

# Uniform Costing Model User Guide

VERSION 3.0

Prepared for

Texas Water Development Board

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Prepared by



The Uniform Costing Model (UCM) for Regional Water Planning is not intended to be used in lieu of professional engineering design or cost estimation procedures for water supply facilities. Results of all applications of the UCM, including those for technical evaluation of water management strategies in the regional water planning process, should be carefully reviewed by professional engineers and other knowledgeable professionals prior to use and publication. This tool was developed for the purpose of preparing regional water planning level cost estimates only. Any use of the UCM and results obtained therefrom will be at the User's sole risk and without liability or legal exposure to the Texas Water Development Board, HDR Engineering, Inc., Freese and Nichols, Inc., CAS Consulting & Services, Inc., and/or Intera Inc.

## Table of Contents

<b>Executive Summary</b> .....	<b>v</b>
<b>Introduction and General Overview</b> .....	<b>1</b>
<b>1.0 Quick Reference Guide</b> .....	<b>2</b>
<b>2.0 Project Information and Assumptions</b> .....	<b>3</b>
2.1 Basic Information .....	3
2.2 TWDB General Guidelines .....	6
2.3 Pumps and Crossings .....	7
<b>3.0 Simplified Hydraulics Calculations</b> .....	<b>8</b>
3.1 Hydraulics Assumptions .....	8
<b>4.0 Advanced Hydraulics Calculations</b> .....	<b>9</b>
4.1 Hydraulics Assumptions .....	10
4.2 Water Delivery Locations .....	11
4.3 Pipeline Route Selection and Profile .....	11
4.3.1 Route Selection and Profile Generation Guidelines .....	12
4.4 Pipeline Hydraulics Calculations .....	13
4.4.1 Pipe Size, Velocity, and Head Loss .....	13
4.4.2 Pipe Pressure .....	15
4.4.3 Pump and Booster Station Locations and Total Dynamic Head .....	15
4.4.4 Pump Station Horsepower (size) and Power Requirements .....	16
<b>5.0 Well Fields</b> .....	<b>17</b>
<b>6.0 Dam Embankment Estimates</b> .....	<b>18</b>
<b>7.0 Land Acquisition</b> .....	<b>19</b>
<b>8.0 Cost Estimating Form</b> .....	<b>20</b>
8.1 Construction Costs .....	22
8.1.1 Pumping Stations .....	22
8.1.2 Pipelines .....	23
8.1.3 Water Treatment Plants .....	24
8.1.4 Advanced Water Treatment Facilities .....	25
8.1.5 Reservoirs, Off-Channel Reservoirs, and Terminal Storage .....	26
8.1.6 Stilling Basins .....	27
8.1.7 Storage Tanks .....	27
8.1.8 Well Fields .....	27
8.1.9 Conservation .....	28
8.1.10 Relocations .....	28
8.1.11 Integration .....	28
8.1.12 Other Capital Cost Items .....	29
8.2 Associated Project Costs .....	29
8.2.1 Engineering, Legal, Financing, and Contingencies .....	29
8.2.2 Land Acquisition .....	29
8.2.3 Surveying .....	30
8.2.4 Environmental and Archaeology Studies, Permitting, and Mitigation .....	30

8.2.5	Interest during Construction.....	31
8.3	Annual Costs .....	32
8.3.1	Debt Service.....	32
8.3.2	Operation and Maintenance.....	32
8.3.3	Pumping Energy Costs .....	32
8.3.4	Purchase of Water .....	32
<b>9.0</b>	<b>Cost Summary .....</b>	<b>32</b>
<b>10.0</b>	<b>Advanced Water Conservation .....</b>	<b>34</b>
10.1	Simplified Approach.....	36
10.2	Detailed Approach .....	36
10.2.1	Savings Rate.....	37
10.2.2	Implementation Rate/Effectiveness .....	37
10.2.3	Program Costs .....	37
<b>11.0</b>	<b>Drought Management Risk Factor and Cost .....</b>	<b>38</b>
11.1	Simplified Approach.....	38
11.2	Detailed Approach .....	38
<b>12.0</b>	<b>Project Phasing.....</b>	<b>40</b>
<b>13.0</b>	<b>References .....</b>	<b>41</b>

## List of Figures

Figure 1.	UCM formatting key.....	2
Figure 2.	Quick Reference Flow Chart .....	2
Figure 3.	Project Information and Assumptions module.....	5
Figure 4.	Simplified Hydraulics module .....	8
Figure 5.	Advanced Hydraulics module .....	10
Figure 6.	Deliveries table in Advanced Hydraulics module .....	11
Figure 7.	Pipeline Profile Data example .....	12
Figure 8.	Advanced Hydraulic Pipeline HGL chart.....	14
Figure 9.	Example well field layout .....	17
Figure 10.	Well Field module .....	18
Figure 11.	Dam Embankment module .....	19
Figure 12.	Land Acquisition module .....	20
Figure 13.	Costing Summary module .....	33
Figure 14.	Water Conservation module.....	35
Figure 15.	Advanced Drought Management Risk Factors module .....	39
Figure 16.	Advanced Drought Management Cost module .....	40

## List of Tables

Table 1. Selections for project layout in UCM .....	6
Table 2. TWDB general guidelines for 2026 regional water plans .....	7
Table 3. Major project cost categories .....	22
Table 4. Water treatment level descriptions .....	24
Table 5. AWTF processes and purposes (adapted from TWDB DPR Resource Document, Table 5-1) .....	25
Table 6. Suggested land area for various facilities.....	30

## Appendices

Appendix A – UCM Change Log	
Appendix B – Pipeline Route and Profile Generation Procedures	
Appendix C – Unit Cost Table Development Technical Memorandum	
Appendix D – Drought Management Methodology	
Appendix E – Scope of Work and Response to TWDB Comments	

## Acronyms

acft/yr	acre-feet per year
AOP	advanced oxidation processes
ASR	aquifer storage and recovery
AWTF	advanced water treatment facilities
BAC	biological activated carbon
CCI	Construction Cost Index
cfs	cubic feet per second
DPR	direct potable reuse
fps	feet per second
gpcd	gallons per capita per day
HGL	hydraulic grade line
HSPS	high service pump station
IDC	interest during construction
IMPLAN	Impact Analysis for Planning
kWh or KW-HR	kilowatt-hour
MBR	membrane bioreactors
mgd	million gallons per day
MF	microfiltration
MWCPT	Municipal Water Conservation Planning Tool
O&M	operations and maintenance
PPI	Producer Price Index
psi	pounds per square inch
RO	reverse osmosis
ROW	right-of-way
SI	International System
TAC	Texas Administrative Code
TDH	total dynamic head
TWDB	Texas Water Development Board
UCM	Uniform Costing Model
UF	ultrafiltration
UV	ultraviolet
WMS	water management strategy
WUG	water user group
WTP	water treatment plant
WWP	Wholesale Water Provider
WWTP	wastewater treatment plant

# Executive Summary

Regional water planning requires the evaluation and comparison of water management strategies (WMSs), including estimating costs to construct the required infrastructure. Additionally, cost estimating procedures are needed for non-infrastructure related water supply projects, such as conservation and drought management.

The Texas Water Development Board (TWDB) compiles cost estimates from all 16 planning regions and uses the information to develop the State Water Plan. Without a standardized costing method (including cost curves for infrastructure elements and assumptions), cost estimates would vary across the state, region by region. The Uniform Costing Model (UCM), developed for the 2016 Regional Plans (Version 1.0), brought a level of consistency between cost estimates developed for the 16 regional water planning groups and their consultants. The UCM was revised for the 2021 Regional Plans (Version 2.0) to update cost data and enhance functionality. The UCM was revised again for the 2026 Regional Plans (Version 3.0) with a focus on updating cost data to reflect recent market volatility and inflation, and to further enhance functionality.

The UCM, along with this user guide, is intended to assist regional water planning groups and their consultants in developing consistent cost estimates across the State of Texas to provide consistency among the 16 regional plans and subsequent State Water Plan. This consistency allows for each WMS to be evaluated on an even playing field with respect to cost estimates. The UCM is designed to be user friendly and relatively intuitive, with individual component modules, some of which are optional, that automatically feed information to a line item costing form when possible. The UCM has been updated with new features to further streamline the process and maintain data integrity. Within the model, there are 11 costing modules along with supporting data. The following modules are included.

1. Quick Reference Guide
2. Project Information and Assumptions
3. Simplified Hydraulics
4. Advanced Hydraulics
5. Well Field
6. Embankment Calculations
7. Land Acquisition
8. Costing Form
9. Cost Summary
10. Conservation
11. Drought Management

The modules, described in this guide, assist the user in developing cost estimates for the most common types of WMSs in regional water planning. Certainly, there are projects or components of projects with unique characteristics beyond the scope of what these modules are designed to evaluate, and in such cases, the user should perform an external cost estimate that may be incorporated into the UCM, where applicable. Using these procedures and methods will provide reliable and consistent preliminary configurations and cost estimates; however, results should always be reviewed and refined with application of professional judgment and experience.

# Introduction and General Overview

A large volume of regional planning work consists of studying alternatives for delivering water from new water sources to demand locations and evaluating ways to optimize management of existing water supplies. Investigating these types of scenarios typically includes performing a preliminary engineering analysis of needed facilities and estimating costs to construct the required infrastructure. Other tasks may involve updating construction cost estimates of alternatives that have previously been examined. Additionally, cost estimating procedures are needed for non-infrastructure related water supply projects, such as conservation and drought management.

The Texas Water Development Board (TWDB) compiles cost estimates from all 16 planning regions and uses the information to develop the State Water Plan. Prior to developing a standardized costing method (including cost curves for infrastructure elements and assumptions), cost estimates varied across the state, region by region. With the development of the Uniform Costing Model (UCM), the TWDB is able to gain a level of consistency between cost estimates developed for the 16 regional water planning groups and their consultants. This, in turn, assures that cost estimates in the State Water Plan are consistent and on equal footing. The UCM allows users to size and estimate costs for water infrastructure facilities (pump stations, water treatment plants, and transmission pipelines) to meet future water needs. It contains tools for modeling hydraulics, pumping energy and costs, and sizing a well field.

The purpose of this user guide is to present Version 3.0 of the UCM for the 2026 Regional Water Plans, which is to be used for planning-level cost estimates. Using these procedures and methods will provide reliable and consistent preliminary configurations and cost estimates; however, results should always be reviewed and refined with application of professional judgment and experience. The UCM provides overrides to cost estimates if more detailed cost estimates are available from engineering studies. Additionally, unique situations and facilities not addressed in the procedures should be evaluated on an individual basis.

The UCM contains a series of modules to aid the user in developing a cost estimate for a water management strategy (WMS) under consideration in regional water plan development. Those modules, discussed in the following sections, include the following:

1. Quick Reference Guide
2. Project Information and Assumptions
3. Simplified Hydraulics
4. Advanced Hydraulics
5. Well Field
6. Embankment Calculations
7. Land Acquisition
8. Costing Form
9. Cost Summary
10. Conservation
11. Drought Management

Each module has been designed to accommodate the most common types of WMSs in regional water planning. Certainly, there are projects or components of projects with unique characteristics



beyond the scope of what these modules are designed to evaluate, and in such cases the user should perform an external cost estimate that may be incorporated into the UCM, where applicable.

Cells requiring user input throughout the UCM are white in color with a blue-colored font, while default values are light green in color with blue-colored font. Default values are editable, and up to the user's discretion. A key is found on the Project Info & Assumptions Module (Figure 1).

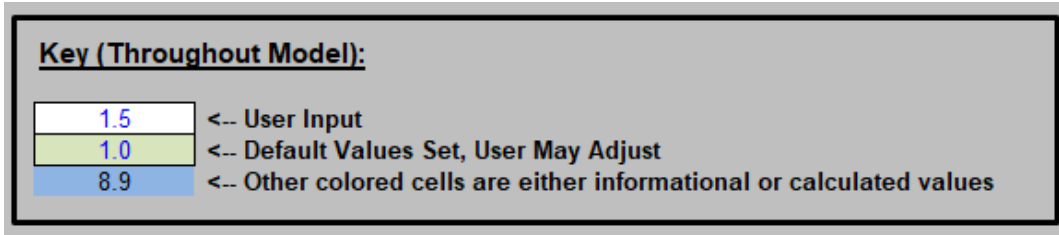


Figure 1. UCM formatting key

## 1.0 Quick Reference Guide

The Quick Reference Guide module (“Quick Reference Guide” tab) of the UCM shows a flow chart to walk the user through the tool (see Figure 2).

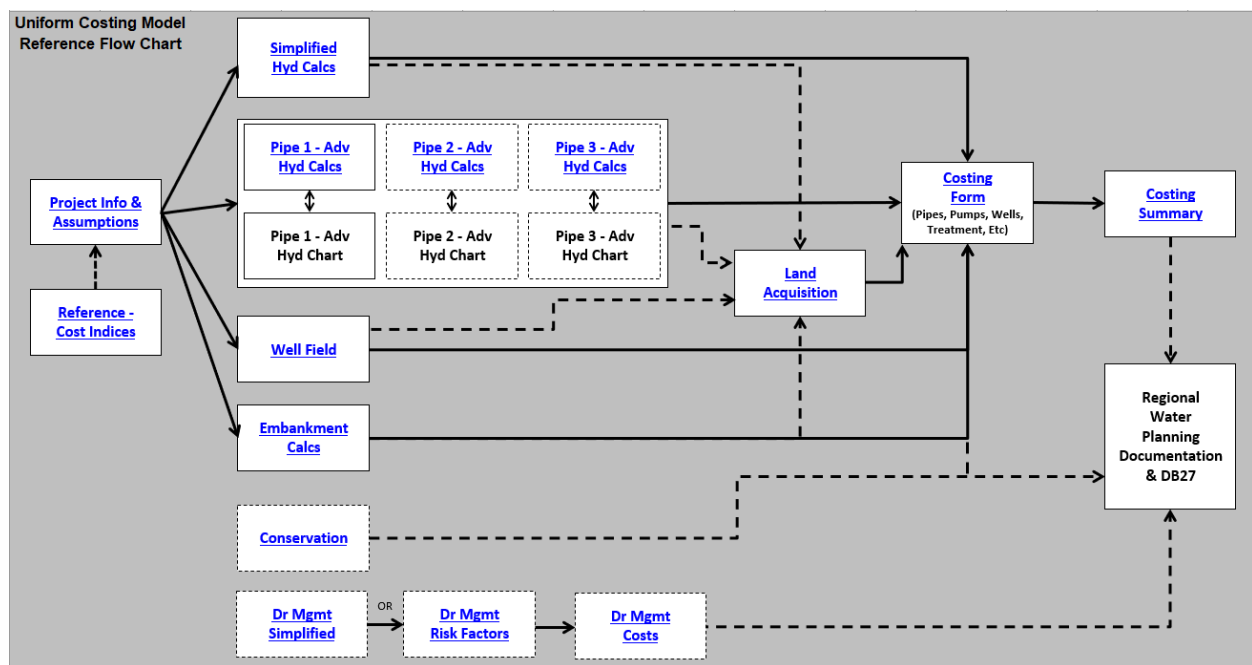


Figure 2. Quick Reference Flow Chart

For a typical WMS that requires the construction of infrastructure, the user begins with the Project Info and Assumptions to enter details about the project. Next, the user enters data regarding the transmission of water via pipelines in one or more of the hydraulic calculations modules. If the project includes a well field or a dam, there are optional modules to assist the user in defining and costing these components. The user then enters information regarding land acquisition. The main hub of the UCM is the costing form, where data from all infrastructure-related components are either

accumulated automatically or defined. This is where the cost estimate is pulled together line-item by line-item. Finally, the user can view a summary of the cost estimate in the Costing Summary, which has been designed to be easily copied and pasted into the Regional Water Plan report.

For non-infrastructure based WMSs, the UCM contains modules to assist the user in determining potential water savings and costs. The UCM includes one module for water conservation. A simplified approach for Drought Management has been added to complement the existing Drought management modules. Discussion of drought management is included in Section 11.0.

Significant updates from the 2018 version (Version 2.0) of the UCM are documented in the Change Log and include the following.

1. Correction of minor programming bugs identified by TWDB and the consulting team.
2. Update of cost curves for water supply infrastructure where appropriate.
3. Update of categories and unit costs of conservation measures in the conservation module.
4. Revision of the costing summary to align with the form TWDB-1201<sup>1</sup> for financial assistance.
5. Enhancements to quality control capabilities.
6. Addition of an option for the user to include backup generator costs.

A full list is included in the UCM and a copy is located in Appendix A.

## 2.0 Project Information and Assumptions

### 2.1 Basic Information

The Project Information and Assumptions module (“Project Info & Assumptions” tab) (Figure 3) of the UCM is where basic project data and the general assumptions used throughout the costing model are entered. There are three sections in the Project Information and Assumptions module.

The first portion (Basic Info) allows the user to enter the following items:

- name of the project
- the Water User Group (WUG) or Wholesale Water Provider (WWP) associated with the project,
- the name of the persons performing and checking the cost estimate, and the date the cost estimation is created, the month and year that will be the cost basis for the WMS for the ENR Construction Cost Index Time Period and the Producer Price Index Time Period. The Producer Price Index<sup>2</sup> (PPI - used for pipelines) and the Engineering News Record

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<sup>1</sup> <http://www.twdb.texas.gov/financial/instructions/doc/TWDB-1201.xlsx>

<sup>2</sup> PPI values can be found at <https://download.bls.gov/pub/time.series/pc/pc.data.18.FabricatedMetalProduct>

Construction Cost Index<sup>3</sup> (CCI - used for all other facilities) values are used to establish the time basis for which the cost estimate is to be made. Historical cost indices are included in the UCM on the “Reference - Cost Indices” tab. Base cost data in the UCM are set to September 2023 dollars per the TWDB guidance for regional water planning for the 2026 Regional Water Plans, and

- the project supply in acre-feet per year (acft/yr). The associated peaking factor for upsizing of facilities is addressed within each module.

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<sup>3</sup> ENR indices can be found at <http://enr.construction.com/economics>

TWDB - Uniform Costing Model for Regional Planning				
Basic Info	Project Name:			
	WUG/WWP:			
	Cost Estimator:			
	Date for Estimation:			
	Checked By:			
	ENR Construction Cost Index Time Period:	September 2023	CCI Factor:	13486
	Producer Price Index Time Period:	September 2023	PPI Factor	277.7
	Available Project Yield		acft/yr	
	Conservation or Drought Management WMS?	No		
	Simplified or Advanced Hydraulics?	Simplified and Advanced		
Number of Pipelines	3			
Does the project include a wellfield?	Yes			
TWDB General Guidelines	Interest During Construction	3.50%	years	
	Rate of Return on Investments	0.50%		
	Construction Period	1.0		
	Engineering - Planning	3%		
	Engineering - Design	7%		
	Construction Engineering	1%	years	
	Legal Assistance	2%		
	Fiscal Services	2%		
	Contingency for Pipelines	15%		
	Contingency for All Other Facilities	20%		
	Debt Service (Non-Reservoirs) Period	20	years	
	Debt Service (Reservoirs) Period	40		
	Annual Interest Rate (Non-Reservoirs)	3.50%	% of Capital Costs	
	Annual Interest Rate (Reservoirs)	3.50%		
	Operations & Maintenance (Pipelines)	1.00%		
Operations & Maintenance (Pump Stations)	2.50%	% of Capital Costs		
Operations & Maintenance (Dams)	1.50%	% of Capital Costs		
Power Costs	\$0.09	/kilowatt-hour		
Pumps & Crossings	Power Connection Costs - Pump Stations	\$200	/HP	
	Pump Station Tank Option	GST w/ Roof		
	Pump Station Tank(s) - % of Daily Flow for Sizing	10%		
	Recommended Crossing Length (2-Lane Roads)	115	LF	
	Recommended Crossing Length (4-Lane Divided Highway)	210	LF	
Recommended Crossing Length (6-Lane Divided Highway)	240	LF		
Recommended Crossing Length (Railways)	100	LF		

Figure 3. Project Information and Assumptions module

The UCM is designed for many different types and sizes of projects and not all modules may be necessary for a WMS. The UCM has been enhanced to simplify the model’s structure based on the type of WMS. Rows are included in the Basic Info section that allow the user to define the project and hide modules that are not being used. Table 1 summarizes the functions of these fields.

**Table 1. Selections for project layout in UCM**

Question	Selections	Comments
Conservation or Drought Management WMS?	Yes / No	For WMS only relating to conservation or drought management. Selecting “Yes” hides all non-relevant modules and infrastructure rows in the Costing Form tab. Selecting “No” hides the Conservation and Drought Management Modules.
Simplified or Advanced Hydraulics?	Simplified	Does not require pipeline profile for calculating hydraulics. Hides Advanced Hydraulic modules and related infrastructure rows in Costing Form tab
	Advanced	Requires a ground profile and user can choose up to three pipelines.
	Simplified and Advanced	Uses both modules and can still select number of pipelines
Number of Pipelines?	1, 2 or 3	Used only in Advanced Hydraulics. Hides unrelated Advanced Calc modules and infrastructure rows in Costing Form
Does the project include a well field?	Yes / No	Selection will hide or show Well Field module and related infrastructure rows in the Costing Form tab

The user first determines how the hydraulics will be calculated. Options include “Simplified,” which does not require a pipeline profile (see Section 3); “Advanced,” which utilizes a ground profile (see Section 4); or “Simplified and Advanced.” Selecting “Simplified” will hide the three advanced hydraulic calculation modules, three advanced hydraulic chart modules, and the corresponding rows on the “Costing Form” tab. If selecting “Advanced,” the user will need to choose between 1 and 3 pipelines. Pipelines can also be evaluated in segments (up to 5) along a pipeline route (see Section 4.4). Once selected, the user always has the option to make changes to their selection if necessary. **If the user does make a selection that hides previously shown module(s) with data entered by the user, costs automatically generated from these hidden modules will be included in hidden rows in the “Costing Form” tabs and will incorrectly be included in the overall project cost estimates.** It is recommended that the user delete any information entered into a module before making a selection that hides the module.

## 2.2 TWDB General Guidelines

The second section of the Project Information and Assumptions module allows users to enter assumptions consistent with the TWDB guidance for regional water planning. These values have been pre-populated with the assumptions to be used in the 2026 regional planning cycle. Table 2 includes the list of project assumptions and the TWDB general guidance.

Power costs and construction periods will be variable based on location and scale of the project. The TWDB general guidance assumes Engineering, Legal, Contingencies are 30 percent of total construction costs for pipeline projects and 35 percent of construction costs for other facilities. These cost items have been further broken out by individual component to better align with form TWDB-1201 for financial assistance. These assumptions were determined based on engineering judgement and in coordination with TWDB staff.

**Table 2. TWDB general guidelines for 2026 regional water plans**

Item		TWDB Guidance	Comment
Interest During Construction		3.5%	Interest on the borrowed funds during the construction period. See Section 8.2.5
Rate of Return on Investment		0.5%	Return on invested funds during construction period. See Section 8.2.5
Construction Period		Input by User	Use engineering judgment to provide appropriate length of construction based on the WMS
Engineering	Planning	3%	See Section 8.2.1.
	Design	7%	
	Construction	1%	
Legal Assistance		2%	
Fiscal Services		2%	
Contingencies (Pipeline)		15%	
Contingencies (All Other Facilities)		20%	
Debt Service (non-reservoirs) period		20 years	
Debt Service (reservoirs) period		40 years	Finance period for all infrastructure related to a reservoir.
Annual Interest Rate (non-reservoirs)		3.5%	Project finance rate on funds borrowed for non – reservoir infrastructure
Annual Interest Rate (reservoirs)		3.5%	Project finance rate on funds borrowed for reservoir infrastructure
Operations & Maintenance (Pipelines)		1% of Capital Costs	Used to determine annual cost to maintain pipeline, tank, and well infrastructure. See Section 8.3.2
Operations & Maintenance (Pump Stations)		2.5% of Capital Costs	Used to determine annual cost to maintain pump station infrastructure. See Section 8.3.2
Operations & Maintenance (Dams)		1.5% of Capital Costs	Used to determine annual cost to maintain reservoir infrastructure. See Section 8.3.2
Power Costs		\$0.09/kilowatt-hr	Cost of electricity. May vary across regions.

### 2.3 Pumps and Crossings

The third section of the Project Information and Assumptions module allows the user to enter assumptions pertaining to power connections, ground storage tanks, and pipeline crossings. Standard values for power connections and pipeline crossings have been pre-populated. Crossing costs are determined in the Costing Form module and users must identify the number and types of crossings to calculate costs. The power connection costs are calculated on the Costing Form once pump station or well field hydraulics have been determined. Minimum costs assumed for connecting power to a pump station or well field is \$75,000, which the user can override if necessary. Note that the minimum cost assumption was increased from \$50,000 in Version 2.0 of the UCM and the default rate of \$150 per horsepower power connection was increased to \$200 per horsepower.

The user also has the option to select the type of ground storage tank (with or without roof) or elevated storage tank and the size of the tank based on the percentage of daily flow for pump

stations. Associated costs related to these assumptions are automatically generated in the Costing Form module.

### 3.0 Simplified Hydraulics Calculations

There are two methods of performing pipeline hydraulics calculations available in the UCM. These methods are used to determine pipeline diameter(s), pump and booster sizes, and pumping energy required. The first is a simplified method presented in this section, and the other is a detailed method in which the user defines a pipeline route and uses an elevation profile (presented in Section 4.0).

The simplified method in the Simplified Hydraulics module (Figure 4) allows the user to quickly determine pipeline diameter(s), pump and booster sizes, and pumping energy given a few basic pieces of information. The user inputs the beginning and ending elevations, pipeline length, water delivery amount, peaking factor, and other basic assumptions.

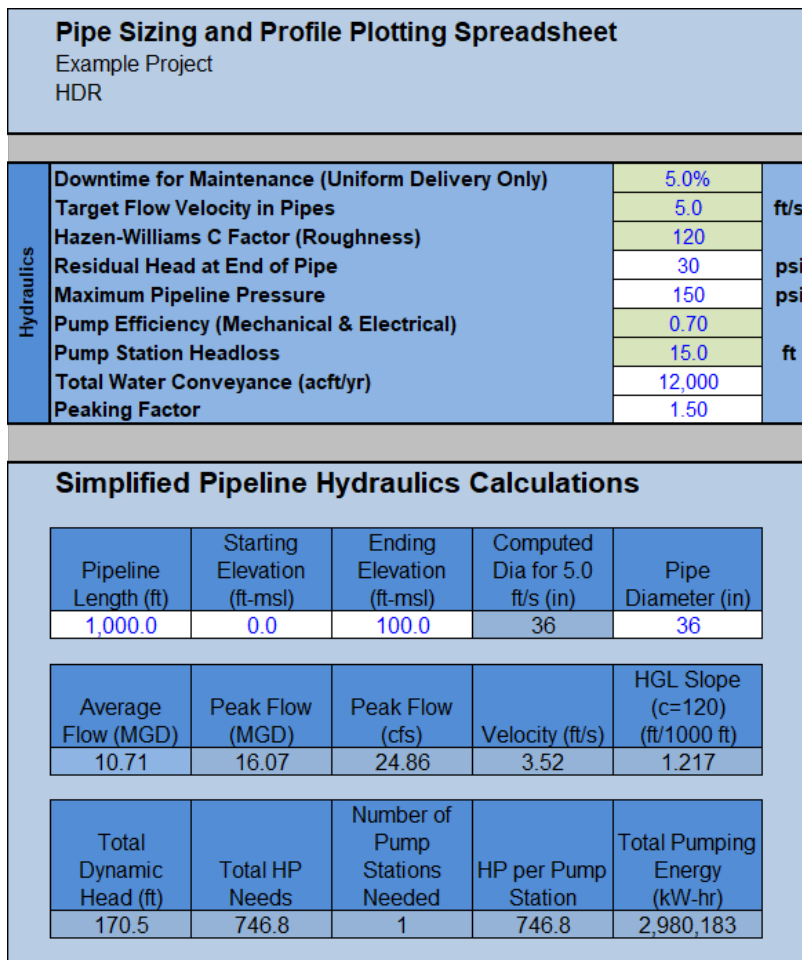


Figure 4. Simplified Hydraulics module

### 3.1 Hydraulics Assumptions

The “Hydraulics” section of the Simplified Hydraulics module allows the user to input basic hydraulics information:

1. **Residual head at end of pipe.** The user enters the residual head at end of pipe, which is often the minimum pressure along the pipeline. For treated water systems a minimum pressure of 25 pounds per square inch (psi) is recommended and 15 psi for raw water delivery.
2. **Maximum pipeline pressure.** The user chooses a pressure class for the pipe (ranging from 100 psi to 350 psi). Pipeline costs are adjusted based on the pressure class chosen.
3. **Total Water Conveyance.** This is the total volume to be delivered every year in acre feet.
4. **Peaking Factor.** Water may be delivered at an average (uniform) rate over the entire year (i.e., the same volume of water would be pumped each day), or the rate may vary from month to month or day to day. The factor is the ratio of the maximum rate to the average rate. The computed diameter for a 5 ft/sec flow rate (cell F20) is calculated based on the peaking factor input by the user and facilities should be sized on peak rates of delivery.

The user can review and revise the default values for pump station downtime for maintenance activities, roughness factor, target flow velocities, pump station head loss, and pump efficiency, if necessary.

To determine pipeline diameter and size the pump station, the user enters the pipeline length and starting and ending elevations. Based on the provided information, the Simplified Hydraulics module aids the user in choosing a pipeline diameter and generates the number of pump stations required, along with their sizes and required pumping energy.

## 4.0 Advanced Hydraulics Calculations

The second method of performing pipeline hydraulics calculations available in the UCM is through use of the Advanced Hydraulics module ("Pipe X - Adv Hyd Calcs" tab) (Figure 5). The user must manually enter a pipeline profile based on an externally selected route. The profile must include station, elevation, ground type (rock or soil), and level of development (rural or urban) along the pipeline route. The Advanced Hydraulic module allows the user to consider the pressure in the pipeline along the entire route to verify if maximum and minimum pressure parameters are met throughout the pipeline route. Additionally, the user may specify delivery amounts and points along the pipeline route, thereby facilitating adjustment of the pipe diameter for varying flow rates, as well as pressure classes along the pipeline.



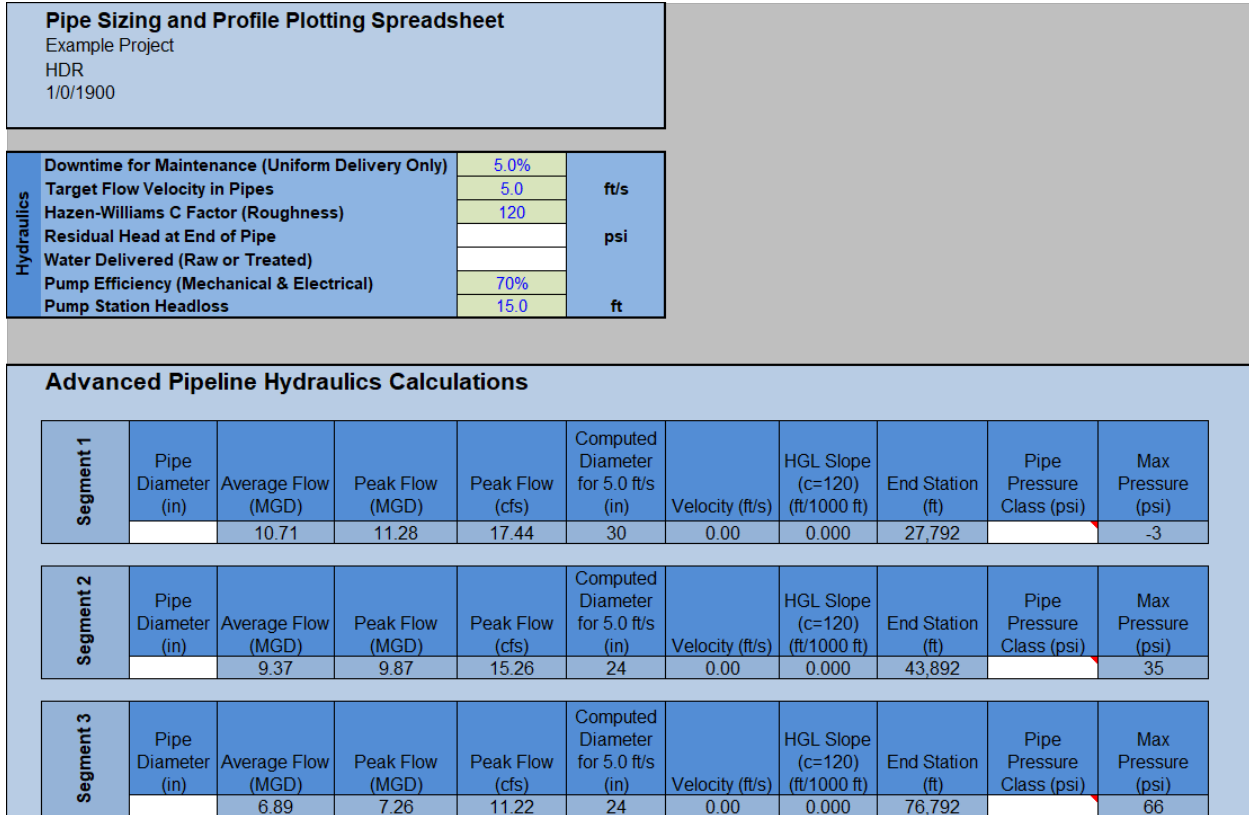


Figure 5. Advanced Hydraulics module

The user may choose up to five delivery locations or five unique segments along the pipeline route to deliver portions of the total water to be conveyed by the transmission system.

The user can also choose locations of booster stations and allocate a portion of the total dynamic head (TDH) to each of the booster stations. Additionally, the user may specify up to five pump/booster stations to gain the necessary lift from the beginning of the pipeline to the end delivery point.

The Advanced Hydraulics tab is linked to a chart (Pipe X – Adv Hyd Chart) that includes the pipeline ground elevation and the hydraulic grade line (HGL) based on selected flow rates and diameters. Finally, because WMSs often include more than one pipeline route (for example, there may be a high-capacity diversion from a river to an off-channel reservoir and a uniform delivery of firm yield from the off-channel reservoir to a water treatment plant), the UCM has included three Advanced Hydraulics modules to allow up to three separate pipelines (transmission sub-systems) to be evaluated for one WMS.

### 4.1 Hydraulics Assumptions

The “Hydraulics” section of the Advanced Hydraulics module allows the user to input basic hydraulics information, including roughness factor, target flow velocities, type of water being transported (raw or treated water), etc. The user chooses a pressure class for the pipe (ranging from 100 psi to 350 psi). Base pipeline costs are adjusted based on the pressure class chosen. The UCM allows the user to select unique pressure class pipe for each of the segments. Pressure classes

range between 100 psi and 350 psi and are set in a dropdown list. Segments can be specified by the station along the profile. To aid the user in selection of pressure class pipe, the maximum pressure in the segment is identified.

The type of water to be transported is a consideration that may have an impact on the engineering analysis. Raw water and treated water comprise the categories that are expected to be encountered in technical evaluation of WMSs. Treated water is water that has been treated for some purpose; generally this would be potable water from a water treatment plant. Raw water is usually thought of as untreated, non-potable surface water that comes from a stream or reservoir. Groundwater may potentially be categorized as potable (classified as treated in the UCM) or non-potable (classified as untreated in the UCM) water depending on resident levels of certain substances found in the water. It is important to be aware of the water type because minimum pipeline pressure requirements vary depending on the type and use. In the UCM, the Advanced Hydraulics module assumes a 15-psi minimum pressure for raw water and a 25-psi minimum pressure for treated water.

## 4.2 Water Delivery Locations

The user specifies the total water conveyance, peaking factor, delivery quantities, and locations in the “Deliveries” portion of the Advanced Hydraulics module (Figure 6). Some amount of water must be delivered to the end of the pipeline. The locations of the delivery points are needed in order to chart a pipeline route. Possible delivery locations include rivers, reservoirs, water treatment plants, storage tanks, and municipal distribution systems.

<b>Deliveries</b>	<b>Total Water Conveyance (acft/yr)</b>		
	<b>Peaking Factor</b>		
	<b>Delivery Amount #1 (acft/yr)</b>		<b>Station (ft):</b>
	<b>Delivery Amount #2 (acft/yr)</b>		<b>Station (ft):</b>
	<b>Delivery Amount #3 (acft/yr)</b>		<b>Station (ft):</b>
	<b>Delivery Amount #4 (acft/yr)</b>		<b>Station (ft):</b>
	<b>Delivery Amount #5 (acft/yr)</b>		<b>Station (ft):</b>

Figure 6. Deliveries table in Advanced Hydraulics module

Delivery amounts are subtracted from the user input field “Total Water Conveyance (acft/yr)”. In order to maintain the full delivery amount but provide two or more pressure classes, the user would enter “0” for delivery amount and select an end station to differentiate the segment.

## 4.3 Pipeline Route Selection and Profile

Generally, the first step in the Advanced Hydraulics module pipeline analysis is to determine a route. The goal is to connect the source with the destination by the most direct and logical route possible. Once a path has been selected, a two-dimensional pipeline profile can be generated from a set of points distributed along the route (Section 4.3.1). Each point represents a station (horizontal dimension), and a corresponding ground elevation (vertical dimension). The number of points and the distances between these locations needed to represent the profile adequately will vary depending on the topography along the route. The goal is to capture the general topographic features or trends while showing points of significant elevation changes (i.e., minimum and maximum points along a route segment). These data, along with the ground type (rock or soil), and level of development (rural or urban) along the pipeline route, are entered into the Pipeline Profile

Data portion of the Advanced Hydraulics module (Figure 7). Ground type and level of development are specified as these attributes affect project costs. Pipeline unit costs include factors for ground type and level of development.

Pipeline Profile Data										
Station (ft)	Ground Elevation (ft-msl)	Soil or Rock	Urban or Rural	Pressure: 100 psi (ft-msl)	HGL (ft-msl)	Hydraulic Calcs (psi)	Soil, Urban	Soil, Rural	Rock, Urban	Rock, Rural
0	5	soil	rural	235.55	109.88	45.60				
50	5	soil	rural	235.55	109.83	45.58	0.00	50.00	0.00	0.00
100	5	soil	rural	235.55	109.79	45.56	0.00	100.00	0.00	0.00
150	5	soil	rural	235.55	109.74	45.54	0.00	150.00	0.00	0.00
200	5	soil	rural	235.55	109.69	45.52	0.00	200.00	0.00	0.00
250	5	soil	rural	235.55	109.65	45.50	0.00	250.00	0.00	0.00
300	5	soil	rural	235.55	109.60	45.48	0.00	300.00	0.00	0.00
350	5	soil	rural	235.55	109.55	45.46	0.00	350.00	0.00	0.00

Figure 7. Pipeline Profile Data example

#### 4.3.1 Route Selection and Profile Generation Guidelines

Pipeline routes are identified and generated using external mapping resources available. Selecting a route to be used in technical evaluation of a WMS is typically an exercise in professional judgment based on experience. However, the following guidelines are recommended in any strategy evaluation:

1. Select the most direct route paralleling existing rights-of-way to the extent possible. Existing rights-of-way include roadways (preferred), pipelines, power transmission lines, and railways (least preferred).
2. Limit pipeline routing across open land to the extent possible. Property division is less desirable than paralleling a boundary, except when following an existing right-of-way. In the design phase, it may be more feasible to cross open land along selected sections of a route if, during the design evaluation, the benefits outweigh the costs.
3. Bypass large water bodies.
4. Bypass cemeteries and sites known to be culturally significant or environmentally sensitive. An environmental and archaeological review may or may not be performed at the regional planning level, but readily available information should be used to help avoid known sensitive areas.
5. Bypass urban centers to the extent possible. Though it may result in a longer route, traversing around a city will likely result in lower construction costs.
6. Avoid rough terrain, if possible; especially bypass hills that could be higher than the hydraulic grade line of the pipeline.
7. Avoid heavily forested areas to the extent possible.

8. Avoid crossing a highway at a major interchange.
9. Avoid areas that require rock excavation if practical. Since soil conditions are usually consistent within some range, moving the pipeline is generally not expected to significantly change the ground conditions encountered. In the event that the ground conditions would change significantly by shifting the pipeline route, the route that would result in lower constructions costs should be selected.

It is recommended that when generating a pipeline route and pipeline profile, the user use GIS technologies. A link to online directions for using the profile tool within ArcGIS Pro is provided in the Advanced Hydraulic Calcs module<sup>4</sup>. Additional profile generation guidance can be found in Appendix B.

## 4.4 Pipeline Hydraulics Calculations

The user selects pipeline diameters for the transmission pipeline segments, along with pump/booster station locations and associated lift in the Advanced Pipeline Hydraulics Calculations portion of the Advanced Hydraulics module. The following sub-sections (4.4.1 through 4.4.4) briefly explain the methodology and assumptions behind the calculations used in the Advanced Pipeline Hydraulics Calculations portion of the UCM to guide the user in making these selections.

### 4.4.1 Pipe Size, Velocity, and Head Loss

The Advanced Pipeline Hydraulics Calculations portion of the Advanced Hydraulics module is used to size pipes and generate the HGL. Using total water conveyance and the peaking factor, the peak delivery rate is established and the process of selecting the size, velocity and head loss is as follows:

1. Estimate a pipe diameter for a corresponding velocity. A target velocity is used at this stage to help establish an appropriate size range. Equation 1 calculates the exact diameter in inches.

$$D(in) = \sqrt{\frac{Q(cfs)}{V(fps) \left( \frac{\pi}{4} \right) \left( \frac{1ft}{12in} \right)^2}} \quad (1)$$

2. The user then picks a standard pipe diameter based on the diameter resulting from Equation 1. Standard pipe sizes are set in a dropdown list.
3. With the standard diameter set, the pipe velocity corresponding to the chosen pipe diameter is calculated using Equation 2. An important guideline to remember is to select pipeline diameter to maintain velocity within the range of 3.5 to 7 feet per second (fps). This range is a general guideline intended to prevent solids deposition in the pipe and to minimize energy requirements associated with friction losses experienced at high velocities.

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<sup>4</sup> <https://pro.arcgis.com/en/pro-app/latest/tool-reference/ready-to-use/profile.htm>

$$V(fps) = \frac{Q(cfs)}{\left(\frac{\pi}{4}\right)\left(\frac{D(in)}{12in/ft}\right)^2} \tag{2}$$

- Using the Hazen-Williams equation (Equation 3), the head loss in the pipe is calculated (hydraulic grade line or HGL slope) with the diameter selected in Step 2 and the velocity found in Step 3. The HGL will be plotted on the same graph (Figure 8) in Advanced Hydraulic Chart (“Pipe X - Adv Hyd Chart” tab) as the ground profile using the calculated slope.

$$S\left(\frac{ft}{ft}\right) = \left[ \frac{V(fps)}{1.32C\left(\frac{D(in)}{4} \cdot \frac{1ft}{12in}\right)^{0.63}} \right]^{\left(\frac{1}{0.54}\right)} \tag{3}$$

City: Pipeline Elevation Profile with Pressure Class Elevations

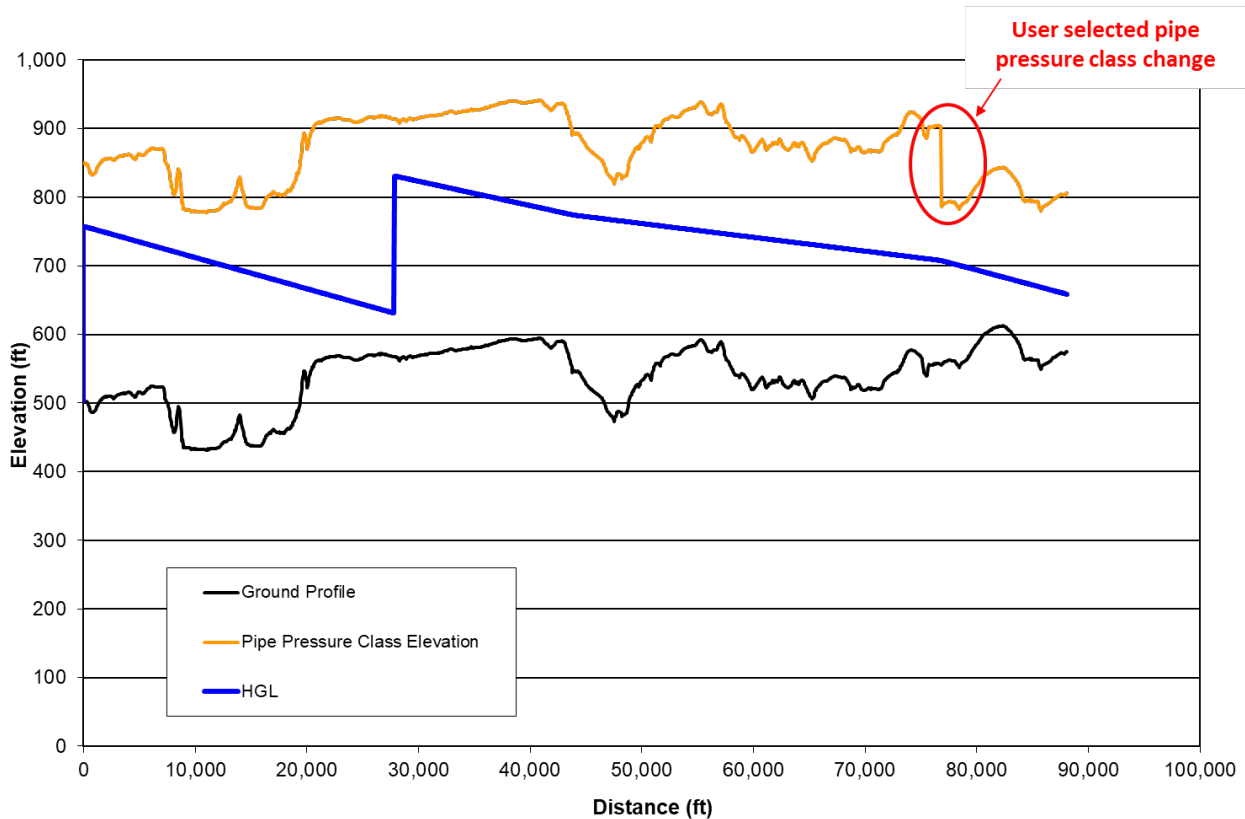


Figure 8. Advanced Hydraulic Pipeline HGL chart

#### 4.4.2 Pipe Pressure

When pumps impart energy to water, or “lift” it, a pressure will be generated within the pipe. This pressure is one component of the total head. Assuming that velocity head is negligible, the pressure head can be estimated using Equation 4.

$$\text{Pressure Head} = \text{Hydraulic Grade Line Elevation} - \text{Profile Elevation} \quad (4)$$

Pressure head can easily be converted to pressure by Equation 5. This equation can also be used to find the pressure head for a given pressure. Using a plot of the hydraulic grade line, it is possible to determine the pressure within the pipe at any point along the length.

$$\text{Pressure}(psi) = \text{Pressure Head}(ft) \left( \frac{62.4lb / ft^3 \text{ for water}}{144in^2 / ft^2} \right) \quad (5)$$

Pipes are manufactured by pressure class providing a factor of safety within certain pressure ranges. A convenient tool for determining the pressure ranges in a pipeline is to plot pressure heads for various pipe pressure classes over the entire length of the pipeline profile, then inspect the grade line to see what lengths of pipe fall within a particular pressure head range. The UCM has also been updated to plot the selected pressure classes as they vary along the pipeline route, as shown in Figure 8. Previous versions of the UCM only plotted one pressure class for the entire pipeline even if different pressure classes were selected for individual segments by the user.

Another guideline to keep in mind is that the HGL must remain above all high-profile points along the route in order to prevent formation of a vacuum within the pipeline and reduce the potential for column separation and water hammers within the pipe. It is desired to clear these points by a minimum water pressure at all times. The minimum line pressures that should be met or exceeded are 15 psi for raw water and 25 psi for treated water. This requirement should be met within all anticipated flow ranges.

#### 4.4.3 Pump and Booster Station Locations and Total Dynamic Head

Pump and booster station locations and sizes are dependent on the flow rate, pipe size, and corresponding head loss. A change in flow rate resulting in a change of pipe size can dramatically impact the number and sizes of pumping stations needed to convey water to the destination. Therefore, the pipeline and pumping requirements must be evaluated together. Several iterations involving different combinations of pipe sizes and pumping station arrangements may be required to obtain an appropriate selection. The combination of pumping stations and pipe size selected must conform to engineering principles, comply with guidelines, and make sense economically.

Determining the size of a pump or booster station entails estimating the amount of energy, or head, needed to lift water to a sufficient level for driving water to a particular destination. This amount of head developed by the pump is the TDH, which is made up of the following:

1. **Static Head** – The total change in elevation of the liquid from the suction level to discharge level, plus the pressure difference between suction and discharge reservoirs if different from atmospheric.

2. **Pipe Friction** – The friction head loss in the suction and discharge line, elbows, and valves, and the suction pipe entrance loss.
3. **Velocity Head** – the head at the end of the discharge pipe.

For study purposes, the TDH will be calculated as the difference between the calculated elevations of the HGL at the pumps and the suction source plus station losses (Equation 6).

$$\text{TDH (ft)} = \text{Final HGL Elevation at Pumping Station (ft)} - \text{Water Surface Elevation (ft)} + \text{Pumping Station Losses (ft)} \quad (6)$$

The simple approach used in the UCM for determining the TDH for sizing a pump station is one that involves starting at the destination at a predetermined elevation, creating a HGL based on the peak flow, and evaluating a number of factors back toward the source. Once a transmission system arrangement is selected for peak flows, the same factors will be evaluated to ensure that the system will function adequately for the lowest anticipated flows.

#### 4.4.4 Pump Station Horsepower (size) and Power Requirements

Pump station sizing and power requirements involve assessing station power needs for different operating conditions. Power is the time rate of energy transfer, with the TDH for a particular flow rate being the amount of energy to be transferred. Horsepower is the unit of power that is used in the UCM and can be calculated with Equation 7. The efficiency of the pumping station is represented by “e”. It is actually a “combined efficiency” that accounts for the efficiencies of the pumps and pump motors. **For regional water planning purposes, assume a combined efficiency of 0.7.** The pump station size, which is based on the greatest amount of horsepower needed, is derived using the peak flow rate and its resulting TDH.

$$HP = \frac{Q(cfs) \cdot TDH(ft)}{8.8 \cdot e} \quad (7)$$

Power consumption for estimating pumping energy costs is based on average flow rate and the head loss associated with the average flow rate. Electric energy is typically billed by the kilowatt-hour (kWh or KW-HR). “Watt” is the International System (SI) unit for power and is related to horsepower by Equation 8.

$$1HP = 746W \quad (8)$$

$$1HP = 0.746KW$$

$$\# \text{ of } KW = \text{Horsepower} * \frac{0.746KW}{1HP}$$

The estimated energy consumed in pumping is calculated by converting power back to energy for the pumping duration, based on average flow rate and the head loss associated with the average flow rate. Equation 9 illustrates this calculation.

$$\text{Annual KW} \cdot \text{HR} = \text{KW} \cdot \text{total hours of pumping operation per year} \quad (9)$$

The number of hours of pumping operation is the total number of hours out of the year needed to deliver the annual water volume at a flow rate which is to be expected the majority of the time when pumping. Annual pumping energy cost is based on the annual energy consumed.

## 5.0 Well Fields

Wells must be constructed to extract water from below the land surface and pump it into a water delivery system. Each well can be considered an individual, or stand alone, pump station for sizing purposes and for pumping energy calculations. Size/horsepower requirements, like pump stations, are based on the flow and the TDH. The TDH for a well pump is the elevation difference between the hydraulic grade line and the estimated groundwater (i.e. piezometric) surface at the well during pumping conditions, plus station losses and friction losses in the casing pipe.

The user lays out a well field as shown in Figure 9 and then determines the connectivity of the wells, collection pipes, and main trunk line(s). This information is then fed into the Well Field module, at which time, the flow, pipe sizes, and pumping energy is calculated.

The Well Field module ("Well Field" tab) (Figure 10) allows the user to layout the facilities to determine costs for the well field. To begin, the user provides:

1. the static water elevation (ft msl),
2. expected drawdown during pumping,
3. the water production for the total well field (acft/yr),
4. the peaking factor used for the wells, and
5. the average flow per well (gpm).

The UCM has been updated in Version 3.0 to allow the user to adjust the well pump efficiency and the contingency backup wells based on a percentage of the active wells required. A recommended well pump efficiency of 80 percent and a 15 percent contingency are included as default values.

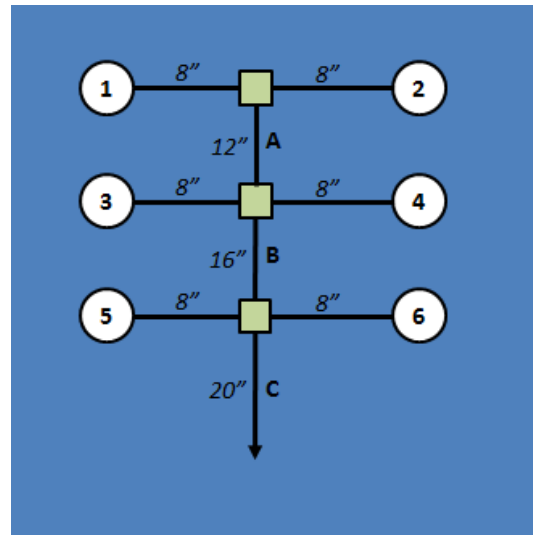


Figure 9. Example well field layout

With this information, the UCM will estimate the required number of active production wells to meet the production goal per year and backup wells required. Taking the number of active and backup wells, the user assigns a well ID and provides the peak flow rate based on the user determined peaking factor. The model provides a suggested pipe diameter for velocities at 5 fps but the user must select a pipe diameter from the dropdown menu.

Next, the user provides a pipe length to the next downstream node for the collection system or to another well ID. Elevation data for well IDs or other junction points are entered in cells M46:O76. The model will read this data and calculate head losses in the pipe due to changes in elevation and friction. Note that if no downstream node is entered, the model will use the value entered in D12



(Elevation of the Delivery Point) as the downstream node elevation. If the downstream node is another well ID, the user must include the well's pump rate plus the rate from the upstream well to provide correct hydraulic calculations when entering the flow rate for the downstream node. Energy calculations, operational time, and collection system piping lengths are all calculated by the model. The energy includes the lift to bring the water from the user defined drawdown level to surface and to convey it through the collection system to the delivery point. The user must transfer the required collection system pipeline lengths and diameters (cells I46:J72) as well as the production wells (capacity and depth) in the Well Field section on the Costing Form module. Required energy is automatically calculated in the Costing Form but should be confirmed by the user.

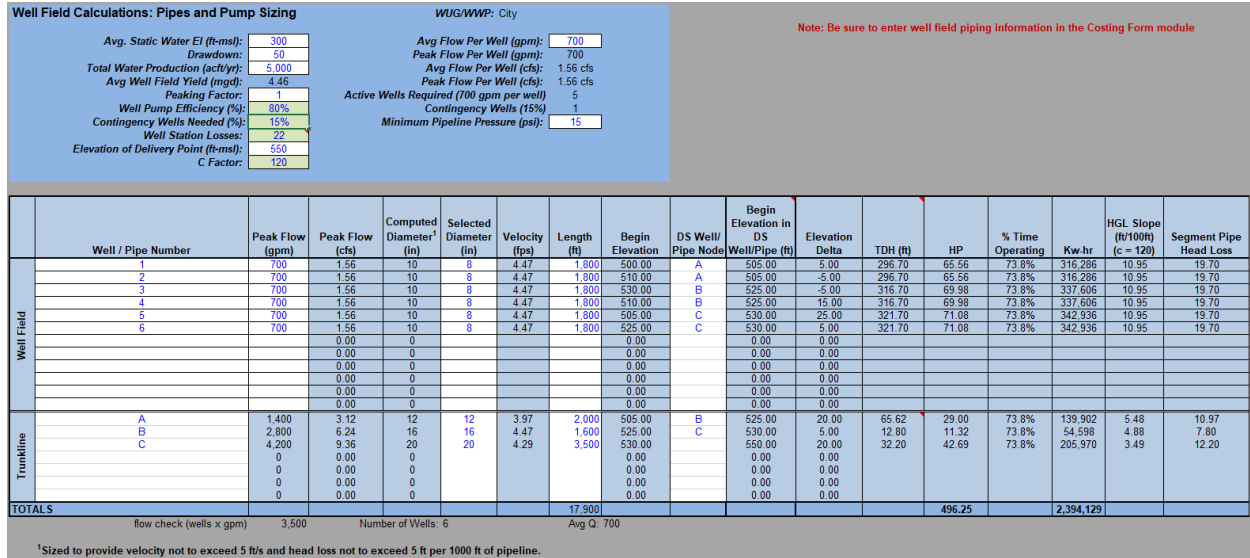


Figure 10. Well Field module

Additionally, there is a portion at the bottom of the module designed to aid the user in selecting operational designs and capacities for reverse osmosis treatment of brackish groundwater.

## 6.0 Dam Embankment Estimates

A basic dam embankment quantity calculator (Figure 11) is included in the UCM in the Embankment Calculator module (“Embankment Calcs” tab) as an alternative to using simplified cost curves (see Section 8.1.5). The user enters information regarding the cross-section and other components of the dam, along with the unit prices of various cost elements associated with the construction of a dam, such as Embankment Fill and Cutoff Trench, Emergency Spillway, etc. The embankment calculator uses this information to determine a cost estimate per linear foot for the dam, given the specifications supplied by the user. Unit costs will need to be provided by the user to determine costs for the embankment and appurtenances.

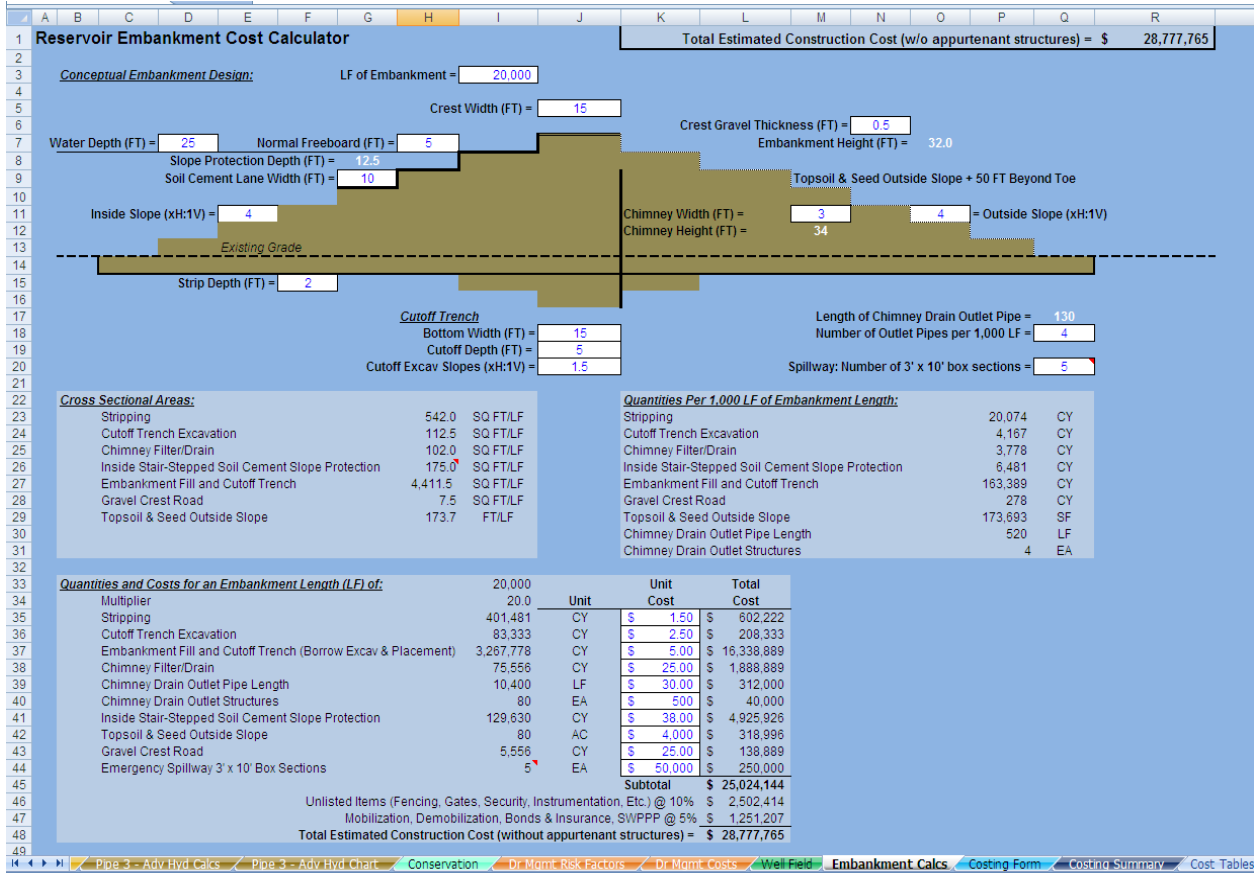


Figure 11. Dam Embankment module

This information is not linked to the Costing Form and must be entered manually into one of the external cost cells for a ring dike reservoir or terminal storage. The user must also manually enter the storage capacity and area in the Costing Form for the UCM to calculate the land, environmental, and surveying costs.

## 7.0 Land Acquisition

The Land Acquisition module (“Land Acquisition” tab – Figure 12) of the UCM is where the user can define land costs values (per acre) for each of the infrastructure components. Land cost vary significantly with location and economic factors. Rural land costs in Texas can be estimated using *Rural Land Values in the Southwest* published biannually by the Real Estate Center at Texas A&M University<sup>5</sup>. Land values are estimated by county and land type. The user should use the Nominal Median Price per Acre when using the Real Estate Center’s land values. A link to the Real Estate Center at Texas A&M University is embedded in the Land Acquisition module of the UCM.

**Other sources of land values, such as county appraisal district records, may be available for use and are recommended for urban areas and areas experiencing the rapid development**

<sup>5</sup> <https://www.recenter.tamu.edu/data/rural-land/>

**typically surrounding urban areas.** Some judgment in the use of suggested land costs is required. For example, the land cost estimate developed from a resource may be appropriate for general land prices but may not be appropriate for prime locations in the same area. In such a situation, the prime land value could be significantly higher than that of the surrounding lands.

Pipeline right-of-way (ROW) may be calculated by two methods: Simplified and Advanced.

- The simplified method simply allows the user to input a total unit cost per acre for ROW land costs.
- The advanced method allows the user to specify the raw land unit cost, an assumption for the number parcels crossed per mile, permanent ROW width, and information regarding administrative costs, condemnation hearings, and trials.

If “Advanced” methodology is selected, flags will appear to indicate where data must be entered to accurately calculate costs. The UCM assumes that 80 percent of the parcels will be acquired without condemnation, 10 percent acquired via a condemnation hearing, and 10 percent will go to trial.

Pipeline Right-Of-Way Costs		
Right-Of-Way Costing Method	Advanced	
Unit Land Cost		/acre
Assumed Parcels per Mile	4	parcels/mile <---Must add value here
Permanent ROW Width	50	ft
ROW Base Administrative Cost (80% of Parcels)	\$14,000	/parcel <---Must add value here
Condemnation Hearing Cost (10% of Parcels)	\$26,500	/parcel <---Must add value here
Trial Cost (10% of Parcels)	\$35,500	/parcel <---Must add value here
Wellfield		

to look

Land Costs for Other Facilities	County	Land Value (\$/acre)
Water Treatment Plant #1		
Water Treatment Plant #2		
Storage Tank		
Storage Tank		
Storage Tank		
Initial Pump Station		
Initial Pump Station		
Initial Pump Station		
Initial Pump Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Booster Station		
Well Field		
Traditional Reservoir		
Off-Channel Reservoir		
Terminal Storage		

Figure 12. Land Acquisition module

## 8.0 Cost Estimating Form

The UCM cost estimate includes three major cost categories:

1. **Construction Costs** - Direct costs, such as those for materials, labor, and equipment, incurred in constructing facilities. These are the costs that are generally submitted by a contractor bidding on a project.
2. **Other Project Costs** – These costs include additional expenses not directly associated with construction activities such as costs for engineering, legal, land acquisition (including surveying for land acquisition), contingencies, environmental/archaeological/cultural resources studies, and interest during construction. The total project costs are the combined construction costs and other project costs.
3. **Annual Costs** – Annual costs include operation and maintenance (O&M), energy costs, and debt service payments are examples of annual costs.

The Costing Form module (“Costing Form” sheet) of the UCM is the primary module for creating the cost estimate. The Costing Form module pulls information calculated in the other modules and allows the user to input additional data to step through the cost estimation.

Warning flags are embedded within the UCM to notify the user of areas where mistakes often occur. These warning flags may appear on the Costing Form if certain information is missing or is inconsistent with another module. Flags will remain until resolved and will also be identified on the Costing Summary module. Flags include:

1. Well Field selected to be included on Project Info & Assumptions, but data from Well Field Module not entered.
  - a. To resolve this flag, the user needs to add data to the Well Field module and copy that into the Costing Form, or
  - b. If costs for a well field are not necessary for the WMS, select “No” on the Project Info & Assumptions module in cell D19
2. Unit Land Cost on Land Acquisition sheet is zero
  - a. Without a land cost, easement or right of way costs may not be calculated. To resolve this flag, add land costs on the Land Acquisition module.

The Costing Form contains subsections to assemble costs for pump station, pipelines, crossings, water treatment plants, dams and reservoirs, storage tanks, and well fields including wells and piping, along with project related costs such as engineering, legal, contingencies, land acquisition, environmental, archaeology studies, mitigation, and interest during construction. Note, if sections are hidden that are necessary for costing of the strategy, proceed to the Project Info & Assumptions module to select the appropriate methodology for hydraulic calculations, number of pipelines, and /or the well field (D17:D19). Major components that may be part of a preliminary cost estimate are listed in Table 3.

**Table 3. Major project cost categories**

Cost Elements	
Capital Costs (Structural Costs)	Other Project Costs (Non-Structural Costs)
<ol style="list-style-type: none"> <li>1. Pump Stations</li> <li>2. Pipelines</li> <li>3. Water Treatment Plants &amp; Advanced Water Treatment Facilities</li> <li>4. Dams and Reservoirs</li> <li>5. Off-Channel Reservoirs</li> <li>6. Water Storage Tanks</li> <li>7. Well Fields                             <ol style="list-style-type: none"> <li>a. Public</li> <li>b. Irrigation</li> <li>c. Aquifer Storage and Recovery (ASR) Wells</li> </ol> </li> <li>8. Relocations, Integration and Other Facilities</li> </ol>	<ol style="list-style-type: none"> <li>1. Engineering (Feasibility Studies, Design, Bidding and Construction Phase Services, Geotechnical, Legal Assistance, Financing, Bond Counsel, and Contingencies)</li> <li>2. Environmental and Archaeological Studies and Mitigation</li> <li>3. Land Acquisition and Surveying</li> <li>4. Interest During Construction</li> </ol>
	Annual Project Costs
	<ol style="list-style-type: none"> <li>1. Debt Service</li> <li>2. Operation and Maintenance (excluding pumping energy)</li> <li>3. Pumping Energy Costs</li> <li>4. Purchase Water Cost (if applicable)</li> </ol>

The following sub-sections briefly describe each of the elements included in creating a cost estimate in the Costing Form module.

## 8.1 Construction Costs

Cost tables have been updated for the 2026 Regional Water Plans and are discussed in the technical memorandum in Appendix C. The construction cost for a project element can be determined by applying a unit cost from the cost tables to a specific unit quantity. For example, pipeline costs can be determined by pipe diameter and linear feet of line. Cost estimates are approximate; therefore, reporting costs to the nearest thousands of dollars are considered acceptable.

Throughout the Costing Form, the user has the option to override a calculated cost estimate for an element with an external cost estimate by simply filling in a value into the “External Cost Estimate” space on each line item. It is recommended the user add notes in Column J for the source(s) of alternate costs overriding the UCM generated costs.

The cost tables report “all-inclusive” costs to construct a particular facility. For example, the pump station cost table values include building, pump, materials, labor, and installation costs. Interpolation between the table values is done automatically by the UCM in order to arrive at the appropriate cost estimate. Each cost table has a reference time period for which the cost data is current. The user can adjust the time period by adjusting the CCI and PPI values on the Project Information and Assumptions module.

### 8.1.1 Pumping Stations

Anticipated primary pump and booster station costs vary according to the discharge and pumping head requirements, structural requirements for housing the equipment and providing proper flow conditions at the pump suction intake. For planning level cost estimates, the cost tables provided are based on the horsepower required for the peak flow rate. The costs include those for pumps, housing, motors, site work, and all materials needed. Electrical connection costs are based on

horsepower and may need to be adjusted based on engineering judgment. If a strategy includes upgrading a pump station where there is sufficient space in the building, the user can override the interpolated cost based on horsepower by adding a quote from the vendor (indexed to the correct date) in the External Cost Estimation section (Column H) on the Costing Form.

The Costing Form has a section for each of the pipelines that use the Advanced Hydraulic Calculations module, each of which has a primary pump station and up to four booster stations. The primary pump station is broken into pump station cost and intake cost. The user may also wish to add a channel dam, if necessary, to this cost estimate. The UCM does not include cost curves for channel dams at this time, and if required, a construction cost estimate must be provided by the user. If the primary pump station is associated with something other than a diversion that requires an intake structure (such as a high service pump station (HSPS)), the user can set the intake cost to zero by entering “0” in the “External Cost Estimate” column on the appropriate row, thereby overriding the cost estimate.

Additionally, the user enters the average flow rate associated with each booster station to establish the cost estimate for the storage tanks associated with the booster stations. The tank size is calculated using the percentage of the daily average flow entered by the user in cell E44 of the Project Info & Assumption tab. The UCM assumes a default value of 10 percent of daily flow for sizing the storage tanks if the user does not enter an alternative value.

### 8.1.2 Pipelines

Pipeline construction costs are influenced by pipe materials, bedding requirements, geologic conditions, urbanization, terrain, and special crossings. Additionally, the pressure class of the pipe can affect the cost. For a planning level cost estimate, pipeline costs will be determined from unit costs based on the pipe diameter, ground type, and level of urban development. The unit costs include installation cost of the pipeline and appurtenances, such as markers, valves, thrust restraint systems, corrosion monitoring and control equipment, air and vacuum valves, blow-off valves, erosion control, revegetation of rights-of-way, fencing and gates.

Based on selections in one or more of the hydraulics spreadsheets, the UCM calculates the cost associated with each pipeline segment based on the pipe diameter, soil type, urbanization condition, pipeline length, and pressure class. Base pipeline costs are adjusted based on the pressure class chosen. The factors for cost adjustment based on pressure class are based on data received from a pipe distributor in March 2013<sup>6</sup>.

Additionally, the user can input crossing information to account for costs associated with various types of pipeline crossings along the route. This information includes pipe diameter, number of crossings, and crossing lengths. Note that crossing lengths for various types of roadways and railroads are input by the user in the Project Info & Assumptions tab while lengths for creeks, utilities, and direction drilling are entered in the Costing Form module.

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<sup>6</sup> Email from Ronny Huffstickler – American Ductile Iron Pipe Company, March 8, 2013.

### 8.1.3 Water Treatment Plants

Construction costs for water treatment facilities are based on plant capacity for six different levels of water treatment. It is not the intent of the cost estimating methodology to establish an exact treatment process but rather to estimate the cost of a general process appropriate for bringing the source water quality to the required standard of the receiving system. The process options presented include disinfection, advanced groundwater treatment, simple filtration, conventional treatment, advanced brackish water treatment, and advanced seawater desalination. Table 4 gives a description of the processes involved in each treatment option. The water treatment plant unit costs include costs for all processes required, site work, buildings, storage tanks, sludge handling and disposal, clearwell, pumps and equipment. The costs assume pumping through and out of the plant as follows:

- Levels 0 and 1 treatment includes finished water pumping only at 300 feet of head.
- Levels 2 through 5 treatment plants include raw water pumping into the plant for a total pumping head of 100 feet and finished water pumping for 300 feet of total head.

Note: the user should include the costs of an HSPS (using the Simplified or Advanced Hydraulic modules) if the water treatment plant (WTP) is not delivering directly to a distribution system. The user may also need to adjust the cost of the treatment facility generated by the UCM to avoid double counting high service pump station costs if separate costs are developed by the user.

Cost tables are based on rated capacity when selecting a WTP size for the project. If a project needs additional peaking at the plant, the user will need to modify the WTP size on the Costing Form accordingly. Annual O&M costs are based on the plant size.

**Table 4. Water treatment level descriptions**

<b>Level 0:</b>	Disinfection Only - This treatment process will be used for groundwater with no contaminants that exceed the regulatory limits. Assumes groundwater does not require treatment for taste and odor reduction and groundwater is stable and requires no treatment for corrosion stabilization. With this treatment, the ground water is suitable for public water system distribution, aquifer injection, and delivery to the recharge zone.
<b>Level 1:</b>	Ground Water Treatment - This treatment process will be used for groundwater to lower the iron and manganese content and to disinfect. The process includes application of an oxidant and addition of phosphate to sequester iron and manganese. Chlorine disinfection is used as the final treatment. With this treatment, the ground water is suitable for public water system distribution, aquifer injection, and delivery to the recharge zone.
<b>Level 2:</b>	Direct Filtration Treatment - This treatment process will be used for treating ground water from sources where iron, manganese, or other constituent concentrations exceed the regulatory limit and require filtration for solids removal. The process assumes turbidity and taste and odor levels are low. In the direct filtration process, low doses of coagulant and polymer are used and settling basins are not required as all suspended solids are removed by filters. The process includes alum and polymer addition, rapid mix, flocculation, filtration, and disinfection. Water treatment with this process is suitable for aquifer injection or for delivery to the recharge zone.
<b>Level 3:</b>	Surface Water Treatment – (new or expansion) This treatment process will be used for treating all surface water sources to be delivered to a potable water distribution system. The process includes coagulant and polymer addition, rapid mix, flocculation, settling, filtration, and disinfection with chlorine. This treatment process also applies for difficult to treat groundwater containing high concentrations of iron (greater than 3 mg/l) and manganese requiring settling before filtration.

<b>Level 4:</b>	Brackish Groundwater Desalination <sup>7</sup> - Note: This treatment cost includes pretreatment for solids removal prior to RO membranes. This treatment process will be used for treatment of groundwater with total dissolved solids (TDS) exceeding the regulatory limit of 1,000 mg/l. Base costs are based on reverse osmosis (RO) membrane desalination of groundwater with 3,000 mg/l of TDS to lower the treated water TDS below the regulatory limit. However, the user enters the TDS associated with the brackish water source (1,000 mg/L to 35,000 mg/L), and costs are adjusted based on the TDS. The desalination concept includes minimal pretreatment (cartridge filtration, antiscalent addition, and acid addition), reverse osmosis membrane system, and disinfection with chlorine. Costs assume desalination concentrate will be discharged to surface water adjacent to treatment plant. With this treatment, the ground water is suitable for public water system distribution, aquifer injection, and delivery to the recharge zone. WTP size is based on finished water from the plant.
<b>Level 5:</b>	Seawater Desalination - Note: This treatment cost includes pretreatment for solids removal prior to RO membranes. This treatment process will be used for treatment of seawater with total dissolved solids (TDS) exceeding the regulatory limit of 1,000 mg/l. Costs are based on reverse osmosis (RO) membrane desalination of a water with 32,000 mg/l of TDS to lower the treated water TDS below the regulatory limit. The desalination concept includes minimal pretreatment (cartridge filtration, antiscalent addition, and acid addition), reverse osmosis membrane system, and disinfection with chlorine. Costs assume desalination concentrate will be discharged to surface water adjacent to treatment plant. With this treatment, the seawater is suitable for public water system distribution, aquifer injection, and delivery to the recharge zone. WTP size is based on finished water from the plant.

#### 8.1.4 Advanced Water Treatment Facilities

More WUGs are considering direct potable reuse (DPR) using advanced water treatment facilities (AWTF) to purify wastewater to the level such that it can be blended with other sources and delivered back to the water treatment plant for additional treatment and distribution. Referencing data provided in the April 2015 TWDB Direct Potable Reuse Resource Document<sup>8</sup>, the UCM includes capital cost and operation and maintenance cost curves for advanced water treatment facilities based on two treatment approaches. These schemes have proven effectiveness based on limited direct or indirect potable reuse projects; however, any treatment scheme should be based on site specific data and limitations.

DPR treatment strategies include a combination of infrastructure and treatment approaches to address regulated and unregulated water quality constituents and to provide redundancy for health and safety. Table 5 includes a list of treatment processes for DPR.

**Table 5. AWTF processes and purposes (adapted from TWDB DPR Resource Document, Table 5-1)**

Process	Purpose
Microfiltration (MF) or Ultrafiltration (UF)	Typically functions as pretreatment for membranes to prevent fouling and removes suspended solids
Membrane Bioreactors (MBR)	Combines wastewater treatment plant (WWTP) biological treatment with MF or UF in one unit process. Removes biological oxygen demand (BOD), ammonia, turbidity, and pathogens

<sup>7</sup> “Graves, M., and Choffel, K., 2004, Economic siting factors for seawater desalination projects using reverse-osmosis processes, in Texas Water Development Board Report 363, Technical Papers, Case Studies and Desalination Technology Resources.”

<sup>8</sup> In addition, 10% for contractor overhead and profit were included with the cost curves for consistency with other facility costs.



Process	Purpose
Reverse Osmosis (RO)	Pressure driven membrane process that separates and removes dissolved solids, bulk organics, nitrate, pesticides, CECs and pathogens. Requires additional disposal of concentrate.
Chlorine	Disinfectant for inactivation of pathogens
Ultraviolet Irradiation (UV) Disinfection	Inactivation of pathogens. Effectiveness based on water quality, exposure time and UV intensity
Advanced Oxidation Processes (AOP)	Chemical process to oxidize organic compounds and CECs
Ozone	Strong disinfectant and oxidant of organics
Ozone / Biological Activated Carbon (BAC)	Strong disinfectant and oxidant of organics. BAC helps remove chemical by products of ozonation
Stabilization	Chemical stabilization via recarbonation and dosing with alkaline source to address corrosivity of RO water.

The AWTF approaches below assume secondary or tertiary treated wastewater as the influent. The two AWTF schemes are below and listed from highest to least cost alternatives:

1. MF/UF+RO+UV/AOP + Stabilization
2. Ozone + BAC + MF/UF + UV + Chlorine

A major difference between these two treatment schemes is the use of RO, which is included in Scheme 1 but not in Scheme 2. In order to utilize Scheme 2, nitrogen must be removed at the WWTP. Scheme 1 is closely associated with the direct reuse project in Big Springs, Texas, and Wichita Falls, Texas.

To add AWTF costs, the user must select treatment scheme 1 or 2 and provide the treatment capacity. Scheme 1 assumes adequate MF / UF components to handle larger flow to provide adequate feed water for the RO process since the RO recovery rate is typically 75 to 80 percent. For example, a 1 million gallons per day (mgd) AWTF using Scheme 1 is sized for 1.2 mgd to provide 1 mgd of product water and resulting 0.2 mgd of concentrate. Note that UCM costs for AWTF do not include transmission pipelines, concentrate disposal, engineered storage, or upgrades to WWTP to meet influent criteria for the AWTF. These additional costs should be estimated and included in the overall project cost. As with other facilities, if the user has more specific costs for a DPR strategy, estimates can be provided in the appropriate external cost cells.

### 8.1.5 Reservoirs, Off-Channel Reservoirs, and Terminal Storage

Reservoir cost estimates in the UCM cost tables are not intended to develop detailed and complete costs, but may be considered to provide context for site specific data and calculations. Standard cost tables for construction costs for on channel reservoirs, off-channel reservoirs, and terminal storage are based on reservoir capacity. The user enters the reservoir conservation capacity, area and quantity and the UCM generates a cost estimate using cost curves based on bid data and engineering estimates. The standard cost curves are available to the user when there are no specific details about a reservoir, outside of a storage capacity. Alternatively, the user may use the Embankment Calculations module to develop a more detailed cost estimate when a specific reservoir site and details are available. The user will need to manually link or enter the costs developed in the Embankment Calculations module to the External Cost Estimation column for the appropriate row.

### 8.1.6 Stilling Basins

If a WMS involves discharging into a water body or perhaps into a recharge structure, it may require that excess energy in the water be dissipated so that scouring and erosion do not become a problem. Energy will be dissipated with the use of stilling basins. The user enters the discharge flow in cubic feet per second (cfs), and the UCM calculates a stilling basin cost based on a cost of \$3,652 per unit flow (cfs)<sup>9</sup>. This unit cost will automatically be adjusted based on the CCI value selected.

### 8.1.7 Storage Tanks

Ground storage tanks may be used for stand-alone storage, as part of a distribution system, or as part of a pumping station. The costs for storage tanks are based on cost per million gallons of capacity. The user specifies the type of storage tank to be used (ground storage with roof, ground storage without roof) and the capacity of the storage tank. Elevated storage tanks are rarely used in water transmission systems and are typically utilized in distribution systems within a water service area; however, elevated storage tanks are included in the UCM.

### 8.1.8 Well Fields

Working with the Well Field module, a user may estimate total lengths and diameters of the collection system which will need to be manually added to the Well Field Piping section on the Costing Form (Rows 161-174). Collection piping uses the same cost curves as the transmission piping and the user will need to add the ground type to generate a unit cost. The power connection costs assume a horsepower based on the depth, pump rate and number of wells. The Well Field module if completed will generate a better estimate of total horsepower for the wells which includes necessary power to convey through the collection system and can be manually entered into the External Cost Est column. Note: If there is data in the Well Field module, a warning flag will appear on the Costing Form to alert the user to enter this data. The flag reads:

1. Well Field selected to be included on Project Info & Assumptions, but data from Well Field Module not entered.
  - a. To resolve this flag, the user needs to add data to the Well Field module and copy that into the Costing Form, or
  - b. If costs for a Well Field are not necessary for the WMS, select “No” on the Project Info & Assumptions module in cell D19

The UCM contains four types of wells:

- **Public Supply Wells** - Wells used by municipalities and other water suppliers to supply groundwater for consumption.
- **Irrigation Wells** – Wells used to provide water for irrigation purposes but may also be used in scenarios involving surface and groundwater exchange.
- **Aquifer Storage and Recovery (ASR) Wells** – ASR is the concept of using wells to inject water into an aquifer for temporary storage and then extracting the water later when needed. ASR wells include injection wells, recovery wells, and wells that can be used for both

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<sup>9</sup>Unit cost updated from Version 2.0 of UCM using CCI values.

injection and recovery. Additionally, there are injection wells for injecting reject water from various types of projects.

Well costs have been generated for the different types of wells for pumping water from various static water level ranges and pumpage rates. The costs include complete installation of the well and pump to include drilling services, materials, pump and control equipment, valves, testing, security fencing, and a small access road. The costs do not include those for a building, surface piping connecting to a transmission/collector pipeline, or power connection costs.

### **8.1.9 Conservation**

Conservation strategies are often program based with annual costs. However, some conservation WMS include replacing leaking pipe, meter replacements or other infrastructure improvements to reduce system losses. The UCM includes capital costs for conservation WMS. Pipeline costs reference the cost tables for the transmission pipe and the user will need to identify the length, diameter, ground type and pressure class of pipe. Unique costs can be added into the External Cost Estimation column.

### **8.1.10 Relocations**

Large-scale projects, such as reservoirs, may require the use of lands that contain existing improvements or facilities such as homes, businesses, utilities, and roads. If the benefits outweigh the costs, the new project element may be constructed, but with the requirement that selected affected improvements or facilities be relocated. An example of a relocation is the rerouting of a highway out of the inundation area of a new reservoir. Because the type of improvements and facilities that may be candidates for relocation can vary significantly, estimating the costs for other relocation items should be handled on an individual basis.

### **8.1.11 Integration**

The introduction of treated water to a city, or other entity, may require improvements to connect to the entity's water distribution system. A detailed analysis of a distribution system is needed to determine the system improvements required to handle the introduction of additional water supplies. The analysis would incorporate the development of a model of the entity's distribution system using a program, such as KYPIPE or EPANET, to determine what improvements are needed. This level of work is usually beyond the scope of a regional water planning analysis.

Cost estimates for distribution system improvements should be handled on an individual basis because the magnitude of improvements will vary significantly with each system. Some systems may require very little improvements, while others may require large-scale advancements.

In accordance with 31 Texas Administrative Code (TAC) §357.34(e)(3)(A) the cost of distribution system improvements within a service area should not be part of the cost for a WMS unless it is associated with water savings in a conservation strategy, or a direct reuse project<sup>10</sup>.

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<sup>10</sup> TWDB, Exhibit C, "General Guidelines for Development of the 2026 Regional Water Plans", Second Amended, September 2023.

### 8.1.12 Other Capital Cost Items

Alternatives may involve elements that are not adequately addressed by the cost tables and guidelines within this section. These additional items will require research on an individual basis to obtain appropriate cost estimates. These additional items can be added in the Costing Form in Row 208.

## 8.2 Associated Project Costs

As previously mentioned, “Associated Project Costs” are costs incurred in a project that are not directly associated with construction activities. These include costs for engineering, legal, financing, contingencies, program management, land, easements, surveying, environmental services, and interest during construction.

### 8.2.1 Engineering, Legal, Financing, and Contingencies

Some “Associated Project” costs can be estimated by applying a percentage to the total capital cost. For planning level cost estimates, a percentage of the construction cost is used to calculate costs for engineering, financial, and legal services, and contingencies. The contingency allowance accounts for unforeseen circumstances and for variances in design and construction. A breakdown of the percentages of the construction cost for each of these components can be found in Table 2.

For large scale projects involving multiple design and construction contracts, a project owner may hire a program manager to keep the project running smoothly. If appropriate to use a program manager, the UCM applies a user input percentage of the total construction cost. The percentage should be based on the size of the project.

### 8.2.2 Land Acquisition

Land related costs for a project can typically be divided into two categories, land purchase costs and easement costs. Land purchase costs are those costs incurred for direct purchase of land areas not currently in the project owner’s possession. Survey and legal service costs for land transactions will be added to land and easement costs to get the total land acquisition costs. Suggested land areas for various facility types are listed in Table 6.

Pipelines may be built on lands that are, or are not, possessed by the project owner. Typically, a pipeline will start on land in the possession of the project owner that was purchased and/or dedicated for use with a specific facility, such as a pump station or water treatment plant, and then traverse cross-country. Rather than purchase land along the pipeline route, easements are usually acquired. The general definition of an easement is a right granted by the owner of a parcel of land to another party. The rights are for use of the land for a specified purpose. There are a number of easement types and methods in which they can be created. For pipelines, the process is usually similar to land purchase, with a price being paid for construction of the pipeline on the landowner’s property and for future entry rights for maintenance activities. Payment for easements may be less than land purchase price since the original owner maintains title, and the land is usually restored after construction by the contractor and used by the landowner.

**Table 6. Suggested land area for various facilities**

Facility	Suggested Land Area (acres)
Pump Station	5
Water Treatment Plant	0.5 million gallons per day (MGD)
Water Storage Tanks	2
Reservoirs	Inundation Area <sup>1</sup>
Well Fields <sup>2</sup>	0.5 per well minimum

<sup>1</sup> Larger land areas may be required to account for flood pool, freeboard, etc.

<sup>2</sup> Larger land areas may be required to obtain a certain quantity of water rights.

Two types of easements are usually acquired for pipeline construction: temporary and permanent. Permanent easements are those, in which the pipeline will reside once constructed, and provide room for future maintenance and protect the line from other parallel underground utilities. Temporary easements provide extra working space during construction for equipment movement, material storage, and related construction activities. Once the pipeline has been installed, the grounds are restored to pre-construction conditions, and the temporary easement ceases to exist. The owner of the property may resume activities over the easements, with the right granted to the project owner allowing entry to the permanent easement for inspection, maintenance, and repair activities. The total construction easement width shown is the sum of the permanent and temporary easements. The width of the easement identified on Land Acquisition module should represent the permanent easement width. However, the costs for easements should assume both permanent and temporary.

For more information regarding land acquisition, see Section 7.0.

### 8.2.3 Surveying

Surveying and legal services are required with most land transactions. The UCM defaults to ten percent (10 percent) of the land cost as a portion of surveying, except for reservoirs. The surveying cost for reservoirs is estimated as \$60 per acre of inundation<sup>11</sup>. These default values can be revised provided there is more precise alternative costs to utilize.

### 8.2.4 Environmental and Archaeology Studies, Permitting, and Mitigation

In general, most construction projects will require some type of approval by governmental agencies. Environmental permits may be required by local, state, and/or the federal agencies for projects that affect land and water resources or generate air pollution. Of particular importance, studies for projects will be performed to determine if environmentally sensitive areas, wetlands, threatened or endangered species, and valuable archaeological/cultural resources exist on or near properties where project facilities are proposed for construction. In addition, such conditions may result in restrictions or modifications in construction, may require mitigation, and in some cases could prevent construction altogether. As related to construction projects, mitigation refers to actions taken to achieve equitable compensation given for environmental impacts relative to construction and/or

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<sup>11</sup> Unit cost for reservoir land surveying updated from Version 2.0 of UCM using CCI values.

operation of the project. This could include purchase of land, enhancement of wildlife habitat and/or money compensation.

Environmental and archaeological studies are usually performed during the design phase of a project, though some investigations may occur during the preliminary engineering phase. In the studies level analysis of a project, it is difficult at best to determine what permits may be required and the costs for environmental studies. There will be some base fee for the initial environmental studies that will be performed on a project. More detailed environmental analysis may be required if any environmental issues are discovered, which could result in increased environmental studies and permitting costs, and perhaps mitigation. Mitigation, if required, can vary significantly, as would the related value/cost. Costs for environmental studies, permitting, and mitigation are project dependent and should be estimated on an individual basis using information available and the judgment of qualified professionals. For all project components except pipelines, the UCM assumes the Environmental/Mitigation Costs are 100 percent of land costs. This assumption can be adjusted by the user as appropriate. The recommended value for environmental studies and mitigation costs for pipelines is \$30,000/mile of pipeline<sup>12</sup>.

### 8.2.5 Interest during Construction

An entity generally funds construction projects by securing loans or selling bonds of some type. Typically, the entity receives the funds at the start of the construction project and pays the contractor from the funds over the duration of the construction period. Interest on the borrowed funds will be charged during the construction period as well. It is desired by the entity not to make payments on the borrowed funds or the interest until the project is complete and is generating revenue. As such, the interest during construction (IDC) is determined and treated as a cost item to be included as part of the total project cost and made part of the loan. In addition, the entity may invest part of the borrowed funds during the construction period and any gains made on the investments can be used to offset interest payments (i.e. reduce the net interest during construction).

IDC is calculated as the cost of interest on the borrowed amount less the return on the proportion of borrowed money invested. The IDC is calculated by applying the net interest rate over the construction period of the project to the average project cost (Equation 10). The net interest rate is the interest rate on borrowed funds less the return interest rate from the investment on unspent borrowed funds. The average project cost is equal to the sum of the capital costs, and all other project costs, excluding IDC, divided by two.

$$\text{IDC} = [\text{Amount Borrowed} \times \text{Annual Rate of Loan} \times \text{Construction Period (years)}] - \quad (10)$$

$$[\text{One-Half Amount Borrowed} \times \text{Annual Rate of Return} \times \text{Construction Period (years)}]$$

The final total project cost is equal to all costs plus the interest during construction. The UCM provides for unique IDC for Reservoir and non-reservoir construction.

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<sup>12</sup> Recommended unit cost for pipeline environmental studies and mitigation costs updated from Version 2.0 of UCM using CCI values.

## 8.3 Annual Costs

The annual costs in a cost estimate are the estimated annual costs that the project owner can expect if the project is implemented. These costs include the costs for repayment of borrowed funds (debt service), operation and maintenance costs of the project facilities, pumping power costs, and possibly water purchase costs.

### 8.3.1 Debt Service

Debt service is the estimated annual payment that can be expected for repayment of borrowed funds based on the total project cost (present worth), the project finance rate, and the finance period in years. The UCM contains the necessary calculations to estimate annual payments based on financing period and interest rates. The financing period and interest rates are entered on the Project Information & Assumptions module.

### 8.3.2 Operation and Maintenance

Operation and maintenance costs for dams, pump stations, pipelines and well fields (excluding pumping power costs) include labor and materials required to maintain the project, regular repair and/or replacement of equipment. O&M costs are calculated as a percent of the total estimated construction cost for various types of facilities.

1. Pipeline, Tank, Distribution, and Well
2. Dams and Reservoirs
3. Intake and Pump Stations

These percentage rates are entered on the Project Information & Assumptions module by the user.

### 8.3.3 Pumping Energy Costs

Power costs are calculated on an annual basis using the appropriate calculated power load and a power rate. The power rate is entered on the Project Information and Assumptions module by the user. For peaking projects, the UCM calculates the annual power not the peaking power. Note that energy costs for WTP and AWTF are included in the O&M estimates.

### 8.3.4 Purchase of Water

The purchase cost, if applicable, should be shown if the alternative involves purchase of raw or treated water from an entity. This cost may include other fees on the water such as groundwater district fees, wheeling fees or others and will vary by source.

## 9.0 Cost Summary

The Cost Summary module (“Cost Summary” sheet – Figure 13) pulls together common costing elements from the Costing Form module and summarizes them and their costs in a simple tabular format capable of being placed directly into a WMS write-up. All the fields within the module are populated automatically. The user may “condense” the summary table to eliminate elements that are not part of the current cost estimate by clicking the “Create Cost Estimate Summary for Report” button. Clicking this button will produce a summary table that only contains line items for elements that contain a cost for the cost estimate. To reset the table, the user can click the “Reset Summary” button. Any warning flags remaining on the Costing Form module will be identified as a warning flag on the Costing Summary.

<b>Cost Estimate Summary Water Supply Project Option September 2023 Prices WUG - Example Project</b>	
<b>Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 277.68 for September 2023</b>	
<i>Item</i>	<i>Estimated Costs for Facilities</i>
<b>CAPITAL COST</b>	
Dam and Reservoir (Conservation Pool acft, acres)	\$0
Off-Channel Storage/Ring Dike (Conservation Pool acft, acres)	\$0
Terminal Storage (Conservation Pool acft, acres)	\$0
Intake Pump Stations (0 MGD)	\$0
Transmission Pipeline (None)	\$0
Transmission Pump Station(s) & Storage Tank(s)	\$0
Well Fields (Wells, Pumps, and Piping)	\$0
Storage Tanks (Other Than at Booster Pump Stations)	\$0
Water Treatment Plant (0 MGD)	\$0
Advanced Water Treatment Facility ( MGD)	\$0
Conservation (Leaking Pipe/Meter Replacement)	\$0
Integration, Relocations, Backup Generator & Other	\$0
<b>TOTAL COST OF FACILITIES</b>	<b>\$0</b>
Engineering:	
- Planning (3%)	\$0
- Design (7%)	\$0
- Construction Engineering (1%)	\$0
Legal Assistance (2%)	\$0
Fiscal Services (2%)	\$0
Pipeline Contingency (15%)	\$0
All Other Facilities Contingency (20%)	\$0
Environmental & Archaeology Studies and Mitigation	\$0
Land Acquisition and Surveying (0 acres)	\$0
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	\$0
<b>TOTAL COST OF PROJECT</b>	<b>\$0</b>
<b>ANNUAL COST</b>	
Debt Service (3.5 percent, 20 years)	\$0
Reservoir Debt Service (3.5 percent, 40 years)	\$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	\$0
Intakes and Pump Stations (2.5% of Cost of Facilities)	\$0
Dam and Reservoir (1.5% of Cost of Facilities)	\$0
Water Treatment Plant	\$0
Advanced Water Treatment Facility	\$0
Pumping Energy Costs (0 kW-hr @ 0.09 \$/kW-hr)	\$0
Purchase of Water ( acft/yr @ \$/acft)	\$0
<b>TOTAL ANNUAL COST</b>	<b>\$0</b>
Available Project Yield (acft/yr)	0
Annual Cost of Water (\$ per acft), based on PF=0	\$0
Annual Cost of Water After Debt Service (\$ per acft), based on PF=0	\$0
Annual Cost of Water (\$ per 1,000 gallons), based on PF=0	\$0.00
Annual Cost of Water After Debt Service (\$ per 1,000 gallons), based on PF=0	\$0.00
HDR	3/1/2024

Figure 13. Costing Summary module



## 10.0 Advanced Water Conservation

Advanced water conservation is considered to be the conservation above and beyond that of the water efficiency savings that are included in the TWDB water demand projections. The Conservation module (“Conservation” tab – Figure 14) of the UCM provides the user an option of a simplified or more detailed method of calculating advanced municipal water conservation savings and associated costs. The TWDB also created the Municipal Water Conservation Planning Tool (MWCPT) in November 2018 to assist with planning and tracking municipal water conservation programs. The MWCPT is available for use but not required for evaluation of water conservation strategies.

Advanced Water Conservation							
Simple Approach							
<u>Municipal Water Conservation</u>							
Conservation Goal (gpcd):	120	Urban Unit Cost (\$/acft/yr):		\$692			
Rate to Achieve Goal (%/yr):	1.0%	Suburban Unit Cost (\$/acft/yr):		\$785			
Rate Once Goal Is Achieved (%/yr):	0.25%	Rural Unit Cost (\$/acft/yr):		\$888			
Location:	Urban						
WUG/WWP:	City						
Planning Year:	2011	2030	2040	2050	2060	2070	2080
Population:		16,563	18,722	21,276	24,114	27,331	30,977
Water Demand (acft/yr):		2,310	2,607	2,955	3,349	3,796	4,303
Per Capita Water Use (gpcd):	126	125	124	124	124	124	124
Base Per Capita Goal (gpcd):		116	113	110	107	105	102
Advanced Water Conservation (acft/yr):		163	241	332	450	591	761
Adv. Water Conservation Cost (\$/yr):		\$113,111	\$166,517	\$229,950	\$311,358	\$409,255	\$526,403
Detailed Approach							
WUG/WWP:	City						
Planning Year:	2011	2030	2040	2050	2060	2070	2080
Population:		16,563	18,722	21,276	24,114	27,331	30,977
Water Demand (acft/yr):		2,310	2,607	2,955	3,349	3,796	4,303
Per Capita Water Use (gpcd):	126	125	124	124	124	124	124
<u>Savings Rate</u>							
Large Meter Replacement		3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Small Meter Replacement		3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Leak Detection and Repair		3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Advanced Pressure Management		3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Public & School Education		1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Water Audits		0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Water Conservation Pricing		1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Landscape Design Conversion		4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Passive Clothes Washer		7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
Plumbing Retrofits		2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Other		2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
<u>Implementation Rate/Effectiveness</u>							
Large Meter Replacement		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Small Meter Replacement		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Leak Detection and Repair		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Advanced Pressure Management		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Public & School Education		50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Water Audits		1.2%	1.4%	1.6%	1.8%	2.0%	2.2%
Water Conservation Pricing		15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Landscape Design Conversion		5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Passive Clothes Washer		10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Plumbing Retrofits		10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Other		5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
<u>Program Costs</u>							
Large Meter Replacement	Unit Cost	\$ 153	\$ 153	\$ 153	\$ 153	\$ 153	\$ 153
Small Meter Replacement	Unit Cost	\$ 380	\$ 380	\$ 380	\$ 380	\$ 380	\$ 380
Leak Detection and Repair	Unit Cost	\$ 164	\$ 164	\$ 164	\$ 164	\$ 164	\$ 164
Advanced Pressure Management	Unit Cost	\$ 210	\$ 210	\$ 210	\$ 210	\$ 210	\$ 210
Public & School Education	Unit Cost	\$ 527	\$ 527	\$ 527	\$ 527	\$ 527	\$ 527
Water Audits	Unit Cost	\$ 940	\$ 940	\$ 940	\$ 940	\$ 940	\$ 940
Water Conservation Pricing	Annual Cost	\$ 1,000	\$ 1,000	\$ 1,000	\$ 1,000	\$ 1,000	\$ 1,000
Landscape Design Conversion	Annual Cost	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500
Passive Clothes Washer	Unit Cost	\$ 350	\$ 350	\$ 350	\$ 350	\$ 350	\$ 350
Plumbing Retrofits	Unit Cost	\$ 155	\$ 155	\$ 155	\$ 155	\$ 155	\$ 155
Other	Unit Cost	\$ 100	\$ 100	\$ 100	\$ 100	\$ 100	\$ 100
<u>Potential Water Savings (acft/yr)</u>							
Large Meter Replacement		18	20	23	26	30	34
Small Meter Replacement		18	20	23	26	30	34
Leak Detection and Repair		18	20	23	26	30	34
Advanced Pressure Management		18	20	23	26	30	34
Public & School Education		17	20	22	25	29	32
Water Audits		0	0	0	0	0	0
Water Conservation Pricing		3	4	4	5	6	6
Landscape Design Conversion		5	5	6	7	8	9
Passive Clothes Washer		16	18	21	23	27	30
Plumbing Retrofits		5	5	6	7	8	9
Other		2	3	3	3	4	4
Advanced Water Conservation (acft/yr):		121	136	154	175	198	225
Adv. Water Conservation Cost (\$/yr):		\$ 33,677	\$ 37,820	\$ 42,676	\$ 48,175	\$ 54,415	\$ 61,494
Adv. Water Conservation Unit Cost (\$/acft/yr):		\$ 278.93	\$ 277.55	\$ 276.29	\$ 275.18	\$ 274.21	\$ 273.35

Figure 14. Water Conservation module

## 10.1 Simplified Approach

Using the Simple Approach, the user enters the population and net water demand for a given WUG/WWP for each decade of the planning period, as well as the historical per capita water use associated with the base water use year (Year 2011 for the 2026 Regional Water Plans). The user specifies a target per capita water use as the conservation goal in gallons per capita per day (gpcd). The user also specifies the rate (percent per year) at which the gpcd should decrease each year until the goal is achieved and the rate of yearly gpcd decrease after the goal has been reached. If no additional conservation is to be included after the goal is met, the “Rate Once Goal Is Achieved” can be set to zero.

Finally, the user sets the unit cost of conservation by specifying the urban/suburban/rural setting of the WUG/WWP. Default unit costs in Version 2.0 for municipal water conservation were obtained from the “Quantifying the Effectiveness of Various Water Conservation Techniques in Texas”<sup>13</sup> study conducted for TWDB in 2003. Version 3.0 includes updated default unit costs from Appendix B of the 2022 report “Hidden Reservoirs: Addressing Water Loss in Texas”<sup>14</sup>. Using the Construction Cost Index, the 2022 urban unit cost of \$675 per ac-ft was indexed to September 2023 dollars (\$692 per ac-ft). The default costs represent an urban unit cost of municipal conservation without agricultural conservation. The default suburban and rural unit cost of conservation were estimated using the same scaling factors as those used in Version 2.0 of the UCM. The adjustments result in a suburban conservation unit cost of \$785 and a rural conservation unit cost of \$888. Note that the user may deviate from these default unit costs if more specific cost information is available.

## 10.2 Detailed Approach

In the Detailed Approach, the user has the option to add conservation goals for the following conservation measures:

- Large Meter Replacement (added in Version 3.0)
- Small Meter Replacement (added in Version 3.0)
- Leak Detection and Repair (added in Version 3.0)
- Advanced Pressure Management (added in Version 3.0)
- Public & School Education,
- Water Audits, Water Conservation Pricing,
- Landscape Design Conversion,
- Passive Clothes Washers,
- Plumbing Retrofits,
- and Other.

The user can specify the savings rate, the effectiveness, and the costs associated with each conservation measure in terms of annual or unit costs. The Conservation module then computes the advanced water conservation savings by multiplying the water demand, savings rate, and effectiveness. The associated combined annual and unit costs of all the conservation measures are

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<sup>13</sup> GDS Associates, “Quantifying the Effectiveness of Various Water Conservation Techniques in Texas; Appendix VI, Region L,” Texas Water Development Board, Austin, Texas, July 2003.

<sup>14</sup> Walker, J., Wyatt, A., Seefeldt, J., Goshen, D., Bock, M., Johnston, I., & Black, M. (2022). Hidden Reservoirs: Addressing Water Loss in Texas. Austin, TX: National Wildlife Federation.

then calculated. Any conservation strategies that include capital costs must be estimated using the Costing Form module as mentioned in Section 8.1.9. A note in the Conservation module redirects the user to the Costing Form for these types of strategies.

Guidance is provided within the UCM as embedded comments and/or default values. This guidance was obtained from the “Water Conservation Best Management Practices Guide<sup>15</sup>”, Hidden Reservoirs Report or previous Regional Water Plans. Further documentation of default values for the Savings Rate, Effectiveness and Program Costs components of the Costing module are provided in the following subsections.

### **10.2.1 Savings Rate**

Default savings rates were obtained from Figure 1 of the Water Management Strategy Analysis Tech Memo of the 2021 Region H Regional Water Plan, where noted<sup>16</sup>.

These values were originally obtained from the municipal conservation technical memorandum focused on the City of Houston in the Region H 2011 Regional Water Plan. Savings and costs identified in the City of Houston water conservation plan were used to help develop savings and costs for the regional plan. For the default values, it is assumed that the percent savings rates are still applicable.

### **10.2.2 Implementation Rate/Effectiveness**

The default implementation rate of water audits was obtained from the Region H 2021 Regional Water Plan. Table 3 of Appendix 5-B identified implementation rates for high to low potential and small to large utilities. The Region H implementation rates are not based on a prior study, but rather from best judgement and available stakeholder feedback on what could be intended as an aggressive but achievable goal. The Region H Regional Water Plan varies implementation rates over time based on both WUG size and initial gpcd. It is assumed that audits and most other measures would be implemented gradually. The mid-potential, medium sized utility implementation rates for irrigation audits for single-family residential high users are assumed as the default values. These rates range from 1.0 percent in 2020 to 2.0 percent in 2070.

### **10.2.3 Program Costs**

The default program costs in the detailed approach were obtained from Appendix B of “Hidden Reservoirs: Addressing Water Loss in Texas”. The average water loss reduction strategy unit costs were assumed for the program cost for large meter replacement, small meter replacement, leak detection and repair, and advanced pressure management.

The small and large meter replacement unit costs include the meters, installation, and any procurement or administrative costs. The unit cost of the leak detection and repair strategy include

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<sup>15</sup> Water Conservation Implementation Task Force, “Water Conservation Best Management Practices Guide,” November 2004. [https://www.twdb.texas.gov/publications/reports/numbered\\_reports/doc/R362/Report362.asp](https://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R362/Report362.asp)

<sup>16</sup> Figure 1 of the 2011 Region H RWP Water Management Strategy Analysis Tech memo for Advanced Municipal Conservation (Appendix 5-B-CNSV-001) reflects TWDB's plumbing code savings, and is not included as part of the WMS savings. Savings rates in the 2021 tech memo are derived primarily from the reference information in TWDB's MWCPT. Separate COH data for conservation was not utilized in the 2021 RWP.

the cost of the survey. It should be noted that the number of installations and the percent pressure reduction influence unit cost.

Public and School Education and Water Audit program unit costs were taken from the Region H 2011 Regional Water Plan and indexed using the construction cost index. These costs came from the municipal conservation technical memorandum focused on the City of Houston. The technical memorandum included data on utility surveys they received and identified the most applicable strategies for different population ranges.

## 11.0 Drought Management Risk Factor and Cost

### 11.1 Simplified Approach

Financial impacts due to water shortages on demands can be significant and can have far ranging socioeconomic impacts. In past planning cycles, the TWDB has assisted the regional water planning groups in estimating the socioeconomic impacts by developing a report using the Impact Analysis for Planning (IMPLAN) economic modeling software package<sup>17</sup>, and made the report available to the planning regions. Impacts include tax losses, utility revenue losses, income and job losses, population and school enrollment losses. The TWDB plans to provide the socioeconomic report to be included in the 2026 Regional Water Plans in August 2025.

In Fall 2019, the TWDB developed a Drought Management Costing Tool and User Guide for the regional water planning groups using the same model for estimating lost consumer surplus, one of the several impact measures included in the socioeconomic impact estimates for the 2021 Regional Water Plan. In March 2024, the TWDB released an updated version of the [Drought Management Costing Tool](#) and [User Guide](#), which are posted on TWDB's [2026 Regional Water Plan Document Page](#) under 5B. The 2024 version of the tool should be utilized for development of the 2026 Regional Water Plans, should RWPGs choose to use the tool.

### 11.2 Detailed Approach

The detailed approach for Drought Management includes two modules “Dr Mgmt Risk Factors” and “Dr Mgmt Costs,” which are used to develop estimates of municipal drought management water savings (i.e., failure to meet projected water needs) and associated costs (i.e. economic impacts of failure to meet projected water needs) for WUGs/WWPs. The calculations are rather complex, and are described in detail in Appendix D, an excerpt from the 2016 South Central Texas Regional Water Plan<sup>18</sup>. (Note the 2021 South Central Texas Regional Water Plan utilized the TWDB Drought Management Costing Tool for evaluation of Drought Management Strategies.) For the UCM, an

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<sup>17</sup> <https://implan.com/>

<sup>18</sup> South Central Texas Regional Water Planning Group, 2016 Regional Water Plan, Volume II, Technical Evaluations of Water Management Strategies, December 2015.

automated process has been included for quantifying drought management savings and estimating economic impacts which are converted to unit costs for direct comparison to other WMSs.

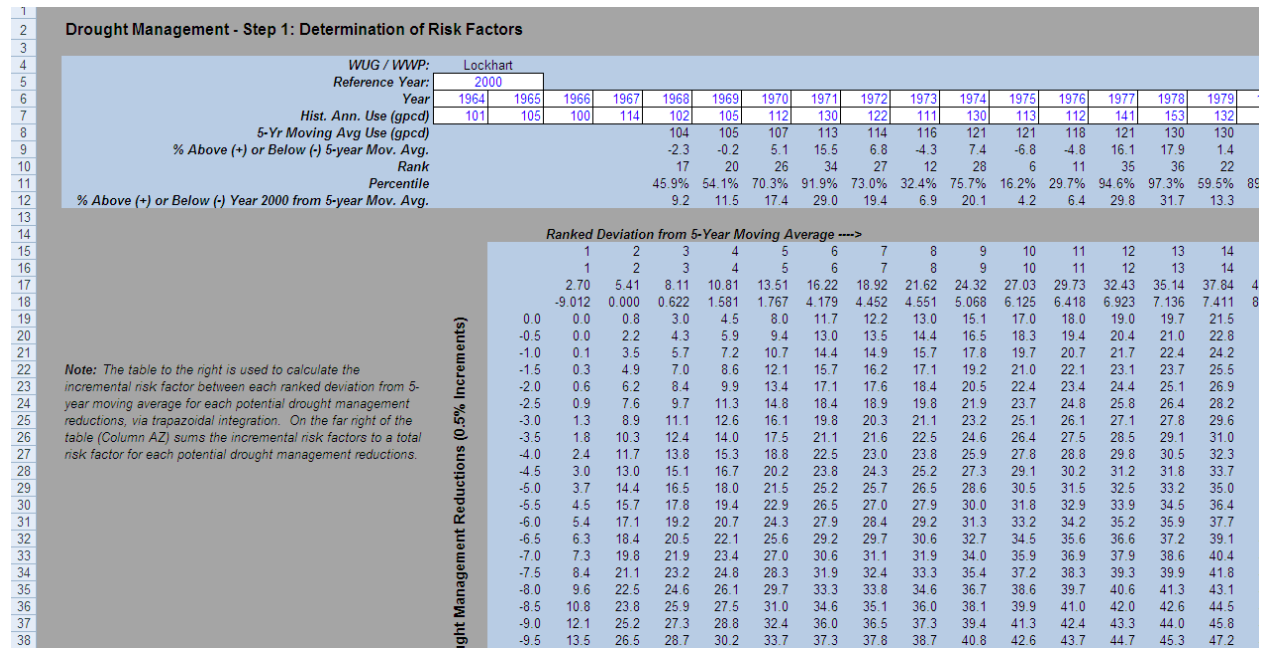


Figure 15. Advanced Drought Management Risk Factors module

The user starts with the Drought Management Risk Factor module (Figure 15) and enters the historical per capita water use data for each WUG/WWP and a reference year. This module calculates the risk associated with making drought management reductions at various levels. The results of this module feed the Drought Management Costs module (Figure 16). It should be noted that drought management WMSs that are evaluated should take into account any previous implementation of drought management that may be embedded in historical gpcd data to avoid under-estimating impacts of annual unit costs of failure to meet projected water need (aka drought management).

The Drought Management Costs module takes results from the Drought Management Risk Factor module and calculates the amount of water saved for 5, 10, 15, and 20 percent reductions, and their associated costs. The user enters the water demand for the municipal WUG/WWP and planning year for which drought management is being considered. Additionally, the user enters the water use sector distribution (domestic/residential, commercial, and manufacturing) for the municipal WUG/WWP and the unit cost of reduction for the various sectors. Information required for this tool is not available from the TWDB and the user will need to use its own data.

	A	B	C	D	E	F	G	H	I	J
1										
2		<b>Drought Management - Step 2: Cost Calculation</b>								
3										
4		<i>Water User Group:</i>	Lockhart							
5		<i>Water Demand (acft/yr):</i>	2 451							
6		<i>Planning Year:</i>	2020							
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	Demand Reduction	Unit Cost
RESIDENTIAL	5%	\$ 920
	10%	\$ 1,030
	20%	\$ 1,290
	30%	\$ 2,130
	40%	\$ 5,780
	50%	\$ 7,040
	60%	\$ 8,950
	70%	\$ 12,120
	80%	\$ 18,460
	>90%	\$ 24,070
Commercial	\$ 35,230	
Industry	\$ -	

Figure 16. Advanced Drought Management Cost module

The Drought Management Costs module processes the inputs and the resulting risk factors from the Drought Management Risk Factor module to determine the amount of water saved due to drought management and the associated economic impact of not meeting water needs.

## 12.0 Project Phasing

The UCM is designed to estimate total project costs for developing WMSs to meet projected water needs through the regional planning period. The UCM has not been designed for the complexities of project phasing and the evaluation of costs at various times during the life of a project. However, if there is a need to demonstrate expansions of WTP or pump stations, or the paralleling of a transmission pipeline, a few items of guidance have been developed below. This is not a comprehensive list but a few examples of how the UCM can be used for project phasing.

The UCM allows for an expansion of existing WTP but only for conventional treatment or Level 3. The user selects the treatment level as “3 (Expansion)” from the drop down menu on the Costing Form. The capacity field represents the incremental capacity for the expansion. For example, if a plant was to expand from a 5 mgd to a 10 mgd plant, the user would enter “5 mgd” for capacity.

A conservative approach for expanding a pump station would require estimating the cost for the current versus the proposed pump station and then adding that difference to the External Cost Est

column. Alternatively, if most of the electrical and structural elements will not be revised, replacing pumps and motors may represent up to 35% of the cost of the pump station.

To estimate the hydraulics of a future parallel pipeline, the user will need to determine the correct balance of flow rate and losses in each pipeline. If the diameters and C-factor are identical in the pipelines, the flow rate will be the same. However, for pipelines originating from the same pump station the hydraulics will be such that the losses in the pipe are identical but the flow rates may be different. The user could approach this using two Advanced Hydraulic Calculation modules to determine the correct flow rates and pumping energy and then revise the Costing Form to account for the necessary infrastructure.

This is not a comprehensive list but provides examples of how the UCM can be used for project phasing.

## 13.0 References

South Central Texas Regional Water Planning Group, 2016 Regional Water Plan, Volume II, Technical Evaluations of Water Management Strategies, December 2015.

GDS Associates, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas; Appendix VI, Region L," Texas Water Development Board, Austin, Texas, July 2003.

Huffstickler, Ronny, Personal Email, American Ductile Iron Pipe Company, March 8, 2013.

Water Conservation Implementation Task Force, "Water Conservation Best Management Practices Guide," November 2004.

Alan Plummer Associates, Inc., "Direct Potable Reuse Resource Document", April 2015.

TWDB, Exhibit C, "General Guidelines for Development of the 2026 Regional Water Plans", First Amended, October 2022.

Walker, J., Wyatt, A., Seefeldt, J, Goshen, D., Bock, M., Johnston, I., & Black, M. (2022). Hidden Reservoirs: Addressing Water Loss in Texas. Austin, TX: National Wildlife Federation.

Region H Regional Water Planning Group, 2011 Regional Water Plan, Region H Water Management Strategy Analysis Technical Memorandum, August 2010.



## **APPENDIX A**

### **UCM Change Log of Updates Completed in Version 3.0**

**(Changes from previous updates can be found in the Change Log included in the UCM)**

Version 3.0 Changes			
Module	Description of Change	Changed Cells	Scope Item
Advanced Hydraulics	If an end station is not entered in V10:V14, the formula defaults to taking the Max of Q20:Q30 rather than Q20:Q5019. Corrected formula.	K20	2C
Costing Form	Directional Drilling cost formula updated to allow an override of \$0. Previous formula required override to be greater than \$0.	I141	2C
Costing Form	Previous formulas did not take into account power connection and real estate for multiple boosters in simplified hydraulics. Corrected.	F65, F244 (real estate)	2C
Costing Summary	Reference for pipeline length set to incorrect cell on Costing Form tab. Corrected.	B11	2A
Costing Summary	Previous formula did not retrieve pump station size if using simplified hydraulics. Corrected.	B10	2A
Cost Tables	Added additional pipeline diameters to match pipe diameter options in the Costing Form	Various	2B
Costing Summary	Corrected cell formatting to properly show pump station size if using simplified hydraulics.	B10	4C
Advanced Hydraulics	Added link to help topic for generating pipeline profiles using ArcGIS Pro's ready-to-use profile tool	N/A	4C
Advanced Hydraulics Chart	Made modification to account for changes in pipe pressure classes for individual pipe segments	Various	4C
Well Field	Made modification to allow UCM user-adjustable value for well-field pump efficiency.	D9,O17:O35, Q17:Q35	4C
Well Field	Made modification to allow UCM user-adjustable value for contingency wells.	D10	4C
Project Info & Assumptions & Costing Form	Made modification to allow storage tank type for pump stations to be user-selectable.	Various	4C
Project Info & Assumptions & Costing Form	Made modification to allow for user-selectable sizing of storage tanks for pump stations based on flow.	Various	4C
Costing Form & Summary	Created sub categories for contingencies to better align with TWDB Form 1201.	Various	4B
Costing Form	Added Backup Generator line item.	Row 209	4C
Conservation	Added new conservation measures and updated default values. See User Guide.	Various	4A
Simplified and Advanced Hydraulics	Made modification to allow for user adjusted pump station headloss.	S-G13, D26, G14 Adv - E38, H38, K38, H41, K41	4C

## **APPENDIX B**

### **Pipeline Route and Profile Generation Procedures**

Using the pipeline route selection guidelines, a route can be defined, and then a corresponding profile generated. Advancements in computer technology and the growth of Geographic Information Systems (GIS) have resulted in mapping tools that can accelerate this process significantly. The definition of GIS is as follows:

*Geographic Information Systems (GIS) – an organized collection of computer hardware, software, geographic data, and personnel, designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced data.*

For study planning purposes, the definition may be summarized as follows:

*Geographic Information Systems (GIS) – a system for utilizing data that is linked spatially to a geographic reference.*

GIS should be used to the greatest extent practical as the means for laying out a pipeline route and “capturing” the profile information because it offers increased efficiency and speed in performing these tasks. An appropriate set of tools useful in determining pipeline routes and profiles consists of the following:

**ArcGIS** – This is a mapping and GIS software package created by Esri<sup>21</sup>. It has capabilities for creating maps, adding features (such as pipeline routes) to existing maps, and for readily integrating multiple geographically referenced databases.

**Digital Elevation Model (DEM)** – DEMs are files that have ground elevation data located at regularly spaced intervals in a geographic area. These files provide elevation data only.

**United States Geological Survey (USGS) Topographic Maps** - USGS topographic maps are available in electronic format locally through the Texas Geographic Information Office (TxGIO)<sup>22</sup>.

**Topologically Integrated Geographic Encoding and Referencing (TIGER) Maps** - These are mapping files prepared by the United States Census Bureau. TIGER maps show many of the items that are shown on USGS topographic maps, such as rivers, lakes, roadways, railroads, and urban centers. It does not, however, provide information on ground elevation data and vegetation conditions. Data such as population counts and political boundaries may be spatially linked to the map. Though void of ground elevation data, these maps can be very useful for determining a pipeline alignment.

**Texas Department of Transportation (TxDOT) Highway Maps** - County highway maps are available in electronic format.

**ArcPro Profile Tool**<sup>23</sup> – This is a custom built tool within the ArcGIS Pro 3.1 software to extract the station, elevation, and crossing data (streams and rivers major roads, railways, etc.) along a specified route and save it to an exportable data file.

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<sup>21</sup> <http://www.esri.com/>

<sup>22</sup> <https://tnris.org/>

<sup>23</sup> <https://pro.arcgis.com/en/pro-app/latest/tool-reference/ready-to-use/profile.htm>

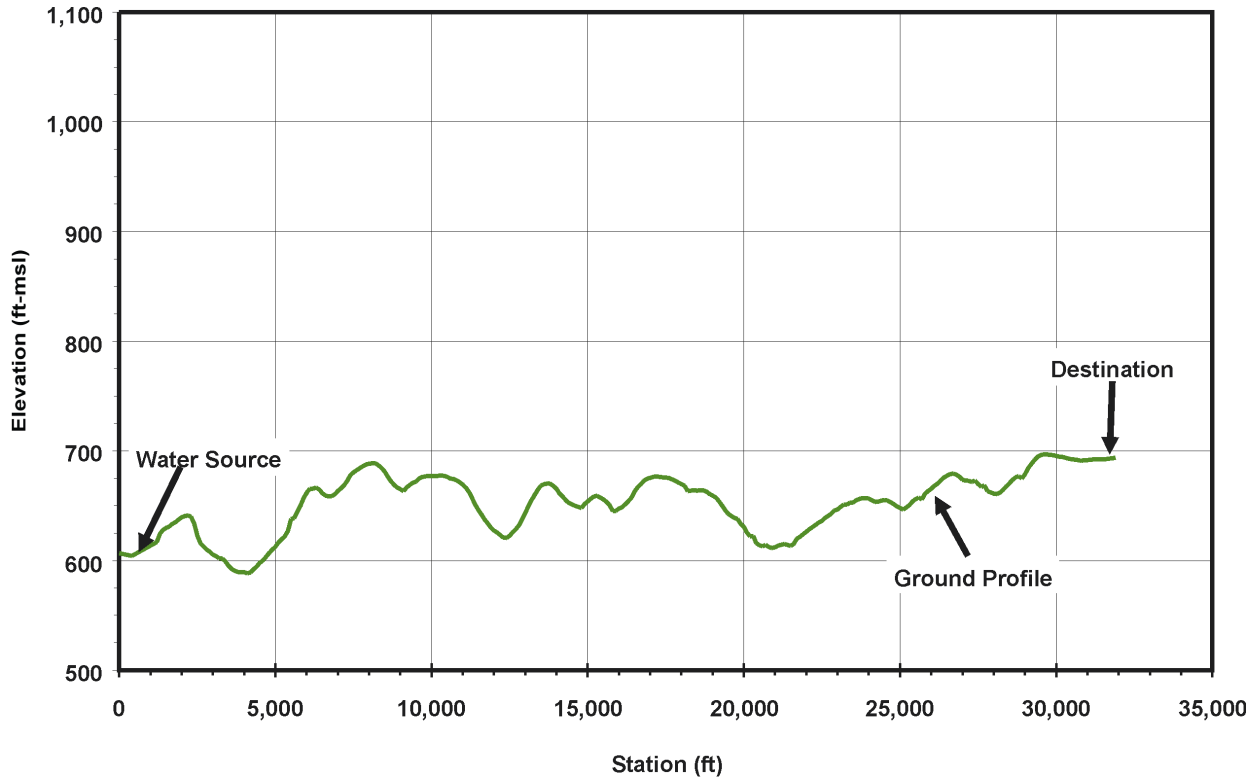
**Aerial Photography** – Current aerial photography, that can be accessed online or via various agencies, that are useful to determine urban development along the specified route.

**Google Earth** – Routes can also be delineated using Google Earth and exporting the alignment as a KML/KMZ file that can be imported into GIS software.

**Note:** Alternative higher resolution datasets can and should be used if readily available.

**Because of the time reduction that GIS can offer in route selection and profile generation, using GIS is the preferred method for technical evaluation of water management strategies considered in the regional water planning process.** The steps for laying out a pipeline and profile generation using GIS are as follows:

1. Consult with a GIS specialist.
2. Using the ArcGIS software, lay out a pipeline route on a topographic, current aerial photography, TIGER, or highway map that is overlaid on a corresponding DEM. Define and draw a route on the map following the route selection guidelines. If a TIGER or TxDOT map is used to layout a route, it is recommended to check the pipeline alignment on a USGS topographic map and current aerial photography to identify potentially undesirable land features along the pipeline. For example, make sure that the route is not traversing extremely rough terrain or that it is not going over a high peak when there is relatively flat ground close by. Additionally, USGS maps may provide more details regarding features that need to be accounted for such as stream crossings along the pipeline route. Once created, the pipeline route can easily be placed on different types of map files, with the location on each being determined using latitude and longitude coordinates (i.e. geo-referenced).
3. Extract profile data using the alignment generated in step 2 and an available elevation dataset. You can use tools within the ArcGIS software to create a listing of stations with X, Y and Z data. Crossing data can then be attributed to these stations based on underlying datasets. Soil types and whether the alignment falls within developed/undeveloped areas can be associated to the stations. The station interval distance between these points should be such that the general land features are recorded while capturing points of significant elevation changes. Begin stationing at the water source for consistency. Save the profile data to an electronic file.
4. Generate a plot of the ground profile using a spreadsheet. The data saved in step three will probably have to be “delimited” so that it can be read directly into columns of a spreadsheet. The plot will have elevations on the vertical axis and stations on the horizontal axis (see Figure 1). Treat the ground profile as if it were the pipeline profile for regional planning purposes, therefore, no adjustments to the elevation data will need to be made for pipe burial. In an actual pipeline design project the ground profile would be plotted along with a profile of the pipeline beneath the ground surface by a specified amount of ground cover.



**Figure 1. Typical Ground Profile Plot**

Once the profile has been generated, the crossing data can be used to determine if any special installations utilizing trenchless technology construction techniques are required. Such crossings may include streams, roads, railways, and major rivers. In addition, urban/rural, land use and soil conditions impacts along the route can be easily categorized. This information is needed in order to prepare the construction cost estimate and can be generated quickly for multiple routes for easy analysis.

## **APPENDIX C**

### **Unit Cost Table Development Technical Memorandum**

<b>TO:</b>	Zachary Stein, P.E.
<b>FROM:</b>	Philip Taucer, P.E.
<b>SUBJECT:</b>	Texas Water Development Board Unified Costing Model Update: Proposed Unit Cost Updates
<b>PROJECT:</b>	HDR23563
<b>DATE:</b>	February 27, 2024
<b>CC:</b>	Gail Hamrick-Pigg, P.E. Neil E. Deeds, PhD, P.E.

<b>DRAFT</b>
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF PHILIP I TAUCER, P.E., TEXAS NO. <u>108912</u> ON <u>FEBRUARY 27, 2024</u> . IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES. FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F- 2144

## 1.0 INTRODUCTION

A team including HDR Inc., Freese and Nichols, Inc. (FNI), CAS Consulting and Services, Inc., and Intera, Inc. was retained by the Texas Water Development Board (TWDB) to update the Uniform Costing Model (UCM). The UCM was originally developed for the 2016 Regional Water Plans (RWPs) (Version 1.0) to provide a level of consistency between cost estimates developed for the 16 Regional Water Planning Groups (RWPGs) and their consultants. The UCM was revised for the 2021 Regional Plans (Version 2.0) to update cost data and enhance functionality. The UCM was revised again for the 2026 Regional Plans (Version 3.0) with a focus on updating cost data to reflect recent market volatility and inflation, but also to further enhance functionality. The updated unit costs for Version 3.0 of the UCM will be used by the RWPGs and their consultants in developing the 2026 RWPs.

The UCM is utilized extensively in the TWDB RWPs to develop planning-level cost estimates for water management strategies and projects. In order to address the evolution of infrastructure economics over time, the UCM update for Version 3.0 utilized construction bid data for recent projects, construction and material cost indices, and other available data to update unit costs for multiple infrastructure components, including:

- Booster and intake pump stations
- Rural and urban pipelines
- Tunneling
- Water treatment plants (WTP)
- Advanced water treatment facilities (AWTF)
- Traditional on-channel dams, off-channel reservoirs (OCR), and terminal storage reservoirs
- Elevated storage tanks and ground storage tanks
- Wells for public water systems (PWS), irrigation, and aquifer storage and recovery (ASR)
- Operations and maintenance (O&M) costs for select infrastructure components.



## **2.0 METHODOLOGY**

### **GENERAL METHODOLOGY**

Recent (typically 2018 or newer) historical bid tab costs compiled by the participating consulting firms were indexed to January 2023 dollars. The existing UCM cost curves from Version 2.0 were also adjusted to January 2023 dollars and plotted for a direct comparison with the recent bid data. The existing curves were then revised as needed based on comparison of the existing cost curves and recent bid data.

All unit costs recommended in this update include the contractor mobilization and demobilization, overhead, and profit. The unit costs do not include engineering, contingency, financial and legal services, costs for land and rights-of-way, permits, environmental and archeological studies, or mitigation. The costs for these elements are determined separately in the UCM based upon TWDB-specified factors or project-specific information. Proposed UCM unit costs, which are presented in January 2023 dollars in this memorandum, are indexed to September 2023 dollars as specified by the 2026 RWP Guidelines.

### **INDEXING UNIT COSTS**

During the original development of the cost curves, it was determined that the curves for the infrastructure components listed in **Section 1.0** should be adjusted for changing construction prices. Adjustment to January 2023 equivalent dollars utilized the Engineering News-Record (ENR) Construction Cost Index (CCI) for all components except for pipelines and tunneling, which were adjusted using the U.S. Bureau of Labor Statistics Producer Price Index (PPI). It was determined during the Version 2.0 update of the UCM that a separate index should be used for pipeline/tunneling projects because pipeline projects are particularly dependent upon the cost of steel for steel pipe and the price of oil for plastic pipe and the PPI better reflects the changes in steel and oil prices.

## **3.0 SPECIFIC CONSIDERATIONS FOR UNIT COST UPDATES**

### **PUMP STATION UNIT COSTS**

New project bid information was available for five new pump station projects as a function of horsepower (HP) and five new projects as a function of capacity in millions of gallons per day (mgd). The pump station project costs include only the pump station facilities and exclude any associated external transmission and distribution components or other infrastructure elements. Cost curves were updated for booster and intake pump stations on both a HP and capacity basis to allow the UCM to accommodate the use of either factor in estimating pump station cost.

The bid data for intake pump stations did not include HP information. Therefore, the existing HP-based intake pump station cost curve for sizes less than 2,000 HP was scaled using the ratio of the updated and existing booster pump station curves. There was insufficient data for larger booster and intake pump stations greater than 5,000 HP and 2,000 HP, respectively. Therefore, the existing curves were updated based on adjustments made to the curves below 5,000 HP and 2,000 HP.

For the capacity-based cost curves, there is insufficient data for both intake and booster stations at 50 mgd capacity and larger. Similar to the HP-based curves, the existing capacity-based curves for the higher ranges were updated based on the adjustments made to the curves below 50 mgd.

The existing curves are plotted alongside the new HP-based bid data and proposed revised cost curves in [Figure 1](#) for sizes less than 5,000 HP. [Figure 2](#) presents the same information for the entire range of sizes. [Figure 3](#) and [Figure 4](#) similarly reflect the analysis for capacity-based pump station cost curves. The inflection points shown in the figures are based on the historical data and the availability of the new bid data. Updated cost curve reference tables are included in [Table 1](#) and [Table 2](#).

Figure 1. Bid Data and Horsepower-Based Cost Curves for Booster and Intake Pump Stations (Less than 5,000 HP, January 2023 Dollars)

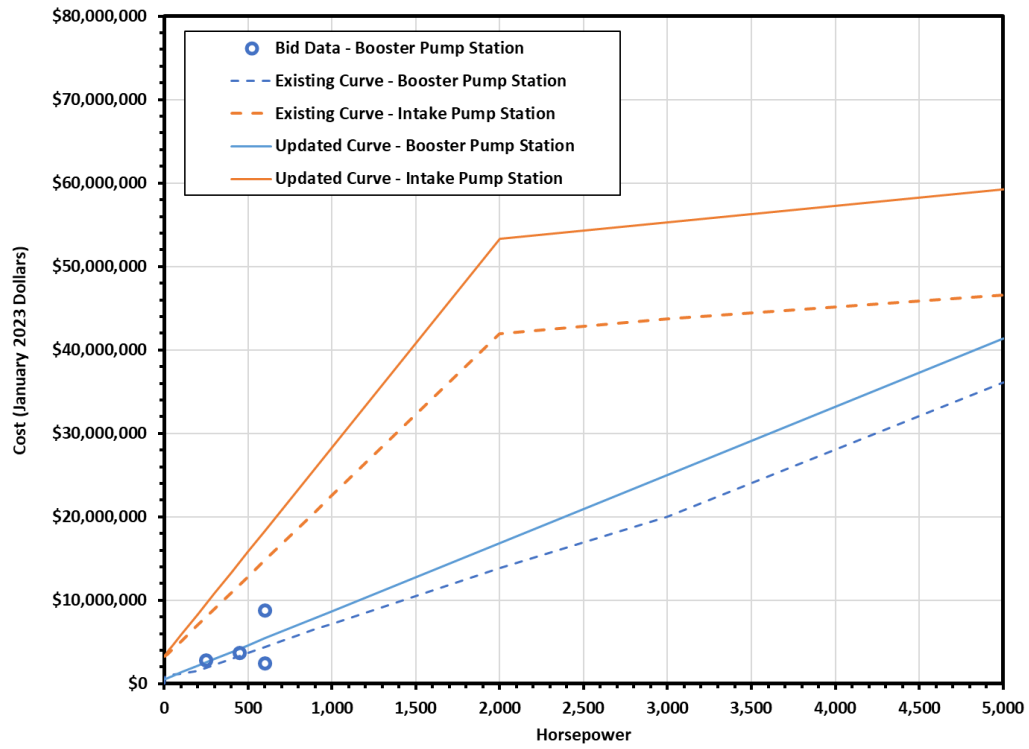


Figure 2. Bid Data and Horsepower-Based Cost Curves for Booster and Intake Pump Stations (January 2023 Dollars)

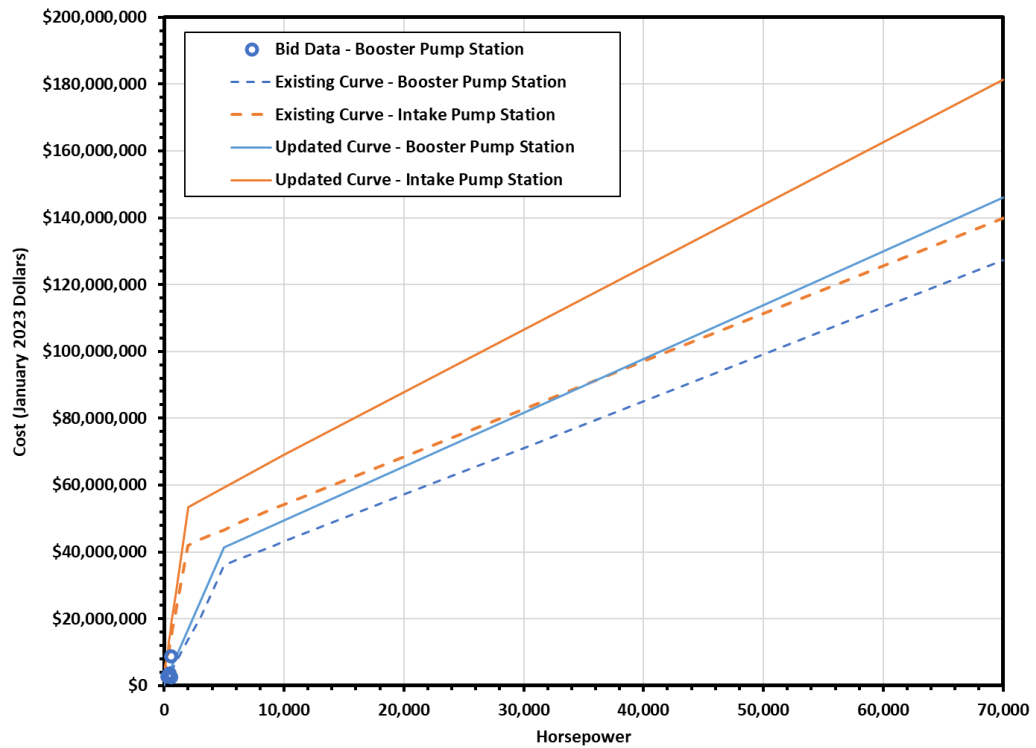


Figure 3. Bid Data and Capacity-Based Cost Curves for Booster and Intake Pump Stations (January 2023 Dollars)

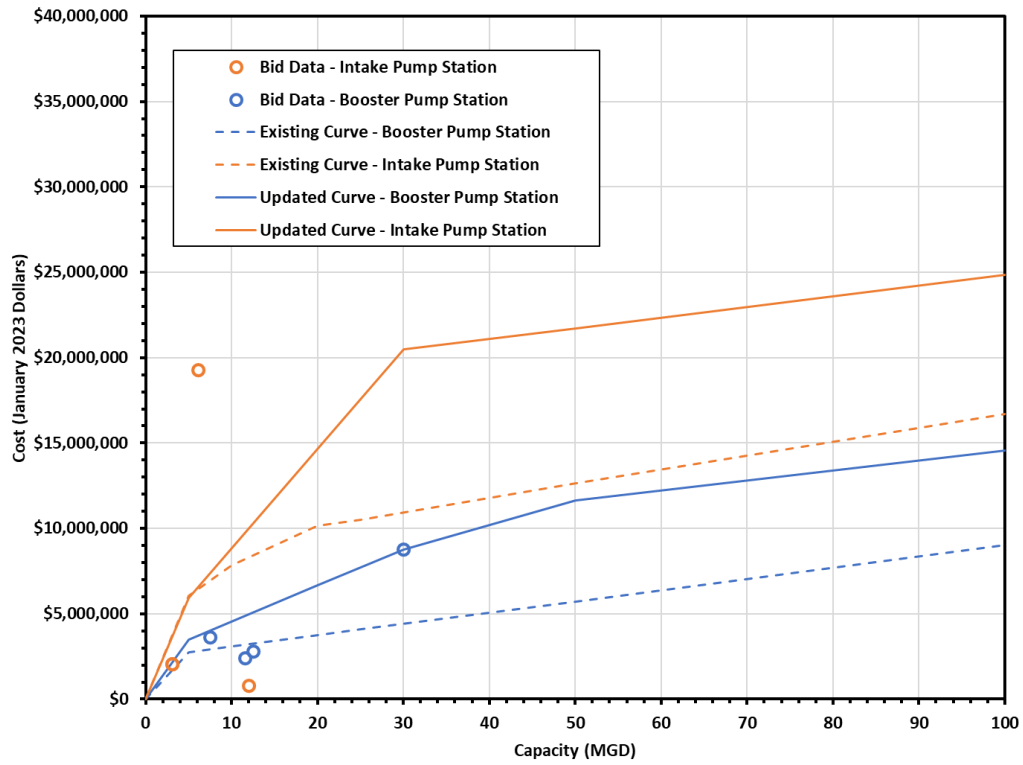


Figure 4. Bid Data and Capacity-Based Cost Curves for Booster and Intake Pump Stations (Lower Capacity Focused, January 2023 Dollars)

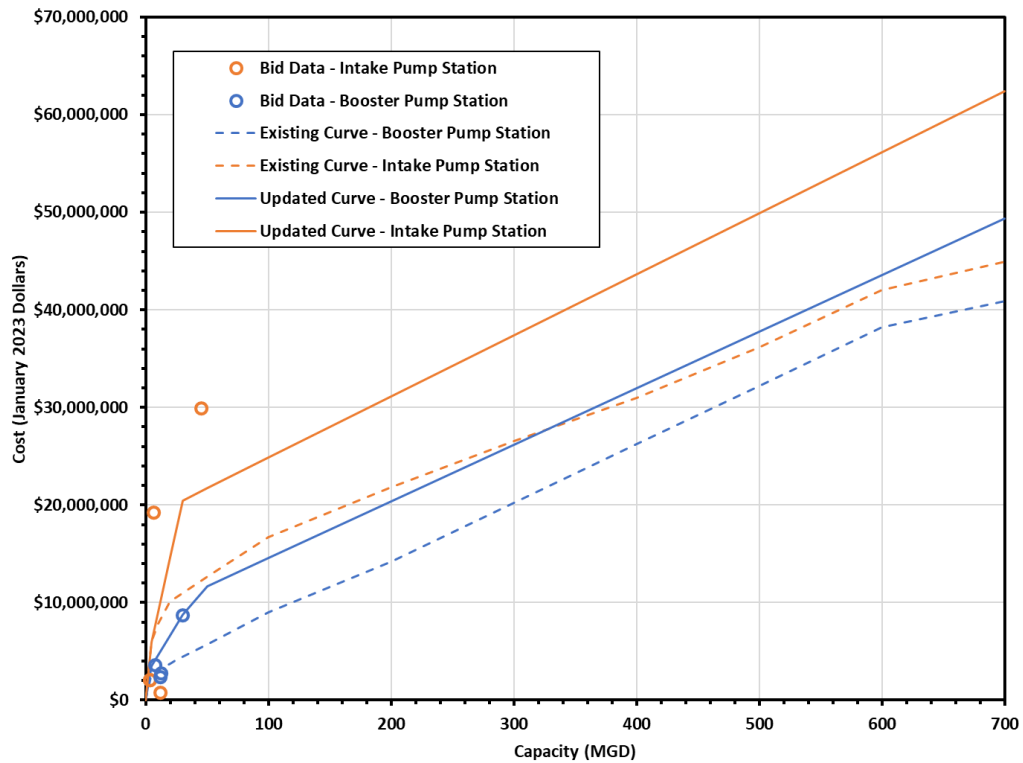


Table 1. Updated Horsepower-Based Unit Costs for Booster and Intake Pump Stations (January 2023 Dollars)

Horsepower (HP)	Booster Pump Station Costs (Millions)	Intake Pump Station Costs (Millions)
5	\$0.57	\$3.43
10	\$0.61	\$3.55
20	\$0.69	\$3.80
25	\$0.73	\$3.93
50	\$0.93	\$4.55
100	\$1.34	\$5.80
200	\$2.16	\$8.30
300	\$2.98	\$10.80
400	\$3.79	\$13.30
500	\$4.61	\$15.80
600	\$5.43	\$18.31
700	\$6.25	\$20.81
800	\$7.06	\$23.31
900	\$7.88	\$25.81
1,000	\$8.70	\$28.31
2,000	\$16.87	\$53.32
3,000	\$25.04	\$55.29
4,000	\$33.21	\$57.27
5,000	\$41.38	\$59.24
6,000	\$43.00	\$61.21
7,000	\$44.61	\$63.19
8,000	\$46.22	\$65.16
9,000	\$47.83	\$67.13
10,000	\$49.44	\$69.10
20,000	\$65.54	\$87.79
30,000	\$81.65	\$106.47
40,000	\$97.75	\$125.15
50,000	\$113.85	\$143.83
60,000	\$129.96	\$162.51
70,000	\$146.06	\$181.19

Table 2. Updated Capacity-Based Unit Costs for Booster and Intake Pump Stations (January 2023 Dollars)

Capacity (mgd)	Booster Pump Station Costs (Millions)	Intake Pump Station Costs (Millions)
5	\$3.50	\$5.91
10	\$4.55	\$8.83
20	\$6.66	\$14.65
25	\$7.71	\$17.56
50	\$11.66	\$21.73
100	\$14.56	\$24.85
200	\$20.35	\$31.11
300	\$26.15	\$37.36
400	\$31.94	\$43.61
500	\$37.74	\$49.86
600	\$43.53	\$56.12
700	\$49.33	\$62.37

## PIPELINE UNIT COSTS

New project bid information was available for thirteen new rural soil pipeline projects, twenty-nine new urban soil projects, and eleven new urban rock projects since the previous UCM update. Costs examined in this update are limited to pipeline infrastructure and do not include costs for right-of-way or other infrastructure elements. In general, the new bid data was higher than the existing curves when scaled to the same cost reference date. Some of the lower average bid data was excluded from the analysis in instances where a certain diameter of pipe had more than one data set for both rural and urban pipeline analysis. No bid data was available for rural-rock pipe; therefore, the existing rural-rock pipe cost curve was scaled using the ratio of the existing soil and rock costs.

The updated cost curves have substantial increases in costs compared to the existing curves for diameters greater than 36-inch. The increase in slope of the curves from 36 to 48-inch is attributed to the following:

- Diameters greater than 36-in result in a decrease in pipe material options and results in less competition, thereby raising material costs. For example, a 30-inch diameter pipe could be either DIP, PVC, HDPE, CCP, or Steel. At 48-inch diameter pipe, material options are only steel or CCP.
- The equipment needed to install the pipe is larger due to the size and weight of the pipe. Due to this equipment, the impacted area of disturbance and site restoration are increased resulting in higher costs.

The costs of the larger diameter pipe (greater than 48-inch) have also been significantly increased from the existing cost curves. This increase is due to the amount of material needed to construct the pipe and the rapid rise in costs of these materials. This increase in material cost is present in the only bid tab (a 66-inch urban soil) that was available for pipe sizes greater than 48-inch. The average bid price for furnishing just the pipe was \$942.57 per linear foot (does not include appurtenances and installation). For comparison, the existing

curves for rural soil estimate a cost of \$680 per linear foot for a 66-inch pipe with appurtenances and installation.

The existing cost curves are plotted alongside the bid data and updated cost curves for rural pipelines in [Figure 5](#), with data for urban pipelines shown in [Figure 6](#). Proposed cost curve information is additionally included in [Table 3](#).

Figure 5. Bid Data and Cost Curves for Rural Pipelines (January 2023 Dollars)

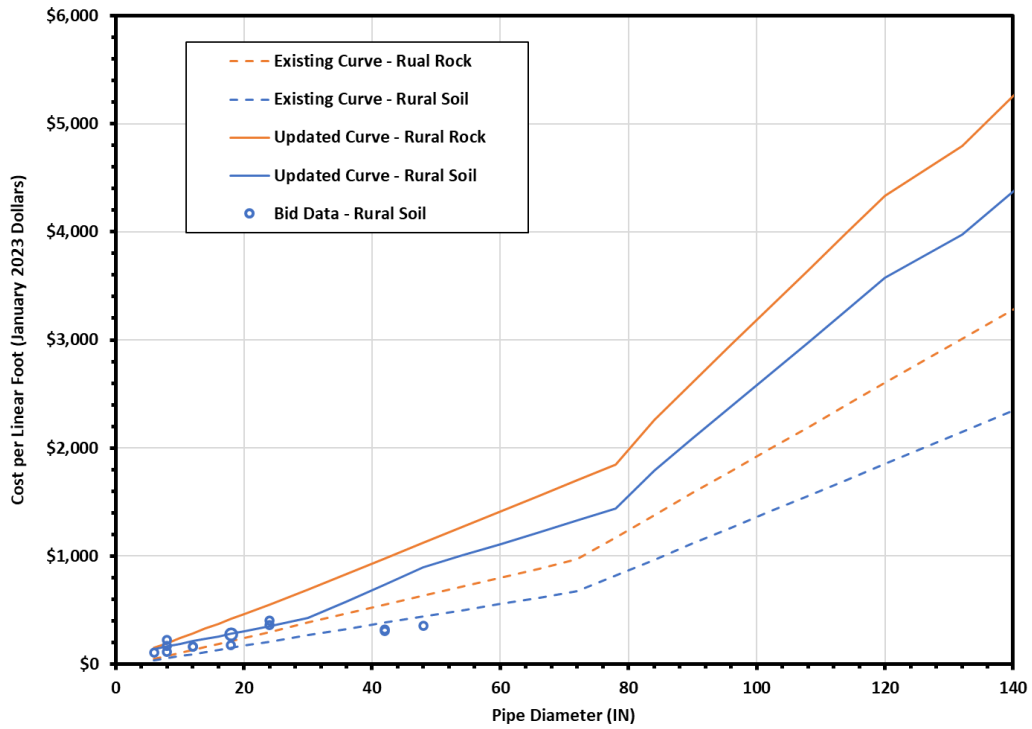


Figure 6. Bid Data and Cost Curves for Urban Pipelines

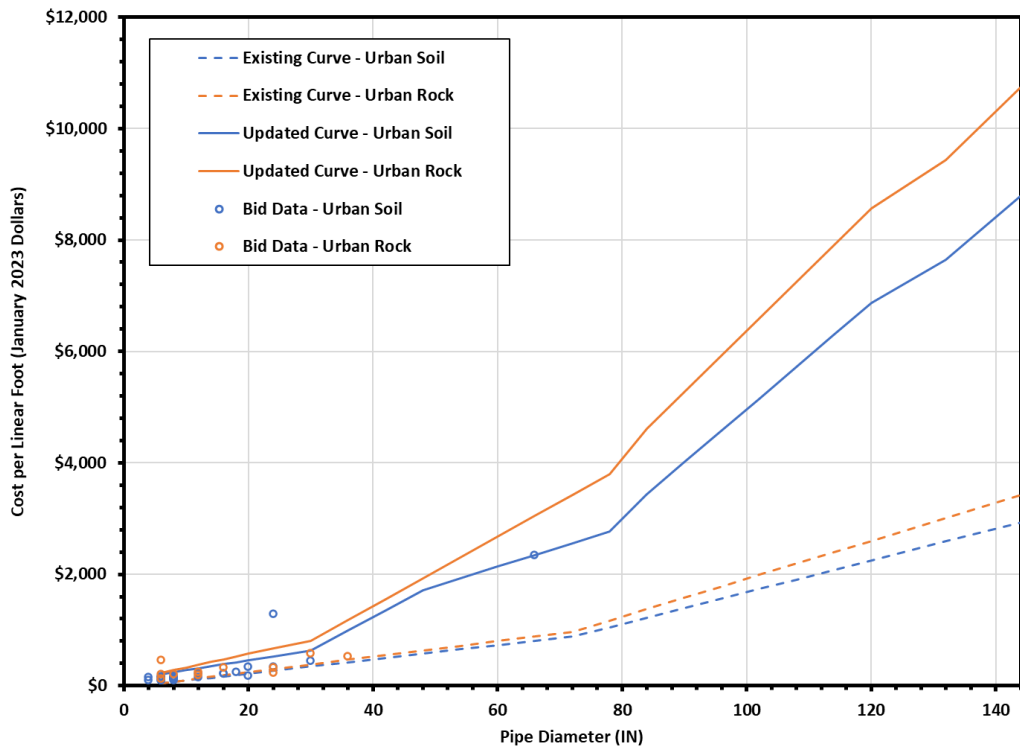




Table 3. Updated Unit Cost Costs for Pipelines (January 2023 Dollars)

Diameter (inches)	Rural Cost with Appurtenances - Soil (\$/Foot)	Rural Cost with Appurtenances - Rock (\$/Foot)	Urban Cost with Appurtenances - Soil (\$/Foot)	Urban Cost with Appurtenances - Rock (\$/Foot)
6	\$139	\$150	\$208	\$232
8	\$162	\$195	\$244	\$282
10	\$186	\$240	\$279	\$331
12	\$210	\$284	\$315	\$381
14	\$234	\$329	\$350	\$428
16	\$257	\$374	\$386	\$475
18	\$281	\$419	\$422	\$523
20	\$305	\$462	\$457	\$572
24	\$352	\$552	\$529	\$666
30	\$424	\$686	\$635	\$809
36	\$580	\$831	\$996	\$1,183
42	\$737	\$976	\$1,356	\$1,558
48	\$893	\$1,121	\$1,717	\$1,932
54	\$1,002	\$1,266	\$1,926	\$2,307
60	\$1,110	\$1,411	\$2,135	\$2,681
66	\$1,220	\$1,556	\$2,347	\$3,055
72	\$1,329	\$1,701	\$2,556	\$3,430
78	\$1,438	\$1,846	\$2,765	\$3,804
84	\$1,788	\$2,262	\$3,439	\$4,611
90	\$2,085	\$2,607	\$4,010	\$5,271
96	\$2,383	\$2,954	\$4,583	\$5,934
102	\$2,680	\$3,299	\$5,154	\$6,593
108	\$2,977	\$3,644	\$5,725	\$7,252
114	\$3,274	\$3,989	\$6,296	\$7,906
120	\$3,572	\$4,335	\$6,869	\$8,566
132	\$3,978	\$4,798	\$7,650	\$9,432
144	\$4,573	\$5,490	\$8,794	\$10,749

## TUNNEL UNIT COSTS

New project bid information was available for nine recent tunneling (trenchless) projects that took place in soil. Jack and bore tunneling bid data were available for 18-inch through 60-inch diameter water lines, while open face tunneling data were available for 42-inch and 48-inch diameter water line projects. Some of the lower average bid data was excluded from the analysis in instances where a certain diameter of tunnel had more than one data set as a planning-level assumption resulting in a higher curve slope. A linear regression produced a trendline slightly below the existing curve. However, due to recent market conditions and increases in bid data beyond inflation observed for other project components, the updated curve was assumed to be identical as the existing curve for diameters below 48-inch.

No data was available for tunneling over 60-inch diameter. For these larger diameters, the linear trend was extended to project estimated tunneling costs at larger diameters. The existing curves assumed a reduction in the slope of the unit costs for the diameters greater than 48-inch; however, due to the upward slope observed in other project components for these larger sizes, this assumption was not retained from the previous update. The existing curves are plotted against the new bid data and the updated curves in [Figure 7](#). Updated cost curve information is additionally included in [Table 4](#).

Figure 7. Bid Data and Cost Curves for Tunneling (January 2023 Dollars)

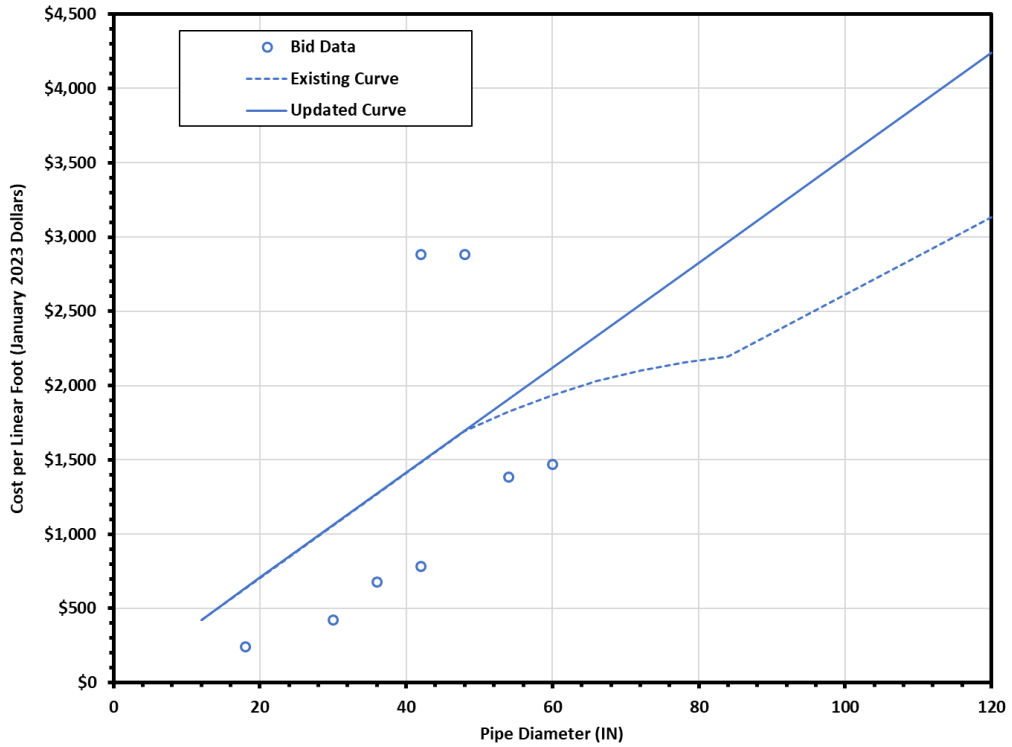


Table 4. Proposed Unit Costs for Tunneling (January 2023 Dollars)

Diameter (inches)	Cost (\$/Foot)
18	\$636
20	\$707
24	\$848
30	\$1,061
36	\$1,273
42	\$1,485
48	\$1,697
54	\$1,909
60	\$2,121
66	\$2,333
72	\$2,545
78	\$2,758
84	\$2,970
90	\$3,182
96	\$3,394
102	\$3,606
108	\$3,818
114	\$4,030
120	\$4,242
132	\$4,667
144	\$5,091

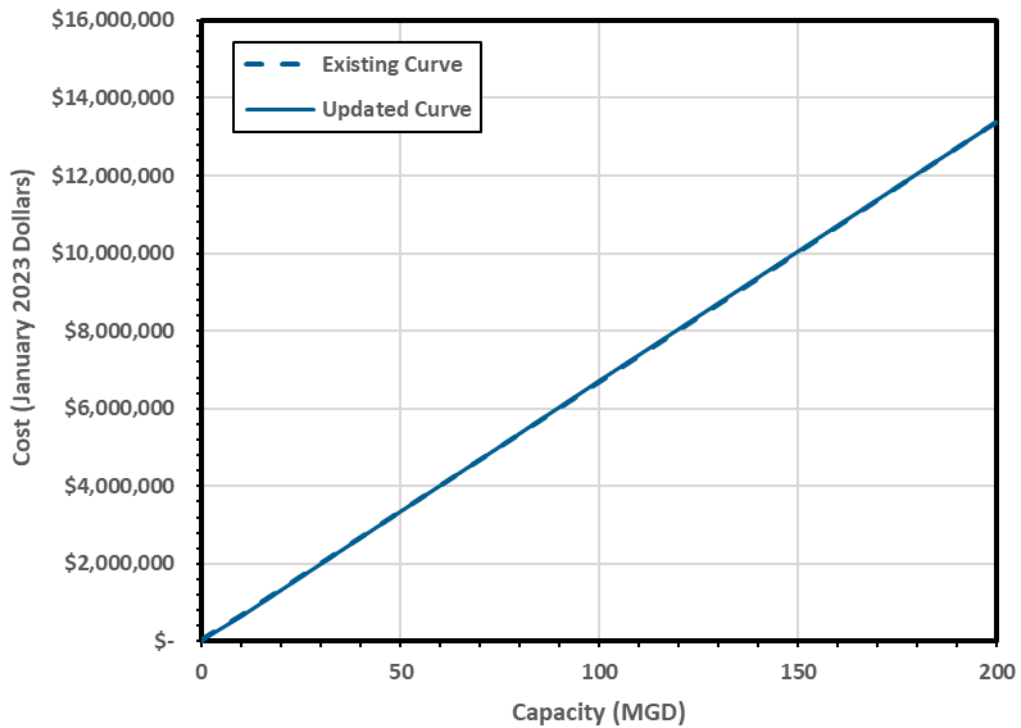
## WATER TREATMENT PLANT UNIT COSTS

Construction costs for WTPs in the UCM are based on both plant capacity and treatment type for six different levels of water treatment categories ranging from basic groundwater disinfection to seawater desalination. Treatment cost curve analyses were performed separately for each treatment level, with available bid data and proposed cost curve revisions summarized in the following memorandum subsections. Costs below reflect costs for all required processes, and include as applicable treatment buildings, storage tanks, sludge handling, sludge disposal, clearwells, pumps, and other appurtenances internal to the treatment facility.

### ***Treatment Level 0 – Disinfection Only***

Treatment Level 0 reflects disinfection of groundwater of generally high quality and not containing contaminants that exceed regulatory limits. Associated facilities include a chlorine treatment system and limited process storage necessary to apply disinfection to create suitable water for public water distribution or aquifer injection. No new project bid data was available for Level 0 treatment facilities. In the absence of specific data, it is proposed that the cost curve from the prior UCM be scaled to the reference cost date for the current planning cycle to reflect Level 0 treatment facility costs. The existing and updated curves are shown in [Figure 8](#). Updated cost curve information is additionally included in [Table 5](#).

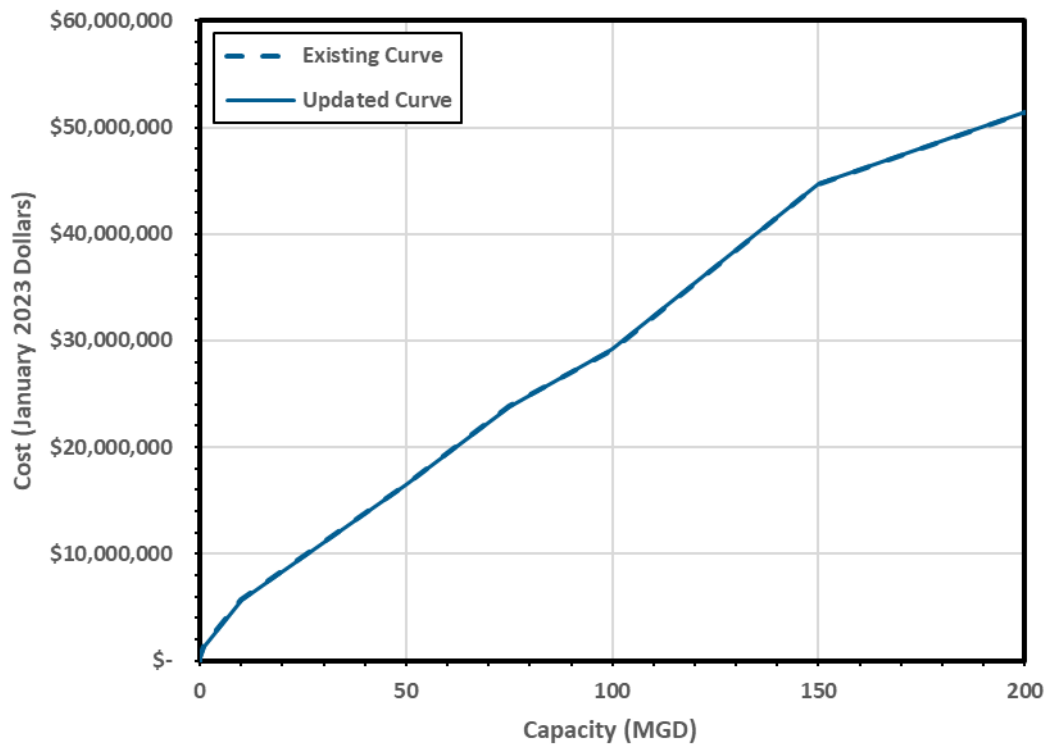
Figure 8. Bid Data and Cost Curves for Treatment Level 0 WTPs (January 2023 Dollars)



**Treatment Level 1 – Groundwater Treatment**

Treatment level 1 reflects conventional groundwater treatment including application of an oxidant and phosphate as well as chlorine disinfection. No new project bid data was available for Level 1 treatment facilities. In the absence of specific data, the existing cost curve was scaled to the reference cost date for the current planning cycle to reflect Level 1 treatment facility costs. The existing and updated curves are shown in [Figure 9](#). Updated cost curve information is additionally included in [Table 5](#).

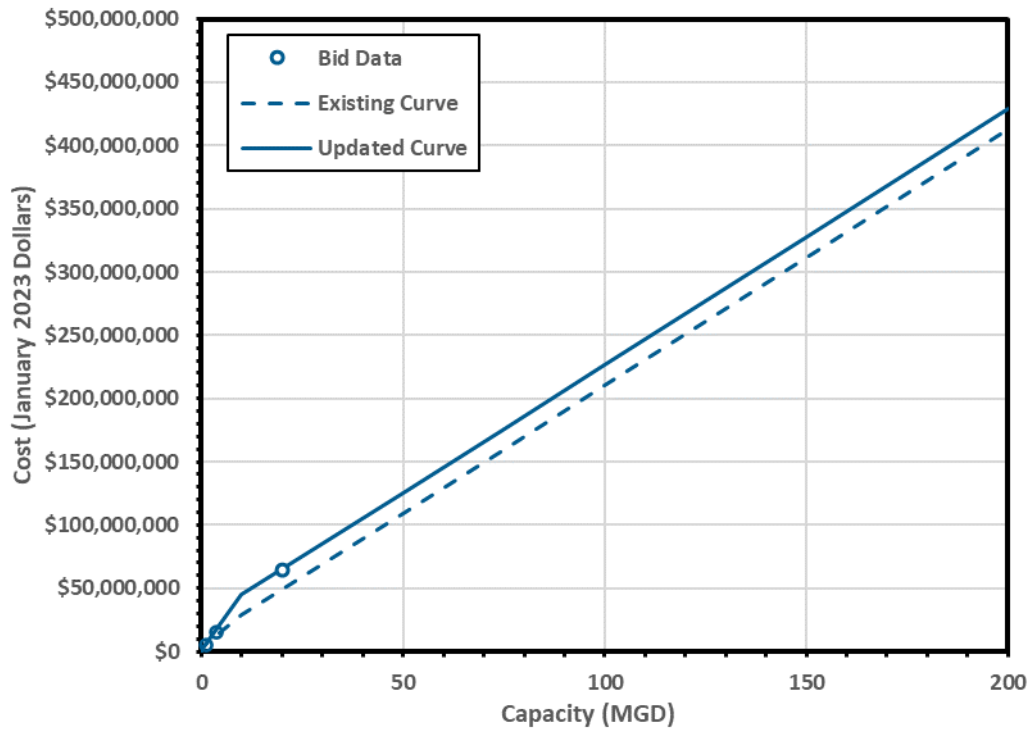
Figure 9. Bid Data and Cost Curves for Treatment Level 1 WTPs (January 2023 Dollars)



### **Treatment Level 2 – Direct Filtration Treatment**

Treatment level 2 reflects the construction of a filter facility for direct filtration treatment of groundwater with concentrations of iron, manganese, or other constituents that exceed the regulatory limit. New project bid information was available for three treatment level 2 projects, including two facilities below 5 mgd capacity and a single 20 mgd facility. Due to the limited number of data points and facility size represented, a linear trend of the new bids was not found to be an appropriate approximation of cost for long-range planning. The updated cost curve assumes scaling of existing curve values for 0.1 mgd and 1 mgd facilities. For larger facility sizes, the updated cost curve maintains the slope of the existing curve, with values uniformly adjusted so that the 20 mgd value for the cost curve matches the available 20 mgd project bid, as the bid data indicated an increase in costs greater than what was predicted by the existing curve, scaled to January 2023 dollars. The existing curves are plotted against the new bid data and the updated cost curves in [Figure 10](#). Updated cost curve information is included in [Table 5](#).

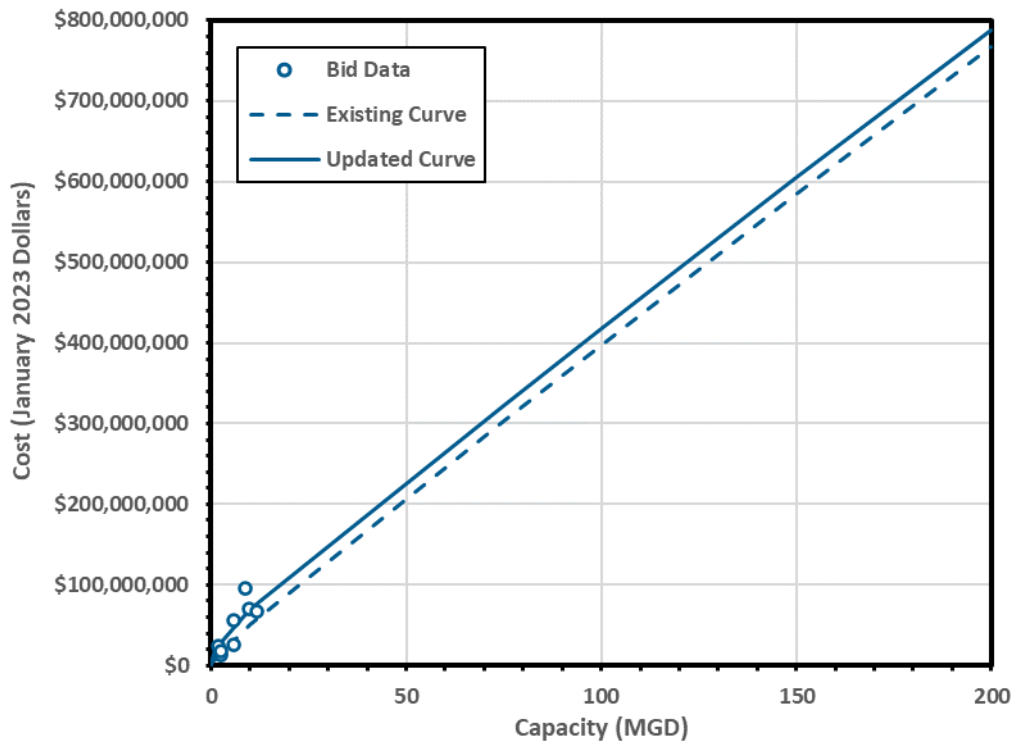
Figure 10. Bid Data and Cost Curves for Treatment Level 2 WTPs (January 2023 Dollars)



### **Treatment Level 3 – Surface Water Treatment**

Treatment level 3 reflects conventional treatment of surface water to be delivered to a potable water distribution system. New project bid information was available for eleven treatment level 3 projects, ranging in size from 2 mgd to 50 mgd capacity. Three of these bids included substantial costs for future expansion phases, non-standard treatment, or other atypical infrastructure and were excluded from the cost update analysis. The updated cost curve for facilities of up to 10 mgd corresponds with an approximate linear trend of the available bid data. Information for capacities larger than 10 mgd was limited. The proposed costs for capacities exceeding 10 mgd therefore maintain the slope of the existing curve, adjusted uniformly upward to extend from the estimated 10 mgd cost. The existing cost curve is plotted against the new bid data and the updated cost curve in [Figure 11](#). Updated cost curve information is additionally included in [Table 5](#).

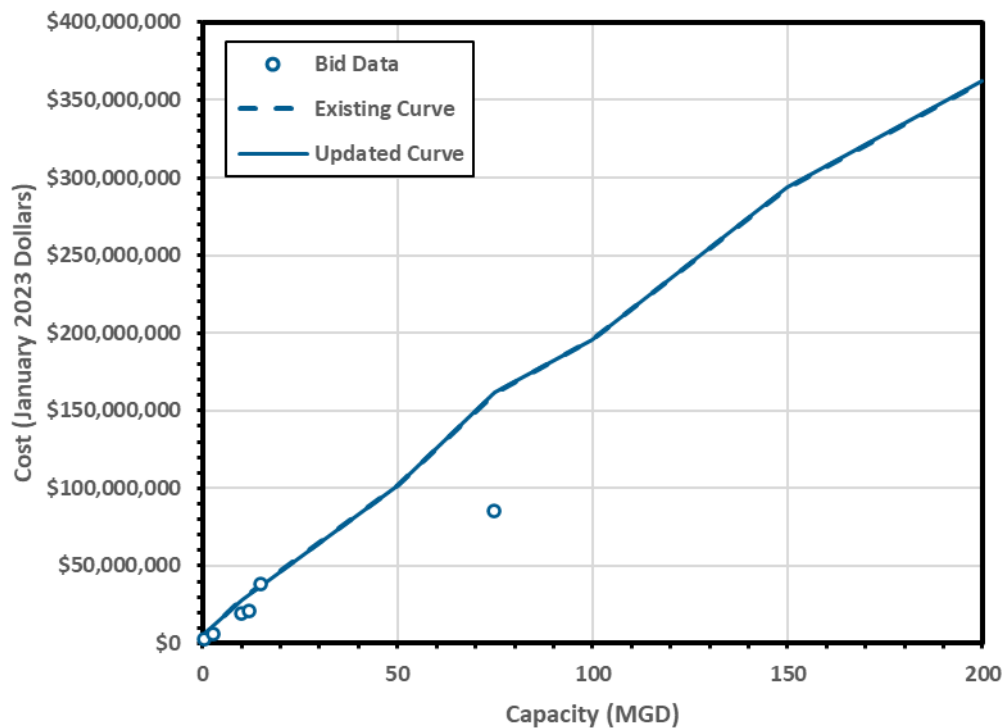
Figure 11. Bid Data and Cost Curves for Treatment Level 3 WTPs (January 2023 Dollars)



### **Treatment Level 3E – Surface Water Treatment Plant Expansion**

Treatment level 3E reflects expansion of an existing level 3 surface water treatment plant (SWTP) through addition of treatment trains on the existing plant site. New project bid information was available for six SWTP expansion projects. Five of the six were for smaller capacity plant expansions, ranging from 0.5 to 50 mgd, and no detailed bid data was available for expansions of greater than 75 mgd. A linear trend of the 0.5 to 50 mgd data corresponds relatively closely to scaled values from the existing curves. Therefore, the existing curve was scaled to the reference cost date for the current planning cycle to reflect Level 3E treatment facility costs. The existing curve is plotted against the new bid data and the updated cost curve in [Figure 12](#). Updated cost curve information is included in [Table 5](#).

Figure 12. Bid Data and Cost Curves for Treatment Level 3 WTP Expansion (January 2023 Dollars)



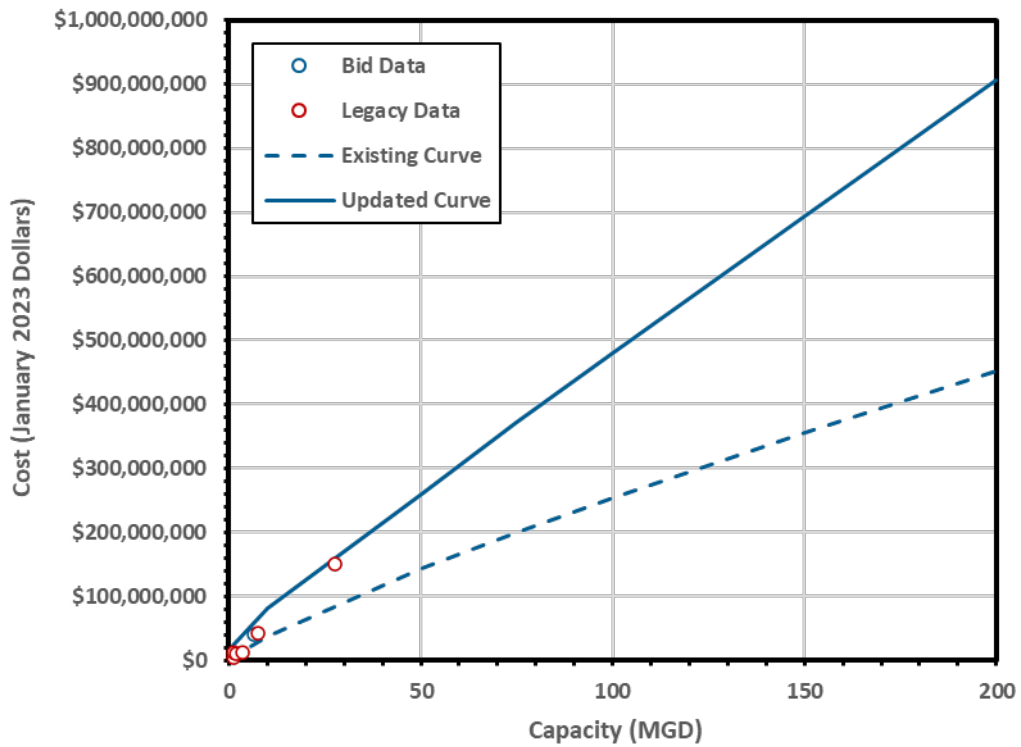
#### **Treatment Level 4 - Brackish Groundwater Desalination**

Treatment level 4 reflects treatment of groundwater with total dissolved solids (TDS) in excess of the regulatory limit of 1,000 mg/l. One bid was available for Level 4 treatment facilities; for purposes of the cost curve update, information from prior TWDB references on brackish groundwater including the 2012 *Cost of Brackish Groundwater Desalination in Texas*<sup>1</sup> study was also considered. In order to better reflect the available data and anticipated relative costs of the treatment types examined in the UCM, the curve for Level 4 treatment was estimated as 115 percent of the cost for Level 3 treatment, based upon a comparison of the linear trends of bid data at a 50 mgd facility size. The existing curve is plotted against the updated cost curve in [Figure 13](#). Updated cost curve information is included in [Table 5](#). It should be noted that the costs presented in [Figure 13](#) and [Table 5](#) for Treatment level 4 correspond with a default TDS level of 5,000 mg/l. The UCM applies additional scaling of Level 4 treatment cost for user-specified source water TDS concentrations above or below this amount.

<sup>1</sup> Arroyo, J.; Shirazi, S. *Cost of Brackish Groundwater Desalination in Texas*; Texas Water Development Board, Innovative Water Technologies: Austin, TX, USA, 2012.



Figure 13. Bid Data and Cost Curves for Treatment Level 4 WTPs (January 2023 Dollars)



#### **Treatment Level 5 – Seawater Desalination**

Treatment level 5 reflects desalination of seawater with TDS that exceed the regulatory limit of 1,000 mg/l. No new project bid data was available for Level 5 treatment facilities. In the absence of specific data, the existing cost curve was scaled to the reference cost date for the current planning cycle to reflect Level 5 treatment facility costs. The existing cost curve and updated scaled curve are shown in [Figure 14](#). Updated cost curve information is included in [Table 5](#).

Figure 14. Bid Data and Cost Curves for Treatment Level 5 WTPs (January 2023 Dollars)

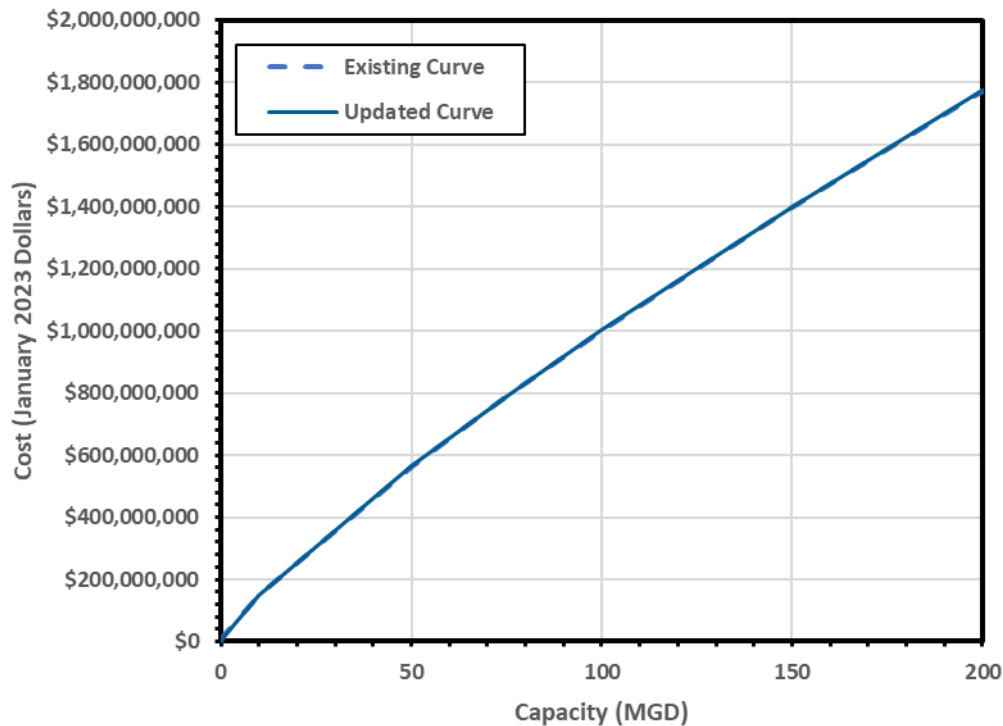


Table 5. Proposed Adjusted WTP Costs Based on Capacity (January 2023 Dollars)

Capacity (mgd)	Treatment Level 0 (Millions)	Treatment Level 1 (Millions)	Treatment Level 2 (Millions)	Treatment Level 3 (Millions)	Treatment Level 3E (Millions)	Treatment Level 4* (Millions)	Treatment Level 5 (Millions)
0.1	\$0.03	\$0.34	\$1.56	\$2.08	\$2.08	\$2.40	\$3.34
1	\$0.10	\$1.37	\$5.47	\$20.84	\$7.35	\$23.97	\$22.36
10	\$0.67	\$5.69	\$44.76	\$70.19	\$28.15	\$80.72	\$149.62
50	\$3.34	\$16.51	\$125.29	\$225.90	\$101.64	\$259.78	\$564.93
75	\$5.01	\$23.82	\$175.85	\$322.58	\$161.59	\$370.97	\$789.51
100	\$6.69	\$29.19	\$226.41	\$417.63	\$195.87	\$480.27	\$1,001.14
150	\$10.03	\$44.66	\$327.53	\$604.40	\$293.80	\$695.06	\$1,399.13
200	\$13.37	\$51.43	\$428.65	\$788.02	\$362.35	\$906.23	\$1,774.17

\*Treatment costs for treatment level 4 correspond with a default TDS level of 5,000 mg/l. The UCM applies additional scaling of Level 4 treatment cost for user-specified source water TDS concentrations above or below this amount.

## WTP OPERATION AND MAINTENANCE

The operation and maintenance costs for WTPs in the UCM are based on a percentage of construction costs. Limited recent detailed data on treatment O&M costs were available. The recommended O&M costs for the updated UCM therefore use the same percentages, applied to the costs recommended in the preceding subsections. Treatment level 4 costs are interpolated within the UCM based on the TDS involved in the treatment process. [Table 6](#) shows the updated O&M costs.

Table 6. Proposed Adjusted WTP O&M Costs Based on Capacity (January 2023 Dollars)

Capacity (mgd)	Treatment Level 0 (Millions)	Treatment Level 1 (Millions)	Treatment Level 2 (Millions)	Treatment Level 3 (Millions)	Treatment Level 3E (Millions)	Treatment Level 4 (Millions)	Treatment Level 5 (Millions)
0.1	\$0.02	\$0.11	\$0.16	\$0.21	\$0.21	Varies*	\$0.50
1	\$0.06	\$0.45	\$0.55	\$2.08	\$0.73	Varies*	\$3.35
10	\$0.40	\$1.88	\$3.13	\$4.91	\$1.97	Varies*	\$22.44
50	\$2.01	\$5.45	\$8.77	\$15.81	\$7.11	Varies*	\$84.74
75	\$3.01	\$7.86	\$12.31	\$22.58	\$11.31	Varies*	\$118.43
100	\$4.01	\$9.63	\$15.85	\$29.23	\$13.71	Varies*	\$150.17
150	\$6.02	\$14.74	\$22.93	\$42.31	\$20.57	Varies*	\$209.87
200	\$8.02	\$16.97	\$30.01	\$55.16	\$25.36	Varies*	\$266.13

\*Varies based on TDS involved in the treatment process.

### ADVANCED WATER TREATMENT AND ADVANCED WATER TREATMENT O&M

AWTF within the UCM reflects the use of advanced treatment trains to purify wastewater to sufficient quality for blending with other sources for direct potable reuse or other applications. No new project bid data was available for AWTF. Therefore, the updated cost curves for the two AWTF schemes utilized by the UCM are the existing curves, scaled to the January 2023 cost index with no other modification ([Table 7](#)). A similar assumption was made for AWTF O&M ([Table 8](#)).

Table 7. Proposed AWTF Costs Based on Capacity (January 2023 Dollars)

Capacity (mgd)	Treatment Scheme 1 (Millions)	Treatment Scheme 2 (Millions)
1	\$11.70	\$11.14
5	\$41.74	\$31.34
10	\$72.30	\$49.80
25	\$179.59	\$112.10

Table 8. Proposed AWTF O&M Costs Based on Capacity (January 2023 Dollars)

Capacity (mgd)	Treatment Scheme 1 (Millions)	Treatment Scheme 2 (Millions)
1	\$1.40	\$0.76
5	\$5.44	\$2.81
10	\$9.77	\$4.94
25	\$21.26	\$10.47

## DAM, LARGE RING DIKES, AND TERMINAL STORAGE UNIT COSTS

The UCM includes consideration for construction costs for traditional on-channel dams and reservoirs, off-channel reservoirs constructed with large ring dikes, and terminal storage reservoirs. Dam and reservoir curve analyses were performed separately for each impoundment type, with available bid data and proposed cost curve revisions summarized in the following memorandum subsections.

### Traditional Dams & Reservoirs

New project bid information was available for two on-channel dams and associated reservoirs. The two bids greatly exceed the costs which would be estimated from scaling the current UCM curve to a January 2023 index. However, it was also noted that both data points correspond to reservoirs of substantially greater impoundment volume than the capacity range included in the UCM. The linear trend of these two points may not be representative of reservoir costs at smaller capacities, as construction and other challenges for extremely large reservoirs can be substantial and may not display a consistent economy of scale with increasing size.

Legacy reservoir bid data from prior UCM updates was scaled to January 2023 equivalents and plotted against the current UCM curve to examine other potential considerations for adjustments. Pre-1980 data was excluded, as reservoir economics have evolved over time. An examination of more recent legacy bids indicates a trend lower than the two new bids but higher than simply scaling the existing curve. It is assumed that the cost curve for traditional dams follows the linear trend of these legacy bids. The existing cost curve is plotted against the new bid data and the updated cost curve in [Figure 15](#). Updated cost curve information is included in [Table 9](#).

Figure 15. Bid Data and Cost Curves for Dams and Reservoirs (January 2023 Dollars)

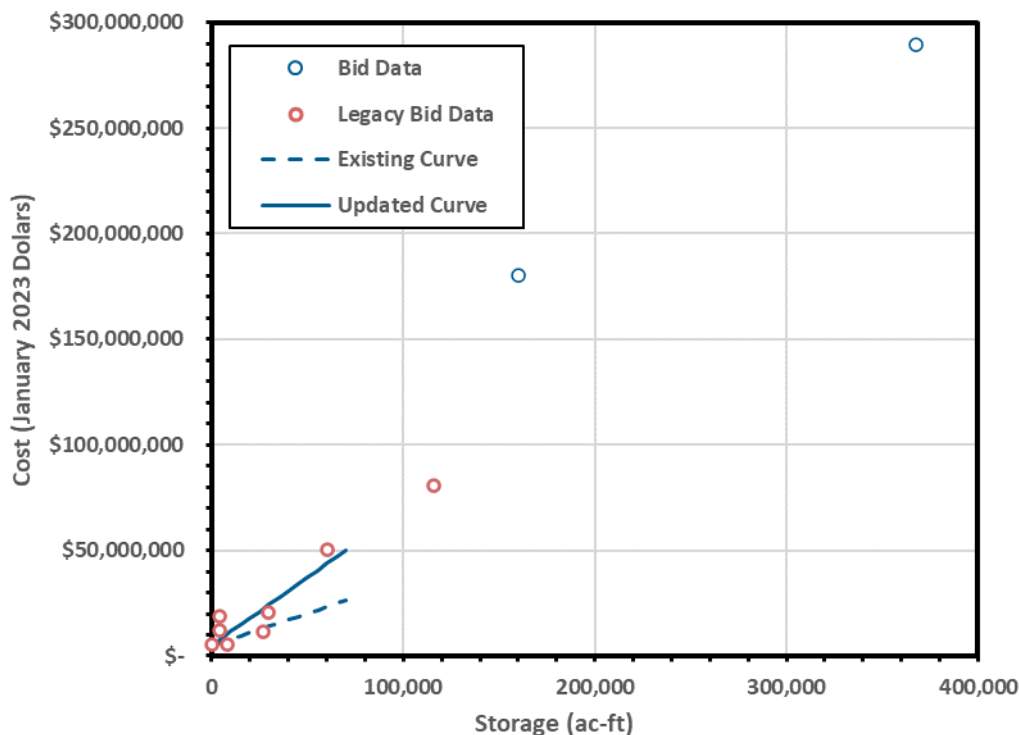


Table 9. Proposed Adjusted Traditional Dams & Reservoirs Cost by Size (January 2023 Dollars)

Reservoir Storage (ac-ft)	Dam and Reservoir Cost (Millions)
50	\$5.13
1,000	\$5.74
5,000	\$8.32
10,000	\$11.53
15,000	\$14.75
20,000	\$17.97
25,000	\$21.19
30,000	\$24.40
35,000	\$27.62
40,000	\$30.84
45,000	\$34.05
50,000	\$37.27
55,000	\$40.49
60,000	\$43.70
65,000	\$46.92
70,000	\$50.14

**Off Channel Reservoirs - Large Ring Dikes**

No new project bid information was available for large ring dike OCRs. In the absence of specific data, the existing curve was scaled to the reference cost date for the current planning cycle to reflect off-channel storage using large ring dikes. The existing cost curve and updated curve are shown in [Figure 16](#). Proposed cost curve information is additionally included in [Table 10](#).

Figure 16. Bid Data and Cost Curves for Large Ring Dikes (January 2023 Dollars)

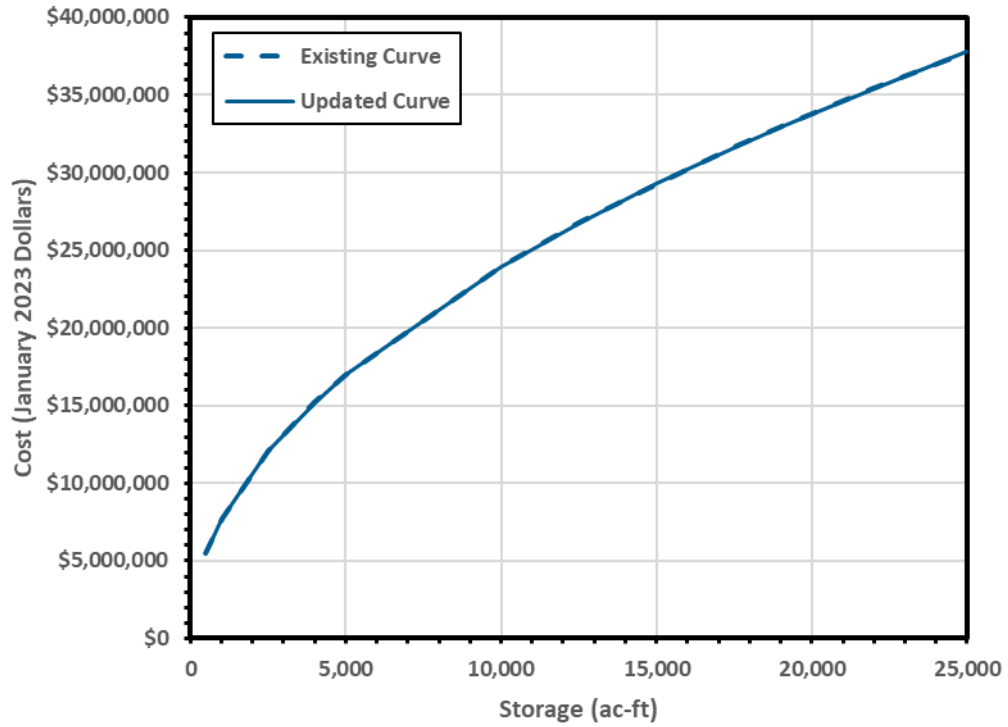


Table 10. Proposed Adjusted Off OCR Ring Dike Cost by Size (January 2023 Dollars)

Reservoir Storage (ac-ft)	Large Ring Dike Cost (Millions)
500	\$5.50
1,000	\$7.70
2,500	\$12.07
4,000	\$15.22
5,000	\$16.99
10,000	\$23.96
12,500	\$26.76
15,000	\$29.30
17,500	\$31.63
19,000	\$32.95
20,000	\$33.80
22,000	\$35.44
25,000	\$37.77

**Off Channel Reservoirs – Terminal Storage**

New project bid information was available for five terminal storage reservoir projects. Of these, four were of traditional earth-bottom terminal storage reservoir construction, with one facility exhibiting more extensive concrete lining. A linear trend of the data for the four traditional terminal storage reservoirs resulted in a close fit to the data points. This linear trend was therefore assumed as the updated cost curve. The existing cost curve is plotted alongside the bid data and updated cost curve in [Figure 17](#). Updated cost curve information is included in [Table 11](#).

Figure 17. Bid Data and Cost Curves for Terminal Storage Reservoir (January 2023 Dollars)

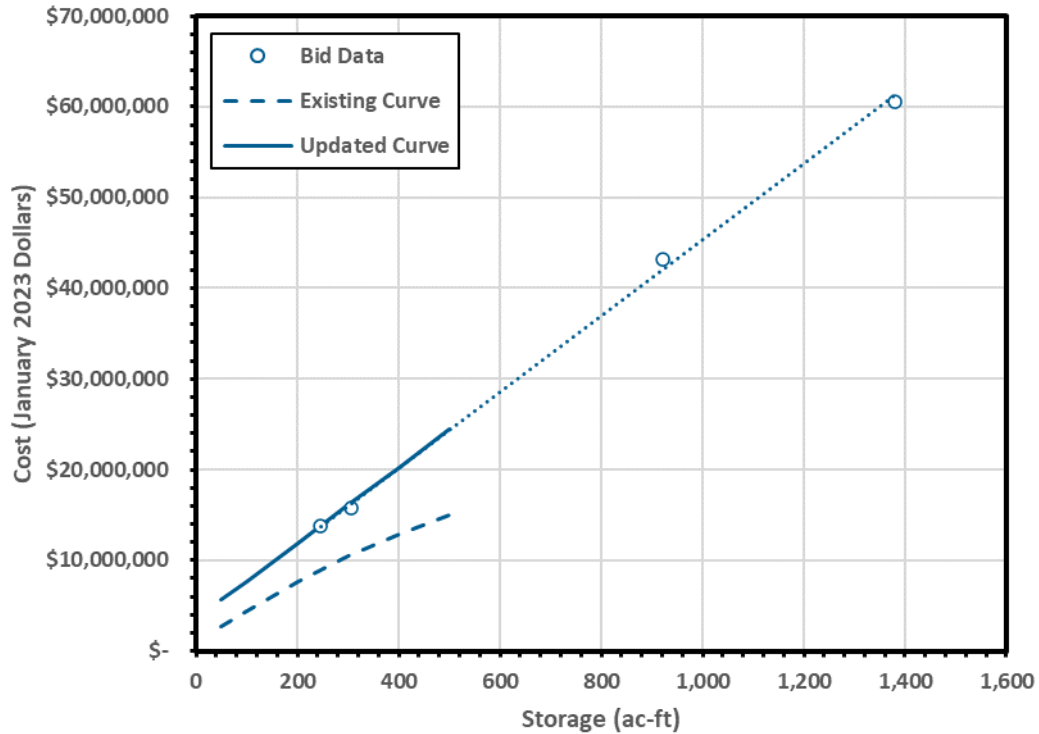


Table 11. Proposed Adjusted Terminal Storage Reservoir Cost by Size (January 2023 Dollars)

Reservoir Storage (ac-ft)	Terminal Storage Cost (Millions)
50	\$5.59
100	\$7.69
200	\$11.87
300	\$16.05
400	\$20.24
500	\$24.42

## DAM, LARGE RING DIKES, AND TERMINAL STORAGE O&M COSTS

O&M costs for reservoirs within the UCM utilize TWDB-specified percentages of construction cost. No detailed data on O&M costs for new reservoirs was readily available, and such costs would be expected to be dependent on project-specific considerations. Therefore, the current O&M factors are retained for the updated UCM.

## RESERVOIR LAND ACQUISITION COST

The current methodology in the UCM for determining reservoir land acquisition costs appears to be appropriate based on current market trends. No changes to this current methodology are recommended.

## TANK UNIT COSTS

New project bid information from recent projects was available for nine elevated storage tanks and eight ground storage tanks. The recent bid data did not distinguish if the ground storage tanks had roofs or not. Therefore, it was assumed that all eight ground storage tanks had roofs. The existing curve for ground storage tanks without roofs was updated based on the increase from the existing to the updated curve for ground storage tanks with roofs. The existing curves are plotted against the new bid data and the updated cost curves in [Figure 18](#) and [Figure 19](#). Based on the new bid data, both the elevated storage tank and ground storage tank costs increased from the existing cost curve. Updated cost curve information is included in [Table 12](#) and [Table 13](#).

Figure 18. Bid Data and Cost Curves for Elevated Storage Tanks (January 2023 Dollars)

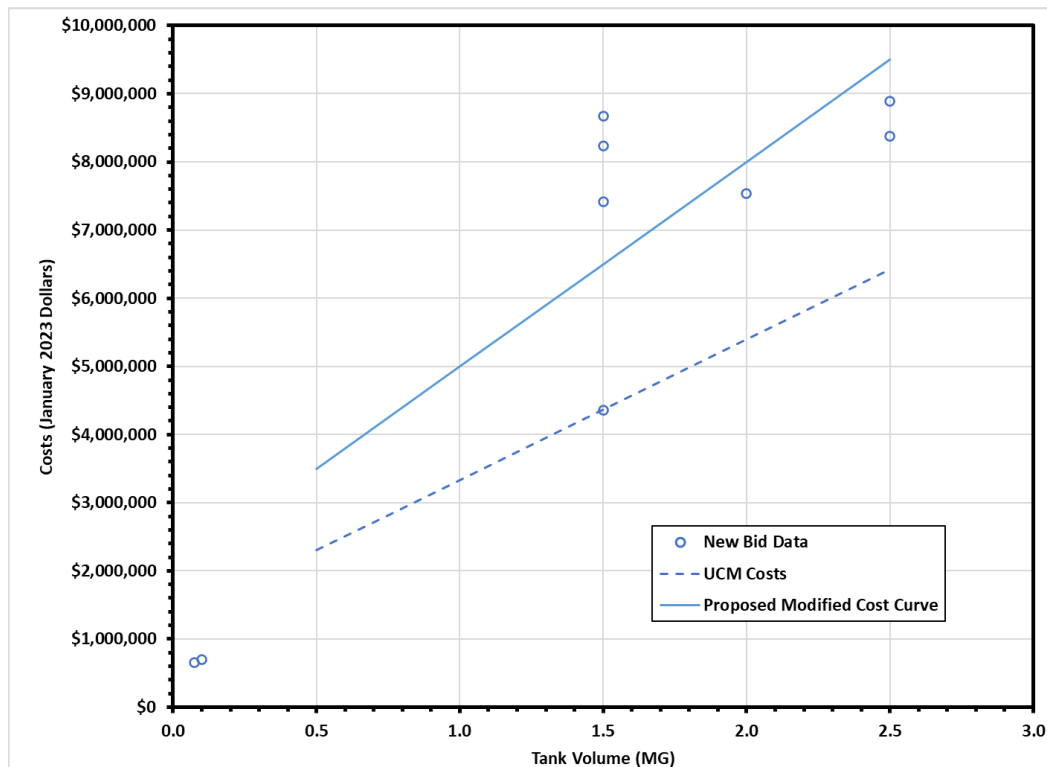




Figure 19. Bid Data and Cost Curves for Ground Storage Tanks with and without Roofs (January 2023 Dollars)

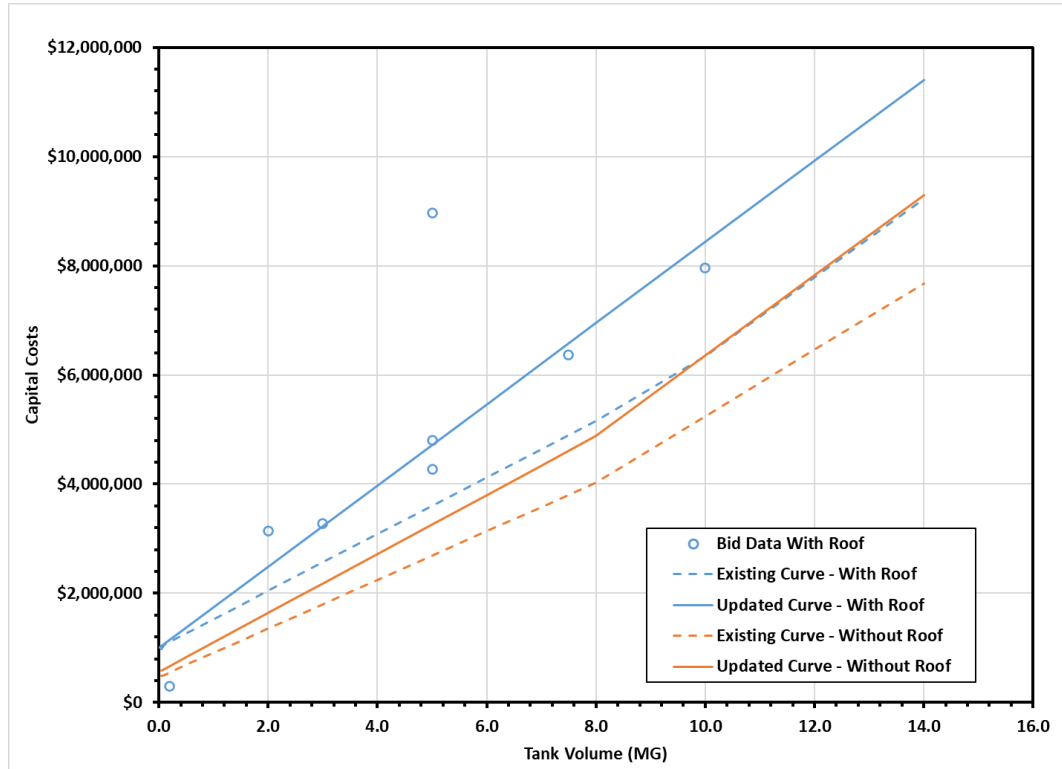


Table 12. Updated Elevated Storage Tank Unit Costs (January 2023 Dollars)

Tank Size (MG)	Tank Cost
0.5	\$3,500,000
0.75	\$4,250,000
1	\$5,000,000
1.5	\$6,500,000
2	\$8,000,000
2.5	\$9,500,000

Table 13. Updated Ground Storage Tank Unit Costs (January 2023 Dollars)

Tank Size (MG)	Tank Cost with Roof	Tank Cost without Roof
0.05	\$1,037,167	\$590,557
0.1	\$1,074,333	\$617,561
0.5	\$1,371,667	\$833,296
1	\$1,743,334	\$1,102,891
1.5	\$2,115,001	\$1,372,487
2	\$2,486,668	\$1,642,230
2.5	\$2,858,335	\$1,911,825
3	\$3,230,002	\$2,181,568
3.5	\$3,601,669	\$2,451,163
4	\$3,973,336	\$2,720,759
5	\$4,716,670	\$3,260,097
6	\$5,460,004	\$3,799,435
7	\$6,203,338	\$4,338,774
8	\$6,946,672	\$4,878,112
10	\$8,433,340	\$6,349,221
12	\$9,920,008	\$7,820,330
14	\$11,406,676	\$9,291,585

## WELL UNIT COSTS

Drilling bid data was obtained from the project consultant team, as well as additional data provided by Mike Keester, PG, of R.W. Harden and Associates. A substantial portion of the available drilling bid data was associated with water sourcing for oil and gas production in western Texas; these bids were found to be consistently low compared to the PWS dataset and were not used in the final analysis.

An informal survey of professional geoscientists and engineers to gather additional context for the UCM update indicates that drilling contractors have been difficult to schedule in recent years, indicating that there is a shortage of contractors to meet demand. This appears to have resulted in both an increase in well construction costs that have outpaced the cost indices for some applications, and potentially a large variation in cost estimates when multiple bids are available. This increase and variability may be due to contractors submitting high bids in anticipation of limited competition, requirements for US-sourced steel, contractor premiums for schedule related to contract backlog or other factors.

Construction costs for wells in the UCM are based on well type, depth, and capacity. Well cost curve analyses were performed separately for each well type, with available bid data and proposed cost curve revisions summarized in the following subsections.

### ***Public Water Supply Wells***

New project bid information for PWS wells was plotted along with the existing well curves, adjusted to January 2023 dollars, as shown in **Figure 20**. Bid points on the figure are labeled with well capacity in gallons per minute (gpm). Because the new PWS well bid dataset is simply not large enough for a rigorous data-fitting exercise, the updates were based on inspection and engineering judgement and not statistical analyses. It was observed from the available data that while the trend of increasing cost with depth is generally present, little correlation with well capacity is shown for a given depth. This correlation would likely be present in a large dataset for a given aquifer, so the same basic conceptual approach of increasing costs with capacity and depth is kept in the updated cost curves.

Inspection of available data for 700 gpm wells indicates that the cost curves should be increased beyond the max depth of 2,000 ft of the existing curves. The existing curves were also adjusted to show a greater cost difference between 350 gpm wells and 700 gpm wells due to the need to increase casing size from 10-inch to 14-inch diameter between these pumping rates. **Figure 20** compares the updated curves for PWS wells with the existing curves and bid data. Updated cost curve information for PWS wells by depth and capacity is additionally included in [Table 14 Ref148679664](#).

Figure 20. Bid Data and Existing and Updated Cost Curves for Public Water Supply Wells (January 2023 Dollars)

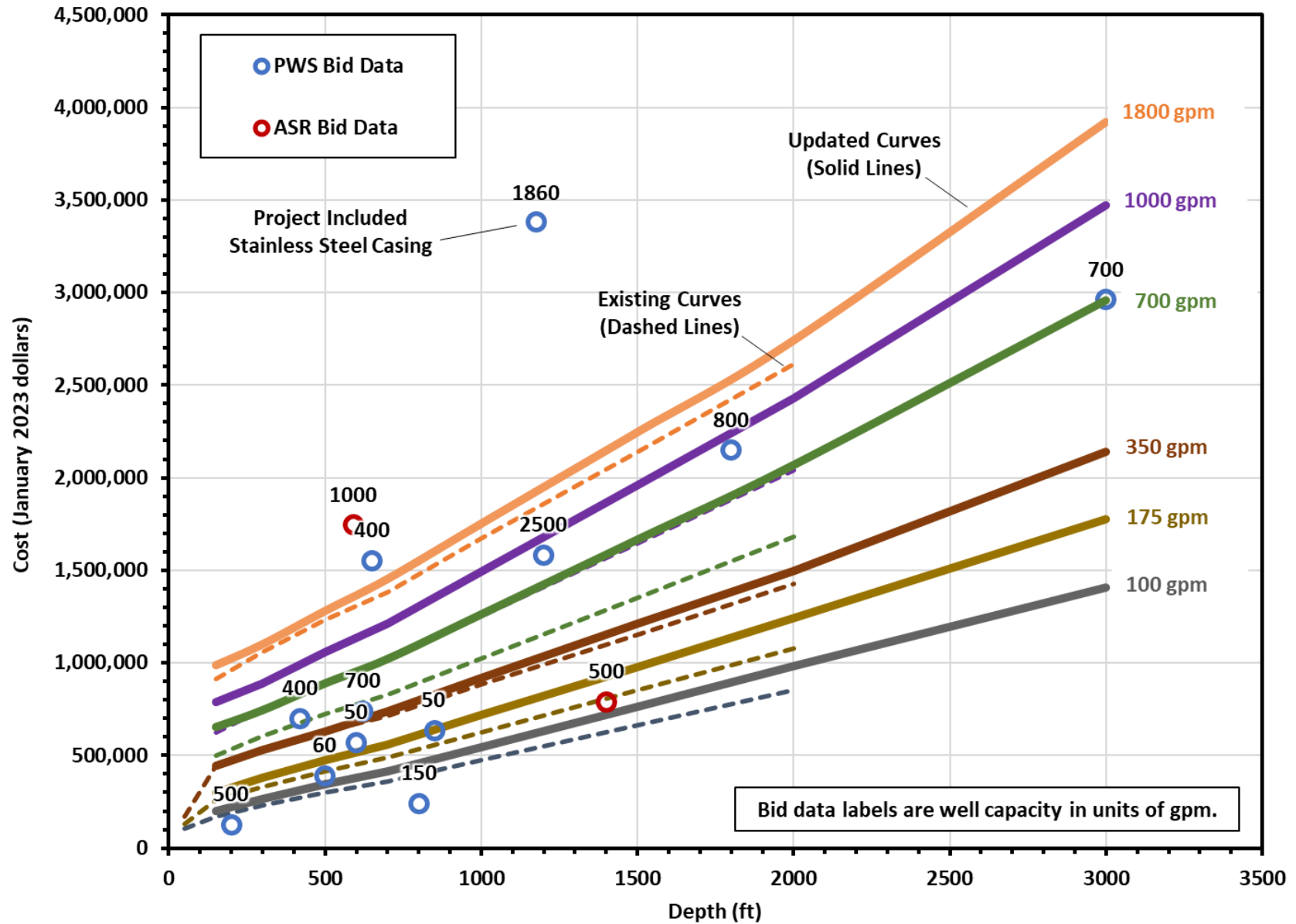
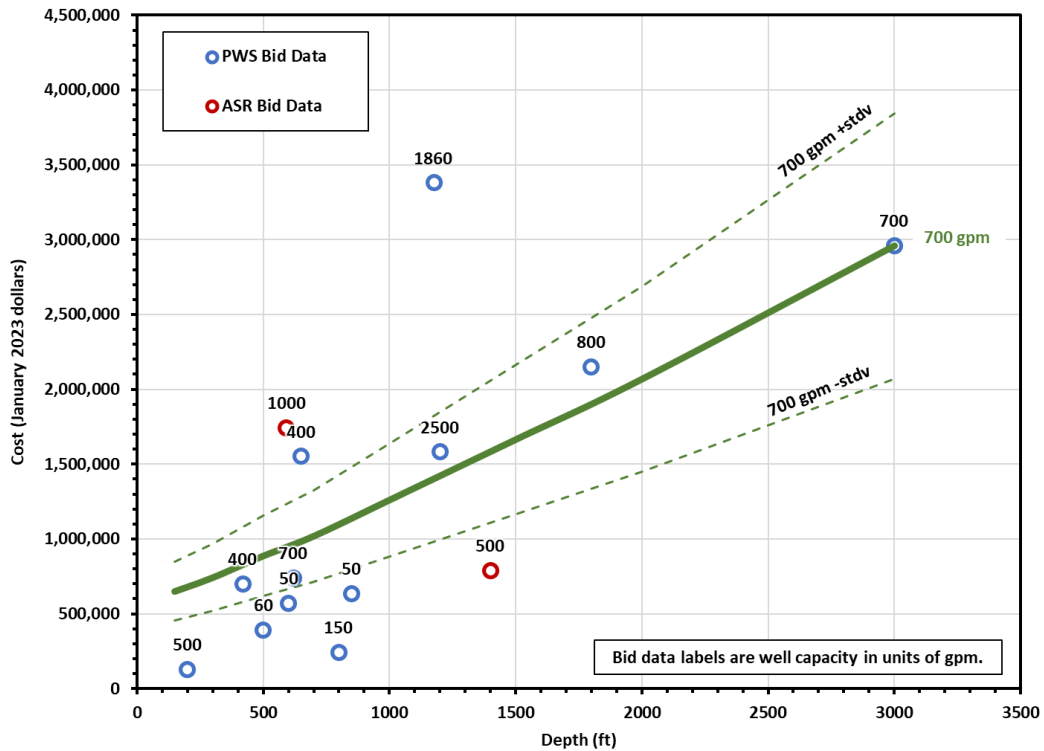


Table 14. Proposed Adjusted PWS Well Unit Costs (January 2023 Dollars)

Well Depth (Feet)	Well Capacity (gpm)					
	100	175	350	700	1,000	1,800
150	\$198,619	\$301,516	\$443,527	\$651,676	\$787,582	\$986,983
300	\$265,703	\$379,577	\$528,107	\$743,455	\$888,665	\$1,100,608
500	\$343,993	\$474,472	\$627,127	\$888,087	\$1,058,050	\$1,280,826
700	\$415,163	\$559,876	\$737,308	\$1,020,030	\$1,210,253	\$1,453,429
1,000	\$545,643	\$716,452	\$916,101	\$1,261,083	\$1,492,563	\$1,752,347
1,500	\$763,899	\$979,784	\$1,210,831	\$1,664,528	\$1,958,989	\$2,246,210
2,000	\$982,155	\$1,240,743	\$1,496,752	\$2,067,973	\$2,427,871	\$2,742,238
3,000	\$1,404,482	\$1,774,263	\$2,140,355	\$2,957,202	\$3,471,856	\$3,921,400

A simple assessment of the uncertainty in the cost estimates can be shown through analysis of those projects where multiple bids were available from different contractors. There were eight projects with multiple bids, for which the median and mean normalized standard deviation (standard deviation divided by the average) were 0.35 and 0.34, respectively. [Figure 21](#) shows the proposed adjusted 700 gpm curve along with curves reflecting one normalized standard deviation from that proposed curve. The spread is significant and indicates that significant uncertainty in well costs is inherent to the planning process.

Figure 21. Bid Data and Cost Curves for Wells (proposed curve for 700 gpm PWS wells w/ normalized std. dev. lines, January 2023 Dollars)



### ***Aquifer Storage and Recovery Wells***

New project bid information for ASR wells was available for two ASR projects and was plotted along with the existing curves for PWS wells, adjusted to a January 2023 cost index, as shown in **Figure 20**. Bid points on the figure are labeled with well capacity in gpm. In the previous UCM update, ASR wells were estimated to cost approximately 30 percent more than a comparable PWS well. In general, the increase in costs for an ASR well compared to a PWS well are associated with:

1. These projects frequently require dedicated monitoring wells not typically associated with conventional production well fields.
2. The potential for an upgrade in production casing to improve corrosion resistance<sup>2</sup>. This is due to the potential for increased corrosivity from oxygenated recharge water or other factors. Note that while PVC casing may sometimes be used in wells that are approximately 1,000 feet deep or less, the current price for PVC is similar to that for mild steel casing. High-strength, low-alloy (HSLA) steel will cost approximately 20 percent more than mild steel, while the price of stainless steel may be as much as twice that for mild steel.
3. The potential need for a downhole control valve (DHCV). Current costs are estimated to be between \$70,000 to \$150,000 based upon recent discussions with engineers working on ASR wells. In addition, the well casing diameter is often upsized to accommodate the DHCV and related control hoses/cables. Downhole valves are not needed for all applications, especially when static water levels are near the ground surface.
4. Upgraded filter pack design and material (not likely to drive costs significantly).
5. More complex headworks, with costs highly dependent on surface piping configuration.

**Figure 20** shows the two ASR well cost estimates in both low and high price ranges for PWS wells, precluding identification of a consistent pattern with respect to the cost premium for an ASR well over a PWS well. For these reasons, it is recommended that the updated curves retain the general guideline of ASR well cost estimates at 30 percent greater than PWS wells of similar depth and capacity. This approach maintains the ASR well costs within the estimated variability in PWS costs (and puts the costs toward the high end for PWS wells, reflecting the typical high-quality construction for ASR wells). [Table 15](#) shows the proposed updated costs for PWS wells by depth and capacity.

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<sup>2</sup> 30 TAC 331.264.1.B.2 requires casing materials for Class V AR injection wells to be constructed of materials resistant to corrosion.

Table 15. Proposed ASR Well Unit Costs (January 2023 Dollars)

Well Depth (Feet)	Well Capacity (gpm)					
	100	175	350	700	1,000	1,800
150	\$258,204	\$391,971	\$576,585	\$847,178	\$1,023,856	\$1,283,078
300	\$345,414	\$493,450	\$686,539	\$966,492	\$1,155,264	\$1,430,791
500	\$447,190	\$616,813	\$815,265	\$1,154,513	\$1,375,466	\$1,665,073
700	\$539,711	\$727,839	\$958,500	\$1,326,040	\$1,573,328	\$1,889,458
1,000	\$709,336	\$931,388	\$1,190,931	\$1,639,408	\$1,940,332	\$2,278,051
1,500	\$993,069	\$1,273,719	\$1,574,080	\$2,163,887	\$2,546,685	\$2,920,074
2,000	\$1,276,802	\$1,612,966	\$1,945,777	\$2,688,365	\$3,156,233	\$3,564,909
3,000	\$1,825,827	\$2,306,541	\$2,782,462	\$3,844,362	\$4,513,413	\$5,097,820

**Irrigation Wells**

No new project bid information was available for irrigation wells. In the absence of specific data, existing cost curves from the prior UCM were scaled to the reference cost date for the current planning cycle to reflect irrigation wells. Proposed cost curve information is included in [Table 16](#).

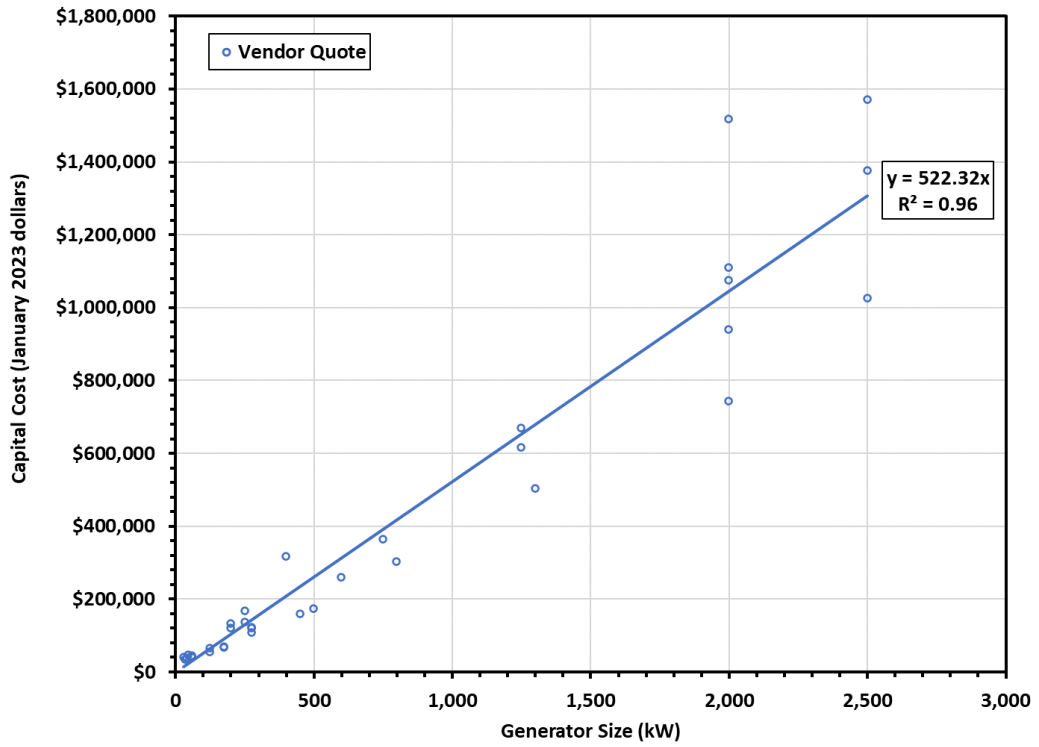
Table 16. Proposed Irrigation Well Unit Costs (January 2023 Dollars)

Well Depth (Feet)	Well Capacity (gpm)					
	100	175	350	700	1,000	1,800
150	\$94,895	\$146,468	\$249,613	\$286,746	\$363,074	\$523,982
300	\$125,838	\$187,726	\$305,312	\$361,011	\$457,969	\$639,505
500	\$156,783	\$235,173	\$365,137	\$441,464	\$561,114	\$773,595
700	\$181,536	\$270,243	\$416,709	\$509,542	\$651,883	\$889,118
1,000	\$237,236	\$348,634	\$523,982	\$649,820	\$831,356	\$1,116,039
1,500	\$332,131	\$482,724	\$701,393	\$882,929	\$1,128,417	\$1,491,491
2,000	\$424,962	\$612,687	\$878,804	\$1,113,977	\$1,427,540	\$1,869,005

**Backup Generators**

As a result of the recent natural disasters experienced in Texas and resulting unreliability of the power grid, backup generators are now typically included in new projects. The option to include backup generators has been added to the UCM in Version 3.0. Vendor quotes were compiled from the previous two years and indexed to January 2023 dollars. A statistical analysis using linear and non-linear regression techniques resulted in a unit cost of \$522 per kilowatt in terms of generator size. The coefficient of determination ( $r^2$ ) value of the linear relationship is 0.96, indicating the relationship explains 96 percent of the variation. Coefficient of determination values for non-linear relationships were found to be less than 0.96 and thus not selected. The corresponding cost curve is shown in [Figure 22](#).

Figure 22. Bid Data and Cost Curves for backup generators (January 2023 Dollars)





## **APPENDIX D**

### **Drought Management Methodology**

**(Excerpt from the 2016 South Central Texas Regional Water Plan)**

## 5.2.2 Drought Management

### 5.2.2.1 Description of Water Management Strategy

Texas Administrative Code (TAC), Chapter 357 Regional Water Planning Guidelines, states that “Regional water plan development shall include an evaluation of all water management strategies the regional water planning group determines to be potentially feasible, including drought management measures including water demand management [357.7(a)(7)(B)].” As defined here, drought management means the periodic activation of approved drought contingency plans resulting in short-term demand reduction and/or rationing. This reduction in demand is then considered a “supply” source. Using this approach, an entity may make the conscious decision not to develop firm water supplies greater than or equal to projected water demands with the understanding that demands will have to be reduced or go unmet during times of drought. Using this rationale, an economic impact of not meeting projected water demands can be estimated and compared with the costs of other potentially feasible water management strategies in terms of annual unit costs.

Figure 5.2.2-1 shows how water supply planning was done in the 2007 State Water Plan and 2006 Regional Water Plans. For each Water User Group (WUG) with an identified shortage or need during the planning period, a future water supply plan was developed consisting of one or more water management strategies. In each case, the planned future water supply was greater than the projected dry weather demand to allow for drought more severe than the drought of record, uncertainty in water demand projections, and/or available supply from recommended water management strategies. This difference between planned water supply and projected dry weather demand is called management supply in Region L.

Figure 5.2.2-2 illustrates how a drought management water management strategy (WMS) could alter the planning paradigm for WUGs with projected needs. Instead of identifying water management strategies to meet the projected need, planned water supply remains below the projected dry weather water demand. The difference between these two lines represents the drought management WMS. Under this concept, a WUG’s water demand would be reduced by activating a drought contingency plan to reduce demands, resulting in unmet needs. This strategy of demand reduction or water rationing could negate the need for water management strategies to meet the full projected need of the WUG. Basically, using this approach, the WUG is planning to manage water shortages through drought contingency plan activation or water rationing if needed. This concept is more fully illustrated in Figure 5.2.2-3, which shows that, in any given year, the actual demand may be above or below the planned supply. During times in which the demand exceeds supply, the WUG would experience shortages and incur associated economic impacts.

Figure 5.2.2-1. Typical Planning in 2011 Regional Water

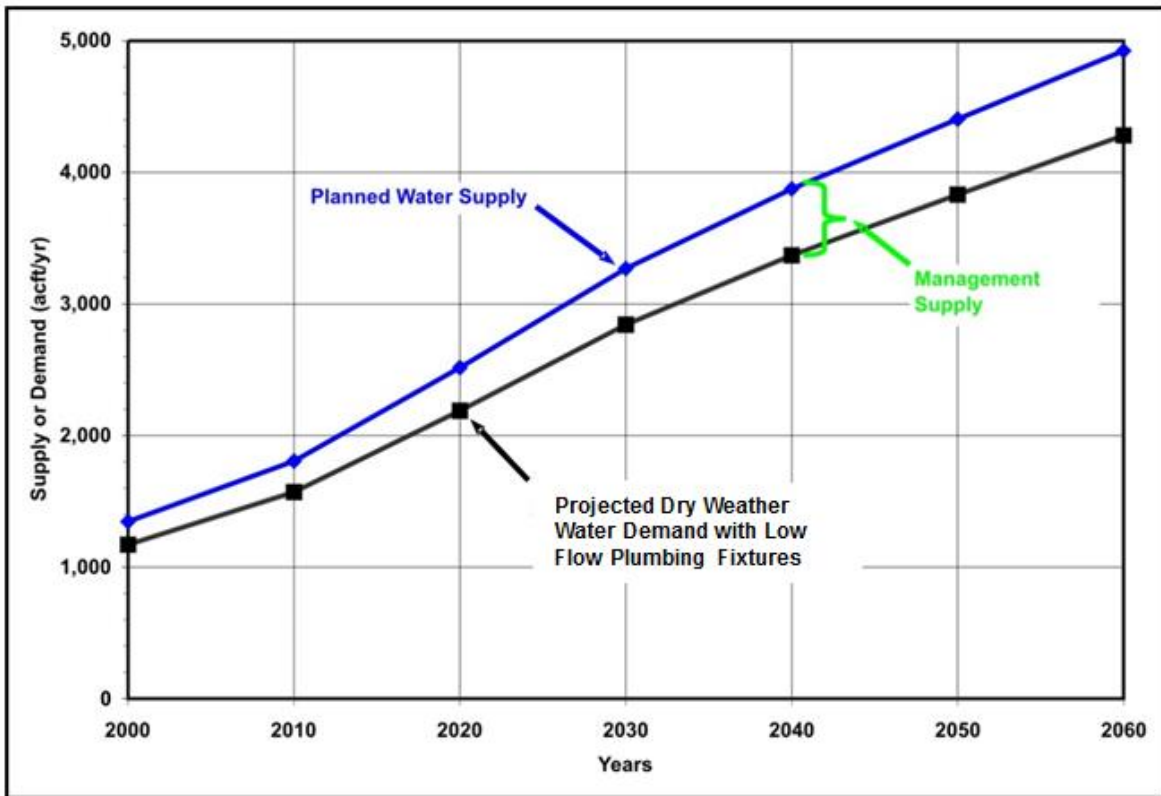
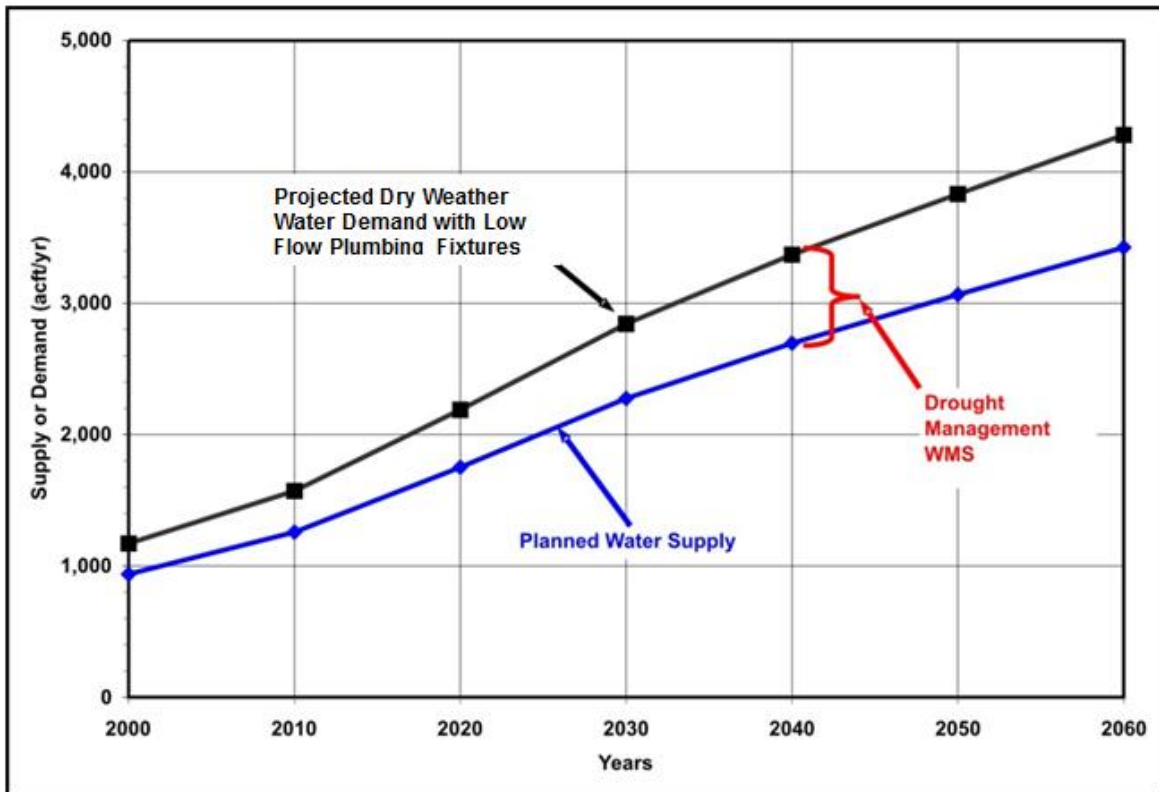
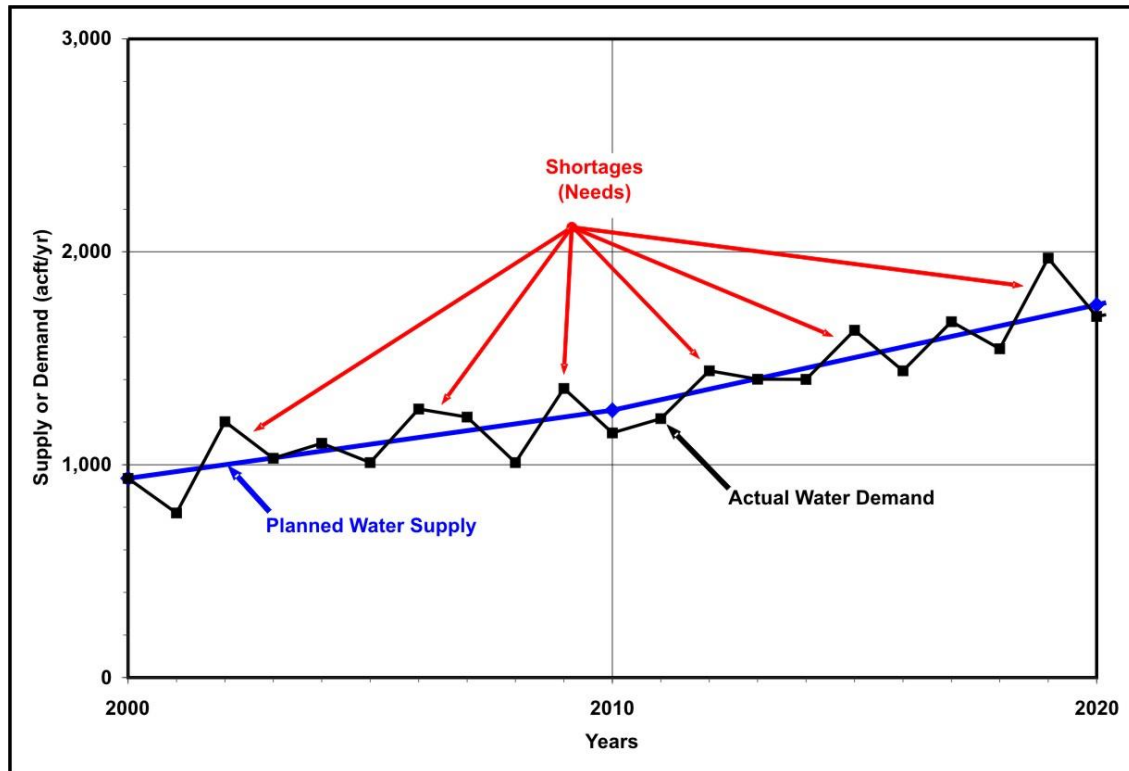


Figure 5.2.2-2. Planning with Drought Management Water Management Strategy



**Figure 5.2.2-3. Example Drought Management Water Management Strategy**



### 5.2.2.2 Drought Management Strategy Methodology

As shown in Figure 5.2.2-4, there are a number of incremental steps to calculating a unit cost for this strategy so that it can be compared to other strategies. The first step in the process is to calculate a risk factor for the 5% reduction, 10% reduction, 15% reduction, and 20% reduction cases. Figure 5.2.2-5 illustrates the 5% reduction scenario. The risk factor is defined as the integrated chance of occurrence of potential annual demands in excess of planned supply based on historical per capita variations for each entity. A 5% Drought Management WMS, for example, equates to planned supply that is 95% of projected demand.

The first step in determining the risk factors was to obtain historical annual per capita water use values. These data were obtained from the TWDB for the period 1964 to 2011, if available. From these data, a 5-year moving per capita water use average was calculated in order to limit the effects of trends in per capita water use rates. Next, an annual percentage above or below the 5-year moving average was calculated. These values were then ranked lowest to highest. A frequency curve was then developed using these data with the percentage above or below the 5-year moving average on the y-axis and the percentage of years less than or equal to that value on the x-axis. Finally, this curve was translated so that the year 2011 value was placed at 0 on the y-axis (Figure 5.2.2-5) because year 2011 was used by the TWDB as the basis for demand projections in the 2016 regional water plans.

Figure 5.2.2-4. Methodology Flowchart

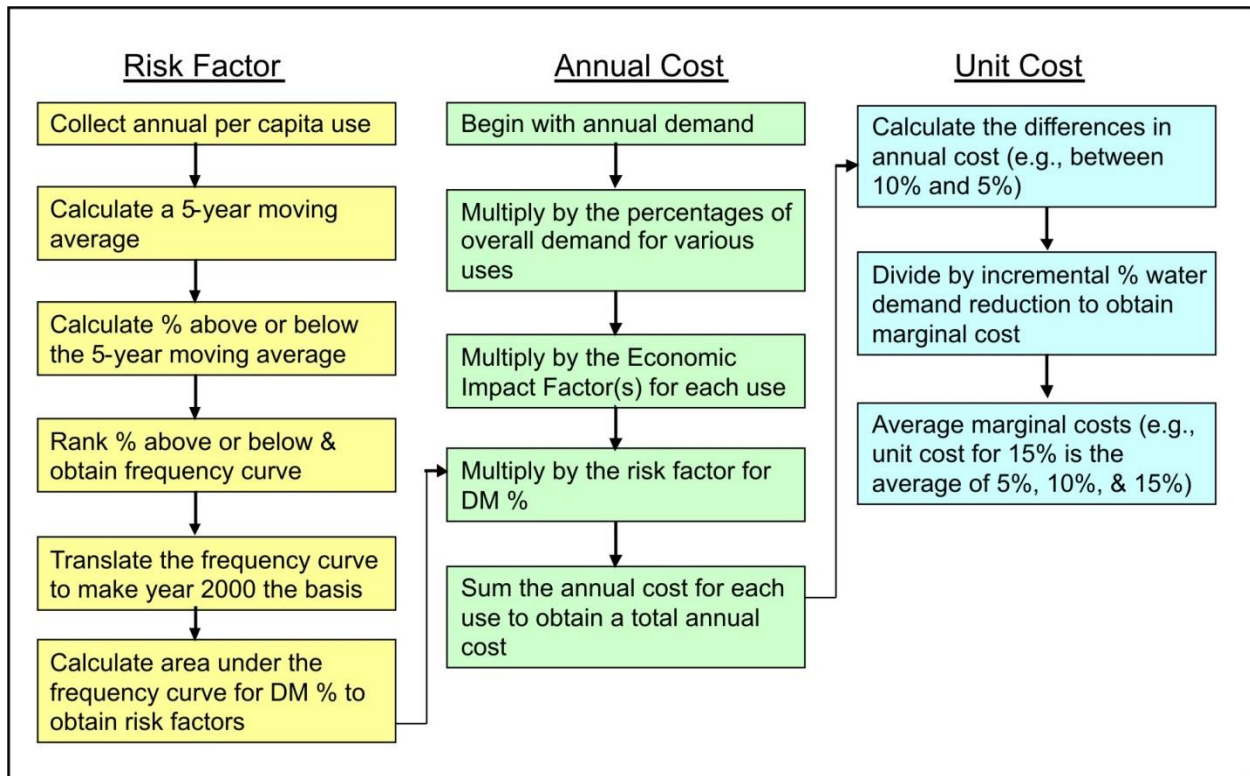
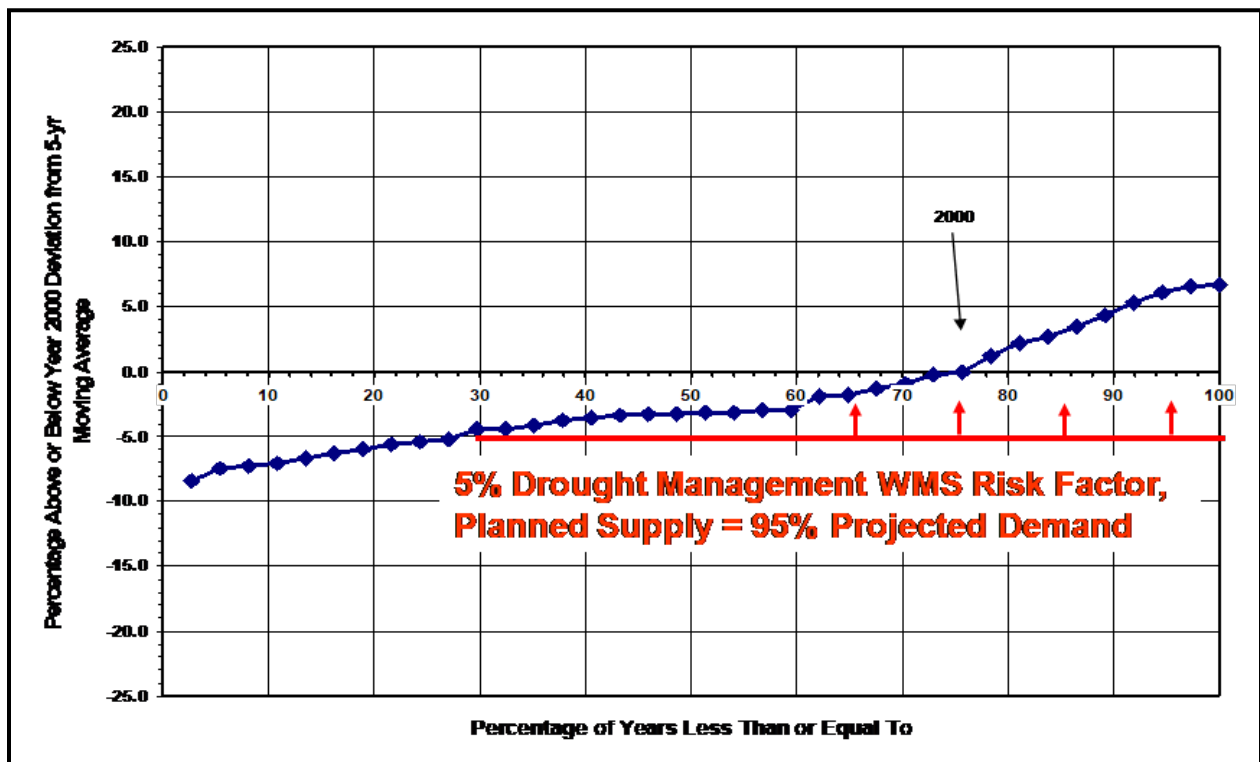


Figure 5.2.2-5. Frequency of Per Capita Water Use Variations



From a plot like Figure 5.2.2-5, the integrated area under the frequency curve was calculated as the risk factor. Using formulas developed in Excel, a chart of risk factors was developed for each WUG for each half percent reduction in water use. Using data supplied by the TWDB which shows the percent of water use for each WUG that is considered to be residential/domestic, the percent reduction in this use type was determined for each of the determined drought management levels (5%, 10%, 15%, and 20%). In other words, reductions in use were focused on residential use first. In this case, all reductions in residential use are attributed to outdoor water use and no reductions in indoor residential water use were assumed to occur. For example, a 10% reduction in overall water use for a WUG may reflect a 12% reduction in residential water use, depending on the amount of water used for other purposes.

Using the chart developed above, the risk factor associated with a 12% reduction in use (10% overall) was determined. If an overall 20% reduction in water use could be obtained without exceeding a 25% reduction in residential use, the use for other water users was not affected. If however, for certain WUGs (Lockhart, Leon Valley, Kirby, Carrizo Springs, Kennedy, Castroville, La Coste, Uvalde and Victoria) this was not the case. For these WUG, residential water use was reduced by 25% with the remaining reduction being split evenly between commercial and industrial use.

After risk factors for each scenario were calculated, an annual cost was then calculated using the following formula:

$$(\text{Demand}) \times (\% \text{Demand}) \times (\text{Risk Factor}) \times (\$ \text{ Impact Factor}) = \text{DM WMS Annual Cost}$$

where:

- Demand (acft/yr) = Projected “dry year” demand from TWDB based on year 2000 per capita use rate (projected demand in year 2010 was used);
- % Demand = Proportion of water demand associated with various use types (i.e., residential, commercial, and manufacturing);
- Risk Factor = Integrated chance of occurrence of potential annual demands in excess of planned supply based on historical per capita use variations for each entity;
- \$ Impact Factor (\$/acft) = Economic impact factors used by TWDB (see Table 5.2.2-1) to calculate economic impacts of not meeting needs. TWDB factors used include (a) lost sales for water-intensive commercial users; (b) costs to non-water-intensive commercial businesses and households; and (c) lost sales for manufacturing; and
- DM WMS Annual Cost (\$/yr) = Typical annual economic impacts of adhering to the Drought Management WMS for that water use type. The annual cost for each use type (i.e., domestic, commercial, and manufacturing) were then summed to obtain a total annual cost.

**Table 5.2.2-1. Texas Water Development Board Economic Impact Factors**

**Table 4C. 2-1  
Texas Water Development Board Economic Impact Factors**

WUG	COUNTY	RESIDENTIAL/DOMESTIC										NON RESIDENTIAL			DISTRIBUTION BY CATEGORY		
		OUTDOOR					INDOOR					COMMERCIAL	INDUSTRIAL (UTILITY SERVICED)	DOMESTIC %	COMMERCIAL (%)	INDUSTRIAL (UTILITY SERVICED)	
		5%	10%	20%	30%	40%	50%	60%	70%	80%	>90%						
% OF TOTAL HOUSEHOLD MONTHLY USE RESTRICTED												COMMERCIAL	INDUSTRIAL (UTILITY SERVICED)	DOMESTIC %	COMMERCIAL (%)	INDUSTRIAL (UTILITY SERVICED)	
ALAMO HEIGHTS	BEAR	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$51,494	\$0	\$0	85%	15%	0%
ASHERTON	DIVMIT	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$24,613	\$0	\$0	79%	21%	0%
ATASCOSA RURAL WSC	BEAR	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$37,778	\$0	\$0	100%	0%	0%
CARRIZO SPRINGS	DIVMIT	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$24,613	\$0	\$0	74%	26%	0%
CASTROVILLE	MEDINA	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$36,223	\$58,320	\$58,320	70%	30%	0%
CIBOLO	GUADALUPE	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$36,223	\$58,320	\$58,320	88%	12%	0%
CONVERSE	BEAR	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$12,571	\$163,480	\$163,480	88%	10%	2%
GARDEN RIDGE	COMAL	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$14,774	\$0	\$0	100%	0%	0%
GREEN VALLEY SUD	GUADALUPE	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$12,571	\$163,480	\$163,480	91%	7%	2%
HONDO	MEDINA	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$74,909	\$437,400	\$437,400	82%	15%	3%
KARNES CITY	KARNES	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$70,135	\$0	\$0	95%	5%	0%
KENNEDY	KARNES	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$24,613	\$0	\$0	70%	30%	0%
KIRBY	BEAR	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$35,370	\$0	\$0	60%	40%	0%
LACOSTE	MEDINA	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$14,494	\$0	\$0	73%	27%	0%
LEON VALLEY	BEAR	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$46,440	\$0	\$0	73%	27%	0%
LOCKHART	CALDWELL	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$38,048	\$0	\$0	61%	39%	0%
LYTLE	ATASCOSA	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$47,725	\$0	\$0	78%	22%	0%
MARTINDALE	CALDWELL	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$8,176	\$0	\$0	80%	20%	0%
MOUNTAIN CITY	HAYS	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$35,370	\$0	\$0	100%	0%	0%
NATALIA	MEDINA	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$24,613	\$0	\$0	90%	10%	0%
NIEDERWALD	CALDWELL	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$36,145	\$0	\$0	90%	10%	0%
SABINAL	UVALDE	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$39,269	\$0	\$0	99%	1%	0%
SAN ANTONIO (SAWS)	BEAR	\$886	\$983	\$1,199	\$1,836	\$4,525	\$5,519	\$7,020	\$9,526	\$14,537	\$25,996	\$93,182	\$290,347	\$290,347	77%	20%	3%
SHAVANO PARK	BEAR	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$43,405	\$0	\$0	100%	0%	0%
UNIVERSAL CITY	BEAR	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$68,148	\$0	\$0	86%	14%	0%
UVALDE	UVALDE	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$56,290	\$0	\$0	65%	35%	0%
VICTORIA	VICTORIA	\$994	\$1,112	\$1,393	\$2,300	\$6,242	\$7,603	\$9,666	\$13,090	\$19,937	\$25,996	\$39,269	\$0	\$0	76%	24%	0%
WINDCREST	BEAR	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$39,269	\$0	\$0	85%	15%	0%
YANCEY WSC	MEDINA	\$1,156	\$1,328	\$1,706	\$3,132	\$9,731	\$11,848	\$15,023	\$20,304	\$25,996	\$25,996	\$14,494	\$0	\$0	97%	3%	0%



The final step in this process was to convert the annual cost to a unit cost so that this strategy could be compared to other potentially feasible water management strategies. In order to do this, the difference between the annual cost for each scenario were first calculated (i.e., between 10% and 5%). This value was then divided by a 5% water demand reduction from the year 2010 demand to obtain a marginal cost. Finally, the marginal cost values were averaged to obtain a unit cost (i.e., the unit cost for 15% is the average of 5%, 10%, and 15%).

An example cost calculation for the City of Uvalde is provided in Table 5.2.2-2 and Table 5.2.2-3. Using data supplied by the TWDB (Table 5.2.2-1), the “Share of WUG’s Need Applied to Factor” row is populated. In this case, 65% of the demand is applied to Domestic/Residential use and 15% to Commercial use. There is no demand associated with Manufacturing for the City of Uvalde. Next, the demand associated with each water use is determined by multiplying the total year 2020 demand times the percentage associated with each use type (i.e., 4,052 acft x .65 = 2,634 acft for domestic/residential demand). Using the methodology described above, the risk factor was determined for each scenario. Next, the economic impact factor was determined for each use type using the data supplied by the TWDB and shown in Table 5.2.2-1. These factors are constant from one drought management scenario to the next, with the exception of the factors for Domestic/Residential which were determined by interpolating between the values supplied by the TWDB for the risk factor associated with scenario. For example, for the 5% drought management scenario (a 7.6% reduction in residential/domestic use) for the City of Uvalde, the associated economic impact factor for domestic/residential is \$1,053; however, for the 10% reduction scenario (a 15.3% reduction in residential/domestic use), the economic impact factor is \$1,267.

Next the total economic impact for each use type is calculated by multiplying the proportional demand times the risk factor times the economic impact factor (i.e., 2,642 acft x 0.1312 x \$1,173/acft = \$437,627 for the residential sector with a 10% reduction). This same formula was used to determine the economic impact for each use type. Note, that the only WUGs for which commercial and manufacturing water use was reduced are Lockhart, Leon Valley, Kirby, Carrizo Springs, Kennedy, Castroville, La Coste, Uvalde and Victoria. Next, the economic impacts for each use type were summed to obtain a total economic impact (in this case and most cases just for domestic/residential). This type of process was used to determine the total economic impact for each of the drought management scenarios.

**Table 5.2.2-2. 5 Percent Drought Management Scenario (City of Uvalde)**

	<i><b>Domestic/ Residential</b></i>	<i><b>Com- mercial</b></i>	<i><b>Manu- facturing</b></i>	<i><b>Total/ Combined</b></i>
Share of WUG’s Need Applied to Factor (%)	65%	35%	0%	
Proportional Demand (acft)	2,642	1,410	0	
5% DM WMS Risk Factor	0.0744	0	0	
5% Reduction Economic Impact Factor (\$/acft)	\$1,053	\$ 56,290	-	
5% DM WMS - Total Economic Impact (\$)	\$ 206,377	\$ -	\$ -	\$ 206,377



**Table 5.2.2-3. 10 Percent Drought Management Scenario (City of Uvalde)**

	<i>Domestic/ Residential</i>	<i>Com- mercial</i>	<i>Manu- facturing</i>	<i>Total/ Combined</i>
Share of WUG's Need Applied to Factor (%)	65%	35%	0%	
Proportional Demand (acft)	2,642	1,410	0	
10% DM WMS Risk Factor	0.1312	0	0	
10% Reduction Economic Impact Factor (\$/acft)	\$ 1,267	\$ 56,290	-	
10% DM WMS - Total Economic Impact (\$)	\$ 437,627	\$ -	\$ -	\$ 437,627

To determine the unit cost for the 10% drought management scenario for Uvalde, the following steps were completed. First, marginal costs for both the 5% and 10% scenarios were calculated. For the 5% scenario, this is simply the total economic impact divided by 5% of the total year 2010 demand (i.e., \$191,091 / 203 acft = \$945/acft). For the 10% scenario, a marginal cost must first be calculated. This is calculated as the difference in total economic impact between the 10% and 5% drought management scenarios, divided by 5% of the total year 2010 demand (i.e., (\$405,211 - \$191,091) / 203 acft = \$1,059/acft). To calculate the unit cost for the 10% drought management scenario, the marginal costs of the 5% and the 10% scenario are averaged (i.e., (\$945 + \$1,059) / 2 = \$1,002/acft).

The methodology was presented above for all WUGs showing a need in 2020. San Antonio Water Supply (SAWS), who does not have a need in 2020, also requested to be included in the drought management analysis. SAWS prefers to utilize a multi-decadal approach to drought Management. They are considering a 5% demand reduction for 2020, a 12% demand reduction for 2030, and 16% demand reductions for 2050-2070.

### 5.2.2.3 Yield from Drought Management Strategy

The yield associated with drought management is simply the year 2020 projected demand times the appropriate percentage depending upon which scenario is used (5%, 10%, 15% or 20%). These values are summarized below in Table 5.2.2-4.

**Table 5.2.2-4. Drought Management Yield**

<i>Entity</i>	<i>Yield (acft)</i>			
	<i>5%</i>	<i>10%</i>	<i>15%</i>	<i>20%</i>
Alamo Heights	111	222	332	443
Asherton	17	34	51	68
Atascosa Rural WSC	80	160	239	319
Carrizo Springs	114	227	341	454



**Table 5.2.2-4 (Continued)**

<b>Entity</b>	<b>Yield (acft)</b>			
	<b>5%</b>	<b>10%</b>	<b>15%</b>	<b>20%</b>
Castroville	40	79	119	159
Cibolo	267	534	801	1,069
Converse	127	254	380	507
Garden Ridge	83	166	249	332
Green Valley SUD	91	182	273	364
Hondo	103	205	308	411
Karnes City	31	63	94	125
Kenedy	71	142	213	284
Kirby	47	94	141	188
LaCoste	6	13	19	25
Leon Valley	93	186	279	372
Lockhart	113	225	338	450
Lytle	29	58	87	115
Martindale	9	19	28	37
Mountain City	1	2	4	5
Natalia	14	28	42	56
Niederwald	4	8	11	15
Sabinal	22	45	67	89
San Antonio/SAWS	55	110	166	221
Shavano Park	160	320	479	639
Universal City	203	405	608	810
Uvalde	856	1,711	2,567	3,422
Victoria	60	120	180	241
Windcrest	33	66	99	132
Yancey WSC	111	222	332	443

#### 5.2.2.4 Drought Management Strategy Costs

For each selected WUG, risk factors for 5%, 10%, 15%, and 20% drought management scenario reductions were calculated (Table 5.2.2-5). For the 5% reduction scenario, the risk factors ranged from 0.0008 for Mountain City, indicating there is very little risk of a higher per capita use rate occurring than what occurred in the year 2011, to 0.7295 for the City of Martindale, indicating a much greater risk of demand being greater than supply. For the 20% scenario, the risk factors ranged from a low of 0.012 for Mountain City to a high of 0.876 for Martindale.

As described above, these risk factors were then used to determine an annual cost for a planned supply less than demand for the year 2020 (Table 5.2.2-6). For the 5% reduction scenario, the annual cost ranged from \$17 for Mountain City to a cost of \$244, for Leon Valley. For the 20% reduction scenario, the annual cost ranged from \$385 for Mountain City to a cost of almost \$9 million for Uvalde. The two most important factors driving the annual cost are the risk factor and whether or not that WUG supplies water for commercial and manufacturing purposes (at the 20% reduction level), as these uses have high impact factors.

Finally, the annual cost data were used to calculate a unit cost so that comparisons could be made with other potentially feasible water management strategies (Table 5.2.2-7). For the 5% scenario (supply equal to 95% of dry condition demand), the unit costs ranged from \$6/acft/yr for Lytle to a high of \$15,038/acft/yr for Martindale. For the 20% scenario (supply equal to 80% of dry condition demand), the unit costs ranged from \$75 for Lytle to a high of \$10,045 for Uvalde. Again, the high unit costs for Uvalde are primarily due to the high risk factors (i.e., the year 2011 per capita was lower than in many previous years) and the high economic impact factors associated with commercial and manufacturing uses. The decadal percent reductions, yields, and costs for SAWS are presented in Table 5.2.2-8.



**Table 5.2.2-5. Risk Factors**

<b>Entity</b>	<b>Risk Factors</b>					
	<b>5%</b>	<b>10%</b>	<b>15%</b>	<b>20%</b>	<b>Commercial</b>	<b>Manufacturing</b>
Alamo Heights	0.0457	0.079	0.123	0.177		
Asherton	0.0010	0.005	0.024	0.055		
Atascosa Rural WSC	0.0262	0.040	0.058	0.079		
Carrizo Springs	0.0720	0.122	0.187	0.231		
Castroville	0.0131	0.024	0.044	0.056	0.015	0.015
Cibolo	0.0312	0.049	0.071	0.109		
Converse	0.0540	0.094	0.140	0.194		
Garden Ridge	0.0126	0.028	0.044	0.066		
Green Valley SUD	0.0912	0.121	0.155	0.193		
Hondo	0.0393	0.078	0.123	0.178		
Karnes City	0.3651	0.414	0.468	0.517		
Kenedy	0.0038	0.014	0.035	0.050		
Kirby	0.0142	0.047	0.115	0.115	0.029	
LaCoste	0.0201	0.042	0.089	0.130	0.016	
Leon Valley	0.1593	0.221	0.282	0.326	0.155	
Lockhart	0.0204	0.060	0.131	0.135	0.037	
Lytle	0.0078	0.027	0.065	0.107		
Martindale	0.7295	0.781	0.829	0.876		
Mountain City	0.0008	0.003	0.007	0.012		
Natalia	0.0357	0.054	0.078	0.111		
Niederwald	0.0687	0.105	0.143	0.182		
Sabinal	0.0162	0.024	0.036	0.053		
Shavano Park	0.0112	0.022	0.037	0.061		
Universal City	0.0173	0.044	0.091	0.143		
Uvalde	0.0744	0.131	0.195	0.213	0.097	
Victoria	0.0010	0.003	0.014	0.041	0.000	
Windcrest	0.0278	0.057	0.103	0.151		
Yancey WSC	0.1768	0.221	0.264	0.309		

**Table 5.2.2-6. Total Annual Cost**

<b>Entity</b>	<b>Total Annual Cost</b>			
	<b>5%</b>	<b>10%</b>	<b>15%</b>	<b>20%</b>
Alamo Heights	\$87,612	\$172,990	\$307,165	\$568,763
Asherton	\$313	\$1,866	\$9,958	\$33,520
Hondo	\$67,015	\$154,377	\$278,585	\$535,657
Karnes City	\$235,400	\$306,600	\$399,868	\$525,068
Kenedy	\$4,346	\$18,771	\$62,388	\$193,881
Kirby	\$8,672	\$34,557	\$177,313	\$507,722
LaCoste	\$2,295	\$5,661	\$14,762	\$37,049
Leon Valley	\$244,245	\$408,575	\$628,175	\$3,852,331
Lockhart	\$29,702	\$106,305	\$322,078	\$1,584,982
Lytle	\$4,244	\$17,546	\$49,259	\$132,900
Martindale	\$153,755	\$192,026	\$232,196	\$283,990
Mountain City	\$17	\$77	\$195	\$385
Natalia	\$10,618	\$18,571	\$31,096	\$56,145
Niederwald	\$5,441	\$9,691	\$15,190	\$24,515
San Antonio/SAWS	\$14,194	\$31,787	\$62,170	\$114,122
Shavano Park	\$48,727	\$138,993	\$333,296	\$659,686
Universal City	\$206,377	\$437,627	\$856,946	\$8,774,270
Uvalde	\$12,788	\$49,551	\$237,222	\$952,662
Victoria	\$31,013	\$75,775	\$157,282	\$312,780
Windcrest	\$120,620	\$175,413	\$239,591	\$324,504
Yancey WSC	\$136,751	\$276,602	\$516,940	\$2,211,819



**Table 5.2.2-7. Average Unit Cost**

<b>Entity</b>	<b>Average Unit Cost</b>			
	<b>5%</b>	<b>10%</b>	<b>15%</b>	<b>20%</b>
Alamo Heights	\$791	\$781	\$924	\$1,283
Cibolo	\$595	\$558	\$617	\$944
Converse	\$1,032	\$1,055	\$1,206	\$1,684
Garden Ridge	\$291	\$367	\$447	\$564
Green Valley SUD	\$1,930	\$1,490	\$1,465	\$1,733
Hondo	\$653	\$752	\$905	\$1,305
Karnes City	\$7,533	\$4,906	\$4,265	\$4,201
Kenedy	\$61	\$132	\$293	\$682
Kirby	\$184	\$367	\$1,255	\$2,695
LaCoste	\$361	\$446	\$775	\$1,459
Leon Valley	\$2,626	\$2,197	\$2,252	\$10,356
Lockhart	\$264	\$472	\$954	\$3,521
Lytle	\$147	\$304	\$569	\$1,152
Martindale	\$16,444	\$10,269	\$8,278	\$7,593
Mountain City	\$14	\$32	\$54	\$80
Natalia	\$756	\$661	\$738	\$999
Niederwald	\$1,451	\$1,292	\$1,350	\$1,634
Sabinal	\$369	\$313	\$354	\$460
San Antonio/SAWS	\$257	\$288	\$375	\$517
Shavano Park	\$305	\$435	\$695	\$1,032
Universal City	\$1,021	\$1,082	\$1,413	\$10,849
Uvalde	\$15	\$29	\$92	\$278
Victoria	\$18	\$781	\$924	\$1,283
Windcrest	\$520	\$444	\$484	\$553
Yancey WSC	\$1,205	\$1,219	\$1,518	\$4,872

**Table 5.2.2-8. SAWS Analysis**

	<b>2020</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>	<b>2060</b>	<b>2070</b>
<b>% Reduction</b>	5%	5%	5%	5%	5%	5%
<b>Yield (acft)</b>	745	910	1,079	1,253	1,429	1,599
<b>Average Unit Cost</b>	\$342	\$342	\$342	\$342	\$342	\$342

## **APPENDIX E**

### **Scope of Work and Response to TWDB Comments**



## EXHIBIT D

### SCOPE OF WORK

The CONTRACTOR will update the current Uniform Costing Model to correct bugs that were discovered during the fifth cycle of planning; reflect more recent construction costs; reflect relevant updates to the regional water planning guidelines; and improve the functionality of specific modules. The Uniform Costing Model must include a password provided to TWDB so costing tables are reviewable. The Scope of Work includes the following tasks, listed in priority order:

1. Project Management and Kickoff Meeting
  - a. Provide project control and accounting services to monitor project quality, progress, budget and invoicing.
  - b. Attend one (1) kickoff meeting with TWDB to review scope and contract, project expectations, and schedule.
2. Identify bugs and errors in the Uniform Costing Model through testing and/or surveying other Uniform Costing Model users. Correct known bugs and errors, including but not limited to:
  - a. Pipe diameter, pipe length, and pump station flow details do not appear in some strategy evaluation costing summary tables due to costing summary table formulas referencing incorrect cells in the costing form.
  - b. Breakdown for additional pipe diameters in the costing form do not appear in the costing summary table, though they can be modeled and included in the costing form.
  - c. Additional bugs or programming issues identified by the CONTRACTOR.
3. Update pertinent cost data where necessary, including:
  - a. Update construction costs for all major project cost categories identified in Table 3 of the most recent [Uniform Costing Model User Guide](#), to reflect recent costs of actual projects from recent project bids across the state. Project bids will be indexed to January 2023 for consistency using the Construction Cost Index (CCI) and Producer Price Index (PPI).
  - b. Tables in the 'Reference – Cost Indices' tab, the CCI and PPI, must be updated through September 2023.
  - c. Revise assumptions regarding interest rates in accordance with agency guidance.
  - d. Cost estimates for aquifer storage & recovery (ASR) wells will be reevaluated and revised accordingly, using data sources recommended by TWDB among other sources.
  - e. Reservoir land acquisition costs will be reevaluated and revised accordingly.
4. Improve the functionality of specific costing modules, including:
  - a. Evaluate the methodology and assumptions in the Conservation module and revise as appropriate, including in coordination with TWDB identified stakeholders.
  - b. Revise the costing summary, where appropriate, to align with the form [TWDB -1201](#) for financial assistance applications.

- c. Complete other model enhancements identified by the CONTRACTOR, where appropriate as determined by the CONTRACTOR.
5. Update the Uniform Costing Model documentation consistent with the most recently updated [regional water planning guidance document](#):
  - a. Provide an update to the accompanying Uniform Costing Model User's Guide document reflecting relevant changes to each module of the Costing Model.
  - b. CONTRACTOR will update the Uniform Costing Model to be consistent with Section 2.5.2.12 of the First Amended General Guidelines for Development of the 2026 Regional Water Plans *see link above*).
  - c. Update the Uniform Costing Model's change log, documenting updates made under this Contract.
  - d. Prepare and present one training session to TWDB staff and regional water planning stakeholders (via webinar). Training may include, but not be limited to, demonstration of new or revised functionality of the costing model and will be recorded.

#### **DELIVERABLES**

- A. Draft and final versions of an updated electronic Uniform Costing Model Microsoft Excel multi-tab spreadsheet file, which includes all requested enhancements outlined above in the SOW.
- B. Draft and final update to the Unified Costing Model User's Guide reflecting revisions made in accordance with the SOW (Microsoft Word and PDF document format). Draft deliverable will be submitted to TWDB for review and comment.
- C. One virtual training session to TWDB staff and regional water planning stakeholders (via webinar) must be provided. Training may include but not be limited to demonstration of new or revised functionality of the costing model.



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Phone (512) 463-7847, Fax (512) 475-2053

Todd Warrix  
HDR Engineering, Inc.  
4401 West Gate Blvd., Suite 400  
Austin, TX 78745

RE: HDR Engineering, Inc. Contract No. 2300012714; TWDB comments on Draft Report titled *“Uniform Costing Model User Guide”* and draft *Uniform Costing Model Microsoft Excel file*.

Dear Mr. Warrix:

Texas Water Development Board (TWDB) staff completed a review of the draft report (user guide) and costing model prepared under the above-referenced contract. Attachment 1 provides the comments resulting from this review. As stated in the TWDB contract, HDR Engineering, Inc. will consider revising the final report and costing model in response to comments. Please also submit electronic copies of raw and processed data, metadata, maps, associated GIS files, any computer programs, models, or operations manuals developed under the terms of this contract.

TWDB staff looks forward to receiving an electronic copy of the entire Final Report in Portable Document Format (PDF) format, and an electronic copy of the Final Uniform Costing Model Microsoft Excel file, accompanied by a Transmittal Letter which identifies how the Executive Administrator’s comments were addressed.

**Note: The electronic copy of a final report(s) or other deliverable(s) must comply with the requirements and standards specified in 1 Texas Administrative Code (TAC) Chapters 206 and 213 (related to Accessibility and Usability of State Web Sites). Web Content Accessibility Guidelines (WCAG) 2.1 Level AA Standard – WCAG 2.1 Quick Reference can be found at: <https://www.w3.org/WAI/WCAG21/quickref/>.**

**Complying with this clause will require demonstrated proof of compliance utilizing TWDB’s checklists. For the deliverable in .pdf format, use the checklist and verification form found at [https://www.twdb.texas.gov/about/contract\\_admin/doc/Accessibility-Checklist-and-Certification-with-Instructions.pdf](https://www.twdb.texas.gov/about/contract_admin/doc/Accessibility-Checklist-and-Certification-with-Instructions.pdf) to demonstrate compliance and submit the completed form with the deliverable. Acceptance of the final report(s) or other deliverable(s) is contingent upon compliance with this clause.**

Final Report Comments Letter

Page 2

If you have any questions or need any further information, please contact your Contract Manager, Kevin Smith of the Planning staff at (512) 475-1561, [kevin.smith@twdb.texas.gov](mailto:kevin.smith@twdb.texas.gov), or Cameron Turner of the Procurement & Contract Services Division at (512) 936-6090, [cameron.turner@twdb.texas.gov](mailto:cameron.turner@twdb.texas.gov).

Sincerely,

Temple McKinnon  
Matt Nelson  
Deputy Executive Administrator  
Planning

1/4/2024  
Date

c w/o att.: Kevin Smith, Planning

## ATTACHMENT 1

### TWDB Comments to Draft Deliverables

**Contract No. 2300012714 – HDR Engineering, Inc.**

### **Report Titled “Uniform Costing Model (UCM) User Guide” and Uniform Costing Model Excel file**

#### Comments:

1. In the UCM Change Log tab, the Scope Item for ID 89 appears to reference the incorrect Scope Item. Please correct the Scope Item reference for this change to 4B.
2. Please clarify whether the change to cell K20 in Advance Hydraulics Pipe 1 tab, should also be made in Pipe 2 and Pipe 3 tabs, and make corrections as appropriate.
3. Change ID 82 in the Change Log to Costing Summary, cell B18, appears to reference the wrong module or cell. Please review and make corrections as appropriate.
4. Please confirm whether Change ID 85 in Change Log tab should reference cell D9, and make corrections as appropriate.
5. In the UCM Costing Summary, please remove the “Contingency” header and “Total Contingency” subtotal.
6. In the UCM Costing Summary, please combine the Financing and Bond Counsel line items and rename this line item as “Fiscal Services.”
7. In the UCM Change Log tab, please insert a row to clearly label the updates made in the 2021 planning cycle UCM update (v. 2.0).
8. User Guide, Page 3: The reference for footnote 1 appears to be missing from text.
9. User Guide, Page 3, Line item 4: Please rename form TWDB-12011 to TWDB-1201.
10. User Guide, Page 28, last paragraph: Please revise the paragraph to the following “In accordance with 31 Texas Administrative Code (TAC) §357.34(e)(3)(A) the cost of distribution system improvements within a service area should not be part of the cost for a WMS unless it is associated with water savings in a conservation strategy, or a direct reuse project”<sup>10</sup>.
11. User Guide, Page 28: Please update footnote 10 to refer to TWDB, Exhibit C, “General Guidelines for Development of the 2026 Regional Water Plans”, Second Amended, September 2023.
12. User Guide, Page 33, Figure 13: Please insert a clear (i.e. non blurry) and updated version of this figure to reflect revisions requested to the Costing Summary.
13. User Guide, Page 34, last sentence: Please revise the sentence to “The MWCPT is available for use but not required for evaluation of water conservation strategies.”
14. User Guide, Page 38, Section 11.1, last paragraph: Please revise the paragraph to the following “In Fall 2019, the TWDB developed a Drought Management Costing Tool<sup>18</sup> and User Guide<sup>19</sup> for the regional water planning groups using the same model for estimating lost consumer surplus, one of the several impact measures included in the socioeconomic impact estimates for the 2021 Regional Water Plan.
15. User Guide, Appendix D: The title page for Appendix D of the User Guide says it’s from the 2011 Region L RWP, please revise the text to refer to the 2016 Region L RWP.

## HDR Comment Response

**1. In the UCM Change Log tab, the Scope Item for ID 89 appears to reference the incorrect Scope Item. Please correct the Scope Item reference for this change to 4B.**

HDR Response: Scope item has been corrected for Item 89.

**2. Please clarify whether the change to cell K20 in Advance Hydraulics Pipe 1 tab, should also be made in Pipe 2 and Pipe 3 tabs, and make corrections as appropriate.**

HDR Response: Change to cell K20 in Advanced Hydraulics Pipe 1 tab is now also included in Pipe 2 and Pipe 3 tabs.

**3. Change ID 82 in the Change Log to Costing Summary, cell B18, appears to reference the wrong module or cell. Please review and make corrections as appropriate.**

HDR Response: Change Log for Item 82 has been corrected to reference cell B10 in Costing Summary.

**4. Please confirm whether Change ID 85 in Change Log tab should reference cell D9, and make corrections as appropriate.**

HDR Response: Change Log for Item 85 has been updated to reference cells O17:O35 and Q17:Q35 in addition to cell D9.

**5. In the UCM Costing Summary, please remove the “Contingency” header and “Total Contingency” subtotal.**

HDR Response: The “Contingency” header and “Total Contingency” subtotal have been removed.

**6. In the UCM Costing Summary, please combine the Financing and Bond Counsel line items and rename this line item as “Fiscal Services.”**

HDR Response: The Financing and Bond Counsel line items have been combined and renamed as “Fiscal Services”.

**7. In the UCM Change Log tab, please insert a row to clearly label the updates made in the 2021 planning cycle UCM update (v. 2.0).**

HDR Response: A row has been added to clearly label the updates made in the 2021 planning cycle.

**8. User Guide, Page 3: The reference for footnote 1 appears to be missing from text.**

HDR Response: Footnote 1 was included in the text but was improperly formatted as non-superscript. The reference for footnote 1 has been properly formatted to superscript.

**9. User Guide, Page 3, Line item 4: Please rename form TWDB-12011 to TWDB-1201.**

HDR Response: The last 1 in “TWDB-12011” was improperly formatted as non-superscript. See response to comment number 8. The text has been properly formatted.

**10. User Guide, Page 28, last paragraph: Please revise the paragraph to the following “In accordance with 31 Texas Administrative Code (TAC) §357.34(e)(3)(A) the cost of distribution system improvements within a service area should not be part of the cost for a WMS unless it is associated with water savings in a conservation strategy, or a direct reuse project”<sup>10</sup>.**

HDR Response: Text has been revised.

**11. User Guide, Page 28: Please update footnote 10 to refer to TWDB, Exhibit C, “General Guidelines for Development of the 2026 Regional Water Plans”, Second Amended, September 2023.**

HDR Response: Footnote has been updated.

**12. User Guide, Page 33, Figure 13: Please insert a clear (i.e. non blurry) and updated version of this figure to reflect revisions requested to the Costing Summary.**

HDR Response: An updated version of the figure has been inserted.

**13. User Guide, Page 34, last sentence: Please revise the sentence to “The MWCPT is available for use but not required for evaluation of water conservation strategies.”**

HDR Response: The sentence was revised.

**14. User Guide, Page 38, Section 11.1, last paragraph: Please revise the paragraph to the following “In Fall 2019, the TWDB developed a Drought Management Costing Tool<sup>18</sup> and User Guide<sup>19</sup> for the regional water planning groups using the same model for estimating lost consumer surplus, one of the several impact measures included in the socioeconomic impact estimates for the 2021 Regional Water Plan. In March 2024, the TWDB released an updated version of the [Drought Management Costing Tool](#) and [User Guide](#), which are posted on TWDB’s [2026 Regional Water Plan Document Page](#) under 5B. The 2024 version of the tool should be utilized for development of the 2026 Regional Water Plans, should RWPGs choose to use the tool.**

HDR Response: The paragraph was revised. Note Comment 14 was revised from original comment per TWDB email on 8March2024 from Kevin Smith.

**15. User Guide, Appendix D: The title page for Appendix D of the User Guide says it’s from the 2011 Region L RWP, please revise the text to refer to the 2016 Region L RWP.**

HDR Response: The Appendix D title has been revised.