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16. Abstract

Tracking environmental costs in the project development process has been a challenging task for state departments of transportation (DOTs). Previous research identified the need to accurately track and subsequently estimate project costs resulting from environmental mitigation requirements. There is currently no single source or management system for capturing and/or estimating the Texas Department of Transportation's (TxDOT's) project-related mitigation costs statewide. The purpose of this continuation project was to determine types of mitigation costs for TxDOT projects and identify the funding sources, mechanisms, and processes for acquiring funding and administering payment, as well as conduct a synthesis of mitigation cost tracking and estimating at selected state DOTs.

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MAXIMIZING MITIGATION BENEFITS: RESEARCH TO SUPPORT A MITIGATION COST FRAMEWORK—FINAL REPORT

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

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INTRODUCTION

Tracking environmental costs in the project development process has been a challenging task for state departments of transportation (DOTs), as highlighted in a 2008 National Cooperative Highway Research Program (NCHRP) study.[1] Challenges outlined in the study include the following (*1*):

- Insufficient labor and financial resources to develop, implement, and maintain data management systems.
- Inconsistencies for breaking down project costs and project cost coding.
- Inconsistencies in differentiating environmental from non-environmental costs.
- Tracking cost savings and avoided expenses.

In light of these difficulties, state DOT officials note that there must be a strong rationale defining specific benefits before a DOT will commit resources to the tracking of environmental costs. One area where DOTs perceive a substantial benefit is the estimation of environmental mitigation costs, including wetlands and habitat replacement.

PROJECT BACKGROUND

The first phase of Texas Department of Transportation (TxDOT) Research Project 0-6762 identified the need to accurately track and subsequently estimate project costs resulting from environmental mitigation requirements. Currently, no single source or management system for capturing and/or estimating TxDOT's project-related mitigation costs statewide exists. Although the research project identified mitigation costs found in the Right of Way Information System (ROWIS), this likely only captures a portion of compensatory mitigation costs associated with Section 404 wetland mitigation. Other project-related mitigation costs (404 and others) must also be tracked and used to estimate future costs. The purpose of this continuation project is the following:

- Determine types of mitigation costs for TxDOT projects and identify the funding sources, mechanisms, and processes for acquiring funding and administering payment.
- Conduct a synthesis of mitigation cost tracking and estimating at selected state DOTs.

This research product is the basis for a guide to track and estimate mitigation costs. The project complements and builds upon other project cost tracking and estimating efforts at TxDOT, including environmental site assessment (ESA) cost-tracking forms used by the Environmental (ENV) Division, TxDOT Research Management Committee Research Project 0-6633 on utility cost practices and efforts in the Project Management Office (PMO) to develop a Total Project Cost Estimating Guide.

[1] M. Miller, K. Miller, and J. Overman, meeting with Curtis Beaty, TTI, January 29, 2016.

SUMMARY OF RESEARCH ACTIVITIES

This research effort comprised three main tasks:

- Task 1—In Task 1, the research team performed a targeted literature review of state practices for state DOTs in Arizona, California, Colorado, Florida, New York, North Carolina, Ohio, Oregon, Pennsylvania, and Virginia and summarized the results.
- Task 2—In Task 2, the research team identified, collected, and reviewed data from TxDOT information systems in order to provide the basis for a guide to track and estimate mitigation costs. The task involved the subtasks of first identifying data sources and systems and then, where possible, querying data for mitigation cost information. Researchers met with staff from the TxDOT PMO and ENV Division at the state and district level to determine which TxDOT systems capture elements of mitigation cost and funding sources and how these elements are stored, entered, and modified throughout the project development process. This research effort revealed that while ENV does set guidelines for tracking mitigation costs, districts have their own tracking mechanisms—each with a different system. There is not a uniform statewide method to track mitigation costs.
- Task 3—In Task 3, the research team prepared a framework for tracking and estimating environmental mitigation costs consistent with existing TxDOT estimating guides and methodologies.

ESTIMATING MITIGATION COSTS IN OTHER STATES

All DOTs have developed accounting systems to track environmental cost at some level, including systems for tracking the following:

- Work, commitment, and workflows.
- Improved project management.
- Financial information management.
- Contractor/consultant contracts.

Mitigation costs are sometimes tracked as part of these systems.

The research team reviewed methods, techniques, and processes at select state DOTs for estimating mitigations costs for the following states: Arizona, California, Colorado, Florida, New York, North Carolina, Ohio, Oregon, Pennsylvania, and Virginia.

The states reviewed for this task each track and inventory mitigation projects, environmental commitments, and mitigation measures used, but actual costs are either not reported or not available. Appendix A provides a detailed description of mitigation cost estimating and tracking efforts from the selected states.

ESTIMATING MITIGATION COSTS AT TXDOT

Researchers met with staff from the TxDOT PMO and ENV Division to determine which TxDOT systems capture elements of mitigation cost and funding sources and to determine how these elements are stored, entered, and modified throughout the project development process. The following sections summarize those findings.

TXDOT ENVIRONMENTAL DIVISION

Researchers met with staff from the TxDOT ENV Division to discuss mitigation cost-tracking responsibilities, mitigation cost estimating, environmental policy of communications and costs, and environmental affairs division research needs on this subject. The following sections summarize that discussion.

Mitigation Cost-Tracking Responsibilities

Mitigation cost-tracking responsibilities reside primarily with the 25 districts and include 404 permitting for the United States Army Corps of Engineers (USACE) and tracking the fulfillment of mitigation requirements and cost estimates. Districts track mitigation and environmental permits issues and commitments (EPICs) using their own processes. There is no uniform process or management tool used across the districts to track mitigation, costs, and EPICs.

Acquisition of Right of Way

In general, when a district identifies the need for compensatory wetland mitigation, the district sends ENV a request along with supporting documentation. While ENV evaluates the need, the Right of Way (ROW) Division is typically given options by USACE for mitigation, with different costs for each option. The selected option is referred to ENV to ensure it meets environmental requirements. ROW then sets up the mitigation as a parcel in ROWIS coded with an “m” for mitigation or “w” for wetland. Once the need, cost, and approach to mitigation is resolved, ENV sends ROW a request to purchase credit or parcels. ROW tracks the mitigation purchases in ROWIS as if these purchases are parcels of land.

Mitigation Cost Estimating

The most common type of mitigation is for USACE 404 permitting. ENV relies on the districts to estimate what the actual cost will be for the parcel acquisition since ROW ultimately must set up the purchase and pay the cost, which also varies based on the transaction date. Non-404 mitigation estimates and costs are usually derived from either construction funds or ROW funds, but other funds may be used.

New ENV Policy on Communications and Costs

ENV is in the process of finalizing a policy that requires every district to provide data to ENV that detail the following:

- What the permit costs.
- When the permit applications are submitted.

- What kind of permit application it is.
- What kind of impacts are in it.
- What type of permit is being requested (e.g., is it for a bank, a responsible permittee).
- How long it takes the USACE to reply.
- Whether permits are complete or if there are additional items needed.

This effort will provide ENV with a baseline permit performance.

TXDOT DALLAS DISTRICT ENVIRONMENTAL DIVISION

Data Systems

The TxDOT Dallas District uses commitment tracking spreadsheets in various phases to track commitments, but no actual costs are documented. Environmental coordinators are responsible for developing the list of commitments and tracking them throughout each phase of the project development process.

Cost Estimating and Tracking Process

The Dallas District estimates the mitigation needs of each project using the Texas Rapid Assessment Method workbook and forms. The mitigations needs are then submitted to all available mitigation banks. Once the banks have determined the type and quantity of mitigation credits they have available, they submit their bid to TxDOT. TxDOT must accept the lowest cost bid for mitigation credits. Once a mitigation bank has been selected, the payment is processed through ROW/ENV and paid by the district using the PeopleSoft expenditure tracking system.

Unfortunately, district staff cannot query PeopleSoft by mitigation type, so there is no way to track costs or payments at this point. They are also unable to query the Environmental Compliance Oversight System (ECOS) for EPIC information or EPIC completions. Information on EPIC sheets is not searchable using the current system. ROWIS contains costs related to the acquisition of parcels, including reimbursable utility facilities and environmental information related to 404 permit information, non-regulatory habitat, biological/ESA and mussels, and 4(f). The construction division typically funds other types of mitigation such as noise wall construction and hazmat.

TXDOT AUSTIN DISTRICT ENVIRONMENTAL DIVISION

Data Systems

The Austin District currently does not have a centralized system to document and manage mitigation activities, costs, and associated commitments, nor is there a standard process to provide uniform information for each project that is developed. TxDOT Austin uses a local Microsoft Access-based system called Blackbook and ECOS to document its environmental commitment tracking; the use of Blackbook is not required, while the use of ECOS is.

Cost Estimating and Tracking Process

District staff do not track mitigation costs for compensatory mitigation, nor do the district staff input them into PeopleSoft. Compensation costs, including in-lieu fees, mitigation banks, and permittee-responsible mitigation for projects, are more likely documented in PeopleSoft, while mitigation costs associated with avoidance and minimization mitigation requirements will require a new policy and framework. Minimization costs recognize that the project will be unable to avoid affecting the resource, so attempts are made to reduce the impact. Minimization costs are incurred typically as part of construction costs and most likely documented as construction costs in PeopleSoft without any reference to the fact they are undertaken to satisfy mitigation requirements. For example, in one Austin District project, during the construction phase, the contractor was instructed to avoid environmental damage by digging up the wetland soil and seedbed located in the ROW and moving it to another location with the seedbed intact. This procedure was part of a requirement that was developed in the preliminary design phase, but the costs for the contractor to perform this task were not linked to environmental function codes, such as 120 or 130, nor do the function codes list this type of activity.

TXDOT PROJECT MANAGEMENT OFFICE

Current Developments in Relation to Cost Documentation and Data at the PMO Office

The TxDOT PMO is pilot testing how to combine risk and cost estimating for the construction phase of projects. The PMO currently does not collect or input any type of mitigation cost data as a result of this pilot or as a part of its schedule management activities into other systems such as ECOS, Primavera (P6), Design and Construction Information System (DCIS), or the Financial Information Management System (FIMS).

TXDOT DATA SYSTEMS

TxDOT's DCIS is central to multiple systems providing automated feeds to them and receiving manual information back containing information on National Environmental Policy Act (NEPA) and letting clearance. TxDOT's current statewide system, ECOS, is being updated to provide individual commitment-level details similar to the Caltrans EIMS based on the Environmental Management System (EMS IS014001) Stage Gate Checklist. Currently, ECOS functions largely as a document repository and does not provide searchable access to many environmental commitment details, such as commitment costs, since they are split up among multiple project documents uploaded to the ECOS project page.

DCIS COST DATA

Most construction and environmental costs, such as authorized costs, estimated costs, and third-party contributions, reside in DCIS. Based on the risk management pilot efforts, the PMO is finding that different costs in DCIS, such as an environmental feasibility study, may get documented incorrectly using construction cost codes and dollars. Typically, costs in DCIS projects are assigned defaults by percentage on various construction costs, ROW costs, and environmental costs depending on the type of project (safety, bridge, etc.). This assignation makes obtaining accurate environmental mitigation costs from DCIS difficult since they are typically documented by the default allotment based on the project type and could be coded incorrectly into project management software. At present, the enterprise resource office is taking an inventory of all business fields, costs, and purposes across various information management systems at TxDOT, including ECOS, ROWIS, DCIS, and other systems, in order to develop a modernized portfolio project management system.

RIGHT OF WAY INFORMATION SYSTEM

Mitigation payments identified in ROWIS only include compensatory wetland mitigation paid in relation to Section 404 mitigation actions involving the purchase of a parcel, credits, or a fee-in-lieu payment. The ROWIS system captures right-of-way, control section job (CSJ) numbers for parcels or payments in-lieu of parcels. ROWIS does not appear to distinguish between the purchase of mitigation bank credits and fee-in-lieu payments; instead, it groups both together. Compensatory mitigation for ESA, hazardous material remediation, or other types of environmental mitigation payments are not discernable or coded within ROWIS because it only tracks the purchase of a parcel or a fee for a parcel. Additionally, compensatory mitigation conducted as part of a comprehensive development agreement or concession agreement does not typically appear in ROWIS. Presumably, the concessionaire tracked these payments outside of ROWIS and TxDOT management systems.

ROWIS Cost Data Search

Researchers conducted a search of ROWIS records to locate data about mitigation parcels that were paid by TxDOT from 2003 through August 1, 2015, using search parameters such as the term "mitigation" within ROWIS database field marked "payments_payee_name." The following sections summarize the findings of that search, and Appendix B provides detailed information. For the 2003–2015 period, the research team found records for 85 mitigation

parcels, with a total payment amount of $60 million. The cost of the parcels varied from $233.00 to $14.7 million, with a median value of $93,421. The following sections summarize the cost information by year, region, district, and ROW CSJ.

Mitigation Payments by Year

Between 2003 and 2011, the annual amount TxDOT paid for mitigation parcels was between $100,000 and $2.8 million, with a median cost per parcel for that period of $78,750 and a total cost of $10.1 million for 40 parcels. In 2012, the annual cost for mitigation parcels increased significantly to $9.5 million, which was only slightly lower than the total amount expended for the period from 2003 to 2011. In 2013, the cost for mitigation parcels almost tripled from 2012, to a total of $35.2 million. The median cost for 45 parcels from 2012–2015 increased to $185,000, which is more than double the median cost per parcel from 2003–2011.

The cause for the increase is a result of the average cost per parcel. From 2003 to 2011, the average cost per parcel was about $250,000, but increased almost fourfold to $945,000 per parcel in 2012 and to $1.2 million per parcel in 2013. The high mitigation costs for 2012 and 2013 are therefore a result of the combination of unusually high parcel costs and an unusually high number of parcels. Another cause for the unusually high parcel cost in 2012 and 2013 was that the ROW Division increased purchases of parcels labeled as "fee-in-lieu of mitigation," which are more expensive. However, the ROWIS codes do not appear to distinguish between in-lieu-fees and mitigation bank credit purchases.

Researchers summed up the cost of all parcels mitigated through land acquisition and all parcels mitigated through fee-in-lieu of mitigation in order to determine the average costs for each parcel. The researchers found that TxDOT paid $9.62 million for 32 land acquisition parcels, and $50.35 million for 53 fee-in-lieu of mitigation parcels. This amounted to an average cost of land acquisition parcels over the study period of $300,000 versus $950,000 for fee-in-lieu of mitigation parcels. In other words, per parcel, TxDOT spent an average amount that was three times higher on fee-in-lieu/credit purchases for parcels as compared to land acquisition parcels.

Mitigation Payments by Region[2]

Eighty-five percent of the overall ROW mitigation costs were expended in the east region, based on a total of 37 parcels. In the north region, 33 parcels were acquired but only amounted to roughly 12 percent of the overall cost. In the south and west region, TxDOT purchased 14 parcels in total since 2003, which amounted to about 3 percent of the total mitigation cost. Based on the number of parcels acquired, the fee-in-lieu of mitigation expense type was the most popular in all but the west region.

Mitigation Payments by District

TxDOT purchased mitigation parcels in 14 of 25 districts, with the vast majority of funds expended in the Houston District. Funds expended in the Houston District amounted to

[2] TxDOT no longer functionally organizes by regions. The ROWIS data allowed for sorting for regions based on the previous organization structure. The use of regions presented here is used to characterize and compare the variability in mitigation cost impact across the state.

78 percent of all mitigation costs from 2003 to 2015. In the Houston District, the majority of parcels were fee-in-lieu of mitigation, while the Dallas District purchased more parcels of the expense type “land acquisition.” The Lufkin District exclusively used the “land acquisition” type, while the Pharr District exclusively used the fee-in-lieu of mitigation type.

ENVIRONMENTAL MITIGATION COST FRAMEWORK

This research effort attempted to determine the data, data systems, and processes at TxDOT most associated with mitigation costs. It focused on mitigation costs associated with easily quantifiable data found within the ROW, Environmental, Planning, Design, and Finance Divisions of TxDOT. This data included purchase of ROW, mitigation bank credits, fee-in-lieu payments, and invoicing during construction resulting from design requirements. Due to the complexity of assigning TxDOT personnel costs to mitigation activities within projects and environmental resources, this cost was not included in the scope of the project efforts.

Multiple data systems and processes at TxDOT collect actual mitigation costs in a variety of formats. The TxDOT Finance department FIMS and PeopleSoft system process much of the cost data based on billing and invoicing from DCIS, ROWIS, and SiteManager™ systems.[3] Mitigation costs are assigned to a project in DCIS based on default percentages for specific project categories; a bridge construction project may have a different default percentage of environmental, PSE, and ROW costs than a safety project.[4] As a result, actual mitigation costs may be truncated by these defaults and not accurately displayed in DCIS. ROWIS and SiteManager™ collect many of the actual mitigation costs, but lack details as to how these cost data link with the environmental resource that is the cause for the mitigation.[5] For example, ROWIS submits invoices and cost data to Finance related to compensatory mitigation activities like parcel purchases, but in the cost data, it does not distinguish between mitigation bank credits or fee-in-lieu payments. SiteManager™, an invoice processing system used during the construction phase of projects, will report mitigation costs using function codes unrelated to mitigation such as construction, which may be caused by the use of assigned project category defaults in DCIS.[6]

Systems and associated mitigation cost data sources are diverse for a variety of reasons. First, mitigation activities cover six different resource categories with 40 subcategories of resources.[7] Second, they occur during multiple project development process periods with associated cost data owners.[8] Third, they generally fall into one of three activities that take place at various stages of the project development process, including:

- Avoidance.
- Minimization.
- Compensation.

[3] M. Miller, K. Miller, and J. Overman, meeting with Curtis Beaty, TTI, January 29, 2016.
[4] M. Miller and K. Miller, telephone conversation with Ben Ramirez and Ray Jeyakumar, TxDOT Project Management Office, November 12, 2015.
[5] M. Miller, K. Miller, and J. Overman, meeting with Edgar Kraus, TTI, December 7, 2015.
[6] M. Miller, K. Miller, and J. Overman, meeting with Curtis Beaty, TTI, January 29, 2016.
[7] Findings from a review of the TxDOT Dallas District's Commitment Tracking Spreadsheet.
[8] M. Miller, telephone conversation with Shelly Eason, TxDOT Austin District, Environmental Division, January 15, 2016.

AVOID AND MINIMIZE

Efforts to avoid and minimize environmental impacts include a host of design requirements that either route the project around an environmental resource or reduce the impact to the resource. These activities are planned during the detailed design phase of the project, with details entered into EPICS sheets that are uploaded to ECOS. However, the actual mitigation work and costs to accommodate these designs are incurred in the construction phase of the project and finalized by TxDOT employees, contractors, sub-contractors, resource experts, and environmental consulting agencies.[9] These groups enter the costs associated with mitigation work either directly into the financial division's FIMS/PeopleSoft billing database or through the invoice system associated with TxDOT SiteManager™, which transmits these data to the PeopleSoft Financial system. Often, these invoices are not linked to mitigation costs when they are being entered into the system.

COMPENSATE

Efforts to compensate include parcel acquisition, credits, or fee-in-lieu payment. In Texas, compensatory mitigation payments often include wetland mitigation paid in relation to Section 404 mitigation actions involving the purchase of a parcel, credits from a third-party bank, or a fee-in-lieu payment (*2*). The ROWIS system captures actual mitigation costs based on ROW CSJs for parcels or payments for bank credits or in-lieu of parcels. However, compensatory mitigation for ESA, hazardous material remediation, or other types of environmental mitigation payments are not discernable or coded within ROWIS because it only tracks the purchase of a parcel or a fee for a parcel. These ROW parcel, credit, and fee-in-lieu payments are all transacted during the detailed design but can also extend into the construction and post-construction stages of project delivery.

Avoidance, minimization, and compensatory mitigation activities encompass the six resource categories and approximately 40 subcategories listed in Table 1.

Examples of the three various types of mitigation activities for the wetlands category include:

- Compensation:
  - Acquisition cost of ROW required for wetland mitigation.
  - Purchase of credits from a wetland bank.
- Minimization:
  - Wetland restoration cost items such as excavation and embankment construction, vegetation.
  - Required fences, including silt fences and high-visibility fencing.
- Avoidance:
  - Removal of invasive plant species and revegetation.
  - Roadway retaining walls, including walls to avoid wetland impacts (*1*).

[9] M. Miller, telephone conversation with Shelly Eason, TxDOT Austin District, Environmental Division, January 15, 2016.

Any framework and guide to track mitigation costs should capture and describe the complexity and order of interactions between activities, resources, and data systems that cover the extent of TxDOT environmental mitigation activities.

Table 1. Major Resource Categories and Associated Subcategories.

Natural Resources	Air, Noise, and Vibrations	Hazardous and Residual Waste Sites	Community Resources	Cultural Resources	Safety and Mobility
Streams, Rivers, and Watercourses	Sensitive Air Quality Receptors	Landfill	Regional and Community Growth Plans	Archaeological Sites	Pedestrian Sidewalks/Crossings
HQ/EV Streams/ Watersheds	Sensitive Noise Receptors	UST/AST	Public Facilities and Services	National Register Listed or Eligible Sites/Districts	Railroad Crossings
Wild or Stocked Trout Streams	Sensitive Vibration Receptors	Brownfield Site	Low-Income or Minority Population Areas	Historic Transportation Corridor	Mass Transit Facilities
National/State Wild and Scenic Rivers and Streams			Residences, Businesses, or Farms	National Historic Landmarks	Hiking Trails/Scenic Walkways
Navigable Waterways			Parks and Recreation Facilities		Bikeways
Other Surface Waters (e.g., reservoir, lake, farm pond, detention basin)			Visually Sensitive Areas		Traffic Controls
Groundwater Resources			Utilities		
Wetlands					
Coastal Zone					
Floodplains/Floodways					
Agricultural Resources					
Vegetation					
Wildlife and Habitat					
Sanctuaries/Refuges					
Threatened and Endangered Plants and Animals					
Unique Geologic Resources (sinkholes, caves, etc.)					
National/State Forests and State Game Lands					
Wilderness, Natural, and Wild Areas					
National Natural Landmarks					

Source: Findings from a review of the TxDOT Dallas District's Commitment Tracking Spreadsheet.

DESCRIPTION OF A POTENTIAL ENVIRONMENTAL MITIGATION COST FRAMEWORK

The 2008 NCHRP study provides a listing of elements that should be included in a sound cost estimation process (*1*):

- Definition of the environmental cost categories.
- Identification of environmental elements in the project being estimated.
- Recording and compilation of all project cost estimates.
- Recording of actual costs as the project progresses.
- A feedback loop to the project manager on actual costs versus estimated costs of a project.
- Evaluation of final costs at the end of the project.
- For special studies: ready access to environmental cost data in a format that is interpretable as environmental cost data.

The research team developed a framework based on TxDOT PMO's cost estimation spreadsheet that would capture data from various TxDOT sources and use it to indicate the mitigation cost categories, cost estimates, and actual costs.[10] This spreadsheet would require the project team to draw this information from ROWIS, ECOS, DCIS, and PeopleSoft. Findings can be used to communicate to the project manager how close mitigation cost estimates match the actual costs for mitigation. A snapshot of the spreadsheet is available in Figure 1.

DCIS PN	CSJ	MITIGATION IDENTIFIER	FUNCTION CODE	DESCRIPTION	DATA SOURCE	ACTIVITY TYPE	RESOURCE	PROJECT PHASE	ESTIMATED COST	ACTUAL COST
	529	*	2004	CONC CURB & GUTTER (TY II)	Site Manager	Avoid	NAtural	Construction	15.00	$15.88
	533	*	2001	SHOULDER TEXTURING (MILLED)	Site Manager	Minimize	Safety	Construction	1,700.00	$1,750.00
	169	*	2002	SOIL RETENTION BLANKETS (CL 1) (TY B)	Site Manager	Avoid	Natural	Construction	0.90	$1.00
	169	*	2005	SOIL RETENTION BLANKETS (CL 2) (TY E)	Site Manager	Avoid	Natural	Construction	0.90	$1.00
	170	*	2001	IRRIGATION SYSTEM	Site Manager	Minimize	Natural	Construction	0.90	$1.00
	192	*	2022	PLANT MATERIAL (10 GAL) (TREE)	Site Manager	Minimize	Natural	Construction	225.00	$250.00
	192	*	2023	PLANT MATERIAL (15 GAL) (TREE)	Site Manager	Minimize	Natural	Construction	275.00	$300.00
	192	*	2028	PLANT MATERIAL (1 GAL) (SHRUB)	Site Manager	Minimize	Natural	Construction	40.00	$50.00
	164	*	2022	CELL FBR MLCH SEED(PERM)(RURAL)(SANDY)	Site Manager	Avoid	Natural	Construction	2,000.00	$2,050.00
	110	*	2003	EXCAVATION (SPECIAL)	Site Manager	Minimize	Natural	Construction	5.00	$5.25
	132		2008	EMBANKMENT (FINAL)(DENS CONT)(TY D)					100.00	$125.00
	420		2013	CL C CONC (MISC)					475.00	$485.36
	432		2030	RIPRAP (CONC)(CL C)					475.00	$483.40
	400		2003	STRUCT EXCAV (PIPE)					15.00	$15.21
	400		2006	CUT & RESTORING PAV					80.00	$85.49
	401		2001	FLOWABLE BACKFILL					140.00	$147.67
	402	*	2001	TRENCH EXCAVATION PROTECTION	Site Manager	2,000.00	2,182.00	2,500.00	2.25	$2.51
	462	*	2001	CONC BOX CULV (3 FT X 2 FT)	Site Manager	75.00	77.00	80.00	185.00	$189.03
	462	*	2003	CONC BOX CULV (4 FT X 2 FT)	Site Manager	85.00	87.00	90.00	190.00	$194.38
	462	*	2006	CONC BOX CULV (5 FT X 2 FT)	Site Manager	280.00	288.00	300.00	305.00	$312.89
	462	*	2009	CONC BOX CULV (5 FT X 5 FT)	Site Manager	1,030.00	1,042.00	1,060.00	308.00	$311.91
	462	*	2010	CONC BOX CULV (6 FT X 3 FT)	Site Manager	950.00	960.00	975.00	260.00	$266.10
	462	*	2013	CONC BOX CULV (6 FT X 6 FT)	Site Manager	255.00	260.00	266.00	460.00	$466.59
	462	*	2030	CONC BOX CULV (10 FT X 6 FT)	Site Manager	2,800.00	2,820.00	2,850.00	575.00	$587.84
	462	*	2032	CONC BOX CULV (10 FT X 8 FT)	Site Manager	2,200.00	2,210.00	2,225.00	710.00	$727.76
	464		2001	RC PIPE (CL III)(12 IN)					50.00	$55.73
	464		2003	RC PIPE (CL III)(18 IN)					42.00	$44.34
	464		2005	RC PIPE (CL III)(24 IN)					60.00	$62.70

Figure 1. Spreadsheet-Based Framework for Tracking Mitigation Costs.

[10] M. Miller and K. Miller, telephone conversation with Ben Ramirez and Ray Jeyakumar, TxDOT Project Management Office, November 12, 2015.

In the spreadsheet, the DCIS project number and CSJ column would be collected from DCIS. A notation identifying the invoice as associated with environmental mitigation would need to be added to invoice processes associated with ROWIS and SiteManager™, and it is from this notation that the Mitigation Identifier column would be populated. PeopleSoft™ would populate the function code, description, data source, and actual cost field, which it gathers from SiteManager™ and ROWIS. Manual entry or some form of automation would be required to draw records from ECOS to populate the columns for activity type, resource, project phase, and estimated costs contained in the EPIC sheets and plans, specifications and estimates (PS&E) packets.

RECOMMENDED MITIGATION COST-TRACKING GUIDES

Table 2 identifies which states have systems capable of achieving the elements necessary to complete a cost estimation process described in the NCHRP 2008 study (*1*). Based on descriptions from the Task 1 Tech Memo, the New York State DOT has one of the more systematic approaches to performing mitigation cost estimation, covering all elements from the NCHRP 2008 study.

Table 2. States with Cost Estimation Process.

	Arizona DOT	Caltrans	Colorado DOT	Florida DOT	NYSDOT	North Carolina DOT	Oregon DOT
Defines Environmental Cost Categories	Yes	Yes	Yes	Yes	Yes	No	Yes
Codifies Environmental Resources in Project Cost Estimates	No	No	No	Yes	Yes	No	Yes
Organizes Cost Estimates	Yes	Partial (Available system—not mandated for use)	No	Yes	Yes	Partial (Wetlands permitting)	Yes/No (Annual report-based, activity-cost estimates are mainly for determining DOT personnel costs—not project cost estimates)
Organizes Actual Costs for Comparison to Estimates	No	Partial (Available system—not mandated for use)	No	Partial (Actual costs are for fee-in-lieu payments)	Yes	Partial (Wetlands permitting)	Yes/No (Does not compare to project estimates for project management purposes)
Feedback Loop to Project Manager on Actual vs. Projected Costs	No	Yes	No	Partial (Fee-in-lieu payments only monitored)	Yes	Yes	No
Final Cost Evaluation	No	Yes	No	No	Yes	Yes	Yes
Archive of Cost Data for Future Studies and Use	No	Yes	No	Yes	Yes	Yes	No

BEST PRACTICES GUIDANCE

The following are cost estimating guides and recognized best practices:

- *Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction,* National Cooperative Highway Research Program (NCHRP) Report 574 (2007).
- *Guidebook on Risk Analysis Tools and Management Practices to Control Transportation Project Costs,* NCHRP Report 658 (2010).
- *Practical Guide to Cost Estimating,* American Association of State Highway and Transportation Officials (2013).
- *Cost Estimation and Cost Management Technical Reference Manual,* Minnesota Department of Transportation (2008).

RELEVANT DATA SYSTEMS AND RESOURCE TYPES FOR MITIGATION COST TRACKING

Table 3 displays TxDOT data systems and associated environmental mitigation activities. Compensation, mitigation, and avoidance costs are all captured based on the details in PeopleSoft across virtually all project development stages. Any effort to develop a system that captures all environmental mitigation activities must therefore involve the finance division for basic cost data and the remainder of the data systems for environmental resource-level details.

Table 3. Mitigation Activities and Associated Cost Data Tied to TxDOT Data Systems.

Resource Category	ROWIS	People Soft	DCIS	SiteManager™	ECOS
Natural Resources (Includes 404 Permitting)	C	A, M, C	A, M	A, M	A, M, C
Air, Noise, and Vibration	C	M, C	M	M	M, C
Hazardous or Residual Waste Sites	C	A, M, C	A, M	A, M	A, M, C
Community Resources	C	A, M, C	A, M	A, M	A, M, C
Cultural Resources	C	A, M, C	A, M	A, M	A, M, C
Safety and Mobility		A, M	A, M	A, M	A, M

Note: A = Avoidance; M = Minimization; C = Compensation.

Table 3 illustrates that mitigation costs are located and contributed from diverse origin data sources, such as ROWIS and SiteManager™, into PeopleSoft through the process of invoicing. The quality of the mitigation cost data varies by the origin system, users of the origin system, and the function codes used at the time of invoicing. This coding process affects mitigation cost tracking by its ability to show which resource are being mitigated, how they are being mitigated, and whether associated maintenance costs are attached to these activities. These function codes are presently being assessed by both the enterprise resource planning and planning division to determine whether they are being used correctly.

FINDINGS AND CONCLUSIONS

Mitigation cost tracking and estimating involves monitoring numerous project information systems and data sources. It can be difficult to identify and quantify mitigation costs that are directly attributed to the different types of mitigation activities within those project information systems. Even when mitigation costs are identified, the cost and payment amounts may have been made for several different combined projects. There is also the matter of when the mitigation occurs in the project development process and whether the mitigation actions take place before, during, or after construction. Other state DOTs have faced similar challenges and have developed their own statewide cost-tracking and estimating processes. The states reviewed for this research effort each track/inventory mitigation projects, environmental commitments, and mitigation measures used, but actual costs are either not reported or not available. Appendix A contains the detailed results of the literature review and synthesis of state practices.

TxDOT ENV does set some of the guidelines for tracking mitigation costs, but there is not a uniform statewide method in place. Districts track their own mitigation costs and have their own tracking mechanisms and process for any cost-tracking requirements. The primary project information resource is DCIS. ECOS is generally used as an environmental document repository, but it is not a searchable system that allows environmental mitigation cost information to be extracted.

The research team attempted to capture cost and pay items from actual projects, but the complexity and scope of that effort exceeded the scope and budget of the original work plan. The project team decided that the research could be concluded without this additional effort. Therefore, this research report includes the results of the literature search on state practices and a general framework for estimating mitigation costs. In an effort to build upon existing resources, the research team identified numerous existing cost estimating resources and guides applicable to mitigation cost estimating and tracking. For example, the risk-based approach used specifically in the "Risk-Based Construction Cost Estimating Reference Guide" (Reference Guide) from the TxDOT PMO office was developed and validated through a series of workshops with select districts around the state. This approach captures and communicates the practices and processes TxDOT will advance to improve its project delivery.

APPENDIX A:
DETAILED REVIEW OF MITIGATION COST ESTIMATING AND TRACKING IN SELECT STATES

ARIZONA

The Environmental and Planning Group (EPG), part of the Arizona Department of Transportation (ADOT), coordinates, prepares, and provides the environmental compliance for ADOT projects, including overseeing the preparation of environmental documents required by NEPA. These interdisciplinary documents ensure that project-associated environmental impacts and subsequent mitigation measures are addressed and implemented appropriately through the life of the project until completion (*3*).

The EPG maintains a table of commonly used mitigation measures used on projects in Arizona.[11] The table outlines the entity responsible for the mitigation, the common mitigation measure, and the time to employ the mitigation. The table is divided into these different mitigation topics:

- General—applies to all projects.
- Biology—includes protected species, native plants, and noxious and invasive species.
- Floodplain.
- Clean Water Act—includes Section 401/404 and Section 402 (AZPDES/SWPP, NPDES/SWPPP).
- Historic Preservation.
- Public Communication/Access/Traffic Control.
- Hazardous Materials—includes lead-based paint, NESHAP, asbestos, and miscellaneous materials.
- Noise.
- Air Quality.
- Miscellaneous Avoidance/Partnering.

Examples of common mitigation measures for the Clean Water Act from the table used by ADOT are shown in Figure 2.

[11] ADOT projects require a similar, state-level environmental evaluation process, even when there is no federal action required.

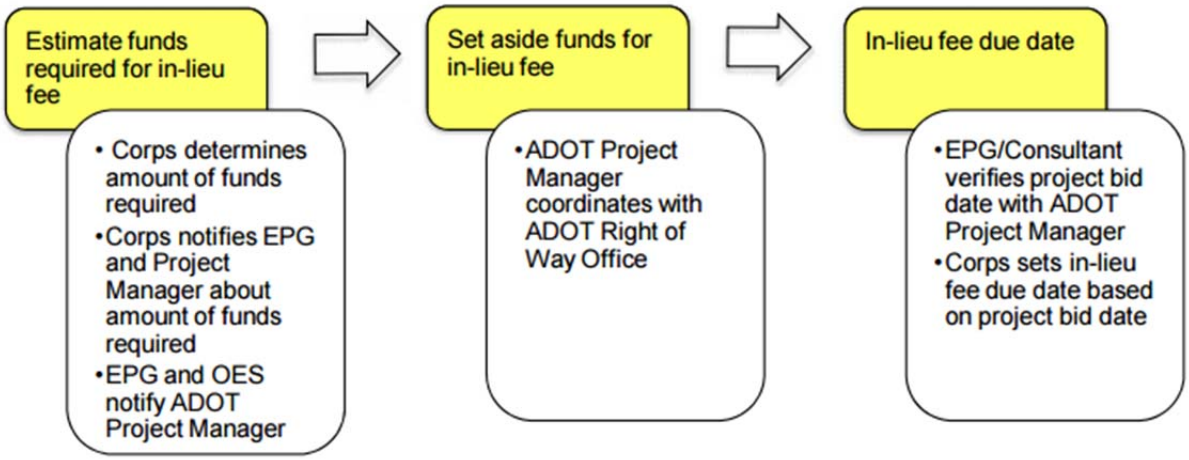
Responsibility	Mitigation Measure	When Used
– ADOT Design	▪ The Arizona Department of Transportation will prepare and submit an application to the US Army Corps of Engineers for a Clean Water Act Section 404 permit for the project.	Section 404 permit notification or application required for an ADOT project but Corps has not yet issued a permit
– Contractor	▪ The contractor, upon approval from the Engineer, shall submit the Stormwater Pollution Prevention Plan's Notice of Intent and Notice of Termination to the Arizona Department of Environmental Quality.	Disturbance of 1 acre or more, non-tribal land
– ADOT District	▪ The project is located within ¼ mile of an _____ *(indicate if outstanding Arizona or impaired)* water, _____ *(name of outstanding Arizona or impaired water)*. The impairment is _____. Therefore, the District Construction Office will retain a copy of the contractor's Stormwater Pollution Prevention Plan as required by the Statewide Stormwater Discharge Permit	Outstanding Arizona or impaired water within ¼ mile, non-tribal land

Source: ADOT (4)

Figure 2. Commonly Used Mitigation Measures for Clean Water Act Used by ADOT.

According to municipal code, several counties in Arizona are mandated to prepare an environmental mitigation fund plan as a basis for expenditures from the environmental hazard mitigation fund (*4*). Unfortunately, ADOT staff track a limited amount of the environmental mitigation costs incurred by the agency during project delivery. When the tracking system is eventually fully implemented, ADOT will have the capability to track actual environmental mitigation costs by resource type (endangered species, wetlands, etc.) for specific projects as they are incurred. The fully implemented program will also have a database of historic environmental mitigation costs, project management benefits, and project-by-project tracking of consultant activities (*3*).

In-lieu fee mitigation is the preferred method for ADOT activities requiring compensatory mitigation, particularly when pertaining to Section 401/404 permitting (*5*). After approval by the USACE, mitigation measures for the activity are included in the environmental clearance information for the project. ADOT has a process by which in-lieu fees are set aside for activities requiring them (*5*), but actual cost figures are not available. This process was developed to assist in managing the budget for in-lieu fees for mitigation activities and to facilitate coordination between the ADOT groups involved in the in-lieu fee process, illustrated in Figure 3.



Source: ADOT Clean Water Act Section 404/401 Guidance Manual (5)

Figure 3. ADOT In-Lieu Fee Fund Process.

CALIFORNIA

In 2005, each district within the California Department of Transportation (Caltrans) established an environmental commitments record (ECR) for each project to effectively track and document the completion of environmental commitments throughout the project delivery process (*6*). The ECR brings all relevant environmental compliance information together in a single place, making it easier to track progress so that project team members can identify actions that need to be taken and to ensure that Caltrans meets its environmental commitments by:

- Recording each environmental mitigation, compensation, and enhancement commitment made for an individual project.
- Specifying how each commitment will be met.
- Documenting the completion of each commitment (*7*).

As of 2006, Caltrans was not compiling environmental mitigation costs on a project-level or statewide basis but did annually report a total cost for endangered and threatened species mitigation and wetland mitigation to the Federal Highway Administration (*8*). At that time, Caltrans developed a work plan for each project and identified the activities required to estimate mitigation costs. Costs associated with mitigation and environmental activities were identified specifically by resource in the work plan.

According to a 2009 report, statewide systems for ongoing tracking of environmental commitments and conditions were lacking, even in California—a state with a larger than average environmental staff (*9*). The lack of permit requirements, as well as resource constraints, prevented many states, including California, from monitoring, or maintaining environmental assets. Also in 2009, Caltrans began developing an environmental commitment tracking tool called the Standard Tracking and Exchange Vehicle for Environmental (STEVE) projects to collect, track, share, and report environmental data (*10*). This documenting tool provides metrics for effective management decisions and an efficient retrieval of project information (*11*). STEVE is used to maintain a centralized electronic record of important information related to mitigation activities and decisions, including costs. Statewide rollout of STEVE was completed in 2011.

A Preliminary Environmental Analysis Report (PEAR) is a project-specific scoping document used to document the issues that are anticipated to be addressed in the NEPA or California Environmental Quality Act document and is only required on some projects (*11*). The Caltrans District biologist must provide the best available mitigation cost estimate, which is used to complete the ROW data sheet and ultimately becomes part of the final project documentation. In the PEAR, cost estimates must identify all potential compensatory mitigation needs that the proposed project might result in and provide the best mitigation cost estimate because the cost estimate will become part of the programmed budget for the proposed project. All ECRs and PEARs should be uploaded to STEVE.

The STEVE database could be improved to better accommodate mitigation cost estimating through tracking. Researchers at the UC Davis Institute of Transportation Studies identified several ways to improve STEVE (*12*):

- Implement a feature to isolate projects that use mitigation bank credits or involve in-house mitigation land acquisition.
- Provide clarity as to which filed should be used, and under what circumstances, for inputting data on the cost of mitigation credits.
- Provide more options to input data describing measurement units for mitigation bank credits (e.g., acreage, linear feet).
- Provide the ability to differentiate the cost of mitigation credits and what the credits were purchased for (e.g., species issues, wetlands, other resource types).

COLORADO

Like many states, Colorado DOT (CDOT) created a tracking mechanism to ensure that departments communicate with each other and that commitments stay attached to a project throughout its life. CDOT Region 6 developed the Mitigation Compliance Tracking System that catalogs project details, including compliance clearance status and mitigation (*13*). The database is contained within a Microsoft Excel spreadsheet (*14*) and lists projects individually and includes information on a project's type of documentation, permits, and clearances.

According to NCHRP Report 25-25, DOTs typically do not estimate costs during the planning, programming, or early project development phase for mitigation; however, some states apply a flat percentage to all projects to help estimate costs for preparing environmental documents. For example, Colorado DOT has estimated and allocated 2 percent of total project costs for NEPA on major projects (*1*).

CDOT developed and utilized an innovative mechanism, a state-funded revolving fund of $5 million, for advance mitigation purposes (*1*). Once under construction, projects using the mitigation funding will later reimburse the fund. The challenge with a mitigation bank or revolving mitigation fund is that projects can "tie up" revolving fund resources for long periods of time before the project is actually constructed and funds are available for other projects to utilize.

FLORIDA

In 1996, the Florida State Legislature established a mitigation program to meet the needs of the Florida Department of Transportation (FDOT). It was determined then that wetland mitigation "would be more effectively achieved with regional, long-range mitigation planning instead of conducting mitigation on a project by project basis" (*15*). In 2013, FDOT published the *Environmental Mitigation Payment Processing Handbook* to provide guidance in determining the appropriate mitigation option and the processing of mitigation payments. The handbook also goes over the agreements FDOT has with the Florida Department of Environmental Protection (DEP) and five water management districts (WMDs). These agreements detail how mitigation will be planned and constructed by the DEP or WMDs and funded by FDOT.

Wetland mitigation is managed by the five WMDs in Florida, to which FDOT pays a set price per acre of wetland impact. FDOT identifies funds quarterly within the State Transportation Trust Fund for the environmental phase of the projects budgeted for the current fiscal year (*15*). The amount transferred each year corresponds to a cost per acre of $75,000 multiplied by the projected acres of impact for that year. Each July 1, the cost per acre is adjusted annually, based on the change in the Consumer Price Index. Figure 4 shows the costs per acre for wetland mitigation used in programming payments to DEP and the WMDs.

FISCAL YEAR	COST PER ACRE
2014/15	$ 111,432
2015/16	$ 113,135
2016/17	$ 115,369
2017/18	$ 116,931
2018/19	$ 118,941
2019/20	$ 121,260

Source: FDOT Work Program Instructions FY 15/16–19/20 (16)

Figure 4. Wetland Mitigation Costs Per Acre in Florida.

NCHRP 25-25 (*1*) reports that DOTs want to devote environmental cost savings to mitigation and are interested in better and earlier estimation of mitigation costs such as those for wetlands and habitat replacement. According to the report, FDOT has made strides in this area by identifying necessary environmental studies for each project through environmental screenings at the planning and pre-programming phases (*1*). The costs for the needed environmental studies are estimated and included in the work program or State Transportation Improvement Program. As part of the Efficient Transportation Decision Making Process program at FDOT, a planning screen occurs in conjunction with the development of long-range transportation plans. This allows participants to review the project purpose and need statements and comment on the potential impact to environmental and community resources early in the planning process. Needed environmental studies, costs, and effects on a project's timeline are all decided prior to programming, effectively increasing the accuracy of the cost estimate.

Environmental review in planning can take several approaches. States are investing in geographic information system (GIS) data to perform early review and analysis used to support expert decision making. According to the *Guide to Estimating Environmental Costs*, one of most developed examples of this approach is the Environmental Screening Tool at FDOT. The tool contains hundreds of data layers and early coordination by resource agencies on technical advisory teams. Projects in the long-range plan are reviewed and screened again at programming. These reviews enable all necessary site studies to be determined (and thus cost estimates generated) prior to project programming (*17*).

FDOT's electronic tracking system (ETS) was developed by the state's District 4 Planning and Environmental Management (PL&EM) services office. The ETS is intended to inform the state's district design, construction, and maintenance departments of the environmental concerns and commitments made during the NEPA process. Th ETS identifies commitments made during the

development and environmental phase and documents how these commitments will be incorporated into final design and monitors their compliance during construction (*1*). The ETS documents the most current status of each environmental commitment on a specific project.

NEW YORK

The New York State DOT (NYSDOT) started a department-wide effort in 1998 to promote an environmental ethic throughout the department, advance state and federal environmental policies and objectives, and strengthen relationships with environmental agencies and the public. This effort was called the Environmental Initiative and provided guidelines and best practices for avoiding and minimizing adverse effects of transportation projects and operations on important elements of the environment and adjacent communities (*18*).

A main goal of the Environmental Initiative was to move practices at the department beyond regulatory compliance with state and federal regulations and actively engage environmental agencies in partnerships with shared goals. NYSDOT developed several action plans to implement the initiative at the main office and regional offices that define discrete tasks, schedule for these tasks, and assign responsibilities to ensure completion.

Environmental projects are tracked on a monthly basis using NYSDOT's Project and Program Management Information System (P/PMIS). To that extent, project managers select one of nine environmental initiative attributes for a particular project as part of a general work type. This allows the tracking of environmental activities as part of NYSDOT's capital construction and maintenance program (*19*). The NYSDOT Engineering Instruction EI 99-026 describes available P/PMIS work types that are in the environmental initiative group (*20*):

- **Water quality improvements.** Any project or work activity that improves existing or future biological or chemical quality of a water resource, including streams, rivers, wetlands, drinking water sources, and highway/storm water runoff. Water quality can be improved by preventing or removing sediments and pollutants; retrofitting highway drainage systems; installing storm water treatment facilities; and preventing or reducing erosion through bioengineering, best management practices' use, or training in best management practices' facilities design and installation.
- **Wetlands creation, restoration, or enhancement.** Creating, restoring or enhancing wetland beyond the minimum required in state and federal wetland permits. The creation of new wetland acreage is one form of mitigation for past wetland impacts in which an upland area is converted, typically by excavation or damming, to a flooded or moist soil condition where wetland vegetation, soil, and hydrology will persist. Restoration and enhancement may include adjusting water flow or level onsite, additional planting or seeding with wetland vegetation, improving habitats and vegetation cover-type diversity within the wetland, removing invasive plant species, or acquiring regionally important wetland areas for preservation purposes.
- **Fish and wildlife habitat improvements.** Habitat enhancements made to improve the life of wildlife, including planting specialized food and cover crops along highway corridors, protecting and managing specific habitats deemed valuable to target wildlife species (endangered species), providing wildlife crossings under highways, and providing nest boxes and various refuge for wildlife. Fisheries habitat can be enhanced by

bioengineering of stream banks and placement of in-stream structures such as boulders and weirs for diversity of cover and nesting sites.

- **Historic/cultural resources preservation and enhancement.** An activity that preserves or enhances the historic or cultural heritage of New York State. Activities incorporate protection of these resources into projects by preserving historic structures, acquiring or stabilizing archaeological sites, supporting archaeological excavations, developing interpretive programs for archaeological and cultural sites, providing street ambience enhancements (such as period lighting fixtures, bollards, benches, and pavers), and adding additional historic markers and interpretive signs.
- **Ecotourism and public access improvements.** A project enhancement that promotes the use, enjoyment, and appreciation of the natural and manmade resources of the state. Ecotourism can be encouraged in highway work projects by simply improving the appearance of roadsides and entrances to natural and cultural features. This improvement can be accomplished by providing new or rehabilitated fishing and boating access and parking, promoting state bike routes and greenways, improving trailhead parking and facilities, and upgrading scenic overlooks and acquisition of scenic easements. Placement of landmarks and interpretive signs or identification of important waterways, watersheds, and habitats are also potential accomplishments toward increasing ecotourism in New York State.
- **Corridor landscaping/streetscape enhancements.** Any additions to NYSDOT projects that enhance the visual, aesthetic, and natural character of the roadside or streetscape. These enhancements may include increasing wildflower and roadside plantings, constructing noise barriers, adding landscaping to enhance the appearance of noise barriers, providing streetscape amenities (such as benches, lighting fixtures, decorative pavers), re-establishing street trees, rehabilitating comfort stations and rest areas, incorporating traffic-calming features, and promoting state bike routes and greenways.
- **Recycling and reducing materials and emissions.** Any project that includes innovative ways to utilize recycled materials, reduce waste generated by NYSDOT, or reduce hazardous substance use. In dealing with solid waste, projects may promote the use of recycled tires in highway embankments; recycled glass, plastics, and aggregate in pavement mixes; and recycled plastic, rubber, and aggregate in noise walls. NYSDOT may minimize herbicide applications, sweep roadsides better and more often, and develop innovative use of salt/sand and other ice-removal substances.
- **Remediating contamination.** Any project that includes innovative ways to clean up contamination, either previously generated by NYSDOT projects, at NYSDOT facilities, or present along NYSDOT ROWs. Whenever possible, activities should be promoted that support brownfield development.
- **Air quality improvements.** Project elements incorporated to reduce emission levels, thereby resulting in cleaner air. These project enhancements are aimed primarily at reducing single-occupancy vehicles (SOVs). Initiatives that will reduce these emissions include supporting mass transit, expanding Ozone Alert Day initiatives, promoting the use of alternative fuel vehicles, encouraging alternatives to SOVs, implementing Transportation Demand Management practices, providing facilities for pedestrians and bicyclists, and replacing fixed-time traffic signals with vehicle-actuated signals, when appropriate.

Appendix B of NYSDOT's Design Procedure Manual (*21*) provided guidance on documenting environmental initiative actions, which was superseded in 2005 by Appendix 7 of its Project Development Manual (*22*). The department's Environmental Procedures Manual (*23*) and the Highway Design Manual (*24*) have also incorporated portions of the Environmental Initiative.

Environmental Management System

NYSDOT also maintains an EMS called an Environmental Tracking Program (ETRACK) that is used to monitor the status of all environmental requirements on NYSDOT projects (*25*). NYSDOT implemented the database in 2004 and progressed toward statewide implementation over the following years. ETRACK is a Microsoft Access database linked to NYSDOT's Program Support System (PSS) that tracks project costs, status, and major project milestones (*26*). PSS is maintained by the NYSDOT central office and provides the official listing of NYSDOT projects that are at various stages of the project development process (*27*). A main function of ETRACK is to address compliance requirements regarding illicit discharge detection and elimination throughout project design and construction. ETRACK also maintains records of environmental, landscape architecture, and social impacts. In 2006, NYSDOT considered moving to a web-based application so that ETRACK could be linked to ECOPAC, which is the NYSDOT's Environmental Commitment and Obligations Package for Construction. ECOPAC is a PDF form checklist developed by the design group for use by the construction group to facilitate follow-up, awareness, and field inspection (*28*).

NORTH CAROLINA

In 1997, the North Carolina legislature founded the Wetlands Restoration Program (WRP) in an effort to improve the poor success rate of compensatory mitigation efforts in the 1990s (*29*). WPR was focused on wetlands and administered by the North Carolina Department of Environment and Natural Resources (NCDENR). The North Carolina Department of Transportation (NCDOT) began utilizing the WRP in 1999 to reduce project delays and meet a portion of its mitigation needs that resulted from NEPA regulations. However, NCDOT and NCDENR mitigation programs functioned independently with different operating processes, which complicated coordination with federal and state regulatory agencies and failed to produce effective mitigation projects. To address these shortcomings, executives from NCDOT, NCDENR, and the USACE developed a new approach and process called the Ecosystem Enhancement Program (EEP) (*30*).

The EEP was officially established in 2003 with the signing of a memorandum of agreement by NCDOT, NCDENR, and USACE (*31*). The memorandum states that the purpose of the EEP is to "provide a comprehensive, natural resource enhancement program that identifies ecosystem needs at the local watershed level and preserves, enhances, and restores ecological functions within the target watersheds while addressing impacts from anticipated NCDOT transportation projects" (*31*). The memorandum further states that the EEP activities will be undertaken by the NCDENR with participation by state and federal agencies and will be eligible for funding through multiple sources, including programmed transportation funding. The memorandum also stated the following goals of the EEP:

- Execute the requirements placed on the NCDENR by the North Carolina WRP Act (NCGS 143-214.8, et seq.).
- Enhance the natural resources of North Carolina by addressing watershed needs.
- Fully satisfy compensatory mitigation requirements for authorized impacts on a programmatic, watershed-level basis.
- Provide in-ground, functioning, compensatory mitigation for authorized impacts in advance of the actual impacts.
- Satisfy the compensatory wetland, stream, and buffer mitigation needs of the NCDOT transportation program.
- Provide a means for organizing, steering, finding, and implementing ecosystem enhancement efforts in the State of North Carolina.

In 2010, the EEP memorandum was superseded by a new legal document, an agreement to continue in-lieu fee programs operated by NCDENR (*32*). When a project involves unavoidable impacts to the surrounding wetlands, compensatory mitigation takes effect, and a mitigation plan is constructed in order to secure a Section 404 permit. The developer/permit applicant has three choices regarding the compensatory mitigation implementation: compensatory mitigation self-implementation, purchase and utilization of mitigation bank credits from established large-scale mitigation sites, or in-lieu fee programs as governed by the EEP. The first choice places the responsibility of compensatory mitigation solely on the developer/permit applicant. The latter two, mitigation bank credits and in-lieu fees, transfer the responsibility of the compensatory mitigation efforts from the developer/permit applicant to the site sponsors. The plan of the developer/permit applicant is reviewed by USACE, a permit is issued, and the execution of the mitigation effort takes place.

Environmental Management System

NCDENR uses an EMS that enables comparison of problems and assets of local watersheds based on GIS data analysis of five broad categories of information (*28*):

1. Baseline watershed conditions.
2. Watershed resources or attributes.
3. Watershed problems.
4. Potential threats and stressors.
5. Other factors.

The EMS includes a screening methodology to identify target areas for restoration and tracks performance by comparing impacts of implemented projects against targeted goals for wetland and riparian functions. A system for assessment of wetland and ecosystem functions that will be linked to the mitigation credit and need accounting system is under development (*28*). The EMS is based on the ISO 14001 standard and a structured management methodology that allows the NCDOT to demonstrate a focus on meeting or, in some cases, exceeding regulatory compliance (*33*). NCDOT also provides a mitigation site map to view the locations of sites purchased and/or maintained by NCDOT, including stream, wetland, or threatened and endangered species' mitigation credit sites as part of various environmental permits. Sites include projects built throughout North Carolina, full delivery projects from consultants, and projects partially built or managed by other agencies (*34*).

Each year, NCDOT provides EEP a project impact report of all anticipated wetland, buffer, and stream impacts by year, for seven years into the future, for each 8-digit watershed (*1*). Project impacts are projected for each Transportation Improvement Program (TIP) project number and/or NCDOT Division operations impacts, and NCDOT submits quarterly updates throughout the year (*35*).

OREGON

In 1999, the Oregon legislature passed HB 2478, which directed the Oregon Department of Transportation (ODOT) to develop a summary that shows how ODOT's costs are affected by environmental regulations (*36*). One goal of this effort was to determine which mandates result in high compliance cost to ODOT and would provide the most benefit if changes to the mandate were considered in the future.

ODOT found that 45 federal mandates, laws, or regulations affect ODOT's costs of environmental compliance, in addition to 22 state and one local mandate. In 2000, compliance with federal environmental mandates totaled $30.1 million, and compliance with state and local mandates totaled $5.4 million (*36*). ODOT breaks down the cost into several cost categories, as shown in Table 4.

Table 4. Cost of Compliance with Federal Mandates, by Subject Area, in 2000 (*36*).

Subject	Expense (thousands)
Air Quality	$177
Biology	$7,278
Cultural Resources	$1,063
General Environmental	$2,459
Haz Mat	$4,535
Land Use/Planning	$418
Noise	$1,234
Roadside	$111
Socioeconomics	$493
Wetlands	$3,302
Water Quality	$9,066
Total	**$30,136**

Table 4 shows that the Water Quality category alone accounts for 30 percent of federal environmental expenses, while Water Quality combined with Biology and Wetlands account for about 65 percent of federal environmental expenses.

Cost Estimation

To develop the cost aggregation, ODOT aggregated cost data by several sets of categories (*36*):

- Budget limitation, including planning, maintenance, preservation, bridge, highway safety, highway operations, modernization, highway planning, special programs, emergency relief, and local government.
- Individual mandate and mandates grouped in subject areas (e.g., air quality, biology).
- Environmental subject and jurisdiction of mandate.

In the annual report, ODOT highlights that the department does not keep cost data by mandate, and many laws and mandates overlap such that a single action by ODOT may meet requirements of several mandates (*36*). For example, the Clean Water Act addresses water quality and wetlands. ODOT's cost aggregation was mainly based on underlying legislation and gathered by subject area. In case of overlap, costs were distributed to individual mandates by professional estimate.

Determining environmental personnel cost was even more challenging because work activities in response to environmental mandates are often related to multiple stages of project development. Cost estimations in this area were best-guess estimates by professional staff. For example, indirect costs, upgrades to project features necessitated by a mandate, and cost savings due to avoidance of impacts were not included in the cost estimate.

According to the 2000 annual cost report, ODOT calculated costs for six functional areas of the department that correspond to major phases of the project development process, as follows (*36*):

- **Planning.** This group does not account costs by environmental mandate, so the group matched mandates that were applicable at the planning stage with budget allocations for activities that would address the mandates. Then a level of effort applicable to the mandate was estimated and finally calculated against the budget for the appropriate activity.
- **Environmental.** This group provided a summary of true costs since all environmental personnel are engaged full time in applying environmental mandates. Since environmental staff are assigned to specialized work groups, there is a very good match between costs and each category, such as wetlands. However, costs are not tracked by mandate, so costs estimates for specific mandates within a category are estimates.
- **Right of Way.** The largest environmental cost factor in ROW is the purchase of property for mitigation sites, usually for wetlands and noise walls, which can be easily matched to cost subject areas. Personnel costs of compliance with mandates are estimates.
- **Design.** ODOT staff had difficulty differentiating design work for normal design and design for an environmental mandate. As a result, staff managers were asked to estimate the time of their crews for each category. Some design functions, namely those dealing with water quality, erosion control, and hydraulic design, were more directly related to environmental functions and therefore easier to relate than were others.
- **Construction.** In bid items, environmental costs are easy to distinguish and summarize; in progress payments, it is more difficult. One issue was that in many cases, contracts are let in one year but continue for a multi-year period so that total contract costs in any one

year do not necessarily reflect the average cost to the department. ODOT collected costs for the last 5 years and then calculated an average cost to give the best yearly estimate of environmental compliance during construction.

- **Maintenance.** Only few maintenance personnel are assigned to environmental issues so that costs can be directly associated. Most costs are based on estimates and include labor, equipment, supplies, services, and contract work. The applicability of environmental requirements varies throughout the state, which results in varying environmental costs from district to district.

The latest version of ODOT's annual environmental cost report was published for the fiscal years 2013 and 2014 (*37*).

Table 5. Cost of Compliance with Federal, State, and Local Mandates, by Functional Area, for the 2013 and 2014 Fiscal Years (*37*).

Functional Area	Expense (thousands)	Expense (% of total)
Planning	$2,250	2.75%
Project Development	$20,908	25.56%
Construction	$8,679	10.61%
Maintenance	$49,955	61.07%
Total	**$81,800**	**100%**

For the biennium, ODOT reported the total estimated cost of compliance with federal, state, and local mandates, but did not break down costs by jurisdiction or subject area. It appears that ODOT realized that there was too much overlap between federal, state, and local mandates to reasonably distribute costs among jurisdictional requirements. Instead, ODOT reported costs by four functional areas of the project development process, as shown in Table 5 above. As compared to the 2000 report, the functional areas of environmental, ROW, and design were grouped into one area called project development. The total estimate for the biennium was $81.8 million.

Based on a 2008 report by the Government Accountability Office, ODOT's costs for environmental compliance have consistently averaged about 4.5 percent of overall project costs over the period of 2000 to 2008 (*38*). Since 2008, based on the most recent available cost reports, environmental compliance costs have decreased to about 3 percent annually.

Coordination with Environmental Agencies

ODOT signed a charter in 2001 with several other environmental agencies to establish the Collaborative Environmental and Transportation Agreement for Streamlining (CETAS) (*39*). The group was formed in response to regulatory requirements in TEA-21 toward environmental streamlining and to better address the complexity of environmental regulation and planning requirements.

In practice, ODOT presents environmental issues of upcoming projects to members of CETAS in a monthly meeting (*39*). ODOT seeks concurrence from regulatory agencies on purpose and need, range of alternatives to be studied by EIS or EA, criteria for selecting the preferred alternative, and selection of the preferred alternative. Decisions are made by the consensus of all CETAS participants, who know that a decision may not be the optimal outcome for any one agency but rather an acceptable outcome to all participants. If CETAS participants cannot come to a consensus, contested issues can be elevated to a higher level of representation from each member agency. According to guidance from ODOT, the essential tasks of CETAS members are the following (*39*):

- Provide a forum for exchange of information and perspectives.
- Establish collaborative opportunities for its work groups to resolve.
- Establish work groups.
- Monitor the progress of work groups.
- Approve work group products.
- Implement CETAS agreements.
- Monitor the implementation of CETAS agreements.
- Engage in other activities as the group decides.

According to a 2008 NCHRP study, ODOT also uses a list of average costs called "Frogger," which is used to determine estimates for various sizes of efforts for environmental products (*1*). The literature review was unable to confirm the existence of this list, so information about this tool is provided solely from the referenced NCHRP study report. The report states that the list is broken down into concrete tasks such as the preliminary mitigation plan, wetlands report, and final mitigation plan. Cost categories are provided in terms of low, medium, or high dollar expenses (not hours), and cost categories are updated using actual prices determined by a fiscal year's invoices that are used to determine averages. Costs are determined separately for each of ODOT's five regions since the rural nature of some regions require much more travel and time to reach the project area for research.

PENNSYLVANIA DOT

The Pennsylvania DOT *Estimating Manual* provides policies and procedures for developing, documenting, and reviewing construction cost estimates throughout the project development process. The *Estimating Manual* includes an engineering and environmental scoping estimate to review the construction cost estimate developed during the TIP development and determine what additional information is currently known regarding the construction cost estimate. The engineering and environmental scoping cost estimate is developed using parametric estimating or similar project estimating. To develop the construction cost estimate using the engineering and environmental scoping, the construction cost estimate is broken down into approximately 15–25 broad categories, including structures, roadway, drainage, and environmental mitigation. The scoping and estimating process is similar to TxDOT's process to use EPIC sheets to represent for permits and commitments. Actual environmental mitigation cost estimating techniques were not identified, but used the same techniques as used in other elements of the engineering and scoping cost estimate (*40*).

OHIO DOT

Ohio has approximately 5,000 acres of mitigation land in its inventory. Approximately 5 percent of ODOT's projects have a mitigation component, some of which have multiple mitigation sites for a particular project. Over half of Ohio's 88 counties have some type of ODOT mitigation project within their boundaries. ODOT owns over 130 acres of wetland bank credits at approximately nine different wetland banks and has pooled credits for future ODOT use, including more than 100,000 linear feet of streams, 50 acres of wetlands, and 2,000 acres of species habitat.

Ohio DOT Mitigation Inventory

ODOT maintains an online mitigation inventory of all ODOT natural resource mitigation projects. The inventory pages include compliance reports, permits, legal documents, maps, and photos. Cost information was not displayed in the inventory or in the technical documents within inventory pages and links. The inventory is categorized by county. The mitigation projects are collected within the Mitigation Inventory List. Project-specific detail pages can be accessed by the county location of the project from the table. Environmental mitigation cost estimation was a listed item in the ODOT *Cost Estimating Procedures for Acquiring ROW*, but mitigation-specific cost ranges and references were not singled out (*41*).

VIRGINIA DOT

Virginia Department of Transportation's (VDOT's) "Comprehensive Environmental Data and Reporting System" (CEDAR) was developed primarily as a tool for improving early project development. CEDAR includes data on historic properties in addition to data on natural resources and other environmental factors. The program organizes all environmental data (including specific project documents, forms, and images) into one system that is accessible to VDOT staff. State Planning and Research (SPR) funds were used to develop the CEDAR program and database. These funds covered staff costs but were not used for software or hardware purchases. The state's IT agency reviewed the development of the GIS, as did an internal VDOT IT board. Since SPR funds were used, FHWA also had a review role.

VDOT's CEDAR is a single, centralized data repository that is integrated with GIS databases and their SHPO-web and GIS-based cultural database system and offers full integration with VDOT's project management system. CEDAR replaced the more than 73 tracking systems previously in use throughout the state and resolved issues of data redundancy and duplicative work. It provides better accountability and improves the documentation and communication of environmental decisions and commitments. The VDOT's CEDAR has an associated GIS database that was developed by in-house information technology experts and augmented with work by consultants. Environmental commitments can be geo-referenced in CEDAR, even though it is not currently in widespread use. Commitments are also tied to the DOT's project management software that is integrated with the CEDAR program. Due to its compatibility with multiple systems across VDOT, CEDAR is reported to have replaced more than 70 individual tracking systems.

Wetlands Catalog

The Virginia Department of Conservation and Recreation created a *Wetlands Restoration Catalog* (WRC) in 2008 that prioritizes wetland and stream restoration and conservation opportunities. Restoration and conservation opportunity areas are selected based on their potential biodiversity and water quality functions.

The WRC uses a combination of national- and state-level ecological and hydrologic data to categorize potential wetland and stream compensation projects by their restoration potential. Data inputs are divided into wetland source layers that portray existing wetland and stream resources, data helpful for predicting unmapped wetlands (e.g., National Wetlands Inventory, National Hydrography Dataset, Digital Flood Insurance Rate Map, and Soil Survey Geographic Database), and priority source layers that "were used to prioritize for mitigation the features in the wetlands map."

The WRC results in four principal outputs:

- A map with individual aquatic resources grouped into five categories based on their restoration potential rating.
- A map with parcels grouped into five categories based on the restoration potential of aquatic resources within their boundaries.
- A table that provides a wetland or stream's overall rating, restoration potential category, surrounding parcel(s), and surrounding sub-watershed(s).
- A table that provides a parcel's overall rating, wetland(s) and stream(s), surrounding sub-watershed(s), and restoration potential category (*42*).

APPENDIX B:
RIGHT OF WAY INFORMATION SYSTEM SEARCH RESULTS

The research team sought to identify costs associated with mitigation on a statewide basis. Since there is no single source or management system for capturing all types of mitigation costs statewide, the researchers queried ROWIS, which tracks costs associated with ROW purchases and issues a ROW CSJ number. As such, any parcel purchase associated with mitigation may be discoverable in ROWIS. Although ROWIS does not capture all mitigation costs on a statewide basis, it does account for mitigation associated with a parcel, and most wetland mitigation costs can be associated to a parcel.

Mitigation payments identified in ROWIS only include compensatory wetland mitigation paid in relation to Section 404 mitigation actions involving the purchase of a parcel, credits, or a fee-in-lieu payment. The ROWIS system captures ROW CSJs for parcels or payments in-lieu of parcels. ROWIS does not appear to distinguish between the purchase of mitigation bank credits and fee-in-lieu payments but instead groups both together. Compensatory mitigation for ESA, hazardous material remediation, or other type of environmental mitigation payments are not discernable or coded within ROWIS because it only tracks the purchase of a parcel or fee for a parcel. Additionally, compensatory mitigation conducted as part of comprehensive development agreement, or concession agreement, does not typically appear in ROWIS. Presumably, the concessionaire tracked these payments outside of ROWIS and TxDOT management systems.

Researchers conducted a search of ROWIS records to locate data about mitigation parcels that were paid by TxDOT from 2003 through August 1, 2015. The search used the following parameters to identify payments for mitigation purposes:

- Search for the term "mitigation" in ROWIS database fields' "payments_comments" and "payments_payee_name."
- Search in field "payments_expense_type_cd" for records with a value equal to "Fee-in-Lieu of Mitigation."
- Search in field associates_tasks_task_id" for records with a value equal to "Mitigation in Lieu."
- Search in field "payments_object_of_expense" for records with a value equal to "336" for land acquisition or "366" for fee-in-lieu of mitigation.

For the 2003–2015 period, the research team found records for 85 mitigation parcels with a total payment amount of $60 million. The earliest payment was paid on December 16, 2003, and the latest payment was executed on July 13, 2015. The cost of the parcels varied from $233 to $14.7 million, with a median value of $93,421. Two of the 85 payments for mitigation parcels were higher than $3.5 million ($14.7 and $11.1 million), so these costs can be considered an unusually high amount. Figure 5 depicts a histogram and cumulative frequency of payments for mitigation parcels from 2003 to mid-2015. There were 61 parcels (72 percent of parcels), with a cost of up to $250,000. The following sections summarize the cost information by year, region, district, and ROW CSJ number.

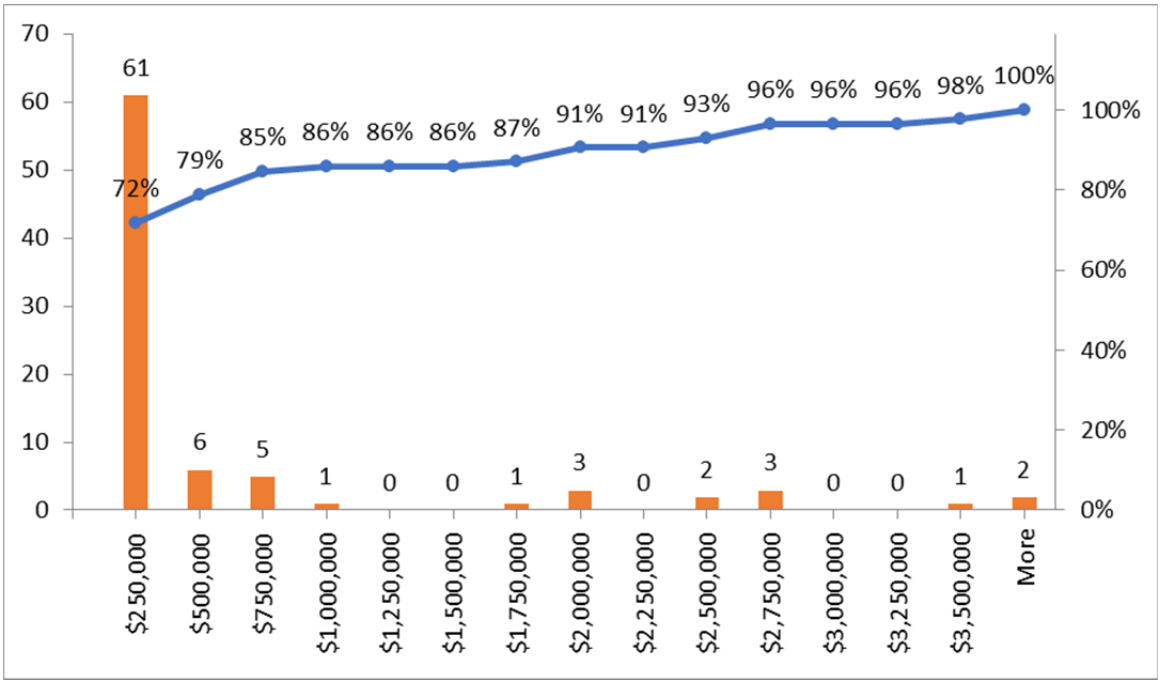


Figure 5. Histogram and Cumulative Frequency of Payments for Mitigation Parcels (2003 to August of 2015).

MITIGATION PAYMENTS BY YEAR

Figure 6 shows the total annual amount TxDOT paid for mitigation parcels from 2003 to August 2015. Between 2003 and 2011, the annual amount was between $100,000 and $2.8 million, with a median cost per parcel for that period of $78,750 and a total cost of $10.1 million for 40 parcels. In 2012, the annual cost for mitigation parcels increased significantly to $9.5 million, which was only slightly lower than the total amount expended for the period from 2003 to 2011. In 2013, the cost for mitigation parcels almost tripled from 2012, for a total of $35.2 million. Expenses in 2014 were comparatively low at about $680,000 but increased in the first of half of 2015, reaching $4.5 million, which is about the same level of expenses as in 2012. The median cost for 45 parcels from 2012–2015 increased to $185,000, which is more than double the median cost per parcel from 2003–2011.

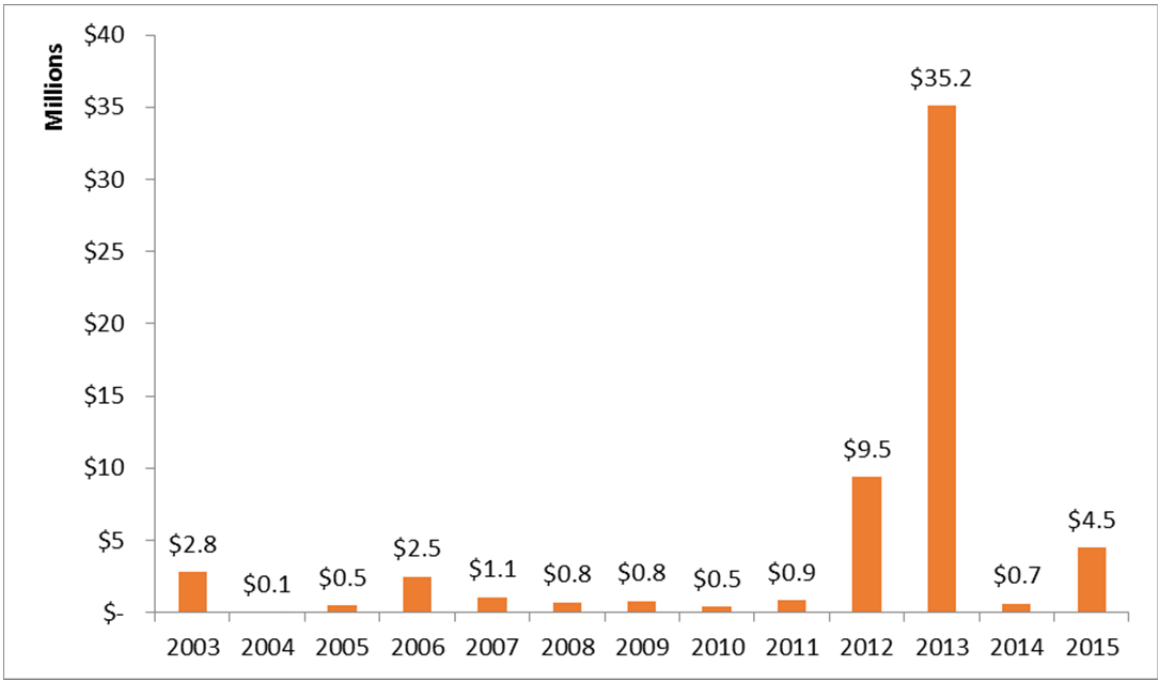


Figure 6. Annual Amount of Payments for Mitigation Parcels (up to August 2015).

A look at the total number of parcels acquired reveals that the cause for the increase is not only a result of the number of parcels paid for, but also the average cost per parcel. For example, Figure 7 shows the number of parcels purchased annually between 2003 and 2015, and Figure 8 shows the average cost per parcel purchased that year. From 2003 to 2011, the average cost per parcel was about $250,000, but increased almost fourfold to $945,000 per parcel in 2012 and to $1.2 million in 2013. However, 2012 and 2013 did not have the highest average cost per mitigation parcel, as shown in Figure 8. In 2006, TxDOT purchased one parcel for $2.5 million. The high mitigation costs for 2012 and 2013 are therefore a result of the combination of unusually high parcel costs and an unusually high number of parcels.

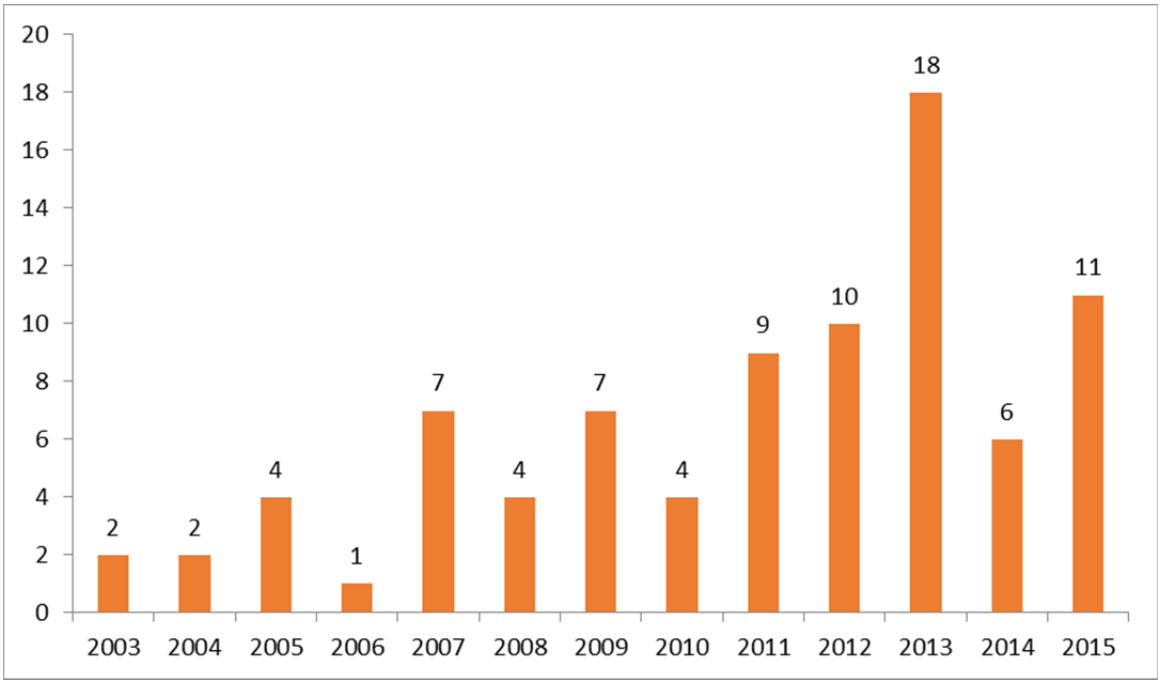


Figure 7. Annual Number of Mitigation Parcels Acquired.

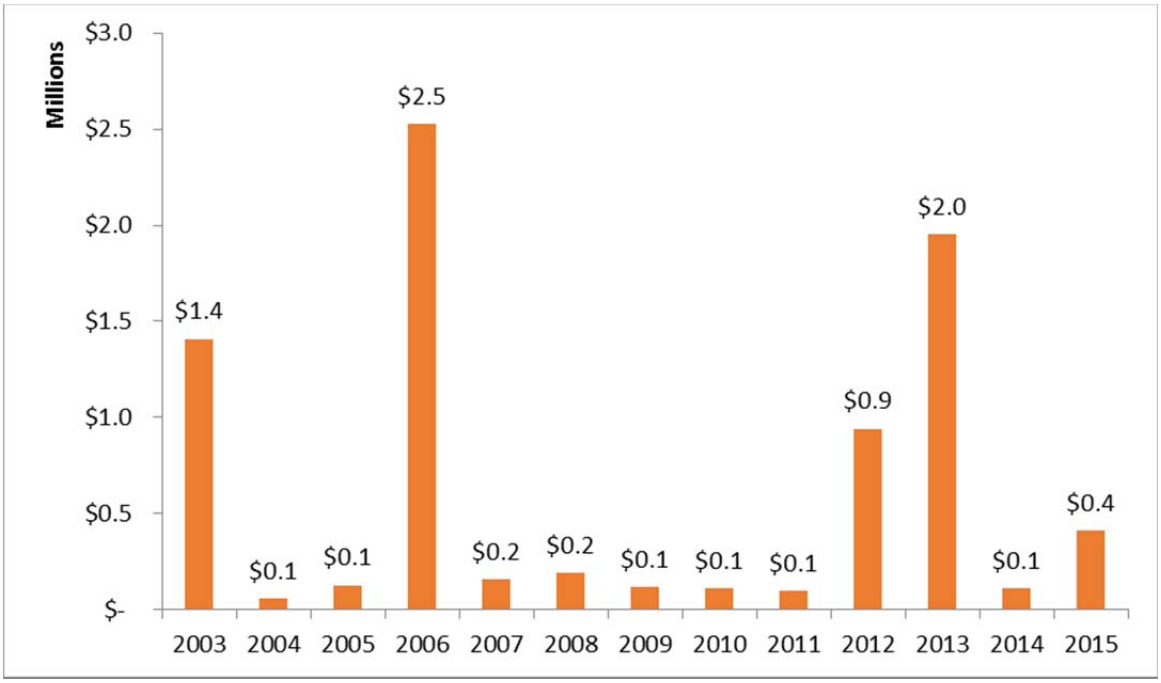


Figure 8. Average Cost per Mitigation Parcel by Year.

To reveal potential causes for the unusual high parcel cost in 2012 and 2013, the research team analyzed the data further. The data in ROWIS included information about the expense type for each parcel acquired, namely "land acquisition" and "fee-in-lieu of mitigation." Figure 9 shows the number of parcels acquired by year (also shown in Figure 7); however, in Figure 9 the numbers are broken down into the two expense types. It becomes clear that, prior to 2009, the ROW Division did not use the fee-in-lieu of mitigation expense type , but starting in 2010

switched to almost exclusively using that expense This shift is a direct response to changes in the USACE rule changes that, beginning in 2009, allowed for in-lieu fee compensatory mitigation. In-lieu-fee mitigation occurs in circumstances where a permittee provides funds to an in-lieu-fee sponsor instead of either completing project-specific mitigation or purchasing credits from a mitigation bank.)

ROWIS codes do not appear to distinguish between in-lieu-fee and mitigation bank credit purchases.

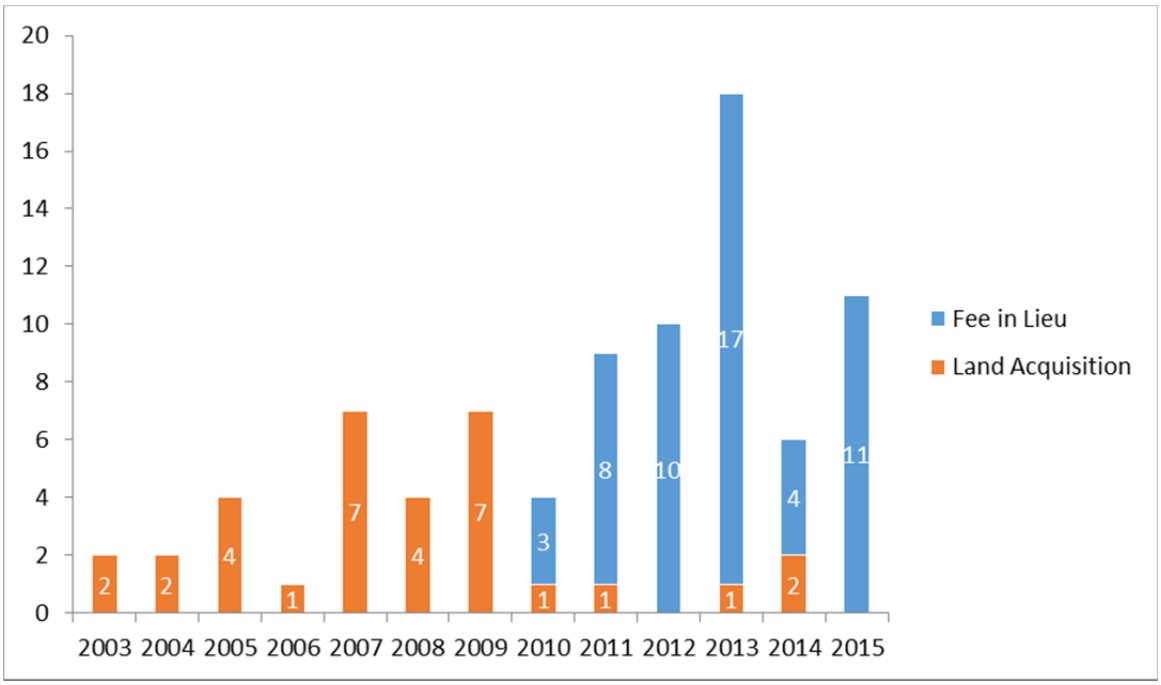


Figure 9. Annual Number of Mitigation Parcels Acquired by Expense Type.

The researchers summed up the cost of all parcels mitigated through land acquisition and all parcels mitigated through fee-in-lieu of mitigation to determine average costs for each. The researchers found that TxDOT paid $9.62 million for 32 land acquisition parcels, and $50.35 million for 53 fee-in-lieu of mitigation parcels. This amounted to an average cost of land acquisition parcels over the study period of $300,000 versus $950,000 for fee-in-lieu of mitigation parcels. In other words, per parcel, TxDOT spent an average amount three times higher on fee-in-lieu/credit purchases for parcels as compared to land acquisition parcels.

MITIGATION PAYMENTS BY REGION[12]

Researchers determined in which region and district TxDOT purchases the most mitigation parcels by value. Figure 10 shows that TxDOT expended the largest amount of funds in the east region. Figure 11 shows that, in relative terms, about 85 percent of the overall cost was expended in the east region, based on a total of 37 parcels. In the north region, 33 parcels were

[12] TxDOT no longer functionally organizes by regions. The ROWIS data allowed for sorting for regions based on the previous organization structure. The use of regions presented here is used to characterize and compare the variability in mitigation cost impact across the state.

acquired, but only amounted to roughly 12 percent of the overall cost. In the south and west regions, TxDOT purchased 14 parcels in toto since 2003, which amounted to about 3 percent of the total mitigation cost. Figure 12 shows that based on the number of parcels acquired, the expense type fee-in-lieu of mitigation was the most popular in all but the west region.

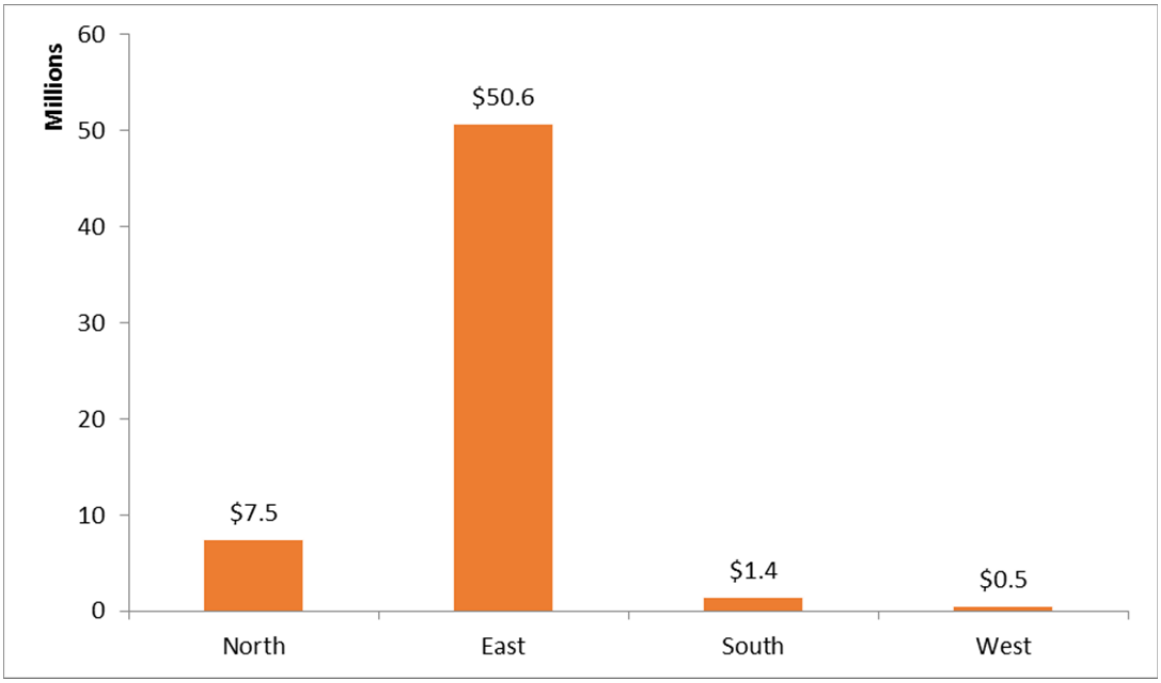


Figure 10. Amount of Mitigation Funds Expended by TxDOT Region (2003 to 2015).

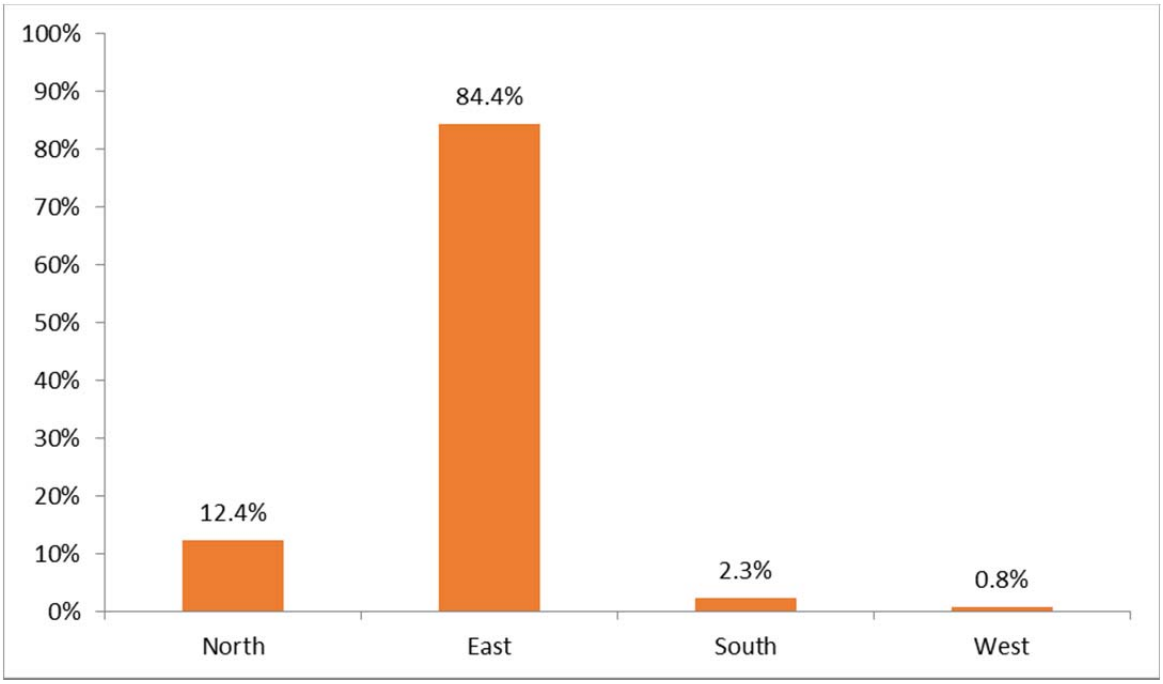


Figure 11. Percentage of Total Mitigation Funds Expended by TxDOT Region (2003 to 2015).

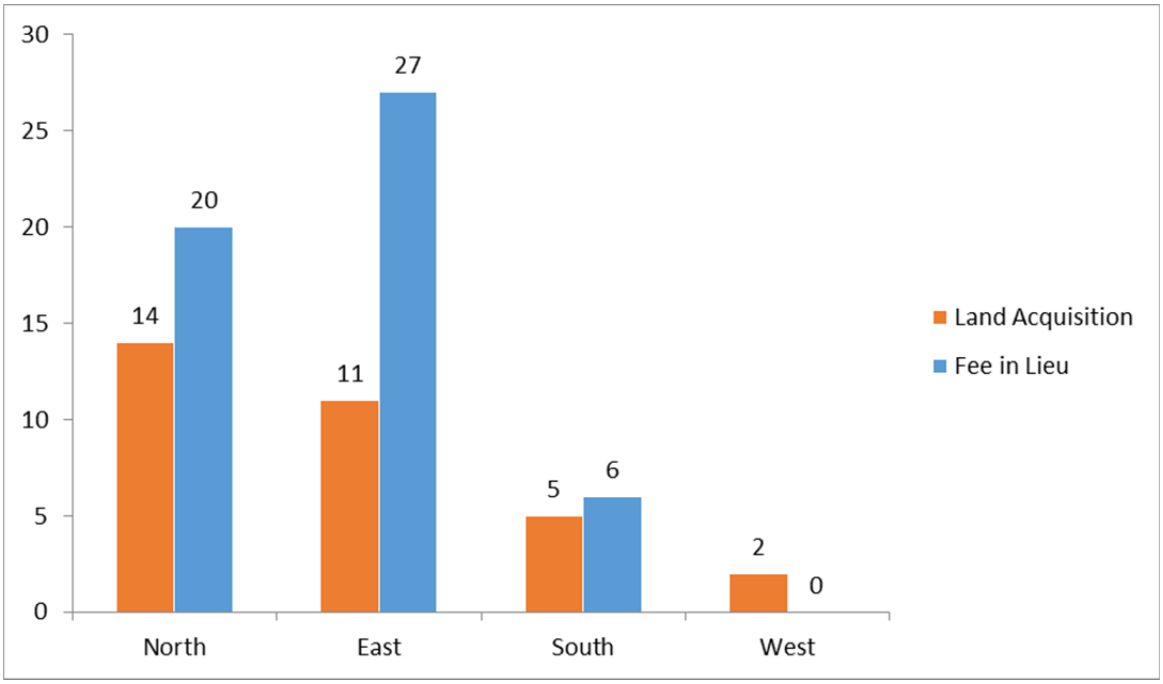


Figure 12. Number of Mitigation Parcels Acquired in Region by Expense Type (2013 to 2015, n=85).

MITIGATION PAYMENTS BY DISTRICT

The cost distribution by district revealed that TxDOT purchased mitigation parcels in 14 of 25 districts, as shown in Figure 13. The figure further shows that the vast majority of funds were expended in the Houston District. Figure 14 shows that in relative terms, the funds expended in the Houston District amounted to 78 percent of all mitigation costs from 2003 to 2015. The Tyler District expended $3.7 million on mitigation parcels, which amounted to 6 percent of all mitigation costs, and the Dallas District spent $3.2 million over the same period, amounting to 5 percent of total expenditures.

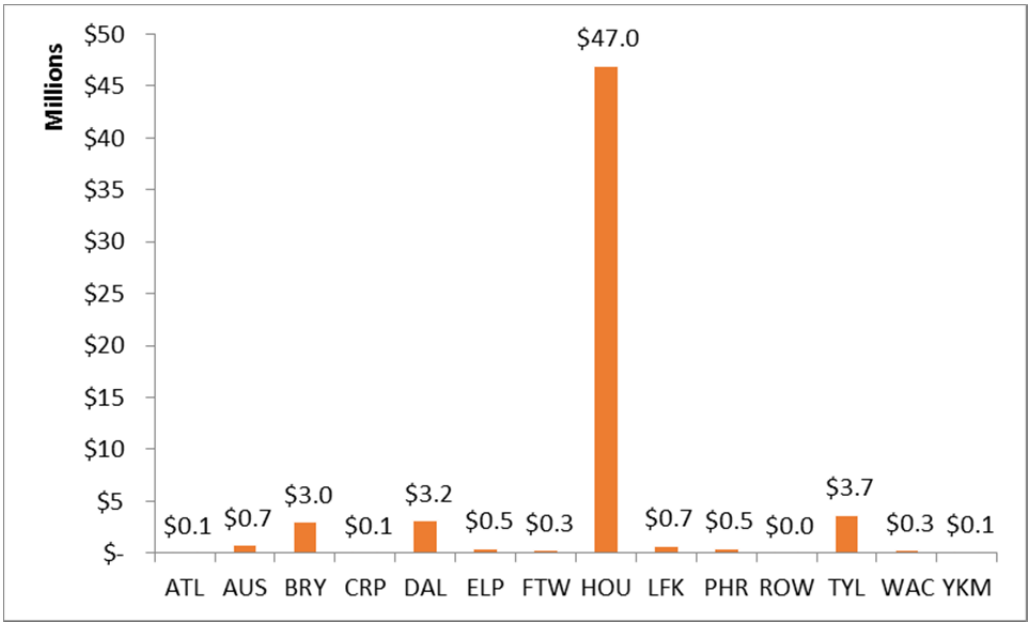


Figure 13. Amount of Mitigation Funds Expended by TxDOT District (2003 to 2015).

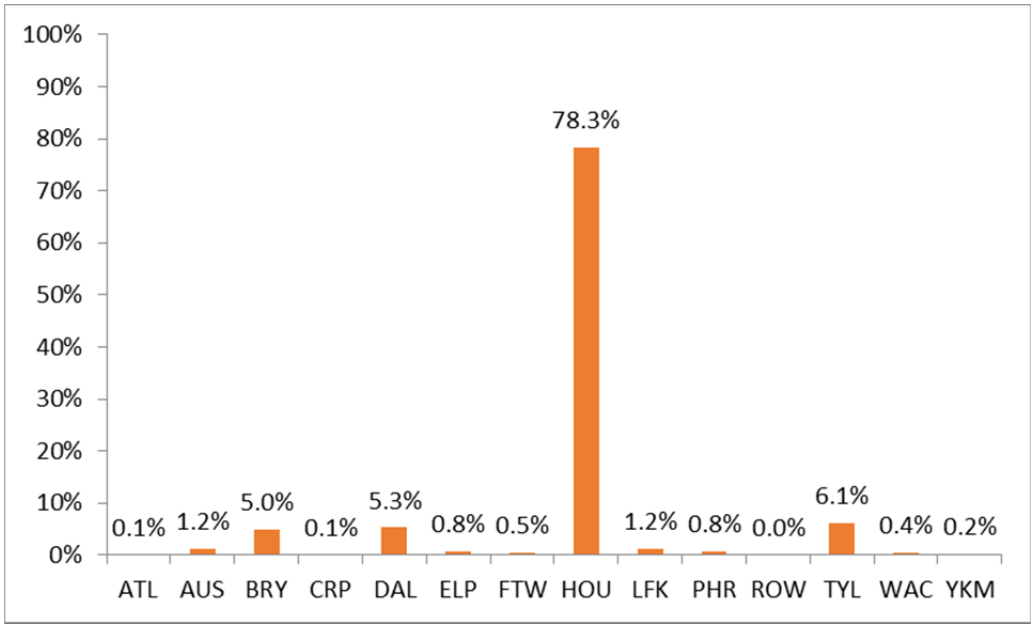


Figure 14. Percentage of Total Mitigation Funds Expended by TxDOT District (2003 to 2015).

Figure 15 shows that in the Houston District, the majority of parcels were fee-in-lieu of mitigation, while the Dallas District purchased more parcels of the expense type land acquisition. The Lufkin District exclusively used the land acquisition type, while the Pharr District exclusively used the fee-in-lieu of mitigation type.

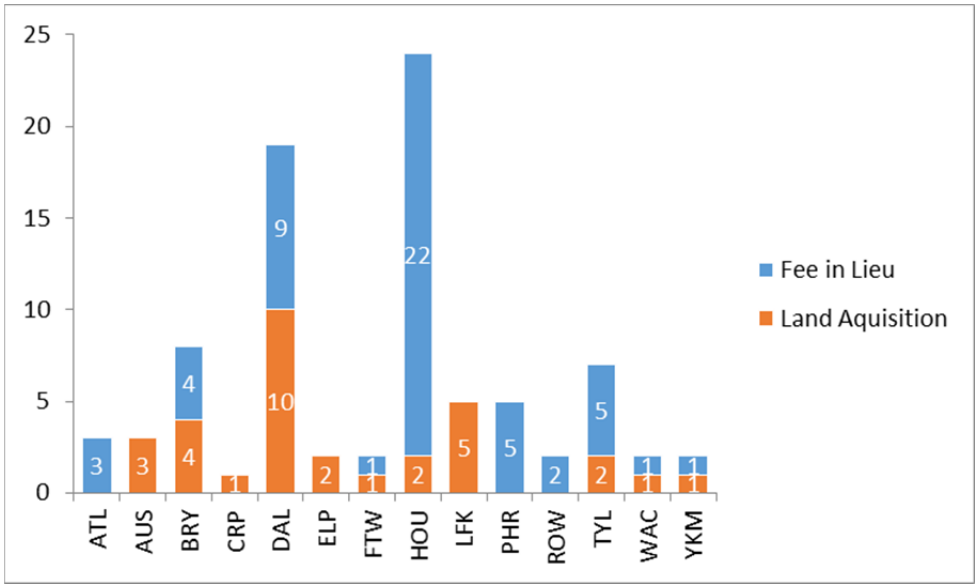


Figure 15. Number of Mitigation Parcels Acquired at District by Expense Type (2003 to 2015, n=85).

MITIGATION PAYMENTS BY RIGHT-OF-WAY CONTROL SECTION JOB NUMBER

The research team also analyzed purchase patterns for ROW CSJs. The research team found that TxDOT purchased mitigation parcels for 60 different ROW CSJs since 2003. TxDOT purchased between two and six mitigation parcels for nine ROW CSJs and one mitigation parcel for the remaining 51 ROW CSJs. Since 2003, expenditures per ROW CSJ have varied from $550 to $21.8 million. The median cost per ROW CSJ was $85,950, and the mean cost per ROW CSJ was $999,584.

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