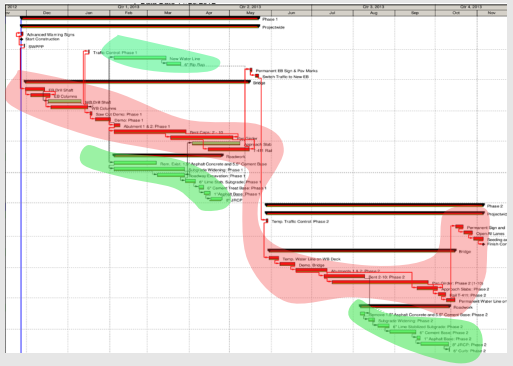
Finish to Start (FS)	Start to Start (SS)	Finish to Finish (FF)
New Water Line → 6" Rip Rap	Abutment 1 & 2: Phase 1 → Bent Caps: 2 - 10	Subgrade Widening: Phase 1 → Roadway Excavation: Phase 1

Activity ID	Activity Name	BL1 Duration	Original Duration	Actual Duration	Start	Finish
Phase 1		**124**	**124**	**0**	**27-Nov-12**	**22-May-13**
Projectwide		124	124	0	27-Nov-12	22-May-13
A1000	Advanced Warning Signs	2	2	0	27-Nov-12	28-Nov-12
A0500	Start Construction	0	0	0	27-Nov-12	
A1010	SWPPP	1	1	0	29-Nov-12	29-Nov-12
A1060	Traffic Control: Phase 1	1	1	0	16-Jan-13	16-Jan-13
A1210	New Water Line	29	29	0	04-Feb-13	14-Mar-13
A1220	6" Rip Rap	7	7	0	15-Mar-13	25-Mar-13
A1270	Permanent EB Sign & Pav Mar	2	2	0	16-May-13	17-May-13
A1240	Switch Traffic to New EB	3	3	0	20-May-13	22-May-13
Bridge		116	116	0	30-Nov-12	15-May-13
A1020	EB Drill Shaft	11	11	0	30-Nov-12	14-Dec-12
A1040	EB Columns	11	11	0	04-Dec-12	18-Dec-12
A1030	WB Drill Shaft	16	16	0	17-Dec-12	10-Jan-13



CON511 – BASIC CONSTRUCTION SCHEDULE ANALYSIS

Introduction

Course Objectives

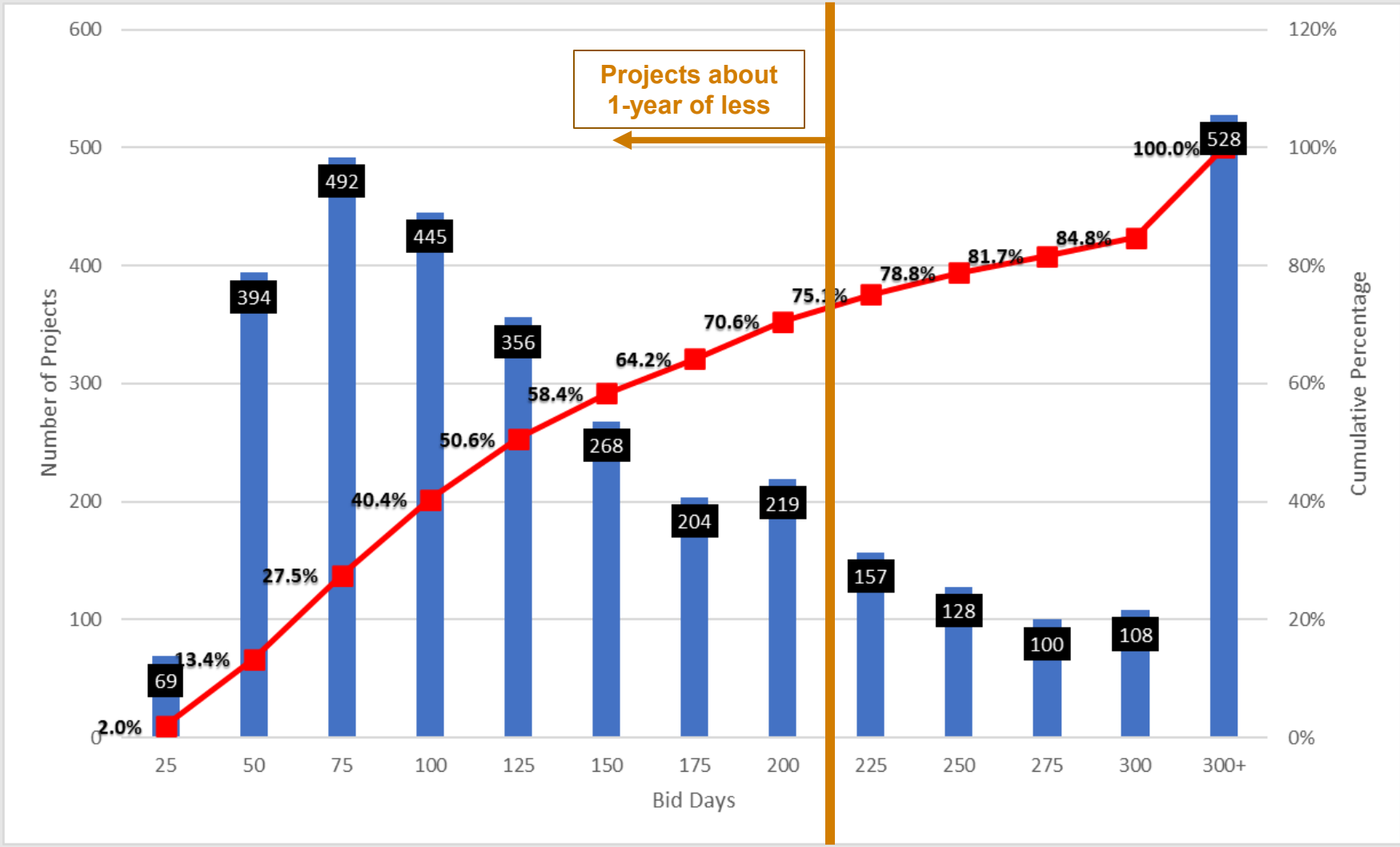
- The application of pertinent items from the 2014 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (Specifications or Specs.).
- The availability and content of other internal resources (i.e., Construction Division and TxDOT manuals).
- The ability to review a contractor's schedule submission and evaluate its compliance with specification requirements.
- The ability to review a contractor's scheduling logic and understand how it coincides with contract time charges and project progress.
- The ability to review contractor schedule updates and compare progress with monthly estimates.

Upon completion…

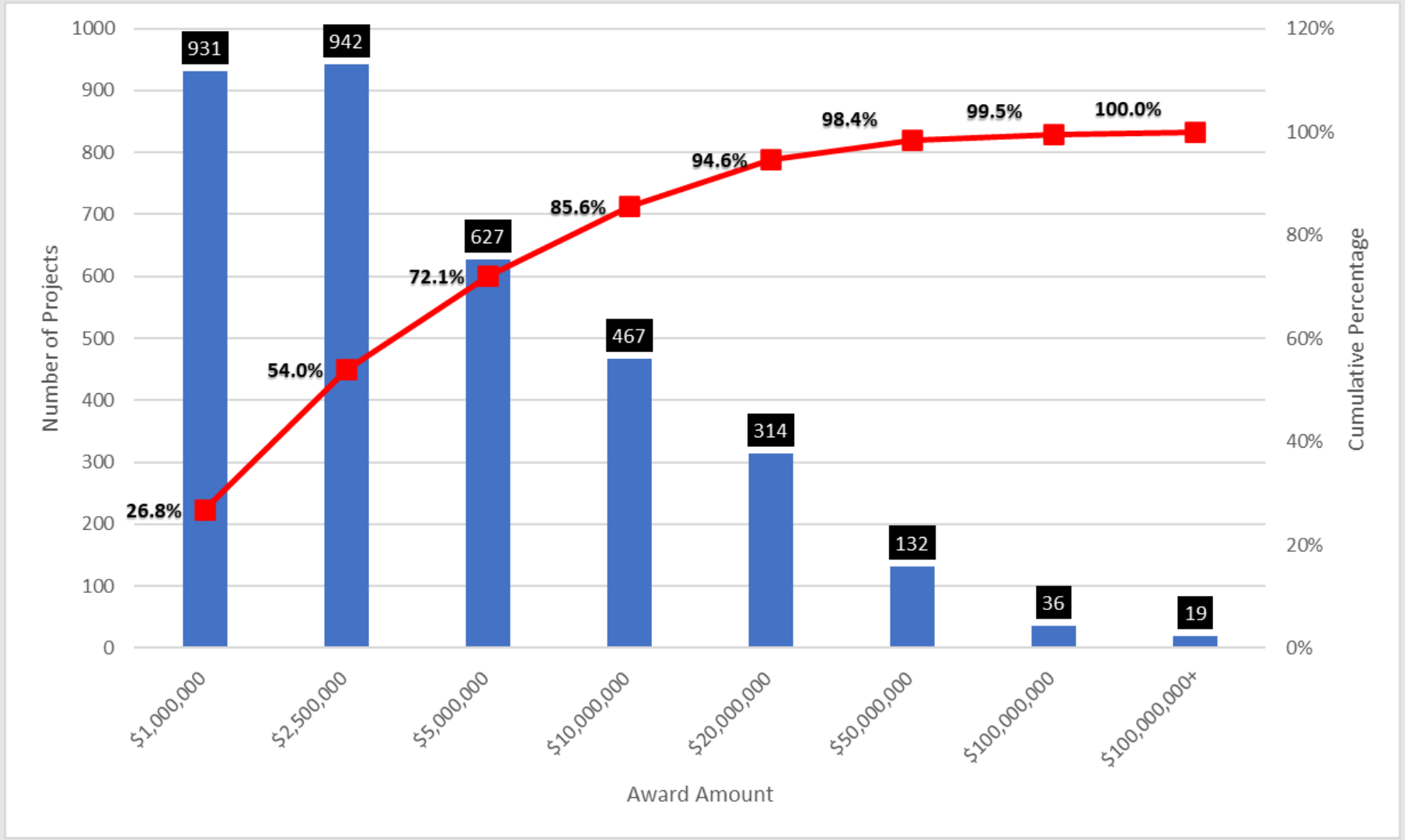
- Review a contractor's preconstruction schedule for compliance with specification requirements and constructability.
- Monitor project progress and constructability compared with monthly estimates.
- Initially identify time impacts to the project using critical thinking skills.
- Engage the contractor regarding time and schedule concerns.
- Apply best practices and create your own best practices for schedule analysis.

Note: Every construction project is <u>unique</u> and creates its own personality depending upon the scope of work, existing conditions, unforeseen issues, and contractor interaction. Participants should develop critical thinking skills that help address a broad spectrum of issues likely to be faced on a variety of construction projects.

Time for TxDOT Construction Projects



Cost for TxDOT Construction Projects



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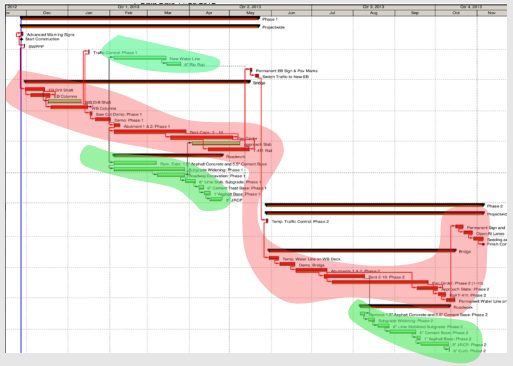

CON511 – BASIC CONSTRUCTION SCHEDULE ANALYSIS

Module 1: Background Information – Part 1

Module 1 Objectives

- Understand what items and articles in the 2014 Specifications have scheduling related elements
- Identify other resources containing construction scheduling and monitoring information
- Understand how time charges accrue on construction projects
- Understand how weather impacts construction activities and time charges

It is important to understand the specifications, the requirements of the contractor, and scheduling practices and principles for all types of projects. Scheduling and scheduling analysis is NOT just for the mega projects that cost hundreds of millions of dollars.

Schedule Specification Requirements for the Preconstruction Phase

Article 8.1 in TxDOT's Standard Specification states, "Begin work within 30 calendar days after the authorization date to begin work".

- An example: If the work authorization is dated March 1st, the first day *after* is March 2nd and starts the 30-calendar day count. Work and time charges should begin by March 30th. Work can begin before this if the preconstruction conference has been held.

Article 4.2 – Preconstruction Conference: **Before** starting work, schedule and attend a preconstruction conference with the engineer.

- "failure to schedule and attend a preconstruction conference is **not** grounds for delaying the beginning of working day charges."

Schedule Specification Requirements for the Preconstruction Phase

Article 8.5.2 states, "**Before** starting work, prepare and submit a progress schedule based on the sequence of work and traffic control plan shown in the contract. Prepare the progress schedule as a bar chart or critical path method (CPM) as shown on the plans."

Article 8.5.5.1 states, "Seven calendar days **before** the preconstruction meeting, prepare and submit a hard copy of the schedule using the bar chart method."

Information in Construction Contract Administration Manual (CCAM)

Chapter 3 of Section 4 includes details about the preconstruction conference that relate to a contractor's schedule:

- Number of work days
- Start date
- Completion date
- Holidays, tax holidays, or other days the highway may not be closed
- Major phases on the contract
- Detailed progress schedule outlining the manner of prosecution of work intended to complete work in the allotted time
- Work plans
- Criteria on working day charges and temporary suspension of work (notify the area engineer [AE] at least 24 hours before beginning work in any new operation)
- Explain the traffic control plan (TCP) and its sequence during the contract
- Determine the contractor's plans for implementing the TCP

CCAM – Contractor's Work Plan

The plan should include:

- Estimated start date.
- Estimated completion date.
- Project schedule—contractor's project schedule to be furnished to AE.
- Acceptable schedule required before work can begin.
- Schedule updates required each month.
- Contractor cannot revise the schedule without notifying TxDOT in writing.
- Contractor responsible for initiating time impact analysis process for delays.

Schedule Specification Requirements for the Construction Phase

Article 8.5 states:
"Prepare, maintain, and **submit** project schedules. Project schedules are used to convey the Contractor's intended work plan to the Department. Prepare project schedules with a level of effort sufficient for the work being performed."

A designated person is required by the specifications to develop and maintain the progress schedule (Article 8.5.1).

Article 8.5.5.1.1 states to "Update the project schedule and submit a hard copy when changes to the schedule occur or when requested."

Schedule Specification Requirements for the Construction Phase

Article 8.3.4 requires that TxDOT provide the contractor with a time statement for the project. TxDOT accomplishes this on a monthly basis through the Contractor's monthly estimate package.

Schedule Specification Requirements for the Construction Phase

Article 8.3.4 further states:

The contractor must protest time charges in writing and within 30 calendar days after receiving the time statement. Failure to protest within 30 calendar days indicates acceptance and no future consideration of that period will be permitted.

Communication and documentation are key; while the Specifications are clear that the contractor must notify TxDOT in writing, it benefits TxDOT to engage with the contractor and notify them in writing as well.

Schedule Specification Requirements for the Construction Phase

Article 8.5.2 says, "Include all planned work activities and sequences and show contract completion within the number of working days specified. Incorporate major material procurements, known utility relocations, and other activities that may affect the completion of the Contract in the progress schedule. **Show a beginning date, ending date, and duration in whole working days for each activity. Do not use activities exceeding 20 working days**, unless agreed upon with the engineer. Show an estimated **production rate per working day** for each work activity, unless agreed upon with the engineer."

Avoid confusing these default requirements for all schedules with CPM specific requirements conveyed in Article 8.5.5.2

Critical Path Method Specification Requirements

The default scheduling requirement in the specifications is ambiguous. If CPM is required, it is typically noted in the General Notes.

Article 8.5.5.2 - **Critical Path Method** – Prepare and submit the schedule using CPM.

Article 8.5.5.2.1 - **Preliminary Schedule** – Seven calendar days before the preconstruction meeting, submit both the plotted and electronic copies of the project schedule showing activities beginning with the authorization date to begin work and including activities to be performed within the first 90 calendar days from the work start date.

All elements of Article 8.5.5.2.X.X pertain to CPM scheduling

Understanding Time and Time Charges

A **workweek** is defined as the method for charging working days to a project.

A **working day** is defined as “any day (other than Sunday or legal holiday) on which legal business can be conducted. Whether Saturday is a working day or not depends on the custom or usage of the trade or jurisdiction.” (http://www.businessdictionary.com/definition/working-day.html)

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.1. Five-Day Workweek

Working days will be charged Monday through Friday, excluding national holidays, regardless of weather conditions or material availability. The Contractor has the option of working on Saturdays. Provide sufficient advance notice to the Engineer when scheduling work on Saturdays. Work on Sundays and national holidays will not be permitted without written permission of the Engineer. If work requiring an Inspector to be present is performed on a Saturday, Sunday, or national holiday, and weather and other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.2. Six-Day Workweek

Working days will be charged Monday through Saturday, excluding national holidays, regardless of weather conditions or material availability. Work on Sundays and national holidays will not be permitted without written permission of the Engineer. If work requiring an Inspector to be present is performed on a Sunday or a national holiday, and weather or other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.3. Seven-Day Workweek

Working days will be charged Monday through Sunday, excluding national holidays, regardless of weather conditions or material availability. Work on national holidays will not be permitted without written permission of the Engineer. If work is performed on any of these holidays requiring an Inspector to be present, and weather or other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.4. Standard Workweek

Working days will be charged Monday through Friday, excluding national or state holidays, if weather or other conditions permit the performance of the principal unit of work underway, as determined by the Engineer, for a continuous period of at least 7 hr. between 7:00 A.M. and 6:00 P.M., unless otherwise shown in the Contract. The Contractor has the option of working on Saturdays or state holidays. Provide sufficient advance notice to the Engineer when scheduling work on Saturdays. Work on Sundays and national holidays will not be permitted without written permission of the Engineer. If work requiring an Inspector to be present is performed on a Saturday, Sunday, or holiday, and weather or other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.5 Calendar Day

Working days will be charged Sunday through Saturday, including all holidays, regardless of weather conditions, material availability, or other conditions not under the control of the Contractor.

Note:

Article 8.3.1.6 allows TxDOT to charge working days as specified in the plans.

Understanding Time and Time Charges

When the project plans or proposal do not specify how time charges are to accrue, the default in the Standard Specifications prevails. Article 8.3.1 sets the default as a Standard Workweek.

8.3.1. Working Day Charges

Working days will be charged in accordance with Article 8.3.1.4, "Standard Workweek," unless otherwise shown on the plans.

Finish to Start (FS)	Start to Start (SS)	Finish to Finish (FF)
New Water Line → 6" Rip Rap	Abutment 1 & 2: Phase 1 → Bent Caps: 2 - 10	Subgrade Widening: Phase 1 → Roadway Excavation: Phase 1

Activity ID	Activity Name	BL1 Duration	Original Duration	Actual Duration	Start	Finish
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A1060	Traffic Control: Phase 1	1	1	0	16-Jan-13	16-Jan-13
A1210	New Water Line	29	29	0	04-Feb-13	14-Mar-13
A1220	6" Rip Rap	7	7	0	15-Mar-13	25-Mar-13
A1270	Permanent EB Sign & Pav Mar	2	2	0	16-May-13	17-May-13
A1240	Switch Traffic to New EB	3	3	0	20-May-13	22-May-13
Bridge		116	116	0	30-Nov-12	15-May-13
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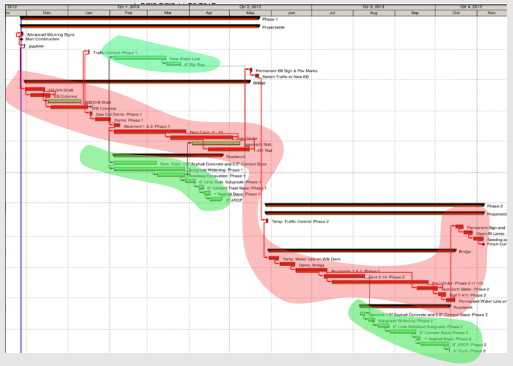
A1030	WB Drill Shaft	16	16	0	17-Dec-12	10-Jan-13



CON511 – BASIC CONSTRUCTION SCHEDULE ANALYSIS

Module 1: Background Information – Part 2

Module 1 Objectives

- Understand what items and articles in the 2014 Specifications have scheduling related elements
- Identify other resources containing construction scheduling and monitoring information
- Understand how time charges accrue on construction projects
- Understand how weather impacts construction activities and time charges

It is important to understand the specifications, the requirements of the contractor, and scheduling practices and principles for all types of projects. Scheduling and scheduling analysis is NOT just for the mega projects that cost hundreds of millions of dollars.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.1. Five-Day Workweek

Working days will be charged Monday through Friday, excluding national holidays, regardless of weather conditions or material availability. The Contractor has the option of working on Saturdays. Provide sufficient advance notice to the Engineer when scheduling work on Saturdays. Work on Sundays and national holidays will not be permitted without written permission of the Engineer. If work requiring an Inspector to be present is performed on a Saturday, Sunday, or national holiday, and weather and other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.2. Six-Day Workweek

Working days will be charged Monday through Saturday, excluding national holidays, regardless of weather conditions or material availability. Work on Sundays and national holidays will not be permitted without written permission of the Engineer. If work requiring an Inspector to be present is performed on a Sunday or a national holiday, and weather or other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.3. Seven-Day Workweek

Working days will be charged Monday through Sunday, excluding national holidays, regardless of weather conditions or material availability. Work on national holidays will not be permitted without written permission of the Engineer. If work is performed on any of these holidays requiring an Inspector to be present, and weather or other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

Understanding Time and Time Charges

Article 8.3 in TxDOT's Standard Specifications defines a workweek in one of five ways:

8.3.1.4. Standard Workweek

Working days will be charged Monday through Friday, excluding national or state holidays, if weather or other conditions permit the performance of the principal unit of work underway, as determined by the Engineer, for a continuous period of at least 7 hr. between 7:00 A.M. and 6:00 P.M., unless otherwise shown in the Contract. The Contractor has the option of working on Saturdays or state holidays. Provide sufficient advance notice to the Engineer when scheduling work on Saturdays. Work on Sundays and national holidays will not be permitted without written permission of the Engineer. If work requiring an Inspector to be present is performed on a Saturday, Sunday, or holiday, and weather or other conditions permit the performance of work for 7 hr. between 7:00 A.M. and 6:00 P.M., a working day will be charged.

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Working days will be charged Sunday through Saturday, including all holidays, regardless of weather conditions, material availability, or other conditions not under the control of the Contractor.

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Understanding Time and Time Charges

When the project plans or proposal do not specify how time charges are to accrue, the default in the Standard Specifications prevails. Article 8.3.1 sets the default as a Standard Workweek.

8.3.1. Working Day Charges

Working days will be charged in accordance with Article 8.3.1.4, "Standard Workweek," unless otherwise shown on the plans.

What impacts how many days a contractor works?

Regardless of how time charges are established in the contract, there are practical impacts to time that should be understood. When evaluating schedules for realistic durations, one must understand these impacts and adjust expectations based on reasonably expected impacts.

Example of time impacts

A $13.7 million project in the Tyler District to construct a Super 2 with a level-up and PFC surface over the entire roadway. The total project length is 10.788 miles. Additional information is below:

- 206 Working Days
- Standard Workweek
- 15 months of barricades

206 working days over 15 months results in an average of 13.7 chargeable days (i.e., working days) per month.

Example of time impacts, continued

How many days within a year should we expect the contractor to work?

Account for Saturdays and Sundays:

Calendar Days Per Year	Weekend Days Per Year	Total Working Days Per Year
365	104	261

Example of time impacts, continued

How many days within a year should we expect the contractor to work?

Account for rain:

The National Oceanic and Atmospheric Administration (NOAA) is a good resource for understanding potential weather impacts to days available for the contractor to work. A good benchmark for rain is days with more than 0.1 in. of rain. Rainfall heavier than this often leads to the suspension of work.

Monthly Number of Days Precipitation >= 0.1 for TYLER, TX

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2014	2	6	5	2	8	9	7	1	3	7	5	8	63
2015	6	5	11	11	16	8	0	4	1	5	13	6	86
2016	2	4	5	8	6	4	4	9	2	2	3	8	57
2017	5	3	6	5	8	6	6	9	0	3	2	6	59
2018	5	12	4	6	1	2	5	4	9	11	5	9	73
Mean	4	6	6	6	8	6	4	5	3	6	6	7	68
Max	6 2015	12 2018	11 2015	11 2015	16 2015	9 2014	7 2014	9 2017	9 2018	11 2018	13 2015	9 2018	86 2015
Min	2 2016	3 2017	4 2018	2 2014	1 2018	2 2018	0 2015	1 2014	0 2017	2 2016	2 2017	6 2017	57 2016

Example of time impacts, continued

How many days within a year should we expect the contractor to work?

Account for rain:

Not all rain occurs on a weekday. If we assume the rain days are just as likely to fall on any given day:

68/365 = 18.6% of calendar days receive 0.1-in. of rain or more

18.6%*261 weekdays = 48.6 weekdays receive 0.1-in. of rain or more. Round to 48.

261 – 48 = 213 working days

Example of time impacts, continued

How many days within a year should we expect the contractor to work?

Account for holidays:

No.	Holiday	Agency Status	Date	Day of Week
1	New Year's Day	All Agencies	1/1/2019	Tuesday
2	Martin Luther King, Jr. Day	All Agencies	1/21/2019	Monday
3	President's Day	All Agencies	2/18/2019	Monday
4	Memorial Day	All Agencies	5/27/2019	Monday
5	Independence Day	All Agencies	7/4/2019	Thursday
6	Labor Day	All Agencies	9/2/2019	Monday
7	Thanksgiving Day	All Agencies	11/28/2019	Thursday
8	Day After Thanksgiving Day	All Agencies	11/29/2019	Friday
9	Christmas Eve Day	All Agencies	12/24/2019	Tuesday
10	Christmas Day	All Agencies	12/25/2019	Wednesday
11	Day After Christmas Day	All Agencies	12/26/2019	Thursday

213 – 9 = 204 working days when accounting for weekends, rain, and holidays.

Example of time impacts, continued

Some factors that could influence a contractor's ability to perform work are detailed in the specifications:

- Surface temperature for HMA paving:
  - Article 341.4.7.1
  - Article 346.4.7.1
- Temperature restrictions for concrete pavements
  - Article 360.4.73.3
- Surface conditions for reflectorized pavement markings
  - Article 666.4.3.1

Air Temperature	Predicted Max Surface Temp.	Predicted Min. Surface Temp.
35	36	36
40	42	41
50	55	53
60	68	64
70	80	75
80	93	86
90	106	97
100	118	108

Example of time impacts, continued

Also, 0.1-in. of rain might not always prevent a contractor from performing work or resuming operations. Therefore, on some days, the contractor might not be charged a day, yet work is performed for less than seven continuous hours.

Even though there could be other reasons that work is not performed, this gives us a pretty good idea of the number of days we should expect the contractor to work.

- 204 working days/12 months per year = 17 working days per month

15 to 17 working days per month is a good average value to assume for the number of days the contractor will perform work during a month.

A good rule of thumb is to assume that **180 to 205** real working days exist during a calendar year.

Time Charges Summary

Anticpated Real Days Required to Complete the Project	206
Months of Barricades	15

		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
	Real Working Days	17	17	14	12	14	11	15	16	14	17	17	17	17	17	14	229
8.3.1.1	5-Day Workweek	21	21	20	20	21	19	23	23	20	22	20	21	21	21	20	313
8.3.1.2	6-Day Workweek	25	26	24	24	25	23	27	27	25	26	25	26	25	26	24	378
8.3.1.3	7-Day Workweek	29	31	28	28	29	27	30	30	30	30	30	31	29	31	28	441
8.3.1.4	Standard Workweek	17	17	14	12	14	11	15	16	14	17	17	17	17	17	14	229
8.3.1.5	Calendar Day	30	31	30	31	31	28	30	30	31	30	31	31	30	31	30	455

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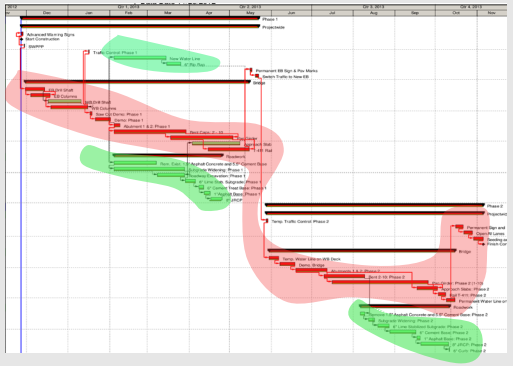


CON511 – BASIC CONSTRUCTION SCHEDULE ANALYSIS

Module 2: Assessment of Construction Schedules

Module 2 Objectives

- Understand the difference between work activity as a component of the contractor's schedule and a pay item as a component of the TxDOT monthly estimate.
- Sort TxDOT pay items and use the sorted list to map the contractor's schedule activities to ensure necessary items are scheduled.
- Evaluate the feasibility of the contractor's production rate(s) and activity duration(s).
- Understand the types of logical schedule activity relationships and assess the reasonableness of the relationships.
- Identify the critical path within a schedule and to track any change(s) to the critical path.
- Evaluate a contractor's schedule update and compare it to TxDOT monthly estimates for accuracy and reasonableness.
- Develop a framework to engage the contractor regarding schedule concerns.

1. SCHEDULE REQUIREMENTS

Required Components in Schedule

- The contractor provides TxDOT with a schedule that illustrates how the contractor intends to construct the project.
  - This schedule should include activities and logic that fit together to achieve an end product…we could call this the Work Breakdown Structures (WBS)

- **Article 8.5.2** lists the elements required in the Schedule:
  - **Contract completion within the number of working days**
  - **Begin date** for each activity
  - **End date** for each activity
  - **Activity duration**
  - **Production rate** for each activity

2. MAPPING ITEMS TO ACTIVITIES

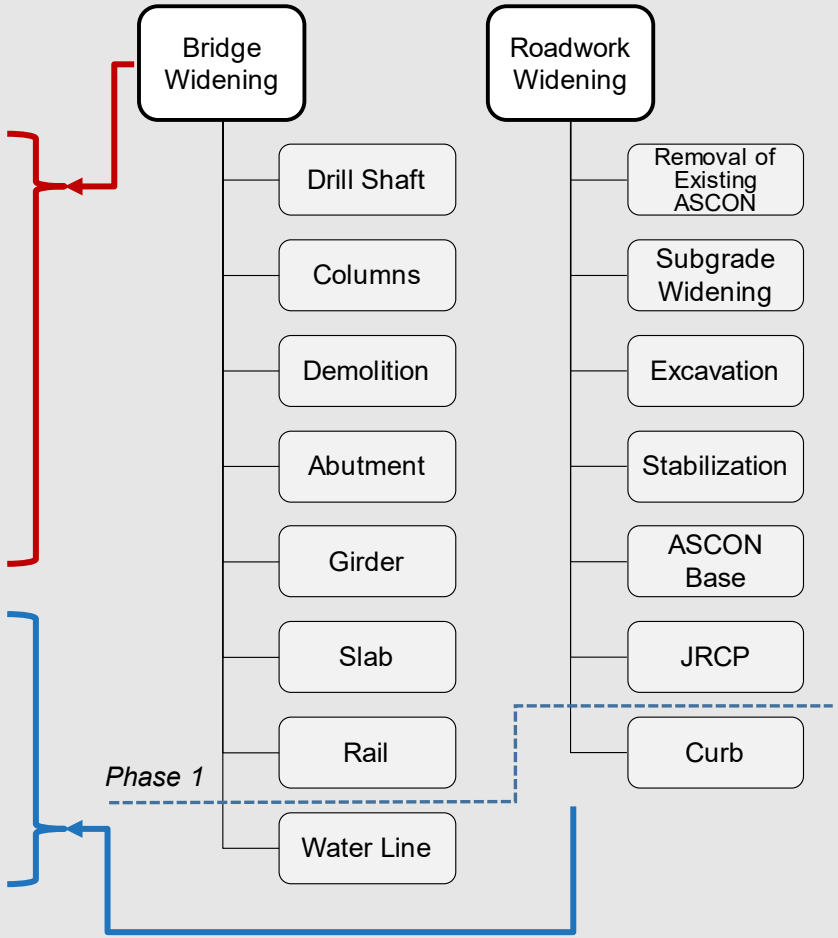
Work Breakdown Structure (WBS)

- The WBS captures “chunks” of work used to construct the project
- For highway projects, the WBS typically includes:
  - Phasing or Milestones
  - Work type
    - i.e., roadway work, bridge work, drainage work
  - Seasonal work
- Look for logical structures based on the scope of the project

Work Breakdown Structure (WBS) in Schedule Using Type of Work

- Work activities in schedule should be well presented by the work breakdown structure (WBS).

Phase 1	
Activity ID	Activity Name
Bridge	
A1020	EB Drill Shaft
A1040	EB Columns
A1030	WB Drill Shaft
A1050	WB Columns
A1070	Saw Cut Demo: Phase 1
A1080	Demo: Phase 1
A1090	Abutment 1 & 2: Phase 1
A1100	Bent Caps: 2 - 10
A1180	Pan Girder
A1200	Approach Slab
A1190	T-411 Rail
Roadwork	
A1110	Rem. Exist. 1.5" Asphalt Concr
A1120	Subgrade Widening: Phase 1
A1130	Roadway Excavation: Phase 1
A1140	6" Lime Stab. Subgrade: Phase
A1150	6" Cement Treat Base: Phase 1
A1160	1"Asphalt Base: Phase 1
A1170	8" JRCP



- **Planned construction** (e.g., place storm drain, pour columns, lay HMA).
- **Major material procurements** (e.g., bridge beams, precast inlets or boxes, seal coat rock).
- **Known utility relocations** (e.g., aerial lines such as electrical or communication, subsurface lines such as water or communication).

Work Breakdown Structure (WBS) in Schedule Using Phasing

- Work activities in schedule should be well presented by the work breakdown structure (WBS).

Baylor County US 82 - 0156-06-052			
1000	Project Duration	09-Jul-18 A	24-May-19
1020	Set Barricades	09-Jul-18 A	12-Jul-18
1030	SW3P	12-Jul-18 A	17-Jul-18
1040	Install Culvert #1	12-Jul-18 A	15-Aug-18
1050	Install Culvert #2	16-Aug-18	23-Aug-18
1060	Install Culvert #3	24-Aug-18	04-Oct-18

- Project wide elements
- Large culvert construction
  - It might be better if the culvert construction was its own WBS with more detail.

Phase 1			
1080	Temporary Pavement	16-Aug-18	24-Aug-18
1090	Shift Traffic	27-Aug-18	27-Aug-18
1100	Install PCTB	28-Aug-18	04-Sep-18
1110	Remove ASB	05-Sep-18	13-Sep-18
1120	Remove Concrete Pav	14-Sep-18	26-Sep-18
1130	Excavation/Embankme	27-Sep-18	06-Nov-18
1140	Cement Treat Subgrac	06-Nov-18	13-Nov-18
1150	12" Flex Base	12-Nov-18	27-Nov-18
1160	MC-30 Prime Coat	03-Dec-18	03-Dec-18
1170	One Course Seal	07-Dec-18	07-Dec-18
1180	2" HMA Type D	10-Dec-18	11-Dec-18
1190	Backfill & Dress Slopes	13-Dec-18	14-Dec-18

- Roadway rehabilitation
  - It might be better if the detour work was its own WBS with more detail.

Phase 2			
2210	Temporary Pavement	17-Dec-18	27-Dec-18
2220	Move PCTB	28-Dec-18	04-Jan-19
2230	Shift Traffic	07-Jan-19	07-Jan-19
2240	Excavation/Embankme	29-Jan-19	01-Mar-19
2250	Cement Treat Subgrac	04-Mar-19	11-Mar-19

- Roadway rehabilitation
  - It might be better if the detour work was its own WBS with more detail.

– **The scope of work is similar across multiple phases** (e.g., Phase 1 and Phase 2 include roadway reconstruction)

– **Includes logical breaks to distinguish between phases**

Pay Item to Schedule Activity

- Contractors can create activities in the schedule by:
  - Considering each pay item as a schedule activity
  - Combining multiple pay items into a single schedule activity
    - E.g., Construct storm drain network A
      - This could include inlets, junction boxes, and various pipe sizes
    - E.g., Construct traffic signal
      - This includes all signal related components
  - Separate a pay item into multiple schedule activities
    - E.g., Construct bridge deck might have an item for set panels, tie steel, set forms, pour deck, groove deck.
      - Most of these items are paid under a single item

Discrepancy Between Pay Items and Work Activities

- Pay items in estimates and work activities in schedules are usually different.

Longer than schedules

ITEM CODE	DESCRIPTION	UNIT	UNIT PRICE	BID QUANTITY	TOTAL PRICE
05022001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	$ 2,000	12.000	$ 24,000
59692006	WATER MAIN PIPE (PVC)(12IN)	LF	$ 40	1,360.000	$ 54,400
59692011	WATER MAIN PIPE (STL)(12IN)	LF	$ 120	410.000	$ 49,200
59692075	WET CONNECTION (12IN)	EA	$ 1,000	6.000	$ 6,000
59692095	GATE VALVE (12IN)	EA	$ 3,000	4.000	$ 12,000
04162001	DRILL SHAFT (18 IN)	LF	$ 100	94.000	$ 9,400
04162002	DRILL SHAFT (24 IN)	LF	$ 90	228.000	$ 20,520
04162003	DRILL SHAFT (30 IN)	LF	$ 150	858.000	$ 128,700
04302002	CL C CONC FOR EXT STR (ABUT)	CY	$ 1,500	27.000	$ 40,500
04302003	CL C CONC FOR EXT STR (BENT)	CY	$ 1,200	89.700	$ 107,640

Example of Pay Items in Estimates

Projectwide	
A1000	Advanced Warning Signs
A0500	Start Construction
A1010	SWPPP
A1060	Traffic Control: Phase 1
A1210	New Water Line

Bridge	
A1020	EB Drill Shaft
A1040	EB Columns
A1090	Abutment 1 & 2: Phase 1
A1100	Bent Caps: 2 - 10
A1180	Pan Girder

Example of Work Activities in Schedules

Where to start?

- Sometimes the project and schedule feels too big to find a place to start.
  - Understanding your high-cost items helps.
  - Sort the estimate or estimate & quantity sheet from highest total cost to lowest total cost.
  - This will allow you to see your high-cost items.
    - It will also allow you to identify these items in the contractor's schedule to ensure those items are included.

Sorting & Mapping Process: a multi-step process

- Sort and Map pay items in monthly estimate to work activities in schedule
  - Sort your estimate first to make sure the most expensive items are in the schedule

a. Sort the pay items based on total price in the descending order

It doesn't take that many items to consume 80% of the total project cost.

Table of Project Estimate

ITEM CODE	DESCRIPTION	UNIT	UNIT PRICE	BID QUANTITY	TOTAL PRICE	CUMULATIVE COST	CUMULATIVE (%)
03446034	SUPERPAVE MIXTURES SP-C PG64-22	TON	$97.00	23,670.000	$2,295,990.00	$2,295,990.00	13.7%
04236001	RETAINING WALL (MSE)	SF	$60.00	29,949.000	$1,796,940.00	$4,092,930.00	24.4%
05006001	MOBILIZATION	LS	$1,400,000.00	1.000	$1,400,000.00	$5,492,930.00	32.7%
04256038	PRESTR CONC GIRDER (TX46)	LF	$145.00	8,096.910	$1,174,051.95	$6,666,981.95	39.7%
03446172	SUPERPAVE MIXTURES SP-C PG64-22(LEV-UP)	TON	$105.00	8,403.000	$882,315.00	$7,549,296.95	45.0%
04226001	REINF CONC SLAB	SF	$14.75	55,200.000	$814,200.00	$8,363,496.95	49.8%
03446047	SUPERPAVE MIXTURES SP-C SAC-A PG70-22	TON	$97.00	6,836.000	$663,092.00	$9,026,588.95	53.8%
01326006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	$7.75	51,283.000	$397,443.25	$9,424,032.20	56.2%
05126005	PORT CTB (FUR & INST)(F-SHAPE)(TY 1)	LF	$80.00	4,920.000	$393,600.00	$9,817,632.20	58.5%
04326001	RIPRAP (CONC)(4 IN)	CY	$400.00	796.000	$318,400.00	$10,136,032.20	60.4%
05086001	CONSTRUCTING DETOURS	SY	$70.00	4,470.000	$312,900.00	$10,448,932.20	62.3%
04506014	RAIL (TY T551)	LF	$62.00	4,932.000	$305,784.00	$10,754,716.20	64.1%
04016001	FLOWABLE BACKFILL	CY	$180.00	1,647.000	$296,460.00	$11,051,176.20	65.9%
04166004	DRILL SHAFT (36 IN)	LF	$140.00	2,067.000	$289,380.00	$11,340,556.20	67.6%
04326036	RIPRAP (STONE PROTECTION)(30 IN)	CY	$140.00	1,596.000	$223,440.00	$11,563,996.20	68.9%
04626018	CONC BOX CULV (7 FT X 7 FT)	LF	$600.00	360.000	$216,000.00	$11,779,996.20	70.2%
04326002	RIPRAP (CONC)(5 IN)	CY	$400.00	529.000	$211,600.00	$11,991,596.20	71.5%
01006002	PREPARING ROW	STA	$3,000.00	65.090	$195,270.00	$12,186,866.20	72.6%
04206029	CL C CONC (CAP)	CY	$830.00	189.200	$157,036.00	$12,343,902.20	73.6%
01106003	EXCAVATION (SPECIAL)	CY	$7.00	19,500.000	$136,500.00	$12,480,402.20	74.4%
05456001	CRASH CUSH ATTEN (INSTL)	EA	$10,500.00	13.000	$136,500.00	$12,616,902.20	75.2%
02756001	CEMENT	TON	$160.00	819.000	$131,040.00	$12,747,942.20	76.0%
01646054	BOND FBR MTRX SEED (PERM)(RURAL)(SAND)	SY	$0.82	154,000.000	$126,280.00	$12,874,222.20	76.7%
06816001	TEMP TRAF SIGNALS	EA	$60,000.00	2.000	$120,000.00	$12,994,222.20	77.4%
05146040	PERM CTB (SSCB)(TY 3)(MOD)	LF	$360.00	330.000	$118,800.00	$13,113,022.20	78.1%
01106001	EXCAVATION (ROADWAY)	CY	$5.50	20,121.000	$110,665.50	$13,223,687.70	78.8%
05066002	ROCK FILTER DAMS (INSTALL) (TY 2)	LF	$33.00	3,330.000	$109,890.00	$13,333,577.70	79.5%

Descending order

Sorting & Mapping Process: a multi-step process

- Map pay items in monthly estimate to work activities in schedule

b. Map the pay items to work activities in schedule

A1210	INSTALL TEMP SPEC SHORING @ 468 - US	SF	600	100	6	06-Mar-1	13-Mar-19
A1220	INSTALL DBL 7X7 BOX CULV @ 468 - US	LF	60	10	6	14-Mar-1	21-Mar-19
A1230	CONST WINGWALL @ 468 - US	EA	1	.17	6	21-Mar-1	28-Mar-19
A1235	PLACE ROCK RIPRAP @ 468 - US	CY	42	30	2	28-Mar-1	02-Apr-19
A1240	INSTALL TEMP SPEC SHORING @ 468 - DS	SF	600	100	6	02-Apr-1	08-Apr-19
A1250	INSTALL DBL 7X7 BOX CULV @ 468 - DS	LF	60	10	6	09-Apr-1	15-Apr-19
A1260	CONST WINGWALL @ 468 - DS	EA	1	.17	6	15-Apr-1	22-Apr-19
A1270	PLACE ROCK RIPRAP @ 468 - DS	CY	651	30	20	22-Apr-1	14-May-19
A1280	INSTALL PIPE CROSSINGS NB	LF	512	25	20	04-Jan-1	25-Jan-19
A1290	DRIVEWAYS AND PIPE/SET'S	SY	1594	80	20	22-Nov-1	14-Dec-18
A1295	EARTHWORK	CY	19885	1000	20	14-May-1	3-Jun-19
A1300	8" CEMENT TREATED SUBGRADE	SY	5597	1000	6	06-Jun-1	13-Jun-19
A1310	10" SUPERPAVE BASE	TON	2911	600	5	13-Jun-1	19-Jun-19
A1320	OCST	GAL	3234	3500	1	19-Jun-1	20-Jun-19
A1330	2" SUPERPAVE SURFACE	TON	841	200	4	20-Jun-1	26-Jun-19
A1340	PAVEMENT MARKINGS	LS	1	.2	5	26-Jun-1	02-Jul-19

A1520	LEVELING PADS - WALLS A, B, & C
A1530	CONST WALL C
A1540	CONST WALL A
A1550	CONST WALL B
A1560	SET COPING - WALLS A, B, & C

Table of Project Estimate

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04236001	RETAINING WALL (MSE)	SF	$60.00	29,949.000	$1,796,940.00	$4,092,930.00	24.4%
05006001	MOBILIZATION	LS	$1,400,000.00	1.000	$1,400,000.00	$5,492,930.00	32.7%
04256038	PRESTR CONC GIRDER (TX46)	LF	$145.00	8,096.910	$1,174,051.95	$6,666,981.95	39.7%
03446172	SUPERPAVE MIXTURES SP-C PG64-22(LEV-UP)	TON	$105.00	8,403.000	$882,315.00	$7,549,296.95	45.0%
04226001	REINF CONC SLAB	SF	$14.75	55,200.000	$814,200.00	$8,363,496.95	49.8%
03446047	SUPERPAVE MIXTURES SP-C SAC-A PG70-22	TON	$97.00	6,836.000	$663,092.00	$9,026,588.95	53.8%
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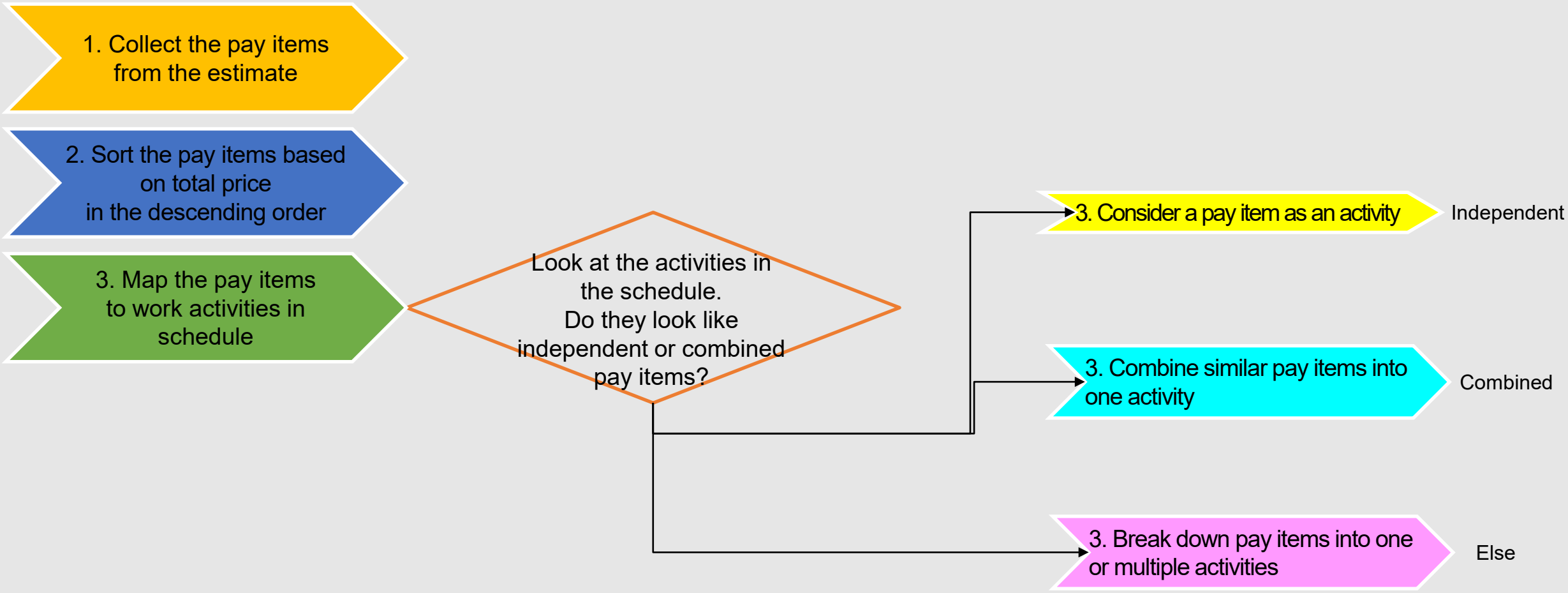
05126005	PORT CTB (FUR & INST)(F-SHAPE)(TY 1)	LF	$80.00	4,920.000	$393,600.00	$9,817,632.20	58.5%
04326001	RIPRAP (CONC)(4 IN)	CY	$400.00	796.000	$318,400.00	$10,136,032.20	60.4%
05086001	CONSTRUCTING DETOURS	SY	$70.00	4,470.000	$312,900.00	$10,448,932.20	62.3%
04506014	RAIL (TY T551)	LF	$62.00	4,932.000	$305,784.00	$10,754,716.20	64.1%
04016001	FLOWABLE BACKFILL	CY	$180.00	1,647.000	$296,460.00	$11,051,176.20	65.9%
04166004	DRILL SHAFT (36 IN)	LF	$140.00	2,067.000	$289,380.00	$11,340,556.20	67.6%
04326036	RIPRAP (STONE PROTECTION)(30 IN)	CY	$140.00	1,596.000	$223,440.00	$11,563,996.20	68.9%
04626018	CONC BOX CULV (7 FT X 7 FT)	LF	$600.00	360.000	$216,000.00	$11,779,996.20	70.2%
04326002	RIPRAP (CONC)(5 IN)	CY	$400.00	529.000	$211,600.00	$11,991,596.20	71.5%
01006002	PREPARING ROW	STA	$3,000.00	65.090	$195,270.00	$12,186,866.20	72.6%
04206029	CL C CONC (CAP)	CY	$830.00	189.200	$157,036.00	$12,343,902.20	73.6%
01106003	EXCAVATION (SPECIAL)	CY	$7.00	19,500.000	$136,500.00	$12,480,402.20	74.4%
05456001	CRASH CUSH ATTEN (INSTL)	EA	$10,500.00	13.000	$136,500.00	$12,616,902.20	75.2%
02756001	CEMENT	TON	$160.00	819.000	$131,040.00	$12,747,942.20	76.0%
01646054	BOND FBR MTRX SEED (PERM)(RURAL)(SAND)	SY	$0.82	154,000.000	$126,280.00	$12,874,222.20	76.7%
06816001	TEMP TRAF SIGNALS	EA	$60,000.00	2.000	$120,000.00	$12,994,222.20	77.4%
05146040	PERM CTB (SSCB)(TY 3)(MOD)	LF	$360.00	330.000	$118,800.00	$13,113,022.20	78.1%
01106001	EXCAVATION (ROADWAY)	CY	$5.50	20,121.000	$110,665.50	$13,223,687.70	78.8%
05066002	ROCK FILTER DAMS (INSTALL) (TY 2)	LF	$33.00	3,330.000	$109,890.00	$13,333,577.70	79.5%

Sorting & Mapping Process: a multi-step process (Summary)

- Sort & Map pay items in monthly estimate (or estimate and quantity sheet) to work activities in schedule:



Mapping Items from the E&Q or Estimate to the Schedule

- Mapping Items

Independent

2. Consider a pay item as an activity

Combined

2. Combine similar pay items into one activity

Else

2. Break down pay items into one or multiple activities

Schedule Activities

A1210	INSTALL TEMP SPEC SHORING @ 468 - US	SF
A1220	INSTALL DBL 7X7 BOX CULV @ 468 - US	LF
A1230	CONST WINGWALL @ 468 - US	EA
A1235	PLACE ROCK RIPRAP @ 468 - US	CY
A1240	INSTALL TEMP SPEC SHORING @ 468 - DS	SF
A1250	INSTALL DBL 7X7 BOX CULV @ 468 - DS	LF
A1260	CONST WINGWALL @ 468 - DS	EA
A1270	PLACE ROCK RIPRAP @ 468 - DS	CY
A1280	INSTALL PIPE CROSSINGS NB	LF
A1290	DRIVEWAYS AND PIPE/SET'S	SY
A1295	EARTHWORK	CY
A1300	8" CEMENT TREATED SUBGRADE	SY
A1310	10" SUPERPAVE BASE	TON
A1320	OCST	GAL
A1330	2" SUPERPAVE SURFACE	TON
A1340	PAVEMENT MARKINGS	LS

A1520	LEVELING PADS - WALLS A, B, & C	LF
A1530	CONST WALL C	SF
A1540	CONST WALL A	SF
A1550	CONST WALL B	SF
A1560	SET COPING - WALLS A, B, & C	LF
A1570	LEVELING PADS - WALLS D & E	LF
A1580	CONST WALL D	SF
A1590	CONST WALL E	SF
A1600	SET COPING - WALLS D & E	LF

Contract Items

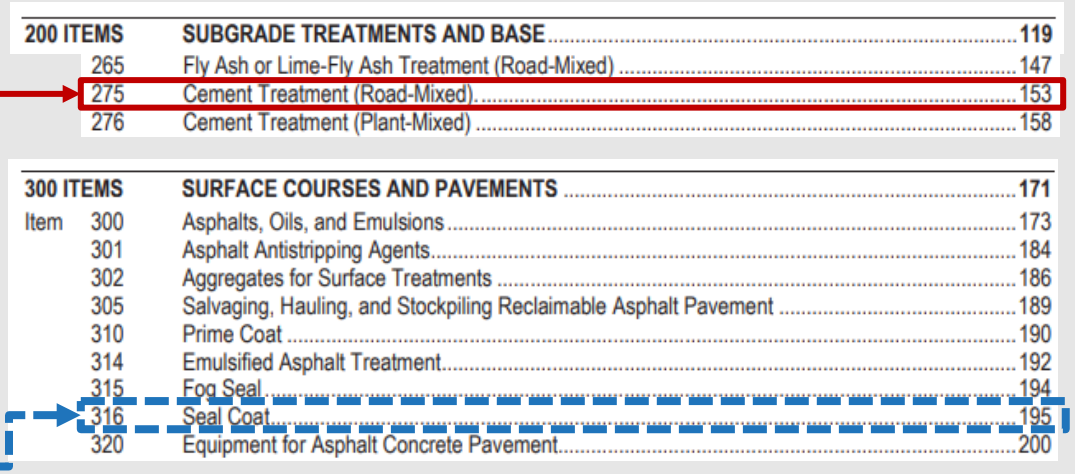
ITEM CODE	DESCRIPTION	UNIT
03446034	SUPERPAVE MIXTURES SP-C PG64-22	TON
04236001	RETAINING WALL (MSE)	SF
05006001	MOBILIZATION	LS
04256038	PRESTR CONC GIRDER (TX46)	LF
03446172	SUPERPAVE MIXTURES SP-C PG64-22(LEV-UP)	TON
04226001	REINF CONC SLAB	SF
03446047	SUPERPAVE MIXTURES SP-C SAC-A PG70-22	TON
01326006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY
05126005	PORT CTB (FUR & INST)(F-SHAPE)(TY 1)	LF
04326001	RIPRAP (CONC)(4 IN)	CY
05086001	CONSTRUCTING DETOURS	SY
04506014	RAIL (TY T551)	LF
04016001	FLOWABLE BACKFILL	CY
04166004	DRILL SHAFT (36 IN)	LF
04326036	RIPRAP (STONE PROTECTION)(30 IN)	CY
04626018	CONC BOX CULV (7 FT X 7 FT)	LF
04326002	RIPRAP (CONC)(5 IN)	CY
01006002	PREPARING ROW	STA
04206029	CL C CONC (CAP)	CY
01106003	EXCAVATION (SPECIAL)	CY
05456001	CRASH CUSH ATTEN (INSTL)	EA
02756001	CEMENT	TON
01646054	BOND FBR MTRX SEED (PERM)(RURAL)(SAND)	SY
06816001	TEMP TRAF SIGNALS	EA
05146040	PERM CTB (SSCB)(TY 3)(MOD)	LF
01106001	EXCAVATION (ROADWAY)	CY
05066002	ROCK FILTER DAMS (INSTALL) (TY 2)	LF

Mapping Process: A starting point.

- Combine similar pay items into one activity
  - Using Experiences and Judgements
  - Using the First Four Digits of Item Code

ITEM CODE	DESCRIPTION
01006002	PREPARING ROW
01046017	REMOVING CONC (DRIVEWAYS)
01106001	EXCAVATION (ROADWAY)
01326005	EMBANKMENT (FINAL)(ORD COMP)(TY C)
01346002	BACKFILL (TY B)
01646041	DRILL SEEDING (TEMP) (WARM)
02476057	FL BS (CMP IN PLC)(TYE GR1-2)(FNAL POS)
02756001	CEMENT
02756002	CEMENT TREAT (EXIST MATL) (6")
03106009	PRIME COAT (MC-30)
03166249	AGGR(TY-PE GR-4 SAC-B)
03166400	ASPH (AC-15P OR AC-10-2TR OR CRS-2P)
03416010	D-GR HMA TY-B PG70-22

Example of Pay Items in Estimates



200 ITEMS		SUBGRADE TREATMENTS AND BASE	119
	265	Fly Ash or Lime-Fly Ash Treatment (Road-Mixed)	147
	275	Cement Treatment (Road-Mixed)	153
	276	Cement Treatment (Plant-Mixed)	158
300 ITEMS		SURFACE COURSES AND PAVEMENTS	171
Item	300	Asphalts, Oils, and Emulsions	173
	301	Asphalt Antistripping Agents	184
	302	Aggregates for Surface Treatments	186
	305	Salvaging, Hauling, and Stockpiling Reclaimable Asphalt Pavement	189
	310	Prime Coat	190
	314	Emulsified Asphalt Treatment	192
	315	Fog Seal	194
	316	Seal Coat	195
	320	Equipment for Asphalt Concrete Pavement	200

Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (TxDOT, 2014)

Reference for Mapping

- Create a list or use your own knowledge to consider which items might map to certain activities.
  - Controlling Activities for Highway Rehabilitation Projects in Texas DOT

No.	Major Work Items
1	Initial traffic control
2	Detour
3	ROW Preparations
	A. Major Structure demolition
	B. Clear and grub
	C. Remove old structures (small)
	D. Remove old pavement
	E. Remove old curb & gutter
	F. Remove old sidewalks
	G. Remove old drainage/ utility structures
4	Excavation/ embankment
	A. Earth excavation
	B. Rock excavation
	C. Embankment
5	Bridge structures
	A. Erect temporary bridge
	B. Bridge demolition
	C. Cofferdams
	D. Piling
	E. Footings
	F. Columns, Caps and Bents
	G. Wingwalls
	H. Beams (erection only)
	I. Bridge deck (total depth)
	J. Bridge curbs/ walks
	K. Bridge handrails
	L. Remove temporary bridge
6	Retaining walls
7	Base preparations
	A. Lime stabilizations
	B. Flexible base material
	C. Cement treated base material
8	New curb and gutter
9	Hot Mix asphalt base
10	Concrete paving
11	Hot mix asphalt surface
12	Precast traffic barriers
13	Permanent signing and traffic signals
	A. Small signs
	B. Overhead signs
	C. Major traffic signals
14	Seeding and landscape
15	Pavement markings
16	Final clean up

Bridge	
A1020	EB Drill Shaft
A1040	EB Columns
A1030	WB Drill Shaft
A1050	WB Columns
A1070	Saw Cut Demo: Phase 1
A1080	Demo: Phase 1
A1090	Abutment 1 & 2: Phase 1
A1100	Bent Caps: 2 - 10
A1180	Pan Girder
A1200	Approach Slab
A1190	T-411 Rail

Hancher, D.E., McFarland, W., and Alabay, R.T. (1992). Construction Contract Time Determination. Texas A&M University System Research Report 1262-1F, College Station, TX: Texas Transportation Institute.

3. PRODUCTION RATE AND DURATION CHECKING

Production Rate Checking

- **Article 8.5.2** requires the contractor to provide production rates on schedule submissions.
- Sometimes this does not happen, but it should be pretty easy to calculate.

user_text1	Activity ID	Activity Name	Unit	Plan Qty	Orig P/R	OD	RD	Start	Finish	Float
PARKER SH 199 - 0171-03-067 - 128 Wk Days				**401047.00**		**128d**	**128d**	**Jul-09-2018 07 AM**	**Jan-08-2019 05 PM**	**0d**
GENERAL				6.00		128d	128d	Jul-09-2018 07 AM	Jan-08-2019 05 PM	0d
01	MS101	TIME CHARGES COMMENCE (MILESTONE)				0d	0d	Jul-09-2018 07 AM		0d
02	502-6011	PROJECT TIME (LOE)	MO	6.00		128d	128d	Jul-09-2018 07 AM	Jan-08-2019 05 PM	0d
CONSTRUCTION				401041.00		128d	128d	Jul-09-2018 07 AM	Jan-08-2019 05 PM	0d
01	MS102	CONSTRUCTION COMMENCEMENT (MILESTONE)				0d	0d	Jul-09-2018 07 AM		0d
05	500-6001	MOBILIZATION	LS	1.00		2d	2d	Jul-09-2018 07 AM	Jul-10-2018 05 PM	0d
06	502-6001	BARRICADES, SIGNS AND TRAFFIC HANDLING (LOE)	MO	6.00		128d	128d	Jul-09-2018 07 AM	Jan-08-2019 05 PM	0d
07	6001-6001	PORTABLE CHANGEABLE MESSAGE SIGN (LOE)	DAY	250.00		128d	128d	Jul-09-2018 07 AM	Jan-08-2019 05 PM	0d
08	506-641	BIODEG EROSN CONT LOGS (INSTL) (12")	LF	200.00	200	1d	1d	Jul-11-2018 07 AM	Jul-11-2018 05 PM	0d
09	354-6002-1	PLAN & TEXT ASPH CONC PAV(0" TO 2") 1	SY	116791.00	5839.55	20d	20d	Jul-11-2018 07 AM	Aug-07-2018 05 PM	0d
09.5	354-6002-2	PLAN & TEXT ASPH CONC PAV(0" TO 2") 2	SY	116791.00	5839.55	20d	20d	Aug-08-2018 07 AM	Sep-05-2018 05 PM	0d
10	662-ALL-1	WORK ZONE STRIPING -ALL	LS	1.00	0.04	40d	40d	Jul-11-2018 07 AM	Sep-05-2018 05 PM	0d
11	351-6006	FLEXIBLE PAVEMENT STRUCTURE REPAIR(10")	SY	5500.00	687.50	8d	8d	Sep-06-2018 07 AM	Sep-17-2018 05 PM	0d
12	341-6278	D-GR HMA TY D PG 70-28(LEV-UP)(LTX ADD)	TON	1000.00	1000	4d	4d	Sep-18-2018 07 AM	Sep-21-2018 05 PM	0d
13	662-ALL-2	WORK ZONE STRIPING - ALL	LS	1.00	1	1d	1d	Sep-21-2018 07 AM	Sep-21-2018 05 PM	0d
14	341-6276-1	D-GR HMA TY-D SAC-B PG70-28 (LATEX ADD) 1	TON	16350.00	817.50	20d	20d	Sep-24-2018 07 AM	Oct-19-2018 05 PM	0d
14	341-6276-2	D-GR HMA TY-D SAC-B PG70-28 (LATEX ADD) 2	TON	13080.00	817.50	16d	16d	Oct-22-2018 07 AM	Nov-12-2018 05 PM	0d

- It is sometimes challenging to determine a production rate when the contractor combines several pay items into a single work activity.

Production Rate Checking

- Compare the production rates and the proposed production rates of TxDOT
  - In accordance with the 2016-2017 Sunset Advisory Commission Staff Report Recommendation 3.7, TxDOT has updated construction production rate information based on analysis of survey data from the Texas districts. This value is updated every two years in March.

Texas Department of Transportation

2022 Construction Production Rates

LINE NO.	MAJOR WORK ITEMS	UNITS	Production Rates		
			LOW	MED	HIGH
	100 ITEMS				
1	PREPARING ROW	AC	1	3	6
2	REMOVING CONC PAV	SY	1,000	2,000	3,000
3	REMOVING CONC	CY	25	100	250
4	REMOVING STAB BASE AND ASPH	SY	1,500	3,000	4,500
5	REMOVING STAB BASE AND ASPH	CY	500	900	1,250
6	EXCAVATION (ROADWAY)(EARTH)	CY	500	2,000	3,500
7	EXCAVATION (ROADWAY)(ROCK)	CY	250	1,000	1,500
8	EMBANKMENT	CY	500	2,000	4,000
10	SEEDING/SOD	SY	800	2,000	3,500
	200 ITEMS				
11	FLEX BASE	CY	350	750	1,250
12	REWORK BS MTL	CY	250	500	750
13	LIME TRT	SY	500	2,500	4,000
14	CEMENT TREAT	SY	1,500	2,500	3,000
15	ASPHALT STAB BASE (PLANT PRODUCED)	TON	300	750	1,250
	300 ITEMS				

Source Link: https://ftp.dot.state.tx.us/pub/txdot/cst/cst-production-rates.pdf

Production Rate Checking

- If production rate is not included, the value is calculated by the formula below.

$$\text{Production Rate} = \frac{\text{Total estimated quantity of the activity}}{\text{Activity Duration}}$$

3) Production Rate

1) Quantity

2) Duration

1) **Quantity** from mapping process

AGGREGATED ITEMS	UNIT	UNIT PRICE	BID QUANTITY	TOTAL PRICE
DRILL SHAFT	LF	$ 340	1180.000	$ 158,620

2) **Duration**

Activity ID	Activity Name	BL1 Duration	Original Duration	Actual Duration	Start	Finish
Bridge		116	116	0	30-Nov-12	15-May-13
A1020	EB Drill Shaft	11	11	0	30-Nov-12	14-Dec-12
A1040	EB Columns	11	11	0	04-Dec-12	18-Dec-12
A1030	WB Drill Shaft	16	16	0	17-Dec-12	10-Jan-13

3) **Production Rate**

- The production rate of Drill Shaft = 1180/(11+16) = 43.7

Revision Date: 31-Mar-20 | Page 1 of 2

LINE NO.	MAJOR WORK ITEMS	UNITS	Proposed Production Rates		
			LOW	MED	HIGH
400 ITEMS					
27	Temp Special Shoring/Cofferdams	SF	100	500	900
28	Soil Nails/Rock Nails	LF	200	400	700
29	Drilled Shafts	LF	30	100	200

Construction Production Rates (TxDOT, 2020)

Activity Duration Checking

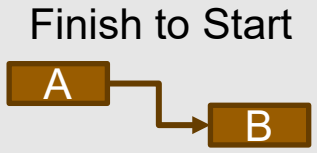
- Check whether durations of work activities are appropriate for the length and complexity of work.

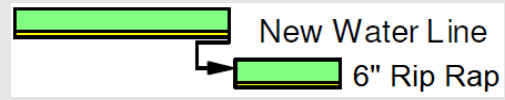
- Remember "**1/20 Rule**":
  - If work package takes less than **a working day ~ too small**
  - If work package takes longer than **1 month of real working days ~ too large**
    - **Article 8.5.2** in the Standard Specifications **maximizes** and activity duration **at 20 working days**

4. ACTIVITY RELATIONSHIP ASSESSMENT

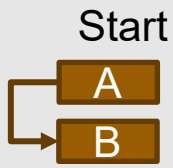
Four Types of Logical relationships

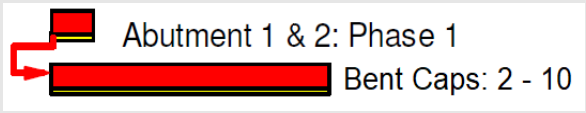
- **Finish to Start (FS)**
  - Activity A must Finish before activity B can Start



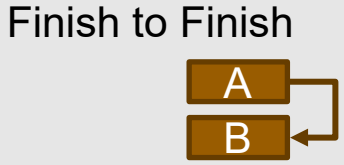


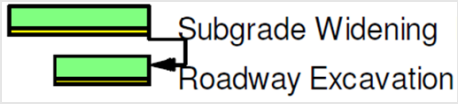
- **Start to Start (SS)**
  - Activity A must Start before activity B can Start



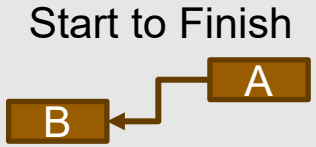


- **Finish to Finish (FF)**
  - Activity A must Finish before activity B can Finish





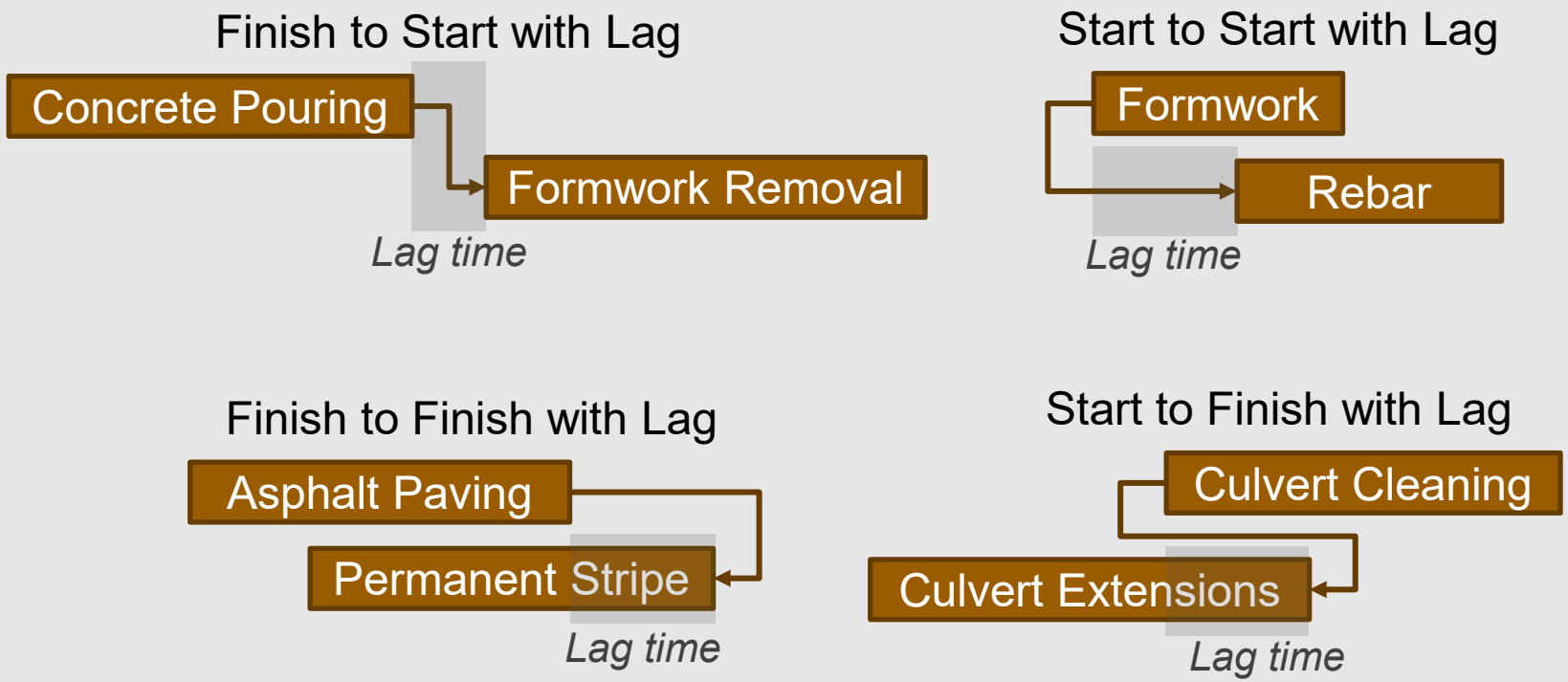
- **Start to Finish (SF)**
  - Activity A must Start before activity B Finishes



Rare for highway projects

Lag Time

- A lag time is the amount of time whereby a successor activity is required to be delayed with respect to a predecessor activity (PMBOK Guide, 6th Ed., 2017).



5. CRITICAL PATH IDENTIFICATION AND CHECKING

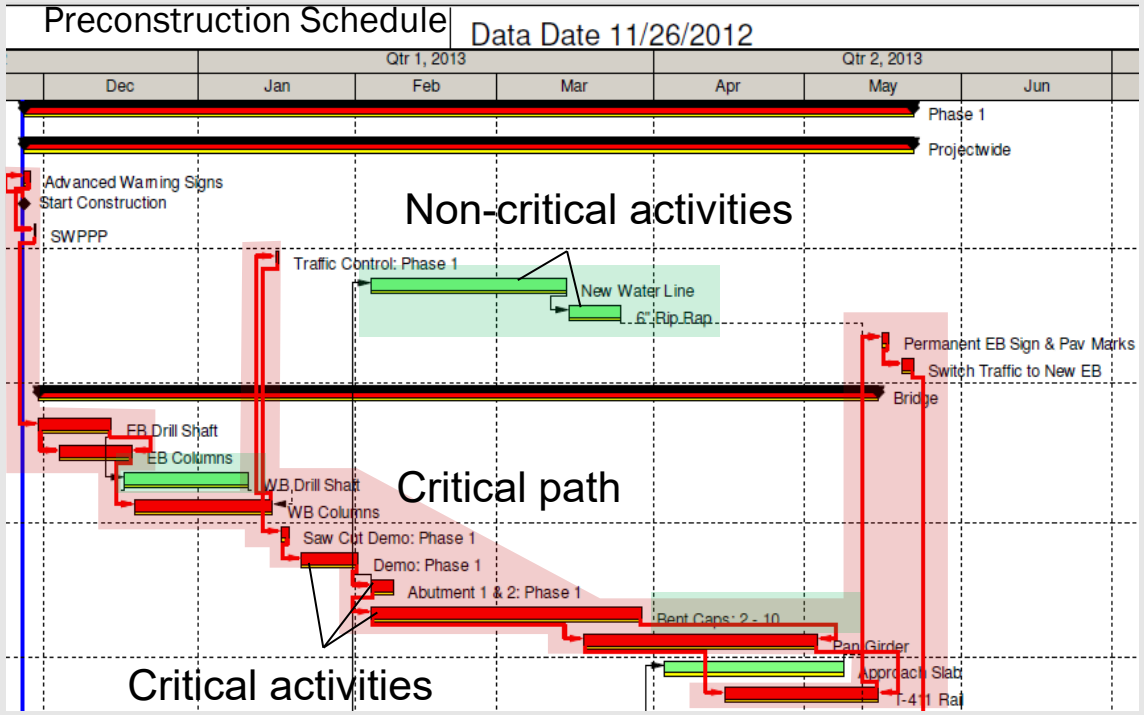
Critical Path Method (CPM) Scheduling

- Basic Information
  - Critical path is the longest chain of dependent activities by which the duration of the chain accounts for the total project duration
  - An activity in the critical path is called a critical activity
  - Any delay in each critical activity would lead to a delay in the end date of the project

- Components of Critical Path
  - A list of all activities (i.e., WBS) required to complete the project
  - The duration that each activity will take to complete
  - The logical relationships between the activities
  - Logical end points such as milestones or deliverable items

Critical Path Identification and Checking (1/2)

- In a **preconstruction schedule**, critical activities that are included in the critical path are identified and their reasonableness is assessed.

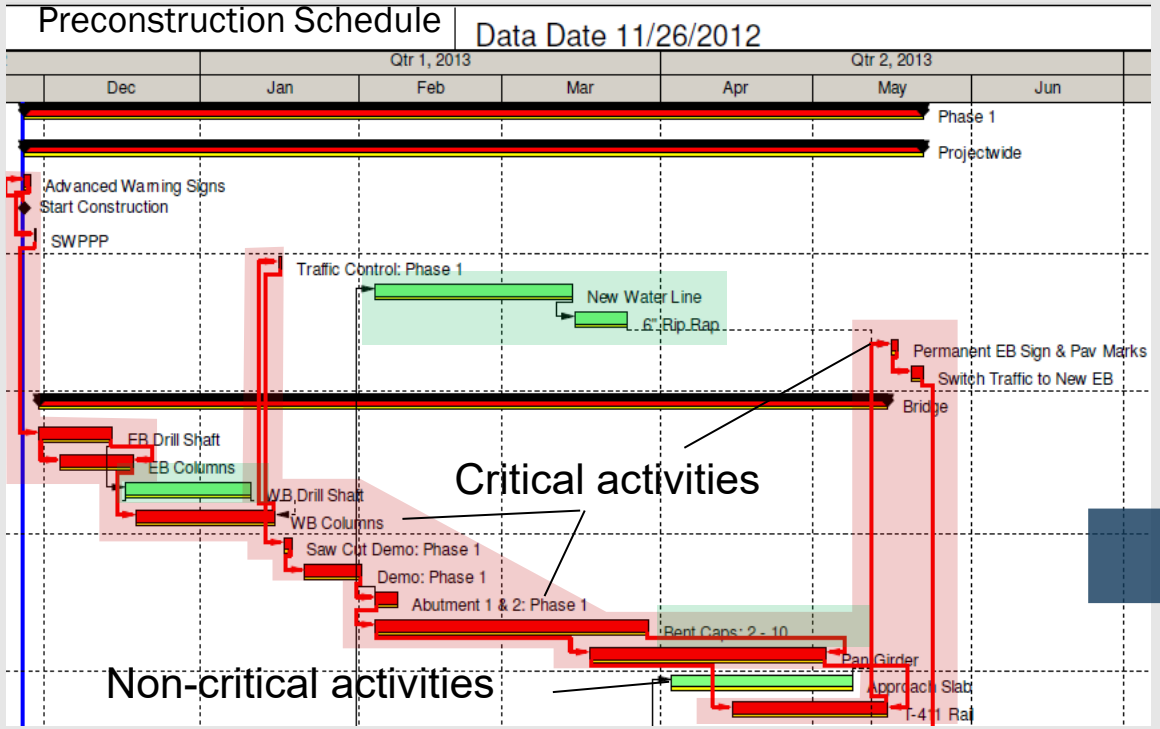


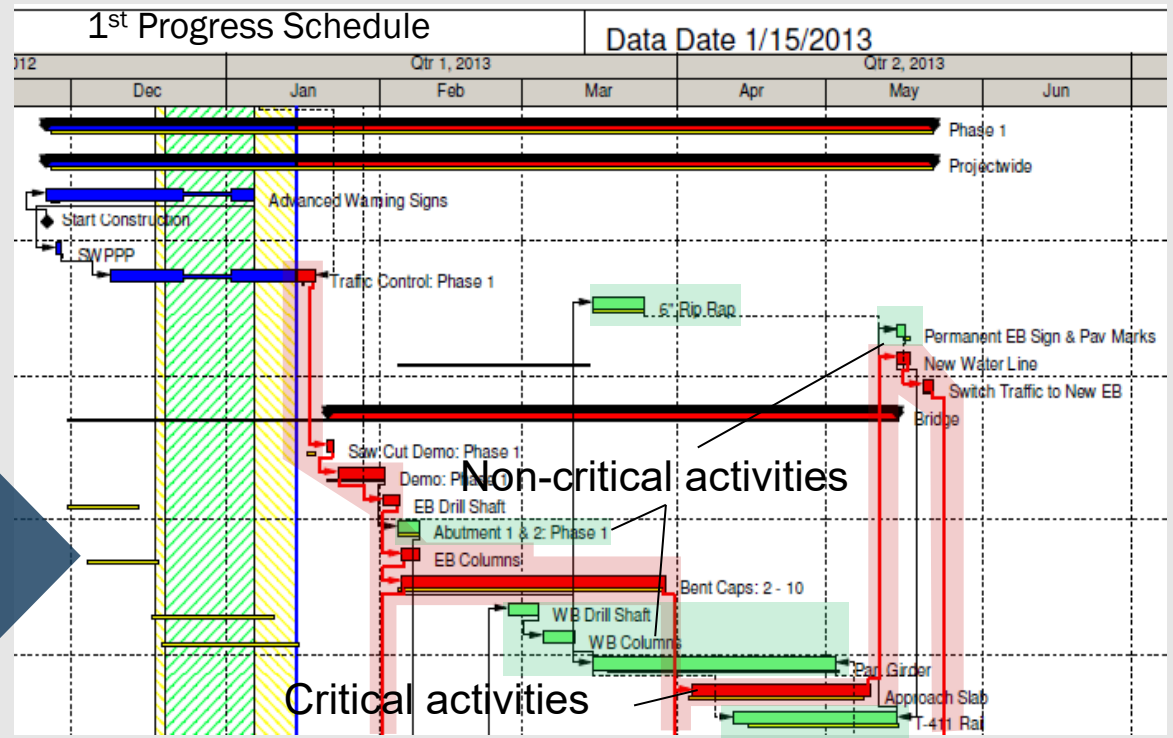
List of critical activities

- Advanced Warning Signs
- SWPPP
- EB Drill Shaft
- EB Columns
- WB Columns
- Saw Cut Demo: Phase 1
- Demo: Phase 1
- Abutment 1 & 2: Phase 1
- Bent Caps: 2 – 10
- Pan Girder
- T-411 Rail
- Permanent EB Sign & Pav Marks
- Switch Traffic to New EB

Critical Path Identification and Checking (2/2)

- In **progress schedules**, changes in critical activities and the critical path are identified and their reasonableness is assessed.

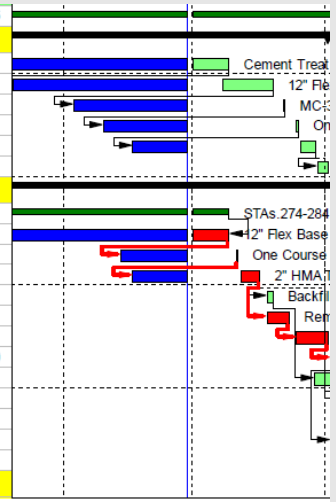




6. SCHEDULE-MONTHLY ESTIMATE AGREEMENT

What you need for monthly updates:

1000	Project Duration	11-Jul-18 A	15-Aug-19	26
Phase II				
1140	Cement Treat Subgrade	13-May-19 A	09-Jul-19	5
1150	12" Flex Base	20-May-19 A	19-Jul-19	8
1160	MC-30 Prime Coat	03-Jun-19 A	22-Jul-19	1
1170	One Course Seal	10-Jun-19 A	25-Jul-19	1
1180	2" HMA Type D	17-Jun-19 A	29-Jul-19	2
1190	Backfill & Dress Slopes	30-Jul-19	01-Aug-19	2
Phase I				
2130	STAs.274-284, 305-329	02-Apr-19 A	09-Jul-19	5
2180	12" Flex Base	01-May-19 A	09-Jul-19	5
2280	One Course Seal	14-Jun-19 A	11-Jul-19	1
2290	2" HMA Type D	17-Jun-19 A	16-Jul-19	3
2300	Backfill & Dress Slopes	18-Jul-19	19-Jul-19	2
2310	Remove ASB	18-Jul-19	23-Jul-19	4
2320	Remove Concrete Pavement	25-Jul-19	01-Aug-19	5
2330	Compost & Revegetation	02-Aug-19	19-Aug-19	10
2340	Remove PCTB	29-Jul-19	02-Aug-19	4
2350	2" HMA Type D Surface	05-Aug-19	08-Aug-19	3
2370	Pavement Markings & Rum	09-Aug-19	15-Aug-19	4
2380	Permanent Signage	02-Aug-19	13-Aug-19	7
2390	PROJECT COMPLETE		15-Aug-19	0
(No WBS)				



Last Month's Schedule Update

Did the contractor do what they planned to do?

LINE NBR	ITEM CODE	SP NBR	DESCRIPTION	UNIT	UNIT PRICE	QTY THIS ESTIMATE	AMOUNT PAID THIS ESTIMATE
0105	01616017	000	COMPOST MANUF TOPSOIL (4")	SY	1.300	16,451.110	$21,386.44
0115	01646042	000	DRILL SEEDING (TEMP) (WARM)	AC	403.000	3.400	$1,370.20
0123	01646046		STRAW OR HAY MULCHING	AC	980.500	3.400	$3,333.70
0165	03416040	000	D-GR HMA TY-D PG64-22	TON	95.000	493.980	$46,928.10
0170	03416042	000	D-GR HMA TY-D SAC-B PG70-22	TON	108.000	1,460.890	$157,776.12
0275	05086001	000	CONSTRUCTING DETOURS	SY	42.400	414.220	$17,562.93
0285	05126029	000	PORT CTB (MOVE)(F-SHAPE)(TY 1)	LF	5.000	3,120.000	$15,600.00
0315	05456003	000	CRASH CUSH ATTEN (MOVE & RESET)	EA	1,300.000	3.000	$3,900.00

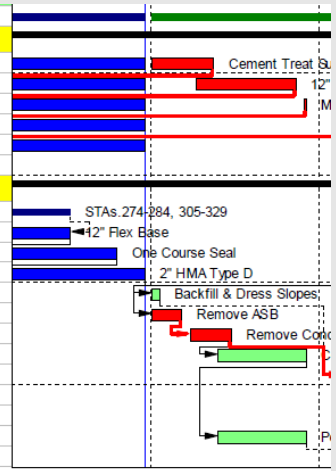
CATEGORY 002 DESCRIPTION BRIDGE

LINE NBR	ITEM CODE	SP NBR	DESCRIPTION	UNIT	UNIT PRICE	QTY THIS ESTIMATE	AMOUNT PAID THIS ESTIMATE
0495	04326006	000	RIPRAP (CONC)(CL B)	CY	500.000	7.000	$3,500.00

TOTAL ITEM EARNINGS THIS ESTIMATE $271,357.49

Monthly Estimate

1000	Project Duration	11-Jul-18 A	23-Sep-19	30
Phase II				
1140	Cement Treat Subgrade	13-May-19 A	12-Aug-19	7
1150	12" Flex Base	20-May-19 A	27-Aug-19	11
1160	MC-30 Prime Coat	03-Jun-19 A	29-Aug-19	1
1170	One Course Seal	10-Jun-19 A	03-Sep-19	1
1180	2" HMA Type D	17-Jun-19 A	10-Sep-19	2
1190	Backfill & Dress Slopes	12-Sep-19	13-Sep-19	2
Phase I				
2130	STAs.274-284, 305-329	02-Apr-19 A	17-Jul-19 A	0
2180	12" Flex Base	01-May-19 A	17-Jul-19 A	0
2280	One Course Seal	14-Jun-19 A	25-Jul-19 A	0
2290	2" HMA Type D	17-Jun-19 A	31-Jul-19 A	0
2300	Backfill & Dress Slopes	01-Aug-19	02-Aug-19	2
2310	Remove ASB	01-Aug-19	06-Aug-19	4
2320	Remove Concrete Pavement	08-Aug-19	15-Aug-19	5
2330	Compost & Revegetation	13-Aug-19	29-Aug-19	10
2340	Remove PCTB	05-Sep-19	10-Sep-19	4
2350	2" HMA Type D Surface	12-Sep-19	16-Sep-19	3
2370	Pavement Markings & Rum	17-Sep-19	23-Sep-19	4
2380	Permanent Signage	13-Aug-19	29-Aug-19	10
2390	PROJECT COMPLETE		23-Sep-19	0



Current Schedule Update

Did TxDOT pay the contractor for work completed?

Is the planned work reasonable?

Key Checkpoints

- 1. Check whether a missing activity in the schedule or a missing item in the estimate exists.
- 2. Check whether the work progress is consistent with the payment amount.
- 3. Check the planned activities for next month are reasonable.
- 4. Compare the production rate in the progress schedule to that in the preconstruction schedule when major changes occur.

Data Date: Jul-25-2018 PARKER

Activity ID	Activity Name	Unit	Plan Qty	Cmpltd Phs Qty	Orig P/R	OD	Actual	RD	Start	Finish	Float
PARKER SH 199 - 0171-03-067 - 128 Wk I			435828.39			129d	14d	92d	Jun-14-2018 A	Dec-04-2018	0d
GENERAL			6.00			129d	14d	92d	Jun-14-2018 A	Dec-04-2018	0d
MS101	TIME CHARGES COMMENCE (MILESTONE)					0d	0d	0d	Jun-14-2018 A		
502-6011	PROJECT TIME (LOE)	MO	6.00			128d	14d	92d	Jun-14-2018 A	Dec-04-2018	0d
TS101	TIME SUSPENSION 1 (TXDOT APPROVED)					0d	0d	0d	Jun-14-2018 A	Jul-09-2018 A	
CONSTRUCTION			435822.39			129d	14d	92d	Jul-09-2018 A	Dec-04-2018	0d
MS102	CONSTRUCTION COMMENCEMENT (MILESTONE)					0d	0d	0d	Jul-09-2018 A		
500-6001 (A)	MOBILIZATION	LS	1.00	1		2d	1d 5h	0d	Jul-09-2018 A	Jul-10-2018 A	
500-6001 (B)	MOBILIZATION	LS	0.25			0d 5h	0d	0d 5h	Jul-26-2018	Jul-26-2018	91d 5h
502-6001	BARRICADES, SIGNS AND TRAFFIC HANDLING (LO	MO	6.00			128d	14d	92d	Jul-09-2018 A	Dec-04-2018	0d
6001-6001	PORTABLE CHANGEABLE MESSAGE SIGN (LOE)	DAY	250.00			128d	14d	92d	Jul-09-2018 A	Dec-04-2018	0d
506-641	BIODEG EROSN CONT LOGS (INSTL) (12")	LF	200.00		200	1d	0d	1d	Jul-26-2018	Jul-26-2018	91d
354-6002-1	PLAN & TEXT ASPH CONC PAV(0" TO 2") 1	SY	116791.00	116791	5839.55	20d	5d	0d	Jul-09-2018 A	Jul-13-2018 A	
354-6002-2 (A)	PLAN & TEXT ASPH CONC PAV(0" TO 2") 2	SY	116791.00	82009.94	5839.55	20d	3d	0d	Jul-16-2018 A	Jul-18-2018 A	
354-6002-2 (B)	PLAN & TEXT ASPH CONC PAV(0" TO 2") 2	SY	34781.00		5839.55	6d	0d	6d	Jul-26-2018	Aug-02-2018	0d
662-ALL-1 (A)	WORK ZONE STRIPING -ALL	LS	1.00	.86	0.04	40d	9d	0d	Jul-09-2018 A	Jul-18-2018 A	
662-ALL-1 (B)	WORK ZONE STRIPING -ALL	LS	0.14		0.04	5d 6h	0d	5d 6h	Jul-26-2018	Aug-02-2018	0d

Schedule

CONTRACT ID 017103067 ESTIMATE 0002 CONTRACTOR'S ESTIMATE PACKAGE Page 3 of 6

WORK PERFORMED THIS PERIOD

PROJECT NH 2018(745) CONTROL 017103067

CATEGORY 001 DESCRIPTION ALL ITEMS

LINE NBR	ITEM CODE	SP NBR	DESCRIPTION	UNIT	UNIT PRICE	QTY THIS ESTIMATE	AMOUNT PAID THIS ESTIMATE	Total Bid Quantity	QTY Paid To Date
0075	03546002	000	PLAN & TEXT ASPH CONC PAV(0" TO 2")	SY	1.190	198,800.940	$236,573.12	233,582.00	198,800.94
0085	05006001	000	MOBILIZATION	LS	172,000.000	0.750	$129,000.00	1.00	0.90
0090	05026001	000	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	3,750.000	1.000	$3,750.00	6.00	6.00
0150	06626001	000	WK ZN PAV MRK NON-REMOV (W)4"(BRK)	LF	0.150	880.000	$132.00	1,520.00	880.00
0155	06626004	000	WK ZN PAV MRK NON-REMOV (W)4"(SLD)	LF	0.150	97,541.000	$14,631.15	98,546.00	97,541.00
0160	06626012	000	WK ZN PAV MRK NON-REMOV (W)8"(SLD)	LF	0.320	872.000	$279.04	1,700.00	872.00
0175	06626032	000	WK ZN PAV MRK NON-REMOV (Y)4"(BRK)	LF	0.150	9,320.000	$1,398.00	7,650.00	15,150.00
0180	06626034	000	WK ZN PAV MRK NON-REMOV (Y)4"(SLD)	LF	0.150	73,992.000	$11,098.80	98,546.00	130,480.00
0185	06626109	000	WK ZN PAV MRK SHT TERM (TAB)TY W	EA	0.800	239.000	$191.20	5,400.00	600.00
0190	06626111	000	WK ZN PAV MRK SHT TERM (TAB)TY Y-2	EA	0.800	92.000	$73.60	80.00	2,559.00
0250	60016001	000	PORTABLE CHANGEABLE MESSAGE SIGN	DAY	95.000	48.000	$4,560.00	250.00	208.00

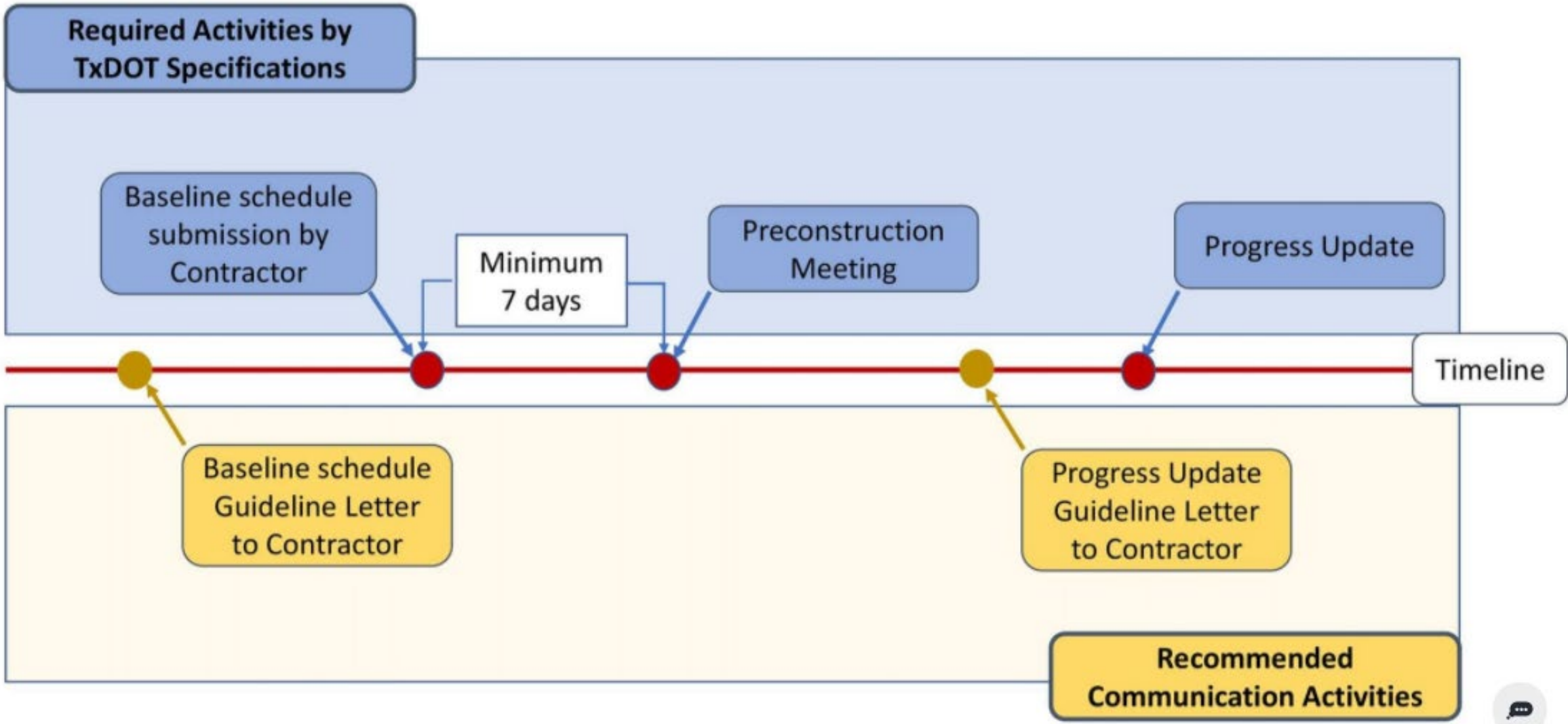
TOTAL ITEM EARNINGS THIS ESTIMATE $401,686.91

Monthly Estimate

BASIC CONSTRUCTION SCHEDULE ANALYSIS

Implementation

Recommended Communication Protocol



Proactive Letters

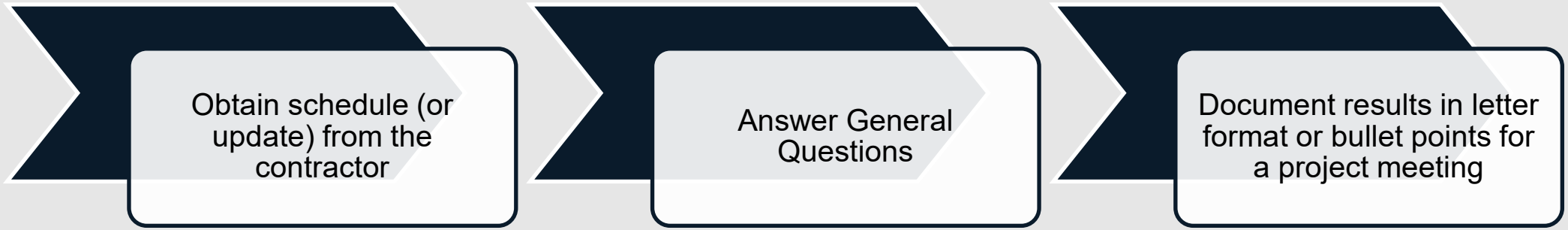
- Preconstruction/Baseline Schedule Guideline letter to the contractor
  - Sent prior to the preconstruction meeting with enough time for the contractor to implement during schedule creation
  - Remind the contractor what is required in the Specifications
  - Set the expectations for schedule submissions
  - Establish the expectations for your office for schedule review

- Progress Update Guideline letter to the contractor
  - Sent prior to the creation of the first estimate
  - Remind the contractor what is required in monthly updates
  - Set the expectations for schedule updates
  - Provide your office with a baseline for review items

The Analysis Process

- Proactive is great, but in reality you still manage projects.
  - Requires a THOROUGH preconstruction/baseline schedule analysis
  - Requires monthly analysis of contractor updates
  - Requires engaging with the contractor to address schedule concerns
  - Vital for using the schedule as a project management tool
  - Helpful in establishing good documentation for time impacts or other disputes
- Use General Questions as a starting point for analysis
  - General Questions for preconstruction/baseline schedule analysis
  - General Questions for monthly update analysis

Engage the Contractor



Thank you!
Please remember to use the Qualtrics links in your email to take the surveys for today's materials.