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PROJECT LIFE CYCLE CHANGE MANAGEMENT FOR THE ASSET OWNER: TREATMENT AND CONTROL

TCM Framework: 6.2 – Asset Change Management
10.3 – Change Management

February 27, 2024

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1. INTRODUCTION

1.1. Scope

This recommended practice (RP) from AACE International focuses on the effective management of changes throughout the project life cycle (PLC), specifically within the context of asset ownership and management engaged in capital project delivery. Its primary objective is to equip the audience with a comprehensive understanding of how changes are integrated into the various stages of the project life cycle, presented from the perspective of an agreement on project life cycle changes between the owner's project team[1] (OPT) and its executive leadership.

To facilitate this understanding, the RP meticulously defines key elements of change, encompassing classifications, driving factors, types of changes, utilization of contingencies, and the optimal timing for implementing changes. Furthermore, the RP offers a strategic and prescriptive process workflow, designed to streamline the coordination of fundamental prerequisites necessary for the efficient management of change within the project.

While this RP addresses many of the issues and circumstances of managing change within the project life cycle, it does not explicitly address contract changes[2] associated with detailed engineering, procurement, and construction work efforts (the execution stage, post-AFE[3] approval). However, this RP will explain how contract changes interact with and support project life cycle change management.

In some circumstances, similar approaches, methodologies, and techniques identified within this RP can be used in different industries of the project delivery world (as warranted). However, this RP's discussion points and examples focus on projects executed by an owner in the process industry.[4]

1.2. Purpose

This RP is intended to be used as a guideline (i.e., not a standard) that provides practitioners with a pragmatic approach to treat and control changes within the entire spectrum of project delivery and the project life cycle cost of building a facility, plant, or other project endeavors.

1.3. Background

The management of change within a project is contingent upon the position of a team member within the project hierarchy. To illustrate this point, one determinant of the project scope for an asset owner is determined by the required throughput capacity (e.g., for a refinery, this may be barrels of oil produced per day) rather than the specific number of pumps and piping systems required. Asset owners establish project evaluations and budgets based on

[1] In the context of this RP, the owner's project team is the project manager or other project team member(s) assigned to ensure that the project meets the business objectives of the business unit or organization's executive leadership.

[2] Please see AACE's RP 100R-19, Contract Change Management – As Applied in Engineering, Procurement, and Construction). This RP complements and supports the project life cycle change management and the stewardship of total installed cost (TIC) of the project. [4]

[3] Authorization for expenditure (AFE) is a formal approval or authorization of expenditure for a project by the authorized organization representative. An AFE is a budgetary document, usually prepared by the business development department that lists the projected expenses for a particular project or a phase of a project and authorizes an individual or group to spend a certain amount of money for that project. Other industries, organizations, and entities may identify this legal instrument of financial award as an authorized work order, request for approval, etc.

[4] A large portion of this RP includes excerpts from TCM-3934, The Project Life Cycle: Treatment and Control of Change, authored by H. Lance Stephenson, CCP FAACE. [5]

this high-level assessment of scope. In contrast, construction contractors base their pricing on detailed issued-for-construction (IFC) drawings, focusing on itemized equipment quantities and bulk materials. These differing approaches significantly impact how changes are identified, addressed, and financed throughout the project life cycle.

Recognizing these divergent perspectives, this recommended practice (RP) is designed to provide valuable support for managing changes within the project life cycle, fostering effective communication and agreement between the executive management of the organization and the owner's project team (OPT).

1.3.1. The Asset Life Cycle

Prior to understanding the project life cycle, the audience needs to first recognize the relationship between a project and the asset. An asset, as defined in RP 10S-90, is “anything owned that has a monetary value, e.g., property, both real and personal, including notes, accounts, and accrued earnings or revenues receivable and cash or its equivalent. Property: real, i.e., physical; or intangible, i.e., knowledge, systems, or practices. Assets are created through the investment of resources in projects.” [1, p. 15]

The development of assets are divided into stages or phases, which form the asset life cycle. “The stages or phases are sequential groupings of a process that result in an intermediate deliverable or progress milestone.” [2, p. 38] The stages within the asset life cycle can consist of ideation, creation, operation, modification, and termination. Figure 1 illustrates the asset life cycle of a factory as it passes through time.

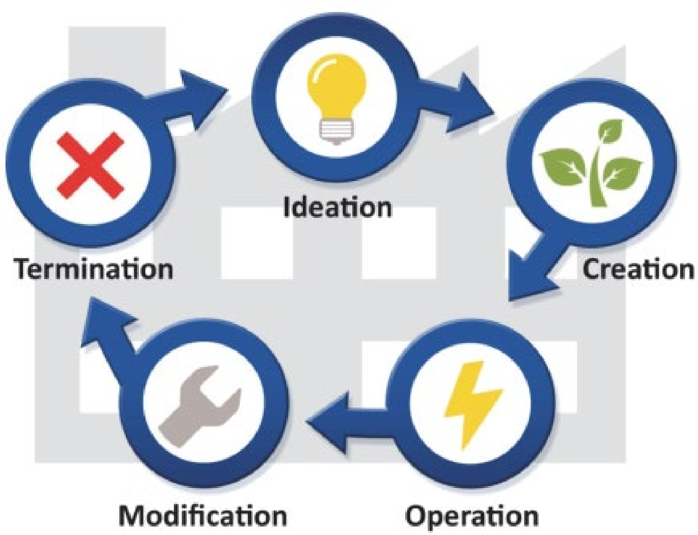


Figure 1–Asset Life Cycle of a Factory [2, p. 39]

Within the asset lifecycle, projects are defined and executed to create, modify, or eventually retire an asset. For example, the ideation and creation phase of developing and constructing a power plant can be considered a project. Once the project has been turned over to operations, the asset is now in service, where operations and production occur. During the asset operations phase, modifications, additions, deletions, etc. to modify or increase production to the current asset may be required. These modifications, deletions, or additions, based on capital investment requirements[5], are also considered projects. Asset modification(s) are typically identified by operations personnel as they evaluate the performance metrics of the asset, a process known as strategic asset management (SAM). Operation teams have the responsibility to optimize production capabilities to ensure capacity and quality expectations are being met. This operational oversight not only maintains but also enhances asset performance throughout its lifecycle, presenting opportunities for continuous improvement. Termination is the final stage within the asset life cycle, where the retiring, decommissioning, or demolition and removal of the asset occurs. The termination of an asset is also considered a project and therefore, would require the same requirements as that of building a new asset or modifying it.

1.3.2. The Project Life Cycle

Within the life cycle of an asset, projects are temporary endeavors for the ideation, creation, modification, or termination of assets. Projects have a defined beginning and end. In the asset life cycle, only operation is not generally considered a project endeavor. However, there may be many projects within the operation phase of an asset to maintain, relocate, modify, repair, enhance, or otherwise improve the utility of the asset.

As indicated above, multiple project life cycles can be nested within the asset life cycle, where the development of the original asset and any subsequent modifications occur. It is within these project life cycles that changes occur. This is also demonstrated in the two levels of the TCM process as illustrated in Figure 2, which are referred to respectively as the strategic asset management and project control processes. The project (and subsequently, project controls) is a recursive process nested within the “do” or project implementation step of the strategic asset management process. In other words, the project life cycle falls within the asset life cycle. This further demonstrates the relationship between the asset management and project management.

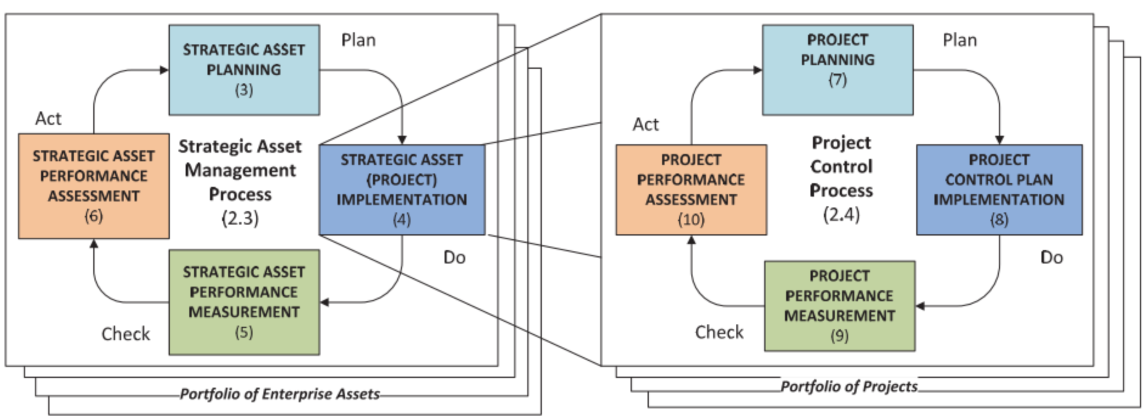


Figure 2–Asset Life Cycle of a Factory [2, p. 43]

1.3.3. Concept of Change within the Project Life Cycle

Change management is a broad topic and can be found in almost all industries. In the context of capital projects, according to the TCM Framework, change management is defined as:

[5] Organizations, with the assistance of operations and business planning, will identify the need to modify an asset or sub-asset. The organization will determine if the requested modification fits the parameters for expending capital funds (CAPEX). If not, these modifications should be introduced as maintenance projects to be funded by operating expenses (OPEX). Organizations will need to review their respective federal, state/provincial tax laws to determine the demarcation rules as applied to CAPEX and OPEX projects.

> …the process of managing any change to the scope of work and/or any deviation, performance trend, or change to an approved or baseline project control plan. The change management process is used to approve or disapprove changes in the scope and baseline plans, thereby closing the project control cycle loop. The process includes the identification, definition, categorization, recording, tracking, analyzing, disposition (i.e., approval or disapproval for incorporation into approved or baseline project control plans), and reporting of deviations, trends, and changes. [2, p. 265]

Whether a change in the project affects the scope of work, schedule, method of performance, cost, or is administrative in nature, change management is defined as "the formal process through which changes to the project plan are identified, assessed, reviewed, approved and introduced." [1, p. 24]

1.3.4. The Benefits of Change Management within the Project Life Cycle

Understanding the project life cycle and the effective implementation of change management provides many benefits that can promote project success. The key benefit of change management is that this methodology assists the OPT in effectively managing their respective project life cycles while enabling them to identify and resolve problems expeditiously. Managing project life cycles and their associated elements effectively is crucial for meeting scope, quality, cost, and schedule targets while managing many risks, uncertainties, and challenges. More specifically, change management offers the following two fundamental benefits:

- Project change management practices introduced across an organization can be more effective when a standard approach is implemented. This practice creates an end-to-end solution to managing change throughout the project life cycle and provides consistency and efficiencies while building internal capabilities and competencies. This practice also prepares the organization for future use by employing the change management process as a collection of lessons learned and risk treatment strategies.
- Improved management and control of the volume, frequency, and magnitude of change that occurs on projects. The change management process provides a more consistent and deliberate approach that promotes engagement from all levels and functions within the organization. Furthermore, it provides the opportunity for analyzing change trends to identify systemic issues driving project change. Finally, managing and controlling the volume, frequency, and the magnitude of change minimizes stress, confusion, and the additional cost of poorly managed change.

These benefits further improve teamwork and collaboration, improving the entire project's efficiency (in terms of time and cost). Finally, the benefits would assist the project team in aligning its practices with its organizational strategies and objectives.

2. RECOMMENDED PRACTICE

2.1. Treatment and Control of Change

The mechanics of change management for the project life cycle can be easily misunderstood if proper guidance is not provided. This section of the RP provides the audience with the appropriate guidance on how changes can affect the project life cycle's cost, schedule, and risk components. This includes understanding the details and expectations of change management, including the classification of change, the type of change, and the change element, to name a few. A process workflow diagram is also provided to the audience with a road map for navigating the change management approach. This information is key in providing an organization with structure and governance for change management within their project delivery system.

2.1.1. Project Life Cycle Cost

"The project life cycle identifies a methodology that advances the development and execution of a project in a systematic approach. This methodology can be further refined by introducing a stage-gate process." [3, p. 11] As an example, a typical stage-gate process within the process industry may include front-end loading (FEL) stages (i.e., FEL 1 = stage 1, FEL 2 = stage 2, FEL 3 = stage 3) and the execution stages (where detailed engineering, procurement, and construction activities are performed). Commissioning and start-up activities are performed in stage 5. As the project progresses through the phases, changes can occur. These changes can be attributed to the development and refinement of the final design and execution of the project, where enhancements are made to improve operability, reliability, and maintainability. Figure 3 illustrates a typical stage-gate arrow[6] for the process industry.

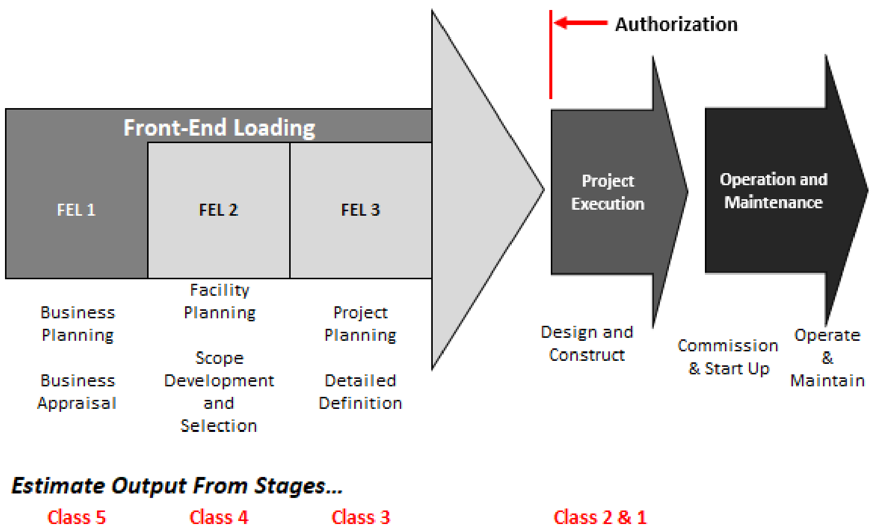


Figure 3–Example of a typical Stage-Gating Arrow in the Process Industry

As the work progresses, the project will experience changes. These changes will be identified and recorded in the project change log for reference purposes and the substantiation of additional costs. There are two specific areas of change that need to be addressed when executing the work using a stage-gate process. These areas include changes that occur prior to AFE submittal (after FEL 3) and changes that occur during the execution stage (post-AFE approval). For the process industry stage-gate, pre-AFE is considered the FEL stages, while post-AFE is the detailed design, construction, commissioning, and startup portion of the work.

2.1.1.1. Change Management During the FEL Stages (Pre-AFE Submittal)

[6] Within the commercial industry, the stage-gate arrow consists of the master planning stage, where programming (business planning), schematic design (facility assessment), design development (scope development), and construction documents (detailed design) are developed. Once the master planning stage is complete and funding (AFE) is approved, the project enters the construction stage, and subsequently, the commissioning & start-up stage as the project is turned over for operations. The Department of Energy manages projects as defined in DOE Order 413.3B Program and Project Management for the Acquisition of Capital Assets where construction of a facility (capital asset) is defined through four critical decisions [6]. Other industries and organizations may introduce a similar stage-gating process to increase the maturity levels of their respective deliverables.

Managing change during the FEL stages is one step that provides an understanding of how these changes affected the overall project life cycle costs. While the business intent of the project would not typically be expected to change during the FEL stages, additions and deletions of specific design elements will occur. Furthermore, the cumulative effect of the changes within each FEL stage will impact the project's estimated cost for appropriating the required funding to advance to the execution stage. As changes are identified during the execution of the FEL stages, the project team is required to update the change log to reflect the most current information.

The project team should introduce change management principles to substantiate the increase (or decrease) of the proposed project value in consideration of any proposed change. If there is a decrease in design intent (i.e., x-number of gallons per minute, barrels per day, mega-watts per hour, etc.), approval should be required. A reduction in design intent will alter the financial justification of the project, which is one factor that drives the return on investment (ROI) for a project. A change request would provide the necessary details supporting any discussions pertaining to this event.

As part of project life cycle change management, the OPT may introduce a configuration management (CM) process that focuses on engineering and system design and documentation. Configuration management is defined as a process to "…identify and document the functional and physical characteristics of a product, result, service, or component; control any changes to such characteristics; record and report each change and its implementation status; and support the audit of the products, results, or components to verify conformance to requirements." [2, p. 75] Configuration management assists in controlling elements within the change process (i.e., tracking design modifications, maintaining system integrity, etc.). It is expected that if an organization employs configuration management, it will be applied throughout the project life cycle.

2.1.1.2. Change Management During the Execution Stage (Post-AFE Approval)

As indicated in footnote 3, AFEs (or similar project funding requests) are financial vehicles typically used to authorize capital project expenditures (CAPEX), distinct from normal operation expenditures (OPEX) for an operating asset. The AFE is a document that identifies the projected commitments and expenses the project team is authorized to spend in the development of the asset. To substantiate the AFE value[7], a clearly defined scope and associated base cost estimate, contingency, and escalation costs should be provided. The AFE is typically submitted at the end of FEL 3 and approval must be provided before moving into the execution stage. For projects not approved to move forward, costs may be transferred to either a research and development budget or an operating budget within the organization. Generally, these retrospective costs cannot be capitalized.

2.1.1.3. Estimating and Estimate Reconciliation

The estimates completed during each stage support the project's financial viability so that the project can be reviewed and approved to advance to the execution stage. With each new estimate at the end of a stage, reconciliation is required. Reconciliations improve the understanding of the cost estimates and their differences so the executive can make better-informed decisions. Reconciliations can also help identify if the differences between the two estimates are appropriate and reasonable. This reconciliation can further mitigate budget shortfalls and correct any identified deficiencies.

[7] Depending on the country, business operations, legal entities, etc., FEL expended costs may be transferred and included as part of the AFE value (as these costs can usually be capitalized).

The reconciliation should be organized by cost streams and sub-elements as defined by a project life cycle cost hierarchy (as defined by the organization). Using this hierarchy allows one to understand the cost drivers, influence, and impacts of cost streams and lower-level accounts. The process typically focuses on the specific maturity level of project definition deliverables, the basis of estimate and methodology, the schedule (and basis), and the risks. In addition, the reconciliation should clearly state the key differences between the two estimates and the rationale for those differences. Preparing the reconciliation requires the following steps:

1. Prepare a comparison between the estimates to be reconciled, usually by cost streams. Where appropriate and with the availability of information (i.e., a Class 5 or 4 estimate will not support a detailed reconciliation), this reconciliation should also include a comparison of directs, indirects/GCs, overheads, design/material allowances, etc.
2. Examine each cost stream and determine if both estimates encompass the same scope, i.e., design intent. Any items that may be difficult to quantify are discussed and thoroughly vetted. For a more detailed understanding, quantities, equipment/material prices, performance expectations, labor rates, required equipment, and any other items that may impact the cost should be reviewed and assessed.
3. After reconciling project costs, examine contingencies and escalation. Determine if the appropriate contingency and escalation costs were developed correctly (if not, learn from the errors).
4. Once this assessment is complete, review and approve the reconciliation findings. A change order can then be completed to finalize the closure of the stage and true up the costs to match the new estimated amount.

Table 1 illustrates an example of a project where reconciliations were completed over time, representing the progression of estimated costs from the original cost budget to the Class 3 estimate submitted for project approval. The reconciliation report is summarized at the account level of the project life cycle cost hierarchy. The reconciliation activities can also be completed for Class 2 (control), and Class 1 (check) estimates. These estimates are usually prepared post-AFE approval.

Wastewater Treatment Plant	Original Cost Budget	Class 5 Estimate	Class 4 Estimate	Class 3 Estimate
Development Costs	**$7,000,000**	**$9,171,500**	**$9,182,900**	**$10,015,400**
Project Delivery Costs				
Owner Costs	**$15,000,000**	**$19,900,000**	**$24,100,000**	**$27,370,000**
OPT		$5,800,000	$7,700,000	$8,170,000
Land & Specialties		$14,100,000	$16,400,000	$19,200,000
Scope of Work	**$650,000,000**	**$695,900,000**	**$1,066,700,000**	**$1,302,600,000**
Detailed Design		$101,500,000	$138,600,000	$171,500,000
Procurement		$181,000,000	$266,800,000	$345,800,000
Construction		$399,000,000	$638,000,000	$756,500,000
Commissioning/SU		$14,400,000	$23,300,000	$28,800,000
Contingency & Escalation	**$217,000,000**	**$403,928,500**	**$275,017,100**	**$202,514,600**
Total Project Delivery Costs	***$889,000,000***	***$1,128,900,000***	***$1,375,000,000***	***$1,542,500,000***

Table 1–Summarized Reconciliation Report

2.1.2. Elements of Change Management

2.1.2.1. Change Classification

Classifying a change is a fundamental decision required to determine the appropriate approach for managing the change within the project life cycle. This classification provides an understanding as to whether the change is considered *in-scope* or *out-of-scope*, which further identifies what path the change will take (as defined by the process map) and how the change will be introduced and funded. Funding requirements for these two types of changes are described below:

- **Scope changes (out-of-scope)** – are changes to add, delete, or alter the design of the asset, subsequently affecting the business intent (changes in through/production). Scope changes *are not funded* by contingency (the AFE is amended to increase the funds required to pay for the change). Scope changes may include a transfer or shift in work between one project and another. Approved scope changes prior to AFE approval are added to the Scope of Work (SOW), where the estimated costs are represented in the current stage estimate, i.e., Class 5, 4, 3. Volatile market conditions or extraordinary random events (force majeure) may also be considered scope changes as these conditions cannot be controlled by the OPT.
- **Project changes (in-scope)** – support and maintain the design to achieve the approved throughput capacity (business intent). Project changes can occur throughout the project life cycle. Prior to AFE approval, approved project changes are added as part of the current stage estimate, i.e., Class 5, 4, and 3. Post-AFE approval and are *funded* by contingency. If the contingency funds have been expended, the OPT will be required to amend the AFE to increase funds to pay for the changes.

Project changes usually occur when the project team determines options that support the completion of the key deliverables (i.e., BFDs and PFDs at FEL 2 for process projects). There is a balance between maturing the scope definition of the project (i.e., scope development process) and changing scope.

2.1.2.2. Change Requestor

Change request(s) should be categorized by the requesting party to identify who initiated the change and the required collaboration between stakeholders and project participants. It is important to identify the requestor of the change so that other parties can collaborate and work with the individual or team to facilitate the disposition of the change. This categorization further identifies whether the change was made external or internal to the project. This further provides an assessment of the relationships and dynamics of the change and subsequent interdependencies between the parties. For project life cycle change management, change requests can be categorized by the following:

- **External change (EC)** – is considered a change initiated or directed by the organization's executive or an external stakeholder (outside the OPT). Funding requirements of the change will depend on whether this change is considered in-scope or out-of-scope. As indicated earlier, if the change is considered out-of-scope, additional funding will be required to be secured. Usually, the executive team makes the decision to approve these types of changes. If approved, the executive will need to collaborate with the OPT to introduce the new work and adjust the AFE accordingly.
- **Internal change (IC)** – is considered a change initiated or directed by the OPT. Depending on an organization’s authority guidelines, the OPT has the decision to approve changes that are considered project changes and use the contingency as allotted under the project AFE value. Internal changes also include budget transfers between accounts within the project environment.

A subset of both external and internal changes are contract changes (CC), which are considered an agreement between the OPT and the third-party contractor to compensate for a change in approved contractual work or other contract conditions. In some circumstances, the contractor may initiate (request) a change of their work. It must be approved by both the OPT and the contractor before it becomes a legal change to the contract. In other circumstances, the OPT can provide directives to the contractor. If this change affects other contracting parties, the

OPT will direct the affected contractors to submit a change request reflecting any cost and schedule impacts to their respective contracts. Contract change orders (CCO) should be bundled under an EC or IC change order.

2.1.2.3. Change Drivers

Applying greater levels of definition to the categorization of a change allows for improved analyses, decision-making, and cost and schedule stewardship. In terms of post-mortem reviews (after the project has been completed and closed out), change drivers, root causes, and lessons learned can be a positive feedback loop for the development of future projects. To further support the understanding of the change, the change request(s) should be categorized by change drivers so that the OPT can better understand the effects of change on their respective projects. The following is a common list of drivers that can be used by each organization. It is recommended that the organization introduce change drivers that support their business experiences.

2.1.2.4. General Change Drivers

- **Estimating/scheduling adjustments** – This element addresses estimated costs and timelines that require an adjustment or are made in error. Most adjustments or errors can be classified as having one or more of the following causes:
    - Omissions, where costs or timelines are accidentally left out of the estimate or schedule due to missing scoping documents, plans, and specifications.
    - Wrong assumptions of what was considered part of the scope of work or who was or was not completing the execution of the work.
    - Inadequate allowances and reserves are considered low for the type of work.
    - For estimates, pricing changes where labor and material costs may increase between the estimated price (at approval) and the project (when executed). An example is when in-house estimators provide summary-level estimates of the construction work for AFE approval only to find out that the price submitted was lower than the price submitted by the contractors during the bid and award cycle.
    - For schedules, the means and methods change where project performance decreases from the baseline plan. An example is when in-house schedulers provide summary-level schedules of the construction work only to find out that the contractor has a different approach (modulization, crew mixing, equipment type and utilization, access/egress, etc.).

- **Vendor material/equipment deficiency, loss, or defect** – These are impacts that may add additional costs and schedule delays to the project caused by the vendor's inability to provide the services, materials, or engineered equipment within a timeframe that is consistent with the requirements defined in the contract. This impact includes any loss, defect, material damage or deficiency (missing components), fabrication error, and non-conformance (to specifications) in the operability and reliability of the procured item.
- **Transportation delays or damages** – These are impacts that may add additional costs and schedule delays in the execution of the project caused by a carrier's negligence that has created cargo loss and damage. This type of impact usually results in a back charge to the carrier or the use of insurance to pay for damages and delays.
- **Project budget transfers** – These changes are issued to transfer funds between project accounts. If one account is forecasted to underspend and is confirmed through analysis and investigation, it is prudent to transfer the unused, remaining funds into the contingency account. This money can then be distributed to negatively impacted accounts due to change. The budget transfer will be required to have a net-zero balance.

- **Schedule impacts** – are considered impacts to portions of the timeline due to a changed condition, delay, or event. Examples include interference, equipment delays, coordination impacts, lost efficiency or productivity, etc.

2.1.2.5. Execution Change Drivers

- **Design issues and resolutions** – Involves revisions to the design drawings and specifications on a project. A change order may be appropriate if a revision to any design aspect occurs before the work has been completed. The design modifications may also affect procurement and construction costs and schedule durations depending on when the project change occurred.
- **Engineering deficiency/error in the drawings** – This element is based on the owner's or other project participant's review of the engineering design or drawings, where incorrect design elements were identified as deficient, in error, or incomplete. A change order may be appropriate to the constructor or other parties (downstream of the engineering deficiency/error) if the subsequent investigation indicates that the work had already been completed and the issue arose after fabrication and installation were complete.
- **Actual field conditions differ from drawings** – This type of change identifies the actual physical conditions encountered but were unforeseen and materially different from the conditions identified in the contract documents or were conditions not typically found in the project site area.
- **Contractor deficiency/rework** – This type of change involves revisions to a project's construction activities and is based on the owner's rejection of work elements that the contractor has completed. In addition, a change order may be appropriate for other affected parties if the subsequent investigation indicates they are required to rework some of their adjacent installations. The modifications may also affect procurement costs and schedule durations depending on when the project change occurred.

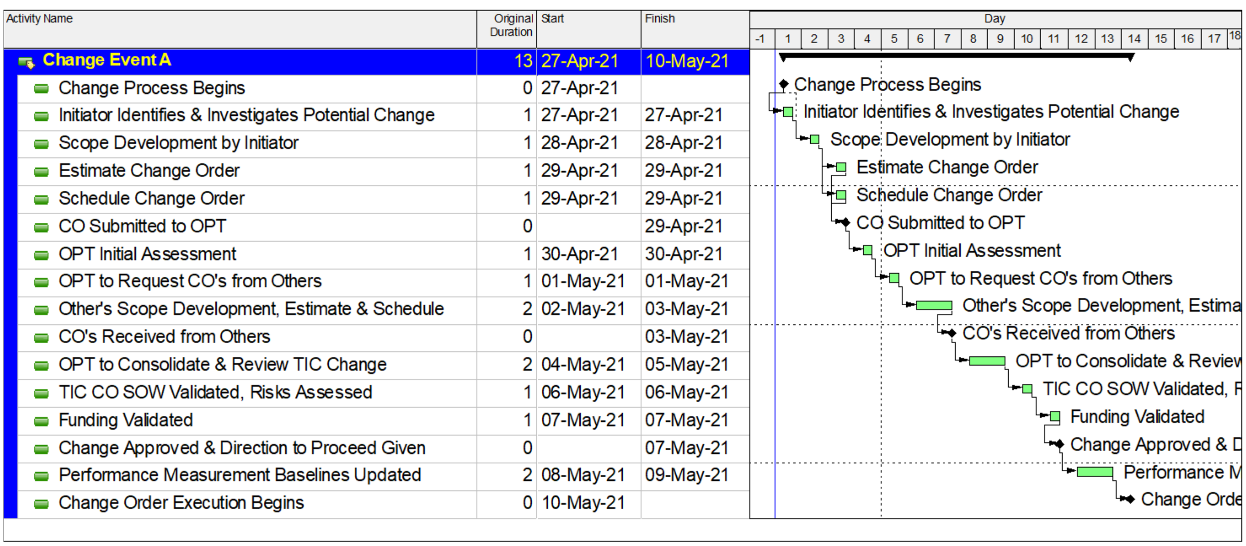
2.1.2.6. Owner Change Drivers

- **Regulatory/environmental/safety requirements** – Regulatory, environmental, and safety regulatory bodies that will enact new regulations or update current ones that can affect the execution of the design and the building of the project. These regulations may include tariff and trade policies, tax policy reform, import/export regulations, and environmental policies. In some circumstances, regulatory changes may affect the design of the physical structure.
- **Operations** – These changes occur when the operations group requests changes to the physical elements of the project after the design has been approved—for instance, access/egress locations, valve locations, etc.
- **Owner's directive** – This occurs when the owner or outside agencies impact the contractor's planned means or methods for executing the work. This change results from the owner's requirement to revise the contract's planned sequence for completing the work tasks on a project. The owner's directive may impact the contractor's scheduled and available labor, material, and equipment, as well as the contract time for completing a project.
- **Owner delays/interference –** This includes issues such as force majeure delays, restricted access to a project site, delays to owner-supplied services and materials, and interference resulting from the owner directing subcontractors, sub-consultants, or vendors without direct contractual authority.
- **Scope transfers** – This change is initiated by the executive or project sponsor and represents a shift in the scope of work between two entities (which may or may not be two or more separate projects). The net effect on the total is always zero, although an external transfer would represent a change to the owner since it would add or delete from the scope of work. These changes are not funded by contingency.

2.1.2.7. Timing of Changes

Time is of the essence is a boilerplate provision that is used in almost all contracts in the capital project world. This clause is equally prudent when managing project life cycle changes. It is considered good business practice to identify changes quickly, which is essential in protecting the project's desired outcome. The earlier the appropriate decisions are made to minimize any impacts on the development and execution of the project, the better. By sitting on change information or not promptly identifying it, the initiator can jeopardize the project's success. This also includes any delays in determining the disposition or the approval of the change by the OPT, specifically around changes that impact the critical path. Every day the disposition of the change request is delayed is another day the in-service date may not be achieved. Therefore, the quicker the appropriate information and requests are identified and submitted for disposition, the better the opportunity to minimize any impact of the change on the project. The resolution of changes should not be deferred.

Bringing a change forward, from initiation to approval, can be time-consuming. If not controlled appropriately, the impact on the project outcomes could be disastrous. Figure 4 illustrates an example schedule for submitting a change request and the potential time required to provide the disposition and approval. In this example, it takes 13 calendar days to execute the work from when the change was first initiated. This example illustrates the urgency behind expediting the change order, from initiation to approval to execution.



Activity Name	Original Duration	Start	Finish
Change Event A	13	27-Apr-21	10-May-21
Change Process Begins	0	27-Apr-21	
Initiator Identifies & Investigates Potential Change	1	27-Apr-21	27-Apr-21
Scope Development by Initiator	1	28-Apr-21	28-Apr-21
Estimate Change Order	1	29-Apr-21	29-Apr-21
Schedule Change Order	1	29-Apr-21	29-Apr-21
CO Submitted to OPT	0		29-Apr-21
OPT Initial Assessment	1	30-Apr-21	30-Apr-21
OPT to Request CO's from Others	1	01-May-21	01-May-21
Other's Scope Development, Estimate & Schedule	2	02-May-21	03-May-21
CO's Received from Others	0		03-May-21
OPT to Consolidate & Review TIC Change	2	04-May-21	05-May-21
TIC CO SOW Validated, Risks Assessed	1	06-May-21	06-May-21
Funding Validated	1	07-May-21	07-May-21
Change Approved & Direction to Proceed Given	0		07-May-21
Performance Measurement Baselines Updated	2	08-May-21	09-May-21
Change Order Execution Begins	0	10-May-21	

Figure 4– Timeline to Approve a Change

Project life cycle changes are more complex than a simple contract change. In most cases, the project life cycle change will require other parties' involvement to complete the change order. For instance, a change in construction may require field engineering to be completed or items to be procured (as described earlier in this RP). This complexity increases the OPT's efforts and oversight, from pricing the project life cycle change order to coordinating the work fronts of the different parties involved.

2.1.2.8. Changes and Contingency

Contingency is a budgeted amount of dollars added to an estimate to be used to incorporate changes to the project scope and baseline plans. As per AACE's definition of contingency[8], it is "an amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience." [1, p. 30] As stated earlier, contingency should be available to fund in-scope changes. Typically, a run-down curve is used to display the expended contingency dollars graphically. To develop the contingency run-down curve, the OPT will need to understand the expected time-phased plan in which costs and schedule contingencies are to be used. The expected time-phased plan is determined by ~~recognizing when event risks and~~ the anticipated use of contingency funds will occur. The usage of contingency dollars can then be tracked against this plan. Managing the run-down curve is crucial in ensuring that funds are available for change requests.

2.1.3. Change Orders – Form, Log, and Report

Documenting the change is key to managing change. Therefore, the OPT should introduce a change order (CO) form and change log as part of this documentation. These two documents provide the OPT will a catalog of information that supports the decisions made in managing the project life cycle. Examples of these two documents are provided in the appendix of this RP.

<u>2.1.3.1. Change Order Form</u>

In the project delivery arena, the primary change management tool used to document and authorize changes to the project is identified as the change order. A change order is defined as:

> *"A document requesting and/or authorizing a scope and/or baseline change or correction. 1) From the owner's perspective, it is an agreement between the project team and higher authority approving a change in the project control baseline. 2) From a contractor's perspective, it is an agreement between the owner and the contractor to compensate for a change in scope or other conditions of a contract."* [4, p. 4]

The form can be separated into three sections: general information, the main body (change description, reason for change, general comments), and the cost, schedule, and risk impact section. An example of the change form is provided in the appendix.

<u>2.1.3.2. Change Log</u>

The CO log is a running list of all the requested change orders submitted by project team members. It provides an account of the details of every single ~~cost~~ submitted by the project team members. Every time a CO is submitted, the CO log should be simultaneously updated. This update protects the project team by ensuring that there is a review of all outstanding costs and schedule items associated with the change, which assists in keeping track of cost exposure and overall project health.

The change log also provides a wealth of information through the collection of change order data. This information provides metrics that can be used to analyze trends and performance, such as change frequency, schedule delay,

[8] As per AACE, contingency usually excludes a) Major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project; b) Extraordinary events such as major strikes and natural disasters; c) Management reserves; and d) Escalation and currency effects.

cost growth, change backlog, rework rate, % of emergent changes vs planned changes, change by initiator, change by cause, average change review and approval cycle time, change by system/area. These metrics can be expanded on depending on the information collected.

It is expected that each contracting party will create and maintain its own respective CO log to ensure that they are managing its portion of the work. These contractor CO logs will need to be reconciled with the project life cycle change log to ensure that conflict between these two documents does not occur. The project life cycle change log is the master log and should be considered the source of truth. An example of the change log is provided in the appendix.

2.1.3.3. Change Order Reporting

The communication of a change order provides the OPT and stakeholders with a detailed understanding of the change and its impact, as well as the opportunity to identify corrective actions based on the information provided. Communicating the change promotes awareness and transparency, enforcing the obligation to collaborate. Subsequently, this also provides an opportunity to proactively manage work areas to minimize delays and disruptions. To support this effort, the project team should seek out and communicate all changes and how they affect the project's outcome, regardless of the status of the change, including approved, pending, canceled, and rejected change orders.

With this said, the OPT should focus on two key areas when communicating change. The first area is for the OPT to identify the cumulative dollar value of the approved changes against the value of the allotted contingency, as illustrated in Figure 5. The contingency profile is developed by distributing the contingency amount over time. For simplicity's sake, the OPT can use the same profile of the performance measurement baseline s-curves to distribute the contingency funds. Once the contingency profile is complete, the project team can track the usage of contingency funds against the cumulative approved change orders.

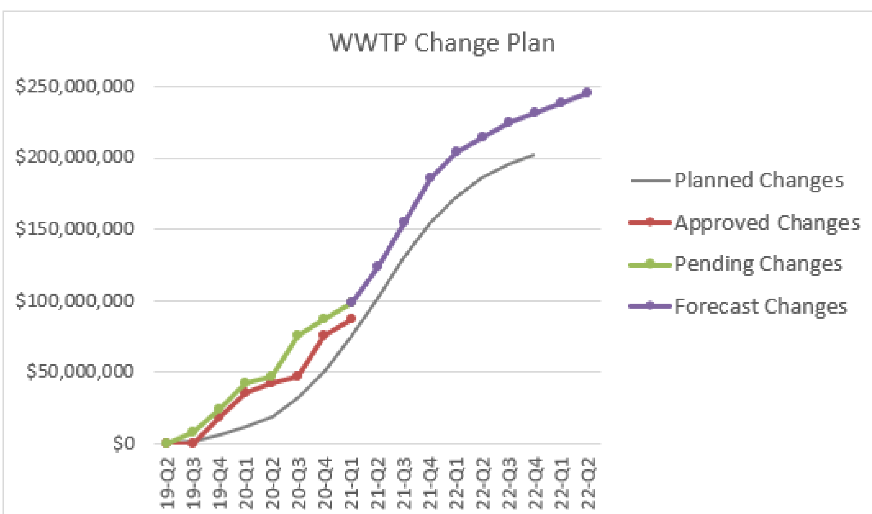


Figure 5– Example – Change Management Expenditure Curve

The planned changes curve is the cumulative value that represents when expected changes are to occur. In some cases, organizations may invert the contingency rundown curve as the basis for the planned value. The contingency run-down curve defines when the contingency funds are drawn down (expended). The approved change curve represents the cumulative value of approved changes, as reflected on the change log. Pending change curves represent the cumulated pending changes and approved changes. This is recognized as the potential exposure of changes that may be incurred by the project. From there, the forecast changes reflect future anticipated changes, which may include risks identified on the risk register that have a high potential of occurring. The forecast curve also anticipates that the project team could expect changes that go beyond the planned finish date. The forecast dates should reflect the dates on the current schedule. This is one example of how the OPT can assess changes, and their impact, in a proactive manner. From the example provided, the OPT can recognize (early) that they may not have the required contingency funds to execute the project.

The other key area is communicating the status of the change orders, as illustrated in Table 2. The status report should break down the value of each status type of change, including all canceled or rejected changes. The purpose of identifying canceled or rejected changes is to identify exposure or risk to the project's final costs. This exposure could also support the identification of potential claims.

Change Order Status	Total	
	# Count	Amount ($)
Under Preparation (Not Submitted):	4	N/A
Submitted:	20	$102,926,777
Pending Decision:	4	$11,392,221
Cancelled:	1	$1,681,395
Rejected:	1	$2,311,919
Approved:	14	$87,541,242

Aging Report	# Count	Average
Overall	20	11.8
> than 14 Days	6	20.1

Table 2– Change Order Status

To assist in the management of the changes throughout the project life cycle, the OPT should use a change management information system. This approach would automate the workflow, expediting notifications, approvals, and reporting. This would in turn reduce delays.

2.1.4. Project Life Cycle Management Process

2.1.4.1. Change Management Planning

The success of change management within the project life cycle begins with planning. For change management to be effective, planning for change should begin once the project life cycle has started. Change management planning defines the actions and steps required to execute change management activities for an organization's project(s). These planning actions and steps will facilitate the change management events as identified in the process map in this section of the RP. This plan will also assist the project team in managing the criticality of a change as well as the volume of change, minimizing any burden that could potentially jeopardize the successful execution of the project.

"The change management plan itself should describe specific systems and approaches to be used in change management in alignment with the other project control planning, measurement, and assessment processes." [2, p. 267] The planning efforts should also ensure that specific roles and responsibilities for change management are developed and understood. For example, while everyone is responsible for actively watching for changes, an owner's cost engineer/project controls professional will usually provide the necessary oversight and perform most of the duties of change management. The roles and responsibilities should also include how team members will support, engage, and communicate with each other, as the change management process for the project life cycle is more complex than just managing contractor changes.

2.1.4.2. Process Map

Once the change management plan has been established, the OPT should review all related scope documents, including any business strategies and technical documents that define the requirements and expected results. As every project is unique in its requirements associated with change, the OPT shall also ensure that all project personnel fully understand the change management requirements for each project. To support these requirements, the organization can implement the process elements of the following roadmap, as illustrated in Figure 6. The process elements are considered a tactical approach for project life cycle change management.

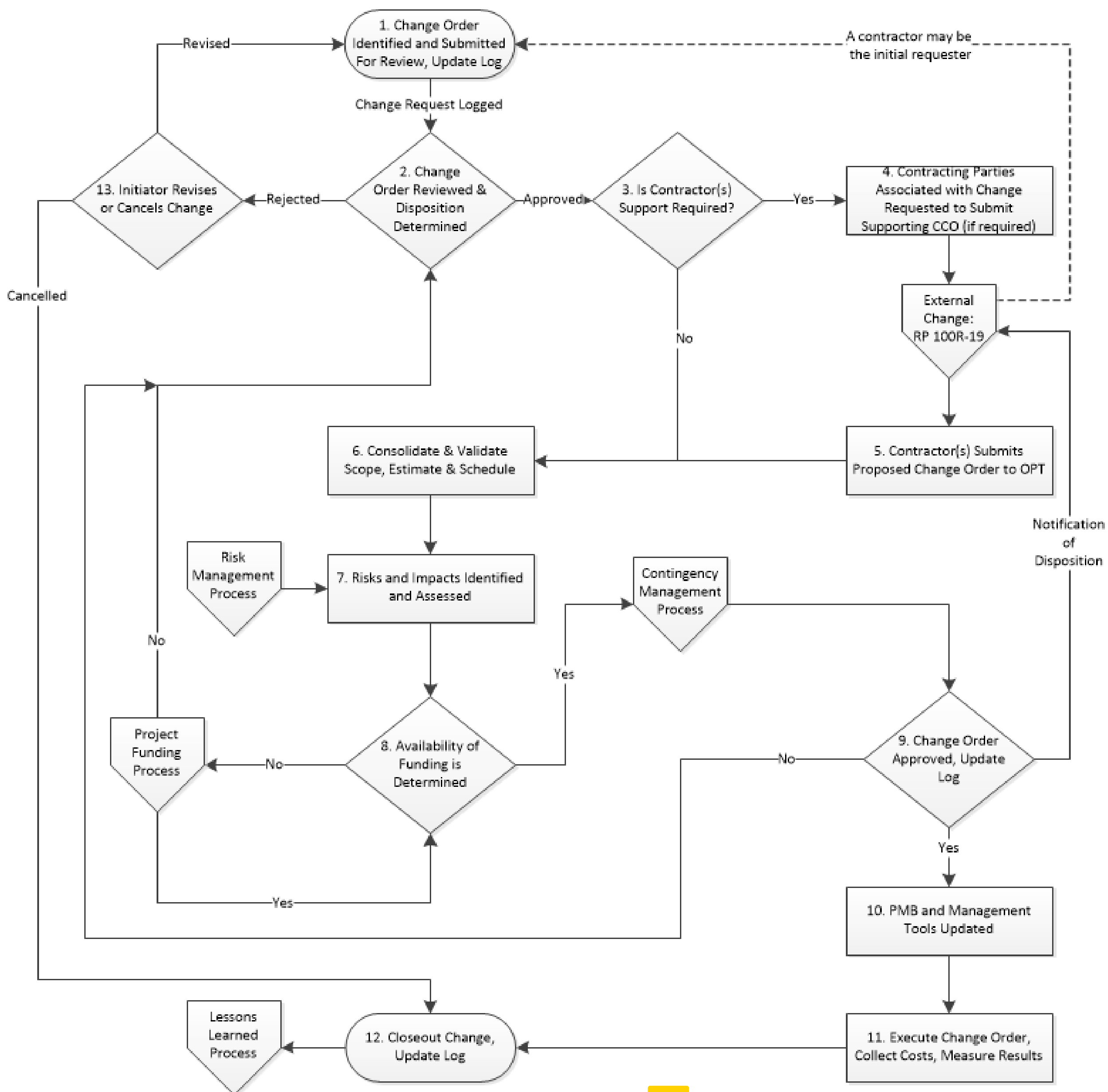


Figure 6–Project Life Cycle Change Management Process [5, p. 29]

1. Change Order Identified and Submitted for Review, Update Log

A change can be identified by any project team member, which includes the executive, OPT member, and contractor. The team member who identified the change will use the CO form to provide the details necessary to evaluate and validate the change. When a contractor identifies a change, it is recommended that the contract change order process and forms be used. Most contractors (and contracts) have a required approach to managing their respective changes. These change forms should support the project life cycle change management process.

2. Change Order Reviewed & Disposition Determined

Once the request has been received, the OPT will record the change, assign a unique identifier, and log the information in a change log (see Appendix 3). Logging this information allows the OPT to track, prioritize, and status the change request(s) to ensure that the change management process addresses each change appropriately.

The OPT will review and evaluate the request to determine if a change is necessary. The OPT will also determine whether the change is considered a project change (change to existing scope) or a scope change (addition of new scope). The OPT may approve or reject the change based on their interpretation of the request. If rejected, the change notice is returned to the initiator to determine the next course of action (see process element 13).

3. Is Contractor(s) Support Required?

As discussed earlier, a change may be requested to support an external, internal, or contract change. In some circumstances, the OPT may be the only entity required to perform the change. In other circumstances, other entities, such as contractors, vendors, etc., may also be required. Regardless of who initiated the change order, the OPT will assess the needs of the change and determine if other entities are affected or if support is required. If so, the OPT will provide direction to the other entities to submit a formal change notice.

If any of the contractors are not impacted or required to support the change order, the OPT can begin to evaluate the scope, estimate, and schedule of the change.

4. Contracting Parties Associated with Change Requested to Submit Supporting CCO (if required)

Once it is determined that contractor support is required, the OPT will engage the other contracting parties who may have been affected by the change and request these parties to submit a supporting change notice. For instance, on a design-build, or EPC project, changes may occur during the detailed design phase of the execution stage of the project. The potential change could impact the procurement and construction scope of work(s), in which these parties would support the change to their respective contracts or purchase orders. If the vendors and constructors have not been awarded their respective contracts, the expectation is the OPT will provide the necessary estimates and pricing to establish a complete understanding of the project life cycle change. In this circumstance, there will be no monetary impact on the vendor or construction contracts; however, their bid packages will be up to date with the most current design and installation requirements.

In another scenario, a vendor may identify the need to change the physical dimensions of a piece of equipment. For example, the vendor may change the pump requirements (i.e., shaft, bearings, and casing size have increased). This change would directly impact the design and construction of the civil foundation of the pump. The vendor would submit a change request for their additional work. The engineering group would submit a change if the vendor change affected the engineer’s scope of work (i.e., an increase in discharge piping is required, for example). If the constructor hasn’t started the work but has been awarded the contract, and subsequently, the construction drawings, the constructor would also submit a change request for the additional work. Again, if the contract has not been awarded, the OPT should provide an estimate and pricing for the construction work activities and then collate all respective changes to develop the project life cycle change request.

The contractor should prepare a change order according to the requirements identified for the project life cycle change order, which should include the contractor’s estimate, schedule, and risk items. In addition, a contractor change management process should be implemented to support the project life cycle change order.

5. Contractor(s) Submits Proposed CCOs to OPT

Based on the direction[9] of the OPT, the contractor(s) will submit their respective contract change order(s) to capture the changes to their scope of work. The OPT will review, assess, and validate each CCO submitted by the contractor(s) and ensure that an agreement concerning the scope, price, and schedule impacts associated with the contract change order has been reached.

6. Consolidate & Validate the Scope, Estimate, & Schedule

Once the change order has been reviewed, including any (individual CCOs), the OPT will consolidate the individual changes under a single change order to determine the total price of the change. This consolidation will include any owner and OPT changes or additional costs required to support the overall change request and include all scope, pricing, schedule information, and analyses agreed upon by all parties. The OPT will then validate the estimate and time of the project life cycle change. This extensive package of information will support the approval of the change notice.

The estimate and schedule process used by the organization should outline the requirements and approach for developing change order estimates and schedules. These processes would support updating the performance measurement baselines as change orders get approved.

7. Risks and Impacts Identified and Assessed

The OPT should identify risks pertaining to the change and assess any impacts on the project, which will include how the proposed change will impact the future risk profile of the project, such as downstream activities. The risk identification will also quantify cost and schedule impacts on the execution of the project, which should recognize the need for increased contingencies for the change order itself. Even change can introduce a level of risk.

If risk impacts have been identified, the OPT must institute ~~measures and~~ treatments ~~for mitigation~~. The OPT should not approve or move forward with the execution of the change without the acceptance of the ~~mitigation~~ strategy. The risk register should be updated to include any risks associated with a change request. The organization's risk process should be used to outline the risk methodologies and treatments required for managing change orders.

8. Availability of Funding is Determined

As discussed earlier, the project life cycle has two distinct phases: the conceptual or pre-AFE phase and the execution or post-AFE phase. The funding for changes within each phase is managed differently, where contingency funds are usually not provided for use during the conceptual phase[10] but are available for use during the execution phase. Another consideration is that the organization may not have a funding process for change orders that occur during the conceptual phase. However, most organizations have a project funding process for approving the AFE to execute projects.

With this said, the OPT should still prepare a change order to increase the budgets for projects that are currently being developed in the conceptual phase (i.e., stages FEL 1,2, 3). Using the change order and process provides the necessary documentation to communicate the decisions made during the specific FEL stage. The change orders will not only identify the increase of additional funds required to complete the development of the current stage but

[9] "If the owner directed the change, then by default, the contractor would be entitled to request relief from potential cost and schedule impacts. On these occasions when the owner has directed the change, the contractor's responsibility is to submit a cost estimate and resulting schedule impacts to the owner." [4, p. 9]

[10] In some circumstances, the author has seen owner organizations assign an allowance or management reserve to offset an increase in costs during the FEL stages.

also support the design changes to substantiate the increase (or decrease) to the project life cycle cost estimate(s) (i.e., Class 5, 4, 3, etc.).

For projects in the execution phase (post-AFE), there is an expectation that the OPT will increase the stewardship and oversight of the capital dollars being expended, including the contingency money allotted. In particular, how contingency funds are used for change orders and the available funds remaining for use. Based on this decision point, the OPT will need to identify the availability of funds for the change.

1. For new *project* changes that have been approved, contingency funds should be used. If the contingency funds have been depleted, the OPT will be required to:
    a. Ask the executive to amend the AFE and increase the funds to execute the changes.
    b. Review the accounts within the project to determine if any other funds are available (through performance assessment and forecasting). The forecasted *unused* funds should be transferred to the contingency account for use. The OPT should use caution in this approach and only be applied if the project delivery team is mature in its approach to project controls, specifically performance measurement and assessment.
2. For new *scope* changes that have been approved to move forward, the AFE is to be amended. Once amended, the change can be approved.

In some circumstances, the executive may not approve additional funding requests and ask the OPT to find the funds from within the project. If this should occur, the change request is routed back to the OPT for revision (see process element 2). The OPT can review the scope, pricing, etc., to determine if an alternate course of action is available. If there are no other options, the change order is rejected and canceled.

Another consideration is that the executive may direct the OPT to utilize contingency funds to execute out-of-scope work (if contingency dollars are available). If a new scope request has been submitted by the executive[11], where the OPT is required to administer the change, a negotiated agreement should be completed and documented. This ensures that all parties understand the history of the request, administration, and execution of the change. Similar to contractors having a contract with the OPT, the OPT has a contract (AFE) with the executive.

Once funds have been determined to be available via the contingency management process, the change order can move to the approval disposition.

9. Change Order Approved[12], Update log

Once all the reviews and assessments have been completed, the OPT can approve or not approve the change order. If approved, the OPT can move to the next step of updating the performance measurement baselines and management tools. The OPT will also notify the affected parties at this time as well.

If the OPT does not approve the change order, it is re-routed back to be re-reviewed. This situation may occur because new facts have developed or reasons have been identified that have changed the circumstances of the change order. The OPT would re-review the findings with the parties involved in the change order and then determine the next steps. At this point, the change request is either revised or canceled (see process element 13).

[11] In most cases, the executive has final say in the execution of capital projects, specifically in regard to funding and the scope of work. The executive is accountable for the fiscal and operational health and well-being of the organization, and therefore, has the authority to influence specific requirements as needed.

[12] Depending on an organization's authority guidelines, approval process and value of the project change order, the project change may require addition levels of approval from the executive.

Once the request has been finalized and approved, the OPT will update the change log and communicate the disposition of the change request to the participating parties in preparation for executing the change. Once endorsed, the change notice should be filed electronically according to the project records management plan.

10. PMB and Management Tools Updated

From the OPT's perspective, any change (and the accumulation of changes) becomes the revised agreement for executing the project. The revision of this agreement includes updating the OPT's and participating party's respective performance measurement baselines and management tools. This includes updating or amending the following:

- The project plan for any additional conditions that must be implemented.
- The project funded amount in the financial reporting systems if the AFE or contract fees increased.
- The EAC forecasts in financial and project management systems.
- The project risk register to capture any new risks that the change may have introduced.
- The contingency run-down curve and change order reporting tools.
- The code of accounts[13] to include the change request ID for the purposes of cost collection.

11. Execute Change Order, Collect Costs, Measure Results

Once the PMB and tools are updated, the OPT and participants can execute the change. Along with executing the physical work, the OPT and project participants will also measure the work completed on the change order and collect the costs. The collection of actual costs for the change order substantiates the estimated value of the change order as well as identifying any change trends and impacts against the control/performance baseline. In addition, it provides an understanding of the cumulative costs of all change orders in relation to the original budget(s). Finally, the OPT should monitor the risks identified during the change order development and provide the necessary treatment if and when required.

12. Closeout Change, Update Log

Once the change order work has been completed, the change order is closed out. The OPT should complete a post-mortem of the change order to identify any issues that may have developed during the execution of the change. For example, any impacts on the performance of other project team members. The OPT should also update the lessons learned log to capture opportunities to minimize change for future projects.

13. Initiator Revises or Cancels change

If the OPT rejects[14] the change request submitted by the initiator, the change notice is returned to the initiator. From there, the initiator has two options to consider on how to proceed with the change order. These options include:

a) Revise the change order and resubmit – the OPT may have identified a particular detail about the change order that caused the rejection. The detail may be small or a significant portion of the change. The OPT may recommend resubmitting the change notice with the specified changes. The initiator has the option to introduce the recommended adjustments and resubmit the change request.
b) Cancel the change order – the OPT may have identified new facts about the circumstances concerning the change request, or for other reasons, the initiator may choose to cancel the change request.

[13] The use of a new task code within the current project provides the opportunity to separate costs out from the project's baseline budget that are associated with the change. A separate task for charging costs is helpful if the change order is disputed in the future.
[14] Please note: For managing rejected or disputed change orders, an escalation clause/process should be made available to assist in advancing the change order in an appropriate manner.

The closeout of all change orders is required. This also includes all supporting CCOs.

2.1.4.3. Change Thresholds and Change Boards

To move the change expeditiously through the process, the OPT should design change approval thresholds, an escalation policy, and a dispute resolution process. Based on the classification, type, and driver of the change, the OPT can determine the level of involvement from specific stakeholders. This involvement requires a balance and desire for flexibility and quick decisions.

Introducing a change board provides the organization with a structured and definitive approach for governance, authority, and approvals. The following provides examples of which parties make up a change board:

- **OPT representatives** - these participants offer the most expertise on the proposed change to the product and its effect on cost, schedule, and functionality. Though the project manager often plays this role, it is also appropriate for other team members to represent the project team.
- **Functional management** - these participants represent company policy, where through advisement, recommend and support the change.
- **Executive management** - this board member must not only approve changes to the cost and schedule but must also understand how the change affects the design intent and project's usefulness.

The larger the project, the larger the change management thresholds. Also, large projects can introduce more complex change boards, with representatives operating at many levels. While this may add complexity, it is an appropriate strategy for controlling project decisions while assigning decision-making authority to the appropriate party.

2.1.5. Change Management Closeout

Once the project is completed, the OPT can then begin to collect all the necessary information to complete an investigation into the costs and schedule changes. This investigation would support the final lessons learned session. The project team can review the final cost report to determine the variances from the Class 3 AFE value to the approved changes and, subsequently, the final actual costs. Like the pre-AFE reconciliation report (table 1), the OPT can complete a final reconciliation report once the project is finished. In addition, the reconciliation activities would include comparing the actual costs to the estimated costs.

Administering change management throughout the project stages to substantiate the cost value is critical for project approval. While examples of the collection of costs of the project are identified, the OPT should also collect the relevant schedule changes, hours, quantities, rates, etc. This information is crucial for improving the estimating and validation processes.

3. CONCLUSION

The project life cycle change management process is one of the most important aspects associated with successfully managing a capital project. The project life cycle change management RP promotes collaborative solutioning by enhancing the relationships of project personnel, where the OPT, leadership, and contractors work together to resolve project issues.

In the absence of a project life cycle change management process, this recommended practice provides an option to consider. By implementing an integrated change management process with other project control processes across project life cycle phases, project teams can further their project delivery capabilities. The change management process provided in this RP can be modified to suit the needs of the user.

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APPENDICES

A1. Case Study: Wastewater Treatment Plant

A municipality within a major city approved the request to allocate funds to develop a new wastewater treatment plant (WWTP). A preliminary study was conducted, and it concluded that the municipality should build a new plant for $889 MM (7,600,000 M^{3}PD – meters-cubed per day, wet-weather capacity) rather than expand two existing facilities at the cost of $765.00 MM. The new facility allowed for expansion as demand increased. A list of 97 locations was identified and scrutinized, of which five (5) potential sites were short-listed and submitted as part of the study. The $889.00 MM budget estimate was validated against historical and bench-marked data of similar projects, including appropriate contingency and escalation. In addition, the municipality introduced a stage-gating[15] process as part of its project life cycle management approach.

The project team met its first roadblock during front-end loading (FEL) stage 1, the business planning stage. Of the five proposed sites selected for the facility, four were rejected. One site location was rejected by city council as environmentalist groups and residents attacked the idea of having a wastewater treatment plant in their backyard. Another site was rejected due to an earlier agreement that set strict limits on the plant's size (no greater than 3,500,000 M^{3}PD) in that respective area. Two other sites were rejected due to increased construction and maintenance costs (wetlands in one case and a higher elevation in the other case). To minimize further scrutiny, it was then decided to build the new facility on a 300-acre site beside an existing power plant owned and operated by the same company. This decision would allow the power facility to provide electricity to operate the wastewater plant and eliminate the need for a substation ($16.50 MM in savings). However, eight miles of intake & discharge pipelines and pumping stations, at the cost of $215.00 MM, were required.

At the end of FEL 1, the project team provided the business case to develop the 7,600,000 M^{3}PD facility with a budget cost estimate (Class 5) of $1.129 BN (a base cost of $725.00 MM with a contingency[16] estimate of $403.93 MM). The Class 5 estimate was over the earlier proposed budget estimate by $239.90 MM (27%). The approved budget for developing the deliverables for FEL 1 was $307,250 (original budget of $272,250 plus approved changes of $35,000). The EAC/Actual costs for FEL 1 were $315,000 (a negative variance of $7,750). The block flow diagrams (BFDs), the key engineering deliverable for stage 1, were approved. Subsequently, the project met all financial requirements and was approved to move into the facility planning and scope development stage, FEL 2.

During FEL 2, the project team stayed true to the design intent of 7,600,000 M^{3}PD; however, due to new regulatory and redundancy requirements, the physical scope of the wastewater treatment plant went from 2 primary and secondary clarifiers to 4, including the addition of other key equipment requirements. (the block flow diagrams (BFDs) were updated and assessed for impact). Soil investigations were also conducted at the new site location, where evidence of contaminated soil was found. Finally, due to the addition of the pipeline system, the routing study identified that boring a tunnel 1.0 mile long, up to 80 feet deep, would be required. This requirement was due to roadway constraints and underground obstructions. However, even after recognizing that tunneling carried significant risks, it was considered the best feasible option.

At the end of FEL 2, a Class 4 estimate was completed, which indicated that the facility's price increased to $1.375 BN (a base cost of $1.100 BN with a contingency estimate of $275.00 MM). The Class 4 estimate was over the previous Class 5 estimate by $246.10 MM (22%). While the total installed costs increased significantly from the Class 5

[15] The stage-gate process is a project delivery technique used within capital projects. The project is divided into distinct stages, separated by decision points or gates. The stages include conceptual design (further broken down into front-end loading stages (FEL 1, 2, and 3), an execution stage (which includes detailed engineering, procurement, and construction), and the commissioning/startup stage.

[16] "Contingency is an amount added to an estimate (of cost, time, or other planned resource) to allow for items, conditions, or events for which the state, occurrence, and/or effect is uncertain and that experience shows will likely result, in aggregate, in additional cost." [2, p. 206]

estimate to the Class 4, the contingency amount decreased. This decrease was because the scope of work was further refined, and the engineering deliverables matured. The project team maintained the original design intent, even as the physical design changed. The approved budget for developing the deliverables for FEL 2 was $1.36 MM (Original budget of $1.09 MM plus approved changes of $275,000). The EAC/Actual costs were $1.42 MM (a negative variance of $51,400). The process flow diagrams (PFDs), a key engineering deliverable for stage 2, were approved. Again, the project was authorized to advance into the project planning and detailed definition stage, FEL 3.

During FEL 3, the project team continued with the design intent and physical requirements identified in the previous stages. All optioneering [17]activities were completed in the previous stage, so changes to the BFDs and PFDs were not expected. However, some changes did occur as it was identified that the equipment arrangement/layouts within the facility would change from the preliminary design. The changes to the equipment arrangements increased the piping and electrical requirements (quantities), which increased the material requirements as well as moved some of the work below ground (underground work such as piping and electrical duct banks) rather than be built above ground, as first assumed. Also, due to the increase in investigations and studies, FEL 3 required an additional 2 ½ months to complete the engineering deliverables. From an execution strategy standpoint, the project team elected to use the competitive bid process once the detailed drawings were completed. Construction companies would provide a firm price bid for all construction activities, including the purchasing of bulks and off-site fabrication.

Once the design and execution strategies were finalized for this stage, a Class 3 estimate for FEL 3 was completed. The estimate indicated that the price of the facility increased by $167.50 MM (12%) from the Class 4 estimate to $1.542 BN (a base cost of $1.340 BN with a contingency estimate of $202.50 MM). The approved budget for developing the deliverables for FEL 3 was $8.19 MM (original budget of $7.77 MM plus the approved changes of $425,000). The EAC/actual costs were $8.29 MM (a negative variance of $92,500). The total FEL costs incurred for front-end development came in at $10.02 MM. While the city was hesitant to proceed with developing the new facility, it was determined that the urgency to build the new plant became more apparent as it was identified that the sludge digesters at the existing facilities were beginning to fail. A total failure would create a catastrophic event. This hesitation also created another schedule delay of over three months. It was also suggested that the new WWTP carry the budget for new sludge digesters for the existing facility at the cost of $30.00 MM to expedite the purchase; however, this request was rejected. An authorization for expenditure (AFE)[18] was finally approved, with an increase of $653.50 MM (42%) from the budget estimate of $889.00 MM. Included in the AFE value was the conceptual design (FEL 1, 2, & 3) expenses[19] for planning, designing (preliminary), assessing, and validating the need to commit and expend capital funds to advance its business operations.

With the AFE now approved, the organization was committed to managing the capital funds of the project, where most of the capital costs, and subsequently, risks, were applied. Also, with this approval, contingency funds were activated for use to manage the commitment of the AFE.

After the announcement from city council that the project was approved, business developers and neighboring residents within the area began to complain about the chosen location of the wastewater treatment plant, even though public hearings and communication sessions had been conducted earlier. To win or at least receive grudging acceptance of the new facility, the project team was required to install the nation's most advanced odor-control system ($65.00 MM). The project team also agreed to pay for parks, trails, ballparks, and other goodies ($80.00 MM)

[17] Optioneering is a term used for identifying engineered alternatives and determining the best option to move the project forward. Optioneering is usually completed in FEL 2.

[18] Authorization for expenditure (AFEs) is considered a budgetary document, usually prepared by an asset owner to provide a draw down against the capital expenditures in relation to specific projects. The AFE accounts for the management and control of the capital budget, projected, and actual costs. Some industries may use terms such as a commitment agreement, capital budget request, etc.

[19] Depending on country, business operations, legal entities, etc., FEL 1, 2, and 3 expended costs may be transferred and included as part of the AFE value (as these costs can usually be capitalized).

for the neighboring jurisdictions near the plant and pipeline system. It was also determined that the sewer bills would pay $15 million for artwork and $100 million for a new education center. The payment of the additional $115.00 MM would affect the facility's revenue and, subsequently, the ROI, IRR, and NPV calculations.

During the detailed design of the execution phase, the design team completed the engineering activities, and in some cases, identified numerous additions or deletions of design elements to ensure operability, quality, and safety. For example, while the project team decided to relocate part of the facilities during FEL 3, specifically the piping systems, it was identified in detailed design that more piling would be required for the pump foundations. It was found through soil/bore sampling that the soil conditions were sub-standard for the design. Also, because of the relocation of the pumps, the static and dynamic head pressure needed to be increased. This relocation subsequently increased the pump capacity, increasing the foundation sizes.

It was also identified that the design team would need to work with the pump vendor to determine any impact on the fabrication of the pumps. Their review indicated that the motor, and subsequently, the shaft and bearings, would need to be increased in size. Due to the increase in motor size, the electrical demand required to operate the pump (i.e., increased motor size to accommodate static and dynamic head pressure requirements) also increased. The pump vendor also changed the impeller pitch to optimize pump efficiencies and minimize electrical demand. The electrical engineers validated whether the electrical load could meet the new requirements and determined that the electrical design would be satisfactory. Changes to the MCCs, VFDs, and switchgear were not required. However, the instrumentation design for the pumps was required to change due to the new pressure calculations; the new type of special instruments was ordered with negligible cost impact to the project (only one vendor manufactured these instruments). The design team was also met with their own performance issues as there were delays in receiving vendor drawings, etc. These vendor delays were caused by the delay in reviewing the technical and commercial requirements of the vendor's bid package. Other performance issues were caused by conflicting priorities and the lack of coordination and planning.

Once the design was completed, the project team issued construction drawings (IFC) to a select group of pre-qualified contractors to secure competitive pricing. It was realized that the contractor's price(s) to construct the facility were much higher than what was estimated[20] during FEL 3. Strategies were discussed as to whether the contract type should change (from firm price to time and material) or the scope of work be partitioned into multiple contracts, where a project management office would oversee the work. An additional $32.00 MM for introducing a larger PMO to manage the contractors would be required. Multiple contractors would also increase the coordination of work efforts. It was determined that the original strategy of using one contractor stood; however, the contract was changed to time & material with a cap, eliminating the contractor's risks of executing the project (which was thought to be the driving issue for the increase in pricing). A large, non-union contractor was awarded the work.

During execution, three major events occurred. One, the owner decided to overturn its past decision and re-instate the design and construction of the substation to support future electrical demands (this substation would be erected between the existing power plant facility and the new wastewater treatment facility). The engineering team scrambled to complete the design, and vendors were brought in to expedite the procured items to minimize delivery impacts. The constructor brought on additional staff and crews to ensure that the substation would be completed at the same time as the wastewater treatment facility. The price for designing, procuring, and constructing the substation was $17.40 MM.

[20] In some circumstances, in-house estimators may be employed by the owner to provide estimates for the construction work efforts. This is required so that the project estimate can be completed in order to support the development of the AFE for review and approval. In-house estimator's need to be prudent in their approach to ensure that construction estimates are correct and complete.

In the second event, it was also identified that the fabricated steel of the scraper blades for the primary and secondary clarifiers was made using inferior material. The stainless steel used was incorrect and would not meet the life expectancy requirements of the equipment. The project team decided to install the fabricated scrapper blades as is. It was decided that the company would ask for the replacement of the scrapper blades, which would be installed during a scheduled outage (at the vendor's expense). This request became contentious as the vendor disagreed with the additional charges. A claim was filed.

Finally, the third event identified an abandoned pipeline that ran parallel to where the new piping systems and electrical underground works were required to be installed. The pipeline was part of an old water system decommissioned 20 years prior but was not identified on the construction drawings. As a result, the project team directed the constructor to remove approximately 300 yards of the existing pipeline to complete the required scope of work. Unfortunately, this additional scope of work also created a schedule delay of 2 months in constructing the new pipeline system.

Other issues came into play. For instance, it was decided that a berm should be installed between the two facilities as a precautionary measure to contain any spills and mitigate direct drainage issues. In other circumstances, the contractor installed the wrong flanges on the pipe connected to the 12 diameter-inch filtration system. The pipe was fabricated off-site with raise-faced flanges, but when installing the piping spools, it was identified that the filter equipment had flat-face flanges. This issue created rework and additional expenses. Another issue that was identified was the delay in receiving the pipe valves (including control valves). To complete the piping fit-up and installation, pipefitters fabricated temporary piping spacers. Unfortunately, instrumentation techs had to wait to terminate the control valves. On top of this, some scaffolding could not be dismantled as it was still required to install and terminate the valves once they arrived. This created inefficiencies for the construction teams (stops and starts).

Other delays included the late shipment of the required instrumentation for the pumps. An earthquake in the Pacific Ocean occurred, creating a tsunami that destroyed the instrumentation factory. This event delayed the manufacturing of the specialized instrumentation for six months. This delay, however, did not affect the critical path of the project but did increase the costs by $200,000. Another issue that came into play was the loss and theft of materials, specifically pipe supports. It was identified that the operations team, who were union employees, would drive over to the construction laydown site at night, take the pipe supports, load them up, and then drive them to the banks of the river and throw them in. The operations team would also puncture thousands of feet of welding hose. This sabotage led to delays, performance issues, and increased costs of $25.00 MM as additional craft was required to fabricate the supports on sight due to time constraints. In addition, the disgruntled union employees would regularly picket the construction job site, creating more delays, inefficiencies, and disruption. Buses were brought in to transport craft on and off-site in a safe and secure manner. Even though the site was secure, this disruption created craft shortages as some of the personnel chose not to work at a site due to the unrest (for example, some of the craft's personal vehicles were vandalized where they were staying).

As the project neared completion, landscaping activities were being conducted. The operations manager from the adjacent power plant (same owner) asked the contractor if 150 yards of 1-inch rock could be brought in to beautify the existing facility and match the new facility since over 1000 yards were already being purchased and put in place for the new facility. The operations manager also asked if the constructor could install new concrete housekeeping pads, bollards, and lamp posts at the exiting security shack (shared by both facilities) as well as fix the power plant's existing fence.

Once the facility was commissioned and turned over to operations, it was also realized after several months of reconfiguring and debottlenecking that the intended capacity of 7,600,000 M^3*PD would not be met. It was identified that the primary clarifiers could not manage the amount of sedimentation. While the circular primary clarifiers installed provided a shorter detention time for settling the sludge, there was a higher flow distribution head-loss. This additional sedimentation was due to the design and location of the intake station. At the six-month mark of* *operations, additional screening systems were engineered and installed, allowing the facility to reach 7,600,000 M^3PD. This additional work was completed for a cost of $50.00 MM. Operations requested that these costs be paid for out of the existing AFE and not the operating expense budget. However, the AFE was closed. With the cumulative effect of all the changes and other project issues, the project's final costs came in at $2.170 BN.*

Today, the facility is running at full capacity; however, it was plagued with reliability issues, where unwanted shutdowns for replacement and refurbishment of equipment and systems were required. Also, additional water basins and holding tanks were installed to provide enough storage to maintain supply and demand (due to the unscheduled outages). These reliability issues further affected both the ROI and IRR calculations of the project and its operations. Ultimately, retiring the project debt burden will take approximately 30 to 35 years of principal and interest payments. It must be noted that the average expected useful life of a new municipal-owned wastewater asset is approximately 35 years.

Based on this case study, one can see that there were numerous changes identified throughout the project's life, even after it was completed and turned over to operations. Some of the above changes may not be considered in-scope changes but rather new, out-of-scope changes. In other circumstances, some of these changes may be considered performance trends, while others may be considered rework and scope creep. This case study provides numerous examples of how the lack of scope development, project preparedness, and mismanagement can contribute to the influx of changes incurred on a project.

A2. Change Request Form – Example

General Information			
AFE:	A60552341	**TIC No.:**	0022
Project ID:	P0001	**Change Name:**	Clarifier Utility Piping - SB
Project Name:	Wastewater Treatment Plant	**Potential Impact:**	Low
Initiating Department:	Bob's Builders	**Schedule Impact:**	No
Initiator:	John Smith	**Change Classifcation:**	PCO - Project Change
Date Initiated:	27-Apr-21	**Change Driver:**	Internal Change (IC)
Required By Date:	30-Apr-21	**Change Type:**	Engineering deficiency
Date Dispositioned:		**Status:**	Pending

Funding Information			
AFE Impact:	No	**Amount:**	$0
Use Contingency:	Yes	**Amount:**	$441,364
Cost Information			
	Estimate	***Previous Control Budget***	***Revised Control Budget***
FEL Costs	$0	$10,015,400	$10,015,400
OPT	$959	$8,322,605	$8,323,564
Land & Specialties	$0	$222,200,000	$222,200,000
Detailed Design	$21,588	$178,933,609	$178,955,197
Procurement	$60,347	$383,247,027	$383,307,374
Construction	$358,470	$856,008,001	$856,366,471
Commissioning/SU	$0	$28,800,000	$28,800,000
Contingency & Escalation	$0	$114,973,358	$114,973,358
Total	**$441,364**	**$1,802,500,000**	**$1,802,941,364**

Schedule Information				
Activity ID	***Baseline***	***Change***	**Schedule ID:**	RC02
Activity Early Start	01-Apr-21	01-Apr-21	**Data Date:**	27-Apr-2021
Activity Early Finish	26-May-21	28-Jun-21		
Activity Late Start	19-Apr-21	15-Apr-21	**Activity ID:**	A28850-50
Activity Late Finish	13-Jul-21	13-Jul-21	**Event ID:**	A28850-51
Activity Total Float	48	15		
Total Activity Dur:	56	89		
Days Spent:	26			
Remaining Dur:	63	63		

Risk Information				
Description & Consequence	***Likelihood***	***$ Impact***	***Time Impact***	***Mitigation***
Due to the re-routing of the pipe, additional pipe supports are required. It was identified that there maybe delivery delays; May affect installation date.	M	L	M	Float after change is 30 days. No mitigation required at this time.

Change Order Description
Re-route small bore utilities piping along the west side of the clarifiers. Field engineering is required to assist in determining the new piping route. Additional pipe supports and piping materials would be required. WBS Element 01-123-4490, Clarifiers, Utility Piping, Small Bore Contracts: 10-895; CCO 085 (Colt Engineering), 20-852; CCO 025 (Bob's Builders)

Reason for Change
The electrical cable tray / cables interferred with the routing of the small bore utilities piping.

Comments
Discuss with engineering group as to why the model did not indicate clash detection. The builder stated they would supply all additional piping and fittings as part of the change order. The routing did change the pipe support requirements, which the fabricator is completing.

A3. Change Log – Example

Project No.:	A60552341
Project Name:	Wastewater Treatment Plant
Construction:	New
AFE Number:	ABC-12345
Client Contact:	John Smith
Contract Type (Designer):	T&M
Contract Type (Constructor):	T&M with Cap
AFE Estimate Class:	Class 3

Change Driver (Cause)

1. Estimating / Scheduling Adjustments
2. Vendor Material/Equipment deficiency, loss or defect
3. Transportation delays, or damages
4. Project Budget Transfers
5. Schedule Impact
6. Escalation
7. Design issues, resolutions
8. Engineering deficiency / error in the drawings
9. Actual field conditions differ from drawings
10. Contractor deficiency / rework
11. Regulatory / Environmental / Safety Requirement
12. Operations
13. Execution Change - Owner's Directive
14. Owner's Delay / Interference
15. Scope Transfers

Change Classification

SCO - Scope Change
PCO - Project Change

Change Type

Internal Change (IC)
External Change (EC)
Contract Change Order (CC)

Potential Impact (Priority)

High
Medium
Low

Status

Approved
Pending
Rejected
Cancelled

Budget Estimate:	$889,000,000
FEL Changes:	*$357,189,628*
AFE Value (Less Conting.):	$1,339,984,600
Contingency Value:	$202,500,000
Total AFE Value:	$1,542,484,600
AFE Changes:	*$940,568,972*
Approved Base Value:	$2,280,553,572
EAC (Forecast) Value	$2,169,525,870
Remaining Contingency:	$3,973,930
Planned Completion Date:	30-Sep-22
Forecasted/ Actual Completion Date:	1-Mar-24

Stage	Phase	ID	AFE Rev.	Description	Funding by Contin.	Cap Adjust.	Change Type	Change Driver	Submittal Date	Disposition Date	Variance (Days)	Disposition Status	OPT	Land & Specialties	Engineering & Design	Procurement	Construction	Commission. / SU	Dollar Value (TIC)	Schedule Impact (Y/N)	Days Impacted	Schedule Activity (ID) Impacted
Exe	DD	PLC-01	C	Re-baseline Schedule	Y	N	IC	5	15-Jun-19	21-Jun-19	6	Approved										
Exe	DD	PLC-02	1	Parks, etc.	N	N	EC	11	15-Aug-19	18-Aug-19	3	Approved	$0	$195,000,000					$195,000,000	N		
Exe	DD	PLC-03	1	Odor	N	Y	EC	11	30-Aug-19	2-Sep-19	3	Approved	$0		$4,000,000	$29,000,000	$32,000,000		$65,000,000	N		
Exe	DD	PLC-04	C	PCO 4	Y	Y	IC	1	19-Oct-19	2-Nov-19	14	Approved	$0	$8,000,000					$8,000,000	N		
Exe	DD	PLC-05	C	PCO 5	Y	Y	IC	8	23-Nov-19	30-Nov-19	7	Approved	$23,302		$524,294	$2,008,449	$8,162,849		$10,718,894	N		
Exe	DD	PLC-06	C	PCO 6	Y	Y	CC	8	7-Jan-20	28-Jan-20	21	Approved	$11,422		$257,006		$4,195,122		$4,463,550	N		
Exe	DD	PLC-07	C	PCO 7	Y	Y	CC	8	11-Feb-20	14-Feb-20	3	Approved	$26,500		$596,255	$1,961,617	$9,231,083		$11,815,455	N		
Exe	DD	PLC-08	C	PCO 8	Y	Y	IC	10	1-Apr-20	11-Apr-20	10	Approved	$10,966		$246,727	$74,397	$4,042,517		$4,374,607	N		
Exe	DD	PLC-09	C	PCO 9	Y	Y	CC	10	16-May-20	30-May-20	14	Approved	$8,681		$195,325	$50,981	$3,279,493		$3,534,480	N		
Exe	DD	PLC-10	C	PCO 10	Y	N	CC	8	25-Jun-20	16-Jul-20	21	Rejected							$0	N		
Exe	DD	PLC-11	C	PCO 11	Y	Y	CC	10	29-Aug-20	5-Sep-20	7	Approved	$10,509		$236,446	$69,714	$3,889,912		$4,206,581	N		
Exe	DD	PLC-12	C	PCO 12	Y	Y	CC	7	21-Sep-20	12-Oct-20	21	Approved	$15,992		$359,809	$1,259,132	$5,721,170		$7,356,103	N		
Exe	DD	PLC-13	C	PCO 13	Y	Y	CC	6	16-Oct-20	26-Oct-20	10	Approved	$19,190		$431,771	$1,586,958	$6,789,405		$8,827,324	N		
Exe	DD	PLC-14	C	PCO 14	Y	Y	CC	8	3-Nov-20	15-Nov-20	12	Approved					$8,010,244		$8,010,244	N		
Exe	DD	PLC-15	C	PCO 15	Y	Y	CC	8	5-Dec-20	10-Dec-20	5	Approved	$8,681		$195,325	$509,814	$3,279,493		$3,993,313	N		
Exe	DD	PLC-16	C	PCO 16	Y	Y	CC	7	28-Dec-20	16-Jan-21	19	Cancelled							$0	N		
Exe	DD	PLC-17	C	PCO 17	Y	Y	CC	8	22-Jan-21	23-Jan-21	1	Approved	$12,793		$287,848		$4,652,937		$4,953,578	N		
Exe	DD	PLC-18	C	PCO 18	Y	N	CC	9	18-Feb-21	26-Feb-21	8	Approved				$837,641	$4,347,727		$5,185,368	N		
Exe	DD	PLC-19	C	PCO 19	Y	Y	CC	8	13-Mar-21	25-Mar-21	12	Approved	$4,569		$102,803	$88,324	$1,906,049		$2,101,745	N		
Exe	DD	PLC-20	2	PCO 20 - Schedule Imp	N	Y	CC	5	15-Mar-21	28-Mar-21	13	Approved							$0	Y	180	All
Exe	DD	PLC-21	C	SCO 21	Y	Y	CC	13	28-Mar-21	16-Apr-21	19	Approved	$5,940		$133,643	$228,820	$2,363,863		$2,732,266	N		
Exe	DD	PLC-22	C	PCO 22	Y	Y	CC	8	27-Apr-21	2-May-21	5	Approved	$959		$21,588	$60,347	$358,470		$441,364	N		
Exe	DD	PLC-23	C	PCO 23	Y	Y	CC	2	22-May-21	10-Jun-21	19	Approved				$41,491	$1,753,444		$1,794,935	N		
Exe	DD	PLC-24	C	PCO 24	Y	Y	CC	8	17-Jun-21	25-Jun-21	8	Approved	$16,906		$380,370		$6,026,380		$6,423,656	N		
Exe	DD	PLC-25	C	PCO 25	Y	Y	CC	8	4-Jul-21	14-Jul-21	10	Approved	$17,362		$1,033,596				$1,050,958	N		
Exe	DD	PLC-26	3	SCO 26	N	Y	CC	12	13-Aug-21	22-Aug-21	9	Approved	$28,785		$1,713,592	$2,570,437	$9,994,107		$14,306,921	N		
Exe	DD	PLC-27	C	PCO 27	Y	Y	CC	7	31-Aug-21	23-Sep-21	23	Approved	$6,396		$380,798	$275,653	$2,516,468		$3,179,315	N		
Exe	DD	PLC-28	C	PCO 28	Y	Y	CC	1	18-Sep-21	23-Sep-21	5	Approved	$15,535		$924,796	$1,212,300	$5,568,566		$7,721,197	N		
Exe	DD	PLC-29	C	PCO 29	Y	Y	CC	10	10-Oct-21	22-Oct-21	12	Approved	$2,284		$135,999	$4,416	$953,024		$1,095,723	N		
Exe	DD	PLC-30	C	PCO 30	Y	Y	CC	7	25-Oct-21	10-Nov-21	16	Approved	$13,707		$815,998	$1,024,970	$4,958,146		$6,812,821	N		
Exe	CO	PLC-31	C	PCO 31	Y	Y	CC	1	19-Nov-21	7-Dec-21	18	Approved	$22,616		$1,346,394	$1,748,201	$8,123,942		$11,241,153	N		
Exe	DD	PLC-32	3	Substation	N	Y	CC	12	19-Dec-21	28-Dec-21	9	Approved	$34,953		$2,080,791	$3,012,673	$12,244,273		$17,372,690	Y	60	A19930-01
Exe	DD	PLC-33	C	PCO 33	Y	Y	CC	6	13-Jan-22	28-Jan-22	15	Approved	$17,134		$1,019,995	$1,186,213	$6,292,683		$8,516,025	N		
Exe	DD	PLC-34	C	PCO 34	Y	Y	CC	7	28-Jan-22	9-Feb-22	12	Approved	$39,750		$2,366,390				$2,406,140	N		
Exe	DD	PLC-35	C	PCO 35	Y	Y	CC	9	22-Feb-22	8-Mar-22	14	Approved	$16,448		$979,195		$6,063,776		$7,059,419	N		
Exe	DD	PLC-36	C	PCO 36	Y	Y	CC	7	4-Mar-22	16-Mar-22	12	Approved	$13,022		$775,197	$764,722	$4,919,239		$6,472,180	N		
Exe	DD	PLC-37	C	PCO 37	Y	Y	CC	1	29-Mar-22	3-Apr-22	5	Cancelled							$0	N		
Exe	DD	PLC-38	C	PCO 38	Y	Y	CC	1	20-Apr-22	9-May-22	19	Approved	$15,763		$938,397	$1,045,716	$5,834,868		$7,834,744	N		
Exe	DD	PLC-39	C	PCO 39	Y	Y	CC	7	8-May-22	9-May-22	1	Approved	$48,660		$2,896,787				$2,945,447	N		
Exe	DD	PLC-40	C	PCO 40	Y	Y	CC	6	18-May-22	26-May-22	8	Approved	$23,987		$1,427,993	$1,888,698	$8,581,756		$11,922,434	N		
Exe	DD	PLC-41	C	PCO 41	Y	Y	CC	6	2-Jun-22	14-Jun-22	12	Approved	$34,268		$2,589,992	$3,642,425	$15,068,366		$21,335,051	N		
Exe	DD	PLC-42	3	PCO 42	N	Y	CC	7	17-Jun-22	6-Jul-22	19	Approved	$28,785		$1,706,592	$2,180,437	$8,184,107		$12,099,921	N		
Exe	DD	PLC-43	3	PCO 43	N	Y	CC	9	7-Jul-22	12-Jul-22	5	Cancelled							$0	N		
Exe	CO	PLC-44	3	PCO 44	N	N	CC	10	25-Jul-22	13-Aug-22	19	Rejected							$0	N		
Exe	DD	PLC-45	3	PCO 45	N	Y	CC	2	24-Aug-22	1-Sep-22	8	Approved			$2,727	$169,696	$857,941		$1,030,364	Y	15	A28620-02
Exe	DD	PLC-46	3	PCO 46	N	Y	CC	9	14-Sep-22	24-Sep-22	10	Approved	$33,582		$152,240		$11,786,458		$11,972,280	N		
Exe	DD	PLC-47	3	PCO 47	N	Y	CC	1	29-Sep-22	2-Oct-22	3	Approved	$22,388		$201,493	$1,914,784	$7,857,639		$9,996,304	N		
Exe	DD	PLC-48	3	PCO 48	N	Y	CC	6	19-Oct-22	5-Nov-22	17	Cancelled							$0	N		
Exe	DD	PLC-49	3	PCO 49	N	Y	CC	12	5-Nov-22	7-Nov-22	2	Approved	$41,807		$212,193	$3,715,159	$14,533,346		$18,502,505	N		
Exe	DD	PLC-50	3	PCO 50	N	Y	CC	7	28-Nov-22	4-Dec-22	6	Approved	$63,737		$230,229	$5,963,111	$21,858,380		$28,115,457	N		
Exe	DD	PLC-51	3	PCO 51	N	Y	CC	10	13-Dec-22	23-Dec-22	10	Approved	$17,819		$189,279	$125,646	$6,521,590		$6,854,334	N		
Exe	CO	PLC-52	4	PCO 52	N	N	CC	8	1-Jan-23	18-Jan-23	17	Rejected							$0	N		
Exe	DD	PLC-53	4	Berm	N	N	CC	12	26-Jan-23	7-Feb-23	12	Approved	$0		$100,000	$400,000	$1,500,000		$2,000,000	N		
Exe	DD	PLC-54	4	PCO 54	N	Y	CC	9	20-Feb-23	23-Feb-23	3	Approved	$8,909		$40,093	$343,231	$3,545,795		$3,938,028	Y	10	A13450-07
Exe	DD	PLC-55	4	PCO 55	N	Y	CC	2	12-Mar-23	29-Mar-23	17	Approved			$6,476	$90,521	$5,377,054		$5,474,051	N		
													$1,842,999	$199,820,100	$91,595,067	$183,886,965	$814,078,094	$6,535,375	$1,297,758,600		265	