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A Case Study for Recovery Scheduling in Transportation

Chris Carson, PMP, CCM, PSP, DRMP, CEP, FAACE; Virginia Beach, VA, USA.
chriswcarson@gmail.com Corresponding Author.

Noah Jones, PSP

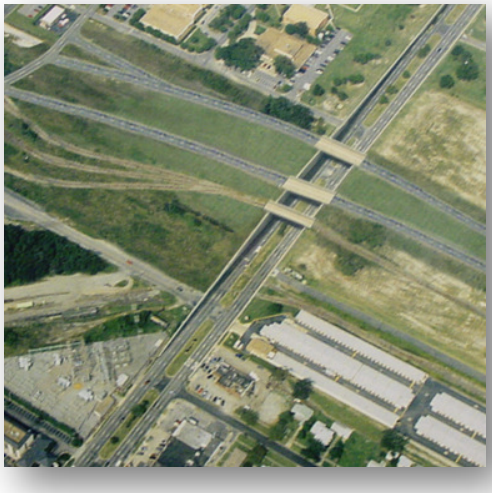
Introduction

When transportation projects fall behind, it can be very difficult to regain the lost time, and even harder without increased costs. This paper walks the reader through the resolution of a schedule recovery need for a transportation project which suffered significant production losses by analyzing the project, identifying specific opportunities for acceleration, hosting a recovery workshop, and implementing the solutions. This structured and cost-effective case study for recovery uses an ongoing project for which the authors provided Project Controls, specifically Schedule Review, support, and demonstrates the technical scheduling process used to recover the time.

Background

Project Description

The approximately $40M Hampton Boulevard project depresses the grade of a four-lane thoroughfare leading to Naval Station Norfolk in order to change grade crossings to bridges and remove traffic interruptions. The Project also includes constructing two bridges, one each for rail and traffic overpasses. The work was divided into four phases. Phase 1 consisted of Building the detour road at the current grade around the primary construction area rerouting all four lanes to the north side while maintaining access for side streets. Phase 2 consisted of demolishing existing Hampton Boulevard, relocating rail access to the terminal, driving sheet piles, excavating to the new grade for approximately 60% of the project, driving piles, pouring slabs, and building bridges over the excavated area. Phase 3 consisted of



driving sheet piles, excavating the remaining 40% of the Project, driving piles, pouring slabs and tying into Phase 2 completed work. Phase 4 is the traffic shift to the newly built roadway, demolishing the detour road, and landscaping. The Original Duration for the Project was 1223 calendar days or just over 40 months.

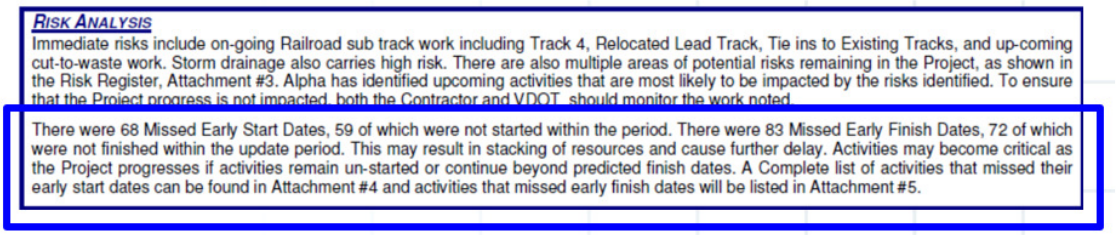
The purpose of this project is to separate the rail traffic servicing the adjacent Norfolk International Terminal (NIT) from the heavy automobile traffic. The current alignment also poses a problem for the Navy. If the Navy recalls all personnel but doesn't get cooperation from the Terminal on the rail traffic, it could negatively affect operational readiness.

Schedule Model

The Baseline Schedule was a 672-activity Critical Path Method schedule ("CPM") that was reasonable and appropriate. The scheduling environment on this job was one of cordial cooperation. We were able to discuss issues with the contractor and resolve disagreements relatively easily.

Statement of Recovery Need

The problem arose when the completion date slipped and the contractor felt that he had exhausted all logical mitigations he could make and still have faith in the schedule as a reasonable and achievable plan to complete the Project. The DOT requested that the contractor provide a recovery schedule. The Contractor wanted relief from liquidated damages; however, the Owner decided that releasing the Contractor from liquidated damages was not in The DOT's best interest. As the consultant to the DOT providing schedule review services, we proposed a schedule recovery workshop to address the production slippage.



Risk Analysis

Immediate risks include on-going Railroad sub track work including Track 4, Relocated Lead Track, Tie ins to Existing Tracks, and up-coming cut-to-waste work. Storm drainage also carries high risk. There are also multiple areas of potential risks remaining in the Project, as shown in the Risk Register, Attachment #3. Alpha has identified upcoming activities that are most likely to be impacted by the risks identified. To ensure that the Project progress is not impacted, both the Contractor and VDOT should monitor the work noted.

There were 68 Missed Early Start Dates, 59 of which were not started within the period. There were 83 Missed Early Finish Dates, 72 of which were not finished within the update period. This may result in stacking of resources and cause further delay. Activities may become critical as the Project progresses if activities remain un-started or continue beyond predicted finish dates. A Complete list of activities that missed their early start dates can be found in Attachment #4 and activities that missed early finish dates will be listed in Attachment #5.

Schedule Status

The schedule at this point had gone through six months of a "slip and recover pattern" where the Contractor updated the schedule, noticed the slip and mitigated that slip through logic changes. In most cases, the logic changes were carefully thought out and implemented, but eventually reasonable changes did not provide the recovery needed, and actions were taken in an optimistic manner anticipating higher production and increased crew resources.

The Contractor's management team had reviewed the schedule and concluded that there were no more cuts to be made, or durations to be trimmed, and no other options than to ask for relief.

Goal

The goal of any Schedule Recovery Workshop is to come together to brainstorm ideas for sequencing, opportunities for additional resources to shorten durations, site conditions or changes that would enable a time savings.

Recovery Workshop

Preparation

In preparation for the Recovery Workshop, all of the participants should prepare a bulleted list of suggestions for discussion with the group. Sending the list ahead of time allows the Contractor time to evaluate these ideas which helps the Recovery Workshop proceed without becoming an interrogation of the Contractor to which there are no answers at this time.

- Cure for 7 days is a VDOT standard, but on the schedule it shows cure driving the CP as if no other work is ongoing in adjacent areas. Is this an accurate model of the real world?
    - What about the use of Curing Compound to maintain the cure after the forms are removed? Does this impede adjacent work?
- What is the constraint to driving the sheet piling on both east and west sides concurrently?
- Two tie back crews running concurrently on both sides would help speed the excavation.
- What about two Cranes for pile driving both sides of the excavation concurrently?
- Fabricating Piles will be from Mid December to Mid Jan, which may be slow months for the fabricator. What about verifying the expected capacity availability of the fab plant at that time? If they can commit to greater production rates, it would help.
- Activity #3AAR0050 "CONCRETE MEDIAN - 15+80 TO 11+88 - HAMPTON BOULEVARD" is a 19 Work Day activity that may need to be broken up to accurately reflect the planned sequence of construction. This further breakdown of the activity could allow staged successors, picking up time.
- Is there a reason for not paving both sides North and South bound concurrently? If paving is driven by physical logic rather than resource logic (assuming one pile driving rig),
- Activity #3AARN040 "PAVE NB 15+60 TO 11+60 - HAMPTON BOULEVARD" is linked in as a successor to the Sidewalks being complete. It appears that this sidewalk is poured between C&G, so paving should be able to start once the C&G has cured sufficiently.

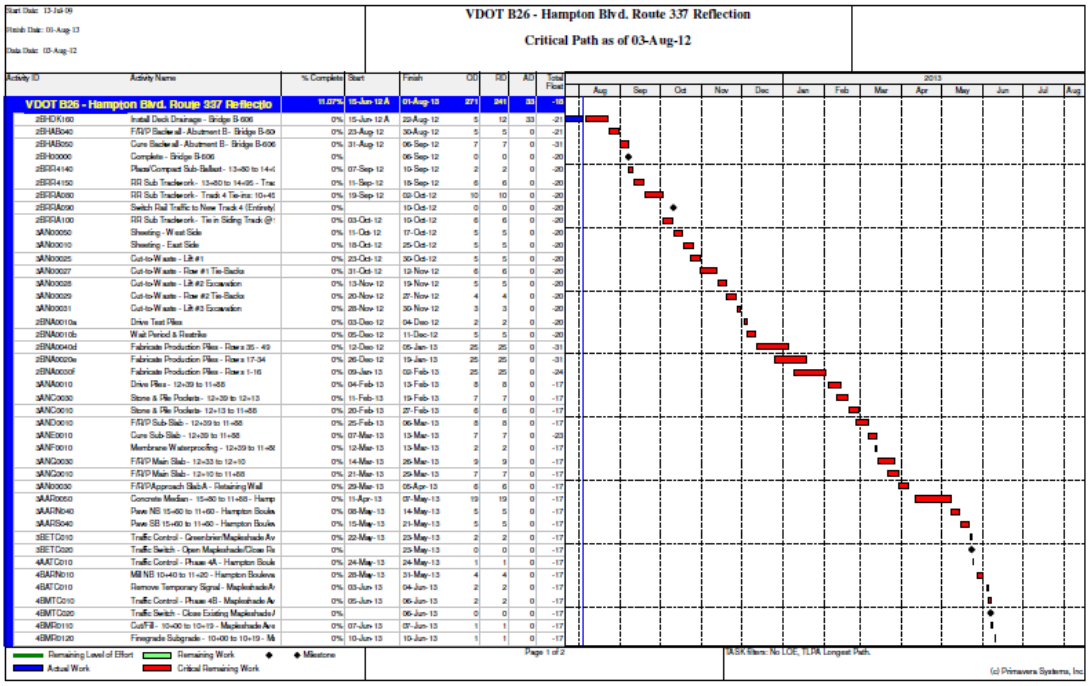
Brainstorming

Brainstorming is critical to allow all participants the chance to contribute and comment. This is a vital part of obtaining the buy-in of all of the participants.

Most effective recovery efforts involve revisions to both the Longest Path and the Near Critical work that becomes the Longest Path as changes to the previous Longest Path shortens the work duration.

Preliminary Analysis

In this case, the authors' brainstorming was facilitated by using the most current updated schedule, filtered to show only the Longest Path, Critical and Near-Critical paths up to the value of the time needed to recovery, which was approximately 45 calendar days. The filtering was done by defining the Critical Path to include all activities up to 45 days of Total Float, inclusive. These are the activities that control project completion for the recovery time frame and all of these activities may need recovery in order to meet the goal.



This approach is much more efficient than starting with just the Longest or Critical Path, which is the typical approach by most schedulers. Starting with the longest pole in the tent, the Critical Path, simply solves the apparent problem, but as the Critical Path is recovered, those activities slip off the path and some other secondary Critical Path takes over, requiring another recovery effort.

Once the schedule is filtered to the recovery duration, the next step relates to choosing the best opportunities for recovery. In recovery efforts, there are generally two choices; fast-tracking or compressing. Fast-tracking is changing the sequencing and logic so as to create more concurrent work, potentially changing one Longest Path into two shorter Longest Paths of the work that does not depend on the original predecessors. Compressing generally requires shortening of durations by adjusting productivity rates with increased efficiencies or increased crews.

The recovery brainstorming should look at both options. Fast-tracking the project is less likely to increase costs than compressing so that is the obvious preferred approach.

Fast-tracking opportunities should start with review of the Critical Paths to see where there might be soft logic driving the Critical Path. Soft logic, which could be resource-driven or simply preference-driven, can often be revised to allow more parallel or concurrent work. Some of the opportunities for fast-tracking are recognized by the longer durations; leading to opportunities to subdivide large scope activities into multiple activities which might be able to progress concurrently.

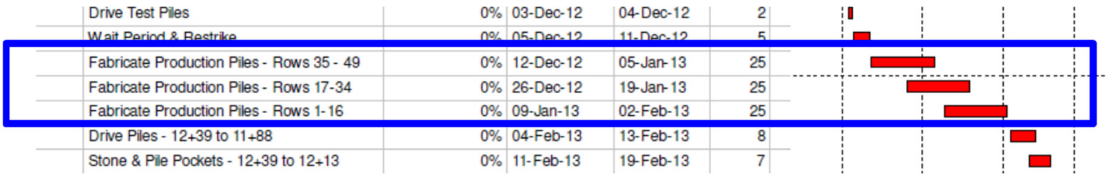
The approach to prioritize this effort starts with changing the sorting of the schedule from Early Dates to Original Durations, with the larger ODs listed first as those are the best opportunities.

Activity ID	Activity Name	% Complete	Start	Finish	OD	RD	AD	Total Float
VDOT B26 - Hampton Blvd. Route 337 Reflectio		**75.41%**	**13-Jul-09 A**	**01-Aug-13**	**980**	**241**	**739**	**-18**
GC-11	Survey	70.39%	13-Jul-09 A	01-Aug-13	814	241	750	-18
GC-1	Trailer	70.06%	13-Jul-09 A	01-Aug-13	805	241	750	-18
2BNA0030f	Fabricate Production Piles - Rows 1-16	0%	09-Jan-13	02-Feb-13	25	25	0	-24
2BNA0020e	Fabricate Production Piles - Rows 17-34	0%	26-Dec-12	19-Jan-13	25	25	0	-31
2BNA0040d	Fabricate Production Piles - Rows 35 - 49	0%	12-Dec-12	05-Jan-13	25	25	0	-31
3AAR0050	Concrete Median - 15+80 to 11+88 - Hamp	0%	11-Apr-13	07-May-13	19	19	0	-17
4BBR0010	Demo Hampton Blvd. Detour Road	0%	18-Jun-13	01-Jul-13	10	10	0	-17
2BRRA080	RR Sub Trackwork - Track 4 Tie-ins: 10+45	0%	19-Sep-12	02-Oct-12	10	10	0	-20
3ANG0030	F/R/P Main Slab - 12+33 to 12+10	0%	14-Mar-13	26-Mar-13	9	9	0	-17
3AND0010	F/R/P Sub-Slab - 12+39 to 11+88	0%	25-Feb-13	06-Mar-13	8	8	0	-17
3ANA0010	Drive Piles - 12+39 to 11+88	0%	04-Feb-13	13-Feb-13	8	8	0	-17
3ANC0030	Stone & Pile Pockets - 12+39 to 12+13	0%	11-Feb-13	19-Feb-13	7	7	0	-17
3ANG0010	F/R/P Main Slab - 12+10 to 11+88	0%	21-Mar-13	29-Mar-13	7	7	0	-17
3ANE0010	Cure Sub-Slab - 12+39 to 11+88	0%	07-Mar-13	13-Mar-13	7	7	0	-23
2AUR0070	Storm 3-5,3-3,3-2,3-1	0%	08-Jul-13	16-Jul-13	7	7	0	-17
2BHAB050	Cure Backwall - Abutment B - Bridge B-606	0%	31-Aug-12	06-Sep-12	7	7	0	-31
3ANC0010	Stone & Pile Pockets- 12+13 to 11+88	0%	20-Feb-13	27-Feb-13	6	6	0	-17
3AN00030	F/R/P Approach Slab A - Retaining Wall	0%	29-Mar-13	05-Apr-13	6	6	0	-17
3AN00027	Cut-to-Waste - Row #1 Tie-Backs	0%	31-Oct-12	12-Nov-12	6	6	0	-20
2BRRA100	RR Sub Trackwork - Tie in Siding Track @	0%	03-Oct-12	10-Oct-12	6	6	0	-20
2BRR4150	RR Sub Trackwork - 13+80 to 14+95 - Trac	0%	11-Sep-12	18-Sep-12	6	6	0	-20
3AARS040	Pave SB 15+60 to 11+60 - Hampton Boulev	0%	15-May-13	21-May-13	5	5	0	-17
3AARN040	Pave NB 15+60 to 11+60 - Hampton Boulev	0%	08-May-13	14-May-13	5	5	0	-17
2BNA0010b	Wait Period & Restrike	0%	05-Dec-12	11-Dec-12	5	5	0	-20
3AN00028	Cut-to-Waste - Lift #2 Excavation	0%	13-Nov-12	19-Nov-12	5	5	0	-20

This project had an activity for concrete curb and gutter (C&G), with monolithic sidewalk, that separated the lane directions, with a single large duration of 18 WD. After review of the plans, it appeared that the C&G activity could be divided into two activities to allow two crews and work on both directions of traffic to occur at the same time.

All options should remain on the table, and this means that some of the suggestions will turn out not to be viable once analysis is done. An example of this was the opportunity identified in the Activity names “Fabricate Production Piles”, which appeared to offer acceleration options from either faster fabrication or quicker delivery.

We also reviewed predecessors to the fabrication activities to examine other opportunities with starting earlier. The schedule showed three groups of production piles to be fabricated, totalling 25 work-days, which is five weeks, and even with the overlap between groups, the entire process was shown to require 6 weeks.



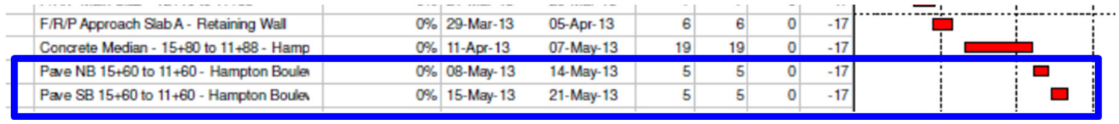
Drive Test Piles	0%	03-Dec-12	04-Dec-12	2	
Wait Period & Restrike	0%	05-Dec-12	11-Dec-12	5	
Fabricate Production Piles - Rows 35 - 49	0%	12-Dec-12	05-Jan-13	25	
Fabricate Production Piles - Rows 17-34	0%	26-Dec-12	19-Jan-13	25	
Fabricate Production Piles - Rows 1-16	0%	09-Jan-13	02-Feb-13	25	
Drive Piles - 12+39 to 11+88	0%	04-Feb-13	13-Feb-13	8	
Stone & Pile Pockets - 12+39 to 12+13	0%	11-Feb-13	19-Feb-13	7	

This opportunity proved not to offer any good options to reduce time, even though it was high on our list.

Other opportunities for recovery included identification of dead time in the longer sequences, such as the Activity names, “Concrete Median”. This activity was scheduled for the full median installation, requiring 19 work-days.

F/R/P Approach Slab A - Retaining Wall	0%	29-Mar-13	05-Apr-13	6	6	0	-17
Concrete Median - 15+80 to 11+88 - Hamp	0%	11-Apr-13	07-May-13	19	19	0	-17
Pave SB 15+60 to 11+60 - Hampton Boulev	0%	15-May-13	21-May-13	5	5	0	-17

The Northbound lane of paving in the depressed area was scheduled to start only after the complete median was installed even though there was work on both the North- and Southbound sides. By starting the paving on the NB side immediately after concrete median was complete on the NB side only, the schedule gained time. This shows how the brainstorming builds on other ideas.



F/R/P Approach Slab A - Retaining Wall	0%	29-Mar-13	05-Apr-13	6	6	0	-17
Concrete Median - 15+80 to 11+88 - Hamp	0%	11-Apr-13	07-May-13	19	19	0	-17
Pave NB 15+60 to 11+60 - Hampton Boulev	0%	08-May-13	14-May-13	5	5	0	-17
Pave SB 15+60 to 11+60 - Hampton Boulev	0%	15-May-13	21-May-13	5	5	0	-17

After review of the fast-tracking opportunities, the next step is to examine compressing the schedule. This requires a review of the quantities and production rates that were used to estimate the durations of activities.

The large duration sort of the Critical and Near-Critical Path filters is a good layout to use to examine the compression opportunities as well. The small durations will likely not yield much savings, whereas the large durations could generate significant savings for the recovery effort.

In this project, the authors reviewed the production rates of the work to see if there were any good opportunities to improve productivity, and discovered that the C&G production rates were based on hand forming and pouring the concrete. If the Contractor could bring in a curb machine instead of hand forming the C&G, the production rate could be increased dramatically.

The brainstorming session continues in this way, addressing all ideas and examining the schedule in as many innovative ways as possible. But the success is based on a technical review of the schedule – remember that the schedule is the technical model of the project plan; if the model is accurate, it will help expose efficiencies in the plan that are not being taken into account.

Facilitating Workshop

Opening Statement

The objective at this meeting was to discuss proposed feasible ideas with all sides to determine what changes could be adopted that would result in an achievable recovery schedule. Use of a

brainstorming meeting was originally conceived by the author Carson of this paper in a Recommended Practice also authored by him in 2007[1].

Discuss Ideas

The result of this meeting is a recovery schedule, but the schedule remains the Contractor's means and methods and sole responsibility.

The beauty of the Recovery Workshop is that different people are looking at the schedule. Individuals perceive the same item slightly differently. This allows for healthy discussion which leads to productive ideas.

Identify Acceptable Targets

Once these ideas have been deemed technically feasible, practical, and discussed with the group, then these specific concepts become the acceptable targets for mitigating the delays in the Project schedule. These targets need to be modelled in the schedule. This list of targets is taken by the Contractor who then needs to perform an analysis to determine which, if any, may be applied to the CPM to produce the Recovery Schedule.

Output/Results

Recovery Analysis

Recovery options were analyzed individually and cumulatively. The cumulative analysis is important as the changing Critical Path will make some ideas less feasible or less attractive as the reductions in Critical Path lengths moves the Critical Path to other activities and sequences.

The workshop yielded a list of proposed schedule changes that were acceptable to all parties and saved the Project 38 calendar days. These changes that were ultimately adopted added no cost to the Project and mostly changed the sequencing of work. Paving, sidewalks, curb and gutter were originally scheduled to be completed at the end of Phase 3 for the entire length of the Project. The proposal to break out the work for Phase 2 and complete this early when the area is complete and available for work, rather than waiting for the completion of Phase 3 saved the majority of the time. Other small changes accumulated to the remaining time savings.

Recovery Plan Acceptance

The Recovery plan must be acceptable to all parties. Both Parties must analyze the Recovery Schedule for feasibility, resources, compliance with the specifications, and the Owner in particular should review to confirm that the recovery effort does not place new burdens or constraints on his in-house and consultant resources.

Implementation of Recovery Plan

Once the Recovery Schedule is approved, it becomes the schedule of record on which Earned Value Management, Earned Schedule Analysis, completion predictions, delay analysis, and Payment

[1] Recommended Practice No. 54R-07, "Recovery Scheduling", Association for the Advancement of Cost Engineering (AACE) International, Morgantown, WV, 2007

Applications will be based. The Recovery Schedule is the new plan to complete the remaining work within the Contract time frame. Future schedule updates will use the Recovery Schedule as the benchmark schedule to create the Updates. The Recovery Schedule or its updates will be used as a basis for any required analysis of potential needs for extensions of time with TIAs for delay events that may impact the job.

It is vital to recognize that recovery scheduling efforts are always more successful when they require the efforts to start immediately rather than counting on a future effort. The project must be turned around to gain recovery, and a small part of the problem is the motivational losses that have occurred due to the recognition of delay. When the project team sees recovery starting and proceeding right away, it helps motivate the entire team to perform at a higher level.

Recovery plans designed to occur in the future can also fail when the project continues to lag or other unforeseen conditions occur to retard performance. The sooner the recovery effort starts, the more likely it will be successful.

Summary/Conclusion

Every project at some point in the project life-cycle is likely to need recovery efforts, and following a structured approach will improve the opportunities to recover as well as reduce the time and effort to develop the recovery plan. Recovery Workshops provide opportunities for partnering, with the Owner and Consultant/CM participating to help the Contractor meet their goals and commitments.