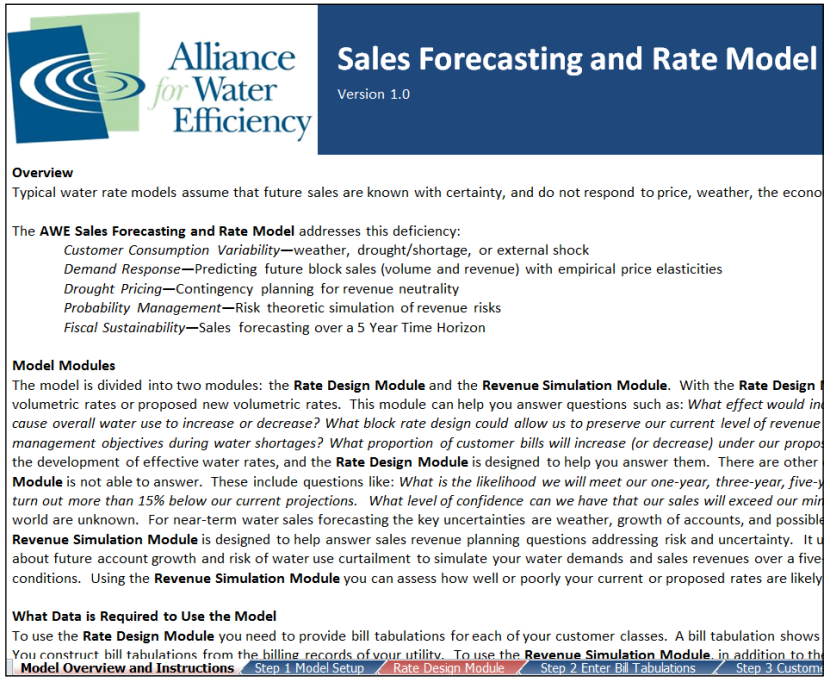
# AWE Sales Forecasting and Rate Model

# Why a New Rate Model?

**Typical water rate models assume that future sales are known with certainty, and do not respond to price, weather, the economy, or supply shortages—that is to say, not the world we live in.**

- The **AWE Sales Forecasting and Rate Model** addresses this deficiency:
  - *Customer Consumption Variability*—weather, drought/shortage, or growth
  - *Demand Response*—Predicting future block sales (volume and revenue) with empirical price elasticity's
  - *Drought Pricing*—Contingency planning for revenue neutrality
  - *Probability Management*—Risk theoretic simulation of revenue risks
  - *Fiscal Sustainability*—Sales forecasting over a 5 Year Time Horizon
  - *Affordability*—Can customers afford water service?


Alliance for Water Efficiency

Sales Forecasting and Rate Model

Version 1.0

**Overview**

Typical water rate models assume that future sales are known with certainty, and do not respond to price, weather, the econo

The **AWE Sales Forecasting and Rate Model** addresses this deficiency:

*Customer Consumption Variability*—weather, drought/shortage, or external shock
*Demand Response*—Predicting future block sales (volume and revenue) with empirical price elasticities
*Drought Pricing*—Contingency planning for revenue neutrality
*Probability Management*—Risk theoretic simulation of revenue risks
*Fiscal Sustainability*—Sales forecasting over a 5 Year Time Horizon

**Model Modules**

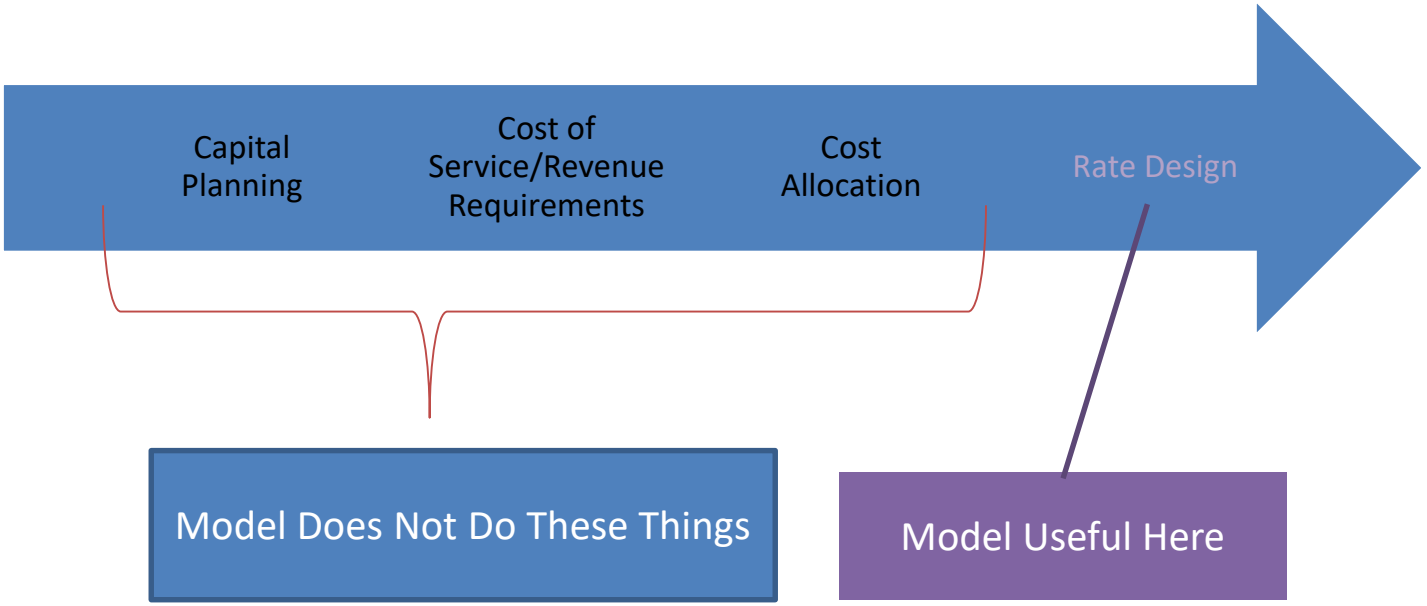
The model is divided into two modules: the **Rate Design Module** and the **Revenue Simulation Module**. With the **Rate Design** volumetric rates or proposed new volumetric rates. This module can help you answer questions such as: *What effect would in cause overall water use to increase or decrease? What block rate design could allow us to preserve our current level of revenue management objectives during water shortages? What proportion of customer bills will increase (or decrease) under our propo* the development of effective water rates, and the **Rate Design Module** is designed to help you answer them. There are other **Module** is not able to answer. These include questions like: *What is the likelihood we will meet our one-year, three-year, five-y turn out more than 15% below our current projections. What level of confidence can we have that our sales will exceed our mir* world are unknown. For near-term water sales forecasting the key uncertainties are weather, growth of accounts, and possible **Revenue Simulation Module** is designed to help answer sales revenue planning questions addressing risk and uncertainty. It u about future account growth and risk of water use curtailment to simulate your water demands and sales revenues over a five conditions. Using the **Revenue Simulation Module** you can assess how well or poorly your current or proposed rates are likely

**What Data is Required to Use the Model**

To use the **Rate Design Module** you need to provide bill tabulations for each of your customer classes. A bill tabulation shows You construct bill tabulations from the billing records of your utility. To use the **Revenue Simulation Module**, in addition to th

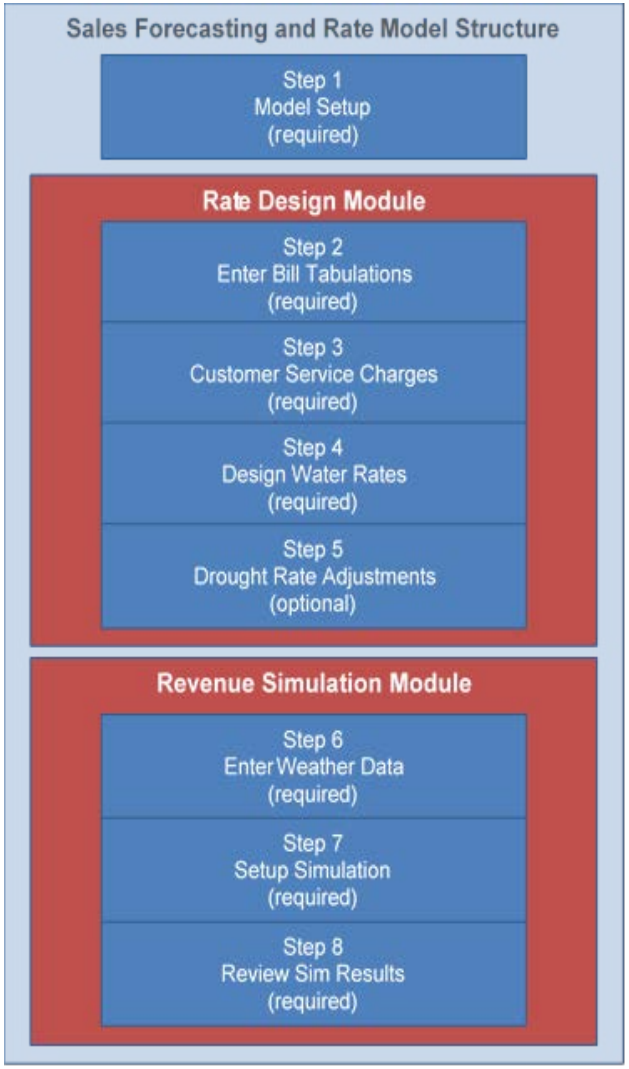
Model Overview and Instructions | Step 1 Model Setup | Rate Design Module | Step 2 Enter Bill Tabulations | Step 3 Customi

# WHERE MODEL FITS INTO RATE SETTING PROCESS



# Modular Design

- Rate Design Module
- Revenue Simulation Module



# Model Setup

## Step 1: Model Setup

On this worksheet you specify the test year, the units volumes, precipitation, and temperature, seasons, customer classes, and ratio c
The model requires these parameters in order to function properly. Therefore this should be the first thing you do if you are using the
on this worksheet. Be sure all sections are completed correctly before moving on to the Rate Design Module.

### 1. Bill Tabulation Year

The model calculates water sales and sales revenue using the distributions of customer water consumption you enter in Step 2 (Bill T
consumption data for a recent year. This is called the Bill Tabulation Year. Use the drop-down list below to specify the year for which
Note: The Bill Tabulation Year must be within the last 10 years, and should be a year for which you provide weather data in Step 4, th

| Bill Tabulation Year: | 2017 |
|---|---|

### 2. Model Units

The model needs to know what billing units you use with your water rates. In the U.S., municipal and industrial water use is typically
(Thou. Gal.). In countries on the metric system, it is typically priced per kilo liter (kL). Use the drop-down list to select the billing units
In Step 6 you will enter historical precipitation and temperature data. Use the drop-down lists to specify units these data are in.

| Billing Units: | Thou. Gal. | Precipitation Units: | in | Temperature Units: | F |
|---|---|---|---|---|---|

### 3. Seasons

The model divides annual water use between Off Peak and Peak seasons. This allows the model to differentiate the change in water
the Peak season is more responsive to rate adjustments than demand in the Off Peak season). It also allows you to specify different
Use the drop-down lists to specify the first and last months for the Off Peak season. The model will then determine the months that a
Note: you do not need to specify the months for the Peak season. The model determines this from your specification of the Off Peak s

| Season | From | Thru | No. Months | Season | From | Thru | No. Months |
|---|---|---|---|---|---|---|---|
| Off Peak: | Oct | Apr | 7 | Peak: | May | Sep | 5 |

# Model Setup

**3. Seasons**

The model divides annual water use between Off Peak and Peak seasons. This allows the model to differentiate the change in water use given a change in rates (the Peak season is more responsive to rate adjustments than demand in the Off Peak season). It also allows you to specify different water rates for each season. Use the drop-down lists to specify the first and last months for the Off Peak season. The model will then determine the months that are in the Peak season.
Note: you do not need to specify the months for the Peak season. The model determines this from your specification of the Off Peak season.

| Season | From | Thru | No. Months | Season | From | Thru | No. Months |
|---|---|---|---|---|---|---|---|
| Off Peak: | Oct | Apr | 7 | Peak: | May | Sep | 5 |

**4. Maximum to Minimum Month Production Ratio**

The model uses the ratio of maximum to the minimum monthly system production to infer the relative importance of outdoor water use in your service area. Since responsive than indoor use to deviations from normal weather patterns, this is important. Enter the maximum to minimum monthly production ratio in the cell bel
Note: It is best to calculate this ratio for several recent years and then enter the average of your results.

Max to Min Monthly Production Ratio: 3.25

**5. Customer Classes**

The model can calculate water use and sales revenue for up to six different customer classes. Use the Number of Customer Classes drop-down list to specify the want to model. Enter names for each class in the Class Names table below the drop-down list.

**Number of Customer Classes:** 4

| | Class Names Table |
|---|---|
| Class 1 | Single Family |
| Class 2 | Multi Family |
| Class 3 | CII |
| Class 4 | Landscape |
| Class 5 | Not in use |
| Class 6 | Not in use |

**6. Median Household Income**

The model calculates the change in affordability between your Current and Proposed rates based on the ratio of water cost to median household income. Enter m your service area and select the Customer Class number you set to your primary residential customer class (e.g. single family customers).

Median household income: $75,000

Select the class number you set to your primary residential customer class: Class 1

**If you have completed this worksheet, go to the Rate Design Module worksheet.**

# Rate Design Module

# Example Questions the Rate Design Module Can Address

- *What effect would increasing the rate in our top tier by 15% have on water demand?*
- *Will shifting to seasonal rates cause overall water use to increase or decrease?*
- *What block rate design could allow us to preserve our current level of revenue while reducing overall demand?*
- *What proportion of customer bills will increase (or decrease) under our proposed rates when compared to our current rates?*
- *How should we adjust our rates to support our water demand management objectives during water shortages?*

# What Rate Designs Can Be Modeled?

- Rate Designs
  - Uniform
  - Seasonal
  - Block
  - Seasonal Block
- Up to 5 blocks
- Can vary rates and blocks by customer class
- Up to six customer classes

# What Data are Needed to Use It?

- Bill Tabulations from Billing System Data
  - By Class
  - By Season (Off-Peak, Peak)
- Follows AWWA M1 Bill Tabulation Methodology
- Allocating Bills to Seasons
  - Easy when bills are rendered monthly
  - Bit harder when bills are rendered bi-monthly or quarterly

# Bill Tabulation Screenshot

**Step 2: Enter Customer Class Bill Tabulations**

On this worksheet, you enter bill tabulations for your Bill Tabulation Year for the customer classes you set up in Step 1. A bill tabulation shows the number of bills may not fall neatly into the seasons you defined in Step 1,creating a seasonal bill tabulation is more challenging than creating an annual bill tabulation. It which this read date corresponds). It will always be the case that consumption will span the two seasons for some bills. In these cases, you will need to have are in the first season, then assign it to the first season). The User Guide provides additional guidance and examples for preparing your bill tabulations. In add using your meter read data.

Go back to Rate Design Module Worksheet

| Usage Bin (Thou. Gal.) | | Customer Class: Single Family | | | | Customer Class: Multi Family | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Off Peak Season Oct - Apr | | Peak Season May - Sep | | Off Peak Season Oct - Apr | | Peak Season May - Sep | |
| From | To | Bills in Bin | Total Use of Bills in Bin (Thou. Gal.) | Bills in Bin | Total Use of Bills in Bin (Thou. Gal.) | Bills in Bin | Total Use of Bills in Bin (Thou. Gal.) | Bills in Bin | Total Use of Bills in Bin (Thou. Gal.) |
| 0 | 0 | 1,854 | 0 | 700 | 0 | 36 | 0 | 17 | 0 |
| 1 | 1 | 1,781 | 1,781 | 601 | 601 | 11 | 11 | 4 | 4 |
| 2 | 2 | 2,073 | 4,146 | 631 | 1,262 | 12 | 24 | 3 | 6 |
| 3 | 3 | 3,122 | 9,366 | 787 | 2,361 | 8 | 24 | 5 | 15 |
| 4 | 4 | 4,084 | 16,336 | 917 | 3,668 | 22 | 88 | 4 | 16 |
| 5 | 5 | 4,974 | 24,870 | 1,122 | 5,610 | 22 | 110 | 9 | 45 |
| 6 | 6 | 5,751 | 34,506 | 1,150 | 6,900 | 20 | 120 | 7 | 42 |
| 7 | 7 | 6,548 | 45,836 | 1,322 | 9,254 | 29 | 203 | 10 | 70 |
| 8 | 8 | 7,080 | 56,640 | 1,354 | 10,832 | 41 | 328 | 6 | 48 |
| 9 | 9 | 7,883 | 70,947 | 1,385 | 12,465 | 49 | 441 | 10 | 90 |
| 10 | 10 | 8,173 | 81,730 | 1,531 | 15,310 | 54 | 540 | 9 | 90 |
| 11 | 11 | 8,333 | 91,663 | 1,554 | 17,094 | 55 | 605 | 10 | 110 |
| 12 | 12 | 8,439 | 101,268 | 1,588 | 19,056 | 45 | 540 | 15 | 180 |
| 13 | 13 | 8,309 | 108,017 | 1,565 | 20,345 | 66 | 858 | 18 | 234 |
| 14 | 14 | 8,377 | 117,278 | 1,552 | 21,728 | 80 | 1,120 | 21 | 294 |
| 15 | 15 | 8,082 | 121,230 | 1,611 | 24,165 | 81 | 1,215 | 17 | 255 |

# Rate Design Table

| Block # | Block Switch Point | Rate for Block |
|---|---|---|
| Block 1 | 10 | $2.50 |
| Block 2 | 20 | $3.00 |
| Block 3 | | $3.75 |
| Block 4 | | $3.75 |
| Block 5 | | $3.75 |

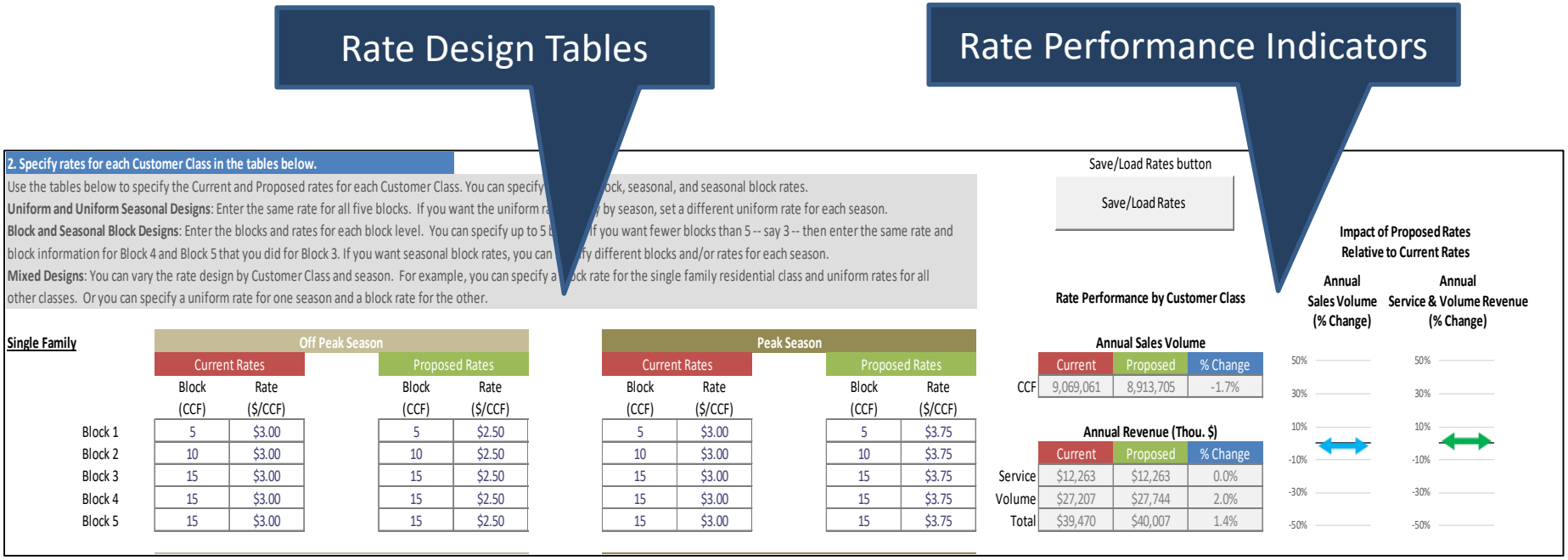
Rate for first 10 units

Rate for next 10 units

Rate for units in excess of 20

Copy rate in last block to unused blocks

# Rate Design Screenshot



# Bill Impacts Screenshot

Avg and median bill impacts

Affordability Indicator

**3. Bill impacts of Proposed rates**

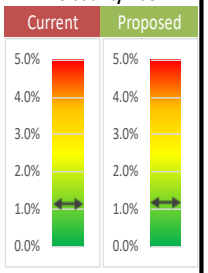
Under your Proposed rates, the volume charge may go up for some customers and down or stay the same for others. The Bill Impacts Table shows the percentage of bills that will go down, stay the same, or go up -- and by how much. Charts showing the distribution of bill impacts for each customer class are provided on the Bill Impacts worksheet.

**% Change in Average and Median Annual Water Service Cost by Customer Class**

| Customer Class | Average Annual Water Service Cost | | | Median Annual Water Service Cost | | |
|---|---|---|---|---|---|---|
| | Current | Proposed | % Change | Current | Proposed | % Change |
| Single Family | $777 | $804 | 3.4% | $650 | $672 | 3.3% |
| Multi Family | $4,254 | $4,294 | 0.9% | $1,930 | $1,942 | 0.6% |
| CII | $3,323 | $3,382 | 1.8% | $1,481 | $1,504 | 1.5% |
| Landscape | $5,599 | $6,007 | 7.3% | $2,503 | $2,720 | 8.7% |
| Not in use | | | | | | |
| Not in use | | | | | | |

Affordability index equals the median annual water cost for the primary residential customer class divided by median household income.

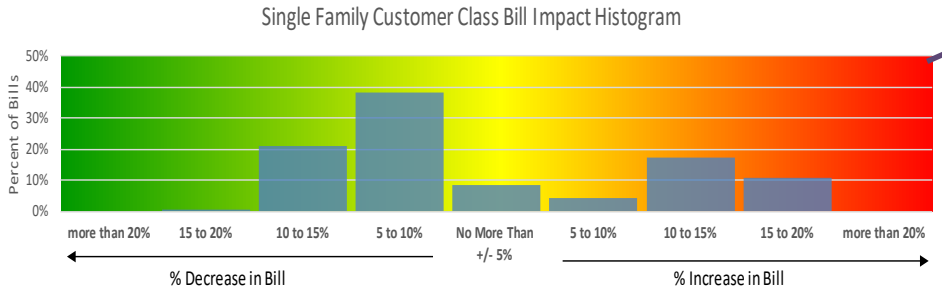
**Affordability Index**




**Bill Impacts Table**

| Customer Class | % of bills decreasing by | | | | No More Than | % of bills increasing by | | | |
|---|---|---|---|---|---|---|---|---|---|
| | more than 20% | 15 to 20% | 10 to 15% | 5 to 10% | +/- 5% | 5 to 10% | 10 to 15% | 15 to 20% | more than 20% |
| Single Family | 0% | 0% | 21% | 38% | 9% | 4% | 17% | 11% | 0% |
| Multi Family | 0% | 1% | 38% | 25% | 4% | 4% | 18% | 12% | 0% |
| CII | 0% | 0% | 25% | 20% | 28% | 7% | 9% | 10% | 0% |
| Landscape | 0% | 0% | 26% | 12% | 33% | 2% | 6% | 20% | 0% |
| Not in use | | | | | | | | | |
| Not in use | | | | | | | | | |

Bill Impact Histograms



# Drought Rates

- Evaluate rate performance under water use curtailment
- Up to 4 drought stages can be specified
- Curtailment levels can vary by customer class
- User can design rates “by hand”, OR
- Use built-in calculator to find revenue-neutral rates by drought stage

# Specifying Curtailment Levels

Requested curtailment level by stage

**1. Specify Curtailment Levels for Drought/Shortage Stages**

1. Enter the Customer Class curtailment levels for each stage. If you have fewer than 4 stag… last curtailment level in the unused stages. Stage 0 is the default No Shortage condition. Do not modify the settings for this stage.
2. For each stage, enter the expected compliance rate. The compliance rate can vary by sta… xample, stages with voluntary curtailment may have lower compliance than stages where curtailment is mandatory and enforced. The expected curtailment level fo… e is the product of the stage's curtailment level and the expected compliance rate.

| | Drought/Shortage Stage Customer Class Curtailment L… s Table | | | | | Expected Curtailment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Customer Class** | **Stage 0** | **Stage 1** | **Stage 2** | **Stage 3** | **Stage 4** | **Stage 0** | **Stage 1** | **Stage 2** | **Stage 3** | **Stage 4** |
| Single Family | 0% | 10% | 15% | 20% | 25% | 0% | 8% | 12% | 17% | 21% |
| Multi Family | 0% | 10% | 15% | 20% | 25% | 0% | 8% | 12% | 17% | 21% |
| CII | 0% | 0% | 10% | 20% | 25% | 0% | 0% | 8% | 17% | 21% |
| Landscape | 0% | 0% | 10% | 20% | 25% | 0% | 0% | 8% | 17% | 21% |
| Not in use | 0% | | | | | 0% | 0% | 0% | 0% | 0% |
| Not in use | 0% | | | | | 0% | 0% | 0% | 0% | 0% |
| **Enter Expected Compliance %** | 100% | 80% | 80% | 85% | 85% | | | | | |

Expected compliance rate

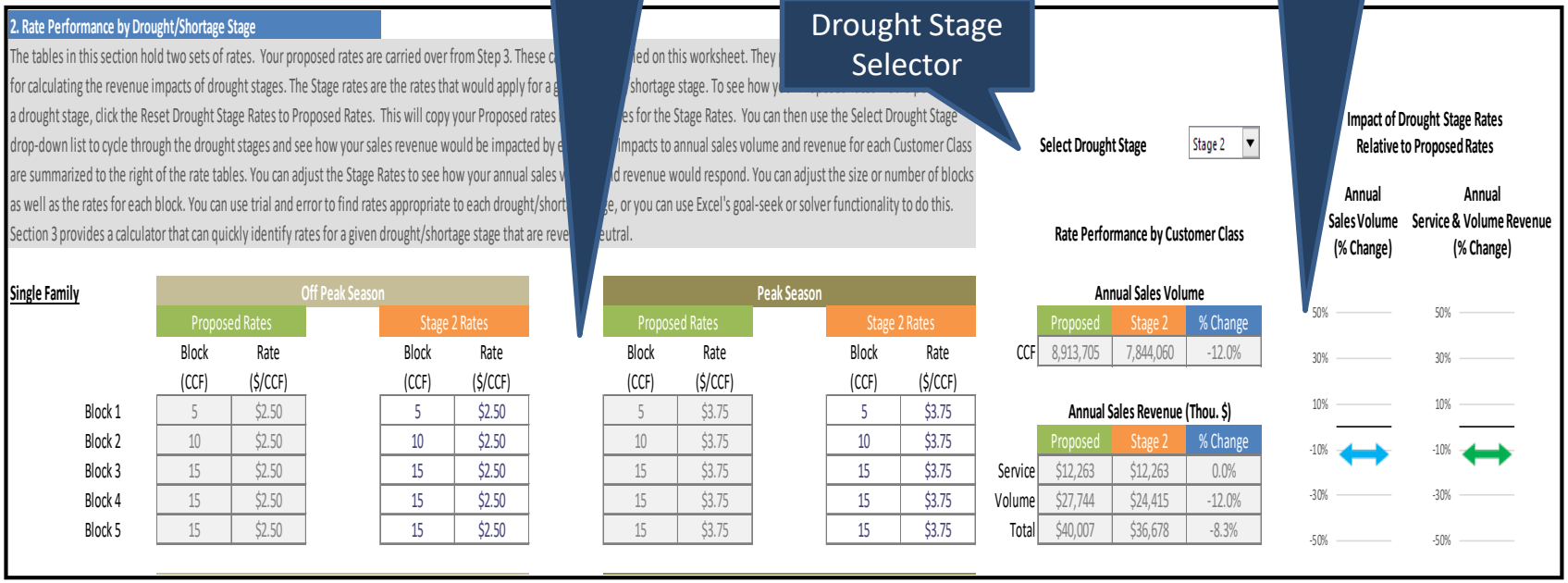
Expected curtailment

# Designing Drought Rates

Rate Design Tables

Drought Stage Selector

Rate Performance Indicators



**2. Rate Performance by Drought/Shortage Stage**

The tables in this section hold two sets of rates. Your proposed rates are carried over from Step 3. These c… …ed on this worksheet. They … for calculating the revenue impacts of drought stages. The Stage rates are the rates that would apply for a g… … shortage stage. To see how y… a drought stage, click the Reset Drought Stage Rates to Proposed Rates. This will copy your Proposed rates … …es for the Stage Rates. You can then use the Select Drought Stage drop-down list to cycle through the drought stages and see how your sales revenue would be impacted by e… …Impacts to annual sales volume and revenue for each Customer Class are summarized to the right of the rate tables. You can adjust the Stage Rates to see how your annual sales v… …d revenue would respond. You can adjust the size or number of blocks as well as the rates for each block. You can use trial and error to find rates appropriate to each drought/short… …e, or you can use Excel's goal-seek or solver functionality to do this. Section 3 provides a calculator that can quickly identify rates for a given drought/shortage stage that are reve… …eutral.

**Single Family**

| | Off Peak Season | | | | Peak Season | | | |
|---|---|---|---|---|---|---|---|---|
| | Proposed Rates | | Stage 2 Rates | | Proposed Rates | | Stage 2 Rates | |
| | Block (CCF) | Rate ($/CCF) | Block (CCF) | Rate ($/CCF) | Block (CCF) | Rate ($/CCF) | Block (CCF) | Rate ($/CCF) |
| Block 1 | 5 | $2.50 | 5 | $2.50 | 5 | $3.75 | 5 | $3.75 |
| Block 2 | 10 | $2.50 | 10 | $2.50 | 10 | $3.75 | 10 | $3.75 |
| Block 3 | 15 | $2.50 | 15 | $2.50 | 15 | $3.75 | 15 | $3.75 |
| Block 4 | 15 | $2.50 | 15 | $2.50 | 15 | $3.75 | 15 | $3.75 |
| Block 5 | 15 | $2.50 | 15 | $2.50 | 15 | $3.75 | 15 | $3.75 |

Select Drought Stage: Stage 2

**Rate Performance by Customer Class**

Annual Sales Volume

| | Proposed | Stage 2 | % Change |
|---|---|---|---|
| CCF | 8,913,705 | 7,844,060 | -12.0% |

Annual Sales Revenue (Thou. $)

| | Proposed | Stage 2 | % Change |
|---|---|---|---|
| Service | $12,263 | $12,263 | 0.0% |
| Volume | $27,744 | $24,415 | -12.0% |
| Total | $40,007 | $36,678 | -8.3% |

**Impact of Drought Stage Rates Relative to Proposed Rates**

# Drought Rate Calculator

**3. Calculate Revenue Neutral Rates by Drought Stage**

The revenue neutral rates calculator will quickly find a set of rates for a given drought/shortage stage that will generate the same revenue as your Proposed rates under a no shortage condition. There are four steps to using the calculator:

1. Choose the drought/shortage stage you want to calculate rates for.
2. Choose the method for calculating the rates. There are two choices. The first choice is to adjust your Proposed rates so that each customer class generates the same revenue it would have generated under your Proposed rates assuming no use curtailment. This may result in significant differences across classes in the amount by which rates are adjusted. The second choice is to adjust your Proposed rates so that all classes when grouped together are revenue neutral. Rates across classes will be adjusted by the same proportionate amount. Revenue neutrality may not hold for individual classes, but overall revenue will be neutral to the Proposed rates assuming no use curtailment.
3. Complete the Leave or Adjust Rate in Block table below. Choose Leave if you want the rate in the block to be the same as it is for your Proposed rates. Choose Adjust if you want the calculator to adjust this rate. For example, if you only want to adjust the upper block rates, choose Leave for lower blocks and Adjust for upper blocks. If you have fewer than 5 blocks, set the unused blocks to the same setting used for your last block.
4. Make desired adjustments to the block widths for the Stage Rates in the Stage Rates tables above.
5. Click the Find Revenue Neutral Rates button.

**Note: The calculator will overwrite the rates that are in the Stage Rates tables above. If you want to preserve these rates, save them as a rate scenario by clicking the Save/Load Rates button before using the calculator.**

**Choose Drought Stage to Evaluate:** Stage 2

**Choose Method for Calculating Revenue Neutral Rates:** 1. Scale rates so that each customer class is revenue neutral

Find Revenue Neutral Rates

Reset Drought Stage Rates to Proposed Rates

Save/Load Rates

**Leave or Adjust Rate in Block?**

| Class | Block 1 | Block 2 | Block 3 | Block 4 | Block 5 |
|---|---|---|---|---|---|
| Single Family | Leave | Adjust | Adjust | Adjust | Adjust |
| Multi Family | Leave | Adjust | Adjust | Adjust | Adjust |
| CII | Leave | Adjust | Adjust | Adjust | Adjust |
| Landscape | Leave | Adjust | Adjust | Adjust | Adjust |
| Not in use | Leave | Leave | Leave | Leave | Leave |
| Not in use | Leave | Leave | Leave | Leave | Leave |

# Limitations of the Rate Design Module

*Plans based on average assumptions are wrong on average* --
Sam Savage, The Flaw of Averages

- Results only as good as the **bill tabulation** data
- Can only evaluate how rates will perform **ON AVERAGE**
- Does not provide insight into **VARIABILITY** of performance
- That's where the **Revenue Simulation Module** steps in

# Revenue Simulation Module

# Example Questions the Simulation Module Can Address

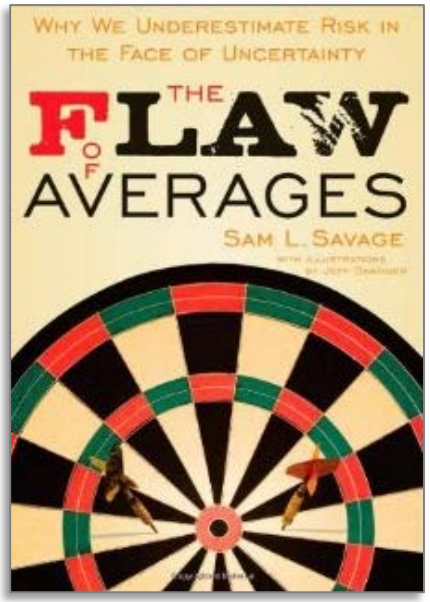
- *What is the likelihood we will meet our one-year, three-year, five-year revenue targets under our current or proposed rates?*
- *What is the chance our revenues will turn out more than 15% below our current projections?*
- *What level of confidence can we have that our sales will exceed our minimum planning estimates?*

# Average Outcome vs. Likely Outcomes

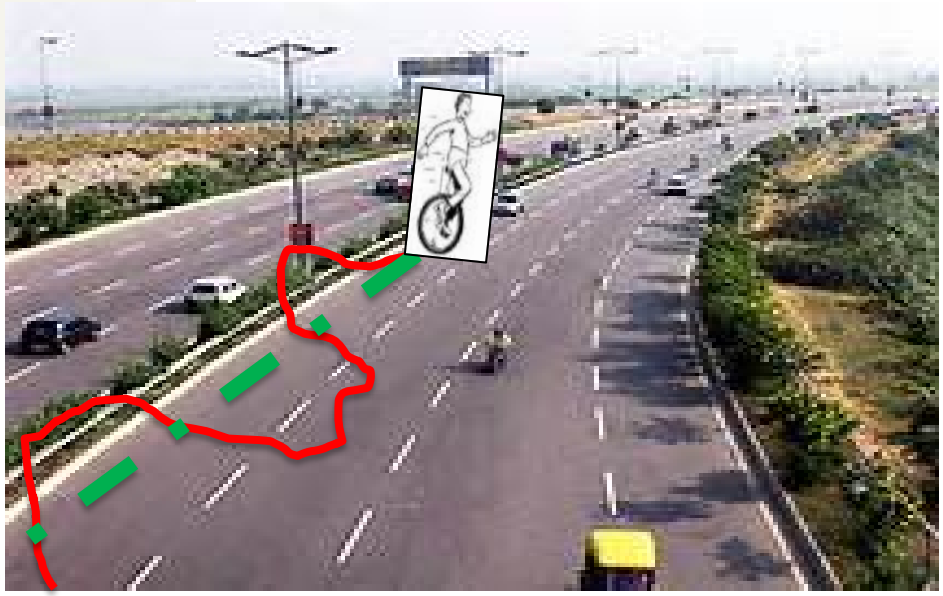
**Flaw of Averages**

- **Fact 1** – Planning for the future is rife with uncertainties.
- **Fact 2** - Most people are not happy with Fact 1 and prefer to think of the future in terms of average outcomes.
- **Fact 3** - The "flaw of averages" states that plans based on average assumptions are, on average, wrong.

-adapted from Savage (2012) Flaw of Averages
www.probabilitymanagment.org

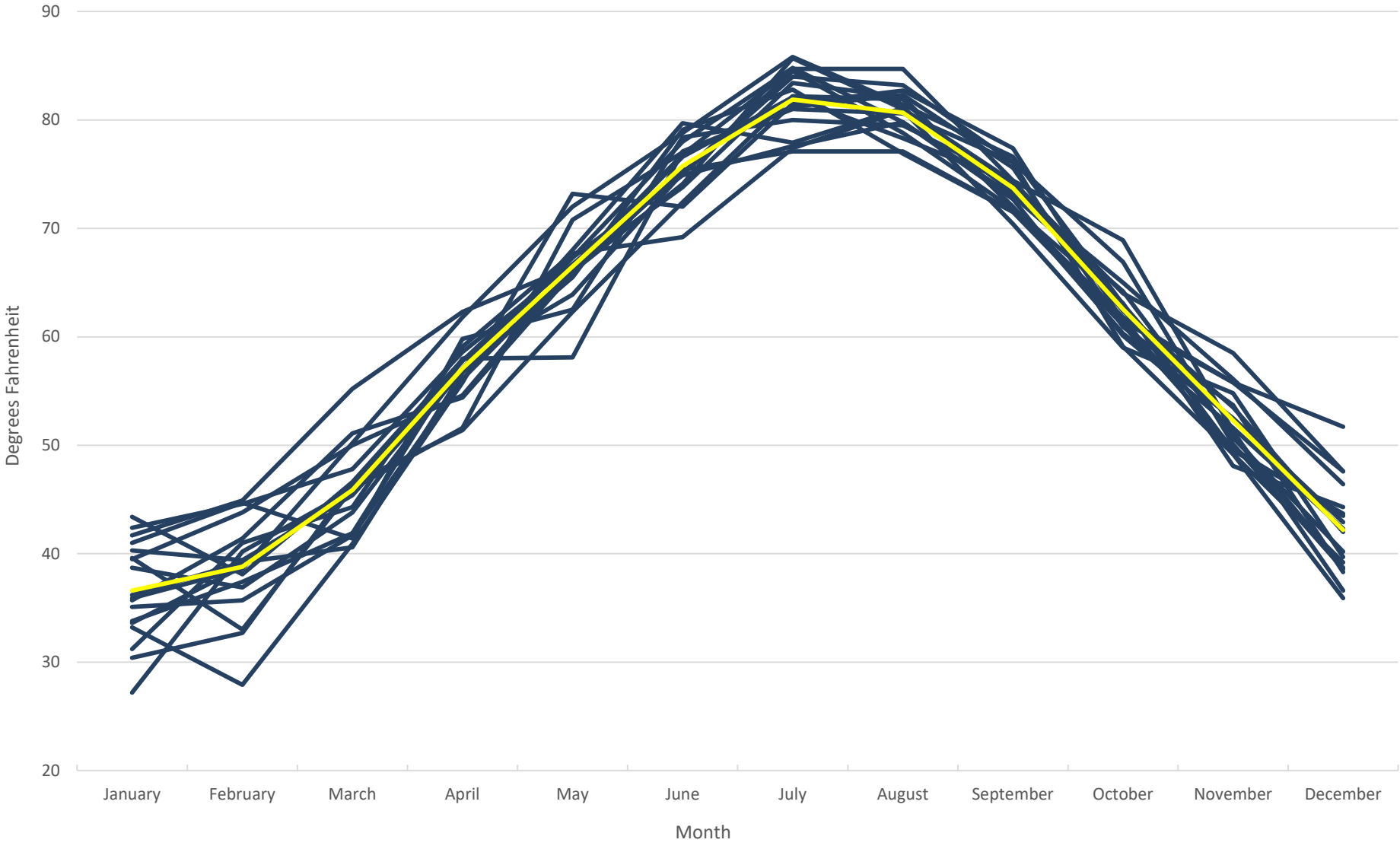



The cyclist is **safe** on the average path

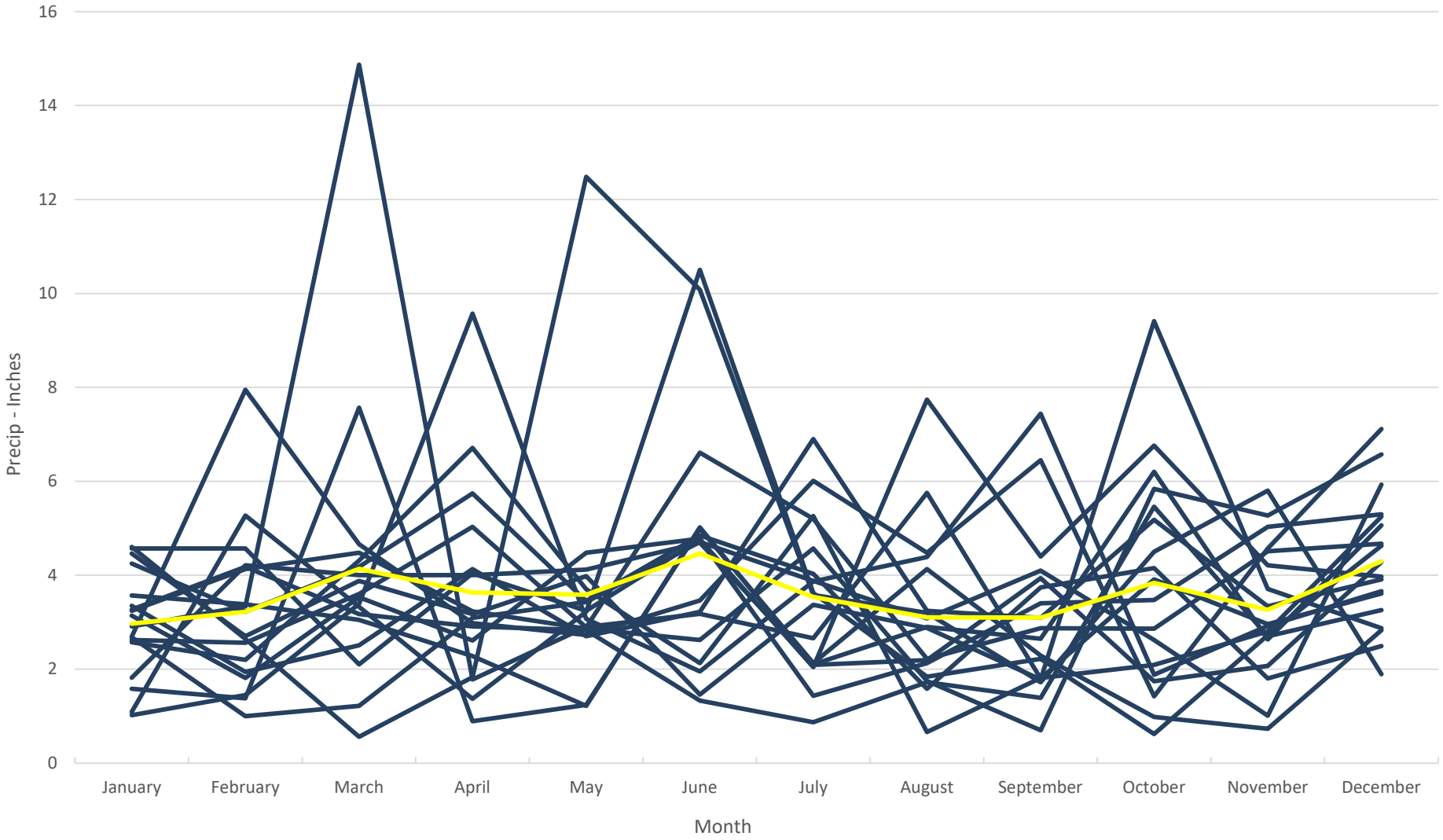


On average, the cyclist is **dead**.

# Boston Average Maximum Temperature
# 2000 – 2017 Mean vs. Actual

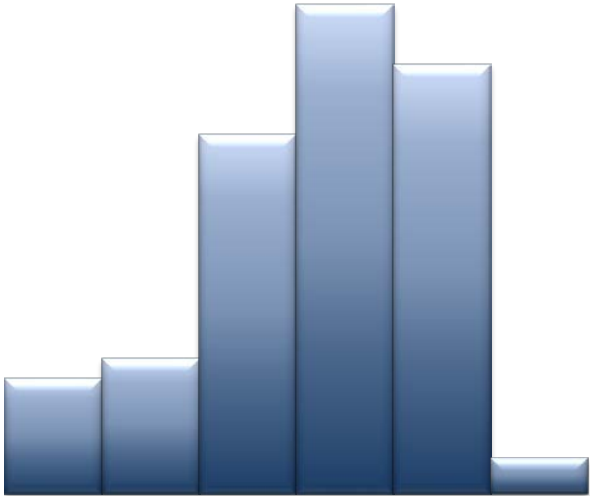


# Boston Monthly Precipitation 2000 - 2017 Mean vs. Actual



# Planning for the Future

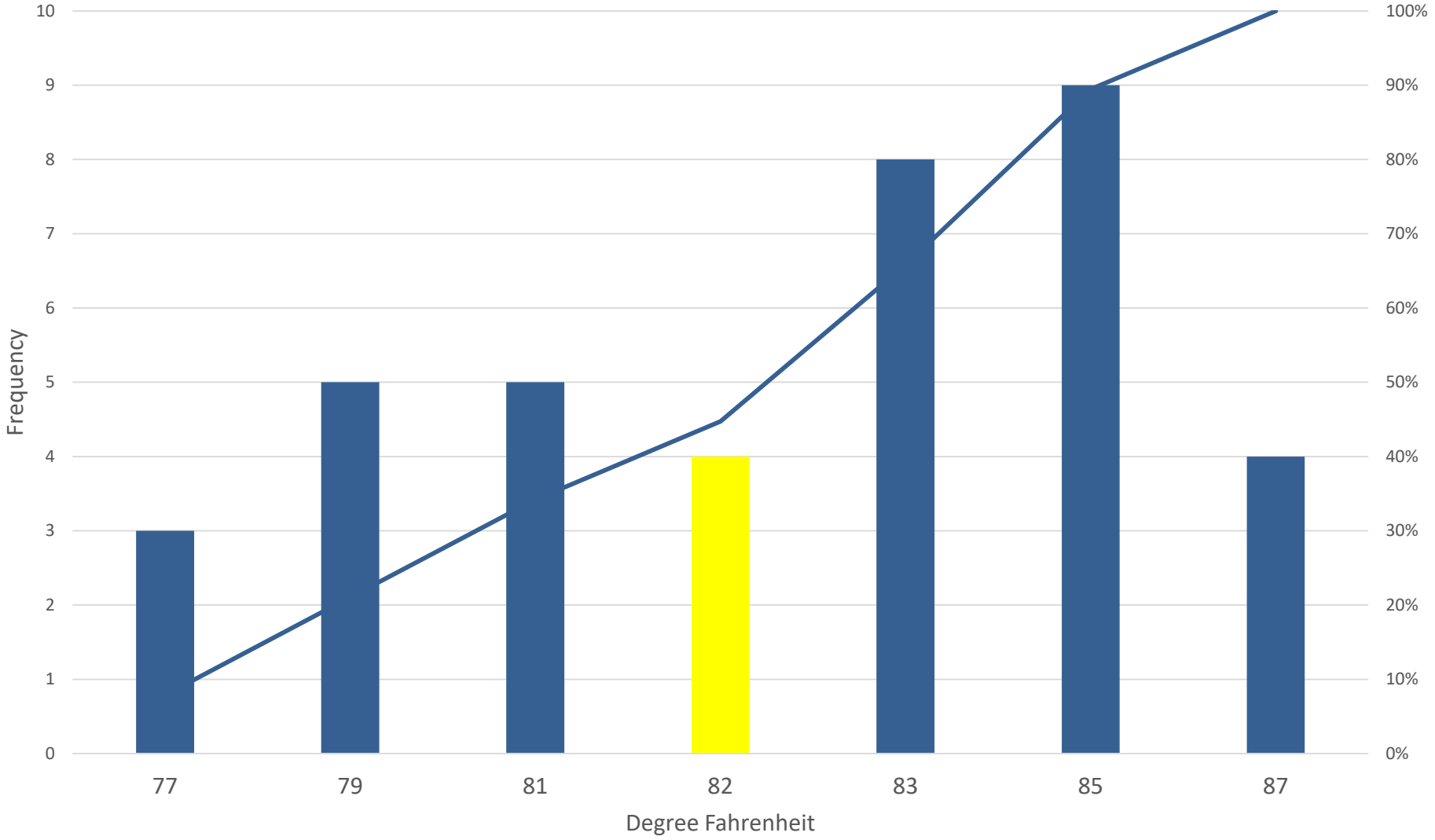
or



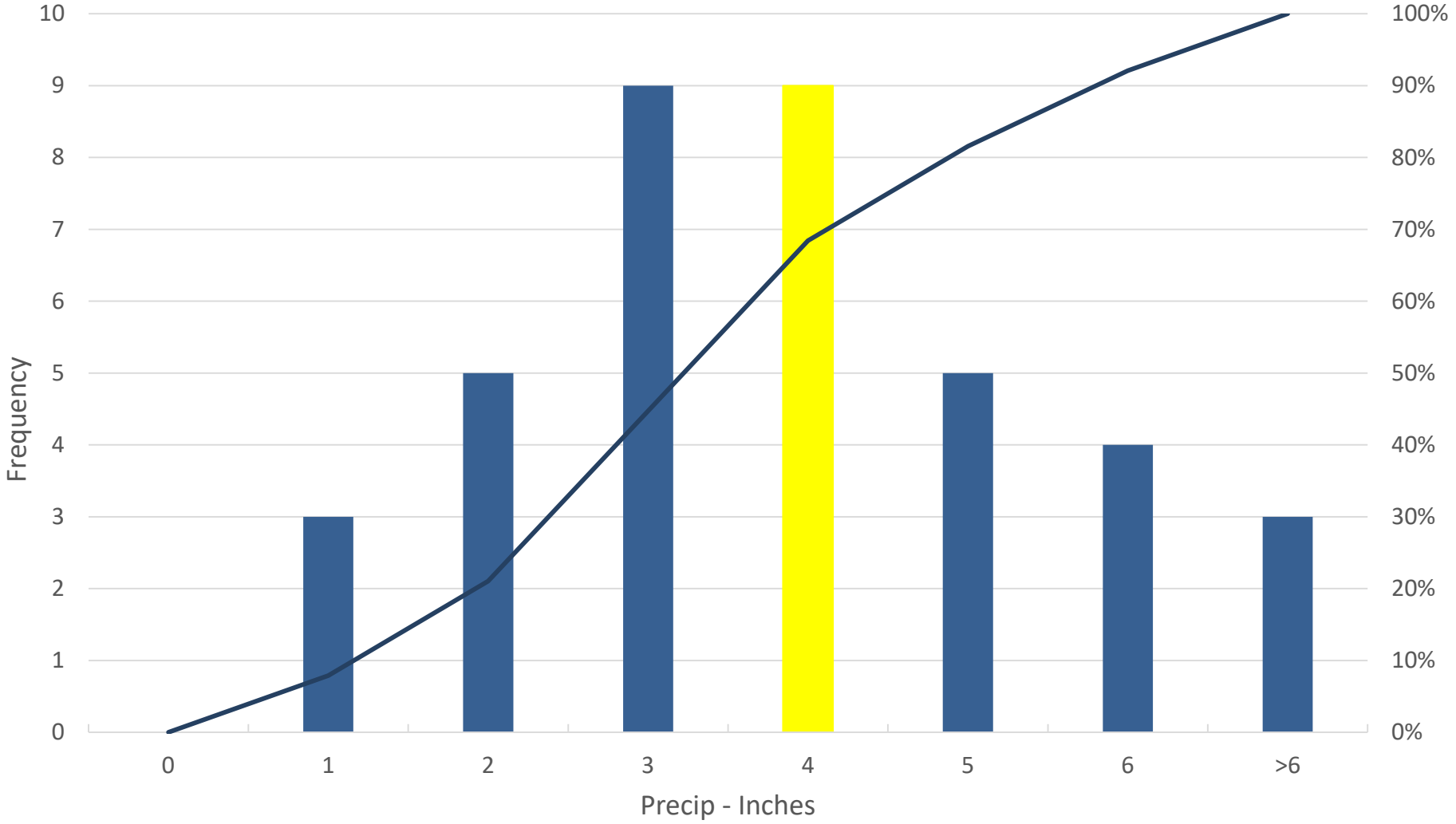
“Many futures are possible, but only one future occurs.”

- Howard Marks

# Boston July Average Max Temp 1980 – 2017 (Mean = 82)



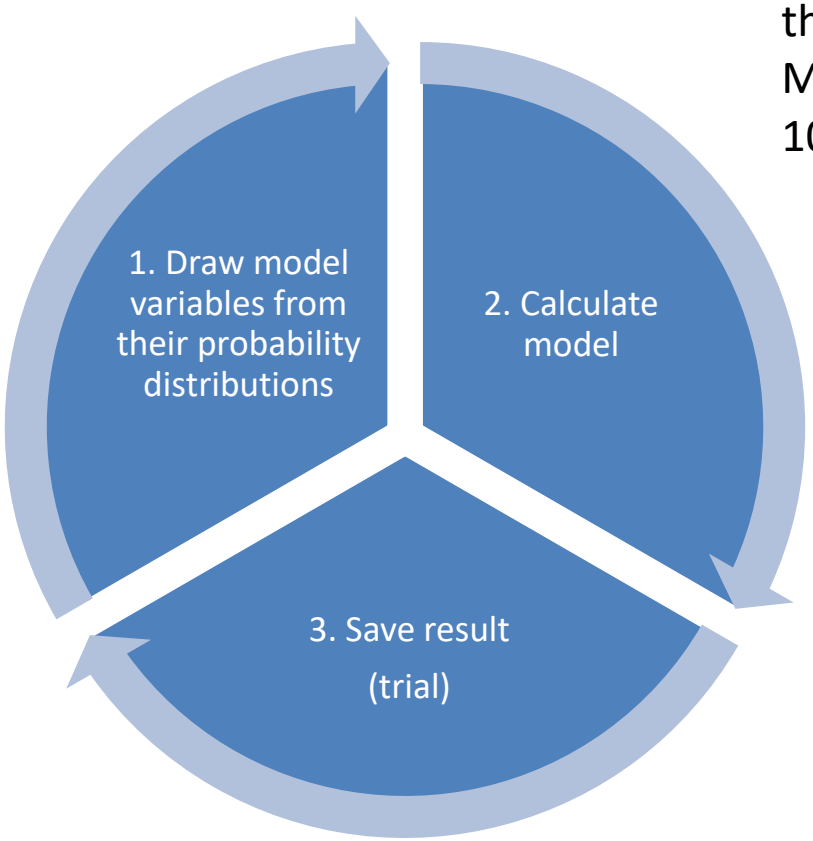
# Boston July Precipitation
# 1980 – 2017 (Mean = 3.32)



# How Does It Work?

- The model focuses on three variables that are key to short-run revenue performance:
  - Weather (historical or synthetic)
  - Growth (projected)
  - Supply disruption/use curtailment (correlated to weather)
- Two rate designs are simultaneously evaluated:
  - Current rate (reference condition)
  - Proposed rate
- Monte Carlo Simulation

# Simulation Process




A cycle constitutes 1 trial. In the Revenue Simulation Module, User can simulate 10, 100, 500, or 1000 trials.

# Why Simulate?

- Alternatives to simulation are:
  - Ignore uncertainty (a common strategy)
  - Construct scenarios (also common)
  - Both are problematic
- Simulation offers:
  - More complete enumeration of possible outcomes
  - Likelihood of particular outcomes

## Blog Topics


- Efficiency and Conservation
- Financial Planning
- Financing Efficiency
- Fiscal Sustainability
- Governance
- Implementation and Communications
- Rate Structures
- Revenue Management
- Sales/Demand Forecasting


## Blog Archives


- 07/2018 (1)
- 02/2018 (1)
- 06/2017 (1)
- 05/2017 (1)
- 02/2017 (1)
- 01/2017 (1)
- 11/2016 (1)
- 09/2016 (1)
- 05/2016 (1)
- 04/2016 (1)
- 02/2016 (1)
- 01/2016 (1)
- 11/2015 (1)

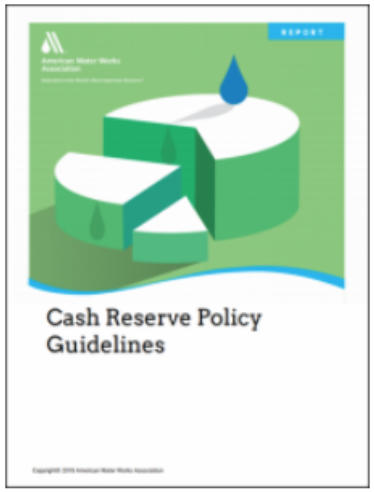

# Evaluating Sales Revenue Volatility to Inform Cash Reserve Policies

## *Connecting the AWE Sales Forecasting and Rate Model and the AWWA Cash Reserve Policy Guidelines Paper*

*Submitted on Friday, July 27, 2018 - 3:00pm*

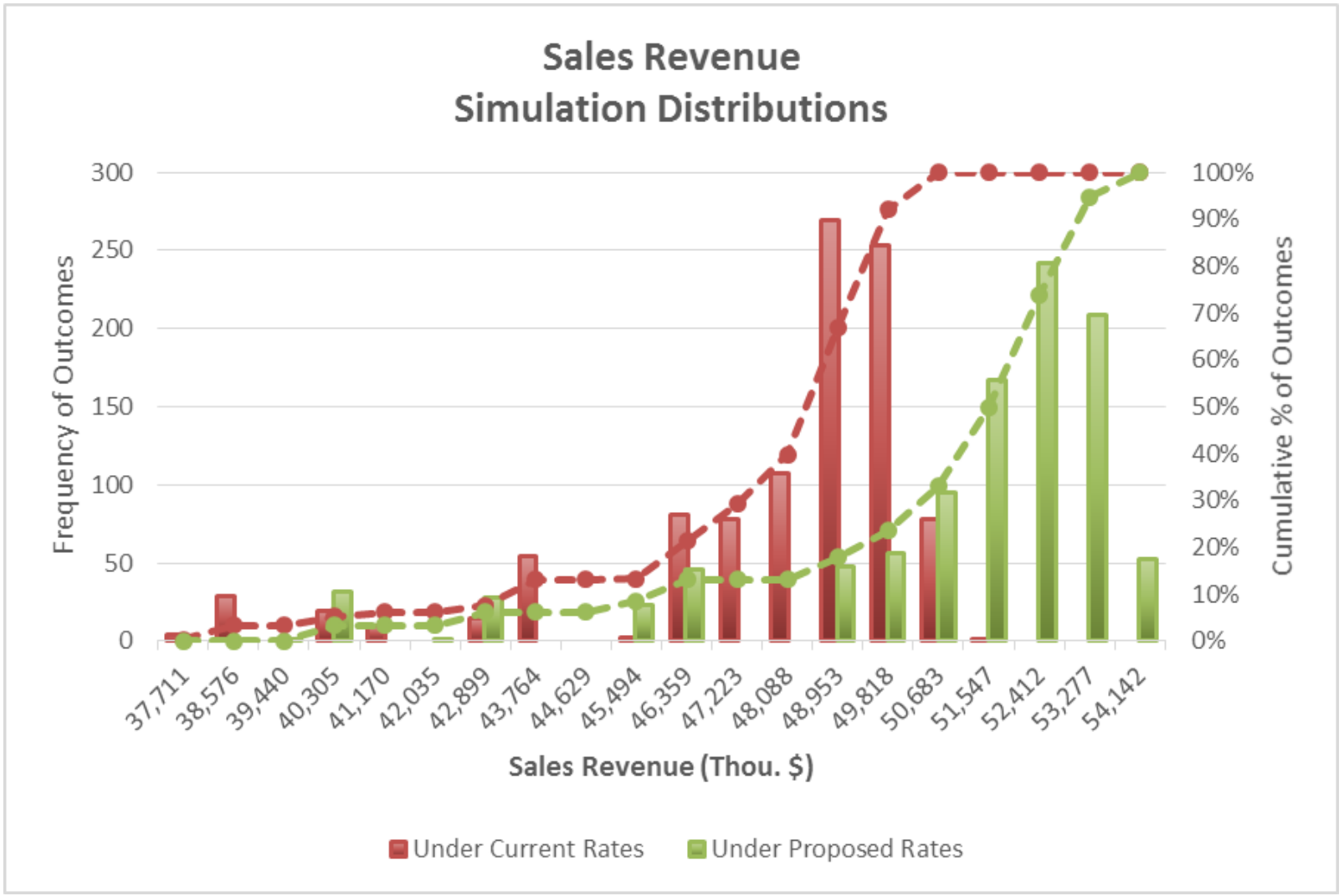
*By Bill Christiansen, Director of Programs, Alliance for Water Efficiency*

The AWWA Rates and Charges Committee recently released a white paper containing cash reserve policy guidelines. In summary, it's really cool. The paper is intended to assist utilities in developing reserve policies, and it features seven water utility case studies. The case studies include key considerations and policies for various types of reserves, and details like the utility's rate structure and the percent of revenue derived from fixed charges. The types of reserves discussed in the white paper are:




- Operating Reserves
- Capital Reserves
  - Rehabilitation and Replacement Reserves
  - Equipment Replacement Reserves
  - Emergency Capital Reserves
  - Special Purpose Capital Reserves
- Debt Service Reserves
- Rate Stabilization Reserves

# Simulation of Sales Revenue Distribution



# Additional Data Needed for Module

- Weather
  - Monthly Precipitation and Temperature data for Service Area
    - *Historical (up to 90 years), OR*
    - *Synthetic (for example, to simulate impact of climate change)*
  - Easy to get historical weather data for service areas – Guidebook recommends several sources for weather data
- Customer Class Account Growth
  - User specifies Low, Medium, High Account Growth Rates, by Class

# Weather Data Screenshot

**Step 6: Enter Weather Data to be Used by Revenue**

On this worksheet you enter historical monthly precipita… demands may vary in response to de…
You can enter up to a maximum of 90 years of historical d… so must be complete across months…
It is not required that you provide data for all 90 years. F… of the tables. To get reliable results…
Consult the user guide for information on weather data s…
Go back to Revenue Simulation Module Worksheet — Go forward to Step 7: Setu…

Can enter up to 90 yrs. Need at least 15. More is better than less.

Can modify historical weather for future climate change if desired.

**1. Set most recent year in your weather data**

Enter the most recent year for which you are providing weather data.

Most recent year: 2012

**2. Enter Monthly Precipitation Totals (in)**

Enter total monthly precipitation in inches for each year of weather data you have for your service area.

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 2.91 | 1.18 | 4.17 | 2.56 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.87 | 4.09 | 5.83 |
| 2011 | 1.18 | 4.06 | 6.26 | 0.28 | 0.79 | 1.93 | 0.00 | 0.00 | 0.00 | 0.91 | 1.22 | 0.08 |
| 2010 | 5.71 | 2.80 | 1.93 | 3.82 | 1.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.83 | 1.85 | 5.71 |
| 2009 | 1.02 | 6.34 | 2.36 | 1.22 | 0.71 | 0.00 | 0.00 | 0.00 | 0.16 | 3.74 | 0.59 | 2.40 |
| 2008 | 7.13 | 1.85 | 0.12 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 2.36 | 1.81 |
| 2007 | 0.43 | 3.70 | 0.24 | 0.59 | 0.28 | 0.00 | 0.00 | 0.00 | 0.12 | 1.22 | 0.75 | 2.40 |
| 2006 | 2.24 | 1.97 | 6.26 | 4.25 | 1.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 1.42 | 2.95 |
| 2005 | 4.33 | 3.31 | 2.60 | 1.46 | 1.26 | 0.28 | 0.00 | 0.00 | 0.00 | 0.12 | 0.94 | 10.04 |
| 2004 | 2.48 | 5.04 | 0.91 | 0.08 | 0.08 | 0.00 | 0.00 | 0.00 | 0.08 | 2.64 | 2.17 | 3.90 |
| 2003 | 1.14 | 0.98 | 1.46 | 3.58 | 0.51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.65 | 5.94 |
| 2002 | 0.75 | 1.54 | 1.89 | 0.16 | 1.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 8.66 |
| 2001 | 1.89 | 5.51 | 1.10 | 1.14 | 0.00 | 0.12 | 0.00 | 0.00 | 0.12 | 0.28 | 3.58 | 7.01 |
| 2000 | 5.79 | 8.11 | 2.01 | 0.79 | 1.14 | 0.08 | 0.00 | 0.00 | 0.04 | 1.34 | 0.75 | 0.39 |
| 1999 | 2.76 | 5.12 | 2.48 | 1.69 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 2.05 | 0.51 |
| 1998 | 8.03 | 12.20 | 2.09 | 1.26 | 2.64 | 0.00 | 0.00 | 0.00 | 0.16 | 0.79 | 3.07 | 0.67 |
| 1997 | 8.19 | 0.20 | 0.24 | 0.24 | 0.28 | 0.20 | 0.00 | 0.47 | 0.00 | 0.79 | 5.47 | 2.56 |
| 1996 | 5.28 | 5.94 | 2.44 | 1.81 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.91 | 2.72 | 6.89 |
| 1995 | 9.84 | 0.20 | 8.62 | 1.06 | 1.22 | 1.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.77 |
| 1994 | 1.77 | 3.94 | 0.20 | 0.87 | 1.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 5.91 | 2.48 |
| 1993 | 8.46 | 4.25 | 2.13 | 0.59 | 0.55 | 0.39 | 0.00 | 0.00 | 0.00 | 0.31 | 2.52 | 2.36 |
| 1992 | 1.38 | 5.94 | 3.11 | 0.31 | 0.00 | 0.28 | 0.00 | 0.00 | 0.00 | 1.38 | 0.16 | 6.02 |

**3. Enter Monthly Average Maximum Air Temperature (degrees F)**

Enter the monthly average daily maximum air temperature in degrees Fahrenheit for each year of weathe… you have for your service area. Be sure you are entering average daily **maximum** air temperature and not average daily air t…perature.

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 61.0 | 63.0 | 63.0 | 70.6 | 78.6 | 82.9 | 85.9 | 87.3 | 83.4 | 75.7 | 65.8 | 56.9 |
| 2011 | 56.2 | 60.5 | 62.7 | 69.0 | 72.4 | 79.2 | 84.3 | 84.5 | 86.4 | 76.5 | 62.8 | 60.0 |
| 2010 | 55.1 | 60.8 | 65.3 | 66.1 | 72.5 | 82.6 | 84.1 | 83.3 | 85.2 | 74.9 | 64.7 | 57.2 |
| 2009 | 60.4 | 59.1 | 65.4 | 70.6 | 78.6 | 80.4 | 86.6 | 87.1 | 88.0 | 73.3 | 65.7 | 54.6 |
| 2008 | 53.7 | 60.8 | 66.5 | 71.6 | 77.7 | 85.3 | 86.7 | 88.5 | 85.1 | 78.1 | 66.9 | 54.7 |
| 2007 | 58.2 | 60.8 | 70.5 | 72.2 | 77.7 | 83.9 | 86.1 | 87.0 | 80.8 | 72.9 | 67.4 | 55.9 |
| 2006 | 58.5 | 63.2 | 59.3 | 66.0 | 77.8 | 84.9 | 91.8 | 83.9 | 83.0 | 74.0 | 64.2 | 57.9 |
| 2005 | 52.7 | 61.3 | 67.0 | 68.8 | 74.9 | 78.7 | 89.7 | 87.2 | 80.1 | 75.6 | 67.8 | 58.8 |
| 2004 | 55.1 | 59.7 | 74.0 | 75.0 | 77.9 | 83.2 | 85.9 | 87.0 | 86.7 | 73.1 | 62.2 | 56.8 |
| 2003 | 59.2 | 61.5 | 67.6 | 64.9 | 76.6 | 83.3 | 91.1 | 86.3 | 86.6 | 81.5 | 61.7 | 56.6 |
| 2002 | 55.0 | 63.0 | 64.6 | 69.5 | 76.1 | 84.0 | 87.5 | 86.1 | 86.1 | 76.2 | 66.9 | 58.1 |
| 2001 | 57.0 | 59.2 | 69.1 | 67.9 | 85.9 | 87.2 | 84.0 | 86.4 | 82.1 | 78.7 | 65.9 | 55.7 |
| 2000 | 58.8 | 60.0 | 66.5 | 72.9 | 76.9 | 84.5 | 82.5 | 86.1 | 84.3 | 73.1 | 61.0 | 59.3 |
| 1999 | 55.3 | 58.5 | 60.8 | 69.1 | 73.0 | 80.7 | 83.2 | 83.3 | 82.8 | 79.3 | 66.4 | 61.2 |
| 1998 | 56.3 | 57.6 | 64.9 | 67.5 | 67.3 | 76.5 | 85.4 | 88.9 | 82.6 | 73.8 | 62.3 | 55.3 |
| 1997 | 56.0 | 63.4 | 69.9 | 73.1 | 82.6 | 83.0 | 86.5 | 84.6 | 86.1 | 75.2 | 65.5 | 56.5 |
| 1996 | 57.9 | 62.1 | 67.1 | 72.9 | 77.5 | 84.3 | 89.5 | 88.9 | 82.1 | 75.5 | 65.1 | 59.0 |
| 1995 | 57.1 | 61.3 | 62.2 | 68.3 | 71.7 | 79.9 | 86.2 | 87.7 | 83.8 | 79.2 | 71.2 | 59.9 |
| 1994 | 58.2 | 58.4 | 68.4 | 70.9 | 74.1 | 83.4 | 84.4 | 87.0 | 82.4 | 75.3 | 58.0 | 53.0 |
| 1993 | 54.8 | 58.7 | 67.2 | 69.9 | 75.8 | 84.6 | 85.7 | 86.6 | 84.1 | 76.8 | 65.3 | 55.0 |
| 1992 | 52.8 | 63.7 | 65.7 | 74.8 | 81.9 | 80.8 | 85.7 | 88.8 | 84.9 | 79.1 | 66.6 | 54.2 |

FSW

# Calculation of Weather Effects

- Based on CUWCC GPCD Weather Normalization Methodology and Empirical Model
- Accounts for impact of
  - Temperature
  - Precipitation
- Weather effect coefficients can be modified by user

# Uncertain Account Growth

- Can simulate with or without growth uncertainty
  - No Growth
  - Certain Growth
  - Uncertain Growth
- If Uncertain Growth, then Low, Medium, High Growth Rates are specified

# Water Use Curtailments

- Three Choices
  - Exclude from simulation
  - Associate with historical weather (preferred method)
  - Specify likelihood

# Associate Drought Stage with Historical Weather

*Preferred Method*

**3. Enter Monthly Average Maximum Air Temperature (degrees F)**

Enter the monthly average daily maximum air temperature in degrees Fahrenheit for each year of weather data you have for your service area. Be sure you are entering average daily **maximum** air temperature and not average daily air temperature.

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 61.0 | 63.0 | 63.0 | 70.6 | 78.6 | 82.9 | 85.9 | 87.3 | 83.4 | 75.7 | 65.8 | 56.9 |
| 2011 | 56.2 | 60.5 | 62.7 | 69.0 | 72.4 | 79.2 | 84.3 | 84.5 | 86.4 | 76.5 | 62.8 | 60.0 |
| 2010 | 55.1 | 60.8 | 65.3 | 66.1 | 72.5 | 82.6 | 84.1 | 83.3 | 85.2 | 74.9 | 64.7 | 57.2 |
| 2009 | 60.4 | 59.1 | 65.4 | 70.6 | 78.6 | 80.4 | 86.6 | 87.1 | 88.0 | 73.3 | 65.7 | 54.6 |
| 2008 | 53.7 | 60.8 | 66.5 | 71.6 | 77.7 | 85.3 | 86.7 | 88.5 | 85.1 | 78.1 | 66.9 | 54.7 |
| 2007 | 58.2 | 60.8 | 70.5 | 72.2 | 77.7 | 83.9 | 86.1 | 87.0 | 80.8 | 72.9 | 67.4 | 55.9 |
| 2006 | 58.5 | 63.2 | 59.3 | 66.0 | 77.8 | 84.9 | 91.8 | 83.9 | 83.0 | 74.0 | 64.2 | 57.9 |
| 2005 | 52.7 | 61.3 | 67.0 | 68.8 | 74.9 | 78.7 | 89.7 | 87.2 | 80.1 | 75.6 | 67.8 | 58.8 |
| 2004 | 55.1 | 59.7 | 74.0 | 75.0 | 77.9 | 83.2 | 85.9 | 87.0 | 86.7 | 73.1 | 62.2 | 56.8 |
| 2003 | 59.2 | 61.5 | 67.6 | 64.9 | 76.6 | 83.3 | 91.1 | 86.3 | 86.6 | 81.5 | 61.7 | 56.6 |
| 2002 | 55.0 | 63.0 | 64.6 | 69.5 | 76.1 | 84.0 | 87.5 | 86.1 | 86.1 | 76.2 | 66.9 | 58.1 |
| 2001 | 57.0 | 59.2 | 69.1 | 67.9 | 85.9 | 87.2 | 84.0 | 86.4 | 82.1 | 78.7 | 65.9 | 55.7 |
| 2000 | 58.8 | 60.0 | 66.5 | 72.9 | 76.9 | 84.5 | 82.5 | 86.1 | 84.3 | 73.1 | 61.0 | 59.3 |
| 1999 | 55.3 | 58.5 | 60.8 | 69.1 | 73.0 | 80.7 | 83.2 | 83.3 | 82.8 | 79.3 | 66.4 | 61.2 |
| 1998 | 56.3 | 57.6 | 64.9 | 67.5 | 67.3 | 76.5 | 85.4 | 88.9 | 82.6 | 73.8 | 62.3 | 55.3 |
| 1997 | 56.0 | 63.4 | 69.9 | 73.1 | 82.6 | 83.0 | 86.5 | 84.6 | 86.1 | 75.2 | 65.5 | 56.5 |
| 1996 | 57.9 | 62.1 | 67.1 | 72.9 | 77.5 | 84.3 | 89.5 | 88.9 | 82.1 | 75.5 | 65.1 | 59.0 |
| 1995 | 57.1 | 61.3 | 62.2 | 68.3 | 71.7 | 79.9 | 86.2 | 87.7 | 83.8 | 79.2 | 71.2 | 59.9 |
| 1994 | 58.2 | 58.4 | 68.4 | 70.9 | 74.1 | 83.4 | 84.4 | 87.0 | 82.4 | 75.3 | 58.0 | 53.0 |
| 1993 | 54.8 | 58.7 | 67.2 | 69.9 | 75.8 | 84.6 | 85.7 | 86.6 | 84.1 | 76.8 | 65.3 | 55.0 |
| 1992 | 52.8 | 63.7 | 65.7 | 74.8 | 81.9 | 80.8 | 85.7 | 88.8 | 84.9 | 79.1 | 66.6 | 54.2 |
| 1991 | 57.8 | 65.3 | 59.6 | 68.5 | 72.7 | 77.9 | 85.1 | 82.0 | 84.4 | 80.6 | 67.6 | 57.1 |
| 1990 | 57.0 | 57.8 | 65.4 | 73.3 | 74.6 | 81.8 | 85.8 | 84.7 | 83.3 | 79.2 | 65.9 | 53.9 |
| 1989 | 55.6 | 56.8 | 63.4 | 73.5 | 75.6 | 80.5 | 86.4 | 83.1 | 79.0 | 74.5 | 67.2 | 57.0 |
| 1988 | 56.2 | 66.0 | 70.1 | 70.9 | 74.6 | 81.3 | 89.2 | 84.5 | 83.1 | 75.7 | 62.6 | 57.1 |
| 1987 | 55.2 | 62.1 | 64.8 | 76.2 | 78.8 | 81.5 | 80.9 | 83.9 | 82.6 | 77.7 | 63.6 | 55.2 |

**4. Enter Drought Shortage Stage**

**(Optional)** For each hydrologic year you can select what drought/shortage stage would have applied given your current system supplies and customer demands. You can then have the model use this information when it simulates water sales. This is explained further in Step 5 Setup Simulation.

| Stage | Index |
|---|---|
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 2 | 2 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 1 | 1 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 0 | 0 |
| Stage 4 | 4 |
| Stage 3 | 3 |
| Stage 2 | 2 |
| Stage 1 | 1 |
| Stage 0 | 0 |

Drought Stage association table

# Specify Drought Stage Likelihood

*Secondary Method*

**Choose Method for Simulating Impact of Droughts/Shortages on Sales Volumes and Revenues:** Use Stage Probabilities Table

**Drought Stage Probabilities Table**

| Drought Stage | Likelihood of Occurrence | Cumulative Probability |
|---|---|---|
| Stage 0 | 90.00% | 90.00% |
| Stage 1 | 5.00% | 95.00% |
| Stage 2 | 2.50% | 97.50% |
| Stage 3 | 1.50% | 99.00% |
| Stage 4 | 1.00% | 100.00% |
| | 100.00% | |

**Table Instructions:** For each stage, enter the likelihood of occurrence. For example, if historically your system has had no water use curtailments in 90% of years, you would enter 90% for Stage 0. The remaining 10% would then be distributed across the other stages according to the likelihood of each stage's occurrence. The sum of the occurrence likelihoods must sum to 100%.

User specifies probability of occurrence

# Simulation Outputs

# Summary Statistics

## 1. Simulation Summary Statistics

Summary statistics for the simulation are provided in the following tables. The average value shows the central tendency while the standard deviation indicates the degree of variability. The minimum and maximum values define the range of outcomes.

*----- Results based on 1000 simulation trials -----*

### Under Current Rates

**Sales Volume (CCF)**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Avg | 15,391,247 | 15,496,019 | 15,635,586 | 15,697,702 | 15,861,245 |
| St Dev | 841,193 | 894,240 | 880,139 | 935,512 | 900,860 |
| Min | 12,254,361 | 12,309,867 | 12,375,362 | 12,440,635 | 12,474,137 |
| Max | 16,200,382 | 16,344,414 | 16,520,316 | 16,657,595 | 16,843,932 |

**Sales Revenue (Thou. $)**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Avg | $69,966 | $70,430 | $70,999 | $71,338 | $71,981 |
| St Dev | $2,524 | $2,682 | $2,645 | $2,809 | $2,706 |
| Min | $60,555 | $60,814 | $61,121 | $61,426 | $61,581 |
| Max | $72,393 | $73,011 | $73,767 | $74,356 | $75,157 |

### Under Proposed Rates

**Sales Volume (CCF)**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Avg | 15,155,448 | 15,259,211 | 15,397,276 | 15,457,801 | 15,619,683 |
| St Dev | 829,223 | 880,884 | 867,799 | 922,020 | 888,074 |
| Min | 12,070,660 | 12,125,441 | 12,190,075 | 12,254,491 | 12,287,565 |
| Max | 15,964,343 | 16,106,516 | 16,280,144 | 16,415,657 | 16,599,589 |

**Sales Revenue (Thou. $)**

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Avg | $70,634 | $71,096 | $71,664 | $72,016 | $72,657 |
| St Dev | $2,551 | $2,719 | $2,670 | $2,842 | $2,735 |
| Min | $61,031 | $61,292 | $61,600 | $61,908 | $62,063 |
| Max | $72,994 | $73,573 | $74,308 | $75,010 | $75,705 |

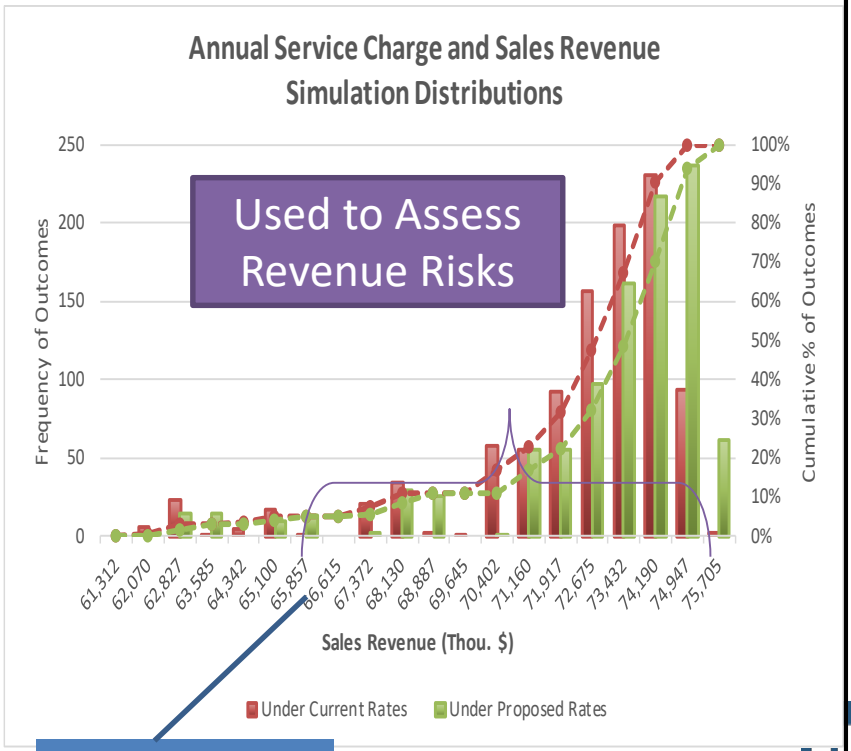
# Simulation Distributions

**2. Sales Volume and Revenue Distributions**

The charts below show the frequency and cumulative distributions for simulated sales volume and revenue. The cumulative distributions (the dashed lines in the charts) show the likelihood of sales volume or revenue being above or below the corresponding value on the x-axis. The frequency distributions (the bars) show the likelihood that sales volume or revenue will fall between the value indicated on the x-axis and the value to its left.

Use the drop-down to choose the forecast year to display: 5

User selects forecast year


Water Sales

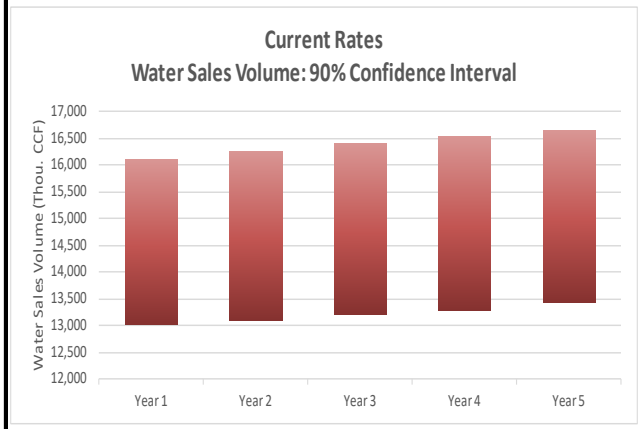
Annual Revenue

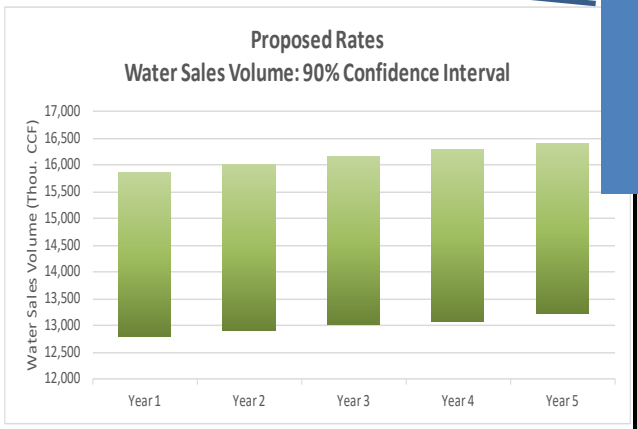
# Confidence Intervals

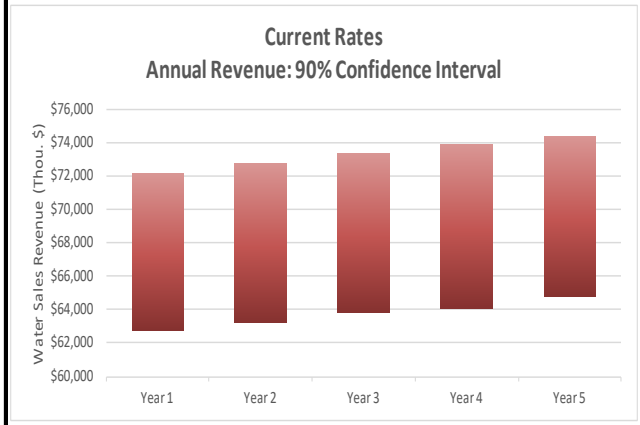
**3. Sales Volume and Revenue Confidence Intervals**

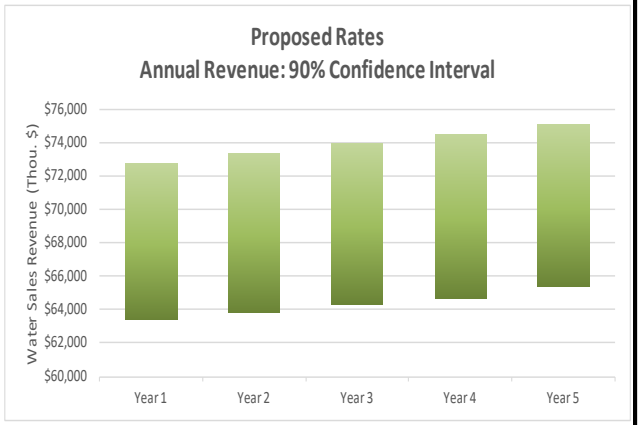
A 95% confidence interval indicates the range of values such that 95% of all simulation outcomes fall within this interval. Similarly, for a 90% confidence interval, 90% of all simulation outcomes would fall within the interval. More generally, for an x% interval, x% of all simulation outcomes would fall within the interval. This means the probability that the outcome variable will take on a value in the indicated range is x%. The charts below show confidence intervals (by year) for sales volume and revenue under your Current and Proposed rates. You can use the drop-down list to select the desired confidence level for the intervals. As you select higher levels of confidence you will note the intervals widen to accommodate the broader range of potential outcomes.

Use drop-down to select confidence level for sales volume and revenue confidence intervals: 90%



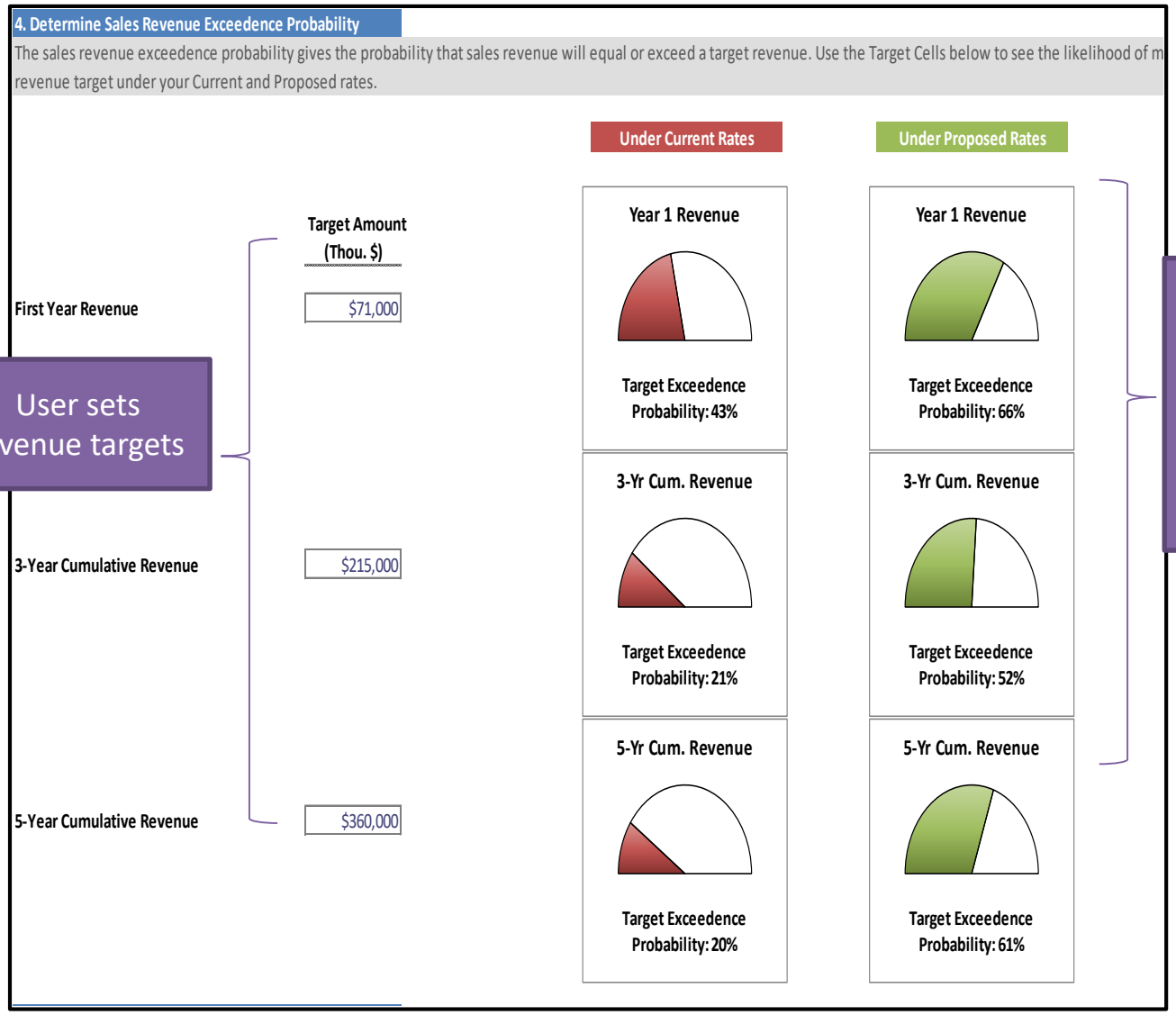




User selects level of confidence for interval (50-95%)

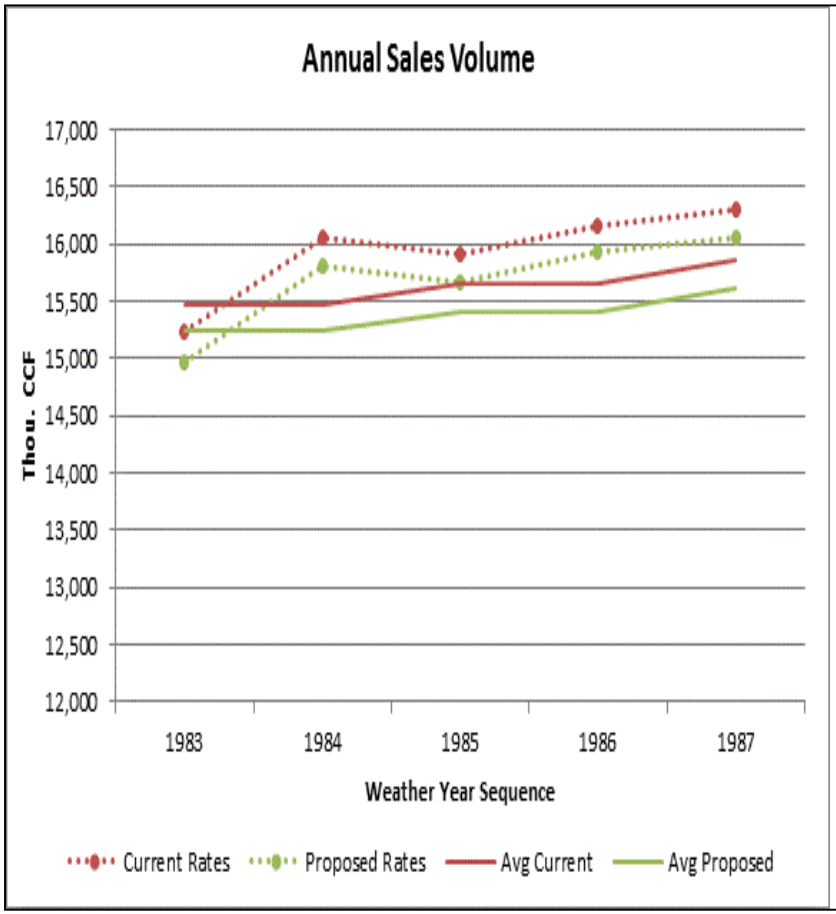
# Exceedence Probabilities

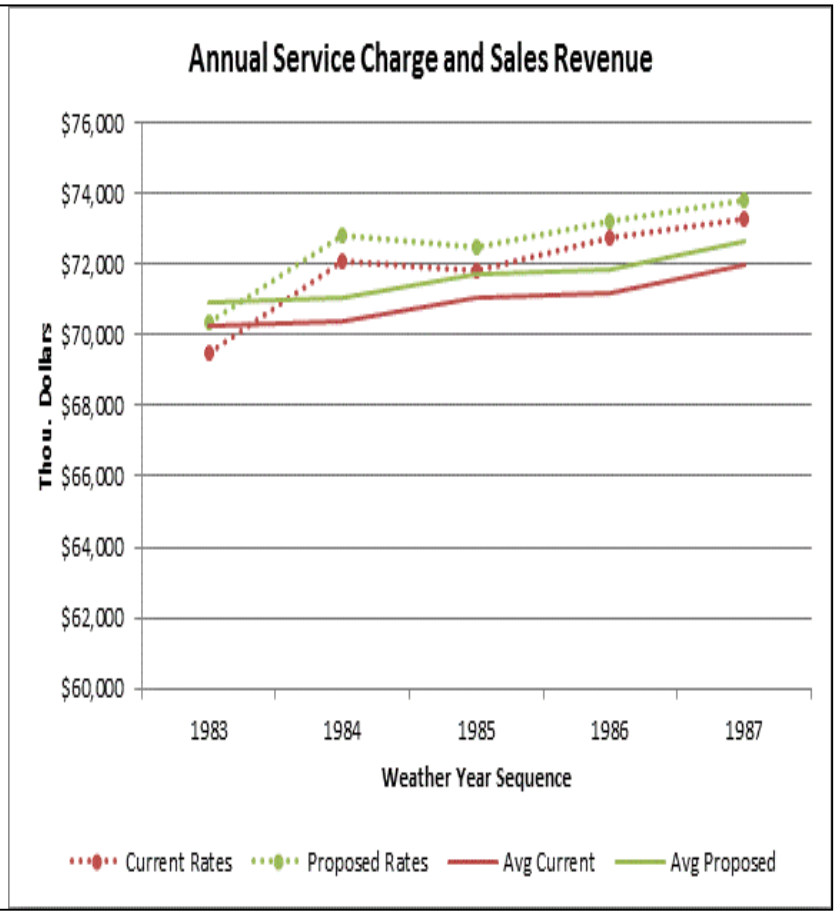



User sets revenue targets

Model calculates likelihood of meeting or exceeding target

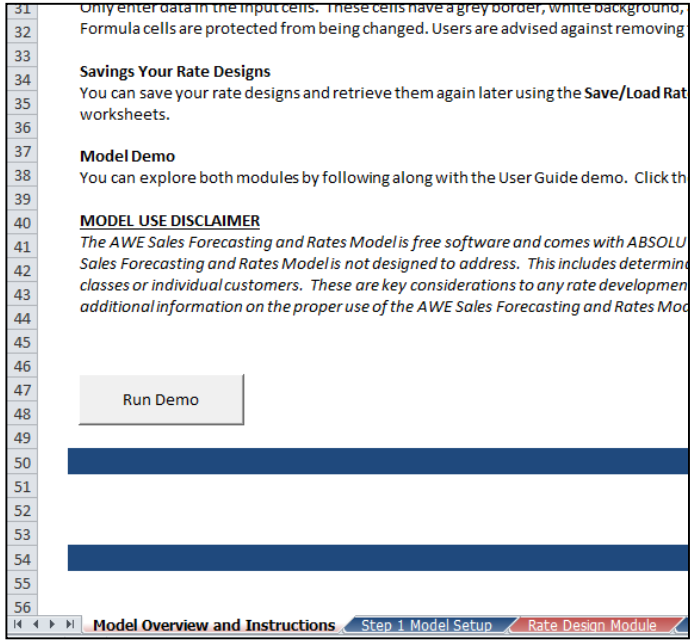
# Dynamic Step-Through Charts



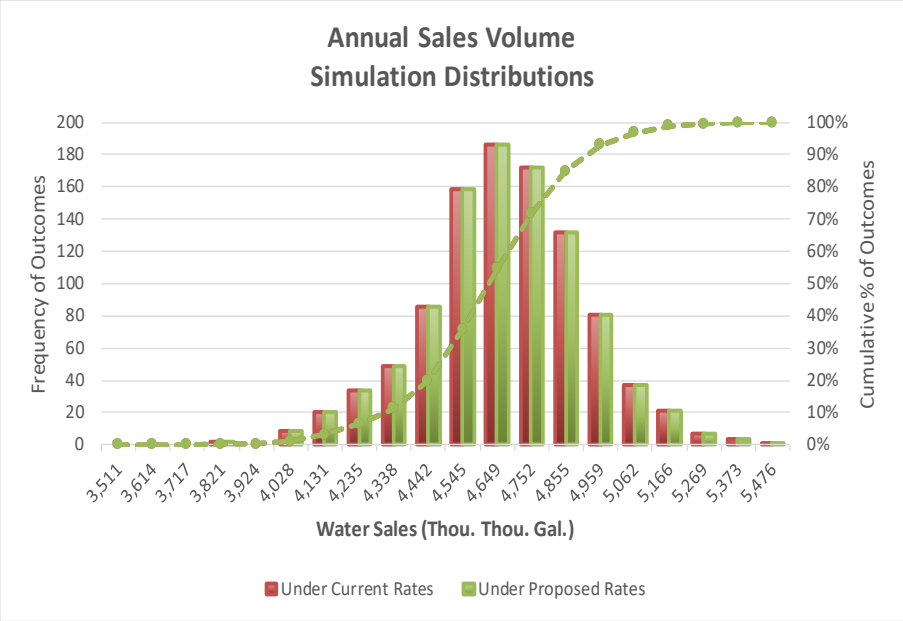



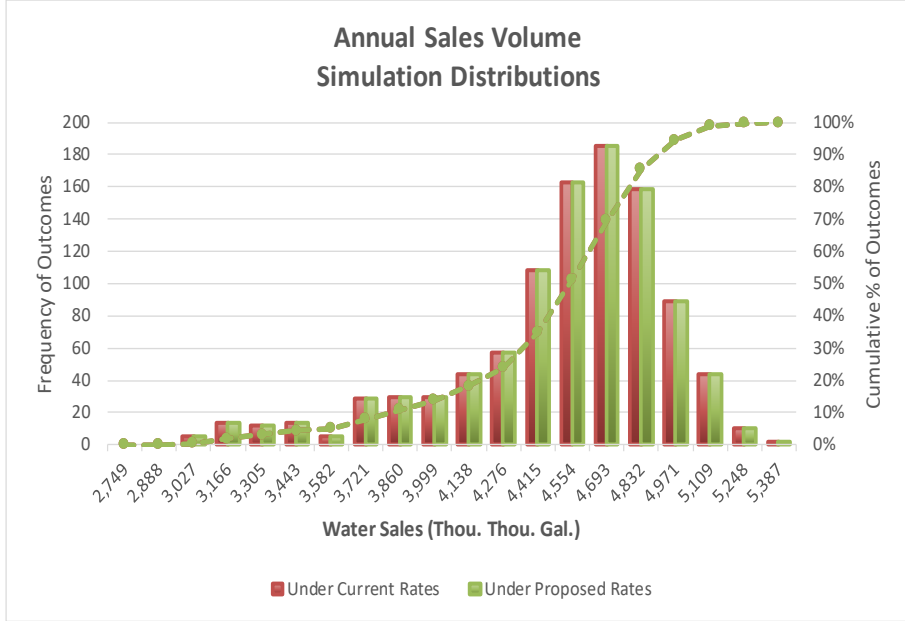
# Demo

- Model includes built-in demonstration data and user guide exercises:
  - Model setup
  - Bill tabulation
  - Setting service charges
  - Designing volume rates
  - Drought rate adjustments
  - Simulation

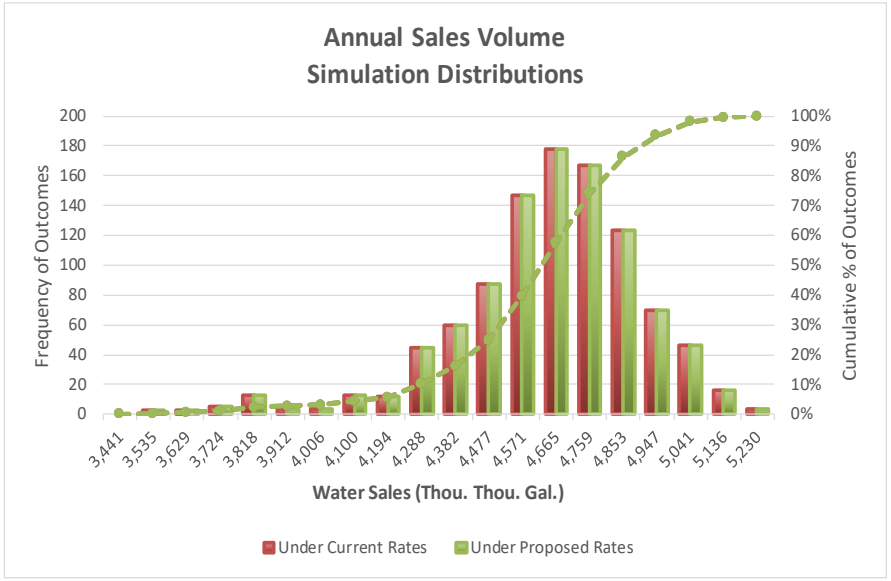


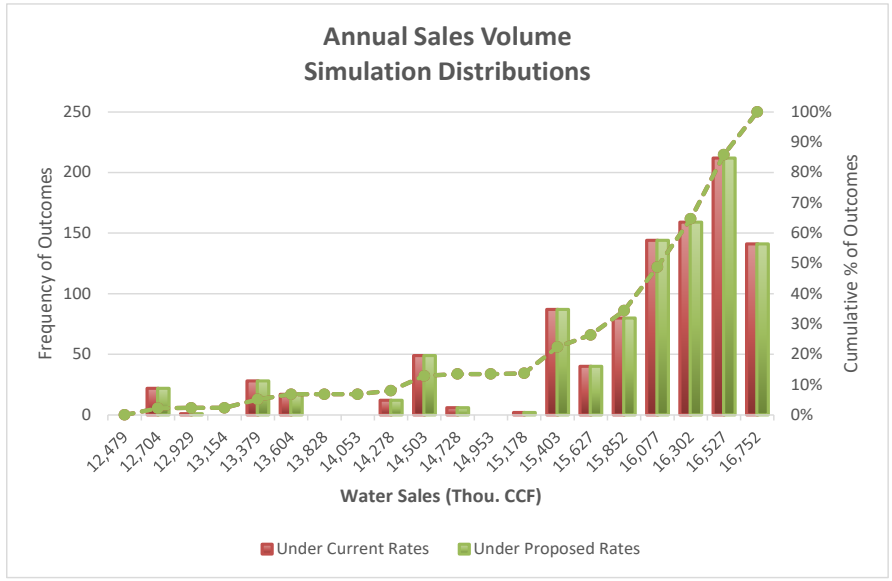
# What if the likelihood of drought restrictions increases?

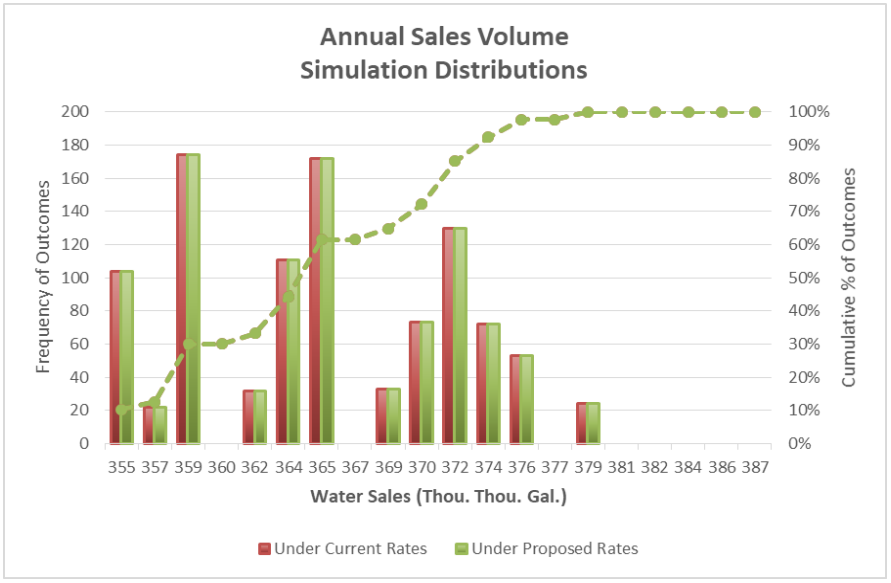


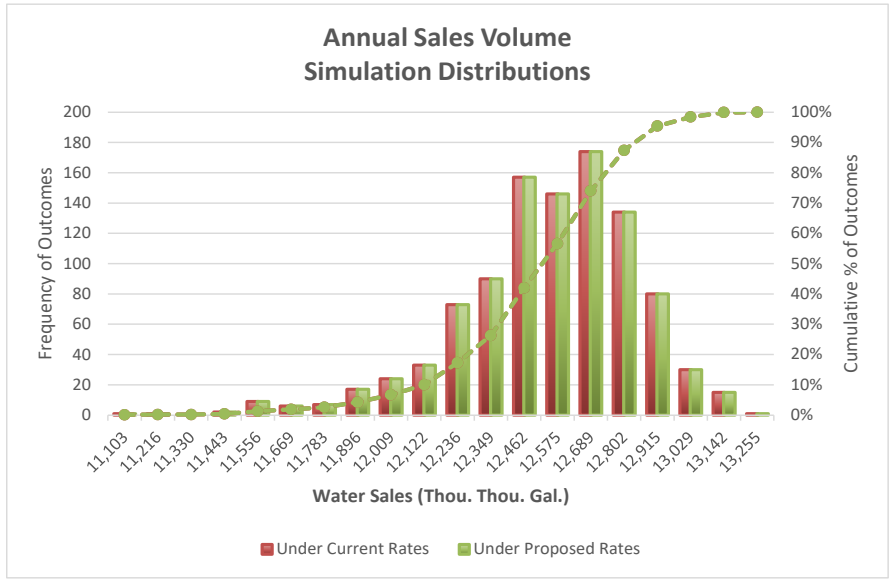



# Examples of Different Locations



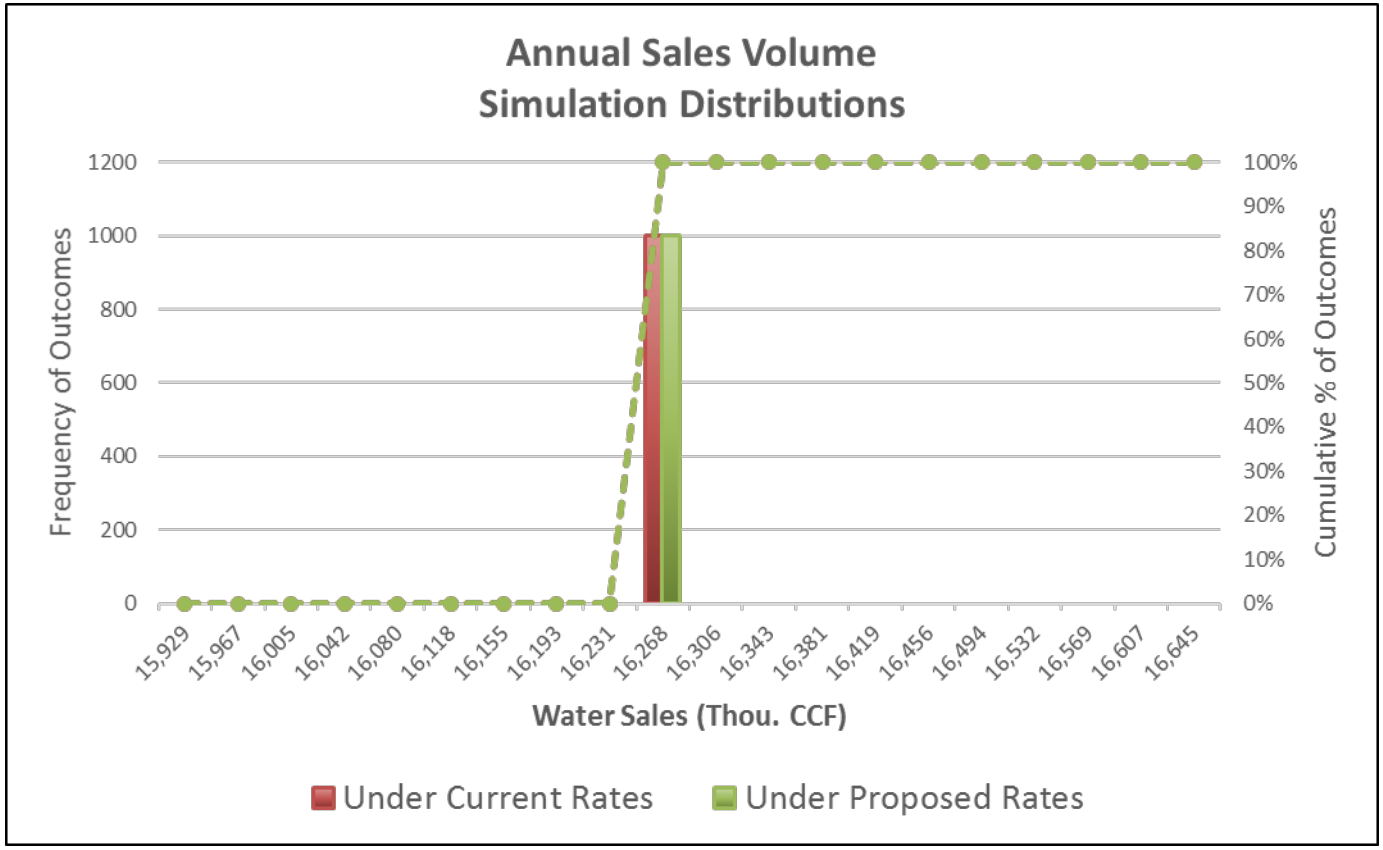



# What if there was…

- No weather variability
- No chance of drought
- No growth uncertainty




# Financing Sustainable Water

FINANCING SUSTAINABLE WATER
Rates. Revenue. Resources.

Alliance for Water Efficiency