

CFL Guidelines for Developing Critical Path Method Schedules (CPMs)

Table of Contents

SECTION 1 INTRODUCTION

- 1.1 Purpose and Background for Construction Schedules
- 1.2 Construction Schedule Submittal Guidelines

SECTION 2 ELEMENTS IN DETERMINING CONTRACT TIME

- 2.1 Production Rates
- 2.2 Other Factors Affecting Contract Times

SECTION 3 STEPS FOR CREATING CPM CONSTRUCTION SCHEDULES

- 3.1 Define Work Day
- 3.2 Define the Project Calendar and Task Calendar
- 3.3 Identify, Group and Sequence the Activities
- 3.4 Set Activity Durations
- 3.5 Link Activities
- 3.6 Documentation
- 3.7 Modify the Construction Schedule
- 3.8 Review CPM Schedule with the CFT

SECTION 4 USING MICROSOFT PROJECT

- 4.1 Create a New CPM Schedule
- 4.2 Define the Project
 - 4.2.1 Environmental/Seasonal Restrictions Using Project Calendars
- 4.3 Input and Organize the Project Activities and Data
- 4.4 Link the Tasks/Activities
- 4.5 Activity Constraints
- 4.6 View and Print the Schedule

SECTION 5 ADDITIONAL RESOURCES AND INFORMATION

- 5.1 CPM Schedules
- 5.2 Microsoft Project
- 5.3 Production Rates
- 5.4 Terms and Definitions
- 5.5 Contract Time and Schedule Checklist Items

1. INTRODUCTION

1.1 Purpose and Background for Construction Schedules

Construction schedules for our projects are used to determine reasonable and accurate contract time for construction. Contract time is the maximum time allowed in the contract for completion of all work contained in the contract documents.

A construction schedule will establish the number of days needed to complete the project. This will help CFL in planning during the development of the project. It will help construction management teams with time frames for staffing a project, for public notifications and help determining warranted closures. It will help in determining construction sequencing, phasing, milestones or alternate bid schedules. It will help to develop funding for Construction Engineering (CE) costs during constructions, and it will also provide background support during reviews of Contractor submitted construction schedules.

If contract time is insufficient to complete the work, bid prices may be higher and there may be an unusual number of time overruns and contractor claims. Contractors should be provided the ability to schedule work to maximize equipment and labor. If contract time is too short, these efficiencies are more difficult to obtain resulting in higher prices.

If the time allowed is excessive, there may be cost inefficiencies by the contractor. The public may be inconvenienced unnecessarily and subjected to traveling on an unsafe roadway for an extended period of time. Excessive contract time can also significantly reduce the efficiency of CFL construction staffing efforts.

In establishing contract time, strive for the shortest practical traffic interruptions to the road user. If the time set is such that all work on a project may be stopped for an extended period (not including necessary winter shutdowns) and the contractor can still complete the project on schedule, it means the contract time allowed was excessive.

Important Note:

The purpose of the Designer's construction schedule is to determine the number of days that is reasonable to complete the work. The schedule may be used as a reference by the Construction staff. The construction schedule generated by the CFL Designer is usually not used by the Contractor. However, it can be requested during Freedom of Information Act reviews and often scrutinized by attorneys and expert witnesses during depositions and legal proceeding.

1.2 Construction Schedule Submittal Guidelines

For typical projects, create the first construction schedule during the 30% design development. Update the schedule for all remaining PS&E submittals.

The construction schedule should be submitted for review along with PS&E submittals.

2. ELEMENTS IN DETERMINING CONTRACT TIME

2.1 Production Rates

A production rate is the quantity produced or constructed over a specified time period. Estimating realistic production rates is important when determining appropriate contract completion time. Production rates may vary considerably depending on project specific conditions, project size, geographic location, and whether the project is in a rural or urban setting.

To establish accurate production rates, use normal historic rates of efficient contractors. A common method of establishing production rates is to divide the total quantity of an item on previously completed projects by the number of days/hours the contractor used to complete the item. Possible resources for historic production rates and construction performance data include: local state DOT websites, RSMeans Cost Data Books, and the CFLHD Typical [Production Rates spreadsheet](#). See also [Section 5](#) (Additional Resources) for links and information on obtaining established production rates. Typically, when determining production rates, assume 8-hour work days and 5-day work weeks.

Important Note: Many CFL projects will not have 8-hour work days or 5-day work weeks. The production rate used should be adjusted for the project's average work-day for that activity. See example in [Subsection 3.4](#).

Production rates developed by reviewing total quantities and total time are not recommended as they may result in misleading rates which tend to be low since they may include startup, cleanup, interruptions, etc. Base production rates on the desired level of resource commitment practical (labor, crew sizes, equipment, etc.), given project specific conditions and limitations. Representatives of the construction industry are also usually willing to assist in developing rates and time schedules.

Review assumptions and update rates regularly to assure accurate representation of the average rate of production for a specific work item and geographical region. Place an emphasis on production rate accuracy for work activities that will determine project critical path. It is very important to document assumptions and verify production rate accuracy and reasonability with the project Cross Functional Team (CFT).

Adjustments to production rates should be made using engineering judgment based on project specific considerations and restrictions. For example:

Hot Asphalt Concrete Pavement (HACP) production rate:

HACP Paving (max) -	1,980 tons/day (from local DOT)
HACP Paving (min) -	1,320 tons/day (from local DOT)

Starting rate = $(1980 + 1320)/2 = \underline{1,650 \text{ tons/day}}$ (assuming an 8-hr day)

Project Specifics (must document):

Paving in early spring. Due to cold temperatures, reduce to a 6-hr day (11am-5pm).

Remote project location will increase haul times, no temporary batch-plant, reduce to a 5-hr day.

Used/adjusted production rate = $1,650 * 5/8 = \underline{1,030 \text{ tons/day (rounded)}}$

2.2 Other Factors Affecting Contract Times

Some of the following items should be considered when determining contract time:

1. Effects of traffic on scheduling, production rates and the sequence of operations.
2. Curing time and waiting periods between successive paving courses or between concrete placement operations, as well as specified embankment settlement periods.
3. Setup times, mobilization, special equipment required.
4. Seasonal limitations for certain items when determining both the number of days the contractor will be able to work as well as production rates such as: rain, runoff, high water conditions and snow.
5. Conflicting operations of adjacent projects, both public and private.
6. Time for Government review of false-work plans, shop drawings, post-tensioning plans, mix designs, etc.
7. Time for fabrication of structural steel and other specialty items.
8. Lead time to obtain necessary permits.
9. The effect of permitting conditions and/or restrictions.
10. Restrictions for nighttime and weekend operations.
11. Time of the year and/or duration of the project.
12. Additional time for obtaining specialty items or materials with long-lead requirements, such as steel girders, large precast concrete members (example: large culvert sections), treated timber, etc.
13. Delays due to normal seasonal weather.
14. Other client agency specified considerations
15. Project or non-project special events and/or milestones, such as holidays, hunting seasons, local celebrations, local events, etc.
16. Number of crews and crew sizes.
17. Type of project, project accessibility and/or difficulty of work.
18. Environmental Commitments (example: migratory bird restrictions).
19. Construction of temporary works, traffic diversions, dewatering structures, etc.
20. Earthwork type (i.e. rock, clay, sands, etc.)

3. STEPS FOR CREATING CPM CONSTRUCTION SCHEDULES

[CFL Construction Schedule Template](#) (Microsoft Project)

3.1 Define Work Day

Work hours establish the daily work times the contractor could work and may be set for each project and/or task calendar. Use an eight hour workday defined as 8:00 am to 5:00 pm unless there are project specific restrictions or requirements.

See [Subsection 4.2](#) for guidance on how to define the normal working day into Microsoft Project.

3.2 Define the Project Calendar and Task Calendar

The project calendar defines the project’s work and non-work days. Non-work days usually include Saturdays, Sundays, Holidays, and any other contractual non-work days. They may also include local events when they would adversely impact construction. Each project will have its own unique set of restrictions.

A task calendar defines the work and non-work days for a task or activity. If the task can only be performed during a limited time frame, the task calendar would show the work and non-work days. For example, the project calendar shows the project lasting one year, January through December. If seeding and turf establishment must be performed after September 1, then a seeding task calendar would show non-work days from January through August and show work days from September through December. Only one task calendar can be assigned to a specific activity.

It is preferable to incorporate environmental or seasonal restrictions using project and task calendars.

See [Subsection 4.2](#) for guidance on how to define the working calendar and incorporate environmental/seasonal restrictions using calendars in Microsoft Project.

3.3 Identify, Group and Sequence the Activities

A key factor in developing a realistic schedule is to include the right activities. Consider the uniqueness of each project and use engineering judgment. In most cases, it is not necessary to include every bid item in the schedule. For example, the following items generally are not shown: construction schedule, QC/QA plan, Contractor testing and watering. Notice to Proceed (NTP) and Project Closeout should be the first and last activities in a schedule. Once the activities are identified and grouped, determine the general sequence of the activities.

The table below offers guidance for typical activity groupings, inclusions and exclusions in a construction schedule.

Activity	Comment
----------	---------

Staking	Only show staking tasks that are necessary to start the project (e.g., clearing limits and slope stakes). Do not show staking as a continuous activity throughout the project.
Clearing & Grubbing	Show clearing & grubbing work needed in order to commence major construction activities.
Erosion Control	Show items of work that are required to be in-place before clearing or grading operations can begin, such as silt fence.
Earthwork	Break out rock excavation as a separate activity from other earthwork items.
Pavement Structure Items	Combine associated bid items into one work activity (for example: paving). Separate the major pavement structure items such as; base course placement and asphalt paving.
Bridge Activities	Show by phase of construction – survey, submittals, dewatering, foundation, substructure forming & reinforcement, substructure concrete, beams/girders, superstructure reinforcement, superstructure concrete, sidewalk/parapets, bridge railing. Note: do not show by individual bid items.
Subexcavaton	Combine subexcavation, geotextile, and select borrow into one activity
Drainage	Show individual major culverts larger than 48 inches in diameter or box culverts that cause significant impacts to traffic or other operations. Generally, most other drainage items can be combined into one activity and not shown on the construction schedule if they don't substantially impact other operations and can be constructed with other activities.
Turf Establishment	Show as one item. Verify that work occurs in seeding window.
Signing & Striping	Show permanent striping and signing as separate activities
Guardrail	Combine all type of guardrail into one activity. Bridge rail should be shown as a separate item and will generally be the final activity under the Bridge Summary Task

See [Subsection 4.3](#) for guidance on how to input the activities into Microsoft Project.

3.4 Set Activity Durations

Developing activity or grouped activity durations is the most important part of establishing reasonable and accurate schedules. Therefore, it is critical that time, effort, research and thought go into these durations. The production rates will need to be computed based on the average anticipated hours in a work day. That is, activity durations are set on a per day basis not by hour. Therefore, to adjust an activity's duration, always use the ratio of the actual day work hours to the established workday. If the production for HACP was 1,030 tons/day (based on an 8 hour work day) and the contractor was only going to work 6 hour day (limited daylight hours) then the adjusted rate would be:

$1,030 \text{ tons/day} \times 6 \text{ hours} / 8 \text{ hours} = 770 \text{ tons/day (rounded)}$.

The Factors Affecting Contract Time items listed in [Subsection 2.2](#) should be given careful consideration and should be included in calculating activity durations. Documenting your assumptions and reviewing them with the CFT is important to optimizing schedule accuracy.

See [Subsection 4.3](#) for guidance on how to input activity durations and assumptions into Microsoft Project.

3.5 Link Activities

Once all the activities necessary to complete a project have been listed, the relationship of these activities to one another needs to be determined by linking activities. In some instances, multiple activities can be undertaken concurrently, while some activities cannot begin until others have been completed. When determining the sequence of operations, the designer should determine the following: "What needs to be done before proceeding with the next activity" or "what can be done concurrently?" Every activity has a definite event to mark its relationship with others with respect to completing a task.

See [Subsection 4.4](#) for guidance on how to link project activities.

3.6 Documentation

Document any assumptions such as: production rates, equipment types, quantities and number/size of crews used. That way, if the schedule is modified, the logic can be followed. It is recommended to document notes using Task Information Notes in the Microsoft Project scheduling software.

See [Subsection 4.3](#) for guidance on documenting assumptions Using Microsoft Project.

3.7 Modify the Construction Schedule

Modify the CPM schedule in conjunction with the CFT by applying constraints, modifying production rates, project or task calendars, or activity sequences.

See [Subsection 4.5](#) for guidance on how to add activity constraints in Microsoft Project.

3.8 Review CPM Schedule with the CFT

Make sure that applicable notes have been added to the activities and phases. For submittal reviews it is a good idea to print the schedule from the Gantt Chart view, the Network Diagram view (showing links/logic) and the notes.

See [Subsection 4.6](#) for guidance on how to view or print the schedule in Microsoft Project.

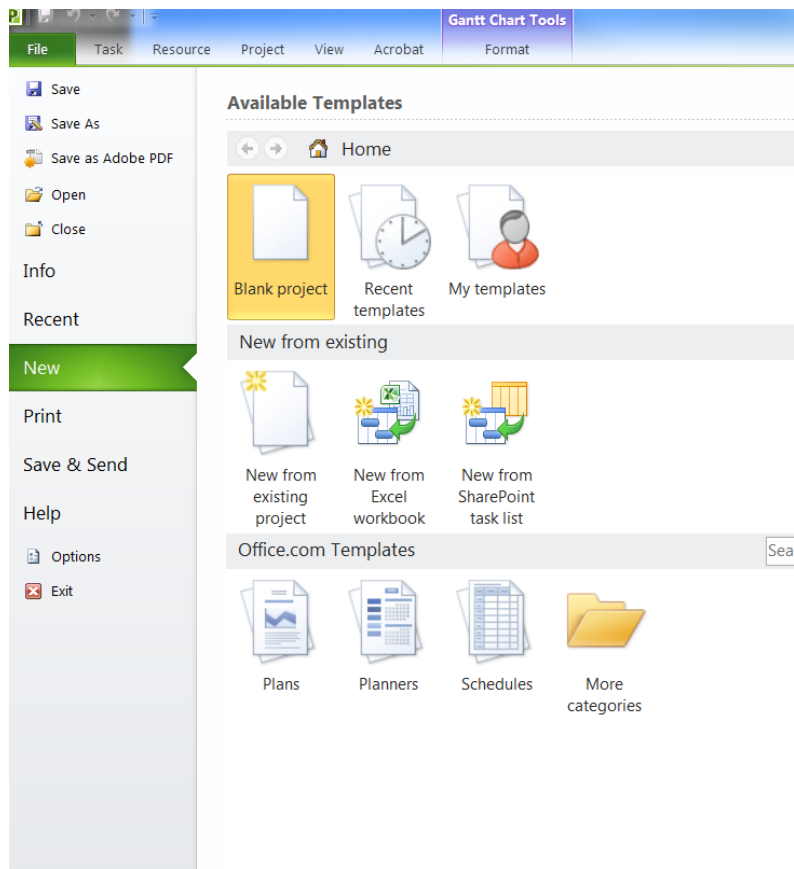
4. USING MICROSOFT PROJECT

4.1 Create a New CPM Schedule

Open Microsoft Project.

Select **File/New**

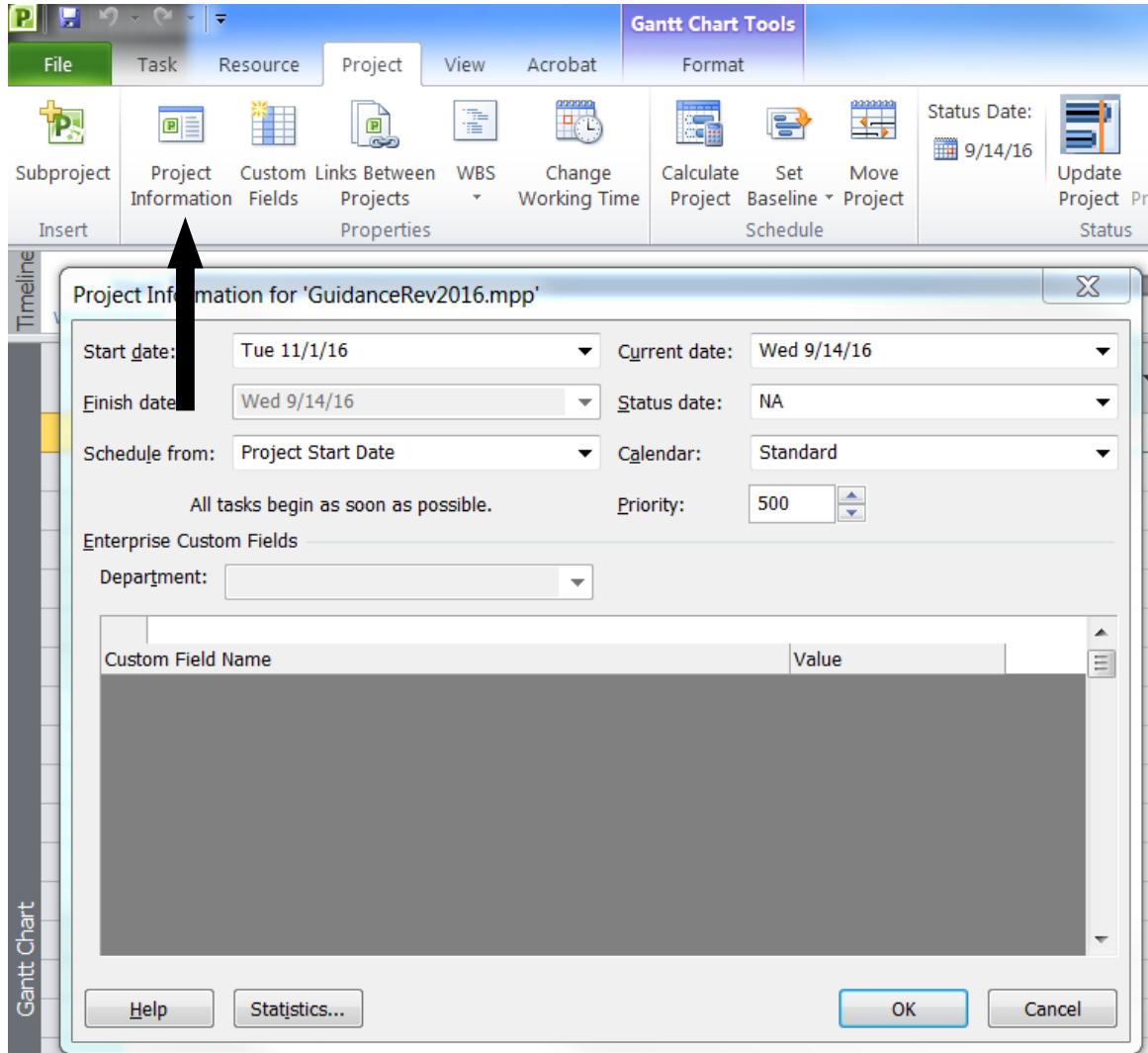
Select **Blank project**



Save the file to your project directory with an appropriate naming convention using **File/Save** from the main pull down menu.

4.2 Define the Project

Under the **Project** toolbar, select **Project Information**. This will open the Project Information dialog window.



Enter the approximate start date (Notice to Proceed). Either type in the date or use the drop down calendar. Check the other entries in the Project Information dialog box.

These defaults should work for almost all projects. Unless it is known that the majority of the project will be constructed at night or with 24 hour shifts, keep the Standard calendar selected.

If you wish to build your schedule backwards from a set final completion date, use the drop down menu in the **Schedule from:** box, select the “Project Finish Date” option, then enter the **Finish Date**.

Project Information for 'GuidanceRev2016.mpp'

Start date: Tue 11/1/16 Current date: Wed 9/14/16

Finish date: Wed 11/30/16 Status date: NA

Schedule from: Project Finish Date Calendar: Standard

All tasks begin as late as possible. Priority: 500

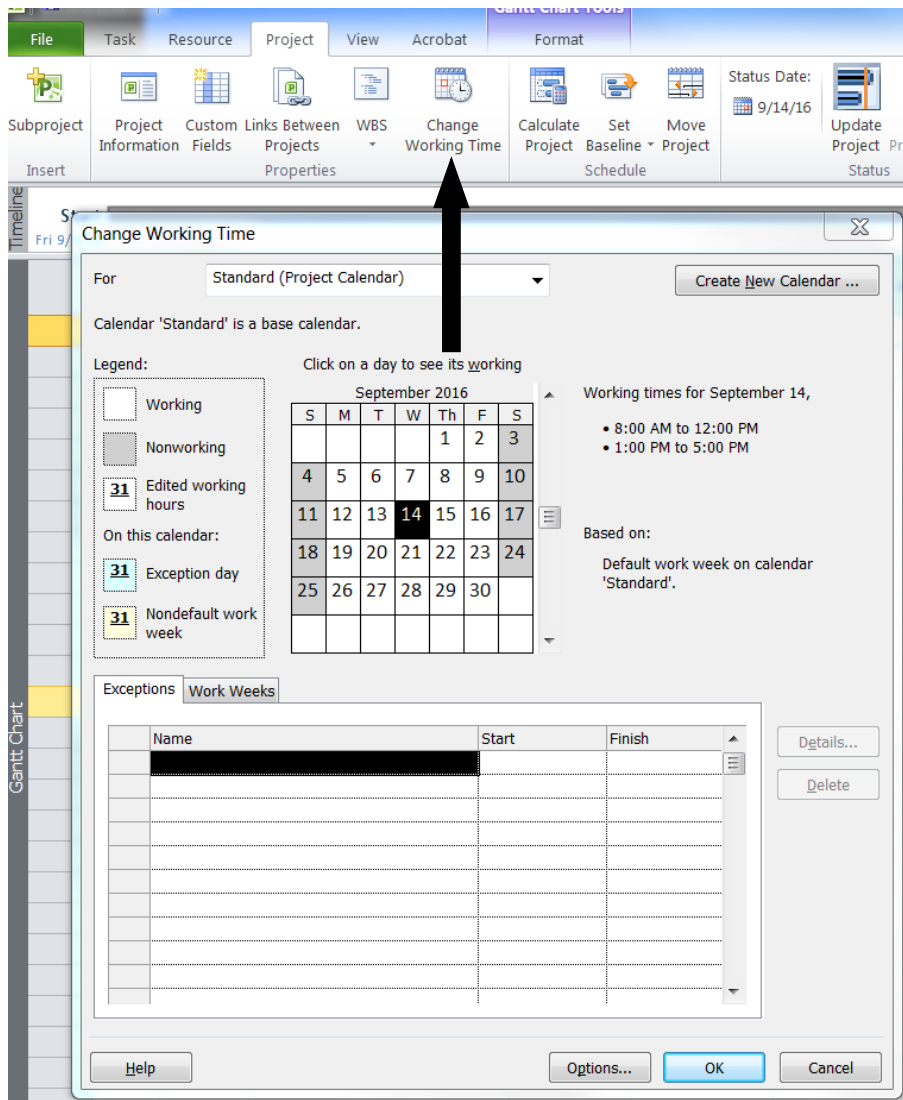
Enterprise Custom Fields

Department: [Empty]

Custom Field Name	Value
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Buttons: Help, Statistics..., OK, Cancel

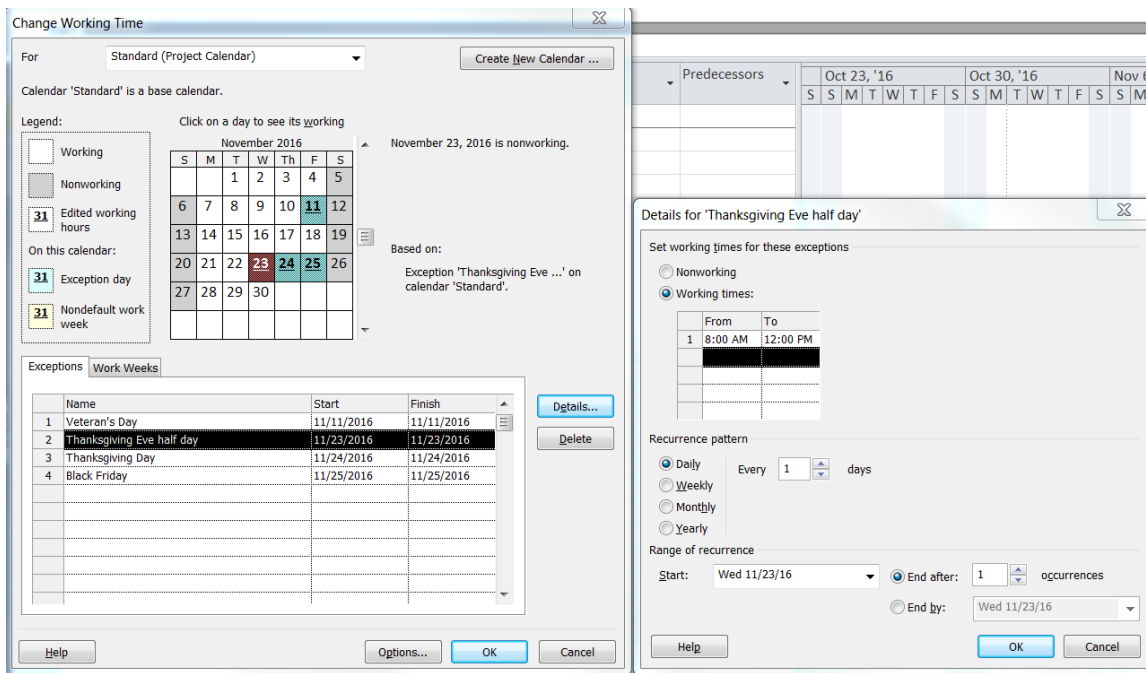
Set the project calendar(s) by selecting the **Change Working Time** icon on the **Project** toolbar.



Modifications to the “Standard (project calendar)” calendar are made in the Change Working Time dialog window. Select each day on the calendar that will have an exception to the standard work day. Setting and modifying the daily work hours will be discussed in the next step.

For each project specific restriction (non-working day), enter the exception **Name** under the **Exception** tab. Do this for the expected duration of the project plus an extended period of time (at least 3-6 months) beyond the expected finish of the project. Show holidays and other non-working days as non-working days.

To make specific work hour modifications for individual exception days (such as mandatory half days that will be specified in the contract), select the exception to be modified on the exceptions list, then select the **Details** button. This will open the Details window. In the Details window, select **Working Times** and modify the working times as applicable.

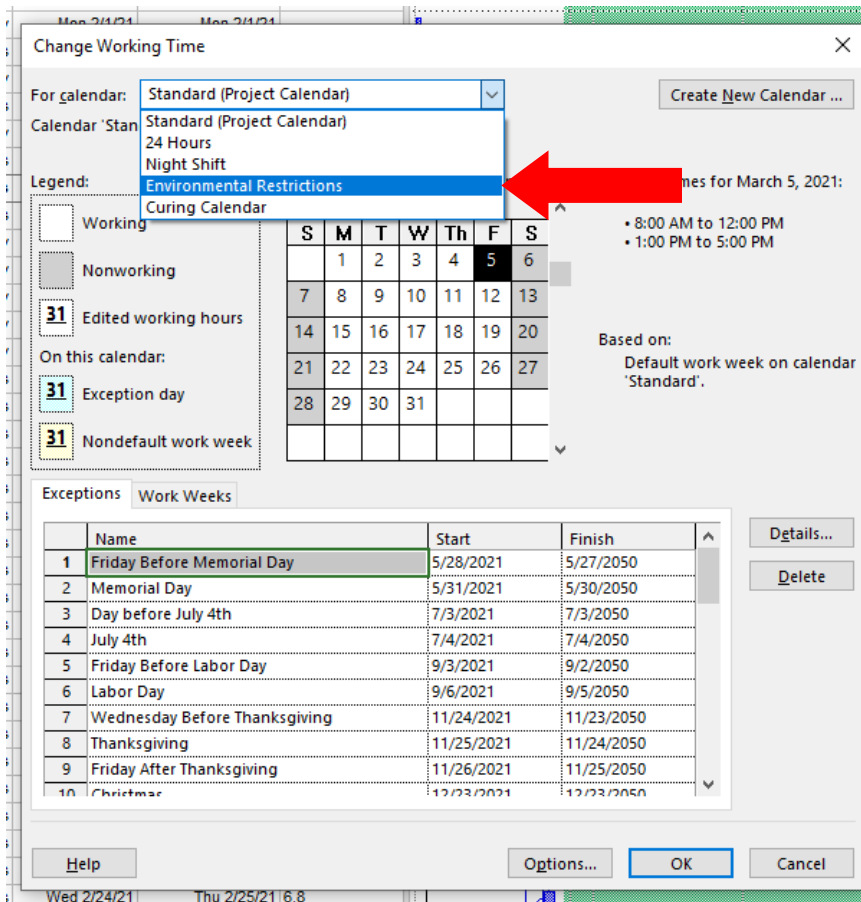


If the project requires more than one calendar for specific construction activities (example: contract options, or multiple independent project sites under one contract) select the **Create New Calendar** button at the top of the Change Working Time dialog box. Complete the task calendar in the same way as the project or “Standard” calendar.

4.2.1 Environmental/Seasonal Restrictions Using Project Calendars

Using project calendars is the preferred way to show environmental or seasonal restrictions. To do this, create a new calendar and add an entry in the exception tab for the desired non-working time related to the restriction desired. The CFL Construction Schedule Template

(link below) contains an “Environmental/Seasonal Restrictions” Calendar that is already set up with a non-working time entry that can be used for this purpose:

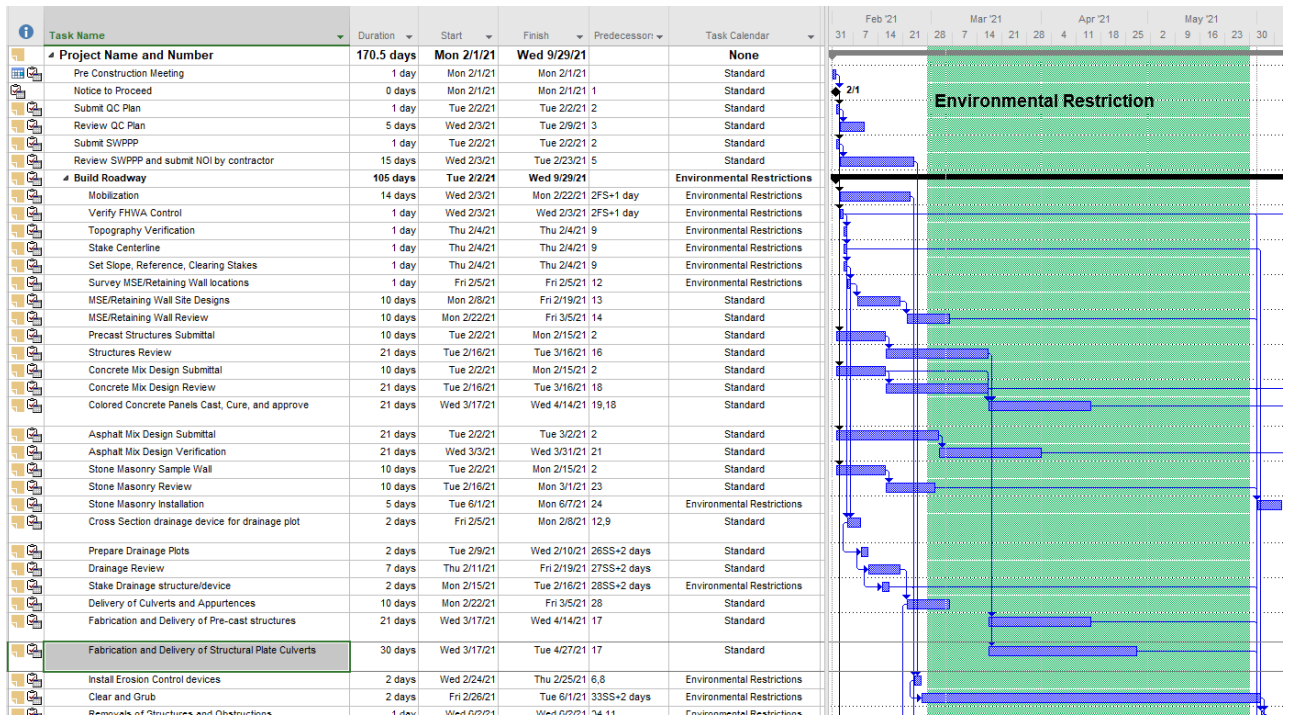


Each task can be assigned a unique calendar. Access the task information by double-clicking on the task or right-click on the task and select “Information...” You can also assign a calendar to multiple tasks by holding down the CTRL button and left-clicking the desired tasks, then right-click and select “Information...”. The task calendar can be found on the “Advanced” tab. Select the appropriate calendar from the pulldown.

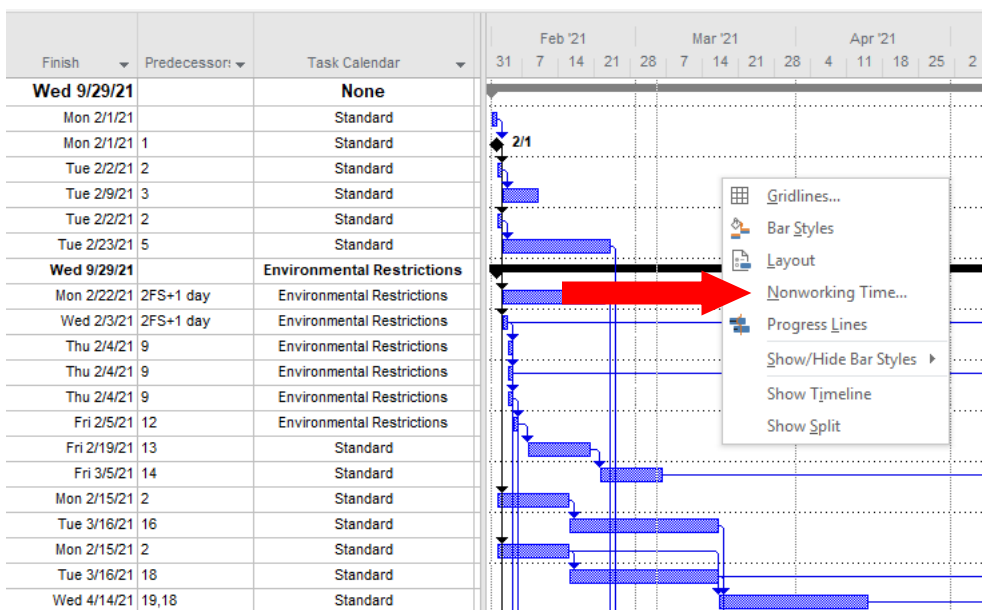
Note that some activities aren't constrained by environmental/seasonal restrictions, such as reviews and submittals, so they can use the project standard calendar, while the construction activities can be assigned a calendar that incorporates the restrictions. The CFL CPM Template is pre-populated with calendars assigned to appropriate activities. Specific task calendars can be selected in the CFL CPM Template by the previous method or using the pull-downs in the column located to the right of the "Predecessor" column:

ID	Task Name	Duration	Start	Finish	Predecessor	Task Calendar
8	Concrete Mix Design Submittal	10 days	Tue 2/2/21	Mon 2/15/21	2	Standard
9	Concrete Mix Design Review	21 days	Tue 2/16/21	Tue 3/16/21	18	Standard
0	Colored Concrete Panels Cast, Cure, and approve	21 days	Wed 3/17/21	Wed 4/14/21	19, 18	Standard
1	Asphalt Mix Design Submittal	21 days	Tue 2/2/21	Tue 3/2/21	2	Standard
2	Asphalt Mix Design Verification	21 days	Wed 3/3/21	Wed 3/31/21	21	Standard
3	Stone Masonry Sample Wall	10 days	Tue 2/2/21	Mon 2/15/21	2	Standard
4	Stone Masonry Review	10 days	Tue 2/16/21	Mon 3/1/21	23	Standard
5	Stone Masonry Installation	5 days	Tue 6/1/21	Mon 6/7/21	24	Environmental Restrictions
6	Cross Section drainage device for drainage plot	2 days	Fri 2/5/21	Mon 2/8/21	12, 9	Standard
7	Prepare Drainage Plots	2 days	Tue 2/9/21	Wed 2/10/21	26SS+2 days	Standard
8	Drainage Review	7 days	Thu 2/11/21	Fri 2/19/21	27SS+2 days	Standard
9	Stake Drainage structure/device	2 days	Mon 2/15/21	Tue 2/16/21	28SS+2 days	Environmental Restrictions
0	Delivery of Culverts and Appurtenances	10 days	Mon 2/22/21	Fri 3/5/21	28	Standard
1	Fabrication and Delivery of Pre-cast structures	21 days	Wed 3/17/21	Wed 4/14/21	17	Standard
2	Fabrication and Delivery of Structural Plate Culverts	30 days	Wed 3/17/21	Tue 4/27/21	17	Standard
3	Install Erosion Control devices	2 days	Wed 2/24/21	Thu 2/25/21	6, 8	Environmental Restrictions
4	Clear and Grub	2 days	Fri 2/26/21	Tue 6/1/21	33SS+2 days	Environmental Restrictions
5	Removals of Structures and Obstructions	1 day	Wed 6/2/21	Wed 6/2/21	34, 11	Standard
6	Strip and stockpile top soil	3 days	Thu 6/3/21	Mon 6/7/21	35	Standard
7	Roadway Excavation and Embankment Construction	10 days	Tue 6/8/21	Mon 6/21/21	36	Standard
8	Subexcavation	2 days	Tue 6/8/21	Wed 6/9/21	36	Environmental Restrictions
9	Subgrade Stabilization	2 days	Tue 6/22/21	Wed 6/23/21	37, 38	Standard
0	Install Underdrain	2 days	Tue 6/8/21	Wed 6/9/21	36	Environmental Restrictions

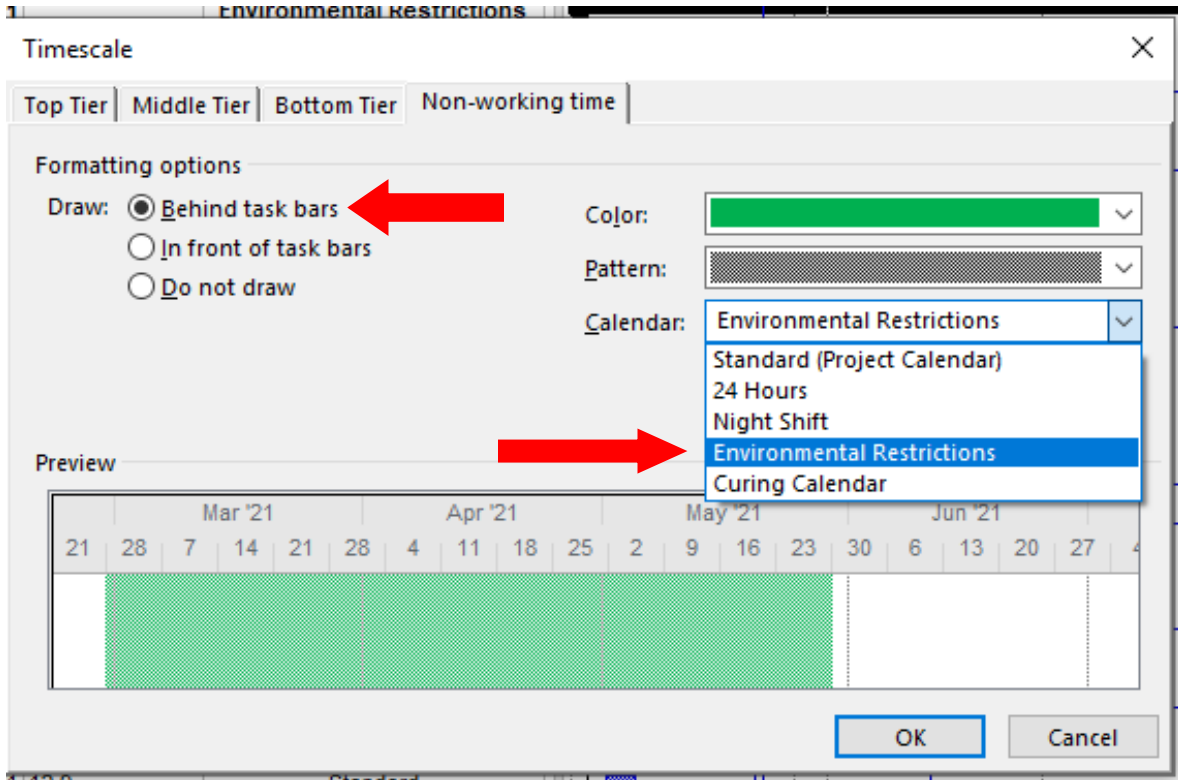
The non-working days for any restriction can be shown in the Gantt chart to quickly provide a visual indication of the timing and duration of the restriction:



To show the non-working days in the Gantt chart, right-click in the calendar display and select “Nonworking time...”

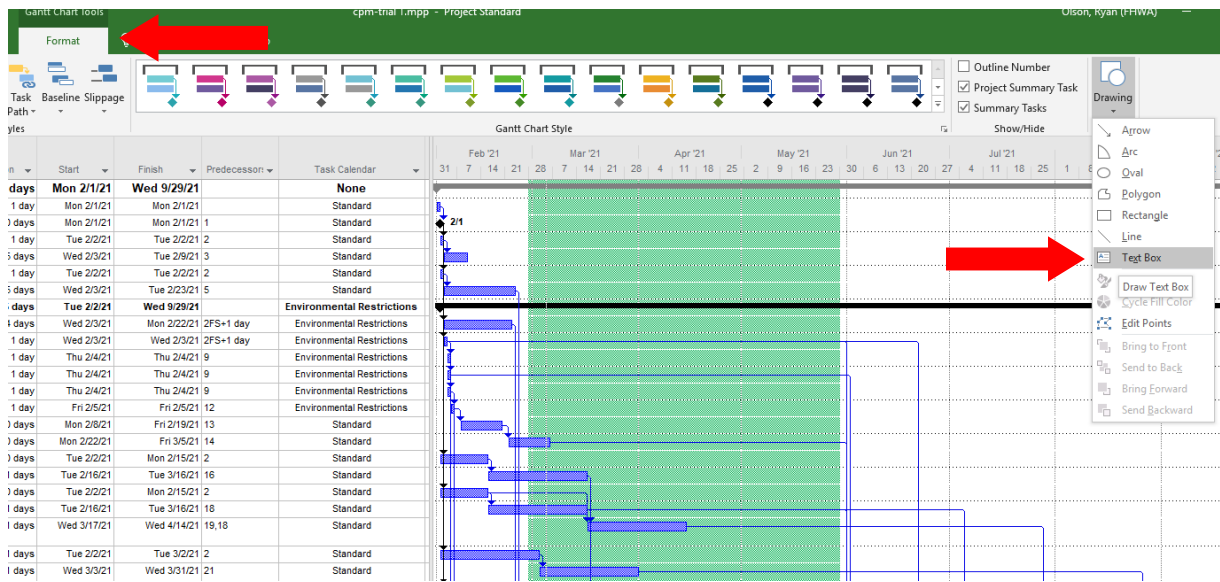


In the Timescale window, select the calendar that contains the non-working times you would like to show. Select the color and pattern as desired. Then, select “Behind task bars” under the Formatting Options on the left side of the window:



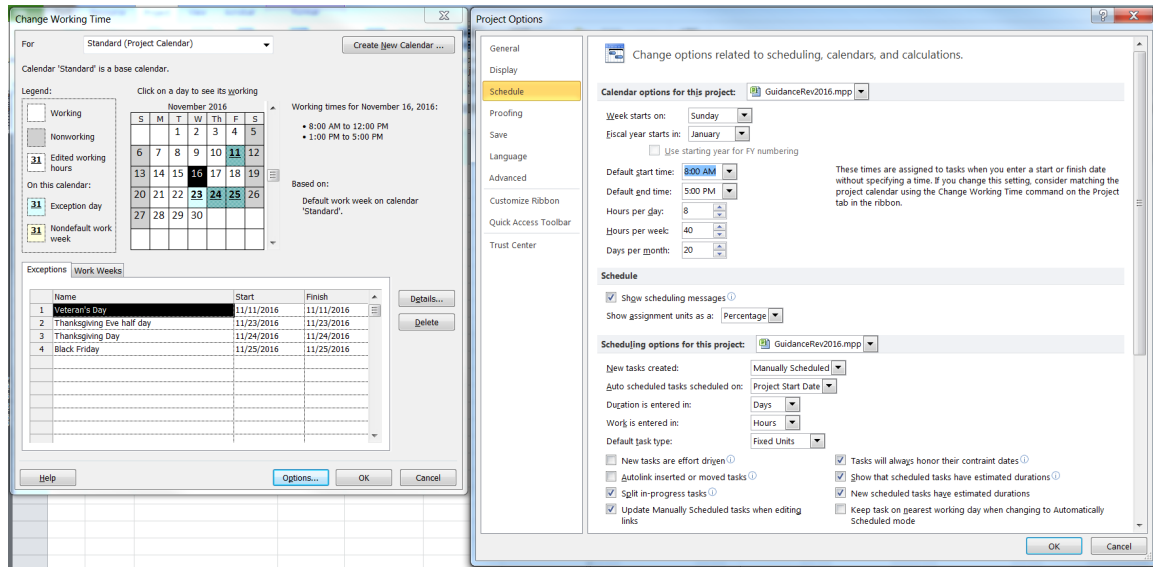
The non-working time can be turned off in the Gantt chart by selecting the “Do not draw” radio button in the Timescale window.

Text can also be added to the calendar view by selecting the “Format” Tab under the Gantt Chart Tools, and then selecting “text box” under the Drawing tools:



Draw the text box at the desired location, add the text and edit the properties as desired by right-clicking on the text box.

To change daily working hours for each calendar, select the **Options** button at the bottom of the Change Working Time window. This will open the Project Options window in which the user may modify calendar and schedule options, such as default work week, daily work hours, etc.

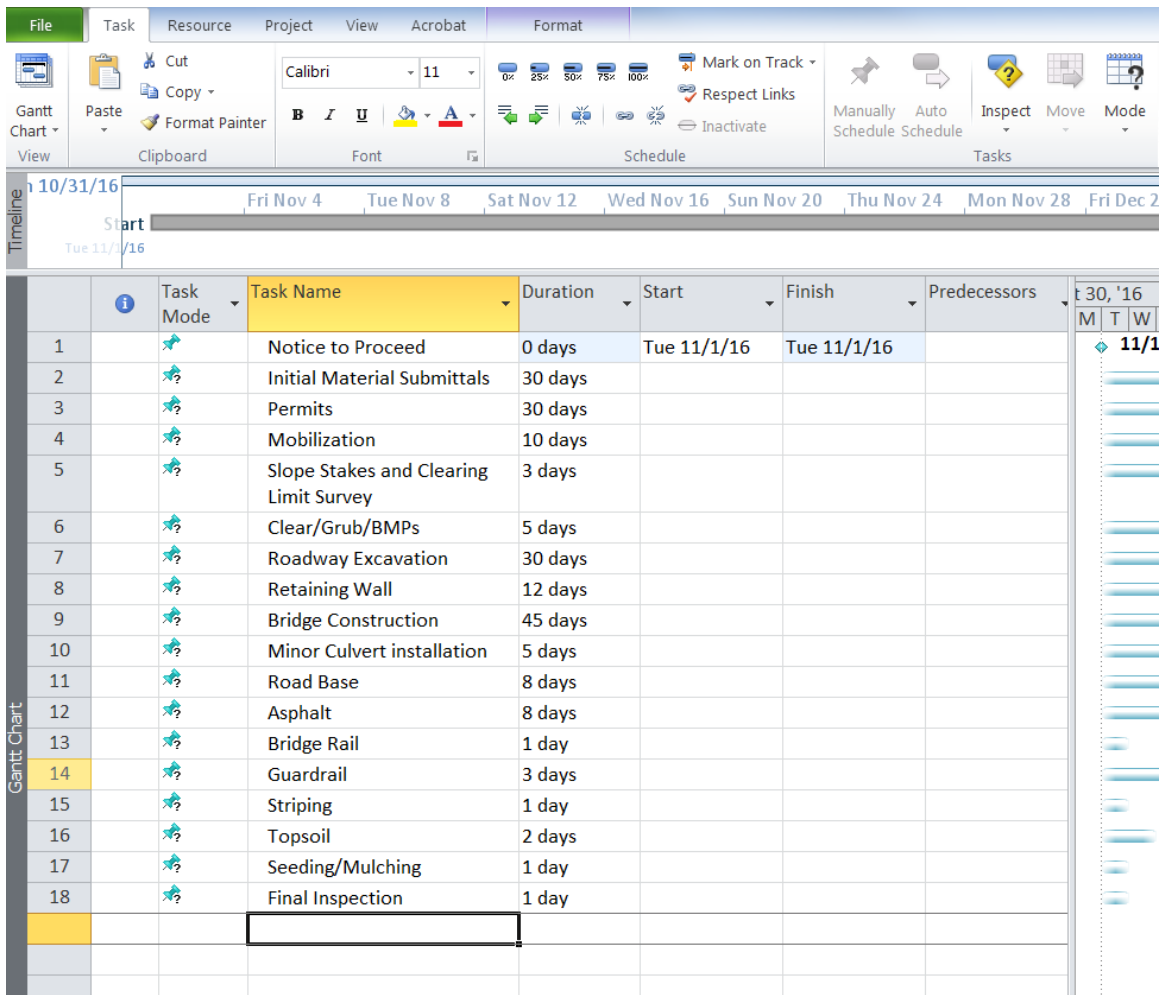


Keep in mind that this is mostly insignificant to construction schedules. The production rates should be established for working hours in a day. This will determine your durations.

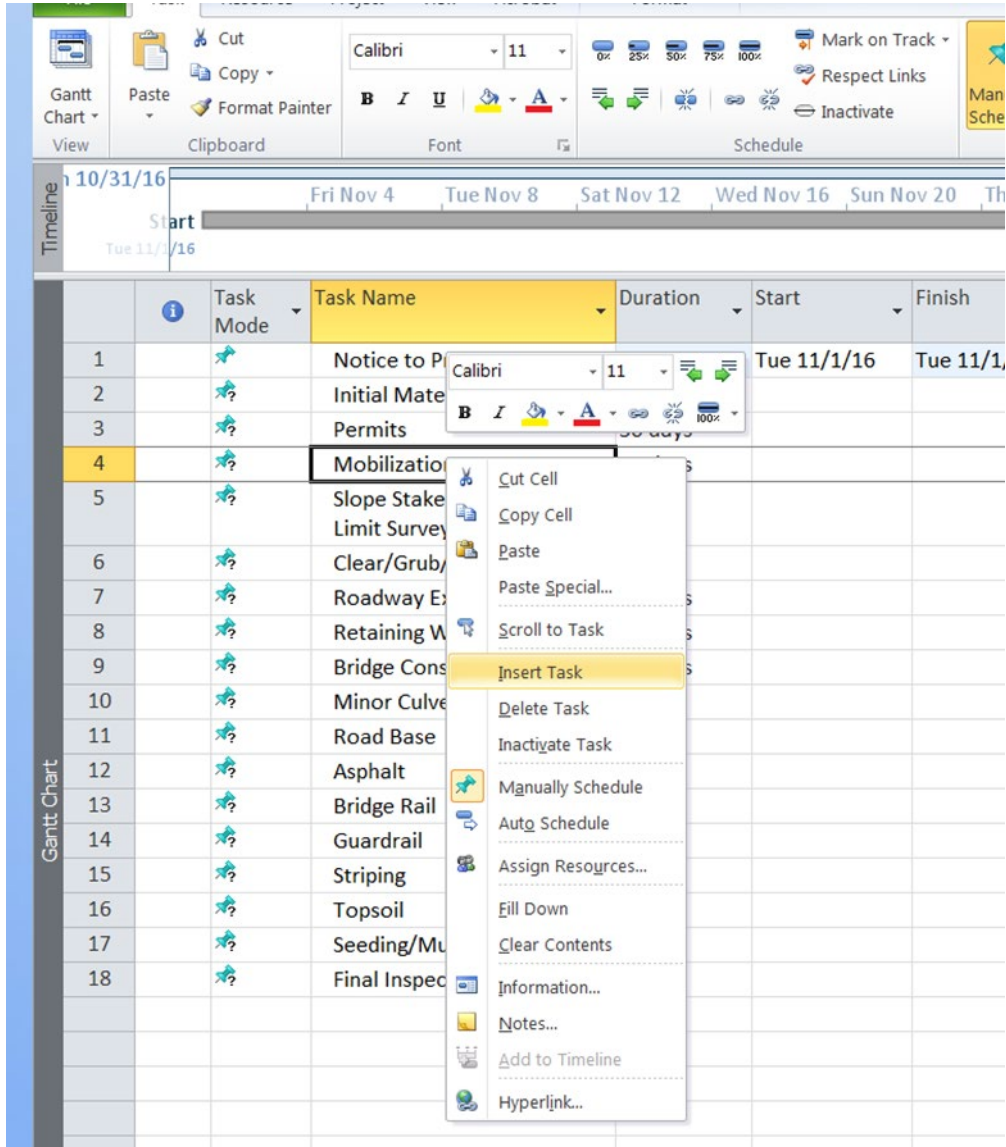
4.3 Input and Organize Project Activities and Data

Make sure the appropriate view is currently in use. Select **View/Gantt Chart** from the main menu.

Under the **Task Name** column, enter the construction activities/tasks and durations in sequential order. Task durations for each construction activity should be determined based on anticipated production rates and estimated quantities. If an activity/task is a milestone, enter 0 for the duration. Documentation of assumptions, including production rate and estimated quantity assumptions, will be done using the Notes Tab in the Task Information window and is discussed below.



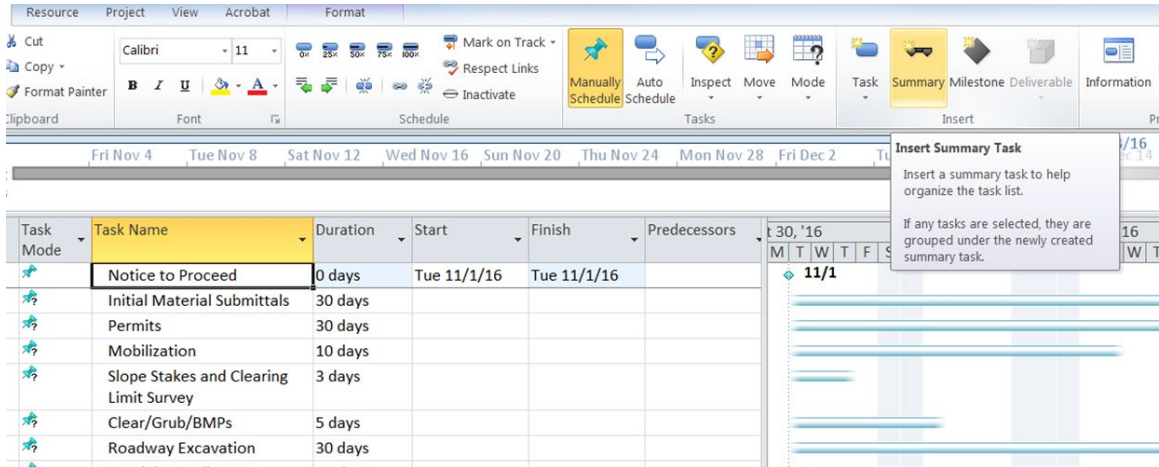
To insert a new task between two that have already been populated, highlight a task, and select the **Task** button in the **Insert** group on the main **Task** tab. Alternatively, right click on a task and select “Insert Task.” Either operation will insert a new task above the task that was highlighted.



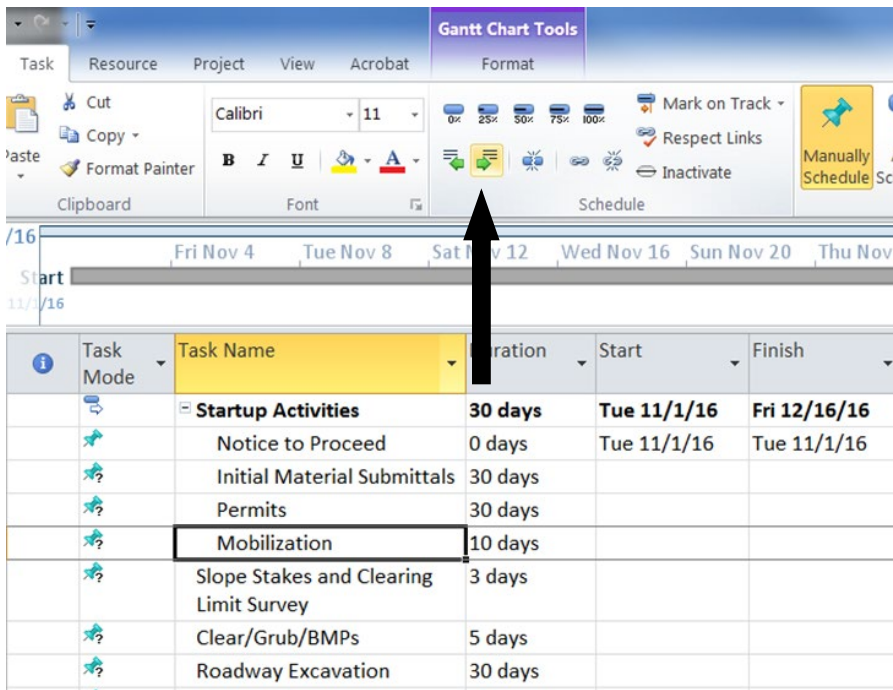
To move tasks sequences on the task list, highlight the row of the task to be moved. Select (left click) on the row again from the Task ID number column and drag it to the new desired position in the Task list.

Gantt Chart	10		Clear/Grub/BMPs	5 days	Fri 12/16/16	Fri 12/23/16	4
	11		Earthwork, Retaining Wall & Culverts	28 days	Mon 12/19/16	Thu 1/26/17	
	12		Roadway Exc. - Sched A	12 days	Mon 12/19/16	Wed 1/4/17	10
	13		Roadway Exc. - Opt. X	12 days	Mon 12/19/16	Wed 1/4/17	12
	14		Embankment Construction	15 days	Mon 12/26/16	Mon 1/16/17	13
	15		Retaining Wall	12 days	Thu 1/5/17	Mon 1/23/17	14
	16		Minor Culvert installation	5 days	Wed 1/11/17	Wed 1/18/17	14
	17		Subgrade finishing operations	3 days	Mon 1/23/17	Thu 1/26/17	14

Construction activities can be grouped together by assigning Summary tasks. Summary tasks are added similarly to regular tasks, by highlighting the task below where the Summary task is to be inserted and selecting the **Summary** button in the **Insert** group on the main **Task** tab.

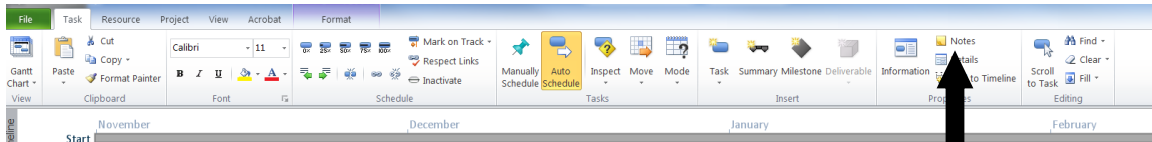


To organize tasks into groups under Summary Tasks, highlight one or more task, then select the right **Indent Task** icon in the **Schedule** group on the **Task** toolbar. The indent controls are the green arrow icons located on the formatting toolbar. By indenting tasks under a Summary task, they automatically become subtasks of the summary task.

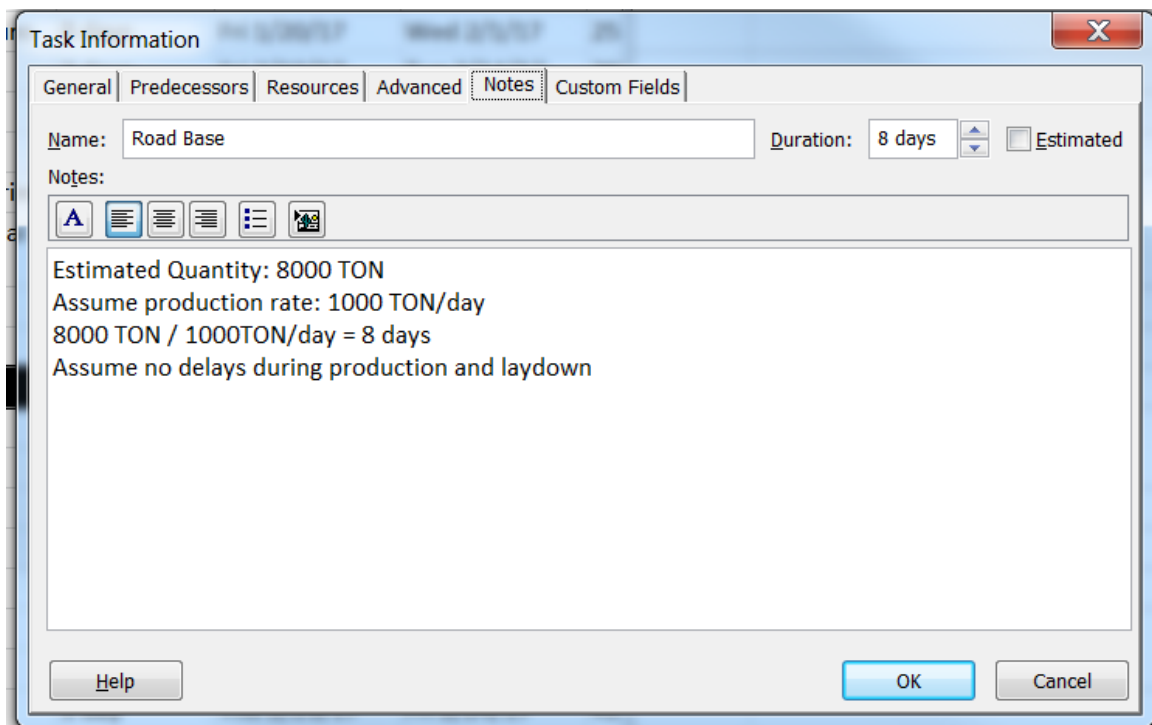


Note: Do not add durations for summary tasks. The summary tasks (in bold) will automatically summarize the durations of all assigned subtasks.

Document assumptions by double-clicking on a task and selecting the **Notes** tab in the Task Information dialog, or by highlighting the task and selecting the **Notes** icon in the **Properties** group on the **Task** toolbar.



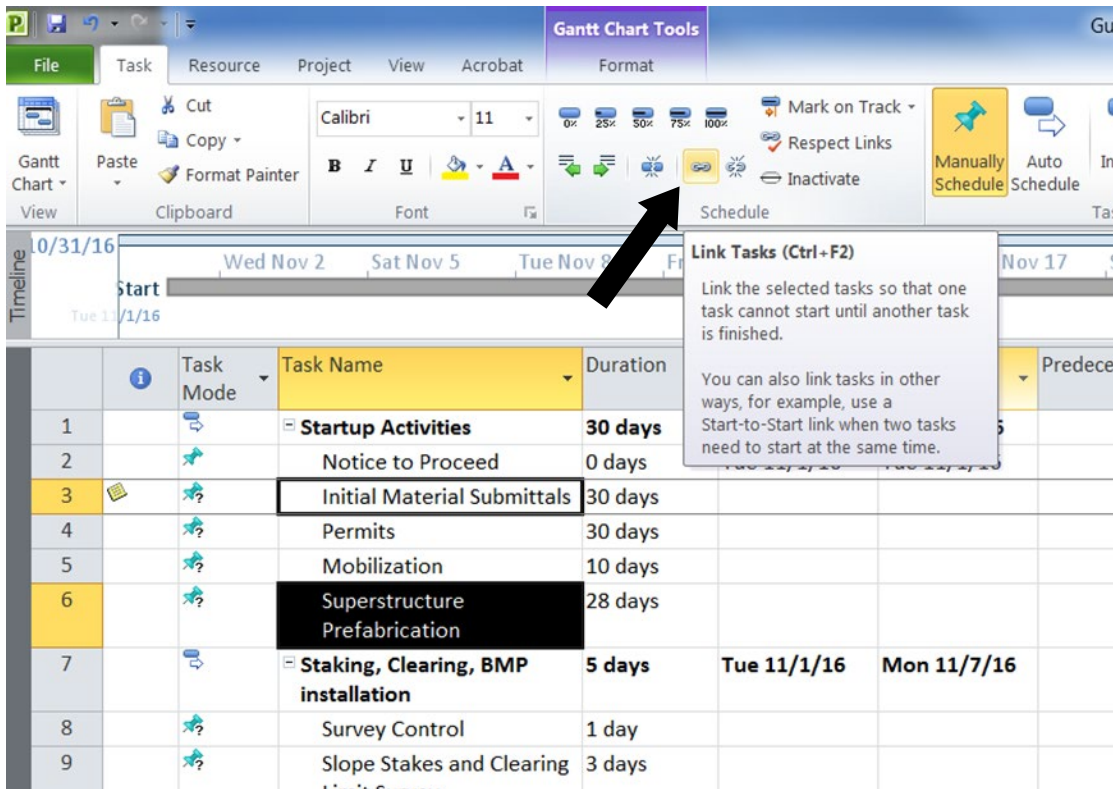
In the **Notes** tab of the **Task Information** dialog, type in estimated quantities, assumptions used for production rates, assumed bad weather days and other items that effect a task or its estimated duration.



4.4 Link the Tasks/Activities

The next step in creating the schedule is to assign “links” between activities. This is often called adding “logic” to the schedule. Here it is important to know the relationship between activities and when the activities can commence or finish as related to other activities. Like estimated task durations, this linking will need coordination, concurrence and review with the CFT.

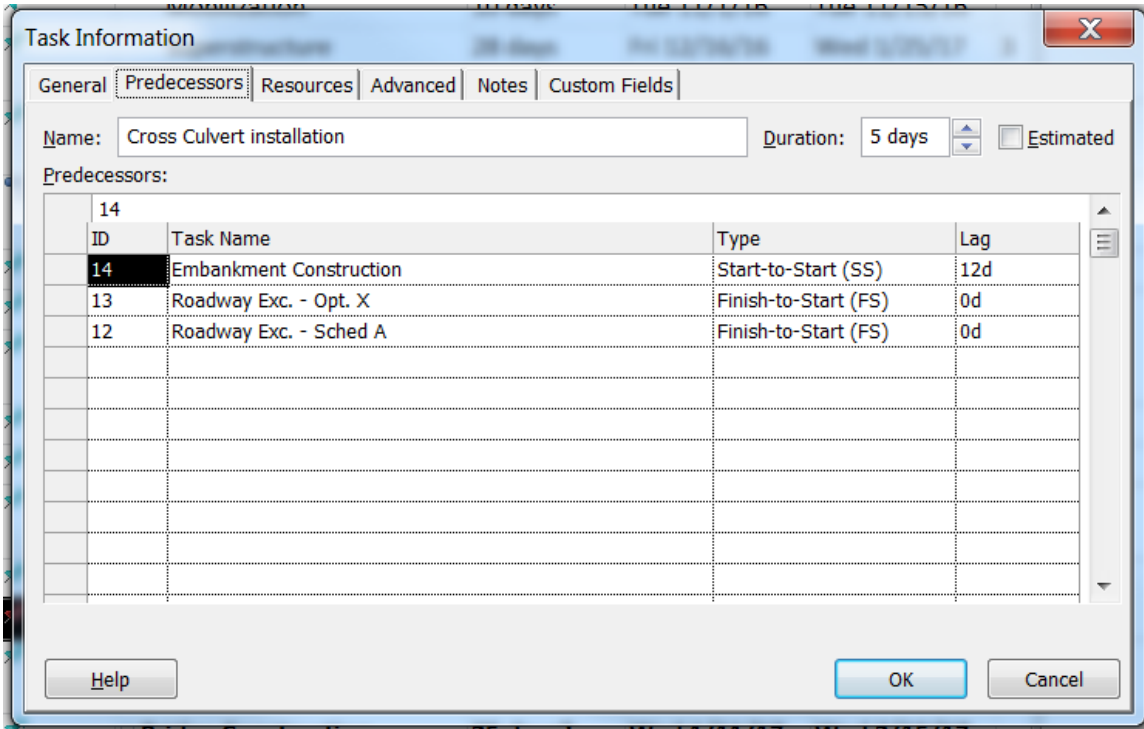
To assign a link, highlight two or more tasks, then select the **Link Tasks** icon from the **Schedule** group on the **Format** toolbar. This is the icon with a segment of chain on it. Doing this will always create a Finish-to-Start link between the selected tasks. Modification of link dependency is discussed below.



Important Note:

Microsoft Project will always link the activity selected first as the predecessor and the activity selected second as the successor. If multiple tasks are highlighted then linked, they will be linked Finish-to-Start in their sequential order.

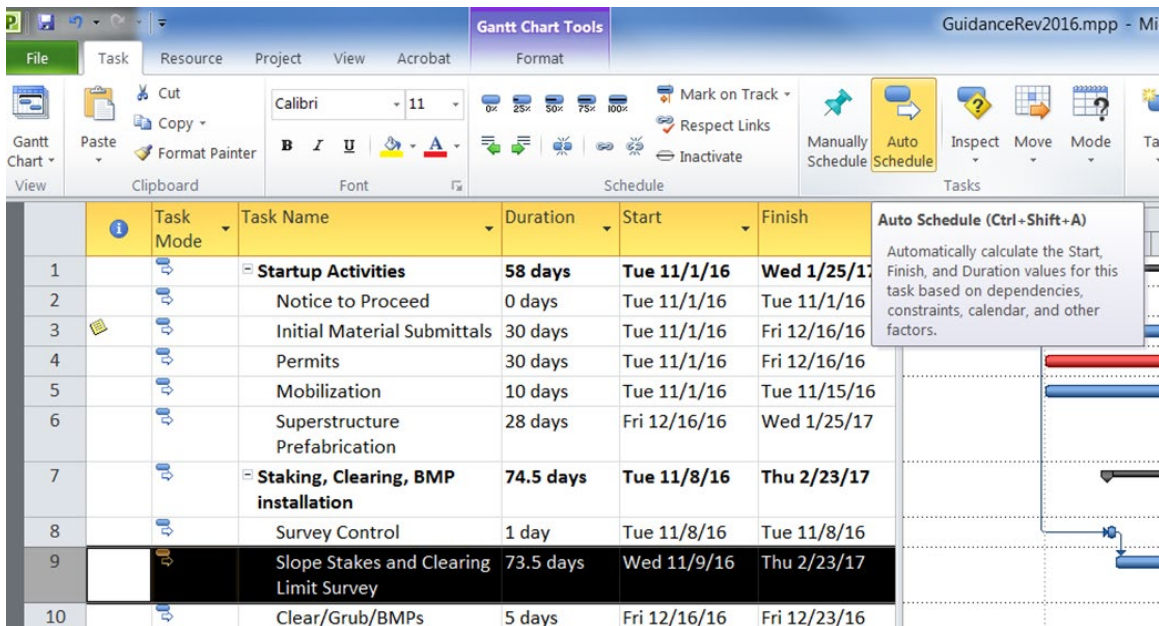
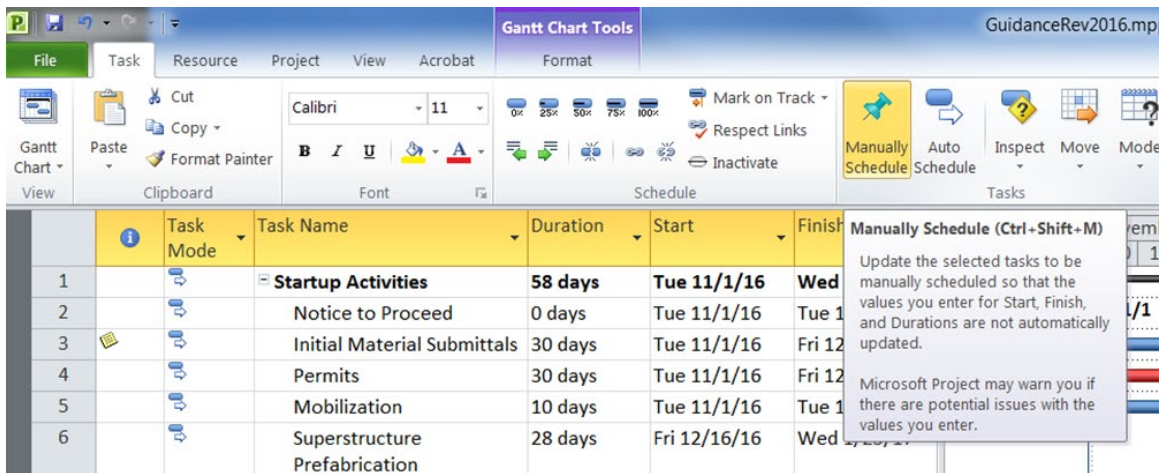
To modify the type of link between tasks, double-click the activity that is the successor task. The Task Information dialog box for that task will open. From here, it is possible to select a different type of link and to assign lags (by selecting from the drop down menus in the “Type” and “Lag” columns). It is possible to have both positive and negative lags as either a specific duration or a percentage of the task’s predecessor.



Note: In the example above, the successor task (the task whose task information dialog box is open), “Cross Culvert installation,” has three predecessor tasks, “Embankment Construction”, “Roadway Exc. – Opt X” and “Roadway Exc. – Sched A.” The link type for the predecessor task “Embankment Construction” has been changed to “Start-to-Start” with a 12 day lag. This indicates that based on assumed production rates for embankment construction, the cross culvert installation task can start 12 days after embankment construction begins, but does not have to wait till embankment construction is complete. Similarly, the link types for the two “Roadway Exc.” predecessor tasks have been left as “Finish-to-Start” with a 0d lag, indicating that roadway excavation must be complete before culvert installation can begin.

Unlike previous editions, Microsoft Project 2010 offers the user a little more flexibility with the **Manually Schedule** option for tasks. All tasks are automatically set to Manually Schedule when they are initially added the Schedule.

For the purposes of CFL Project Development Construction Schedules, it is recommended to set all tasks to **Auto Schedule**. Auto Schedule will automatically shift tasks based on the task organization (duration, links, constraints, etc...) as changes are made to the schedule. If not done already, once all other task organization is complete, it is a good time to set all tasks to Auto Schedule. This is done by highlighting one or more task and selecting the **Auto Schedule** icon in the **Tasks** group on the **Format** toolbar.



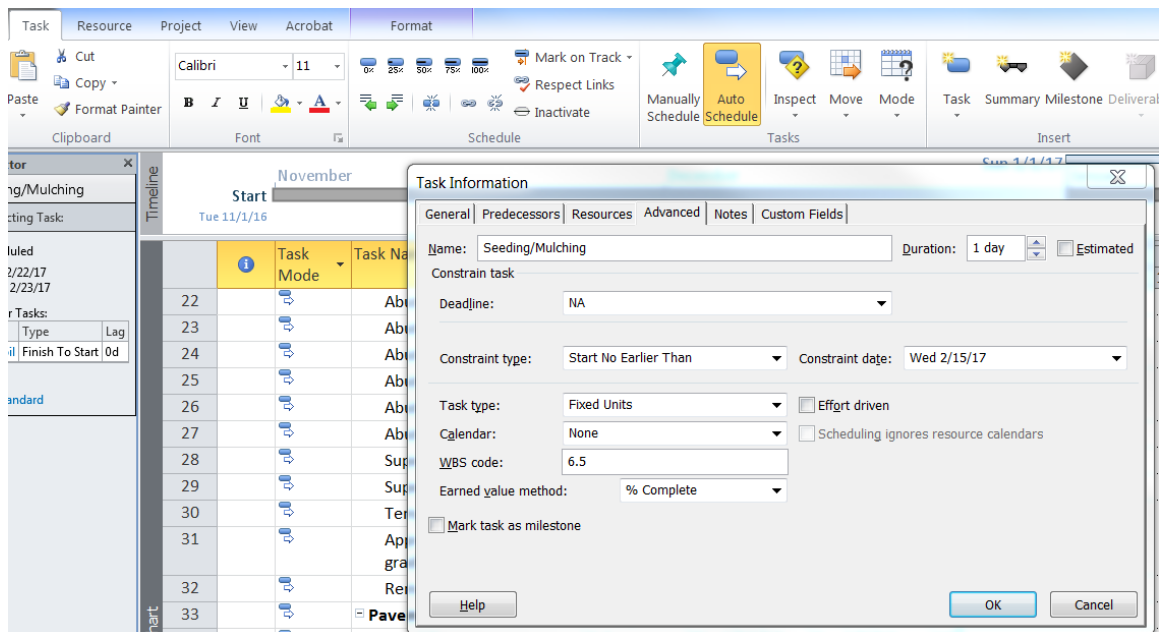
Special Note: Tasks can be changed between Manual to Auto schedule at any time.

4.5 Activity Constraints

A constraint is a restriction placed on the start or finish date of a task. Constraints can be “flexible” (not tied to a specific date, but instead tied to another task) or “inflexible” (tied to a specific date.) Constraints are not deadlines. A deadline is a target completion date for an activity. Example constraint types applied to an activity are: As Late As Possible, As Soon As Possible, Finish No Earlier Than, Finish No Later Than, Must Start On, Must Finish On, Start No Earlier Than & Start No Later Than.

Generally, it is not necessary or desirable to add a constraint to an activity. Linking activities usually is all that is needed. Therefore it is recommended to limit the use of constraints. An example of an activity that might have a constraint is “Setting Bridge Girders.” In this case it would make sense to add a “Start No Earlier Than” or “Must Start On” a set delivery date to the project. Another example would be to set a seeding task to “Start No Earlier Than” the first day of the seeding/germination period.

To add or change a constraint in Microsoft Project select a task, and then click **Task Information**. Alternatively, the user could right click on any activity and then click **Task Information**, or double click any task; these will also open the Task Information dialog. Select the **Advanced** tab. In the **Constraint type** box, click a constraint type. If you selected a constraint other than **As Late As Possible** or **As Soon As Possible**, type a constraint date in the **Constraint date** box.

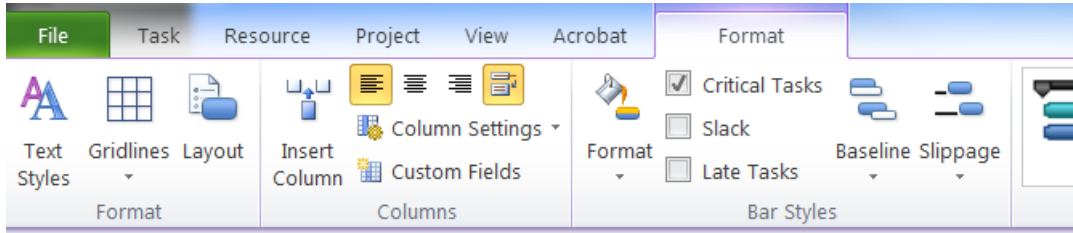


Special Note:

A task must be set to **Auto Schedule** in order to modify/add constraints. If the task is set to Manual Schedule, the Constraint type and date drop down menus will be unavailable, because manually scheduled tasks can't be constrained.

4.6 View and Print the Schedule

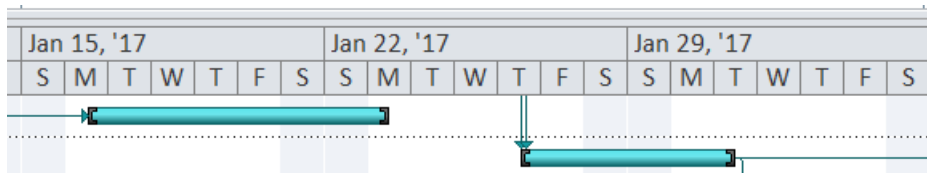
The critical path of the project can be automatically generated and displayed by MS Project. To do so, turn on **Critical Path** in the **Bar Style** group on the **Format** toolbar.



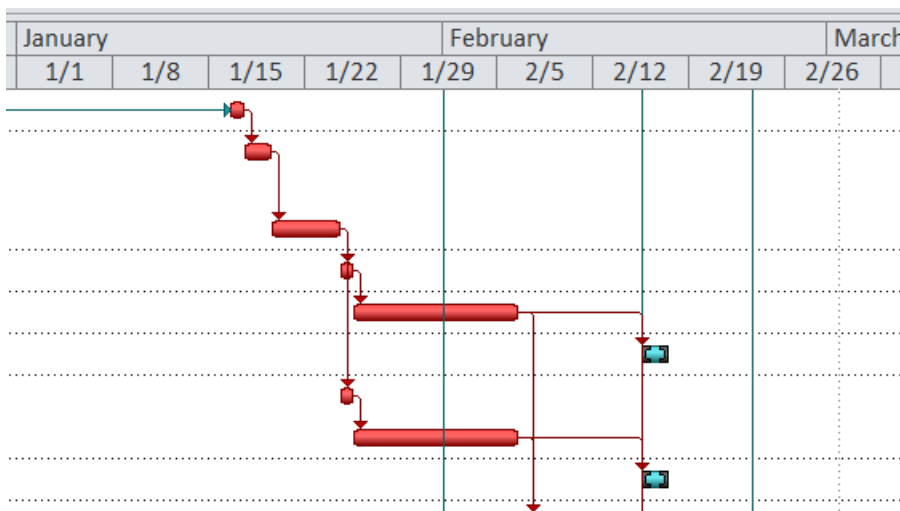
Special Note: It is not necessary to input and view resources on CFL Project Development construction schedules. Resources are typically used for resource management and tracking during project execution.

The Gantt Chart view can be easily manipulated using the **Zoom** group of controls on the **View** toolbar. The **Timescale** dropdown controls the scale of the timeline at the top of the schedule. The timescale to use depends on the overall project duration.

For short projects (less than 2 month) it is recommended to use the **DAYS** timescale.



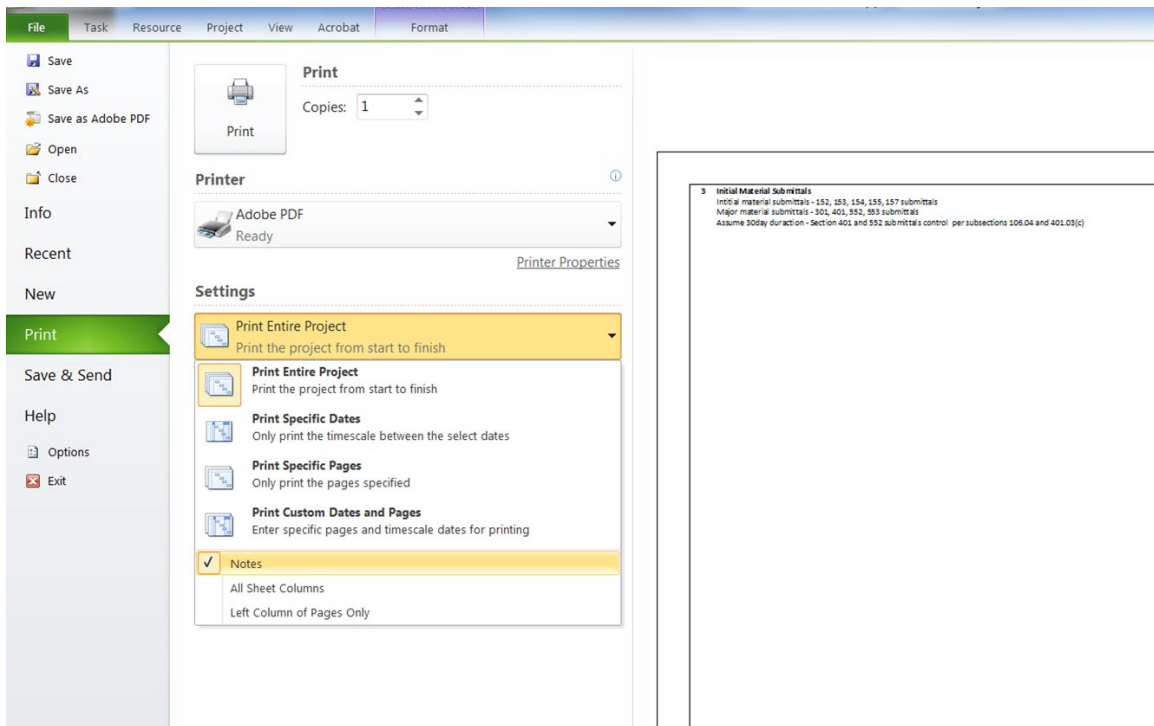
For longer project, use the **WEEKS** timescale. For select projects, it may be necessary to use an even larger timescale.



The simplest way to print a Microsoft Project schedule is by going to **File/Print**. It is recommended to print construction schedules to 11x17 PDF. As with other Microsoft programs, from the File/Print window, the user can select the printer and/or .pdf driver to print to, set printer properties, and print settings.

Special Note:

To view and print task notes, select the first drop down menu below **Settings**. Then select the **Notes** icon. This will add a page (or pages) at the end of the Gant Chart schedule with all task notes, including row ID number for each note.



5. ADDITIONAL RESOURCES AND INFORMATION

5.1 CPM Schedules

To access a guide published by FHWA “FHWA GUIDE FOR CONSTRUCTION CONTRACT TIME DETERMINATION PROCEDURES”, use the following link:

<http://www.fhwa.dot.gov/construction/contracts/t508015.cfm>

5.2 Microsoft Project

Using Microsoft Project – Project Guide:

<https://flh.fhwa.dot.gov/resources/design/tools/wfl/cpm-made-easy.pdf>

How Scheduling works in MS Project:

<https://support.office.com/en-us/article/How-scheduling-works-in-Project-5d4f5981-4e9f-4e8e-a699-2ef2a419252f?ui=en-US&rs=en-US&ad=US&fromAR=1>

CFL Construction Schedule Template:

[CFL Construction Schedule Template](#)

5.3 Production Rates

[Production Rate Spreadsheet](#)

5.4 Terms and Definitions

Activity: Performance of a specific task having a duration.
Bar Chart (Gantt Chart): A schedule format (type) showing activities, sequencing, durations, task interrelationships and start & finish dates.
Calendar: The scheduling mechanism that determines working time for resources and tasks.
Concurrent Activities: Activities which occur at the same time.
Constraint: Limitations placed on an activity, usually a "must start" or "must finish" date.
CPM: Critical Path Method predicts project duration by analyzing with sequence of activities.
Critical Path: The series of tasks that must be completed on schedule for a project to finish on schedule. Or, the longest path for the earliest completion having zero (or least) float.
Duration: Time to complete an activity.
Early Start (ES)/Early Finish (EF): The earliest an activity can start or finish on the schedule.
Event: A zero-duration activity.
Finish-to-Finish (FF): Relationship between activities where the finish of the first activity is tied to the finish of the second activity.
Finish-to-Start (FS): Relationship between activities where the start of the first activity is tied to the finish of the second activity. (Most common).
Float: The amount of time between the early start and late start of an activity or group of activities.
Free Float (FF): The amount of time an activity can be delayed before it impacts the next activity.
Lag: Time offset between activities.
Late Start (LS)/Late Finish (FS): The latest an activity can start or finish without delaying project completion.
Logic Loop: Sequence of activities with no end.
Logic: The relationship or "link" between activities or groups of activities.
Milestone: A reference point marking a major event in a project and used to monitor the project's progress. Any task with zero duration is automatically displayed as a milestone within Microsoft Project.
Negative Float: Total float that is less than zero.
Network: graphical model of the project which shows activities and interrelationships.
Nonworking time: Hours or days designated in a resource or project calendar when Project should not schedule tasks because work is not done. Nonworking time can include lunch breaks, weekends, and holidays, for example.
Predecessors: Activities that must precede any given activity.
Pure Logic Diagram: A schedule format (type) showing tasks, sequencing and interrelationships between tasks.
Start-to-Finish (SF): Relationship between activities where the start of the first activity is tied to the finish of the second activity.
Start-to-Start (SS): Relationship between activities where the start of the first activity is tied to the start of the second activity.
Subtask: A task that is part of a summary task. The subtask information is consolidated into the summary task.
Successors: Activities that must succeed any given activity.
Task: An activity that has a beginning and an end.
Time Logic Network Diagrams (CPM): A schedule format (type) showing activities, sequencing, time-scaled durations, and task interrelationships with lags, float and start & finish dates.
Total Float (TF): The amount of time an event can be delayed without delaying project completion.

5.5 Contract Time and Schedule Checklist Items

The following is a list of items to review the completeness of the construction schedule:

- Reviews/Submittals
 - Are there critical Submittals? What time is needed?
 - Are there critical testing periods and how long?
 - Are there critical review times and how long?
 - What are the assigned calendars for submittals & review times?
 - What are the logical connections between review activities and contractor's actual work?
 - Procurement activities
 - Time for reviewing false-work plans, shop drawings, post-tensioning plans, mix designs, etc.

- Permits
 - Are permits required?
 - Time to obtain necessary permits?

- Specific Activity Requirements
 - Additional time for obtaining specialty items or materials with long-lead requirements (i.e. Traffic Signal Equipment)
 - Curing time and waiting periods between successive paving courses or between concrete operations
 - Embankment settlement periods or embankment surcharges.
 - Coordination with utilities
 - False-work & shoring activities
 - Punch-list and cleanup activities

- Material/Product Testing and Delays
 - Government Furnished Material request?
 - Trial shafts or piles
 - Sample walls
 - Time for fabrication of structural steel and other specialty items
 - Staining, painting or other samples needing approvals

- Construction Limitations and Requirements
 - Haul characteristics
 - Type of earthwork (sliver cuts, benching)
 - Work area restrictions
 - Equipment congestion
 - Allowable bad weather days
 - Material availability
 - Labor shortages and resource loading
 - Traffic Volumes

- Traffic Staging events (closures, detours, etc)
- Critical interface activities (utilities, RR, etc.)
- Restrictions for nighttime and weekend operations
- Conflicting operations of adjacent projects, both public and private
- Are the NTP and Project Closeout activities shown?

- Project Commitments
 - Environmental Commitments
 - Winter season
 - clearing, grubbing, grading restrictions in FP
 - Noise restrictions
 - SWPPP
 - Seasonal limitations for certain activities
 - Project Calendar Requirements
 - Work week (5-day, 7-day weeks)
 - Holidays
 - Other non-working times

- Does the final schedule include/show:
 - Critical Path?
 - NTP date and completion date
 - Entire work scope, all activities in plans and specs?
 - Construction Staging and Mobilization?
 - Realistic duration of individual activities?
 - Activities have at least one predecessor and 1 successor, except for first and last activity?
 - Negative lag for activities? Should activities be reorganized?
 - Project Duration, Interim Milestones, Black-out dates, Contract work Days