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This project for the Texas Department of Transportation (TxDOT) developed a simple but sound methodology for estimating the cost of delaying most types of highway projects. Researchers considered the cost of delays during the pre-construction phases of project development: planning and scoping, preliminary engineering, final design, and letting. Researchers developed a simplified model that incorporates 16 user-controlled variables and produces estimates of the effect of project delay on personal and commercial travel and the cost to the general economy. While the methodology is simple, there is no rule of thumb because project delay costs depend on several variables, primarily location, traffic, construction costs, and travel speeds.

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ASSESSING THE COSTS ATTRIBUTED TO PROJECT DELAY DURING PROJECT PRE-CONSTRUCTION STAGES

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DISCLAIMER

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LIST OF ACRONYMS

CE	Categorical Exclusion
CSJ	Control-Section-Job
EA	Environmental Assessment
EIS	Environmental Impact Statement
FONSI	Finding of No Significant Impact
HCI	Highway Cost Index
NEPA	National Environmental Policy Act
PS&E	Plan, Specification, and Estimation
ROD	Record of Decision
ROW	Right of Way
S.T.I.P.	Statewide Transportation Improvement Program
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation

EXECUTIVE SUMMARY

All departments of transportation face delays on highway projects. They often have anecdotal accounts of the significant financial impact that the delay of a highway project had on project costs, local businesses, commuters, and other users of the highway. But in many cases hard data on the financial impact are lacking. This project for the Texas Department of Transportation (TxDOT) developed a simple but sound methodology for estimating the cost of delaying most types of highway projects. In 2011, the Texas A&M Transportation Institute (TTI) performed a study examining the cost associated with delays during the construction phase (i.e., post letting) of highway projects. This project considered the cost of delays during the pre-construction phases of project development: planning and scoping, preliminary engineering, final design, and letting.

The project draws on two main resources to produce reliable estimates of impacts:

- Existing data from projects originally scheduled to let between January 2012 and March 2014 and reported in TxDOT's Design Construction Information System, SiteManager™, and Primavera™.
- Methodologies developed for other applications that can be applied to estimating the cost of project delay.

DELAY DURING PROJECT PHASES

Delay can occur in any phase in the project:

- Planning/scoping phase: Delay can be significant when litigation is initiated.
- Development phase: Permitting (environmental, fish and wildlife, railroad, etc.), right-of-way acquisition, and utility agreements can be significant causes of delay.
- Contracting phase: Generally, this phase has less incidence of delay but can still have issues.
- Construction phase: This phase has numerous opportunities for delay and is often the delay most visible to the public.

Project delay almost always has some costs associated with it, but not all project delay is a waste of time and public money. In some instances, the reason for the delay is to make an improvement in the design or construction of the project that will ultimately deliver better value to the public. At the same time, delays during the pre-construction phases of project development can be introduced due to poor project management activities (e.g., failing to publicly advertise a project's bid request the required numbers of days before the bidding deadline) that can have minor direct costs but with more significant indirect costs to commuters and businesses.

ESTIMATION MODEL

This project developed a simplified model that incorporates 17 user-controlled variables and produces estimates of the effect of project delay on personal and commercial travel and the cost to the general economy. While the methodology is simple, there is no rule of thumb because project delay costs depend on several variables, primarily location, traffic, construction costs, travel speeds, fuel prices, construction prices, and the change in prices as influenced by the general economy.

Three projects of varying size were used as examples:

- The *small project* illustrates delay to a $10.6 million, reconstruction of four-lane roadway project in a rural setting. The project's 6-month delay produced an additional cost of $570,000, or a cost of *$87,000 for every month of delay.*

- The *medium project* illustrates delay to a $28.5 million, widening of a semi-rural highway project. The project's 2-month delay produced an additional cost of $870,000, or a cost of over *$420,000 for every month of delay.*

- The *large project* illustrates delay to an $85.2 million freeway reconstruction in a large metro area. The project's 3-month delay produced an additional cost of $4 million, or a cost *of $1.3 million for every month of delay.*

PURPOSE AND SCOPE OF THE REPORT

This report helps identify the costs of delays to completing the pre-construction phases of roadway projects, and a methodology for estimating those additional costs to the state and to users. The report also addresses three basic elements related to project delay:

- Definitions and types of project delay.
- Analysis of pre-construction delays for projects for a specified group of projects.
- Methodology for estimating project-specific delay costs.

For this report, TTI examined relatively recent TxDOT projects that meet the following requirements:

- Construction projects (e.g., new construction, reconstruction, and rehabilitation) where the original letting date was scheduled from January 2012 to March 2014.
- Projects that had sufficient data requirements in order to be analyzed (e.g., projects in metropolitan planning organization jurisdictions with readily available travel demand data).

The following types of transportation projects were excluded from this analysis:

- Locally let and other non-state let projects that were not reported within the TxDOT data provided.
- Maintenance projects.

In most cases examined in this study, delay occurred because the project missed one or more letting milestones according to the project schedule dates established by the project engineer and the respective TxDOT district. This study did not examine the scheduling process itself to see if that aspect of a project (i.e., overly optimistic schedules) might be an inherent source of delay.

TERMINOLOGY

The following glossary defines certain terms and phrases used within this report. It also clarifies what is and is not included in the various types of costs associated with project delays. See the List of Acronyms for a complete list of acronyms used in this document.

Direct Costs of Project Delay—actual out-of-pocket costs borne by any stakeholder affected by a delay in project delivery. Most of the direct costs accrue to TxDOT and are passed on to the public in the form of less-efficient use of taxpayer resources.

Indirect Costs of Project Delay—hidden costs that are borne by stakeholders, often a much greater amount than the direct costs of project delay. Indirect costs include:

- Wasted traveler fuel and time.
- Economic impacts in the vicinity of the project.
- Loss of business efficiency for those businesses that rely on the transportation system for their productivity.

Project Delay—Pre-construction delay is the difference between the originally scheduled letting date and the actual letting dates. This report assumes that the duration for project construction remains the same.

Project Stages—usually divided into four distinct stages: planning, development (i.e., preliminary engineering and final design), contracting, and construction. Delays that occur during the various stages typically affect different stakeholders (e.g., the state, contractors, businesses, or the public) in different ways. Once a project has been identified, its life cycle includes defined stages and milestones. Figure 1 illustrates the general project stages, basic activities that occur in each stage, and some of the major milestones.

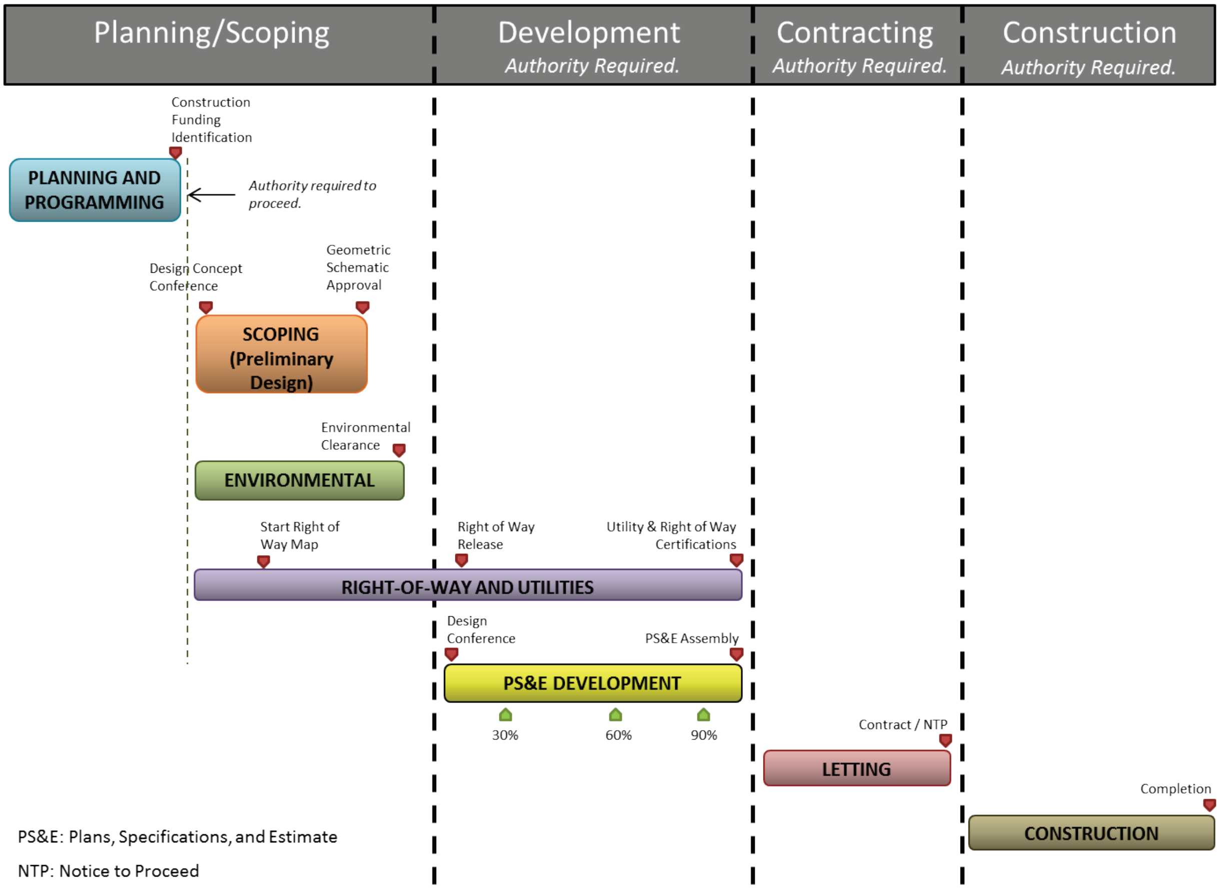

Figure 1. Life Cycle of a Typical Roadway Project (*1*).

WHO BEARS THE COST OF PROJECT DELAY?

Ultimately, the public bears the cost of project delay. Three major groups of stakeholders are affected by project delay:

- The agency.
- The public.
- Contractors (and their suppliers).

Figure 2 provides a conceptual schematic diagram of how direct and indirect costs can affect these stakeholders.

The costs of project delays can be classified as either direct or indirect costs to the public, the agency, or contractors. Some costs to the agency or contractors associated with contract delay are recoverable by the entity incurring the cost; others are not. As shown in Figure 2, ultimately, all costs are eventually borne by the public.

Direct costs are divided into three categories:

1. **Agency costs.** The cost cited in Figure 2 is the expense associated with additional engineering services. These costs may or may not be recoverable. In some cases, the agency can recover the costs if they are due to errors by others. If the costs are not recoverable, the expense becomes an indirect cost that is ultimately paid by the public.

2. **The cost in extra fuel and time wasted by the public because of project delay.** The public is not reimbursed for that cost.

3. **Contractor costs.** The contractor absorbs costs due to unproductive labor (e.g., the contractor is told by the agency or some other authority to cease construction or has to, for some other reason, pay labor costs on a standby basis). The agency may reimburse the contractor. But for the agency, the cost is likely not reimbursable and is ultimately borne by the public. If the cost is not reimbursable to the contractor directly, it becomes an indirect cost to the contractor that is ultimately transferred to the agency or the public in some other form (e.g., higher contract prices in the future).

Since this study is examining the delay associated with pre-construction project phases, only the delay costs associated with the agency (TxDOT) and the public are considered.

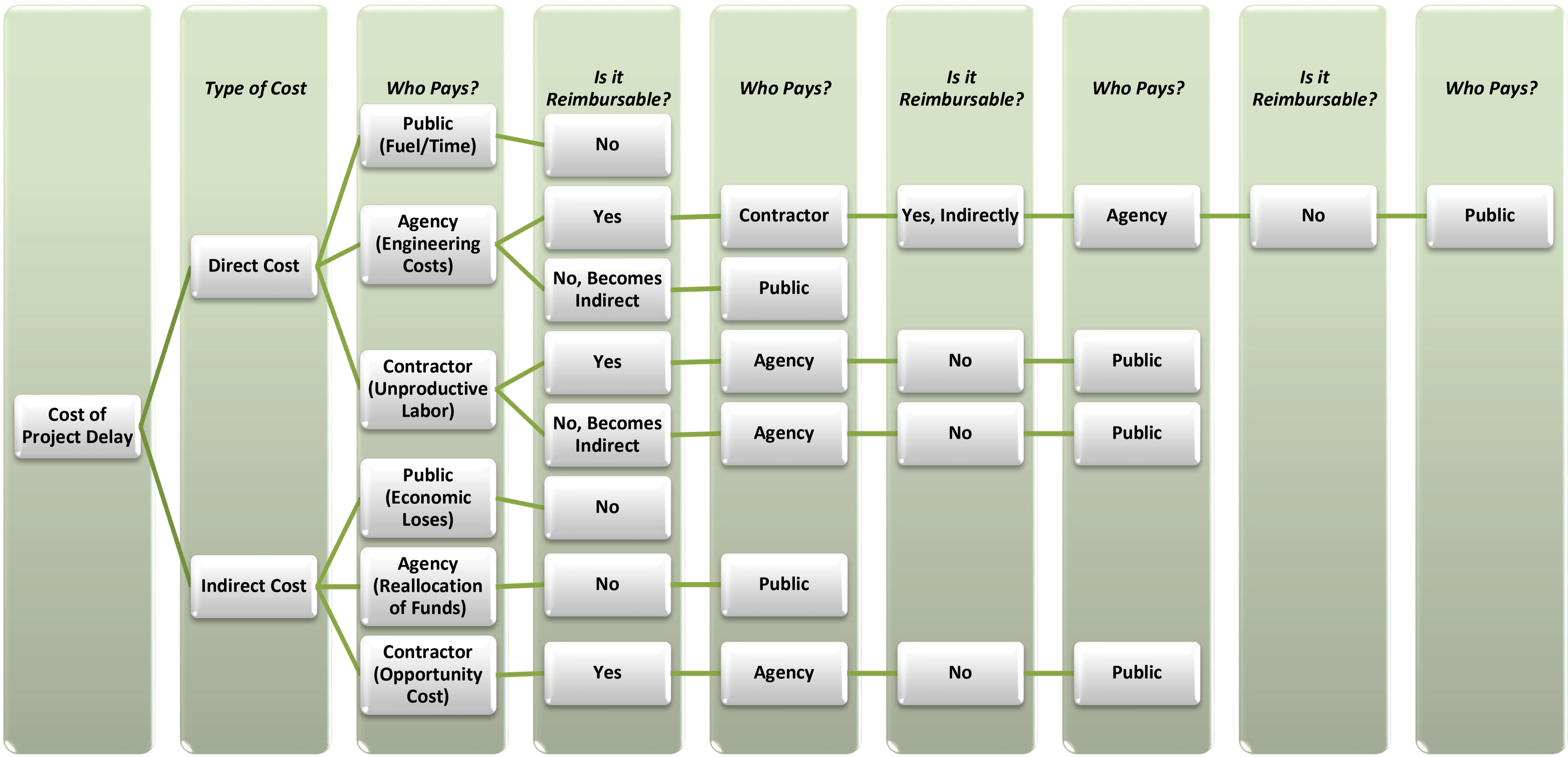

Figure 2. Stakeholder Impacts of Direct and Indirect Project Costs.

COSTS TO THE PUBLIC

Direct and indirect costs paid initially by the agency are ultimately borne by the public. For example, when a project is delayed early in the process, engineering, right-of-way, material, labor, or other cost elements may increase because of the delay. This is a direct cost of project delay that is ultimately paid by the public.

Additionally, because TxDOT has a finite supply of funds with which to operate in a given year, the increased costs will likely mean that other previously scheduled and budgeted projects will have to be postponed and their benefits delayed. These are considered indirect costs to the public.

Costs to Travelers in the Affected Corridor

Two of the most recognized costs to the public are associated with wasted time and fuel cost. We all place a value on our time. When a project is delayed and improvements to the particular corridor postponed, the benefits associated with that improvement (e.g., higher speeds and shorter commute times) are not realized. Furthermore, with the slower commute speeds, fuel efficiency may be reduced, resulting in higher fuel costs for travelers.

Costs to Businesses and Their Consumers

One of the most important cost aspects of project delay is the impact on businesses and consumers. Businesses are affected by roadway congestion in much the same way as motorists. As speeds are reduced, operating costs (i.e., driver time, vehicle operating costs, fuel costs) are increased. Ultimately, these costs are passed on to the consumer. But there can be other, more pervasive impacts as well.

Almost all surveys that ask businesses about factors that influence location decisions show similar results. They indicate that businesses most value the following when deciding where to locate a facility:

- A fair and reasonable tax system.
- An educated and available workforce.
- Access to markets.

Reduced mobility affects businesses in two ways: it reduces the supply of qualified workers who live within a reasonable commute distance, and it increases the cost of accessing markets, causing increased shipping costs for both raw materials and finished products.

With respect to labor markets, as mobility is reduced and commute times lengthen, the labor pool within a one-hour commute to a particular location is reduced. To attract a wider number of potential employees, some companies may find it necessary to offer higher wages to offset the higher costs of commuting. If they do, those higher wages are potentially reflected in higher finished product cost, hindering the company's ability to compete in a market. If the costs of higher wages are not reflected in higher product costs, then income to the company's shareholders is reduced.

Similarly, reduced mobility affects the cost of finished goods when fuel cost, driver time, and vehicle-operating costs are increased because of lower speeds and other mobility impairments on the roadways.

COSTS TO CONTRACTORS

Contractor costs also increase because of project delay. If a project is delayed after a contractor has mobilized a workforce and obtained equipment, consumables, and other materials, the contractor must often absorb those costs. This reduces income to the company and to its shareholders. To the extent that those costs are recoverable, they are passed on to consumers during a subsequent project.

In addition, the uncertainty associated with project delays can impede a contractor from bidding on other projects. These lost opportunities can reduce competition, which may result in higher construction bids on other projects.

CONCLUSION

With few exceptions, the public ultimately bears the cost of delays—traveler costs, added transportation costs in retail products, loss of business efficiency (resulting in higher costs and lower profits), and fewer public (TxDOT) dollars available to spend on a variety of project needs.

IMPACT OF PRECONSTRUCTION DELAYS ON CONSTRUCTION

This study examined the cost of delays that occur during the pre-construction stages of a project. To accomplish the calculation of delay costs, it was necessary to make some assumptions regarding the entirety of the project. Specifically, it was assumed that duration of construction remained the same regardless of how much delay a project incurred during the pre-construction stages as illustrated in Figure 3. For example, a project that is calculated to take 18 months for construction would take those same 18 months regardless if preconstruction delays were one month or seven months.

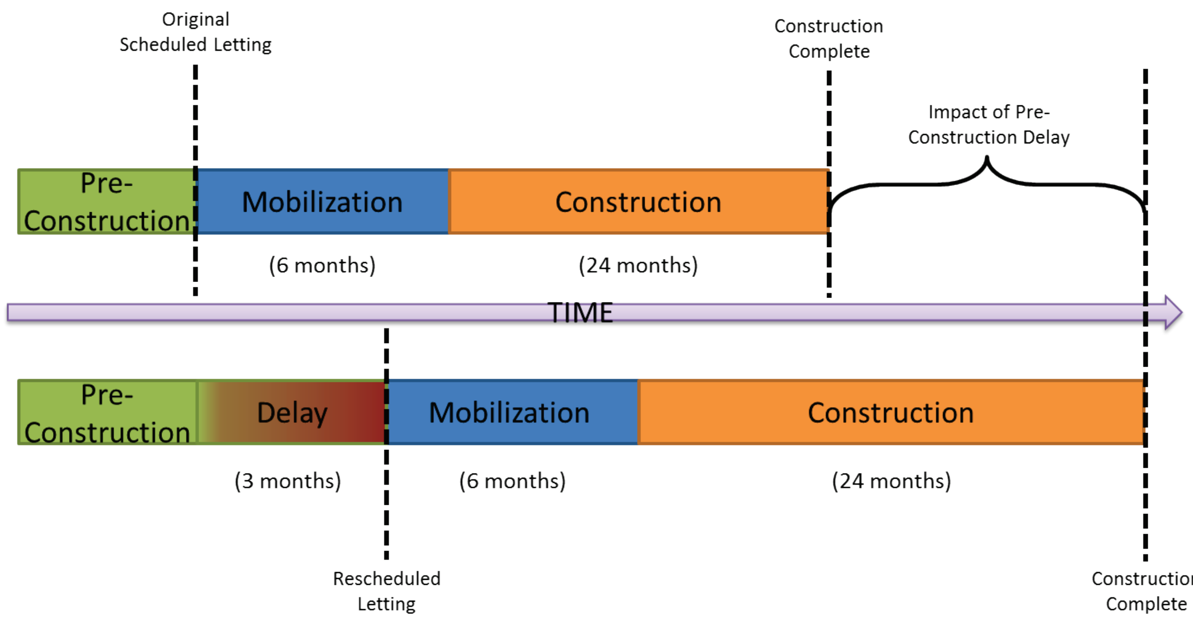

Figure 3. Pre-Construction Delays Impact Completion of Construction

It is possible that some delays that occur during pre-construction do not translate into delayed end of construction. Every contract has a mobilization window whereby the constructor must organize on-site and begin work. It may be, for example, that a contract had a 120 days mobilization window. Suppose the project went to letting 60 days later than originally scheduled due to late plan, specification, and estimation (PS&E) submittal, but the contractor was able to mobilize in 60 days. This means mobilization occurred within the originally planned window although a delay did transpire during the pre-construction stages. This situation would result in little to no costs—direct or indirect—attributed to the delay. Figure 4 illustrates this concept of pre-construction delays having little to no impact on completion of construction.

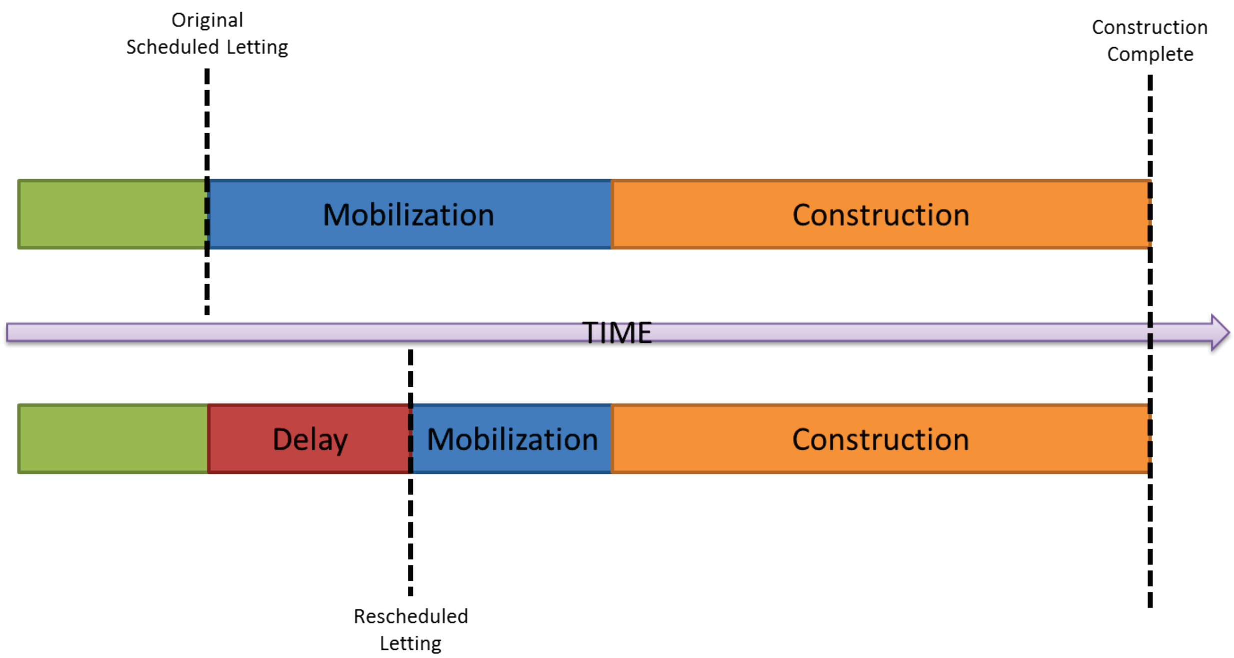

Figure 4. Pre-Construction Delays May Not Impact Construction Due to Mobilization.

SAMPLE METHODOLOGY FOR ESTIMATING COST IMPACTS OF PROJECT DELAY

TYPES OF EXAMPLE PROJECTS

Table 1 shows three different example projects:

- Small projects range in cost from $7 million to $20 million.
- Medium projects range in cost from $20 million to $80 million.
- Large projects cost more than $80 million.

The small project illustrates the costs associated with a two-lane roadway in a semi-rural setting. In this example, the roadway is a 1.8-mile-long widening project on FM 685 in the Austin District. The project stretched from US 79 to SH 130. The two-lane roadway was widened to a four-lane divided roadway. The project let February 2014 after 6 months of delay. The cost associated with this delay is estimated at $570,000, or $87,000 for every month of delay.

The medium project depicts the cost associated with a rural freeway project, in this instance a 3.9-mile-long widening project on US 67 in the Fort Worth District. The project segment stretched east of SH 174 to just west of Spur 102. The freeway was widened to consist of a four-lane divided roadway with bridges. After two month delay in letting, the project began in September 2013. The estimated cost of delay is estimated at $870,000, or a cost of over $420,000 for every month of delay.

The final example is the large project, showing costs associated with a freeway project in a large metro area—the reconstruction of US 290 to eight lanes with two reversible managed lanes, and two-lane frontage roads. The 5-mile-long project is from east of Mueschke Road to east of Telge Road. This project began in November 2013 and experienced a 3-month delay in letting. The cost of delay was estimated at $4 million, or a cost of $1.3 million for every month of delay.

Table 1. Sample Costs to the Public Resulting from Project Delays.

ESTIMATED COST OF PROJECT DELAY			
PROJECT DESCRIPTION			
PROJECT RELATED VARIABLES			
	SMALL PROJECT	**MEDIUM PROJECT**	**LARGE PROJECT**
Project Cost (millions)	$10.6	$28.5	$85.2
Total Months Project was Delayed	6.1	2.1	3.1
Change in Highway Cost Index (during delay)	3%	3%	4%
TRAVEL RELATED VARIABLES			
Length of Project	1.8	3.9	5.0
Average Daily Traffic- Before Improvement	17,612	13,902	158,000
Average Daily Traffic- After Improvement	24,650	19,460	196,000
Travel Speed- Before	68	57	59
Travel Speed- After	72	60	61
Percent Trucks- Before	18.5%	3.1%	9.7%
Percent Trucks- After	19.5%	5.0%	10.5%
COMMONLY USED ASSUMPTIONS			
Persons per Vehicle	1.25	1.25	1.25
Value of Time- Cars	$16.28	$16.28	$16.28
Value of Time- Trucks	$107.42	$107.42	$107.42
Cost of Fuel- Cars	$3.15	$3.78	$3.78
Cost of Fuel- Trucks	$3.78	$3.95	$3.95
Return on Investment Associated with Economic Impacts	8.0%	8.0%	8.0%
MONTHLY COST OF PROJECT DELAY			
Wasted Time from Project Delay- Personal	$9,985	$10,042	$59,942
Wasted Fuel from Project Delay- Personal	($775)	$1,385	$13,661
Wasted Time from Project Delay- Commercial	$12,192	$2,004	$34,592
Wasted Fuel from Project Delay- Commercial	$879	$1,729	$4,764
TOTAL DIRECT COST TO TRAVELERS	**$21,402**	**$13,431**	**$108,195**
Construction Cost Increase per Month (based on HCI)	$55,260	$356,160	$1,101,473
SUB-TOTAL, DIRECT COSTS	$76,662	$369,591	$1,209,668
Economic Impact of Project Delay	**$10,036**	**$47,170**	**$81,040**
TOTAL COST OF PROJECT DELAY PER MONTH	**$86,697**	**$416,761**	**$1,290,708**
TOTAL COST OF PROJECT DELAY	**$570,583**	**$870,253**	**$4,023,590**

DISCUSSION OF MEDIUM PROJECT EXAMPLE

Using the medium project as an example illustrates how project delays can ultimately cost the public. In this example, a $28.5 million project had its letting delayed for 2 months prior to construction. The following conditions on the roadway were present:

- 13,900 vehicles in average daily traffic.
- Commercial trucks making up 3.1 percent of vehicles.
- 1.25 persons per automobile.
- 57 mph average speed before the improvements.
- 60 mph average speed after the improvements.
- A 3 percent increase in the price of construction during the time the project was delayed.[1]

The medium project, as shown in Table 1, demonstrates that when applying standard values of time for both individuals and commercial vehicles—and assuming a conservative 8 percent return on investment in roadway infrastructure (*2*) (national studies indicate the return is more likely in the 10 to 12 percent range)—the 2-month delay had a total cost of $870,000, or almost $420,000 per month.

Of that cost, slightly over $356,000 per month was the result of construction price increases estimated by using HCI. Almost all of this increase resulted from the increases in commodity prices (e.g., cement, base material, steel, asphalt, and fuel) experienced during the period. Almost $12,000 per month was the result of delays in commuter and business delivery times, while almost $3,100 per month was the result of increased fuel costs associated with higher consumption at slower speeds. Finally, over $47,000 per month was associated with the economic impact of delay.

The expansion of the roadway allowed substantially more throughput, though only modest changes in speed. Because of the induced demand associated with expanded roadways, speeds can actually stay the same or slightly decrease as more vehicles use the freeway. When that occurs, vehicles are drawn to the new/expanded facility from other highways and/or arterial streets, improving travel times, reducing wasted fuel, and generating a positive economic effect on those particular roadways. In general, the magnitude of the impact of project delay depends on traffic volume and speed, percent trucks, spikes in construction costs, and duration of delay.

Also, because of the number of variables involved (and their relative importance depending upon roadway location, roadway type, availability of transportation alternatives, traffic mix, cost of materials, etc.), in almost every instance where a project is delayed, the cost of delay can vary significantly. As a result, every instance of pre-construction delay, even on projects that appear to be similar in nature, can result in a different cost of delay estimate. See Appendix A for a description of the variables and methodology used for the cost calculations.

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[1] Project inflation calculations taken from the Highway Cost Index produced by the Texas Department of Transportation (http://ftp.dot.state.tx.us/pub/txdot-info/cst/hci_binder.pdf).

SUMMARY

This brief research project examined the costs that result when a roadway project is delayed. It examined both direct and indirect impacts of project delays and found that the public almost always bears the costs, either directly through wasted fuel and time or indirectly through less-efficient use of the limited supply of roadway funds. This project did not directly examine the *value* of any of the delays, though it was evident while examining the data that many delays actually produced benefits that equaled or exceeded the *cost* of the delay.

The simple methodology developed in this project allows TxDOT to quickly estimate the cost of delay to a roadway project. Using that methodology, researchers examined three actual projects. The smallest of the three resulted in project delay costs of $500,000, while the largest project resulted in project delay costs of $3,900,000.

While the methodology is simple, there is no rule of thumb because project delay costs depend on several variables, primarily location, construction costs, travel speeds, fuel prices, construction prices, and the change in prices as influenced by the general economy.

The methodology also includes a monthly local economic impact component, which for the three examples ranged from $78,000 per month to $1.2 million per month.

The appendices to this report contain data, terminology, and methodologies developed in this research:

- Appendix A—Description of Calculations Used in Estimating Project Delay Costs.
- Appendix B—General Information Regarding Delays.
- Appendix C—Typical Causes of Delay.
- Appendix D—Analysis of Preconstruction Delay.

APPENDIX A—DESCRIPTION OF CALCULATIONS USED IN ESTIMATING PROJECT DELAY COSTS

VARIABLES

The output of the model provides both direct and indirect cost estimates. Direct cost estimates include wasted time and fuel for both personal and commercial travel. Indirect cost includes the economic impact of project delay. The spreadsheet-based model uses 17 variables divided into three categories to calculate direct and indirect costs associated with project delay. Those variables include the following:

- **Calculations Tab:**
  - **Project Cost**—in millions of dollars. This is the contracted amount.
  - **Average Annual Daily Traffic before the Improvement**—determined for the segment that most closely represents the roadway segment under construction.
  - **Average Annual Daily Traffic after the Improvement**—determined for the segment that most closely represents the roadway segment under construction.
  - **Percent of Trucks before Improvement**—determined for the segment that most closely represents the roadway segment under construction.
  - **Percent of Trucks after Improvement**—determined for the segment that most closely represents the roadway segment under construction.
  - **Persons per Vehicle**—a default value of 1.25 persons per personal vehicle.
  - **Average Speed before Improvement**—determined for the segment that most closely represents the roadway segment under construction.
  - **Average Speed after Improvement**—determined for the segment that most closely represents the roadway segment under construction.
  - **Length of Segment in Miles**—determined from the construction contact.
  - **Personal Value of Time**—determined by using the value of personal time used in the most recent *Urban Mobility Report* published by TTI.
  - **Commercial Value of Time**—determined by using the value of personal time used in the most recent *Urban Mobility Report* published by TTI.
  - **Return on Investment**—the default is 8 percent annually, based on a Federal Highway Administration report by Nadiri and Mamuneas (*2*).
  - **Percent of Increase in Highway Cost Index**—determined by using the Highway Cost Index published monthly by TxDOT.
  - **Total Months of Delay**—determined using the dataset of highway construction projects furnished for this study by TxDOT.
- **Fuel Tab:**
  - **Fuel Price**—the current fuel price.
- **Economic Impact Tab:**
  - **Multiplier**—an estimate of the general multiplier for economic activity based on the state's economic profile.
  - **Percent Profit**—the average profit margin across all business based on the state's economic profile.

CALCULATIONS

The following general steps are used in calculating an estimate of the cost of project delay:

1. Convert daily traffic into monthly traffic volume.
2. Calculate the travel time for the segment under construction for both before the improvement was started and after it was completed.
3. Calculate the total hours of travel over the segment for both before the improvement was started and after it was completed.
4. Calculate the total personal hours of travel using the number of personal vehicles traveling the segment multiplied by average occupancy. Calculations are performed for both before and after the improvement.
5. Calculate the total vehicle hours of travel for commercial vehicles. Calculations are performed for both before and after the improvement.
6. Calculate the net hours of delay by subtracting the before and after delay for both personal and commercial travel.
7. Multiply the excess hours of delay for personal and commercial travel by the respective value of time to obtain the delay cost associated with the construction delay.
8. Determine the net cost of fuel for commercial vehicles using a fuel/speed curve developed for use in TTI's *Urban Mobility Report,* comparing the amount of fuel consumed at the before speed versus the after speed, and using the respective volumes for the two periods.
9. Multiply the difference in fuel consumption at the before speed and the after speed by the prevailing retail fuel price to obtain the fuel cost for personal and commercial travel associated with the construction delay.
10. Calculate the economic impact by multiplying the capital investment by the rate of return (assumed to be 8 percent per annum) plus the annual return multiplied by the assumed rate returned to profit.
11. Calculate the cost of construction inflation by taking the difference between the contract amount at the date the project begins minus the discounted value of the contract at the date the project was originally scheduled to begin. Use HCI to calculate the discount rate.

APPENDIX B—GENERAL INFORMATION REGARDING DELAYS

This appendix contains a general explanation of three typical areas in which projects can be delayed: regulatory delays, environmental review delays, and legal actions. Because of the statutory nature of these processes, TxDOT must follow defined procedures throughout each area until the final resolution.

REGULATORY DELAYS

The National Environmental Policy Act (NEPA) requires federal agencies to outline the environmental impact their proposed actions will have and to assess the impacts of alternative actions (*3*). TxDOT projects funded in any part by federal monies are required to gain environmental approval through the NEPA regulatory process defined by three levels of analysis as shown in Table 2.

Table 2. NEPA Levels of Analysis.

NEPA Level	Description
Categorical Exclusion (CE)	This status is given to those projects that do not significantly impact the environment.
Environmental Assessment (EA)	An EA must be conducted when the environmental significance is unknown. The results of an EA can lead to one of the following: • Finding of No Significant Impact (FONSI). • Environmental Impact Statement.
Environmental Impact Statement (EIS)	An EIS is a more in-depth report that must include consideration of alternatives and public involvement. The EIS consists of four steps: 1. Notice of Intent. 2. Draft EIS. 3. Final EIS. 4. Record of Decision (ROD).

If a final EIS is not submitted within three years from the date of the draft EIS, or there have been no major steps to advance the action three years after a final EIS (e.g., authority to begin final design or to acquire right of way), a written evaluation should be prepared to determine if a supplemental EIS is warranted (*4*). A supplemental EIS is necessary if considerable changes have been made to the project, or there is significant new information available. A supplemental EIS is developed like any other EIS, excluding the need for scoping. Furthermore, once a project has received an ROD, FONSI, or CE, a verification that the designation remains in place should be made prior to any major approvals or grants (*4*).

ENVIRONMENTAL REVIEW DELAYS

Projects that do not necessarily fall under NEPA regulations may still have environmental impacts that must be addressed. The safety of roadway users and the cost of avoiding environmental impacts are factors that must be weighed against environmental and aesthetic interests. A concerned citizen or environmental group may delay the project by requesting changes that mitigate the harm or by bringing suit in a state court (as opposed to a NEPA suit in federal court).

LEGAL ACTIONS

When a lawsuit is filed in reference to a proposed or active project, the party bringing suit may seek an injunction to bring current work to a halt regardless of the stage of progress. If the court grants the injunction, the project will be suspended in its entirety or in part until a court can hear arguments from both sides and rule on the matter. If the injunction is denied, the opposing party can still file suit with the hope of either receiving a favorable ruling before damage has been done or TxDOT addressing the problem to avoid the additional cost and delay.

APPENDIX C—TYPICAL CAUSES OF DELAY

During each stage of a project, numerous events can cause project delays. Table 3 summarizes the typical causes of delay for a roadway construction project during the four major phases of a project. While the nature of delays can vary among the four stages of a project (planning and scoping, development, contracting, and construction), the results are quite similar: impacts on travelers and businesses.

First, with respect to delays during the planning and scoping phase, while the number of potential reasons for delay is relatively small, the length of delay based on these reasons can be significant, especially if the project becomes the subject of litigation.

Although delays during the project development phase can have numerous causes, they are typically invisible to the public unless they have been told a project would start construction by a certain time (e.g., summer 2012). If the construction has not started as anticipated, local stakeholders, citizens, and local media may want to know the causes of the delay. One exception is when litigation occurs. Such litigation mostly occurs during a statutory review process (e.g., environmental clearance or U.S. Corps of Engineers clearance) or during right-of-way acquisition.

Delay during the contracting phase is typically minimal, with a project only being delayed one or two months from the original letting date due to last-minute procedural missteps and/or project management inefficiencies.

The public generally understands that once a project begins construction, there will be a period of inconvenience while the project is underway. As TxDOT and local media announce the anticipated duration of construction, the public takes a grin-and-bear-it attitude, looking forward to the completion of the project. Delays during construction are the most visible and draw substantial attention.

Table 3. Typical Causes of Project Delay.[2]

Planning & Scoping

• Project priority changes in relationship to other projects
• Federal/state legislation
• Interagency coordination
• Project management issues:
    o Poor project definition
    o Lack of documentation of assumptions
    o Missed milestones
• Funding
• Litigation

[2] The information contained in Table 3 is a compilation of data from multiple sources:
- Meeting with TxDOT, Associated General Contractors of Texas, and Highway Contractors in Austin, Texas, June 8, 2011.
- R.D. Ellis and H.R. Thomas. "The Root Causes of Delays in Highway Construction." Transportation Research Board 82nd Annual Meeting, Washington, D.C., January 2003.
- J. Ahn and R.E. Minchin, Jr. "Identifying Causes for Delay in Highway Construction Projects." Transportation Research Board 87th Annual Meeting, Washington, D.C., January 2007.

Development

- Project management issues:
  - Poor project definition
  - Lack of documentation of assumptions
  - Missed milestones
- Railroad permits not obtained as anticipated
- Acquisition of necessary right of way (ROW) not completed as anticipated
- Utility accommodation agreements not completed as anticipated
- Mandatory review processes (e.g., environmental and fish and wildlife) not completed as anticipated
- U.S. Corps of Engineers permits not obtained as anticipated
- Local funding agreements not executed as anticipated
- Delay in PS&E preparation (either in-house or by consultant)
- Litigation

Contracting

- Unanticipated letting events (e.g., bids greatly exceeding engineer's estimate)
- Delayed assembly of PS&E/letting package
- Did not meet requirements for publically advertising the bid
- Projects pulled from letting schedule
- Bid protests
- Litigation

Construction (after Contract Award)

- Additional work desired by TxDOT
- Additional work desired by another party
- Contractor delays
- Project management issues:
  - Lack of communications, collaboration, and cooperation
  - Lack of approval authority
  - Coordination with stakeholders (local governments and other agencies)
- Utility conflicts/untimely utility accommodations
- Unacquired ROW
- Railroad conflicts (scheduling of work and project prioritization)
- Permitting issues/approvals
- Unforeseen project site conditions:
  - Differing subsurface conditions
  - Archeological impacts
  - Endangered species impacts
  - Environmental impacts
- Design errors/omissions
- Unfavorable weather
- Insufficient work effort:
  - Skilled workforce shortages
  - Equipment shortages
  - Material shortages/price increases
- Events (e.g., holidays, special events, and local events)
- Changes solely for public convenience
- Act of God
- Litigation

APPENDIX D—ANALYSIS OF PRECONSTRUCTION DELAYS

To conduct the analysis for this report, TxDOT provided data files that contained basic information for projects that were originally scheduled to let between January 2012 and March 2014. The data included projects that were let as originally scheduled and projects that were scheduled between these dates but incurred one or more letting delays. In total, the data represented approximately 3800 unique projects. Of those projects, records indicated that there were 955 letting changes that occurred with 150 individual projects incurring more than one letting delay. This resulted in 726 unique projects where the originally scheduled letting date was changed. Figure 5 illustrates the comparison of projects having a change in letting status between January 2012 and March 2014 against projects not requiring a change in the letting schedule. Figure 6 shows the distribution of all 955 letting changes by district. The data used to compile Figure 6 are found in Table 4.

Not all projects tracked by TxDOT are let through the state letting process. For various reasons, some projects are let by a local agency (e.g., city, county, or metropolitan planning organization), or proceed through some other advertising and contracting process. Of the 726 unique projects with letting date changes, 603 were processed through the state (i.e., TxDOT) while 123 projects were locally let or contracted otherwise. Although ROW and utilities adjustments can have an individual control-section-job (CSJ) designation and included in monthly lettings, these projects are different from traditional highway construction projects. Between January 2012 and March 2014, the TxDOT data indicated that 16 CSJs were associated with ROW and utility projects. Removing these from the analysis resulted in 587 unique projects to examine.

When a letting change occurs, the type of change falls into one of three types: add a new project to the letting schedule, reschedule a previously scheduled letting, or remove a project from the letting schedule. The data indicated that 85 projects were removed from letting for various reasons and 246 projects that were added. The projects removed or added to the letting schedule will be examined in greater detail later in this report. Because some of the projects had to be removed from the analysis due to incomplete details, the final number of projects that had rescheduled letting delays total 282.

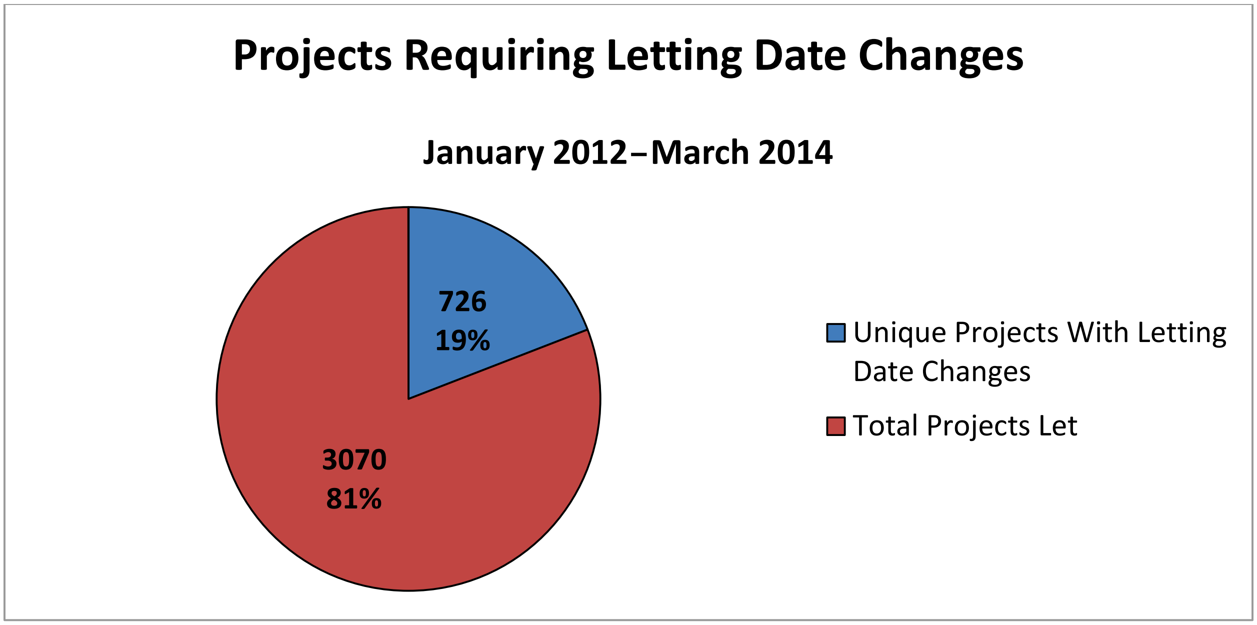

Figure 5. Comparison of Projects Requiring Letting Date Changes to All Projects.

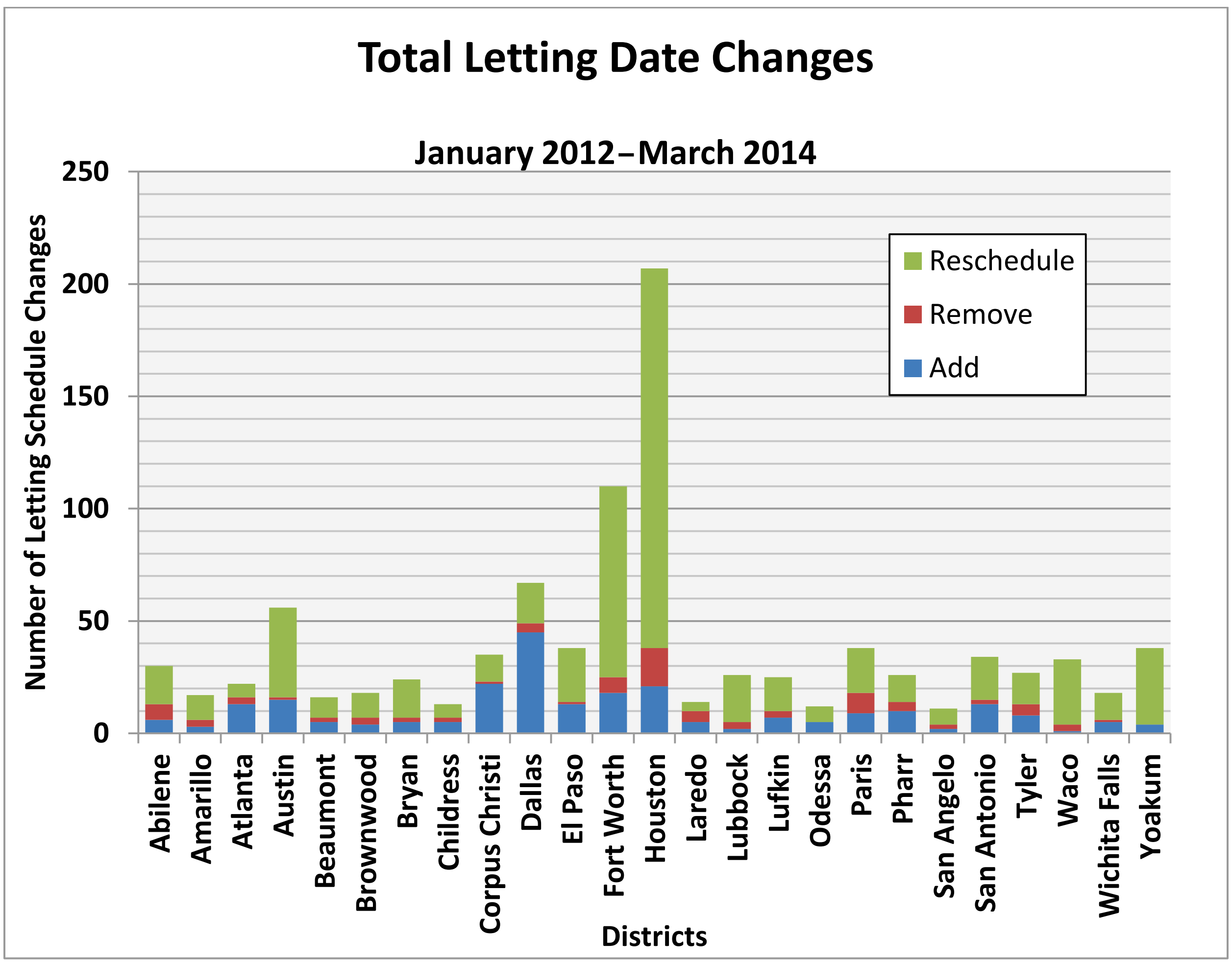

Figure 6. Distribution of All Letting Changes by District.

Table 4. Letting Date Changes by Type and District.

Districts	Type of Letting Date Changes: Add	Remove	Reschedule	Grand Total	Percent of Letting Changes
Abilene	6	7	17	**30**	**3.1%**
Amarillo	3	3	11	**17**	**1.8%**
Atlanta	13	3	6	**22**	**2.3%**
Austin	15	1	40	**56**	**5.9%**
Beaumont	5	2	9	**16**	**1.7%**
Brownwood	4	3	11	**18**	**1.9%**
Bryan	5	2	17	**24**	**2.5%**
Childress	5	2	6	**13**	**1.4%**
Corpus Christi	22	1	12	**35**	**3.7%**
Dallas	45	4	18	**67**	**7.0%**
El Paso	13	1	24	**38**	**4.0%**
Fort Worth	18	7	85	**110**	**11.5%**
Houston	21	17	169	**207**	**21.7%**
Laredo	5	5	4	**14**	**1.5%**
Lubbock	2	3	21	**26**	**2.7%**
Lufkin	7	3	15	**25**	**2.6%**
Odessa	5		7	**12**	**1.3%**
Paris	9	9	20	**38**	**4.0%**
Pharr	10	4	12	**26**	**2.7%**
San Angelo	2	2	7	**11**	**1.2%**
San Antonio	13	2	19	**34**	**3.6%**
Tyler	8	5	14	**27**	**2.8%**
Waco	1	3	29	**33**	**3.5%**
Wichita Falls	5	1	12	**18**	**1.9%**
Yoakum	4		34	**38**	**4.0%**
Grand Total	**246**	**90**	**619**	**955**	**100.0%**
Percent of Letting Changes	**25.8%**	**9.4%**	**64.8%**	**100%**	

Those same 955 letting schedule change events are distributed by change type across the districts for projects that went through the state letting process (Figure 7) and those that did not (Figure 8). Likewise, the data used to produce Figure 7 and Figure 8 are summarized in Table 5 and Table 6, respectively.

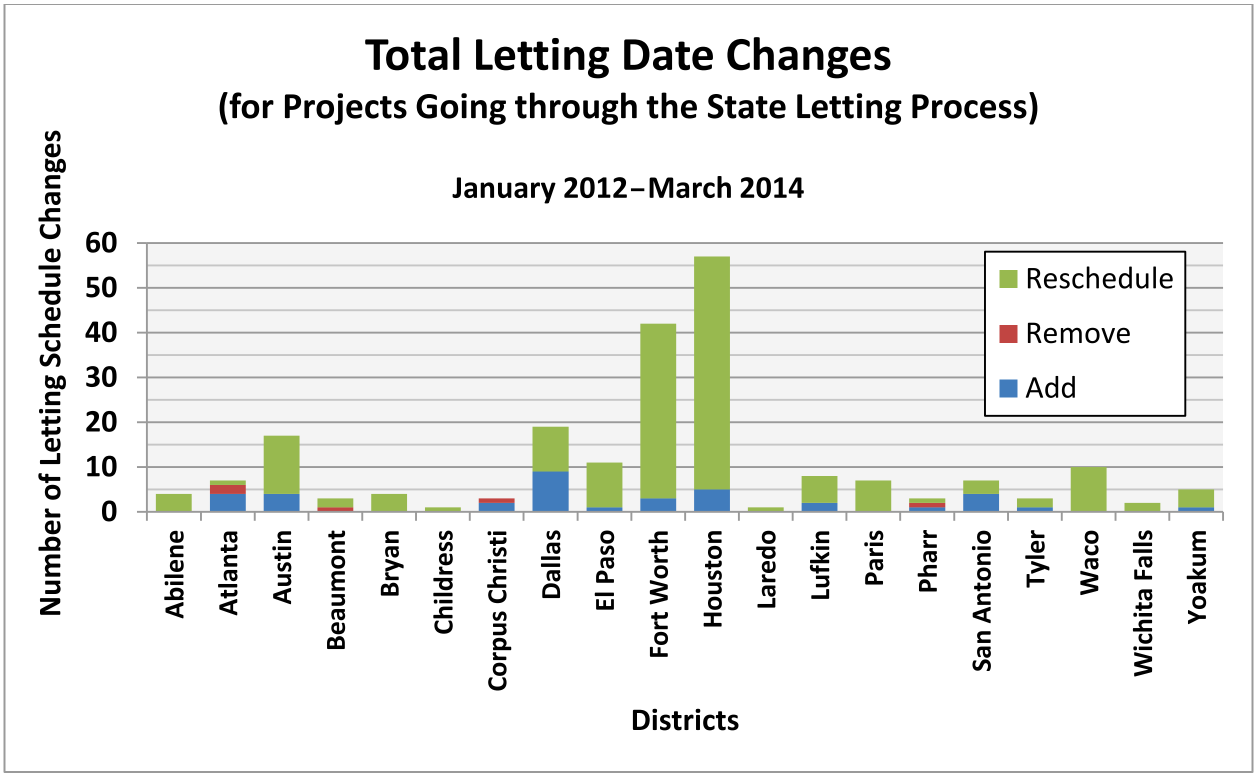

Figure 7. Distribution of Letting Changes for State-Let Projects.

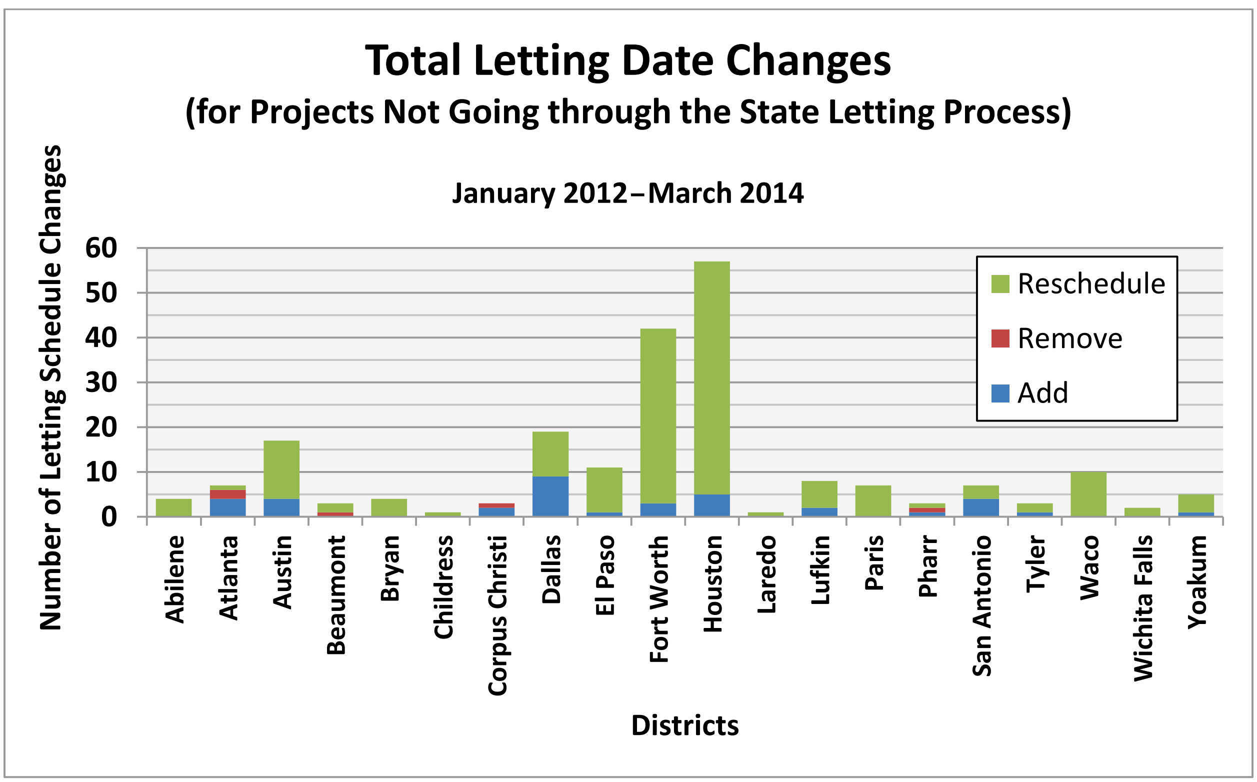

Figure 8. Distribution of Letting Changes for Non-State-Let Projects.

Table 5. Letting Date Changes for State-Let Projects.

	Type of Letting Date Changes				
Districts	**Add**	**Remove**	**Reschedule**	**Grand Total**	**Percent of Letting Changes**
Abilene	6	7	13	**26**	**3.5%**
Amarillo	3	3	11	**17**	**2.3%**
Atlanta	9	1	5	**15**	**2.0%**
Austin	11	1	27	**39**	**5.3%**
Beaumont	5	1	7	**13**	**1.8%**
Brownwood	4	3	11	**18**	**2.5%**
Bryan	5	2	13	**20**	**2.7%**
Childress	5	2	5	**12**	**1.6%**
Corpus Christi	20	-	12	**32**	**4.4%**
Dallas	36	4	8	**48**	**6.5%**
El Paso	11	1	14	**26**	**3.5%**
Fort Worth	15	7	46	**68**	**9.3%**
Houston	12	17	114	**143**	**19.5%**
Laredo	5	5	3	**13**	**1.8%**
Lubbock	2	3	21	**26**	**3.5%**
Lufkin	5	3	9	**17**	**2.3%**
Odessa	5	-	7	**12**	**1.6%**
Paris	9	9	13	**31**	**4.2%**
Pharr	9	3	11	**23**	**3.1%**
San Angelo	2	2	7	**11**	**1.5%**
San Antonio	9	2	16	**27**	**3.7%**
Tyler	7	5	12	**24**	**3.3%**
Waco	1	3	19	**23**	**3.1%**
Wichita Falls	5	1	10	**16**	**2.2%**
Yoakum	3	-	30	**33**	**4.5%**
Grand Total	**204**	**85**	**444**	**733**	**100.0%**
	27.8%	**11.6%**	**60.6%**	**100.0%**	

Table 6. Letting Date Changes for Non-State-Let Projects.

Districts	Type of Letting Date Changes: Add	Remove	Reschedule	Grand Total	Percent of Letting Changes
Abilene	-	-	4	**4**	**1.8%**
Atlanta	4	2	1	**7**	**3.2%**
Austin	4	-	13	**17**	**7.7%**
Beaumont	-	1	2	**3**	**1.4%**
Bryan	-	-	4	**4**	**1.8%**
Childress	-	-	1	**1**	**0.5%**
Corpus Christi	2	1	-	**3**	**1.4%**
Dallas	9	-	10	**19**	**8.6%**
El Paso	2	-	10	**12**	**5.4%**
Fort Worth	3	-	39	**42**	**18.9%**
Houston	9	-	55	**64**	**28.8%**
Laredo	-	-	1	**1**	**0.5%**
Lufkin	2	-	6	**8**	**3.6%**
Paris	-	-	7	**7**	**3.2%**
Pharr	1	1	1	**3**	**1.4%**
San Antonio	4	-	3	**7**	**3.2%**
Tyler	1	-	2	**3**	**1.4%**
Waco	-	-	10	**10**	**4.5%**
Wichita Falls	-	-	2	**2**	**0.9%**
Yoakum	1		4	**5**	**2.3%**
Grand Total	**42**	**5**	**175**	**222**	**100.0%**
	18.9%	**2.3%**	**78.8%**	**100.0%**	

In addition to classifying letting date changes by type (remove, reschedule, or add), the reason for the changes is also noted. Figure 9 shows the breakdown of the 955 letting date change by the reason for the change. The data are tabulated in Table 4. The reason code none represents new projects that were added to the letting schedule. The reason code other predominately consists of rescheduled lettings dates but can also include some of the removed letting changes.

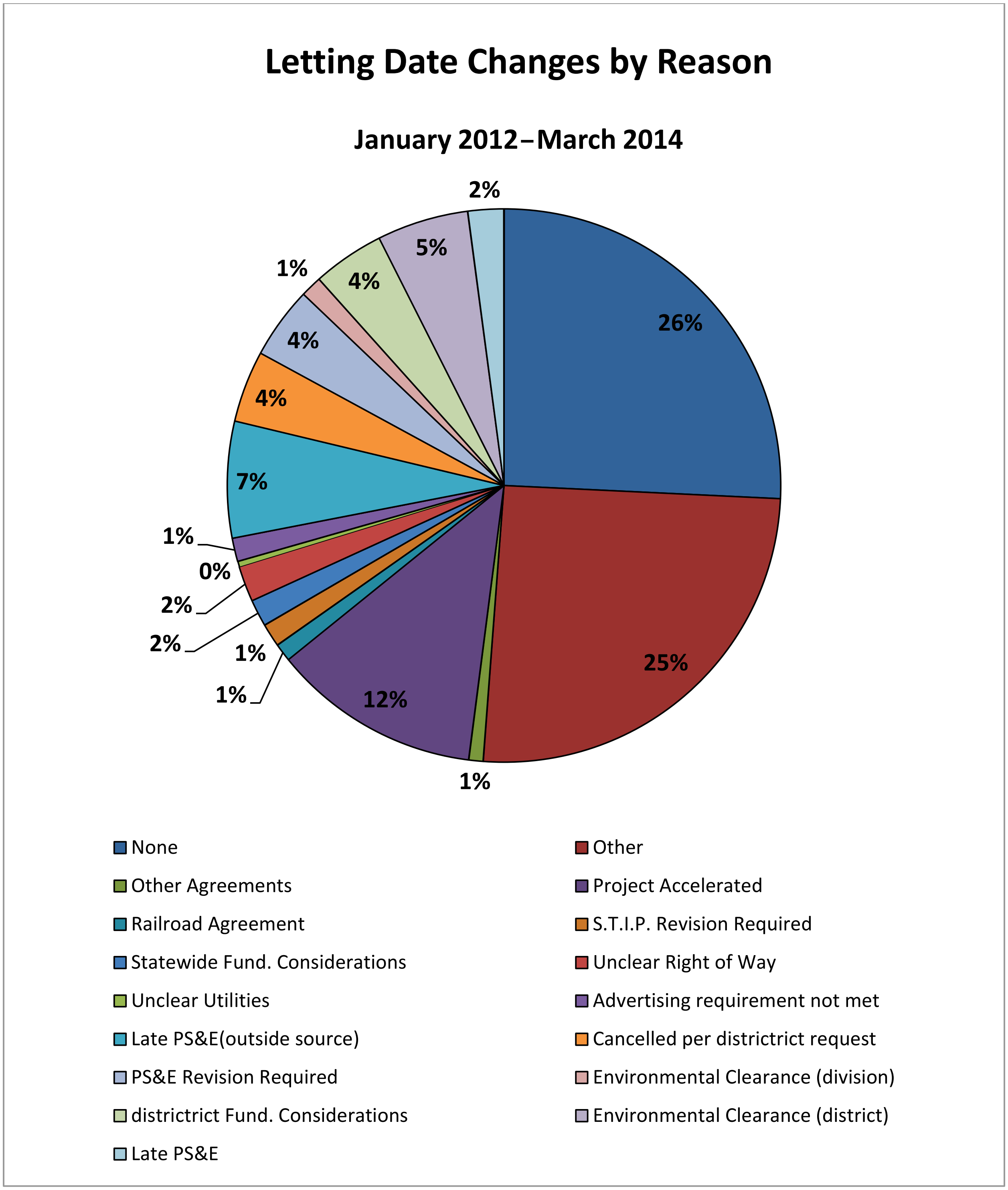

Figure 9. Distribution of Letting Date Changes by Reason for Change.

Table 7. Letting Date Changes by Reason for Change.

Reason for Letting Change	Count of Reason for Removal	Percentage of Letting Changes
None	246	26%
Other	243	25%
Project Accelerated	116	12%
Late PS&E (outside source)	65	7%
Environmental Clearance (district)	51	5%
Cancelled per district request	40	4%
District Funding Considerations	40	4%
PS&E Revision Required	40	4%
Unclear Right of Way	20	2%
Late PS&E	20	2%
Statewide Funding Considerations	15	2%
Statewide Transportation Improvement Plan (S.T.I.P.) Revision Required	13	1%
Advertising requirement not met	13	1%
Environmental Clearance (division)	12	1%
Railroad Agreement	10	1%
Other Agreements	8	1%
Unclear Utilities	3	0%
Grand Total	**955**	**100%**

By further examining the letting changes that occurred because the project was accelerated, 10 of those changes were mislabeled and actually were rescheduled to later dates. Of those 10 delayed projects, 7 had delays more than 30 days (1 month) and the average delay of those 7 projects was approximately 126 days (4 months). The 7 projects delayed more than 30 days represent locally let projects (5 projects) and state-let projects (2 projects). Six of the accelerated letting events did not have sufficient information in the data records for further analysis. Figure 10 illustrates the distribution of projects that had accelerated lettings.

The reasons for letting changes are also separated into those projects that went through the state-letting process (Figure 11 and Table 8) and those that did not go through the state-letting process (Figure 12 and Table 9.)

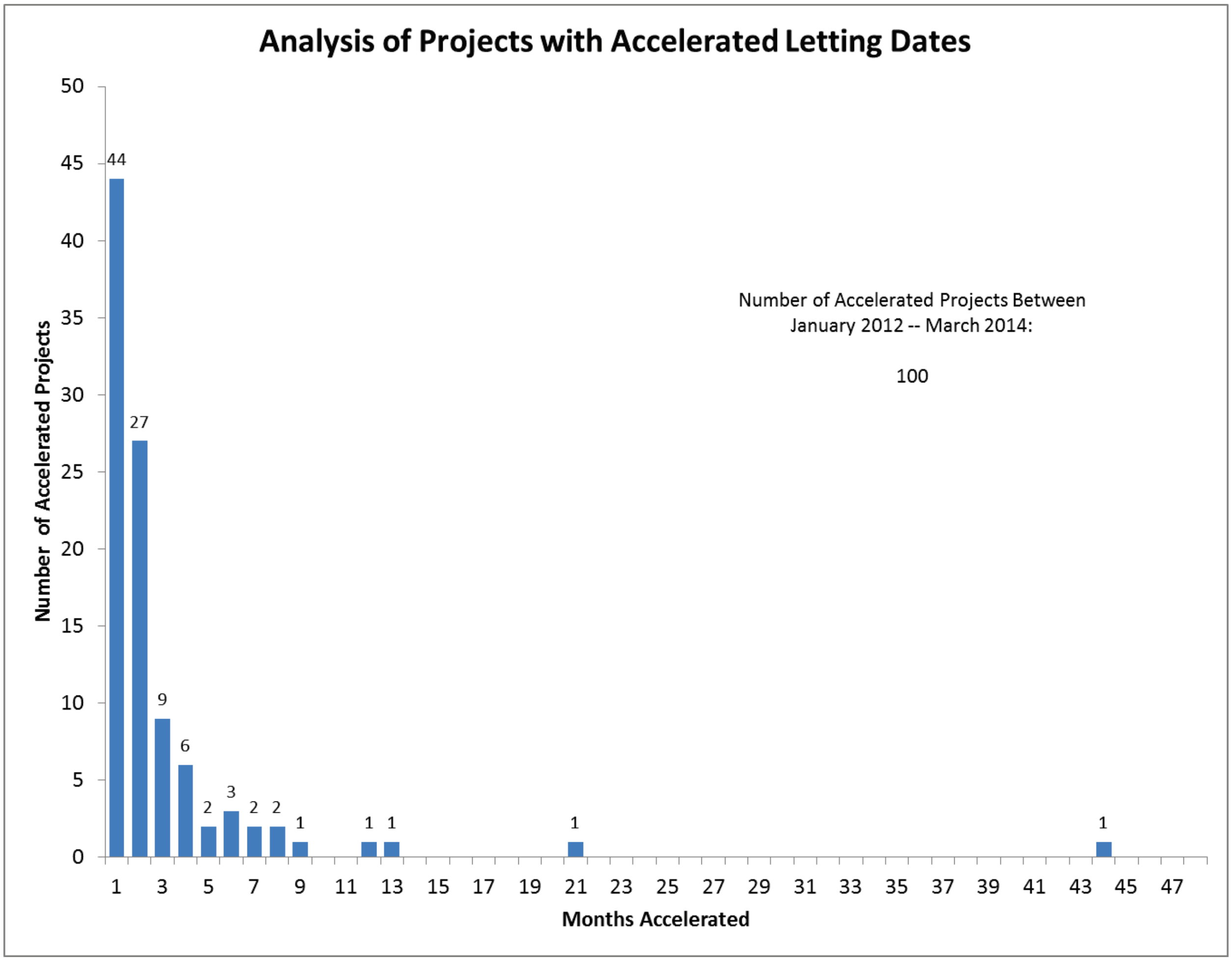

Figure 10. Distribution of Letting Changes Coded as Accelerated.

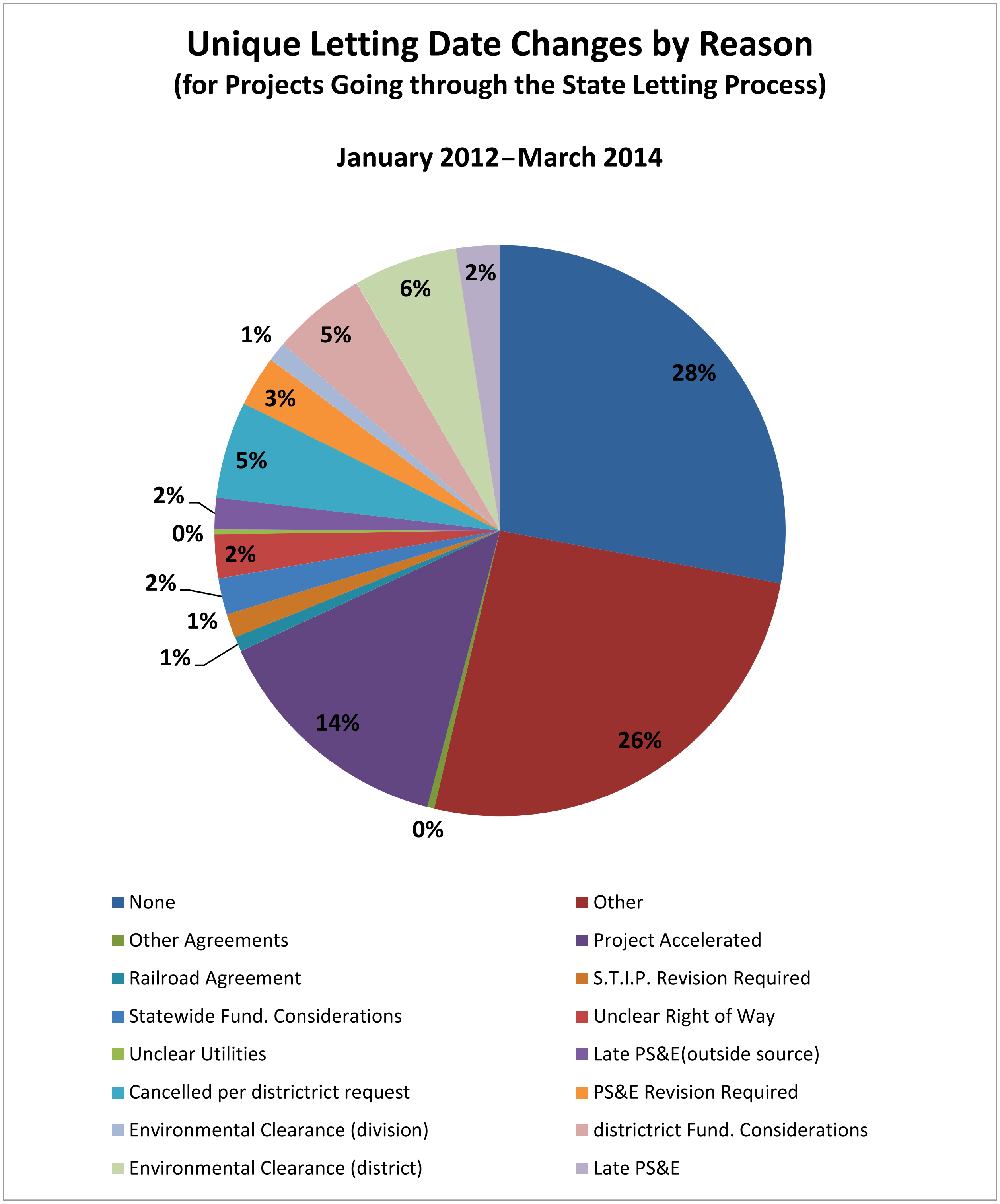

Figure 11. Distribution of Letting Date Changes by Reason for Change for State-Let Projects.

Table 8. Letting Date Changes by Reason of Change for State-Let Projects.

Reason for Letting Change	Count of Reason for Removal	Percent of Letting Changes
Cancelled per district request	40	5%
District Funding Considerations	39	5%
Environmental Clearance (district)	43	6%
Environmental Clearance (division)	8	1%
Late PS&E	18	2%
Late PS&E (outside source)	13	2%
None	204	28%
Other	189	26%
Other Agreements	3	0%
PS&E Revision Required	21	3%
Project Accelerated	103	14%
Railroad Agreement	6	1%
S.T.I.P. Revision Required	11	2%
Statewide Funding Considerations	15	2%
Unclear Right of Way	18	2%
Unclear Utilities	2	0%
Grand Total	**733**	**100%**

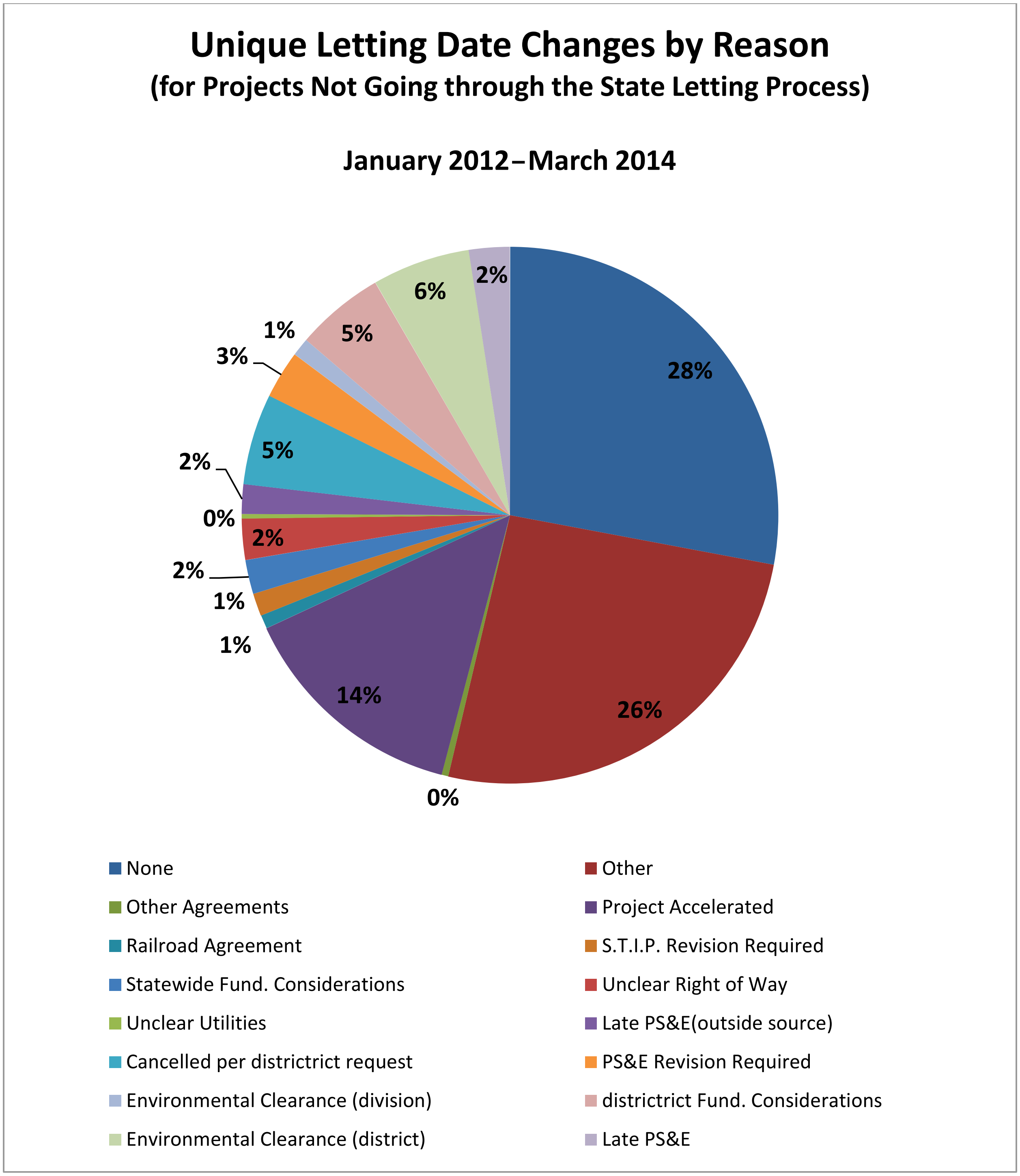

Figure 12. Distribution of Letting Date Changes by Reason for Change for Non-State-Let Projects.

Table 9. Letting Date Changes by Reason for Change for Non-State-Let Projects.

Reason for Letting Change	Count of Reason for Removal	Percent of Letting Change
Advertising requirement not met	13	6%
District Funding Considerations	1	0%
Environmental Clearance (district)	8	4%
Environmental Clearance (division)	4	2%
Late PS&E	2	1%
Late PS&E (outside source)	52	23%
None	42	19%
Other	54	24%
Other Agreements	5	2%
PS&E Revision Required	19	9%
Project Accelerated	13	6%
Railroad Agreement	4	2%
S.T.I.P. Revision Required	2	1%
Unclear Right of Way	2	1%
Unclear Utilities	1	0%
Grand Total	**222**	**100%**

Up to this point, the figures and tables summarized the analysis of the 955 letting change *events* between January 2012 and March 2014. As previously mentioned, some projects had multiple letting changes events associated with the CSJ. The next step of the analysis examined the summary of the change events into unique projects.

Of the projects that were added, 52 were delayed from the let date assumed at the time the project was added. These projects experienced on average 179 days (6 months) of delay with a standard deviation of 526 days (~ 17 months). For projects that were removed from the letting schedule, 11 experienced letting delays prior to being removed from letting. These projects experienced on average 229 days (7.6 months) of delay with a standard deviation of 267 (8.9 months).

Between January 2012 and March 2014, unique projects were rescheduled 436 times; a few projects experienced as many as 6 delays in letting. Of the 282 projects that had delayed lettings, 200 went through the state letting process; 82 projects went through local letting or other process (Table 10).

Table 10. Summary of Rescheduled/Delayed Projects.

Reason for Change	Total Projects		State Let Projects		Non-State Projects	
Advertising requirement not met	5	1.8%	0	0%	5	6.1%
District Funding Considerations	25	8.9%	24	12%	1	1.2%
Environmental Clearance (district)	34	12.1%	28	14%	6	7.3%
Environmental Clearance (division)	6	2.1%	4	2%	2	2.4%
Late PS&E	14	5.0%	13	7%	1	1.2%
Late PS&E (outside source)	38	13.5%	6	3%	32	39.0%
Other	105	37.2%	86	43%	19	23.2%
Other Agreements	3	1.1%	1	1%	2	2.4%
PS&E Revision Required	23	8.2%	12	6%	11	13.4%
Railroad Agreement	7	2.5%	5	3%	2	2.4%
S.T.I.P. Revision Required	7	2.5%	7	4%	0	0.0%
Statewide Funding Considerations	5	1.8%	5	3%	0	0.0%
Unclear Right of Way	7	2.5%	7	4%	0	0.0%
Unclear Utilities	3	1.1%	2	1%	1	1.2%
Grand Total	**282**	**100.0%**	**200**	**100%**	**82**	**100.0%**

Of the 282 projects that incurred delayed lettings, 84 percent (~237) of those had their lettings delayed more than 60 days (2 months). Figure 13 shows the distribution of delay duration for the 282 projects incurring letting delays. Table 11, Table 12, and Table 13 show the summary of delayed projects for all projects, state-let projects, and non-state-let projects, respectively. The distributions of delayed project for each of the reasons for delay are presented in Figure 14 through Figure 27.

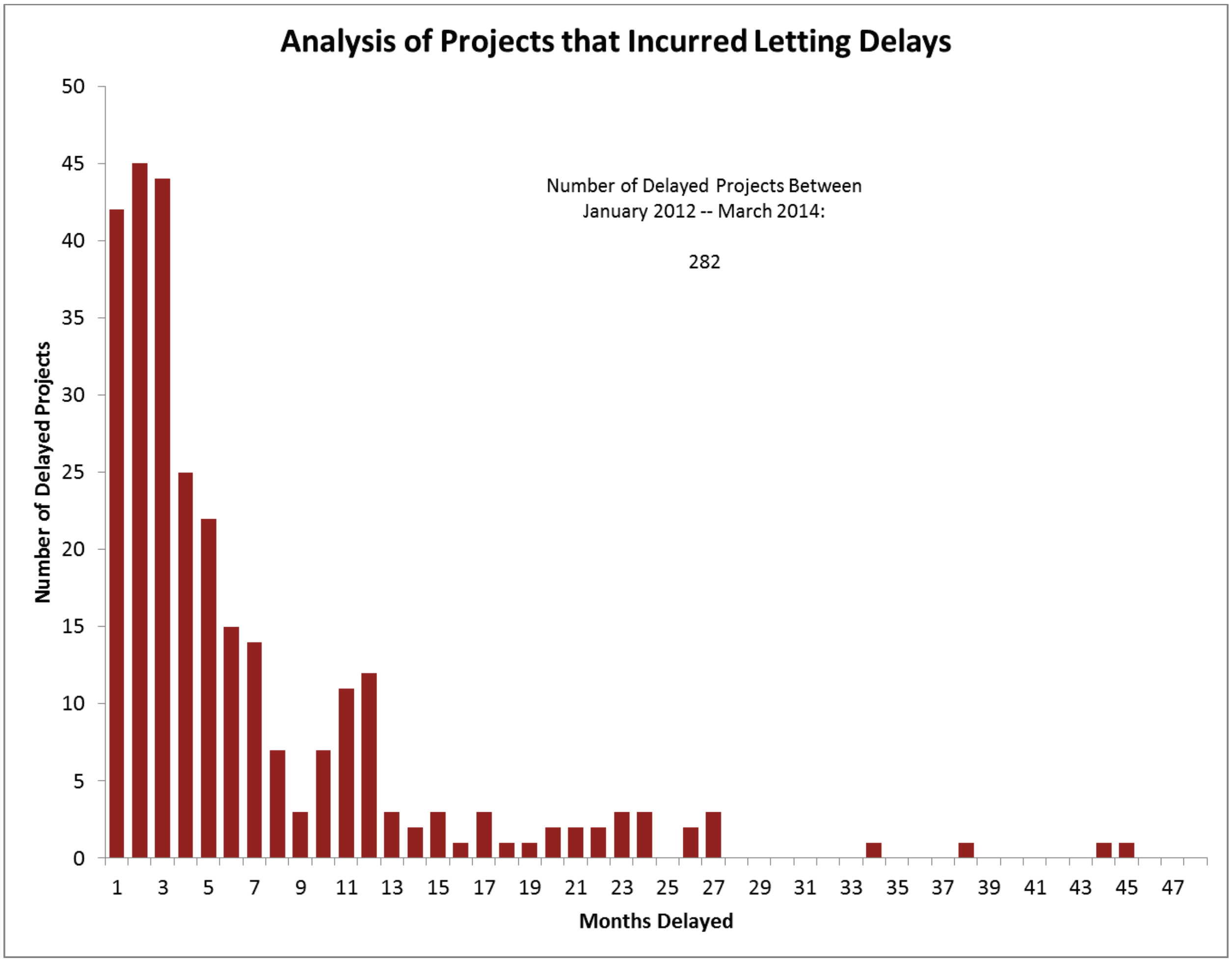

Figure 13. Length of Delay for Projects with Changed Letting Dates.

Table 11. Analysis of Delays for All Delayed Projects.

Reason for Delay	Number of Delayed Projects	Percentage of Delayed Projects	Average Delay (Days)	Maximum Delay (Days)	Minimum Delay (Days)
Other	105	37.2%	125	791	28
Late PS&E (outside source)	38	13.5%	342	-310	91
Environmental Clearance (district)	34	12.1%	243	-22	30
District Funding Considerations	25	8.9%	243	365	30
PS&E Revision Required	23	8.2%	164	427	31
Late PS&E	14	5.0%	105	396	30
Railroad Agreement	7	2.5%	122	365	31
S.T.I.P. Revision Required	7	2.5%	348	1338	31
Unclear Right of Way	7	2.5%	261	730	30
Environmental Clearance (division)	6	2.1%	218	516	62
Advertising requirement not met	5	1.8%	256	639	92
Advertising requirement not met	5	1.8%	256	639	92
Other Agreements	3	1.1%	477	1034	92
Unclear Utilities	3	1.1%	173	365	61
Grand Total	**282**	**100.0%**	**200**	**1338**	**28**

Table 12. Analysis of Delays for State-Let Projects.

Reason for Delay	Number of Delayed Projects	Percentage of Delayed Projects	Average Delay (Days)	Maximum Delay (Days)	Minimum Delay (Days)
Other	86	43.0%	114	791	28
Environmental Clearance (district)	28	14.0%	181	700	30
District Funding Considerations	24	12.0%	247	365	30
Late PS&E	13	6.5%	82	337	30
PS&E Revision Required	12	6.0%	114	273	31
S.T.I.P. Revision Required	7	3.5%	348	1338	31
Unclear Right of Way	7	3.5%	261	730	30
Late PS&E (outside source)	6	3.0%	598	1310	243
Railroad Agreement	5	2.5%	116	365	31
Statewide Funding Considerations	5	2.5%	219	699	31
Environmental Clearance (division)	4	2.0%	168	335	62
Unclear Utilities	2	1.0%	77	92	61
Other Agreements	1	0.5%	92	92	92
Grand Total	**200**	**100.0%**	**168**	**1338**	**28**

Table 13. Analysis of Delays for Non-State-Let Projects.

Reason for Delay	Number of Delayed Projects	Percentage of Delayed Projects	Average Delay (Days)	Maximum Delay (Days)	Minimum Delay (Days)
Late PS&E (outside source)	32	39.0%	294	1126	91
Other	19	23.2%	178	579	59
PS&E Revision Required	11	13.4%	218	427	151
Environmental Clearance (district)	6	7.3%	532	822	273
Advertising requirement not met	5	6.1%	256	639	92
Environmental Clearance (division)	2	2.4%	319	516	122
Other Agreements	2	2.4%	670	1034	306
Railroad Agreement	2	2.4%	138	214	61
District Funding Considerations	1	1.2%	151	151	151
Late PS&E	1	1.2%	396	396	396
Unclear Utilities	1	1.2%	365	365	365
Grand Total	**82**	**100.0%**	**278**	**1126**	**59**

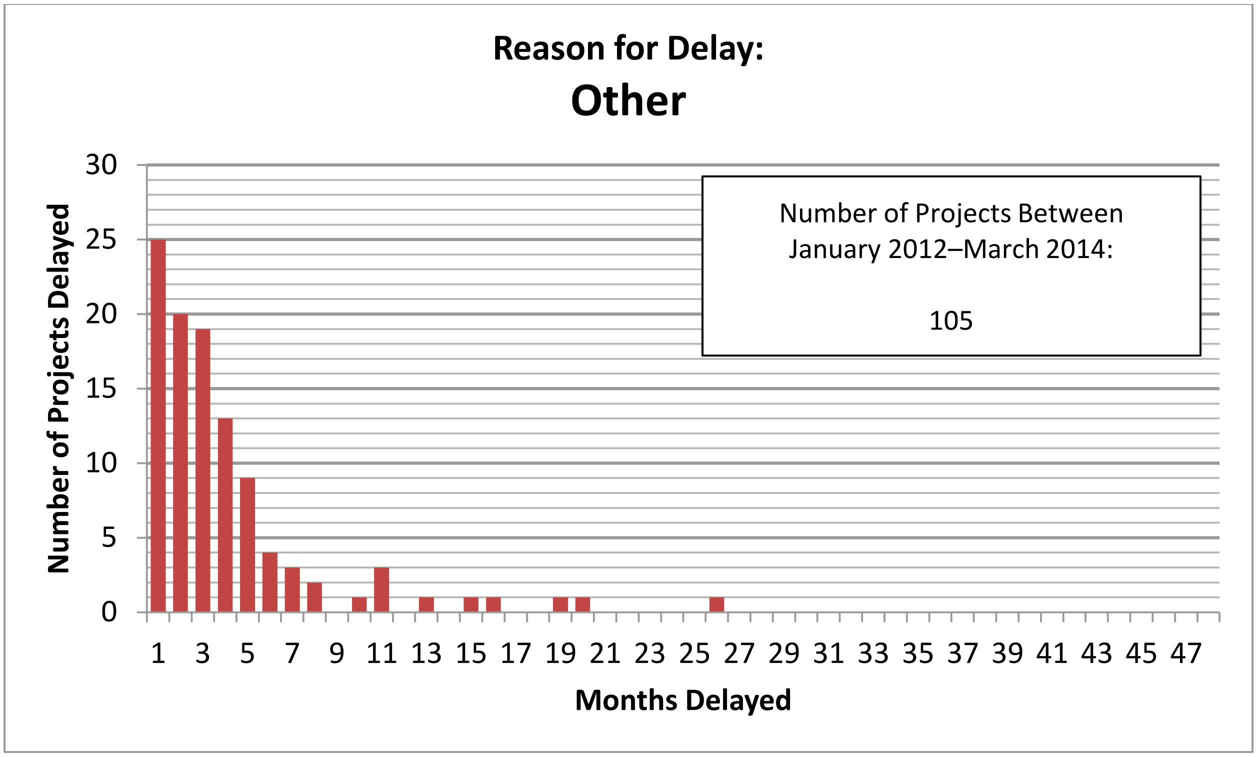

Figure 14. Projects Delayed for Other Reasons.

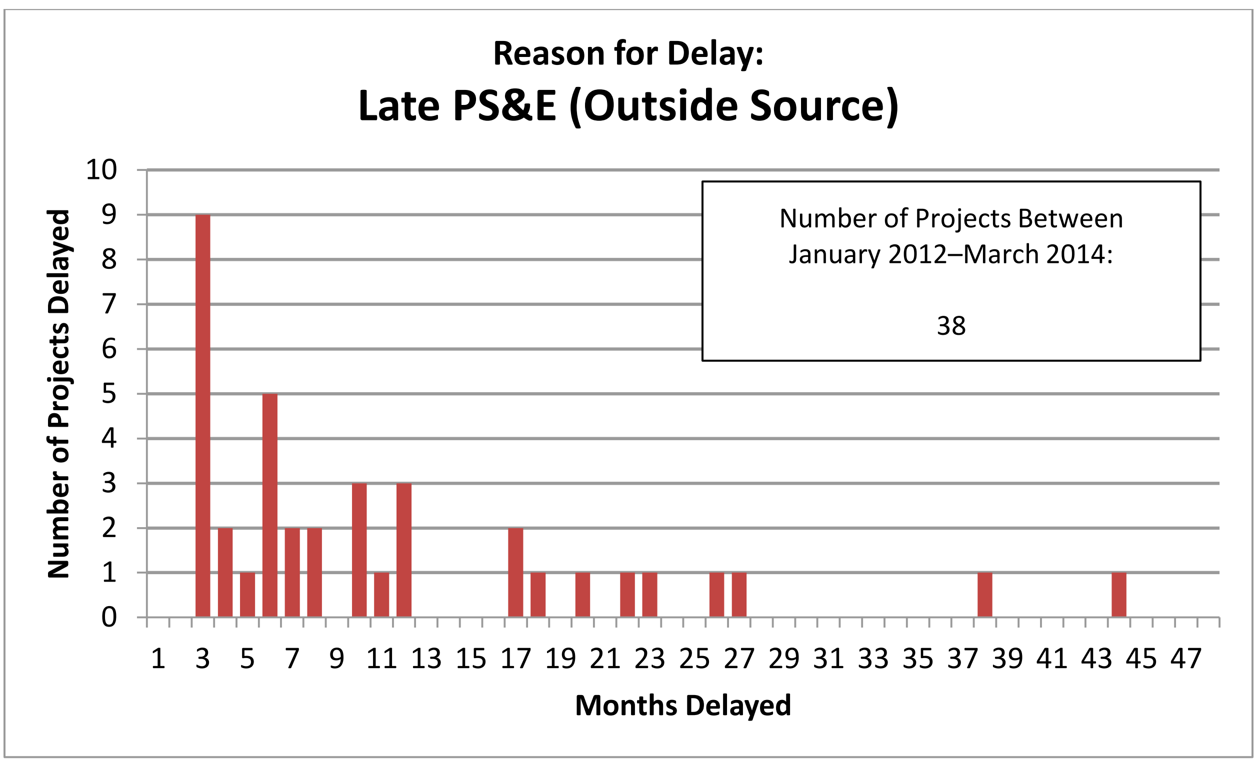

Figure 15. Projects Delayed for Late PS&E Submittal by Non-TxDOT Parties.

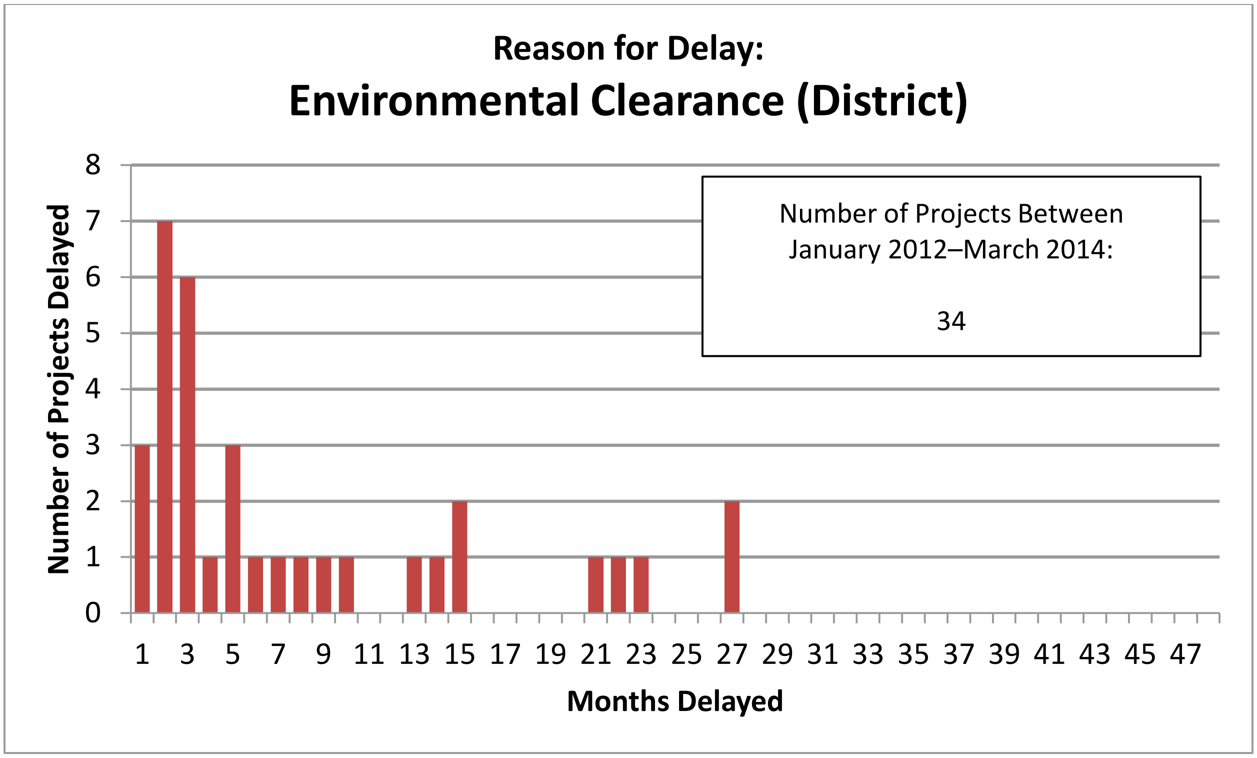

Figure 16. Projects Delayed for Environmental Clearance at the District Level.

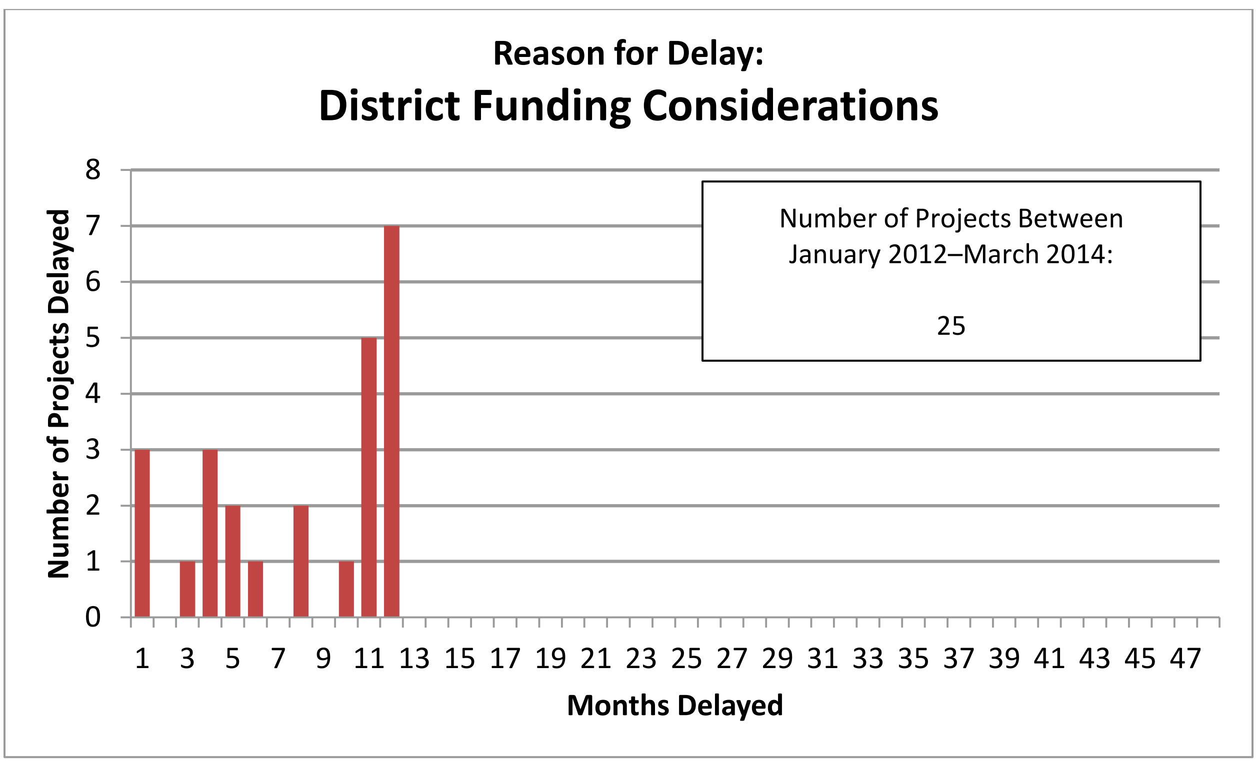

Figure 17. Projects Delayed for District Funding Considerations.

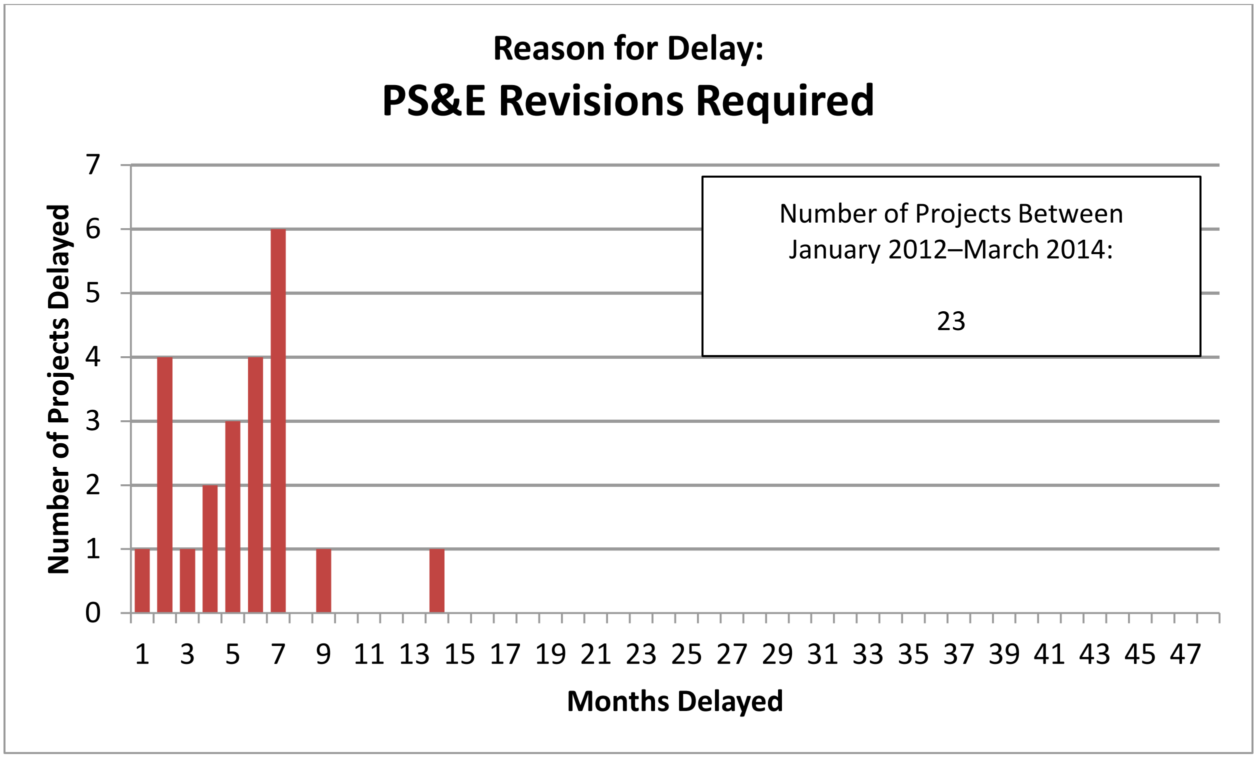

Figure 18. Projects Delayed for Required PS&E Revisions.

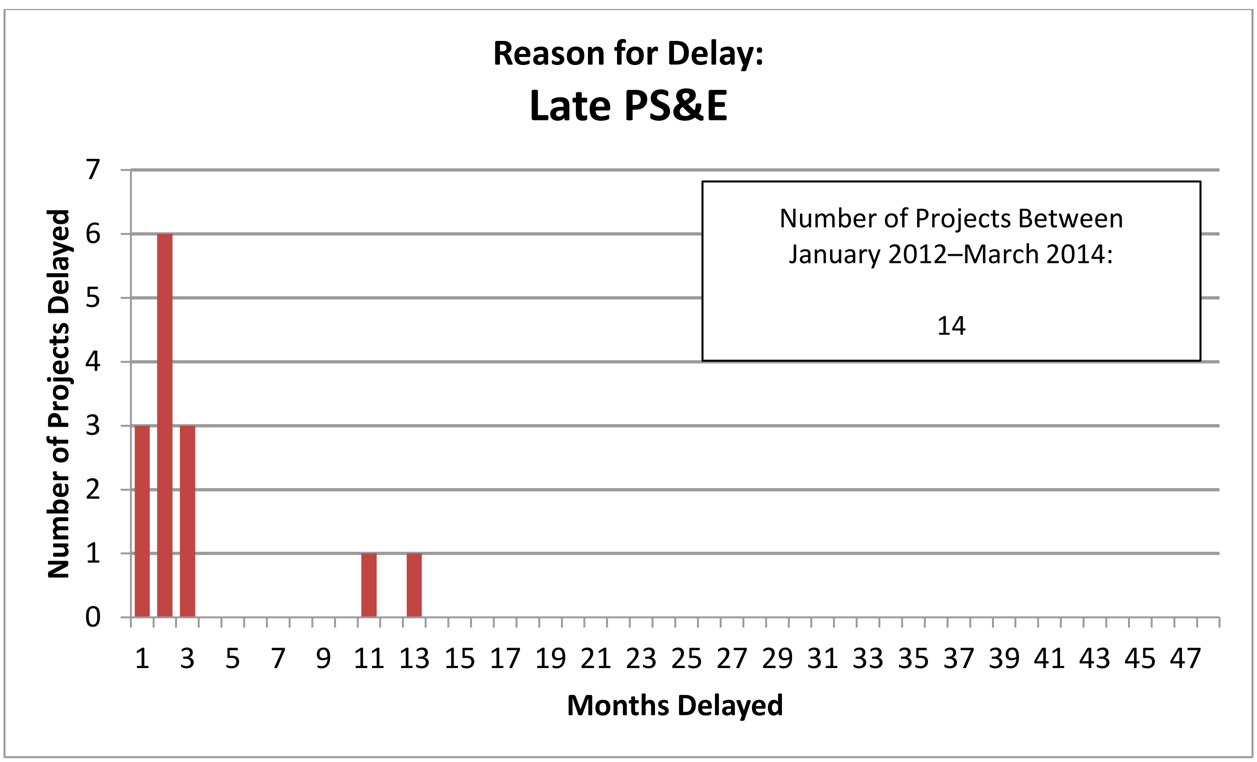

Figure 19. Projects Delayed for Late PS&E Submittal TxDOT.

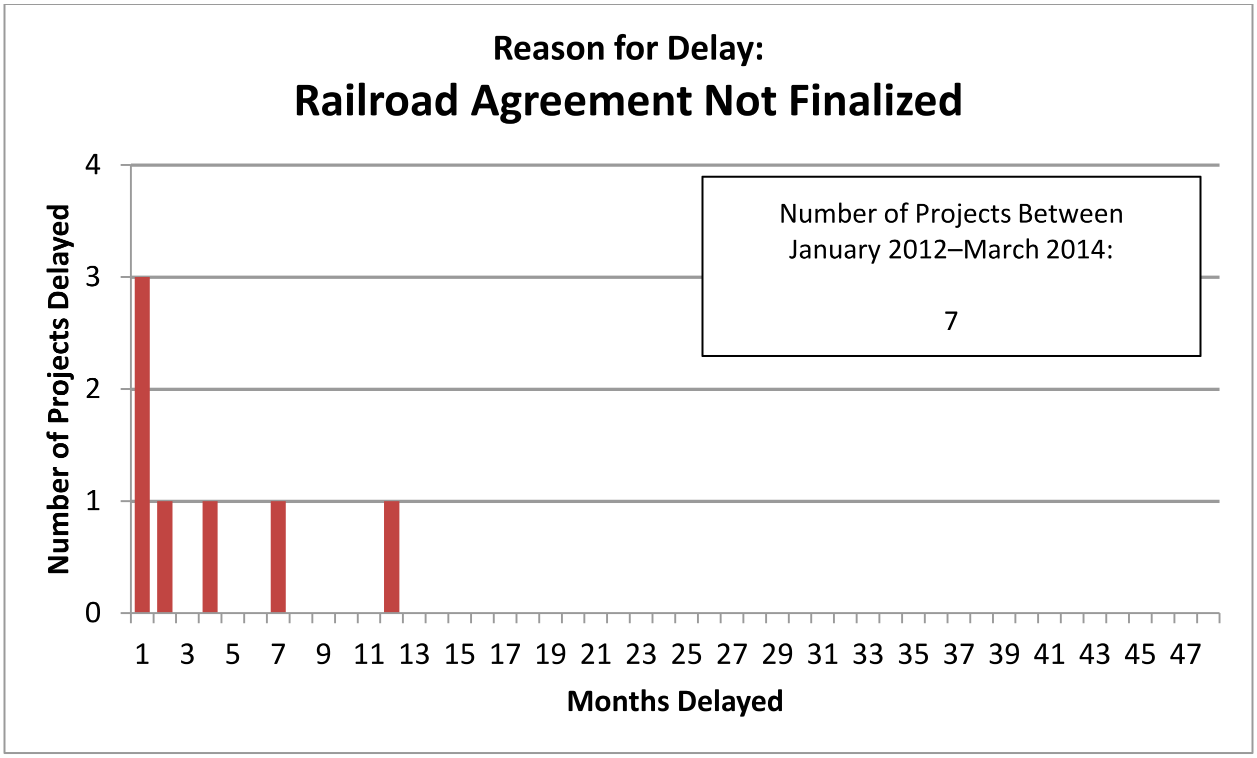

Figure 20. Projects Delayed for Railroad Agreements Not Being Finalized.

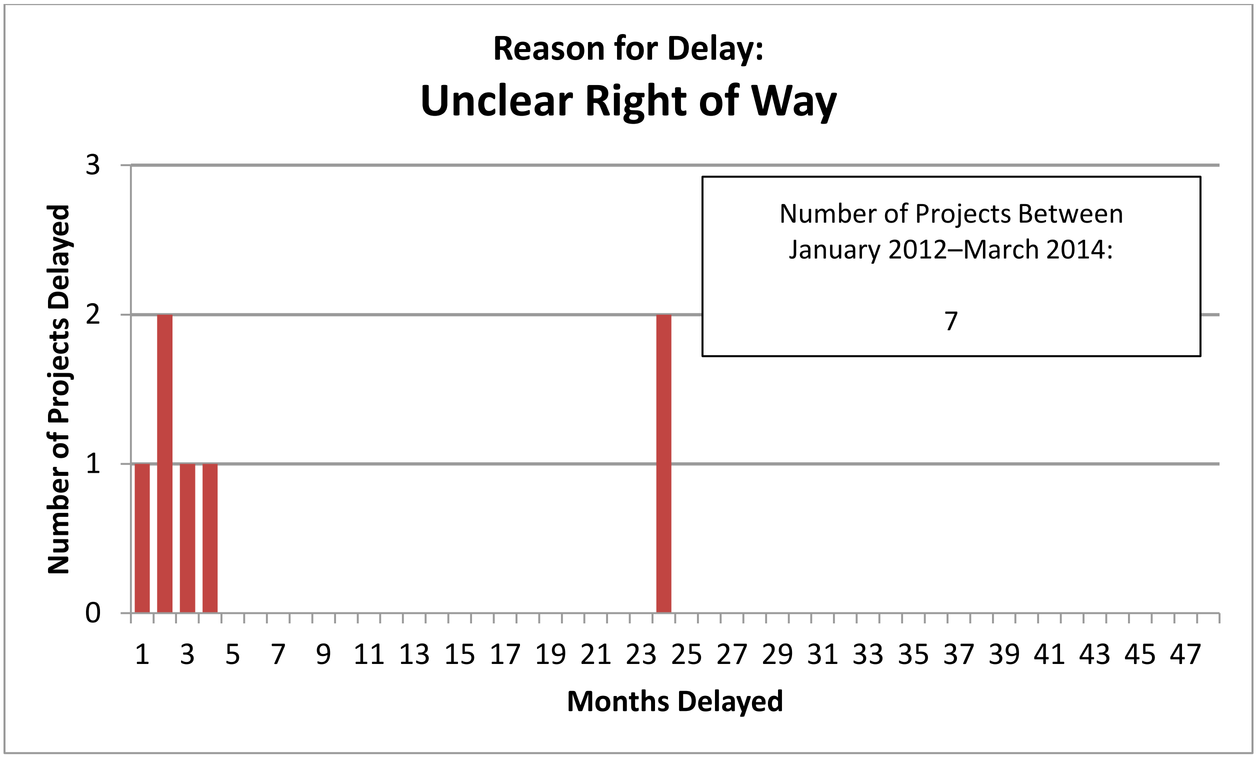

Figure 21. Projects Delayed for Unclear Right of Way.

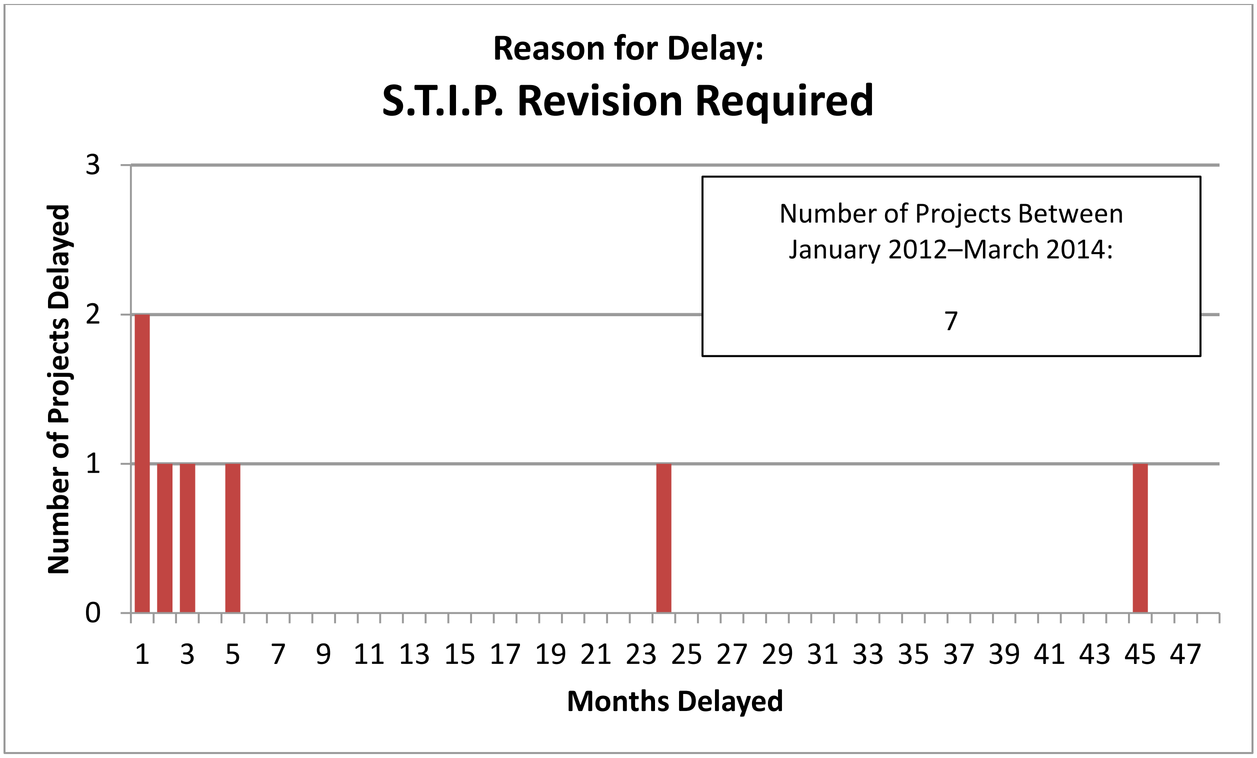

Figure 22. Projects Delayed for Required S.T.I.P. Revisions.

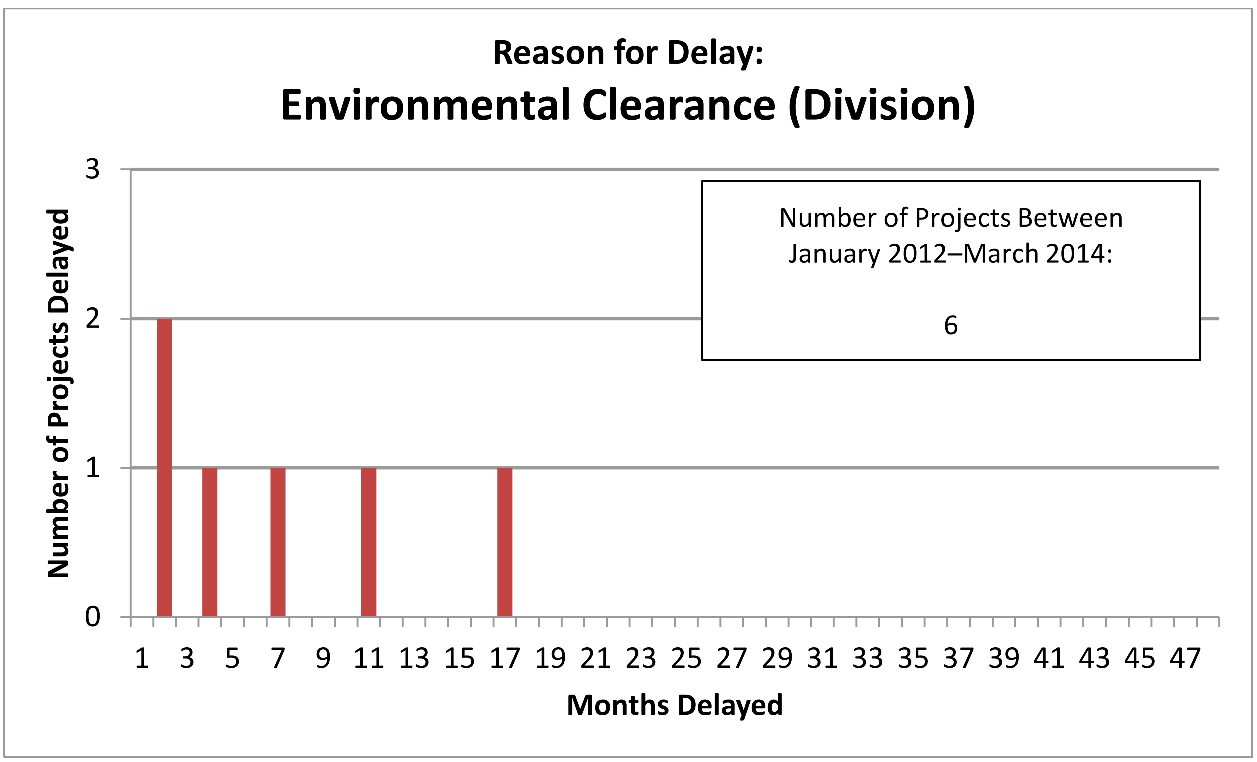

Figure 23. Projected Delayed for Environmental Clearance at the Division Level.

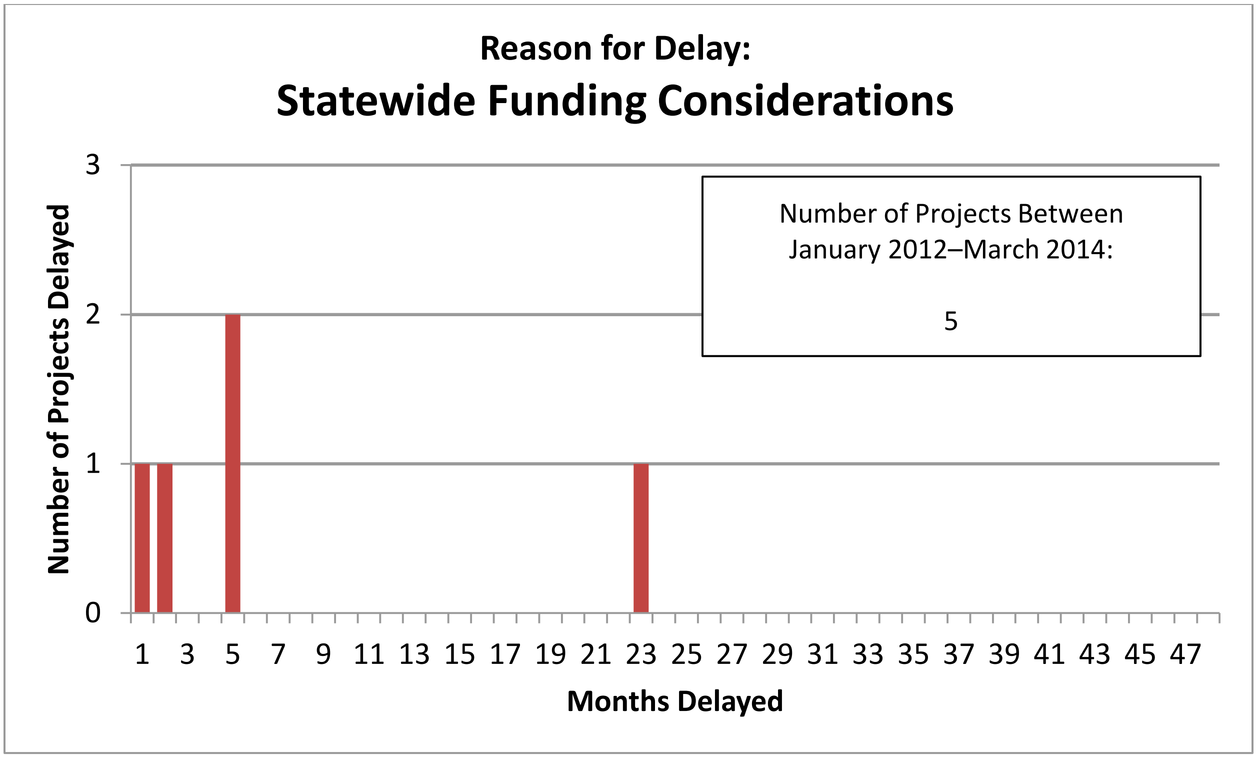

Figure 24. Projects Delayed for Statewide Funding Considerations.

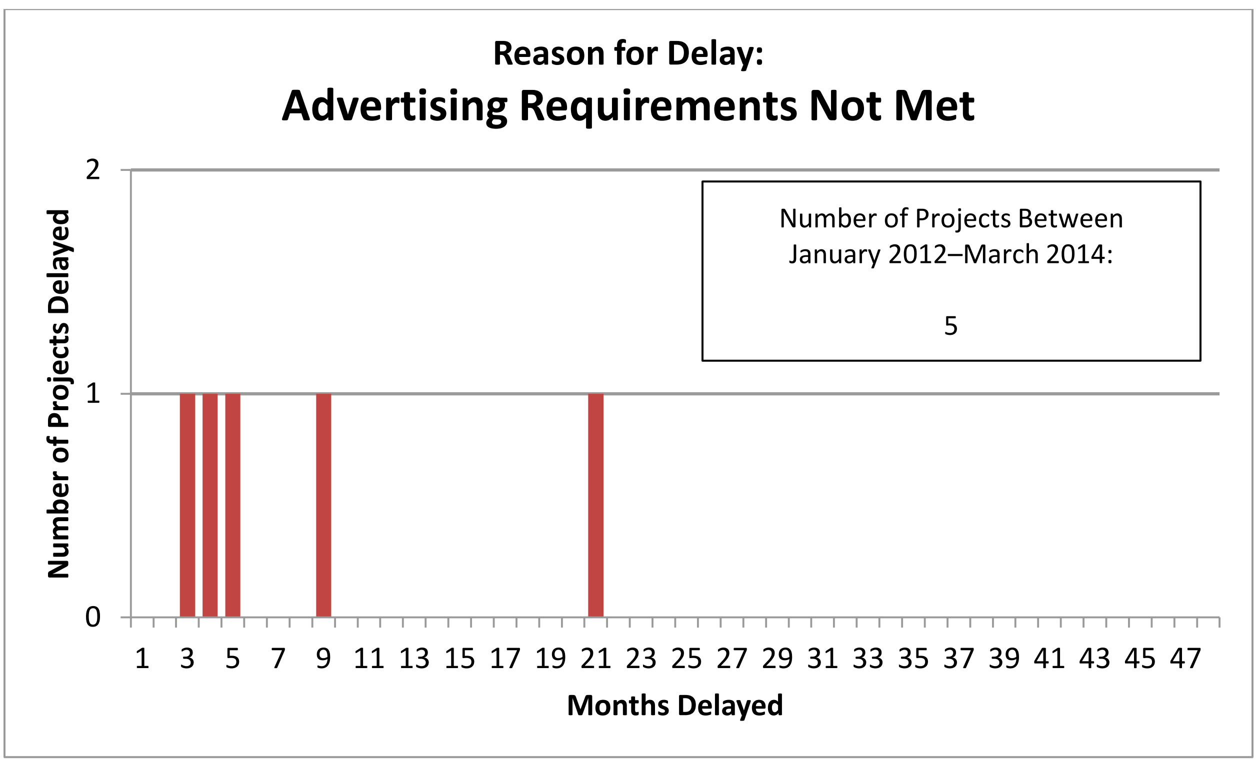

Figure 25. Projects Delayed because Advertising Requirements Were Not Met.

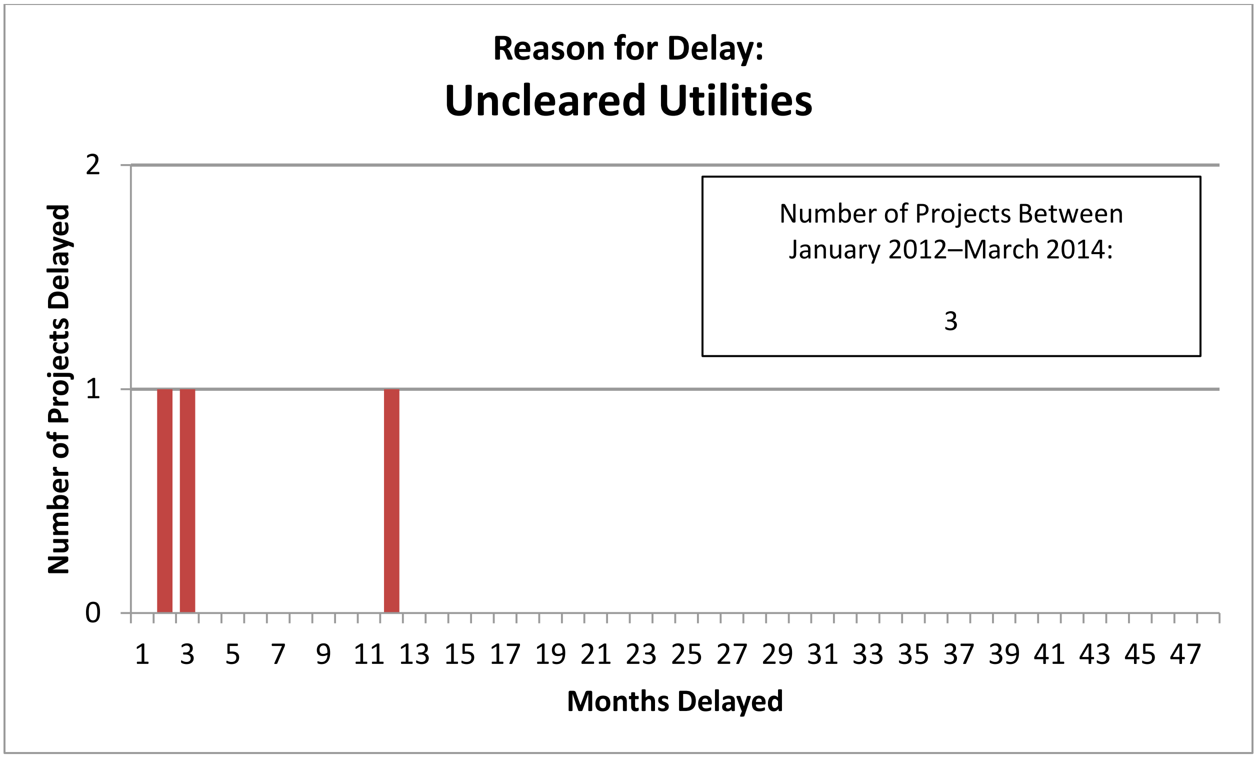

Figure 26. Projects Delayed due to Uncleared Utilities.

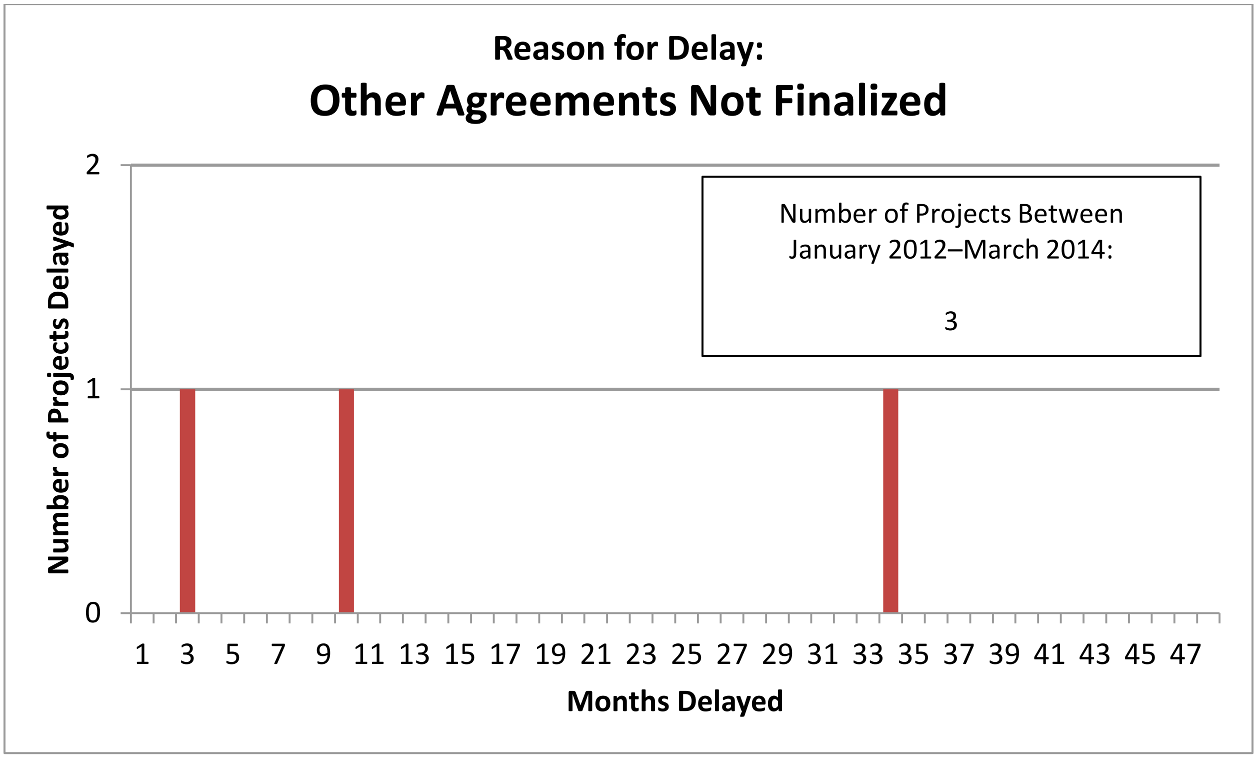

Figure 27. Projects Delayed due to Other Agreements Not Finalized.

REFERENCES

1 C.A. Quiroga, E. Kraus, J.H. Overman, and N.A. Koncz. *Integration of Utility and Environmental Activities in the Project Development Process.* Report 0-6065-1, Texas Transportation Institute, http://tti.tamu.edu/documents/0-6065-1.pdf.

2 M. Ishaq Nadiri and Theofanis P. Mamuneas. "Contribution of Highway Capital to Output and Productivity Growth in the US Economy and Industries." http://www.fhwa.dot.gov/policy/gro98cvr.htm.

3 U.S. Environmental Protection Agency. Environmental Impact Statement Process. http://www.epa.gov/compliance/nepa/eisdata.html.

4 CFR Title 23, §771.129. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title23/23cfr771_main_02.tpl.