

Memorandum



Date: 6/3/2022
To: City and County of Broomfield
From: Burns & McDonnell
Subject: Tank Selection Analysis

As part of the design for the Broomfield Tanks project Burns & McDonnell (BMcD), in conjunction with the City and County of Broomfield (City) project manager and operations manager performed a paired comparison analysis of the different methods for building the tanks. The purpose of the analysis is to assist the City in making an informed decision on the best tank type to install.

Step 1 in the process is to define the criteria that will impact the success of the project. A description of each category is developed to help compare the criteria against each other. The criteria are listed in Table 1.

In Step 2, each of the criteria is compared against the other criteria in terms of importance to the City. First, the more important criteria is determined based on the descriptions of each criteria. Once the more important criteria is decided, the level of importance over the other criteria is assigned a value from 1 to 3 with the higher number equaling a greater importance. The weighted matrix results are presented in Table 2.

Step 3 of the process brings in the different design options for the project. Each of the design options is then scored for each of the defined criteria. The scores for each design option are presented in Table 3. For this project, three design options are considered for building the tanks:

- Fully burying the tanks below grade.
- Partially burying the tanks leaving just the domed roof exposed.
- Building the tanks entirely above grade

Step 4 of the process combines the weighted score for each criteria with the scores for each design option and sums up the total to develop a score for the design option. The highest value for this step returns the most desirable option, independent of cost. The results of the analysis are presented in Table 4.

The last step, Step 5, in the process incorporates Cost into the analysis. Cost opinions were developed for each design option. The total cost of each option is divided by the weighted score for that option to determine the cost/weighted score ratio. A lower cost/weighted score number indicates the most favorable outcome for the project. The results are presented in Table 5.

Based this analysis, the most favorable outcome for the project when considering cost would be to build the tanks entirely above ground. When cost is not considered the most desirable outcome for the project would be to bury the tanks, however, the cost for this option may be not be feasible.

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Table 1: Comparison Criteria

DEFINE CRITERIA	
CRITERIA	DESCRIPTION
Constructability	Risk during construction, the level of difficulty to install the project, ease of access to the site, and available space during construction. Size of excavation for different tank types
Short-Term Community Impacts	General disturbance to nearby open space and residences associated with the project during construction; availability of laydown and storage areas; issues with noise, dust and litter; impacts to local businesses and communities; and safety risks.
Long-Term Community Impacts	Unsightliness of above ground tank and appurtenances (vaults, marker posts, etc.) vs buried tank. Disturbances to open space and residences due to regular O&M of the Tank. Light pollution of site to surrounding neighbors. Limited public access to viewpoint
Ease of Maintenance	The effort required to locate and repair leaks on the Tank or make repairs to tank appurtenances.
Ease of Access and Operations	Access to the tank via side access manways and stairs inside the tank vs top access ladders only

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Table 2: Criteria Comparison

CRITERIA WEIGHTED MATRIX							
ITEM	CRITERIA	RELATIVE IMPORTANCE					SCORE
A	Constructability	A	B 2	C 2	D 3	E 3	0
B	Short-Term Community Impacts		B	C 1	D 2	E 2	2
C	Long-Term Community Impacts			C	D 1	E 2	3
D	Ease of Maintenance				D	E 1	6
E	Ease of Access and Operations					E	8
For each pair:							19
1. Select the more important criteria (A,B,C,D,E)							
2. Choose relative importance to you between 1-3 (3 = most important)							

Table 3: Design Option Scoring

SCORE OPTIONS						
Option	Constructability	Short-Term Community Impacts	Long-Term Community Impacts	Ease of Maintenance	Ease of Access and Operations	Total
Fully Buried Tanks - D110	1	2	5	4	3	15
Partially Buried Tanks - Exposed Dome - D110	2	2	4	3	2	13
Above Grade Tanks - D110	5	3	2	2	4	16
Score each option for each criteria between 1-5 (1 means the option performs poorly for the criteria, 5 means the option performs highly for the criteria).						

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Table 4: Weighting the Design Option

WEIGHT SCORED OPTIONS						
Option	Constructability	Short-Term Community Impacts	Long-Term Community Impacts	Ease of Maintenance	Ease of Access and Operations	Total
Fully Buried Tanks - D110	0	4	15	24	24	67
Partially Buried Tanks - Exposed Dome - D110	0	4	12	18	16	50
Above Grade Tanks - D110	0	6	6	12	32	56
Table auto populates based on weight of criteria and scored options.						
High Score						Fully Buried Tanks - D110

Table 5: Cost to Benefit Comparison

Comparison of EOPCC and Weighted Score			
Option	EOPCC	Weighted Score	Cost/Weighted Score
Above Grade Tanks - D110	\$12,610,000	56	\$225,000
Partially Buried Tanks - Exposed Dome - D110	\$15,870,000	50	\$317,000
Fully Buried Tanks - D110	\$23,160,000	67	\$346,000
Low Score			Above Grade Tanks - D110

1. Costs are comparing only AWWA D110 Tanks.
2. Costs include installation of the three tanks, tank appurtenances and piping inside the tanks and are not representative of the overall project costs. Costs are shown in 2023 dollars.
3. EOPCC: Engineers Opinion of Probable Construction Costs