West Basin Facility Plan Project 7054

PART 3 - TECHNICAL MEMORANDUM 3

Conveyance - Flow Development

FINAL /October 2025

Jacobs

Produced by: carollo

Clean Water Services

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Abbreviations

AAF	Average Annual Flow
Ac.	Acres
ADWF	Average Dry Weather Flow
AGC	AGC Electronic America
AWWF	Average Wet Weather Flow
CC	Central Commercial
CG	General Commercial
CN	Neighborhood Commercial
CO	Office Commercial
DEQ	Department of Environmental Quality
DS+	Design Storm plus increased depth and frequency
DS+INT	Design Storm plus increased depth, frequency, and peak hour intensity
DWF	Dry Weather Flow
EFU	Exclusive Farm or Forest Use
EPASWMM5	Environmental Protection Agency Stormwater Management Model 5
FUD	Future Urban Development
GIS	Geographic Information System
gpcd	Gallons per capita per day
GPNAD	Gallons per Net Acre per Day
GWI	Groundwater Infiltration
IC	Industrial Campus
ICM	Integrated Catchment Model
ID	Identifier
IH	Heavy Industrial
IL	Light Industrial
INFOWORKS/ICM	InfoWorks ICM Modeling Software
IO	Industrial Office
IPS	Influent Pump Station
MDDW	Maximum Day Dry Weather Flow
MDWW	Maximum Day Wet Weather Flow
Metro	Regional Planning Agency

MFR	Multi-Family Residential
MG	Million Gallons
mg/L	Milligrams per Liter
mgd	Million Gallons per Day
MHDW	Maximum Hour Dry Weather Flow
MHWW	Maximum Hour Wet Weather Flow
MMDW	Maximum Month Dry Weather Flow
MMWW	Maximum Month Wet Weather Flow
MUR	Mixed Use Residential
MWDW	Maximum Week Dry Weather Flow
MWWW	Maximum Week Wet Weather Flow
ONPRC	Oregon National Primate Research Center
PF	Peaking Factor / Public Facilities
PH	Peak Hour Wet Weather Flow
POS	Parks and Open Space
psi	Pounds per Square Inch
PSU	Portland State University
RC	Rural Commercial
RDI/I	Rainfall Derived Infiltration and Inflow
RLIS	Regional Land Information System
RRFU	Rural Residential Future Urban
RTK	Unit Hydrograph Parameters (R1, R2, R3, T1, T2, T3, K1, K2, K3)
SCADA	Supervisory Control and Data Acquisition
SF	Square Feet
SFR	Single Family Residential
TAZ	Transportation Analysis Zone
TM	Technical Memorandum
UGB	Urban Growth Boundary
WWF	Wet Weather Flow

CONVEYANCE FLOW DEVELOPMENT

3.1 Objective

This technical memorandum (TM) summarizes flow development for Clean Water Services (District) West Basin Facility and Collection System Plan.

The objectives of this TM include:

Document existing and future flow development for the sanitary conveyance system.

- Describe flow development relative to population and employment projections.
- Provide assumptions for unit flow factors by zoning classification.
- Describe efforts to coordinate conveyance system and treatment facility flow projections.

3.2 Summary

Three InfoWorks ICM (AutoDesk) models were developed for Rock Creek, Hillsboro, and Forest Grove, to generate existing and future system flow rates through the sanitary conveyance system and generate influent flows to each respective Water Resource Recovery Facility (WRRF). Local flow monitoring data was used to calibrate dry weather unit flow factors and wintertime unit groundwater infiltration factors. These factors were then used to extrapolate future system dry weather flows in each model. Several wet weather periods were selected from the meter record between 2015-2021 to calibrate the models for rainfall derived infiltration and inflow (RDI/I). Updated West Basin design storms were applied to the calibrated models to generate existing and future wet weather flow responses. Modeled flows were compared with historic flows at each WRRF.

3.3 Reference

This TM references the following:

- PART1 – TM1 – Flow and Load Projections
- PART 1 – TM1 – Flow and Load Projections Summary (Phase 1 and 2 Revisions)
- PART 2 - TM2 – Study Area Characteristics
- PART 3 – TM 2 – Conveyance Basis of Planning
- PART 3 - TM 3 – Conveyance Flow Development
- PART 3 – TM 4 – Conveyance Model Development

3.4 Flow Definition

The components of the Wastewater flow identified for the collection system are described below and highlighted in Figure 3.1.

- *Dry Weather Flow (DWF):* Wastewater from residential, commercial, institutional, and industrial sources. DWF is primarily a function of population and employment with varied wastewater discharge throughout the day. Typical diurnal variation includes low flow rates in the middle of the night and peaks during the morning and early evening hours. Average DWF for the conveyance system is the same as base flow in treatment plant terminology (average DWF flow for base period from July 1st through September 30th with limited impact from groundwater infiltration and rainfall derived infiltration and inflow).
- *Groundwater Infiltration (GWI)***:** Defined as groundwater entering the conveyance system unrelated to a specific rain event. GWI occurs when groundwater levels are above the sewer pipe invert, and infiltrate through defective pipes, pipe joints, and manhole walls. This component of the wastewater flow is typically seasonal and higher during the winter months.
- *Wet Weather Flow (WWF or RDI/I):* Also known as *rainfall derived infiltration and inflow* (RDI/I). Stormwater that enters the conveyance system during or immediately following a rain event. Stormwater inflow reaches the system by direct connections, such as roof downspouts connected to sanitary sewers, yard and area drains, holes in manhole covers, or cross-connections with storm drains or catch basins. Infiltration includes flow that enters defective pipes, pipe joints, and manhole walls after percolating through the soil during and immediately following a storm event.

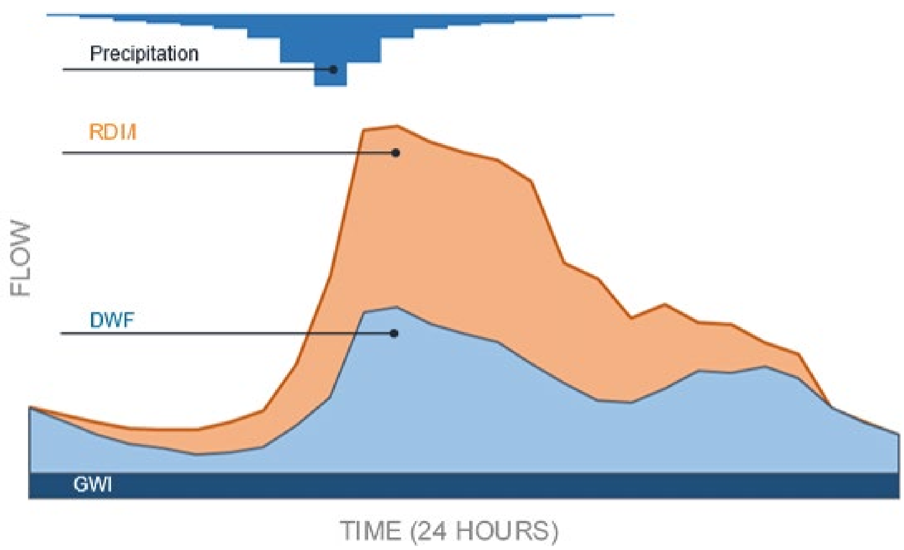

Figure 3.1 Conveyance System Flow Definition

3.5 Model Flow Development

InfoWorks ICM (AutoDesk) models were developed to generate existing and future system flows in the conveyance system and to estimate flow contributions to the Rock Creek, Hillsboro, and Forest Grove WRRFs. The models perform dynamic simulations, which account for time varied system operations and flow attenuation. This TM focuses on the approach to flow development within the models, for system analysis. For detailed documentation relating to the calibration of each model, see *PART 3 – TM 4, Conveyance Model Development*.

3.5.1 Data Sources

The following sources of information were used to develop inputs for the model, as provided by the District:

- Collection System Geographic Information System (GIS).
- Flow, velocity, and depth meter data in 15-minute increments at 41 locations throughout the West Basin from 2015-2021 as shown in Figure 3.2.
- Rainfall data in 15-minute increments at 6-gauge locations throughout the West Basin from 2015-2021 as shown in Figure 3.2
- Wet permitted industry users, historical flows from 2015-2021, and regulated flow limits as shown in Figure 3.3.
- Influent flow data in daily and 15-minute time increments at each WRRF, from 2015-2021.
- Supervisory Control and Data Acquisition (SCADA) pump station flow rates or pump run times at system pump stations in 15-minute time increments from 2015-2021.
- Other data was provided by Portland State University (PSU) and Oregon Metro including population and employment forecasts and Regional Land Information System (RLIS) GIS as described in *PART 2 - TM2, Study Area Characteristics*.

3.5.2 System Delineation

To facilitate flow development and assignment to manholes within the conveyance system models, the available GIS data were used to delineate basins, sub-basins, and sewershed areas as described below.

- *Meter Basins* - Delineated service area consisting of all parcels upstream of each meter location.
- *Service Area Sub-basins (small)* - Delineated service area upstream of each system manhole including all parcels that flow to the manhole location. Parcels were assigned to manholes based on spatial proximity with adjustments to ensure that parcel centroid elevation was greater than manhole invert elevation. Each model service area sub-basin is also assigned a meter basin.
- *Model Service Area Sub-basins (large)* - Accumulated small service area sub-basins or subcatchments and associated parcels into the downstream model manholes. The model includes trunk sewers 10-inch and larger and excludes many of the 8-inch diameter system piping and local manholes. Each model service area sub-basin or subcatchment is also assigned a meter basin.
- *Sewersheds* - 50-foot buffer (100-foot width) around all system piping used to define the wet weather area of influence for accumulating RDI/I into the system. Sewershed buffer areas are additionally subdivided and assigned a model service area sub-basin and meter basin.

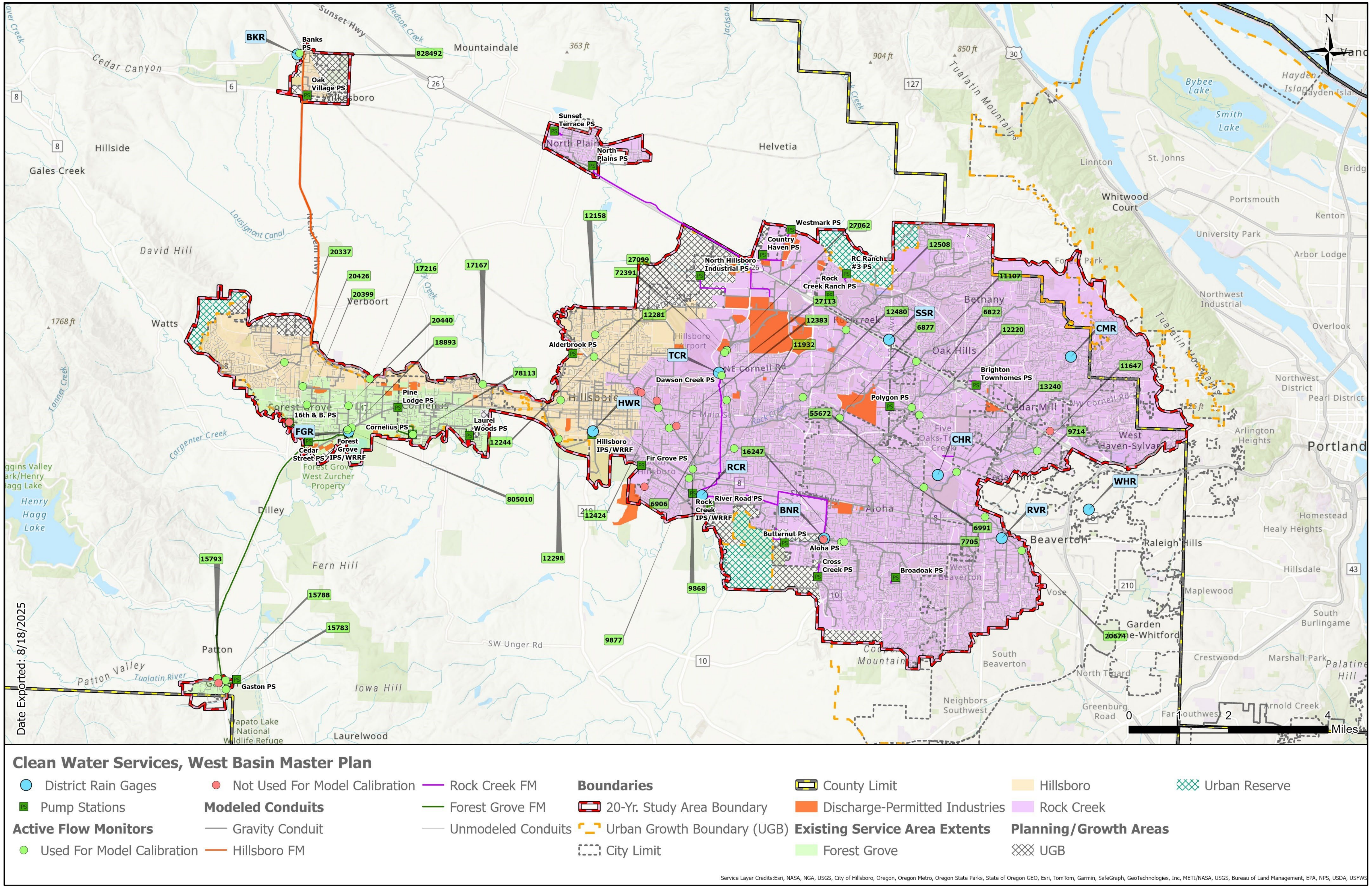

Figure 3.2 West Basin Flow Meters and Rainfall Gages

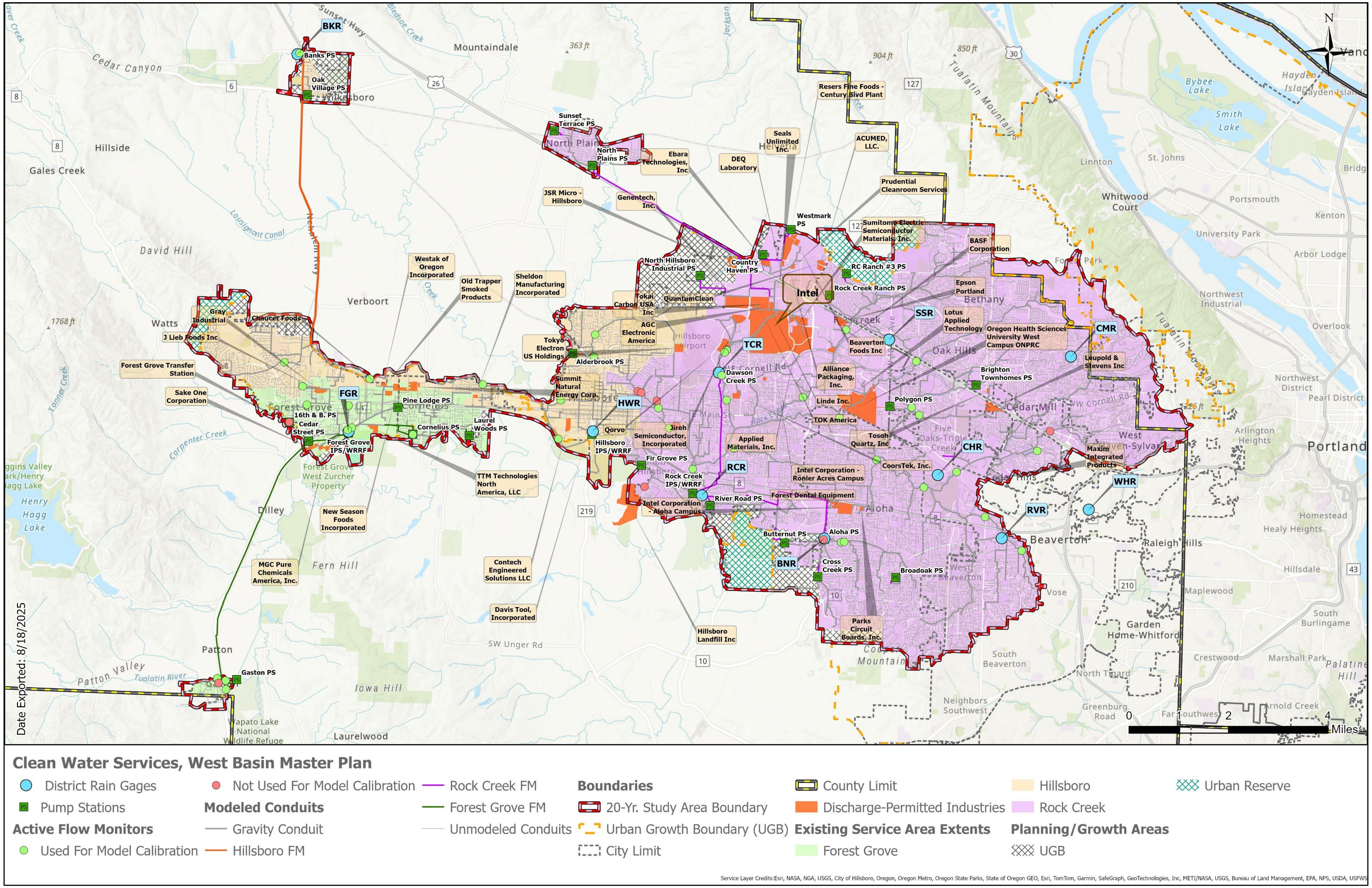

Figure 3.3 West Basin Permitted Wet Industries

3.5.3 Flow Generation Overview

The approach used in the conveyance system models to generate system flow rates is described below. The model setup approach for InfoWorks ICM is provided in Appendix 3A.

3.5.3.1 Dry Weather Flow

The DWF component of the model consists of a base flow (daily average) and a normalized diurnal pattern that informs the model how to adjust the average flow on an hourly basis:

- Existing flow monitoring data is used to calibrate diurnal patterns for weekdays and weekend days within each meter basin.
- Existing observed average DWF is used to define zoning specific unit flow factors on a net acreage basis, where net acreage is a reduction of gross area to account for non-developable land within each parcel. Net acreage is typically 65 to 75 percent of unconstrained gross acreage.
- Existing and future DWF is generated by applying the zoning specific unit flow factors to each parcel's net area.
- Future flow conditions utilize known planning data to assign a development time frame to each parcel, or to scale infill development to system-wide population and employment projections when development timing is not specifically known.
- The DWF for each parcel is accumulated into the system using the model service area sub-basin delineation.

3.5.3.2 Groundwater Infiltration

The existing GWI component of the model is calculated as the differential between average DWF during the summer months and average DWF during non-rain periods for winter months for each meter basin:

- GWI is represented as an average flow without diurnal variation in the model.
- GWI is distributed to model manholes based on area weighting for each service area within the meter basin.
- Future GWI is calculated by applying a 200 gallons per net acre per day (gpnad) flow factor to each future parcel net acreage. The future GWI net area factor is representative of limited groundwater influence due to newly constructed infrastructure.
- GWI for each parcel is accumulated into the system using the model service area sub-basin delineation.

3.5.3.3 Wet Weather Flow

The RDI/I component of the model consists of a storm event, sewershed area (wet weather area of impact), and unit hydrograph:

- The volume of water generated by the storm is equal to the sewershed area multiplied by rainfall depth. The unit hydrograph defines the percentage of rainfall runoff which enters the system and the lag time for system entry.
- The RTK unit hydrograph method is used to generate RDI/I. The unit hydrograph is broken into an initial, intermediate, and long-term hydrograph response with parameters as described below and shown in Figure 3.4:
  - » *Unit Hydrograph Parameter 1 - R1, R2, R3 - Runoff rate* (percent of rainfall volume entering the system) for the short-term, intermediate-term, and long-term system responses.
  - » *Unit Hydrograph Parameter 2 - T1, T2, T3* - Time to peak flow for the short-term, intermediate-term, and long-term system responses.
  - » *Unit Hydrograph Parameter 3 - K1, K2, K3* **-** Recession limb multiplier for short-term, intermediate-term, and long-term system responses, where recession limb of the unit hygrograph = K_i x T_i.
- Existing flow meter data is used to calibrate RTK unit hydrographs within each meter basin.
- Existing sewersheds are defined as 100-foot buffer (50-feet each side) around all existing system pipelines including pipelines that are not modeled.
- Future sewersheds are calculated by applying a 0.8 sewershed area per net acreage factor to each future parcel net area.
- Future development is assigned a unit hydrograph that represents a peak RDI/I a minimum contribution of 1,500 gpnad and 2,500 gpnad for industrial and non-industrial parcels respectively. The future unit hydrograph is representative of limited RDI/I due to newly constructed infrastructure and is consistent with District design criteria for new trunk sewers and regional pump stations.
- Sewersheds are accumulated into the system using the model service area sub-basin delineation.

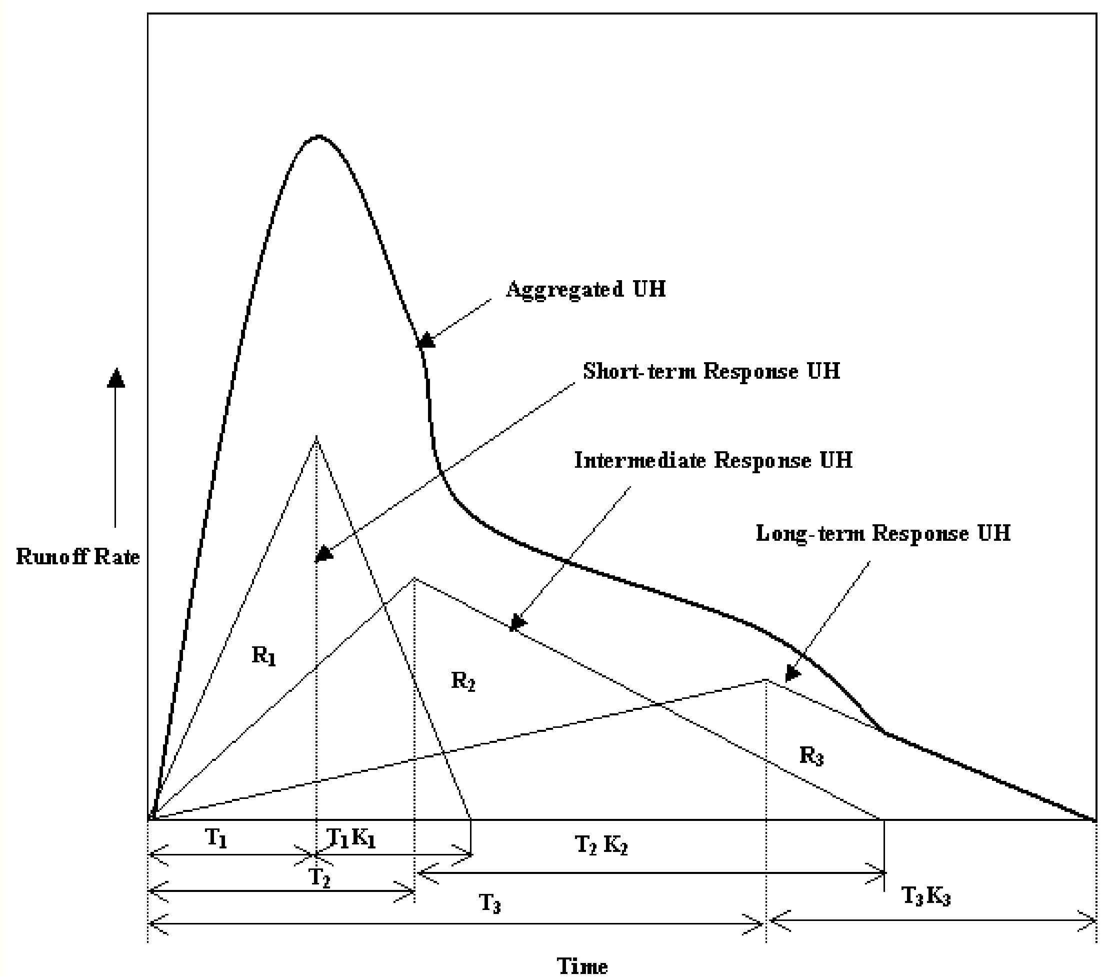

Figure 3.4 RTK Unit Hydrograph Approach (EPASWMM5, Environmental Protection Agency Stormwater Management Model 5 User's Manual)

3.5.3.4 Design Storm

During the model development, actual rainfall data are used to perform the wet weather simulations and calibrate unit hydrograph parameters for each meter basin. Once the model is calibrated, a design storm event is used to simulate design flow rates in the system using the calibrated unit hydrographs.

Oregon Department of Environmental Quality (DEQ) guidelines (*Oregon Administrative Rule 340-041-0009*) indicate that sanitary sewer overflows are prohibited except during a winter storm event exceeding the one in five-year frequency and a summer storm event exceeding the one in ten-year frequency.

The design storm selection process and application of climate intensification factors are documented in detail in *PART 3 – TM 2, Conveyance Basis of Planning*. The West Basin utilizes two distinct 5-year design storms (one for the Forest Grove/Hillsboro systems, the other for the Rock Creek system); details related to each are provided in Table 3.1, and illustrated in Figure 3.5, Figure 3.6, and Figure 3.7 for Rock Creek, Hillsboro, and Forest Grove Basins, respectively.

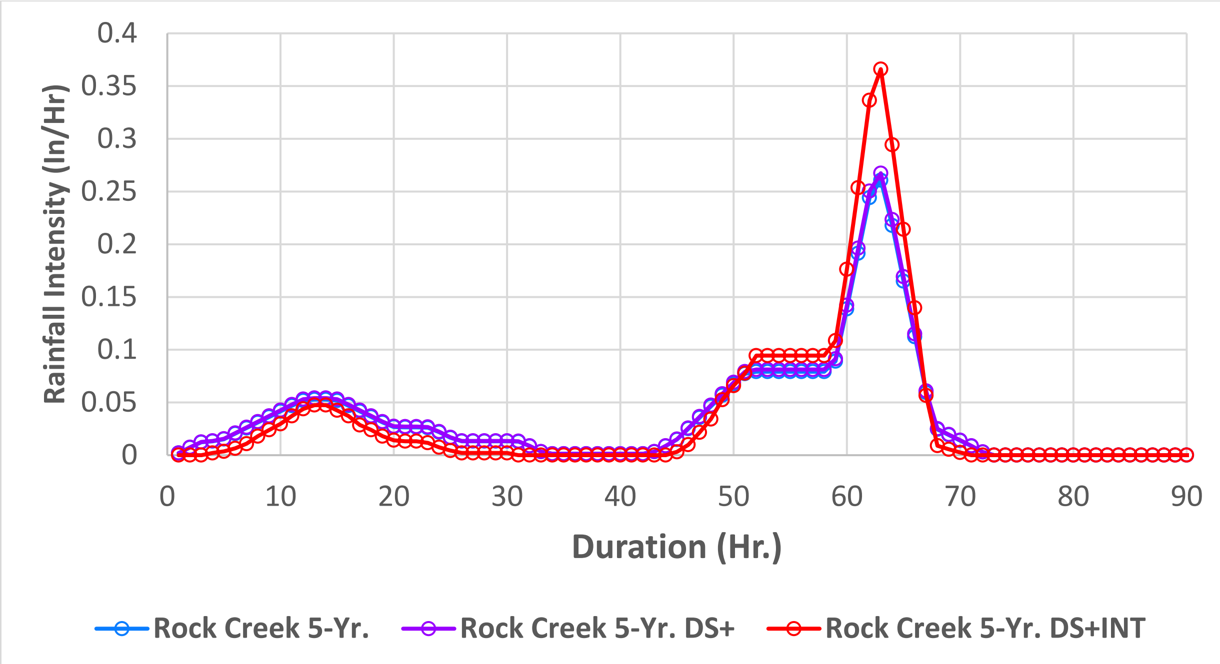

Figure 3.5 Rock Creek Basin Design Storm and Climate Intensified Design Storms. DS+ = design storm plus increased depth and frequency. DS+INT = design storm plus increased depth, frequency, and peak hour intensity (inches per hour).

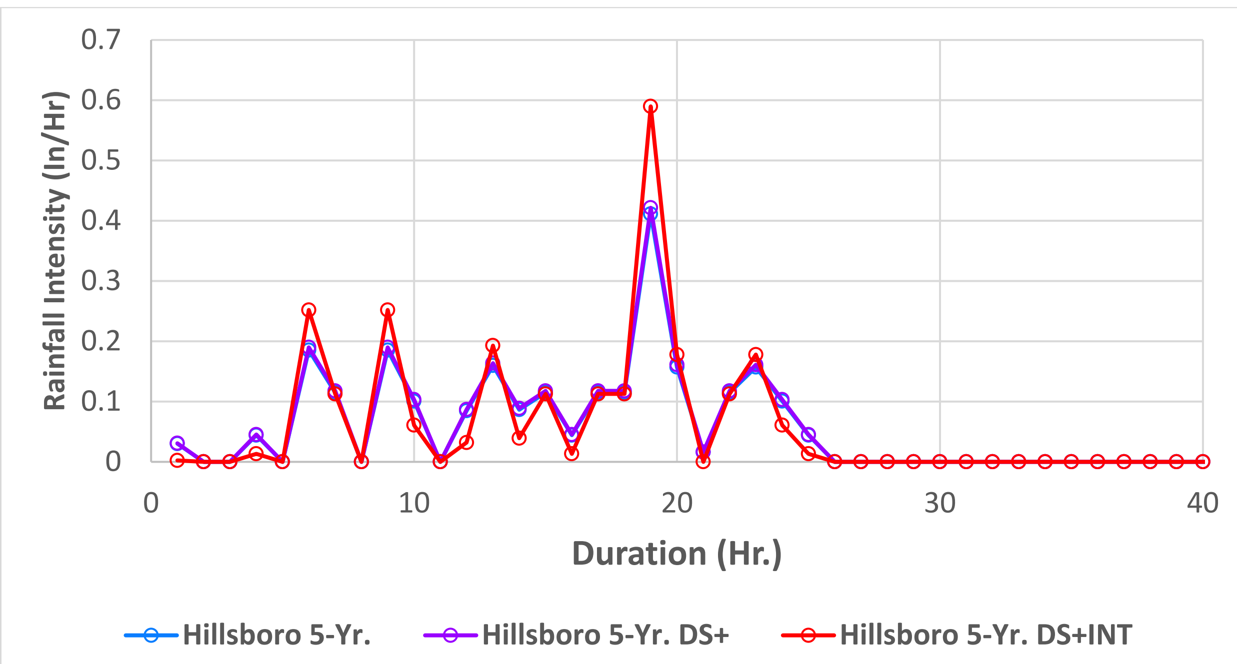

Figure 3.6 Hillsboro Basin Design Storm and Climate Intensified Design Storms. DS+ = design storm plus increased depth and frequency. DS+INT = design storm plus increased depth, frequency, and peak hour intensity.

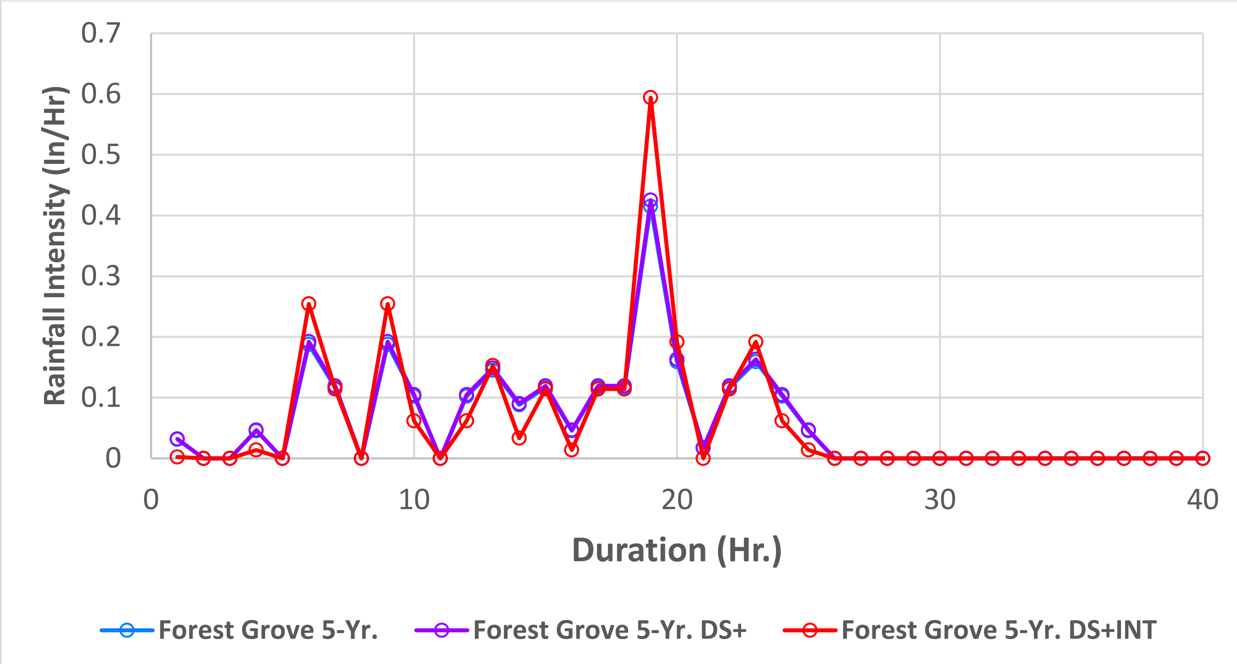

Figure 3.7 Forest Grove Basin Design Storm and Climate Intensified Design Storms. DS+ = design storm plus increased depth and frequency. DS+INT = design storm plus increased depth, frequency, and peak hour intensity.

Table 3.1 Design Storm Characteristics and Climate Intensified Design Storm Characteristics

Storm ID	Duration (Hr.)	Peak Intensity (In./Hr.)	Total Rainfall Depth (In.)
Rock Creek 5-Yr.	72	0.26	3.30
Rock Creek 5-Yr. DS+	72	0.27	3.38
Rock Creek 5-Yr. DS+INT	72	0.37	3.38
Hillsboro 5-Yr.	25	0.41	2.38
Hillsboro 5-Yr. DS+	25	0.42	2.44
Hillsboro 5-Yr. DS+INT	25	0.59	2.44
Forest Grove 5-Yr.	25	0.41	2.42
Forest Grove 5-Yr. DS+	25	0.43	2.48
Forest Grove 5-Yr. DS+INT	25	0.59	2.47

In/hr = inches per hour

3.5.3.5 Historical Data Review and Calibration Periods

Historic data from 2015-2021 at each West Basin WRRFs was reviewed to identify potential time periods for conveyance model calibration including periods specific to DWF (base flow), GWI, and RDI/I. An initial overarching period of 2015-2020 was analyzed for calibration purposes, however the inclusion of a 2020-2021 monitoring period was implemented to provide additional meter coverage, as well as to utilize periods with better data quality. The following periods were selected for DWF (base flow), GWI, and WWF (RDI/I) model calibration scenarios:

- *DWF (Base Flow)* **–** Two periods were selected for the DWF calibration as a reflection of recent sanitary flow contributions from customers in the West Basin. Flows observed during these periods exhibit limited groundwater and rainfall influence.
  - 7/1/2018-9/30/2018
  - 7/15/2020-8/5/2020
- *GWI* **–** Two periods were selected for the GWI calibration, because of the lengthy wet weather season and associated elevated groundwater conditions.
  - 12/24/2016-1/7/2017
  - 1/17/2021-1/26/2021
- *WWF* and RDI/I – Several events were selected for the wet weather calibration to effectively understand the variability of system response to RDI/I over time and for varied storm event characteristics:
  - 11/30/2015-2/10/2016 (Secondary)
  - 1/7/2017-3/2/2017 (Primary)
  - 1/9/2021-1/17/2021 (Primary)

Example historic flows at each WRRF and rainfall data for the Rock Creek, Hillsboro, and Forest Grove WRRFs are shown in Figure 3.8 and Figure 3.9, Figure 3.10 and 3.11, and 3.12 and 3.13, respectively.

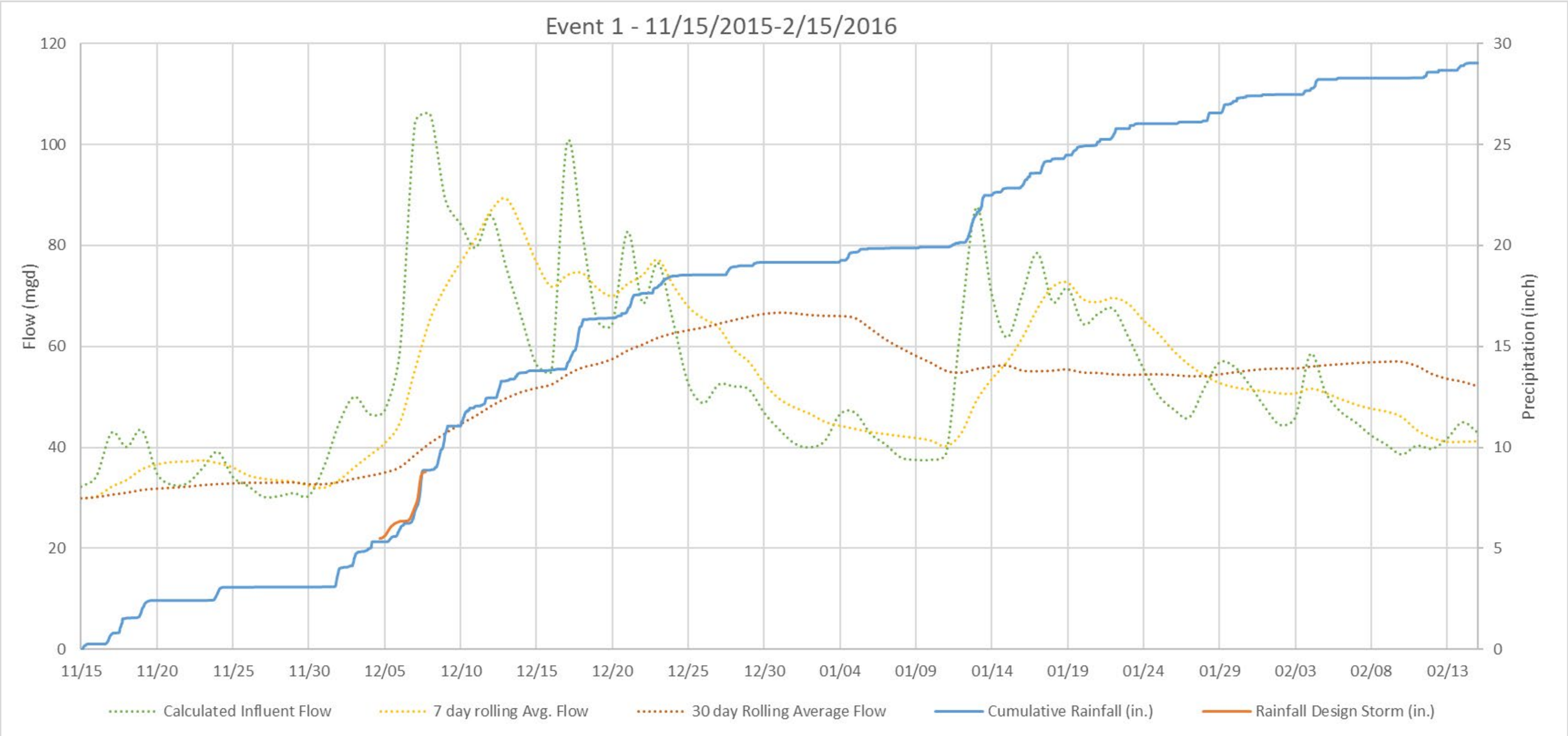

Figure 3.8 Historical Flow and Rainfall Data, Rock Creek WRRF (11/30/2015-2/10/2016) Used to Select Secondary Calibration Event Periods

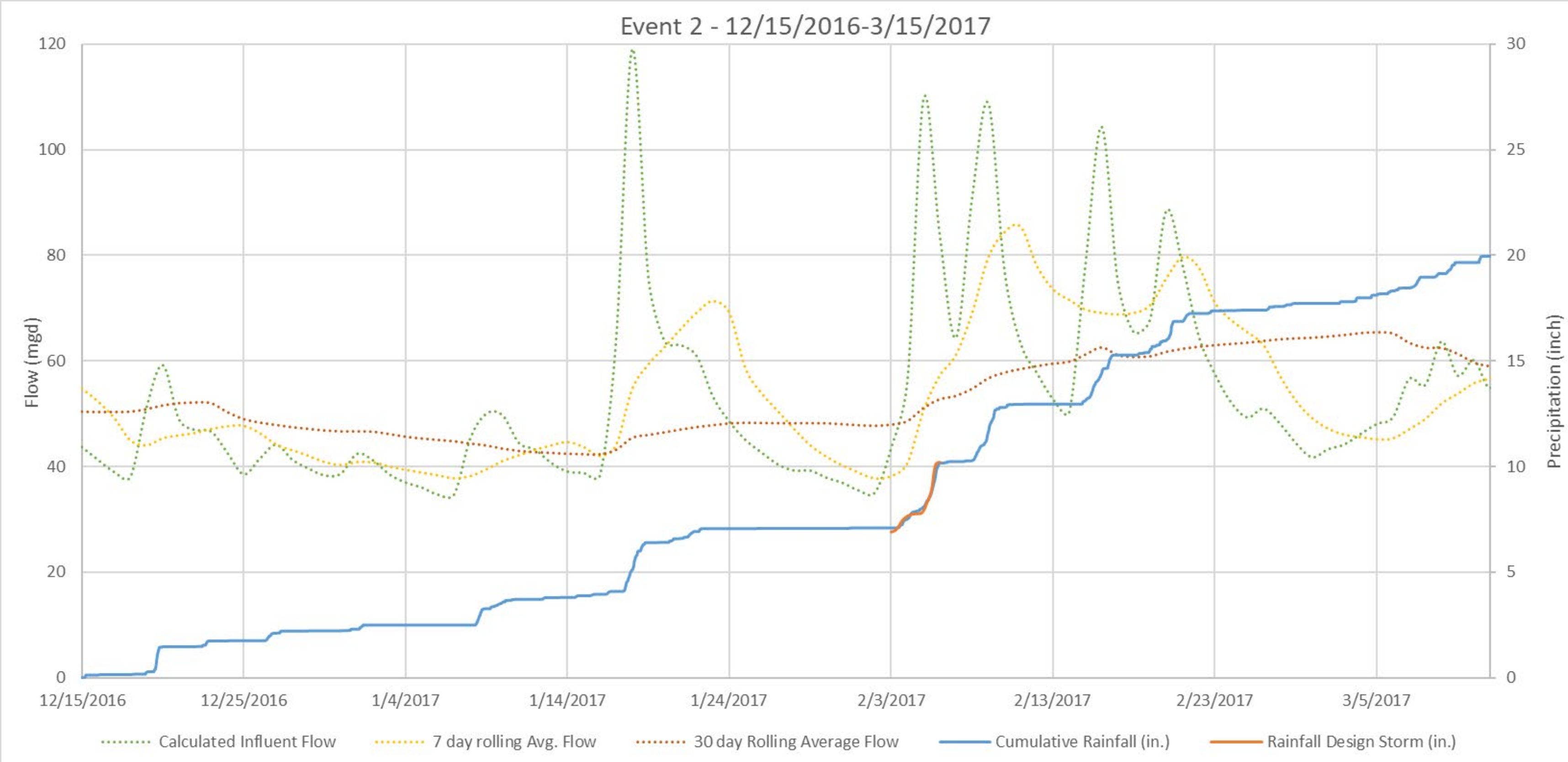

Figure 3.9 Historical Flow and Rainfall Data, Rock Creek WRRF (1/7/2017-3/2/2017) Used to Select Primary Calibration Event Periods

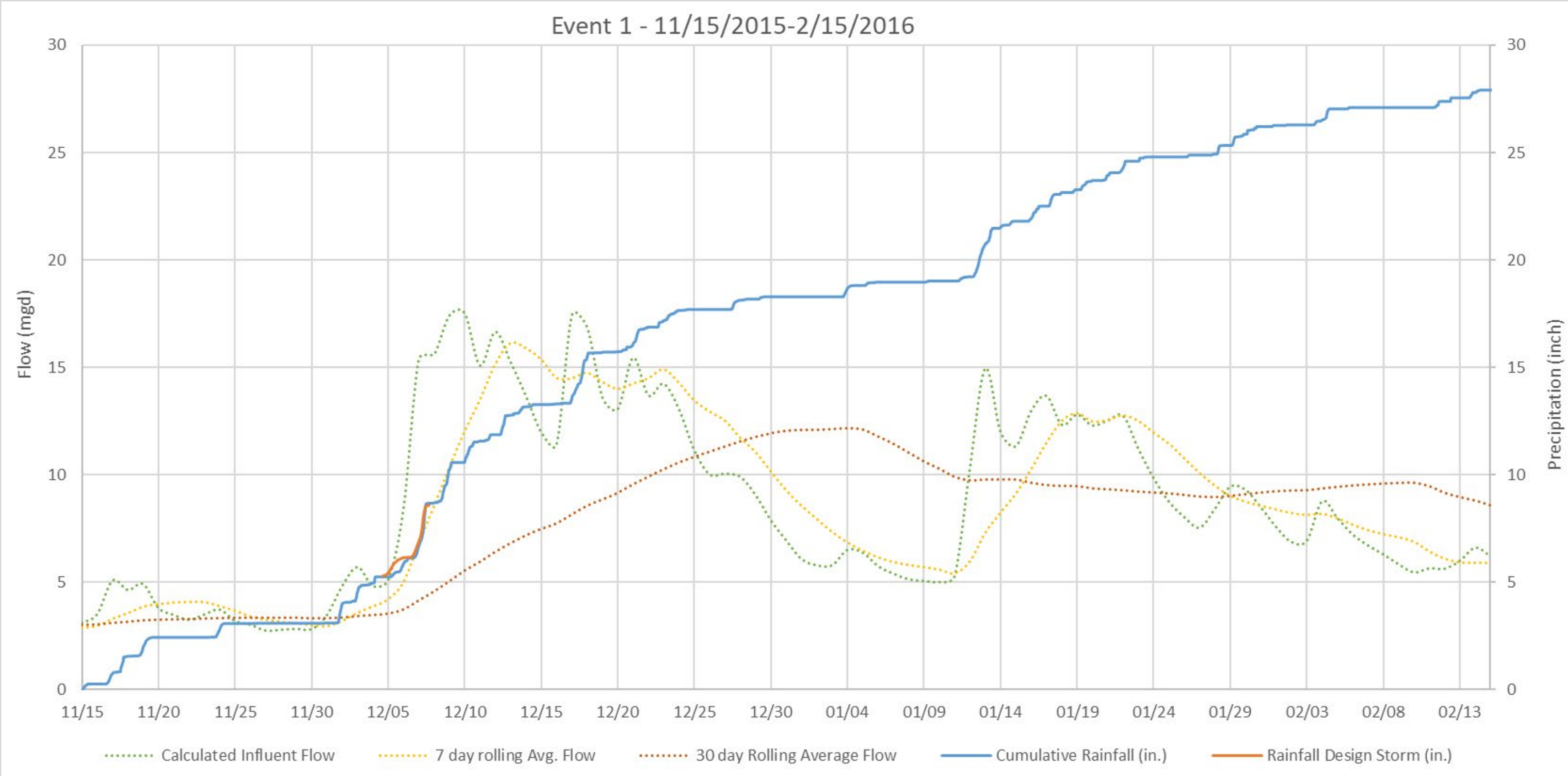

Figure 3.10 Historical Flow and Rainfall Data, Hillsboro WRRF (11/30/2015-2/10/2016) Used to Select Secondary Calibration Event Periods

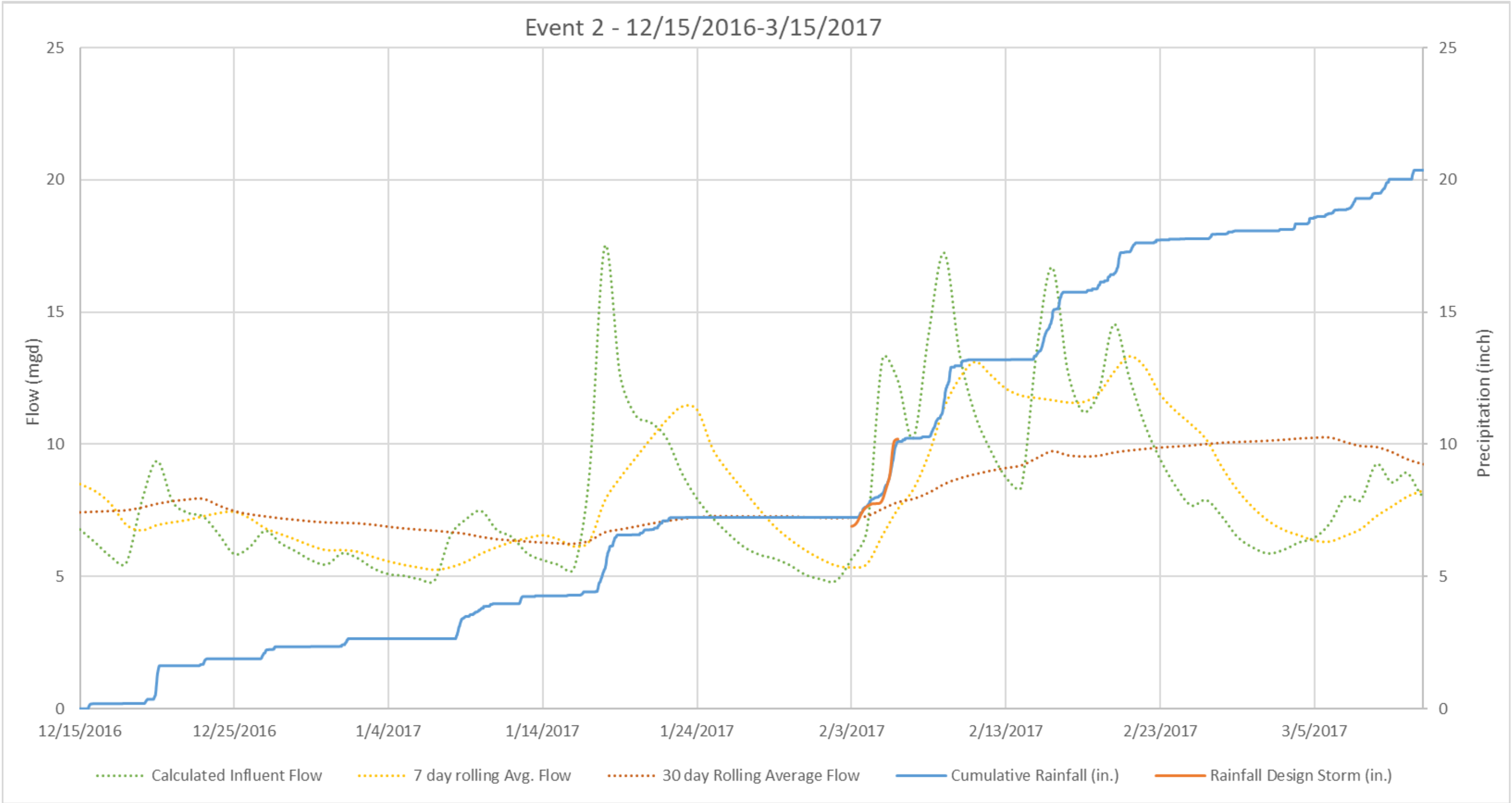

Figure 3.11 Historical Flow and Rainfall Data, Hillsboro WRRF (1/7/2017-3/2/2017) Used to Select Primary Calibration Event Periods

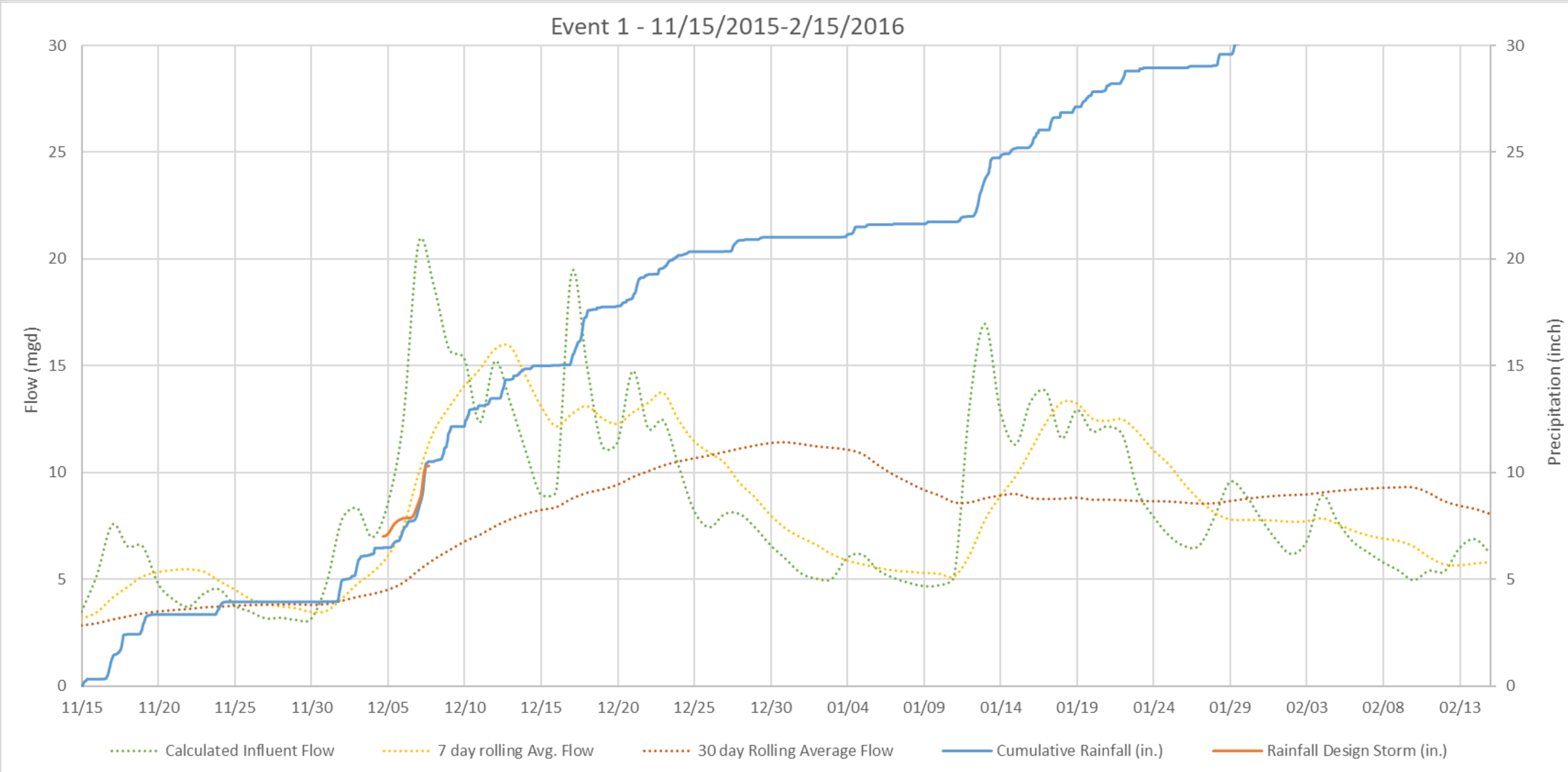

Figure 3.12 Historical Flow and Rainfall Data, Forest Grove WRRF (11/30/2015-2/10/2016) Used to Select Secondary Calibration Event Periods

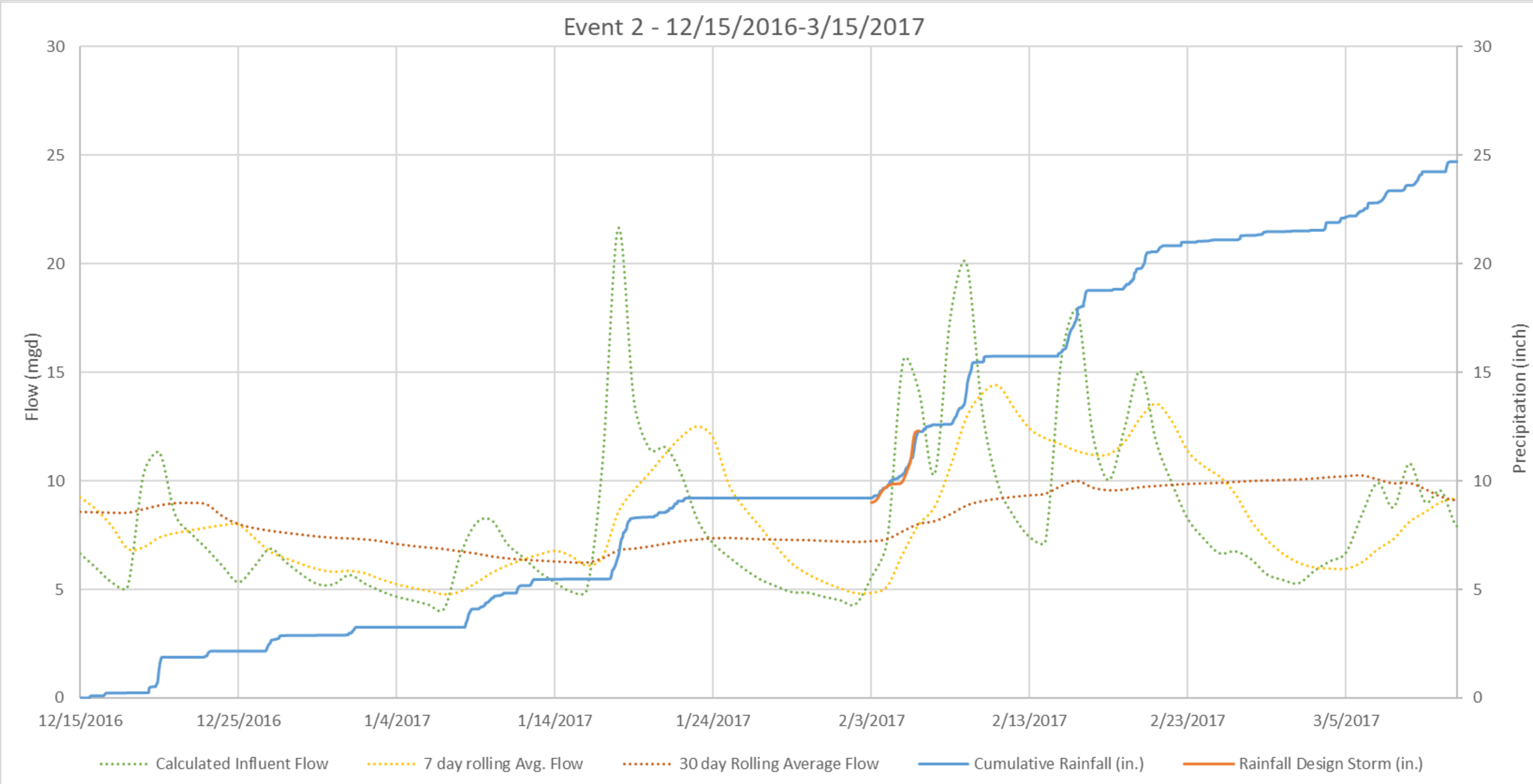

Figure 3.13 Historical Flow and Rainfall Data, Forest Grove WRRF (1/7/2017-3/2/2017) Used to Select Primary Calibration Event Periods

3.5.4 Historical Data Review Local Meters

Local flow meter data from 2015-2021 were reviewed during the key calibration periods at 48 locations. Flow, depth, surcharged depth, and velocity plots were examined for data availability and data quality. Meter data quality was flagged as “Good”, “Fair”, or “Poor”. Sample data quality review plots are provided in Figure 3.14 through Figure 3.15. From the data review, upwards of 40 monitoring locations were recommended for the model calibrations. The data quality and selection of flow monitoring data for calibration are presented in Table 3.3.

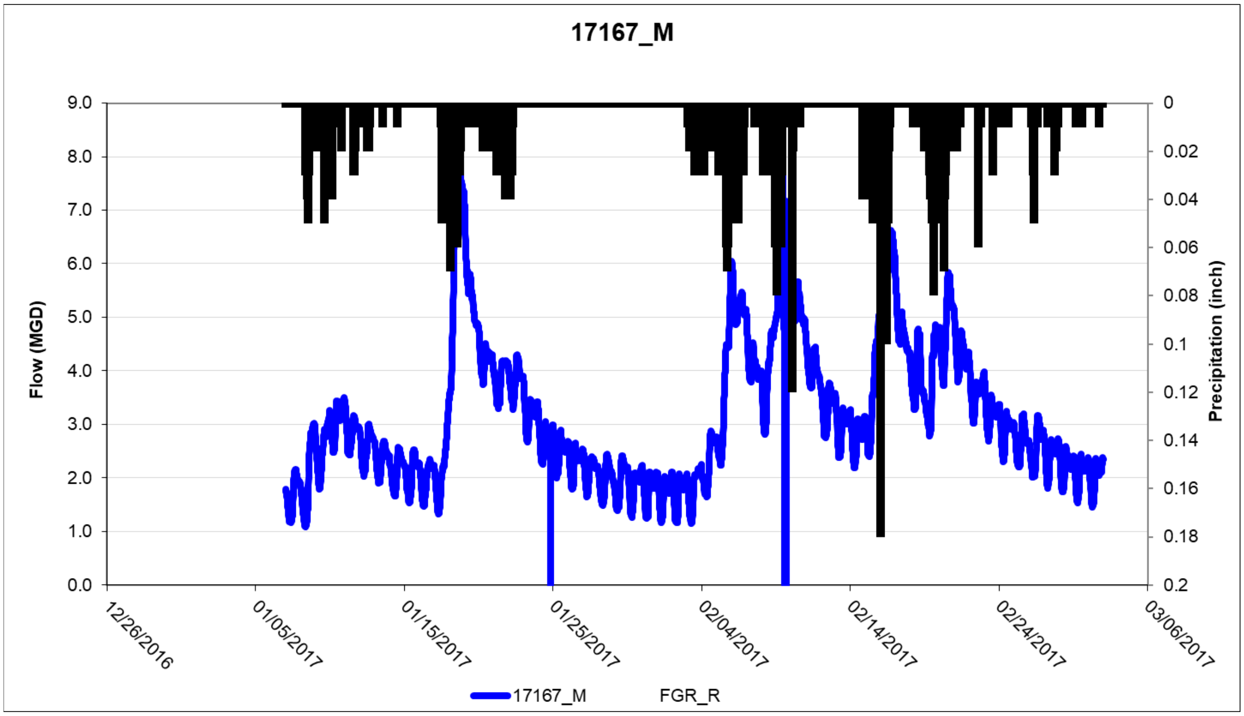

Figure 3.14 Example Data Review Plot (Flow and Precipitation Data Timeseries); Black bar represents precipitation.

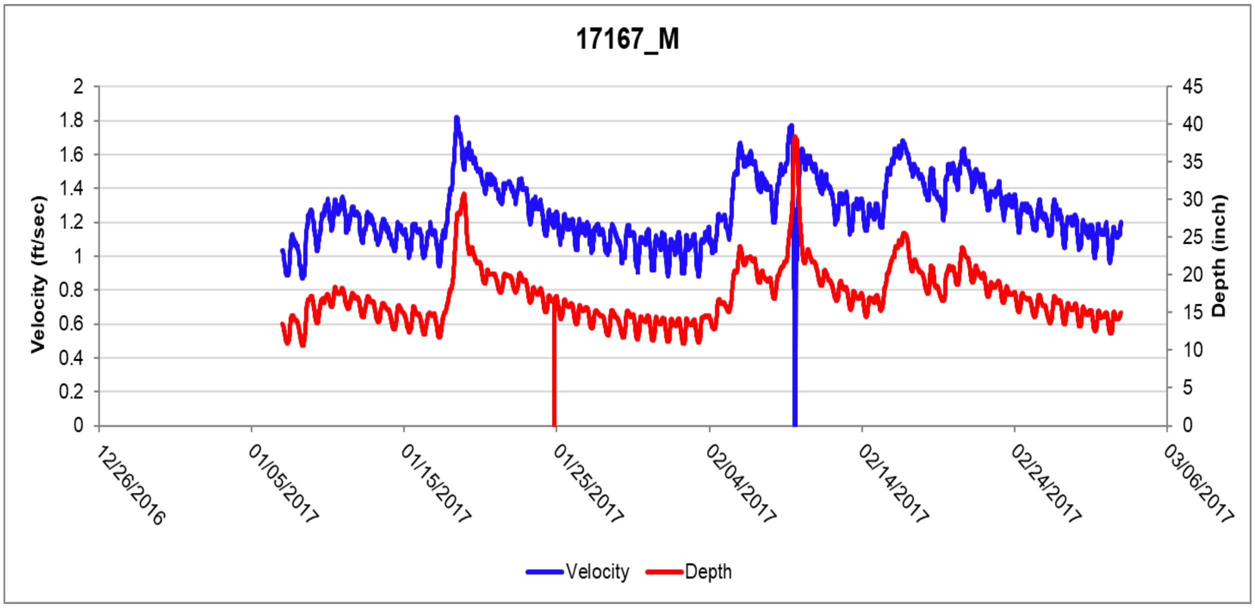

Figure 3.15 Example Data Review Plot (Flow and Precipitation Data Timeseries)

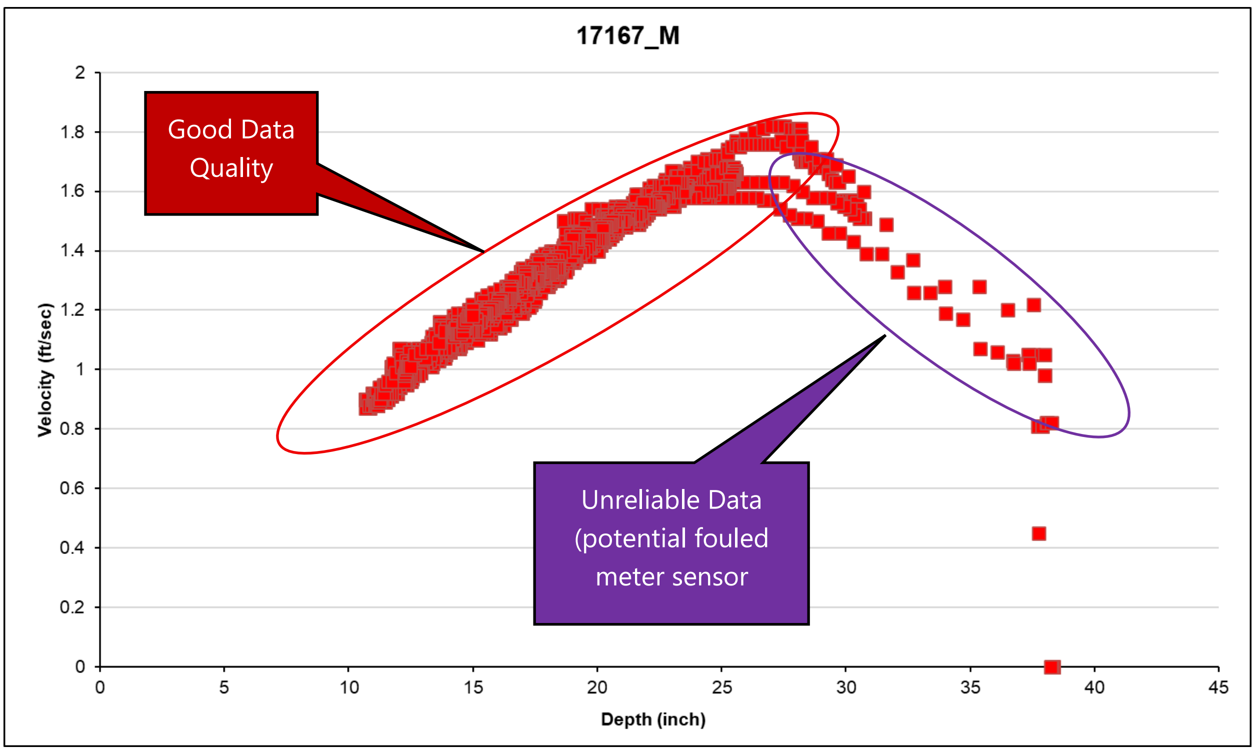

Figure 3.16 Example Data Review Plot (Velocity vs Flow Depth Correlation)

3.5.5 Unit Flow Factor Development and Application

Unit flow factors (flow per net acre) for average DWF (base flow) were established for each Metro zoning classification utilizing the residential and employment densities and people per household data documented in *PART1 - TM 2, Study Area Characteristics*. The formulations for residential and non-residential unit flow factors are presented below:

- *Residential Unit Flow Factor* (DWF, gpnad) = Flow per Capita (gallons per capita day) x People per Household x Residential Density (household units per net acre).
- *Non-residential Unit Flow Factor* (DWF, gpand) = Flow per Employee (gallons per employee per day x Employment Density (units per net acre).

Per capita and per employee wastewater rates were calibrated to local flow metering data and flow data at each WRRF from 2015-2021. The calibration methodology, first, applies estimated per capita and employee rates and applicable unit flow factors to each developed parcel. Then, the parcel-level DWFs are summed within each meter basin and system-wide. The calculated values are compared to metered DWF. Finally, per capita and per employee Wastewater rates are adjusted until calculated DWF and metered DWF match within a 10-percent tolerance. The calibrated unit flow factors are in Table 3.4.

Future DWF was calculated at the parcel-level by multiplying developable net acres by the zoning specific unit flow factor. Parcels-level DWF was assigned to the model network using the model service area sub-basins using GIS. For intermediate 5-year periods between 2025 and buildout, the development-specific timing provided by partner cities and documented in *PART 1 - TM 2, Study Area Characteristics*, was used to distribute parcel-level net acres and future DWF to the model. Where partner cities did not provide specific development timing, parcel infill development was assumed to occur linearly across time. Planned development was scaled to not exceed system-wide population and employment projects for each intermediate 5-year period.

Weekday and weekend hourly diurnal patterns were calibrated for each meter basin and applied to existing and future DWF for the DWF model scenarios. Typical weekday and weekend diurnal patterns for non-industrial services are shown in Figure 3.17. The diurnal pattern calibration is further documented in *PART 1- TM 4, Collection System Model Development*.

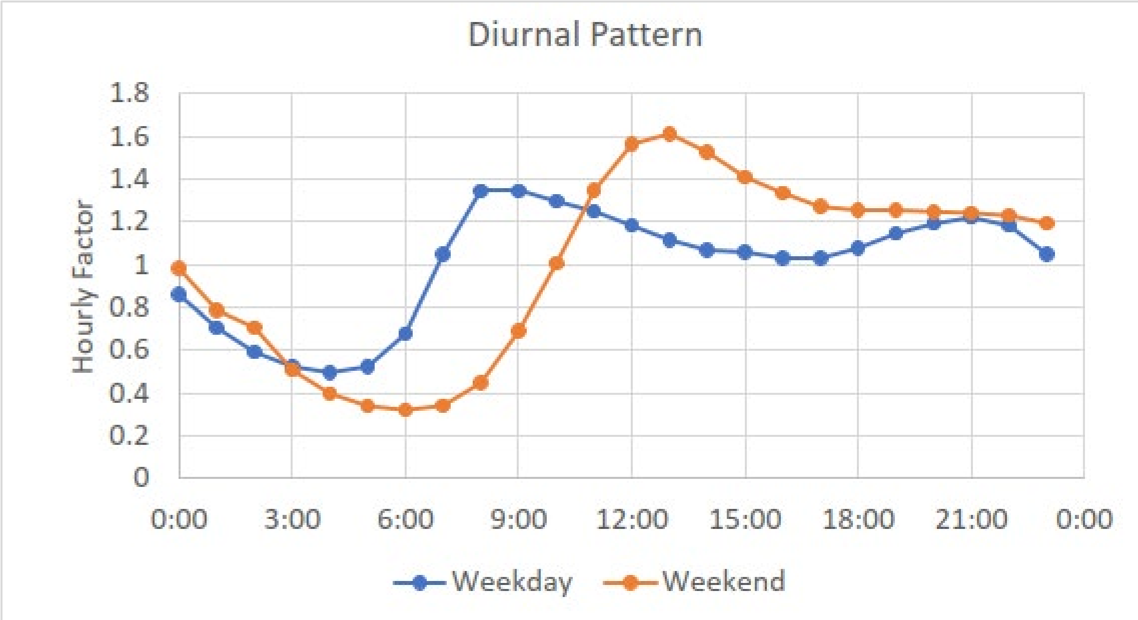

Figure 3.17 Typical Weekday and Weekend Hourly Diurnal Patterns for the West Basin (non-industrial)

3.5.6 Wet Industry Data

Metered wet industry average flows were applied to the model for 46 customers based on historic meter readings from 2020-2021. Wet industry customers are shown in Figure 3.3 and historical flow and permitted data is presented in Table 3.5. Permitted industries typically have a uniform diurnal pattern and occasionally may increase system flows by 10 percent. Industry specific patterns were included in the model with the 10 percent peak.

Wet industry growth assumptions were developed as follows:

- *Existing Metered Industrial Customers* – Base flows were averaged from 2015-2019 and increased annually using the employment growth rate for each treatment basin between 2020 and 2075
- *Intel*- Planned base flows were provided by the customer from 2020-2025 as shown in Table 3.2**.** A maximum rate of 14.2 mgd was assumed based on previous planning efforts. Base flows were increased up to the maximum between 2025 and 2075 using the annual employment growth rate.

Table 3.2 Intel Base Flow/DWF Projections

Year	Base Flow (mgd)
2019	6.0
2021	6.9
2022	7.7
2025	9.2
maximum	14.2

- *North Hillsboro Industrial Area (including Jacobson and Helvetia)* - Planned base flows were a combination of known industrial development and base flow per net acre assuming a mix of heavy industrial land use (wet industry) and light industrial land use (warehouses and data centers). The mixed rate assumes 65-percent light industry and 35-percent heavy industry with per acre base flow of 2,600 gpnad. These assumptions were replaced where more specific information was available from a proposed development. Timing of growth was estimated from information gathered in discussions with the City of Hillsboro by District staff with 50-percent of flow contributions occurring by 2030 and 80-percent of flow contributions occurring by 2040. The North Hillsboro Industrial Area impacts both the Rock Creek and Hillsboro Basins with approximately 98-percent of the flow contributing to Rock Creek.
- *North Hillsboro Expansion Area (Jackson School West and North of Hwy 26 + North Plains)* – The areas immediately west and north of the North Hillsboro Industrial Area were formerly urban reserves and were historically considered for urban growth expansion by the City of Hillsboro. These areas were initially considered based on the City of Hillsboro's request that the lands be reconsidered for urban growth expansion through the State/Federal Funded Chips Act. The lands were assumed to contribute the similar base flow and exhibit the same rate of growth as the North Hillsboro Industrial Area; however, timing was delayed by ten years. Most of the growth was assumed to occur between 2030 and 2050. The expansion area was assumed to impact the Rock Creek Basin. Work with the City of Hillsboro include specific adjustments to base flows and coordination on priority of lands added to the UGB with more specific timing. Ultimately the expansion lands for the City of Hillsboro were excluded from the plan as petitions to expand the UGB were not successful (as of August 2025). A growth area for North Plains related to the State/Funded Chips Act was also initially considered but later excluded from the plan as the City of North Plains was also not successful at their petition to expand the UGB.

3.5.7 GWI Unit Flow Rate Development and Application

GWI unit flow rates (GWI per net acre) were estimated for each meter basin and system-wide by subtracting the average flow for the GWI calibration period from the average flow for the DWF calibration period and dividing by developed net acres. GWI unit flow rates are summarized in Table 3.6. The existing GWI unit flow rates were applied to each developed parcel for the existing GWI model calibration without any diurnal or seasonal peaking. The lower 10th-percentile GWI unit flow rate (200 gpnad) was applied to future developed net acreage for future flow scenarios. Developed GWI net acres for intermediate 5-year periods were applied using the same development assumptions outlined in preceding sections.

3.5.8 Unit Sewershed Development and Application

As previously described, WWF or RDI/I component of the model consists of a storm event, sewershed area (wet weather area of impact), and unit hydrograph:

- Existing sewersheds are defined as 100-foot buffer (50-feet each side) around all existing system pipelines including pipelines that are not modeled.
- Future sewersheds are calculated by applying a 0.8 sewershed area per net acreage factor to each future parcel net area. The 0.8 ratio is based on existing ratio of net developed acreage to existing sewershed acreage system wide.

- Future development is assigned a unit hydrograph that represents a peak RDI/I contribution of 2,500 gpnad which equates to 1600-1700 gallons per gross acre per day for non-industrial parcels. Future industrial development is assigned a unit hydrograph that represents a peak RDI/I contribution of 1,500 gpnad which equates to 900-1,000 gallons per grows acre per day for industrial parcels and similar to measured RDI/I for existing industrial customers. The future unit hydrograph is representative of limited RDI/I due to newly constructed infrastructure and is consistent with District design criteria for new trunk sewers and regional pump stations.

RTK parameters were calibrated for each meter basin as shown in Table 3.7 The RTK unit hydrograph calibration is further documented in *Part 3 - TM 4, Collection System Model Development*.

Table 3.3 Flow Meter Data Quality Review and Calibration Recommendations

Model	Meter	Period 1 Rating Dry Weather (Base) (7/1/2018-9/30/2018)	Period 2 Rating Dry Weather (GWI) (12/24/2016-1/7/2017)	Period 3 Rating Wet Weather Primary Period (1/7/2017-3/2/2017)	Period 4 Rating Wet Weather Secondary Period (11/30/2015-2/10/2016)	Period 5 Rating Dry Weather (Base) (7/15/2020-8/5/2020)	Period 6 Rating Wet Weather Primary Period (1/9/2021-1/17/2021)	Period 7 Rating Dry Weather (GWI) (1/17/2021-1/26/2021)	Used For WWF CAL
Forest Grove	18893	Fair	Good	Good	Good	N/A	N/A	N/A	Yes
Forest Grove	20399	Good	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Forest Grove	20440	Fair	Fair	Fair	Fair	N/A	N/A	N/A	Yes
Forest Grove	78113	Good	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Forest Grove	78829	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
Forest Grove	805010	Good	Good	Good	Good	N/A	N/A	N/A	Yes
Forest Grove	FG IPS/WRRF	Fair	Good	Good	Good	N/A	N/A	N/A	Yes
Hillsboro	12158	Good	Good	Good	Good	Good	Good	Good	Yes
Hillsboro	12244	Good	N/A	N/A	N/A	Good	Good	Good	Yes
Hillsboro	12281	Fair	Good	Good	Good	Fair	N/A	N/A	Yes
Hillsboro	12298	Fair	Good	Good	Good	Good	Fair	Good	Yes
Hillsboro	17167	N/A	N/A	N/A	N/A	Good	Good	Good	Yes
Hillsboro	17216	N/A	N/A	N/A	N/A	Good	Good	Good	Yes
Hillsboro	20337	Good	N/A	N/A	N/A	Good	Good	Good	Yes
Hillsboro	828492	Fair	Fair	Fair	Fair	Fair	Good	Good	Yes
Hillsboro	HB IPS/WRRF	N/A	N/A	N/A	N/A	Good	Good	Good	Yes
Rock Creek	6822	Good	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	6877	Good	Good	Good	Good	Fair	Fair	N/A	Yes
Rock Creek	6906	Good	Good	Good	Fair	Fair	Poor	Poor	Yes
Rock Creek	6991	Good	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	7705	Good	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	9714	Good	Good	Good	N/A	Good	Good	Good	Yes
Rock Creek	9868	Poor	Fair	Poor	Fair	Good	Poor	Fair	Yes
Rock Creek	9877	Fair	Good	N/A	N/A	Good	Fair	Good	Yes
Rock Creek	11107	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Rock Creek	11647	Fair	Fair	Good	Good	N/A	N/A	N/A	Yes
Rock Creek	11932	Good	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	12220	Fair	Good	Good	Fair	Good	Good	Good	Yes
Rock Creek	12383	N/A	N/A	N/A	N/A	N/A	Fair	Good	Yes
Rock Creek	12424	Good	Good	Fair	Good	Good	Fair	Good	Yes
Rock Creek	12480	Good	Good	Fair	Fair	Good	Poor	Good	Yes
Rock Creek	12508	Good	Poor	Good	Fair	Good	Good	Good	Yes
Rock Creek	13240	Good	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	16247	Good	Good	Good	Good	Good	Fair	Good	Yes

Model	Meter	Period 1 Rating Dry Weather (Base) (7/1/2018-9/30/2018)	Period 2 Rating Dry Weather (GWI) (12/24/2016-1/7/2017)	Period 3 Rating Wet Weather Primary Period (1/7/2017-3/2/2017)	Period 4 Rating Wet Weather Secondary Period (11/30/2015-2/10/2016)	Period 5 Rating Dry Weather (Base) (7/15/2020-8/5/2020)	Period 6 Rating Wet Weather Primary Period (1/9/2021-1/17/2021)	Period 7 Rating Dry Weather (GWI) (1/17/2021-1/26/2021)	Used For WWF CAL
Rock Creek	20242	Good	N/A	N/A	N/A	Fair	Good	Good	No
Rock Creek	20280	Poor	N/A	N/A	N/A	Good	Fair	Good	No
Rock Creek	20569	Poor	N/A	N/A	N/A	Fair	N/A	N/A	No
Rock Creek	20674	Poor	N/A	N/A	N/A	Good	Fair	Good	Yes
Rock Creek	27062	Good	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	27099	Good	Fair	Good	Good	Good	Good	Good	Yes
Rock Creek	27113	Good	Fair	Fair	Poor	Good	Good	Good	Yes
Rock Creek	55672	Good	Good	Good	Good	Fair	Poor	Fair	Yes
Rock Creek	64864	N/A	N/A	N/A	N/A	Good	Fair	Good	No
Rock Creek	70257	Fair	N/A	N/A	N/A	Good	Good	Good	No
Rock Creek	72391	Fair	Good	Good	Good	Good	Good	Good	Yes
Rock Creek	822355	N/A	N/A	N/A	N/A	Good	Good	Good	No
Rock Creek	832455	N/A	N/A	N/A	N/A	Fair	Good	Good	No
Rock Creek	RC IPS/WRRF	N/A	N/A	N/A	N/A	Good	Good	Good	Yes

Table 3.4 Calibrated Unit Flow Factors by Metro Zoning Classification

Zoning Category	General Category	Description	Minimum Residential Household Density (Units per Net Acre)	Maximum Residential Household Density (Units per Net Acre)	Nominal Residential Household Density (Units per Net Acre)	Employee Density (Employees per Net Acre)	Rock Creek				Hillsboro				Forest Grove			
							Existing Residential Unit Flow Factor (GPNAD)	Buildout Residential Unit Flow Factor (GPNAD)	Existing Non-Residential Unit Flow Factor (GPNAD)	Buildout Non-Residential Unit Flow Factor (GPNAD)	Existing Residential Unit Flow Factor (GPNAD)	Buildout Residential Unit Flow Factor (GPNAD)	Existing Non-Residential Unit Flow Factor (GPNAD)	Buildout Non-Residential Unit Flow Factor (GPNAD)	Existing Residential Unit Flow Factor (GPNAD)	Buildout Residential Unit Flow Factor (GPNAD)	Existing Non-Residential Unit Flow Factor (GPNAD)	Buildout Non-Residential Unit Flow Factor (GPNAD)
SFR1	Residential	Single Family 1 Acre Tax Lot	0	1	1	---	145	111	---	---	151	112	---	---	235	157	---	---
SFR2	Residential	Single Family 1/2 Acre Tax Lot	1.1	2	2	---	---	---	---	---	---	---	---	---	470	315	---	---
SFR3	Residential	Single Family 10,000 SF Lot	2.1	3	3	---	435	332	---	---	---	---	---	---	---	---	---	---
SFR4	Residential	Single Family 9,000 SF Lot	3.1	4	4	---	580	443	---	---	603	448	---	---	941	629	---	---
SFR5	Residential	Single Family 7,000 SF Lot	4.1	5	5	---	725	553	---	---	754	560	---	---	1176	787	---	---
SFR6	Residential	Single Family 6,000 SF Lot	5.1	6	6	---	870	664	---	---	904	672	---	---	1411	944	---	---
SFR7	Residential	Single Family 5,000 SF Lot	6.1	7	7	---	1015	774	---	---	1055	784	---	---	---	---	---	---
SFR8	Residential	Single Family 4,500 SF Lot	7.1	8	8	---	1160	885	---	---	1206	896	---	---	---	---	---	---
SFR9	Residential	Single Family 4,000 SF Lot	8.1	9	9	---	1305	996	---	---	1357	1008	---	---	2116	1416	---	---
SFR10	Residential	Single Family 3,500 SF Lot	9.1	10	10	---	---	---	---	---	1507	1120	---	---	2351	1573	---	---
SFR11	Residential	Single Family 3,000 SF Lot	10.1	11	11	---	1595	1217	---	---	1658	1232	---	---	---	---	---	---
SFR12	Residential	Single Family 2,900 SF Lot	11.1	12	12	---	---	---	---	---	1809	1344	---	---	2822	1888	---	---
SFR13	Residential	Single Family 2,700 SF Lot	12.1	13	13	---	---	---	---	---	---	---	---	---	---	---	---	---
SFR14	Residential	Single Family 2,500 SF Lot	13.1	14	14	---	---	---	---	---	---	---	---	---	---	---	---	---
SFR15	Residential	Single Family 2,300 SF Lot	14.1	15	15	---	2175	1660	---	---	---	---	---	---	---	---	---	---
SFR16	Residential	Single Family 2,000 SF Lot	15.1	16	16	---	---	---	---	---	---	---	---	---	---	---	---	---
MFR1	Residential	Multi-Family-Very Low Density	4	15	12.3	---	1783	1361	---	---	1854	1378	---	---	2892	1935	---	---
MFR2	Residential	Multi-Family- Low Density	16	20	17.8	---	2581	1969	---	---	2683	1994	---	---	---	---	---	---
MFR3	Residential	Multi-Family-Moderate Density	21	25	23.3	---	3378	2578	---	---	3512	2610	---	---	5479	3665	---	---
MFR4	Residential	Multi-Family-Medium Density	26	30	29.4	---	4263	3253	---	---	4431	3293	---	---	---	---	---	---
MFR5	Residential	Multi-Family-Medium-High Density	31	35	33.4	---	4843	3695	---	---	---	---	---	---	---	---	---	---
MFR6	Residential	Multi-Family-High Density	36	45	40	---	5800	4425	---	---	---	---	---	---	---	---	---	---
MFR7	Residential	Multi-Family-Very High Density	46	85	73.1	---	10599	8088	---	---	---	---	---	---	---	---	---	---
MUR1	Mixed	Mixed Use	4	15	11.2	17.5	1299	991	153	111	---	---	---	---	---	---	---	---
MUR2	Mixed	Mixed Use	16	20	18.2	17.5	2111	1611	153	111	---	---	---	---	---	---	---	---
MUR3	Mixed	Mixed Use	21	25	23.1	17.5	2679	2045	153	111	2611	1941	103	213	4074	2725	194	141
MUR4	Mixed	Mixed Use	26	30	29.1	17.5	3375	2576	153	111	---	---	---	---	---	---	---	---
MUR5	Mixed	Mixed Use	31	35	34.6	17.5	4013	3062	153	111	---	---	---	---	---	---	---	---
MUR6	Mixed	Mixed Use	36	45	40.1	17.5	4651	3549	153	111	4533	3369	103	213	---	---	---	---
MUR7	Mixed	Mixed Use	46	65	54.6	17.5	6333	4833	153	111	---	---	---	---	---	---	---	---
MUR8	Mixed	Mixed Use	66	100	75.5	17.5	8758	6682	153	111	---	---	---	---	---	---	---	---

Zoning Category	General Category	Description	Minimum Residential Household Density (Units per Net Acre)	Maximum Residential Household Density (Units per Net Acre)	Nominal Residential Household Density (Units per Net Acre)	Employee Density (Employees per Net Acre)	Rock Creek				Hillsboro				Forest Grove			
							Existing Residential Unit Flow Factor (GPNAD)	Buildout Residential Unit Flow Factor (GPNAD)	Existing Non-Residential Unit Flow Factor (GPNAD)	Buildout Non-Residential Unit Flow Factor (GPNAD)	Existing Residential Unit Flow Factor (GPNAD)	Buildout Residential Unit Flow Factor (GPNAD)	Existing Non-Residential Unit Flow Factor (GPNAD)	Buildout Non-Residential Unit Flow Factor (GPNAD)	Existing Residential Unit Flow Factor (GPNAD)	Buildout Residential Unit Flow Factor (GPNAD)	Existing Non-Residential Unit Flow Factor (GPNAD)	Buildout Non-Residential Unit Flow Factor (GPNAD)
MUR9	Mixed	Mixed Use	101	125	110.5	17.5	---	9780	---	111	---	---	---	---	---	---	---	---
MUR10	Mixed	Mixed Use	126	700	222.5	17.5	---	---	---	---	---	---	---	---	---	---	---	---
FUD	Re-zoned to Mixed	Future Urban Development	10	20	10.0 – 20.0	17.5	1160	885	153	111	1130	840	103	213	1764	1180	194	141
EFU	Re-zoned to Mixed	Exclusive Farm Or Forest Use	15	20	15.0 – 20.0	17.5	1740	1328	153	111	1696	1260	103	213	2645	1770	194	141
RRFU	Re-zoned to Mixed	Rural Residential	15	20	15.0 – 20.0	17.5	1740	1328	153	111	1696	1260	103	213	2645	1770	194	141
CC	Commercial	Central Commercial	---	---	---	50	---	---	766	557	---	---	413	854	---	---	775	562
CG	Commercial	General Commercial	---	---	---	50	---	---	766	557	---	---	413	854	---	---	775	562
CN	Commercial	Neighborhood Commercial	---	---	---	50	---	---	766	557	---	---	413	854	---	---	---	---
CO	Commercial	Office Commercial	---	---	---	50	---	---	766	557	---	---	---	---	---	---	---	---
RC	Commercial	Rural Commercial	---	---	---	50	---	---	766	557	---	---	---	---	---	---	---	---
PF	Public	Public Facilities	---	---	---	50	---	---	766	557	---	---	413	854	---	---	775	562
IC	Industrial	Campus/Industrial/Business Park	---	---	---	50	---	---	766	557	---	---	413	854	---	---	775	562
IO	Industrial	Industrial Office	---	---	---	50	---	---	766	557	---	---	---	---	---	---	---	---
IL	Industrial	Light Industrial	---	---	---	50	---	---	766	557	---	---	413	854	---	---	775	562
IH	Industrial	Heavy Industrial	---	---	---	50	---	---	766	557	---	---	413	854	---	---	775	562
RI	Industrial	Rural Industrial	---	---	---	50	---	---	766	557	---	---	413	854	---	---	---	---
POS	Open Space	Parks And Open Space	---	---	---	0	---	---	---	557	---	---	---	---	---	---	775	562

Table 3.5 Existing Permitted Wet Industrial Customers and Project Flows

Industry Characterization		Permitted Flow (MGD)	Monitored Flows (2020-2021) (MGD)		Projected Flows (Used for ICM (Future Condition) Simulations) (MGD)											
Industry Name	Basin		Avg. Actual	Max. Actual	Existing Conditions	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	Buildout Conditions
Chaucer Foods	Forest Grove	0.0086	0.0069	0.0177	0.0177	0.0201	0.0197	0.0189	0.0216	0.0232	0.0249	0.0267	0.0285	0.0303	0.0320	0.0338
Forest Grove Transfer Station	Forest Grove	0.0024	0.0017	0.0094	0.0094	0.0106	0.0104	0.0100	0.0114	0.0123	0.0132	0.0142	0.0151	0.0161	0.0170	0.0179
Gray Industrial	Forest Grove	0.1250	0.1250	0.1250	0.1250	0.1418	0.1390	0.1333	0.1524	0.1636	0.1762	0.1887	0.2013	0.2139	0.2261	0.2384
J Lieb Foods Inc	Forest Grove	0.0416	0.0197	0.0265	0.0265	0.0301	0.0295	0.0283	0.0324	0.0347	0.0374	0.0401	0.0427	0.0454	0.0480	0.0506
MGC Pure Chemicals America, Inc.	Forest Grove	0.0250	0.0023	0.0035	0.0035	0.0040	0.0039	0.0037	0.0043	0.0046	0.0049	0.0053	0.0056	0.0060	0.0063	0.0067
New Season Foods Incorporated	Forest Grove	0.2500	0.0106	0.0528	0.0528	0.0599	0.0588	0.0564	0.0644	0.0691	0.0745	0.0798	0.0851	0.0904	0.0956	0.1008
Old Trapper Smoked Products	Forest Grove	0.1632	0.0218	0.0381	0.0381	0.0432	0.0424	0.0406	0.0464	0.0498	0.0537	0.0575	0.0613	0.0652	0.0689	0.0726
Sake One Corporation	Forest Grove	0.0042	0.0027	0.0040	0.0040	0.0045	0.0044	0.0042	0.0048	0.0052	0.0056	0.0060	0.0064	0.0068	0.0072	0.0076
Summit Natural Energy Corp.	Forest Grove	0.0719	0.0098	0.0137	0.0137	0.0155	0.0152	0.0146	0.0167	0.0179	0.0193	0.0207	0.0220	0.0234	0.0248	0.0261
TTM Technologies North America, LLC	Forest Grove	0.2500	0.1424	0.1611	0.1611	0.1827	0.1792	0.1718	0.1964	0.2108	0.2270	0.2432	0.2594	0.2756	0.2914	0.3072

Industry Characterization		Permitted Flow (MGD)	Monitored Flows (2020-2021) (MGD)		Projected Flows (Used for ICM (Future Condition) Simulations) (MGD)											
Industry Name	Basin		Avg. Actual	Max. Actual	Existing Conditions	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	Buildout Conditions
Contech Engineered Solutions LLC	Hillsboro	0.0012	0.0003	0.0006	0.0006	0.0007	0.0007	0.0008	0.0011	0.0012	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018
Davis Tool, Incorporated	Hillsboro	0.0043	0.0028	0.0055	0.0055	0.0062	0.0067	0.0071	0.0102	0.0109	0.0117	0.0126	0.0134	0.0142	0.0151	0.0159
Sheldon Manufacturing Incorporated	Hillsboro	0.0013	0.0005	0.0012	0.0012	0.0013	0.0014	0.0015	0.0022	0.0023	0.0025	0.0027	0.0029	0.0030	0.0032	0.0034
Westak of Oregon Incorporated	Hillsboro	0.0608	0.0353	0.0433	0.0433	0.0491	0.0526	0.0560	0.0804	0.0863	0.0929	0.0995	0.1061	0.1128	0.1192	0.1257
ACUMED, LLC.	Rock Creek	0.0063	0.0016	0.0021	0.0021	0.0024	0.0027	0.0030	0.0032	0.0034	0.0037	0.0039	0.0042	0.0044	0.0047	0.0050
AGC Electronic America	Rock Creek	0.0169	0.0139	0.0171	0.0171	0.0194	0.0216	0.0238	0.0253	0.0272	0.0293	0.0314	0.0335	0.0355	0.0376	0.0402
Alliance Packaging, Inc.	Rock Creek	0.0013	0.0004	0.0006	0.0006	0.0007	0.0008	0.0008	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013	0.0013	0.0014
Applied Materials, Inc.	Rock Creek	0.0150	0.0107	0.0143	0.0143	0.0162	0.0181	0.0199	0.0212	0.0227	0.0245	0.0262	0.0280	0.0297	0.0314	0.0336
BASF Corporation	Rock Creek	0.0031	0.0001	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004
Beaverton Foods Inc	Rock Creek	0.0135	0.0126	0.0153	0.0153	0.0173	0.0192	0.0212	0.0226	0.0242	0.0261	0.0279	0.0298	0.0316	0.0335	0.0358
CoorsTek, Inc.	Rock Creek	0.0110	0.0024	0.0036	0.0036	0.0041	0.0046	0.0050	0.0054	0.0057	0.0062	0.0066	0.0071	0.0075	0.0079	0.0085
DEQ Laboratory	Rock Creek	0.0069	0.0044	0.0063	0.0063	0.0071	0.0079	0.0087	0.0093	0.0100	0.0107	0.0115	0.0123	0.0130	0.0138	0.0147
Ebara Technologies, Inc	Rock Creek	0.0081	0.0056	0.0068	0.0068	0.0077	0.0085	0.0094	0.0100	0.0108	0.0116	0.0124	0.0132	0.0141	0.0149	0.0159
Epson Portland	Rock Creek	0.0053	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005
Forest Dental Equipment	Rock Creek	0.0008	0.0002	0.0003	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006
Genentech, Inc.	Rock Creek	0.0900	0.0356	0.0505	0.0505	0.0573	0.0637	0.0703	0.0747	0.0802	0.0863	0.0925	0.0987	0.1048	0.1108	0.1187
Hillsboro Landfill Inc	Rock Creek	0.1650	0.0857	0.1584	0.1584	0.1797	0.1998	0.2205	0.2343	0.2514	0.2707	0.2900	0.3094	0.3287	0.3475	0.3720
Intel Corporation - Aloha Campus	Rock Creek	0.7900	0.2937	0.6994	0.6994	0.7933	0.8823	0.9733	1.0342	1.1098	1.1952	1.2805	1.3658	1.4512	1.5343	1.6424
Intel Corporation - Ronler Acres Campus	Rock Creek	6.8911	1.7225	5.3089	5.3000	8.2000	11.3000	11.3000	12.0000	12.9000	13.9000	14.2000	14.2000	14.2000	14.2000	14.2000
Jireh Semiconductor, Incorporated	Rock Creek	0.5360	0.4591	0.5149	0.5149	0.5841	0.6496	0.7166	0.7615	0.8171	0.8800	0.9428	1.0056	1.0684	1.1296	1.2092
JSR Micro - Hillsboro	Rock Creek	0.0063	0.0057	0.0061	0.0061	0.0069	0.0077	0.0085	0.0091	0.0097	0.0105	0.0112	0.0120	0.0127	0.0134	0.0144
Leupold & Stevens Inc	Rock Creek	0.0053	0.0037	0.0054	0.0054	0.0061	0.0068	0.0075	0.0080	0.0085	0.0092	0.0099	0.0105	0.0112	0.0118	0.0127
Linde Inc.	Rock Creek	0.0260	0.0100	0.0129	0.0129	0.0146	0.0162	0.0179	0.0190	0.0204	0.0220	0.0236	0.0251	0.0267	0.0282	0.0302
Lotus Applied Technology	Rock Creek	0.0028	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003
Oregon Health Sciences University West Campus ONPRC	Rock Creek	0.0564	0.0233	0.0405	0.0405	0.0459	0.0511	0.0564	0.0599	0.0643	0.0692	0.0742	0.0791	0.0840	0.0889	0.0951
Parks Circuit Boards, Inc.	Rock Creek	0.0026	0.0002	0.0003	0.0003	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	0.0006	0.0006	0.0007	0.0007	0.0007
Prudential Cleanroom Services	Rock Creek	0.0411	0.0341	0.0403	0.0403	0.0458	0.0509	0.0562	0.0597	0.0640	0.0690	0.0739	0.0788	0.0837	0.0885	0.0948
Qorvo	Rock Creek	0.1561	0.1161	0.1307	0.1307	0.1483	0.1649	0.1819	0.1933	0.2074	0.2234	0.2393	0.2553	0.2712	0.2868	0.3070
QuantumClean	Rock Creek	0.0131	0.0097	0.0122	0.0122	0.0138	0.0153	0.0169	0.0180	0.0193	0.0208	0.0223	0.0237	0.0252	0.0267	0.0285
Resers Fine Foods - Century Blvd Plant	Rock Creek	0.2174	0.2456	0.3371	0.3371	0.3824	0.4253	0.4692	0.4986	0.5350	0.5762	0.6173	0.6584	0.6996	0.7396	0.7917
Seals Unlimited Inc.	Rock Creek	0.0006	0.0002	0.0004	0.0004	0.0005	0.0005	0.0006	0.0006	0.0007	0.0007	0.0008	0.0008	0.0009	0.0009	0.0010
Sumitomo Electric Semiconductor Materials, Inc.	Rock Creek	0.0668	0.0544	0.0615	0.0615	0.0698	0.0776	0.0856	0.0910	0.0976	0.1051	0.1126	0.1201	0.1276	0.1349	0.1444
TOK America	Rock Creek	0.0553	0.0350	0.0571	0.0571	0.0648	0.0721	0.0795	0.0845	0.0907	0.0976	0.1046	0.1116	0.1186	0.1253	0.1342
Tokai Carbon USA Inc	Rock Creek	0.0236	0.0064	0.0126	0.0126	0.0143	0.0159	0.0176	0.0187	0.0200	0.0216	0.0231	0.0246	0.0262	0.0277	0.0296
Tokyo Electron US Holdings	Rock Creek	0.0276	0.0200	0.0240	0.0240	0.0272	0.0302	0.0333	0.0354	0.0380	0.0409	0.0439	0.0468	0.0497	0.0525	0.0562
Tosoh Quartz, Inc	Rock Creek	0.0140	0.0089	0.0138	0.0138	0.0156	0.0174	0.0192	0.0204	0.0219	0.0236	0.0253	0.0269	0.0286	0.0303	0.0324

Table 3.6 Existing Groundwater Infiltration Rates by Meter Basin

Model	Meter/RTK ID	Developed Net Acres (Ac.)	GWI (MGD)	GWI (GPNAD)
Forest Grove	15783	5.1	0.011	2160
Forest Grove	15788	28.0	0.019	680
Forest Grove	15793	5.5	0.005	880
Forest Grove	18893	158.3	0.258	1630
Forest Grove	20399	88.9	0.275	3090
Forest Grove	20426	6.4	0.254	39530
Forest Grove	20440	35.3	0.125	3540
Forest Grove	78113	420.3	1.499	3570
Forest Grove	805010	147.5	1.201	8140
Forest Grove	FG IPS/WRRF	157.6	0.000	0
Hillsboro	12158	364.5	0.000	0
Hillsboro	12244	210.3	0.499	2370
Hillsboro	12281	280.4	0.701	2500
Hillsboro	12298	177.9	0.000	0
Hillsboro	17167	93.3	0.022	240
Hillsboro	17216	433.8	0.556	1280
Hillsboro	20337	215.9	0.312	1440
Hillsboro	828492	28.6	0.158	5530
Hillsboro	HB IPS/WRRF	440.0	0.000	0
Rock Creek	6822	1050.3	1.096	1040
Rock Creek	6877	375.3	1.045	2780
Rock Creek	6906	151.8	0.051	340
Rock Creek	6991	323.0	0.000	0
Rock Creek	7705	670.4	1.111	1660
Rock Creek	9714	479.3	0.917	1910
Rock Creek	9868	1964.5	7.602	3870
Rock Creek	9877	595.2	0.468	790
Rock Creek	11107	1155.8	0.001	0
Rock Creek	11647	117.1	0.094	800
Rock Creek	11932	624.3	0.952	1530
Rock Creek	12220	874.5	0.932	1070
Rock Creek	12383	91.0	0.007	80
Rock Creek	12424	432.5	1.001	2310
Rock Creek	12480	583.2	0.543	930
Rock Creek	12508	2064.1	0.695	340
Rock Creek	13240	2969.2	0.000	0

Model	Meter/RTK ID	Developed Net Acres (Ac.)	GWI (MGD)	GWI (GPNAD)
Rock Creek	16247	261.0	0.000	0
Rock Creek	20674	165.0	0.114	690
Rock Creek	27062	978.9	0.160	160
Rock Creek	27099	471.7	0.050	110
Rock Creek	27113	5.9	0.043	7240
Rock Creek	55672	1318.9	1.853	1400
Rock Creek	72391	307.3	0.427	1390
Rock Creek	RC IPS/WRRF	1331.5	0.034	30

Table 3.7 Calibrate RTK Unit Hydrographs by Meter Basin (used to model WWF or RDI/I)

Model	Meter/RTK ID	R1	T1	K1	R2	T2	K2	R3	T3	K3	Total R
Forest Grove	15783	0.021	1.0	1.0	0.110	7.5	4.0	0.480	12.0	15.0	0.611
Forest Grove	15788	0.030	2.0	2.0	0.100	5.0	6.0	0.100	12.0	10.0	0.230
Forest Grove	15793	0.020	1.5	1.5	0.050	5.0	4.5	0.100	8.0	9.0	0.170
Forest Grove	18893	0.015	1.1	0.8	0.180	3.8	3.5	0.340	14.0	5.5	0.535
Forest Grove	20399	0.220	1.0	1.0	0.250	4.0	4.0	0.350	9.0	9.0	0.820
Forest Grove	20426	0.250	1.2	1.2	0.250	5.5	3.0	0.500	10.0	11.0	1.000
Forest Grove	20440	0.010	0.8	0.7	0.070	2.6	2.4	0.239	10.0	4.7	0.319
Forest Grove	78113	0.018	2.0	2.5	0.036	3.0	3.0	0.107	8.0	10.0	0.161
Forest Grove	805010	0.360	2.0	1.5	0.040	4.0	4.0	0.000	0.0	0.0	0.400
Forest Grove	FG IPS/WRRF	0.000	0.0	0.0	0.110	5.0	5.0	0.600	12.0	11.0	0.710
Hillsboro	12158	0.020	1.0	1.0	0.018	4.8	2.5	0.040	8.0	14.0	0.078
Hillsboro	12244	0.100	1.0	0.9	0.180	6.0	1.3	0.120	10.0	12.4	0.400
Hillsboro	12281	0.005	0.7	0.9	0.015	5.0	3.9	0.050	12.0	14.0	0.070
Hillsboro	12298	0.005	0.7	0.9	0.015	5.0	3.9	0.050	12.0	14.0	0.070
Hillsboro	17167	0.012	0.8	0.8	0.072	8.0	2.5	0.240	11.0	11.0	0.324
Hillsboro	17216	0.007	0.5	0.5	0.042	4.0	1.9	0.200	10.0	11.5	0.249
Hillsboro	20337	0.030	1.0	0.9	0.070	5.0	5.0	0.200	9.0	14.0	0.300
Hillsboro	828492	0.088	0.3	0.8	0.210	3.0	4.0	0.500	10.0	11.0	0.798
Hillsboro	HB IPS/WRRF	0.050	0.7	0.9	0.170	5.0	6.0	0.290	13.0	14.0	0.510
Rock Creek	6822	0.013	1.0	2.0	0.059	2.0	4.0	0.119	8.0	12.0	0.191
Rock Creek	6877	0.028	1.0	2.0	0.114	2.0	4.0	0.230	6.4	12.0	0.372
Rock Creek	6906	0.004	1.5	3.0	0.076	3.0	5.0	0.265	0.0	0.0	0.345
Rock Creek	6991	0.008	0.5	2.0	0.145	3.0	4.0	0.370	6.0	12.0	0.523
Rock Creek	7705	0.024	0.5	1.0	0.149	3.0	4.0	0.594	8.0	12.0	0.767
Rock Creek	9714	0.011	0.5	1.0	0.219	2.0	4.0	0.769	8.0	12.0	0.999

Model	Meter/RTK ID	R1	T1	K1	R2	T2	K2	R3	T3	K3	Total R
Rock Creek	9868	0.016	0.5	1.0	0.062	2.0	4.0	0.125	8.0	12.0	0.203
Rock Creek	9877	0.026	0.9	1.8	0.390	3.6	7.2	0.584	14.4	21.6	1.000
Rock Creek	11107	0.007	0.5	2.0	0.126	3.0	4.0	0.322	6.0	12.0	0.455
Rock Creek	11647	0.037	0.4	0.5	0.152	2.0	4.0	0.285	8.0	12.0	0.474
Rock Creek	11932	0.007	0.5	1.0	0.030	3.0	4.0	0.298	8.0	12.0	0.335
Rock Creek	12220	0.037	0.4	1.1	0.049	3.0	6.0	0.293	8.0	12.0	0.379
Rock Creek	12383	0.026	0.4	0.8	0.166	1.6	3.0	0.330	8.0	12.0	0.522
Rock Creek	12424	0.022	0.4	0.8	0.145	1.6	3.0	0.288	8.0	12.0	0.455
Rock Creek	12480	0.038	0.8	1.5	0.060	4.5	6.0	0.091	9.0	18.0	0.189
Rock Creek	12508	0.034	0.8	1.5	0.136	4.5	6.0	0.085	9.0	18.0	0.255
Rock Creek	13240	0.037	0.5	0.5	0.061	1.0	3.0	0.055	4.0	9.0	0.153
Rock Creek	16247	0.023	0.5	1.0	0.142	3.0	4.0	0.567	8.0	12.0	0.732
Rock Creek	20674	0.013	0.5	1.0	0.219	2.0	4.0	0.768	8.0	12.0	1.000
Rock Creek	27062	0.042	1.5	3.0	0.049	3.0	5.0	0.000	0.0	0.0	0.091
Rock Creek	27099	0.324	0.3	0.5	0.000	0.0	0.0	0.000	0.0	0.0	0.324
Rock Creek	27113	0.142	2.0	3.0	0.083	3.0	5.0	0.000	0.0	0.0	0.225
Rock Creek	55672	0.313	1.0	2.0	0.375	2.0	4.0	0.312	8.0	12.0	1.000
Rock Creek	72391	0.164	0.5	1.1	0.148	3.6	6.0	0.166	9.0	18.0	0.478
Rock Creek	RC IPS/WRRF	0.018	0.5	1.0	0.183	3.0	4.0	0.366	8.0	12.0	0.567

3.6 Peaking Factor Development and Application

The conveyance system model was used to evaluate flow to the Rock Creek, Hillsboro, and Forest Grove WRRFs and to provide data for the treatment plant basis of design related to peaking factors and flow projections. The treatment flow projections are documented in detail in *PART1 – TM1, Flow and Load Projections* from preliminary work performed for the West Basin Master Plan. Minor revisions to the preliminary work were completed during Phase 1 of the West Basin Master Plan. The revisions to flow and load are documented in *PART1 – TM1, Flow and Load Projections Summary (Phase 1 and 2 Revisions).*

3.6.1 Peaking Factor Development

A peaking factor is defined as the ratio of flow (category specific) divided by the average DWF (base flow). The peaking factor development. Flow categories reviewed in the conveyance system model include:

- *Maximum Month Wet Weather (MMWW) Flow:* The maximum average month observed (from a 30-day running average) in the wet weather period that includes November 1st of the previous year through April 30th of the seasonal year.
- *Maximum Week Wet Weather (MWWW) Flow***:** The maximum average week observed (from a 7-day running average) in the wet weather period that includes November 1st of the previous year through April 30th of the seasonal year.

- *Maximum Day Wet Weather (MDWW) Flow:* The maximum average day observed in the wet weather period that includes November 1st of the previous year through April 30th of the seasonal year.
- *Maximum Hour Wet Weather (MHWW) Flow:* The maximum average hour observed during the maximum day wet weather.

3.6.1.1 Conveyance System Modeling

The conveyance system model was run for the West Basin design storm events to review MHWW and MDWW. The model was also run for several historic storm periods between 2015-2021 to review MHWW, MDWW, MWWW and MMWW compared to historic measured flows at each WRRF. The model captures system overflows which are not measured through influent metering at the WRRFs during large storm events. A description of the modeled storms is presented below.

- 5-year Design Storms - For the West Basin, the District utilizes 1-in-5-year frequency design storms for each treatment and conveyance basin as summarized in Table 3.1. These storms were used to generate peaking factors for MHWW and MDWW.
- January to March 2017 (three months historic precipitation) - The maximum precipitation accumulation is similar to the design storms over 24-hours (2.4 inches) and greater for the maximum 72-hour accumulation (3.8 inches). Historic storms periods were considered for flow categories exceeding 72-hours in duration (MWWW, MHWW). This period of historic precipitation approximates the 1-in-5-year storm event within a full month of high precipitation accumulation.
- December 2015 to January 2016 (two months historic precipitation) - The maximum precipitation accumulation is greater than the design storm over 24-hours (3.0 inches) and greater for the maximum 72-hour accumulation (5.4 inches). This period of historic precipitation exceeds the 1-in-5-year storm event within a full month of higher precipitation accumulation.
- January 11 – 13, 2021 (recent historic and intense storm event) – The maximum precipitation accumulation is similar to the design storm over 24-hours (2.6 inches) and similar to the maximum design storm 72-hour accumulation (3.5 inches). This period reflects existing system conditions with implementation of recent RDI/I reduction work and was used in recent conveyance system model calibrations to refine model wet weather response. The metered flow into each treatment facility is reported to compare against the modeled design storm.

Additionally, an Oregon Department of Environmental Quality (DEQ) methodology for extrapolating peak flows in multiple categories was performed for comparison. The DEQ method is documented in *PART1 – TM1, Flow and Load Projections*.

3.6.1.2 Selected Peaking Factors

A comparison of the peaking factors developed using historical data, the DEQ methodology and the conveyance models and selected flow peaking factors are documented in *PART1 – TM1, Flow and Load Projections.* Minor revisions to peaking factors are documented in *PART1 – TM1, Flow and Load Projections Summary (Phase 1 and 2 Revisions)*. Flow peaking factors were developed for non-industrial (residential/commercial), Intel wet industry, and other metered wet industry.

The final selection of existing flow peaking factors for total influent flow and non-industrial (residential /commercial) was based on the following:

- Historic peaking factors for dry weather flow categories.

- Historical peaking factors were selected for wet weather maximum month and maximum week. The historical peaking factors were typically more conservative than the peaking factors generated using the DEQ methodology for these flow categories.
- The peaking factors developed using the conveyance system models and the 5-year design storm were selected for wet weather maximum day and maximum hour. These peaking factors were selected over the more conservative peaking factors estimated using the DEQ methodology. Generally, the modeled design storm produces wet weather flows consistent with recent historic events or lower than recent historic storm events (since 2015). The collection system models were used in place of historic events because the modeled wet weather response reflects recent targeted RDI/I reduction projects particularly in the Forest Grove and Hillsboro Basins and system aging. The RDI/I reduction projects for Forest Grove, for example, were completed after large storm events occurring in 2015 and 2017. A summary of changes in wet weather peaking factors for each treatment basin is described below. The changes reflect adjusted wet weather response between models calibrated in 2012 and models calibrated in 2021.

  Rock Creek (aging system with limited RDI/I reduction work)
  - MDWW increased from 3.55 to 4.09 (15-percent increase)
  - MHWW increased from 4.84 to 5.19 (7-percent increase)

  Hillsboro (targeted RDI/I reduction work)
  - MDWW reduced from 6.55 to 6.29 (4-percent decrease)
  - MHWW reduced from 8.25 to 7.09 (14-percent decrease)

  Forest Grove (targeted RDI/I reduction work)
  - MDWW reduced from 10.67 to 8.15 (24-percent decrease)
  - MHWW reduced from 12.83 to 11.90 (7-percent decrease)

The final selection of peaking factors for metered wet industry and Intel for all flow categories were based on historic metered data. Maximum historic values were used to define all wet weather peaking factors. Where maximum hour meter data was unavailable, the maximum hour flows for wet industry assume the greater of maximum daily flow or 110-percent of average daily flow. The 110-percent multiplier is based on available hourly metered data at Intel.

3.6.1.3 New Development Peaking Factors

New development wet weather peaking factors should be lower than existing wet weather peaking factors due to standards for plastic piping, standards for manhole joints, and strong construction inspection practices. To develop residential/commercial (non-industrial) peaking factors for future customers during wet weather flow, a sampling of recently developed areas with RDI/I rates below 4,000 gpnad were evaluated from the East Basin where new development areas are more easily isolated in the modeled system. The results of the analysis and the associated MHWW peaking factors are presented in Table 3.8.

Table 3.8 Maximum Hour Wet Weather Flow Peaking Factor Development for New Residential & Commercial Customers

Peaking Factor Development for Low RDI/I (2,500 gpnad - 4,000 gpnad) New Residential/Commercial Development			
New Development Location (East Basin)	**Base Flow (mgd)**	**MHWW Flow (mgd)**	**MHWW Peaking Factor**
1 - Sherwood (Sherwood Trunk)	0.7	3.2	4.8
2 - Sherwood (Onion Flats Trunk)	0.5	1.7	3.6
3 - King City (Bull Mountain Trunk)	1.1	4.7	4.4
4 - Tualatin (Lower Tualatin Interceptor)	1.2	4.9	4.2
5 - Beaverton (Summer Creek Trunk)	1.8	7.1	4.0
TOTAL (selected)	5.1	21.5	4.2

Other wet weather flow category peaking factors for new development were generated by the following:

(1) Calculating the ratio of MHWW peaking factors for new development vs existing system
(2) Applying the ratio to the flow category peaking factor for the existing system

An example is provided below for MDWW:

$$MDWW\ PF\ (new) = \frac{MDWW\ PF\ (existing)\ x\ MHWW\ PF\ (new)}{MHWW\ PF\ (existing)}$$

Where: PF = Peaking Factor, new = new development, $existing$ = existing system

New development wet weather flow peaking factors were applied to the portion of the base flow attributed to population and employment growth to calculate new residential/commercial flows. New development dry weather flow peaking factors were assumed to be equal to existing dry weather peaking factors for residential/commercial flows based on standard non-residential diurnal variation.

3.7 Flow Projections

The flow projections based on conveyance modeling and application of peaking factors for the Rock Creek, Hillsboro, and Forest Grove Basins are presented in Figure 3.18, Figure 3.19, and Figure 3.20 respectively. The flow projections represent the influent flow from the conveyance system to the treatment plants for Rock Creek, Hillsboro, and Forest Grove respectively. Flow projections are prior to any flow transfer between basins including a future Council Creek Pump Station which will divert flow from the Hillsboro Basin to the Forest Grove WRRF.

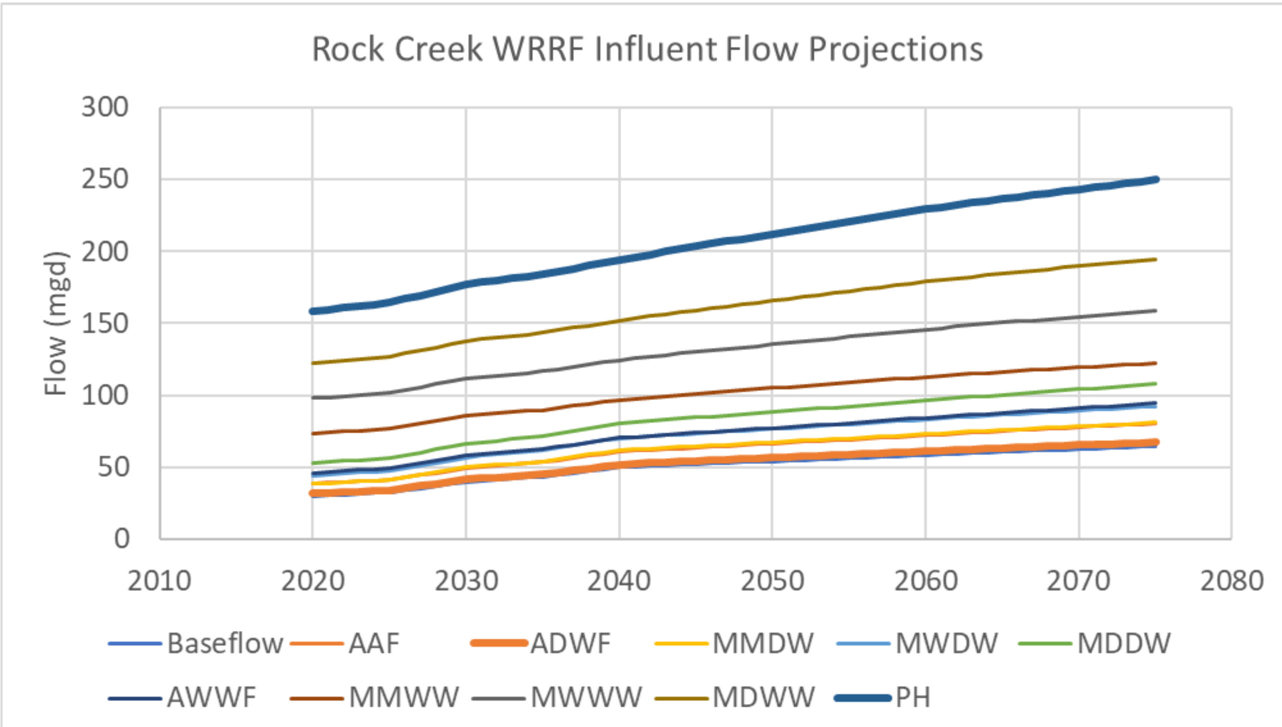

Figure 3.18 Rock Creek WRRF Influent Flow Projections

AAF = average annual flow, ADWF = average dry weather flow, MMDW = maximum month dry weather flow, MWDW = maximum week dry weather flow. MDDW = maximum day dry weather flow, AWWF = average wet weather flow, MMWW = maximum month wet weather flow, MWWW = maximum week wet weather flow, MDWW = maximum day wet weather flow, PH = peak hour wet weather flow

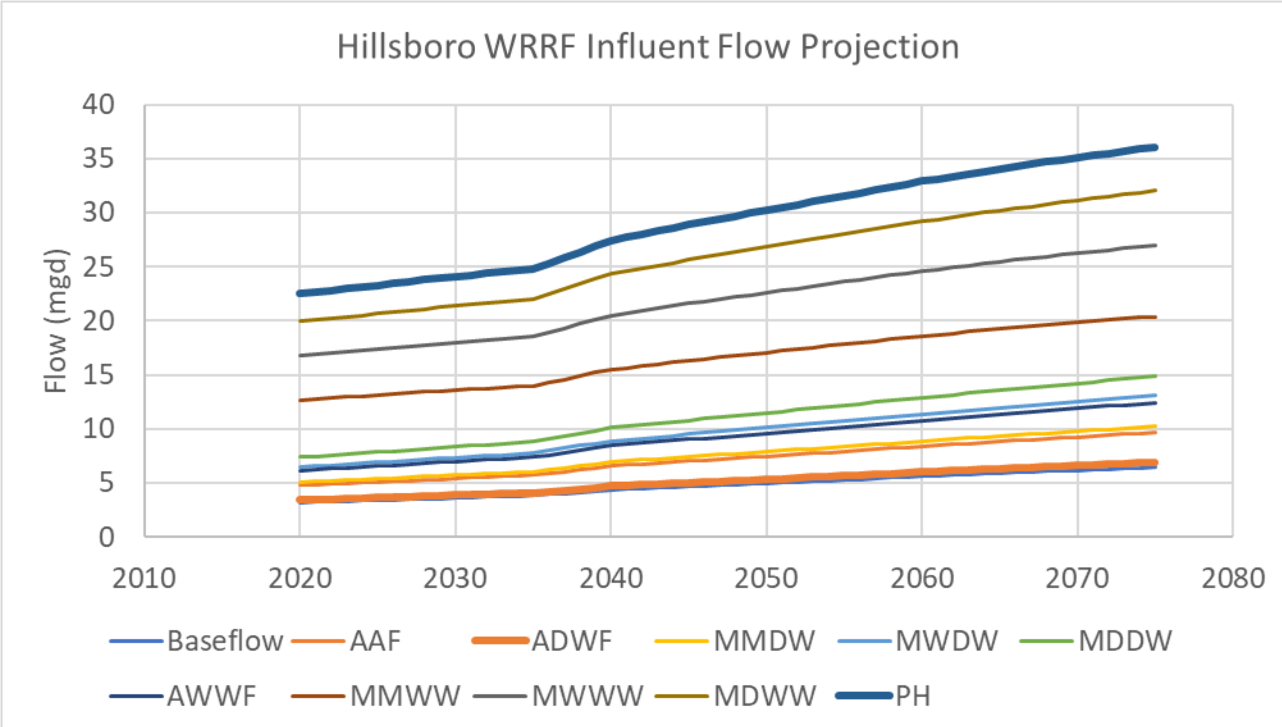

Figure 3.19 Hillsboro WRRF Influent Flow Projections

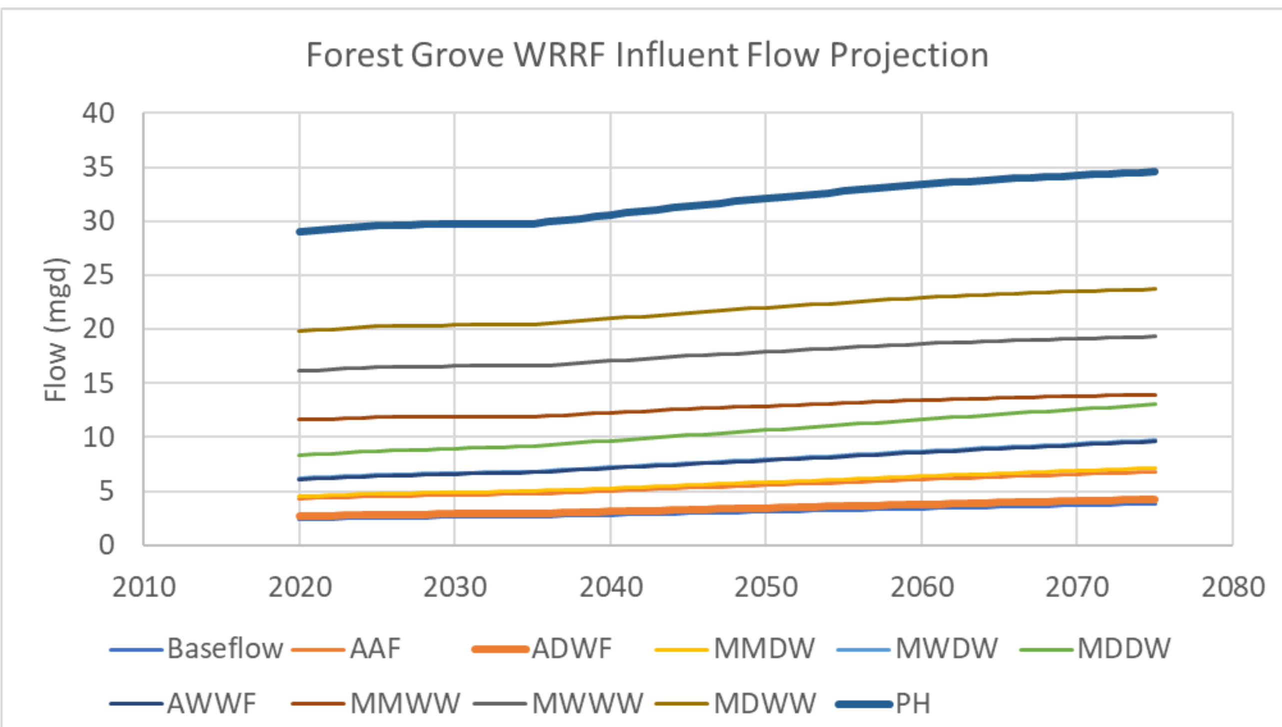

Figure 3.20 Forest Grove WRRF Influent Flow Projections

3.8 Future Base Flow Uncertainty Analysis

As part of temperature compliance evaluations for the Tualatin River, a Monte Carlo simulation was performed to evaluate the level of uncertainty for the planned base flows at each WRRF. The simulation uses a range of high to low population growth rates (2 percent to 0.6 percent) and employment growth rates (1.6 percent to 1 percent) from the planning period and randomly applies these rates over 1,100 iterations to generate a range of normally distributed base flows. Growth rates were applied uniformly across the entire planning period (2020-buildout) for each Monte Carlo iteration. Industrial flows were tied directly to employment growth rates for existing metered customers. The planned base flows, which use varied growth rates over time, were plotted on the normal distribution to determine the probability of occurrence relative to the normally distributed range from the Monte Carlo simulation as shown in example Figure 3.21. Confidence intervals for one, two, and three standard deviations from the mean are also referenced on the plots. Guidelines for interpreting probability of occurrence, uncertainty, and confidence intervals are provided below:

- A planned base flow equal to or less than the mean has a 50-percent probability of occurrence. A base flow value with a high probability of occurrence (approaching 100-percent) indicates less certainty and a more conservative estimate. A base flow with a low probability of occurrence (approaching 0-percent) indicates high certainty and a less conservative estimate.
- A 68-percent confidence interval: 68-percent of the normalized flow distribution occurs within one standard deviation from the mean. Data is considered more certain in this range.
- A 95-percent confidence interval: 95-percent of the normalized flow distribution occurs within two standard deviations from the mean. Data is considered less certain in the ranges between one and two standard deviations from the mean.
- A 99.7-percent confidence interval: 99.7-percent of the normalized flow distribution occurs within three standard deviations from the mean. Data is considered very uncertain in the ranges between two and three standard deviations from the mean.

Plots of normalized flow distributions and planned flow for each 5-year time period to buildout are provided in Appendix 3B. A summary of the planned base flows by year, normalized base flow range from the Monte Carlo simulation, and probability of occurrence is also provided for the West Basin in Appendix 3B. Notes are provided on uncertainty and confidence intervals including explanations for values that land on the more conservative end of the normalized distribution.

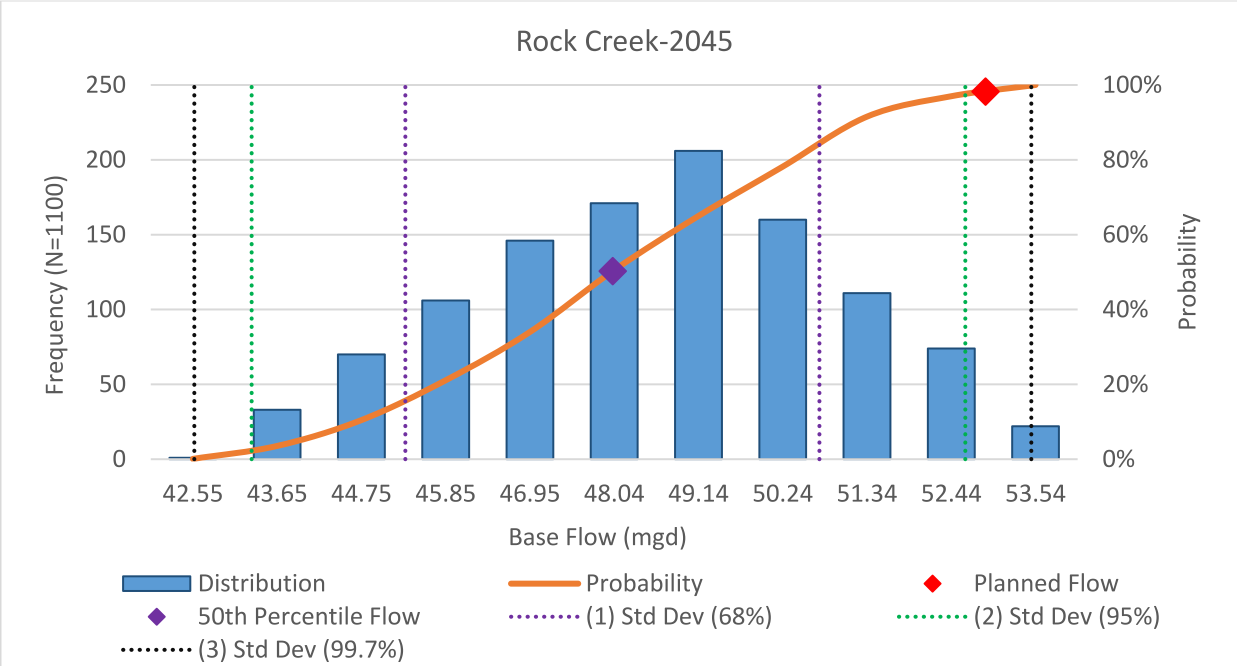

Figure 3.21 Example Base Flow Distribution, Planned Base Flow, Probability, and Confidence Interval Plot

APPENDIX 3A INFOWORKS ICM MODEL SETUP FLOW GENERATION

The flow generation variables were added to the InfoWorks ICM model using the model subcatchment grid table. The following describes the contents of the grid table:

- Subcatchment ID – Unique identifier for each subcatchment or subbasin (row in grid table). All flow parameters are entered at the subcatchment level of detail to the model. Subcatchments are delineated by model manhole loading location and zoning classification.
- Node ID – Model manhole location where subcatchment discharges to the collection system.
- Population – Equivalent population used to generate base or average dry weather flow in the model. The population equivalent includes population within the subcatchment and employees in the subcatchment converted to an equivalent population by using the ratio of per employee Wastewater usage (30 gallons per employee per day) to per capita Wastewater usage (57.5 gallons per person per day). The base or average dry weather flow is generated by multiplying the equivalent population by 57.5 gallons per person per day.
- Wastewater Profile – Weekday and weekend diurnal patterns for each meter basin and applied to average dry weather flow to generate hourly flows for continuous simulation modeling.
- Base flow (mgd) – Average groundwater infiltration in each subcatchment. Peaking was not applied to the groundwater component of the model.
- Trade flow (mgd) – Wet industry base or average dry weather flow in each subcatchment.
- Rainfall Profile – Rain gauge reference used to apply precipitation to each subcatchment for wet weather flow generation. The profile can reference historic rain gauge data or the West Basin design storm event.
- Trade Profile – May be used to establish diurnal variation for wet industry customers. Currently set to "1" – no diurnal variation.
- RTK Hydrograph – Unit hydrograph for each meter basin and applied to sewershed area to generate wet weather flow in each subcatchment.
- Contributing area (acres) – Sewershed area in each subcatchment used to generate wet weather flow.
- In addition to flow generation variables, several user descriptors were also added for reference to the InfoWorks ICM model using the subcatchment grid table. The following describes the content of the user descriptor fields:
  - Developed net acres – Estimated number of acres developed in each subcatchment.
  - Developable net acres – Estimated total number of acres that may be developed in the each subcatchment.
  - Population – Estimated population in each subcatchment.
  - Employee – Estimated number of employees in each subcatchment.
  - Percent developed by net acre – Estimated percent developed in each subcatchment. Ratio of developed net acres to developable net acres.
  - Industry Names – Reference to specific wet industry customers in each subcatchment.

APPENDIX 3B UNCERTAINTY EVALUATION PLOTS AND TABLES FOR THE WEST BASIN

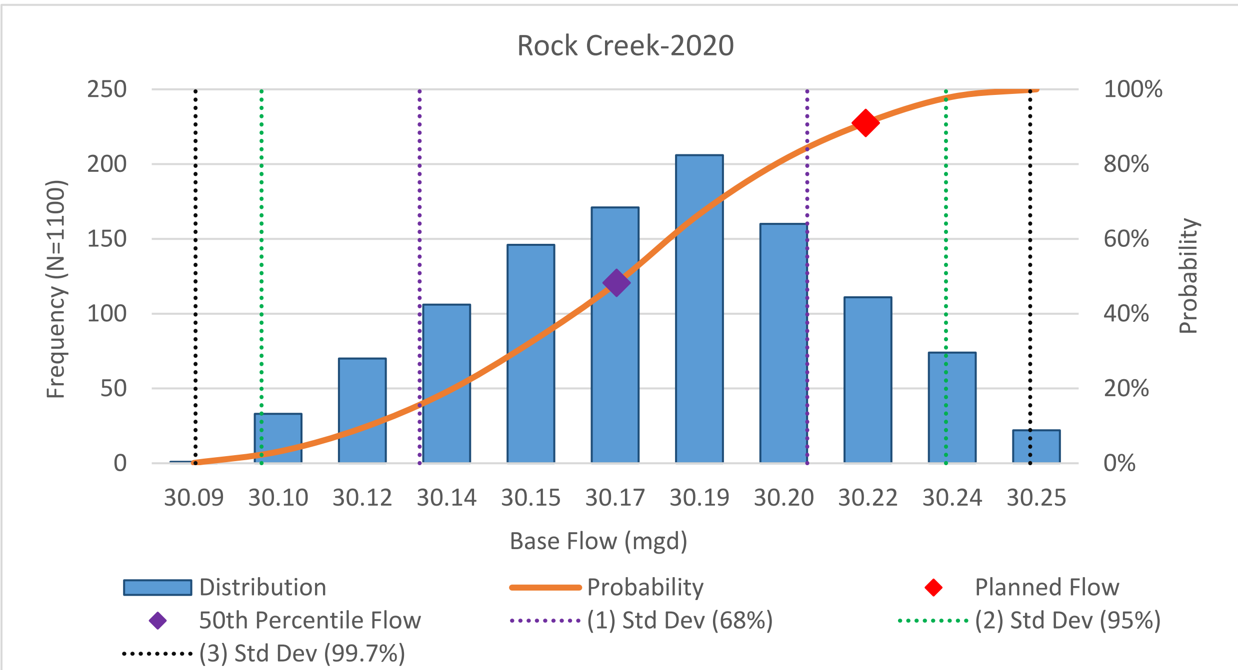

Figure 3B.1 Rock Creek, Base Flow Distribution, 2020

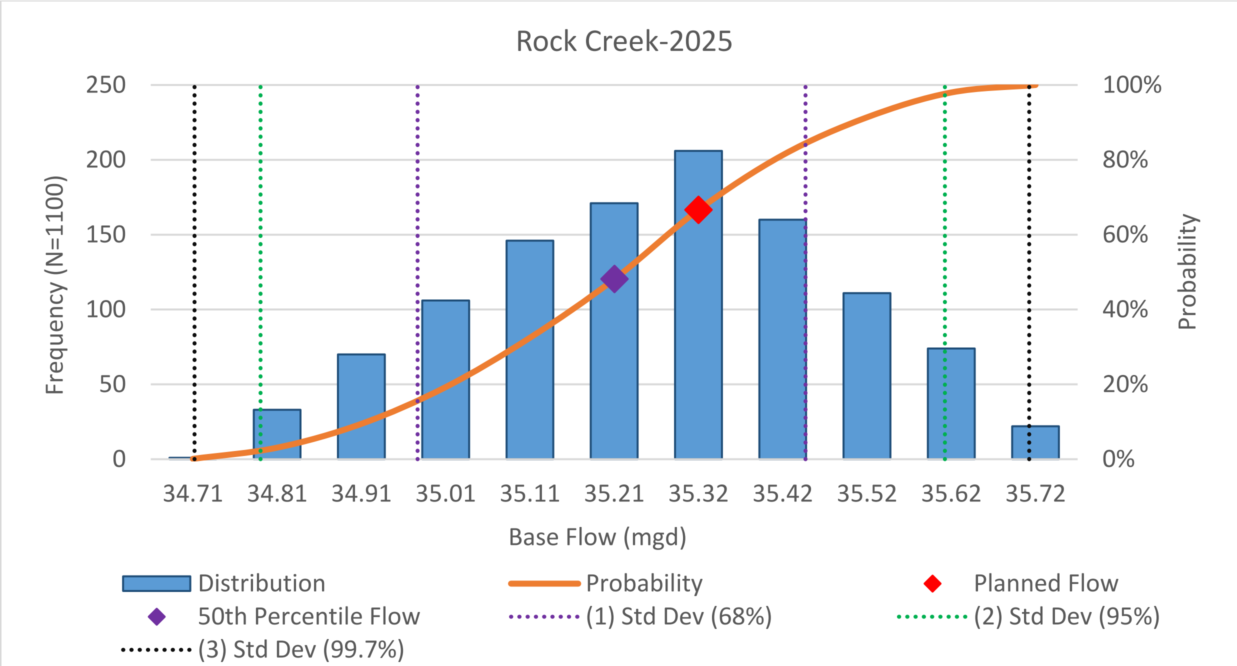

Figure 3B.2 Rock Creek, Base Flow Distribution, 2025

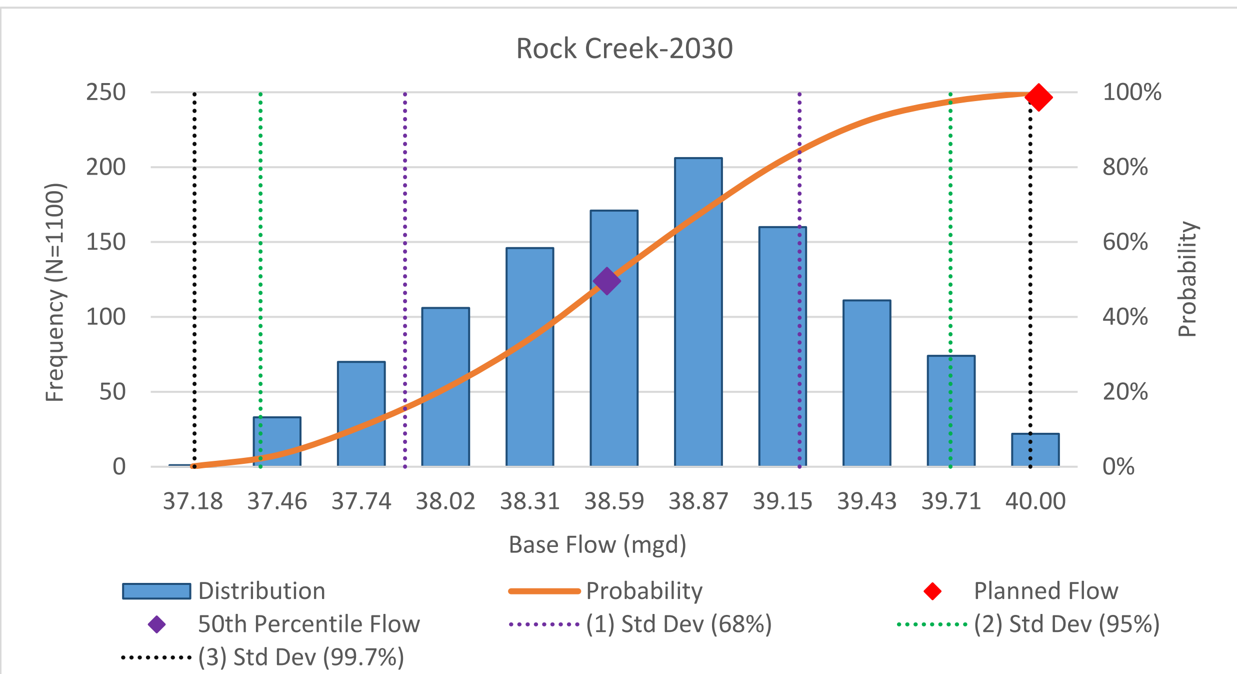

Figure 3B.3 Rock Creek, Base Flow Distribution, 2030

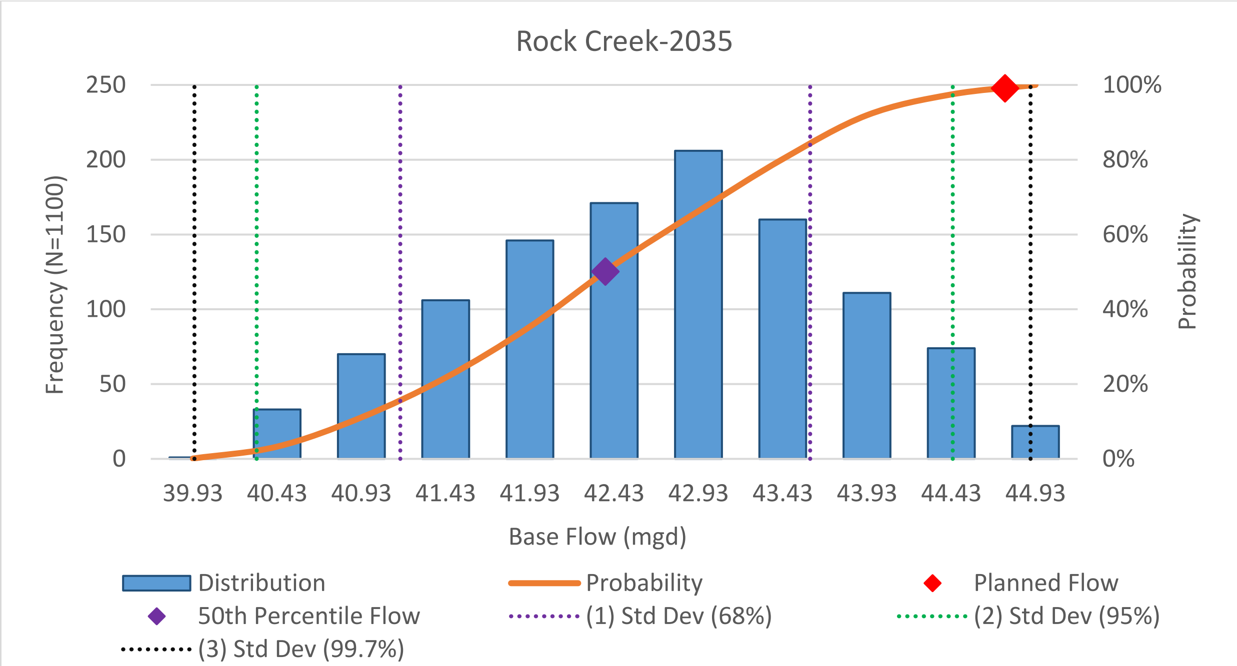

Figure 3B.4 Rock Creek, Base Flow Distribution, 2035

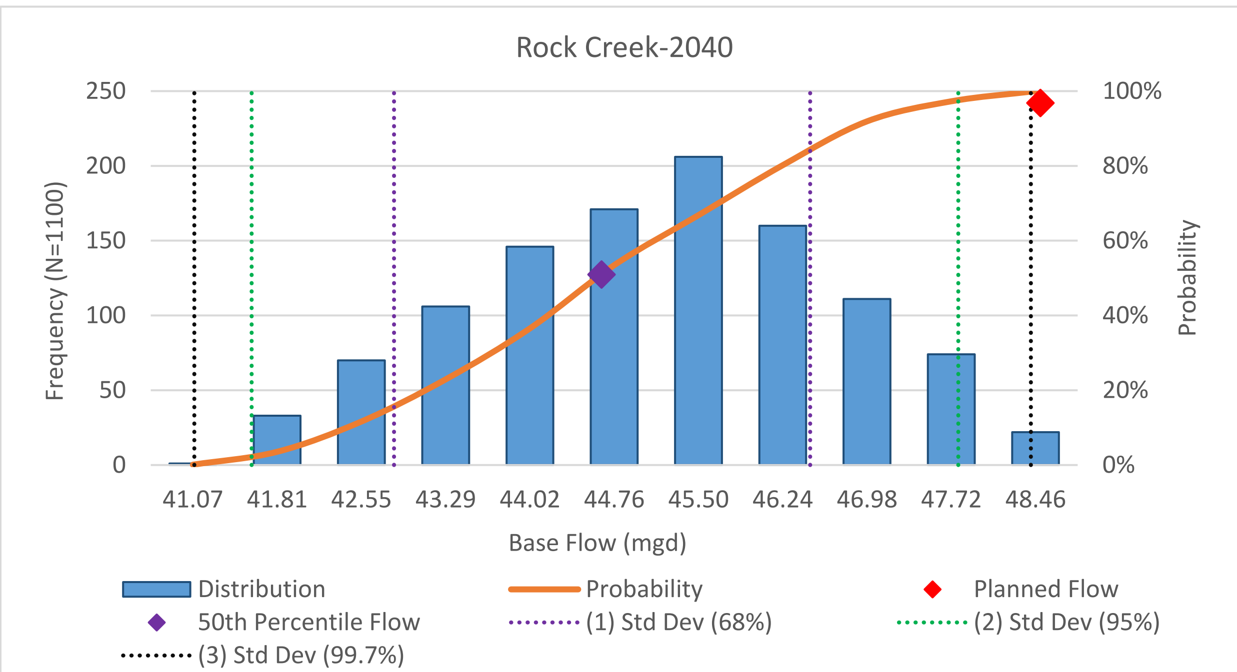

Figure 3B.5 Rock Creek, Base Flow Distribution, 2040

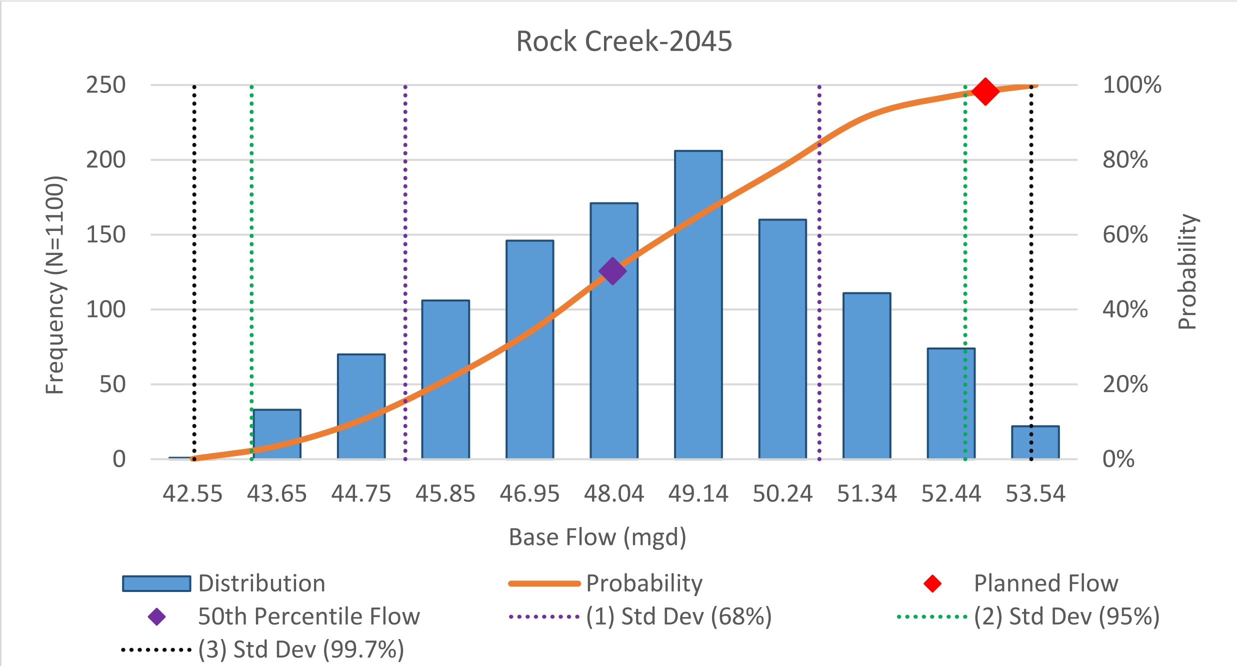

Figure 3B.6 Rock Creek, Base Flow Distribution, 2045

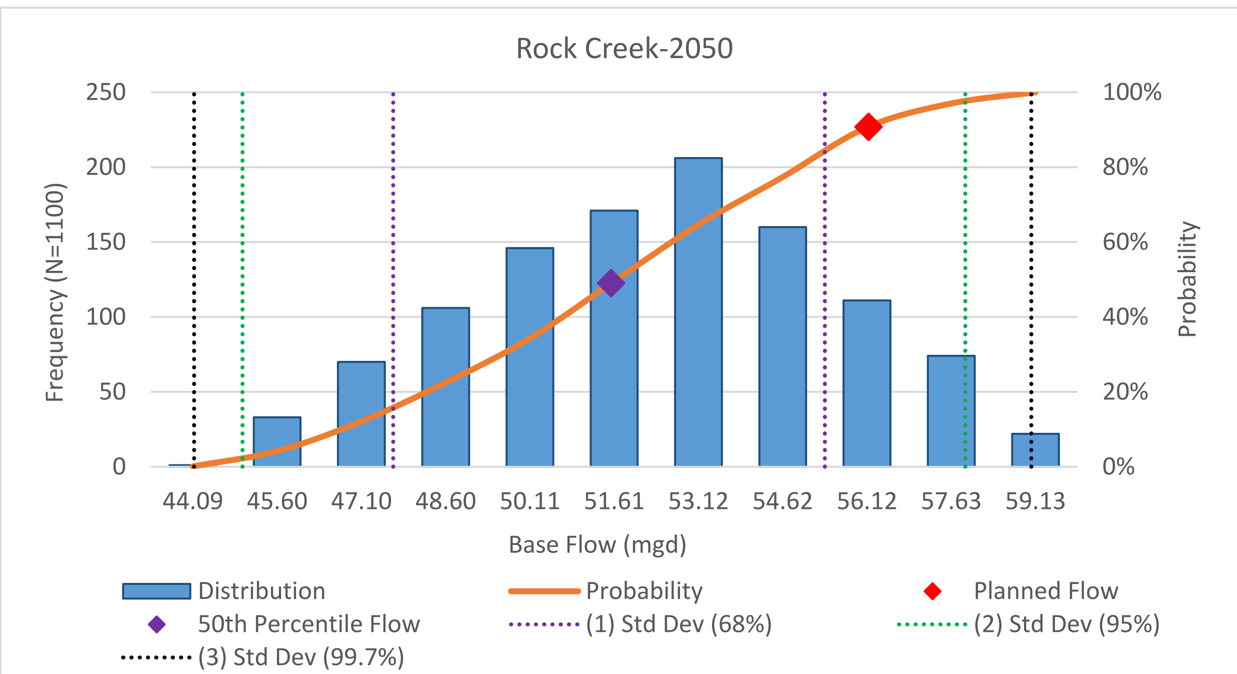

Figure 3B.7 Rock Creek, Base Flow Distribution, 2050

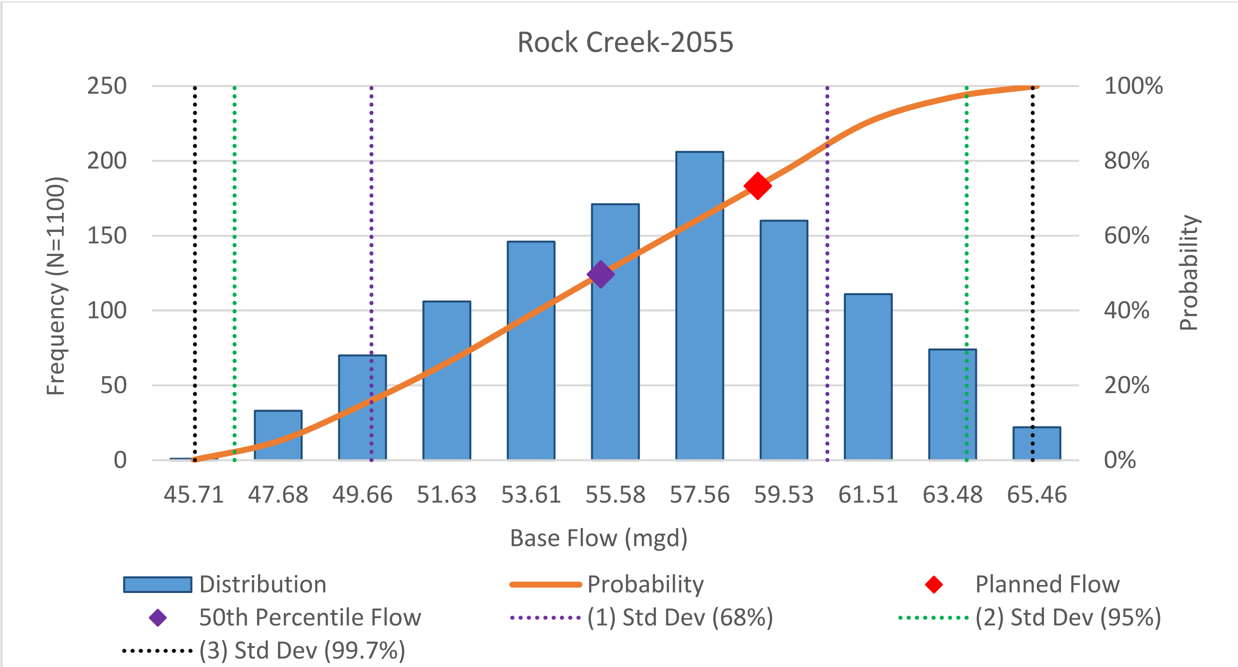

Figure 3B.8 Rock Creek, Base Flow Distribution, 2055

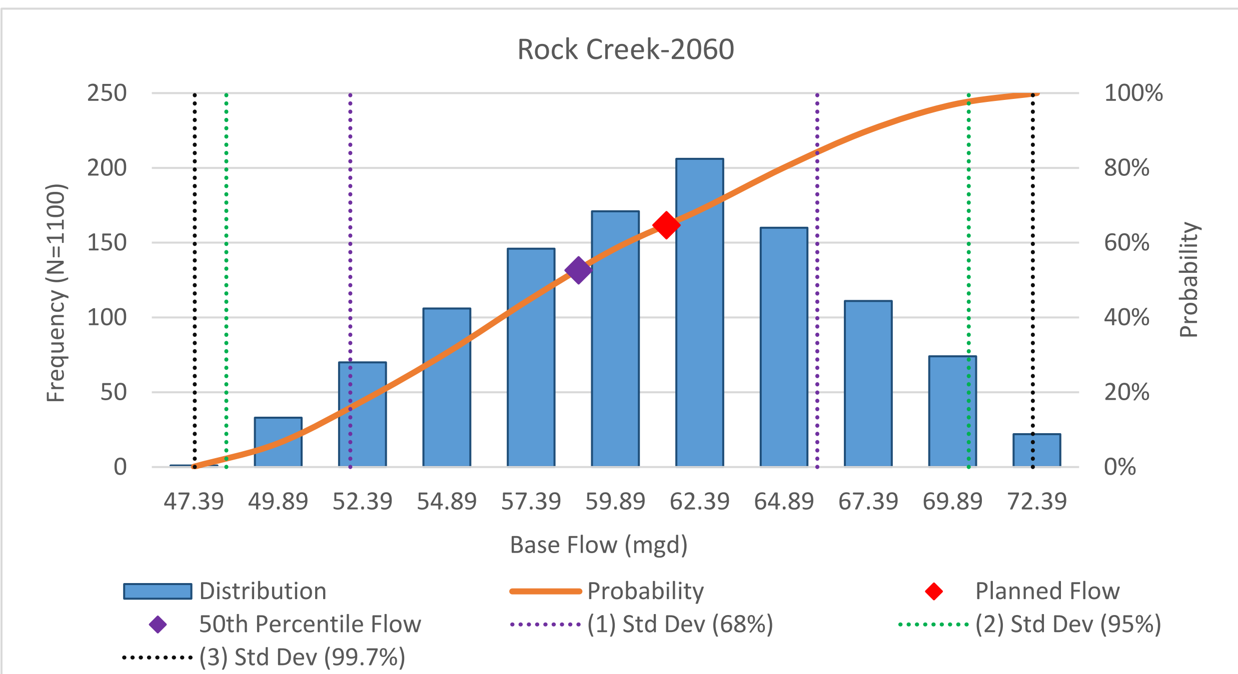

Figure 3B.9 Rock Creek, Base Flow Distribution, 2060

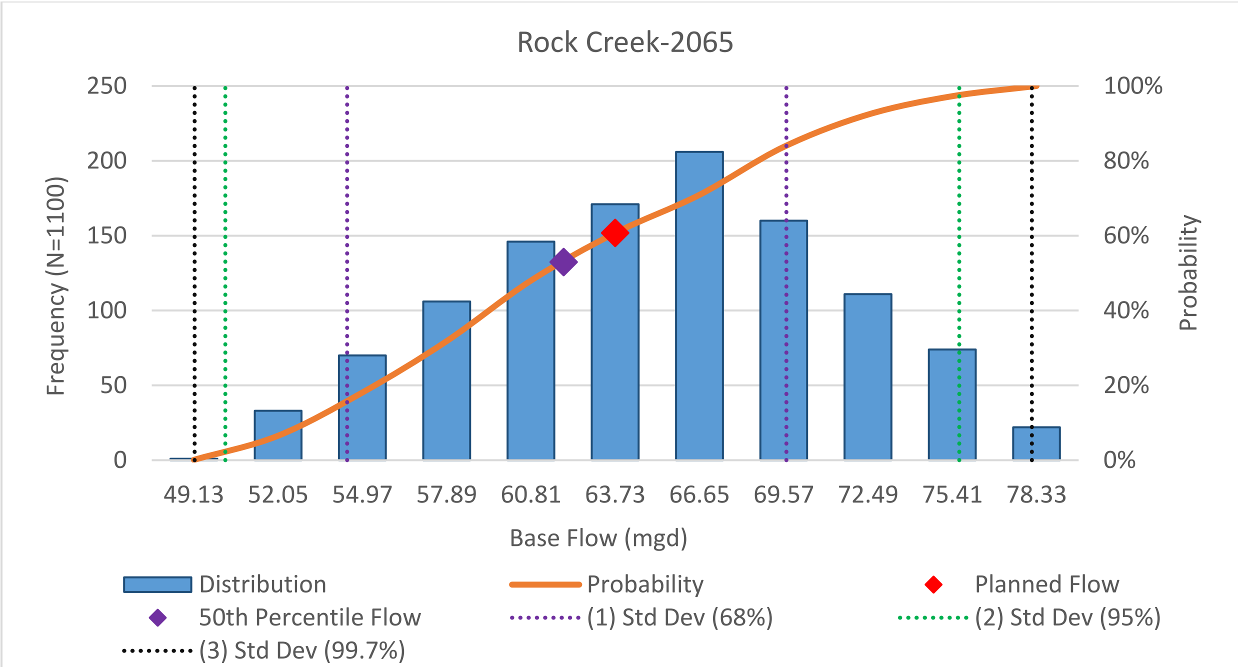

Figure 3B.10 Rock Creek, Base Flow Distribution, 2065

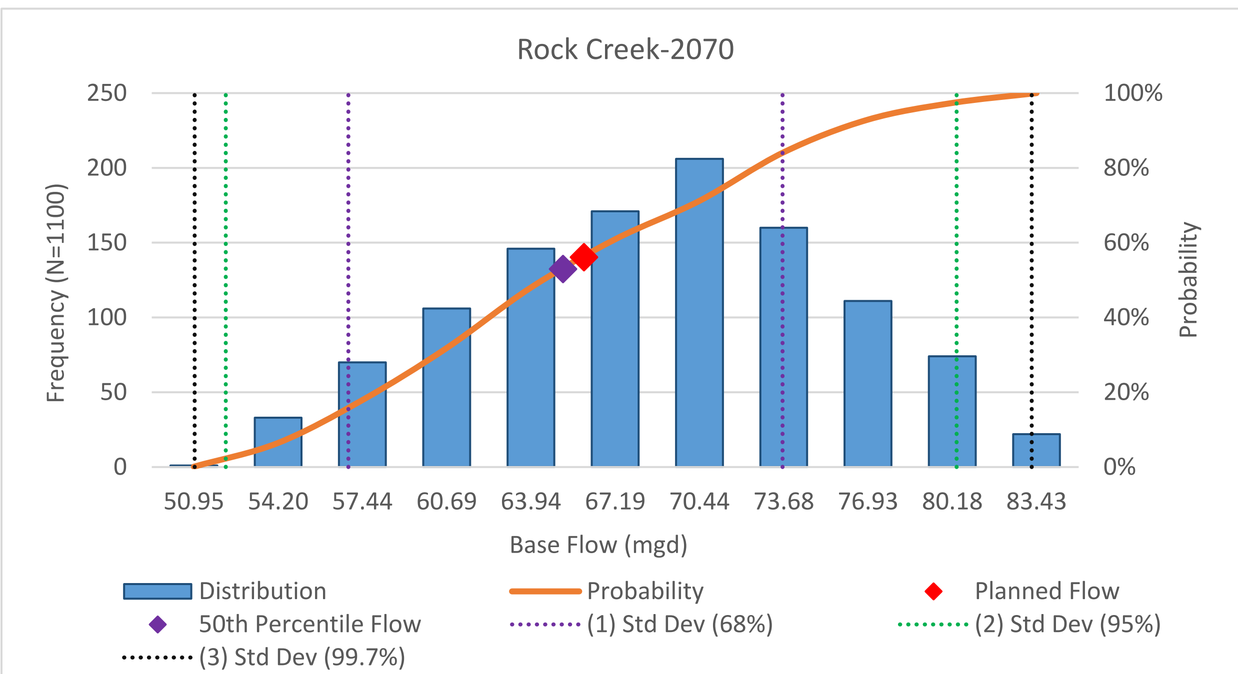

Figure 3B.11 Rock Creek, Base Flow Distribution, 2070

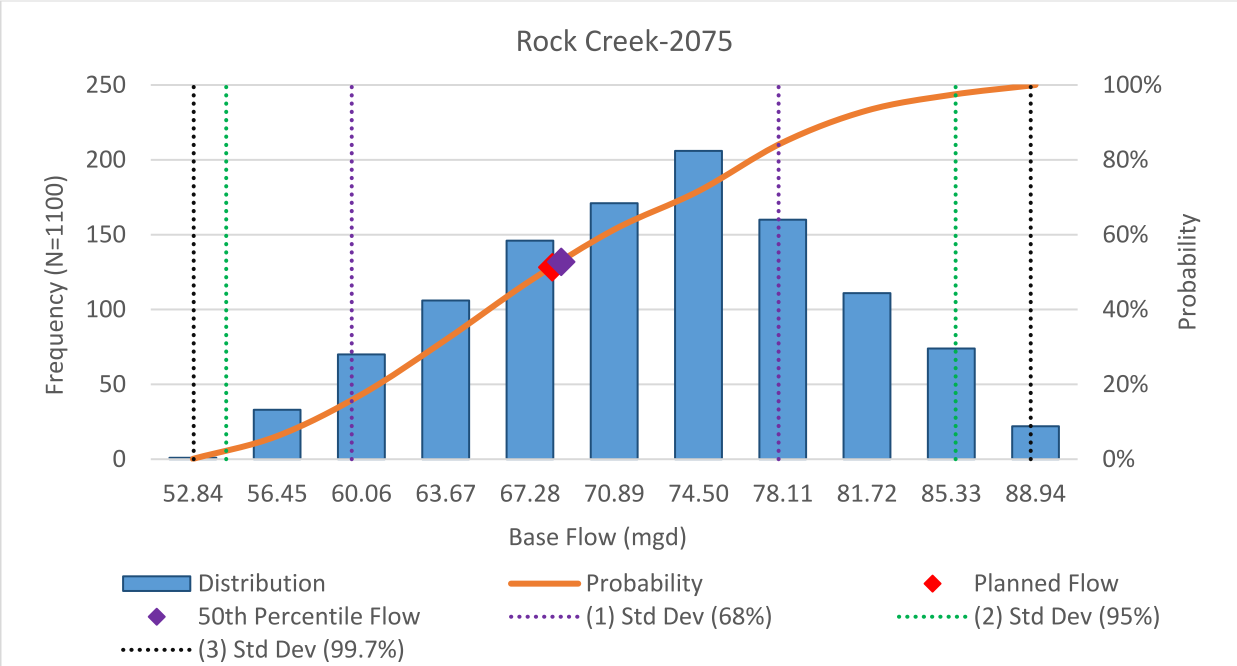

Figure 3B.12 Rock Creek, Base Flow Distribution, 2075

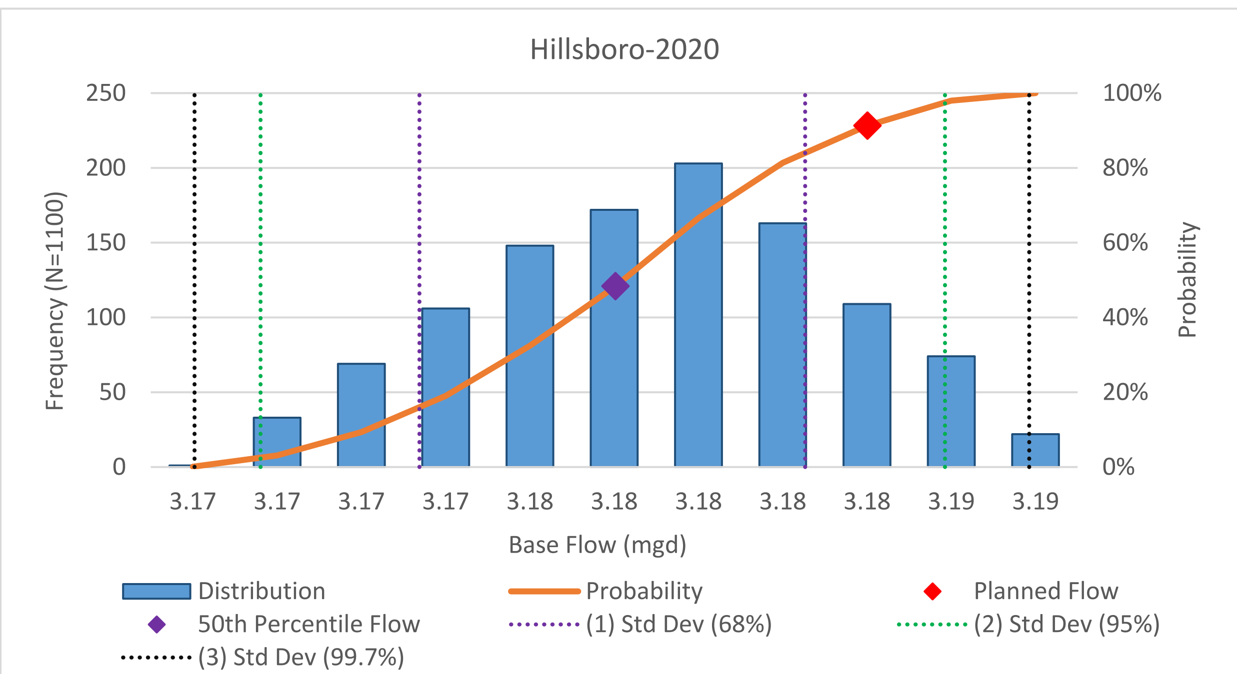

Figure 3B.13 Hillsboro, Base Flow Distribution, 2020

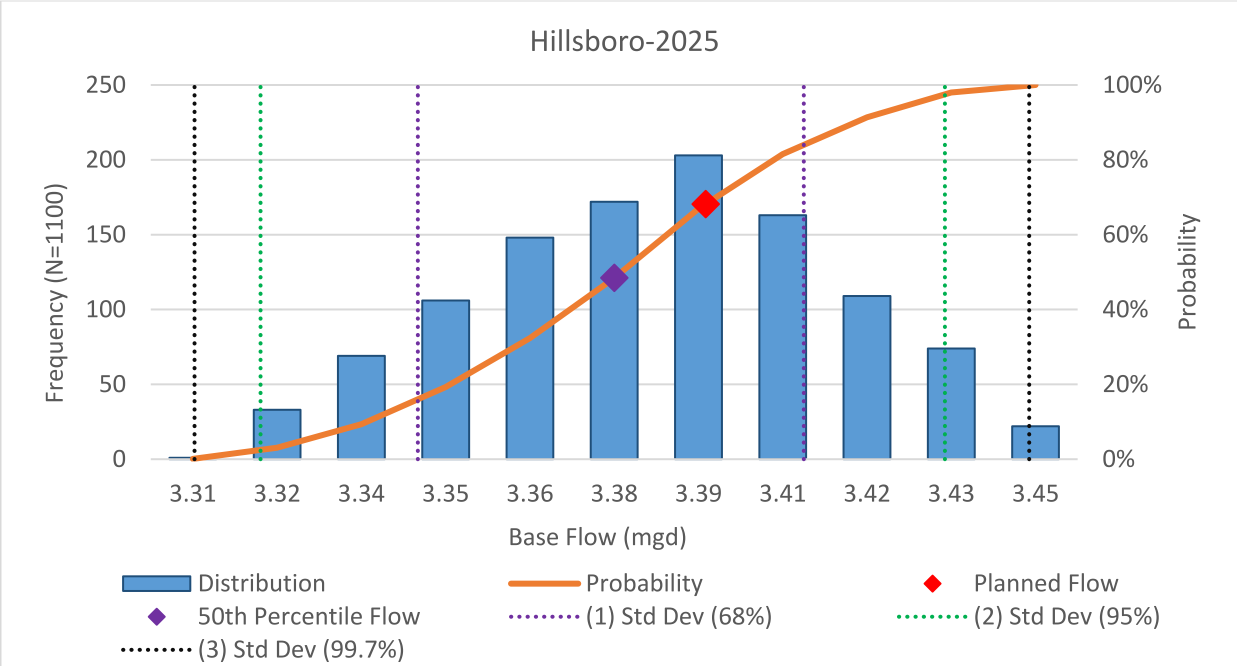

Figure 3B.14 Hillsboro, Base Flow Distribution, 2025

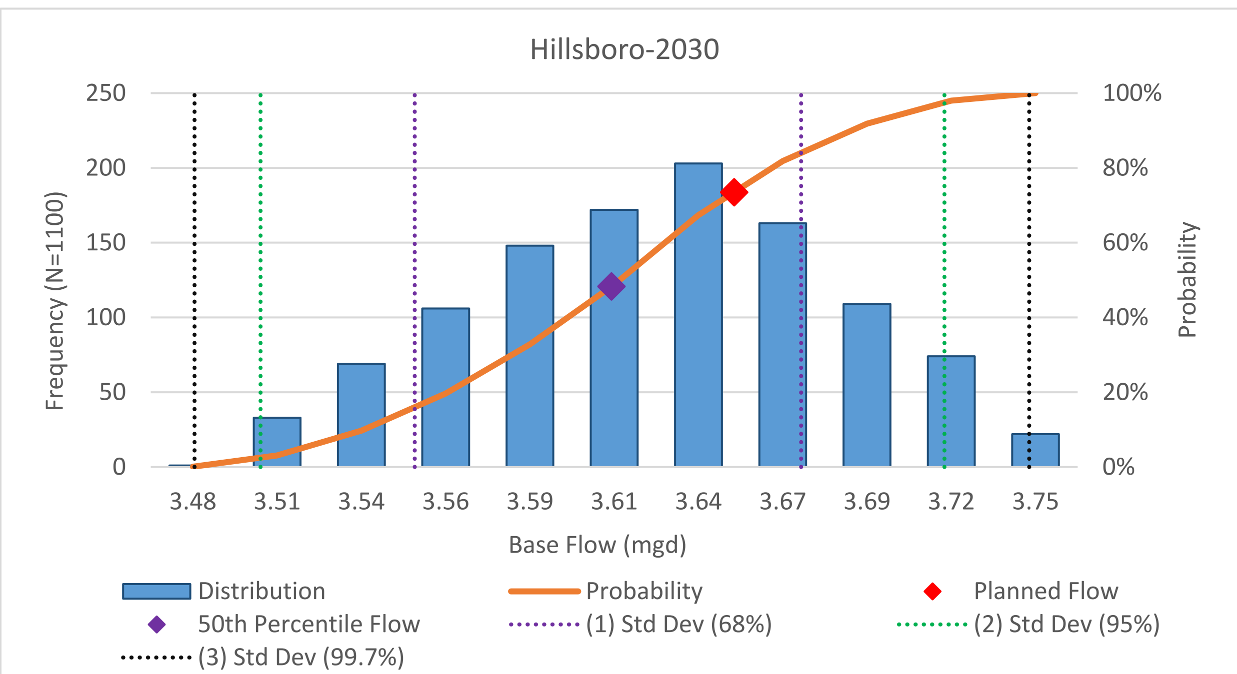

Figure 3B.15 Hillsboro, Base Flow Distribution, 2030

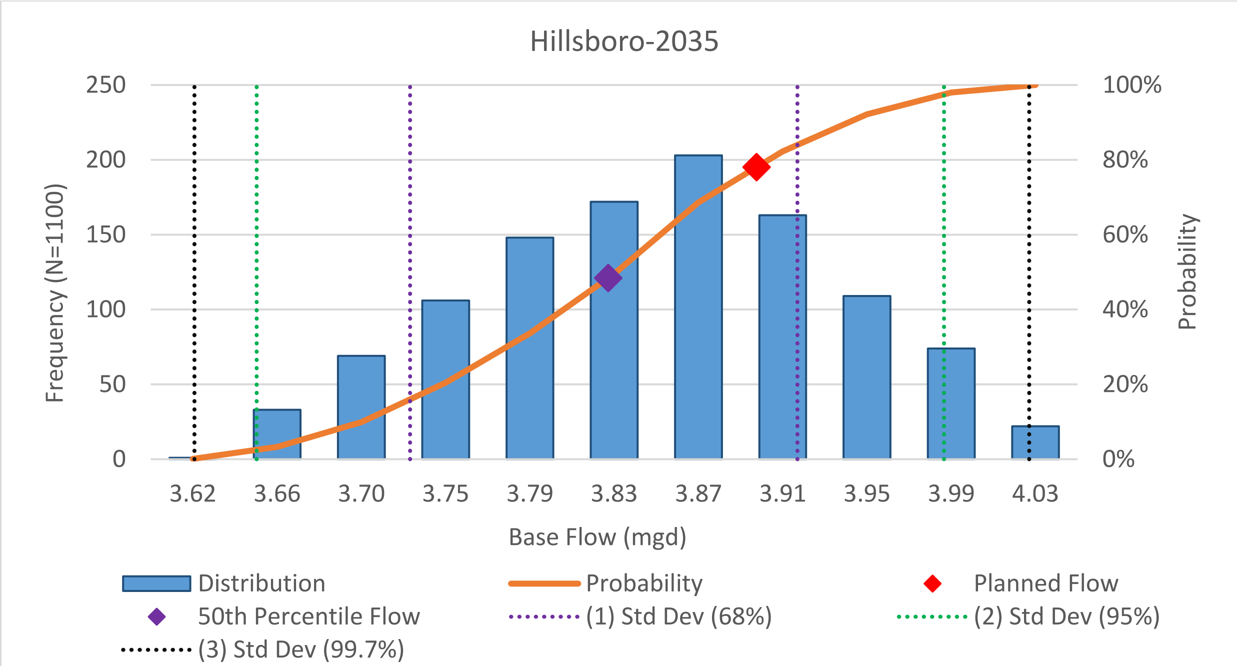

Figure 3B.16 Hillsboro, Base Flow Distribution, 2035

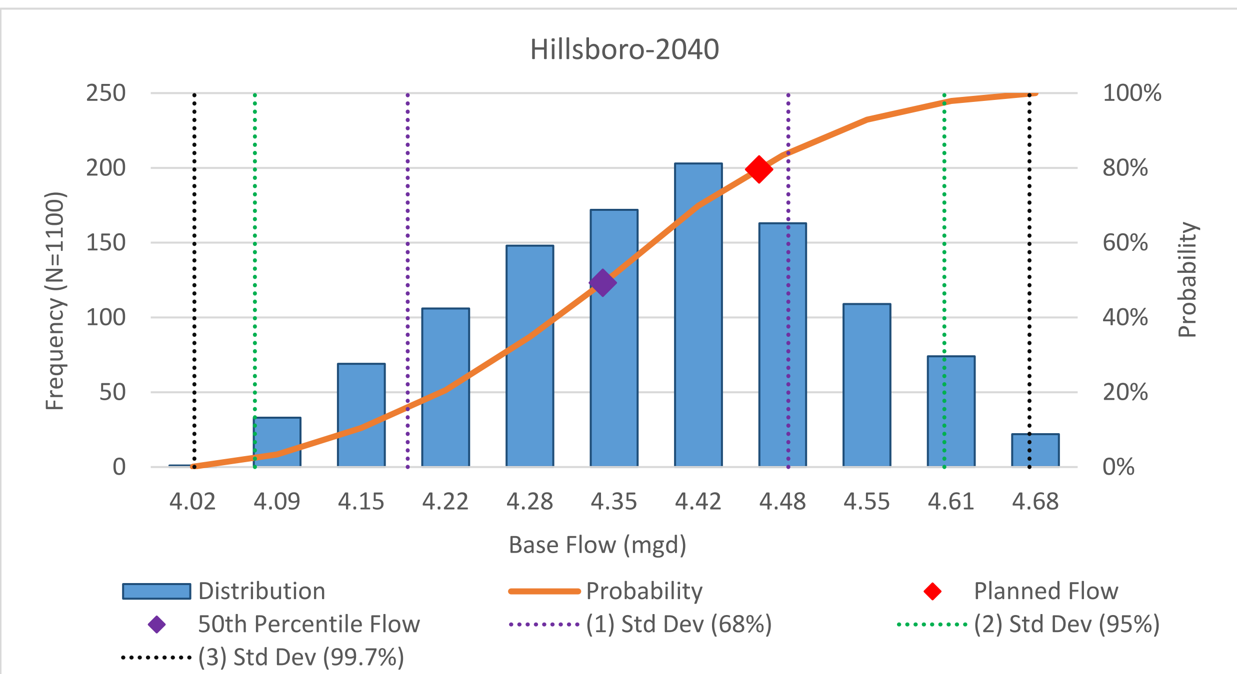

Figure 3B.17 Hillsboro, Base Flow Distribution, 2040

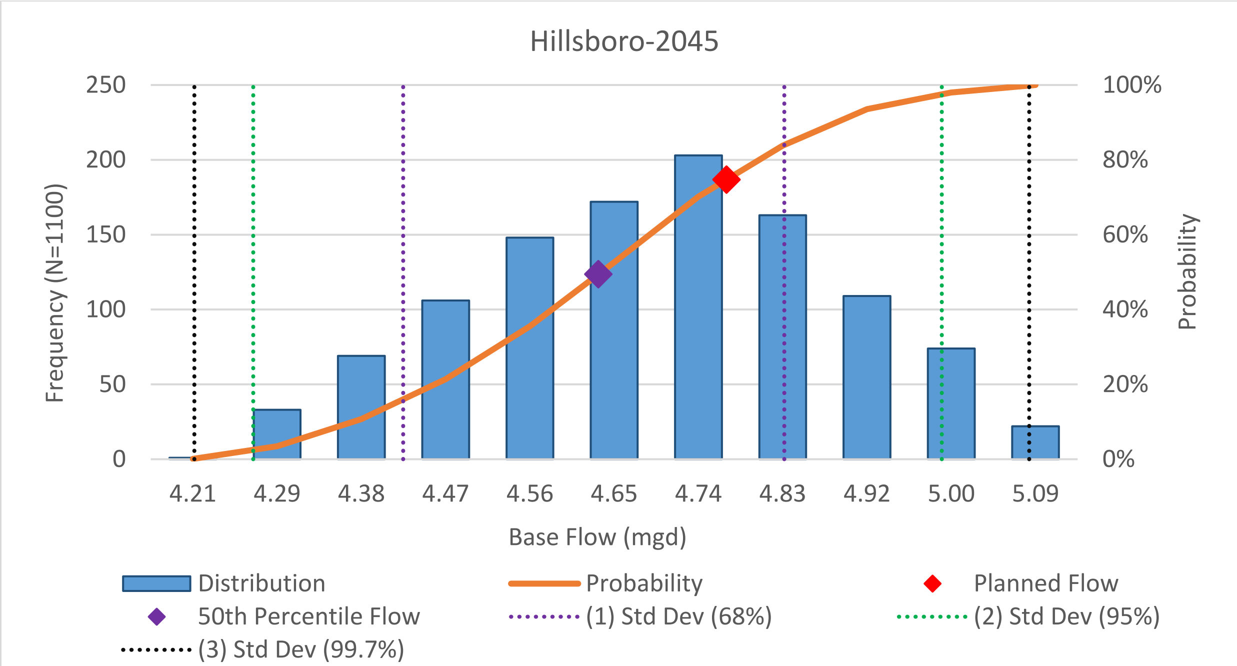

Figure 3B.18 Hillsboro, Base Flow Distribution, 2045

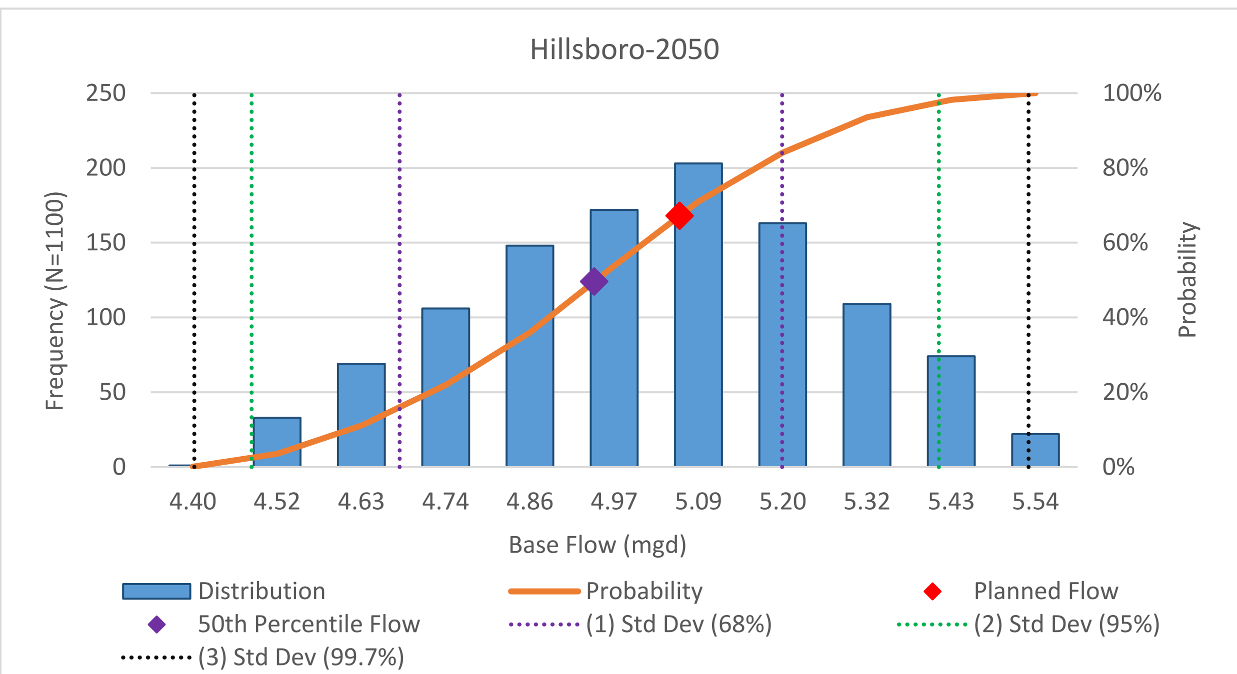

Figure 3B.19 Hillsboro, Base Flow Distribution, 2050

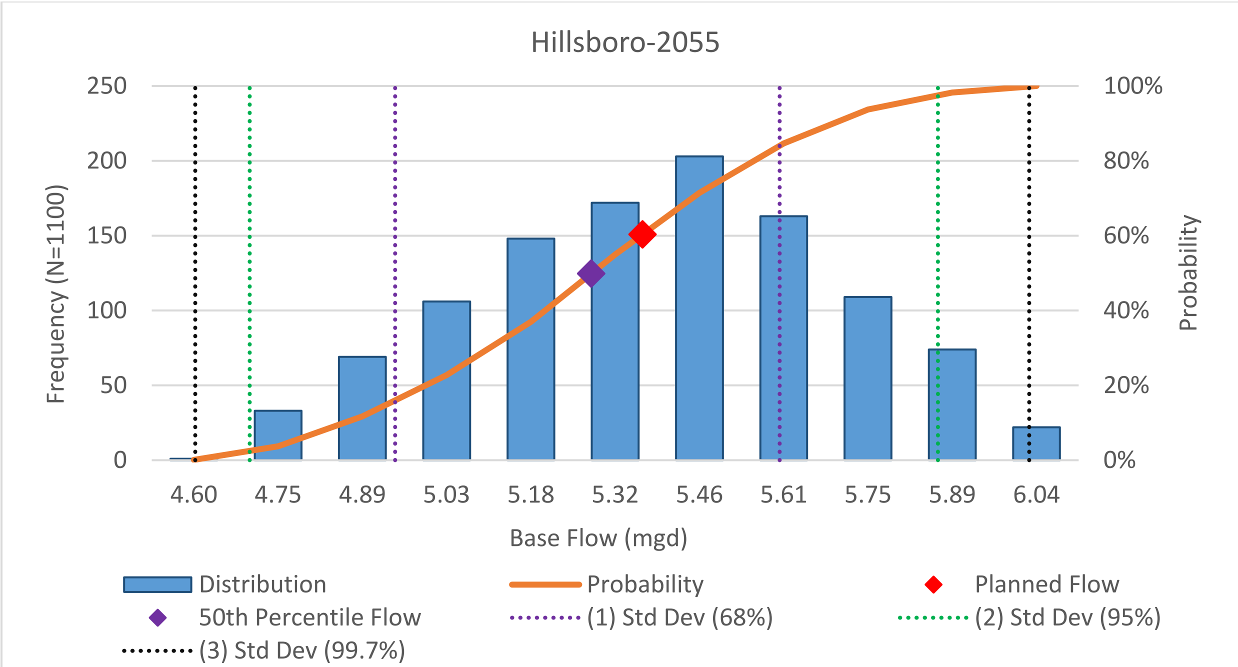

Figure 3B.20 Hillsboro, Base Flow Distribution, 2055

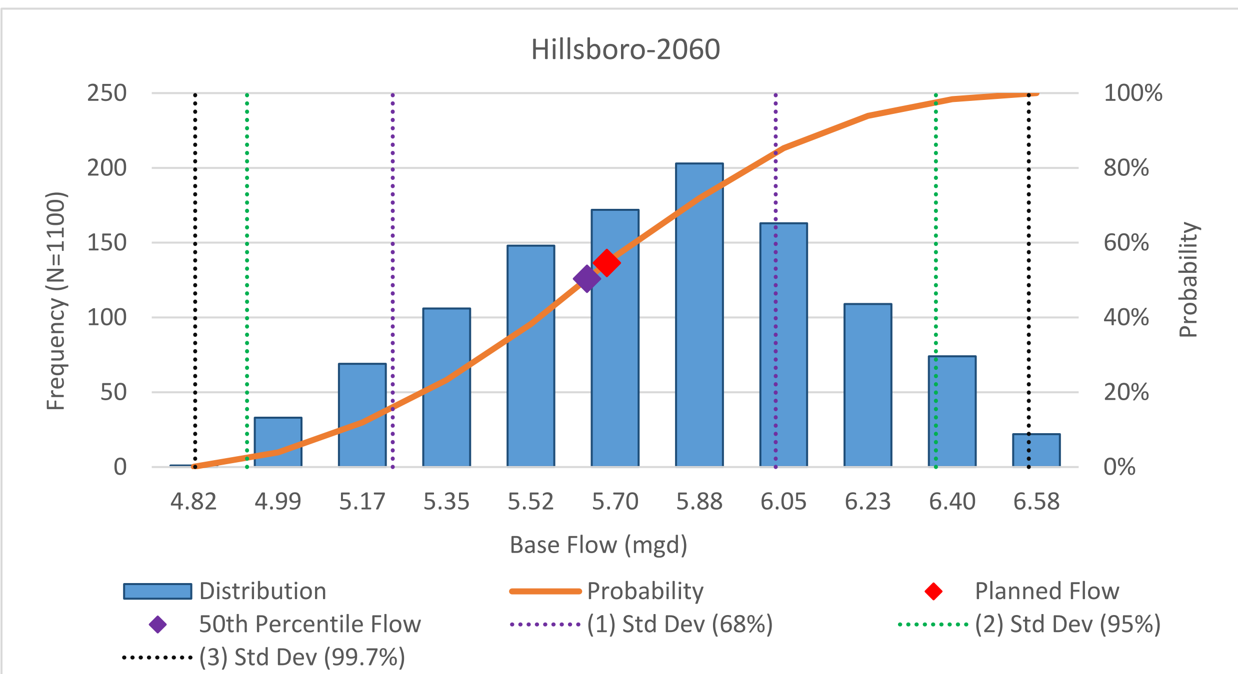

Figure 3B.21 Hillsboro, Base Flow Distribution, 2060

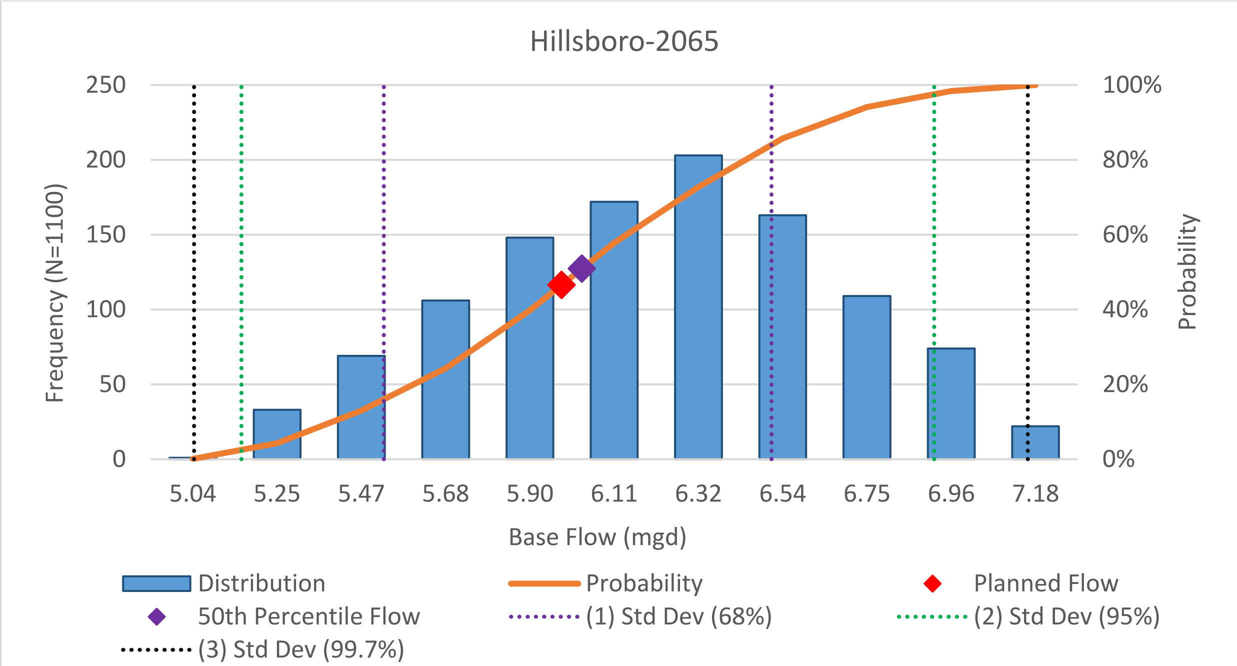

Figure 3B.22 Hillsboro, Base Flow Distribution, 2065

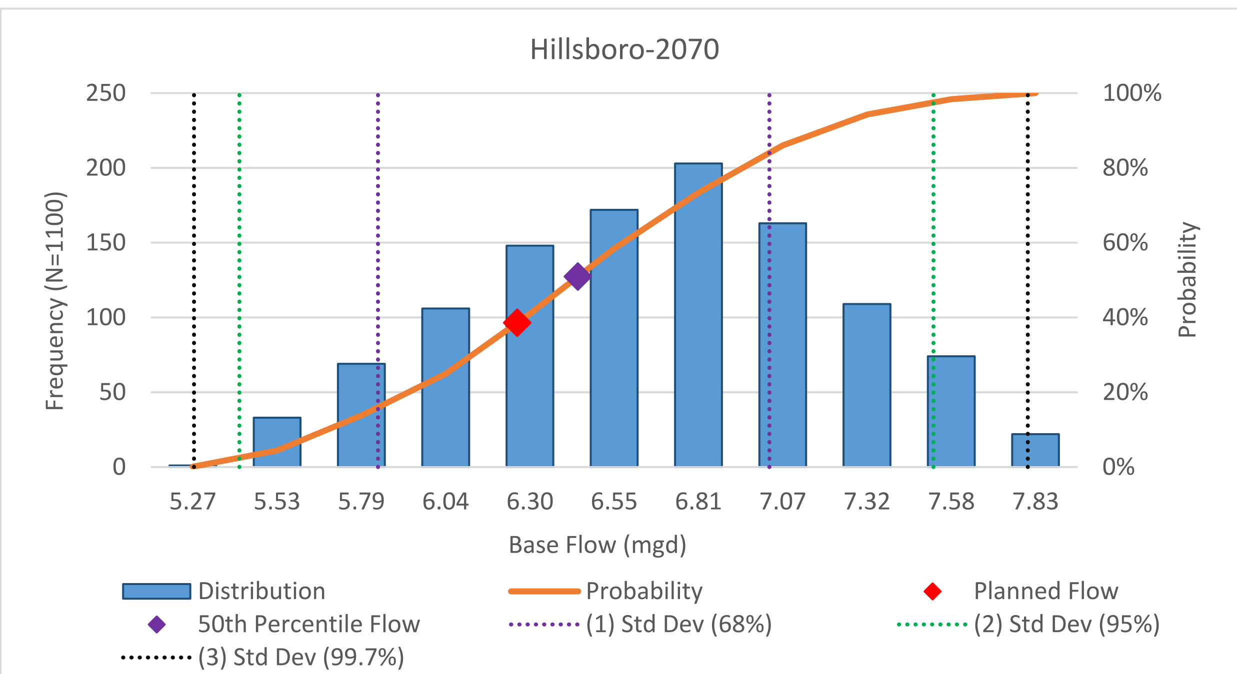

Figure 3B.23 Hillsboro, Base Flow Distribution, 2070

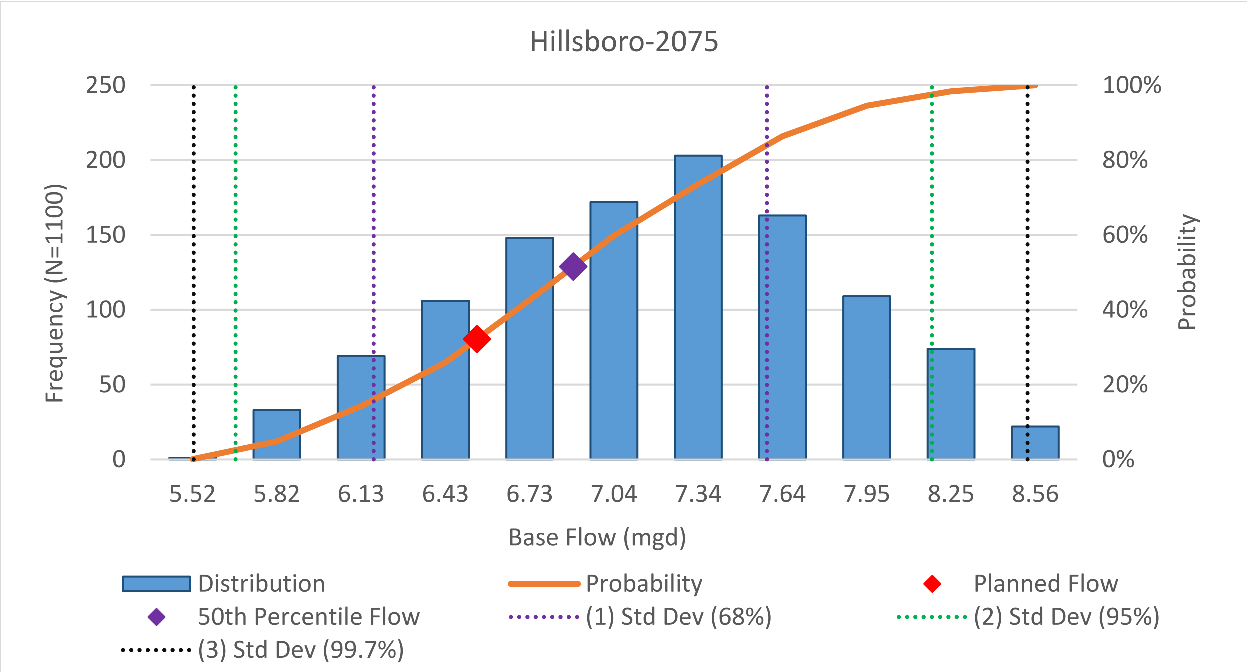

Figure 3B.24 Hillsboro, Base Flow Distribution, 2075

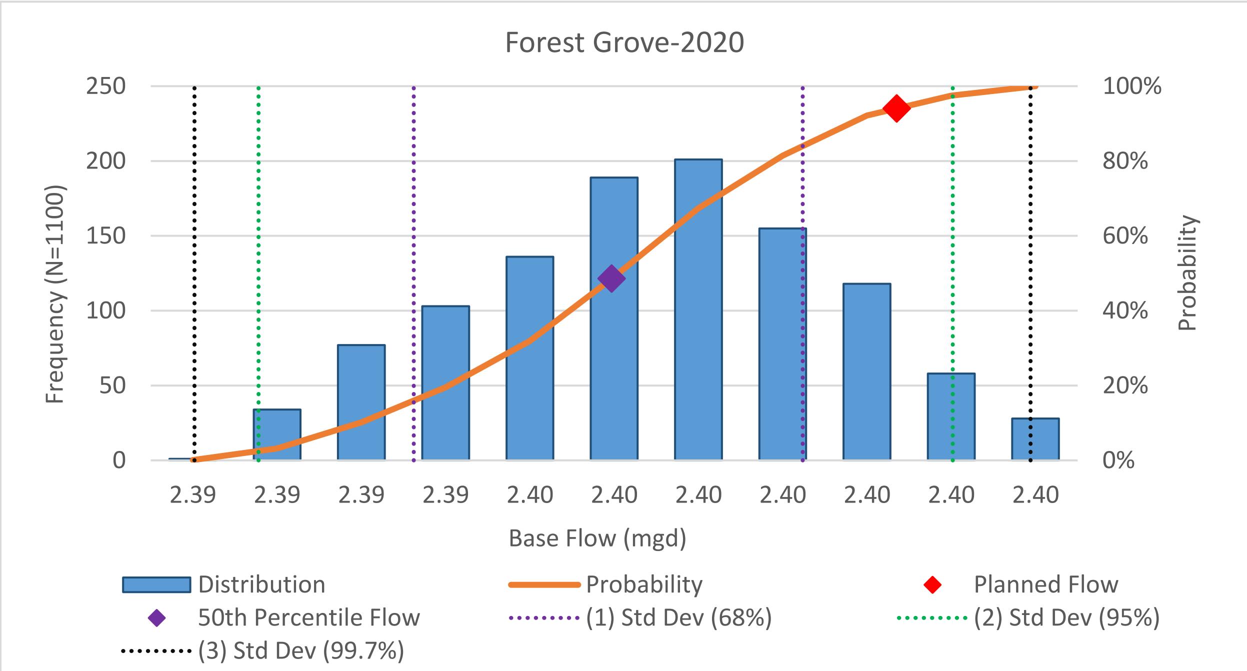

Figure 3B.25 Forest Grove, Base Flow Distribution, 2020

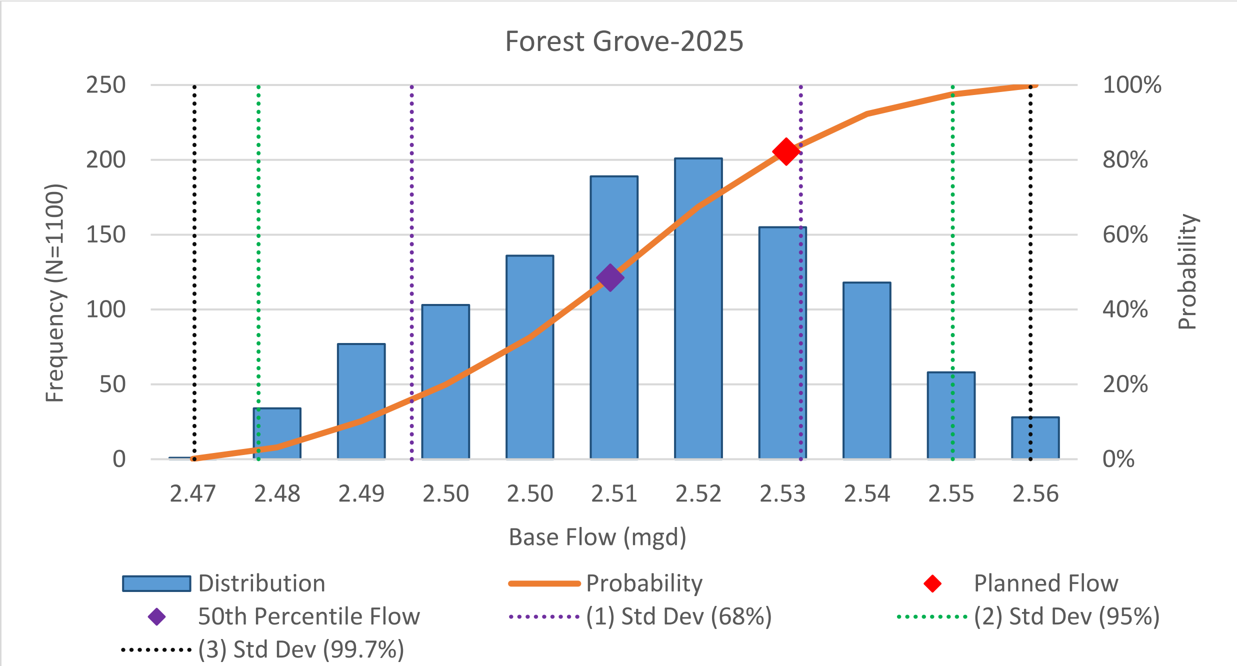

Figure 3B.26 Forest Grove, Base Flow Distribution, 2025

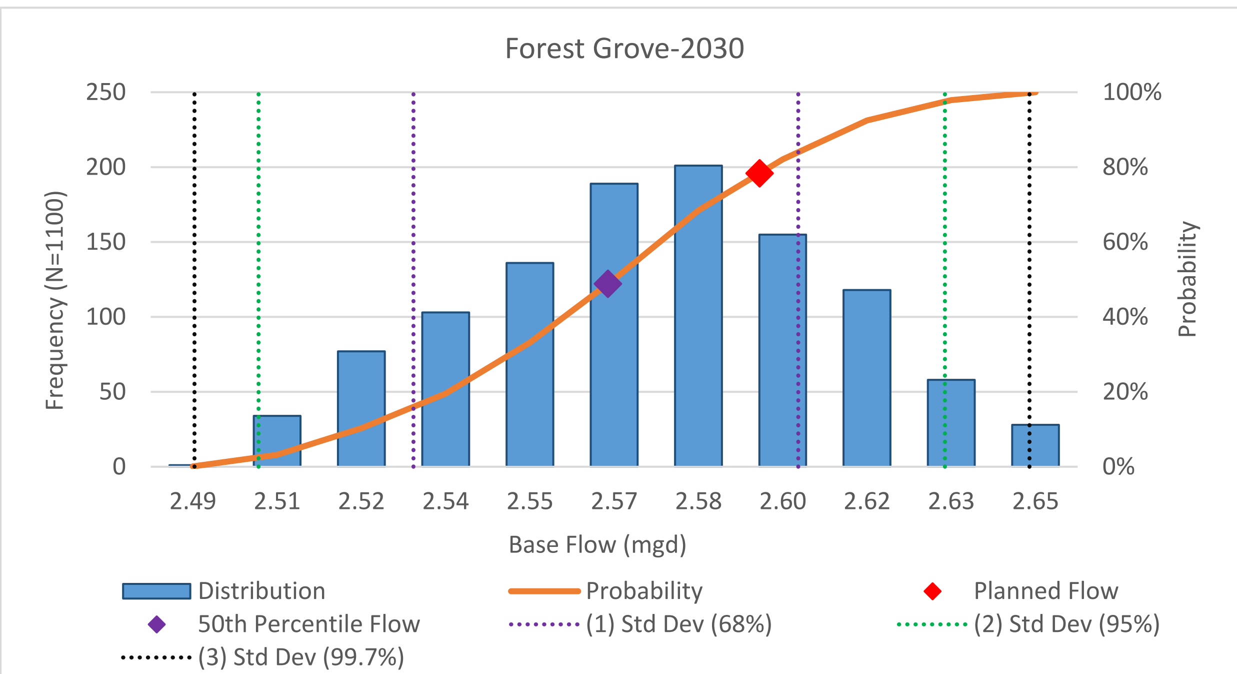

Figure 3B.27 Forest Grove, Base Flow Distribution, 2030

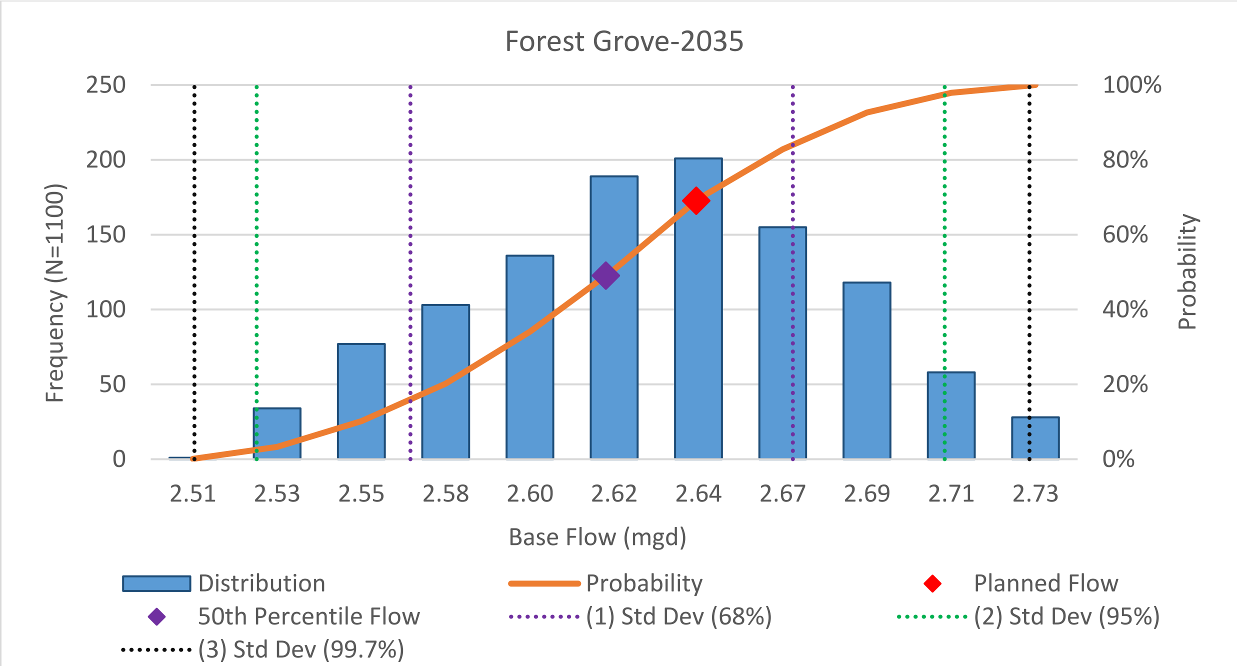

Figure 3B.28 Forest Grove, Base Flow Distribution, 2035

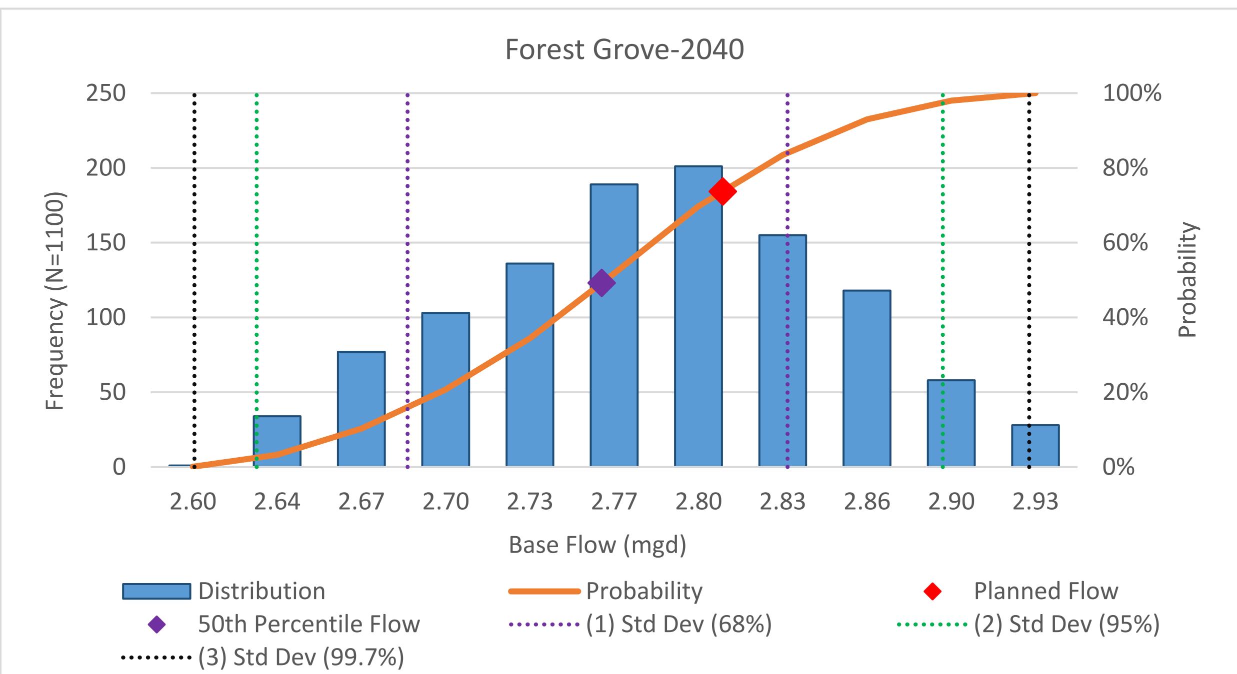

Figure 3B.29 Forest Grove, Base Flow Distribution, 2040

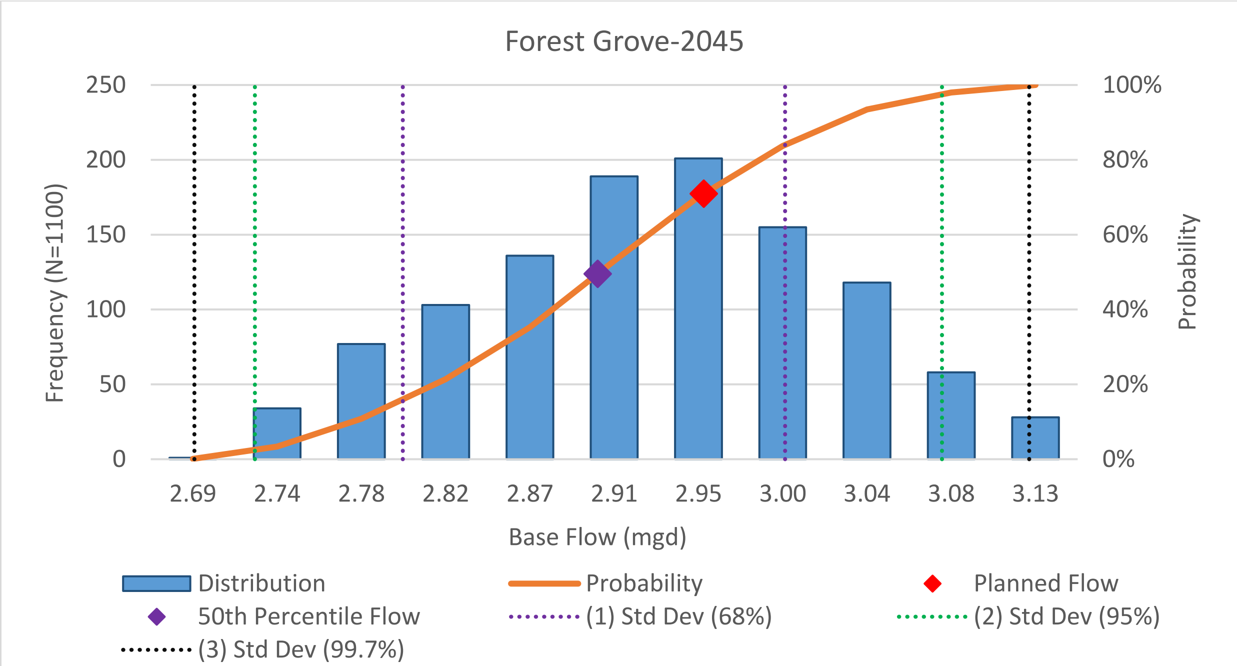

Figure 3B.30 Forest Grove, Base Flow Distribution, 2045

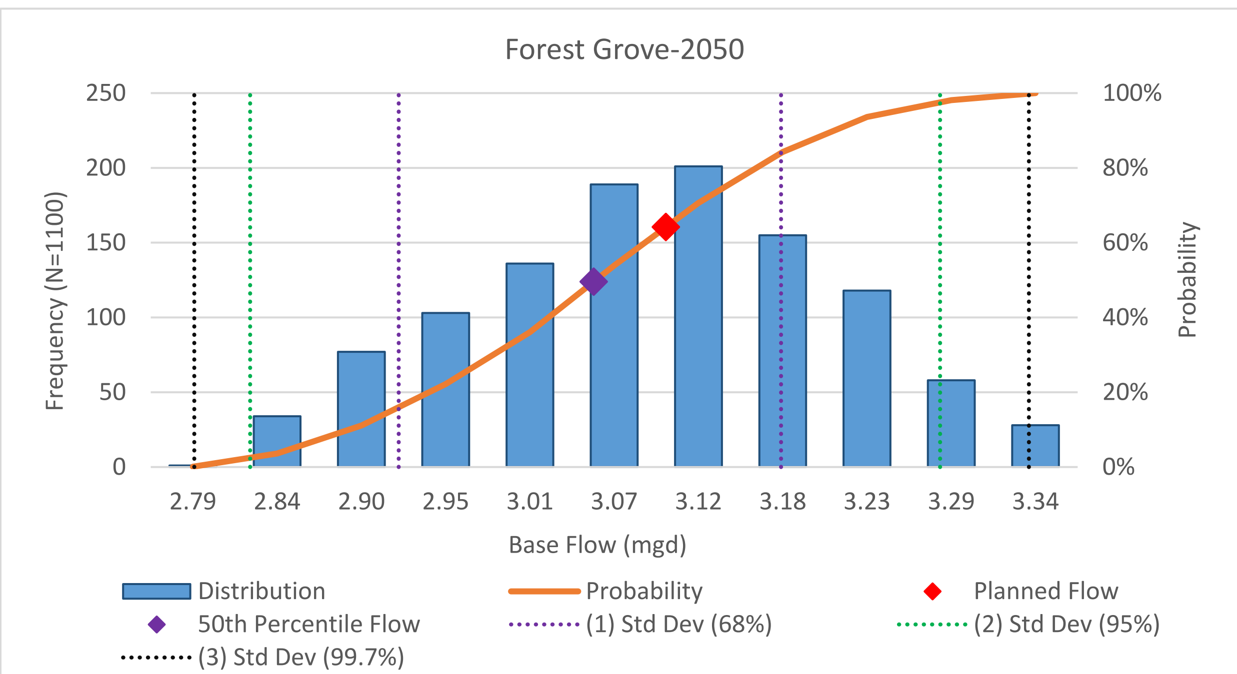

Figure 3B.31 Forest Grove, Base Flow Distribution, 2050

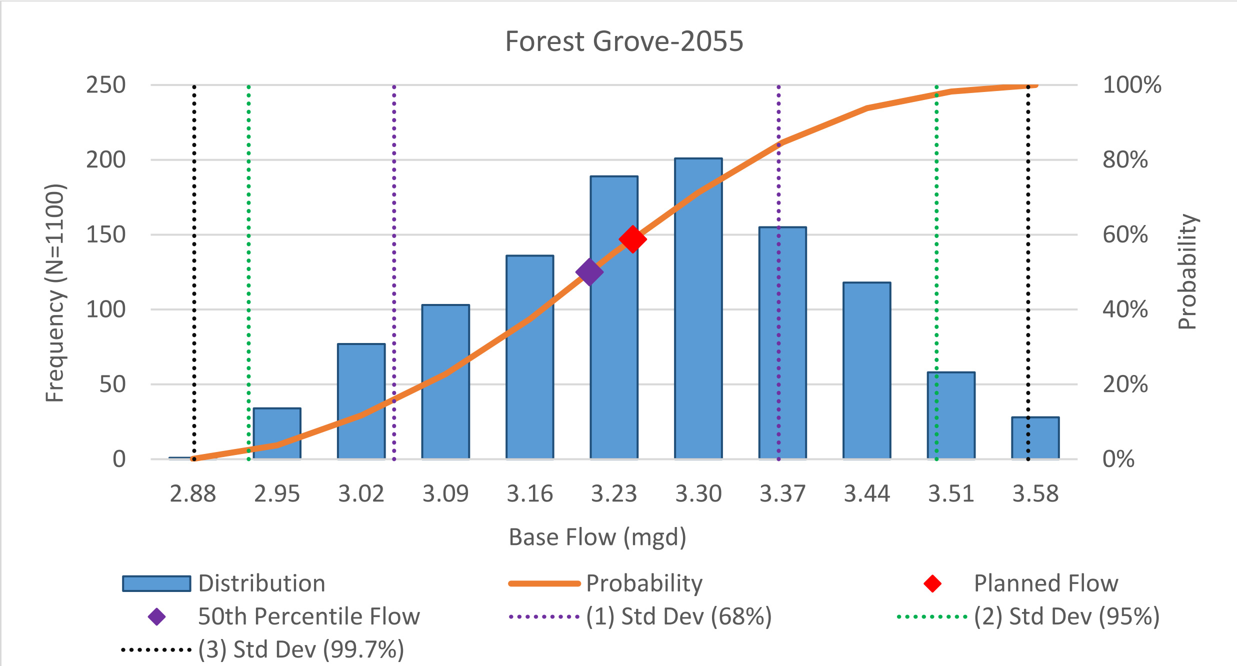

Figure 3B.32 Forest Grove, Base Flow Distribution, 2055

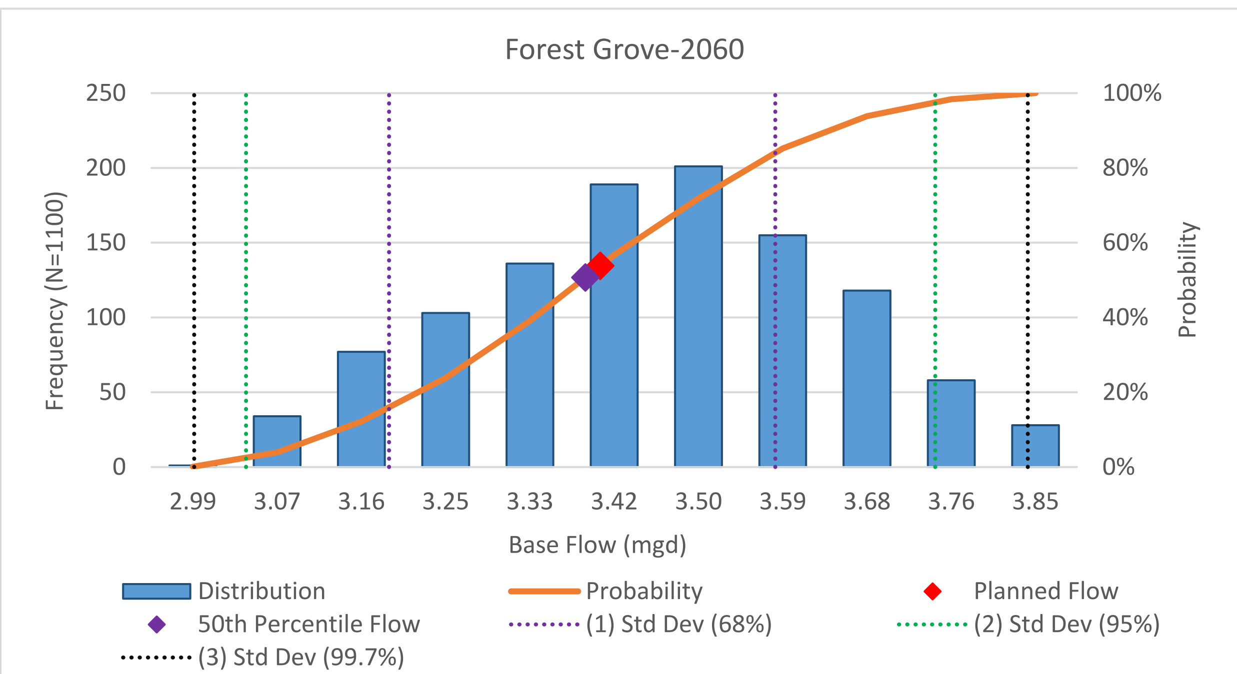

Figure 3B.33 Forest Grove, Base Flow Distribution, 2060

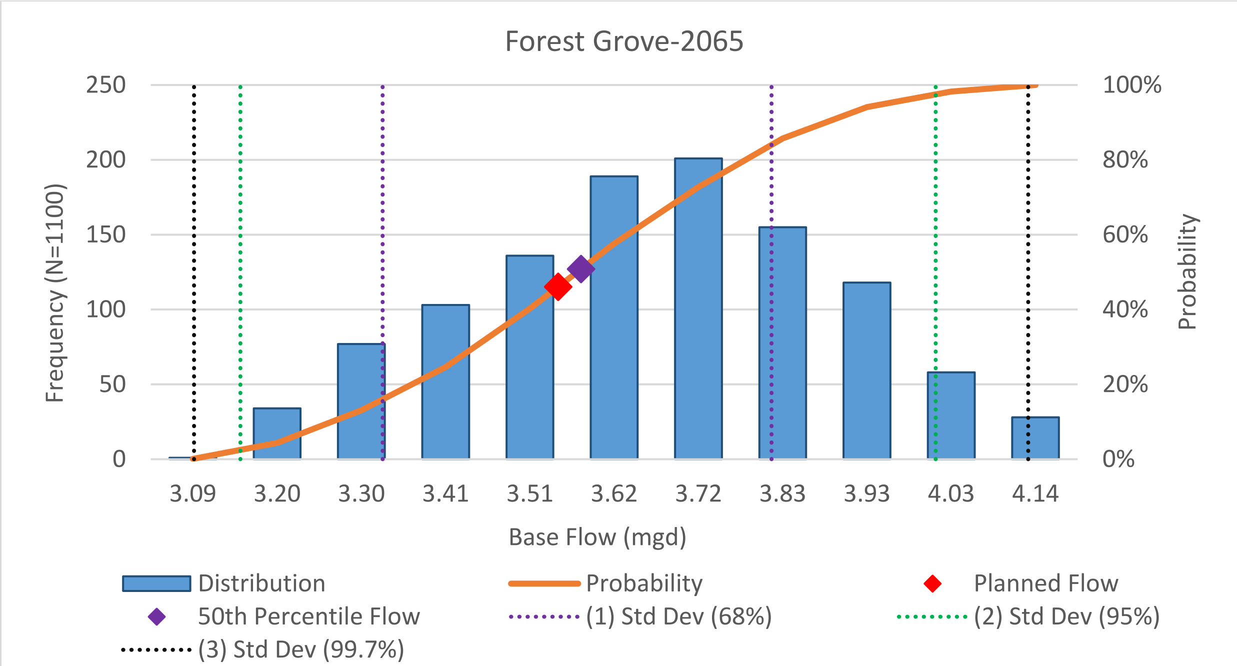

Figure 3B.34 Forest Grove, Base Flow Distribution, 2065

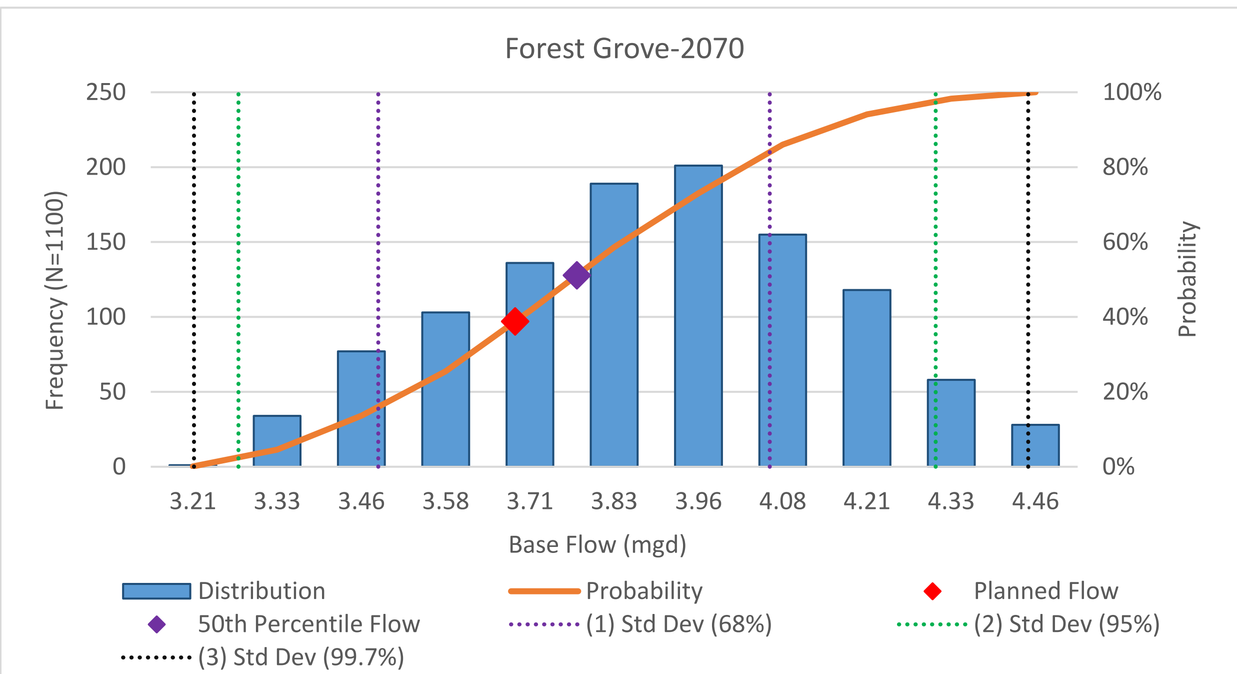

Figure 3B.35 Forest Grove, Base Flow Distribution, 2070

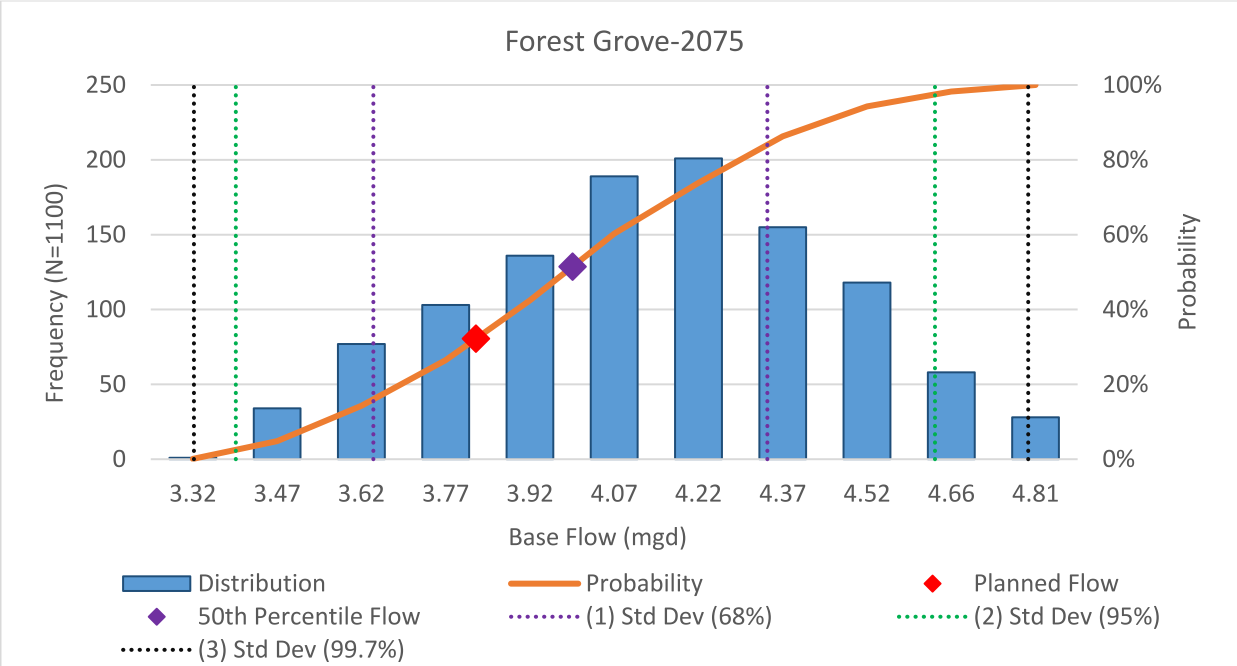

Figure 3B.36 Forest Grove, Base Flow Distribution, 2075

Table 3B.9 Rock Creek, Base Flow Range, Confidence Interval, and Level of Uncertainty Summary

Year	Minimum Potential Base Flow (mgd)	Maximum Potential Base Flow (mgd)	Planned Base Flow (mgd)	Probability of Planned Base Flow or Lower	Confidence Interval	Level of Uncertainty (conservatism)	Note
2020	30.1	30.3	30.2	91%	95%	moderately high uncertainty, conservative	differential between min and max is low due to limited years of growth
2025	34.7	35.7	35.3	67%	68%	less uncertainty, less conservative	
2030	37.2	40.0	40.1	99%	>99.7%	highest uncertainty, very conservative	uncertainty and conservatism caused by growth assumption in North Hillsboro between 2030 and 2050
2035	39.9	44.9	44.8	99%	99.7%	high uncertainty, very conservative	
2040	41.1	48.5	48.7	97%	>99.7%	highest uncertainty, very conservative	
2045	42.6	53.5	52.9	98%	99.7%	high uncertainty, very conservative	
2050	44.1	59.1	56.2	91%	95%	moderately high uncertainty, conservative	
2055	45.7	65.5	58.9	73%	68%	less uncertainty, less conservative	less uncertainty with decreased growth rate in North Hillsboro after 2050
2060	47.4	72.4	61.4	65%	68%	less uncertainty, less conservative	
2065	49.1	78.3	63.7	61%	68%	less uncertainty, less conservative	

Year	Minimum Potential Base Flow (mgd)	Maximum Potential Base Flow (mgd)	Planned Base Flow (mgd)	Probability of Planned Base Flow or Lower	Confidence Interval	Level of Uncertainty (conservatism)	Note
2070	50.9	83.4	66.0	56%	68%	less uncertainty, less conservative	
2075	52.8	88.9	68.2	51%	68%	less uncertainty, less conservative	

Table 3B.2 Hillsboro, Base Flow Range, Confidence Interval, and Level of Uncertainty Summary[1]

Year	Minimum Potential Base Flow (mgd)	Maximum Potential Base Flow (mgd)	Planned Base Flow (mgd)	Probability of Planned Base Flow or Lower	Confidence Interval	Level of Uncertainty (conservatism)	Note
2020	3.17	3.19	3.18	91%	95%	moderately high uncertainty, conservative	differential between min and max is low due to limited years of growth
2025	3.31	3.45	3.39	68%	68%	less uncertainty, less conservative	
2030	3.48	3.75	3.65	73%	68%	less uncertainty, less conservative	probability of occurrence is greater than the mean through 2060 but within one standard deviation; probability approaches the mean slightly before 2065 indicating that planned base flows are slightly conservative
2035	3.62	4.03	3.90	78%	68%	less uncertainty, less conservative	
2040	4.02	4.68	4.46	80%	68%	less uncertainty, less conservative	
2045	4.21	5.09	4.77	75%	68%	less uncertainty, less conservative	

Year	Minimum Potential Base Flow (mgd)	Maximum Potential Base Flow (mgd)	Planned Base Flow (mgd)	Probability of Planned Base Flow or Lower	Confidence Interval	Level of Uncertainty (conservatism)	Note
2050	4.40	5.54	5.06	67%	68%	less uncertainty, less conservative	
2055	4.60	6.04	5.37	60%	68%	less uncertainty, less conservative	
2060	4.82	6.58	5.68	55%	68%	less uncertainty, less conservative	
2065	5.04	7.18	5.98	47%	68%	less uncertainty, less conservative	
2070	5.27	7.83	6.26	39%	68%	less uncertainty, less conservative	probability of occurrence is lower than the mean after 2065 indicating that planned base flows are not conservative
2075	5.52	8.56	6.54	32%	68%	less uncertainty, less conservative	

Note 1, Table 3B.2. The sudden increase in employment growth rate between 2035-2040 in the Hillsboro treatment basin, as extracted from the Metro TAZ data, results in an additional 10,000 employees and 0.3 mgd of base flow when compared to a constant employment growth rate. The 0.3 mgd increase represents approximately 8-percent of the planned base flow by 2040. The uncertainty analysis considers a range of employment growth rates including iterations that produce base flows if the employment rate is held constant. As currently planned, with the sudden increase, the probability of flow occurrence is 80% by 2040 (conservative, less certain). Reduced by 0.3 mgd the probability of flow occurrence drops to 18% by 2040 (less conservative, more certain). See figure below.

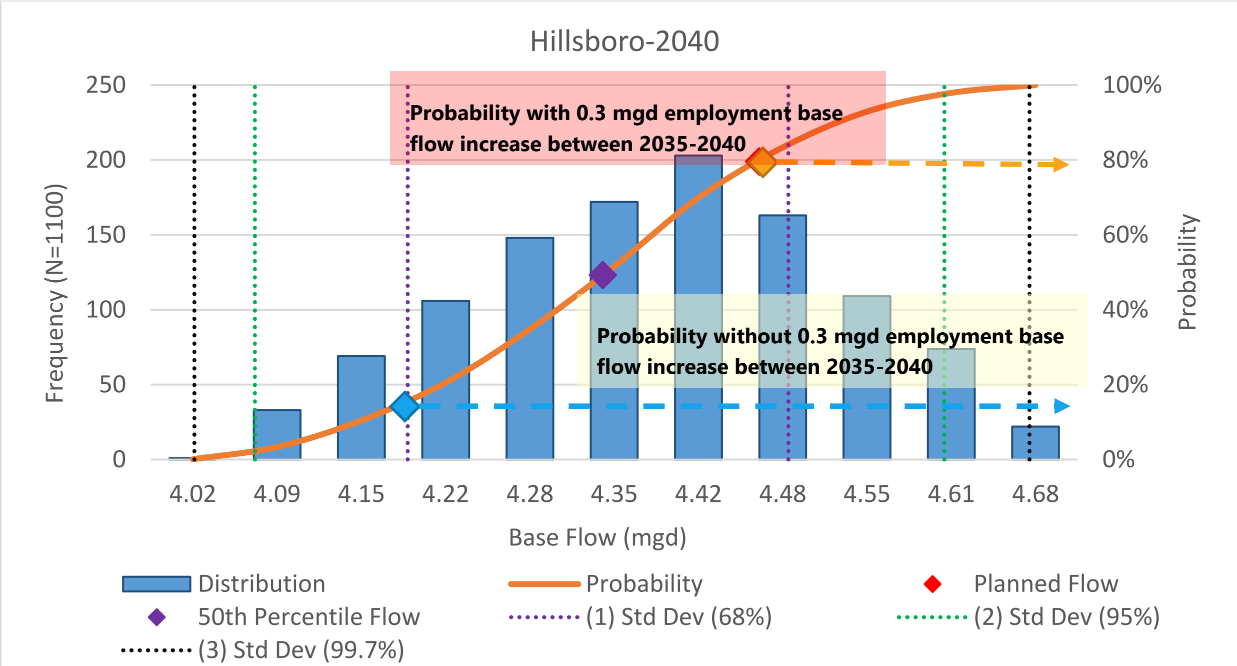

Figure 3B.37 Base Flow Distribution, Planned Base Flow, Probability, and Confidence Interval Plot, Hillsboro 2040

Table 3B.3 Forest Grove, Base Flow Range, Confidence Interval, and Level of Uncertainty Summary[1]

Year	Minimum Potential Base Flow (mgd)	Maximum Potential Base Flow (mgd)	Planned Base Flow (mgd)	Probability of Planned Base Flow or Lower	Confidence Interval	Level of Uncertainty (conservatism)	Note
2020	2.39	2.40	2.40	94%	95%	moderately high uncertainty, conservative	differential between min and max is low due to limited years of growth
2025	2.47	2.56	2.53	82%	68%	less uncertainty, less conservative	
2030	2.49	2.65	2.60	78%	68%	less uncertainty, less conservative	probability of occurrence is greater than the mean through 2060 but within one standard deviation; probability approaches the mean slightly before 2065 indicating that planned base flows are slightly conservative
2035	2.51	2.73	2.64	69%	68%	less uncertainty, less conservative	
2040	2.60	2.93	2.81	74%	68%	less uncertainty, less conservative	
2045	2.69	3.13	2.96	71%	68%	less uncertainty, less conservative	
2050	2.79	3.34	3.10	64%	68%	less uncertainty, less conservative	
2055	2.88	3.58	3.25	59%	68%	less uncertainty, less conservative	
2060	2.99	3.85	3.40	54%	68%	less uncertainty, less conservative	
2065	3.09	4.14	3.55	46%	68%	less uncertainty, less conservative	
2070	3.21	4.46	3.69	39%	68%	less uncertainty, less conservative	probability of occurrence is lower than the mean after 2065

Year	Minimum Potential Base Flow (mgd)	Maximum Potential Base Flow (mgd)	Planned Base Flow (mgd)	Probability of Planned Base Flow or Lower	Confidence Interval	Level of Uncertainty (conservatism)	Note
2075	3.32	4.81	3.82	32%	68%	less uncertainty, less conservative	indicating that planned base flows are not conservative