



Project  
Management  
Institute.  
Kingdom of Saudi  
Arabia

# [2024] Challenges and Solutions in Cost Estimation for Brownfield Projects

**Written By:** Hazim S. Alhazmi

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## ABSTRACT

This paper explores the challenges of cost estimation in brownfield upgrade projects, which are fraught with uncertainties due to environmental contamination, legacy infrastructure/equipment, and work permits complexities. These factors can lead to substantial budget overruns if not accurately anticipated. The paper examines the key difficulties in forecasting costs for these projects, including the unpredictable nature of site conditions and the need for extensive environmental remediation. Additionally, it reviews innovative tools and techniques—such as advanced risk assessment models, Building Information Modeling (BIM), and drone surveys—that can help improve estimation accuracy. By applying these modern strategies, project managers can better manage financial risk and achieve more predictable project outcomes.

## INTRODUCTION:

Redeveloping brownfield sites poses a unique set of challenges for project managers, particularly when it comes to estimating costs. Unlike greenfield projects, where development begins on undeveloped land, brownfield sites have a history of prior use, often bringing hidden complications such as contamination, aging equipment and infrastructure, and regulatory & permits hurdles. These factors make cost estimation difficult and prone to inaccuracies, which can lead to budget overruns and project delays. This paper aims to explore the key challenges faced in brownfield cost estimation and introduce some approaches, tools, and strategies that could help Project Managers achieve more accurate forecasts.



## BROWNFIELD CHALLENGES:

Cost estimation in brownfield projects is tough—there's no getting around it. These types of projects come with a lot more uncertainty compared to starting from scratch on undeveloped land (greenfield projects), and those uncertainties can impact the budget hardily. Here are some of the biggest challenges when estimating costs for brownfield projects:

### 1. UNPREDICTABLE SITE CONDITIONS

One of the trickiest parts of brownfield projects is that you never really know what you're going to uncover. These sites were previously used for other purposes, and that often means things like hidden contamination. You might find polluted soil or groundwater from past industrial use, and fixing that can be expensive. Also, sometimes you run into things like old underground storage tanks or utility lines no one knew were there or what is it for. All of this adds extra work and cost, and it's hard to anticipate.

### 2. ENVIRONMENTAL REMEDIATION

Cleaning up contamination is a big item on brownfield sites, that needs environmental assessments, and if the soil or groundwater is contaminated, project team has to consider cleaning and perform precautions to meet government standards. The cost of remediation can be high, especially if it's required specialized services, and sometimes it's hard to know how bad the contamination is until you start excavating. In addition to that regulations are strict, and it can take a long time to get approvals from environmental agencies, which adds even more to the cost of the project.



### 3. RISK OF THE UNKNOWN

No matter how much planning project team do, brownfield projects are full of unknowns. Even with thorough site assessments, surprises always arise once construction starts. Because of this uncertainty, project managers usually build a big contingency into the budget, sometimes as much as %30-20 of the project cost, just to be safe. This can make the project look more expensive from the start, which might frighten off stakeholders or sponsor.

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### 4. DEALING WITH EXISTING INFRASTRUCTURE

In some cases, brownfield sites have existing infrastructure—roads, buildings, or utility systems—that project team might be able to reuse. But more often than not, that infrastructure is outdated and doesn't meet recent standards, meaning project team will need to consider more budget to upgrades or completely replace it. Trying to integrate old systems with new development can also be an engineering headache, adding more cost to the project.



## 5. REGULATORY AND PERMITTING DELAYS

Working in live facilities such as plant, Refinery, or building, is a challenge as this means a longer permitting process and possibly having to deal with multiple stakeholders that each have their own timelines and requirements. All of this slows things down and increases costs as you wait for approvals and inspections.

## 6. PROJECT DELAYS

One of the biggest problems with brownfield projects is that they tend to drag on longer than expected. Remediation can take more time than planned, especially if new issues come up as you go. Also, waiting for permits or dealing with unexpected site conditions slows everything down. As the project stretches out, labor costs increase, and you might face consequences for missing project milestones.

## 7. COST ESCALATION

Costs tend to pile up quickly on brownfield projects. Even if project team got a tight budget, unexpected issues can push it over. For example, you might discover mid-project that a lot more remediation is needed, or that the existing facility requires more upgrading than they have planned for. Scope creep is real—what starts as a simple project can turn into something much more complex and costlier.

Tools & Solutions to Enhance Developing Cost Estimate for Brownfield Projects:



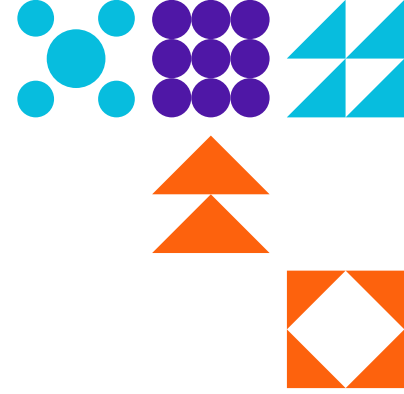
When developing the most accurate cost estimate for a brownfield project, it is critical to consider a wide range of factors due to the inherent uncertainties and complexities of upgrade existing facility, redeveloping previously used or contaminated land. Here are the key things to consider to enhance accuracy in project team estimate:

### **WELL-DEFINE SCOPE OF WORK:**

In Brownfield projects the scope of work has to be well define and maybe has more details than greenfield projects, addressing the constrains and interfaces with the existing facility. Developing the scope shall be focused on achieving the project objective as per the business case. However, due to the nature of the work in brownfield, many scope items could be requested by stakeholders to upgrade the existing facility, so the project team has to evaluate the scope based on the project objectives and business case document, to avoid scope creep which has more chances in this type of projects. Also, one of the important items is to seek all stakeholders review to the project scope and secure their alignment and agreement on the assumptions and exclusions at early stage during the Front-End Engineering Design phase. Project Team target shall be to have minimum scope change during the execution.

### **COMPREHENSIVE SITE ASSESSMENT:**

Accurate estimates start with a thorough understanding of the site. This includes environmental, structural, and geotechnical evaluations to uncover any hidden risks, such as contamination, unstable soil, or buried infrastructure. Without this information, project team could face costly surprises during execution. Also, It is recommended that project team with an expert estimator are visiting the sites frequently to feel and observes any factors needs to be considered in the cost estimate.



One of the biggest challenges in brownfield projects is dealing with environmental contamination. Site surveys, especially those that involve environmental assessments, are crucial in detecting contaminants such as heavy metals, asbestos, or chemical residues. Early identification of these risks allows for more accurate cost estimates and remediation plans. In addition to Identify any potential permits or approvals needed from environmental agencies with its associated costs.

Many brownfield sites contain outdated or abandoned utilities that may still be underground. A comprehensive survey and exploratory excavation help map these elements, so the project team knows where existing pipes, cables, and other infrastructure are located. This prevents damage during construction and allows for proper integration of new infrastructure with the old.

**Topography and Site Layout:** Understanding the site's physical layout is crucial for planning construction activities. Site surveys provide data on the topography, which influences how materials are stored, how vehicles move around the site, and the overall design of new structures.

## **VENDORS DATA:**

It is crucial in brownfield projects to collect the existing systems and equipment data and condition, to approach the vendors and confirm its integration and compatibility with the new systems under the project scope. A site survey combined with detailed vendor information (equipment data) helps project team decide whether equipment shall be repaired, replaced, or decommissioned. This avoids unexpected failures or additional costs once the project is underway. The existing equipment data is essential for designing new systems that will integrate with old infrastructure. Whether it's connecting to existing water lines, electrical grids, control or mechanical systems, knowing the exact specifications of the equipment ensures a seamless transition and reduces project complexity. Accurate equipment data helps project team factor in the costs of maintaining, upgrading, or decommissioning old equipment. It also influences the project timeline, especially if certain equipment needs to be removed or replaced before construction can proceed.





## **RISK ASSESSMENT AND CONTINGENCY PLANNING**

Brownfield projects are highly susceptible to unknown risks, so a robust risk management plan is crucial to avoid budget overruns. Use Risk-Based cost models to account for varying degrees of uncertainty and risk. This can help provide a range of cost outcomes rather than a single estimate. Build contingency allowances into the budget to cover unforeseen issues such as additional remediation, hidden infrastructure, or new standards requirements. Typical contingencies for brownfield projects range from %15 to %30, depending on the complexity and risks involved. Also, project team may consider phasing the project to reduce the risk of cost overruns by addressing high-risk areas first, then adjusting the budget as more is known.

## **INCORPORATING TECHNOLOGICAL TOOLS**

The use of modern technology can greatly improve cost estimation accuracy by providing more precise data on site conditions and project variables.

**Building Information Modeling (BIM):** Use BIM to create a digital representation of the project, allowing for more precise integration of existing infrastructure and environmental factors.

**Drone Surveys and LiDAR Scanning:** Incorporate the cost of high-tech surveys, such as drones and LiDAR, to get accurate measurements of the site's topography, contamination levels, and infrastructure conditions.

**Data Analytics and AI:** Utilize AI and data analytics tools to review historical data from similar brownfield projects and predict cost factors more accurately.



## **ACCURATE HISTORICAL DATA AND RECORDS**

Historical records can provide insight into the site's previous use, the likelihood of contamination, and the condition of existing infrastructure and equipment. However, incomplete or inaccurate records can lead to cost estimation errors. Project Team shall consider investigate past uses of the site to anticipate potential contaminants and remediation needs in addition to collect the inspection and maintenance records for the equipment before considering any upgrade in scope. This may require detailed reviews of historical maps, aerial photos, and previous environmental reports. If there's existing infrastructure on the site, factor in the costs for its assessment, potential upgrades, or demolition shall be consider.

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## **INFLATION AND MARKET FLUCTUATIONS**

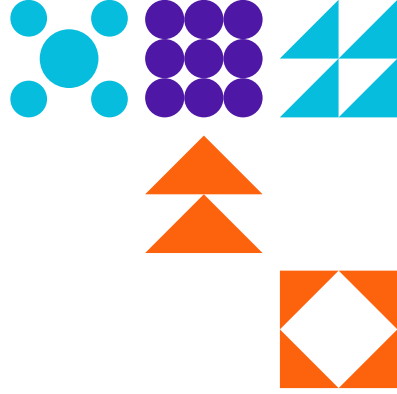
Brownfield projects often have longer timelines than greenfield projects, making them more susceptible to inflation and changes in material and labor costs. Given the longer duration, it is important to account for inflation and fluctuating material prices. Use up-to-date market rates, and consider locking in prices with suppliers when possible. Longer project durations might also mean higher financing costs. Be sure to account for interest rates and potential changes in the cost of capital over the life of the project.

## **PHASING AND SCHEDULING**

A phased approach allows for more flexible cost management as issues are discovered and dealt with over time, rather than all upfront. As you move from one phase to the next, continuously adjust the cost estimate based on new information (e.g., contamination levels, site conditions). Build flexibility into the project schedule to accommodate delays from remediation work, regulatory approvals, or changes in site conditions. Include these factors in both the time and cost estimates.

## **CONCLUSION**

To develop the most accurate cost estimate for a brownfield project, it's essential to thoroughly assess the site, account for risks and lessons learned, use advanced tools and technologies, and stay flexible as new information emerges. Incorporating detailed environmental data, understanding regulatory requirements, and considering market conditions will help you produce more reliable estimates, minimize unexpected costs, and manage the inherent uncertainty of brownfield redevelopment. Ultimately, a cautious and well-planned approach is key to avoiding budget overruns and ensuring the success of the project



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