



Author: Ángel Antonio Olivieri Olmeda  
 Advisor: Dr. Christian Villalta Calderón, Ph.D.

Civil Engineering, Environmental Engineering & Surveying Department

## Abstract

On January 7, 2020 occurred a magnitude 6.4 Mw earthquake with epicenter 12.7 km south of Guayanilla. This strong tremor with a depth of 7 km, had a maximum intensity of VIII in Guánica and caused considerable damage throughout Puerto Rico. Since then this area has remained active, registering over 16,000 tremors until August 2021. Among the damages caused by said telluric movements is a landslide due to a fault in the slope where the Monte Pelao Tank is, in the community of Alturas de Belgica. in Guanica. This project has the objective of establishing a cost estimate for the demolition works of the existing tank and the construction of a new tank and pumping station for the supply of drinking water to the families of the mentioned sector.

## Introduction

On January 7, 2020, a strong earthquake was registered in the south of Puerto Rico that shook the entire Island. The earthquake with a magnitude of 6.4 Mw had an epicenter south of Guayanilla and is considered to be the strongest telluric movement since the historic earthquake of San Fermín in 1918. Among the municipalities most affected by the tremors is Guánica. The Monte Pealo pumping station is located in this municipality. These facilities consisted of two tanks of 30K and 50K gallons each, respectively. The 2019-2020 seismic events caused a landslide near the tank site, which in turn compromised the stability of the nearby hillside, so the 30,000-gallon elevated tank was demolished as a safety measure. This project aims to generate a construction cost estimate for the demolition of the remaining tank and construction of a new tanks and pump station.

## Background

Preparing an accurate construction estimate is a crucial part of the success of a project. Preparing such an estimate requires a great deal of skill and knowledge. The estimator must be detailed, structured. You must have the ability to read plans, knowledge in construction and nowadays it is of vital importance to have knowledge in the management of associated computer programs for the management of plans and documentation.

## Problem



The main objective of this project is to determine the construction cost for the Monte Pealo Tank Relocation project in Guanica. This project is part of the PRASA Capital Improvements Program and is part of the reconstruction projects after the January 2020 earthquake.

## Methodology

**Prepare to estimate:** this stage of the life cycle is the creation of the estimation approach. In this stage the activities of the project are identified, better tools and techniques to be used for estimating are determined, estimating team is identified, preparing estimating inputs, and documenting any constraints and assumptions to the estimate (e.g. funding limits, resource constraints, or required dates.)

**Create estimates:** In this stage, estimating effort, activity resources, activity durations, and costs are performed.

**Manage estimate:** once the original estimate has been completed, validated, and baselined with the project team members and the project work has started, this stage of project estimating includes many activities that are used to manage the estimate, including change controls, calibrating the forecast, and comparing actuals to the baseline estimate.

Once the project documents have been studied and the available data verified, the list of activities is established, which will serve as an outline to prepare the project cost estimate. We call this list "Work breakdown structure". The WBS for this project has been organized following the divisions established by the CSI Masterformat (1995 Edition), as shown on Table 3. The MasterFormat is a standard utilized by the architecture, engineering, and construction (AEC) industry for organizing and communicating specifications and work results for construction projects.

Monte Pelao Tank Relocation Project - WBS	
<b>01 - GENERAL REQUIREMENTS</b>	
Supervision (Project manager, project engineer, foreman, safety officer)	
Required permits (Incidental Single Permit, SWPPP, etc)	
Construction facilities	
Mobilization to the project area, applies to both sites	
Preparation of staging area, applies to both work sites	
Demobilization	
<b>02 - SITEWORKS</b>	
Implementation of CEST plan, applies to both work sites - Truck entrance	
Implementation of CEST plan, applies to both work sites - Inlet protection installation to avoid sedimentation	
Implementation of CEST plan, applies to both work sites - silt fence	
Demolition of existing tank, pump station & related infrastructure	
Removal of pumping and metering equipment to be salvaged and delivered to AAA	
Removal of electrical equipment to be salvaged and delivered to AAA	
Debris removal and disposal	
Backfill void left per tank (A-2-4)	
Actividades de movimiento de tierra para preparar área donde se construirá el tanque	
Earthwork new tank site - Cut to waste	
Earthwork new tank site - Fill	
Soil stabilization	
Chainlink fence & gates	
<b>03 - CONCRETE WORKS</b>	
New concrete tank construction (foundation, walls, columns, roof slab)	
Concrete pad for electrical & mechanical equipment	
Sidewalks, curbs & retention wall.	
<b>05 - METALS</b>	
Vertical ladder	
<b>07 - THERMAL &amp; MOISTURE PROTECTION</b>	
Damproofing	
Roof hatch	
<b>09 - FINISHES</b>	
Paint	
<b>15 - MECHANICAL WORKS</b>	
Installation of pumping equipment	
Pipe connection to the existing system	
<b>16 - ELECTRICAL WORKS</b>	
Electric generator installation	
Metering equipment	
Electric connections	

## Results and Discussion

BID FORM					
Item No.	Work Description	Qty	Unit	Unit Cost	TOTAL
1	Insurances	1	lump sum	\$ 27,451.60	\$ 27,451.60
2	Patents	1	lump sum	\$ 4,875.00	\$ 4,875.00
3	Taxes	1	lump sum	\$ 13,650.17	\$ 13,650.17
4	Payment & Performance Bond	1	lump sum	\$ 13,400.00	\$ 13,400.00
5	Contingency	1	lump sum	\$ 36,968.07	\$ 36,968.07
6	Contractor's fees & overhead	1	lump sum	\$ 166,356.32	\$ 166,356.32
TOTAL =					\$ 262,701.17
<b>LUMP SUM TOTAL=</b>					<b>\$ 262,701.17</b>
BREAKDOWN (Sixteen divisions [15] listed in the CSI Master					TOTAL
Division 01	General Requirements	1	lump sum	\$ 209,976.25	\$ 209,976.25
Division 02	Site Construction	1	lump sum	\$ 42,942.32	\$ 42,942.32
Division 03	Concrete	1	lump sum	\$ 145,375.06	\$ 145,375.06
Division 04	Masonry	1	lump sum	\$ -	\$ -
Division 05	Metals	1	lump sum	\$ 7,427.70	\$ 7,427.70
Division 06	Wood and Plastics	1	lump sum	\$ -	\$ -
Division 07	Thermal and Moisture Protection	1	lump sum	\$ 5,836.10	\$ 5,836.10
Division 08	Doors and Windows	1	lump sum	\$ -	\$ -
Division 09	Finishes	1	lump sum	\$ -	\$ -
Division 10	Specialties	1	lump sum	\$ -	\$ -
Division 11	Equipment	1	lump sum	\$ -	\$ -
Division 12	Furnishings	1	lump sum	\$ -	\$ -
Division 13	Special Construction	1	lump sum	\$ -	\$ -
Division 14	Conveying Systems	1	lump sum	\$ -	\$ -
Division 15	Mechanical	1	lump sum	\$ 190,204.00	\$ 190,204.00
Division 16	Electrical	1	lump sum	\$ 137,600.00	\$ 137,600.00
TOTAL					\$ 739,361.43
<b>TOTAL=</b>					<b>\$1,002,062.60</b>

The results of this work are shown in Table 4. The table summarizes the costs of the estimate made for the demolition of the existing tank and the construction of a new tank with all the infrastructure and its auxiliary equipment. The estimated cost for this project, based on the drawings (deliverable of 90%) and the information available at the time, is (\$1,002,062.60).

In addition to the administrative costs (contractor's fee, insurances, payment and performance bond and municipal patents) given that the plans are not completed and there is project information that was not available at the time of preparing the estimate (technical specifications, soil survey report, etc.), a contingency equivalent to five percent (5%) of the total direct costs of the project was assumed.

The estimated construction cost is above Engineer's estimate by (\$184,735.60), which represents (22.6%) difference. This difference in cost could be due to several factors such as the values assumed for the Contractor's fees, overhead and insurance items; to the costs of the general conditions considered to complete the works. In addition, it must be taken into account that the construction materials industry is a volatile one and that costs can vary considerably depending on various factors such as supply and demand or the cost of raw materials. At the moment the construction industry, like other industries, is affected by shipping problems, this has had an effect on the availability, delivery time and therefore on the cost of materials. Similarly, the effects of the pandemic caused by COVID-19 have had adverse effects on the industry. More recently, the rise in fuel costs has caused a considerable increase in all items.

## Conclusions

In summary, throughout this work, the author tried to explain what a cost estimate consists of, the steps to follow, and the importance of the available information when establishing the budget for a project. Using this as a basis, the cost estimate for the Relocation project of the Monte Pelao Tank in Guánica was generated. The estimated cost for this project, based on the information available and the assumptions made, is \$1,002,062.60. This represents 22.6% over engineer's budget stated in the Pre-construction summary report generated by the management office for this project.

As discussed in the results section, this variation may depend on multiple factors such as contractor's fees, performance period, insurance and general conditions. On the other hand, situations such as freight problems, availability of raw material, Covid-19 pandemic and now the rise in fuel prices, maintain instability in the market, which in turn results in considerable increases in the cost of the projects.

## Future Work

The Monte Pealo Relocation project will be put up for bid in the coming months. Once the results of the bid are published, the award costs can be compared against the cost established in the article.

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