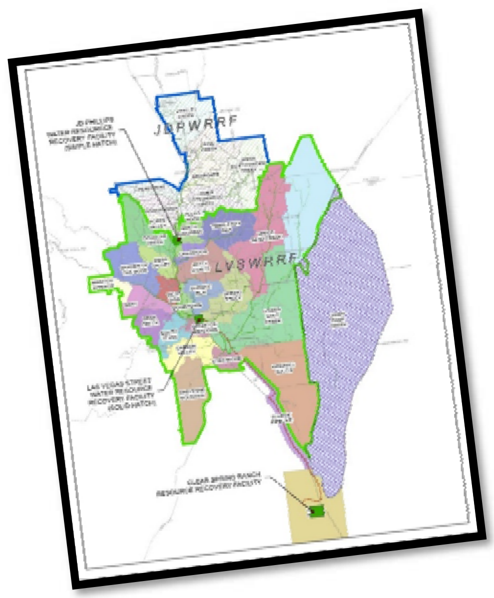
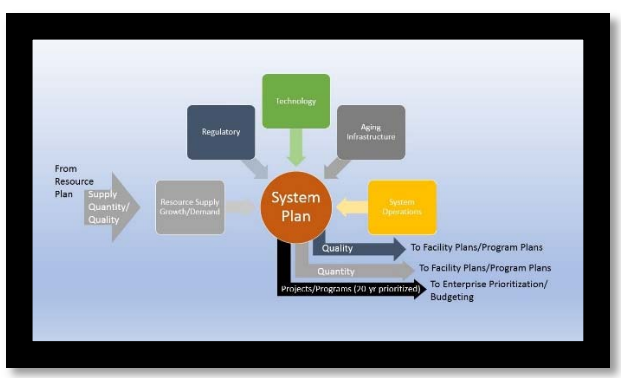
WASTEWATER SYSTEM PLAN

FINAL DRAFT MARCH 18, 2019





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Wastewater Planning and Design

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Chapter 1

Executive Summary

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1 Executive Summary

The *Wastewater System Plan* (*WWSP*) is a planning document that evaluates all components of Colorado Springs Utilities' (Utilities) wastewater system that includes collection, conveyance and resource recovery (previously referred to as wastewater treatment) infrastructure at a high level to enable Utilities to strategically plan for, prioritize, and fund projects and programs that support established levels of service. The plan includes recommendations for projects and programs, both capital, and operation and maintenance (O&M), based on short-term and long-term needs through analysis and evaluations performed and documented within the *WWSP*. One of the key aspects of the *WWSP* is to assess capacities for major wastewater system components for current and projected system flows and loads. The capacity assessment guides investment for the Wastewater System.

The WWSP key focus areas and recommendations include:

- 20-Year Capital Improvement Plan – a technical analysis, updated annually, that includes capital projects and programs identified in the WWSP and lower level Facility and Program Planning documents necessary to support wastewater system LOS goals.
- System Model Updates – WWSP planning efforts indicate the need to update (revise and improve) the models that are used to evaluate and analyze wastewater system component capacities; Utilities has a collection system model and models for the Las Vegas Street Water Resource Recovery Facility (LVSWRRF) and J.D. Phillips Water Resource Recovery Facility (JDPWRRF). These models are updated routinely to identify the impacts of new/revised system changes.
- Banning Lewis Ranch Service Plan – a detailed Study and Alternatives Analysis (SAA) is recommended to evaluate and initially select the best value alternative(s) for service to the Ranch as it develops.
- Regionalization – further evaluate potential "win/win" opportunities to provide wholesale wastewater service(s) to outside of service territory providers in the region that result in mutual benefit to both Utilities' customers and the regional service providers. A project under consideration is the North Monument Creek Interceptor (NMCI) project.
- Future Regulatory Compliance – take advantage of the Colorado Department of Public Health and Environment (CDPHE) Voluntary Incentive Program (VIP) to delay by up to 10-years the large capital investments anticipated to comply with future more stringent nutrient discharge requirements under proposed Regulation 31.
- Industrial Pre-Treatment (IPT) Drivers – IPT regulations can be re-drafted to evaluate the acceptance of industrial discharges under "good carbon and bad carbon" which are a necessity to support nutrient removal to meet future regulatory changes from CDPHE.
- Agreement Obligations – the wastewater collection system improvements program includes projects that meet the terms of the Pueblo County 1041 Permit for the construction of the Southern Delivery System (SDS) and a 2016 Intergovernmental Agreement (IGA) with the City of Colorado Springs for storm water improvements throughout the City. These projects are independent of Springs Utilities' normal operation and maintenance programs.

- Reuse/Recovery Projects - the wastewater system is an integral component of Utilities capability to produce non-potable reuse water as well as return flows for raw water exchanges. Utilities is in the process of preparing a Non-potable Water Resource Plan which is part of a comprehensive planning effort to update the 2001 Non-potable Master Plan. Results of this overall planning effort, particularly those that have a direct impact on the RRF's, will be incorporated into future WWSP true-ups and revisions. Other resource recovery projects that have the potential to generate revenue include the Biogas Utilization project at CSRRRF.

As with any planning document, a variety of assumptions have been used; the assumptions should be carefully monitored, validated and re-evaluated over time as subsequent iterations of the *WWSP* are developed. It is recommended that the *WWSP* be updated once every five years to incorporate and update conditions that have occurred within the 5-year planning window. Subsequently, the next *WWSP* should increase the planning horizon by an additional 5 years. One of the main goals of this *WWSP* is to identify major projects and program needs for the entire wastewater system. In accordance with Utilities' planning framework, the *WWSP* will need to align with the lower level facility plans and program plans by collaboratively exchanging information back and forth so that all plans remain relevant and consistent with the latest findings and information produced across the planning document spectrum.

The executive summary is organized in four main sections. Section 1 presents an overview of the wastewater system components. Section 2 discusses regulatory requirements. Section 3 provides flow and load projections, and a capacity analysis of the wastewater system from a collection and resource recovery standpoint. Lastly, Section 4 summarizes the major programs and projects including important studies and alternatives analyses (SAAs) for the 20-year planning horizon of the wastewater system.

1.1 Background and Introduction to the Wastewater System

The four main components of the wastewater system discussed and referenced throughout the *WWSP* are:

- The Wastewater Collection System
- J.D. Phillips Water Resource Recovery Facility (JDPWRRF)
- Las Vegas Street Water Resource Recovery Facility (LVSWRRF)
- Clear Spring Ranch Resource Recovery Facility (CSRRRF)

These components function and operate together seamlessly within the overall infrastructure system to provide reliable wastewater service within Utilities' service territory.

1.1.1 Collection System

Utilities has the largest sanitary sewer system in Colorado. The collection system conveys wastewater from the City of Colorado Springs (City) and City Council approved service areas like Peterson Air Force Base, Manitou Springs, and Stratmoor Hills to either of the two water resource recovery facilities (WRRFs) that the Utilities owns and operates. The collection system is comprised of roughly 1,700 miles of gravity sewer main, 36,300 manholes, 13 miles of pressurized force main, and 19 lift stations.

1.1.2 J.D. Phillips Water Resource Recovery Facility

Commissioned in 2007, the JDPWRRF is a state-of-the-art facility located near the intersection of Garden of the Gods Road and Mark Dabling Boulevard. The northern area of Colorado Springs is served by the JDPWRRF, with the remainder of the city served by the LVSWRRF. The JDPWRRF has a hydraulic rated capacity of 20 mgd and currently treats approximately 9 mgd. The facility can be expanded in the future to 30 mgd by adding a third 10-mgd train to most of the process units. The JDPWRRF is a conventional activated sludge based advanced WRRF with biological nutrient removal (BNR) capabilities. The treated effluent is discharged to Monument Creek. All the solids that are removed from the JDPWRRF, including primary and secondary sludge and scum, are discharged into the Monument Creek Interceptor (MCI) and ultimately routed downstream to the LVSWRRF located about 10 miles south of the JDPWRRF. A portion of the treated effluent undergoes tertiary treatment and is reused for non-potable purposes.

Figure 1-1 J.D. Phillips Water Resource Recovery Facility

1.1.3 Las Vegas Street Water Resource Recovery Facility

The LVSWRRF is the older and larger WRRF operated by Utilities - serving and treating most of the wastewater flows originating within Utilities' service territory. It has a rated capacity of 75 mgd and currently treats about 30 mgd. Like the JDPWRRF, the LVSWRRF employs a conventional activated sludge process with biological nutrient removal (BNR) capabilities. Again, a portion of the treated effluent undergoes tertiary treatment for non-potable reuse, and the remaining treated effluent is discharged into Fountain Creek in accordance with permit limits. All the solids that are removed from

LVSWRRF (including primary and secondary sludge and scum) are pumped through a 17-mile pipeline to the CSRRRF for final solids treatment and disposal.

The LVSWRRF recently completed major upgrades to its secondary treatment process to provide full BNR capabilities to meet the new nitrogen and phosphorous limits (15 mg/L and 1 mg/L respectively) promulgated under the CDPHE Regulation No. 85. With these improvements the LVSWRRF should be able to consistentely and reliably meet the new regulations for nitrogen and phosphorous.

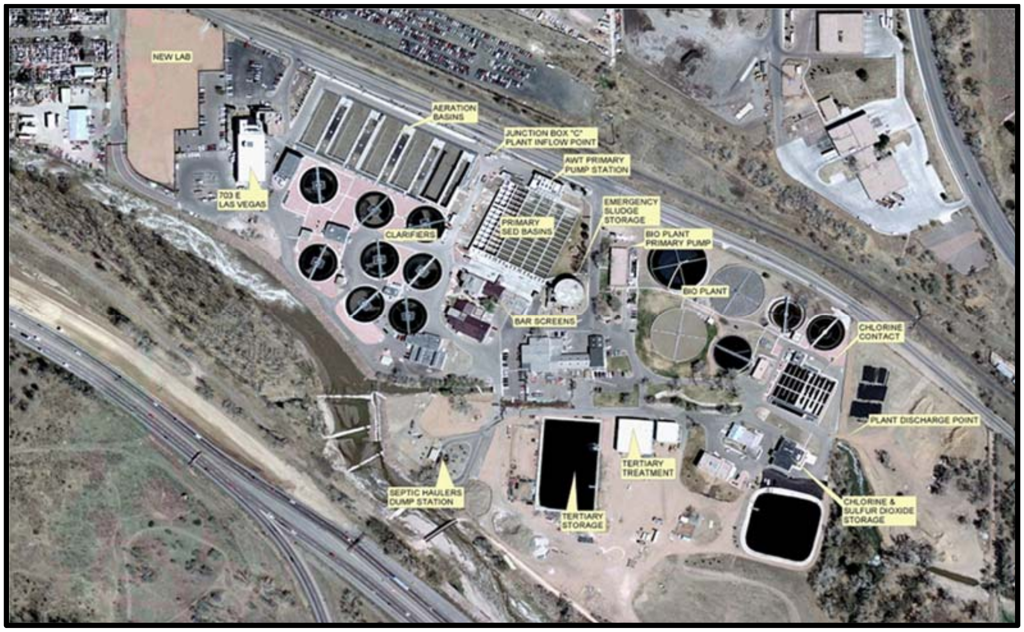

Figure 1-2 Las Vegas Street Water Resource Recovery Facility

1.1.4 Clear Spring Ranch Resource Recovery Facility

The CSRRRF is located roughly 17 miles southwest of downtown Colorado Springs on a 4,000-acre property. The CSRRRF collects, stabilizes, stores, and disposes of all sludge produced from the WRRFs. The main process at CSRRRF is anaerobic digestion which produces a class B biosolids product for final disposal through sub-surface land injection. The CSRRRF facility is a zero-discharge facility, meaning all process fluids and groundwater are contained on the site and not allowed to run off into external water sources. The only means of removing water from the site is through evaporation.

Figure 1-3 Clear Spring Ranch Resource Recovery Facility

1.2 Regulatory Requirements

Regulations can impact current and future system capabilities and require forethought from a system level planning effort to ensure long-term compliance. Violations of regulatory criteria can result in legal actions and/or fines and can damage Utilities' reputation and credibility with customers and the public at large. Operations at the RRFs are overseen by various federal, state, and local regulations.

1.2.1 Existing Regulatory Compliance

1.2.1.1 Collection System

The following regulations apply to the collection system:

- CDPHE Regulation No. 61 states "No person shall discharge any pollutant into any state waters from a point source without first having obtained a permit from the Division for such discharge",
- CDPHE Regulation No. 65 states "No person shall discharge any pollutant from a point source that flows directly into a storm sewer pipe or inlet to such pipe".
- CDPHE Regulation No. 22 requires site applications for construction of domestic wastewater treatment works, including wastewater treatment plants or resource recovery facilities (RRFs), individual sewage disposal systems, lift (pumping) stations, and certain interceptor sewers with a capacity of 2,000 gallons per day or greater, as well as certain facilities that produce reclaimed domestic wastewater.

Additionally, the storm water Intergovernmental Agreement (IGA) between Pueblo County, the City and Utilities was signed on 4/24/2016 and is scheduled to continue through 12/31/2035. The agreement is closely related to the Pueblo County 1041 permit for Utilities' Southern Delivery System (SDS), wherein the conditions of the permit included storm water improvements in the Fountain Creek Watershed. Utilities' Sanitary Sewer Creek Crossing (SSCC) program commits approximately $3.0 M/YR for the first five years, $3.3 M/YR for the second five-year period, $3.6 M/YR for the third five-year period, and $3.9 M/YR for the fourth five-year period for a total of $69.0 Million over 20 years to help fulfill Utilities' IGA commitments. The primary purpose of the SSCC program is to design and construct stream stabilization measures to protect wastewater infrastructure from stream/drainage erosion impacts.

As another condition of the 1041 Permit for the SDS, Pueblo County requested a commitment of $75 million in improvements to Utilities' wastewater system and reuse systems to enhance system integrity.

The projects/programs that meet the terms of Condition No. 7 of the SDS Pueblo County 1041 permit are:

1) Local Collectors Evaluation and Rehabilitation Program (LCERP) ~$2.6 to $1.6 Million/year
2) Manhole Evaluation and Rehabilitation Project (MHERP) ~$0.15 Million/year
3) Collection System Rehabilitation and Replacement Project (Col Sys R&R) ~$0.35 million/year

1.2.1.2 JDPWRRF and LVSWRRF

Both WRRFs are regulated under individual Colorado Discharge Permit System (CDPS) permits. CDPS Permit #CO-0046850 (JDPWRRF) and CDPS Permit #CO-0026735 (LVSWRRF) were last renewed on June 1, 2015 and are set to expire on May 31, 2020. The notable changes from the last permits (issued in 2015) are new discharge limits for total inorganic nitrogen (TIN) and total phosphorous (TP) at the facilities based on the promulgation of Regulation 85 (Reg 85) standards. These nutrient limits of 15 mg/L TIN and 1.0 mg/L TP under Reg 85 were issued by CDPHE and go into effect July 1, 2020.

Some of the key permit effluent criteria for JDPWRRF and LVSWRRF are provided in the tables below:

Table 1-1 Key Permit Criteria for JDPWRRF and LVSWRRF

Effluent Parameter	**Effluent Limit Concentrations**	
	JDPWRRF	**LVSWRRF**
Flow (MGD)	20	75
Total Ammonia as N (mg/L)	Varies Seasonally. Ranges from 2.6-5.0	Varies Seasonally. Ranges from 2.6-5.0
cBOD5 (mg/L)	25	25
TSS (mg/L)	30	30
TIN (mg/L)	15	15
TP (mg/L)	1	1

Both JDPWRRF and LVSWRRF have been meeting all the effluent criteria required by the current permits without violation or fines over the last five years and are undergoing operational and constructed improvements to enable compliance with the Regulation 85 requirements that will be included in the 2020 permit renewals.

1.2.1.3 CSRRRF

The CSRRRF meets all the regulations mandated by the EPA and produces a class B biosolids product. CSRRRF does not have any active permit regulations similar to JDPWRRF and/or LVSWRRF since nothing gets discharged from the facility.

1.2.2 Upcoming Regulations

One of the biggest regulatory changes that is anticipated in the upcoming years is CDPHE Regulation 31, titled “The Basic Standards and Methodologies for Surface Water.” Section 31.17 of Reg 31, which will include numeric stream standards for nutrients, will contain extremely low N and P limits for effluent discharge from publicly owned treatment works (POTWs). The proposed anticipated limits for N and P in Reg 31.17 are 2.01 mg/L expressed as total nitrogen (TN) and 0.17 mg/L expressed as total phosphorus (TP). The rulemaking process is expected to be completed around the year 2027.

Once the final effluent limits are established, it is recommended that a studies and alternatives analysis (SAA) be initiated to evaluate alternatives for level of treatment, technology and reuse options to determine the overall best value approach for compliance and water resource supply management (i.e. discharge and exchange, non-potable reuse, indirect potable reuse, and direct potable reuse).

1.2.2.1 Voluntary Incentive Program

Another regulatory program that is available for both JDPWRRF and LVSWRRF is the Voluntary Incentive Program (VIP) for nutrient removal. As the name suggests, participation in the VIP is not mandatory. This is an incentive-based program that the CDPHE has developed which allows WRRFs to earn credits (in the form of delayed implementation or longer compliance schedules) to meet Reg 31.17 limits when they go into effect. If a facility chooses to participate in the VIP program, it can earn up to 10 years of delayed compliance for nitrogen and/or phosphorous removal under Reg 31.17. The credits earned are purely performance based and are in addition to the compliance schedule that the facility would have otherwise received if they had not participated in the VIP (typically five years). The purpose of the program is to encourage performance beyond what is currently required by Reg 85 limits, through incentives. Utilities is currently participating in the VIP and anticipates a delayed compliance up to 15 years (around 2042) before JDPWRRF and LVSWRRF will have to meet the new Reg 31.17 stream standards.

1.2.2.2 Temperature

The LVSWRRF has temperature monitoring and reporting requirements in its permit, but no effluent limits. JDPWRRF currently does not have any monitoring, or reporting requirements nor effluent limits for temperature. Temperature stream standards for protection of aquatic life in the receiving streams has resulted in the requirement for monitoring of temperature both upstream of LVSWRRF and of the effluent. If an effluent limit is imposed for temperature, it can result in significant capital and O&M costs. This is one of the parameters that’s Utilities is continuously monitoring and will be monitoring both from a regulatory standpoint as well as from needing to address a solution if temperature does indeed become an issue for the LVSWRRF effluent.

1.3 Levels of Service

Levels of Service (LoS) define goals, operational requirements, or regulatory requirements that the wastewater system needs to meet or comply with. While it is the goal to develop a comprehensive set of LoS criteria that will establish performance requirements of the wastewater system, this version of the *WWSP* has developed a preliminary listing of Primary and Secondary LoS that have been listed in Chapter 9. LoS requirements are established for both the Collection System and the WRRFs. Each LoS requirement needs to be monitored over time using measurable indicators. Corresponding performance metrics are also provided in Chapter 9.

1.4 Flow/Load Projections & Capacity Analysis

Another goal of the *WWSP* is to define current and forecasted loading and compare the estimated loading to the system capacity. The loading to the wastewater system includes both hydraulic loading (flow) and organic/nutrient loading (concentration of various constituents), and is expected to be influenced by population growth, city land use, and changes in water use patterns.

Average daily wastewater discharge in Colorado Springs is projected to increase from 39 MGD currently (2018), to about 47 MGD in 2040 based upon the population estimates included in the 2014 small area forecast (SAF) published by Pikes Peak Area Council of Governments (PPACG).

The majority of future development in Colorado Springs is expected to occur in the northeastern and northern parts of the city, including residential development areas such as Banning Lewis Ranch (BLR), Wolf Ranch, Cordera, Flying Horse and The Farm. Utilities is also in the process of evaluating regionalization opportunities that may result in additional flows into the wastewater system.

1.4.1 Collection System Capacity

The *WWSP* utilized a computer model (InfoSWMM^{TM}) of the collection system to evaluate system capacity. The computer model helps Utilities proactively address capacity concerns by identifying areas where risk of system overload exists. The model is also used through the planning process to adequately size mains for future connections resulting from growth.

The model is used to evaluate dry (non-precipitation influenced) and wet weather loading scenarios for current and 2040 conditions.

1.4.1.1 2017 Current Dry Weather Loading

The model indicates that the system is performing well with respect to the current dry weather loading scenarios and there are no currently known capacity issues with the collection system.

1.4.1.2 2040 Projected Dry Weather Loading

The model identifies the following areas that could face future capacity challenges in the year 2040 under dry weather conditions:

- North Area/Kettle Creek Lift Station
- The BLR-outfall/Sand Creek Lift Station

1.4.1.3 2017 Current Wet Weather Loading

Wet weather modeling highlights areas that are more susceptible to capacity issues should Rain Derived Inflow and Infiltration (RDII) enter the system and cause an overflow. The risk of system overload continuously increases with additional development (i.e. the amount of rainfall required to cause degraded level of service is reduced, making the failure more likely to occur).

The current (2017) system has some possible problem areas under wet weather loading conditions that are scheduled for further review:

- West Side near Colorado Avenue and 31st Street
- Carson Valley near Old Broadmoor Road and W Cheyenne Mountain Boulevard
- Grand Vista Circle

These areas have previously exhibited field observed capacity issues under heavy wet weather loading like the rain events in May 2015. These deficiencies are not of critical nature and are being reviewed and will be addressed appropriately.

1.4.1.4 2040 Projected Wet Weather Loading

The notable capacity concerns identified in the year 2040 under wet weather conditions that will require future upgrades are:

- BLR related collection system alternatives components including –
  - 'Zigzag', a portion of 18" pipe north of the airport that was installed as temporary pipe for interim service to BLR north of Highway 24
  - Pipe segments downstream of zigzag
  - Sand Creek Lift Station,
- North Area / Kettle Creek capacity concern.

The anticipated population growth in these areas will require system upgrades to meet the projected capacity needs. There are some advanced recovery agreements in place that currently collect money from development in tributary areas to help fund the potential future upgrades.

The capacity concerns that need more investigation through the proposed model update include areas like Carson Valley World Arena, and the 'GoG'/Westside area.

1.4.2 RRFs Capacity

The *WWSP* analyzes current and future projected loading trends for flows and key loading constituents at the three RRFs and projects future flows and loadings into the year 2040. Flow and loading projections corresponding to the year 2040 were developed using two methods; a trendline based on historical data and a forecast based on TAZ population data. The two projection methods provide a range for estimated future flows/loading conditions at the RRFs.

1.4.2.1 JDPWRRF and LVSWRRF

The JDPWRRF and the LVSWRRF have current rated capacities of 20 MGD and 75 MGD respectively. In recent years, the influent wastewater flows to the two WRRFs have decreased, despite an increase in population, due to factors such as wastewater collection system improvements, water efficient fixtures and appliances, and water conservation efforts. The 2017 average flows for JDPWRRF and LVSWRRF were 8.54 mgd and 29.5 mgd, respectively.

A calibrated process model (Biowin™)was used to determine the capacities of JDPWRRF and LVSWRRF using simulated influent conditions and compliance with anticipated Regulation 31 effluent concentration limits. Based on the process model, the JDPWRRF and the LVSWRRF have estimated annual average daily flow (AADF) capacities of 20 mgd and 40 mgd respectively when subjected to Reg 31 regulation limits for N and P. It should be noted that the capacities indicated are for existing unit processes at the two facilities. To meet Reg 31 requirements, additional unit processes such as advanced biological treatment units and tertiary filtration systems will need to be added to both facilities.

The two flow estimating methods – a trendline based on historical data and a forecast based on TAZ population data - predict the following future flows for the year 2040 at the JDPWRRF and the LVSWRRF. These future flows do not include any additional flows due to regionalization.

Table 1-2 2017 Average Flow and Flow Projections at JDPWRRF and LVSWRRF

	JDPWRRF					LVSWRRF				
	2017 Average	TAZ Projection		Historic Trendline Projection		2017 Average	TAZ Projection		Historic Trendline Projection	
		2040	Buildout	2040	Buildout		2040	Buildout	2040	Buildout
Flow (MGD)	8.54	10.06	12.21	13.5	17.5	29.5	36.40	37.33	36.0	36.7

The JDPWRRF and the LVSWRRF will operate well within the capacity of their current unit processes into the year 2040. In other words, the JDPWRRF and the LVSWRRF have plenty of capacity irrespective of which method is used to arrive at the maximum flow values.

It is also of interest to evaluate the capacity of the JDPWRRF and the LVSWRRF based on the loading values of various constituents. Although the permits only address influent carbonaceous biochemical oxygen demand (cBOD) loading and flows, the influent loading for total suspended solids (TSS), ammonia (NH_3), TP, carbonaceous oxygen demand (COD), and total Kjeldahl nitrogen (TKN) are also considered because both JDPWRRF and LVSWRRF are limited by NH_3 and TP loadings rather than cBOD and/or TSS loadings from a plant capacity perspective. Loading projections for the constituents of interest are made into the year 2040 using the TAZ population projection method and the historical data trendline method discussed above. It was determined that LVSWRRF may reach capacity from a loading perspective for constituents such as NH_3, TP, TKN, and COD by the year 2040. For NH_3, TP and TKN, the historical data trendlines project capacities being met or exceeded by 2040, though the TAZ population projections do not reach capacity before 2040. Due to the discrepancy between the two projection methods, these capacity analyses will need to be updated and analyzed in future *WWSP's* to better predict the likelihood of these constituents impacting the capacity at LVSWRRF. On the other hand, both loading projection methods (historical trendline and TAZ population projection) for COD predict that capacity could be reached at LVSWRRF before 2040 (approximately in the year 2034). Therefore, it is recommended that the COD loading over time is closely monitored for the next few years to get a better understanding on this potential capacity constraint for LVSWRRF. Due to the projection accuracy and extended time to occurrence, these capacity limitations do not warrant the immediate need for any major improvements or projects. These capacity analyses will be updated and analyzed in future updates of the *WWSP* to better predict the likelihood of these constituents approaching loading capacity before the year 2040.

The tables below summarize the current and projected loading values for JDPWRRF and LVSWRRF determined using the methods discussed above.

Table 1-3 2017 Loading Projections, and Estimated Capacities for JDPWRRF

	JDPWRRF						
	2017 Conc. (mg/L)	2017 Loading (lbs./day)	Estimated Constituent Loading Capacity (lbs./day)	Calculated Loading (lbs./day)		Trendline Loading (lbs./day)	
				2040	Buildout	2040	Buildout
NH_3	35	2,460	6,200	2,900	3,500	3,400	4,000
cBOD	317	22,600	54,500	27,000	32,500	34,000	47,000
TSS	260	18,600	52,000	22,300	26,800	22,300	26,000
TP	7	470	1,670	560	680	1,100	1,500
COD	760	54,000	129,000	63,800	78,000	80,000	105,000
TKN	53	3,700	9,340	4,400	5,400	5,000	6,200

Table 1-4 2017 Loading Projections, and Estimated Capacities for LVSWRRF

	LVSWRRF						
	2017 Conc. (mg/L)	2017 Loading (lbs./day)	Estimated Constituent Loading Capacity (lbs./day)	Calculated Loading (lbs./day)		Trendline Loading (lbs./day)	
				2040	Buildout	2040	Buildout
NH_3	30	7,300	10,300	9,000	9,400	11,200	11,400
cBOD	360	88,700	123,800	110,000	114,000	110,000	111,000
TSS	336	82,800	104,750	102,500	107,000	82,000	81,000
TP	8	1,990	2,670	2,500	2,600	3,900	4,000
COD	850	209,750	256,200	260,000	270,000	260,000	263,000
TKN	49	12,000	17,700	15,000	15,500	18,100	18,400

1.4.2.2 CSRRRF

Influent total volatile solids (TVS) loading is the key parameter used to evaluate the capacity of the anaerobic digesters at CSRRRF.

The loading projections corresponding to year 2040 and buildout were developed using two methods. The first method used the trendline created from the historical data (last 10 years) and extrapolated that to the year 2040 to estimate the future loadings. The second method assumed a straight-line growth between the 2017 average TVS loadings and the 2040 loading values estimated using TAZ population data.

Based on CDPHE recommended loading criteria for anaerobic digestion and the projected TVS loading values calculated using the methods discussed above, CSRRRF will operate well within capacity into the year 2040. In other words, the CSRRRF has plenty of capacity irrespective of which method is used to arrive at the maximum TVS loading value.

The tables below summarize the current and projected blended sludge flow and loading values for the CSRRRF determined using the methods discussed above.

Table 1-5 2017 average Blended Sludge Flows Projections for CSRRRF

	CSRRRF				
	2017 Average	Calculated Projection		Trendline Projection	
		2040	Buildout	2040	Buildout
Flow (gal/day)	304,000	380,000	396,000	250,000	215,000

Table 1-6 2017 Average TVS Loading and Loading Projections for CSRRRF

	CSRRRF					
	2017 Loading (lbs./day)	Estimated Loading Capacity (lbs./day)	Calculated Loading (lbs./day)		Trendline Loading (lbs./day)	
			2040	Buildout	2040	Buildout
TVS	70,100	147,000	87,600	91,300	70,200	74,500

1.5 Projects and Programs

The *WWSP* has identified some key projects and activities that will need to be completed over the 20-year planning period. Each of the identified projects will require further development of the scope and best value alternative for implementation through the delivery lifecycle Studies and Alternatives Analysis (SAA) phase. The table below presents a summary of the key projects and activities and associated timing and rough order of magnitude budget.

Table 1-7 List of Recommended Wastewater System Projects and Activities

Project/ Activity Name	Description	Anticipated Year		Anticipated Cost	
		SAA	Project	SAA	Project
Kettle Creek Lift Station and Force Main SAA **(Collection System)**	Alternatives need to be explored for upsizing the Kettle Creek Lift Station due to growth upstream of the station. (Completely external SAA).	2027	2030	$200,000	$3M
Wastewater Service for Banning Lewis Ranch (BLR) SAA **(RRFs & Collection System)**	Alternatives need to be developed for the best ways to provide wastewater service to the Ranch. Unique strategies will likely be needed for different areas of the Ranch. (Mostly internal SAA with some support from external consultants).	2022	2030	$200,000 + Staff time	$80M
Process Model Update **(RRFs)**	The process model was developed and calibrated in the 2008/2009 timeframe. It is a helpful tool for evaluating plant capabilities in the light of upcoming regulatory impacts. The model needs to be updated for that use and for exploring plant optimization. (Mostly internal SAA with some support from external consultants).	2022	N/A	$200,000 + Staff time	N/A
Carbon Supply Planning **(RRFs)**	A study needs to be undertaken to determine the carbon needs of the WRRFs and identify potential sources of carbon from waste products in the	2024	N/A	Staff time	N/A

Project/ Activity Name	Description	Anticipated Year		Anticipated Cost	
		SAA	Project	SAA	Project
	City of Colorado Springs. (Completely internal study).				
Regionalization SAAs **(RRFs & Collection System)**	As regionalization discussions progress with various wastewater service providers, an SAA to identify the best way to provide regional service to each entity is likely to be needed. (Mostly internal SAA with some support from external consultants).	2020	Varies	Staff time	TBD
Collection System Model Update **(Collection System)**	As winter water usage data becomes more available, linking it to the collection system model will provide valuable data for the model to use in addition to data that comes from specific flow monitoring locations. (Mostly internal SAA with some support from external consultants).	2022	N/A	$50,000 + Staff time	Varies
Regulation 31 **(RRFs)**	As Reg 31 limits are confirmed, it is recommended that a SAA be completed to evaluate different technologies for meeting stringent N and P limits and estimating cost of necessary improvements. (completely external SAA).	2035	2036	$500,000	$182.5M
CSRRRF Facility Plan **(RRFs)**	See recommended list of projects in Chapter 11	Varies	Varies	Varies	$15.5 M
LVSWRRF Facility Plan **(RRFs)**	Ongoing (To be completed by December 2019)	Varies	Varies	Varies	TBD
Lift Station Facility Plan **(Collection System)**	To be completed by December 2020	Varies	Varies	Varies	TBD
JDPWRRF Facility Plan **(RRFs)**	To be completed by December 2021	Varies	Varies	Varies	TBD

Additionally, programs are used to accomplish objectives related to linear assets in the collection system.

The wastewater collection system program goals include eliminating SSOs, reducing infiltration and inflow and extending/preserving infrastructure life. The collection system programs that are currently in place are described in the tables below:

Table 1-8 Summary of Current Collection System Programs (Capital)

Program	Summary	Budget
Local Collectors Evaluation and Rehabilitation Program (LCERP)	The LCERP consists of the evaluation and rehabilitation of sewer collection pipes less than 10-inches in diameter.	2019 through 2023 ~$2.6 Million each year 2024 through 2028 ~$1.6 Million each year
Collection System Rehabilitation and Replacement Program (CSRRP)	The CSRRP monitors/rehabilitates 10-inch to 66-inch sewer pipes.	2019 through 2023 Varies ($1.0 Million to $360K) 2023 to 2028 $350K each year
Sanitary Sewer Creek Crossing Program (SSCC)	SSCC plans and prioritizes stream stabilization projects to protect infrastructure near or in drainage ways.	2018 through 2022 Varies ($3.0 Million to $3.3 Million) 2023 through 2025 ~$3.3 million each year 2026 through 2028 ~$3.6 Million each year
Manhole Evaluation and Rehabilitation Program (MHERP)		2018 through 2021 Varies ($20K to $30K each year) 2022 through 2028 ~$150K each year
Wastewater Lift Station and Force Main Evaluation and Rehabilitation Program (LSFMERP)	The LSFMERP assesses/rehabilitates wastewater lift stations and force mains.	~$500K each year

Table 1-9 Summary of Current Collection System Programs (O&M)

Asset Class	Program of Work	Description
WW Mains		
	Wastewater Point repairs	Damage to a sewer main at a point, like a hole. Point repairs are identified by Engineering, Wastewater Programs or CCTV group.

Asset Class	Program of Work	Description
	CCTV O&M Inspection (NASSCO)	CCTV investigation and condition assessment of pipe within the NASSCO (national association of sewer service company) and PACP (pipeline assessment certification program) standard guidelines.
	CCTV RE-CON NASSCO	CCTV inspection of sewer mains to review pipe prior to cleaning to determine type/extent of cleaning method required. This ensures infrastructure stability and performance.
	CCTV QC NON-NASSCO	CCTV inspections to review quality of maintenance/cleaning.
	Chemical Root Control	Chemical treatment to control root growth in the wastewater collections system. Based on 1-2-3-year frequency based on regrowth.
	Basin Maintenance Program	Cleaning and maintenance of wastewater basins in accordance with basin cleaning frequencies. 1-5 years based on basin frequency.
Manholes		
	Manhole Rehab (MHERP)	Tools and equipment for manhole rehab relining projects.
	MH Repair Internal	Repair of Manholes including channels, inverts or to remove barrel sections and remove and replace cones.
	MH Structure Repairs	Repair of Manholes and replacement of deteriorated ring and covers/asphalt repair. Emergency and non-emergency work.
Lift Stations		
	Lift Station Maintenance	Materials, repairs and replacements of grinders, pumps, check valves, pump drives and other pump station equipment for the Lift Stations.
	Lift Station Utilities	Utilities at Lift Stations.
	Lift Station Operations	Preventative maintenance/operational rounds at lift stations.

For additional detail for the programs (forecasted projects, activities, budgets and schedules and metrics), see the program plans.

Overall, the wastewater system appears to be in good shape from both the collection system and resource recovery perspective at least in the near-term perspective (5-10 years) from a capacity standpoint. The ongoing programs to maintain the condition of assets coupled with project requirements originating from regulatory drivers and growth-based demands will need to be carefully monitored, planned and executed to provide the required level of service for wastewater. Other drivers such as regionalization and technology changes can have significant impacts to both capital and O&M spend for the wastewater system. As stated earlier, it is recommended that the planning needs be evaluated on a five-year rolling basis and assumptions be validated through time, so forecasts can be continuously updated.

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Chapter 2

Assumptions Summary

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2 Assumptions Summary

In order to conduct many of the evaluations and analysis in the *Wastewater System Plan* (*WWSP*), assumptions need to be made regarding unknowns with respect to both current and future conditions. Assumptions are made using a combination of the best available information, reasoning, experience, and engineering judgement. The major assumptions incorporated throughout the *Wastewater System Plan* (*WWSP*) are listed below. The validity of these assumptions will be re-assessed in future iterations of the *WWSP* and modified as necessary.

- The *WWSP* plans and documents key upcoming investment needs related to the Wastewater System within a 20-year planning period.

- A full buildout discussion is included to plan and document the capacity needs for collection system and the three RRFs.

- Although Regulation 31 is outside of the 20-year time frame, it is likely to be the driver for the next major phase of process improvements at both the LVSWRRF and the JDPWRRF. The magnitude of these improvements requires significant advanced planning; therefore Regulation 31 is discussed from a planning perspective in this *WWSP*.

- At this time, it is projected that the Regulation 31 limits for N and P will be 2.01mg/L expressed as total nitrogen (TN) and 0.17mg/L expressed as total phosphorous (TP). These limits are discussed and used throughout this *WWSP* to analyze facility capacity.

- The goal is to complete a comprehensive update of the *WWSP* every five years to keep content relevant and current. Project prioritization updates will occur annually.

- At this time, there are no known plans for additional areas to be annexed in the city limits.

- Average daily wastewater discharge projections for the year 2040 are based upon the population estimates included in the 2014 Small Area Forecast (SAF) published by Pikes Peak Area Council of Governments (PPACG). The SAF provides transportation planning information in the form of Transportation Area Zone (TAZ) data which helps to strategically identify the needs for the region's transportation investments. The SAF is a socioeconomic forecast based on U.S. Census data, commercial employment databases, and local planning knowledge. The SAF begins with the State of Colorado Demographers' Office' regional level analysis that provides bulk data for the Pikes Peak Region. The SAF divides the Pikes Peak Region into smaller sub-regions. The sub regions, or TAZs, are forecasted using local knowledge and local planning. It should be noted that the SAF estimates the future population for each TAZ.

- The SAF forecasts employment data to determine the areas where people are likely to work versus the areas where they are likely to live to estimate the transportation needs. Employment data from the SAF is not fully incorporated into the *WWSP*; instead growth areas are identified, and future wastewater flows are forecasted.

- The population growth is assumed to be linear from the current population to the TAZ projected population for the year 2040.

- The land area available for growth was determined using the City land use data in the Geographic Information System (GIS). Areas within the City limits coded as agricultural, vacant, or vacant/parking are assumed to be available for future development.

- The *WWSP* utilized a basin approach to help evaluate flow, load, and demand. In the context of this analysis, a basin is defined as the area tributary to a flow monitoring point of interest (usually a critical system junction/node from a flow capacity perspective).

- A straight-line growth estimate from 2010 to 2040 based on SAF data (that included 2010 census data) was used to estimate the number of people currently in the basin.

- It is assumed that areas currently outside of the city limits would not significantly impact the future system loading except those being considered under potential regionalization opportunities.

- The TAZ population was assumed to be evenly distributed throughout the TAZ zones based on SAF data. GIS was used to accumulate and split bordering TAZ zones into their respective basins so that the future basin population could be estimated.

- The Collection System’s ability to meet level of service criteria was evaluated for the current (2017) flow conditions and the future 2040 flow conditions using the InfoSWMM™ model for the collection system. The model uses dynamic wave simulation to route flows through the collection system. The model assumes that the pipes function as designed, i.e. there are no impacts due to issues such as root penetration, pipe collapses etc.

- Flow and loading projections corresponding to the year 2040 were developed using two methods. The first method used a trendline created from the historical data (last five to ten years) and extrapolated that to the year 2040 to estimate the future flows. The second method assumed a straight-line growth between the 2017 average flows and the 2040 estimated flows based on TAZ population data. The two methods for flow and loading projections provide a range for estimated future flows at the two WRRF's. Future iterations of the *WWSP* will re-evaluate and update these projected flows.

- For this *WWSP*, the projected influent loading rates for cBOD, TSS, NH_3 and oP have been used to determine plant capacity based on anticipated effluent limits under Regulation 31 (2.01mg/L expressed as total nitrogen (TN) and 0.17mg/L expressed as total phosphorous (TP)). The process models used for this purpose were calibrated and validated using previous plant performance data from an earlier time frame (2008/2009). The process models need to be updated in the future to recalibrate to current operating conditions. For the scope and accuracy required in this *WWSP*, it is assumed that the outputs from the current models using the 2008/2009 loading data will not be significantly different when adjusted for 2017 loading data.

- Capacities at the RRFs were determined using constant influent concentrations for COD, cBOD, TSS, TKN, ammonia, and TP and increasing the flows until the point where the facility started exceeding the projected permit limits under 20-year and buildout scenarios.

- The influent blended sludge flow at CSRRRF for the year 2040 and for buildout were developed using the assumption that the rate of increase of blended sludge flow at CSRRRF is the same as the rate of increase of influent flows at JDPWRRF and LVSWRRF.

- The capacity of CSRRRF is based on the loading rates of organic solids and CDPHE recommended minimum residence time in the anaerobic digesters for volatile solids reduction.

Chapter 3

Projects and Programs Summary

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3 Projects and Programs Summary

This section summarizes capital projects and capital programs at the system plan level. Detailed capital projects at facilities are covered under four facility plans.

3.1 Projects Summary

At this time the wastewater system in general has adequate capacity and there are few anticipated capacity related projects in the 20-year planning horizon. For these projects, this *Wastewater System Plan* (*WWSP*) has identified several Studies and Alternatives Analysis (SAAs) that need to be completed in the planning horizon. These and other SAAs are listed below and discussed in detail in Chapter 11 of this *WWSP*.

Table 3-1 List of Recommended SAA's

Name	Description	Anticipated Year		Anticipated Costs	
		SAA	Project	SAA	Project
Kettle Creek Lift Station and Force Main SAA	Alternatives need to be explored for upsizing the Kettle Creek Lift Station due to growth upstream of the station. (Completely external SAA).	2027	2030	$200,000	$3M
Collection System Model Update	As winter water usage data becomes more available, linking it to the collection system model will provide valuable data for the model to use in addition to data that comes from specific flow monitoring locations. (Mostly internal SAA with some support from external consultants).	2022	N/A	$50,000 + Staff time	Varies
Wastewater Service for Banning Lewis Ranch (BLR) SAA	Alternatives need to be developed for the best ways to provide wastewater service to the Ranch. Unique strategies will likely be needed for different areas of the Ranch. (Mostly internal SAA with some support from external consultants).	2022	2030	$200,000 + Staff time	$40M
Carbon Supply Planning	A study needs to be undertaken to determine the carbon needs of the WRRFs and identify potential sources of carbon from waste	2024	N/A	Staff time	N/A

Name	Description	Anticipated Year		Anticipated Costs	
		SAA	Project	SAA	Project
	products in the City of Colorado Springs. (Completely internal study).				
Process Model Update	The process model was developed and calibrated in the 2008/2009 timeframe. It is a helpful tool for evaluating plant capabilities in the light of upcoming regulatory impacts. The model needs to be updated for that use and for exploring plant optimization. (Mostly internal SAA with some support from external consultants).	2022	N/A	$200,000 + Staff time	N/A
Regionalization SAAs	As regionalization discussions progress with various wastewater service providers, an SAA to identify the best way to provide regional service to each entity is likely to be needed. (Mostly internal SAA with some support from external consultants).	2020	Varies	Staff time	TBD
Regulation 31	As Reg 31 limits are confirmed, it is recommended that a SAA be completed to evaluate different technologies for meeting stringent N and P limits and estimating cost of necessary improvements. (completely external SAA).	2035	2036	$500,000	$182.5M
CSRRRF Facility Plan **(RRFs)**	See recommended list of projects in Chapter 11	Varies	Varies	Varies	$15.5 M
LVSWRRF Facility Plan **(RRFs)**	Ongoing (To be completed by December 2019)	Varies	Varies	Varies	TBD

Name	Description	Anticipated Year		Anticipated Costs	
		SAA	Project	SAA	Project
Lift Station Facility Plan **(Collection System)**	To be completed by December 2020	Varies	Varies	Varies	TBD
JDPWRRF Facility Plan **(RRFs)**	To be completed by December 2021	Varies	Varies	Varies	TBD

Table 3-2 List of Previously Completed SAA's

Name	Description	Anticipated Year		Anticipated Costs	
		SAA	Project	SAA	Project
J.D. Phillips Water Resource Recovery Facility (JDPWRRF) Diversion Study	An SAA that was previously completed looked at the best location in the collection system that could divert up to 4 million gallons per day (mgd) of flow from Las Vegas Street Resource Recovery Facility (LVSWWRF) to JDPWRRF if this was needed.	N/A	2030 if needed		

3.2 Programs Summary

Programs accomplish several objectives for linear assets in the collection system that include condition assessment, capital project identification, rehabilitation and replacement work, and in some cases, protection of infrastructure. Program goals include reducing risk of stoppages that leads to minimizing/eliminating sanitary sewer overflows, reducing infiltration and inflow and extending/preserving infrastructure life. Programs typically have a rolling annual budget with a long or undefined duration to continually address asset variation over time. Programs are generally comprised of several projects and/or activities. Due to common scope and quality of work, programs are efficient and streamlined to execute and adaptable to organizational strategy changes that support either O&M or capital development needs. Programs are guided by individual program plans that use a risk-based asset management approach to prioritize and guide investment in the Wastewater System.

Programs reduce/eliminate sanitary sewer overflows (SSOs) by:

- Maintaining conveyance capacity by reducing the chance of stoppages through cleaning and root removal
- Extending/preserving infrastructure life by preventing structural collapse
- Minimizing/eliminating reducing infiltration and inflow (I&I)

There are currently 5 capital, and 12 operations and maintenance (O&M) collection system programs described in Table 3-3 and Table 3-4 below.

Table 3-3 Summary of Current Collection System Programs (Capital)

Program	Summary
Local Collectors Evaluation and Rehabilitation Program (LCERP)	LCERP evaluates and rehabilitates pipes less than 10-inches in diameter, which accounts for about 83% of the wastewater collection system. LCERP assesses the condition of sewer pipes via Closed Circuit Television (CCTV) and rates pipe condition based on the National Association of Sewer Service Companies (NASSCO). Using the ratings, LCERP schedules the pipes to be re-inspected, rehabilitated, repaired and/or replaced. Over 100 miles of pipe has been rehabilitated under this program.
Collection System Rehabilitation and Replacement Program (CSRRP)	The CSRRP monitors 10-inch to 66-inch sewer pipes. Approximately 80 miles of pipe have been rehabilitated under this program and its predecessor the Sanitary Sewer Evaluation and Rehabilitation Program (SSERP).
Sanitary Sewer Creek Crossing Program (SSCC)	SSCC plans and prioritizes stream stabilization projects near or in drainageways by evaluating and mitigating the risk of drainageway erosion effects on collection system infrastructure.
Manhole Evaluation and Rehabilitation Program (MHERP)	The MHERP evaluates the condition of approximately 33,000 manholes in the collection system. Approximately 15,000 manholes are over 30 years old. To date over 880 manholes have been rehabilitated.
Wastewater Lift Station and Force Main Evaluation and Rehabilitation Program (LSFMERP)	The LSFMERP assesses the condition of 19 wastewater pump stations and force mains. Capital projects are identified and covered under this program.

Table 3-4 Summary of Current Collection System Programs (O&M)

Asset Class	Program	Summary
	Wastewater Point repairs	Damage to a sewer main at a point, like a hole. Point repairs are identified by Engineering, Wastewater Programs or CCTV group.

Asset Class	Program	Summary
WW Mains	CCTV O&M Inspection (NASSCO)	CCTV investigation and condition assessment of pipe within the NASSCO (national association of sewer service company) and PACP (pipeline assessment certification program) standard guidelines.
	CCTV RE-CON NASSCO	CCTV inspection of sewer mains to review pipe prior to cleaning to determine type/extent of cleaning method required. This ensures infrastructure stability and performance.
WW Mains	CCTV QC NON-NASSCO	CCTV inspections to review quality of maintenance/cleaning.
	Chemical Root Control	Chemical treatment to control root growth in the wastewater collections system. Based on 1-2-3 year frequency based on regrowth.
	Basin Maintenance Program	Cleaning and maintenance of wastewater basins in accordance with basin cleaning frequencies. 1-5 years based on basin frequency.
Manholes	Manhole Rehab (MHERP)	Tools and equipment for manhole rehab relining projects.
	MH Repair Internal	Repair of Manholes including channels, inverts or to remove barrel sections and remove and replace cones.
	MH Structure Repairs	Repair of Manholes and replacement of deteriorated ring and covers/asphalt repair. Emergency and non-emergency work.
Lift Stations	Lift Station Maintenance	Materials, repairs and replacements of grinders, pumps, check valves, pump drives and other pump station equipment for the Lift Stations.
	Lift Station Utilities	Utilities at Lift Stations.
	Lift Station Operations	Preventative maintenance/operational rounds at lift stations.

Table 3-5 Summary of Additional Wastewater Programs

Program	Summary
Industrial Pre-treatment	Eliminates impact from fats oil grease (FOG) by monitoring and implementing grease handling equipment such as grease interceptors, designed to prevent impacts to the system. Prevents wastewater constituents that are difficult to remove via typical recovery process from entering the wastewater system

External Corrosion	Currently the Cathodic Protection group monitors the external condition of the ferrous materials in the collection system, primarily force mains and lift station cans, and implements projects designed to extend the service life of the infrastructure.

3.2.1 Additional Drivers for Wastewater Programs

3.2.1.1 Stormwater IGA

The *Stormwater Intergovernmental Agreement* (IGA) between Pueblo County, the City of Colorado Springs, and Utilities was signed on 4/24/2016 and is scheduled to continue through 12/31/2035. A combined City and Utilities $460 Million is expected to be spent under the IGA. Utilities' Sanitary Sewer Creek Crossing (SSCC) program commits $3.0 M/YR for 1st five years, $3.3 M/YR for 2nd five years, $3.6 M/YR for the 3rd five years, $3.9 M/YR for 4th five-year period for a total of $69.0 Million over 20 years to help fulfill the IGA requirements. The primary mission of the SSCC program is to protect wastewater infrastructure from stream/drainage erosion impacts.

3.2.1.2 1041 Permit

As another condition of the 1041 Permit for the Southern Delivery System, Pueblo County requested a commitment of $75 million in improvements to Utilities' wastewater system to enhance system integrity.

The projects/programs that meet the terms of Condition No. 7 of the SDS Pueblo County 1041 permit are:

1) Local Collectors Evaluation and Rehabilitation Project (LCERP) ~$3.2 Million/year
2) Manhole Evaluation and Rehabilitation Project (MHERP) ~$0.15 Million/year
3) Collection System Rehabilitation and Replacement (R&R) Project ~$1.2 million/year

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Chapter 4

Introduction

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4 Introduction

The *WWSP* plans and documents key upcoming Wastewater System investment needs for the next 20 years from a high level. A primary input to the *WWSP* is the *Integrated Water Resource Plan (IWRP)*. The *IWRP* level identifies the future raw resource supply needs of the community – WATER, in this case, and the *WWSP* identifies the subsequent infrastructure required for wastewater conveyance and treatment (or resource recovery) from residential, commercial, and industrial water use accounting for:

- Growth/Demand
- Regulatory Compliance
- Technology Improvements
- Aging Infrastructure
- System Operations

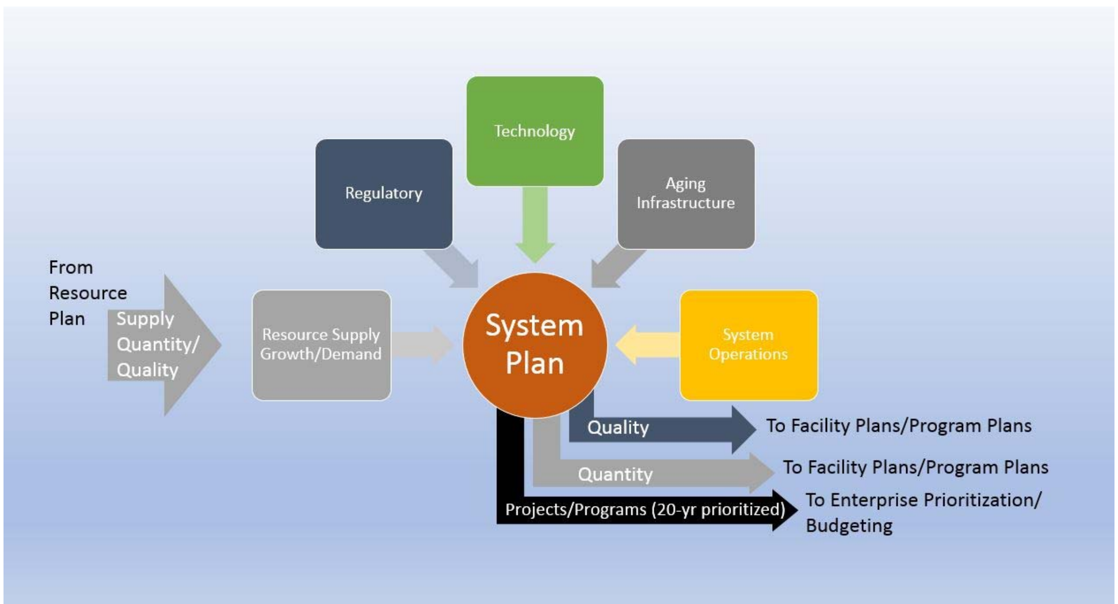

Figure 4-1 System Plan Components

The *WWSP*, analogous to the beam loading diagram below, identifies the following:

- Current and future system loading through growth or demand
- System & Facility capabilities to handle the loading
- Areas where system capability is reduced, such as aging infrastructure, or increased regulatory requirements
- LoS - Future planning documents will develop and document level of service requirements for the full spectrum of the wastewater system – this version of the *WWSP* plan outlines only some of the high LoS criteria that are being proposed
- Products to maintain or increase system capability

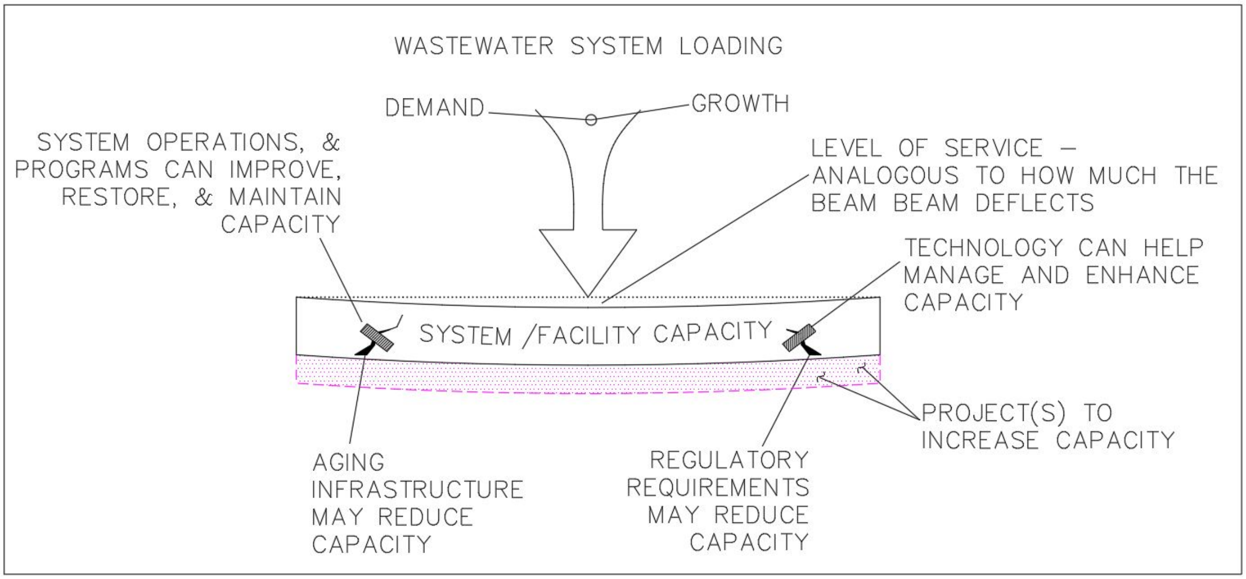

Figure 4-2 System Plan Beam Analogy

The *WWSP* summarizes the products needed to achieve acceptable system capability and performance based on the level of service requirements that can be summarized in tabular format.

PRODUCT ID	DESCRIPTION	QUANTITY	QUALITY	COST	START DATE	IN SERVICE DATE	RISK	FUNDING SOURCE

- Product ID – ID number or tag for the project
- Description – summary of the project e.g. "Plan for SAA to support increased loading at Kettle Creek Lift Station."
- Quantity – Identify conceptual design criteria e.g. 5 mgd
- Quality – Used if a quality design parameter is designated
- Cost – Rough Order of Magnitude (ROM) e.g. $3 Million
- Start Date – Date for project satisfying product requirements would need to start to be completed by the in-service date.
- In Service Date – Date capability is required
- Risk – Probability of occurrence and consequence of foregoing the product (normalized risk score)
- Funding Source – Used to designate funding e.g. "Advanced Recovery Agreement"

The requirements identified by the *WWSP* could then be weighed against other requirements from this, as well as other planning documents, allowing for more objective prioritization and planning of investment needs across the service line.

4.1 Scope

The four main components of the wastewater system used throughout the *WWSP* are:

- The Wastewater Collection System
- J.D. Phillips Water Resource Recovery Facility (JDPWRRF)
- Las Vegas Street Water Resource Recovery Facility (LVSWRRF)
- Clear Spring Ranch Resource Recovery Facility (CSRRRF)

These components function and operate together as an integrated system to provide reliable wastewater service to the Utilities' service territory (generally Colorado Springs city limits).

This introduction provides a brief description of the four main components and their typical operating parameters. Refer to the specific Facility Plan or Program Plan for additional process, capacity analysis information and details related to specific investment requirements for that facility or collection system component.

4.2 Planning Period

The designated planning period for the *WWSP* is 20 years. The planning period for the budget will be broken into two parts. The first 10-year window (years 1-10) will capture the immediate needs that are known to be occurring with more certainty and stay within an accurate display of finance projections. The second 10-year window will try to capture high level planning costs for critical projects and program components outside of the first 10-year financial tracking window that may impact the long-term forecasting for wastewater assets and infrastructure. The goal is to update the *WWSP* every five years to keep the content relevant and current.

4.3 Background

Table 4-1 provides high level information about the Colorado Springs wastewater system. The Wastewater System Planning Map or, "Green Map", included as Figure 4-3 separately, shows wastewater mains 10" and larger, all lift stations, and force mains. The service boundary for the collection system generally corresponds to the city limits of Colorado Springs.

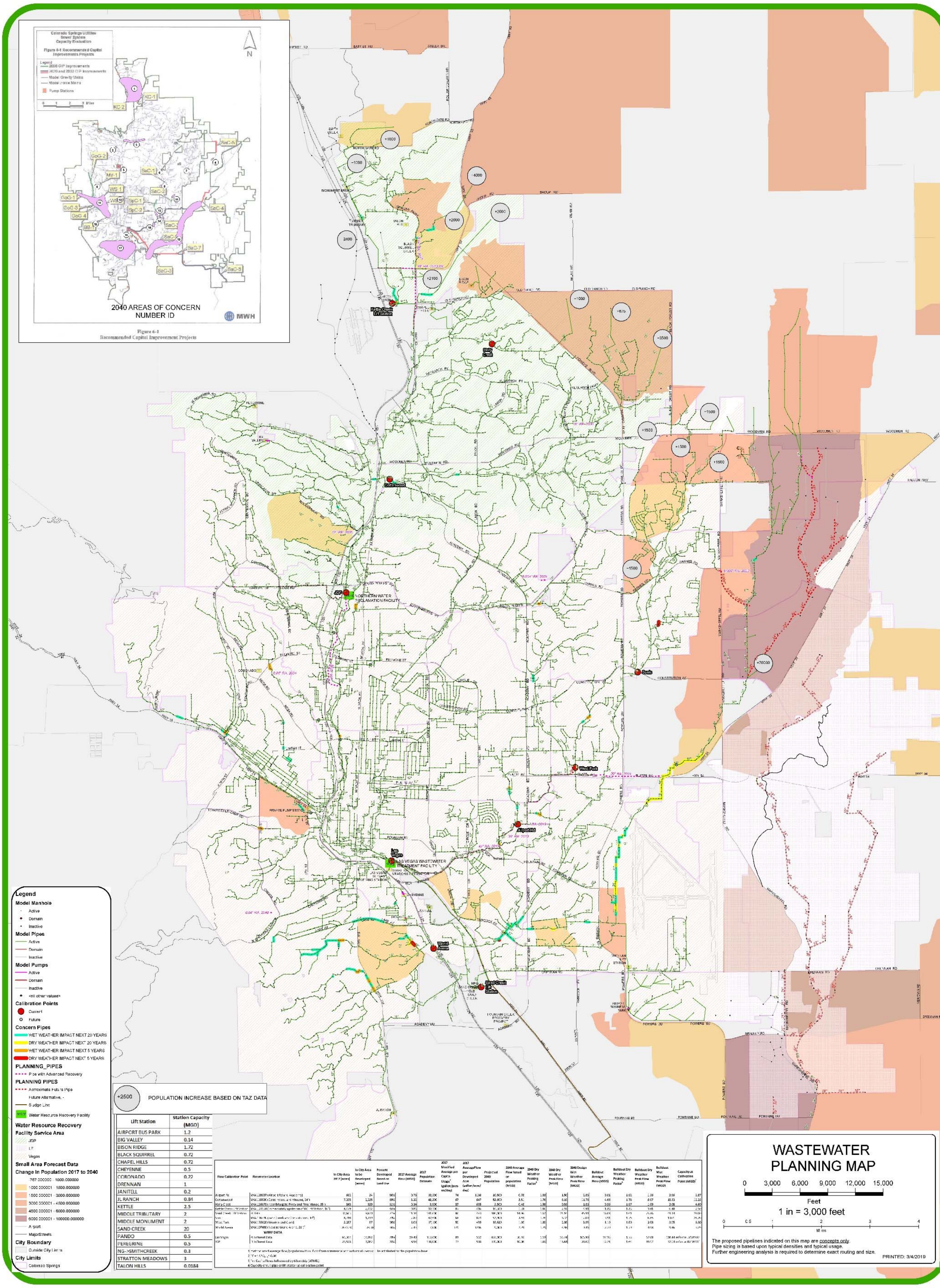

Figure 4-3 Wastewater System Planning Map or "Green Map"

Table 4-1 Colorado Springs Utilities Wastewater System Facts

Operating Parameter	Value	Definition/Details/Notes
Annual average wastewater flow	38.04 mgd	Based on the average annual daily flow for the year from JDPWRRF and LVSWRRF.
Combined permitted treatment capacity	Total 95 MGD 20 MGD (JDPWRRF) 75 MGD (LVSWRRF)	Based on most recent permits for JDPWRRF and LVSWRRF.
Service area - Wastewater	195 square miles	A designated area where wastewater is collected by Springs Utilities.
Sewer main (pipes)	1,700 miles	A network of pipes used for transporting sewage from residential and commercial sites to a resource recovery facility.
Wastewater Service Boundary	-	See service area map
Wastewater Service Points	136,147	Service points (Metered or Non-Metered) being billed for consumption under a tariffed wastewater rate.
Water Resource Recovery Facilities	3	A facility designed to remove biological or chemical waste products from wastewater- Includes JDPWRRF, LVSWRRF, and CSRRRF.
Wastewater Lift Stations	19	A facility designed to hydraulically lift and convey the wastewater from a low point to an elevation that allows it to flow by gravity to the WRRFs.

4.4 Existing System Description

4.4.1 Collection System

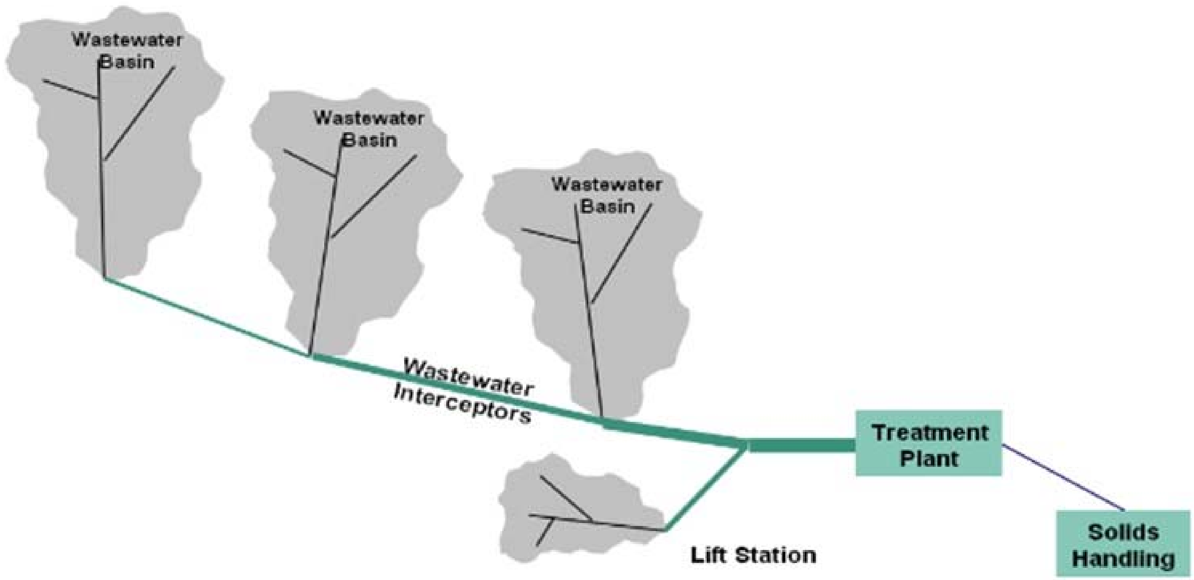

Figure 4-4 Overview of a Typical Wastewater System

Utilities' Wastewater Collection System is similar to the collection system schematic shown in Figure 4-4. The Collection System provides wastewater services for the City of Colorado Springs and City Council approved customers and service areas such as: Peterson Air Force Base, Manitou Springs, and Stratmoor Hills.

The Wastewater Collection System has been developed as an integral element throughout most of City's development. Portions of the system, installed as early as 1890, are still in use today. Figure 4-5 shows the expansion of the Collection System over the past 110 years.

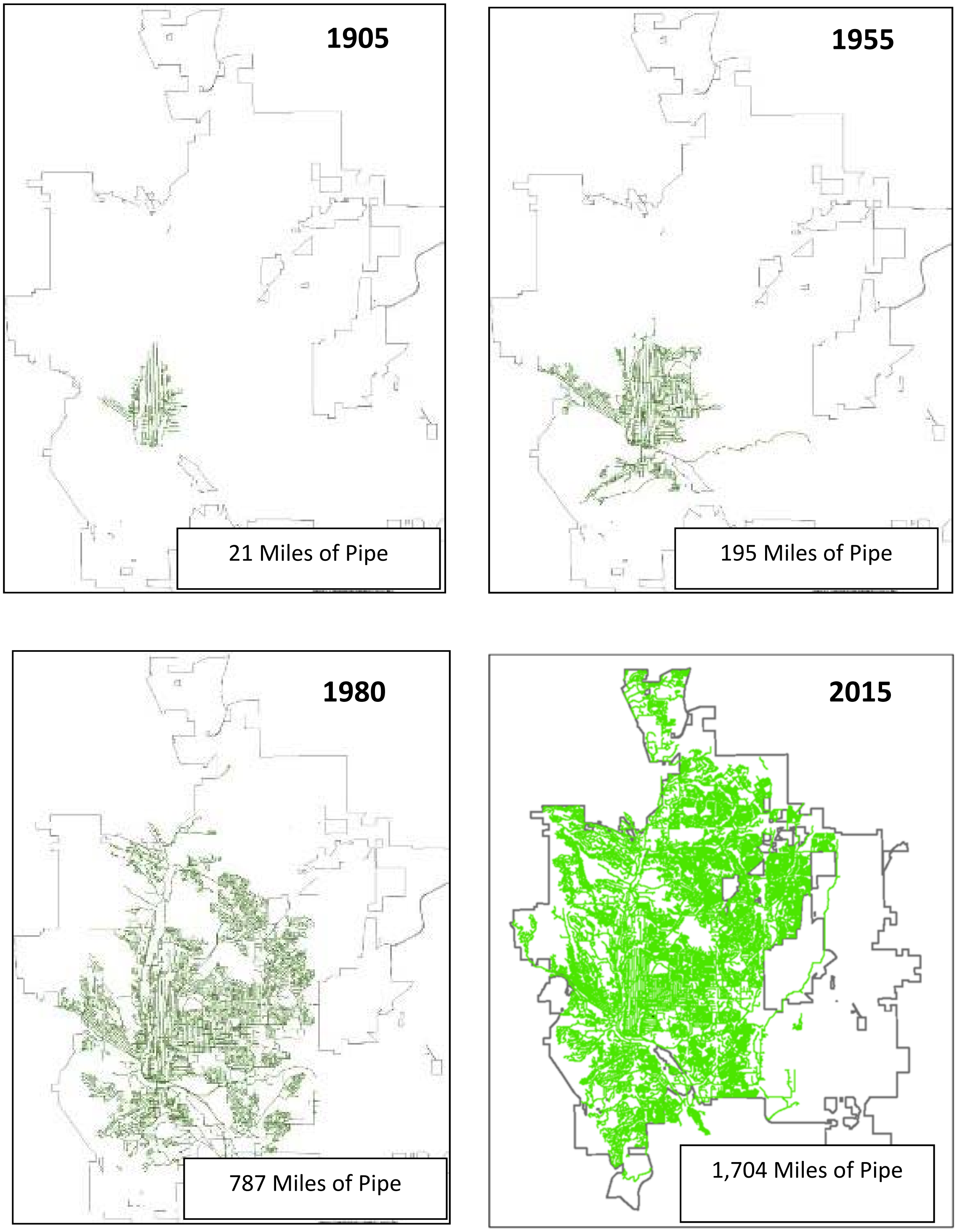

Figure 4-5 Collection System Growth

The Collection System is designed and installed in accordance with the Wastewater Line Extension Service Standards as codified by City Code. The cost and installation of sewer main extensions are the responsibility of the owner/developer, which means development directly drives the growth of the collection system.

Utilities inspects and evaluates the design, materials, and construction of a new wastewater main prior to its acceptance into the system. After a warranty period, a bill of sale is used to transfer the pipe from the developer to Utilities for long term operations and maintenance.

The long history of the collection system means that a variety of pipe materials have been used overtime and are still in use today. The oldest pipes in the system are usually vitrified clay pipes (VCP) whereas, construction projects today typically utilize polyvinyl chloride (PVC) pipes. Types of pipe in the collection system include:

- Vitrified Clay Pipe (VCP)
- Poly Vinyl Chloride (PVC)
- High Density Polyethylene (HDPE)
- Ductile Iron Pipe (DIP)
- Armco Truss Pipe (TRUSS)
- Unreinforced Concrete (UCON)
- Reinforced Concrete Pipe (RCP)

According to the *Wastewater Line Extension Service Standards*, the following pipe materials are currently approved for use in the Collection System - DIP, PVC, HDPE, and Steel.

Manholes, used to access, inspect, and maintain the sewer system, are typically constructed from precast concrete with a cast iron frame and cover. Typical manhole diameters range from 4ft to 6 ft.

Wastewater pipes ranging in size from 6” to 66” diameter are used to convey wastewater in Colorado Springs. Mains smaller than 15” installed in the last 30 years have primarily been PVC.

Force mains and lift stations are used when local topography precludes gravity service. Lift stations use centrifugal pumps to pressurize the wastewater and a force main, or pressurized main, is used to convey flow to a point where flow by gravity can be resumed. Force mains are typically constructed from PVC, DIP or HDPE. Force main diameters in Colorado Springs range between 4” and 30”.

The layout of the Collection System begins at a service point which is point at which a home, business or other wastewater connection discharges to a service line. The service line is the property owners maintenance responsibility from the service point up to the main line tap. From the main line tap, local collectors, usually 8” diameter pipes, convey wastewater to increasingly larger diameter pipes. The larger 12”-18” pipes, called trunk mains, eventually discharge into an interceptor sewer, ranging from 24” to 66” diameter pipes. Interceptor sewers discharge to either of the two WRRFs that serve the collection system - the JDPWRRF for the northern sections of the City, and the LVSWRRF for the remaining southern and eastern sections. All solids are discharged for further treatment to the CSRRRF. Figure 4-6 below shows the map indicating the various collection system basins and the WRRF service area boundaries within Utilities' overall wastewater service area.

A useful reference for understanding the extents, sizing, and location of the major components of Utilities' Wastewater System is provided in the "Green Map".

4.4.2 Resource Recovery Facilities

Utilities treats approximately 38 million gallons of wastewater per day. Wastewater generated by the service area flows to one of the two WRRFs that are owned and operated by Utilities. The JDPWRRF discharges treated effluent into Monument Creek and the LVSWRRF into Fountain Creek. All the solids that are removed from the JDPWRRF including primary and secondary sludge and scum are discharged into the Monument Creek Interceptor (MCI) and routed to the LVSWRRF. The solids are sent from LVSWRRF about 17 miles south to CSRRRF where further processing and land application of the processed biosolids takes place. The locations of the three RRFs are shown below in Figure 4-6.

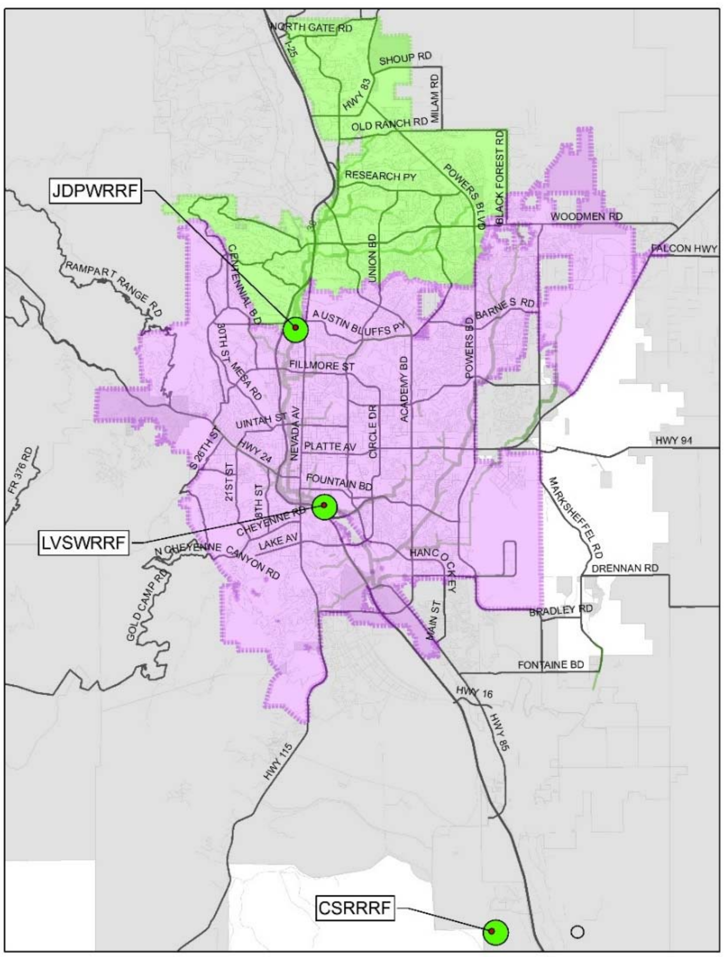

Figure 4-6 Resource Recovery Facilities and Service Area Boundaries

4.4.2.1 JD Phillips Resource Recovery Facility

Located near the intersection of Garden of the Gods Rd and Mark Dabling, the JDPWRRF is a state of the art WRRF; it is also the newest WRRF owned by Utilities, becoming operational in 2007.

The JDPWRRF serves the northern part of Colorado Springs. A large amount of development has occurred on the north side of Colorado Springs. To convey wastewater from the north to the LVSWRRF, extensive upgrades of the collection system through the Monument Creek corridor would have been required. This was avoided by locating the JDPWRRF to receive flow from the north part of Colorado Springs. In addition, the location of the facility reduces risks of flood impacts to the Monument Creek corridor.

The JDPWRRF currently has a hydraulic rated capacity of 20 mgd. The facility can be expanded in the future to 30 mgd by adding a third 10-mgd train to most of the process units. The JDPWRRF is a conventional activated sludge advanced WRRF with biological nutrient removal (BNR) capabilities. The other processes at JDPWRRF include preliminary (screening and grit removal), primary (sedimentation), secondary (BNR and settling), and tertiary treatment (filtration and UV disinfection).

The treated effluent is discharged to Monument Creek. However, in case of an emergency (e.g. poor treatment performance at JDPWRRF) all the incoming wastewater flows to JDPWRRF can be diverted to the LVSWRRF via the MCI by opening the flow diversion structure upstream of JDPWRRF. The diversion structure is not presently functional due to mechanical issues; a project is currently underway as part of the NMCI which will provide full redundancy to JDPWRRF with the ability to divert all flows to LVSWRRF.

All the solids that are removed from the JDPWRRF including primary sludge and scum, and secondary sludge and scum are discharged into the MCI and routed to the LVSWRRF.

A portion of the treated effluent undergoes tertiary treatment and is reused for non-potable purposes. Photos of JDPWRRF are shown in Figures 4-7 and 4-8. The facility is currently treating an AADF of approximately 9 mgd.

Figure 4-7 J.D. Phillips Water Resource Recovery Facility

Figure 4-8 J.D. Phillips Water Resource Recovery Facility

4.4.2.2 Las Vegas Street Water Resource Recovery Facility

Of the two WRRFs, LVSWRRF treats a greater quantity of wastewater. The LVSWRRF treats the wastewater from all the collection basins shown in Figure 4-6 except for the Upper Monument Creek Basins. Built over 75 years ago, LVSWRRF is the oldest and largest of Utilities' three resource recovery facilities. Over the course of its lifetime, LVSWRRF has seen various types of wastewater treatment technologies being implemented at the facility that have evolved over time. LVSWRRF has continued to adapt to changing technologies over the years to make it an efficient facility that treats the majority of wastewater from the Colorado Springs service territory.

The LVSWRRF has a rated capacity of 75 mgd out of which 18 mgd comes from an out of commission trickling filter solids contact basin (TF/SC) process. The remaining 57 mgd comes from an advanced wastewater treatment train comprised of an activated sludge process. This advanced treatment train of the secondary treatment process was upgraded in early 2019 by converting the BNR process from a Modified Ludzack Ettinger (MLE) to an Anaerobic-Anoxic-Oxic (A2O) process. These modifications were necessary to comply with the new Regulation 85 nutrient regulations implemented by CDPHE) which go into effect July 1, 2020. The rest of the processes at LVSWRRF are very similar to those at JDPWRRF consisting of preliminary (screening and grit removal), primary (sedimentation), secondary (BNR and settling), and tertiary treatment (filtration and UV disinfection). A portion of the treated effluent undergoes tertiary treatment for non-potable reuse, and the remainder is discharged into Fountain Creek. All the solids that are removed from LVSWRRF including primary sludge and scum and secondary sludge and scum are pumped from a Blended Sludge Pump Station (BSPS) though a 17-mile pipeline to CSRRRF. A photo of LVSWRRF is shown in Figure 4-9. The facility is currently treating an AADF of approximately 29 mgd.

Figure 4-9 Las Vegas Street Water Resource Recovery Facility

4.4.2.3 Clear Spring Ranch Resource Recovery Facility

Located roughly 17 miles southwest of downtown Colorado Springs on the 5,000-acre Clear Spring Ranch property, the CSRRRF collects, stabilizes, stores, and disposes off all treatment generated sludge (biosolids and primary settled sludge) produced at the LVWRRF and the JDPWRRF. It is the last step of the "wastewater treatment process" from the time raw sewage is collected and processed in Utilities' network of wastewater assets prior to final discharge into the environment. CSRRRF was built as a response to the need for more efficient solids disposal. The sludge pipeline between LVSWRRF and CSRRRF and the solids treatment and disposal infrastructure developed at CSRRRF was an innovative solution for this need. The facility now provides a very cost effective and efficient means of solids disposal for Utilities. The cost per pound of solids disposal is one of the lowest in the country for a facility of CSRRRF's size.

Figure 4-10 Sludge Pipeline Connecting LVSWRRF and CSRRRF

At the CSRRRF, the solids are sent through an anaerobic digestion process and then stored in facultative sludge basins (FSBs) where additional stabilization takes place. The biosolids are then pumped from the FSBs and injected below the soil surface in fields called dedicated land disposal units (DLDs). The land disposal units are located behind a dam that prevents any runoff or groundwater from leaving the disposal site. On the downstream side of the dam, a French drain/pump back system returns seepage to the pond behind the dam. The CSRRRF facility is a zero-discharge facility meaning all liquids on the site are contained on the site and not allowed to be conveyed to any external water sources. The primary means of reducing water on the site is through evaporation from the FSBs and supernatant lagoons. The CSRRRF has had several names since being built in 1984. In the *Wastewater Integrated Masterplan* of 2009, it was referred to as the Solids Handling and Disposal Facility (SHDF). The new name of CSRRRF is consistent with Water Environment Federations' nomenclature to identify wastewater treatment facilities as resource recovery facilities as long as some form of resource is being recovered at that facility. At the CSRRRF, partial energy recovery has always been occurring in the form of heat that is used for heating the building and digesters. Even the new names for JDPWRRF and LVSWRRF from J D Phillips Water

Reclamation Facility (JDPWRF) and Las Vegas Street Wastewater Treatment Facility (LVSWWTF) embrace the resource recovery philosophy and are consistent with WEFs new naming convention for such facilities. A photo of the CSRRRF is shown in Figure 4-11.

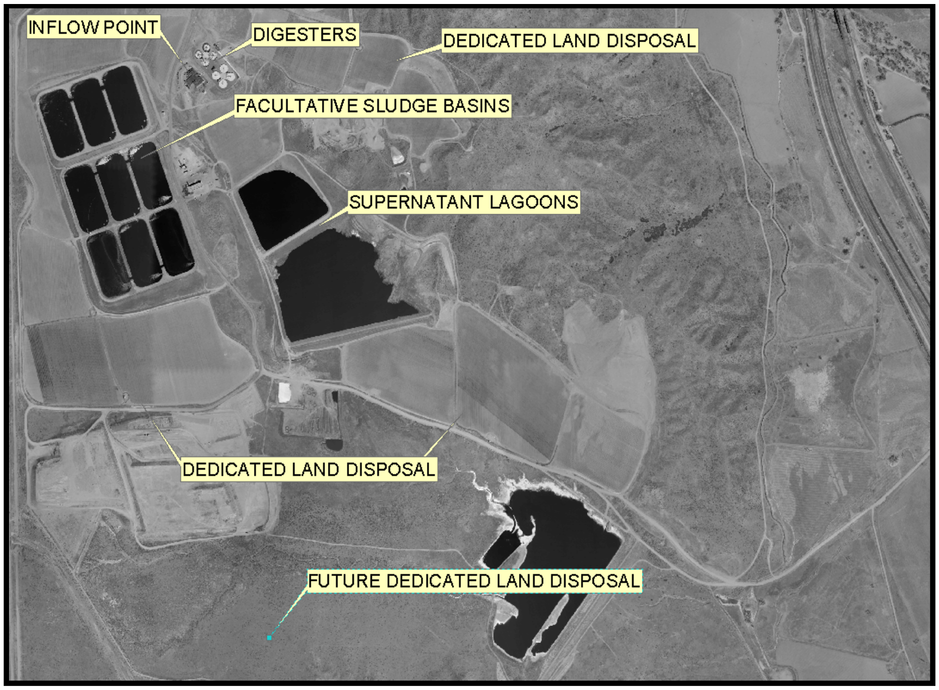

Figure 4-11 Clear Spring Ranch Resource Recovery Facility

4.5 Known Issues

Some of the known issues that impact the wastewater system are highlighted below. For more details, please refer to sections and documents indicated.

1. Aging infrastructure:
   This category can be divided into two broad asset categories - 1. Linear/ Horizontal Assets (e.g. mains, manholes): These assets are renewed and replaced through programmatic efforts that have established cyclical cleaning, inspection/ condition assessment, and renewal/ replacement activities. Detailed descriptions of the programs and their planned renewal and replacement activities will be developed in the program plans. 2. Vertical Assets (e.g. resource recovery facilities (RRF's) and lift stations): These assets are renewed and replaced through needs identified in facility plans based on condition assessment, asset criticality, and capacity evaluations. For detailed description of the vertical asset renewal and replacement needs see the following facility plans:
   - CSRRRF Facility Plan (completed in 2017)
   - LVSWRRF Facility Plan (currently ongoing, scheduled to be completed in 2019)
   - JDPWRRF Facility Plan (scheduled to be completed in 2021)

- Lift Station Facility Plan (scheduled to be completed in 2020)

2. Regulatory drivers:
   This category is the main driver for system wide and facility level improvements triggered due to regulatory changes. One of the key regulatory changes that is expected in the next 20-year planning cycle is Regulation 31 that will propose reduced Nitrogen (N) and Phosphorus (P) limits along with chlorophyll ‘a’. This regulation is likely to drive the next major phase of process improvements at both LVSWRRF and JDPWRRF. The magnitude of these improvements requires significant advanced planning prior to the regulations going into effect. There is an interim voluntary incentive program (VIP) that has been proposed by CDPHE that offers an opportunity to take a step-wise decrease in nutrient limits by performing better than the current Regulation 85 limits for N and P and earn incentive in the form of delayed Regulation 31 compliance. Utilities is actively working towards participating in this program that will potentially help earn the credits necessary to delay compliance with Regulation 31 limits as far out as 2040. For details on this aspect, please refer to Section 6.1. Other potential regulatory driven changes include temperature standards for effluent. Utilities is currently monitoring upstream and downstream temperatures to see how the effluent temperature impacts the receiving stream. Though there is potential for the effluent from LVSWRRF to impact the temperature of Fountain Creek, it is anticipated that LVSWRRF should be able to comply with the proposed stream standard for temperature (for Fountain Creek). There are also potential regulatory impacts from metals such as cadmium, copper and selenium. These metals are currently not being regulated but have the potential to be in the future.

3. Growth/Population:
   This is the more conventional driver for infrastructure development that is based on population increase, growth of the city, and expanded service area added to Utilities service territory through annexation agreements. Based on population projections in the city, flow projections have been calculated and are summarized in Chapter 5. These calculated flows have been used to estimate available capacity in the collection system and RRFs and identify triggers for infrastructure development and improvements.

4. Changing Influent Characteristics:
   Wastewater characteristics are subject to change based on water use trends, changing customer behavior and customer base composition (residential, commercial, and industrial). Over the last 10 years or so, wastewater characteristics have changed due to use of high efficiency appliances, low flush toilets/low flow shower heads. Additionally, changing customer habits both voluntarily and due to water conservation measures (imposed externally due to environmental factors such as drought), have resulted in flows going down

thereby increasing concentrations of wastewater constituents of concern (e.g. biological oxygen demand (BOD), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorous (TP)). Recent historical loading trends show that with a relatively modest increase in population, the loading (flow x concentration) has generally been stable or flat. The trend with the decrease in water usage appears to have bottomed out as can be seen by the overall decrease in the wastewater flows. For details on this aspect, please refer to Chapter 5. Increasing concentrations of constituents, such as ammonia and ortho phosphate, is another aspect that can significantly impact the performance of the WRRFs and will have to be closely monitored.

5. Carbon is another key parameter of wastewater characterization that will need to be carefully monitored over time. Historically, carbon, measured as BOD, has been a key indicator and limiting factor of wastewater treatment capacity. However, readily biodegradable carbon is now a valuable component necessary for nutrient removal under current and anticipated future discharge regulations. Utilities will need to do a ‘carbon’ supply plan to ensure enough good carbon is available for meeting nutrient regulations over the long term especially when Regulation 31 goes into effect. Lack of sufficient carbon in the influent could force Utilities to buy industrially manufactured supplemental carbon such as acetic acid which would result in additional O&M expenditures. Management of existing available carbon sources is an important task that will be tracked through development of a robust carbon supply plan. For details on this aspect, please refer to Chapter 11 – Project Details and Alternatives Development.

6. Regionalization:
   Over the course of producing the *WWSP* the concept of regionalization has developed considerably. Regionalization from Utilities’ wastewater perspective means providing “wholesale” wastewater service to Districts outside the city limits when approved by City Council for outside City service. Wastewater is generally delivered to Utilities through a metered connection and is billed based on volume. The concerned District is responsible for the cost of extending wastewater mains for service.

   Regional level projects that have gained traction during the development of the *WWSP* include the NMCI project and potentially the Sterling Ranch Wastewater project.

   The NMCI regionalization project is a collaborative partnership that is investigating the construction of a 10-mile interceptor with portions of the pipeline located on United States Air Force Academy (USAFA) owned land. The NMCI considers consolidation of up to three other regional WRRFs and the elimination of several Utilities owned lift stations. Based on excess capacity available at

JDPWRRF (see Chapter 9 – Capacity Analysis for detailed capacity analysis and discussion) it has been determined that all the additional wastewater flows from the NMCI will be accepted at the JDPWRRF.

Sterling Ranch is an area north of Woodmen Rd. and east of Black Forest Rd. that Utilities has the possibility to partner with to provide wastewater service for Stirling Ranch' customers. Through preliminary investigations it appears that Utilities' existing wastewater system (both collection system and RRFs) has adequate capacity to accept wastewater from Sterling Ranch.

7. Resource Recovery:
   The paradigm is shifting in how resources are recovered from wastewater treatment. A lot of emphasis is being placed on resource recovery which can be for nutrients (N and P), energy (carbon (C) through biogas) or heat. Newer technologies are developing that can take resource recovery to a whole new level. Some of these technologies are nascent or in the pilot phase but that can change over time which may make this category more influential on how infrastructure and project developments occur. For details on this aspect, please refer to Chapter 11 - Project Details and Alternatives Development.

8. The primary issues affecting the collection system are infiltration and inflow (I&I), maintenance items such as roots and grease, deteriorating infrastructure, odor control, and erosional effects from creeks and drainages. Most of these issues were included under the Compliance on Consent issued by the state of Colorado as mitigation objectives and remain primary focuses to this day.

4.6 Reference Reports

The following previously completed studies and reports have been used as a basis for the *WWSP*.

- 2008 *JDP Diversion Study* (Stantec)
- 2009 *Wastewater Integrated Masterplan* (Utilities Internal)
- 2009 *Wastewater Collection System Capacity Evaluation* (Stantec)
- 2010 *Nutrient Removal Study* (Stantec)

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Chapter 5

Flow, Load and Demand Projections

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5 Flow, Load and Demand Projections

The goal of this chapter is to define the current and forecasted system loading. The loading will be compared to system capacity developed in Chapter 9 – Capacity Analysis. Figure 5-1 below provides an illustrative analogy of the influencing factors and relationship between system loading and capacity. The loading of the wastewater system includes hydraulic loading and organic/nutrient loading, and is expected to be influenced by population growth, city land use, and changes in water usage patterns.

The information sources used in the flow/load analyses include: field measurements, data from laboratory analysis, along with forecasted projections such as the 2014 Small Area Forecast (SAF), and City land use. Historical data was used to develop trendlines that show the relationships between current and past loadings. In addition, plots of the projected system loading were developed, which should be progressively monitored and refined in future revisions of the *WWSP*.

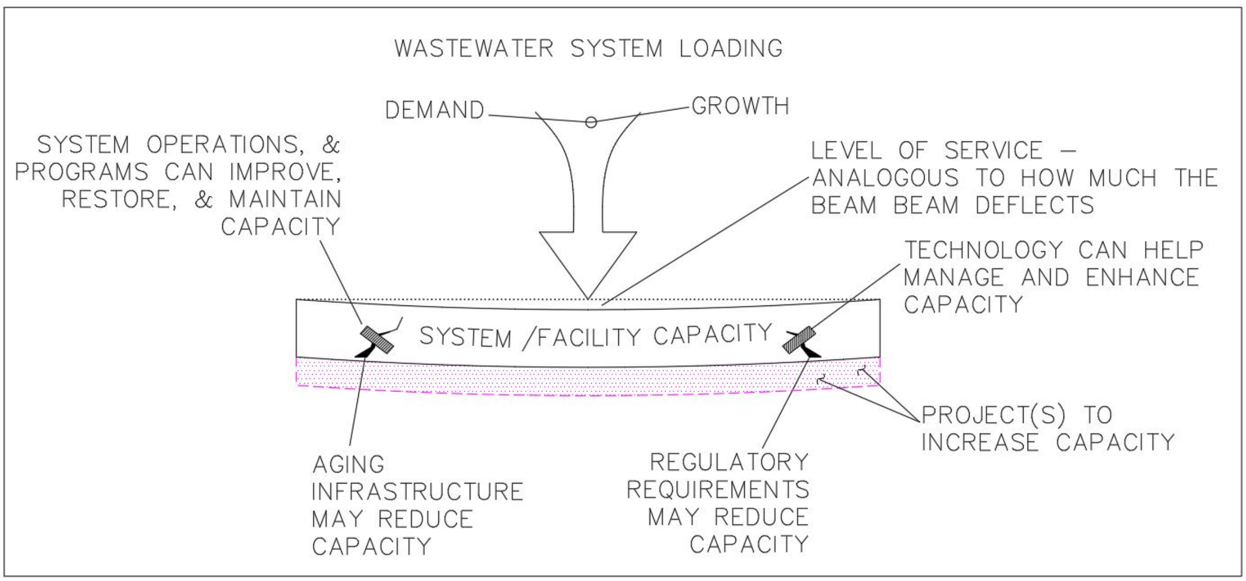

Figure 5-1 Arrow and Beam Analogy for Load/Capacity Analysis

5.1 Future Development

Average daily wastewater discharge in Colorado Springs is projected to increase from about 39 mgd currently (2017), to about 47 mgd in 2040 based upon the population estimates included in the 2014 Small Area Forecast (SAF) published by the Pikes Peak Area Council of Governments (PPACG). Future development in Colorado Springs is expected to occur in the north and northeastern parts of the city, including some of the larger residential development areas such as Banning Lewis Ranch, Wolf Ranch, Cordera, Flying Horse Ranch and The Farm.

Since 2005, the demand for major annexations to the City of Colorado Springs has been minimal. Smaller areas such as Mountain Vista Enclaves (2017) and the proposed Sands Annexation (TBD) are recent examples of annexations, and generally consist of ~250 houses so are not expected to significantly impact the wastewater system.

Northern districts including Tri Lakes (Woodmoor, Monument and Palmer Lakes) and Upper Monument Creek (Triview, Donala and Forest Lakes), along with the USAFA are considering the possibility of partnering with Utilities under a regionalization initiative. In the past, Utilities' development charges have limited interest and implementation of regionalization projects. Historically, these entities would have likely invested in their own system improvements to meet regulatory or growth driven infrastructure needs. Lowering the development charges for large "wholesale" customers may spur regionalization by enabling regional partners to connect more cost effectively to Utilities' wastewater system. This will allow these entities to utilize Utilities' infrastructure as an alternative to upgrading their current treatment process and help them meet current (Regulation 85 and VIP), and future (Regulation 31) regulatory limits. The potential future flows from the northern regional entities is approximately 2.6 MGD (current conditions) and 5.9 MGD at build out conditions).

Regionalization offers a win-win opportunity for both Utilities and the regional entity to save significant costs through sharing the available infrastructure; especially as Utilities has surplus capacity in many of its wastewater system assets. This will also optimize the infrastructure use in the region, thereby benefitting the customer base for partnering entities, as well as Utilities.

At this time (2018) efforts are ongoing to identify regionalization potential and create a framework under which agreements can be forged. Table 5-1 identifies districts close to Utilities' service area that could potentially be a part of regionalization opportunities for wastewater service. The table will be refined with the regionalization study currently underway. The current *WWSP* does not account for regionalization loads shown in the table.

Table 5-1 Preliminary Regional Entity Potential Table

Regional District	Current ADF (MGD)	Future ADF (MGD)	Notes
Palmer Lake	0.23	0.7	Potential Northern Monument Creek Interceptor (NMCI) Partner
Woodmoor	0.85	1.9	
Monument	0.21	0.8	
Donala	0.36	0.9	
Tri-view	0.36	0.8	
Forest Lakes	0.04	0.3	
USAFA	0.5	0.5	
Ft. Carson	1.3	1.5	
Cherokee	1.8	TBD	
Meridian Ranch			
Falcon Highlands	1.3	TBD	
Woodmen Hills			
Paint Brush			
Sterling Ranch	0	1.0	
Rock Creek	TBD		
Park Forest	TBD		

5.2 Demographics

5.2.1 Population

The Pikes Peak Region's 2014 SAF was used to evaluate the wastewater system's demographics. The SAF provides transportation planning information in the form of Transportation Area Zone (TAZ) data which helps to strategically identify the needs for the region's transportation investments. The SAF is a socioeconomic forecast based on U.S. Census data, commercial employment databases, and local planning knowledge. The SAF begins with the State of Colorado Demographers' Office' regional level analysis that provides bulk data for the Pikes Peak Region[1]. The SAF divides the Pikes Peak Region into smaller sub-regions. The sub-regions, or TAZs, are forecasted using local knowledge and local planning. It should be noted that the SAF estimates the future population for each TAZ. This estimated population is used for the *WWSP's* 2040 population projection. Figure 5-2 demonstrates the population growth projections for Colorado Springs to the year 2040, based on TAZ data.

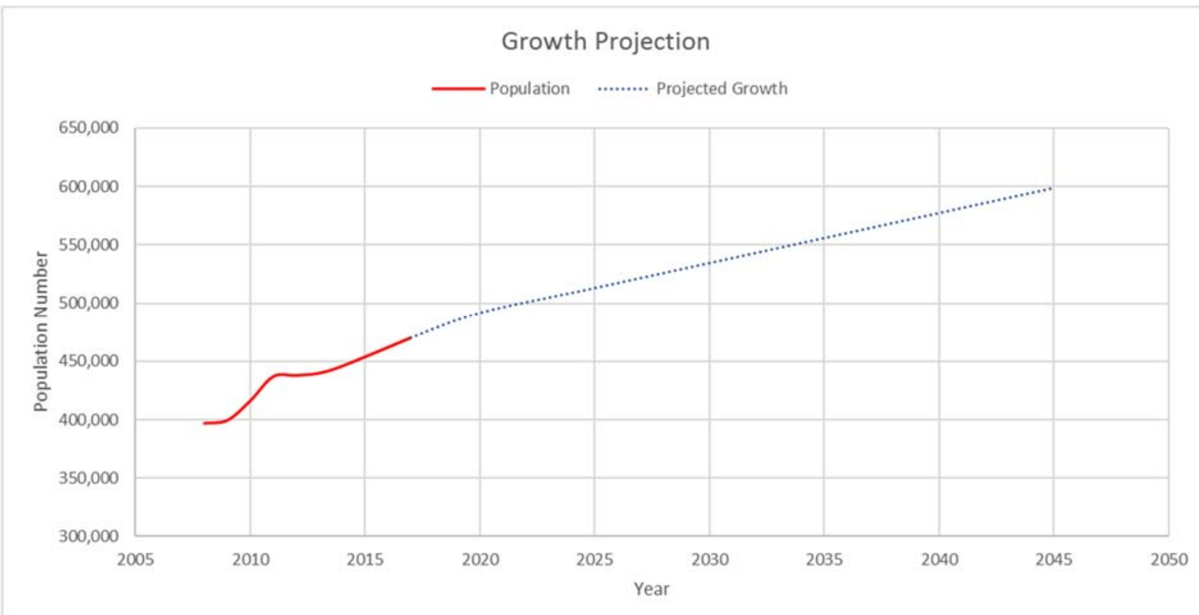

Figure 5-2 Population Growth Projections for Colorado Springs

[1] PPACG, 2040 Long Range Transportation Plan, Chapter 5, p.2 (2015)

5.2.2 Employment

The SAF forecasts employment data to determine the areas where people are likely to work versus the areas where they are likely to live to estimate the transportation needs. Employment data from the SAF is not fully incorporated into the *WWSP*; instead growth areas are identified, and future wastewater flows are forecasted based on population and wastewater generation per capita.

5.2.3 Growth Projections/Assumptions

The growth is assumed to be linear from the current population to the TAZ projected population.

5.3 Land Use

5.3.1 Existing Land Use

Current land use in Colorado Springs is 71% residential, with most of the residential development in the form of low to medium density housing. Based on 2010 census data, the population density is approximately 3.6 people per acre, and based on the 2040 SAF projection, the expected population density is approximately 5 people per acre. The commercial areas of Colorado Springs are primarily, retail, light office, and some industrial areas. The commercial areas are generally focused along the major road corridors and are largely comprised of restaurants, shopping areas, entertainment venues, and lodging.

5.3.2 Buildout Land Use

The land area available for growth was determined using the City land use data. Areas within the city limits coded as agricultural, vacant, or vacant/parking are assumed to be available for future development and are shown on the map provided in Appendix 5B on page 5B-1. Buildout land use is expected to reflect existing land use with slightly higher population densities in some areas as infill projects are completed.

5.4 Flow/Load

5.4.1 Wastewater Collection System

5.4.1.1 Basis of Methodology and Assumptions

The *WWSP* utilized flow calibration points to help evaluate flow, load, and demand. A calibration point is a measured flow location in the collection system and was used to determine current and project future loading. Figure 5-3 shows the locations of the calibration points used within Utilities' wastewater service territory on a single map. For sake of clarity, the individual maps are included in Appendix 5B on pages 5B-2 through 5B-31.

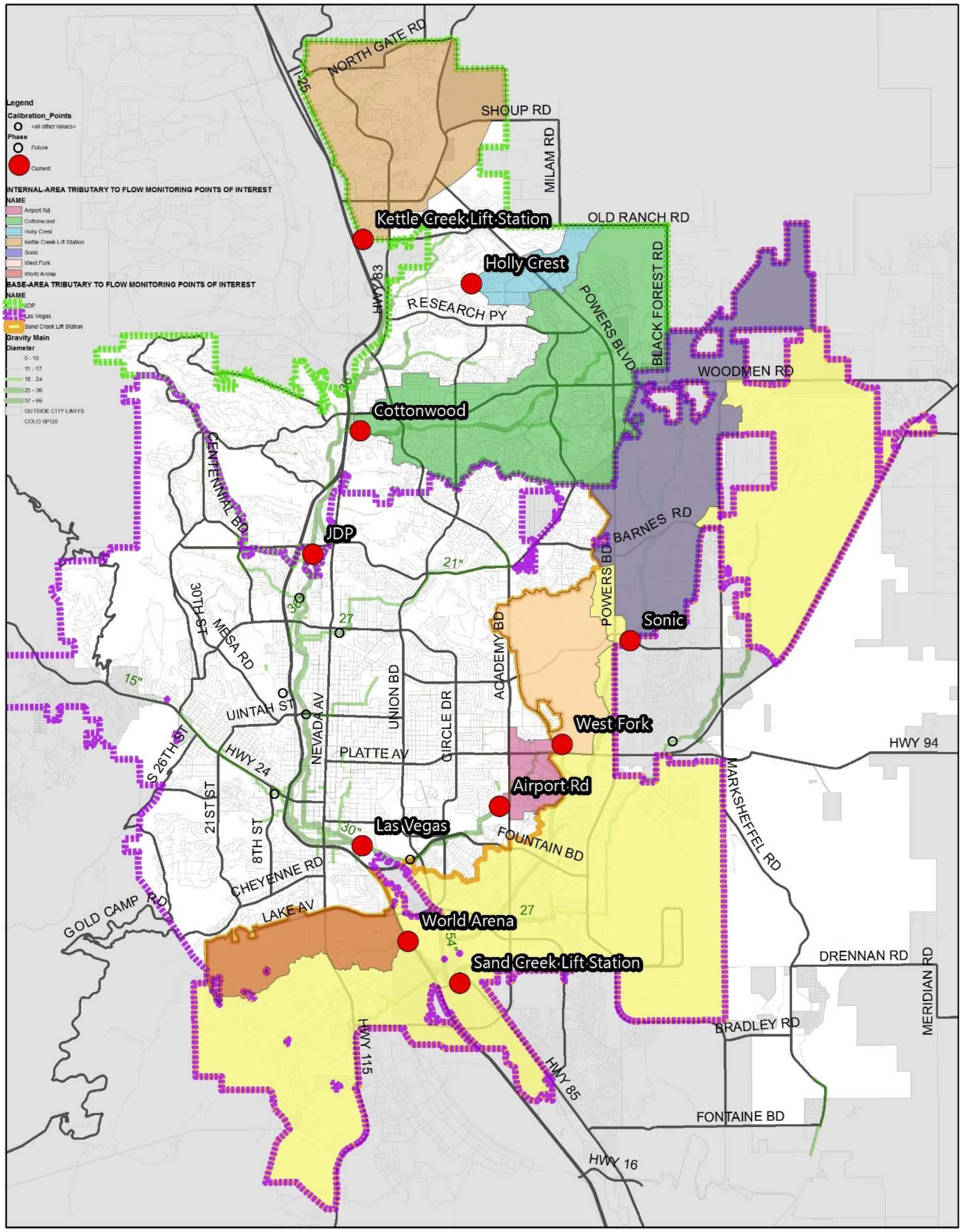

Figure 5-3 Wastewater Flow Calibration Points

The important parameters analyzed for each calibration point are listed below and Table 5-2 (on page 5-12) summarizes the results of the analysis

In City Area 2017 – Area within the city limits and is important because of the assumption that areas currently outside of the city limits would not significantly impact the future system loading.

In City Area to be Developed – Area with a land use code of Agricultural, Vacant, or Parking/Vacant AND a tax code equal to City of Colorado Springs. The Agricultural, Vacant, Parking/Vacant codes are assumed to be indicative of areas that may be developed in the future.

Percent Developed Based on Land Use – Calculated as

$$= 1 - \frac{In\ City\ Area\ to\ be\ Developed}{In\ City\ Area\ 2017}$$

2017 Average Flow –Current collection system flow data was obtained from temporary flow monitoring measurements and PI data. Flow records were developed into average hydrographs, which are provided in Appendix 5B. The hydrographs show the average daily flows for 2017, illustrating the typical diurnal wastewater flow patterns in the various basins.

2017 Population Estimate – A straight-line growth estimate from 2010 to 2040 based on SAF data (that included 2010 census data) was used to estimate the number of people currently in the basin.

2017 Modified Average per Capita usage – Calculated as

$$= \frac{2017\ Average\ Flow}{2017\ Population\ Estimate}$$

2017 Average Flow per Developed Acre – Calculated as

$$= \frac{2017\ Average\ Flow}{(Developed\ Area)}$$

Projected 2040 Population – The TAZ population was assumed to be evenly distributed throughout the TAZ zones based on SAF data. GIS was used to accumulate and split bordering TAZ zones into their respective basins so that the future basin population could be estimated.

2040 Average Flow based on population – Calculated as

$$= 2040\ Population * 2017\ Modified\ Average\ per\ Capita\ Usage$$

2040 Dry Weather Peaking Factor – Discussed in detail below, the peaking factor (PF) indicates the dry weather peak flow, or peak flow that is expected on a daily basis. This parameter helps define a level of service criteria - a d/D ratio of 0.7 (Figure 5-4) that should not be exceeded on a daily basis.

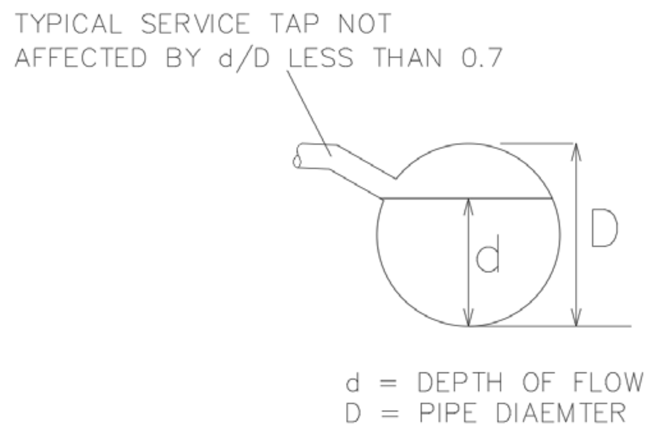

Figure 5-4 Dry Weather Depth Service Criteria

2040 Dry Weather Peak Flow – Calculated as

$$= 2040\ Average\ Flow * 2040\ Dry\ Weather\ Peaking\ Factor$$

2040 Design Wet Weather Peak Flow – Discussed in detail in Section 5.4.2, the estimated peak wet weather flow is used to define another service level based on the following criteria:

- No surcharging of 12” and smaller pipes
- Maximum of 125% surcharging of pipes 15” and larger

Buildout Average Flow – Calculated as, higher of,

$$= 2040\ Average\ Flow\ Based\ on\ Population$$

or

$$= 2017\ Average\ Flow\ per\ Acre * In\ City\ Area\ to\ be\ developed + 2017\ Average\ Flow$$

Buildout Dry Weather Peaking Factor – similar to 2040 Dry Weather peaking factor with the Buildout Average flow used.

Buildout Dry Weather Peak Flow – similar to 2040 Dry Weather Peak Flow

Buildout Wet Weather Peak Flow – similar to 2040 Wet Weather Peak Flow

Graphs in Appendix 5B (pages 5B-2 through 5B-31) show the 2017 average day hydrographs for each wastewater calibration point and document the projected future dry and wet weather flows. The projection graphs include a dashed trended projection based on flow increases (slope of trend line) observed over the past 5 to 10 years. The purpose of including two projections, one based on straight line growth from SAF data and the other based on recently observed data is to provide a range of growth rates at the calibration point.

5.4.1.2 Collection System Peaking Factors

For this version of the *WWSP*, peaking factors as defined below are used to estimate peak flows for dry and wet weather conditions.

$$PF_{dry} = 1.9 * Q_{avg}{}^{-0.06}$$

$$PF_{wet} = 3.61 * Q_{avg}{}^{-0.06}$$

The peaking factor equations yielded mixed results. Figure 5-5 plots the results of the calculated design peaking factor equations vs. flow monitor measurements. The data indicates that the dry weather peaking factor formula was more consistent when compared to measured data, and is slightly conservative.

Wet weather peaking was more difficult to define as a formula and it should be noted that the measured results shown are merely the highest flow the monitor measured, meaning the results don't reflect the difference in rainfall depths or storm return frequency experienced in each basin. For example, a review of wet weather points near a peaking factor of 6.5 shows that peak flows at these locations occurred on either 9/12/2013, or 5/9/2015 – both events were 100yr + rainfall events that resulted in FEMA declared disasters eligible for emergency funding.

Significant improvement in estimating Rainfall Derived Inflow and Infiltration (RDII) could be made in future *WWSP's* if more specific RTK[1] parameters were developed based on flow monitor and United States Geological Survey (USGS) rain gage data. These RTK parameters help characterize the amount of RDII that would be expected and could be applied based on criteria such as, location, basin, or pipe age & material. Once the RTK parameters are developed, a design rainfall event could be more accurately modeled, thus better characterizing the risk to the system.

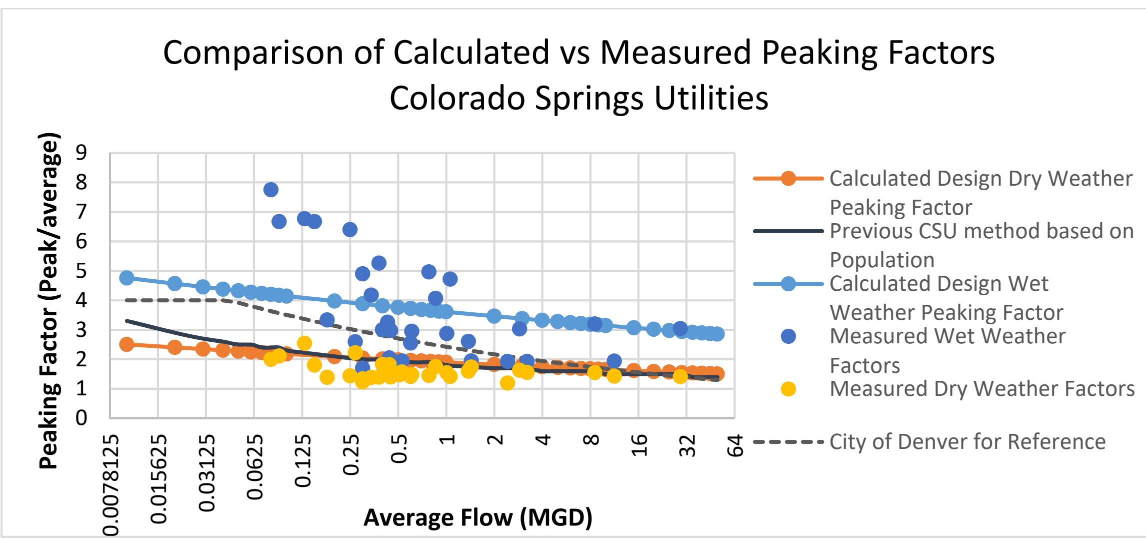

Figure 5-5 Comparison of Calculated vs Measured Peaking Factors

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[1] The RTK method is based on fitting up to three triangular unit hydrographs to an observed RDII hydrograph to estimate the fast, medium, and slow RDII responses. The R_i parameter is the fraction of rainfall volume entering the sewer system as RDII, T_i is the time to peak, and K_i is the ratio of time of recession to T_i. The RDII volumes of three-unit hydrographs are designated as R_1, R_2, and R_3. A high R_1 value indicates that the RDII is primarily inflow driven. If more of the total R value is allocated to R_2 and R_3, this will indicate that the RDII is primarily infiltration driven. (https://www.epa.gov/water-research/sanitary-sewer-overflow-analysis-and-planning-ssoap-toolbox)

Through the flow monitor analysis and peaking factor work, a change in hydrographs from 2005 to 2017 was seen. For example, in the Cottonwood basin, hydrographs from 1994 and 2005 have similar dry weather peaking factors. When the 1994 and 2005 hydrographs are compared to the 2017 hydrograph, the peaking factor is reduced, and time shifted slightly as seen in Figure 5-7 - the measured dry weather peak flow was higher and earlier in the day in 2005 than it is today (2017).

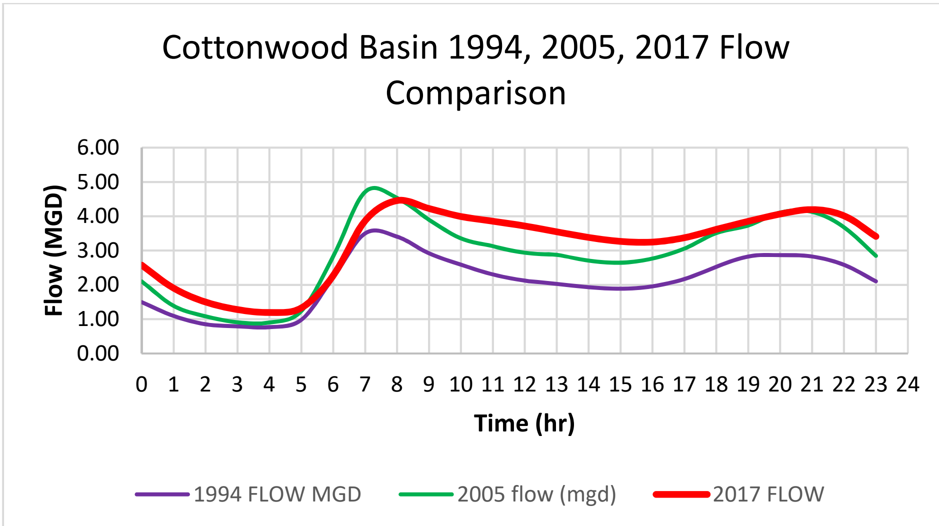

Figure 5-6 Cottonwood Basin 1994, 2005, 2017 Flow Comparison

While more analysis is needed, the reduction in peak flows may have been driven by the 1994 Federal regulations resulting in lower flow showers and low flush toilets plus the combined drought pressures that water consumers felt in Colorado Springs in the early 2000's and again in 2013. As older fixtures were upgraded and replaced a change in the water use pattern is reflected in the lower peak flows as seen in the 2017 hydrographs.

Table 5-2 highlights the key estimates from future flow projection graphs that are included in Appendix 5B (pages 5B-2 through 5B-31).

Table 5-2 Summary of Projected Flow Estimates for Calibration Points in the Wastewater Service Territory for Colorado Springs Utilities

Flow Calibration Point	Flowmeter Location	In City Area 2017 (acres)	In City Area to be Developed (acres)	Percent Developed Based on Land Use	2017 Average Flow (MGD)	2017 Population Estimate	2017 Modified Average per Capita Usage[1] (gallons/ person/ day)	2017 Average Flow per Developed Acre (gallons/ acre/ day)	Projected 2040 Population	2040 Average Flow based on population (MGD)	2040 Dry Weather Peaking Factor[2]	2040 Dry Weather Peak Flow (MGD)	2040 Design Wet Weather Peak Flow (MGD)	Buildout Average Day Flow (MGD)	Buildout Dry Weather Peaking Factor[2]	Buildout Dry Weather Peak Flow (MGD)	Buildout Wet Weather Peak Flow (MGD)	Capacity at Calibration Point (MGD)[4]
Airport Rd	WW.119507 (Airport Rd and Academy)	682	24	96%	0.78	10,500	74	1186	10,500	0.78	1.93	1.50	2.86	0.81	1.92	1.56	2.96	2.87
Cottonwood	WW.110800 (Cottonwood and Vincent, 24")	7,205	2,225	69%	3.22	48,200	67	647	52,600	3.51	1.76	6.19	11.76	4.66	1.73	8.07	15.33	12.22
Holly Crest	WW.126679 (near Briargate Pkwy and Pine Manor, 15")	848	329	61%	0.34	3,900	87	655	5,500	0.48	1.99	0.95	1.81	0.56	1.97	1.09	2.08	4.60
Kettle Creek Lift Station	WW.124634 (Immediately upstream of KC lift Station, 16")	4,479	2,412	46%	0.86	10,100	85	416	16,300	1.39	1.86	2.59	4.91	1.86	1.83	3.41	6.48	2.50
Sand Creek Lift Station	PI data	32,603	9,610	71%	11.34	141,000	80	493	186,000	14.96	1.62	24.16	45.91	16.08	1.61	25.86	49.14	20.00
Sonic	WW.116590 (Sand Creek and Constitution, 30")	4,748	1,239	74%	2.89	42,600	68	824	52,900	3.59	1.76	6.32	12.00	3.91	1.75	6.85	13.01	24.20
West Fork	WW.130628 (Wooten and Clark)	2,287	87	96%	1.01	17,100	59	459	18,620	1.10	1.89	2.08	3.95	1.10	1.89	2.08	3.95	6.30
World Arena	WW.107499 (Next to World Arena, 21")[3]	2077.40	78.38	96%	2.43	7,000	179	1216	9,000	2.79	1.79	4.98	9.46	2.79	1.79	4.98	9.46	9.26
WRRF DATA																		
Las Vegas	PI Influent Data	66,364	14,092	79%	29.40	353,000	83	562	437,000	36.40	1.53	55.74	105.90	37.33	1.53	57.08	108.44	refer to LVSWRRF
JDP	PI Influent Data	23,556	7,082	70%	8.54	118,000	72	518	139,000	10.06	1.65	16.64	31.62	12.21	1.64	19.97	37.94	refer to JDPWRRF

Notes

1 method used average flow/population thus, flow from commercial and industrial users will be attributed to the population base

2 PF = 1.9*Q_{avg}^-0.06

3 Per Capita Flows Influenced by Microchip (ATMEL)

4 Capacity of full pipe or lift station at calibration point

5.4.2 Resource Recovery Facilities

The goal of this section is to analyze current loading trends for flows and loading constituents at the three RRF's – JDPWRRF, LVSWRRF, and CSRRRF, and project future flow and loading based on TAZ projections, and historical data trendlines. The projected flow and loading values will be used in Chapter 9 for a load versus capacity analysis.

5.4.2.1 JDPWRRF and LVSWRRF

5.4.2.1.1 Flows

JDPWRRF and LVSWRRF have rated capacities of 20 mgd and 75 mgd respectively. In recent years, the influent wastewater flows to the two WRRF's have decreased, despite an increase in population, due to factors such as wastewater collection system improvements, adoption of water efficient appliances, and water conservation efforts. Flow graphs for both JDPWRRF and LVSWRRF are presented in Appendix 5B on pages 5B-32 through 5B-33 and 5B-46 through 5B-47. The graphs present data for historical flow trends over the past five years, as well as flow projections for the year 2040. The year 2040 corresponds to the end of the period to which TAZ data is projected as part of the SAF.

Flow projections corresponding to the year 2040 were developed using two methods. The first method used a trendline created from the historical data (last five years), and extrapolated that to the year 2040 to estimate the future flows. The second method assumed a straight-line growth between the 2017 average flows and the 2040 estimated flows based on TAZ population data. The two methods for flow projections provide a range for estimated future flows at the two WRRF's.

Table 5-3 provides a summary of the 2017 average flow values, and 2040 and buildout projected flows based on trendline developed from historical data as well as TAZ projection values for both JDPWRRF and LVSWRRF.

Table 5-3 2017 average Flow and Flow Projections at JDPWRRF and LVSWRRF

	JDPWRRF					**LVSWRRF**				
	2017 Average	**TAZ Projection**		**Historic Trendline Projection**		**2017 Average**	**TAZ Projection**		**Historic Trendline Projection**	
		2040	Buildout	2040	Buildout		2040	Buildout	2040	Buildout
Flow (MGD)	8.54	10.06	12.21	13.5	17.5	29.5	36.40	37.33	36.0	36.7

5.4.2.1.2 Nutrient, Organic and TSS Loading

The current permits issued by CDPHE for JDPWRRF and LVSWRRF specify the rated capacities for influent flows and carbonaceous biochemical oxygen demand (cBOD) loading besides stipulating the effluent limits for pollutants such as cBOD, TSS, ammonia (NH_3), TP, total inorganic nitrogen (TIN), etc.

The rated capacities for the two WRRFs are:

- JDPWRRF Flow: 20 mgd
- LVSWRRF Flow: 75 mgd
- JDPWRRF Influent cBOD Loading: 51,374 lbs./day
- LVSWRRF Influent cBOD Loading: 238,000 lbs./day

Although the permits only address influent cBOD loading and flows, the influent loading for TSS, NH_3, TP, carbonaceous oxygen demand (COD), and TKN are also considered because both JDPWRRF and LVSWRRF are limited by NH_3 and TP loadings rather than cBOD and/or TSS loadings from a plant capacity perspective. More specifically, the ability of the facilities to biologically remove nitrogen (NH_3) and phosphorous (TP) are limited by the secondary treatment process capacity. As such a better indication to track N and P loading is the influent to the secondary treatment processes instead of the raw influent to the WRRFs. Moving forward, it is anticipated that instead of the permit being regulated by influent loading characteristics, it will likely be based on the WRRF's ability to meet effluent limits for N and P (or any other regulated parameter in the future).

Until the last permit renewal in 2015 and 2016 for JDPWRRF and LVSWRRF respectively, both WRRFs had effluent limits in the form of cBOD, NH_3, and TSS. After the promulgation of Regulation 85, new effluent limits for TIN and TP have been introduced along with those for cBOD, NH_3 and TSS under the new permit.

Regulation 31, when implemented, is expected to introduce even more stringent limits for total nitrogen (TN) and TP in the upcoming years. For this *WWSP*, the projected influent loading rates for cBOD, TSS, NH_3, TP, COD, and TKN have been used to determine plant capacity based on projected effluent limits under Regulation 31. The process models used for this purpose were calibrated and validated using previous plant performance data from an earlier time frame (2008/2009). The process models need to be updated in the future to recalibrate to current operating conditions. For the scope and accuracy required in this *WWSP*, it is assumed that the outputs from the current models using the 2008/2009 loading data will not be significantly different when adjusted for 2017 loading data.

Future loading rates for NH_3, cBOD, TSS, TP, COD, and TKN were estimated using average 2017 concentrations and future flows using the formula below:

$$Future\ Loading\ \left(\frac{mass}{time}\right) = \frac{\text{Average 2017 Loading }\left(\frac{mass}{time}\right)}{\text{2017 Population}} * \text{2040 Projected Population}$$

Loading graphs for NH_3, cBOD, TSS, TP, COD, and TKN are presented in Appendix 5B on pages 5B-32 through 5B-59 for JDPWRRF and LVSWRRF. The graphs present data for historical flows versus loadings, as well as future loadings for the year 2040 calculated using the method above. The year 2040 corresponds to the end of the period to which TAZ data is projected to as part of the SAF.

The intent of the flows versus loadings graphs is to demonstrate how the loading trends have compared to the flow trends historically. The second objective for these graphs is to project the flows and loadings into the year 2040. The loading projections corresponding to year 2040 were developed using two methods. The first method used the trendline created from the cleaned historical data (last five to 10 years) and extrapolated that to the year 2040 to estimate the future loadings. The methodology used to clean the raw historical data is presented in Appendix 5A. The second method assumed a straight-line growth between the 2017 average loadings and the 2040 loading values estimated using the formula above. The two methods for loading projections provide a range of estimated future loadings for the various constituents at the two WRRFs. It should be noted that both the methods to estimate loading are based on assumptions and portray a general range of future conditions that could occur over time. It is anticipated that future conditions fall within the range defined by these two "book end" values. The next iteration of the WWSP with five more years of currently projected data (which will become historical data in five years) will validate and give more confidence in future projected values.

Tables 5-4 and 5-5 provide a summary of the 2017 average concentrations and loading values, 2040 and buildout projected loading values based on calculated values and trendlines developed from historical data for both JDPWRRF and LVSWRRF.

Table 5-4 2017 Average Loading and Loading Projections for JDPWRRF

		JDPWRRF				
Constituent	**2017 Conc. (mg/L)**	**2017 Loading (lbs./day)**	**Calculated Loading (lbs./day)**		**Trendline Loading (lbs./day)**	
			2040	**Buildout**	**2040**	**Buildout**
NH_3	35	2,460	2,900	3,500	3,400	4,000
cBOD	317	22,600	27,000	32,500	34,000	47,000
TSS	260	18,600	22,300	26,800	22,300	26,000
TP	7	470	560	680	1,100	1,500
COD	760	54,000	63,800	78,000	80,000	105,000
TKN	53	3,700	4,400	5,400	5,000	6,200

Table 5-5 2017 Average Loading and Loading Projections for LVSWRRF

		LVSWRRF				
Constituent	**2017 Conc. (mg/L)**	**2017 Loading (lbs./day)**	**Calculated Loading (lbs./day)**		**Trendline Loading (lbs./day)**	
			2040	**Buildout**	**2040**	**Buildout**
NH_3	30	7,300	9,000	9,400	11,200	11,400
cBOD	360	88,700	110,000	114,000	110,000	111,000
TSS	336	82,800	102,500	107,000	82,000	81,000
TP	8	1,990	2,500	2,600	3,900	4,000
COD	850	209,750	260,000	270,000	260,000	263,000
TKN	49	12,000	15,000	15,500	18,100	18,400

5.4.2.2 CSRRRF

5.4.2.2.1 Blended Sludge Flows

The influent blended sludge (B.S.) flow at CSRRRF for the year 2040 and for buildout were developed using the assumption that the rate of increase of B.S. flow at CSRRRF is the same as the rate of increase of influent flows at JDPWRRF and LVSWRRF. The formula used to calculate the projected B.S. flow at CSRRRF is given below:

$$Future\ B.S.Flow\ (gal) = \frac{\text{Future Flow at JDPWRRF and LVSWRRF (MGD)}}{\text{Average 2017 Flow at JDPWRRF and LVSWRRF (MGD)}} * \text{Average 2017 B.S. Flow (gal)}$$

B.S. Flow Graphs are presented in Appendix 5B on pages 5B-60 through 5B-61. The graphs present data for historical flow trends over the past five years, as well as flow projections for the year 2040. The year 2040 corresponds to the end of the period to which TAZ data is projected as part of the SAF.

The B.S. flow values corresponding to the year 2040 were developed using two methods. The first method used a trendline created from the cleaned historical data (last ten years) and extrapolated that to the year 2040 to estimate the future flows. The methodology used to clean the raw historical data is presented in Appendix 5A. The second method assumed a straight-line growth between the 2017 average B.S. flows and the 2040 B.S. flows estimated using the equation above. The two methods for flow projections provide a range for estimated future B.S. flows at CSRRRF.

Table 5-6 provides a summary of the 2017 average B.S. flow values, and 2040 and buildout projected flows based on trendline developed from historical data as well as calculated values for CSRRRF.

Table 5-6 2017 Average Blended Sludge Flow and Flow Projections for CSRRRF

	CSRRRF				
	2017 Average	Calculated Projection		Trendline Projection	
		2040	Buildout	2040	Buildout
Flow (gal/day)	304,000	380,000	396,000	250,000	215,000

5.4.2.2.2 Total Volatile Solids Loading

Influent Total Volatile Solids (TVS) loading is the key parameter used to evaluate the capacity of the anaerobic digesters at CSRRRF.

Future loading rates for TVS for the year 2040 and for buildout were developed using the assumption that the rate of increase of B.S. flow at CSRRRF is the same as the rate of increase of influent flows at JDPWRRF and LVSWRRF. The formula used to calculate the projected TVS loading at CSRRRF is given below:

$$Future\ TVS\ Loading\left(\frac{mass}{time}\right) = \frac{\text{Future Flow at JDPWRRF and LVSWRRF}}{\text{Average 2017 Flow at JDPWRRF and LVSWRRF}} * \text{Average 2017 TVS Loading}$$

Loading graphs for TVS are presented in Appendix 5B on pages 5B-62 through 5B-63 for CSRRRF. The graphs present data for historical flows versus loadings, as well as future loadings for the year 2040 calculated using the method above. The year 2040 corresponds to the end of the period to which TAZ data is projected to as part of the SAF.

The intent of the B.S. flows versus TVS loadings graphs is to demonstrate how the loading trends have compared to the flow trends historically. The second objective for these graphs is to project the flows and loadings in the year 2040. The loading projections corresponding to year 2040 were developed using two methods. The first method used the trendline created from the historical data (last 10 years) and extrapolated that to the year 2040 to estimate the future loadings. The second method assumed a straight-line growth between the 2017 average TVS loadings and the 2040 loading values estimated using the formula above. The two methods for loading projections provide a range for the estimated future loadings for TVS at CSRRRF.

Table 5-7 provides a summary of the 2017 average loading values, 2040 and buildout projected loading values based on trendline developed from historical data as well as calculated values for TVS at CSRRRF.

Table 5-7 2017 Average TVS Loading and Loading Projections for CSRRRF

	CSRRRF				
	2017 Loading (lbs./day)	**Calculated Loading (lbs./day)**		**Trendline Loading (lbs./day)**	
		2040	Buildout	2040	Buildout
TVS	70,100	87,600	91,300	70,200	74,500

Appendix 5A
Data Scrubbing Methodology

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Appendix 5A: Data Scrubbing Methodology

In chapter 5 of the *WWSP*, historical flow and concentration data for various constituents is used to evaluate and define the historical flow and loading trends at the RRF's. Additionally, the cleaned data is also used to calculate and project trendlines to estimate the future flow and loading conditions for the year 2040 and buildout. These projections are analyzed in chapter 9 to assess the RRF's capacity for flow and various loading conditions. This appendix describes the methodology used to clean the raw data which was subsequently used to develop the trendlines and complete the analysis.

CBOD to TSS Test Ratio to Clean CBOD and TSS influent Concentration Data

- The industry guideline ratio of 0.7-1.3 for CBOD to TSS was applied to the raw influent concentration data to complete a preliminary screening for identifying outliers.
- A second test was applied to the CBOD and TSS data that fell outside of the CBOD to TSS test ratio of 0.7-1.3:
    - The average concentration values for CBOD and TSS were calculated for the concentration data after the obvious outliers were removed.
    - If the CBOD to TSS ratio had a value outside of the 0.7-1.3 range but the individual concentration values for CBOD and/or TSS agreed with the average concentration values, the data was kept
        - For example: If the average CBOD and TSS concentrations are 320 mg/L and 260mg/L, and the CBOD and TSS concentration values for a given day are 420mg/L and 280mg/L, the CBOD to TSS ratio is outside the range of 0.7-1.3. The CBOD concentration of 420mg/L is significantly deviating from the average CBOD concentration value and should be deleted, but the TSS concentration value of 280mg/L is within an acceptable range to the average and should be kept.
- All CBOD and TSS concentration data that fell within the CBOD to TSS ratio of 0.7-1.3 was also analyzed:
    - If the CBOD to TSS ratio had a value between 0.7-1.3 but the individual concentration values for CBOD and/or TSS did not agree with the average concentration values, the values were deleted.
        - For example: If the average CBOD and TSS concentrations are 320 mg/L and 260mg/L, and the CBOD and TSS concentration values for a given day are 350mg/L and 500mg/L, the CBOD to TSS ratio is within the range of 0.7-1.3. The concentration value for CBOD is within an acceptable range of the average concentration and should be kept, but the TSS concentration value of 500mg/L is deviating from the average value of 260mg/L and should be deleted.

NH_3 Concentration Data Cleaning

The daily influent NH_3 concentration data was plotted on a concentration versus time graph for each WRRF to demonstrate the concentration trends over time. The data points that deviated from the concentration trends were analyzed, and if they significantly deviated from the average NH_3 concentration, they were deleted.

For example, if the NH_3 concentrations were trending around an average concentration of 37mg/L at JDPWRRF consecutively for several days and a single data point within this time range had a concentration value of 90mg/L, that data point would be deleted due to its deviation from the trends and average.

Estimating Influent Concentration Data for TP, COD, TKN

The PI database does not contain all the recent historical data for TP, COD, or TKN (2013 through 2017). The influent concentration values and ratios used in the process models for JDPWRRF and LVSWRRF (developed in 2008) were used in conjunction with the historical daily concentration values for OP, CBOD, and NH_3 to estimate the historical daily concentrations for TP, COD, and TKN.

The following table provides the influent concentrations in mg/L used in the development of the 2008 process models.

Constituent	JDPWRRF	LVSWRRF
COD	773	768
CBOD	327	371
TKN	56	53
NH_3	37	31
TP	10	8
TSS	312	314

Note: The *WWSP* calls for a process model update, therefor future iterations of the *WWSP* may have updated model concentrations.

The following ratios of the process model concentration values multiplied by the historical daily concentration values of OP, CBOD and NH_3 provides an estimate for the historical daily concentration values for TP, COD, and TKN.

$$TP\ Conc.Value = \frac{TP\ Influent\ Model\ Conc.}{OP\ Influent\ Model\ Conc.} * Actual\ OP\ Influent\ Conc.Value$$

$$COD\ Conc.Value = \frac{COD\ Influent\ Model\ Conc.}{CBOD\ Influent\ Model\ Conc.} * Actual\ CBOD\ Influent\ Conc.Value$$

$$TKN\ Conc.Value = \frac{TKN\ Influent\ Model\ Conc.}{NH_3\ Influent\ Model\ Conc.} * Actual\ NH_3\ Influent\ Conc.Value$$

For example: If the CBOD concentration value for a given day is 317mg/L at JDPWRRF, the estimated COD concentration value for that day would be 749mg/L:

$$COD\ Conc.Value = \frac{773mg/L}{327mg/L} * 317\frac{mg}{L} = 749\frac{mg}{L}$$

OP and TP Data Cleaning

- The average OP and TP concentrations were calculated from the influent concentration data after removing the obvious outliers.
- Acceptable test ratios of OP to TP of 0.55-0.8 for JDPWRRF and 0.45-0.55 for LVSWRRF were determined based on the average concentration values at each WRRF.
- An additional test was applied to the concentration data that fell within the OP to TP ratio values:
    - The OP and TP concentration values must fall within the mean concentration value plus or minus a 20% standard deviation
        - $Conc.Range = Average\ Conc. \pm 20\% * Average\ Conc.$
        - For example: if the TP average concentration is 5.38mg/L, the acceptable concentration range would be:
          $TP\ Conc.Range = 5.38\frac{mg}{L} \pm 20\% * 5.38\frac{mg}{L} = 4.30\frac{mg}{L}\ to\ 6.46\frac{mg}{L}$
        -
    - If the Concentration value that fell within the TP to OP ratio is outside of the average concentration value plus or minus a 20% standard deviation, the value would be deleted.
- An additional test was applied to the concentration data that fell outside of the OP to TP test ratio:
    - If the OP and TP concentration data fell outside of the OP to TP test ratio, but the concentration values for OP and/or TP were within the range of the average concentration plus or minus 20% standard deviation, then the data would be kept.

Influent Flow Data Cleaning for JDPWRRF and LVSWRRF

The daily flow data was plotted on a flow versus time graph for each WRRF to demonstrate the flow trends over time. The data points that greatly deviated from the flow trends were analyzed, and if they deviated from the average flow greatly, they were deleted.

Influent Blended Sludge Data Cleaning for CSRRRF

The daily blended sludge flow data was plotted on a blended sludge flow versus time graph to demonstrate the flow trends over time. The data points that greatly deviated from the flow trends were analyzed, and if they deviated from the average flow greatly, they were deleted.

Additionally, in 2017 the pipeline from the LVSWRRF to CSRRRF broke. The plot of blended sludge flow versus time shows that there was little to no flow during this few day period, and the data was deleted from the dataset due to its inaccuracy.

Appendix 5B

Overview and Graphs

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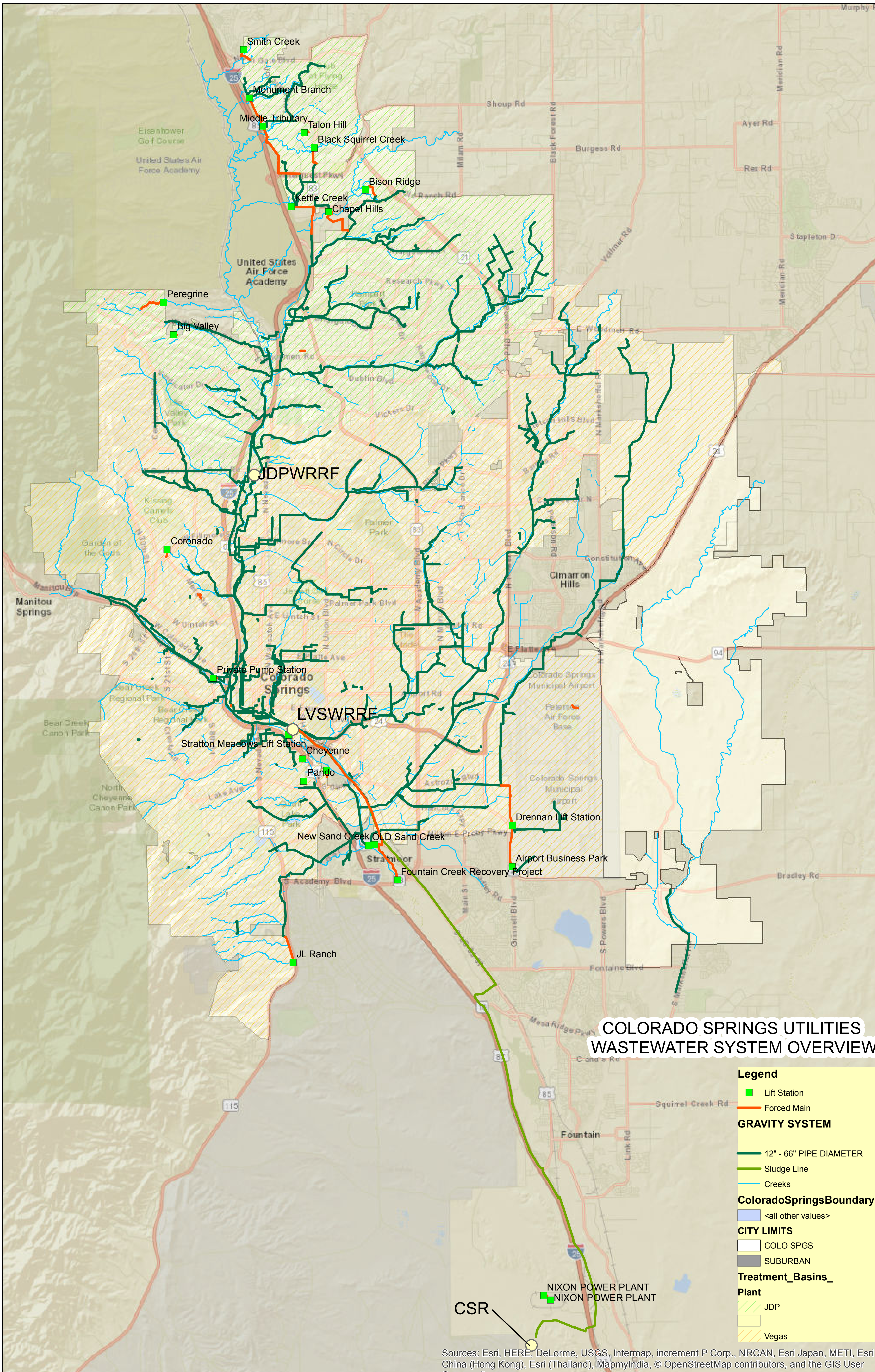
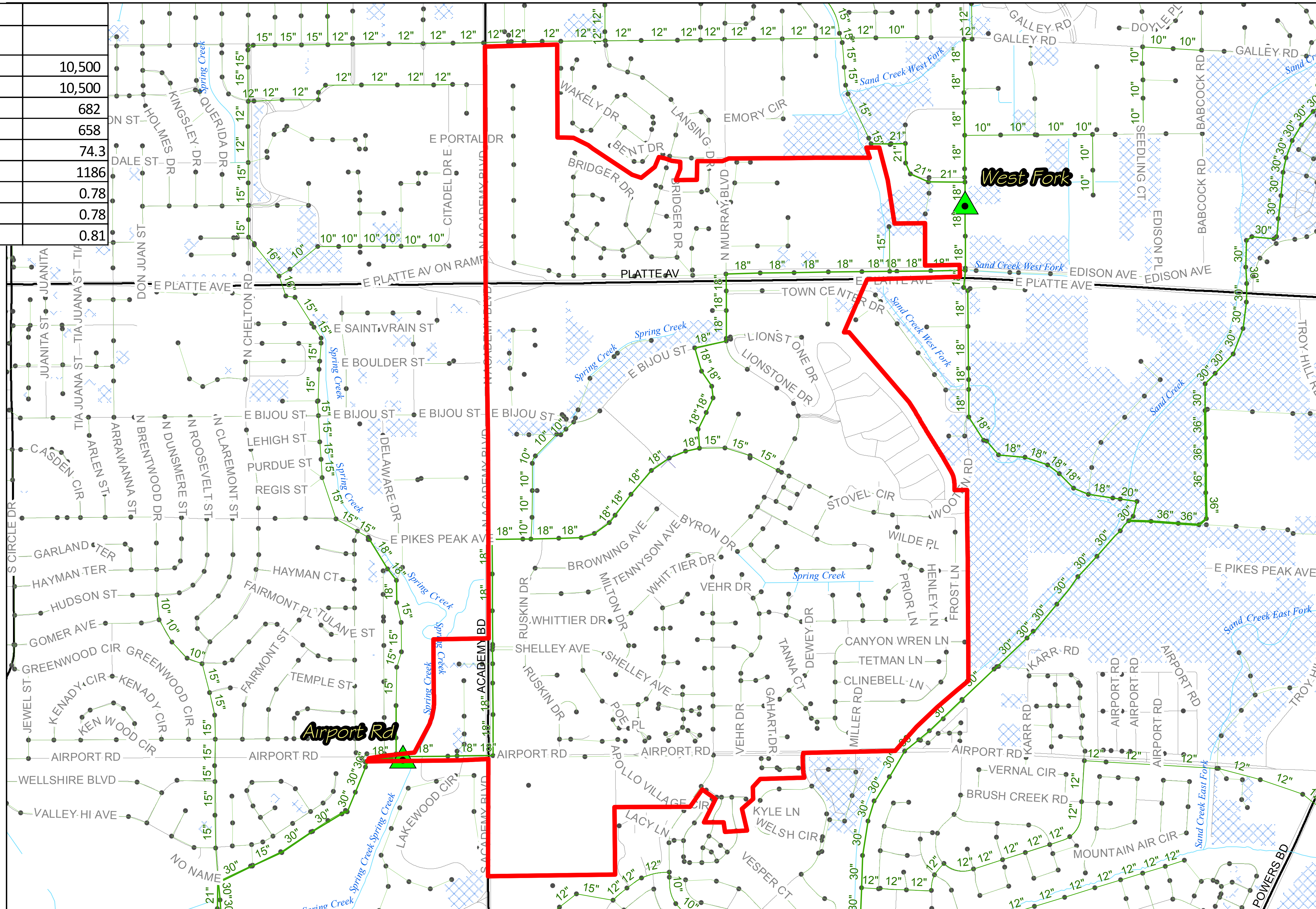
Colorado Springs Utilities Wastewater System Overview



Flow Calibration Point Area: Airport Rd

METER POINT	
Airport Rd	
Population 2017	10,500
Population 2040	10,500
In City Area (acres)	682
Developed Area (acres)	658
Per Capita Usage (gal/cap)	74.3
per acre daily use (gal/acre/day)	1186
2017 Average Flow (MGD)	0.78
2040 Average Flow (MGD)	0.78
Build Out Average Flow (MGD)	0.81



Legend

Meter Point

Current

Limits of Contributing Area

Airport Rd

Gravity Main

Subtype

- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Manhole
- Drainage
- MajorStreets
- Street

EXTERNALDATA.LANDUSE

Areas of Future Growth

- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

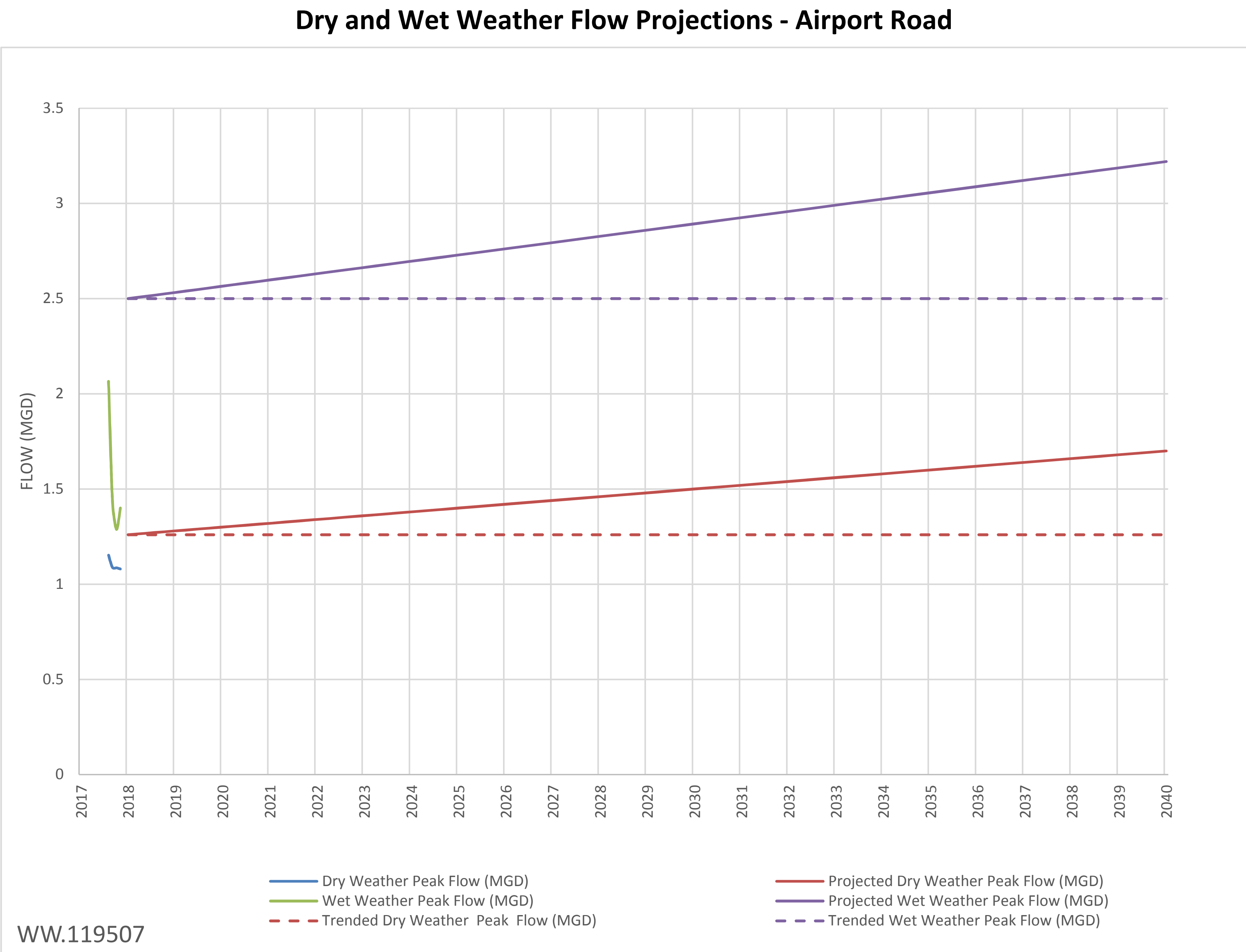
City Boundary

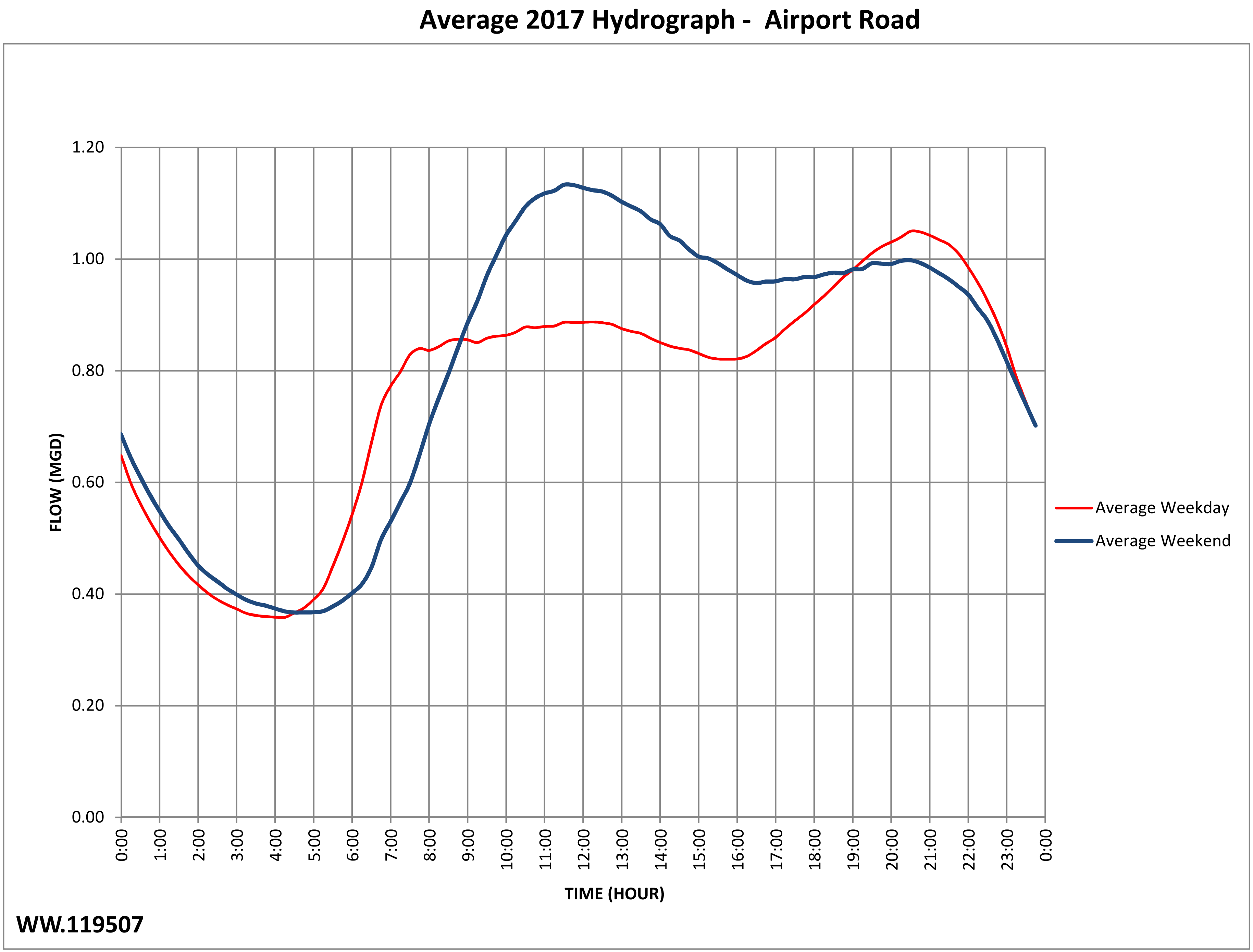
Out Side Colorado Springs Limits

City Boundary

Colorado Springs

N

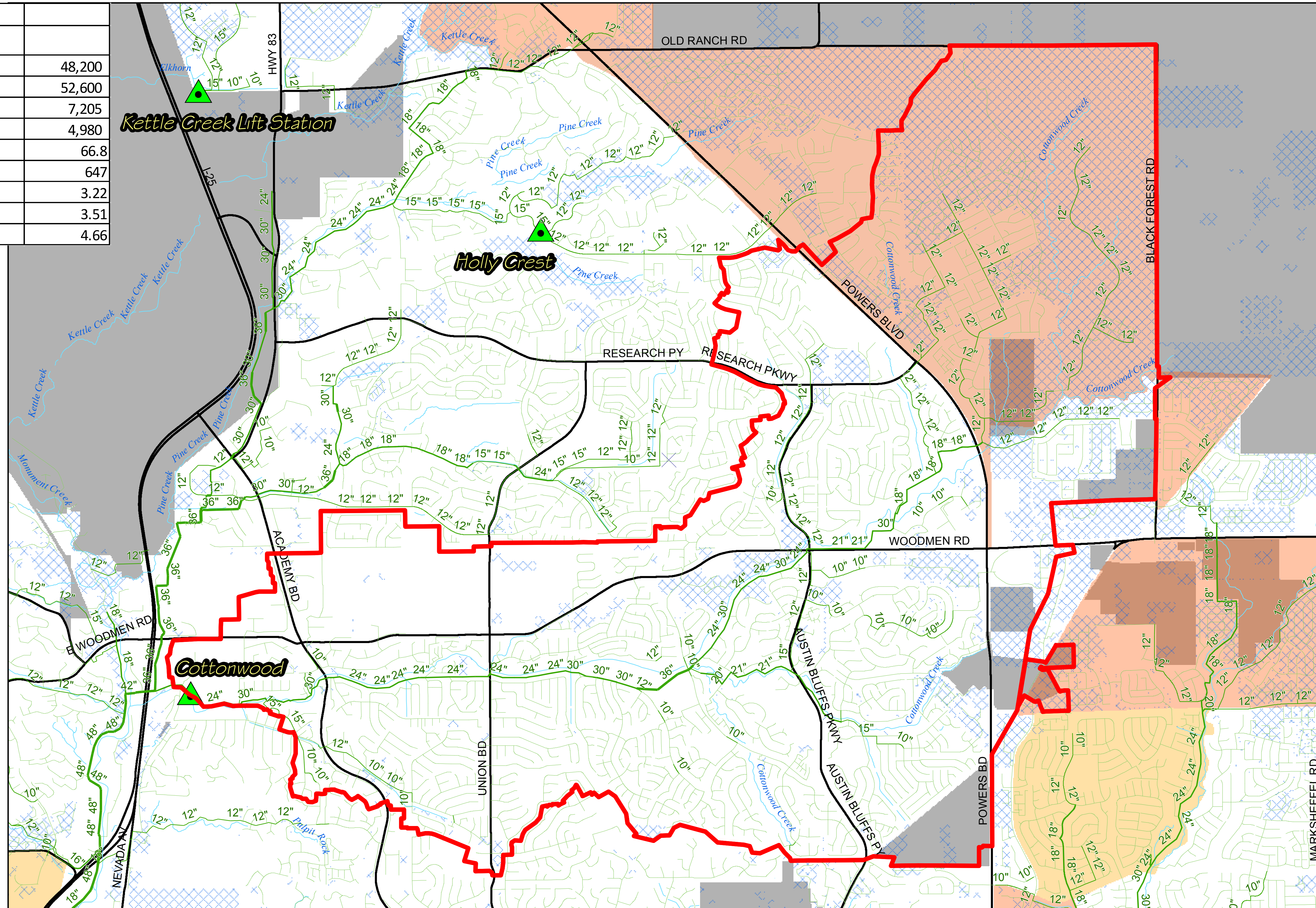

Dry and Wet Weather Flow Projections - Airport Road
FLOW (MGD)
3.5
3
2.5
2
1.5
1
0.5
0
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
Dry Weather Peak Flow (MGD)
Wet Weather Peak Flow (MGD)
Trended Dry Weather Peak Flow (MGD)
Projected Dry Weather Peak Flow (MGD)
Projected Wet Weather Peak Flow (MGD)
Trended Wet Weather Peak Flow (MGD)
WW.119507



Average 2017 Hydrograph - Airport Road
1.20
1.00
0.80
0.60
0.40
0.20
0.00
FLOW (MGD)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
TIME (HOUR)
Average Weekday
Average Weekend
WW.119507

Flow Calibration Point Area: Cottonwood

METER POINT	
Cottonwood	
Population 2017	48,200
Population 2040	52,600
In City Area (acres)	7,205
Developed Area (acres)	4,980
Per Capita Usage (gal/cap)	66.8
per acre daily use (gal/acre/day)	647
2017 Average Flow (MGD)	3.22
2040 Average Flow (MGD)	3.51
Build Out Average Flow (MGD)	4.66



Legend

Meter Point

Current

Limits of Contributing Area

Cottonwood

Gravity Main

Subtype

- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Drainage
- MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

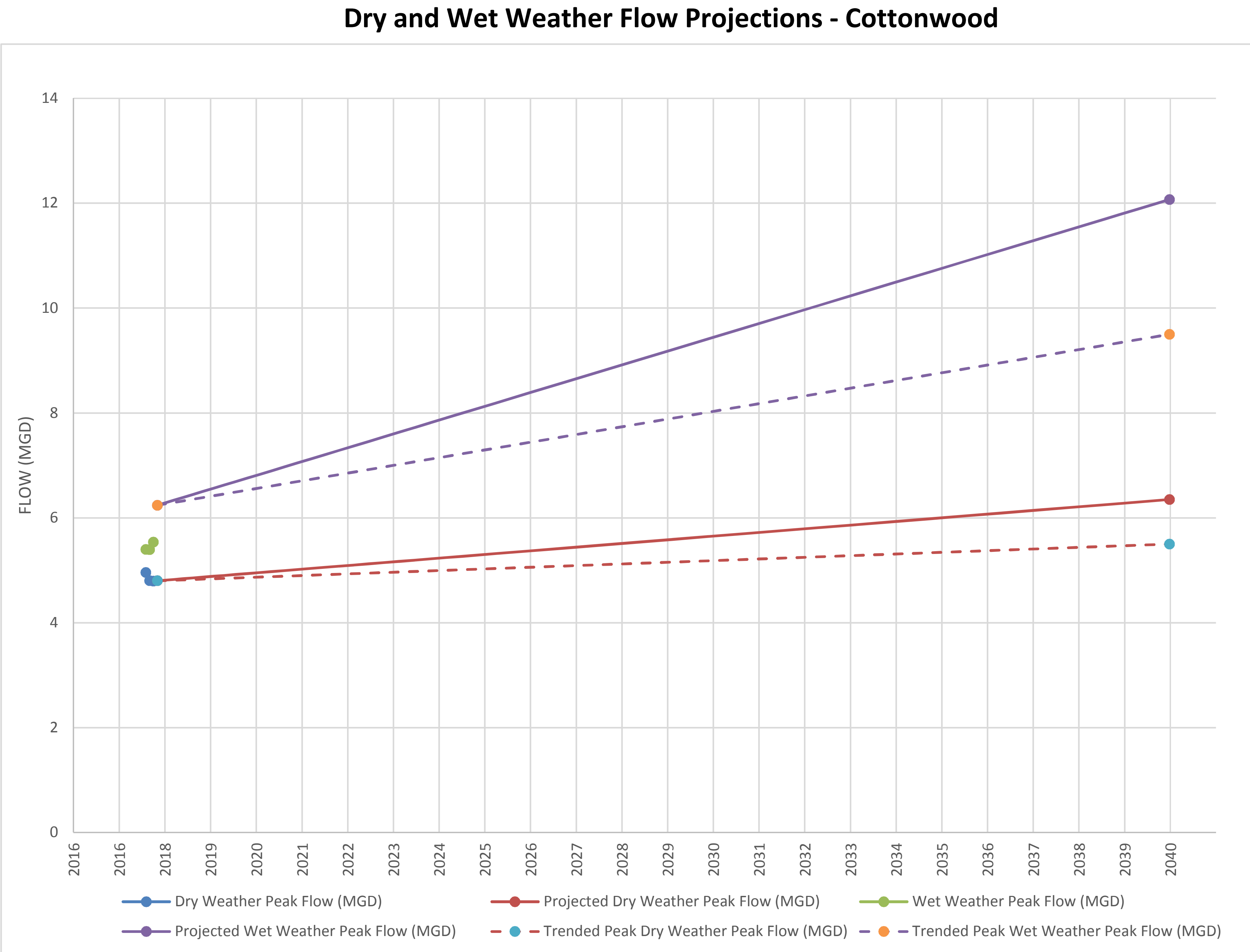
City Boundary

Out Side Colorado Springs Limits

City Boundary

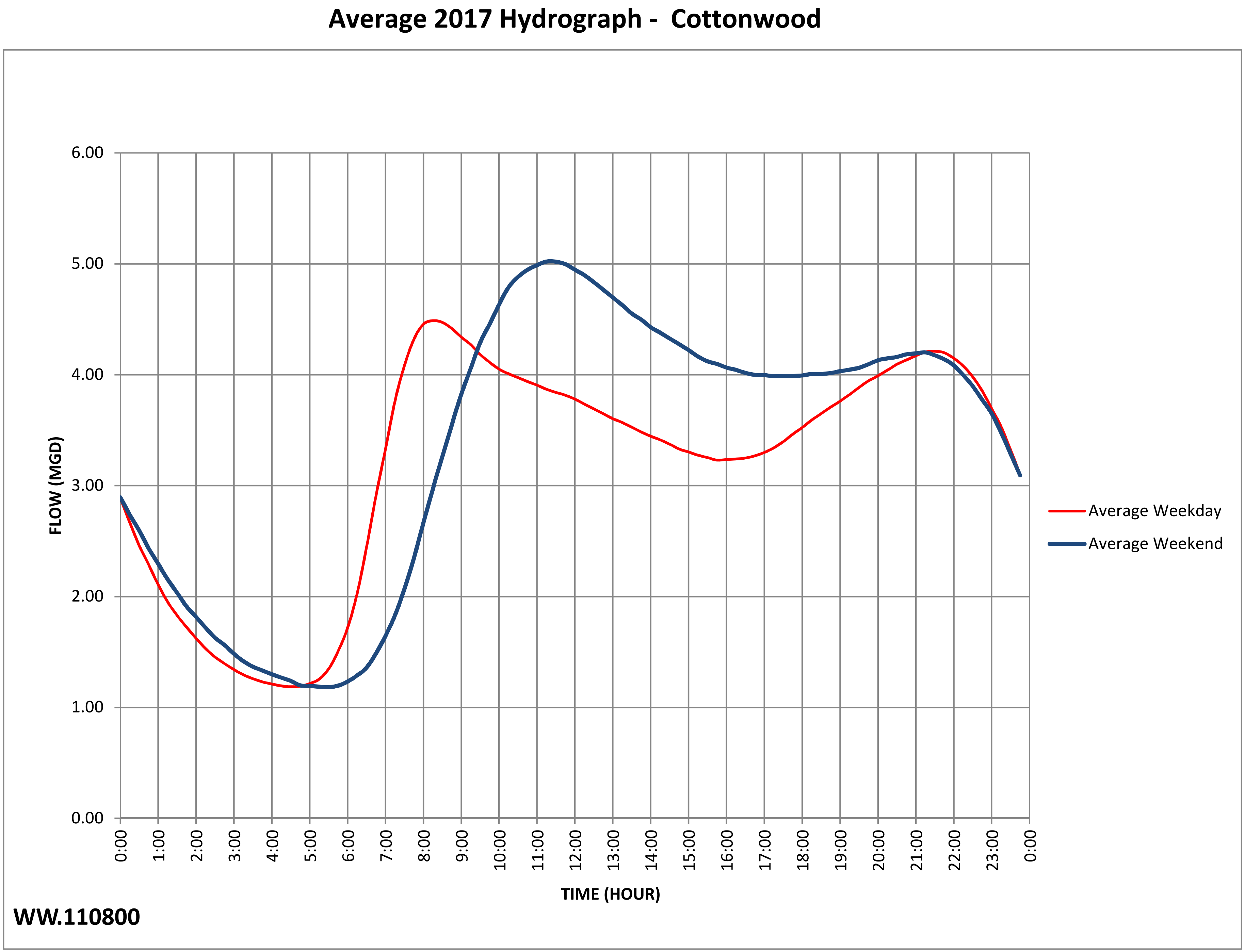
Colorado Springs

N



Dry and Wet Weather Flow Projections - Cottonwood
FLOW (MGD)
0
2
4
6
8
10
12
14
2016
2016
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
Dry Weather Peak Flow (MGD)
Projected Dry Weather Peak Flow (MGD)
Wet Weather Peak Flow (MGD)
Projected Wet Weather Peak Flow (MGD)
Trended Peak Dry Weather Peak Flow (MGD)
Trended Peak Wet Weather Peak Flow (MGD)

WW.110800


Average 2017 Hydrograph - Cottonwood
6.00
5.00
4.00
3.00
2.00
1.00
0.00
FLOW (MGD)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
TIME (HOUR)
Average Weekday
Average Weekend
WW.110800

Flow Calibration Point Area: Holly Crest

METER POINT	
Holly Crest	
Population 2017	3,900
Population 2040	5,500
In City Area (acres)	848
Developed Area (acres)	519
Per Capita Usage (gal/cap)	87.2
per acre daily use (gal/acre/day)	655
2017 Average Flow (MGD)	0.34
2040 Average Flow (MGD)	0.48
Build Out Average Flow (MGD)	0.56

Legend

Meter Point
- Current

Limits of Contributing Area
- Holly Crest

Gravity Main
Subtype
- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Manhole
- Drainage
- MajorStreets
- Street

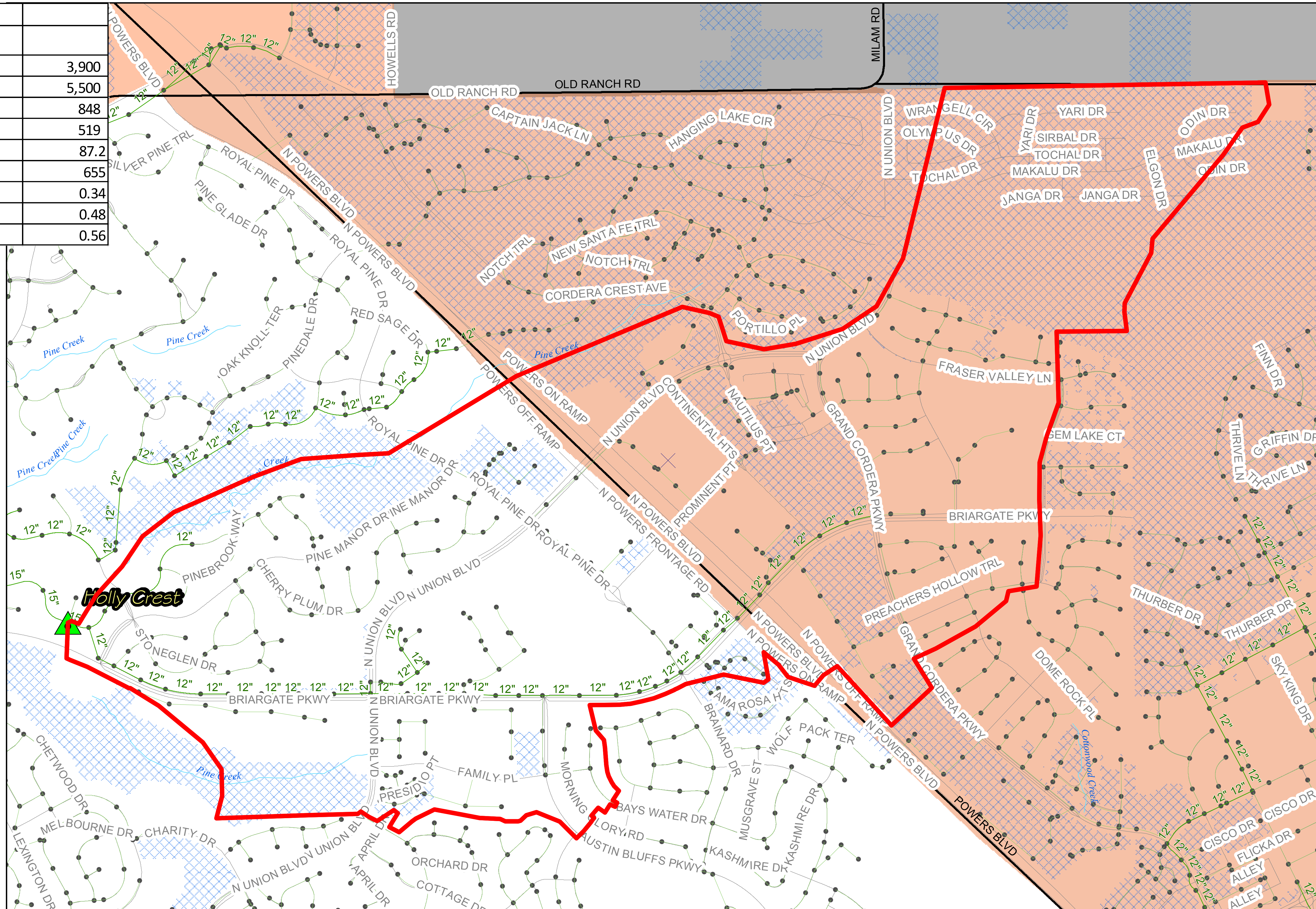
EXTERNALDATA.LANDUSE
Areas of Future Growth
- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data
Change in Population 2017 to 2040
- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

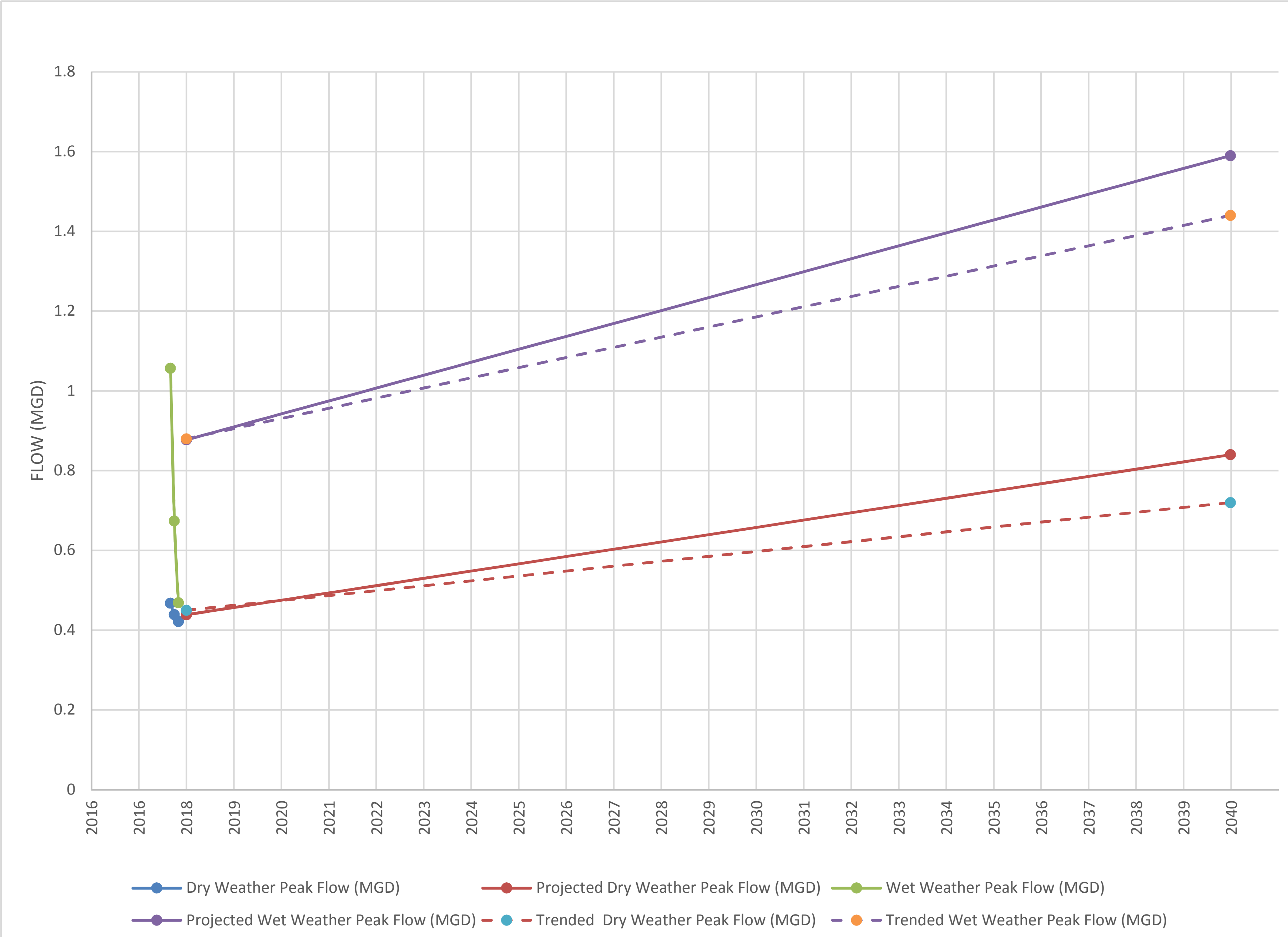
City Boundary
- Out Side Colorado Springs Limits

City Boundary
- Colorado Springs

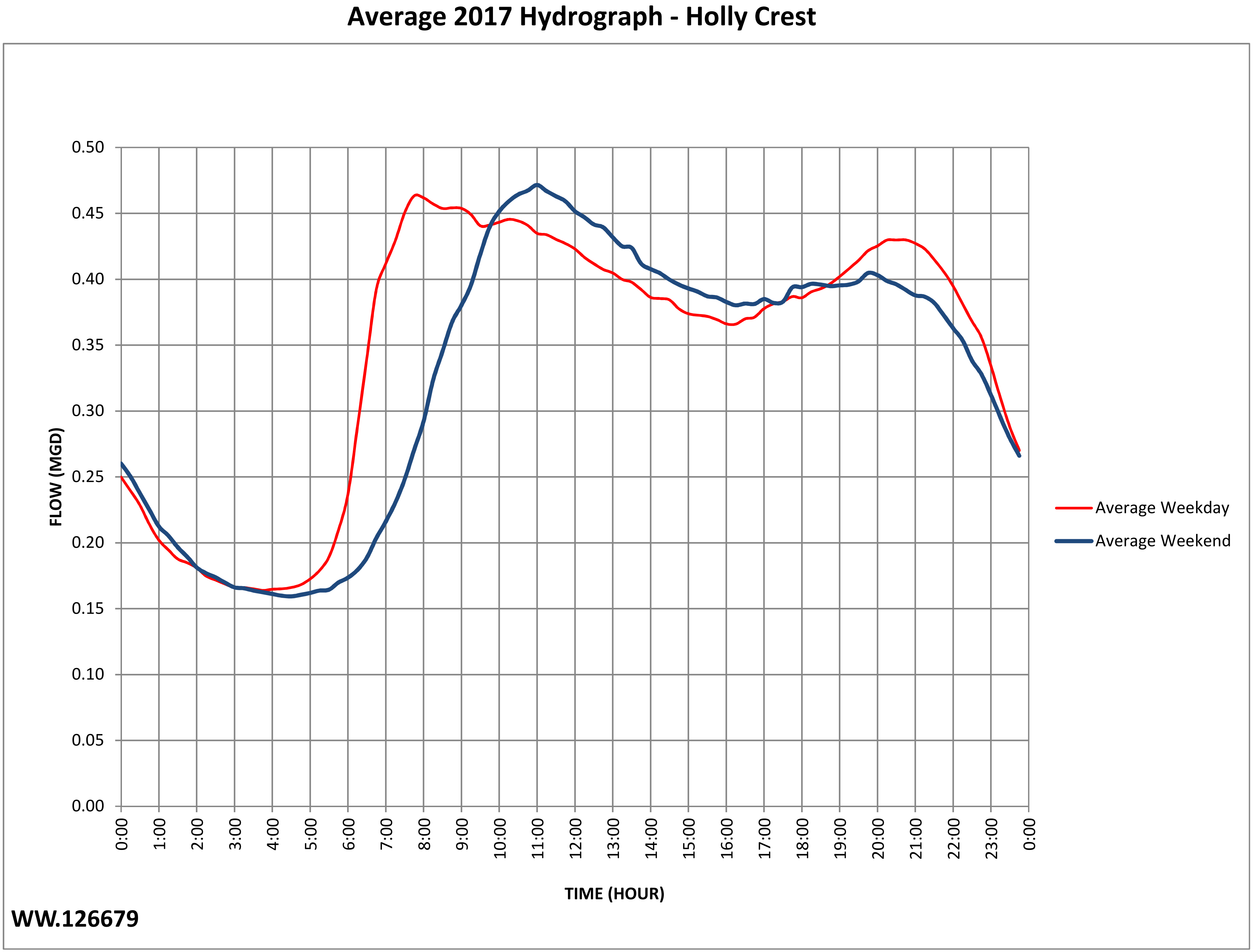
N



Dry and Wet Weather Flow Projections - Holly Crest

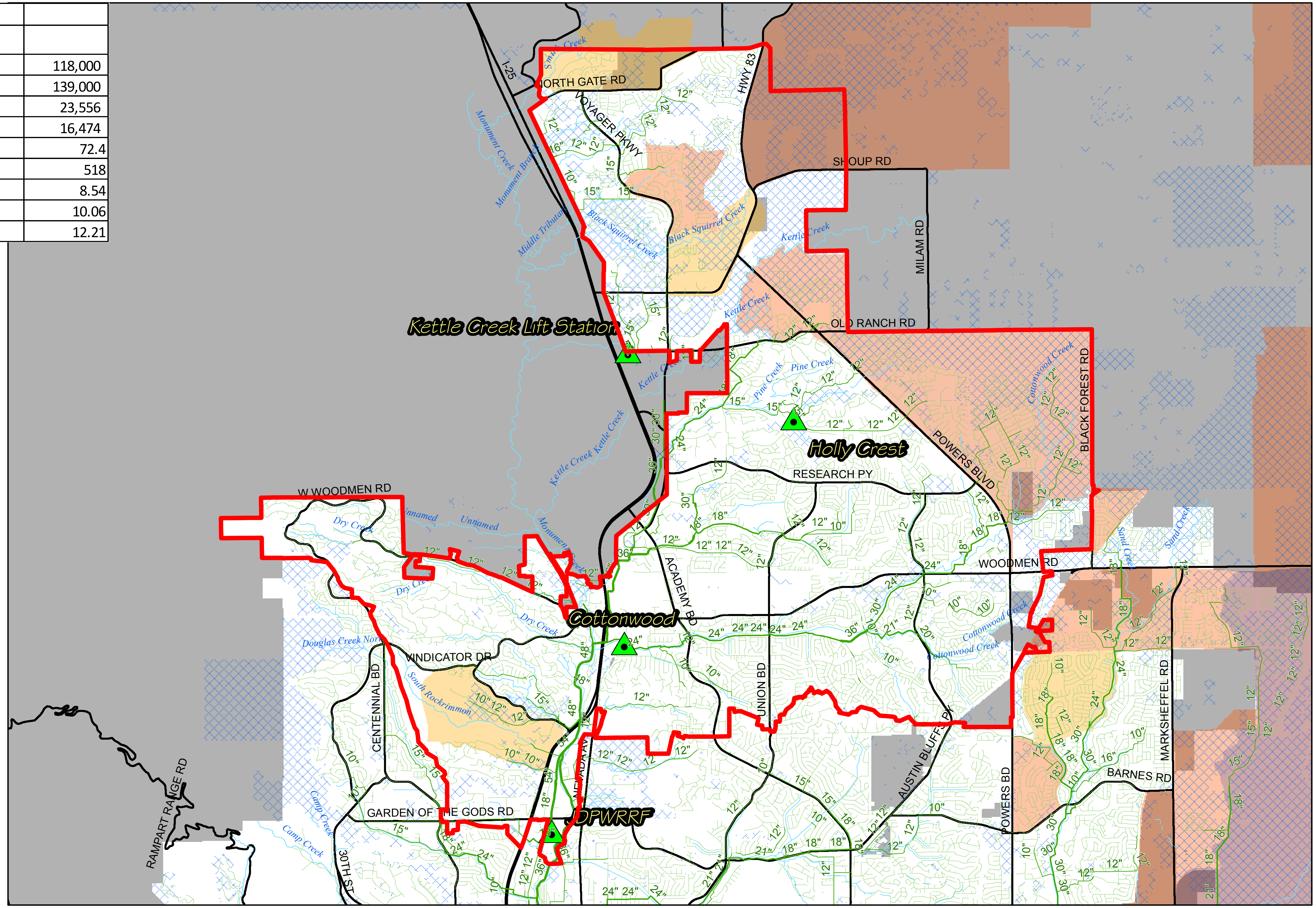


WW.126679


Average 2017 Hydrograph - Holly Crest
FLOW (MGD)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
TIME (HOUR)
Average Weekday
Average Weekend
WW.126679

Flow Calibration Point Area: JDPWRRF

METER POINT	
JDPWRRF	
Population 2017	118,000
Population 2040	139,000
In City Area (acres)	23,556
Developed Area (acres)	16,474
Per Capita Usage (gal/cap)	72.4
per acre daily use (gal/acre/day)	518
2017 Average Flow (MGD)	8.54
2040 Average Flow (MGD)	10.06
Build Out Average Flow (MGD)	12.21



Legend

Meter Point

Current

Limits of Contributing Area

JDPWRRF

Gravity Main

Subtype

- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Drainage
- MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

City Boundary

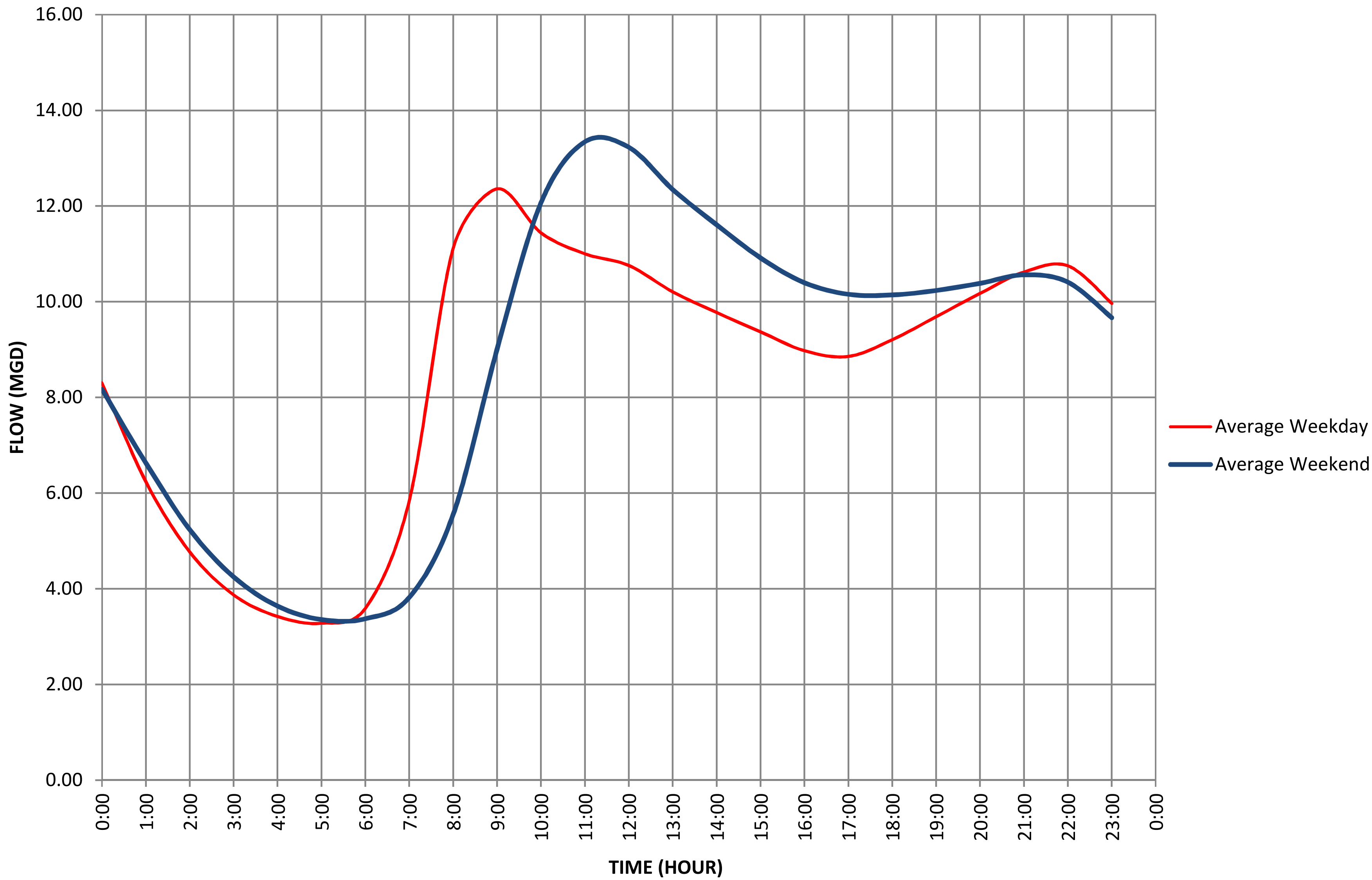
- Out Side Colorado Springs Limits

City Boundary

- Colorado Springs

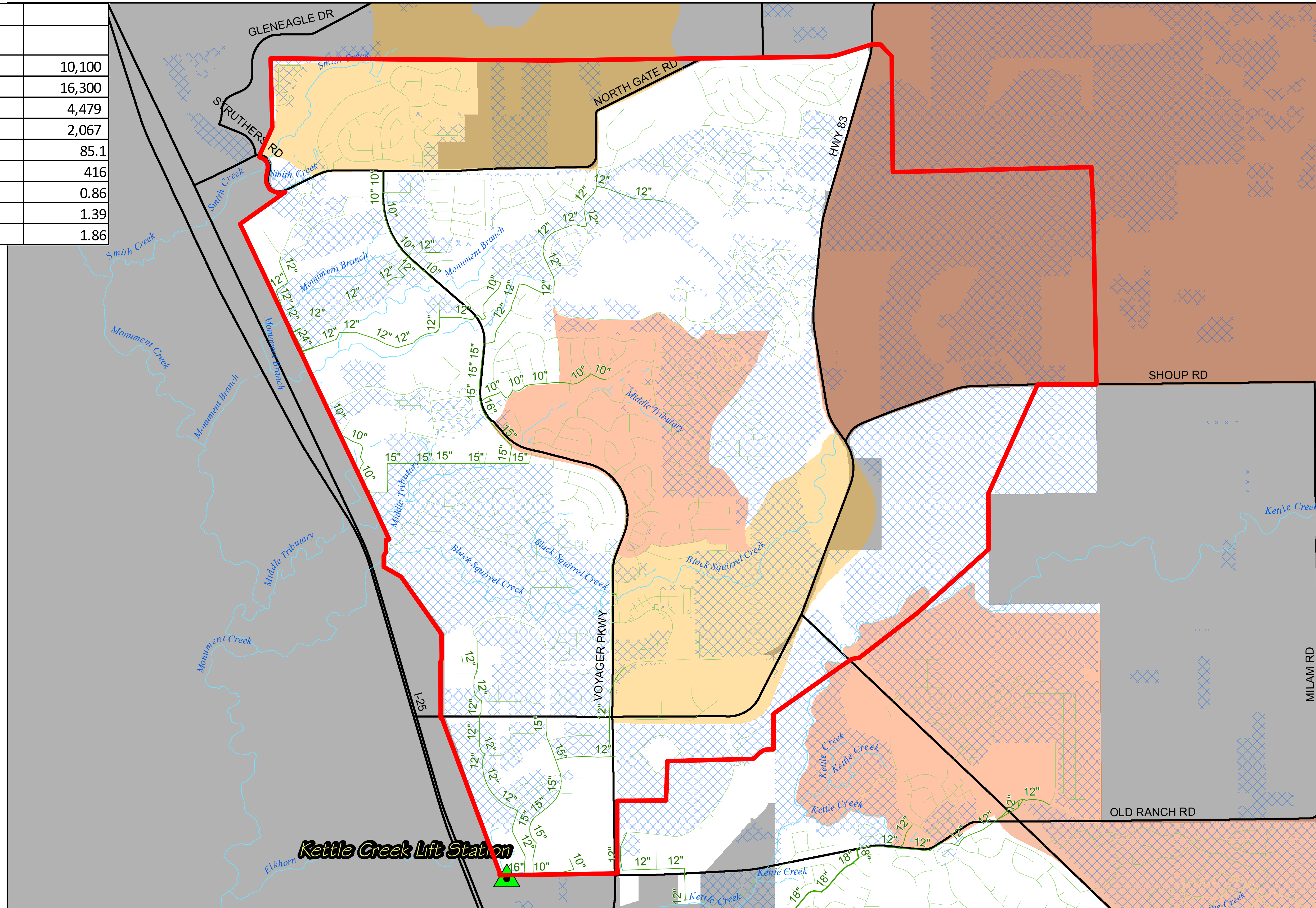

Flow Projections - JDPWRRF
FLOW (MGD)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
2016
2016
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
Projected Flow (MGD)
Average Flow (MGD)
Trended Flow (MGD)

Average 2017 Hydrograph - JDPWRRF



Flow Calibration Point Area: Kettle Creek Lift Station

METER POINT	
Kettle Creek Lift Station	
Population 2017	10,100
Population 2040	16,300
In City Area (acres)	4,479
Developed Area (acres)	2,067
Per Capita Usage (gal/cap)	85.1
per acre daily use (gal/acre/day)	416
2017 Average Flow (MGD)	0.86
2040 Average Flow (MGD)	1.39
Build Out Average Flow (MGD)	1.86



Legend

Meter Point

Current

Limits of Contributing Area

Kettle Creek Lift Station

Gravity Main

Subtype

8"

10"-16"

16"-35"

36" and larger

Drainage

MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

Agriculture

Parking/Vacant

Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

-767.000000 - 1000.000000

1000.000001 - 1500.000000

1500.000001 - 3000.000000

3000.000001 - 4500.000000

4500.000001 - 6000.000000

6000.000001 - 100000.000000

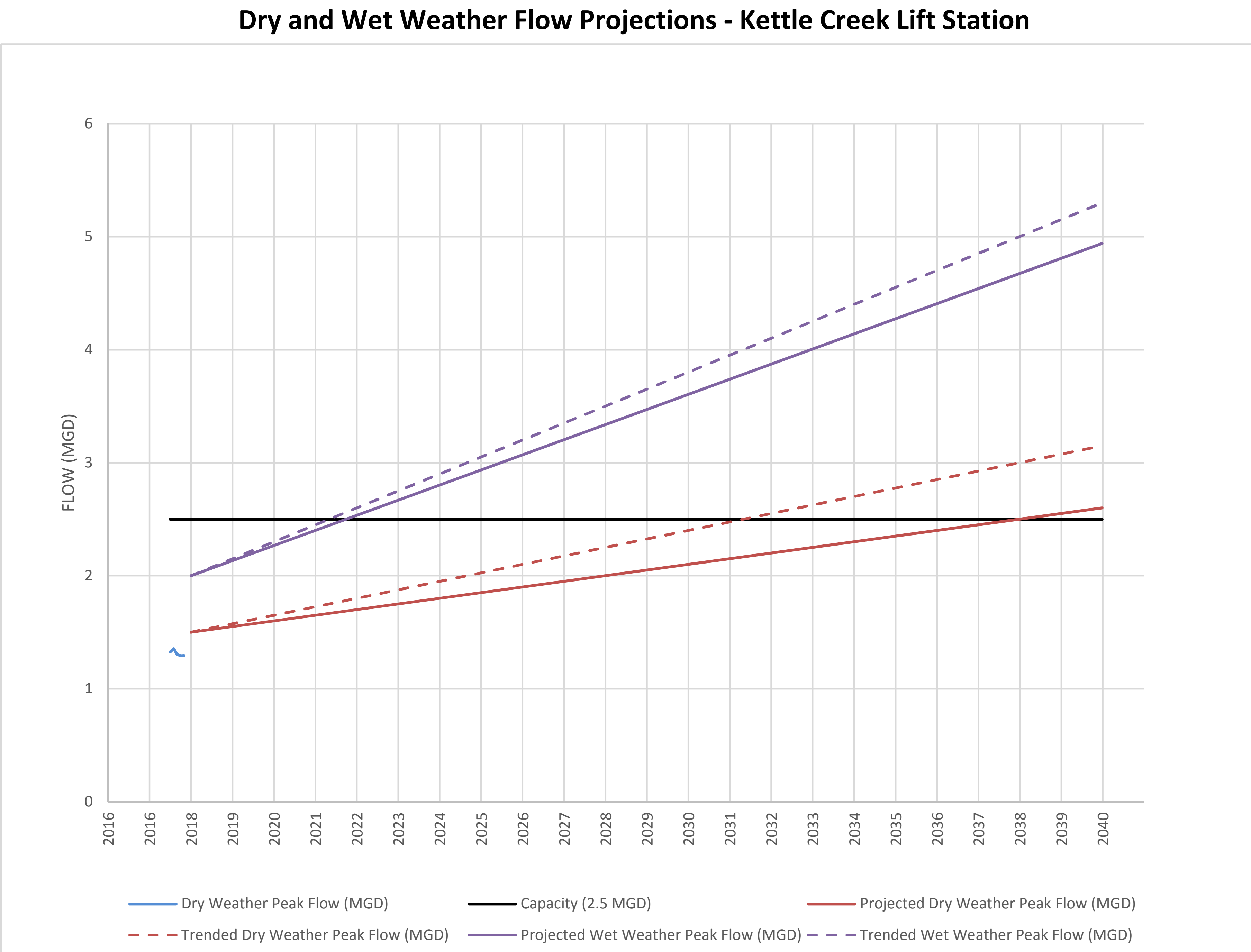
City Boundary

Out Side Colorado Springs Limits

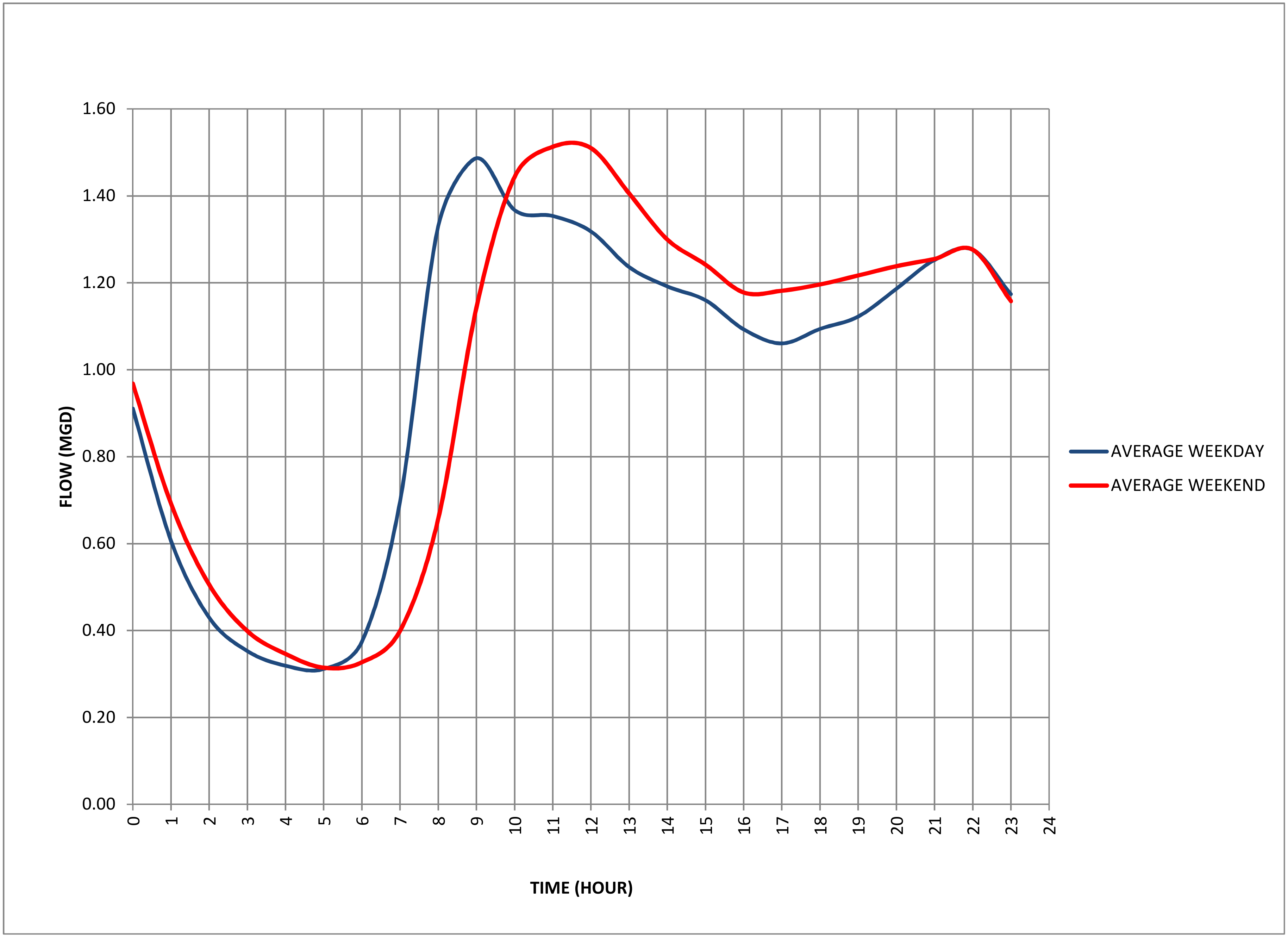
City Boundary

Colorado Springs

N

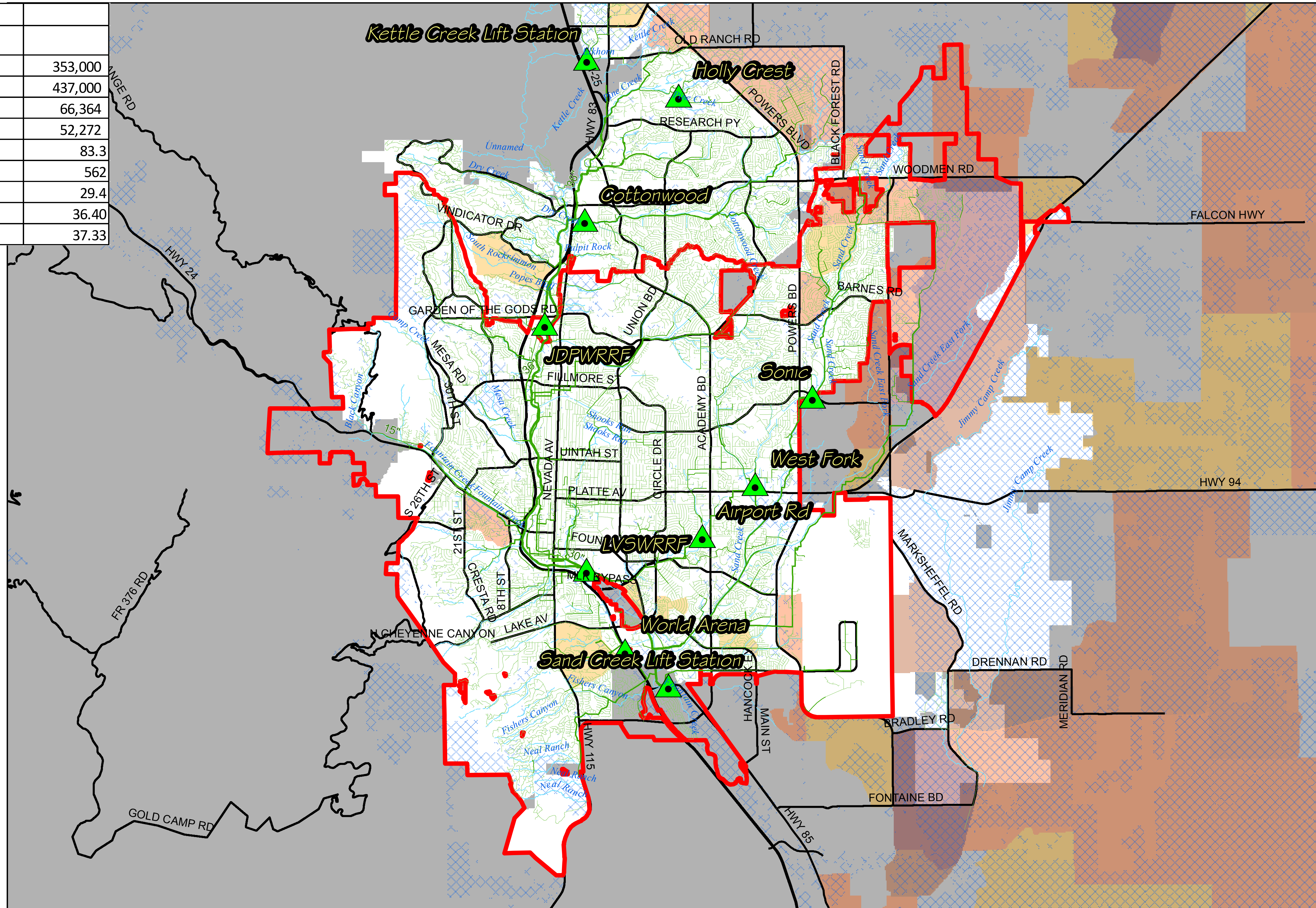

Dry and Wet Weather Flow Projections - Kettle Creek Lift Station
FLOW (MGD)
0
1
2
3
4
5
6
2016
2016
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
Dry Weather Peak Flow (MGD)
Capacity (2.5 MGD)
Projected Dry Weather Peak Flow (MGD)
Trended Dry Weather Peak Flow (MGD)
Projected Wet Weather Peak Flow (MGD)
Trended Wet Weather Peak Flow (MGD)

Average 2017 Hydrograph - Kettle Creek Lift Station



Flow Calibration Point Area: LVSWRRF

METER POINT	
LVSWRRF	
Population 2017	353,000
Population 2040	437,000
In City Area (acres)	66,364
Developed Area (acres)	52,272
Per Capita Usage (gal/cap)	83.3
per acre daily use (gal/acre/day)	562
2017 Average Flow (MGD)	29.4
2040 Average Flow (MGD)	36.40
Build Out Average Flow (MGD)	37.33



Legend

Meter Point

Current

Limits of Contributing Area

LVSWRRF

Gravity Main

Subtype

- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Drainage
- MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

City Boundary

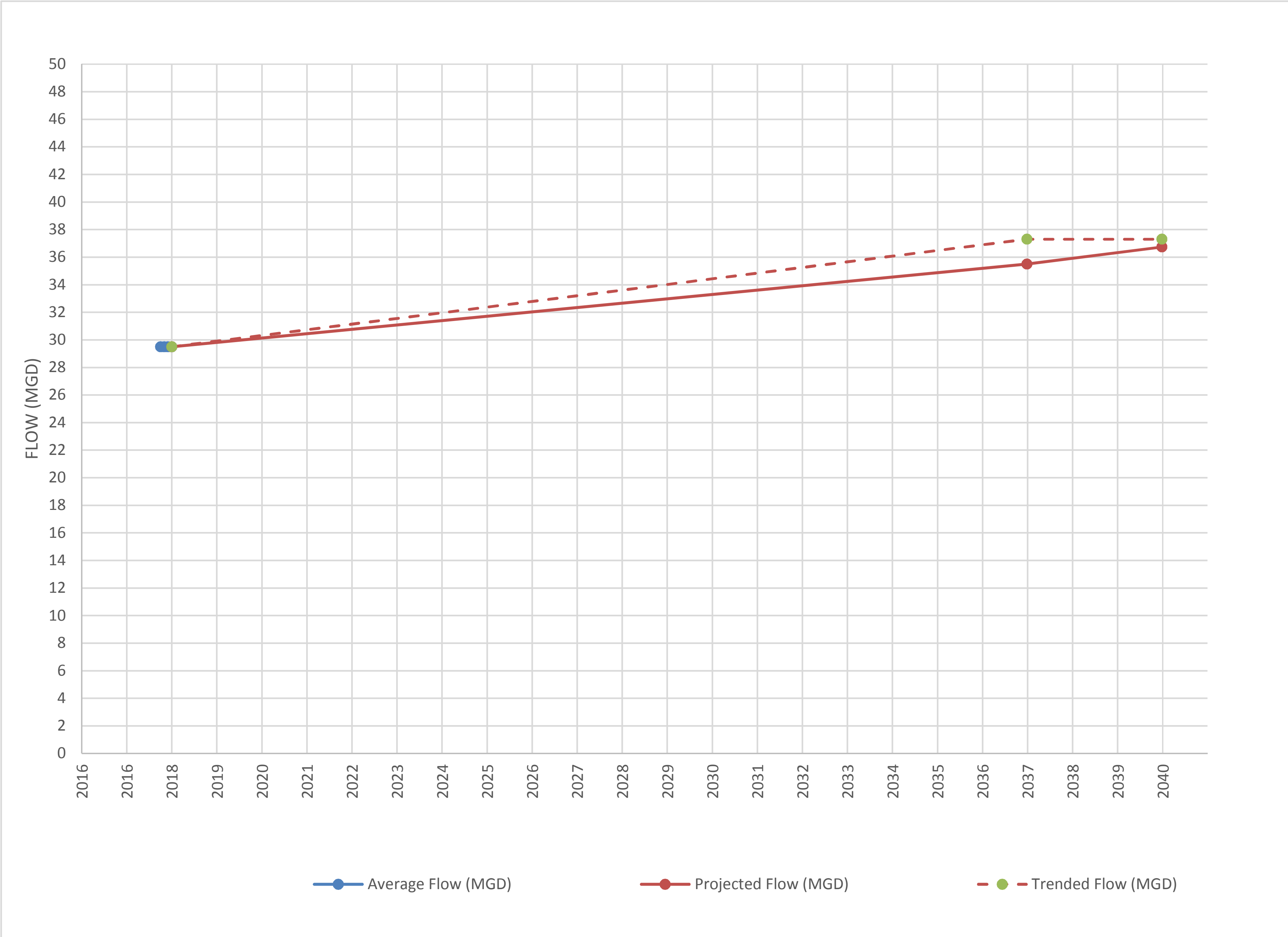
Out Side Colorado Springs Limits

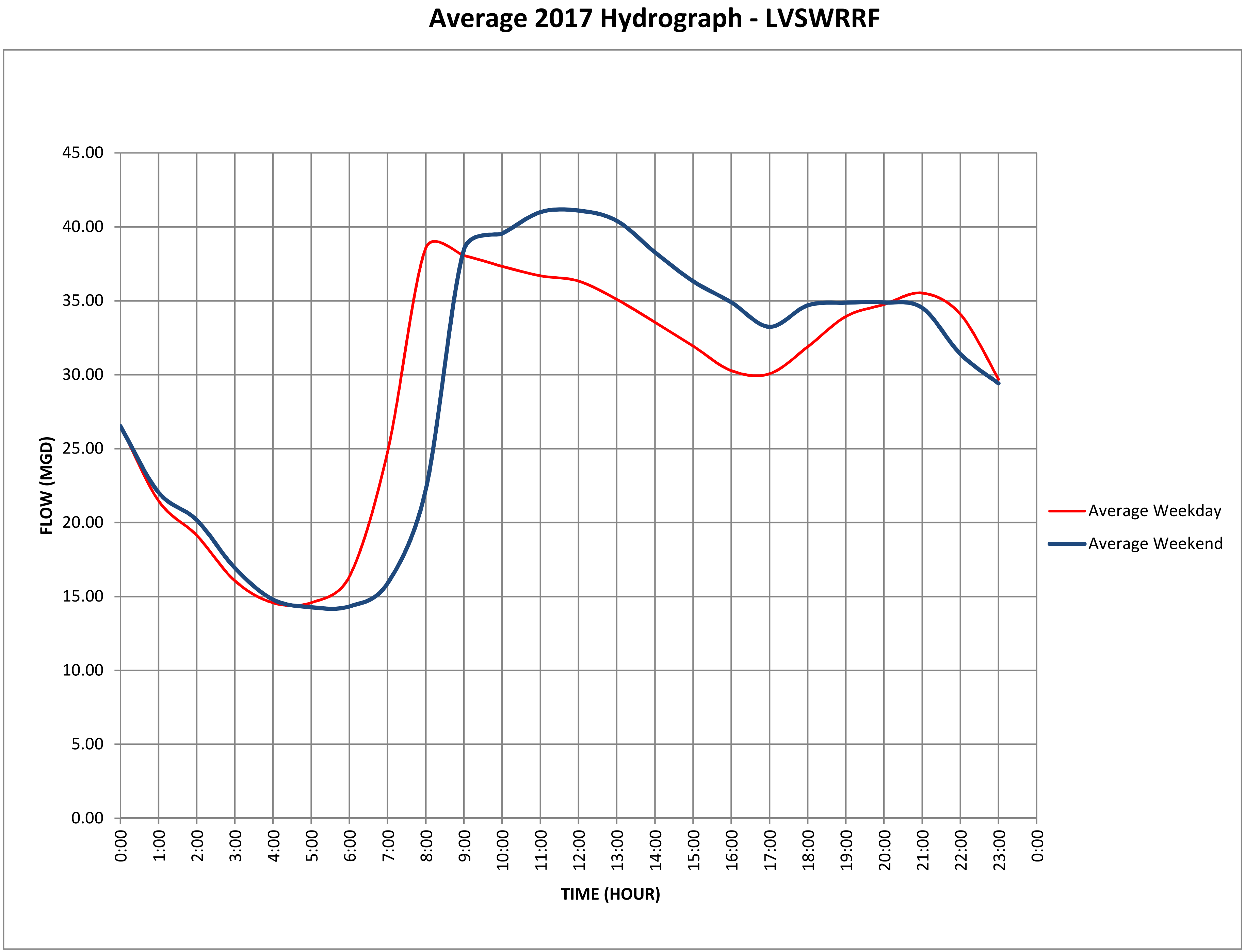
City Boundary

Colorado Springs

N

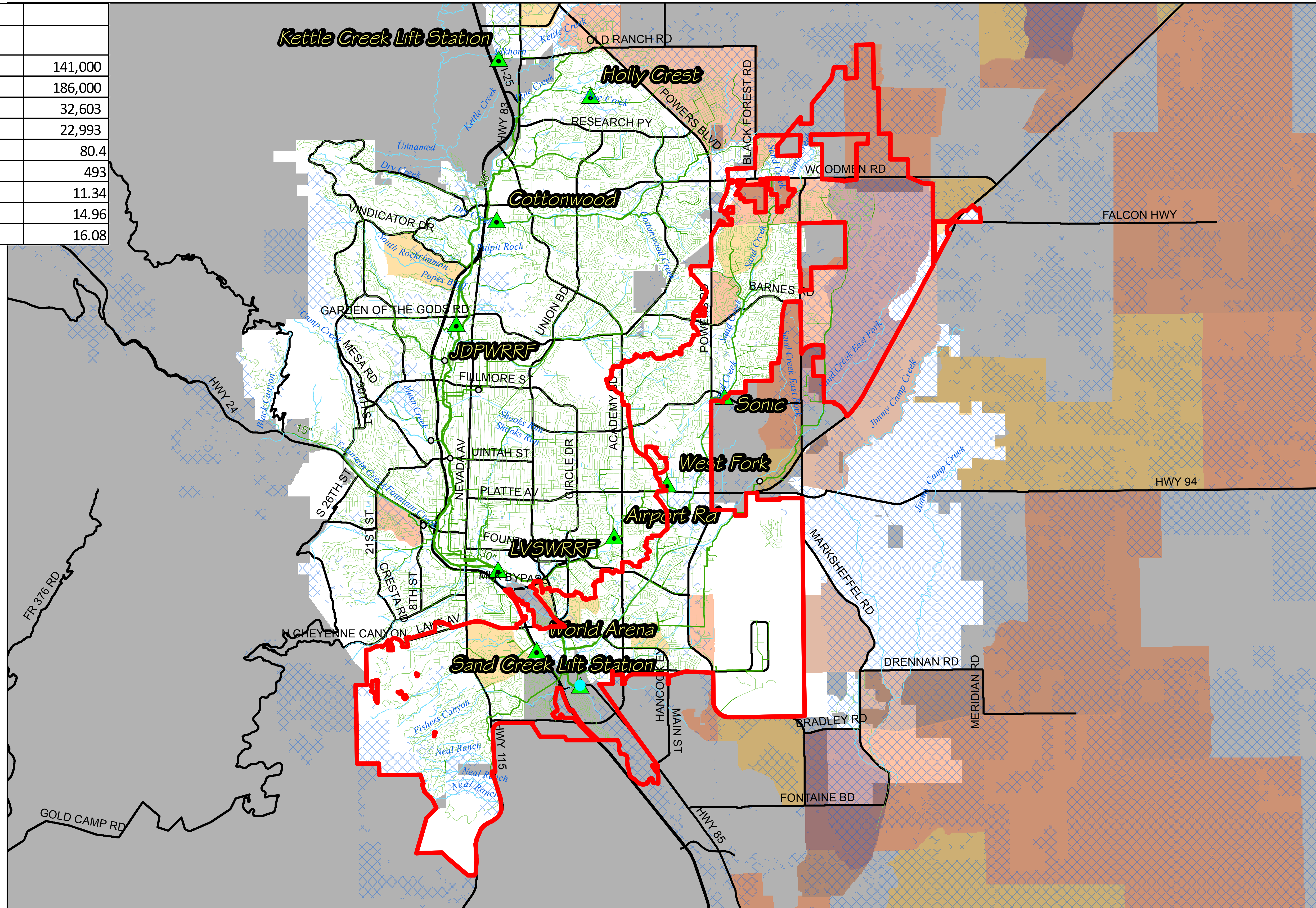
Flow Projections - LVSWRRF




Average 2017 Hydrograph - LVSWRRF
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
FLOW (MGD)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
TIME (HOUR)
Average Weekday
Average Weekend

Flow Calibration Point Area: Sand Creek Lift Station

METER POINT	
Sand Creek Lift Station	
Population 2017	141,000
Population 2040	186,000
In City Area (acres)	32,603
Developed Area (acres)	22,993
Per Capita Usage (gal/cap)	80.4
per acre daily use (gal/acre/day)	493
2017 Average Flow (MGD)	11.34
2040 Average Flow (MGD)	14.96
Build Out Average Flow (MGD)	16.08



Legend

Meter Point

<all other values>

Phase

Current

Limits of Contributing Area

Sand Creek Lift Station

Gravity Main

Subtype

- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Drainage
- MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

City Boundary

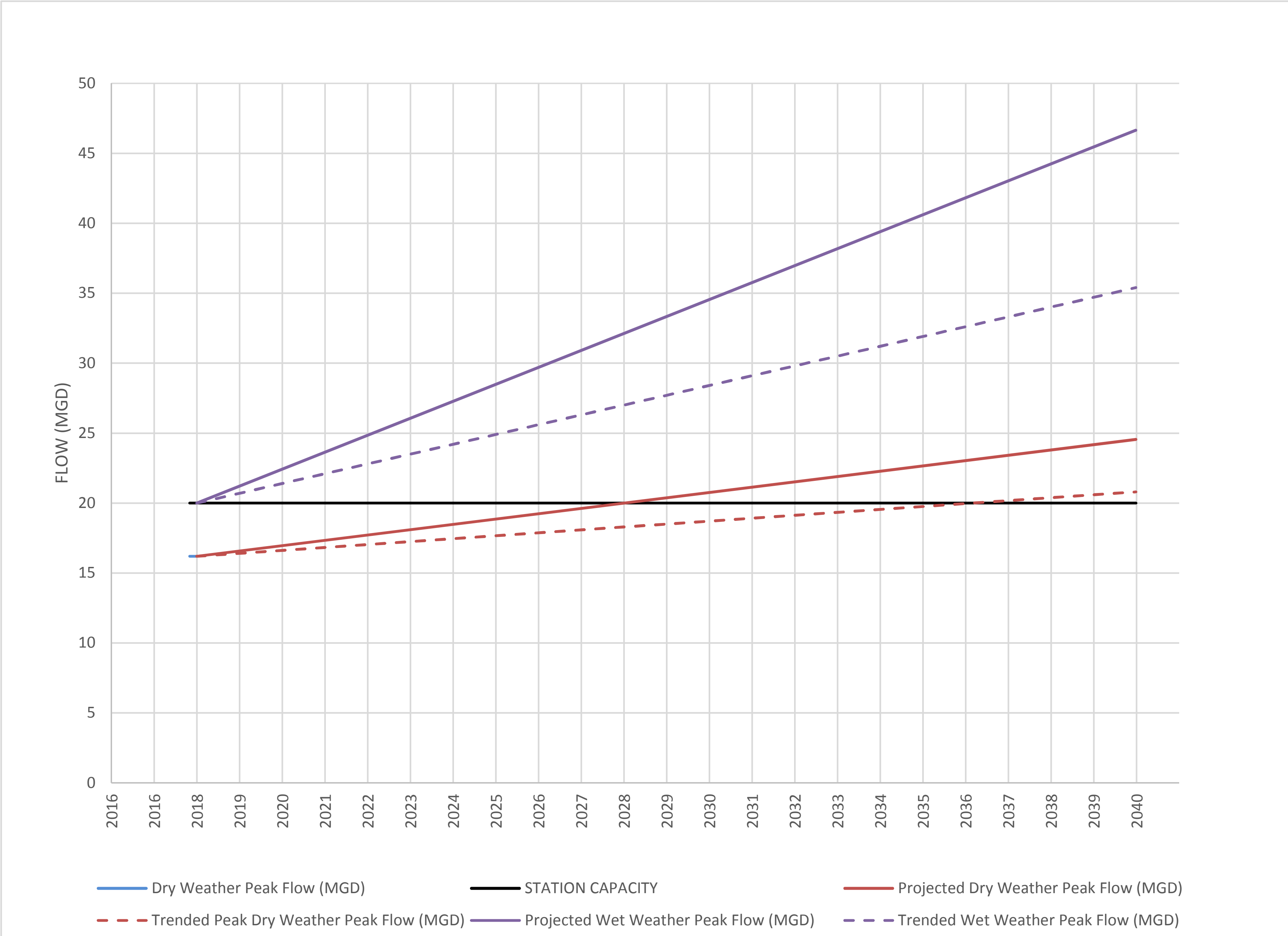
Out Side Colorado Springs Limits

City Boundary

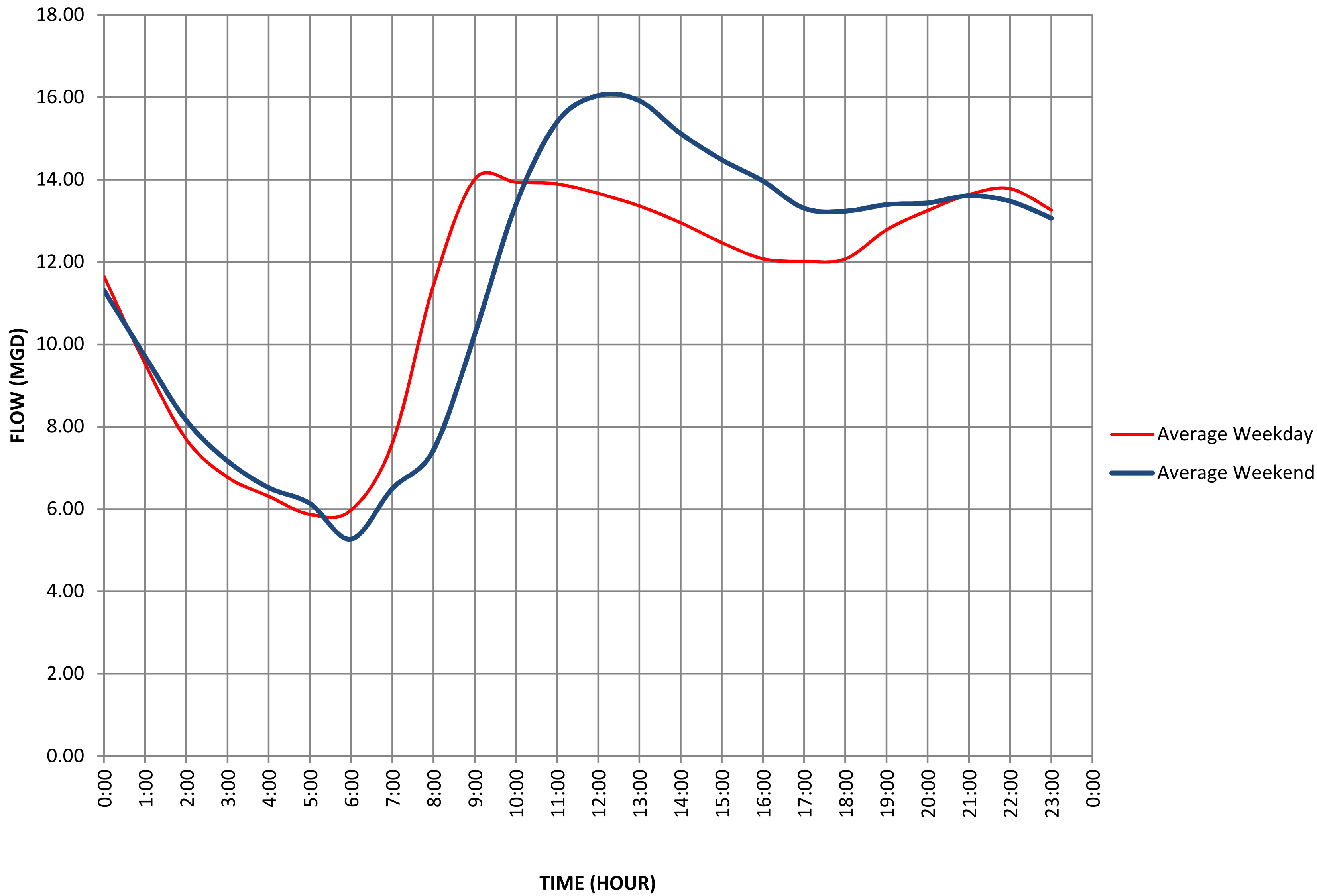
Colorado Springs

N

Dry and Wet Weather Flow Projections - Sand Creek Lift Station



Average 2017 Hydrograph - Sand Creek Lift Station



Flow Calibration Point Area: Sonic

METER POINT	
Sonic	
Population 2017	42,600
Population 2040	52,900
In City Area (acres)	4,748
Developed Area (acres)	3,509
Per Capita Usage (gal/cap)	67.8
per acre daily use (gal/acre/day)	824
2017 Average Flow (MGD)	2.89
2040 Average Flow (MGD)	3.59
Build Out Average Flow (MGD)	3.91

Legend

Meter Point

Current

Limits of Contributing Area

Sonic

Gravity Main

Subtype

8"

10"-16"

16"-35"

36" and larger

Drainage

MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

Agriculture

Parking/Vacant

Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

-767.000000 - 1000.000000

1000.000001 - 1500.000000

1500.000001 - 3000.000000

3000.000001 - 4500.000000

4500.000001 - 6000.000000

6000.000001 - 100000.000000

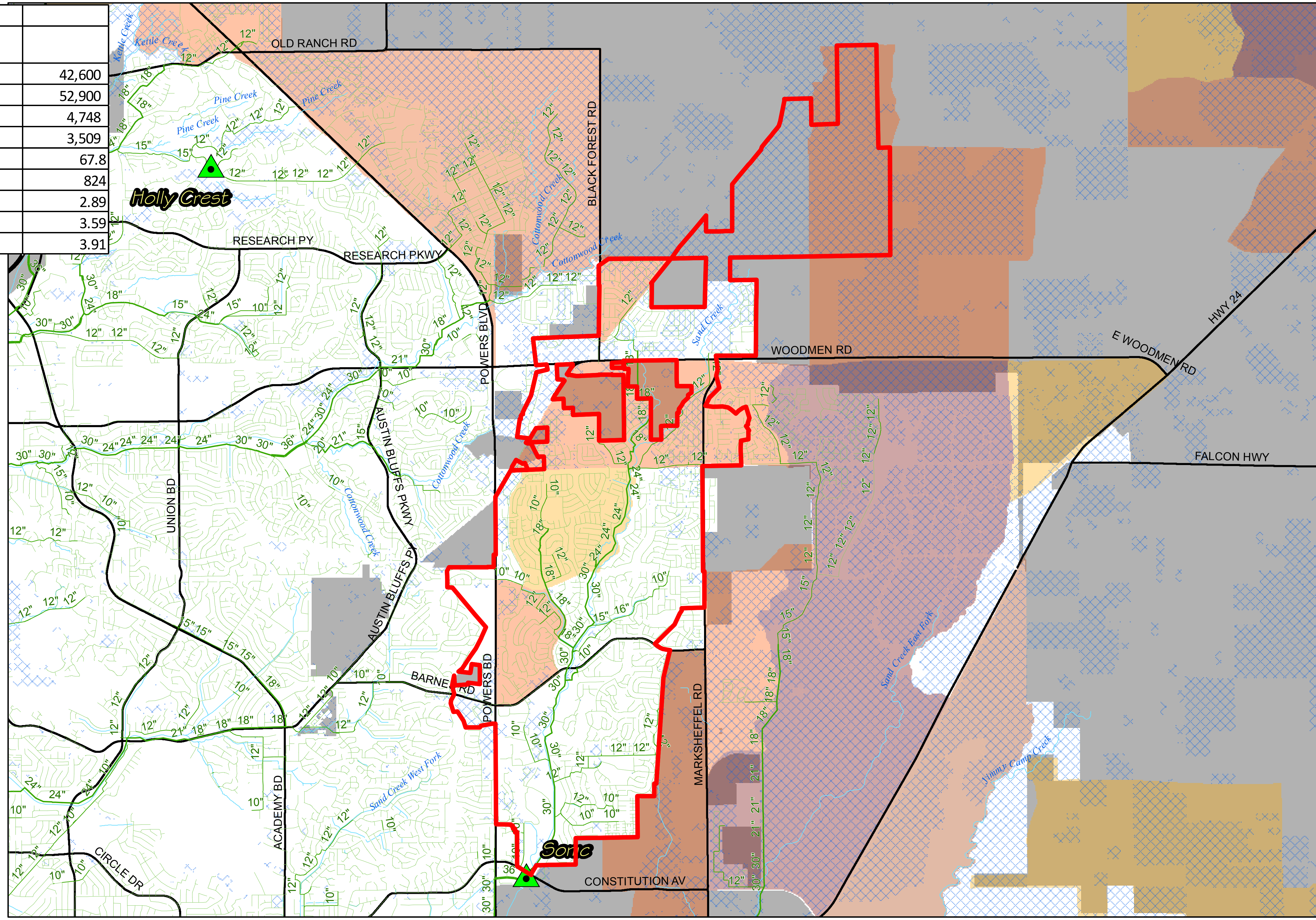
City Boundary

Out Side Colorado Springs Limits

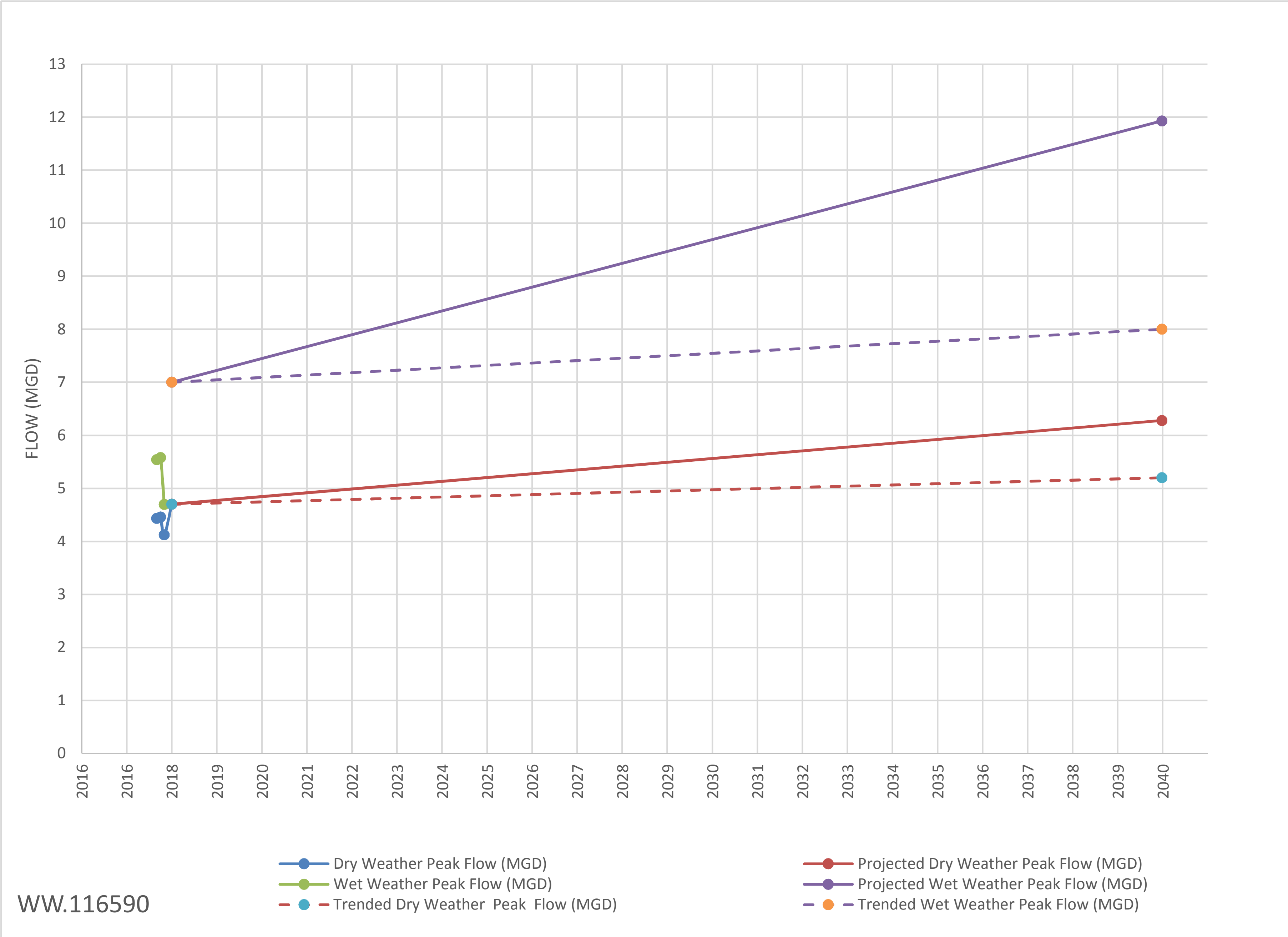
City Boundary

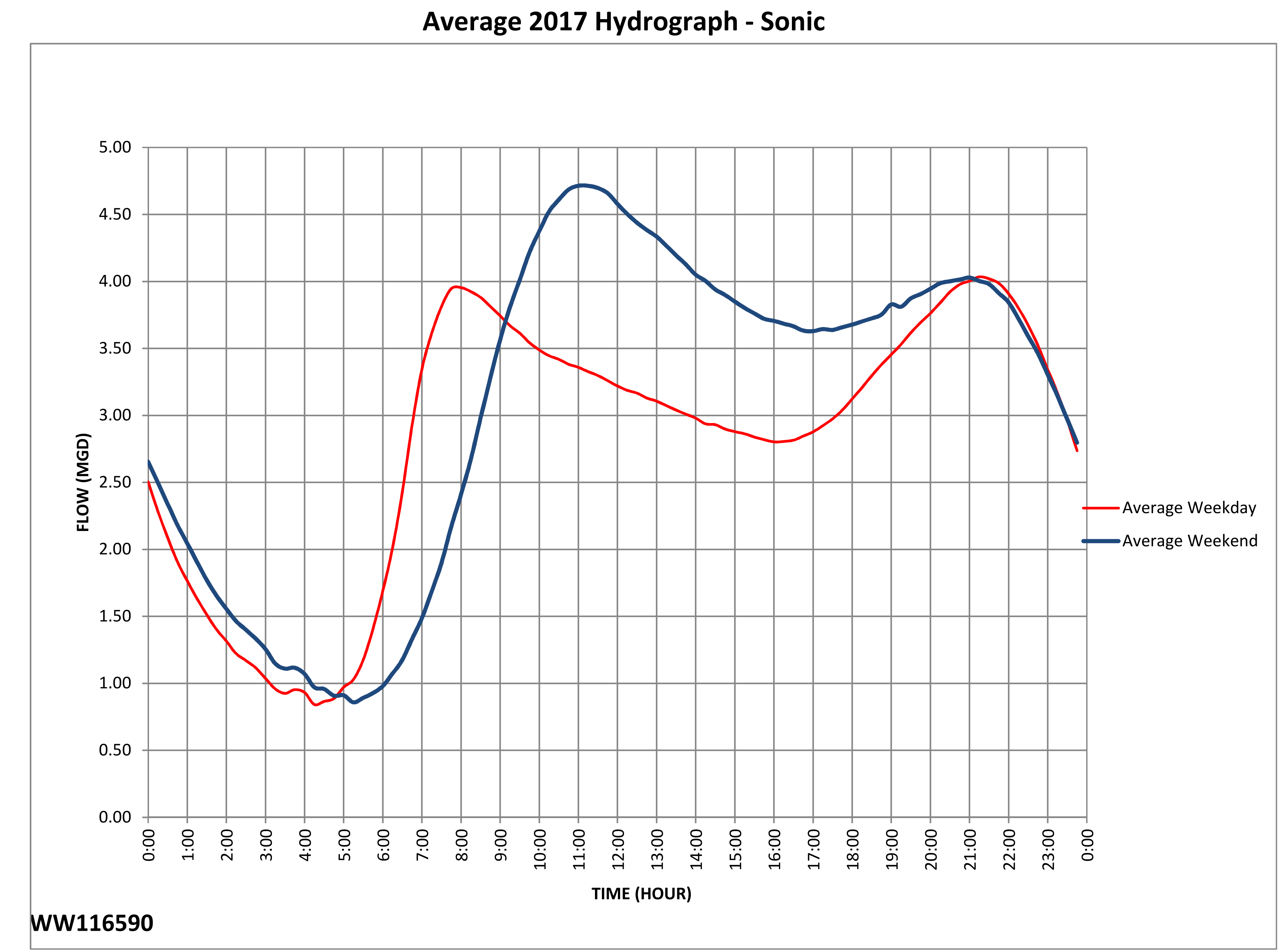
Colorado Springs

N



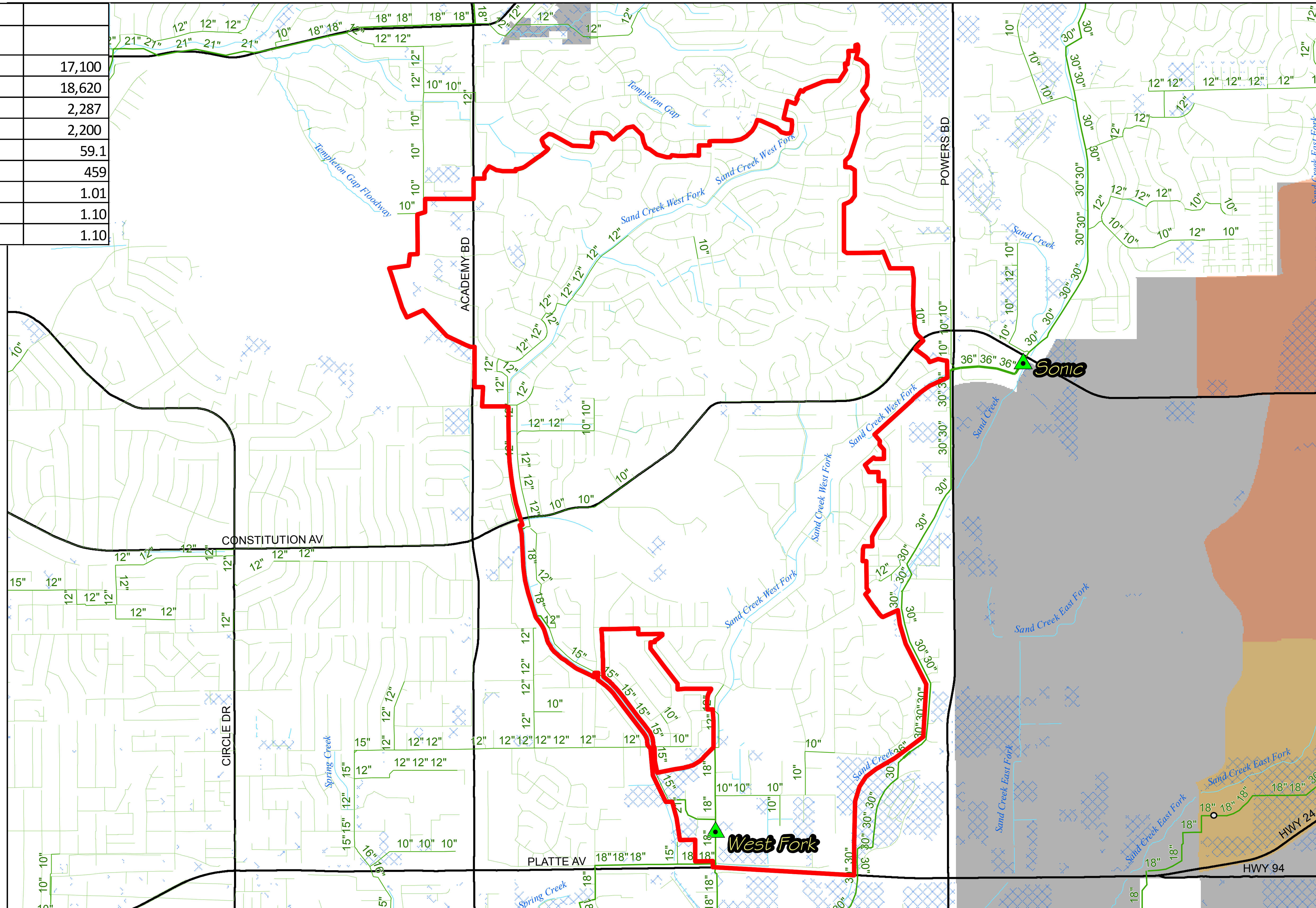
Dry and Wet Weather Flow Projections - Sonic




Average 2017 Hydrograph - Sonic
FLOW (MGD)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
TIME (HOUR)
Average Weekday
Average Weekend
WW116590

Flow Calibration Point Area: West Fork

METER POINT	
West Fork	
Population 2017	17,100
Population 2040	18,620
In City Area (acres)	2,287
Developed Area (acres)	2,200
Per Capita Usage (gal/cap)	59.1
per acre daily use (gal/acre/day)	459
2017 Average Flow (MGD)	1.01
2040 Average Flow (MGD)	1.10
Build Out Average Flow (MGD)	1.10



Legend

Meter Point

<all other values>

Phase

Current

Limits of Contributing Area

West Fork

Gravity Main

Subtype

- 8"
- 10"-16"
- 16"-35"
- 36" and larger
- Drainage
- MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

- Agriculture
- Parking/Vacant
- Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

- -767.000000 - 1000.000000
- 1000.000001 - 1500.000000
- 1500.000001 - 3000.000000
- 3000.000001 - 4500.000000
- 4500.000001 - 6000.000000
- 6000.000001 - 100000.000000

City Boundary

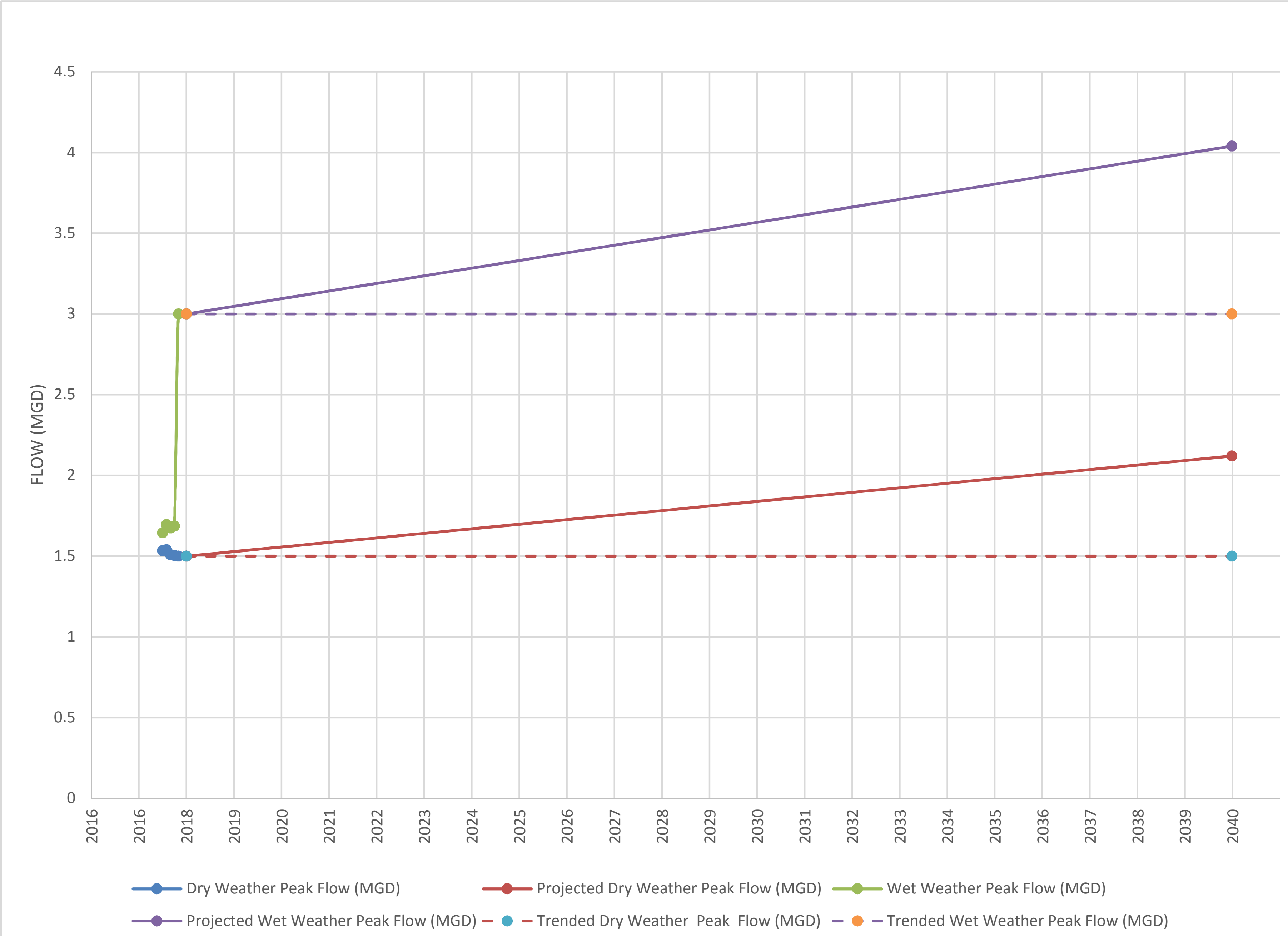
Out Side Colorado Springs Limits

City Boundary

Colorado Springs

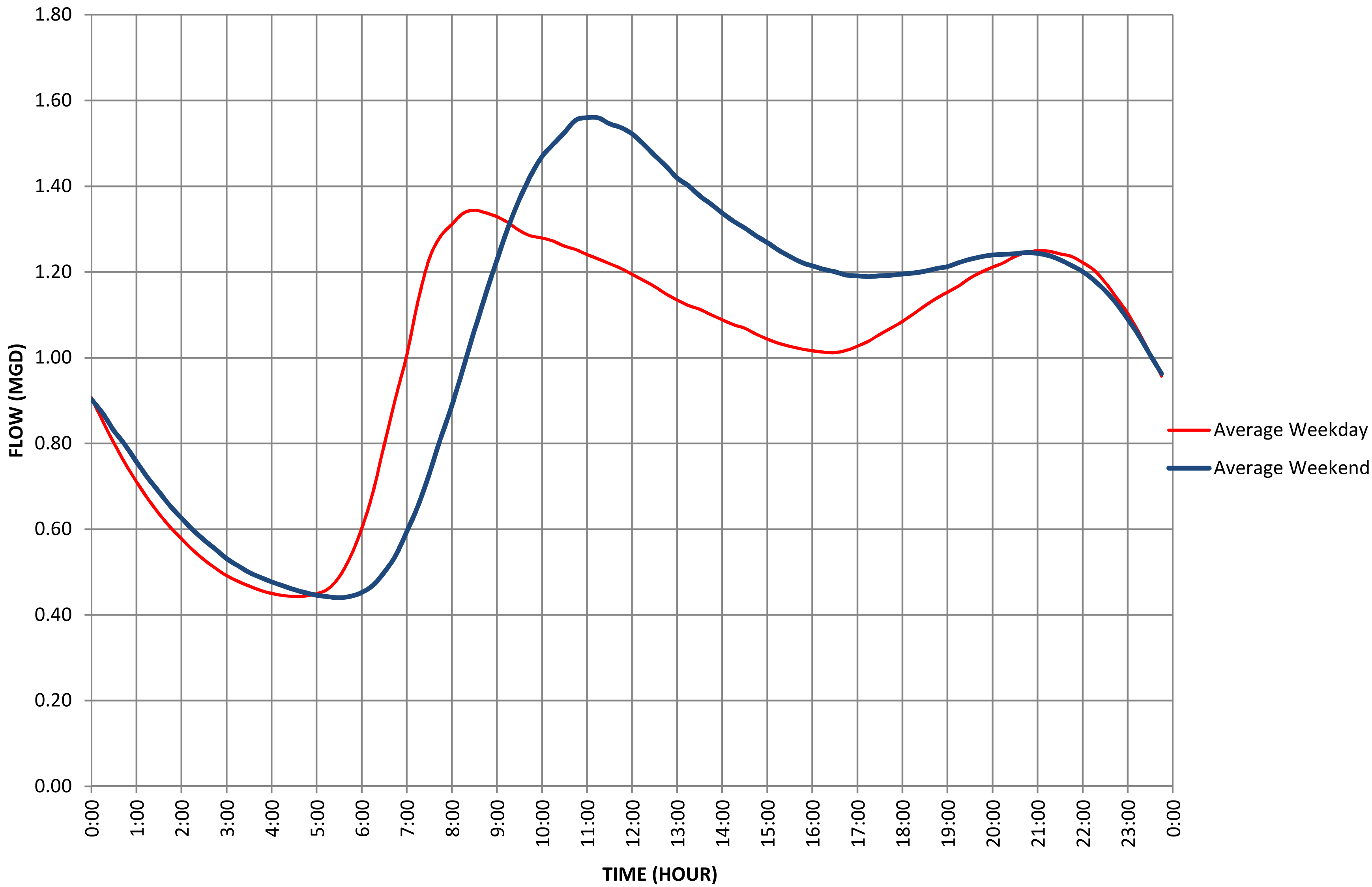
N

Dry and Wet Weather Flow Projections - West Fork



WW.130628

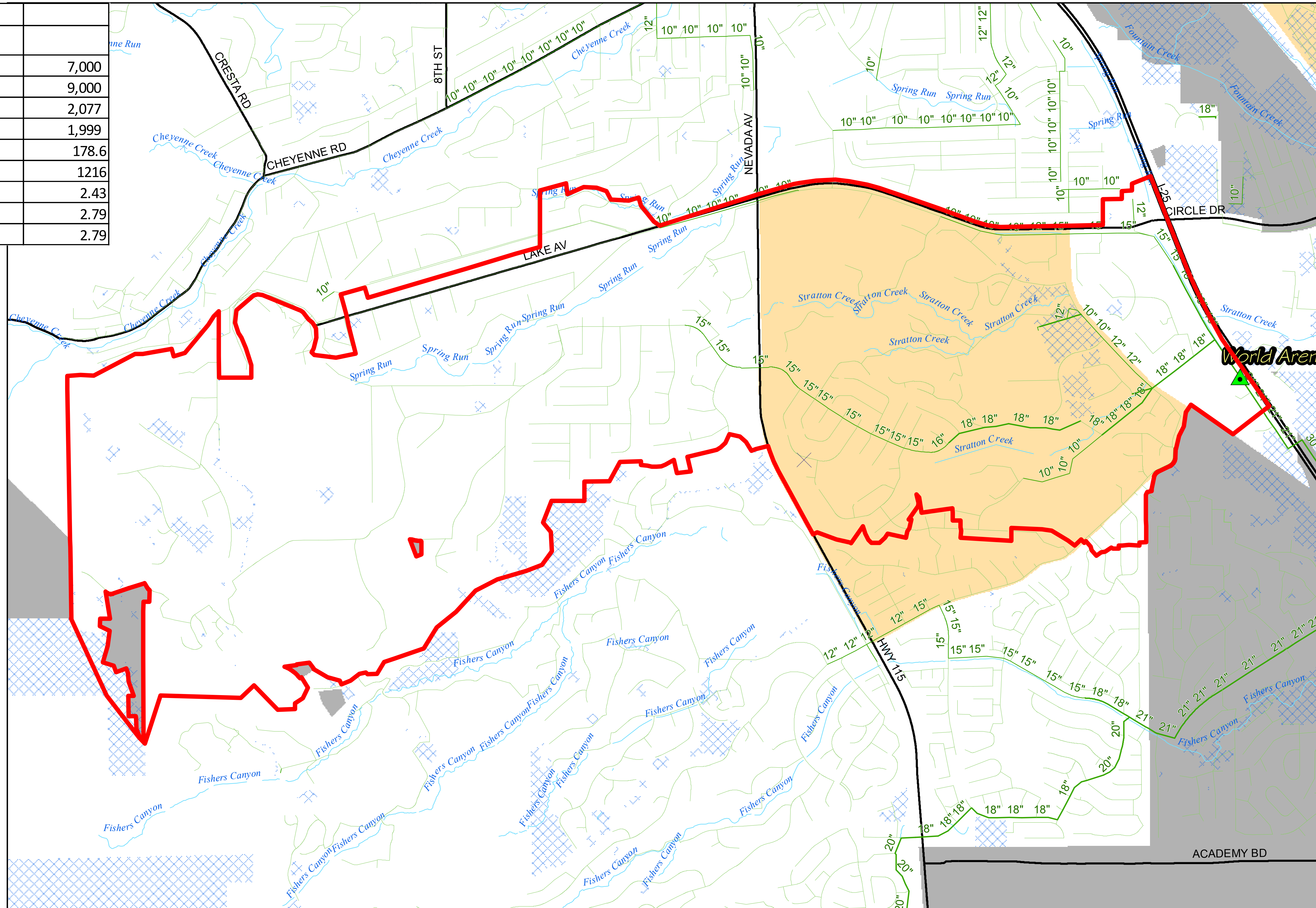
Average 2017 Hydrograph - West Fork



WW130628

Flow Calibration Point Area: World Arena

METER POINT	
World Arena	
Population 2017	7,000
Population 2040	9,000
In City Area (acres)	2,077
Developed Area (acres)	1,999
Per Capita Usage (gal/cap)	178.6
per acre daily use (gal/acre/day)	1216
2017 Average Flow (MGD)	2.43
2040 Average Flow (MGD)	2.79
Build Out Average Flow (MGD)	2.79



Legend

Meter Point

<all other values>

Phase

Current

Limits of Contributing Area

West Fork

Gravity Main

Subtype

8"

10"-16"

16"-35"

36" and larger

Drainage

MajorStreets

EXTERNALDATA.LANDUSE

Areas of Future Growth

Agriculture

Parking/Vacant

Vacant Land

Small Area Forecast Data

Change in Population 2017 to 2040

-767.000000 - 1000.000000

1000.000001 - 1500.000000

1500.000001 - 3000.000000

3000.000001 - 4500.000000

4500.000001 - 6000.000000

6000.000001 - 100000.000000

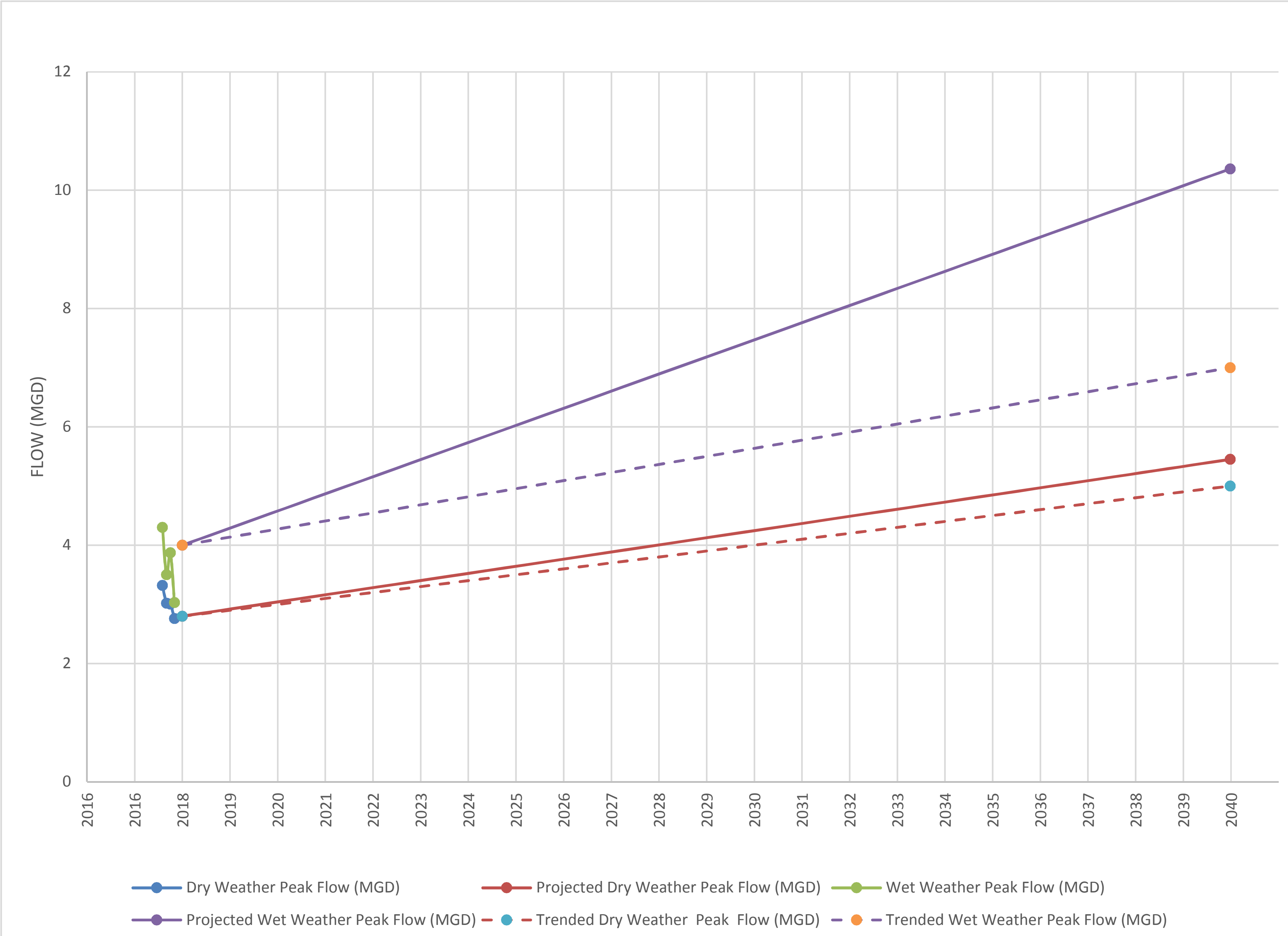
City Boundary

Out Side Colorado Springs Limits

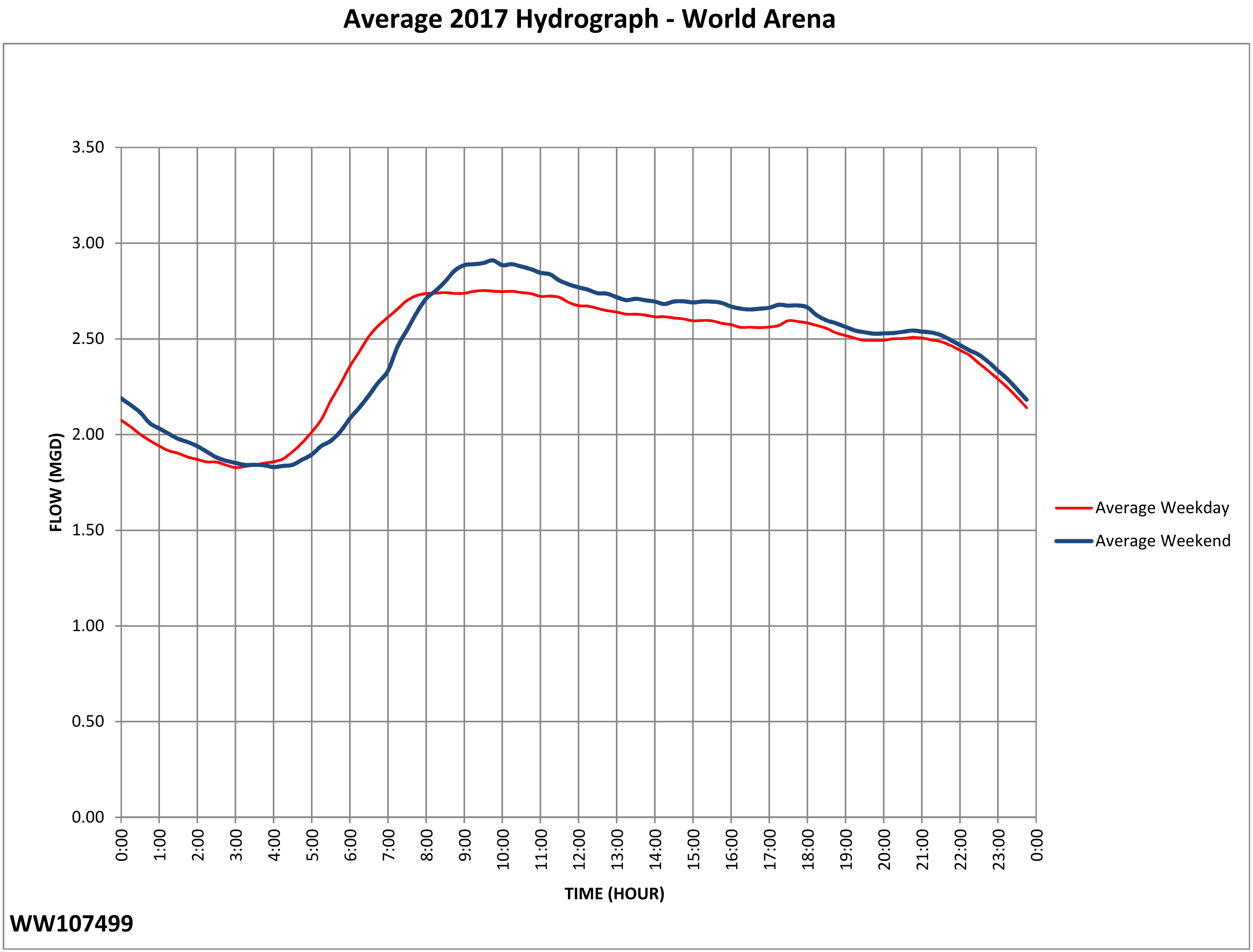
City Boundary

Colorado Springs

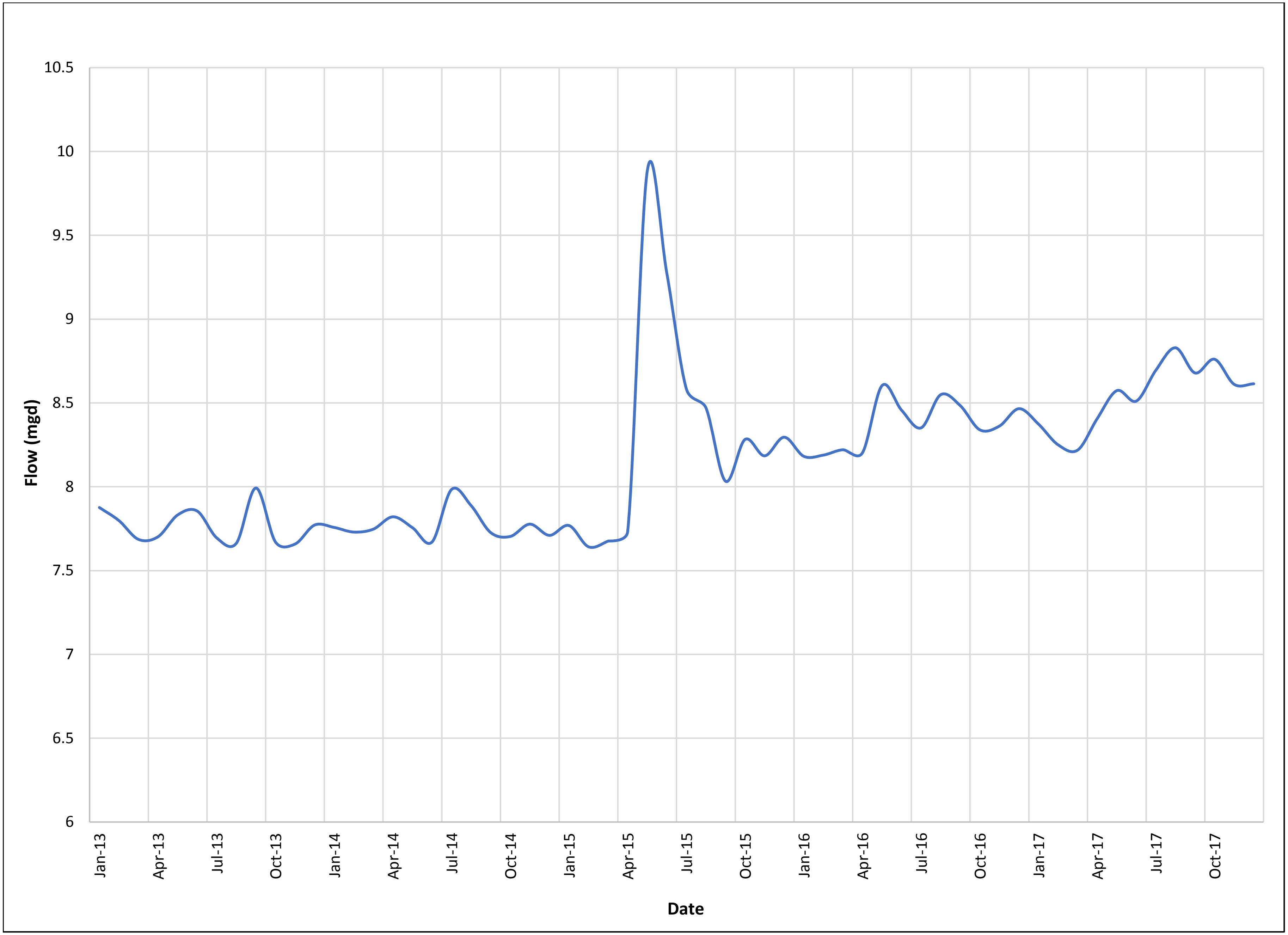
Dry and Wet Weather Flow Projections - World Arena



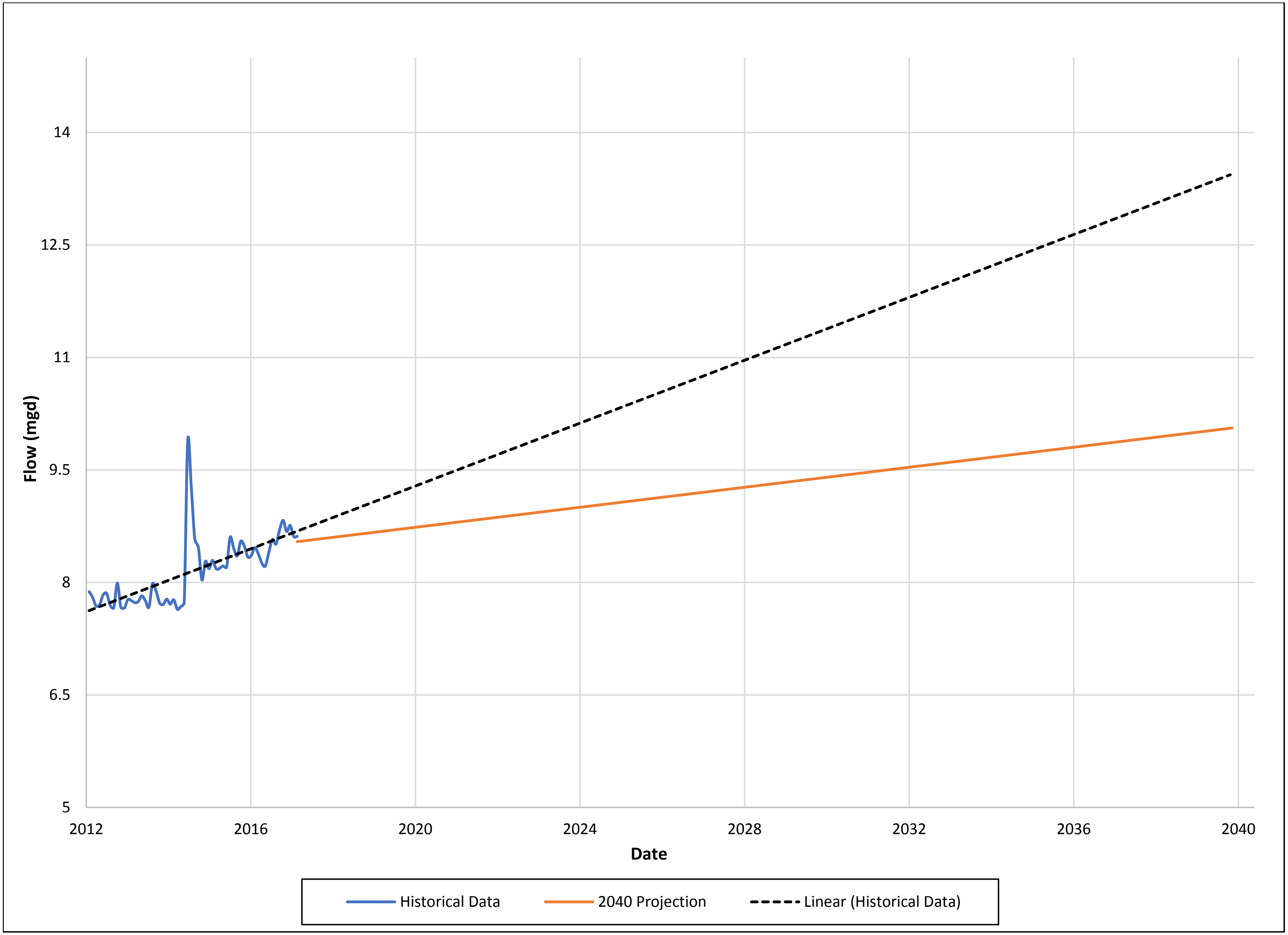
WW.107499

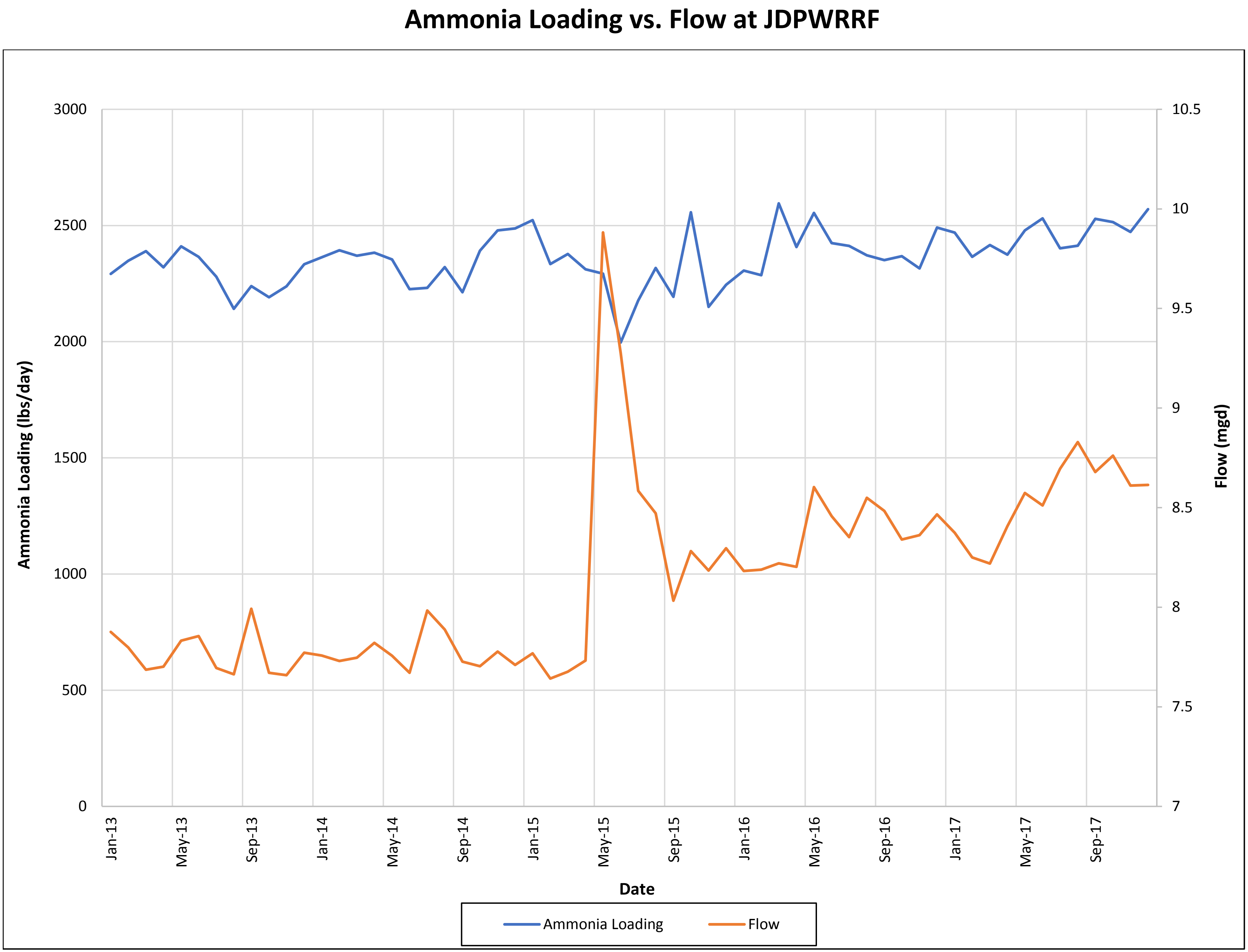

Average 2017 Hydrograph - World Arena
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
FLOW (MGD)
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
TIME (HOUR)
Average Weekday
Average Weekend
WW107499

Historical Flow at JDPWRRF

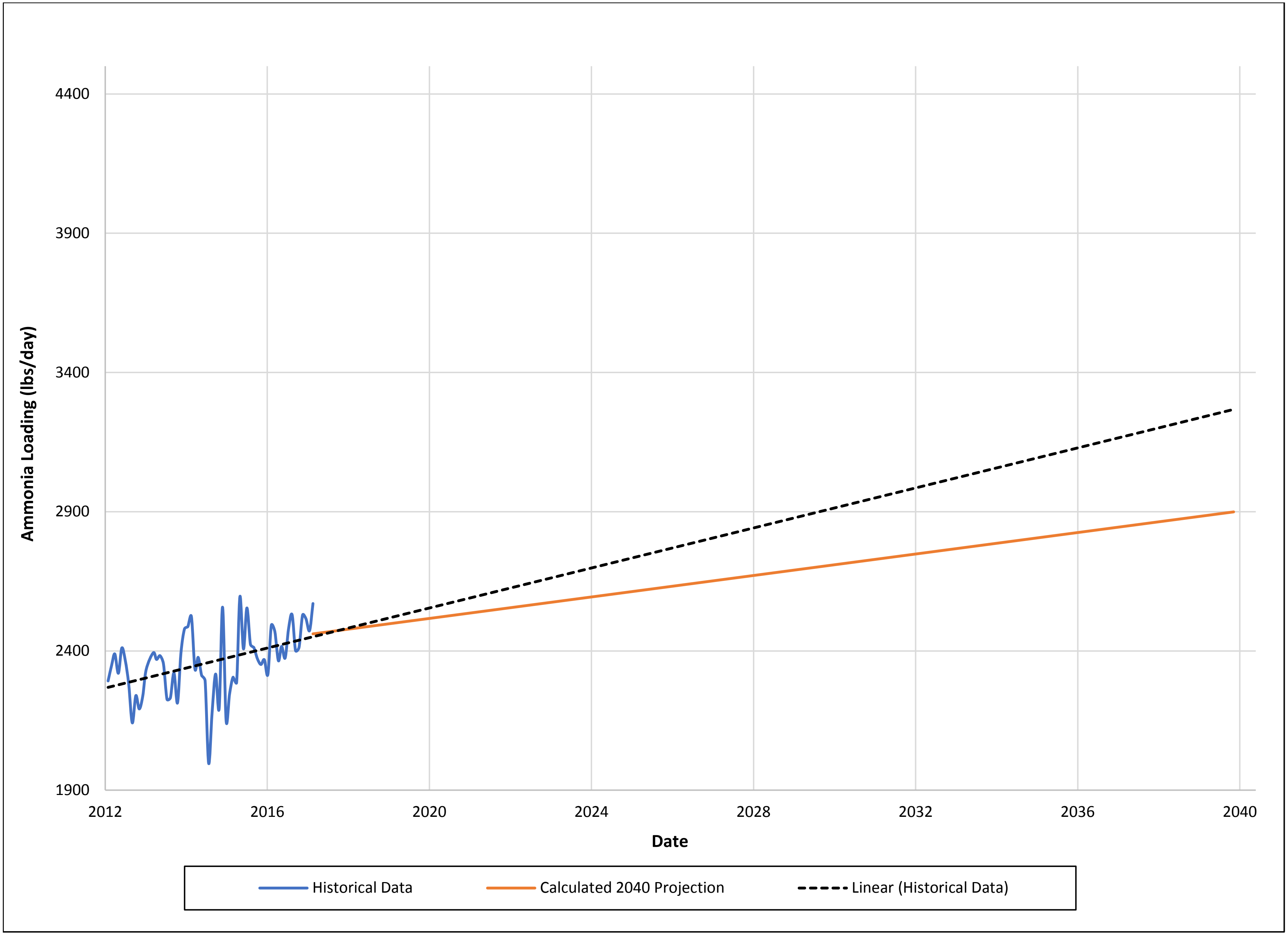


Flow Projection for JDPWRRF

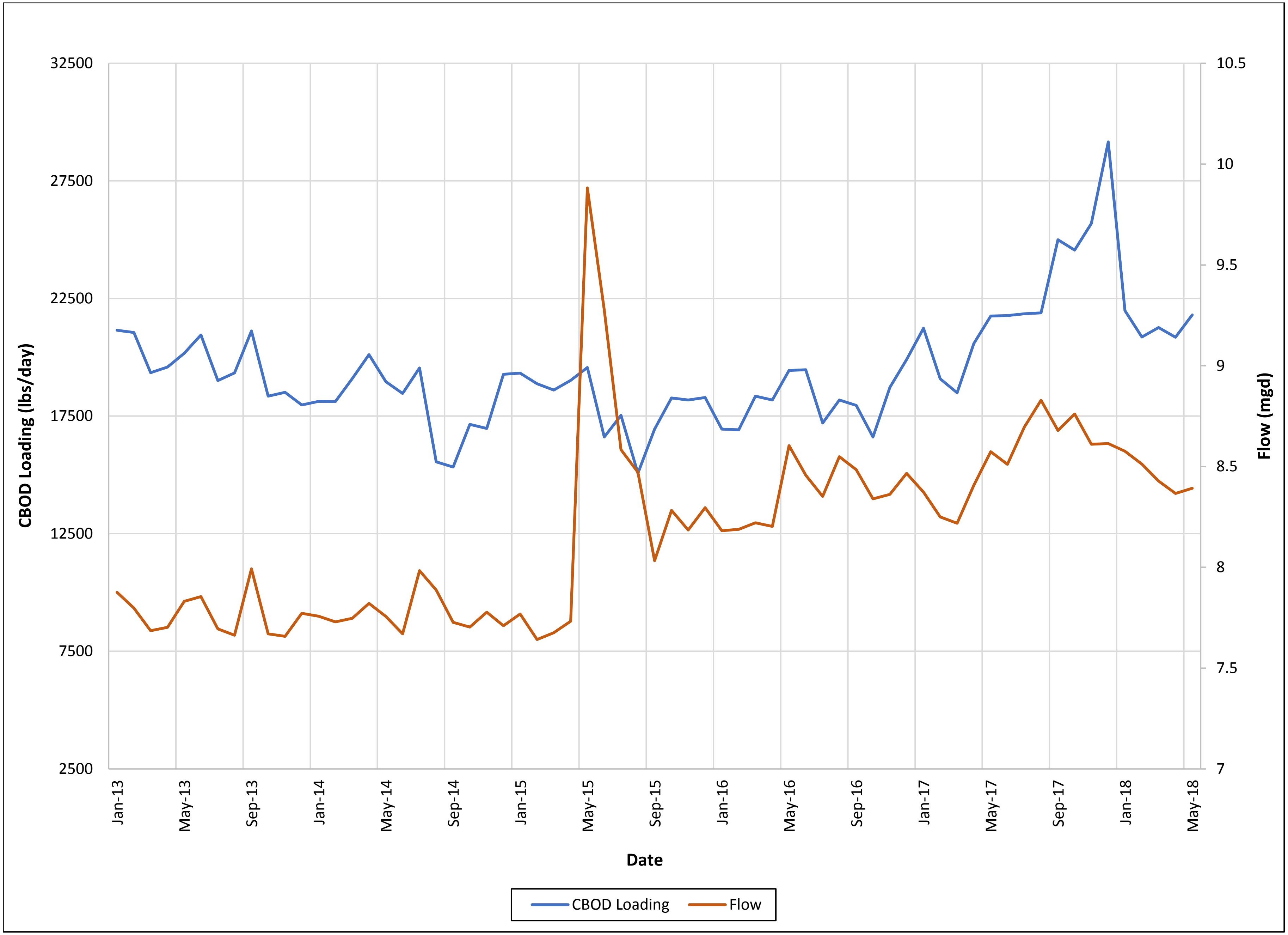



Ammonia Loading vs. Flow at JDPWRRF
3000
2500
2000
1500
1000
500
0
Ammonia Loading (lbs/day)
10.5
10
9.5
9
8.5
8
7.5
7
Flow (mgd)
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Date
Ammonia Loading
Flow

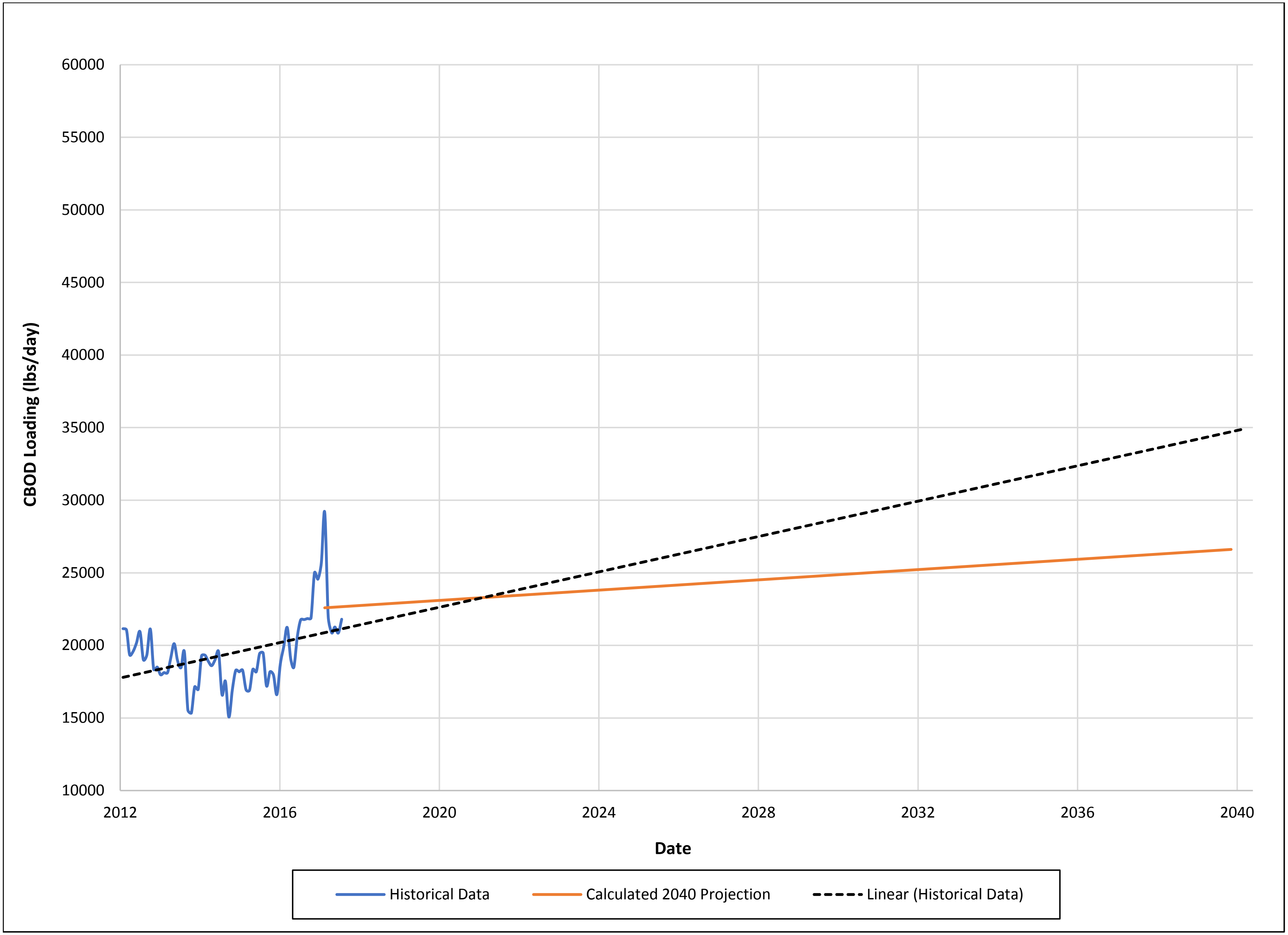
Ammonia Loading Projection for JDPWRRF

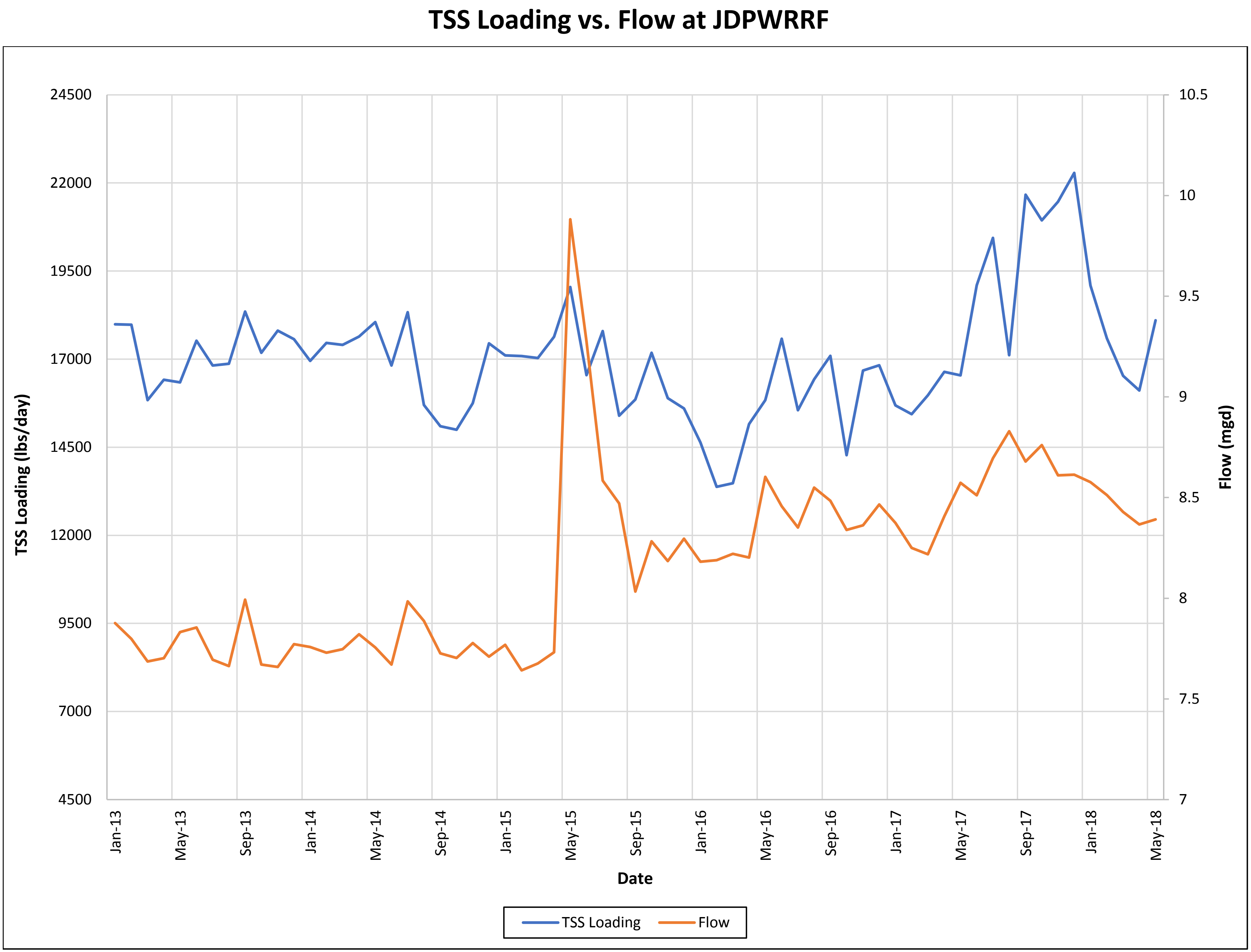


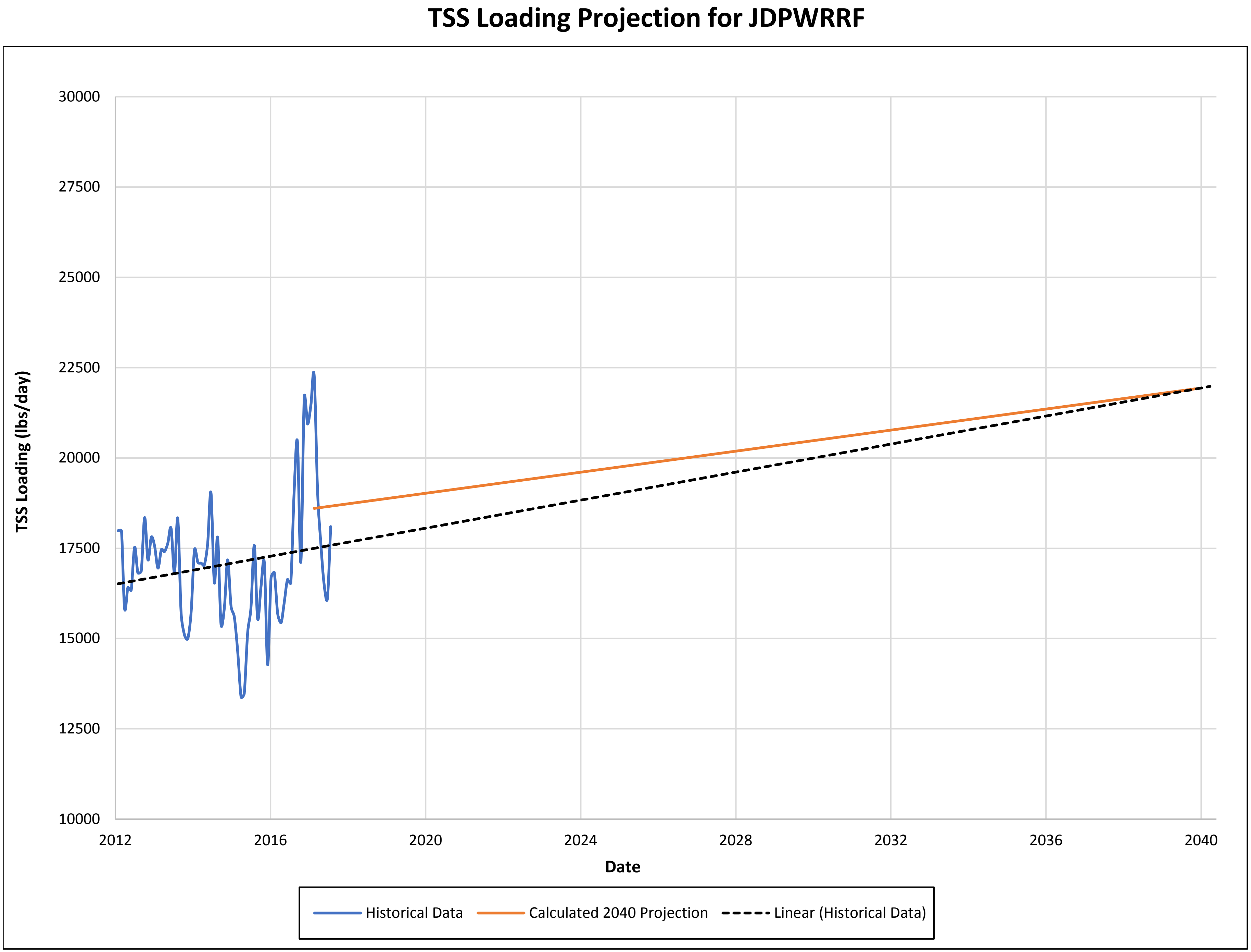
CBOD Loading vs. Flow at JDPWRRF



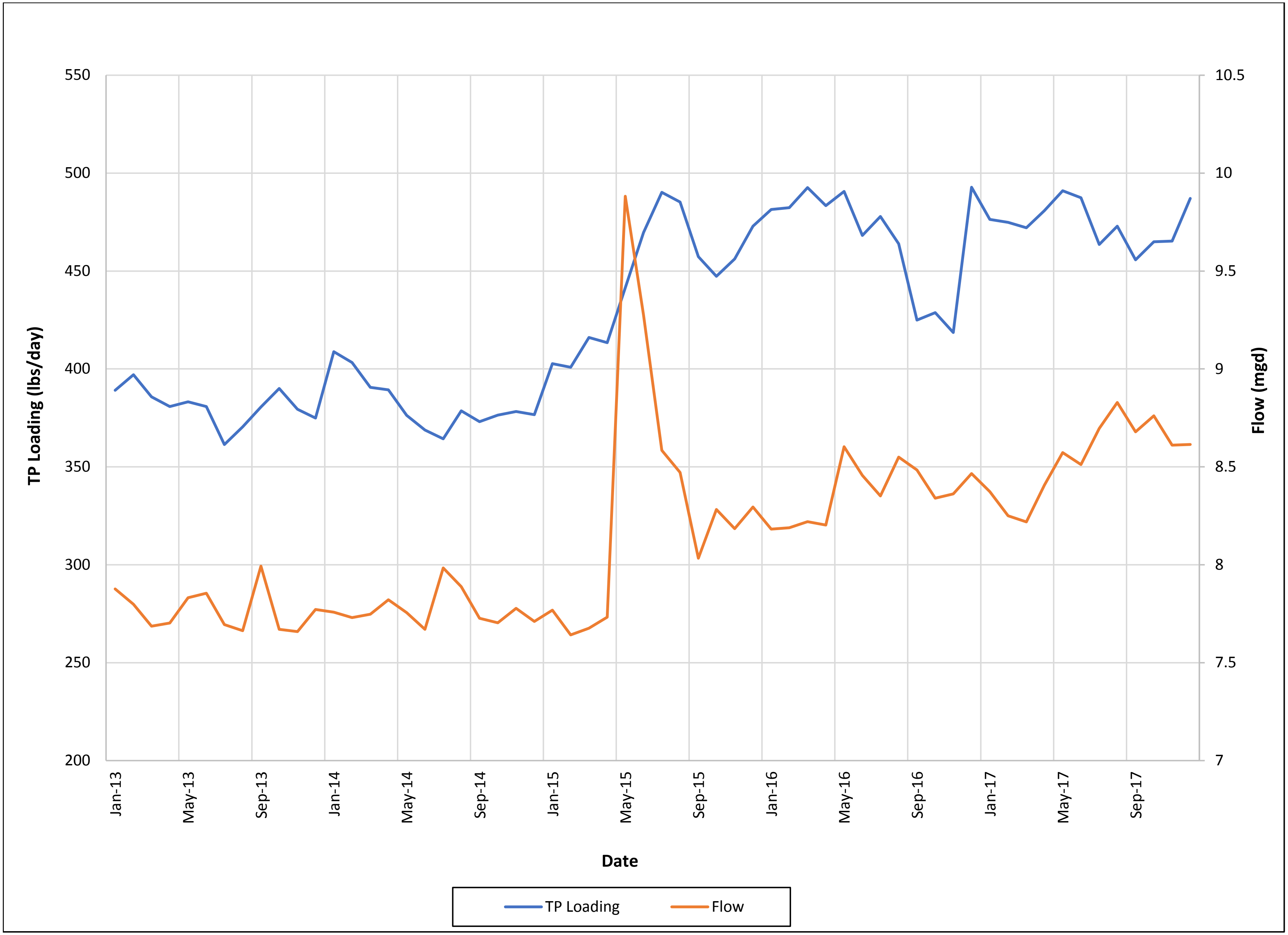
CBOD Loading Future Projection for JDPWRRF



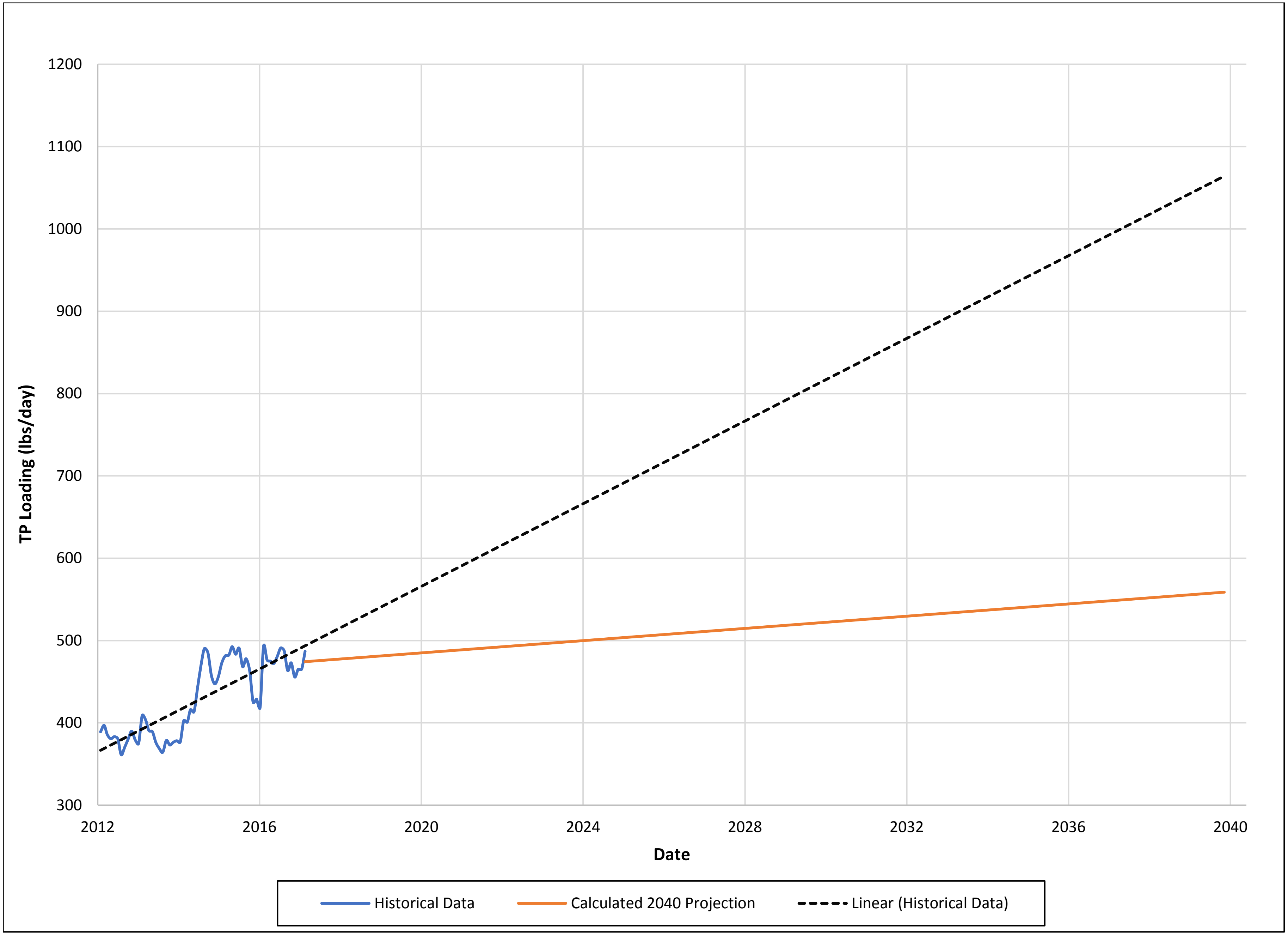

TSS Loading vs. Flow at JDPWRRF
24500
22000
19500
17000
14500
12000
9500
7000
4500
TSS Loading (lbs/day)
10.5
10
9.5
9
8.5
8
7.5
7
Flow (mgd)
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
May-18
Date
TSS Loading
Flow

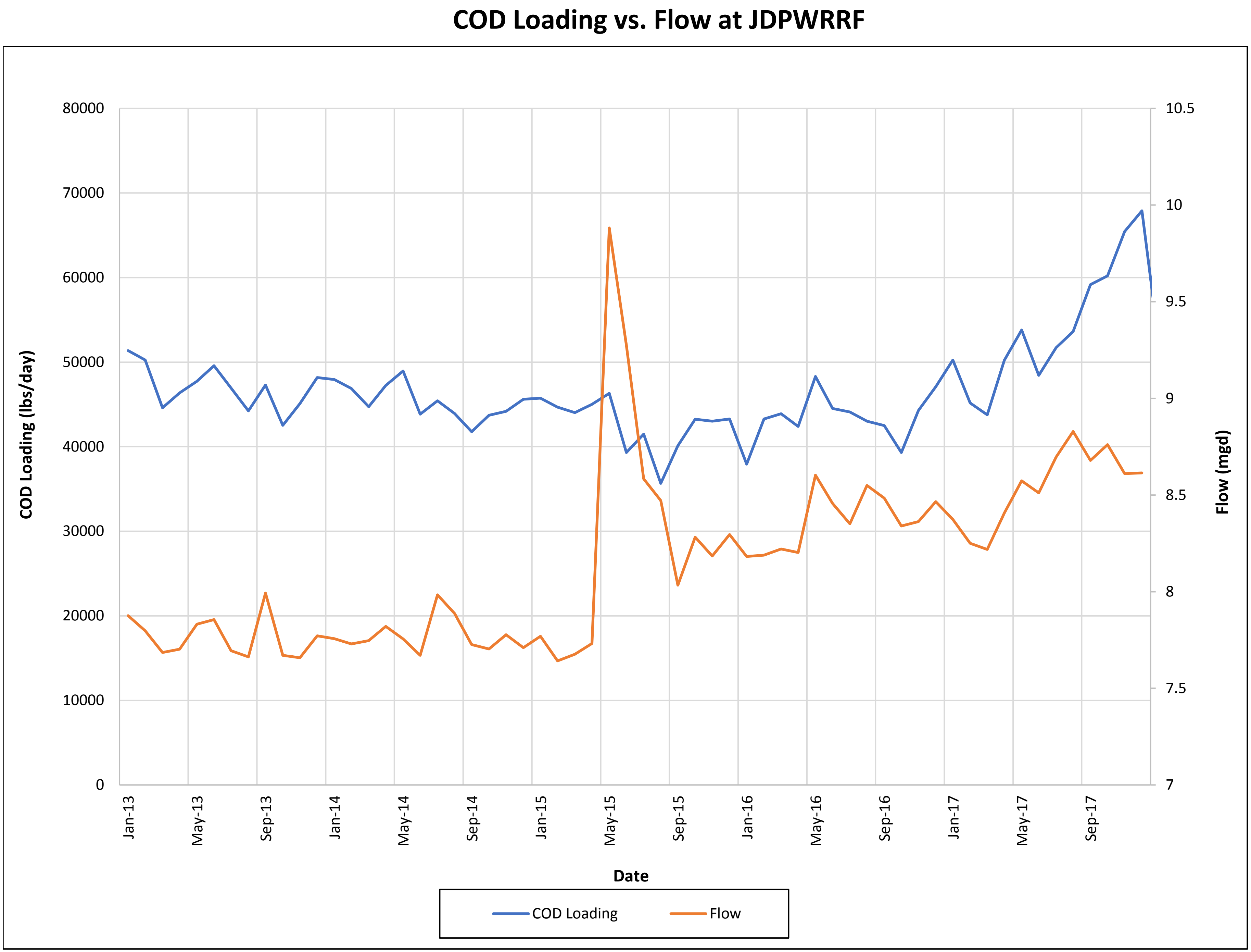

TSS Loading Projection for JDPWRRF
30000
27500
25000
22500
20000
17500
15000
12500
10000
TSS Loading (lbs/day)
2012
2016
2020
2024
2028
2032
2036
2040
Date
Historical Data
Calculated 2040 Projection
Linear (Historical Data)

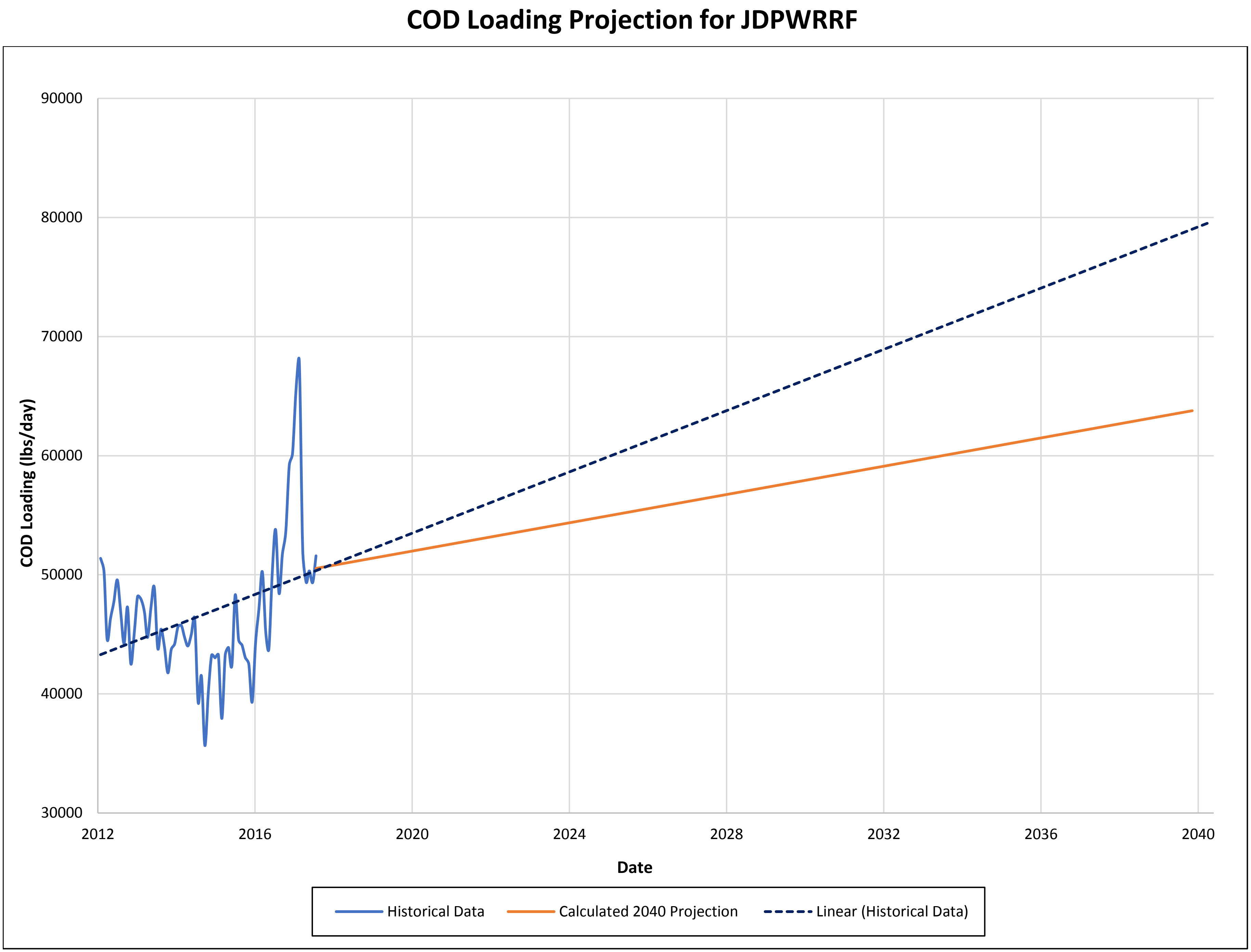
Total Phosphorus Loading vs. Flow at JDPWRRF



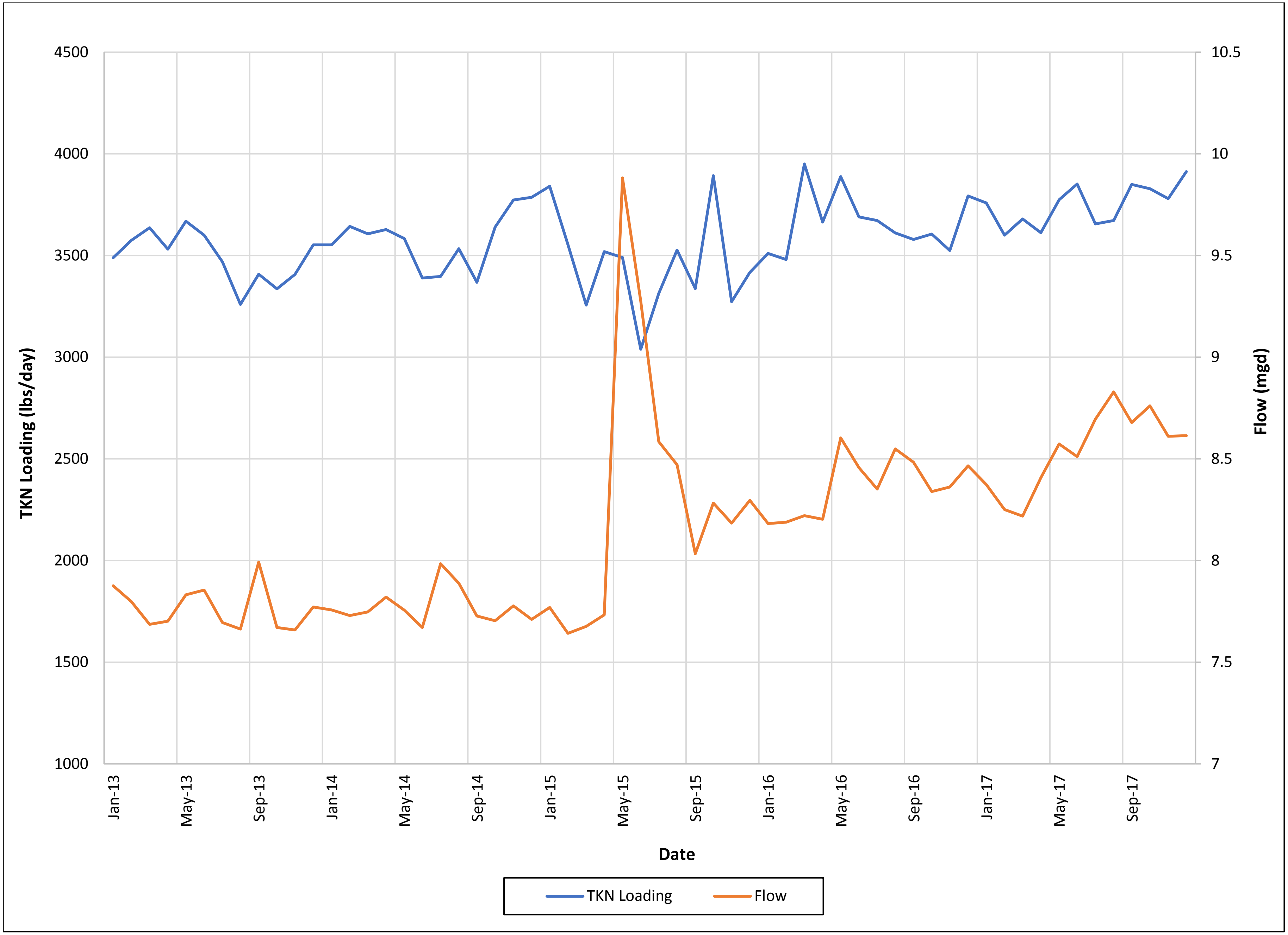
Total Phosphorus Loading Projection for JDPWRRF

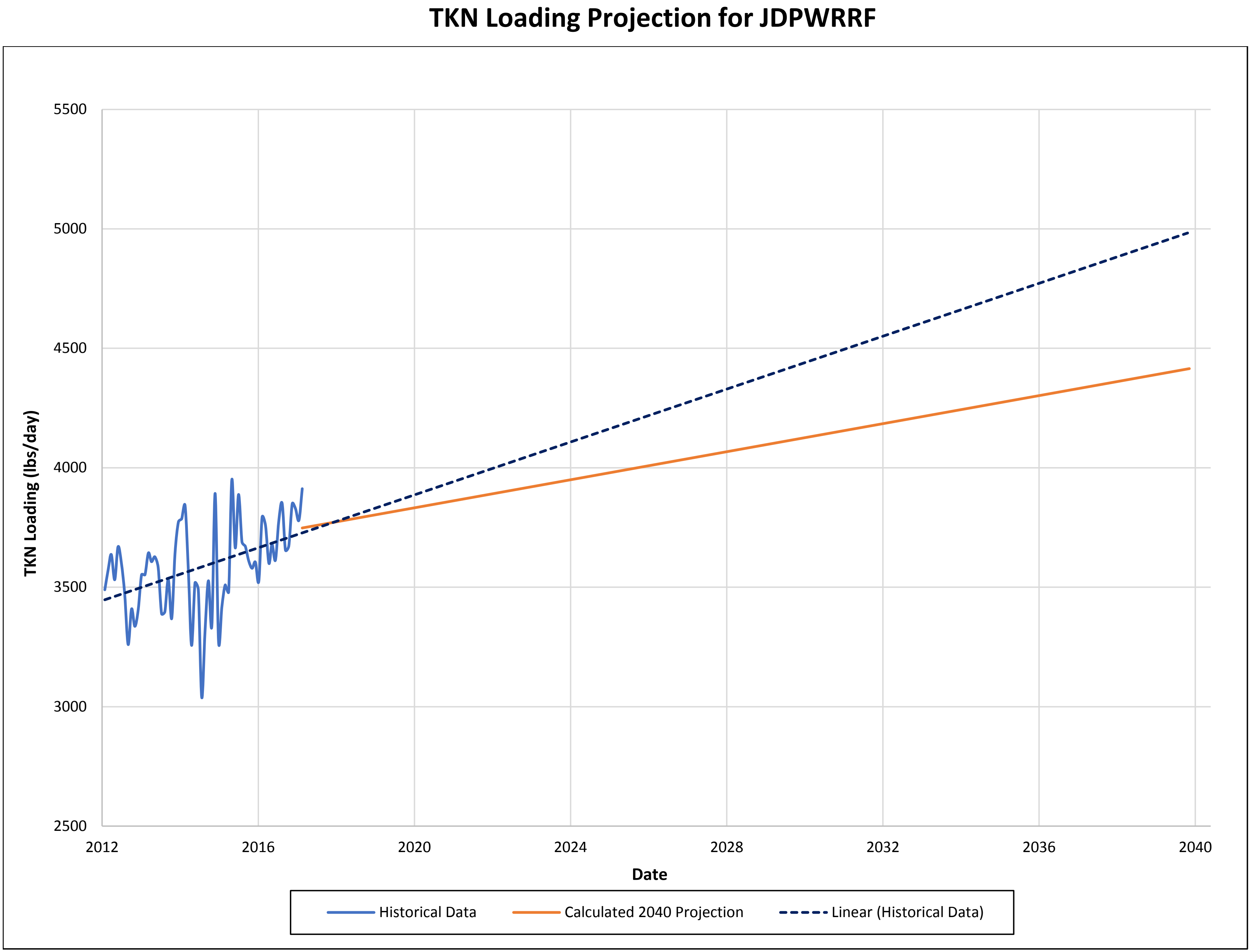



COD Loading vs. Flow at JDPWRRF
COD Loading (lbs/day)
80000
70000
60000
50000
40000
30000
20000
10000
0
Flow (mgd)
10.5
10
9.5
9
8.5
8
7.5
7
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Date
COD Loading
Flow

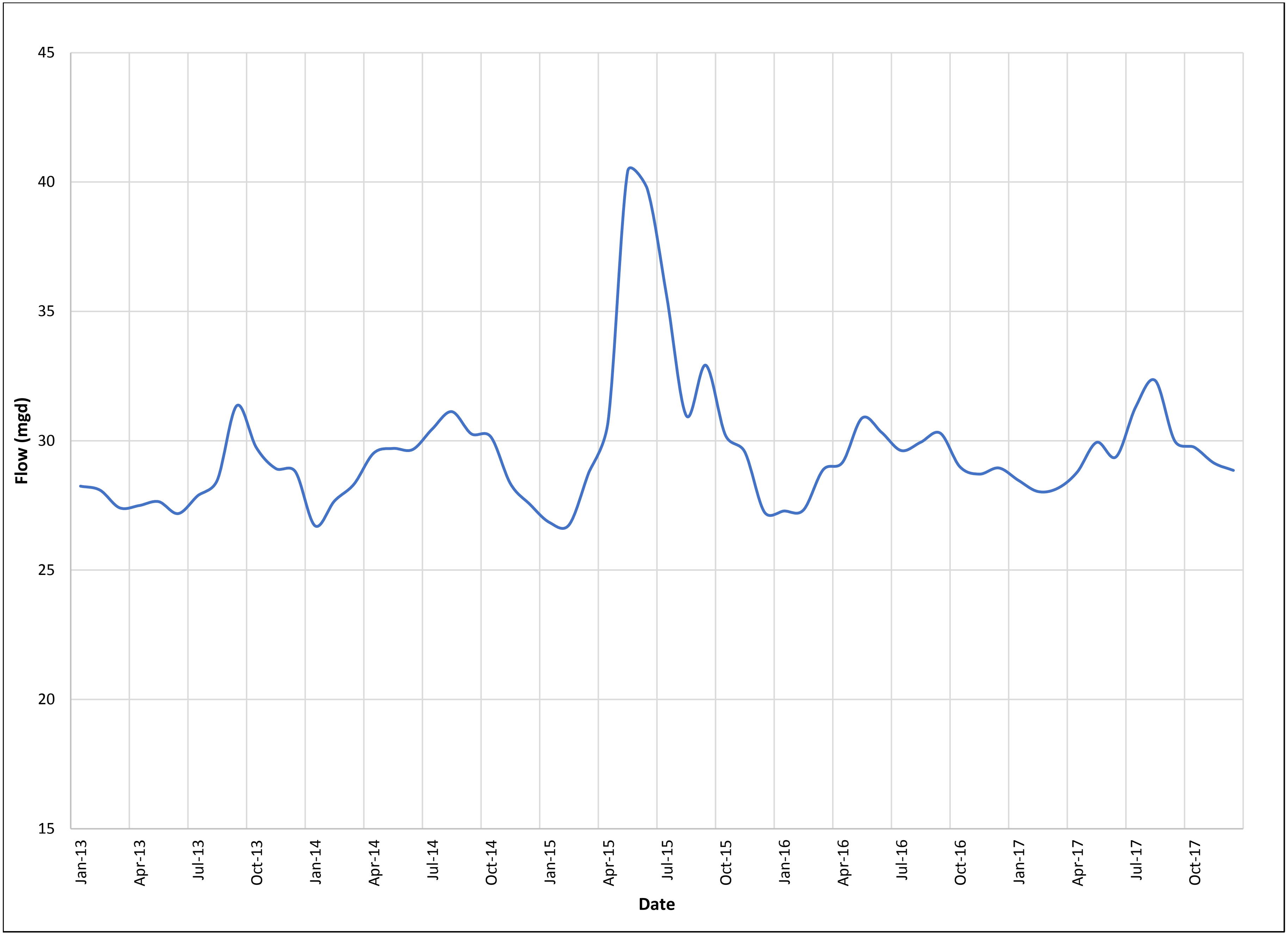

COD Loading Projection for JDPWRRF
90000
80000
70000
60000
50000
40000
30000
COD Loading (lbs/day)
2012
2016
2020
2024
2028
2032
2036
2040
Date
Historical Data
Calculated 2040 Projection
Linear (Historical Data)

TKN Loading vs. Flow at JDPWRRF

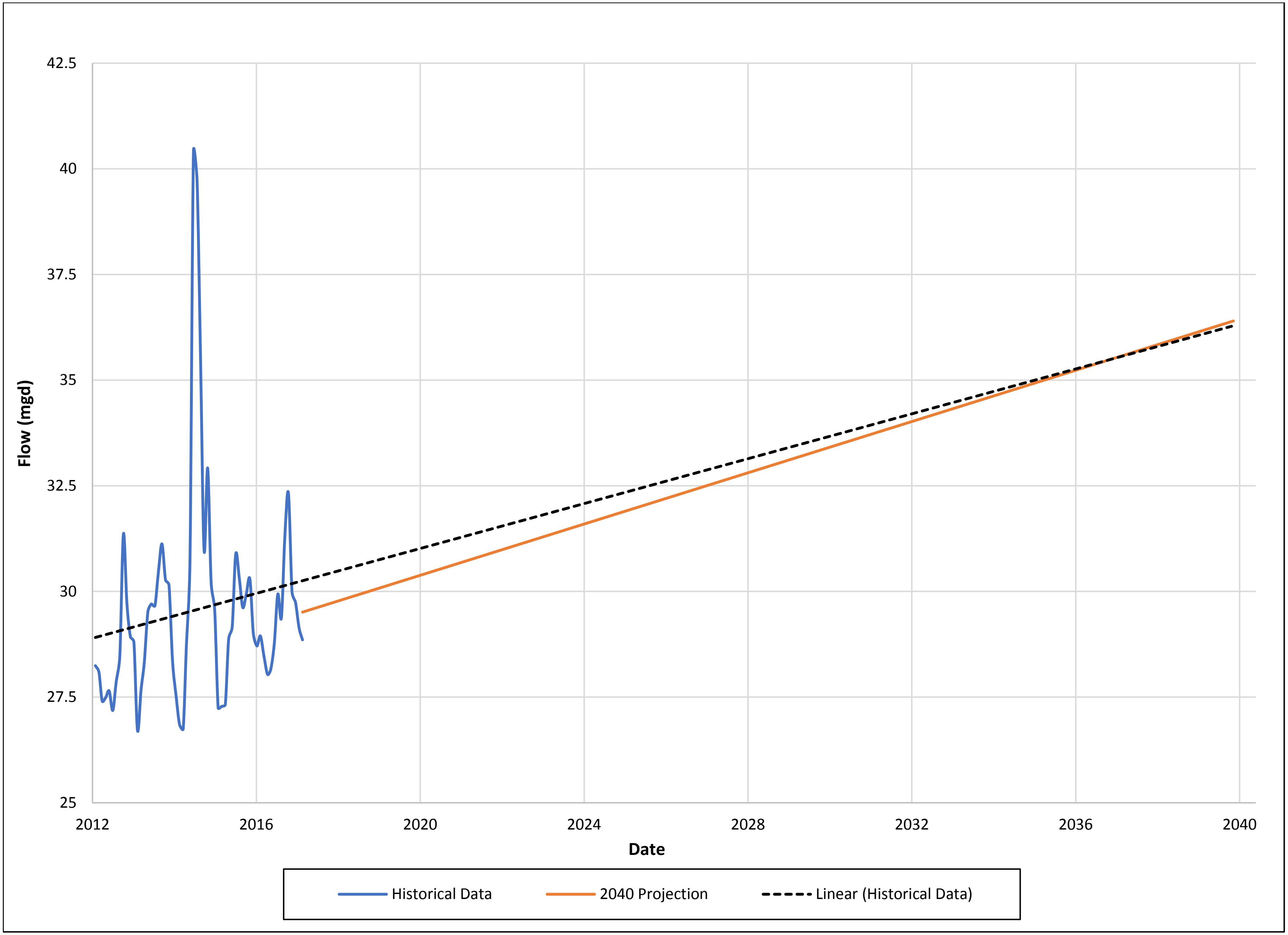



TKN Loading Projection for JDPWRRF
TKN Loading (lbs/day)
5500
5000
4500
4000
3500
3000
2500
2012
2016
2020
2024
2028
2032
2036
2040
Date
Historical Data
Calculated 2040 Projection
Linear (Historical Data)

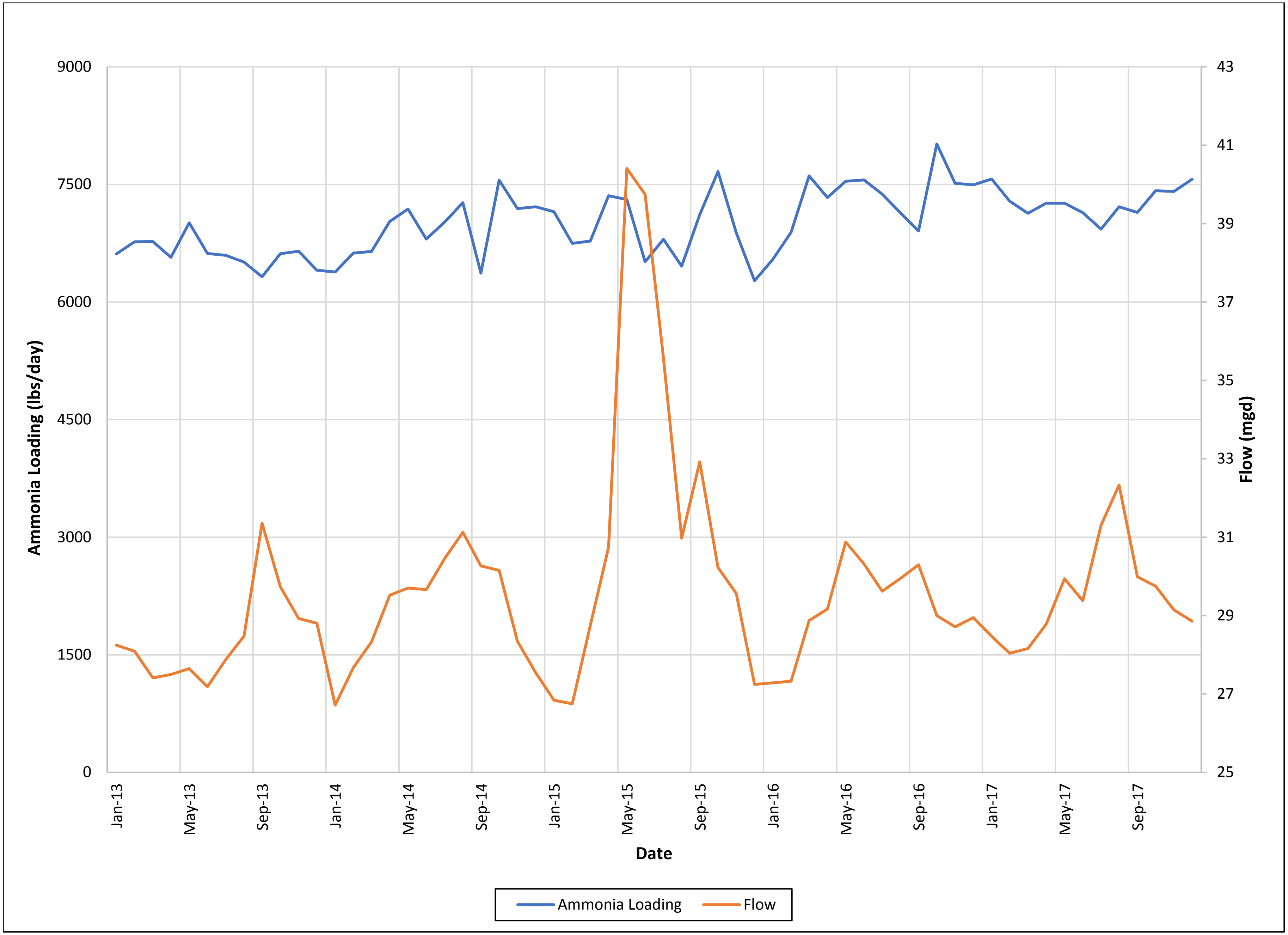
Historical Flow at LVSWRRF



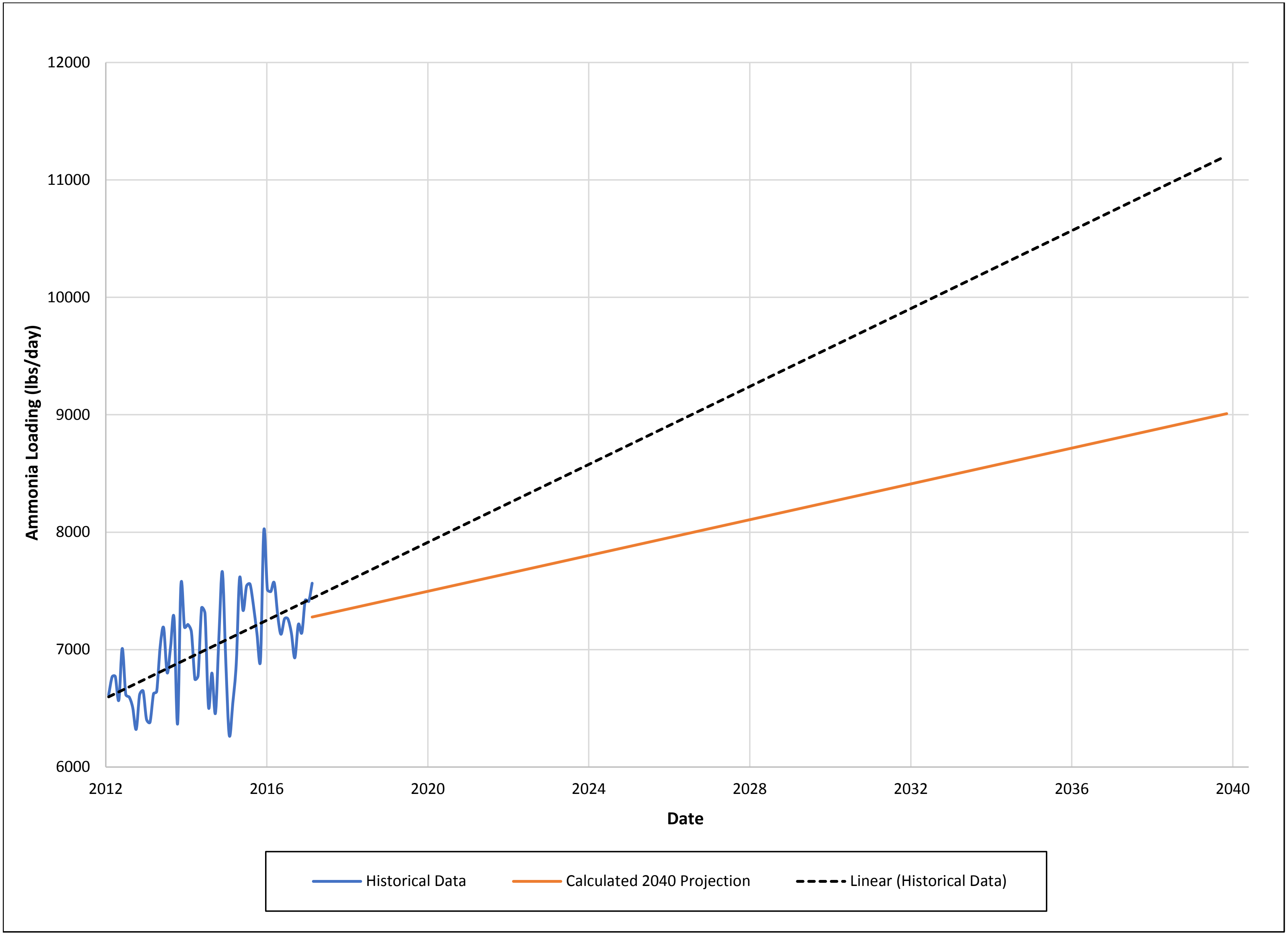
Flow Projection for LVSWRRF

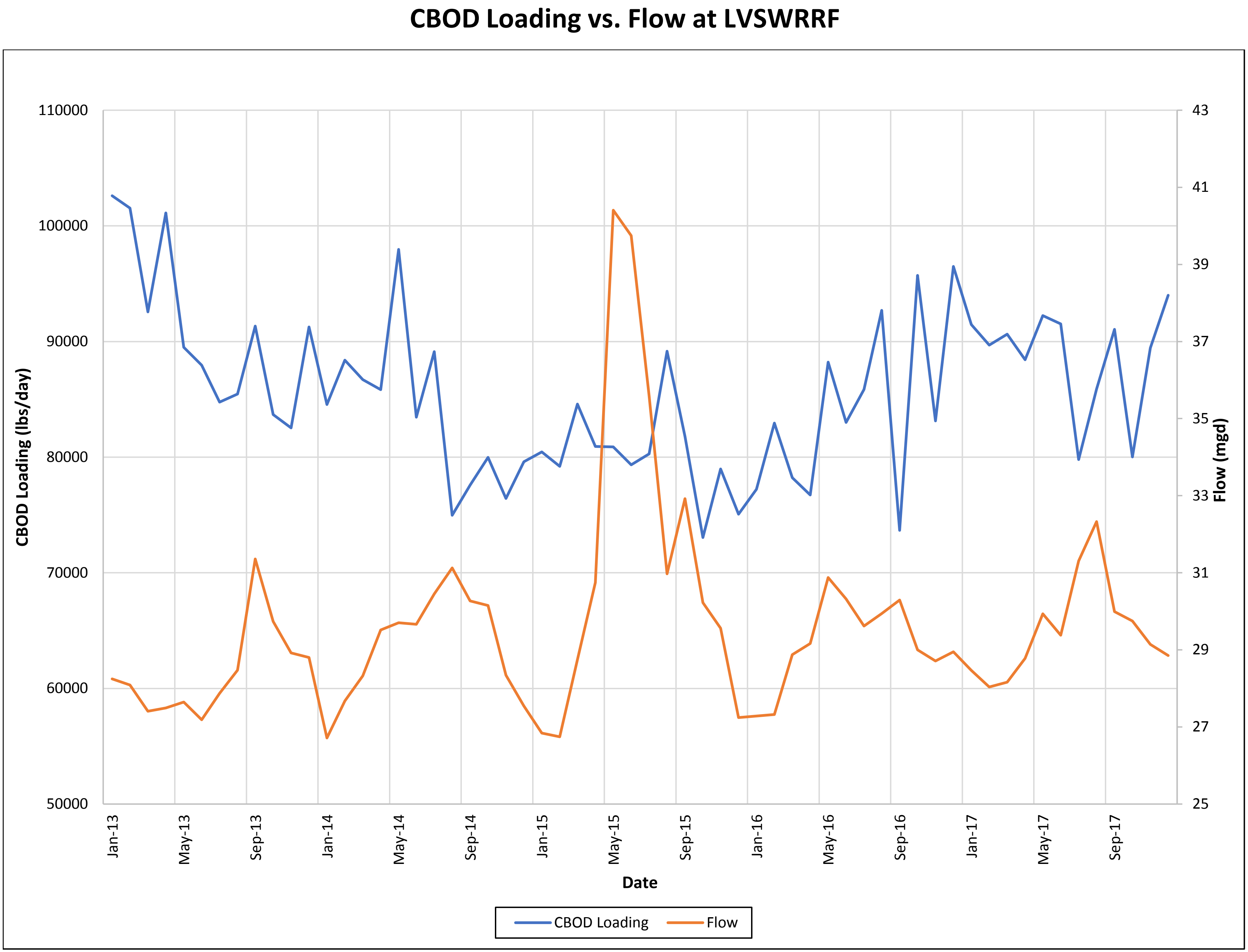


Ammonia Loading vs. Flow at LVSWRRF

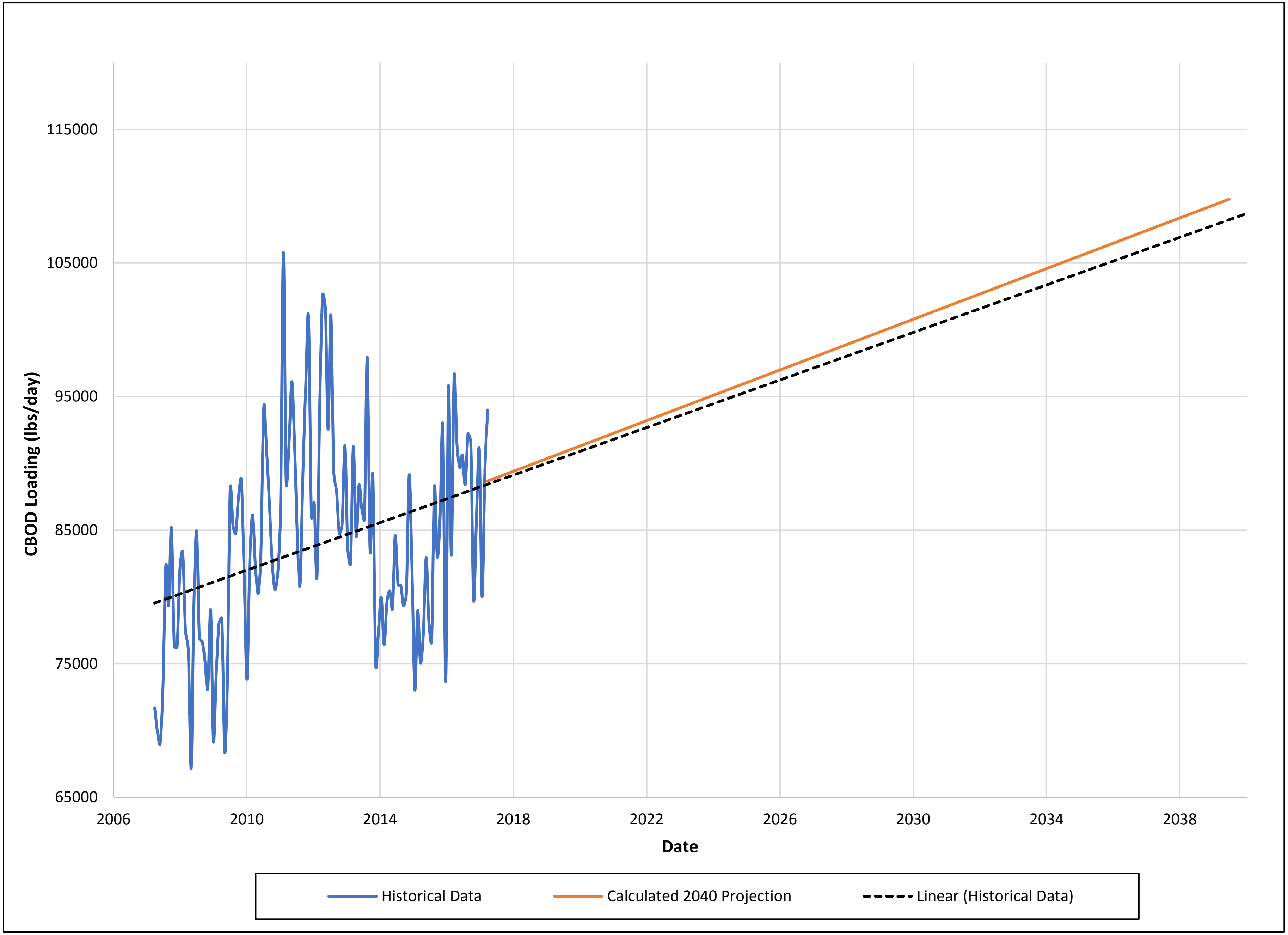


Ammonia Loading Projection for LVSWRRF

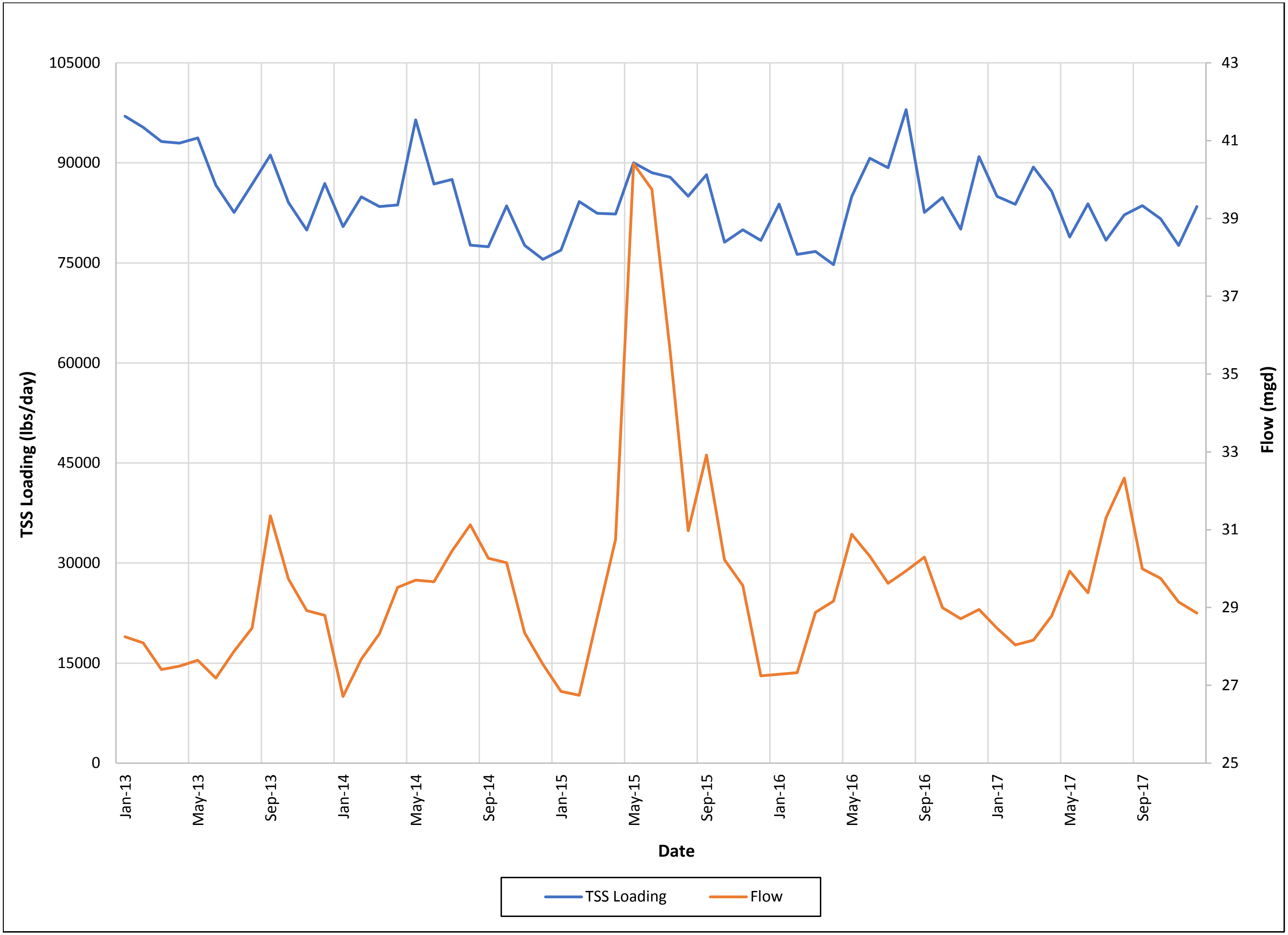



CBOD Loading vs. Flow at LVSWRRF
CBOD Loading (lbs/day)
110000
100000
90000
80000
70000
60000
50000
Flow (mgd)
43
41
39
37
35
33
31
29
27
25
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Date
CBOD Loading
Flow

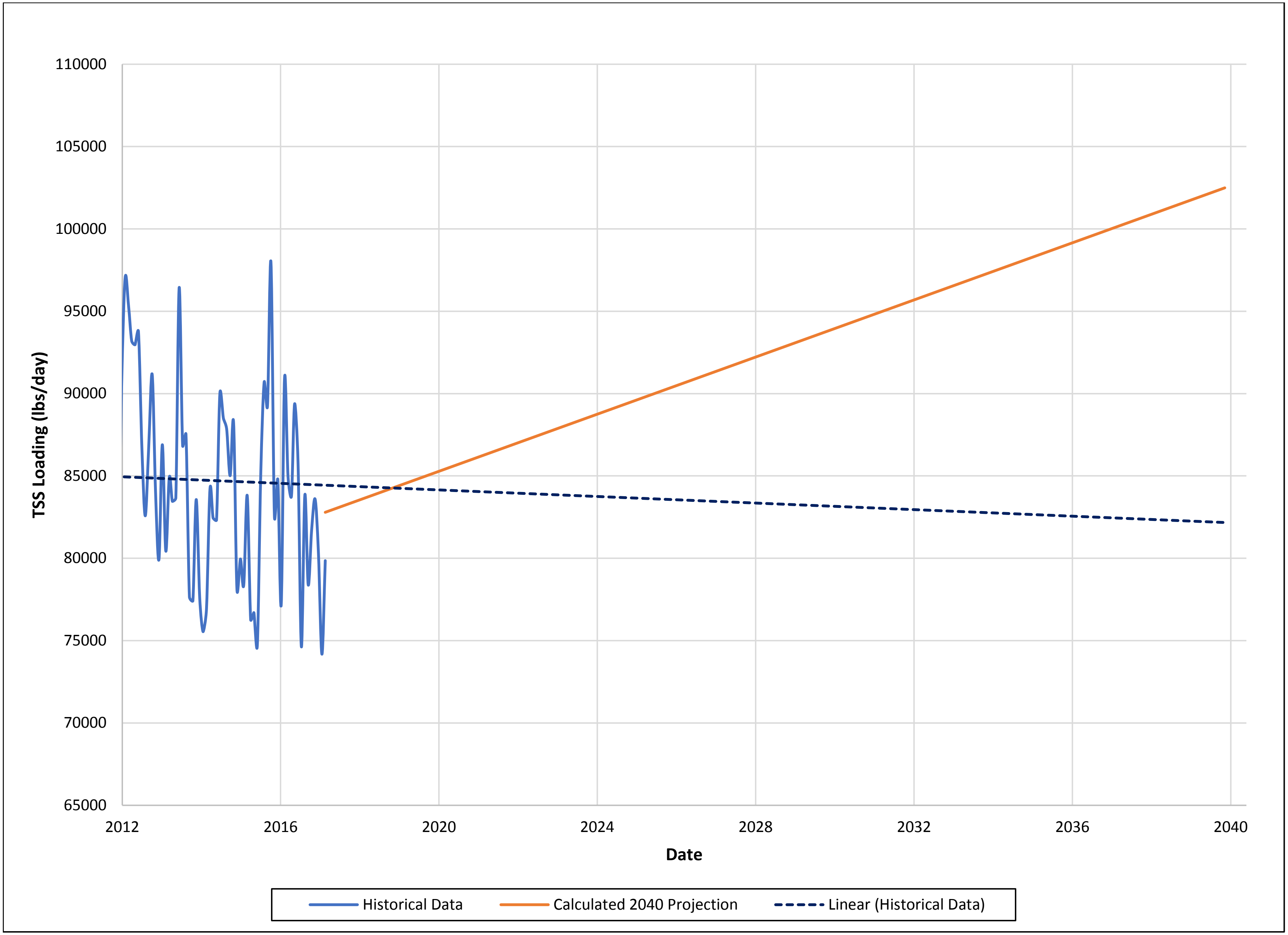
CBOD Loading Projection at LVSWRRF

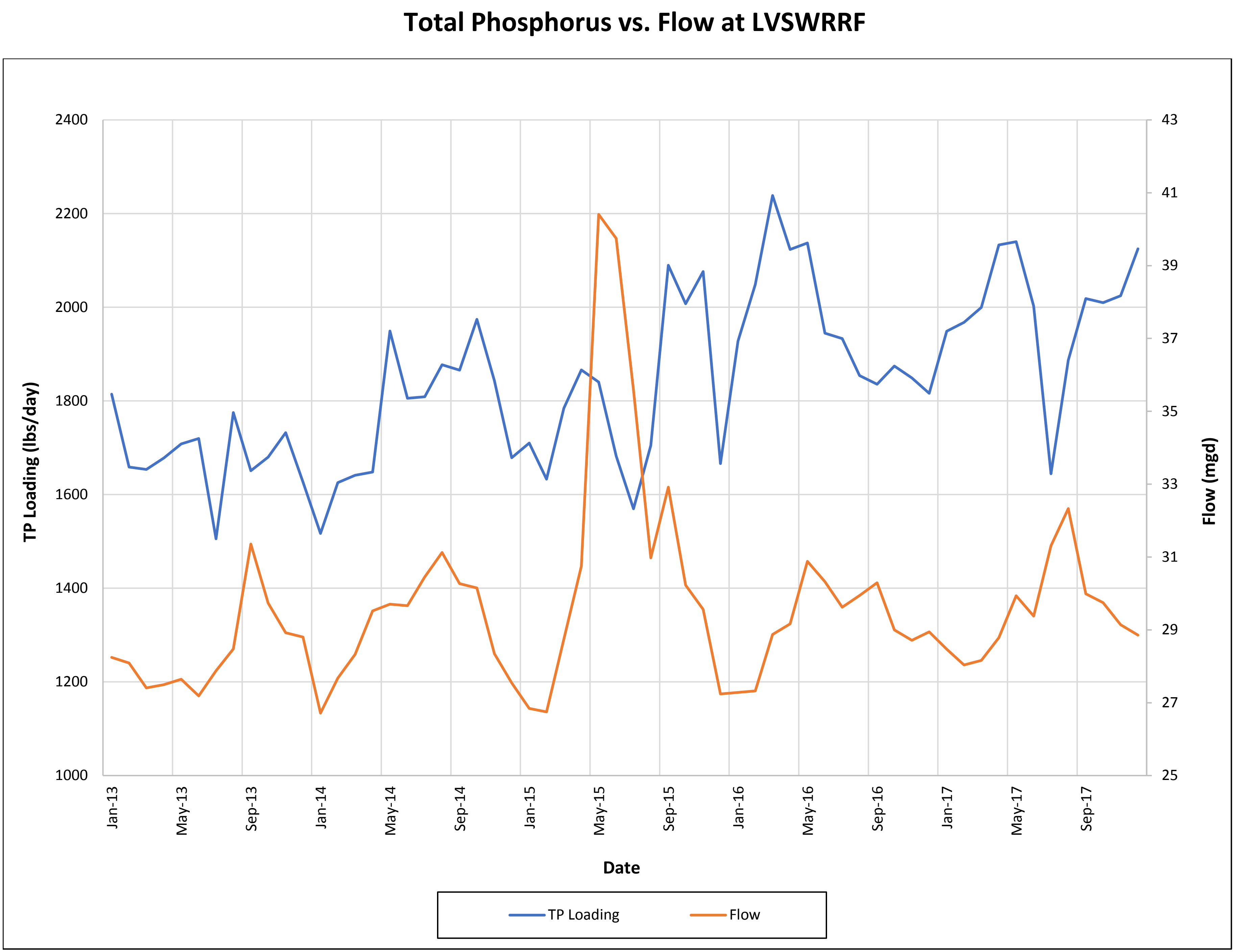


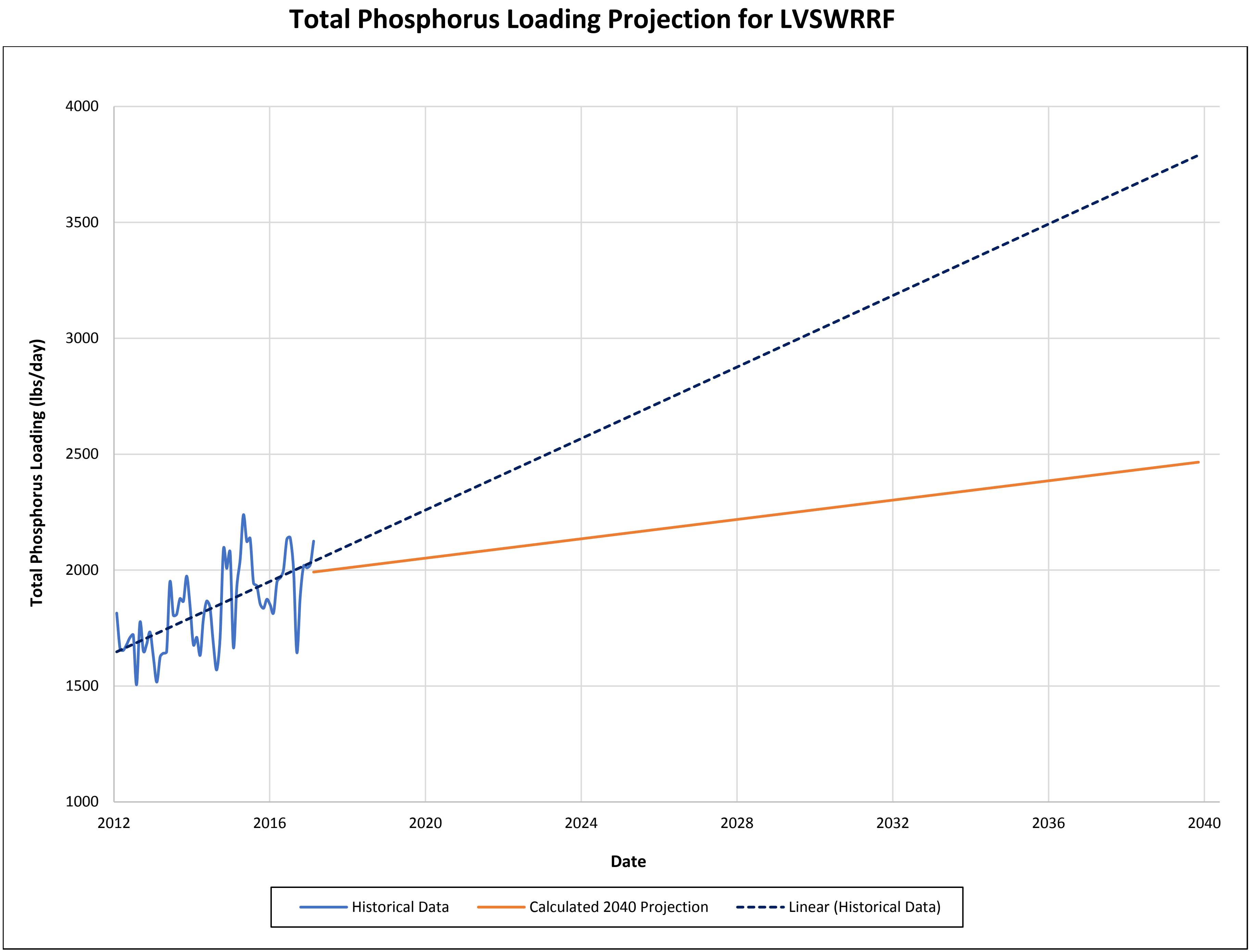
TSS Loading vs. Flow at LVSWRRF

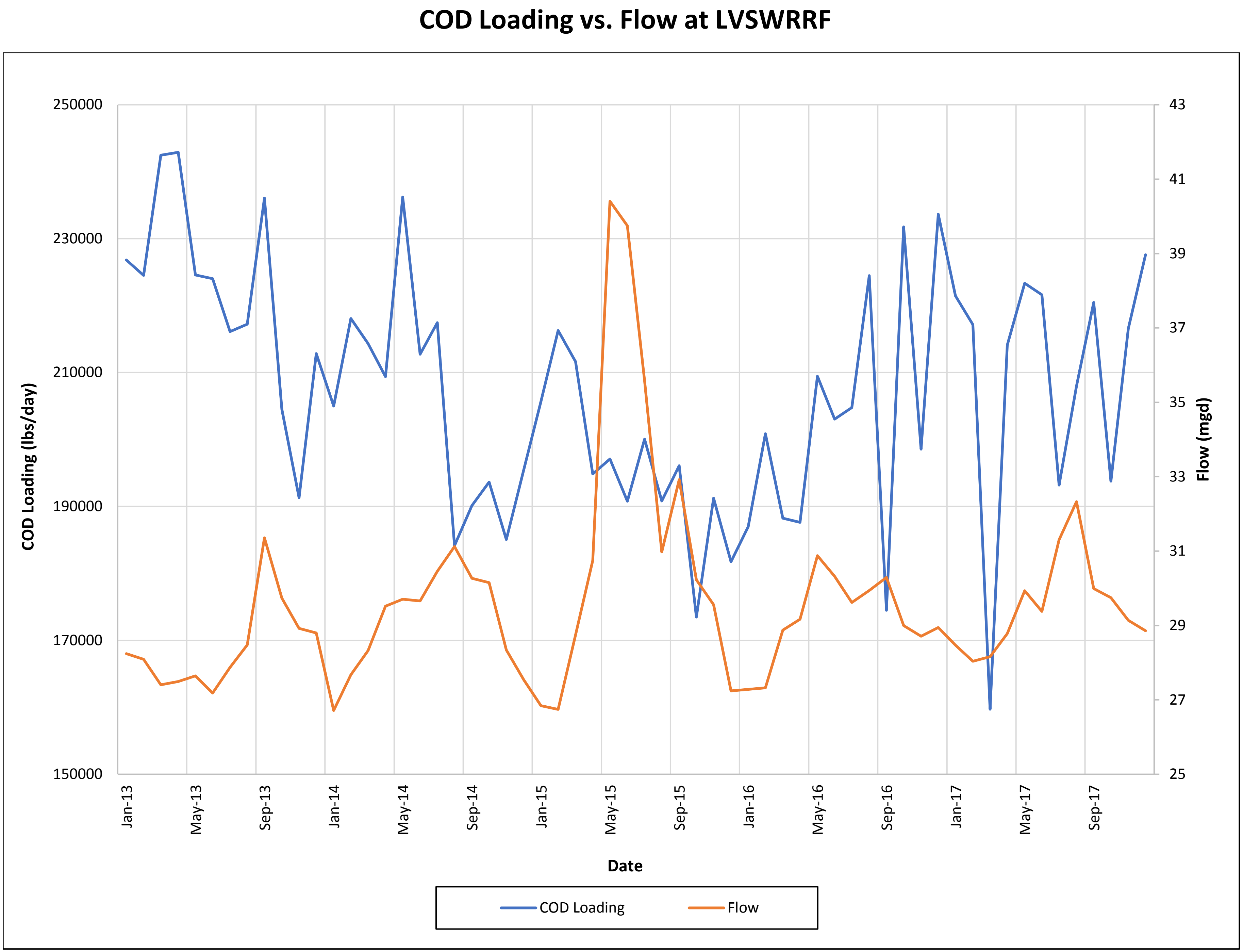


TSS Loading Projection for LVSWRRF

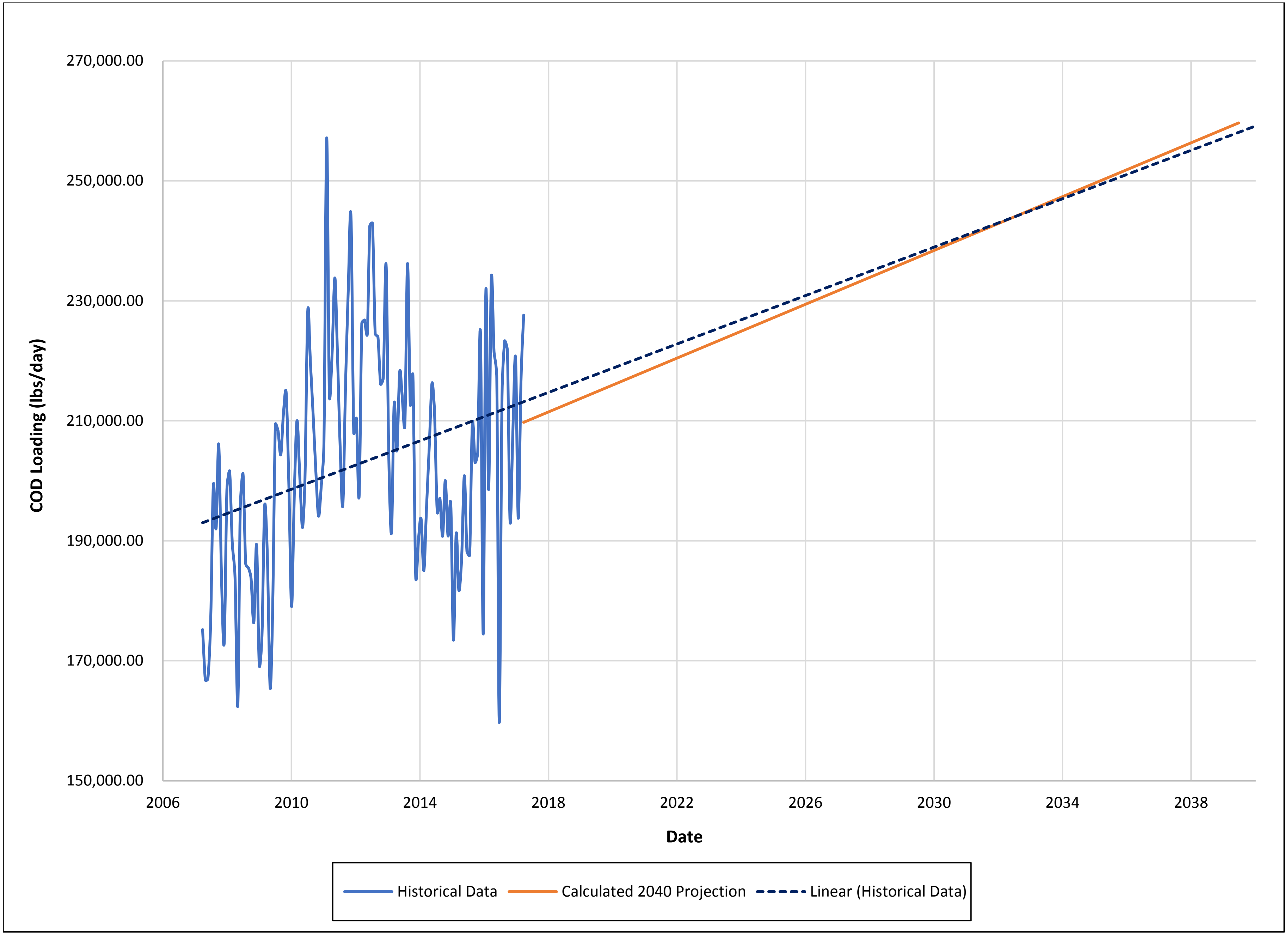


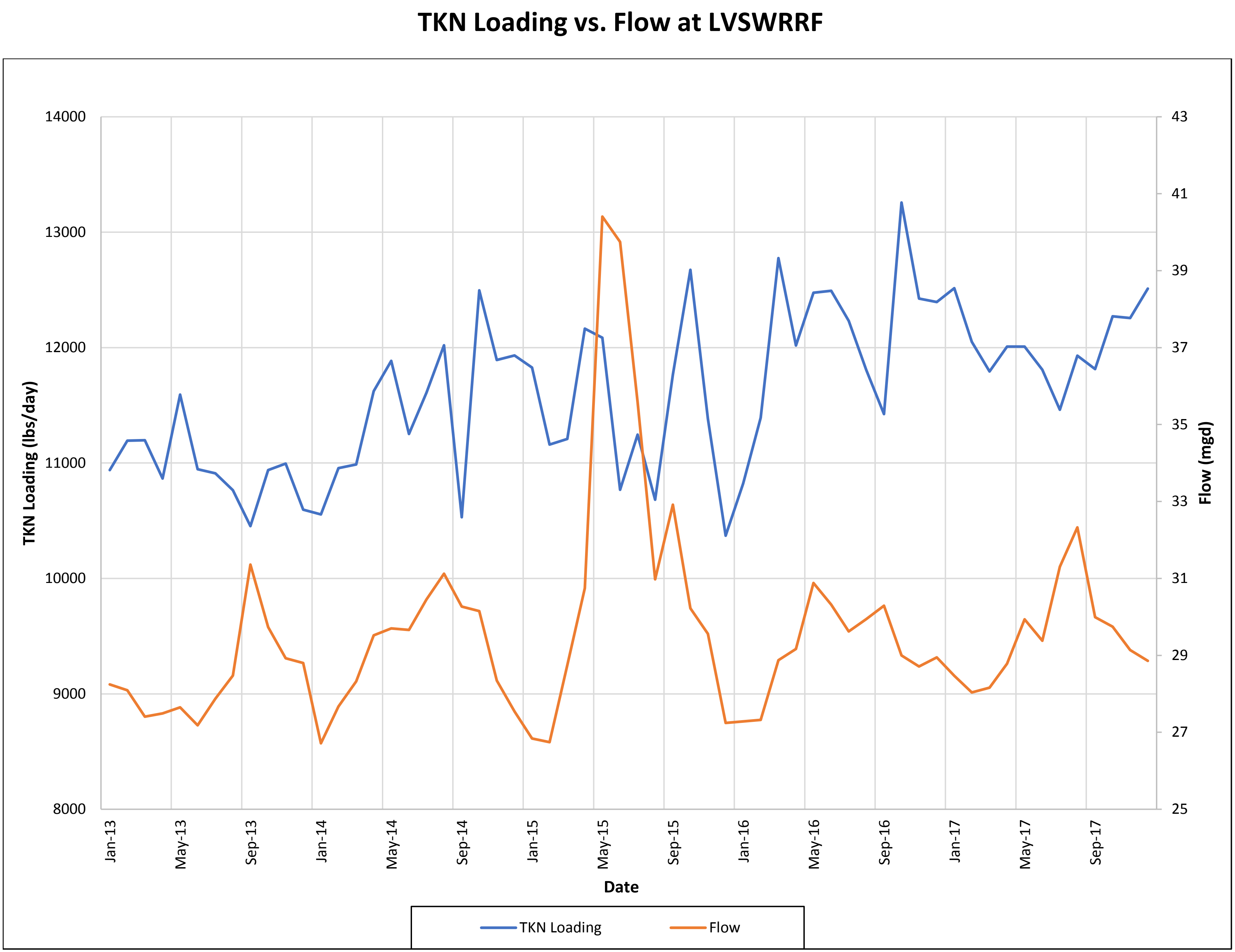

Total Phosphorus vs. Flow at LVSWRRF
TP Loading (lbs/day)
Flow (mgd)
Date
2400
2200
2000
1800
1600
1400
1200
1000
43
41
39
37
35
33
31
29
27
25
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
TP Loading
Flow


Total Phosphorus Loading Projection for LVSWRRF
Total Phosphorus Loading (lbs/day)
4000
3500
3000
2500
2000
1500
1000
2012
2016
2020
2024
2028
2032
2036
2040
Date
Historical Data
Calculated 2040 Projection
Linear (Historical Data)

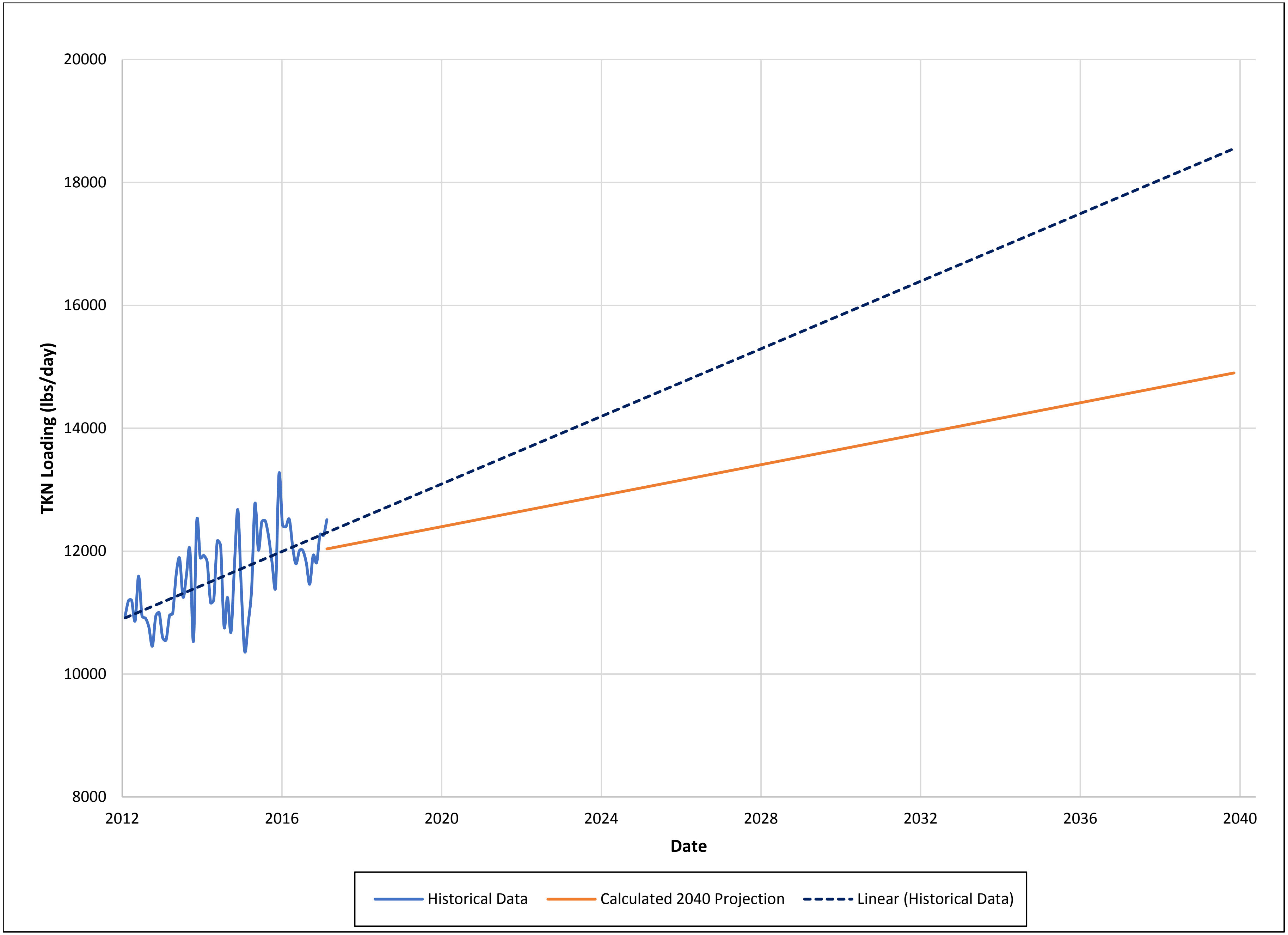

COD Loading vs. Flow at LVSWRRF
250000
230000
210000
190000
170000
150000
43
41
39
37
35
33
31
29
27
25
COD Loading (lbs/day)
Flow (mgd)
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Date
COD Loading
Flow

COD Loading Projections for LVSWRRF

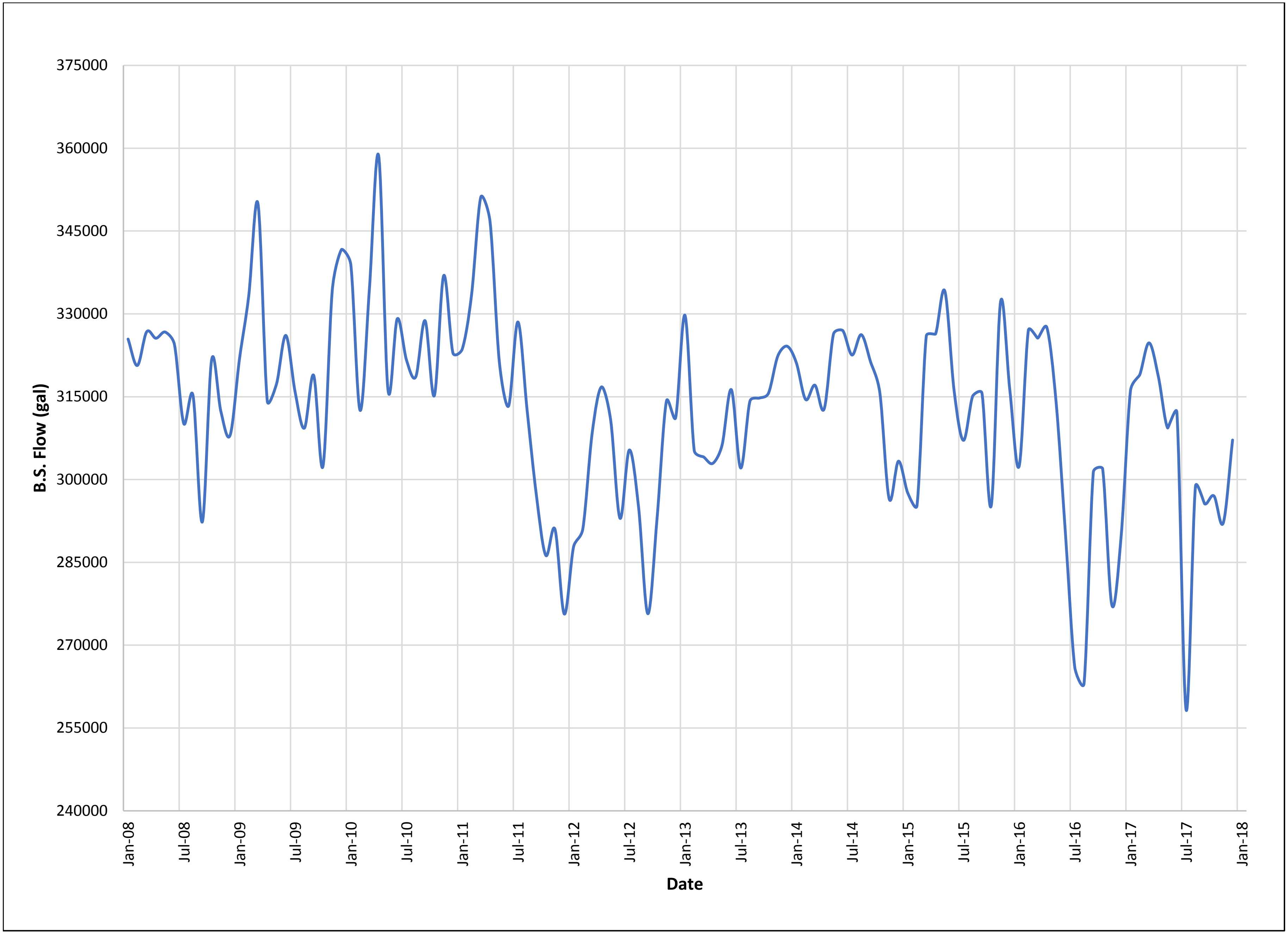



TKN Loading vs. Flow at LVSWRRF
TKN Loading (lbs/day)
14000
13000
12000
11000
10000
9000
8000
Flow (mgd)
43
41
39
37
35
33
31
29
27
25
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Date
TKN Loading
Flow

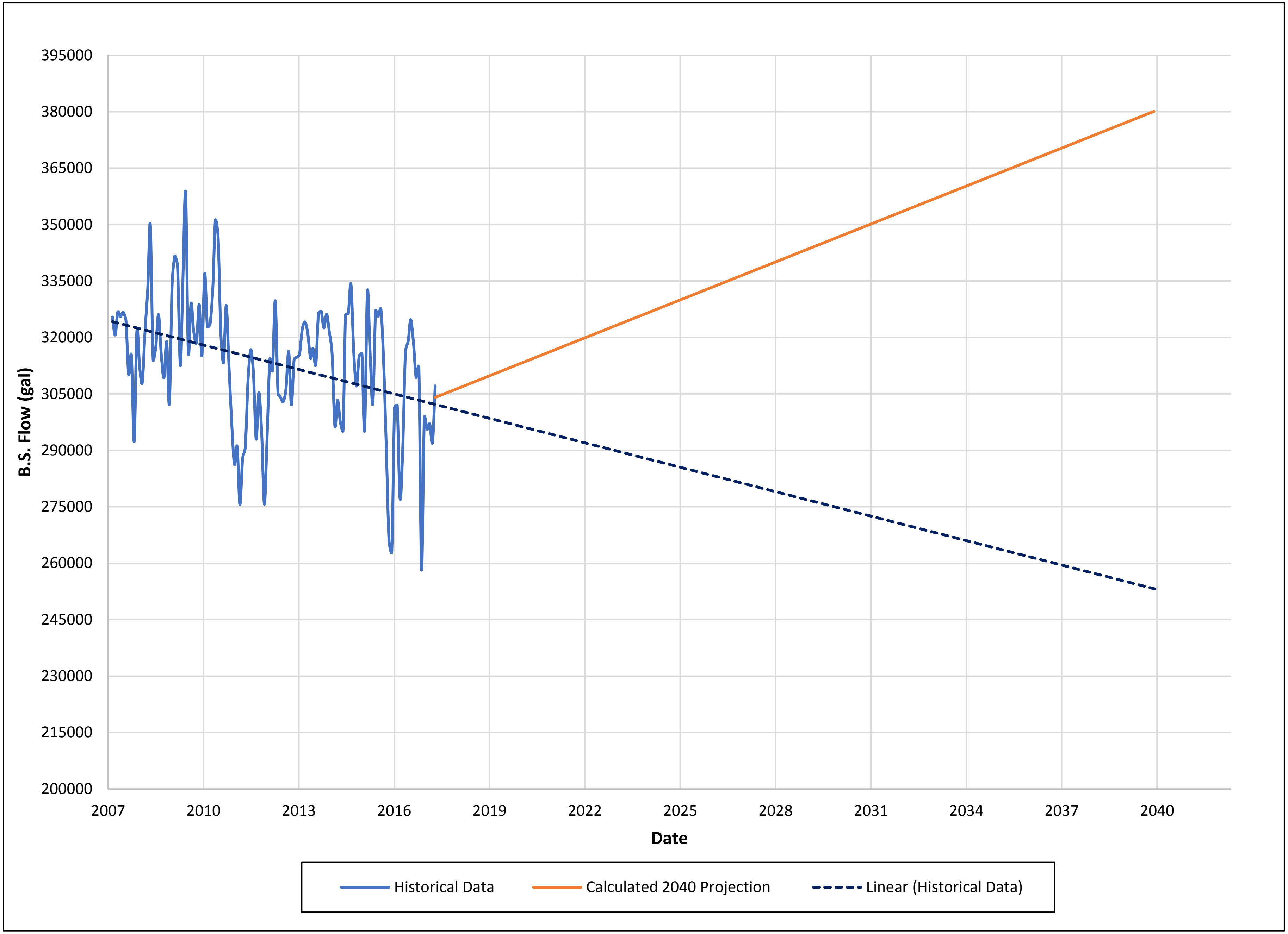
TKN Loading Projections for LVSWRRF



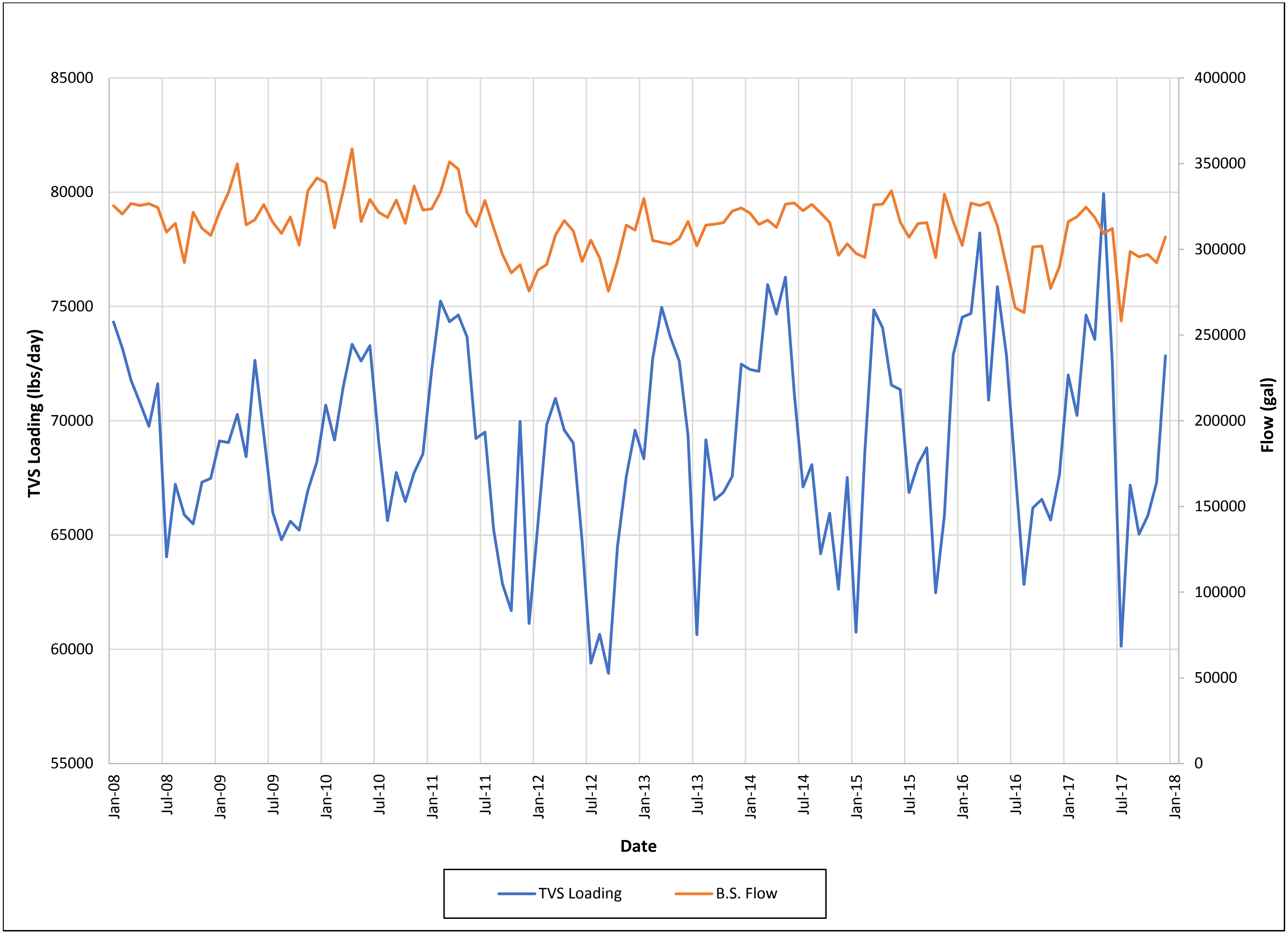
Historical Blended Sludge Flow at CSRRRF



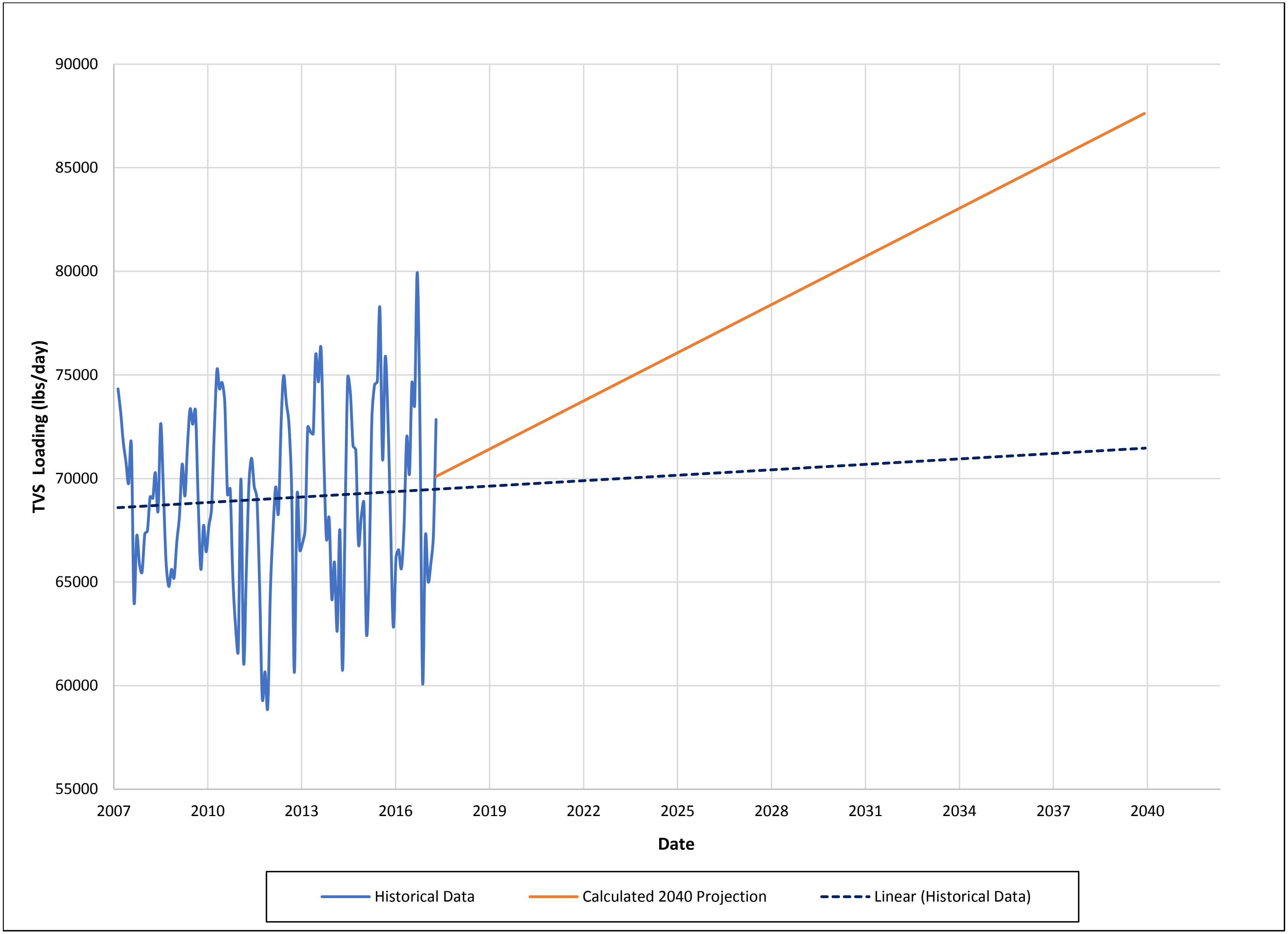
Blended Sludge Flow Projection for CSRRRF



Historical TVS Loading vs. Flow at CSRRRF



TVS Loading Projection for CSRRRF



Chapter 6

Regulatory Requirements

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6 Regulatory Requirements

Regulations can impact current and future system capabilities and require forethought from a system level planning effort to ensure long-term compliance. Violations of regulatory criteria can result in legal actions and/or fines and can damage Utilities' reputation and credibility with customers and the public at large. Levels of regulation that impact Utilities wastewater system include: Federal, State, Local. Additionally, Utilities has established its own performance (level of service) criteria for wastewater system components.

6.1 Existing Regulatory Compliance

6.1.1 Collection System

Under the Federal Water Pollution Control Act, better known as the Clean Water Act, discharge of non-permitted pollutants into waters of the U.S. by owner operators of a municipal wastewater sewer system is prohibited. The State of Colorado promulgated Regulation 61 to establish the Colorado Discharge Permit System (CDPS) to be in conformity with the Colorado Water Quality Control Act, as well as the Federal Clean Water Act. Utilities defines a discharge of wastewater that reaches waters of the U.S. as a release. The following regulations apply to the collection system.

- CDPHE Regulation No. 61 states "No person shall discharge any pollutant into any state water from a point source without first having obtained a permit from the Division for such discharge",
- CDPHE Regulation No. 65 states "No person shall discharge any pollutant from a point source that flows directly into a storm sewer pipe or inlet to such pipe".
- CDPHE Regulation No. 22 requires site applications for construction of domestic wastewater treatment works, including wastewater treatment plants, individual sewage disposal systems, lift (pumping) stations, and certain interceptor sewers with a capacity of 2,000 gallons per day or greater, as well as certain facilities that produce reclaimed domestic wastewater.

In addition to the regulations above, the Compliance on Consent (CoC) decree with the State of Colorado dated 2003 created additional regulatory compliance requirements. Several wastewater Programs were established to address compliance issues from the State. Since the decree, Springs Utilities has spent over $200 million in capital work to rehabilitate the wastewater collection system. The State consent period has ended, but Utilities continues to invest in the wastewater system through programs listed below to help maintain system integrity and uphold agreements from the Stormwater IGA and 1041.

- Sanitary Sewer Creek Crossing Program (SSCC)
- Local Collectors Evaluation and Rehabilitation Program (LCERP)
- Collection System Rehabilitation and Replacement Program (CollSys R&R Program)
- Manhole Evaluation and Rehabilitation Program (MHERP)
- Lift Station Force Main Evaluation and Rehabilitation Program (LSFMERP)

6.1.1.1 Stormwater IGA

The Storm water IGA between Pueblo County, the City of Colorado Springs and Utilities was signed on 4/24/2016 and is scheduled to continue through 12/31/2035. The agreement is closely related to the Pueblo County 1041 permit for Utilities' Southern Delivery System (SDS), wherein the conditions of the permit included storm water improvements in the Fountain Creek Watershed. A combined City and Utilities $460 Million is expected to be spent under the IGA. Utilities' SSCC program commits $3.0 M/YR for the first five years, $3.3 M/YR for second five-year period, $3.6 M/YR for the third five-year period, and $3.9 M/YR for the fourth five-year period for a total of $69.0 Million over 20 years to help fulfill the IGA requirements. The primary mission of the SSCC program is to design and construct stream stabilization measures, such as drop structures, to protect wastewater infrastructure from stream/drainage erosion impacts.

6.1.1.2 1041 Permit

As another condition of the 1041 Permit for the Southern Delivery System, Pueblo County requested a commitment of $75 million in improvements to Utilities' Wastewater System and Reuse Systems to enhance system integrity.

The projects/programs that meet the terms of Condition No. 7 of the SDS Pueblo County 1041 permit are:

1) Local Collectors Evaluation and Rehabilitation Program (LCERP) ~$3.2 Million/year
2) Manhole Evaluation and Rehabilitation Project (MHERP) ~$0.15 Million/year
3) Collection System Rehabilitation and Replacement Project (CollSys R&R) ~$1.2 million/year

Most of the work under the LCERP, MHERP, and CollSys R&R programs include lining existing infrastructure through trenchless technologies like cured-in-place Pipe.

More detailed program information will be developed in Program Plans under the Utilities' Planning Initiative.

6.1.2 J.D. Phillips Water Resource Recovery Facility Permit Limits

The JDPWRRF operates under CDPS Permit No. CO-0046850, which was last renewed on June 1, 2015. The current permit has an expiration date of May 31, 2020, with an application to renew the permit due 180 days prior to expiration. The key permit criteria are listed below in Table 6-1. One notable change in this permit issuance was the addition of Regulation 85 (Reg 85) discharge limits for TIN and TP at the facility, which are listed below in Table 6-2.

Table 6-1 Key Permit Criteria for JDPWRRF

Effluent Parameter	Effluent Limitations Concentrations			Monitoring Requirements	
	30-day Average	7-Day Average	Daily Maximum	Frequency	Sample Type
Flow (MGD)	20	-	Report	Continuous	Recorder
pH (su)			6.5 – 9.0	Daily	Grab
E.coli (#/100 ml)	126	252		2 Days/Week	Grab
TRC (mg/L)	0.012		0.020	5 Days/Week	Grab
Total Ammonia as N (mg/L)					
January	5.0		12	5 Days/Week	Composite
February	5.0		11	5 Days/Week	Composite
March	4.7		12	5 Days/Week	Composite
April	3.3		11	5 Days/Week	Composite
May	3.4		12	5 Days/Week	Composite
June	3.5		15	5 Days/Week	Composite
July	3.4		18	5 Days/Week	Composite
August	2.6		12	5 Days/Week	Composite
September	4.0		16	5 Days/Week	Composite
October	4.3		14	5 Days/Week	Composite
November	5.0		14	5 Days/Week	Composite
December	4.5		12	5 Days/Week	Composite
cBOD5 (mg/L)	25	40		2 Days/Week	Composite
TSS (mg/L)	30	45		2 Days/Week	Composite
Chromium (hex) (dis) (ug/L)	Report		Report	Monthly	Grab
Copper (PD) Through 4/30/2020 (ug/L)	Report		Report	Monthly	Composite
Copper (PD) Beginning 5/1/2020 (ug/L)	16		Report	Monthly	Composite
Cyanide (tot) (ug/L)			Report	Monthly	Grab
Mercury (tot) (ug/L)	Report			Quarterly	Composite

Effluent Parameter	Effluent Limitations Concentrations			Monitoring Requirements	
	30-day Average	7-Day Average	Daily Maximum	Frequency	Sample Type
Zinc (PD) (ug/L)	Report		Report	Monthly	Composite
Nonylphenol (ug/L)	Report		Report	Monthly	Grab

Table 6-2 TIN and TP Permit Criteria for JDPWRRF

Effluent Parameter	Effluent Limitations Concentrations		Monitoring Requirements	
	Running Annual Median	95^{th} Percentile	Frequency	Sample Type
TIN Through 6/30/2020 (mg/L)	Report	Report	Monthly	Composite
TIN Beginning 7/1/2020 (mg/L)	15	20	Monthly	Composite
TP Through 6/30/2020 (mg/L)	Report	Report	Monthly	Composite
TP Beginning 7/1/2020 (mg/L)	1.0	2.5	Monthly	Composite

An additional permit change in the 2015 issuance was inclusion of Whole Effluent Toxicity (WET) criteria. WET measures the effect of a sample on an organism to assess the toxicity of the sample. WET criteria were report only through June 30, 2018, and effective thereafter.

Table 6-3 WET Criteria for JDPWRRF

Effluent Parameter	Effluent Limitations Concentrations	Monitoring Requirements	
	Daily Maximum	Frequency	Sample Type
Static Renewal 7 Day Chronic *Pimephales promelas* Until 6/30/2018	Report NOEC and IC25	Quarterly	3 Composites / Test
Static Renewal 7 Day Chronic *Ceriodaphnia dubia* Until 6/30/2018	Report NOEC and IC25	Quarterly	3 Composites / Test

Static Renewal 7 Day Chronic *Pimephales promelas* Beginning 7/1/2018	NOEC or IC25 ≥ IWC of 93%	Quarterly	3 Composites / Test
Static Renewal 7 Day Chronic *Ceriodaphnia dubia* Beginning 7/1/2018	NOEC or IC25 ≥ IWC of 93%	Quarterly	3 Composites / Test

JDPWRRF has been meeting the effluent criteria required by the permit without violation or fines over the last five years. For many of the major criteria, such as cBOD, TSS, NH_3, the facility often operates well below limits, maintaining a considerable compliance margin.

6.1.3 Las Vegas Street Water Resource Recovery Facility Permit Limits

The LVSWRRF operates under CDPS Permit No. CO-0026735 which was last renewed on June 1, 2015. The current permit has an expiration date of May 31, 2020, with an application to renew the permit due 180 days prior to expiration. The key permit criteria are listed below in Table 6-4. One notable change in this permit issuance was the addition of Reg 85 discharge limits for TIN and TP at the facility, which are listed below in Table 6-5.

Table 6-4 Key Permit Criteria for LVSWRRF

Effluent Parameter	Effluent Limitations Concentrations			Monitoring Requirements	
	30-day Average	7-Day Average	Daily Maximum	Frequency	Sample Type
Flow (MGD)	75	-	Report	Continuous	Recorder
pH (su)			6.5 – 9.0	Daily	Grab
E. coli (#/100 ml)	126	252		2 Days/Week	Grab
TRC (mg/L)	0.012		0.020	5 Days/Week	Grab
Total Ammonia as N (mg/L)					
January	5.3		7.3	2 Days/Week	Composite
February	5.3		9	2 Days/Week	Composite
March	3.6		6	2 Days/Week	Composite
April	4.1		9	2 Days/Week	Composite
May	4.5		10	2 Days/Week	Composite
June	4.8		15	2 Days/Week	Composite
July	4.1		15	2 Days/Week	Composite
August	3.9		15	2 Days/Week	Composite
September	3.2		14	2 Days/Week	Composite

Effluent Parameter	Effluent Limitations Concentrations			Monitoring Requirements	
	30-day Average	7-Day Average	Daily Maximum	Frequency	Sample Type
October	4.6		9	2 Days/Week	Composite
November	4.0		9	2 Days/Week	Composite
December	5.2		8	2 Days/Week	Composite
cBOD5 (mg/L)	25	40		2 Days/Week	Composite
TSS (mg/L)	30	45		2 Days/Week	Composite
Arsenic (TR) (ug/L)	Report		Report	Weekly	Composite
Copper (PD) (ug/L)	Report		Report	Quarterly	Composite
Iron (TR) (ug/L)	Report			Quarterly	Composite
Mercury (tot) (ug/L)	Report			Quarterly	Composite
Selenium (PD) (ug/L)	Report		Report	Quarterly	Composite
Zinc (PD) (ug/L)	Report		Report	Weekly	Composite
Nonylphenol (ug/L)	Report		Report	Quarterly	Grab

Table 6-5 TIN and TP Permit Criteria for LVSWRRF

Effluent Parameter	Effluent Limitations Concentrations		Monitoring Requirements	
	Running Annual Median	95th Percentile	Frequency	Sample Type
TIN Through 6/30/2020 (mg/L)	Report	Report	Monthly	Composite
TIN Beginning 7/1/2020 (mg/L)	15	20	Monthly	Composite
TP Through 6/30/2020 (mg/L)	Report	Report	Monthly	Composite
TP Beginning 7/1/2020 (mg/L)	1.0	2.5	Monthly	Composite

An additional permit change in the 2015 issuance was inclusion of WET criteria. WET criteria were report only through June 30, 2018, and effective thereafter. WET measures the effect of a sample on an organism to assess the toxicity of the sample.

Table 6-6 WET Criteria for LVSWRRF

Effluent Parameter	Effluent Limitations Concentrations	Monitoring Requirements	
	Daily Maximum	Frequency	Sample Type
Static Renewal 7 Day Chronic *Pimephales promelas* Until 6/30/2018	Report NOEC and IC25	Quarterly	3 Composites / Test
Static Renewal 7 Day Chronic *Ceriodaphnia dubia* Until 6/30/2018	Report NOEC and IC25	Quarterly	3 Composites / Test
Static Renewal 7 Day Chronic *Pimephales promelas* Beginning 7/1/2018	NOEC or IC25 ≥ IWC of 85%	Quarterly	3 Composites / Test
Static Renewal 7 Day Chronic *Ceriodaphnia dubia* Beginning 7/1/2018	NOEC or IC25 ≥ IWC of 85%	Quarterly	3 Composites / Test

LVSWRRF has been meeting the effluent criteria required by the permit without violation or fines over the last five years. For many of the major criteria, such as cBOD, TSS, NH_3, the facility often operates well below limits, maintaining a considerable compliance margin.

6.1.4 Clear Spring Ranch Resource Recovery Facility Permit Limits

Biosolids regulations vary depending on the method used for final biosolids disposal. The CSRRRF produces a Class B biosolids product that is sub-surface injected and as such is quite different than land application or other forms of beneficial reuse such as generation of a soil amendment product.

6.1.4.1 Air Quality Requirements

The CSRRRF is categorized as a major stationary source (Potential to Emit > 250 Tons/Year for PM, PM_{10}, SO_2, NOx, CO) when considered with the associated operations at the Nixon Power Plant and Front Range Power Plant. As a result, the CSRRRF operates under a Title V Permit 96OPEP152 issued by the CDPHE Air Pollution Control Division (APCD).

The CSRRRF Title V permit was renewed most recently on April 1, 2013 and has an expiration date of April 1, 2018. A renewal application was submitted to the APCD on March 24, 2017, which met the requirement of being at least twelve months prior to permit expiration. As a result, the permit is administratively extended, pending the APCD issuing a renewed permit at some point in the future.

The emissions units regulated by this permit include the four (4) digester gas boilers, the two (2) digester gas flares, and fugitive particulate matter associated with the sludge handling and disposal operation. In addition, there are certain federal only requirements that apply to the emergency generator. Generally, compliance is demonstrated by fuel tracking, fuel quality demonstrations or restrictions, calculations and recordkeeping.

Some facility projects, typically capital projects, may require air permit modifications or records to be filed if they have the potential to change air emissions. Coordination with Utilities' Environmental Services Department (EVS) is necessary when capital projects with this potential are planned.

6.1.4.2 Federal Biosolids Regulations

40 CFR Part 503 addresses disposal of sewage sludge. The facility formerly operated under its own permit issued by the EPA. This permit was terminated under a directive by EPA in 2015. As a result, the facility is now under 'direct enforceability' by EPA Region 8 (over the State of Colorado) under the 503 Regulation.

6.1.4.3 Class B Requirements

In order for sewage sludge to be surface disposed, it must meet the requirements to be Class B sludge as required by Regulation 503. Several ways of qualifying sludge as Class B are listed in the regulation. CSRRRF produces Class B biosolids by maintaining the anaerobic reactors at 85F for a residence time in excess of 18 days and by achieving a volatile solids reduction in excess of 38%.

6.1.4.4 Vector Attraction Reduction Limitations for Surface Disposal

The vector attraction reduction limitations pertain to the biosolids' contact with potential disease vectors such as mosquitos and flies. For surface disposal of sewage sludge, one out of nine alternatives as prescribed by Regulation 503 must be met to comply with for vector attraction reduction. One of the most common ways to meet compliance for production of Class B biosolids is to have a 38% reduction in volatile solids in the sludge. Utilities practices subsurface injection in addition to the 38% reduction.

6.1.4.5 Pathogens and Fecal Coliforms

The geometric mean of the density of fecal coliform in seven representative samples collected shall be less than either 2,000,000 Most Probable Number (MPN) per gram of total solids (dry weight basis) or 2,000,000 Colony Forming Units per gram of total solids (dry weight basis). Utilities practices anaerobic digestion for the destruction of pathogens and fecal coliform.

6.1.4.6 Metals

Metals in sewage sludge are of concern and the operating permits for biosolids operations address how metals in sewage sludge are to be measured and establishes maximum metals concentrations. The three main metals of concern are arsenic, chromium and nickel. Depending on the distance between the location of final disposal and the property line the concentration of the metals that can be disposed in a particular land disposal unit varies. If the sludge does not meet the requirements for a certain distance it cannot be surface disposed in that location. The requirements for separation distances between the disposal location (DLDs in this instance) and the CSRRRF property line became effective in 2007.

If the distance from the property boundary to the edge of the closest sludge disposal site is 150 meters (492.1 ft) or greater, then the metal concentrations have a daily maximum concentration that cannot be exceeded as listed below.

Table 6-7 Maximum Concentration of Metals

Pollutant	Daily Maximum Conc. (mg/Kg)
Total Arsenic	73
Total Chromium	600
Total Nickel	420

Table 6-7 presents the maximum allowable concentrations of metals when the distance between the DLDs and the property line is less than 150 meters (492.1 feet).

Table 6-8 Maximum Conc. Of Metals when DLDs < 150 Meters

Distance from Unit Boundary to Property Line (meters)	Pollutant Concentration on Dry-weight Basis		
	Arsenic (mg/Kg)	*Chromium (mg/Kg)*	*Nickel (mg/Kg)*
0 to less than 25	30	200	210
25 to less than 50	34	220	240
50 to less than 75	39	260	270
75 to less than 100	46	300	320
100 to less than 125	53	360	390
125 to less than 150	62	450	420

In compliance with 40 CFR Part 503, the facility is required to monitor the sludge for arsenic, chromium, and nickel. The frequency of testing depends on the quantity of sludge the facility is producing. Based Utilities annual sludge production of approximately 13,370 dry metric tons, Utilities is required to monitor at least six times per year but monitors monthly when actively disposing of biosolids.

Table 6-9 Monitoring Requirements (Frequency)

Amount of sludge (dry metric tons) per Year	Frequency of Monitoring per Year
Less than 290	1
Less than 1,500	4
Less than 15,000	6
Greater than 15,000	12

6.1.4.7 State and Local Regulations

6.1.4.7.1 Groundwater

CSRRRF is subject to groundwater monitoring regulations issued by the CDPHE. Groundwater monitoring plans are reviewed and approved by the CDPHE. Utilities' EVS collects upgradient and downgradient well samples quarterly. A statistical software program is used to analyze the data to determine if the downgradient concentrations are higher than upgradient concentrations at a statistically significant level. CSRRRF has operated in compliance with the groundwater monitoring regulations.

Two years ago, the CDPHE requested a change in the statistical method used to compare upgradient and downgradient concentration. The statistical method requested by the CDPHE has reduced the margin of compliance for nitrates in groundwater at the facility and is being monitored closely. Over time, nitrate compliance could drive changes in disposal operations and/or result in additional treatment requirements.

6.1.4.7.2 Impoundments

Mid 2008, CPDHE proposed to update the regulations for solid waste impoundments. The new requirements for impoundments will have impacts on solid waste facilities.

For now, facilities are submitting data to the CDPHE on their impoundments. This information includes impoundment construction information, geological information, and characterization data of the waste held in the impoundments.

The full impact of the updated regulation is not known at this time. Additional groundwater monitoring wells may need to be installed and analyzed on a quarterly basis once the regulations have been updated.

6.1.4.7.3 Financial Assurance

Every five years financial assurance documents have to be updated and submitted to the CPDHE. The financial assurance process ensures that the operator of a solid waste facility has the financial means to close the facility at the end of active operations. A closure plan is submitted along with cost estimates for closure activities. Utilities and the City of Colorado Springs submit a combined financial assurance document for all solid waste facilities operated by Utilities and the City. The basic objective behind this requirement is to show that Utilities and the City have the financial means to close their facilities by demonstrating that the total closure costs are a small percentage of the annual revenue stream of Utilities and the City. Annual updates applying inflation to the closure costs are submitted to the State with the continued demonstration that the closure costs are a small percentage of total revenue.

6.2 Upcoming Regulation Compliance

One of the biggest regulatory changes that is anticipated in the upcoming years is Regulation 31.17 (Revisions to Basic Standards and Methodologies for Surface Waters to include interim numerical values for phosphorus, nitrogen, and chlorophyll a for rivers, stream, lakes and reservoirs) that includes numeric stream standards for nutrients. Even though the stream standards do not always equate to the effluent limits in the permits, they will likely result in lower nutrient limits for effluent discharge from publicly owned treatment works (POTWs). The previously proposed nutrient limits for N and P in Reg 31.17 were 2.01 mg/L expressed as total nitrogen (TN) and 0.17 mg/L expressed as total phosphorous (TP). Although these Reg 31.17 limits were ultimately not approved by the U.S. EPA, they still likely provide the best indication of future potential limits. These low limits might exceed those as achievable by current limits of technology (LOT). A 2010 study completed by MWH (now Stantec) identified five levels of nutrient removal options and corresponding treatment technologies and associated costs. Based on that preliminary study, Utilities should be able to meet the proposed Reg 31.17 nutrient standards with available technology; however, the process improvements at both JDPWRRF and LVSWRRF are expected to be extremely costly if only current technologies are utilized.

Another concern besides the high costs of nutrient removal are the dissolved organic nitrogen (DON) and dissolved organic phosphorous (DOP) in Colorado POTW effluents which historically tend to be in high concentrations along the Front Range. The table below shows a summary of DON and DOP values at Utilities' two facilities.

Table 6-10 DON and DOP Values at JDPWRRF and LVSWRRF

	JDPWRRF Conc. (mg/L)	LVSWRRF Conc. (mg/L)
Influent		
DON (min)	2.45	4.75
DON (max)	22.8	22.8
DON (avg)	13.2	13.7
DOP (min)	0.34	0.35
DOP (max)	0.68	0.63
DOP (avg)	0.50	0.5
Effluent		
DON (min)	1.13	1.03
DON (max)	2.00	2.40
DON (avg)	1.71	1.66

DOP (min)	0.08	0.07
DOP (max)	0.17	0.31
DOP (avg)	0.11	0.20

As seen from the table above, it could be a challenge to meet the proposed low limits of 2.01 mg/L for TN and 0.17 mg/L for TP when the current averages for effluent DON and DOP are about 1.71 mg/L and 0.11 mg/L and 1.66 mg/L and 0.2 mg/L at JDPWRRF and LVSWRRF respectively. The currently available technologies to remove DON and DOP are membrane ultrafiltration and/or reverse osmosis processes. Though the technology exists, and the proposed limits can be met at a high cost, it may be worthwhile to consider direct or indirect potable water reuse at that point due to the level of treatment and associated costs required to achieve these stringent nutrient limits. A detailed evaluation is recommended once the limits under Reg 31.17 are finalized after the rulemaking process is completed around 2027. Once the final effluent limits are established, it is recommended to initiate a SAA to evaluate alternatives for level of treatment, technology and reuse alternatives to determine an overall best value approach for compliance and water resource supply.

6.2.1 Voluntary Incentive Program (VIP)

Another regulatory program that is available for both JDPWRRF and LVSWRRF is the Voluntary Incentive Program (VIP) for nutrient removal. This is an incentive-based program developed by CDPHE that allows WRRFs to earn credits (in the form of delayed implementation or longer compliance schedules) to meet Reg 31.17 limits when they go into effect.

If a facility chooses to participate in the VIP program, they can earn up to 10 years of delayed compliance for N or P removal under Reg 31.17 or for both parameters as per the following schedule.

Table 6-11 Accumulation of Incentive Months

TP (annual median mg/L)	≥1	≤0.7
Months earned	0	12
TIN (annual median mg/L)	≥15	≤7
Months earned	0	12

For example, if a facility's TP effluent concentration is 0.85 mg/L (annual median), it can earn up to six months of credits for P. At the same time, if the facility's effluent TIN concentration is 9 mg/L, it can earn up to nine months of credit for N. The program follows a linear scale between the upper and lower threshold values for N and P as indicated in the table above. The months of incentive credit from each year will be summed at the end of the 10-year period and rounded down to the next whole month to calculate the total credits earned. There is a maximum cap of 10 years that can be earned via this program. These earned credits are purely performance based and are in addition to the compliance schedule that the facility would have otherwise received if they had not participated in the VIP (typically five years). The purpose of the program is to encourage performance beyond what is currently required by Reg 85 limits, through incentives.

LVSWRRF has recently undergone modifications to its secondary treatment process, by upgrading the MLE process to an A2O process which will help it reliably meet both N and P limits under Reg 85.

The graphs below show the performance of LVSWRRF TP and TIN removal over the last four years (prior to the secondary process modifications). These are rolling annual average medians over a 12-month period. As can be seen from the graphs, LVSWRRF can partially remove N and P beyond what is required by Reg 85 limits. The facility is currently able to remove TIN to about 8 to 10 mg/L consistently and reliably. For TP, the facility can remove TP to as low as 0.4 mg/L. The historical rolling average exceeded the TP limit in 2015 because of wet weather impacts due to exceptional precipitation events. Once the full-scale modifications are complete, plant operations will focus on getting TIN and TP as close to 7 mg/L and 0.7 mg/L respectively to earn the maximum allowable credits under the VIP program.

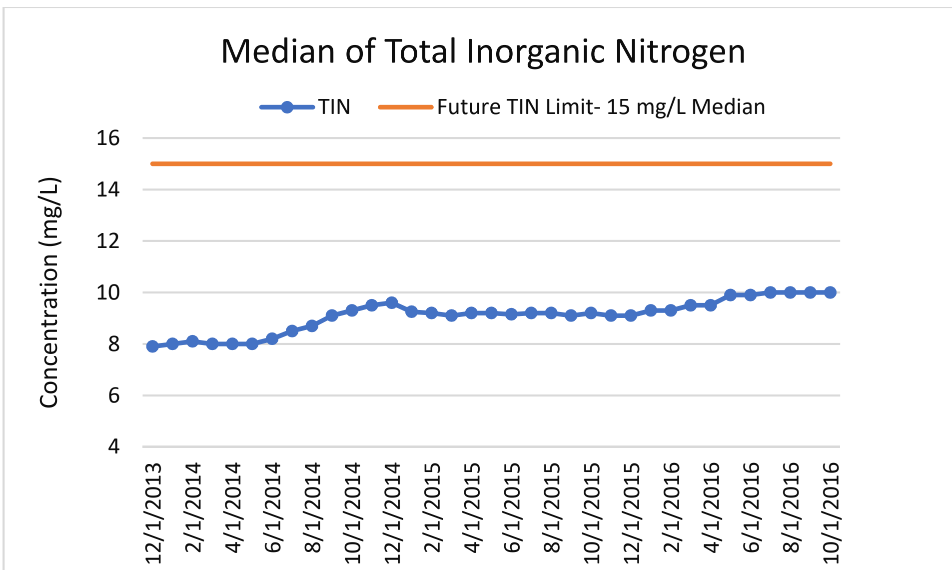

Figure 6-1 LVSWRRF Median Total Inorganic Nitrogen Values

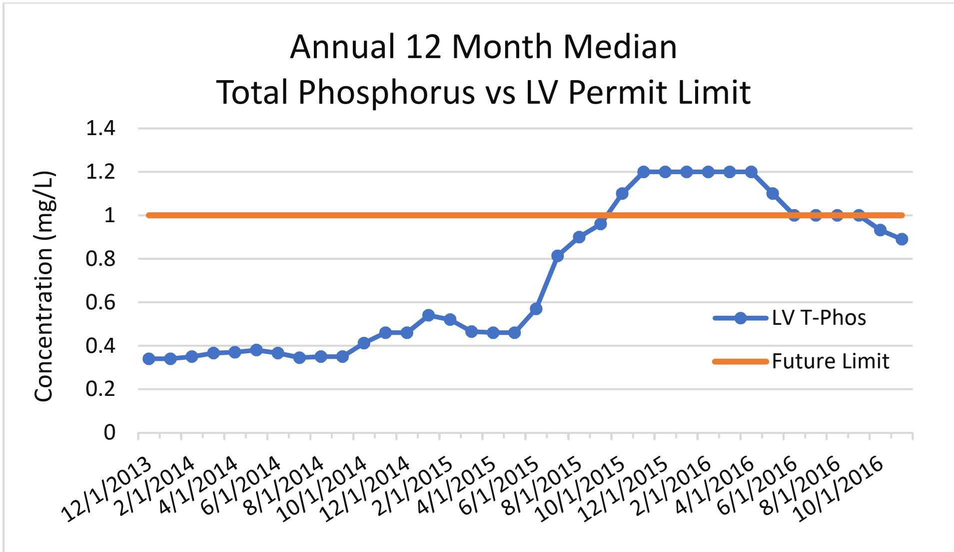

Figure 6-2 Historical 12-Month Rolling Annual Median Total Phosphorus vs Future LVSWRRF Permit Limits

Figure 6-3 JDPWRRF Total Inorganic Nitrogen Values (Individual Data Points)

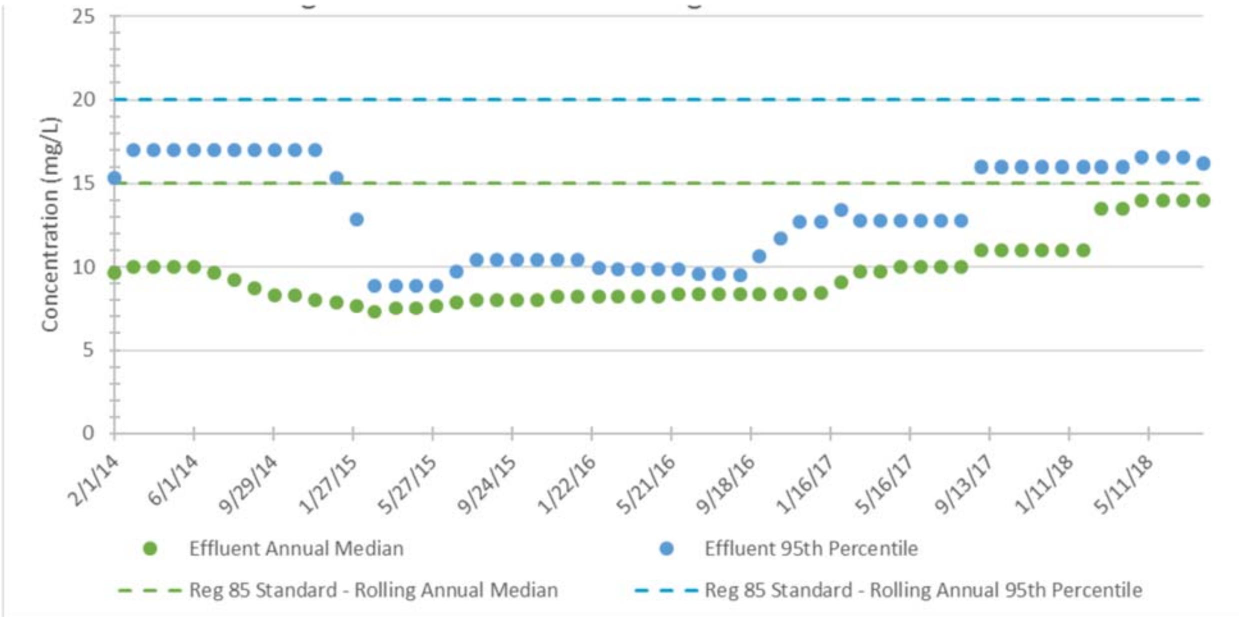

Figure 6-4 JDPWRRF 12-Month Rolling Annual Total Inorganic Nitrogen (Median and 95th Percentile)

Figure 6-5 LVSWRRF Total Inorganic Nitrogen Values (Individual Data Points)

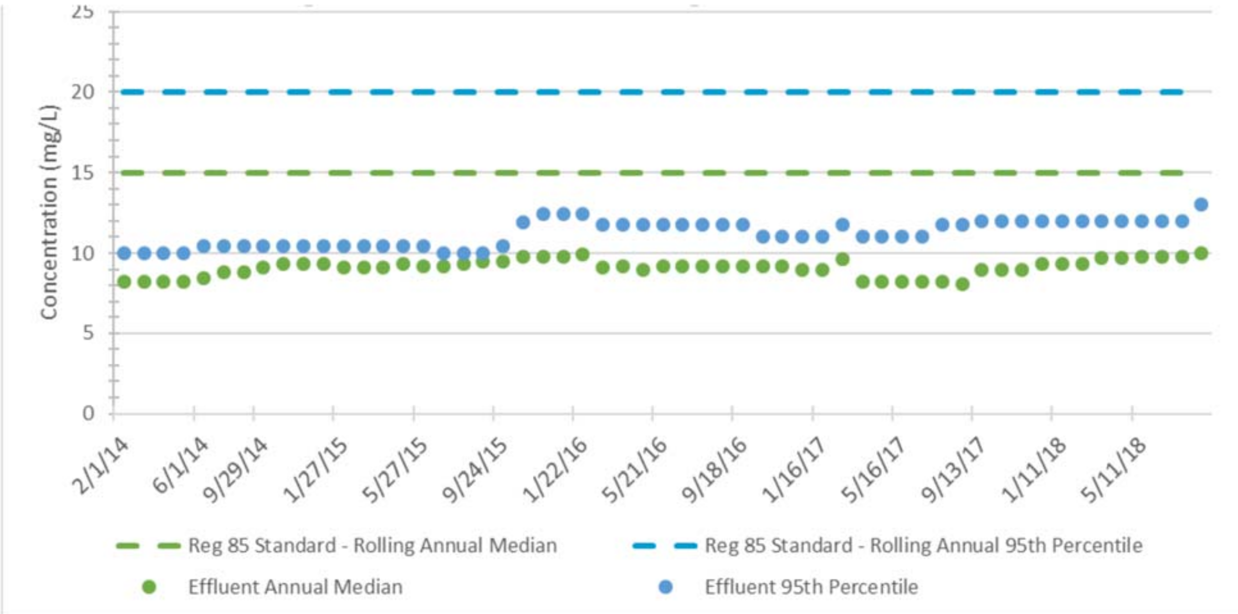

Figure 6-6 LVSWRRF 12-Month Rolling Annual Total Inorganic Nitrogen (Median and 95th Percentile)

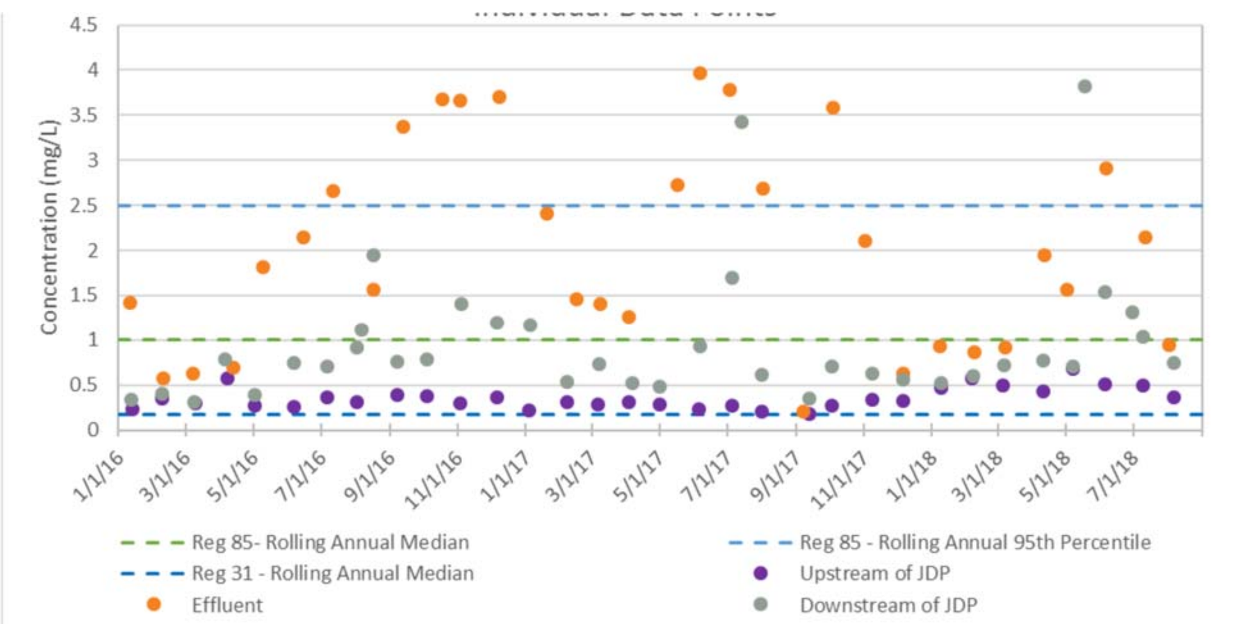

Figure 6-7 JDPWRRF and Monument Creek Total Phosphorous (Individual Data Points)

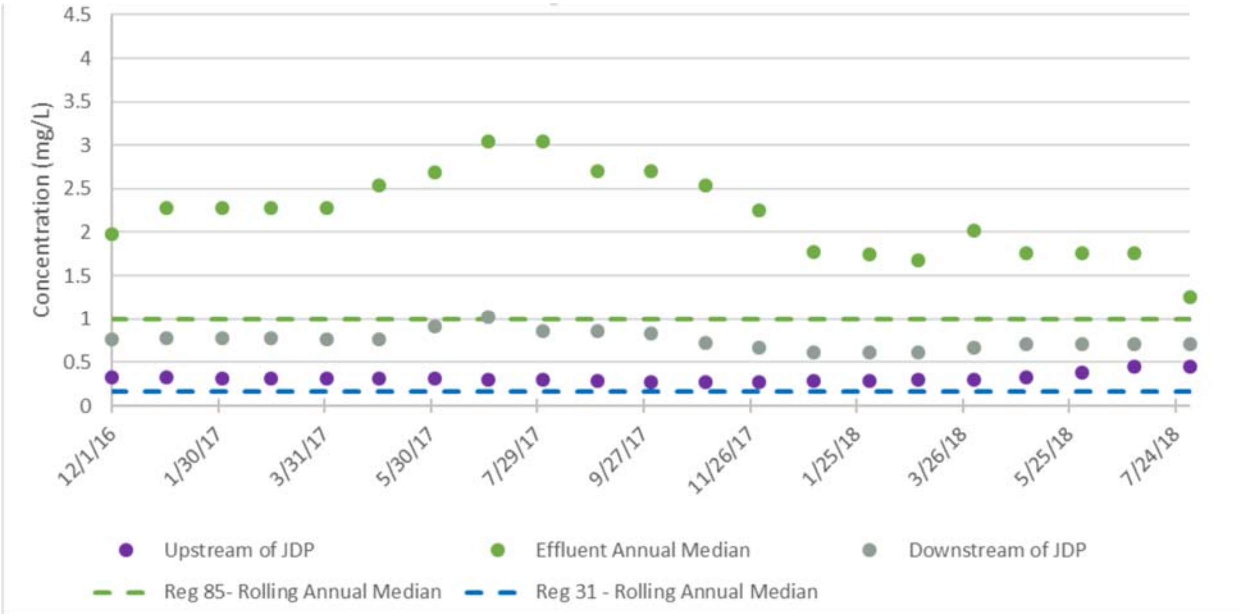

Figure 6-8 JDPWRRF and Monument Creek Total Phosphorous Rolling Annual Median

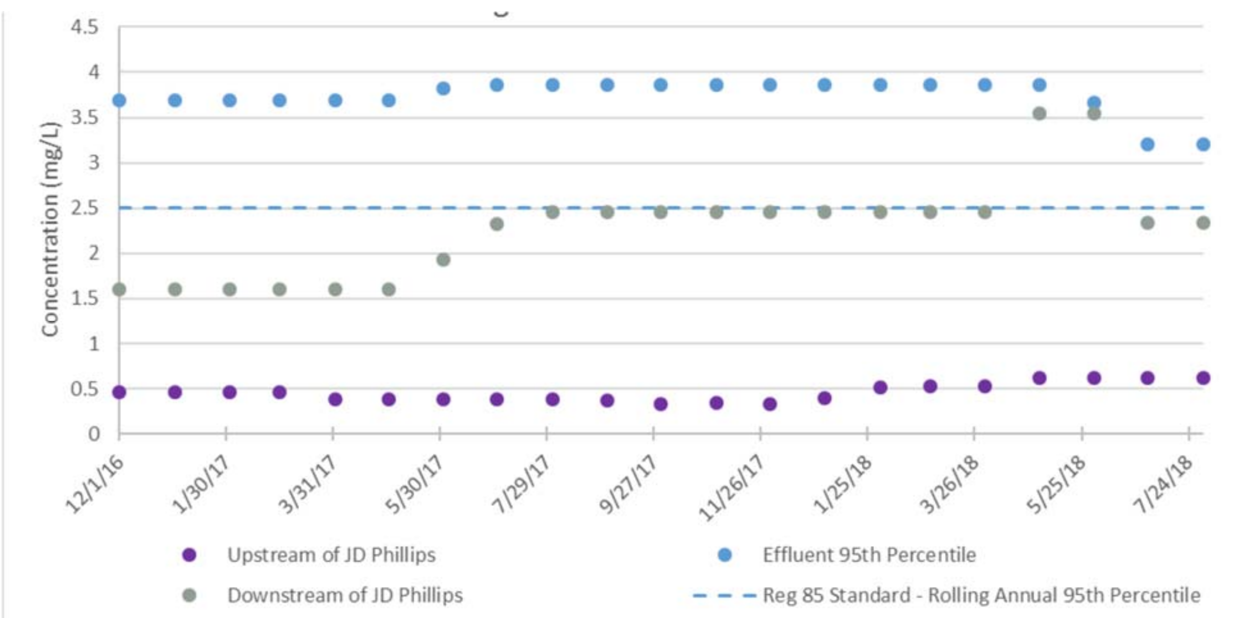

Figure 6-9 JDPWRRF and Monument Creek Total Phosphorous Rolling Annual 95th Percentile

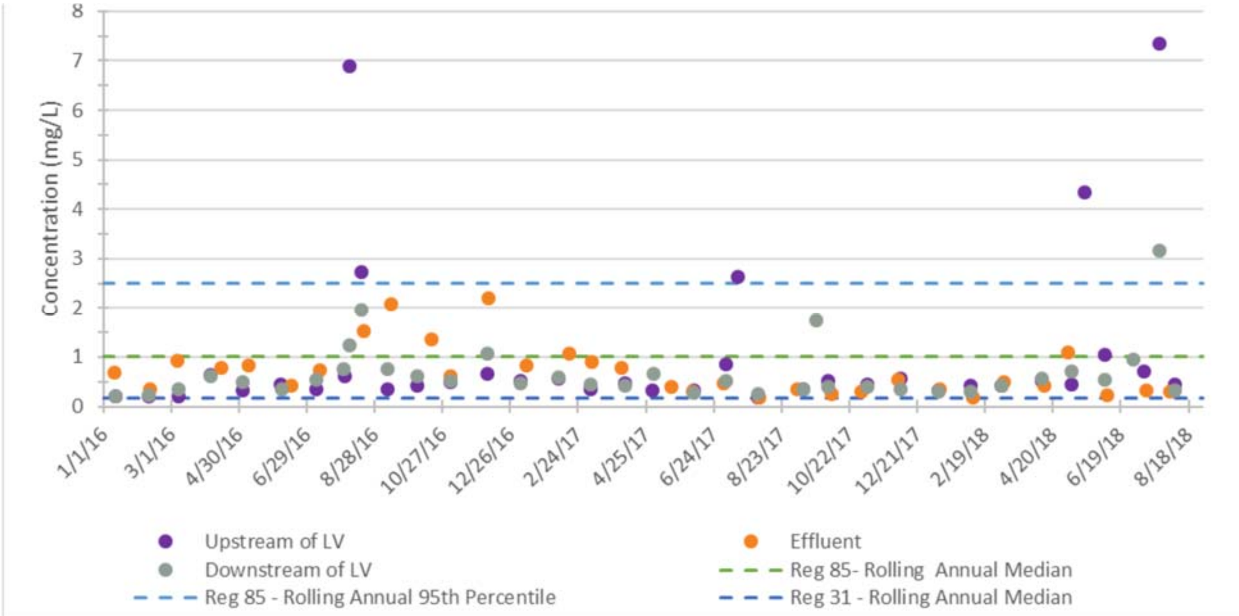

Figure 6-10 LVSWRRF and Fountain Creek Total Phosphorous (Individual Data Points)

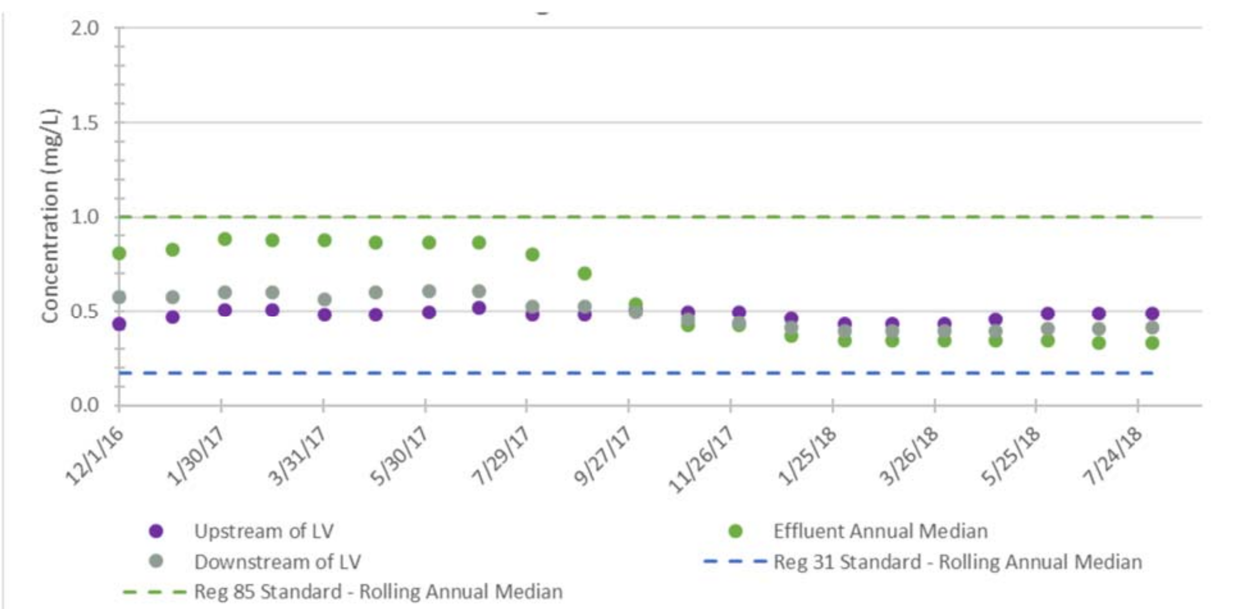

Figure 6-11 LVSWRRF and Fountain Creek Total Phosphorous Rolling Annual Median

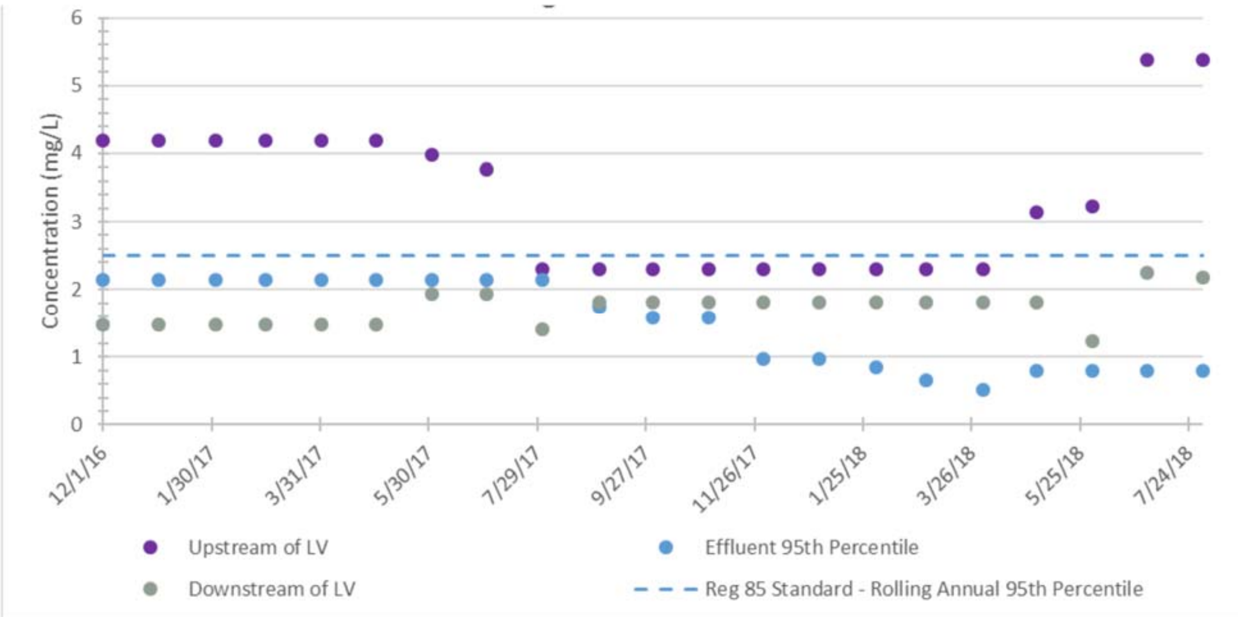

Figure 6-12 LVSWRRF and Fountain Creek Total Phosphorous Rolling Annual 95th Percentile

The JDPWRRF was originally built as an A2O facility thereby making it capable of BNR from its inception. However, due to the length of its collection system, JDPWRRF has limited carbon availability which inhibits its nutrient removal capabilities. In 2015, a system was installed at JDPWRRF to store and dose dairy whey which is an alternative carbon source that can supply the carbon needed for BNR. Even though the whey project has been completed, there have been some significant problems making it unavailable for carbon dosing currently. Utilities' expects the whey system to be fully available by the second quarter of 2019 which will provide sufficient carbon for the BNR process. Based on pilot studies, using fermented whey as an alternative carbon system demonstrated good removal of nitrates and ortho-P as can be seen from the graph below where the average effluent N concentration was 5.43 mg/L and the average P concentration was 0.42 mg/L over the nine-month period shown in the graph.

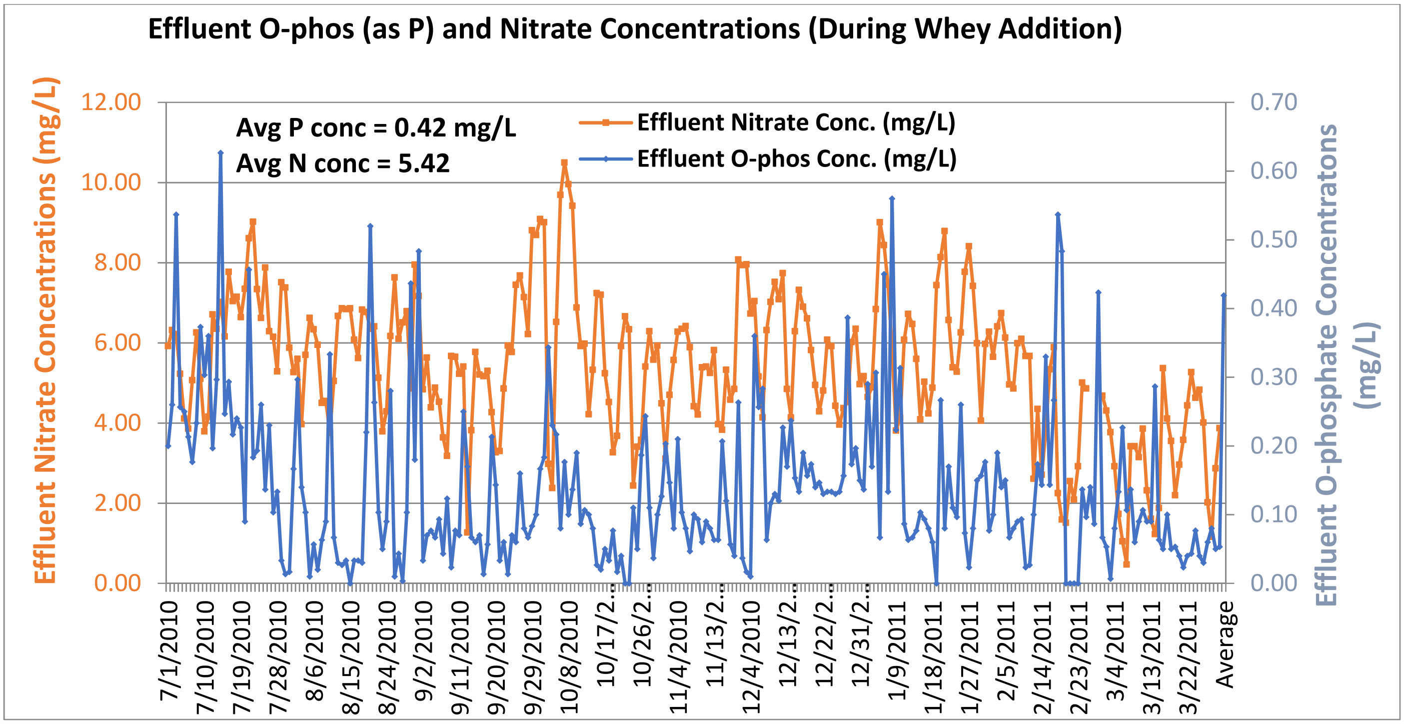

Figure 6-13 Effluent O-phos (as P) and Nitrate Concentrations (During Whey Addition)

6.2.2 Temperature

Temperature stream standards exist to protect the aquatic life in the receiving streams. As a result, the LVSWRRF has temperature monitoring and reporting requirements in its current CDPS permit, but no temperature limits. Monitoring locations include the effluent and at an upstream permitted feature. The effluent discharged from the WRRF could potentially increase temperatures above aquatic life tolerance levels. Both JDPWRRF and LVSWRRF discharge to Tier II, Class II warm water biota stream segments, which have chronic and acute temperature standards as shown in the following table. These criteria can be found in Table 6-12 below.

Table 6-12 Temperature Standards

Temperature Tier	Tier Code	Species Expected to Be Present	Applicable Months	Temperature Standard (deg C)	
				MWAT (chronic)	DM (acute)
Warm Stream Tier 2	WS-II	Brook stickleback, central stoneroller, creek	March – Nov	27.5	28.6
			Dec – Feb	13.8	25.2

Since 2015, Utilities has been monitoring effluent temperatures and collecting temperature data upstream and downstream of the facility for the LVSWRRF. Based on the data collected to date, the temperature standards for the creek are not exceeded. Utilities will continue collecting the temperature data, especially around the seasonal shoulder months, when there appears to be the greatest risk of not meeting the standard. If a limit is imposed on temperature, it could have significant ramifications to O&M costs.

Chapter 7

Water Quality

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7 Water Quality

Water quality with respect to the WRRFs consists of three components: influent characteristics, effluent characteristics and receiving stream considerations. Each of these water quality components is addressed in other sections of the *WWSP*. Influent characteristics are discussed in Section 5.4 of Chapter 5 Flow, Load and Demand Projections. Effluent water quality is addressed in Section 6.2 of Chapter 6 – Regulatory Requirements. Receiving stream considerations are regulatory driven and are discussed in Section 6.1 of Chapter 6 – Regulatory Requirements.

Chapter 8

Levels of Service

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8 Levels of Service

Levels of Service (LoS) define goals, operational requirements, or regulatory requirements that the wastewater system needs to meet or comply with. Some LoS have been defined in Scorecards in the past. The goal is to develop a holistic set of LoS that will measure performance of the wastewater system.

It is beyond the scope of this current *WWSP* to develop a complete set of Levels of Service. However, proposed and current LoS are included in Table 8.1 as a starting point.

Table 8.1 Levels of Service

Operational Area	Primary or Secondary LoS	Level of Service
Collection System	Primary	SSOs per 100 miles of pipe (12-month rolling average basis)-Less than 1.0 stoppages/100 miles per year.
	Primary	WW Failures per 100 miles of pipe (12-month rolling average basis)- Less than 0.5 failure/ 100 miles per year.
	Secondary	Miles of pipe cleaned per year- 950 miles/year
	Secondary	Miles of pipe treated with root control- 30 miles/yr
	Secondary	Miles of pipe assessed by CCTV for cleaning or root control- 35 miles/yr
	Primary	For dry weather flow, Depth of flow less than 70% of pipe diameter for all pipe sizes
	Primary	No surcharging in wet weather flow for all pipe 12” and smaller
	Primary	Maximum surcharge of 125% in wet weather flow for all pipe larger than 15” in diameter
	Primary	Compliance with all regulations
WRRFs	Primary	Compliance with all regulations and operating permit requirements
LVSWRRF and JDPWRRF	Primary	Voluntary reductions of effluent Nitrogen and Phosphorous concentrations sufficient to secure a ten-year extension in facility upgrade requirements for nutrients under Colorado’s Voluntary Incentive Program (VIP)

In some cases, primary LoS are impacted by secondary LoS. For example, in Table 8-1 above, the primary LoS for stoppages has secondary levels of service for root control, cleaning of sewer pipe, grease treatment of pipe and CCTV surveillance that all directly impact the primary LoS for stoppages.

8.1 Performance Measurement

For each LoS, performance needs to be measured. If a LoS cannot be measured, then it is not likely to be effective. Performance measures have not yet been developed for most of the LoS defined in Table 8.1 above. As this is a new concept that is being developed, performance measures will be developed as further work is completed on risk-based prioritization. Performance measures that have been defined are included below:

Table 8.2 Performance Measures for Levels of Service

Rating	Stoppages per 100 miles of Pipe
Does not Meet Expectations	>2.79
Partially Meets Expectations	2.79-2.50
Meets Expectations	2.49-2.30
Exceeds Expectations	2.29-2.09
Far Exceeds Expectations	<2.09

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Chapter 9

Capacity Analysis

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9 Capacity Analysis

9.1 Collection System Capacity

This section investigates the system's ability to convey and treat wastewater to meet permit limits and provide acceptable levels of service. Specific areas where capacity concerns are identified call for a SAA to more accurately define the problem, quantify the risk, develop and evaluate alternatives, and identify the best alternative that could address future capacity. For example, Banning Lewis Ranch is an area of concern that will be highlighted in this section due to capacity needs that are likely to arise in the future as growth and development continue.

9.1.1 Collection System Capacity

The Collection System's ability to meet level of service criteria was evaluated for current (2017) loading conditions and future 2040 loading conditions developed in Chapter 5 – Flow, Load and Demand Projections. [The future iterations of the WWSP will also start tracking an intermediate point on the timeline (say year 2030) to give more definition to interim necessary improvements.] Evaluation was accomplished by using the InfoSWMM^{TM} model for the collection system. The model uses dynamic wave simulation to route flows through the collection system. The output can be searched to locate pipes that meet certain failure criteria like d/D greater than 0.7, or pipes that are surcharged at both ends.

Under current dry weather conditions, the collection system performs well. The pipes that indicate a degraded level of service under current dry weather conditions may be modeled incorrectly – for example the modeled invert elevations may not match the actual inverts, or the pipe is correctly modeled and functions under a degraded level of service that does not negatively impact customers. The pipes that are highlighted as failing to meet the d/D less than 0.7 criteria should be field checked to validate the model inputs. This finding is similar to findings in the previous capacity study, *Wastewater Collection System Capacity Evaluation* (Stantec, 2009).

Wet weather modeling highlights areas that are more susceptible to capacity issues should excess RDII enter the system and cause an overload. The risk of system overload continuously increases with additional development (i.e. the amount of rainfall required to cause degraded level of service is reduced). As development occurs the predicted wet weather failure is more likely to occur. Since the increased loading is dependent on development, the timing of upgrades and potential risks are linked to the rate of development.

The wet weather hydraulic capacity performance criteria used in the previous *Wastewater Collection System Capacity Evaluation* was also used in this analysis:

- No surcharging of 12" and smaller pipe allowed
- Maximum 125% surcharging of pipe 15" and larger allowed

The above criteria are based on the theory that peak wet weather flows are rare events, and that the period of surcharge would be expected to last only 1-2 hours with no significant adverse consequences (e.g. customer back-ups/basement intrusion, overflows). Fewer service taps/connections to homes and businesses are included on

15” and larger mains since a variance to Utilities’ Wastewater Standards is required to tap a main larger than 12” allowing for a lower performance level for large mains.

The following dry weather capacity criteria was used for analysis:

- Peak flow should not exceed a d/D ratio of 0.70

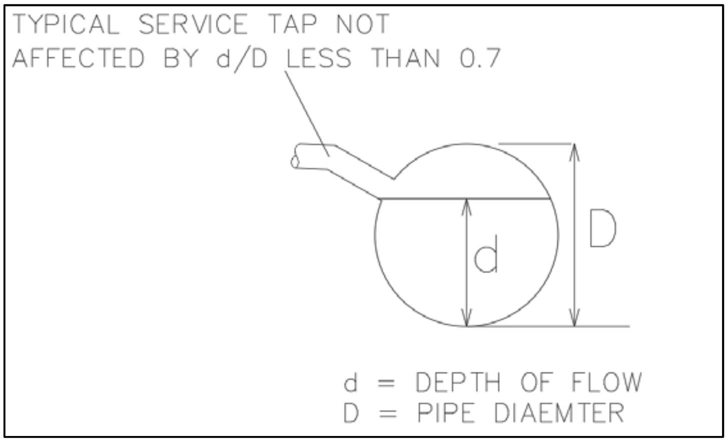

Figure 9-1 Utilities’ d/D Criteria

The flow monitoring points analyzed in Table 5-1 served as calibration points for the four scenarios analyzed. The scenarios considered were: Current Dry Weather, Current Wet Weather, 2040 Dry Weather and 2040 Wet Weather.

For the current/existing conditions scenario, the model was calibrated to field measured flows at the calibration points.

For 2040 conditions, average day flows based on Small Area Forecast Data and the peaking factors below (developed in Chapter 5) were used to estimate flows.

$$PF_{dry} = 1.9 * Q_{avg}{}^{-0.06}$$

$$PF_{wet} = 3.61 * Q_{avg}{}^{-0.06}$$

Adjustments to the model to estimate future conditions included:

- Adding 2040 population nodes at areas poised for growth based on the SAF. This helps the model to route the increased flows from the future population.
- The time series patterns used in the previous model were updated to match the observed field flow monitoring records.
- Synthetic rainfall data was used to simulate a high intensity rainstorm (National Oceanic and Atmospheric Administration (NOAA) Type II Distribution with a total depth of 3 inches).
- RTK parameters used to calculate RDII hydrographs were bulk adjusted in the model. As discussed in Section 5, further refinement to the RTK parameters would help the model to determine risk more accurately. The bulk adjustments that were used helped to correct some of the model discrepancies, but additional work is needed in this area.

- Model Sewersheds were adjusted/scaled to correlate design wet weather peaks with modeled peaks.

The sample model output shown in Figure 9-2 depicts the 2040 wet weather hydrograph generated by the model for WW.110800 (Cottonwood Creek). The blue model output is compared to the calculated future peak (green horizontal sections of the graph).

The green horizontal sections of the graph for this location (WW.110800 Cottonwood Creek) are based on the following: the dry weather peak occurring in the morning is the predicted average 2040 flow, of 3.6 MGD multiplied by PF_{dry} = 1.76 and equals 6.35 MGD for this location. The wet weather peak flow is 3.6 MGD * PF_{wet} of 3.34 = 12.03 MGD for this location. The summary of design values for all calibration points can be found in the loading table 5-2 in Chapter 5.

The model output in Figure 9-2 shows that the design flowrates were achieved at the calibration point. This analysis was done for each calibration point.

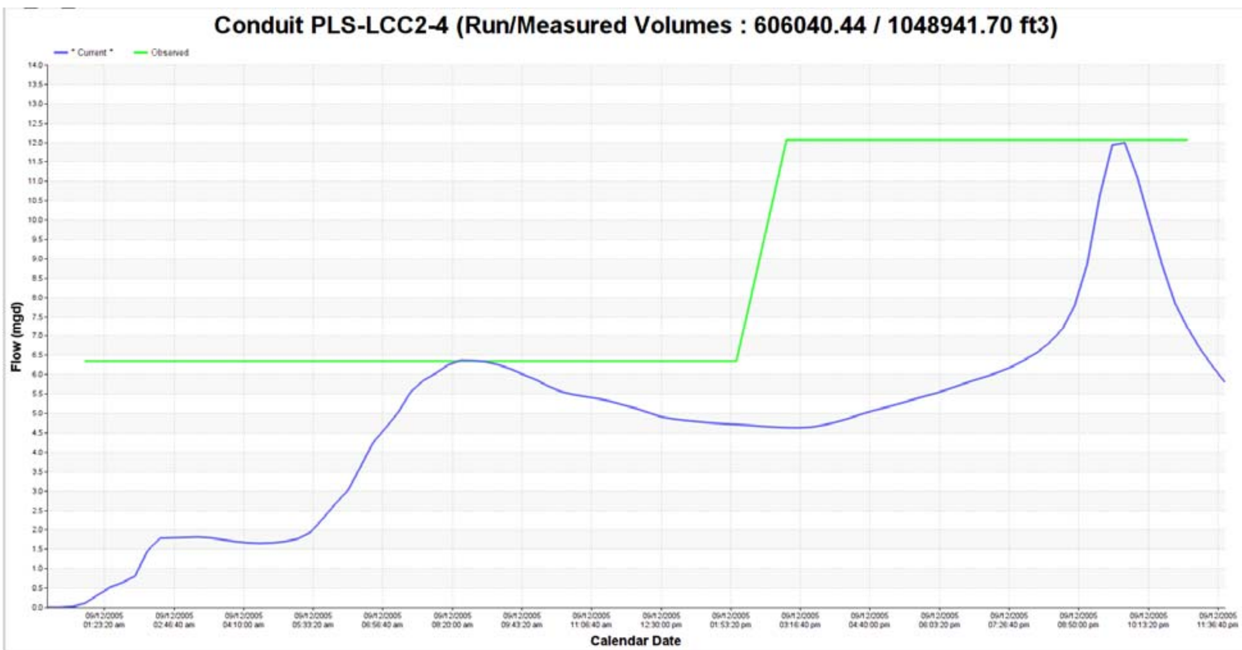

Figure 9-2 The Estimated Future Peak Flows for Dry and Wet Weather Events Were Used to Ensure the Modeled Flow Matched the Projected Flow

The model assumes that the pipes function as designed (n value for modeling is 0.013), i.e. there are no impacts due to issues such as root penetration, pipe collapses etc. This important assumption of the system operation should be addressed in the various *Operations and Maintenance Program Plans.*

9.1.2 2017 Current Dry Weather Loading

The model indicates that the system is performing well with respect to the current dry weather loading scenario. The areas of failure indicated in the modeling output are likely attributed to incorrect invert elevations in the model leading to backwater conditions where the main connects to a larger pipe. Observed dry weather operational problems are rarely attributed solely to pipe size but are likely attributed to O&M related issues such as grease, roots, sags, and failed lift station equipment.

9.1.3 2017 Current Wet Weather Loading

Modeling results indicate that the system has some possible problem areas under wet weather loading conditions. Problem areas indicated by the modeling results generally fall into two categories:

1. Problem areas resulting from known or suspected inaccuracies of model inputs (e.g. invert elevations, flow generation/nodal allocation, RDII hydrographs)
2. Legitimate capacity problems

Of the problem areas identified by modeling results, three areas are considered legitimate problem areas as follows:

- West Side near Colorado and 31st St.
- Carson Valley near Old Broadmoor Rd and W Cheyenne Mountain Blvd.
- Grand Vista Circle

These areas are included in Table 9-1 of surcharged pipes for current wet weather loading and have also previously exhibited field observed capacity issues under wet weather loading. 2017 Wet weather impacted pipes are also shown on the “Green Map” in orange. The 2015 RDII loading that caused the observed past problems is highlighted in section 9.1.4. The other problem areas in Table 9-1 appear to be caused by bad invert evaluations in the model or by an overestimated RDII. Model adjustments (e.g. obtaining correct invert elevations or adjusting RDII) will be further evaluated to address these areas of concern.

It should be noted that Utilities has taken action to address the field observed capacity issues highlighted in 2015. The actions taken included:

- Repairing/modifying the weir that allowed Manitou flow to enter the 15” line that generally flows along Colorado to now route flows to the 18” line the flows generally along Hwy 24.
- Increased maintenance of the underdrain at Westmoor Park that helps alleviate ground water in the area.
- Increased CIPP lining in the area
- Installed flow monitoring devices with alarm capabilities.

Table 9-1- Current Wet Weather Capacity Concerns

Model ID	CSU LID	2040 Area ID	Likely Cause	Notes	Action
PLS-BC1-15	WW.140941	15	Over predicted RDII	Slight Surcharge - O&M for the pipe shows a spill related to grease. With line rehab in 2017. Video shows sag camera underwater	Evaluate model
PLS-BC1-16	WW.163446	15	Over predicted RDII	Slight Surcharge - O&M does not indicate wet weather response has been required	Evaluate model
PLS-CV6-58	WW.151369	17	Bad inverts	Slight Surcharge. No Video Available - O&M does not indicate wet weather response	Field Verify Pipe Elevations
PLS-GOG10-203	WW.162170	11	Over predicted RDII	Surcharge. No video. O&M does not indicate wet weather response	Evaluate model
PLS-GOG7-150	WW.160019	11	Over predicted RDII	Backwater due to downstream (Colorado and 31st) - pipe normally dry dead-end MH. Known issues at the intersection	Evaluate model
PLS-GOG7-151	WW.175890	11	Over predicted RDII	Surcharge - Known problem area (31st and Colorado)	Evaluate model
PLS-GOG7-71	WW.164224	11	Over predicted RDII	Surcharge - Likely the model is overestimating RDII	Evaluate model
PLS-GOG7-72	WW.139648	11	Over predicted RDII	Surcharge - Likely the model is overestimating RDII	Evaluate model
PLS-MV7-3	WW.132326	8	Pipe over capacity	Surcharge - Pipe appears to be under capacity - video shows underwater camera	Evaluate model - Put on Project List

Model ID	**CSU LID**	**2040 Area ID**	**Likely Cause**	**Notes**	**Action**
PLS-MV7-5	WW.142277	8	Pipe over capacity	Surcharge - Pipe appears to be under capacity -	Evaluate model - Put on Project List
PLS-MV7-6	WW.144335	8	Pipe over capacity	Surcharge - Pipe appears to be under capacity - video shows underwater camera	Evaluate model - Put on Project List
PLS-NS2-29	WW.153400	5	Over predicted RDII	Slight Surcharge - Line on frequent PM list	Evaluate model
PLS-PJ1-133	WW.137683	12	Bad inverts	Video shows pipe is above the influence of the Interceptor	Field Verify Pipe Elevations
PLS-SC7-143	WW.151760	18	Bad inverts	No Video	Field Verify Pipe Elevations
PLS-TG20-35-2	WW.179965	6	Over predicted RDII	Slight Surcharge - No O&M to support problem.	Evaluate model
PLS-USC20-99	WW.132820	7	Bad inverts	Back water. No O&M to support - No video	Field Verify Pipe Elevations
WW.196548	WW.208127	11	Over predicted RDII	Backwater due to downstream (Colorado and 31st) - pipe normally dry dead-end MH. Known issues at the intersection	Evaluate model
WW187629_1_SOFT	WW.187651	1	Bad inverts	Surcharge. No O&M to support problem. Video from acceptance does not indicate problem	Field Verify Pipe Elevations

9.1.4 2015 Wet Weather Rainfall Data

Locations and flow data from the 2015 wet weather event that stressed the collection system are shown in the maps and graphs below. This data, coupled with system performance, provides insight into the system's actual response to wet weather events, and is used to inform and evaluate collection system improvements.

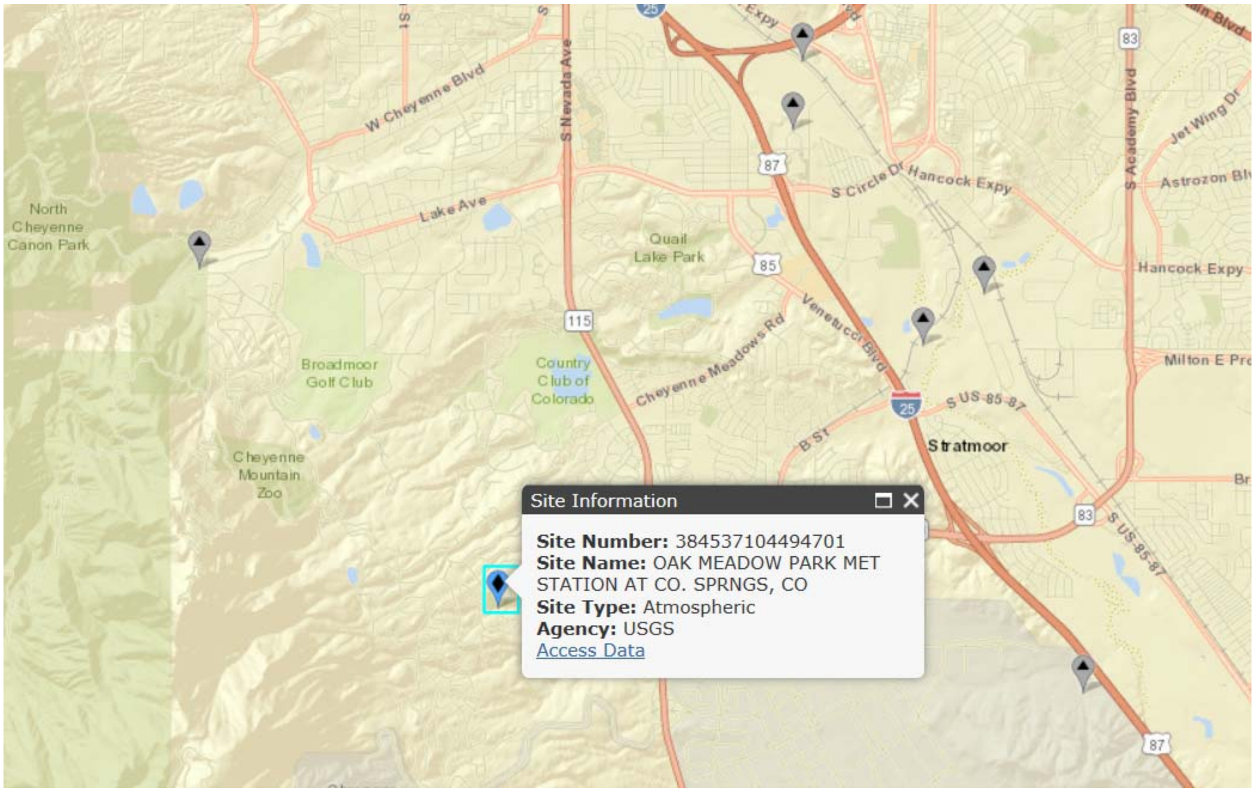

Figure 9-3 Oak Meadow Park USGS Gauge Location

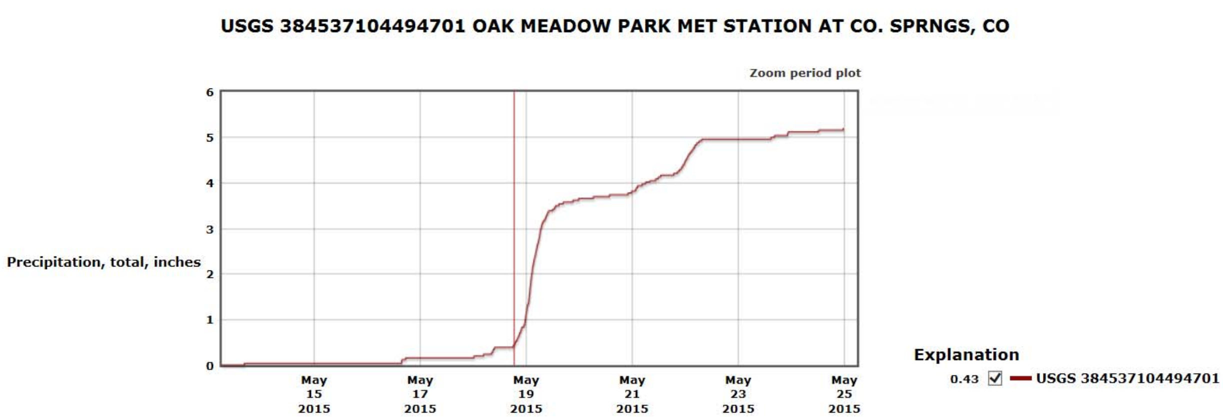

Figure 9-4 Oak meadow Park, May 2015 Rainfall

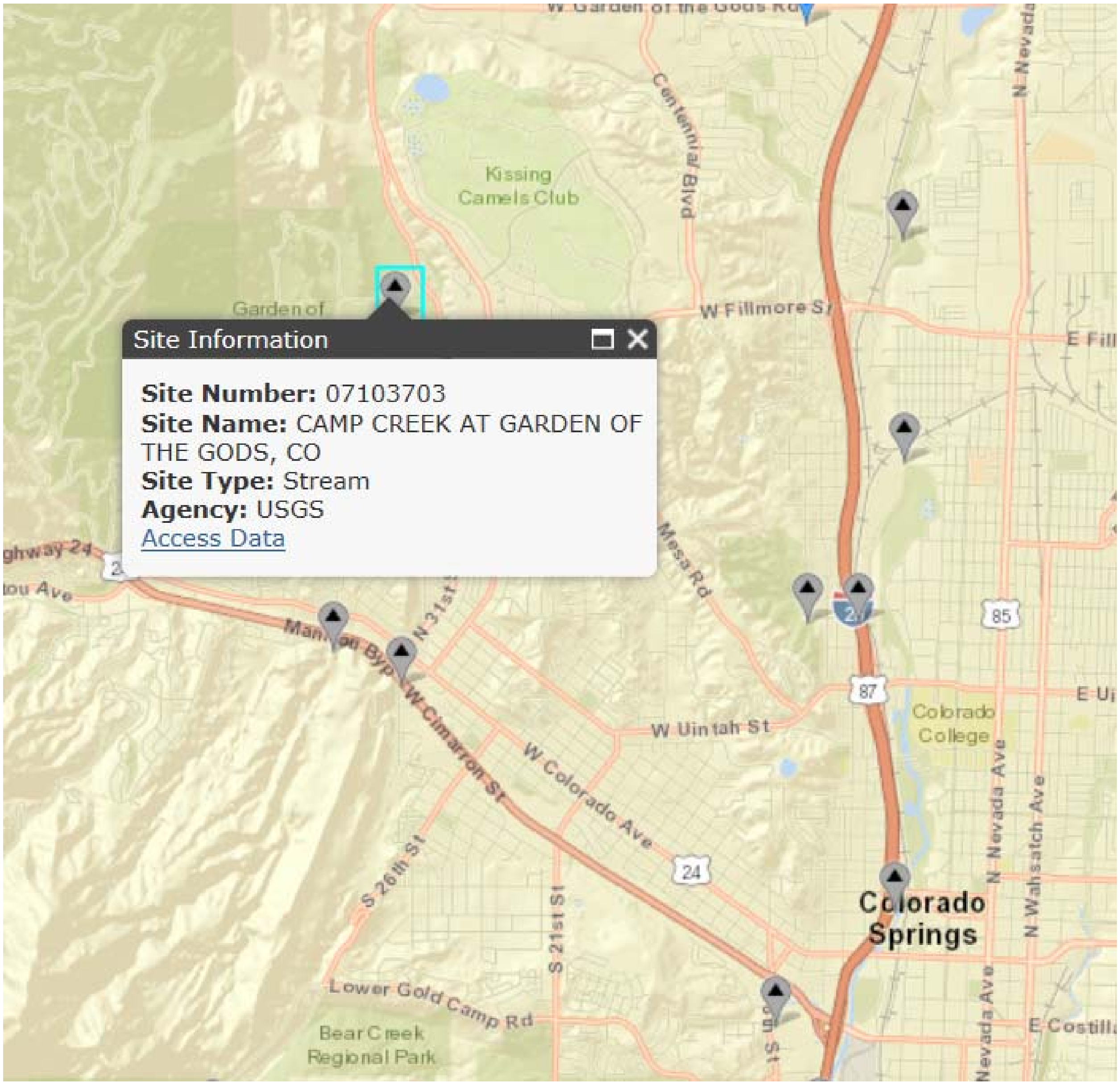

Figure 9-5 Camp Creek USGS Gauge Location

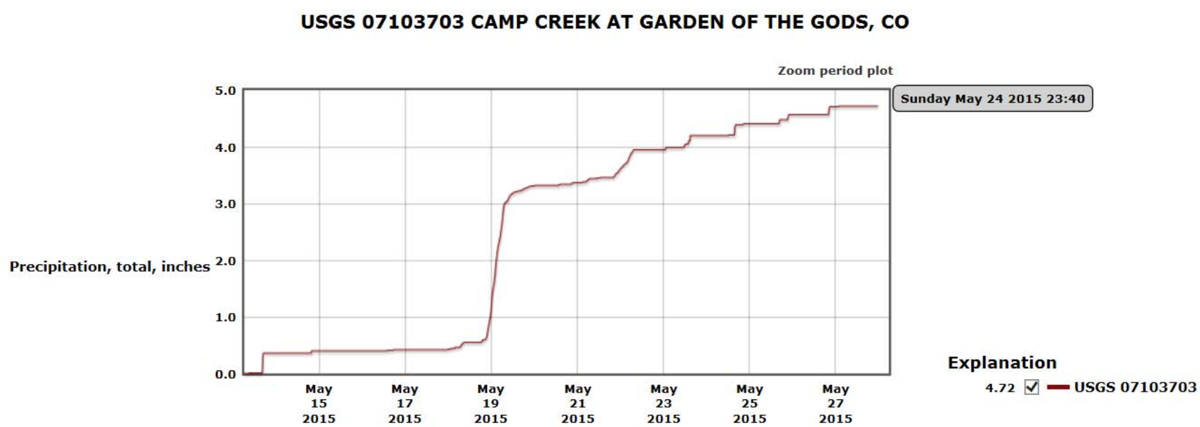

Figure 9-6 Camp Creek May 2015 Rainfall Depth Information

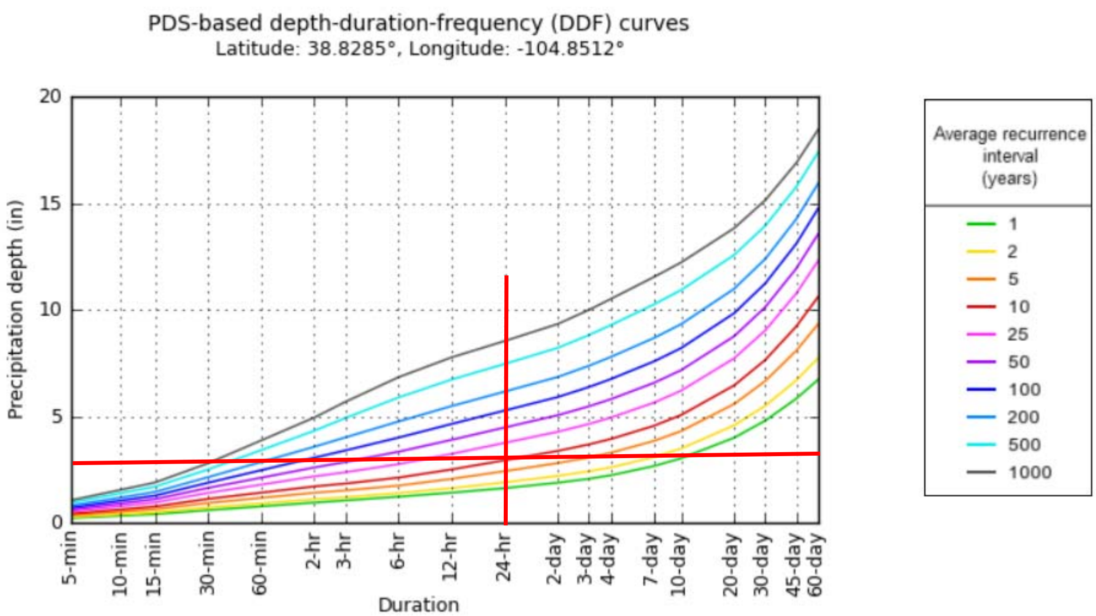

Figure 9-7 NOAA Rainfall Return Information for Area Near Oak Meadow and Camp Creek Sikes (the 24-hour 10-year Event is Highlighted in Red)

The USGS gauge data and the NOAA estimated return frequency are included to provide information around the wet weather event that caused flooding at 31st and Colorado and at MH WW.131019 near Cheyenne Mountain Blvd and Old Broadmoor Rd. This event also stressed the pumps at Sand Creek, resulting in the use of the emergency storage as shown in Figure 9-8.

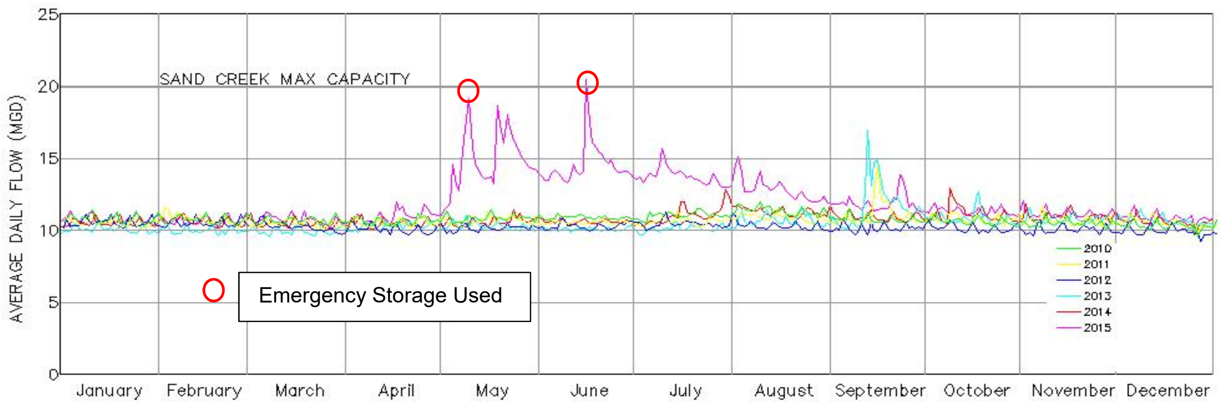

Figure 9-8 Sand Creek Flow 2015 Event in Magenta

9.1.5 2040 Dry Weather

Dry weather flow is not impacted by RDII and represents the base daily usage. Dry weather flowrates occur daily, and it is important to evaluate the system performance under the expected dry weather loading as issues occurring at this level would continuously affect level of service parameters. Areas of concern were determined using the model outputs to identify pipes that experienced d/D greater than 0.7 under the forecasted dry weather flow conditions. The 2040 dry weather modeling results indicate capacity limitations in the North Area/Kettle Creek, the BLR-Sand Creek outfall, and a portion of pipe in the Carson Valley including WW.136977. These areas are indicated as concern areas #1, #19 and #17 (see the inset of the "Green Map" in Chapter 4 - Introduction). These pipes are also shaded yellow on the "Green Map"

9.1.6 2040 Wet Weather

Table 9A-1 (Appendix 9A) highlights the areas of capacity concern for the modeled 2040 wet weather peak flow conditions. Areas of concern were determined using the model outputs to identify pipes that experienced surcharging under the forecasted wet weather flow conditions. The "Green Map" shows the 2040 wet weather impacted or surcharged pipes in blue. A comparison to the *Wastewater Collection System Capacity Evaluation (Stantec)* study was made in Table 9A-2 (Appendix 9A) to highlight similarities and discrepancies, and to document areas that have been resolved since the publication of the previous report.

The notable capacity concerns identified in both studies that will require future upgrades are:

- BLR related collection system alternatives including –
  - "Zigzag", a portion of 18" pipe north of the airport that was installed as temporary pipe,
  - Pipe segments downstream of "zigzag"
  - Sand Creek Lift Station,
- North Area Kettle Creek Capacity concern.

The anticipated population growth from these areas is going to require upgrades to serve the capacity needs. There are Advanced Recovery Agreements in place that currently collect money from development in tributary areas to fund the future upgrades. Kettle Creek's advanced recovery agreement is set to collect $3 million as residential and commercial development pay their pro rata share of the expected upgrade cost. Sand Creek's advanced recovery agreement was recently updated under the revision to the BLR annexation agreement and is designed to collect $24 million.

The capacity concerns that need more investigation through the proposed model update are also listed in Table 9-1 (Appendix 9A). These include areas like Carson Valley World Arena, and the Garden of the Gods (GoG)/Westside area. Both areas experienced wet weather loading that exceeded the system capacity in 2015. The reason more investigation is required is to more accurately determine the risk of not meeting the proposed level of service associated with each area of concern in the system. Once the design loading and probability of failure is more accurately determined, an appropriate plan to address deficiencies can be developed.

9.2 Resource Recovery Facility Capacity

The purpose of this section is to analyze the capacity of the three RRF's (JDPWRRF, LVSWRRF, and CSRRRF). The graphs discussed in section 5.4.2.1, which predict future flow and loading into the year 2040, are used as a basis to evaluate facility capacities over time. Utilities is currently participating in the VIP (see Section 6), with the intention of earning credits towards delayed compliance when Regulation 31 limits get enforced. The calibrated process models for JDPWRRF and LVSWRRF are used along with anticipated Regulation 31 effluent limits to determine the capacity of the facilities from both a flow and load perspective. The capacity of CSRRRF is based on the loading rates of organic solids and CDPHE recommended minimum residence time in the anaerobic digesters for volatile solids reduction.

9.2.1 JDPWRRF Permit Limits

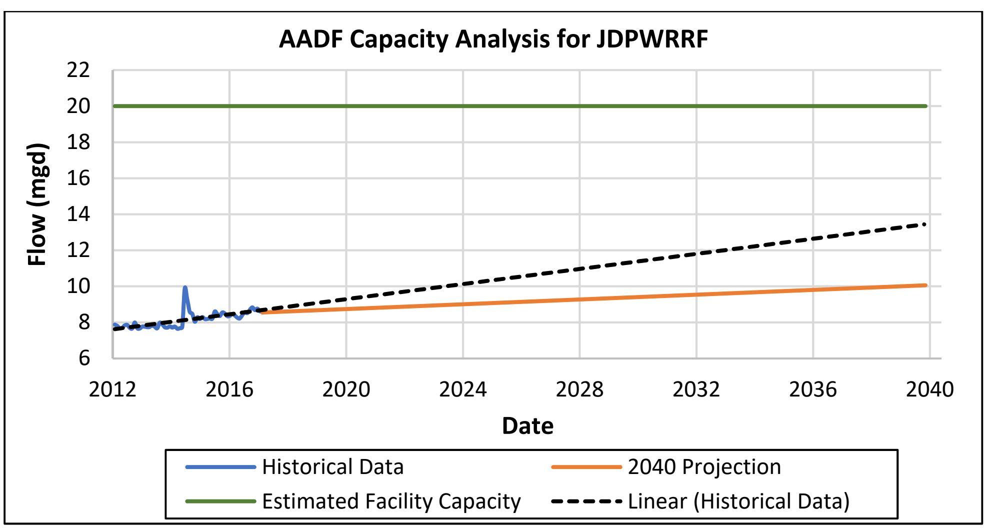

Figure 9-9 AADF Capacity Analysis for JDPWRRF

Figure 9-9 shows historical flow data, flow projections into the year 2040, and the estimated facility capacity of JPDWRRF. A calibrated process model was used to estimate the capacity of JDPWRRF using simulated influent conditions based on wastewater characterization data and flow projections. The capacity estimate assumes that influent characteristics (especially constituent ratios) for COD, cBOD, TSS, TKN, ammonia, and TP will not significantly change over time.

The process modelling analysis completed as part of the *2010 Nutrient Removal Study (Stantec)* indicates that the effluent TN and TP values are the limiting factors in determining the capacity of the facility. The process model predicts that JDPWRRF has a capacity of 20 mgd based on effluent values of 4 mg/L for TN and 0.25 mg/L for TP. It should be noted that JDPWRRF has average DON and DOP concentrations of about 1.71 mg/L and 0.11 mg/L respectively. DON and DOP by their nature are difficult to remove through biological means in an RRF. If these DON and DOP values are subtracted from the modeled TN and TP values for JDPWRRF, the simulated effluent limits that the facility can biologically achieve are roughly about 2.3 mg/L and 0.14 mg/L for TN and TP respectively which are close to the anticipated Reg 31 limits for these parameters. These TN and TP effluent limits are indicative of what can be reliably and consistently achieved through a BNR process. Removal of DON and DOP will require incorporation of additional advanced treatment processes employing chemical and physical means such as precipitation, reverse osmosis, or ultra-filtration. These improvements will require significant capital investment and will result in significant increases in operation and maintenance costs.

Using these effluent limits, the JDPWRRF has a predicted capacity of about 20 mgd. The two flow prediction methods discussed in Section 5.4.2.1, a trendline based on historical data and a prediction based on TAZ population data, provide projected flow values of 14 mgd and 10 mgd for the year 2040. Based on the collection system modeling, the build out flows estimated for JDPWRRF is about 12.2 mgd. Figure 9-9 demonstrates that JDPWRRF will operate well within it’s estimated capacity in the year 2040. In other words, JDPWRRF has plenty of capacity irrespective of whether the maximum flow in the future is 14 mgd (trendline projection based on historical flows) or 12 mgd (based on build out predicted population and flow per capita).

It should be noted that for JDPWRRF to meet the future anticipated regulatory limits under Regulation 31, significant treatment process improvements will have to be made which can include

- Reconfiguration of existing A2O process to 5-stage Bardenpho
- Supplemental carbon source
- Tertiary treatment using sand or other media-based filtration
- Alum sand filter aid polymer storage and feed system to aid with tertiary treatment
- Advanced tertiary treatment such as ultrafiltration and reverse osmosis
- Brine management system
- Pumping system to transfer fluids between processes

The process model that was used to determine the capacity assumes that those changes have been made at JDPWRRF which will allow it to meet the advanced nutrient limits. A schematic of the process model along with some of the key influent characteristics used in the model are shown below.

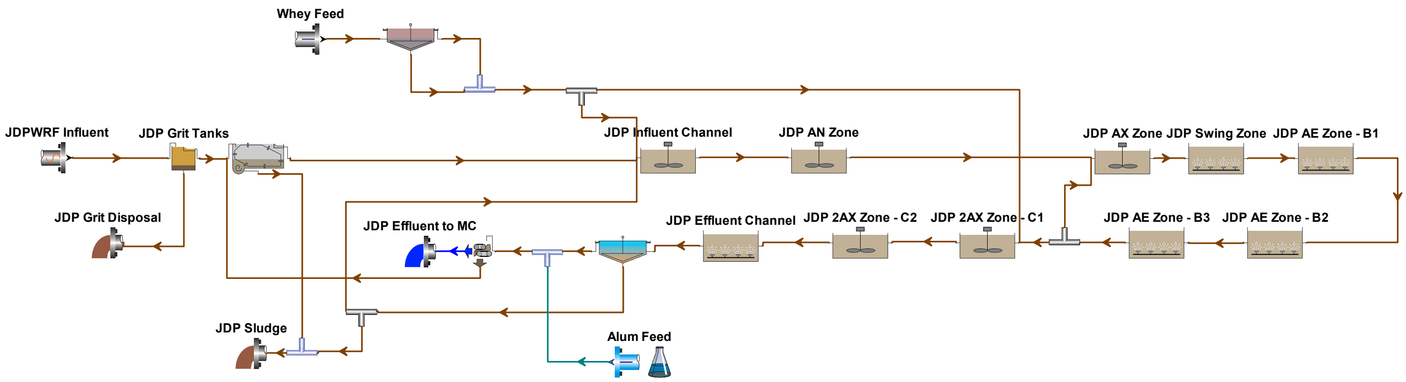

Figure 9-10 Process Model Schematic for JDPWRRF Enhanced BNR and Tertiary P Removal

Table 9-2 JDPWRRF Representative Influent Concentrations for Key Constituents

Constituent	Concentration (mg/L)
TSS (mg/L)	312
COD (mg/L)	773
$CBOD_5$ (mg/L)	327
TKN (mg/L)	56
NH_3 (mg/L)	37
TP (mg/L)	10

It is also of interest to evaluate the capacity of JDPWRRF based on the loading values of NH_3, cBOD, TSS, TP, COD, TKN. An assumption is made that only the flow of JDPWRRF will increase in the next 20 years, and the influent concentrations of the constituents will remain constant. This assumption is used to determine the capacity of JDPWRRF based on the loading conditions for the various constituents of interest using the formula below:

$$\text{Estimated Loading Capacity}\left(\frac{\text{mass}}{\text{time}}\right) = \text{Estimated AADF Capacity}\left(\frac{\text{volume}}{\text{time}}\right) * \text{Constituent Concentration}\left(\frac{\text{mass}}{\text{volume}}\right)$$

The two loading projection methods discussed in section 5.4.2.1, a trendline based on historical data and a projection based on TAZ population data, provide projected loading data for the year 2040. Loading graphs for various constituents are presented below demonstrating the historical loading data, loading projections into the year 2040, and the estimated loading capacity values for JDPWRRF.

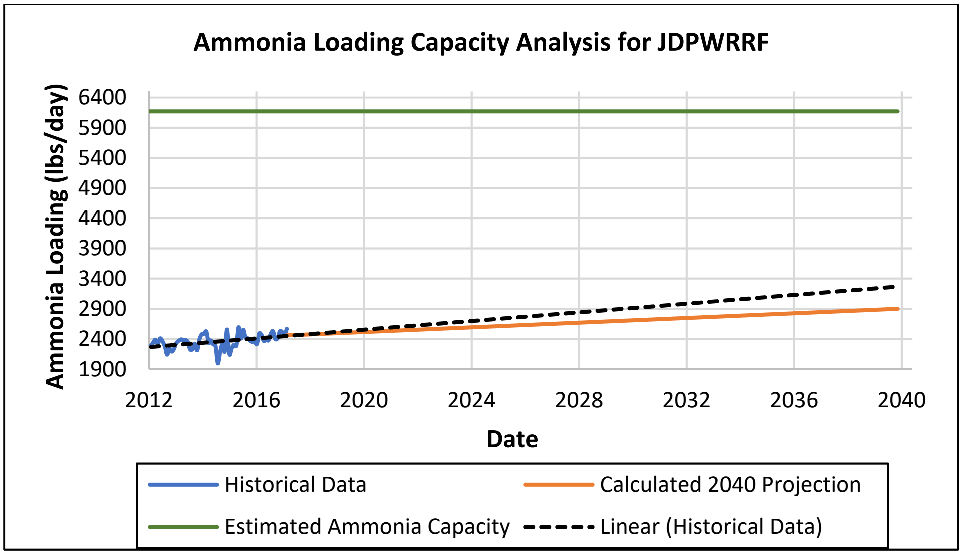

Figure 9-11 Ammonia Loading Capacity Analysis for JDPWRRF

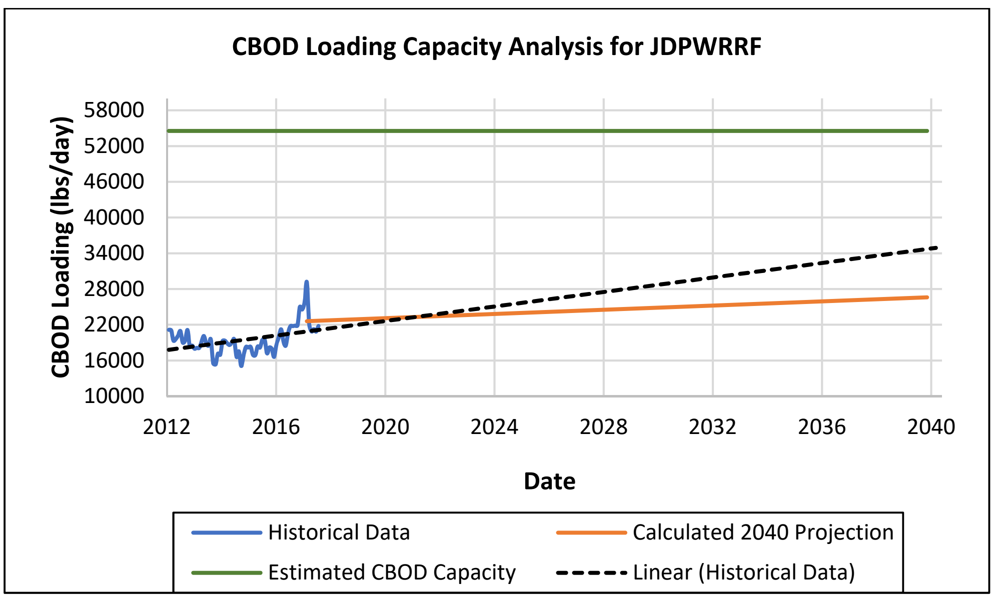

Figure 9-12 CBOD Loading Capacity Analysis for JDPWRRF

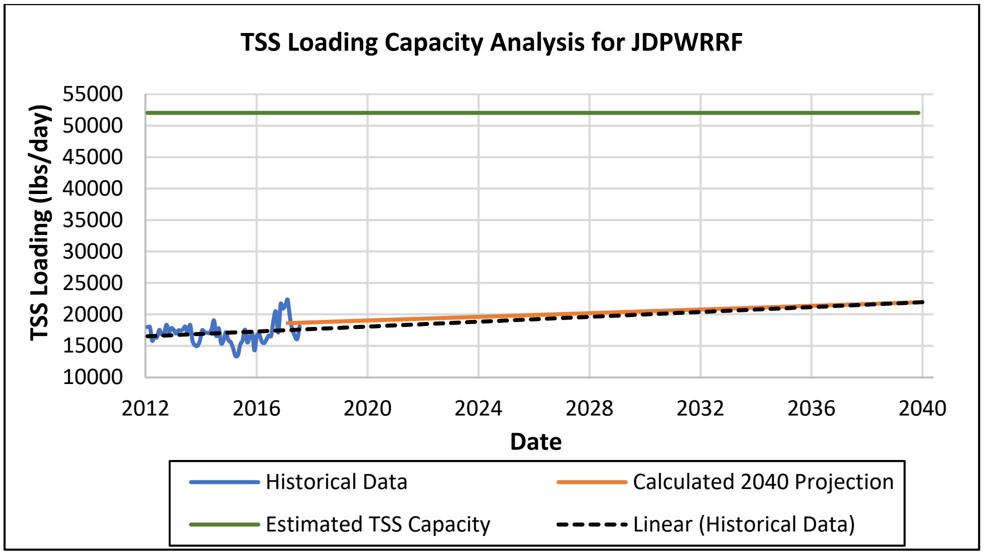

Figure 9-13 TSS Loading Capacity Analysis for JDPWRRF

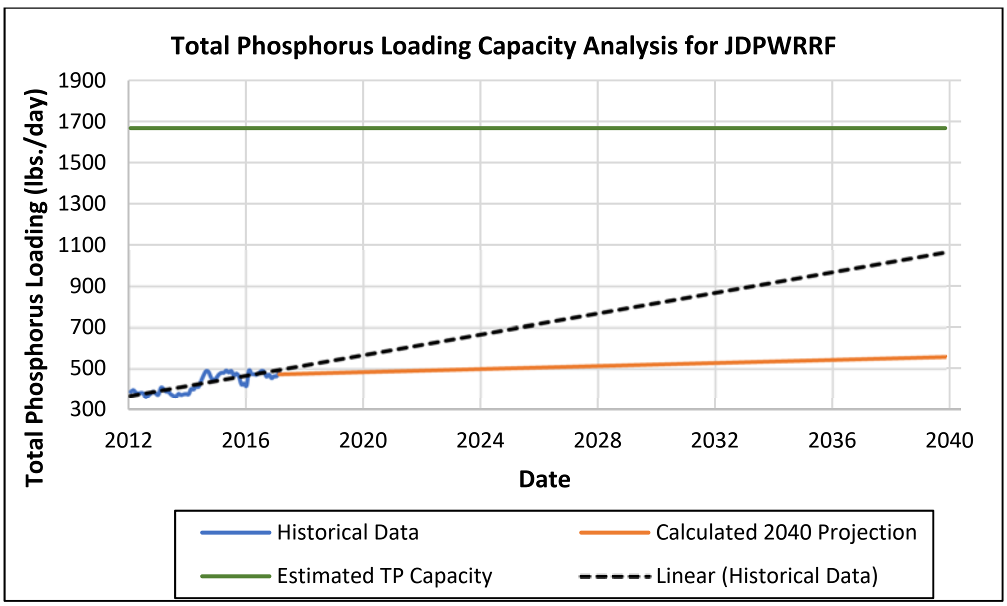

Figure 9-14 Total Phosphorus Loading Capacity Analysis for JDPWRRF

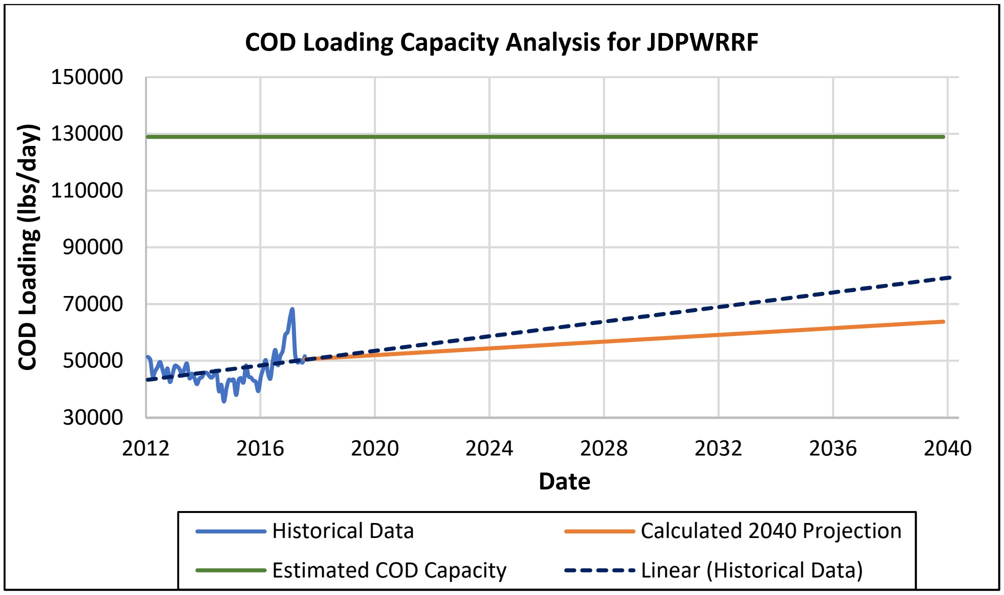

Figure 9-15 COD Loading Capacity Analysis for JDPWRRF

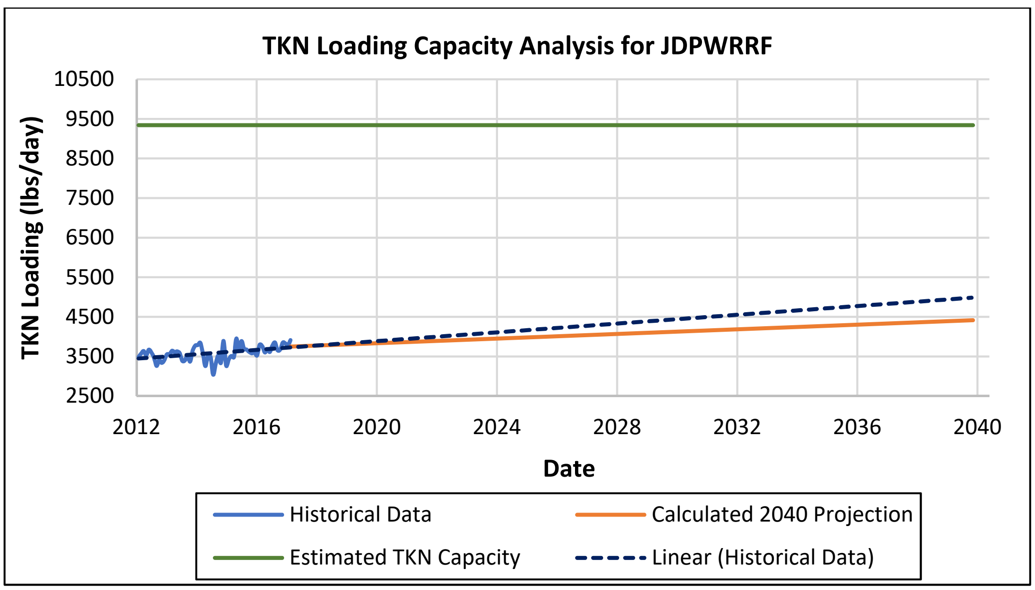

Figure 9-16 TKN Loading Capacity Analysis for JDPWRRF

Figures 9-11 through 9-16 demonstrate that JDPWRRF will operate well within available capacity in the year 2040. In other words, JDPWRRF has plenty of loading capacity for the various constituents irrespective of whether the loading is based on historical trendline projections or TAZ population projections. However, as indicated above it is anticipated that significant process improvements will be required to meet future, more stringent, discharge permit requirements.

9.2.2 LVSWRRF Permit Limits

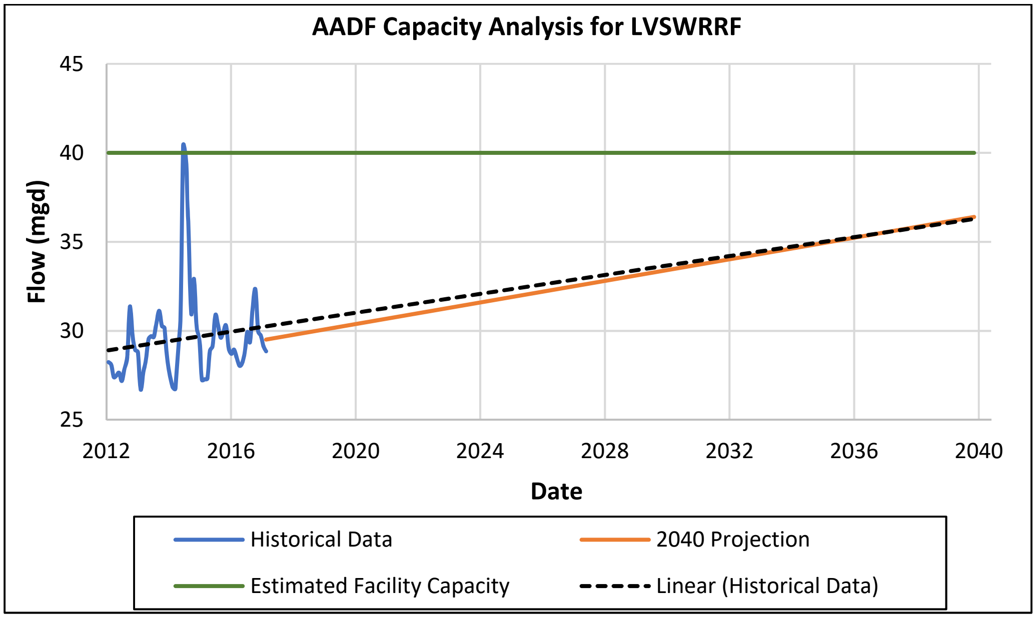

Figure 9-17 AADF Capacity Analysis for LVSWRRF

Figure 9-17 demonstrates historical flow data, flow projections into the year 2040, and the estimated facility capacity of LVSWRRF based on predicted Regulation 31 effluent concentration limits. A similar approach to JDPWRRF was used for determining future capacity for LVSWWRF. A calibrated process model was used to estimate the capacity of LVSWRRF using simulated influent conditions based on wastewater characterization data and flow projections. The capacity estimate assumes that influent characteristics (especially constituent ratios) for COD, cBOD, TSS, TKN, ammonia, and TP will not significantly change over time.

The process modelling analysis completed as part of the *2010 Nutrient Removal Study (Stantec)* indicates that the effluent TN and TP values are the limiting factors in determining the capacity of the facility. The process model predicts that LVSWRRF has a capacity of 40 mgd based on effluent values of 3.47 mg/L for TN and 0.28 mg/L for TP. It should be noted that LVSWRRF has average DON and DOP concentrations of about 1.66 mg/L and 0.20 mg/L respectively. If these DON and DOP values are subtracted from the modeled TN and TP values for LVSWRRF, the simulated effluent limits that the facility can biologically achieve are roughly about 1.81 mg/L and 0.08 mg/L for TN and TP respectively which are close to the anticipated Reg 31 limits for these parameters. These TN and TP effluent limits are indicative of what can be reliably and consistently achieved through a BNR process. Removal of DON and DOP will require incorporation of advanced treatment process employing chemical and physical means such as precipitation, reverse osmosis, or ultra-filtration.

Using these effluent limits, the LVSWRRF has an estimated capacity of about 40 mgd. The two flow prediction methods discussed in Section 5.4.2.1, a trendline based on historical data and a prediction based on TAZ population data, provide projected flow values of 37 mgd for the year 2040. Based on the collection system modeling, the build out flows estimated for LVSWRRF is about 37.33 mgd. Figure 9-1 demonstrates that LVSWRRF will operate within capacity in the year 2040. In other words, LVSWRRF has available capacity irrespective of whether the maximum flow of around 37 mgd in the future is estimated based on historical flows or build out predicted conditions. Unlike JDPWRRF, LVSWRRF does not have plenty of surplus available capacity in the year 2040 but sufficient to meet the forecasted needs.

It should be noted that for LVSWRRF to meet the future anticipated regulatory limits under Regulation 31, significant treatment process improvements will have to be made which can include

- Reconfiguration of existing A2O process to 5-stage Bardenpho
- Supplemental carbon source
- Tertiary treatment using sand or other media-based filtration
- Alum sand filter aid polymer storage and feed system to aid with tertiary treatment
- Advanced tertiary treatment such as ultrafiltration and reverse osmosis
- Brine management system
- Pumping system to transfer fluids between processes

The process model that was used to determine the capacity assumes that those changes have been made at LVSWRRF which will allow it to meet the advanced nutrient limits. A schematic of the process model along with some of the key influent characteristics used in the model are shown below.

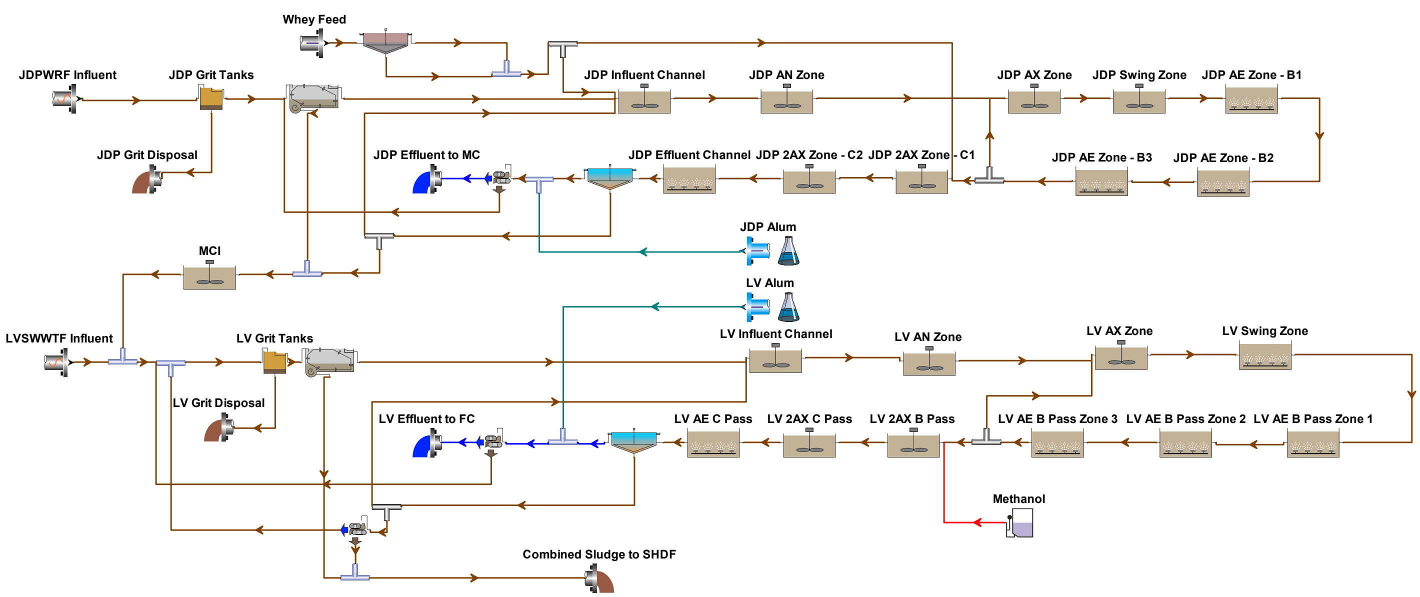

Figure 9-18 Process Model Schematic for LVSWRRF Enhanced BNR and Tertiary P Removal

Table 9-3 LVSWRRF Representative Influent Concentrations for Key Constituents

Constituent	Concentration (mg/L)
TSS (mg/L)	314
COD (mg/L)	768
$CBOD_5$ (mg/L)	371
TKN (mg/L)	53
NH_3 (mg/L)	31
TP (mg/L)	8

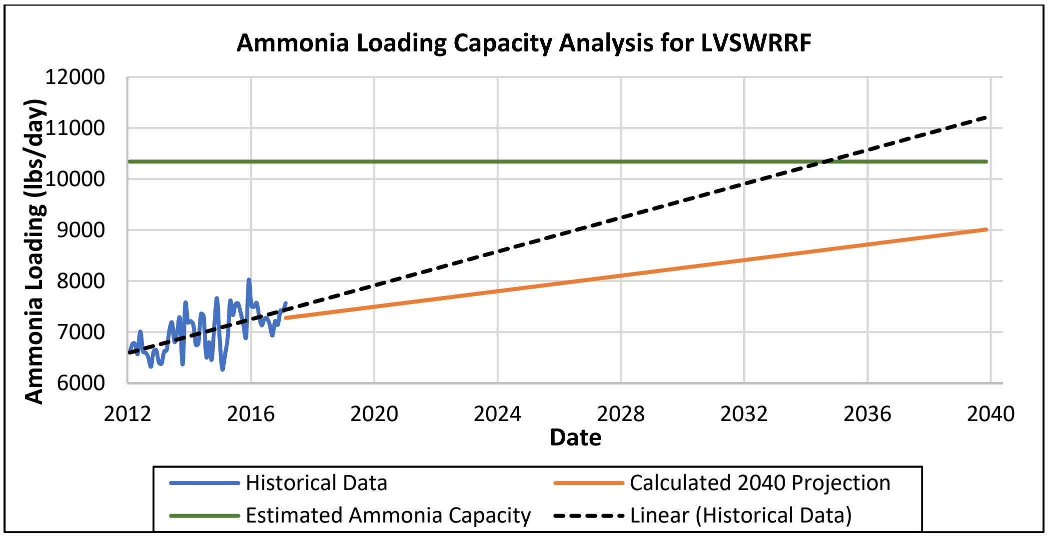

Figure 9-19 Ammonia Loading Capacity Analysis for LVSWRRF

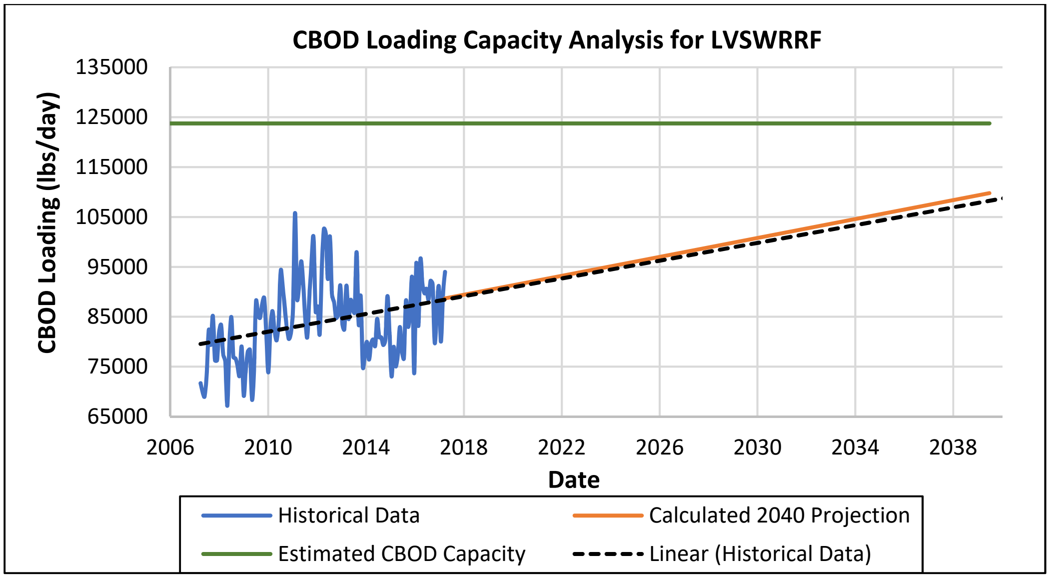

Figure 9-20 CBOD Loading Capacity Analysis for LVSWRRF

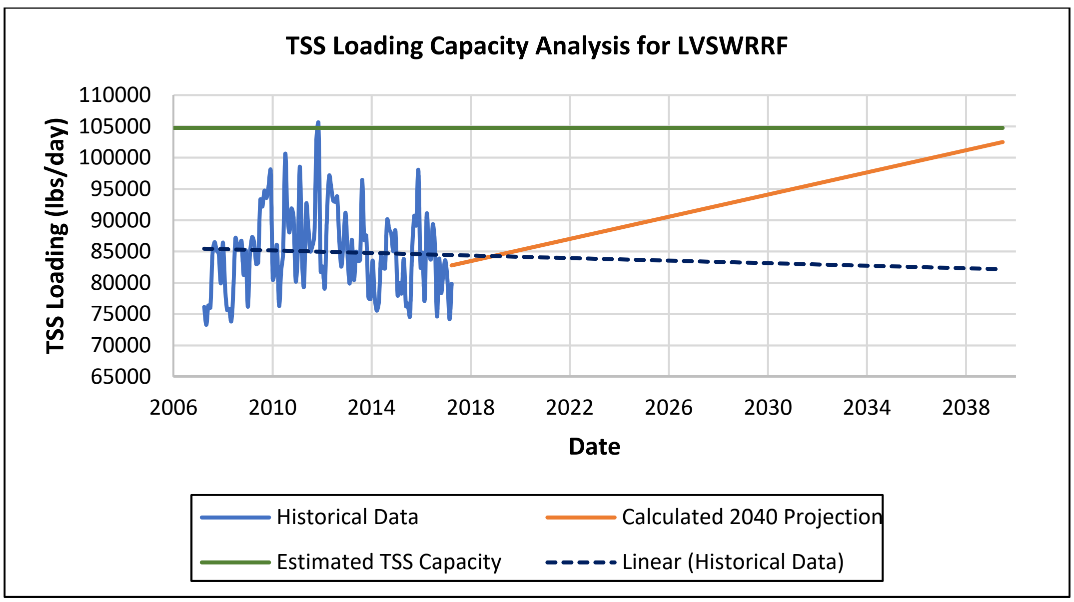

Figure 9-21 TSS Loading Capacity Analysis for LVSWRRF

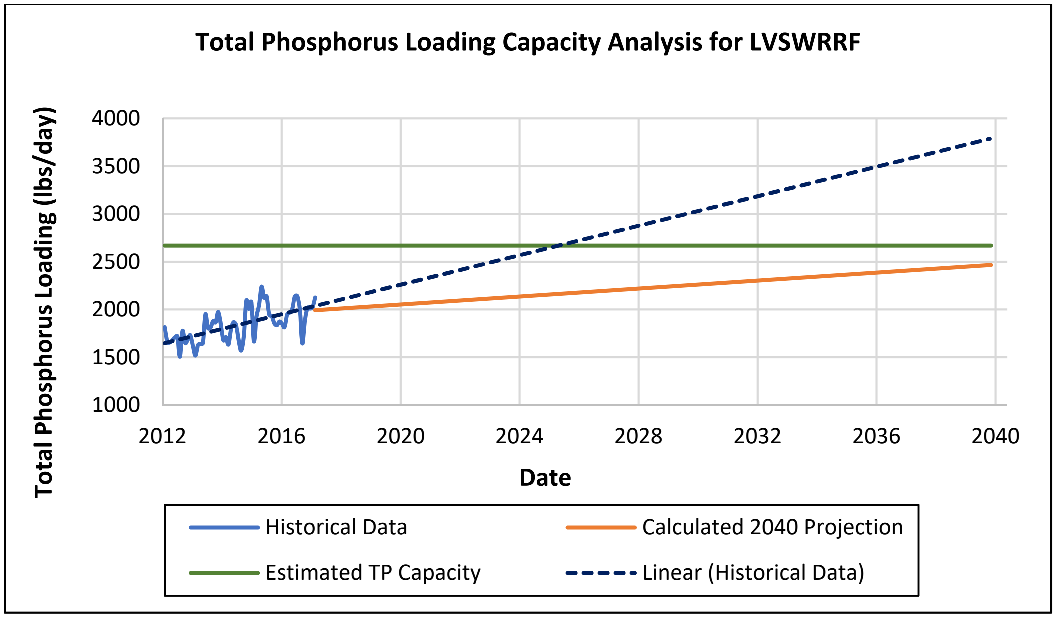

Figure 9-22 Total Phosphorus Loading Capacity Analysis for LVSWRRF

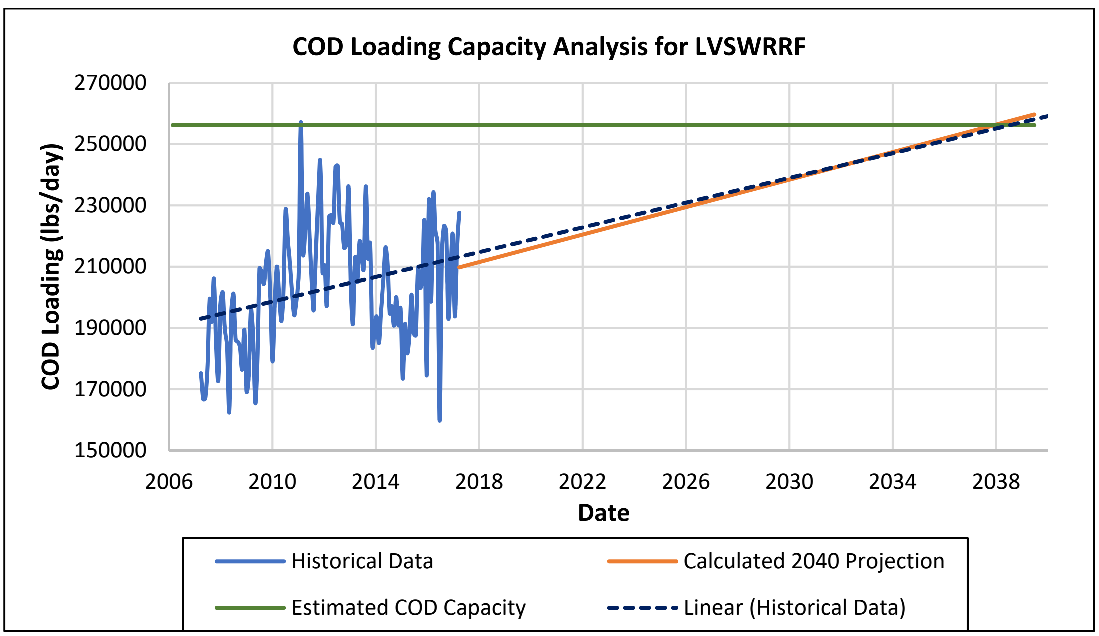

Figure 9-23 COD Loading Capacity Analysis for LVSWRRF

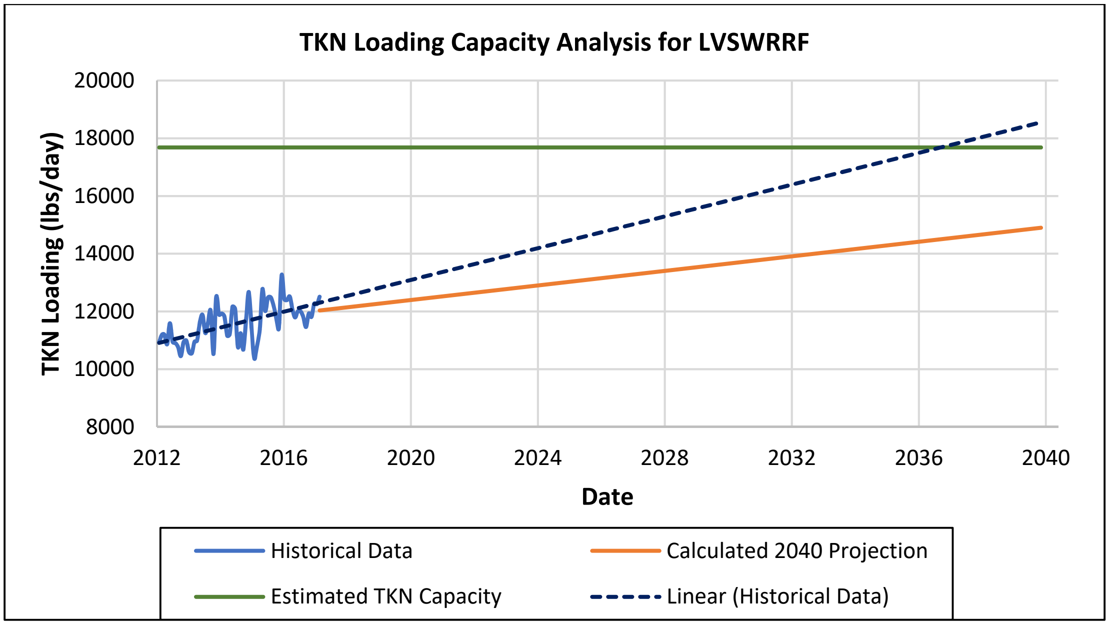

Figure 9-24 TKN Loading Capacity Analysis for LVSWRRF

Figures 9-19 through 9-24 indicate that LVSWRRF may reach capacity from a loading perspective for constituents such as NH_3, TP, TKN, and COD by the year 2040. For NH_3, TP and TKN, the historical data trendlines project that capacities may be exceeded by 2040, though the TAZ population projections do not reach capacity before 2040. Due to the discrepancy between the two projection methods, these capacity analyses will need to be updated and analyzed in future *WWSP*'s to better predict the likelihood of these constituents impacting the capacity at LVSWRRF. On the other hand, both loading projection methods (historical trendline and TAZ population projection) for COD predict that capacity could be reached at LVSWRRF before 2040 (approximately in the year 2034). Therefore, it is recommended that the COD loading and characterization is closely monitored for the next few years to get a better understanding of this potential capacity constraint for LVSWRRF. It is also recommended that the process model be used to investigate the possibility that the RRF could treat a higher COD load without adversely affecting effluent quality. This is because the RRFs usually tend to be "carbon limited" in other words they require carbon for the necessary nitrogen and phosphorus removal. Therefore, depending on the portion of the influent carbon (measured in terms of COD) that is readily biodegradable (aka "good carbon") a higher COD loading might not necessarily adversely impact effluent quality.

9.2.3 CSRRRF Permit Limits

The following is the recommended CDPHE design TVS loading for sludge stabilization using anaerobic digestion:

$$Recommended\ Design\ TVS\ Loading = \ 0.1\ to\ 0.2 \frac{lbs}{day * ft^3}$$

The maximum TVS loading capacity at CSRRRF is determined using the following equation:

$$Estimated\ TVS\ Loading\ Capacity\left(\frac{mass}{time}\right) = Design\ TVS\ Loading\ \left(\frac{mass}{time * volume}\right) * Total\ Digester\ Volume(volume)$$

CSRRRF currently operates six out of the eight available digesters; two digesters are unavailable. The total volume of five operable digesters (with one digester for standby or redundancy) was multiplied by the conservative TVS loading value of 0.1 lbs/day/ft^3 to estimate the TVS loading capacity for CSRRRF.

The following graph demonstrates the historical loading data, loading projections into the year 2040, and the estimated loading capacity for TVS at CSRRRF:

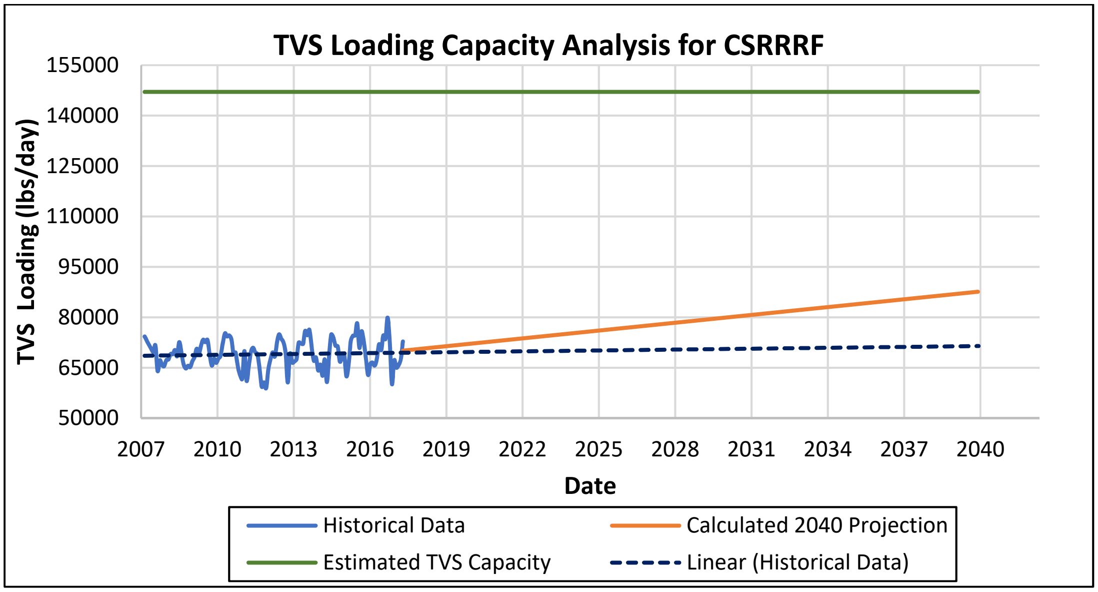

Figure 9-25 TVS Loading Capacity Analysis for CSRRRF

Figure 9-25 demonstrates that CSRRRF will operate well within available capacity in the year 2040. In other words, CSRRRF has plenty of capacity irrespective of whether the loading is based on historical trendline projections or TAZ population projections. The capacity at CSRRRF is mainly a function of the TVS loading to the anaerobic digesters. For capacity evaluation related to the FSBs, and DLDs, please refer to additional details in the *CSRRRF Facility Plan*.

Appendix 9A

Wet Weather Areas of Concerns and Comparison to Previous Studies

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Table 9A-1: 2040 Wet Weather Areas of Concern

2040 Area ID #	Name	Pipe	2017 DRY weather list?	2017 WET Weather List?	Problem	Action
1	North Area	PLS-KC1-45		0	North area growth will produce flows expected to exceed system capacity at Kettle Creek Lift Station. The connections from future growth areas may need a more refined modeling approach to determine "tie-in" impacts	Develop **North SAA** to determine best option(s) for system upgrades.
		PLS-KC5-89		0		
		PLS-KC5-91		0		
		WW101601_1_SOFT		0		
		PLS-KC3-30		0		
		WW104681_1_SOFT		0		
		PLS-PC9-16		0		
		PLS-KC3-76		0		
		PLS-KC5-90		0		
		PLS-KC3-66		0		
		PLS-KC3-65		0		
		PLS-KC1-44		0		
		PLS-PC9-20		0		
		PLS-KC5-20		0		
		PLS-KC3-26		0		
		PLS-PC9-18		0		
		WW124633_1_SOFT		0		
		WW124634_1_SOFT		0		
		WW187625_1_SOFT		0		
		WW187626_1_SOFT		0		
		WW187628_1_SOFT		0		
		WW187629_1_SOFT		**Y**		
		PLS-KC1-46		0		
		WW187636_1_SOFT		0		
		WW187637_1_SOFT		0		
		WW187639_1_SOFT		0		
		KETTLE CREEK LIFT STATION		0		
2		PLS-R4-117		0	Very Slight surcharge on 10" main	Review with **improvements to model.**
3	Cottonwood Creek Interceptor	PLS-LCC10-32		0	2' Surcharge	This problem was not identified in the previous study and needs further investigation through **improving modeled** accuracy of wet weather loading.
		PLS-LCC2-3		0		
		PLS-P1-32		0		
		PLS-LCC2-4		0		
		PLS-P1-52		0		
		PLS-LCC10-34		0		
		PLS-P1-53		0		
		PLS-LCC2-8		0		
		PLS-LCC2-9		0		
4	Northern BLR outfall	WW186017_1_SOFT		0	2-3' Surcharge induced by future BLR flows	**Monitor** the area as this may be a capacity limiting section of main (full flow of this segment = 5.18 MGD)
5		**PLS-NS2-29**		**Y**	0.5' surcharge	Review with **improvements to model.**
6	Siferd	**PLS-TG20-35-2**		**Y**	0.5' surcharge	Review with **improvements to model.**
7	Blazing Trails	**PLS-USC20-99**	**Y**	**Y**	Model shows backwater created by large incoming flow from 12" on	Review with **improvements to model. Verify invert elevations**
		PLS-USC20-50	**Y**	**0**		
8	Grand Vista Circle	**PLS-MV7-3**		**Y**	Undersized main that has had past problems under wet weather loading. The main in this area was replaced with a flatter main that caused the reduced capacity.	Review with **improvements to model**. Plan a pipe upsizing project using Advanced Recovery funds
		PLS-MV7-5		**Y**		
		PLS-MV7-6		**Y**		
9	Radiant Drive	PLS-USC9-107		0	2' surcharge	Review with **improvements to model. Verify invert elevations**
		PLS-USC9-100		0		
		PLS-USC9-101		0		
10	Wooten Road	PLS-USC3-66		0	2-3' Surcharge	Review with **improvement to model**
		PLS-USC3-70		0		
		PLS-USC3-88		0		
11	West Side	PLS-GOG10-202		0	Surcharges dues to RDII- the West Side has had a history of problems due to wet weather flows, most recently in 2015.	**Improvements to the model** along with **specific evaluation of the West Side GoG area** to determine impacts and develop alternatives.
		PLS-GOG10-203		Y		
		PLS-GOG7-149		0		
		PLS-GOG7-151		**Y**		
		PLS-GOG1-18		0		
		PLS-GOG7-150		**Y**		
		WW.196548		**Y**		
		PLS-GOG1-50		0		
		PLS-WS6-96		0		
		PLS-WS8-99		0		
		PLS-WS8-38-2		0		
		PLS-BOT2-47		0		
		PLS-BOT2-44-2		0		
		PLS-BOT2-44-3		0		
		PLS-BOT2-44		0		
12		**PLS-PJ1-133**		**Y**	Low invert causes backwater where it connects to the larger Sierra Madre 30"	**Verify Invert Elevation**
13	Spring Creek south of Platte north of Airport	WW170428_2_SOFT		0	Surcharging of about 1-2'	**Review in updated model**
		PLS-SC10-62		0		
		PLS-SC10-59		0		
		PLS-SC10-50		0		
14	Shelley Ave	PLS-SC11-140		0	Surcharging of about 2'	**Review in updated model**
		PLS-SC11-132		0		
15	Rio Grande and 21st St	**PLS-BC1-16**		**Y**	Surcharging of about 1-2'	**Review in updated model**
		PLS-BC1-15		**Y**		
16		PLS-SM4-120		0	Slight surcharge	**Review in updated model**
17	Carson Valley	PLS-CV10-17		0	Wide Spread surcharging based on modeled conditions	Model conditions likely over estimate the wet weather response in the system in this area. However, past problems have occurred in this basin due to wet weather flow and need to be taken into consideration. **The model should be updated.**
		PLS-CV10-20		0		
		PLS-CV10-23		0		
		PLS-CV2-95		0		
		PLS-CV2-98		0		
		PLS-CV10-50		0		
		PLS-CV6-49		0		
		PLS-CV7-27		0		
		PLS-CV7-32		0		
		PLS-CV10-25		0		
		PLS-CV10-26		0		
		PLS-CV2-3		0		
		PLS-CV2-82		0		
		PLS-CV7-21		0		
		PLS-CV2-8		0		
		PLS-CV6-53		0		
		PLS-CV6-58		**Y**		
		PLS-CV7-8		0		
		PLS-CV2-7		0		
		PLS-CV8-86		0		
		PLS-CV8-89		0		
		PLS-CV7-4		0		
		PLS-CV7-13		0		
		PLS-CV10-21		0		
		PLS-CV8-84		0		
		PLS-CV8-90		0		
		PLS-CV2-80		0		
		PLS-CV10-53		0		
		PLS-CV7-19		0		
		PLS-CV10-24		0		
		PLS-CV2-85		0		
		PLS-CV2-73		0		
		PLS-CV6-51		0		
		PLS-CV6-65		0		
		PLS-CV7-7		0		
		PLS-CV7-29		0		
		PLS-CV6-56		0		
		PLS-CV6-59		0		
		PLS-CV2-6		0		
		PLS-CV8-87		0		
		PLS-CV6-31		0		
		PLS-CV6-57		0		
		PLS-CV6-66		0		
		PLS-ST6-68		0		
		PLS-CV10-9		0		
		PLS-CV7-35		0		
		PLS-CV10-27		0		
		PLS-CV2-10		0		
		PLS-CV2-11		0		
		PLS-CV10-10		0		
		PLS-CV7-5		0		
		PLS-CV8-91		0		
		PLS-CV2-83		0		
		PLS-CV7-10		0		
		PLS-CV7-22		0		
		PLS-CV7-43		0		
		PLS-CV2-103		0		
		PLS-CV2-4		0		
		PLS-CV6-62		0		
		PLS-CV6-64		0		
		PLS-CV7-16		0		
		PLS-CV2-5		0		
		PLS-CV8-85		0		
		PLS-CV6-63		0		
18		**PLS-SC7-143**		**Y**	low invert causes backwater where it connects to the larger Spring Creek Interceptor 30"	**Verify Invert Elevation**
19	BLR	PLS-LSC27-15		0	BLR Flows on the Zig Zag and points downstream including the Sand Creek Lift Station	It has been long anticipated that the system to support BLR growth will need improvements. **Updates to the BLR Study and Alternative Analysis** are needed due to changes in wastewater use that may alter the planned upgrades.
		PLS-LSC27-18		0		
		PLS-LSC27-21		0		
		PLS-LSC27-43		0		
		PLS-LSC27-93		0		
		PLS-LSC27-92		0		
		PLS-LSC27-95		0		
		PLS-LSC27-102		0		
		PLS-LSC20-87		0		
		PLS-LSC18-117		0		
		PLS-LSC10-146		0		
		PLS-LSC10-158		0		
		PLS-LSC10-160		0		
		PLS-LSC10-161		0		
		PLS-LSC13-4		0		
		PLS-LSC27-81		0		
		PLS-LSC27-59		0		
		PLS-LSC20-92		0		
		PLS-LSC9-98		0		
		PLS-LSC27-90		0		
		PLS-LSC27-98		0		
		PLS-LSC10-143		0		
		PLS-LSC10-145		0		
		PLS-LSC27-51		0		
		PLS-LSC20-89		0		
		PLS-LSC9-95		0		
		PLS-LSC27-14		0		
		PLS-LSC27-39		0		
		PLS-LSC27-46		0		
		PLS-LSC27-48		0		
		PLS-LSC27-63		0		
		PLS-LSC27-70		0		
		PLS-LSC27-76		0		
		PLS-LSC18-117-2		0		
		PLS-LSC27-44		0		
		PLS-LSC27-72		0		
		PLS-LSC27-78		0		
		PLS-LSC27-50		0		
		PLS-LSC9-97		0		
		PLS-LSC9-99		0		
		PLS-LSC27-40		0		
		PLS-LSC27-47		0		
		PLS-LSC27-16		0		
		PLS-LSC27-24		0		
		PLS-LSC27-38		0		
		PLS-LSC10-156		0		
		PLS-LSC13-5		0		
		PLS-LSC22-112		0		
		PLS-LSC27-25		0		
		PLS-LSC27-22		0		
		PLS-LSC10-150		0		
		PLS-LSC10-162		0		
		PLS-LSC27-56		0		
		PLS-LSC20-3		0		
		PLS-LSC27-17		0		
		PLS-LSC27-87		0		
		PLS-LSC10-151		0		
		PLS-LSC13-6		0		
		PLS-LSC20-186		0		
		PLS-LSC27-20		0		
		PLS-LSC27-52		0		
		PLS-LSC27-53		0		
		PLS-LSC27-85		0		
		PLS-LSC20-90		0		
		PLS-LSC13-2		0		
		PLS-LSC9-101		0		
		PLS-LSC20-182		0		
		WW165961_1_SOFT		0		
		PLS-LSC10-154		0		
		PLS-LSC27-38-2		0		
		WW181504_1_SOFT		0		
		WW181505_1_SOFT		0		
		WW181506_1_SOFT		0		
		WW181508_1_SOFT		0		
		WW181509_1_SOFT		0		
		WW181510_1_SOFT		0		
		WW181511_1_SOFT		0		
		WW181512_1_SOFT		0		
		WW181513_1_SOFT		0		
		WW181514_1_SOFT		0		
		WW181515_1_SOFT		0		
		WW181644_1_SOFT		0		
		WW181645_1_SOFT		0		
		WW181646_1_SOFT		0		
		WW181647_1_SOFT		0		
		WW181648_1_SOFT		0		
		WW183564_1_SOFT		0		
		WW183571_1_SOFT		0		
		WW183574_1_SOFT		0		
		WW183575_1_SOFT		0		
		WW183577_1_SOFT		0		
		WW187224_1_SOFT		0		
		PLS-LSC27-16-2		0		
		WW187704_1_SOFT		0		
		WW187705_1_SOFT		0		
		WW187706_1_SOFT		0		
		WW187707_1_SOFT		0		
		WW187709_1_SOFT		0		
		WW187710_1_SOFT		0		
		WW187711_1_SOFT		0		
		WW187712_1_SOFT		0		
		WW187713_1_SOFT		0		
		WW187715_1_SOFT		0		
		WW187716_1_SOFT		0		
		WW187717_1_SOFT		0		
		WW187718_1_SOFT		0		
		WW187719_1_SOFT		0		
		WW187720_1_SOFT		0		
		WW187721_1_SOFT		0		
		WW187722_1_SOFT		0		
		WW187723_1_SOFT		0		
		WW187724_1_SOFT		0		
		WW187725_1_SOFT		0		
		WW.186988		0		
		WW.186994		0		
		WW.187002		0		
		WW.186978		0		
		SAND CREEK LIFT STATION		0		

Table 9A-2: Comparison to Previous Study

Previous MWH Potential Dry Weather Deficiencies (rows WW123705 through WW117646)

Previous Study M.H. ID	*Previous Study Project Identifier*	*Previous Study Notes*	**2017 Wet Weather Condition**	**2040 WWF Conditions**	**Action/Notes**
WW123705	*?*	*Slight Localized surcharging due to capacity deficiency*	no modeled issues	No modeled issues	Model was corrected to reflect new main size
WW109565	*SpC-2*	*...note in report does not correlate with the location*	no modeled issues	Model shows some issues remaining under this scenario	CSU Project Completed. Some issues remain. Project N of Airport helped. **Review surcharging limits**
WW114705	*SpC-1*	*Localized Surcharging*	no modeled issues	No modeled issues - see new notes	CSU Project Completed. **Issue resolved**
WW125631	*SaC-10*	*Localized Surcharging*	no modeled issues	Model shows impact from BLR flows	**BLR SAA**
WW187634	*KC-2*	*Backup due to pump station as well as downstream line flat slope*	Same Issue in current model.	Same Issues in current model	**North SAA - Kettle Creek Lift Station will need to be upgraded**
WW123610	*SaC-7*	*Line Surcharges because of tie-in of BLR Area 3*	no modeled issues	no modeled issues	The previous study had a large upgrade planned for the main north of Milton Proby. This will be revised with a new **BLR SAA**
WW131648	*?*	*Localized Surcharging*	no modeled issues	Issues attributed to BLR outfall	**BLR SAA**
WW170142	*KC-1*	*Predicting overflow due future flow from undeveloped land*	no modeled issues	No modeled issues	Likelihood of using this tie in is low based on development to the south and Kettle Creek conflicts. **Monitor**
WW182083	*SaC-5*	*Localized Surcharging*	no modeled issues	Model shows issues further downstream	**Monitor** this area as it has been constructed and tie area to the north is undetermined
WW182055	*SaC-5*	*Localized Surcharging*	no modeled issues	No modeled issues	The outfall of BLR North of Stetson Hills is currently being developed. Capacity of this line will remain a priority in the system strategy. **Monitor**
WW183575	*SaC-4*	*Predicting overflow without improvements*	no modeled issues	Same Issues in current model	BLR Zig-zag will need to be addressed in **BLR SAA**
WW117646	*?*	*Localized Surcharging*	no modeled issues	Same Issues in current model	**BLR** affected area downstream of Zig Zag
WW106497	*SaC-1*	*None*	no modeled issues	No modeled issues	
WW120594	*SaC-2*	*None*	no modeled issues	No modeled issues	
WW112689	*SpC-1*	*Additional upstream section of 8-inch that is under capacity once this section is upsized*	Pipe Project resolved issues.	No modeled issues	Pipe Project **resolved issues**
WW119473	*SpC-2*	*15-inch sewer lines with insufficient capacity*	Pipe Project resolved issues.	Model shows some issues remaining under this scenario	CSU Project Completed. Some issues remain. Project N of Airport helped. **Review surcharging limits**
WW104126	*MV-1*	*Existing 8-inch on flatter grade than the existing 8-inch upstream and downstream*	same issues remain and have been observed in the field under heavy flow condition	Same Issues in current model	same issues remain and have been observed in the field under heavy flow condition. **Develop project to resolve**
WW108160	*?*	*none*	No modeled issues	No modeled issues	
WW123980	*GoG-2*	*Overflows predicted at ww.115734 & WW.103646. Downstream is 8-inch pipe that will need capacity improvements if this stretch is improved*	Revised model - previous model was too conservative on area that would contribute flow at WW127687 (Garden of the Gods Open Space area). Still predicting surcharge at WW105751 , which is well downstream of the area but mentioned here. WW105751 has had a history of surcharging (West Side) and is worth additional investigation to determine risk in the area. **GoG & WS RDII Analysis**		
WW111724	*GoG-1*	*The model shows existing 8-inch sewer upstream and downstream of this pipe segment making this segment a bottleneck*	Pipes upstream of WW111724 are surcharged in the 2017 WWF model		**GoG & WS RDII Analysis**
WW103736	*GoG-4*	*None*	no modeled issues	no modeled issues	
WW108168	*WS-1*	*None*	no modeled issues	Issue downstream	**GoG & WS RDII Analysis**
WW127733	*WS-2*	*Overflow predicted at WW129742*	no modeled issues	Issue up stream	**GoG & WS RDII Analysis**
WW129750	*WS-2*	*8-inch line with a small run of 12-inch sewers in the middle of the stretch. Overflow predicted at WW129750 & WW103799*	no modeled issues. Pipe upgrades may have resolved did not find 8-inch from previous study	Issue up stream	**GoG & WS RDII Analysis**
WW113976	*???*	*none*	no modeled issues	no modeled issue	
WW131726	*?*	*Pipe grade is flat, needs slight re-grading*	Same issues noted	Same Issues in current model	**GoG & WS RDII Analysis**
WW183575	*?*	*Overflows predicted at WW187718m WW187707, & WW183564*	No modeled issues - BLR outfall zig zag	Same Issues in current model	**BLR SAA**
WW115672	*?*	*Existing 21-inch line on flatter grade than the existing 8-inch upstream and downstream*	No modeled issues - BLR outfall downstream of Zig Zag	Same Issues in current model	**BLR SAA**
WW131644	*SaC-10*	*Existing 30-inch line on flatter grade*	No modeled issues. SSCC project upsized to 36" pipe.	More Issues noted due to BLR flow	**BLR SAA**
WW123610	*SaC-7*	*Overflow predicted at WW123610. Line surcharges because of the tie-in of BLR Area 3. It is a known problem that this line cannot support BLR Area 3 without being surcharged*	No modeled issues - pipe was part of the BLR strategy in 2008 and may be revised with new SAA		
KETTLE CREEK PS		*Peak flow reaching lift station in 2020 is 3.3. MGD, 4.2 MGD in 2030*	Peak flow (3.0 MGD - modeled) is above pump capacity, 2.5 MGD. Wet well depth increases providing storage. No flooding modeled but lift station is at its max capacity	Same Issues in current model	Address Kettle Creek in **North SAA**
BLACK SQUIRREL PS		*Peak flow reaching LS in 2020 is 1.2 MGD, 1.7 MGD in 2030*	No modeled issues. Black Squirrel pumping capacity from PI is estimated at 1.5 MGD	Same Issues in current model	Black Squirrel could be reviewed in the **North SAA**
SAND CREEK PS		*Peak flow reaching LS in 2020 is 30.7 MGD, 33.2 MGD in 2030*	Revised model with "ideal pump". Capacity issue is indicated as peak flows (23.8 MGD - modeled) exceed pumping capacity of 20 MGD. This condition was observed in May 2015 when emergency storage was utilized to prevent SSO at the lift station.	Same Issues in current model	Address in **BLR SAA**
LVSWRRF PEPS		*Peak flow reaching WRRF LS in 2020 is 104 MGD, 110 MGD in 2030.*	Peak modeled flow (2017) = 76 MGD		Check in **LVWRRF Facility Plan**
BLR AREA 3 PS		*New LS -*	This lift station/concept was not utilized		
WW181569	*?*	*none*	No modeled issues - BLR outfall	No modeled issues	Line is built **manage development vs capacity**
WW179510	*?*	*Surcharging within 4-feet of the ground at WW179504*	No modeled issues - BLR outfall	No modeled issues	Line is built **manage development vs capacity**
WW170142	*KC-1*	*Predicting overflow at WW170141 and WW170424. Assumed portion of undeveloped area to the east will tie into this line, which will result in the surcharge*	No modeled issues	No modeled issues	**Manage future tie in locations**

Chapter 10

Risk, Redundancy and Reliability

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10 Risk, Redundancy, Reliability

This chapter is a place holder for this, and future, versions of the *WWSP.* The objective for this system plan is to begin documenting high level scenarios that can be passed to lower level planning documents such as facility plans, program plans, and emergency response scenarios. These planning documents can report up Risk, Reliability, and Redundancy factors that may strategically affect operations, goals, and design from a system level planning initiative.

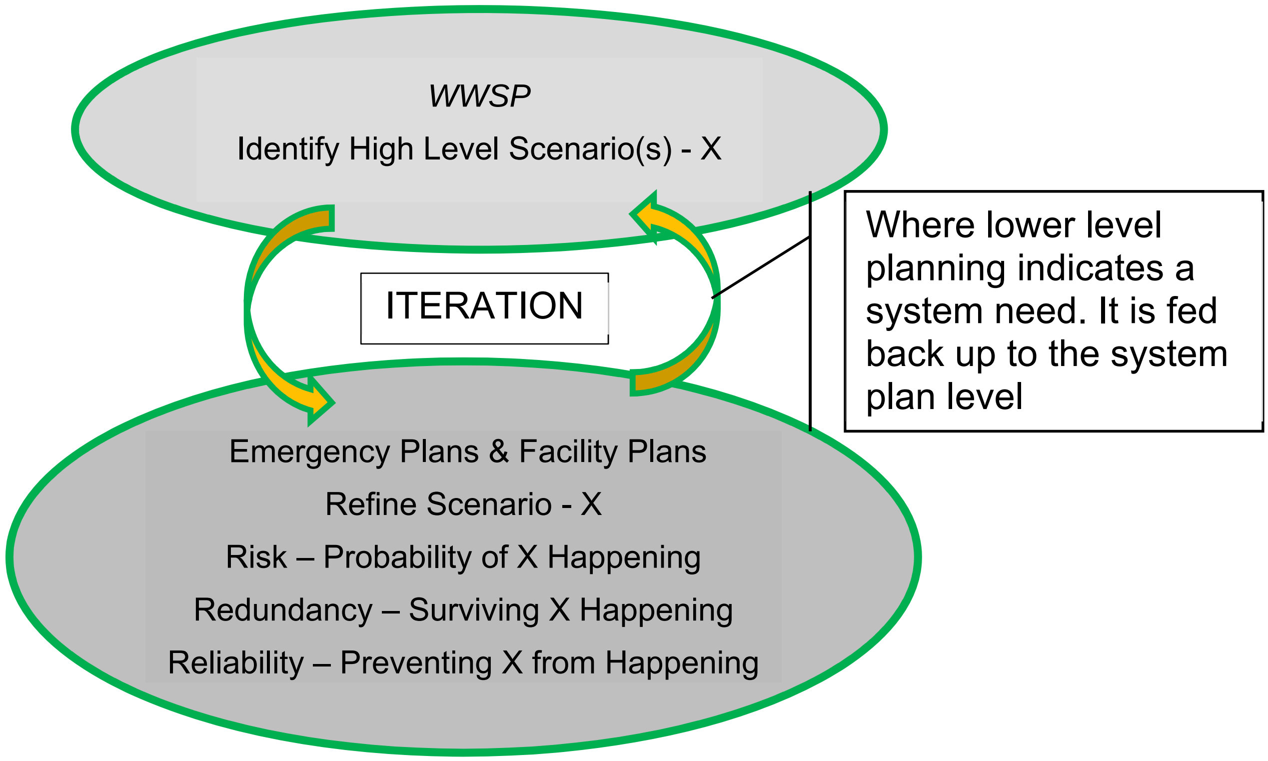

Figure 10-1 Risk Redundancy Reliability Planning Hierarchy

Strategies developed in the lower level planning documents can be passed up to the system level planning through an iterative process if they require implementation at a system level. These strategies will begin to influence Utilities' system criteria. For example, through emergency planning scenarios it could be determined that lift station design and retrofitting should mandate the installation of emergency overflow storage to allow for a specific response time. At this point, a system level policy would be implemented to provide the required improvements. Another example scenario could determine that no practical solution exists for providing redundant measures to a component and that the best course is to design the infrastructure with a higher degree of reliability and limit outside influences like construction impacts to these components.

10.1 Identifying Scenarios

Identifying the right scenarios is an important aspect of risk, redundancy and reliability planning. Sections 10.1.1 and 10.1.2 begin to examine some potential failure scenarios. The goal at the system planning level is to provide broad scenarios as opposed to specific detailed versions.

10.1.1 Recent Experiences

Below are some high-level examples of experiences that may serve as catalysts for identifying additional risk, reliability, redundancy scenarios in lower level planning documents.

1. Rainfall Derived Inflow and Infiltration – excessive rain runoff entering the system has negatively impacted collection system capacity and affects WRRF ability to remove constituents of concern.
2. Failed equipment – a broad category, example failures include electrical issues causing failed pumping equipment, failed force mains, etc.
3. Construction damage – outside influences cause failure in system components that were in otherwise suitable condition.

10.1.2 Potential What-Ifs

Some potential what-if scenarios for consideration include

1. Failed Interceptor – example pipe collapse
2. Failed force main – example construction impact to a force main
3. Fire – example fire at a lift station
4. Flood – example catastrophic flood on Monument Creek impacts LVSWRRF
5. Loss of SCADA communication
6. Loss of treatment biology – example chemicals introduced into the collection system that affect treatment biology
7. Reduction of treatment capacity – example one treatment train out of service

10.2 Potential Mitigation

Potential mitigation measures include providing redundancy to cope with system failures and improving reliability to prevent failure.

A balance between redundancy, reliability, economics, risk and level of service is required to produce successful risk, redundancy and reliability planning.

10.2.1 Redundancy

Redundancy, or a backup system, can improve the “survivability” of a failure. Examples of redundant measures already included in the wastewater system include: limiting dry weather gravity system flow to provide a capacity buffer, including a redundant pump at lift stations, providing a backup power generation provision at lift stations, providing a 3-day sludge storage capability at LVSWRRF, and incorporating a 3-day Fountain Creek emergency storage system that allows Fountain Creek to be diverted to a large holding reservoir to be able to be pumped back to LVSWRRF for treatment.

Incorporation of measures through an enhanced understanding of emergency equipment capabilities is also providing a form of redundancy. For example, discharge capacity of portable pumps, vacuum truck (vac-truck) capabilities, single treatment train capacities can help formulate plans and strategies to pull through a pressing situation. Understanding the options and the capability/capacity of emergency equipment can help make informed decisions under duress. The capacities of emergency equipment could be summarized and consolidated in an appendix in future versions of the *WWSP*.

Through emergency response planning scenarios redundancy strategies that need to be applied system wide can be identified, or specific system improvements at a lower level such as flow diversion could be identified and passed up to the system plan.

10.2.2 Reliability

Reliability can be interpreted as the prevention of system failures.

Monitoring activities like condition assessment, where the chances of failure are estimated consistently across an asset class and compared to the criticality of the system component help define a risk score and can be used to guide investment in the system. Condition assessment activities ensure that the capability of the system components remain as designed.

Programmatic work can help maintain system reliability. For example, cleaning a wastewater main prevents backups which would call into action the emergency redundancy procedures designed to cope with circumstances of a sanitary sewer overflow

Reliability may also be inherent in design criteria where reliability over the life cycle of an asset is factored into the initial materials and specifications of the infrastructure.

Reliability measures can also be protection of critical assets from outside harm. For example, close monitoring of construction activities taking place near critical assets could help prevent undue failure.

10.3 Planning Drivers and Objectives

These failure scenarios are expected to be refined through future system planning efforts to provide robust failure analysis and response planning and mitigation measures.

Risk, redundancy and reliability planning may lead to asset classification. As a theoretical example, failure planning for every pipe in the system is impractical, but asset classes can be developed where failures on pipes with lower flow rates can be handled using vac-trucks. Failures on the next asset class level could be handled via portable pumping whereas failures at the highest asset class level could require special contracting to provide by-pass pumping. The facility planning and emergency response scenarios can help identify these different classes and appropriate responses, as applicable.

LoS would also drive the conditions and situations that Utilities would use to identify a failure condition. The LoS would also inform, if or when additional redundancy and reliability measures are warranted. For example, preventing I&I failures during a 1,000-

year rain event with an annual occurrence probability of 0.1% may not be warranted, but failure during a 5-year rain event with an annual occurrence probability of 20% would be unacceptable.

The future iterations of the *WWSP* will build up on these concepts and identify and define both, lower level facility and program-based risk, redundancy and reliability requirements as well as system wide measures that will influence and build upon each other.

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Chapter 11

Project Details and Alternatives Development

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11 Project Details and Alternatives Development

This chapter describes the major wastewater system improvement projects and programs based on the evaluations and analysis conducted as a part of this plan. A summary of projects identified in facility and program planning documents is included in Chapter 3 – Projects and Programs Summary. Many of the identified projects require additional evaluation and analysis to select the best value alternative for future delivery implementation. This analysis will be performed in the SAA phase of the delivery lifecycle of the project. The SAAs identified in Chapter 3 – Projects and Programs Summary are presented in this chapter providing additional detail including some of the alternatives that will be evaluated. The alternatives presented are not meant to be exhaustive, but rather a starting point to begin the future SAAs. For the purpose of this system plan, the most preferred alternative, as perceived at this time, (where applicable) is highlighted along with anticipated costs and timeline for delivery implementation of the project including the date to start the SAA phase. These recommendations, timeline and estimated costs are based on the best information available today. The recommended alternative could change during the SAA phase or as more information comes to light over time in future system plan revisions and as technology and/or policy cause changes in direction.

11.1 *JDP Diversion Study (Completed)*

The 2008 *JDPWRRF Diversion Study* (Stantec) reviewed alternatives to divert flows from LVSWRRF to JDPWRRF and serves to preserve the analysis and results from the study, should future needs arise where the previous work could be beneficial. The original intent of the *Study* was twofold. First, interim service was being provided to BLR, and the interim service period could be extended by diverting flows from LVSWRRF to JDPWRRF. Second, at the time, revisions to NH_3 limits were expected to reduce capacity at LVSWRRF to a point where it may be necessary to increase RRF capacity, or at least offload enough flow so that one basin could be offline while process improvements at LVSWRRF could be made.

The study found that a lift station on the Tremont Interceptor could offload 3.1 mgd from LVSWRRF to JDPWRRF. The RRF impacts were expected to be minimal since the inceptor wastewater characteristics were quantified through a sampling and analysis program. The lift station was expected to have a capital cost of approximately $5 million.

At the time, the flow to LVSWRRF was 35-36 mgd compared to 30 mgd today. Effectively, the desired diversion occurred naturally due to the reduction in wastewater usage. However, the *Study* retains relevance as an opportunity to increase system reliability and redundancy. As flows and loads increase over time, a future capacity shift from LVSWRRF to JDPWRRF may be desired to facilitate RRF planned maintenance or unplanned outage scenarios (e.g. taking an activated sludge basin out of service).

11.1.1 Implementation timeline and costs

The preferred alternative is to build a lift station on the Tremont Interceptor that can offload about 3.1 mgd from LVSWRRF to JDPWRRF. The SAA was completed in 2008. Capital improvement costs are about $5 million and can be required any time over the next 5-10 years especially as regionalization flows from BLR come into play.

11.2 *Kettle Creek Lift Station SAA*

The Kettle Creek Basin in Colorado Springs is expected to grow significantly in the next 20 years. The area includes new developments such as The Farm, Flying Horse, Polaris Pointe (Bass Pro Shop area), and commercial developments near the intersection of InterQuest Parkway and Voyager Parkway. Under forecasted loading conditions, the Kettle Creek Lift Station is anticipated to be under capacity, shown as area of concern #1 (the inset of the “Green Map”). The current conveyance capacity for this segment of the collection system is expected to be reached in the early 2030s.

There is an Advanced Recovery Agreement - AR2013 in place to help fund the future upgrades. The recovery was based on a project cost of $3 million and was designed to extend the Middle Tributary (Mid-Trib) /Monument Branch force main to a gravity discharge past the Kettle Creek Lift Station, effectively offloading the lift station. The recovery money could be applied to another project so long as the same benefit to the area as the original option is achieved.

The planned average day flow for the Kettle Creek Basin is ~2.5 to 3 mgd. Some of the alternatives (Figure 11-1) that should be investigated further include:

a. Current Plan- extending the Mid-Trib /Monument Branch Force Main
   The current plan was developed in 2003 when peak flow rates were expected to be much higher and replacement of the Mid-Trib, Monument Branch, and Kettle Creek Lift stations were expected to be required. Since that time, the Mid-Trib and Monument Branch lift stations are expected to have capacity to convey the expected buildout flows in their current configuration.
b. Gravity interceptor through the USAFA
   As of the writing of the *WWSP*, a collaborative partnership to extend a gravity interceptor through the USAFA has been identified that could provide gravity alternatives for the Kettle Creek, Mid-Trib, and Monument Branch Lift Stations. The NMCI would also connect regional partners allowing for consolidated treatment at JDPWRRF or LVSWRRF. The final execution status of the NMCI should be accounted for in the planning and ultimate implementation of improvements for the Kettle Creek Lift Station.
c. Local Gravity around the Kettle Creek detention pond
   A more challenging gravity route east of I-25 may exist to connect the Kettle Creek Lift Station via gravity to the Pine Creek Interceptor.
d. Upsize Kettle Creek Lift Station
   Upsizing the pump capacity to handle the expected buildout flows.

Figure 11-1 shows the Kettle Creek Lift Station Alternatives.

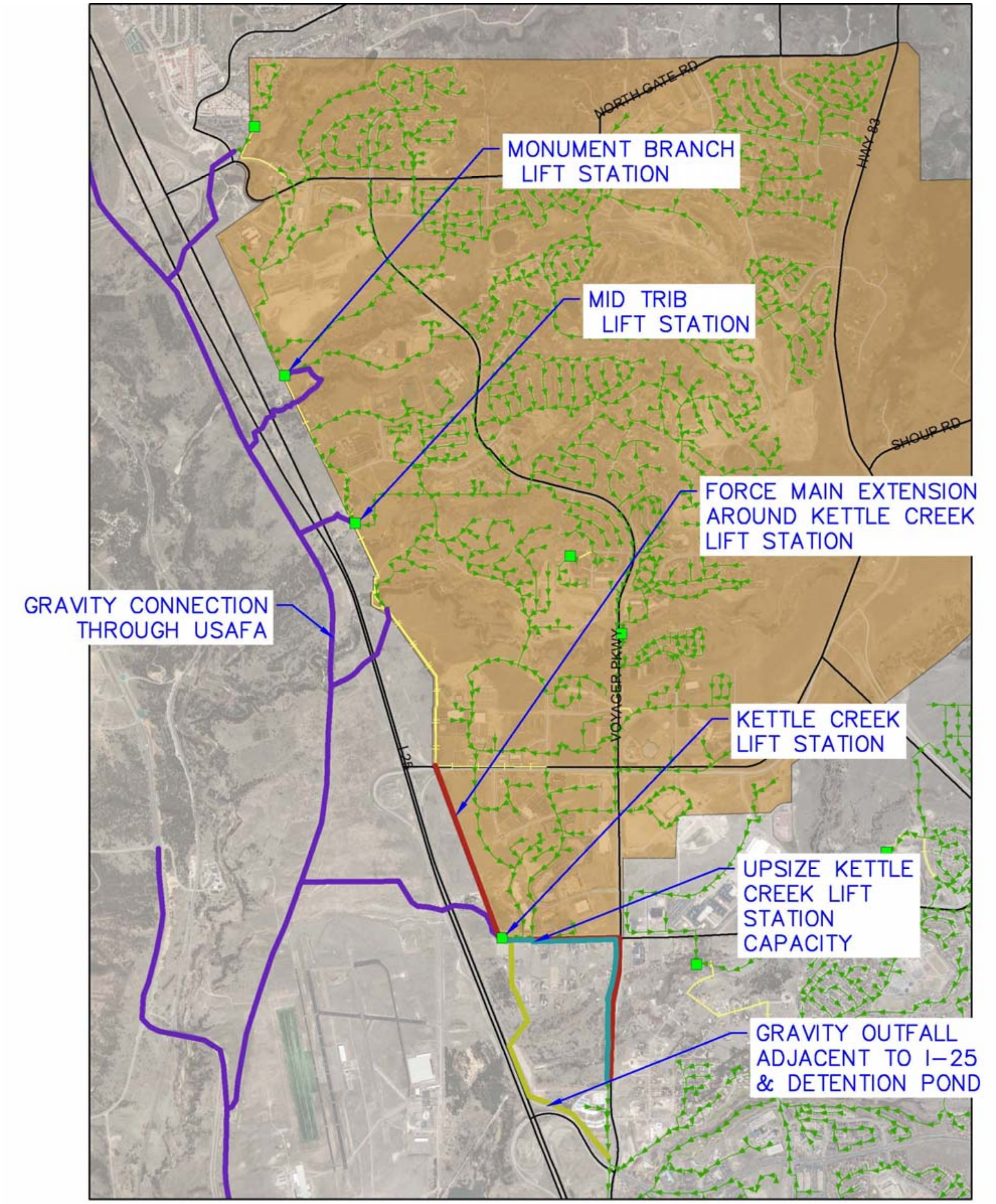

Figure 11-1 Kettle Creek Lift Station Alternatives

11.2.1 Implementation timeline and costs

The preferred alternative to address the long-term requirements for Kettle Creek wastewater flows is to route the flows through a gravity interceptor located on the west side of interstate I-25 on the USAFA property. If the regionalization agreement advances it would allow for collaboration with other wastewater entities and take a more holistic approach towards addressing the Kettle Creek LS and Force Main improvements along with regional wastewater flows. For planning purposes, however the best alternative recommended assumes that the Kettle Creek LS project will be implemented on its own. The project is likely to cost around $3M and will be mostly funded through advanced recovery agreements. A SAA estimated at around $200,000 should be initiated around year 2027 with project construction completion around the year 2030. A capital budget of $3M (mostly funded through advanced recovery agreements) is earmarked for this purpose. If the regionalization opportunity with the Northern Monument Creek Interceptor (NMCI) project (see below) moves forward, the SAA will no longer be necessary and wastewater service currently provided by Kettle Creek Lift Station should be fulfilled through gravity means. The estimated cost for a ~5410 LF gravity main connecting the Kettle Creek Lift Station to the NMCI is between $2.7 Million to $4 million

11.3 *Collection System Model Update*

Through the development of the *System Plan*, it was found that the collection system model needs to be updated. The predicted areas of concern #11 and #17 which show the wet weather flow failures in the Garden of the Gods/Westside Basin and Carson Valley Basin (the inset of the “Green Map”) should be re-evaluated after model improvement to provide an increased level of confidence regarding the failure evaluation and analysis (model predicted flows vs. capacity). In addition to the wet weather areas of concern, flow usage patterns have shifted based on comparisons to field flow monitoring data. The collection system model was corrected to more accurately represent actual system flows; however, the model should be revised to capture the changes in water usage and the changes in growth at individual metering point levels. The flow monitoring program was very beneficial to determine system changes and should be continued with additional key monitoring points used to strategically update/calibrate the model. It is recommended that billing water meter usage data be analyzed as another potential means to update the system loading and create alignment with the *Finished Water System Plan*. I&I represents a risk that should be better understood by development of RTK parameters through review of the flow monitoring location meter data and USGS rainfall data for selected rainfall events.

11.3.1 Implementation timeline and costs

It is recommended that the collection system model be updated within the next five years. The bulk of the update work can be done with internal staffing resources if made available. Specialty outside professional support services would be engaged only as necessary. An O&M budget of $50,000 is estimated to cover any outside professional services support.

11.4 *BLR SAA*

11.4.1 LFMSDD and HDTRWRF

This section is an overview of the area that is planned to receive wastewater service from the Lower Fountain Metropolitan Sewage Disposal District (LFMSDD) and is included in the BLR Alternatives to highlight the strategy for BLR south of Drenann Rd.

An Intergovernmental Agreement (IGA) between Utilities and Colorado Centre Metropolitan District (CCMD) is currently used to acquire interim service in the CCMD Interceptor and LFMSDD Facilities up to 198,000 gpd average flow. It is anticipated that interim service will be purchased through the IGA up to the 198,000 gpd limit. Beyond 198,000 gpd, Utilities has requested inclusion into the Lower Fountain Metropolitan Sewage Disposal District – connections at this point would be in accordance with the inclusion provisions. The rate of growth used in the LFMSDD inclusion application assumed 100 houses per year and anticipated using the entirety of the 198,00 gpd in ~2025. It should be noted that the 2025 date is entirely development driven.

The proposed average daily flow from the area within the City Limits is estimated at 2.2 MGD at buildout including wastewater flow from the Bradley Heights Master Plan, a more detailed portion of the service area. The proposed buildout flow from the Bradley Heights area is planned at 0.48 MGD based on information from the Wastewater Master Facility Form (WWMFF) for the Bradley Heights Master Plan submitted in 2014. The first phase of Bradley Heights is considering the development of about 460 single family homes in the near term (2018).

Currently flows in the “service area” will be conveyed to the Harold D. Thompson Regional Water Reclamation Facility (HDTRWRF). The HDTRWRF has a design capacity of 2.50 MGD average day flow. In total, the facility received ~0.88 MGD (daily average) in 2016.

The CCMD IGA will be sufficient to address wastewater service in the area until about 2025. Past 2025, the area would seek service through the LFMSDD inclusion agreement, pending LFMSDD capacity availability and LFSMDD approval. Future loading from Colorado Springs Utilities service area may require treatment plant capacity expansion that would require necessary permitting and agreements at that time. The wastewater service strategy in the area north of LFMSDD served area should be examined further as part of the overall BLR SAA strategy. The service area for the LFMSDD and the HDTRWRF are shown in a map in Figure 11-2.

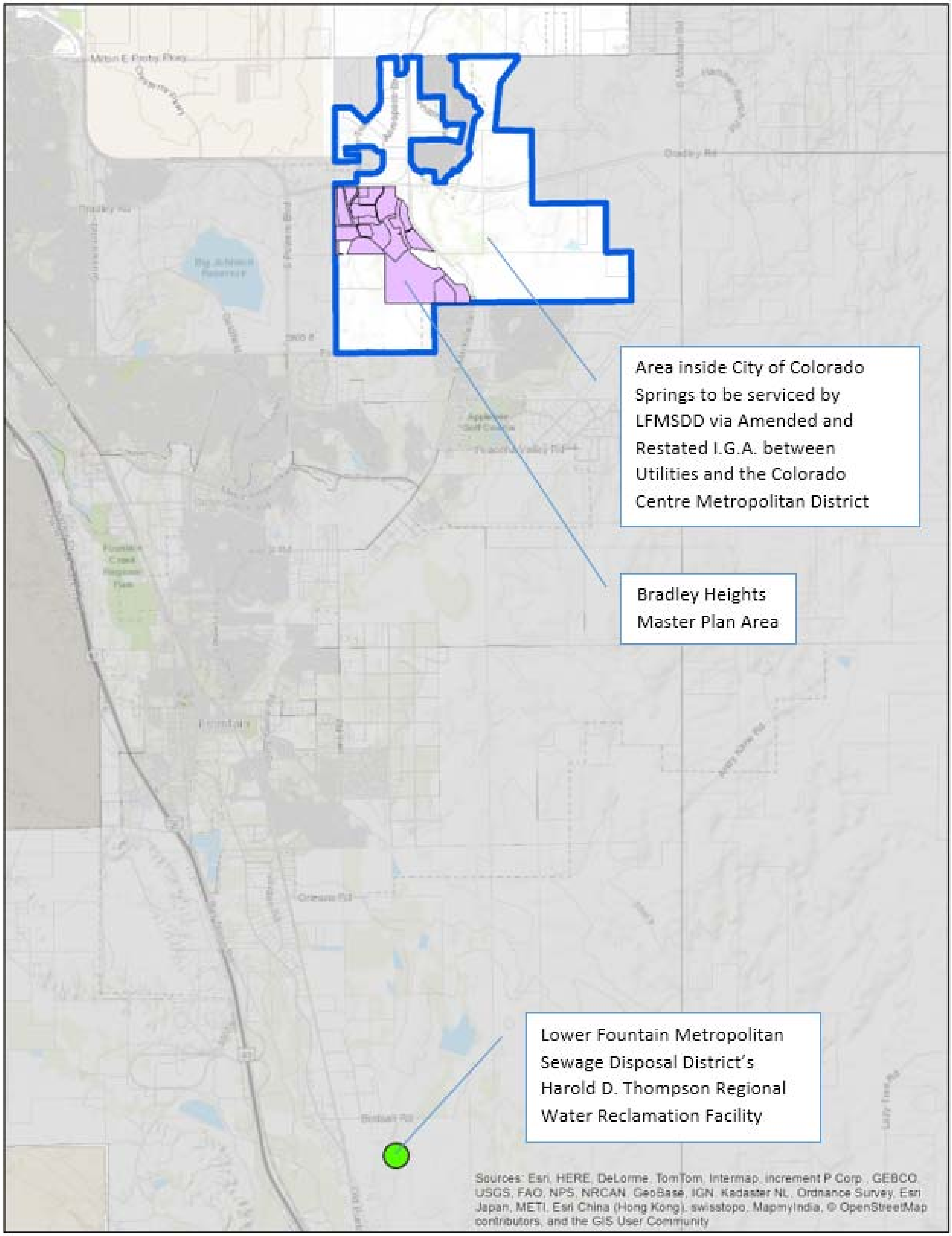

Figure 11-2 Lower Fountain Metropolitan Sewage Disposal District and Harold D. Thompson Regional Water Reclamation Facility

11.4.2 BLR Development

The BLR is a developing community in eastern Colorado Springs. It is the largest area of developable land in Colorado Springs that will likely see growth over the long term in the region and can have significant impacts to the wastewater system both from a collection system and resource recovery (treatment) perspective. BLR can be divided into a north portion and a south portion separated by Hwy 24, each uniquely impacting Utilities' overall wastewater system. The solutions for providing wastewater service to these two portions of BLR can potentially be different and warrant evaluation of alternatives, both on an individual basis, as well as from a holistic perspective.

1. BLR Collection System Options
   The flow generated from the northern area of BLR is expected to exceed collection system capacity in the early 2030's and is indicated as area of concern #19 on the planning map. Capacity is exceeded at the Sand Creek Lift Station and through sections of 18" and 21" pipe that currently connect the northern BLR area to the LVSWRRF. A coordinated study that includes conveyance from the north and south BLR to an RRF is required since the combined flow routing and treatment strategy will affect system configuration. The study should include Utilities' System Extensions group as a key stakeholder to facilitate coordination with the development community to improve planning. Planning average day flow from the Northern BLR area ranges from 3.5 to 4 mgd. Conceptual Alternatives for collection system upgrades for the Northern BLR area – some of which may need be simultaneously implemented include:
   a. "Platte Interceptor" – Current
      The Platte Interceptor is indicated on the planning map and was associated with Advanced Recovery 2019. The plan extended an interceptor along Hwy 24 / Platte Ave to convey northern BLR flow to the Spring Creek Basin. The Spring Creek Interceptor would then be upsized to allow for gravity flow to LVSWRRF.
   b. Deep Diversion along Fountain Blvd and upsizing Spring Creek Interceptor
      This project is similar to the Platte Interceptor, but diverts the flow lower in the Sand Creek Basin along Fountain Blvd. The location reduces the amount of pipe that needs to be upsized and increases the amount of flow diverted away from the Sand Creek Lift Station, but requires the use of advanced micro-tunneling type construction to construct the deep portion of main near Academy Blvd.
   c. Scalping plant near Hwy 24 and Marksheffel to reduce flow
      As an alternative to upgrading the collection system, a small packaged decentralized RRF positioned to offload the northern BLR flows and provide a source of non-potable water to eastern Colorado Springs may help the Wastewater and Non-Potable Systems collaboratively achieve desired outcomes. See Option 3 under the RRF section below.

Flows from the south area of Highway 24 will also need to be planned for as some of the options use the Sand Creek Lift Station. The options for these southerly flows include

a. Conveyance to the HDTRWRF by gravity
   This option plans for the southerly BLR area to be treated at the HDTRWRF.
b. Pumping Southern BLR flows to LVSWRRF
   Conceptually there may be available capacity at LVSWRRF. The southerly portion of BLR could be pumped to the Milton Proby gravity main which would be upsized along with the Sand Creek Lift Station to convey flow to the LVSWRRF.

More details regarding the resource recovery aspect associated with some of these collection system options are described in the RRF section below.

2. BLR Resource Recovery Options
   Some of the potential options and associated rationale for providing reliable wastewater service for BLR from a resource recovery perspective are listed below:
   a. Wastewater flows originating from the northern portion of BLR lend themselves to be treated at the LVSWRRF and are already included in the buildout flows for the facility. The additional solids generated at LVSWRRF from the BLR derived wastewater flows can be conveyed to CSRRRF using the existing sludge pipeline; there are no forecasted capacity issues at CSRRRF.
   b. Wastewater flows originating from the southern portion of BLR are more naturally aligned to be treated at the HDTRWRF where the flows can be delivered by gravity. Utilities currently has a small stake in the HDTRWRF which can be increased if there is a need for additional treatment capacity due to BLR wastewater flows. The HDTRWRF has plenty of space available on site to increase its capacity to potentially treat most of the additional wastewater flows from the southern portion of the BLR. The additional solids generated from the BLR derived wastewater flows at HDTRWRF will need to be either conveyed to CSRRRF using a new pipeline or the HDTRWRF will need to be upgraded to handle the increased solids. The current solids handling process at HDTRWRF is aerobic digestion which may need to be converted to anaerobic digestion to more efficiently increase the wastewater solids treatment capacity. The SAA will need to evaluate the options for solids handling if wastewater flows from BLR are diverted to HDTRWRF.
   c. A third option is to look at the entire BLR property and evaluate the possibility of a satellite or decentralized RRF. This could be a modular packaged type facility that can be increased in size as capacity needs go up. The discharge from the new satellite RRF can either serve non-potable needs in BLR or other parts of the City. Complete consumption of the non-potable supply would likely be a challenge requiring treated effluent to be discharged under a new wastewater discharge permit. The wastewater residuals from the satellite facility would need to be transported via truck or solids pipeline to CSRRRF.

A BLR Wastewater Service SAA is recommended to evaluate all the different alternatives for both the collection system and for resource recovery. Another criterion to consider is the timing of the various development phases within BLR. Housing development has already started in the northern portion of BLR which is being delivered to LVSWWRF through the existing collection system. How the housing development in BLR progresses may dictate not only the alternative that gets selected, but also how it gets implemented. A map showing the BLR service along with some of the collection system and RRF options to serve the BLR area is included in Figure 11-3.

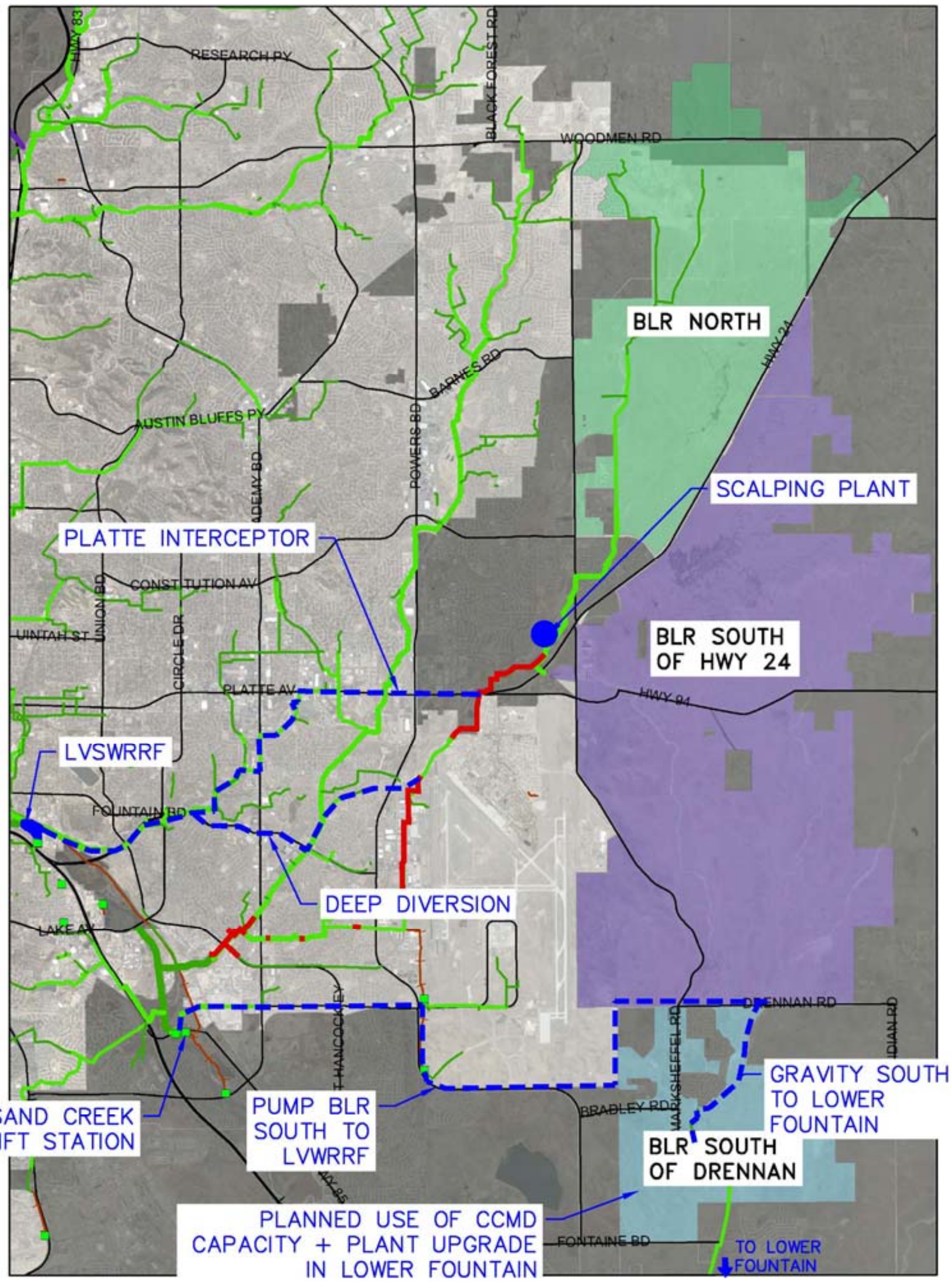

Figure 11-3 BLR Alternatives

11.4.3 Implementation timeline and costs

The timing on completing the BLR SAA is not critical but it is recommended that the SAA be completed within the next five years to have a reliable and robust plan to provide wastewater service for that area of the City as it continues to grow. Again, most of the analysis can be completed internally using specialized services as necessary. An O&M budget of $200,000 is earmarked to help with this effort for outside professional services. The BLR delivery implementation need is expected to occur around the 2030 timeframe as the community gradually grows over time. The preferred alternative at this time would be to build a decentralized facility to serve the resource recovery needs from the northern portion of BLR and route all flows from the southern portions of the BLR to the HDTRWRF. The advantage of this option is the minimal impact to the collection system upgrades. A capital budget of $163M is estimated to cover this current preferred alternative.

11.5 *Carbon Supply Planning*

Carbon is a key requirement for BNR at any WRRF. With changing regulatory scenarios driving lower nutrient limits, the carbon available in the incoming raw wastewater may not be sufficient to organically support BNR at either JDPWRRF or LVSWRRF. Carbon has historically been viewed as a liability from a wastewater treatment perspective. In fact, currently both JDPWRRF's and LVSWRRF's permits are based on an organic loading measured in cBOD. This paradigm is changing and eventually the industry will start distinguishing between "good" (readily biodegradable) and "bad" (slowly or unbiodegradable) carbon in the incoming organic loading (measure of carbon). To support higher levels of BNR, a facility requires "good" carbon that is readily biodegradable. For bio-P removal, if the collection system is long and provides enough detention time, VFAs are generated in the pipeline from by anaerobic conditions before it reaches the facility. LVSWWRF is a good example of this scenario. JDPWRRRF on the other has a relatively short and steeply graded collection system which reduces the available detention time for fermentation reactions, thereby minimizing the VFA portion of the CBOD coming into the facility. This adversely affects the bio-P process at JDPWRRF. Process modelling evaluations indicate that as nutrient limits continue to get more stringent, the carbon deficiency will increase, therefore requiring that it be addressed via alternative carbon sources.

To address the carbon deficiency, most WRRFs look at procuring carbon externally in the form of acetic acid, methanol, or Micro C^{TM} (a proprietary carbon source designed and targeted for BNR) etc. Some of these carbon sources are effective for both nitrogen and phosphorous removal whereas others tend to work preferentially for one nutrient over the other. At JDPWRRF, the carbon deficiency is even more pronounced, causing process and permit compliance issues without respect to discharge requirements for nutrient removal (e.g. Regulation 85). At the outset of facility operations in 2007, JDPWRRF experienced poor denitrification capabilities due to carbon limitations which significantly impacted the denitrification alkalinity recovery at the facility. This in turn led to low effluent pH issues and kept the facility from discharging until a sodium hydroxide feed system for effluent pH adjustment could be added to the facility. This resulted in an unanticipated increase in O&M expenses due to the required chemical addition. The first step in a long-term strategy to address the carbon deficiency was achieved through whey fermentation which took a waste byproduct from a local dairy to produce VFAs through fermentation reactions. The fermented whey yields VFAs that serve as a readily bioavailable carbon source for BNR at the JDPWRRF. During the design of the whey system, a preliminary carbon supply analysis was completed for which some of the summary results are depicted in the graph below. The carbon supply plan basically accounted for carbon requirements at JDPWWRF through time (a 30-year planning period was envisioned) through stochiometric calculations. Assumptions were made for future changing regulations such as Reg 31, and increased loading for N and P due to population and growth triggered changes. The carbon requirements were then calculated to provide a planning level estimate of carbon needs through time. The preliminary carbon source plan also considered primary sludge as a potential carbon source.

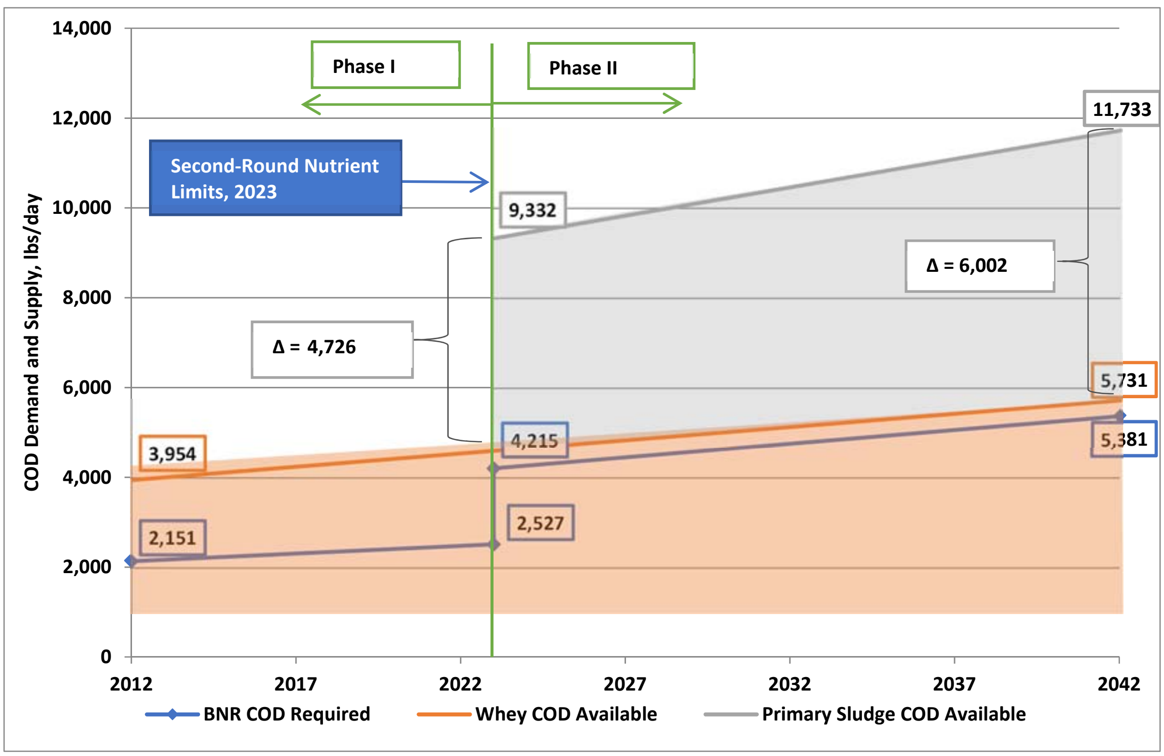

Figure 11-4 Example of Carbon Supply Planning for JDPWRRF

The premise behind completing a carbon supply plan is to ensure that as regulations are getting more stringent, a sufficient and cost-effective carbon supply is available to enable BNR (the preferred process for nutrient removal). Lack of “good” carbon can have a significant impact on the operation of a WRRF from an O&M perspective. It is recommended that Utilities develop a comprehensive carbon supply plan for both WRRFs by evaluating the full spectrum of alternative carbon sources including whey and /or other industrial by-product or waste carbon sources. Brewery waste is another potential carbon source that can be considered. It is also important to keep in perspective that as new industries and local businesses change, they may offer additional opportunities for alternative carbon sources that are waste streams for that business/organization.

Another key aspect that needs to be addressed as part of the carbon supply plan is to update the industrial pretreatment program (IPT) standards to more appropriately differentiate between “good” carbon and “bad” carbon and to address the wastewater constituents that truly increase O&M costs and limit RRF capacity. This should result in a re-structuring of the BOD surcharge rates and the potential to create new surcharges for other constituents of concern (e.g. nitrogen and phosphorus). This will not only bring Utilities’ IPT program up to date with the wastewater industry O&M cost drivers, but also incentivize dischargers to source separate potential sources of “good” carbon from their facility. These carbon sources can help Utilities with its BNR objectives by making these waste products available as an alternative carbon source.

11.5.1 Implementation timeline and costs

This will be an ongoing task as Utilities continues to scout for alternative carbon sources to support BNR at its two WRRFs. A key time critical aspect will be to draft a tariff structure and relevant policy to address BOD and other surcharges as part of the IPT program. It is recommended that this portion of the task be completed by 2023 so an appropriate framework is established as Utilities begins to negotiate with potential industrial dischargers to accept the right form of waste to supplement its carbon requirements. No external support services are anticipated to complete this task with the task mostly requiring internal resources, particularly from IPT.

11.6 *Process Model Updates*

A comprehensive sampling and analysis, data collection, and process modeling and evaluation effort for the LVSWRRF and JDPWRRF was completed in 2008/2009. The effort involved developing a calibrated and validated process model using BioWin™ for JDPWRRF and LVSWRRF and linking the two facilities together to model the sludge flows from JDPWRRF to LVSWRRF. The model was used to identify and troubleshoot process issues under current performance conditions and was also used to simulate facility performance under projected flows and loadings and anticipated future regulatory conditions. One of the key uses of the process model was to plan for nutrient regulations such as Reg 85 and Reg 31. These conditions were simulated using the process models. Process changes and improvements required to meet future anticipated nutrient limits were evaluated and used to develop conceptual improvement/upgrade requirements that served as the basis for developing the cost estimates for future improvements. Up-to-date process models provide a valuable and necessary tool for planning, project development scenario analysis, and process performance management (e.g. energy and chemical consumption).

Influent conditions and flows (to an extent) have changed considerably in the last decade. As a result, the model developed in 2008 and 2009 is likely not truly representative of the current wastewater characteristics and facility operating conditions. Therefore, the model needs to be updated to reflect current conditions, so it can be used to more accurately simulate performance and provide more reliable and relevant decision support information for planning and operational performance management. It is generally recommended that the model be updated once every five years to account for changes in flow, load, and operating conditions. One of the reasons for the delay in getting the process model updated is because LVSWRRF is currently implementing full-scale process changes as part of the BNR project which is a major process reconfiguration. Once these changes are complete in 2019, and the facility is given sufficient time to settle down with the changes that have been implemented, the process model should be updated.

The 2008/2009 effort was fully outsourced due to lack of availability of in-house resources and capabilities. It is recommended that the upcoming effort be developed in-house due to the long-term need for conducting this task periodically and maintaining the models over time to ensure reliable outputs for planning, scenario analysis, and O&M support. One of the key elements required to successfully complete this effort is to gather a comprehensive set of process and operational data which will require analytical support from Utilities' laboratory services. The support required is both in terms of resources (material and personnel) and time. Additional specialty services in the form of engineering consulting from technical experts in the field of modeling will be required which can be supplemented on a time and material basis. The process model update task is not critical in terms of time because there are no looming regulatory drivers. However, it is recommended that the task be completed at the earliest possible opportunity to increase O&M decision support capabilities including optimization opportunities to reduce O&M costs and prepare for future regulatory compliance needs.

11.6.1 Implementation timeline and costs

It is recommended that the process model be updated in the near-term (within three years) as staffing resources can be made available. The bulk of the work can be done internally with specialty support services being procured as necessary. Resources, time and material from laboratory services to help with sample analysis will need to be planned as part of this effort. An O&M budget of $200,000 is estimated to help with this effort for outside professional services and specialty analysis of samples that cannot be supported by Utilities' laboratory services.

11.7 *Regionalization SAAs*

Regionalization is a key planning aspect for Utilities, not only from a wastewater perspective but also at a Water Services Division level that can include water rights, potable water supply, wastewater service and non-potable water service. The City of Colorado Springs is growing at a rapid rate and so are other surrounding communities that are not currently served by Utilities. (Note – there are some parcels of land and communities within the city that are not currently within the service territory of Utilities). As demand for water and wastewater service within these communities grows, the communities may experience challenges similar to Utilities from a regulatory and growth/demand standpoint. These challenges present opportunities for collaboration to reduce overall infrastructure and service costs for both Utilities and the other regional service providers.

A list of potential regional partners is identified in Chapter 5 to whom Utilities can provide wastewater service. One of the key drivers for some of these entities to partner with Utilities is to reduce their capital and O&M requirements to meet future regulatory obligations. As regulations become more stringent, the cost to comply with those regulations can be significant. For example, the costs to meet regulation 31 limits for a 5 mgd facility is much higher than those for a 20 mgd facility when calculated on a per mgd basis (both capital and O&M). This is purely due to an economy of scale where treatment costs on a flow rate basis are reduced at higher flows. If some of these entities were to partner with Utilities for wastewater treatment service, they can potentially reduce their long-term capital and O&M expenditures necessary to comply with future regulations. Under a “wholesale” service type agreement, these entities would no longer need to operate and maintain their treatment facilities since the treatment responsibility would be transferred to Utilities in exchange for service payment. Their responsibility would be limited to collecting and conveying the wastewater to Utilities’ collection system through a metering station under the terms and conditions of the agreement.

As one of the key business drivers for mutually beneficial regional partnerships, Utilities’ excess capacity within a section of the collection system as well as near and long-term surplus capacity in the RRFs needs to be carefully considered. For example, there is sufficient excess capacity at JDPWRRF in the short-term as well as under build-out conditions even under a future stringent regulatory outlook. The LVSWRRF on the other hand does not have much excess capacity especially under future growth and regulatory scenarios. Thus, JDPWRRF lends itself more favorably to accommodate additional wastewater flows stemming from regionalization, especially from the north-west corridor of the region from entities such as Tri-Lakes Wastewater Treatment Facility (TLWWTF) and Upper Monument Creek Regional Wastewater Treatment Plant (UMCRWWTP). This is based on a high-level capacity analysis as summarized in Chapter 9. Detailed analysis will need to account for impacts from a process performance standpoint as well figuring out how the flows can be conveyed to the RRF in a reasonably cost-effective manner.

The major benefit to Utilities from regionalization is the potential to generate additional revenue from customers outside of its existing service territory, leveraging the ability to increase the use of its currently underutilized treatment (resource recovery) assets. Other benefits include gaining operational efficiencies by strategically eliminating lift stations. A gravity system is always desirable compared to a pumped system due to its lower O&M costs. An example of this is the potential opportunity to optimize collection of wastewater flows from the north-west region of Colorado Springs by eliminating the Mid-Trib lift station, Monument Branch lift station and the Kettle Creek lift station and using a gravity interceptor instead of the current force main system. This concept can be considered if there are sufficient wastewater flows originating from the area that will justify construction of a new gravity interceptor along the west side of I-25 through the USAFA property corridor.

In this way, regionalization partnerships can potentially benefit both parties. Care will need to be exercised in how the regionalization prioritization occurs. An impact and value analysis from both the collection system and RRF’s perspective will need to be completed prior to pursuing regionalization contracts with any entity. The goal of the regionalization SAA will be to identify possible opportunities and implementation strategies to provide regional wastewater service to potential customers outside of

Utilities' current service area. One of the key attributes in making this determination is to understand the impacts to Utilities' current wastewater system due to the additional service demands.

In the past, Utilities' 1.5x service charge multiplier for out of service area customers has been a deterrent to establishing mutually beneficial regionalization agreements. This multiplier is deemed to be too high to be attractive or sustainable long term forcing potential partners to opt for non-connected less costly alternatives to provide their own water and wastewater services. Based on preliminary discussions with some of these entities such as TLWWTF and UMCRWWTP, there is a high level of interest to pursue a regionalization agreement for wastewater service in light of more stringent regulations looming on the horizon. A holistic plan needs to be outlined that considers short-term and long-term planning needs, financial, and legal requirements for both Utilities and the prospective regional partner to develop mutually beneficial partnering agreements. Specific considerations for a regionalization plan include:

- Singular wastewater service or necessarily combined with (potable) water and/or non-potable service
- First come first serve basis of service vs. service at any time
- Fixed vs. variable tariffs

A one-size-fits-all approach for regionalization is not practical due to the unique needs of each potential partnering entity; however, it is recommended that Utilities come up with a general "80-20" regionalization framework where in 80 percent of the potential opportunities can be accommodated within a standard template and the remaining 20 percent be addressed on a case by case basis. Utilities is currently working on a regionalization policy at the Water Services Division level with participation from a variety of stakeholders that will structure the 80-20 framework for water and wastewater regionalization service considering technical, legal and financial impacts and implications.

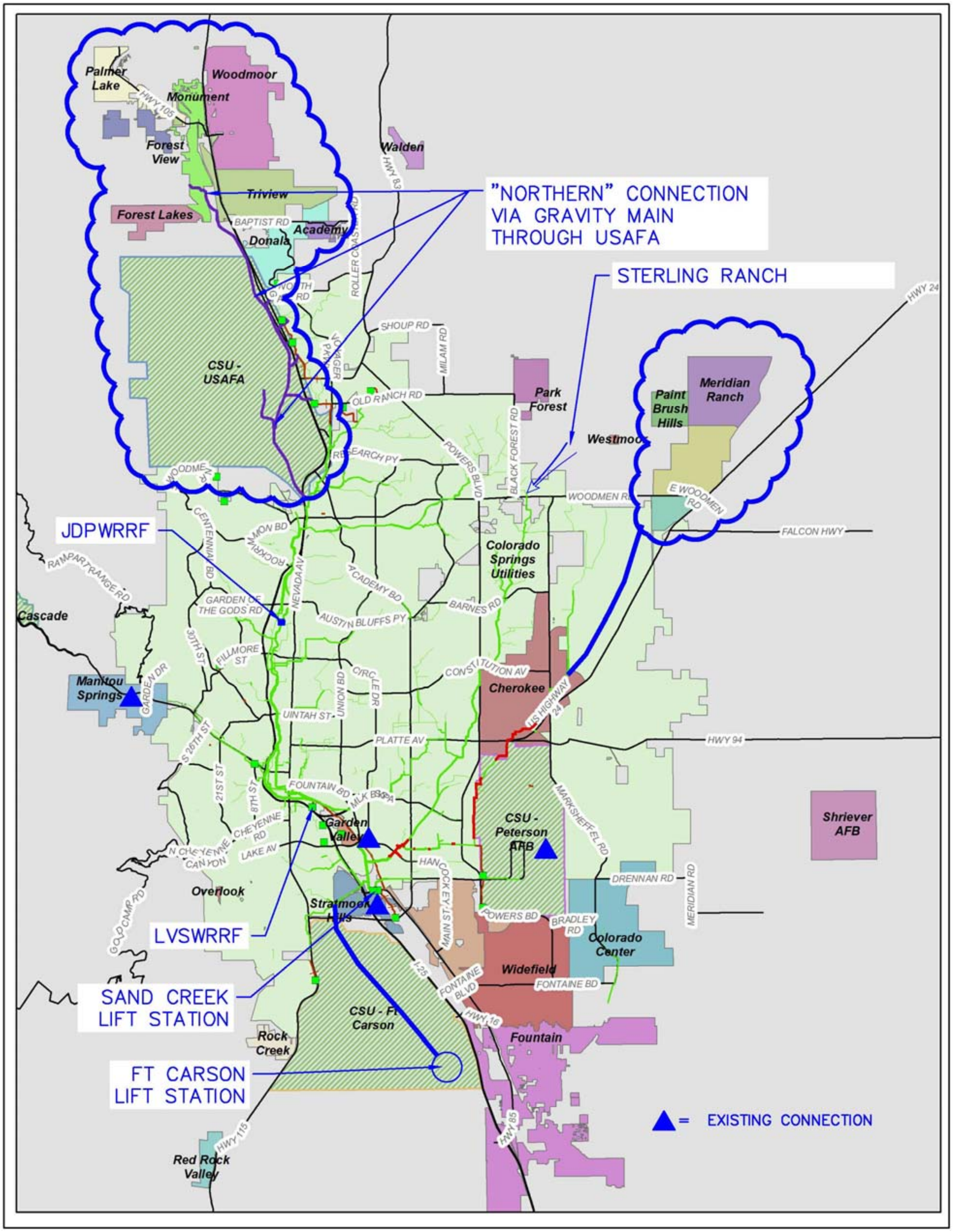

Figure 11-5 Potential Regional Wastewater Service Options

11.7.1 Implementation timeline and costs

An evaluation of regionalization opportunities at the WSD level is underway from a policy standpoint through a task force with specialty services being provided through a consultant. Specific pursuits related to individual opportunities such as the Northern Monument Creek Interceptor are also being evaluated on a case by case basis as they get prioritized based on potential. The bulk of the work can be done internally with specialty support services being procured as necessary.

11.8 *Regulation 31 SAA*

Though the Reg 31 proposed limits of 2.01 mg/L for TN and 0.17 mg/L for TP give an idea on how low the limits are likely to be, they are still unconfirmed and are being evaluated and discussed. There is ambiguity regarding both the final limits as well as implementation schedule which will be determined through a series of stakeholder workshops and meetings. The limits are expected to be finalized around 2027. in the interim, CDPHE has rolled out the VIP which bridges the gap between the nutrient limits under Reg 85 and Reg 31 so that utilities around the state can plan for a long-term nutrient strategy in a systematic manner rather than react in a knee-jerk fashion. The intent of the VIP is to allow the various utilities to earn credits that will help them delay improvements to meet the stringent nutrient limits under Reg 31 whatever they end up being. In reality, the implementation of Reg 31 limits can be delayed as far out as 2040 depending on how many years of credits are earned under the VIP. It is also expected that limits of technology, as well as associated costs, will change considerably over the next 10 – 15 years which can have a big impact on how POTWs along the Front Range will respond to future nutrient limits under Reg 31. Resource recovery technologies such as Clearas™ could get further developed and proven commercially viable or direct reuse might become much more economically beneficial. Any one or combination of these developments could significantly change the paradigm under which utilities operates in the future by shifting the focus to more economically efficient resource recovery and revenue generation opportunities instead of simply treating the wastewater for surface water discharge and recovery through exchange.

It is proposed that once the Reg 31 nutrient limits are confirmed, and a realistic timeline on when Utilities will need to comply with those limits is determined (based on credits earned under the VIP), a SAA be initiated to determine the right strategy for Utilities to meet Reg 31 nutrient limits. The SAA for Reg 31 strategy could take both a holistic perspective that evaluates and addresses nutrients at a system wide macro level across all RRFs (JDPWRRF, LVSWRRF, CSRRRF, HDTRWRF or the new RRF for BLR, if applicable) and even involve nutrient trading amongst utilities' facilities as well as a micro level look at strategies pertaining to individual facilities and its associated collection basin(s). The need for implementation strategies related to Reg 31 improvements are relatively far out into the future. However, it is recommended that this need be tracked over the long-term since it is likely to have significant operating and financial impacts for Utilities. As more certainty is established a SAA can be triggered to come up with the right strategy as necessary.

11.8.1 Implementation timeline and costs

Once the Reg 31 limits and a timeline to meet those limits are firmly established, a SAA will be initiated to determine the best alternative that will help meet those nutrient limits. Based on information available to date, the best alternative to meet expected limits around 2.01 mg/L for TN and 0.17 mg/L will be a five stage Bardenpho process with tertiary treatment provided through membrane ultrafiltration and reverse osmosis. These treatment options are estimated to cost around $182.5M* (in 2012 dollars) and will likely be required around the 2036 to 2040 timeframe depending on how many years of credits Utilities is able to earn under the VIP. About $500,000 is estimated to be needed to support the SAA efforts with external consulting services. However, it is expected that new technology will come to the market in the next 10 to 15 years that will significantly reduce the magnitude of the capital costs required to comply with Reg 31.

*These costs do not include the $40M required to provide wastewater service for the BLR area. Those are tracked under Section 10.4 Wastewater Service for BLR SAA.

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Glossary

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Glossary

A2O – Anaerobic-Anoxic-Oxic

AADF – Annual Average Daily Flow

B.S. – Blended Sludge

BLR- Banning Lewis Ranch Development

BNR – Biological Nutrient Removal

BOD – Biological Oxygen Demand

BSPS – Blended Sludge Pump Station

C – Carbon

CBOD or $CBOD_5$ – Carbonaceous Biochemical Oxygen Demand

CCTV – Closed Circuit Television

CDPHE – Colorado Department of Public Health and Environment

CDPS – Colorado Discharge Permit System

City – City of Colorado Springs

COD – Carbonaceous Oxygen Demand

CollSys R&R – Collection System Rehabilitation and Replacement Program

CSRRP – Collection System Rehabilitation and Replacement Program

CSRRRF – Clear Spring Ranch Resource Recovery Facility

d/D – Depth of flow/ Pipe Diameter

DI – Ductile Iron

DLD – Dedicated Land Disposal Units

DON – Dissolved Organic Nitrogen

DOP – Dissolved Organic Phosphorous

EPA – Environmental Protection Agency

ESD – Environmental Services Department

FOG – Fats, Oil and Grease

FSBs – Facultative Sludge Basins

GIS – Geographic Information System

GPM – Gallons per Minute

HDPE – High Density Polyethylene

I&I – Inflow and Infiltration

IGA – Stormwater Intergovernmental Agreement

IGA –Intergovernmental Agreement

IPT – Industrial Pretreatment Program

IWRP – Integrated Water Resource Plan

JDPWRRF – J.D. Phillips Water Resource Recovery Facility

LCEPR – Local Collectors Evaluation and Rehabilitation Program

LCERP – Local Collectors Evaluation and Rehabilitation Program

LFWRF – Lower Fountain Water Reclamation Facility

LOS – Levels of Service

LOT – Limits of Technology

LSFMERP – Wastewater Lift Station and Force Mail Evaluation and Rehabilitation Program

LVSWRRF – Las Vegas Street Water Resource Recovery Facility

MCI – Monument Creek Interceptor

MGD – Million Gallons per Day

MHERP – Manhole Evaluation and Rehabilitation Program

Mid-Trib – Middle Tributary

MLE – Modified Ludzack Ettinger

MPN – Most Probable Number

N – Nitrogen

NASSCO – National Association of Sewer Service Companies

NH_3 – Ammonia

NOAA- National Oceanic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

O&M – Operations and maintenance

P – Phosphorus

PEL – Primary Effluent Limit

PF – Peaking factor

POTWs – Publicly Owned Treatment Works

PPACG – Pikes Peak Area Council of Governments

PVC – Polyvinyl Chloride

Q – Flow

QC – Quality Control

R&R – Rehabilitation and Replacement

RDII – Rainfall Derived Inflow and Infiltration

ROM – Rough Order of Magnitude

RRF – Resource Recovery Facilities

SAA – Study and Alternative Analysis

SAF – Small Area Forecast

SDS – Southern Delivery System

SHDF – Solids Handling and Disposal Facility

SSCC – Sanitary Sewer Creek Crossing Program

SSCCP – Sanitary Sewer Creek Crossing Program

SSERP – Sanitary Sewer Evaluation and Rehabilitation Program

SSO – Sanitary Sewer Overflow

TAZ – Transportation Area

TF/SC – Trickling Filter Solids Contact Basin

TIN – Total Inorganic Nitrogen

TKN – Total Kjeldahl Nitrogen

TLWWTF – Tri-Lakes Wastewater Treatment Facility

TN – Total Nitrogen

TP – Total Phosphorous

TSS – Total Suspended Solids

TVS – Total Volatile Solids

UMCRWWTP – Upper Monument Creek Regional Wastewater Treatment Plant

USAFA – United States Air Force Academy

USGS – United States Geological Survey

UTILITIES – Colorado Springs Utilities

UV – Ultraviolet Radiation

VCP – Vitrified Clay Pipes

VFA -Volatile Fatty Acid

VIP – Voluntary Incentive Program

WET – Whole Effluent Toxicity

WRRF – Water Resource Recovery Facility

WWSP- Wastewater System Plan