	XX	XX	XX
Percent of Respondents	4%	0%	0%	0%	0%	0%
Living Snow Fence		MN	MN	MN		0%
Percent of Respondents	0%	4%	4%	4%	0%	0%

6

Summary of Survey Responses

NCHRP 25-25 (51)
Environmental Asset Management at State DOTs

	Listing	GPS location	Condition Ratings	Regular surveys	Performance Measures for Asset Mgmt & Regular Maint.	Incorporated in DOT Maintenance Mgmt System
Structured Snow Fence		MN	MN	MN		
Percent of Respondents	0%	4%	4%	4%	0%	0%

XX - No respondents

APPENDIX D

New York DOT
Adopt-a-Nest Box Agreement

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
ADOPT - A - NEST BOX AGREEMENT

The New York State Department of Transportation, having offices at Region 4, 1530 Jefferson Rd., Rochester, NY, hereafter called the "Department" and the organization known as the following and using the mailing address of:

Hereafter called the Group, recognize the need for and desirability of preserving, protecting, and promoting native wildlife along State Highway R. O. W. as described in the Highway Work Permit, hereafter known as the segment, and are entering into this agreement to enable the Group to contribute toward the effort by monitoring and maintaining bird nest boxes along this segment. By signature below the Group acknowledges the hazardous nature of the activity and agrees to the following terms and conditions:

- No work of any nature will be performed on the pavement or shoulder of the traveled way.
- No participants' vehicles may be parked on the travel lanes or shoulders of a highway. Pull off onto a side road and walk when possible.
- The Group will organize and supervise all activities.
- The Group will organize and conduct a "safety briefing". All participants must attend the safety briefing before participating in the field activity. The Department will provide a representative to present the safety briefing for the first meeting and after that a designated person from the Group will conduct such briefings. The designated safety person's sole responsibility must be assuring the safety of the workers and the traveling public.
- Participants must wear department approved orange safety gear including orange shirts or vests and approved protective head gear. The Department will provide orange shirts or vests and head gear. The Group may provide to itself, approved Department safety gear. The Group will pick up supplies and materials from the Residency during normal working hours.
- The Group will obtain a Highway Work Permit from the Resident Engineer. The Department will waive the permit fee and each group participant (or parent or guardian if participant is 12 to 18 years old) will sign and date the "Acknowledgement of Statutory Limit on Liability" found in §14(29) of the Transportation Law, to be kept on file at the Residency for the duration of the Highway Work Permit.

The Department will publicize the execution of the Agreement and will highlight it at various periods thereafter.

This Agreement shall be for a five year period commencing on _____, and terminate at 12:01 a. m. on _____.

Notwithstanding any other provisions of this Agreement, if in the sole judgment of the Department, it is determined that the Group or organization is not meeting the terms and conditions of this Agreement, upon 30 days notice, or summarily if based upon unsafe activity, the Department may terminate this Agreement as otherwise provided herein, and take such other action as it deems appropriate.

The Department recognizes the Group as the adopting organization for the segment and the Group accepts the responsibility of monitoring the bird nest boxes and of promoting and enhancing native species in the community for the term of this Agreement.

The relationship of the Group to the Department arising out of this Agreement shall be that of an independent contractor. Any and all members or employees of the Group under this Agreement, shall be considered agents of the group, and all claims arising under the Worker's Compensation Law of the State of New York on behalf of said employees while so engaged, and any act or omission on the part of the Group employees while so engaged in any of the work or services provided or herein, shall be the sole obligation and responsibility of the Group. The Group shall secure Workers' Compensation Insurance, for the benefit of, and keep insured during the life of this Agreement, such employees engaged therein as are required to be insured by the provisions of the Workers' Compensation Law.

Attached hereto and made a part hereof is "Appendix A" Standard clauses for All New York State Contracts.

ACKNOWLEDGMENT OF STATUTORY LIMIT ON LIABILITY

THE UNDERSIGNED ACKNOWLEDGES AND UNDERSTANDS THAT TRANSPORTATION LAW §14(29) PROVIDES AS FOLLOWS;

"NOT WITHSTANDING ANY INCONSISTENT PROVISIONS OF LAW, THE STATE AND IT'S EMPLOYEES SHALL NOT BE LIABLE FOR DAMAGE SUFFERED BY ANY PERSON RESULTING FROM ACTIONS OR ACTIVITIES OF SUCH VOLUNTEERS OR GROUP."

REGION 4

ADOPT - A - NEST BOX

DATA SHEET

Group Name:_____

Address_____

1st Contact Person:

Name:_____

Address:_____

_____

Phone:

Home: _____

Work: _____

2nd Contact Person:

Name:_____

Address_____

_____

Phone:

Home _____

Work _____

Site Locations:(Include: Route number or highway name, nearest cross streets, milemarker numbers, and closest landmarks, if any.)

*See attached sheet*_____

_____

_____

_____

_____

_____Total Miles:_____

Number of group participants:

Date of Commitment:_____to_____

SAFETY CHECKLIST

- **NO HORSEPLAY**

- Wear orange shirts or vests and hardhats at all times.

- No vehicles should stop on roadways or roadway shoulder.

- Wear appropriate gloves and long pants on the job.

- No horseplay or other activity that will compromise either your safety or distract motorists.

- Avoid overexertion and make arrangements to provide drinking water in hot weather.

- When possible work with a partner, always tell someone you are going out to monitor and when you plan to be back.

- Ladders should be ANSI rated and in good working order.

Use common sense on safety issues. Report unsafe conditions to the Department.

[1] M. Markow and J. Racosky, Asset Management Implementation Plan and Tiered System Process, Colorado Department of Transportation Report No. CDOT-DTD-R-2001-13, p. vii. http://www.dot.state.co.us/Publications/PDFFiles/assetmanagement.pdf

[2] Personal communication/interviews with Bill Warncke, Mitigation Program Manager, Oregon DOT, January 27- February 5, 2009.

[3] http://www.icoet.net/ICOET_2007/proceedings/Chapter3a.pdf P 81

[4] Cambridge Systematics 2001, *Colorado Department of Transportation Asset Management Plan, p.* xvi.

[5] Cambridge Systematics 2001, *Colorado Department of Transportation Asset Management Plan, p.* xvi.

[6] Gail Achterman remarks at 2006 TRB Programming conference, *TRB Conference Proceedings 43: Key Issues in Transportation* Programming, published December 2008, p. 5. http://onlinepubs.trb.org/onlinepubs/conf/CP43.pdf.

[7]American Association of State Highway and Transportation Officials, "National Value Engineering Award," Newsletter, July 2003, (http://www.wsdot.wa.gov/eesc/design/ve/pdf/2003Innovative.pdf).

[8]. AASHTO, "National Value Engineering Award," http://www.wsdot.wa.gov/eesc/design/ve/pdf/2003Innovative.pdf.

[9] New Mexico DOT Research Update, State Fiscal Year 2006 – Environment, NM05ENV-02, Wetland Mitigation Tracking, http://www.nmshtd.state.nm.us/main.asp?secid=14832.

[10] Personal communication, Deborah Nelson, New York State DOT, February 13, 2009.

[11] Personal communication, Gregg Erickson, Caltrans Natural Resources Manager, December 9, 2008. These remarks were echoed by a number of other DOT environmental managers.

[12] Personal communication, Janet Fittipaldi, New Jersey DOT, Nov. 12, 2008.

[13] Personal communication, Yates Opperman, Colorado DOT, Dec. 15, 2008.

[14] *TRB Conference Proceedings 43: Key Issues in Transportation* Programming, published December 2008. http://onlinepubs.trb.org/onlinepubs/conf/CP43.pdf. p. 7.

[15] Wisconsin DOT, Transportation Research Summary, http://on.dot.wi.gov/wisdotresearch/database/tsrs/tsrenvironmentalmitigation.pdf

[16] M. Venner. "Measuring Environmental Performance at State Transportation Agencies," Transportation Research Record: Sustainability and Environmental Concerns in Transportation, National Academy of Sciences, Vol. 1859, 2003. pp. 9-18.

[17] Washington State Department of Transportation. Measures, Markers and Mileposts. The Gray Notebook for the quarter ending December 31, 2007. Accessed on Dec. 4, 2008. http://www.wsdot.wa.gov/NR/rdonlyres/10F993AB-A9FA-4686-A1CD-4BBAFF9D3F83/0/GrayNotebookDec07.pdf

[18] Personal communication, Craig Babowicz, Connecticut DOT, Dec. 9, 2008.

[19] Venner, 2006 & 2008, benchmarking studies on DOT electronic environmental commitment tracking systems.

[20] Wisconsin Transportation Center, Tracking Tool Literature Review, distributed February 20, 2009.

[21] Washington State Department of Transportation. Measures, Markers, and Mileposts. The Gray Notebook for the quarter ending December 31, 2007. Accessed on Dec. 12, 2008. http://www.wsdot.wa.gov/NR/rdonlyres/10F993AB-A9FA-4686-A1CD-4BBAFF9D3F83/0/GrayNotebookDec07.pdf#page=76

[22] Ibid.

[23] Caltrans. Maintenance Manual Volume 1, July 2006. Accessed at: http://www.dot.ca.gov/hq/maint/manual/maintman.htm

[24] Virginia Department of Transportation. Annual Report on the Condition of the Transportation Infrastructure and Initiatives to Improve Operations. Appropriation Act Item 444B. (Special Session I, 2006) Report to the Governor, General Assembly of Virginia, and the Commonwealth Transportation Board. Nov. 2007. Accessed at: http://www.virginiadot.org/projects/resources/StateoftheAssetsReportforVDOTwebsite.pdf

[25] Ohio Department of Transportation. Culvert Maintenance Manual. Dec. 2003. Accessed at: http://www.dot.state.oh.us/Divisions/HighwayOps/Structures/Hydraulic/Documents/CMM_12-2003[1].pdf

[26] Personal communication with Craig Babowicz. Dec. 12, 2008. Response to NCHRP 25-25-51 survey

[27] May 2008 VDOT Asset Management, Random Condition Assessment (RCA) Data Collection Manual

[28] Sprayberry, Mike, P.E. State Administrator for Maintenance Contracting. "Asset Management & Performance Based Maintenance " Florida Department of Transportation, Webinar – Florida Asset Management 1-30-2008. ppt presentation.

[29] Washington State DOT, Environmental GIS page, http://www.wsdot.wa.gov/Environment/GIS/default.htm, accessed March 12, 2009.

[30.] U.S. Government Accounting Office, "Managing for Results: EPA Faces Challenges in Developing Results-Oriented Performance Goals and Measures." *GAO/RCED-00-77* (April 2000).

[31] Erik Stokstad "Heinz Center Wants Feds to Build Ecosystem Indicator Partnership," *Science,* 20 June 2008: Vol. 320. no. 5883, p. 1575. Also see: http://www.heinzctr.org/ecosystems/

[32] Erik Stokstad "Heinz Center Wants Feds to Build Ecosystem Indicator Partnership," *Science,* 20 June 2008: Vol. 320. no. 5883, p. 1575. Also see: http://www.heinzctr.org/ecosystems/

[33] Gregg Erickson, Proceedings of the International Conference on Ecology and Transportation, 2007, p. 254. Also personal communication, Gregg Erickson, Caltrans Natural Resources Manager, December 9, 2008.

[34] Caltrans, Acceleration Guide, p. 52.

[35] Personal communication, Amy Kahn, New York Department of Transportation. Dec. 18, 2008.

[36]Personal communication with Scott Kappler, New York Department of Transportation. Dec. 12, 2008.

[37] Venner, 2006 & 2008, benchmarking studies on DOT electronic environmental commitment tracking systems.

[38] Personal communication, Gregg Erickson, Caltrans Natural Resources Manager, December 9, 2008.

[39] Joe Demko, "PennDOT's Roadside Spray Future with RoSA," Maintenance Management 2006: Presentations from the 11th AASHTO-TRB Maintenance Management Conference, pp. 57-66. http://onlinepubs.trb.org/onlinepubs/circulars/ec098.pdf

[40]. Personal communication, Leroy Irwin, FDOT Environmental Manager, April 2003.

[41]. Michael Barber, Shari Schaftlein, Dale Anderson, WSDOT, Stormwater Runoff Cost/Benefit Project Prioritizing Stormwater Outfalls, WA-RD 418.1, (1997) , 99 pp., NTIS publication number PB98-108962.

[42] McColeman, Mike P.E. Assistant Maintenance Administrator. Ohio Department of Transportation. "Defining Desired Outcomes." Ohio DOT Webinar January 2008 Maintenance Levels of Performance.ppt.

[43]. Lauzon, R.G. and Dewolf, J.T., "Connecticut's Bridge Monitoring Program: Making Important Connections Last." *TRB E-Newsletter*, Vol. 224 (January-February, 2003) 2 pp., http://gulliver.trb.org/publications/trnews/rpo/rpo.trn224.pdf.

[44]. Webb, A., and Ridder, N.M., "New Mexico University Designs High-Tech Beams to Monitor Bridge Soundness." *Miami Herald* (March 1, 2004) http://www.miami.com/mld/miamiherald/business/national/8087309.htm.

[45] Caltrans, Acceleration Guide, p. 38. Accessed at: http://www.dot.ca.gov/hq/oppd/projaccel/2008-Acceleration-Toolbox-Final.pdf

[46] Caltrans, Acceleration Guide, p. 52. Accessed at: http://www.dot.ca.gov/hq/oppd/projaccel/2008-Acceleration-Toolbox-Final.pdf

[47]Marie Venner, Maintenance Quality Management and Environmental Stewardship: Best Practices in Information Management and Decision Support, National Academies Transportation Research Record, Volume 1911, 2005, pp. 2-12.

[48]. Sitvers, M.L., Smith, K.L., Hoerner, T.E., and Romine, A.R., "Maintenance QA Implementation Manual." *NCHRP Report 422*, National Academy Press, Washington DC (1999) p. 9.

49. Jackson, S. L. The ISO 14001 Implementation Guide: Creating an Integrated Management System. John Wiley & Sons (February 1997).

[50] District of Columbia DOT Environmental Management System Plan, October 2008, p. 59.

[51] District of Columbia DOT Environmental Management System Plan, October 2008, p. 36.

[52] District of Columbia DOT Environmental Management System Plan, October 2008, p. 109.

[53] American Association of State Highway and Transportation Officials http://environment.transportation.org/environmental_issues/invasive_species/

[54] Caltrans Risk Management Handbook and Tools. May 2007. Accessed at: http://www.dot.ca.gov/hq/projmgmt/guidance_prmhb.htm

[55] Washington State DOT. Cost Risk Assessment website accessed at: http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/