AN OPTIMIZED APPROACH TO RESOURCE LOADING HYPERSCALE TECHNOLOGY PROJECTS TO BALANCE FEASIBILITY, SUITABILITY, AND ACCEPTABILITY

By

Shane Barrett, Bachelor of Science in Construction Management

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APPROVED:

Roger Hull, CRISC, CISM, CISSP, PMP, Committee Chair
LuAnn Piccard, M.S., PMP, Committee Member
Walter Almon, MSPM, PMP, Committee Member

LuAnn Piccard, M.S., PMP, Chair

Department of Project Management

Kenrick Mock, Ph.D., Interim Dean

College of Engineering

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Abstract

In the construction industry, project schedules are invariably dynamic, uncertain, and subject to significant change thru the execution cycle. Therefore, effective planning and scheduling are fundamental activities and correlate closely with the success or failure of a project.

Unfortunately, schedule approach invariably focuses on timing, durations, and milestones without equitable consideration to the interconnection between resource availability, capabilities, and schedule feasibility. A project schedule that does not include resource allocations implies that the contractor has unlimited resources and has the flexibility to apply all necessary resources to a project change, without incurring added costs.

Unlike traditional scheduling techniques, Resourced Loaded Scheduling captures & integrates the interdependencies between activities and resources and effective utilization. Moreover, it involves the prioritization of activities based on utilization strategies, determination of resource availabilities, and the utilization of alternate resources. By doing so, decisions about capacity are incorporated into the scheduling process.

The project hypothesis, which was partially confirmed, stated that depending on project type, parameters and financial thresholds need to be established for Resource Loaded Schedules (RLS) to achieve optimum results. The research included examination of effective Resource Management and Scheduling from literature, peer reviewed article publications, interviews with Subject Matter Experts and a case study implementing Resource Loaded Scheduling on a capacity project, executed in a finite time period.

Key Word Choice

Resource Loading, Planning & Management, Project scheduling Best Practices, Efficient, Intelligent, Deliberate utilization, Accuracy, Overallocation, Finite resources & Predictability.

Introduction

Project description

Construction project scheduling has evolved into a powerful and complex management tool. The level of expertise for schedulers has risen considerably; however, the level of understanding of managers and executives who supervise them has lagged. Therefore, developing a good schedule for managing the execution of a project is paramount to good project management practice. However, managing a project schedule can be one of the most formidable parts of project management.

An accepted truth in project management is that the majority of projects have defined limits on the pool of resources available for utilization due to costs, disciplines and skills required, demographics, and other factors. An opportunity to this limitation exists in the form Resource Loaded Scheduling (Loading each schedule activity with available resources). Evaluating a resource-loaded schedule will help determine if the planned approach, timeline, and project cost are all feasible in execution which adds incredible dynamism and depth to the schedule.

Fully loading the schedule with resources, including materials, equipment, direct labor, travel, facilities, equipment, and level-of-effort activities, provides the basis for the performance measurement baseline (PMB), which can be used to monitor the project using earned value management (EVM). When a schedule is fully resource loaded, budgets for direct labor, travel, facilities, equipment, material, and the like are assigned to both work and planning packages so that total costs to complete the program are identified at the outset.

Examples of this can be seen in Resource Loaded Scheduling being a requirement in many mission critical organizations across a plethora of industries. NASA's Schedule Management Handbook provides guidance on meeting NASA's schedule requirements, best practices, concepts, and techniques associated with schedule management. NASA's handbook emphasizes the importance of loading and assigning resources. The handbook states that resources should be assigned within the schedule itself to ensure proper cost and schedule integration. In addition,

NASA guidance stresses that resource loading and leveling is recommended to ensure that the plan is complete and credible; otherwise, significant risk is assumed if a schedule is baselined without first being resource loaded and leveled. Per the U.S. Government Accountability Office, Schedule Assessment Guide, Best Practices for Project Schedules, a schedule should reflect the resources (labor, materials, travel, facilities, equipment, and the like) needed to do the work. As resource requirements directly relate to an activity's duration, assigning resources to activities ensures that the duration of activities using them will be realistic and rational.

Yet regrettably Resource loading and leveling of schedules appears to be a mysterious process that is not well understood. Requests for implementation of Resource-loaded Schedules are met with resistance across the industry. The common rationale for this resistance is cost or uncertainty regarding the true value add. However, the most obvious rationale is the aforementioned manager and executives lagging levels of understanding juxtaposed to the expertise of the project schedulers. The output of this resistance or lack of knowledge at an Exec level is a continuance of wholly avoidable schedule impacts

Problem Statement

A Critical Path Method project schedule identifies the activities, tasks, milestones, interdependencies, and sequencing logic to successfully complete a project. However, an executable construction schedule should also explicitly and systematically incorporate an organization's capacity to complete a project. In order for the project to succeed, the project team must know answers to resource availability (Unless infinite capacity exists) and any competing priorities as they are important to the planning and control of any project.

Resource Loaded scheduling involves allocating and scheduling resources based on resource capacity, availability, effort, as well as project scope. This level of detail allows real time decisions or pivots to be completed, factoring time, costs, and resources. Yet, implementation of Resource-loaded Schedules is met with resistance across the industry, both by clients, General Contractors and Trade partners alike. The common rationale for this resistance is one or a combination of the below:

- Cost of implementation is prohibitive.
- Tool value or appropriate use is ambiguous.
- Objective & benefits are unclear.
- Use of tool requires too much upfront work, time better spend on Precon or Engineering.
- Tool maintenance is time-consuming and requires too much analysis thru the project lifecycle.

The output of this resistance is a continuance of the historical "surprise" when project or organizational change or plan deviation occurs. These understandable, yet inherently avoidable resource limitations then begin to drive the schedule, changing the critical path and result in costly extensions or change.

Hypothesis

The project premise is to test the hypothesis that parameters and financial threshold requirements need to be established, depending on project type, for optimum results in the Construction Tech sector. Testing the stated hypothesis will involve the following.

- An examination of effective Resource Management and scheduling from literature.
- Peer reviewed article publications and results from real world organizations using resource management.
- A case study implementing Resource Loaded scheduling in a retrofit construction setting
- A survey and interviews with peers in the Preconstruction, Controls and Execution fronts, on both the Owner and General Contractor (GC)/Trade Partner (TP) sides of the industry.

Once finalized, all of this information will be compiled, analyzed, and then presented to test the stated hypothesis.

Project Scope

1. Evaluation of steps to accurately resource load a schedule & associated costs.
2. Resource load a physical Mechanical, Electrical, Plumbing (MEP) Capacity project.

3. Understand level of effort required to track, maintain and status a resource loaded schedule & associated costs.
4. Conduct research to identify themes, evaluate and build off existing understanding of this topic and how it relates to the project hypothesis.
5. Create (based on existing theories and knowledge) and test the hypothesis - Parameters and financial thresholds need to be established, depending on project type, for optimum results.
6. Compile conclusions, recommendations and areas of future research based on project findings.

Project Goals and Objectives

1. Actively engage, manage & control a range of stakeholders to successful completion
2. Complement and expand upon industry & classroom knowledge on topic while sharpening critical and analytical research & thinking skills.
3. Gain a better understanding, at a micro level, industry reluctance to wide scale utilization of Resource Loaded scheduling.
4. State the findings, without bias or interpretation, proving, disproving, or adding clarity around the stated hypothesis.
5. Detail the influence of project management processes & the focus knowledge areas, Communications Management, Risk Management & Stakeholder Management, highlighting their importance successful Project Management.

Acceptance criteria

1. Prove or disprove the hypothesis that parameters and financial thresholds need to be established, depending on project type, for optimum results.
2. Complete this effort within the roadmap identified, Fall semester 2020 for PM 686A & Spring semester for PM 686B.
3. Complete a literary review, questionnaire, and interviews with Subject Matter experts to test and validate theory.
4. Successful implementation of the Resource Loaded schedule on the case study.

Assumptions

1. Full access to an MEP project implementing the Resource Loading approach
2. Based on experience, the author expect projects less than $500,000 in total value need an alternate approach or a scaled version of Resource loading and maintenance.
3. Resistance to more frequent usage is driven by lack of knowledge / Fear of the unknown
4. Available tech, namely MS Project or Primavera, does not limit ability to Resource load.
5. An objective and efficient approach to Biweekly activity progress reporting exists.

Constraints

1. Maximum 20 available labor hours per week to invest in the project.
2. Accepted time constrains to complete project & document development may impact research methodology depth and limit available results for analysis.
3. Interest and experience in but no professional background in project controls
4. Not impartial, author acknowledges bias toward more control and accountability.

Project Management Knowledge Focus Areas

As addressed in the Project Goals and Objectives, three knowledge areas from the Project Management Body of Knowledge to be addressed, capturing a professional level of competency. The focus Knowledge Areas selected were Communication, Stakeholder, and Risk Management.

- Communications Management - Effective communication ensures the project team is providing information in the right format, at the right time, and with the right impact. A key project goal was to ensure timely and appropriate identification, collection, distribution, and disposition of project information to the project team, Stakeholders, and the Project Sponsor. See **Appendix C** for full breath of the Communication Plan
- Stakeholder Management – This includes the processes required to identify the people, groups and organizations that could affect or be affected by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate strategies and tactics for effectively engaging stakeholders in a manner appropriate to the

stakeholders' interest and involvement in the project. See **Appendix D** for full Stakeholder Management details

- Risk management - This identifies the processes and structures that are directed towards realizing potential opportunities, while simultaneously managing possible adverse impacts. Risk management is a continuous activity conducted throughout the life of the project. It seeks to identify potential risks, evaluate their likely impact, develop mitigation plans, and monitor progress. Reference **Appendix E** which encapsulates Risk Management plan.

Project Expected outcomes

It is expected the hypothesis is accurate, the Resource Loading approach applied to $1Billion Greenfield project cannot be replicated on a sustaining Type C retrofit project, totaling ~$500K. The author believes this to be the accurate based on a number of factors:

1. Implementation of Resource Loading for the Case Study project (Valued at ~$23MM) required dedicating a field engineer and scheduler which would typically have been a half time, due to the added resource activities. Smaller sustaining Type C projects will not have the available budget to dedicate resources.
2. When the subject of Resource Loading is discussed this can encompass labor resources, non-labor resources (material / equipment), and / or cost loading. Once more, depending on the scale and complexity, parameters will need to be agreed upon to ensure the value derived matches the Level Of Effort involved and associated cost.
3. Strategic partners and vendors need to be able to plan for intelligent resource usage and efficiencies. Establishing parameters for implementation as part of the scheduling spec will ensure all parties can respond and scale appropriately.

Finally, based on lessons learned from initial General Contractor resource loaded schedule submittal to baseline acceptance and execution, multiple recommendations and best practices have been realized. These recommendations will hopefully form the bedrock for a best practices section to be added to the Orgs global scheduling spec.

Literary review

Research Approach

Hart (1998) defined the literature review as "the use of ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new". He also noted that for the literature review, "quality means appropriate breadth and depth, rigor and consistency, clarity and brevity, and effective analysis and synthesis"

From these definitions it is clear that an effective literature review should include the following characteristics:

1. Methodologically analyze and synthesize quality literature
2. Provide a firm foundation to a research topic
3. Demonstrate that the proposed research contributes something new to the overall body of knowledge or advances the research field's knowledgebase

For this paper, the research of existing literature and resources was conducted by online research methodology and secondary data analysis, including guidance and references from Subject Matter Experts. This paper presents the literature review process in a systematic way following the "input-processing-output" approach. The sequential steps followed of collecting, comprehending, applying, analyzing, synthesizing, and evaluating quality literature were followed.

Scheduling best practices, optimization of schedules, Efficient utilization, Intelligent/Deliberate usage, and Resource Constrained Project Scheduling problems were the subject of research. The purpose of this research methodology was to identify themes, evaluate existing understanding and the body of expert knowledge that exists on this topic and how it relates to the project hypothesis

An immense amount of information is available relating to scheduling best practices, optimization, Efficient & Intelligent utilization, and Resource Constrained Project Scheduling

problems. The review of literature provided details surrounding the earliest developments in scheduling practices, differences in methodologies, advantages associated with Resource Loading scheduling and the perceived decaying of schedule knowledge at Exec level.

Literary Research Background

The baseline or construction schedule is a prediction based on the quality of the inputs and previous experiences. It represents the original understanding of the project and the intended schedule for completing the project. Therefore, the baseline must be reasonable realistic and account for the following.

- Size and complexity of the project
- Local codes and regulations
- Location and access, labor market
- Materials and equipment availability
- Prices & Procurement time

These considerations should appropriately influence the inputs and then are suitably reflected in the contractor's baseline schedule. Traditionally, the schedule is prepared prior to the start of the project but used throughout the project to detect any deviations and to compare performance. Ideally, the construction schedule should be used daily to build the project and updated frequently in order to accurately measure progress.

Some of the precursors to todays detailed approaches include, bar charts, Activity-on-Arrow or Arrow Diagramming Method (ADM), The Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). However, developments were required based on limitations of the traditional methods such as CPM/PERT. Approaches such as Resource Loaded Scheduling offered more effective scheduling and solved issues such as vagueness in Critical path. Literature also showed a trend in scheduling methods to not only include one critical path, as in the traditional approach but multiple critical paths. In the majority of literature reviewed the main focus was on ensuring resource continuity as well as managing cost. Literature on major constraints associated with scheduling was also reviewed. The most common constraints include,

resource constraints, time constraints as well as problems associated with the job shop scheduling.

Developed in 1917 by Henry Gantt, Bar Charts are depictions of when activities are scheduled. Within the industry, they are the most often used scheduling visualization tools because of their simplicity and unsurpassed visual clarity; anyone can read and prepare them. Therein lies the greatest asset of the bar chart and its greatest weakness—its simplicity. A bar chart does not show logical dependency among activities and does not support manual project progress measurement. Although the status of an activity is easily determined, the status of the overall project is very unclear. **Figure 1.0** below highlights clear durations and sequence, but progress and resource management is an unknown

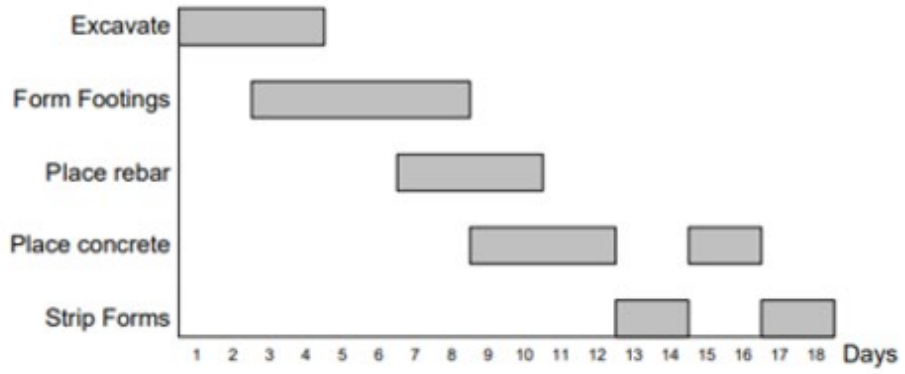

Exhibit 1.0 Bar Chart - Slab on grade activities

The science of scheduling as defined by Critical Path Analysis (CPA) was developed in 1956/57 by Morgan Walker and James Kelley Jr who started developing the algorithms that became the Activity-on-Arrow or Arrow Diagramming Method (ADM) scheduling methodology for DuPont. The program they developed was trialed on plant shutdowns in 1957 and their first paper on critical path scheduling was published in March 1959. The Program Evaluation and Review Technique (PERT) system was developed by the US Navy Special Projects Office (SPO) for a missile program (Polaris) at around the same time but lagged Critical Path Method (CPM) by six to twelve months, although the PERT team first coined the term ‘critical path’.

They are remarkably similar to each other, both using an arrow diagramming method, but were developed for fundamentally different business fields. CPM was aimed for the construction and maintenance industry where technologies and processes were largely known, and estimations of task durations could be done with some accuracy. In contrast to CPM, PERT was focused on military research and development (R&D) where time pressures were high and cost a secondary issue. In an R&D environment, activity durations were difficult to estimate, thus, PERT emphasized probability.

A CPM schedule is a type of schedule that prioritizes construction activities and their predecessors in the order in which they need to be completed to reach the project's targeted completion date. This type of schedule proves to be beneficial in many ways. If executed properly, the project is broken down into discrete activities with estimated durations and forces the project team to logically sequence each construction activity. The CPM process then forces the team to address critical questions that might not have otherwise been considered. The final project schedule will show the critical path and float time between each activity, which is an excellent tool for controlling the project during execution (Griffith, 2006). When it comes to CPM, however, there are certain limitations.

In a paper by Herbets, J. S. (1976). "Will the real critical path please stand up", published by the Project Management Institute, the limitations of CPM are explained in a clear model. See **Figure 2.0** below

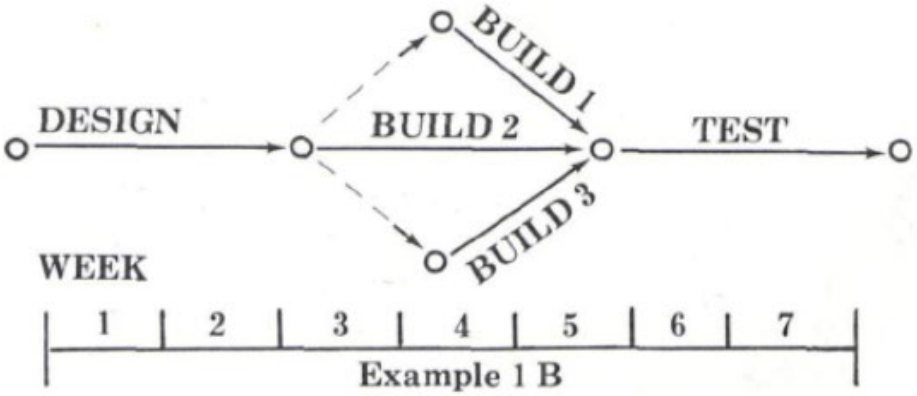

Exhibit 2.0 - CPM schedule with rudimentary activities

In this basic schedule, there is a Design activity, three Build activities that are dependent upon the design activities, and a Test activity that is dependent upon the three build activities. It is easy to see that the critical path can be followed to be Design, Build 2, and Test in that order, with float time between the start of Build 2 and the start of activities Build 1 and Build 3. Herbets uses this example because it is so easy to understand. However, Herbets then asks if it is still easy to understand after he proposes the following questions:

- *Who is going to work on these activities?*
- *Can we assume this project is standing alone, or is it one of twenty, or more projects, of differing priorities?*
- *Can we assume unlimited resources available for each project and is each resource able to spend full time on all activities assigned?*
- *Can we assume that Build 1, Build 2, and Build 3 will be assigned different, and available resources?*

After observing the CPM and asking the above questions it becomes clear that CPM is limited to only providing activities and the sequence in which they flow in. In order for the job to succeed, the project team should know answers to the points mentioned above as they are important to the planning and control of any project (Herbets, 1976).

Resource-loaded scheduling is substantially different from CPM because it loads physical resources into the project schedule such as labor, capital equipment, facilities, and materials. By doing so, making decisions about capacity is then incorporated into the scheduling process. It is a methodology that encompasses resource loading, resource leveling, and time analysis (critical path) all in one dynamic schedule. After evaluating a resource-loaded schedule, it will help determine if the planned approach, schedule, and project cost are all feasible (Griffith, 2006).

Resource-loaded scheduling methods typically begin by establishing an initial set of dates based on time analysis, or critical path analysis. The activities and dates that are created are then used as inputs for the resource scheduling process. Next, resource requirements and/or targets for each

activity are loaded. Lastly, dates and quantities available are established for each resource (Matthews, 1994).

Resources are materials, equipment, labor, or anything needed to complete an activity and most activities will require one or more resources. Activities consume time and resources; therefore, they must be assigned and measured. Assigning activities to responsible parties is imperative because it significantly helps divide the project into manageable pieces, assigning them to the party best suited to perform the work. In addition to determining what an activity is and how long it should take, the assignment tells who is responsible. In order to control the progress of the entire project, the progress of each activity must be measured, and the assigned party held responsible for its sufficient progress. Once resources are applied to an activity, the project resources should be leveled to improve work efficiency and minimize cost. Resource leveling is the process of smoothing out daily resource demands by shifting the time at which an activity is performed without violating the job logic. To do so effectively, the scheduler must employ resource constraints. No contractor has unlimited resources and the constraints placed on resources should reflect the most likely amount of labor, equipment, and materials available to the contractor under normal conditions. These resource limitations may drive the schedule, changing the critical path.

If we Take Herbets' simple model mentioned above, and load labor resources to it, we can see how the critical path and time analysis change. See approach to assigning resources below:

- *Designer #1 to design the project*
- *Engineer #1 to Build 1 & Build 3*
- *Engineer #2 to Build 2*
- *Tester #1 to test the project.*

The results are illustrated in a new model below. See **Figure 3.0** below

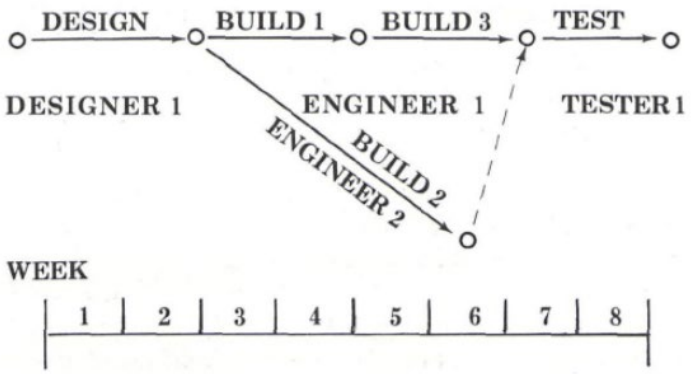

Exhibit 3.0 A Resource-Loaded Model

Resource availability has been added to the model and this important component changes the sequence of activities. Before, in the CPM model, Build 3 did not depend on Build 1, but now that Engineer #1 is assigned to those two activities the required resource now becomes critical. One could assume infinite available engineers, but the reality is that all projects have head count and specialty trade limitations. When adding the availability of a resource to work on an activity, the activity and subsequent dependent activities may alter the critical path.

Research conclusions

The level of scheduling understanding by managers and executives who supervise schedulers has declined. As a result, the proper use of scheduling language and an appreciation of the importance and complexity of the scheduling process have also decayed. In general, scheduling answers who and when, determining the sequence and timing of construction operations. The schedule is the end result of planning which conveys what must be done, how and where it will be performed, and in what general sequential order it will be completed. Essentially, the inputs to the scheduling process are direct results of the planning efforts. Therefore, an inability to schedule stems from a reluctance or incapacity to plan. The underlying principle of the entire process is to make abstraction fit real project conditions, to narrow the gap between the model and the construction project. A fundamental element to this process in an understanding of the resources involved.

The authors research identifies four characteristics of a high-quality & reliable schedule, it must be comprehensive, well-constructed, credible, and controlled. This level of sophistication includes all activities necessary to accomplish a projects' objectives as defined in the WBS. The schedule includes the labor, materials, facilities, equipment, and the like needed to do the work and depicts what resources are needed, when they will be needed & as importantly when they will actually be available.

While resource loading an entire schedule may be a difficult exercise, it encourages management to assess the amount of resources available and encourages a discussion of difficult questions early in program planning. If the resource-loaded schedule alerts decision makers that the available resources will not suffice to execute the work on time as planned, management can begin negotiating for additional resources early in the program. Finally, linking available resources to activity durations may expose infeasible durations to scrutiny or show opportunities to reduce durations with the application of more resources. The intrinsic rationale for implementing resource loading is outlined below

- Incorrect resource assumptions (*usually in the form of unwarranted optimism*) will lend unreasonable credence, and the resulting schedule will convey a false sense of precision and confidence to senior decision makers.
- The amount of available resources, whether labor or nonlabor, affects estimates of work and duration, as well as the availability of resources for subsequent activities.
- The schedule should realistically reflect the resources that are needed to do the work and—compared to total available resources—should determine whether all required resources will be available when they are needed
- Activity owners are able to explain the logic behind their resource estimates.
- The same assumptions that formed resource estimates for the cost estimate are applied to the estimated resources loaded into the schedule and are documented in the Basis of Estimate (BOE).

Implications and effects if Resource Loading **is not implemented**

- Resources must be considered in the creation of a schedule because their availability directly affects an activity's duration.
- A schedule without resources implies an unlimited number of resources and their unlimited availability.
- If there is no justification for allocating and assigning resources, the schedule will convey accuracy falsely.
- Unrealistic peaks in forecasts of resource assignments represent the need for large amounts of resources near the end of work streams to finish deferred or delayed work on time. Often the quantity of resources and funding required at the peak is unrealistic.
- Information on resource needs and availability in each work period assists in forecasting whether activities will be completed as scheduled. If the current schedule does not allow insight into the current or projected allocation of resources, then the risk of the project slipping is significantly increased. Overallocated resources result in inefficiency or delays from unavailable resources.
- A schedule that has not reviewed and resolved resource use issues is not reliable.
- If the baseline schedule does not identify the planned resources, it cannot be used to make important management decisions, such as reallocating resources from activities with significant float to critical activities that are behind schedule.
- If the schedule does not have resource assignments, management's ability to monitor crew productivity, allocate idle resources, monitor resource-constrained activities, and level resources across activities is severely limited.

Finally, according to The Construction Labor Market Analyzer, construction labor cost averages 20 to 40% of total project costs. Therefore, success on construction projects is highly dependent on the efficient utilization of limited and costly resources. Because activities consume resources they must be assigned and measured or they have the ability to drive the schedule, change the critical path and be detrimental to project budget and organizational reputation.

Case study

Description

One of the primary focus areas of this project was the Case study. This involved the implementation of a Resource Loaded Schedule on a physical Mechanical, Electrical, Plumbing and Building Management Systems (MEP/BMS) project, managed and controlled by the author. Execution commenced on 9/21/2020, and the schedule was updated weekly with incorporation of a physical percent complete, actual labor hours spent for each activity with Labor histograms by trade & a productivity index.

Initial drafts of baseline schedule contained various labor peaks and troughs and Phase 1 scope was over twelve (12) months in total duration. It would have been difficult to ascertain these resource fluctuations and general incoherence by just evaluating scheduled activities in isolation. It is also highly likely this inefficient and poor-quality baseline schedule may have been accepted without this added layer of detail. As the GC and strategic partners involved and working multiple campus projects simultaneously the Resource Loaded approach has many benefits

1. Particularly useful when multiple retrofit projects are taking place in parallel and the same trade partners are being used for different projects
2. Allows for comparison and analysis of progress and performance against baseline metrics

Based on the detail provided, the Owner and Contractor collaborated on a more strategic approach . The GC resubmitted a baseline schedule with increased focus on evaluation of labor peaks and used labor hours to validate utilization and efficient approach. This resulted in an updated Phase 1 duration of nine (9) months and less planned mobilizations and remobilizations which reduced the Safety and QAQC risk models across the project

Background

This project was evaluated for potential utilization of the Resource Loaded Schedule approach and was chosen for the following reasons

- Maturity level of the project team and an acknowledgement of the need for continual improvement in schedule proficiency
- An agreement that resource inefficiencies likely exist but a lack of quantifiable data to validate the suspicion.
- A willingness to explore options to empower better resource utilization with an understanding of the need to scale in the short to medium term.
- A preference to maintain strategic partners as opposed to competitive bidding for all programs but an understanding that this decision limited skilled labor available
- Phase II needing to be completed in a finite timeframe with heavy penalties for poor performance or potential impacts to Provision Ready (PR) date, when the network is ready to be brought online and serving traffic

Details

The project schedule was developed with the following agreed upon criterial for implementation, control, and monitoring.

- The baseline schedule was loaded with all direct labor hours, capturing the three major trade partners and the associated sub vendors.
- The use of an early plan curve and a late plan curve was implemented.
- Labor histograms by trade & productivity index to be captured.
- Assign unit budget values to activities for labor hours. This value should represent the lump sum of the direct labor hours associated with each activity and should tie to the hours in the GMP.
- Contract Milestone Summary:
- Milestones will be constrained to show negative float when the calculated late finish date of the last Activity is later than the specified interim and/or Final Completion date.
- Large portion of scope takes place during the Suite-Level Retrofit (SLR) windows, a finite time period similar to a Petrochemical “Planned Turnaround”
- Imperative that the schedule is developed using labor hours to validate the feasibility of durations and labor density in the data halls during the time critical SLR window.

- Initial drafts of baseline schedule contained various labor peaks & troughs. Contractor resubmitted baseline schedule with increased focus on evaluation of labor peaks and used labor hours to validate a more reasonable target duration.

Execution

As previously identified, execution on this MEP project commenced on 9/21/2020. This project was broken into two (2) phases:

- Phase 1 - Captured all demo, equipment installation & terminations and Back of house reprogramming work.
- Phase II – All cutovers, terminations, startup, testing and Commissioning

Schedule submissions from the GC are biweekly and include a percentage completion walk with the project team and owner prior. This walk is for validation purposes, to verify what has been captured by the trade partners and verified by the field engineer. Once alignment is reached the Owner receives the following submission.

- 6 Week Look Ahead (6WLA) Schedule Submission
- Critical Path Schedule Submission
- Full Schedule Submission
- XML File
- Resource Curves
- End of Month, schedule narrative

Project Performance Highlights

October Month End update: Phase 1 completion dates expedited from previous update due to procedure approval allowing overhead conduit in Area B to start sooner. Phase 1 tracking 13 calendar days ahead of project baseline per **Exhibit Four**. The To Complete Performance Index is at 1.01, but Productivity Index is still low at .69, though trending more positively, see **Exhibit Seven.** Actual labor count on site continued to exceed budgeted totals, reference **Exhibit Six**, and discussions were held with the general Contractor and Electrical Contractor regarding project burn rates.

Activity ID	Activity Name	Baseline Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	22-Feb-21	22-Feb-21	0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	9-Mar-21	9-Mar-21	0
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	18-Mar-21	18-Mar-21	0
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	5-May-21	05-May-21*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	5-May-21	5-May-21	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/05/2021)	5-Oct-21	5-Oct-21	05-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

Exhibit 4.0 October variance tracker

FTW1 - RRL: Overall Progress Curve

	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020
Total	Hours													
	Period													
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0
662	Earned	220	73	223	146	0	0	0	0	0	0	0	0	0
36507	Forecast (Earned)	0	0	0	0	581	153	933	783	0	320	1023	802	0
	Percentage													
	Period													
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%
	Earned	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Forecast	0%	0%	0%	0%	2%	0%	3%	2%	0%	1%	3%	2%	0%
	Cumulative													
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%
	Earned	1%	1%	1%	2%									
	Forecast (Earned)		1%	1%	2%	3%	4%	6%	8%	8%	9%	12%	14%	14%

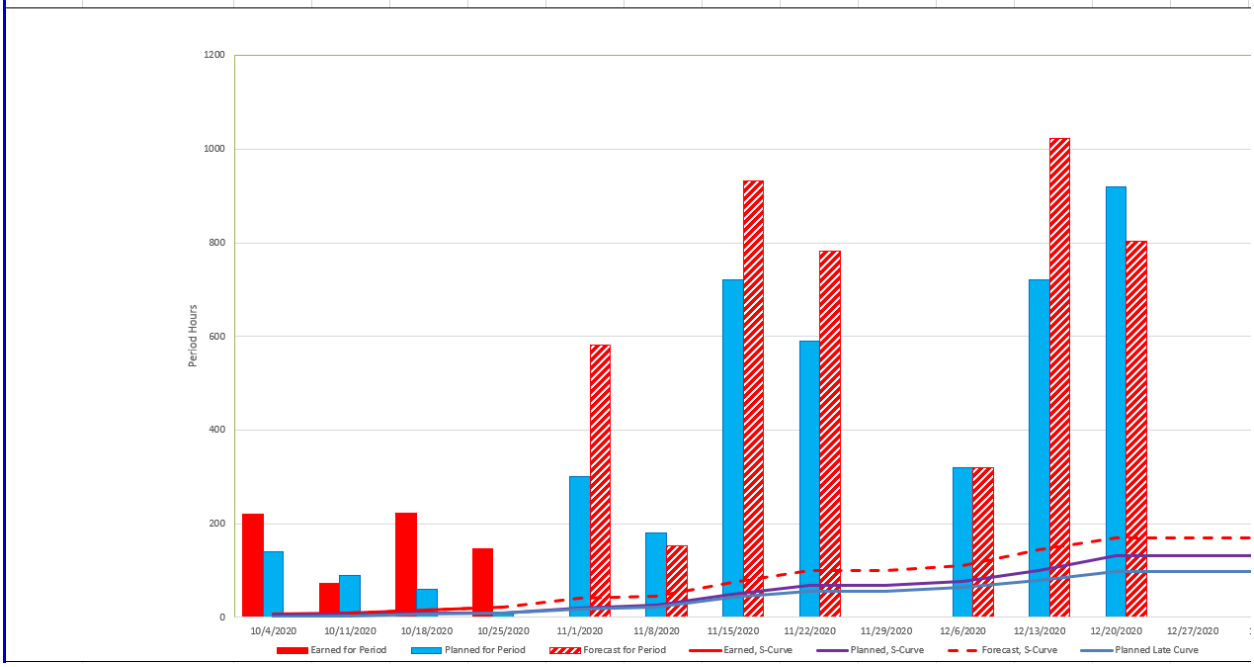

Exhibit 5.0 October progress curve

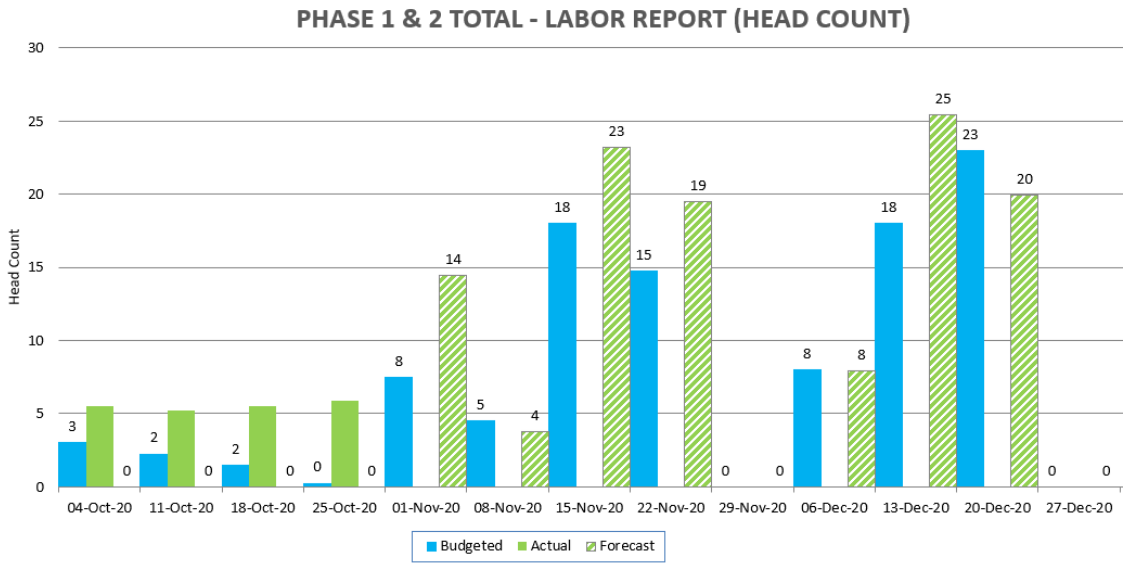

Exhibit 6.0 October Labor report & forecast

FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.02	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20				
29-Nov-20				
13-Dec-20				
3-Jan-21				
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*

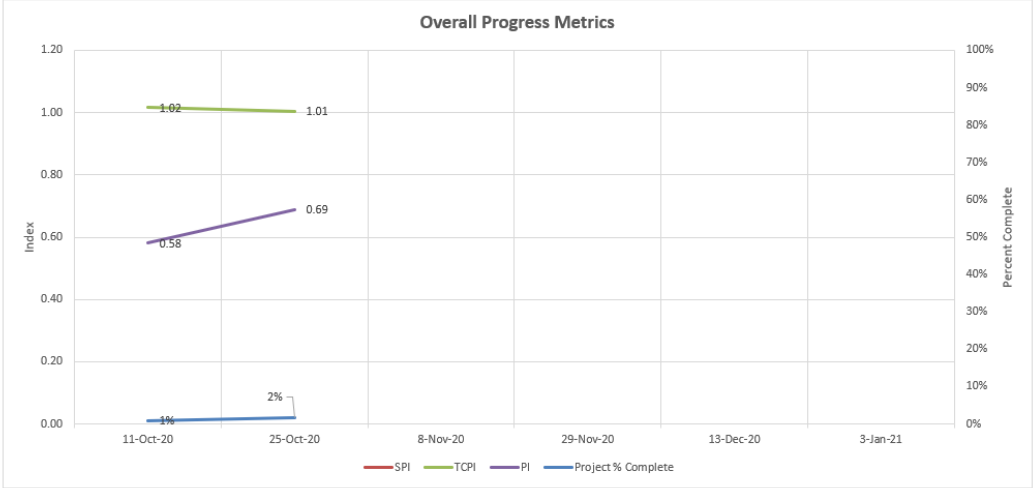

Exhibit 7.0 October key progress metrics (SPI, PI, TCPI & %Complete)

<u>January Month End update</u>: Area C extended 12 days from previous submission, due to an incorrect tie that was realized and lost time due to the Winter Storm. However, per **Exhibit Eight**, Phase 1 Completion date gained one day of efficiency overall due to Area B being on Critical Path. The To Complete Performance Index is at 1.24, SPI at 1.0 and the Productivity Index continues trending positively, see **Exhibit Eleven**. Actual labor count on site continued to trend below budgeted totals, reference **Exhibit Ten** with established teams proving to be more efficient and all teams being mindful of high densities, simultaneous projects and COVID threats

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Fin	Variance to Previous Update
FB.MS.1480.1B10	Project Team Mobilize				0
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	18-Feb-21	17-Feb-21	1
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	8-Mar-21	8-Mar-21	0
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	17-Mar-21	29-Mar-21	-12
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	4-May-21	04-May-21*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	4-May-21	4-May-21	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	4-Oct-21	4-Oct-21	04-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

Exhibit 8.0 January variance tracker

FTW1 - RRL: Overall Progress Curve

Total	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021	1/17/2021	1/24/2021	1/31/2021
	Hours																		
	Period																		
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0	0	740	980	700	770
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450	480	360	470
7099	Earned	220	73	223	146	320	111	864	781	0	381	973	1049	0	0	488	1042	428	0
30070	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	952
	Percentage																		
	Period																		
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%	3%	2%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%	1%	1%	1%
	Earned	1%	0%	1%	0%	1%	0%	2%	2%	0%	1%	3%	3%	0%	0%	1%	3%	1%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
	Cumulative																		
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%	16%	17%	19%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%	11%	12%	13%
	Earned	1%	1%	1%	2%	3%	3%	5%	7%	7%	8%	11%	14%	14%	14%	15%	18%	19%	
	Forecast (Earned)																	19%	22%

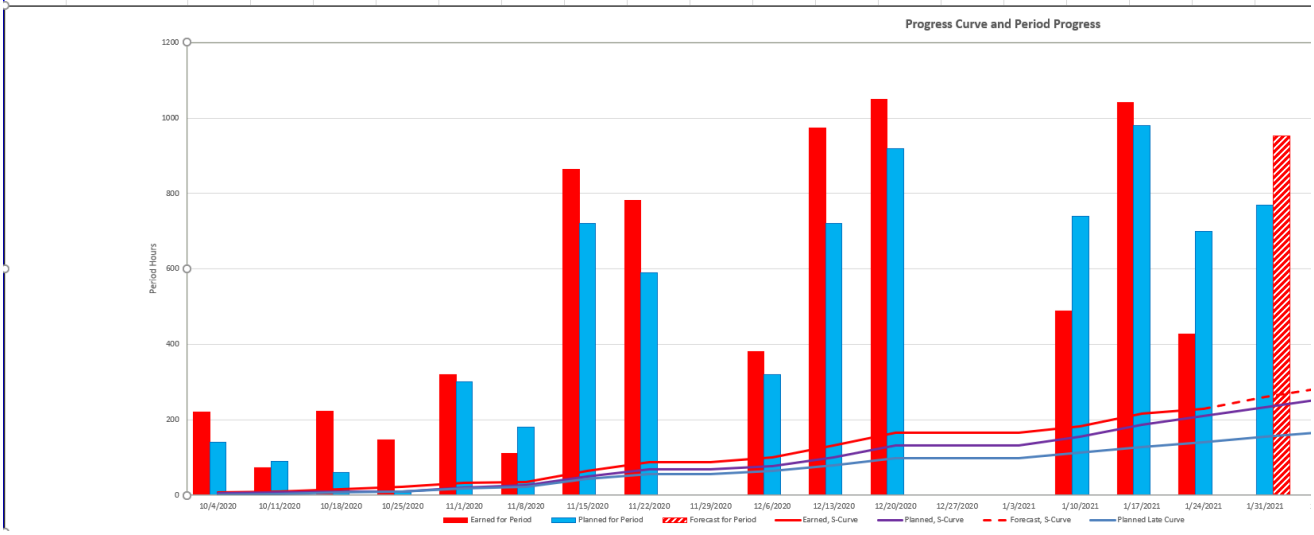

Exhibit 9.0 January progress curve

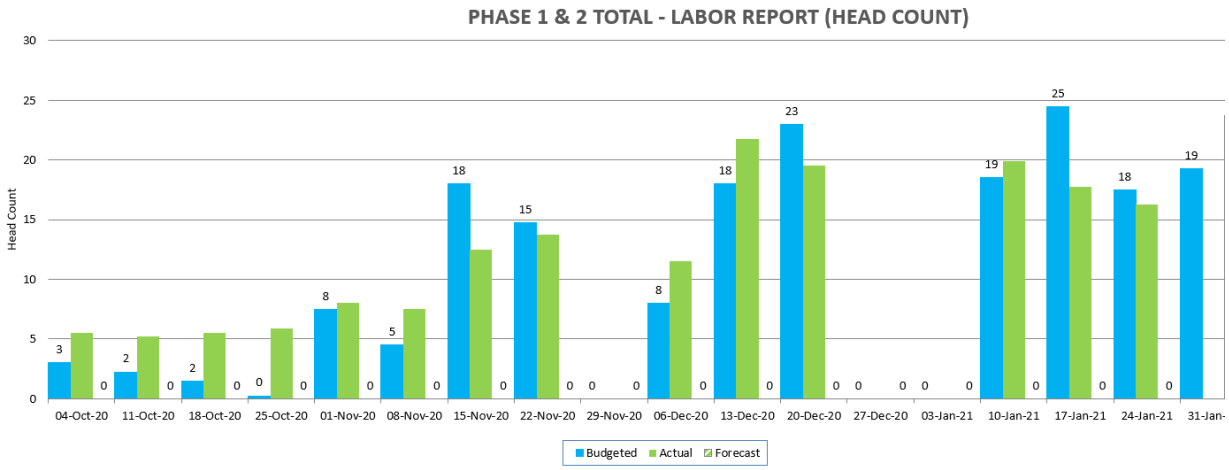

Exhibit 10.0 January Labor report & forecast

FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20	3%	1.40	1.01	0.69
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.10	1.03
3-Jan-21	14%	1.27	1.07	1.08
24-Jan-21	19%	1.00	1.24	1.03
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*

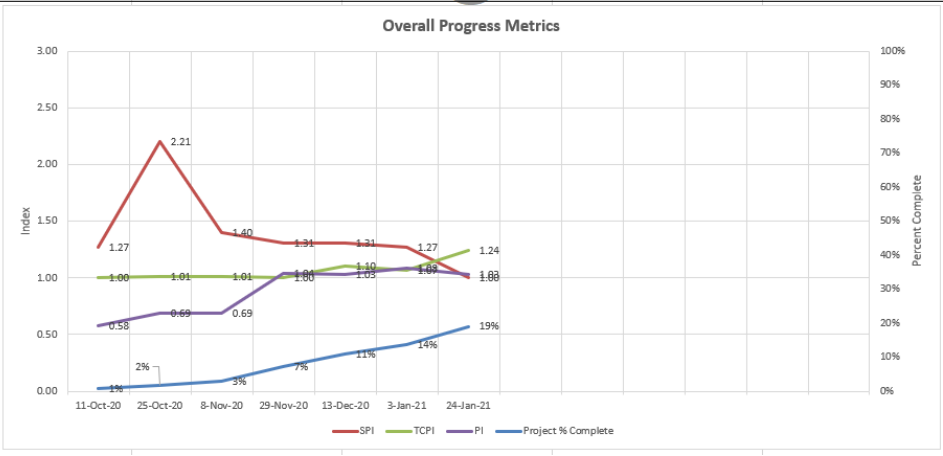

Exhibit 11.0 January Key Progress Metrics (SPI, PI, TCPI & %Complete)

March Month End update: Overall Phase 1 Areas A&B were both completed ahead of contract schedule. Per **Exhibit Twelve**, the largest variance throughout the month was in Phase 1 Area B due to an extensive effort constructing a safe way to complete the fire caulking. The To Complete Performance Index is at 1.02, SPI at 1.06 and the Productivity Index continues trending positively at 1.09, see **Exhibit Fifteen**. Actual labor count on site continued to trend at or below budgeted totals, reference **Exhibit Fourteen**. Finally, per **Exhibit Thirteen**, Phase 1 continues to trend closer to the Early completion curve with a projected completion date of 5/10.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
CONSTRUCTION MILESTONES		05-Oct-22 17	05-Oct-22 17	05-Oct-22 17	0
FB.MS.1480.1B10	Project Team Mobilize				0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	14-Mar-21 07	09-Mar-21 17	09-Mar-21 07 A	1
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	16-Mar-21 17	10-Mar-21 17	15-Mar-21 17 A	-5
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	30-Mar-21 17	31-Mar-21 17	30-Mar-21 17	1
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	10-May-21 17	10-May-21 17	10-May-21 17*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	10-May-21 17	10-May-21 17	10-May-21 17	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	04-Oct-21 17	04-Oct-21 17	04-Oct-21 17*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	04-Feb-22 17	04-Feb-22 17	04-Feb-22 17*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	07-Jun-22 17	07-Jun-22 17	07-Jun-22 17*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22 17	19-Aug-22 17	19-Aug-22 17	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0

Exhibit 12.0 March variance tracker

FTW1 - RRL: Overall Progress Curve

	Data Date	1/3/2021	1/10/2021	1/17/2021	1/24/2021	1/31/2021	2/7/2021	2/14/2021	2/21/2021	2/28/2021	3/7/2021	3/14/2021	3/21/2021	3/28/20
Total	Hours													
	Period													
37169	Planned Early Curve	0	740	980	700	770	670	720	540	660	540	630	750	640
	Planned Late Curve	0	450	480	360	470	440	440	450	740	680	680	640	720
12472	Earned	0	488	1042	428	785	696	831	0	792	859	725	685	0
24697	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	657
	Percentage													
	Period													
	Planned Early Curve	0%	2%	3%	2%	2%	2%	2%	1%	2%	1%	2%	2%	2%
	Planned Late Curve	0%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
	Earned	0%	1%	3%	1%	2%	2%	2%	0%	2%	2%	2%	2%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
	Cumulative													
	Planned Early Curve	11%	13%	16%	17%	19%	21%	23%	25%	26%	28%	30%	32%	33%
	Planned Late Curve	8%	9%	11%	12%	13%	14%	15%	16%	18%	20%	22%	24%	26%
	Earned	14%	15%	18%	19%	21%	23%	25%	25%	27%	30%	32%	34%	
	Forecast (Earned)												34%	35%

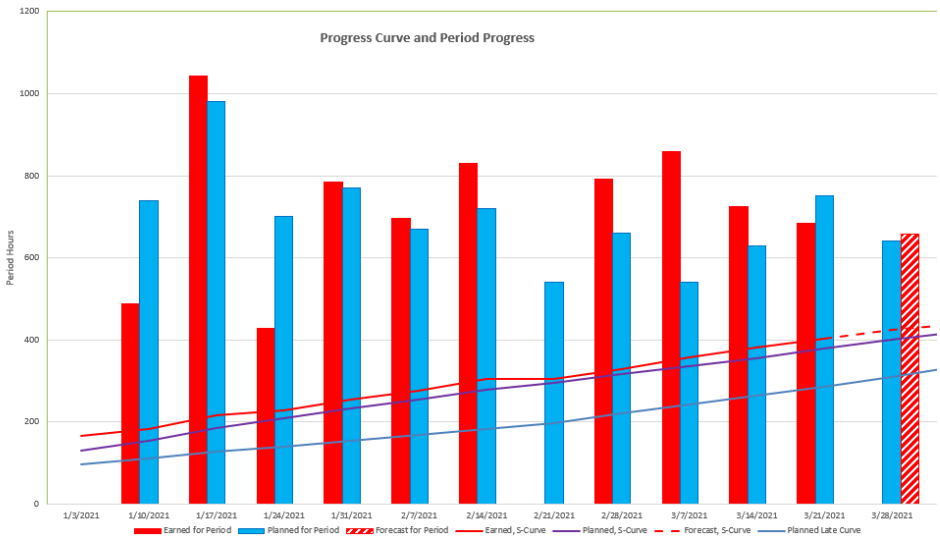

Exhibit 13.0 March progress curve

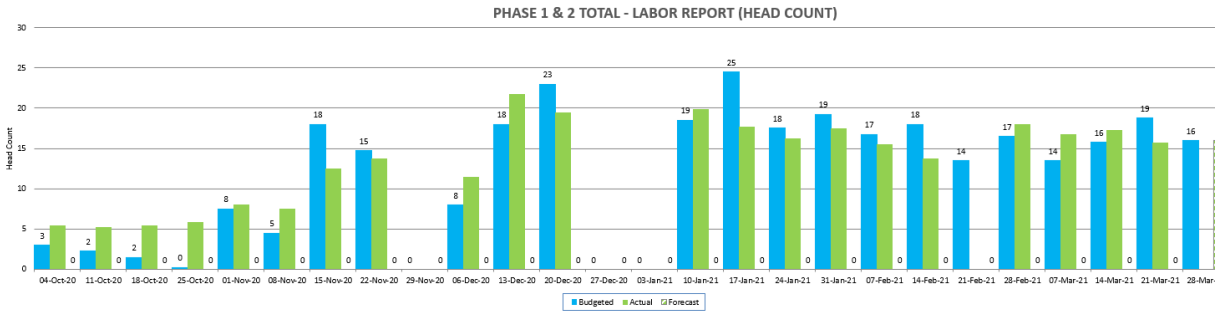

Exhibit 14.0 March Labor report & forecast

FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20	3%	1.40	1.01	0.69
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.00	1.03
3-Jan-21	14%	1.27	1.00	1.08
24-Jan-21	19%	1.10	1.00	1.03
7-Feb-21	23%	1.08	1.02	1.04
21-Feb-21	25%	1.03	1.02	1.07
7-Mar-21	30%	1.07	1.03	1.09
21-Mar-21	34%	1.06	1.02	1.09
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*

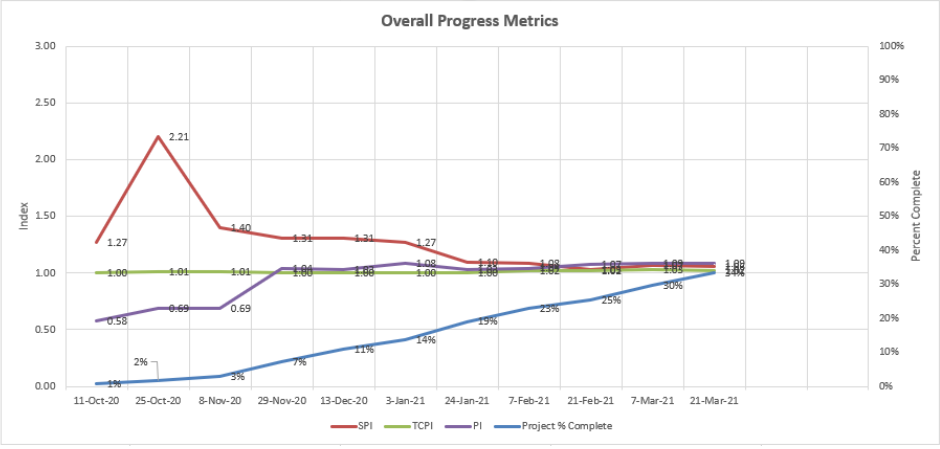

Exhibit 15.0 March Key Progress Metrics (SPI, PI, TCPI & %Complete)

Cumulative Performance

Status of the project: **On-Time Completion.**

1. The current project substantial completion date of October 10, 2022 aligns with GMP Baseline submission end date.
2. This includes Area C pushing out 12 days due to an incorrect logic tie that was realized post acceptance of Baseline schedule
3. This includes Area B completion trending 5 days behind due to issues in the completion of fire caulking in Electrical Room B.
4. This includes 6 business days of lost production (February 11th, 2021 through February 19th, 2021) due to Winter weather storm
5. **Exhibit Sixteen** represents milestone variance from March EOM Submission.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
CONSTRUCTION MILESTONES		05-Oct-22 17	05-Oct-22 17	05-Oct-22 17	0
FB.MS.1480.1B10	Project Team Mobilize				0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	14-Mar-21 07	09-Mar-21 17	09-Mar-21 07 A	1
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	16-Mar-21 17	10-Mar-21 17	15-Mar-21 17 A	-5
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	30-Mar-21 17	31-Mar-21 17	30-Mar-21 17	1
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	10-May-21 17	10-May-21 17	10-May-21 17*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	10-May-21 17	10-May-21 17	10-May-21 17	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	04-Oct-21 17	04-Oct-21 17	04-Oct-21 17*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	04-Feb-22 17	04-Feb-22 17	04-Feb-22 17*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	07-Jun-22 17	07-Jun-22 17	07-Jun-22 17*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22 17	19-Aug-22 17	19-Aug-22 17	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0

Exhibit 16.0 Milestone tracker

Analysis

Key benefits identified

1. Quantitative and non-subjective insight into likelihood of project finishing ahead of schedule, on schedule, behind schedule
2. Early evaluation of labor requirements to identify potential labor risk
    a. Particularly useful when multiple retrofit projects are taking place in parallel and the same trade partners are being used for different projects
3. Allows for comparison and analysis of progress and performance against baseline metrics
4. Large portion of project scope takes place during the Suite-Level Retrofit windows
    a. Imperative that the schedule is developed using labor hours to validate the feasibility of durations and labor density in the data halls during the time critical SLR window
5. As the Resource Loaded Schedule approach is proving successful and becoming normalized, there is heightened focus on front-end planning during the baseline schedule

development on other procurement programs, leading to higher quality schedule submissions

6. Ability to identify issues or logic flaws to GC/TPs
    a. In Dec 2020, Owner team was able to identify Mech contractor charging idle Hours when Mech contractor submitted abnormal hours to multiple activities in their dailies.
7. The project is now 7 months into execution, and 30% complete.
    a. Schedule performance and percentage complete are ahead of plan.
    b. Early spikes in data have levelled out as we calibrate and dial in the percent complete walks, the data being requested & evaluated.
    c. We are also seeing the GC use this data to drive conversations and efficiencies with the trade partners which is satisfying.
    d. Opportunities continue to be evaluated to bring in the baseline completion date, originally 5/18, now tracking to 5/4

Resource Loaded Schedule Data driving improvements

Issue - Initial drafts of baseline schedule contained various labor peaks and had stretched Phase 1 scope out to over 12 months in total duration, see **Exhibit Seventeen.**

    a. It would have been difficult to ascertain these peaks just by looking at scheduled activities in isolation and may have led to acceptance of a poor-quality baseline schedule

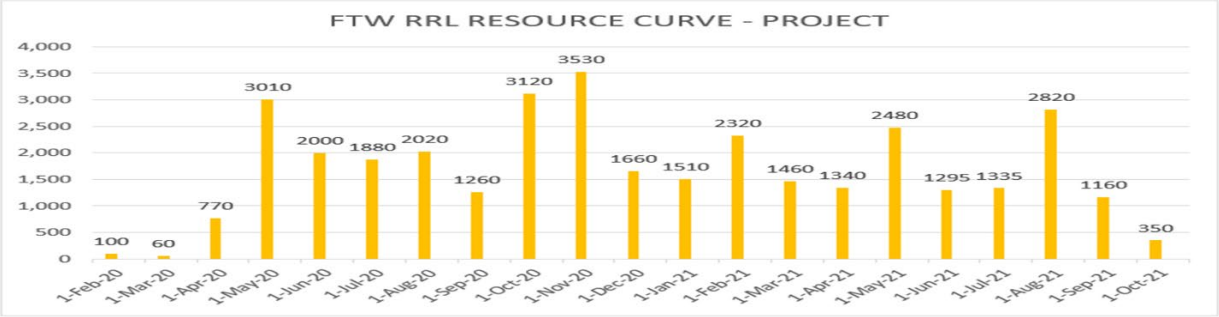

Exhibit 17.0 Original Resource curve

Action Taken - Contractor asked to resubmit baseline schedule with increased focus on evaluation of labor peaks and used labor hours to validate a more reasonable target duration.

    b. Identified approximately 13,300 labor hours for Phase 1 scope with desire for a more deliberate approach to ramp up and maintaining consistency

Result - Revised baseline schedule submitted, see **Exhibit Eighteen**, showing a more defined ramp-up and ramp-down phase, as well as adhering to the desired target duration for Phase 1 scope.

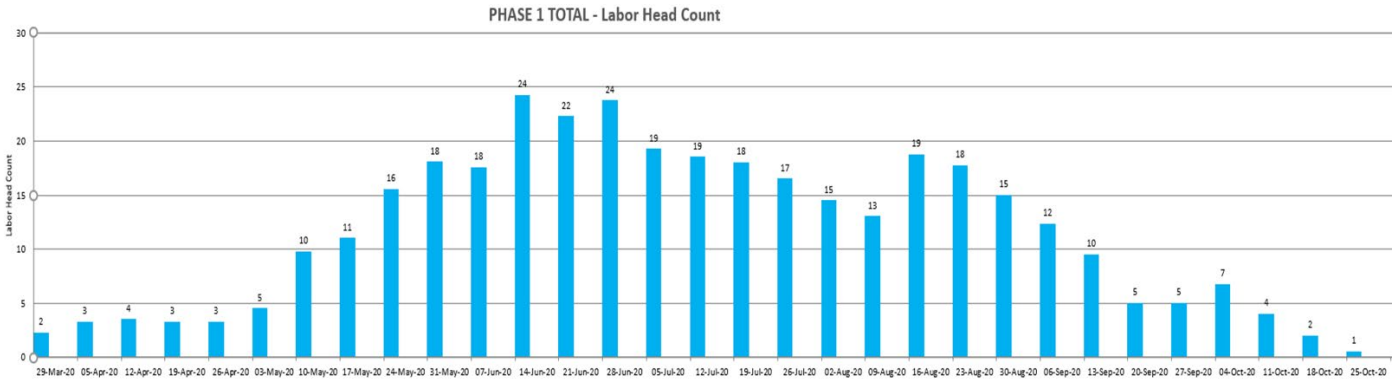

Exhibit 18.0 Revised Resource curve

Potential Risks identified

1. Based on a cursory review, the Resource Loading field resource job description appears very easy. That is a falsehood, the main task is to sync daily report data with actual activities happening at site. Trade Partner and GC Rep executing the synced daily report every day is one of the primary areas of disagreement and conflict.
2. The identified resource may not be the right person to implement resource loading.
3. The approach to percent complete and activity status evaluation needs to be agreed upon, standardized and scalable. If not, conflict between parties, morale and trust will be lost
4. Threats – The EC is becoming acutely aware of productivity, how it relates to schedule performance and without contract incentives there is not much to encourage overperformance.

Survey / Interviews

Description

The Surveys of, and Interviews with, Subject Matter Experts (SME) was a fundamental part of this effort to expand subject understanding. The traditional definition of survey research is a quantitative method for collecting information from a pool of respondents by asking multiple survey questions. This research type includes the recruitment of individuals, collection, and analysis of data.

Surveys are proven and continue to be one of the most effective and trustworthy research methods. This survey was a method for extracting information from a group of Subject Matter Experts consisting of structured survey questions that motivate the participants to respond, and focus each respondent before the follow up , one on one, more informal interview.

Details

The key recipients were members of support pillars such as Pre-Construction, Controls and Execution team leads on both Owner and GC/Trade partner sides. These individuals have extensive knowledge on this topic, come from various parts of the construction industry, have worked on both the Owner and Contractor side, and could provide a wealth of information and insight.

Subject Matter Experts (SME) were interviewed to learn, challenge and understand their thoughts on schedule best practices, the subject of Resource Loaded Scheduling, approach to integration, how to scale across a myriad of Green field, Type A, B & sustaining projects and what key specifications need to be established for true value to be derived.

Background

There were multiple iterations of the survey and interview templates for key stakeholder input as the author sought to capture honest, objective, and constructive feedback. The author utilized the project sponsor and key confidants to review and provide input before finalizing the final version of the survey. It was important to follow the following rules in crafting the Survey:

- At the top of your survey, write a brief statement clearly stating intentions with the research
- Follow the funnel approach, easier, more straightforward questions in the beginning
- Be clear, specific, and direct
- Keep your survey questions neutral
- Avoid loaded questions or leading words

The questionnaire captured thoughts and inputs related to the field of resource loading, its criticality to the business and approach to implementation, eliciting a trove of Qualitative data. The questionnaire was also utilized as a precursor to completing interviews. The interviews took place after the questionnaire has been responded to, so all participants had a solid grounding in the topic. Most of the questionnaire questions were open-ended and as such were used as a guide through the individual face-to-face interviews. Questions were sent to each SME prior to the interview and the sessions were recorded so full focus was on the discussion yet no important details were lost due to multi-tasking.

Analysis approach

The author identified and followed this 5-step process for Qualitative data analysis

1. Prepare and organize the data -

Print out your transcripts, compile notes, documents, or other materials. Mark the source, any demographics collected, or any other information that will help analyze data.

2. Review and explore the data -

This will require in depth review of the data, multiple times, to get a sense of what it contains. Notes will need to be retained regarding thoughts, ideas, or any questions that emerge.

3. Create initial codes -

Use of indicators, concept maps, or anything else that helps to connect with the data.

4. Review those codes and revise or combine into themes -

Identify recurring themes, language, opinions, and beliefs.

5. Present themes in a cohesive manner –

Consider the purpose or premise of the study, and what content should be included to best highlight the data captured

Expected outcome

Initial appraisal of this topic as potential project for the PM 686A/B and discussions with various internal and external stakeholders highlighted a wealth of knowledge in the area coupled with a lot of opinions on best practice, approach and what would work best for the business and strategic partners.

At the outset, the author was confident a validation of the hypothesis, that parameters and financial thresholds need to be established for optimum utilization of resource scheduling in the Construction Tech sector, would be the outcome of the endeavor. A “sliding scale” of implementation appeared to be the preferred and most implementable approach when juxtaposing multi-year high dollar projects with more sustainable, shorter duration and lower dollar projects. Based on the above, Resource Loaded Scheduling would allow incorporation of Earned Value Metrics and Key Performance Indicator initiatives, adding great value related to predictability, accuracy, key Organizational themes.

Surveys & Interviews

The survey and Interviews were completed over a 3-month period, December to February due to schedules, COVID and desire to get key and balanced (Owner & GC/Trade partner) inputs. A

total of ten (10) interviews were conducted based on survey responses, see **Appendix B,** Consent form & Questionnaire for full details. Interview formats were mostly in the form of an informal discussion. Each interview was primarily based on gaining a qualitative sense of the employee's attitudes towards Resource Loaded Scheduling to determine benefits if this should be an area of focus and scalable approach.

Data analysis and responses of significance

Once collected the data was reviewed with notes on first impressions for interpretation. Next step included importing all data to the Qualitative data tool (MAXQDA) for manageability and to make analysis easier to navigate. Coding the data started the process of identifying and labeling themes within data that corresponded with the evaluation questions captured in the questionnaire and expanded upon on the subsequent interviews.

Themes or common trends or ideas that appeared repeatedly throughout the data were clear.

1. Some divergence existed on roll out approach, but consensus was that **Focus should be on Capacity projects** - (Parameter - Hypothesis)
2. All interviewees agreed, **if data is not diligently entered** or tracked/maintained in the schedule, it **will produce inaccurate results.**
3. **Standardization is paramount** across a program so that this does not become overly burdensome to the GC and trade partners. **Standardize by capturing in Schedule specification** (Acceptance criteria)
4. **Activity coding** vital for integrated scheduling purposes & standardization (Acceptance Criteria)
5. Interviewees internal to the Org all agreed, upper Leadership/**Exec level leadership commitment vital** or this will not be maintained due to perceived costs and LOE.
6. Consensus feedback was **trial runs needs to be completed** on 3 or 4 projects for "on the fence" people in higher management **to realize the usefulness and feasibility of resource loading**.
7. GC & Trade partners - **RLS = Efficient Preplanning & tracking of work**
8. GC & Trade partners - **RLS = Informed decision making**
9. Internal stakeholders - **RLS = Meets intent of established Org goals i.e. Nested goal**
10. **Capacity demand and efficiency are ubiquitous -** (Optimum results - Hypothesis)

More detailed appraisal of the surveys and interviews saw questions #1, #2, #3, #4a & #5 provide the expected feedback to the author. Definition of RLS, the overall objective of RLS, the

benefits derived, interdependence between scale and need for more solid data and the Level of Effort and costs all corresponded with the authors impressions at the outset of the project.

1. What is your definition of a Resource (Labor) Loaded Schedule
2. What is the overall objective of resource loading in your opinion
3. What benefits does it produce and what are the delta's, in your experience
4. Does an interdependence exist or is this a distraction from more acute business needs
5. Does the business need outweigh the front-end cost and LOE involved for support pillars and strategic partners

However, for question #4, #7 & #8, which partially underpinned the project hypothesis, the expected outcomes and subsequent discussions deviated from the authors expectation. It was expected that all SME's engaged would agree a Resource Loading approach applied to $1Billion Greenfield project cannot be replicated on a sustaining Type C retrofit project. This was the authors expectation due to value derived needing to match the LOE/Cost involved, specialized labor and budget constraints and scalability. Nevertheless, the consensus was much narrower, Resource Loaded Scheduling should only be applied to Capacity driven projects (*At least in the near term*), see **Exhibit Nineteen & Twenty**

Capacity projects are major infrastructure expansions, critical to the business meeting customer demand and that is where the greatest risk exists. The time and cost required to properly implement a resource loaded project can be substantial. As such, the feedback was that it should not be implemented across all projects and all scopes, but rather should be selectively used for high value, critical, business impacting scope / projects.

4. Should this be a point of focus as we scale to meet capacity demand
7. What would implementation roll out look like, and why
8. If a broad stroke approach applied, how do you implement the concept across such a wide spectrum of projects

Color	Document name	Code	Segment	Modified by	Created by	Area	Coverage %
●	Consent Form Questionnaire_2021 (TV)	Question 4 - Should this be a focus as we scale to meet demand	RESPONSE: Yes, for capacity driven projects.	sbarrett2018	sbarrett2018	44	0.49
●	Consent Form & Questionnaire_2021 - Albert Lee R1	Question 4 - Should this be a focus as we scale to meet demand	Albert] Depends. What's the end goal? What's the $ volume and length of project? Probably more helpful for bigger projects or complex projects. Can you elaborate on the basis of this question and "scaling to meet capacity demand?" At a minimum, baseline schedule should include key schedule assumptions (e.g. # of crews, key crew handoffs – e.g. from drywall 75% to electrical OH to plumbing OH, etc)	sbarrett2018	sbarrett2018	404	4.34
●	Consent Form Questionnairre_Fahad	Question 4 - Should this be a focus as we scale to meet demand	Yes. Getting more data like cost and labor hours always help in hedging risks and reducing cost in long run. If the cost of getting this additional data is feasible, it should be implemented for sure.	sbarrett2018	sbarrett2018	202	2.58
●	Consent Form Questionnaire_2021_NS	Question 4 - Should this be a focus as we scale to meet demand	It should. Implementing RLS will drive better informed decisions and lessen a risk of not meeting business critical deadlines.	sbarrett2018	sbarrett2018	127	1.48
●	Consent Form Questionnaire_2021_Milind	Question 4 - Should this be a focus as we scale to meet demand	If the business objective is to attain capacity demand in a time bound manner, Resource Loading would be one of the effective and efficient ways of providing the signal back to business.	sbarrett2018	sbarrett2018	188	2.32
●	Consent Form Questionnaire_2021_F	Question 4 - Should this be a focus as we scale to meet demand	Yes. The only thing I would change with how we are currently accomplishing this is it should be quantitative and not qualitative. The tracking of physical installed material is more consumable and accountable by project teams. With current modeling technology, estimating and tracking systems are much easier to implement.	sbarrett2018	sbarrett2018	326	2.79
●	Consent Form Questionnaire_2021 DA	Question 4 - Should this be a focus as we scale to meet demand	If resources are limited (CFE/SMEs, electricians in region, etc) then resource loading has benefits in making sure the plan of work is not impacted by a lack of resources. If resources are not an issue, the benefit of resource loading is still there with earned value metrics, but is a lesser priority vs the resource limited sites.	sbarrett2018	sbarrett2018	335	3.90
●	Consent Form Questionnaire_2021 _ BKB	Question 4 - Should this be a focus as we scale to meet demand	I think a resource loaded schedule is necessary to have a plan/schedule/budget you can be confident in	sbarrett2018	sbarrett2018	102	1.24

Exhibit 19.0 Question 4 - Survey & Interview responses

Color	Document name	Code	Segment	Modified by	Created by	Area	Coverage
●	Consent Form Questionnaire_2021 (TV)	Question 7 - What would implementation roll out look lik	RESPONSE: b. The time and cost required to properly implement a resource loaded project can be substantial. As such, it should not be implemented across all projects and all scopes, but rather should be selectively used for high value, critical, business impacting scope / projects.	sbarrett2018	sbarrett2018	284	3.15
●	Consent Form & Questionnaire_2021 - Albert Lee R1	Question 7 - What would implementation roll out look lik	[Albert] I wouldn't resource load low risk projects. I would focus on larger / higher risk projects. Let's discuss further	sbarrett2018	sbarrett2018	123	1.32
●	Consent Form Questionnairre_Fahad	Question 7 - What would implementation roll out look lik	Not feasible for Type C if it really is a low risk. Its prudent to point out some low cost projects are very complex and high risk in construction and those SHOULD be resource loaded. Cost should not be the criteria to decide if resource loading is required or not. Definitely Yes for Large Greenfield projects and additional General Conditions are surely worth the return on investment.	sbarrett2018	sbarrett2018	391	4.99
●	Consent Form Questionnaire_2021_NS	Question 7 - What would implementation roll out look lik	From an owner's perspective, the first and foremost step is to get the GC onboarded with the idea. On the GC side, it is imperative to have a solid team with a solid scheduling understanding. They need to have the proper tools (such as a well-executed scheduling procedure with logical coding) in place for the resource loading to be more efficient (speaking automation using data imports through Primavera API, instead of manual loading of resources into activities through P6). Having this set up it will not make a difference of the size of the project in the aspect of resource loading. The schedule still needs to be built, regardless of RLS. Once the project is estimated using the established coding system, the data can be uploaded rather painlessly	sbarrett2018	sbarrett2018	767	8.92
●	Consent Form Questionnaire_2021_Milind	Question 7 - What would implementation roll out look lik	We need to first understand what the business goals are, what the maturity level of owner and contractor is. We could then build process, tools, skill-sets, training support required to achieve these goals in a timebound manner. In general, a phased approach will be beneficial. Initial focus on identifying the pain points associated with a greenfield project / trade. In parallel, a small scale project full resource loading will benefit so as to showcase the benefits across all trades.	sbarrett2018	sbarrett2018	494	6.10
●	Consent Form Questionnaire_2021_F	Question 7 - What would implementation roll out look lik	All projects. This level of planning is not new to contractors but the implementation can be improved. If the entire project team from estimation to execution is aligned with the process, there is not a huge long term cost on management	sbarrett2018	sbarrett2018	239	2.05
●	Consent Form Questionnaire_2021 DA	Question 7 - What would implementation roll out look lik	Prioritize limited resource projects. Determine if focus should be on initial resource loading only, or if actuals also need to be loaded into schedule each update period.	sbarrett2018	sbarrett2018	172	2.00
●	Consent Form Questionnaire_2021 _ BKB	Question 7 - What would implementation roll out look lik	Implementation on a special project, would be less time consuming, due to less scope, however I think they would both be just as rewarding regarding proving the plan with quantities and production rates prior to mobilization. That would be the first step, in my opinion of the implementation: Step 1: Prove schedule durations with what is in each trades bid [total labor hours, total quantities, production rates(quantities per day), total number of workers]. Step 2: Track hours through duration of job Step 3: Track Quantities	sbarrett2018	sbarrett2018	534	6.52

Exhibit 20.0 Question 7 - Survey & Interview responses

Conclusions

The intent of the project was to test the hypothesis that parameters and financial threshold requirements need to be established, depending on project type, for optimum results in the Construction Tech sector. The study included a literary review evaluating some of the precursors to Resource Loaded Scheduling including bar charts, Activity-on-Arrow or Arrow Diagramming Method (ADM), The Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). It also incorporated information from a real time case study of the organization's performance implementing Resource Loaded scheduling and access to the thoughts, musings, and opinions of Subject Matter Experts in this field. This information was analyzed to create test the stated hypothesis, identify recommendations, areas of Future Research & reach conclusions.

Research of commonly utilized schedule techniques point to focus being solely on the scope, interdependencies, and sequencing logic. A CPM schedule prioritizes construction activities and their predecessors in the order in which they need to be completed. If executed properly, the project is broken down into discrete activities with estimated durations, each activity is logically sequenced and as such is an excellent tool for controlling the project during execution. However, there are serious limitations that leave all parties exposed to significant risk. This technique fails to address resources of any kind, *Who will work on these activities, Are all resource fully dedicated and is it just one or multiple projects ongoing simultaneously.* When you consider resources account for a cumulative 20%-40% of total project costs, the exposure to schedule risk is perplexing.

Resource-loaded scheduling is substantially different from CPM because it loads physical resources into the project schedule such as labor, capital equipment, facilities, and materials. By doing so, making decisions about what resources are needed, when they will be needed & as importantly, when they will actually be available is then incorporated into the scheduling process. It is a methodology that encompasses resource loading, leveling, and time analysis (critical path) all in one dynamic schedule. Other important advantages of RLS are as follows:

- Incorrect resource assumptions (Optimism) will lend unreasonable credence, and the resulting schedule will convey a false sense of precision and confidence to senior decision makers.
- Activity owners are able to explain and accountable to the logic behind their resource estimates.
- The same assumptions that formed resource estimates for the cost estimate are applied to the estimated resources loaded into the schedule and are documented in the Basis of Estimate (BOE)
- A schedule without resources implies an unlimited number and their unlimited availability.
- A schedule that has not reviewed and resolved resource use issues is unreliable.
- Management's ability to monitor crew productivity, allocate idle resources, monitor resource-constrained activities, and level resources across programs is severely limited without RLS

The Case study which involved the implementation of a Resource Loaded Schedule on a physical MEP project was a magnificent opportunity to see the value (or not) of this approach. This was important considering the added Precon & Procurement efforts, plus the added resource costs for schedule maintenance and status. The results were almost immediate.
Initial drafts of baseline schedule contained various labor peaks and stretched Phase 1 duration. This would have been difficult to ascertain just by looking at scheduled activities in isolation. Working collaboratively the Contractor resubmitted the baseline schedule with increased focus on labor peak, a more defined ramp-up and ramp-down phase, as well as adhering to the desired target duration for Phase 1 scope. With the goal of utilizing strategic partners for Capacity projects, efficiently utilizing labor resources is of paramount important and a win for the Organization.
This was the first but certainly not a win in isolation. Other critical benefits of the RLS method were:

1. Quantitative/Non-subjective insight into project phases finishing ahead of, on or behind schedule

2. Comparison and analysis of progress and performance against baseline metrics
3. Ability to identify issues or logic flaws to GC/TPs
    - In Dec 2020, author was able to identify contractor charging idle hours when Mech contractor submitted abnormal hours to multiple activities in their dailies.
    - GC utilization of data derived in conversations and efficiencies with the trade partners

Finally, the most diverse and inconsistent (Subjective) inputs were certainly via the Surveys and interviews with Subject Matter experts. It was expected that all SME's engaged would agree a Resource Loading approach needed to be customized to the specific project value and type. However, the consensus was much narrower. For the authors Organization, RLS should only be applied to Capacity driven projects, those critical to the business meeting customer demand, where greatest risk exists.
This was contrary to the authors position; the value add is beyond question and as such a sliding scale approach should be implemented Vs. selectively used solely capacity projects.

In summary the hypothesis that parameters and financial threshold requirements need to be established for RLS, depending on project type, for optimum results in the Construction Tech sector was proved partially correct. The research and case study fully vindicated the value to the client, the GC, trade partners, craft workers and the industry at large. However, even with this information , detailed approach and proof of concept, Subject Matter Experts in the Hyperscale field were undeterred and felt the benefit should only apply to Capacity projects for the authors organization.

Recommendations

Whether or not the authors research and conclusions are indisputable could be debated, however there are certain components identified in the project that reinforce best management practices.

1. Success on construction projects is highly dependent on the efficient utilization of limited and costly resources. As activities consume resources they must be assigned and measured, and Resource Loading a Schedule is a verifiable method to achieve this.
2. Management assessment of required resources and proactively discussing difficult resourcing questions early in program planning stage is vital and needs to occur with all parties to the project
    - Will the available resources suffice to execute the work on time as planned?
    - Do management need to commence negotiating for additional resources?
    - Linking available resources to activity durations, are these durations feasible or show opportunities to reduce durations with the application of more resources?
3. Resource loading schedules for baseline submissions, without the requirement to maintain over the project lifecycle, still adds value with minimal level of effort
    a. Labor peaks and troughs that are difficult to ascertain by looking at scheduled activities in isolation can be addressed
    b. Increases focus on evaluation of labor for a more deliberate approach to ramp-up and ramp-down phase maintaining consistency
4. Strategic partners and vendors need to be able to plan for intelligent resource usage and efficiencies. Establishing RLS as part of the scheduling specification will ensure all parties understand the requirements, guidelines and can respond and scale appropriately.
5. While the Hyperscale Construction Tech industry is still in its infancy, relative to more established sectors, publicly traded organizations require accuracy and predictability related to capital expenditure. Resource Loading ensures construction labor cost, the biggest single cost in each Work breakdown Structure, has the requisite level of review and accuracy.

Future research

Without time and resource constraints, one area the author would have captured in scope and explored and developed further would have been the topic of **Critical Chain Management.**

According to the Goldratt Institute, Critical Chain Management can help organizations to be more efficient with their existing resources. Data shows significant performance increases by companies including Nike, Boeing & Lockheed Martin, Harris Semiconductor, and the US Naval Aviation Enterprises of the US Navy and Marine Corps. If critical chain management can be so beneficial why are firms in the construction industry not using this project management method for scheduling?

CCPM focuses on scheduling and managing projects based on the resources available to complete the work. CCPM also focuses on managing projects by the resources necessary to complete the schedule and not the activities in the schedule. As identified by Herroelen, Leus & Demeulemeester, 2002, "CCPM methodology recognizes that the interaction between time requirements of the project activities, the precedence relations defined among them, the activity resource requirements, and the resource availabilities has a crucial impact on the duration of a project"

As captured thru literary review in this project, Resource Loaded Scheduling is built on the premise of prioritization of activities based on utilization strategies, determination of resource availabilities, and the utilization of alternate resources. Exploring overlaps with Resource Loaded Scheduling and CCPM methodologies would be an interesting next step to understand similarities and where the theories diverge.

Contribution to the Project Management Body of Knowledge

Developing an effective schedule for managing the execution of a project is paramount to good project management practice. However, managing the project schedule can be one of the most formidable parts of project management. That is why the Project Management Body of Knowledge's (PMBOK) Schedule Management Knowledge Area contains the following Six processes: Define Activities, Sequence Activities, Estimate Activity Durations, Develop Schedule, and Control Schedule.

The contributions from the project to positively impact the industry and the body of knowledge include the following.

1. **A resource loading template – The Key primary components**
    a. KPI Summary (Construction % Complete, SPI, Labor Units, TCPI, EAC)
    b. Earned Labor Hour Progress "S" Curve and Period Progress (Planned, Forecast & Actual)
        i. Basis for Construction % Complete
        ii. Labor Histogram (by Trade Partner and Overall)
        iii. Productivity Index (by Trade Partner and Overall
    c. Physical % complete must be entered for each activity with loaded hours (basis for calculating earned value)
    d. Budget direct labor hours at activity level in P6 (tie to GMP)
2. **Lessons learned from Case Study implementing Resource Loaded approach**
    a. Changes from initial GC resource loaded schedule to the schedule baseline acceptance highlight gaps or potential flaws in traditional schedules. These gaps may not have been identified without the inclusion of the resources.
    b. Early evaluation of labor requirements considerably reduces risk exposure
    c. Comparison and analysis of progress and performance against baseline metrics are good data for the client and the Trade partners for continued improvements
3. **Best practices**
    a. Based on the progress and outputs of the Case study a section is being drafted to add to the global scheduling spec for the Owners Organization.

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Key Terms / Acronyms

Term or Acronym	Definition
PPM deliverables	Progress Performance Milestones
PMI	Project Management Institute
CPI	Cost Performance Index
SPI	Schedule Performance Index
WBS	Work Breakdown Structure
CPM	Critical Path Method
PMBOK	Project Management Body of Knowledge
EVM	Earned Value Management
RLS	Resource Loaded Schedule
MEP	Mechanical Electrical Plumbing
SLD	Suite Level Decom – A Building Decommissioning
SLR	Suite Level Retrofit – Retrofit work completed in Decom
GC	General Contractor
TP	Trade Partner
SME	Subject Matter Experts
WBS and WBS dictionary	Work Breakdown Structure
CCB	Change Control Board
CCP	Change Control Process
CR	Change Request
Requirements Traceability Matrix	Depicts relationships between project phases, allowing Stakeholders to track and manage requirements
Cost variance (CV)	The difference between the amount budgeted and the amount actually spent for the work performed.
SMP	Stakeholder Management Plan
FTE	Full Time Equivalent
Type C retrofit project	Maximum total cost, $500k
KPI	Key Performance Indicator
EAC	Estimate at Completion
TCPI	To-complete performance index
CPM	Critical Path Method
PERT	Program Evaluation and Review Technique
Greenfield	New, undeveloped site
PMLC	Project Management Lifecycle
Hyperscale	In computing, “hyperscale” is the ability of an architecture to scale appropriately as increased demand is added
PMB	Performance measurement baseline
Green field	A development on a completely vacant site.
Type A & B projects	Projects at or above certain financial thresholds
Sustaining projects	Ongoing/Repeating projects
MAXQDA	Qualitative data tool
Capacity Projects	Capacity (Rack power utilization) based on organic growth

Signature Page

This capstone project submitted to the College of Engineering Graduate Project Management Program

at University of Alaska Anchorage, has been read, approved, and accepted by the candidate's committee,

in Partial Fulfillment of the Requirements for the Degree of Master of Science in Project Management

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Roger Hull, PMP,

Committee Chair

_____

LuAnn Piccard, M.S.,

Committee Member

_____

Walter Almon PE, PMP,

Committee Member

Appendices

Appendix A – Complete Case Study

One of the primary focus areas of this project was the Case study, the resource loading of a physical Mechanical, Electrical and Building Management Systems (MEP/BMS) project.

Approach

The following was the agreed upon approach to implementation

- The baseline schedule was loaded with all direct labor hours, capturing the three major trade partners (Walker, TDI, ATS) and the associated sub vendors.
- The use of an early plan curve and a late plan curve was implemented
- Labor histograms by trade & productivity index to be captured
- Calendar: Any 5 Day Workweek Global Calendar (Work Hours: 8 A.M. – 12 P.M. & 1 P.M – 5 P.M)
- Assign unit budget values to activities for labor hours. This value should represent the lump sum of the direct labor hours associated with each activity and should tie to the hours in the GMP.
- Contract Milestone Summary:
    - Milestones will be constrained to show negative float when the calculated late finish date of the last Activity is later than the specified interim and/or Final Completion date.
- Large portion of RRL scope takes place during the Suite-Level Retrofit windows (Similar to Petrochem turnarounds)
    - Imperative that the schedule is developed using labor hours to validate the feasibility of durations and labor density in the data halls during the time critical SLR window
- Initial drafts of baseline schedule contained various labor peaks & troughs. Contractor resubmitted baseline schedule with increased focus on evaluation of labor peaks and used labor hours to validate a more reasonable target duration

Progress

Physical work commenced on site on 9/21, and the schedule is updated weekly with incorporation of a physical percent complete and actual labor hours spent for each activity.

Submissions from the GC are Biweekly and include a percentage completion walk with the project team and client prior. This walk is for validation purposes, to verify what has been captured by the trade partners and verified by the field engineer. Once alignment is reached the client receives the following submission.

- 6 Week Look Ahead (6WLA) Schedule Submission
- Critical Path Schedule Submission
- Full Schedule Submission
- XML File
- Resource Curves
- End of Month, schedule narrative

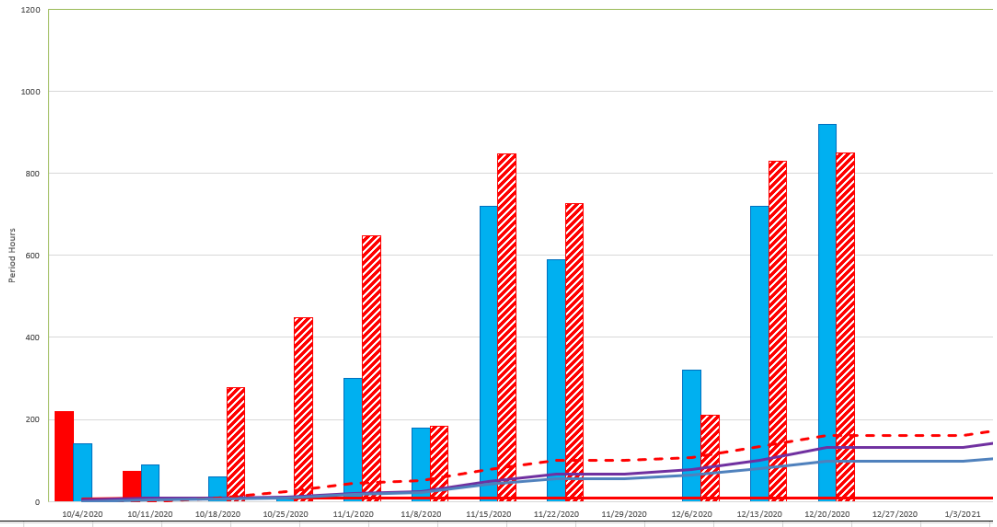
October Mid-Month

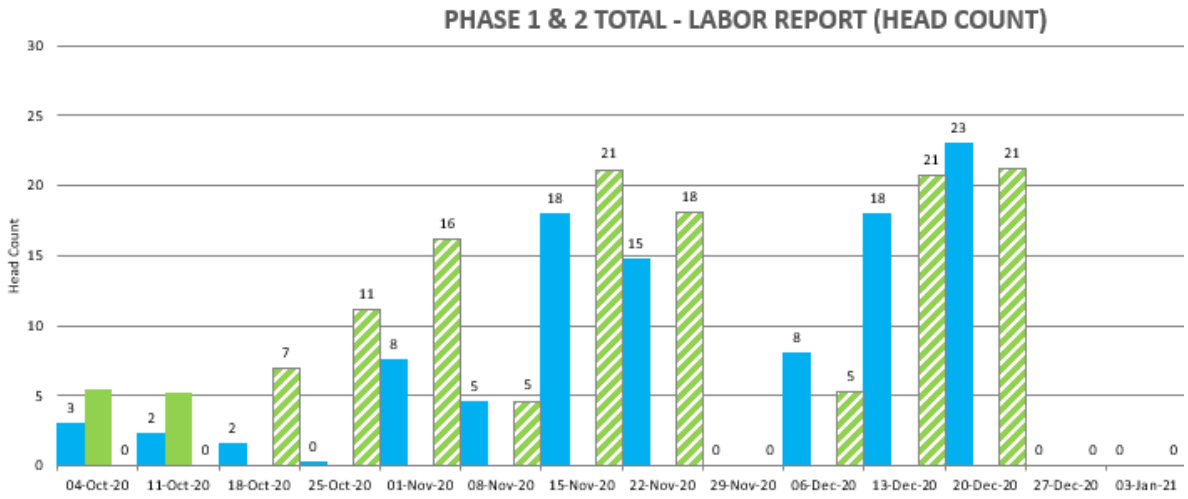
- **Milestone Variance Comments:** Phase 1 Completion dates have been expedited from previous update due to MOP approval allowed overhead conduit in Area B to start sooner.

Activity ID	Activity Name	Baseline Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	24-Feb-21	22-Feb-21	2
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	11-Mar-21	9-Mar-21	2
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	23-Mar-21	18-Mar-21	5
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	10-May-21	05-May-21*	5
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	10-May-21	5-May-21	5
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/05/2021)	5-Oct-21	5-Oct-21	05-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

FTW1 - RRL: Overall Progress Curve

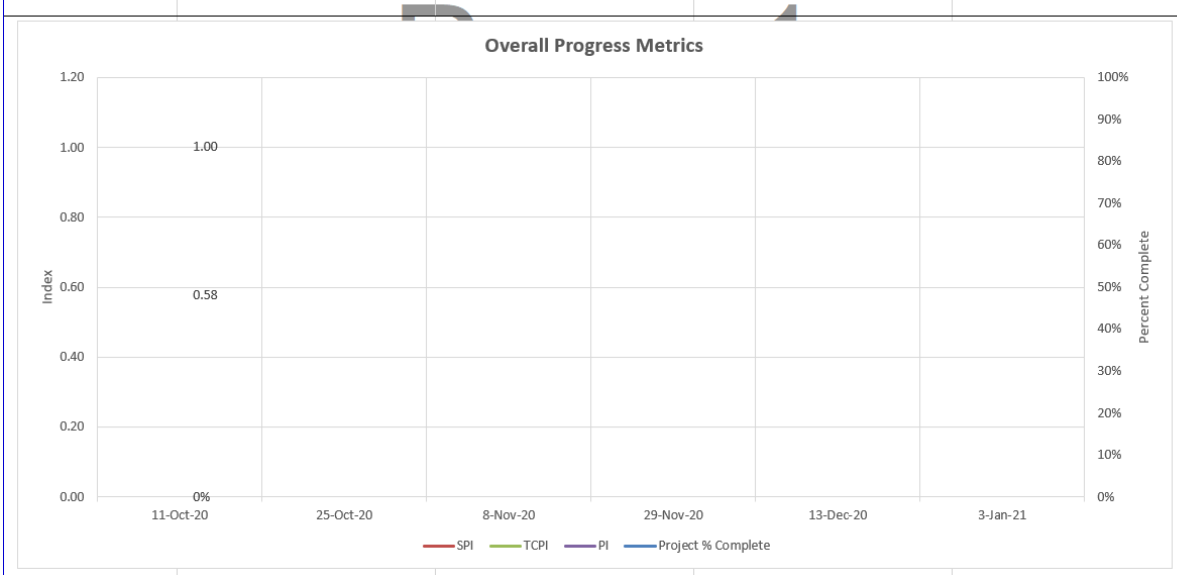
	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021
Total	Hours															
	Period															
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0	0	740
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450
293	Earned	220	73	0	0	0	0	0	0	0	0	0	0	0	0	0
36876	Forecast (Earned)	0	0	277	447	648	184	848	726	0	211	830	850	0	0	700
	Percentage															
	Period															
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%
	Earned	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Forecast	0%	0%	1%	1%	2%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%
	Cumulative															
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%
	Earned	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
	Forecast (Earned)	0%	0%	1%	2%	4%	4%	6%	8%	8%	9%	11%	14%	14%	14%	15%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	0%	1.27	1.00	0.58
25-Oct-20				
8-Nov-20				
29-Nov-20				
13-Dec-20				
3-Jan-21				
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



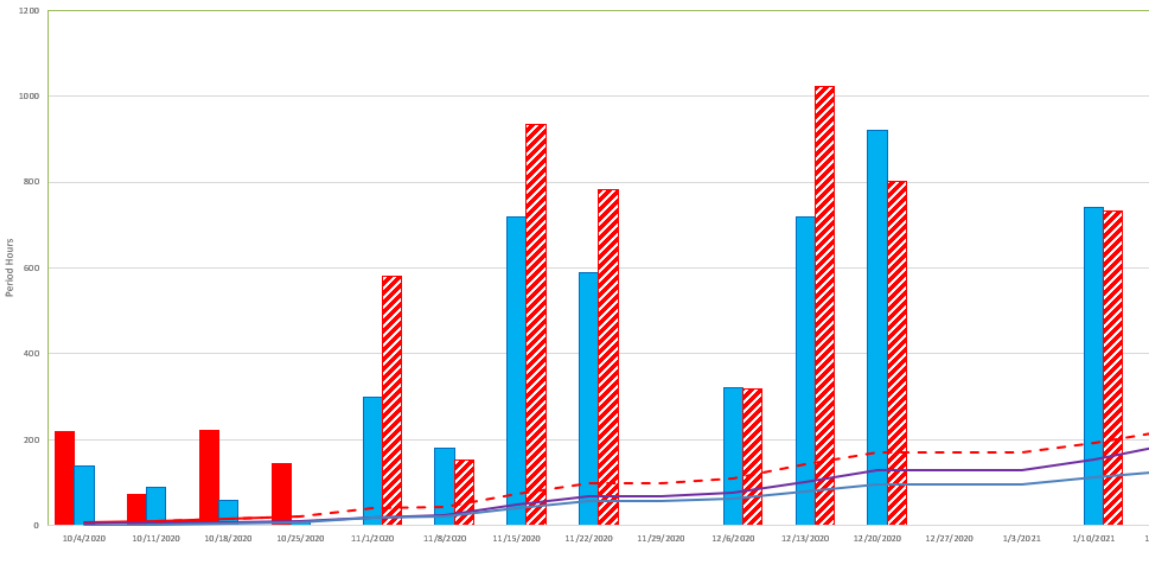
October Month-End

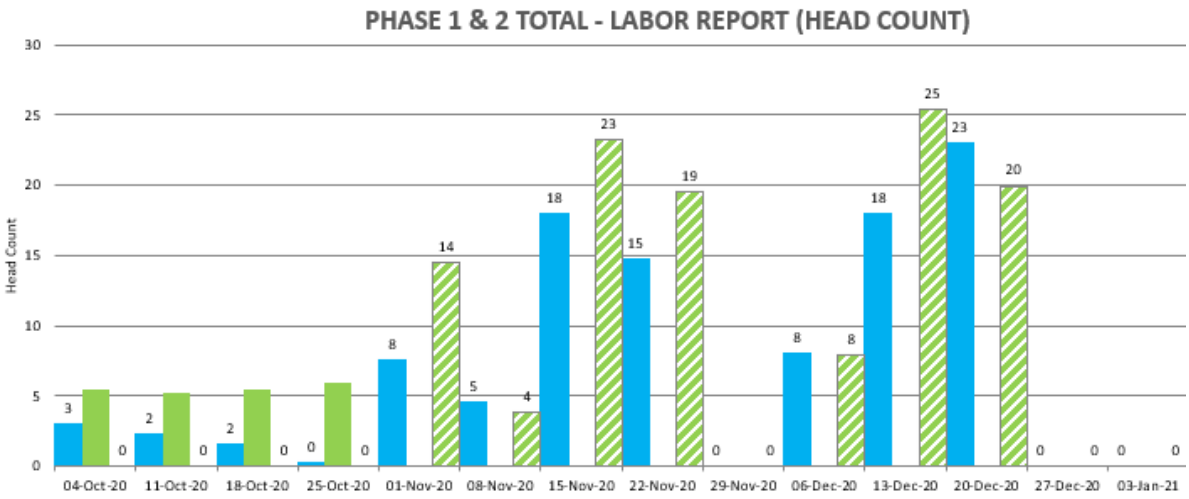
- **Milestone Variance Comments:** There were no changes in Milestones from October's mid-month submission.

Activity ID	Activity Name	Baseline Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	22-Feb-21	22-Feb-21	0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	9-Mar-21	9-Mar-21	0
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	18-Mar-21	18-Mar-21	0
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	5-May-21	05-May-21*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	5-May-21	5-May-21	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/05/2021)	5-Oct-21	5-Oct-21	05-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

FTW1 - RRL: Overall Progress Curve

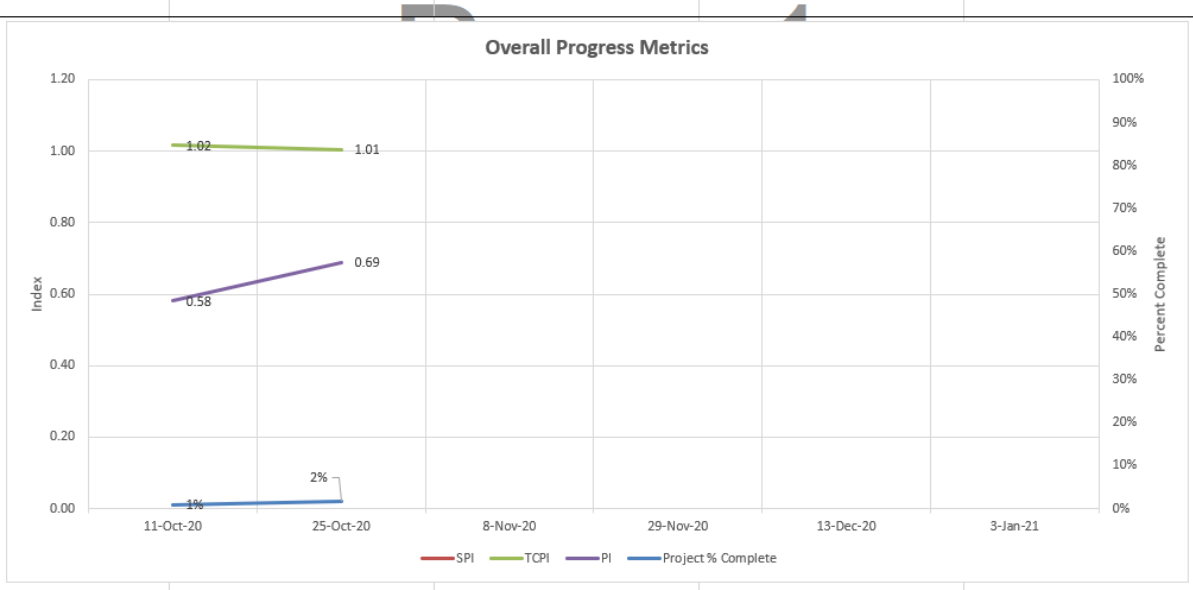
	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021
Total	Hours															
	Period															
37163	Planned Early Curve	140	30	60	10	300	180	720	530	0	320	720	320	0	0	740
	Planned Late Curve	0	100	30	30	280	150	600	440	0	250	470	550	0	0	450
662	Earned	220	73	223	146	0	0	0	0	0	0	0	0	0	0	0
36501	Forecast (Earned)	0	0	0	0	581	153	933	783	0	320	1023	802	0	0	732
	Percentage															
	Period															
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%
	Earned	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Forecast	0%	0%	0%	0%	2%	0%	3%	2%	0%	1%	3%	2%	0%	0%	2%
	Cumulative															
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%
	Earned	1%	1%	1%	2%											
	Forecast (Earned)		1%	1%	2%	3%	4%	6%	8%	8%	9%	12%	14%	14%	14%	16%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.02	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20				
29-Nov-20				
13-Dec-20				
3-Jan-21				
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



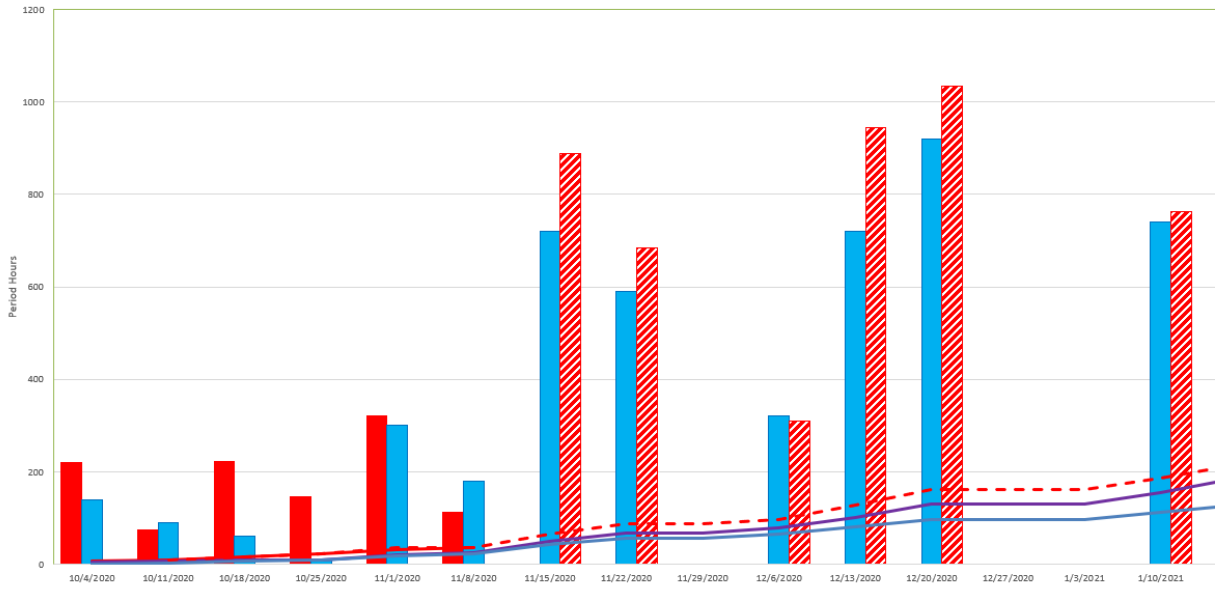
November Mid-Month

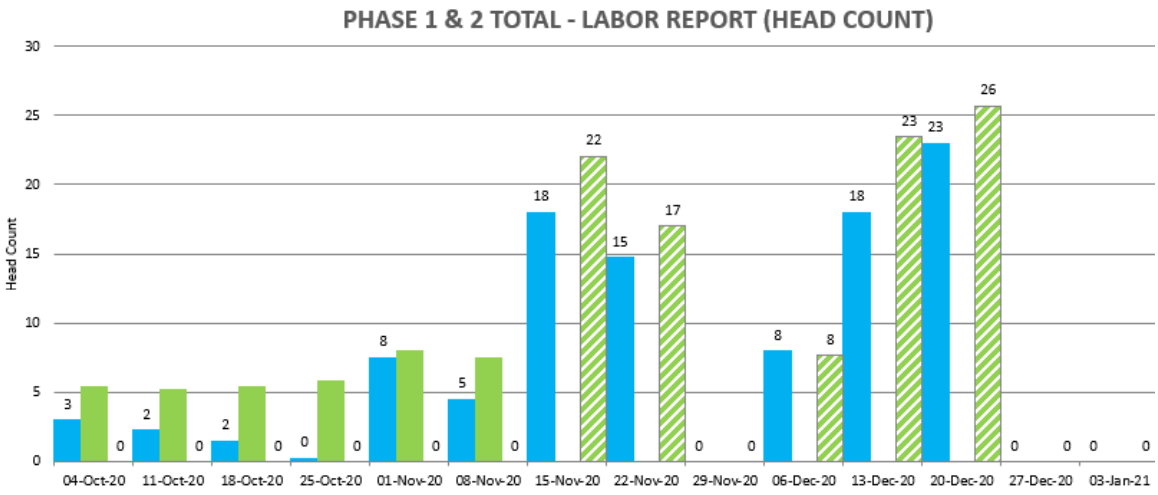
- **Milestone Variance Comments:** There were no changes in Milestones from October's end of month submission.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Fini	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	22-Feb-21	22-Feb-21	0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	9-Mar-21	9-Mar-21	0
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	18-Mar-21	18-Mar-21	0
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	5-May-21	05-May-21*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	5-May-21	5-May-21	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/05/2021)	5-Oct-21	5-Oct-21	05-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

FTW1 - RRL: Overall Progress Curve

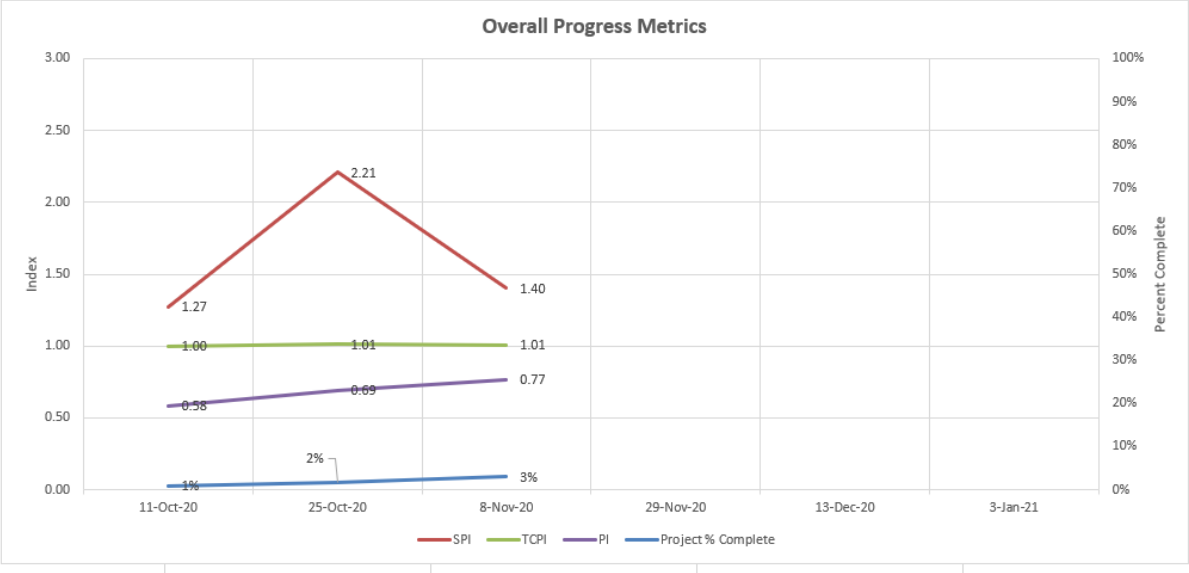
	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021
Total	Hours															
	Period															
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0	0	740
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450
1093	Earned	220	73	223	146	320	111	0	0	0	0	0	0	0	0	0
36076	Forecast (Earned)	0	0	0	0	0	0	887	685	0	309	944	1034	0	0	763
	Percentage															
	Period															
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%
	Earned	1%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Forecast	0%	0%	0%	0%	0%	0%	2%	2%	0%	1%	3%	3%	0%	0%	2%
	Cumulative															
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%
	Earned	1%	1%	1%	2%	3%	3%									
	Forecast (Earned)		1%	1%	2%	3%	3%	5%	7%	7%	8%	11%	13%	13%	13%	15%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20	3%	1.40	1.01	0.77
29-Nov-20				
13-Dec-20				
3-Jan-21				
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



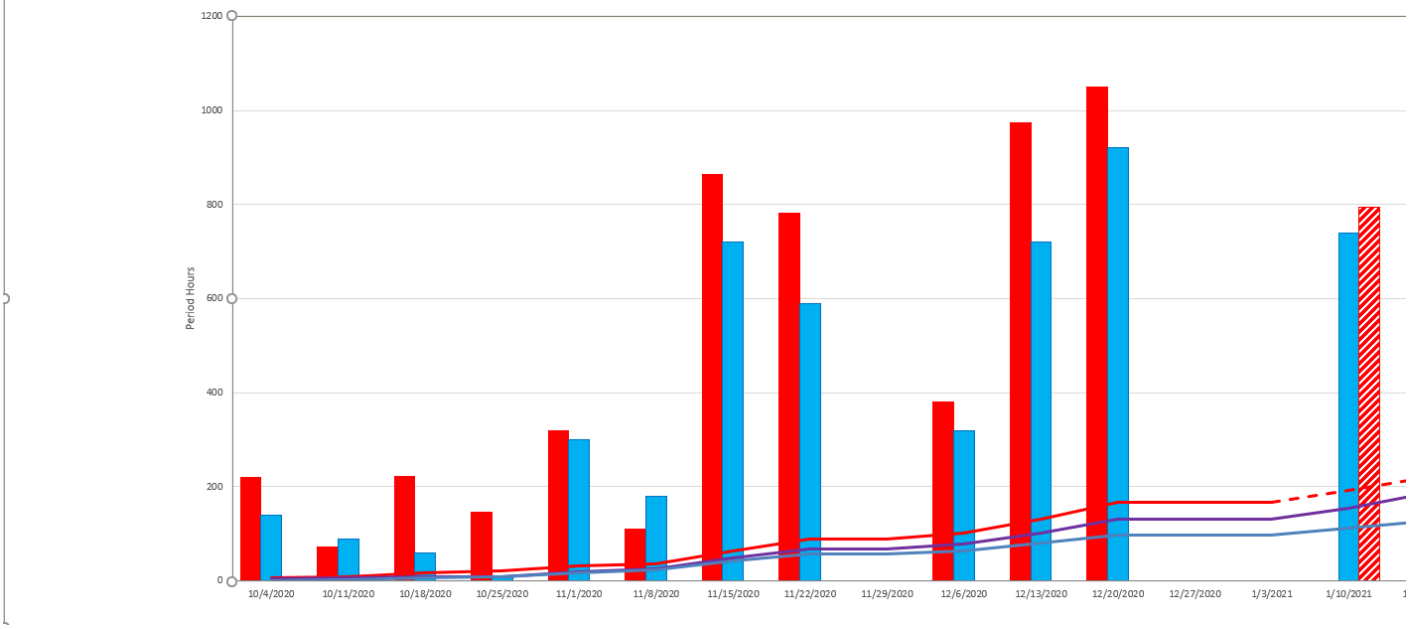
December Month-End

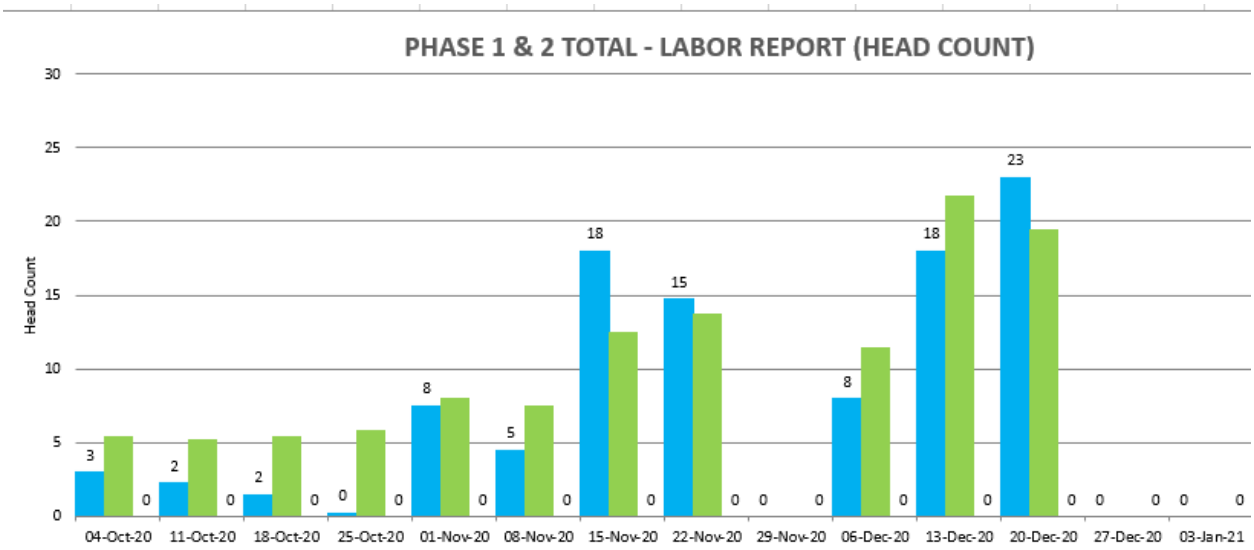
- **Milestone Variance Comments:** There were no milestone variances from previous December Mid-Month Submission. Status of the project: On-Time Completion.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Fini	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	18-Feb-21	18-Feb-21	0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	8-Mar-21	8-Mar-21	0
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	17-Mar-21	17-Mar-21	0
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	4-May-21	04-May-21*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	4-May-21	4-May-21	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	4-Oct-21	4-Oct-21	04-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

FTW1 - RRL: Overall Progress Curve

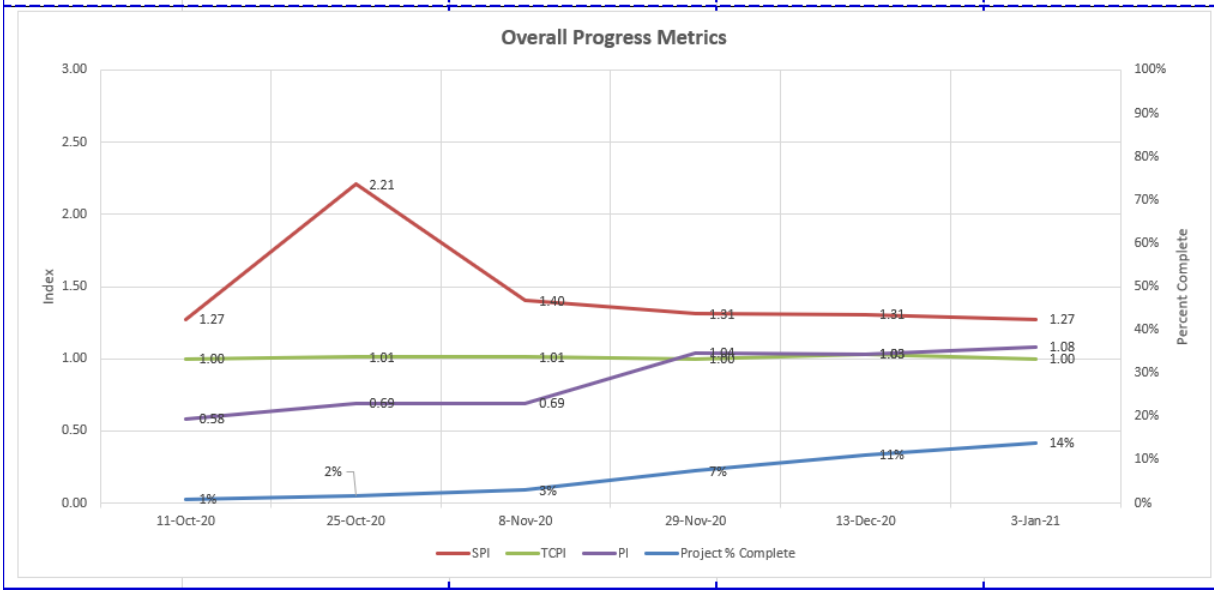
	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021
Total	Hours															
	Period															
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0	0	740
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450
5141	Earned	220	73	223	146	320	111	864	781	0	381	973	1049	0	0	0
32028	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	795
	Percentage															
	Period															
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%
	Earned	1%	0%	1%	0%	1%	0%	2%	2%	0%	1%	3%	3%	0%	0%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
	Cumulative															
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%
	Earned	1%	1%	1%	2%	3%	3%	5%	7%	7%	8%	11%	14%	14%	14%	
	Forecast (Earned)														14%	16%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20	3%	1.40	1.01	0.69
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.03	1.03
3-Jan-21	14%	1.27	1.00	1.08
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



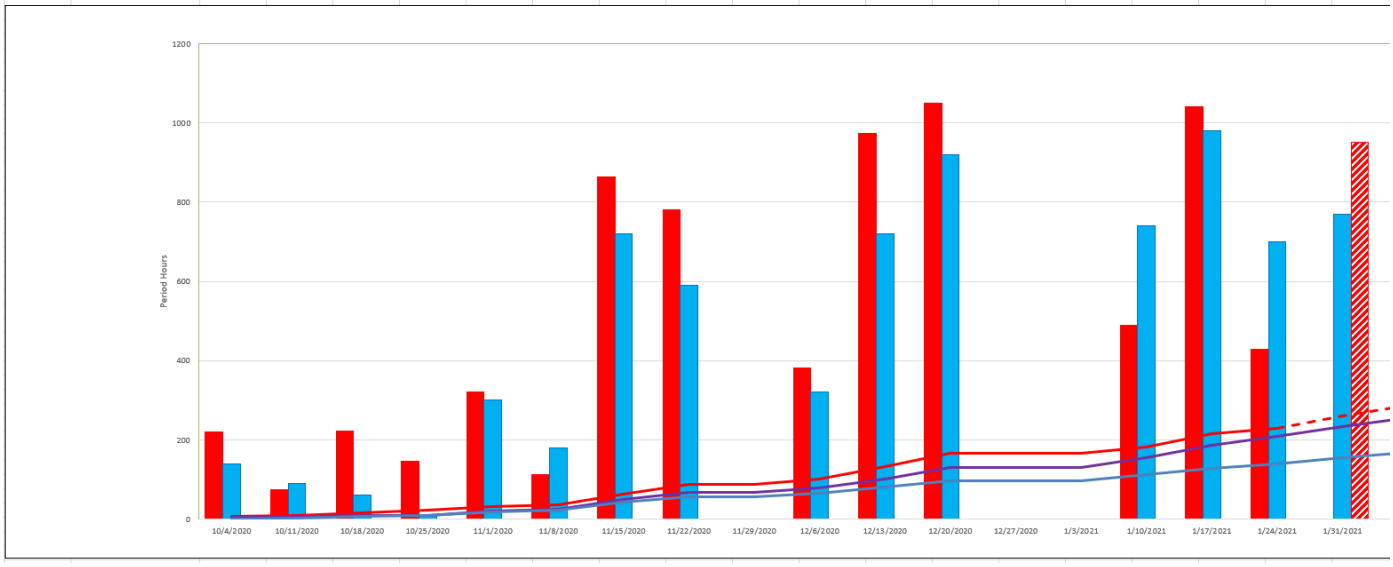
January Month-End

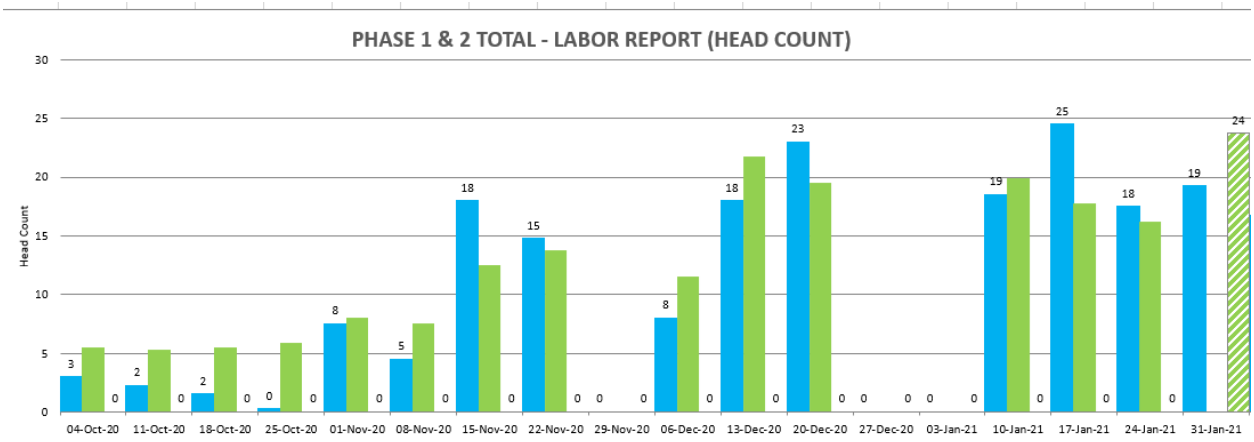
- **Milestone Variance Comments:** The PH1 Area B gained one day of efficiency, however, Area C pushed out 12 days from previous submission (still 2 days earlier than baseline submission). This push was due to an incorrect tie that was realized.
- Pulling/terminating wire activities were shown as a SS relationship, while all other areas (A, B & D) had crew logic (FS relationships) between pulling wire activities. The flow of the area is to pull/terminate wire at CPP, then pull wire to RPP's with the same crew.
- We tied the activities as FS, to show crew logic, in-turn pushing out our area C milestone. We could not see any trickle effects that impacted other areas, or that effect critical path, so we agreed to make relationship change to show smoother flow.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Fin	Variance to Previous Update
FB.MS.1480.1B10	Project Team Mobilize				0
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	1-Mar-21	18-Feb-21	17-Feb-21	1
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21	8-Mar-21	8-Mar-21	0
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21	17-Mar-21	29-Mar-21	-12
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21	4-May-21	04-May-21*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21	4-May-21	4-May-21	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	4-Oct-21	4-Oct-21	04-Oct-21*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	4-Feb-22	4-Feb-22	04-Feb-22*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	7-Jun-22	7-Jun-22	07-Jun-22*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22	19-Aug-22	19-Aug-22	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	5-Oct-22	5-Oct-22	05-Oct-22*	0

FTW1 - RRL: Overall Progress Curve

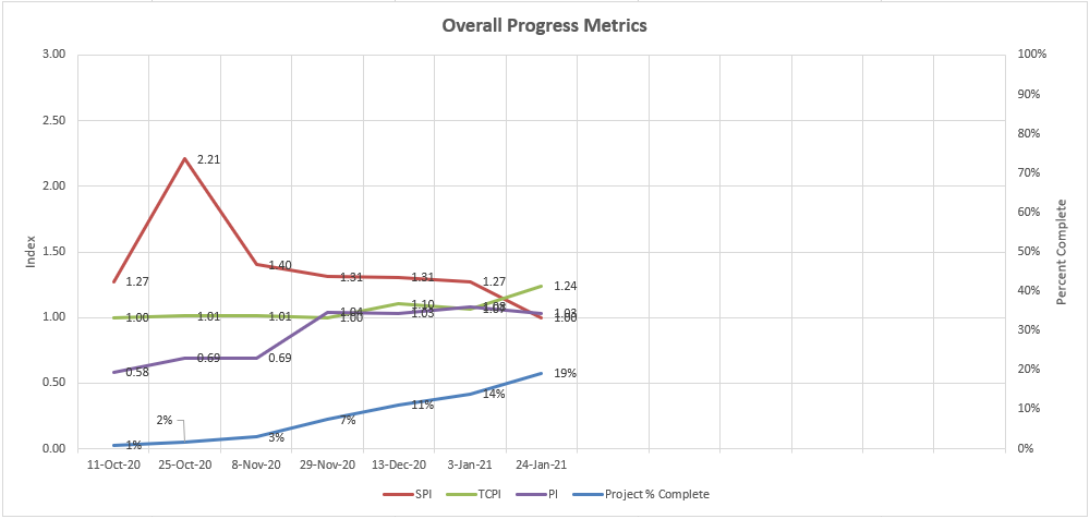
	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021	1/17/2021	1/24/2021	1/31/2021
Total	Hours																		
	Period																		
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0	0	740	980	700	770
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450	480	360	470
7099	Earned	220	73	223	146	320	111	864	781	0	381	973	1049	0	0	488	1042	428	0
30070	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	952
	Percentage																		
	Period																		
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%	3%	2%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%	1%	1%	1%
	Earned	1%	0%	1%	0%	1%	0%	2%	2%	0%	1%	3%	3%	0%	0%	1%	3%	1%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
	Cumulative																		
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%	16%	17%	19%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%	11%	12%	13%
	Earned	1%	1%	1%	2%	3%	3%	5%	7%	7%	8%	11%	14%	14%	14%	15%	18%	19%	
	Forecast (Earned)																	19%	22%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20	3%	1.40	1.01	0.69
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.10	1.03
3-Jan-21	14%	1.27	1.07	1.08
24-Jan-21	19%	1.00	1.24	1.03
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



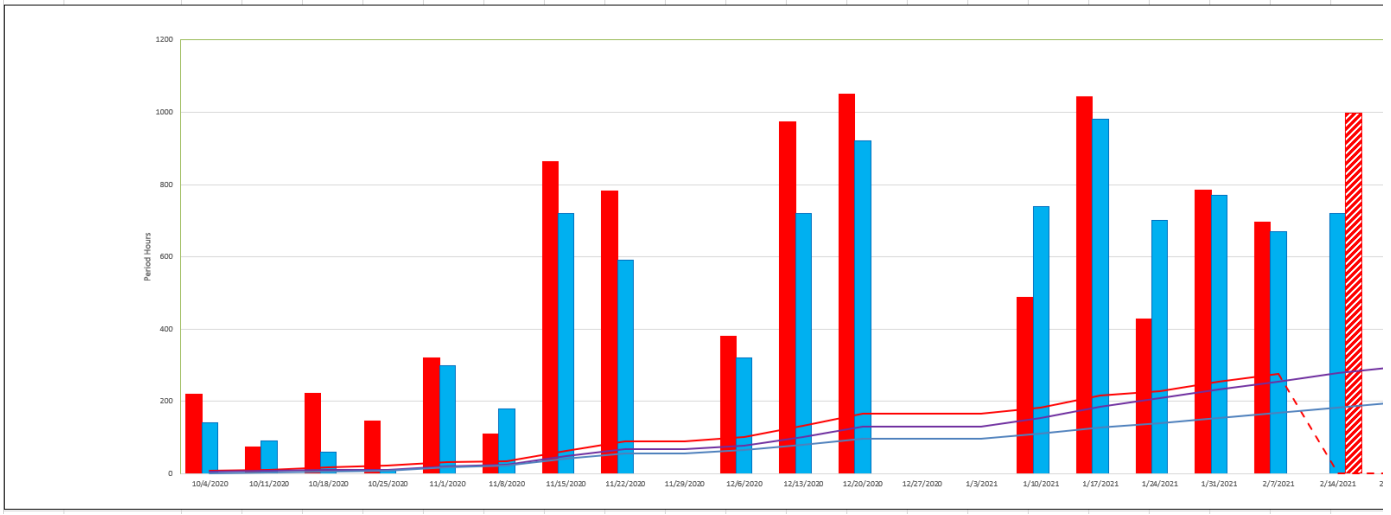
February Mid-Month

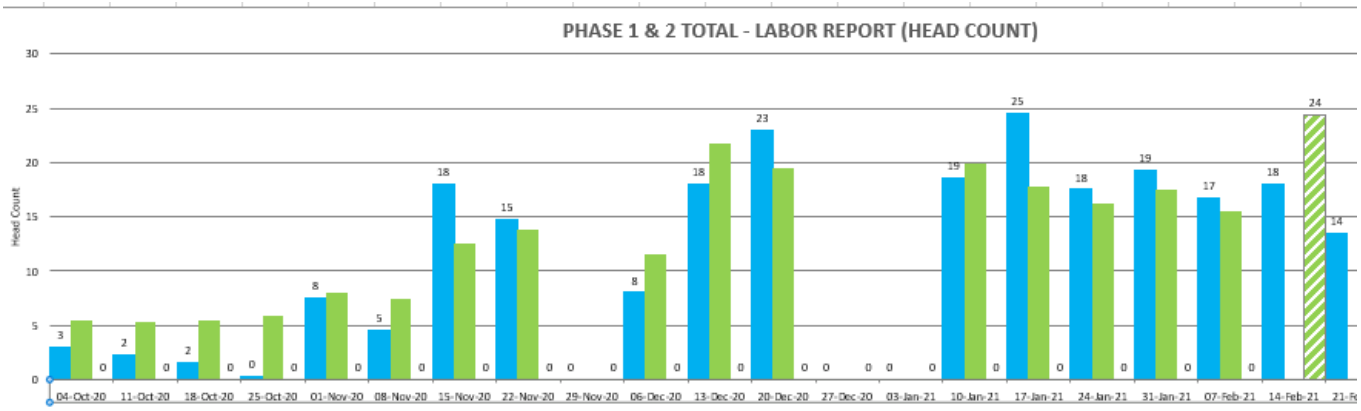
- **Milestone Variance Comments:** Area A completion slipped 2 days from previous update (due to crew that was working in area A had to move back to area B to finish pulling wire). We are still tracking 12 days ahead of baseline schedule for area A completion.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	01-Mar-21 17	17-Feb-21 17	17-Feb-21 17	0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21 17	08-Mar-21 17	10-Mar-21 17	-2
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21 17	29-Mar-21 17	29-Mar-21 17	0
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21 17	04-May-21 17	04-May-21 17*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21 17	04-May-21 17	04-May-21 17	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	04-Oct-21 17	04-Oct-21 17	04-Oct-21 17*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	04-Feb-22 17	04-Feb-22 17	04-Feb-22 17*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	07-Jun-22 17	07-Jun-22 17	07-Jun-22 17*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22 17	19-Aug-22 17	19-Aug-22 17	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0

FTW1 - RRL: Overall Progress Curve

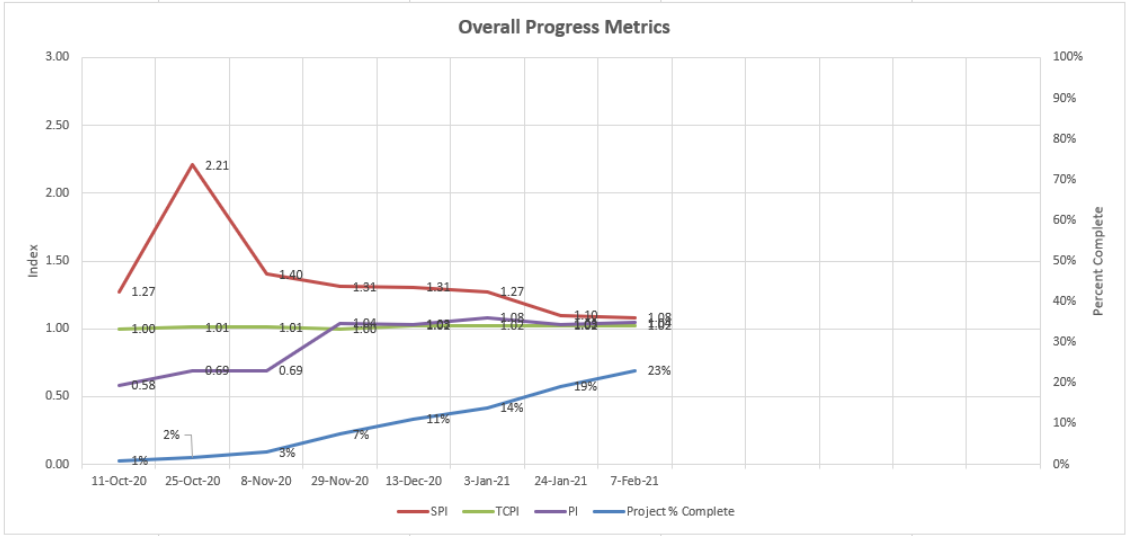
	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021	1/17/2021	1/24/2021	1/31/2021	2/7/2021	2/14/2021
Total	Hours																				
	Period																				
37169	Planned Early Curve	140	90	60	10	300	180	720	590	0	320	720	920	0	0	740	980	700	770	670	720
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450	480	360	470	440	440
8580	Earned	220	73	223	146	320	111	864	781	0	381	973	1049	0	0	488	1042	428	785	696	0
28589	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	998
	Percentage																				
	Period																				
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%	3%	2%	2%	2%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%	1%	1%	1%	1%	1%
	Earned	1%	0%	1%	0%	1%	0%	2%	2%	0%	1%	3%	3%	0%	0%	1%	3%	1%	2%	2%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
	Cumulative																				
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%	16%	17%	19%	21%	23%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%	11%	12%	13%	14%	15%
	Earned	1%	1%	1%	2%	3%	3%	5%	7%	7%	8%	11%	14%	14%	14%	15%	18%	19%	21%	23%	
	Forecast (Earned)																			23%	0%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
8-Nov-20	3%	1.40	1.01	0.69
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.02	1.03
3-Jan-21	14%	1.27	1.02	1.08
24-Jan-21	19%	1.10	1.02	1.03
7-Feb-21	23%	1.08	1.02	1.04
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



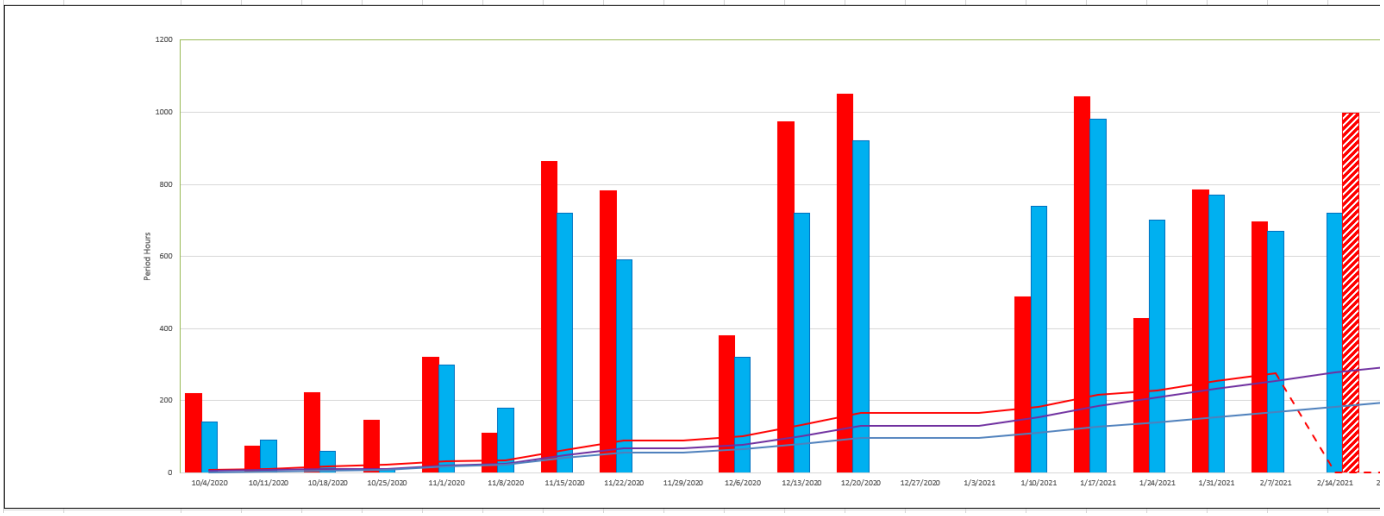
February Month-End

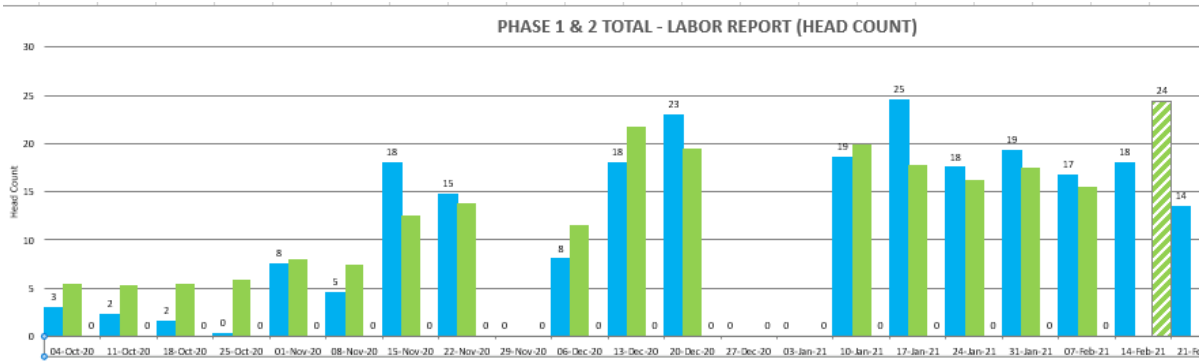
- **Milestone Variance Comments:** Area A completion slipped 2 days from previous update (due to crew that was working in area A had to move back to area B to finish pulling wire). We are still tracking 12 days ahead of baseline schedule for area A completion.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	01-Mar-21 17	17-Feb-21 17	17-Feb-21 17	0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	22-Mar-21 17	08-Mar-21 17	10-Mar-21 17	-2
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	31-Mar-21 17	29-Mar-21 17	29-Mar-21 17	0
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	18-May-21 17	04-May-21 17	04-May-21 17*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	18-May-21 17	04-May-21 17	04-May-21 17	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	04-Oct-21 17	04-Oct-21 17	04-Oct-21 17*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	04-Feb-22 17	04-Feb-22 17	04-Feb-22 17*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	07-Jun-22 17	07-Jun-22 17	07-Jun-22 17*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22 17	19-Aug-22 17	19-Aug-22 17	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0

FTW1 - RRL: Overall Progress Curve

	Data Date	10/4/2020	10/11/2020	10/18/2020	10/25/2020	11/1/2020	11/8/2020	11/15/2020	11/22/2020	11/29/2020	12/6/2020	12/13/2020	12/20/2020	12/27/2020	1/3/2021	1/10/2021	1/17/2021	1/24/2021	1/31/2021	2/7/2021	2/14/2021
Total	Hours																				
	Period																				
37169	Planned Early Curve	140	90	60	10	300	180	720	530	0	320	720	920	0	0	740	980	700	770	670	720
	Planned Late Curve	0	100	90	90	280	150	600	440	0	250	470	550	0	0	450	480	360	470	440	440
8580	Earned	220	73	223	146	320	111	864	781	0	381	973	1049	0	0	488	1042	428	785	696	0
28589	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	998
	Percentage																				
	Period																				
	Planned Early Curve	0%	0%	0%	0%	1%	0%	2%	2%	0%	1%	2%	2%	0%	0%	2%	3%	2%	2%	2%	2%
	Planned Late Curve	0%	0%	0%	0%	1%	0%	2%	1%	0%	1%	1%	1%	0%	0%	1%	1%	1%	1%	1%	1%
	Earned	1%	0%	1%	0%	1%	0%	2%	2%	0%	1%	3%	3%	0%	0%	1%	3%	1%	2%	2%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
	Cumulative																				
	Planned Early Curve	0%	1%	1%	1%	2%	2%	4%	6%	6%	6%	8%	11%	11%	11%	13%	16%	17%	19%	21%	23%
	Planned Late Curve	0%	0%	1%	1%	2%	2%	4%	5%	5%	5%	7%	8%	8%	8%	9%	11%	12%	13%	14%	15%
	Earned	1%	1%	1%	2%	3%	3%	5%	7%	7%	8%	11%	14%	14%	14%	15%	18%	19%	21%	23%	
	Forecast (Earned)																			23%	0%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
11-Oct-20	1%	1.27	1.00	0.58
25-Oct-20	2%	2.21	1.01	0.69
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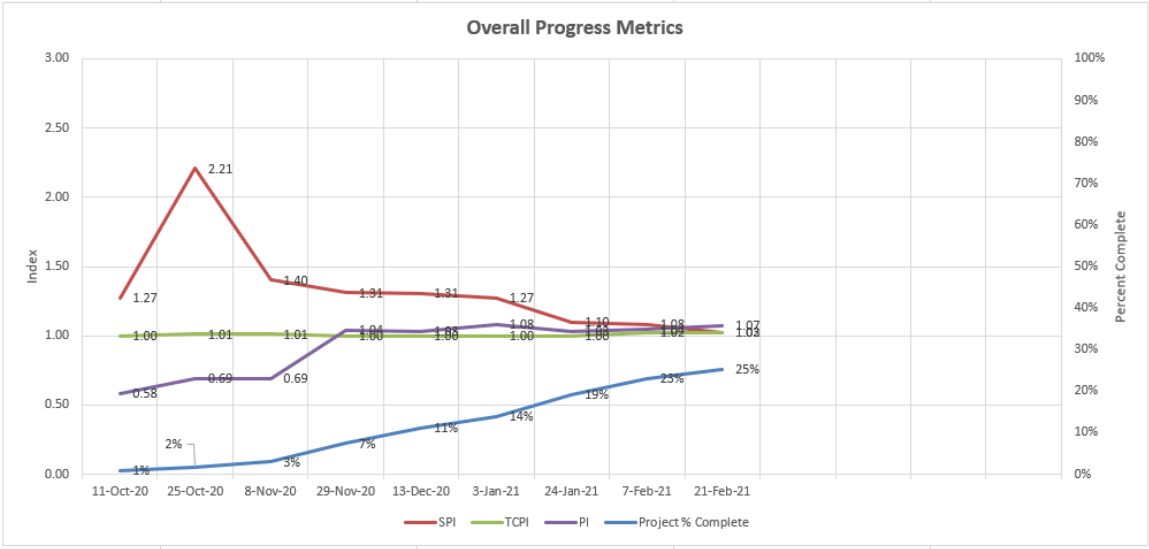
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.00	1.03
3-Jan-21	14%	1.27	1.00	1.08
24-Jan-21	19%	1.10	1.00	1.03
7-Feb-21	23%	1.08	1.02	1.04
21-Feb-21	25%	1.03	1.02	1.07
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



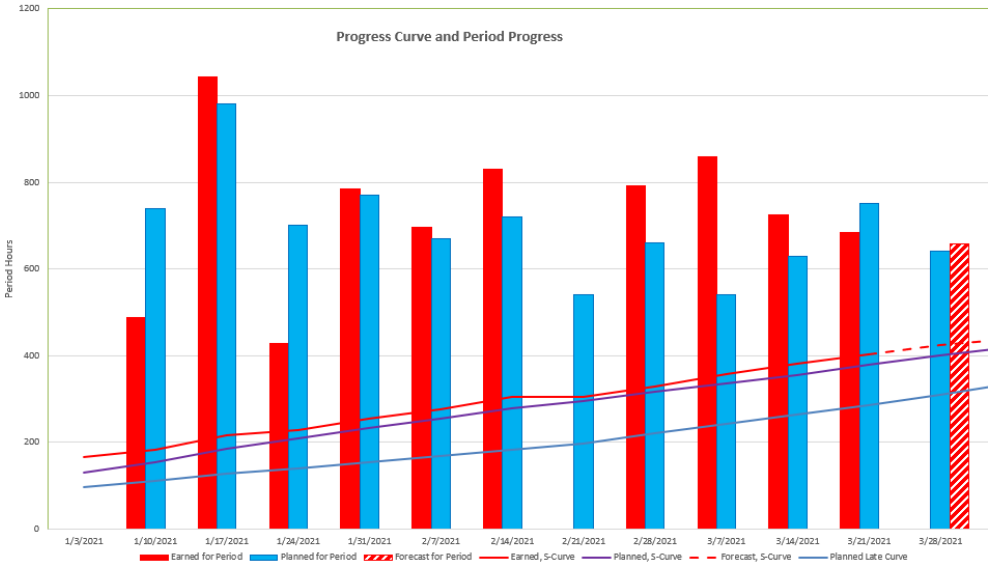
March Month-End

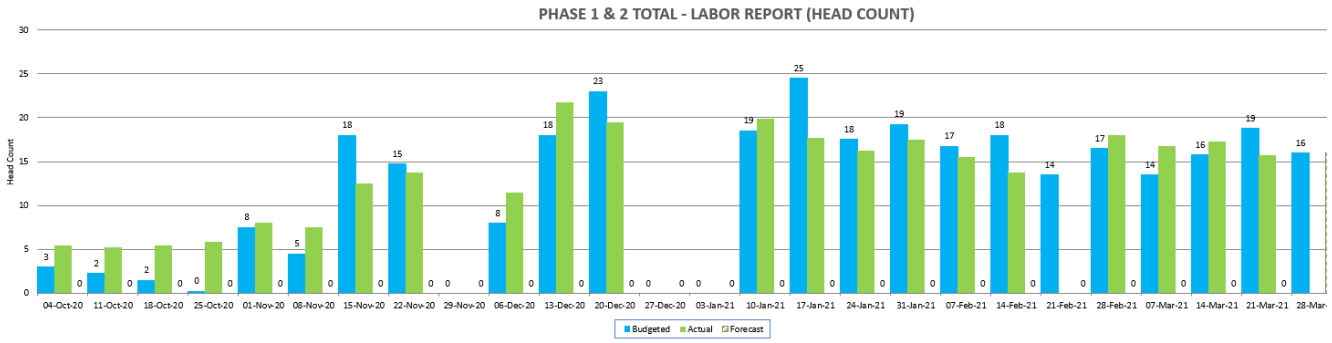
- **Milestone Variance Comments** Overall Phase 1 Areas A&B were both completed ahead of contract schedule, the largest variance throughout the month was in Phase 1 Area B due to an extensive effort constructing a safe way to complete the fire caulking. The To Complete Performance Index is at 1.02, SPI at 1.06 and the Productivity Index continues trending positively at 1.09. Actual labor count on site continued to trend at or below budgeted totals. Finally, Phase 1 continues to trend closer to the Early completion curve with a current projected completion date of 5/10.

Activity ID	Activity Name	BL Project Finish	Previous Update Finish	Current Update Finish	Variance to Previous Update
CONSTRUCTION MILESTONES		05-Oct-22 17	05-Oct-22 17	05-Oct-22 17	0
FB.MS.1480.1B10	Project Team Mobilize				0
FB.MS.1480.1A	PHASE 1 AREA A COMPLETE	14-Mar-21 07	09-Mar-21 17	09-Mar-21 07 A	1
FB.MS.1480.1B	PHASE 1 AREA B COMPLETE	16-Mar-21 17	10-Mar-21 17	15-Mar-21 17 A	-5
FB.MS.1480.1C	PHASE 1 AREA C COMPLETE	30-Mar-21 17	31-Mar-21 17	30-Mar-21 17	1
FB.MS.1480	PHASE 1 COMPLETE (Target 5/18/2021)	10-May-21 17	10-May-21 17	10-May-21 17*	0
FB.MS.1480.1D	PHASE 1 AREA D COMPLETE	10-May-21 17	10-May-21 17	10-May-21 17	0
FB.MS.1500.2B	PHASE 2 AREA B COMPLETE (Target 10/04/2021)	04-Oct-21 17	04-Oct-21 17	04-Oct-21 17*	0
FB.MS.1500.2A	PHASE 2 AREA A COMPLETE (Target 02/04/2022)	04-Feb-22 17	04-Feb-22 17	04-Feb-22 17*	0
FB.MS.1500.2C	PHASE 2 AREA C COMPLETE (Target 06/07/2022)	07-Jun-22 17	07-Jun-22 17	07-Jun-22 17*	0
FB.MS.1510	ELECTRICAL FINAL INSPECTION	19-Aug-22 17	19-Aug-22 17	19-Aug-22 17	0
FB.MS.1500	PHASE 2 SUBSTANTIAL COMPLETION (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0
FB.MS.1500.2D	PHASE 2 AREA D COMPLETE (Target 10/05/2022)	05-Oct-22 17	05-Oct-22 17	05-Oct-22 17*	0

FTW1 - RRL: Overall Progress Curve

	Data Date	1/3/2021	1/10/2021	1/17/2021	1/24/2021	1/31/2021	2/7/2021	2/14/2021	2/21/2021	2/28/2021	3/7/2021	3/14/2021	3/21/2021	3/28/20
Total	Hours													
	Period													
37169	Planned Early Curve	0	740	980	700	770	670	720	540	660	540	630	750	640
	Planned Late Curve	0	450	480	360	470	440	440	450	740	680	680	640	720
12472	Earned	0	488	1042	428	785	696	831	0	792	859	725	685	0
24697	Forecast (Earned)	0	0	0	0	0	0	0	0	0	0	0	0	657
	Percentage													
	Period													
	Planned Early Curve	0%	2%	3%	2%	2%	2%	2%	1%	2%	1%	2%	2%	2%
	Planned Late Curve	0%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
	Earned	0%	1%	3%	1%	2%	2%	2%	0%	2%	2%	2%	2%	0%
	Forecast	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
	Cumulative													
	Planned Early Curve	11%	13%	16%	17%	19%	21%	23%	25%	26%	28%	30%	32%	33%
	Planned Late Curve	8%	9%	11%	12%	13%	14%	15%	16%	18%	20%	22%	24%	26%
	Earned	14%	15%	18%	19%	21%	23%	25%	25%	27%	30%	32%	34%	
	Forecast (Earned)												34%	35%





FTW1 - RRL: Overall Progress Metrics

Update Period (P6 Data Date)	Project % Complete	SPI	TCPI	PI
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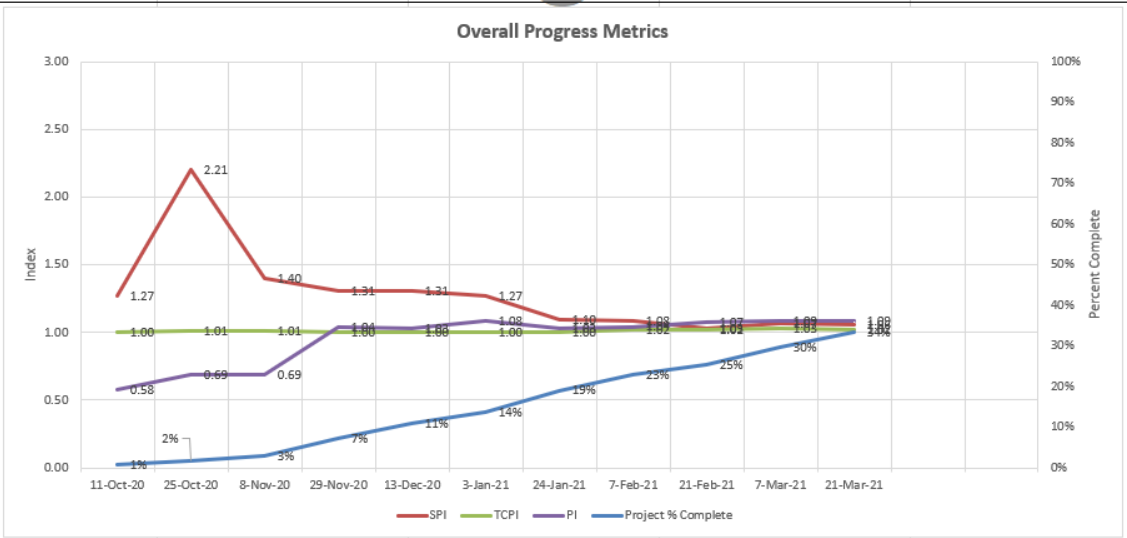
29-Nov-20	7%	1.31	1.00	1.04
13-Dec-20	11%	1.31	1.00	1.03
3-Jan-21	14%	1.27	1.00	1.08
24-Jan-21	19%	1.10	1.00	1.03
7-Feb-21	23%	1.08	1.02	1.04
21-Feb-21	25%	1.03	1.02	1.07
7-Mar-21	30%	1.07	1.03	1.09
21-Mar-21	34%	1.06	1.02	1.09
Calculation Basis	*Project % Complete based on Earned Progress.*	*Schedule Performance Index (SPI) = Earned Value Labor Units / Planned Value Labor Units.*	*To Complete Performance Index (TCPI) = (Budget at Completion - Earned Value) / (Estimate at Completion - Actual Labor Units).*	*Performance Index (PI) = Earned Value Labor Units / Actual Labor Units.*



Progress synopsis & Key benefits to date – 686A

Synopsis

- 8 weeks including mobilization is a small sample data set.
- Schedule performance and percentage complete are ahead of plan.
- Productivity Index is lower than desirable.
- Trending away from the early curve towards the late curve, but still maintaining the end date.
- Early warning flag that we will monitor very closely in the coming weeks to act if needed.

Quantitative and non-subjective insight into likelihood of project finishing ahead of schedule, on schedule, behind schedule.

- Early evaluation of labor requirements to identify potential labor risk
- Allows for comparison and analysis of progress and performance against baseline metrics
- Initial drafts of baseline schedule contained various labor peaks and had stretched Phase 1 scope out to over 12 months in total duration. It would have been difficult to ascertain these peaks just by looking at scheduled activities in isolation and may lead to acceptance of a poor-quality baseline schedule w/out utilization of Resource loading
- Particularly useful when multiple retrofit projects are taking place in parallel and the same trade partners are being used for different projects
- SPI in excess of 1.0 but a productivity factor of .58 - .77 indicates inflated estimates.

Progress synopsis & Key benefits to date – 686B

Synopsis

- The project is now 7 months into execution, and 30% complete.
- Schedule performance and percentage complete are ahead of plan.
- Early spikes in data have levelled out as we calibrate and dial in the percent complete walks, the data being requested, evaluated.
- We are also seeing the GC use this data to drive conversations and efficiencies with the trade partners which is satisfying.
- Opportunities continue to be evaluated to bring in the baseline completion date, originally 5/18, now tracking to 5/4
- Threats – The EC is becoming acutely aware of productivity, how it relates to schedule performance and without contract incentives there isn’t much to encourage overperformance.

Analysis

Key benefits identified

1. Quantitative and non-subjective insight into likelihood of project finishing ahead of schedule, on schedule, behind schedule
2. Early evaluation of labor requirements to identify potential labor risk
    a. Particularly useful when multiple retrofit projects are taking place in parallel and the same trade partners are being used for different projects
3. Allows for comparison and analysis of progress and performance against baseline metrics
4. Large portion of project scope takes place during the Suite-Level Retrofit windows
    a. Imperative that the schedule is developed using labor hours to validate the feasibility of durations and labor density in the data halls during the time critical SLR window
5. As the Resource Loaded Schedule approach is proving successful and becoming normalized, there is heightened focus on front-end planning during the baseline schedule development on other procurement programs, leading to higher quality schedule submissions
6. Ability to identify issues or logic flaws to GC/TPs
    a. In Dec 2020, Owner team was able to identify Mech contractor charging idle Hours when Mech contractor submitted abnormal hours to multiple activities in their dailies.

RLS Data driving improvements

Issue - Initial drafts of baseline schedule contained various labor peaks and had stretched Phase 1 scope out to over 12 months in total duration.

    a. It would have been difficult to ascertain these peaks just by looking at scheduled activities in isolation and may have led to acceptance of a poor-quality baseline schedule

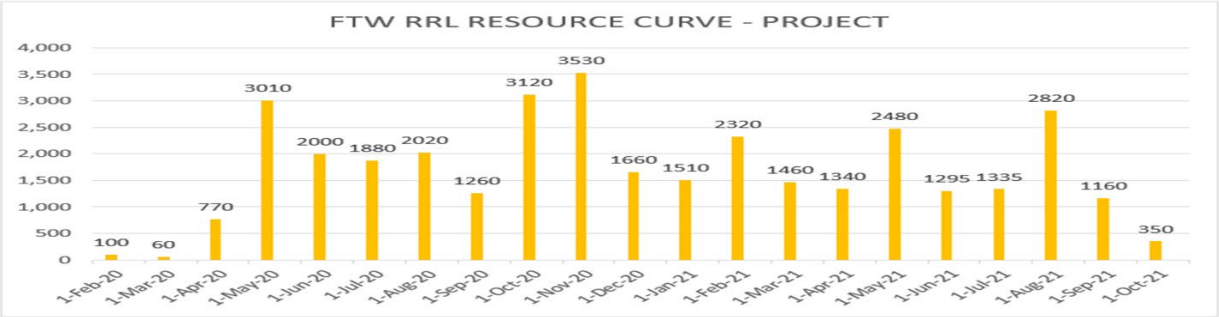


Figure 5.0 Original Resource curve

Action Taken - Contractor asked to resubmit baseline schedule with increased focus on evaluation of labor peaks and used labor hours to validate a more reasonable target duration.

b. Identified approximately 13,300 labor hours for Phase 1 scope with desire for a more deliberate approach to ramp up and maintaining consistency

Result - Revised baseline schedule submitted as follows, showing a more defined ramp-up and ramp-down phase, as well as adhering to the desired target duration for Phase 1 scope.

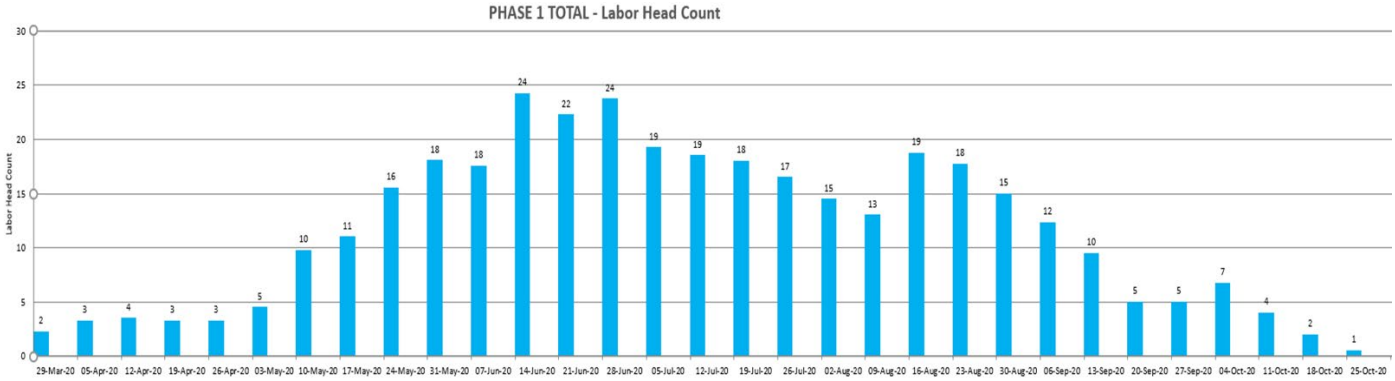


Figure 6.0 Revised Resource curve

Potential Risks identified

1. Based on a cursory review, the Resource Loading field resource job description appears very easy…. "just has to count heads". That is a falsehood, the main task is to sync daily report data with actual activities happening at site. Trade Partner and GC Rep executing the synced daily report every day is one of the primary areas of disagreement and conflict.
2. The identified resource may not be the right person to implement resource loading.
3. The approach to percent complete and activity status evaluation needs to be agreed upon, standardized and scalable. If not, conflict between parties, morale and trust will be undone
4. Threats – The EC is becoming acutely aware of productivity, how it relates to schedule performance and without contract incentives there is not much to encourage overperformance.

Appendix B – Consent form & Questionnaire survey

Informed Consent Form

An optimized approach to resource loading hyperscale technology projects to balance feasibility, suitability, and acceptability

Researcher:

Shane Barrett

607 7683005

Department of Project Management, University of Alaska Anchorage

Description:

You are being asked to participate in a research project on optimizing the approach to resource loading schedules in hyperscale technology projects . The information you provide will be used to test the hypothesis that parameters and financial thresholds need to be established for optimum utilization of resource scheduling in the Construction Tech sector.

This is the Capstone Project for the completion of my Master of Science in Project Management through the University of Alaska Anchorage. You are being asked to participate in this project because of your expertise and knowledge in the field or resource loading. Please read this form and ask any questions you may have before you agree to participate in the project.

Voluntary Nature of Participation:

Your participation in this study is voluntary. You may stop at any time and you do not have to answer any questions you do not want to.

Confidentiality:

Any information obtained about you from the research including answers to questionnaires and discussion will be kept strictly confidential. Your information will be coded with a number so no one can trace your answers to your name

Potential Benefits and Risks:

Your participation in this study requires a commitment of time on your part. However, if you decide to participate, your willingness to share your experiences and knowledge may provide valuable insights for testing the hypothesis outlined and the overall optimization of RLS. There are no foreseeable risks or benefits to you personally with respect to your personal or professional status from participation in this study.

Compensation:

No compensation will be offered for participation.

Contact People

If you have any questions about this study or concerns about your rights as a research participant, please contact Sharilyn Mumaw, M.P.A., Research Compliance Officer, University of Alaska Anchorage, simumaw@uaa.alaska.edu, 907-786-1099786-6581.

Signature

Your signature below means that you have read the information above and agree to participate in this study.

Signature_____ Date _____

Print Name _____

A copy of this consent form is attached for you to keep.

This is a questionnaire on Schedule Resource Loading capturing the thoughts, insights, and opinions of a select group of Subject Matter Experts and is being conducted by UAA MSPM Student, Shane Barrett, as part of a capstone research project.

The purpose of this brief questionnaire is to gather information on current approaches or practices that will be a vital input to testing the project hypothesis; that parameters and financial thresholds need to be established for optimum utilization of resource scheduling in the Construction Tech sector. The survey itself consists of 10 questions and will take most participants no longer than 20 minutes to complete.

You can be assured that no identifying information will be used in the analysis. Also, your responses will be kept confidential, and will automatically be compiled in the online survey tool, known as Qualtrics. All data will be stored in a password protected electronic format. The results of the study will be used as a baseline to prove or disprove the underlying hypothesis.

By moving on to the next page, you acknowledge that you have read this information and agree to participate in this research. You are free to withdraw your participation at any time.

If you have any questions or concerns, please submit them to sbarrett3@alaska.edu, or sbarrett2018@fb.com

Thank you. Your time, cooperation and insights are very much appreciated.

1. What is your definition of a Resource (Labor) Loaded Schedule

   _____
   _____
   _____

2. What is the overall objective of resource loading in your opinion

   _____
   _____
   _____

3. What benefits does it produce and what are the delta's, in your experience

   _____
   _____
   _____

4. Should this be a point of focus as we scale to meet capacity demand

   _____
   _____
   _____
   _____

   a. Does an interdependence exist or is this a distraction from more acute business need

      _____
      _____
      _____

5. Does the business need outweigh the front-end cost and LOE involved for support pillars and strategic partners

   _____
   _____
   _____

6. If not, why not and are there factors that change this landscape

   _____
   _____
   _____

7. What would implementation roll out look like, and why

    a. Low risk Type C (Sustaining projects) utilized to refine approach

    OR

    b. Large greenfield projects targeted for optimum return on investment

_____
_____
_____

8. If a broad stroke approach applied, how do you implement the concept across such a wide spectrum of projects

_____
_____
_____

9. For strategic partners and vendors, how can we ensure this requirement does not become overly burdensome and impact competitive bidding

_____
_____
_____

10. Thoughts regarding the concept of resource loading the baseline schedule to validate the plan & headcount needs vs. actively using the resource loading throughout the project and collecting metrics, etc. to actively track performance / progress

    i.e. A single phase, heavy Precon involvement at the outset to generate a high-quality plan to execute against and eliminate the second phase of continual intensive engagement throughout the life of the project

_____
_____
_____

Key points

Resource planning	Volume	Future state
Efficient utilization	Accuracy	Overallocation
Finite resources	Predictability	Growth
Intelligent/Deliberate usage	Constraints	Cost

Appendix C – Communication Management Plan

Introduction

Communication is a fundamental way to manage Stakeholder expectations about how the project is progressing. Managing communications is about making sure that everyone involved and interested in the project is kept informed. Information is made available to appropriate audiences, at the appropriate time. Regular internal and external communications are necessary to sustain project momentum, fulfill organizational reporting requirements, and provide appropriate monitoring and control over the project.

The purpose of the Communication Management Plan is to define the project's communication requirements and how information will be distributed to the project team, management, and other Stakeholders. The Communication Management Plan sets the communications framework. It will serve as a guide and will be updated as communication needs change. The plan also includes a communications matrix that maps the project communication requirements and provides a description of communications methods, cadence, and vehicles.

Approach

Effective communication means the project team is providing information in the right format, at the right time, and with the right impact. A key project goal is to ensure timely and appropriate identification, collection, distribution, storage, retrieval, and disposition of project information to the project team, Stakeholders, and the Project Sponsor. To that end, this Communication Management Plan includes, but is not limited to, the following:

- Identification of Stakeholder communications requirements
- Information collection sources and responsibilities
- Communication distribution channels
- Frequency and recipients of communication
- Assignments for information collection and distribution
- Guidelines for effective and efficient meetings
- Storage, retrieval, and disposition methods

Roles and Responsibilities

The Roles and Responsibilities of those involved in the Communication Management Process are captured and detailed in the following table. The stakeholder type (Internal or External) and their influence on the project is also addressed. See portions below and reference the Stakeholder Register for full details

Name of Stakeholder	Role in Project	Type of Stakeholder	Influence on Project Outcome
Shane Barrett	Project Owner	Internal	Influencer - Main decision maker, ability to defer project and/or expert advice of advisory committee
Joel Baldwin	Project Sponsor	Internal	Supporter - Provides resources and support for the project, enabling environment for the project to be a success.
Roger Hull	Primary Advisor	Internal	Influencer - Provides technical expertise and advice to the project Owner. Brings impartial/objective insights to help the project be successful
LuAnn Piccard	Committee Member #1	Internal	Influencer - Outlines project expectations and provide guidance and feedback to illuminate areas for improvement/refinement
Walter Almon	Committee Member #2	Internal	Influencer - Outlines project expectations and provide guidance and feedback to illuminate areas for improvement/refinement
Fahad Masoud	Schedule analysis	External	Influence - Provides the raw data for the initial schedule loading & the progress inputs
Thomas Vanelli	Schedule analysis	External	Influence - Analyzes the data and provides Owner feedback and direction
Estimating team	Cost analysis	External	Influence - Provides inputs on physical project trends and potential Change Orders or impacts
Precon team	Cost analysis	External	Influence - Provide feedback on approach to resource loading and value add to projects and expert insights
Execution team	Construction execution	External	Influence - Provides inputs on physical project trends and value or impacts of the resource Loading approach
Project management team	Construction execution	External	Influence - Provides inputs on physical project trends and value or impacts of the resource Loading approach
PM 686 peers	L/learned, shared experiences	External	Influence - Generates ideas and discussion for areas of improvement, shares issues etc.

Communications Management Process

The Communication Management Plan contains the approach for project communications to suit specific project needs. It is based on Stakeholders' information needs and requirements, as well as the available organizational assets (reusable items such as technology and tools). Although the general communication process from project to project may be similar, each project may have specific processes or approaches necessary to align with the sponsoring organization's normal communications practices more closely. The following sections identify a management process that can be adapted to specific project needs.

Identify Stakeholder Communication Requirements

The table below outlines all Stakeholder groups, the specific communications items related to the Stakeholder group, and the purpose for communication with the Stakeholder group.

Stakeholder Group	Communication Items	Purpose
Executive committee	• Status reports • Project Announcements	• Update management on project progress, risks, issues and forecast. • Provide project performance information (cost, schedule, and quality). • Anticipated Changes/Key Risks/Corrective Actions • Decision-making - Provide summary information regarding proposed project changes.
Project sponsor	• Project Announcements • Status updates	• Communicate new information about project status, activities, and issues. • Provide project performance information & Anticipated Changes/Key Risks/Corrective Actions
Scheduling teams	• Status reporting • Plan validation • Research & Analysis	• Validate progress Vs. baseline • Receive expert inputs • Alling on decision making • Identify, track, and mitigate and control risks
Estimating teams	• Status reporting • Plan validation • Research & Analysis	• Validate progress Vs. baseline • Receive expert inputs • Alling on decision making • Identify, track, and mitigate and control risks
Execution teams	• Status reporting • Plan validation • Research & Analysis	• Validate progress Vs. baseline • Receive expert inputs • Alling on decision making • Identify, track, and mitigate and control risks
PM686 Peers	• Status reports • Lessons learned	• Update management on project progress, • Anticipated Changes/Key Risks/Corrective Actions

Identify Information Collection Sources and Responsibilities

The planning process requires discussion and dialogue with the project team to determine the most appropriate way to update and communicate project information, respond to requests from various Stakeholders for that information and decide from where and what source that information should come.

The table below identifies the communication items that will be used for disseminating information. For each communication item, the data source is identified, how often the source data is collected, and from what team member. It also identifies who is responsible for information dissemination.

Communication Item	Data Sources (Frequency of Data Collection)	Dissemination Responsibility	Distribution Channel	Target Audience(s)	Frequency
Status reports	• Project team individual status reports (weekly) • Project schedule (Microsoft Project Plan) updates (weekly) • Verbal progress reports (weekly from all team members) • Change control requests (as identified)	Shane Barrett	• Email • Collaboration Site • Group Status Meetings	• All Stakeholders • Project Team	• Cadence established per syllabus
Leadership project updates	• Project status reports (weekly) • Project schedule (Microsoft Project Plan) updates (weekly)	Shane Barrett	• Email • Collaboration Site	• All Stakeholders • Project Team	• Throughout the project
Project announcements	• Project Manager (As needed)	Shane Barrett	• Email • Collaboration Site • Instant Messaging	• Advisory committee/Sponsor • All Stakeholders)	• As needed
Risk meeting/reviews	• Risk register updates (Bi-Weekly)	Shane Barrett	• Collaboration Site • Group Status Meetings	• All Stakeholders • Project Team	• Bi-weekly
QAQC / KPI's	• QAQC reviews (Bi-Weekly)	Shane Barrett	• Collaboration Site • Group Status Meeting	• All Stakeholders • Project Team	• Bi-weekly
Requirements validation	• Requirements Traceability (Bi-Weekly)	Shane Barrett	• Collaboration Site • Group Status Meetings	• All Stakeholders • Project Team	• Bi-weekly •
PPMs	• Cadence established per syllabus	Shane Barrett	• Collaboration Site	• Advisory committee	• Cadence established per syllabus

Define Distribution Channels

Methods and technologies used to communicate may be just as important as the information being communicated. Differing technological capabilities should be considered when planning the various distribution channels. As the choice of communication channels can vary significantly from project to project, the focus is to make selections most appropriate for the information that is being communicated.

Communication methods and technologies were determined based on Stakeholder communication requirements, available technologies (internal and external), and organizational policies and standards.

Communication Item	Distribution Channel
Status reports	• Email • Collaboration Site • Group Status Meetings
Quarterly project updates	• Email
Project announcements	• Email • Collaboration Site • Instant Messaging
PPMs	• Email • Collaboration Site

Define Communications Register

The Communications Register contains a high-level schedule of project communication items. This section summarizes all recipients of each communication item and includes the planned frequency of distribution.

Communication Item	Target Audiences(s)	Frequency
Status Reports	• All Stakeholders Project Team	Bi-Weekly
Project Announcements	• All Stakeholders	Throughout the project
PPMs	• Advisory committee	Cadence established per syllabus

Define Guidelines for Project Communication Meetings

Communication planning discussions and dialogue are commonly supported through meetings, normally conducted face-to-face or in our current COVID environment are all virtual video conferences.

There are several types of meetings where project communications may occur. Most project meetings consist of Stakeholders coming together for the purpose of resolving problems or making decisions. The majority of project meetings are formal with a prearranged time, place, and agenda.

Below are typical guidelines for project meetings detailing expected meeting facilitation activities and participant expectations:

- The Project Owner will typically facilitate each meeting.
- The meeting facilitator will distribute the agenda at least 24 hours prior to the meeting.
- All inputs and pre-read information will be distributed in advance with the agenda.
- The agenda will contain a description of the meeting purpose, topics for discussion, and expected outcomes.
- All participants will arrive on time and be prepared to contribute to meeting agenda topics.
- All cellular phones and electronic devices will be switched to silent mode during meetings.
- Only one person will speak at a time during meetings.
- Minutes, including action items, will be delivered to participants within one business day

Develop Project Meetings Schedule

The table below outlines the type, frequency, purpose, and participants for regularly cadenced meetings

Communication	Target Audience	Purpose	Frequency
Project Kick-off Meeting	All Stakeholders	Communicate the project plan, and confirm project roles and responsibilities	On the project start date
Core Team Meetings	Project team members - Precon / Controls / Execution	Review detailed project schedule, tasks, assignments, issues, risks, and action items	Bi-Weekly
Project Sponsor meeting	Project Sponsor	Update the Project Sponsor on the project status, budget, critical issues, and change requests	Bi-Weekly or as necessary to address significant project issues and/or decisions
Committee	Advisory committee	Update on the project status, gain insights or information to guide decision making	Bi-Weekly or as necessary to address significant project issues and/or decisions
Lessons Learned Meeting	All Stakeholders	Capture lessons learned that may benefit future project work	Upon completion of major project activities and during Post Implementation Review

Identify Communications Tools

Common communication tools include tools, online collaboration sites, email, and text messaging, established and used by the project team to support efficient communication.

Communication Tool	Tool Description
Email	• The project will use email for general project correspondence and to send out formal messages to project Stakeholders.
Instant Messaging and Text Messaging	• For informal communication, the project team may use a text messaging for internal team communication. • No formal communications will be provided through text messaging.
Collaboration site	• A formal website will be used to post various types of project information, including: ▪ Project Status Reports ▪ Project Communication Information ▪ PPMs

Define Methods for Storage, Retrieval and Disposal

The methods used to organize, store, and retrieve project documentation. Along with the methods used to organize, store, and retrieve project documentation, online project collaboration sites should be considered for real-time sharing of project information.

Method	Electronic Media	Paper Media
Storage and Retrieval	• Project information will be stored on the projects collaboration site. • The Project Owner will also have back up of everything on the Collaboration site	N/A
Archive	• Project information will be exported from the collaboration site and archived on the ESPM PROJECT AND THESIS LIBRARY • The project owner will transfer to a removable storage device, and stored with the project's other historical artifacts	A hard copy will be created

Appendix D – Stakeholder Management Plan

Introduction

The project premise is to test the hypothesis that parameters and financial thresholds need to be established for optimum utilization of resource scheduling in the Construction Tech sector. This research includes examination of effective Resource Management and scheduling from literature, peer reviewed article publications, results from real world organizations using resource management, a case study of a Mechanical, electrical and plumbing (MEP) project implementing resource scheduling in a retrofit construction setting, and a survey of peers in the Precon, Controls and Execution fronts, on both the Owner and GC/trade partner sides of the industry. All of this information will be presented and then analyzed to test the stated hypothesis.

Roles and Responsibilities

Name of Stakeholder	Role in Project	Type of Stakeholder	Influence on Project Outcome
Shane Barrett	Project Owner	Internal	Influencer - Main decision maker, ability to defer project and/or expert advice of advisory committee
Joel Baldwin	Project Sponsor	Internal	Supporter - Provides resources and support for the project, enabling environment for the project to be a success.
Roger Hull	Primary Advisor	Internal	Influencer - Provides technical expertise and advice to the project Owner. Brings impartial/objective insights to help the project be successful
LuAnn Piccard	Committee Member #1	Internal	Influencer - Outlines project expectations and provide guidance and feedback to illuminate areas for improvement/refinement
Walter Almon	Committee Member #2	Internal	Influencer - Outlines project expectations and provide guidance and feedback to illuminate areas for improvement/refinement
Fahad Masoud	Schedule analysis	External	Influence - Provides the raw data for the initial schedule loading & the progress inputs
Thomas Vanelli	Schedule analysis	External	Influence - Analyzes the data and provides Owner feedback and direction
Estimating team	Cost analysis	External	Influence - Provides inputs on physical project trends and potential Change Orders or impacts
Precon team	Cost analysis	External	Influence - Provide feedback on approach to resource loading and value add to projects and expert insights
Execution team	Construction execution	External	Influence - Provides inputs on physical project trends and value or impacts of the resource Loading approach
Project management team	Construction execution	External	Influence - Provides inputs on physical project trends and value or impacts of the resource Loading approach
PM 686 peers	L/learned, shared experiences	External	Influence - Generates ideas and discussion for areas of improvement, shares issues etc.
GC Prog controls team	Questionnaire & Interviews	External	Valuable insights gained from a GC and Trade partner perspective on RLS approach
Owner Controls and Owner Contingent worker controls team input	Questionnaire & Interviews	Internal	Valuable insights gained from an internal perspective on RLS approach, implementation, and level of priority it deserves Vs other important initiatives

Stakeholder Management Processes

Stakeholder Management includes the processes required to identify the people, groups and organizations that could affect or be affected by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate strategies and tactics for effectively engaging stakeholders in a manner appropriate to the stakeholders' interest and involvement in the project. The Stakeholder Management Plan (SMP) helps ensure that stakeholders are effectively involved in project decisions and execution (PMBOK 5th Edition) throughout the lifecycle of the project, to gain support for the project and anticipate resistance, conflict, or competing objectives among the project's stakeholders. The SMP will be a living document that will need to be updated as the project evolves, and stakeholders change.

Stakeholder Identification

In order to develop an effective plan for managing stakeholders, they first need to be clearly identified and assessed. Stakeholders will be identified by performing a stakeholder analysis in which potential stakeholders and relevant information (interests, involvement, interdependencies, influence, and potential impact on project success) are gathered, documented, and analyzed. (PMBOK 5th Edition).

Some questions that are relevant for deciding who should be considered a stakeholder for the project:

1) Will the person or their organization be directly or indirectly affected by this project?
2) Does the person or their organization hold a position from which they can influence the project?
3) Does the person have an impact on the project's resources (material, personnel, funding)?
4) Does the person or their organization have any special skills or capabilities the project will require?
5) Does the person potentially benefit from the project or are they in a position to resist this change?
6) At what point does the person have the greatest impact on the project

To assist with stakeholder identification and analysis, the team has created and is maintaining a Stakeholder Analysis Register. The Stakeholder Analysis Register captures the following information.

- Name of Stakeholder
- Department
- Role in Project
- Type of Stakeholder
- Type of Communication
- Expectations
- Influence on Project Outcome

A snapshot from the Stakeholder Analysis Register is provided below.

Stakeholder Register

	Project Name:	An optimized approach to resource loading hyperscale technology projects to balance feasibility, suitability and acceptability.			**Date: 11/13/'20**		
	Project Phase:	Planning and Initiation					
#	Name of Stakeholder	Department	Role in Project	Type of Stakeholder	Type of Communication	Expectations	Influence on Project Outcome
A	Shane Barrett	ESPM	Project Owner	Internal	Email, video conference, status reporting Adhoc Q&A	Meets/Exceeds project requirements and the agreed upon milestones and agreements with Advisory committee	Influencer - Main decision maker, ability to defer project and/or expert advise of advisory committee
B	Joel Baldwin	Construction	Project Sponsor	Internal	Weekly video conference	Provides required resources and Org support to help ensure project success	Supporter - Provides resources and support for the project, enabling environment for the project to be a success.
C	Roger Hull	ESPM	Primary Advisor	Internal	Email, video conference, status reporting, Adhoc Q&A	Provides technical expertise, expands on the roles of the advisory committee and makes the GO/No Go Decision	Influencer - Provides technical expertise and advice to the project Owner. Brings impartial/objective insights to help the project be successful
D	LuAnn Piccard	ESPM	Committee Member #1	Internal	Email, video conference, status reporting, Adhoc Q&A	Provide valuable and timely feedback, outline project expectations and provide guidance and focused level setting over the course of the semester.	Influencer - Outlines project expectations and provide guidance and feedback to illuminate areas for improvement/refinement
E	Walter Almon	ESPM	Committee Member #2	Internal	Email, video conference, status reporting, Adhoc Q&A	Provide valuable and timely feedback, outline project expectations and provide guidance and focused level setting over the course of the semester.	Influencer - Outlines project expectations and provide guidance and feedback to illuminate areas for improvement/refinement
F	Fahad Masoud	GC scheduling team	Schedule analysis	External	Daily - Email, VC, progress walks	Provides schedule inputs and status reporting for physical project	Influence - Provides the raw data for the initial schedule loading & the progress inputs
G	Thomas Vanelli	Owner Scheduling Team	Schedule analysis	External	Multiple interactions/week	Analyzes schedule data inputs/outputs and reporting	Influence - Analyzes the data and provides Owner feedback and direction
H	Estimating team	GC Estimation	Cost analysis	External	Multiple interactions in Planning phase	Provide inputs regarding GMP, estimates, Change Orders and schedule efficiencies	Influence - Provides inputs on physical project trends and potential Change Orders or impacts
I	Precon team	Owner Preconstruction	Cost analysis	External	Multiple interactions/week	Provide inputs regarding GMP and estimates	Influence - Provide feedback on approach to resource loading and value add to projects and expert insights
J	Execution team	GC Construction Team	Construction execution	External	Daily - Email, VC, progress walks	Provides execution planning and Work in place reporting and tracking	Influence - Provides inputs on physical project trends and value or impacts of the resource Loading approach
K	Project management team	Owner Construction Team	Construction execution	External	Daily - Email, VC, progress walks	Validates execution planning and Work in place reporting and tracking	Influence - Provides inputs on physical project trends and value or impacts of the resource Loading approach
L	PM 686 peers	MSPM	L/learned, shared experiences	External	Bi Weekly VC	Share L/learned and provide feedback	Influence - Generates ideas and discussion for areas of improvement, shares issues etc.
M	GC Prog controls team	GC Program controls	Questionnaire & Interview input	External	Email, video conference, Q&A follow up	Questionnaire & Interview input	Data to help evaluate hypothesis
N	Owner Controls and Owner Contingent worker controls team input	Owner Prog controls	Questionnaire & Interview input	Internal	Email, video conference, Q&A follow up	Questionnaire & Interview input	Data to help evaluate hypothesis

Stakeholder Analysis: Influence and Impact

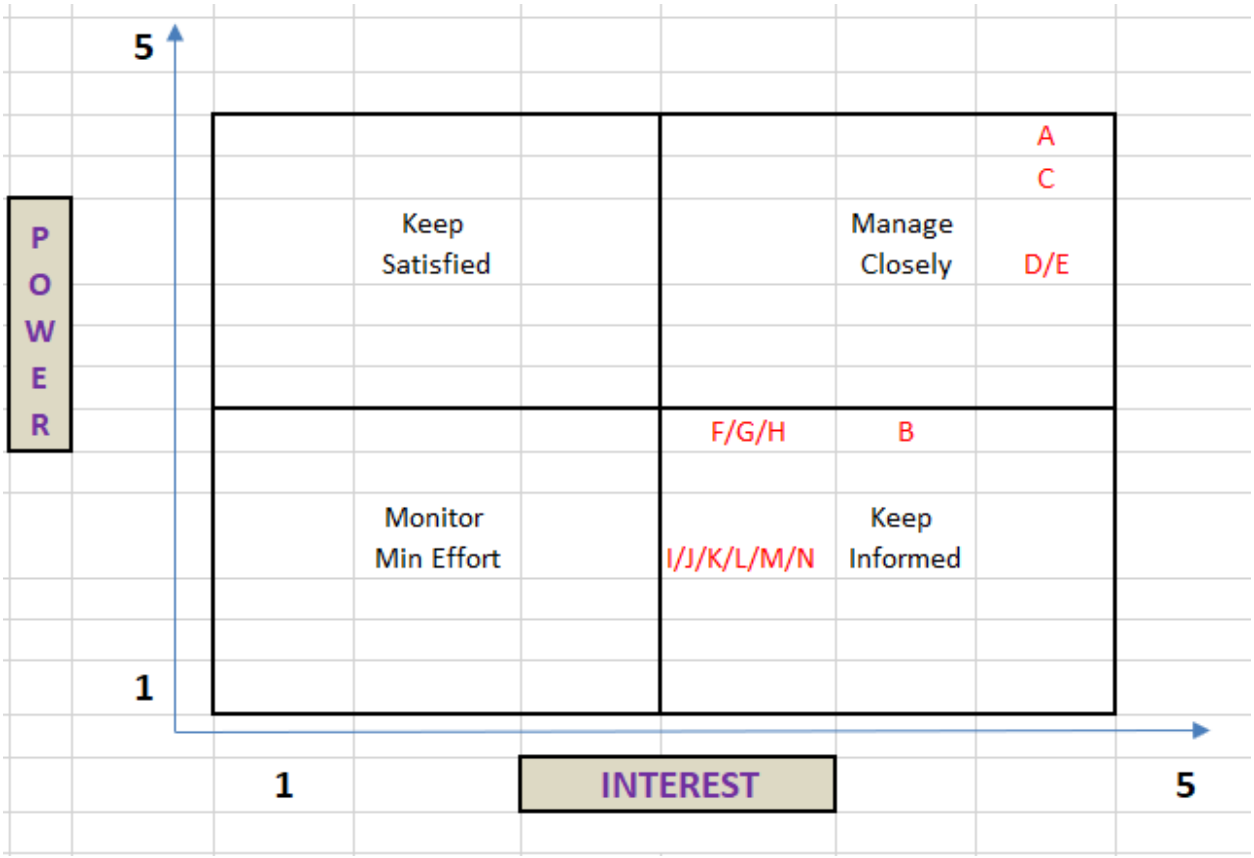
As mentioned above, the project is assessing each role , as well as their impact on the project and/or how they are impacted by the project. One purpose of this activity is to help identify and categorize individuals or groupings so that appropriate attention can be given to each according to the level of engagement needed. To help in this process, the project will use the PMBOK Power/Interest Grid to categorize each stakeholder group. The Power/Interest Grid analyzes stakeholder groups in a visual manner, the analysis involves determining the following for each Stakeholder identified:

- Project Influence – How much control does the Stakeholder have over project decisions regarding project cost, schedule, scope, and ultimate success?
- Project Impact – How much impact does the Stakeholder have on the project and/or how much impact does the project have on the Stakeholder?

These dimensions help define spheres of influence. For example, some Stakeholders (Project Sponsor and Project Manager) have direct control over project decisions and some Stakeholders (End User, Interface Partners, etc.) are heavily affected by the project's outcome.

An important outcome of the stakeholder identification and analysis work, including the Power/Interest Grid, is to identify the most influential and most impacted stakeholder groups so that a focused stakeholder management strategy and plan can be developed and executed.

Provided below is an example Power/Interest Grid with letters representing stakeholders. The results of the Power/Interest Grid will be added to the Stakeholder Analysis Register document



Stakeholder Management Strategies

Plan Stakeholder Management is the process of developing appropriate management strategies to effectively engage stakeholders throughout the lifecycle of the project, based on the analysis of their needs, interest, methods, frequency of communication and potential impact on project success. The key benefit of this process is that it provides a clear, actionable plan to interact with project stakeholders to support the project's interests (PMBOK 5th Edition).

Based upon the information gathered in the Stakeholder Analysis Register and Communication Plan, the Project Manager is responsible for engaging stakeholders throughout the lifecycle of the project. The level of engagement required for each stakeholder may vary over the course of the project.

The Stakeholder Management Plan should be reviewed and assessed on a regular basis to determine:

- If the project team is effectively engaging Stakeholders
- If the Stakeholder levels of interest or impact have changed
- Whether more needs to be done to obtain the needed level of Stakeholder support

To ensure the correct level of engagement is being achieved by each stakeholder, the Project Manager will analyze current levels of engagement by using the PMBOK Stakeholders Engagement Assessment Matrix. As noted above in the Stakeholder Analysis Register, each stakeholder group shall be assessed in terms of their current and desired level of engagement.

Name	Position	Interest	Message	Communication Channel	Frequency	Potential Impact
Shane Barrett	Project Owner	High - All facets of project of interest	Project Progression	Email, video conference, status reporting, Adhoc Q&A	Daily	1
Joel Baldwin	Project Sponsor	Medium - Progress and potential roadblocks to success	Project Progression	Weekly video conference & Workchat for emergency inputs	Weekly	3
Roger Hull	Primary Advisor	High - All facets of project, progress, issues & change all of interest	Project Progression	Email, video conference, status reporting, Adhoc Q&A	Weekly/Daily	2
LuAnn Piccard	Committee Member #1	High - All facets of project, progress, issues & change all of interest	Project Progression	Email, video conference, status reporting, Adhoc Q&A	Weekly/Daily	2
Walter Almon	Committee Member #2	High - All facets of project, progress, issues & change all of interest	Project Progression	Email, video conference, status reporting, Adhoc Q&A	Weekly/Daily	2
Fahad Masoud	GC scheduling team	Medium - % Complete walk an Bi weekly submissions	Schedule accuracy & approach	Daily - Email, VC, progress walks	Bi Weekly schedule meetings	3
Thomas Vanelli	Owner Scheduling Team	Medium - Progress and validation of the hypothesis	Recommendations & Hypothesis	Multiple interactions/week	Multiple touch points/week	3
Estimating team	GC Estimation	Medium - Bid accuracy & PCO's	Estimate accuracy	Multiple interactions in Planning phase	Multiple touch points/week	3
Precon team	Owner Preconstruction	Medium - Schedule and cost accuracy	Bid accuracy	Multiple interactions/week		3
Execution team	GC Construction Team	Medium - % complete walks and project trending	Project trending & indicators	Daily - Email, VC, progress walks	Daily	3
Project management team	Owner Construction Team	Medium - Cost and Schedule accuracy and project trending	Project trending & indicators	Daily - Email, VC, progress walks	Daily	3
PM 686 peers	MSPM	Medium - L/learned	Project Progression	Bi Weekly VC	Bi Weekly meetings	3
GC Prog controls team	GC Program controls	Medium	Data insights/Validation	Email, video conference, Q&A follow up	As required	3
Owner Controls and Owner Contingent worker controls team input	Owner Prog controls	Medium	Data insights/Validation	Email, video conference, Q&A follow up	As required	3

Stakeholder Engagement Management is the process of communicating and working with stakeholders to meet their needs and expectations, and to address issues as they occur. Stakeholder Engagement Management is the process to systematically foster appropriate stakeholder engagement in project activities throughout the life of the project. The key benefit of this process is that it allows the Project Manager to increase support and minimize resistance from stakeholders, significantly increasing the chances to achieve project success (PMBOK 5th Edition).

To effectively manage stakeholder engagement, this project will utilize the Communication Plan and strategies identified above to communicate project related information to key stakeholders in a proactive and timely manner. Managing stakeholder engagement helps to increase the probability of project success by ensuring that stakeholders clearly understand the project goals, objectives, benefits, and risks.

In line with the analysis above, the project team will also be actively listening and soliciting input and feedback to make sure communications are being received and understood, and also to capture important information to help make adjustments and to respond to problem areas.

Execution of Management Strategies

Execution of Management Strategies includes the processes for monitoring overall project stakeholder relationships and adjusting strategies and plans for engaging stakeholders. Monitoring Stakeholder engagement involves collecting data, assessing the level of engagement, and using insights from the data collection to adjust strategies and tactics for engaging effectively with stakeholders.

This project will have mechanisms to receive ongoing direct feedback from key stakeholders, including weekly touch points, open forum Q&A, request for feedback/improvements etc. Individual stakeholders will be encouraged to participate and to voice any questions and concerns.

Stakeholders are critical to the project's success. The project team has planned for and will work to involve, engage, and listen to all key stakeholders throughout the project lifecycle. Finally, the Stakeholder Management Plan and associated documents are not static. The stakeholders identified and their information documented in the Stakeholder Analysis Register will be reviewed frequently to ensure the plan is meeting project expectations and to make modifications if required.

Appendix E - Risk Management Plan

Introduction

Risk management is the processes and structures that are directed towards realizing potential opportunities, while simultaneously managing possible adverse impacts. Risk management is a continuous activity conducted throughout the life of the project. It seeks to identify potential risks, evaluate their likely impact, develop mitigation plans, and monitor progress.

As described in PMI's PMBOK, project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project. Key objectives are to increase the likelihood and impact of positive events while decreasing the likelihood and impact of negative events.

Roles and Responsibilities

See the table below outlining who, their role, and the corresponding responsibility for each Risk Management related activity.

Name	Role	Responsibility
Shane Barrett	*Project Owner*	• Tracks progress of the risk management effort by reviewing and updating the Risk Register • Escalates mitigation approaches for identified high severity risks that are beyond the Project Owner's control • Ensures the entire project team are following this Plan. • Ensures all other project processes that interact or provide input to the risk management effort are being adhered to. • Ensures that the risk management activities are being performed in a timely manner. • Assigns risks to owners.
Joel Baldwin	*Project Sponsor*	• Provides the necessary support and insight to the Project Owner to support the execution of this Plan. • Provides the necessary oversight to ensure commitment to the risk management efforts. • Monitors the efforts to address risks and provides leadership to focus on resolving open unplanned risk events. • Provides guidance on escalated risk events and assists in their resolution.
Roger Hull LuAnn Piccard Walter Almon	Advisory committee	• Provides the necessary support and insight to the Project Owner to support the execution of this Plan.

Name	Role	Responsibility
		• Reviews the Risk Register and/or risk reports provided to the Committee in accordance with this Plan. • Provides the necessary oversight to ensure commitment to the risk management efforts. • Provides guidance on escalated risk events and assists in their resolution. • Ensures the Project Manager has a sound plan for mitigating the impacts of risks that have been escalated.
Fahad Masoud	GC Scheduler	• Responsible for identifying risks and risk events in a timely manner to mitigate the risk and minimize impact to the Project.
Thomas Vanelli	Owner Scheduler	• Shares responsibility for identifying risks and risk events in a timely manner to mitigate the risk and minimize impact to the Project.

Risk Management Processes

Define the Risk Management Process involved in identifying the necessary steps, activities, and responsibilities to manage risk for the entire project lifecycle.

Identify Risks

Risk identification is the first step in the risk management process that projects should employ. Risk identification involves identifying risks, identifying which of those risks are likely to affect the project and documenting characteristics of those risks. Spotting a potential risk is accomplished by recognizing that an event, state, or condition within the boundaries of a project may occur with unplanned consequences, which are usually undesirable, however it may be desirable leading to a positive opportunity.

Identifying risks is an iterative process because new risks may become known as the project progresses through its project life cycle. Risk information can initially be gathered from the business case, accumulated lessons learned and an initial risk brainstorming session. Risks can also be identified during project meetings and should be incorporated into the meeting agenda and minutes for all meetings.

Risk Register

The risk register details all risks, provides descriptions of them, categorizes them, and also discusses potential causes as well as probability. Also captured are the potential responses as well as who would be responsible for dealing with the risks. The risk register is an integral part of the risk identification, understanding, management and control strategy.

Analyze Risks

The main focus of analyzing risks is to examine each identified risk to assess the likelihood of the risk event occurring, and the probability outcomes associated with the risk event in order to determine its potential impact on the success of the project. This in turn provides the ability to prioritize each risk to

ensure that the risks with the greatest potential impact to the project are addressed with first. The organization can then improve upon project performance by focusing on high priority risks.

Risk Response Planning

Risk response planning is the process of selecting the appropriate response strategy for each identified risk. This in turn helps the project to escalate risks, avoid risks, transfer responsibility for risks, mitigate the consequences of risks, reduce the probability of occurrence of risks, accept the consequences of risks, enhance the opportunity to benefit from positive risks, and watch risks. There are strategies for both negative and positive risks.

Strategies for Negative Risks:

- **Escalate:** Risk escalation involves notifying and transferring the risk to another person or group that may be outside of the project. For example, if the risk is outside the scope of the project or the project team is unable to appropriately respond, the risk should be escalated. In this case, the risk should still be monitored.
- **Avoid:** Risk Avoidance involves changing the project management plan to eliminate the threat posed by the risk. Some risks can be avoided by clarifying requirements, obtaining additional information, improving communication, or acquiring expertise.
- **Transfer:** Transferring a risk requires moving, shifting, or reassigning some or all of the negative impact and ownership to a third party. This does not eliminate the risk but gives another party the responsibility to manage it.
- **Mitigate:** Risk Mitigation implies a reduction in the probability and/or impact of a negative risk. Reducing the probability and/or impact of a risk occurring is often more effective than dealing with the risk after it has occurred.
- **Accept:** This strategy indicates that the project team has decided not to change the project management plan: schedule, approach or reduce project scope or is unable to identify another suitable response strategy.
- **Watch:** If the risk does not pose an immediate threat to the project, the project team may choose to watch the risk rather than use resources to analyze the risk.

Strategies for positive risks or opportunities:

- **Escalate:** Risk escalation involves notifying and transferring the risk to another person or group that may be outside of the project. For example, if the risk is outside the scope of the project or the project team is unable to appropriately respond, the risk should be escalated. In this case, the risk should still be monitored.
- **Exploit:** This strategy may be selected for risks with positive impacts where the organization wishes to ensure that the opportunity is realized. This strategy eliminates the uncertainty associated with a positive risk by ensuring that the opportunity definitely happens.
- **Share:** Sharing a positive risk involves allocating some or all of the ownership of the opportunity to a third party who is best able to capture the opportunity for the benefit of the project.
- **Enhance:** This strategy is used to increase the probability and or the positive impact of an opportunity, identifying and maximizing key drivers of positive risks.

- **Accept:** Accepting a positive risk or opportunity is being willing to take advantage of it should the opportunity come along.
- **Watch:** If the risk does not pose an immediate opportunity to the project, the project team may choose to watch the risk rather than use resources to analyze the risk.

Risk Monitoring and Control

Once a risk is established for the project, it is monitored on an ongoing basis:

- Monitor if a risk escalation trigger has occurred.
- Monitor if risk response actions are as effective as anticipated.
- Monitor if risk responses are implemented as planned.
- Monitor for Residual Risks (element of a risk that remains once the risk assessment has been made and responses implemented).
- Monitor systematically to:
    - Assess currently defined risks
    - Determine actions to be taken
    - Evaluate effectiveness of actions taken
    - Report on the status of actions to be taken
    - Validate previous risk assessment (likelihood and impact)
    - Validate previous assumptions
    - State new assumptions
    - Identify new risks

Risk Control Activities

Once a risk is established, it is controlled on an ongoing basis:

- Validate mitigation strategies and alternatives
- Assess impact on the 'Project' of actions taken (scope, cost, time, schedule, & resources)
- Identify new risks resulting from risk mitigation actions
- Ensure that the projects' Risk Management Plan is maintained
- Revise Risk Response plan(s)

Appendix F - Lessons Learned

Introduction

Lessons learned allows a project team to retrospectively contemplate and document the failures and successes experienced on a project to facilitate the knowledge transfer from one team to the next. Capturing this information in a formal fashion creates an artifact that can be utilized during future endeavors to mitigate the chances of repeating a mistake. Project Managers will use this document as they begin planning new projects by instilling the lessons learned in their approach. This lessons learned document includes input from the project team as to what went well, what did not go well, why, and what could have been done differently during each phase of the project.

Lessons Learned Approach

All project team members and key Stakeholders participated in lessons learned for this project. Interviews were conducted with the Project Sponsor, Advisory committee, and primary stakeholders. The separate sessions will ensure that there are peer-to-peer relationships within each group to facilitate open and honest communication.

Project Owner reflections – Planning & Initiation phase

The items below catalogue the Projects Owners weekly reflections, lessons learned, best practices, struggles and main victories thru the first phase of the project

1. Meetings with stakeholders are always a good reminder that not all parties have the same expectations regarding formal or informal communications, information delivery/mediums and project context
2. Differing opinions are a good thing as it adds perspective and can widen the horizon of scope or help highlights specific areas of focus
3. Biases, not just the project managers exist, depending on stakeholder backgrounds or their sector, be it in Execution, Controls or Preconstruction
4. Established meetings, especially with the project sponsor, help ensure the right focus and attention on topic.
5. A second set of eyes on a document, agenda or early draft is helpful for feedback. The project owner is invested and deeply in the details but afresh set of eyes adds perspective and can add clarity for other less involved/interested parties.
6. One is not constrained by the sector they work in to draw experience or insights from. It can be easy to become pigeonholed based on what is familiar.
7. Survey and questionnaire development, data analysis, approach and best practices is far more involved and scientific than expected.
8. Recognize analysis paralysis, how to avoid or more importantly how to pull one’s self out of the proverbial “rabbit hole”
9. Being direct, to the point and ensuring no ambiguity or expansiveness exists in the various documents is something I need to continually address.

10. Thinking in terms of an academic endeavor yet completing a physical project can be difficult to comprehend and capture
11. I remain very optimistic when it comes to timeframes and what is feasible Vs. what I would like to commit to.
12. Clear understanding of workable scope of your project (what is in, what is out)
13. Clear distinction between project report and product deliverables from project
14. Capture draft deadlines for project reports that are "in-between" or 24hrs prior to formal deadlines.
15. Unforeseen impacts/constraints related to COVID-19 continue are a real threat during project development and will continue thru execution and monitoring.
16. In the current environment of Work from Home, home schooling, stakeholders balancing multiple professional and private roles, flexibility in communications and timing is key
17. In the current environment schedule buffers for all activities including creation of project deliverables (report, end products, etc.) is a must
18. As I am part of essential Operations, dealing with COVID events, the associated HR issues and maintaining professional commitments is impactful to the 20.hr/week commitment I outlined at project outset.
19. The continual updating of existing documents, as new documents are developed and more research is completed , plus the PPM commitments lead to a heavy workload
20. Update the settings for your office and other applications to auto save every fifteen minutes. Unfortunately, I lost 3+ hrs. of MS Project schedule work earlier this week – Lesson learned!
21. Q4 with Election interruptions, infrastructure freezes and multiple holidays make it difficult to arrange and align multiple schedule for meetings, inputs, and feedback loops.
22. End of year deadlines mean shifting priorities and limited availability for multiple stakeholders. Q4 needs to be scheduled and treated differently to other times of year.
23. Case study involvement has increased awareness of labor & resource requirements their criticality to evaluating risk & risk exposure
24. Positive and negative data brings valuable learnings that allow the team to make subtle & timely changes to correct course or identify opportunities

Project Owner reflections – Executing & Closeout phase

1. 7 months into the process and the General Contractor and Trade partners have a lot more appreciation for what we are trying to do, and the data being generated.
2. Rather than just providing a report with PF, SPI etc the GC at pre agreed cadences the GC is actually using the data in its interactions with Trade partners.
3. Alignment exists on Definition and objective of a Resource (Labor) Loaded Schedule
4. The advantages/benefits being derived are different depending on your side of the contract, Owner or Contractor. Both are positive for the initiative.
5. Divergence on roll out approach among the various interviewees.
6. All interviewees agreed, if data is not diligently entered or tracked/maintained into the schedule, it may produce inaccurate results….Garbage in, Garbage out
7. Interviewees internal to the Org seem to see less of a need as it relates to our mission to scale.

8. Interviewees internal to the Org all agreed this should be focused on capacity driven projects.
9. Interviewees internal to the Org all agreed, upper Leadership/Exec level leadership need to "Buy in" or this will not be maintained due to perceived costs and LOE.
10. Standardization is paramount across a program so that this does not become overly burdensome to the GCS and trade partners.
11. A consensus feedback was this trial run needs to be completed on 3 or 4 projects for "on the fence" people in higher management to realize the usefulness and feasibility of resource loading.
12. Activity coding with reporting in P6 is vital for standardization.
13. Of all the research completed – Surveys and Interviews are the most subjective feedback. I assumed more clarity of thought among SMEs but bias, entrenched beliefs, feeling without logic or science all exist, likewise for the author.
14. Future research highlights multiple other avenues that could have been explored and shows the importance of a tight scope statement.
15. Concise and succinct conclusions are difficult after 6 months of time investment and research
16. Constantly referring to your Hypothesis, scope statement and Project goals are important to level set the objective and what you are trying to produce
17. Level of effort involved in correctly formatting, editing and finalizing a professional grade document far greater than originally captured in schedule