NCHRP Project 25-25, Task 73

FY 2011

Research for the AASHTO

Standing Committee on the Environment

Improved Environmental Performance of Highway Maintenance

Final Report

APPENDICIES

Prepared for
AASHTO Standing Committee on the Environment

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Appendix A – Tables

DISCUSSION:

Table A-1: Range of Maintenance Activities

The range of activity categories typically performed by a state DOT maintenance and operations organization at the highest level have been identified and keyed to the AASHTO Maintenance Manual for Roadways & Bridges, 4th ed. The relationship and importance of these activities to the particulars of environmental stewardship and sustainability are presented in the matrix of activities, Table 1, Typical Maintenance Activities.

To facilitate the linkage between the listed Maintenance Manual activities and existing "best practice" methods, Table 1 goes on to reference these activities to the AASHTO Compendium of Best Stewardship Practices, Procedures and Policies for Highway Construction and Maintenance (AASHTO Compendium). With this as a base structure, the matrix is "built out" as information is derived from the survey results presented in Appendix 2. Further context for the Table A-1 maintenance activities, within the precepts of the Triple Bottom Line, is presented in Table A-2 below.

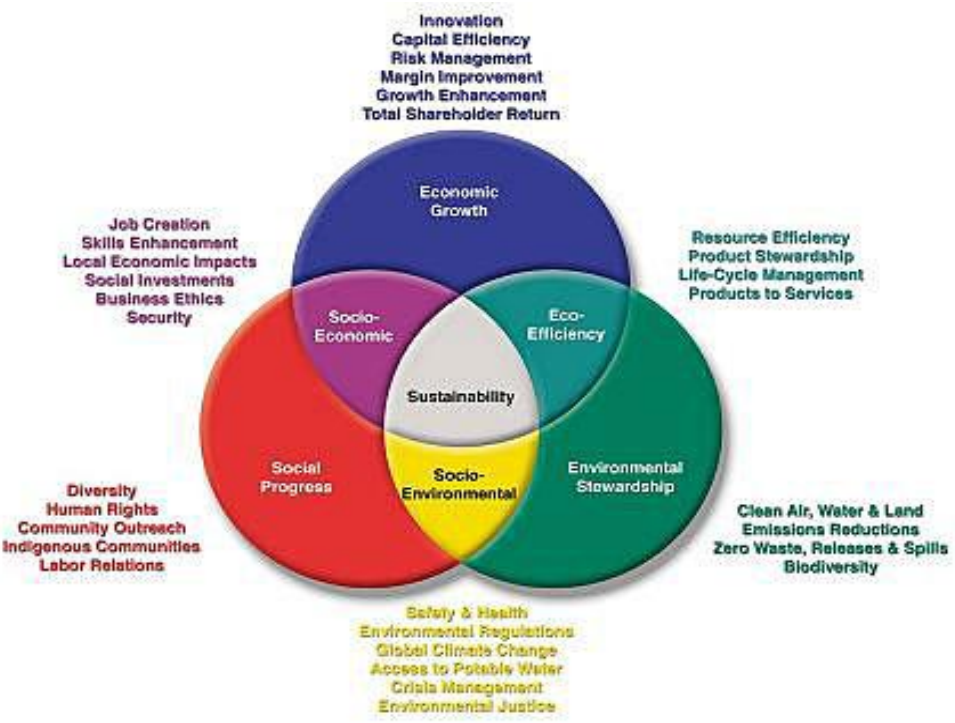
Specific Details Presented in Table A-1, Typical Maintenance Activities are:

- Column 1 (Activity), lists typical maintenance and operations activities.
- Column 2 (Examples of Selected Best Management Practices), offers a selected sampling of Best Management Practices (BMPs) that are often associated with Column 1 activities.
- Column 3 (Examples of Some Potential Environmental Offsets), lists a sampling of potential environmental impacts and benefits of Column 1 activities.
- Column 4 (**Examples of Probable Environmental, Social, and Economic Benefits**), lists examples of probable benefits by implementing the selected BMPS.
- Column 5 (AASHTO Maintenance Manual for Roadways and Bridges (Links)) provide links to the AASHTO Maintenance Manual for Roadways & Bridges, 4th ed. for ease of reference among DOT practitioners and subsequent development and sharing of guidance material.
- Column 6 (AASHTO Compendium (Links), provide links to the AASHTO Compendium of Environmental Stewardship Practices, Procedures, and Policies for Highway Construction and Maintenance (September 2004) for ease of reference among DOT practitioners and subsequent development and sharing of guidance material.

During the survey each DOT, or involved unit within the DOT (e.g., bridge, highway, environmental), was asked to review the list of activities and "check the corresponding box" if their organization is currently conducting training, auditing or assessing activities included on the list.

Table A-2: Examples of Triple Bottom Line Linkages

As discussed in the Task 73 request for proposals, a new framework is needed for integrating environmental performance and sustainability into the existing state highway maintenance systems. The Triple Bottom Line, as depicted in Table A-2, provides a qualitative assessment of how the activities listed in Table A-1 relate to the classic "triple bottom line" sustainability categories: environmental, economic, and social.. The following figure presents the triple bottom line concept as it relates to highway maintenance.



Graphic from: http://www.gcbl.org/economy

While not intended as a definitive statement on all of the impacts and benefits that might derive from a particular activity, Table 2 graphically illustrates examples of how these activities can generate environmental impacts/benefits and goes on to sketch out their possible economic and social implications as well so that the "framework" for these activities within the larger context of the Triple Bottom Line becomes clear.

- Column 1 (Maintenance Activities), lists typical maintenance and operations activities.
- Column 2 (Environment), includes sub columns for Air Resources, Water Resources, Noise Effects, Waste Reduction/Recycling, Wildlife Habitat, and Energy Conservation & Efficiency.
- Column 3, Social, includes the sub columns of Access, Safety, and Equity.
- Column 4, Economic, includes the sub columns of Costs, Jobs, and Mobility.

Boxes marked with a minus sign (-) in the Environmental columns indicate that these activities correlate with potential negative environmental impacts. Note that Table 1 identifies more specifically the types of impacts that might occur from these activities. Boxes marked with a plus sign (+) indicate that there is an opportunity for impact minimization, mitigation, or an opportunity for enhancement activities that in some cases could offset the potential impact(s). Some boxes will have both minus and plus signs. Understanding the environmental aspects and impacts of business activities is a first step in developing an environmental management system or program.

Boxes marked with an 'X' in the Social and Economic columns is intended to indicate that there is a potential major cost or benefit associated with that activity.

Observation:

Taken together, Tables A-1 & A-2 suggest:

- Maintenance activities affect a full range of environmental and other sustainability concerns
- The environmental benefits of preventative and preservation maintenance activities are clear. Preservation treatments slow the rate of deterioration, maximize the use of existing materials and infrastructure, reduce waste, and minimize footprint. Preservation treatments are cost-effective and provide social benefits with quality of life improvements. There are impacts and costs associated with those activities, however when conducted in accord with basic mitigation, net benefits outweigh the cost, which is why they are considered best practice
- Most of the activities listed can be mapped to the AASHTO Compendium, though several have no direct linkage
- Arraying the information in a comprehensive Triple Bottom Line fashion cannot only provide linkages to AASHTO Maintenance Manual activities, it can also identify gaps, and provide a structure for filling these gaps, as further information is developed in this and other, projects.

TABLE A-1 – TYPICAL MAINTENANCE ACTIVITIES

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Traveled Way		Energy usage in all cases plus impacts noted below		2.1.2 Maintenance of Roadway Surfaces	5.0 Pavement, Materials, and Recycling
Sweep and vacuum roads and bridges	Remove dust and sediments from roadways and bridges	Air and water pollution, waste generation	Reduce impacts to water from sediment loading; improve air quality		10.10 Sweeping and Vacuuming Roads, Decks, Water quality Facilities, and Bridge Scuppers
Maintain pavement markings	Restore pavement stripes and markings	Air pollution, waste generation, haz mat disposal	Improve traveler safety		5.5 Pavement Marking
Patch deteriorated pavements	Cold patch potholes	Waste generation	Extend the pavement life; reduce waste and energy consumption		
Seal cracks and joints	Clean and fill cracks and joints	Waste, noise, dust & odor generation	Extend the pavement life; reduce waste and energy consumption		

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Resurface pavements	Mill and reuse existing pavement	Noise and air pollution	Extend the pavement life; reduce waste and energy consumption and need for new materials		
Control snow and ice	Reduce salt and sand pollution	Air and water pollution, plant damage, and waste disposal	Improve traveler safety; reduce impacts to roadside plants and waterbodies	2.1.9 Snow and Ice Control	3.7 Designing To Reduce Snow, Ice and Chemical Accumulation
	Use sensor based information systems to improve timing of applications	(Reduced impacts using good planning)	Improve traveler safety; reduce impacts to roadside plants and waterbodies		8.0 Winter Operations and Salt, Sand, and Chemical Management
	Select materials based on performance, impacts, costs and site specific conditions	Water pollution, plant damage	Improve traveler safety; reduce impacts to roadside plants and waterbodies		8.1 Selecting Snow and Ice Control Materials to Mitigate Environmental Impacts
	Control run-off near wells	Water pollution, plant damage	Protect private and public water supplies; reduce impacts to roadside plants and waterbodies		

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Shoulders/Side Road				2.1.3 Shoulder Maintenance	
Clean shoulders	Sweep shoulders	Dust & waste generation	Improve highway surface runoff and traveler safety		10.10 Sweeping and Vacuuming
Repair/replace shoulder pavements	Seal, patch, or repave as necessary	Waste generation	Extend the pavement life; reduce waste and energy consumption		
Reseed and mulch grass shoulders	Re-grade and maintain low growing grasses for turf shoulders		Improve drainage and traveler safety		
Roadsides				2.1.5 Roadside Maintenance	3.9 Design For Sustainable, Low Maintenance Roadsides
Restore erosion controls	Install silt fence, mulch, re-seed	Water pollution, soil disturbance	Stabilize soils and reduce wind erosion and impacts to water from sediment loading		4.12 Soil Management in Construction
					10.12 Erosion and Sediment Control in Maintenance

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Maintain vegetation	Mowing and tree trimming	"Green" waste generation	Improve roadside drainage and clear zones and traveler sight distances		9.0 Roadside Vegetation Management
	Reduce mowing	Excessive use of energy and manpower	Minimize air pollution and fuel usage		9.5 Reduced Mowing Policies and Other Mechanical Vegetation Stewardship Practices
	Remove invasive species	Use of herbicides with impacts to non-target species	Protect native and indigenous species		
	Plant native species		Reduce maintenance costs and energy consumption		
Maintain guiderail	Control plant growth	Waste generation, use of herbicides	Improve traveler safety	2.1.6 Maintenance of Safety Features	
Maintain/Enhance cultural resources	Screen for A & H sites; install gateway signs and historic markers		Improve sense of place		3.3 Avoiding Impacts To Archeological and Historic Sites
	Provide/replace street furniture		Provide for pedestrian comfort and safety		

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
	Install signs to identify waterbodies and watersheds		Improve awareness of water resources		
Improve Public Access	Develop/maintain trailheads with parking		Improve public access and safety		
	Provide access to boat launches/fishing access		Improve public access and safety		
	Provide accessible pathways		Improve recreational opportunities	2.1.8 Special Pathways	
Develop/maintain Safety Rest Areas	Preserve existing landscape features, use water efficient fixtures, use green cleaning products	Waste generation, water pollution	Improve traveler safety and comfort		3.16 Safety Rest Areas, Traveler Services, and Parking Area Design
Drainage				2.1.4 Roadway Drainage Maintenance	3.8 Drainage Ditches, Berms, Dikes and Swales
Improve drainage facilities	Clean, re-shape ditches and swales	Water pollution, soil and habitat disturbance	Improve drainage, extend pavement life, protect waterbodies		10.11 Maintenance Stewardship Practices For Slopes, Drainage Ditches, Swales and Diversions

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Deal with beaver dams		Flooding, loss of embankment and pavement integrity, and impair traveler safety	Improve drainage, extend pavement life, protect waterbodies and improve traveler safety		
Reduce erosion and sedimentation	Install water quality inlets	Water pollution, soil and habitat disturbance	Stabilize soils and reduce impacts to nearby waterbodies and roadside habitats		3.7 Design Guidance for Stormwater and Erosion and Sedimentation Control
	Install/repair check dams	Water pollution, soil and habitat disturbance	Stabilize soils and reduce impacts to nearby waterbodies and roadside habitats		
	Immediately re-seed ditches after cleaning/re-shaping	Invasive species, unless seeding with natives	Stabilize soils and reduce impacts to nearby waterbodies and roadside habitats		
Reduce runoff/Improve infiltration	Install/maintain retention basins and bio-filtration swales	Water pollution, soil and habitat disturbance	Reduce impacts to nearby waterbodies, recharge groundwater and protect roadside habitats		

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Structures				3.1 Bridge Maintenance	7.0 Bridge Maintenance
Maintain deck surfaces			Extend the pavement life; reduce waste and energy consumption	3.1.3 Structural Decks	
Repair substructures	Install turbidity curtains to protect waterbodies	Water pollution	Extend the structure life; reduce waste and energy consumption	3.1.5 Substructure	
Protect watercourses and embankments	Install silt fence	Habitat disturbance	Reduce impacts to nearby waterbodies and protect watercourse habitats	3.1.6 Watercourse and Embankments	10.4 Maintenance Near Water bodies
Clean bridge bearings	Capture wash water	Water pollution	Reduce impacts to waterbodies and aquatic habitats		
Wash bridges	Capture wash water and debris	Water pollution, haz mat generation	Reduce impacts to waterbodies and aquatic habitats		

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Paint bridges	Capture paint chips and abrasives	Water & air pollution, odor generation	Extend the structure life; reduce waste and energy consumption, and reduce impacts to waterbodies and aquatic habitats	3.1.8.1 Lead-Based Paint Removal	7.3 Bridge Painting, Coating, Sealing and Containment Stewardship Practices
					10.15 Painting Operation Stormwater BMPs
Minimize habitat and stream impacts	Avoid spawning and migration periods, retrofit bridges for birds and bats	Habitat disturbance	Avoid and minimize habitat impacts and provide new nesting/roosting opportunities	3.1.8.2 Other Environmental Concerns	7.2 Avoiding and Minimizing Impacts to Fish and Wildlife and Enhancing Habitat
Clean culverts	Remove brush and debris at inlets and outlets; avoid depositing in wetlands	Water pollution, habitat impacts	Extend the structure life; reduce waste and energy consumption, and reduce impacts to waterbodies and aquatic habitats	2.1.4.2 Maintenance of Subsurface Drainage	10.6 Maintenance of Stormwater Facilities
Replace culverts	Install baffled culverts and jump pools for fish passage	Water pollution, habitat impacts	Improve fish habitat		3.5 Culverts and Fish Passage

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
	Design / retrofit culverts for targeted wildlife passage	Water pollution, habitat impacts	Improve wildlife passage		
Traffic Control and Service Facilities				2.1.10 Traffic Control Devices	
Maintain regulatory/informati on signs	Replace signs as needed		Improve public safety		
Maintain/install signals and street lighting	Use “dark sky” friendly fixtures and energy efficient luminaires		Reduce energy usage		3.14 Lighting Control/Minimization
Maintain safety rest areas	Select native vegetation to minimize water usage and maintenance		Improve aesthetics and minimize long-term vegetation maintenance		3.16 Safety Rest Areas, Travelers Services and Parking Area Design
Waste Management /Recycling					3.12 Design and Specification For Recycling
	Use compost to stabilize steep slopes; reuse and recycle waste materials and equipment		Reduce waste and energy consumption		10.13 Recycling in Roadside Maintenance and Operations

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Reduce waste	Reclaim broken/milled pavements	Dust and waste generation and energy usage	Reduce waste and energy consumption		5.7 Recycling in Pavement and Roadside Appurtenances
Re-use excavated/blasted materials	Re-use waste rock	Material waste and energy usage	Reduce waste and energy consumption		10.17 Stockpiling, Soil Disposal and Placement of Inert Fill
Recycle demolition materials	Recycle C&D Waste	Material waste and air & water pollution and energy usage	Reduce waste and energy consumption	3.1.8.3 Hauling and Disposal Regulations	
Dispose of hazardous wastes	Properly dispose of hazardous materials	Air & water pollution	Avoid or minimize air, water, and habitat impacts	3.1.8.4 Hazardous Wastes	
Store and use toxic materials	Have fuel spill kits onsite; properly dispose of used fluids, tires and batteries	Air & water pollution	Avoid or minimize air, water, and habitat impacts	3.1.8.10 Toxic Materials	4.10 Materials Storage, Collection, and Spill Prevention on Construction Sites
Control vehicle fluid spills and washwater	Refuel, wash and service vehicles away from watercourses	Air & water pollution	Avoid or minimize water, and habitat impacts		4.7 Vehicle Fluid, Fuel and Washwater Control

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Energy Conservation /Efficiency					3.15 Design For Sustainability and Energy Conservation
Conserve energy	Construct energy-efficient building envelopes	Energy Usage	Reduce waste and energy consumption		6.4 Energy Conservation
	Install energy-efficient appliances and equipment	Energy Usage	Reduce waste and energy consumption		
	Install energy-efficient lighting	Energy Usage	Reduce energy usage		
Improve energy efficiency	Purchase energy efficient vehicles	Energy Usage	Improve energy efficiency		
	Purchase energy efficient equipment	Energy Usage	Improve energy efficiency		
Other Environmental Aspects				2.1.13 Environmental Aspects of Roadway Maintenance	
Improve aesthetics and visual quality	Plant wildflowers		Improve roadside appearance		3.2 Context Sensitive Design/Solutions

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Maintain / enhance wildlife habitat	Use underpasses, culvert modifications, fencing, and eco-walls to facilitate wildlife movement		Minimize impacts to wildlife habitat		3.4 Habitat Connectivity and Wildlife Crossings
	Maintain culverts, bridges and fences to facilitate roosting and wildlife passage		Minimize impacts to wildlife habitat		10.5 Maintenance of Structures for Wildlife
Improve air quality	Reduce hydrocarbon emissions by tree shading parking areas	Air pollution	Improve air quality		3.11 Designing To Minimize Air Quality Problems
	Minimize vehicle idling; avoid material with high VOC emissions	Air pollution	Improve air quality and reduce energy usage		4.8 Air Quality Control Practices
	Regular vehicle maintenance and tune-ups; avoid open burning	Air pollution	Improve air quality and reduce energy usage		10.14 Preserving Air Quality in Maintenance Operations
Reduce noise impacts	Install noise barriers and berms	Noise pollution	Reduce noise impacts and improve quality of life		3.13 Designing To Minimize Noise

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
	Limit blasting charge size and velocity; use newer quieter equipment; limit hours of operation	Noise pollution	Reduce noise impacts and improve quality of life		4.9 Noise Minimization
Protect / enhance wetlands and streams	Minimize disturbance of stable stream channels; use bio-engineering to stabilize stream banks	Water pollution, soil and habitat disruption	Stabilize soils and reduce impacts to nearby waterbodies and stream habitats		3.6 Stream Restoration and Bio-engineering
	Delineate wetland boundaries; avoid use of herbicides in or near wetlands; eradicate invasive species	Wetland impacts and loss of wetland functions	Protect wetland values and functions		10.3 Maintenance in Wetlands

TABLE A-2 – EXAMPLES OF POSSIBLE TRIPLE BOTTOM LINE LINKAGES

(--) potential environmental impact (+) potential for minimization, mitigation or enhancement (X) potential for material cost or benefit

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	Water Resources	Noise Effects	Waste Reduction /Recycling	Wildlife Habitat	Energy Conservation & Efficiency	Access	Safety	Equity	Costs	Jobs	Mobility
Traveled Way												
Sweep and vacuum roads and bridges	--	+										
Maintain pavement markings	--							+				
Patch deteriorated pavements				+						x		
Seal cracks and joints				+						x		
Resurface pavements	--			+			x	x				x

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	Water Resources	Noise Effects	Waste Reduction /Recycling	Wildlife Habitat	Energy Conservation & Efficiency	Access	Safety	Equity	Costs	Jobs	Mobility
Control Snow and Ice	--	--			--		x	+		x	x	+
Shoulders/Side Road												
Clean shoulders	--							+				
Repair/replace shoulder pavements	--	--		--				+				
Re-seed and mulch grass shoulders		+			+							
Roadsides												
Restore erosion controls		+			+							
Maintain vegetation		+			--			x		x		
Maintain guiderail								x		x		
Maintain/Enhance cultural									+			x

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	**Water Resources**	**Noise Effects**	**Waste Reduction /Recycling**	**Wildlife Habitat**	**Energy Conservation & Efficiency**	**Access**	**Safety**	**Equity**	**Costs**	**Jobs**	**Mobility**
resources												
Improve Public Access							+		+	x		x
Develop/maintain Safety Rest Areas						+		+		x	x	+
Drainage												
Improve drainage facilities		-- /+						+				
Reduce erosion and sedimentation		-- /+										
Reduce runoff/Improve infiltration		+										
Structures												
Maintain deck surfaces	--			+				x		x		

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	Water Resources	Noise Effects	Waste Reduction /Recycling	Wildlife Habitat	Energy Conservation & Efficiency	Access	Safety	Equity	Costs	Jobs	Mobility
Repair substructures		--		+				x		x		
Protect watercourses and embankments		+			--/+							
Clean bridge bearings		--				+		x				
Wash bridges	--	--		+						X		
Paint bridges	--	--		+		+				x		
Minimize habitat and stream impacts		+			+							
Clean culverts		--/+			+					x		
Replace culverts					+	--				--		
Traffic Control and Service Facilities												

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	Water Resources	Noise Effects	Waste Reduction /Recycling	Wildlife Habitat	Energy Conservation & Efficiency	Access	Safety	Equity	Costs	Jobs	Mobility
Maintain regulatory & information signs								x				
Maintain/install signals and street lighting						+		x		x		
Maintain safety rest areas		--		+		+	x	x		x	x	
Waste Management/ Recycling												
Reduce waste				+		+				x		
Re-use excavated/blasted materials		--		+		+				x		
Recycle demolition materials	-- /+	-- /+		+		+				x		
Dispose of hazardous	--	--						x				

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	**Water Resources**	**Noise Effects**	**Waste Reduction /Recycling**	**Wildlife Habitat**	**Energy Conservation & Efficiency**	**Access**	**Safety**	**Equity**	**Costs**	**Jobs**	**Mobility**
wastes												
Store and use toxic materials	--	--						x				
Control vehicle fluid spills and wash water	--	--/+						x		x		
Energy Conservation /Efficiency												
Conserve energy						+				X		
Improve energy efficiency						+				X		
Other Environmental Aspects												
Improve aesthetics and visual quality									+			
Maintain					+							

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	Water Resources	Noise Effects	Waste Reduction /Recycling	Wildlife Habitat	Energy Conservation & Efficiency	Access	Safety	Equity	Costs	Jobs	Mobility
wildlife habitat												
Improve air quality	+							x	x	x		
Reduce noise impacts			+					x	x			
Protect wetlands and streams		+			+							

TABLE A-3 – MAINTENANCE TRAINING BY STATE

State	Training Programs	Focus	Participants, Frequency and Methods	Training Links
California - Caltrans				
	General Housekeeping Training	Staff receives training on the importance of General Housekeeping BMPs and their relation to overall environmental compliance. New environmental requirements are incorporated into Division of Maintenance policy and training, the materials for which are revised as needed.	Training is delivered to the Maintenance Division's 5,600 employees by various means, including external resources and Division of Maintenance staff. New mandates that require immediate compliance are presented in Tailgate Meetings and a Maintenance Bulletin is prepared to provide information to Maintenance field supervisors. Staff members are required to receive classroom or on-line training on various minimum intervals depending on the type of training. In addition, Tailgate training sessions are held every two weeks or whenever there is a change in work activity.	http://www.dot.ca.gov/hq/env/stormwater/_pdfs/maintain/m699.pdf http://www.dot.ca.gov/hq/env/

	Landscape Maintenance	Each employee is trained in the proper application methods for pesticide usage, understanding Labels, Materials Specification Data Sheet (MSDS), mixing, loading, storage, Personal Protective Equipment (PPE), and environmental concerns.	Supervisors have the responsibility to train employees on new pesticide products by reading and understanding the label, and MSDS prior to the employee using the product. During the annual pesticide training employee are taught to identify and help manage stewardship practices in their daily pesticide usage. Training consists of awareness of adjacent property owners, water ways, and environmental concerns.	http://www.dot.ca.gov/dist05/maint/ivm/index.htm
	Stormwater	Maintenance is having regular teleconferences. District stormwater supervisors come to centralized locations for bi-annual meetings; to be updated them on changes in procedures and guidance. This information is then communicated to Maintenance Field Supervisors.	Division of Maintenance policy is that Supervisors conduct stormwater BMP tailgate meetings a minimum of every 10 working days or when there is a change in the type of work activity. Stormwater BMP tailgate meetings are usually scheduled for one half hour. Stormwater Bulletins, Activity Cut-Sheets, and videos are available to assist in the tailgate meetings. Training attendance is tracked in the Division of Maintenance IMMS and the Department's LMS information systems.	http://www.dot.ca.gov/hq/construc/stormwater/ http://www.dot.ca.gov/hq/construc/stormwater/swppp_training.html
	Maintenance Leadership Academy (MLA)	Emphasize to maintenance managers, supervisors, and lead workers "the importance of our workforce." They discuss upward mobility training, employee input, how their jobs are important to the goals of the department. The training focuses on self-motivation and awareness of health impacts and minimizes discussion of regulations and punitive actions.		

Colorado DOT				
	Maintenance Academy	Review of CDOT environmental ethic and technical issues such as protecting water quality and truck spills	1,500 employees through its Maintenance Academy on an annual basis	
	Stormwater Best Management Practices Training Facility	How to properly install BMPs, with hands-on opportunities to install BMPs, such as hay bales, slope runoff protection, and silt fence in the field and evaluate their performance under simulated precipitation run-off conditions.	As scheduled, with day-long, hands on classes. CDOT Headquarters staff provides the training for field staff and non-CDOT employees and industry professionals.	http://www.coloradodot.info/programs/environmental/water-quality/bmp-training-facility
	Snow and Ice	New focus on mobility and tourism economy and importance of open roads.	New staff members receive a 40 hour course on snow and ice control. All staff members receive an 8 hour refresher on snow removal.	
Florida DOT				
	Herbicide	Training is provided for the herbicide program with continuing education credits provided to keep licenses active. FDOT's Drainage Manual is the primary way FDOT staff gets information on appropriate stormwater practices.	Annual training is given for the Maintenance Reporting Program	http://www.dot.state.fl.us/statemaintenanceoffice/MaintRatingProgram.shtm
Maryland DOT – State Highway Administration				

	MDOT provides mandatory environmental ethics training along with their customer service training and an annual highway maintenance seminar.	Environmental topics are on the agenda at their annual Highway Maintenance Seminar where some District maintenance shops are recognized for their EPA compliance. There is an annual Awards Day.	Annually to all employees. Because the seven Districts have different types of projects and highway environments they have different concerns. Annual NPDES Permit Report identifies ongoing environmental training.	http://www.mde.state.md.us/assets/document/SHA2008AnnualReview.pdf
	General Environmental Training	Town meetings are held in the maintenance shops where environmental issues such as control of invasive species are included on the agenda along with safety and other operational aspects.	Town meetings are held monthly.	
Michigan DOT				
	Limited environmental training is focused on what's needed for regulatory reporting.	At the present time, there is no formal stormwater training component; however, they anticipate addressing that need in 2012.	Most environmental training is done on the regional level. Region resource specialists, provide necessary outreach to the maintenance garage staff for stormwater and other environmental guidance as needed.	
Minnesota DOT				
	Snow and Ice Control	Big emphasis area.	Given to maintenance crews annually in pre-season winter training and road salt symposiums	http://www.dot.state.mn.us/maintenance/docs/MnDOTWinterAt-a-Glance.pdf

	Broad Environmental Training	Pesticide training and invasive species control; recycling, noxious weed control. Minimal direct training on drainage and ditch cleaning.	Maintenance crews	http://www.dot.state.mn.us/roadsides/vegetation/herbicide.html
New York State DOT				
	General Maintenance Training	Design/install living snow fence, stream restoration, hazardous trees, and herbicide use	Tailgate and field exercises	Maintenance Managers train the maintenance crews https://www.dot.ny.gov/programs/trns-maint-train
	Cross Training with Design and Construction staff and other agencies	Stormwater Management Erosion and Sediment Control Stream Restoration	As scheduled in various statewide sessions and locations involving NYSDOT Design, Construction, and Maintenance and other state and federal regulatory agencies.	
	Environmental and Landscape Architecture Training Series (ELATS)	Solicited ideas from Maintenance, Design and Construction	Open to all NYSDOT staff monthly every second Wednesday by statewide Webinar. Available on internal website and CD. There are about 130 participants in the Webinar. Training is provided by Main Office and Regional Environmental staff.	
North Carolina DOT				

	Stormwater and housekeeping training	Stormwater, road salt management, good housekeeping, and spill containment.	Given to lower level staff in the NCDOT facilities.	http://www.ncdot.gov/programs/srmu/ http://www.ncdot.gov/programs/srmu/videos/
Oregon DOT				
	Broad Environmental Training	ODOT policies, goals, and practices are discussed.	ODOT conducts full-day environmental training twice a year, in spring and fall. Managers and peers show PowerPoints and give "practicals" on how to keep appropriate records	http://www.oregon.gov/ODOT/HWY/OOM/CW.shtml
	Training for ODOT's Maintenance Environmental Management System	Activities within the maintenance yards.	District EMS Coordinators train maintenance managers, coordinators, and crew leaders, and the key person who does the monthly EMS paperwork.	
Washington State DOT				
	WSDOT uses their Academy to deliver most of their maintenance training. Every new hire is trained in their Academy.	Regulatory compliance, stormwater and watersheds, vegetation management, wetlands, fish passage, wildlife	WSDOT also has field books, manuals and notebooks in their trucks. Maintenance staff members are beginning to use new tools in the field, including personal data collectors. Compliance environmental staff works closely with maintenance staff in each of WSDOT's six regions.	WSDOT Environmental Training Programs: http://www.wsdot.wa.gov/Environment/EMS/ems_training.htm

	Integrated Vegetation Management (IVM) program	Weed control through intelligent, targeted/tailored programs that has dramatically reduced, mowing has been reduced, and roadside maintenance has become more sustainable.	Annual day and one-half Westside-Eastside Conference in the spring with continuing education credits that help maintenance staff retain their herbicide applicators' licenses.	http://www.wsdot.wa.gov/Maintenance/Roadside/vegetation.htm
	WSDOT is implementing a comprehensive Environmental Management Program (EMP) for Road Maintenance that includes a Regional Road Maintenance Program (RRMP).	The EMP also includes a Maintenance Violation Notification Process (as found in the WSDOT Environmental Procedures Manual), which constitutes an Environmental Compliance Assurance Procedure for maintenance.	WSDOT reports on progress in reducing violations annually in the Gray Notebook.	http://www.wsdot.wa.gov/Environment/EMS/ems_construction.htm#road

TABLE A-4 – MEASURING COMPLIANCE, STEWARDSHIP ACCOMPLISHMENTS AND METRICS

State	Program	Purposes	Audit/self-evaluation	Reporting Results
California -- Caltrans				
	Caltrans' Integrated Maintenance Management System (IMMS) provides the principal accountability mechanism for the Division of Maintenance.	The Division of Maintenance has an audit of both its activities conducted in the roadside environment and at yards and stations.	Environmental performance evaluations are conducted in accordance with: The Maintenance Activities Compliance Review Plan at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-05-999_99_2.pdf and the Maintenance Facilities Compliance Review Plan at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-05-999_99_3.pdf Each document contains the evaluation criteria.	The Division of Maintenance tracks its environmental compliance activities and generates the following databases annually which are summarized and reported annually to the State Water Resources Control Board and other regulatory agencies. • Erosion Inventory Database; • Storm Drain System Inventory Database ; • Illegal Connection/Illicit Discharge Database; • Pesticide Use Database; Maintenance Facility and Activity BMP Implementation Database; • Facilities Pollution Prevention Plans (FPPPs) Database;

State	Program	Purposes	Audit/self-evaluation	Reporting Results
				• Training Database; • Level of Service (LOS) - a performance based system designed to measure progress on departmental goals.
Colorado DOT				
	Maintenance Yard Audits	Oil use and management, fuel, aerosols, lighting, winter maintenance chemicals, drainage, and pesticides	Maintenance Yard Audits – once every 3 years	
Florida DOT				
	Asset Management Contracts	FDOT evaluates the performance outcomes of its asset maintenance contracts by undertaking quality assurance reviews of its roadways and reviewing required paperwork in its Maintenance Rating Program Handbook. Disincentives are included in maintenance contracts.	While compliance by contractors is not tracked on a statewide basis, violations are rare and when they do occur, they are used as a learning experience. Any violations are handled in the District offices. If FDOT is fined for a violation, FDOT seeks to recover the cost from the contractors who committed the violation	
	Maintenance Rating Program	FDOT's Maintenance Rating Program is a method of conducting a visual and mechanical evaluation of routine highway maintenance conditions. The purpose of this evaluation is	FDOT ensures condition assessments are conducted for roadsides, ditches, stormwater facilities, culverts, inlets, and cross-drains. With the new MS4 permit, FDOT is now trying to quantify how much debris they are picking up as well, and, by	Maintenance Rating Program: http://www.dot.state.fl.us/statemaintenanceoffice/MaintRatingP

State	Program	Purposes	Audit/self-evaluation	Reporting Results
		to provide information that should be used to schedule and prioritize routine maintenance activities and provide uniform maintenance conditions that meet established Departmental objectives.	extension, the prevention of nitrogen entering the aquatic system through runoff.	rogram.shtm
	MS4 and NPDES Permits	FDOT has regular meetings with the Florida Department of Environmental Protection relating to MS4 and NPDES permit inspection requirements.	FDOT has a process for randomly inspecting pipes subject to these permits and has discussed ways to target/reduce this work and increase overall efficiency in locating and addressing illicit connections to and discharges from the MS4 system.	
Maryland DOT – State Highway Administration				
	Environmental Management System (EMS) (in development)	In 2006, MDSHA decided to develop and fund an EMS effort for maintenance facilities, in order to Improve environmental performance, directly incorporate environmental requirements into daily operations and be held accountable for achieving environmental goals, ensure ongoing compliance, put programs in place to identify root causes for problems and ensure ongoing compliance, to avoid	As part of EMS implementation, MDSHA plans to bring all SHA buildings and maintenance facilities into compliance with environmental laws and regulations by 2015.	

State	Program	Purposes	Audit/self-evaluation	Reporting Results
		having to address (and pay for) the same issues again down the road. MDSHA also aimed to save money, reduce the risk of highly expensive cleanups and regulatory fines, train employees, and achieve/improve employee awareness of environmental issues and responsibilities. MDSHA also wanted to do the right thing and develop and implement the procedures and tools to help protect our environment. It is everyone's collective responsibility to ensure that our air, water, soil, and natural resources are protected for future generations.		
	Audits	MDOT developed a voluntary Self-Audit Program in cooperation with EPA region 3, a first in the nation to continually assess, correct and improve operational practices that may impact the environment. The self-audit program helps ensure MDOT's compliance with all applicable federal, state and local regulations.	MDOT ensures multi-media audits are performed at all 109 facilities and storage yards for all modes of transportation, including ports and aviation. These involve third party inspections and disclose the findings publicly. MDOT built their facilities and compliance EMS on the results of the audit, which was also used to justify increased capital and maintenance funding. Improvements at the facilities are ongoing, including those for salt storage facilities, communications towers, sign shops, moveable bridges and materials labs. Performance metrics built into the annual	

State	Program	Purposes	Audit/self-evaluation	Reporting Results
			inspections have led to a healthy competition between the shops to improve housekeeping and environmental compliance.	
	Business Plan Commitments	MDSHA has incorporated environmental performance metrics into agency business plans longer than any other state DOT. Environmental metrics were fully incorporated into the SHA's business processes a decade ago.	Metrics measured include: • Area spread of invasive plants in the rights-of-way (acres of Canada thistle reduced) • Wetland acres mitigated annually, toward goal of mitigation of historical impacts to tidal and non-tidal wetlands (by implication, improved water quality) • Sediment and erosion control ratings of B or better on 90% of construction projects annually (by implication, benefit or minimize impact to all resources) • Meet all environmental commitments (by implication, improve water quality) • Meet or exceed NPDES permit requirements • Implement methods to reduce the preparation and review time for environmental documents for proposed improvements along existing highways (regulatory streamlining)	http://www.marylandroads.com/oc/shabusinessetnl.pdf

State	Program	Purposes	Audit/self-evaluation	Reporting Results
	Annual Attainment Report On Transportation System Performance	Identify successes, strategies, and challenges for improving transportation services.	Performance Measures: • Acres of wetlands restored and miles of streams restored • Total fuel usage of the light fleet	http://www.mdot.maryland.gov/Office%20of%20Planning%20and%20Capital%20Programming/CTP/CTP_Documents/Final_CTP/2012_Attainment_Report.pdf
	Environmental Monitor Toolkit	MDOT was also the first DOT to provide other agencies access to the agency commitment tracking system.	The system has increased trust and confidence MDSHA and resource agencies; agencies are notified, and can see online how problems are being dealt with and resolved, within 24 hours of a problem being found by the monitors.	http://ram-corp.com/?option=com_content&view=article&id=97&Itemid=81
	Sustainable strategies	Maintain SHA highways and facilities in an environmentally sensitive manner	Being measured: • Number of acres of roadside planted/replanted in no/low maintenance groundcovers or native meadows. • Number of road salt management best practices pilot projects implemented each fiscal year. • Number of staff trained in each district each fiscal year for winter maintenance activities involving use of road salt. • Number of SHA operations and maintenance staff (sign, signal shops, labs and maintenance staff) receiving environmental	http://www.mdot.maryland.gov/Office%20of%20Planning%20and%20Capital%20Programming/Smart%20Green%20and%20Growing/LeadingByExample.html

State	Program	Purposes	Audit/self-evaluation	Reporting Results
			compliance training each fiscal yr. • Percentage of stormwater management facilities rated as functionally adequate each year. • Number of SHA buildings and maintenance facilities assessed annually. • Number of non-compliance findings for SHA buildings and maintenance facilities. • Number of SHA buildings and maintenance facilities with non-compliance findings. • Number of non-compliance findings addressed according to schedule for SHA buildings and maintenance facilities. • Percentage of targeted non-compliance findings addressed for SHA buildings and maintenance facilities. • Acres of Canada thistle identified in SHA right-of-way each year. • Acres of phragmites identified in SHA right-of-way each year. • Acres of Canada thistle treated each year. • Acres of phragmites treated each year. • Number of Partnership Planting projects completed each year.	

State	Program	Purposes	Audit/self-evaluation	Reporting Results
Michigan DOT				
	Environmental Compliance	Environmental compliance in maintenance is "pretty well accepted" by front line staff now as "something that needs to be done." The level of buy-in and enthusiasm does vary from office to office.	Standard operating procedures routinely address environmental compliance. MDOT posts a scorecard on their website; however, the only environmental measure they display is for increasing the number of alternatively fueled vehicles being added to the fleet.	
	Core Function Metrics	MDOT is in the process of developing actual metrics for recently evaluated core functions. While it is a work in progress, draft metrics may be available in mid-May 2012.	Performance metrics are intended to be measurable and become part of individual performance evaluations.	
Minnesota DOT				
	MnDOT has had difficulty identifying practical environmental performance measures in maintenance.	MnDOT's metrics on the maintenance side are toward the outcome basis of products and services.	The agency does use a number of indicators and tracks the following environmental aspects in maintenance: • MnDOT tracks salt usage and calibrates equipment both to save money on materials and control environmental impacts. • Measurement is occurring through the pesticide applicators log – track what, when, where spraying	

State	Program	Purposes	Audit/self-evaluation	Reporting Results
			occurs. MnDOT is using GPS to see where problem areas are located. Clear metrics are not currently in place for such issues as control of invasive species and drainage/water quality improvements.	
New York State DOT				
	Green-LITES (Leadership In Transportation and Environmental Sustainability)	Certification program to help integrate sustainability principles into transportation operations and maintenance	Self Evaluation using rating systems, spreadsheets, and other metrics	Maintenance/Operations Plan Spreadsheet https://www.dot.ny.gov/programs/greenlites/operations-cert
	Compliance with State Environmental Regulations	Assess Compliance with NYS DEC Regulations	Self Audit	Checklist used by NYSDOT staff and results of non-compliance reported to NYSDEC
North Carolina DOT				
	Maintenance Condition Assessment	Bi-annually assess environmental condition of sampled highway road sections	NCDOT reviews selected road segments on a two-year cycle of its 81,000 miles of highway for erosion and sediment control, vegetation control, and riparian buffer restoration and conduct inspections of structural water quality controls.	Whenever land-disturbing activities occur in projects, field inspection staff checks on erosion and sediment control practices and give a LOS rating or compliance score. NCDOT routinely inspects large reinforced concrete box culverts every 2 years, while smaller corrugated pipe culverts are not

State	Program	Purposes	Audit/self-evaluation	Reporting Results
				routinely inspected.
	Stormwater Pollution Prevention Plans	Comply with Clean Water Act and Safe Drinking Water Act requirements	There are 120 stormwater pollution prevention plans (SWPPP) in place at NCDOT facilities. They have well established BMPS, guidance manuals and training. They have an online SWPPP compliance reporting system so they can track compliance from a central location. They recently integrated spill prevention control system that can also be tracked online.	Central office managers can go to an internal online website to each facility and see where they are at in terms of compliance.
	Organizational Performance Dashboard	NCDOT compliance metrics are rolled up through the counties, the divisions, and to executive staff where it is shown to the public. NCDOT tracks internal corrective actions.	Includes the "Field Maintenance Projects Score" which is the average score for sediment and erosion control compliance for all projects and activities administered by field maintenance personnel.	http://www.ncdot.gov/download/performance/dashboarddetails.pdf
	Staff performance Reviews	Improve environmental compliance	Staff has had environmental metrics included in their performance reviews for the past 4 years. Staff can be rewarded for good compliance or given bad scores for compliance violations.	http://www.performancesolutions.nc.gov/motivationInitiatives/PerformanceMgmt/Resources/docs/Policies%20&%20forms/DOT%20Performance%20Management%20Policy.pdf
Oregon DOT				
	Maintenance Environmental Management System	Establish and maintain practices to prevent or reduce impacts to the environment. Encourage use	ODOT M&O metrics are based on the audits of the seven priority areas, which they conduct every three years for each of the	Audit and other forms may be

State	Program	Purposes	Audit/self-evaluation	Reporting Results
	(EMS)	of methods and materials that reduce burdens on the environment. Maintain emergency preparedness and response plans to safeguard the health and safety of Department employees.	103 maintenance yards. The audits focus on oil use and management, fuel, aerosols, lighting, winter maintenance chemicals, drainage, and pesticides.	found at: http://www.oregon.gov/ODOT/HWY/OOM/EMS.shtml
	ODOT Sustainability Plan, Volume 2	Sets goals, strategies and performance measures for ODOT's internal operations.	Environmental Stewardship Performance Measures: • Percentage of landscaping at all new facilities with native or non-invasive plants • Percentage of runoff being treated at major facility paved parking surfaces before being discharged into a stream or surface water body • Aggregate measure of number of maintenance yards in compliance with EMS • Amount of hazardous waste generated at each maintenance yard and truck shop each year • Total gallons of water used by a major facility • Percent of rest areas participating in water saving pilot initiative.	Annual Progress Reports describe some of the sustainable projects occurring at ODOT and progress the agency is making towards the goals outlined in the Sustainability Plan. http://www.oregon.gov/ODOT/SUS/docs/sustainability.progress_report_2011.pdf

State	Program	Purposes	Audit/self-evaluation	Reporting Results
Washington State DOT				
	Environmental Protection	Assess the condition and quality of implemented wetlands projects; track fish passage improvements and culvert barriers removed; track herbicide use reductions; track reductions in wildlife collisions.	Developed 240 individual measurable standards to provide "an observable or measurable bench-mark for a particular performance objective, against which wetland mitigation projects can be compared.	http://www.wsdot.wa.gov/environment/
	System-wide Inventories	WSDOT performs system-wide inventories and annual inspections, as part of WSDOT's Maintenance Accountability Process (MAP), which has been in place for a decade.	The MAP is a tool which measures and communicates the outcomes of the maintenance activities. It provides the tools to link strategic planning, the budget and maintenance service delivery. Once a year, field inspections are made of randomly selected sections of highway. The results of WSDOT's work are measured, recorded and compared to the MAP criteria to determine the level of service delivered. Activity Service Levels Targets are established for: • Drainage Maintenance and Slope Repair • Roadside and Vegetation Management WSDOT's NPDES stormwater permit requires inspection and maintenance of all BMPs annually. An inventory of all the catch basins is now being compiled and a tracking	WSDOT's Maintenance Performance Measures http://www.wsdot.wa.gov/Maintenance/Accountability/

State	Program	Purposes	Audit/self-evaluation	Reporting Results
			system put in place to monitor it. Within their IVM program, WSDOT tracks key locations on an annual cycle, evaluates completed work, and refines work plans.	
	The Gray Notebook	Quarterly document to provide the latest information on system performance and project delivery.	Performance measures focus on multi-modal system performance and include organizational performance reports for select topics such as project delivery and worker safety	Starting with the first report in May 2001, the agency has used the quarterly document to provide the latest information on system performance and project delivery. http://www.wsdot.wa.gov/accountability/GrayNotebook.pdf
	The Performance Dashboard	Show the alignment of WSDOT's performance measures with the six state transportation policy goals and the WSDOT strategic business plan, *Business Directions.* WSDOT has made the budget system responsive to the agency's maintenance objectives and responsibilities and has	Measured Annual Environmental Goals: • Conformance of WSDOT projects and programs with environmental legal requirements • Number of fish passage barriers fixed and miles of stream habitat opened up • Percent of WSDOT stormwater outfalls inventoried by 2014 • Conformance of WSDOT projects and programs with environmental legal requirements	The Performance Dashboard shows the current and previous performance mark for each measure, and indicates which way the program is trending, and why. http://www.wsdot.wa.gov/NR/rdonlyres/279F4319-7199-4FD9-88ED-

State	Program	Purposes	Audit/self-evaluation	Reporting Results
		successfully documented maintenance backlogs and the need to do more preventive maintenance.	• Number of vehicle miles traveled Compliance parameters have been important in establishing priorities and measurement related to environmental matters. Maintenance funding is accompanied by record-keeping requirements and accountability; compliance and progress are expected.	081AA47A4B84/0/GrayNotebook45Dashboard_Mar12.pdf

Table A-5 – Stewardship and Sustainability – Policies and Practices

State	Policies/ Programs	Purpose/ Understandings	Supporting Programs and Efforts	Technical Guidance and Links
Minnesota DOT				
	Stewardship Ethic	Maintenance staff have internalized stewardship concepts and believe in it ; more of a grassroots effort than top-down formalized policy	Maintenance staff members have incorporated environmental considerations into their regular work. MnDOT recently combined management directives and previous governor executive orders into one Executive Order, to refocus the agency's efforts. MnDOT has a new focus on sustainability, moving to alternative fuels, reducing carbon footprint, and trying to recycle more.	
	Sustainability	The concept of sustainability is mostly tied to environmental rather than engineering areas. The primary focus has been saving money and identifying where environmental benefits may be achieved in tandem.	MnDOT has a new focus on sustainability, moving to alternative fuels, reducing carbon footprint, and trying to recycle more.	Sustainability in Operations and Maintenance http://www.dot.state.mn.us/sustainability/OpsandMaint.html
Washington State DOT				
	Stewardship through compliance focus	Permit compliance has also been a big emphasis over the last decade. Permit compliance pressure from	WSDOT developed the ECAP – Environmental Compliance Assurance Procedures, which was	WSDOT Environmental Procedures Manual, Chapter 700

		external agencies caused WSDOT to develop systems to assure that project commitments and permit conditions were conveyed to maintenance and that the needed "follow through" occurred.	developed "to avoid environmental problems that could occur during highway maintenance activities and to understand the appropriate response measures to prevent violations". WSDOT environmental staff members work closely with maintenance staff to assure compliance with permit conditions and project commitments. WSDOT effectively used the state budget system, auditing processes, and their own accounting and reporting processes to document maintenance needs, the implications of delayed maintenance, and the funding and staff resources needed to take care of what they built.	"Maintenance and Operations" at: http://www.wsdot.wa.gov/publications/manuals/fulltext/M31-11/700.pdf WSDOT Environmental Procedures Manual, Chapter 790 "Implementing Environmental Commitments" at: http://www.wsdot.wa.gov/NR/rdonlyres/4F8AE3D2-5619-48CA-8063-5D1F6802A4ED/0/MaintenanceECAP.pdf
	Washington State (Chapter 516, Laws of 2007)	Established five policy goals for transportation agencies, including environment - To enhance Washington's quality of life through transportation investments that promote energy conservation, enhance healthy communities, and protect the environment.	WSDOT is developing the necessary business direction plans through the agency's strategic planning process.	
	Pending Executive order on Sustainability	Begin to build awareness, not to define specific outcomes.	A working committee of WSDOT program directors in five areas is involved in the process and is	Drafts in progress.

			working on educating on sustainability and creating awareness of sustainable practice and organizational expectations, throughout the department.	
Oregon DOT				
	Environmental Leadership in Programmatic Agreements	The Water Quality and Habitat Guide Best Management Practices for Routine Road Maintenance is an agreement with National Marine Fisheries Service exempting ODOT from the take prohibition on salmonids if ODOT implements BMPs outlined there. This 4(d) exemption for the DOT's maintenance work is intended to comply with the federal Endangered Species Act (ESA). The 4(d) or "Blue Book" was one of the ODOTs' first programmatic approaches, instituting a standard of practice across maintenance.	Updated every five years, the latest version dated 2009.	Water Quality and Habitat Guide Best Management Practices 2009 (Blue Book): http://www.oregon.gov/ODOT/HWY/OOM/docs/blue_book.pdf
	Environmental Management and Operations of Maintenance Compounds	Focuses on BMPs for the storage, handling and use of maintenance liquids and materials and identifying and implementing recycling options, increasing the use of recycled materials, and expanding the use of alternative products.	An audit is conducted on a three-year cycle for each of the 103 maintenance yards. Corrective actions are identified, prioritized and undertaken.	ODOT EMS Policy Statement and *ODOT Maintenance Yards EMS Policy and Procedures Manual 2009,* found at: http://www.oregon.gov/ODOT/HWY/OOM/emsdoc/policy.pdf

	Sustainability Plan	Goal 4 of the Oregon Transportation Plan is *Sustainability* and calls for providing a transportation system that meets present needs without compromising the ability of future generations to meet their needs, distributes benefits and burdens fairly, and is operated, maintained and improved to be sensitive to both the natural and built environments.	ODOT has incorporated sustainability and environmental stewardship goals for maintenance in the larger agency Plan. One goal calls for a formal Maintenance Yard Environmental Management System (EMS) in and is described in Volume 2 of the ODOT Sustainability Plan.	ODOT Sustainability Plan: http://www.oregon.gov/ODOT/SUS/Pages/sustainability_plans.aspx ODOT Sustainability Plan Volume 2: http://www.oregon.gov/ODOT/SUS/docs/sustainability_vol2_fin.pdf
North Carolina DOT				
	Environmental Stewardship Policy	NCDOT's transportation system is charged with enhancing the state's "well being" and supporting "the development of sustainable, vibrant communities" while "preserving and enhancing our natural and cultural resources."	NCDOT has a strong environmental compliance program rooted in its state water quality program and Integrated Vegetation Management for roadsides, backed up by strong training and state of the art procedures for these topic areas.	http://www.ncdot.gov/programs/environment/download/environmental_policy.pdf
	Sustainability Blueprint (Draft)	Focuses on a broad look at sustainability and includes a set of key principles and objectives. Will institutionalize sustainable principles and practices throughout all phases and functions of NCDOT, including planning, project/program development,	NCDOT is trying to determine what the right performance metrics should be. NCDOT is working with the Center for Transportation and the Environment (CTE) and has not yet formally rolled out the blueprint to staff.	Link to CTE site: http://www.itre.ncsu.edu/cte/Projects/sustainability-blueprint.asp

		project delivery, and internal operations.		
Florida DOT				
	FDOT is guided by its Environmental Policy.	Policy references transportation services and goods while encouraging environmental stewardship to protect the human and natural environment.	FDOT's mission is defined in statute and is also a state constitutional provision.	
	Maintenance work largely contracted out.	About 83% of FDOT's maintenance work is already contracted out, making the agency a national leader in maintenance contracting and performance-based contracting. Further, future reductions of in-house crews are anticipated as FDOT moves toward a goal of maintenance work that is 90% outsourced.	FDOT expects their contractors to be knowledgeable of state and federal environmental regulations. Contractors are expected to comply with all environmental policies and regulations, and FDOT has instituted a system of performance deductions if contractors do not comply.	
	Partnerships and External Networking	FDOT is well-integrated into a statewide network of external environmental land managers that are actively coordinating and eradicating invasive plants and animals throughout the state. FDOT is participating in a number of research projects.	While FDOT does not have partnerships with NGOs to put out bird boxes or similar habitat enhancement activities in the right-of-way, some Districts have aggressive programs to control invasive plants and animals. One research project involves the University of Florida to assess highway related mowing practices to determine how mowing cycles affect bees, important as agricultural insect	

			pollinators. Stormwater research involves runoff re-use, erosion and sediment control best management practices, as well as floating island technology for stormwater ponds.	
Maryland DOT – State Highway Administration				
	Environmental Policy	MDOT believes that environmental protection and principles of sustainability should be integrated into the Headquarters Facility's everyday business activities and operations. MDOT will manage the facility in a manner that protects the environment and the safety of our employees.	MDOT goes beyond compliance to emphasize pollution prevention, energy reduction, environmental restoration on land (reforestation, replacement of historical wetlands) and in the Bay), continuous improvement (agency EMS development), implementation of cutting edge tracking and accountability systems, training and celebration of accomplishments.	MDOT Environmental Policy at: http://www.mdot.maryland.gov/Office%20of%20Environmental%20Programs/EnvironmentalPolicy.html
	Environmental Management System (EMS)	Self-audit program and centralized support for the administration of long-term environmental compliance and stewardship goals.		
Caltrans				
	Environmental Performance Policies	Policies for delivering environmental performance are defined in the Department's Environmental Handbook.		Environmental Handbook at: http://www.dot.ca.gov/ser/vol1/vol1.htm.

	Official environmental policy and regulatory compliance mandates	The Maintenance Manual defines official environmental policy and regulatory compliance mandates including NPDES (Stormwater), RCRA (Hazardous Waste) and Integrated Vegetation Management. Maintenance Manual at: http://www.dot.ca.gov/hq/maint/manual/maintman.htm	The Maintenance Manual also refers to appropriate Plans, Handbooks, Guides and Policy Directives which further delineate compliance responsibilities.	Caltrans' Maintenance Division has a wide variety of environmental guidance documents and Tailgate Meeting resources available to share with other DOTs, including: ▪ Maintenance Hazardous Waste Manual ▪ Statewide NPDES Permit ▪ Stormwater Quality Handbook-Maintenance Staff Guide ▪ Structural Treatment BMP Guidebook ▪ Maintenance Bulletins ▪ Maintenance BMPs Video Training Modules ▪ Maintenance Facility Compliance Review Plan ▪ Maintenance Activity Compliance Review Plan ▪ Roadway, Sweeper and Decanting Waste Storage and Disposal Sites Compliance Certification Guidance and Scheduling Document ▪ Litter Abatement Plan ▪ Division of Maintenance website location dedicated to stormwater and environmental compliance containing reference and training materials
Michigan DOT				

	Interagency Partnerships	MDOT and regulatory agencies developed a Memorandum of Agreement setting up an interagency committee to address and work on environmental issues. The primary focus is permitting and the capital program.	MDOT provides funding for staff at regulatory agencies to do permitting, increasing the capacity for environmental reviews, and has refined partnerships in other areas, such as joint resource mapping and mitigation/enhancement siting.	
	Sustainability	MDOT does not have a formal sustainability policy, although "Sustainability" is a good word at MDOT.	Improving mobility, minimizing delays, reducing greenhouse gas emissions are driving their decisions. They are focusing on what needs to be done for the economic benefit of the state.	
New York DOT				
	Environmental Initiative (1999)	Purposes: 1) advance State environmental policies and objectives; 2) promote an environmental ethic throughout the Department; and 3) strengthen relationships with environmental agencies and groups.	Extensive policy and procedures guidance was developed. Each Region developed specific work plans on how they would institute the Environmental Initiative. NYSDOT created dedicated environmental positions in design, construction, and maintenance in the 11 Regions	Environmental Initiative Statement https://www.dot.ny.gov/divisions/engineering/environmental-analysis/environmental-initiative/environmental-initiative-statement *Environmental Procedures Manual* (EPM) https://www.dot.ny.gov/divisions/engineering/environmental-analysis/manuals-and-guidance/epm

				Guidelines for the Adirondack Park (Green Book) https://www.dot.ny.gov/divisions/engineering/environmental-analysis/repository/CH_as_PRINTED.pdf *The Environmental Handbook for Transportation Operations* https://www.dot.ny.gov/divisions/engineering/environmental-analysis/repository/oprhbook.pdf
	Green and Blue Highways Initiative (2005)	Integrate environmental stewardship and context-sensitive solutions in its planning, design, construction and operations	Region Maintenance and Residencies annually undertake many spot improvements to improve the environment	*Annual Green and Blue Highways Reports* https://www.dot.ny.gov/divisions/operating/oom/transportation-maintenance/green-blue-highways https://www.dot.ny.gov/programs/greenlites/repository/Green%20and%20Blue%20Highways%20Report%20for%202008-9%20and%202009-10.pdf

	Sustainability Policy (2010)	Integrate sustainability into the Department's decisions and practices in planning, designing, constructing, maintaining and operating New York State's transportation system	Green-LITES Operations (Leadership In Transportation and Environmental Sustainability) (2009)	*GreenLITES Operations Certification Program* https://www.dot.ny.gov/programs/greenlites/sustainability
	Stewardship Partnerships	Work with other stakeholders to address regional and statewide environmental issues, including invasive species, deer management and watershed management.	NYSDOT is partnering with other state agencies, resource managers, non-governmental organizations, industry, resource users, citizens and stakeholders to combat invasive species, including the emerald ash borer. Invasive species are managed statewide through eight Partnerships for Invasive Species Management (PRISM) managed by NYS DEC. Maintenance staff members participate on the deer management citizen task forces to represent DOTs concerns. NYSDOT maintenance forces also participate on statewide watershed management groups.	Partnerships for Invasive Species Management (PRISM): http://www.dec.ny.gov/animals/47433.html
Colorado DOT				
	Environmental	Clarifies responsibilities and recognizes the need for good		*Environmental Stewardship Guide (2003)*

	Stewardship Guide	environmental practices in maintenance.		http://www.coloradodot.info/programs/environmental/resources/guidance-standards/esguide5-12-05prepress.pdf/view
	Environmental Ethic (2007)	Support and enhance efforts to protect the environment and quality of life for all of Colorado's citizens in the pursuit of providing the best transportation systems and services possible.		
	Statewide Transportation Operating Principles – Policy Directive 13(2008)	Support and enhance efforts to protect the environment and quality of life for all its citizens in the pursuit of providing the best transportation systems and services possible		2009 Operating Principles http://www.coloradodot.info/programs/statewide-planning/documents/Transportation%20Commission%20Planning%20Policies.pdf
	Sustainability Transportation Environmental Resource Council (TERC) (200	A forum in which to discuss state transportation decisions and plan for environmental stewardship and sustainability	The TERC Sustainability Subcommittee (TSSC) was tasked with developing a common language and framework within the realm of sustainability statewide.	

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Research for the AASHTO

Standing Committee on the Environment

Improved Environmental Performance of Highway Maintenance

Appendix B - Survey Questionnaire

SURVEY QUESTIONNAIRE - SEPTEMBER 23, 2011

The purpose of this survey is to help determine the current training, auditing, and evaluation/measurement efforts being undertaken at state Departments of Transportation as part of institutionalizing environmental sensitivity, stewardship, and sustainability in maintenance and operations activities.

*Please supplement this survey by completing the self-assessment found in the last three columns of **Table 1 – Typical Maintenance Activities** and provide a copy of the completed table along with your answers to this questionnaire and copies of training, auditing, or measurement resources your agency may have. This will help us to better understand the specific activities for which you provide training, auditing or measuring for environmental performance.*

Training

1. Does your state DOT provide specific environmental training for maintenance and operations? (Yes/No)

2. If yes to Q1, is the training provided by:

   a) DOT staff? (Yes/No)

   b) Other state and federal regulatory/resource agencies? (Yes/No)

   c) NGOs or independent consultants? (Yes/No)

3. Does your state DOT have specific training manuals or other internal guidance documents that are provided to maintenance staff for their use? (Yes/No)

4. If yes to Q3, are guidance materials readily available at the maintenance shops or in the trucks for use by the maintenance field staff? (Yes/No)

5. Does your state DOT have formal written policies prepared by management that promotes or requires maintenance staff to perform their work in ways that encourage environmental sensitivity, stewardship, and/or sustainability? (Yes/No)

6. In general, do maintenance and operations staffs see environmental stewardship as something “extra” to do rather than being an integral consideration in every activity? (Yes/No)

7. In general, do maintenance and operations staffs understand the potential environmental impacts and/or ecological value (benefits) of their work activities? (Yes/No)

8. Does senior DOT management provide encouragement at staff meetings, training sessions, or conferences that encourage or reinforce the importance of an environmental or stewardship ethic? (Yes/No)

9. In what areas do you believe additional environmental training is required? Please list:

10. Are monies and time specifically budgeted for environmental training at your DOT? (Yes/No)

Auditing

1. Does your DOT conduct internal audits of your maintenance programs or activities for conformance with your DOT environmental policies and guidance (Yes/No) or state and federal regulatory requirements? (Yes/No)

2. If yes to Q1, are the results of the audits specifically shared with maintenance and operations managers (Yes/No) or their staffs (Yes/No) so that they can improve future performance?

3. Does your state DOT participate in external audits performed by regulatory agencies? (Yes/No)

4. If yes, please list the involved agencies and the types of audits performed:

5. Are follow-up actions undertaken to see if any deficiencies identified in the audits were corrected? (Yes/No)

6. Were internal DOT policies, guidance documents or training materials modified to address the cause and prevention of the deficiencies? (Yes/No)

7. In what program or activity areas do you believe audits would be useful to your DOT to assess environmental compliance or sustainability? Please list and describe:

Measuring – What gets measured, gets done

1. Does your DOT have any specific written benchmarks or goals related to improving environmental performance or stewardship? (Yes/No)

2. Does your DOT have any specific measurement tools or metrics to assess efforts to improve environmental conformance with state and federal regulatory requirements? (Yes/No)

3. Does your DOT have environmental management systems (EMS) for your facilities? (Yes/No)

4. If yes to Q5, describe any measurable goals for your facilities including, but not limited to, such actions as energy conservation, energy efficiency, waste reduction, spill containment, handling of hazardous wastes, recycling, and use of "green: cleaning products:

5. Does your DOT have asset management tools that focus on environmental costs and benefits of improvements to pavements, roadsides, drainage, lighting, signing and other traffic control facilities? (Yes/No)

6. Does your DOT allocate funds for voluntary environmental betterments? (Yes/No) Note: This might include specific habitat improvement projects (e.g., bat houses on bridges, wildlife underpasses, culvert retrofits for fish passage); construction of safety rest areas, trailhead parking, boat launches, and handicapped fishing access; watershed and invasive species signing, wildflower and other landscape plantings; bicycle lanes; and other context sensitive design projects.

7. If yes to Q8, list and describe the environmental betterment projects that your department is involved in and how accomplishments are tracked and measured:

8. Is there any component in group or individual performance evaluations that relate to improving the environmental performance of the DOT? (Yes/No)

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Appendix C – Case Studies

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Case Studies:

After panel approval of the final survey questions, the research team designed an electronic survey, sent a questionnaire link to all 50 states and was able to secure responses from almost two thirds of the states. Highlights from these responses are included in Appendix 2 of this report. The survey was intended to help determine the current training, auditing, and evaluation/measurement efforts being undertaken at state DOTs on environmental sensitivity, stewardship, and sustainability across the full range of maintenance and operations activities.

Ten state DOTs from across the country (at least two from each AASHTO region) were kind enough to relate their experience in improving environmental performance and tracking progress. Materials and documents were reviewed and interviews conducted to get "the back story" from these leading organizations.

The set of case study participants included states that have been developing their programs for more than a decade, and as well as more recent practitioners. Each demonstrated successes in some aspect of evaluation and training for sustainability, environmental stewardship, and / or environmental compliance in highway maintenance. Final interview states were chosen from the initially recommended set (based on geography and known work) to highlight environmental efforts in maintenance that were noteworthy in various respects.

These states are listed below and unless otherwise noted, any quotes cited from these states were taken from the primary interviews that occurred on the following dates, with the parties noted in the case studies:

- California DOT (Caltrans) – March 19, 2012
- Colorado DOT (CDOT) – April 13, 2012
- Florida DOT (FDOT) – March 6, 2012
- Maryland DOT (MDOT) and State Highway Administration (SHA) – March 7, 2012
- Michigan DOT (MDOT) – April 9, 2012
- Minnesota DOT (MnDOT) – February 15, 2012
- New York State DOT (NYSDOT) – April 11, 2012
- North Carolina DOT (NCDOT) – February 29, 2012
- Oregon DOT (ODT) – February 22, 2012
- Washington State DOT (WSDOT) – February 21, 2012

Interviews were performed with both environmental / sustainability program and maintenance managers and three members of the research team were in attendance at each. The research team chose to visit many of these states in person, and also added states beyond the proposed eight to increase comprehensiveness. This portion of the project looked for reference materials

and studied reasons why the maintenance and environmental leaders at these state DOTs considered their different program elements a success as well as why they had shortcomings.

Interviews were structured along the following lines, but handled on a conversational level in order for the research team to truly understand what was going on at the state in question, and more importantly - why initial notes and observations were shared with the Panel in a technical memorandum. The following more nuanced version will stand as the "official record" upon acceptance by the interviewees.

INTERVIEW TOPICS

AASHTO Subcommittee on Maintenance, NCHRP 25-25 Program, Task 73 Interviews & Case Studies

How are state DOTs incorporating environmental requirements, stewardship, and sustainability into their existing highway maintenance programs?

Produce/review:

In-depth descriptions of effective programs

- Processes to track progress
- A range of types and styles of training
- A range of auditing/self-evaluation programs that are currently being used
- A range of stewardship practices and ways that environmental management is being systematized

Culture/Organizational Change Topics

- Organizational culture change efforts and methods, including cultivation of staff involvement and buy-in
- DOT mission and policy statements and supporting resources, addressing environmental stewardship goals and objectives
    - How are these really used in your agency?
    - Have they penetrated the organization?
    - How have they been institutionalized/made meaningful?
- DOT executive orders, management guides and procedures, maintenance planning and budget decision support, quality assurance data, sustainability policies, and other tools?

- Stewardship policies and practices that are in place and how the notion of stewardship is engendered in the agency. Do sustainability programs and resources extend to maintenance, at your agency?
- Are environmentally sensitive activities seen as something "extra" to do rather than being an integral consideration of every activity? How has your DOT addressed this challenge?
- Do highway workers understand the environmental or ecological value or significance of their activities? How are you attempting to influence that? How successfully? How would you notice or mark change in this area?
- How are maintenance personnel motivated to embrace and incorporate changes that will improve environmental performance? Why/why not? What would make a difference?
- How do you keep staff interested, involved, aware, and the organization building on initial impetus in the environmental area? How does impetus initially arise?
- How do you elicit staff ideas, knowledge, enthusiasm, potential contribution?
- How are you folding change efforts in with existing procedure and accountability mechanisms?
- What are your leadership lessons? Does your DOT support knowledge management/exchange of lessons learned and continuous improvement of environmental performance?
- What are your best stories?

Structure and Coordination

- How are DOT maintenance staff made aware of and accountable for environmental requirements and sustainability/stewardship practice in highway maintenance?
- How are roles and responsibilities being clarified and systematically understood, even embraced?
- Is budget allocated for environmental improvements or remediation?
- Is risk management a consideration?
- How are increased risks of extreme weather and other risks from climate change being considered?
- (How) does your DOT maintenance coordinate with communities?
- (How) does your DOT maintenance coordinate with regulatory agencies occur?
- (How) does your DOT maintenance coordinate with non-regulatory resource agencies occur?

Systems, Practice, and Accountability

- Do all maintenance activities have guidance on associated environmental practices/requirements?
- Does your state have an environmental manual for maintenance? How is that operationalized? Any tailgate resources? To what extent are training and refreshers needed and implemented?
- What are the key stewardship policies and practices delivering improved environmental performance and/or commitment to stewardship and sustainability, in your agency, e.g.,
    - Environmental policies in Maintenance
    - Environmental elements incorporated into MMS
    - New engineering directives
    - New environmental procedures (describe how development and delivery occurred)
    - Environmental audits of maintenance facilities, beyond SPCCs
    - EMSs or other feedback and continuous improvement systems (facilities, other areas)
- Environmental accountability in performance evaluation (indicate at what staff level this occurs and what the metrics are)
- Maintenance involvement in voluntary environmental enhancements – how do these come about and what are their major functions for the DOT
- Maintenance involvement in GHG reduction efforts
- Maintenance involvement in energy saving efforts, documentation of progress
- Maintenance involvement in planning for extreme weather or other effects of climate change
- Maintenance involvement in waste reduction, documentation of progress
- Maintenance salt reduction effort, documentation of progress
- Herbicide reduction effort and measurement of process
- Mowing reduction effort and measurement of process
- Staff driving reductions and tracking
- Culvert retrofit/fish passage improvement and documentation of progress
- Water quality retrofits and reporting/documentation of progress
- Roadside erosion repair and reporting/documentation of progress
- Equipment upgrades to improve environmental performance, documentation of progress
- Green purchasing/materials, documentation of progress

- Asset management, condition assessment, and LOS for drainage system, reporting structure, effectiveness of use
- Asset management, condition assessment, and LOS for roadside
- Other initiative by leadership or line staff (please describe)

Training

- How are maintenance personnel trained so that the staff are aware of/and understand compliance with environmental requirements and are motivated and how do they come to embrace and incorporate changes that will improve environmental performance.
- Does your state DOT offer environmental training for maintenance?
- Is training delivered by "one of their own," as is standard in DOT equipment and safety training? Do you think this is important?
- Are maintenance staff education programs updated periodically to keep them fresh, interesting, and motivating for staff?
- Are meaningful connections made between, environmental housekeeping of the right-of-way and drainage areas and keeping maintenance yards clean, orderly, and functional?
- In what areas have you felt or seen that more environmental training is needed?
- What key areas of training or support resources are you lacking funding, currently?
- What incentives or management tools help build on the instruction personnel are receiving?
- What other stewardship or sustainability resources do you use or have you developed for maintenance staff? What tools or communication have they found useful?

Quality Assurance / Metrics

- To what extent and with what methods are you tracking and measuring environmental activities and stewardship opportunities? Is asset management being related to sustainability?
- What (environmental performance/quality assurance) metrics do you use? Are you documenting the occurrence of: violations/fines incurred, fewer unforeseen problems, or fewer resources impacted, enhancement/restoration that you do?
- How are environmental results evaluated?
    - Condition assessments
    - Level of service established for environmental attributes
    - Check for consultation or consistency with resource agencies' plans
    - Performance metrics

  - Performance per EMS or sustainability plan
  - Individual performance evaluation
  - Audits and/or environmental compliance or sustainability reporting
  - Other self-evaluation practices
- Can you see (how do you assess?) environmental and stewardship outcomes of the different training and assessment programs?
- Does your DOT maintenance employ self-evaluation practices along with the metrics being used to evaluate success?
- What metrics do you think are valuable for measuring success of process improvements, practices and infrastructure investments?

Other

- What key observations or lessons can you share with your colleagues?
- Do you have a DOT sustainability program in maintenance, or does a broader program directly incorporate or address maintenance?
- How do these efforts relate to GHG mitigation and/or climate change adaptation?
- What trends do you see emerging and what is your best advice for the next generation of DOT maintenance managers?

CALIFORNIA

Caltrans Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interview was conducted by phone with:

Tony Tavares, Chief, Division of Maintenance

Jay Norvell, Environmental Manager

Structure, Culture, and Staffing

California has an eighth of the nation's population. It is a very large state with diverse geography and rural and heavily urbanized areas. Caltrans has twelve autonomous Districts that deal with local issues. The organization distributes authority, but functional areas support each other across programmatic lines.

The Department has established organizational responsibility charts regarding stormwater and environmental compliance. Headquarters, District Executive staff, and field supervisory staff all have defined responsibilities. NPDES compliance responsibilities are documented in the Department's Stormwater Management Plan. The official policy of the Division is to follow all appropriate State, Federal and local laws including Orders and consent decrees and to implement best management practices while conducting essential activities.

Caltrans has had a statewide Stormwater Permit for Design, Construction and Maintenance since 1990 that includes solid waste management. There has been an effort over the past 15 years to provide resources and staff in Maintenance and Construction to deal with permit requirements. There has also been a proactive and green approach, focused on stormwater requirements and opportunities.

Caltrans established a Headquarters Stormwater Management team and four Department-wide Stormwater Advisory Teams (SWATs) from various Divisions including Maintenance. The purpose of the SWATs is to advise the Department's Chief Environmental Engineer of technical issues of concern within the program, including those that may arise as a result of the quality control, quality assurance, and the enforcement response program. Any program recommendations and critical issues discussed during SWAT meetings that require resolution and action are discussed with the Headquarters Stormwater Management Team before implementing program revisions or improvements.

Caltrans has also taken a national leadership role in implementing green approaches in several areas, from climate change adaptation to a statewide initiative to implement LED lighting, and Green Fleet issues. Caltrans is a leader in clean diesel and responding to California Air Resources Board (CARB) requirements to purchase alternative fuels and low emissions vehicles.

Maintenance forces face extraordinary pressure to just maintain highways with limited resources, while also trying to do it in the best "green" way.

Caltrans has 5,600 field staff with dedicated environmental staff in Maintenance and Stormwater Coordinators in all 12 districts. There is a dedicated stormwater compliance officer in their main office. Main Office staff does training, including weekly and biweekly teleconferences with the District Stormwater Coordinators. The SW Coordinators in turn coordinate with District environmental staff. Together they deal with hazardous waste, stormwater, and water quality issues.

Caltrans funding for dedicated staff in state and federal resource agencies comes entirely out of capital construction funding. The Division of Maintenance has assigned District Coordinators who respond to regulatory agencies when required to do so depending on the nature of issue, and some contacts are made through the district NPDES coordinator who reports to the Division of Environmental Analysis. Coordination is done through interagency agreements, emails, phone calls, and meetings.

The Division of Maintenance also has contacts in each District to provide environmental support, program suggestions and recommendations. Capital funding to local agencies is through the local assistance program for federal "pass through" funds. The California Stormwater Quality Association (CASQA) is a partner on research and best management practices among MS4 permit holders.

The statewide Stormwater Permit was fundamental in creating awareness in maintenance and its compliance mandate prompted a cultural change. The Department's Mission and Goals includes stewardship to preserve and enhance California's resources and assets. Stewardship is one of Caltrans primary goals and is integral to its Mission, Vision and Goals. The agency's expectations extend to maintenance staff. The Maintenance Manual incorporates and helps implement stewardship objectives.

The State of California is an environmentally conscious state and the overwhelming majority of Division of Maintenance staff has an appreciation for the environment in which they work. Department staff has organized and also participates as partners in such annual events as statewide coastal cleanup days and litter collection days to raise public awareness on these issues.

The Department evaluates the environmental benefits and consequences of its activities and implements practices that minimize environmental impacts. Caltrans' Environmental Division inventories, evaluate for significance, and mitigates for impacts to biological resources from transportation projects. The Division conducts general biological surveys including endangered species surveys and coordination with State and Federal resource agencies, Natural Environment Studies, wetland delineation, and participates in the Project Development Process. Caltrans' Environmental Division assisted in the preparation of a programmatic authorization to conduct routine maintenance and repair activities in accordance with Section 7 of the Endangered Species Act, involving 3 north coast Districts.

The Division of Maintenance performs its responsibilities of ensuring the safety and preservation of California's state highway system in compliance with a wide range of regulatory requirements including the Federal Endangered Species Act Section 7, the California Endangered Species Act, the California Porter-Cologne Water Quality Control Act, Cal-Recycle Waste Management regulations, the Federal Clean Water Act , the Federal Resource Conservation and Recovery Act, Air Resources Control Board regulations and Air Quality Act, the California Emergency Management Agency requirements and California Fish and Game Codes. The Division of Maintenance has many of its facilities permitted as Limited Volume Transfer Operations for waste management.

Maintenance understanding of environmental stewardship and sustainability

Highway workers understand the environmental or ecological value or significance of their activities. Statewide self-audit results indicate that Division field crews recognize the importance of incorporating best management practices into their activities. Staff training emphasizes this point. Independent reviews of activities consistently indicate high (90-100%) compliance with Department environmental policies. Some maintenance environmental training is developed not so much to familiarize with regulations, but to focus on why the effort was being done and the health effects to the workers and their families.

Periodic statewide meetings for Maintenance staff involved in environmental compliance

Staff interest and awareness in environmental issues is supported through in-person meetings and exchange of lessons learned. The Division of Maintenance conducts periodic statewide meetings for staff involved in various aspects of environmental compliance. District approaches for compliance requirements are presented and discussed. Lessons learned are shared on successful and/or failed projects. Liaisons work between Environmental and Maintenance to ensure compliance with Federal and State agency requirements while conducting maintenance activities.

Leadership and participation, on multiple levels

Caltrans recognizes that to successfully implement an environmental program, knowledge and participation and communication are required at all levels of the organization from executive staff to the employee working in the roadside environment. The Department participates in Federal, State and local conferences and associations to exchange experiences and ideas related to its environmental compliance. The Department has a website which provides access to various studies and reports.

Funding and Potential Efficiencies Are Key Drivers

Caltrans is most able to implement green practices when such approaches offer efficiencies as well. Caltrans is using more rubber and recycled materials in pavement. Maintenance program

is moving toward LEDs to reduce electric power usage, greenhouse gas emissions, and need for maintenance staff to be exposed to traffic to change bulbs. In the stormwater area, Caltrans had been implementing a concrete basin approach to collecting and treating stormwater. They are now trying to move to grassed swales where right-of-way is available because they are more cost-effective and easier to maintain.

Environmental Mandates

The Maintenance Facility Group in headquarters oversees 300 maintenance stations in the Caltrans system. Each maintenance facility has or will have a facility management plan that includes stormwater management and solid waste plans.

Caltrans is under a state mandate to reduce energy use. Their goal is to reach Silver LEED status or 50% reduction in energy usage at their facilities. They have an aggressive program to put solar panels on the roofs of their facilities, although this has raised some aesthetic concerns in some locations. Caltrans has investigated its ability to add solar developments and many substantial solar developments are off the ROW, but many of the areas Caltrans has available are not large enough to be financially viable.

Fleet and equipment upgrades and alternative fuels to meet Air Rule compliance

Caltrans is purchasing low emission vehicles and is retrofitting hundreds of pieces of equipment to meet new standards. The Division of Equipment is documenting fleet upgrades and reporting progress to a Statewide Regulator; internally the Division is tracking bio-diesel and other alternative fuel usage and measuring displacement of conventional fuels.

Where required for Air Rule compliance, the Division of Maintenance has upgraded its heavy equipment fleet to alternative fuel in specific Air Quality Management Districts. The Division also uses upgraded vacuum assist sweeper equipment in the Lake Tahoe basin to reduce potential sediment loading of the lake. Supervisors submit annual requests for repairing and upgrading outdated equipment.

The California Department of Transportation (Caltrans) will significantly reduce the exhaust emissions from it’s on and off road mobile fleet in a program known within Caltrans as "Greening the Fleet." This program will move the Caltrans fleet above and beyond the emissions levels required by government regulation, and generate mobile source emission reduction credits which can be used in local areas for conformity to the State Implementation Plan or to offset emissions from local construction projects such as power plants. Many areas in California are in non-attainment to the National Ambient Air Quality Standards for ozone and particulate matter (PM), two principal air pollutants in California.

Caltrans will implement emissions reducing fuels and technologies to reduce NOx (precursor to ozone) primarily, and PM secondarily. These strategies consist of converting the Caltrans diesel fleet to ultra-low sulfur diesel along with retrofitting the heavy duty diesel fleet with exhaust

treatment devices, as well as expanding the use of gasoline, LPG, electric, solar, and low dust emitting technologies. In addition, Caltrans will participate in special projects to study the applicability and performance of emerging technologies. Partnering with private and public entities Caltrans will demonstrate the most viable emissions reduction technologies and assist California in meeting its air quality goals.

Pesticide use and exposure

Caltrans has been focused on pesticide reduction since 1992, when a programmatic EIR was conducted. The results of this EIR included that the Department develop an Integrated Vegetation Management (IVM) Program and internal "goals" were put in place for reductions in pesticide use. There were 2 milestones set for pesticide reduction – 50% reduction in 2000 and an 80% reduction in 2012. The 50% reduction goal was achieved and the Department prepared a written report documenting the methods for achieving that task.

Currently, Caltrans is working on another document to record what has been done since 2000 to try and meet the 2012 milestone. Caltrans analyzes and revises its pesticide lists looking for reduced Active Ingredient (AI) pesticides that perform the same as higher AI on the approved list. This way Caltrans is able to reduce the total amount of AI use and still meet vegetation control efforts in the roadside. The Department has and is working on improved design standards to assist Maintenance with vegetation control issues and constantly evaluating alternative methods, ranging from mechanical control to manual control, thermal control, steam applications, corn meal, mulching, etc.

Equipment use is balanced with use of pesticides which is more effective in reducing vehicle emissions since large areas are covered with minimal equipment use. Closed container pesticide systems are utilized that reduce time and exposure of employees when loading pesticides into tank mixes.

Safer alternative products and green purchasing

Statewide, the Division of Maintenance incorporates a Safer Alternative Products BMP into its practices. The Division has a checklist for safer product selection in its chemical application program and documents the types and quantities of products used. This information is submitted monthly to the Department of Pesticide Regulation and annually to the State Water resources Control Board. Mulch is used for controlling vegetation growth in the roadside. Caltrans annually reports on the total use of mulched material.

Sensitive resources

All Districts have an inventory of cultural resources available to District maintenance staff. They are now trying to centralize these into a statewide database. Some Districts have "paddle sign" systems where they demarcate environmentally sensitive areas in the ROW, such as no herbicide spray zones. Caltrans has localized agreements in environmentally sensitive areas, including the Big Sur Coast and Merced River Canyon where there special treatment is given in coordination with other agencies.

Caltrans Senate Bill 857 that requires an inventory for salmon and anadromous fish that is shared with the Department of Fish and Game (DFG) and fish passage data is collected during culvert inspection.

Training and Communication

New environmental requirements are incorporated into Division of Maintenance policy and training, the materials for which are revised as needed. New mandates that require immediate compliance are presented in Tailgate Meetings and a Maintenance Bulletin is prepared to provide information to Maintenance field supervisors.

Training is delivered to the Maintenance Division's 5,600 employees by various means, including external resources and Division of Maintenance staff. Peer involvement increases participation and interest. Staff members are required to receive classroom or on-line training on various minimum intervals depending on the type of training. In addition, Tailgate training sessions are held every two weeks or whenever there is a change in work activity. All training activities are documented through the Learning Management System (LMS). For example, all new employees attend stormwater management training sessions when they start and existing staff are receiving updates at least once every four years.

Tailgate meetings assist Field Crew awareness

Division of Maintenance policy is that Supervisors conduct stormwater BMP tailgate meetings a minimum of every 10 working days or when there is a change in the type of work activity. Stormwater BMP tailgate meetings are usually scheduled for one half hour. Stormwater Bulletins, Activity Cut-Sheets, and videos are available to assist in the tailgate meetings. Training attendance is tracked in the Division of Maintenance Integrated Maintenance Management System (IMMS) and the Department's Learning Management System (LMS) information systems.

The Division's frequent Tailgate Meeting mandate assists in field crews' awareness of the best management practices expected for the work to be conducted. Caltrans has developed tailgate resources (one-page fact sheets or monthly bulletins) for maintenance, pertaining to stormwater that have been national models. These are available on Caltrans' website.[1]

Landscape maintenance-related training

Annually each landscape maintenance employee is trained in the proper application methods for pesticide usage, understanding Labels, Materials Specification Data Sheet (MSDS), mixing, loading, storage, Personal Protective Equipment (PPE), and environmental concerns. Additionally each maintenance employees receives BMP for each activity or type of work being performed. Supervisors have the responsibility to train employees on new pesticide products by reading and understanding the label, and MSDS prior to the employee using the product. IMMS keeps a data base of ESA areas.

During the annual pesticide training employee are taught to identify and help manage stewardship practices in their daily pesticide usage. Training consists of awareness of adjacent property owners, water ways, and environmental concerns.

The Division of Maintenance has District Coordinators who conduct needs assessments with field staff and listen to their concerns and program recommendations for such things as new BMPs and types of equipment. The Division of Maintenance annually allocates resources to the Department's twelve Districts and compiles a prioritized needs assessment list for funding. The Division of Maintenance has an audit of both its activities conducted in the roadside environment and at yards and stations.

Staff receives training on the importance of General Housekeeping BMPs and their relation to overall environmental compliance. Maintenance District Stormwater Coordinators also conduct needs assessments in coordination with field supervisory staff. These assessments are the basis for determining immediate or future resource requirements; The Division's Roadside website has proven to be a useful tool in providing compliance information.

Instruction by Maintenance peers

The Division of Maintenance training videos use District Maintenance staff to illustrate best management practices for roadside and maintenance facility activities. Caltrans has found that employees relate and tend to be more focused when peers are an integral part of the instruction.

Extensive written manuals and tools guide staff

All maintenance activities have guidance on associated environmental practices/requirements. Policies for delivering environmental performance are defined in the Department's Environmental Handbook which is available online: http://www.dot.ca.gov/ser/vol1/vol1.htm. Environmental policies are defined in the Division of Maintenance, Maintenance Manual and in Division Policy Directives. The Maintenance Manual defines official environmental policy and regulatory compliance mandates including NPDES (Stormwater), RCRA (Hazardous Waste) and Integrated Vegetation Management. The Maintenance Manual also refers to appropriate Plans, Handbooks, Guides and Policy Directives which further delineate compliance responsibilities; For stormwater, the policy states that the Division of Maintenance will implement BMPs for its defined activities as specified in the Maintenance Staff Guide, follow all appropriate laws and regulations and meet all requirements of Regional Water Quality Control Boards and the State Water Resources Control Board.

Caltrans' Maintenance Division has a wide variety of environmental guidance documents and Tailgate Meeting resources available to share with other DOTs, including:

Maintenance Manual

Department Environmental Handbook

Maintenance Hazardous Waste Manual

Statewide NPDES Permit

Stormwater Quality Handbook-Maintenance Staff Guide

Structural Treatment BMP Guidebook

Maintenance Bulletins

Maintenance BMPs Video Training Modules

Maintenance Facility Compliance Review Plan

Maintenance Activity Compliance Review Plan

Roadway, Sweeper and Decanting Waste Storage and Disposal Sites Compliance Certification Guidance and Scheduling Document

Litter Abatement Plan

Division of Maintenance website location dedicated to stormwater and environmental compliance containing reference and training materials

The Department has developed guidance that addresses the implementation of mandated stormwater BMPs during highway maintenance activities and activities conducted at maintenance facilities such as storage of equipment and materials and waste management. The BMPs are grouped into families of various maintenance activities and are referenced in the Stormwater Quality Handbook-Maintenance Staff Guide.

Maintenance Area Supervisors are responsible for ensuring that the personnel under their direct supervision are implementing the BMPs in the Staff Guide. The Department encourages experimentation and innovation on deploying enhanced BMPs to minimize pollution. Feedback from the implementation of innovative measures is gathered for analysis and reporting in the Annual Report process as required by the Department's NPDES permit. Stormwater manuals and training materials can be found at:
http://onramp.dot.ca.gov/hq/maint/roadside/storm_water/watqual.htm

Systems, Practice, Quality Assurance and Accountability

Caltrans has proven systems for implementing new environmental requirements and responding to environmental needs.

Roles, responsibilities outlined, and resources allocated

Roles and responsibilities are defined in Department policy documents and re-iterated through chain of command and other means including direct delegation and written instruction. The Division of Maintenance includes environmental compliance, improvements, and site remediation in its budget. Division of Maintenance staff is made aware of environmental requirements through emails, formal and informal training sessions and mentoring, policy documents, guidance materials, District and Statewide meetings and the Division's website. Staff members are accountable through Department audits and employee disciplinary

programs. Caltrans contracts with a third party (consultant) to conduct a compliance review of maintenance activities and facilities for stormwater NPDES Permit compliance.

Principal accountability through Integrated Maintenance Management System

Caltrans' Integrated Maintenance Management System provides the principal accountability mechanism for the Division of Maintenance. This is an online data entry system which collects the information of work activities performed throughout the State. As new activities are generated by mandated regulations, the data entry system is revised to accommodate them.

The Division of Maintenance tracks its environmental compliance activities and generates the following databases annually which are summarized and reported annually to the State water resources Control Board and other regulatory agencies.

Erosion Inventory Database;

Storm Drain System Inventory Database ;

Illegal Connection/Illicit Discharge Database;

Pesticide Use Database; Maintenance Facility and Activity BMP Implementation Database;

Facilities Pollution Prevention Plans (FPPPs) Database;

Training Database;

Level of Service (LOS) - a performance based system designed to measure progress on departmental goals;

Equipment retirement and upgrades driven by outside regulatory agency.

Asset management is conducted in accordance with the Director's Policy. The Department is revisiting and updating its asset management program

Environmental performance evaluations follow Maintenance Compliance Plans

Environmental performance evaluations are conducted in accordance with the Maintenance Activities Compliance Review Plan and the Maintenance Facilities Compliance Review Plan. Each document contains the evaluation criteria. It applies to Supervisor level and above; those staff with oversight responsibilities. On a statewide basis, Maintenance voluntary environmental enhancements include participation in annual Coastal Clean Up and Litter Abatement events.

Pesticide usage tracked and reported annually by Districts

Caltrans tracks pesticide usage monthly and report yearly on pesticide usage. The Integrated Maintenance Management System (IMMS) keeps track of work orders and enables the Department to track usage, hours, time, type of equipment used, number of employees involved in application of pesticides, etc. This is an extremely useful tool to see how effective efforts are and where reductions occur and allocation of efforts for the future. Most

importantly, the individual District's prepare a yearly report – Vegetation Control Plan (Vegcon). This report is used for the annual spray programs in each District.

These reports contain the type of control needed for a particular route, the type of pesticide that is to be used to achieve that control, and identifies ESA's (Environmentally Sensitive Areas) that need to be avoided due to location (public school, bus stop where children/people are readily present), sensitive plants/animals, well heads, shallow groundwater that may become easily contaminated, etc.

Stormwater BMP implementation is evaluated, graded and reported for compliance

Caltrans evaluates compliance with Division of Maintenance BMPs developed for facilities and activities. Documentation of the compliance status is reported annually as part of the report to the State Water Resources Control Board and other regulatory agencies. Results are evaluated using a standardized grading system for correct BMP implementation. These grading checklists are part of the Maintenance Activity and Maintenance Facility Compliance review Plans. Condition assessments are conducted as part of monthly and annual mandated facility inspections. These are documented and attached to Facility Pollution Prevention Plan (FPPP) at each site. Deficiencies are noted and inspections repeated until corrected.

A rating system has been developed to determine the LOS achieved for facility and activity BMP implementation. The performance metric for the Division of Maintenance is the level of correct implementation of Division policy mandated BMPs. Performance evaluations are facility and field activity based. The Division has an on-going monthly and annual audit program and participates in an annual independent third party audit program conducted by the Department.

Storm patrol inspections and erosion control program

Caltrans' Division of Maintenance has an ongoing program in accordance with the Department's Statewide Stormwater Management Plan (SWMP) to inspect roadside vegetated slopes for erosion. This requirement is led by District Maintenance Stormwater Coordinators. The inspections are conducted on a five-year cycle. In addition to the SWMP mandated program, the Division of Maintenance conducts a storm patrol and erosion control program. Maintenance Supervisors and delegated staff patrol the State's highway system to inspect for any issues related to safety, facility preservation and erosion control do to storm events.

The Division of Maintenance also investigates complaints by the public related to stormwater damage during these times. These inspections and patrols generate erosion control projects. The Division of Maintenance will normally conduct minor storm damage repair. During Fiscal Year 2010-2011, District Maintenance staff logged over 2 million storm patrol inspection miles, completed 3680 minor storm repair projects and 65 major storm repair projects, completed 1,125 highway storm related clearings and responded to 103 storm related public complaints. Documentation is provided in the Department's Annual Report to the State Water resources Control Board. Major projects are addressed by the Capital Program.

Highway Slope and Erosion Inspection Program

Caltrans has established a program to periodically inspect roadside segments prone to erosion to determine the need for remedial measures. The program is coordinated by the District Divisions of Maintenance. Inspections are performed by maintenance managers, superintendents, supervisors, landscape specialists, maintenance storm water coordinators, lead workers, and other maintenance personnel. These inspections are conducted along all roadsides at least once during an established 5-year schedule. Roadsides found to be of significant concern are inspected on a more frequent basis.

In addition, all newly completed slopes resulting from construction projects are inspected on a more frequent basis up to one year after project completion. Caltrans uses a standard reporting form for recording inspection findings and identifying recommended repairs. Slides and slips encountered during routine surveillance and inspections are evaluated for repair. Recommendations are developed for site-specific remedial measures to maintain slope and soil stability. Remedial measures can range from minor grading or seeding to installation of major slope stabilization systems. A summary of the inspections conducted by each District is submitted with the Annual Report required by the Department's NPDES permit along with statewide maps defining route segments prone to erosion for the reporting period.

These programs are linked to the Maintenance Stormwater Program Enforcement Response Plan for evaluating and improving maintenance facilities and activities to ensure that they are in compliance with the statewide stormwater permit (Permit), the Stormwater Management Plan (SWMP), and Caltrans Maintenance Program guidance documents. This effort includes inspecting and evaluating compliance at the maintenance facilities as well as the field activities, assessing the trends, identifying recommendations for improvements, and incorporating appropriate feedback loops to assure implementation of improvements and correction of any identified deficiencies.

This independent assurance program provides oversight inspection to ensure that Maintenance Division actions are implemented and facilities are operated and maintained so that they are protective of water quality. The inspections are usually unannounced, unless safety or other considerations necessitate reasonable pre-inspection notification; are conducted by properly trained personnel who are not affiliated with the location; and are documented and information is entered into a Maintenance Facility database for tracking. The enforcement response program includes inspection and follow up policies that improve overall compliance and utilize data tracking tools.

Culvert inspections and LOS surveys and reports

The Division of Maintenance has an ongoing Culvert Inspection Program including annual status reports and website information, for public safety, asset management, and environmental reasons. Roadside Level of Service (LOS) is surveyed and reported annually and covers roadsides elements, including: vegetation, fences, trees/shrub encroachment, litter & debris, graffiti, and ramps.

Facility Programs

Statewide, Facility Pollution Prevention Plans (FPPPs) are required for each subject maintenance facility owned or operated by Caltrans. The FPPP describes the activities conducted at the facility, the potential pollutants or issues at the facility, the BMPs to be implemented, and the inspections that will be conducted. Facilities subject to FPPPs include: maintenance yards/stations, material storage facilities, equipment storage and repair facilities, roadside rest areas, agricultural and Commercial Vehicle Enforcement Facilities (CVEF), vacuum truck decant storage or disposal locations and permanent and temporary solid and liquid waste management sites. The FPPPs describe the activities conducted at the facility and the BMPs to be implemented to reduce the discharge of pollutants in storm water runoff from these facilities.

Supervisors inspect their maintenance facilities monthly to monitor the implementation and adequacy of the BMPs. In addition to monthly facility inspections conducted by the facility supervisor, the District Maintenance Stormwater Coordinators review at least 20% of each District's facilities each year. District Maintenance Stormwater Coordinators confirm that facility supervisors are inspecting all facilities over which they have jurisdiction, and determine that corrective actions recommended for a particular facility are being implemented. The District Maintenance Stormwater Coordinator works with the facility supervisor to correct any observed instances of noncompliance identified during supervisor's monthly facility inspections. Each District Maintenance Stormwater Coordinator prepares a report including the date of the inspection, name(s) of the inspector, observations, and recommended corrective actions.

Other

Division of Maintenance is constantly monitoring pesticide usage to try and meet internal goals. Caltrans met its goal in 2000 of a 50% reduction in pesticide use and working towards the 2012 milestone of an 80% reduction as well.

Innovative pollution control in the Lake Tahoe Basin

Caltrans' Division of Maintenance plays a major role in controlling sediment, sand and deicing materials in the Lake Tahoe Basin. As a result, the Department has received several Governor's Environmental and Economic Leadership Awards from the Cal-EPA for its Lake Tahoe Environmental Improvement Program (EIP). The Division was part of the team which developed a new traction sand which contains 98% less phosphorous than sand used in the past. The Division has a state of the art reverse-osmosis filtration system for vehicle washing for snow plow and spreader equipment, which is incorporated as part of a wash facility at the Whitmore Maintenance Station.

The Division is also testing liquid deicing as part of its effort to find ways to reduce the amount of deicing and traction materials. Plowed snow which is located in areas which drain to Lake Tahoe is hauled to a facility for it to melt without residual abrasives entering the lake; the Division of Maintenance uses state of the art sweepers and increased sweeping frequency in

the Lake Tahoe Basin to control sediment and sand deposition. The Division also uses vacuum assisted highway sweepers in the basin, underscoring the Department's commitment to its Lake Tahoe EIP.

Caltrans' Maintenance is responding to climate change

The increased incidence of extreme weather and other potential risks from climate change are being considered. California has 16 climatic zones and 12 districts; each district has a distinct ecosystems. The Department has established a Climate Change Branch office and internal website that provides information and resources. The Department has also developed a document, *Guidance on Incorporating Sea Level Rise,* for the planning program which will assist in reducing potential maintenance requirements as adaptation is properly planned and implemented in current projects.

Illicit Connection/Illegal Discharge (IC/ID) Program

District Maintenance staff implement the Division's IC/ID program which includes: Initial documentation of alleged IC/IDs on a standardized form;

Inter-departmental notifications of alleged IC/IDs;

Investigation and source identification of IC/IDs, including actions to take when dealing with

known or suspected hazardous materials;

Cleanup activities; and

Methods for pursuing parties responsible for IC/ID

Litter/Debris/Graffiti Removal Program

The Department conducts roadbed and roadside cleanup operations to provide safe highway conditions, keep gross pollutants from the drainage system and maintain a neat and clean appearance appropriate for the type and use of the road. Litter and debris removal activities include sweeping of shoulders, paved medians, etc., and litter removal along the roadsides. Litter removal also includes the maintenance of gross solids removal devices (GSRDs) which are end of culvert structural treatment BMP collection devices. Graffiti defaces facilities, most commonly with paint, and also by markers and stickers. The Department routinely removes graffiti from concrete structures, road signs, sound walls, steel bridge beams and other facilities, such as buildings and roadside rest area restrooms.

Vegetation Control Program

Integrated Vegetation Management (IVM) is a philosophy for determining the most appropriate vegetation management strategy based on economic, ecological, and sociological considerations. The strategy often includes a combination of many methods. Environmentally sensitive (ESA) areas are identified and recorded into a data base. The Department's vegetation control program is based on integrated pest management principles, including the use of physical, chemical and biological methods. An annual Vegetation Control Plan (VCP) is prepared

by each district to address the Department's need to eradicate noxious and invasive weeds and maintain fire control strips. The vegetation control plans contain elements designed to:

Enhance the use of appropriate native and adapted vegetation throughout all the Department's rights-of-way for the purpose of preventing erosion and removing pollutants in storm water and non-stormwater runoff.

Apply herbicides in a manner that minimizes or eliminates the discharge of herbicides to receiving waters. Factors to be considered include timing in relation to expected precipitation events, proximity to water bodies, and the effects of using combinations of chemicals.

Restrict the application of nutrients to rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface water.

Structural Treatment BMP Maintenance Program

The effectiveness of a structural treatment BMPs is dependent on its maintenance. The Division of Maintenance is responsible for ensuring the operation of: structural treatment systems such as bio-strips and bio-swales; infiltration devices; detention basins; filter devices and sediment and litter trapping devices. The Division is responsible for cleaning and maintaining a series of sand traps in the Lake Tahoe Basin which are part of an overall sediment reduction program from the State's highways and facilities. Guidance manuals have been developed for this activity including device specific information, photographs and flow diagrams.

Snow and Ice Control Program

The snow removal and ice control program includes snow and ice removal operations and opening of drainage inlets that get covered or blocked by snow and ice. Because salt, deicing chemicals and abrasives may pollute storm water runoff, the Department uses no more than the minimum amount of these materials necessary for effective snow and ice control. The minimum amount of salt will be applied at the most effective time, as determined by the snowstorm severity, duration and temperature.

Districts are to comply with the following requirements regarding their snow and ice control programs:

Maintain accurate records of the locations and quantities where salt and other deicers are used.

Provide necessary training for Maintenance personnel involved in snow and ice control efforts.

Calibrate equipment used to apply deicing and anti-icing chemicals or abrasives.

Identify areas that are potentially environmentally sensitive. This includes vegetation areas and bodies of water receiving direct roadway runoff.

Submit to the Chief, Division of Maintenance, no later than October 15th of each year, an annual Snow Plan for the next winter season, including proposed levels of service, chemical usage, and any proposed changes to operations in environmentally sensitive areas.

At the close of each winter season, no later than August 1st, each district is to submit to the Chief, Division of Maintenance, a complete report specifying the quality of salt and other deicers used. This report, commonly referred to as the "Salt Report", will also include a recapitulation of the salt inventory at the beginning of the season, the quantity of salt received during the season and the inventory of salt on hand at the end of the season. The same usage information is required for all other deicers used.

Highway Spill Program

When spills of hazardous or nonhazardous materials occur on state roadways or the right-of-way, the agency with jurisdiction assumes authority as the incident commander. These spills are illicit discharges resulting from one-time deposits of materials or wastes. The Department's lead is in charge of the cleanup activity unless directed otherwise by the incident commander. All spilled materials are managed to protect public safety and the environment, including water quality.

The Department coordinates with local health agencies and other local, state and federal agencies (e.g., Department of Fish and Game, Coast Guard, RWQCB, etc.) as appropriate to determine the approach and level of cleanup needed. Depending on the circumstances of the spill, this coordination is made directly or through the California Emergency Management Agency. The Department tracks all incidences and maintains a list of contractors available statewide to assist in cleaning up spilled materials if additional resources are needed.

COLORADO

Colorado DOT (CDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interview was conducted by phone and in person with:

David Wieder – Maintenance and Operations Manager

Sarah Mitchell – Sustainability Coordinator

Structure, Culture, and Staffing

The Colorado Department of Transportation (CDOT) is responsible for a 9,146 mile highway system, including 3,447 bridges. Each year, this system handles over 27.4 billion vehicle miles of travel. Although the Interstate system accounts for only about 10 percent (914 miles) of the total mileage on the state system, 40 percent of vehicle miles traveled in the state take place on Interstate highways. CDOT is organized into six regions.

CDOT Maintenance utilizes headquarters landscape architects and environmental specialists to conduct environmental training for maintenance, and CDOT Maintenance has its own environmental personnel to deal with hazardous waste and certifications. The headquarters maintenance director's office includes three environmental staff (one is a microbiologist, two geologists) and are responsible for asbestos testing for all demolitions, whether a bridge or a house, and meth lab testing.

Outside of these, Regional Maintenance offices can call on environmental generalists in the Regions or environmental specialists at headquarters, for support as needed. Landscape architects and water quality staff are most likely to be called, given Maintenance familiarity with these staff members through training events or these staff members' other field work. Main Office environmental staff members also oversee the Maintenance Facility Runoff Control Plans and Spill Prevention Control Plans.

Regional environmental groups guide regional permitting efforts and advise Maintenance staff

CDOT Regions each have their own design, construction and maintenance programs. Each Region has its own environmental group to guide the regional groups in permitting. Regional environmental staff members also go out and review construction projects and advise maintenance before they take over the facility.

Regional environmental staff, as well as headquarters water quality specialists and landscape architects also help train staff in construction of stormwater facilities. CDOT maintenance staff members are also willing to help each other out however it is needed; there is a real ethic of cooperation. Maintenance staff members also participate on the Regional Erosion Control

Assessment Teams, which primarily assess erosion and sedimentation control activities on active projects.

CDOT formalized the agency's environmental ethic in 2003

The Colorado Transportation Commission adopted CDOT's environmental ethic in 2003, which states that: "The Colorado Department of Transportation will support and enhance efforts to protect the environment and quality of life for all of Colorado's citizens in the pursuit of providing the best transportation systems and services possible."

Developing an environmental ethic in Maintenance was not a big stretch; most staff come from farming or ranching backgrounds or are fisherman and hunters. The nature of the transportation business tracks outdoor activities. CDOT's Maintenance and Operations Manager comes from a ranching family in the northern part of the state and still helps out there. As he describes, "It's not a stretch to get them thinking green, when your supper sometimes comes out of the stream behind the maintenance shed."

CDOT also has an Environmental Stewardship Guide, adopted in 2003, that clarifies responsibilities and recognizes the need for good environmental practices in maintenance. This guide describes "how the agency will go out and protect the environment while going about its mission."[2]

Greening State Government Executive Orders

In 2007, the Governor issued two "Greening of State Government" Executive Orders. One set goals and objectives and the other serves as the implementing document. It establishes several goals for the reduction of energy consumption in state facilities and vehicles, and for the use of efficient materials and resources by 2012

Reduce energy consumption by 20%

Cut the use of paper by 20%

Reduce water consumption by 10%

Purchase more environmentally friendly products

Cut the use of petroleum products in state vehicles by 25%

Leadership from the top and competition among regions

The nine Maintenance Superintendents provide leadership and "really push the environmental ethic." Also, the Regional Transportation Directors are very competitive. Part of what they compete is the Executive Director's Cup every year. And, part of that competition is their environmental program. Region 4 won this year due to the strength of their environmental program.

Context Sensitive Solutions involving the local communities has been embraced by CDOT Design and Construction since the early 1990s. Management leadership in the early 2000s helped set the environmental ethic within CDOT.

Interagency collaboration has helped advance culture change

Colorado's Greening Government Council encourages interagency sharing, so relationships are improving as well. Agencies are willing to share best practices and lessons learned. For example, CDOT has installed photovoltaic and solar thermal projects and the Colorado Department of Public Health and the Environment is leading in waste diversion. CDOT has been invited to participate in an electronics recycling event. CDOT is also exploring hybrids for its hydraulic boom trucks.

CDOT's Green Maintenance initiative developed a set of guidelines and checklists

The Green Maintenance Program was developed by 2 of CDOT's 9 Maintenance Sections as a Pilot Program in response to interests that ranged from environmental stewardship and commitment to best practice usage and pollution prevention, to environmental compliance, and more efficient, healthier, and cost-effective facilities. The program also highlighted current effective environmental activities and developed an awards program to recognize existing and new environmentally sound practices.

The project attempted to instill a sense of pride in the environmental accomplishments of CDOT Maintenance, encourage reuse and waste minimization practices, and improve environmental performance. Expected co-benefits were: reduced environmental impacts associated with maintenance facilities and operations, avoided potential violations, and a positive image of CDOT facilities. CDOT Maintenance demonstrated that environmental stewardship and efficient business operations can go hand in hand. They also expected they could stimulate further cost saving suggestions.

CDOT's Transportation Operating Principles guides efforts to protect and enhance the environment and quality of life

In 2008, CDOT issued Policy Directive 13, stating CDOT's Transportation Operating Principles. CDOT will support efforts to enhance environment by preserving the natural and enhancing the created environment. A Sustainability Coordinator position was established.[3] The 2008 Statewide Transportation Operating Principles stated that CDOT will support and enhance efforts to protect the environment and quality of life for all its citizens in the pursuit of providing the best transportation systems and services possible.

CDOT will:

Promote a transportation system that is environmentally responsible and encourages preservation of the natural and enhancement of the created environment for current and future generations;

Incorporate social, economic, environmental concerns into the planning, design, construction, maintenance, and operations of the state's existing and future transportation system;

Through the active participation of the general public, federal, state and local agencies, objectively consider all reasonable alternatives to avoid or minimize adverse impacts;

Ensure that measures are taken to avoid and minimize the environmental impacts of construction and maintenance of the transportation system, all activities are in compliance with all environmental statutes and regulations, and that mitigation commitments are implemented and maintained;

Plan, design, construct, maintain and operate the transportation system in a manner which helps preserve Colorado's historic and natural heritage and fits harmoniously into the community, local culture and the natural environment; and

Promote a sense of environmental responsibility for all employees in the course of all CDOT activities and we will go beyond environmental compliance and strive for environmental excellence.

Federal, state, and local resource agencies participate in a forum to improve working relationships

CDOT and FHWA initiated the effort in 2002 to form the Transportation Environmental Resource Council (TERC). The TERC provides a forum in which to discuss state transportation decisions and plan for environmental stewardship. A strong working relationship has blossomed and continues to grow among fifteen federal, state and local resource agencies in Colorado. The forum allows the resource agencies to anticipate and get ahead of interagency challenges.[4]

The TERC's sustainability committee has become one of its most active subprograms. The TERC Sustainability Subcommittee (TSSC) was tasked with developing a common language and framework within the realm of sustainability statewide. Agency members from the TSSC attended the structured, sequential series of workshops which focused on refining and advancing existing sustainability principles into a meaningful framework.

The topics of the workshops were as follows:

Workshop #1 – Moving from Principles to Guiding Framework

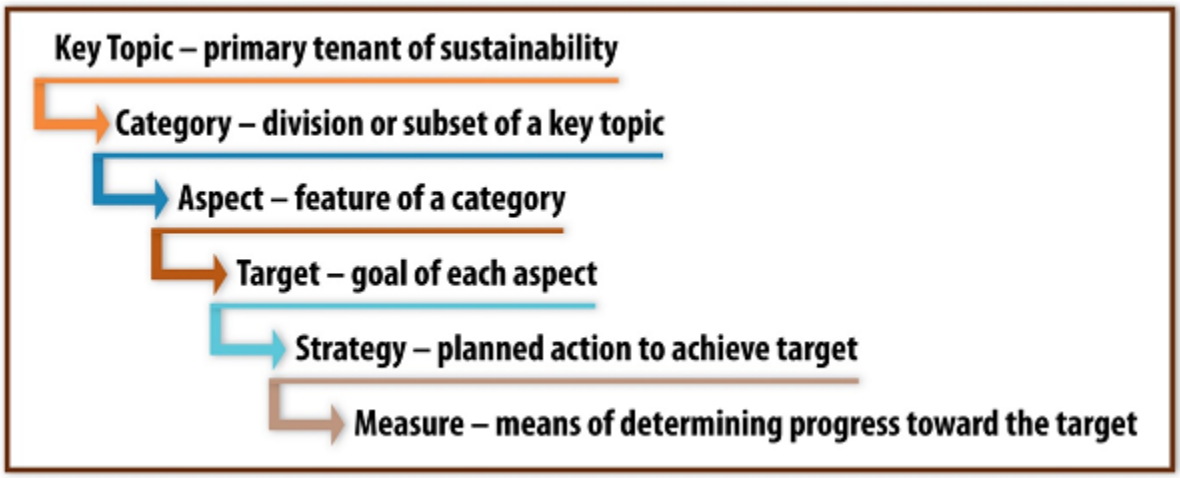
Workshop #2 – Developing Performance Measures for Sustainability

Workshop #3 – Evaluating and Planning for Sustainability in Projects

Workshop #4 – Resolving Conflicts and Constructing Partnerships

Workshop #5 – Building the Centralized Resource

During the workshops the TSSC agreed to a common language and framework that included three Key Topic areas: community well-being, environmental stewardship, and economic vitality and quality. A hierarchy of terms was agreed to beneath the Key Topic areas:



Participants agreed that the workshop:[5]

Resulted in a common language and framework structure for agencies to use in streamlining and enhancing statewide sustainability work thus providing a more effective mechanism for agencies to collaborate on and achieve success with sustainability goals and objectives.

Advanced individual agencies' efforts to become more effective, efficient, and elegant in their sustainability programs benefitting both internal and external agency sustainability functions.

Set the foundation for the TERC to achieve success in sustainability by providing tools to facilitate the development of setting achievable goals and priorities, determining strategic agency teaming partners, measuring and monitoring progress, and prioritizing initiatives to best use limited funds.

The five workshops also included the development and dissemination of eight tools to assist agencies with integrating sustainability into their policies and projects.[6] (See table on the following page).

Figure 1: Tools Developed - TERC Sustainability Subcommittee Workshops

Tool	Value of Tool
1. **Program Inventory and Planning Worksheet**	Inventory the programs, assets, and activities that are currently occurring within the agency in order to develop a baseline for comparing future sustainability activities.
2. **Handbook to Develop Sustainability Measures**	A 30-page handbook to understand how to effectively measure sustainability and to understand how to rigorously manage sustainability performance. Practice tables were provided to measure existing efforts.
3. **Sustainability Evaluation Tool Worksheet**	Spreadsheets to evaluate projects and initiatives at a high level or to a very detailed, quantitative level. Provides information on life-cycle analysis.
4. **Tool to Determine Topics – Categories – Aspects**	This spreadsheet helps establish short- and long-term internal and external goals, as well as responsible parties, performance measures, and data sources.
5. **Decision Flow Chart**	This flow chart provides a path for decision-making when conflict is encountered within a project or program which may occur between sustainability measures/strategies and between agencies.
6. **Mitigation Screening Tool**	If conflict is encountered within a project or program this matrix allows for screening various sustainability strategies to ultimately determine which strategy is preferred.
7. **Identifying Key Partners**	This worksheet guides the process of determining the key partners that should be invited into the project process.
8. **Strategy Plan**	After sustainability strategies have been identified, this plan can be utilized to break down those strategies into smaller components (e.g. contracting, technologies, risk).

Training and Communications

CDOT's Maintenance Academy annually teaches environmental ethic and technical skills

CDOT takes 1,500 employees through its Maintenance Academy on an annual basis. They review CDOT's environmental ethic and cover a wide variety of issue areas. New hires receive two weeks of training and existing staff receive one week. Last year, a new session was developed, called "Water Quality - Friend or Foe?" Instructors initiated a discussion with Maintenance staff, who decided it is both. The class included instruction on water quality permits in Colorado.

Environmental awareness training is its own class; new hires and returning staff receive 4-6 hours annually.

Hands on work in the field is key to Maintenance Academy

The Maintenance Academy and environmental courses are well-received. Because the maintenance workforce is so involved in the outdoors, CDOT's training gets staff members out of the classroom and into the field for hands on exercises as quickly as possible.

CDOT has a Best Management Practices training facility used to train construction as well as maintenance staff. At day-long sessions, headquarters staff teach field staff how to properly install BMPs, with hands-on opportunities to install BMPs, such as hay bales, slope runoff protection, and silt fence in the field and evaluate their performance under simulated precipitation run-off conditions.[7] These training sessions are open to non-CDOT employees and industry professionals that have completed the CDOT Erosion and Sedimentation Control Certification training, as well as CDOT staff.

Systems, Practice, Quality Assurance and Accountability

Annual road condition surveys tied to performance based budget

CDOT performs annual surveys of roadway conditions. There are nine (9) maintenance program areas covering all activities. Two of those have environmental activities – roadside facilities including maintaining drainage structures and keeping ditches cleaned and mowed and maintaining grass-lined swales. The results of these surveys are used in CDOT's performance-based budget system.[8]

CDOT maintains animal crossings, including one near Golden, Colorado, and an elk crossing structure with a 96-inch high fence and one-way ramps and gates. The crossing structure includes large animal detectors that activate flashing lights to warn motorists.

The structure has significantly reduced vehicle-elk accidents. Maintenance staff uses software to track roadkill cleanup locations; noting the type of animal killed and the nearest mile marker post. This information is made available to designers for consideration of animal crossing signs or crossing structures.[9]

Other

Capturing brine wash water keeps salt for reuse

A Maintenance professional in CDOT Region 5 came to the property management group and proposed a method to capture wash water from the snow plows, remove heavy metals, and keep the salt brine for reuse. CDOT is now using 3/5 less salt and another good idea from staff was implemented, with social, economic, and environmental benefits.

Recycled asphalt shingles are now used in asphalt repaving projects

CDOT uses about 134,000 tons of recycled asphalt pavement (RAP) annually, containing 4% asphalt binder and used millings as aggregate. In using the recycled asphalt shingles for binder, CDOT did not have to pay for additional binder. Millings are also used under guardrail and on maintenance yards.

Idle reduction equipment is saving fuel and greenhouse gas emissions

There is a fuel reduction executive order to reduce miles driven. CDOT Maintenance is purchasing vehicles, 1 ton and above, with an automatic governor so that after 10 minutes of idle they shut off automatically.

FLORIDA

Florida DOT (FDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interview was conducted by phone with:

Tim Lattner, Director, Office of Maintenance

Chris McGrary, Roadway Maintenance Engineer

Jeff Caster, State Transportation Landscape Architect

Marjorie Bixby, Manager, Environmental Management Office

Structure, Culture, and Staffing

Decentralized structure with increasing outsourcing of maintenance activities

FDOT has a decentralized structure with seven (7) regional Districts and a Turnpike District. Maintenance currently has about 1,900 staff. About 83% of FDOT's maintenance work is already contracted out, making the agency a national leader in maintenance contracting and performance-based contracting. Further, future reductions of in-house crews are anticipated as FDOT moves toward a goal of maintenance work that is 90% outsourced.

"Push button" contracts have good track record of environmental compliance

About 50% of the outsourced maintenance program is conducted with small-scale "push-button" contracts, while the remaining is set by larger, asset maintenance contracts. These small scale contracts are designed to be streamlined and easy to use. Push button contracts also allow FDOT to respond rapidly to observed needs. They have their own set of specifications. FDOT's Push Button Contract is similar to the NYDOT Job Order Contracting (JOC) for multiple tasks. The "push button" contracts are reviewed by Environmental Management Office and recommendations are made on environmental requirements.

FDOT's staff and its contractors have a good track record of compliance with environmental rules and regulations.

FDOT expects their contractors to be knowledgeable of state and federal environmental regulations. Contract documents refer them to FDOTs *Environmental Manual*.[10] Contractors are expected to comply with all environmental policies and regulations, and FDOT has instituted a system of performance deductions if contractors do not comply. FDOT has found that the system works effectively for them and the agency believes they have few if any compliance problems.

Environmental Management Office provides assistance to Districts and oversees work permits

Housekeeping at District maintenance facilities is overseen by District Contamination Impact Coordinators. Assistance is provided by the Environmental Management Office on an as needed basis. District Maintenance Engineers are concerned with environmental issues and seek assistance from the Environmental Management Office in the course of their work, as needed. Their concerns vary widely based on the type of work to be done, the physical location of the projects, and the sensitivities of the areas they work in.

Environmental stewardship and awareness supplements safety and infrastructure preservation focus

FDOT is guided by its Environmental Policy, which references transportation services and goods while encouraging environmental stewardship to protect the human and natural environment. FDOT's mission is defined in statute and is also a state constitutional provision.

Maintenance forces are aware of FDOT's environmental policy and mission, in conducting their maintenance activities. Safety and infrastructure preservation are the two top priorities for maintenance, as they are for many other DOTs, but "compliance with environmental rules and regulations is well understood and is a constant consideration as they do their work."

To the maintenance staff, environmental stewardship means protection of air, water, vegetation, and wildlife resources.

Among other things, environmental stewardship means conserving energy and reducing emissions by using 20% E10 biodiesel fuel in their vehicles. Also, tourism is a key industry in which the natural environment plays a critical role in Florida and everyone understands this.

FDOT tries to build environmental amenities into projects and maintenance supports this, for example, turtle lighting under which maintenance forces manage overhead lights during the nesting season.[11] FDOT acknowledged that previous roadway lighting standards addressed motorist and pedestrian safety in the design of roadway lighting systems, but improvements were needed to more fully consider and respond to conditions in the surrounding environment.

Accordingly, Florida Atlantic University (FAU) conducted a research study to determine the effects of embedded LED lighting system in Boca Raton on sea turtle hatchlings and found a 98 percent decrease in disoriented hatchlings on the adjacent beach (i.e., hatchlings went the "right" way, to the water, after hatching, rather than being attracted to roadway lights).[12] FDOT and partner agencies know that, "of the estimated 6.2 million hatchlings in Florida each year, about 1 million die from predation, dehydration, collisions with vehicles on roadways, or sun and heat exposure." [13]

Communication and Training

FDOT is well-integrated into a statewide network of external environmental land managers

Training is provided for the herbicide program with continuing education credits provided to keep licenses active. FDOT's Drainage Manual is the primary way FDOT staff gets information on appropriate stormwater practices.

Systems, Practice, Quality Assurance, and Accountability

Well-established rating program guides condition assessments

FDOT's Maintenance Rating Program has been in effect since the 1980s and Florida DOT was one of the first DOTs to invest in mapping of culvert and drainage infrastructure locations. FDOT's investment in this was also used to launch and underwrite FDOT's initial funding of the Florida Geographic Data Library, which initially became the core of FDOT and other agencies' Efficient Transportation Decision Making Process.

FDOT ensures condition assessments are conducted for roadsides, ditches, stormwater facilities, culverts, inlets, and cross-drains. With the new MS4 permit, FDOT is now trying to quantify how much debris they are picking up as well, and, by extension, the prevention of nitrogen entering the aquatic system through runoff.

FDOT conducts quality assurance reviews for maintenance contracts

FDOT evaluates the performance outcomes of its asset maintenance contracts by undertaking quality assurance reviews of its roadways and reviewing required paperwork in its Maintenance Rating Program Handbook. Disincentives are included in maintenance contracts.

Other

Partnerships, Research, and Environmental Enhancement Efforts

FDOT is participating in a number of research projects. One involves the University of Florida to assess highway related mowing practices to determine how mowing cycles affect bees, important as agricultural insect pollinators. Stormwater research involves runoff re-use, erosion and sediment control best management practices, as well as floating island technology for stormwater ponds. This information is then incorporated into FDOT's Drainage Design Manual.

Habitat improvement features including wildlife crossings, which are included in FDOT projects as appropriate. These best practices are documented on FHWA's State Stewardship Practices website. Turtle lighting and tunnels have been provided in some critical areas.

Partnerships look to restore lands and manage forests

Ten years ago, FDOT worked with The Nature Conservancy (TNC) on a property TNC owned and was interested in restoring. TNC's heavily disturbed property was similar to the after effects of roadway construction, so FDOT partnered with them on a multi-year study

FDOT maintains an extensive heavily forested right-of-way (ROW), particularly in the I-10, I-95, and I-75 interstate corridors. FDOT ROW management is based, in part, on maintaining the clear zone horizontal and vertical geometry from encroachment. FDOT worked with the Florida State Forest Service to see whether timber harvesting within the highway ROW could be a source of revenue for the State of Florida and determined it would not generate significant revenue. Now that the forest is reaching a mature state, it is seen as an attractive roadside feature to be maintained. FDOT is working with the Florida State Forest Service to determine ways to improve forest health, wildlife habitat, and to provide storm damage mitigation within the highway ROW.

Well established partnerships effectively control invasive species

FDOT is partnering with FDEP and local groups to deal with invasive plant species within the ROW and on adjacent private lands. Cooperative Invasive Species Management Agreements have been established throughout the state involving interagency, inter-governmental, and public-private groups that share equipment and manpower to provide weed and invasive species management in natural areas. In order to provide effective weed control, treatments must be conducted simultaneously on the highway ROW and adjacent private lands, and so the agreements facilitate timing for maximally effective results. Through this partnership, FDOT and other agencies are making headway in a very difficult area.

Prescribed burning maintains open landscapes

FDOT is a leader in prescribed burning within the highway ROW. There is more prescribed burning in Florida than any other state, an effort for which FDOT has received awards. FDOT has demonstrated that prescribed burning can be done safely along its roadway.

In one case, prescribed burning was mainly done for aesthetics; where a two-lane road was widened to 4-lane. The adjacent plantation owners on either side of the ROW donated land for the widening. One of the conditions of the acquisition agreements was that DOT would continue to maintain the land as it had been, with beautiful open landscapes and views to the long-leaf pine forests.[14]

Sub-Appendix - Maintaining Native Ecosystems on Florida's Kate Ireland Parkway

The Kate Ireland Parkway is a 9-mile stretch of US-319 (Florida SR-61) that runs from Tallahassee, Florida, to the Florida-Georgia border. In 2008, the Federal Highway Administration (FHWA) recognized the ecological importance of a public-private partnership that crafted a unique landscape and maintenance plan for the Kate Ireland Parkway. This partnership pioneered the use of prescribed burning on the highway median to conserve and restore the native longleaf pine-wiregrass ecosystem.

Longleaf pine-wiregrass ecosystems are one of the most densely diverse environments in North America. As many as 40 plant species, including forbs, grasses, and woody plants, can grow within a 10-square-foot area. Many of these species depend on frequent fires to thin the tree canopy and provide ground-level sunlight. Ongoing development in longleaf pine-wiregrass areas in the Red Hills region of northern Florida and southern Georgia has threatened these plants' survival.

In 1992, the Florida Department of Transportation (FDOT) planned to widen US Highway 319 (SR-61). US-319 winds through Tallahassee and the Red Hills region of the Florida Panhandle. In order to widen the road, FDOT needed to acquire additional right-of-way, largely from the owner of a single historic plantation. The owner of Foshallee Plantation, Miss Kate Ireland, agreed to donate enough right-of-way and scenic easements to construct four traffic lanes — as long as FDOT agreed to preserve the rural character of the corridor and use prescribed burns to maintain the donated right of way. Prescribed burning replicates the effects of frequent natural fires that allow longleaf pine-wiregrass ecosystems to survive. The controlled fires help to cycle nutrients, control invasive species, and reduce the chances of destructive wildfires. Prescribed burn maintenance has been used on Foshallee Plantation and other Red Hills plantations for generations. After FDOT completed the highway widening project in 2001, Miss Ireland donated an additional $300,000 to landscape the median with native oak hammock and longleaf pine-wiregrass plants. This donation allowed FDOT and the Florida Division of Forestry to add valuable habitat for threatened plants.

FDOT brought together a mix of public and private entities to

analyze the planting strategy for the median and the safety strategy for the prescribed burns. Partner agencies included the Tall Timbers Research Center, a local nonprofit devoted to researching the native ecology of the Longleaf Pine-Wiregrass system; the Florida Division of Forestry; the Florida Highway Patrol; and the Florida Department of Environmental Protection.

The Tall Timbers Research Center and the Division of Forestry developed a plan to plant a mixture of native oak hammock, longleaf pine-wiregrass, and wetland plants. This mixture of ecosystems replicated the Kate Ireland Parkway's surrounding environment and was highly suitable for prescribed burn maintenance. In order to ensure public safety during prescribed burns, the Division of Forestry planned to carefully manage the plant fuels used in the burns. In conjunction with the Florida Highway Patrol FDOT developed a safety plan to address possible smoke-related visibility problems and other hazardous conditions.

As of February 2009, seven miles of the Kate Ireland Parkway project were complete. The highway median and scenic easements surrounding the highway provide an opportunity for motorists to experience the beauty and diversity of the Red Hills landscape. The median also provides a haven for the plants of the longleaf pine-wiregrass ecosystem.

The success of the Kate Ireland Parkway project led FDOT to consider a wider application of prescribed burning on right-of-way vegetation. This public-private partnership may soon lead to a more sustainable and less energy intensive practice of highway maintenance across Florida and the United States.

MARYLAND

Maryland State Highway Administration (SHA) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interview was conducted by phone with the following staff and supplemented with additional research and team knowledge.

Russell Yurek, Director, Office of Maintenance

Sonal Sanghavi , Director, Office of Environmental Design

Structure, Culture, and Staffing

Office of Environment provides compliance, stewardship and sustainability leadership across all modes of transportation

The Maryland Department of Transportation (MDOT) Headquarters' Office of Environment provides leadership and guidance in the areas of environmental compliance, stewardship and sustainability to the Department's six transportation agencies -- Maryland Aviation Administration, Maryland Transportation Authority, Maryland Port Administration, Maryland Transit Administration, Motor Vehicle Administration, and State Highway Administration (SHA). MDOT is the only state DOT nationally to comprehensively encompass all modes of transportation within a single Department, itself an environmental achievement in their degree of commitment to multi-modality.

Under its State Highway Administration, MDOT has seven Districts in Operations. The Office of Maintenance holds a monthly Statewide Maintenance Council meeting to discuss key aspects of their program. The MDOT Environmental Compliance Division works with the district maintenance staff in this geographically small state. Environmental staff members are not embedded in the maintenance shops as headquarters is not far away. Four District Environmental Coordinators support highway maintenance and operations in the seven districts.

SHA has a Performance Excellence Division in the SHA Administrator's Office, which oversees business planning on a three-year cycle. An impressive array of objectives and strategies for the agency's priorities populate the SHA's FHY 2012-2015 business plan, which is available at: http://www.marylandroads.com/oc/shabusinessetnl.pdf.

SHA has an Environmental Compliance Division and that Division led development and implementation of a compliance-focused Environmental Management System (EMS) at SHA, developed and administered the self-audit program, and centralized support for the administration of long-term environmental compliance and stewardship goals. The District-level positions helped implement the changes and SHA assessed performance improvements in five

outcome areas (compliance performance, cost-effective strategies, best management practices, intergovernmental relationships, and stakeholder confidence).

As described by Sanghavi et al. in 2007, SHA's EMS framework fits within the context of the SHA's environmental stewardship framework. In addition to documenting regulatory compliance, SHA's objectives in developing an EMS were achieving higher levels of environmental stewardship, building the agency's "trust bank" with regulatory agencies, providing increased confidence to internal management, and improving the agency's image and relationships with the public.

MDOT & SHA help execute state environmental improvement objectives, including reforestation and water quality improvement

SHA says, "As an organization whose goal it is to construct highways, it is sometimes easy to overlook the environmental responsibilities we have as stewards of large amounts of land within the State."[15] While the agency pays careful attention to impact avoidance, where avoidance "is not possible, every effort is made to replace the impacted area with carefully designed plantings to help speed up the 'environmental healing' that must take place in order to return the impacted area to a sound ecological community."[16]

SHA also "develops partnerships with local governments, community organizations and garden clubs for the purpose of beautifying highways and improving the environment. Community gateway plantings, reforestation plantings, streetscapes and highway beautification plantings are examples of the types of projects that have been completed within the Partnership Planting Program."[17] SHA is also helping implement state goals related to water quality improvement, reforestation, and restoration.

A cooperative, collaborative approach with environmental agencies and stakeholders has been the key to SHA's success. SHA reaches out to stakeholders at project initiation, identifies their needs and interests, and then strives diligently and creatively to accomplish those, along with the agency's transportation mission.

Stewardship built on business planning, performance and compliance orientation

SHA has a strong culture of environmental stewardship, built on a long-standing commitment to environmental compliance. The agency has worked on making the business case of the importance of environmental management to improving overall agency performance. MDOT has adopted an Environmental Policy, which is publicly available on the agency's website:[18]

MDOT goes beyond compliance to emphasize pollution prevention, energy reduction, environmental restoration on land (reforestation, replacement of historical wetlands in the Bay), continuous improvement (agency EMS development), implementation of cutting edge tracking and accountability systems, training and celebration of accomplishments. MDOT's environmental policy supports the state's "Smart, Green & Growing" initiative to help Marylanders create a more sustainable future for their State; the goal is to involve every Marylander in reducing his or her carbon footprint, preserving our most valuable resource lands and restoring the health of the Chesapeake Bay."[19]

With its long tradition of environmental performance measurement and accountability, SHA has incorporated environmental performance metrics into agency business plans as long as or longer than any other state DOT. Environmental metrics were fully incorporated into the SHA's business processes a decade ago; at that time, SHA not only had established a goal of doing its work in an environmentally responsible manner, their program of tracking environmental performance included maintenance as well as other areas of organizational operations.[20] Metrics include:

MDOT Environmental Policy

MDOT believes that environmental protection and principles of sustainability should be integrated into the Department's everyday business activities and operations. MDOT will manage the facility in a manner that protects the environment and the safety of our employees. Guided by our policy, we will:

- Comply fully with all Federal, State and local environmental laws and regulations.
- Prevent pollution by reducing energy consumption, water usage, and waste production, and recycling whenever possible.
- Consider environmental factors when making planning, purchasing and operating decisions.
- Establish an Environmental Management System for the Headquarters Facility and strive for its continuous improvement.
- Provide training to employees so they can be environmentally responsible on the job.
- Recognize and celebrate environmental accomplishments.
- Communicate and reinforce this policy throughout the Headquarters' Organization.

In addition to an annual review of our progress on environmental goals and adherence to this policy, we invite interested parties to provide us feedback on this policy.

Area spread of invasive plants in the rights-of-way (acres of Canada thistle reduced)

Wetland acres mitigated annually, toward goal of mitigation of historical impacts to tidal and non-tidal wetlands (by implication, improved water quality)

Sediment and erosion control ratings of B or better on 90% of construction projects annually (by implication, benefit or minimize impact to all resources)

Satisfaction of environmental commitments (by implication, improve water quality)

Satisfaction of NPDES permit requirements

Review time for environmental documents for proposed improvements along existing highways (regulatory streamlining)

SHA's stewardship orientation was not only evident in its early utilization of environmental metrics and development of EMSs for all maintenance facilities, but also in stretch goals such as mitigating for historic (not just current) impacts to non-tidal wetlands

Maintenance facility EMS addresses many agency environmental objectives

In 2006, SHA decided to develop and fund an EMS effort for maintenance facilities, in order to:[21]

Improve environmental performance.

Directly incorporate environmental requirements into daily operations and be held accountable

For achieving environmental goals.

Ensure ongoing compliance.

Put programs in place to identify root causes for problems and ensure ongoing compliance, to avoid having to address (and pay for) the same issues again down the road.

Save money. Reduce the risk of highly expensive cleanups and regulatory fines.

Train employees. Achieve/improve employee awareness of environmental issues and responsibilities.

Do the right thing. It is everyone's collective responsibility to ensure that our air, water, soil, and natural resources are protected for future generations.

Develop and implement the procedures and tools to help protect our environment.

As part of EMS implementation, SHA plans to bring all SHA buildings and maintenance facilities into compliance with environmental goals by 2015.[22]

Sustainability means smart and focused management of natural resources

Sustainability is understood by the maintenance staff to mean "being smart and conscious of how you manage your resources." It involves minimizing work, assessing cost-effectiveness of operations, and being aware of life-cycle costs. "Staff will make good choices if it makes sense to them."

Stewardship and sustainability are focused on natural resources. The Governor has specific initiatives for environmental improvement including such goals as planting one million trees, creating 200 acres of wetlands and restoring five miles of streams. MDOT has received funding to plant trees in the right-of-way and in Department of Natural Resources (DNR) state parks and natural areas.

Good coordination and keeping commitments improves relationships with state and federal agencies

MDOT has a very positive working relationship with DNR and other state and federal environmental agencies. MDOT realizes that the coordination and commitments made in the permitting process must be followed up in maintaining the completed capital and maintenance projects. While permitting for capital projects occurs over lengthy timeframes of a year or more, maintenance staff members are oriented to short timelines and are called when emergency fixes are needed. SHA is able to rely on good working relationships with DNR based on the DOT and SHA's track record of good work. MDOT staff built good trust and communication with DNR by asking DNR staff to tell maintenance staff what they would like to see in completed work. When emergencies like Hurricane Irene and Tropical Storm Lee occurred, MDOT maintenance staff by a single email were able to get permission to do repair work on short notice, based on the trust that has been developed over the years.

Training and Communication

Annual, mandatory environmental ethics training, monthly discussion of environmental agenda items at maintenance shops

MDOT provides mandatory environmental ethics training along with their customer service training annually to all employees. SHA conducts annual environmental ethics training for all staff and an annual highway maintenance seminar. Environmental topics are on the agenda at their annual Highway Maintenance Seminar where some District maintenance shops are recognized for their EPA compliance. There is an annual Awards Day.

Town meetings are held monthly in the maintenance shops where environmental issues such as control of invasive species are included on the agenda along with safety and other operational aspects. Because the seven Districts have different types of projects and highway environments they have different concerns.

Transparency and communication with agencies and the public are important aspects of MDOT's approach

MDOT has been opting for greater levels of transparency, openness, and collaboration with agencies and the public for a long time. As the agency states on their website: "This is where you can see how our department is performing in critical areas. Explore this site and let us know where we can improve our performance as well as the way we communicate about our performance. We encourage you to come back and check our progress." [23]

MDOT was also the first DOT to provide other agencies access to the agency commitment tracking system, which MDOT calls the Independent Environmental Monitor Toolkit. SHA tells how the system has increased trust and confidence among resource agencies; agencies know, are notified, and can see online how problems are being dealt with and resolved, within 24 hours of a problem being found by the monitors.

Improved communication between Design, Construction, and Maintenance leading to more easily maintainable designs

During the past three years, SHA has been working on better communication between design, construction and maintenance. This has led to better designs and thus fewer maintenance problems in the future. For example, grass medians need to be sufficiently wide so that they can be mowed. In the future, brick or paved medians may be used in some locations because it is safer if maintenance staff does not have to mow in heavy traffic areas. If projects are constructed properly it reduces future maintenance. A recent focus has been to assure that turf is properly established at the end of construction and the contract not closed out too early. Properly established turf reduces future erosion problems and prevents water quality impacts.

Systems, Practice, Quality Assurance and Accountability

National acknowledgement for performance assessment and reporting

In 2011, MDOT received national recognition from the Association of Government Accountants both for the agency's performance management programs and the agency's annual reporting. "Additionally, a joint report by the Pew Center on the States and the Rockefeller Foundation identified Maryland as one of five states 'leading the way' in tracking how our transportation system is advancing safety, jobs and commerce, mobility, access, environmental stewardship and infrastructure preservation."[24]

MDOT also adds context and avoids going for the minimum/easy measurement of number of violations on permits annually, for its 100% compliance goal. For example, in its most recent Annual Attainment report, MDOT reported the agency is tracking and estimating pounds of various pollutants released as runoff every year, not just a paper-based process or compliance violation. SHA is tracking:

Number of pounds per year of nitrogen pollution abated.

Number of pounds per year of phosphorus pollution abated.

Number of pounds per year of sediment abated.

Number of acres of untreated pavement retrofitted for stormwater management (SWM) controls each fiscal year.

Combined annual cost in dollars of total maximum daily load (TMDL) program.

SHA's strategies in these areas include:

Addressing water quality and natural resources goals through development and implementation of a green asset management plan.

Developing watershed implementation plans (WIP) to comprehensively reduce pollutant loads from SHA right-of-way.

Communicate SHA environmental initiatives and accomplishments for Chesapeake Bay restoration to internal and external customers through effective use of training and web-based messaging and other social media.

Pursuing banking opportunities for project mitigation and TMDL compliance for wetlands, streams and forests.

Comprehensive drainage infrastructure condition assessment and asset management system was the first in the country, at a state highway agency

SHA's comprehensive drainage infrastructure condition assessment and asset management system was the first in the country, at a state highway agency. SHA "developed a thorough and duplicable grade-based rating system for stormwater management facilities and has developed an inventory, database, and photographic record of all facilities statewide and their maintenance status (those graded A or B are considered functionally adequate)."[25] After establishing a baseline, SHA set goals.

By 2006, the agency aimed to have 80% or more of the state highway storm water management facilities rated functionally adequate, and 95% by 2010, goals the agency exceeded; information in SHA's drainage management system assists the agency with decisions on inspection, maintenance, repair, and retro-fit of BMP facilities.[26] SHA's system allows GIS-based queries for systems according to the following:[27]

By individual structure or system and BMPs (e.g., pipes, inlets, manholes, end walls) and their associated data attributes

By outfall (e.g., size, type)

Within a drainage area

Within a watershed

Within a jurisdiction

Statewide and Roadway contract

SHA's system also supports hydrologic analysis of the drainage systems for the preparation of estimates of the quantity and quality of storm water runoff from the ROW, with the goal of analyzing the effects of changes the agency can conceivably make in storm water management practices. Initially, SHA scanned existing hard copy plans and located all facilities with GPS. Now, SHA tries to ensure that its database is automatically updated as water quality facilities are developed. Upon completion of construction of all stormwater management facilities on state projects, SHA requires submission of both an As-built Plan Certification Statement and As-built Tabulations.

Maintenance sustainability performance measures in use by the SHA

To ensure ongoing compliance and environmental enhancements "on SHA Highways and at SHA Facilities," SHA is integrating "sustainable strategies to maintain SHA highways and facilities in an environmentally sensitive manner" and is measuring:[28]

Number of acres of roadside planted/replanted in no/low maintenance groundcovers or native meadows.

Number of road salt management best practices pilot projects implemented each fiscal year.

Number of staff trained in each district each fiscal year for winter maintenance activities involving use of road salt.

Number of SHA operations and maintenance staff (sign, signal shops, labs and maintenance staff) receiving environmental compliance training each fiscal year.

Percentage of stormwater management facilities rated as functionally adequate each fiscal year.

Number of SHA buildings and maintenance facilities assessed annually.

Number of non-compliance findings for SHA buildings and maintenance facilities.

Number of SHA buildings and maintenance facilities with non-compliance findings.

Number of non-compliance findings addressed according to schedule for SHA buildings and maintenance facilities.

Percentage of targeted non-compliance findings addressed for SHA buildings and maintenance facilities.

Acres of Canada thistle identified in SHA right-of-way each calendar year.

Acres of phragmites identified in SHA right-of-way each calendar year.

Acres of Canada thistle treated each calendar year.

Acres of phragmites treated each calendar year.

Number of Partnership Planting projects completed each calendar year.

To help address these priority areas, SHA is moving to a more sustainable vegetation management approach based on individualized plans for every major highway corridor (includes US and interstate routes) and a general plan for non-targeted roads based on highway classification, context, and geographical area. SHA implements Partnership Planting projects to enhance the appearance of communities adjacent to state highways and has a visual assessment component of assessment of its stormwater management facilities, where the SHA maintains a high level of service.

SHA continues to improve invasive species control outcomes through innovative vegetation management techniques. For water quality and resource savings, SHA is developing and implementing a plan to manage salt. Environmental Compliance and Stewardship co-chairs also

periodically attend SHA maintenance council meetings to facilitate discussion on what and how the maintenance community is doing to promote environmental stewardship and sustainability.

To mitigate for climate change, save energy, and reduce greenhouse gas (GHG) emissions, SHA is continuing to increase usage of alternative fuels, fleet and congestion management and emissions reduction strategies in highway maintenance and construction, using the following performance measures:

Annual percentage increase in use of E-85 in the SHA light fleet.

Annual carbon footprint (CO2e) calculated for total SHA fuel usage.

Annual percentage increase in the number of flex-fuel vehicles added to the SHA fleet each year.

Annual reduction in GHG resulting from congestion management projects.

Annual usage of alternative fuels.

Percent of fuel usage that is alternative fuel.

Total fuel usage of the SHA light fleet.

SHA is continuing to try to reduce GHG emissions through fuel and fleet management practices, by adding specs to contracts and requiring contractors to follow contract specifications, and building an inventory of opportunities for GHG reduction in construction activities. SHA is also reducing GHG emissions through roadside maintenance policies and activities, including developing a carbon management program that operates to reduce SHA's carbon footprint while saving energy and enhancing sustainability credentials.

SHA's Climate Change Adaptation efforts include implementation of strategies to manage SHA assets, modify business practices and adapt infrastructure to climate change. The agency is working on developing a long-term strategic climate change plan and working with OOTS to identify traffic signals vulnerable to power loss and develop plan to provide battery back-up systems. Measures include:

Number of SHA facilities with adaptation strategies documented in the SHA Climate Adaptation Plan.

Number of state-maintained lane-miles with adaptation strategies documented in the SHA Climate Adaptation Plan.

Number of SHA bridges, structures and culverts with adaptation strategies documented in the SHA Climate Adaptation Plan.

Number of traffic signals where battery back-ups have been installed.

SHA is also adopting a green materials management approach to reduce waste and achieve higher levels of re-use and recycling, tracking:

Total non-Maryland Recycling Act (MRA) tons recycled each calendar year.

Total MRA tons recycled each calendar year.

MRA recycling rate each calendar year.

Tons of reclaimed concrete aggregate used annually on SHA paving projects to replace virgin graded aggregate base (GAB).

Tons of fly ash used annually in SHA concrete pavement applications.

Tons of blast furnace slag used annually as aggregate in SHA concrete pavement applications.

Number of recyclable material applications covered by SHA policies or specifications.

Percent of recycled asphalt pavement (RAP) used annually on SHA paving projects. (Expressed as a percent of the total hot mixed asphalt (HMA) tonnage placed on state roadways).

Tons of RAP used annually in HMA on SHA paving projects.

Toward this end, the agency has been creating a recycling clearinghouse/business unit to coordinate facility and equipment recycling initiatives and to develop policy and programs to identify resources and uses, create or promote markets, facilitate procurement services and revenue streams.

To reduce energy consumption for highways and other facilities, SHA has been undertaking an ongoing process of researching and implementing new technologies and business processes while continuing to encourage an SHA-wide conservation culture. SHA has been developing an SHA policy for best management practices to reduce usage and conserve energy in highway lighting, signage and signals. They are tracking:

Annual percentage reduction in kilowatt hours resulting from LED conversion of traffic signals.

Percentage of poles eliminated each fiscal year under the SHA lighting reduction program.

SHA is also implementing organization-wide energy reduction strategies at facilities.

Audits demonstrate compliance and lead to ongoing improvements

MDOT developed a voluntary Self-Audit Program in cooperation with EPA region 3, a first in the nation to continually assess, correct and improve operational practices that may impact the environment. The self-audit program helps ensure MDOT's compliance with all applicable federal, state and local regulations. NYSDOT undertakes a self-audit now as well.

MDOT ensures multi-media audits are performed at all 109 facilities and storage yards for all modes of transportation, including ports and aviation. These involve third party inspections and disclose the findings publicly.

MDOT built their facilities and compliance EMS on the results of the audit, which was also used to justify increased capital and maintenance funding. Improvements at the facilities are ongoing, including those for salt storage facilities, communications towers, sign shops,

moveable bridges and materials labs. Performance metrics built into the annual inspections have led to a healthy competition between the shops to improve housekeeping and environmental compliance.

Asset management program helps create the business case for maintenance funding

The MDOT larger asset management program is robust and focused on pavement and large structure preservation. With their detailed inventory, SHA has a listing of backlogged capital and maintenance projects that are ready to go, as WSDOT is doing. The agency is then able to document the business case to justify needed funding. There are still some gaps, but the program serves the SHA very well.

MDOT has a performance measurement component for compliance in their maintenance facilities and operations, as well as measures related to vegetation management and invasive species. Based on these performance measures, MDOT has been able to obtain capital funds for environmental improvements at their shops, including new tools, storage bins, underground tanks and stormwater facilities.

SHA and other modes each report on current environmental priorities in Annual Attainment report

SHA's current environmental compliance and stewardship goals, performance measures, and strategies are included in the agency's business plan. While compliance is at the heart of a stated goal, SHA's performance measures go beyond, to effectively "provide a positive contribution to Chesapeake Bay water quality;" thus the department estimates its pollutants and doesn't just track permit violations.

In their 2012 Annual Attainment Report, SHA lists the following initiatives or priorities:[29]

Vegetation Management: Continue to expand and enhance the "Mowing for Meadows" program, which has reduced mowing costs by over $1 million each year and avoided significant emissions from mowing equipment and pollutant runoff.

Climate Change:

- Develop SHA's draft adaptation plan/risk policy into a Climate Action Plan
- Continue to track vulnerable transportation assets and climate adaptation measures
- Identify opportunities to address climate change in project development.

Stormwater Management: Develop a draft plan for SHA pollutant load reductions to achieve Chesapeake Bay Total Maximum Daily Load goals and to safeguard water quality. SHA identified $55.1 million in the FY2012–FY2017 CTP toward restoration of the Chesapeake Bay and compliance with Total Maximum Daily Load standards.

MICHIGAN

Michigan DOT (MDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interviews were conducted by phone with:

Steven Cook

Margaret Barondess

Kristin Schuster

Structure, Culture, and Staffing

MDOT's environmental functions are mostly compliance based, although there is a stewardship focus as well. For example, MDOT has undertaken joint research efforts with DEQ and DNR to look at green infrastructure in a partnering effort and in siting DOT mitigation or ecological investments.

Standard operating procedures routinely address environmental compliance, and a recent audit of about one-third of the maintenance garages revealed a high level of compliance along with opportunities for improvement at many others. Michigan DOT has found success teaching stormwater management expectations along with safety and security procedures and incorporating stormwater procedures into the latter.

MDOT well understands that their maintenance and operations activities support the economic leg of the triple bottom line. In the I-94 Corridor from Chicago to Detroit, they are tracking user delay costs. New software is being used to measure real-time travel speeds down through the corridor. The specific goal is to avoid delays of more than 40 minutes from Chicago to Detroit (10 minutes within the SW region, 10 minutes within the university region, and 15 min in Detroit area). They are assessing how much time it takes to get travel back up to the original speed when traffic encounters snow removal equipment or a work zone.

Interagency partnership and working group provides support on environmental issues

MDOT and regulatory agencies developed a Memorandum of Agreement setting up an interagency committee to address and work on environmental issues. The primary focus is permitting and the capital program. MDOT has found that the counties often struggle with some of the environmental aspects because they do not have environmental specialists and are not active with the committee, which proactively works out some issues. MDOT provides funding for staff at regulatory agencies to do permitting, increasing the capacity for environmental reviews, and has refined partnerships in other areas, such as joint resource mapping and mitigation/enhancement siting.

Training and Communications

Environmental training is focused on regulatory reporting. Most of this is done on the regional level. Formal stormwater training will be addressed next year, but for now stormwater management expectations, procedures, and training are combined with safety and security. Region Resource Specialists provide necessary to the maintenance staff for stormwater and other environmental guidance as needed.

Systems, Practice, Quality Assurance and Accountability

Maintenance monitoring focuses on reductions in salt usage and environmental performance at yards.

MINNESOTA

Minnesota DOT (MnDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interviews were conducted by phone with:

Steve Lund, MnDOT Maintenance Director

Frank Pafko, MnDOT Environmental Director

Structure, Culture, and Staffing

Stewardship culture is well established

MnDOT staff's local familiarity with and respect for their environment drive their efforts towards environmental protection. MnDOT's internal discussions on building a stewardship culture started over two decades ago, beginning as a follow-up to an NCHRP project where building an "environmental culture" was discussed.

MnDOT's stewardship effort began with staff that had an outdoor hunting and fishing orientation, responding with practical ideas that made sense and that benefited wildlife and fisheries. The stewardship focus has had a strong "bottom-up" component. Kestrel and bluebird nesting boxes were constructed and native prairie grasses were established and maintenance staff helped with controlled burns. MnDOT built a rest area on the shores of a premier fishery and installed a boat ramp.

Maintenance staff has internalized stewardship concepts and believe in it. MnDOT Environmental and Maintenance Directors noted that if maintenance staff members think an (environmental) action makes sense, they will buy into it. The stewardship ethic is re-invigorated by annual messaging in pre-season winter training and road salt symposiums.

There is considerable attention given to stewardship and environmental protection that staff has picked up on. Acceptance turns into belief and then into expectation. Vegetation management and wildlife enhancement are accepted practices even to a focus on proper grass seed selection to reduce future maintenance.

Executive Order focuses current efforts

MnDOT recently combined management directives and previous governor executive orders into one Executive Order, to refocus the agency's efforts. MnDOT has a new focus on sustainability, moving to alternative fuels, reducing carbon footprint, and trying to recycle more.

MnDOT leadership guided and encouraged stewardship practice with awards and recognition

MnDOT leaders have used staff recognition and awards to create an atmosphere where sound environmental work is recognized and encouraged. The Commissioner recognizes the top three residencies in an annual ceremony. And, maintenance staff also appreciated environmental excellence awards and plaques from FHWA, notably for their archaeology decision support system and for the historic bridge programmatic agreement. The latter helped bridge engineers take extra care in maintaining what they came to view as "their" historic bridge.

Training and communications

Environmentally-related training areas include the following: Formal training is conducted for pesticide application and management of invasive species where MnDOT is beginning to experiment with biological controls. Other training has been more of a grassroots effort. MnDOT forestry and vegetation units assist with ongoing problems identifying hazard trees, controlling emerald ash borer, and advising on erosion control problems. These staff visits enable one-on-one interaction with the in-house environmental expert and the maintenance personnel building trust and embedding an environmental awareness in the overall organization.

Systems, Practice, Quality Assurance & Accountability

MnDOT tracks salt usage and pesticide application as environmental metrics.

NEW YORK

New York State DOT (NYSDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interviews were conducted on-site and by phone with:

Debra Nelson, Assistant to the Operations Director, NYSDOT

John Rowen, Vegetation and Environmental Program Manager - Maintenance

Kyle Williams, Environmental Science Bureau

Dave Graves, Environmental Sciences Bureau, Water/Ecology Section

Joe Doherty, Roadside Maintenance

Structure, Culture, and Staffing

The transportation network under NYSDOT includes a state and local highway system that annually handles over 130 billion vehicle miles encompassing more than 113,000 highway miles and more than 17,400 bridges, an extensive 35,000-mile rail network, 85 public and private aviation facilities through which more than 80 million people travel each year, over 130 public transit operators serving more than 80 million passengers each day, and 12 major public and private ports.

Environmental Initiative

In the late 1990s, NYSDOT embarked on an "Environmental Initiative" to:

Advance State environmental policies and objectives;

Promote an environmental ethic throughout the Department; and

Strengthen relationships with environmental agencies and groups.[30]

The initiative had three components:

First, NYSDOT funded and implemented a number of "environmental benefit projects" on property owned by the NYSDOT as a straightforward and visible demonstration of environmental commitment. These enhancement projects were designed to improve water quality, restore wetlands, protect fish and wildlife, promote eco-tourism, and enhance transportation corridors.

Second, NYSDOT initiated an "environmental betterments program" in which specific environmental improvements were advanced as part of NYSDOT's capital construction program. This included landscaping, park amenities, historic preservation, noise barriers, wetlands, stormwater basins, and wildlife plantings that were funded by local agencies or groups and were incorporated into NYSDOT capital projects. The "better than before" concept

became widely influential among DOTs nationwide, and was supported by a video profiling agency environmental activities around the state. It was used both internally and externally to build understanding and support of the environmental work the agency could and would do.

Third, NYSDOT committed to "improve its environmental performance" by reducing environmental toxins, improve air quality, increase the use of recycled materials, and preserve and enhance New York's historic and natural character.

The Environmental Initiative required each Region to develop specific work plans on how they would institute the Environmental Initiative and the three approaches. The Environmental Initiative was undertaken at the same time the DOT was implementing "Quality through Participation." From the main office, the guidance to the regions was broad. Regional staff was empowered to come back with their specific programs and good ideas in response to the agency priority areas.

EAB staff tried to maximize their ownership, initiative and enthusiasm; they avoided dictating to staff and encouraged the staff to think more deeply about how to make changes in their own work. The program areas had ownership and decided how to implement the initiative. As they described it, EAB often "re-drew the bulls-eye" based on what they observed and what Regions suggested, so the Regions did not see it incorporated and understood their concerns and objectives. The environmental initiative fit with the decentralized nature of the agency. The Regions owned it and it became part of their culture.

The Environmental Initiative work plans developed by the Regions varied in scope and complexity. To further support implementation, EAB developed report formats for Regions to use that tracked progress. Some Regions were clearly further along in their environmental awareness and in developing environmental benefit and betterment projects. There is always a certain amount of peer pressure/competitiveness among regions – regions could see what others were doing and want to "up their game".

Environmental positions

As the Environmental Initiative progressed, NYSDOT realized that addressing environmental issues in the permitting design phase did not ensure environmental compliance in Construction or Maintenance. More support was needed in these critical areas. Consequently, The Environmental Analysis Bureau (EAB) together with DOT executive management made a deliberate effort to create environmental positions in Design, Construction, and Maintenance. The Regional Environmental Coordinators (RECs) in Design, the Construction Environmental Coordinators (CECs) and the Maintenance Environmental Coordinators (MECs) were established in all eleven Regions. They are all "coordinators", not necessarily the environmental "doers." Their role is to pull people together, collaborate, come up with solutions, and involve other people to foster awareness, buy-in, and implement solutions. This is fundamentally a technical management role, with a high degree of sophistication and responsibility.

When setting up the MEC positions, it was determined that the positions had to actually be imbedded in the regional Maintenance units so that the MECs knew, on a day-to- day basis, what the maintenance staff did and how best to support them. Establishing a senior Civil Service grade level was critical for the sense of authority and responsibility. NYSDOT believed the new duties would be very challenging. Candidates for the MEC positions had to be solution oriented and good communicators in order to collaborate and co-develop improved practical solutions.

Since establishment the MEC's have accumulated a wealth of knowledge on what matters to, and works for, front line staff in construction and maintenance. In addition to "how to" knowledge with regard to practical implementation of environmental needs and opportunities, MEC's have developed longstanding relationships with resource agency staff on the local and state level, facilitating collaborative relationships that further benefit the department. Supervisory responsibilities have been added to several of the CEC and MEC positions as their workload and stature has increased in the Regions.

Another coordination change implemented in 2008 is the establishment of Regional Liaisons within EAB. Each Regional Liaison is responsible for working closely with assigned Regions to help address their specific support needs on a daily basis and to help identify statewide priorities. The Liaisons also travel to the Regions once or twice per year and meet face-to-face with the Regional Environmental Unit Supervisors, CECs and MECs to discuss needs, challenges, successes, etc. as a group. As usual, there are standard agendas and written summaries and follow-ups with identified action items and responsible parties.

Executive support

Having executive level support for any culture change is important and certainly was critical in expanding the environmental positions into design, construction and maintenance. As EAB leaders stated, "You need to have the people doing the work fired up to do it, but they will keep hitting a wall unless mid-level managers get the message and direction from executive leadership." NYSDOT started with an Environmental Initiative, environmental policy, and associated engineering directive. Executives backed this up with funding for additional environmental technical assistance expertise for Construction and Operations. Further leadership and executive support extended these initiatives with the agency's sustainability policy.

Environmental Policy

In 2000 NYSDOT developed an Environmental Policy, now supplanted by a Sustainability Policy.[31] The Environmental Initiative can now be viewed as an early take on one circle of the sustainability triple-bottom line that now also focuses on economic competitiveness and social benefits. This was an evolutionary process.

Sustainability is now in the capital program update. Regions must now address how their capital projects relate to sustainability and is incorporated into the Department's preservation strategy. This helped to make the concept of sustainability more understandable and raised

awareness. Every region is to have a sustainability and asset management team, developing common language and approaches.

Green and Blue Highways

NYSDOT continues to integrate environmental stewardship and context-sensitive solutions in its planning, design, construction and operations. In 2005, the Office of Transportation Maintenance started Green and Blue Highways as a further grassroots effort to support & capitalize on field staff insights and capabilities.[32] The Green and Blue Highways Initiative is another of the NYSDOT maintenance program's evolving efforts to bring environmental stewardship and sustainability into maintenance activities. The initiative encourages a stewardship /operations maintenance synergy. Under this program regions and Residencies annually undertake many spot improvements to improve the environment, such as installation of nesting boxes for the American Kestrel, an endangered bird of prey, at safe locations on the right of way - - or providing millings to improve fishing and trailhead parking lots.

Completed projects include:

Planting living snow fence to address the safety issue of blowing/drifting snow on highways and in maintenance facility yards;

Re-vegetating rights of way with native vegetation;

Improving parking areas with new paving, fencing, and picnic tables for parking area users;

Testing low and no mow grasses to simplify right of way management; and

Using vegetation to screen maintenance facilities.

Training and Communication

Maintenance staff has developed - -and actively participate in - - training that improves the environment, including courses on: how to design and install living snow fence, stream restoration, hazardous tree and tree skills and safe and productive herbicide use. Many of these courses are structured so maintenance staff learns by doing, and much of what the workers do is provided and explained by the maintenance workers themselves. For example, the living snow fence class actually installs a living snow fence, which provides future snow and ice control benefits. A bi-annual report is prepared and shared among the Regions. This way they can hear about the good things others are doing and consider whether they can do these things themselves.

NYSDOT also provides internal training for its maintenance managers on building trust, choosing a leadership style, explaining work, and demonstrating skills, which may be found at. https://www.dot.ny.gov/programs/trns-maint-train

When the Environmental Initiative was begun, Main Office environmental staff organized environmental training for regional staff. In setting up stormwater and erosion and sediment control training around the state, DOT staff members from Design, Construction, and

Maintenance and other state and federal regulatory agencies were invited. Within the DOT, the goal was to have Design, Construction and Maintenance staff participate in the courses together so that they could better understand how stormwater facilities and erosion and sedimentation control best management practices (BMPs) were designed, how they needed to be constructed to operate properly, and how they would need to be maintained once turned over to maintenance forces. This generated good dialogue while helping staff to get to know one another across functional lines.

Monthly statewide training

Three years ago, NYSDOT Office of Environment initiated an Environmental and Landscape Architecture Training Series (ELATS). It occurs monthly in the form of a statewide Webinar for regional staff. There are ELATS Coordinators in every region that facilitate facilities, attendance lists, and manage CEU and PDH credits. Average attendance is about 130 people, due to the convenient, regular format and interesting content. RECs, CECs, and MECs frequently participate. The presentations are also available on the DOT internal website or on CD. The topics that are selected come from solicited ideas. The topics are focused on Maintenance, Construction, and Design.

Involving regulatory agencies

NYSDOT EAB staff also makes a deliberate effort to invite state and federal agencies to DOT training courses so that the regulatory agencies can see what the DOT is doing and to give staff from the different agencies a chance to get to know one another. This has significantly improved interagency trust, communication, and coordination; and has been of help when the inevitable problems arise in the field. DEC, Army Corps, and Adirondack Park Agency staff have all participated in various trainings. Recent courses were given on the Rosgen Training for stream restoration. Many RECs and MECs have excellent experience in stream restoration work. DEC wants to get training out to local agencies on remedial stream work following recent tropical storms. NYSDOT offered to could help and improve credibility since NYSDOT staff often more experience with construction than the DEC staff.

Local governments

NYSDOT participates in training for local governments through the Local Technical Assistance Program (LTAP). The LTAP Center enables local counties, townships, cities and towns to improve their abilities to maintain roads and bridges under their jurisdiction.

New York State's LTAP Center provides technical engineering services and training in several highway-related transportation applications and associated issues to local highway personnel from rural and small urbanized areas, towns, counties, cities, and villages. NYS LTAP Program services provide assistance and information to municipal officials and employees responsible for the maintenance, construction and management of local highways and bridges in New York State. Technology transfer services are provided through formal instructional classes, delivered throughout the State and through other means, such as direct mailings, conferences, phone calls, e-mails, maintenance of a website and reference/library.

The following technical topics are the subjects of NYS's LTAP training program:

Asphalt paving principles,

Basics of a good road,

Complete streets,

Planning safer communities for bicyclists and pedestrians,

Effective communications skills for highway and public works officials,

Managing people,

Pavement maintenance,

Power and duties of local highway officials,

Reduction liability for local highway officials,

Road safety fundamentals,

Roadway and roadside drainage,

Signs, small Highways department management,

Snow and ice control operations for local highway departments,

Surveying methods for local highway department, and

Work zone traffic control for local roads.

NYSDOT maintenance staff also participate in the NY Local Roads Program out of Cornell University, a land grant college. Every June, they conduct a roads school and bring in local government highway managers, and they put on other programs as well. At a recent meeting, FHWA contributed and talked about invasive species and living snow fences. Typically when maintenance does training at the regional or residency level, they invite their regulatory counterparts to come. The relationships are such that the agencies often invite each other to field meetings and have regional points of contact, fostering cooperation. [33]

Materials and Documentation

The Office of Environment (OOE) develops policies, procedures and technical guidance materials to Department staff to ensure compliance with State and Federal laws and regulations. *The Environmental Manual* (TEM) is a comprehensive source for the Department of Transportation's policy, procedure and technical guidance on environmental matters relating to the planning, design, construction and maintenance of transportation facilities. As such, it is the basis for most of NYSDOT's environmental quality assurance, training and continuous improvement processes. This manual is undergoing revisions.[34] Staff clarify reasons and requirements, along with guidance. As chapters in the TEM are revised, a new section specific to "Maintenance" is being added. The *Guidelines for the Adirondack Park* provides additional interagency (DOT, DEC, APA) direction for the design, construction and maintenance of

highways and maintenance facilities in the Adirondack Park, a unique area roughly 1/6th in size of the State of New York.[35]

The Environmental Handbook for Transportation Operations is a summary of the environmental requirements and best practices for maintaining and constructing highways and transportation systems.[36] This handbook is intended to provide NYSDOT personnel with general awareness and guidance of the primary requirements that apply to the types of activities conducted by NYSDOT Operations. Achieving the Department's mission requires NYSDOT to conduct maintenance, manage equipment, and perform construction activities appropriately to prevent and/or minimize adverse impacts to the environment. The handbook is updated every two years.

Systems, Practice, Quality Assurance & Accountability

GreenLITES integrates sustainability principles into programs and projects

NYSDOT developed the Green-LITES (Leadership In Transportation and Environmental Sustainability) certification program to help integrate sustainability principles into transportation using the building industry's LEED system as a model. https://www.dot.ny.gov/programs/greenlites The program is used on a continuous basis and formally ranks capital projects as well as operations and maintenance work on a sub-regional basis, and all region-wide investments made (and not made) on an annual cycle for internal review and comparison.

Initially used as a tool for the assessment of environmental sustainability on individual capital projects, GreenLITES' potential to address transportation investments across a range of program areas soon became apparent, and a more holistic approach to the "triple bottom line" of economy, society, and environment was adopted. As a result, the GreenLITES program now includes a growing collection of tools (rating systems, spreadsheets, and other metrics) for the planning and assessment of projects, operational activities, maintenance programs, and regional investments.

GreenLITES is a transparent, metrics based, self-assessment program to institutionalize triple bottom line thinking, continuously measure performance, and foster best practices throughout NYSDOT. GreenLITES also provides an impetus for partnering with others and helps relate transportation investments to jobs, quality of life, and environmental stewardship. A continuing work in progress, the program has been implemented in stages, starting with the September 2008 Green-LITES Project Design Program.

Green-LITES Operations was launched into its pilot year on Earth Day 2009. The program encourages Transportation Maintenance, Fleet Administration, Traffic, Safety & Mobility, and Modal Safety and Security to advance sustainability principles in all aspects of DOT's work. The GreenLITES Maintenance/Operations Plan Spreadsheet is tied to the Maintenance and Operations Plan (MOP – Budget development system) and the ongoing March 2010 Regional Pilot Program. GreenLITES Operations tracks what they have done for the year. NYSDOT has a

draft Operations Certification Program. https://www.dot.ny.gov/programs/greenlites/operations-cert They are also working on a draft Regional Infrastructure Sustainability Elements (RISE) table.

Audits

NYSDOT does self-audits to measure compliance with all NYS Department of Environmental Conservation environmental regulations. The audits are implemented regionally. Typically the MEC is the audit coordinator.

Other

Working in partnerships to manage watersheds and control invasive species

NYSDOT maintenance staff brings critical perspective and contributions to the many partnerships. For example, New York State Department of Environmental Conservation (DEC) is partnering with other state agencies, resource managers, non-governmental organizations, industry, resource users, citizens and stakeholders to combat invasive species. Invasive species are managed statewide through eight Partnerships for Invasive Species Management (PRISM) managed by NYS DEC. NYSDOT is an active participant and NYSDOT maintenance staff represents the department on many of the PRISMs. The strategy is to give a reality check to what is practical and providing grassroots bottom-up input and capacity to management strategies.

DEC manages Deer Management Units throughout New York State. Each unit has a Citizen Task Force. Each is directed by DEC and decides what level the deer herd will be managed at in different units of the state. Sportsmen want deer populations high and farmers want it lower, as does the DOT for highway safety. Maintenance staff members participate on the citizen task forces to represent DOTs concerns.

NYSDOT maintenance forces also participate on watershed management groups. NYSDOT interfaces with the streams more than any other entity, given their 18,000 bridges and one million culverts. NYSDOT is heavily engaged in the business end of watershed management as the state agency with “boots and equipment” on the ground.

DOT Maintenance staff also coordinated with DEC staff on the Emerald ash borer and best management practices to control it. The borer is an invasive species affecting ash trees that was initially found in the southern part of the state, and DEC has regulatory restrictions on moving firewood and downed wood. DOT staff had to deal with lots of damaged trees and wood debris from Tropical Storms Lee and Irene. DOT equipment operator instructors turned out to be a great resource. They met with DEC staff and were able to show them how certain DOT wood chippers could chip the fallen wood to a small size that could prevent the spread of Emerald Ash Borer larvae.

Proactively Addressing Climate Change

NYSDOT plays an active role in addressing climate change and trying to reduce greenhouse gas emissions.[37] NYSDOT is one of 15 member agencies that comprise the New York Climate Action Council (CAC). The CAC was created by and is responsible for all charges set forth in Governor's Executive Order 24 . NYSDOT sponsors Clean Air NY, a marketing and outreach program in the New York City metro area to educate travelers about the small changes they can make every day in their transportation choices. The goal is to reduce the number of vehicular miles traveled (VMT), thus improving air quality. NYSDOT is working on several fronts to reduce the number of vehicle miles traveled (VMT). In 2007, NYSDOT displaced more than 750,000 gallons of petroleum by using Compressed Natural Gas (CNG) light-duty vehicles in its fleet.

NORTH CAROLINA

North Carolina DOT (NCDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interviews were conducted by phone with:

Julie Hunkins, Director, NCDOT Office of Environmental Quality

Ken Pace, Environmental Operations and Rest Area

Structure, Culture, and Staffing

NCDOT has environmental sensitivity in its mission statement and the agency has an environmental stewardship policy. NCDOT's mission was broadened recently and now states: "Connecting people and places, safely and efficiently, with accountability and environmental sensitivity to enhance the economy, health and well-being of North Carolina". [38] Customer expectations include protection of natural resources as well as the cultural and social values of their communities. [39]

NCDOT has 14 statewide divisions, 100 counties, and different types of roadways. All fourteen divisions have environmental staff that serve environmental program delivery roles. Division Environmental Officers handle resource agency permitting and provide some construction oversight for permit compliance, particularly for Section 401 and 404 permits. The Division Environmental Officers have varying reporting structures within the Divisions. Some report directly to the Division Engineer, or are staffed directly to Maintenance, Construction or Operations Sections within the divisions.

NCDOT's stewardship activities in maintenance started with erosion and sedimentation control in the 1970s and a delegated erosion and sedimentation control program, with performance tracking. Environmental stewardship and sustainability, with continuous improvement, are the agency's way of doing business. NCDOT has an Integrated Vegetation Management (IVM) Policy with associated manuals and training programs. If protected species sites are identified, they avoid or specially manage those sites. NCDOT also has its own National Pollutant Discharge Elimination System Individual Permit that allows the

Department to discharge general roadway and railway drainage, non-roadway drainage, construction stormwater, borrow pit wastewater and stormwater associated with industrial activities. NCDOT has a strong environmental compliance program rooted in its state water quality program and Integrated Vegetation Management for roadsides, backed up by strong training and state of the art procedures for these topic areas.

Progress in other areas of environmental stewardship and sustainability is following these models, and NCDOT has made a significant investment in the development of a framework that will support the integration of sustainability throughout the department's policies, projects, programs and services. The Center for Transportation and the Environment (CTE) at NC State University has provided research, analysis, synthesis and support for the development of the framework, which includes triple-bottom line Principles and Objectives, as well as performance metrics.

Communication and Training

NCDOT continuously provides training to its maintenance staff through various initiatives. There are formal training programs and operations manuals for IVM, Erosion and Sediment Control, and Stormwater Management. NCDOT requires its contractors and maintenance staff that perform erosion and sediment control functions to maintain an Erosion and Sediment Control/Stormwater certification. There are three training levels for this program: Level 1 – for crew supervisors who manage the installation of erosion and sediment control on project construction sites, Level 2 – supervisors who manage grading work, culvert replacement work and bridge construction, and Level 3 – for those with design responsibilities.

Stormwater Pollution Prevention training is provided to operations staff in the NCDOT facilities, including training on salt management, good housekeeping, and spill containment. Educational flyers are periodically distributed to county maintenance facilities to educate staff on stormwater pollution prevention. An example is a flyer entitled "Stormwater, What's My Connection" pointing out different ways maintenance activities could impact water resources.

NCDOT also has a Continuous Improvement Program with an environmental stewardship category that encourages staff to submit ways to do work more efficiently and in a more environmentally responsible manner. Staff are encouraged to identify the problems they are trying to solve and to quantify the difference that their new process or standard would make. NCDOT has a "Fail quickly, scale quickly" motto that encourages getting innovative ideas out there quickly so staff can try them and see if they are effective. The program scales across divisions and the state and provides recognition for staff. Quantifying the benefits has been challenging. Improvement efforts have been focused mainly on saving time and money. NCDOT is also looking at other benefits, including safety, public health, injury avoidance, and improved water quality or habitat.

Systems, Practice, Quality Assurance and Accountability

NCDOT compliance metrics are rolled up through the counties, the divisions, and to executive staff and are reported to the public on NCDOT's Organizational Performance Dashboard; this underscores NCDOT's commitment to accountability and transparency. NCDOT tracks internal corrective actions. The E&S Control program has been so successful that it is ingrained in the culture. Managers and supervisors understand the environmental significance of maintaining the delegated program. Some sustainability benefits and objectives will be in alignment with the current executive dashboard and will compare outputs versus outcomes.

From the secretary's level down, NCDOT has excellent managers who provide leadership and articulate the need to work together with an emphasis on environmental stewardship. Staff has had environmental metrics included in their performance reviews for the past 4 years.

NCDOT has embarked on a number of efforts that are helping them do a better job on environmental issues in maintenance. Their E&S Control program set the stage for the stewardship policy and having it make sense to staff. The policy translated into focused training – policy, process, guidance, and performance metrics.

Condition Assessment

NCDOT conducts a Maintenance Condition Assessment on a two-year cycle to evaluate the condition of the state's highway infrastructure. In addition to the evaluation of bridges, pavements and various roadside elements, these assessments report on the condition of vegetative elements and overall environmental quality. NCDOT reviews selected road segments of its 80,000 miles of highway for erosion and sediment control, vegetation control and conducts inspections of structural stormwater controls. Whenever land-disturbing activities occur in projects, field inspection staff check on erosion and sediment control practices and give a LOS rating or compliance score.

There are 120 stormwater pollution prevention plans (SPPP) in place at NCDOT facilities. They have well established Best Management Practices (BMPs), guidance manuals and training, and an online SPPP compliance reporting system so they can track compliance from a central location. They recently integrated a spill prevention, control and counter measure (SPCC) system that can also be tracked online. Central office managers can go to an online website for each facility and see where they are at in terms of compliance.

Other

Sustainability principles guide ongoing green improvements and programs

NCDOT considers sustainability in terms of both the natural environment and in human concerns for safety, aesthetics and multi-modal facilities. In their resurfacing program and consistent with NCDOT's Complete Streets implementation, NCDOT is looking at how to re-stripe the road differently to accommodate multi-modal use while improving safety. They are

using biofuels in their vehicle fleet. They are greening their rest areas and have one gold, LEED-Certified rest area. NCDOT was instrumental in developing the "Drive Green/Save Green" campaign, which was scaled up through the I-95 corridor last year. NCDOT also provides teaching materials relating to stormwater management and initiated a river basin signing program through a partnership with the NC Department of Environment and Natural Resources.

NCDOT developed an initial video on sustainability. It provides some examples, including a vegetation management effort to plant slow and low growing turf grass to lower the frequency of the mowing cycle, improve work safety and reduce emissions. NCDOT also has a clear zone improvement program where larger trees are removed and replaced with small native flowering trees (dogwoods, red buds) and native grasses. They are researching carbon sequestration. They planted canola in the ROW near one of the biofuels facilities to draw attention to the issue and are participating in educational outreach to draw attention to green industries in NC.

As the sustainability program progresses, NCDOT is asking about how to incentivize good results. They may revamp their continuous improvement program categories to fit sustainability principles. Currently, there is also legislated program, called NCThinks, where staff can submit a basic improvement ideas; if it is subsequently chosen for a pilot and if there are cost savings that accrue, then the employee can receive a certain percentage of the actual cost savings, or get a few days off, or get a combination thereof; but it has been difficult to quantify the actual cost savings and cannot be used if federal money is involved.

Positions in state and federal resource agencies

NCDOT funds about 25 positions in state and federal resource agencies (including NC Department of Environment and Natural Resources, NC Department of Wildlife, NC Cultural Resources, NC Coastal Resources, USFWS, USEPA). Maintenance field staff has a good understanding of when to involve NCDOT environmental staff and the resource agencies. The federal agencies work with NCDOT in the NEPA process. NCDOT upholds their responsibilities and commitments on the maintenance end so as not to affect project delivery. At all levels, the relationship and trust NCDOT has developed across the agency and with the resource agency partners is important**.**

OREGON

Oregon DOT (ODOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

This interview was conducted on-site and by phone with:

Patti Caswell, ODOT Maintenance Environmental Section Manager

With follow-up with:

Luci Moore, ODOT Maintenance Manager

Margi Lifsey Bradway, Sustainability Program Manager

Structure, Culture, and Staffing

In the 1990s, Oregon DOT focused a high degree of attention to the environment and a number of their programs achieved and retain national prominence. A key step was the ODOT's 4(d) exemption for routine road maintenance work to comply with the federal Endangered Species Act (ESA). Their Water Quality and Habitat Guide Best Management Practices for Routine Road Maintenance was a condition for National Marine Fisheries Service exempting ODOT from the take prohibition on salmonids (allowed under Section 4(d) of the Endangered Species Act), per the BMPs outlined. The "Blue Book" was initially completed in 1997-98 and was one of the DOTs first programmatic approaches, initiating a standard of practice across maintenance. Now it is updated every five years, the latest version dated 2009.

To develop the programmatic standards contained in the guide, ODOT convened a collaborative process to develop the BMPs and ensure they would meet the intent of environmental regulations that protect water quality and fish habitat, and be workable for maintenance forces. ODOT developed color-coded GIS mapping of restricted area management zones for various maintenance activities that noted which activities were restricted or subject to caution in sensitive environmental areas. The system ODOT remains a national best practice.

Environmental staff assist Maintenance forces

Each of ODOT's five Regions has at least one Region Environmental Coordinator (REC), who provides direct support for both construction project development and maintenance projects/work. Each Region has technical experts in biology, wetlands, and other environmental disciplines. ODOT has a well-established process for coordination between environmental staff and maintenance staff, so that consultation occurs as needed. Region 5 is the only region with REC dedicated to providing support to Maintenance, without added construction project development responsibilities. The Statewide Office of Maintenance and Operations provides statewide policy and standards including the development of statewide programmatic agreements that benefit maintenance, such as the blue book. Additional support is provided by ODOT Technical Services Branch, which houses the Geo Environmental

Section (GE). ODOT GE provides technical support for biology, wetlands, NEPA, and Erosion and Sediment Control.

At the Statewide Office of Maintenance and Operations, ODOT staffs a management position that is responsible for overseeing, among other things, Maintenance environmental initiatives, including the ODOT Environmental Management System for Maintenance Yards (EMS) and who is involved in ODOT's sustainability planning. The statewide office has six staff that work on environmental issues, among other things; one focused on roadside Integrated Vegetation Management (IVM), two foresters for hazard tree identification and timber sales, and three water quality specialists. Environmental staff members provide training on winter deicing chemicals, Storm water (MS4), and Environmental Management System (EMS).

ODOT has a Sustainability Plan in Volume 2 of their EMS focusing on the seven key areas covered by an audit the agency performed. This plan provides support and direction for sustainability efforts. ODOT has incorporated sustainability goals for maintenance in the larger agency Plan supported by a formal Environmental Management System (EMS) in Maintenance. Resources related to ODOT's EMS are available at http://egov.oregon.gov/ODOT/HWY/OOM/EMS.shtml,

Communication and Training

Biannual full day training in spring and fall

As part of the ODOT Maintenance academy ODOT conducts full-day environmental training twice a year to new maintenance employees, in spring and fall, where ODOT policies, goals, and practice are discussed. Managers and peers show PowerPoints and give "practicals" on how to keep appropriate records as well as additional training on erosion and sediment control (ESC).

Further communication occurs through newsletters celebrating the good work staff is doing. Environmental and safety focused newsletters are sent to staff twice a year. They address everything from why a clean, safe maintenance yard is desirable to how to safely handle materials commonly found in maintenance yards such as mercury-containing light bulbs. The newsletters list the staff that participated in EMS regional audits and thank them for their great work.

EMS training, focused on the use, storage, and disposal of materials commonly found in maintenance yards is for maintenance managers, coordinators, and crew leaders, and the key person who does the monthly EMS paperwork.

Systems, Practice, Quality Assurance and Accountability

ODOT's Maintenance Environmental Management System (EMS) provides a pathway for achieving and tracking stewardship objectives. As ODOT's Maintenance & Operations Leadership Team stated in their March 2009 letter, ODOT's Environmental Management System (EMS) Policy and Procedures Manual represents a commitment by them and the agency. "The EMS is a cornerstone of the Maintenance commitment in the ODOT Sustainability

Plan, identifying and implementing recycling options, increasing the use of recycled materials, and expanding the use of alternative products." [40]

ODOT's EMS system facilitates an understanding of priorities by dividing actions into "must," per ODOT policy or state/federal regulation, those that are "should" and those that are "recommended."

Audits

ODOT Office of Maintenance and Operations keeps metrics are based on the audits of the seven priority areas, which they conduct every three years for each of the 103 maintenance yards. Every maintenance yard is audited at least once every 3 years, with about 35 of the 103 yards audited each year. The audits focus on oil use and management, fuel, aerosols, lighting, winter maintenance chemicals, drainage, and pesticides.

ODOT environmental leaders find that the audits provide a good opportunity to talk about the program and its intent at a higher level and compare targets and objectives to on-the-ground results. It is great opportunity for folks in the statewide Office of Maintenance and Operations to meet face-to-face with the maintenance staff to hear their concerns and learn their perspective and issues.

At ODOT, District Managers must be present during EMS audits. There is a department policy encouraging managers to recognize employees for their good work in EMS. "Driving Force Awards" are given to deserving staff.

While all ODOT maintenance yards are recognized as conditionally exempt under hazardous waste management regulations, ODOT maintenance staff routinely complete waste generation and disposal logs. Thus, the EMS has helped the agency to meet a higher standard than environmental compliance alone would dictate.

ODOT has found that EMS implementation is more efficient, consistent, and reliable if one person does the monthly paperwork for the whole crew, as it takes some specialty knowledge to learn how to do the paperwork correctly. The downside is other staff may not be relied upon to learn, know and implement the program.

Complete EMS Manual available

Oregon DOT's entire EMS manual is available on the web as well, for other DOTs to use. It represents both an investment and a resource.

1.1 Storage

1.2 Materials Handling

1.3 Wastes

1.4 Empty Containers

1.5 Absorbents and Spills

1.6 Secondary Containers

2. LABELS AND SIGNS

2.1 Identification Labels

2.2 Hazard Warning Labels and Signs

2.3 Signs on Buildings, Room or Cargo Containers

2.4 Signs and Posted Permits at ODOT Fueling Stations

2.5 Labels on Containers and Tanks

3. TANKS

3.1 Stationary (Fixed Location) Tanks

3.2 Mobile Tanks

4. DRAINAGE AND WATER QUALITY

4.1 Stormwater Conveyances

4.2 Septic Systems

4.3 Wastewater Discharges

4.4 Water Treatment

Primary Forms
Monthly Field Audit
Corrective Action (page 1)
Corrective Action (page 2)

Waste Generation Log (blank)
Waste Generation Log (started)
Waste Disposal Log

Other Forms (as needed)
Poly Tank Inspection - Stationary
Poly Tank Inspection - Transport
Poly Tank Inventory
Used Oil Transfer
Waste Profile
Emergency Contacts
Spill Response
EMS Crew-level Course Outline
Self Check for the Waste Generation Logs

Other

Budgets reflect environmental concern

The Statewide Maintenance Engineer and each District Manager work on an annual budget that includes a facilities inventory and maintenance BMPs to address environmental needs and priorities. Maintenance tracks and posts how much money they spent on ditch cleaning every quarter, but they lack more granular data on the stormwater facilities that they have been routinely maintaining for years. ODOT tracks expenditure and work by section of highway they maintain and type of activity (e.g., culvert cleaning, etc), but not always specifically work by facility type (such as stormwater treatment facility).

WASHINGTON STATE

Washington State DOT (WSDOT) Case Study on Incorporation of Environmental Requirements, Stewardship, and Sustainability into Highway Maintenance Programs

Interviews were conducted in person and by phone with:

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Structure, Culture, and Staffing

Strategic Goals and Where Sustainability Fits In

In 2007, the Governor and Legislature enacted a law establishing five policy goals for transportation agencies in Washington State (Chapter 516, Laws of 2007). The five statewide transportation policy goals initially developed include:

Safety: To provide for and improve the safety and security of transportation customers and the transportation system;

Preservation: To maintain, preserve, and extend the life and utility of prior investments in transportation systems and services;

Mobility (Congestion Relief): To improve the predictable movement of goods and people throughout Washington;

Environment: To enhance Washington's quality of life through transportation investments that promote energy conservation, enhance healthy communities, and protect the environment;

Stewardship: To continuously improve the quality, effectiveness, and efficiency of the transportation system.

In March 2010, the Governor and Legislature added a new policy goal for transportation: **Economic Vitality**. It directs WSDOT to "promote and develop transportation systems that stimulate, support, and enhance the movement of people and goods to ensure a prosperous

economy." WSDOT is developing the necessary business direction plans through the agency's strategic planning process.

WSDOT responds to the environmental standards of a very aware populace and reports their performance to environmental agencies and the public, in reports, in the press, and in the agency's nationally acclaimed *Gray Notebook*.

Regional Maintenance Environmental Coordinators

WSDOT funds Regional Maintenance Environmental Coordinators (RMECs) to support maintenance forces and provide technical assistance. RMECs also serve as contacts for WSDOT's Environmental Compliance Assurance Procedure (ECAP) for Maintenance Work Activities. In addition to other Regional environmental staff, WSDOT also has a full complement of environmental specialists serving the entire state at headquarters, in addition to funded positions or liaisons at state and federal resource agencies.

Permit compliance

WSDOT has a well-established stewardship focus. Permit compliance has also been a big emphasis over the last decade. WSDOT environmental staff members work closely with maintenance staff to assure compliance with permit conditions and project commitments.

Permit compliance helped motivate WSDOT to develop systems to assure that project commitments and permit conditions were conveyed to maintenance and that the needed "follow through" occurred. Compliance parameters have been important in establishing priorities and what the agency will measure. For example, in the past WSDOT was not maintaining water quality facilities at the prescribed interval because it was not really "required" to do so.

The new NPDES clarifies expectations of the department, and maintenance planning staff members are helping to translate those requirements into costs. As WSDOT's maintenance leaders described, "While crews understand the value of installing and maintaining a BMP, budget priorities and the tight linkage between that and organizational performance objectives guide their approach to their responsibilities." WSDOT recently spent $4-5 million installing hundreds of water quality best management practices (BMPs). Further, WSDOT has committed funding to maintain and monitor these BMPs and to keep necessary records to demonstrate that they met their commitments to maintain these facilities.

Training and Communication

The Vegetation Management section has a training program focused on weed control. Endangered species concerns led the need for compliance 15 years earlier. Now, the crews are trained and experienced in species identification and can better target control practices. IVM has developed intelligent, targeted/tailored programs for the roadsides, tailored to each District, using trained professionals.

WSDOT conducts an annual day and a half Westside-Eastside Conference in the spring. This involves training sessions and staff gets continuing education credits that help maintenance staff retain their herbicide applicators' licenses. Over the last decade, licensed applicators have moved into supervisory positions improving awareness and acceptance of environmental stewardship.

Systems, Practice, Quality Assurance and Accountability

WSDOT tracks fish passage improvements and culvert barriers removed, as well as the number of stream miles above the removed barrier subsequently opened up as potential habitat for the target species. WSDOT also tracks herbicide use and the beneficial use of recycled materials, as well as noncompliance events. The agency also correlated the number of dead deer maintenance forces were picking along the highways with "investments in fencing specialized roadside reflectors, wildlife crossings, and flashing signs to make inferences regarding the effectiveness of these efforts."[41], but this is just a small part of a large effort,

Gray Notebook

At WSDOT, a new level of data collection and analysis began with a series of legislative mandates and transitioned into performance measurement over the course of the decade over which their "Gray Notebook" expanded and continued to build on WSDOT's legacy of data collection and systems analysis. Performance measures focus on multi-modal system performance and includes organizational performance reports for select topics such as project delivery and worker safety.

Annually, WSDOT uses well over 100 specific performance measures in its accountability reporting that encompass all key agency mandates, functions, and transportation modes. Internally, the performance measures have become a core management tool and cultural philosophy at WSDOT – "What gets measured gets managed." WSDOT reports on performance to multiple audiences through several mechanisms.

In particular, WSDOT must report on attainment or progress toward Strategic Plan objectives:

Attainment Report (OFM). The Washington State Office of Financial Management (OFM) ensures objectives and performance measures are set for state goals and reports on attainment to the Governor and Legislature each biennium.

WSDOT Strategic Plan (WSDOT) is the agency's primary business documentation provided to OFM, the Legislature, and the Governor. In it, WSDOT provides a six year outlook on agency financial obligations and priorities, utilizing performance measures found in the OFM Attainment Report, POG, and GMAP. The Strategic Plan has specific, measurable objectives for each of the six transportation policy goals. The document is updated every two years to be reflective of past performance, and the direction that WSDOT will take in the next six years. Strategic plan and OFM work is informed by an investment prioritization process, supported by workgroups composed of government agency and private sector representatives that identify results that citizens expect from government

and evaluate the performance of state agency activities and services against those expected results.

WSDOT Accountability website includes a performance measure index, GNB Archive, Performance Audits, and updates for the Attainment Report, GMAP, and the Strategic Plan.

Budget cycle

WSDOT has made the budget system responsive to the agency's maintenance objectives and responsibilities and has successfully documented maintenance backlogs and the need to do more preventive maintenance. Similarly, compliance parameters have been important in establishing priorities and measurement related to environmental matters. Maintenance funding is accompanied by record-keeping requirements and accountability; compliance and progress are expected. This is building a culture of accountability and performance metrics, as well as increasingly responsible environmental stewardship.

In the budget cycle, WSDOT's National Pollutant Discharge Elimination System (NPDES) permit is a major driver, with explicit requirements for maintenance of catch basins, swales, etc., and WSDOT's Maintenance Management System for inspection and maintenance of catch basins and stormwater treatments, called Highway Activity Tracking System or HATS will help provide the needed information. By monitoring performance and reporting back through the budget process, WSDOT management "closes the loop" and documents WSDOT's progress both in maintaining the system and complying with environmental permits and expectations

Automated data systems

To respond to maintenance staff needing to do more with less, WSDOT is trying to implement more automated data systems. GPS/AVL equipment has been installed on about half of the fleet and provides real-time location, condition recording, materials use, and application rates. The data is sent to a vendor and the vendor feeds the WSDOT database. WSDOT is doing this with striping trucks, vacuum trucks, and snow and ice treatment.

For field staff managing many functional elements across broad geographic areas, WSDOT has developed systems staff can use to retrieve information on the work that was done and to serve as a basis for lessons learned and establishing new priorities. Within their IVM program, WSDOT tracks key locations on an annual cycle, evaluates completed work, and refines work plans. WSDOT's NPDES stormwater permit requires inspection and maintenance of all BMPs annually. An inventory of all the catch basins is now being compiled and a tracking system put in place to monitor it. WSDOT anticipates this will produce valuable information on maintenance practices and needs.

Other

Passing on environmental commitments from construction to maintenance

WSDOT has ECAP – Environmental Compliance Assurance Procedures, which was developed "to avoid environmental problems that could occur during highway maintenance activities and to understand the appropriate response measures to prevent violations."[42] The procedure is a supplement to the Programmatic Field Book for Maintenance Work and serves as ECAP for maintenance as provisioned in WSDOT General HPA permits and consistent with Chapter 790 Implementing Environmental Commitments of the WSDOT Environmental Procedures Manual (EPM).[43]

Environmental commitments made in the capital program are passed on to maintenance staff for long-term compliance and monitoring. At the regional level, when a non-compliance event occurs, the violation quickly gets communicated up for action and resolution. The situation is examined for lessons learned to help assure it doesn't happen again. ECAP also includes the contact information for Regional Maintenance Environmental Coordinators.

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Research for the AASHTO

Standing Committee on the Environment

Improved Environmental Performance of Highway Maintenance

Appendix D – Acronyms and Abbreviations

Acronym	Definition
AASHTO	American Association of State Highway and Transportation Officials
APA	American Planning Association
BMP	Best Management Practice
Caltrans	California DOT
CARB	California Air Resources Board
CDOT	Colorado DOT
CEC	Construction Environmental Coordinator
CNG	Compressed Natural Gas
CTE	Center for Transportation and the Environment (NC)
DEC	Department of Environmental Conservation (NY)
DNR	Department of Natural Resources (MD)
DOT	Department of Transportation
E-85	Gasoline with 85% Ethanol
EAB	Environmental Analysis Bureau (NYSDOT)
ECAP	Environmental Compliance Assurance Procedure
ELATS	Environmental Landscape Architecture Training System (NYSDOT)
EMS	Environmental Management System
EPM	Environmental Procedures Manual
ESA	Endangered Species Act (Federal)

Acronym	Definition
ESC	Erosion and Sediment Control
FAQ	Frequently Asked Questions
FDEP	Florida Department of Environmental Protection
FDOT	Florida DOT
FHWA	Federal Highway Administration
FY	Fiscal Year
GHG	Green House Gas
GIS	Geographic Information Systems
GPS	Global Positioning System
GPS/AVL	Global Positioning System/ Automatic Vehicle LocationHPA - Historic Preservation Act
HPA	
IVM	Integrated Vegetation Management
LED	Light Emitting Diode
LOS	Level of Service
M&O	Maintenance and Operations
MDOT	Michigan or Maryland DOT
MEC	Maintenance Environmental Coordinator
MMS	Maintenance Management System
MnDOT	Minnesota DOT
MOP	Maintenance and Operations Plan (NYSDOT)
MS4	Municipal Separate Storm Sewer System

Acronym	Definition
	(**MS4**) Permits
MSDS	Maintenance Support Decision System or Material Safety Data Sheet
NCDOT	North Carolina DOT
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NGO	Non Government Organization
NPDES	National Pollutant Discharge Elimination System
NYSDOT	New York State DOT
ODOT	Oregon DOT
PDH	Professional Development Hour
PM	Project Manager
RAP	Recycled Asphalt Pavement or
	Remedial Action Plan
RECs	Regional Environmental Contacts
RMECs	Regional Maintenance Environmental Coordinator
ROW	Right of Way
SCOE	Standing Committee on Environment
SHA	State Highway Administration (Maryland)
SOM	Standing Committee on Highway Subcommittee on Maintenance

Acronym	Definition
SOP	Standard Operating Procedure
SWM	Stormwater Management
TBL	Triple Bottom Line
TMDL	Total Maximum Discharge Load (water)
USCOE	US Army Corps of Engineers
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
UST	Underground Storage Tank
VTrans	Vermont Transportation Agency
WIP	Watershed Implementation Plan
WSDOT	Washington State DOT