TAMPA BAY WATER
Supplying Water To The Region

AGENDA ITEM I2

DATE: December 2, 2019

TO: Matt Jordan, General Manager

FROM: Kenneth R. Herd, Chief Science and Technical Officer KRH

SUBJECT: Annual Demand Forecast Evaluation and Long-term Demand Forecast Update – *Presentation*

SUMMARY

Tampa Bay Water has redeveloped its Long-term Demand Forecasting System to provide annual and long-term water demand projections for the seven water demand planning areas of the six member governments. Each year, a model forecast is evaluated and verified, and new water demand projections are developed based on updated socio-economic projections and normal weather conditions.

RECOMMENDATION

Receive presentation. Continue annual updates of long-term demand forecasts.

COST/FUNDING SOURCE

N/A

DISCUSSION

The annual update of the Agency's long-term demand forecast and review and evaluation of forecast performance for the period July 1, 2018 through June 30, 2019, and Water Year 2017 for the City of Tampa are complete. A detailed discussion of the process used to update the water demand projections is contained in the attached technical report, with additional explanation provided in the references cited therein. A summary of results will be presented to the Board at its December 16, 2019 meeting. Tampa Bay Water uses the results of the long-term demand forecast models for two primary purposes:

1. Annual budgeting and source allocation—near-term projections up to six years using median population projections.
2. Long-range water supply planning—a probabilistic forecast for at least the 20-year time horizon.

Demand Forecast Update

The redeveloped long-term demand forecast model can now be run with data compiled through most of the previous water year (this is the second update since 2018 using billing data through June 2019

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to estimate the future state of water demand. The previous updates were run with a one-year delay due to lack of process automation). This is also achieved partially because member governments continue to supply data in a timely fashion. For the City of Tampa, the model ran with base year 2017 data as the City is not currently supplying the Agency with billing information. Tampa's billing data had been supplied monthly from 2000 through 2017.

The total regional demand projected for Water Year 2021 is **261.43 million gallons per day (mgd)**. The updated demand projection is about 2.48 mgd higher than last year's projected demand for Water Year 2021. The higher demand forecast for Water Year 2021 is primarily due to continued increase in housing units in the Tampa Bay Water service area (see attached technical report). Actual water demand for the Tampa Bay Water service area for Water Year 2019 was **252.81 mgd**. This was about 7 mgd lower than the actual demand for Water Year 2017 (2018 demand was also lower). The decrease in actual water use in Water Year 2018 and 2019 relative to 2017 was primarily due to an exceptionally dry spring in 2017 coupled with wetter than normal winter/spring rainfall conditions in 2019 except for St. Petersburg Water Demand Planning Area which was near normal.

Total population in the Tampa Bay Tri-county area based on the Bureau of Economic and Business Research was estimated to be 2.9 million in 2019. The total population served by Tampa Bay Water and the Member Governments in 2018/2019 base year is approximately 2.4 million people, about 83% of the total population.

Updated projections for demographic and socioeconomic variables show the projected annual growth rate for the total number of housing units in the Tampa Bay region has fluctuated slightly between forecast models from **1% in the 2017/2018 Base Year to 0.91 % in the 2018/2019 Water Year** (see Figure 6 in attached technical report). The highest growth rates in the recent forecast are projected to occur in the City of Tampa and South-Central Hillsborough County, with a slightly lower projected growth rate than the previous year projections. Growth in housing units within the Tampa Bay Water service area results in long-term growth in regional water demands for our service area (see Figure 1 and Table 1).

The 2045 median regional demand projection for the Tampa Bay Water service area is about 4.89 mgd lower than last year's 2045 regional demand projection (298.32 mgd). The current update exhibits higher demand between 2019 and 2035 and flattens for the rest of the planning period resulting slightly lower demand in 2045 than the previous year update. Projected water demands are also based on normal weather conditions using the last 30 years of data. Year-to-year variability in water demands will occur as actual weather conditions deviate from long-term norms.

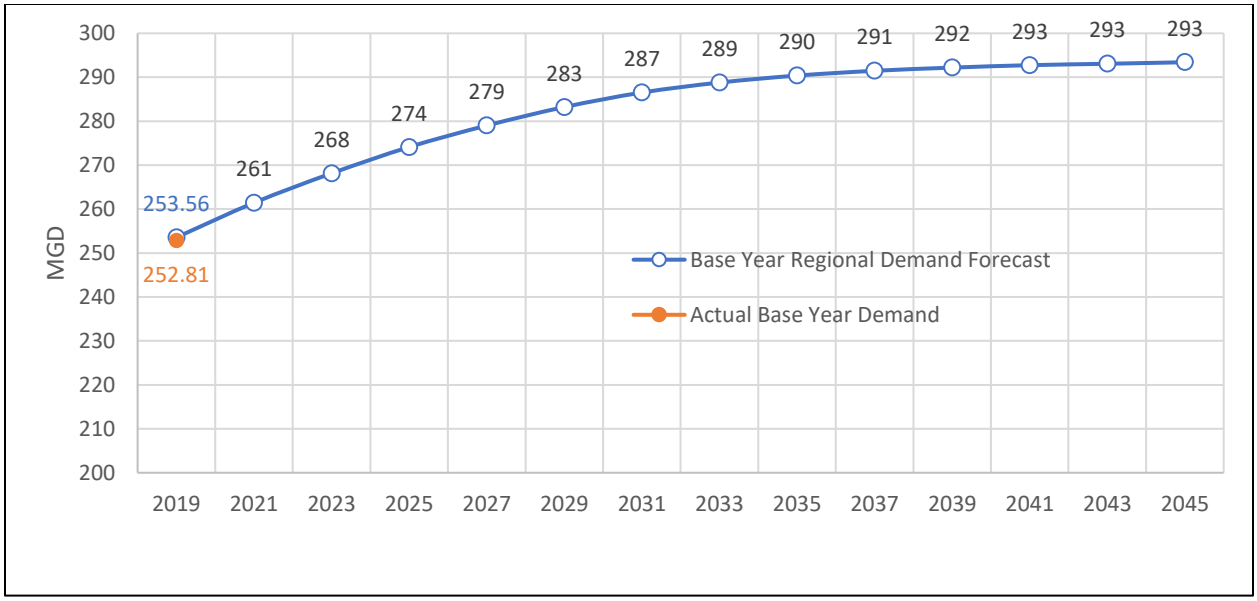

Figure 1. Updated Long-term Regional Demand Forecast for Tampa Bay Water Service Area

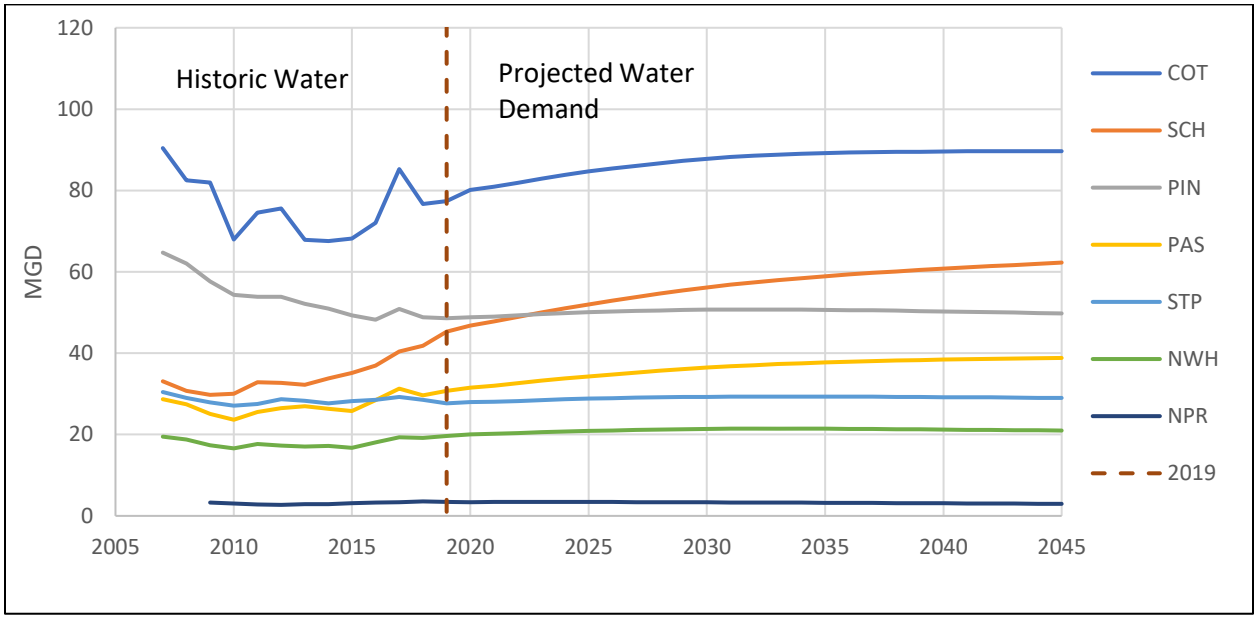

Figure 2. Historic and Projected Demands by Member Government

Figure 2 shows historic water demands by member government service areas from 2007 through 2019 and projected water demands starting in 2020 through the 2045 forecast period. All areas experienced significant declines in historic demand through 2010 due to the past economic recession. Year-to-year variability from 2010 through 2019 has been primarily driven by deviations from normal spring hydrologic conditions. For example, spring 2015 was extremely wet which contributed to lower demands, while 2017 demand was higher than normal due to extremely dry fall to spring conditions

as well as an underlying increase in economic activity. Relative to 2017, the 2019 demand was relatively low which explains the effect of above normal rainfall in the service area except for the City of St. Petersburg which was about normal. (See Table 7 in the technical report). Additional declines in Pinellas County water demands are primarily due to a loss of wholesale water customers. This loss in wholesale water demand is a major contributing factor to the relatively flat growth in water demands in the Pinellas County water demand planning area through the forecast period.

The regional demand forecast (Figure 1) shows higher demand growth rate from 2019 to 2035 and is projected to remain relatively flat from 2035 to 2045. The South-Central Hillsborough County, Pasco County and City of Tampa water demand planning areas show increases in projected water demands for the 2019 to 2045-time horizon. Results indicate a slight demand increase in Northwest Hillsborough County, with little to no growth for the Pinellas County, City of St. Petersburg and City of New Port Richey water demand planning areas.

The demand forecast model employs effective building square footage as a driver to determine the nonresidential sector water demand. The benefit of this approach is disaggregation of the non-residential water use into sub sectors. Square footage for non-residential sub-sectors (e.g., hotel, restaurants, schools, etc.) provided by the respective county property appraiser offices is used to develop relationships between the number of employees and square footage.

Table 1. Updated Long-term Demand Forecast by Member Government, in million gallons per day

Year	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW
2019*	30.71	3.46	19.64	45.32	77.42	48.59	27.67	252.81
2019	30.59	3.45	19.64	45.36	78.24	48.59	27.68	253.56
2020	31.51	3.46	20.01	46.78	80.15	48.85	27.96	258.71
2025	34.29	3.39	20.88	52.00	84.68	50.08	28.81	274.12
2030	36.45	3.29	21.37	56.15	87.81	50.68	29.28	285.02
2035	37.73	3.16	21.41	58.91	89.18	50.65	29.33	290.38
2040	38.43	3.03	21.21	60.77	89.59	50.27	29.19	292.50
2045	38.83	2.92	20.99	62.27	89.63	49.78	29.01	293.42

2019* is actual annual average of water demand delivered from Tampa Bay Water in water year 2019. City of Tampa delivery data is through July 2019.

Table 1 provides actual water use for Water Year 2019 and projected water use for Water Years 2020 through 2045 by member government and water demand planning area in mgd. The projected demands for Pinellas County, through the planning horizon, do not reflect additional reductions in wholesale water sales as the City of Clearwater continues to purchase water from the County. Information from County staff indicate they expect the City of Clearwater to continue purchasing 3 to 4 mgd from the County due to delays in bringing their new purification plant on line.

Tampa Bay Water is closely monitoring the South-Central Hillsborough Water Demand Planning Area growth. For the past few years, the area has outperformed aggregate economic projections for the region and demands forecasted by both Tampa Bay Water and Hillsborough County. Updated forecast show demand picking up in the near future compared to what was projected last year. Table 2 shows Tampa Bay Water's 2018 and 2019 projections as well as Hillsborough County's updated demand forecast.

Table 2. South Central Hillsborough Demand Planning Area projections by Tampa Bay Water and Hillsborough County

Year	2018 Tampa Bay Water Forecast (mgd)	2019 Tampa Bay Water Forecast (mgd)	2019 County Forecast (mgd)
2019	42.4	45.3 [(1)]	43.0
2020	43.5	46.8	44.3
2021	44.4	47.8	45.7
2022	45.3	48.9	47.1
2023	46.3	50.0	48.4
2024	47.2	51.0	49.8
2025	48.1	52.0	51.2
2030	51.8	56.2	57.3
2035	54.5	58.9	61.9
2040	56.9	60.8	66.9

[(1)]Actual Regional Demands for 2019

Budgeted Water Delivery

The updated regional demand forecast is used for estimating how much water Tampa Bay Water should expect to deliver to the member governments for the next six years. Tampa Bay Water deducts from the total regional demand forecast the amount of water self-supplied by certain member governments, given normal hydrologic conditions. Tampa Bay Water is currently allocating an annual planned delivery of six mgd to the City of Tampa for 2020 and 2021 to account for uncertainty in Hillsborough River flow. The proposed Fiscal Year 2021 and five-year water delivery projections for each member government are shown in Table 3.

Table 3. Six Year Budgeted Water Delivery Projection, in mgd

Member Government	Proposed FY 2021	Proposed FY 2022	FY 2023	FY 2024	FY 2025	FY2026
Pinellas County	49.0	49.3	49.6	49.9	50.1	50.3
City of St. Petersburg	28.1	28.2	28.5	28.6	28.8	28.9
Hillsborough County	68.0	69.2	70.5	71.7	72.9	73.9
City of Tampa [(1)]	6.0	6.0	6.9	7.8	8.7	9.4
Pasco County	30.6	31.2	31.8	32.4	32.9	33.4
City of New Port Richey	3.0	3.0	3.0	3.0	3.0	3.0
Total	184.7	187.0	190.3	193.5	196.3	198.9

[(1)] Last complete billing data from the City is October 2017

The Tampa Bay Water's Fiscal Year 2021 budget is based on a budgeted delivery of 184.7 mgd, assuming normal hydrologic conditions prevail. Currently, staff is working on source allocation to meet these projected demands.

Demand Forecast Evaluation

June 2019 was the most recent complete billing data available from the member governments except for the City of Tampa. The attached technical report provides a detailed discussion of the model output. Some highlights of the updated model output include:

- Single-family forecast models performed the best of the three sector models (single-family, multi-family, non-residential).
- Real median household income was used in the base year 2018/2019 forecast. This variable reflects the central income level across all households in a geography and is a more robust measure than the mean.
- Model variable coefficients were not updated because the model reproduced the base year 2018/2019 water demand very well. However, the model was calibrated to the most recent total demands (Water Year 2019) to account for differences across service areas and sectoral models.
- A primary source of model error is contained within the projected driver variables (e.g., single-family units, multi-family units, non-residential sector square footage), which uses regional socio-economic projection and are updated annually.
- Temperatures were warmer than average in the Base Year 2018/2019 except for the City of Tampa. March to June of 2019 exhibit below averages temperatures except for the SCH which is near normal condition. The November 2018 to January 2019 temperatures were

significantly higher than the long-term averages. Overall, the region experienced above normal temperature which contributes to increased regional demand. (Table 8 in attached technical report)

- In base year 2018/2019, the region experienced wetter than average conditions except for the City of St. Petersburg which was slightly less than average. December 2018 was the wettest month in the Base Year where all water demand planning areas received significantly higher than average rainfall. Since demand is negatively affected by increased rainfall, above normal conditions tend to decrease water demand in the base year. (Table 7 in attached technical report)

BACKGROUND:

The Long-term Demand Forecast Models were recently re-developed and applied to determine the future water demand in 2020 with billing account data through Water Year 2019, linkage of property appraiser data with member government billing data, creation of sub-sectors in the non-residential sector to reflect relationships between actual square footage and employment data on a parcel level and future forecasts of employment, socio-economic data, and weather data (e.g., rainfall and temperature). Documentation of the redeveloped models and forecast results are completed.

Each year, forecasts are obtained for demographic and socio-economic variables used in the models, and an updated median long-term demand forecast over the planning horizon to 2045 will be prepared. The variables include income, single-family and multi-family housing, non-residential square footage relationships to employment, development densities, persons per household, fraction of water accounts with reclaimed water and water price. The long-term demand forecasts also are based on long-term normal weather parameters for rainfall and temperature.

Attachment on CD

Demand Forecast Annual Evaluation and Update

November

2019

Tampa Bay Water has completed the annual demand forecast evaluation for Water Year 2018/19 and has updated the long-term demand forecast for the agency's seven water demand planning areas to the year 2045.

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Acknowledgments

Receipt of member government billing data allows the agency to use actual data in its development of annual forecasting efforts. Without the provision of these data, the accuracy of the demand forecasts would be severely impacted. The following agencies, along with their identified representatives either coordinating or providing these data, are deeply appreciated by Tampa Bay Water. Thank you!

- Hillsborough County- John McCary
- Pasco County- Dave Hernandez
- Pinellas County- Stanley Pasek/Cristiane Smith/Vertex Group
- City of New Port Richey- Bryan Weed
- City of St. Petersburg- Joann Matri/Lindsey Denzer (wholesale)
- City of Tampa- Did not provide data

1. INTRODUCTION

Tampa Bay Water provides water demand forecasts for its six Member Governments specifically to project and support decisions about the amount of water supply needed within Tampa Bay Water's service area. The Long-Term Demand Forecasting (LTDF) models are designed primarily for the purpose of longer-term planning and forecasting, over 20 to 30-year time horizons. The models follow a monthly and yearly time step, which provides the capability of predicting water use over shorter intervals.

Since 2009 Tampa Bay Water has updated its long-term demand forecast annually to capture changes in socioeconomic trends. This report utilized the LTDF model developed in 2017. In 2019, the Agency updated its LTDF models[1] using additional member government billing data[2] along with updated data sources used in model. This model expands the modeling dataset and provides a richer set of potential predictor variables for demand, which are used to develop the LTDF model equations relating these variables and demand (Hazen and Sawyer, 2018a). The water demand forecast presented in this report is the second update of the 2017 model.

The primary purposes of providing annually updated forecasts for the seven water demand planning areas (WDPAs) of the six-member governments are:

1. Annual budgeting and source allocation – near term forecasting up to five years into the future.
2. Long-range water supply planning – forecasting median water demands for at least 20 years into the future.

Development of annual forecasts and comparison with actual water use can assist Tampa Bay Water in learning how to adapt to changes in water use and related weather and socioeconomic conditions. A set of procedures have been developed to conduct an annual evaluation of the predictive capability of the demand forecast models based on the most recent model

[1] Developed in WY2017 with base year 2014-16 data.

[2] Data collected from all member governments through 2019 except from the city of Tampa

[2] Data collected from all member governments through 2019 except from the city of Tampa

predictions and actual water use, and updated model predictions based on revised socioeconomic conditions and most recent billing data (complete through June 2019), except the city of Tampa (Water Year 2017). Tampa Bay Water conducted the base year 2018/2019 (July 2018 to June 2019) update with recommendations provided by Hazen and Sawyer, who was previously contracted to develop the demand models and support Tampa Bay Water in developing the modeling and forecasting datasets. The July 2018 to June 2019 base year equivalent period will be referred here after as Base Year.

As described by Hazen and Saywer (2018a), retail demand is modeled using three sector-specific, Single Family (SF), Multi Family (MF) and Non-Residential (NR) econometric models. Each model generates demand forecasts based on specific weather and socioeconomic projections for Water Demand Planning Areas (WDPAs). Sector-specific models satisfy the need for modeling retail demand on a member-by-member basis. From these results, sector-specific results can be aggregated as needed into various time periods and geographic delineations.

Tampa Bay Water's annual demand forecasting evaluation procedure is used to perform a comparison between the forecasted and actual retail water use for each WDPA (Figure 1). The analysis compares observed water use for the most recent water year equivalent timeframe having a complete data set against the predicted water use for the same year equivalent period. This analysis verifies the predictive capability of the demand forecast models and provides information regarding the uncertainty of the socioeconomic projections (Tables 9 through 12).

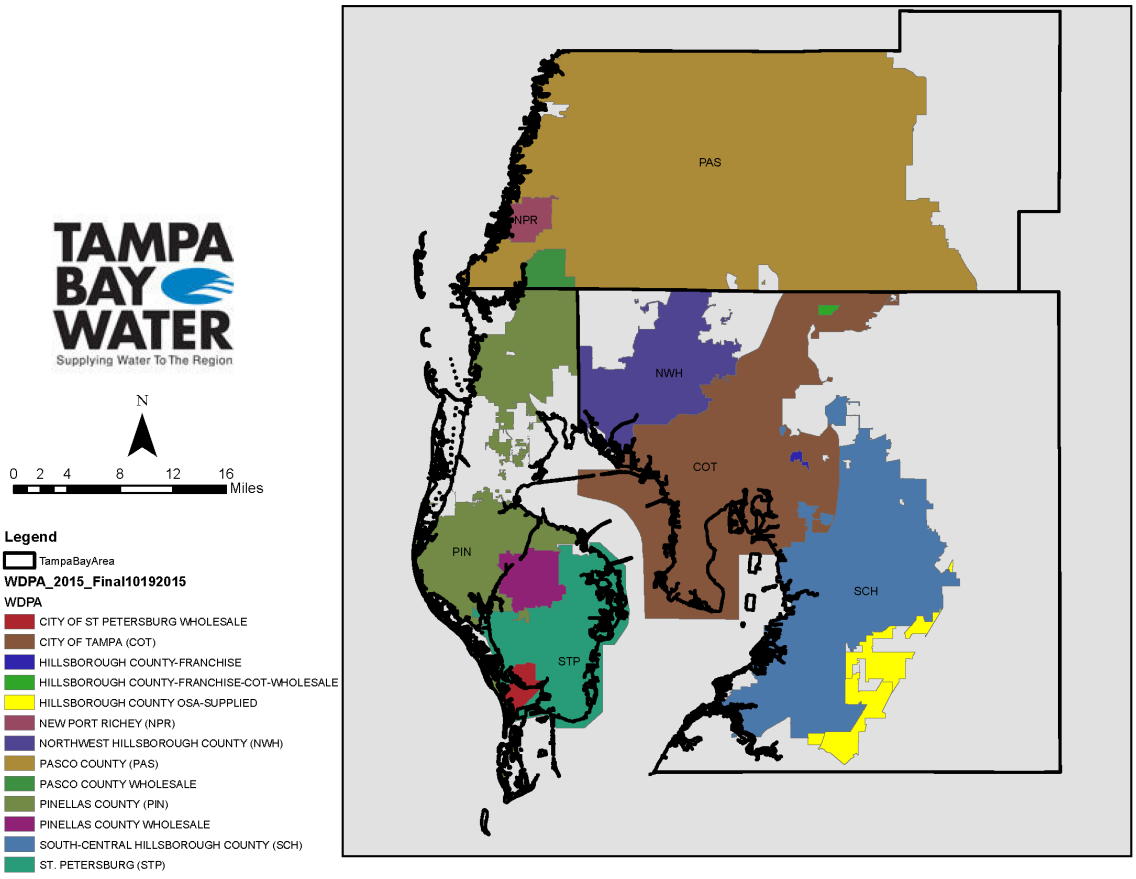

Figure 1. Water Demand Planning Areas

2. MODEL PREDICTED VERSUS ACTUAL FOR Base Year 2018/2019

The forecasting models relate water consumption to weather and socioeconomic factors which influence the use of water (e.g., rainfall, temperature, price, income, housing density, persons per household, growth in housing, NR square footage, and breakdown of that square footage according to NR subsectors). The evaluation of the models requires collection and input of recent data for all the model factors for a complete Base Year. For this evaluation, July 2018 to June 2019 is used as the most recent billing data for all but one WDPA. For the city of Tampa, the period October 2016-September 2017 is used as a Base Year. The most recent Base Year data needed to complete the annual evaluation include:

- Member water use data by account, including wholesale water delivered by members to their wholesale customers
- Tampa Bay Water delivery and total demand data by WDPA
- Base Year 2018/2019 actual daily temperature and rainfall data (for a list of rainfall and temperature stations used see Hazen and Sawyer, 2018a)
- Updated water rate schedules for each member in effect during the Base Year 2018/2019
- Updated property appraiser data for 2019 (consisting of parcels with land use characteristics, acreage, and characteristics of buildings located on those parcels) and association of water use accounts with the parcels they serve.
- Most recent socioeconomic data derived from updated sources including the US Census - American Community Survey (ACS), University of Florida Bureau of Economic and Business Research (BEBR), and Moody's Analytics
    - Single-family (SF) and multi-family (MF) housing units (sector drivers)
    - Persons per household (explanatory variable)
    - Median Household Income (explanatory variable)
    - Housing Density (explanatory variable)
    - Reclaimed Fraction (Proportion of water accounts with reclaimed account) (explanatory variable)
    - NR indoor square footage (sector driver)
    - Distribution of total NR indoor square footage in each of ten NR subsectors (explanatory variable)

2.1. Base Year 2018/2019 Model Drivers (SF and MF Housing Units and NR Indoor Square Footage)

The forecasting methodology employs a "rate-of-use-times-driver" approach for calculating sectoral demands. Each sector-specific model calculates average monthly demand, or *rate of use*, per water consuming entity, or *driver unit*. A different driver unit is defined for each sector (e.g., SF, MF and NR). The SF sectoral model calculates retail demand per SF housing unit, with the number of SF housing units serving as a driver unit. Likewise, the MF sectoral model calculates retail demand per MF housing unit, with the number of MF housing units serving as a driver unit. The NR sectoral model calculates retail demand per 1000 square feet (ksf) of indoor area, with number of square feet divided by 1000 serving as a driver unit. A forecast of demand for any given sector is a simple product of predicted rate of use and the predicted number of driver units.

Table 1 shows driver totals for the three sectors in the Base Year 2018/2019.

- SF housing units are determined based on the number of housing units on SF parcels associated with active accounts in Tampa Bay Water's service area. The total number of SF housing units in the Base Year (July 2018 to June 2019) was 519,600. The City of Tampa WDPA has the largest number of SF housing units among the water demand planning areas (107,191, 20.7% of total region (estimated based on the 2017 data).

- Multi-family (MF) housing units are determined based on the number of housing units on MF parcels associated with active accounts in Tampa Bay Water's service area. The total number of MF housing units in the Base Yearwas 324,250. The Pinellas County WDPA has the largest number of MF housing units among the water demand planning areas (95,339, 26% of total).

- Non-residential (NR) thousands of square feet (ksf) are determined based on the indoor square footage on NR parcels associated with active accounts in Tampa Bay Water's service area. The total NR ksf in the Base Yearwas 553,489. The City of Tampa generally has the largest ksf among the water demand planning areas (252,444, 45.6% of total (estimated based on the 2017 data).

Table 1. Base Year 2018/2019 Driver Units

	PAS	NPR	NWH	SCH	COT*	PIN	STP	TBW
SF Dwelling Units	90,274	6,985	46,793	103,191	107,362	89,488	75,506	519,600
MF Dwelling Units	18,819	4,368	26,595	32,108	84,206	95,339	62,815	324,250
NR (units of 1000 ft2)	39,118	6,385	28,498	56,370	252,444	86,817	83,857	553,489

*COT Units are estimated based on the 2017 values.

2.2. Explanatory Variables

Each sectoral model has a set of explanatory variables that explains the rate of water use by sector, WDPA, and month. Examples of explanatory variables include rainfall, temperature, real median household income, real marginal price, persons per household, and housing unit density. By conducting regression analyses on historic water use, weather, and socioeconomic data, coefficients for each explanatory variable are determined that measure the relationship between the explanatory variable and the per unit sector water use, which vary by month and by geographic area (such as WDPAs)[3].

2.2.1. Persons Per Household

Information used to determine the Base Year SF and MF persons per household (PPH) was obtained from the American Community Survey (ACS). This source provides estimates of SF and MF households and residents at a small geographic scale (Block Group). These data are then mapped to WDPAs (a larger geographic scale) and summed to determine SF and MF population, number of households, and subsequently PPH at a WDPA level.

Table 2 shows the Base Year SF and MF PPH. SF PPH ranges from 2.22 for New Port Richey WDPA to 2.8 for South Central Hillsborough WDPA. MF PPH ranges from 1.69 for Pinellas WDPA to 2.29 for South Central Hillsborough WDPA. These values exhibit a similar pattern to values encountered in prior forecast updates but show a slight drop in magnitude.

Table 2. Base Year 2018/2019 SF and MF Persons Per Household

	PAS	NPR	NWH	SCH	COT	PIN	STP
SF	2.55	2.22	2.78	2.8	2.67	2.31	2.48
MF	2	1.5	2.03	2.29	1.97	1.69	1.76

[3] For a detailed discussion of the development of the long-term demand forecast models and their coefficients, see (Hazen and Sawyer, 2018a).

2.2.2. Real Median Household Income

Information used to determine Base Year 2018/2019Real Median Household Income was obtained from the ACS. This source provides estimates of total number of households within various income ranges at a small geographic scale (Block Group). These data are then mapped to WDPAs (a larger geographic scale) and summed to determine number of households within income ranges at a WDPA level. These range totals are then used to estimate Median Household Income in each WDPA. Finally, to account for the effects of inflation, Median Household Income estimates are then adjusted to 2015 dollars using Consumer Price Index data from the Bureau of Labor Statistics, to determine values for *Real* Median Household Income. Note that Real Median Household Income is not differentiated by SF or MF sector; it is determined across the geographic areas for the residential sector.

Table 3 shows Real Median Household Income by WDPA. Values range from $34,150 in New Port Richey to $66,963 in Northwest Hillsborough.

Table 3. Real Median Household Income and Real Marginal Price by WDPA, in 2015 dollars

WDPA	Real Median Household Income	Real Marginal Price of Water and Sewer at 8001 gallons monthly consumption
PAS	50,708	7.63
NPR	34,150	8.12
NWH	66,963	8.35
SCH	60,918	8.35
COT	44,587	8.48
PIN	51,618	8.96
STP	47,763	12.47

2.2.3. Real Marginal Price (RMP)

Information to determine values for Real Marginal Price (RMP) for each WDPA is taken from Member Government rate structures in effect during the Base Year. First, marginal price is determined by summing three components

- the SF volumetric water rate (price per thousand gallons of consumption of potable water for the residential sector) at the rate tier containing 8001 gallons per month[4]

[4] In cases where tiers are not defined, the single volumetric price per thousand gallons is used. In cases where rates are differentiated by customer location, the "In Retail Service Area" rate is used.

- the SF volumetric sewer rate (price per thousand gallons of consumption potable water consumption for the residential sector)[5]
- any volumetric Tampa Bay Water "pass through" charges.

RMP is meant to portray the incremental cost of consumption. Note that fixed charges or total charges at tiers below those containing 8001 gallons are not used in determining the RMP for the demand forecasts. In addition, only the SF RMP is used in model development as well as forecasting future water demands and is therefore considered an instrument for capturing pricing trends. The SF RMP is applied in all three sectors. RMP is only differentiated between WDPAs[6] and is projected to increase by 1.28%. The only exception is the 2020 price which is based on the latest price increase after June 2019.

Table 3 also shows Real Marginal Price by WDPA. Values range from $7.63 per kgal in Pasco to $12.47 per kgal in St. Petersburg.

2.2.4. SF and MF Housing Densities

SF and MF Housing density variables are defined as the average number of housing units per acre and are based on 2017 property appraiser unit and acreage data for parcels associated with SF- and MF-classified accounts. These data are shown in Table 4. Values for SF Density range from 2.99 units per acre in Northwest Hillsborough to 5.07 units per acre in New Port Richey. Values for MF Density range from 4.89 units per acre in Pasco to 56.01 units per acre in New Port Richey[7].

[5] No Member Governments have differentiated sewer rates at the level of 8001 gallons potable consumption per month. In cases where rates are differentiated by customer location, the "In Retail Service Area" rate is used.

[6] This convention of using SF rates as an instrument for price was adopted as a matter of modeling convenience. In reality, water rates may differ between sectors now and in the future, but as rates rise in general, they should rise for individual sectors as well.

[7] This high value for New Port Richey is a result of a preponderance of dense apartment-style condominiums on smaller lots which are classified as Multifamily by the Property Appraiser.

Table 4. Base Year 2018/2019 SF and MF Housing Densities

WDPA	SF Housing Density (Units/acre)	MF Housing Density (Units/acre)
PAS	3.71	4.89
NPR	5.07	56.01
NWH	2.99	9.44
SCH	3.14	8.87
COT	4.57	17.63
PIN	3.26	10.20
STP	4.96	7.51

2.2.5. Fraction of SF and NR Water Use Locations with Reclaimed Service[8]

Reclaimed water use is accounted for in the demand forecast models by WDPA and sector. The parameter is fraction of accounts that also use or have access to reclaimed water. Data for fraction of the Base Year SF and NR water use locations with reclaimed water service are taken from member government billing data. Within each sector and WDPA, the reclaimed fraction is derived as the proportion of all water use locations that have at least one reclaimed connection[9]. Base year Reclaimed Fractions are shown in Table 5.

Table 5. Base Year 2018/2019 fraction of reclaimed water locations (SF, MF and NR)

	PAS	NPR	NWH	SCH	COT	PIN	STP
Percentage of SF Locations with Reclaimed	0.149	0.023	0.318	0.057	0.038	0.323	0.16
Percentage of MF Locations with Reclaimed	0.008	0.002	0.127	0.008	0.065	0.254	0.066
Percentage of NR Locations with Reclaimed	0.018	0.048	0.079	0.026	0.031	0.191	0.077

2.2.6. NR Square Footage Fractions in Subsectors

Tampa Bay Water's 2013 Demand Management Plan (DMP) defined ten NR subsectors (DMP Subsectors) most critical to tracking and addressing water conservation potential

[8] The MF sector does contain accounts with access to reclaimed water. However, the reclaimed fraction variable was found to be a significant variable only in the SF and NR sector models of the revised LTDFS.

[9] The concept of "water use locations" is discussed in (Hazen and Sawyer, 2018a).

through active conservation efforts and passive efficiency increases. The LTDF models adopt these same subsectors as classifications for describing how total NR square footage is distributed and represents a proxy for measuring differences in the mix of commercial, industrial, and institutional activity across the region. The fraction of total NR square footage within each DMP subsector is determined for the Base Yearusing property appraiser data for parcels linked to NR-classified accounts as follows:

- NR parcels linked to Base-Year accounts are further classified into DMP subsectors using land use information
- Total indoor square footage for each DMP subsector and WDPA is determined by summing indoor square footage across parcels in that subsector and WDPA, and
- Subsectoral fractions are determined by dividing square footage for each subsector and WDPA by total NR square footage for the WDPA.

Table 6 contains square footage fractions by WDPA and DMP sector for Base Year.

Table 6. DMP Subsector Square Footage Fractions for the Base Year 2018/2019

WDPA	Education	Government	Health Care	Heavy Manufacturing	Hotels, motels	Light Manufacturing	Office Buildings	Restaurants and Fast Food Outlets	Retail Stores	Retirement	Other
PAS	0.16392	0.03816	0.09445	0.00964	0.01539	0.03419	0.05144	0.01193	0.24860	0.01062	0.32166
NPR	0.13571	0.05376	0.12841	0.00000	0.03580	0.00152	0.08599	0.01900	0.20141	0.05393	0.28446
NWH	0.13655	0.02310	0.04733	0.00711	0.00629	0.01890	0.12979	0.01181	0.27398	0.03310	0.31204
SCH	0.17712	0.02371	0.07091	0.02248	0.00858	0.01611	0.06493	0.01206	0.22531	0.02887	0.34992
COT	0.07137	0.09046	0.04946	0.01820	0.04067	0.03393	0.16942	0.00790	0.08787	0.00371	0.42700
PIN	0.08027	0.08343	0.04440	0.01854	0.06983	0.15194	0.11068	0.01114	0.12825	0.04843	0.25309
STP	0.09801	0.06199	0.07096	0.01281	0.02996	0.08493	0.20712	0.00845	0.12526	0.04259	0.25792

2.2.7. Efficiency Factors

The efficiency factor is an indexed annual value that reflects estimates of the degree of market penetration of new high-efficiency water fixtures in the SF sector by WDPA due to natural fixture deterioration and replacement. Market saturation levels for 2014 are given an index value of 1, while greater saturation levels are given lower index values (less water used based on more efficient technology) following assumed market penetration rates from 2015 to 2045.

This demand update does not incorporate water savings due to passive efficiency increases with time. Hence, the efficiency factors for all WDPAs are set to a value of 1. The efficiency factors can be reduced to values less than 1 based on the agency's Demand Management Plan study. This will allow evaluating the effects of replacement of future efficient fixtures on the future demand projections.

2.2.8. Weather Variables (Rainfall and Temperature)

Input data for the weather variables include both Base Year weather data and long-term average weather data for the model parameters. All weather data are log transformed as inputs into the long-term demand forecasting models; details are explained in (Hazen and Sawyer, 2018a).

Table 7 shows departure of the Base Year actual monthly rainfall from the long-term average. The table also highlights the spatial variability of rainfall in the Tampa Bay Water's service areas. Green shades indicate that the actual rainfall is above the long-term average. Red shades indicate that the actual rainfall was less than long term average. All WDPAs seems to follow the same modes of variability with the maximum rainfall in July and minimum in May. Rainfall in December 2018 was exceptional, all service areas received above normal rainfall. However, the October to November period was drier than normal. The Base Year total rainfall, blue shading in Table 7, is the Base Year total annual rainfall deviation from the long-term annual average. During this period, all service areas received above average rainfall except in STP WPDA with the maximum rainfall in NWH WDPA and the minimum in STP WDPA.

Table 7. Base Year 2018/20198 actual minus long term average rainfall (inches)

Year	Month	PAS	NPR	NWH	SCH	COT	PIN	STP
2018	7	2.55	0.84	4.39	4.46	0.85	0.66	-3.44
2018	8	-0.41	0.81	1.70	1.24	2.62	-3.50	-0.22
2018	9	-0.54	2.32	2.55	1.89	0.56	-0.79	-2.25
2018	10	-0.66	-0.23	0.25	-0.47	-0.07	0.13	-0.04
2018	11	0.21	0.34	0.07	0.46	-0.14	-0.37	-0.11
2018	12	7.93	8.37	8.14	6.48	6.44	5.60	4.50
2019	1	1.72	2.47	1.86	2.10	2.27	1.78	1.90
2019	2	-0.34	-0.19	1.63	-0.32	0.72	-0.24	0.00
2019	3	-1.24	-0.80	-0.82	0.48	-0.41	-1.05	-1.56
2019	4	2.18	2.81	1.30	0.97	1.18	0.51	0.31
2019	5	1.12	3.66	1.58	2.96	2.40	2.45	2.17
2019	6	1.55	4.73	4.10	1.11	3.35	0.68	-1.59
Base Year Total		14.08	25.13	26.73	21.37	19.79	5.87	-0.34

Notes: Negative (positive) numbers means actual rainfall less (more) than long-term averages. Red shading indicates rainfall less than average (darker the shading = less rainfall). Green shading indicates rainfall greater than average (darker the shading = more rainfall). The Base Year totals are positive indicating that all WDPAs have received above average rainfall during the one-year period from Jul 2018 to June 2019 except for STP which is slightly below average.

Table 8 shows the departure of maximum temperature from the long-term average maximum temperatures in each WDPA. The July to November of 2018 maximum temperature were observed to be above the long-term maximum average temperatures. The base year average shown in blue shading in Table 8 indicates the average annual maximum temperature minus the long-term average. For the Base Year period, COT experienced slightly cooler than the long-term average and the SCH experienced the highest above average temperatures.

Results shown in Tables 7 and 8 indicate that the Base Year weather conditions were wetter and warmer than the long-term average values for almost all WDPAs except for STP's slightly dryer condition.

Table 8. Base Year 2018/2019 actual maximum temperatures minus long term average of maximum temperatures (F)

Year	Month	PAS	NPR	NWH	SCH	COT	PIN	STP
2018	7	4.33	3.40	2.26	6.37	-0.27	1.35	2.50
2018	8	1.92	1.51	-0.15	3.08	-2.80	0.38	0.15
2018	9	3.42	4.05	2.00	4.91	-0.99	2.54	2.62
2018	10	4.06	5.24	3.56	6.11	0.55	4.21	4.10
2018	11	9.03	9.68	7.65	10.16	4.81	8.26	7.97
2018	12	9.84	11.01	8.28	9.49	5.83	8.15	3.27
2019	1	7.30	8.65	6.56	9.97	4.41	7.08	7.25
2019	2	2.95	4.18	0.57	3.96	-1.31	1.52	1.08
2019	3	-1.46	-0.31	-3.57	0.44	-5.43	-2.29	-2.24
2019	4	-4.01	-3.32	-5.57	-2.02	-7.56	-4.83	-5.08
2019	5	-1.58	-2.06	-3.89	0.23	-6.19	-3.33	-3.32
2019	6	-2.30	-2.88	-3.23	-0.86	-5.83	-4.31	-4.30
Base Year Average		2.79	3.26	1.20	4.32	-1.23	1.56	1.17

Notes: Negative (positive) numbers mean actual temperatures were cooler (warmer) than long-term averages. Green shading indicates temperature cooler than average (darker green = much cooler).

Red shading indicates temperature warmer than average (darker red = much warmer). The base year average temperatures for all WDPAs, except for COT, are warmer than average during the July 2018 – June 2019 one-year period.

Seasonal differences between actual weather and long-term normal weather are used to predict future water use. Since long-term normal weather is assumed in all future months throughout the forecast period, observed water use in any future year will differ from the forecast, in part, due to actual weather conditions for that year. Warmer and drier than normal weather generally leads to higher water use, while cooler and wetter than normal conditions caused actual water use to be less than what would be predicted under the long-term normal climate.

3. BASE YEAR 2018/2019 PREDICTED VERSUS ACTUAL WATER USE RESULTS

The demand forecast models are verified each year by comparing the prior year forecast of the Base Year to actual demand observations for the new Base Year. Then, the prediction accuracy of the prior year predictions of the new Base Year is compared by replacing prior-year projections for driver units and explanatory variables with the new Base Year observations and noting how prediction accuracy changed with these substitutions.

This process allows the model to be verified each year by measuring the total deviation of the prior year's forecast from the demands that eventually occurred, then noting the portions of this overall deviation that arose from inaccuracy in projection inputs versus inaccuracy in the model itself. Tables 9 through 12 show the predictive performance of the prior year forecast by comparing the predicted and observed water demands in the 2019 forecast Base Year (July 2018 – June 2019).

This process is used to evaluate two questions

1. Should the coefficients of the demand models be updated?
2. Should the models be calibrated to the new Base Year and then the prediction updated?

The forecast model for the SF sector, shown in Table 9 captures the water demand reasonably well with the regional forecast deviation of 2.4 MGD (2.68%) from observed data. Since this model is developed as one regional water demand forecast model, deviations across all the service areas are not the same. The deviation is observed high with 16.93% (3.41 MGD) for PAS and low with -0.57% (-0.1 MGD) for PIN. The deviation for NPR is 15.54 % with just 0.14 MGD deviation from the observation. The 16.93% deviation in PAS SF water use is 2.93% of the total SF demand and 1.62 % of the total retail billed demand for Tampa Bay Water's service area. The overall 2.68% error in predicting the SF water demand demonstrates how well the model is performing at a sector level especially since the model is calibrated to the 2014 – 2016 base period.

Table 9. SF Demand Observations and Model Predictions for the Base Year 2018/2019 (MGD)

WDPA	Observed	Estimated	Estimated – Observed	% Error
PAS	20.14	23.55	3.41	16.93%
NPR	1.02	1.18	0.16	15.54%
NWH	11.13	11.68	0.55	4.91%
SCH	30.08	28.31	-1.77	-5.88%
COT	NA	24.39	NA	NA
PIN	17.22	17.12	-0.10	-0.57%
STP	9.95	10.10	0.16	1.57%
TBW	89.54	91.94	2.40	2.68%

Compared to the SF sector, the total MF sector demand forecast is estimated to have an overall deviation -8.48% from observed data, which is a higher percentage error than the SF model forecasts. The MF model underestimates the 2019 regional demand by 2.51 MGD with error percentages ranging from -31.09% for STP to 0.14% for NPR (Table 10). Since the MF sector is small compared to the total Tampa Bay Water service area demands, the -31.09 % deviation in STP MF water demands represents 6.2% of the total MF sector and 1.27 % of Tampa Bay Water service area total retail billed demand.

Table 10. MF Demand Observations and Model Predictions for the Base Year 2018/2019 (MGD)

WDPA	Observed	Estimated	Estimated – Observed	% Error
PAS	2.37	2.49	0.12	5.19%
NPR	0.45	0.45	0.00	0.14%
NWH	3.36	3.43	0.07	2.08%
SCH	5.79	5.90	0.11	1.96%
COT	NA	15.84	NA	NA
PIN	9.05	8.90	-0.15	-1.69%
STP	8.56	5.90	-2.66	-31.09%
TBW	29.57	27.07	-2.51	-8.48%

The NR sector (Table 11) forecast has overall accuracy of 1.87% deviation from the observed demand. This level of accuracy is remarkable especially considering the 2014 – 2016 calibration period. Similar to the SF and MF sectors, the NR model is developed regionally, hence deviations vary across service areas. The highest percentage error of -18.04 % is observed in STP with a magnitude of -1.29 MGD which is 2.53% of the total NR demand and 0.61 % of the billed retail demand.

In general, WDPAs with small sectoral demand exhibit higher percentage but often small water volumes which account for a very small percentage of the overall regional demand.

Table 11. NR Demand Observations and Model Predictions for the Base Year 2018/2019 (MGD)

WDPA	Observed	Estimated	Estimated – Observed	% Error
PAS	5.43	5.57	0.14	2.55%
NPR	0.48	0.53	0.04	8.42%
NWH	2.49	2.73	0.24	9.60%
SCH	4.61	5.39	0.78	16.91%
COT	0.00	23.39	NA	NA
PIN	6.86	7.46	0.60	8.73%
STP	7.16	5.87	-1.29	-18.04%
TBW	27.04	27.55	0.51	1.87%

Table 12 is designed to illustrate the overall accuracy of the total retail forecast in comparison with the observed retail demand in 2019. Its accuracy ranges from the minimum percentage of deviation from the observation of 1.05 % for PIN (or 0.35 MGD) to a maximum percentage of -14.79% (or -3.8 MGD) deviation from observed total retail demand in STP. The maximum deviation in terms of volume seen in STP accounts for 1.75% of the total regional retail demand.

Table 12. Total Retail Demand Observations and Model Predictions for the Base Year 2018/2019 (MGD)

WDPA	Observed	Estimated	Estimated – Observed	% Error
PAS	27.93	31.60	3.67	13.14%
NPR	1.95	2.15	0.20	10.21%
NWH	16.98	17.84	0.86	5.03%
SCH	40.48	39.60	-0.88	-2.16%
COT	NA	63.62	NA	NA
PIN	33.13	33.48	0.35	1.05%
STP	25.67	21.87	-3.80	-14.79%
TBW	146.16	146.56	0.40	0.27%

The Base Year (July 2018 to June 2019) average of the total retail billed demands are estimated very well in the model. Predicted demand is overall very close to the observed data. This is at least partially attributable to the model being calibrated to a three-year period of observations (July 2014- June 2016). This calibration approach is robust, being developed over the long-term rather than a single-year calibration. It allows calibration to encompass a wider range of driver and explanatory conditions (notably weather) than calibrating to a single year. A side effect of this calibration approach is, while average sectoral demands over 2014-2016 are perfectly reproduced by definition, they are not perfectly reproduced in any single year. According to Tables 9-12, model prediction errors are generally small in MGD and percentage terms, particularly for the region as a whole.

The total retail forecast for the Base Year is estimated with just 0.27% error is equivalent to 0.4 MGD above the observed 2019 retail demand. This demonstrates how well the model reproduced the 2019 Base Year total billed retail demand. This result confirms the suitability of model coefficients to be used for the current annual demand forecast update without a need to update them. However, to correct the uneven error across sectors and service areas, the model is calibrated to the 2019 Water Year data, the most recent total water demand data. The next section presents the long-term demand forecast results based on the updated calibration period.

4. LONG-TERM DEMAND FORECAST UPDATE

Next, the median long-term forecast of demand (i.e., for the years subsequent to the Base Year) is produced using revised socio-economic projections if they are available and assumptions where predictions are not available. The forecast period is through 2045. The revised median long-term demand forecast is then presented to the Board of Directors, generally each December, and used to estimate how much water Tampa Bay Water budgets for delivery in the upcoming water year.

Data sources used for the Base Year evaluation were:

- Updated American Community Survey (ACS) 5-year average observations over 2013-2017, including statistical estimates at block group level aggregated to WDPA for
  - Total, Single family, and Multi-family Population
  - Occupied Single family and Multi-family Housing Units
  - Median Household Income
- University of Florida Bureau of Economic and Business Research (BEBR) (2020 to 2045 with estimates for 2018)
  - Total population
- MOODY'S County-level projections for 2019-2045
  - Total population and households
  - Single family and multi-family housing stock
  - Total employment and employment by various subsectors
  - Median household income
- FDOT TAZ-level projections for 2010, 2030, and 2040 (updated 2014)
  - Total dwelling units
  - Total population
  - Total employment and employment by various subsectors
- Tampa Bay Water/Members
  - historical marginal price including the October 2019 update for water and sewer at 8001 gallons per month for single family residential use (for each member)
  - Base Year consumption* and accounts by sector (derived from property appraiser) and WDPA
  - Base Year wholesale and total delivery by WDPA

An interpolated BEBR estimate of total population in Hillsborough, Pasco, and Pinellas counties for 2019 is 2.9 million people. The total population served by Tampa Bay Water and the Member Governments is approximately 2.4 million people, about 83% of the total population. The regional population growth rate through the year 2045 based on BEBR

projections is about 0.9 % per year. As shown on Figure 2, population in Pinellas County is projected to remain relatively constant through the forecast period through 2045, population for Hillsborough County is projected to increase through the forecast period at a higher rate, while population in Pasco County is projected to increase at a slower rate. Population growth rate trends are similar to last year's projections.

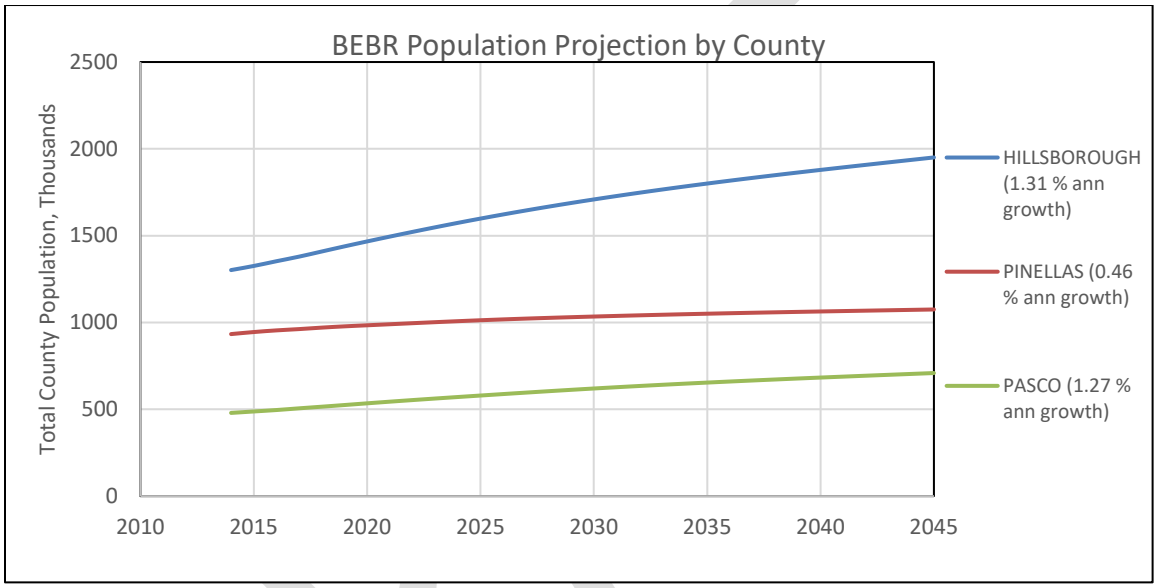

Figure 2. Total County Population Projections.

4.1. Update of Model Variable Projection Data

This section presents results of driver and explanatory variable projections used to develop the updated Base Year long term demand forecast.

Model input variables, particularly, socioeconomic projection data are first collected. Explanatory variables used to calculate the unit use of water and the numbers of units (drivers) for each sector (SF, MF and NR) and WDPA are then used to in conjunction with the sectoral models to estimate possible future demand.

4.1.1. Single-family and Multi-family Units

SF and MF Housing units are projected by growing base-year unit totals according to growth rates derived from BEBR county population projections, Moody's County-level population,

household, and SF and MF sectoral stock projections, and FDOT population and housing unit projections by Traffic Analysis Zones (TAZ).

The 2019 projections of single family and multi-family units by WDPA are shown on Figures 3 and 4 and Tables 14 and 15. Agency-wide,

- SF housing units are projected to grow from 519,600 units in 2019 to 695,901 units in 2045, a change of 176,302 units (total change of 34%, 1.13% per year compounded)
- MF housing units are projected to grow from about 324,250 units in 2019 to 372,398 units in 2045, a change of about 48,148 units (total change of 14.85%, 0.53% per year compounded)

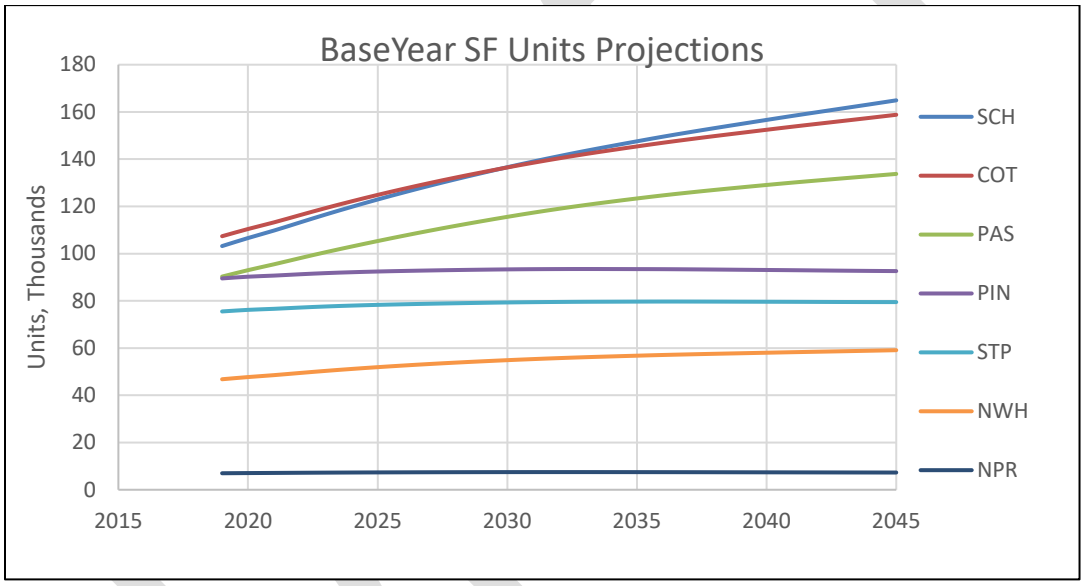

Figure 3. Single Family Units Projections by WDPA

Table 13. Starting and Ending-year Projections of SF Housing Units for the Base Year 2018/2019 Forecast

	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW
2019	**90,274**	**6,985**	**46,793**	**103,191**	**107,362**	**89,488**	**75,506**	**519,600**
2045	**133,746**	**7,291**	**59,104**	**164,905**	**158,792**	**92,597**	**79,466**	**695,901**
Change	**43,472**	**306**	**12,311**	**61,714**	**51,430**	**3,109**	**3,960**	**176,302**
% Change	**48.16%**	**4.38%**	**26.31%**	**59.81%**	**47.90%**	**3.47%**	**5.25%**	**33.93%**
Growth Rate	**1.52%**	**0.16%**	**0.90%**	**1.82%**	**1.52%**	**0.13%**	**0.20%**	**1.13%**

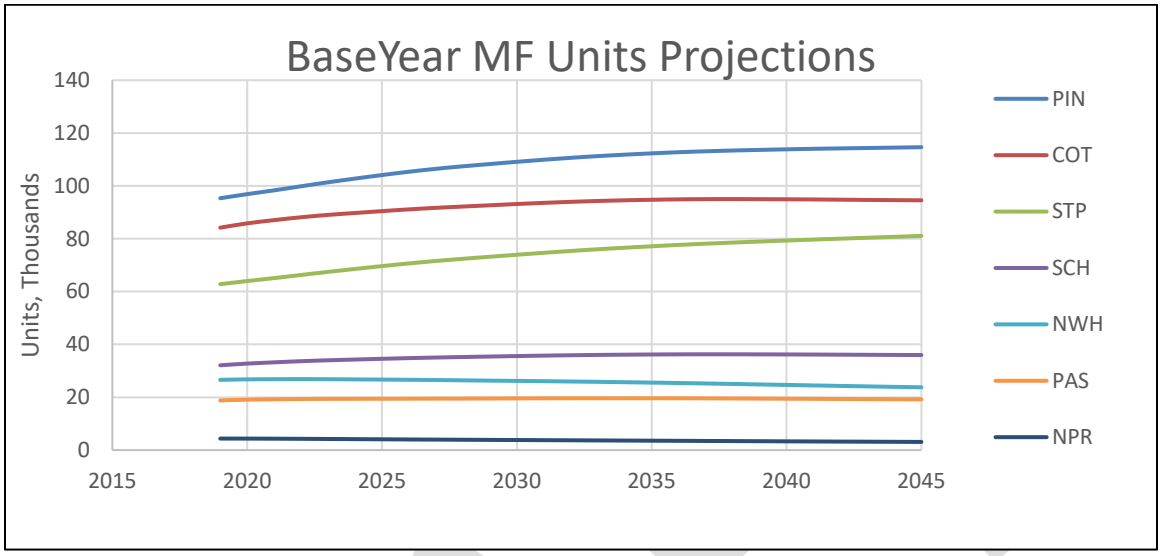

Figure 4. Multi-Family Units Projections by WDPA

Table 14. Starting and Ending-year Projections of MF Housing Units for the Base Year 2018/2019 Forecast

	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW
2019	**18,819**	**4,368**	**26,595**	**32,108**	**84,206**	**95,339**	**62,815**	**324,250**
2045	**19,217**	**3,098**	**23,774**	**35,989**	**94,565**	**114,665**	**81,091**	**372,398**
Change	**398**	**(1,270)**	**(2,821)**	**3,880**	**10,359**	**19,325**	**18,277**	**48,148**
% Change	**2.11%**	**-29.07%**	**-10.61%**	**12.08%**	**12.30%**	**20.27%**	**29.10%**	**14.85%**
Growth Rate	**0.08%**	**-1.31%**	**-0.43%**	**0.44%**	**0.45%**	**0.71%**	**0.99%**	**0.53%**

Note that while SF unit projections show relatively persistent increases over time, MF unit projections show relatively slower growth over time. Figure 5 illustrates a regional trend, showing projected total SF and MF units over 2019-2045 along with annual average growth rates. In this figure, projections of SF housing units are shown to grow annually at 1.13%, while projections of MF housing units are shown to grow at 0.53% annually over the whole period. This reflects a projection of new development becoming relatively more dominated by SF dwellings in the future regionally. Prior forecasts have shown similar trends.

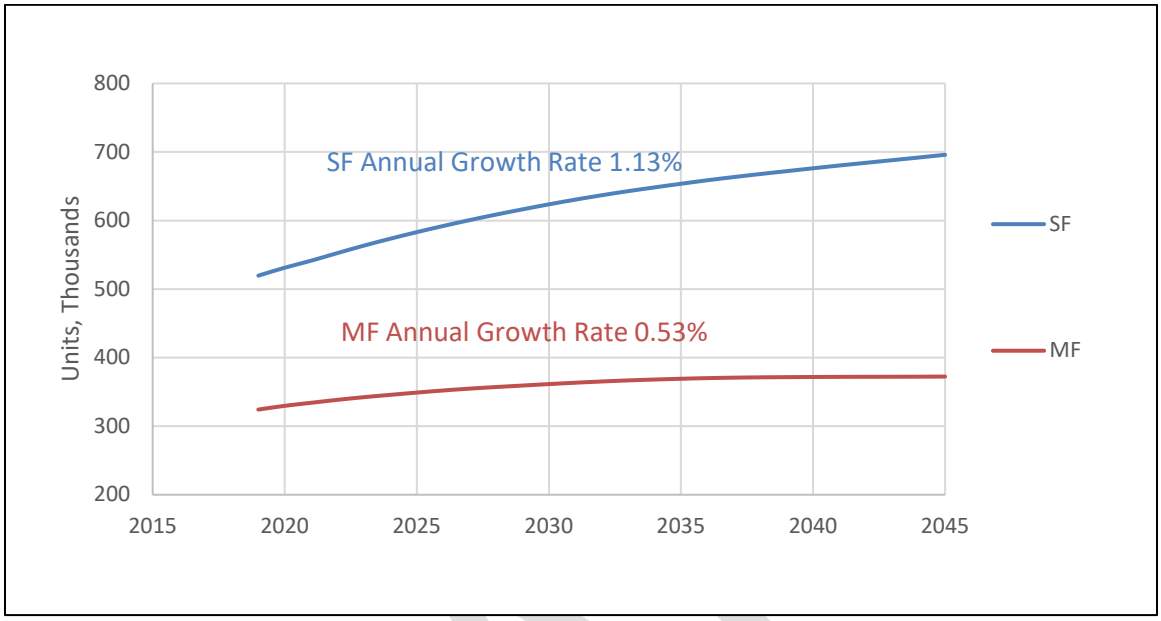

Figure 5. Total Regional Projected SF and MF Housing Units Projections with Annual Average Growth Rates

Figure 6 shows a comparison of total (SF + MF) projected dwelling units in the Base Year 2017/2018 forecast with the projections used in the currentBase Year 2018/2019 forecast.

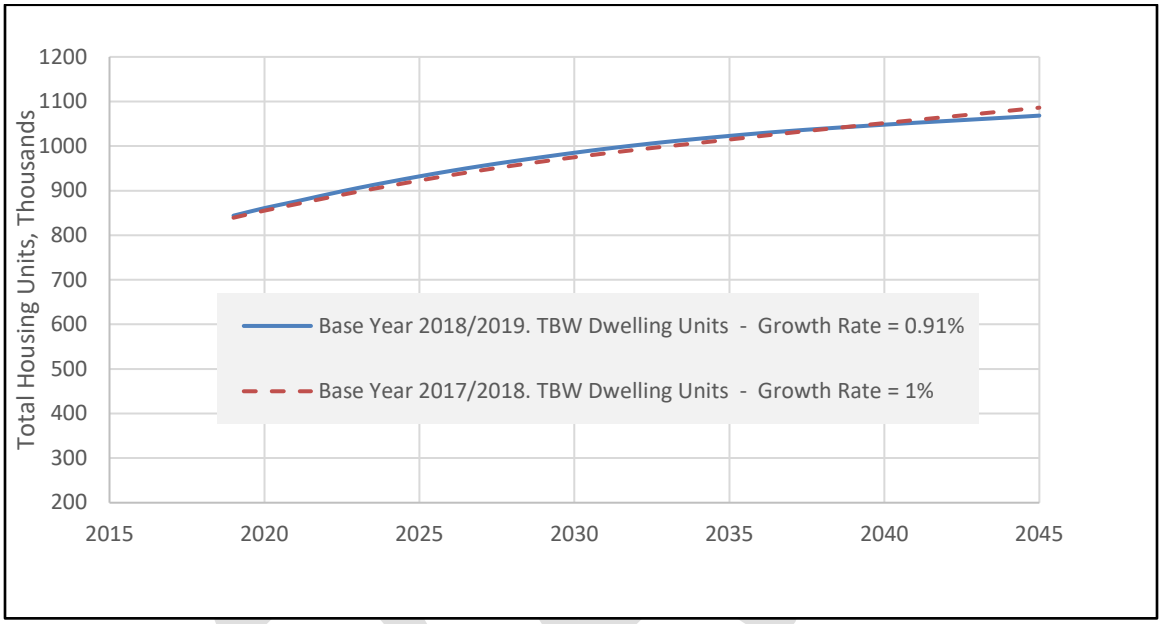

Figure 6. Projections of Housing Units in Tampa Bay Water Service Area

The Base Year2017/2018 Forecast (dashed red line in Figure 6) shows the projected annual growth rate for total number of housing units in the Tampa Bay region was 1%. The current Base Year (2018/2019) forecast (solid blue line in Figure 6) has almost the same growth rate as the previous year forecast.

4.1.2. Non-Residential Square Footage Projections

The Base Year projections of NR square footage (in ksf) by WDPA are shown in Figure 7 and Table 15. These projections were developed by growing DMP sub sectoral square footage totals for the Base Year according to sub-sectoral employment projections compiled from Moody's Analytics and FDOT, then summing to total square footage. Agency-wide, square footage is projected to grow from about 553,489 ksf in 2019 to 607,866 ksf in 2045, a change of about 54,376 ksf (total change of 9.82%) which is 0.36% per year compounded.

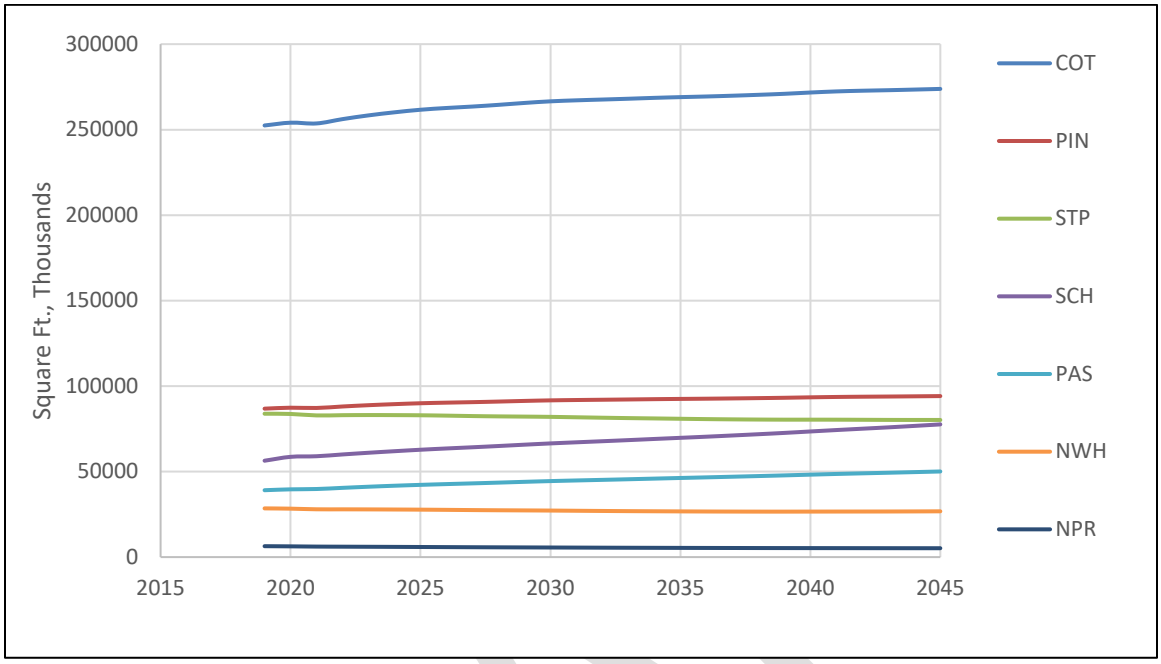

Figure 7. NR Square Footage Projection by WDPA

Table 15. Starting and Ending-year Projections of NR ksf for the Base Year 2018/2019 Forecast

	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW
2019	**39,118**	**6,385**	**28,498**	**56,370**	**252,444**	**86,817**	**83,857**	**553,489**
2045	**50,077**	**5,192**	**26,780**	**77,610**	**273,824**	**94,170**	**80,213**	**607,866**
Change	**10,959**	**-1,193**	**-1,718**	**21,239**	**21,380**	**7,353**	**-3,644**	**54,376**
% Change	**28.02%**	**-18.69%**	**-6.03%**	**37.68%**	**8.47%**	**8.47%**	**-4.35%**	**9.82%**
Growth Rate	**0.95%**	**-0.79%**	**-0.24%**	**1.24%**	**0.31%**	**0.31%**	**-0.17%**	**0.36%**

4.1.3. Real Median Household Income Projections

Projected real median household income levels for the forecast period are shown in Figure 8 and Table 16. Projected incomes are derived by growing base-year estimates according to Moody's Analytics projections of median income growth for each county and then adjusting to constant dollar terms by assuming 3% annual inflation. At this assumed rate of inflation, real median household incomes across the WDPAs are projected to grow at between 0.29% and 0.83% annually.

4.1.4. Real Marginal Price of Water and Sewer Projections

Projected real marginal price of water and sewer for the forecast period are shown in Figure 9 and Table 17. Projected prices are derived by growing base-year estimates by 1.28% per year in real dollar terms, which reflects the average annual inflation-adjusted growth rate in RMP across all WDPAs over the period 2003-2013. This growth rate is the same rate that has been used in the previous four demand forecast updates.

4.1.5. SF and MF Persons Per Household Projections

SF and MF Persons per Household were projected by

- deriving annual rates of change in SF and MF PPH from
  - BEBR county population projections,
  - Moody's County-level population, household, and SF and MF sectoral stock projections, and
  - FDOT population and housing unit projections by TAZ (all in tandem with development of dwelling unit projections), then
- applying those rates of change to Base Year SF and MF PPH estimates by WDPA

Results of updated projections of persons per household for the single family and multi-family sectors for each WDPA are shown in Figures 10 and 11 and Tables 18 and 19.

4.1.6 SF and MF Housing Density Assumptions

Projected SF and MF housing densities are held constant at Base-Year values (Table 4). Over short-term projection periods, average densities for the WDPAs are not likely to change rapidly as the majority of residential units in existence at the end of such periods will have already been in existence in the Base Year. This prevents large changes in WDPA-average density from new incremental development. Until additional information becomes available to project how and when development density will change in the future, the assumption of fixed density is used in this forecast.

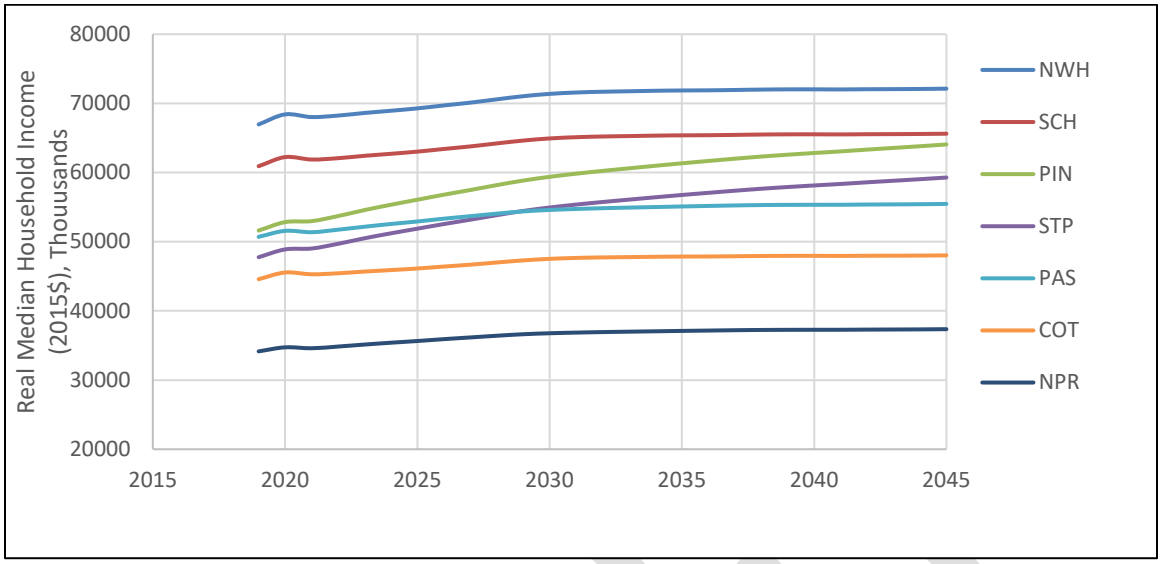

Figure 8. Base Year 2018/2019 Real Median Household Income Projection by WDPA

Table 16. Starting and Ending-year Projections of Real Median Household Income for the Base Year 2018/2019 Forecast adjusted to the 2015 dollars at assumed 3 percent inflation rate.

	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW
2019	**50,708**	**34,150**	**66,963**	**60,918**	**44,587**	**51,618**	**47,763**	**50,958**
2045	**55,469**	**37,356**	**72,129**	**65,618**	**48,027**	**64,064**	**59,280**	**57,420**
Change	**4,761**	**3,206**	**5,167**	**4,700**	**3,440**	**12,446**	**11,517**	**6,462**
% Change	**9.39%**	**9.39%**	**7.72%**	**7.72%**	**7.72%**	**24.11%**	**24.11%**	**12.68%**
Growth Rate	**0.35%**	**0.35%**	**0.29%**	**0.29%**	**0.29%**	**0.83%**	**0.83%**	**0.46%**

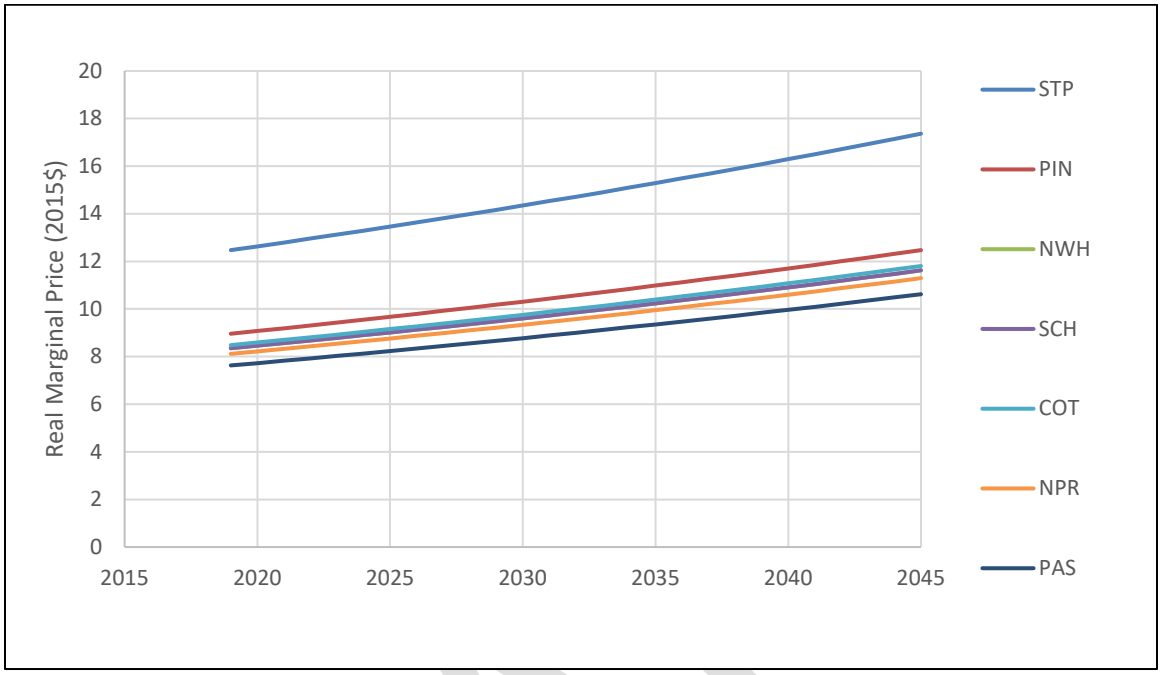

Figure 9. Projections of Real Marginal Price by WDPA

Table 17. Starting and Ending-year Projections of Real Marginal Price of Water and Sewer for the Base Year 2018/2019 Forecast adjusted to the 2015 dollars

	PAS	NPR	NWH	SCH	COT	PIN	STP
2019	**7.63**	**8.12**	**8.35**	**8.35**	**8.48**	**8.96**	**12.47**
2045	**10.62**	**11.30**	**11.63**	**11.63**	**11.80**	**12.47**	**17.36**
Change	**2.99**	**3.18**	**3.27**	**3.27**	**3.32**	**3.51**	**4.89**
% Change	**39.19%**	**39.19%**	**39.19%**	**39.19%**	**39.19%**	**39.19%**	**39.19%**
Growth Rate	**1.28%**	**1.28%**	**1.28%**	**1.28%**	**1.28%**	**1.28%**	**1.28%**

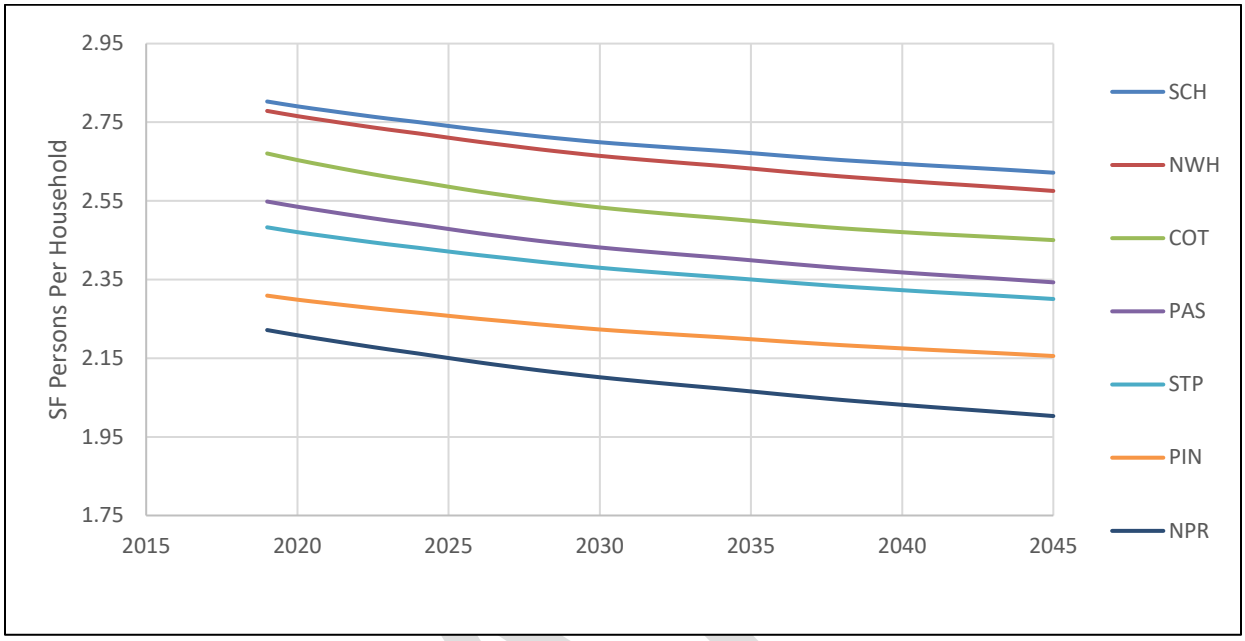

Figure 10. Projections of SF Persons Per Household by WDPA

Table 18. Starting and Ending-year Projections of SF Persons Per Household for the Base Year 2018/2019 Forecast

	PAS	NPR	NWH	SCH	COT	PIN	STP
2019	2.55	2.22	2.78	2.80	2.67	2.31	2.48
2045	2.34	2.00	2.58	2.62	2.45	2.16	2.30
Change	-0.21	-0.22	-0.20	-0.18	-0.22	-0.15	-0.18
Change	-8.06%	-9.84%	-7.32%	-6.46%	-8.25%	-6.65%	-7.34%
Growth Rate	-0.32%	-0.40%	-0.29%	-0.26%	-0.33%	-0.26%	-0.29%

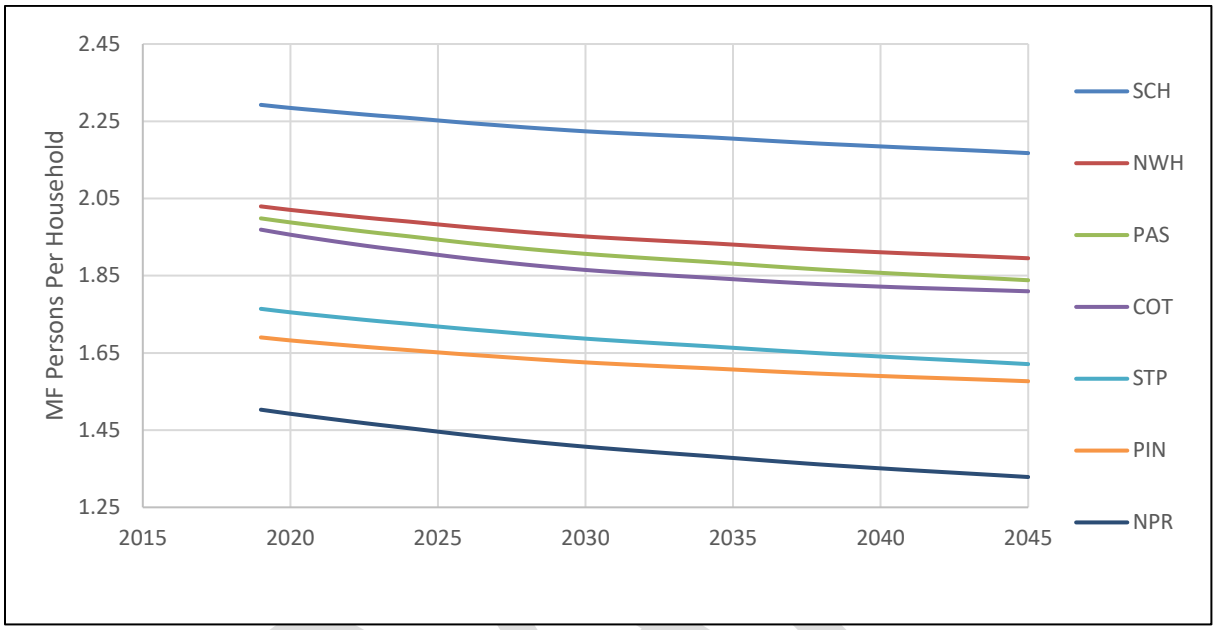

Figure 11. Projections of Multi-Family Persons Per Household by WDPA

Table 19. Starting and Ending-year Projections of MF Persons Per Household for the Base Year 2018/2019 Forecast

	PAS	NPR	NWH	SCH	COT	PIN	STP
2019	**2.00**	**1.50**	**2.03**	**2.29**	**1.97**	**1.69**	**1.76**
2045	**1.84**	**1.33**	**1.90**	**2.17**	**1.81**	**1.58**	**1.62**
Change	**-0.16**	**-0.17**	**-0.13**	**-0.12**	**-0.16**	**-0.11**	**-0.14**
% Change	**-8.02%**	**-11.60%**	**-6.62%**	**-5.45%**	**-8.11%**	**-6.72%**	**-8.12%**
Growth Rate	**-0.32%**	**-0.47%**	**-0.26%**	**-0.22%**	**-0.32%**	**-0.27%**	**-0.33%**

4.1.7. Projections of Fraction of SF and NR Water Use Locations with Reclaimed Service

Projected fractions of SF, MF, and NR water use locations with reclaimed service are shown in Tables 21 and 22. In all WDPAs except Pasco, the fraction of SF and NR water use locations with reclaimed service is projected to decline over time. This reflects an assumption that no new customer reclaimed connections will occur beyond those in existence in the Base

Year, even as new potable water customers are established as the region develops. This assumption was made based on

- limited availability of additional reclaimed supply for some WDPAs due to slow projected growth, and
- high likelihood of other, non-customer reclaimed projects in the future (e.g. various forms of supply augmentation) for other WDPAs.

In these cases, projections for the SF and NR sectors were made by holding the number of reclaimed locations constant at Base Year levels for each of the WDPAs and then growing number of non-reclaimed locations from the Base Year at the same rates as projected SF dwelling units and NR square footage.

In the Pasco WDPA, projected reclaimed fractions for SF and NR sectors were held constant at Base Year values. This assumption implies that, as the WDPA grows, it will extend reclaimed service to customers at rates that maintain existing proportion of customers that have access reclaimed service. The assumption is based on,

- Pasco WDPA will likely have additional reclaimed supply available as that WDPA grows, and
- there are currently no plans for application of future reclaimed supply in non-customer applications.

Table 20. Starting and Ending-year Projections of SF Reclaimed Fractions

	PAS	NPR	NWH	SCH	COT	PIN	STP
2019	**0.149**	**0.031**	**0.251**	**0.050**	**0.037**	**0.245**	**0.146**
2045	**0.149**	**0.018**	**0.148**	**0.030**	**0.022**	**0.226**	**0.134**
Change	**0.000**	**-0.013**	**-0.103**	**-0.021**	**-0.015**	**-0.019**	**-0.011**
% Change	**0.00%**	**-41.33%**	**-41.07%**	**-41.07%**	**-41.07%**	**-7.74%**	**-7.74%**
Growth Rate	**0.00%**	**-2.03%**	**-2.01%**	**-2.01%**	**-2.01%**	**-0.31%**	**-0.31%**

Table 21. Starting and Ending-year Projections of MF Reclaimed Fractions

	PAS	NPR	NWH	SCH	COT	PIN	STP
2019	0.01	0.00	0.08	0.00	0.03	0.36	0.05
2045	0.01	0.00	0.06	0.00	0.03	0.28	0.04
Change	0.00	0.00	-0.02	0.00	-0.01	-0.08	-0.01
% Change	0.00%	-13.45%	-23.64%	-23.63%	-23.64%	-22.31%	-22.31%
Growth Rate	0.00%	-0.55%	-1.03%	-1.03%	-1.03%	-0.97%	-0.97%

Table 22. Starting and Ending-year Projections of NR Reclaimed Fractions

	PAS	NPR	NWH	SCH	COT	PIN	STP
2019	0.018	0.055	0.060	0.014	0.031	0.193	0.098
2045	0.018	0.068	0.064	0.010	0.028	0.202	0.095
Change	0.000	0.013	0.004	-0.004	-0.002	0.009	-0.002
% Change	0.00%	22.99%	6.41%	-25.48%	-7.81%	4.54%	-2.50%
Growth Rate	0.00%	0.80%	0.24%	-1.12%	-0.31%	0.17%	-0.10%

4.1.8. Projections of Fraction of NR Square Footage in DMP Subsectors

Projections of fractions of NR square footage in DMP Subsectors were developed in tandem with the NR square footage driver projections themselves (Section 4.1.2). In the NR square footage procedure, projections of square footage are developed for each DMP subsector within the WDPA, then summed across subsectors to project total square feet. To project subsectoral square footage fractions, projected subsector square footage was simply divided by projected total square footage. Projections summarized in Table 23 show the same distribution of sub sectors as in the previous update except for the "retirement" and "other" sub sectors

4.1.9. Weather Projections

Long-term normal weather is assumed for all months and years in the forecast period except for Base Year, where observed monthly weather variables are used.

Table 23. Starting and Ending-year Projections of DMP Sub sectoral Square Footage Fractions

WDPA	Year	Education	Government	Health Care	Heavy Manufacturing	Hotels, motels	Light Manufacturing	Office Buildings	Restaurants and Fast Food Outlets	Retail Stores	Retirement	Other
PAS	2019	0.17	0.04	0.10	0.01	0.02	0.03	0.06	0.01	0.25	0.01	0.32
	2045	0.19	0.04	0.11	0.01	0.02	0.02	0.08	0.01	0.22	0.01	0.28
	Change	0.02	0.00	0.01	0.00	0.00	-0.01	0.03	0.00	-0.03	0.00	-0.04
NPR	2019	0.14	0.05	0.13	0.00	0.03	0.00	0.09	0.02	0.20	0.06	0.27
	2045	0.17	0.04	0.16	0.00	0.03	0.00	0.10	0.02	0.19	0.07	0.22
	Change	0.03	-0.01	0.03	0.00	0.00	0.00	0.01	0.00	-0.01	0.01	-0.06
NWH	2019	0.14	0.02	0.05	0.01	0.01	0.02	0.14	0.01	0.27	0.03	0.31
	2045	0.17	0.02	0.06	0.01	0.01	0.01	0.18	0.01	0.22	0.04	0.27
	Change	0.03	0.00	0.01	0.00	0.00	0.00	0.04	0.00	-0.04	0.01	-0.03
SCH	2019	0.18	0.02	0.07	0.02	0.01	0.02	0.07	0.01	0.21	0.03	0.35
	2045	0.18	0.03	0.07	0.03	0.01	0.02	0.10	0.01	0.16	0.03	0.36
	Change	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.00	-0.06	0.00	0.01
COT	2019	0.07	0.09	0.05	0.02	0.04	0.03	0.18	0.01	0.09	0.00	0.42
	2045	0.07	0.08	0.05	0.02	0.05	0.02	0.25	0.01	0.09	0.00	0.36
	Change	0.00	0.00	0.00	0.00	0.01	-0.01	0.06	0.00	0.00	0.00	-0.06
PIN	2019	0.08	0.08	0.04	0.02	0.07	0.15	0.12	0.01	0.13	0.05	0.25
	2045	0.09	0.07	0.05	0.01	0.08	0.12	0.17	0.01	0.12	0.05	0.23
	Change	0.01	0.00	0.00	0.00	0.01	-0.03	0.05	0.00	-0.01	0.00	-0.02
STP	2019	0.10	0.06	0.07	0.01	0.03	0.08	0.23	0.01	0.12	0.04	0.25
	2045	0.10	0.05	0.07	0.01	0.03	0.06	0.30	0.01	0.11	0.04	0.22
	Change	0.00	0.00	0.00	0.00	0.00	-0.02	0.07	0.00	-0.02	0.00	-0.03
TBW	2019	0.12	0.05	0.07	0.01	0.03	0.05	0.13	0.01	0.18	0.03	0.31
	2045	0.14	0.05	0.08	0.01	0.03	0.04	0.17	0.01	0.16	0.04	0.28
	Change	0.01	0.00	0.01	0.00	0.00	-0.01	0.04	0.00	-0.02	0.00	-0.03

4.2. Updated Long-term Demand Forecast Results

This section presents the Base Year long-term demand forecast models and comparisons to the forecast performed last year using the same model, but with the Base Year being 2017/2018 (July 2017 to June 2018).

Figure 12 presents retail (SF + MF + NR) water use using the current Base Year 2018/2019 forecast and compares the results with total retail use using the Base Year 2017/2018 forecast inputs. For both the current and previous Base Year forecasts, the effects of continued growth in housing units and NR square footage outweigh effects of slow projected income growth relative to growth in projected prices and overall declining persons per household. Unlike the prior forecast, the current forecast shows similar growth in retail demand in the first half of the forecast period (2019 to 2035), followed by slower growth in the latter half of the period.

Total projected water demand includes wholesale water and unbilled water use in addition to retail use. Pinellas County WDPA has the largest wholesale water use among all WDPAs, though wholesale use occurs to some extent in all WDPAs except Northwest and South-Central Hillsborough WDPA's. Unbilled use for each WDPA represents the difference between

- the total of retail and wholesale water use within the WDPA, and
- the total of water delivered to the WDPA by Tampa Bay Water and any self-supply by the WDPA.

Wholesale demand for each WDPA is projected to remain at the Base Year values throughout the forecast period (i.e. no growth or decline in MGD), while unbilled demand in each forecast year is assumed to be the same percent of total demand as in the Base Year. This allows for growth in the amount of unbilled demand as the total retail and wholesale usage in a WDPA grows.

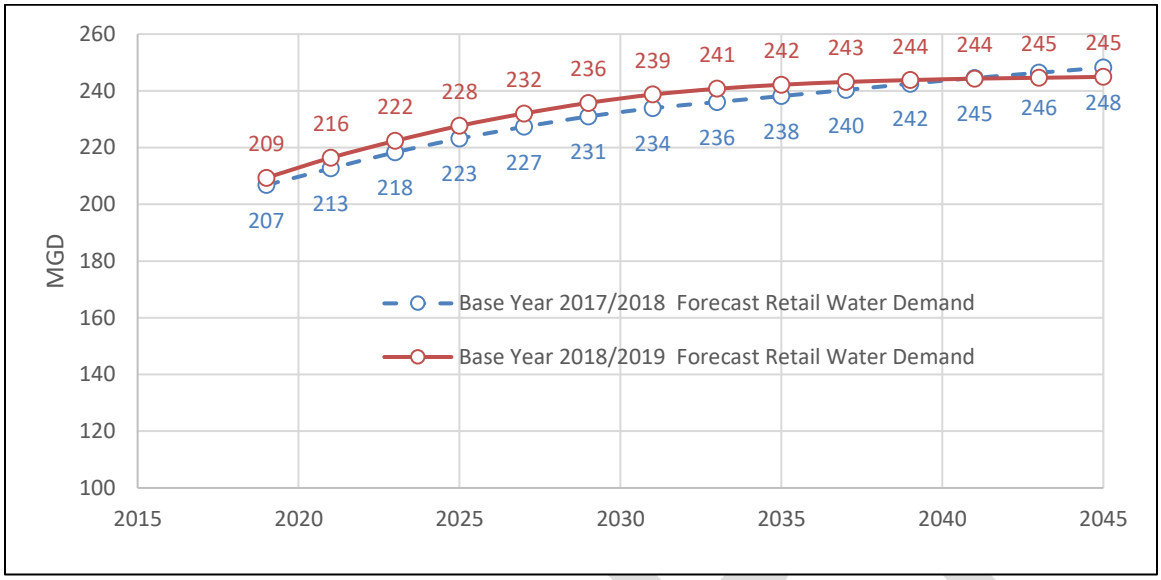

Figure 12. Comparison of Retail Water Use Projections for Tampa Bay Water Area

Throughout the first half of the 2010-decade, large changes have occurred in the amounts of water Pinellas County delivers to wholesale customers, as several former wholesale customers have developed their own supplies and ceased or dramatically reduced wholesale purchases. As of this update, the only remaining wholesale customer that may cease wholesale purchases from Pinellas County in the future is the City of Clearwater. While the City of Clearwater's wholesale demand was originally projected to come off-line in WY2015, bulk purchases have continued through and beyond the Base Year (2019).

Figure 13 provides the forecasts for each component (retail, unbilled, and wholesale water use) of the total regional water demand through the 2045 forecast period. Unbilled water use percentages are assumed constant based on the most recent water year demand data.

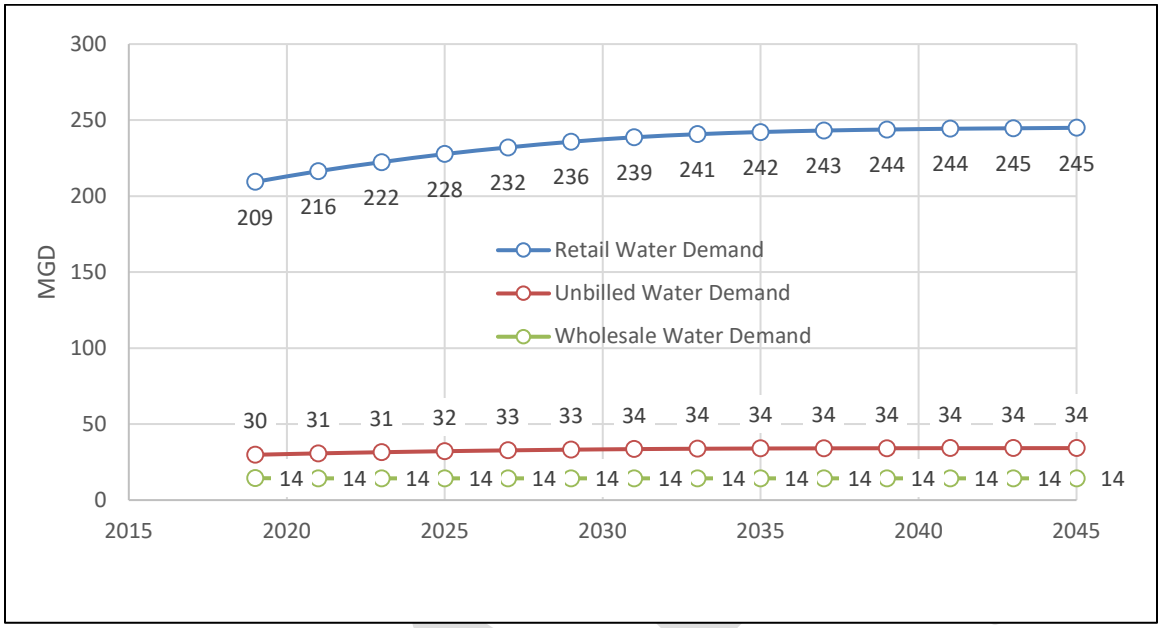

Figure 13. Total Retail, Unbilled and Wholesale Water Use Projections

Figure 14 shows the regional historic demand from 1999 through 2019, the Base Year 2017/2018 forecast, and the current Base Year 2018/2019 forecast. As seen in retail forecasts, the new total regional forecast (red line in Figure 14) shows similar growth in demand in the first half of the forecast period, followed by slower growth in the latter half of the period. Reasons behind this trend are the same as mentioned for retail demand and are discussed in a technical report (Hazen and Sawyer, 2018a).

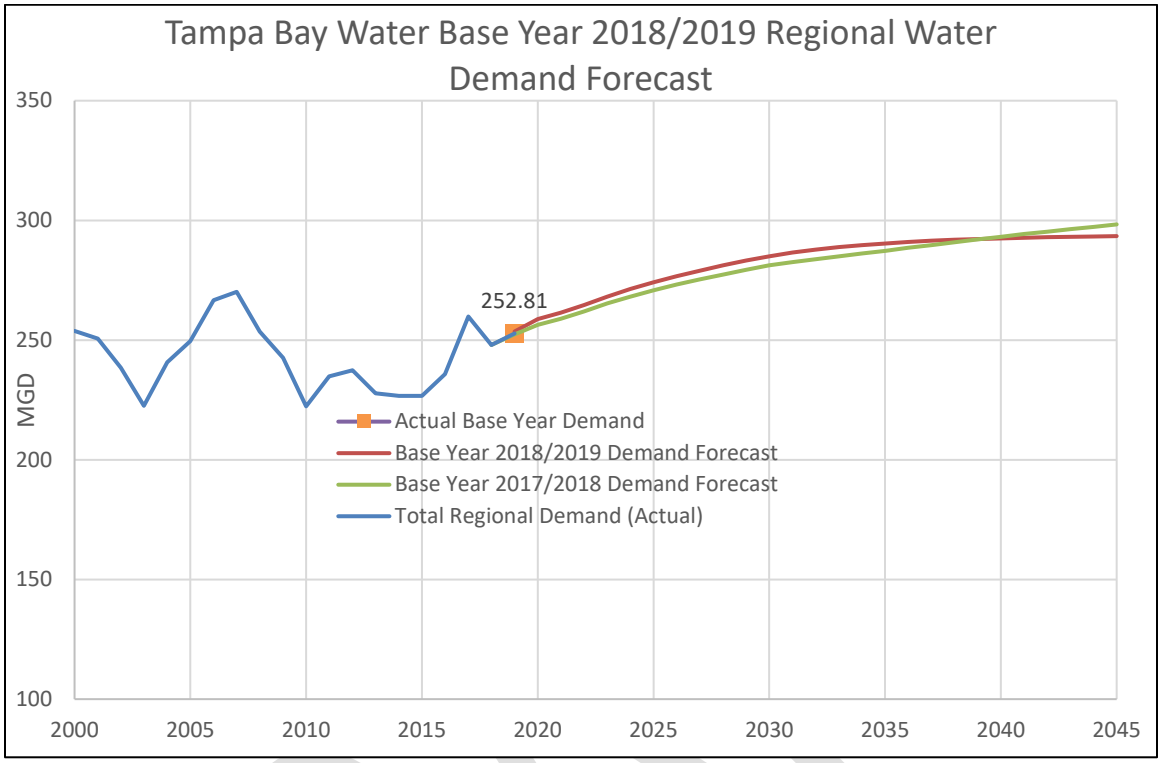

Figure 14. Historic Demand, Base Year 2017/2018 and the current (Base Year 2018/2019) Regional Demand Forecasts

The final updated long-term demand forecast through the year 2045 using the period July 2018 to June 2019 as the new Base Year is shown in Figure 15. The model was calibrated to the 2019 water Year and the Base Year actual demands are almost the same, slightly higher by 0.7 MGD than the predicted Base Year demand.

Table 24 provides projected water use for selected years from 2019 through 2045 for each water demand planning area and for the Tampa Bay Water service area total.

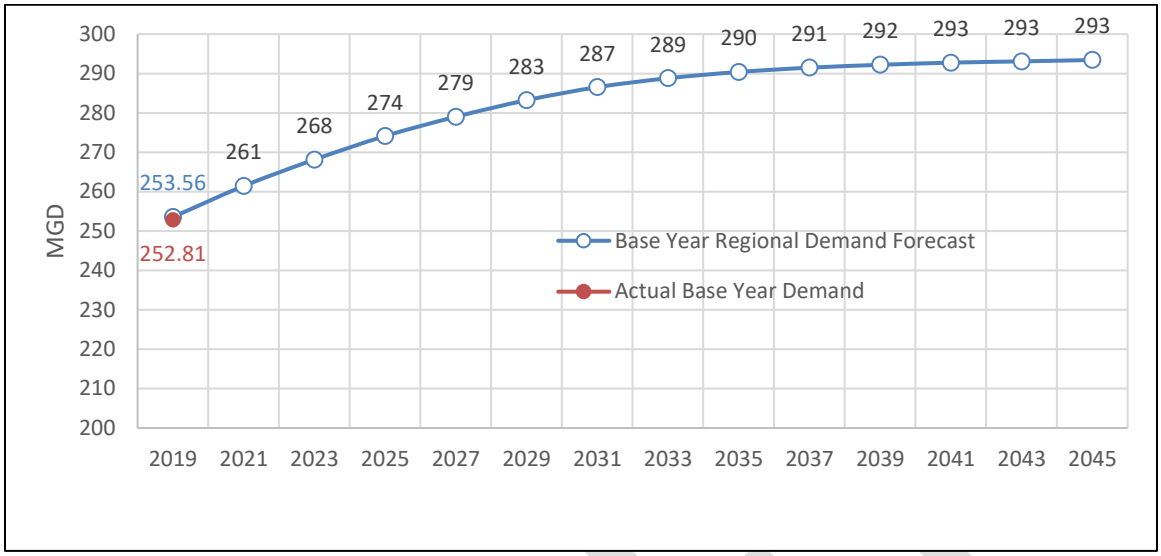

Figure 15. Tampa Bay Water Updated Regional Demand Forecast, **Base Year** 2018/2019

Table 24. Updated Regional Long-term Demand Forecast 2019-2045, 2018/2019 Base Year

Year	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW
2019*	**30.71**	**3.46**	**19.64**	**45.32**	**77.42**	**48.59**	**27.67**	**252.81**
2019	30.59	3.45	19.64	45.36	78.24	48.59	27.68	253.56
2020	31.51	3.46	20.01	46.78	80.15	48.85	27.96	258.71
2025	34.29	3.39	20.88	52.00	84.68	50.08	28.81	274.12
2030	36.45	3.29	21.37	56.15	87.81	50.68	29.28	285.02
2035	37.73	3.16	21.41	58.91	89.18	50.65	29.33	290.38
2040	38.43	3.03	21.21	60.77	89.59	50.27	29.19	292.50
2045	38.83	2.92	20.99	62.27	89.63	49.78	29.01	293.42

2019*, the orange shading, is the water Year 2019 actual water demand. The city of Tampa actual water demand lags by two months.

5. REFERENCES

Hazen and Sawyer, 2018a, Tampa Bay Water's Revised Long-term Water Demand Forecasting System and Base Year 2016 Point Demand Forecast, Prepared for Tampa Bay Water

Hazen and Sawyer, 2018b, Tampa Bay Water's Revised Water Demand Forecasting Process, Prepared for Tampa Bay Water

Tampa Bay Water, Demand Forecast Annual Evaluation and Update, November 2018