WASTEWATER UTILITY

MASTER PLAN

February 2025

AIM NORMAN
AREA & INFRASTRUCTURE MASTER PLAN

WASTEWATER UTILITY MASTER PLAN

CITY OF NORMAN AND NORMAN UTILITIES AUTHORITY

NORMAN, OKLAHOMA

AIM NORMAN
AREA & INFRASTRUCTURE MASTER PLAN

Prepared by:

GARVER

In Partnership with:

RDG PLANNING • DESIGN

February 2025

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I hereby certify that this Wastewater Utility Master Plan for the City of Norman Area & Infrastructure Master Plan was prepared by Garver under my direct supervision for the City of Norman and Norman Utilities Authority.

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Acronym	Definition
AACE	Association for the Advancement of Cost Engineering
ADF	average day flow
ADWF	average dry-weather flows
AIM	Area and Infrastructure Master
City	City of Norman
CIP	Capital Improvement Plan
fps	feet per second
GIS	Geographical Information System
gpd	gallons per day
gpcd	gallons per capita day
IPR	indirect potable reuse
LCC	life-cycle cost
LF	linear feet
MG	million gallons
MGD	million gallons per day
NOAA	National Oceanic and Atmospheric Administration
NUA	Norman Utilities Authority
ODEQ	Oklahoma Department of Environmental Quality
RDII	rainfall-derived infiltration and inflow
SFE	single-family equivalent
SSO	sanitary sewer overflows
WRF	Water Reclamation Facility
WWCS	wastewater collection system
WWSA	wastewater service area

INTRODUCTION TO AIM NORMAN

In 2023, the City of Norman embarked on an ambitious endeavor: The Norman Area & Infrastructure Master Plan (AIM Norman). Decisions made in Norman today and in the years to come will shape city's growth, development patterns, and the community image for decades. Rapidly changing and evolving technology, extreme weather events, and the University of Oklahoma's growing national audience as a new member of the Southeastern Conference will all impact these decisions.

AIM Norman examines all elements of city development and quality of life to help shape the community's growth through 2045. Together, all seven Master Plans of AIM Norman provide a roadmap that will provide essential guidance to leaders and decision-makers, representing the City and its partners' plan for growth, change, and adaptation.

AIM Norman is:

- A combination of processes and Master Plans.
- A blueprint for a sustainable and resilient future that embraces Norman's unique character.
- A collective vision for Norman that should resonate with every community member.
- All-encompassing and inclusive, supported by every facet of the community, and align with the values and aspirations of Norman residents.

AIM Norman encompasses distinct master planning elements, with the Land Use Plan as the guide for development and land use policy to help inform all Master Plans.

HOUSING

A safe, comfortable, and attainable home for all is critical to Norman's future success. Rising home prices contribute to housing challenges. The recognition of poverty and unhoused populations in Norman is growing, while limited student housing options strain existing neighborhoods. The increasing popularity of the Oklahoma City metro as a place to live creates more demand, coupled with long-time residents wanting to age in the community. The AIM Norman Housing Plan analyzes the housing market and outlines a strategic plan for addressing housing needs.

STORMWATER

Major rain events impact Norman's residents and infrastructure. The City has recently shifted away from the traditional system of hard, channelized drainage paths and concentration of stormwater flows toward more sustainable stormwater policies. However, challenges remain, including flooding, erosion, and pollution of streams flowing into Lake Thunderbird. As growth and development increase impervious surface coverage, the City must accommodate stormwater effectively throughout the community. The AIM Norman 2025 Stormwater Master Plan Update outlines resilient solutions to help Norman's stormwater management systems adapt to both current and future challenges.

TRANSPORTATION

Mobility routes create a more connected community when it feels safe, comfortable, and accessible for all users. As the Norman community grows geographically and in population, so too must the routes and options to get to places. Car-centric communities like Norman are considering a more multi-modal approach to transportation. People are looking for connected trails and safe bike routes when choosing where to live, as new personal transportation devices grant more people opportunities to leverage trails. The AIM Norman Comprehensive Transportation Plan Update identifies future mobility projects in existing and new neighborhoods for motorists and active transportation users to cast a positive vision for mobility in Norman.

PARKS, RECREATION, AND CULTURE

Along with a comprehensive trail network, residents value cities with unique quality of life amenities — particularly parks, recreational opportunities, and special events. Norman has more parks per capita than many comparable cities. Maintaining these parks at a first-class level is a high priority that grows in difficulty as costs rise and resources decline. Residents desire a connection to nature and each other, along with vibrant cultural and community events and facilities for all ages and abilities. The AIM Norman Parks, Recreation, and Culture Master Plan aims to provide current and future residents with safe and engaging parks, recreation, events, and cultural activities to access and enjoy.

WASTEWATER

Reliable and resilient wastewater service is vital for existing and future homes, businesses, and industries. As more users are added and the wastewater collection system is expanded, adequate treatment facilities for quantity and quality must also be in place to meet environmental standards and water quality requirements. The AIM Wastewater Master Plan analyzes wastewater capacity needs and identifies improvements to the collection and treatment of wastewater to meet current and future needs in accordance with environmental regulations while minimizing costs to ratepayers.

WATER

Access to quality water supply is critical for existing and future homes, businesses, and industries. Currently, Norman's critical water supply comes from Lake Thunderbird, the Garber-Wellington Aquifer, and wholesale water purchases from Oklahoma City. With projected residential and commercial growth, future constraints on the water supply and infrastructure are expected and must be addressed. The AIM Norman Water Master Plan analyzes the water system's capacity and water supply needs and identifies improvements to meet existing and future demands.

INTEGRATING THE AIM NORMAN MASTER PLANS

A thoughtful, coordinated approach ensures that all seven elements of AIM Norman work together to create a balanced, sustainable, and thriving community for current and future residents. Together, they shape how Norman looks, feels, and functions. Major decisions in one component influence the others and determine the trajectory of land use development.

DEVELOPMENT PRINCIPLES

The AIM Norman Land Use Plan's Development Principles stem from Norman residents' input and Smart Growth for America's Principles of Smart Growth. The ten Development Principles align AIM Norman's plans and studies to guide Norman's evolution through 2045.

AIM NORMAN DEVELOPMENT PRINCIPLES

1. Manage urban services efficiently.
2. Promote diverse housing options.
3. Promote infill development and neighborhood reinvestment.
4. Protect the environment in all decision-making.
5. Enhance distinctive neighborhoods, business districts, and natural areas with a strong sense of place.
6. Provide a multi-modal and connected transportation network.
7. Enhance public safety and minimize hazards.
8. Encourage balanced and connected neighborhoods.
9. Make development decisions predictable, fair, and cost effective.
10. Make decisions in a transparent and collaborative manner.

WASTEWATER MASTER PLAN EXECUTIVE SUMMARY

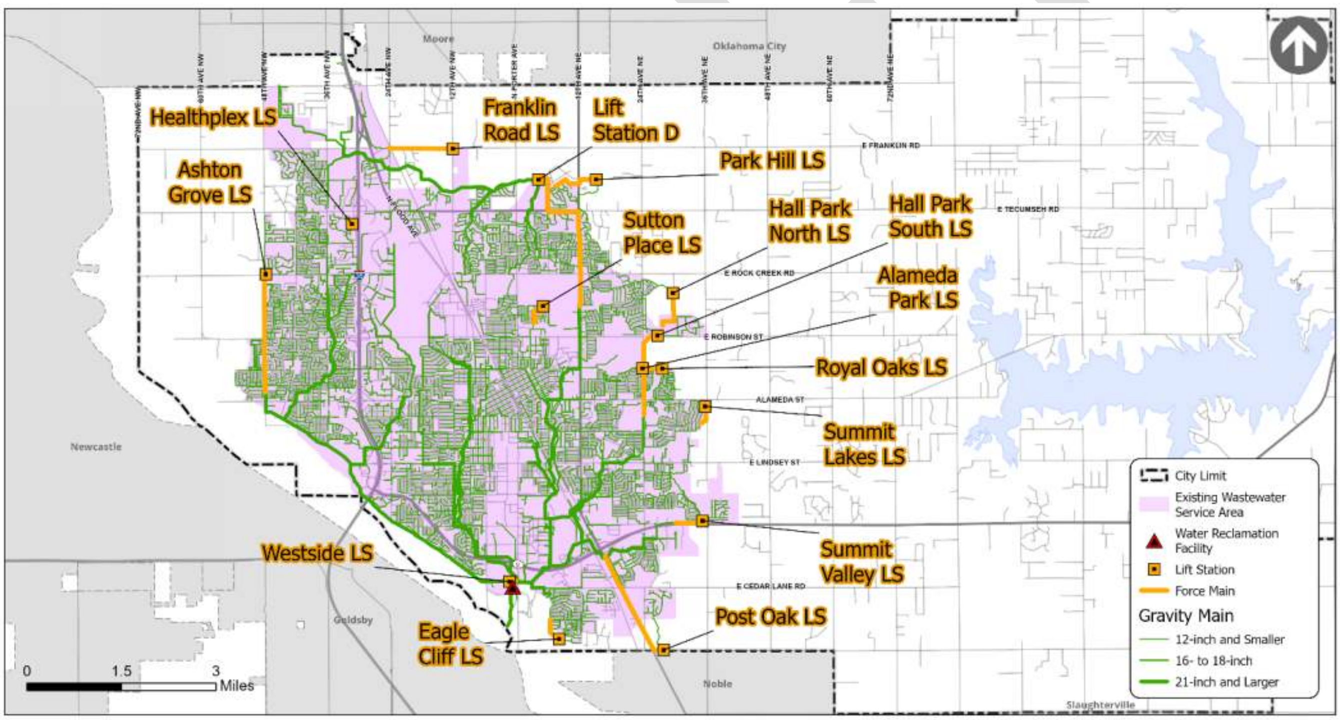
The City of Norman and the Norman Utilities Authority (NUA) are committed to providing reliable wastewater services. This Wastewater Utility Master Plan (Master Plan), which is part of a larger plan called AIM Norman, aims to improve and sustain the wastewater system.

The main goals of this Master Plan are to:

1. **Evaluate Current Infrastructure**: Identify strengths and weaknesses in the existing system.
2. **Plan for Future Growth**: Prepare for future population increases and development.
3. **Improve Efficiency**: Upgrade the system to make it more efficient and reliable.
4. **Protect the Environment**: Reduce the environmental impact of wastewater processes.
5. **Enhance Resilience**: Make the system stronger against emergencies like natural disasters.

NUA's current wastewater service area (WWSA) generally extends from 48th Avenue West to 36th Avenue East shown below in Map ES. Approximately 90% of the City's population resides within the WWSA.

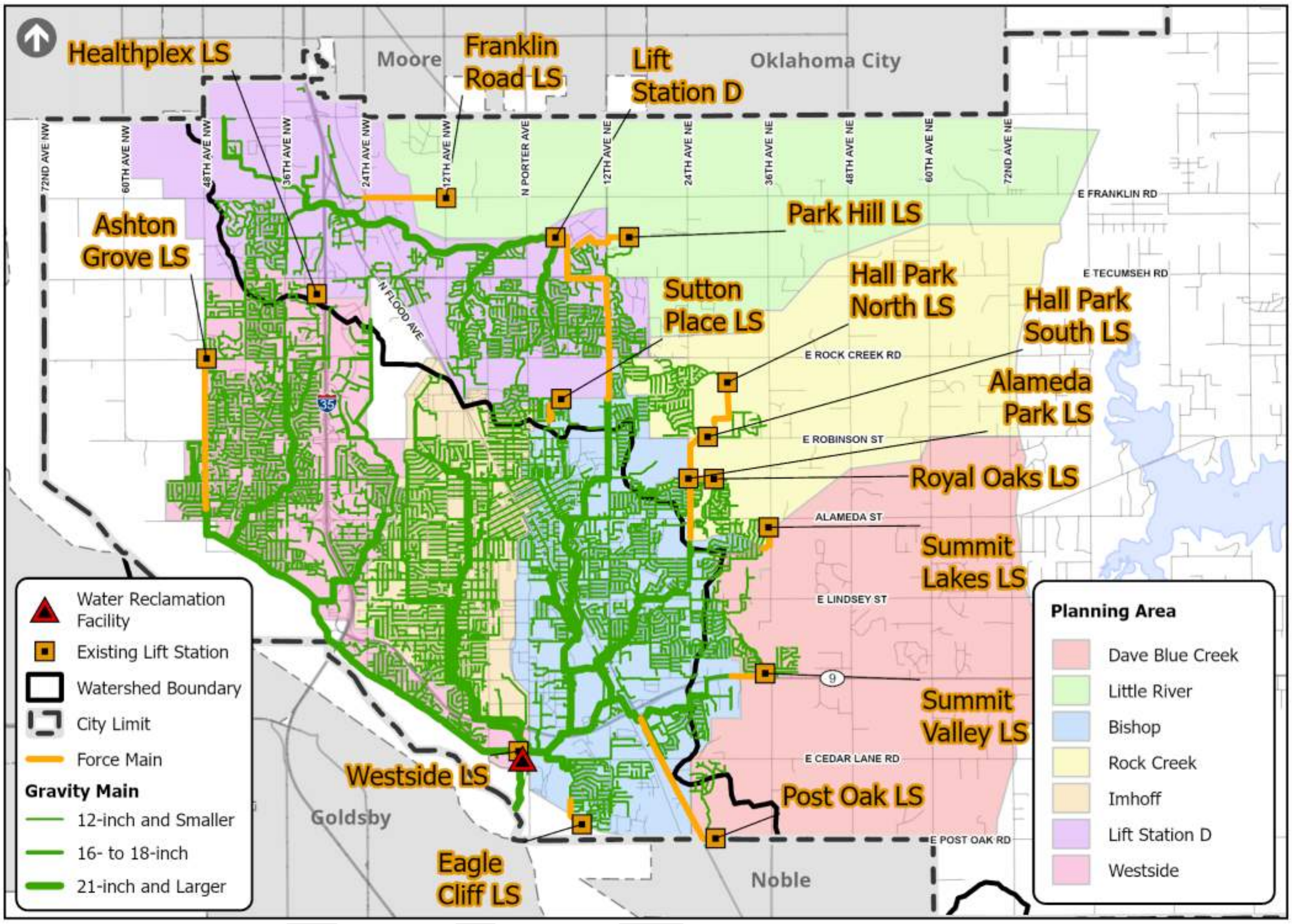
Map ES-1: Wastewater System Overview



The existing collection system can be subdivided into four major wastewater planning basins: Westside basin, Imhoff basin, Bishop basin, and Lift Station D. The Imhoff and Bishop basins discharge to the WRF via a network of gravity interceptors. Flows from the Lift Station D basin are pumped to interceptors in the Bishop basin. The Westside basin gravity flows to the Westside Lift Station, which pumps flow to the WRF.

In addition to the four existing major wastewater planning basins, anticipated growth is expected to expand the collection network eastward. Three new basins are expected to be incorporated into the collection system. These basins are Little River, Rock Creek, and Dave Blue Creek. The wastewater planning basins are shown in Map ES.

Map ES-2: Wastewater Planning Basins



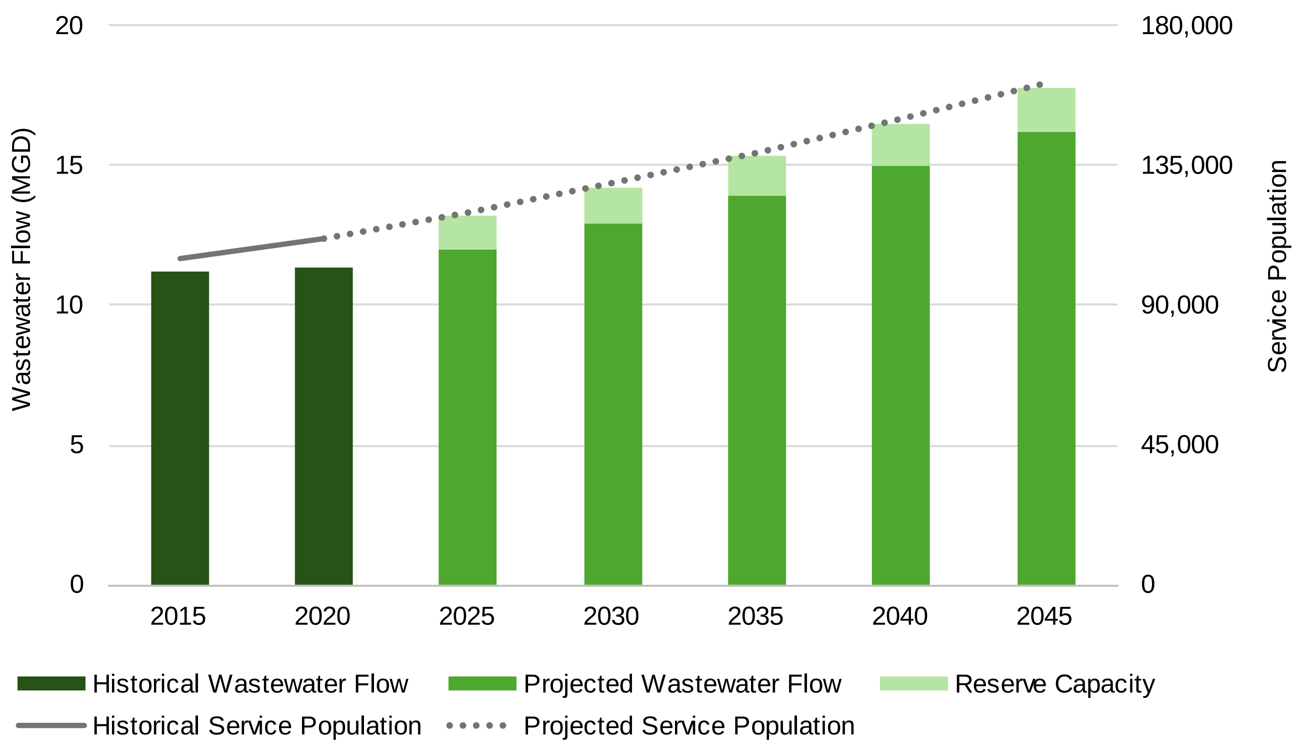
The wastewater flow rate projections are calculated based on the anticipated service population and an average day flow (ADF) of 100 gallons per capita day (gpcd). Garver used the 1.5% annual growth rate projection included in the Norman Today report as the basis of the City's population projections through the year 2045. The growth rate percentage was applied independently to both the city population and the service population. The service population and ADF projected through the planning period are shown in Table ES-1.

In addition to the flow calculated based on population growth, a reserve capacity of 10% was included to remain consistent with the reserve capacity included for the water system. Garver recommends the inclusion of a reserve capacity to mitigate any potential changes to per capita flows because of new industrial flows, unanticipated growth, or severe weather events. Figure ES-1 shows the historical and projected wastewater flow and service population through 2045. Projections through the year 2045 were used for CIP development. The projections through buildout were determined based off the land use capacity of the service area and were used to determine sizing.

Table ES-1: Projected Wastewater Flows

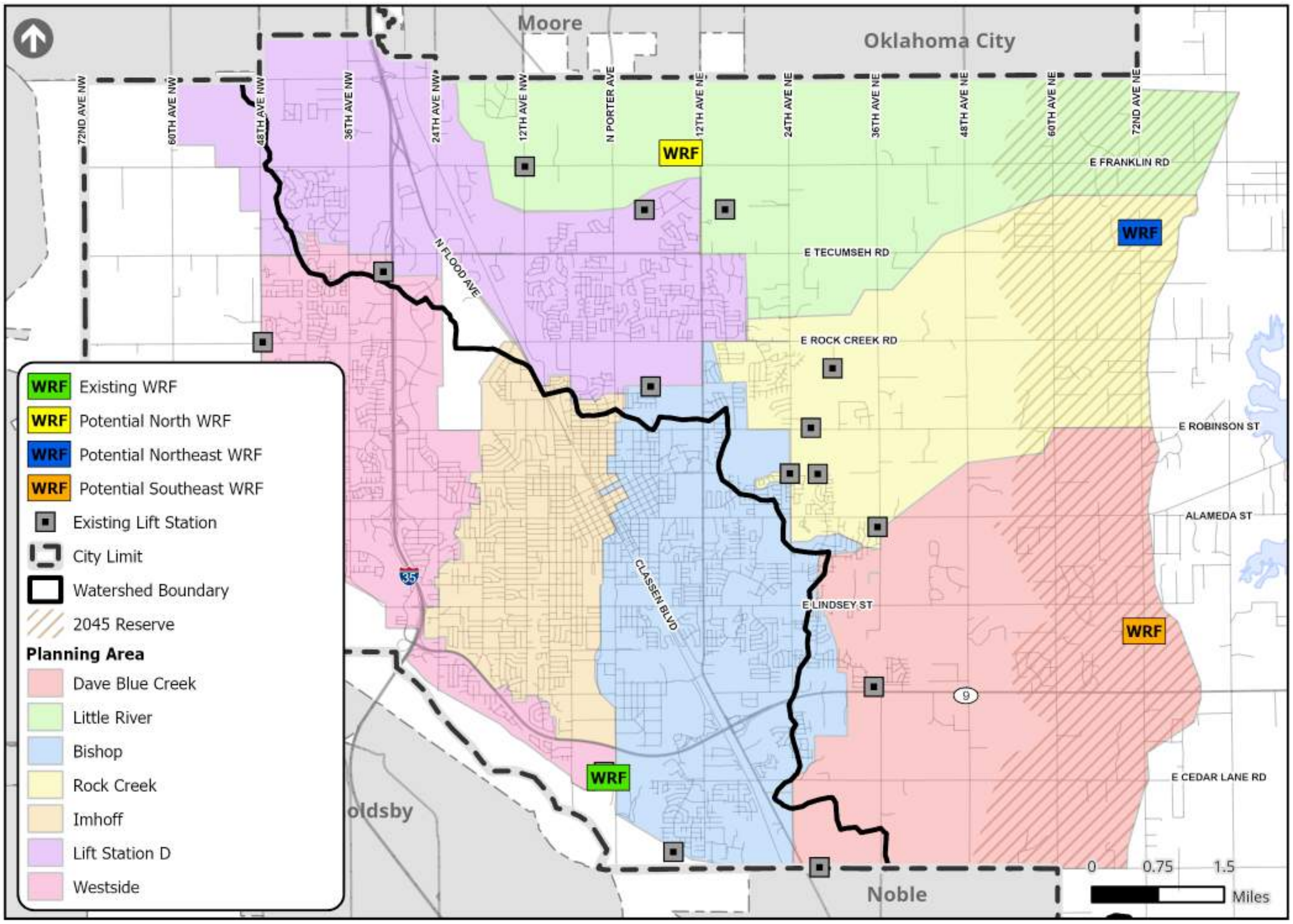
Year	Service Population	ADF (MGD)	ADF Reserve Capacity (MGD)	ADF Total (MGD)
2025	119,990	12.00	1.20	13.20
2030	129,264	12.93	1.29	14.22
2035	139,254	13.93	1.39	15.32
2040	150,016	15.00	1.50	16.50
2045	161,610	16.16	1.62	17.78

Figure ES-1: Historical and Projected Wastewater Flows



Garver conducted a thorough review of historical data spanning several years to establish the planning criteria for the wastewater treatment evaluation and sizing of a potential new WRF. Using projected flows shown in Figure ES-1, it is anticipated that the entire system will generate a future ADF of 17.8 million gallons per day (MGD) of wastewater (including 10% reserve capacity). This Master Plan evaluates the capacity to treat this flow either entirely at the existing WRF or through a combination of the existing facility and a potential new WRF with three potential sites, shown in Map ES-3. A gap analysis was performed to identify the necessary scope of improvements at the existing WRF, which is currently rated for 16 MGD but can be expanded to accommodate the projected 17.8 MGD.

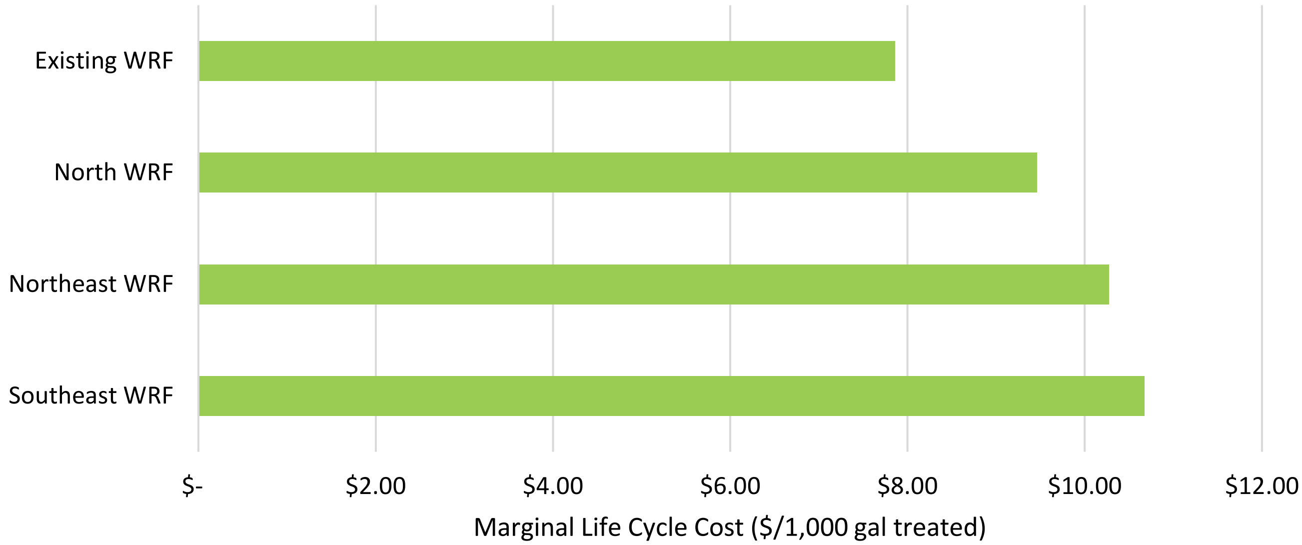
Map ES-3: Potential WRF Locations



Detailed life-cycle cost (LCC) comparisons support the conclusion that expanding the existing WRF is the most financially sound option for wastewater treatment, with a marginal LCC of $7.86 per thousand gallons (kgal) of wastewater treated. The costs of a new WRF are 20-40% higher, varying by location. Figure ES-2 shows the marginal LCC comparison of wastewater alternatives. Marginal LCC is the cost associated with improvements beyond the existing infrastructure. Marginal LCC is calculated for each alternative based on anticipated costs to upgrade and operate conveyance and treatment infrastructure. The intention of marginal LCC is to provide a basis for comparing relative costs, not to capture all possible costs or serve as the basis for budgeting. Many of these costs would come in phases and will depend on the actual growth and flows experienced over time.

A new WRF could still be considered for future development. The majority of population growth is anticipated in the northern and eastern parts of the City, and significant collection system improvements will be required regardless of the selected option. A decision on constructing a new WRF can be made later, depending on how actual flows are realized within the system. Although not the most cost-effective solution, a new WRF could offer advantages by reducing the need for long-distance pumping from the northern and northeastern areas of the City to the existing WRF, which is located to the south. Replacing miles of raw wastewater force main with treated effluent force main lowers long-term environmental risks from leaks. Non-monetary criteria such as strategic location, reduced pumping distances, environmental benefits, and the potential to better serve areas of projected growth may outweigh the fact that the marginal LCC for a new WRF is not the lowest cost alternative.

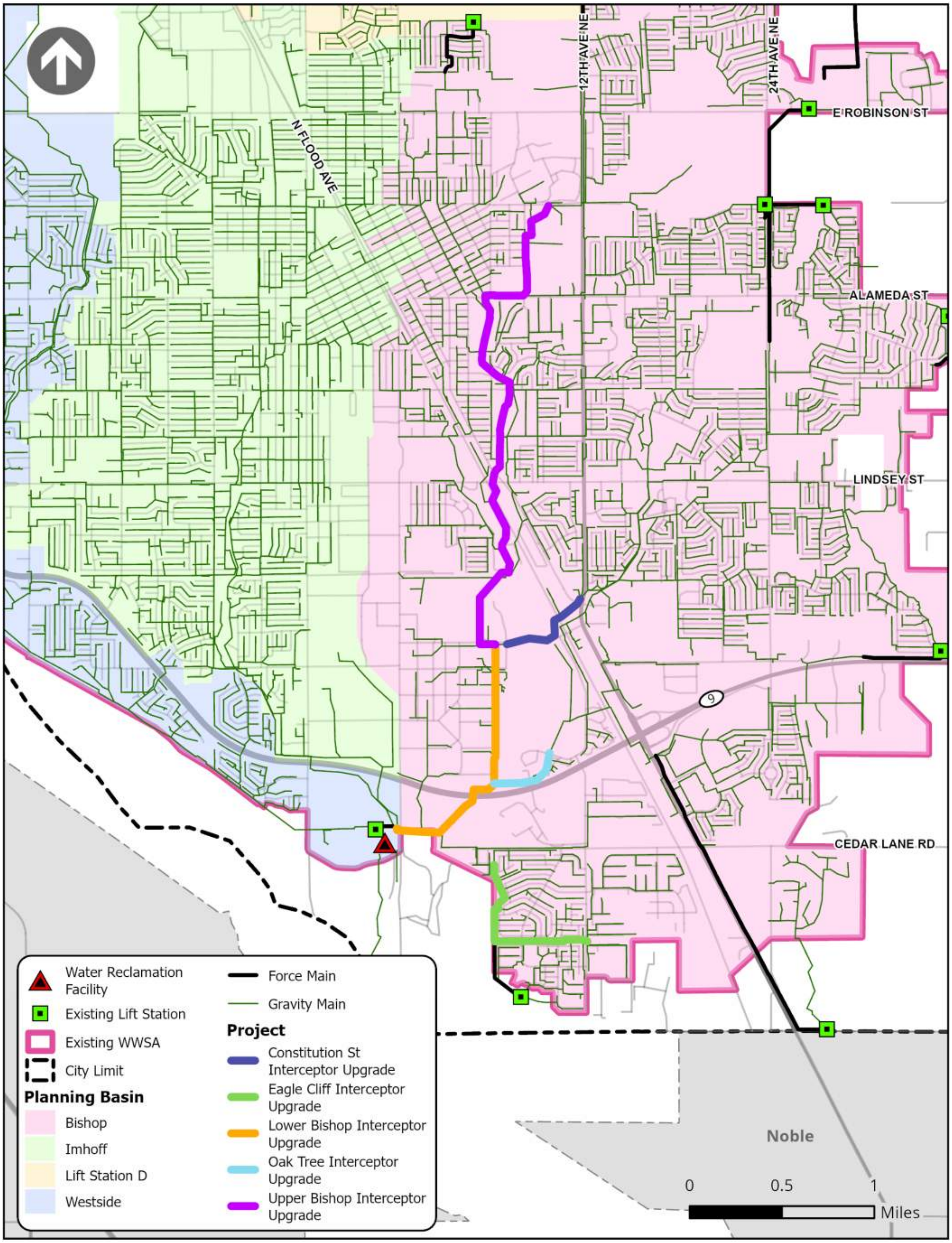
Figure ES-2: Marginal LCC Comparison of Wastewater Alternatives



The marginal LCC is the costs associated with an alternative beyond the operations and maintenance of the existing facilities.

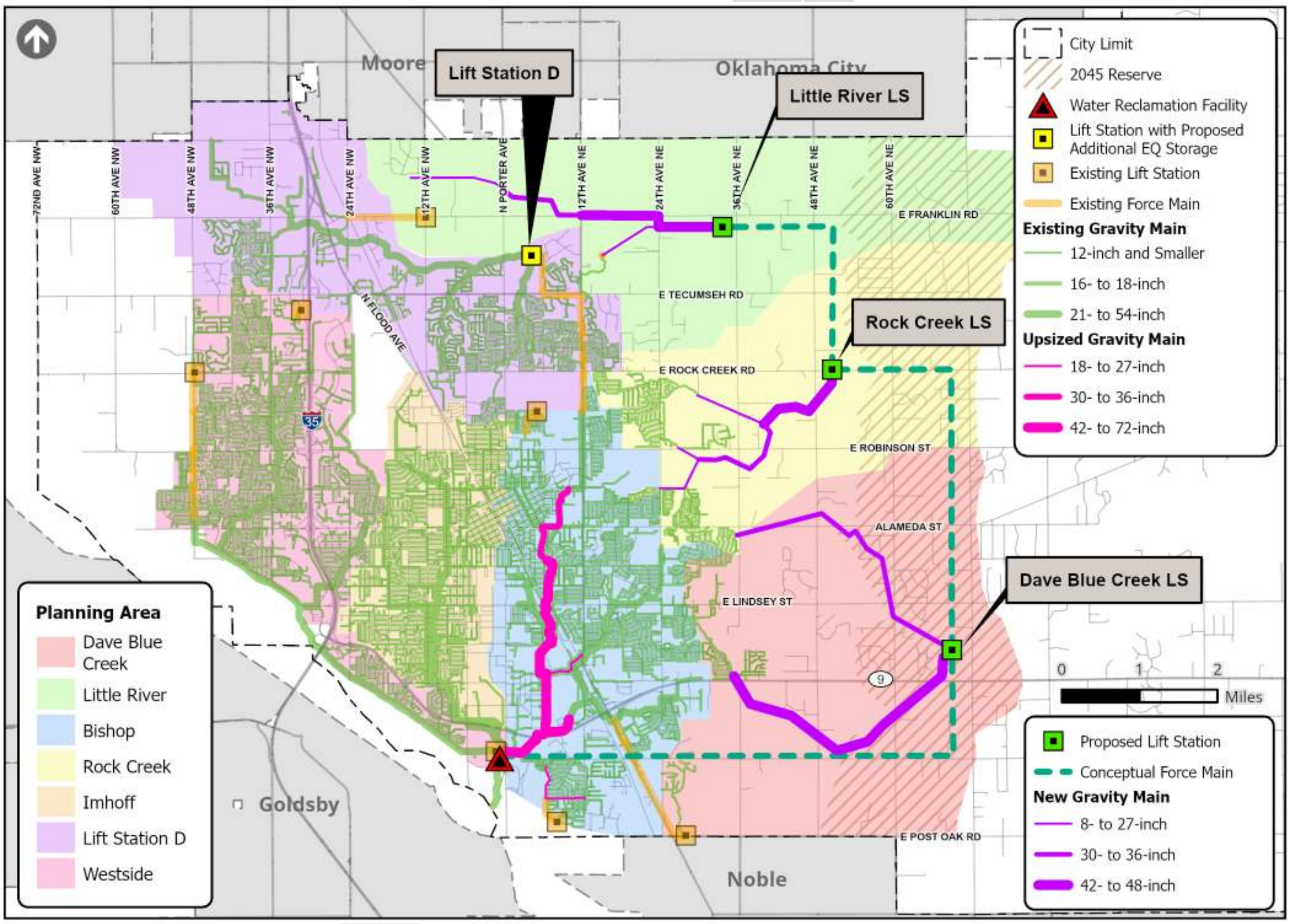
Garver also evaluated the capacity of collection system infrastructure to accommodate existing and future flows. Capacity constraints in the existing collection network were identified under existing and future flow horizons. Map ES shows the proposed gravity interceptor improvements to the existing collection network. These improvements alleviate existing capacity constraints and accommodate future growth in the Bishop planning area.

Map ES-4: Existing Collection Network Proposed Improvements



Growth to the east of the current WWSA will introduce the need for a new conveyance route to the existing WRF. The eastern conveyance plan includes a new regional lift station in each of the three future planning areas (Little River, Rock Creek, and Dave Blue Creek). The Little River Lift Station will receive flows from a proposed interceptor in the Little River basin. Flows will then be pumped to the Rock Creek Lift Station, which additionally receives flow from proposed interceptors in the Rock Creek basin. The Rock Creek Lift Station will pump flows to the Dave Blue Creek Lift Station. The Dave Blue Creek Lift Station will additionally receive flow from the proposed Dave Blue Creek Interceptors. The Dave Blue Creek Lift Station will pump to the existing WRF site, which is assumed to undergo expansion to accommodate existing flows and future growth. The proposed gravity interceptors in the Little River, Rock Creek, and Dave Blue basins will convey future projected flow, as well as flow from existing lift stations that currently pump to the west over the ridge line. These existing lift stations will be decommissioned. The future eastern conveyance network is shown in Map ES.

Map ES-5: Future East Conveyance Network

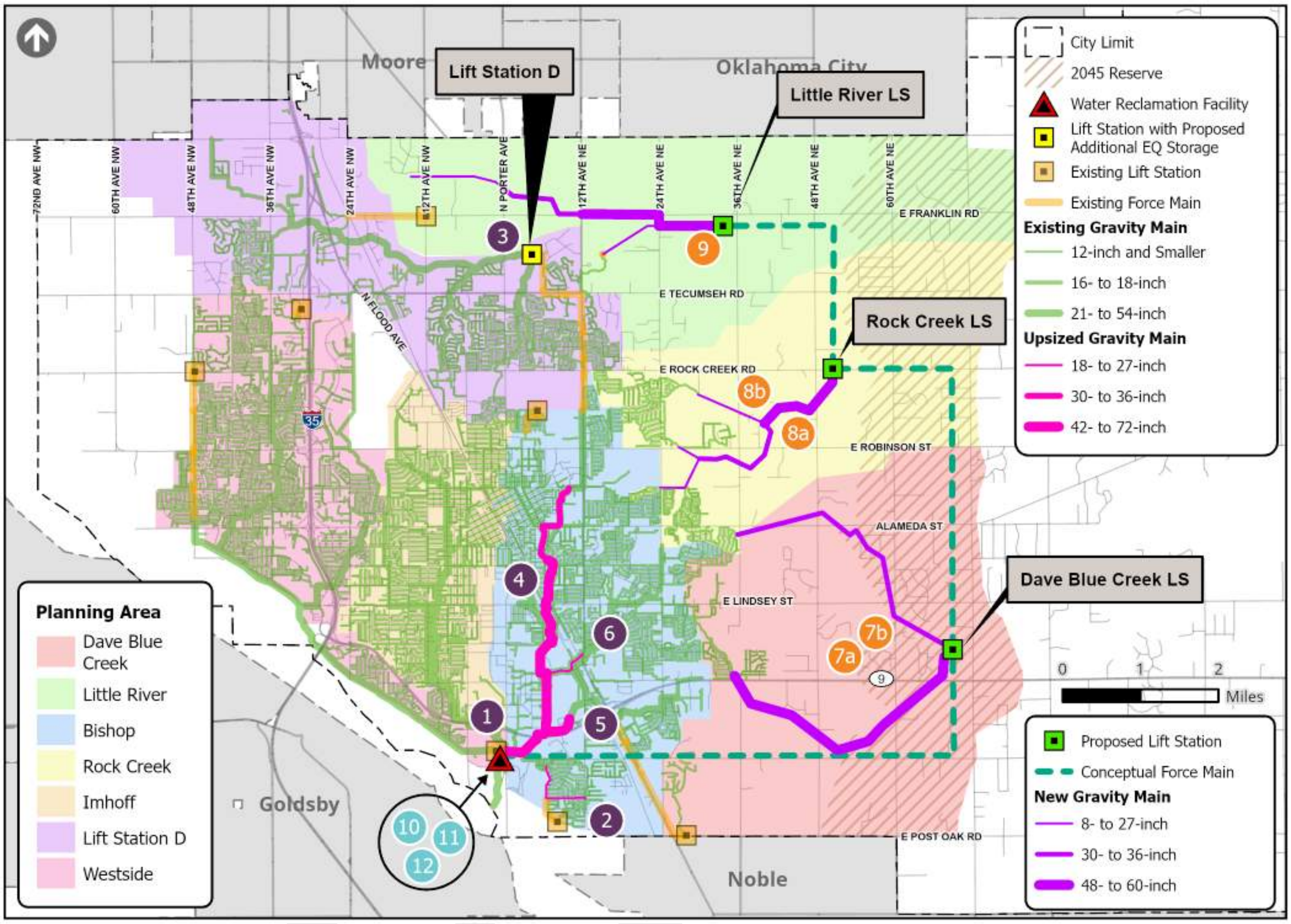


Garver identified several projects as part of a 20-year CIP with the intent of improving existing WWSA infrastructure, constructing new infrastructure for the eastern conveyance network, and an expansion of the existing WRF to accommodate future growth over the next 20 years. The individual project costs are presented in Table ES-2. The total system improvements proposed for the 20-year CIP are shown in Map ES.

Table ES-2: 20-Year CIP Cost Summary

Project Number	Existing Wastewater Service Area (WWSA) Improvements Projects	Anticipated Date of Project	Estimated Project Cost (2024 Dollars)
1	Lower Bishop Interceptor Upsizing	2025	$22.5M
2	Eagle Cliff Interceptor Upsizing	2025	$4.5M
3	Lift Station D Equalization	2027	$7.4M
4	Upper Bishop Interceptor Upsizing	2027	$27.3M
5	Oak Tree Interceptor Upsizing	2029	$4.4M
6	Constitution St. Interceptor Upsizing	2033	$3.1M
		Existing WWSA Improvements Subtotal	**$69.3M**
Project Number	Eastern Conveyance Improvements Projects	Anticipated Date of Project	Estimated Project Cost (2024 Dollars)
7a	Dave Blue Creek Eastern Conveyance Network	2027	$154.6M
8a	Rock Creek Eastern Conveyance Network	2031	$76.8M
9	Little River Eastern Conveyance Network	2037	$63.8M
7b	Dave Blue Creek Expansion	2035	$75.3M
8b	Rock Creek Expansion	2036	$32.2M
		Eastern Conveyance Improvements Subtotal	**$402.7M**
Project Number	Existing WRF Improvement Projects	Anticipated Date of Project	Estimated Project Cost (2024 Dollars)
10	Additional Equalization Basin	2025	$29.8M
11	Additional Grit Removal	2026	$7.7M
12	Existing WRF Rehabilitation and Equipment Replacement	As needed	$25.0M
		Existing WRF Improvements Subtotal	**$62.6M**
		Improvements Total	**$534.6M**

Map ES-6: Total System Improvements for 20-Year CIP



1.0 INTRODUCTION

The City of Norman (City) and the Norman Utilities Authority (NUA) are dedicated to providing efficient and reliable wastewater services to their community. This Wastewater Utility Master Plan (Master Plan) is a crucial part of our comprehensive Area & Infrastructure Master Plan (AIM Norman), aimed at enhancing the performance and sustainability of this Master Plan.

The primary objectives of this Master Plan are to:

1. Assess Current Infrastructure: Evaluate the existing wastewater collection system to identify strengths, weaknesses, and areas needing improvement.
2. Plan for Future Growth: Analyze population trends and development patterns to plan system improvements to accommodate future loads.
3. Improve System Efficiency: Propose upgrades and optimizations to enhance the efficiency and reliability of the wastewater collection network.
4. Protect the Environment: Implement practices that minimize the environmental impact of wastewater collection, treatment, and effluent discharge.
5. Enhance Resilience: Strengthen the system’s ability to withstand and recover from emergencies, such as natural disasters and infrastructure failures.

This Master Plan is the result of extensive research, stakeholder engagement, and collaboration with industry experts. It reflects our commitment to maintaining a high standard of wastewater services while supporting the growth and sustainability of NUA. Through planning and investment, the goal is to maintain a wastewater system that serves the community's current and future needs.

1.1 WASTEWATER SYSTEM OVERVIEW

The NUA wastewater system serves the urban area within the city limits. The wastewater system includes two primary components:

- Wastewater Collection System (WWCS): The gravity sewers, lift stations, and force mains that collect wastewater from customers and convey it to the treatment facility.
- Water Reclamation Facility (WRF): The treatment facility that treats wastewater received from the collection system and returns highly-treated water to the Canadian River.

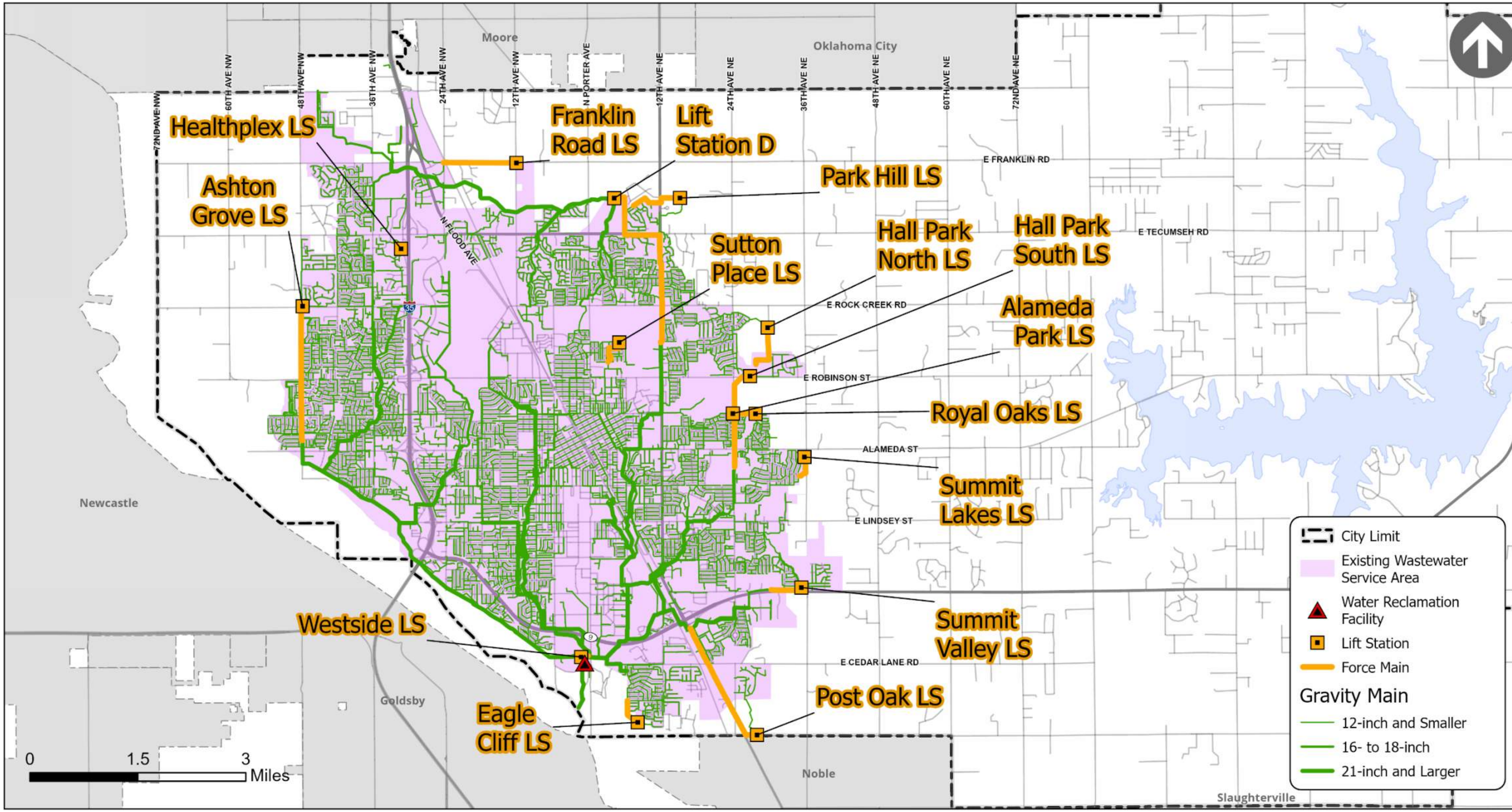
NUA's current wastewater service area (WWSA) extends from 48th Avenue West to 36th Avenue East as shown in Map 1-1.

1.2 OPERATIONS AND MANAGEMENT

The NUA is a public trust that oversees policy and financial authorizations as they relate to City-managed utilities. The Mayor and City Council act as Trustees of the NUA. Three of the Norman Utilities Department Divisions administer and operate the water and wastewater utility: Administration & Engineering, Water Reclamation, and Line Maintenance. The Utilities Department has adopted the following Mission Statement:

> *Providing environmentally sound, efficient utility service to our customers in a professional, safe manner at sustainable rates through six divisions.*

Map 1-1: Wastewater System Overview Map



1.3 RELATED DOCUMENTS

Table 1-1 summarizes the previous work by others that was used in this Master Plan. The reference names listed in the table are used throughout this report to refer to each document.

Table 1-1: Related Documents

Document	Author/Agency	Date	Reference Name
Wastewater Systems Master Plan	CDM Smith	2001	2001 WWMP
WRF Phase II Improvements Engineering Report	Garver, Carollo	2011	WRF Phase 2 ER
Wastewater Flow Monitoring & Modeling Report	HDR	2013	2013 WW Modeling Report
Wastewater Flow Monitoring & Modeling Report	HDR	2018	2018 WW Modeling Report
North Water Reclamation Facility Engineering Report	HDR	2018	2018 North WRF ER
AIM Norman Area & Infrastructure Master Plan - Norman Today	RDG	2024	Norman Today
AIM Norman Comprehensive Plan	RDG	2025	Norman Comprehensive Plan

1.4 HISTORICAL DATA COLLECTION

The following data was provided by NUA for use in development of this Master Plan:

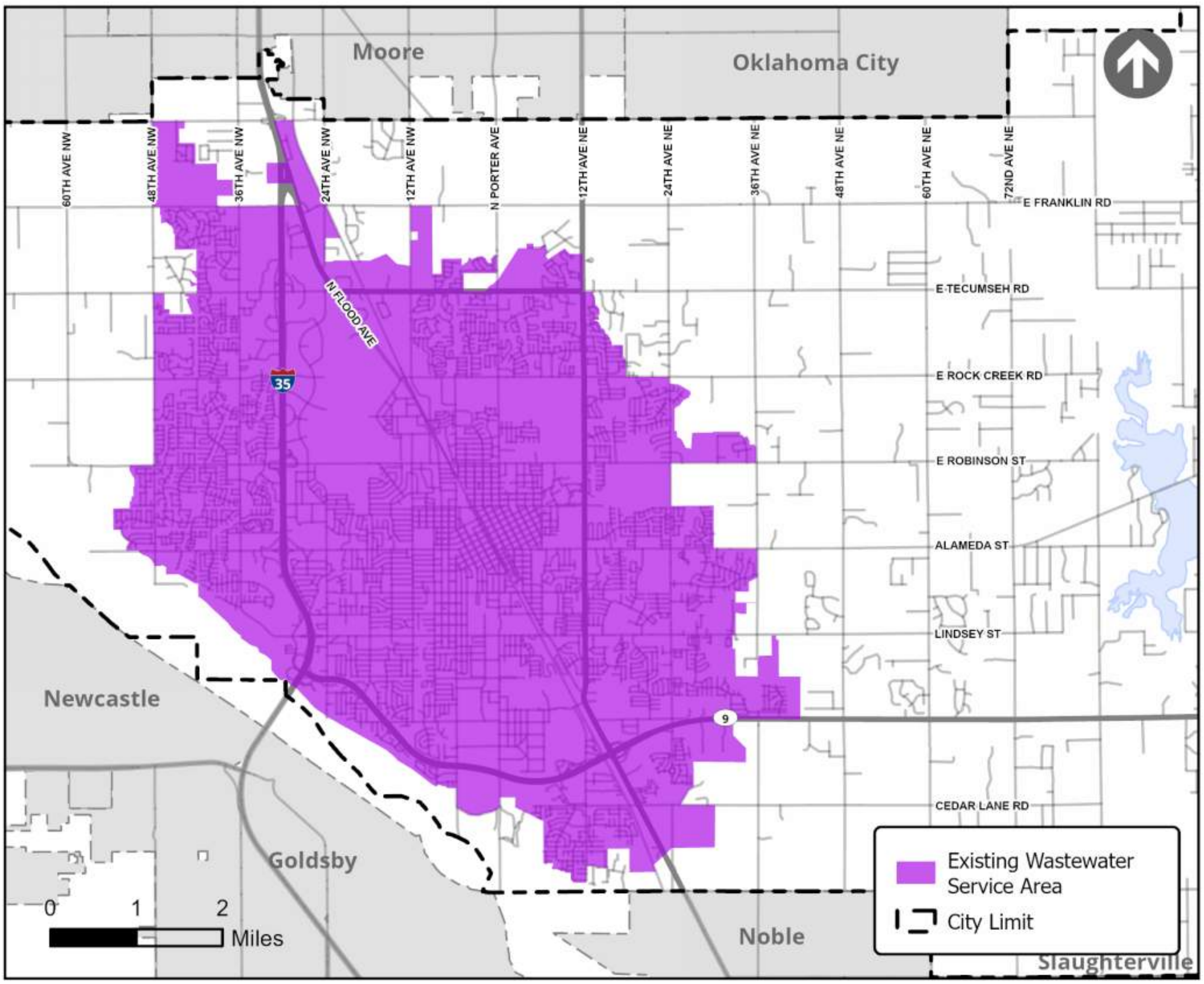
- Discharge monitoring reports (2021–2023)
- Geographical Information System (GIS) files with wastewater infrastructure information
- Rain and flow metering data between April 2023 and August 2023
- WRF monthly operating reports (2015–January 2024)

2.0 WASTEWATER SERVICE AREA

2.1 EXISTING WASTEWATER SERVICE AREA

The existing NUA WWCS serves the urban portion of the area within the city limits. Slightly less than 90% of the City's population resides within the wastewater service area (WWSA). Residents outside the WWSA boundary are served by private septic systems. The wastewater for a small area near I-35 at the border with the City of Moore currently discharges to the Moore WWCS. The WWSA is illustrated in Map 2-1. The current boundary generally extends from 48th Avenue West to 36th Avenue East and was based on the existing infrastructure and existing land use derived from the Norman Today report which can be found in Appendix A.

Map 2-1: Wastewater Service Area Overview



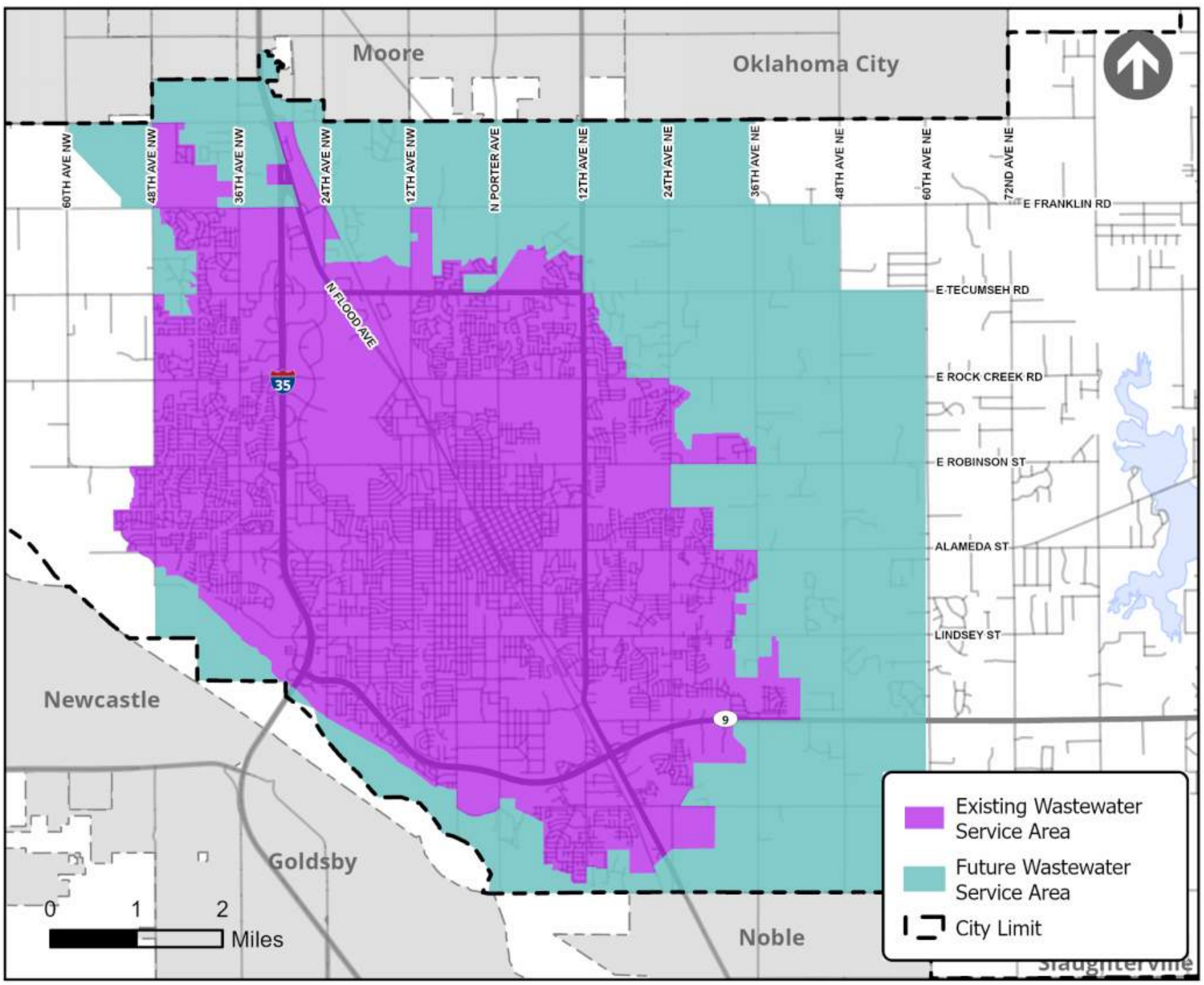
2.2 FUTURE WASTEWATER SERVICE

Future land use was developed for the Comprehensive Plan and was used to estimate the anticipated future needs and necessary improvements to the collection system. These areas and their anticipated land use classification are shown in Map 2-2. A more detailed future land use classification map is presented in Appendix B

The Comprehensive Plan shows a significant expansion of the existing WWSA based on the future land use, as well as the associated increases in flows through 2045. Growth is not anticipated east of 60th Avenue East into the 2045 Reserve, nor is it anticipated west of 60th Avenue West, as shown in Map 2-2.

Additionally, there is a reserve area east of the anticipated future WWSA, which the Comprehensive Plan describes as a sparsely developed area east of the existing WWSA with mainly large-lot residential users. High-intensity urban development in this area is not expected due to access to existing infrastructure and challenges with water quality from runoff into the Lake Thunderbird watershed. However, development in this area may be considered when City services are available to adequately serve future users.

Map 2-2: Future Wastewater Service Area



3.0 HISTORICAL POPULATION AND WASTEWATER FLOW

3.1 HISTORICAL WASTEWATER SERVICE POPULATION

According to the 2060 Water Supply Plan, the water service population has historically been approximately 88% of the City's total population. Based on recent GIS data, approximately 450 properties with water connections do not have connections to the City's WWCS. Most of these properties are residential. Assuming an average of 2.3 persons per household per the 2020 US Census, and the remainder of the water service population being connected to the wastewater system, the wastewater system currently serves approximately 1,000 fewer people than the water system. This equated to nearly 1% less of the City's total population. For the purposes of this analysis, Garver will use a historical wastewater service population of 87% of the City's total population. The historical estimated WWSA service population is summarized in Table 3-1.

Table 3-1: Historical Wastewater Service Population Estimates

Year	Service Population	Percent of Total City Population
2015	104,042	87%
2016	105,426	87%
2017	106,810	87%
2018	108,194	87%
2019	109,579	87%
2020	111,383	87%
2021	111,444	87%
2022	112,775	87%

3.2 HISTORICAL WATER RECLAMATION FACILTY FLOWS

Figure 3-1 illustrates the historical influent flow to the Norman WRF spanning between January 2015 and January 2024. The figure includes daily data points along with lines representing the annual and monthly averages. Rolling averages are taken on a 30-day (monthly) and a 365-day (annual) basis for the influent flow data. The 30-day peaking factors are calculated according to the equation shown below. Here, the monthly average influent flow is divided by the annual average influent flow at a specific date to calculate the 30-day peaking factor. A 30-day peaking factor represents a peak month condition when the facility receives maximum flow and potentially maximum contaminant loadings over the course of a consecutive 30-day period. The identified 30-day peaking factor(s) can be used in establishing the proper maximum month conditions when the facility receives maximum levels of loadings over a month.

$$\textbf{Peaking Factor}(\textbf{Date}) = \frac{\textbf{30-day Average Flow }(\textbf{Date})}{\textbf{365-day Average Flow }(\textbf{Date})}$$

Figure 3-2 shows the historical minimum monthly average and the annual average influent flows to the WRF by year from 2015 to 2023. The minimum monthly flows during dry-weather periods gradually increased over this period, while the annual average has fluctuated due to the variability in storm events.

The data from 2015 indicates a period of elevated flows, with daily rates reaching up to 36 MGD. However, the subsequent timeframe demonstrates a more consistent flow pattern. The month of May 2015 experienced record rainfall (23.4 inches, more than four times normal May rainfall), leading to exceptionally high flows. While the methodology employed does not allow for an exact calculation of the mid-2015 annual average flow, it is estimated that the 2015 had a maximum 30-day peaking factor of nearly 2. This peak significantly exceeds the 30-day peaking factors recorded in subsequent years and surpasses the typical monthly peaking factors for a municipal treatment facility of comparable size. Figure 3-3 summarizes the historical rainfall between 2002 and 2024 and showcases the level of intensity of the May 2015 rainfall relative to other years.

Between 2016 and January 2024, the 30-day average flow fluctuated within an estimated range of 13.0 to 16.6 MGD. Although there has been a slight increase in the annual average flow since 2018, it has remained relatively stable, hovering around 11 to 12 MGD. A 30-day peaking factor of 1.4 is recommended to be used for treatment capacity planning purposes within this project. It must be noted that the assessment of the treatment capacity requirements at the existing and any potential future Norman WRFs will also be considering maximum month contaminant loadings. Treatment capacity evaluations are further discussed in the Wastewater Treatment Evaluation Technical Memorandum found in Appendix I

Figure 3-1: Historical Influent Flows to WRF for January 2015 to January 2024

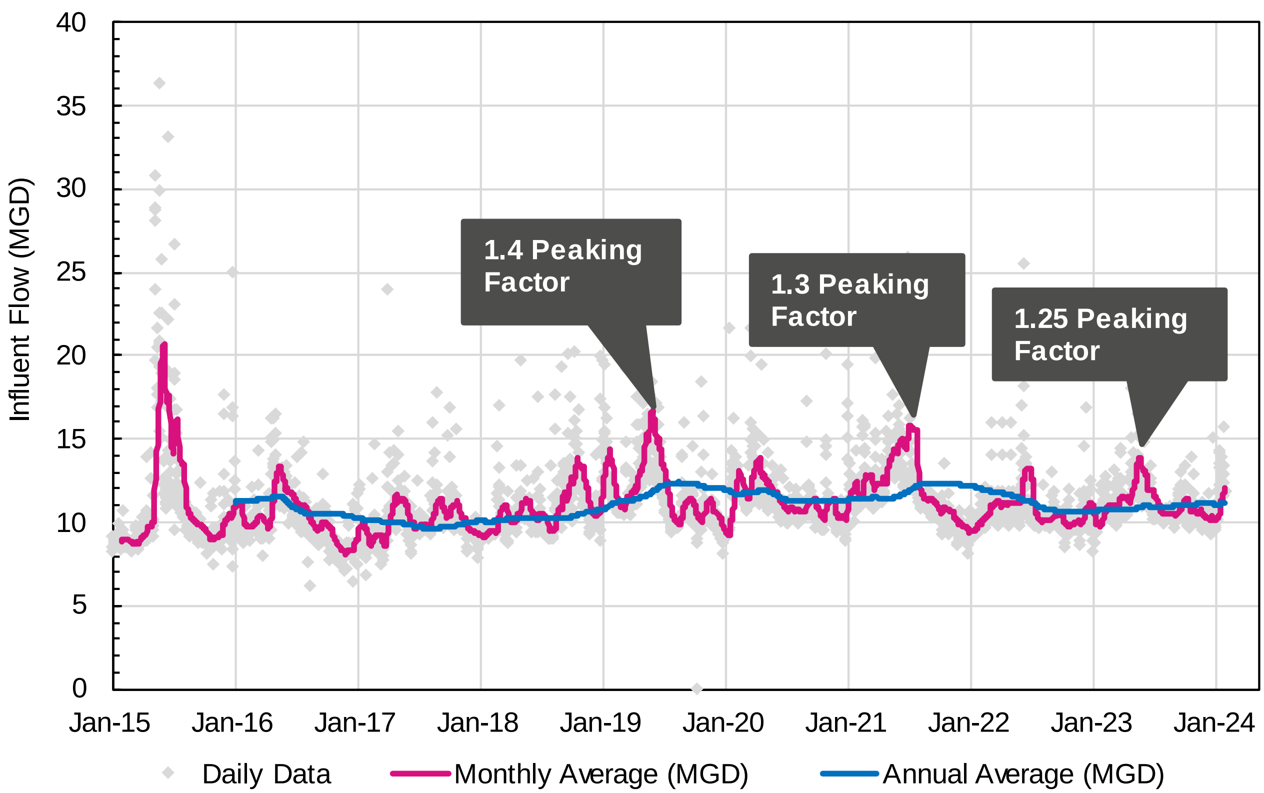


Figure 3-2: Historical Minimum Monthly Average (left) and Annual Average (right) Influent Flows to WRF by year from 2015 to 2023

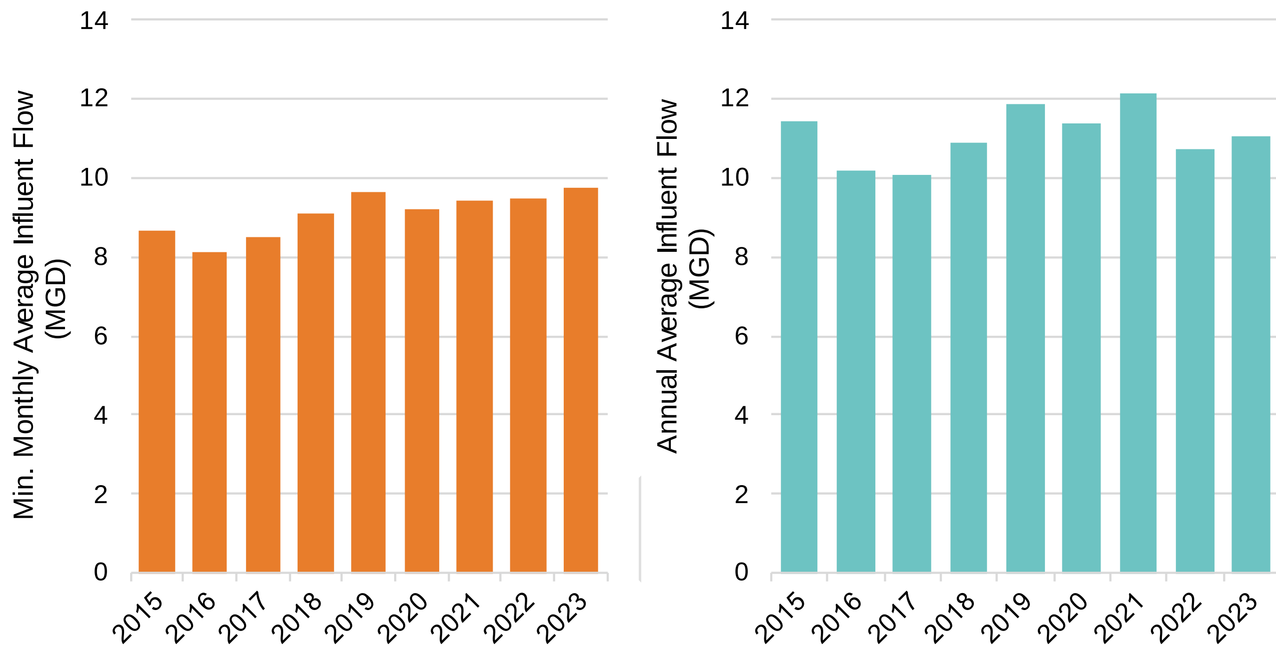
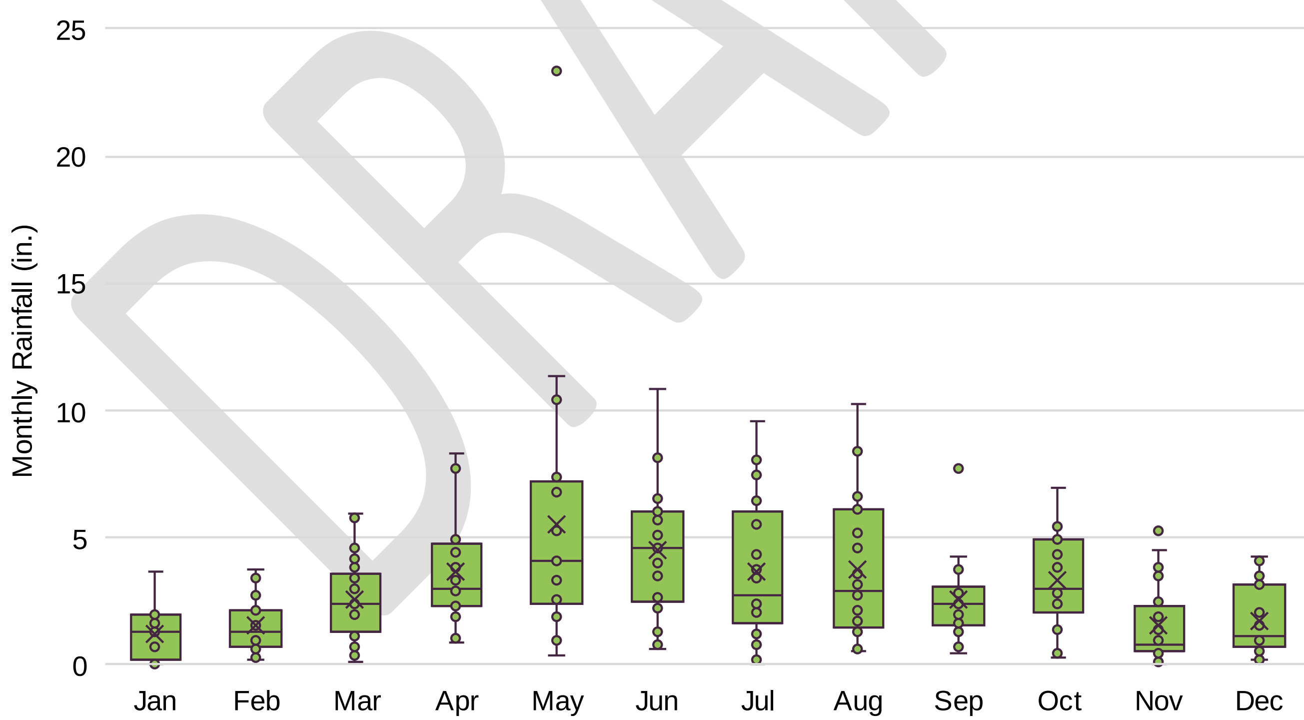


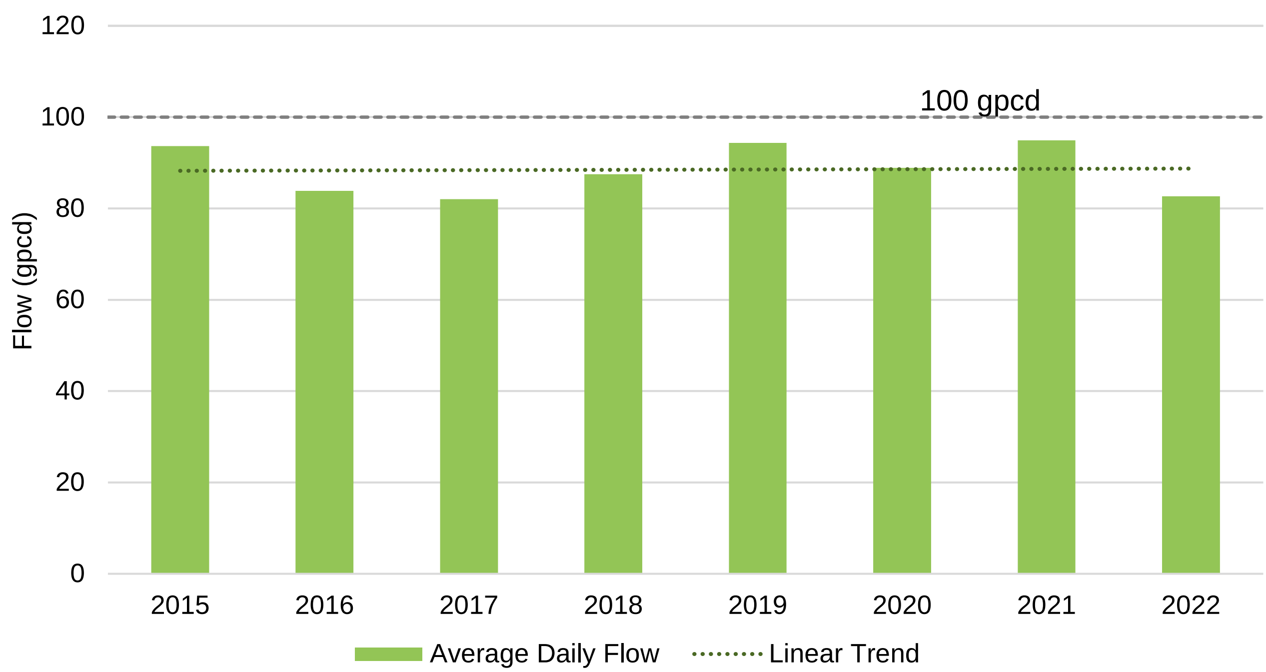
Figure 3-3: Historical Monthly Rainfall July 2002 to February 2024



3.3 PER CAPITA WASTEWATER FLOWS

Garver evaluated per capita ADF using historical service population data and annual average WRF flows. Figure 3-4 summarizes the historical ADF per capita. A value of 100 gallons per capita per day (gpcd) was used to project future flows based on population projections. This value is slightly higher than recent ADF per capita and aligns with the ODEQ ADF design requirement of 100 gpcd.

Figure 3-4: Historical ADF Per Capita



3.4 SINGLE-FAMILY EQUIVALENTS

A single-family equivalent (SFE) value was determined using historical billed water consumption data provided by NUA. SFE values are used to compare collection system flows for other customer classes and the system overall to the flows for a typical single-family detached dwelling. Single-family residential flows are often used as the benchmark for flow planning because they tend to represent most of the system and remains more stable over time compared to other benchmarks. Multi-unit, industrial, and commercial flows tend to vary significantly, and changes in these types of flows over time can cause variability in a collection system's per capita flows. Once the SFE value is determined, it can be used to express the system capacity as the number of single-family customer connections the collection system can serve currently or in the future.

Garver compared historical water consumption data with historical wastewater ADF data to determine an equivalency between the water consumption data and ADF. Winter water consumption data (occurring between November and February) was used to reduce the impact of irrigation. Average winter water consumption was determined to be approximately equivalent to ADF. Therefore, winter water consumption was used as a surrogate for wastewater ADF load. Single-family wastewater load was determined using the total 2022 water consumption between November and February for all meters classified as single-family with a diameter of 1-inch or less. The total demand was then divided by the total number of single-family meters within the system. A summary of the data used to determine the SFE value is presented in Table 3-2.

Table 3-2: Single-Family Equivalent Projection

Total SFE Winter Water Demand		Number of Meters	ADF SFE Value (gpd/SFE)
(MG)	(MGD)		
828.1	6.9	33,641	205

3.5 WASTEWATER FLOWS BY LAND USE

Garver used historical winter water consumption data between November 2022 and February 2023 and GIS data to determine historical land use loading rates, due to winter water consumption being approximately equivalent to wastewater ADF. A GIS analysis was completed to determine the lot size and the existing land use associated with each geolocated meter by extracting data for the nearest parcel. Table 3-3 summarizes the loading rate by land use category. The projected loading rate values were used to determine future wastewater flows for new developments. For single-family residential developments, the residential areasv were assumed to be approximately 80% of the total development area for high-density developments and 70% for low-density developments to account for streets, detention ponds, and other open spaces.

Table 3-3: Historical Loading Rates by Customer Class

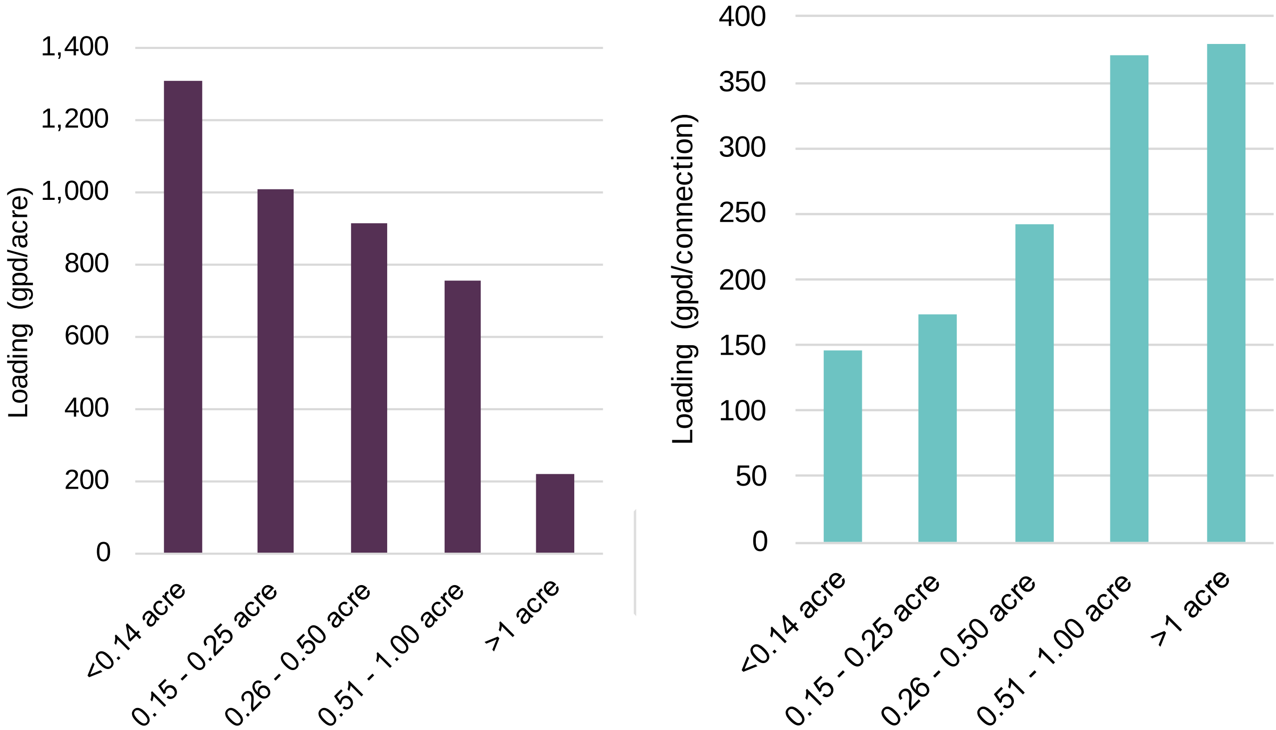
Customer Class	Customer Sub Class	Winter Water Demand (MG)	Total Area (acre)	Historical Loading Rate (gpd/acre)	Projected Loading Rate (gpd/acre)
Residential	Residential - Multi-Unit	216	700	2,567	2,600
	Residential - Single-Family Attached	62	311	1,664	1,700
	Residential - Single-Family Detached	757	7,575	833	See Table 3-5
Industrial	Light Industrial	27	293	768	800
	Heavy Industrial	12	94	1,035	1,100
Commercial	Commercial	162	1,745	775	800
	Office	87	403	1,802	1,800

Residential users make up a large percentage of wastewater connections with most residential users being classified as single-family detached. Due to the large percentage of single-family detached users, further analysis was completed to determine how flows vary based on lot size. An analysis was completed to determine the correlation between lot size and flows to better predict future loading rates for new subdivision developments. Table 3-4 and Figure 3-5 summarize the differences in flows related to differing lot sizes.

Table 3-4: Single-Family Detached Historical and Projected Loading Rates by Lot Size

Lot Size (acre)	Number of Connections	Winter Water Demand (MG)	Total Area (acre)	Historical Loading (gpd/acre)	Projected Loading Rate (gpd/acre)	Historical Loading (gpd/connection)
<0.14	3,198	56	358	1,304	1,300	146
0.15 - 0.25	20,722	430	3,557	1,008	1,000	173
0.26 - 0.50	7,263	211	1,925	915	900	243
0.51 - 1.00	743	33	366	754	800	371
>1.00	595	27	1,041	216	250	379

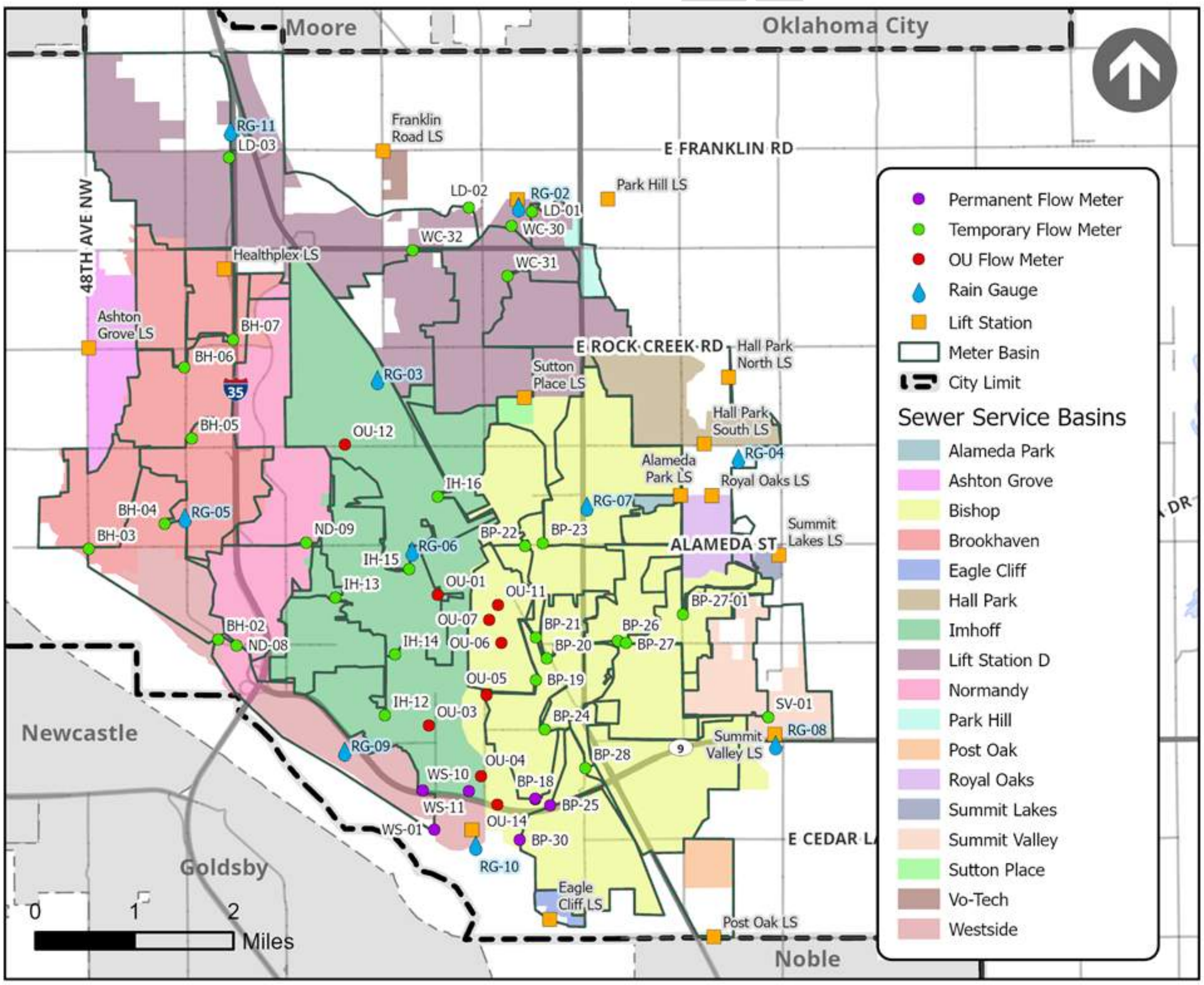
Figure 3-5: Historical Single-Family Detached Loading Rates by Lot Size



4.0 FLOW METERING DATA ANALYSIS

Flow meter data was collected to assess existing dry- and wet-weather flows in the collection system. The flow meter data was analyzed to develop dry-weather flow loadings and wet-weather flow responses that were calibrated to observed conditions and used for capacity assessment scenarios in the hydraulic model, as discussed in Section 7.0. Thirty temporary flow meters and ten temporary rain gauges were installed throughout the collection system. Temporary flow metering data was supplemented by seven permanent flow meters that are installed just upstream of the WRF. A map of the flow metering basins is shown in Map 4-1. Flow metering and rainfall data were collected on 5- to 15-minute increments between April 20and August 1, 2023. Site sheets showing detailed location and hydraulic information for the flow meter and rain gauge sites are provided in Appendix C. The flow monitoring hydrographs are included in Appendix D.

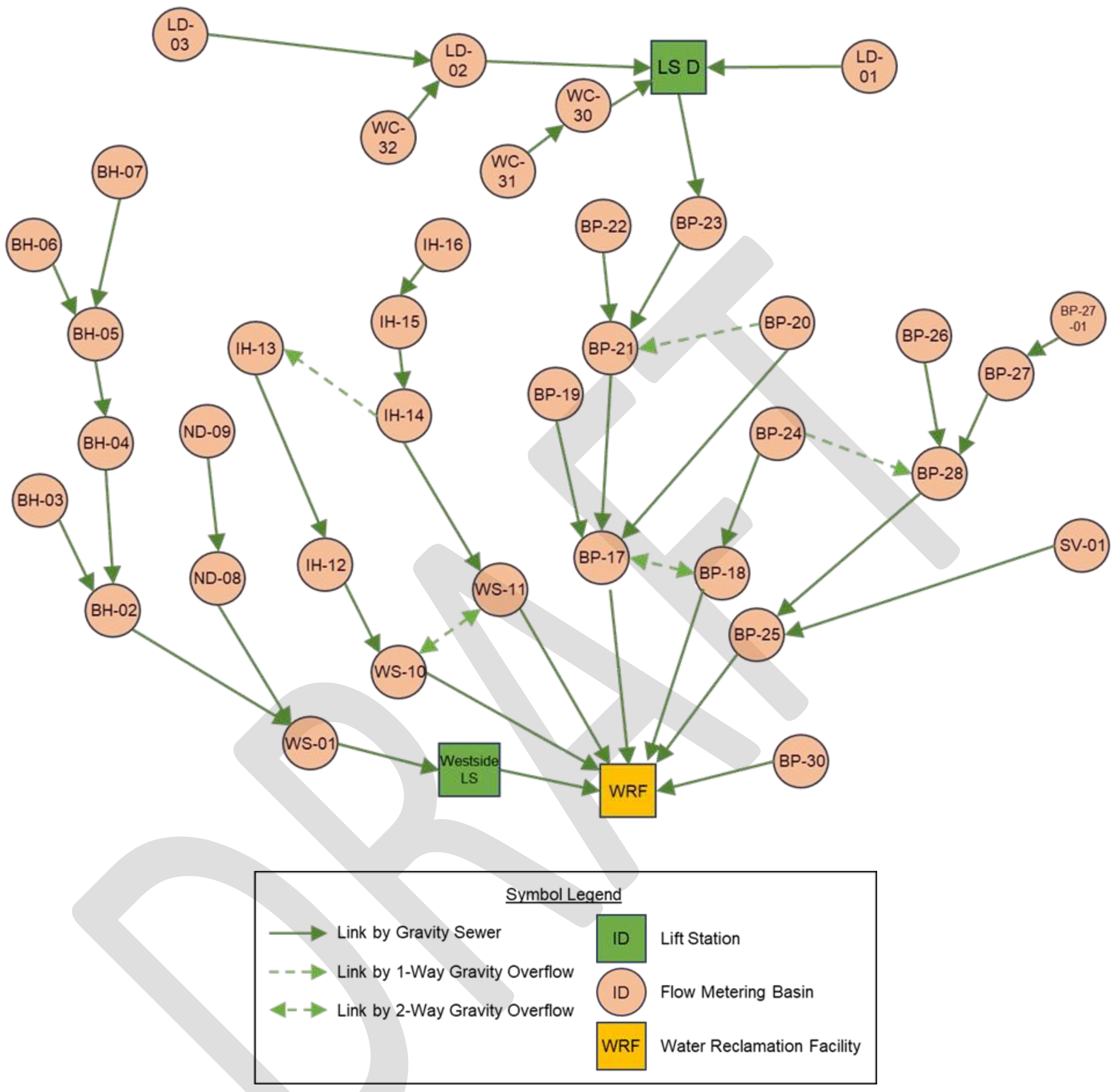
Map 4-1: Flow Monitoring Basin Map



Note: The University of Oklahoma flow meters included in the above figure were used for validation purposes, but were not used for flow metering data analysis due to inconsistent reporting with the temporary flow meters.

Flow meter analysis involved determination of average dry-weather flows (ADWF) and diurnal patterns, as well as rainfall-derived infiltration and inflow (RDII) during wet-weather events. Figure 4-1 shows a schematic of the flow network of all the metered basins.

Figure 4-1: Flow Meter Schematic



Dry-weather flow days were used for calculation of ADWF and diurnal patterns. A dry-weather flow day is any day in the flow metering period that had five or more days without rainfall preceding it. Depending on the rain gauge associated with the metered basin, between 18 and 30 dry-weather days were used to determine dry-weather flow conditions. Table 4-1 shows the ADWF and the dry-weather flow peaking factor for each basin. The values shown are for the discrete metered flow at each flow meter, with upstream flows subtracted out. Flow from meters BP-17 and BP-18 were summed and evaluated together due to these meters being on parallel lines with many upstream cross-connection points. WS-10 and WS-11 are also cross-connected parallel lines that were summed and evaluated together. The dry-weather flow peaking factor is the ratio of the peak hour dry-weather flow to the ADWF. The dry-weather peaking factors range from 1.19 to 1.93, and the mean flow-weighted dry-weather peaking factor is 1.29.

Table 4-1: Dry-Weather Flows

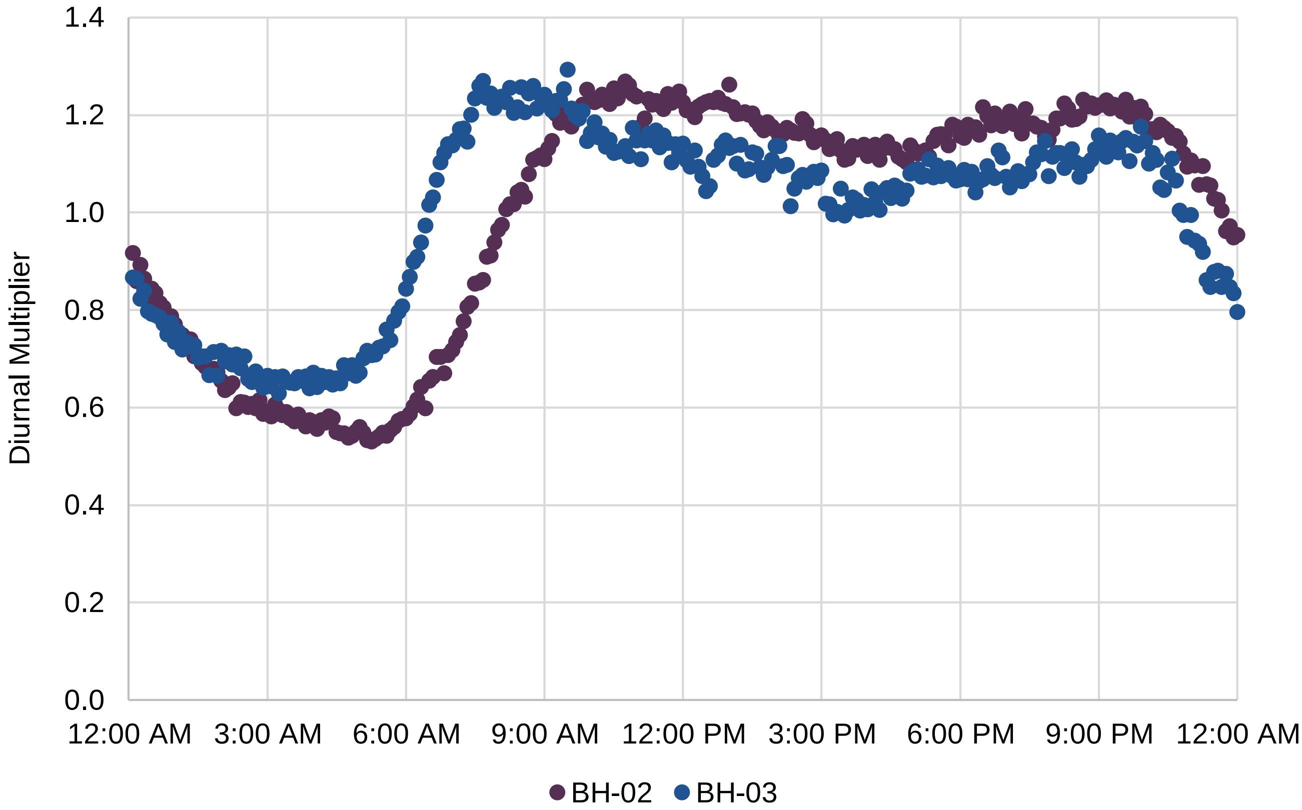
Flow Meter	Average Dry-Weather Flow (MGD)	Peak Hour Dry-Weather Flow (MGD)	Dry-Weather Flow Peaking Factor
BH-02	0.18	0.23	1.28
BH-03	0.37	0.48	1.30
BH-04	1.15	1.43	1.24
BH-05	0.47	0.62	1.32
BH-06	0.62	0.80	1.29
BH-07	0.25	0.36	1.45
BP-19	0.04	0.05	1.20
BP-20	0.07	0.09	1.32
BP-21	0.39	0.47	1.21
BP-22	0.38	0.46	1.22
BP-23	0.11	0.13	1.19
BP-24	0.57	0.75	1.32
BP-25	0.56	0.70	1.25
BP-26	0.26	0.33	1.28
BP-27	0.21	0.28	1.33
BP-27-01	0.50	0.75	1.50
BP-28	0.60	0.77	1.29
BP-30	0.24	0.36	1.48
IH-12	0.26	0.32	1.24
IH-13	0.47	0.60	1.28
IH-14	0.22	0.29	1.31
IH-15	0.40	0.49	1.22
IH-16	0.34	0.40	1.18
LD-01	0.04	0.08	1.93
LD-02	0.26	0.33	1.25
LD-03	0.03	0.04	1.30
ND-08	0.07	0.09	1.31
ND-09	0.70	0.90	1.29
SV-01	0.12	0.17	1.43
WC-30	0.57	0.75	1.31
WC-31	0.31	0.42	1.35
WC-32	0.22	0.32	1.44
WS-01	0.64	0.81	1.27

Notes:

1. Permanent Flow Meters BP-17, BP-18, WS-10, and WS-11 were not analyzed due to being located on parallel mains that overflow to each other. Flows in these basins were assessed during dry and wet-weather calibration of the hydraulic model.

Dry-weather diurnal patterns were developed for each flow meter. Figure 4-2 shows an example of the dry-weather diurnal patterns that were developed for flow meters BH-02 and BH-03. Dry-weather diurnal patterns are developed by subtracting medium-term infiltration volumes from preceding rainfall events from the identified dry-weather flow days (determined by an analysis of daily flow volumes). Base groundwater infiltration is included in the dry-weather flows and dry-weather diurnal patterns. For each of the analyzed meters, the dry-weather flow data was split into weekday and weekend groupings and unique diurnals were developed for each. Holidays and outlier data points were excluded. Average flows were then calculated for each timestep in the data. These values were then divided by the daily average flow for each meter, resulting in unitless values representing a multiplier of the ADF.

Figure 4-2: Example Dry-Weather Diurnal Patterns

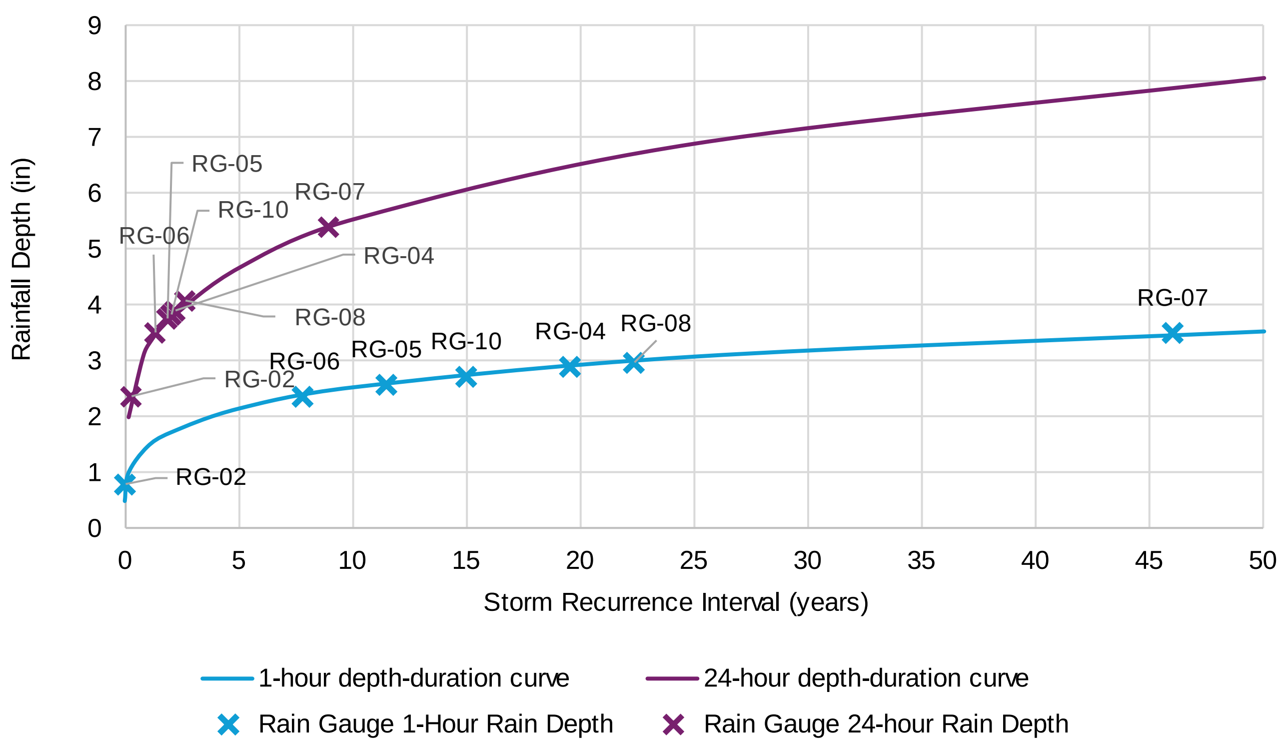


Each flow meter is associated to the nearest rain gauge in the rainfall monitoring network. Wet-weather events were determined for each rain gauge, and the wet-weather events were used as analysis periods for wet-weather flows. Wet-weather events are rainfall events in which 24-hour rainfall totals exceed 0.9 inches. This 24-hour rainfall total was selected so that multiple qualifying wet-weather events could be evaluated at each flow meter, while focusing on only significant rainfall events. Several rain gauges did not have multiple events that met this criterion due to a combination of spatial rainfall variability and periods of time in which some rain gauges were not consistently reporting data. In the case that a rain-gauge did not meet the 0.9-inch criterion for a wet-weather event, the criterion was lowered to 0.5 inches of rainfall in a 24-hour period. A summary of the rainfall experienced at each of the rain gauges during the monitoring period is shown in Table 4-2. This table also shows an estimate of the maximum 24-hour and 1-hour frequency storms experienced during the monitoring period (according to the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation frequency-duration curves). Figure 4-3 also shows a graphical representation of the of the maximum 24-hour and 1-hour recurrence intervals observed in the rain gauge data.

Table 4-2: Wet-Weather Events

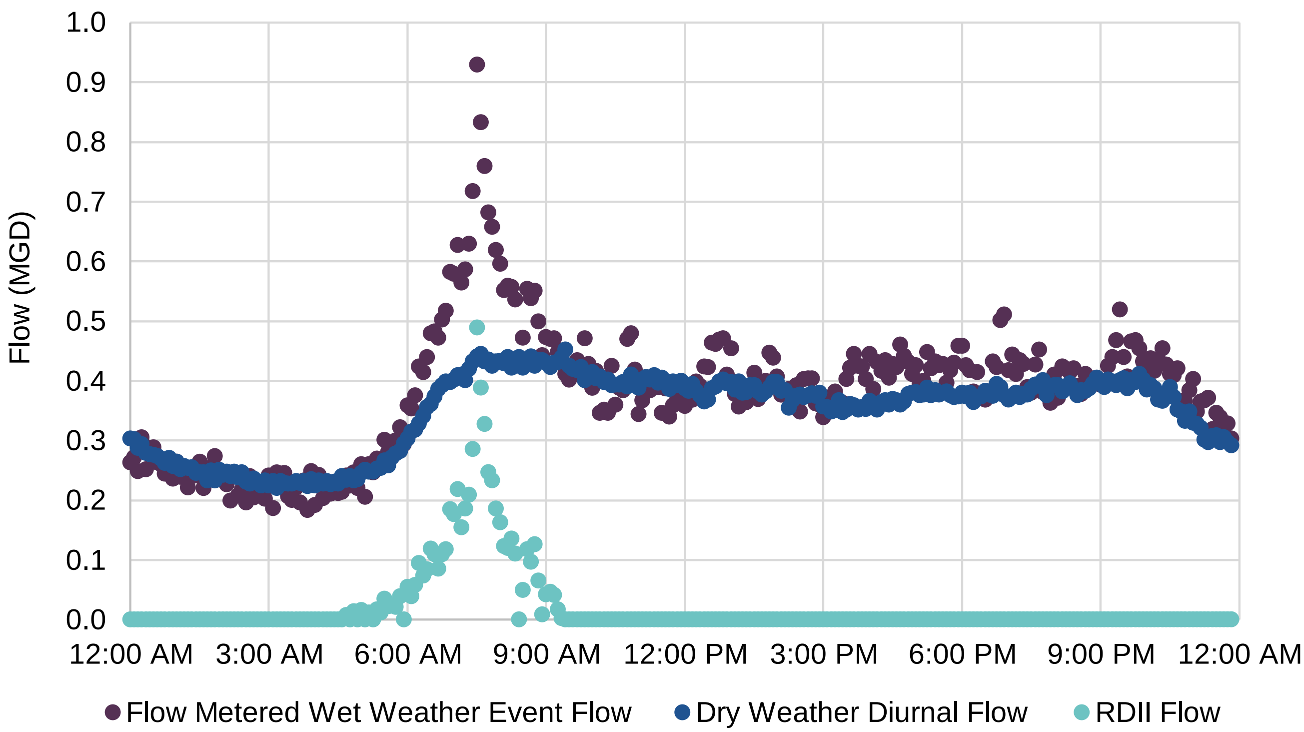
Rain Gauge	Associated Flow Meters	Number of Wet-Weather Events	Maximum 24-hour Rainfall (in)	Equivalent 24-hour Frequency Storm	Maximum 1-hour Rainfall (in)	Equivalent 1-hour Frequency Storm
RG-02	LD-01, LD-02, WC-30, WC-31, WC-32	4	2.36	< 1-year	0.78	< 1-year
RG-04	BP-18, BP-22, BP-23, BP-26, BP-27-01, BP-28, IH-14	4	3.91	2-year	2.90	20-year
RG-05	BH-02, BH-03, BH-04, BH-05, BH-06, BH-07, ND-08, LD-03	4	3.77	2-year	2.57	11-year
RG-06	IH-13, IH-15, IH-16, ND-09	3	3.50	1-year	2.36	8-year
RG-07	BP-19, BP-20, BP-21, BP-24, BP-27	3	5.41	5-year	3.52	46-year
RG-08	SV-01	4	4.08	2-year	2.99	22-year
RG-10	BP-25, BP-30, WS-01, WS-10 WS-11, BP-17	2	3.83	2-year	2.73	15-year

Figure 4-3: Recurrence Intervals of Rain Gauge Data



The RDII was calculated at each basin for each wet-weather event. RDII was calculated as the difference between the wet-weather event flow and the typical dry-weather flow of the basin. Figure 4-4 shows an example of the wet-weather (combined dry-weather and RDII flow), RDII, and dry-weather flow for flow meter basin BH-03.

Figure 4-4: Example RDII Flow



Garver conducted an initial analysis of the wet-weather events recorded during the flow monitoring period. This analysis was conducted on total flows to each flow meter and provides an understanding of overall wet-weather response to design storms, as well as design storm peaking factors experienced at each flow meter location.

For each wet-weather event, the RDII flow was parameterized using the RTK method. The RTK method is a parameterization of RDII flow that estimates flow by defining three separate unit hydrographs (the hypothetical flow response to a unit of rainfall). The three hydrographs represent inflow, short-term infiltration, and long-term infiltration of rainwater into the wastewater system after a rainfall event. The RTK parameters were generated with a genetic algorithm that selects parameters with the goal of minimizing errors associated with peak flows and total RDII volume across all wet-weather events in the monitoring period.

Table 4-3 shows the average peak flow error the selected RTK parameters result in for the monitored wet-weather events. The peak flow and volume errors represent the average overestimation (positive error) or underestimation (negative error) of RDII peak flow for each wet-weather event. There are several basins that have peak flow and volume errors over 15%. This is typically caused by inconsistent wet-weather responses in the flow metering data, often because of the influence of lift station pumping on the flow patterns or due to high geospatial variability in the rainfall data.

Table 4-3: Flow Meter Wet-Weather Parameterization Error

	Number of Wet-Weather Events	Average Event Peak Flow Error	Average Event Volume Error
BH-02	3	7%	-3%
BH-03	3	0%	-1%
BH-04	3	0%	17%
BH-05	3	13%	20%
BH-06	2	0%	1%
BH-07	4	10%	25%
BP-19	2	1%	0%
BP-20	3	-3%	8%
BP-21	1	1%	0%
BP-22	2	-3%	7%
BP-23	1	0%	0%
BP-24	3	8%	17%
BP-26	1	3%	1%
BP-27	2	0%	1%
BP-27-01	1	1%	0%
BP-28	3	-3%	-1%
IH-13	3	-4%	2%
IH-14	4	-5%	2%
IH-15	3	15%	14%
IH-16	3	2%	18%
LD-02	4	10%	1%
LD-03	3	9%	4%
ND-08	4	15%	1%
ND-09	2	1%	-1%
SV-01	4	12%	10%
WC-30	3	12%	30%
WC-31	3	-9%	1%
WC-32	4	19%	12%

The RTK parameters generated for each basin are used to simulate wet-weather flows for the 2-year, 5-year, and 10-year 24-hour design storms. The design storm depths were taken from the NOAA Atlas 14 precipitation frequency-duration tables. The design storm volumes were distributed over 24 hours using the SCS Type II temporal rainfall distribution. The rain volumes and the maximum 1-hour rainfall intensities used for the design storms are shown in Table 4-4. Figure 4-5 shows the cumulative rainfall depths over 24 hours for the 2-year, 5-year, and 10-year storms using the SCS Type II temporal distribution.

Table 4-4: Design Storm Rain Depth

Design Storm	24-Hour Rain Depth (inches)	Maximum 1-hour Intensity (inch/hour)
2-year	3.77	1.71
5-year	4.67	2.12
10-year	5.53	2.51

Figure 4-5: Temporal Distribution of Design Storms

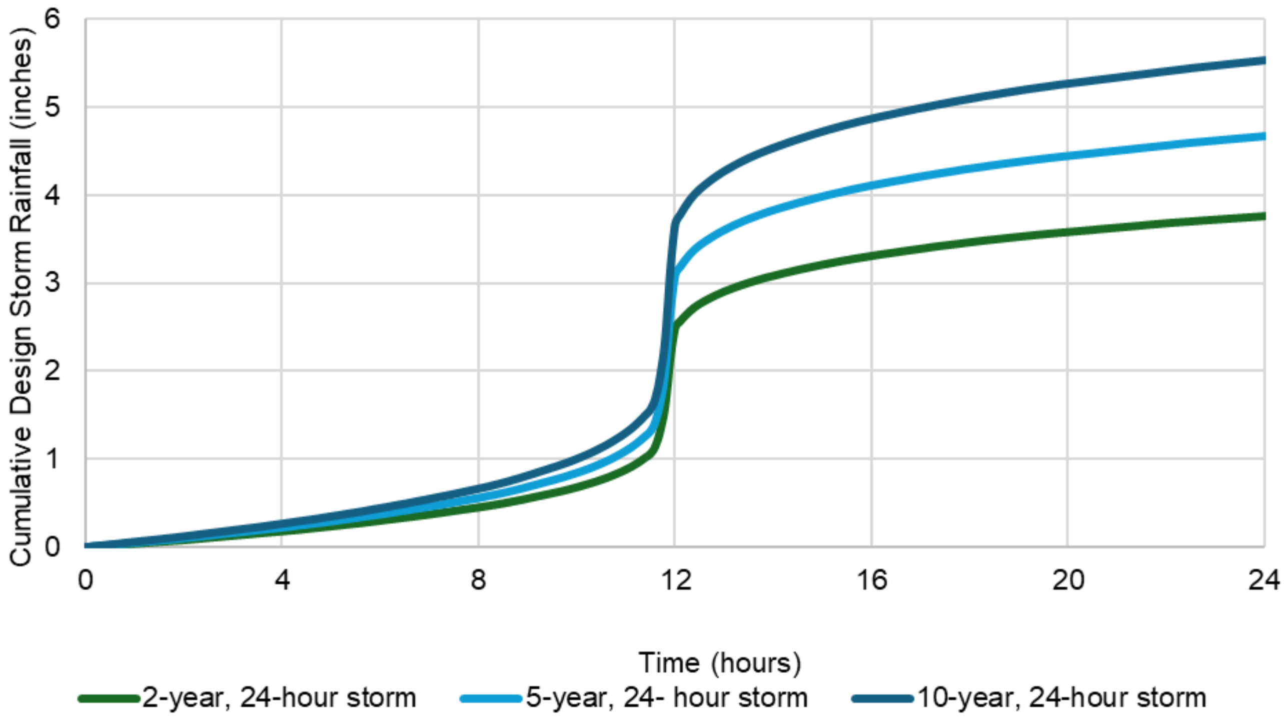


Table 4-5 shows the resulting peaking factors and design peak flows from applying the design storms to the generated RTK parameters for each basin. Further calibration of the wet-weather response for simulation in the hydraulic model is discussed in Section 7.5

Table 4-5: Projected Design Wet-Weather Flows at Flow Metering Locations

Flow Meter	Design Storm Peak Flows (MGD)			Peaking Factors		
	2-Year Storm	5-Year Storm	10-Year Storm	2-Year Storm	5-Year Storm	10-Year Storm
BH-02	17.28	20.83	24.19	9.33	11.25	13.06
BH-03	3.35	4.02	4.66	8.6	10.33	11.97
BH-04	6.79	8	9.14	4.88	5.75	6.57
BH-05	9.54	11.55	13.46	11.8	14.3	16.65
BH-06	2.23	2.69	3.12	9.66	11.65	13.54
BH-07	1.56	1.87	2.16	8.28	9.91	11.45
BP-19	5.65	6.84	7.96	10.28	12.44	14.48
BP-20	1.39	1.68	1.94	8.68	10.44	12.09
BP-21	12.64	14.87	16.97	4.68	5.51	6.29
BP-22	3.58	4.33	5.04	10.44	12.63	14.7
BP-23	16.06	19.19	22.14	6.55	7.82	9.03
BP-24	2.79	3.36	3.89	9.33	11.24	13.04
BP-26	9.46	11.52	13.47	15.15	18.45	21.57
BP-27	2.94	3.46	3.95	5.17	6.08	6.95
BP-27-01	8.58	10.45	12.23	18.55	22.61	26.45
BP-28	4.16	4.94	5.67	6.03	7.16	8.22
IH-13	1.37	1.63	1.87	5.83	6.91	7.94
IH-14	5.83	6.86	7.84	5.12	6.02	6.88
IH-15	7.66	9.31	10.86	12.75	15.49	18.09
IH-16	3.49	4.22	4.9	9.04	10.91	12.68
LD-02	12.76	15.56	18.2	15.77	19.23	22.5
LD-03	2.12	2.55	2.95	8.49	10.2	11.82
ND-08	3.98	4.71	5.4	5.68	6.72	7.71
ND-09	3.68	4.36	5	5.67	6.71	7.69
SV-01	1.28	1.55	1.81	12.67	15.34	17.87
WC-30	8	9.69	11.28	11.59	14.04	16.35
WC-31	2.5	3.01	3.48	8.87	10.66	12.35
WC-32	3.09	3.76	4.39	15.23	18.52	21.62

Table 4-6 shows the statistics of the basin peaking factors for the 2-year, 5-year, and 10-year design storms. The median peaking factor for the 2-year storm is 8.5. The median peaking factor for the 5-year storm is 10.3, and the median peaking factor for the 10-year storm is 11.9. These peaking factors represent the impact of RDII on collection system flows. Actual peak flows experienced at the WRF and at other locations in the system will depend on travel time, flow attenuation, and storage as wastewater is conveyed through the collection system. The peak influent flows to the WRF were evaluated in hydraulic modeling scenarios.

Table 4-6: Basin Peaking Factor Summary for 2-Year, 5-Year, and 10-Year Design Storms

Design Storm	Minimum Peaking Factor	Median Peaking Factor	Maximum Peaking Factor
2-year	4.7	8.5	14.4
5-year	5.5	10.3	17.4
10-year	6.3	11.9	20.3

Note: Peaking factors shown represent 5-minute peak flows divided by ADWF to be used for collection system infrastructure capacity evaluations. These peaking factors do not represent multipliers of ADF. Peaking factors applied to the ADF would be about 10% lower.

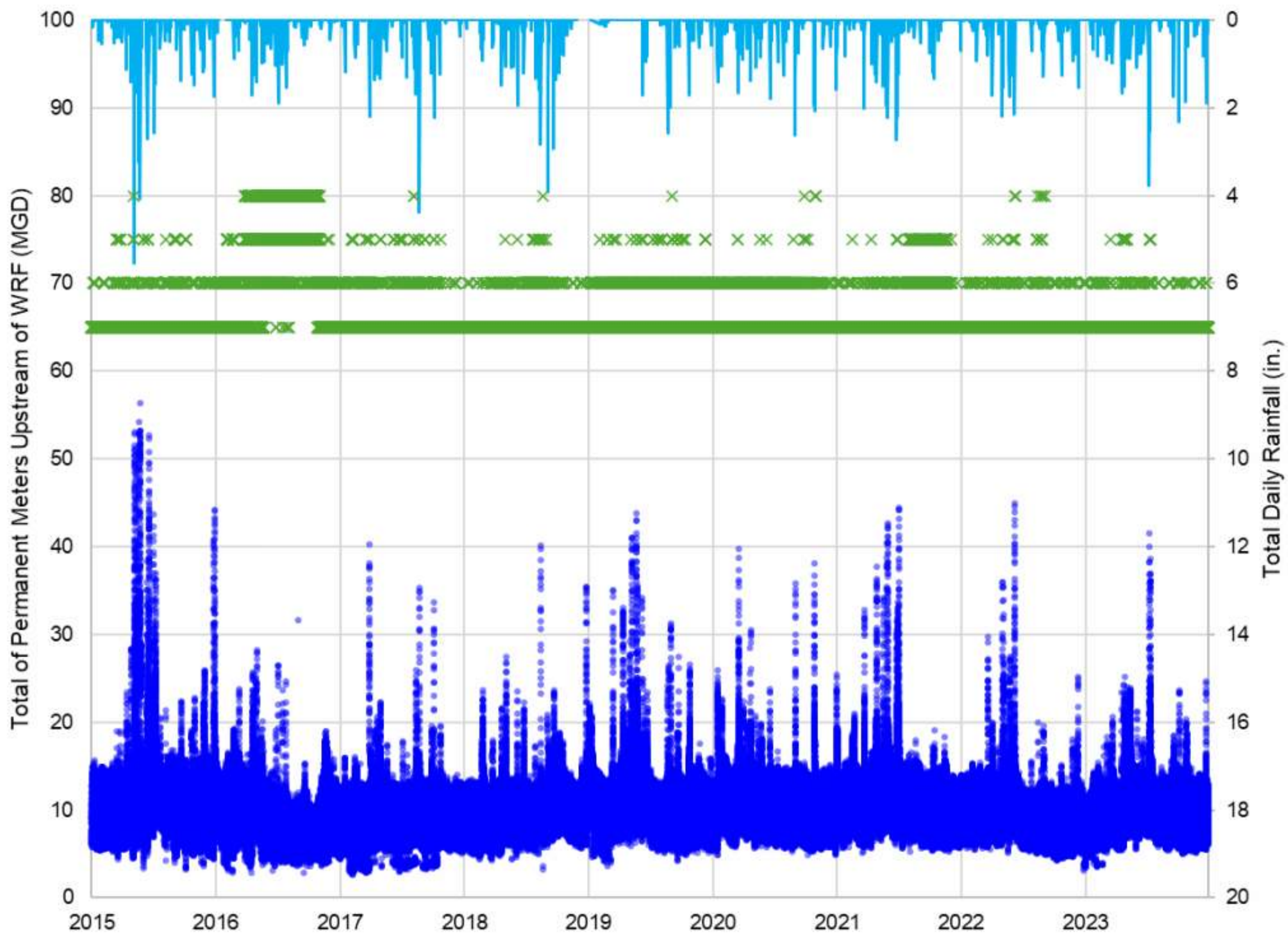
The seven permanent flow meters were not included in the initial wet-weather analysis. These flow meters are located on interceptors at the downstream end of the collection system, just upstream of the outfall to the WRF. These meters were not included in the evaluation because they are located on interceptors that are designed to surcharge, store water, and attenuate peak flow rates through diversions to other interceptors. However, data from these flow meters was used in the wet-weather calibration of the hydraulic model, as discussed in Section 8.5. The permanent flow meters and their maximum observed flows reported during the flow metering period are shown in Table 4-7.

Table 4-7: Permanent Flow Meters Wet-Weather Flows

Flow Meter	Maximum Observed Flow (MGD)
BP-17	11.15
BP-18	9.02
BP-25	7.55
BP-30	1.32
WS-01	12.57
WS-10	2.00
WS-11	12.74

NUA provided additional permanent flow meter data for the period of 2015 through 2023. Figure 4-6 shows the total of the 15-minute flow rates for all seven flow meters upstream of the WRF. At high flow rates, several of the permanent meters error out and do not register flow. Total flows of above 40 MGD have been observed upstream of the WRF for periods of up to a few hours. Even higher flows were observed during the record-setting rainfalls in May 2015, which are discussed in Section 3.2.

Figure 4-6: Total Flow for Permanent Meters Upstream of WRF for 2015 to 2023

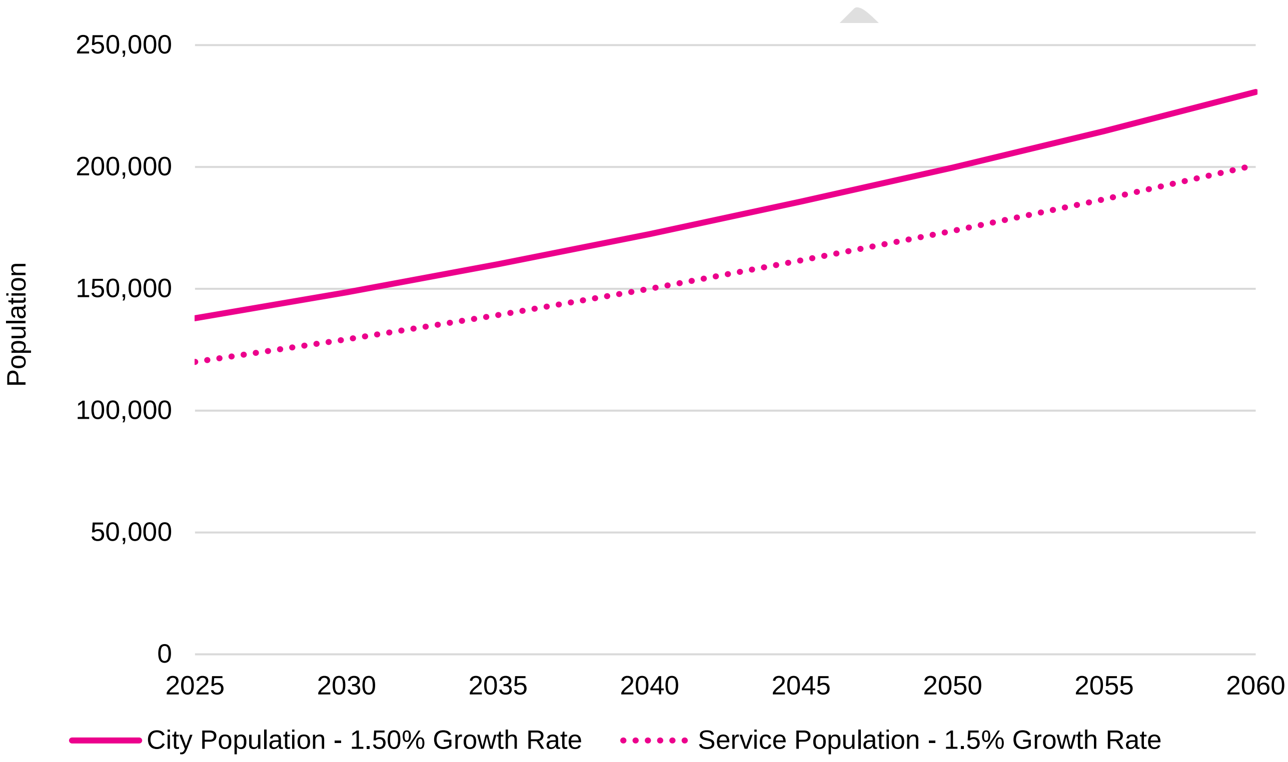


5.0 WASTEWATER POPULATION AND FLOW PROJECTIONS

5.1 POPULATION PROJECTION

Garver used the 1.5% annual growth rate projection included in the Norman Today report as the basis of the City's population projections through the year 2045 which are presented in Figure 5-1. It was assumed that the service population would be approximately 87% of the City's population, and the growth rate percentage was applied independently to both the City and NUA service populations.

Figure 5-1: City and NUA Service Area Population Projections



5.2 FLOW PROJECTION

As discussed in Section 3.3, the wastewater flow rate projections are calculated based on the anticipated service population and an ADF per capita of 100 gpcd. Garver used the 1.5% annual growth rate projection included in the Norman Today report as the basis of the population projections through the year 2045. The growth rate percentage was applied independently to both the City's population and the NUA service population. The projected service population and ADF for the WWSA throughout the planning period are shown in Table 5-1 and Figure 5-2. Projections through the year 2045 were used to develop the CIP.

In addition to the flow calculated based on population growth, a reserve capacity of 10% was included to remain consistent with the reserve capacity projected for the water system. The inclusion of a reserve capacity mitigates any potential changes to per capita flows because of new industrial flows, unanticipated growth, or severe weather events.

Table 5-1: Projected Wastewater Flows

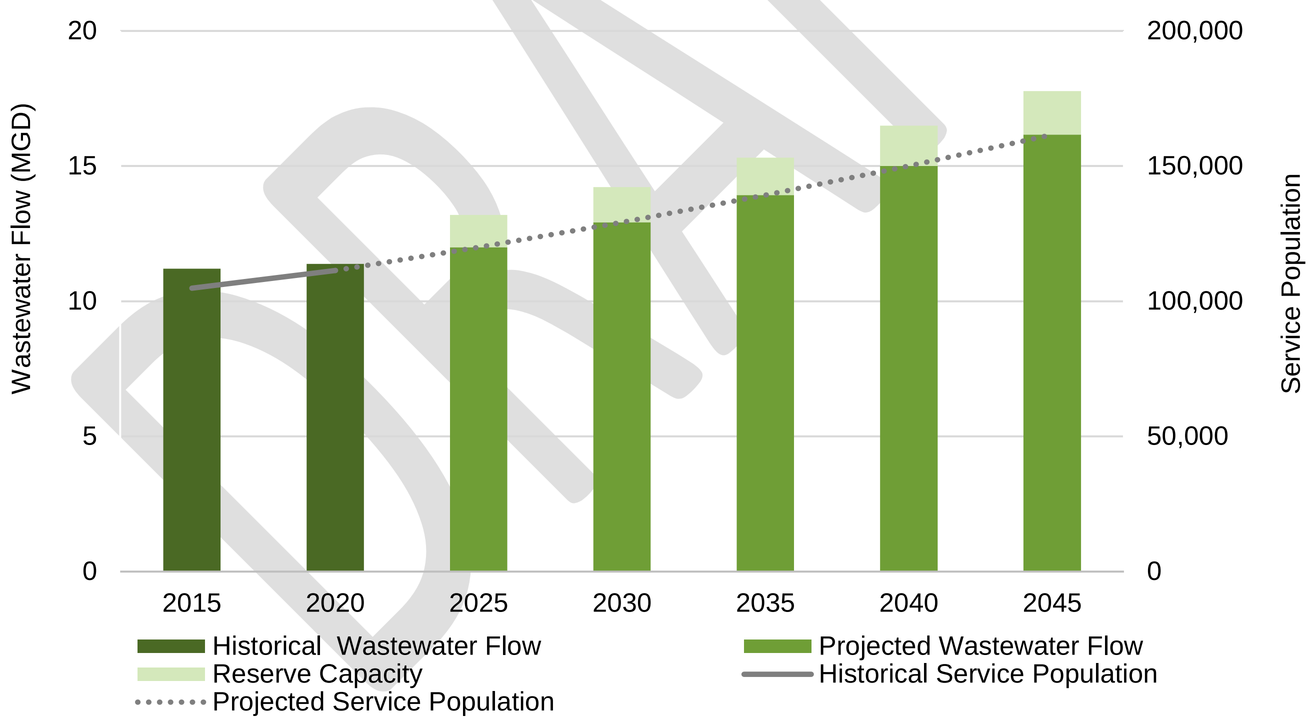
Year	Service Population	ADF (MGD)	ADF Reserve Capacity (MGD)	ADF Total (MGD)	SFE[1]
2025	119,990	12.00	1.20	13.20	58,532
2030	129,264	12.93	1.29	14.22	63,055
2035	139,254	13.93	1.39	15.32	67,929
2040	150,016	15.00	1.50	16.50	73,178
2045	161,610	16.16	1.62	17.78	78,834

Notes:

1. Based on projected ADF with reserve capacity and value of 205 gpd/SFE discussed in Section 3.4

Previous wastewater flow projection efforts have focused on buildout flows based on the future WWSA anticipated at the time of their development. The 2001 WWMP predicted that the buildout ADF would be 20.5 MGD and the ADF plus planning capacity would be 21.5 MGD. The 2013 WW Modeling Report buildout projection, which is also referenced in the 2018 WW Modeling Report, predicted that the ADF would be 17.1 MGD and the ADF plus planning capacity would be 18.0 MGD.

Figure 5-2: Projected Wastewater Flows



6.0 WASTEWATER SYSTEM EVALUATION CRITERIA

Design criteria and regulatory requirements from a variety of sources were assembled to develop the evaluation criteria for analysis of the wastewater system. Specifically, documents from the following sources were reviewed:

- ODEQ
- City of Norman 2023 Engineering Design Criteria and Standard Specifications (Norman EDC)
- Water Environment Federation's Manual of Practice 8

Table 6-1 summarizes the evaluation criteria that will be used to evaluate the wastewater system's performance and identify potential capital improvement projects. The table also includes NUA system-specific goals/criteria recommended by Garver for evaluating the existing collection system. Some of the criteria presented in the table have "NUA system performance target" or "NUA system performance criteria" set as the limiting source. Infrastructure that fails to meet the NUA system performance criteria will trigger a project in this Master Plan. Infrastructure that meets the NUA system performance criteria but fails to meet the NUA system performance target are potential capacity constraints that should be monitored and addressed as necessary.

Table 6-1: Wastewater System Evaluation Criteria

Criteria	Limiting Source	Description
Treatment Plant Design Life	ODEQ	Design wastewater treatment plants for an estimated 20-year population projection. Construction may occur in phases.
Gravity Sewer Sizing	Norman EDC	No public gravity sewer should be less than 8 inches in diameter.
Gravity Pipe Velocity	ODEQ	Gravity pipes should obtain a velocity of 2 ft/s.
Minimum Gravity Pipe Slope	Norman EDC	Minimum pipe grade by diameter as presented in the 2023 Norman EDC.
Gravity Sewer Hydraulic Capacity	Industry Standard	A d/D ratio of 0.75 will be used to determine the sizing of future infrastructure. The d/D ratio is defined as the depth of water in the gravity main during peak flow conditions divided by the inside diameter.
Maximum Surcharge	NUA system performance target	Existing gravity mains should surcharge no more than 1 foot above the crown of pipe.
Minimum Freeboard	NUA system performance target	Existing gravity mains should surcharge to no more than 3 feet below the manhole rim elevation.
	NUA system performance criteria	Existing gravity mains should surcharge to no more than 1 foot below the manhole rim elevation.
Lift Station Capacity	ODEQ	All lift stations shall have a minimum of two pumping units. With any pump out of service, the remaining pump(s) shall be capable of conveying the maximum wastewater flows of the system.
Force Main Velocity	ODEQ	Force mains should obtain a velocity of at least 2 ft/s.
Force Main Maximum Flow Velocity	Industry Standard	Force mains should not experience a maximum flow velocity of greater than 6 ft/s. (Note: Guideline is not a regulatory requirement)

7.0 HYDRAULIC MODEL UPDATE

Garver evaluated the WWCS using Innovyze's InfoWorks ICM hydraulic modeling software. Previous modeling efforts, including the 2013 WW Modeling Report and the 2018 WW Modeling Report completed by others, were used during this model development process. The following sections describe the update of the hydraulic model.

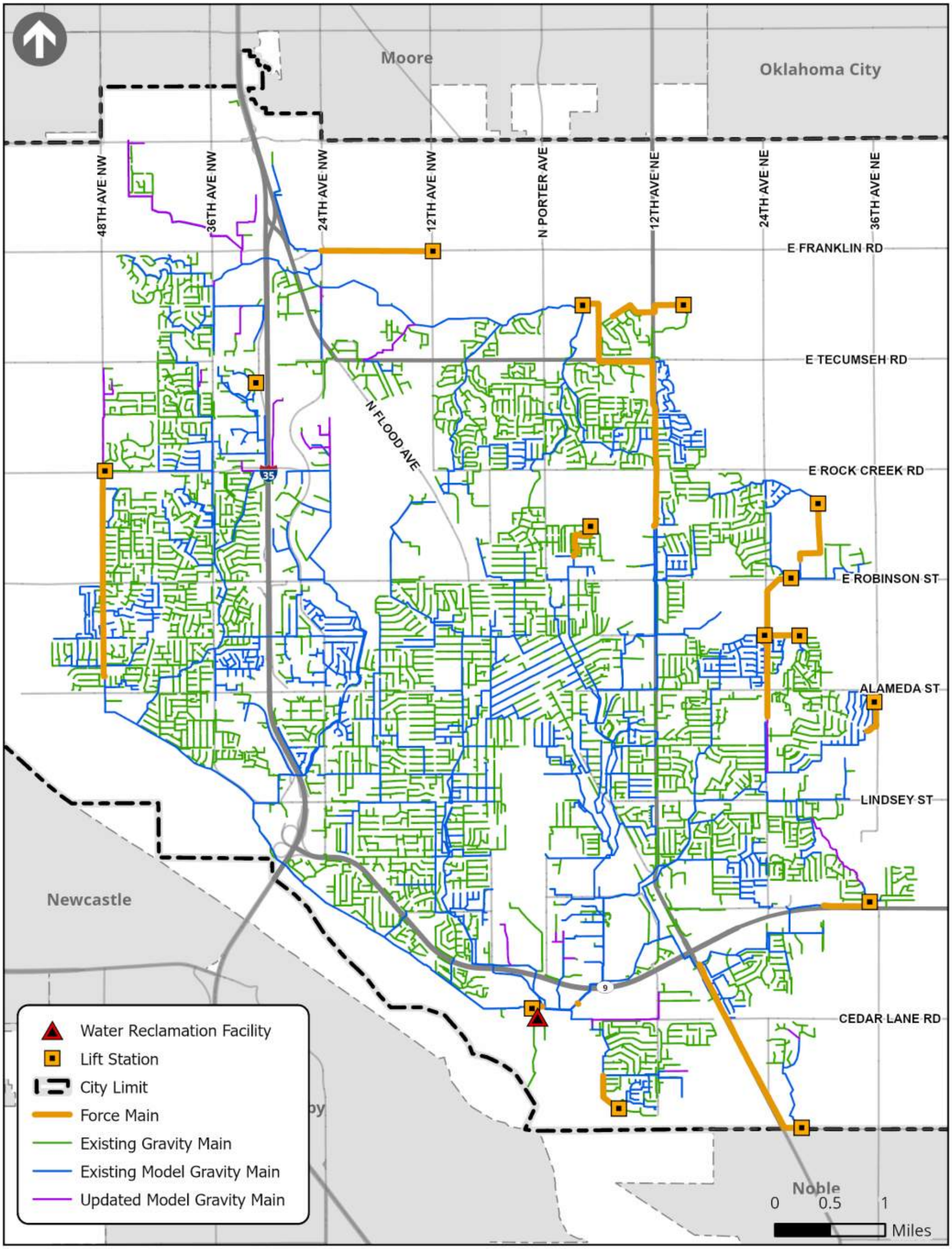
7.1 GRAVITY MAINS

The gravity mains in the 2018 model were compared to NUA's GIS data. The 2018 model did not model all gravity mains in the collection system. Hydraulically important gravity mains were modeled, which generally are 10-inch or larger pipes as well as smaller pipes carrying large amounts of flow or connecting larger-diameter pipes. Garver maintained this methodology in the gravity main infrastructure update. In total, 204 gravity main segments with a total length of 55,502 linear feet (LF) were identified to be added to the model from the GIS database. This represents 6% of the total modeled LF of gravity main. The GIS database contains invert elevations for all but 14 of the gravity main segments system-wide. Missing inverts were interpolated based on slopes of upstream and downstream gravity mains. A summary table of gravity mains added to the model is shown in Table 7-1. Pipe diameters for modeled pipes were also compared to the GIS database. A total of 14,625 LF of gravity main were identified as being upsized or having a different diameter than what was present in the 2018 model. This represents 2% of the total modeled LF of gravity main. Map 7-1 shows the new gravity mains added to the model, as well as gravity mains with updated pipe diameters.

Table 7-1: New Gravity Main Summary

Diameter (inch)	Length (LF)
10	2,512
12	28,195
15	14,005
18	10,164
24	625
Total	**55,502**

Map 7-1: Hydraulic Model Gravity Main Updates



In total, over 900,000 LF of gravity mains are included in the hydraulic model. Most of the modeled gravity mains are 8 to 12-inch. The largest diameter interceptor modeled is 48-inch. A summary of all modeled gravity mains is shown in Table 7-2.

Table 7-2: All Modeled Gravity Mains

Diameter (inch)	Length (LF)	% of Total LF
4	394	0.0%
6	5,633	0.6%
8	268,352	28.5%
10	145,338	15.4%
12	204,588	21.7%
14	138	0.0%
15	51,029	5.4%
16	11,149	1.2%
18	71,132	7.5%
21	27,278	2.9%
24	54,738	5.8%
27	6,863	0.7%
30	21,473	2.3%
33	16,895	1.8%
36	20,303	2.2%
42	35,510	3.8%
48	1,397	0.1%
Total	**942,210**	100.0%

7.2 MODEL MANHOLES

The manholes in the 2018 model were compared to NUA's provided GIS data. New manhole locations were added to the existing hydraulic model based on NUA's provided GIS data. The new modeled manholes are located on the new gravity mains added to the model network. GIS data provided by NUA contained information related to manhole diameters and rim elevations. The model has 4,108 manholes.

7.3 MODEL LIFT STATIONS

The 16 lift stations that were modeled in the 2018 analysis were retained in the updated model. The pump curves and level set points used in the 2018 model were also retained. Table 7-3 shows a summary of the modeled lift stations. All but two lift stations (Lift Station D and Westside Lift Station) are duplex lift stations. Lift Station D and Westside Lift Station each have three pumps.

Table 7-3: Modeled Lift Stations Summary

Lift Station	Number of Pumps Modeled	Firm Capacity (MGD)	Total Capacity (MGD)
Alameda Park	2	0.13	0.26
Ashton Grove	2	0.62	1.24
Eagle Cliff South	2	0.29	0.59
Hall Park North	2	0.80	1.60
Hall Park South	2	1.23	2.46
Lift Station D	3	4.62	10.62
Park Hill	2	0.18	0.36
Post Oak	2	0.99	1.97
Royal Oaks	2	0.85	1.70
Summit Lakes	2	0.22	0.44
Summit Valley	2	1.11	2.22
Sutton Place	2	0.29	0.58
Vo-Tech	2	0.44	0.88
Westside	3	14.11	21.17
Total	34	25.88	46.09

As a part of the model update process, 4.8 MG of equalization storage that was not included in the previous model was added to Lift Station D, and pump operation at Lift Station D was updated so that the largest 6 MGD pump at Lift Station D does not turn on. Instead, the two smaller 2.3 MGD pumps convey flow from the Lift Station D wet well, and any excess peak flow is diverted to the equalization storage. The Lift Station D wet well diverts to the equalization storage via a 30-inch pipe when the wet well level reaches 15 feet.

7.4 DRY-WEATHER CALIBRATION

The hydraulic model was calibrated to dry-weather conditions using the 2023 flow monitoring data. Discrete dry-weather flow diurnal patterns were developed for each flow monitoring basin. Dry-weather diurnal development involves processing of dry-weather flow days, which are defined as days that have 0.01 inches of rainfall or less for all evaluated flow meters and have at least three preceding days with less than 0.01 inches of rainfall.

To arrive at discrete dry-weather flows, upstream flow must be subtracted from downstream flow meters. The steps for developing a dry-weather flow patterns are therefore slightly different for upstream and downstream flow meters. The processing steps for both cases include:

Upstream Basins:

1. Identify dry-weather days with at least three days of no preceding rainfall.
2. Remove medium to long-term rainfall infiltration influence from the dry-weather flows.
3. Determine daily dry-weather flow using median of ADF values for the identified and processed dry-weather days.
4. Split dry-weather flow data into weekdays and weekends, identify outlier points, and remove outliers from each data grouping.
5. Average flows are calculated for each timestep to develop a diurnal flow pattern.
6. Divide the diurnal flow pattern by the daily dry-weather flow to generate a normalized diurnal pattern that represents a multiplier of the average daily dry flow.

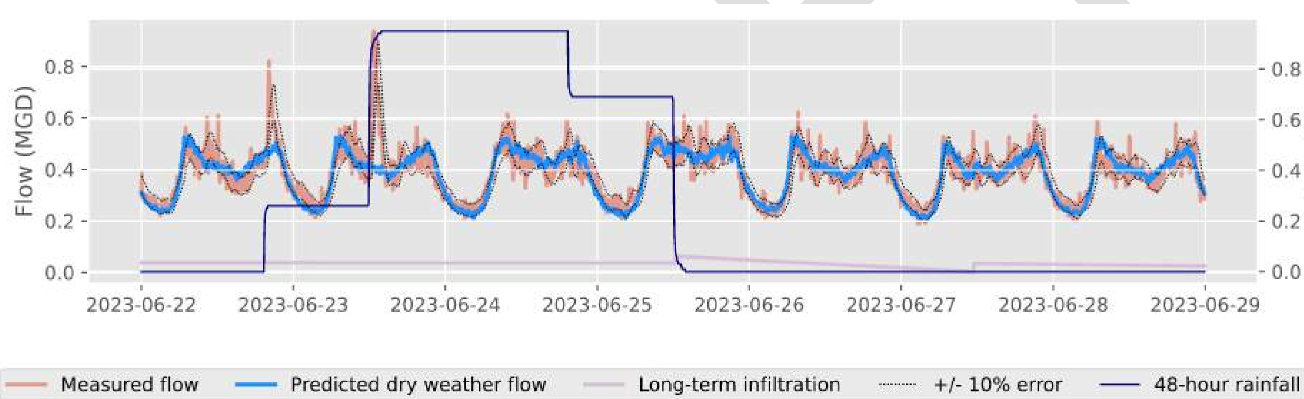
Downstream Basins:

1. Identify dry-weather days with at least three days of no preceding rainfall.
2. Dry-weather flow from upstream basins is routed through the model network. The resulting flow values at the relevant downstream flow meter are subtracted from the meter's raw flow monitoring data. The result is the discrete (upstream basins subtracted) flow for that meter.
3. The dry-weather flows are processed using the same steps as the upstream basins.

The diurnal patterns for each basin are shown in Appendix E.

In the absence of rainfall, there is often groundwater infiltration or long-term rainfall-derived infiltration from a rainfall event that occurred more than three days previously present in the sewer flows. Slow, long-term infiltration can cause variation in daily flow volumes on dry-weather days. To estimate infiltration, the predicted dry-weather flows derived from the dry-weather diurnal patterns are subtracted from the flow meter data on all days that have a running 48-hour rainfall total of less than 0.1 inches. A straight line is then fitted to the flow difference values. This straight line is assumed to be long-term infiltration. An example of the assumed long-term infiltration is shown in Figure 7-1. This figure also shows the measured flow, predicted dry-weather flow, and 10% error tolerances for the 1-hour rolling average of the measured flow.

Figure 7-1: BH-03 Example Dry-Weather Calibration



Appendix F, Dry-Weather Calibration Results, shows the predicted dry-weather flow resulting from the dry-weather calibration process, along with assumed long-term infiltration values.

7.5 WET-WEATHER CALIBRATION

The RTK method was used to define a discrete wet-weather response for each flow metering basin. The RTK method assumes that there are three distinct rainfall responses: rapid inflow, moderate infiltration, and slow infiltration. A triangular unit hydrograph is generated for each response by defining R, T, and K parameters. The R parameter is defined as the ratio of rainfall volume over the basin that enters the sewer as RDII. The T parameter is the time to peak, or the time after rainfall it takes for peak RDII to occur. The K parameter is the ratio of time to peak (T parameter) to the recession time (time it takes for flow to return to normal dry-weather). The total wet-weather response to a unit of rainfall is then the sum of the three unit hydrographs generated by the three sets of R, T, and K parameters.

RTK parameterization was performed on wet-weather events. Wet-weather events are defined as rainfall events with minimum 48-hour rainfall totals of 0.9 inches for which a visible wet-weather flow response was observed. Events in which flow meter data analysis reveals suspected sanitary sewer overflows (SSO) may be occurring were excluded from this analysis. Calibration to events in which SSO occur can cause underestimation of the wet-weather flow response. Additionally, it is difficult to calibrate SSO as there is no measured data indicating the volume of flow lost to SSO.

RTK parameters for discrete flows from each flow monitoring basin were generated using a genetic algorithm that attempts to define the best fit for discrete RDII hydrographs for each of the flow meters. The process for determination of RTK parameters is as follows:

Upstream Basins:

1. Identify wet-weather events.
2. Generate RDII hydrographs by subtracting predicted dry-weather flow, including long-term infiltration, from flow metering data during wet-weather events.
3. Determine a set of RTK parameters that result in the best-fit RDII hydrographs for all included wet-weather events.

Downstream Basins:

1. Flow from upstream basins is routed through the model network. The resulting flow values at the relevant downstream flow meter are subtracted from the meter's raw flow monitoring data. The result is the discrete (upstream basins subtracted) flow for that meter.
2. The wet-weather flows are processed using the same steps as the upstream basins.

The RTK parameters generated for each meter and the resulting predicted RDII hydrographs are included in Appendix G.

The RTK parameters were applied to the model subcatchments. The resulting modeled flows were compared to the observed flows for the rainfall event occurring between 05/11/23 and 05/16/23. RTK parameters were additionally adjusted to improve the modeled fit. The results of the wet-weather calibration and validation analysis are shown in Appendix H.

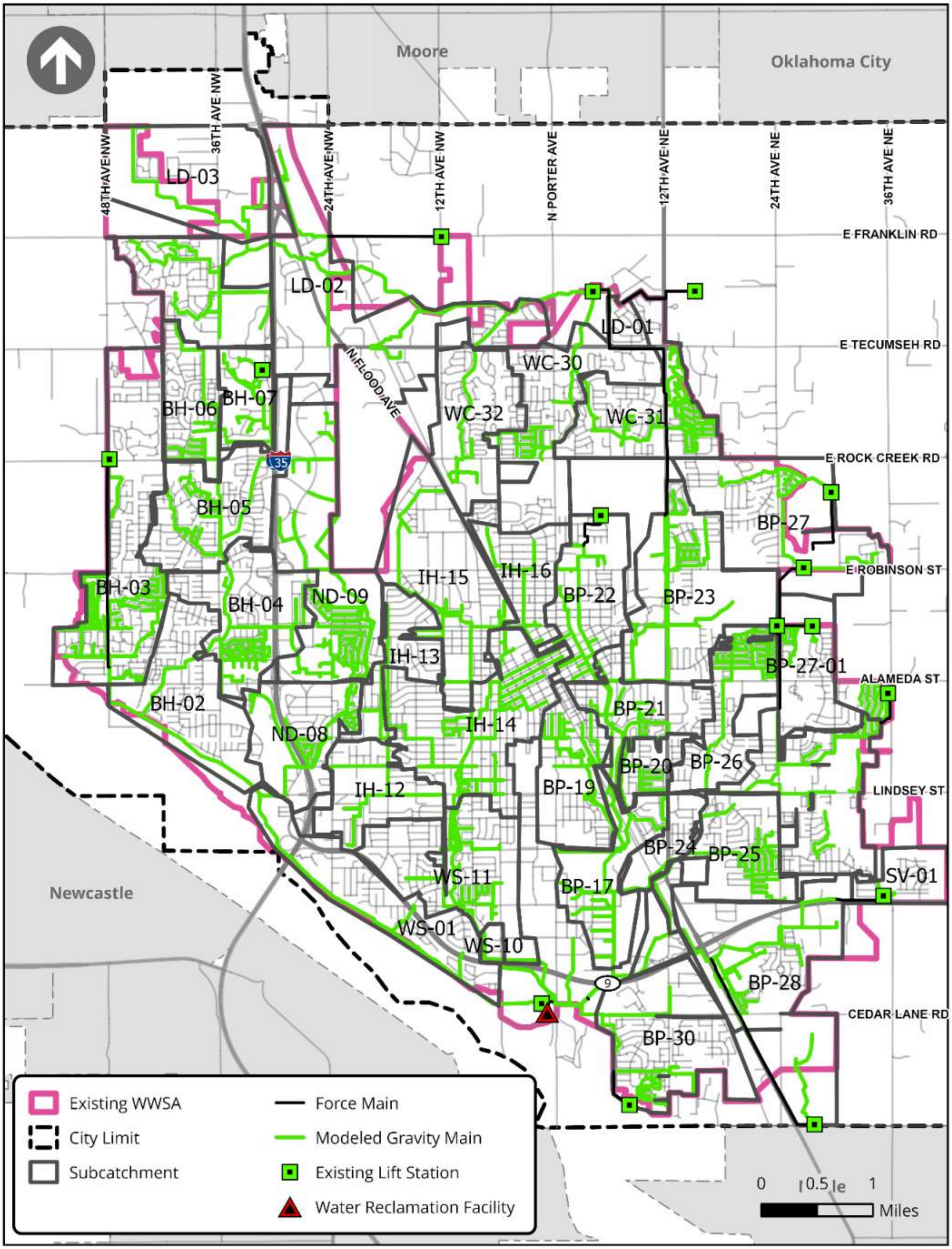
7.6 MODEL SEWER LOADING

Dry and wet-weather flows from the flow monitoring analysis were loaded into the model using subcatchments. Subcatchments were generated by dividing flow monitoring basins and allocating the resulting areas to manholes within the system. A map of modeled subcatchments and their associated flow meter basins shown in Map 7-2.

Dry-weather flows within a flow meter basin were allocated among subcatchments proportional to the average winter water demand within each subcatchment.

Wet-weather flows were allocated by applying the RTK parameters generated during wet-weather calibration (see Section 7.5) to the model subcatchments. The R parameter in the RTK hydrograph represents the ratio of rainfall over the contributing area in each flow monitoring basin that makes its way into the collection system. Therefore, basin area is an important parameter that will determine the volume of RDII experienced in the model. To maintain a consistent contributing area methodology across all basins, the contributing area within a particular subcatchment is the area resulting from a 100-foot buffer of all gravity mains (taken from NUA's GIS database) within that subcatchment.

Map 7-2: Modeled Subcatchments

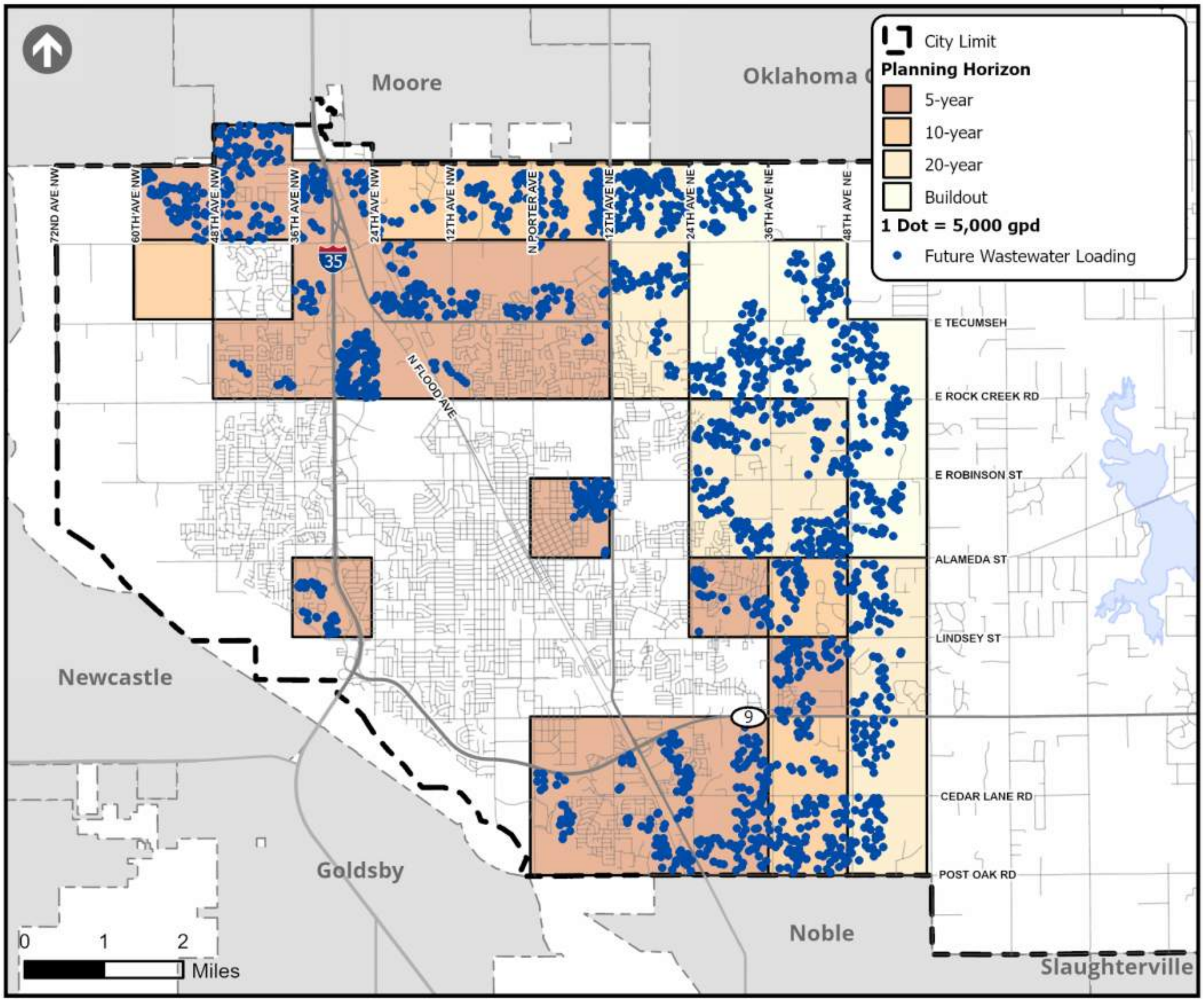


Future flows were added to the model based on the future land use and developable parcel designation developed for the Norman Comprehensive Plan. The future land use map is included in Appendix B.

Future wet-weather loading used the RTK parameters from flow meter basin IH-16. Flow meter IH-16 has a wet-weather peaking factor of 9.12 (see Section 7.5), which is slightly below the median basin peaking factor of 10.54. The IH-16 RTK parameters were chosen due to having a similar peaking factor to the median basin peaking factor, as well as being a basin that is generally representative of the primary land use in the future growth areas. The wet-weather contributing area for each future subcatchment was set so that peak future wet-weather flow is 9.12 times the projected future dry-weather flow.

Future flows were allocated to planning horizons to match the overall average wastewater flow projections discussed in Section 5.0. As discussed in Section 5.0, ADF is expected to be 14.22 MGD in the 5-year horizon, 15.32 MGD in the 10-year horizon, and 17.78 MGD in the 20-year horizon. Starting with an existing ADWF of 12.28 MGD (derived from flow metering data, as discussed in Sections 4.0 and 7.4), flow from the developable parcels was added until the target average day flow for each horizon was reached. Developable parcels were allocated to the planning horizons in order of proximity to existing infrastructure, so that parcels that would be easiest to connect to the existing system or more likely to develop first are allocated to earlier horizons. Map 7-3 shows the allocation of the developable parcels to the planning horizons. Parcels not allocated to a planning horizon are not anticipated to be developed in the 20-year horizon but are considered in development of buildout flows used for infrastructure sizing.

Map 7-3: Developable Areas by Planning Horizon



7.7 MODEL SCENARIOS

Scenarios were developed within the hydraulic model to assess system performance under wet-weather conditions for multiple design storms. The developed hydraulic model scenarios are outlined in Table 7-4. The 2-, 5-, and 10-year, 24-hour design storms were simulated as part of the wet-weather scenarios for the existing system.

In addition to existing scenarios, future model scenarios were also developed. The 5-year, 24-hour design storm was used to assess future conditions at the 5-, 10-, and 20-year horizons. Pipe improvements and CIP projects were incorporated and the resulting system, performance was evaluated at the future horizons.

Table 7-4: Modeled Scenarios

Scenario	Future Flow Horizon	Design Storm	Infrastructure Alternative
Existing Assessment, 2-Year Storm	Existing	2-year, 24-hour	Existing System
Existing Assessment, 5-Year Storm	Existing	5-year, 24-hour	Existing System
Existing Assessment, 10-Year Storm	Existing	10-year, 24-hour	Existing System
Future Assessment, 5-Year Storm	20-year	5-year, 24-hour	Existing System

Scenario	Future Flow Horizon	Design Storm	Infrastructure Alternative
5-Year Future System, 5-Year Storm	5-year	5-year, 24-hour	5-year CIP
10-Year Future System, 5-Year Storm	10-year	5-year, 24-hour	10-year CIP
20-Year Future System, 5-Year Storm	20-year	5-year, 24-hour	20-year CIP

8.0 EXISTING SYSTEM ASSESSMENT

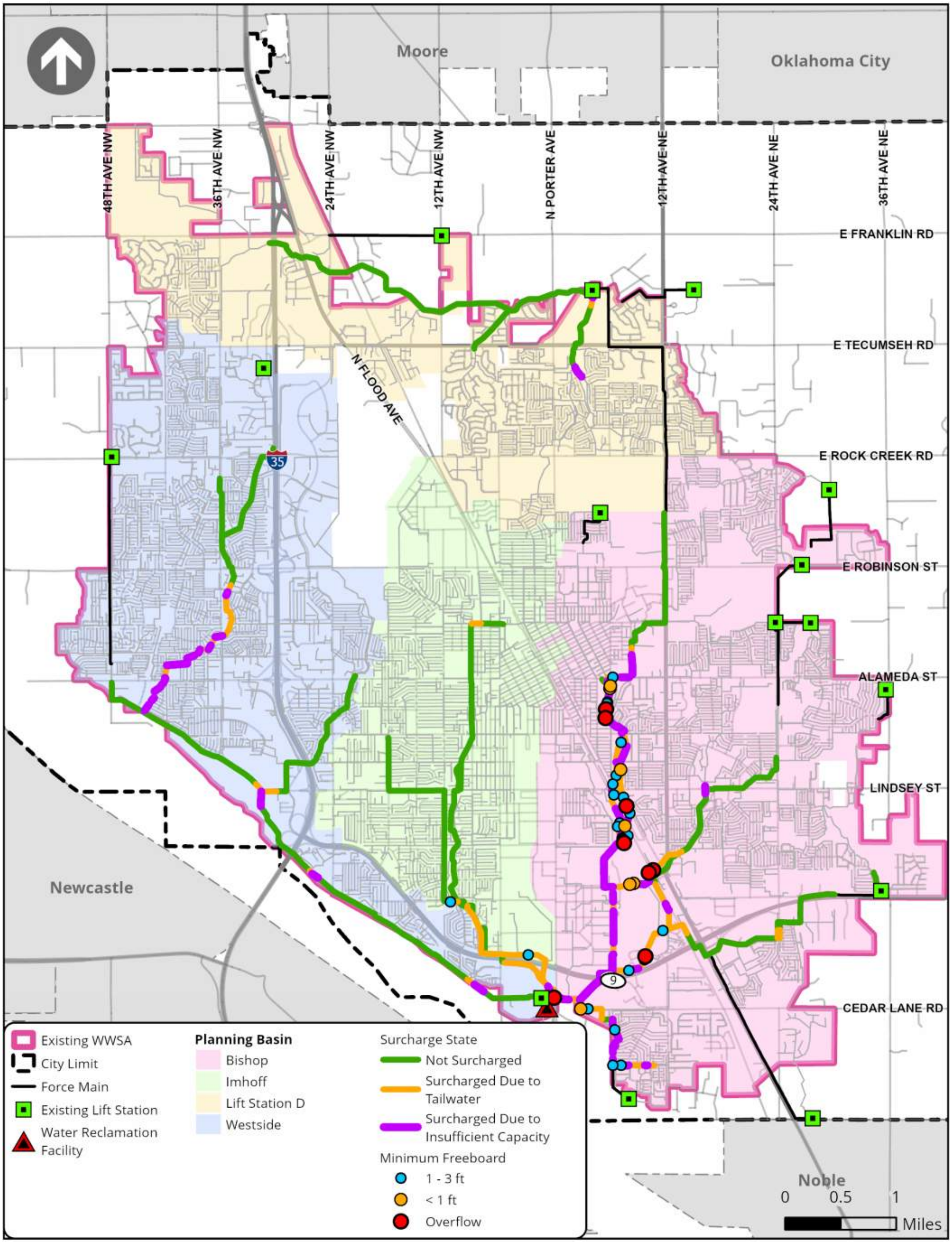
The existing system was assessed under wet-weather conditions for the 2-year, 5-year, and 10-year, 24-hour storms. The system was evaluated against the performance criteria discussed in Section 6.0. The performance criteria are applied to modeling for the 5-year, 24-hour storm, while the 2-year and 10-year, 24-hour storm simulations are included for further context of system performance and resiliency. The 2-year storm represents a more frequent rainfall event that has a 50% chance of occurring in any given year, while the 10-year storm represents a more extreme event that has a 10% chance of occurring in any given year.

8.1 GRAVITY SYSTEM ASSESSMENT

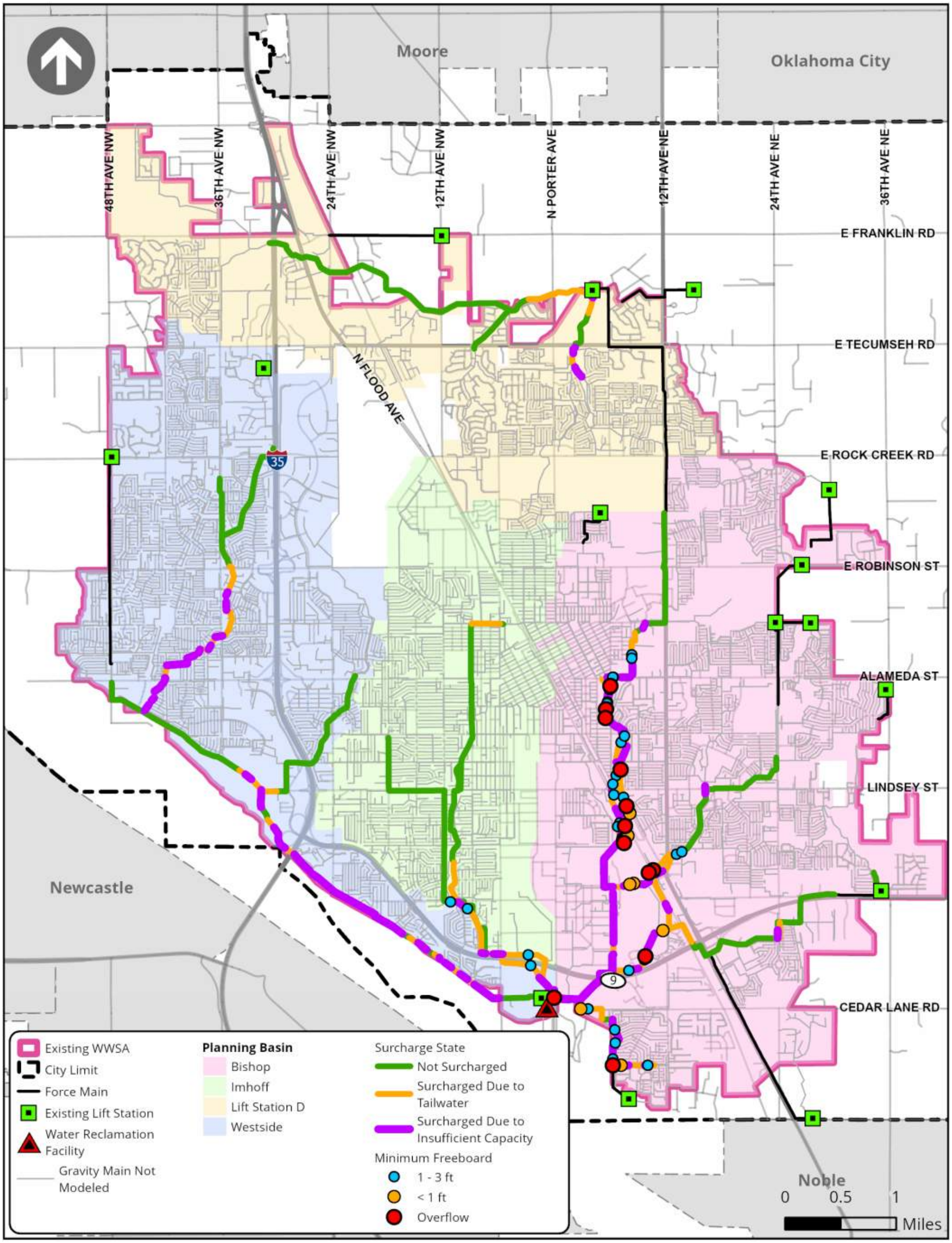
8.1.1 MINIMUM FREEBOARD

According to the system evaluation criteria (Section 6.0), minimum freeboard (depth from manhole rim to maximum water level) must be at least 1 foot. Additionally, minimum freeboard of at least 3 feet is set as a performance target. Map 8-1, Map 8-2, and Map 8-3 show the minimum freeboard for major interceptors for the 2-year, 5-year, and 10-year storms, respectively. For the purpose of this Master Plan, major interceptors are defined as mains that are downstream of flow monitors. There is high certainty for the capacity constraints in these gravity mains. As shown in these maps, major interceptors in the Bishop basin experience low freeboard and SSO and do not meet the freeboard criteria. Additionally, interceptors in the Westside and Imhoff basins do not meet the freeboard target of at least 3 feet. Interceptors in the Imhoff basin do not meet this target for all design-storm events. Interceptors in the Westside basin do not meet this target for the 10-year design-storm event. The interceptor just upstream of Lift Station D also experiences SSOs for the 10-year design storm event.

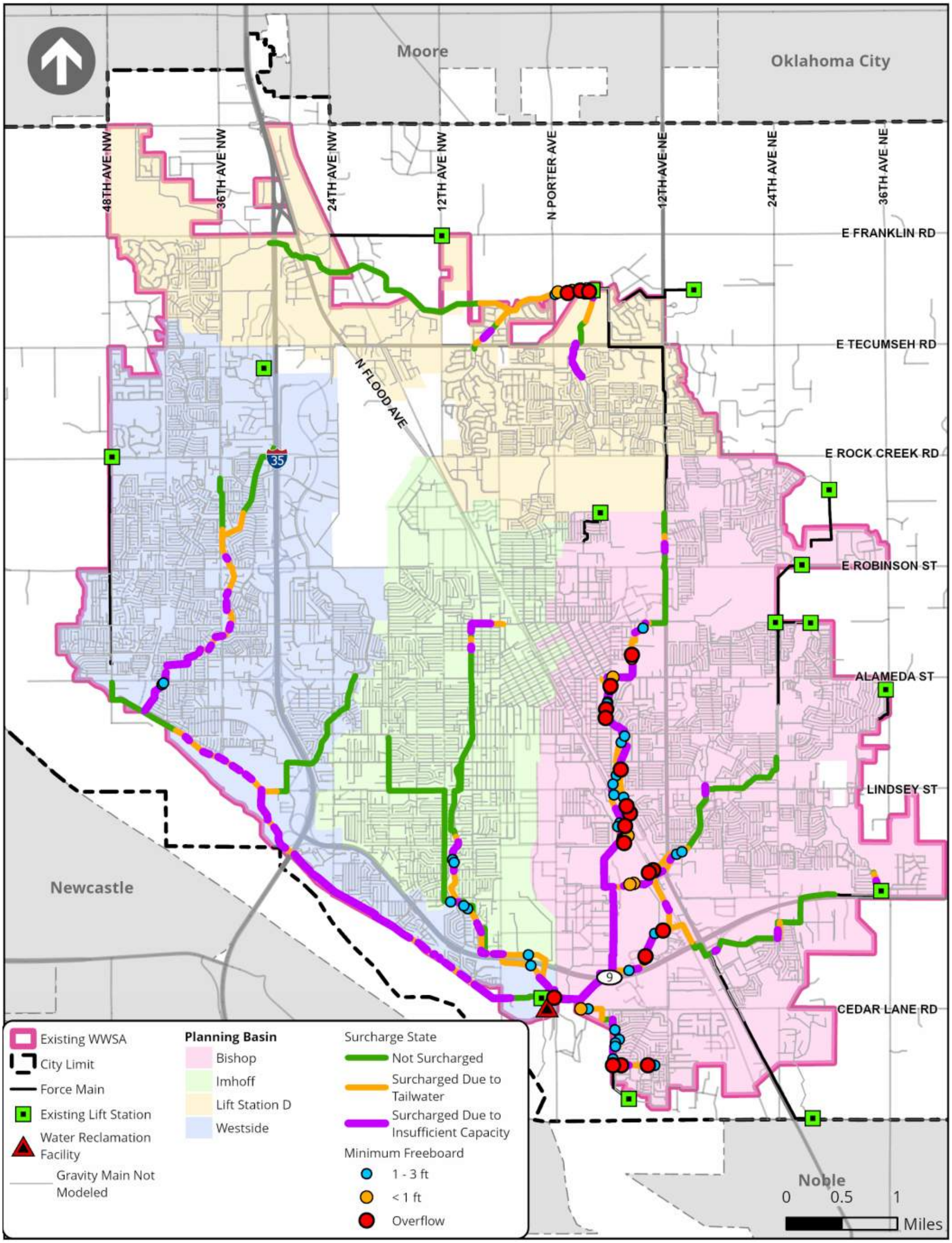
Map 8-1: Existing System 2-Year, 24-hour Storm Minimum Freeboard, Major Interceptors



Map 8-2: Existing System 5-Year, 24-hour Storm Minimum Freeboard, Major Interceptors

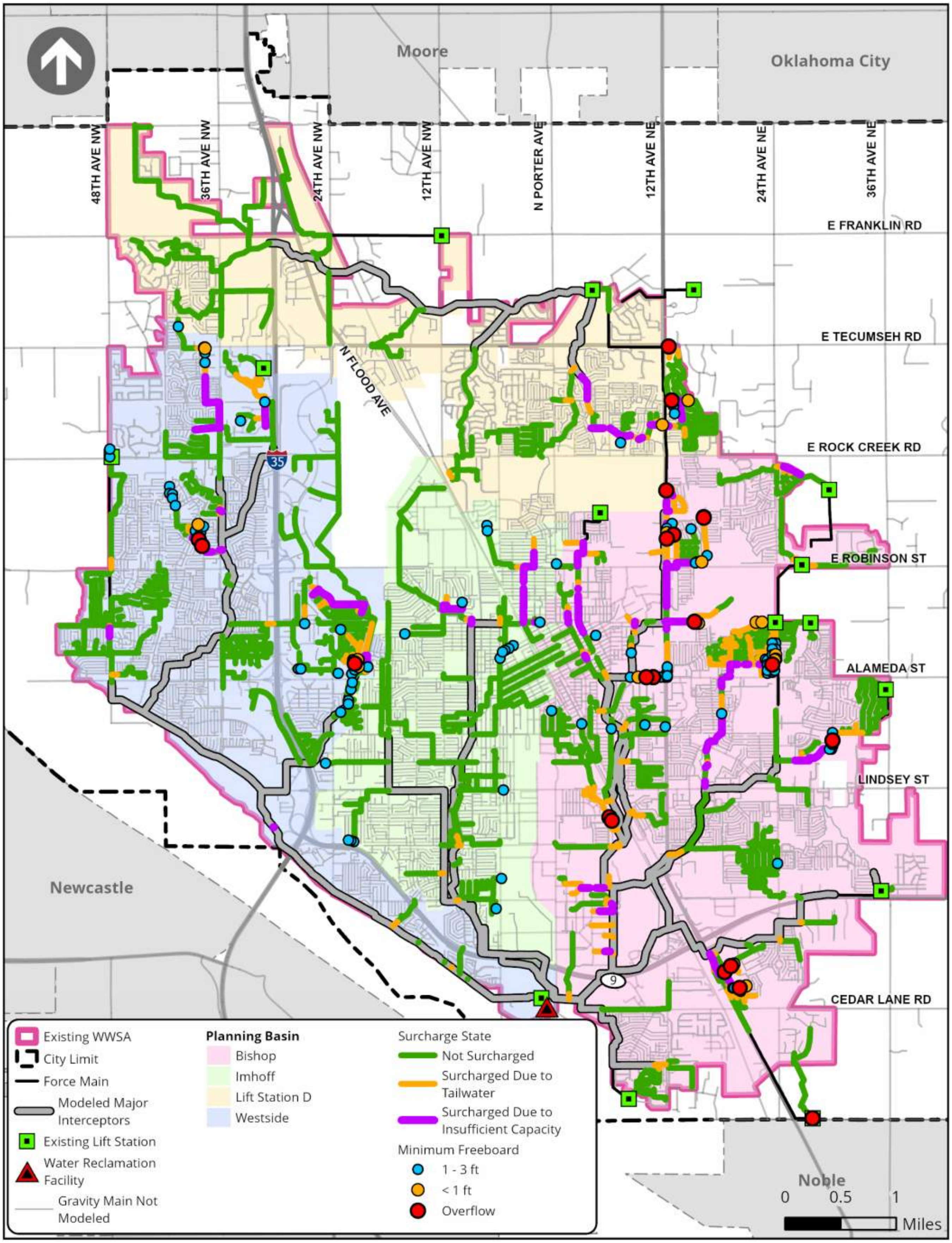


Map 8-3: Existing System 10-Year, 24-hour Storm Minimum Freeboard, Major Interceptors



There are several smaller mains that have localized low freeboard or SSO occurring. These smaller gravity mains are often upstream branches of interceptors that are upstream of flow metering locations. Therefore, there is some amount of uncertainty in the flow allocation to these gravity mains. CIP projects were not developed to address capacity constraints in these mains. Instead, they are being flagged as localized capacity concern areas, and it is recommended that NUA monitor and address these areas, as necessary. These areas are shown in Map 8-4.

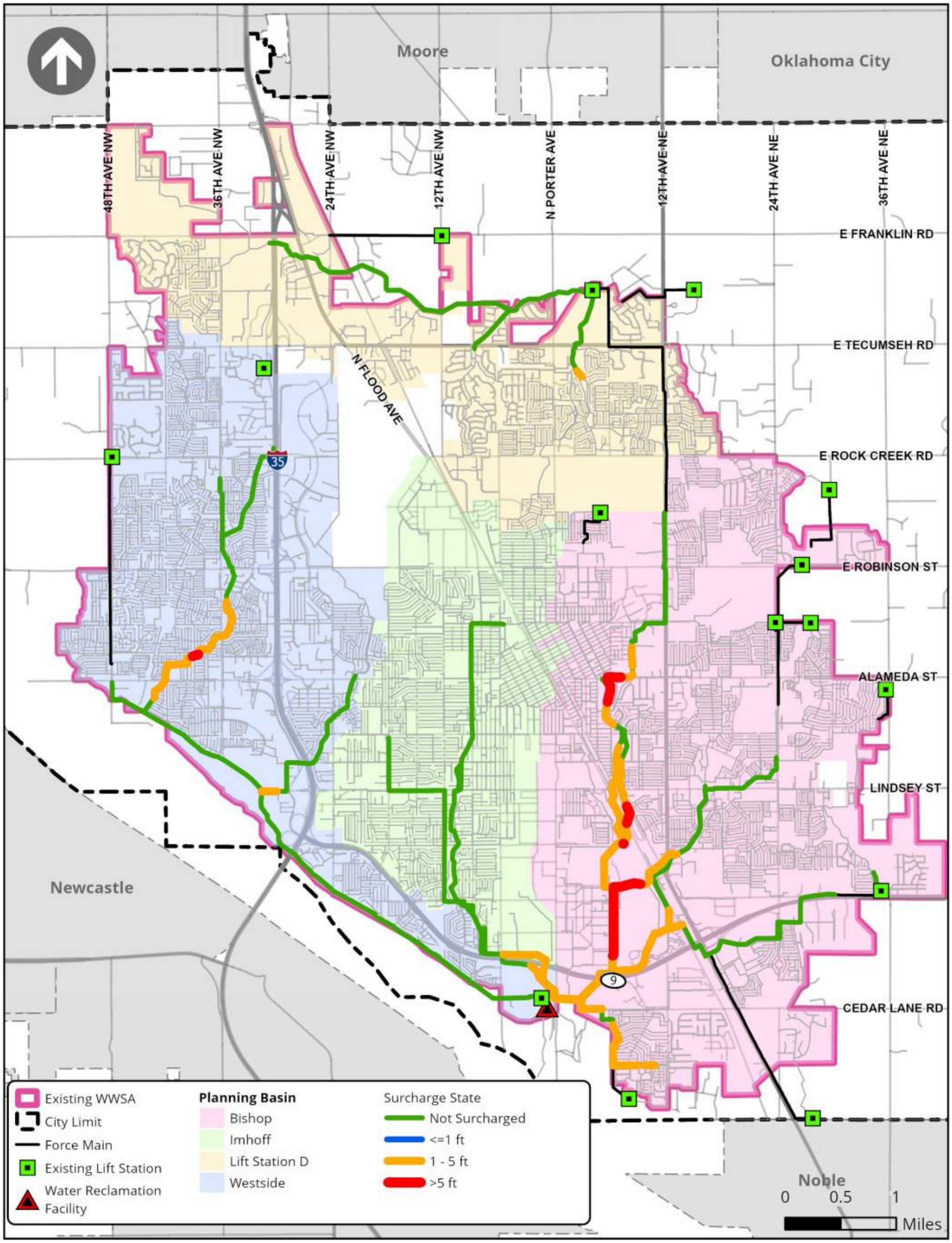
Map 8-4: Existing System 5-Year, 24-hour Storm Minimum Freeboard, Non-Major Interceptors



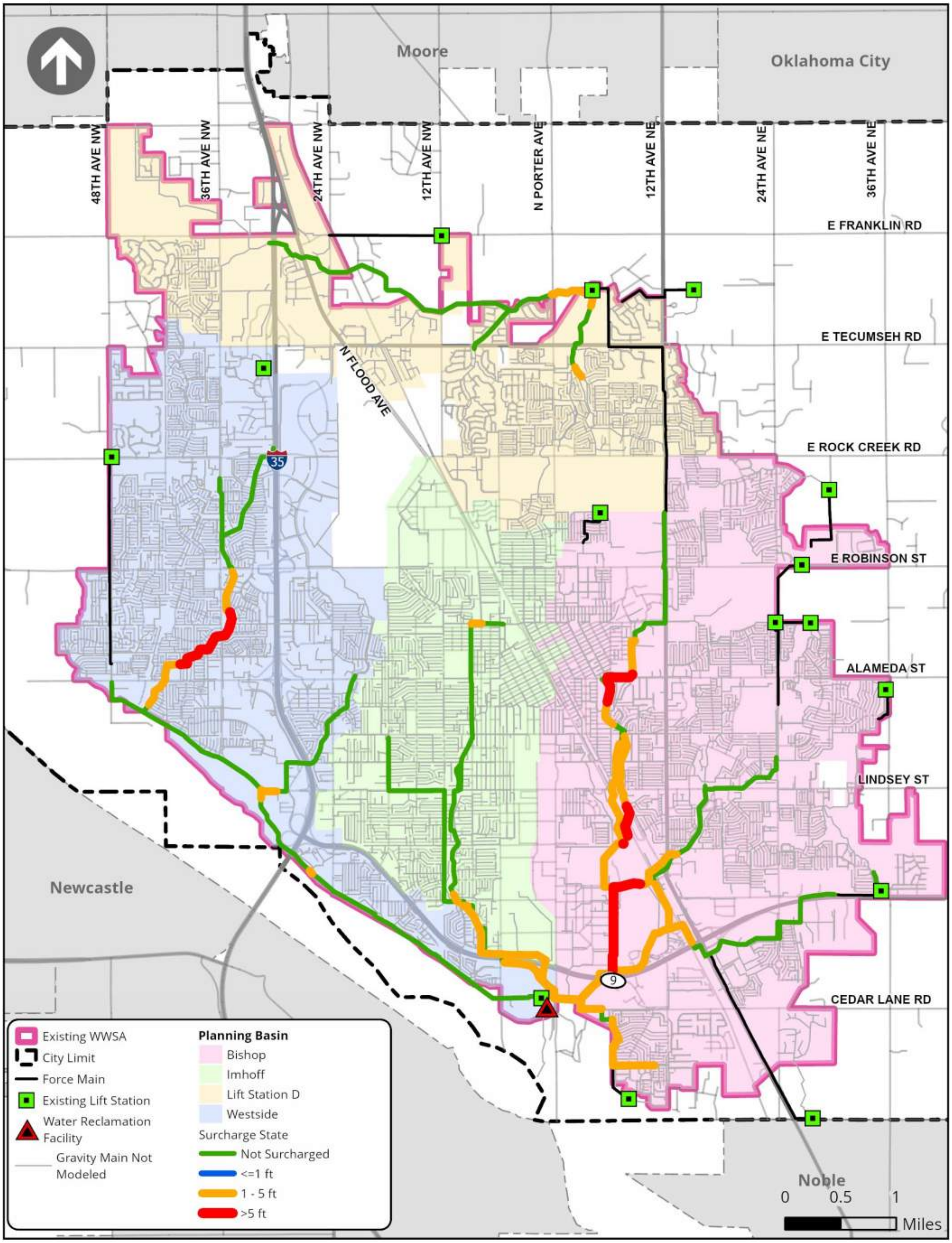
8.1.2 SURCHARGE LEVEL

A maximum surcharge level of 1 foot above the top of pipe is a system performance target, per Section 6.0. Map 8-5, Map 8-6, and Map 8-7 show the maximum surcharge level for the 2-year, 5-year, and 10-year storms, respectively. As shown in these maps, major interceptors in the Bishop, Imhoff, and Westside basins experience surcharge levels above 1 foot for all design storms. The model results also show that interceptors in the Bishop basin have surcharge levels that exceed 5 feet for all design storms, while interceptors in the Westside basin have surcharge levels that exceed 5 feet for the 5-Year and 10-Year design storms. The interceptor upstream of Lift Station D experiences surcharge levels above 5 feet for the 10-Year design storm event.

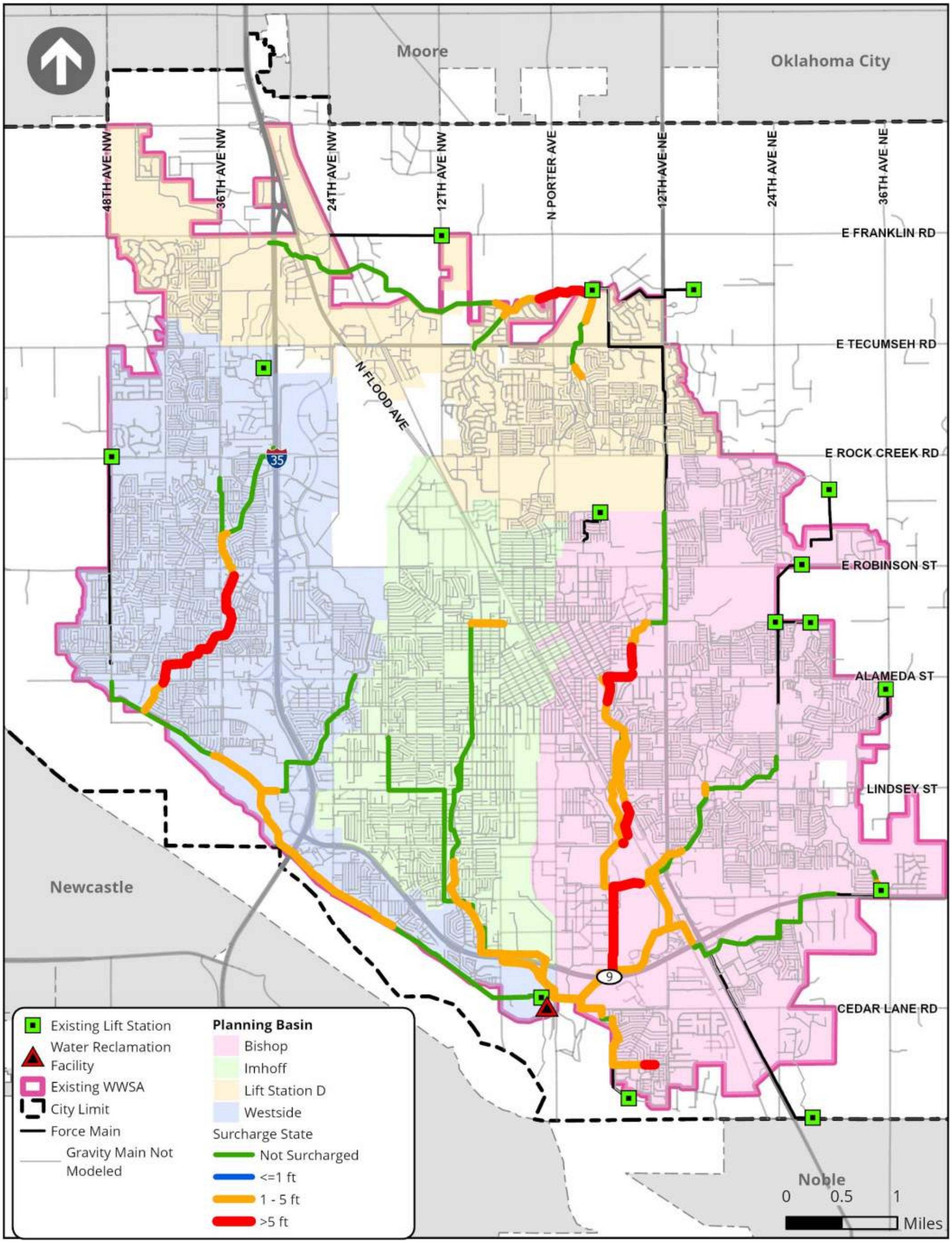
Map 8-5: Existing System 2-Year, 24-hour Storm Maximum Surcharge Level



Map 8-6: Existing System 5-Year, 24-hour Storm Maximum Surcharge Level

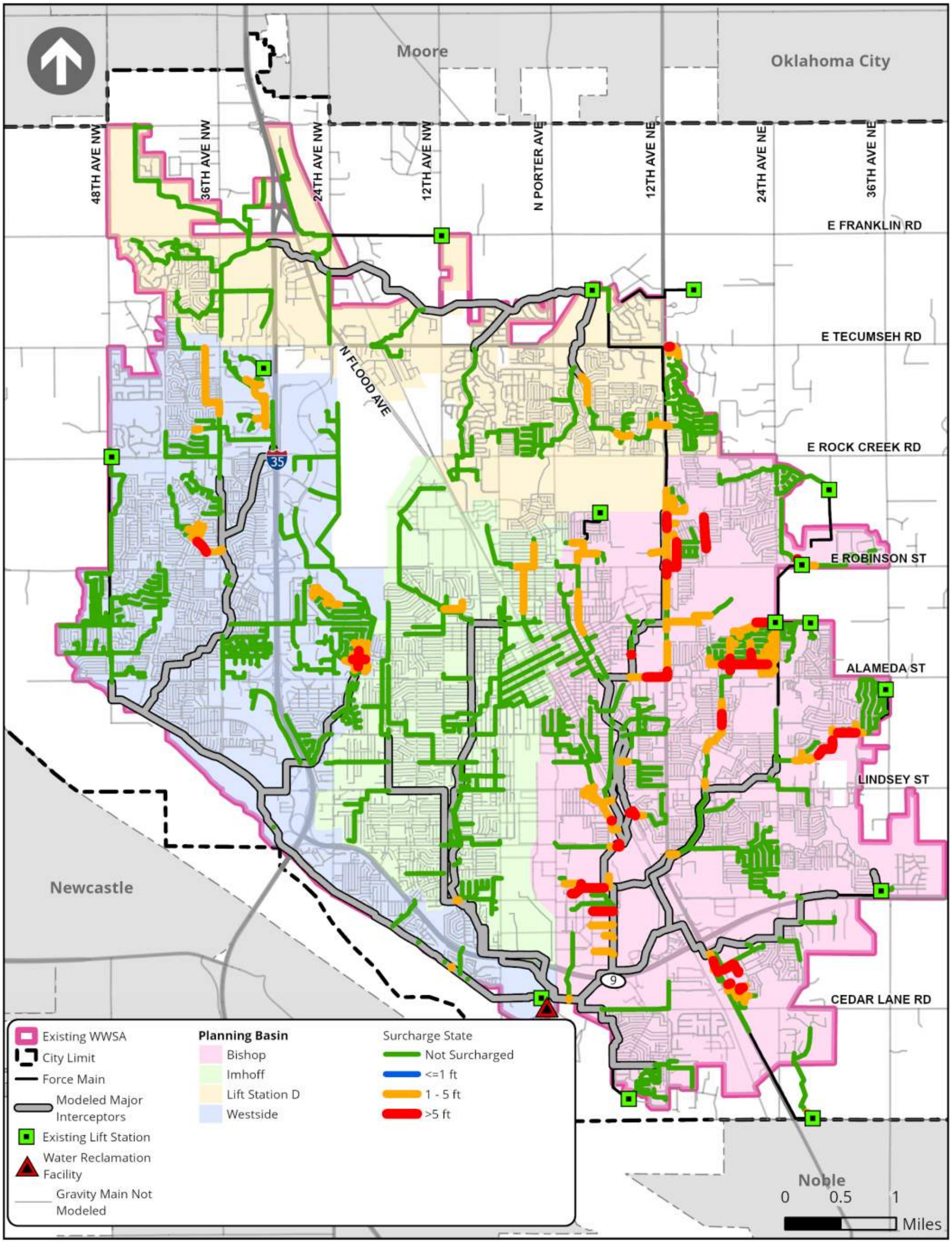


Map 8-7: Existing System 10-Year, 24-hour Storm Maximum Surcharge Level



There are several smaller mains that have localized low freeboard or SSO occurring. These smaller gravity mains are often upstream branches of interceptors that are upstream of flow metering locations. Therefore, there is some amount of uncertainty in the flow allocation to these gravity mains. CIP projects were not developed to address capacity constraints in these mains. Instead, they are being flagged as localized capacity concern areas, and it is recommended that NUA monitor and address these areas, as necessary. These areas are shown in Map 8-8.

Map 8-8: Existing System 5-Year, 24-hour Storm Maximum Surcharge Level, Non-Major Interceptors



8.2 LIFT STATION AND FORCE MAIN ASSESSMENT

According to the system evaluation criteria (Section 6.0), lift station firm capacity (pumping capacity with the largest pump out of service) should be capable of conveying peak flows for the 5-year, 24-hour storm. Peak inflows to each of the modeled lift stations, as well as their firm and total capacities, are shown in Table 8-1. As shown in the table, Ashton Grove, Park Hill, Post Oak, Summit Valley, and Westside Lift Stations have peak inflows that exceed firm capacities. These lift stations are not causing SSO or low freeboard per the system evaluation criteria. The peak inflow at Lift Station D also exceeds firm capacity; however, this lift station has equalization storage to handle peak flows.

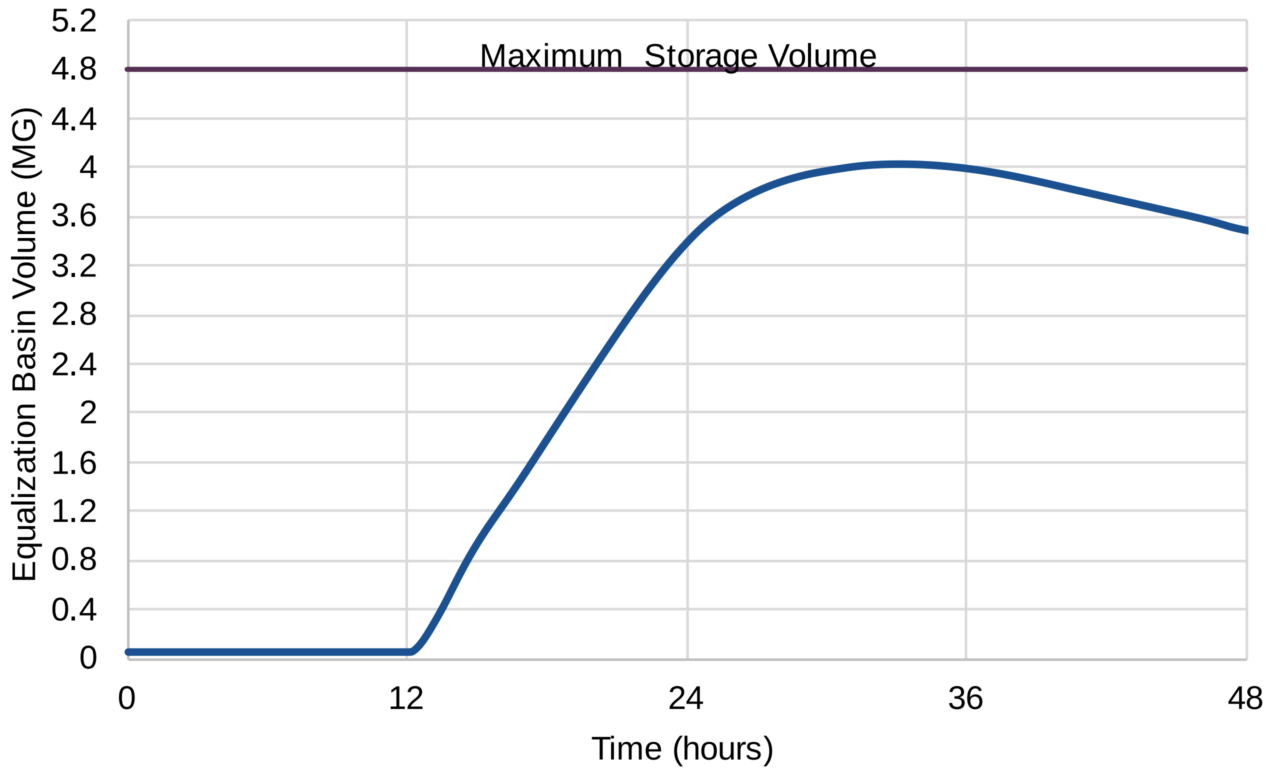
The table also shows force main velocities for firm capacity and peak influent flows. According to the system evaluation criteria, force mains should not experience a maximum flow velocity greater than 6 fps. This is an industry standard guideline and not a regulatory requirement. As shown in the lift station capacity table, the Westside Lift Station force main exceeds the 6 fps guideline for both firm capacity and peak influent flows.

Table 8-1: Lift Station Capacities

Lift Station	Number of Pumps Modeled	Firm Capacity (MGD)	Total Capacity (MGD)	Peak Inflow (MGD)	Force Main Diameter (inch)	Force Main Velocity (fps)	
						Firm Capacity	Peak Inflow
Alameda Park	2	0.13	0.26	0.10	4	2.30	1.77
Ashton Grove	2	0.62	1.24	0.93	12	1.22	1.83
Eagle Cliff South	2	0.29	0.59	0.22	6	2.29	1.73
Hall Park North	2	0.80	1.60	0.46	8	3.55	2.04
Hall Park South	2	1.23	2.46	1.22	12	2.42	2.40
Park Hill	2	0.18	0.36	0.24	4	3.19	4.26
Post Oak	2	0.99	1.97	2.11	12	1.95	4.16
Royal Oaks	2	1.18	2.36	1.05	12	2.32	2.07
Summit Lakes	2	0.22	0.44	0.18	4	3.90	3.19
Summit Valley	2	1.11	2.22	2.50	12	2.19	4.92
Sutton Place	2	0.58	1.16	0.58	6	4.57	4.57
Vo-Tech	2	0.44	0.88	0.38	10	1.25	1.08
Westside	3	14.11	21.17	18.9	24	6.95	9.31
Lift Station D	3	4.2	10.2	13.5	16	4.62	11.30

Lift Station D has 4.8 million gallons (MG) of equalization storage. The model simulations limit pumped flow from Lift Station D to 4.2 MGD, and the remaining inflow that the pumps cannot handle is stored in the Lift Station D wet well and equalization basins. Figure 8-1 shows the equalization basin volume used during the 5-year, 24-hour storm. During the 5-year, 24-hour storm, 4.0 MG of the 4.8 MG gallons is used, or 83% of the available storage capacity.

Figure 8-1: Lift Station D Equalization Basin Volume, Existing System 5-Year, 24-Hour Storm Simulation



8.3 WATER RECLAMATION FACILITY

A comprehensive evaluation of wastewater treatment alternatives for the City was completed to address future (20-year) wastewater treatment needs. Most growth is anticipated in the northern and eastern parts of the City, and significant collection system improvements will be required. Additionally, it is recommended that raw wastewater force mains be replaced with treated effluent force mains to reduce long-term environmental risks from leaks.

Future ADF is estimated at 17.8 MGD versus the existing water reclamation facility's ADF capacity of 16 MGD. Anticipated growth areas are mostly outside the existing WRF's sewer shed, which prompted the evaluation of either a potential new WRF location alternative or upgrading the existing WRF. A new WRF would allow many processes at the existing WRF to operate further from their capacity limits and could also reduce the need for long-distance pumping from the northern and northeastern areas of the City to the existing WRF. It was determined that the most cost-effective alternative would be to upgrade the existing WRF. The full evaluation is discussed in the Water Treatment Evaluation in Appendix I.

Upgrading the existing WRF is used as the basis for the CIP development for wastewater treatment over the planning horizon. Most of the existing WRF processes are capable of higher flows, so needed upgrades primarily consist of increasing grit removal and stormwater equalization storage capacity. The costs of a new WRF are 20-40% higher, varying by location. However, a new WRF could still be considered for future development.

9.0 FUTURE SYSTEM ASSESSMENT

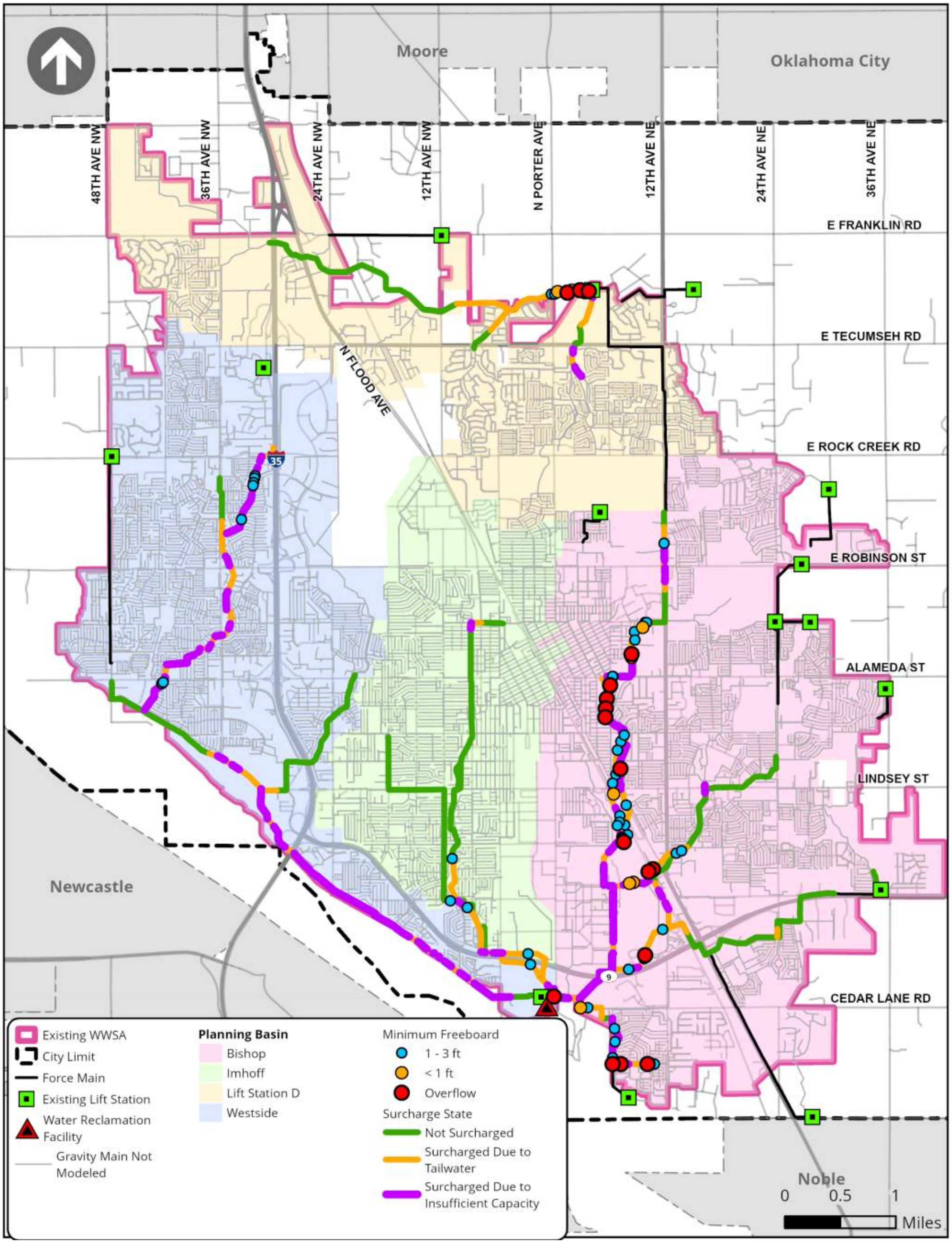
The future system was assessed using 20-year projected flows under wet-weather conditions for a 5-year, 24-hour storm. The system was evaluated against the performance criteria discussed in Section 6.0.

9.1 GRAVITY SYSTEM ASSESSMENT

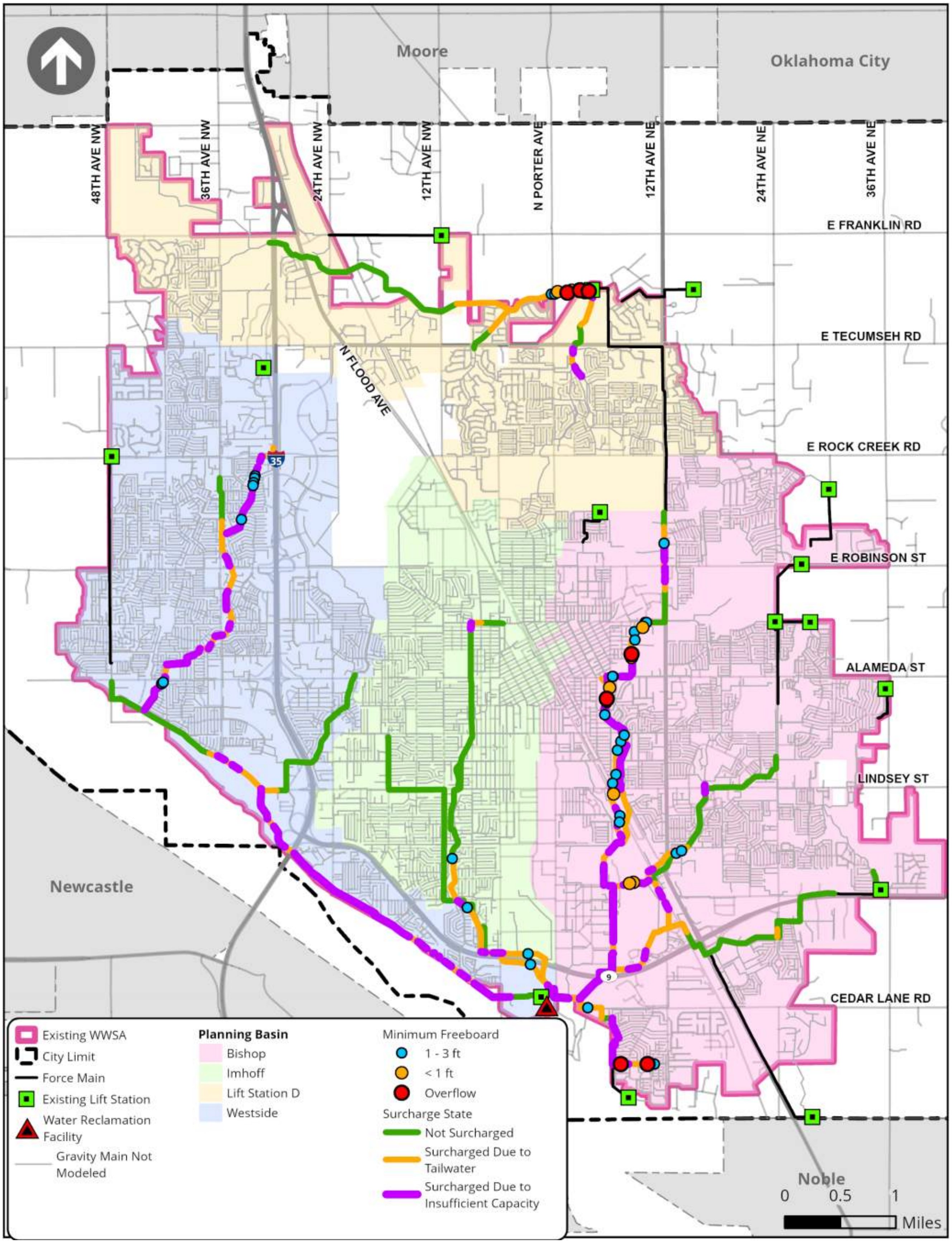
According to the system evaluation criteria (Section 6.0), minimum freeboard (depth from manhole rim to maximum water level) must be at least 1 foot. Additionally, minimum freeboard of at least 3 feet is set as a performance target. Map 9-1 shows the minimum freeboard for the 20-year horizon flows for the 5-year, 24-hour storm. Map 9-2 shows the manholes that exceed the performance target and performance criteria for future flow conditions that did not exceed these criteria for existing flow conditions. Future flows cause low freeboard in the Eagle Cliff subdivision in the south end of the Bishop planning basin, in the upper part of the Bishop basin, and upstream of Lift Station D.

The results shown assume a typical outfall water level at the WRF headworks. Analysis of WRF SCADA data shows that headworks operations can cause water level at the headworks can greatly increase above normal levels. It is anticipated that even with the interceptor upgrades proposed in this plan, the interceptors upstream of the headworks would continue to surcharge and potentially have freeboard concerns if the headworks water level is higher than typical. It is recommended that necessary updates be made to the headworks to maintain normal outfall levels.

Map 9-1: Minimum Freeboard at 20-Year Horizon for 5-Year, 24-Hour Storm



Map 9-2: 20-Year Horizon for 5-Year, 24-hour Storm, Freeboard Change from Existing



9.2 LIFT STATIONS AND FORCE MAIN ASSESSMENT

According to the system evaluation criteria (Section 6.0), lift station firm capacity (pumping capacity with the largest pump out of service) should be capable of conveying peak flows for the 5-year, 24 hour storm. Peak inflows to each of the modeled lift stations that experience an increase in flows due to future growth are shown in Table 9-1. As shown in the table, Westside Lift Station and Lift Station D both exceed existing firm capacity. Both lift stations have existing flows that also exceed firm capacity. The Westside Lift Station does not cause backups to the extent of triggering freeboard criteria in the upstream manholes. However, Lift Station D does cause water to back up to the point of SSO occurring at upstream manholes.

Table 9-1: Lift Station Capacities, 20-Year Flows

Lift Station	Number of Pumps Modeled	Firm Capacity (MGD)	Total Capacity (MGD)	Peak Inflow (MGD)	Force Main Diameter (inch)	Force Main Velocity (fps)	
						Firm Capacity	Peak Inflow
Westside	3	14.11	21.17	19.9	24	6.95	9.80
Lift Station D	3	4.2	10.2	20.9	16	4.62	23.16

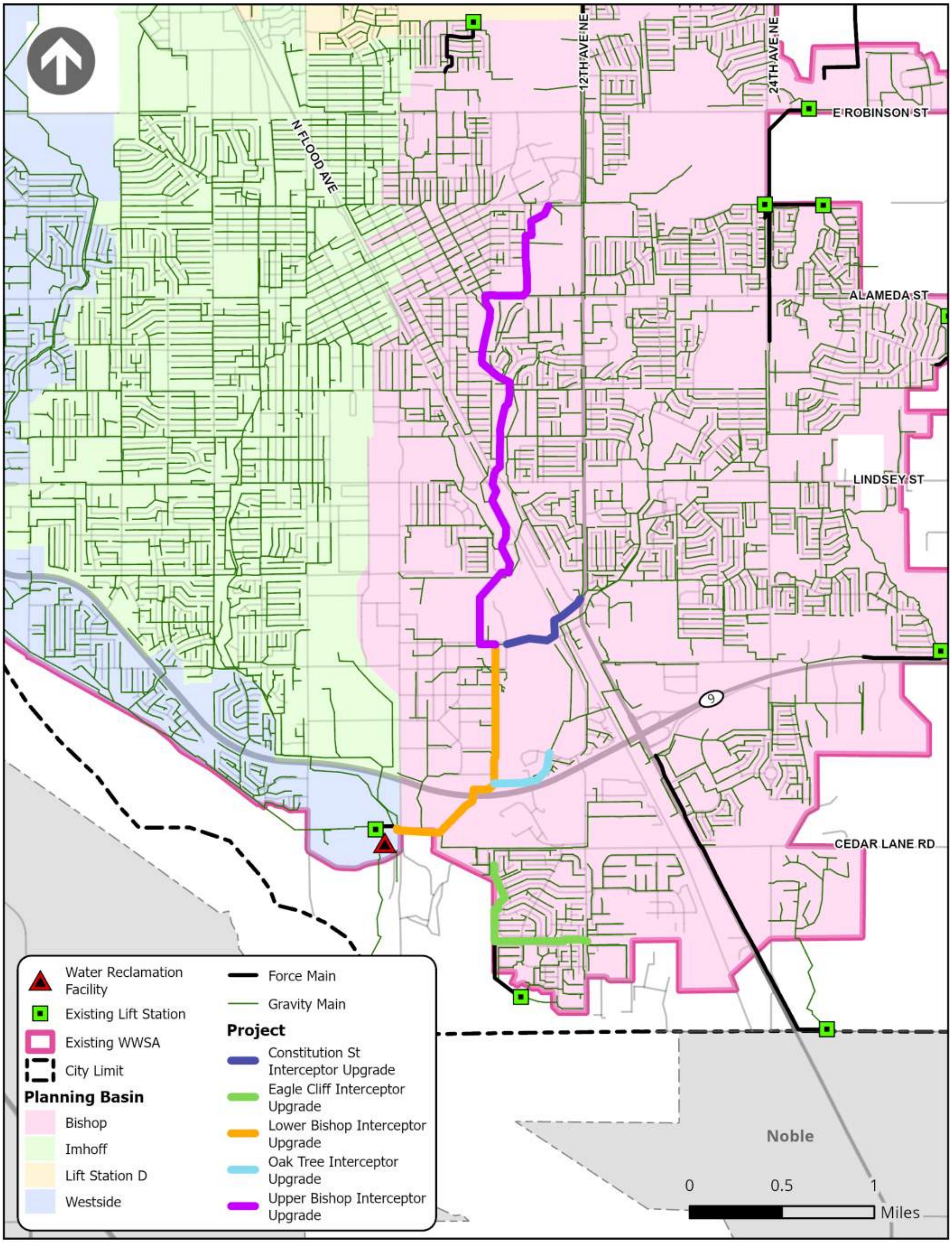
9.3 FUTURE SYSTEM IMPROVEMENTS

9.3.1 MAJOR INTERCEPTOR PROJECTS

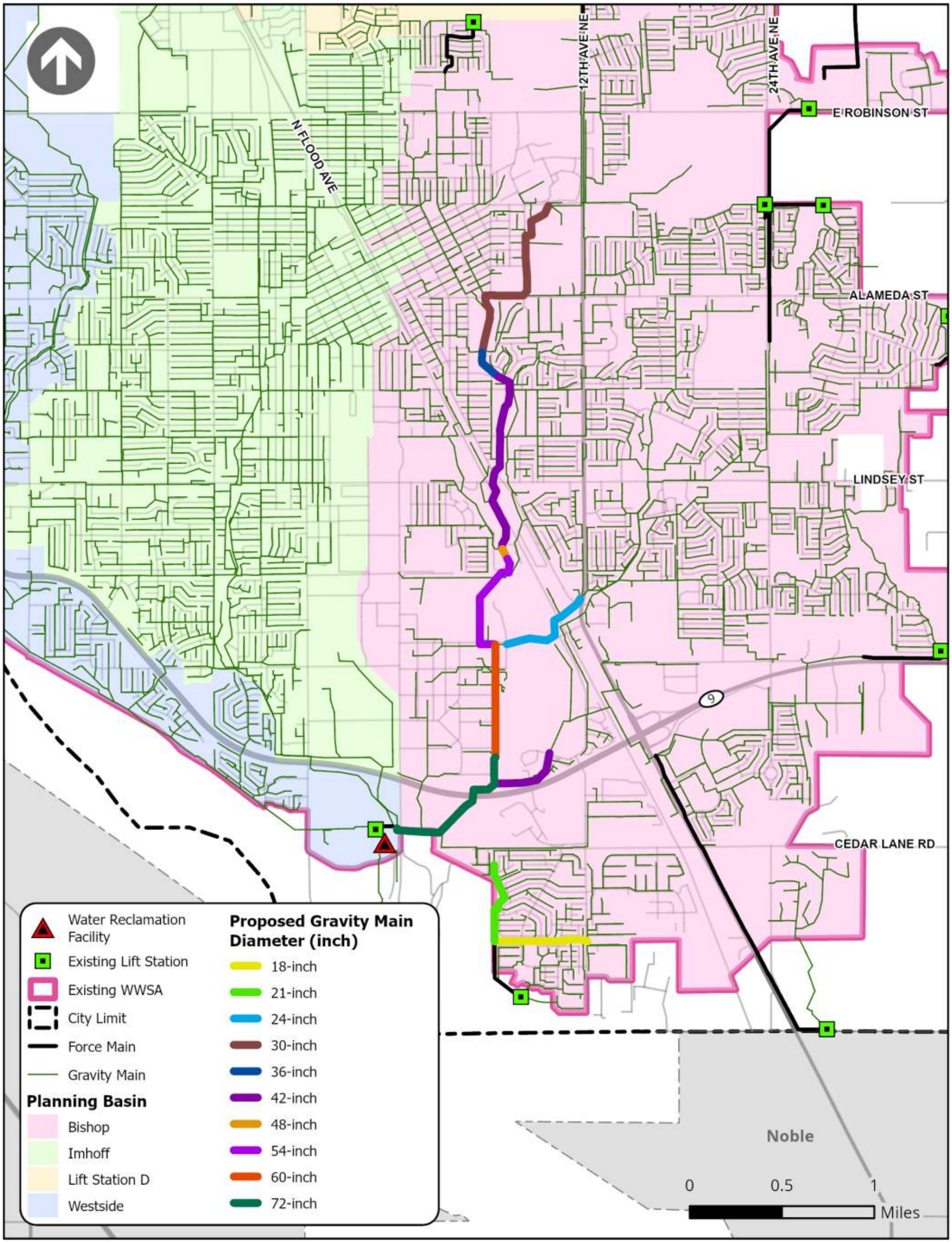
Map 9-3 shows the major interceptor projects that are proposed to address existing and future capacity concerns within the existing collection system. Map 9-4 shows the proposed interceptor sizing for these projects. These projects are included in the 20-year CIP and address low freeboard and SSO on major interceptors in the collection system. All proposed major interceptor upgrades are located within the Bishop planning basin. The Upper Bishop Interceptor Upgrade Project involves upsizing of existing parallel interceptors. Low freeboard or SSO manholes occurring on smaller gravity mains that are tributaries to the major interceptor network were not included in the CIP, as discussed in Section 8.1. It is recommended that NUA monitor flows to these areas of concern and address capacity constraints as needed.

In addition to the proposed interceptor upgrades, an additional 2.4 MG of equalization storage is recommended at Lift Station D to provide capacity for additional flow anticipated from future growth.

Map 9-3: Proposed Gravity Main Projects



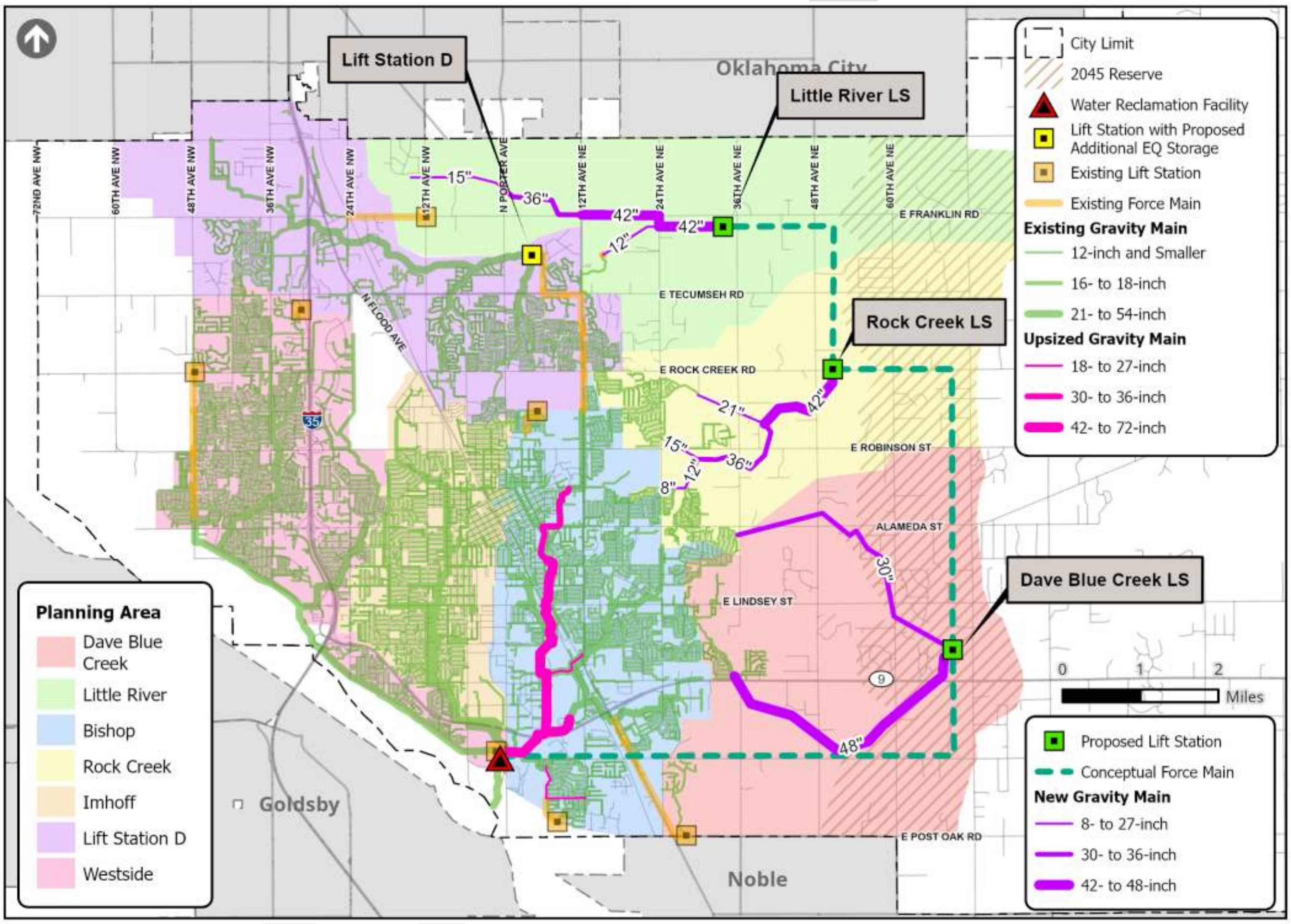
Map 9-4: Proposed Gravity Main Sizing



9.3.2 EASTERN CONVEYANCE NETWORK

Flows from new developments outside of the existing WWSA will be handled by a new eastern conveyance network. Map 9-5 shows the proposed eastern conveyance network. Future developments in the Little River, Rock Creek, and Dave Blue Creek basins will gravity flow to the new Little River Lift Station, Rock Creek Lift Station, and Dave Blue Creek Lift Station, respectively. Little River Lift Station will pump to the Rock Creek Lift Station, and Rock Creek Lift Station will pump to the Dave Blue Creek Lift Station. The Dave Blue Creek Lift Station pumps flow to the existing WRF. Sizing and configuration of the future eastern conveyance network is conceptual. Pre-design efforts are anticipated to finalize sizing, layout, and sequencing of the infrastructure.

Map 9-5: Future Eastern Conveyance Network

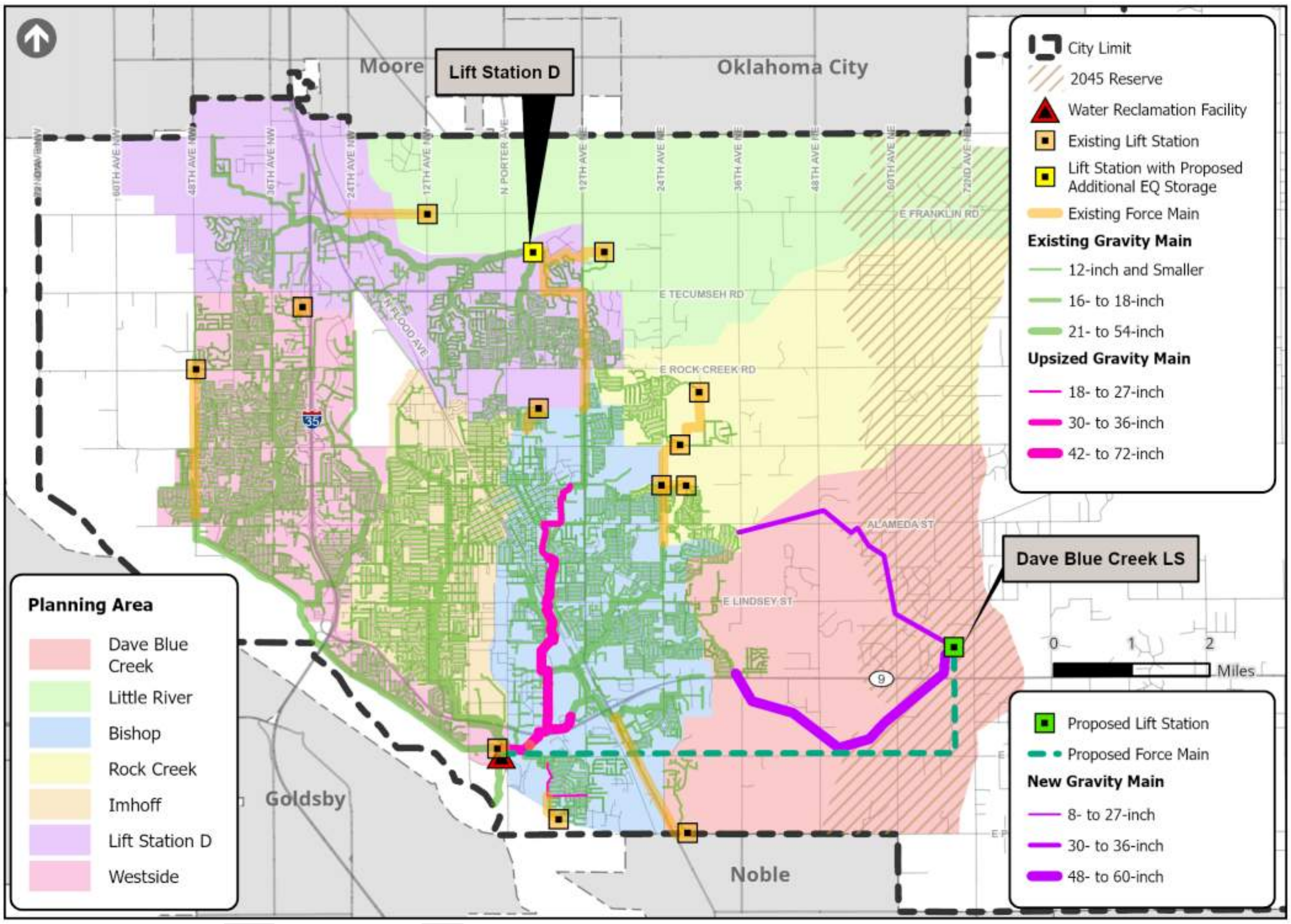


9.3.3 TOTAL SYSTEM IMPROVEMENTS

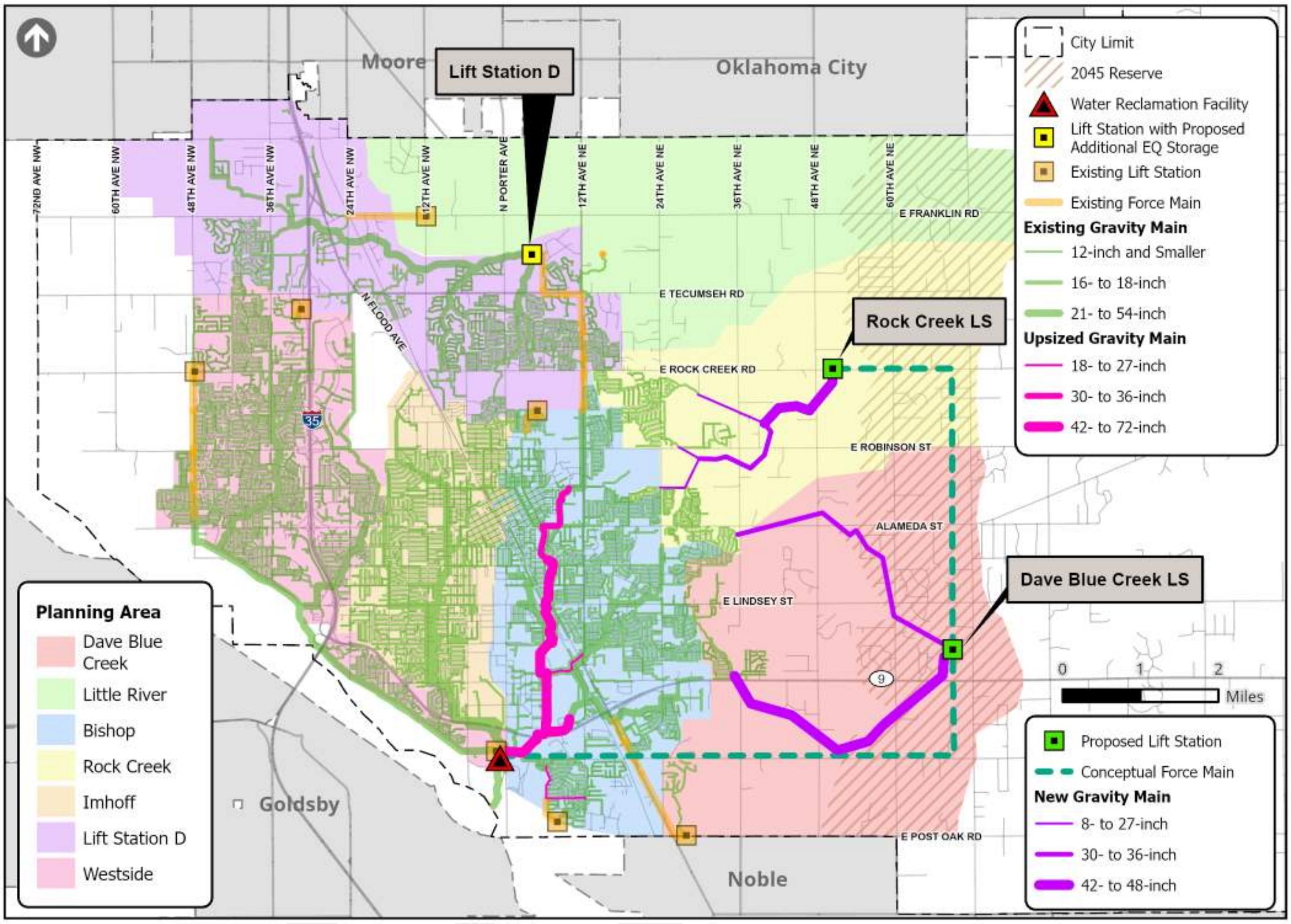
Map 9-6 and Map 9-8 show the recommended improvements for the 5-year and 10-year planning horizons, respectively. These maps show recommended improvements for both the existing WWSA and the future eastern conveyance network.

The 20-Year CIP Projects include expansion of the proposed Dave Blue Creek Lift Station and Rock Creek Lift Station by increasing firm capacity and installing parallel force mains to convey the additional projected flow.

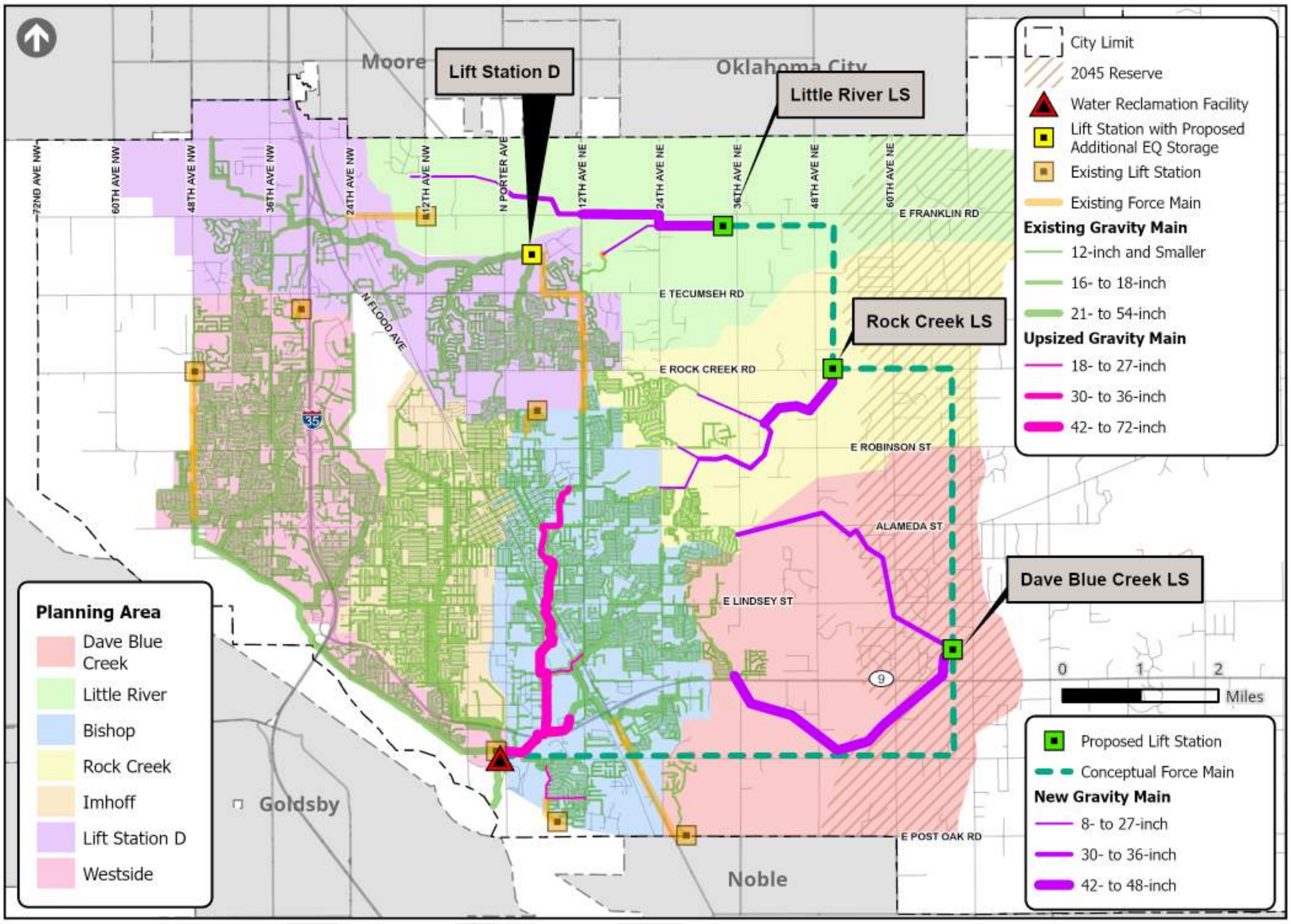
Map 9-6: 5-Year Planning Horizon Improvements



Map 9-7: 10-Year Planning Horizon Improvements



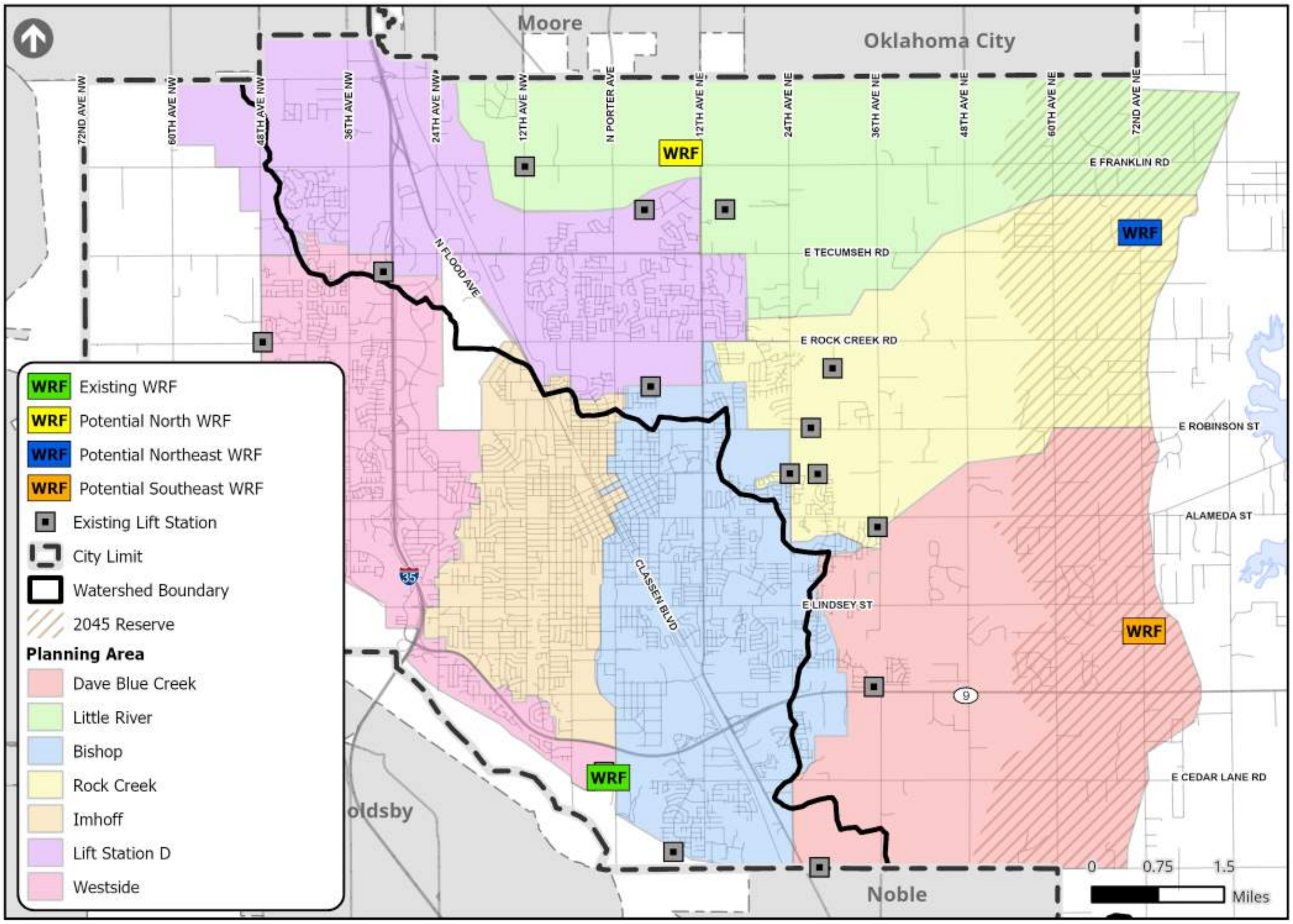
Map 9-8: 20-Year Planning Horizon Improvements



9.4 TREATMENT ALTERNATIVES EVALUATION

An alternatives analysis for evaluation of increased treatment capacity for treatment of future flows was conducted. Details of this analysis can be found in Appendix I. The alternatives analysis found that upgrading the existing WRF is the most cost-effective solution to meet regulatory requirements and provide capacity for projected wastewater flows. However, the construction of a new WRF is not ruled out as a potentially viable solution. Three potential new WRF sites were evaluated: North WRF, Northeast WRF, and Southeast WRF, as shown in Map 9-9.

Map 9-9: Evaluated New WRF Sites



The 20-year Wastewater CIP assumes that the existing WRF will be upgraded and all future flow will be routed to the existing WRF site. The proposed eastern conveyance network framework is compatible with all evaluated future WRF sites, with some adjustments. Adjustments needed to accommodate each WRF site are as follows:

- North WRF Site: The Little River Lift Station would pump to the North WRF site instead of Dave Blue Creek Lift Station. The Rock Creek Lift Station could also be configured to pump to the Little River Lift Station, and then onward to the new North WRF. Lift Station D would be diverted to the North WRF.

- Northeast WRF Site: The Rock Creek Lift Station would pump to the Northeast WRF site instead of to Dave Blue Creek Lift Station. The Little River Lift Station would become an influent lift station for the Northeast WRF. Lift Station D flows can be diverted to Little River Lift Station and subsequently pumped to the Northeast WRF.

- Southeast WRF Site: This site is located at the same location as the proposed Dave Blue Creek Lift Station. The Dave Blue Creek Lift Station would become an influent lift station for the WRF instead of pumping to the existing WRF.

10.0 CAPITAL IMPROVEMENTS PLAN

10.1 CIP PROJECT DEVELOPMENT

10.1.1 PROJECT IDENTIFICATION AND TRIGGERS

Each project was prioritized based on project triggers or project justifications. Project triggers are described in Table 10-1 and listed in order of priority, from highest to lowest priority. Projects were prioritized and phased over the planning horizons based on occurrence of project triggers. In addition, flexibility was assigned to projects based on their prioritization, and phasing, with highly flexible projects being able to potentially be moved to later dates.

Table 10-1: Project Triggers

Project Trigger	Project Type
Capacity	This trigger is activated when there is insufficient capacity for flows such that the system performance criteria are not met
Growth	This trigger is activated if an extension of the existing service area is required to serve anticipated developments
Operational	This trigger is activated when an improvement will provide an operational benefit.

10.1.2 PROJECT TIMELINES

Project priorities were set based on identified triggers to create a timeline that aligns with the anticipated planning horizon. Each project has also been assigned a flexibility rating of low, medium, or high. Projects with higher flexibility can be deferred until later in the planning horizon, depending on the available funding or changing system conditions that would impact the need for the project (such as unexpected delays in development that delay the need for growth and/or capacity improvements).

The threshold date is the year the existing capacity of the system would be exceeded without the proposed project. Start dates were selected based on the anticipated project duration to achieve completion before the threshold date. The start date is then used to capture anticipated costs for the life of the project by escalating the total estimated 2024 costs at a rate of 3% annually.

10.1.3 COST DEVELOPMENT

Cost estimates were prepared for each individual project based on industry standards and the 2024 bidding environment. These costs are an estimate and should be re-evaluated as each project nears its start date. Each project has the following costs associated with the total project cost estimate:

- Construction Cost/Bid Items
- Easement Acquisition
- Engineering Design/Professional Services

The cost estimates included in this CIP are Class 4 estimates as defined by the Association for the Advancement of Cost Engineering (AACE), which is consistent with cost estimates developed for studies.

10.1.3.1 CONSTRUCTION COSTS

Construction cost is the estimated cost once the project has been designed and is ready for the bid phase to begin. The construction costs are comprised of bid items and include a construction cost contingency of 30%.

Costs for Individual bid items are described as follows:

- **Gravity Main Installation:** Material, labor, and contractor's overhead costs associated with pipe and manhole installation on a linear footage basis depending on the gravity main size
- **Force Main Installation:** Material, labor, and contractor's overhead costs associated with pipe installation on a linear footage basis depending on the force main size
- **Lift Station Installation:** Material, labor, and contractor's overhead costs associated with lift station installation based on firm pumping capacity of the proposed lift station
- **Storage Installation:** Material, labor, and contractor's overhead costs associated with equalization storage installation based on volume of storage

Gravity main and force main costs have been estimated based on per linear foot unit costs, presented in Figure 10-1 and Figure 10-2, respectively. Costs are based upon similar facilities completed by Garver. The actual project costs will vary based on a variety of factors, including the amount of asphalt and concrete repair; number, length, and type of crossings (creeks, roads, railroads, etc.); and pipe material and pressure class. Soil characteristics in the project area were also considered.

Figure 10-1: Construction Cost Estimation for Gravity Mains

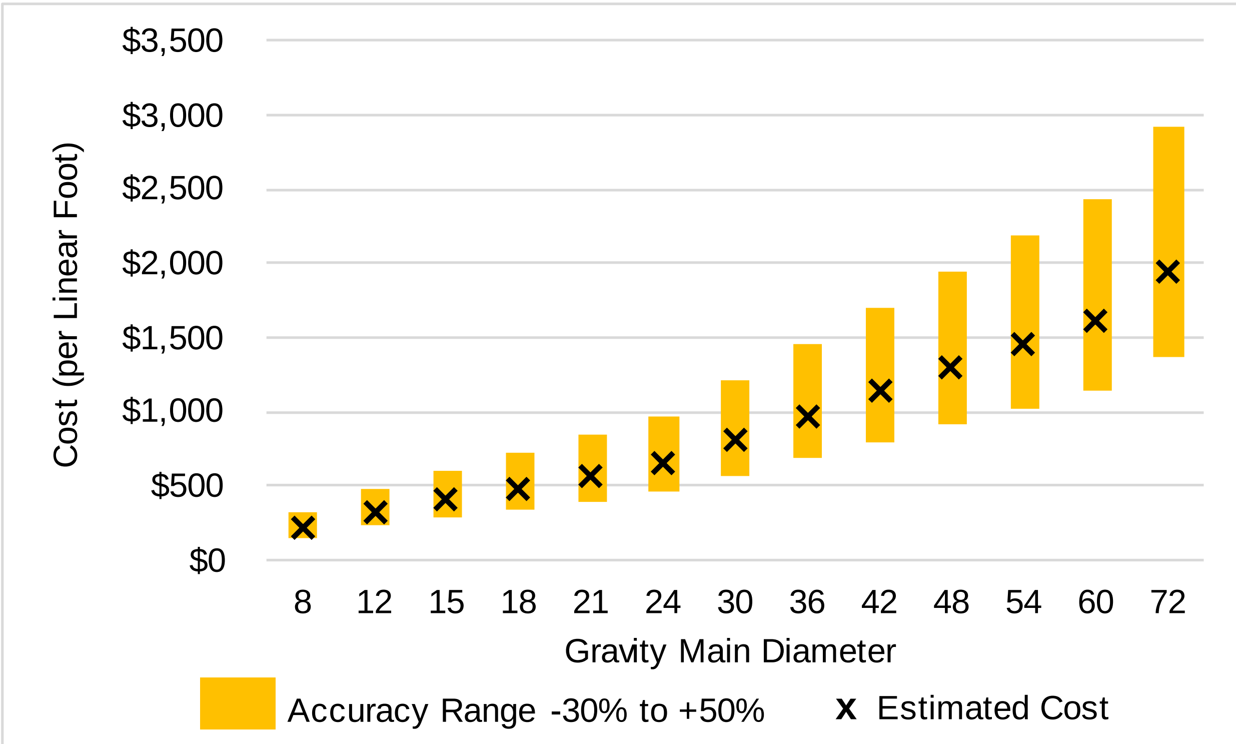
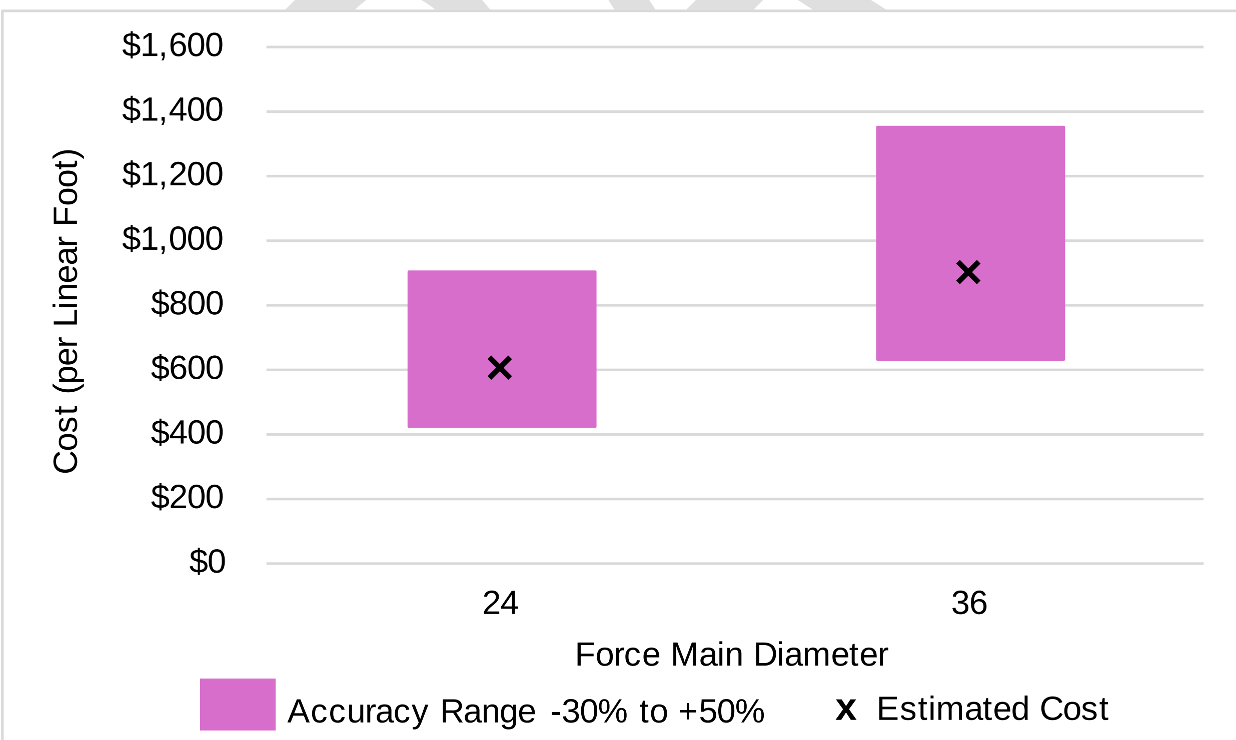


Figure 10-2: Construction Cost Estimation for Force Mains



10.1.3.2 PROFESSIONAL SERVICES

The cost estimate includes all professional services needed to bid each project including survey, deed research (as needed), preliminary design, final design, and construction phase services. The professional services cost, based on the total estimated construction costs with contingency concluded, is assumed to be 25%.

10.1.3.3 EASEMENT ACQUISITION

The engineering estimate includes easement acquisitions needed for relevant projects, including coordination of land acquisition and land value. The cost is assumed to be 10% of the construction subtotal including 30% contingency. Easement acquisition cost was applied only to projects that expand the existing WWSA.

10.2 CIP SUMMARY

This section summarizes the methodology used to develop the 5-, 10-, 20-year CIP. The project prioritization and cost estimates for proposed improvements are presented in Table 10-2. An overview map of the CIP projects is shown in Map 10-1.

Table 10-2: 20-Year CIP Cost Summary

Project Number	Existing Wastewater Service Area (WWSA) Improvements Projects	Anticipated Date of Project	Estimated Project Cost (2024 Dollars)
1	Lower Bishop Interceptor Upsizing	2025	$22.5M
2	Eagle Cliff Interceptor Upsizing	2025	$4.5M
3	Lift Station D Equalization	2027	$7.4M
4	Upper Bishop Interceptor Upsizing	2027	$27.3M
5	Oak Tree Interceptor Upsizing	2029	$4.4M
6	Constitution St. Interceptor Upsizing	2033	$3.1M
		Existing WWSA Improvements Subtotal	**$69.3M**
Project Number	**Eastern Conveyance Improvements Projects**	**Anticipated Date of Project**	**Estimated Project Cost (2024 Dollars)**
7a	Dave Blue Creek Eastern Conveyance Network	2027	$154.6M
8a	Rock Creek Eastern Conveyance Network	2031	$76.8M
9	Little River Eastern Conveyance Network	2037	$63.8M
7b	Dave Blue Creek Expansion	2035	$75.3M
8b	Rock Creek Expansion	2036	$32.2M
		Eastern Conveyance Improvements Subtotal	**$402.7M**
Project Number	**Existing WRF Improvement Projects**	**Anticipated Date of Project**	**Estimated Project Cost (2024 Dollars)**
10	Additional Equalization Basin	2025	$29.8M
11	Additional Grit Removal	2026	$7.7M
12	Existing WRF Rehabilitation and Equipment Replacement	As needed	$25.0M
		Existing WRF Improvements Subtotal	**$62.6M**
		Improvements Total	**$534.6M**

Map 10-1: 20-Year CIP Summary

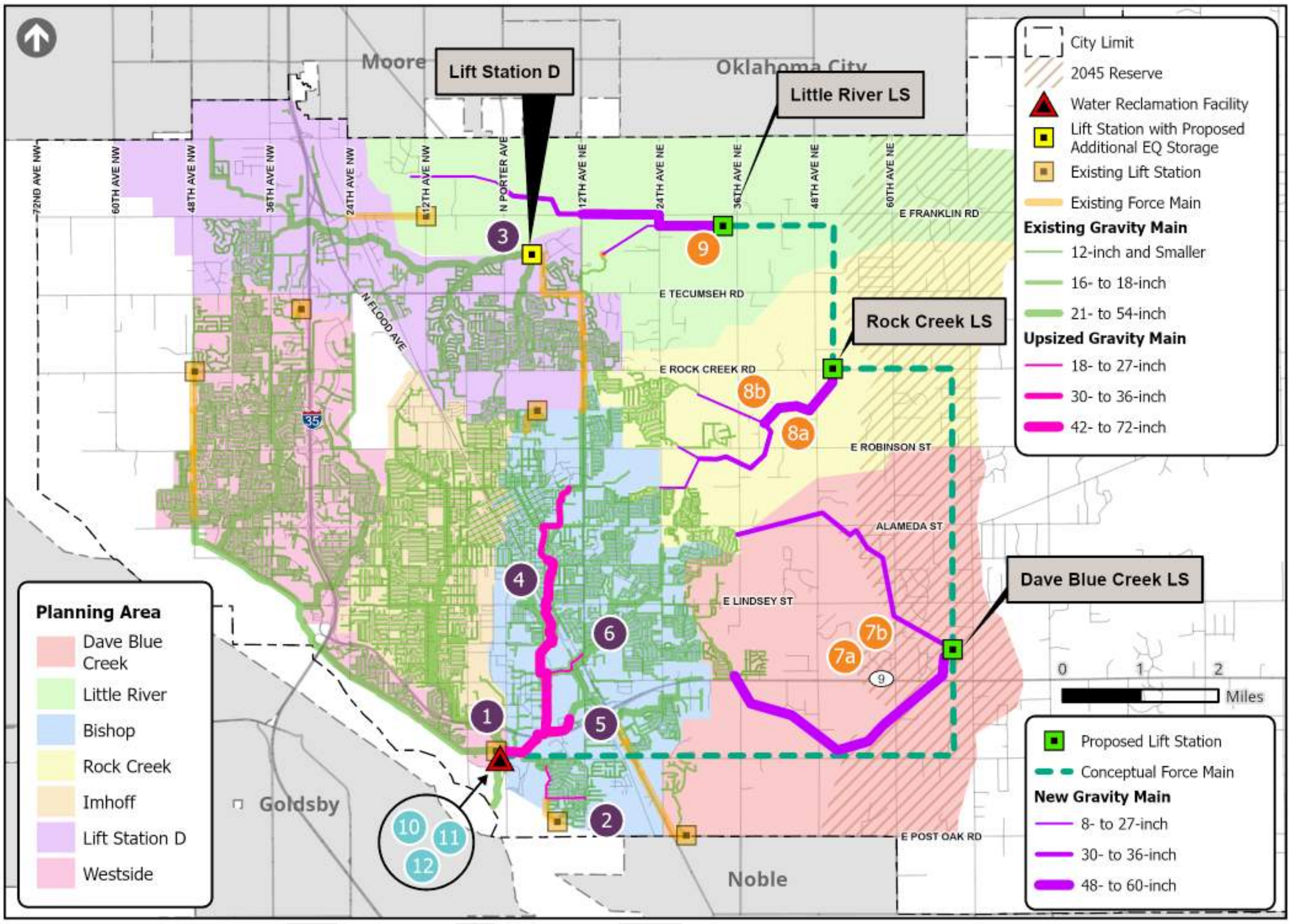


Figure 10-3 and Figure 10-4 summarize the proposed project schedule and proposed spending schedule with construction cost contingency to complete the CIP projects. The full cost estimates for each CIP project can be found in Appendix J.

Figure 10-3: Proposed Capital Outlay Schedule

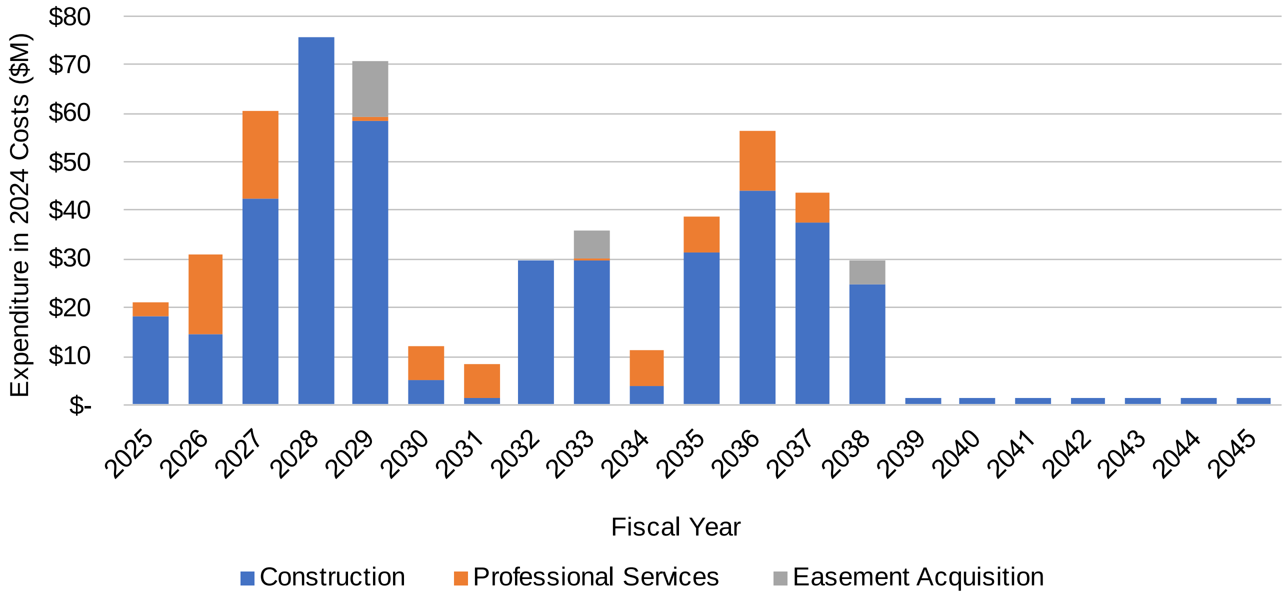


Figure 10-4: Proposed Capital Outlay Schedule by Project Type

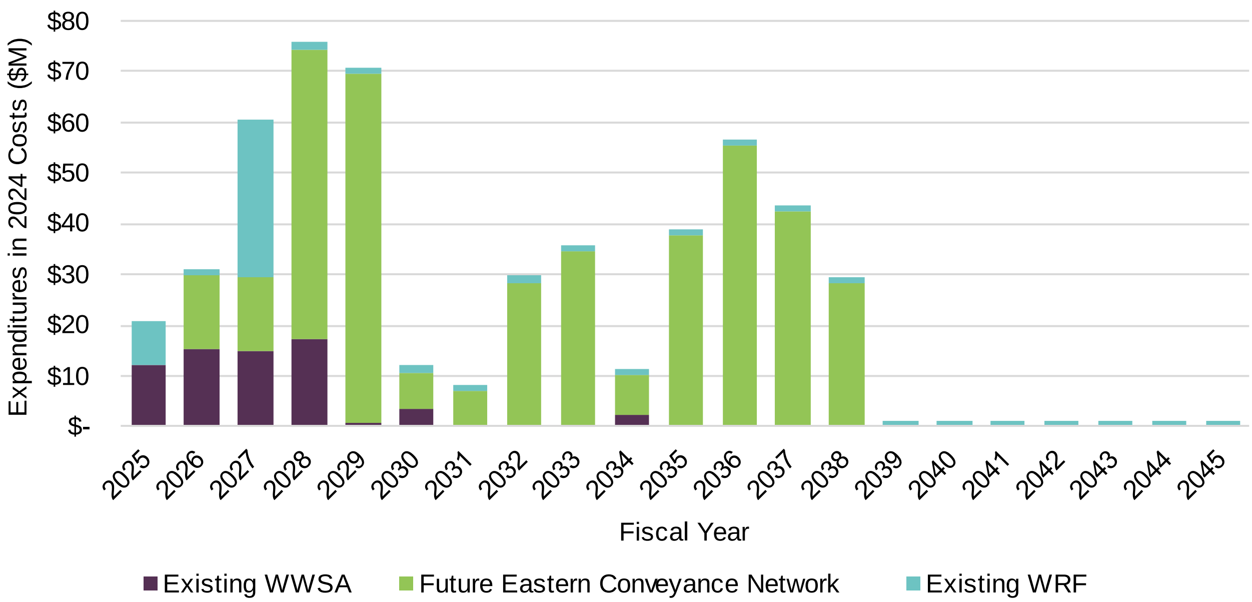


Table 10-3: Wastewater CIP Project Details

Project Identification					Project Schedule				
Project	Description	Location	Flexibility	Primary Trigger	Capacity Threshold	Threshold Year	Start Date	Project Complete	Total Project Duration (months)
1	Lower Bishop Interceptor Upgrade	Dewey Avenue	Low	Capacity	N/A	N/A	1/1/2025	2027	30
2	Upper Bishop Interceptor Upgrade	Along Bishop Creek from Main Street to Constitution Street	Low	Capacity	N/A	N/A	1/1/2027	2029	30
3	Oak Tree Interceptor Upgrade	Marshall Avenue	Low	Capacity	N/A	N/A	1/1/2029	2031	30
4	Constitution St Interceptor Upgrade	Constitution Street	High	Capacity	N/A	N/A	1/1/2029	2035	30
5	Eagle Cliff Interceptor Upgrade	Eagle Cliff Subdivision, near Night Hawk Drive and Coopers Hawk Drive	Medium	Capacity	Eagle Cliff ADF = 0.20 MGD	2030	1/1/2025	2027	30
6	Lift Station D Equalization Basin	Lift Station D	Medium	Capacity	Lift Station D ADF = 1 MGD	2030	1/1/2027	2029	30
7	Dave Blue Creek Eastern Conveyance Network	Along 72nd Avenue Southeast and East Cedar Lane	Medium	Growth	N/A	N/A	1/1/2027	2030	36
8	Rock Creek Eastern Conveyance Network	Along East Rock Creek Road and 72nd Avenue East	High	Growth	N/A	N/A	1/1/2031	2034	36
9	Little River Eastern Conveyance Network	Along East Franklin Road and 48th Avenue East	High	Growth	N/A	N/A	1/1/2037	2039	30
10	Dave Blue Creek Expansion	Along 72nd Avenue Southeast and East Cedar Lane	High	Growth	Future Dave Blue Creek + Rock Creek + Little River ADF = 3.33 MGD	2039	1/1/2035	2037	30
11	Rock Creek Expansion	Along East Rock Creek Road and 72nd Avenue East	High	Growth	Future Rock Creek + Little River ADF = 1.42 MGD	2039	1/1/2036	2038	30
12	Grit Removal	Existing WRF	Medium	Operational	N/A	N/A	1/1/2024	2026	30
13	WRF Equalization Storage	Existing WRF	Medium	Operational	N/A	N/A	1/1/2026	2028	30
14	WRF Rehabilitation and Equipment Replacement	Existing WRF	High	Operational	N/A	N/A	As Needed	2045	N/A

Table 10-4: Wastewater CIP Project Costs

Project	Description	2024 Cost					Forecasted Costs			
		Professional Services	Easement Acquisition	Construction with 30% Cost Contingency	Total Project Cost	Forecasted Year	Professional Services	Easement Acquisition	Construction with 30% Cost Contingency	OPCC
1	Lower Bishop Interceptor Upgrade	$3,862,000	$0	$18,744,000	$22,493,000	2027	$3,862,000	$0	$19,886,000	$23,748,000
2	Upper Bishop Interceptor Upgrade	$4,963,000	$0	$22,704,000	$27,245,000	2029	$4,963,000	$0	$25,554,000	$30,517,000
3	Oak Tree Interceptor Upgrade	$856,000	$0	$3,686,000	$4,424,000	2031	$856,000	$0	$4,402,000	$5,258,000
4	Constitution St Interceptor Upgrade	$661,000	$0	$2,528,000	$3,034,000	2035	$661,000	$0	$3,398,000	$4,059,000
5	Eagle Cliff Interceptor Upgrade	$771,000	$0	$3,739,000	$4,487,000	2027	$771,000	$0	$3,967,000	$4,738,000
6	Lift Station D Equalization Basin	$1,599,000	$0	$5,850,000	$7,313,000	2029	$1,599,000	$0	$6,585,000	$8,184,000
7	Dave Blue Creek Eastern Conveyance Network	$31,278,000	$11,450,000	$114,491,000	$154,564,000	2030	$31,278,000	$12,512,000	$128,861,000	$172,651,000
8	Rock Creek Eastern Conveyance Network	$17,492,000	$5,689,000	$56,887,000	$76,798,000	2034	$17,492,000	$6,997,000	$72,063,000	$96,552,000
9	Little River Eastern Conveyance Network	$17,332,000	$4,721,000	$47,206,000	$63,728,888	2039	$17,332,000	$6,933,000	$71,404,000	$95,669,000
10	Dave Blue Creek Expansion	$20,836,000	$0	$60,206,000	$75,258,000	2037	$20,836,000	$0	$85,840,000	$106,676,000
11	Rock Creek Expansion	$9,170,000	$0	$25,724,000	$32,155,000	2038	$9,170,000	$0	$37,777,000	$46,947,000
12	Grit Removal	--	$0	$7,718,000	$7,718,000	2026	--	--	$7,950,000	$7,950,000
13	WRF Equalization Storage	--	$0	$29,803,000	$29,803,000	2028	--	--	$32,567,000	$32,567,000
14	WRF Rehabilitation and Equipment Replacement	--	$0	$25,000,000	$25,000,000	2045	--	--	$9,179,000	$9,179,000

10.3 5-Year CIP Improvements

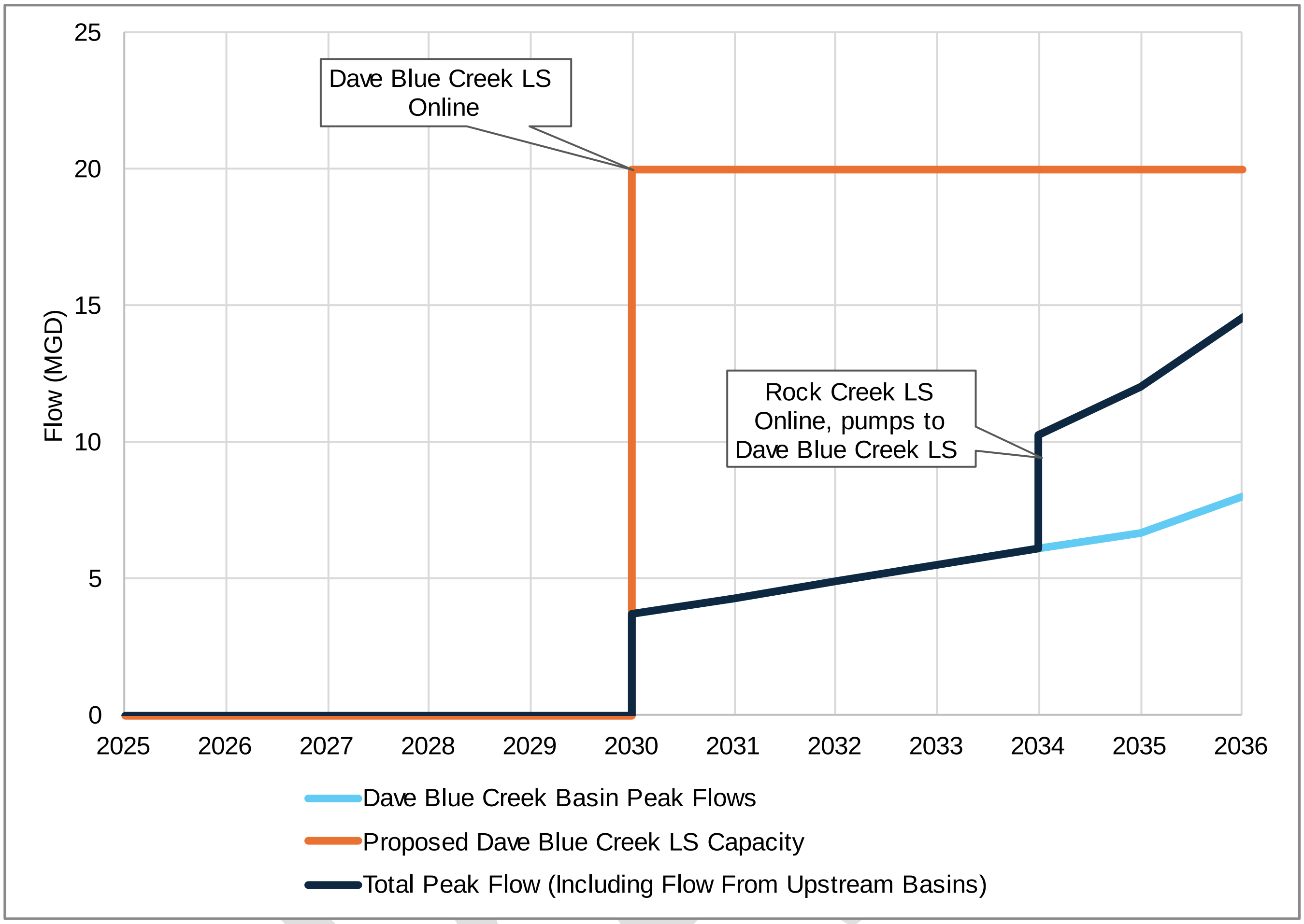
The 2030 CIP projects are driven by the constraints of the existing collection system that were identified during the existing system assessment and the anticipated growth in the projected development areas. The following projects are proposed to increase capacity and reduce SSO and low freeboard conditions in the existing WWSA:

- Upsize existing interceptor along Dewey Avenue and lower Bishop Creek to 60-inch to 72-inch diameter interceptor
- Upsize existing gravity main along west side of Bishop Creek from Main St to Constitution St to 30, 36, 42, 48, and 54-inch gravity mains
- Upsize existing gravity main along Marshall Avenue in the Oak Tree area to 42-inch gravity main
- Upsize existing gravity main in Eagle Cliff subdivision, near Night Hawk Drive and Coopers Hawk Drive, to 18 and 21-inch gravity main
- Install 3 MG of equalization storage at Lift Station D

In addition to projects that increase capacity in the existing collection system, establishment of an eastern conveyance network is projected to be needed by 2030 to accommodate development outside of the existing WWSA. The proposed Dave Blue Creek Lift Station will receive all future flow from the eastern conveyance network. Therefore, it must be in place to open up expanded development to the east of the existing WWSA.

The Dave Blue Creek Lift Station project will include installation of 33-inch and 36-inch interceptors that will divert flow from the existing Summit Lakes and Summit Valley Lift Station to the new Dave Blue Creek Lift Station. These gravity mains are also sized to convey future projected flow within the Dave Blue Creek basin. The Dave Blue Creek Lift Station is proposed to have a firm capacity of 20 MGD. This proposed capacity will allow for receipt of flows from the future proposed Rock Creek Lift Station and is projected to provide sufficient flow capacity until 2036, when the Dave Blue Creek Lift Station will need to be expanded. Figure 10-5 shows the projected flows to the future Dave Blue Creek Lift Station through 2036, when the Lift Station is projected to need expansion.

Figure 10-5: Flows to Proposed Dave Blue Creek Lift Station



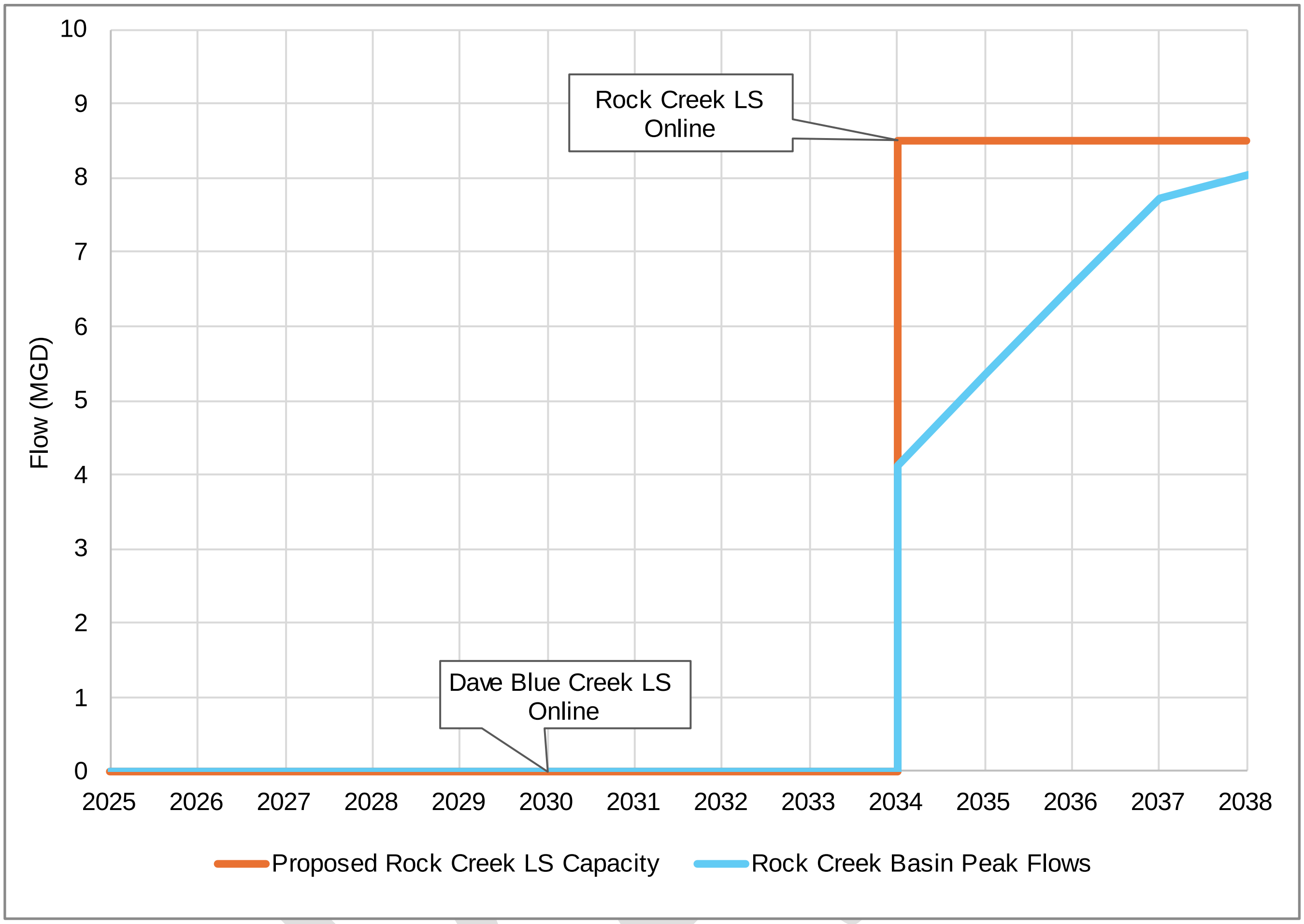
10.4 10-YEAR CIP IMPROVEMENTS

The 2035 CIP projects are driven by the anticipated growth in the projected development areas previously discussed. The primary impacts of these improvements will be expansion of the new eastern conveyance network near the projected growth areas. Additionally, upsizing of the existing gravity main along Constitution St is in the 10-year CIP due to the high flexibility of this project given that the Bishop interceptor upgrades in the 5-year CIP will greatly reduce freeboard concerns in this area. These projects can be added on an as-need basis as expansion occurs in real-time based on projected growth. It is anticipated that these projects will be needed around 2035. The following projects are proposed to address the projected system constraints:

- Rock Creek Eastern Conveyance Network
- Upsize existing gravity main along Constitution St to 24-inch interceptor

The Rock Creek Eastern Conveyance Network project will include installation of several gravity mains ranging from 8-inch to 42-inch that will divert flow from the existing Alameda Park, Royal Oaks, Hall Park South, and Hall Park North Lift Station to the proposed Rock Creek Lift Station. The gravity main network is sized to convey additional future projected flow within the Rock Creek basin. The Rock Creek Lift Station is proposed to have a firm capacity of 10 MGD. This capacity will allow for receipt of flows from the future proposed Little River Lift Station and is projected to provide sufficient flow capacity until 2038, when the lift station is projected to need to be expanded. Figure 10-6 shows the projected flows to the Rock Creek Lift Station through 2038.

Figure 10-6: Flows to Proposed Rock Creek Lift Station



10.5 20-YEAR CIP IMPROVEMENTS

The 2045 CIP projects are driven by further anticipated growth in the projected development areas. These projects can be added on an as-need basis as expansion occurs in real-time. The following projects are proposed to address the projected system constraints:

- Dave Blue Creek Expansion
- Rock Creek Expansion

The Dave Blue Creek Expansion includes upgrading the lift station firm capacity to 40 MGD and installing a parallel 36-inch force main. The Rock Creek Expansion includes upgrading the lift station firm capacity to 20 MGD and installing a parallel 24-inch force main. Figure 10-7 and Figure 10-8 show the flows to the expanded Dave Blue Creek and Rock Creek Lift Station facilities through 2045.

Figure 10-7: Flows to the Expanded Dave Blue Creek Lift Station through 2045

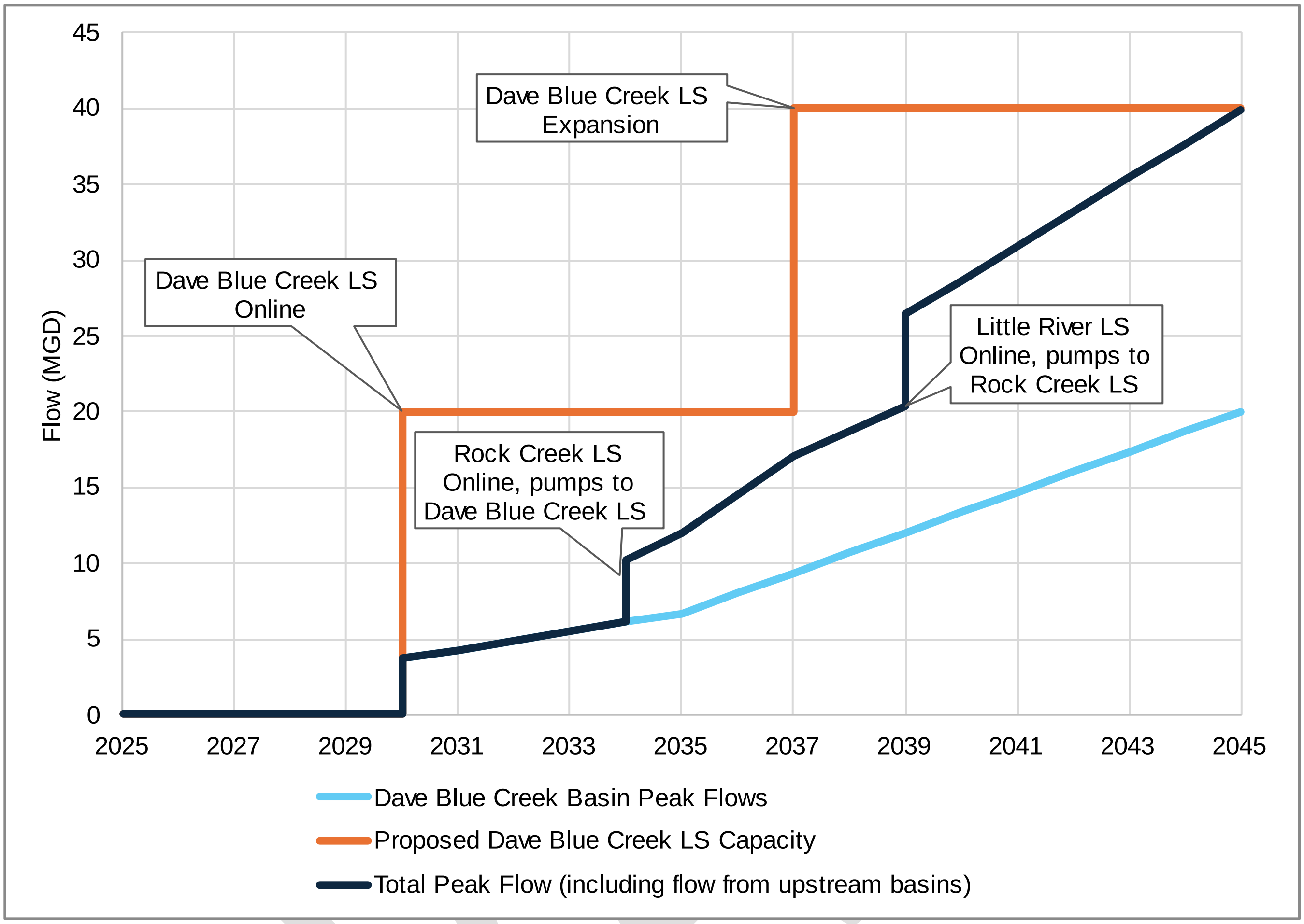
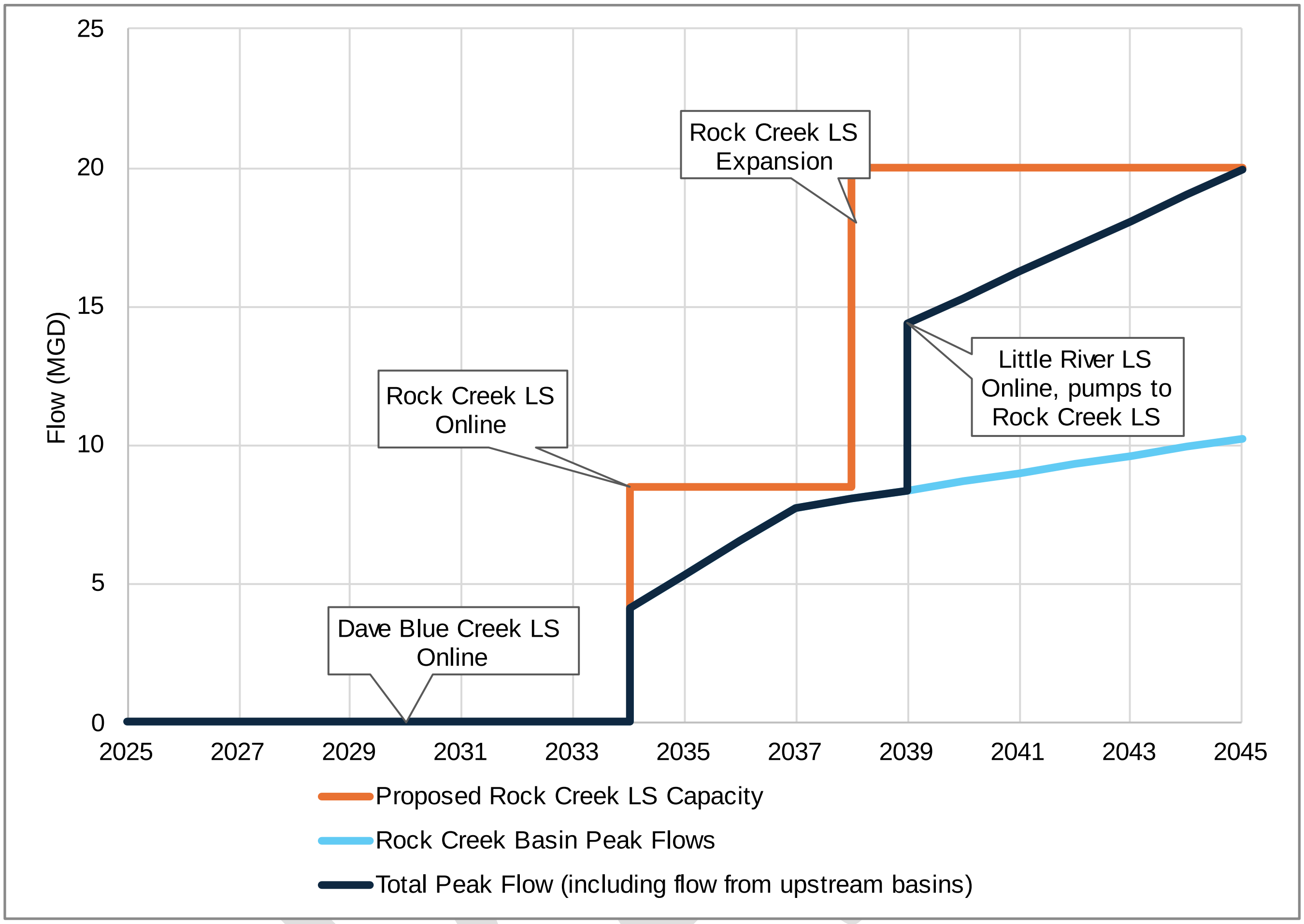
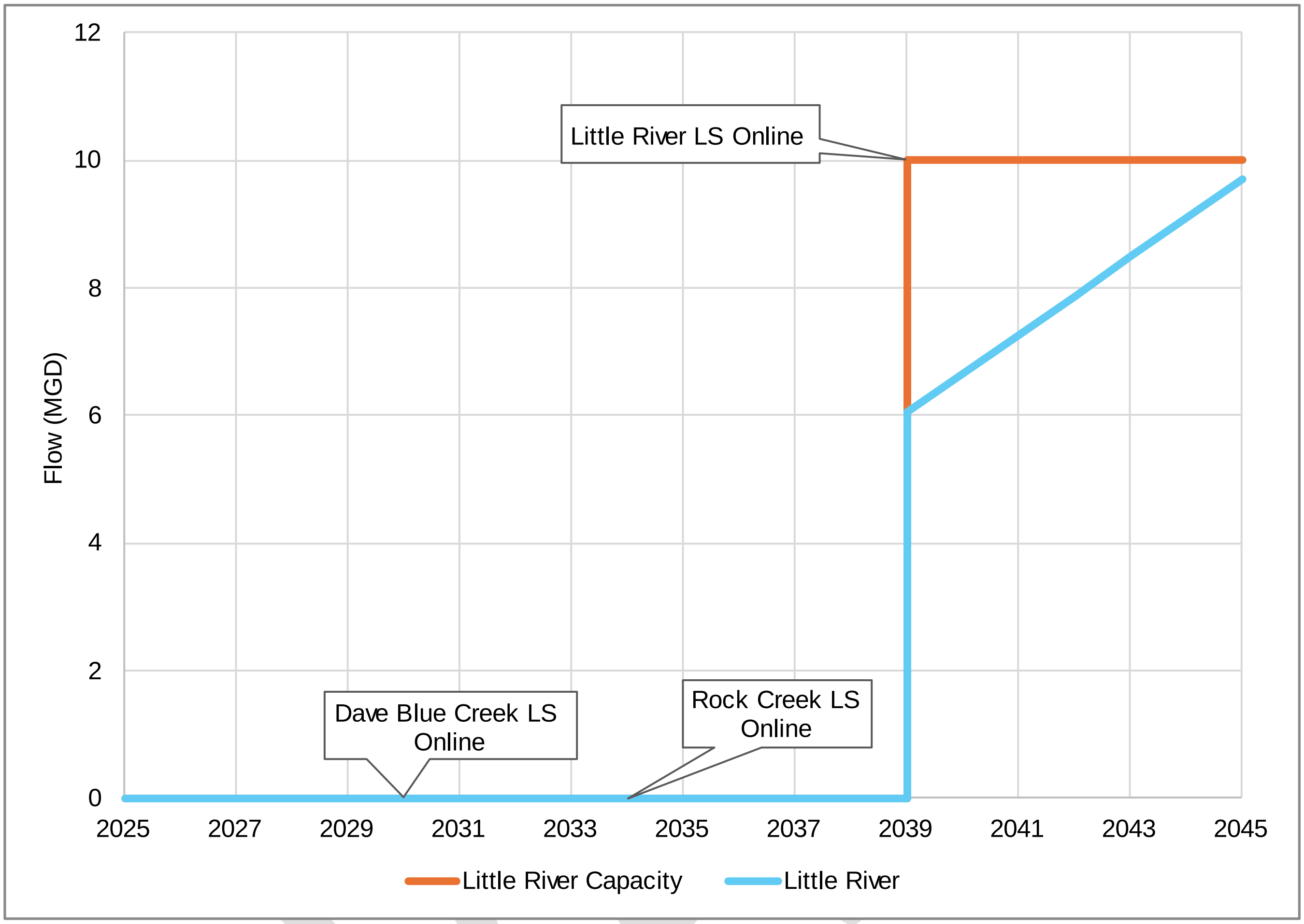


Figure 10-8: Flows to the Expanded Rock Creek Lift Station through 2045



The Rock Creek Eastern Conveyance Network project will include installation of a 12-inch to 42-inch gravity main that will divert flow from the existing Park Hill Lift Station and convey flow from new development in the to the proposed Rock Creek Lift Station. The gravity main network is sized to convey additional future projected flow within the Little River basin. The Little River Lift Station is proposed to have a firm capacity of 10 MGD, which is projected to provide sufficient flow capacity through 2045. Figure 10-9 shows the projected flows to the Little River Lift Station through 2045.

Figure 10-9: Flows to Proposed Little River Lift Station



10.6 CORE REDEVELOPMENT

NUA staff identified an area of Norman that is already developed but is likely to redevelop. A scenario was created in the hydraulic model to represent the core area being redeveloped at a higher density. To be conservative, Garver applied the highest wastewater loading per acre value established in Table 3-3 to the core area.

The highest water demand per acre value established in Table 3-3 was 2,600 gpd/acre. This loading rate was applied to the model basins with the same dry-weather diurnal patterns and wet-weather responses developed during dry- and wet-weather calibration of the model. Assuming it would take many years for the core area to redevelop to such a high density, these scaled up core demands were applied to the 2045 scenario.

Because this core redevelopment scenario is set in 2045, the 20-year CIP improvements are active. The modeling analysis revealed that the 20-year CIP projects are sufficient to handle increased densification of the core area.

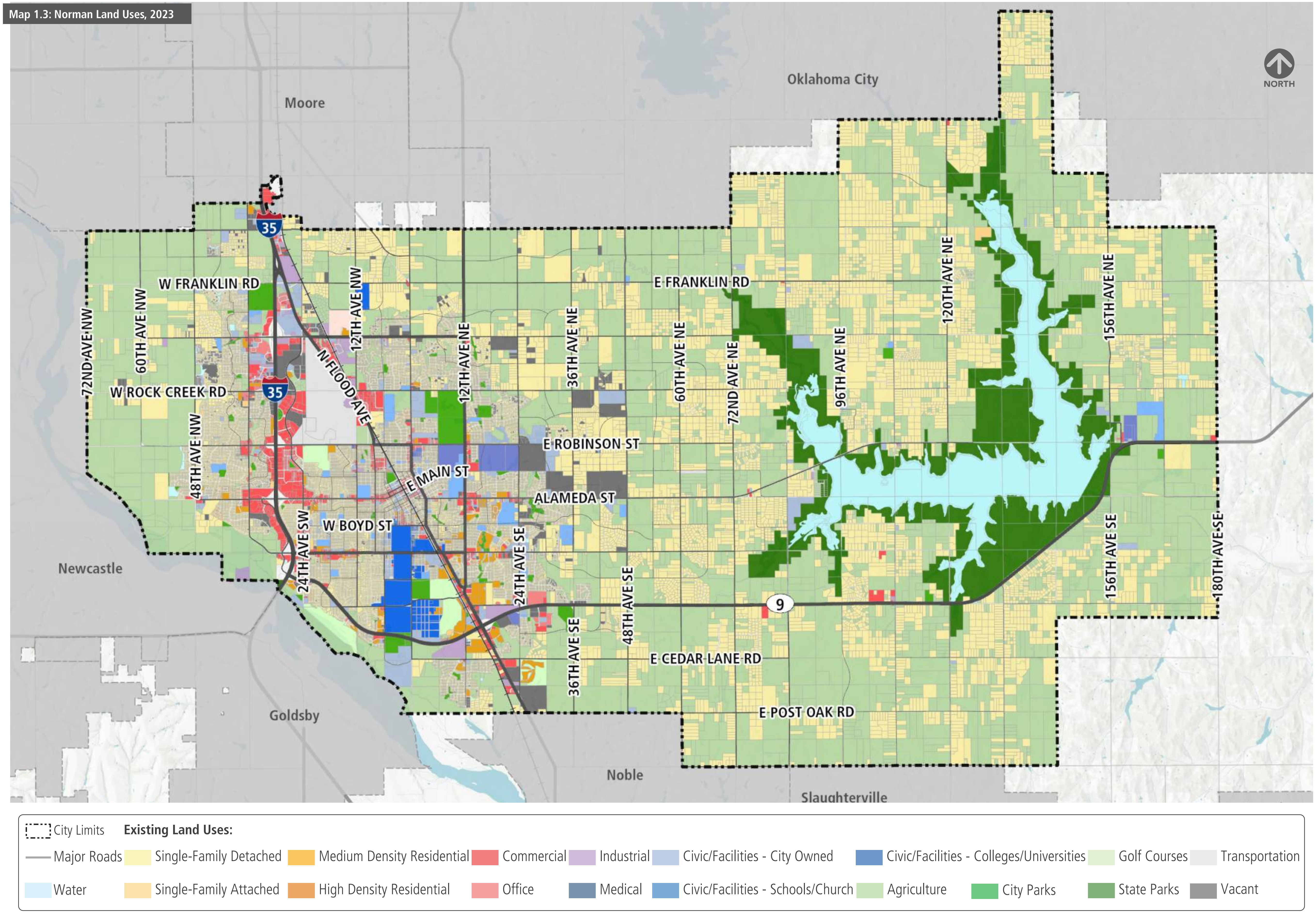
APPENDIX A

EXISTING LAND USE CLASSIFICATION

AIM NORMAN AREA & INFRASTRUTURE MASTER PLAN - NORMAN TODAY

PAGE 8

Map 1.3: Norman Land Uses, 2023



Source: City of Norman; UrbanFootprint (2023)

APPENDIX B

FUTURE LAND USE CLASSIFICATION

AIM NORMAN COMPREHENSIVE PLAN

PAGES 56-57

DEVELOPING THE LAND USE MAP

This map shows general patterns of proposed uses, rather than the use of individual sites or lots. The map provides a general vision of Norman's land use future and guidance for private and public sector decision-makers.

Where different land use categories are located on the Land Use map depends on such factors as:

- **Existing land use patterns.** The land use map reflects how land is used today, unless the overall comprehensive plan recommends major redevelopment or redirection.
- **Adjacencies.** Adjacent uses should be reasonably compatible with each other. Locational criteria should be followed to ensure reasonable compatibility.
- **Infrastructure.** Systems should be adequate to serve the recommended development pattern either with existing or cost-effective extensions.
- **Transportation.** Transportation facilities should be adequate to serve proposed uses, with higher intensity uses located at points or areas with maximum transportation service.
- **Environmental impact.** Proposed use patterns should minimize impact on major environmental resources, including Lake Thunderbird, the Garber-Wellington aquaduct, drainageways, and wetland areas.

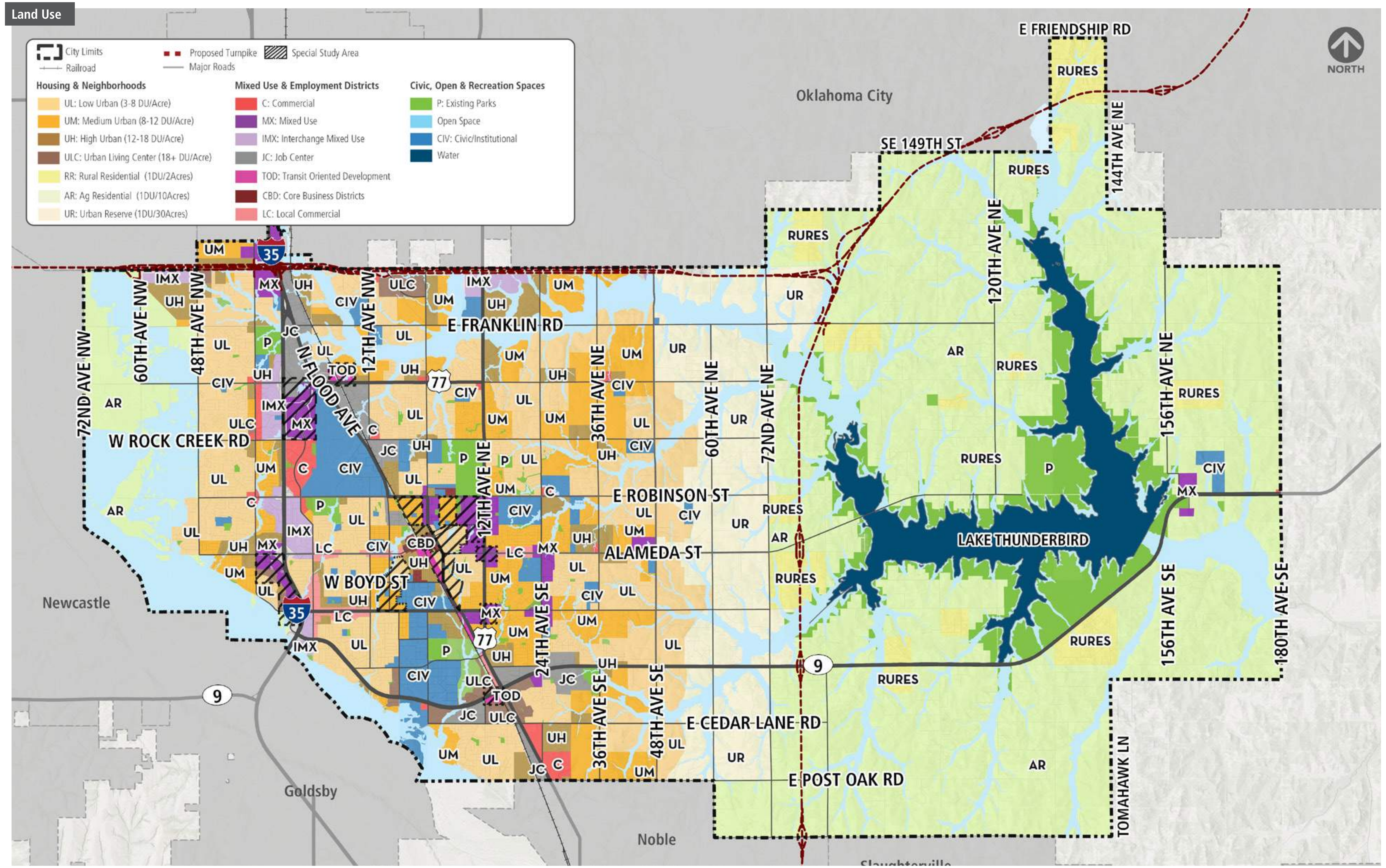
URBAN NEIGHBORHOODS

These categories are primarily residential with a gradient of density ranges, but include some non-residential uses and different intensities. Included uses are grouped together in terms of their impact rather than their specific type of use. In all cases, these areas use urban infrastructure now or in the future.

- **UL: Urban Low.** This category includes built-up areas of largely single-unit developments within the Current Development Character Area east of 12th Avenue East and west of Interstate 35. New growth UL areas are located toward the interior of areas bounded by major streets east of 24th Avenue East, open sites where the predominant form are relatively large lot, urban single-unit subdivisions, and in areas to the east where development densities transition to more rural levels to the east.
- **UM: Urban Medium.** Urban Medium includes most of Norman's established neighborhoods west of 48th Avenue East. Within new growth UM areas, this category is located along and behind section-line arterials that can support higher density environments and neighborhoods with a variety of housing forms. It also follows potential trail and greenway corridors where creative site design can provide larger stormwater management facilities and recreational, walking, and bicyling amenities can serve more people.
- **UH: Urban High.** This category is located along major transportation and amenity corridors and corridors with high residential demand. These include the Classen Boulevard/Legacy Trail/BNSF corridor, on the edges of major mixed-use centers, near and around major intersections, around the OU campus, between Downtown and OU, and as a transitional use between potential commercial nodes and low- and medium density neighbors.
- **ULC: Urban Living Center.** These very high density centers, are focused at points of very high transportation access and existing or future urban services, making a walking distance environment feasible. Other locations include redevelopment projects, such as conversion of underused commercial centers to mixed-uses.

MIXED-USE & EMPLOYMENT CENTERS

- **C: Commercial.** The commercial category is generally reserved for large format retail and commercial concentrations. Mixed-uses may be included, but commercial uses dominate. The land use map recognizes existing commercial concentrations such as University North Park and proposes new focuses at principal arterial intersections, including the access points of the east-west Turnpike.
- **MX: Mixed-Use Development.** This category includes both existing developed areas that include a variety of uses with opportunities for greater connectedness and infill development (12th Avenue East and 24th Avenue East at Alameda and Lindsay; Porter and Robinson; and Ed Noble Parkway); redevelopment sites (Griffin Hospital); and new Turnpike related areas (Indian Hills and I-35).
- **IMX: Interchange Mixed-Use.** This category is logically located along Interstate corridors with parallel service streets, creating the linear pattern with diverse uses along I-35 between 24th and 36th Avenues West.
- **JC: Job Center.** Employment-intensive uses, including low-impact industry, office, and research uses, along major transportation corridors.
- **TOD: Transit Oriented Development.** TOD's are very high intensity mixed-use areas within easy pedestrian or bicycle distance from major transit stations. These are located at future stations of a proposed passenger rail line from Norman to Edmond through Downtown Oklahoma City. TOD's may also develop along bus rapid transit lines or a major community transit center.
- **CBD: Core Business District.** This encompasses Norman's two "main street" mixed-use areas with street-oriented, pedestrian environments – Downtown and Campus Corner. New commercial or mixed-use development could conceivably generate a similar type of district in developing areas.
- **LC: Local Commercial Corridors.** These urban corridors are characterized by a mix of commercial and limited residential uses and relatively shallow commercial sites with small scale businesses and strip centers. Policies will include spot redevelopment, improved multi-modal access, and introduction of residential uses while building on the character of these urban streets. This category include the Main, Lindsay, and Porter corridors.



RESERVE AND RURAL CATEGORIES

- **UR: Urban Reserve.** These areas extend out to approximately 72nd Avenue East and represent the likely limit of Norman's future urban development in the life of this plan. Acreage subdivision would compromise the feasibility of future urban services.
- **RR: Rural Residential.** This designation is limited to existing large lot or rural subdivisions in the eastern fringes of the city and are unlikely to ever change in character.
- **AR: Agricultural Residential.** This category includes land that is unlikely to receive urban services and where rural subdivision is likely to be the end use for the foreseeable future. Conservation development should be encouraged in these areas, permitting smaller lots with preservation of open space to achieve the permitted density.

APPENDIX C

FLOW METER AND RAIN GAUGE SITE SHEETS

Norman,OK

2023 Norman Temporary Flow Monitoring

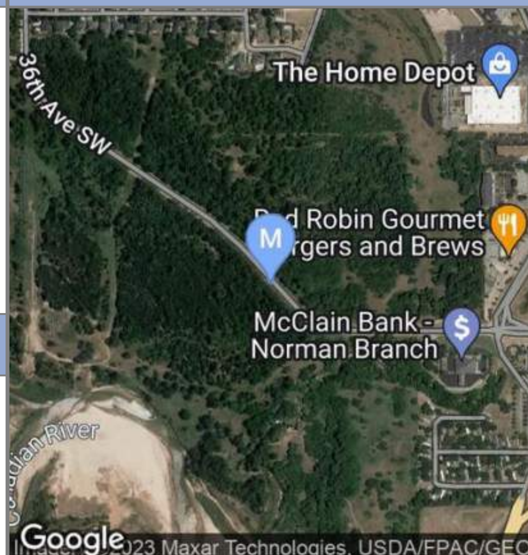
Site Name
BH-02

		Project No.	Site Code
Inspected By	mjaurez		
Inspected Date/Time	3/22/2023 9:24 AM	30-3984-00	T

System Information

Target Pipe Dia. (in)	43.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	253006
U/S Connecting MH I.D	253005
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	600-672 36th Ave SW
Site Access	Off-Road
Longitude	-97.48880000
Latitude	35.20480000
MH Type	Precast Concrete
Manhole Depth (ft)	13.90
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	1.5
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

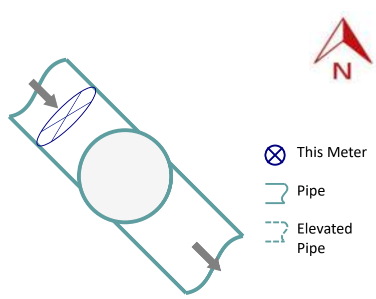
Site Information

Pipe Height (in)	42.50		
Pipe Width (in)	42.50		
Pipe Type	Other		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

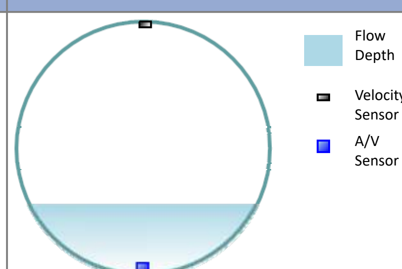
Hydraulic Information

Flow Depth (in)	12.00
Instant Velocity (fps)	1.84
Surcharge Evidence (ft)	13.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP	Client Approval

Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name BH-03

		Project No.	Site Code
Inspected By	mjaurez		
Inspected Date/Time	3/21/2023 7:15 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	22.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	235001
U/S Connecting MH I.D	204039
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	

Location Information

Site Address	4746 W Main St
Site Access	Sidewalk
Longitude	-97.51180000
Latitude	35.21810000
MH Type	Precast Concrete
Manhole Depth (ft)	10.00
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	22.00		
Pipe Width (in)	22.00		
Pipe Type	Other		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	4.00
Instant Velocity (fps)	2.02
Surcharge Evidence (ft)	5.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

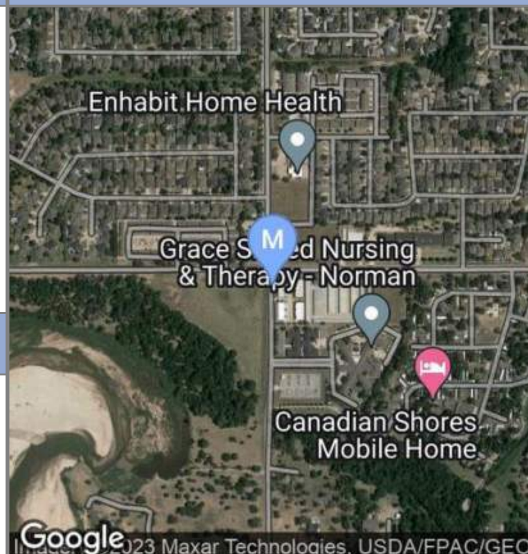
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Area Location Map



Area View Picture

Top View Picture

Access Notes

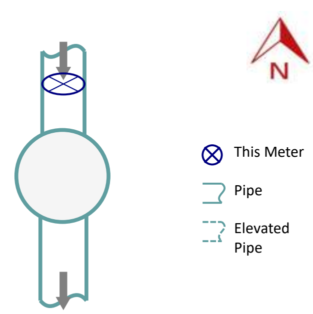
Investigation Photo

Installation Photo

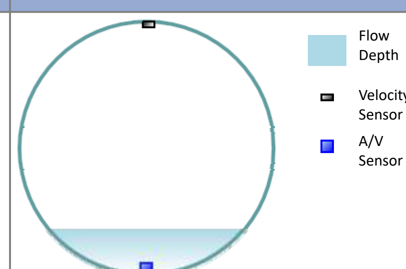
Hydraulic Characteristics

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



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Velocity Clock Position: 0:00

Approvals

Recommended by FSP	Client Approval

Norman,OK	Site Name
2023 Norman Temporary Flow Monitoring	BH-04

Inspected By	mjaurez	Project No.	Site Code
Inspected Date/Time	3/21/2023 6:41 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	24.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	205071
U/S Connecting MH I.D	205063
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	

Location Information

Site Address	3837 Cedar Ridge Dr
Site Access	Off-Road
Longitude	-97.49820000
Latitude	35.22180000
MH Type	Precast Concrete
Manhole Depth (ft)	25.00
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.0
Structural Integrity	Safe

Site Information

Pipe Height (in)	23.00		
Pipe Width (in)	23.00		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

Hydraulic Information

Flow Depth (in)	10.00
Instant Velocity (fps)	1.78
Surcharge Evidence (ft)	13.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

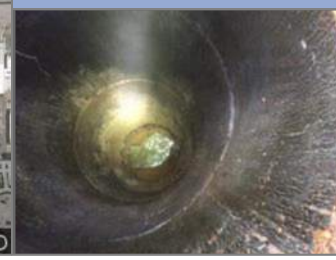
Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/27/2023

Area Location Map

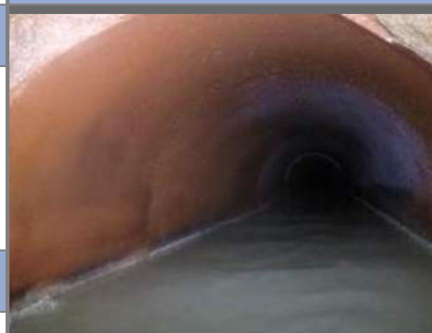
Area View Picture

Top View Picture



Access Notes

Investigation Photo

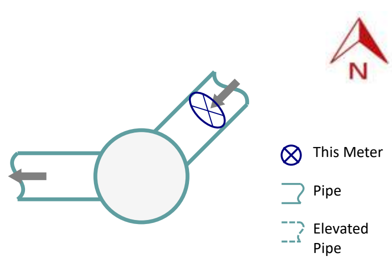


Hydraulic Characteristics

Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Approvals

Recommended by FSP	Client Approval

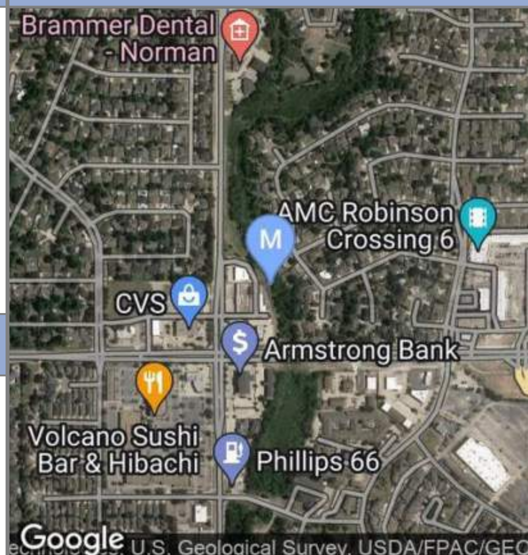
rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name BH-05

Inspected By	mjaurez	Project No.	Site Code
Inspected Date/Time	3/21/2023 6:12 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	24.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	158106
U/S Connecting MH I.D	158105
System Characteristics:	Residential - ☐ Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

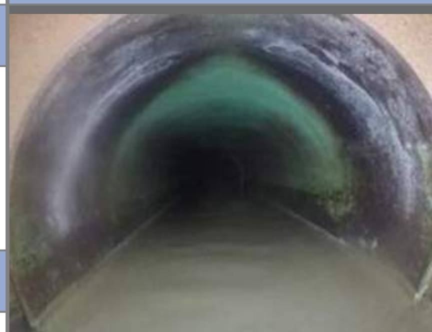
Top View Picture

Access Notes

Location Information

Site Address	1219 36th Ave NW
Site Access	Off-Road
Longitude	-97.49330000
Latitude	35.23420000
MH Type	Precast Concrete
Manhole Depth (ft)	15.50
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.0
Structural Integrity	Safe

Investigation Photo



Installation Photo

Hydraulic Characteristics

Installation Notes

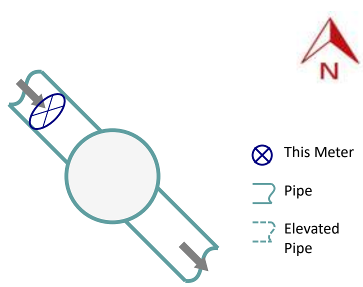
Site Information

Pipe Height (in)	23.00		
Pipe Width (in)	23.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

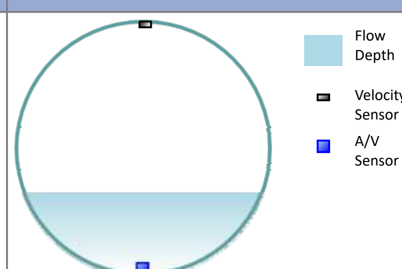
Hydraulic Information

Flow Depth (in)	7.50
Instant Velocity (fps)	2.24
Surcharge Evidence (ft)	10.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/19/2023

Approvals

Recommended by FSP	Client Approval

	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name BH-06
Inspected By	mjaurez	

Inspected By	mjaurez	Project No.	Site Code
Inspected Date/Time	3/21/2023 5:49 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	143107
U/S Connecting MH I.D	143106
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map

Area View Picture

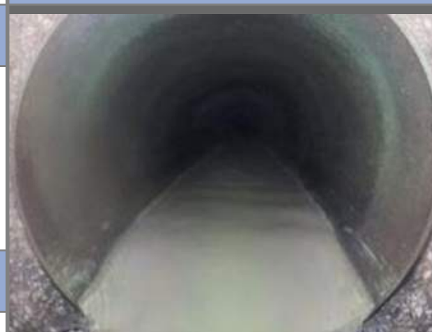
Top View Picture

Access Notes

Location Information

Site Address	2252 36th Ave NW
Site Access	Off-Road
Longitude	-97.49460000
Latitude	35.24470000
MH Type	Precast Concrete
Manhole Depth (ft)	18.80
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	1.5
Structural Integrity	Safe

Investigation Photo



Installation Photo

Hydraulic Characteristics

Installation Notes

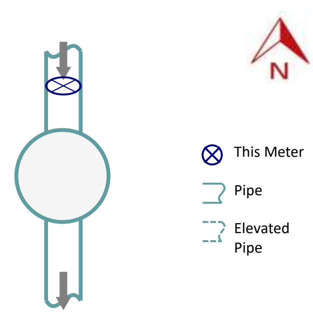
Site Information

Pipe Height (in)	17.50		
Pipe Width (in)	17.50		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

Hydraulic Information

Flow Depth (in)	3.50
Instant Velocity (fps)	2.31
Surcharge Evidence (ft)	8.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/19/2023

Approvals

Recommended by FSP	Client Approval

Norman,OK

2023 Norman Temporary Flow Monitoring

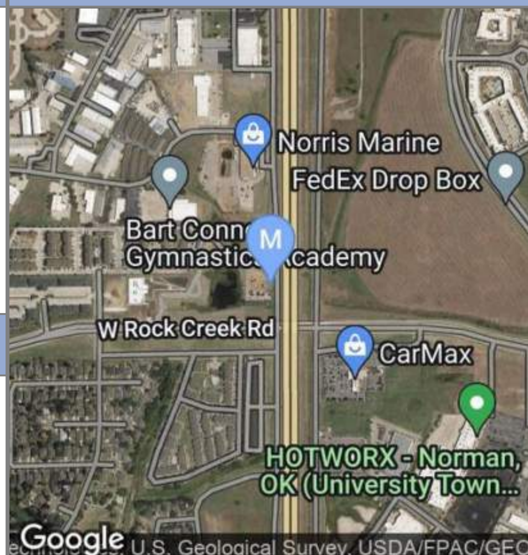
Site Name	Project No.	Site Code
BH-07	30-3984-00	T

Inspected By	zsanders
Inspected Date/Time	4/4/2023 3:18 PM

System Information

Target Pipe Dia. (in)	
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	113038
U/S Connecting MH I.D	113036
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	3050 Yarbrough Way
Site Access	Off-Road
Longitude	-97.48590000
Latitude	35.24870000
MH Type	Precast Concrete
Manhole Depth (ft)	12.30
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	16.50		
Pipe Width (in)	16.50		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Investigation Photo

Installation Photo

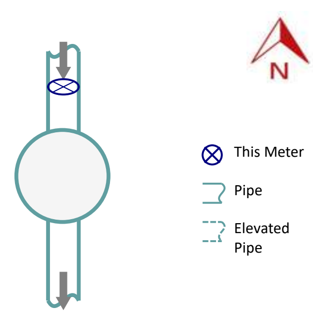
Hydraulic Characteristics

Installation Notes

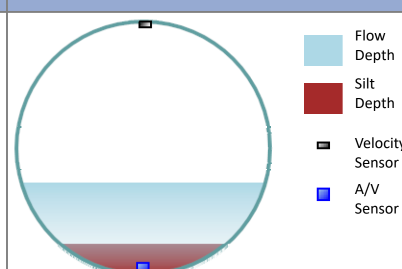
Hydraulic Information

Flow Depth (in)	6.00
Instant Velocity (fps)	0.40
Surcharge Evidence (ft)	1.00
Silt Type	Fine
Silt Depth (in)	2.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/25/2023

Approvals

Recommended by FSP

Client Approval

Norman,OK	Site Name
Norman Utilities Authority	BP-17

		Project No.	Site Code
Inspected By	r_bass		
Inspected Date/Time	12/10/2014 12:48 PM	30-3884-00	T

System Information

Target Pipe Dia. (in)	33.5
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-04
Client Manhole #	329011
U/S Connecting MH I.D	329012
System Characteristics:	Residential - ☑ Commercial - ☑ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	500 E Constellation St
Site Access	Off-Road
Longitude	-97.43244600
Latitude	35.18106800
MH Type	Poured Concrete
Manhole Depth (ft)	17.60
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.3
Structural Integrity	Safe

Site Information

Pipe Height (in)	32.94
Pipe Width (in)	33.98
Pipe Type	Concrete
Pipe Shape	Elliptical
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	20.00
Instant Velocity (fps)	2.74
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

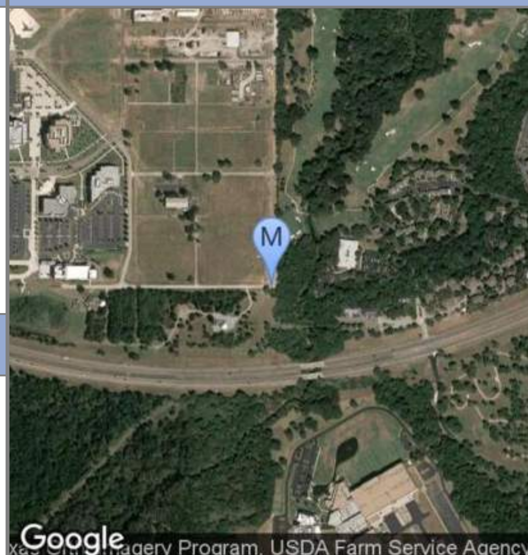
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Non-Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	1/8/2015

Area Location Map



Area View Picture

Top View Picture

Access Notes

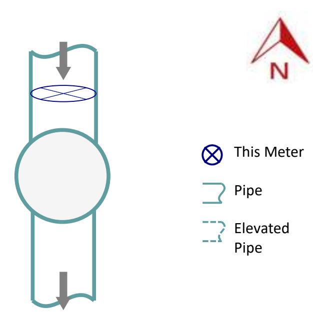
Investigation Photo

Hydraulic Characteristics

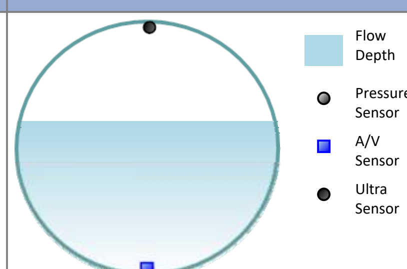
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Approvals

Recommended by FSP	Client Approval
Yes	Yes

	Norman,OK Norman Utilities Authority	Site Name BP-18

Inspected By	RJNGROUP\Kgarrett	**Project No.**	**Site Code**
Inspected Date/Time	6/17/2014 5:23 PM	30-3884-00	T

System Information

Target Pipe Dia. (in)	36.0
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-04
Client Manhole #	329010
U/S Connecting MH I.D	329002
System Characteristics:	
Residential - ☑ Commercial - ☑ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	500 E Constellation St
Site Access	Off-Road
Longitude	-97.43236400
Latitude	35.18122300
MH Type	Precast Concrete
Manhole Depth (ft)	16.50
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	36.88
Pipe Width (in)	36.88
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	19.00
Instant Velocity (fps)	0.60
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	5/7/2015

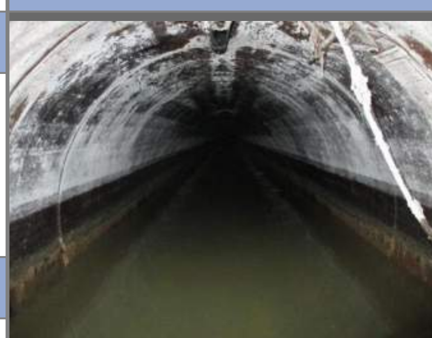
Area Location Map

Area View Picture

Top View Picture

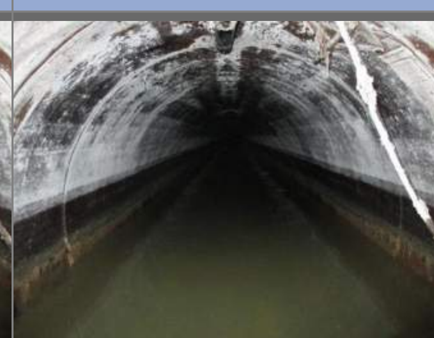
Access Notes

Investigation Photo



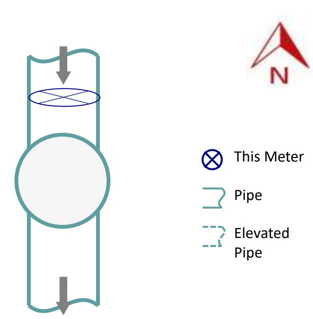
Hydraulic Characteristics

Installation Photo

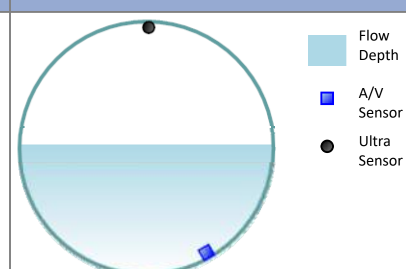


Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 5:00

Approvals

Recommended by FSP	Client Approval
Yes	Yes

Norman,OK

2023 Norman Temporary Flow Monitoring

Site Name
BP-19

Inspected By	zsanders	Project No.	Site Code
Inspected Date/Time	3/21/2023 4:04 PM	30-3984-00	T

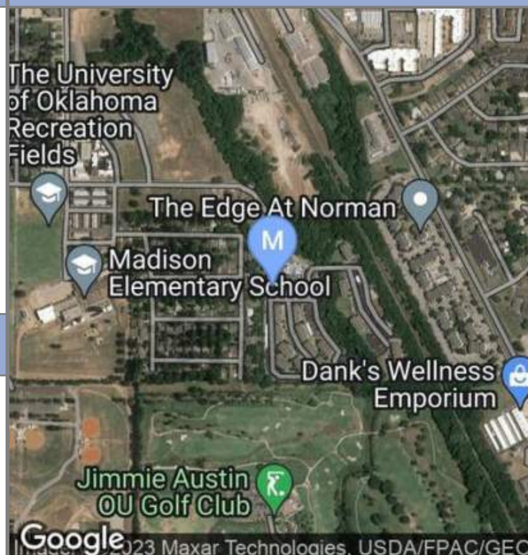
System Information

Target Pipe Dia. (in)	30.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	286085
U/S Connecting MH I.D	286084
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	730 Stinson St
Site Access	Sidewalk
Longitude	-97.43220000
Latitude	35.19860000
MH Type	Precast Concrete
Manhole Depth (ft)	12.50
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

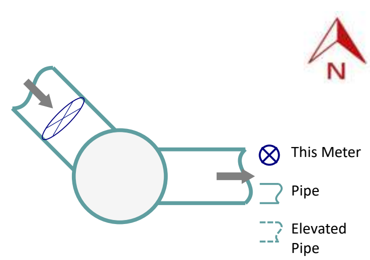
Site Information

Pipe Height (in)	29.50		
Pipe Width (in)	29.50		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	8.40
Instant Velocity (fps)	1.30
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/26/2023

Approvals

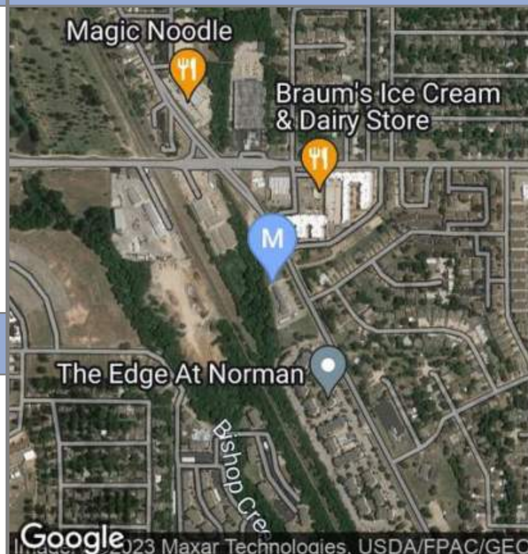
Recommended by FSP **Client Approval**

rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name BP-20
Inspected By zsanders	**Project No.**	**Site Code**
Inspected Date/Time 3/21/2023 4:25 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	286013
U/S Connecting MH I.D	286012
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes Parking lot of carwash

Location Information

Site Address	2100 Classen Blvd
Site Access	Other
Longitude	-97.43020000
Latitude	35.20170000
MH Type	Brick
Manhole Depth (ft)	6.20
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	18.50		
Pipe Width (in)	18.50		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Investigation Photo

Hydraulic Characteristics

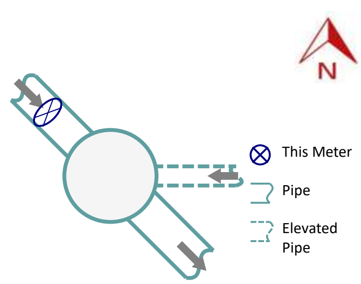
Installation Photo

Installation Notes

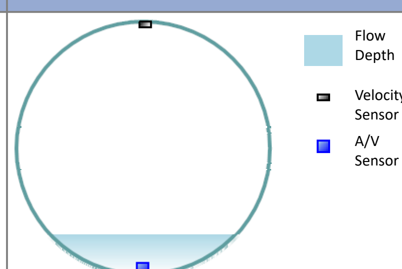
Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	0.75
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/26/2023

Approvals

Recommended by FSP	**Client Approval**

Norman,OK	Site Name
2023 Norman Temporary Flow Monitoring	BP-21

		Project No.	Site Code
Inspected By	zsanders		
Inspected Date/Time	3/21/2023 4:44 PM	30-3984-00	T

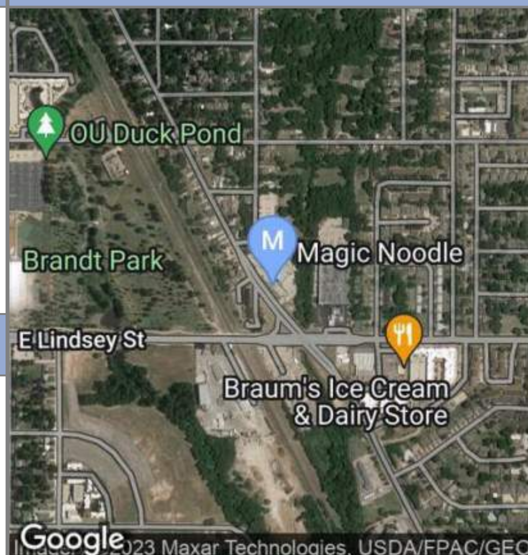
System Information

Target Pipe Dia. (in)	30.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	260116
U/S Connecting MH I.D	260117
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Location Information

Site Address	Suite 115 1915
Site Access	Off-Road
Longitude	-97.43210000
Latitude	35.20480000
MH Type	Precast Concrete
Manhole Depth (ft)	10.30
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Access Notes

Site Information

Pipe Height (in)	29.75		
Pipe Width (in)	28.75		
Pipe Type	Concrete		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Investigation Photo

Hydraulic Characteristics

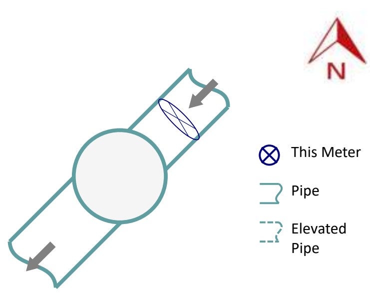
Installation Photo

Installation Notes

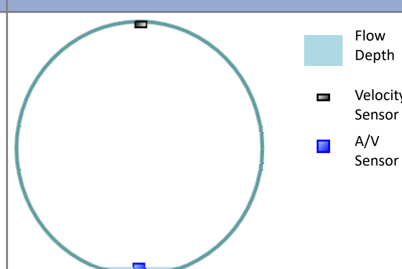
Hydraulic Information

Flow Depth (in)	1.00
Instant Velocity (fps)	1.50
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP	Client Approval

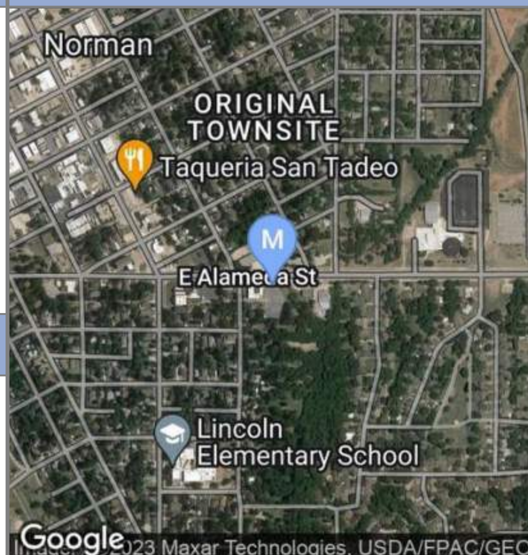
Norman,OK	Site Name
2023 Norman Temporary Flow Monitoring	BP-22

Inspected By	zsanders	Project No.	Site Code
Inspected Date/Time	3/22/2023 9:23 AM	30-3984-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	243054
U/S Connecting MH I.D	212067
System Characteristics:	Residential - ☐ Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	500 E Alameda St
Site Access	Sidewalk
Longitude	-97.43390000
Latitude	35.21820000
MH Type	Precast Concrete
Manhole Depth (ft)	14.70
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Hydraulic Characteristics

Installation Photo

Installation Notes

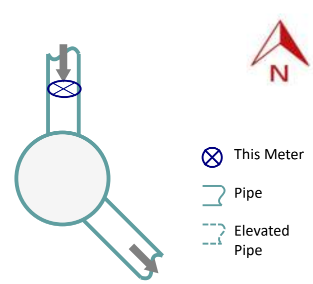
Site Information

Pipe Height (in)	16.50		
Pipe Width (in)	17.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

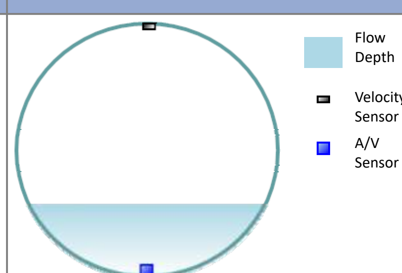
Hydraulic Information

Flow Depth (in)	4.80
Instant Velocity (fps)	0.75
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/26/2023

Approvals

Recommended by FSP	Client Approval

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** BP-23

Inspected By	zsanders	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 6:01 PM	30-3984-00	T

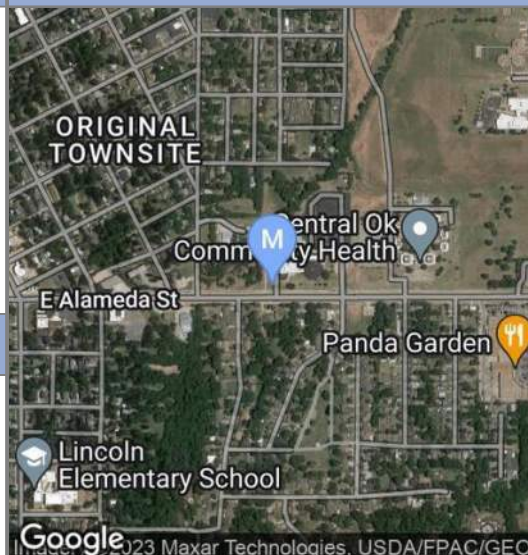
System Information

Target Pipe Dia. (in)	24.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	213051
U/S Connecting MH I.D	213035
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	801 E Alameda St
Site Access	Sidewalk
Longitude	-97.43080000
Latitude	35.21860000
MH Type	Poured Concrete
Manhole Depth (ft)	12.10
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

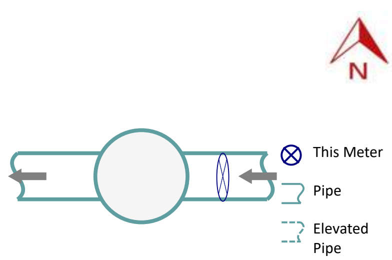
Site Information

Pipe Height (in)	23.50		
Pipe Width (in)	25.00		
Pipe Type	Concrete		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	8.40
Instant Velocity (fps)	2.40
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/26/2023

Approvals

Recommended by FSP	**Client Approval**

Norman,OK

2023 Norman Temporary Flow Monitoring

Site Name	
BP-24	

Inspected By	zsanders	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 3:35 PM	30-3984-00	

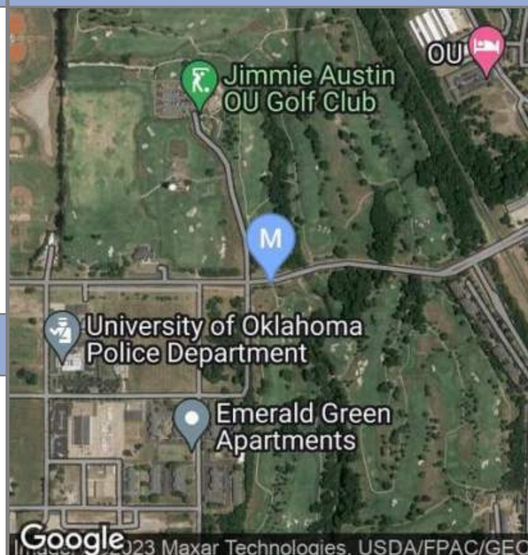
System Information

Target Pipe Dia. (in)	19.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	297022
U/S Connecting MH I.D	297099
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes Need 9 foot tripod

Location Information

Site Address	720 E Constitution St
Site Access	Off-Road
Longitude	-97.43060000
Latitude	35.19130000
MH Type	Brick
Manhole Depth (ft)	17.60
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	3.0
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

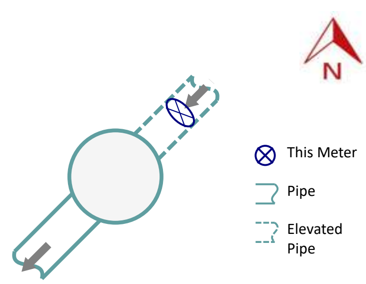
Site Information

Pipe Height (in)	19.00		
Pipe Width (in)	18.50		
Pipe Type	Lined		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

Hydraulic Information

Flow Depth (in)	3.60
Instant Velocity (fps)	2.10
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/27/2023

Approvals

Recommended by FSP	Client Approval

Norman,OK	Site Name
Norman Utilities Authority	BP-25

Inspected By	r_bass	Project No.	Site Code
Inspected Date/Time	1/7/2015 10:38 AM	30-3884-00	T

System Information

Target Pipe Dia. (in)	36.0
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-04
Client Manhole #	330006
U/S Connecting MH I.D	330030
System Characteristics:	
Residential - ☑ Commercial - ☑ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	3240 Marshall Ave
Site Access	Other
Longitude	-97.42970000
Latitude	35.18020000
MH Type	Poured Concrete
Manhole Depth (ft)	8.57
Manhole Width (ft)	5.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	35.75
Pipe Width (in)	35.75
Pipe Type	Concrete
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	17.06
Instant Velocity (fps)	1.41
Surcharge Evidence (ft)	
Silt Type	Fine
Silt Depth (in)	6.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

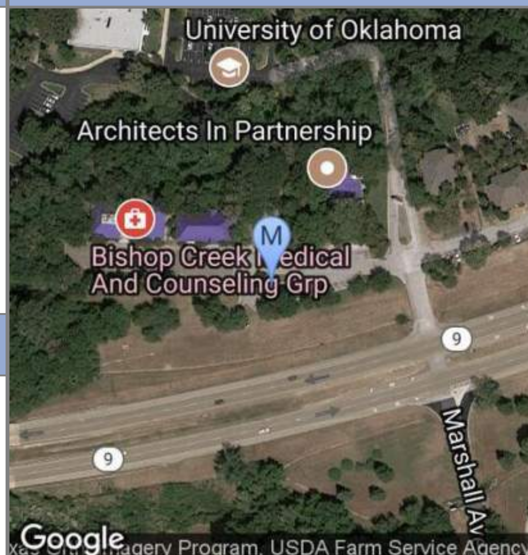
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Non-Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	11/5/2014

Area Location Map



Area View Picture

Top View Picture

Access Notes In island

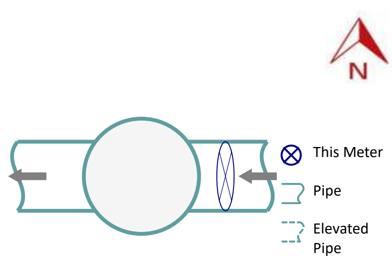
Investigation Photo

Hydraulic Characteristics

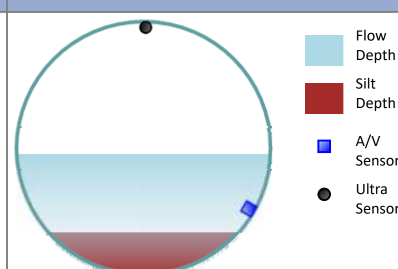
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 4:00

Approvals

Recommended by FSP	Client Approval
Yes	Yes

rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name BP-26

		Project No.	Site Code
Inspected By	zsanders		
Inspected Date/Time	3/21/2023 5:04 PM	30-3984-00	T

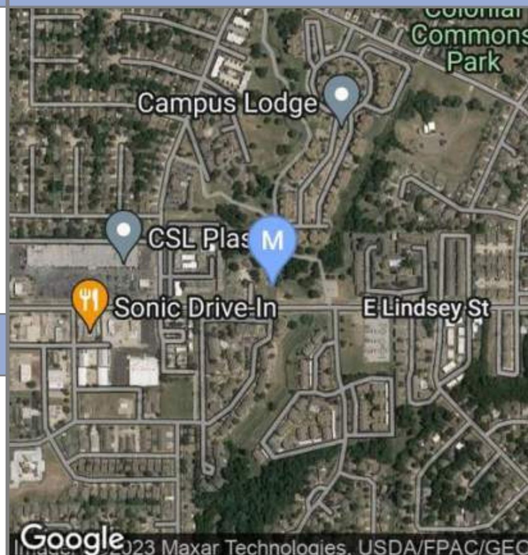
System Information

Target Pipe Dia. (in)	15.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	261088
U/S Connecting MH I.D	261058
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes Park, inside drop influenced by water park

Location Information

Site Address	1531 E Lindsey St
Site Access	Other
Longitude	-97.41750000
Latitude	35.20420000
MH Type	Precast Concrete
Manhole Depth (ft)	15.50
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	2.0
Structural Integrity	Safe

Investigation Photo

Hydraulic Characteristics

Installation Photo

Installation Notes Flow picked up as we were finishing, may be a pump near by, heights and flow speed both increas

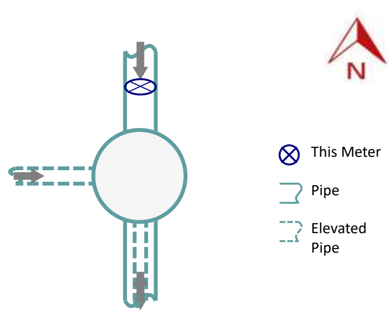
Site Information

Pipe Height (in)	14.50		
Pipe Width (in)	15.62		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

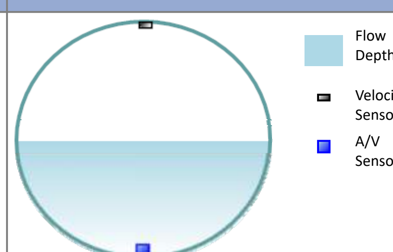
Hydraulic Information

Flow Depth (in)	7.20
Instant Velocity (fps)	0.80
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	Yes
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP **Client Approval**

Norman,OK	Site Name
2023 Norman Temporary Flow Monitoring	BP-27

		Project No.	Site Code
Inspected By	zsanders		
Inspected Date/Time	3/21/2023 5:21 PM	30-3984-00	T

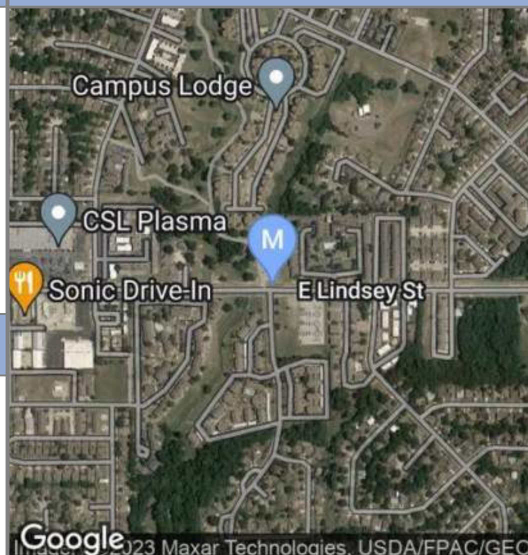
System Information

Target Pipe Dia. (in)	21.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	261092
U/S Connecting MH I.D	262109
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	1699 E Lindsey St
Site Access	Sidewalk
Longitude	-97.41610000
Latitude	35.20390000
MH Type	Brick
Manhole Depth (ft)	10.90
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	20.25		
Pipe Width (in)	20.25		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Investigation Photo

Installation Photo

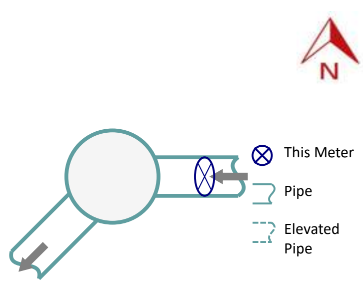
Hydraulic Characteristics

Installation Notes Flow rates vary up and down from 6 to 9 inches

Hydraulic Information

Flow Depth (in)	6.00
Instant Velocity (fps)	1.10
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP	Client Approval

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** BP-27-01

Inspected By	zsanders	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 5:41 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	263060
U/S Connecting MH I.D	263059
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	Yes
WWTP Influence	

Area Location Map

Area View Picture

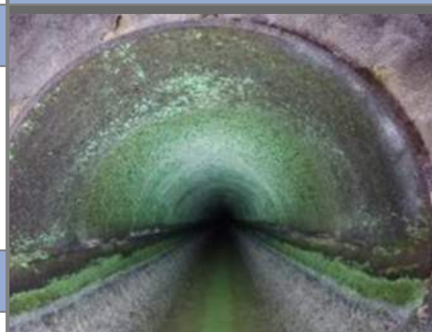
Top View Picture

Access Notes

Location Information

Site Address	769 24th Ave SE
Site Access	Off-Road
Longitude	-97.40580000
Latitude	35.20810000
MH Type	Precast Concrete
Manhole Depth (ft)	13.90
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo



Installation Photo

Hydraulic Characteristics

Installation Notes Flow fluctuates from 1.5 to 4.5 inches, when flow is at its lowest, the av sensor is no longer submerge

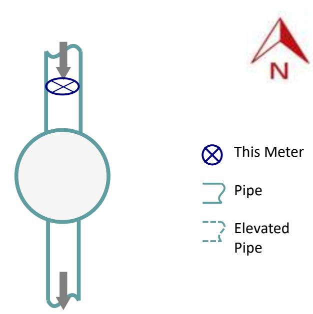
Site Information

Pipe Height (in)	16.94		
Pipe Width (in)	17.25		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

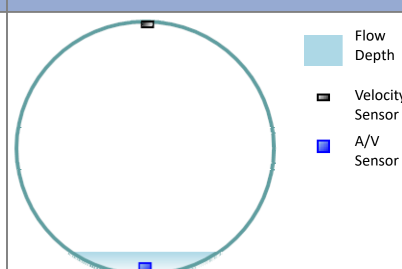
Hydraulic Information

Flow Depth (in)	1.50
Instant Velocity (fps)	0.60
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP	**Client Approval**

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** BP-28

Inspected By	zsanders	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 2:51 PM	30-3984-00	T

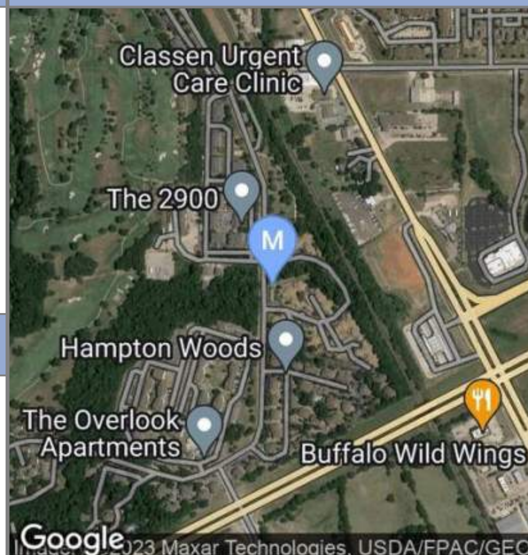
System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	322001
U/S Connecting MH I.D	322070
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

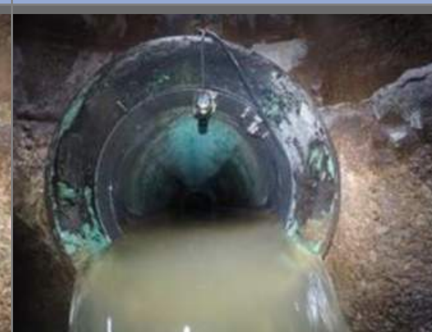
Access Notes Gate was open during investigation, #1590 gate code

Location Information

Site Address	700 Oak Tree Ave
Site Access	Off-Road
Longitude	-97.42340000
Latitude	35.18560000
MH Type	Precast Concrete
Manhole Depth (ft)	14.30
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Installation Photo



Hydraulic Characteristics

Installation Notes Flow changes from 4.5 to 6 inches variably

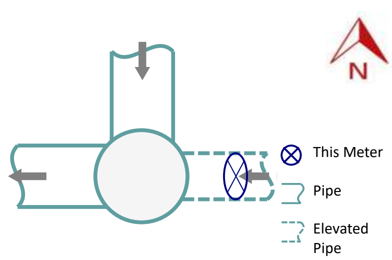
Site Information

Pipe Height (in)	23.50		
Pipe Width (in)	23.81		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

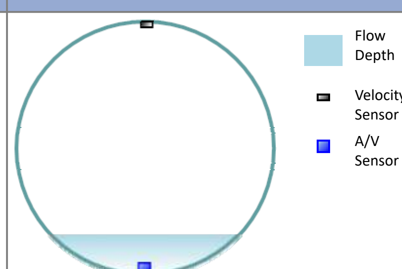
Hydraulic Information

Flow Depth (in)	3.70
Instant Velocity (fps)	2.00
Surcharge Evidence (ft)	9.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP	**Client Approval**

rjn group	**Norman,OK** Norman Utilities Authority	**Site Name** BP-30
Inspected By	r_bass	**Project No.** / **Site Code**
Inspected Date/Time	10/7/2014 3:07 PM	30-3884-00

System Information

Target Pipe Dia. (in)	24.0
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-10
Client Manhole #	329087
U/S Connecting MH I.D	329051
System Characteristics:	Residential - ☑ Commercial - ☑ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	400 East Cedar Ln
Site Access	Fenced In
Longitude	-97.43520000
Latitude	35.17520000
MH Type	Precast Concrete
Manhole Depth (ft)	14.48
Manhole Width (ft)	5.0
Elevated MH	Yes
Height Elevated (ft)	1.7
Structural Integrity	Safe

Site Information

Pipe Height (in)	23.06
Pipe Width (in)	23.31
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	3.50
Instant Velocity (fps)	0.70
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	No Flow

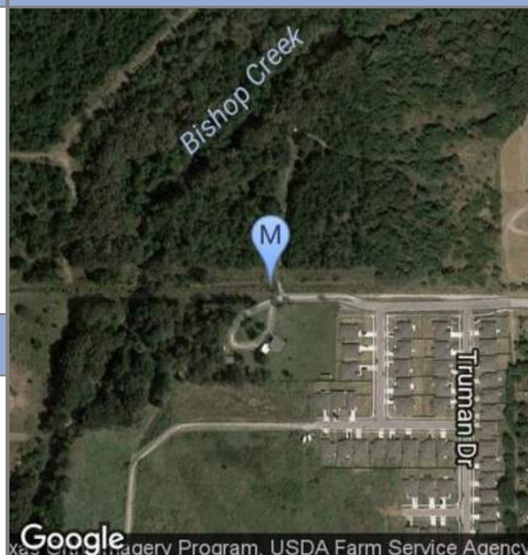
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Non-Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	11/7/2014

Area Location Map

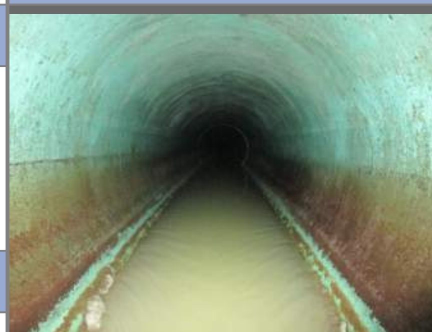


Area View Picture

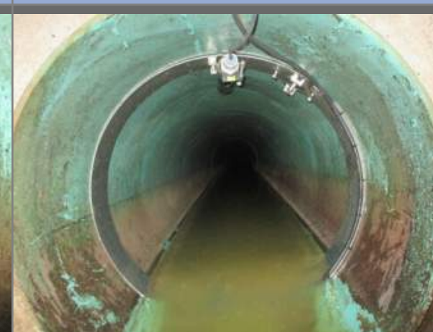
Top View Picture

Access Notes Enter through red gate at end of East Cedar Lane, (RJN owned lock on gate) Follow fence line to the west, pass black iron gate...MH located next to gate

Investigation Photo



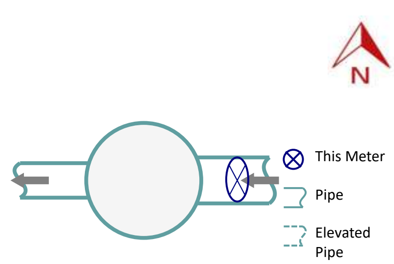
Installation Photo



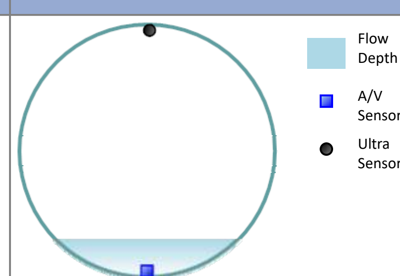
Hydraulic Characteristics

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Approvals

Recommended by FSP	Client Approval
Yes	Yes

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** IH-12

Inspected By	zsanders	**Project No.**	**Site Code**
Inspected Date/Time	3/22/2023 10:51 AM	30-3984-00	T

System Information

Target Pipe Dia. (in)	21.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	293010
U/S Connecting MH I.D	293009
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map

Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	2522 S Berry Rd
Site Access	Roadway, Low Traffic
Longitude	-97.45910000
Latitude	35.19350000
MH Type	Precast Concrete
Manhole Depth (ft)	11.70
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

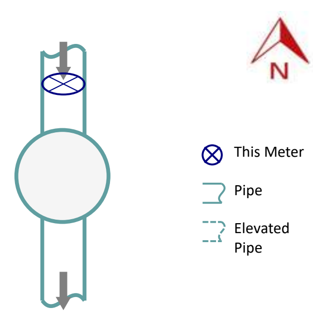
Site Information

Pipe Height (in)	22.12		
Pipe Width (in)	22.25		
Pipe Type	Concrete		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	8.40
Instant Velocity (fps)	0.50
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/21/2023

Approvals

Recommended by FSP **Client Approval**

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** IH-13

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/22/2023 10:22 AM	30-3984-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	255052
U/S Connecting MH I.D	239129
System Characteristics:	Residential - ☐ Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	

Location Information

Site Address	708 McGee Dr
Site Access	Roadway, Low Traffic
Longitude	-97.46780000
Latitude	35.21080000
MH Type	Brick
Manhole Depth (ft)	16.80
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	18.00		
Pipe Width (in)	18.00		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	6.00
Instant Velocity (fps)	0.88
Surcharge Evidence (ft)	11.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Area Location Map

Area View Picture

Top View Picture

Access Notes

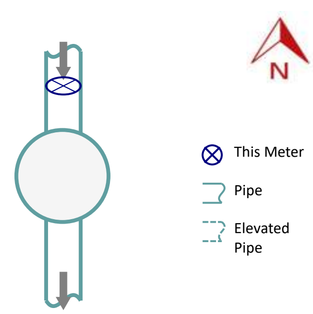
Investigation Photo

Installation Photo

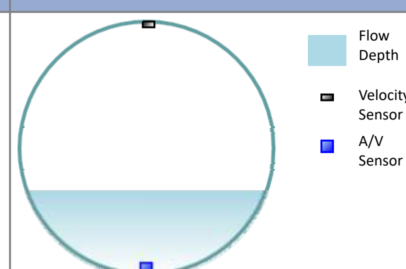
Hydraulic Characteristics

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Approvals

Recommended by FSP	**Client Approval**

Norman,OK	Site Name
2023 Norman Temporary Flow Monitoring	IH-14

		Project No.	Site Code
Inspected By	mjaurez		
Inspected Date/Time	3/22/2023 10:44 AM	30-3984-00	T

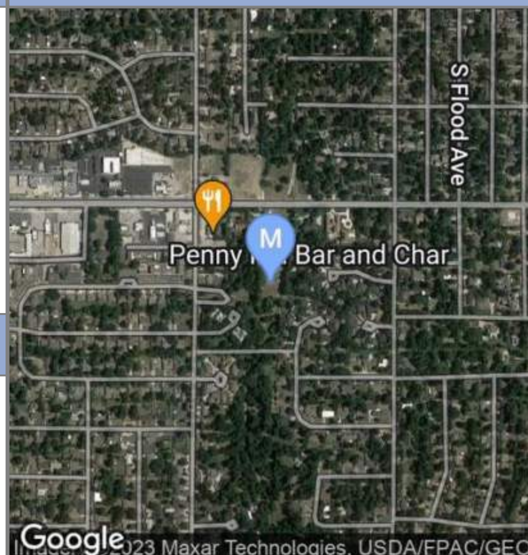
System Information

Target Pipe Dia. (in)	36.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	283007
U/S Connecting MH I.D	283003
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	1101 Cherrystone Cir
Site Access	Off-Road
Longitude	-97.45730000
Latitude	35.20240000
MH Type	Precast Concrete
Manhole Depth (ft)	15.60
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

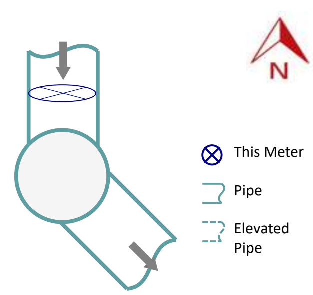
Site Information

Pipe Height (in)	34.00		
Pipe Width (in)	35.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

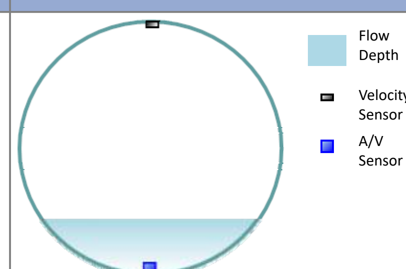
Hydraulic Information

Flow Depth (in)	7.50
Instant Velocity (fps)	1.98
Surcharge Evidence (ft)	11.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

Recommended by FSP	Client Approval

Norman,OK

2023 Norman Temporary Flow Monitoring

Site Name	Project No.	Site Code
IH-15	30-3984-00	T

Inspected By	zsanders
Inspected Date/Time	3/22/2023 10:24 AM

System Information

Target Pipe Dia. (in)	30.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	241027
U/S Connecting MH I.D	241020
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	

Location Information

Site Address	949 W Symmes St
Site Access	Sidewalk
Longitude	-97.45460000
Latitude	35.21490000
MH Type	Precast Concrete
Manhole Depth (ft)	12.80
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	29.00		
Pipe Width (in)	30.25		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	3.60
Instant Velocity (fps)	1.80
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

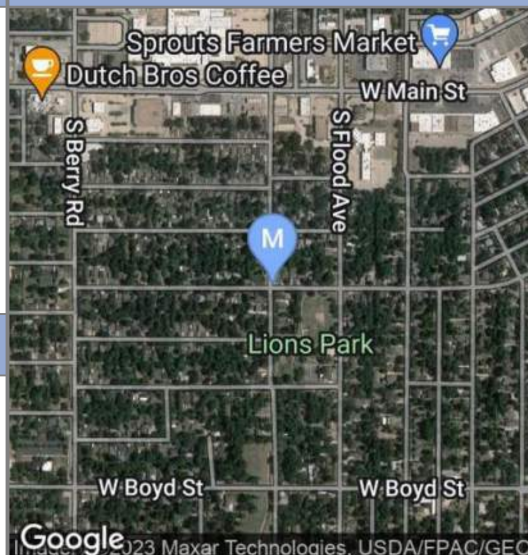
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/21/2023

Area Location Map



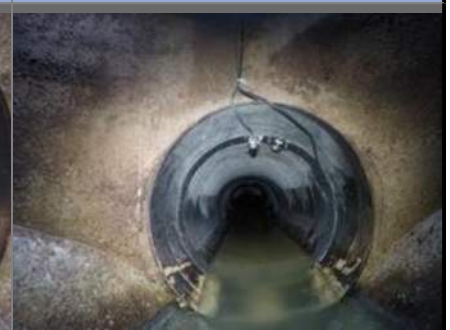
Area View Picture

Top View Picture

Access Notes

Investigation Photo

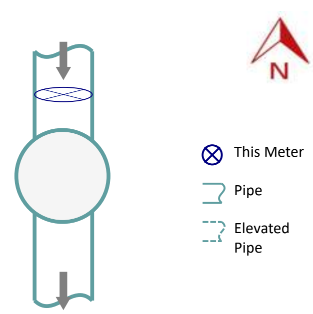
Installation Photo



Hydraulic Characteristics

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Approvals

Recommended by FSP	Client Approval

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** IH-16

Inspected By	zsanders	**Project No.**	**Site Code**
Inspected Date/Time	3/22/2023 9:47 AM	30-3984-00	T

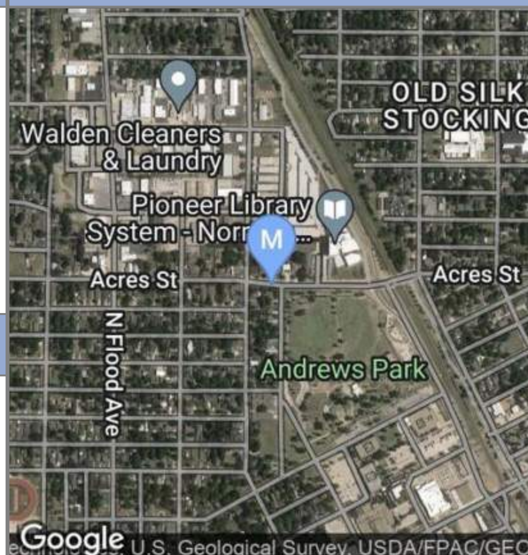
System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	211076
U/S Connecting MH I.D	211077
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	301 W Acres St
Site Access	Roadway, Low Traffic
Longitude	-97.44950000
Latitude	35.22550000
MH Type	Precast Concrete
Manhole Depth (ft)	17.20
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes Flow fluctuates between 3 and 4 inches during calibration, speed also 2 to 3 fps

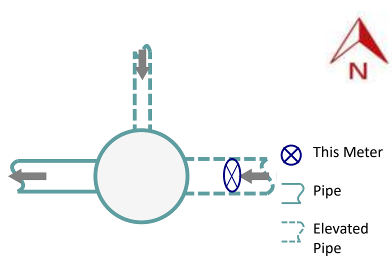
Site Information

Pipe Height (in)	17.44		
Pipe Width (in)	17.44		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	1.70
Surcharge Evidence (ft)	1.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

Pressure Clock Position: 0:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/21/2023

Approvals

Recommended by FSP	**Client Approval**

Norman,OK

2023 Norman Temporary Flow Monitoring

Site Name
LD-01

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 3:16 PM	30-3984-00	

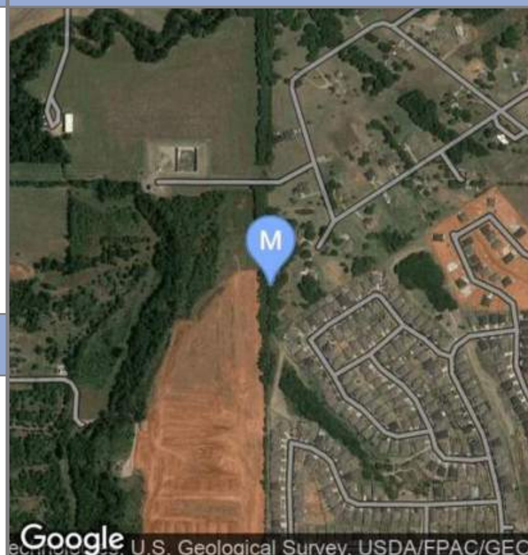
System Information

Target Pipe Dia. (in)	10.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	79023
U/S Connecting MH I.D	79022
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes Through drainage ditch off of road that goes to the treatment plant. Drive through the easement.

Location Information

Site Address	4011 8th Ave Cir NE
Site Access	Off-Road
Longitude	-97.43240000
Latitude	35.26720000
MH Type	Poured Concrete
Manhole Depth (ft)	3.80
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.5
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

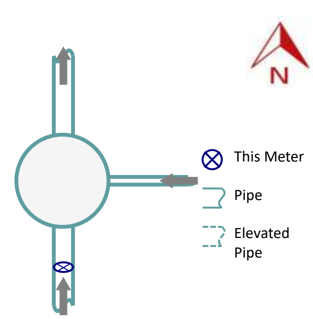
Site Information

Pipe Height (in)	9.75		
Pipe Width (in)	9.75		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

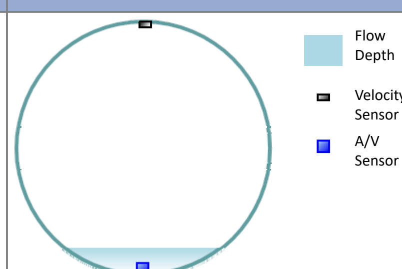
Hydraulic Information

Flow Depth (in)	1.00
Instant Velocity (fps)	2.13
Surcharge Evidence (ft)	3.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/25/2023

Approvals

Recommended by FSP	Client Approval

Norman,OK

2023 Norman Temporary Flow Monitoring

Site Name
LD-02

		Project No.	Site Code
Inspected By	mjaurez		
Inspected Date/Time	3/21/2023 2:30 PM	30-3984-00	T

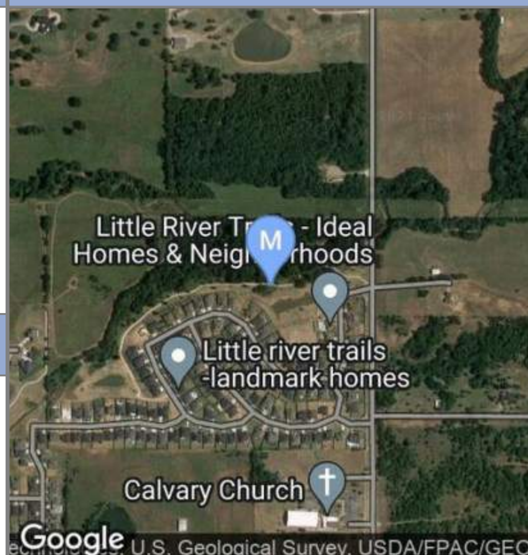
System Information

Target Pipe Dia. (in)	36.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	78009
U/S Connecting MH I.D	78008
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes Access On walking trail off of N porter and Bandera Trail.

Location Information

Site Address	301 Sonora Ln
Site Access	Off-Road
Longitude	-97.44360000
Latitude	35.26790000
MH Type	Lined
Manhole Depth (ft)	16.70
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	1.5
Structural Integrity	Safe

Site Information

Pipe Height (in)	35.50		
Pipe Width (in)	36.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		LEL %	0.0
H2S 0.0		CO	0.0

Investigation Photo

Installation Photo

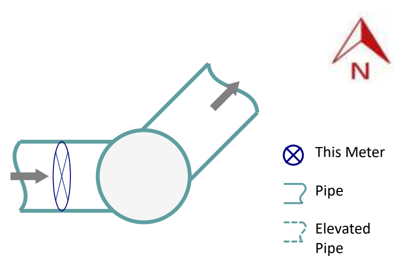
Hydraulic Characteristics

Installation Notes

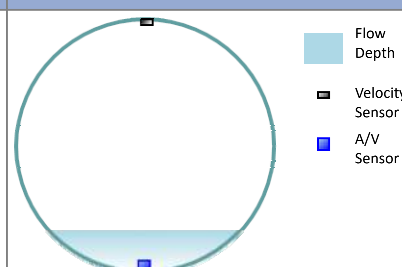
Hydraulic Information

Flow Depth (in)	6.00
Instant Velocity (fps)	1.25
Surcharge Evidence (ft)	9.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/24/2023

Approvals

Recommended by FSP	Client Approval

rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name LD-03

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 12:29 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	24.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	69012
U/S Connecting MH I.D	69011
System Characteristics:	

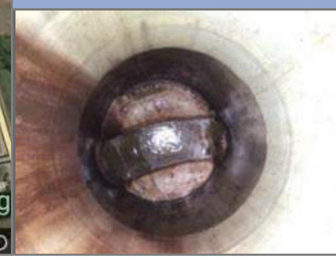
Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map

Area View Picture

Top View Picture



Access Notes

Location Information

Site Address	7GG7+5F Norman
Site Access	Off-Road
Longitude	-97.48640000
Latitude	35.27540000
MH Type	Lined
Manhole Depth (ft)	12.60
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	22.00		
Pipe Width (in)	23.50		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

Investigation Photo

Hydraulic Characteristics

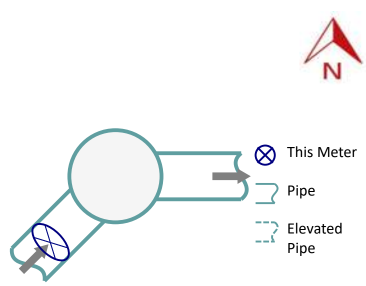
Installation Photo

Installation Notes

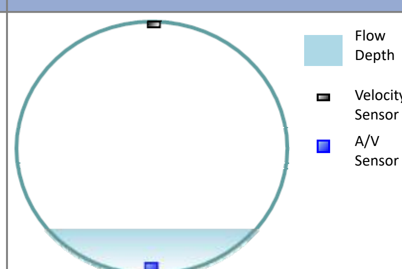
Hydraulic Information

Flow Depth (in)	4.00
Instant Velocity (fps)	0.76
Surcharge Evidence (ft)	7.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/19/2023

Approvals

Recommended by FSP	Client Approval

rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name ND-08

		Project No.	Site Code
Inspected By	mjaurez	30-3984-00	T
Inspected Date/Time	3/22/2023 9:41 AM		

System Information

Target Pipe Dia. (in)	24.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	279003
U/S Connecting MH I.D	254073
System Characteristics:	Residential - ☐ Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	

Location Information

Site Address	2900 W Lindsey St
Site Access	Off-Road
Longitude	-97.48550000
Latitude	35.20390000
MH Type	Poured Concrete
Manhole Depth (ft)	12.50
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	2.0
Structural Integrity	Safe

Site Information

Pipe Height (in)	24.00		
Pipe Width (in)	24.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Hydraulic Information

Flow Depth (in)	8.00
Instant Velocity (fps)	1.43
Surcharge Evidence (ft)	5.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

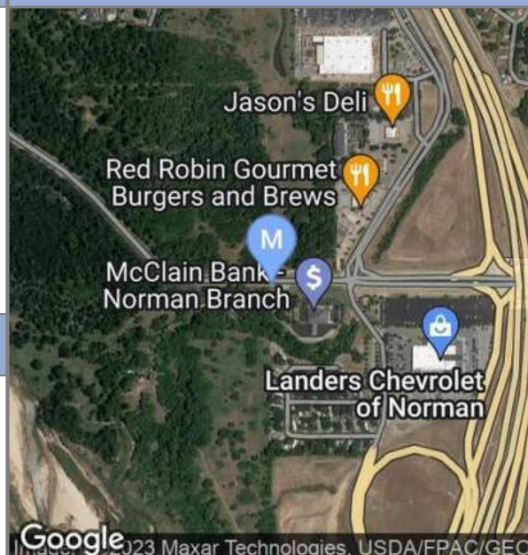
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Area Location Map



Area View Picture

Top View Picture

Access Notes

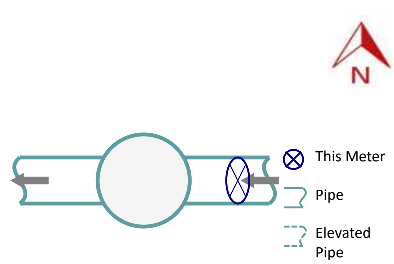
Investigation Photo

Hydraulic Characteristics

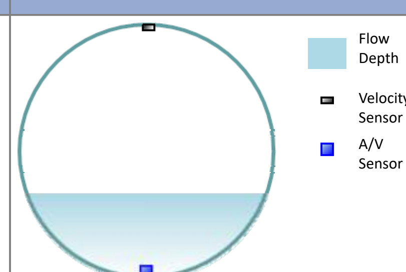
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Approvals

Recommended by FSP	Client Approval

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** ND-09

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/22/2023 10:00 AM	30-3984-00	T

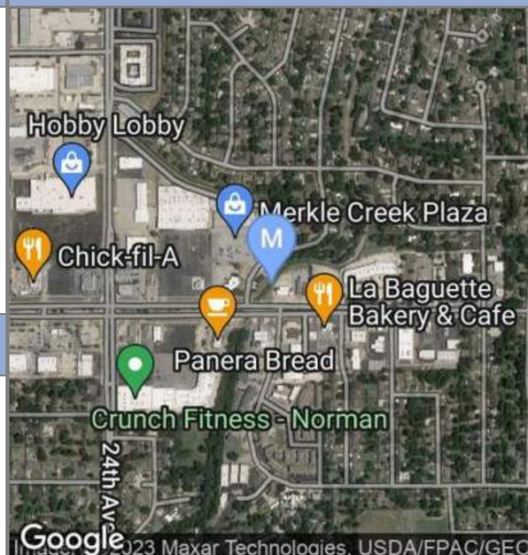
System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	208122
U/S Connecting MH I.D	208121
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	2121 W Main St
Site Access	Off-Road
Longitude	-97.47300000
Latitude	35.21890000
MH Type	Poured Concrete
Manhole Depth (ft)	14.30
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.5
Structural Integrity	Questionable

Site Information

Pipe Height (in)	17.00		
Pipe Width (in)	17.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Investigation Photo

Hydraulic Characteristics

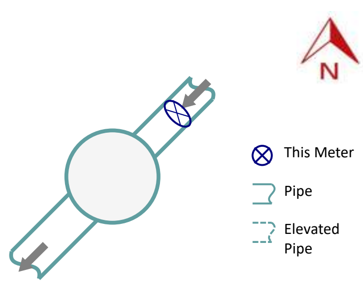
Installation Photo

Installation Notes

Hydraulic Information

Flow Depth (in)	5.00
Instant Velocity (fps)	2.14
Surcharge Evidence (ft)	8.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/20/2023

Approvals

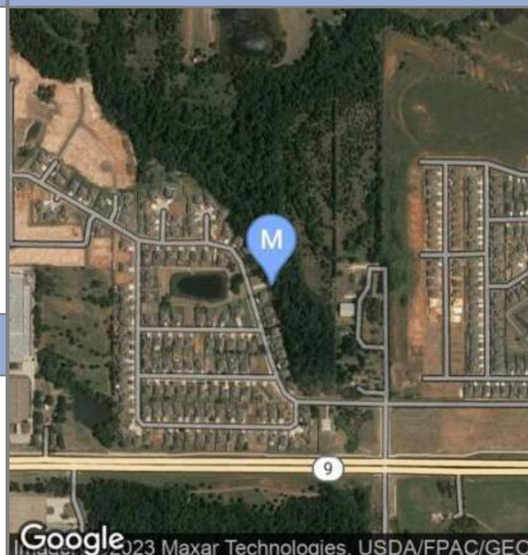
Recommended by FSP	**Client Approval**

rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name SV-01
Inspected By zsanders	**Project No.**	**Site Code**
Inspected Date/Time 3/21/2023 2:22 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	8.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	301022
U/S Connecting MH I.D	301038
System Characteristics:	Residential - ☐ Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	3301 Wood Valley Rd
Site Access	Off-Road
Longitude	-97.39080000
Latitude	35.19290000
MH Type	Precast Concrete
Manhole Depth (ft)	7.30
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Investigation Photo

Hydraulic Characteristics

Installation Photo

Installation Notes

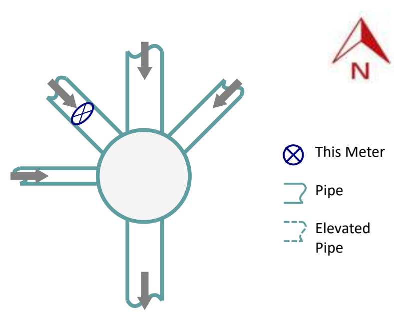
Site Information

Pipe Height (in)	14.50		
Pipe Width (in)	14.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

Hydraulic Information

Flow Depth (in)	2.75
Instant Velocity (fps)	1.00
Surcharge Evidence (ft)	1.50
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch

A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/19/2023

Approvals

Recommended by FSP	Client Approval

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** WC-30

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 4:58 PM	30-3984-00	T

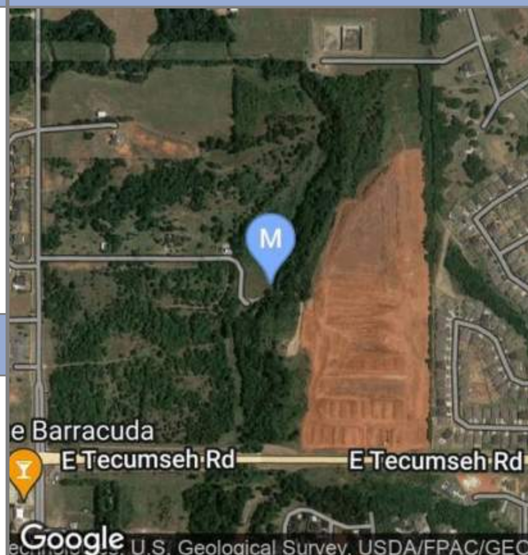
System Information

Target Pipe Dia. (in)	18.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	79037
U/S Connecting MH I.D	79036
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map



Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	7H87+2H Norman
Site Access	Off-Road
Longitude	-97.43610000
Latitude	35.26510000
MH Type	Precast Concrete
Manhole Depth (ft)	10.90
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	1.5
Structural Integrity	Safe

Site Information

Pipe Height (in)	23.00		
Pipe Width (in)	23.00		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

Investigation Photo

Hydraulic Characteristics

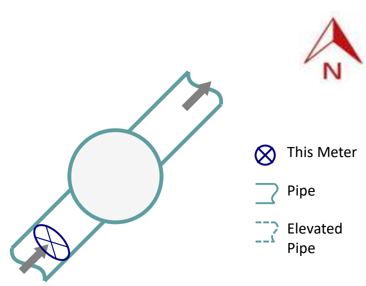
Installation Photo

Installation Notes

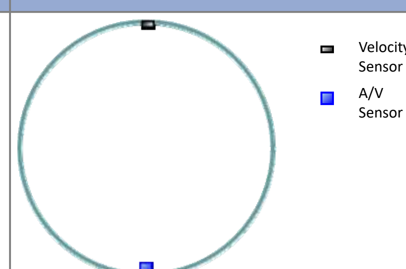
Hydraulic Information

Flow Depth (in)	
Instant Velocity (fps)	2.12
Surcharge Evidence (ft)	2.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/27/2023

Approvals

Recommended by FSP	**Client Approval**

rjn group	**Norman,OK** 2023 Norman Temporary Flow Monitoring	**Site Name** WC-31

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 5:13 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	15.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	105128
U/S Connecting MH I.D	105025
System Characteristics:	

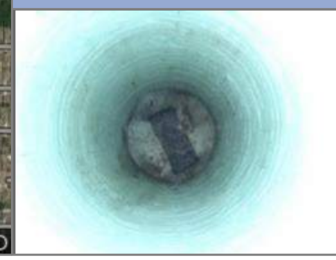
Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map

Area View Picture

Top View Picture



Access Notes

Location Information

Site Address	400 Nantucket Blvd
Site Access	Off-Road
Longitude	-97.43680000
Latitude	35.25780000
MH Type	Precast Concrete
Manhole Depth (ft)	15.00
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	1.5
Structural Integrity	Safe

Investigation Photo

Hydraulic Characteristics

Installation Photo

Installation Notes

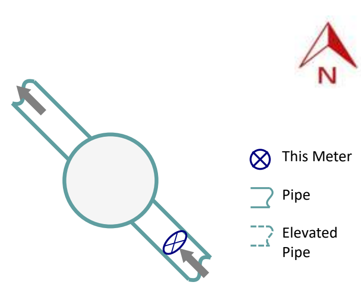
Site Information

Pipe Height (in)	14.50		
Pipe Width (in)	15.00		
Pipe Type	Iron		
Pipe Shape	Circular		
O2 20.9		**LEL %**	0.0
H2S 0.0		**CO**	0.0

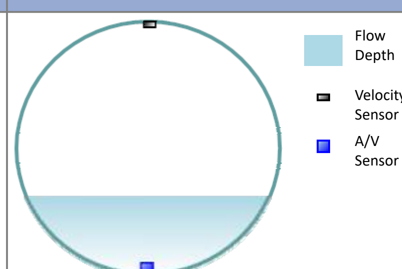
Hydraulic Information

Flow Depth (in)	4.50
Instant Velocity (fps)	1.39
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/21/2023

Approvals

Recommended by FSP	**Client Approval**

rjn group	Norman,OK 2023 Norman Temporary Flow Monitoring	Site Name WC-32

Inspected By	mjaurez	**Project No.**	**Site Code**
Inspected Date/Time	3/21/2023 4:26 PM	30-3984-00	T

System Information

Target Pipe Dia. (in)	21.0
Municipality	Norman
District	
Assigned Rain Gauge	
Client Manhole #	103013
U/S Connecting MH I.D	103012
System Characteristics:	

Residential - ☐ Commercial - ☐ Industrial - ☐

P/S Influence	No
WWTP Influence	

Area Location Map

Area View Picture

Top View Picture

Access Notes

Location Information

Site Address	796 W Tecumseh Rd
Site Access	Off-Road
Longitude	-97.45370000
Latitude	35.26170000
MH Type	Precast Concrete
Manhole Depth (ft)	18.30
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	2.0
Structural Integrity	Safe

Investigation Photo

Installation Photo

Site Information

Pipe Height (in)	20.50		
Pipe Width (in)	20.50		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

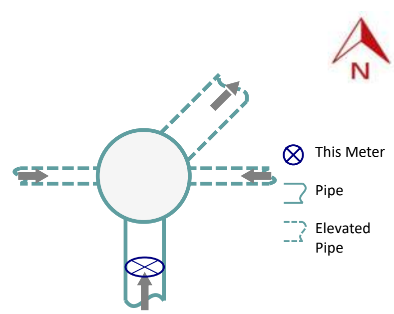
Hydraulic Characteristics

Installation Notes

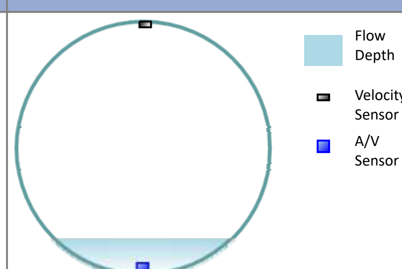
Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	1.02
Surcharge Evidence (ft)	16.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Velocity Clock Position: 0:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	

Post Installation Notes

Meter Type	-
Telemetry Type	
Installation Date	4/25/2023

Approvals

Recommended by FSP **Client Approval**

rjn group	**Norman,OK** Norman Utilities Authority	**Site Name** WS-01

		Project No.	**Site Code**
Inspected By	r_bass		
Inspected Date/Time	1/7/2015 9:12 AM	30-3884-00	T

System Information

Target Pipe Dia. (in)	42.0
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-03
Client Manhole #	327074
U/S Connecting MH I.D	327075
System Characteristics:	
Residential - ☑	Commercial - ☑ Industrial - ☐
P/S Influence	No
WWTP Influence	Yes

Area Location Map

Area View Picture

Top View Picture

Access Notes By cattle gate on Chatauqua

Location Information

Site Address	3901 Chautauqua Ave, Norman, OK 73072
Site Access	Off-Road
Longitude	-97.45040000
Latitude	35.17670000
MH Type	Poured Concrete
Manhole Depth (ft)	13.00
Manhole Width (ft)	5.8
Elevated MH	Yes
Height Elevated (ft)	0.8
Structural Integrity	Safe

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

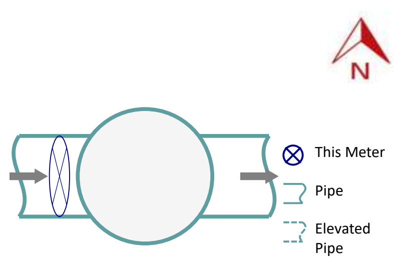
Site Information

Pipe Height (in)	41.62
Pipe Width (in)	41.69
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

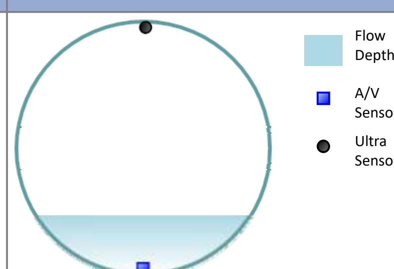
Hydraulic Information

Flow Depth (in)	9.62
Instant Velocity (fps)	2.13
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 6:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	3/2/2017

Approvals

Recommended by FSP	**Client Approval**
Yes	Yes

Norman,OK	Site Name
Norman Utilities Authority	WS-10

Inspected By	r_bass	Project No.	Site Code
Inspected Date/Time	1/7/2015 9:45 AM	30-3884-00	T

System Information

Target Pipe Dia. (in)	22.0
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-03
Client Manhole #	318010
U/S Connecting MH I.D	318011
System Characteristics:	
Residential - ☑ Commercial - ☑	Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	3204 Ridgecrest Cir
Site Access	Off-Road
Longitude	-97.45240000
Latitude	35.18250000
MH Type	Brick
Manhole Depth (ft)	8.06
Manhole Width (ft)	5.0
Elevated MH	Yes
Height Elevated (ft)	0.3
Structural Integrity	Safe

Site Information

Pipe Height (in)	22.62
Pipe Width (in)	22.88
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	8.44
Instant Velocity (fps)	1.62
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

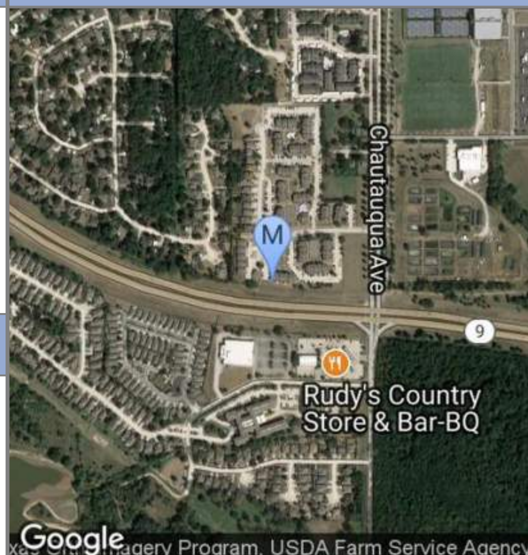
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Non-Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	10/7/2014

Area Location Map



Area View Picture

Top View Picture

Access Notes South of Post Oak apartments.

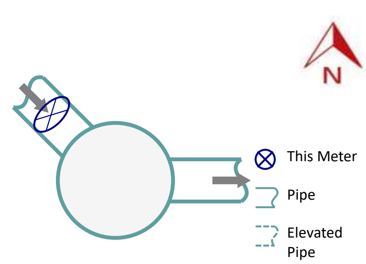
Investigation Photo

Hydraulic Characteristics

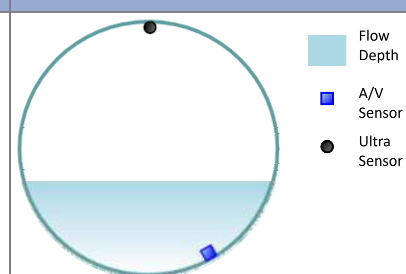
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 5:00

Approvals

Recommended by FSP	Client Approval
Yes	Yes

rjn group	**Norman,OK** Norman Utilities Authority	**Site Name** WS-11

Inspected By	r_bass	**Project No.**	**Site Code**
Inspected Date/Time	1/8/2015 10:01 AM	30-3884-00	T

System Information

Target Pipe Dia. (in)	42.0
Municipality	Norman
District	Norman
Assigned Rain Gauge	RG-03
Client Manhole #	328046
U/S Connecting MH I.D	328045
System Characteristics:	

Residential - ☑ Commercial - ☑ Industrial - ☐

P/S Influence	No
WWTP Influence	No

Area Location Map

Area View Picture

Top View Picture

Location Information

Site Address	3428 Jenkins Ave Norman, OK 73072
Site Access	Other
Longitude	-97.44420000
Latitude	35.18230000
MH Type	Poured Concrete
Manhole Depth (ft)	22.60
Manhole Width (ft)	5.0
Elevated MH	Yes
Height Elevated (ft)	0.4
Structural Integrity	Safe

Access Notes ROTC training ground

Investigation Photo

Installation Photo

Hydraulic Characteristics

Installation Notes

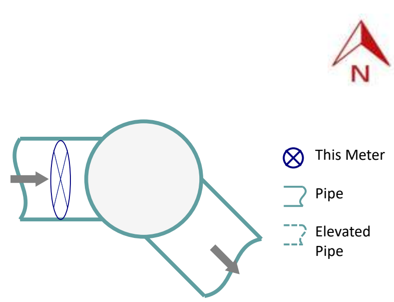
Site Information

Pipe Height (in)	41.25
Pipe Width (in)	41.13
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

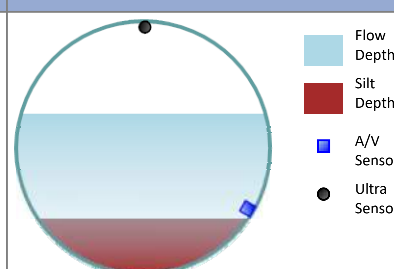
Hydraulic Information

Flow Depth (in)	26.13
Instant Velocity (fps)	0.78
Surcharge Evidence (ft)	
Silt Type	Fine
Silt Depth (in)	9.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Install Plan Sketch



Install Cross-Section Sketch



A/V Clock Position: 4:00

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	
Antenna Surface	Non-Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	
Telemetry Type	
Installation Date	6/9/2017

Approvals

Recommended by FSP	**Client Approval**
Yes	Yes

rjngroup

Norman,OK

2023 Norman Temporary Flow Monitoring

Monitor Site

Monitor Site: RG-02

Monitor Location: D Pump station

Metadata

Date	Mar 22 2023 12:10PM
Crew	C. Lyda; M. Juarez
Coordinates	[35.2693105, -97.434748]

Location

Facility Name	D Pump station
Location Description	7H98+MG Norman

Investigation

Arrival Time	Mar 22 2023 11:07AM
Departure Time	Mar 22 2023 11:20AM
Setup Conditions	Standard

Access and Safety

Contact Name	N/A
Phone Number	329-0703
Contact Title	N/A

Review

Recommended for Installation	Yes

Location

Area

Area

Area

Monitor Site

Monitor Site: RG-03

Monitor Location: Norman City Yard

Metadata

Date	Jun 4 2021 12:48PM
Creator	Blangdon
Coordinates	[35.244104, -97.460121]

Location

Facility Name	Norman City Yard
Location Description	1301 Da Vinci St

Investigation

Arrival Time	Jun 4 2021 11:46AM
Departure Time	Jun 4 2021 11:53AM
Setup Conditions	Standard

Access and Safety

Contact Name	City
Phone Number	NA
Contact Title	Yard
Access Instructions	Access through South East part of the city building. Use permanent black ladder that is attached to the building, rain gauge is right up on the roof there.

Review

Recommended for Installation	Yes

Location

Area

Monitor Site

Monitor Site: RG-04

Monitor Location: Vernon Campbell Water Treatment Plant

Metadata

Date	Sep 11 2015 10:46AM
Creator	mhuska
Coordinates	[35.232275, -97.395774]

Location

Location

Facility Name	Vernon Campbell Water Treatment Plant
Location Description	3000 East robinson St

Investigation

Arrival Time	Sep 11 2015 10:46AM
Setup Conditions	Standard

Access and Safety

Contact Name	Jared Mattern
Phone Number	405-329-0703
Contact Title	Utility Supervisor
Access Instructions	Coordinate with City

Review

Recommended for Installation	Yes

Monitor Site

Monitor Site: RG-05

Monitor Location: Millenium Medical

Metadata

Date	May 2 2023 3:07PM
Crew	C. Lyda; M. Juarez
Coordinates	[35.22404, -97.494612]

Location

Facility Name	Millenium Medical
Location Description	448 36th Ave NW

Investigation

Arrival Time	May 2 2023 2:05PM
Departure Time	May 2 2023 2:18PM
Setup Conditions	Standard

Access and Safety

Contact Name	Owner
Phone Number	4055739905
Contact Title	Owner
Access Instructions	On top of the NE part of the roof by the front corner of building.

Review

Recommended for Installation	Yes

Location

Area

Monitor Site

Monitor Site: RG-06

Monitor Location: Taco Casa

Metadata

Date	May 2 2023 2:02PM
Crew	C. Lyda; M. Juarez
Coordinates	[35.218927, -97.454122]

Location

Facility Name	Taco Casa
Location Description	731 W Main St

Investigation

Arrival Time	May 2 2023 12:57PM
Departure Time	May 2 2023 1:06PM
Setup Conditions	Standard

Access and Safety

Contact Name	Manager
Phone Number	4058014104
Contact Title	Manager
Access Instructions	On top of small NE corner building in the back.

Review

Recommended for Installation	Yes

Location

Area

Monitor Site

Monitor Site: RG-07

Monitor Location: Folks Auto Machine

Metadata

Date	May 2 2023 2:15PM
Crew	C. Lyda; M. Juarez
Coordinates	[35.225407, -97.422871]

Location

Facility Name	Folks Auto Machine
Location Description	541 12th Ave NE

Investigation

Arrival Time	May 2 2023 1:14PM
Departure Time	May 2 2023 1:21PM
Setup Conditions	Standard

Access and Safety

Contact Name	Owner
Phone Number	4053292287
Contact Title	Owner
Access Instructions	On top of NE vehicle awning.

Review

Recommended for Installation	Yes

Location

Area

Norman,OK

2023 Norman Temporary Flow Monitoring

Monitor Site

Monitor Site: RG-08

Monitor Location: Summit Valley L/S

Metadata

Date	May 11 2023 9:34AM
Creator	danglemartin
Coordinates	[35.1902413, -97.389453]

Location

Facility Name	Summit Valley L/S
Location Description	Wood Valley Road\n

Investigation

Arrival Time	Apr 25 2023 10:40AM

Review

Recommended for Installation	Yes

Location

Monitor Site

Monitor Site: RG-09

Monitor Location: St Michael's Episcopal Church

Metadata

Date	May 11 2023 9:46AM
Creator	danglemartin
Coordinates	[35.1896856, -97.466331]

Location

Facility Name	St Michael''s Episcopal Church
Location Description	1601 W Imhoff RD\n

Investigation

Arrival Time	Apr 26 2023 10:30AM

Review

Recommended for Installation	Yes

Location

Monitor Site

Monitor Site: RG-10

Monitor Location: City of Norman Water Reclamation Facility

Metadata

Date	Sep 11 2015 10:46AM
Creator	mhuska
Coordinates	[35.1757793, -97.443034]

Location

Location

Facility Name	City of Norman Water Reclamation Facility
Location Description	3500 Jenkins ave

Investigation

Arrival Time	Sep 11 2015 11:46AM
Departure Time	Sep 11 2015 12:46PM
Setup Conditions	Standard

Access and Safety

Contact Name	Jared Mattern
Phone Number	405-329-0703
Contact Title	Utility Supervisor
Access Instructions	Norman waste water treatment plant on top of chlorine building.

Review

Recommended for Installation	Yes

Monitor Site

Monitor Site: RG-11

Monitor Location: Community Christian School Athletics

Metadata

Date	Mar 22 2023 11:42AM
Crew	S. Gentry; Z. Sanders
Coordinates	[35.280651, -97.486143]

Location

Facility Name	Community Christian School Athleti
Location Description	5336 N Interstate Dr

Investigation

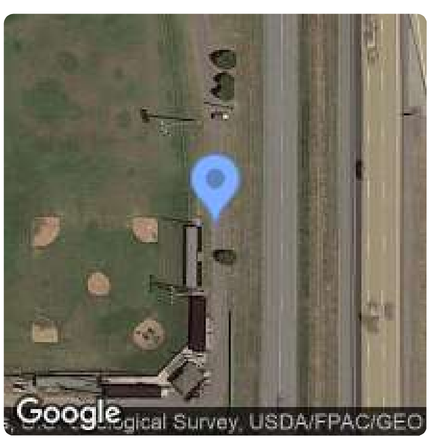
Arrival Time	Mar 22 2023 10:41AM
Departure Time	Mar 22 2023 11:46AM
Setup Conditions	Standard

Access and Safety

Contact Name	Kerry Filmore
Phone Number	4056205487
Contact Title	Maintenance

Review

Installation Instructions	On the dugout closest to the road, at the field south of the parking lot, or on a bleacher awning
Recommended for Installation	Yes



Location

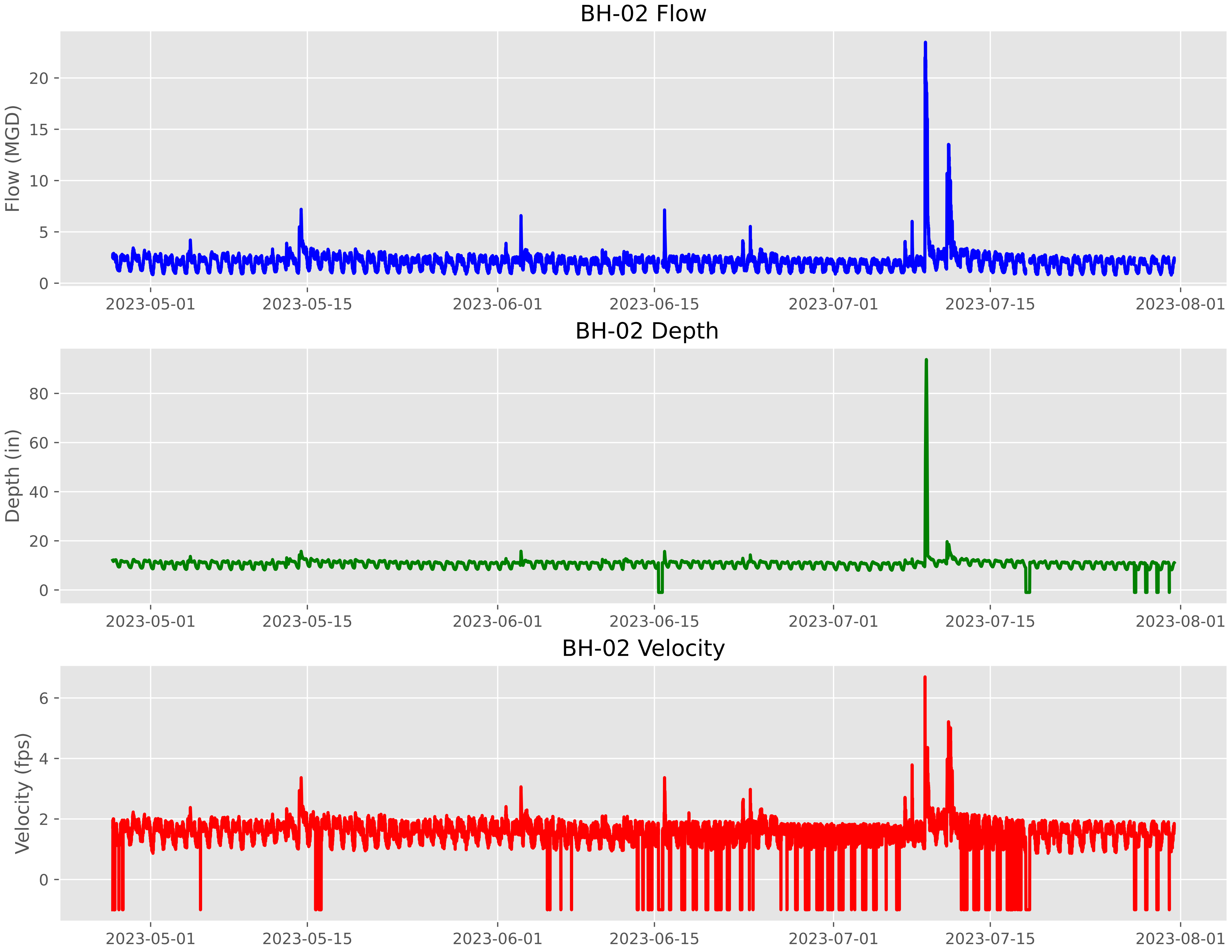
Area

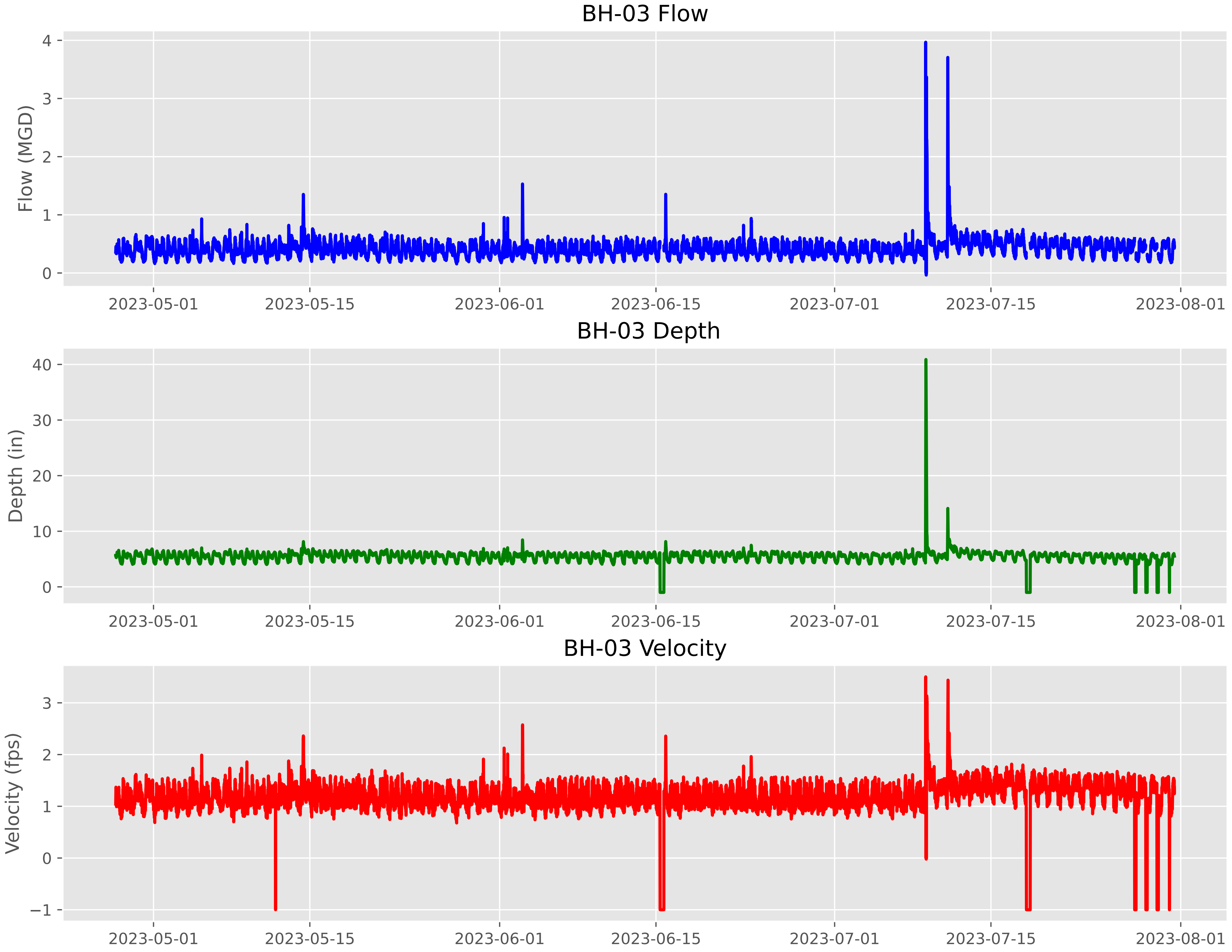
Area

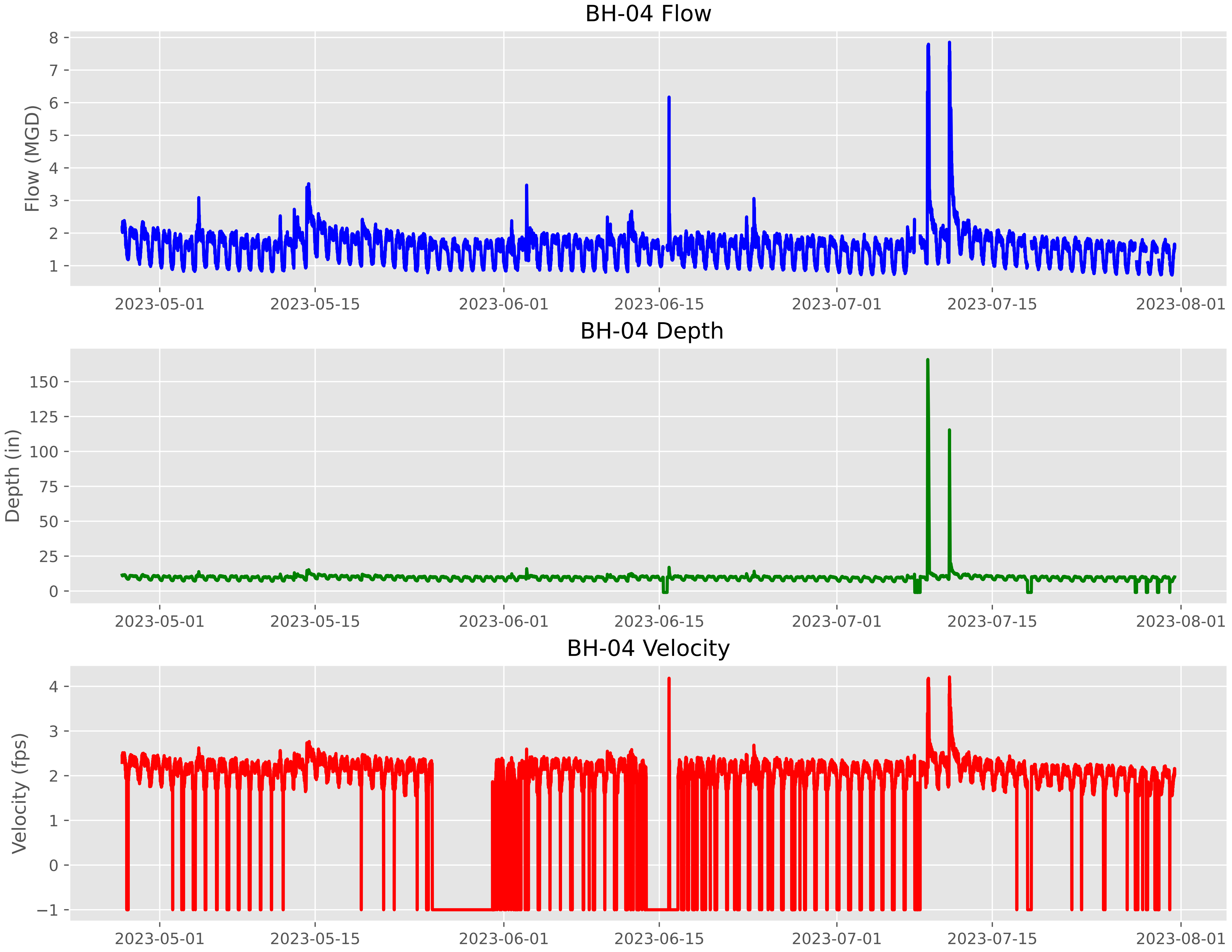
Area

APPENDIX D

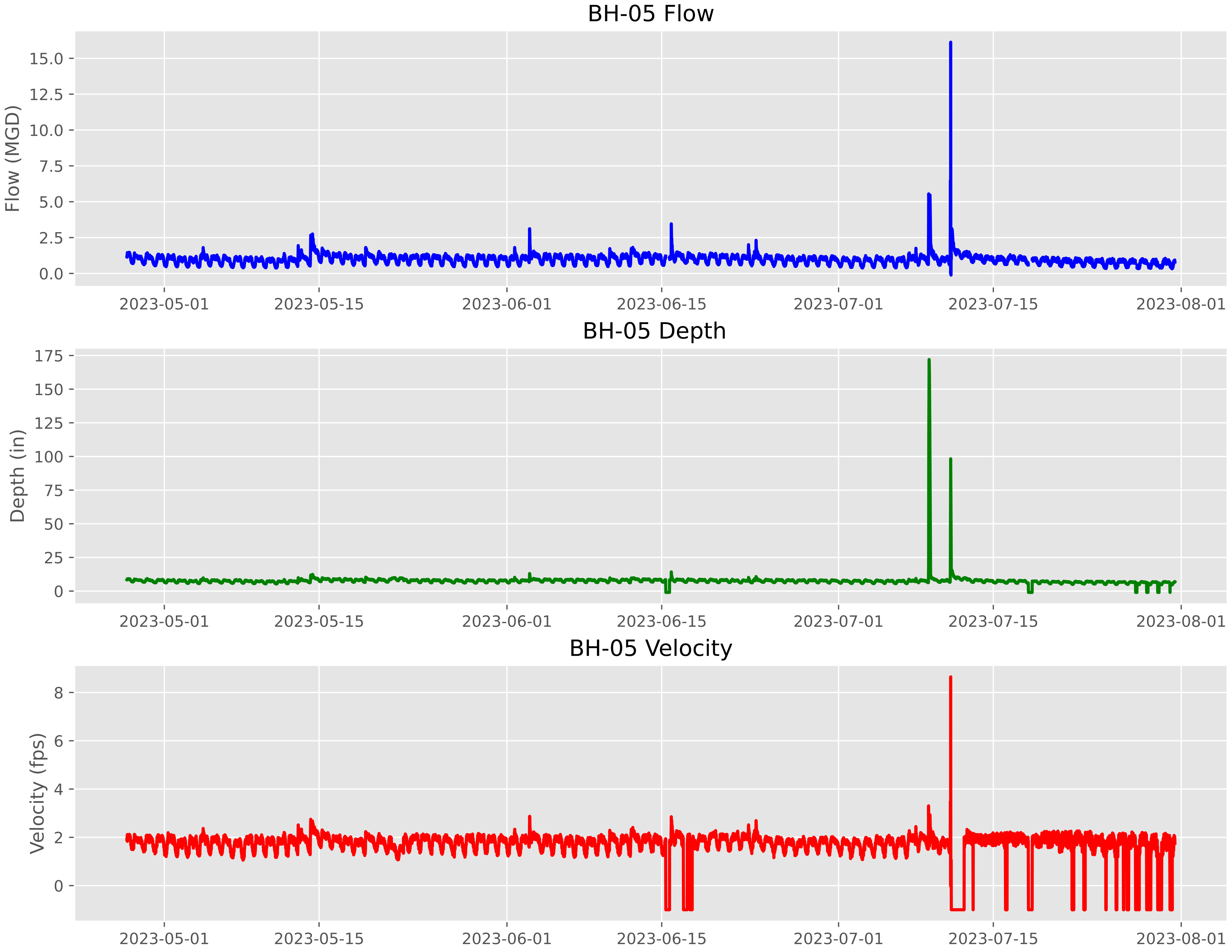
FLOW MONITORING HYDROGRAPHS


BH-02 Flow
Flow (MGD)
0
5
10
15
20
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-02 Depth
Depth (in)
0
20
40
60
80
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-02 Velocity
Velocity (fps)
0
2
4
6
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

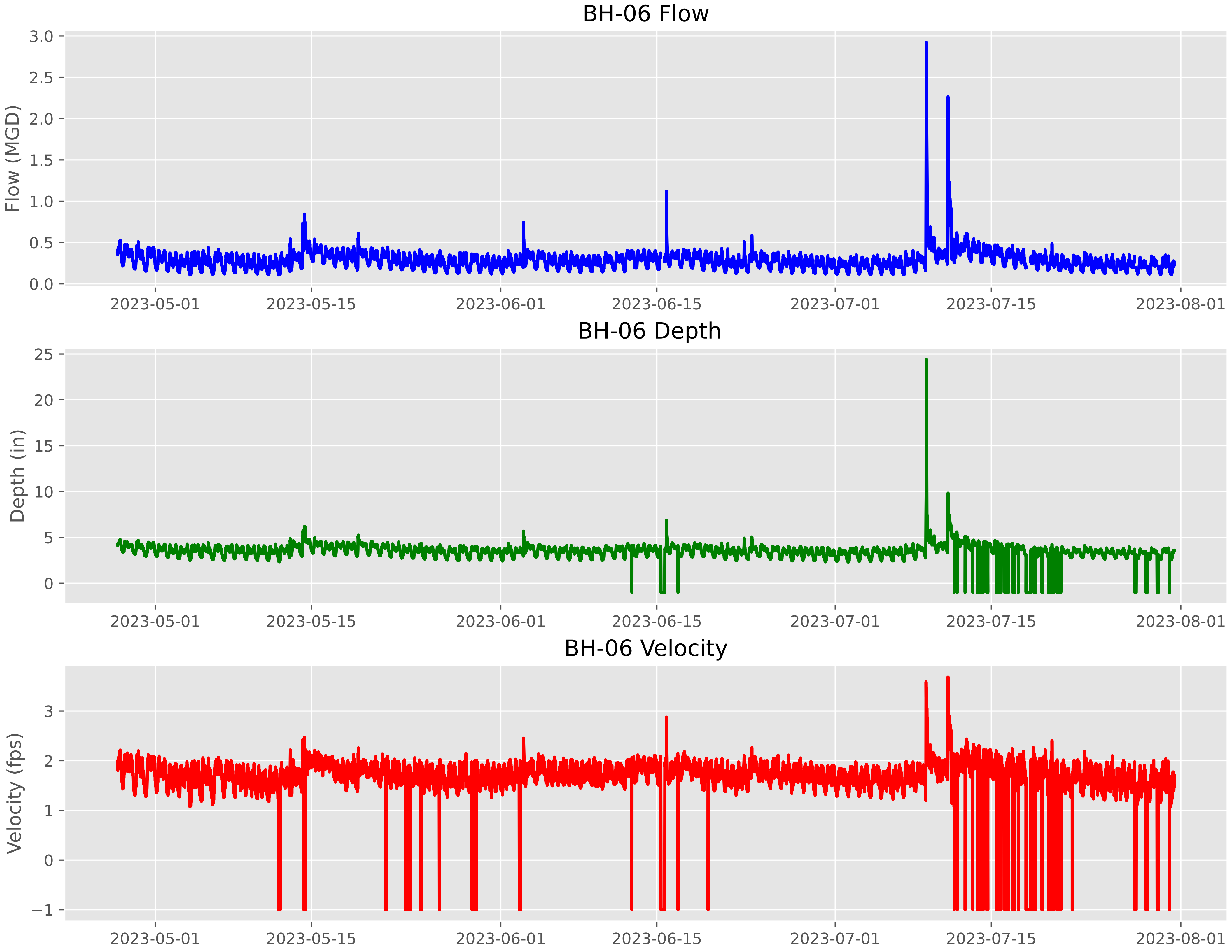

BH-03 Flow
Flow (MGD)
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-03 Depth
Depth (in)
0
10
20
30
40
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-03 Velocity
Velocity (fps)
−1
0
1
2
3
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

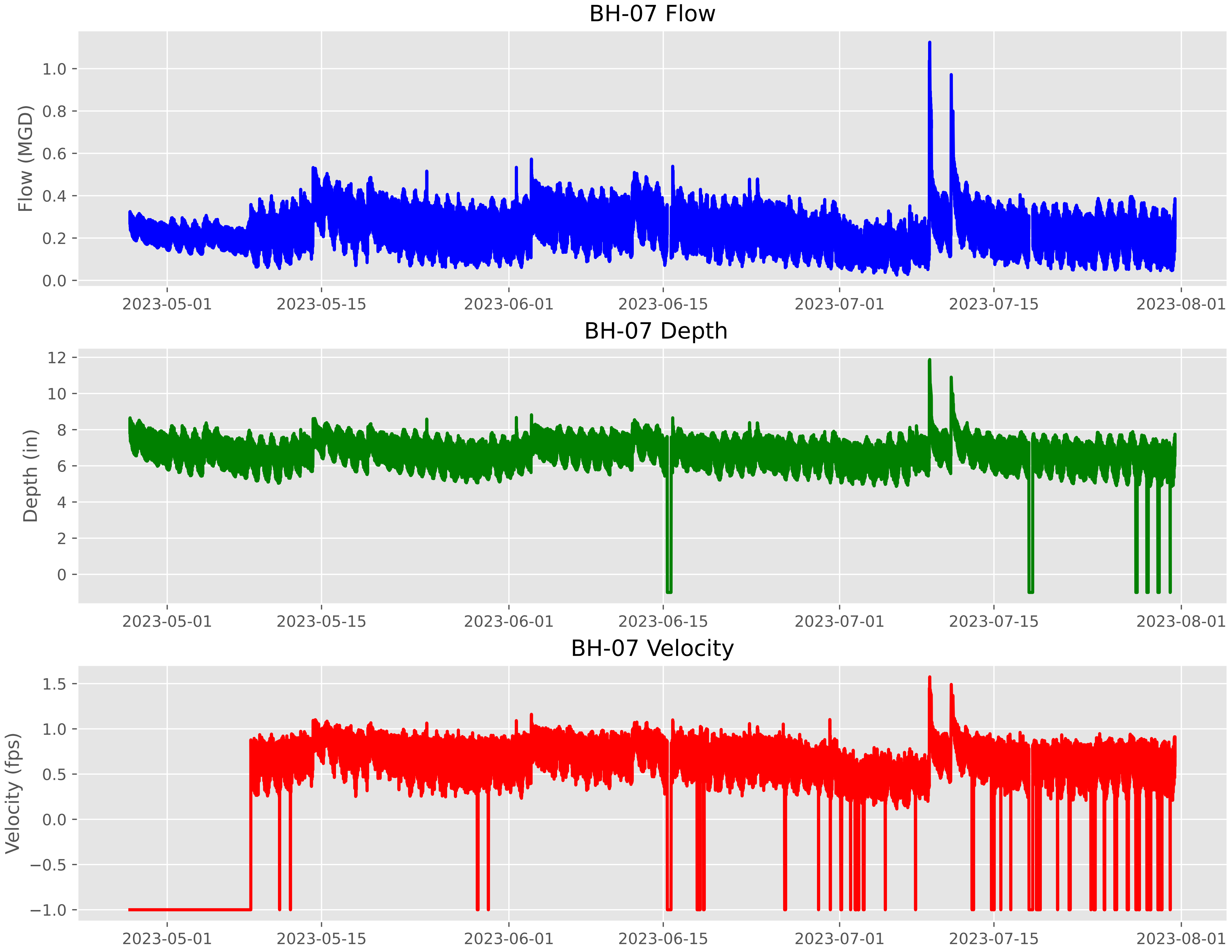


BH-04 Flow
Flow (MGD)
1
2
3
4
5
6
7
8
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-04 Depth
Depth (in)
0
25
50
75
100
125
150
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-04 Velocity
Velocity (fps)
−1
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

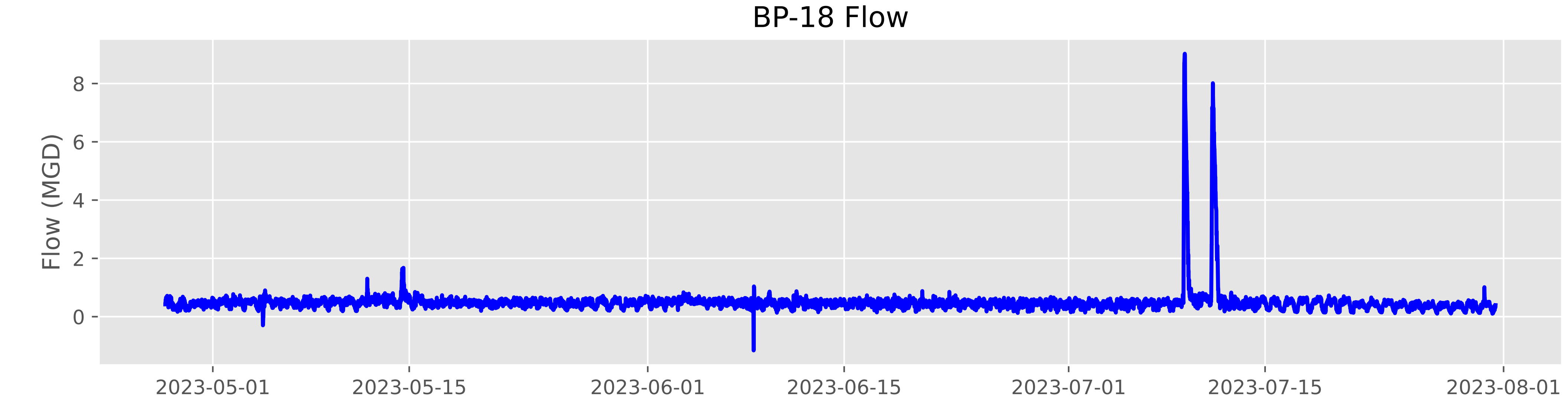


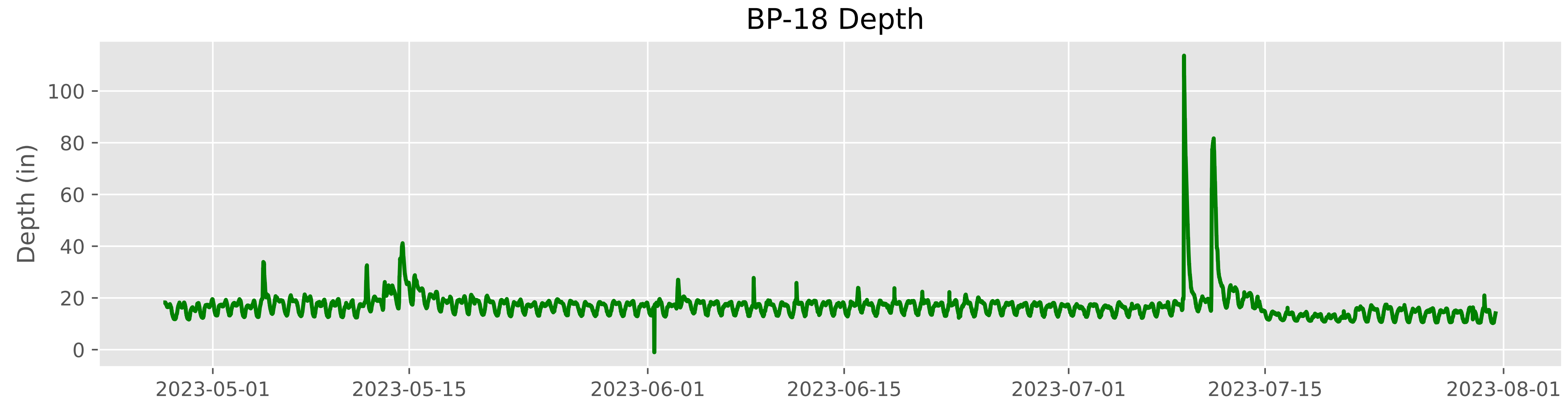
BH-05 Flow
Flow (MGD)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-05 Depth
Depth (in)
0
25
50
75
100
125
150
175
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-05 Velocity
Velocity (fps)
0
2
4
6
8
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

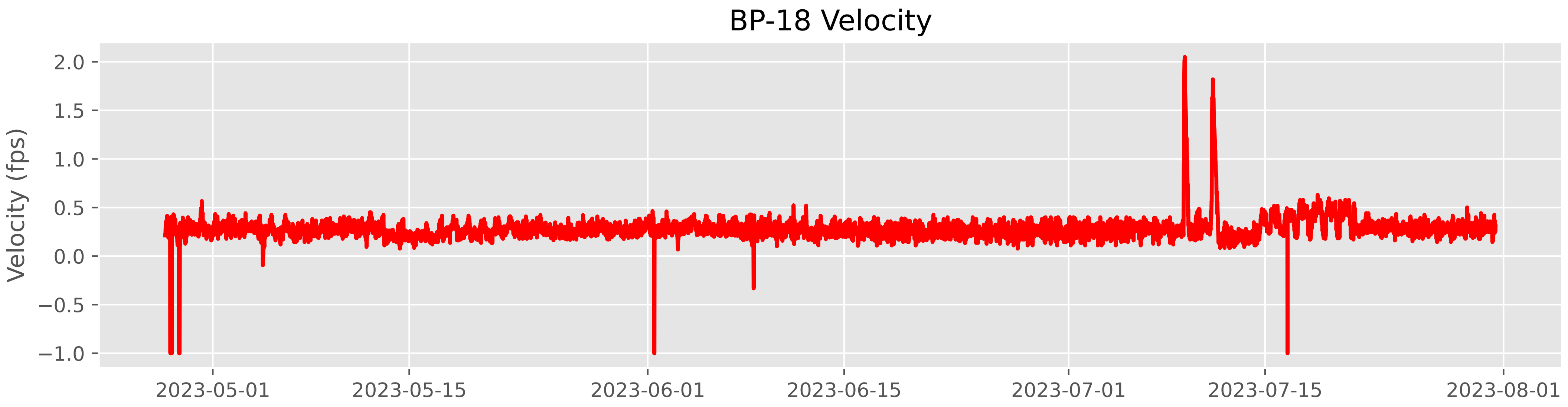

BH-06 Flow
Flow (MGD)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-06 Depth
Depth (in)
25
20
15
10
5
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-06 Velocity
Velocity (fps)
3
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

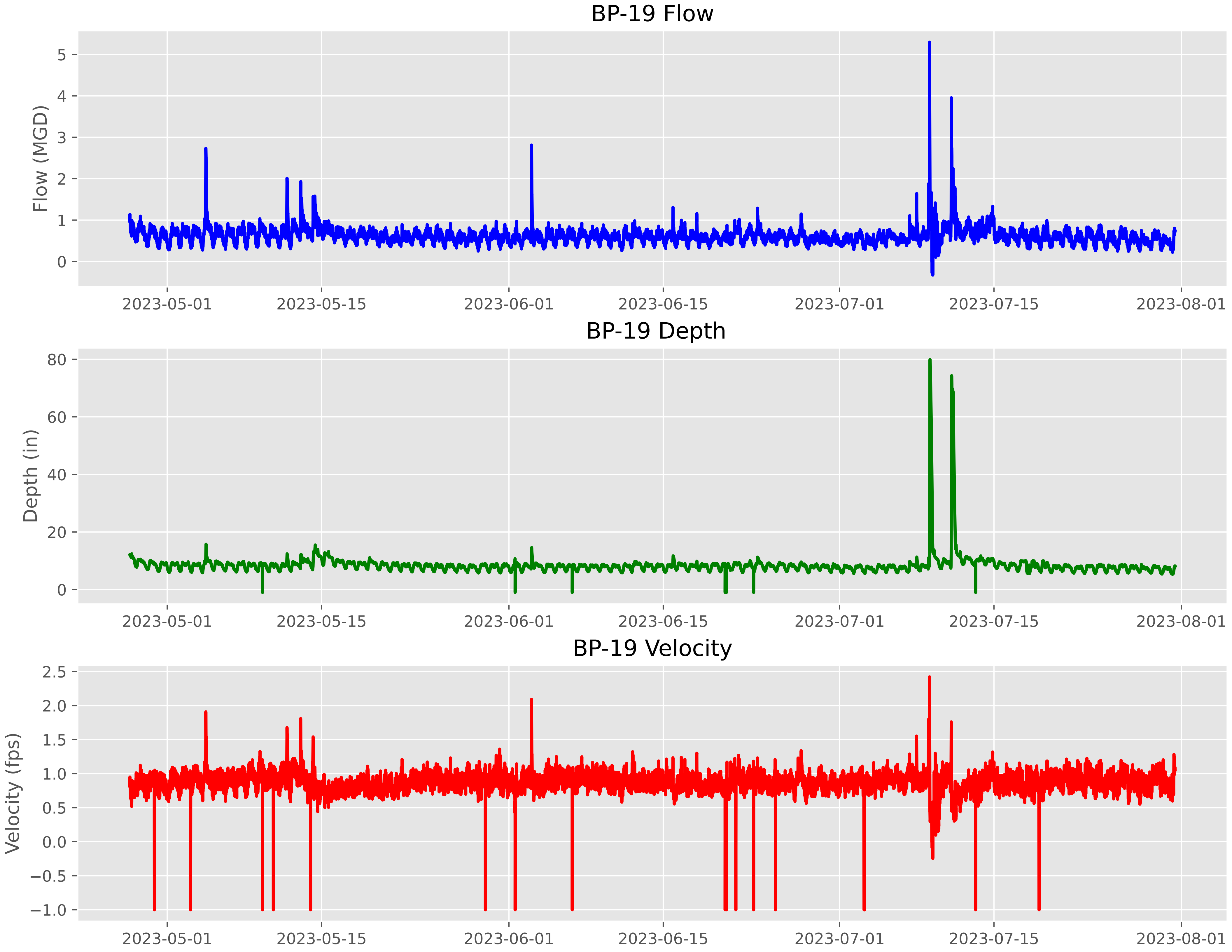

BH-07 Flow
Flow (MGD)
0.0
0.2
0.4
0.6
0.8
1.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BH-07 Depth
Depth (in)
0
2
4
6
8
10
12
BH-07 Velocity
Velocity (fps)
−1.0
−0.5
0.0
0.5
1.0
1.5

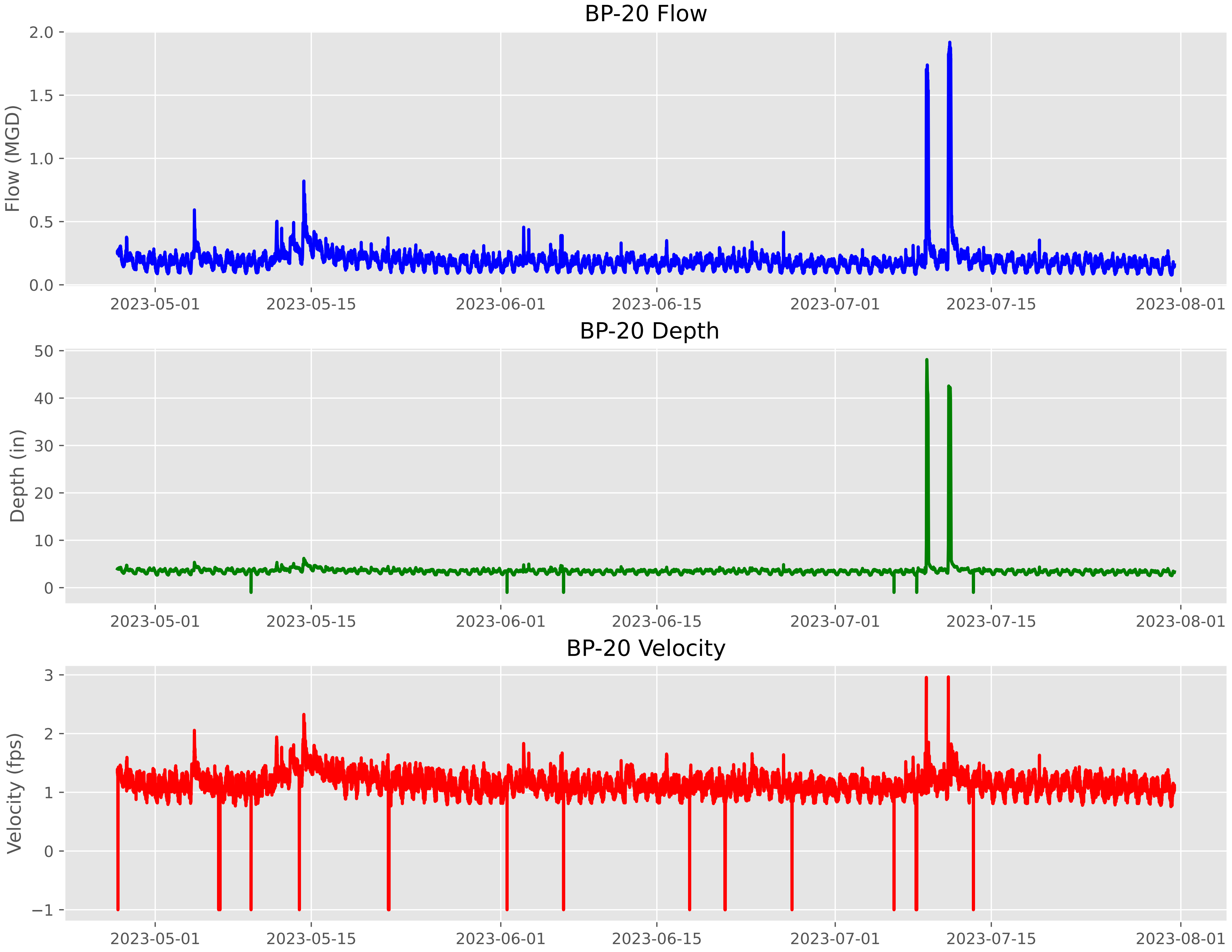

BP-17 Flow
Flow (MGD)
2
4
6
8
10
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-17 Depth
Depth (in)
0
5
10
15
20
25
30
BP-17 Velocity
Velocity (fps)
−1
0
1
2
3


BP-18 Flow
Flow (MGD)
0
2
4
6
8
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

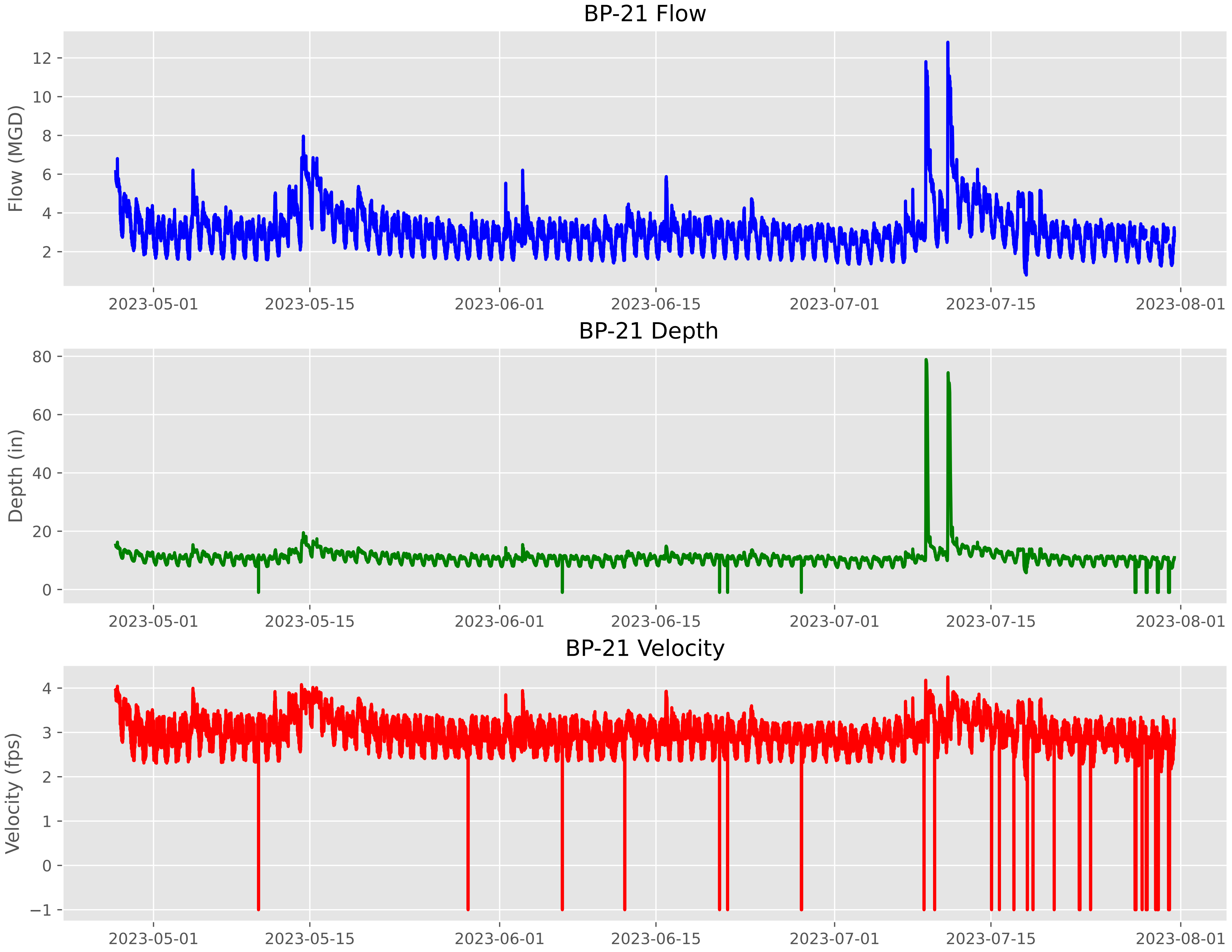

BP-18 Depth
Depth (in)
0
20
40
60
80
100
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

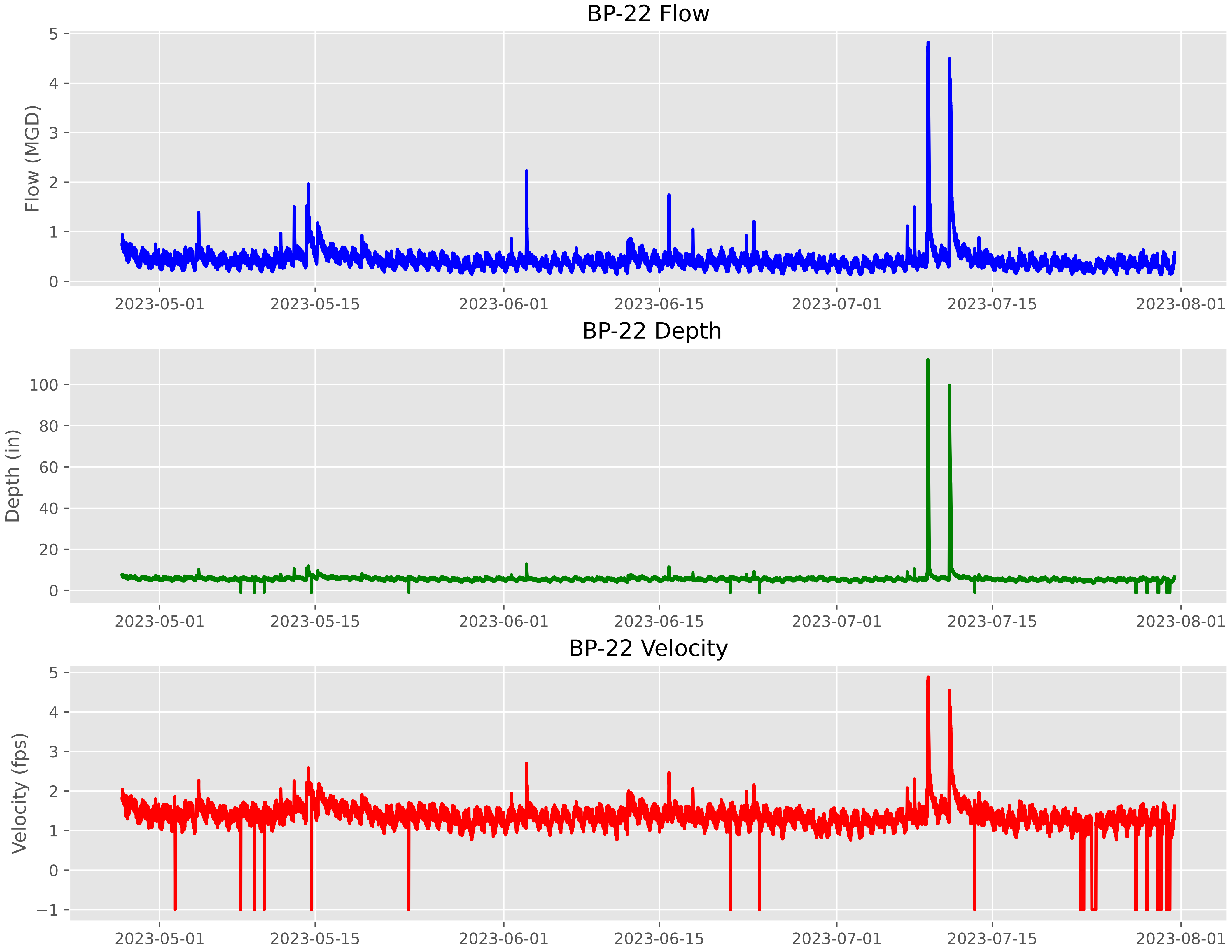

BP-18 Velocity
Velocity (fps)
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


BP-19 Flow
Flow (MGD)
0
1
2
3
4
5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-19 Depth
Depth (in)
0
20
40
60
80
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-19 Velocity
Velocity (fps)
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

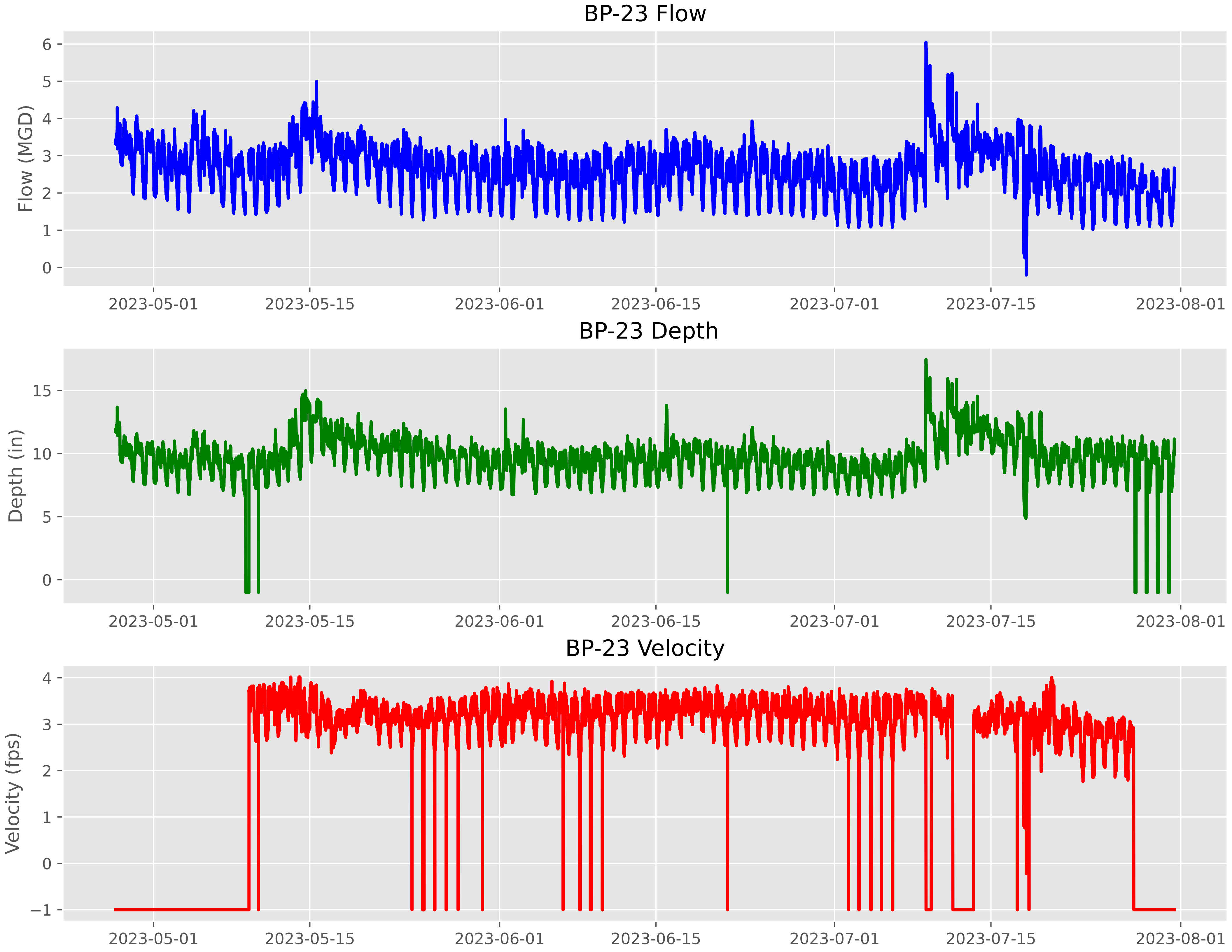


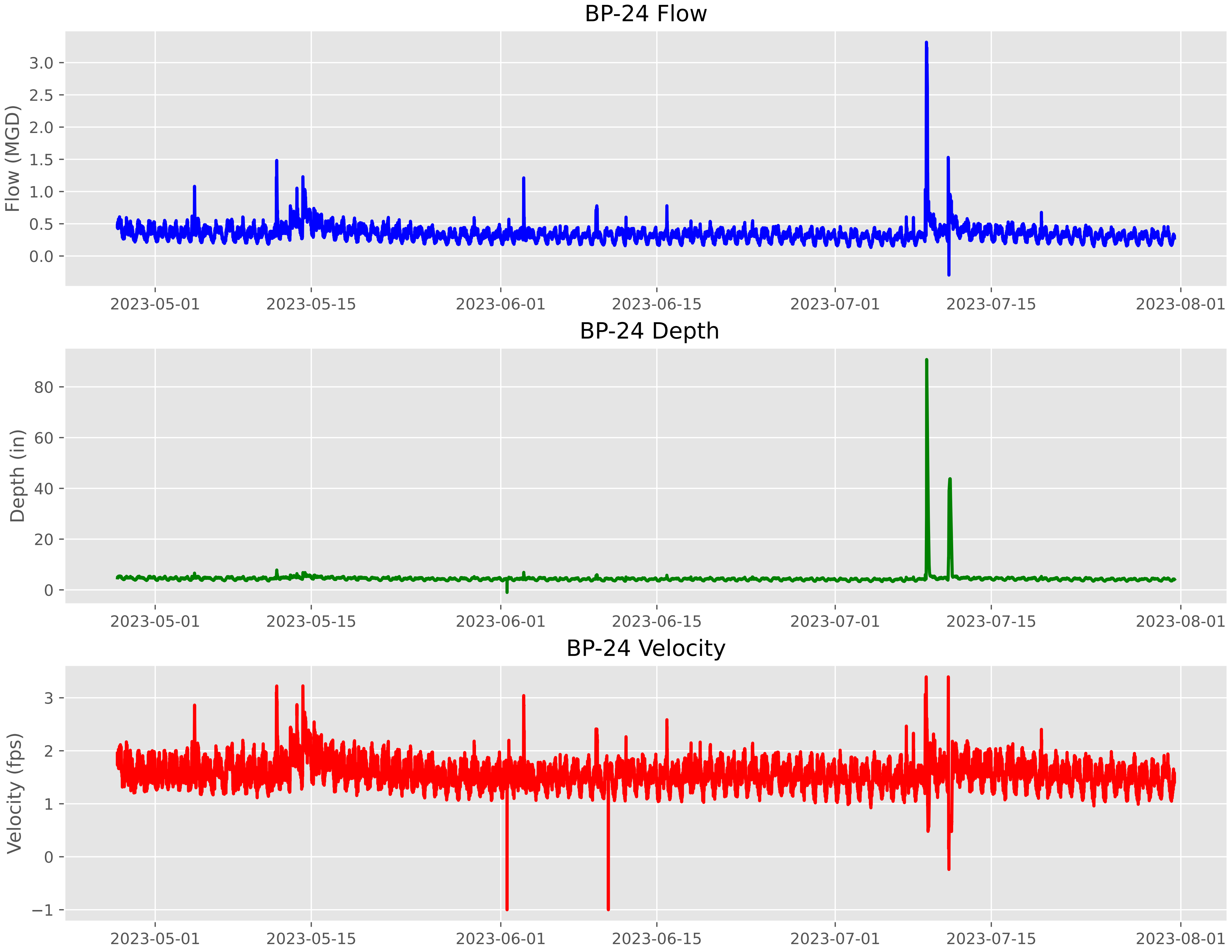
BP-20 Flow
Flow (MGD)
2.0
1.5
1.0
0.5
0.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-20 Depth
Depth (in)
50
40
30
20
10
0
BP-20 Velocity
Velocity (fps)
3
2
1
0
−1

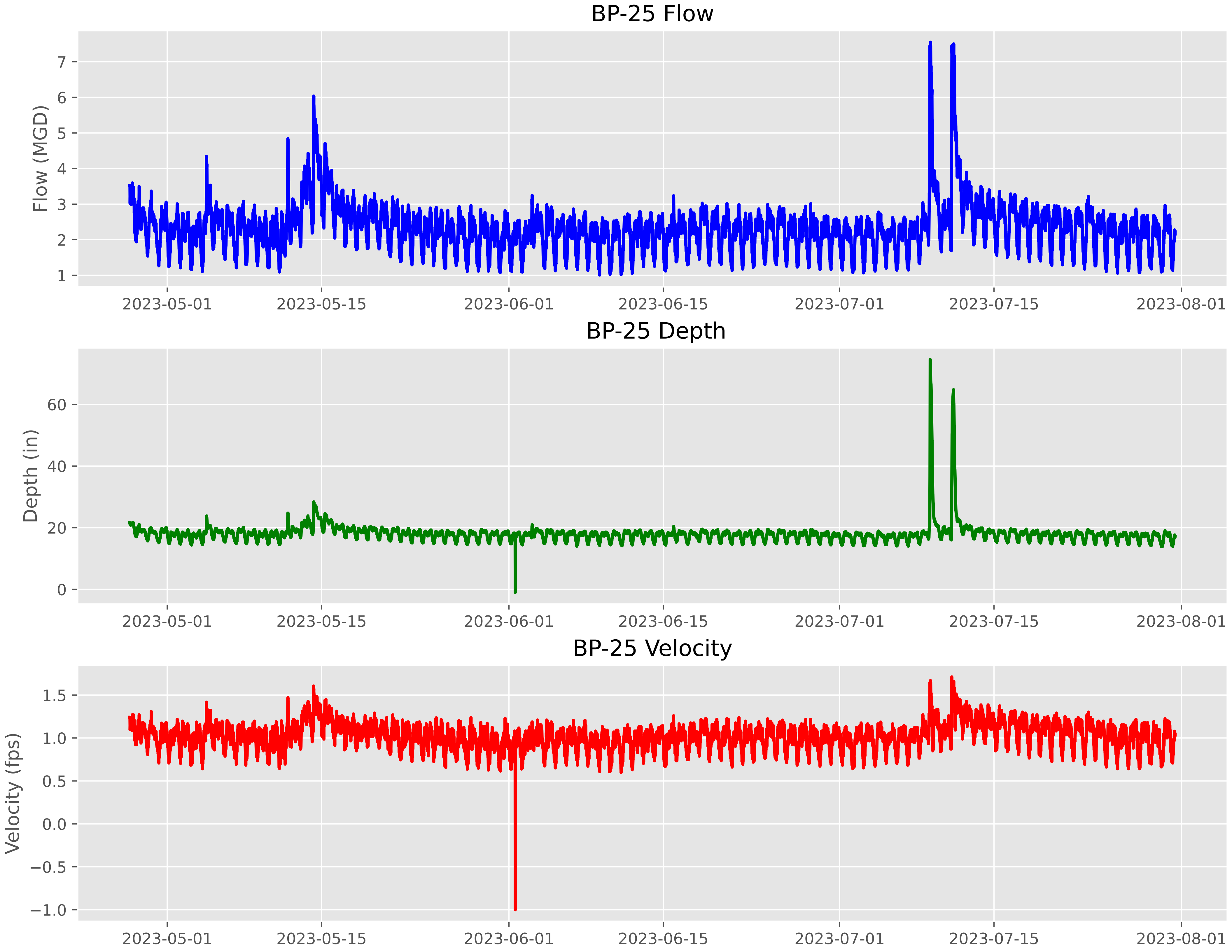

BP-21 Flow
Flow (MGD)
BP-21 Depth
Depth (in)
BP-21 Velocity
Velocity (fps)
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

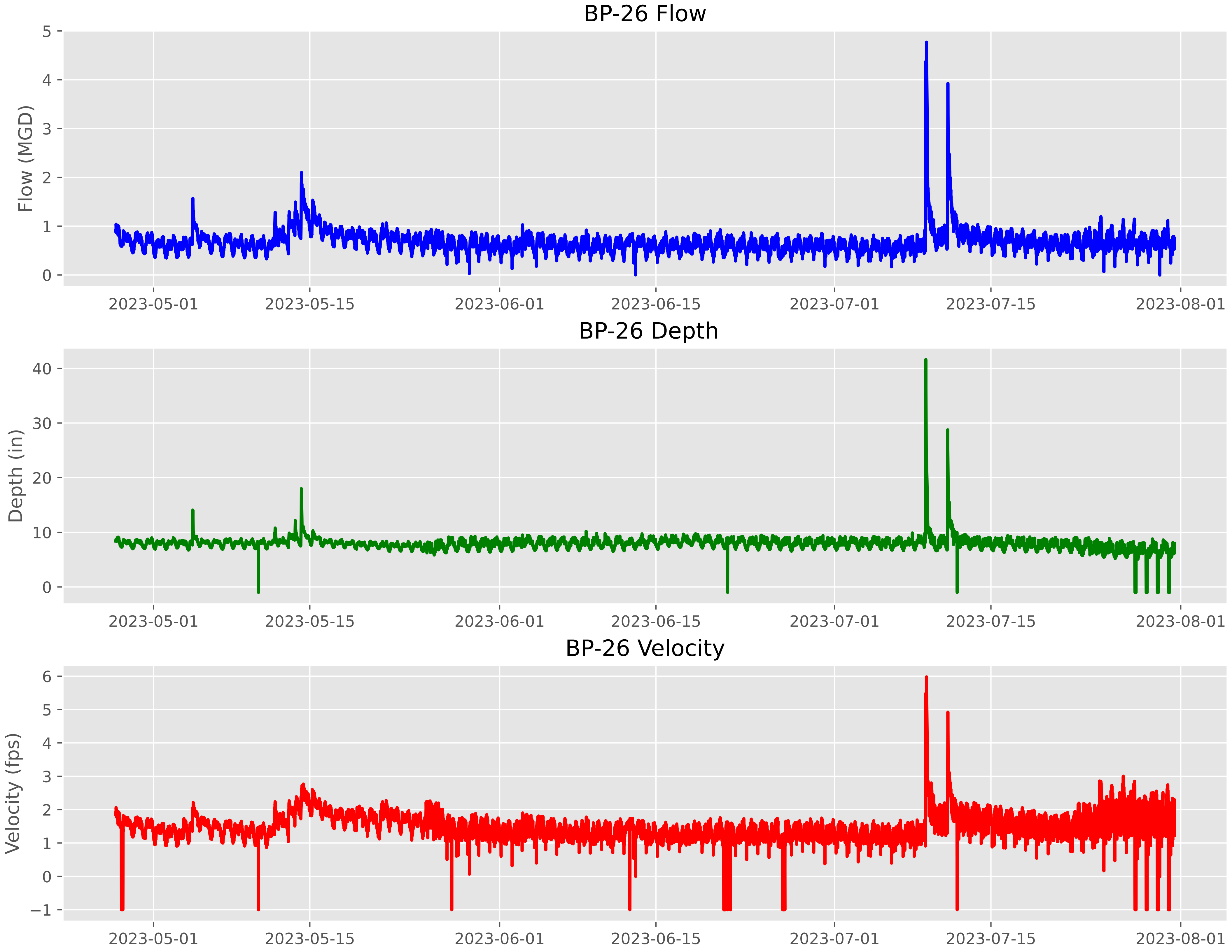


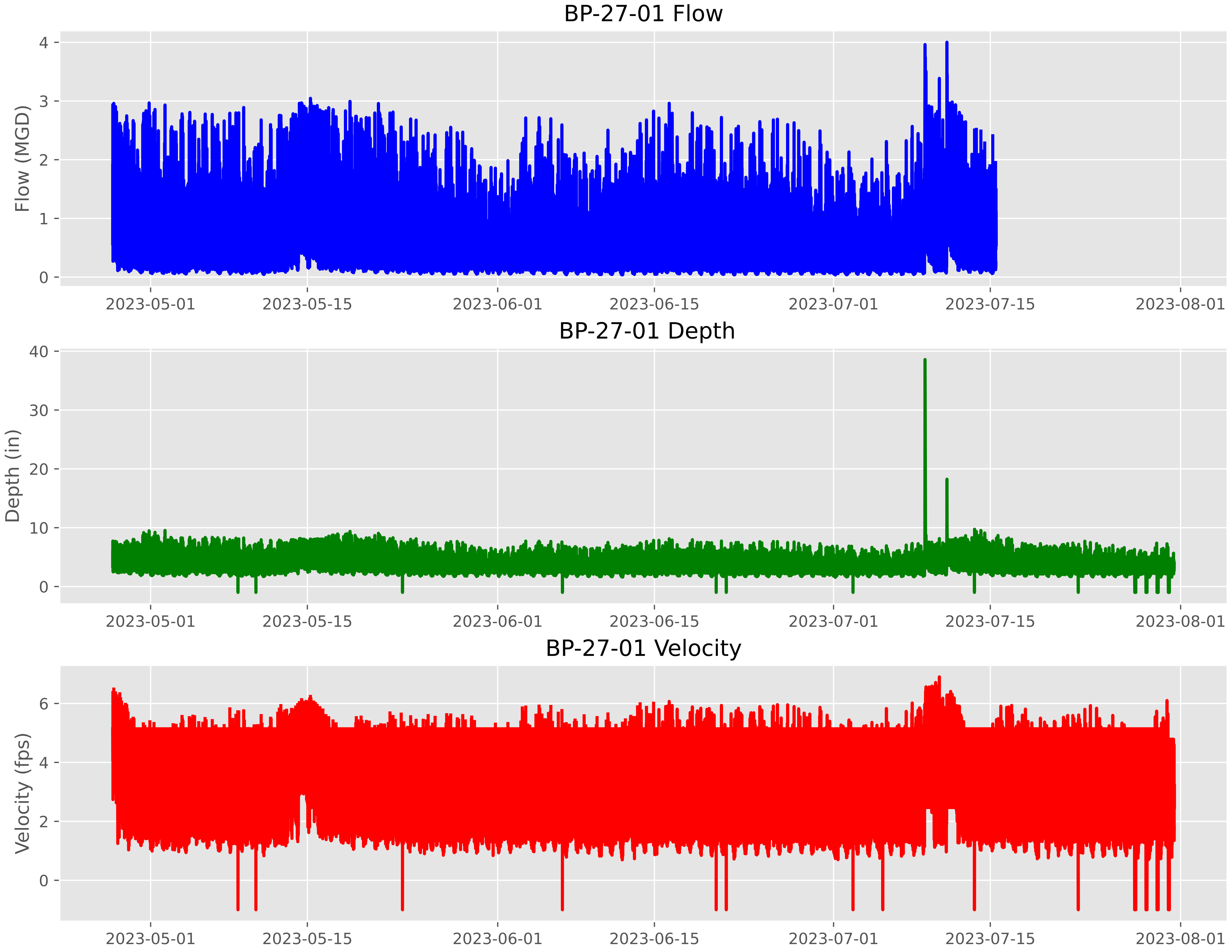
BP-22 Flow
Flow (MGD)
5
4
3
2
1
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-22 Depth
Depth (in)
100
80
60
40
20
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-22 Velocity
Velocity (fps)
5
4
3
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

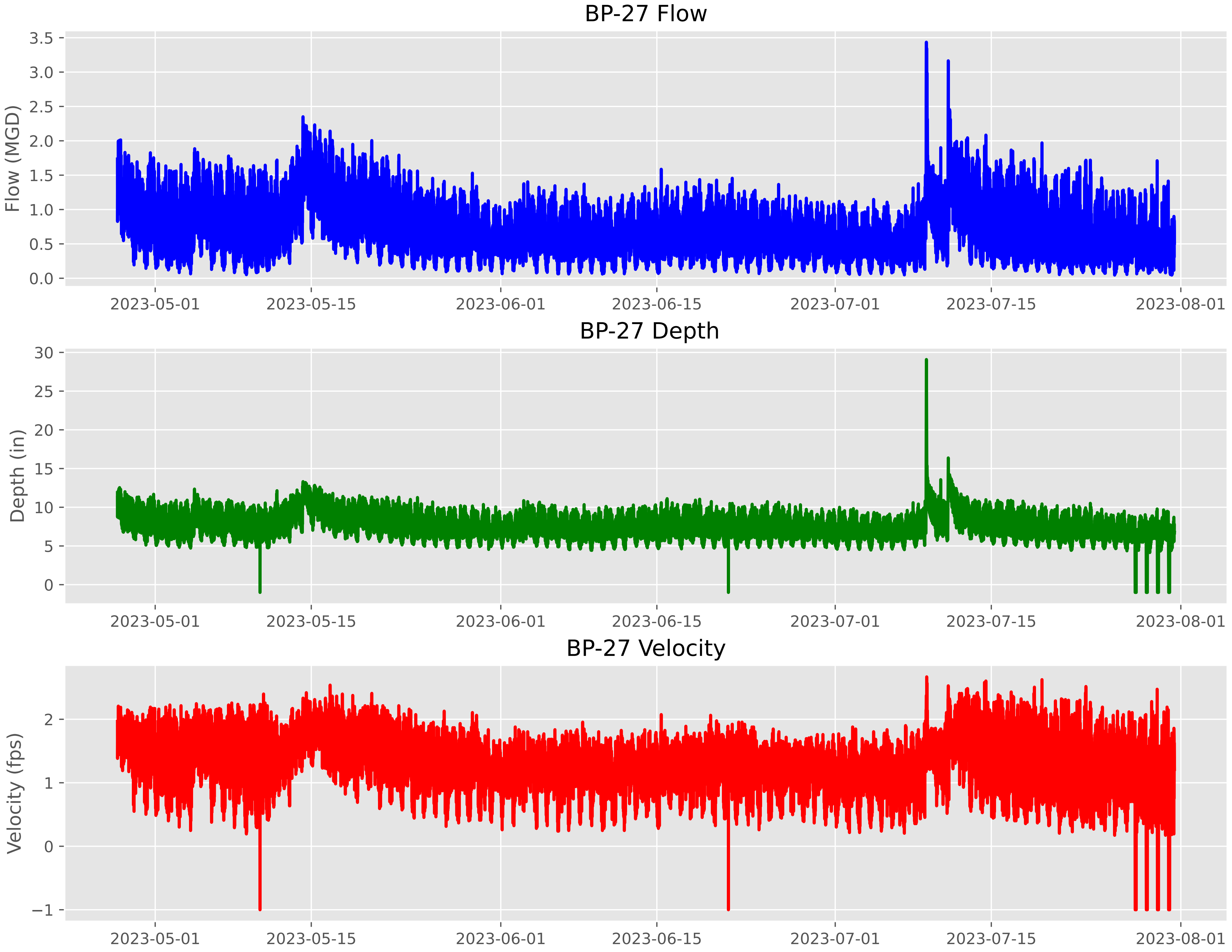

BP-23 Flow
Flow (MGD)
6
5
4
3
2
1
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-23 Depth
Depth (in)
15
10
5
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-23 Velocity
Velocity (fps)
4
3
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

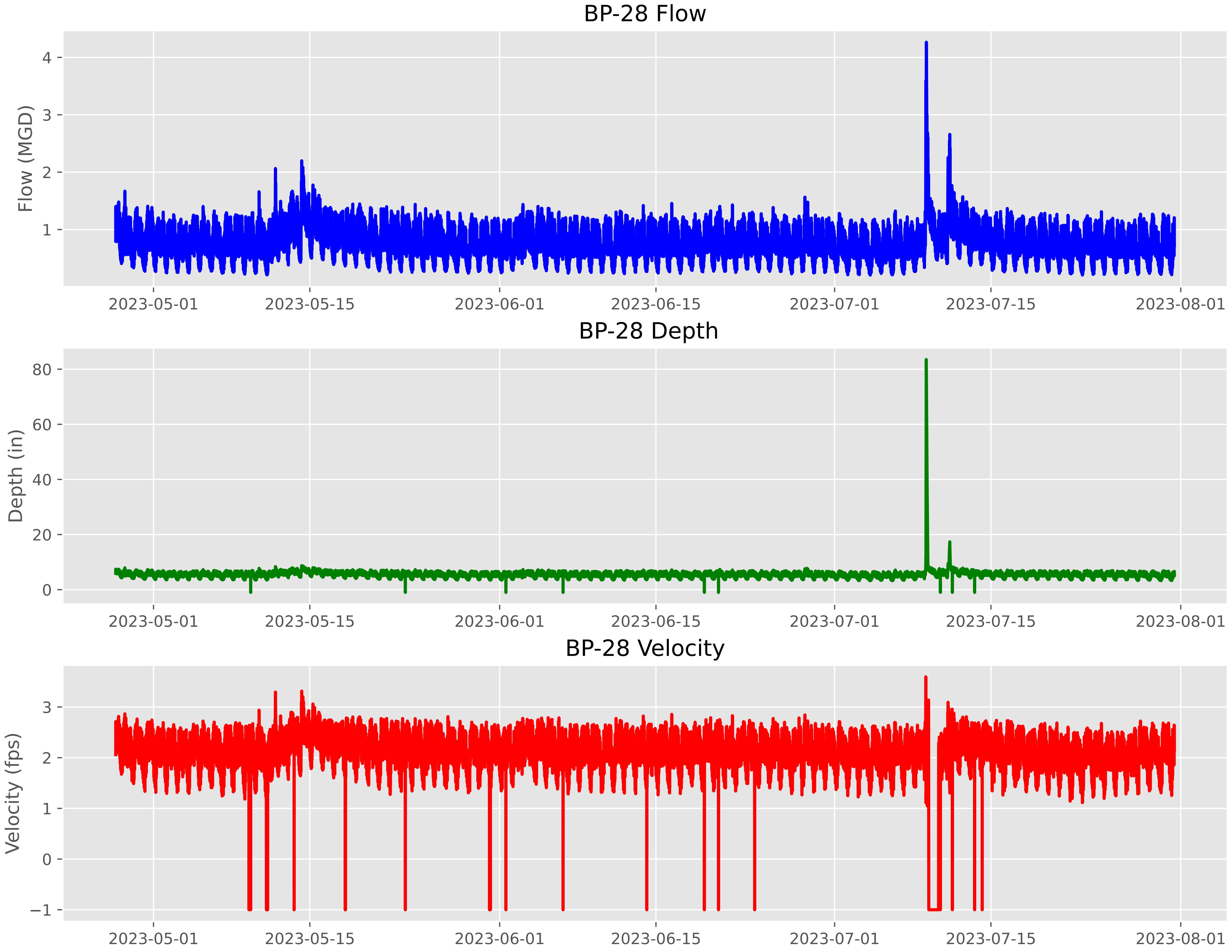

BP-24 Flow
Flow (MGD)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-24 Depth
Depth (in)
80
60
40
20
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-24 Velocity
Velocity (fps)
3
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

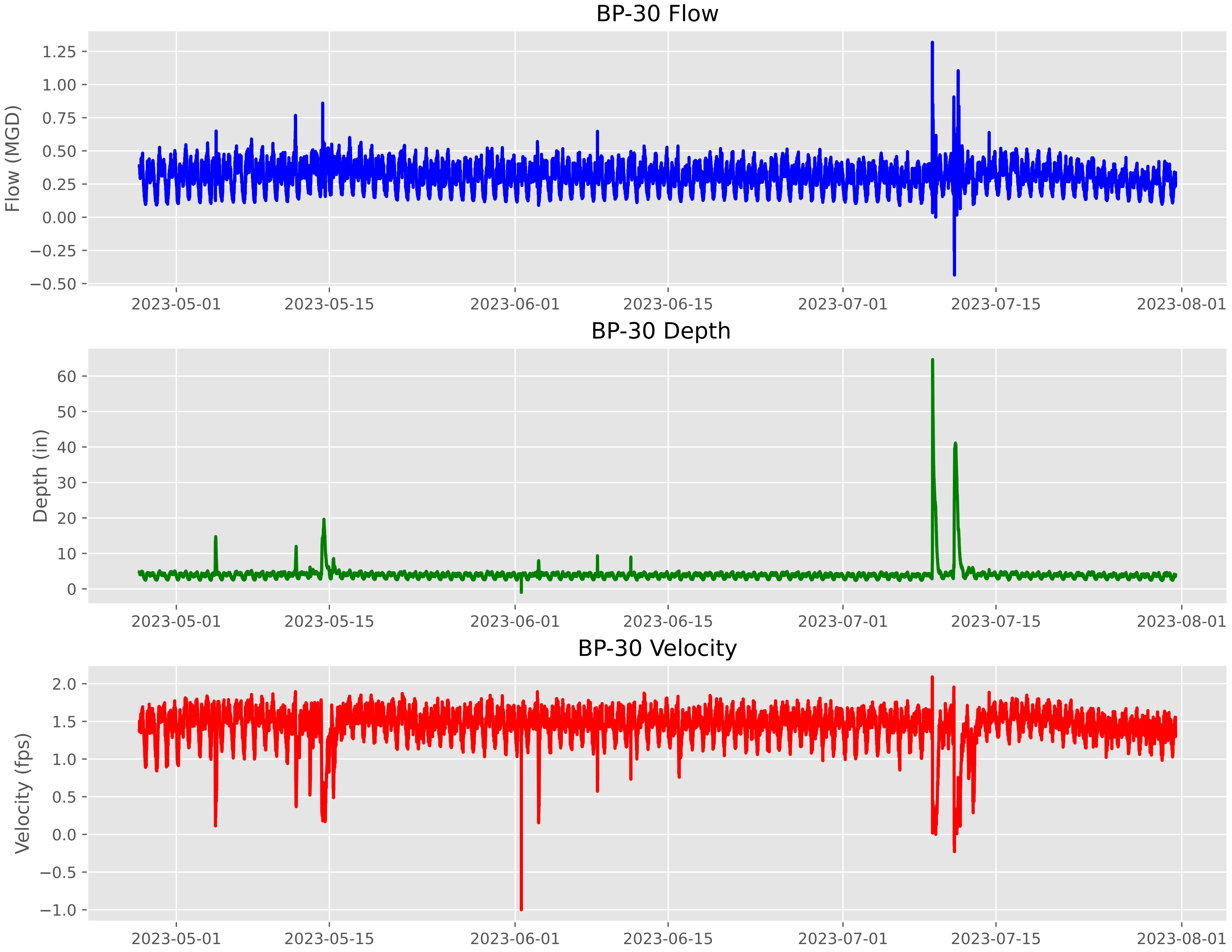

BP-25 Flow
Flow (MGD)
BP-25 Depth
Depth (in)
BP-25 Velocity
Velocity (fps)
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


BP-26 Flow
Flow (MGD)
5
4
3
2
1
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-26 Depth
Depth (in)
40
30
20
10
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-26 Velocity
Velocity (fps)
6
5
4
3
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

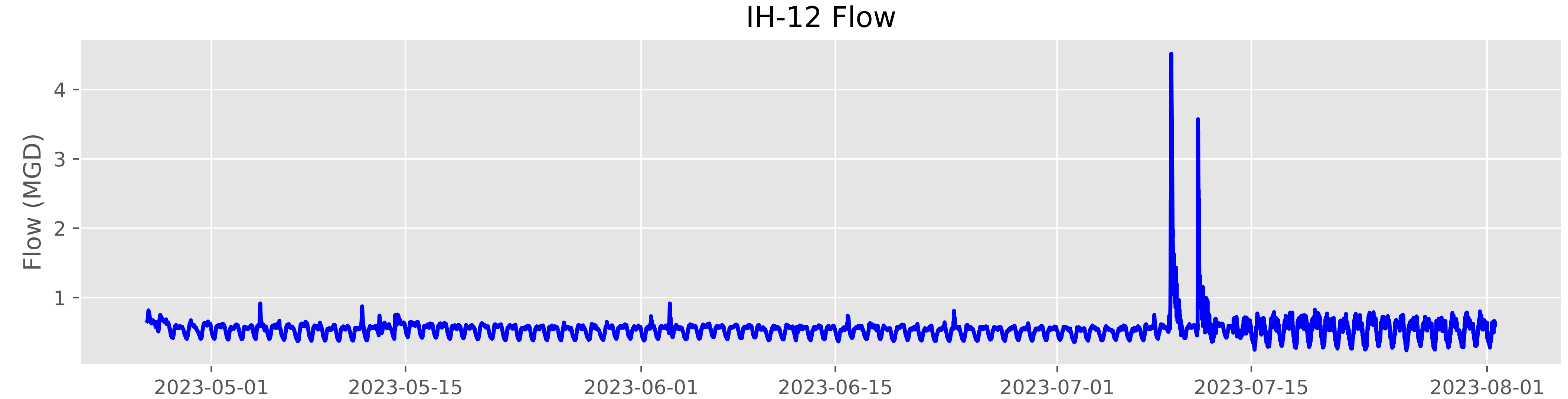

BP-27-01 Flow
Flow (MGD)
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-27-01 Depth
Depth (in)
0
10
20
30
40
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-27-01 Velocity
Velocity (fps)
0
2
4
6
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

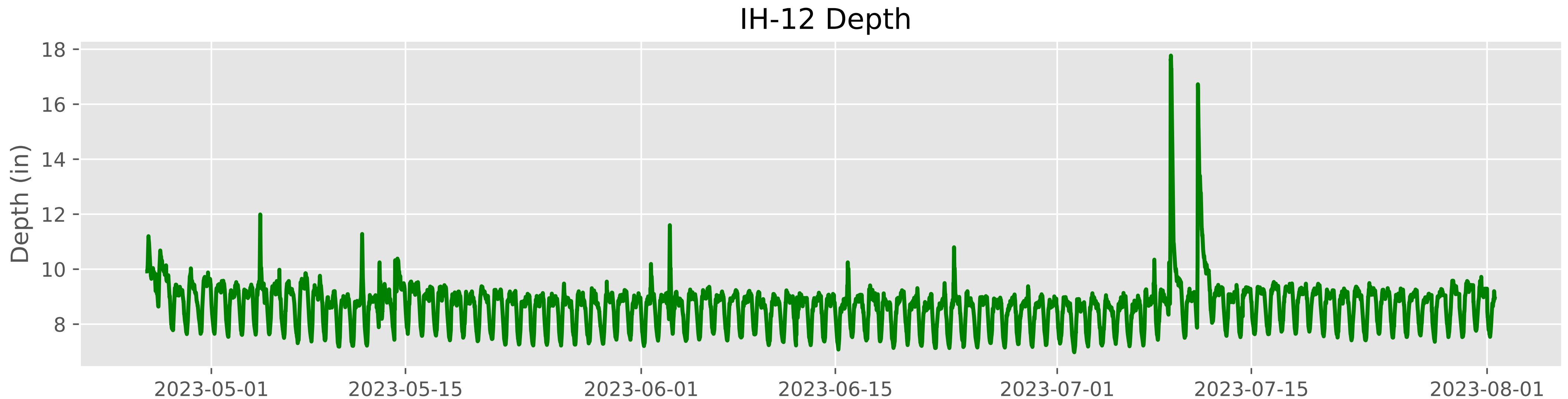

BP-27 Flow
Flow (MGD)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-27 Depth
Depth (in)
30
25
20
15
10
5
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-27 Velocity
Velocity (fps)
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

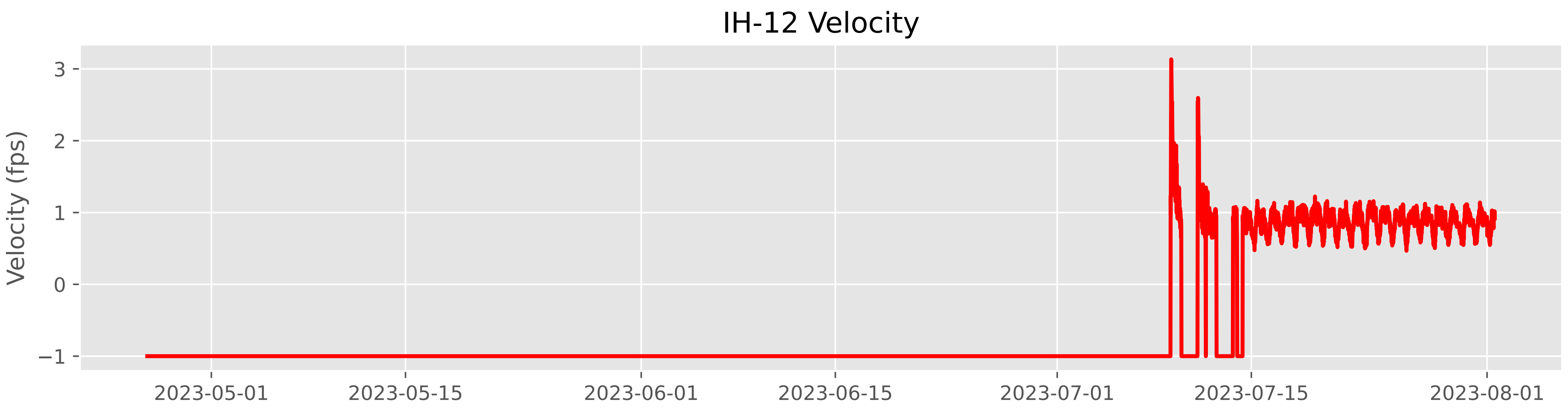

BP-28 Flow
Flow (MGD)
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-28 Depth
Depth (in)
0
20
40
60
80
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-28 Velocity
Velocity (fps)
−1
0
1
2
3
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

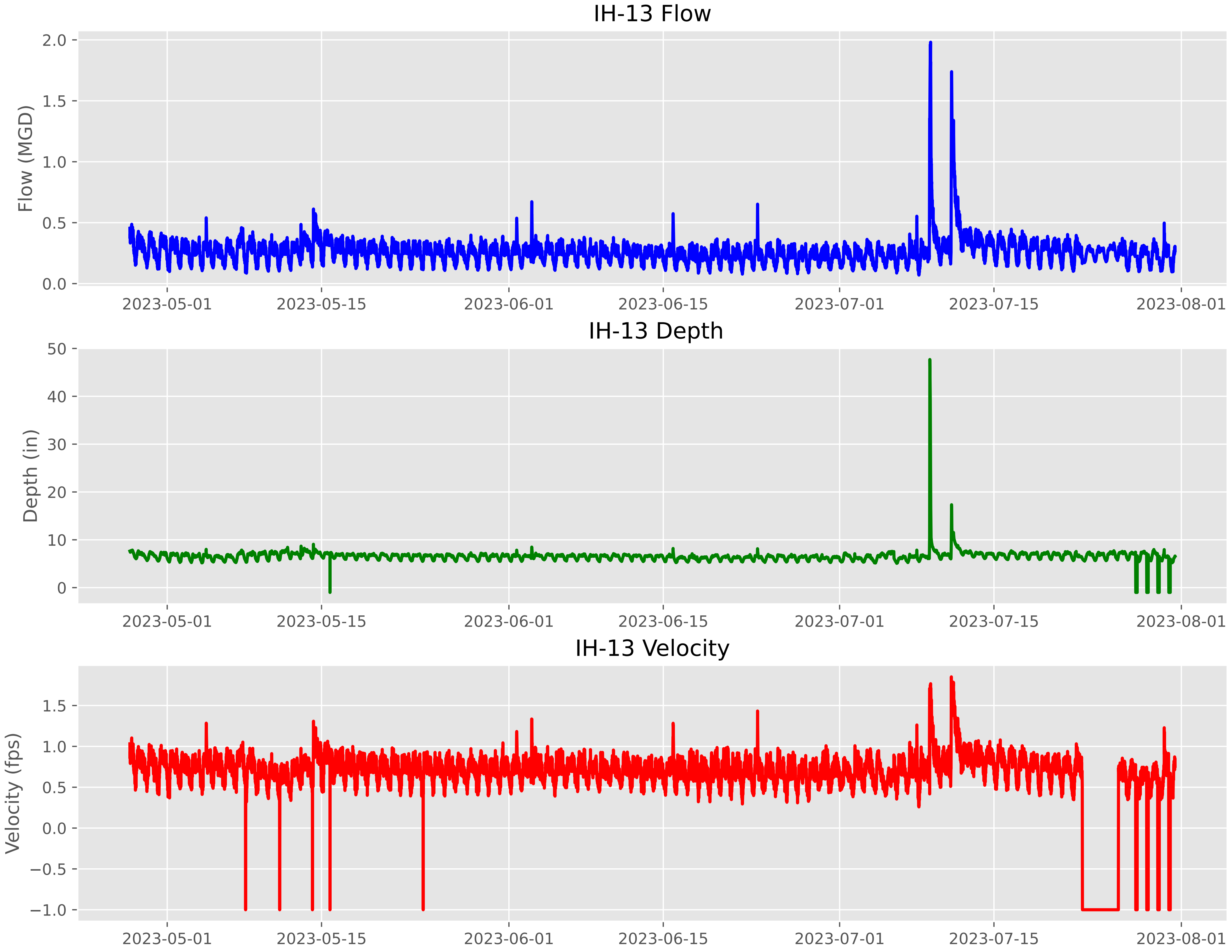


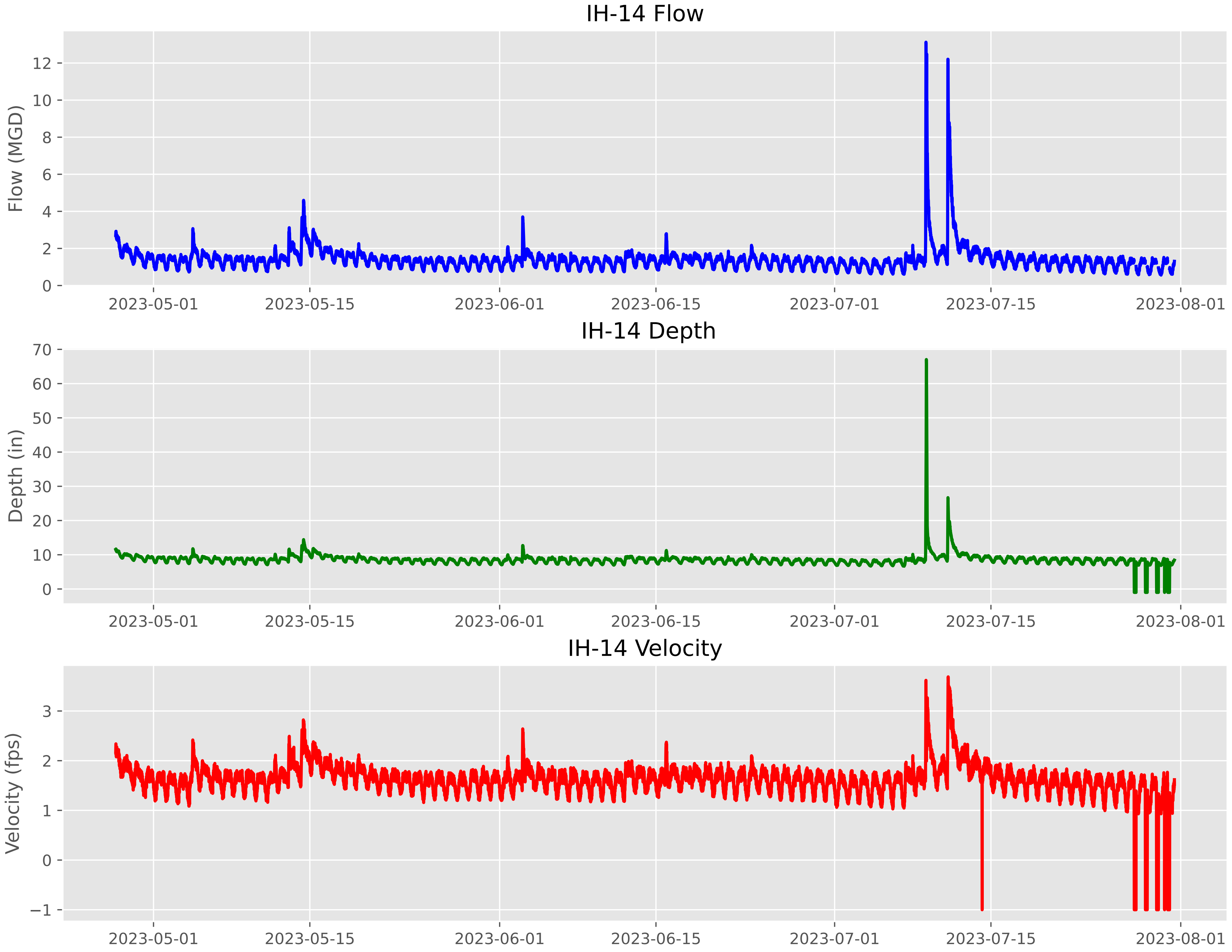
BP-30 Flow
Flow (MGD)
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-30 Depth
Depth (in)
60
50
40
30
20
10
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
BP-30 Velocity
Velocity (fps)
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

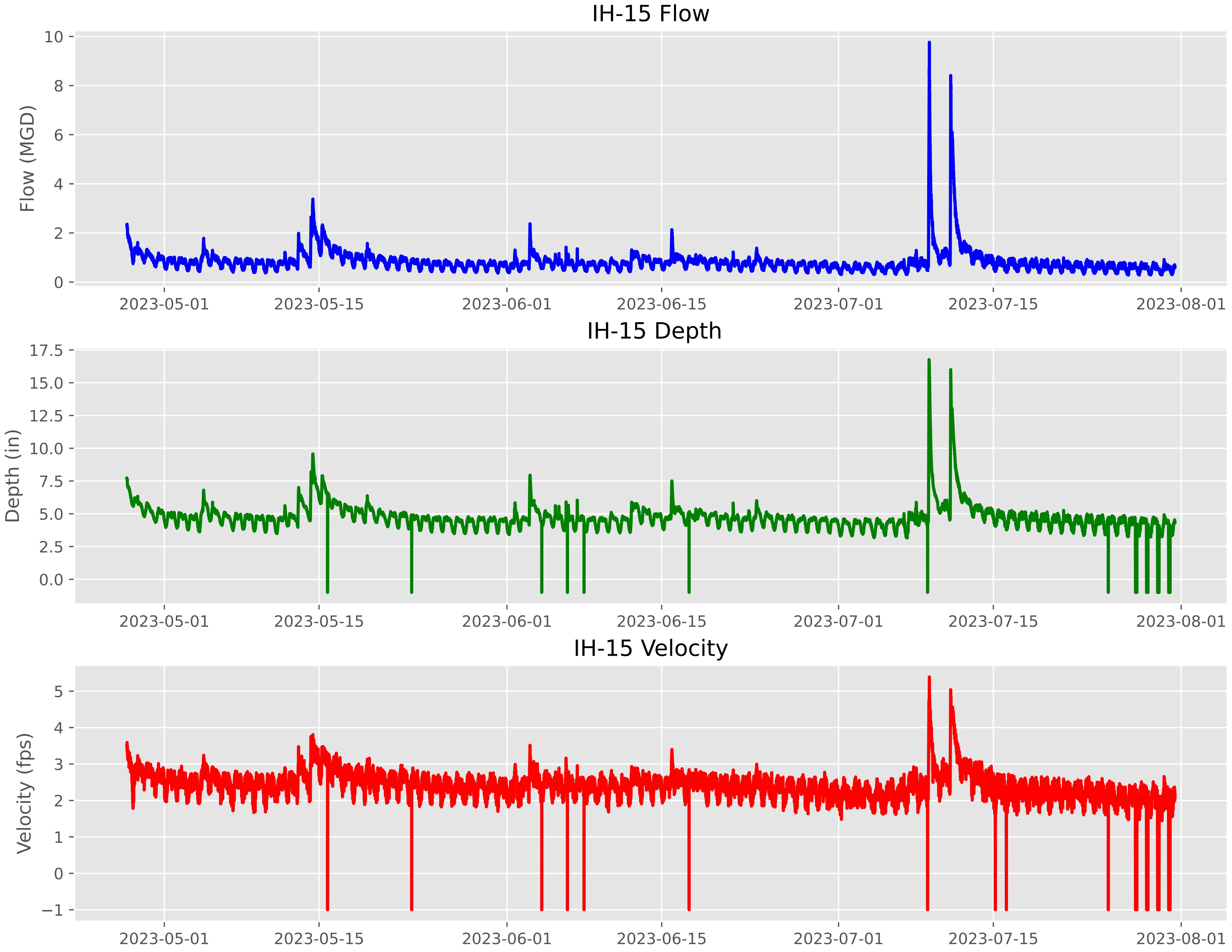

IH-12 Flow
Flow (MGD)
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

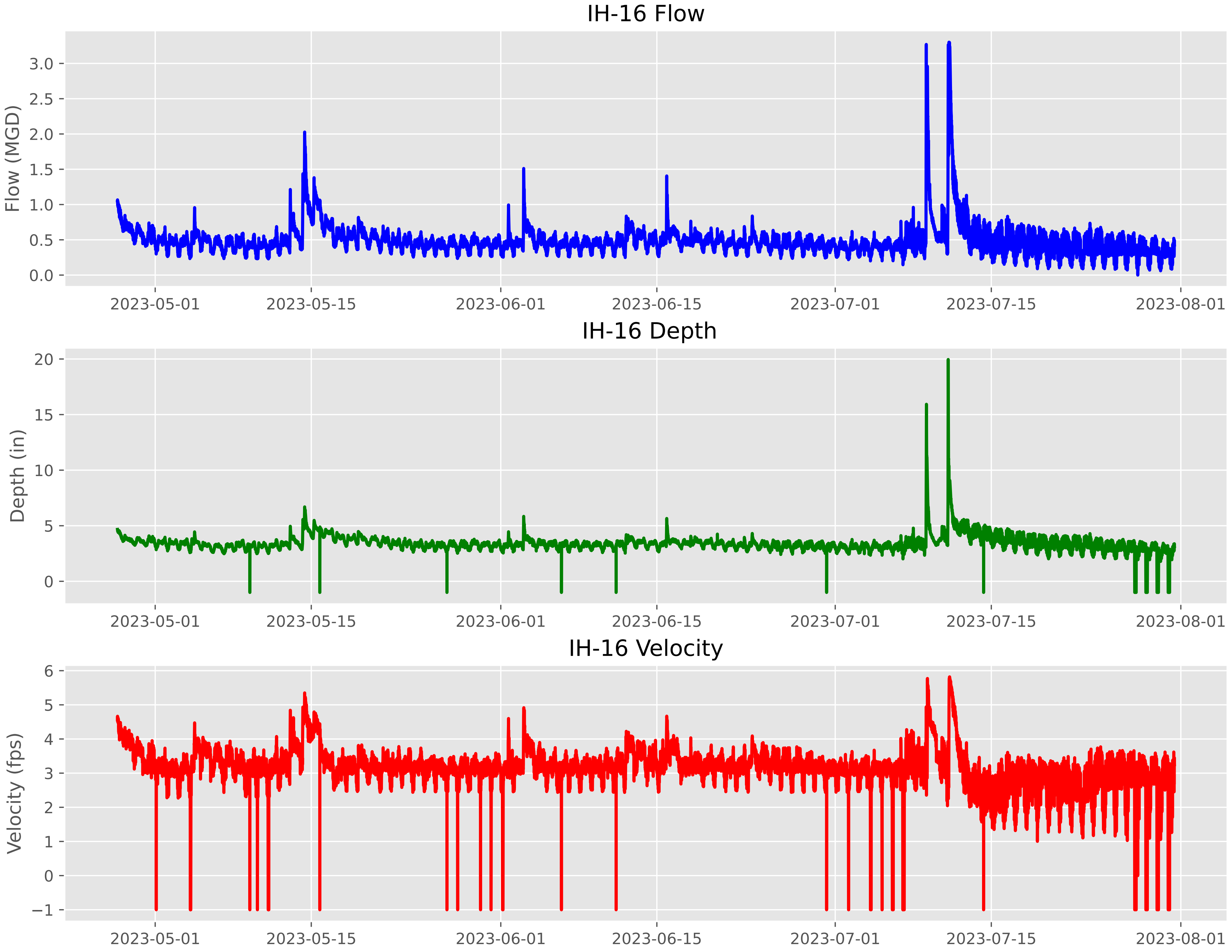

IH-12 Depth
Depth (in)
8
10
12
14
16
18
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

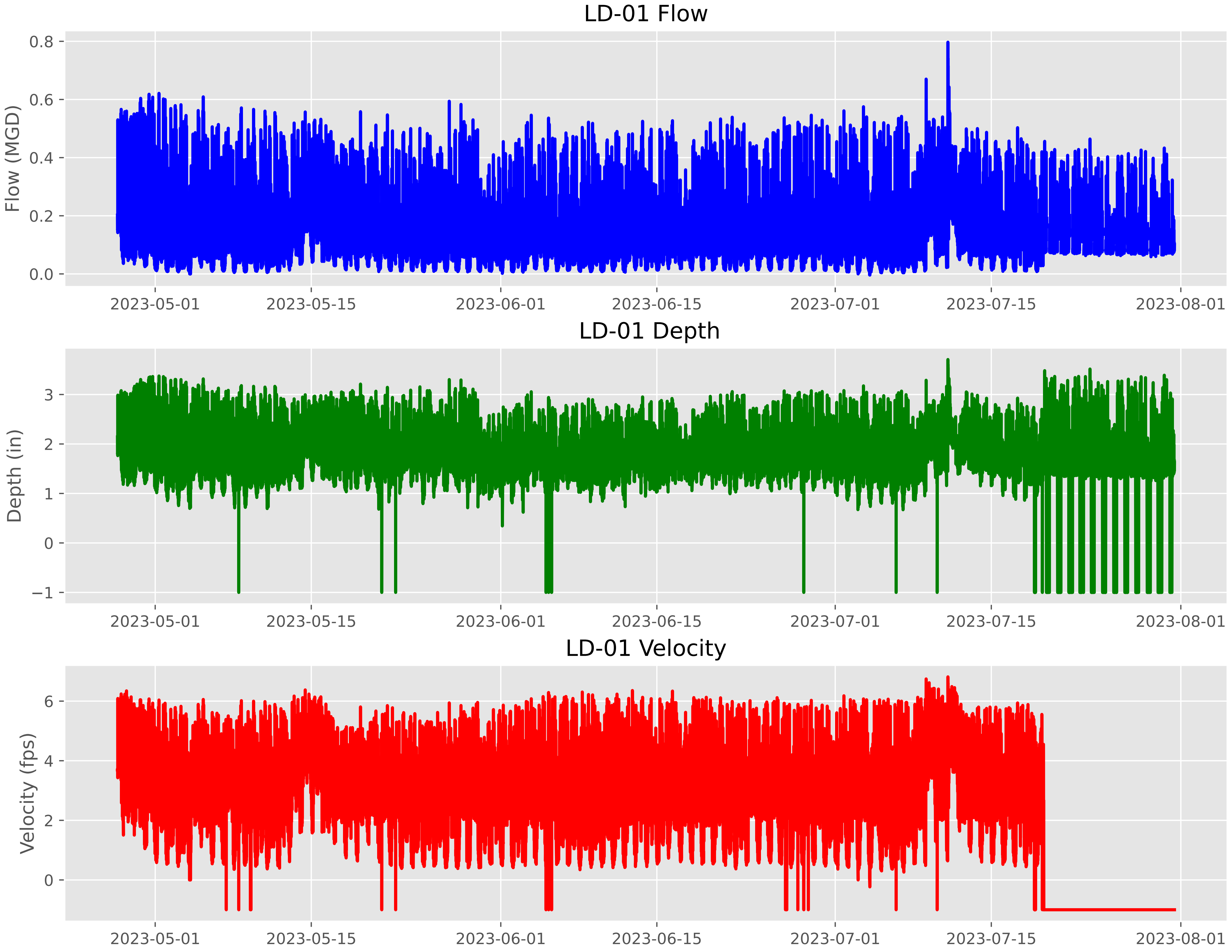

IH-12 Velocity
Velocity (fps)
−1
0
1
2
3
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


IH-13 Flow
Flow (MGD)
2.0
1.5
1.0
0.5
0.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-13 Depth
Depth (in)
50
40
30
20
10
0
IH-13 Velocity
Velocity (fps)
1.5
1.0
0.5
0.0
−0.5
−1.0

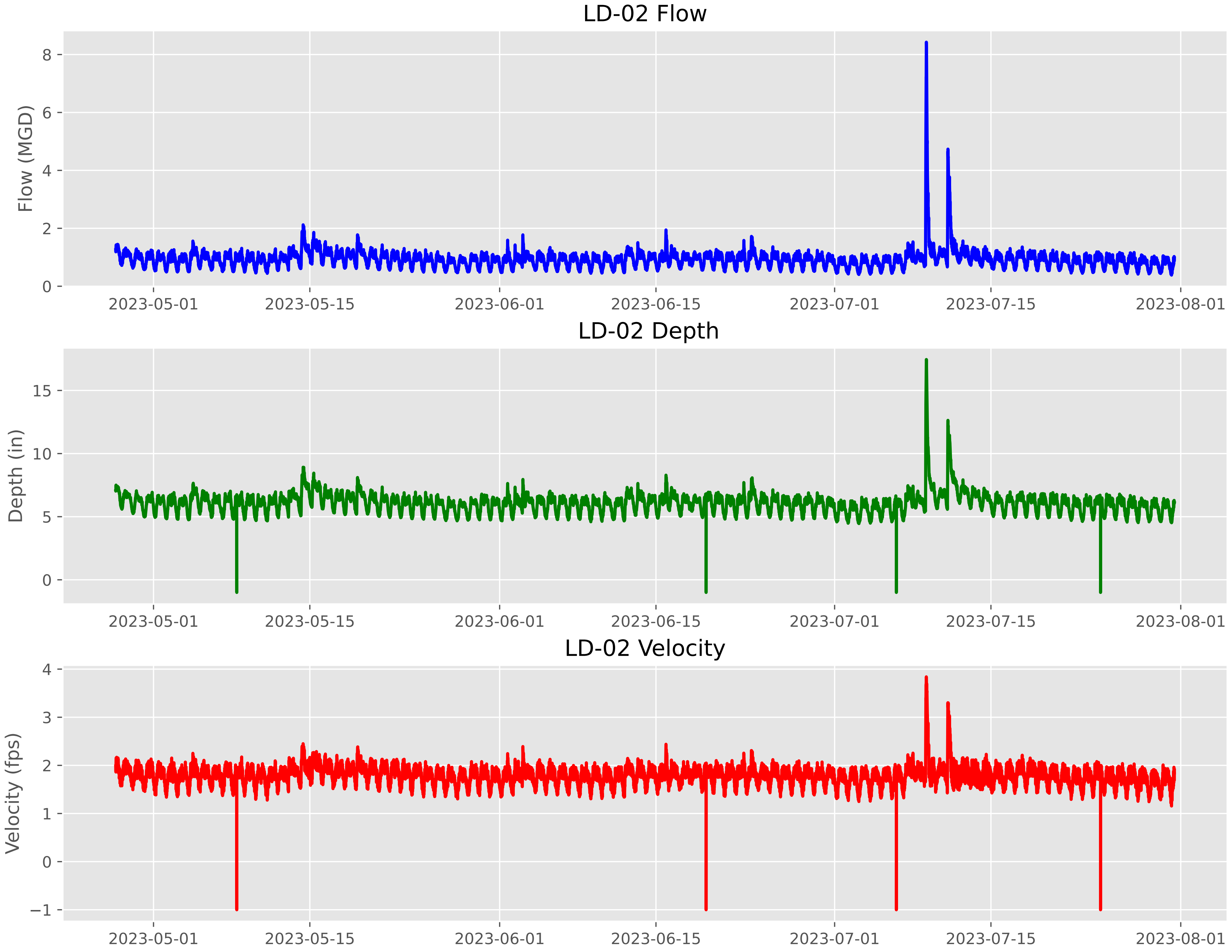

IH-14 Flow
Flow (MGD)
0
2
4
6
8
10
12
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-14 Depth
Depth (in)
0
10
20
30
40
50
60
70
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-14 Velocity
Velocity (fps)
−1
0
1
2
3
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

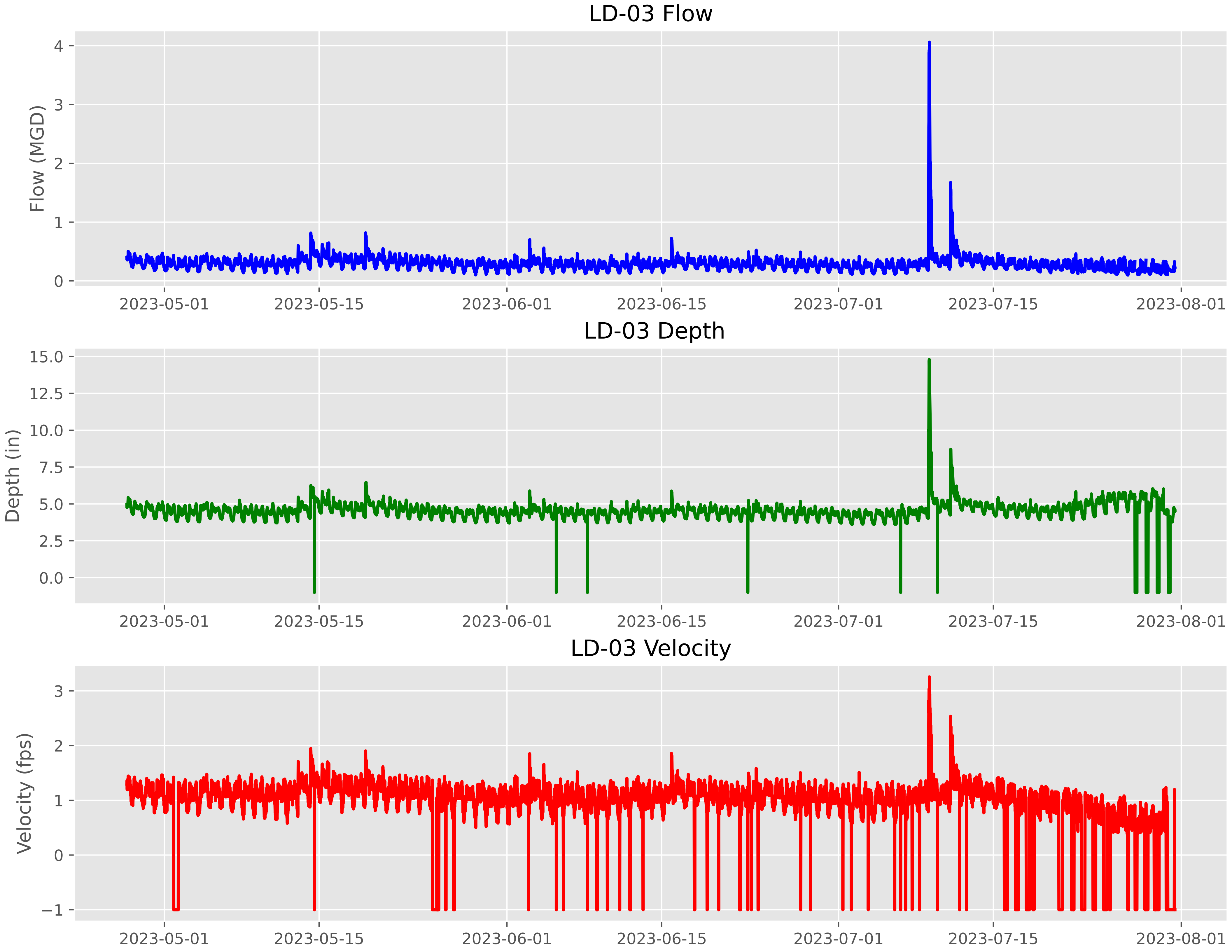

IH-15 Flow
Flow (MGD)
0
2
4
6
8
10
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-15 Depth
Depth (in)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-15 Velocity
Velocity (fps)
−1
0
1
2
3
4
5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

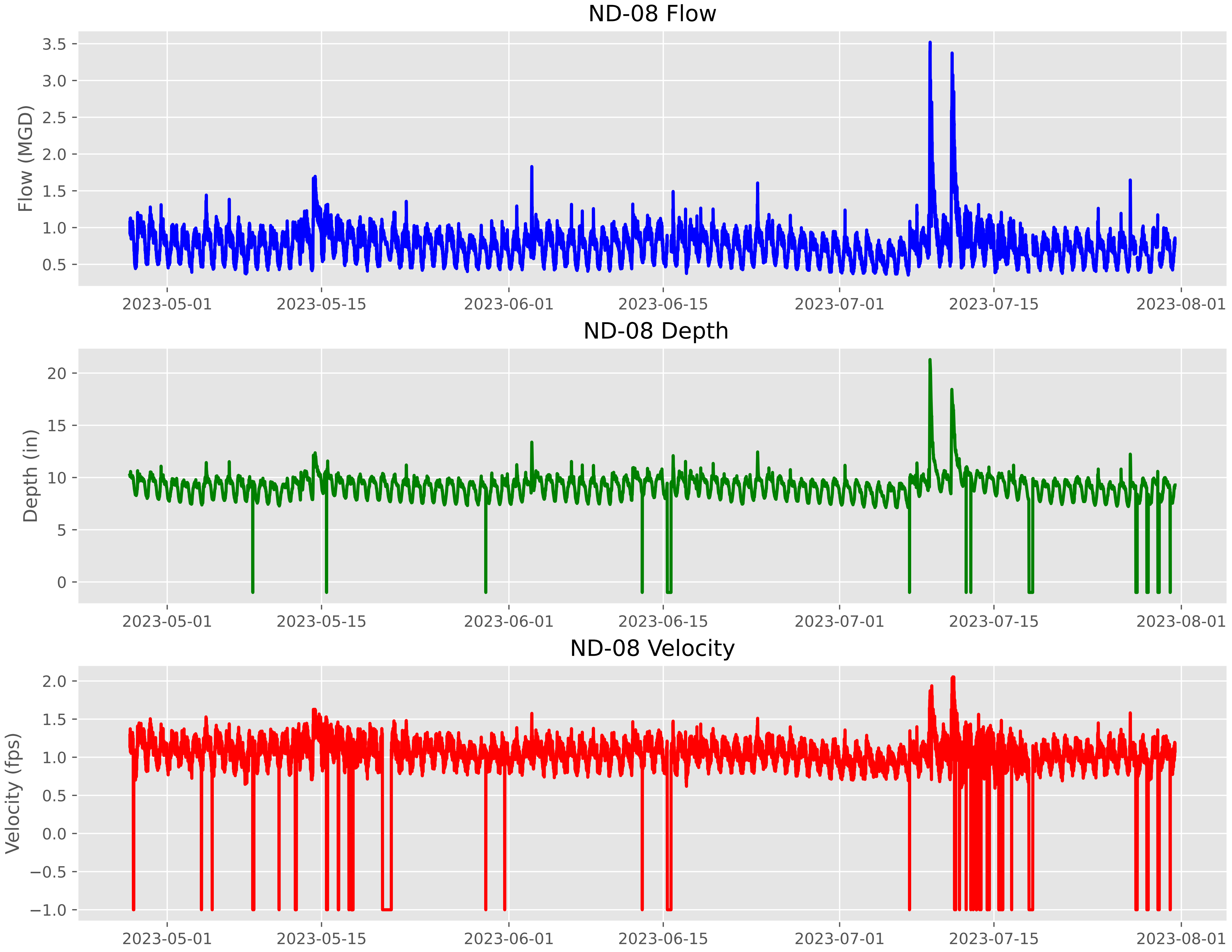

IH-16 Flow
Flow (MGD)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-16 Depth
Depth (in)
0
5
10
15
20
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
IH-16 Velocity
Velocity (fps)
−1
0
1
2
3
4
5
6
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01



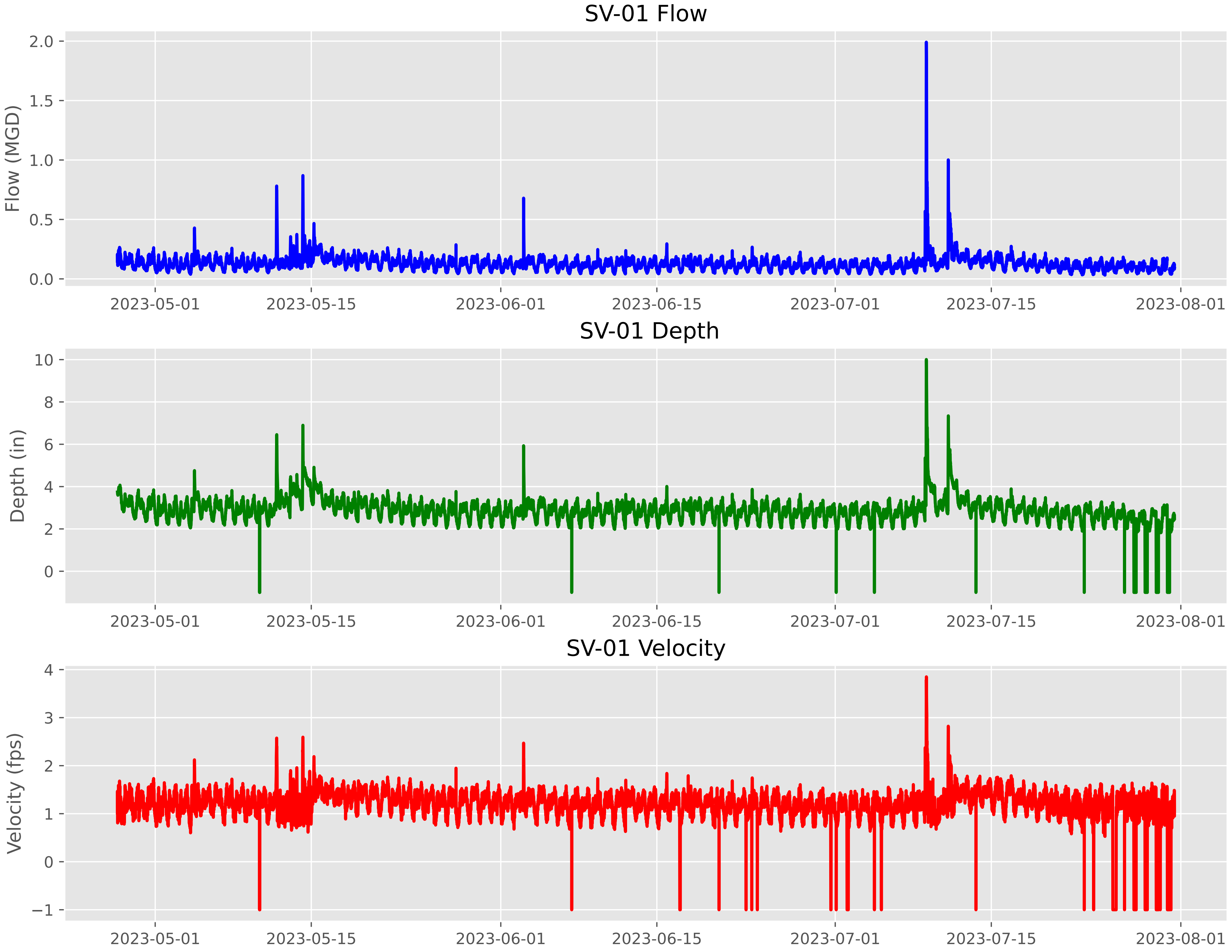
LD-01 Flow
Flow (MGD)
0.0
0.2
0.4
0.6
0.8
LD-01 Depth
Depth (in)
−1
0
1
2
3
LD-01 Velocity
Velocity (fps)
0
2
4
6
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

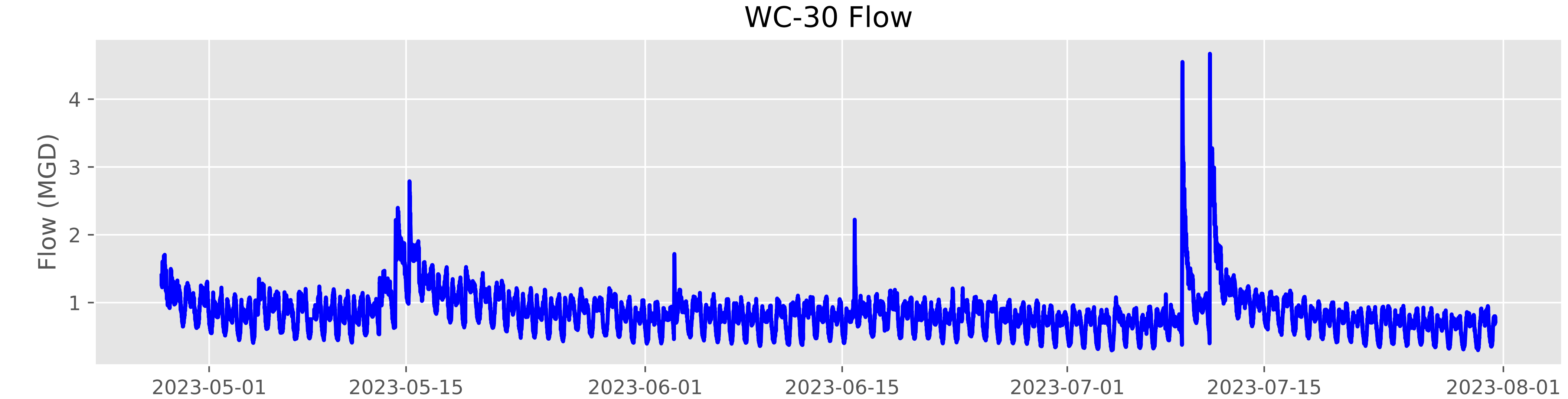

LD-02 Flow
Flow (MGD)
0
2
4
6
8
LD-02 Depth
Depth (in)
0
5
10
15
LD-02 Velocity
Velocity (fps)
−1
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

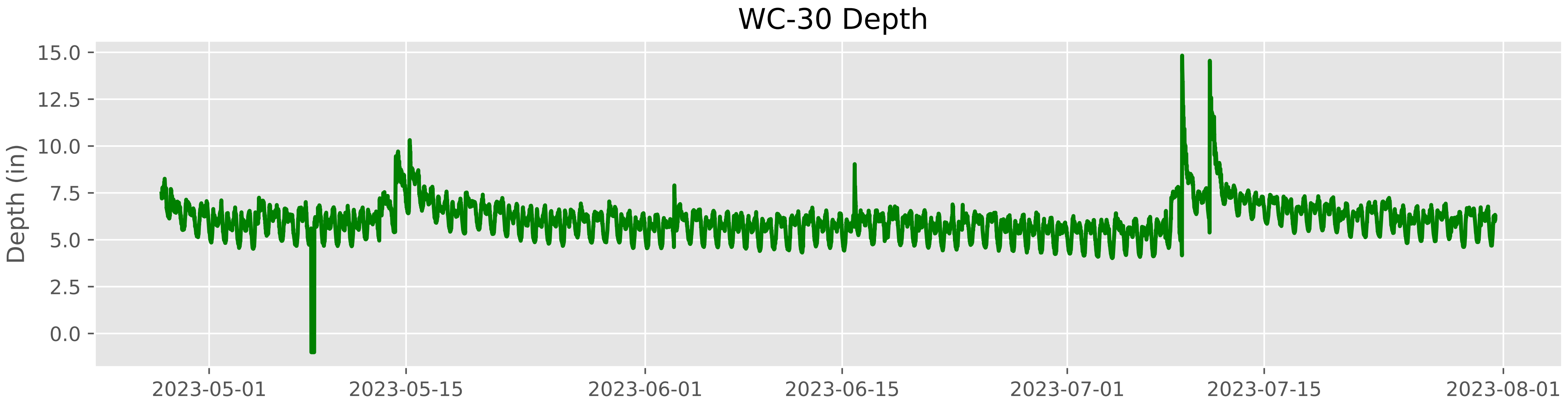

LD-03 Flow
Flow (MGD)
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
LD-03 Depth
Depth (in)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
LD-03 Velocity
Velocity (fps)
−1
0
1
2
3
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

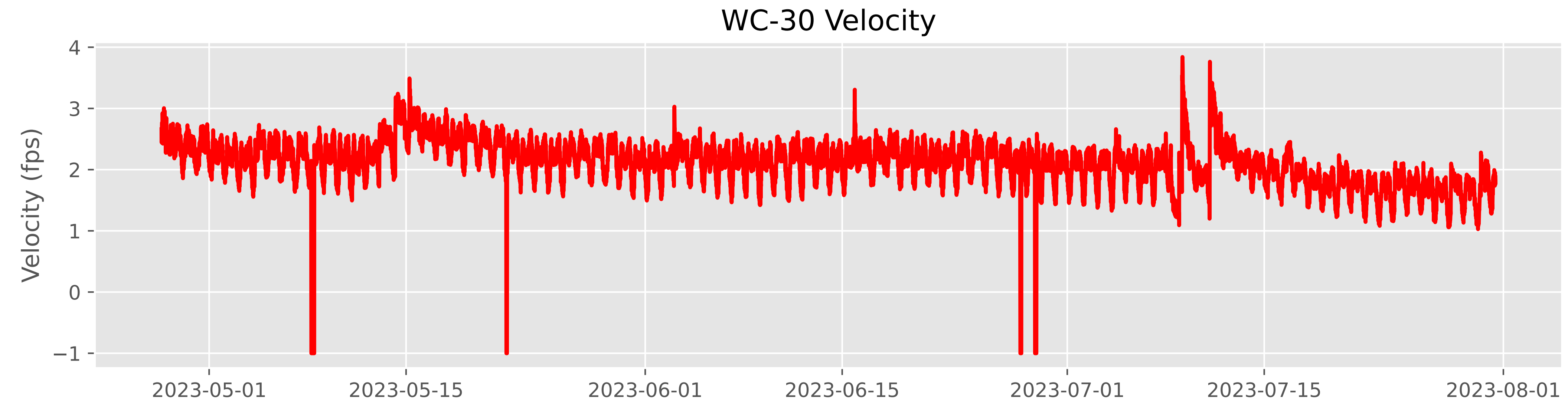

ND-08 Flow
Flow (MGD)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
ND-08 Depth
Depth (in)
20
15
10
5
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
ND-08 Velocity
Velocity (fps)
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

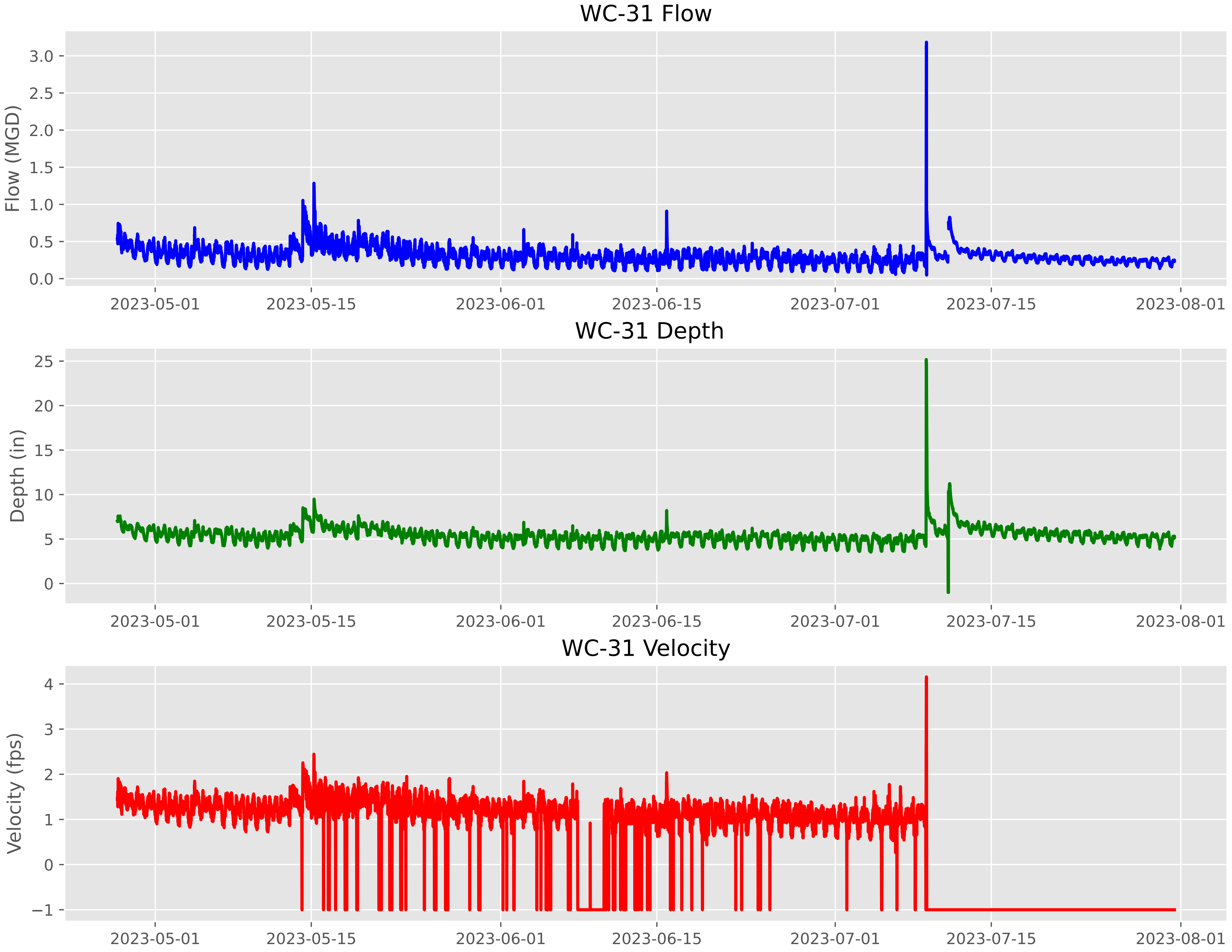

ND-09 Flow
Flow (MGD)
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
ND-09 Depth
Depth (in)
0
5
10
15
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
ND-09 Velocity
Velocity (fps)
−1
0
1
2
3
4
5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

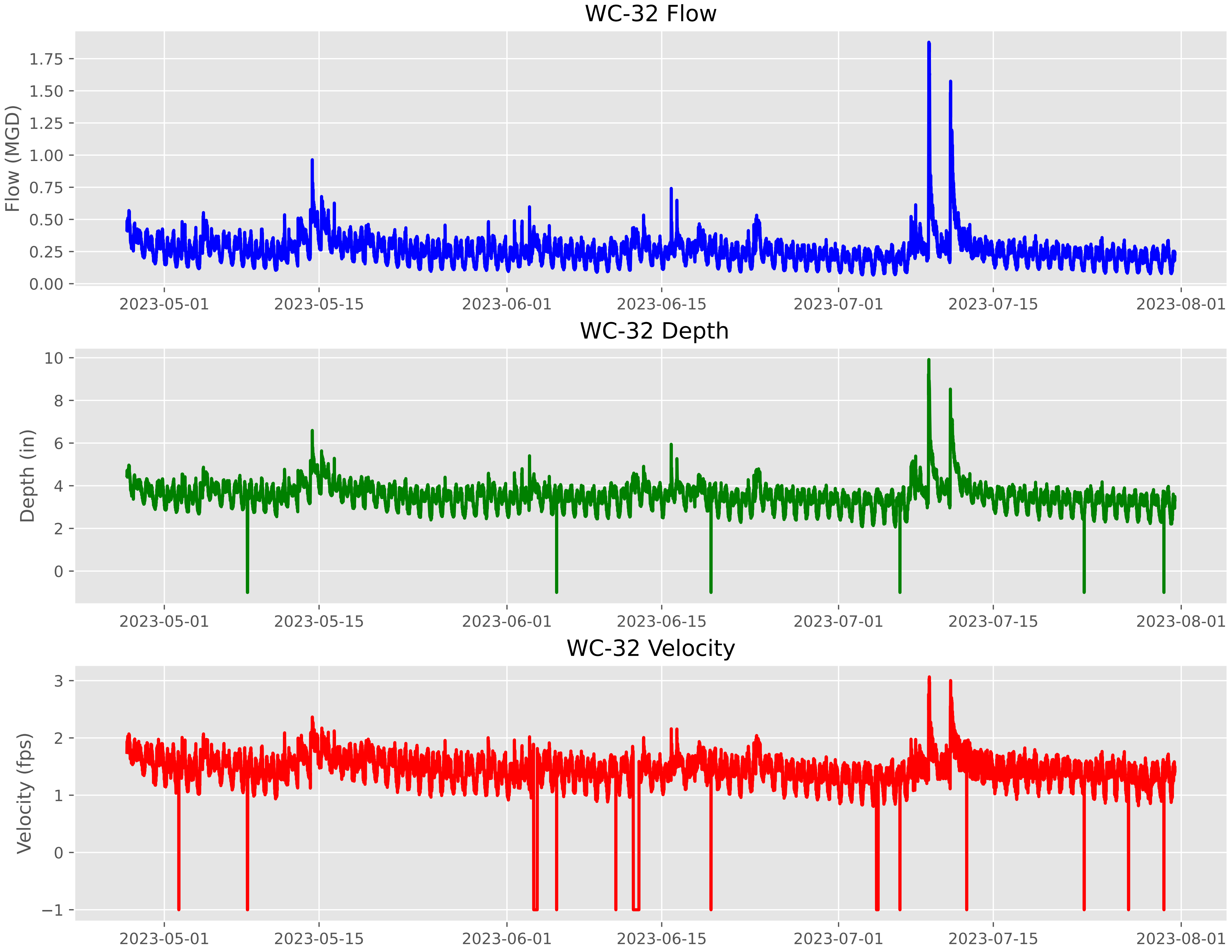

SV-01 Flow
Flow (MGD)
0.0
0.5
1.0
1.5
2.0
SV-01 Depth
Depth (in)
0
2
4
6
8
10
SV-01 Velocity
Velocity (fps)
−1
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


WC-30 Flow
Flow (MGD)
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

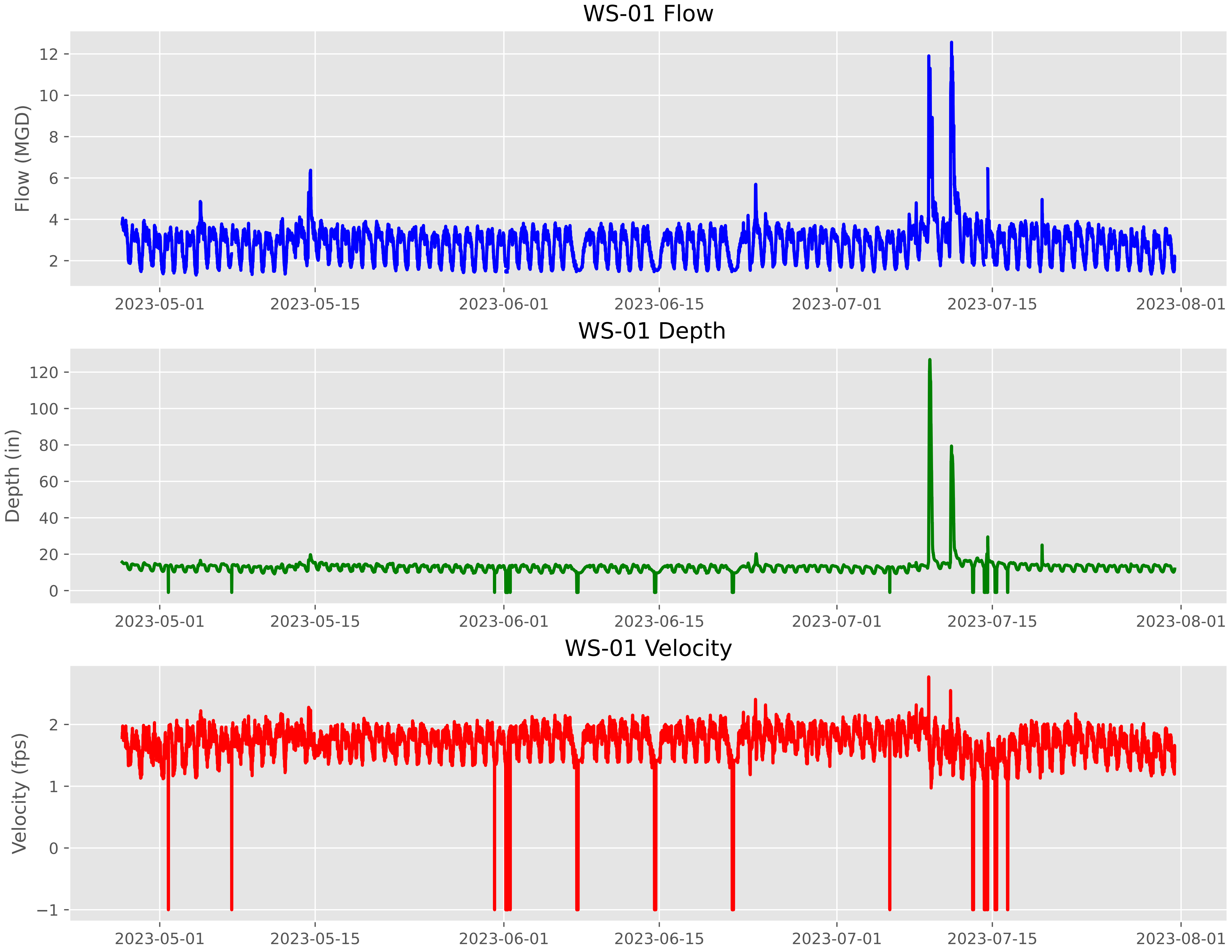

WC-30 Depth
Depth (in)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

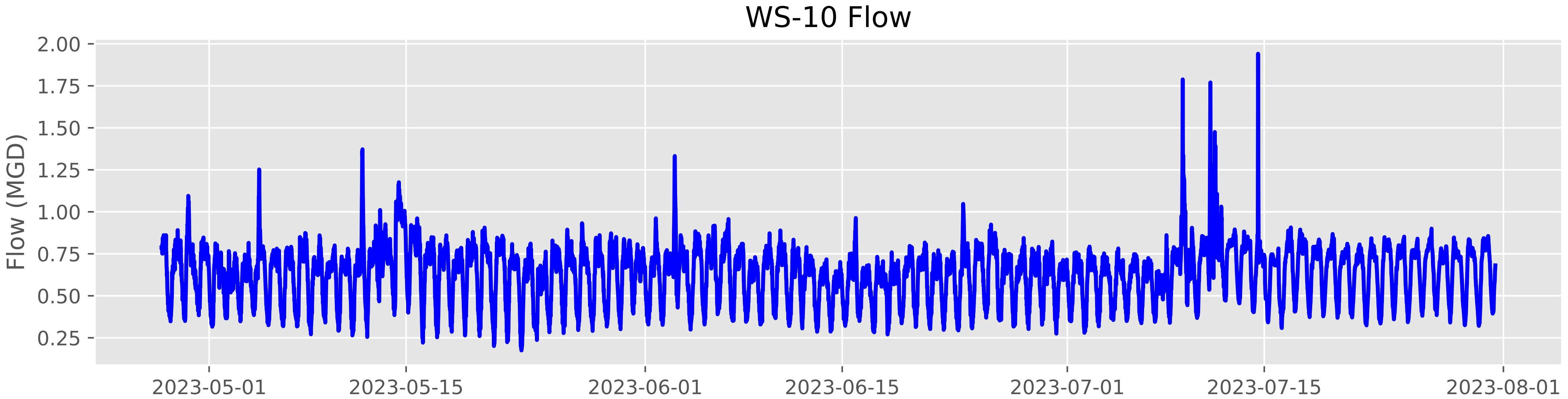

WC-30 Velocity
Velocity (fps)
−1
0
1
2
3
4
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

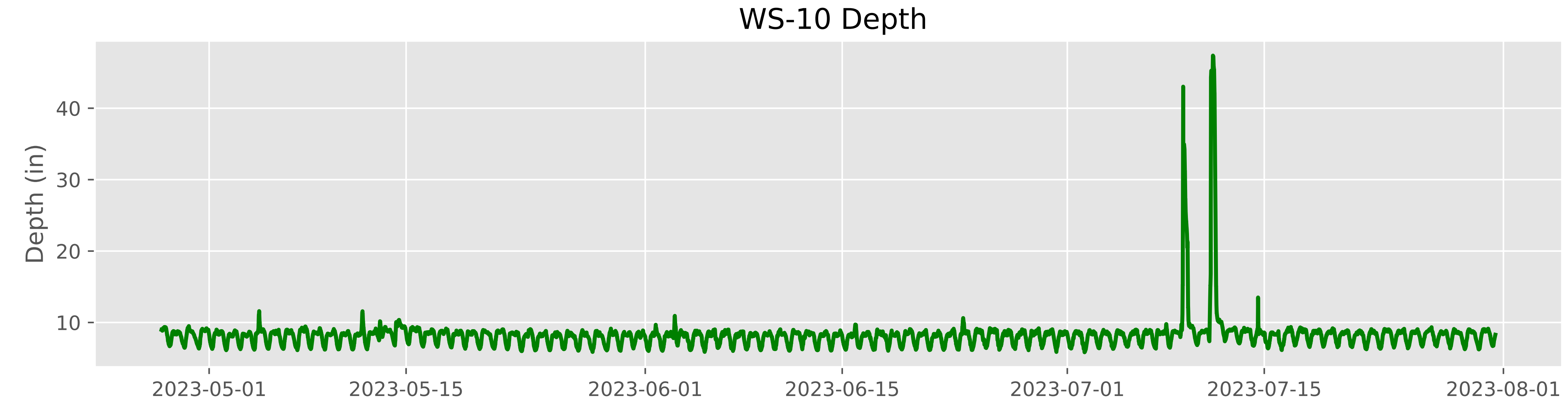

WC-31 Flow
Flow (MGD)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
WC-31 Depth
Depth (in)
25
20
15
10
5
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
WC-31 Velocity
Velocity (fps)
4
3
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

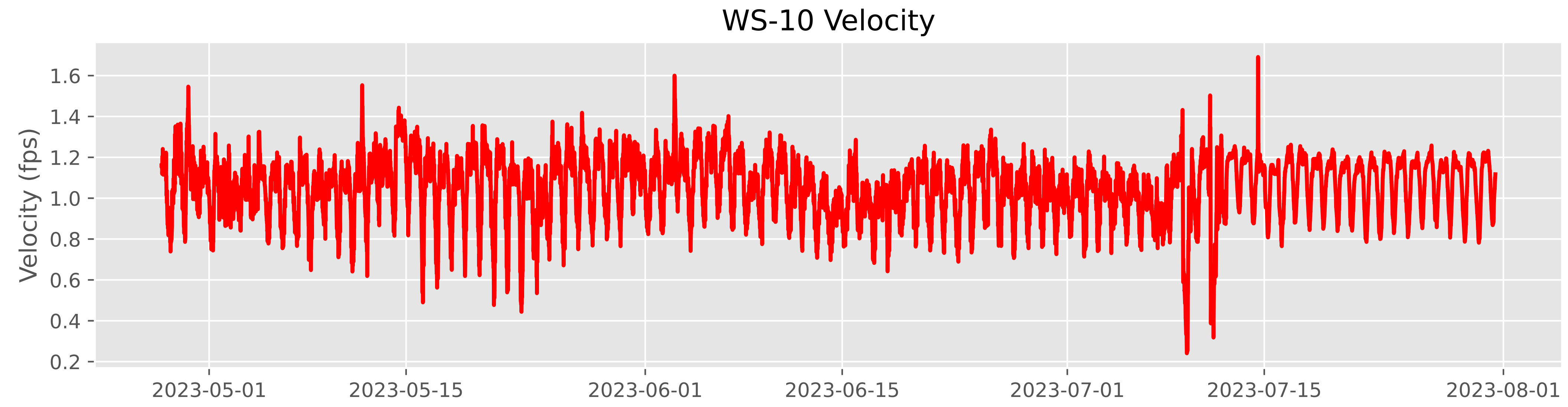


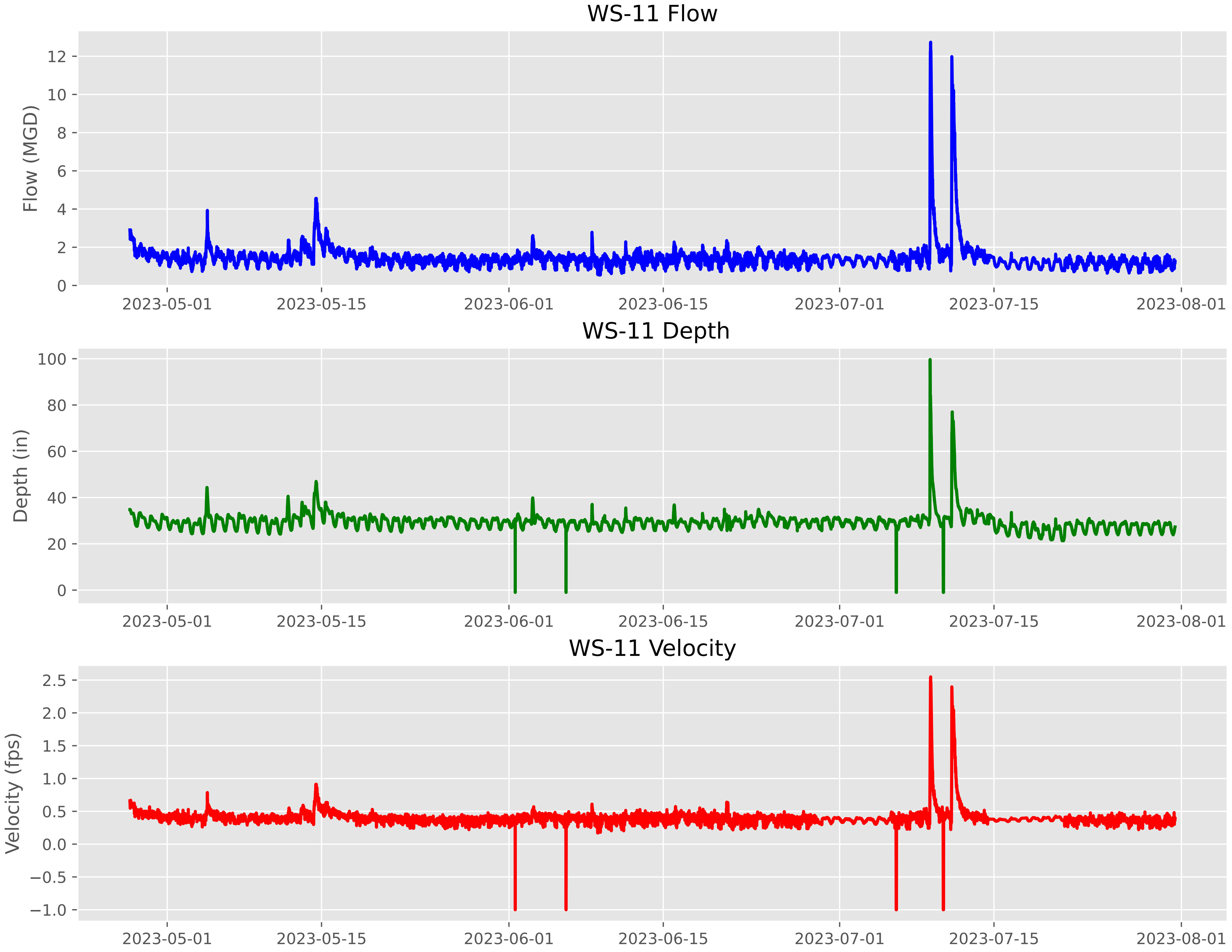
WC-32 Flow
Flow (MGD)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
WC-32 Depth
Depth (in)
0
2
4
6
8
10
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
WC-32 Velocity
Velocity (fps)
−1
0
1
2
3
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


WS-01 Flow
Flow (MGD)
12
10
8
6
4
2
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
WS-01 Depth
Depth (in)
120
100
80
60
40
20
0
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01
WS-01 Velocity
Velocity (fps)
2
1
0
−1
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


WS-10 Flow
Flow (MGD)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01


WS-10 Depth
Depth (in)
40
30
20
10
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

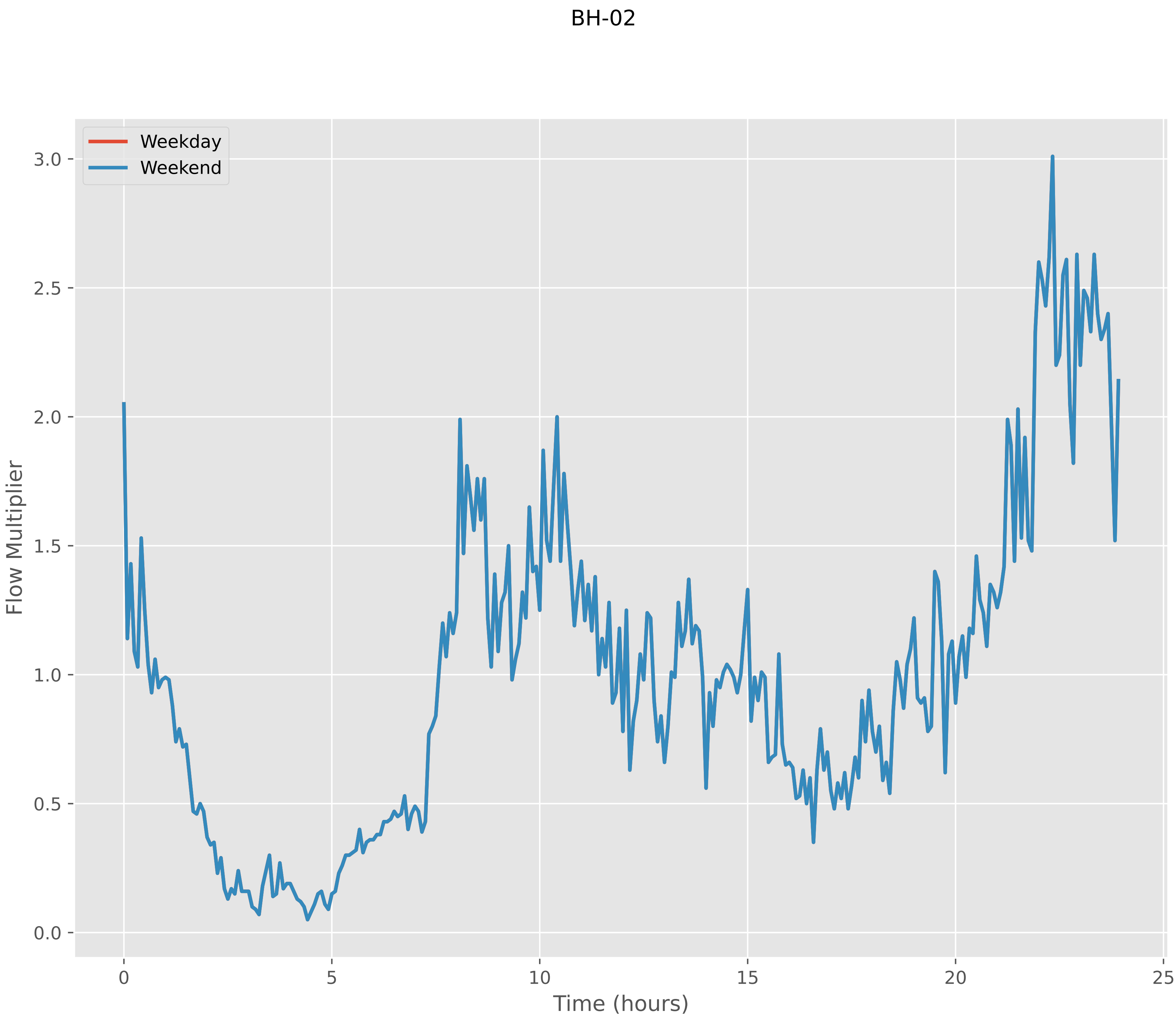

WS-10 Velocity
Velocity (fps)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

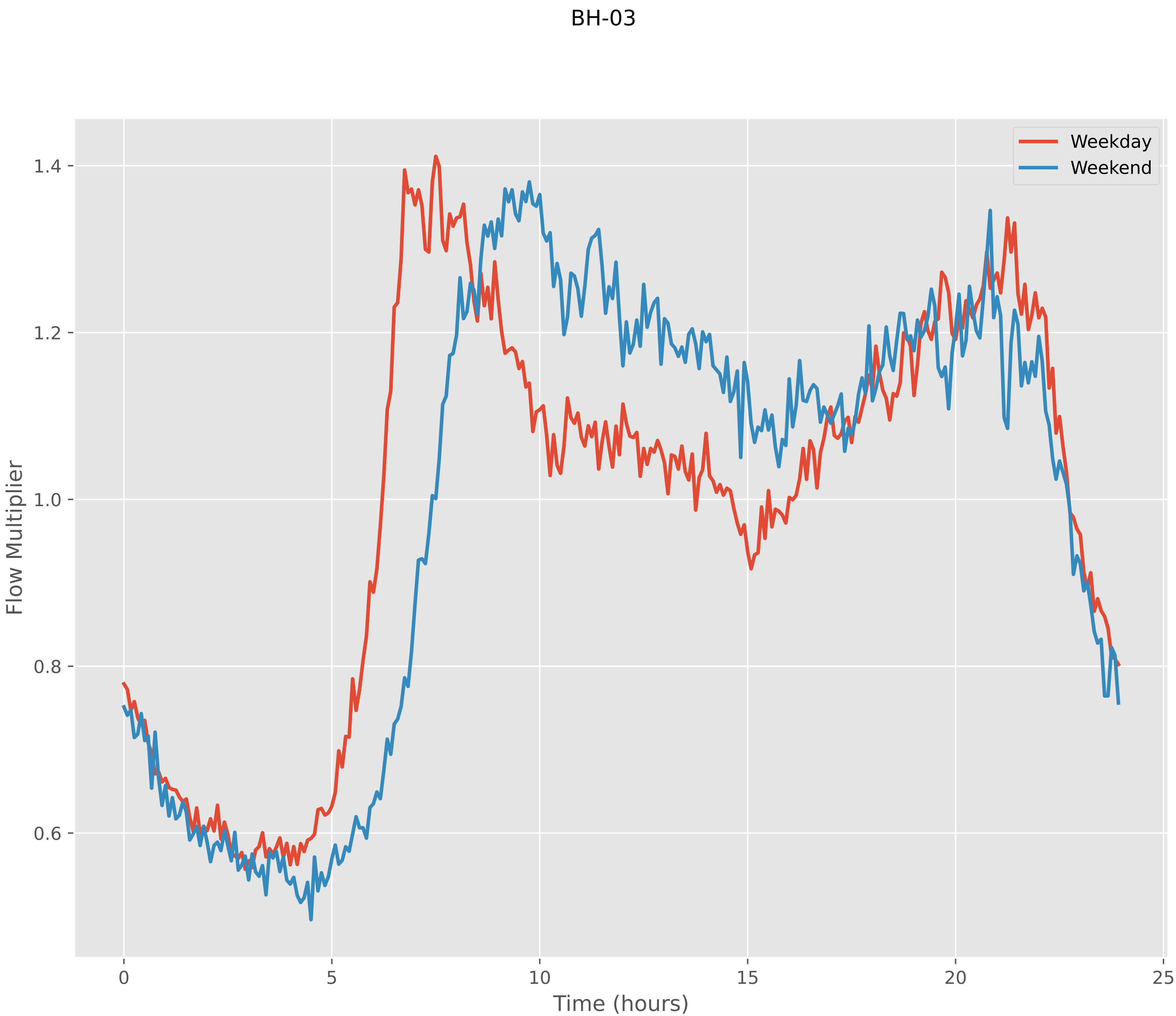


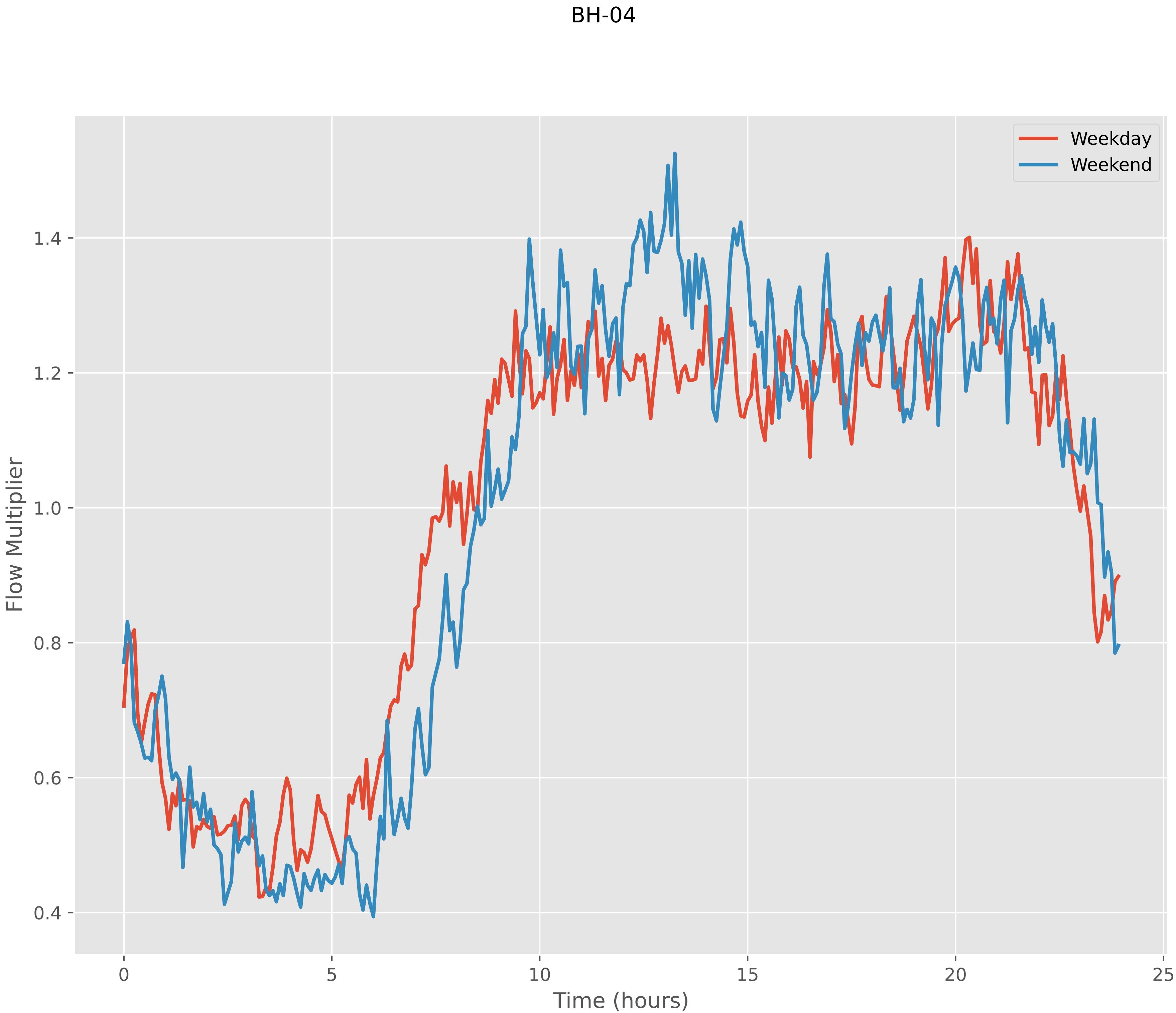
WS-11 Flow
Flow (MGD)
0
2
4
6
8
10
12
WS-11 Depth
Depth (in)
0
20
40
60
80
100
WS-11 Velocity
Velocity (fps)
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
2023-05-01
2023-05-15
2023-06-01
2023-06-15
2023-07-01
2023-07-15
2023-08-01

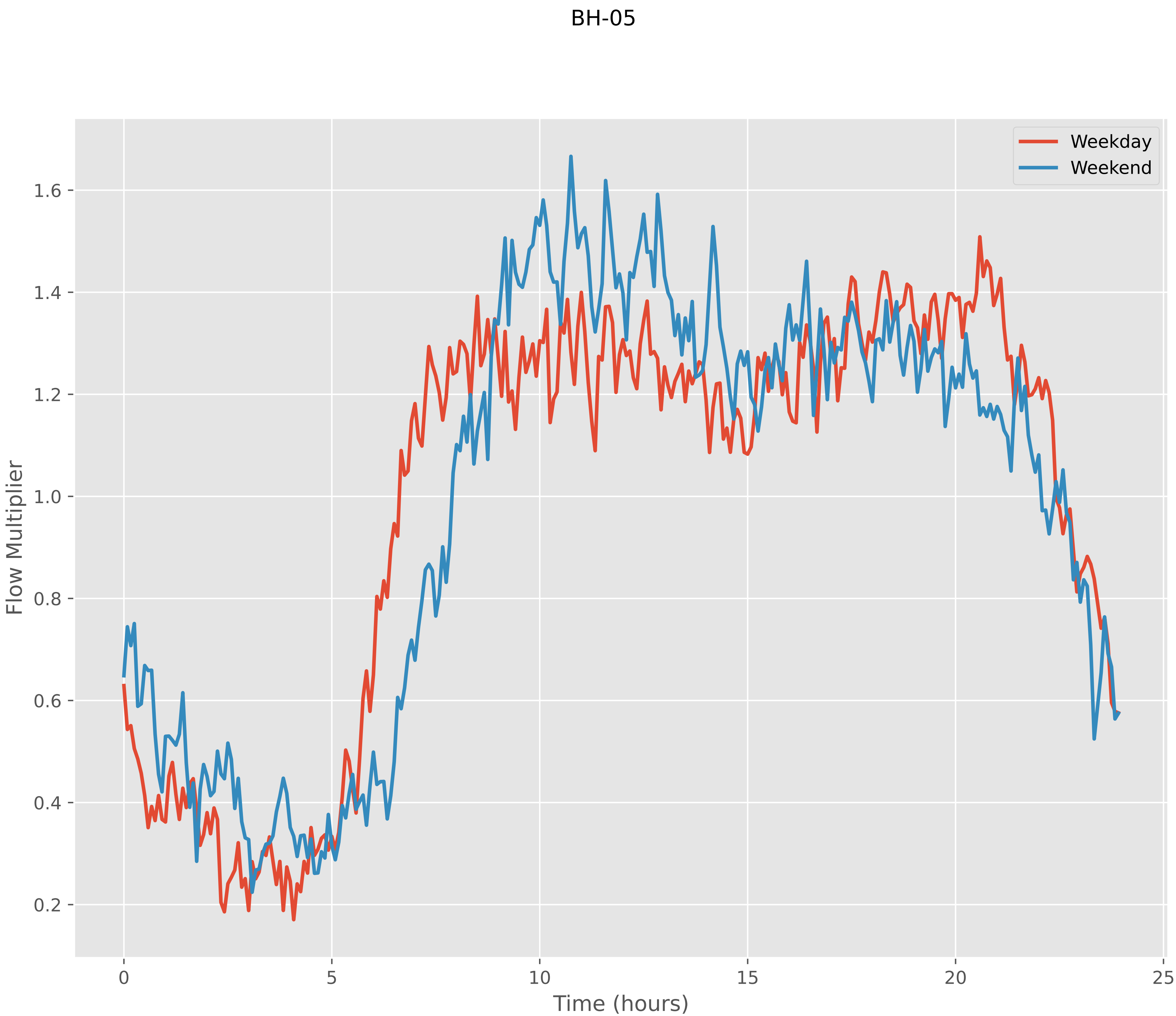
APPENDIX E

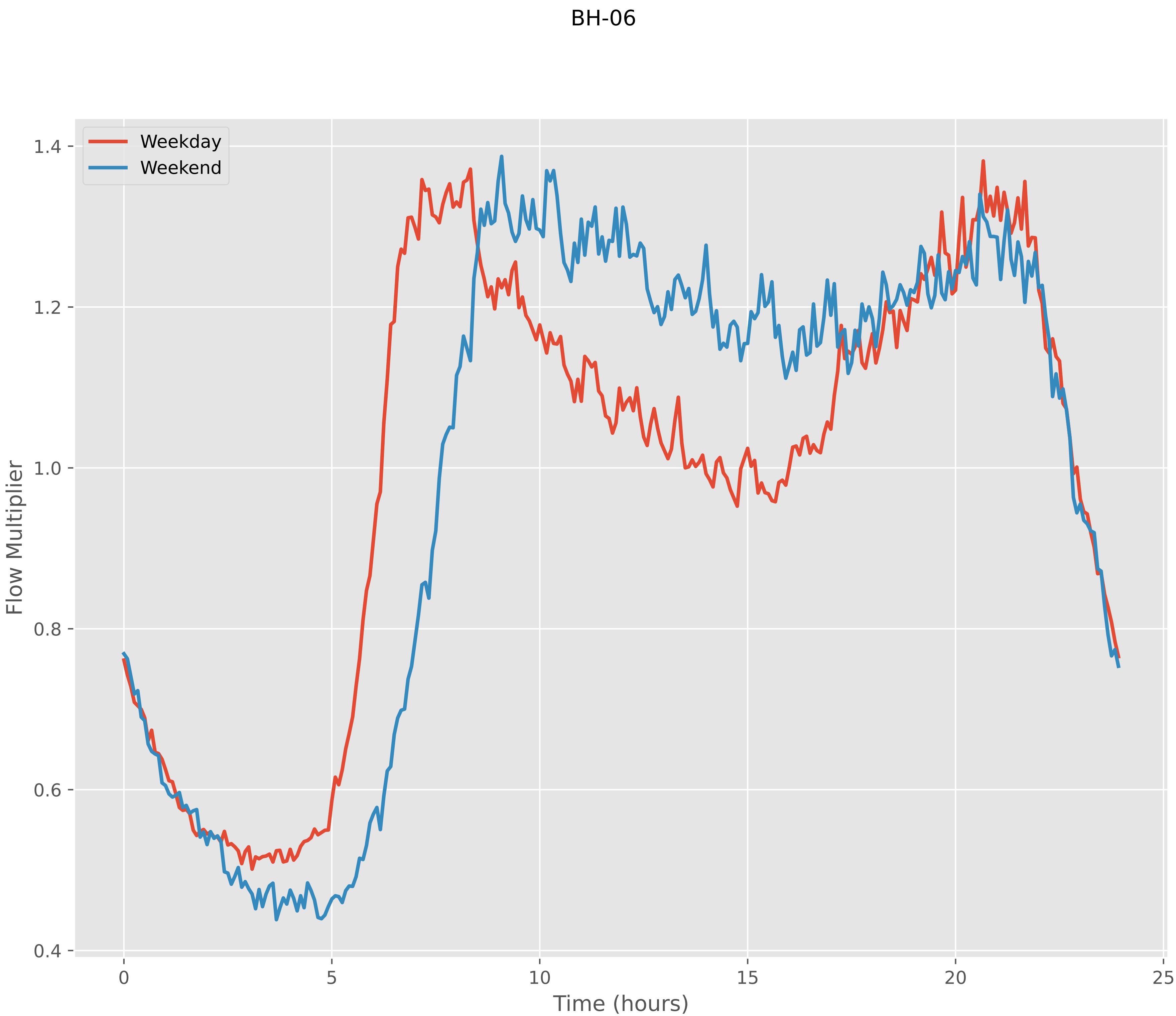
DRY-WEATHER DIURNAL PATTERNS

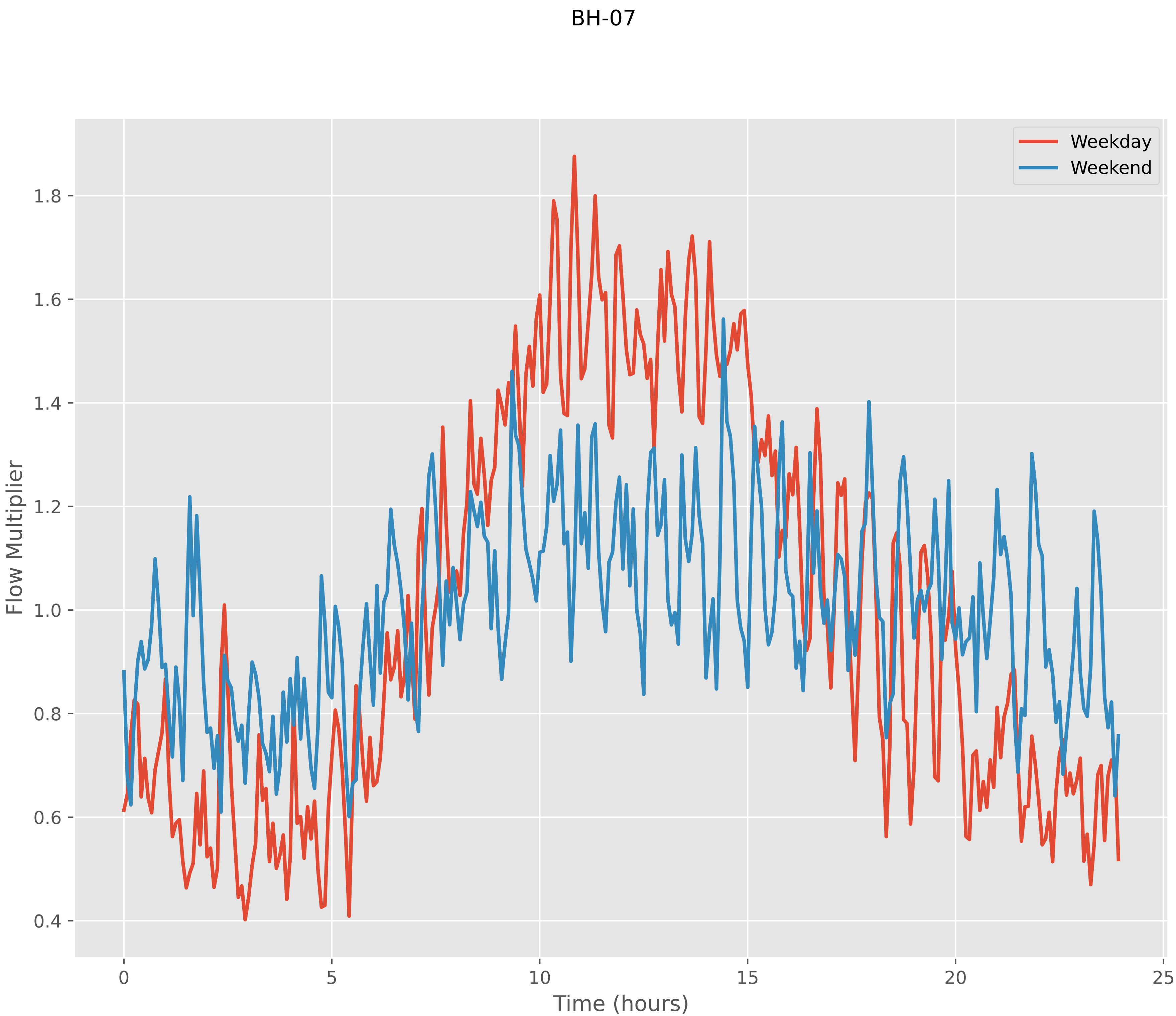

BH-02
Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
5
10
15
20
25

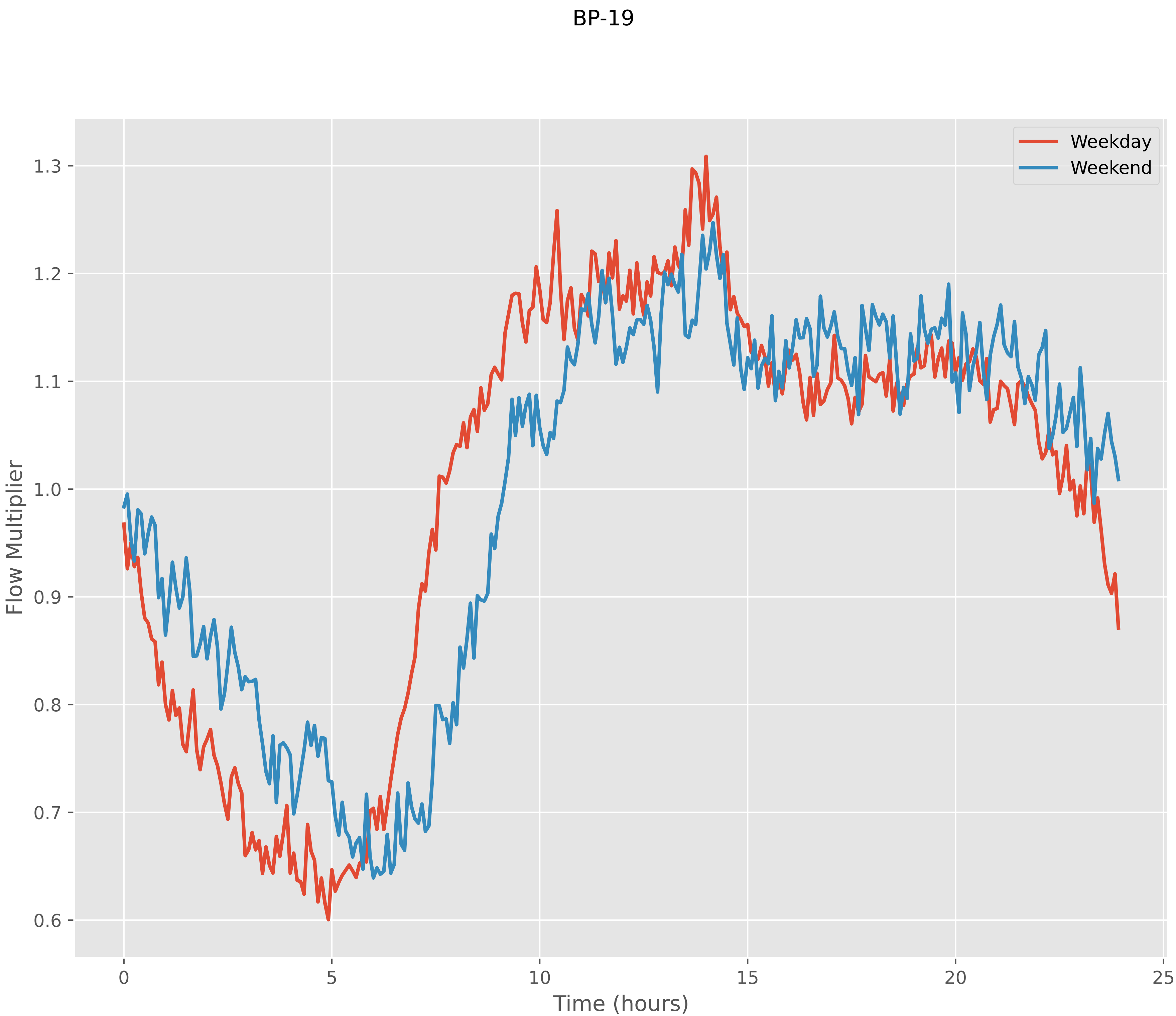

BH-03
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25

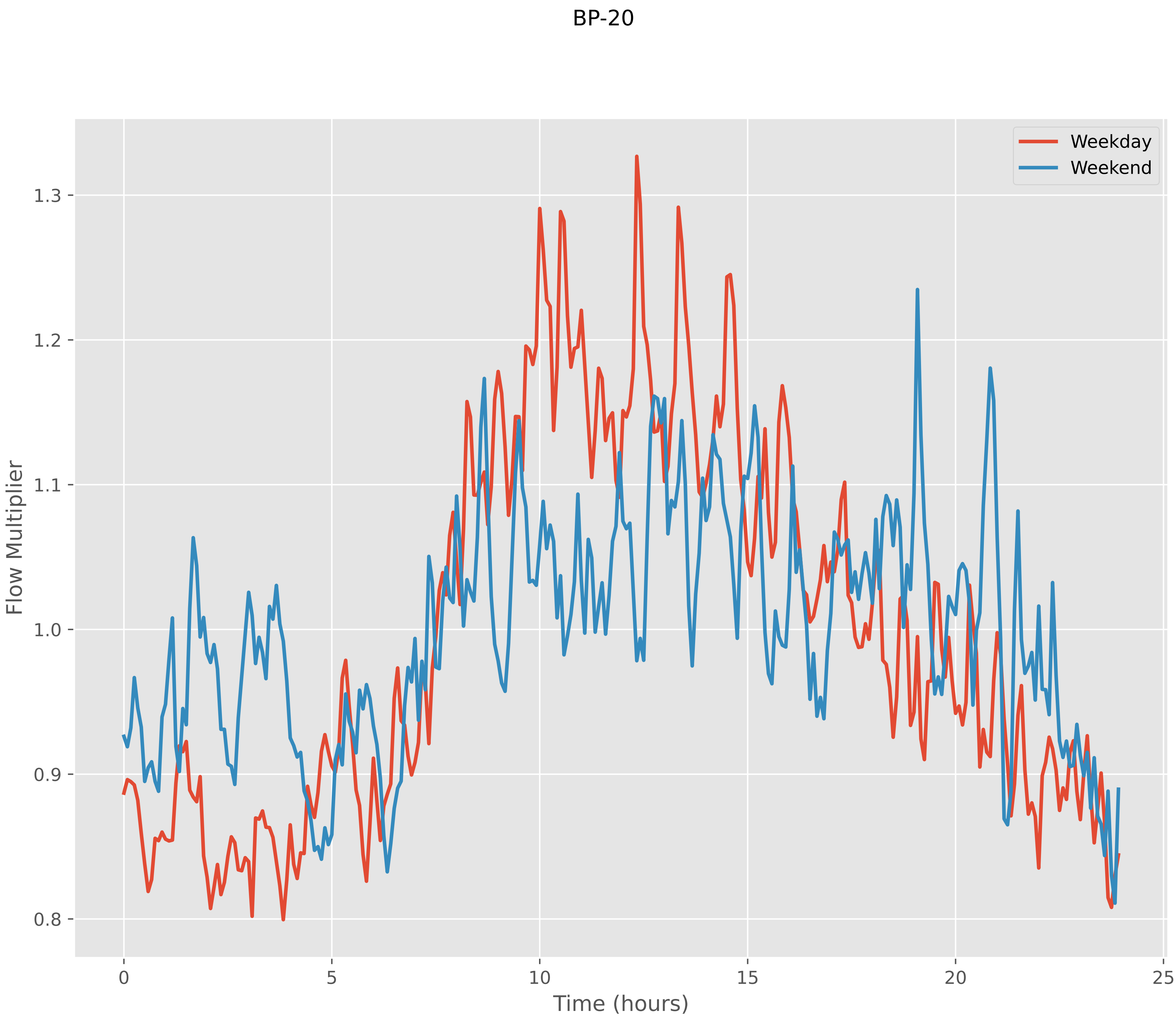

BH-04
Weekday
Weekend
Flow Multiplier
Time (hours)
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25

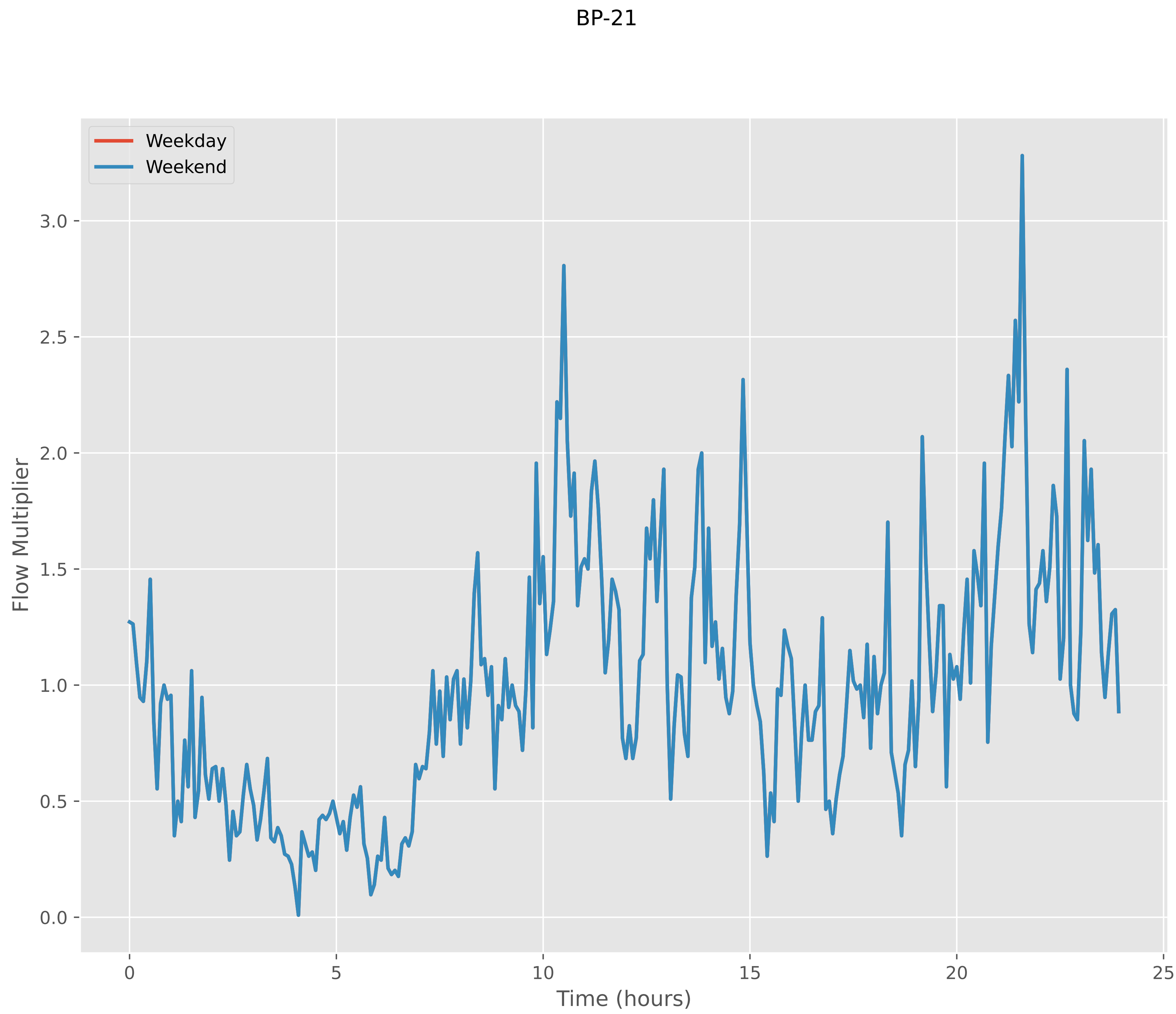

BH-05
Weekday
Weekend
Flow Multiplier
Time (hours)
0
5
10
15
20
25
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6


BH-06
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25

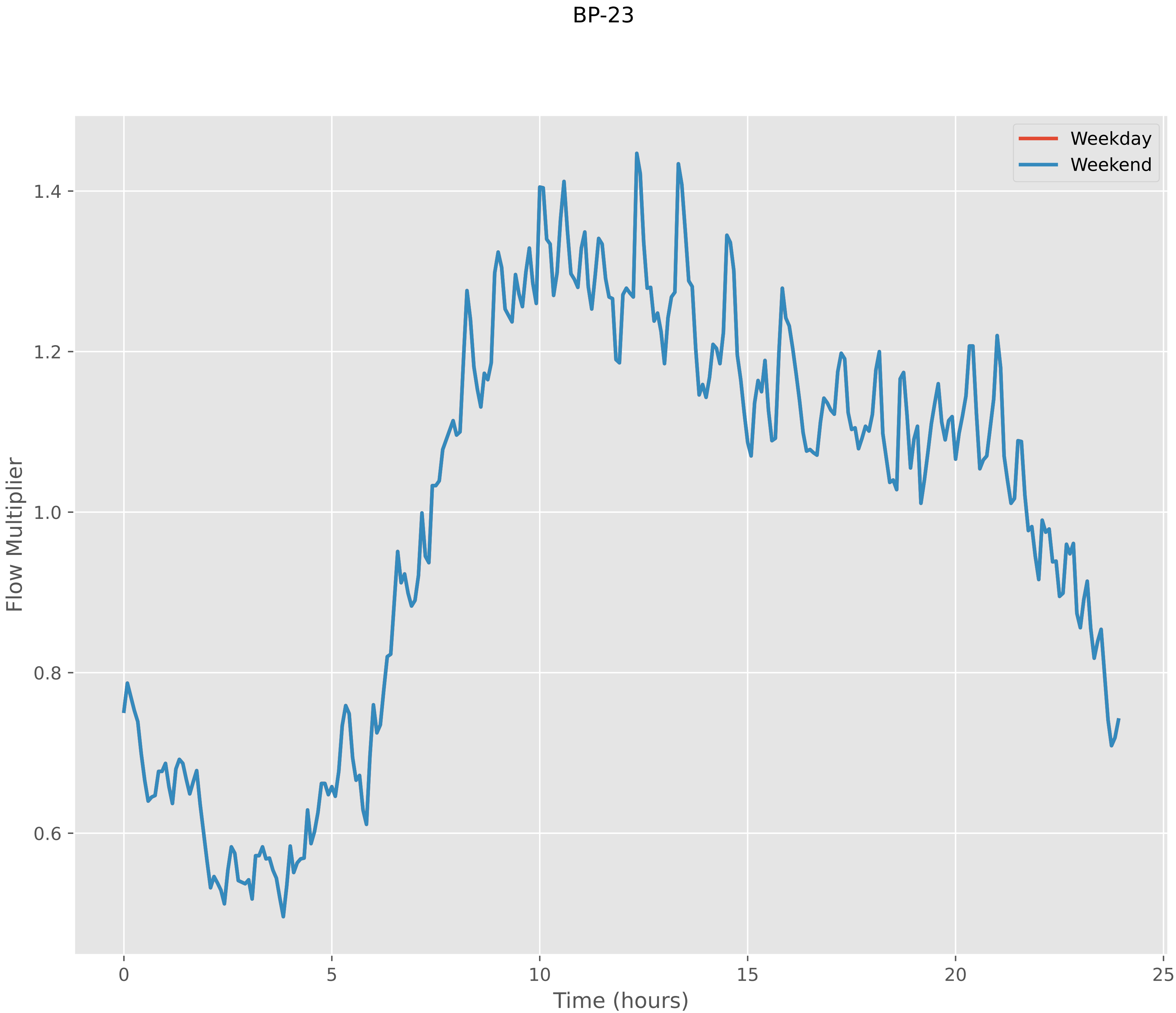

BH-07
Weekday
Weekend
Flow Multiplier
Time (hours)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25


BP-19
Weekday
Weekend
Flow Multiplier
Time (hours)
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
0
5
10
15
20
25


BP-20
Weekday
Weekend
Flow Multiplier
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
Time (hours)

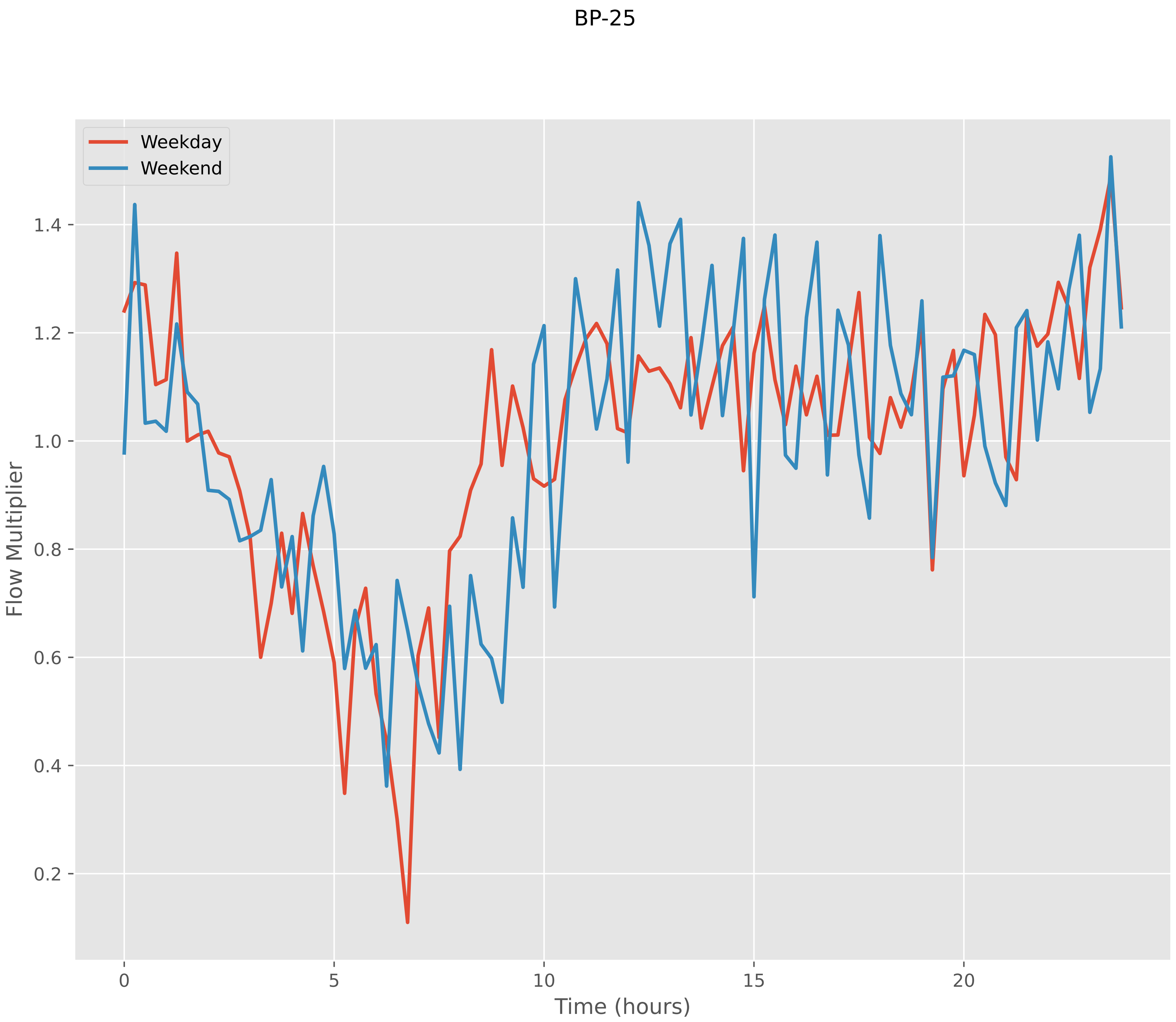

BP-21
Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
5
10
15
20
25

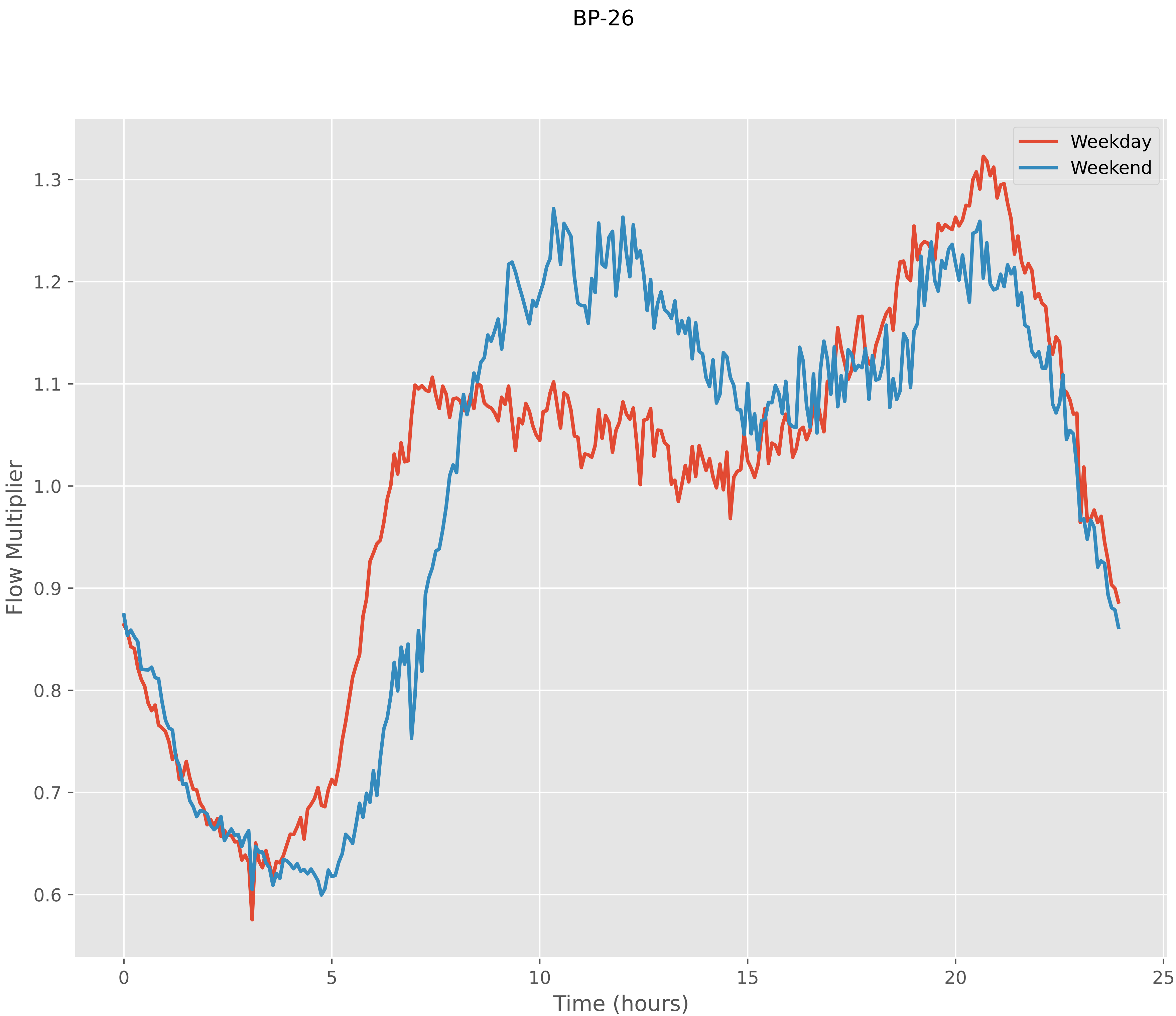
BP-22
Weekday
Weekend
Flow Multiplier
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25
Time (hours)



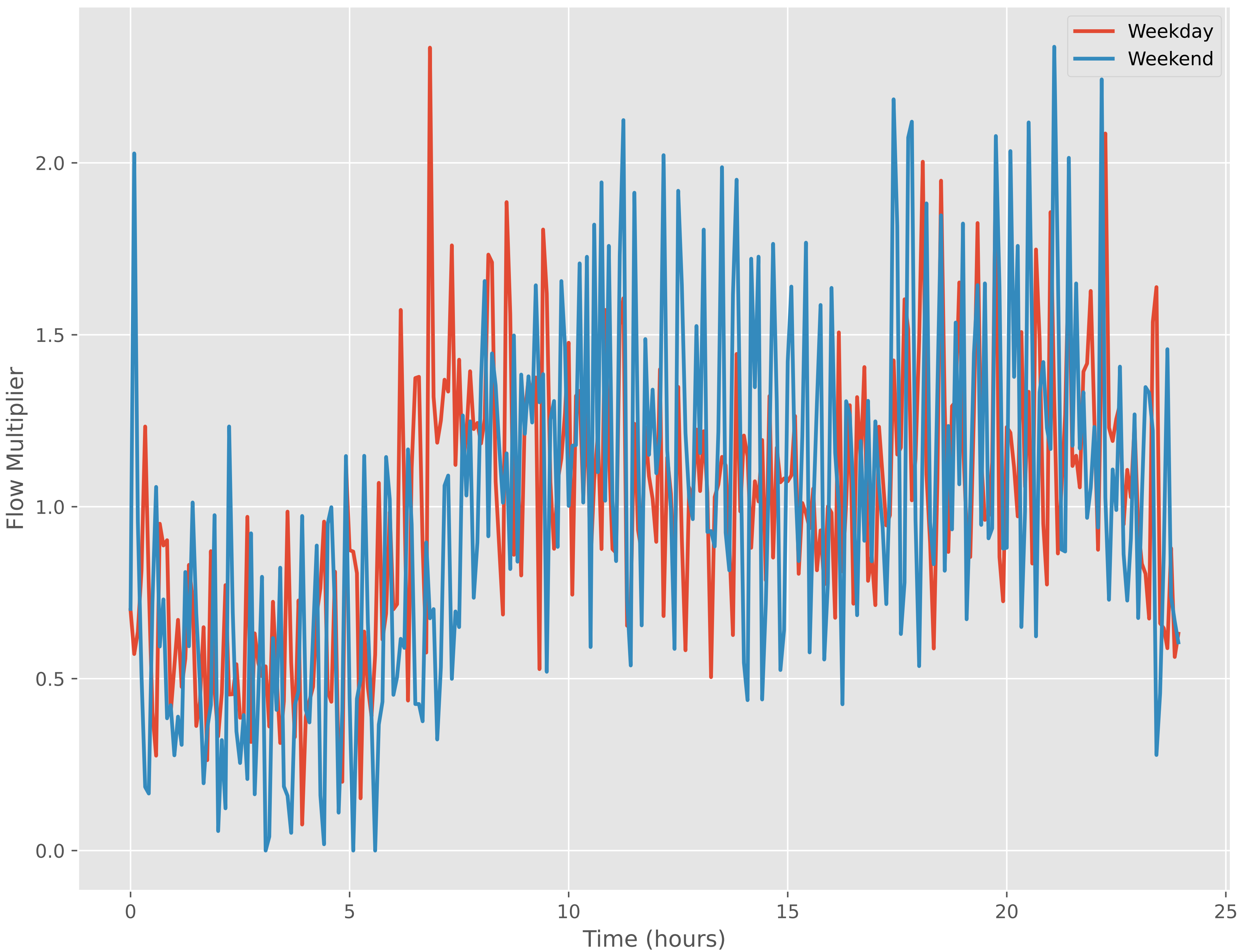
BP-23
Weekday
Weekend
1.4
1.2
1.0
0.8
0.6
Flow Multiplier
0
5
10
15
20
25
Time (hours)

BP-24
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25

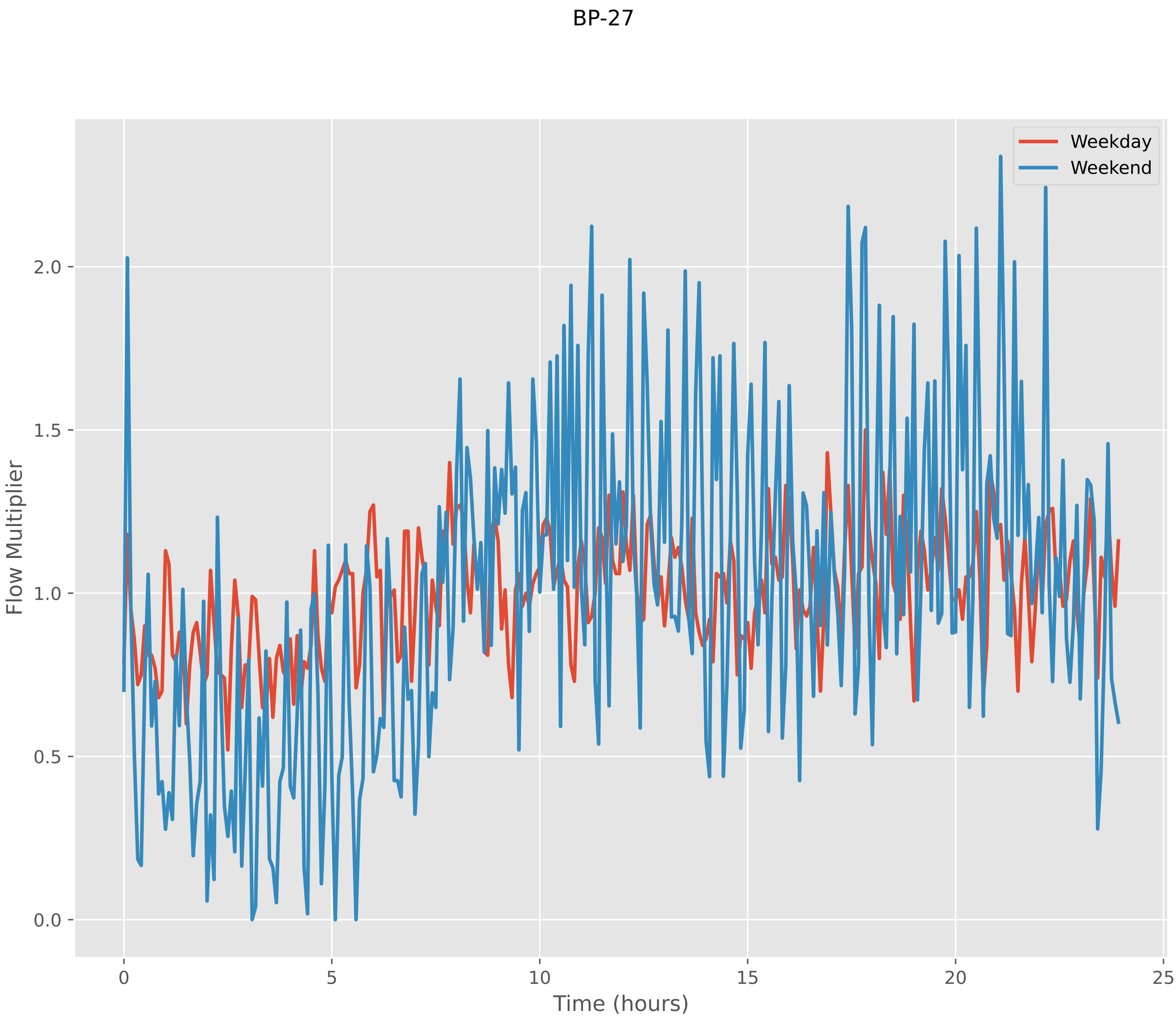

BP-25
Weekday
Weekend
Flow Multiplier
Time (hours)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20

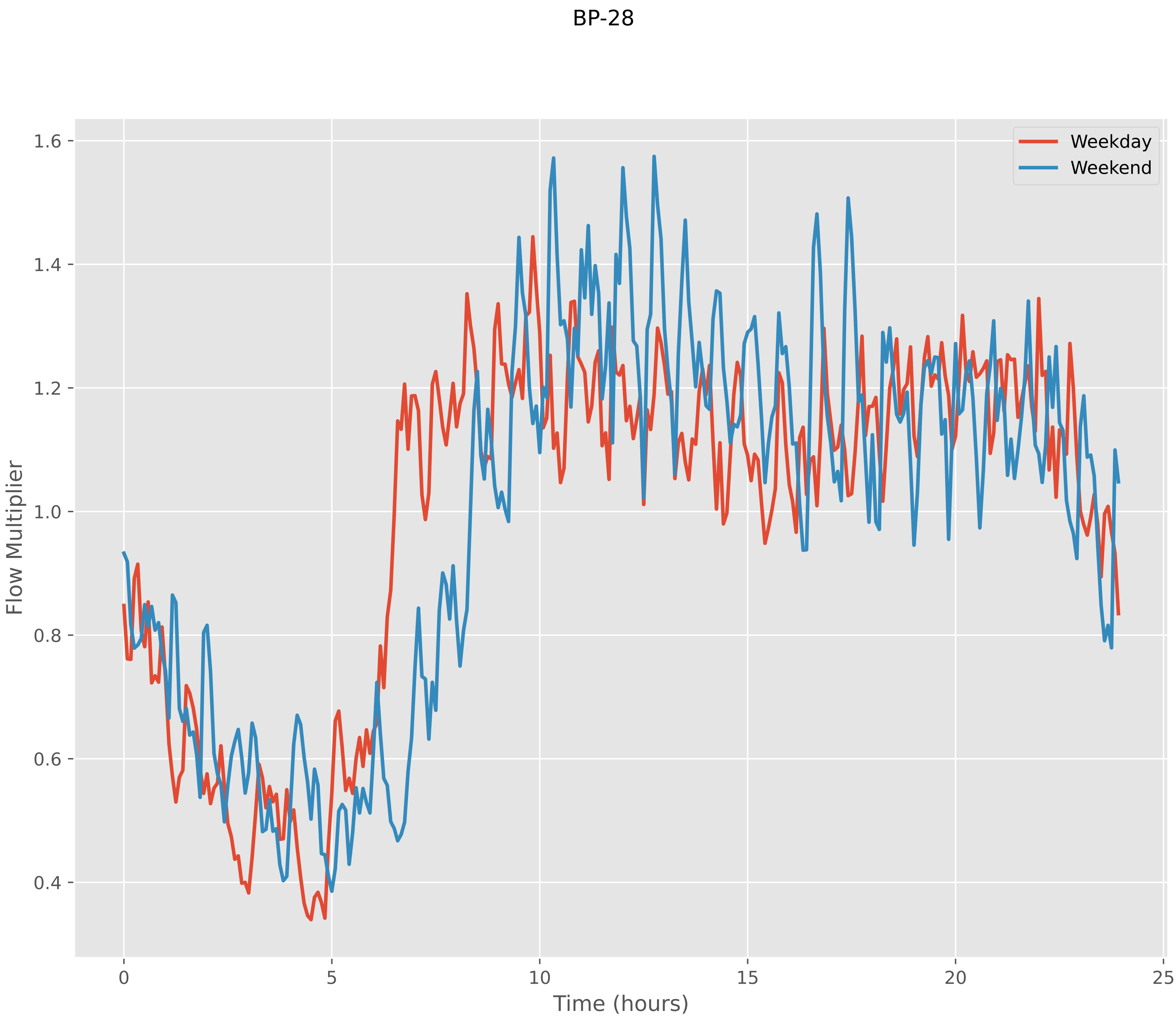

BP-26
Weekday
Weekend
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
Flow Multiplier
0
5
10
15
20
25
Time (hours)

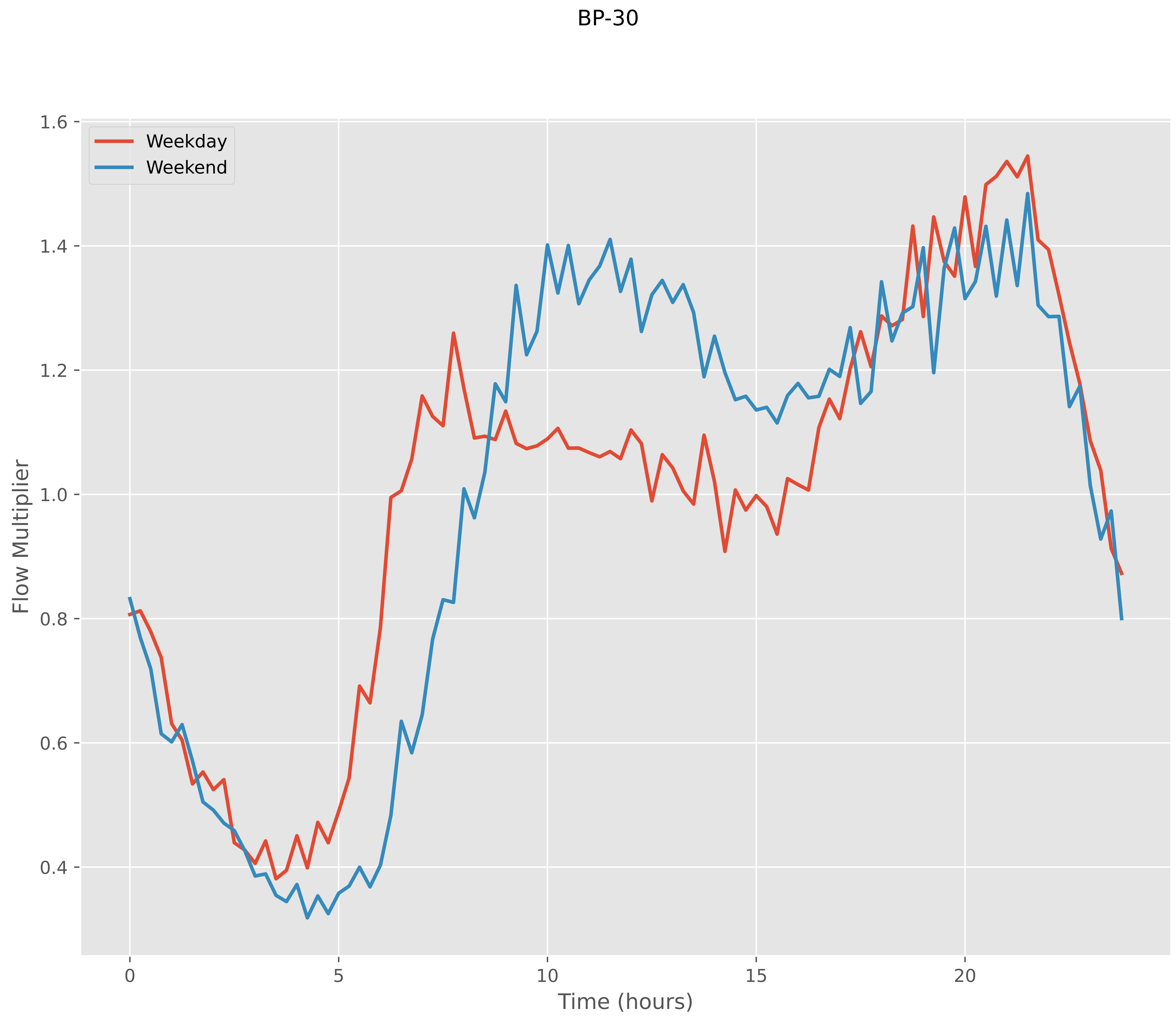
BP-27-01



Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
0
5
10
15
20
25


BP-27
Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
0
5
10
15
20
25

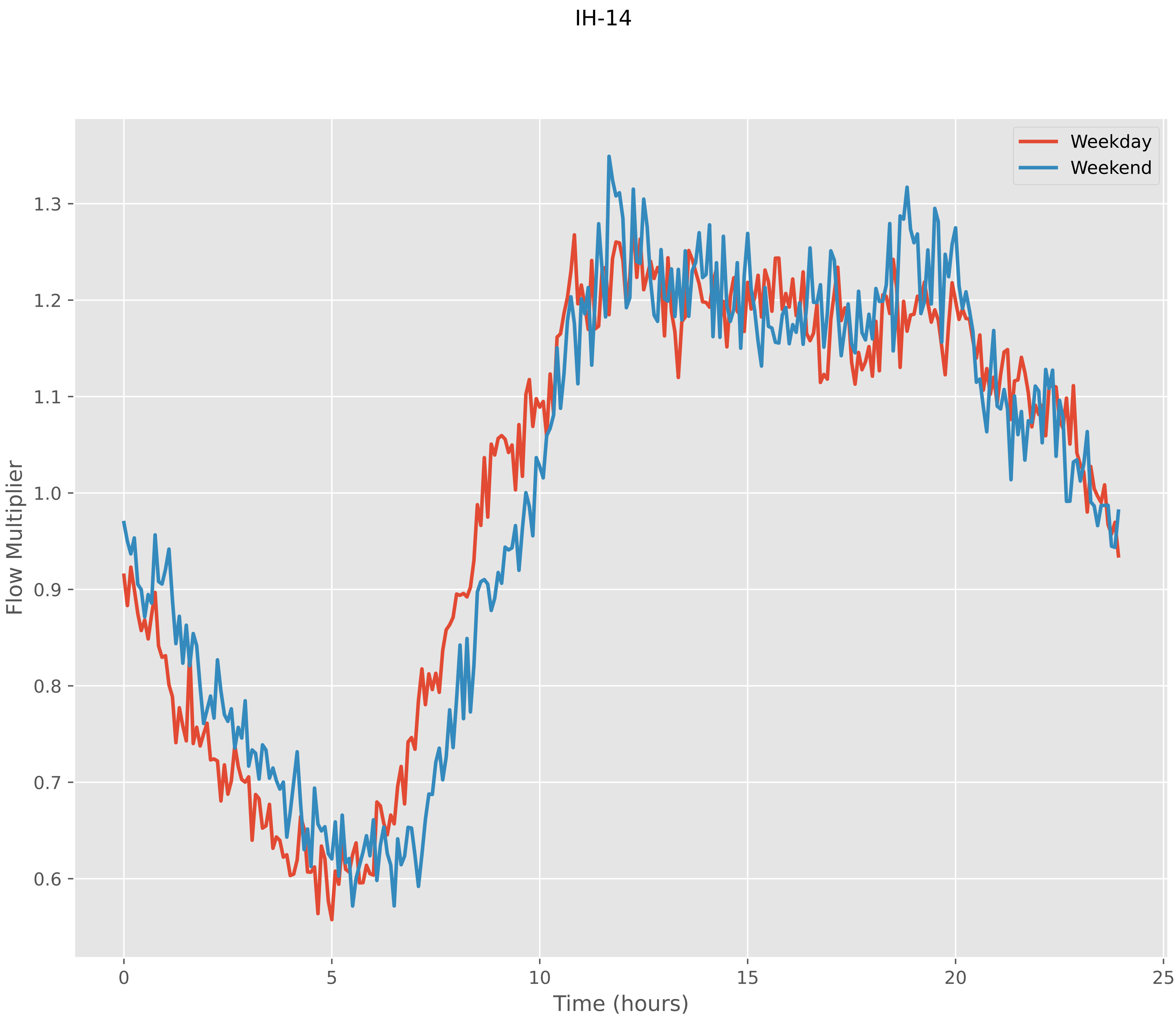

BP-28
Flow Multiplier
Time (hours)
Weekday
Weekend
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25

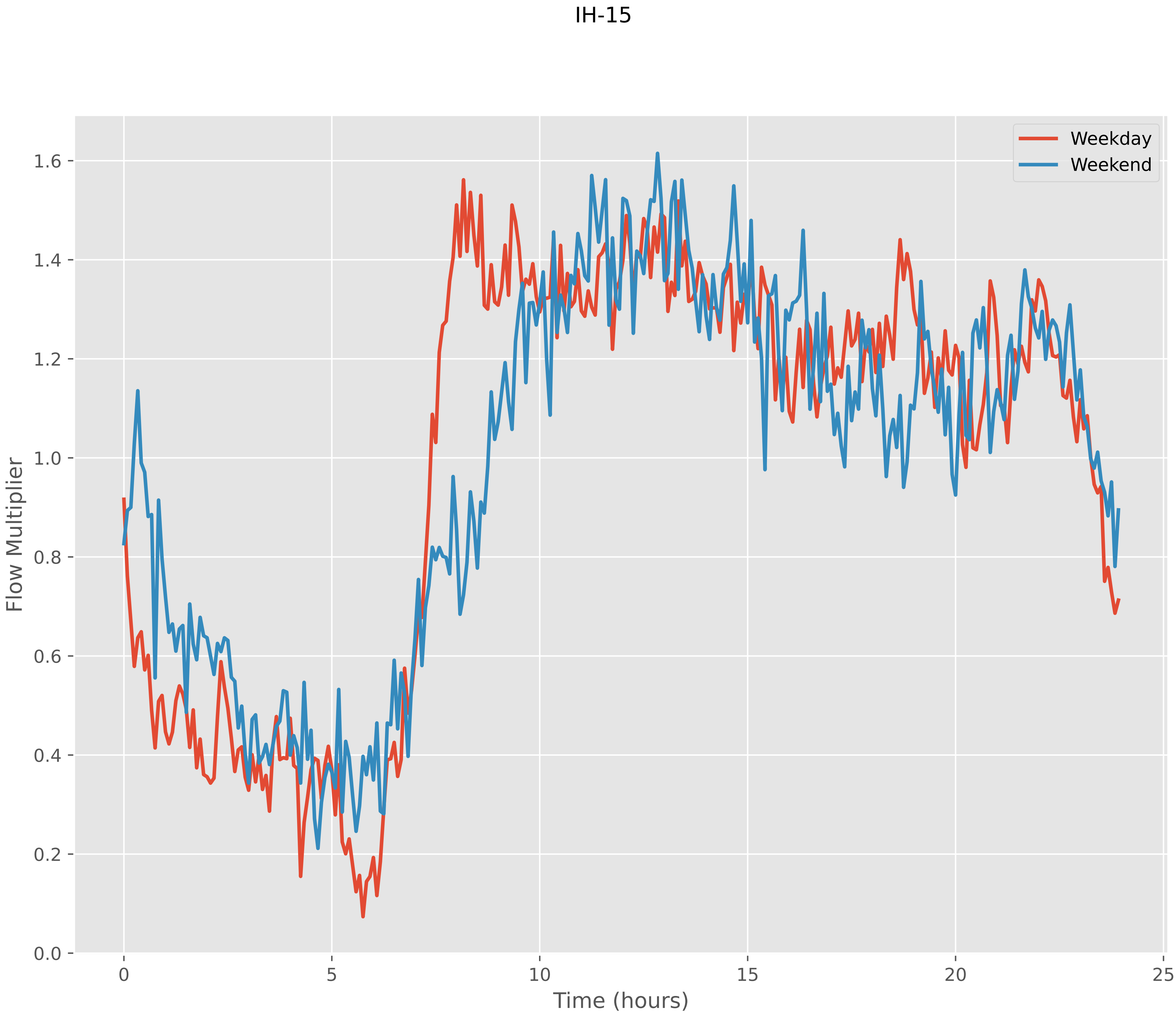


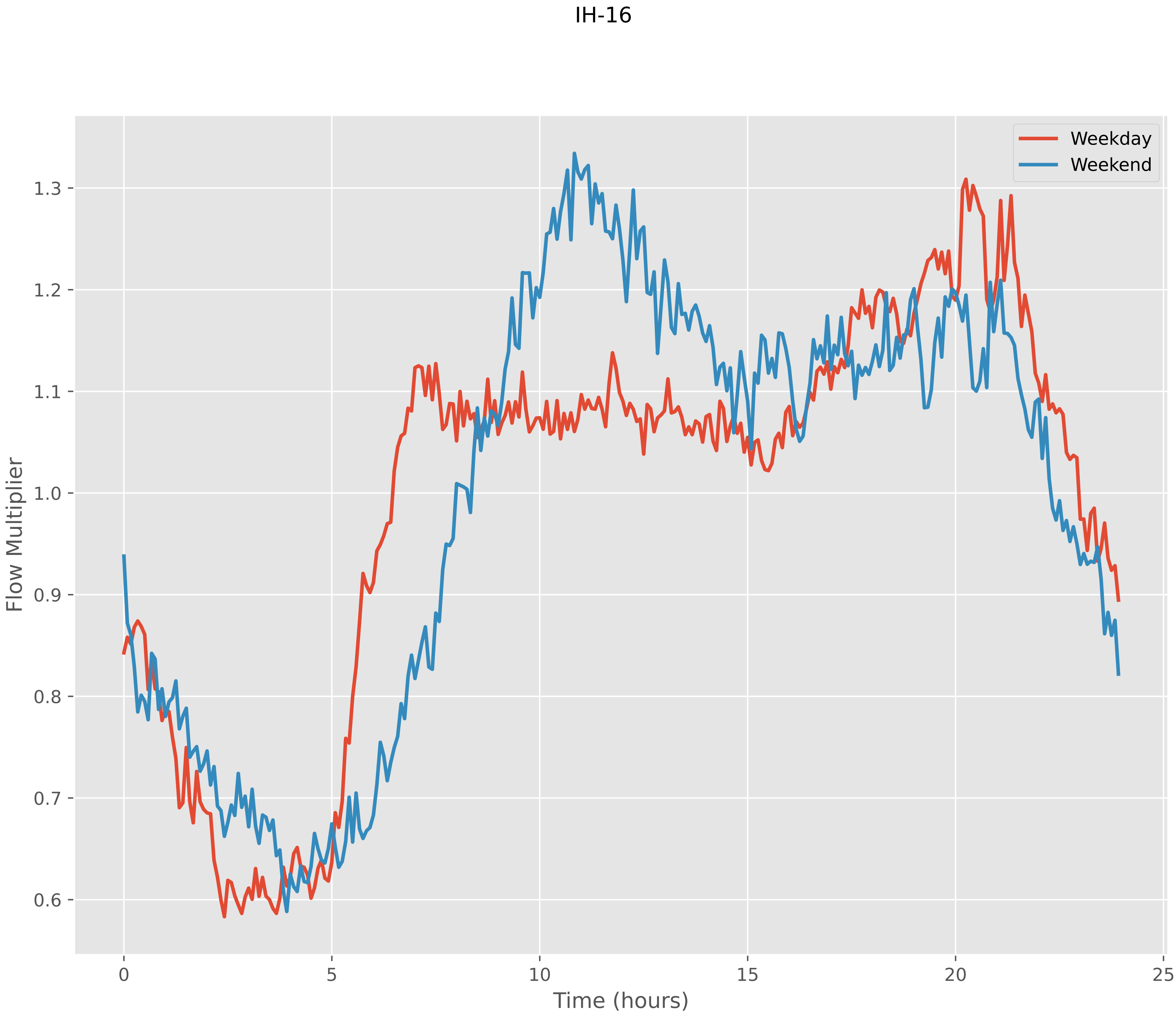
BP-30
Weekday
Weekend
Flow Multiplier
Time (hours)
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20

IH-12
Flow Multiplier
Time (hours)
Weekday
Weekend
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0
5
10
15
20
25

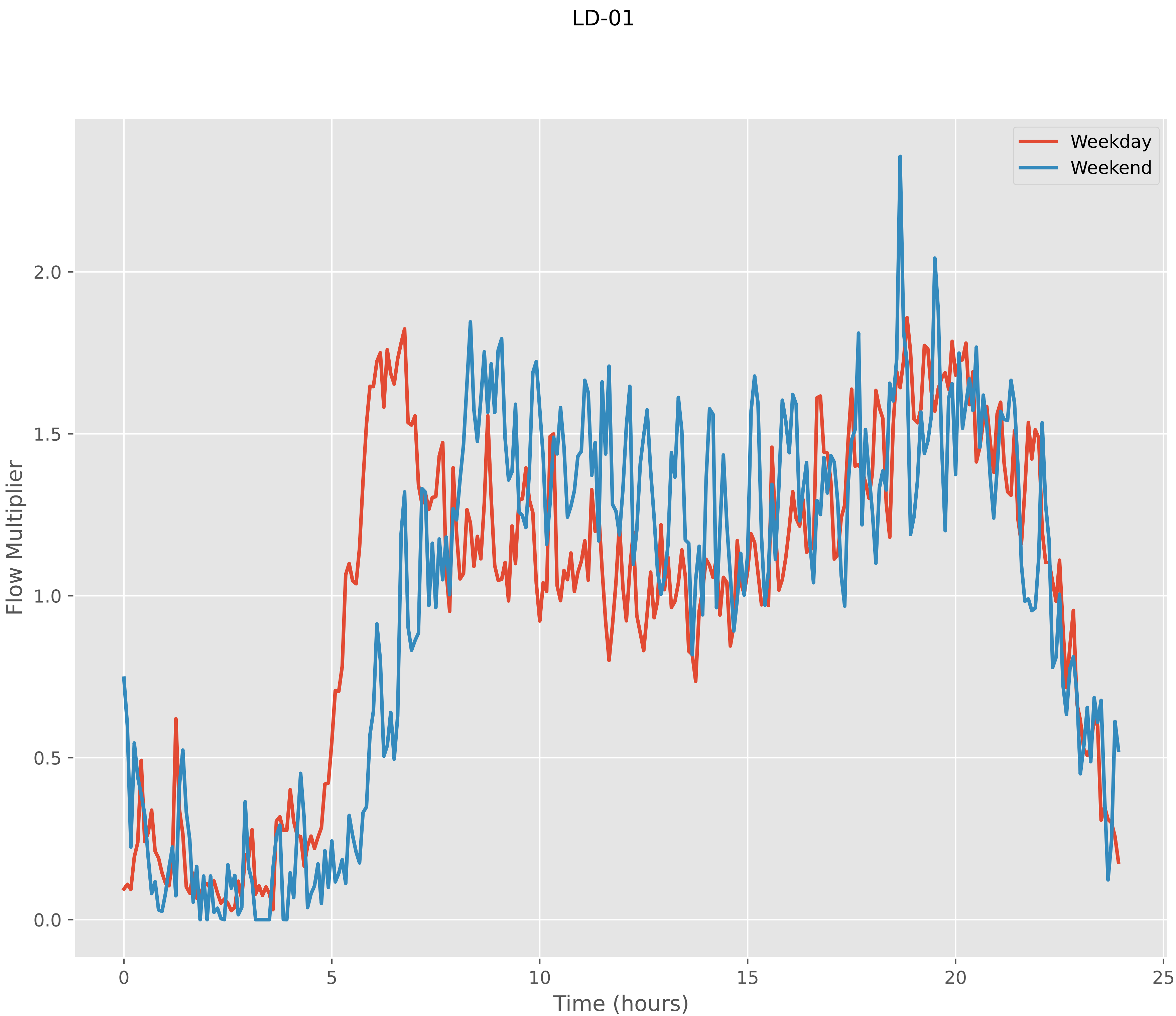
IH-13
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25

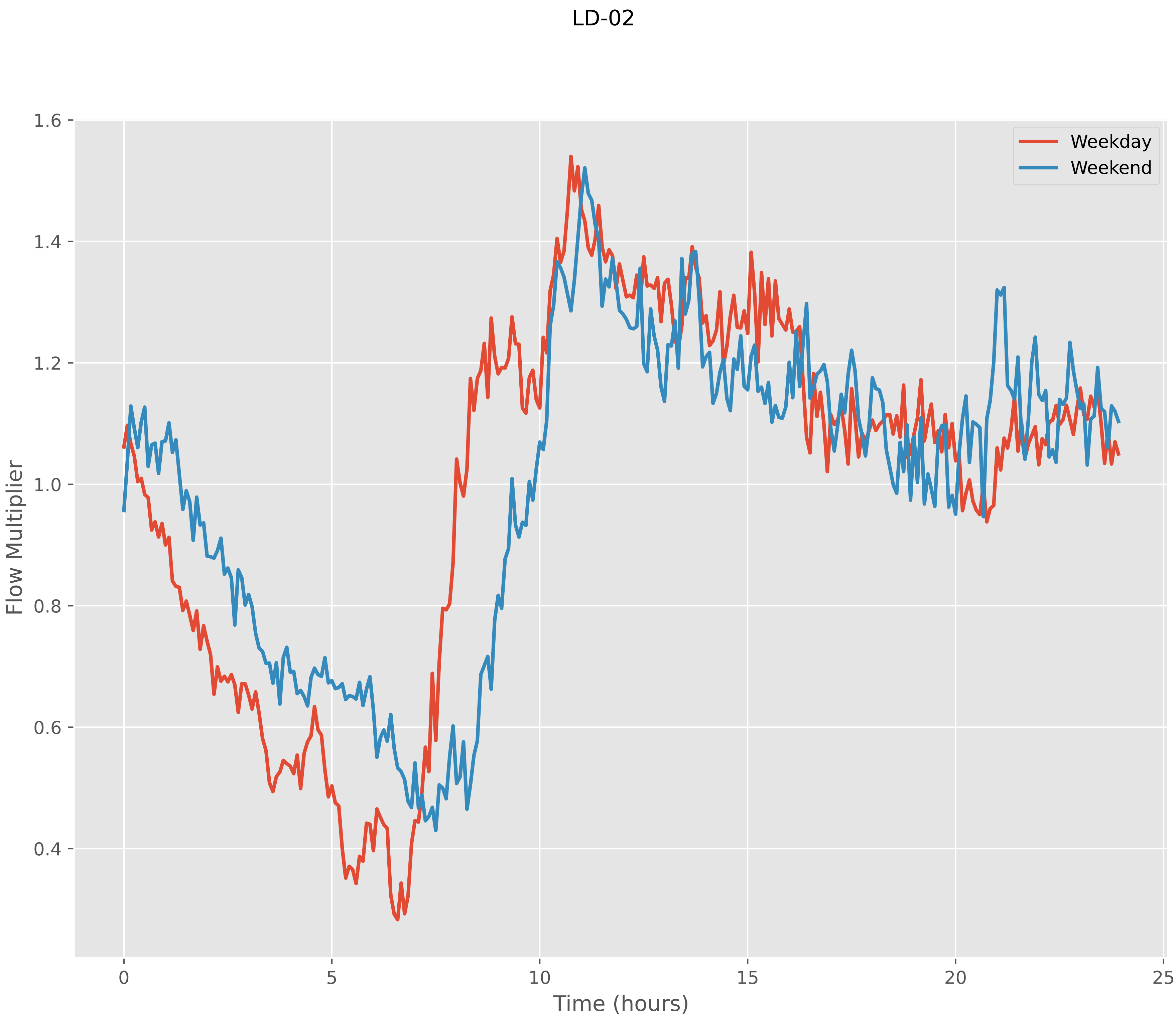

IH-14
Weekday
Weekend
Flow Multiplier
Time (hours)
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
0
5
10
15
20
25

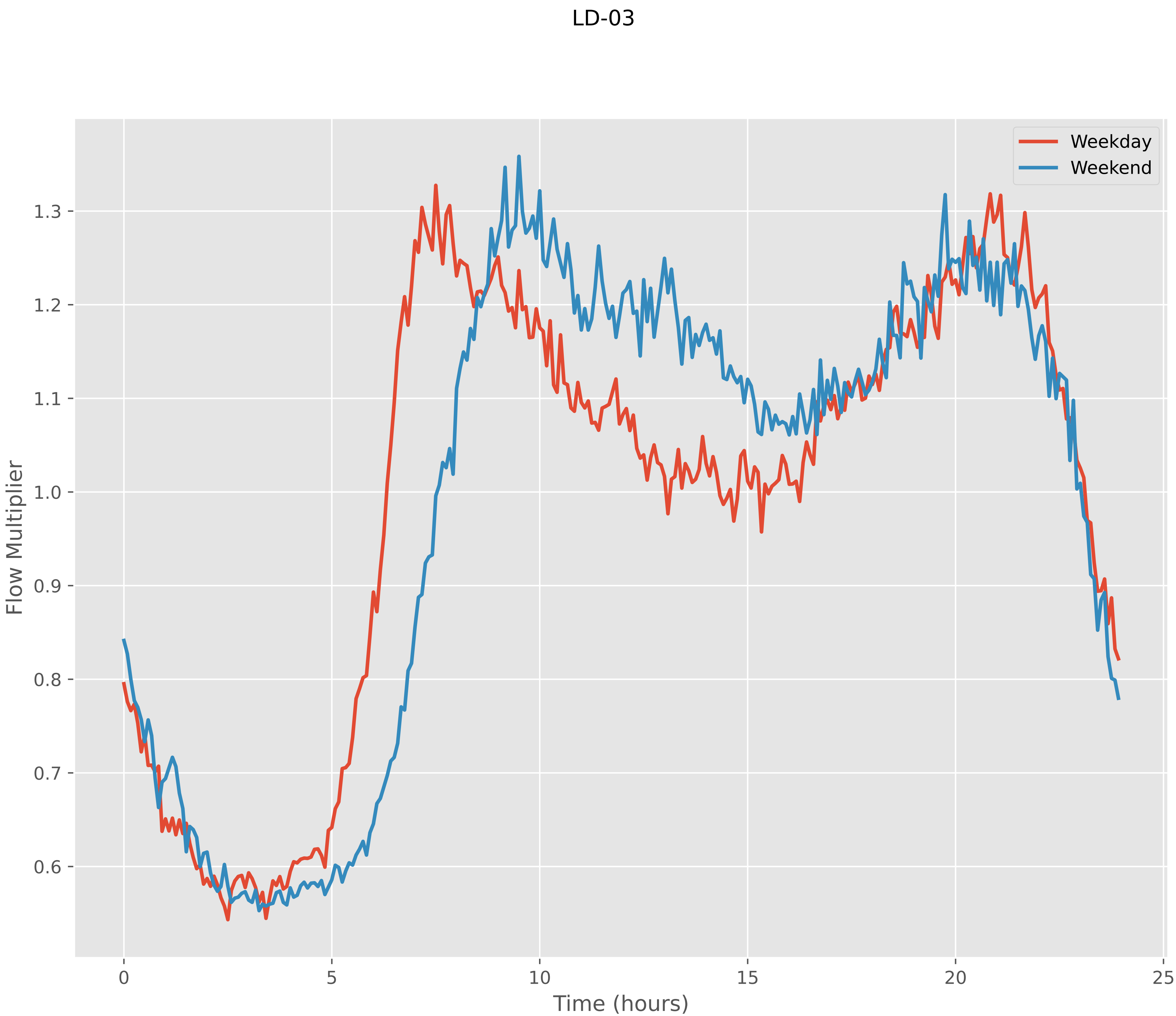

IH-15
Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25



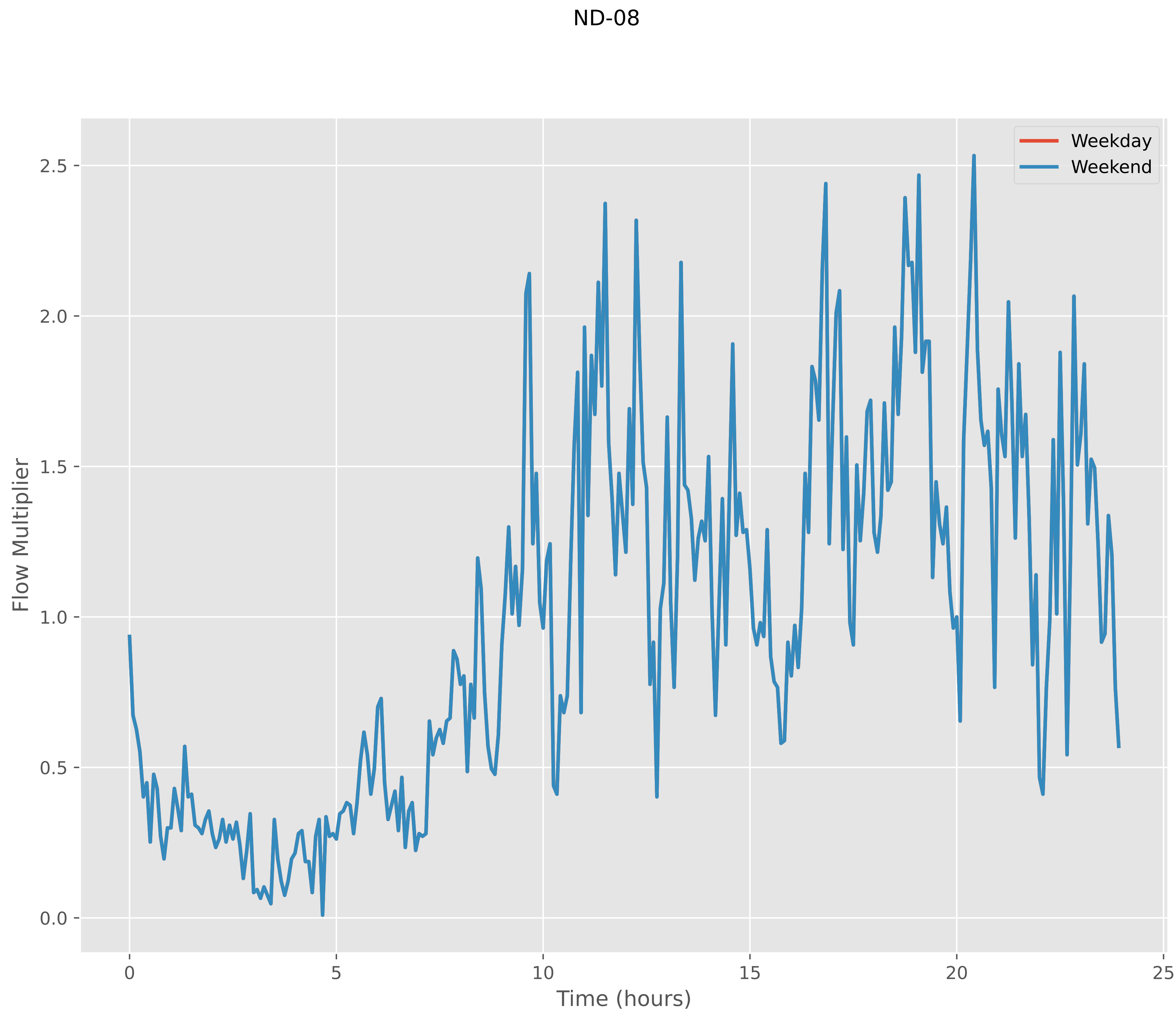
IH-16
Weekday
Weekend
Flow Multiplier
Time (hours)
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0
5
10
15
20
25

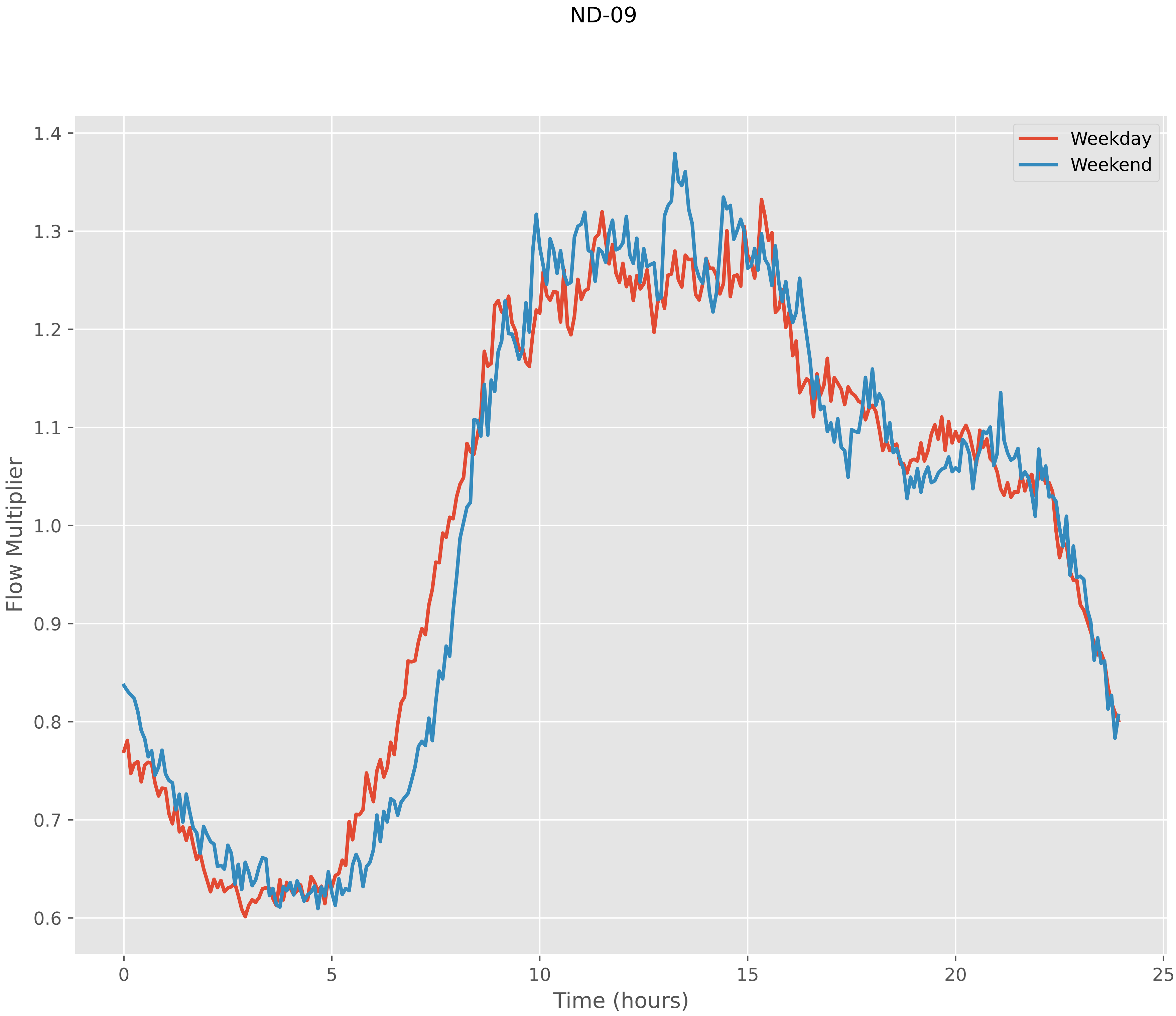

LD-01
Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
0
5
10
15
20
25


LD-02
Weekday
Weekend
Flow Multiplier
Time (hours)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25

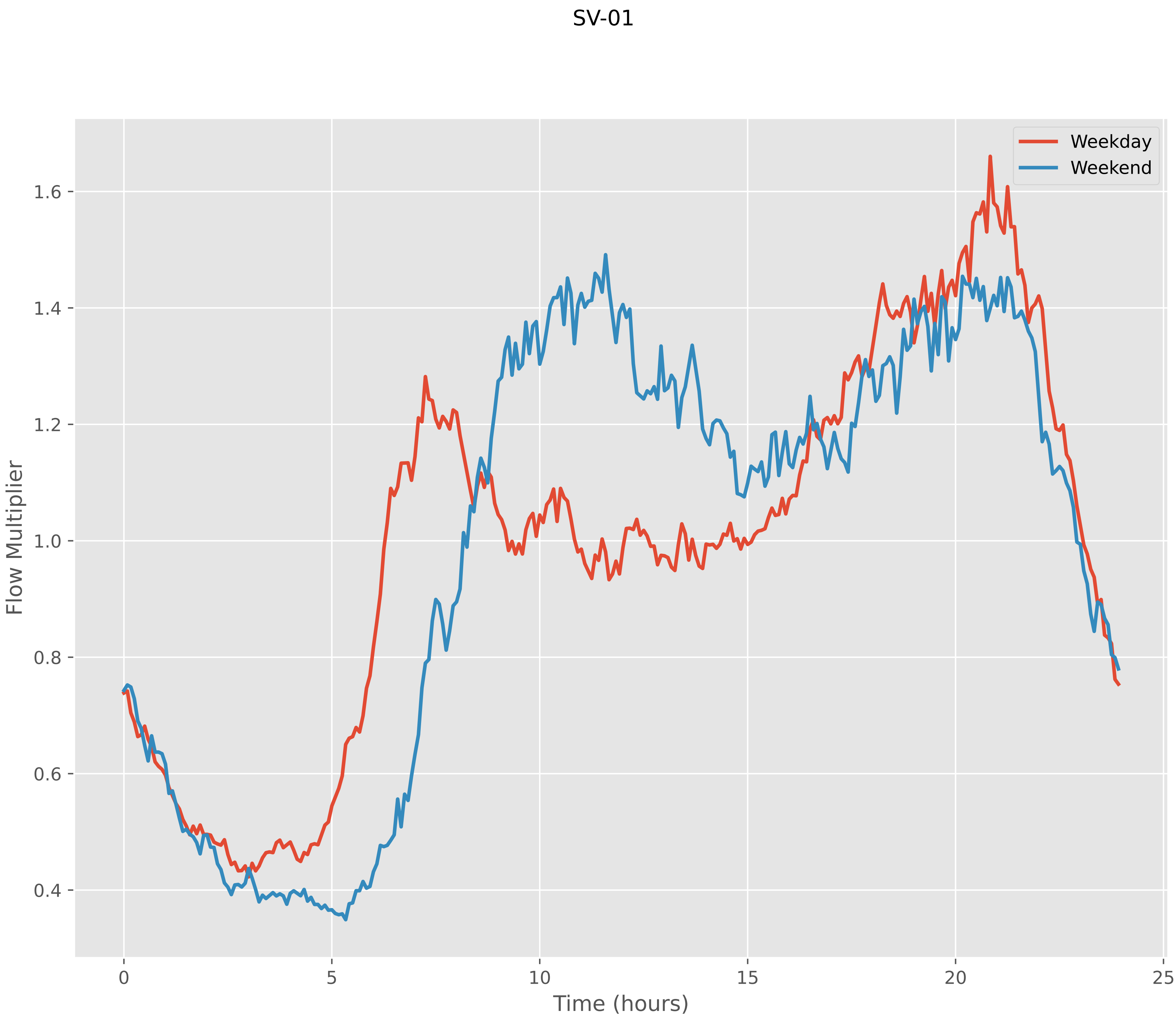


LD-03
Weekday
Weekend
Flow Multiplier
Time (hours)
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0
5
10
15
20
25

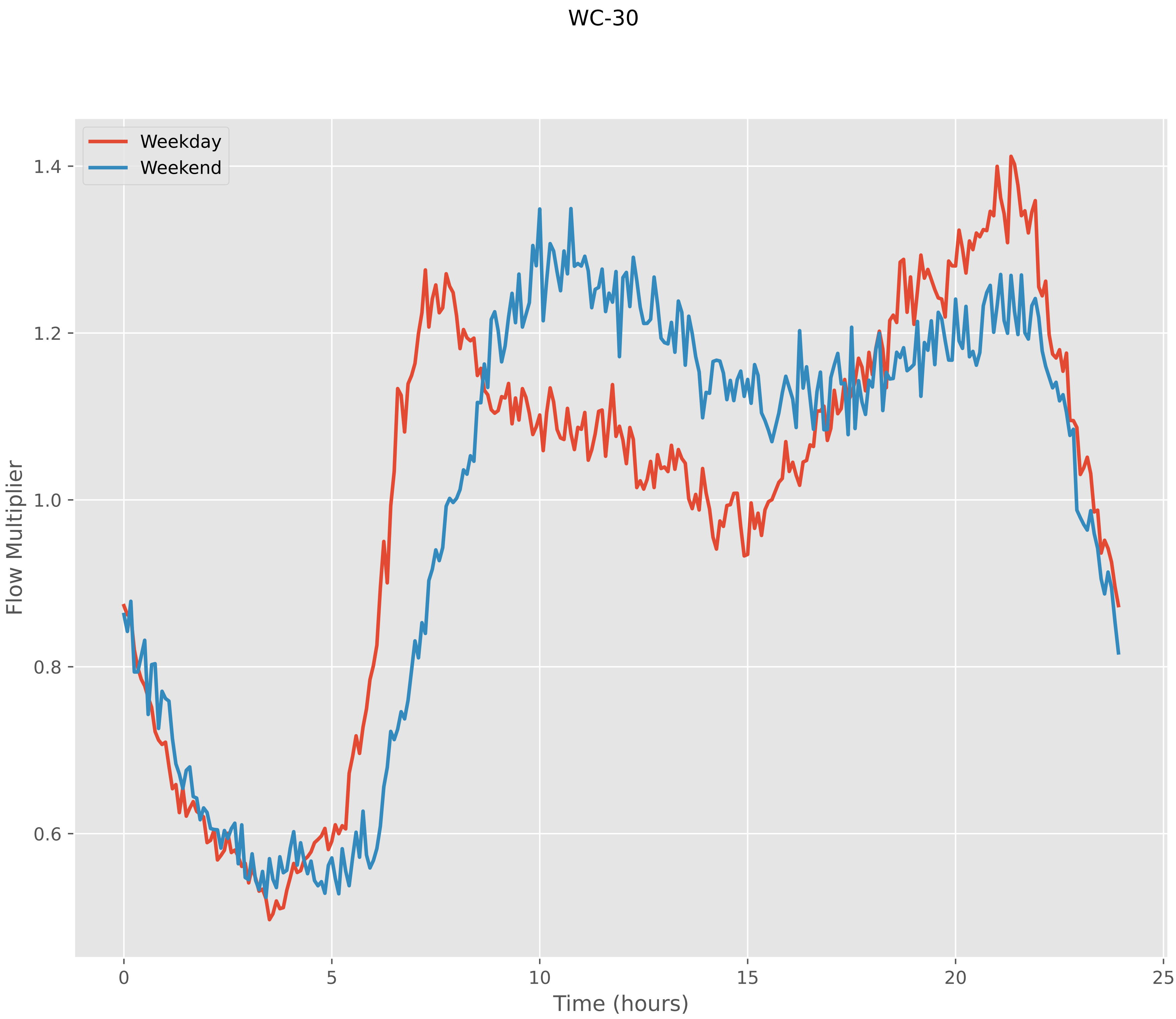

ND-08
Flow Multiplier
Time (hours)
Weekday
Weekend
0.0
0.5
1.0
1.5
2.0
2.5
0
5
10
15
20
25



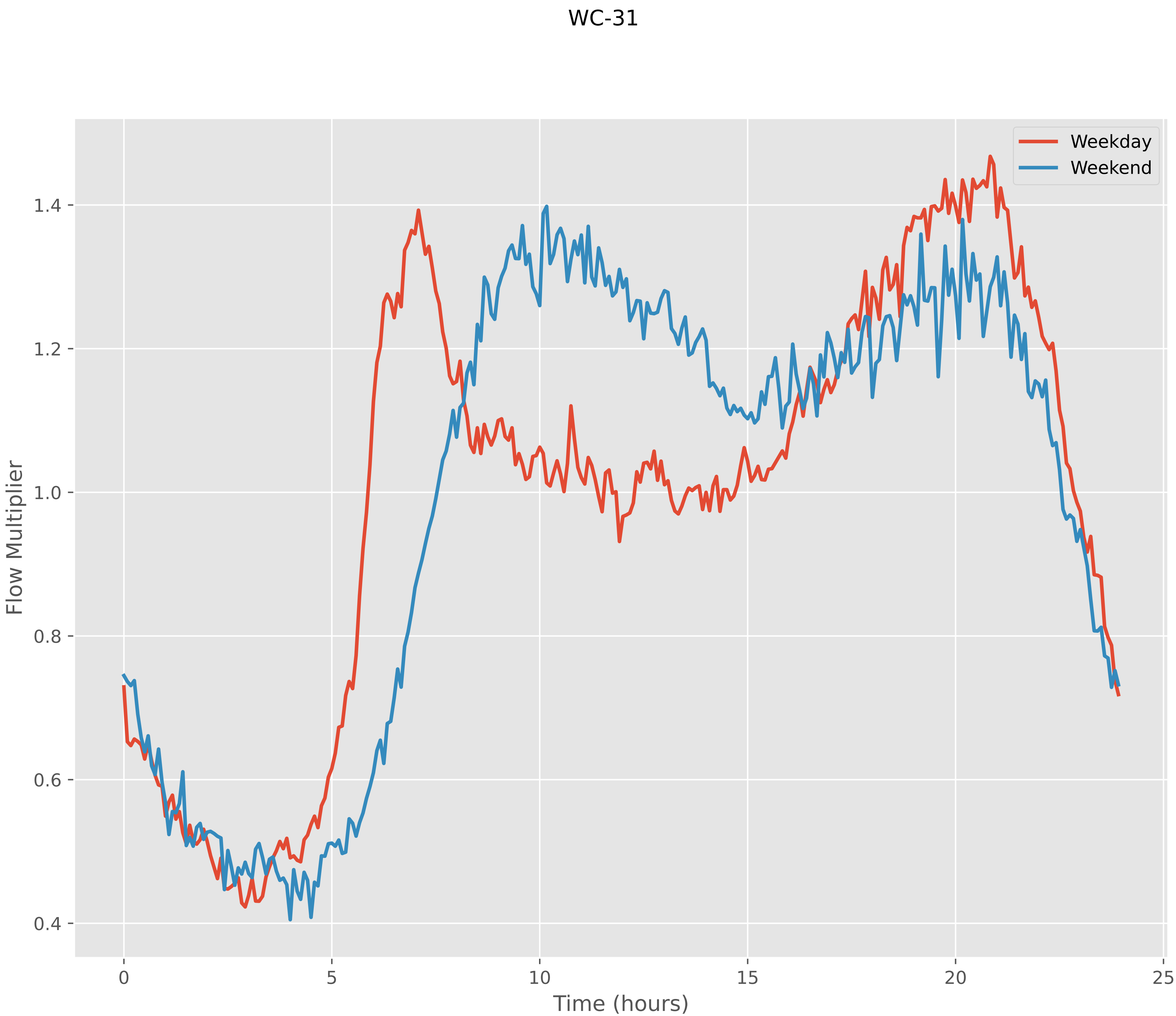
ND-09
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0
5
10
15
20
25



SV-01
Weekday
Weekend
Flow Multiplier
Time (hours)
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25



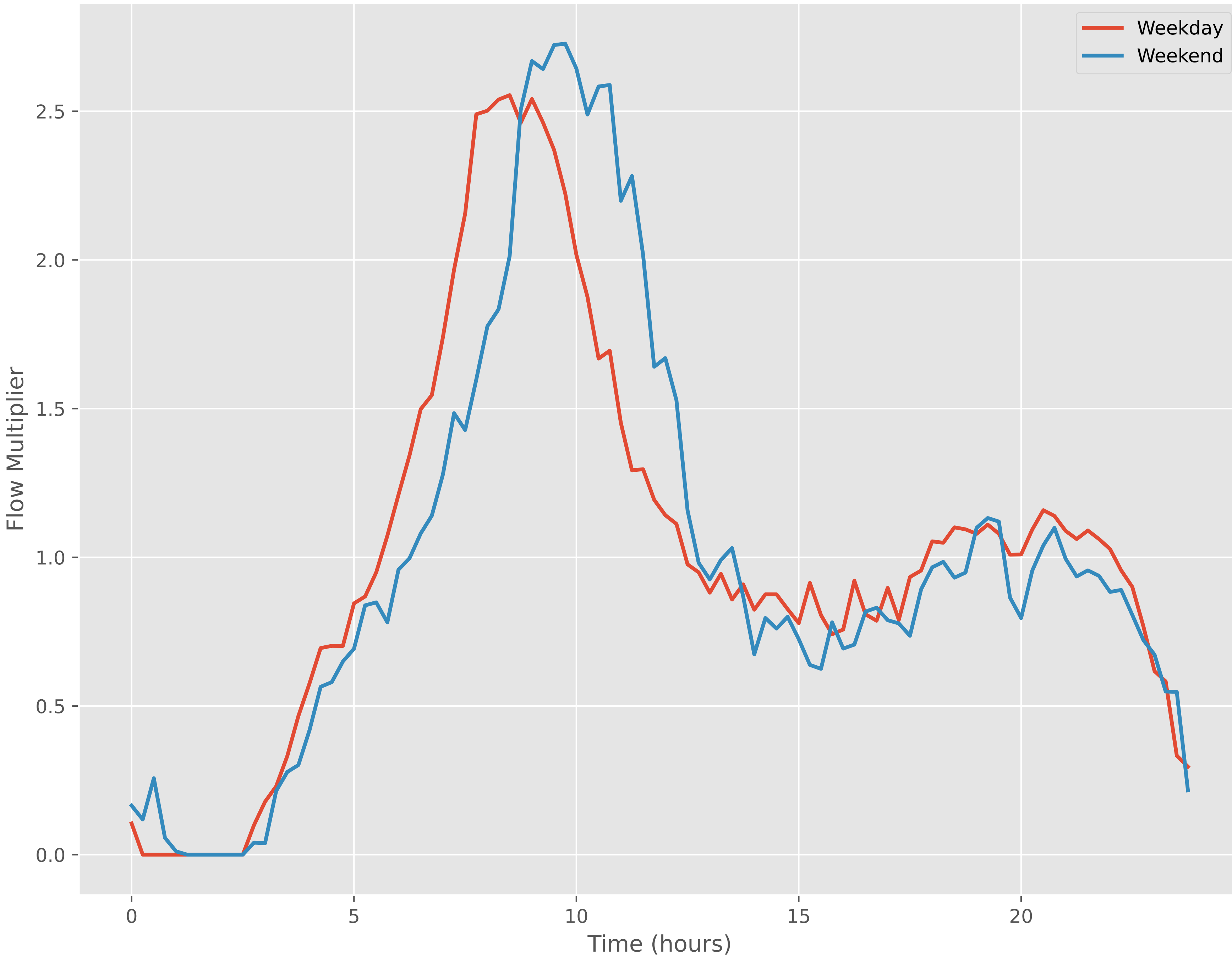
WC-30
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25

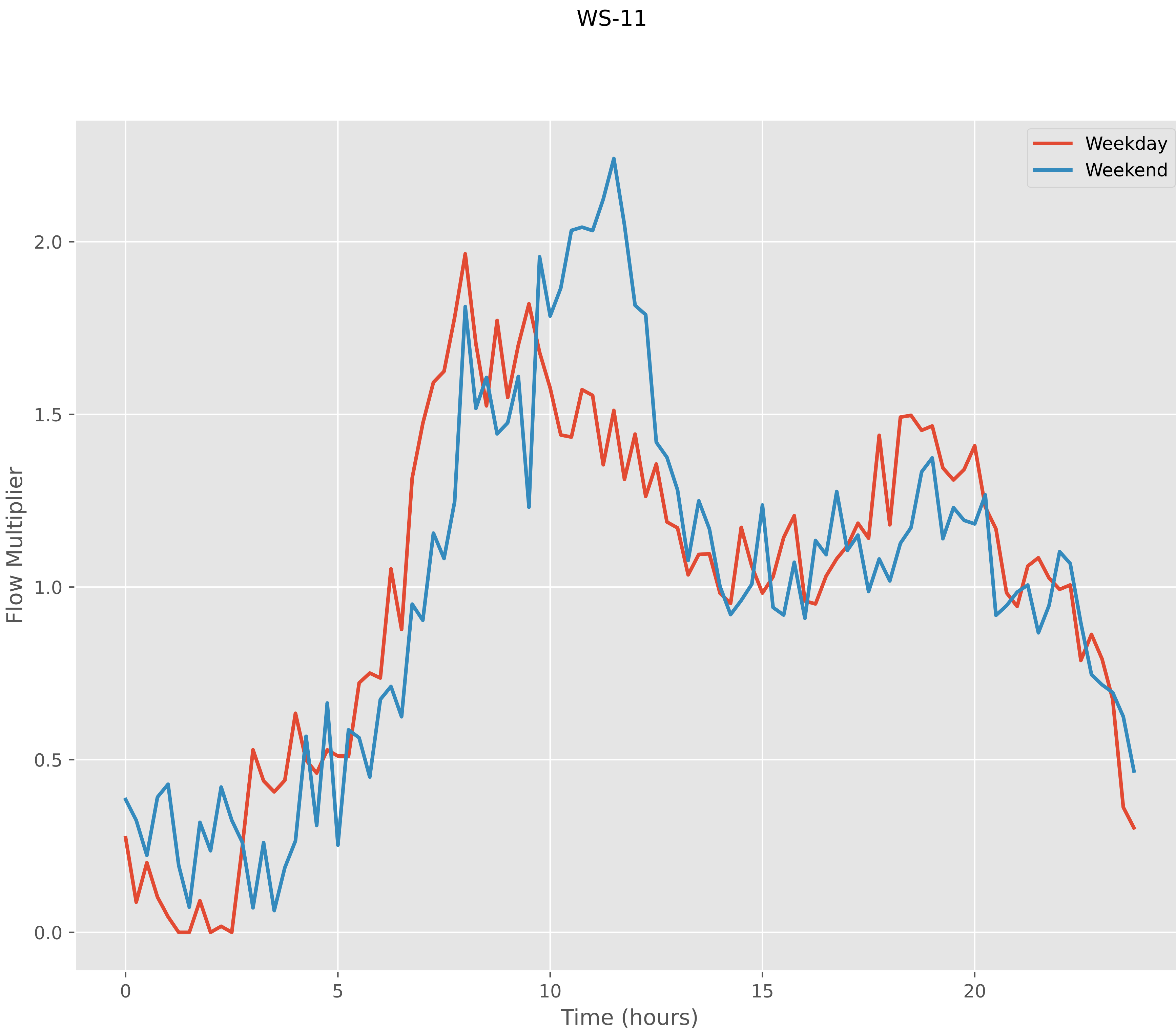


WC-31
Weekday
Weekend
Flow Multiplier
Time (hours)
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25


WC-32
Weekday
Weekend
Flow Multiplier
Time (hours)
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25

WS-01

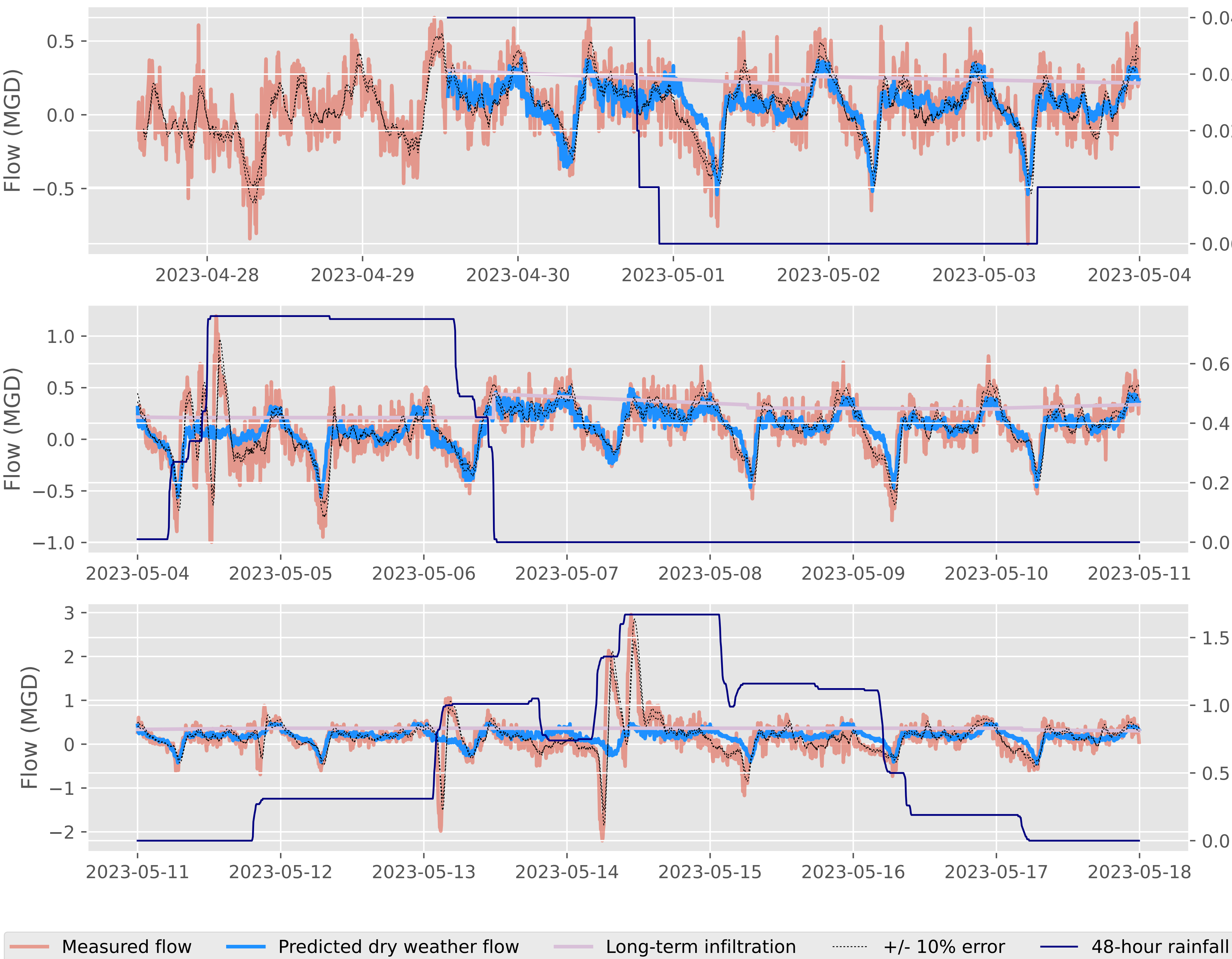

Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
2.5
0
5
10
15
20


WS-11
Weekday
Weekend
Flow Multiplier
Time (hours)
0.0
0.5
1.0
1.5
2.0
0
5
10
15
20

APPENDIX F

DRY-WEATHER CALIBRATION RESULTS

BH-02 Dry Weather Calibration Results

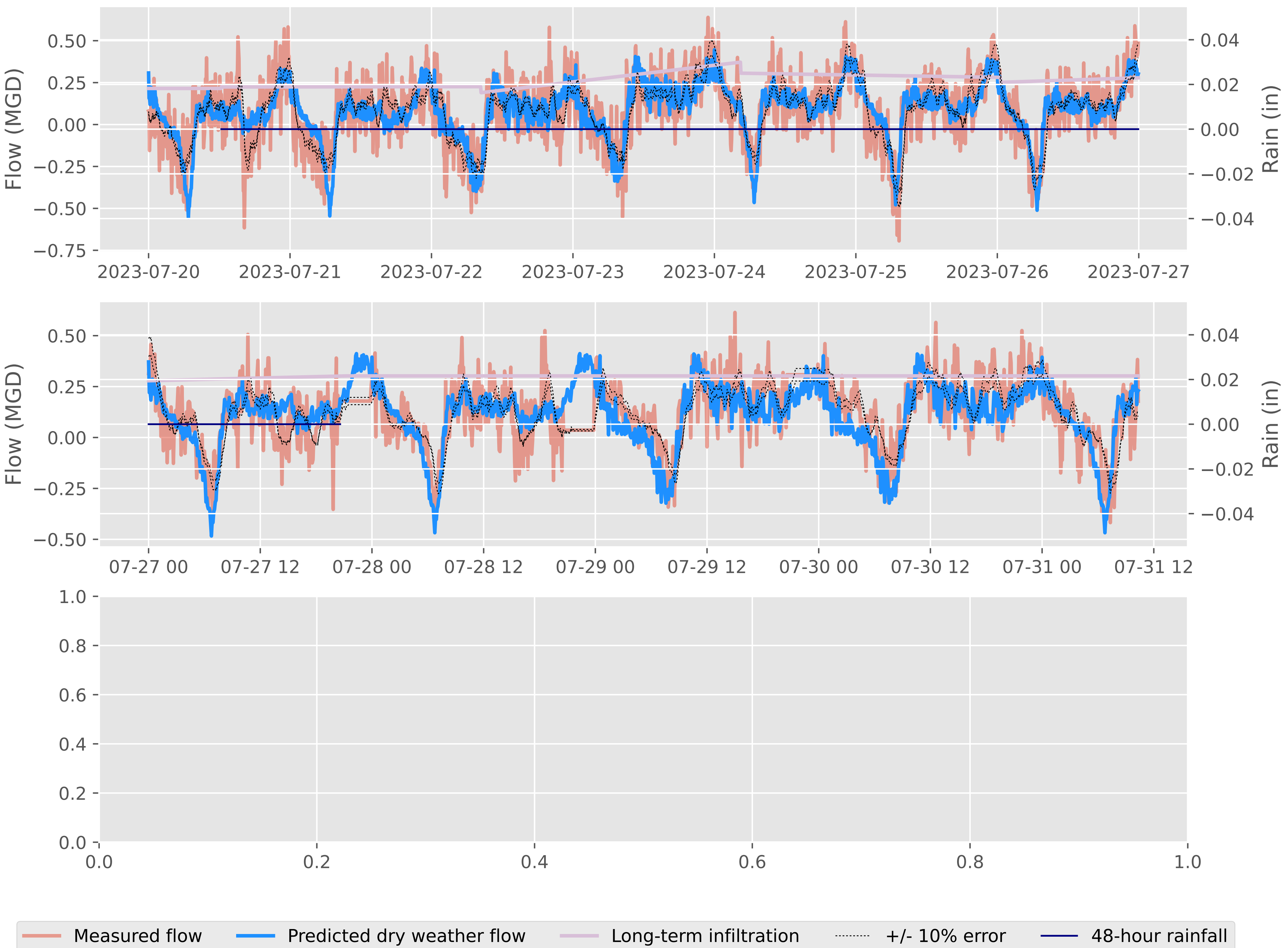


BH-02 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.5
0.0
−0.5
−1.0
−1.5
0.15
0.10
0.05
0.00
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
0.20
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2
0
−2
1.25
1.00
0.75
0.50
0.25
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

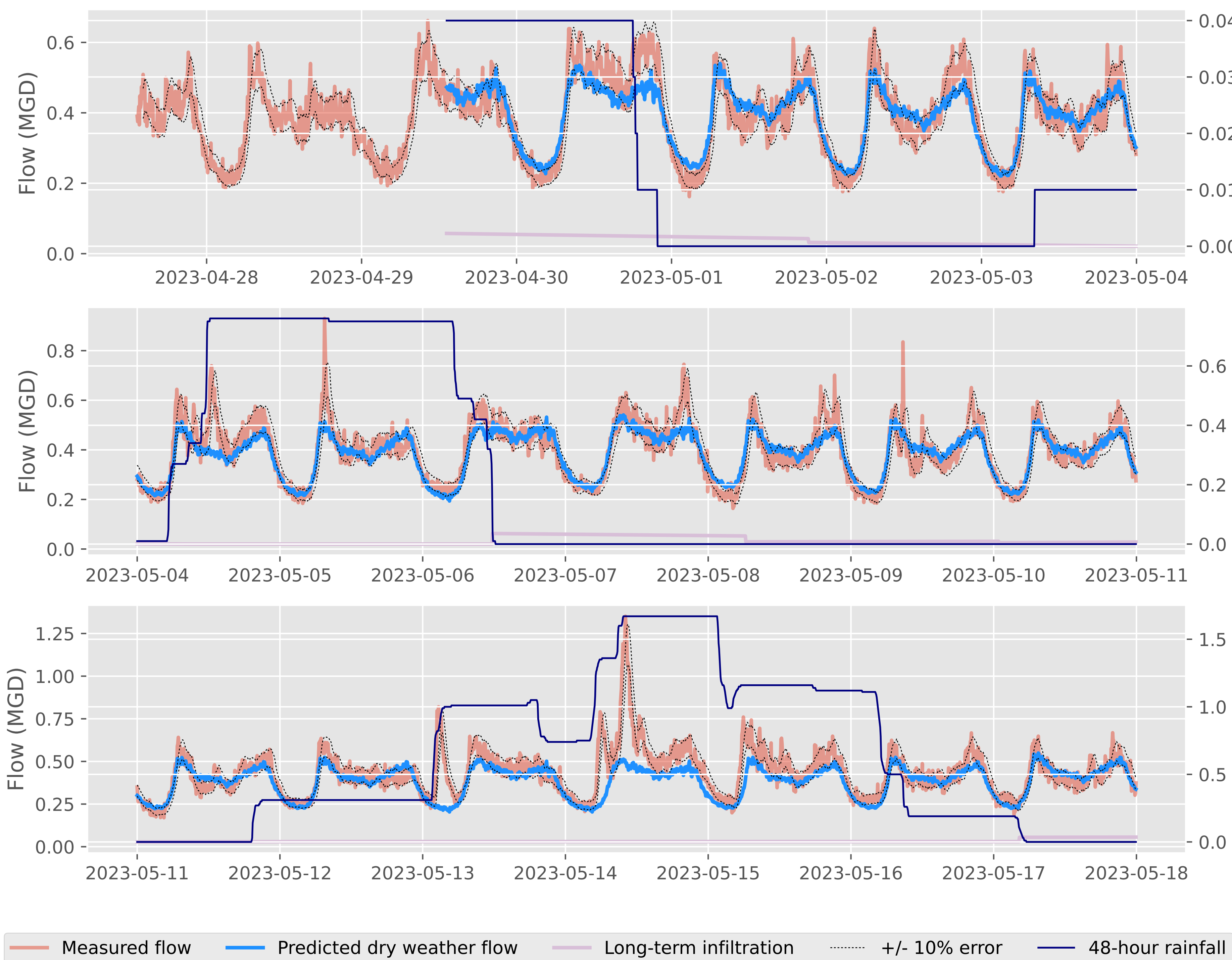
BH-02 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

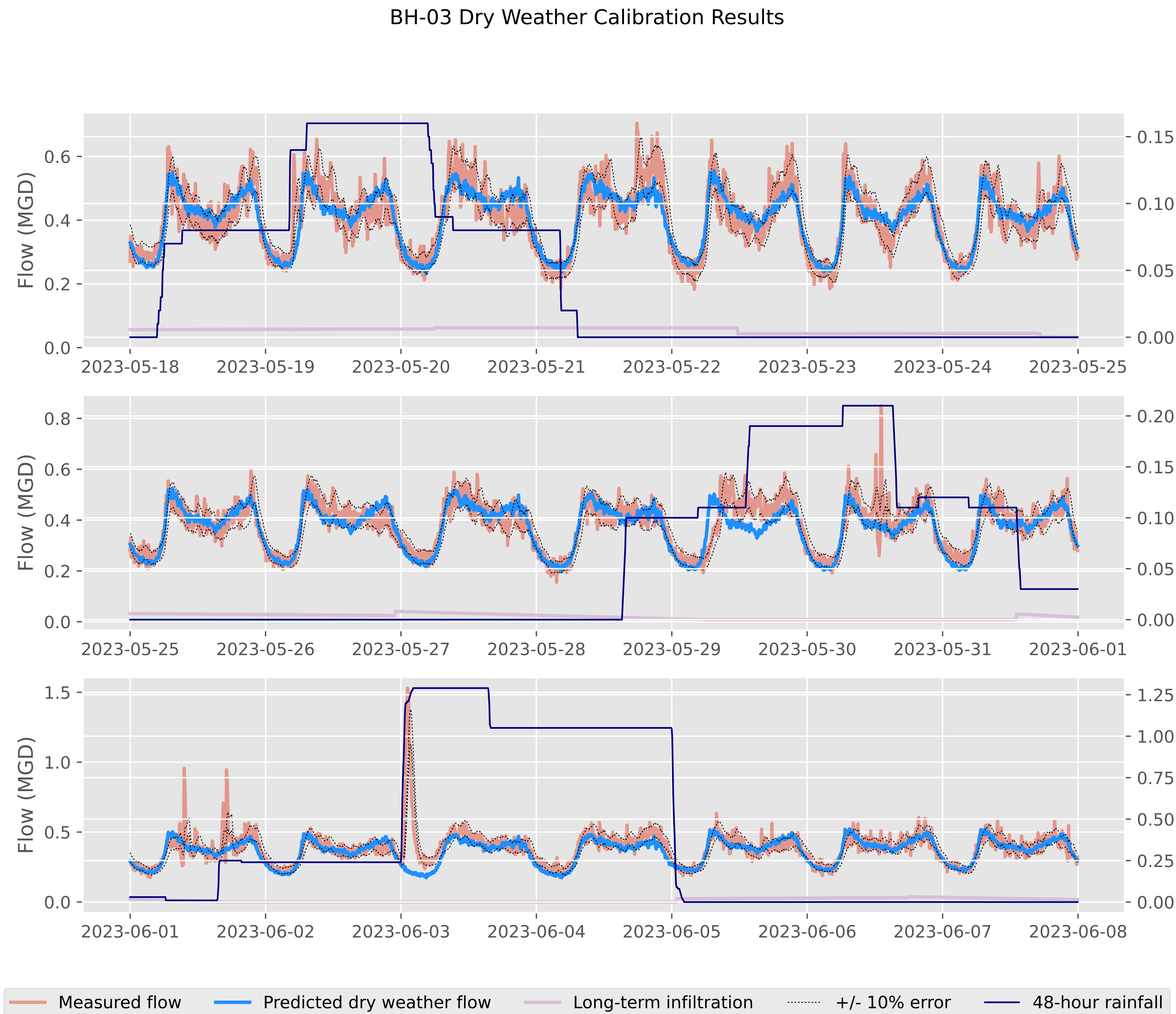
BH-02 Dry Weather Calibration Results

BH-02 Dry Weather Calibration Results



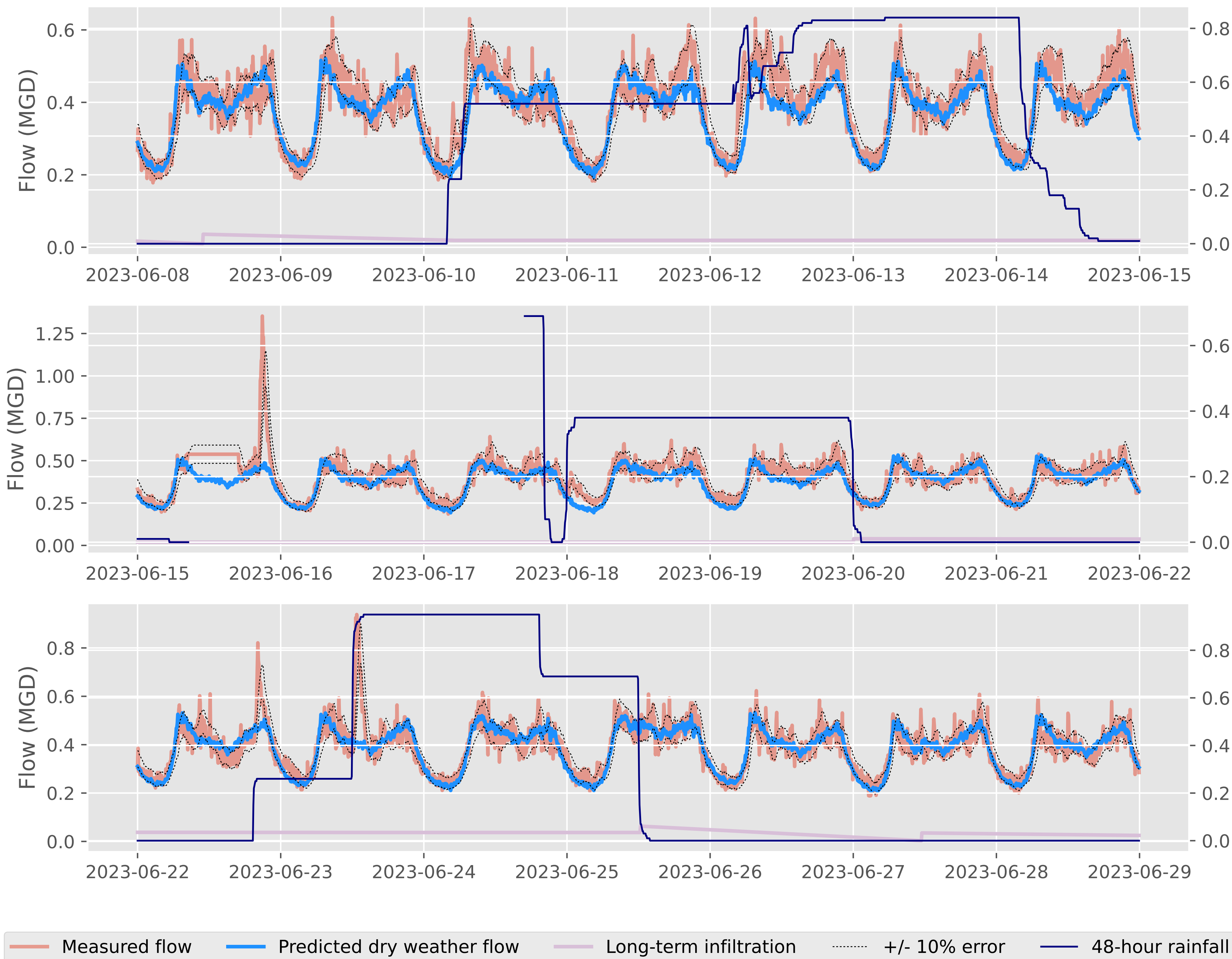
BH-03 Dry Weather Calibration Results



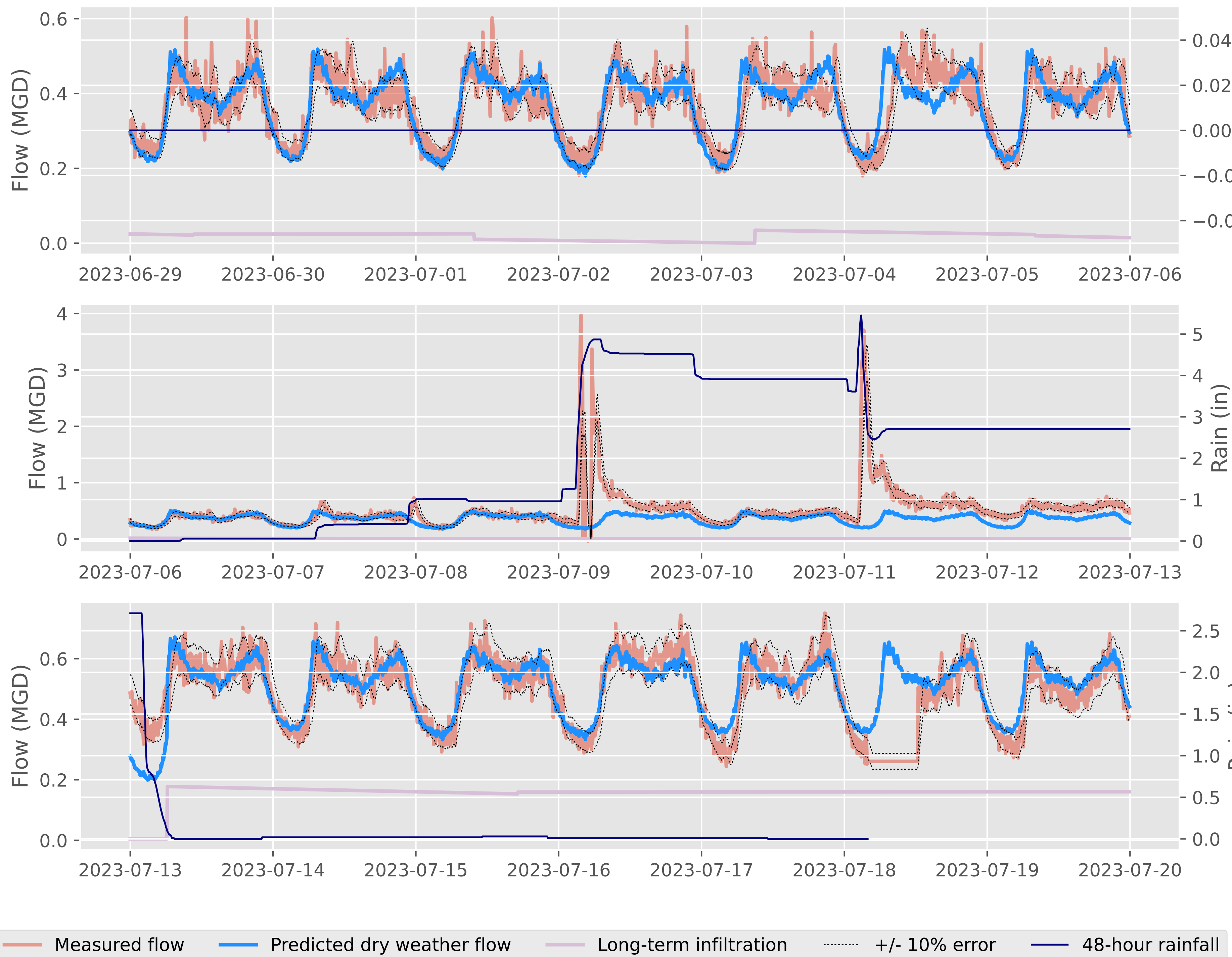


BH-03 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.0
0.2
0.4
0.6
0.00
0.05
0.10
0.15
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
0.8
0.20
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
0.5
1.0
1.5
0.25
0.50
0.75
1.00
1.25
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

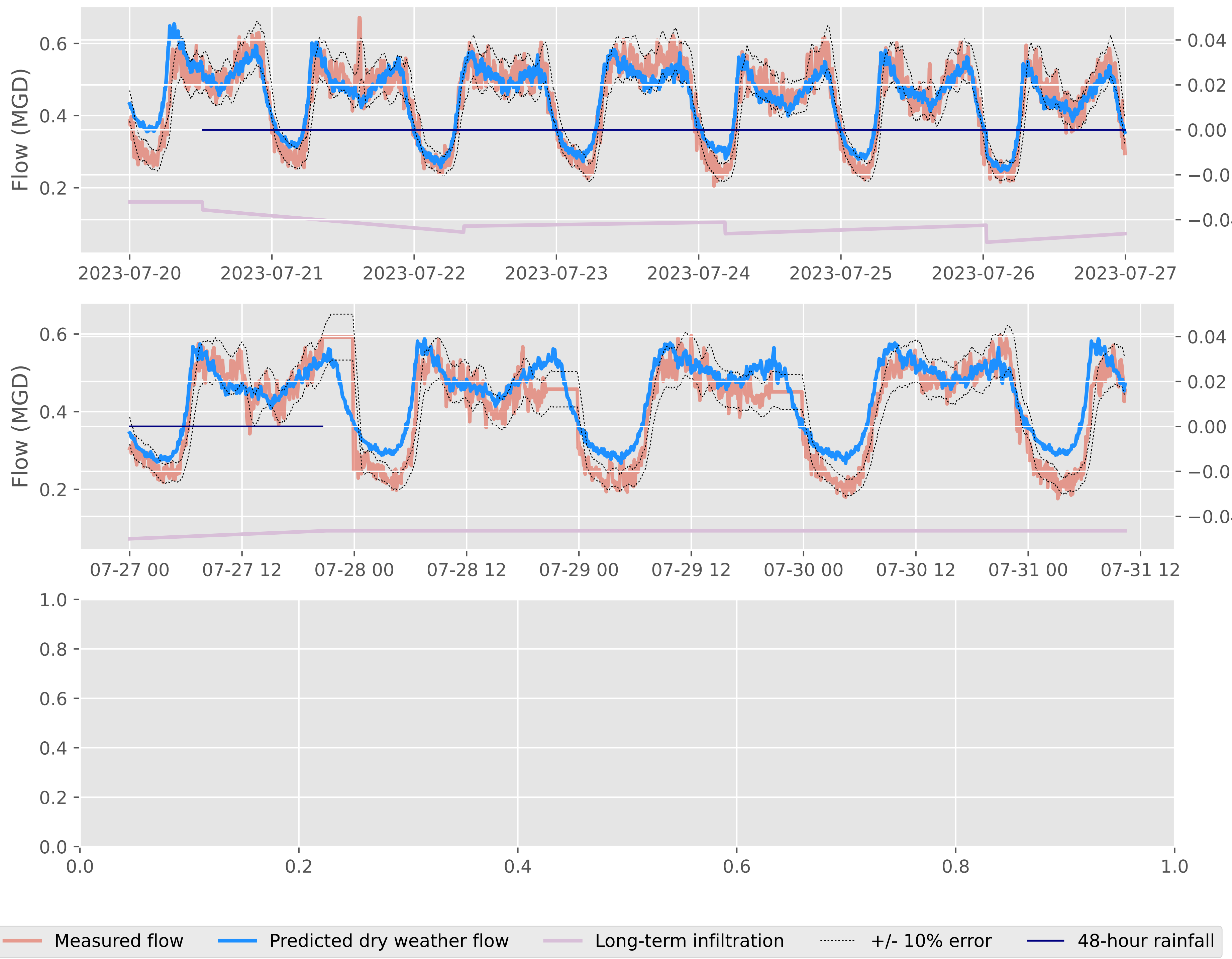
BH-03 Dry Weather Calibration Results



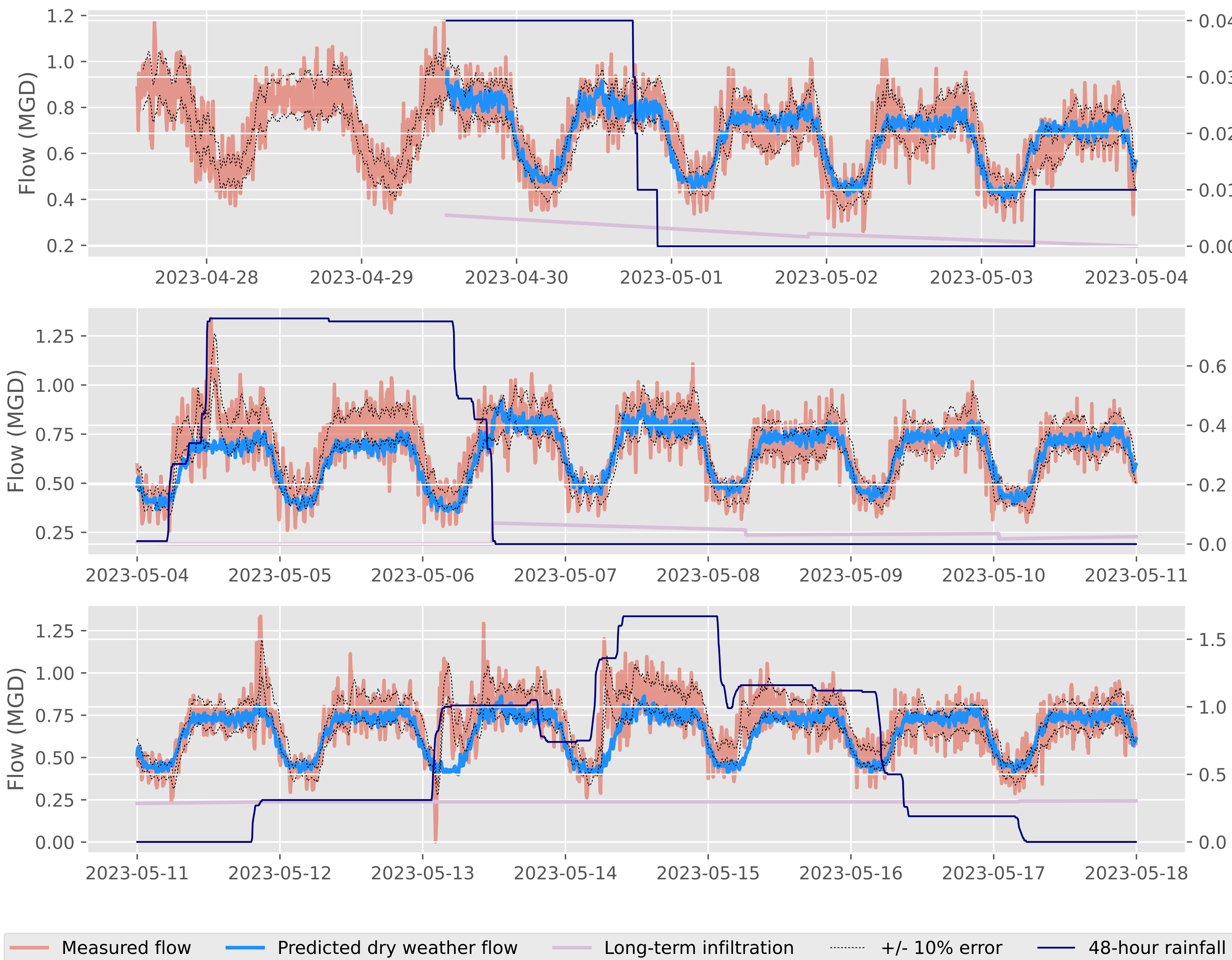
BH-03 Dry Weather Calibration Results



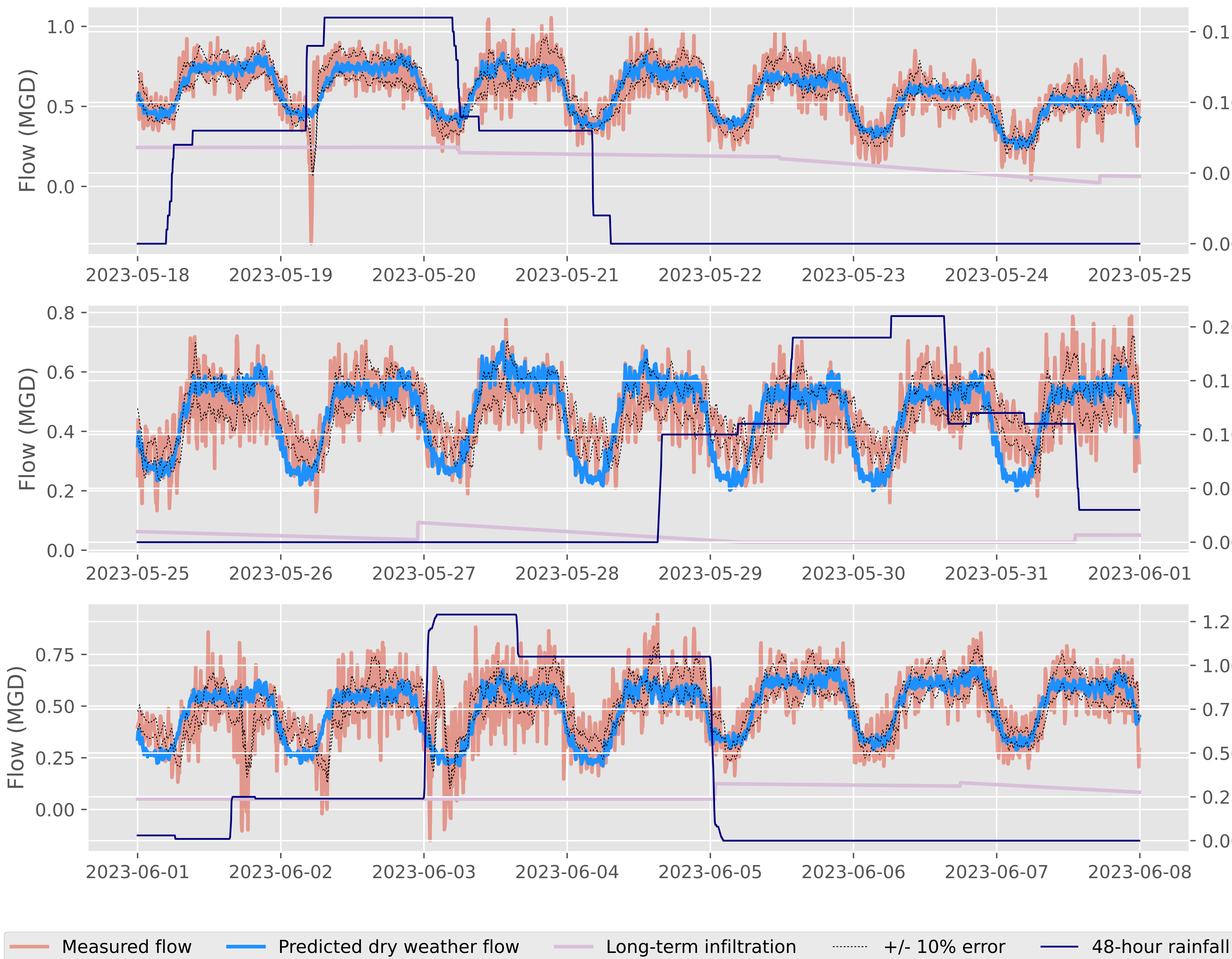
BH-03 Dry Weather Calibration Results

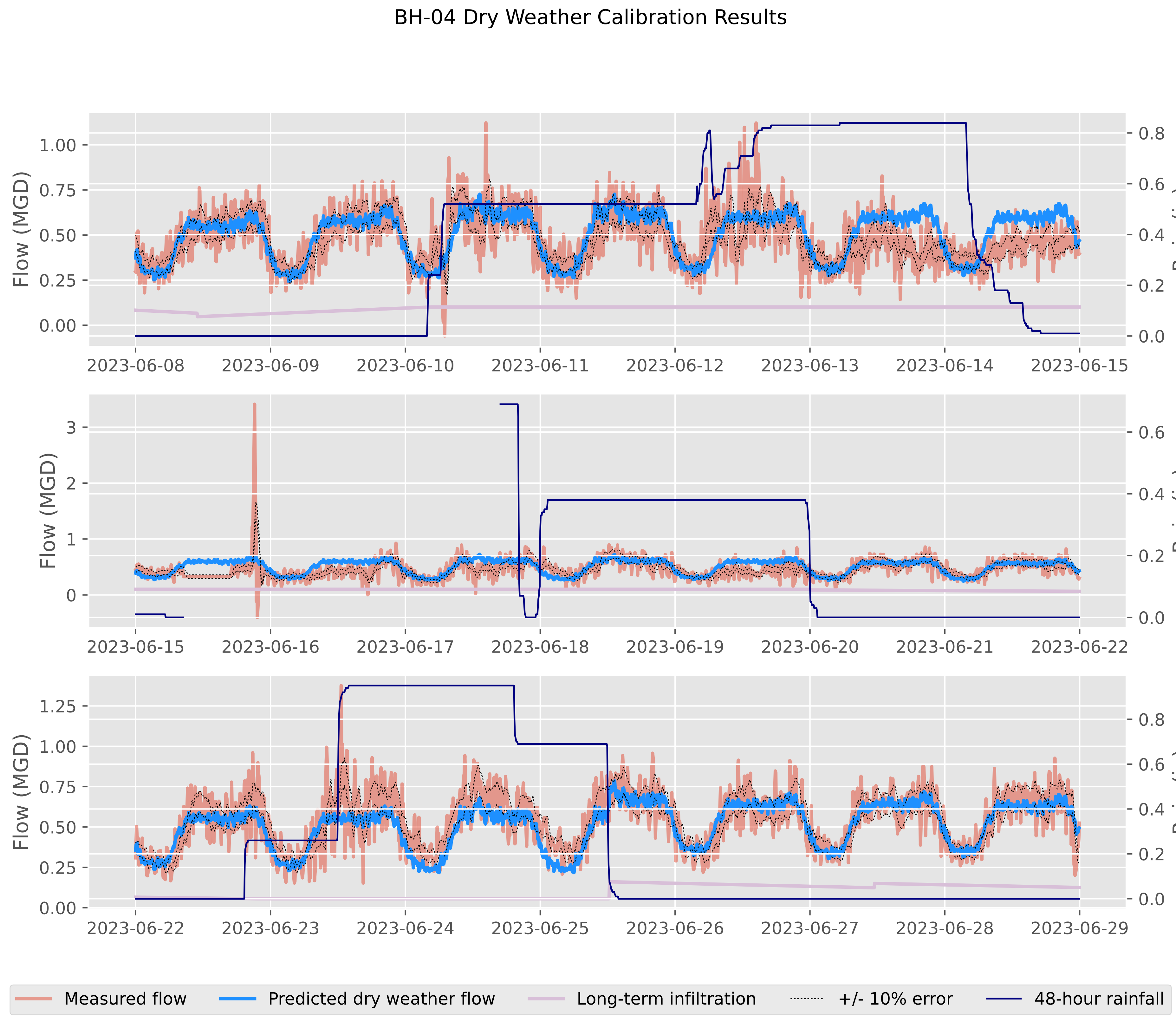


BH-04 Dry Weather Calibration Results



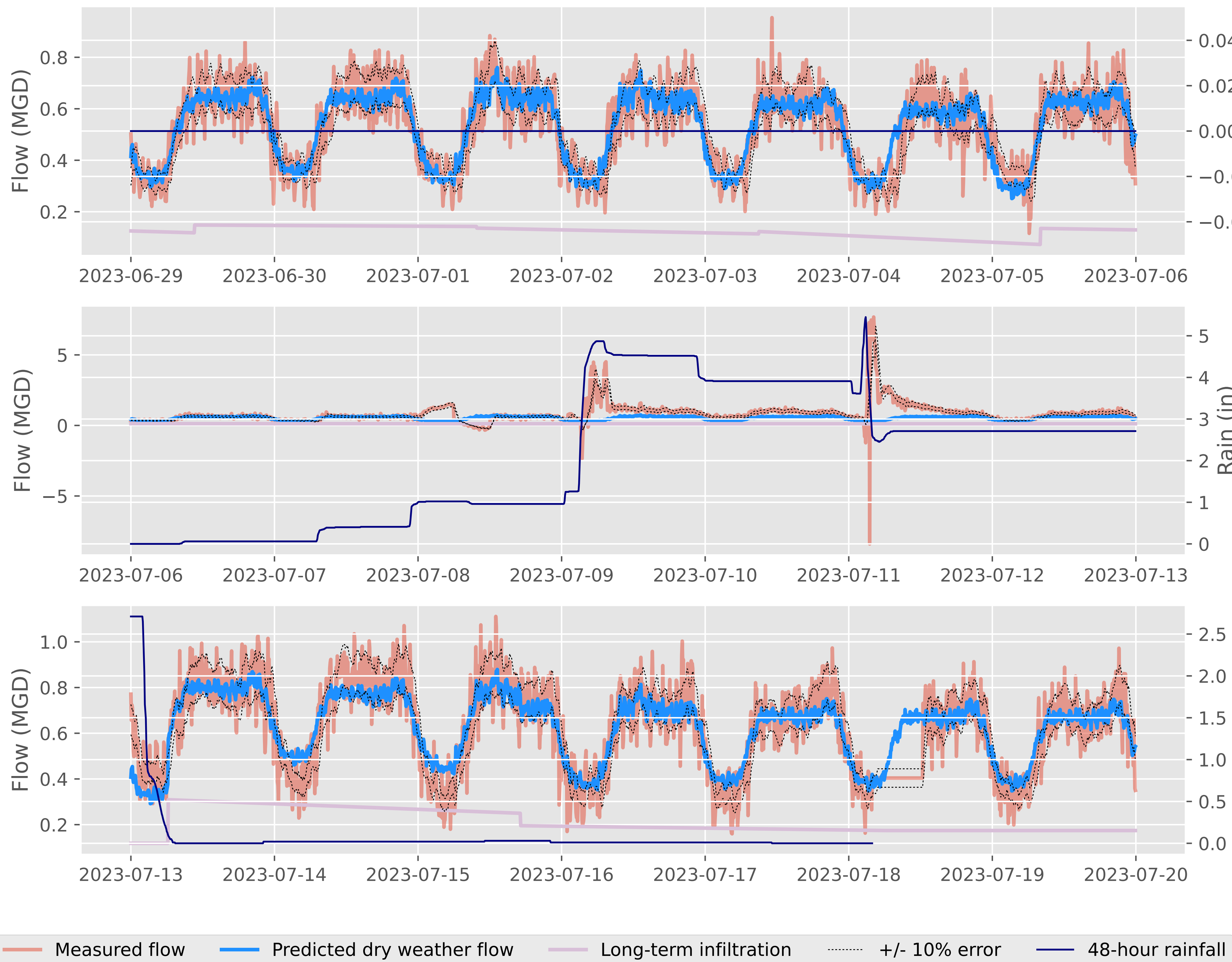
BH-04 Dry Weather Calibration Results



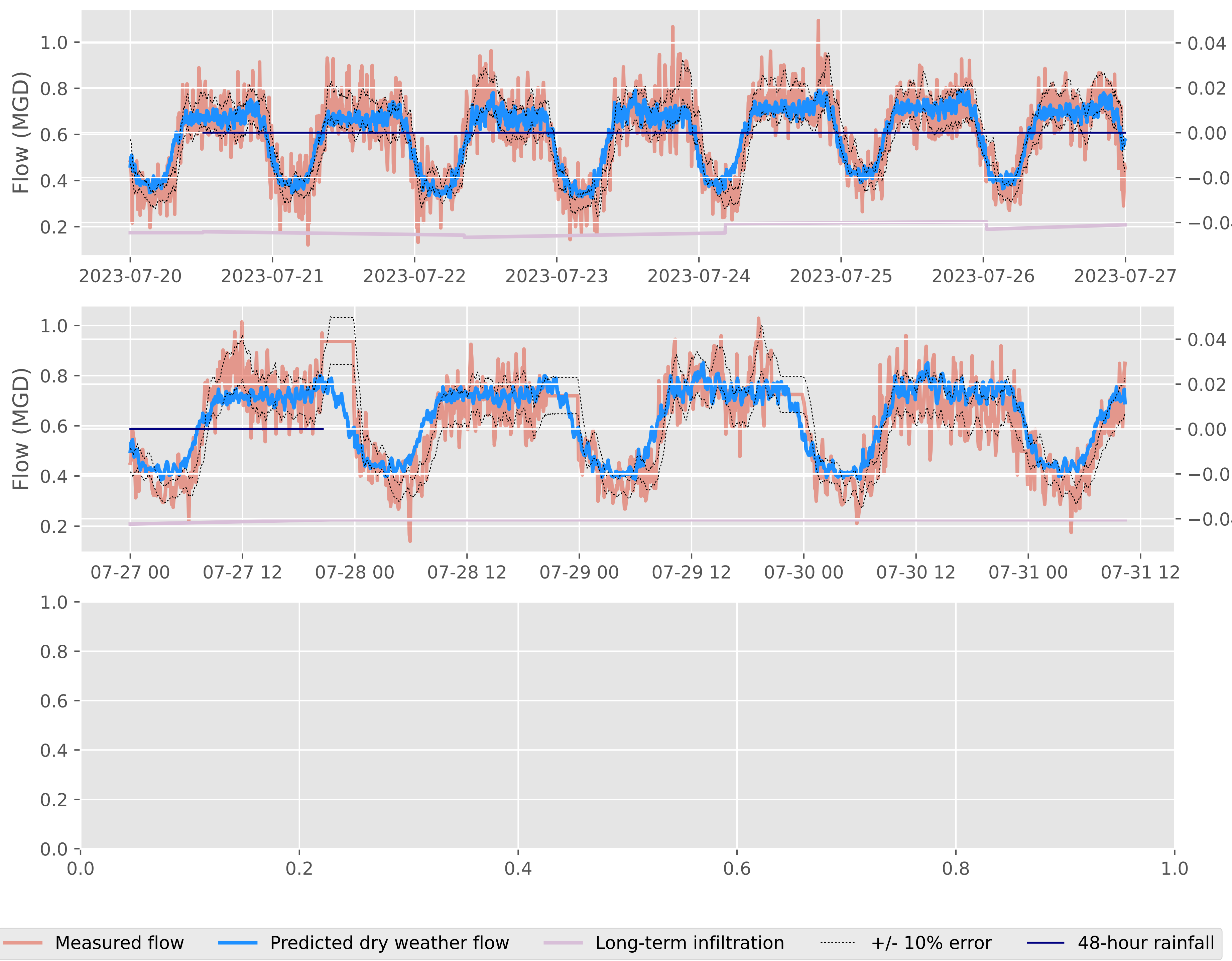


BH-04 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

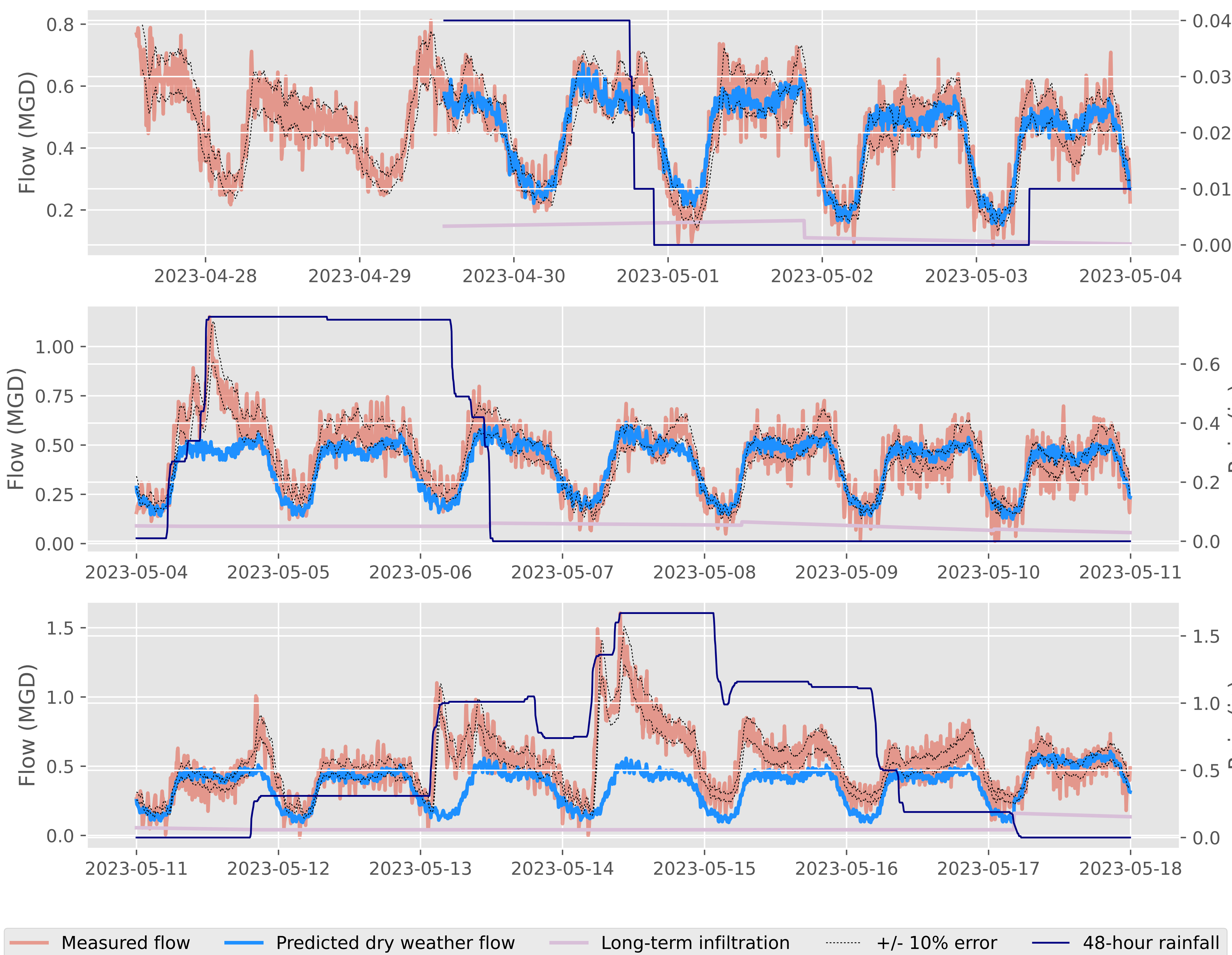
BH-04 Dry Weather Calibration Results

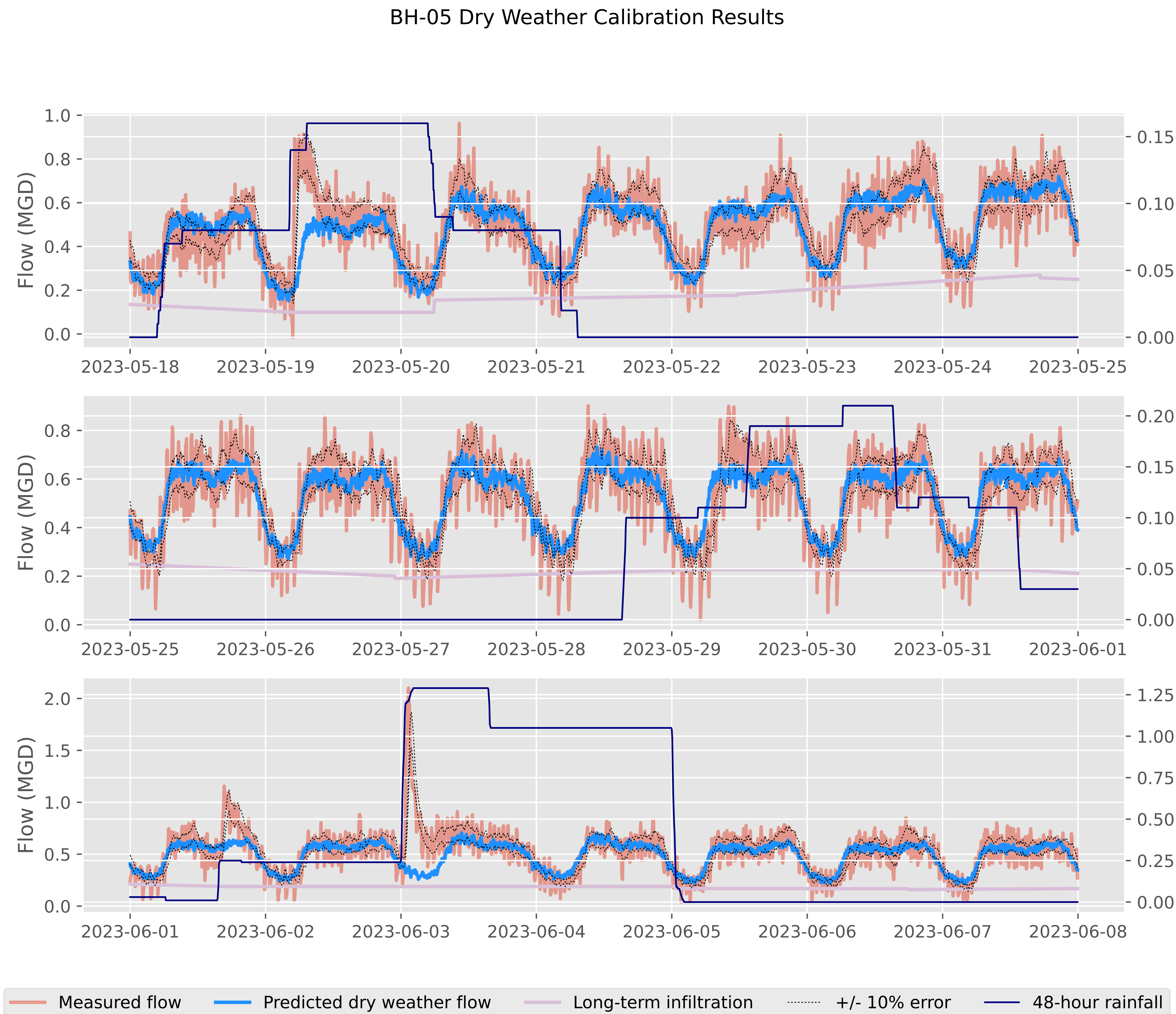


BH-04 Dry Weather Calibration Results



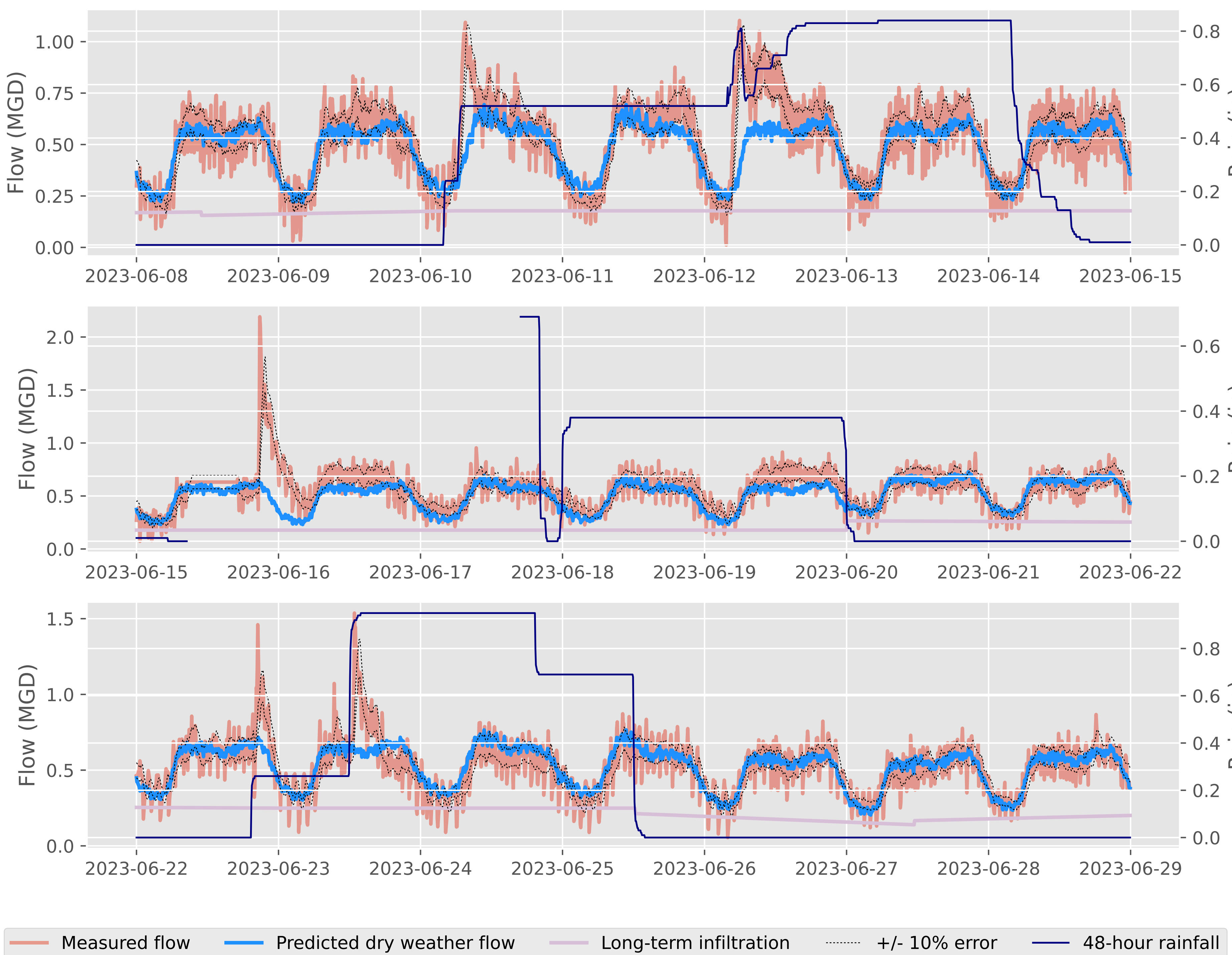
BH-05 Dry Weather Calibration Results



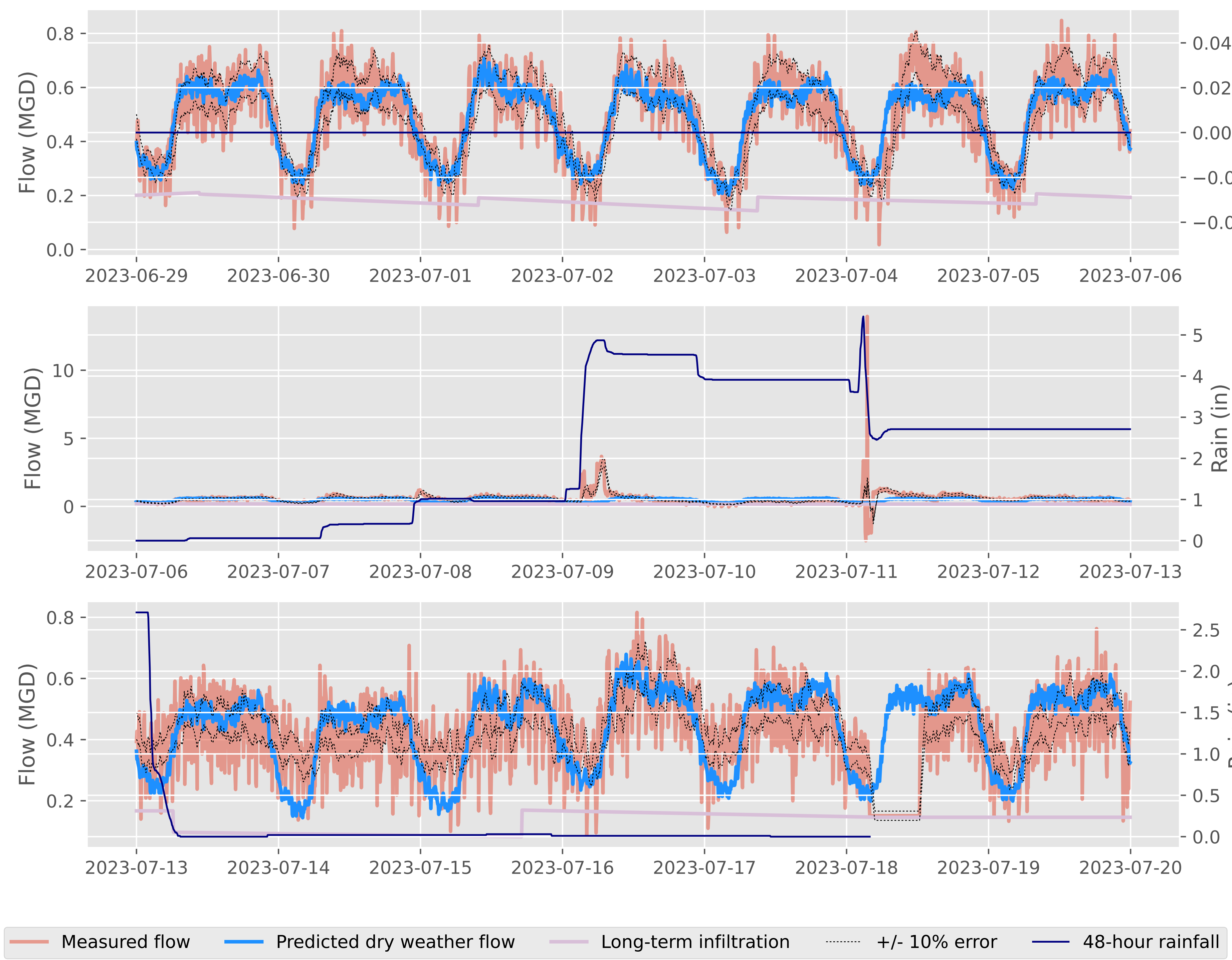


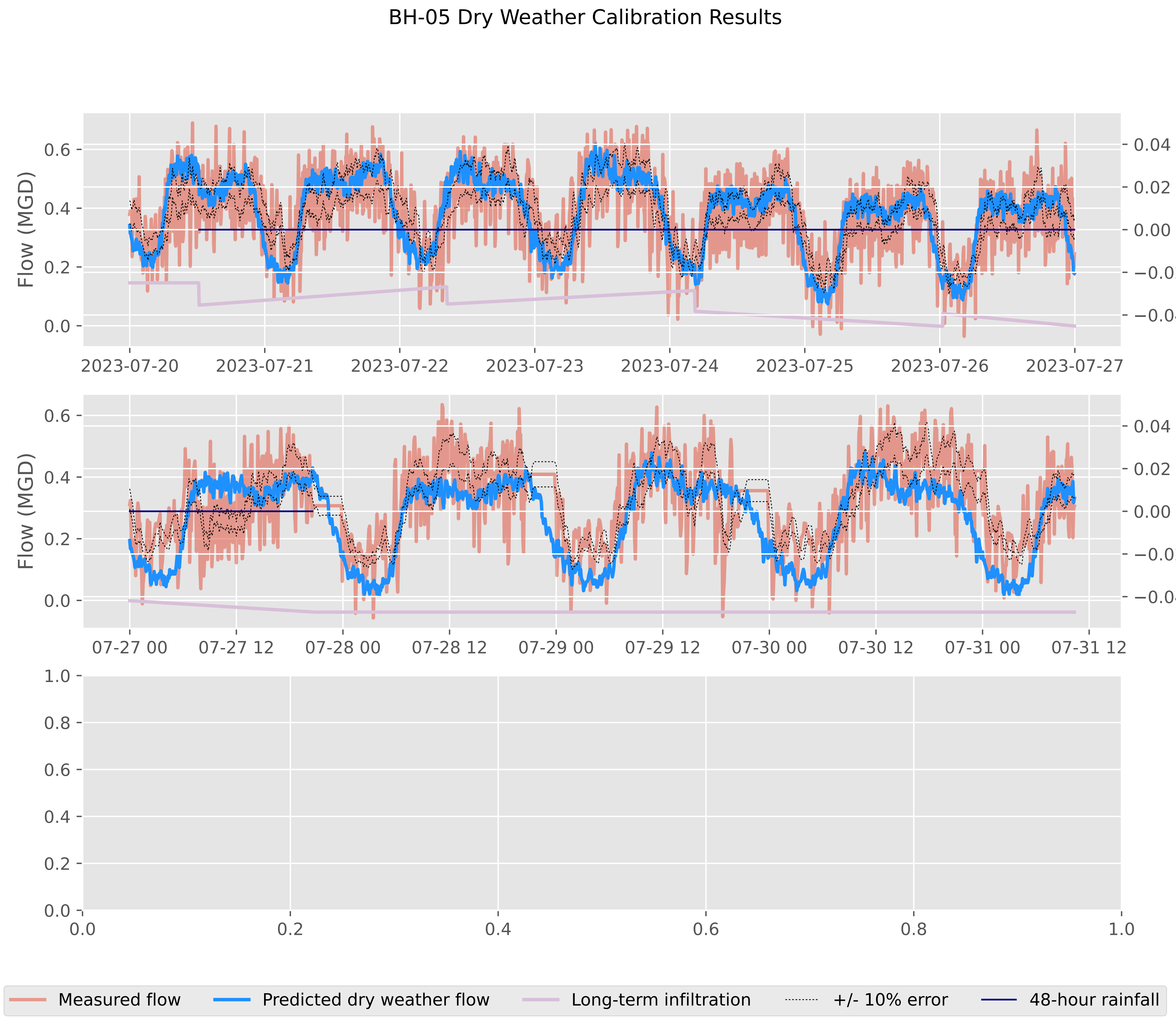
BH-05 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BH-05 Dry Weather Calibration Results

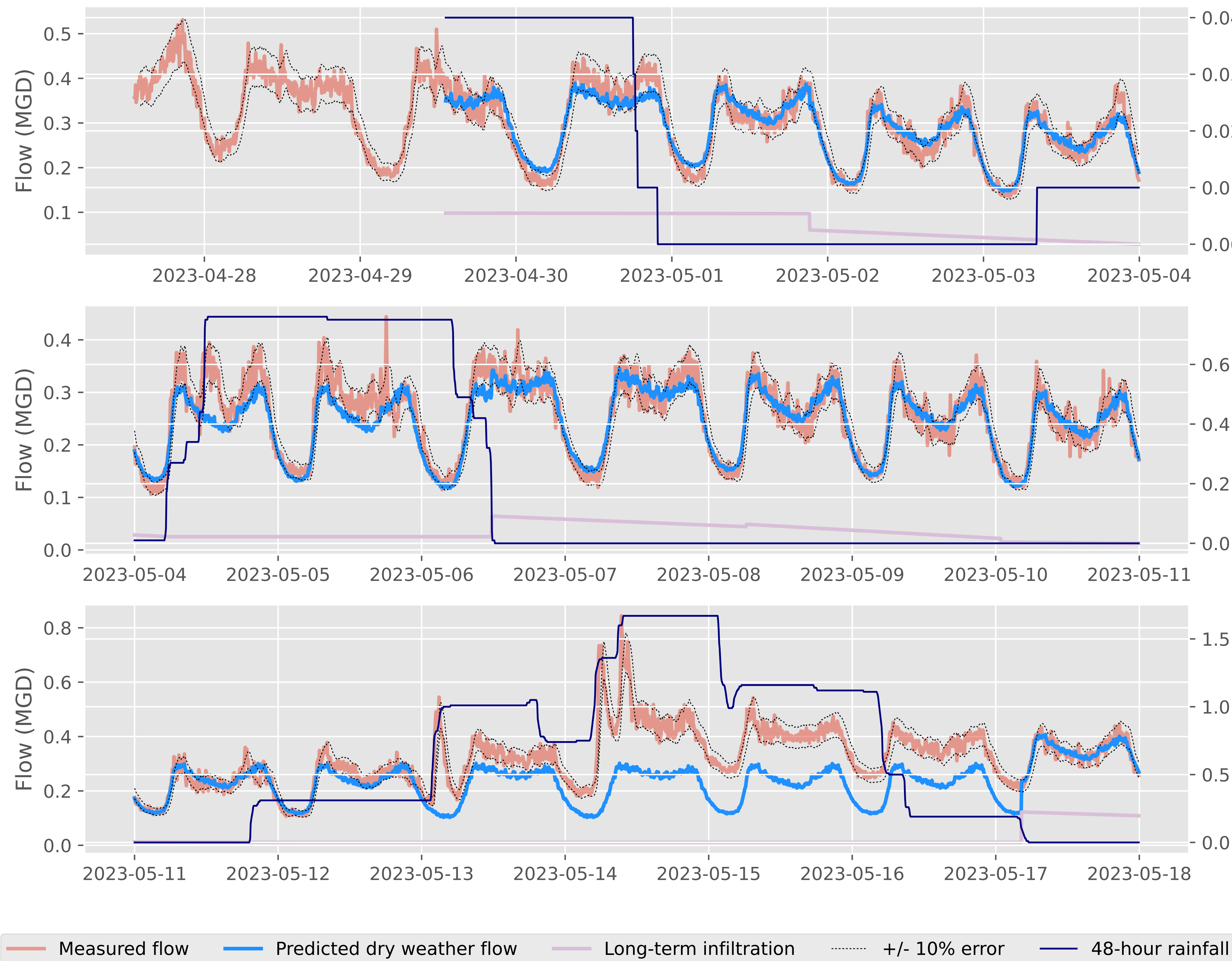


BH-05 Dry Weather Calibration Results

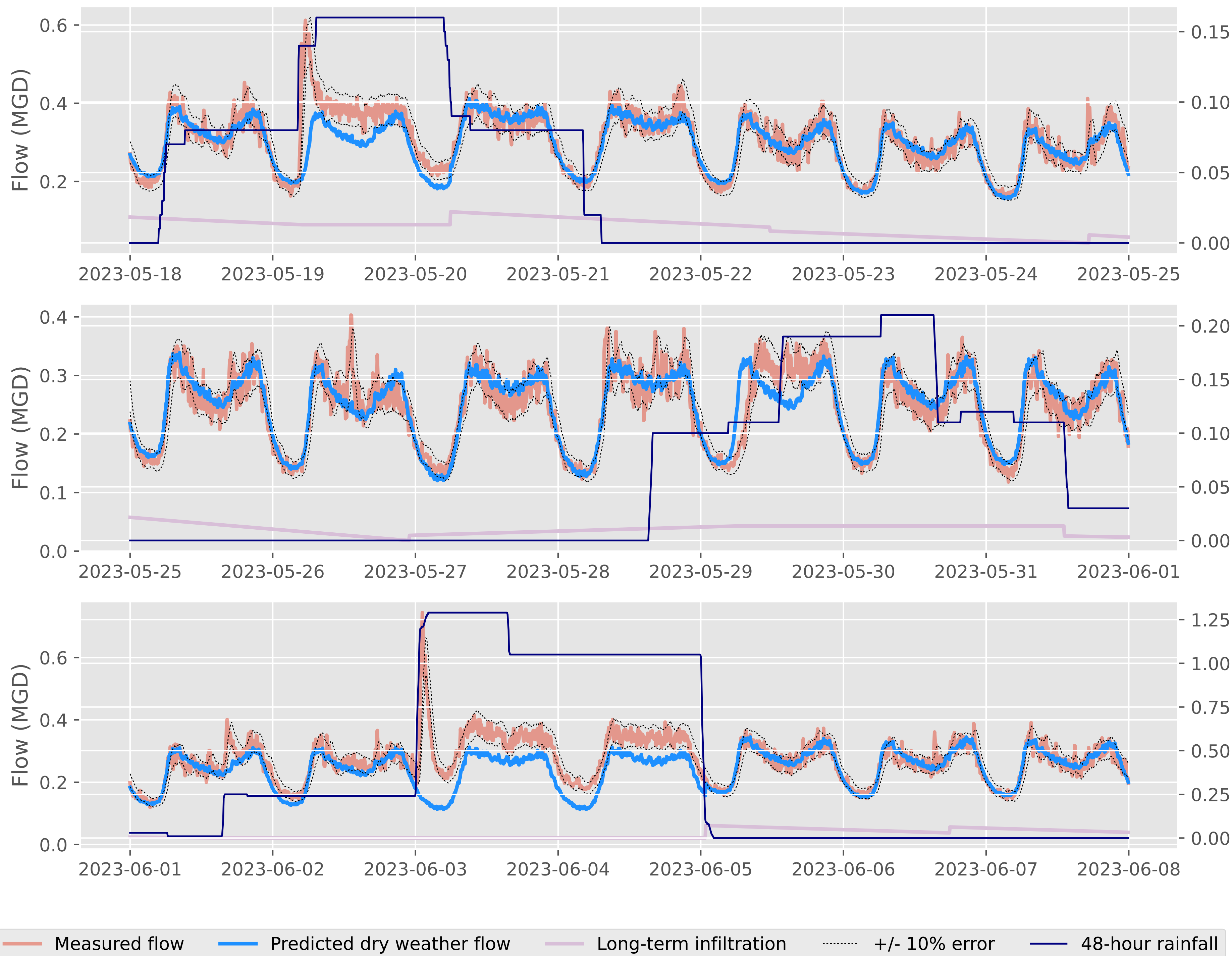


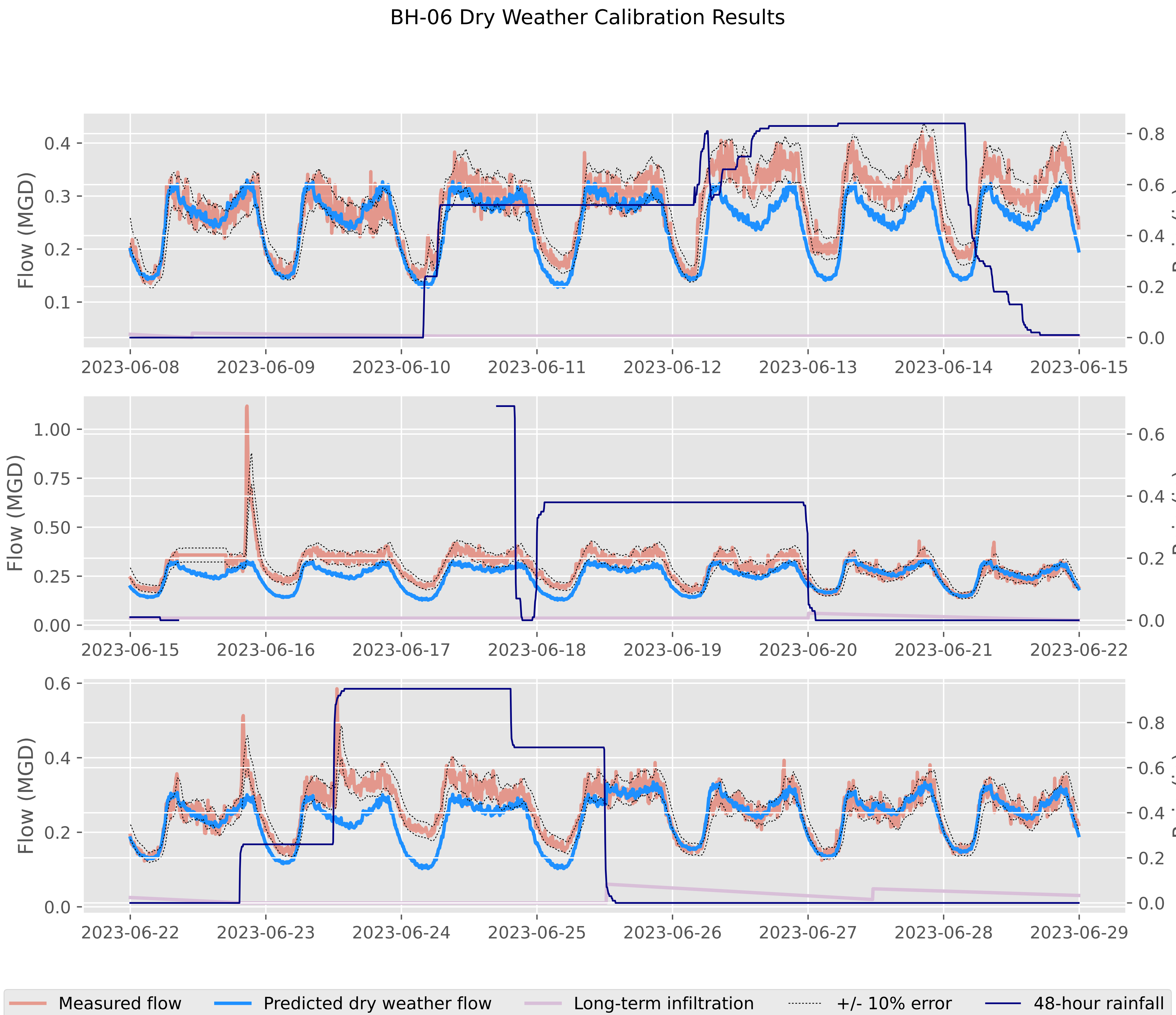

BH-05 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BH-06 Dry Weather Calibration Results

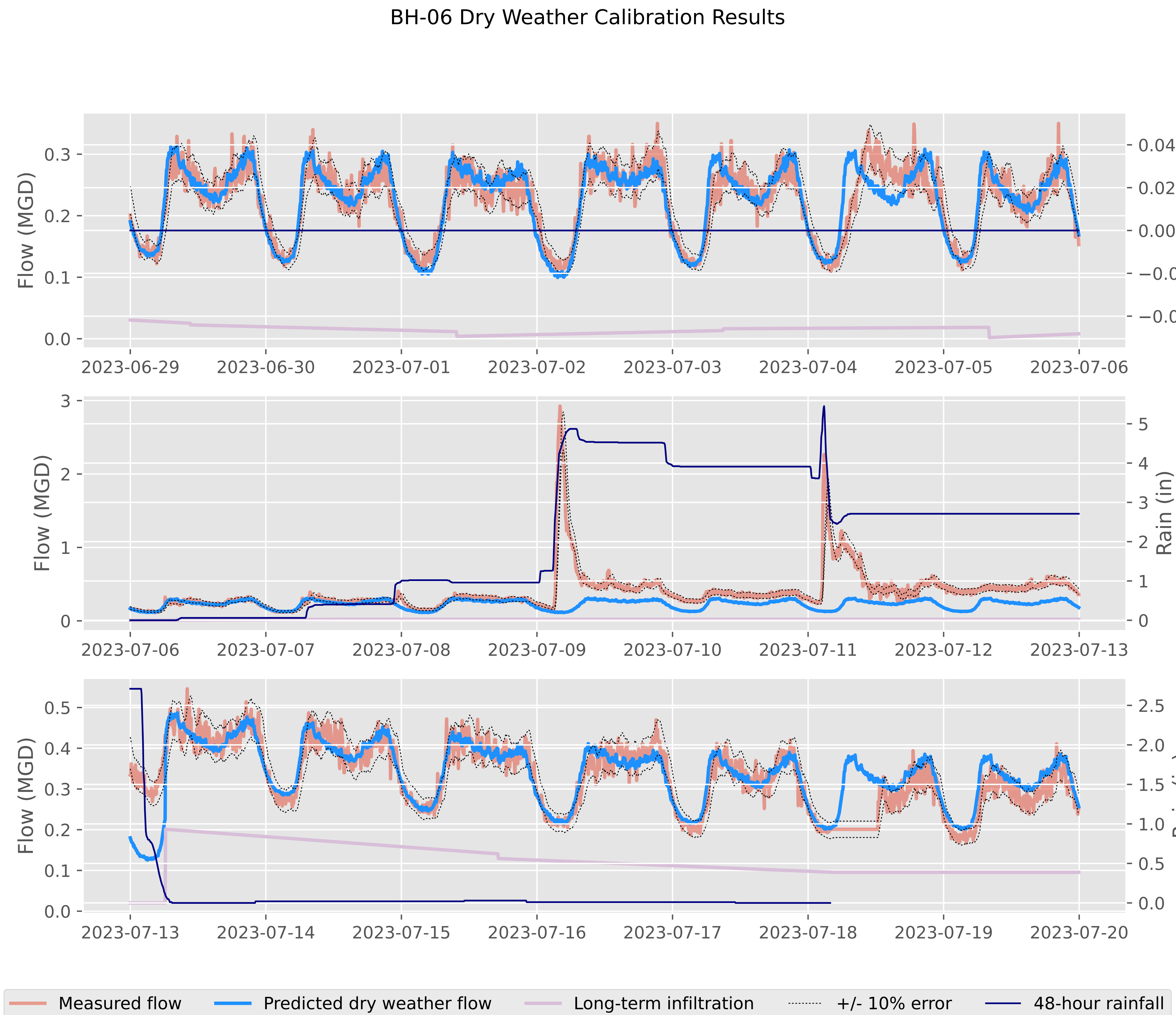


BH-06 Dry Weather Calibration Results



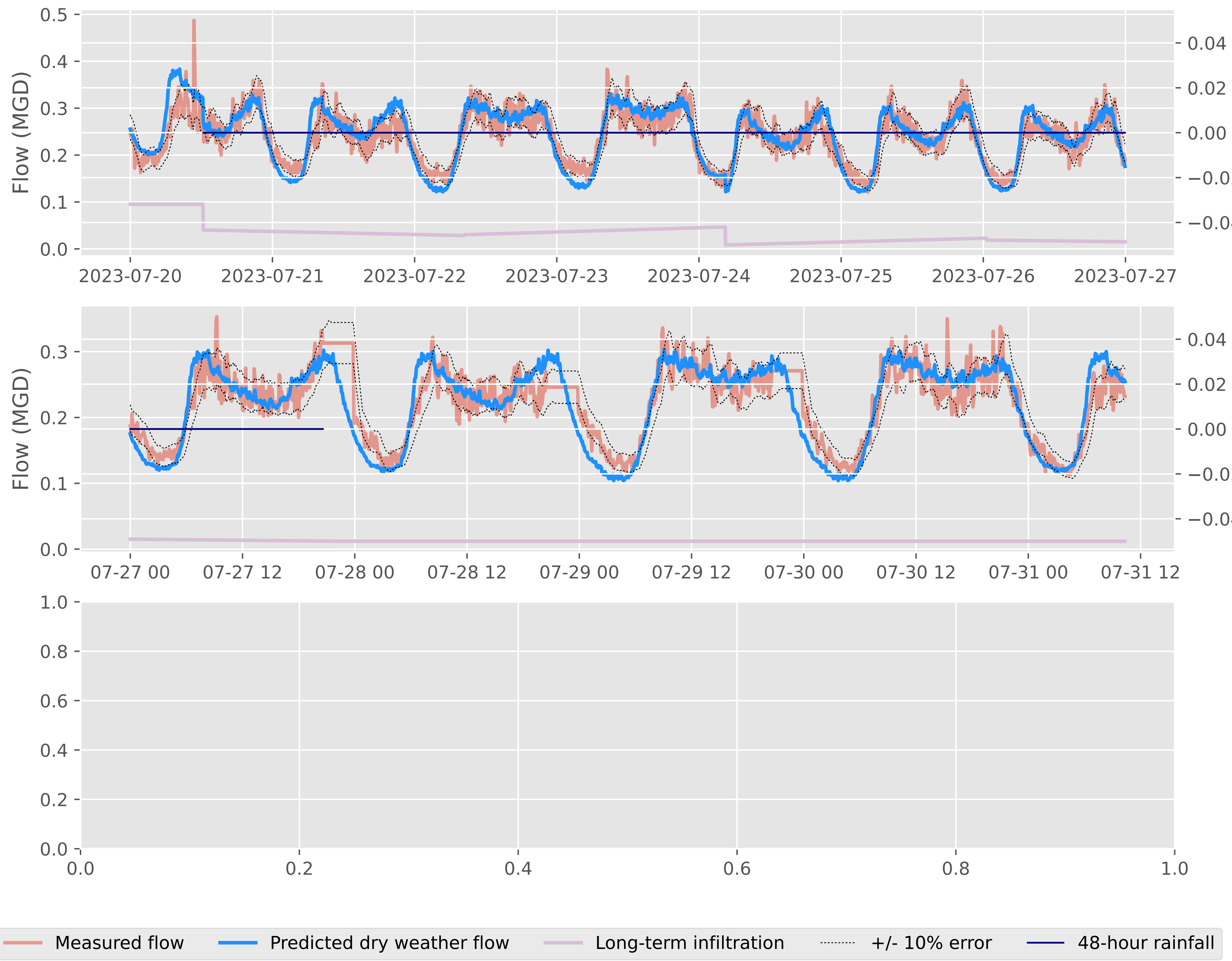


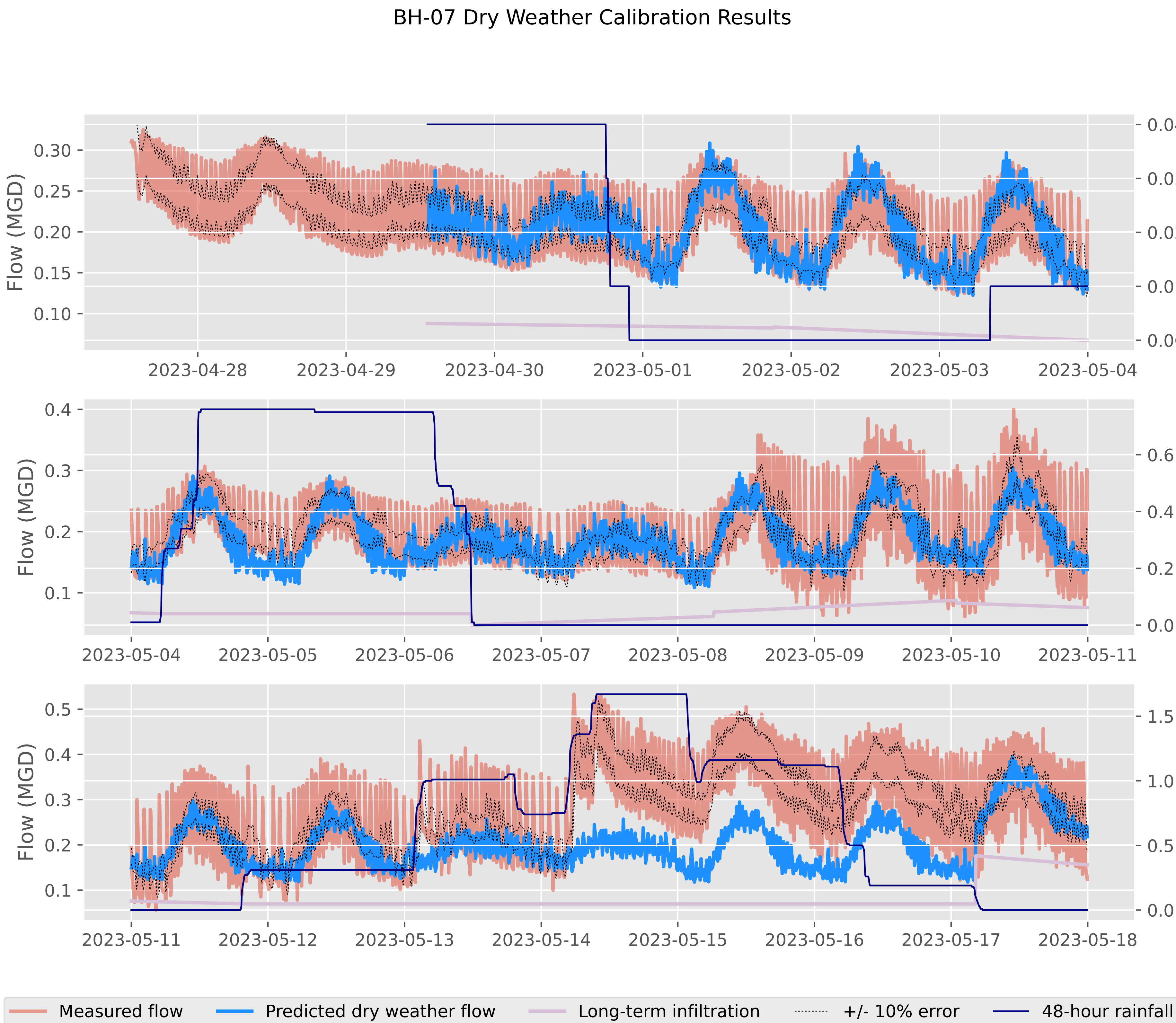
BH-06 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall



BH-06 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

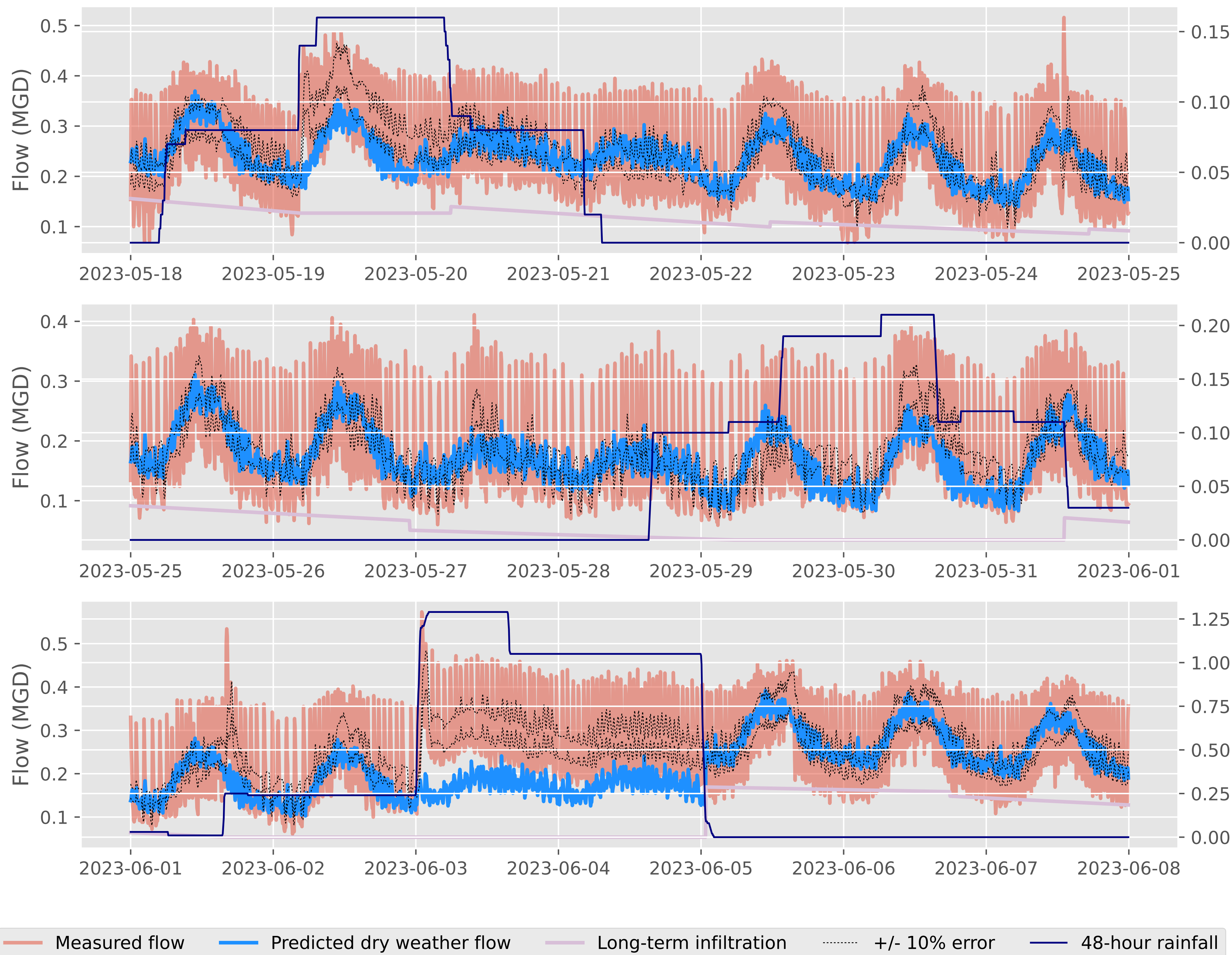
BH-06 Dry Weather Calibration Results

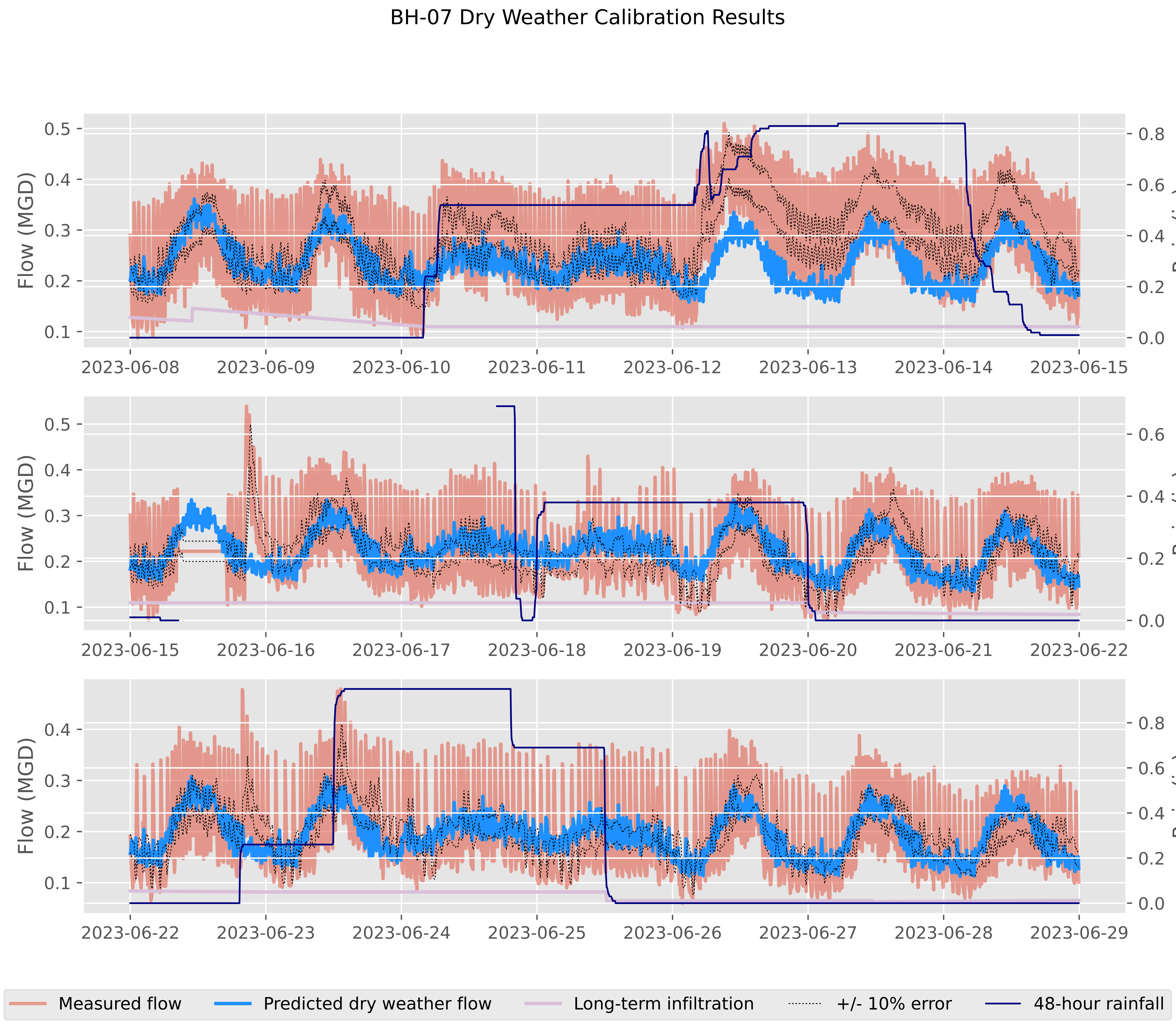


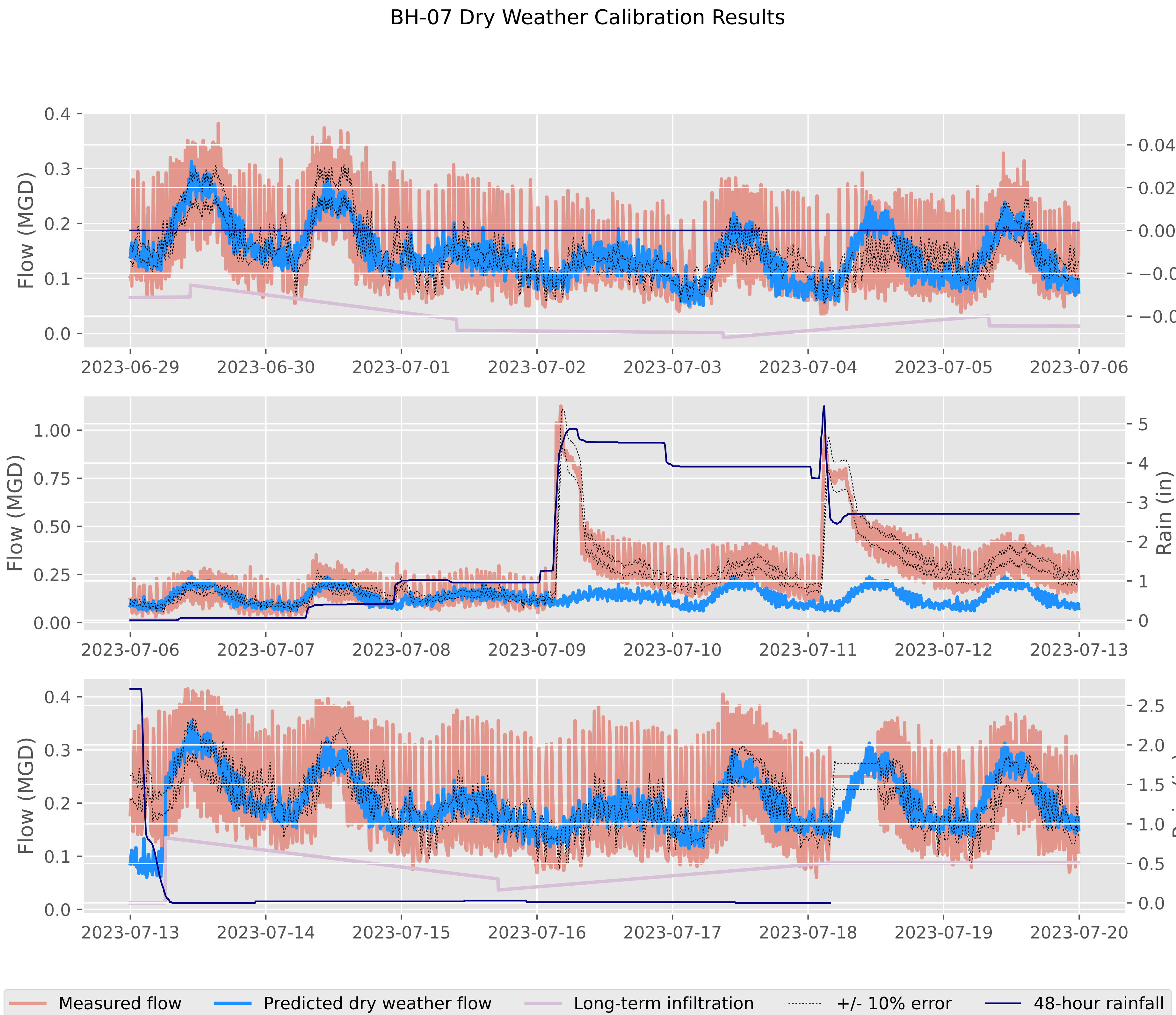


BH-07 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BH-07 Dry Weather Calibration Results

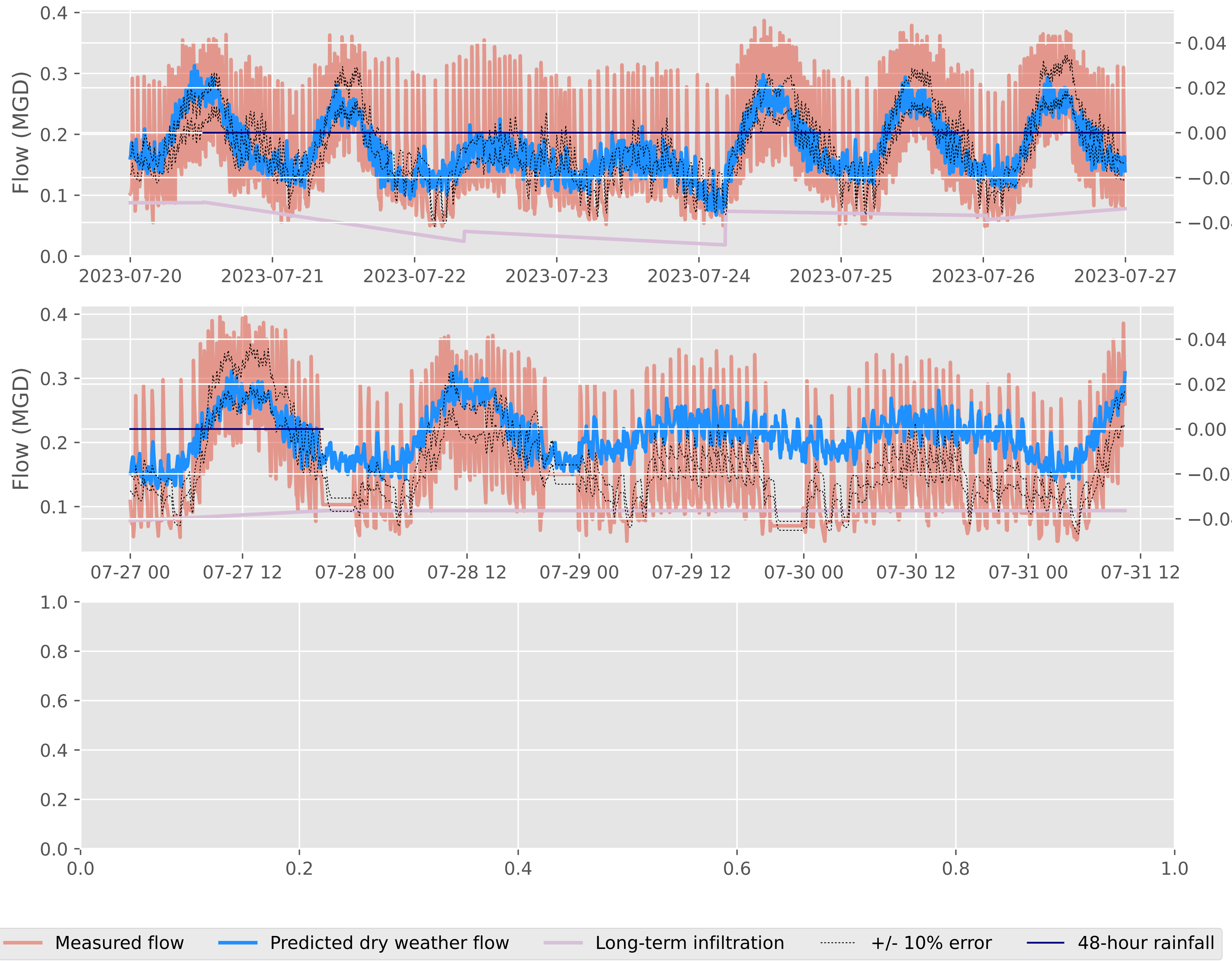


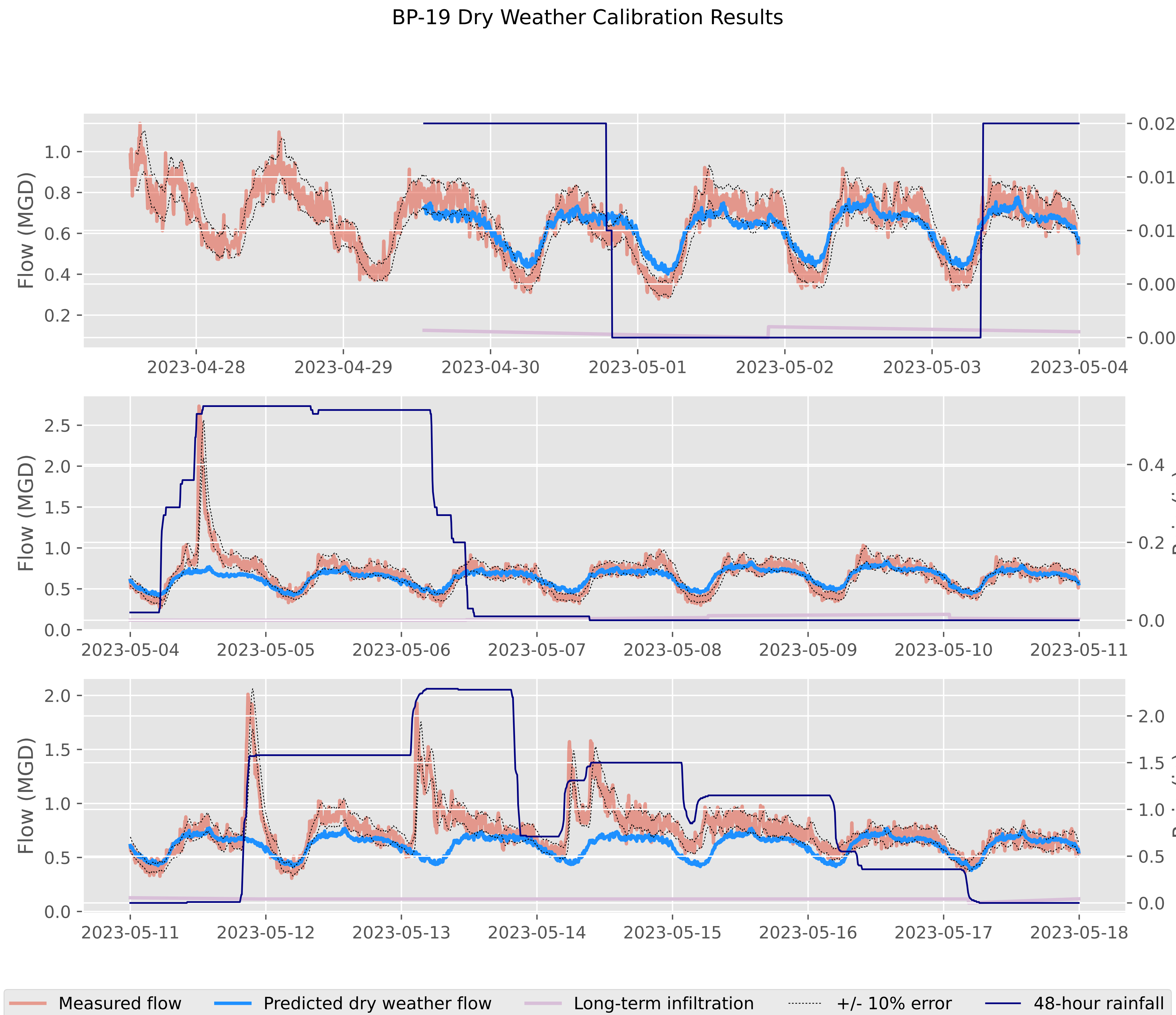

BH-07 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall



BH-07 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

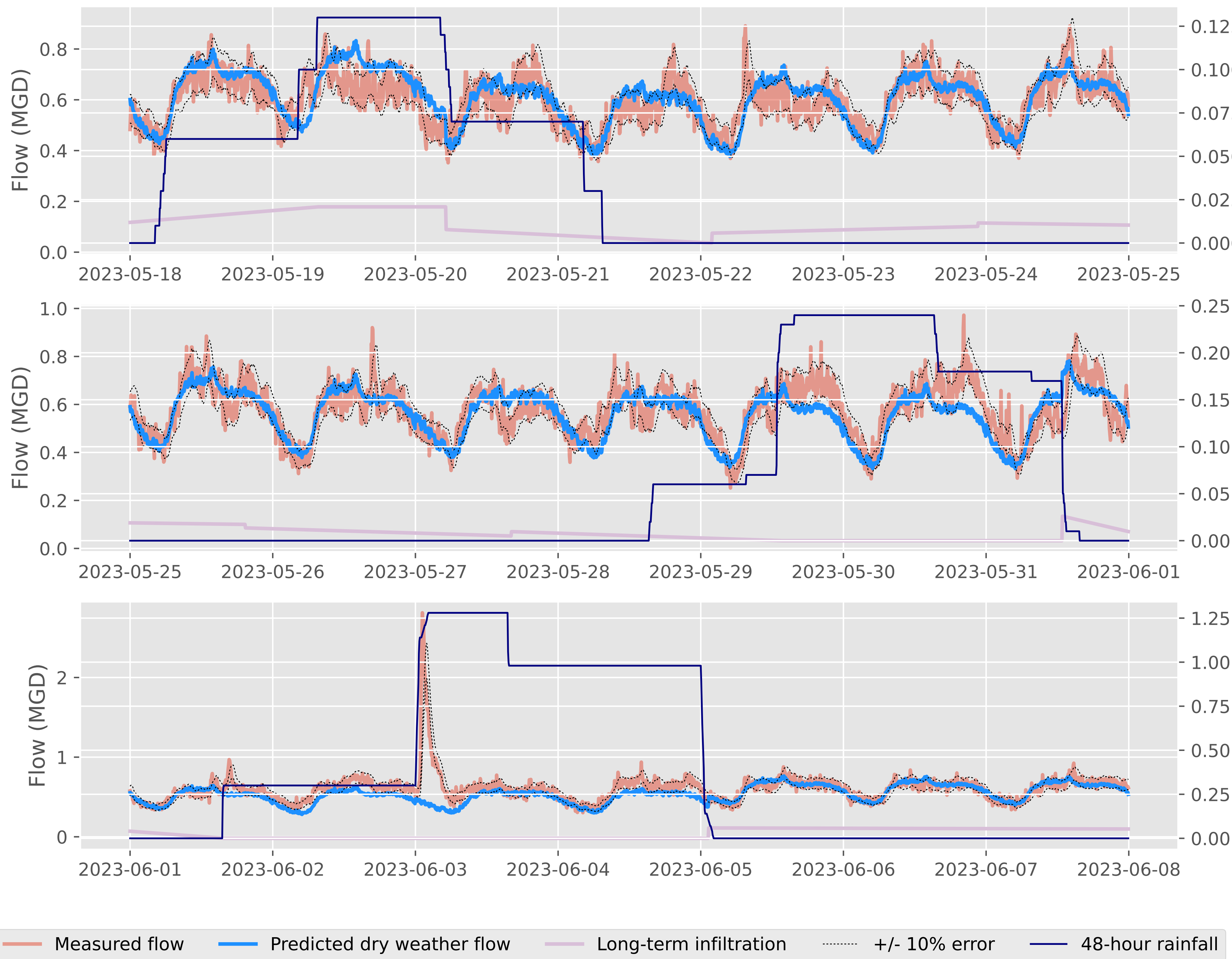
BH-07 Dry Weather Calibration Results

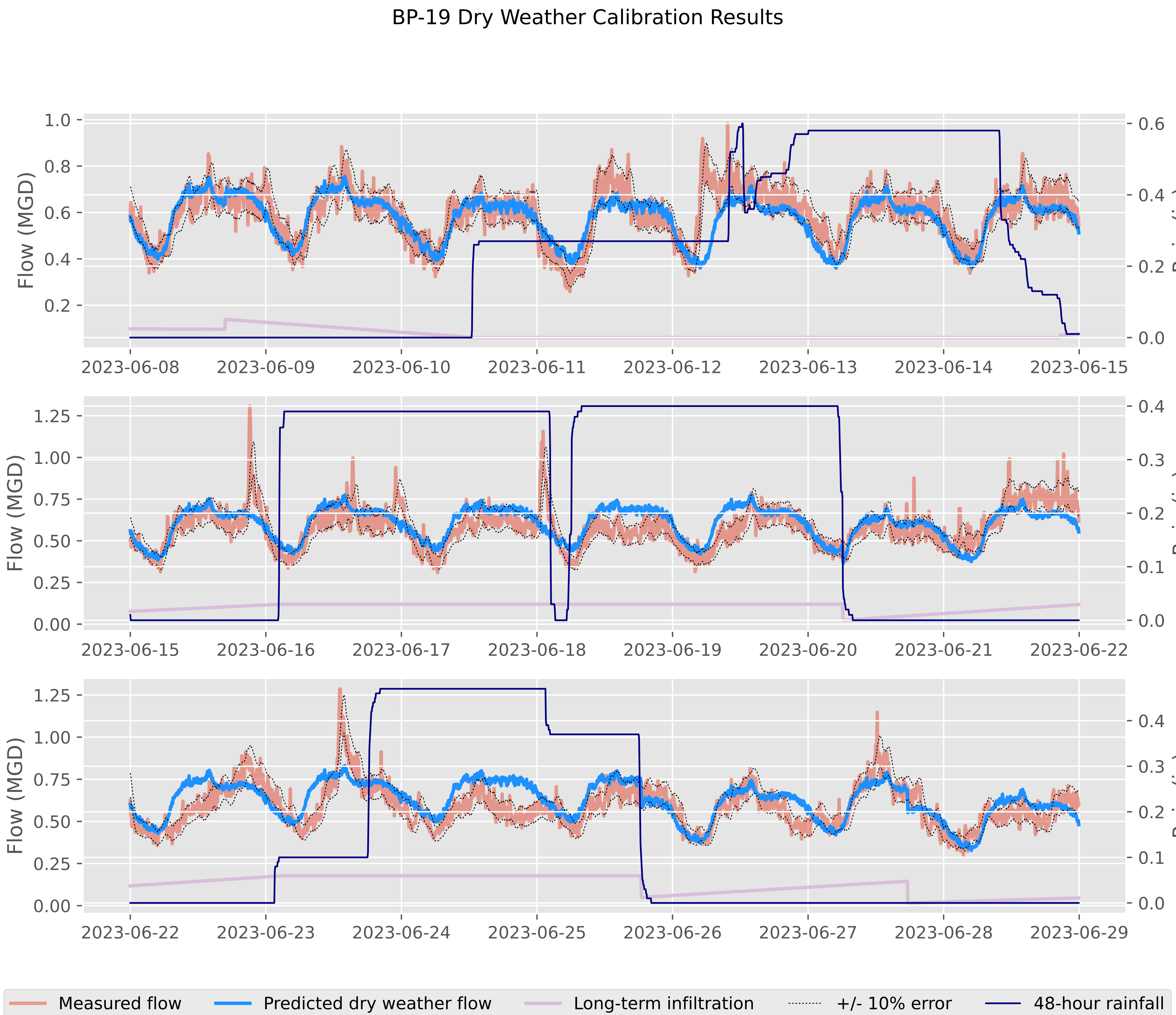




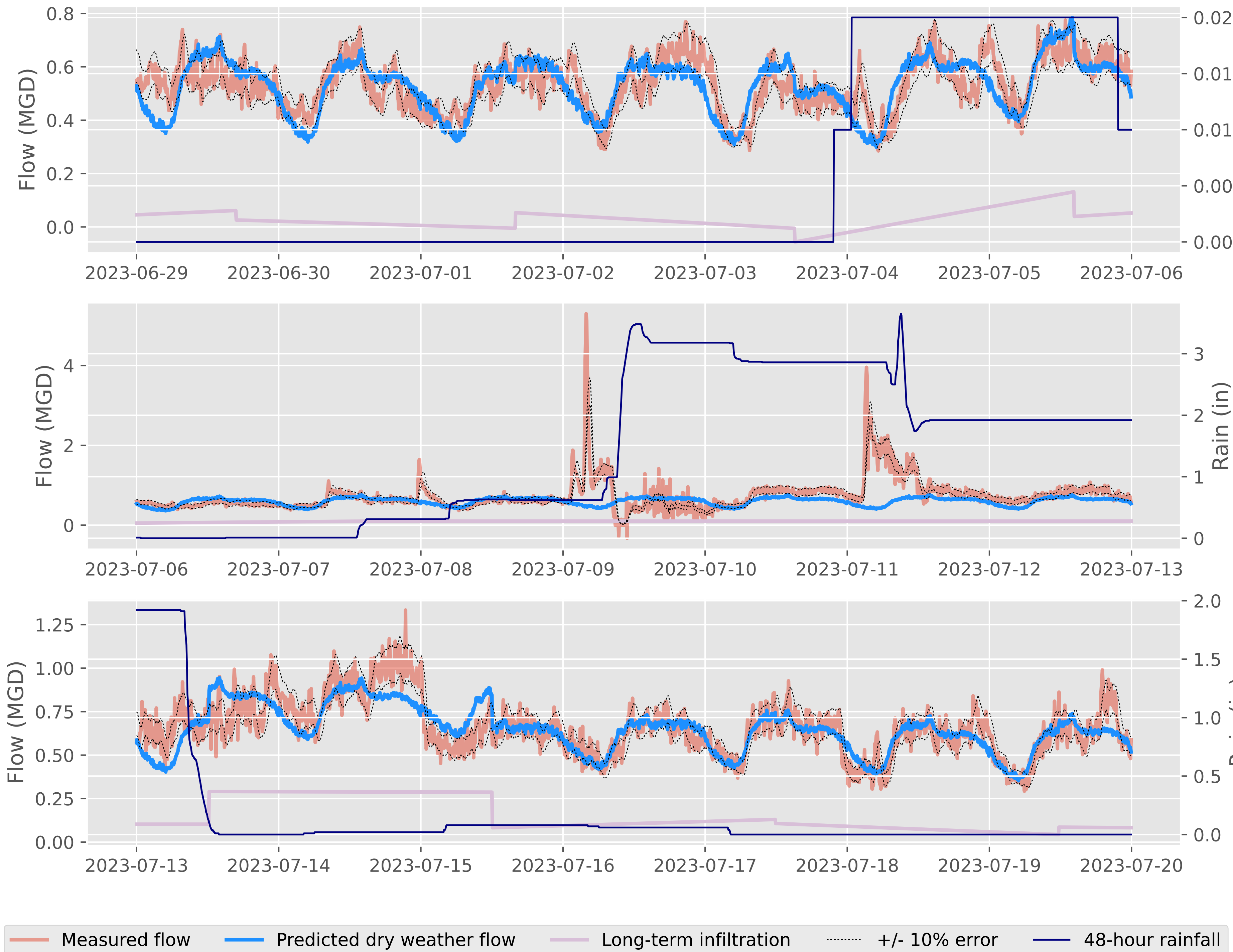
BP-19 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BP-19 Dry Weather Calibration Results

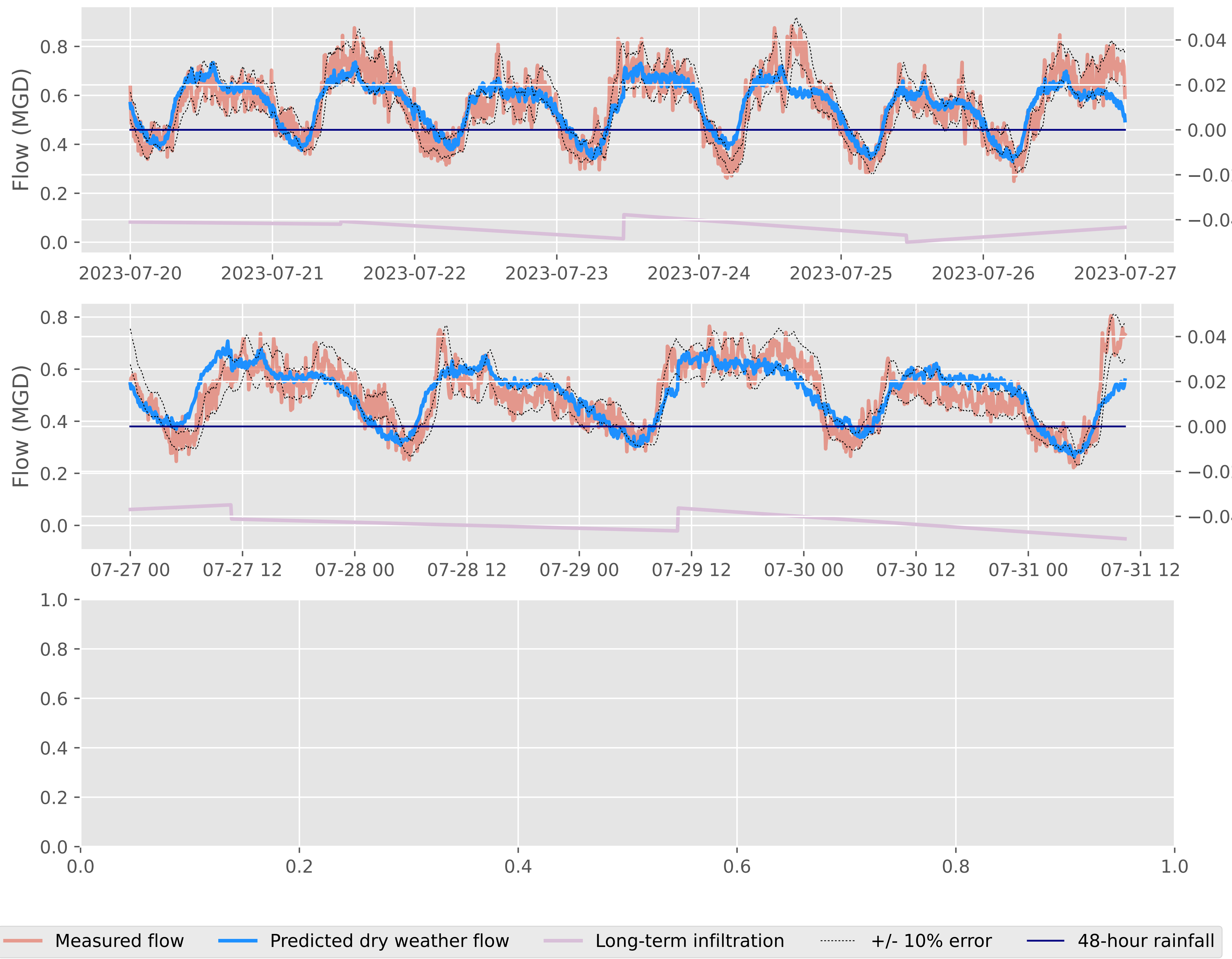



BP-19 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

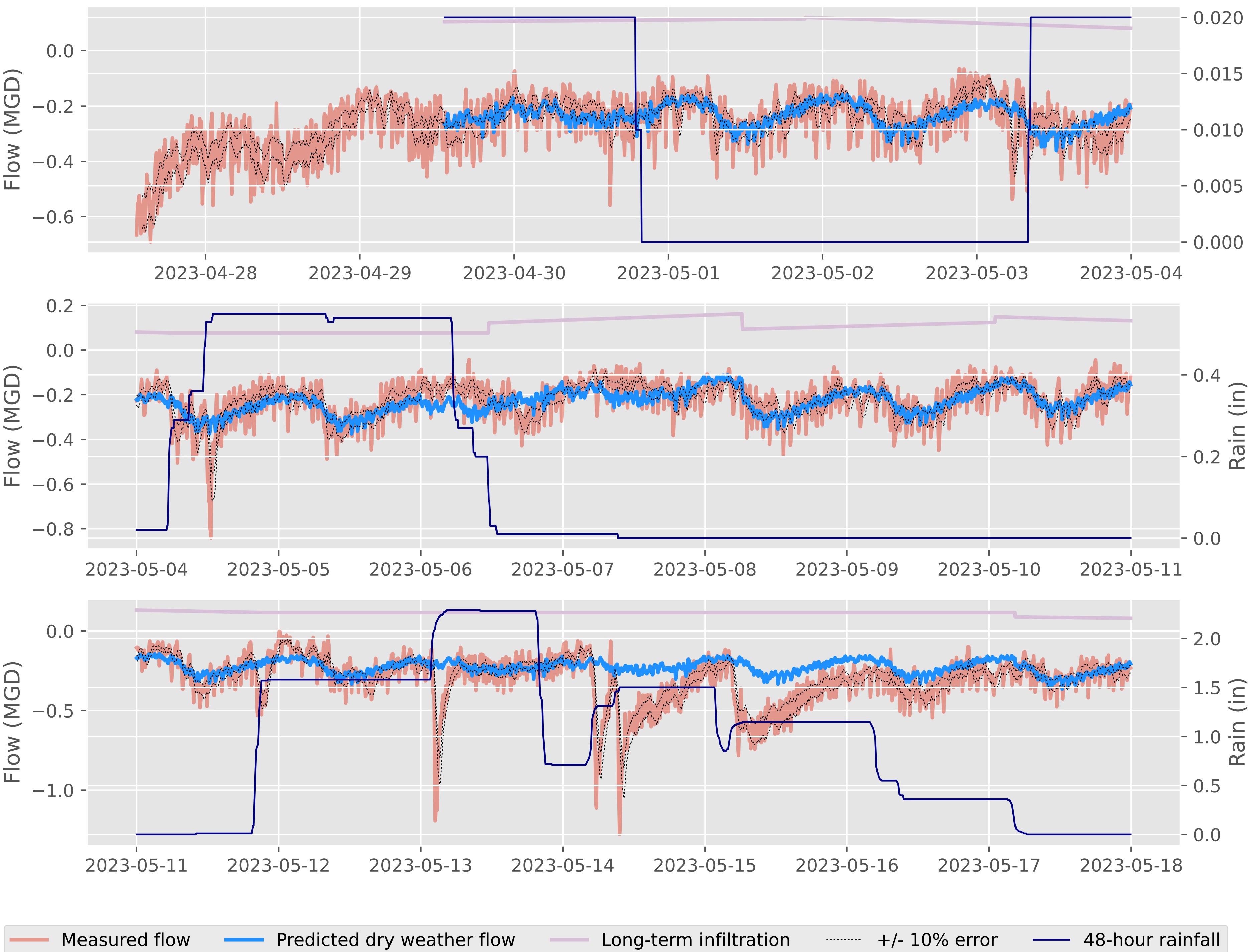
BP-19 Dry Weather Calibration Results

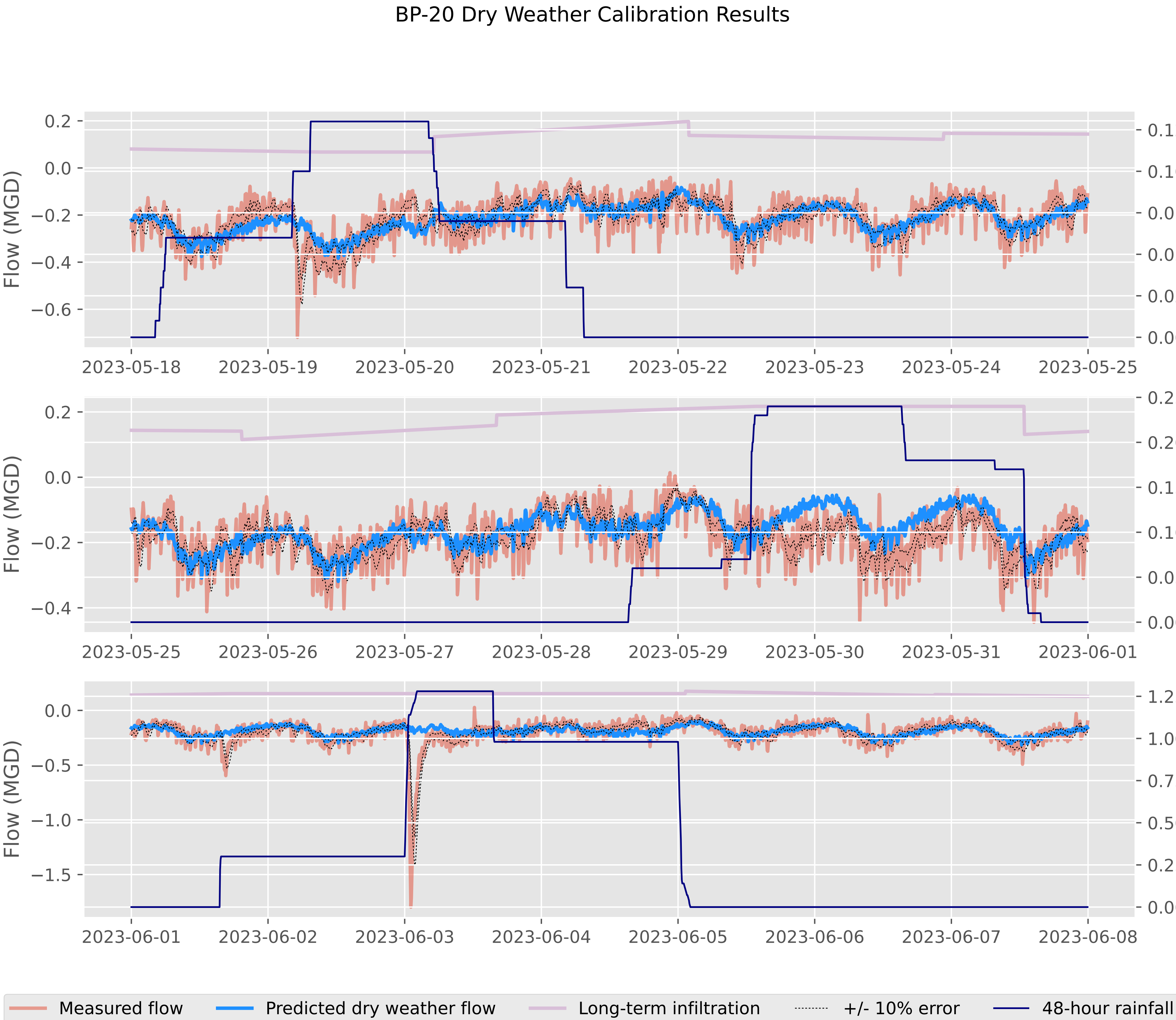


BP-19 Dry Weather Calibration Results

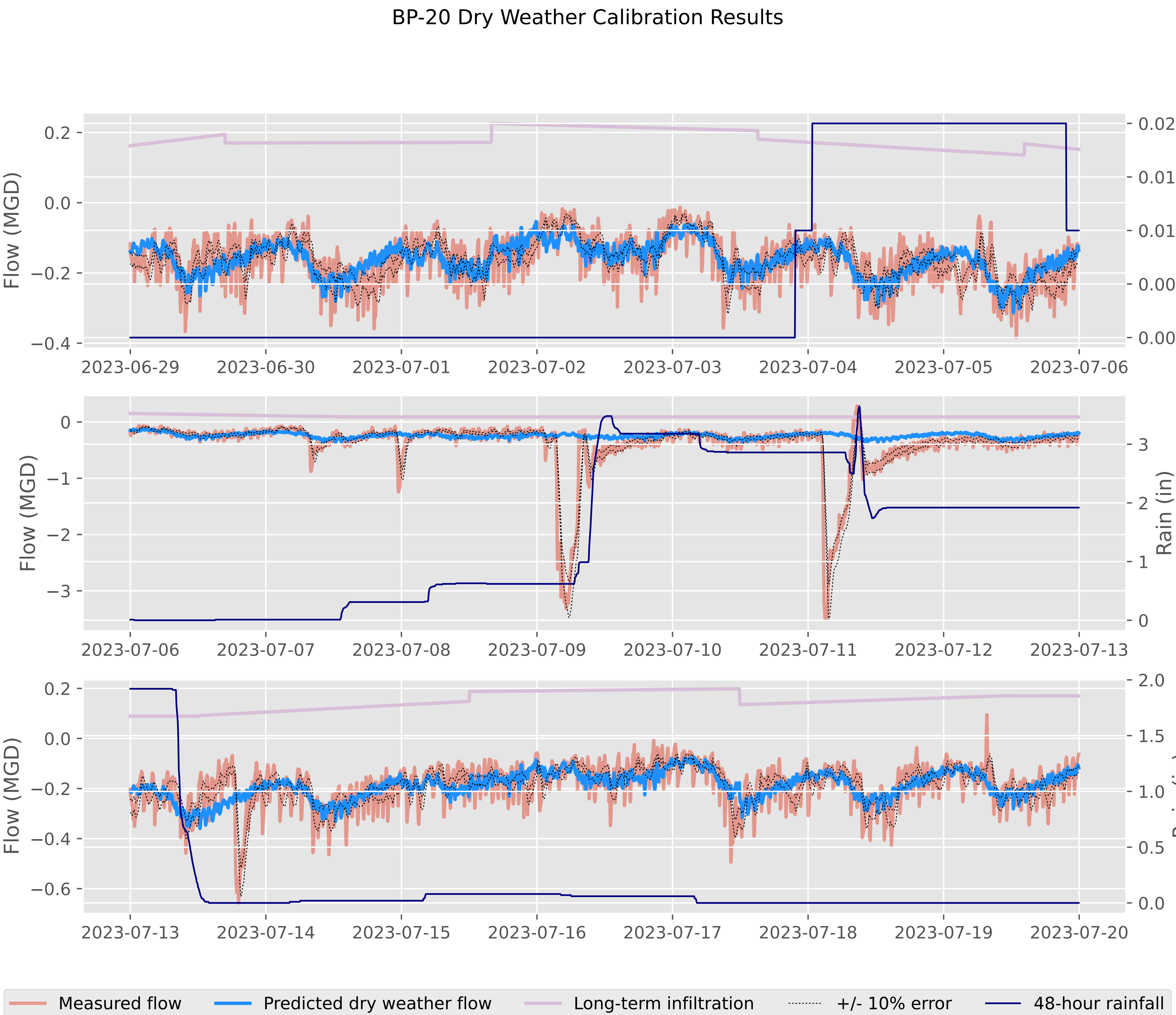


BP-20 Dry Weather Calibration Results

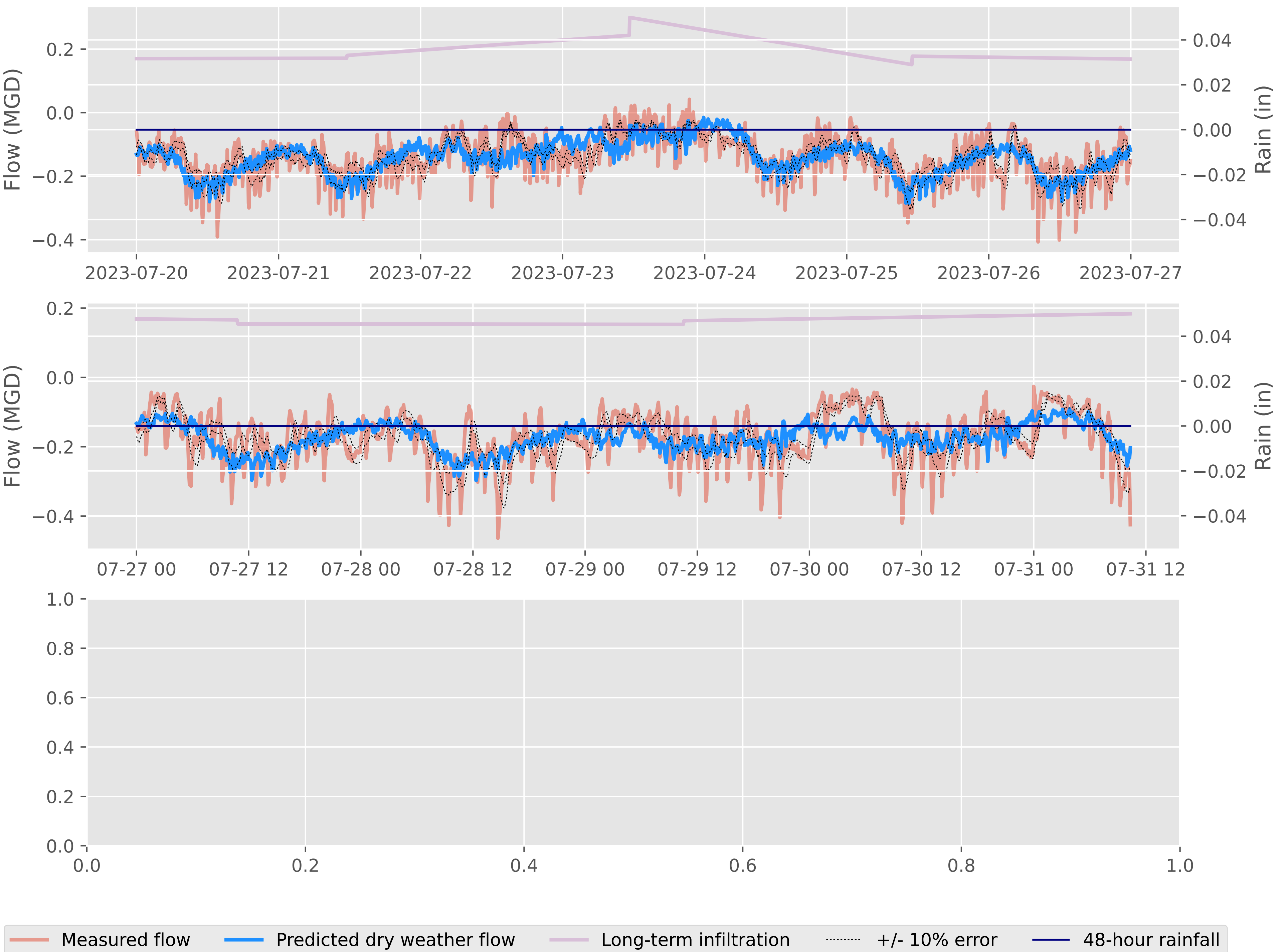



BP-20 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

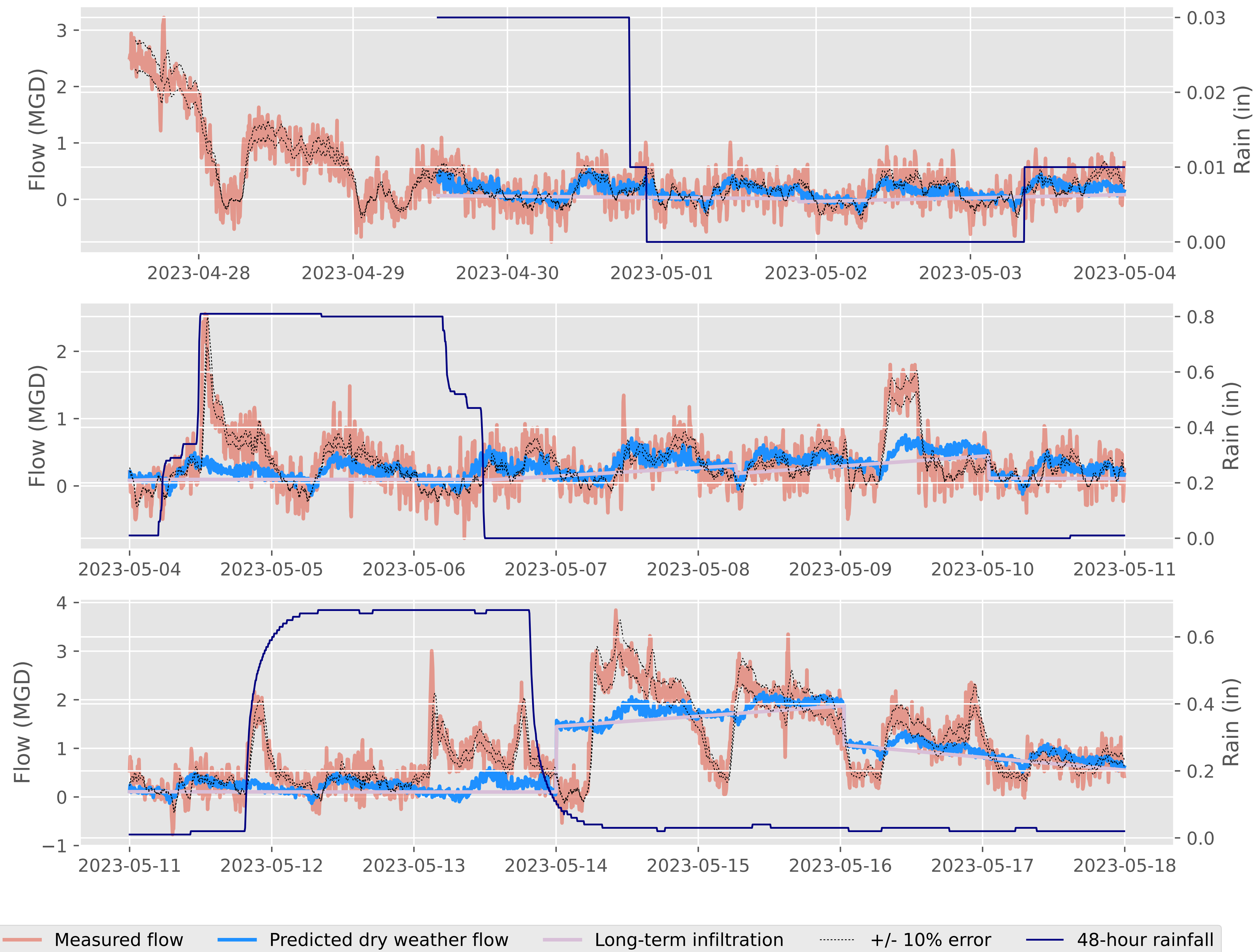
BP-20 Dry Weather Calibration Results


BP-20 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

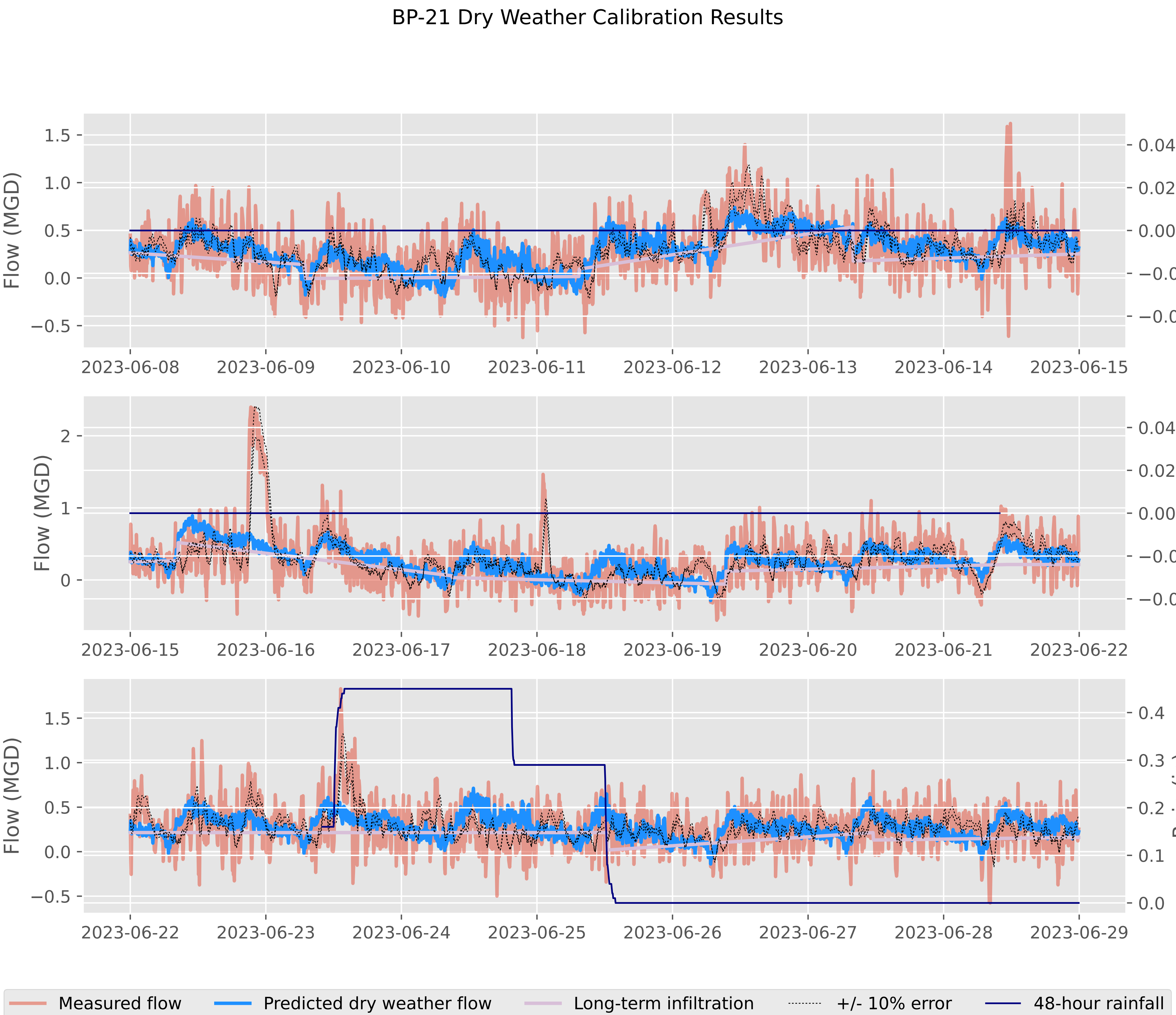
BP-20 Dry Weather Calibration Results

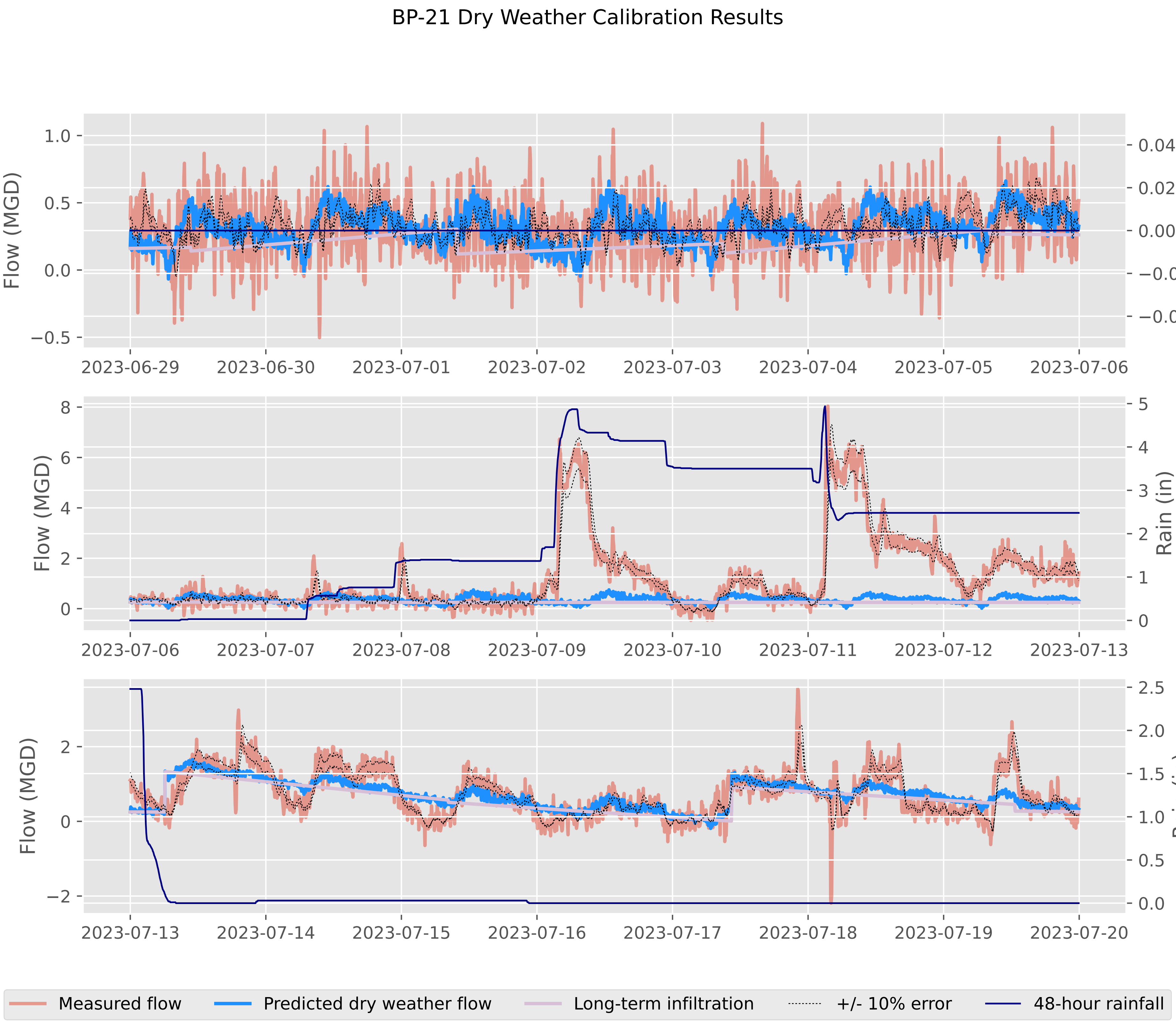


BP-21 Dry Weather Calibration Results

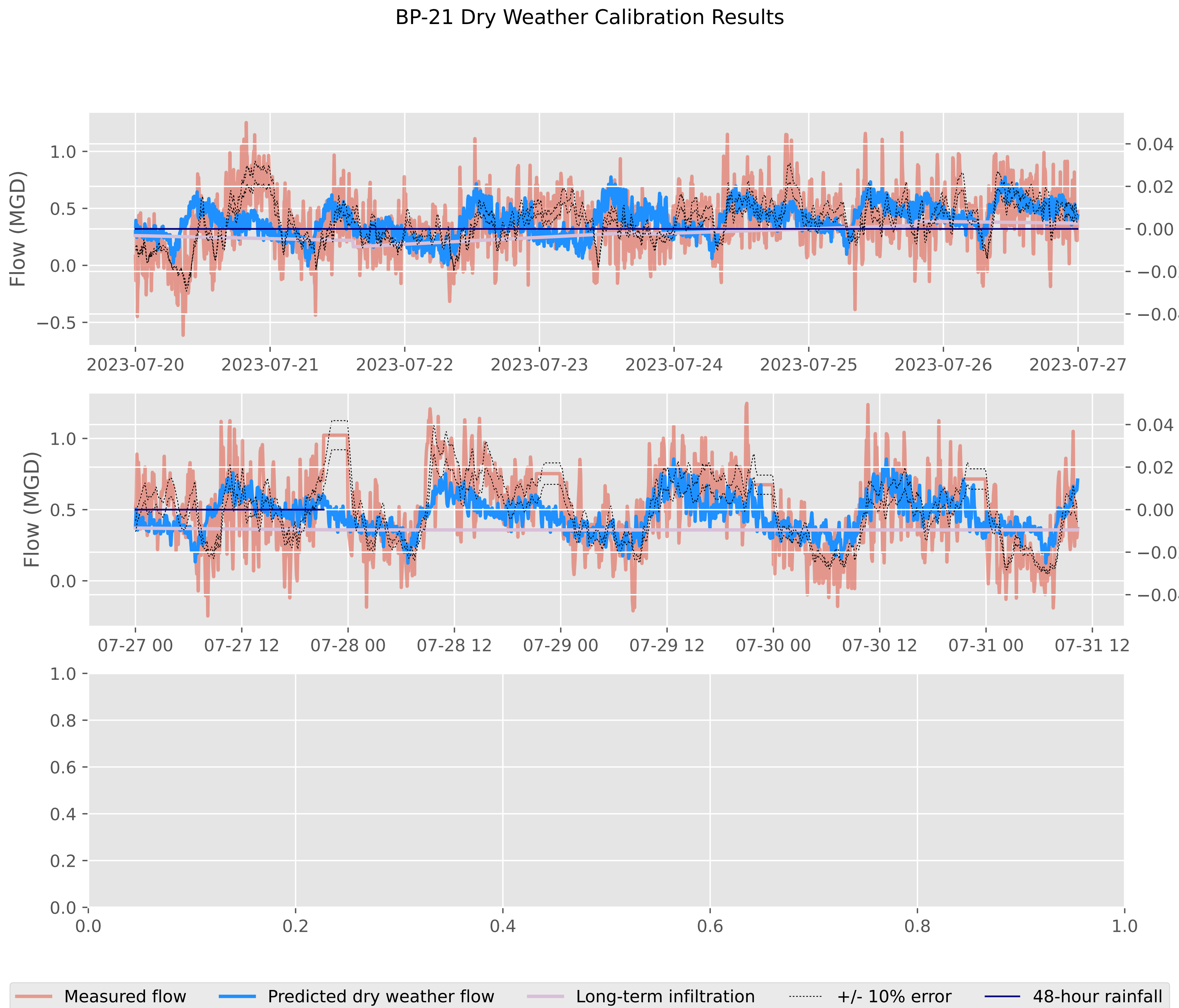


BP-21 Dry Weather Calibration Results


BP-21 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

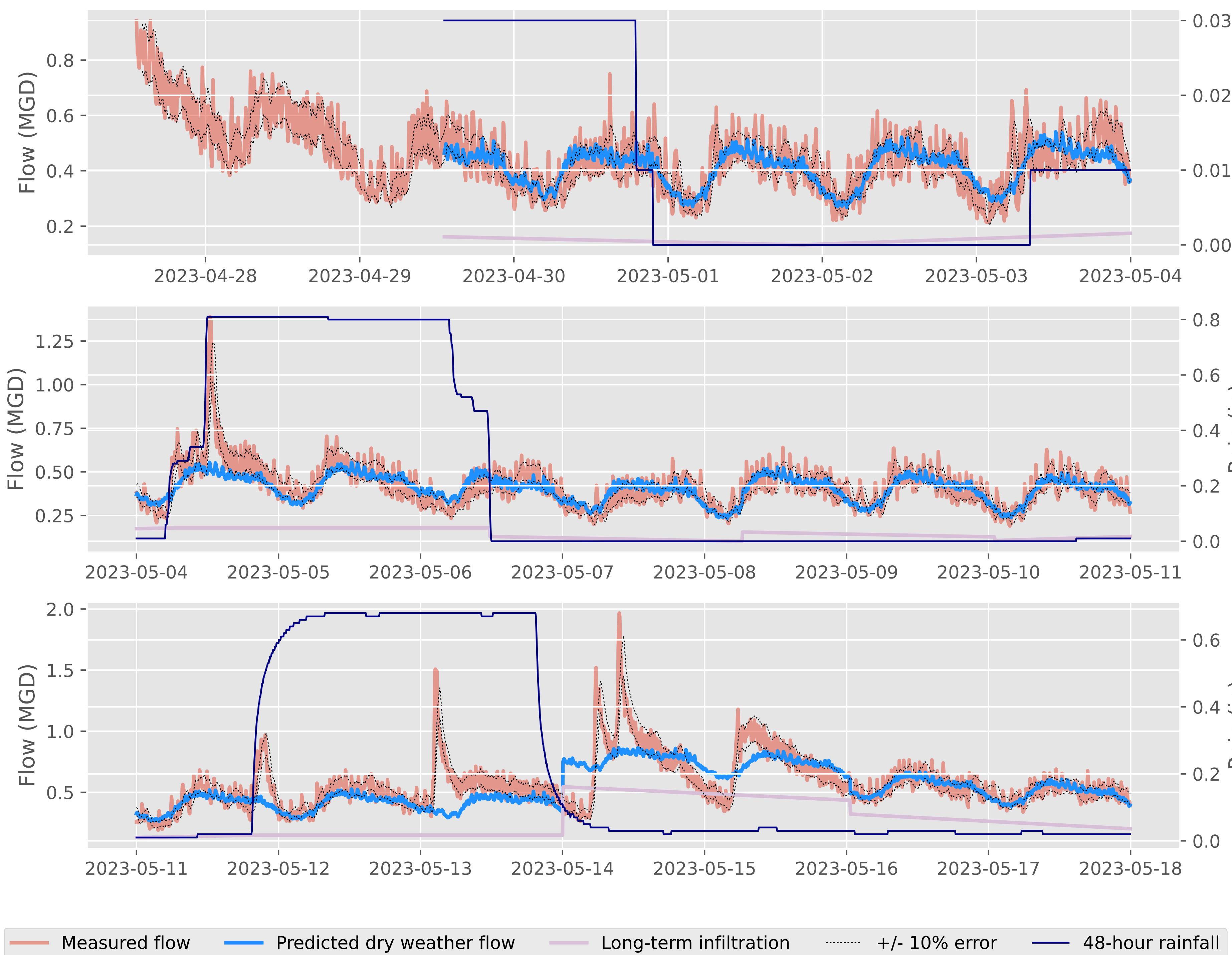


BP-21 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
−0.5
0.0
0.5
1.0
−0.04
−0.02
0.00
0.02
0.04
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
0
2
4
6
8
1
3
5
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
−2
0.0
0.5
1.0
1.5
2.0
2.5
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

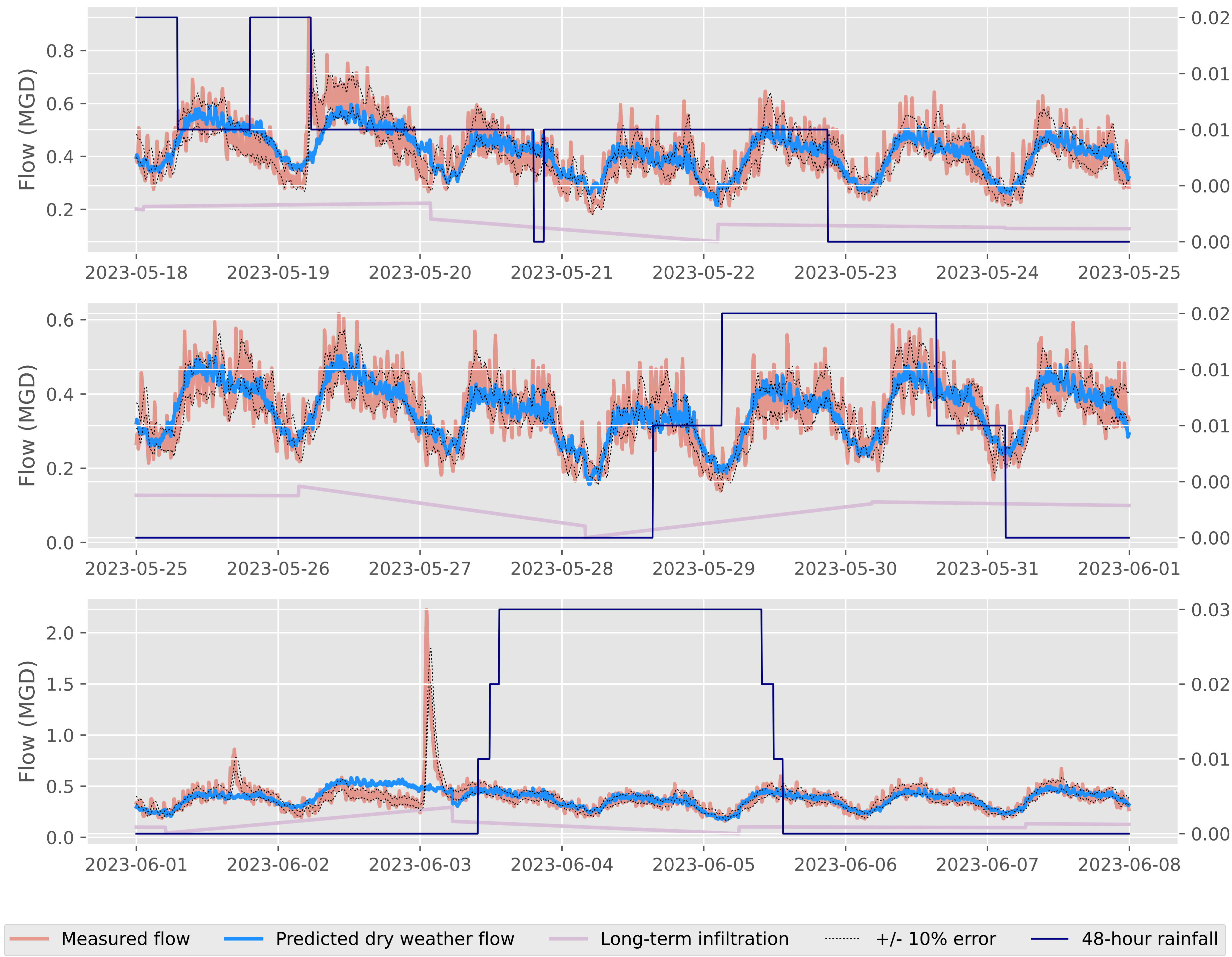


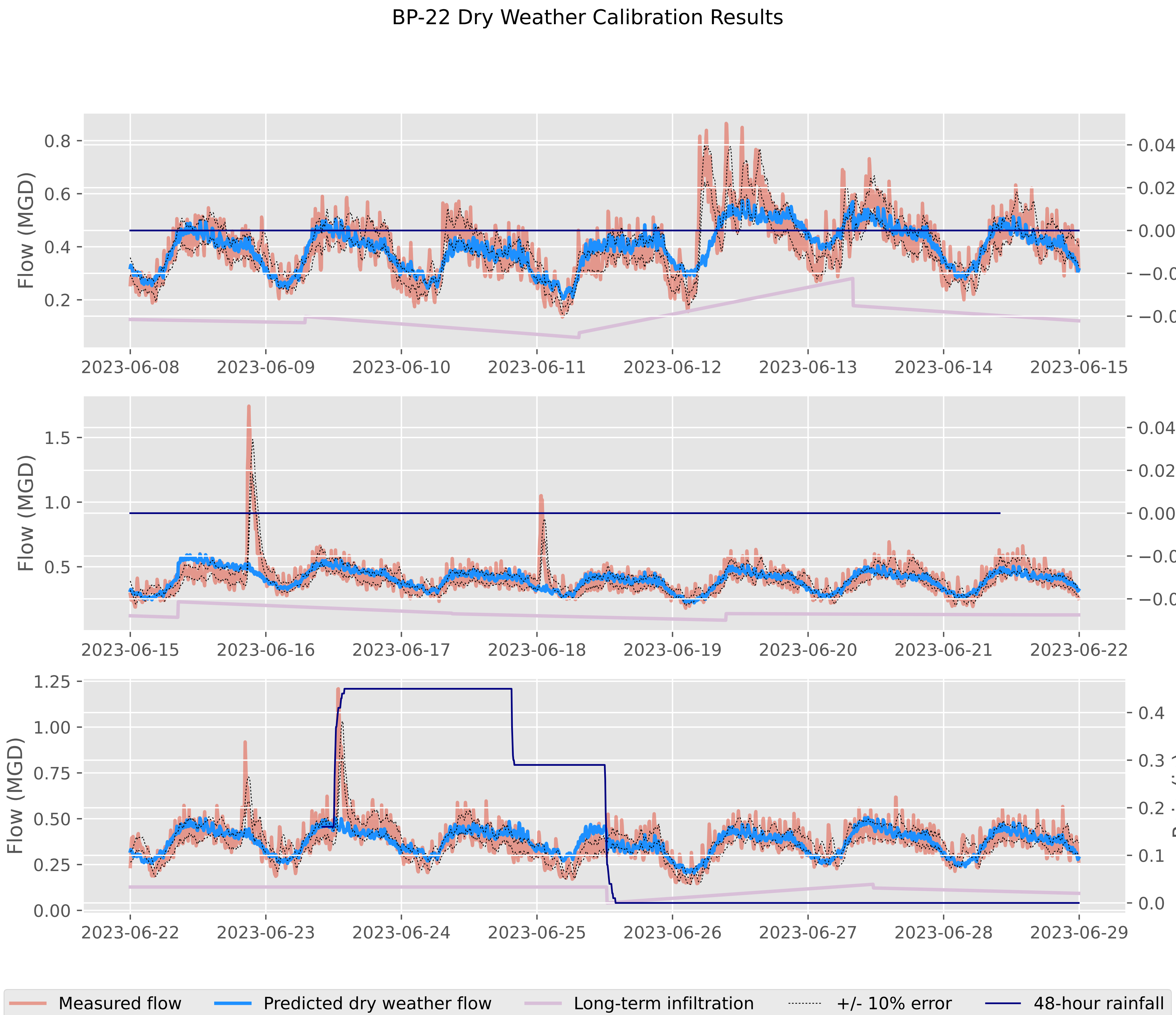
BP-21 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BP-22 Dry Weather Calibration Results

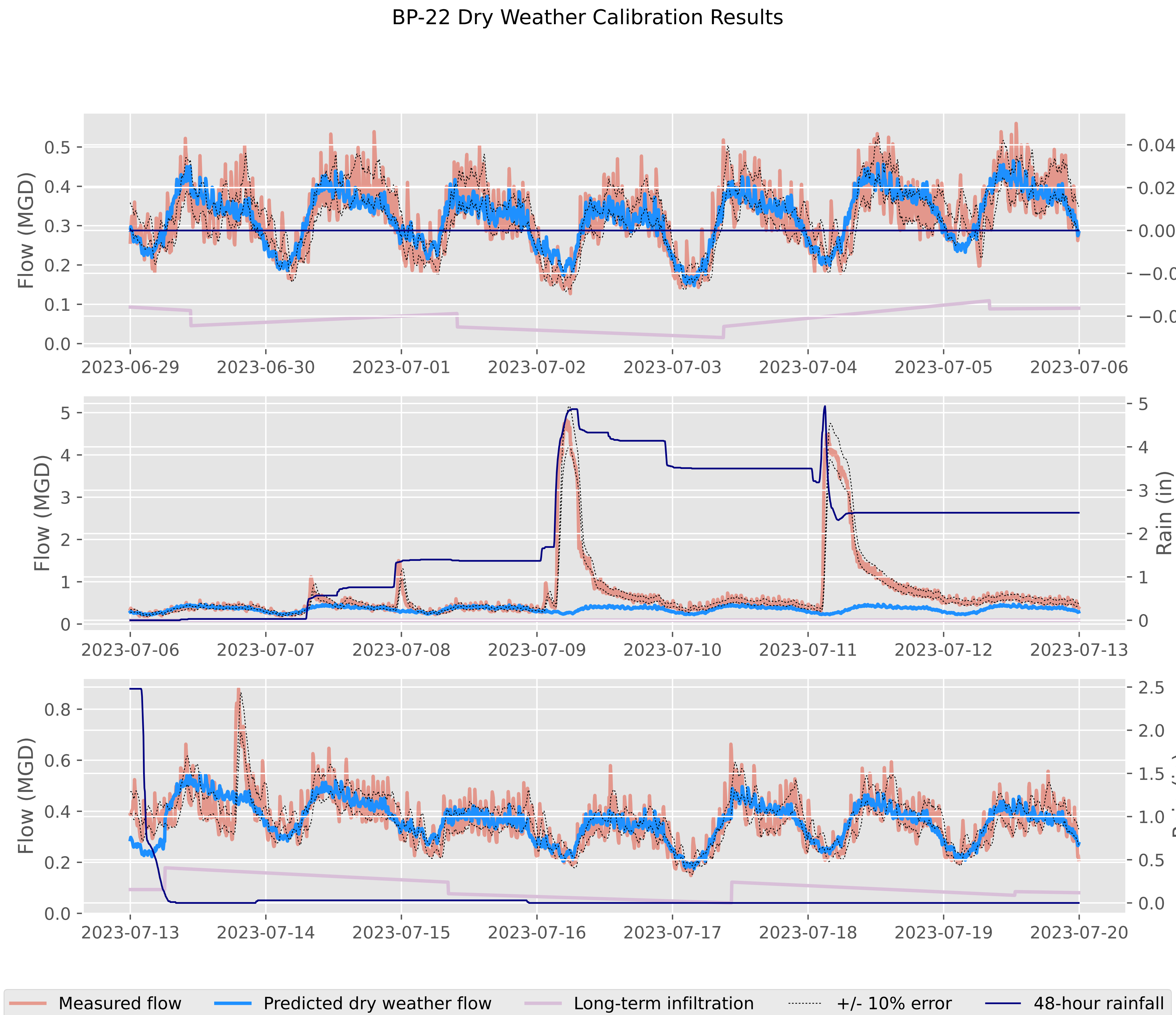


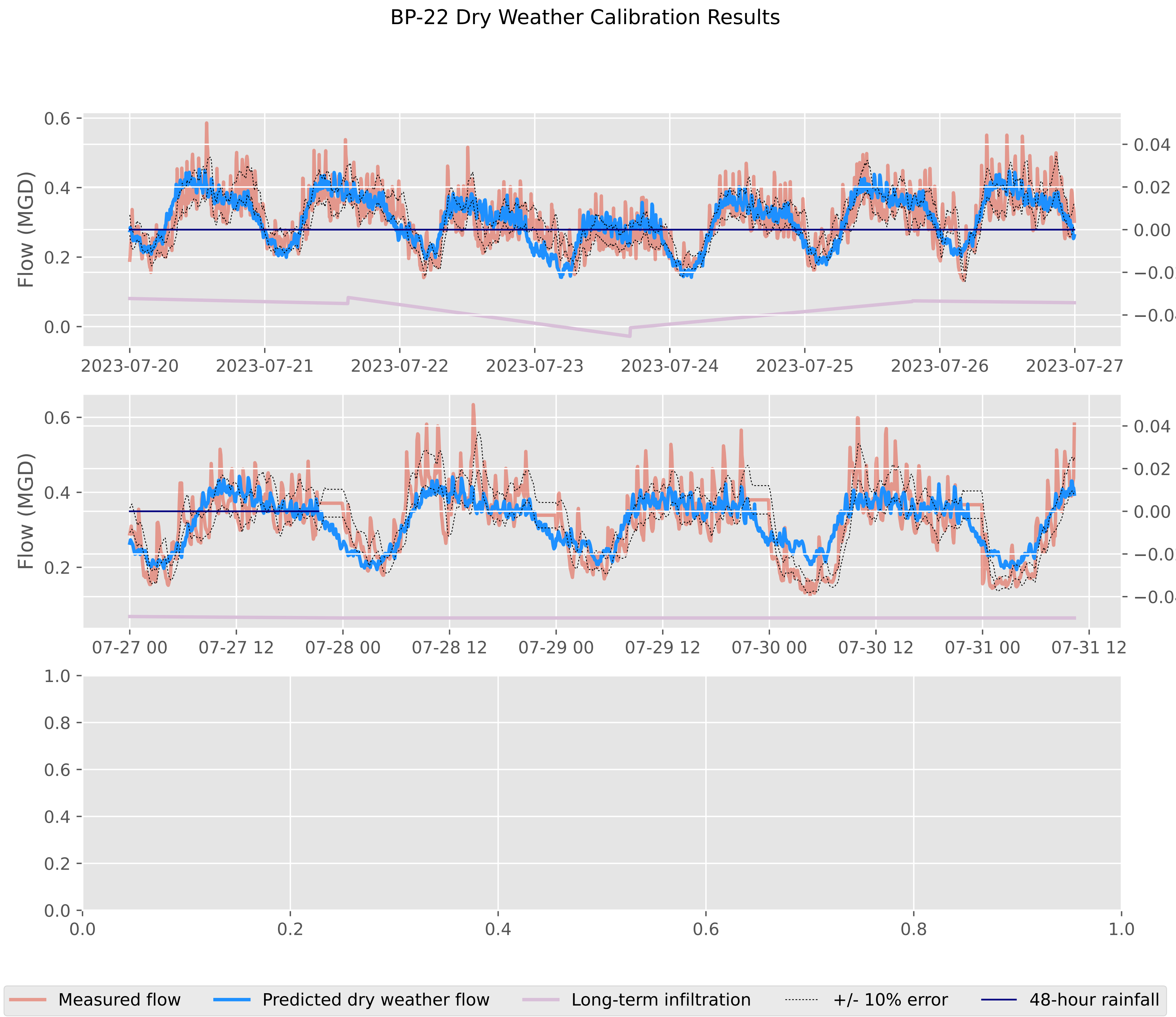
BP-22 Dry Weather Calibration Results



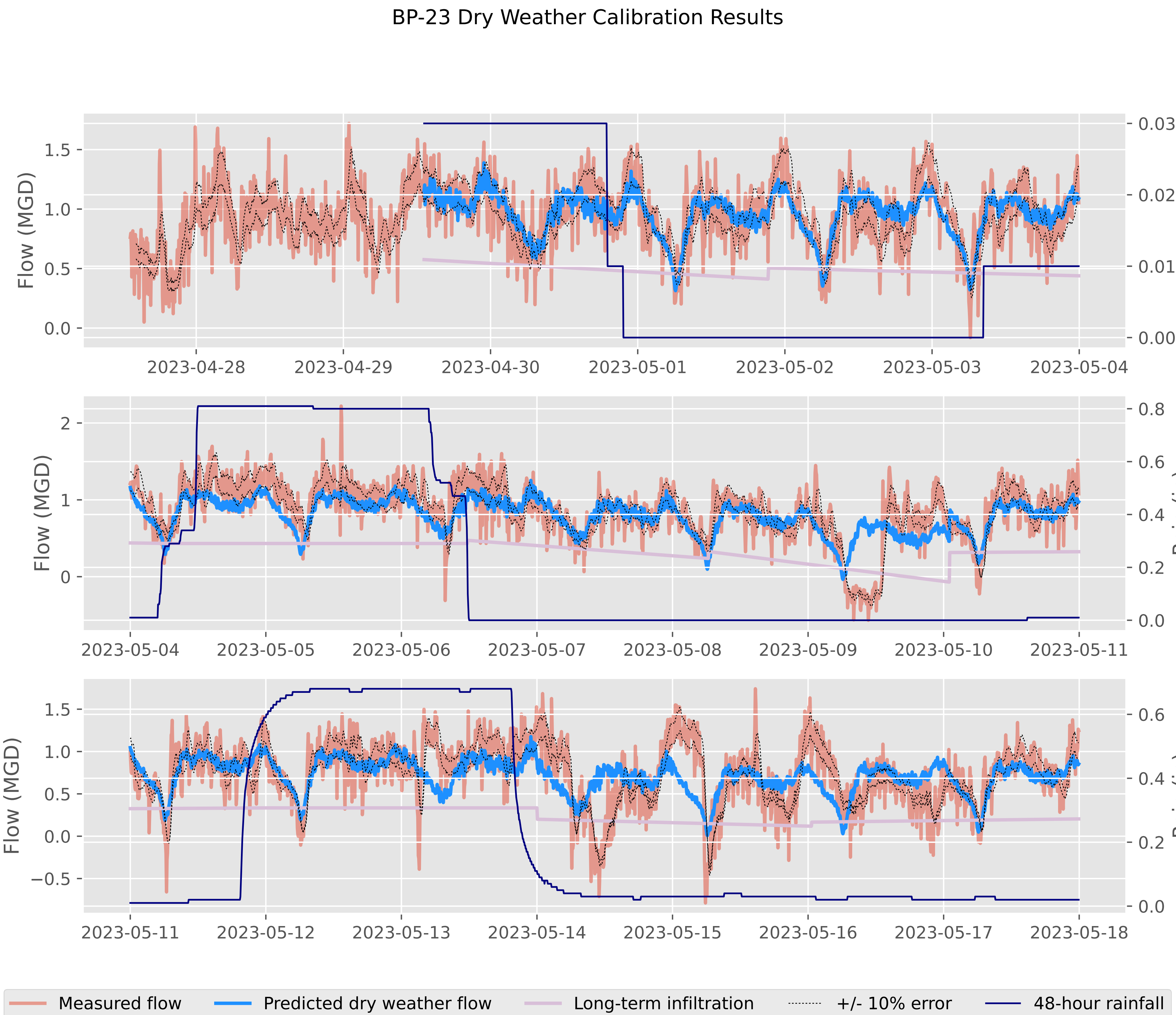


BP-22 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.8
0.6
0.4
0.2
0.04
0.02
0.00
−0.02
−0.04
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
1.5
1.0
0.5
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
1.25
1.00
0.75
0.50
0.25
0.00
0.4
0.3
0.2
0.1
0.0
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

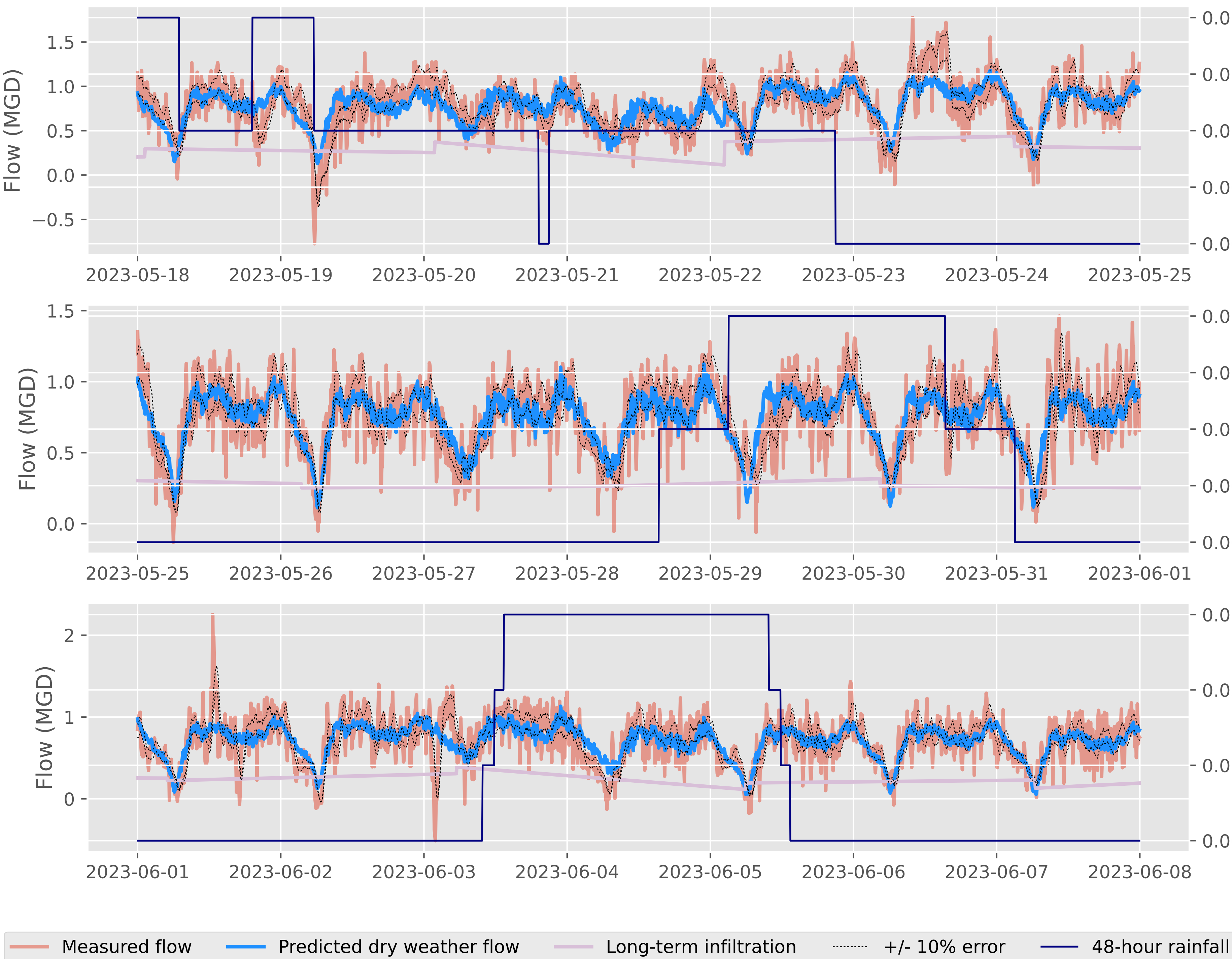

BP-22 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

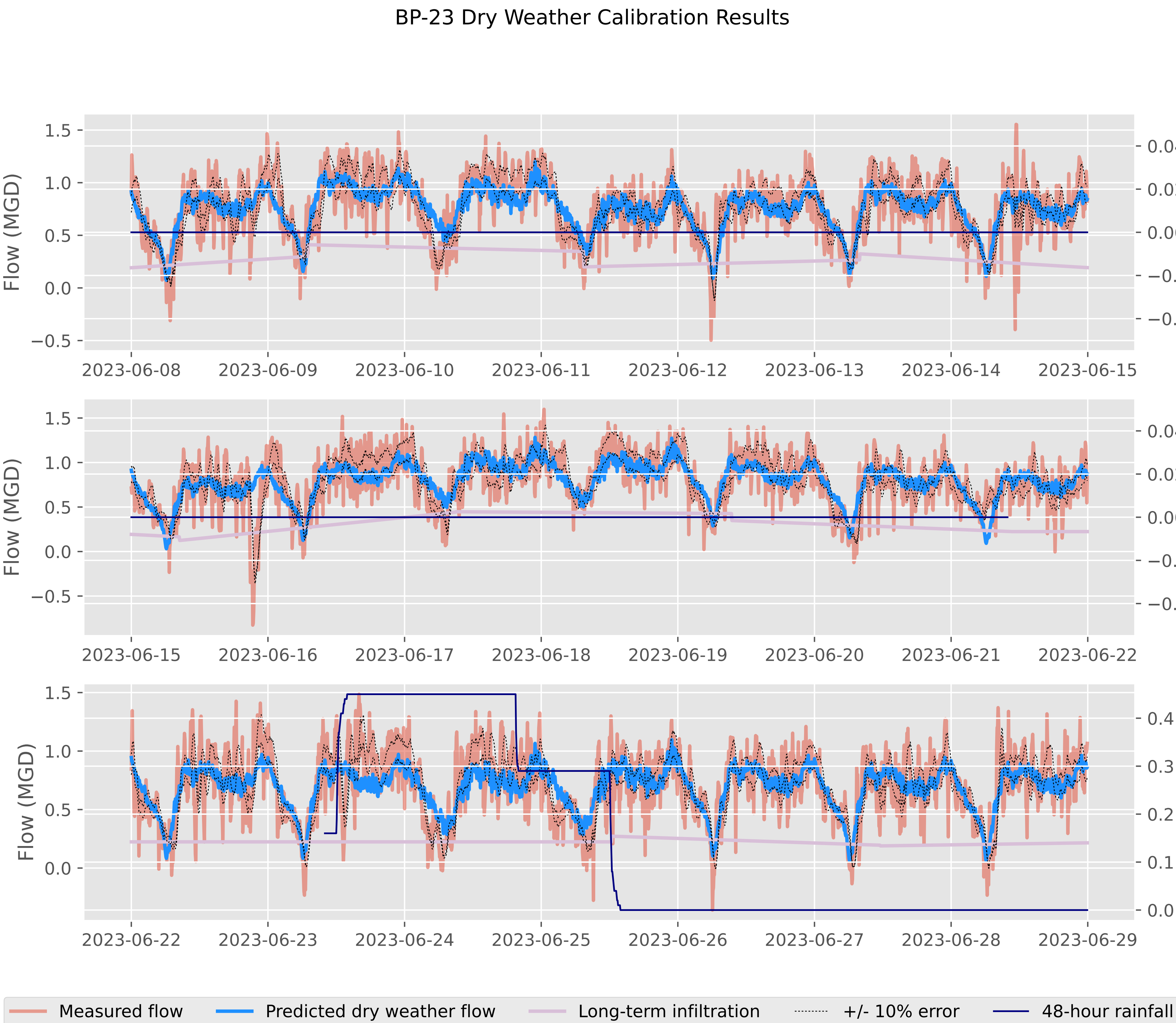


BP-22 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


BP-23 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

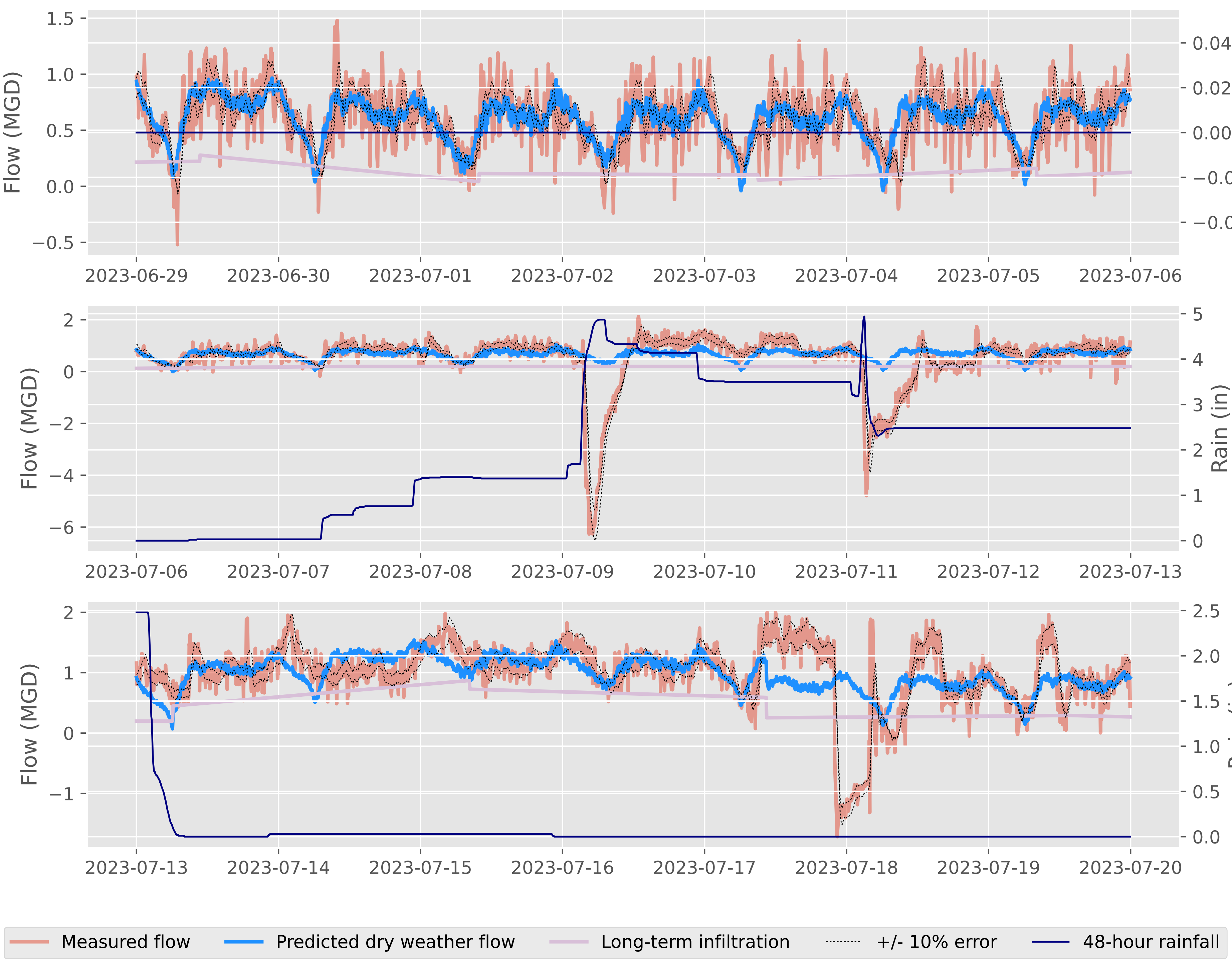
BP-23 Dry Weather Calibration Results

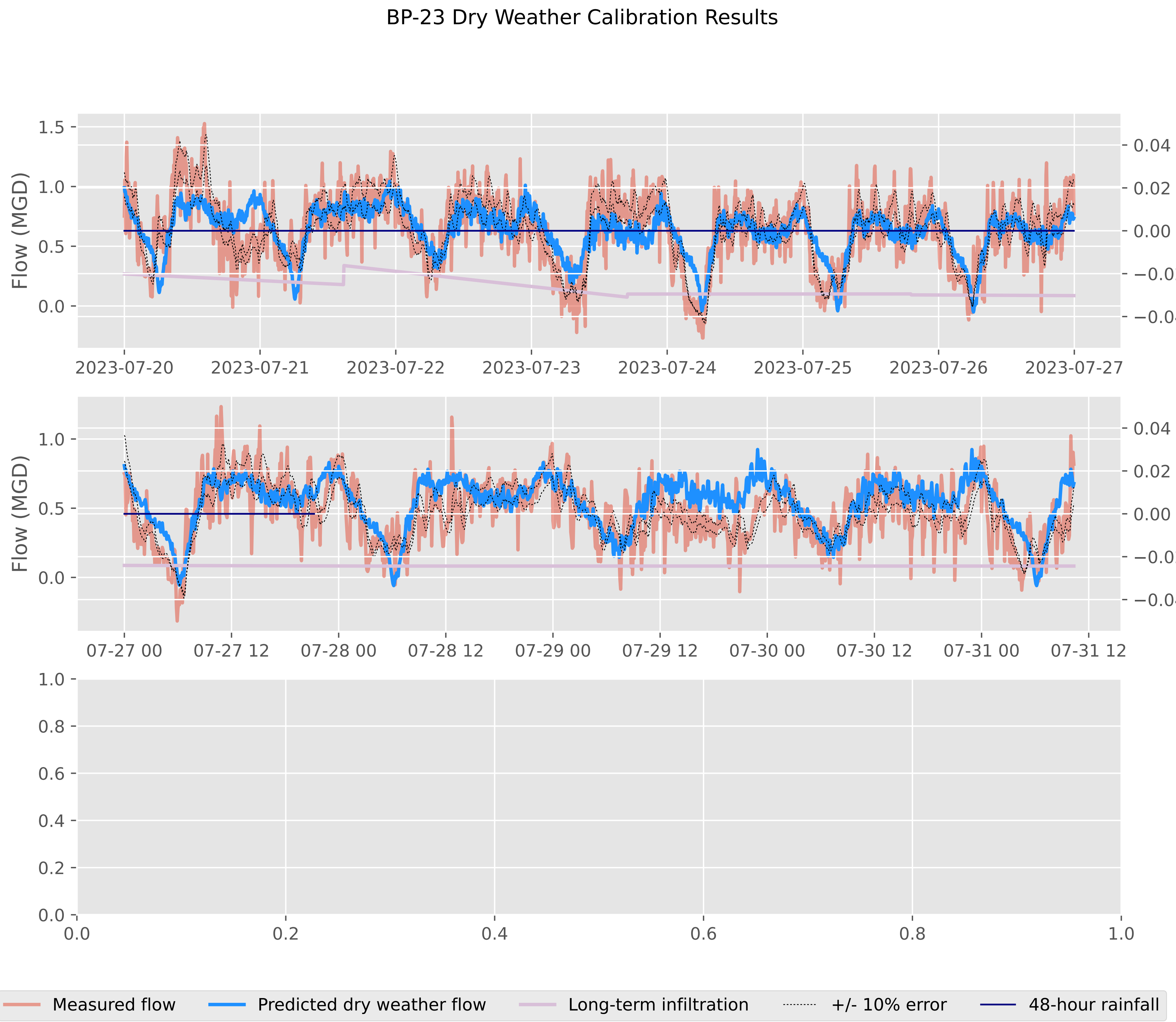


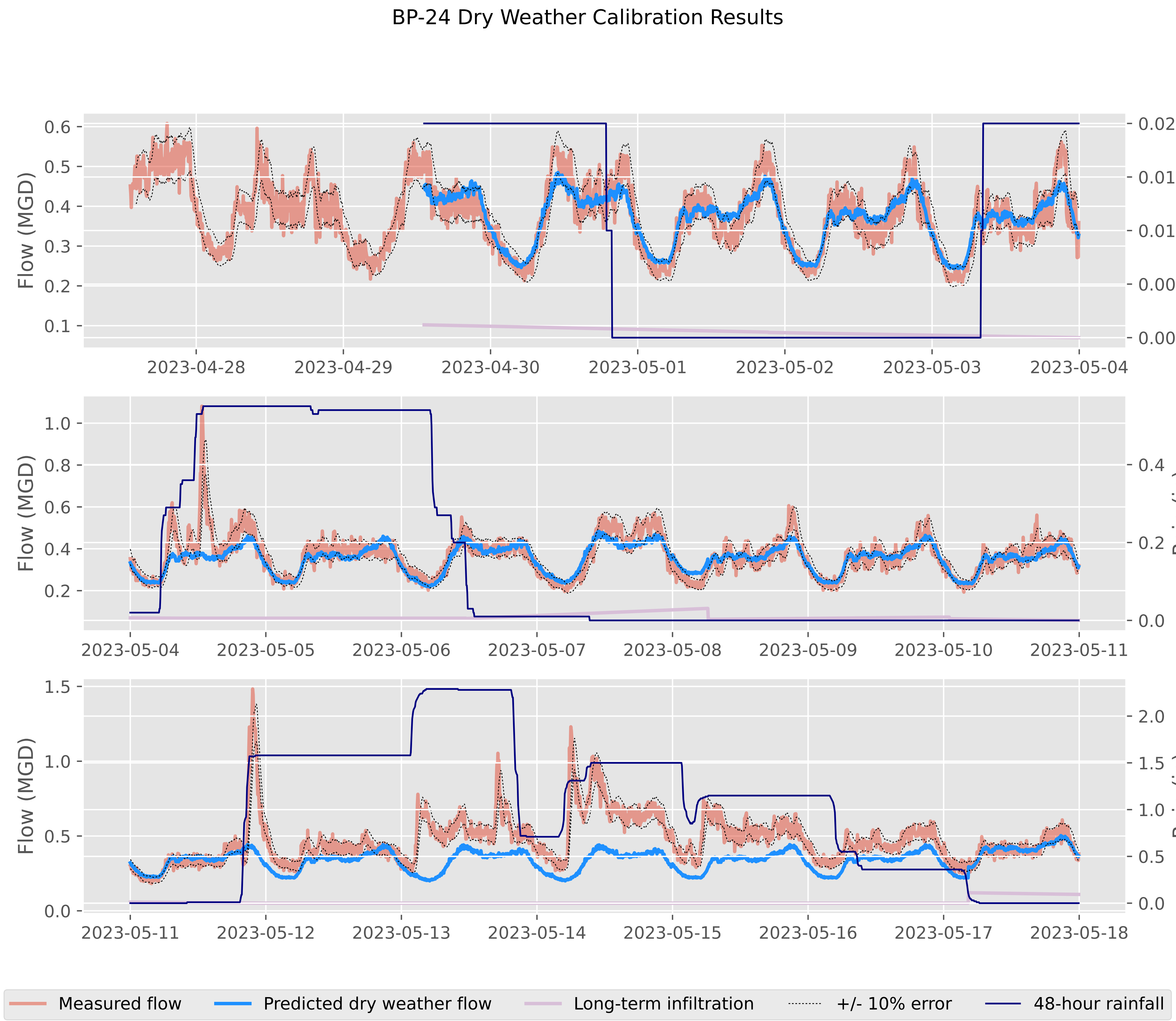


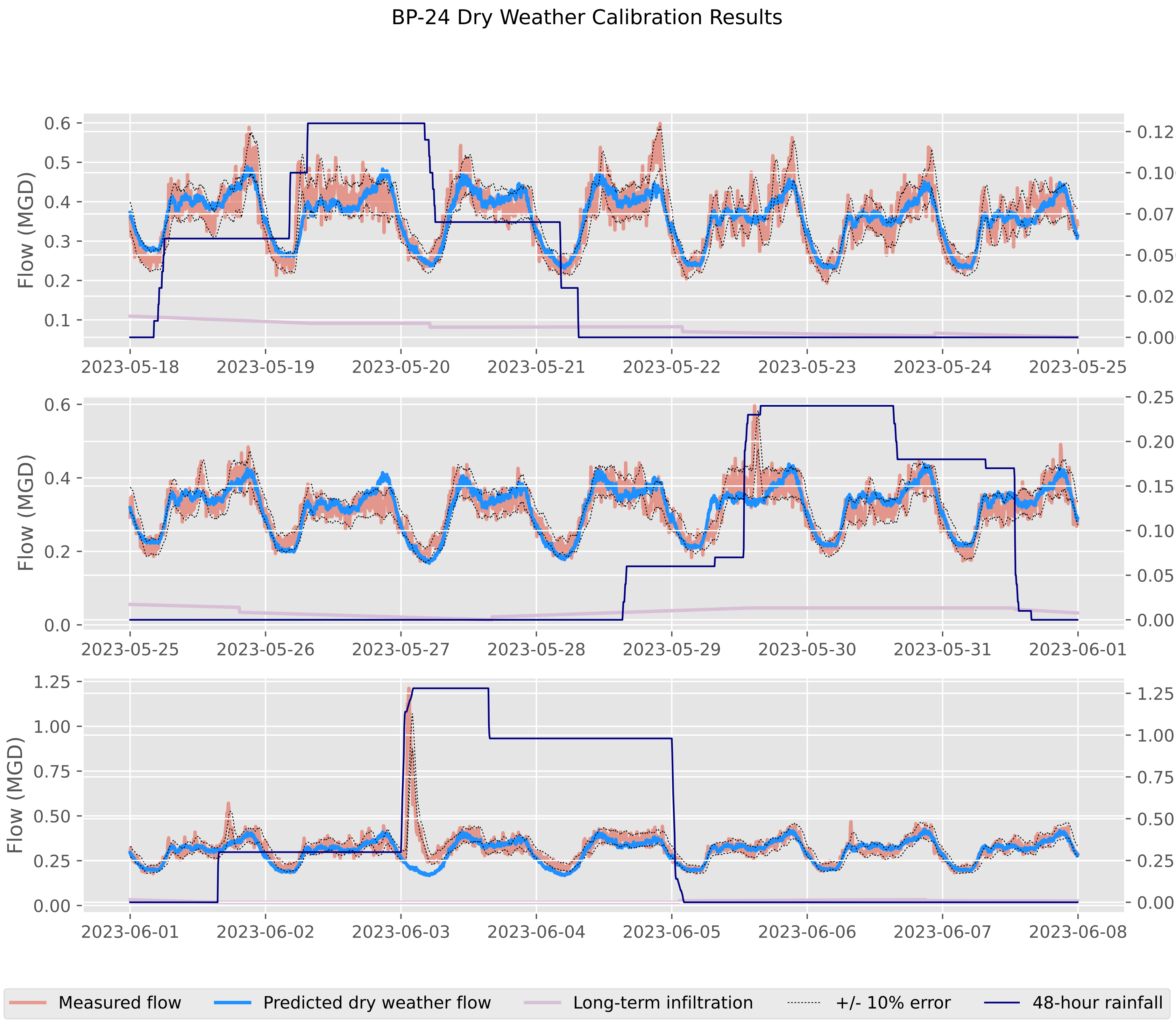
BP-23 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
1.5
1.0
0.5
0.0
−0.5
0.04
0.02
0.00
−0.02
−0.04
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
0.4
0.3
0.2
0.1
0.0
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BP-23 Dry Weather Calibration Results



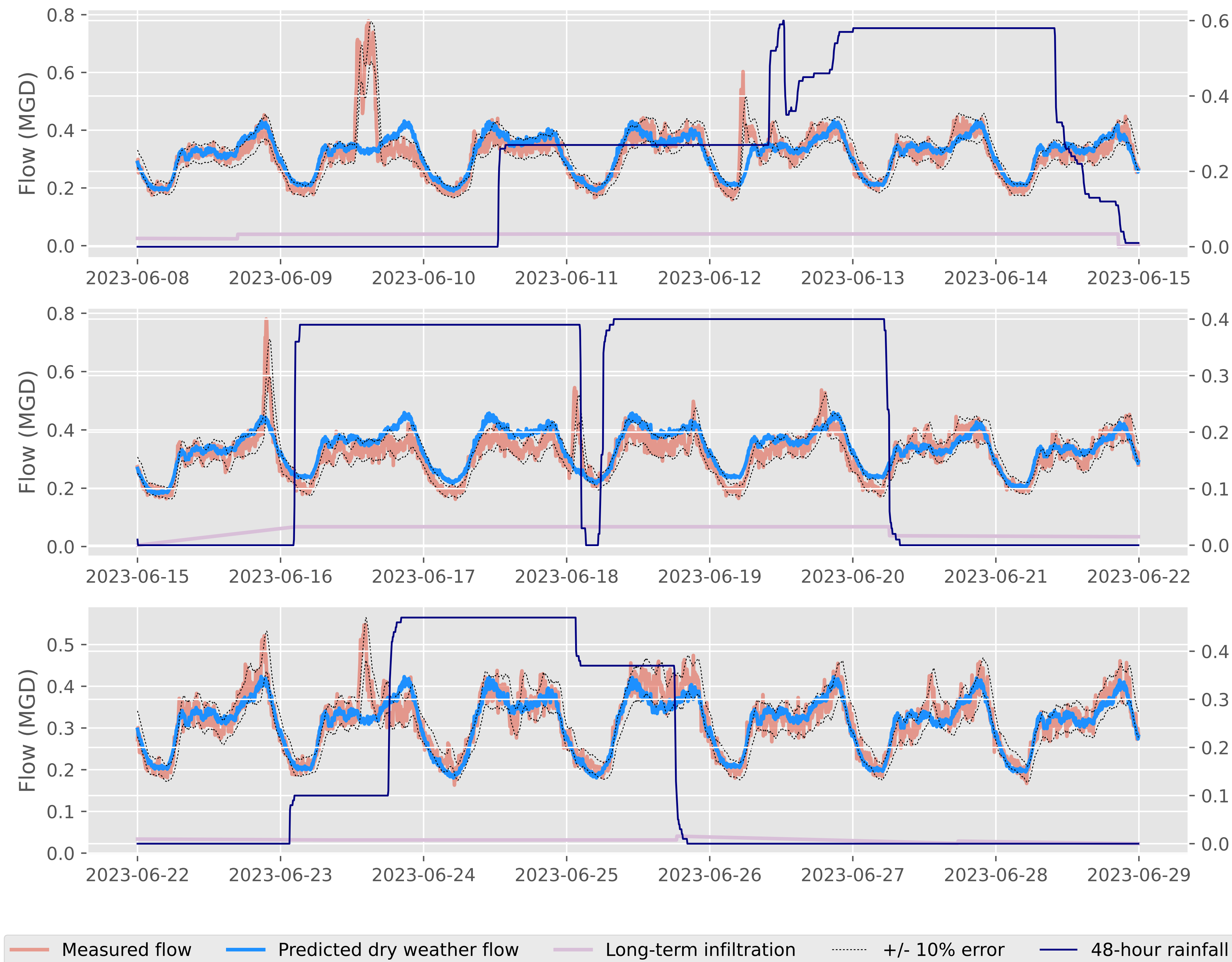

BP-23 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


BP-24 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

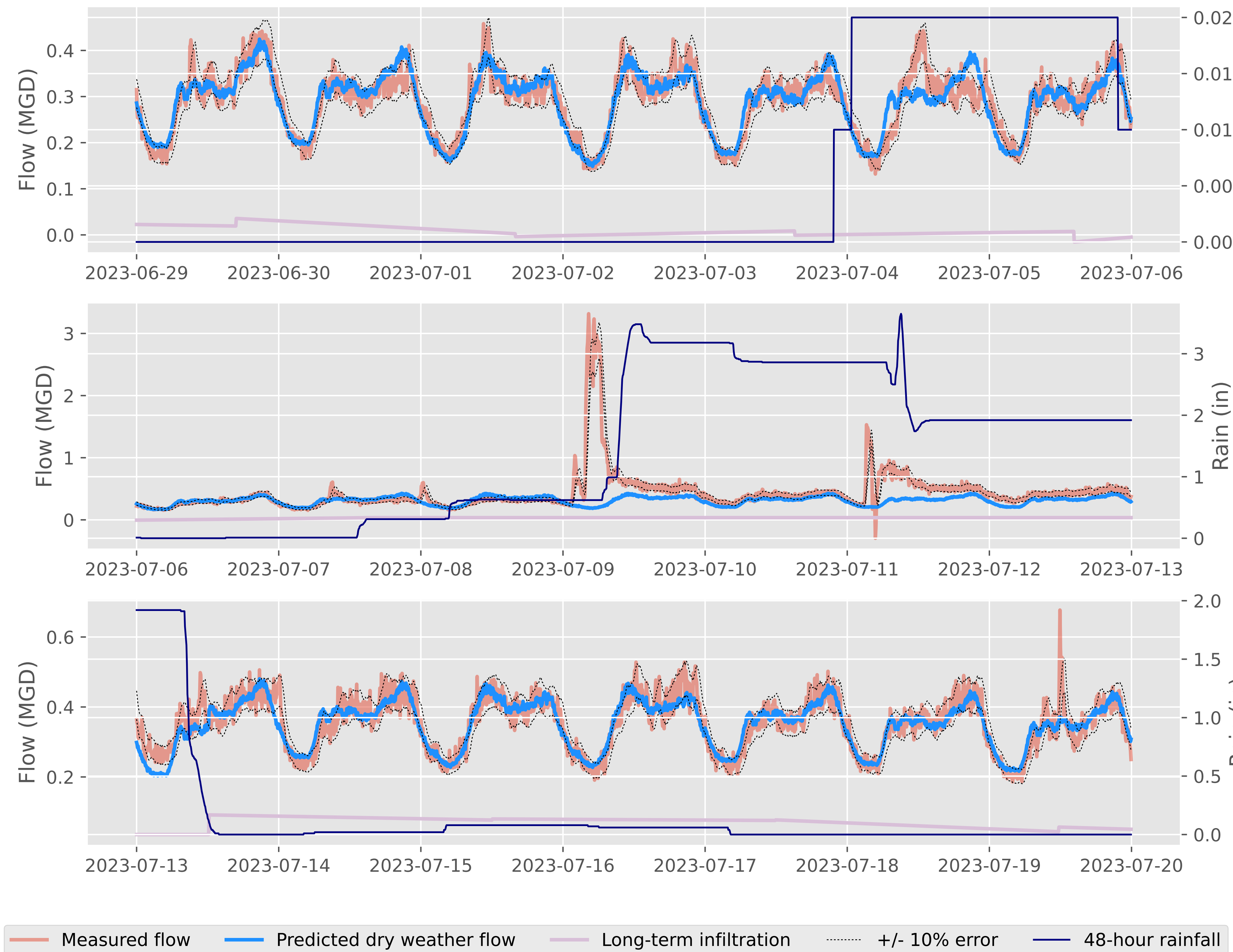


BP-24 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

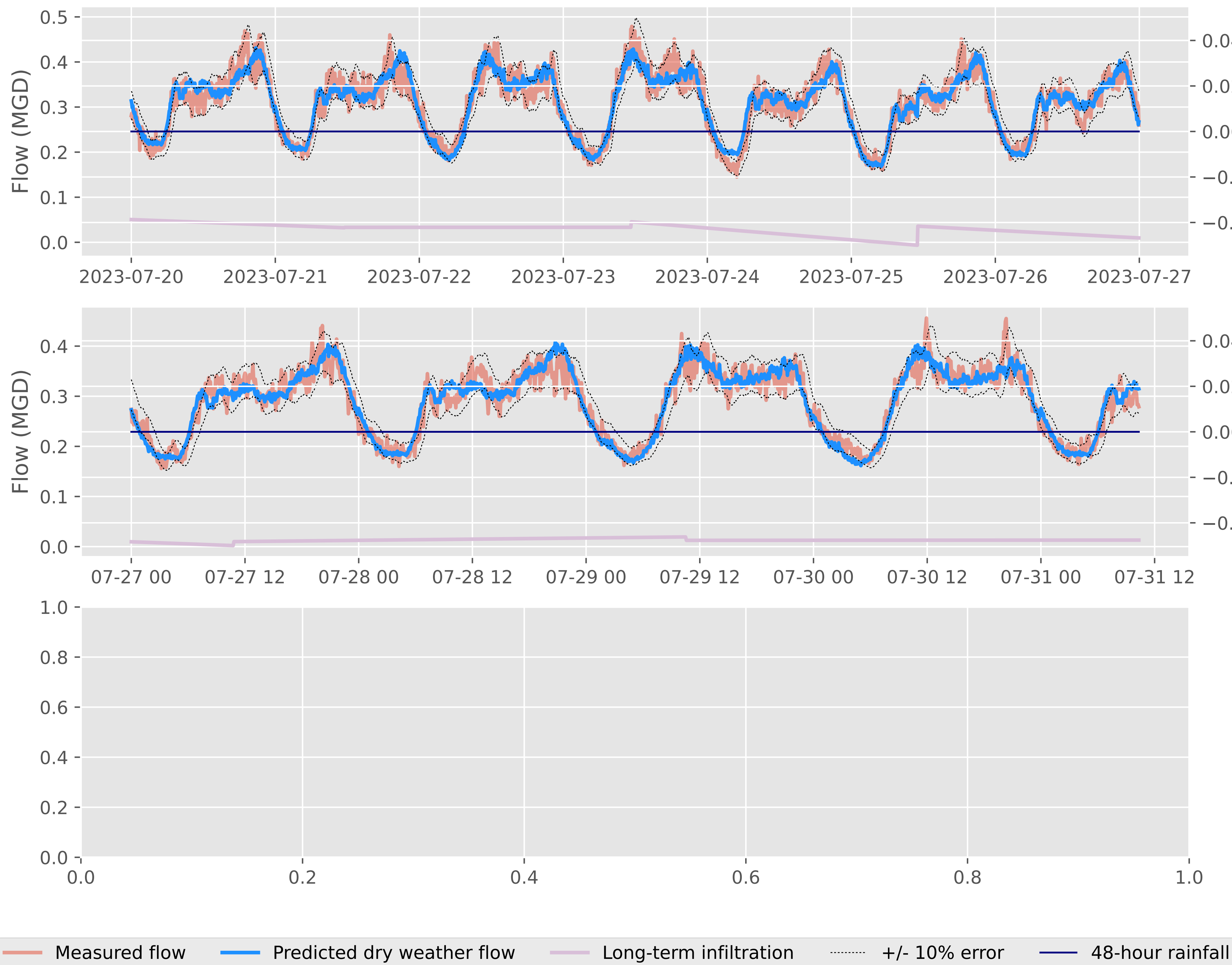
BP-24 Dry Weather Calibration Results



BP-24 Dry Weather Calibration Results



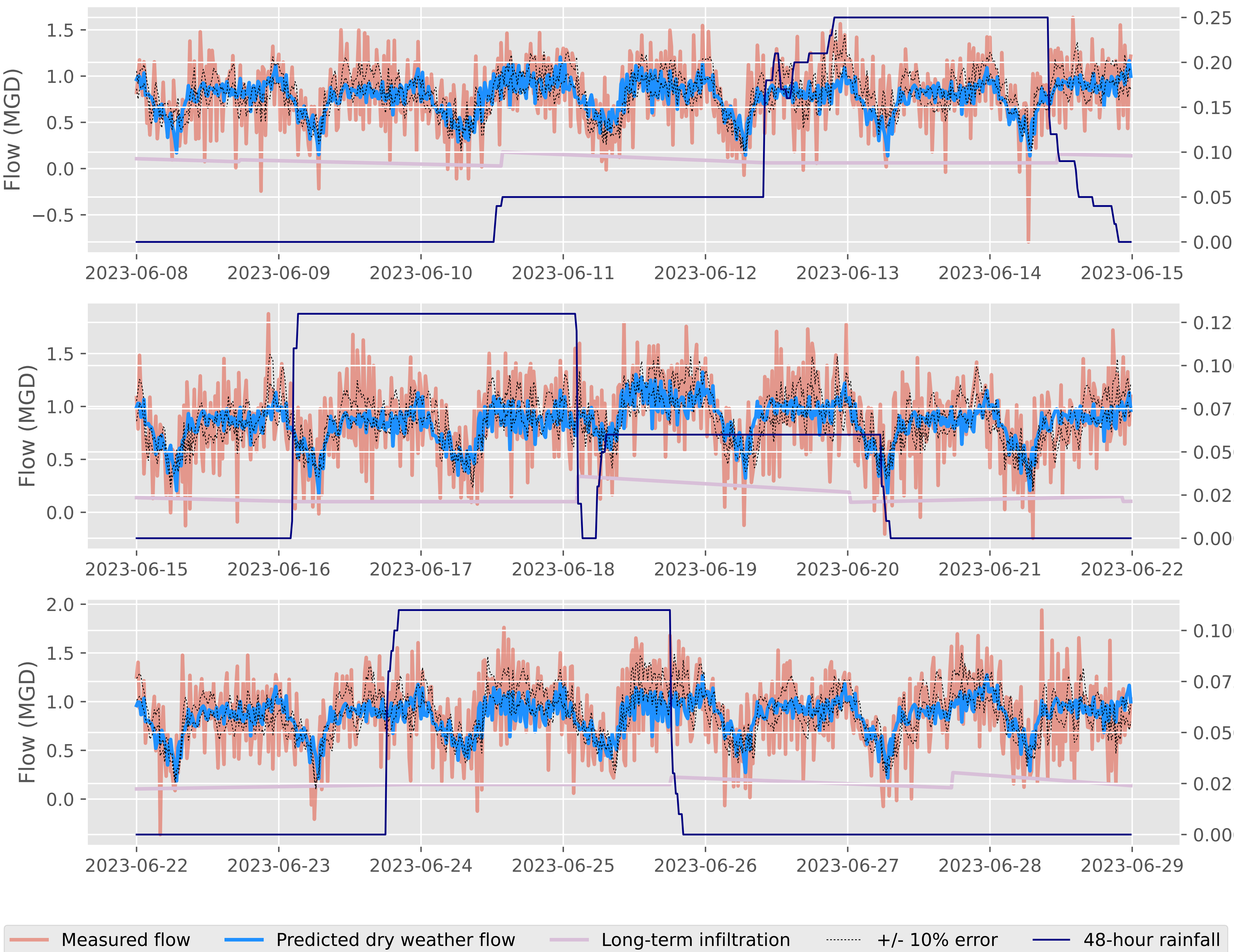
BP-24 Dry Weather Calibration Results

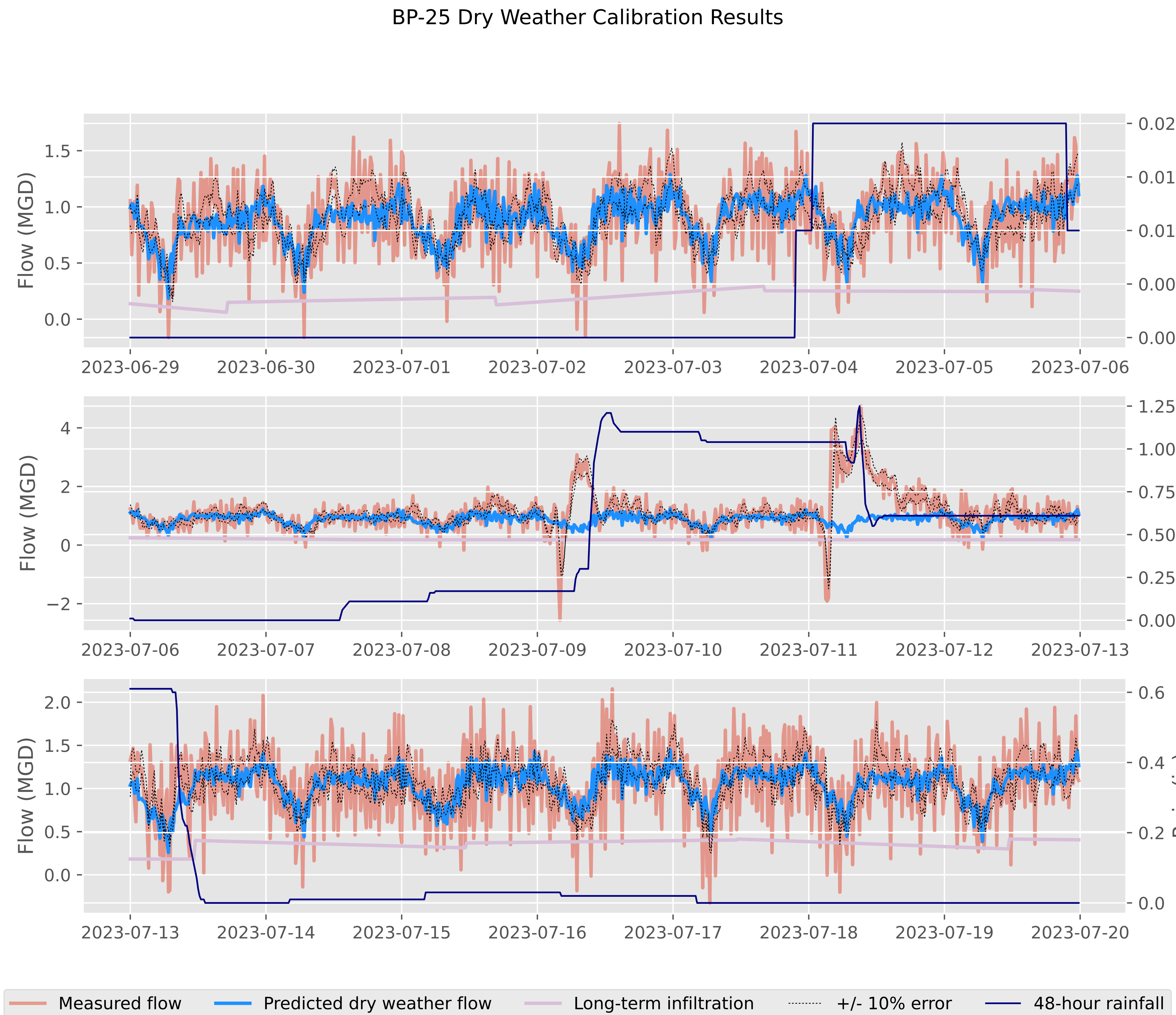


BP-25 Dry Weather Calibration Results


BP-25 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

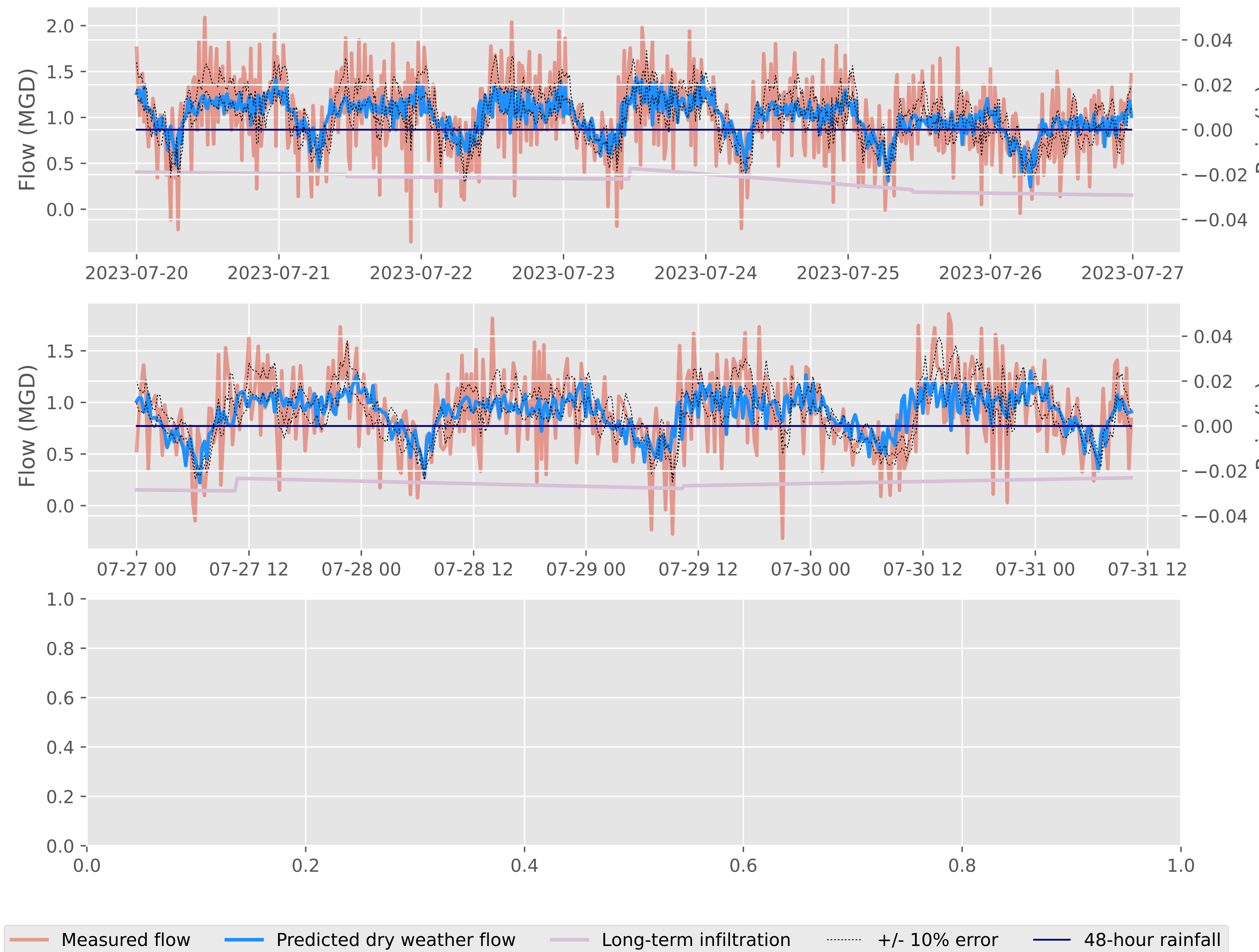
BP-25 Dry Weather Calibration Results

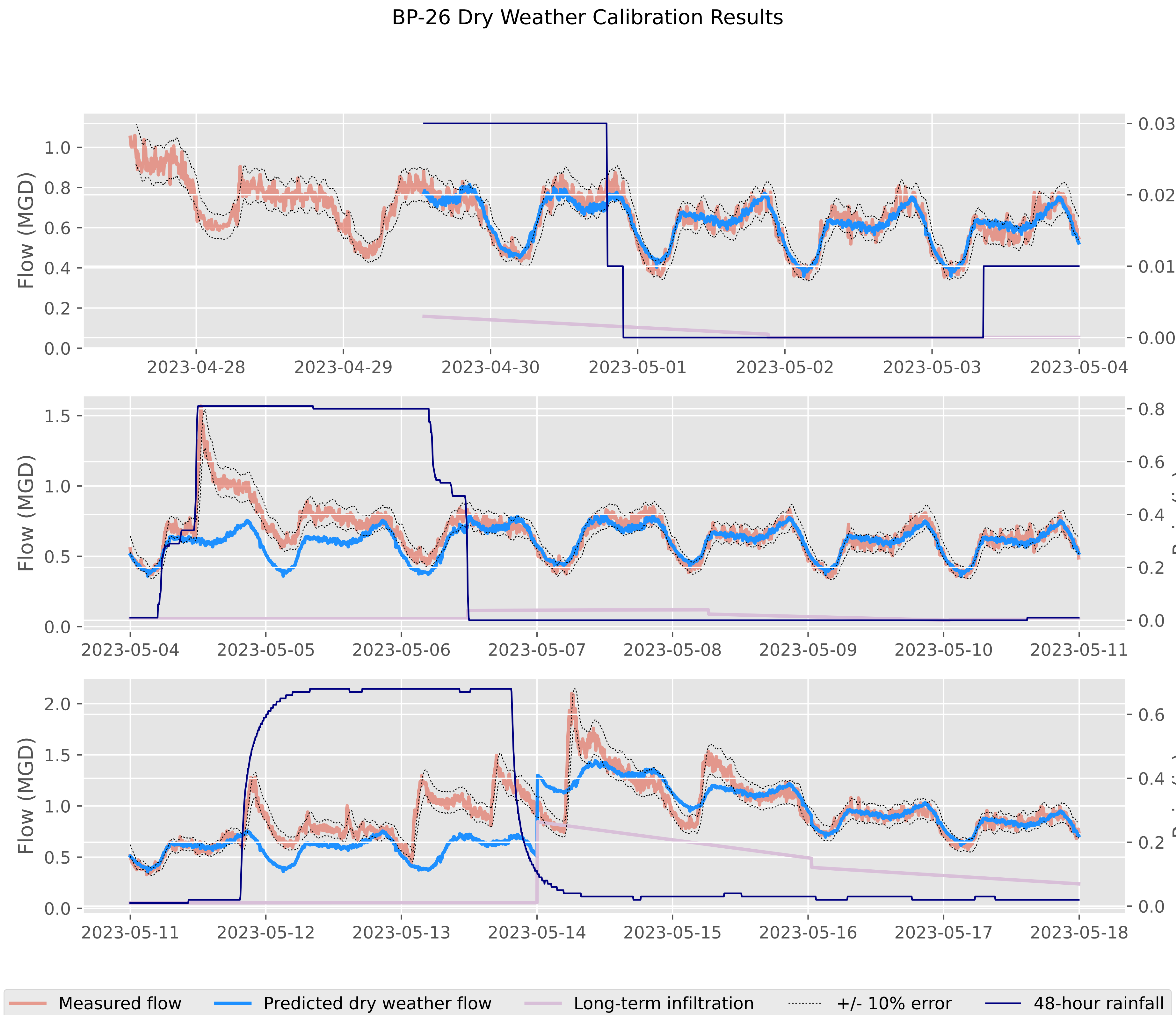




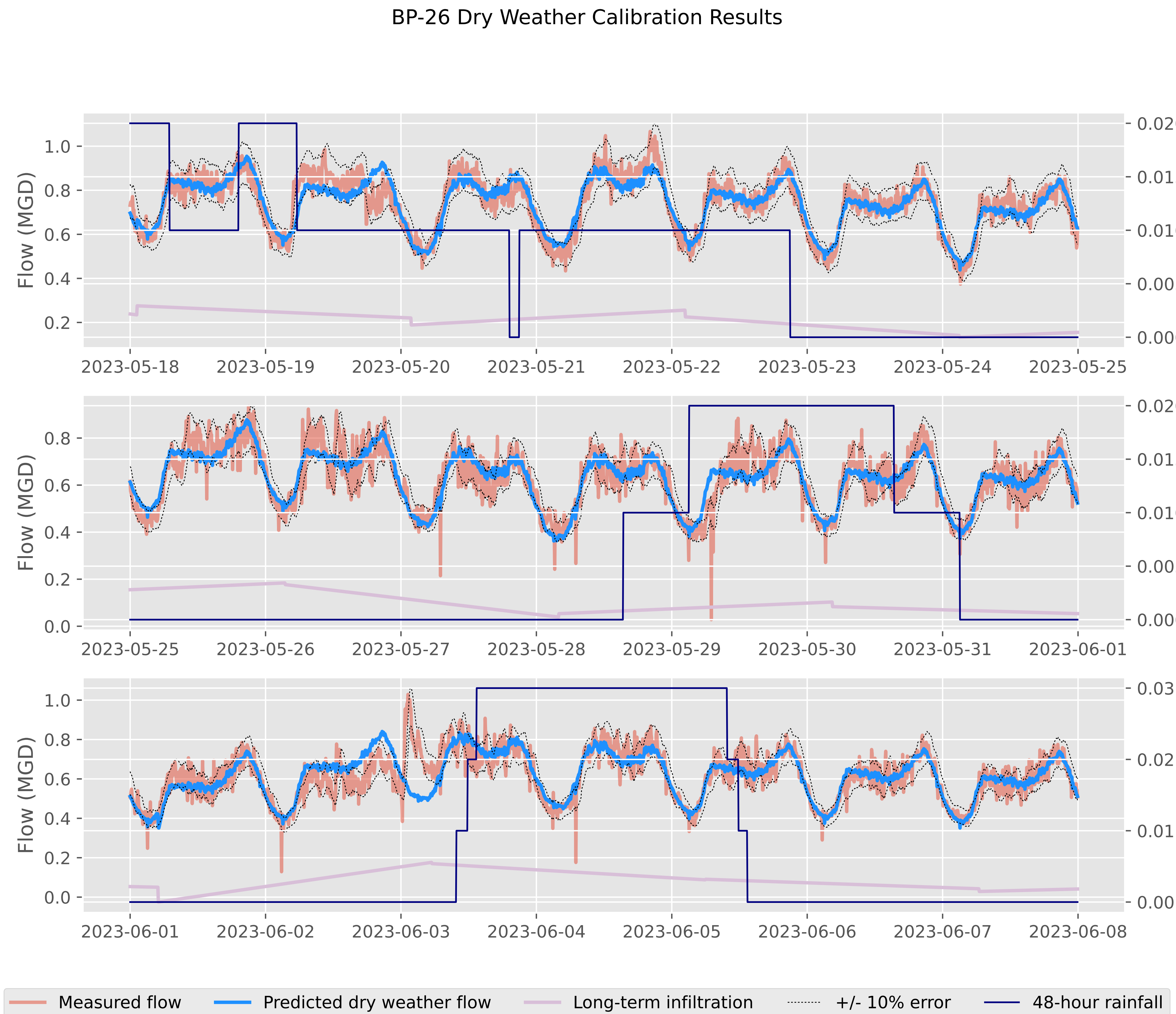
BP-25 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BP-25 Dry Weather Calibration Results

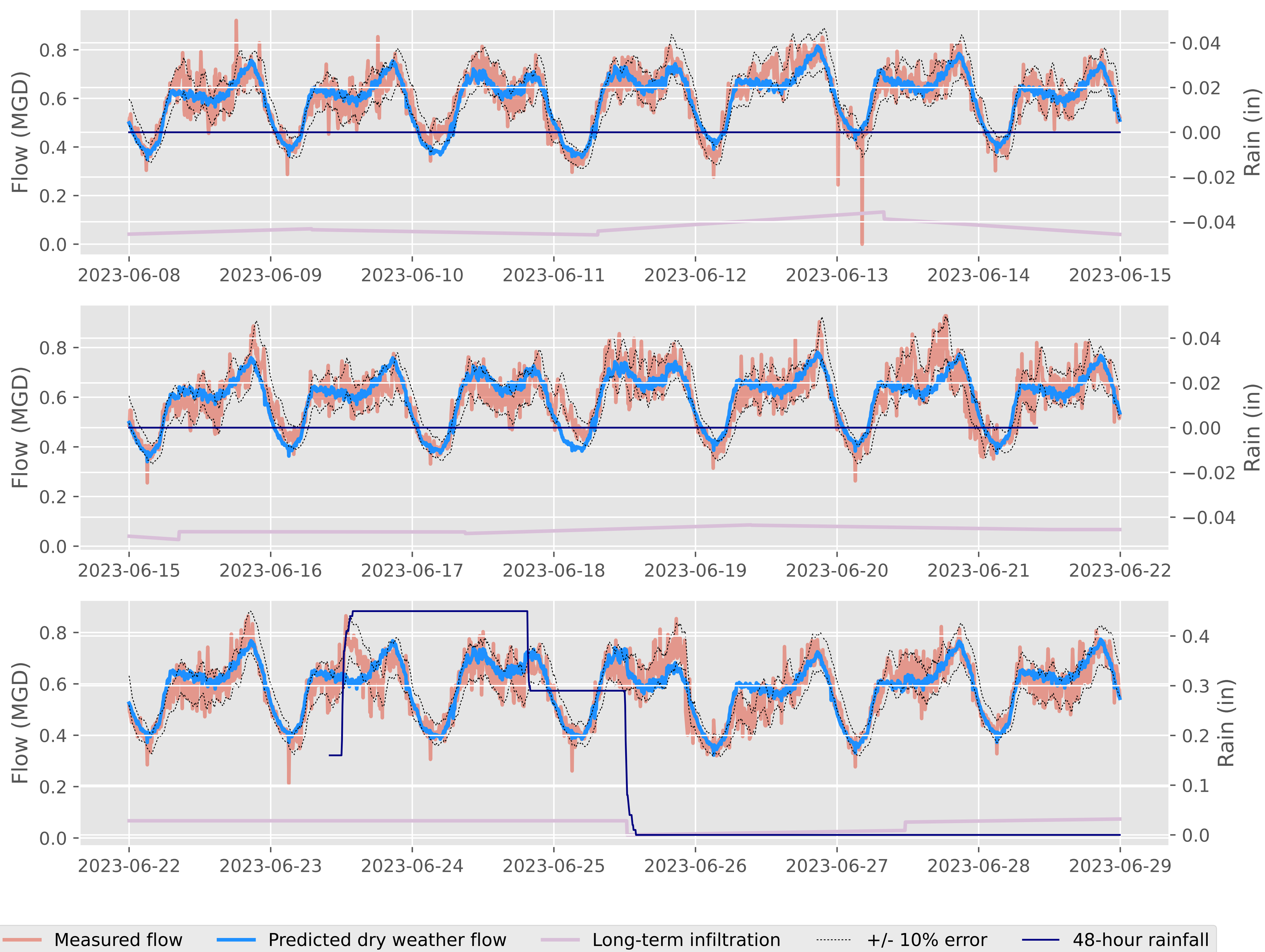




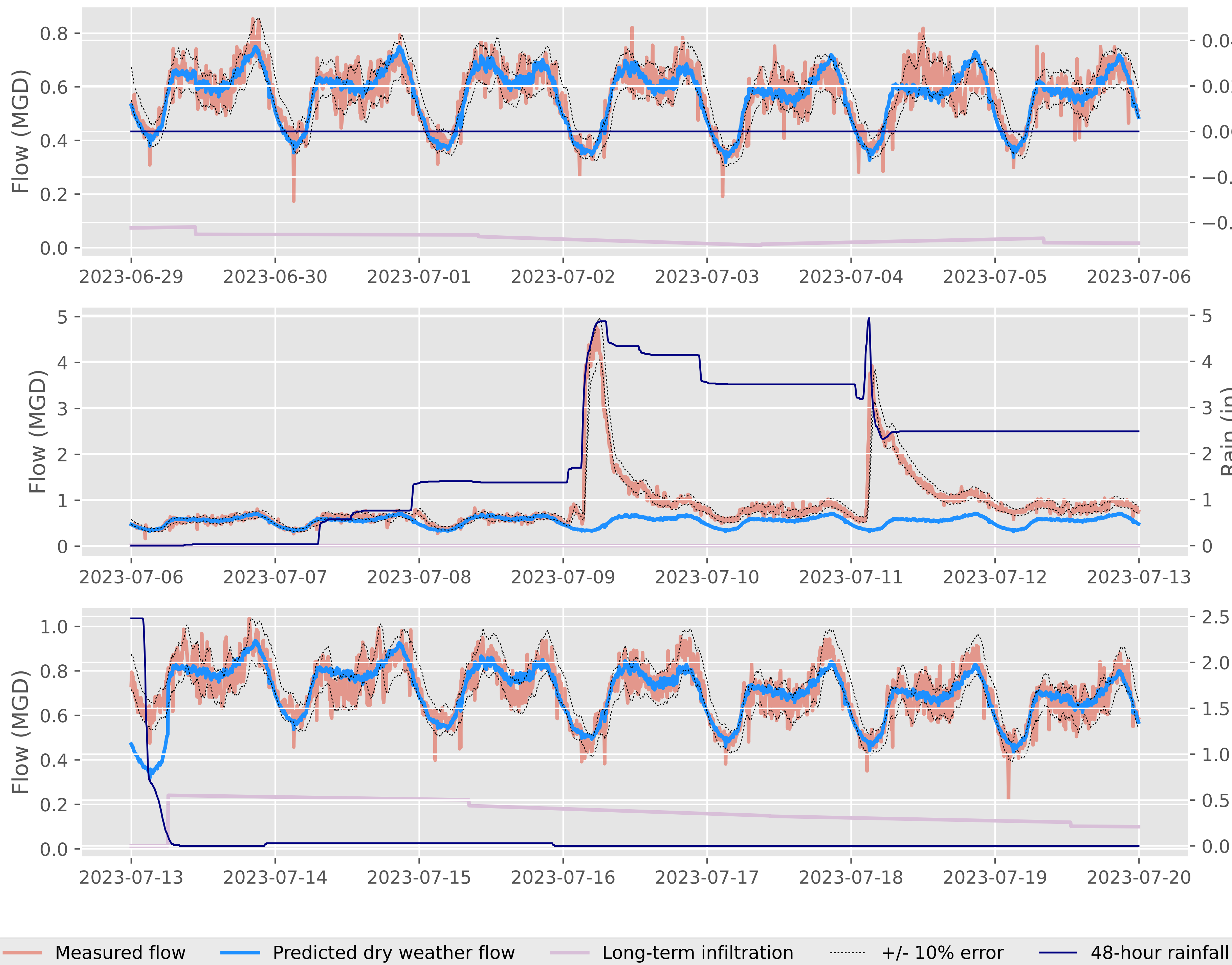
BP-26 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


BP-26 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

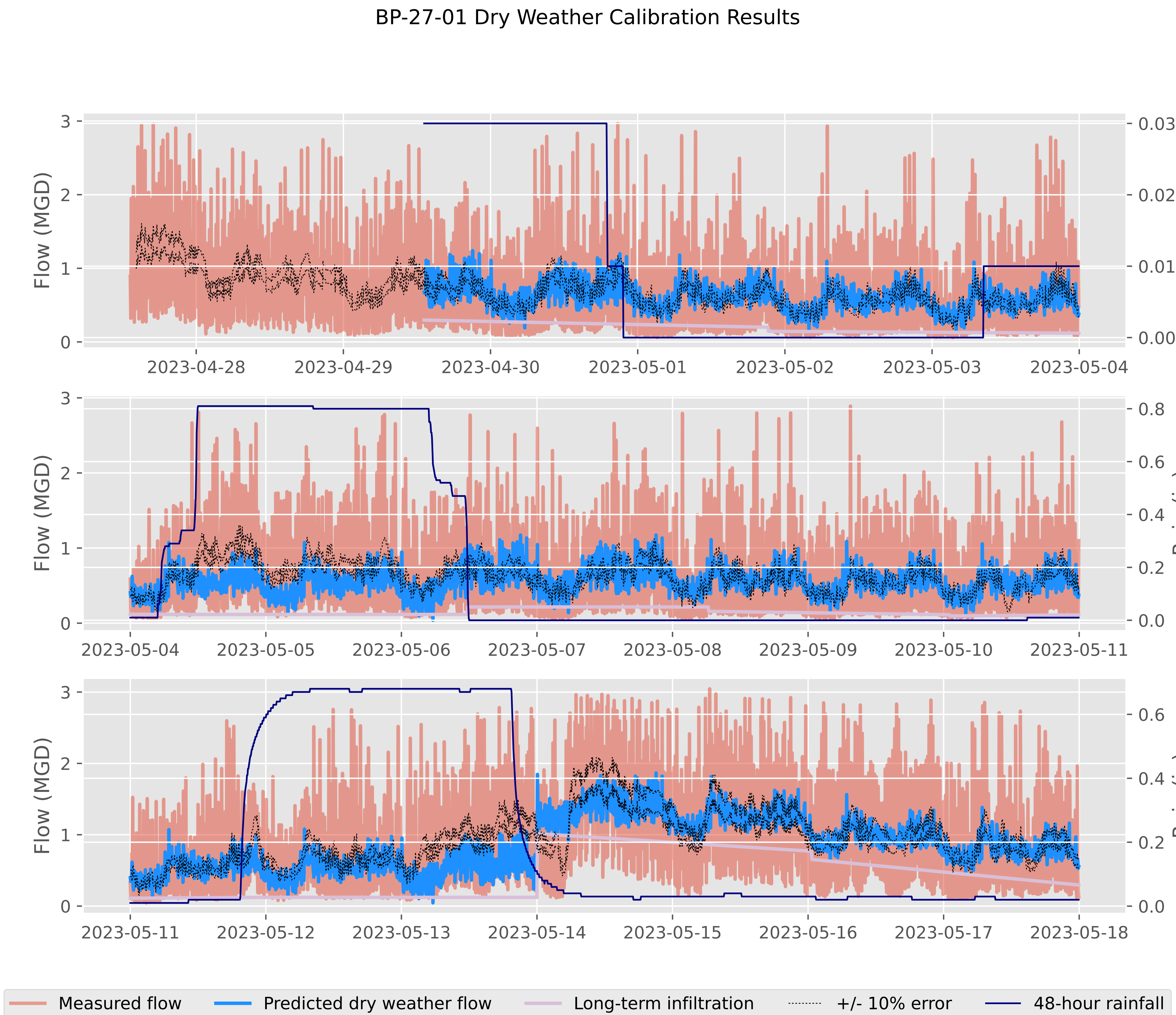
BP-26 Dry Weather Calibration Results



BP-26 Dry Weather Calibration Results

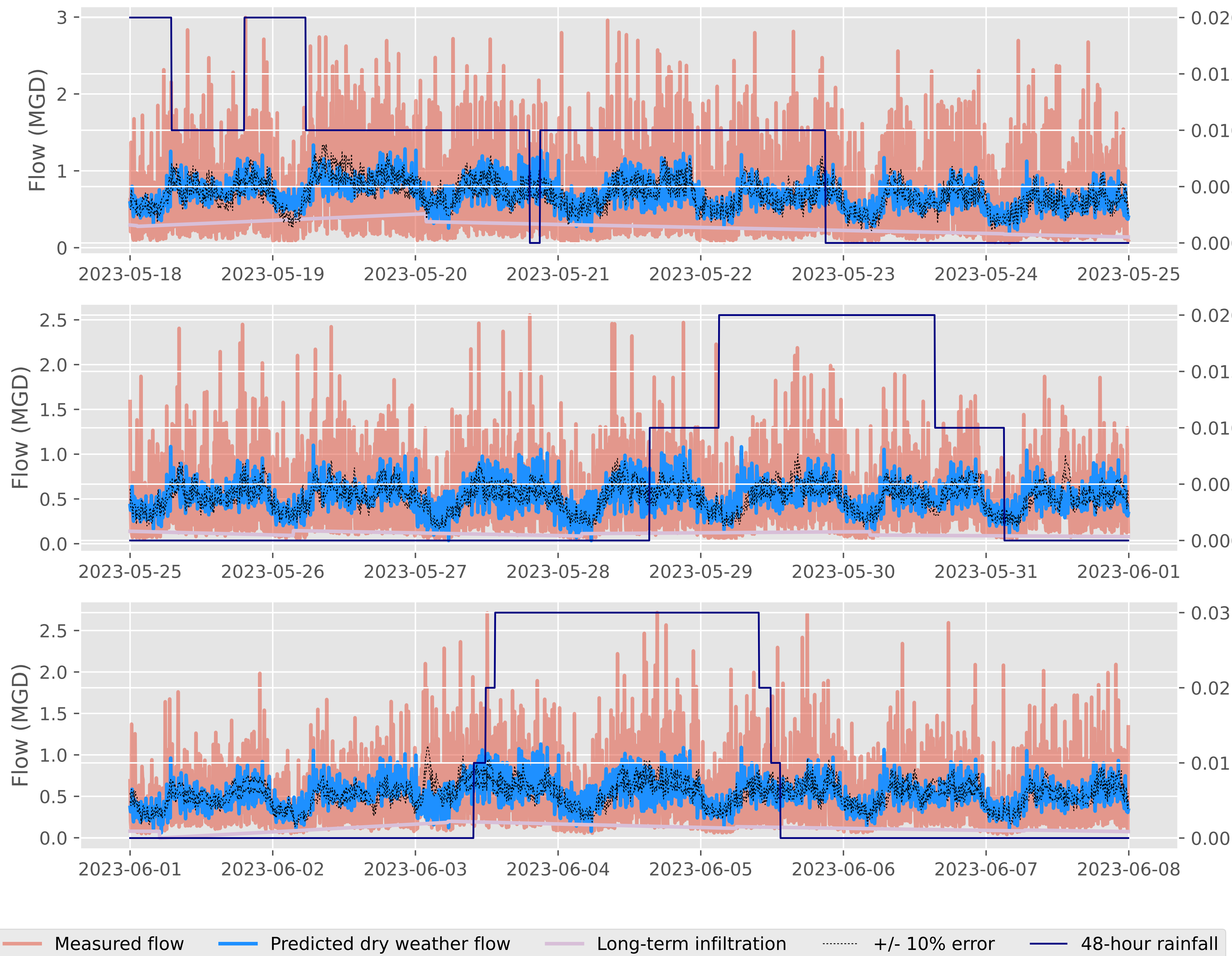


BP-26 Dry Weather Calibration Results

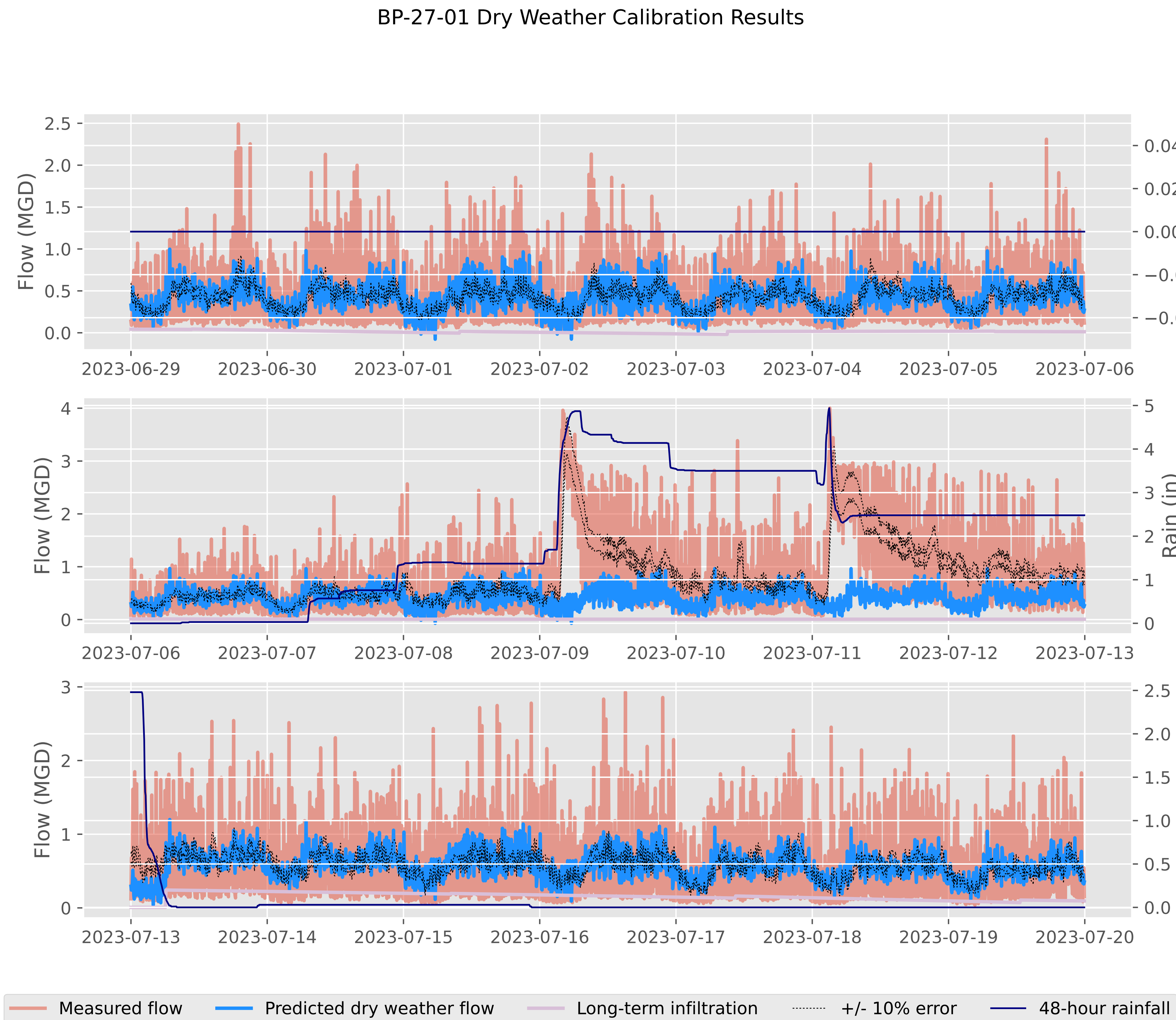


BP-27-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

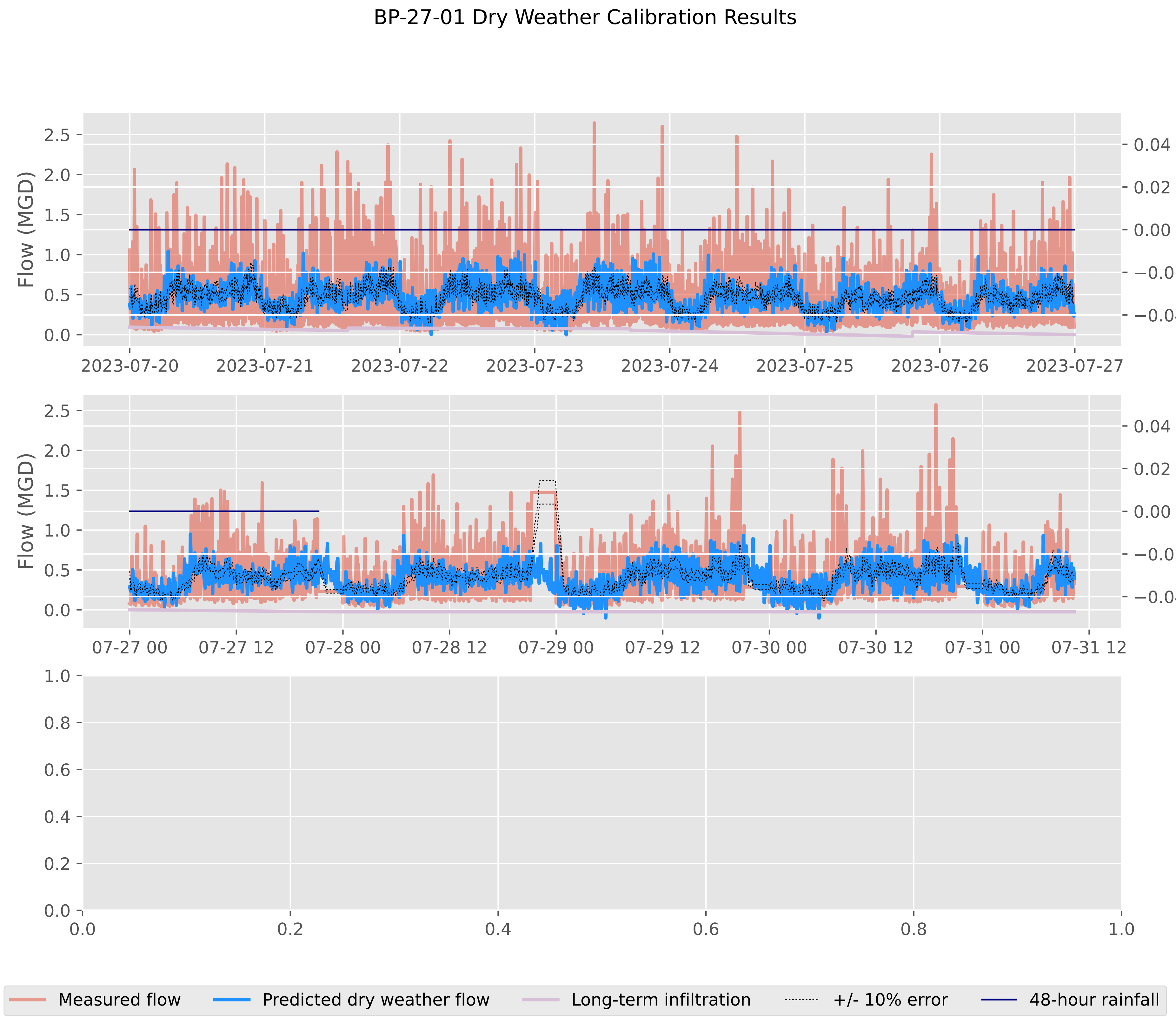
BP-27-01 Dry Weather Calibration Results



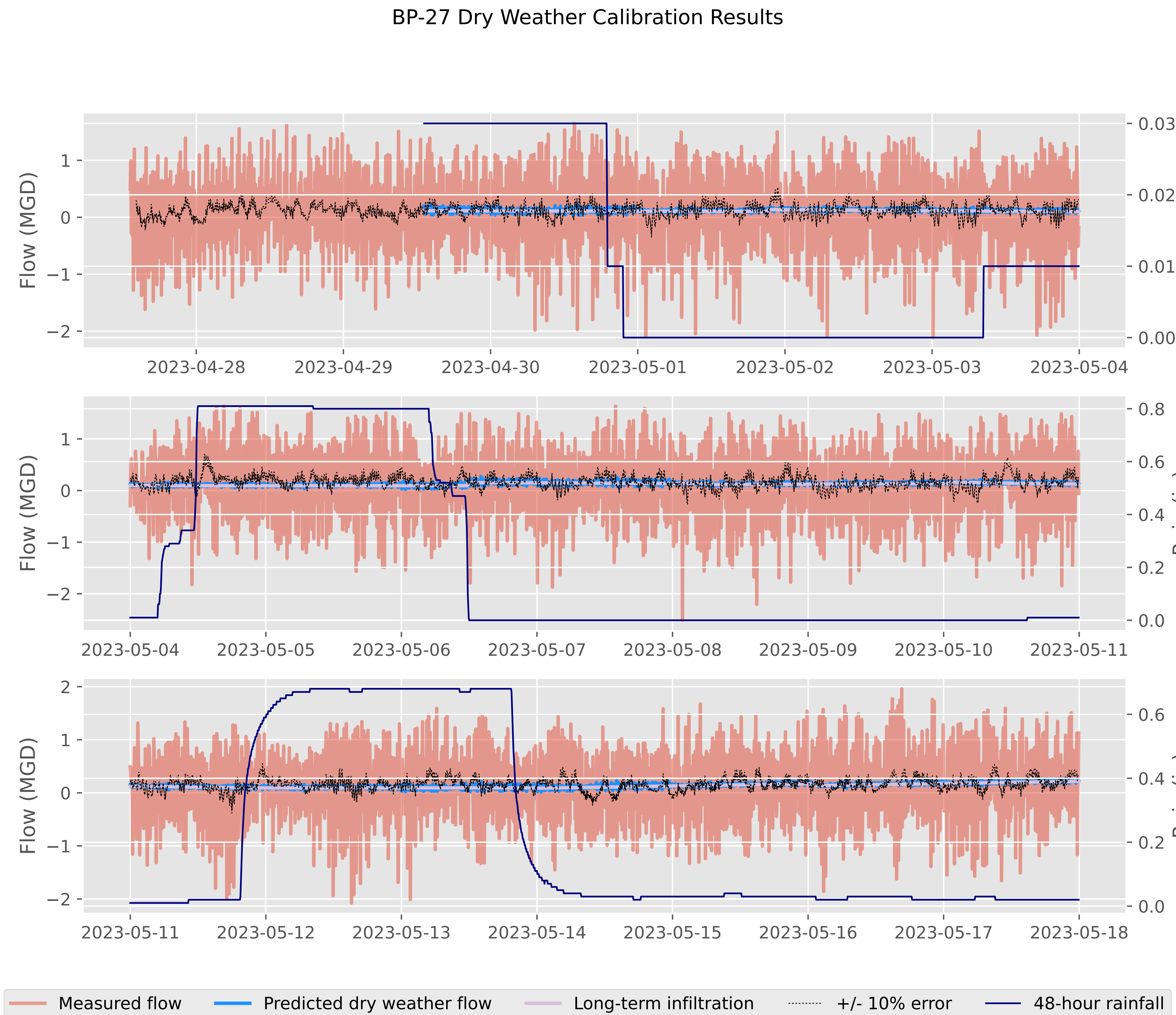
BP-27-01 Dry Weather Calibration Results

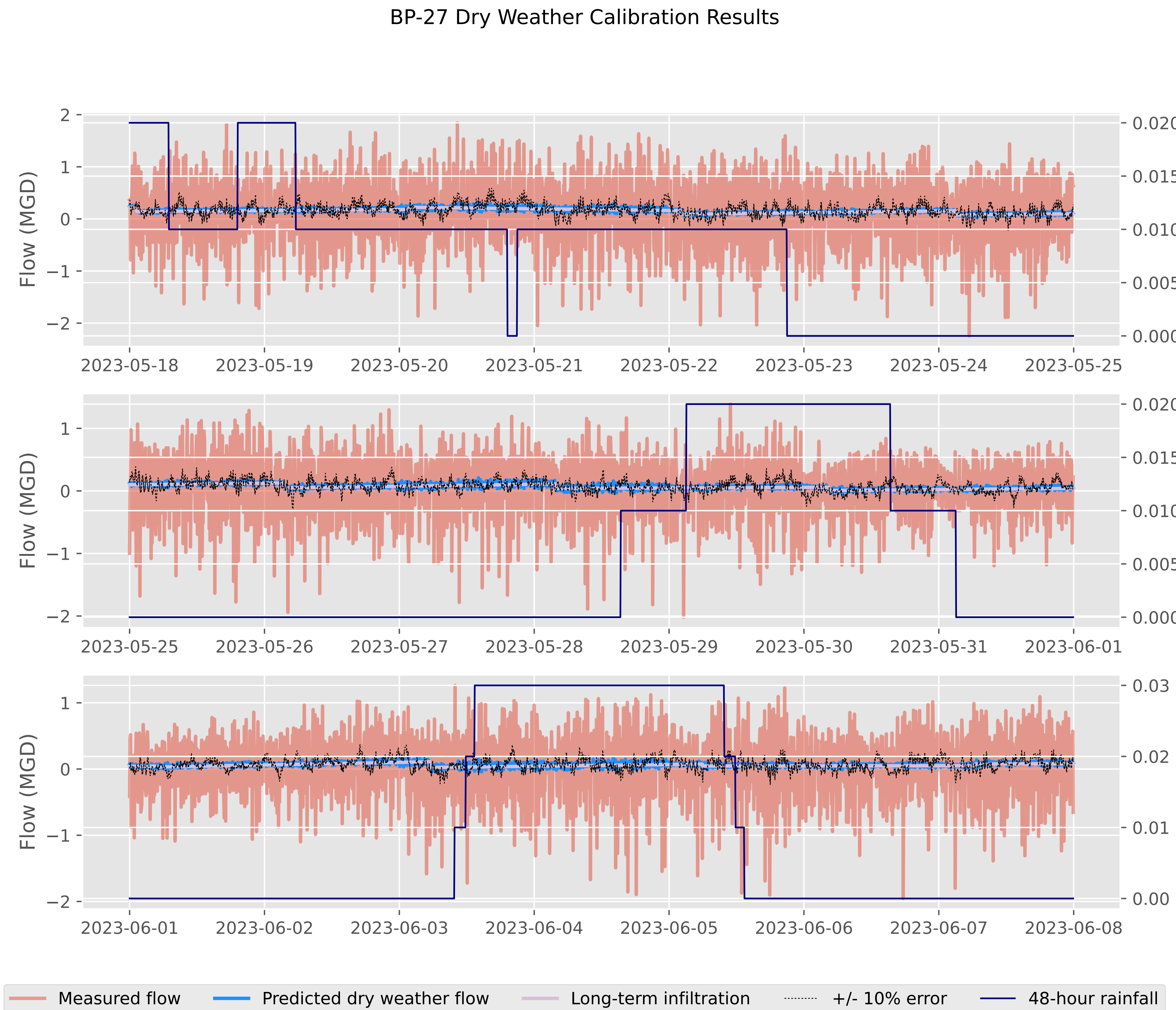


BP-27-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

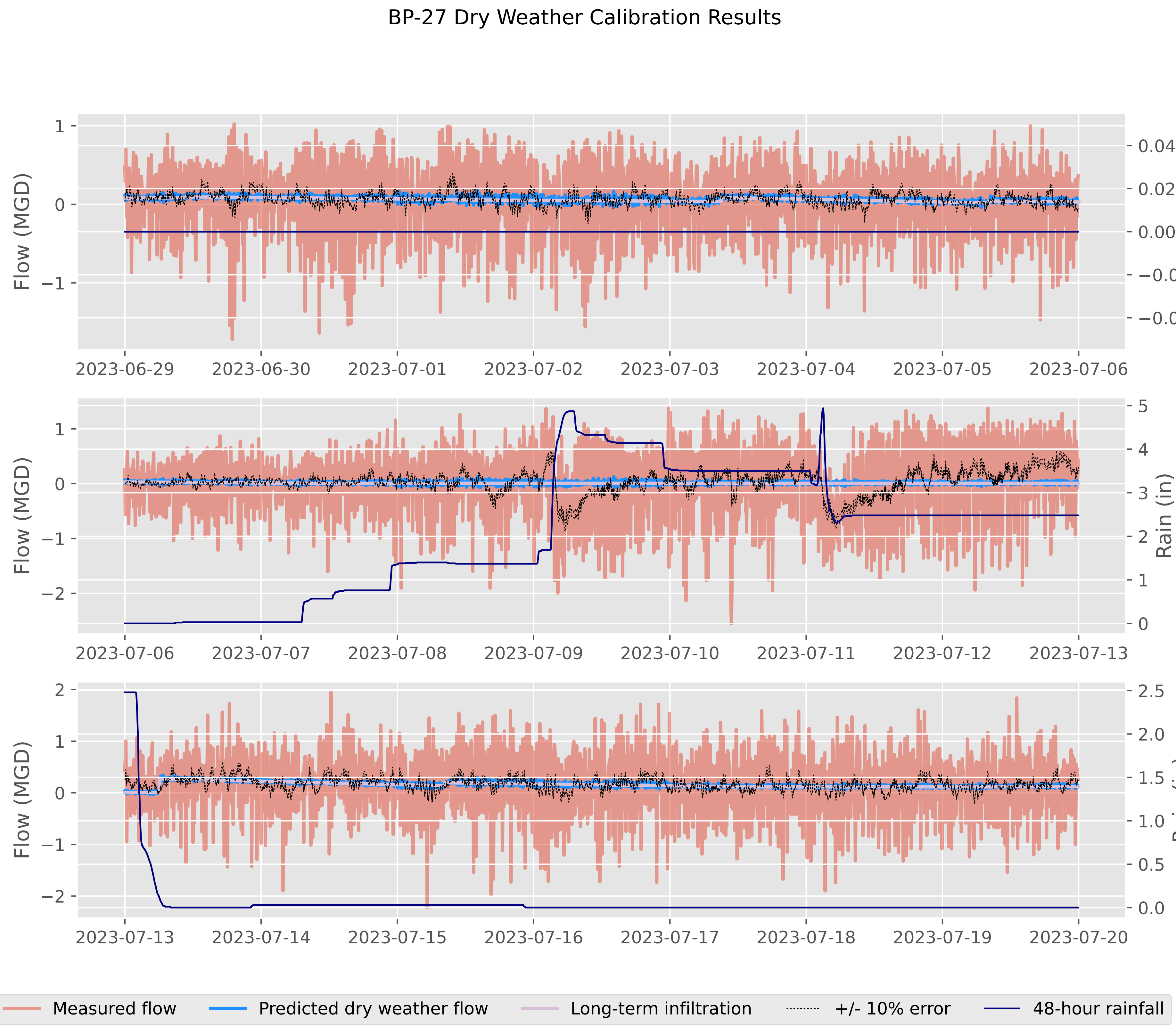


BP-27-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

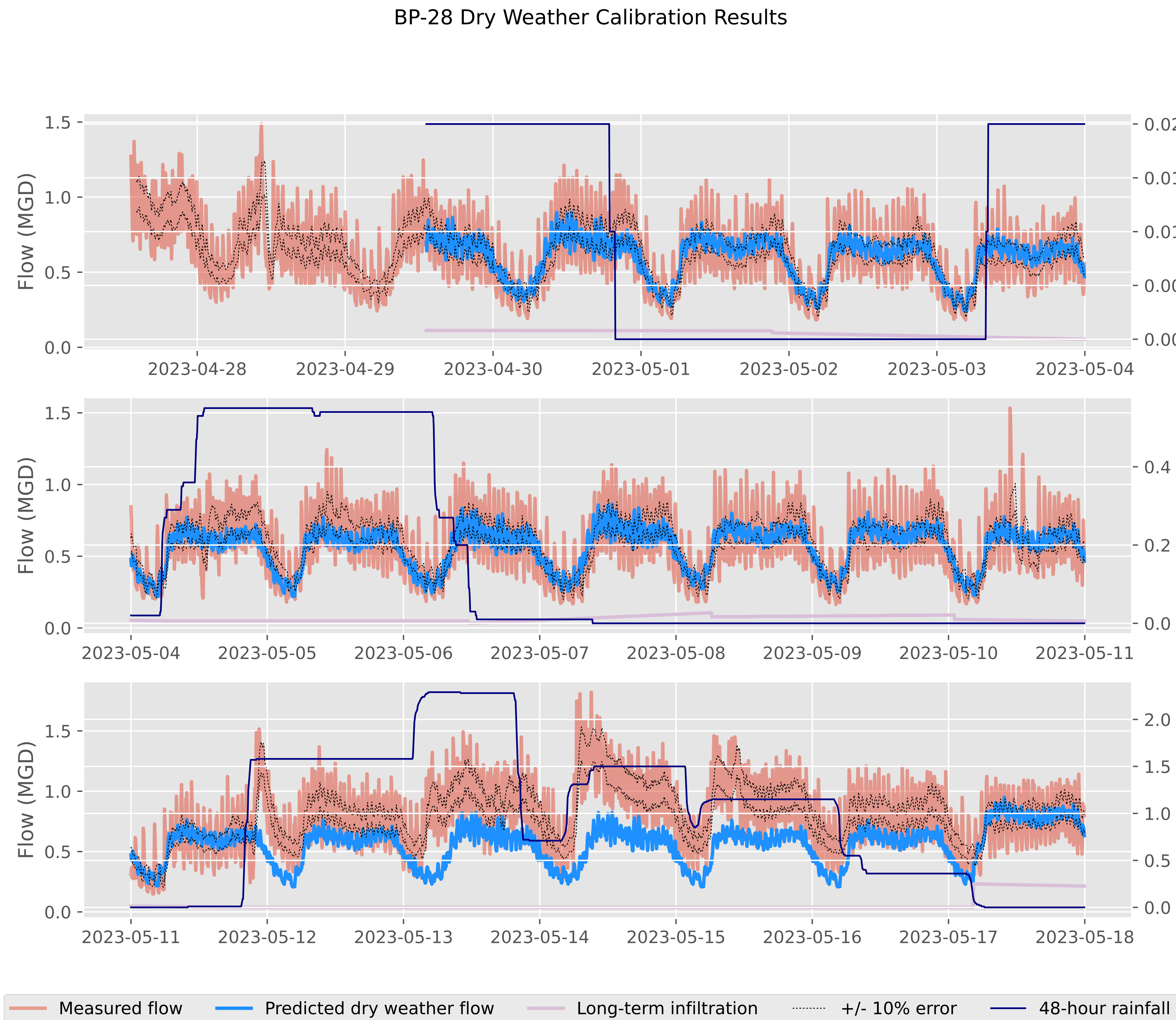

BP-27 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

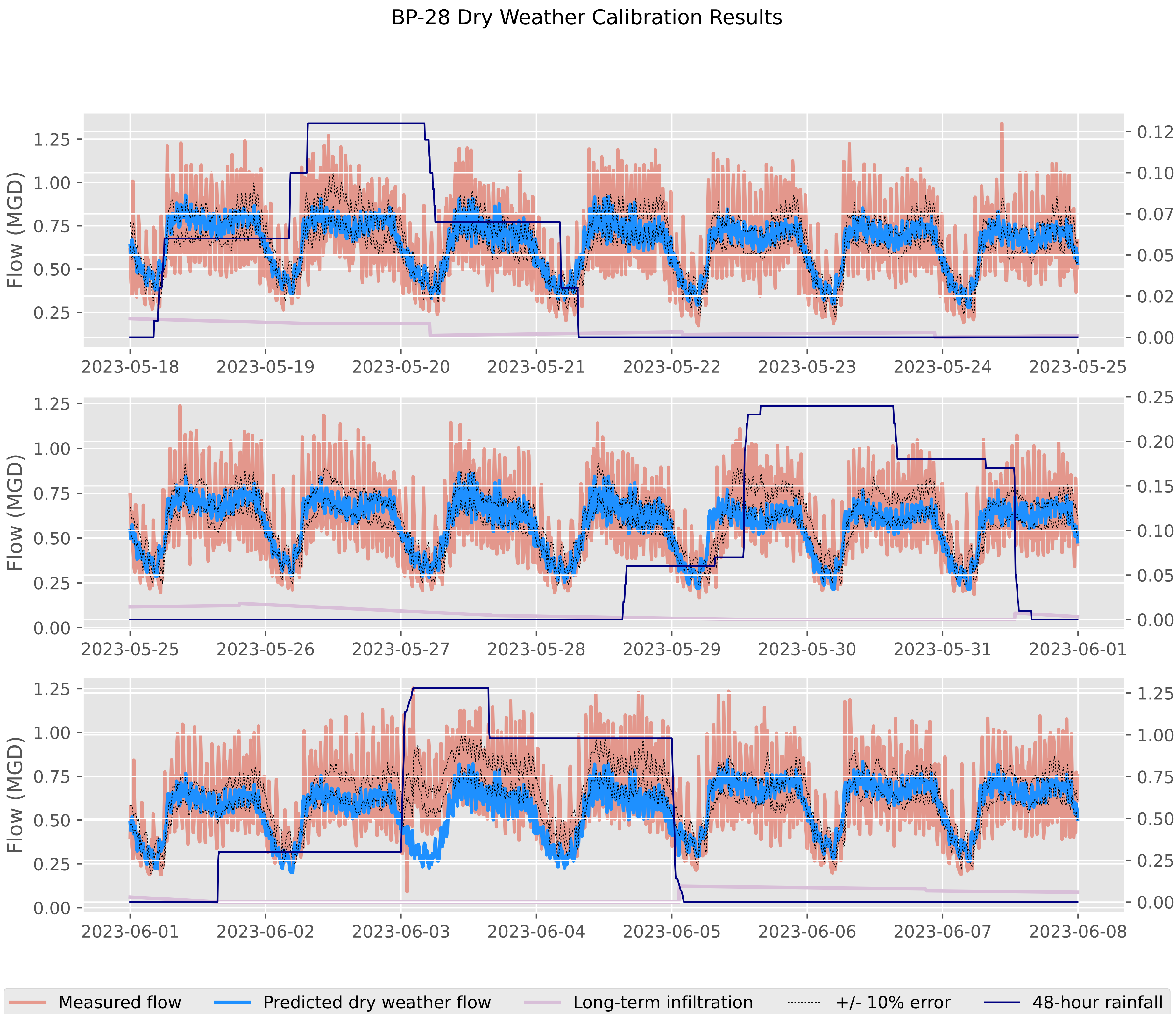

BP-27 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

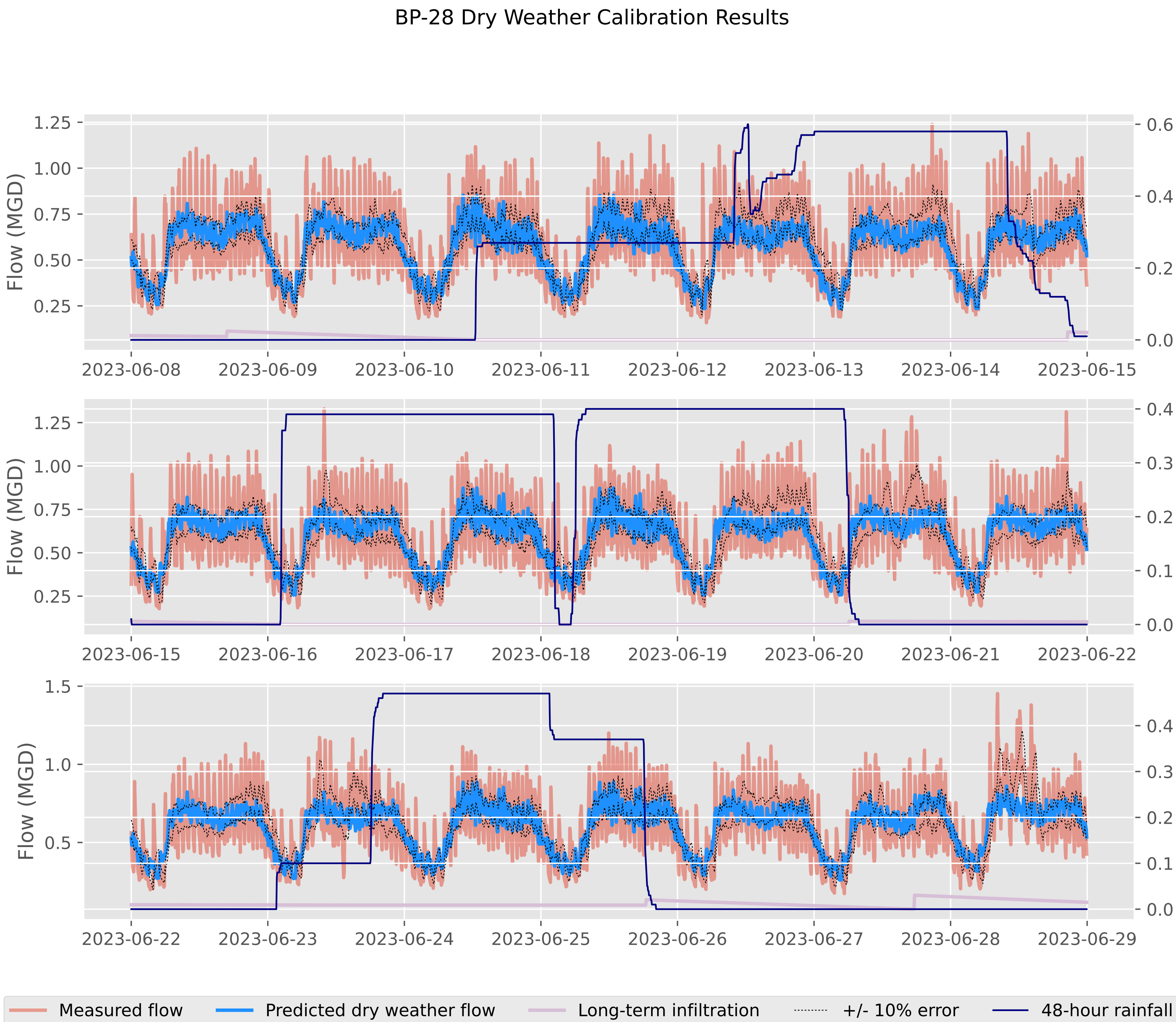
BP-27 Dry Weather Calibration Results


BP-27 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

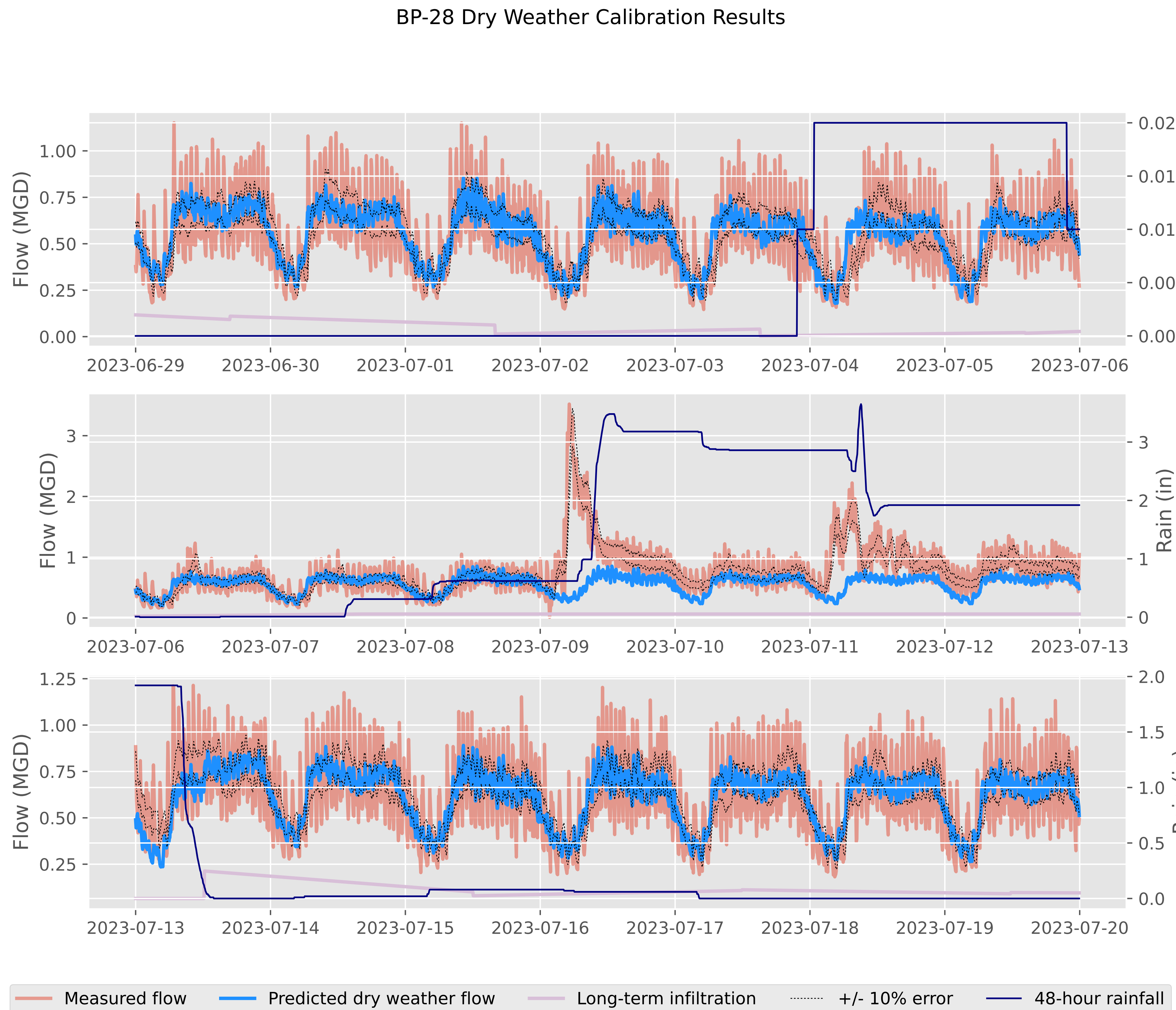
BP-27 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


BP-28 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

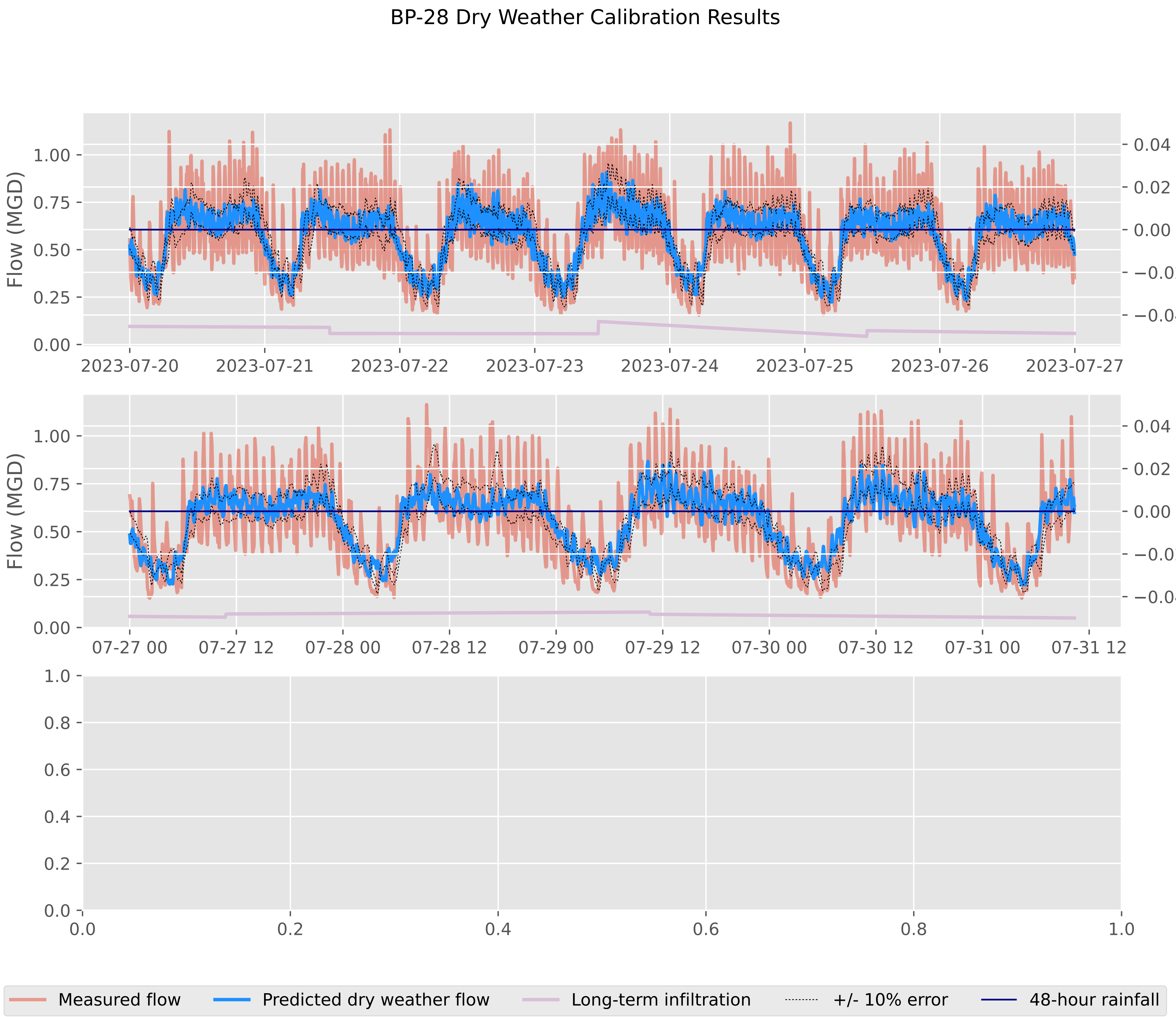

BP-28 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
1.25
1.00
0.75
0.50
0.25
0.00
0.125
0.100
0.075
0.050
0.025
0.000
0.25
0.20
0.15
0.10
0.05
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall



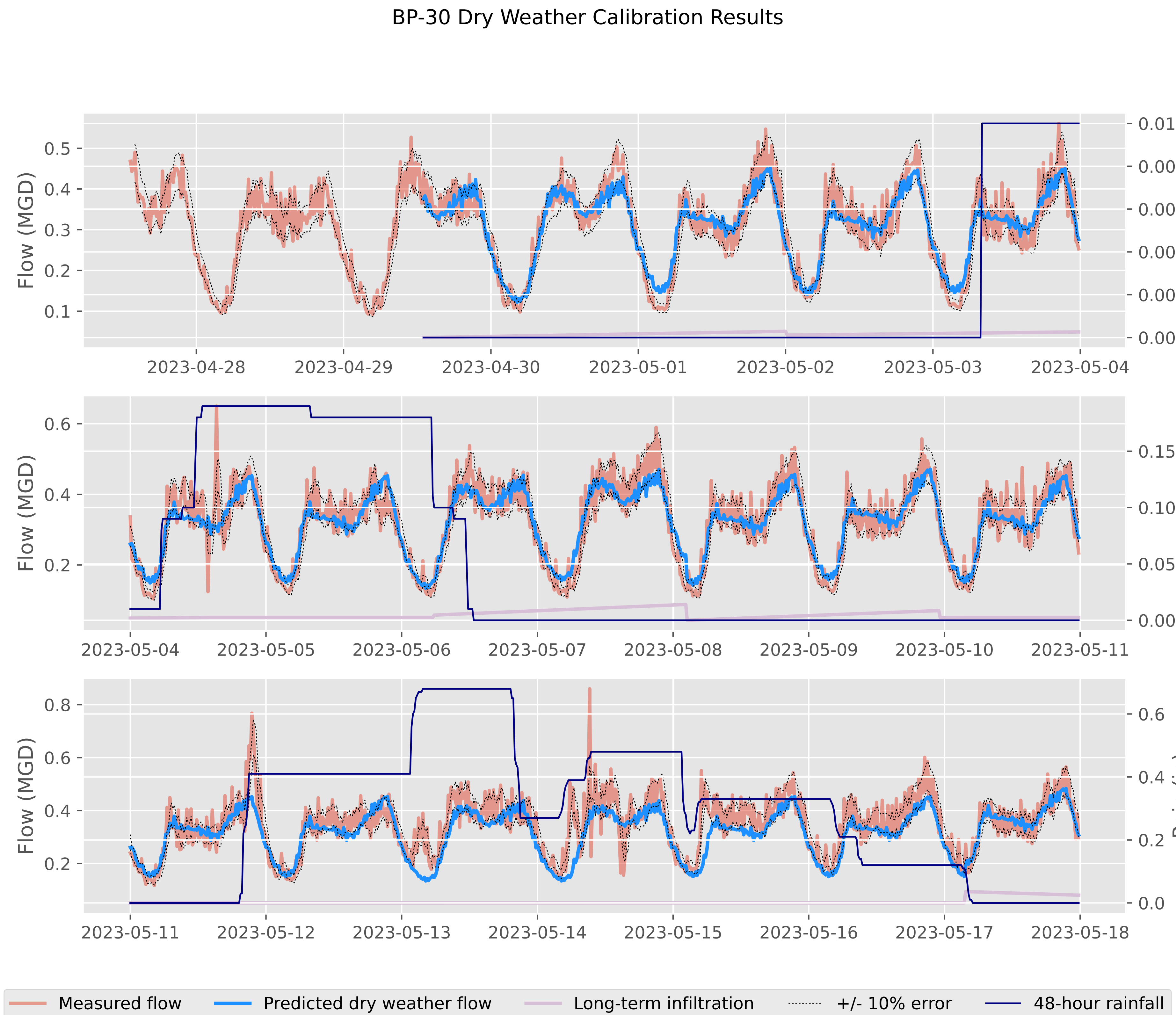
BP-28 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
1.25
1.00
0.75
0.50
0.25
0.6
0.4
0.2
0.0
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
Flow (MGD)
Rain (in)
1.25
1.00
0.75
0.50
0.25
0.4
0.3
0.2
0.1
0.0
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
Flow (MGD)
Rain (in)
1.5
1.0
0.5
0.4
0.3
0.2
0.1
0.0
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

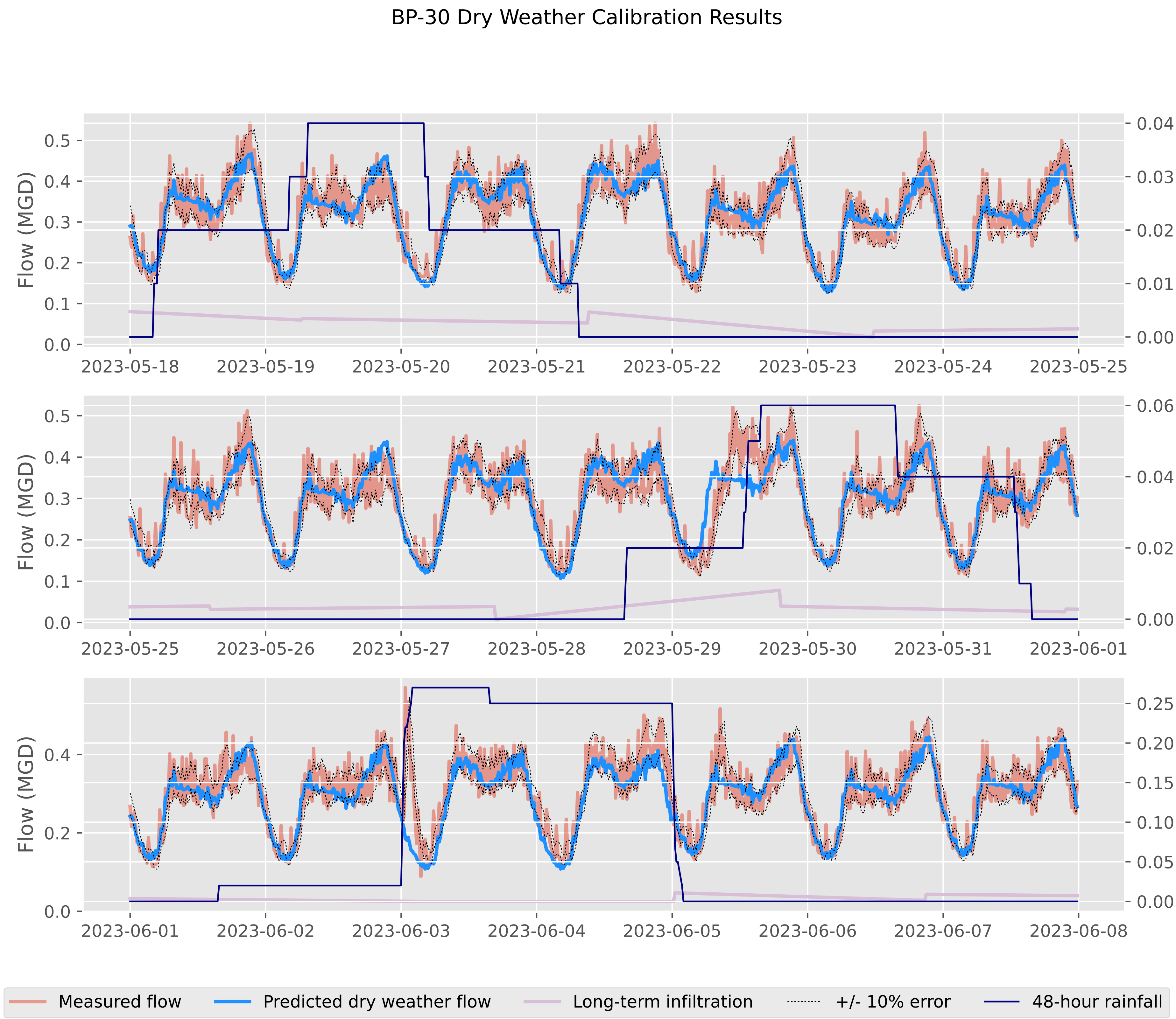


BP-28 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

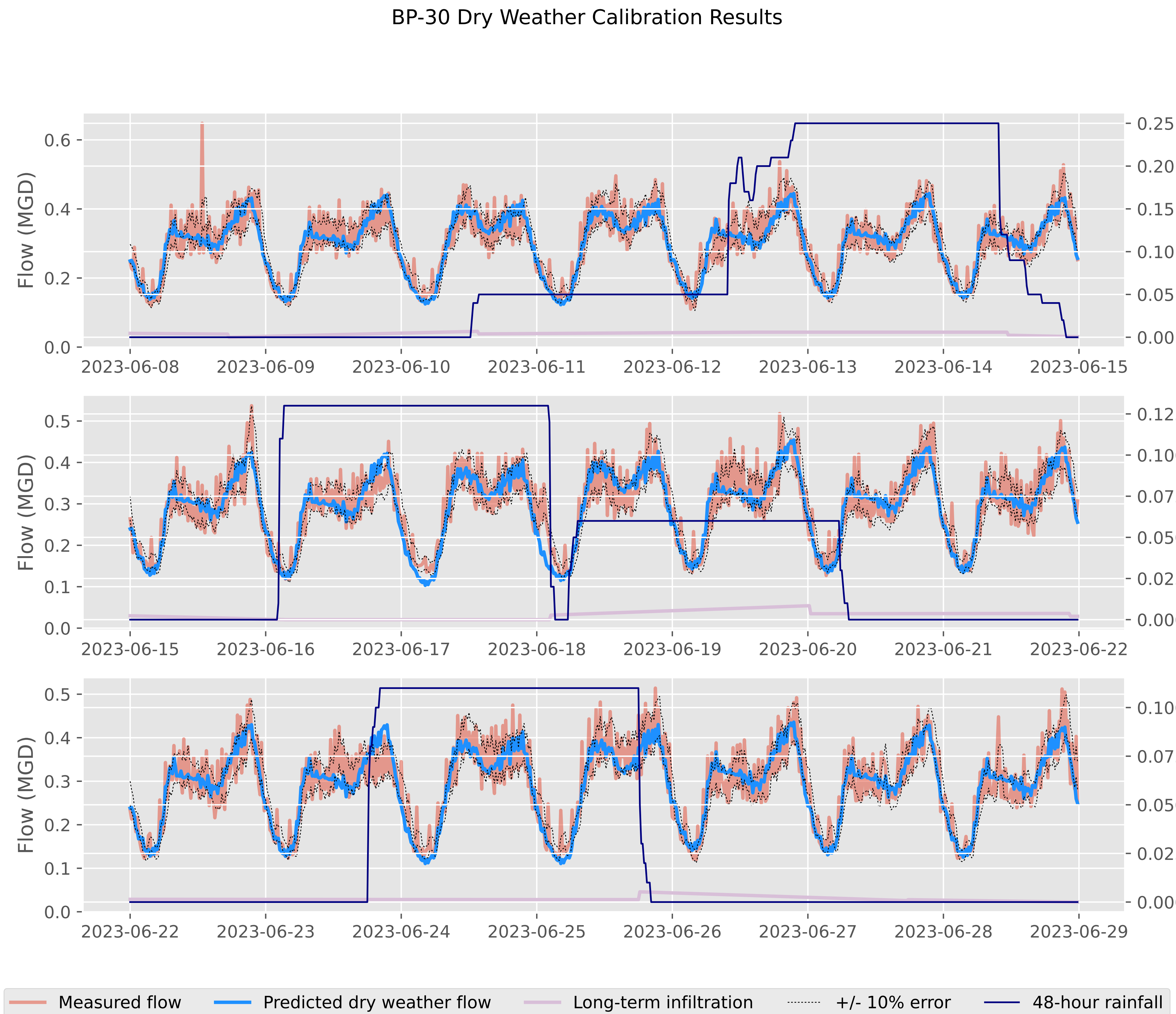


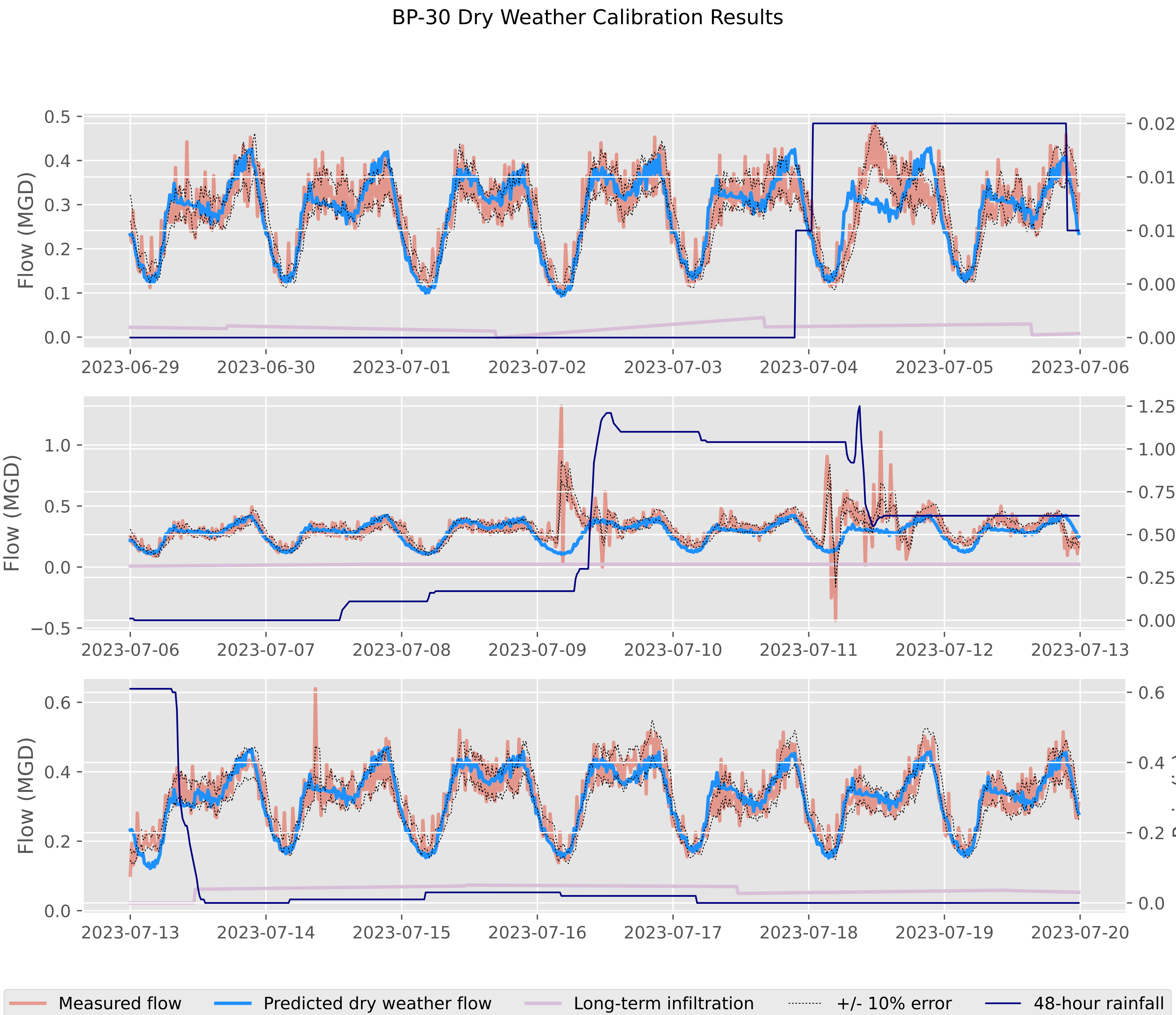
BP-28 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
1.00
0.75
0.50
0.25
0.00
0.04
0.02
0.00
−0.02
−0.04
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
0.0
0.2
0.4
0.6
0.8
1.0
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


BP-30 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

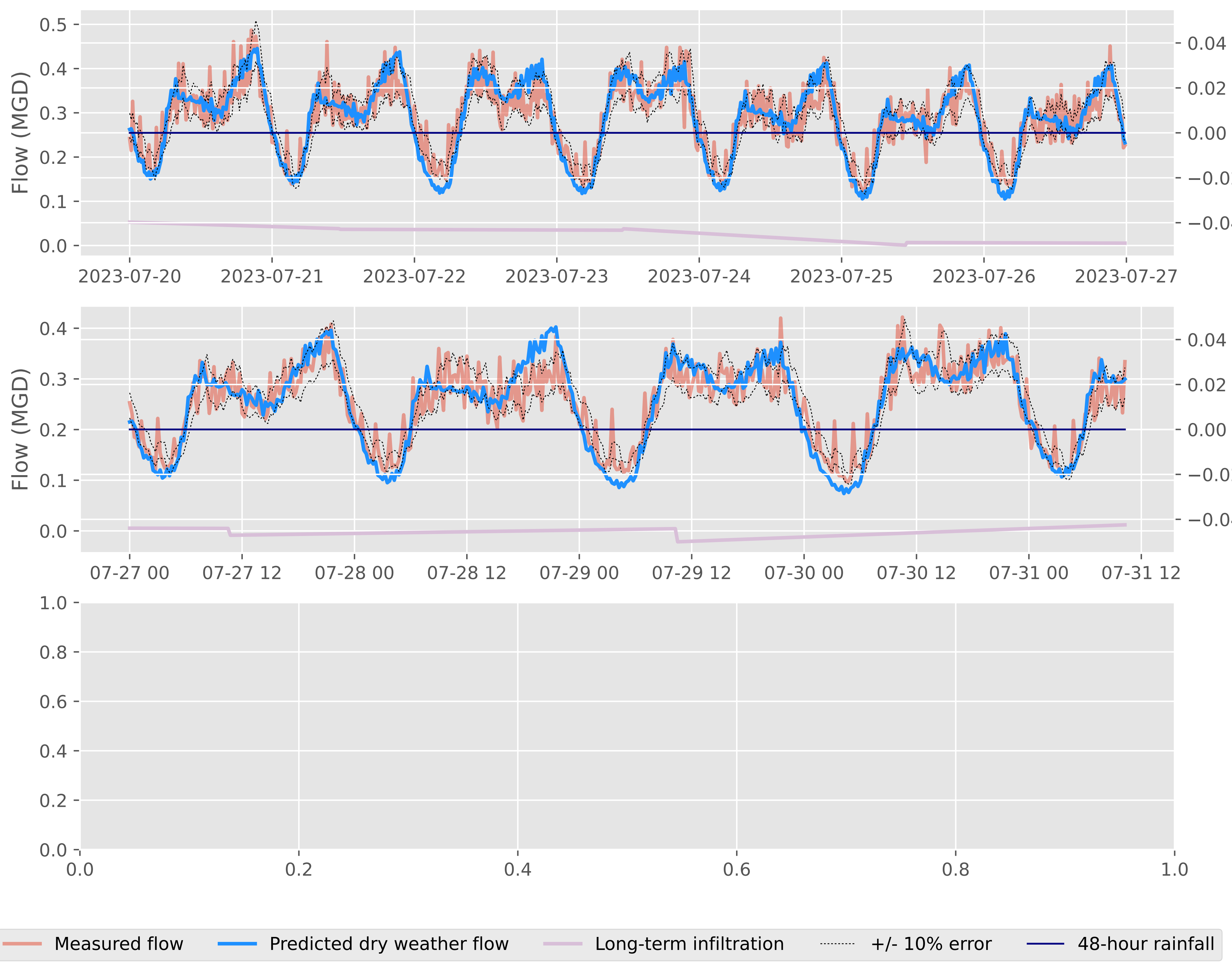


BP-30 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

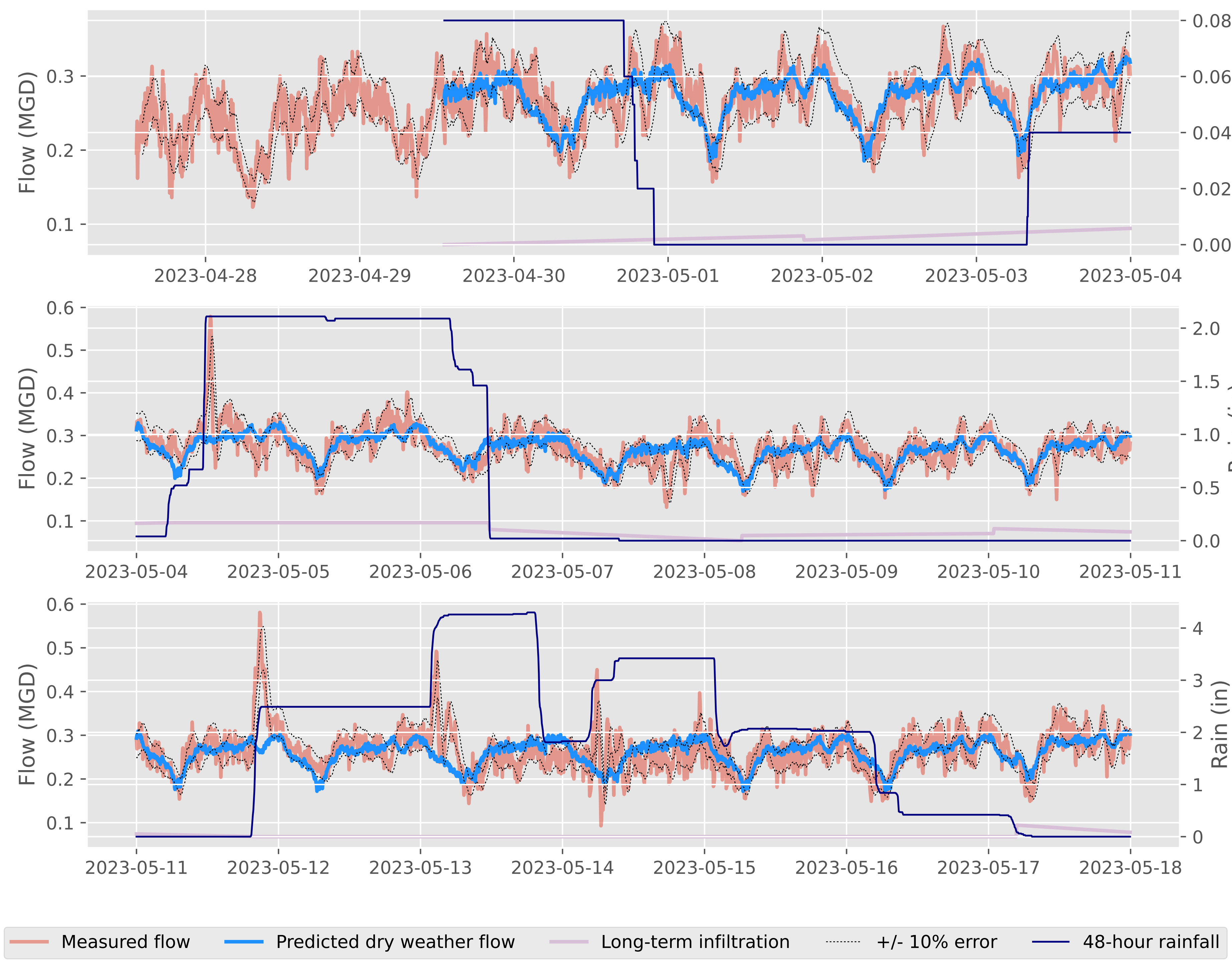

BP-30 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.0
0.2
0.4
0.6
0.00
0.05
0.10
0.15
0.20
0.25
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
0.1
0.3
0.5
0.000
0.025
0.050
0.075
0.100
0.125
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

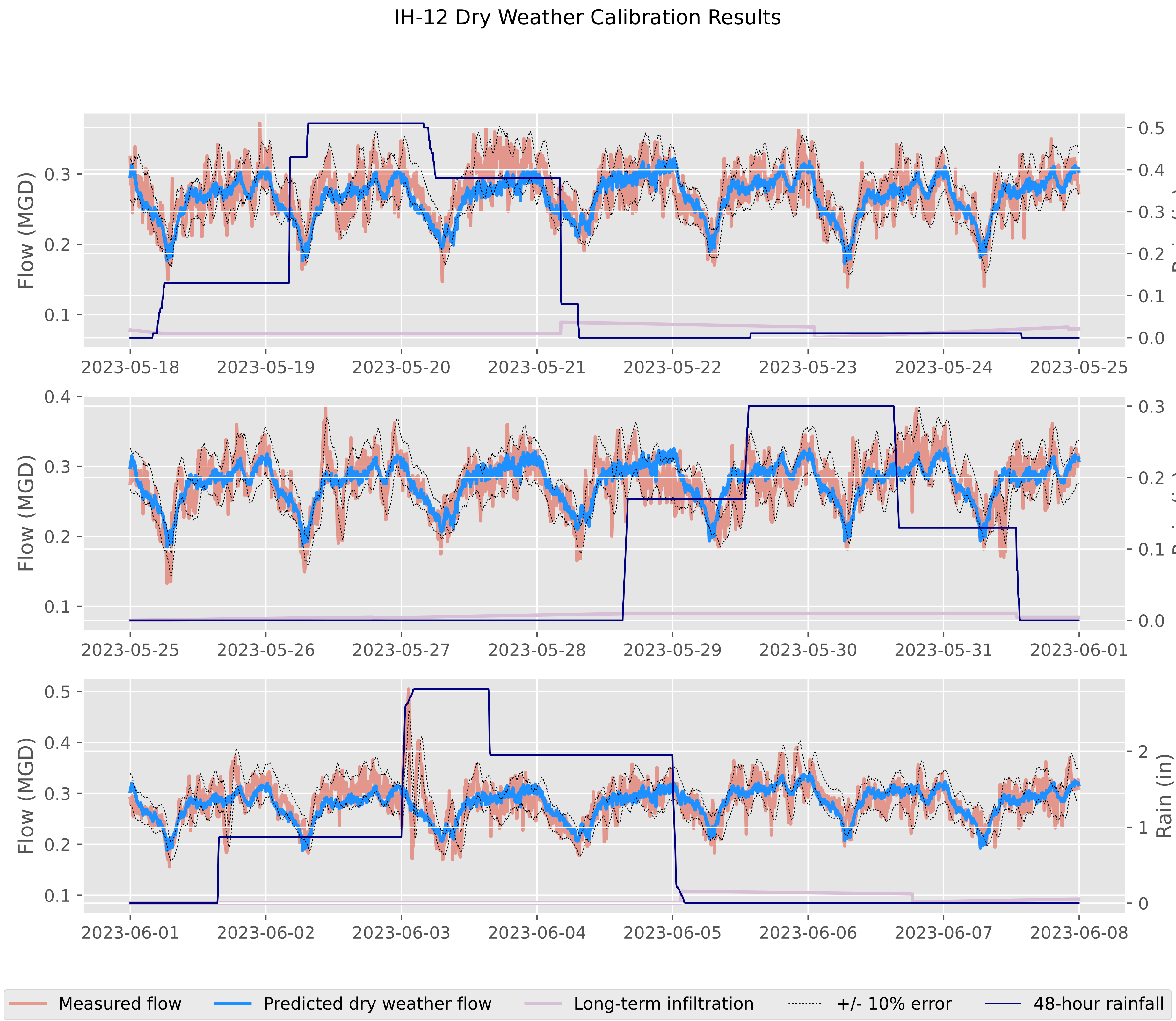

BP-30 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

BP-30 Dry Weather Calibration Results

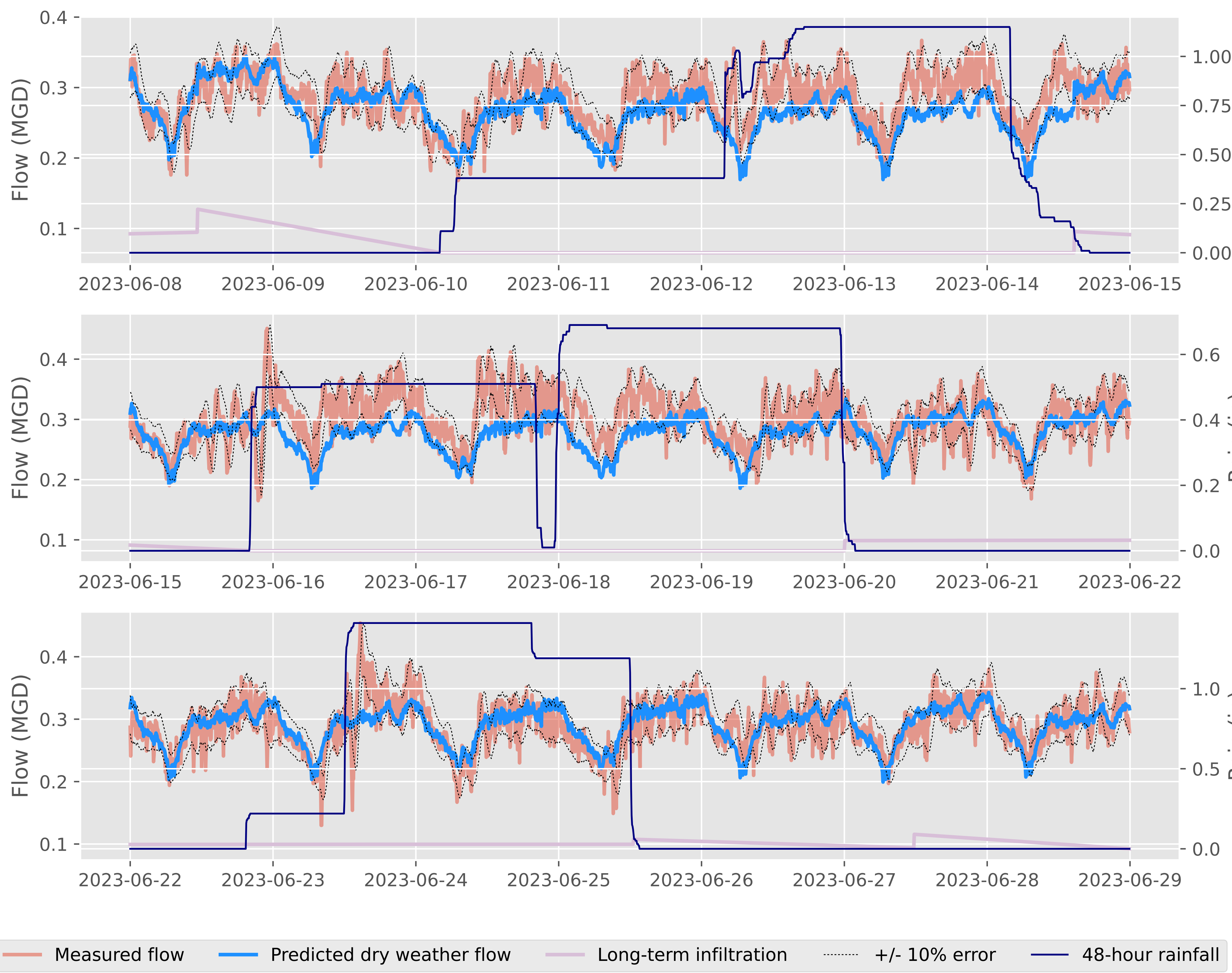


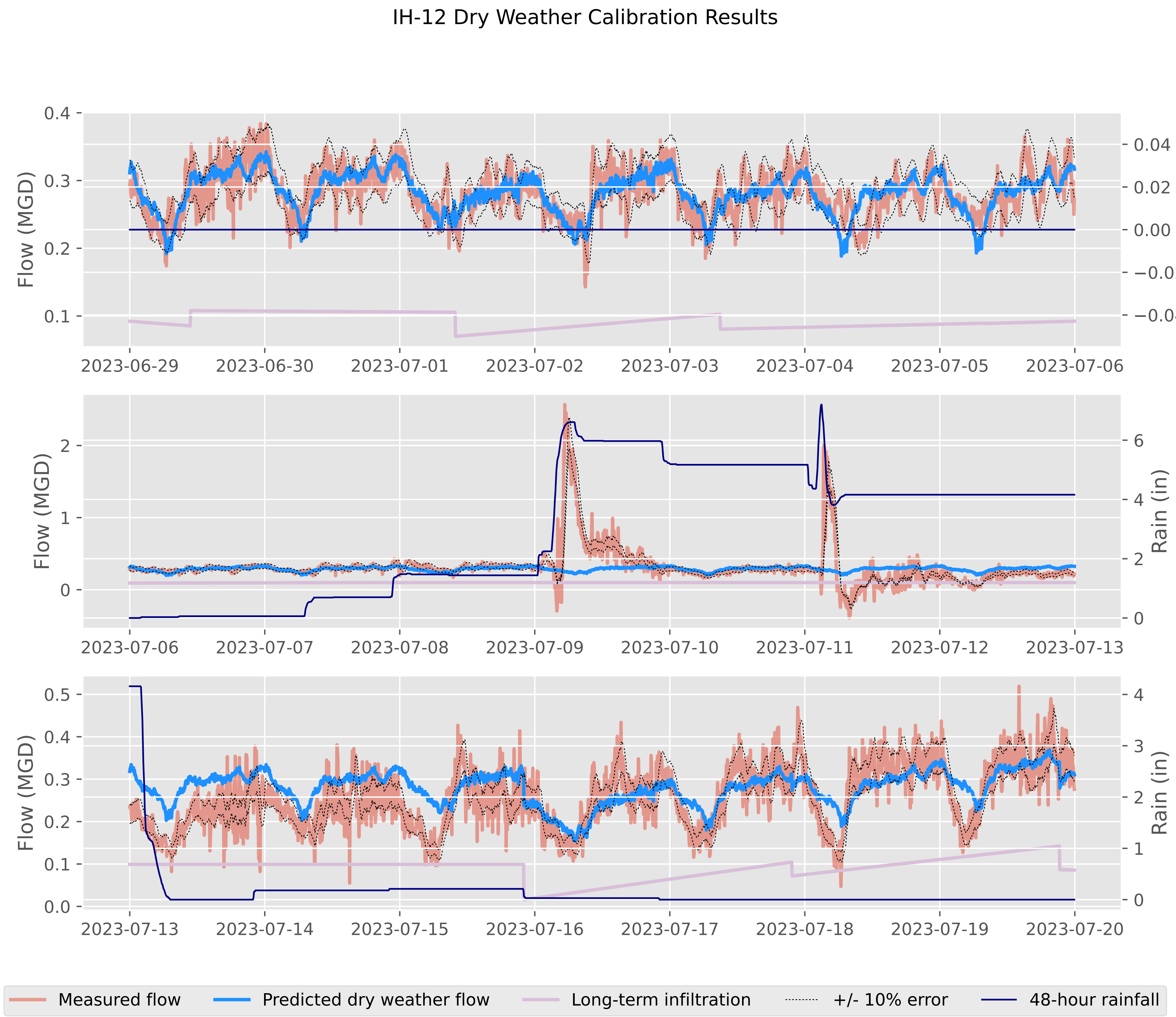
IH-12 Dry Weather Calibration Results

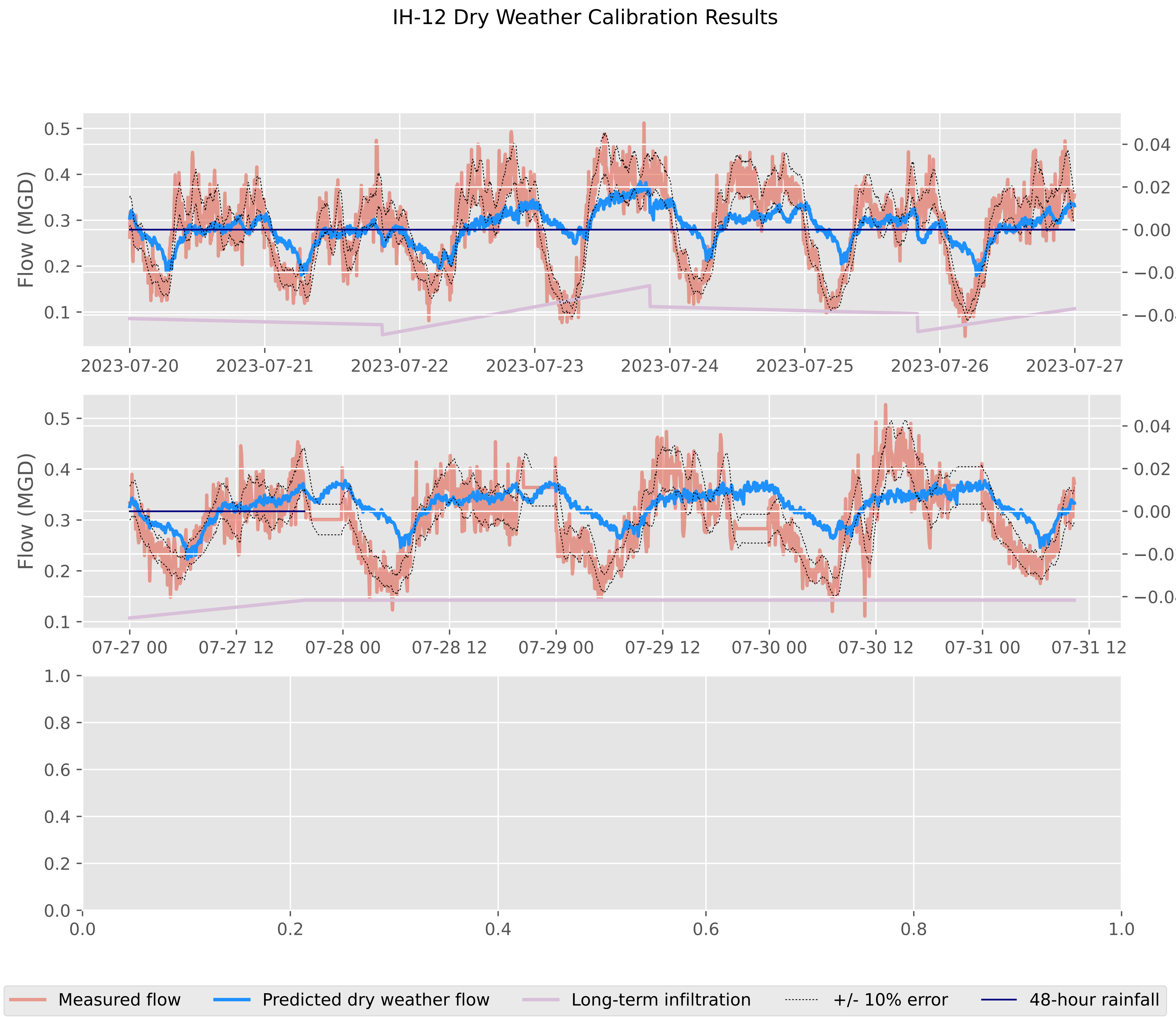


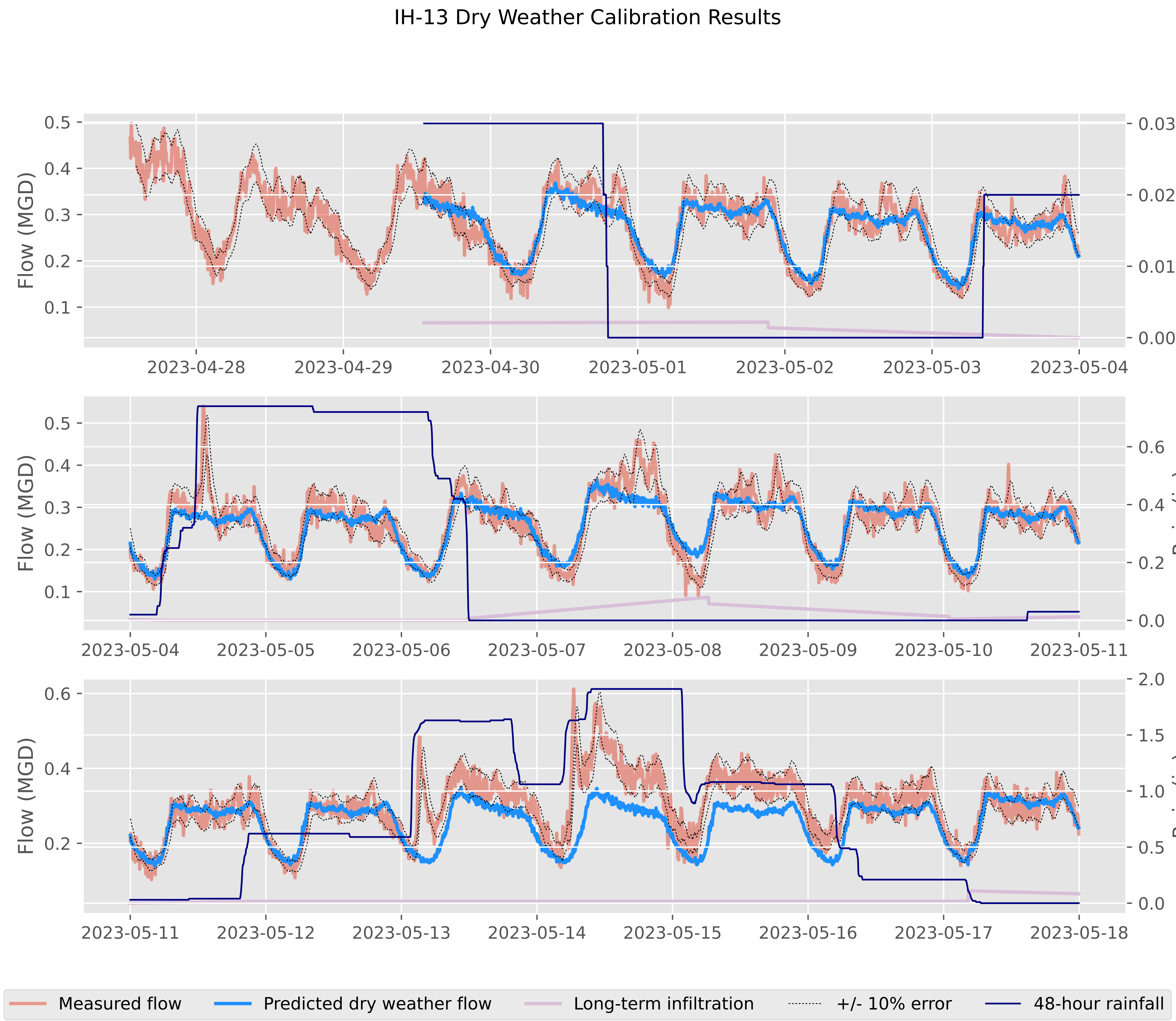

IH-12 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.1
0.2
0.3
0.4
0.5
0.0
1
2
0
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

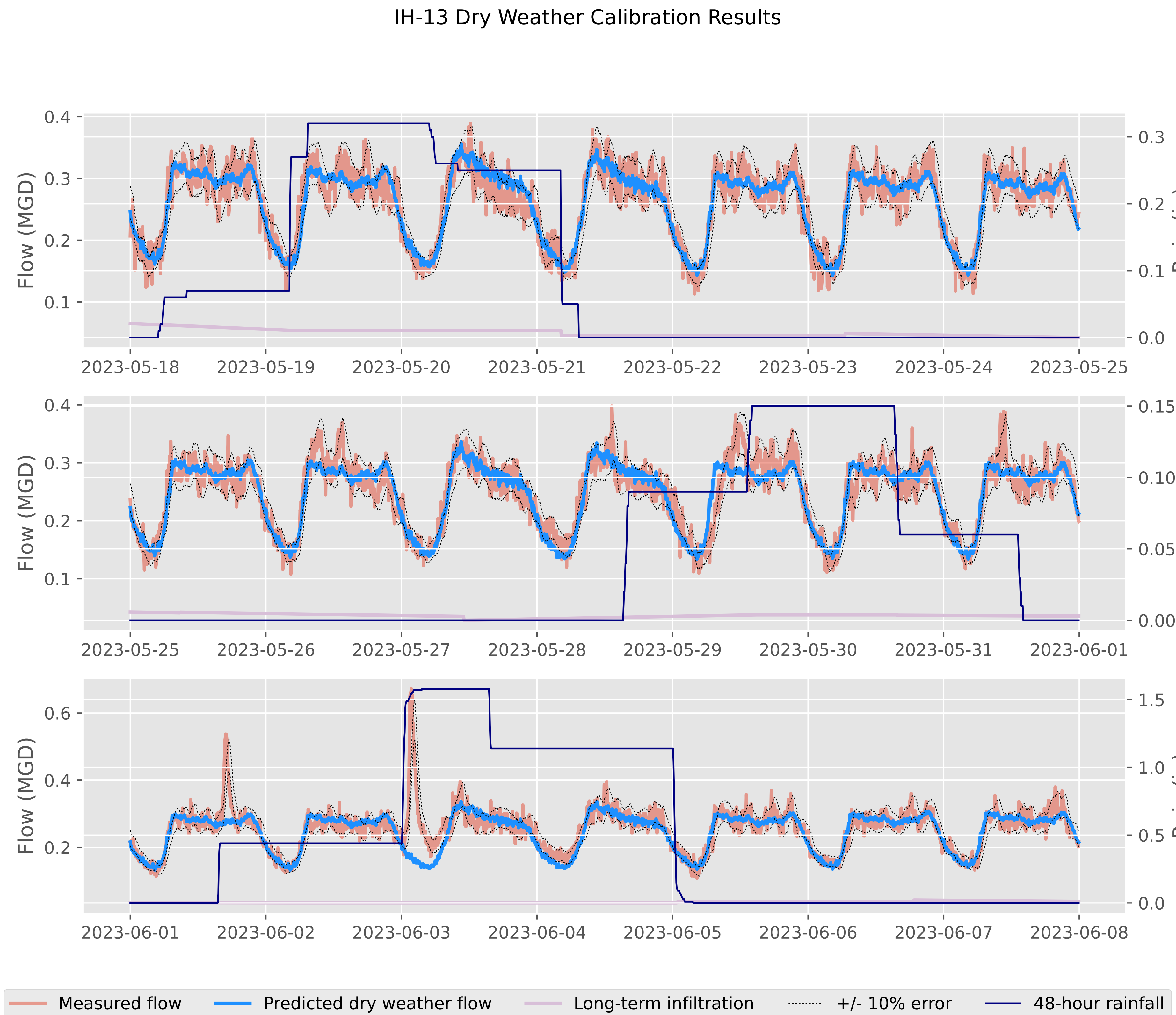
IH-12 Dry Weather Calibration Results



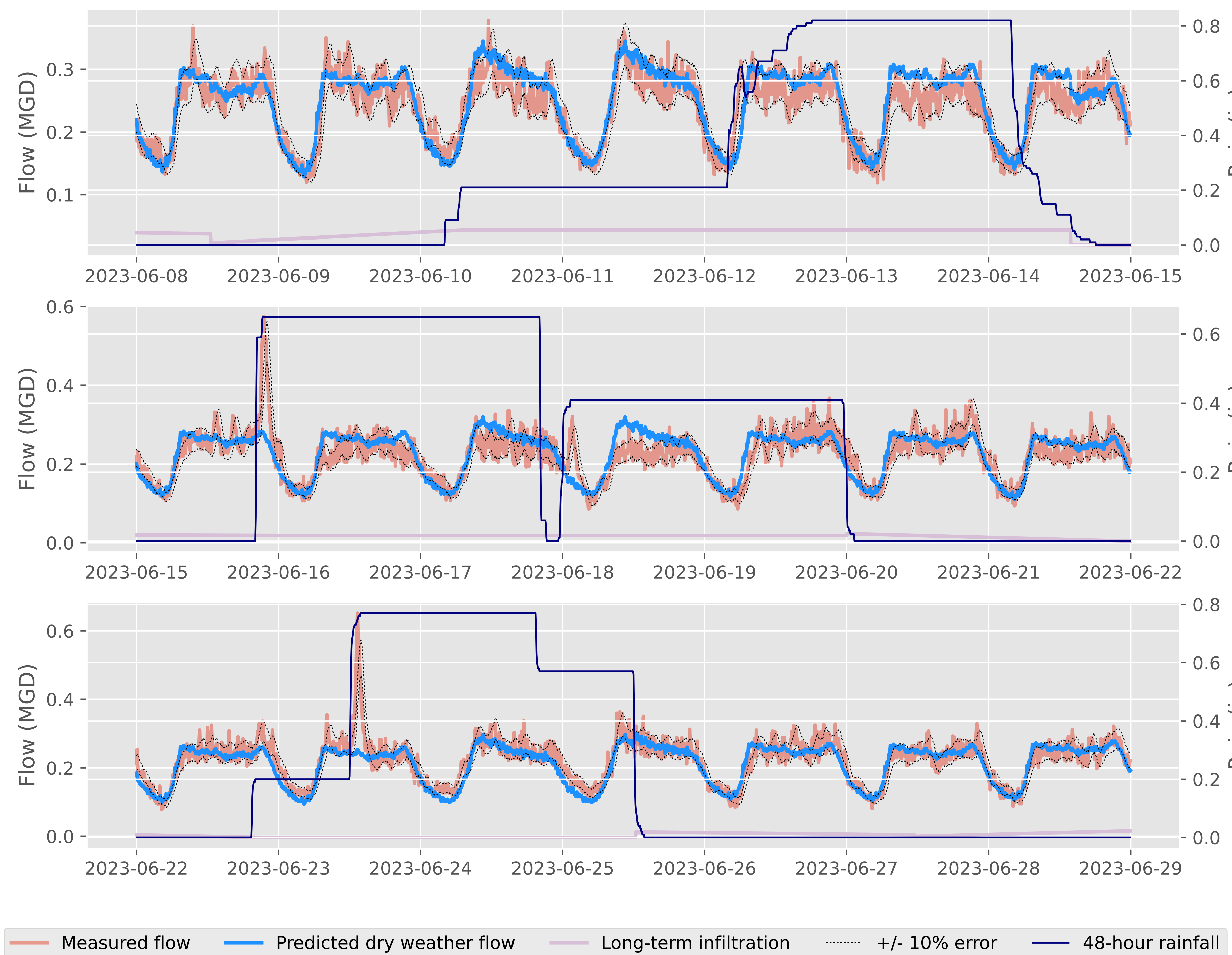

IH-12 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

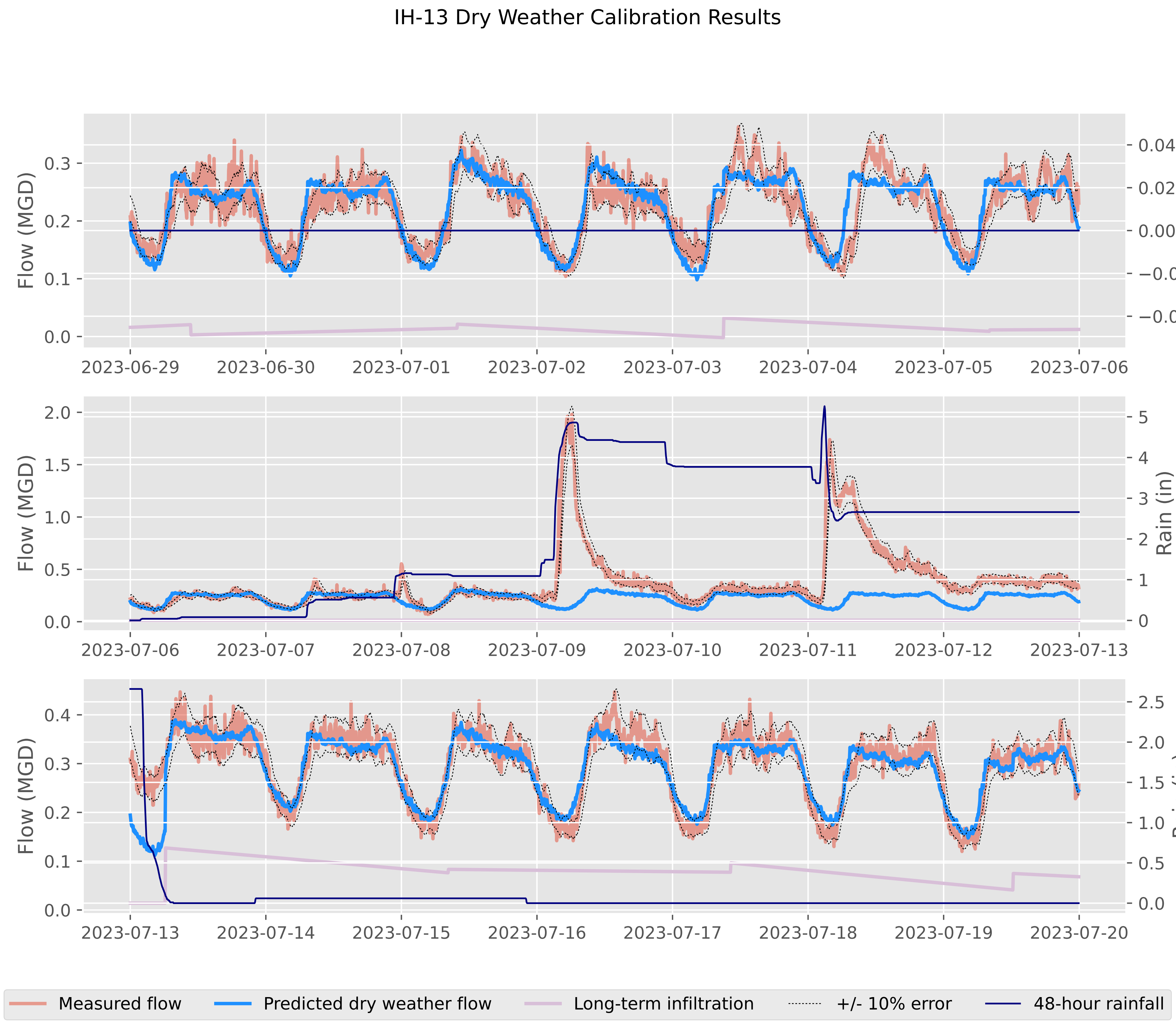

IH-12 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.5
0.4
0.3
0.2
0.1
0.04
0.02
0.00
−0.02
−0.04
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
1.0
0.8
0.6
0.4
0.2
0.0
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


IH-13 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

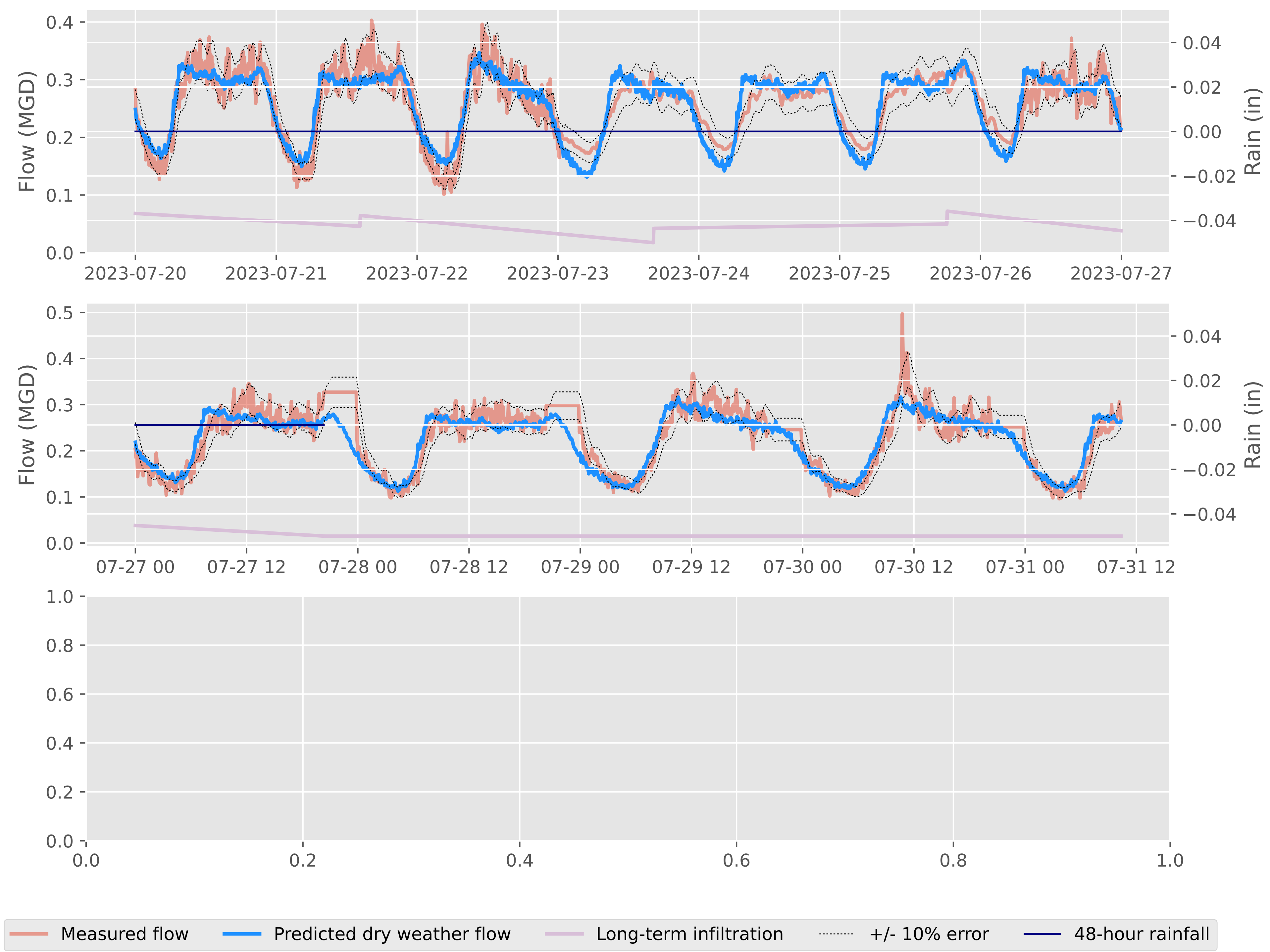

IH-13 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

IH-13 Dry Weather Calibration Results

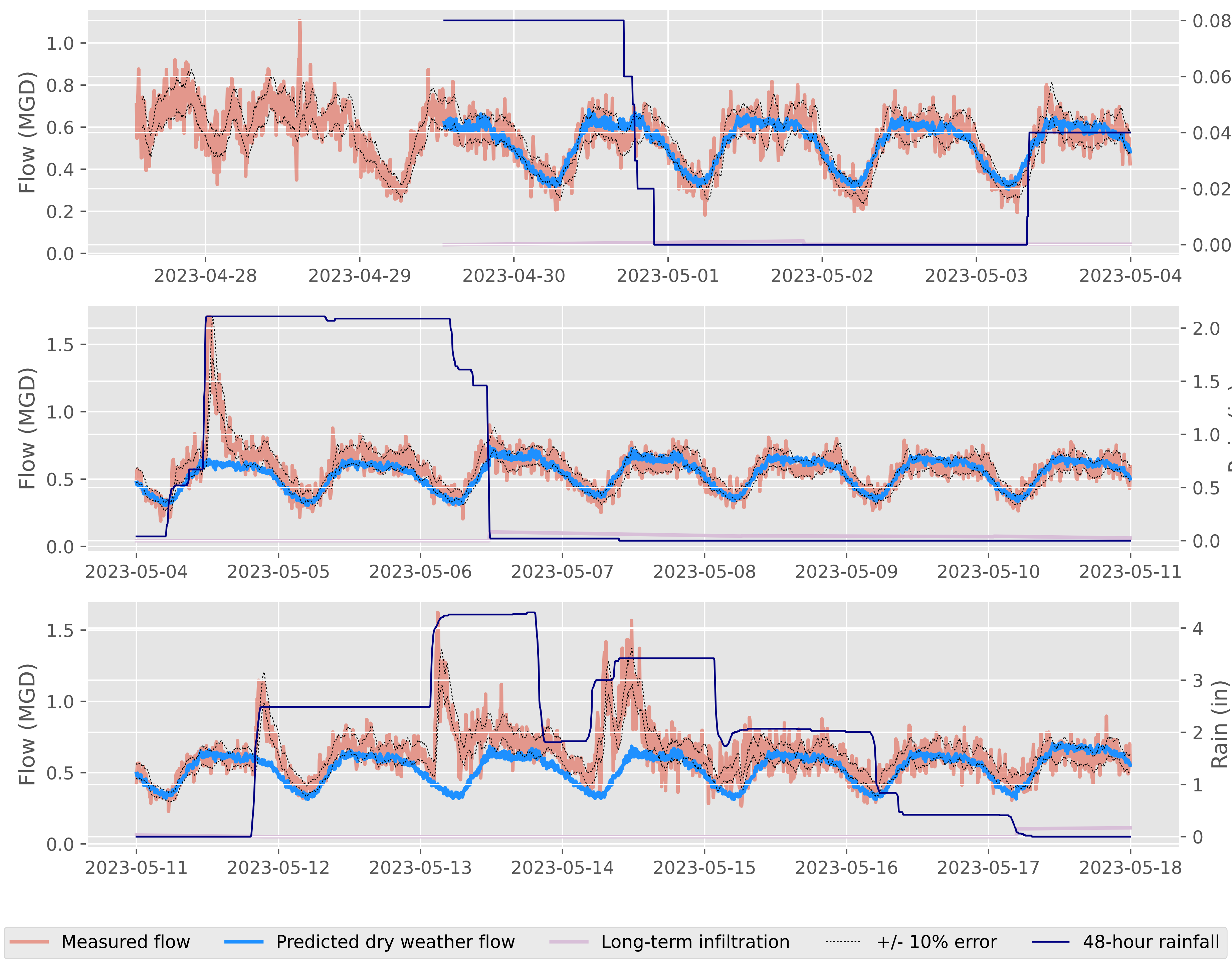


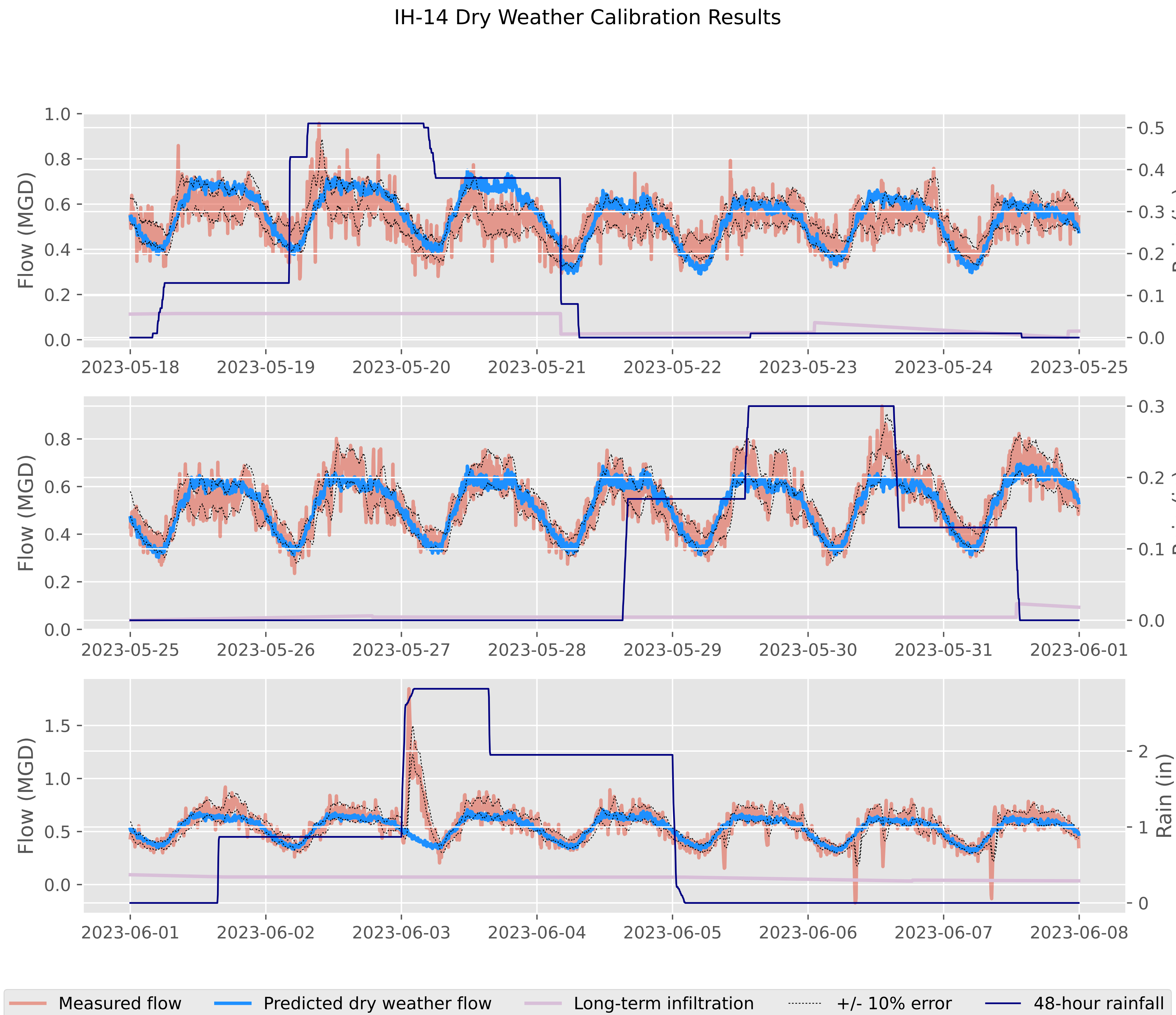

IH-13 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

IH-13 Dry Weather Calibration Results



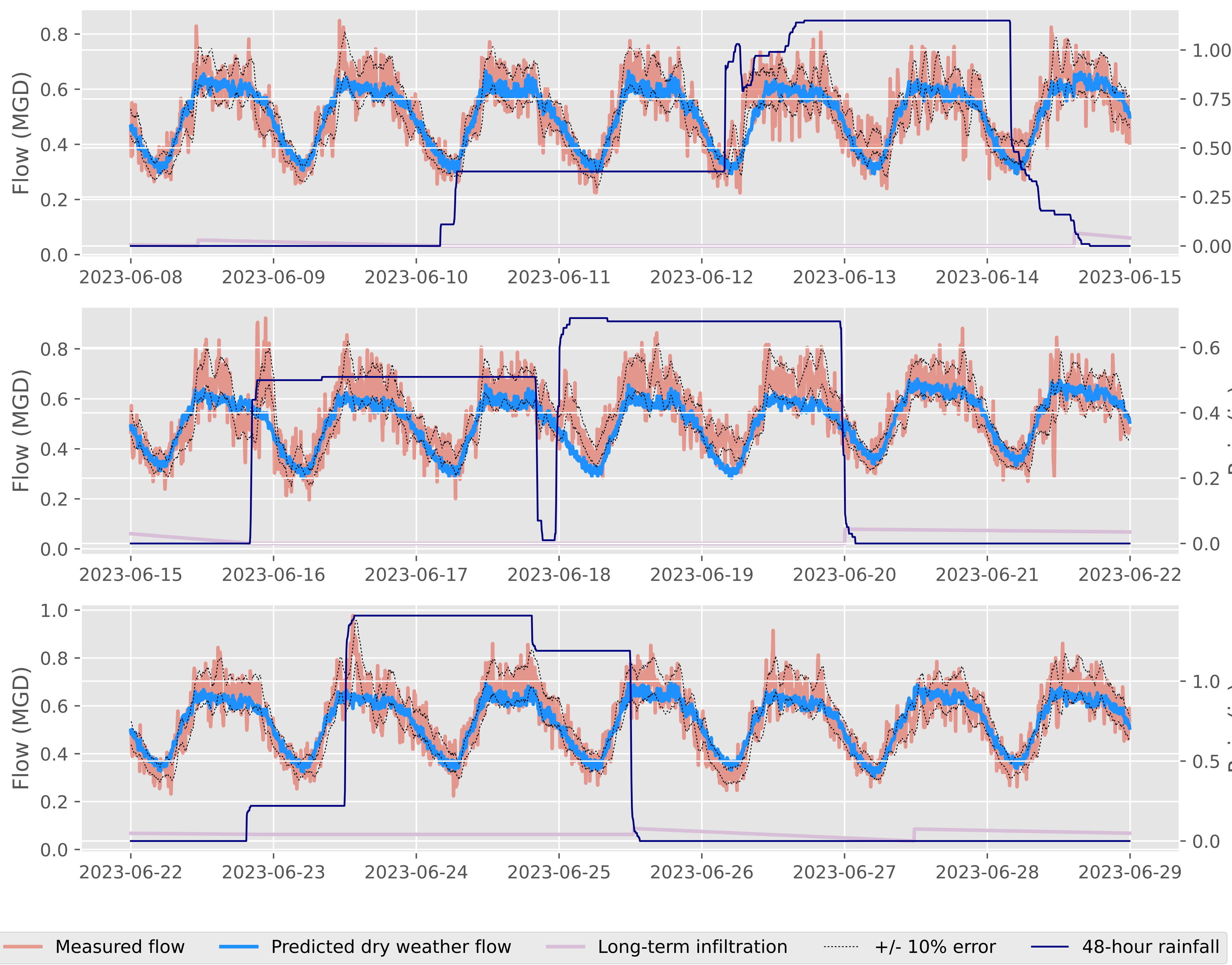
IH-14 Dry Weather Calibration Results



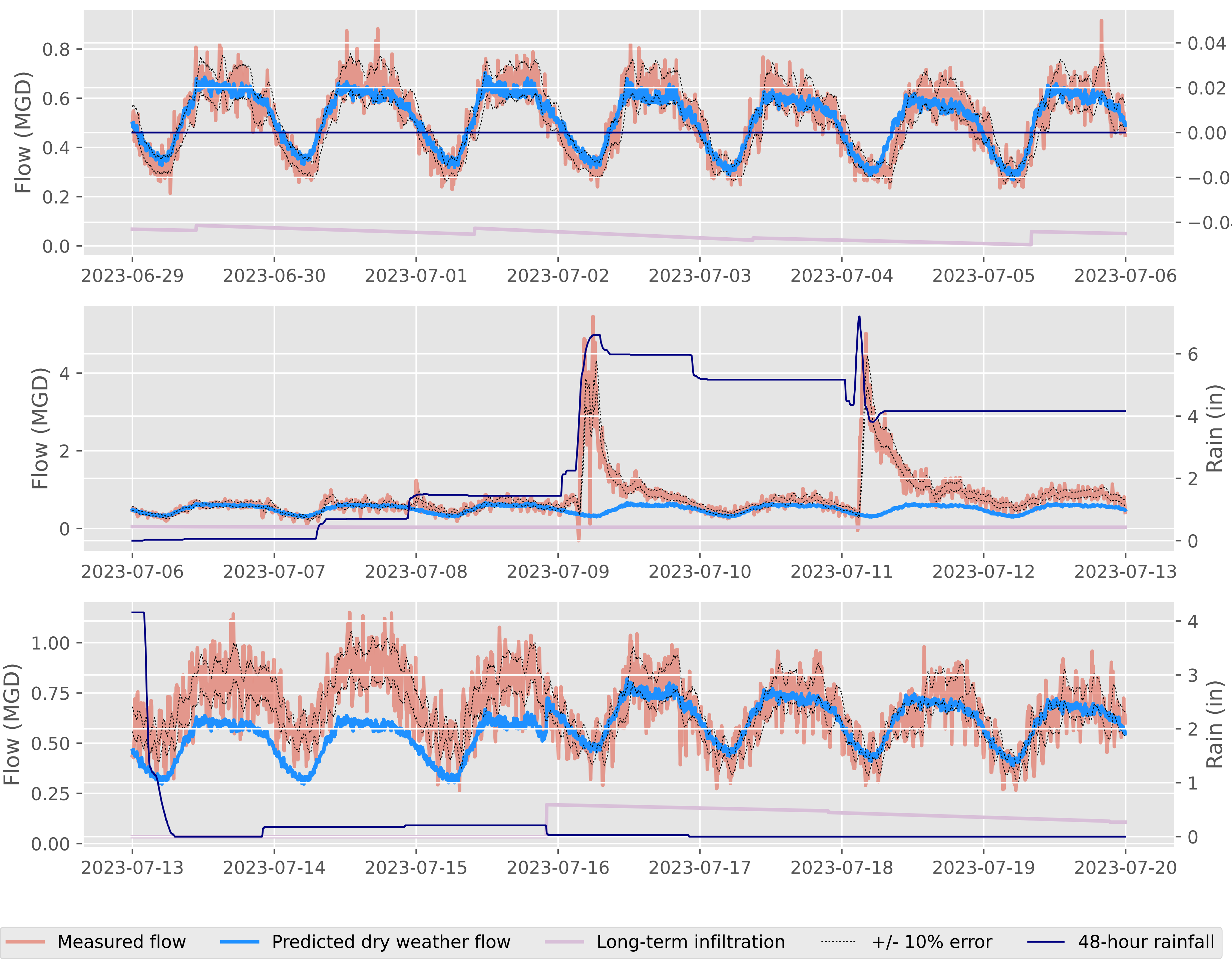


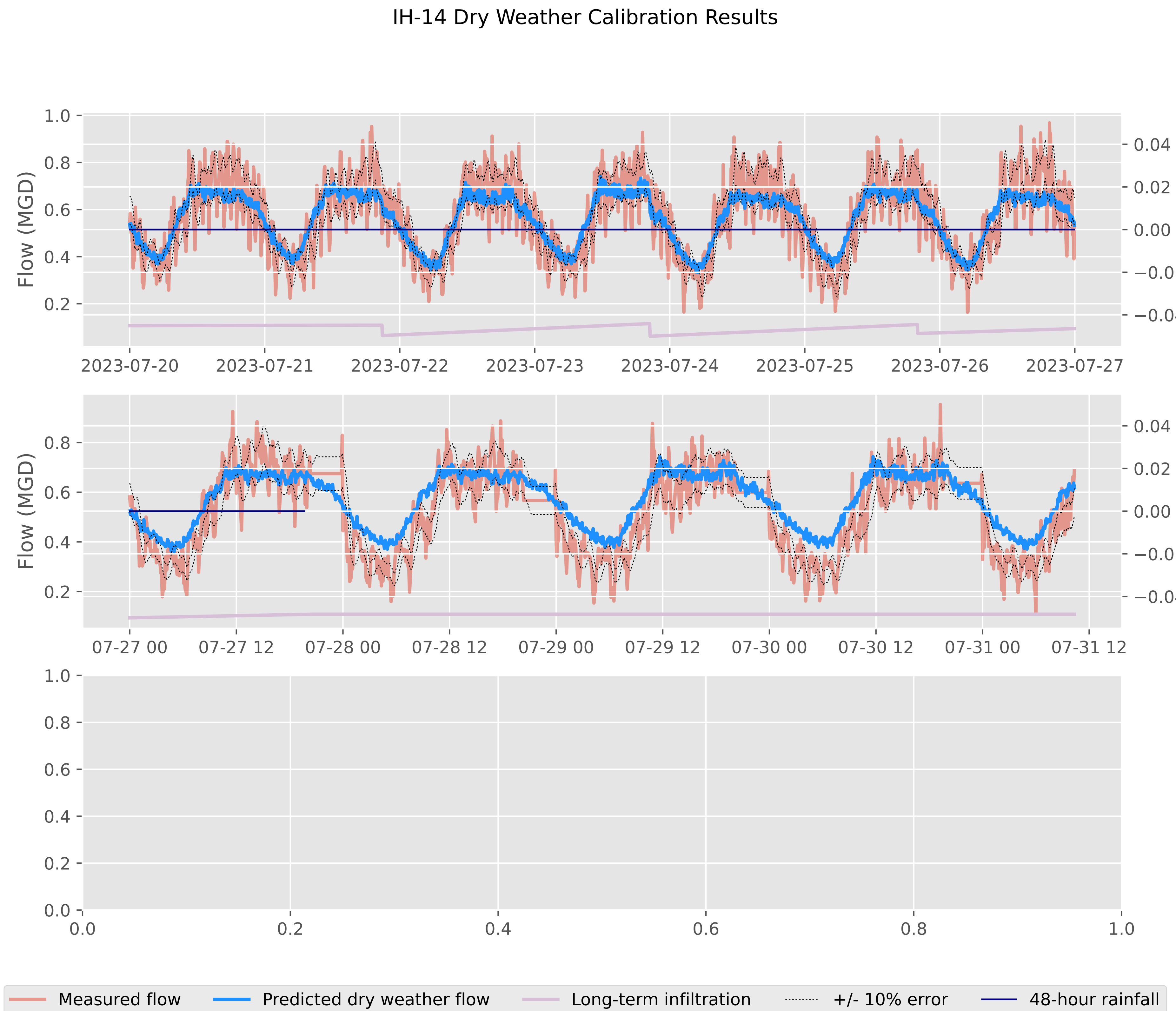
IH-14 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

IH-14 Dry Weather Calibration Results



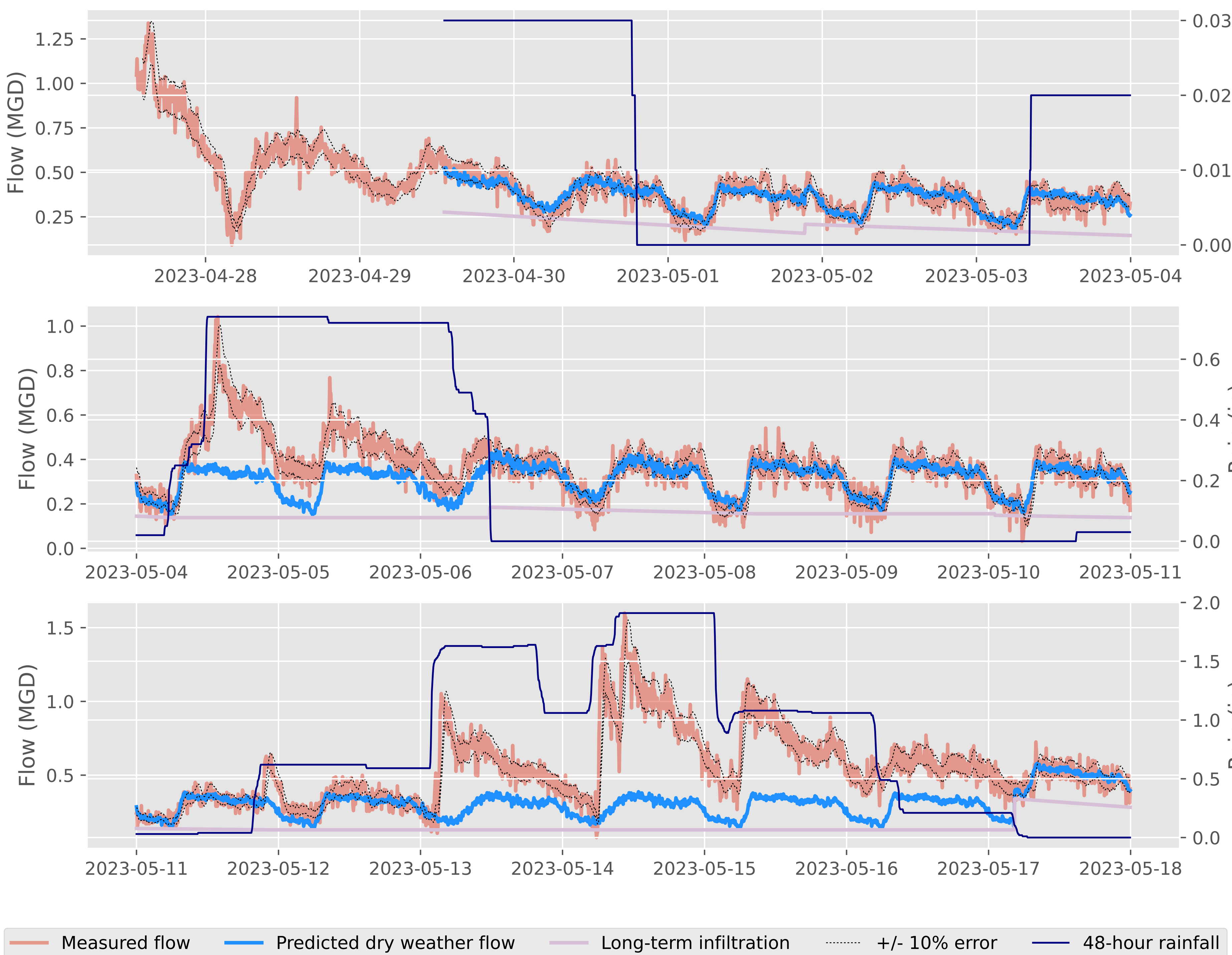
IH-14 Dry Weather Calibration Results



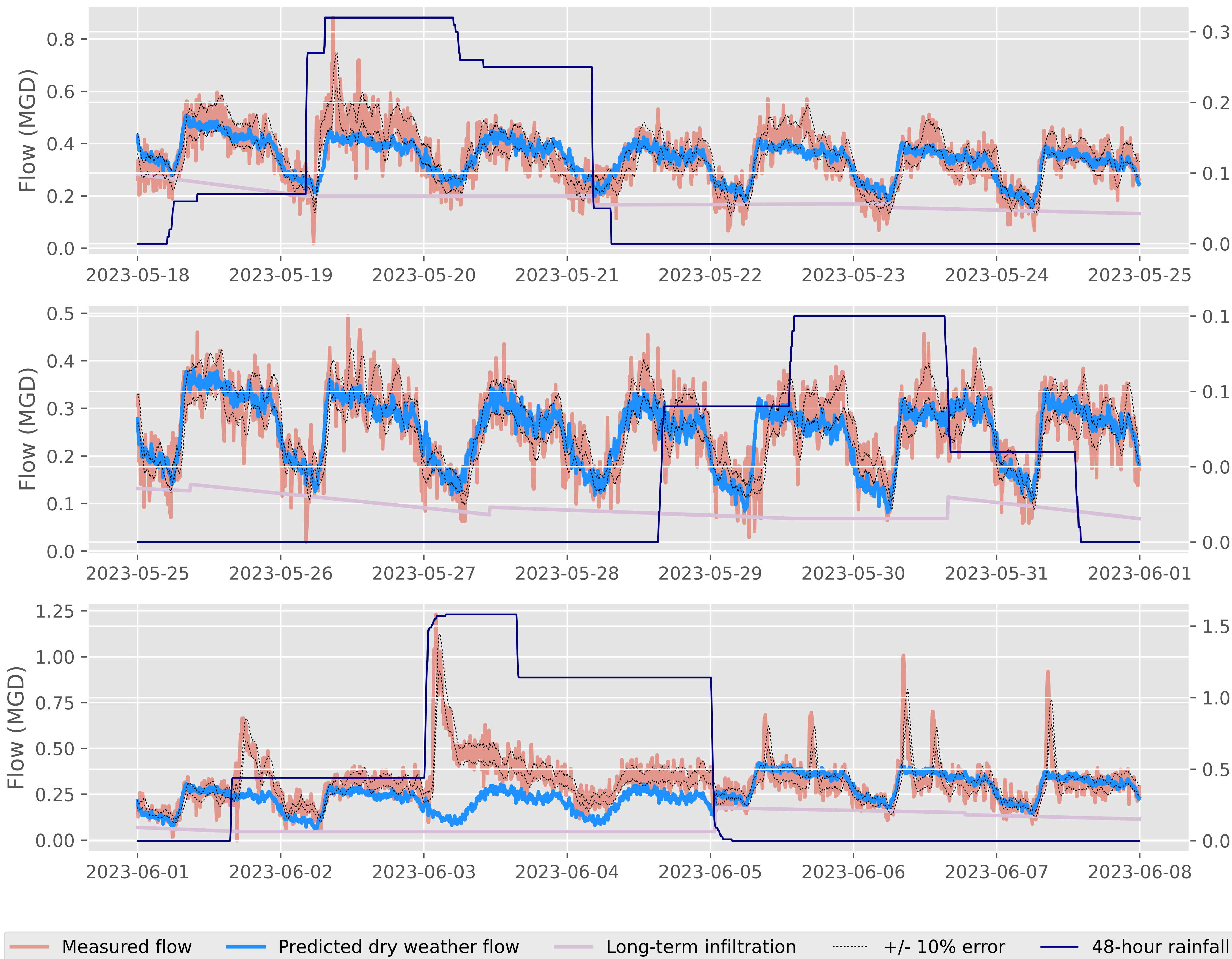


IH-14 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

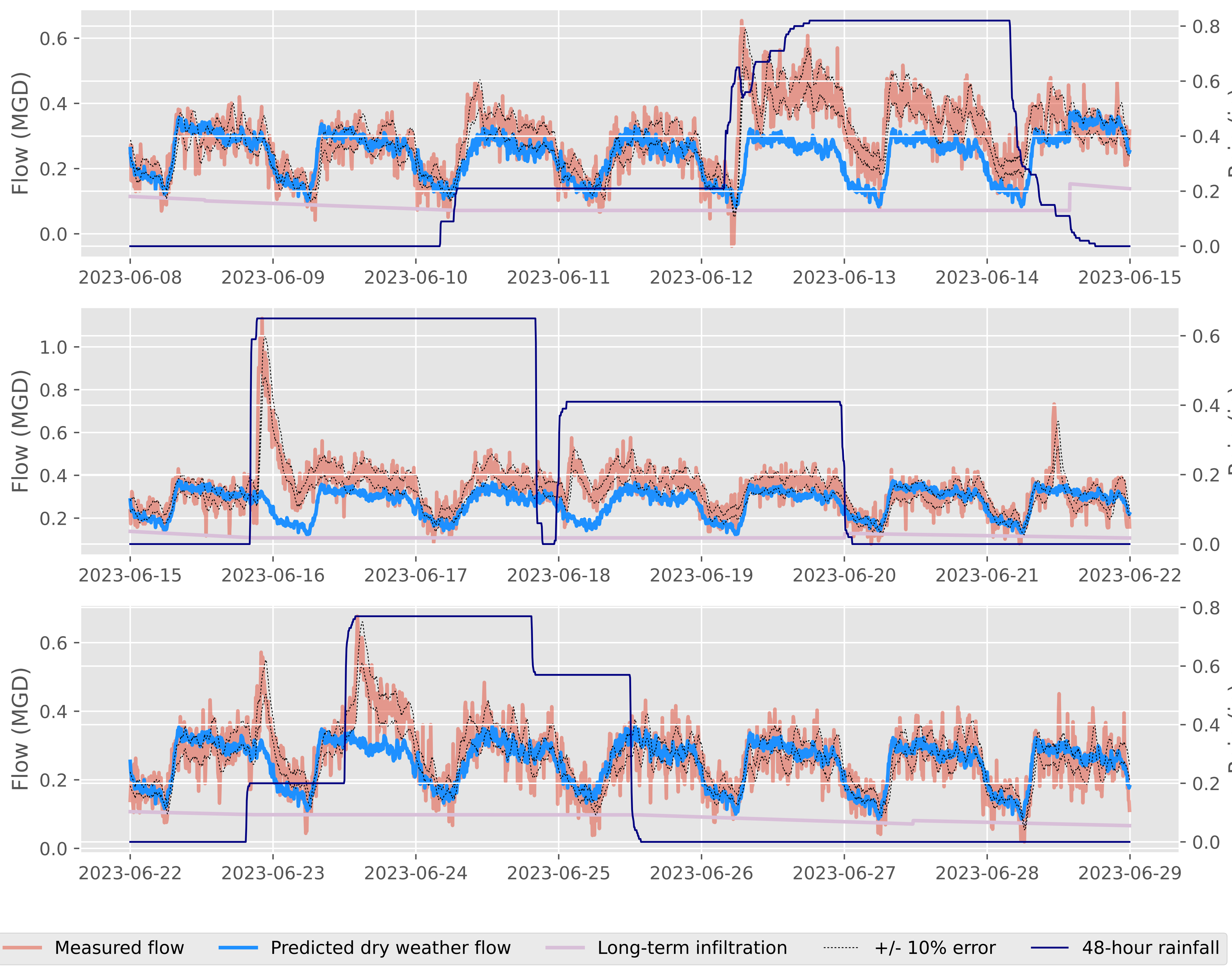
IH-15 Dry Weather Calibration Results

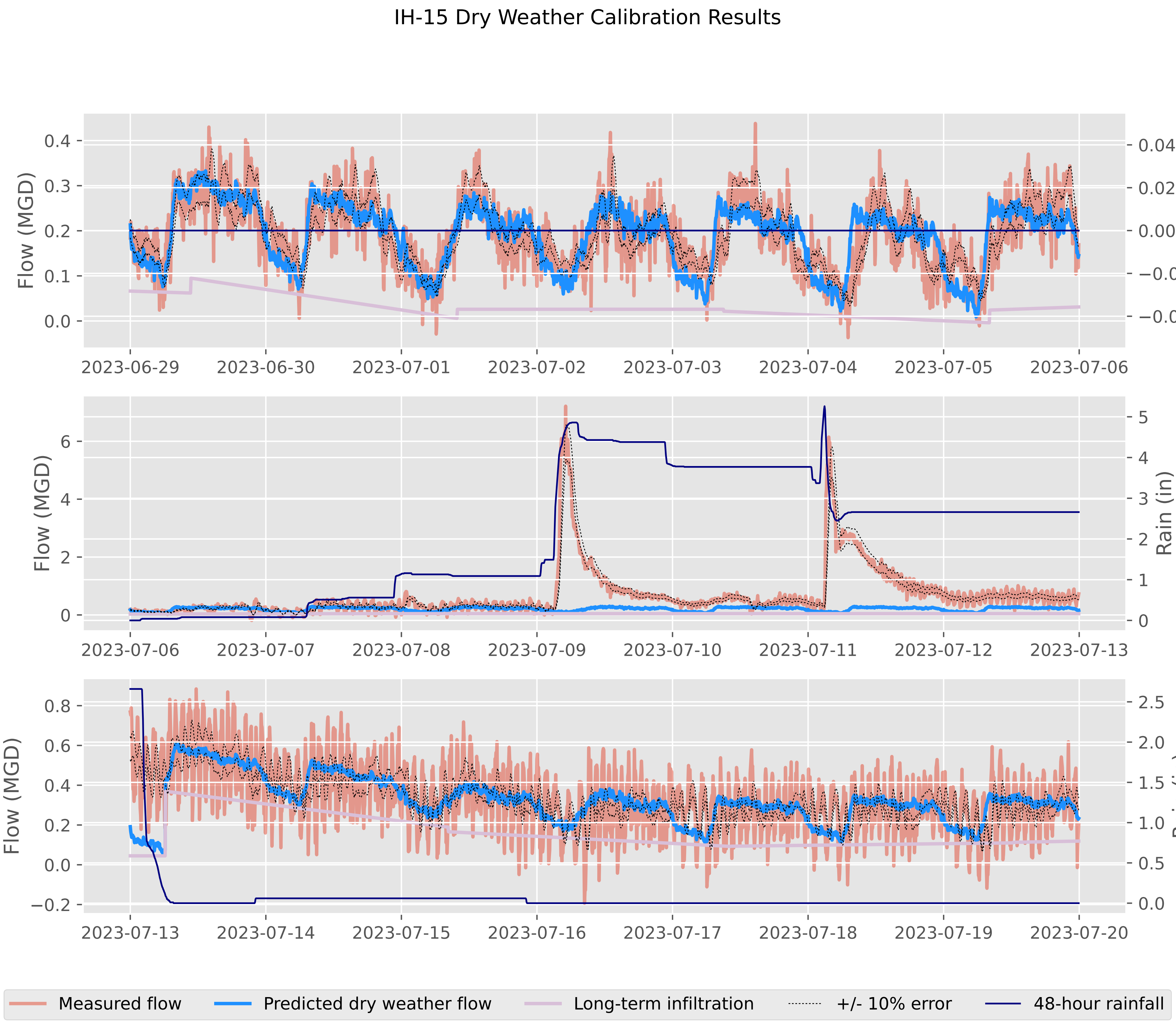


IH-15 Dry Weather Calibration Results



IH-15 Dry Weather Calibration Results

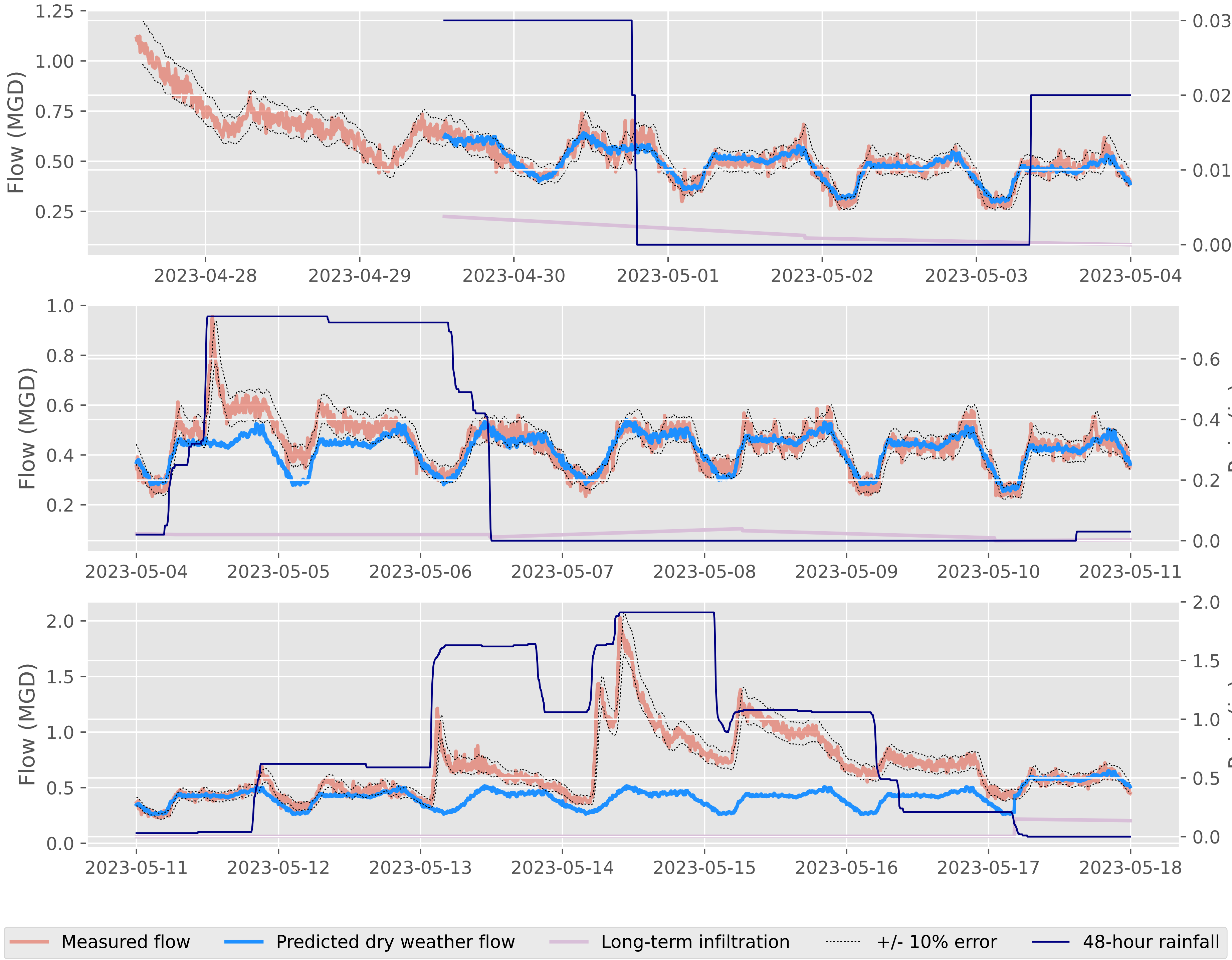


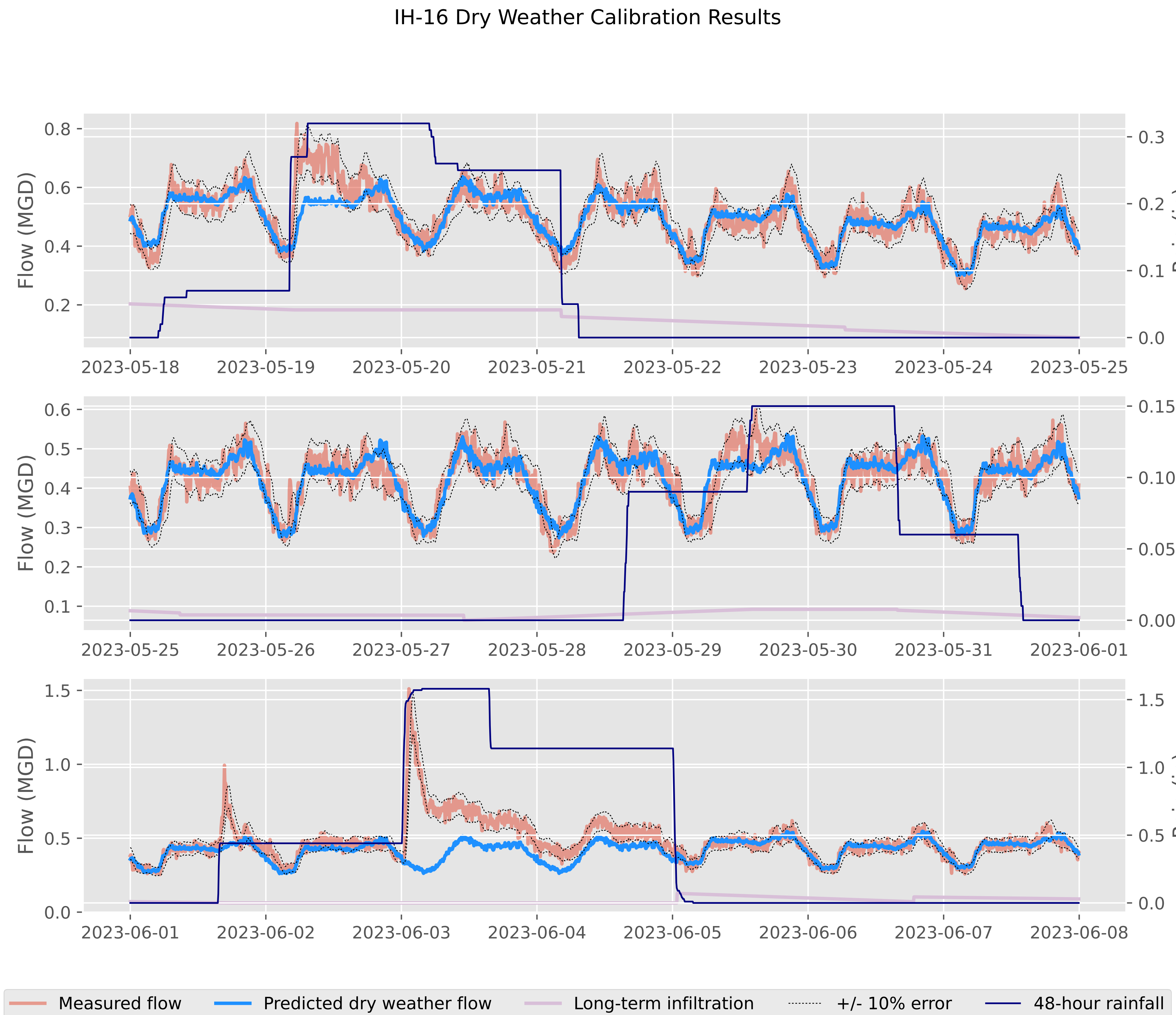


IH-15 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


IH-15 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

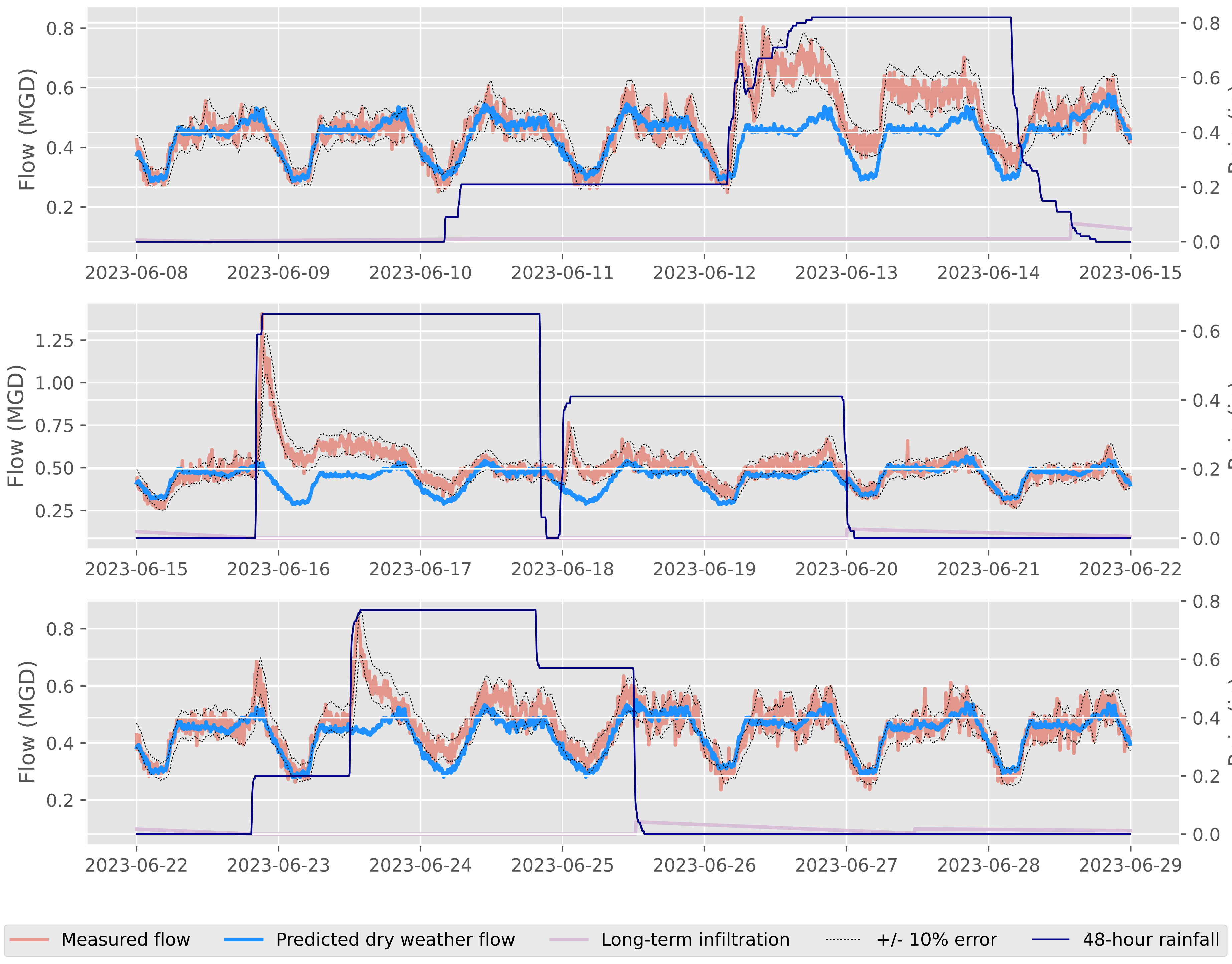
IH-16 Dry Weather Calibration Results

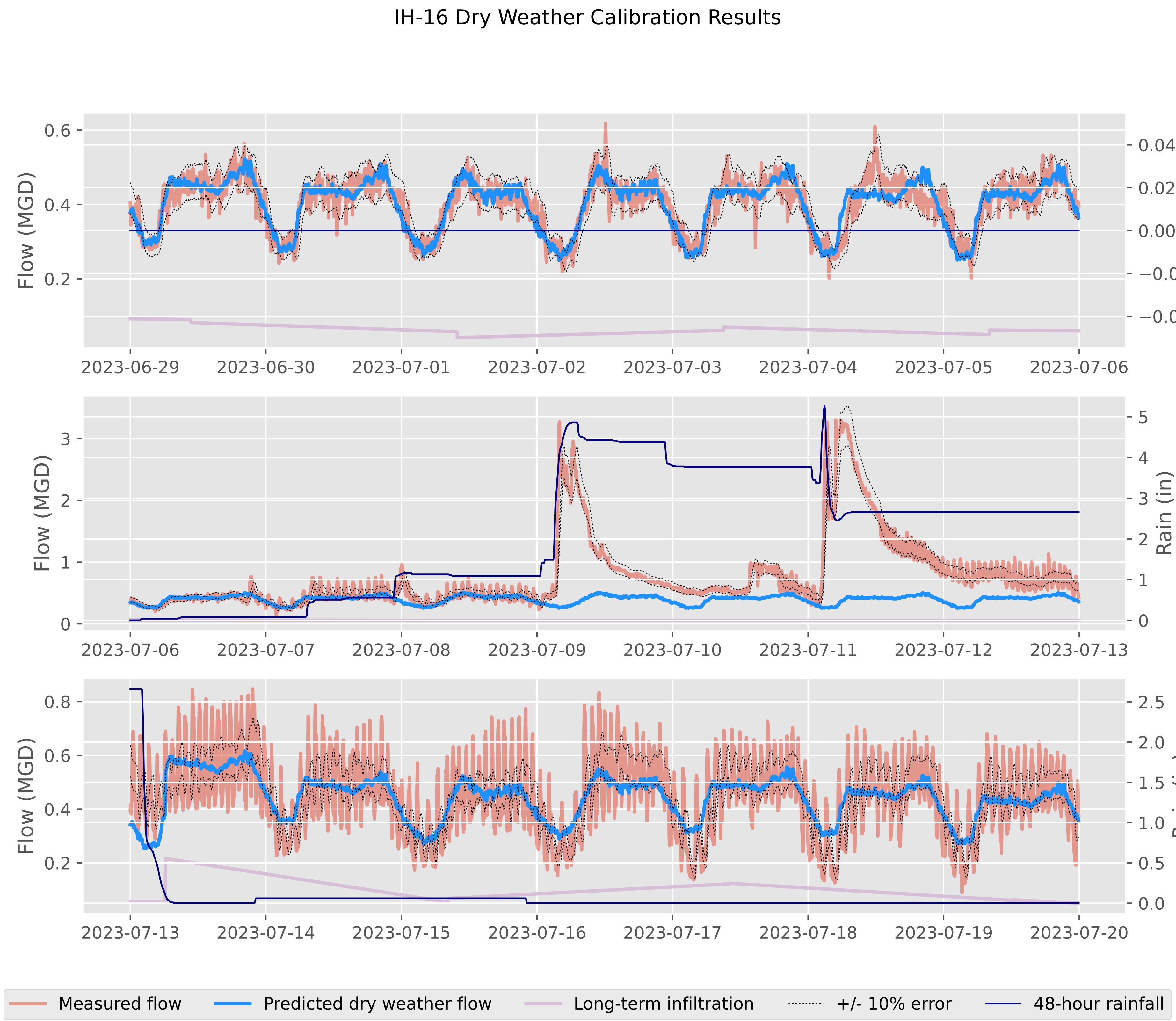




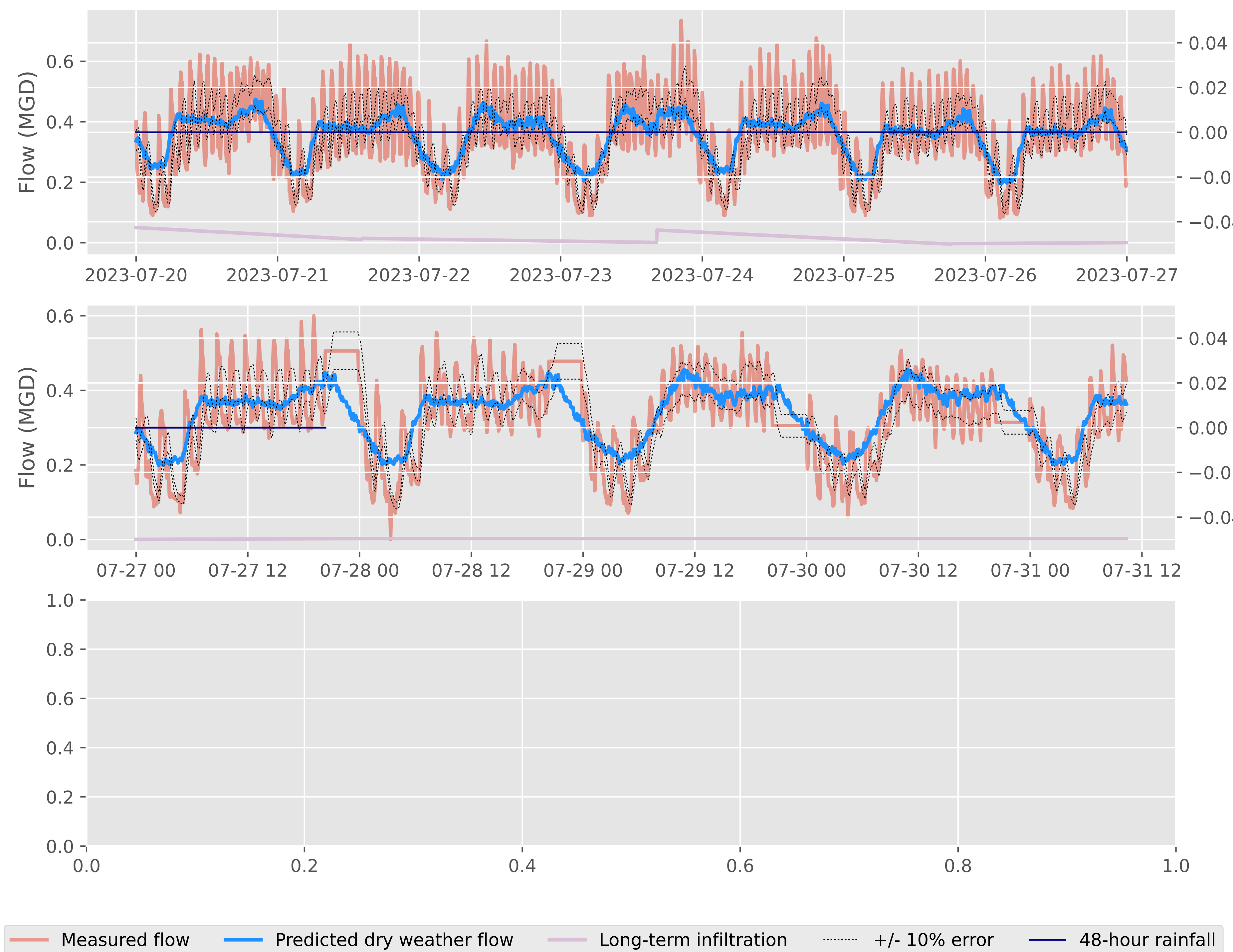
IH-16 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.2
0.4
0.6
0.8
0.0
0.1
0.2
0.3
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
0.1
0.2
0.3
0.4
0.5
0.6
0.00
0.05
0.10
0.15
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
0.0
0.5
1.0
1.5
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

IH-16 Dry Weather Calibration Results

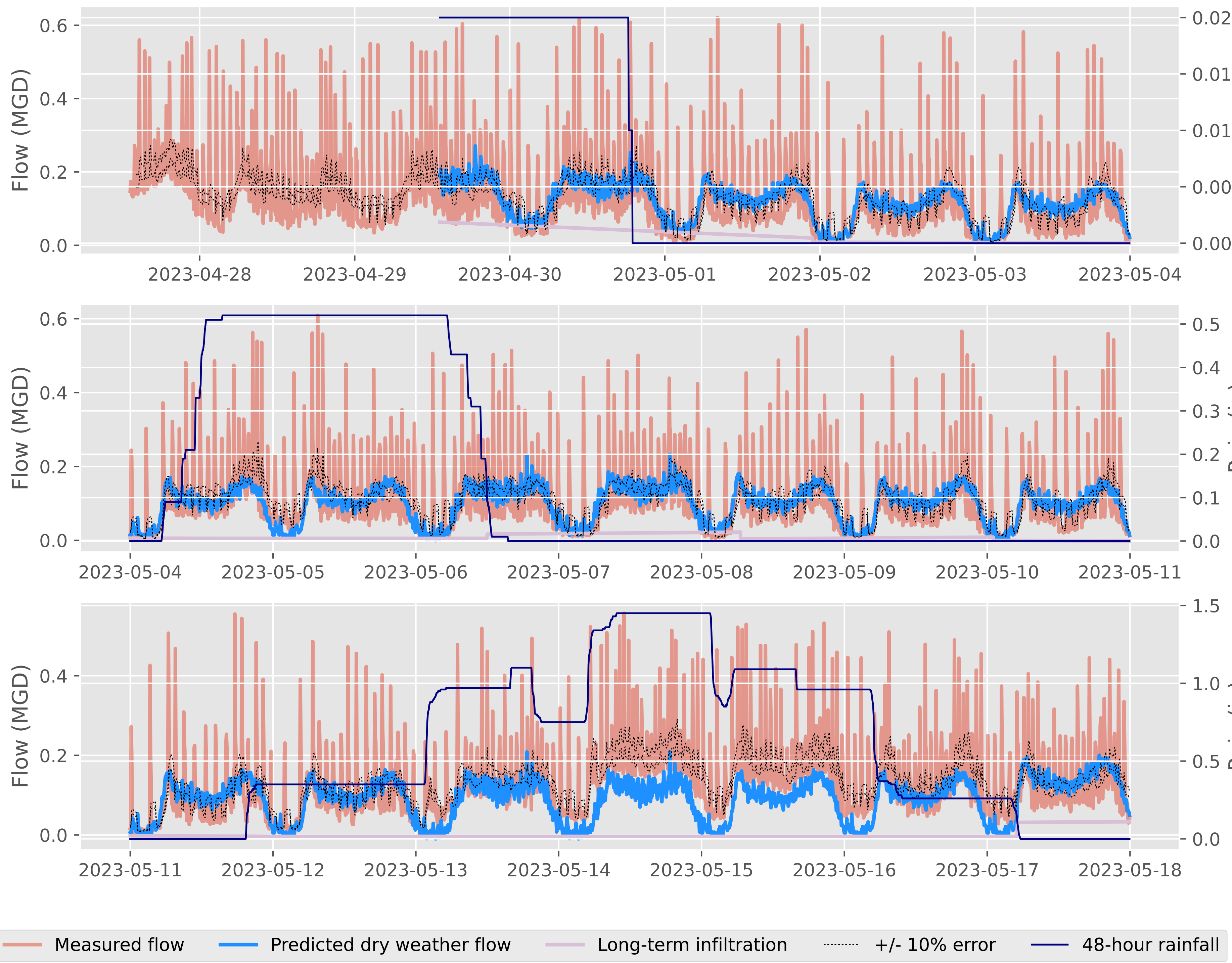



IH-16 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

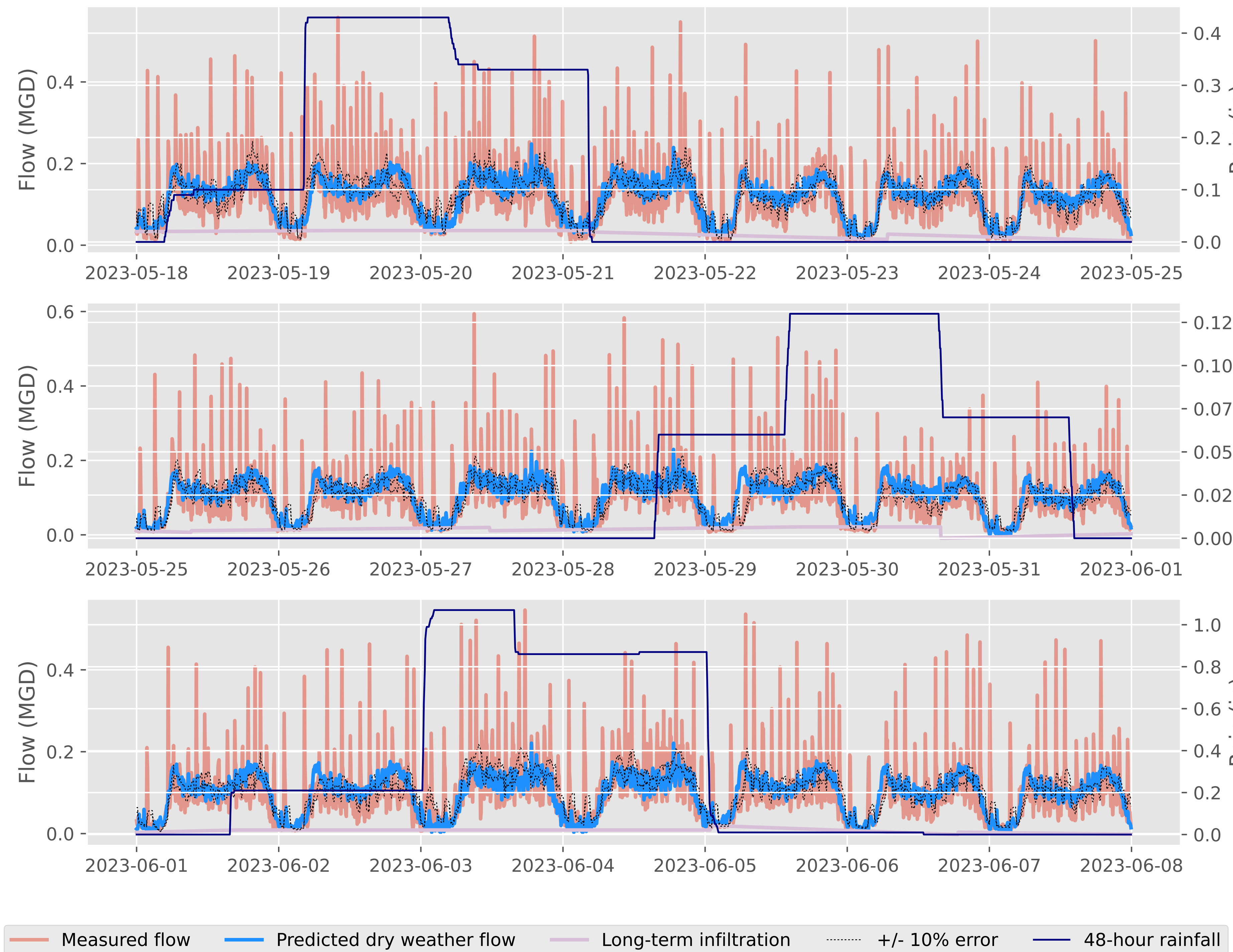
IH-16 Dry Weather Calibration Results

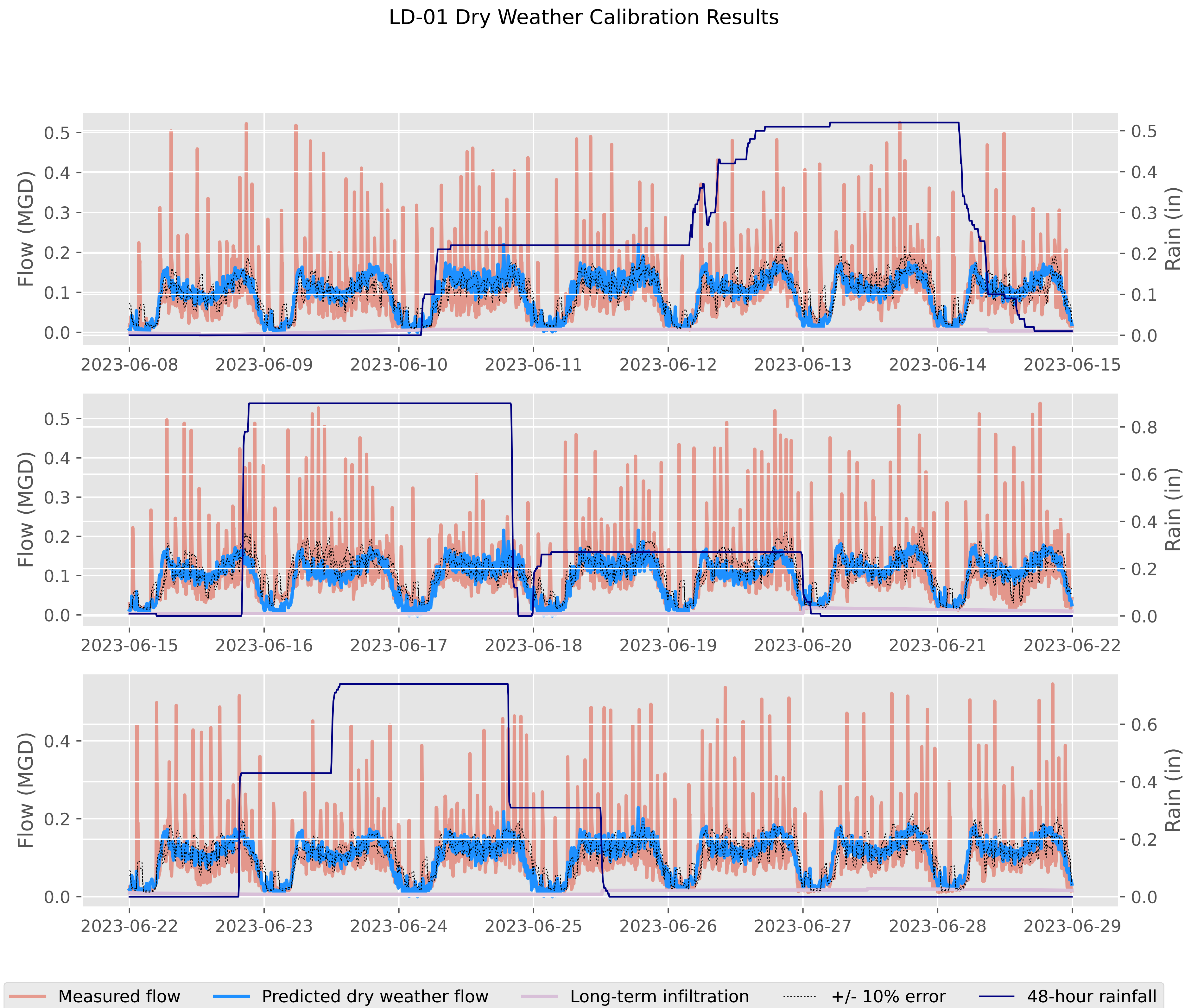


LD-01 Dry Weather Calibration Results

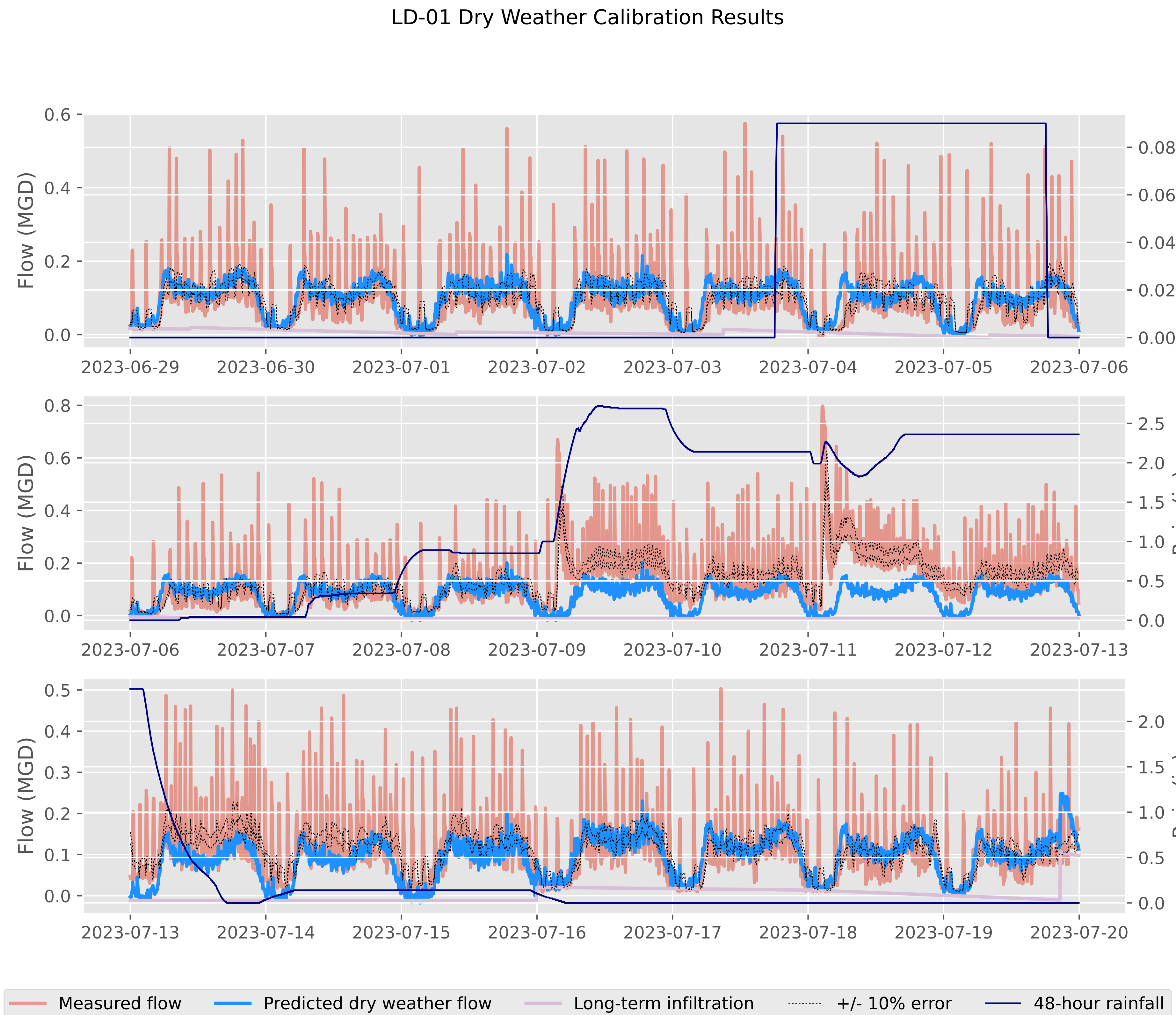


LD-01 Dry Weather Calibration Results



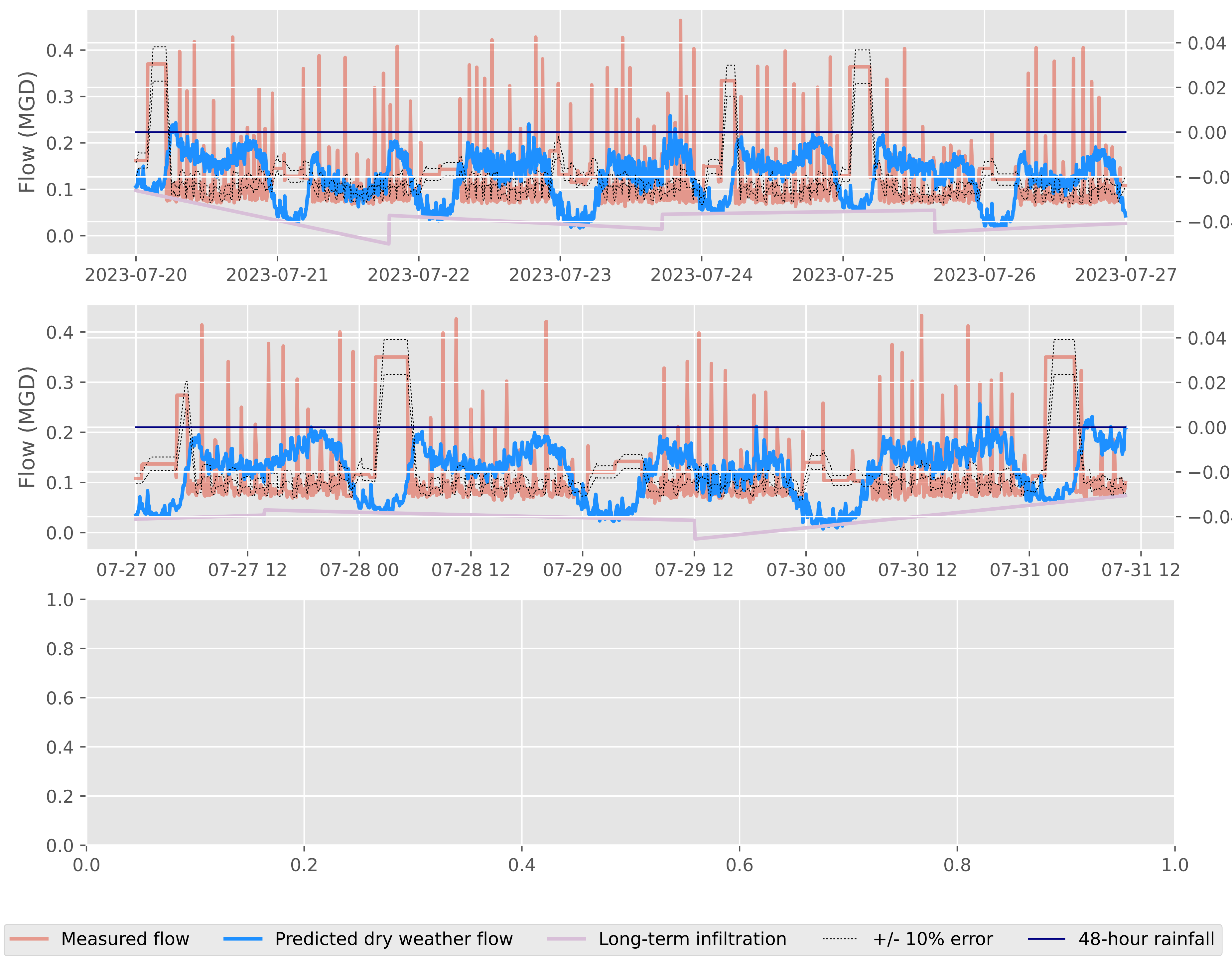


LD-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

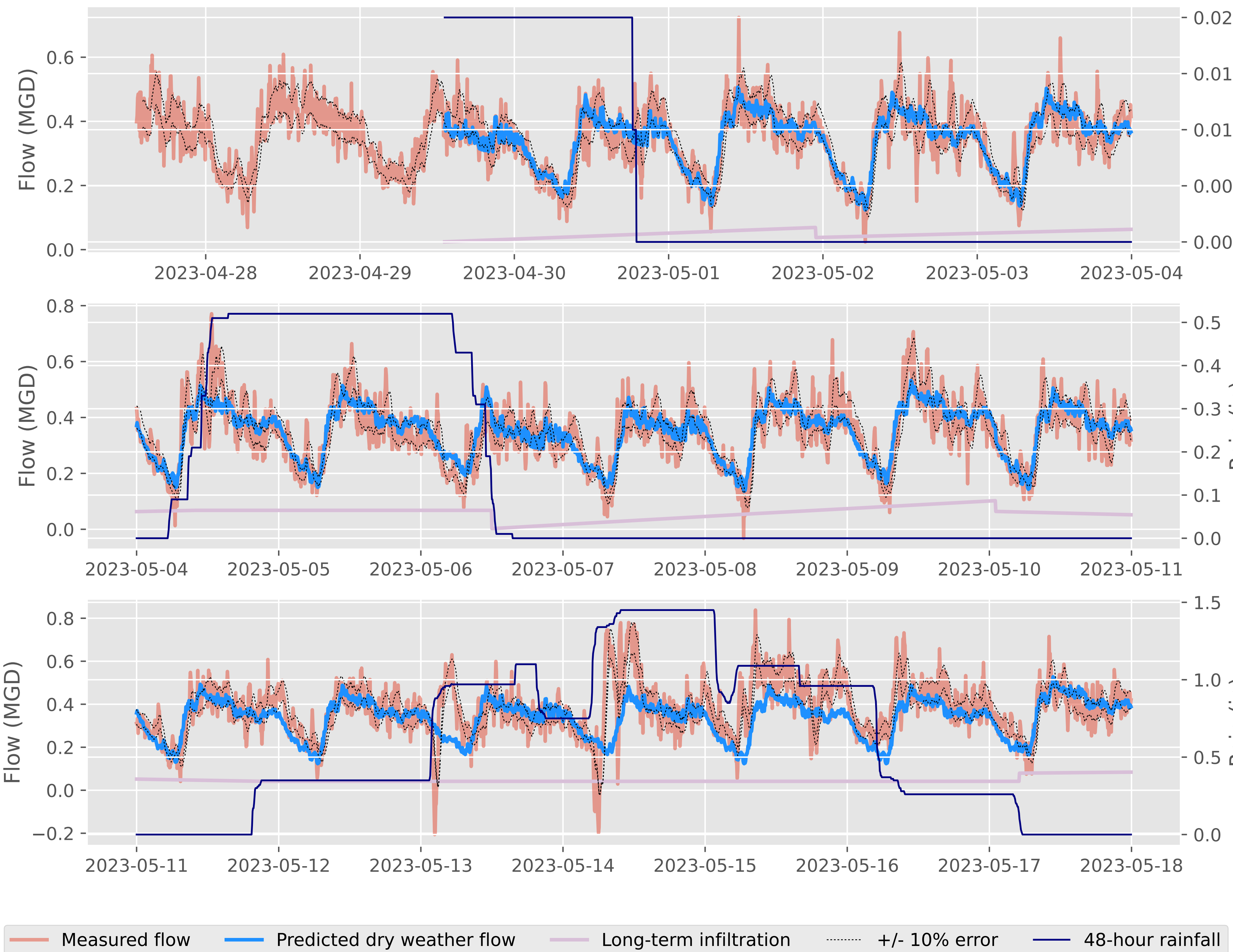


LD-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

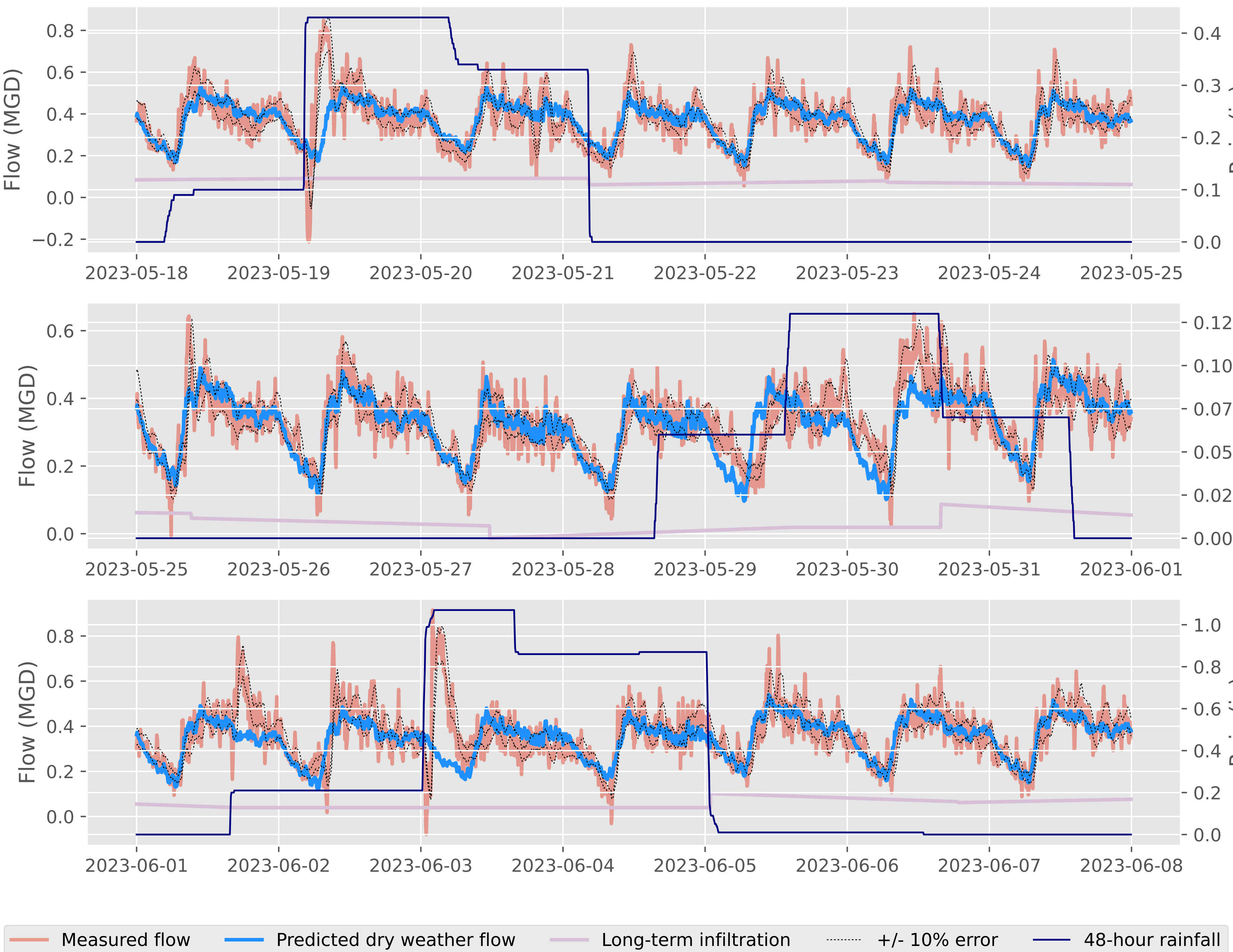
LD-01 Dry Weather Calibration Results

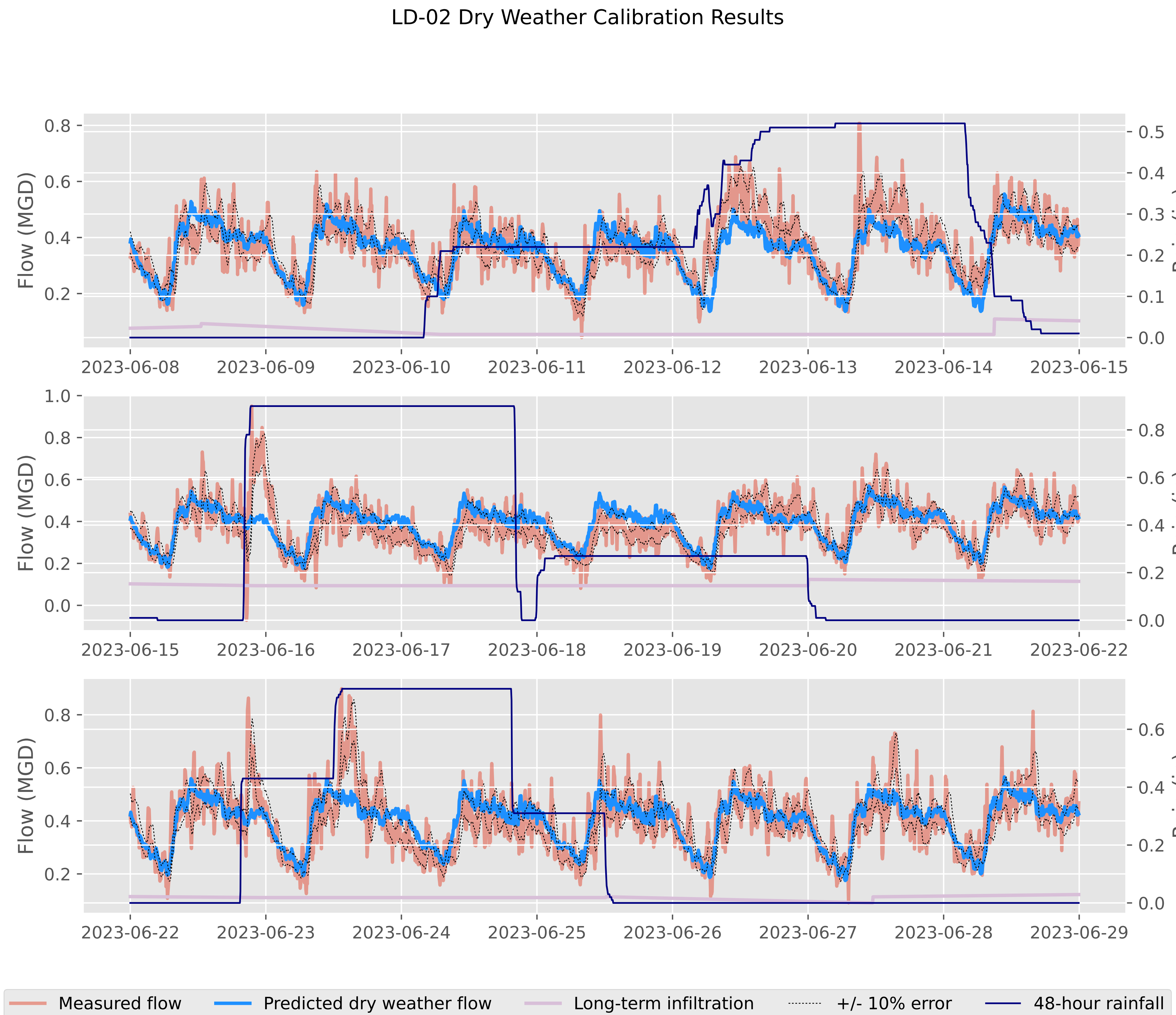


LD-02 Dry Weather Calibration Results

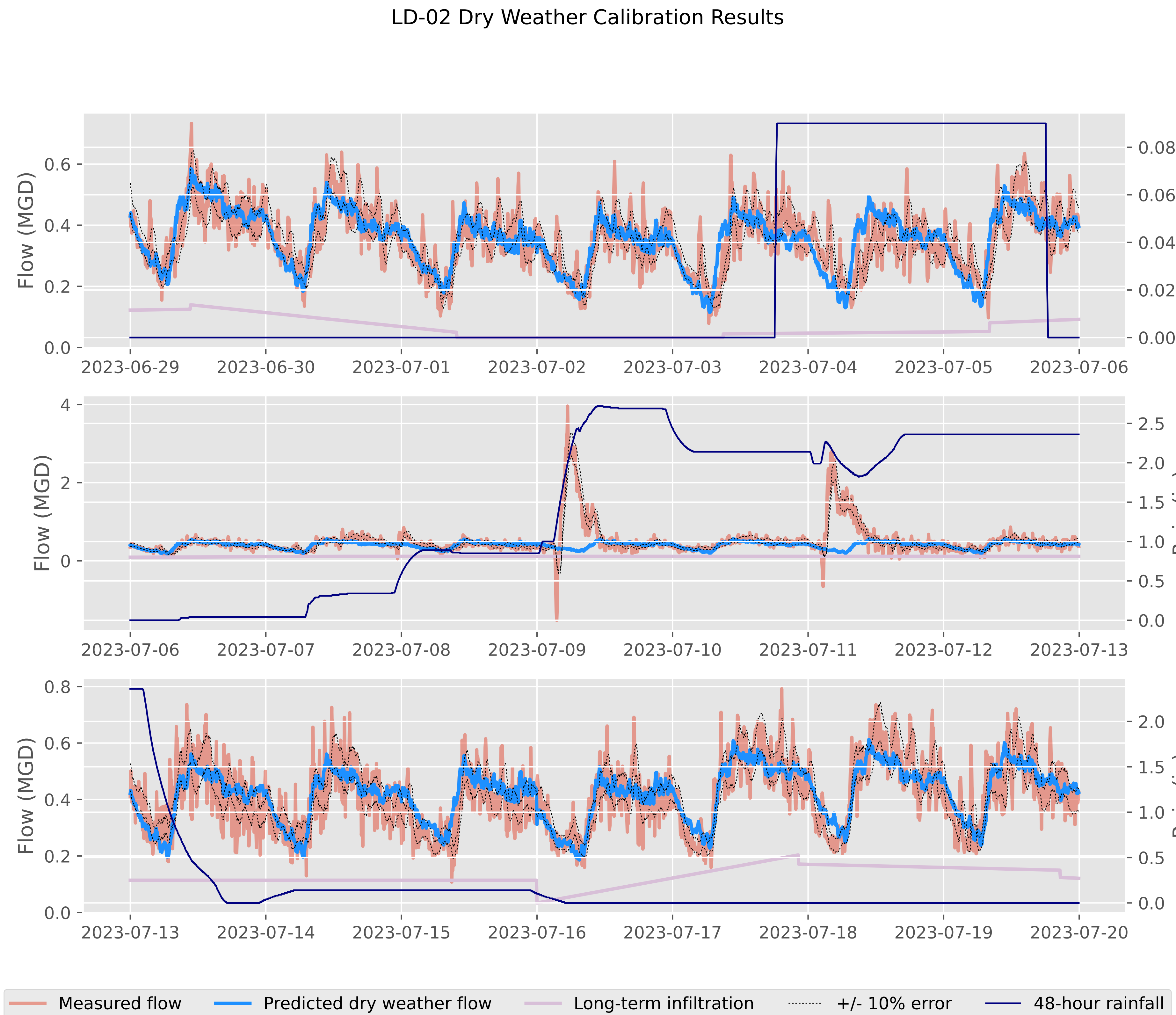


LD-02 Dry Weather Calibration Results

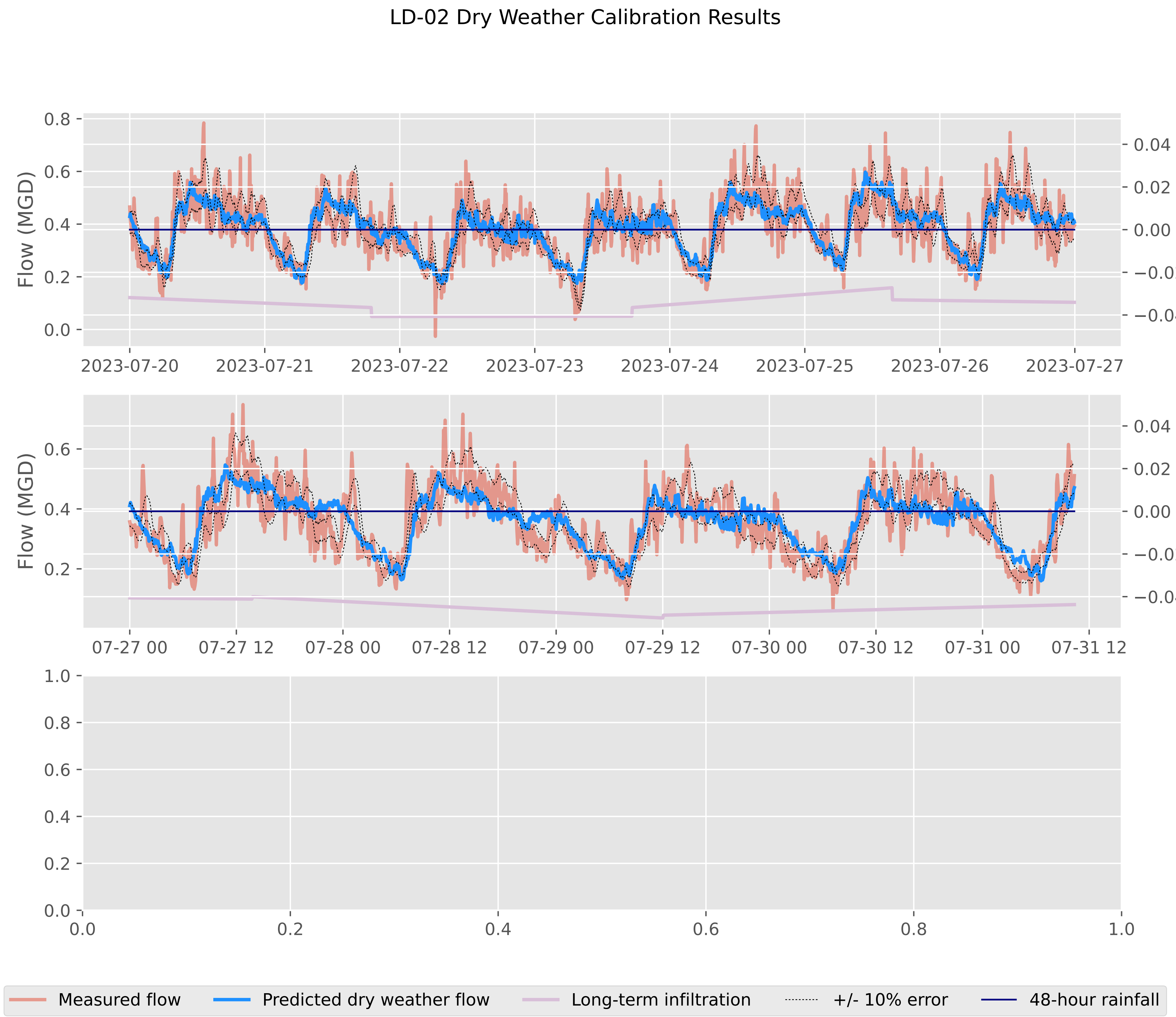




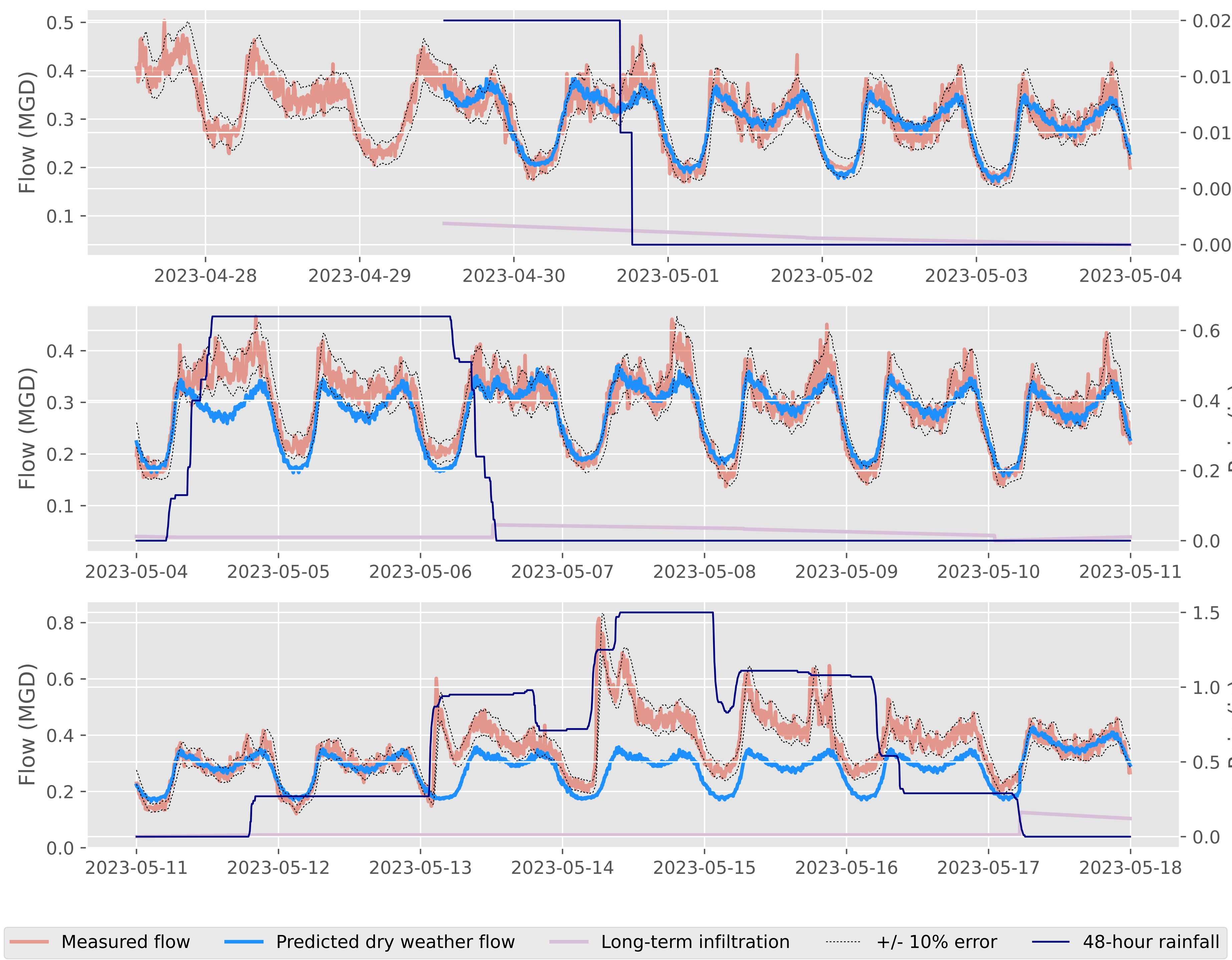
LD-02 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall



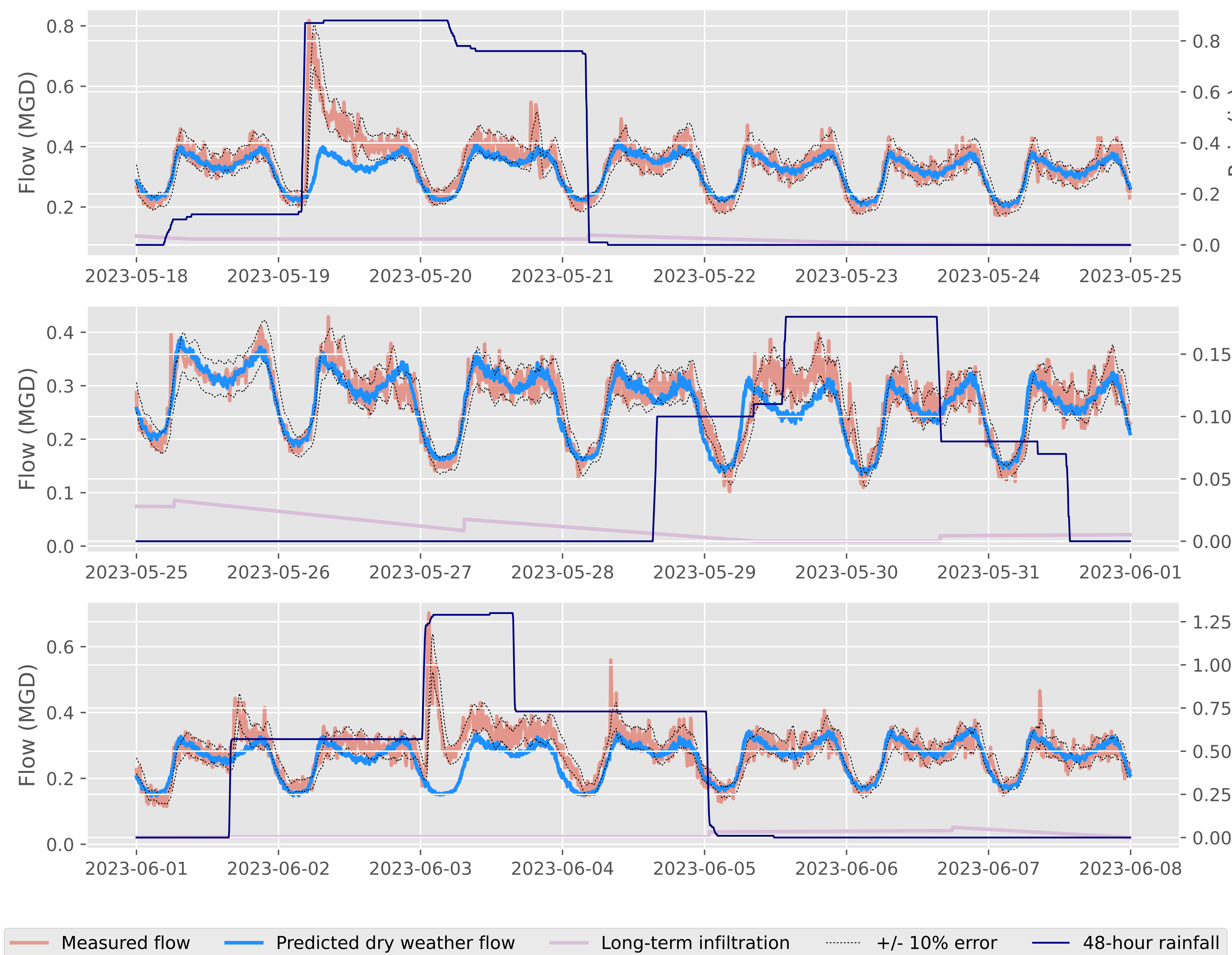
LD-02 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

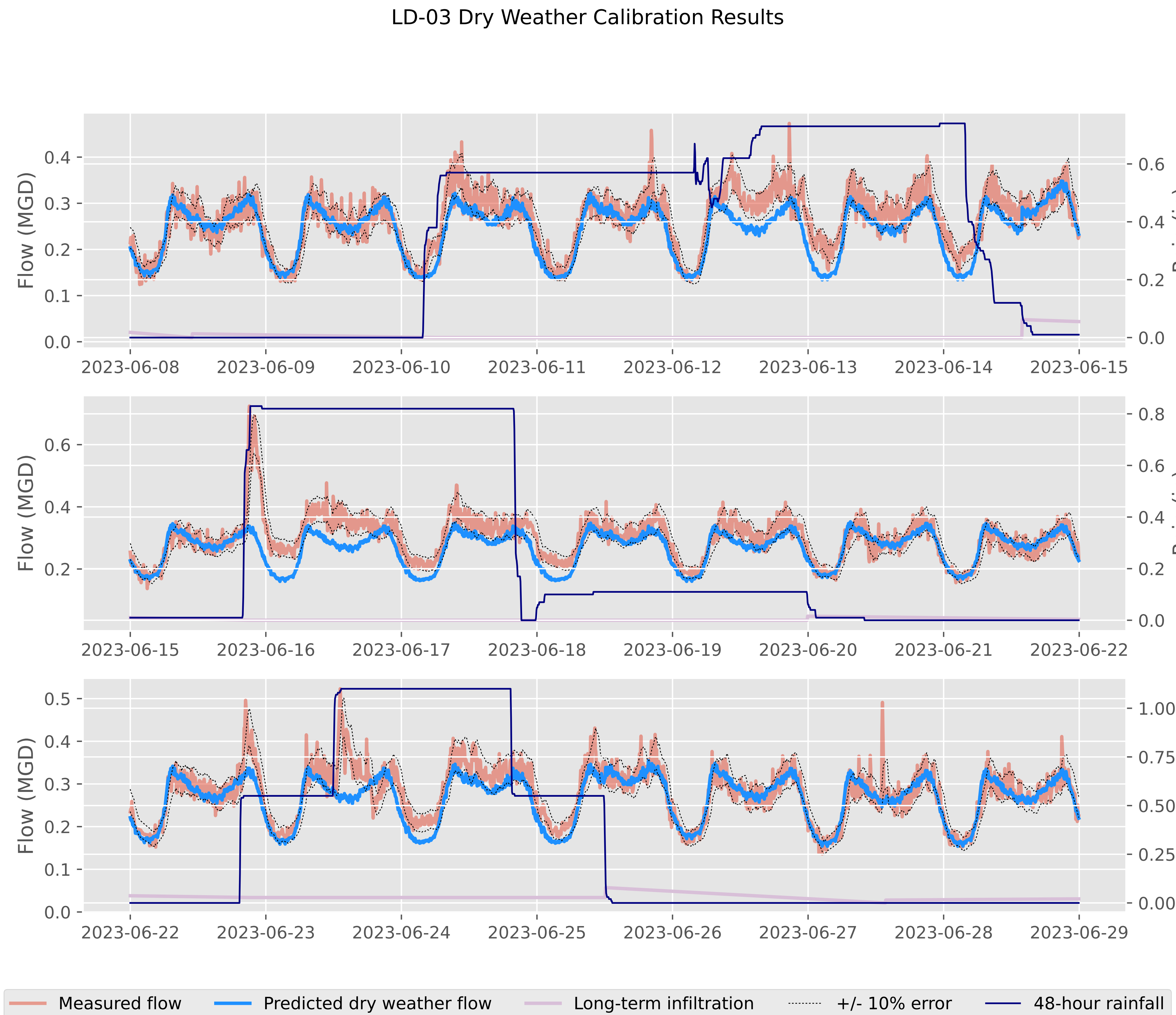

LD-02 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.0
0.2
0.4
0.6
0.8
0.04
0.02
0.00
−0.02
−0.04
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
1.0
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

LD-03 Dry Weather Calibration Results



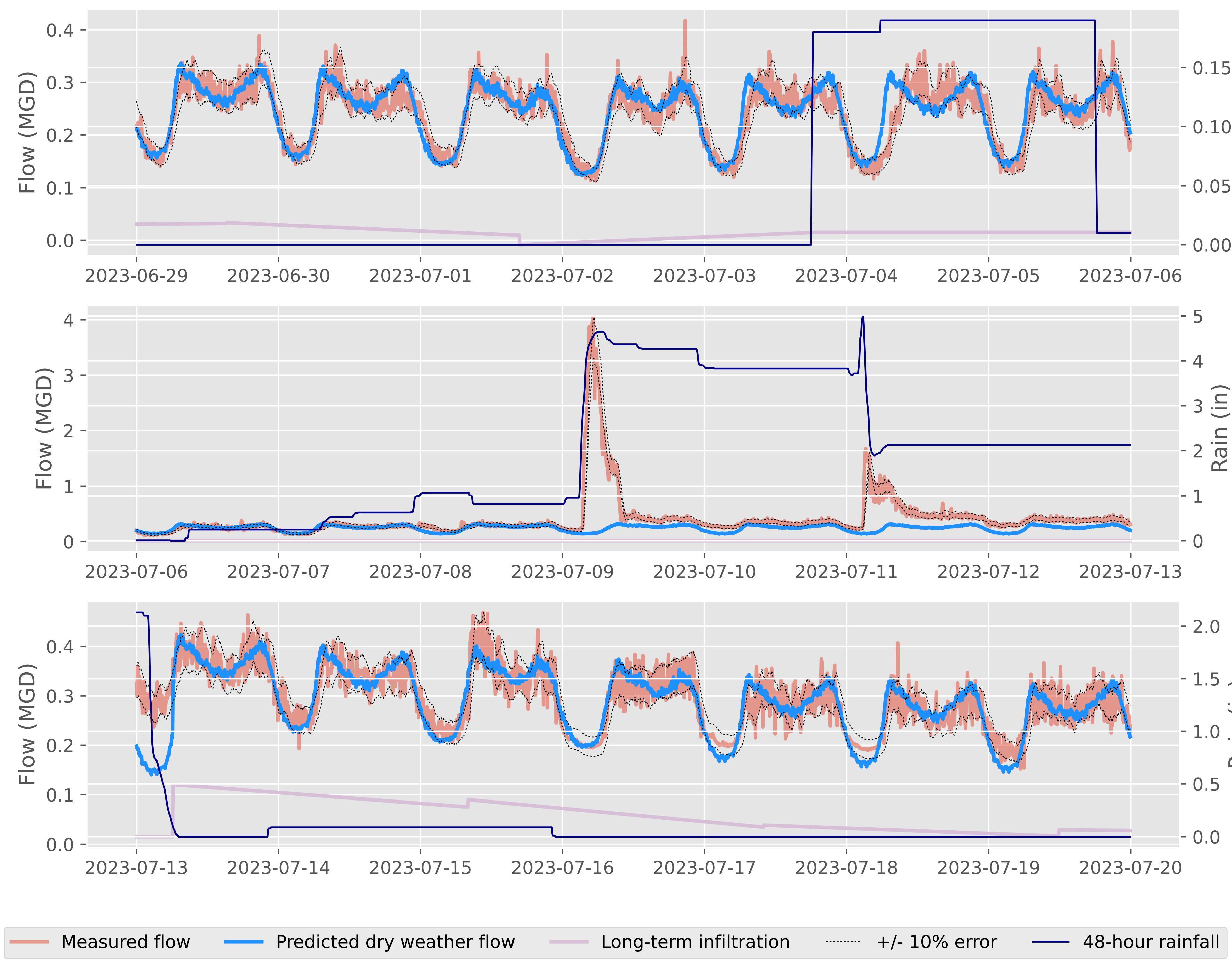
LD-03 Dry Weather Calibration Results

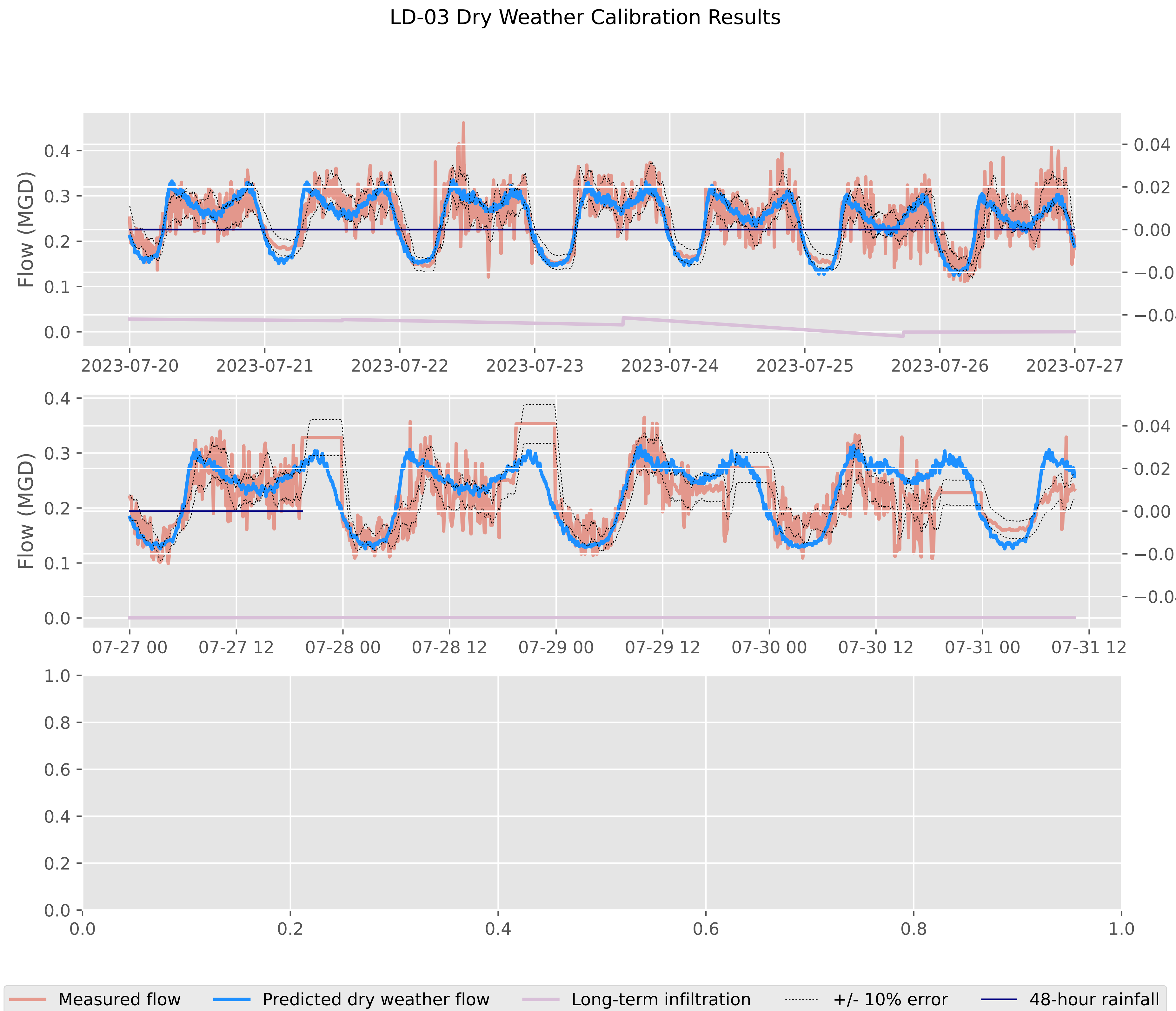




LD-03 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

LD-03 Dry Weather Calibration Results



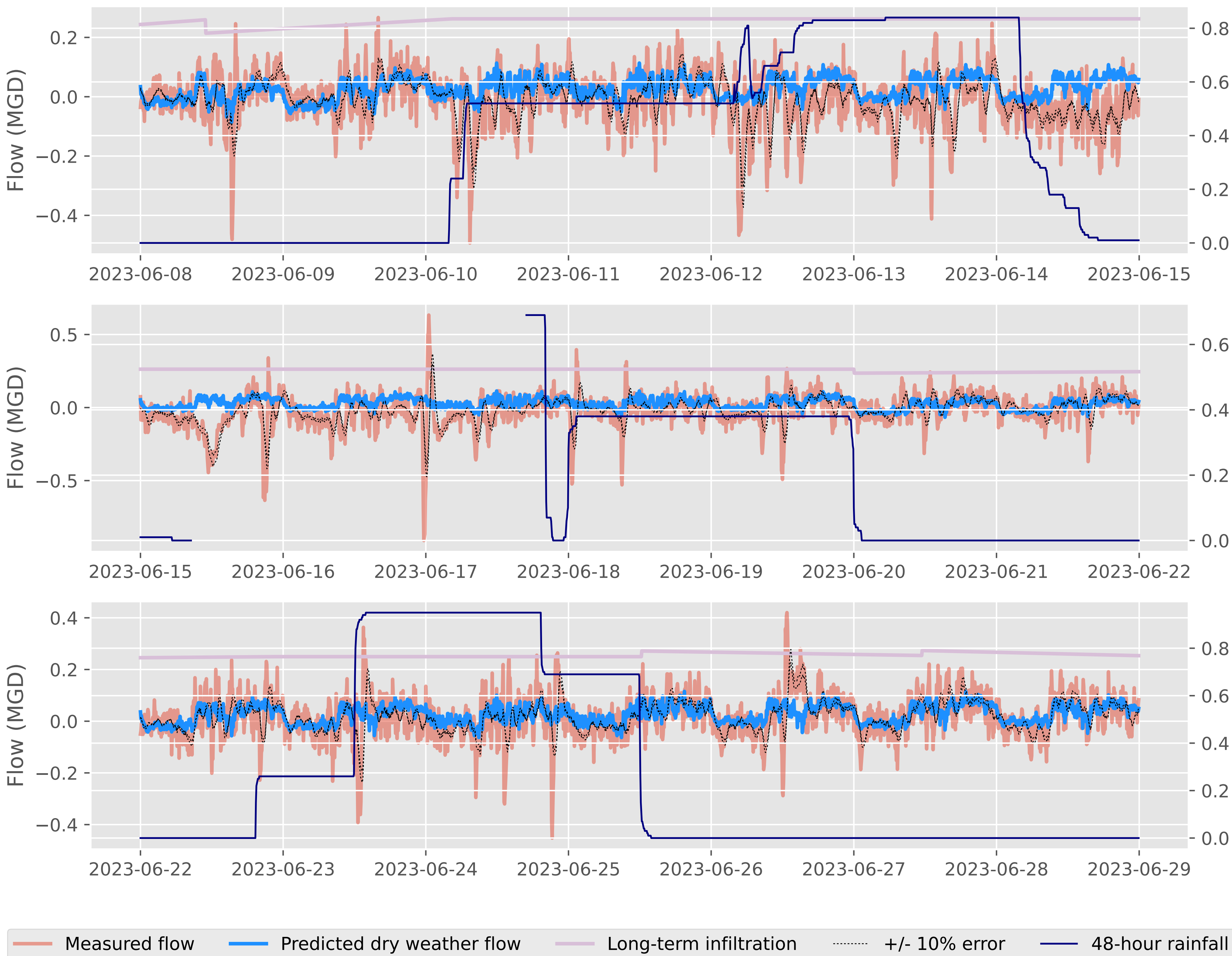


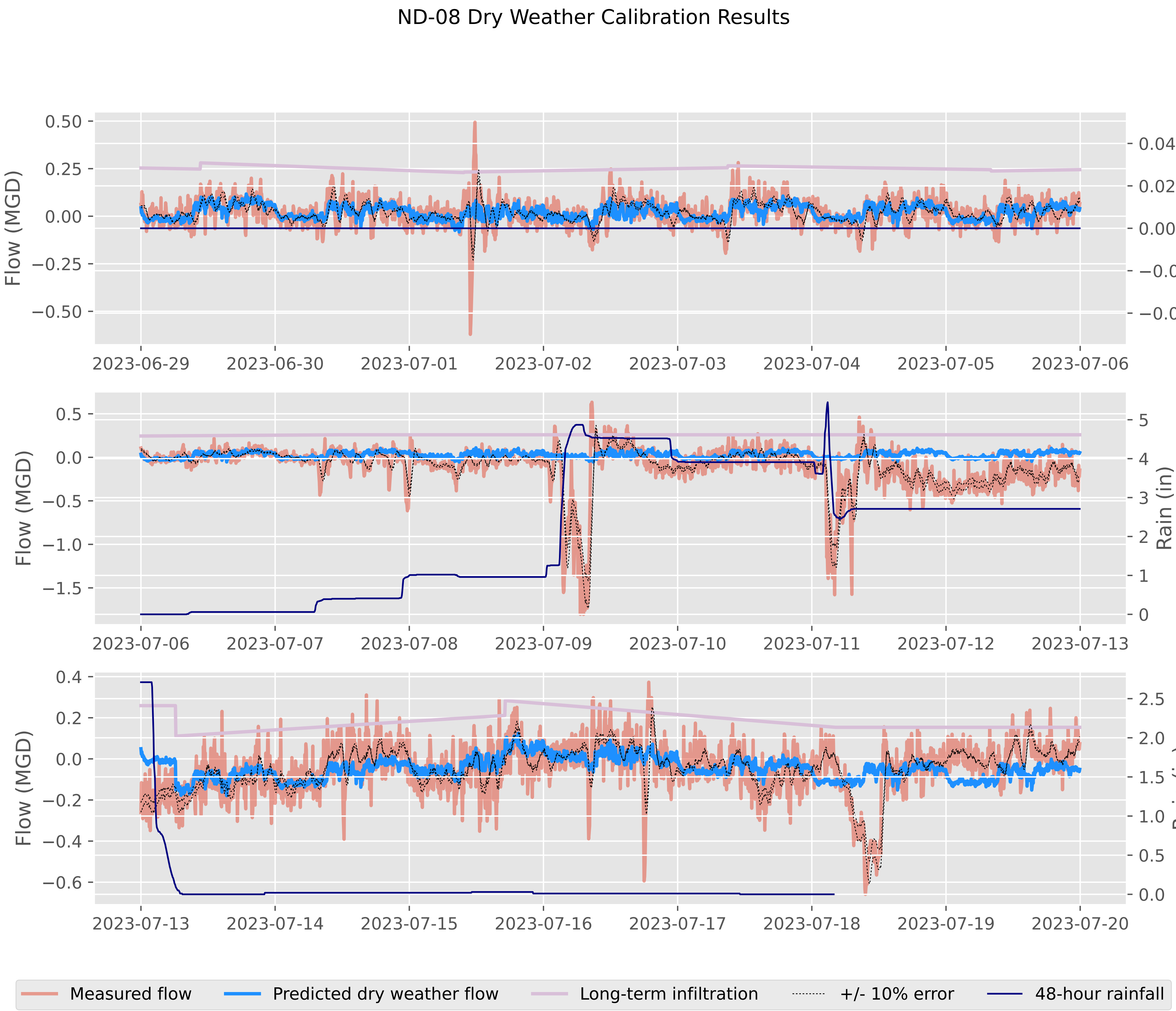
LD-03 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-07-20
2023-07-21
2023-07-22
2023-07-23
2023-07-24
2023-07-25
2023-07-26
2023-07-27
07-27 00
07-27 12
07-28 00
07-28 12
07-29 00
07-29 12
07-30 00
07-30 12
07-31 00
07-31 12
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

ND-08 Dry Weather Calibration Results

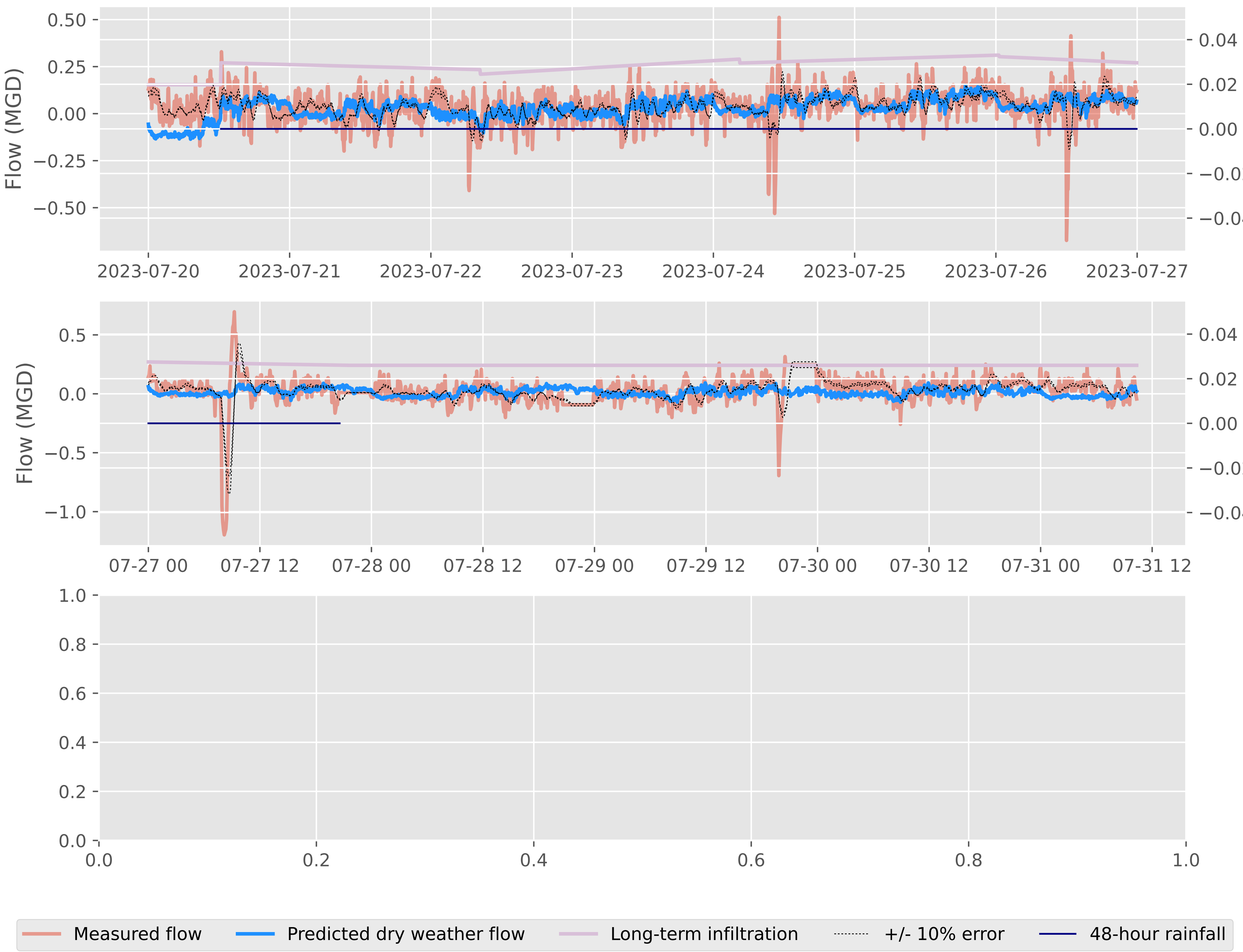
ND-08 Dry Weather Calibration Results

ND-08 Dry Weather Calibration Results

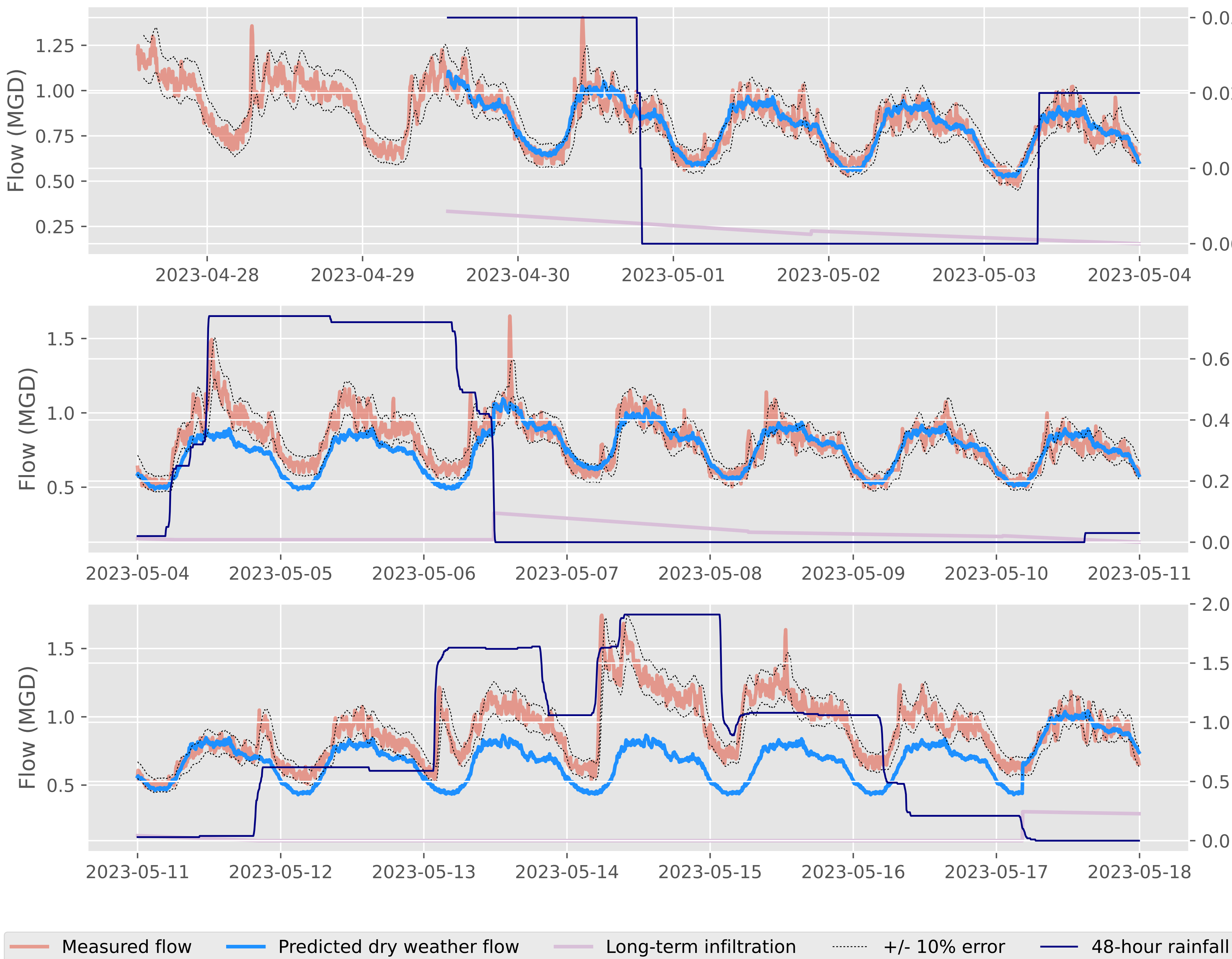



ND-08 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.50
0.25
0.00
−0.25
−0.50
0.04
0.02
0.00
−0.02
−0.04
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
0.5
0.0
−0.5
−1.0
−1.5
5
4
3
2
1
0
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
0.4
0.2
0.0
−0.2
−0.4
−0.6
2.5
2.0
1.5
1.0
0.5
0.0
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

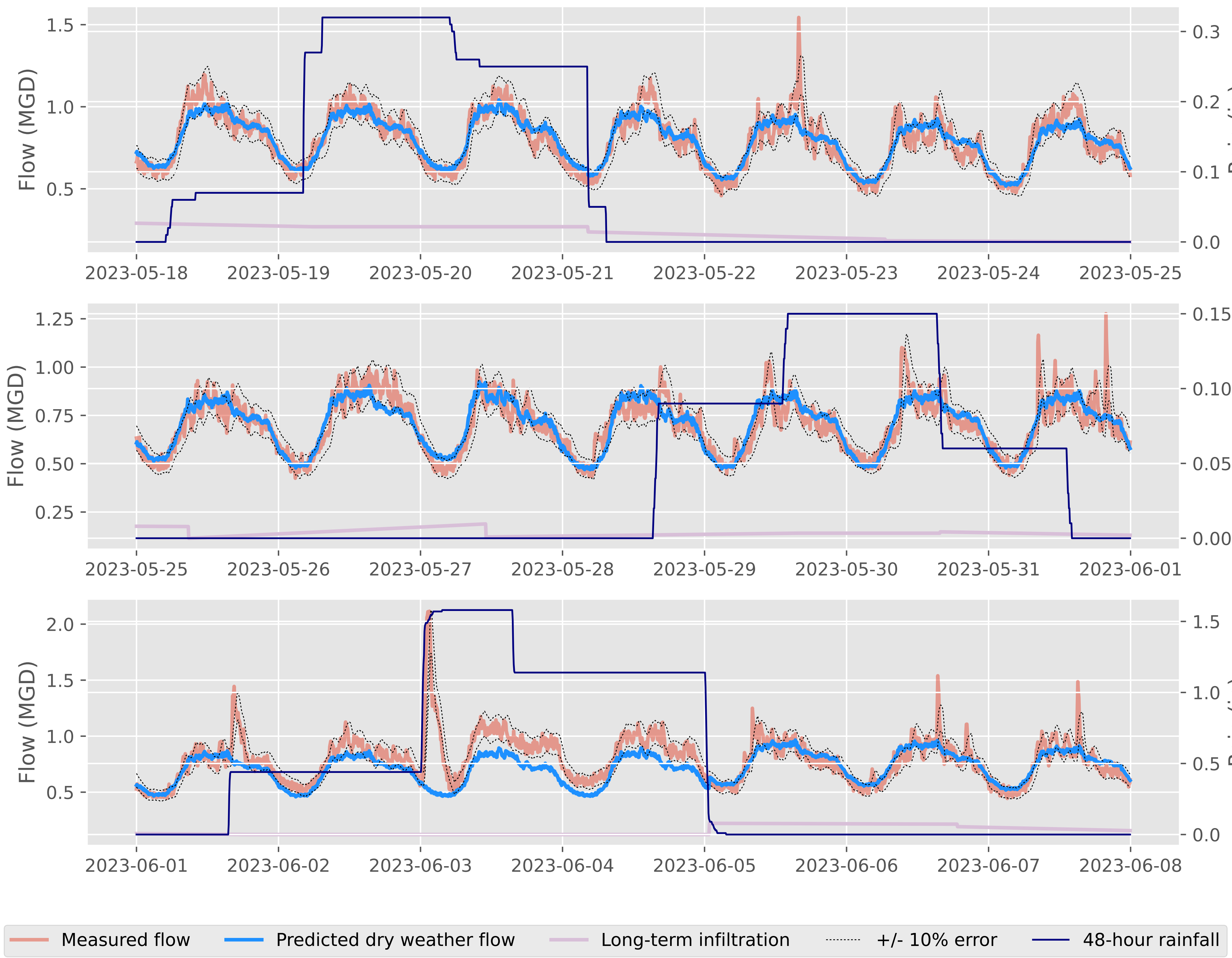
ND-08 Dry Weather Calibration Results

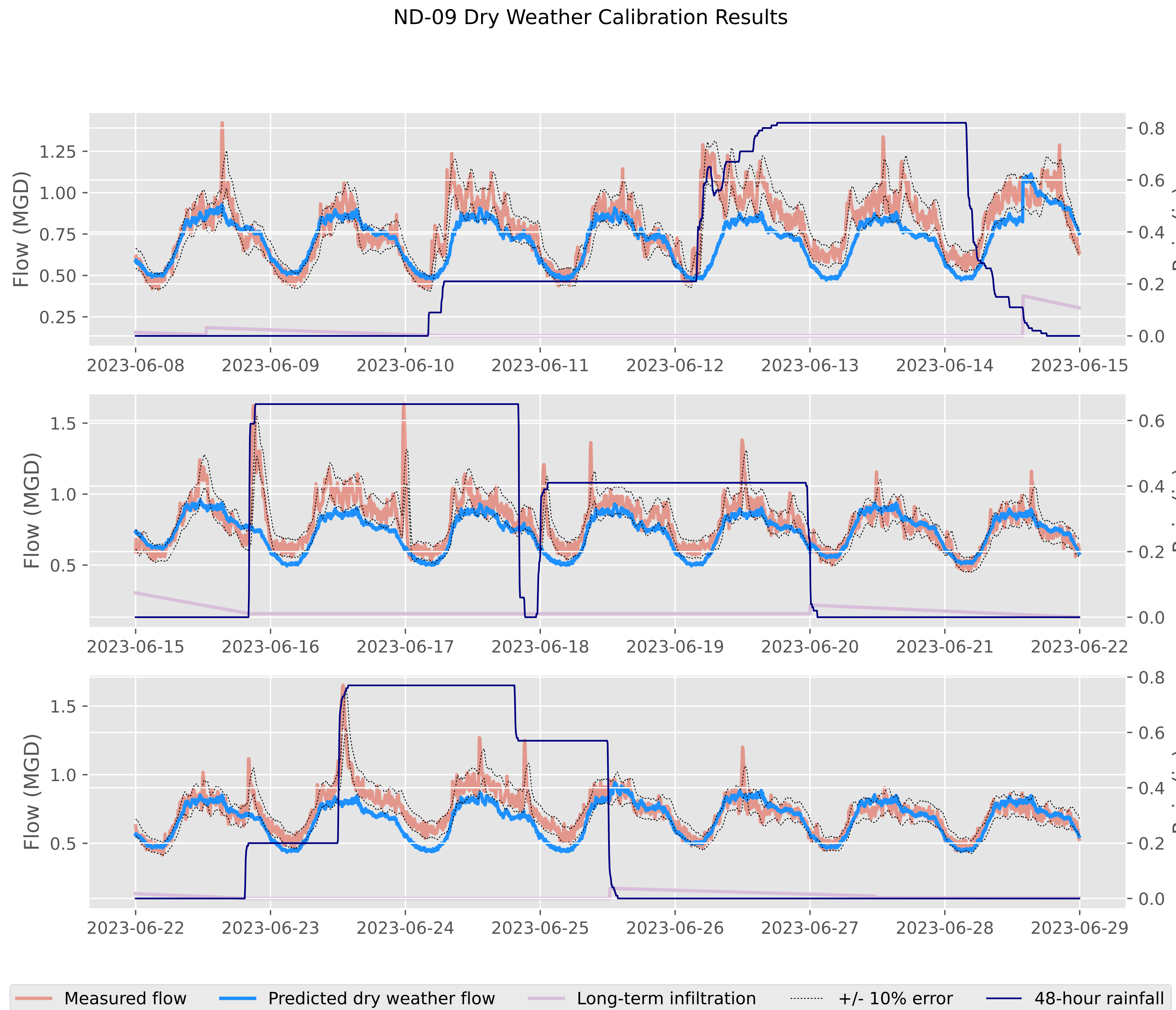


ND-09 Dry Weather Calibration Results

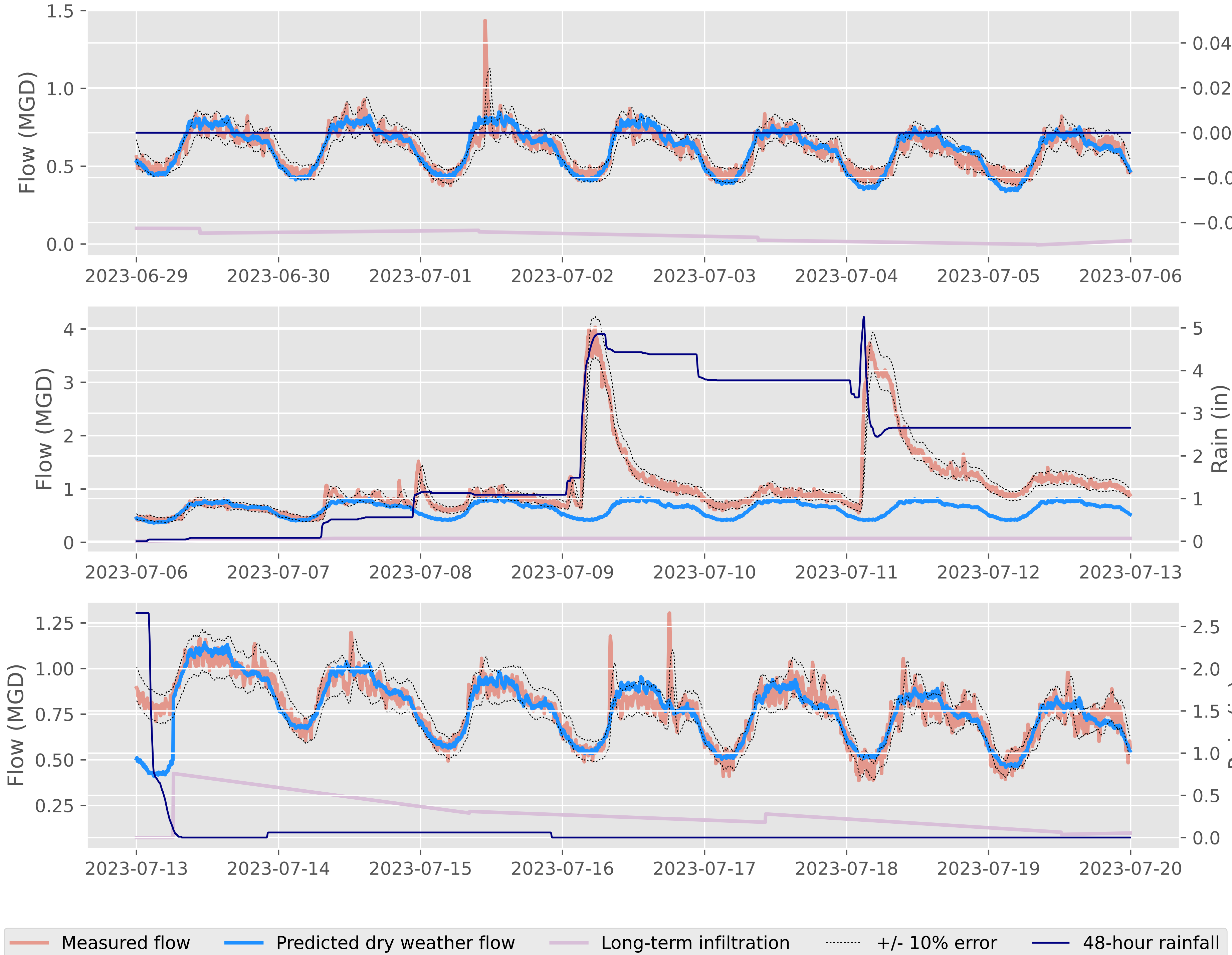


ND-09 Dry Weather Calibration Results

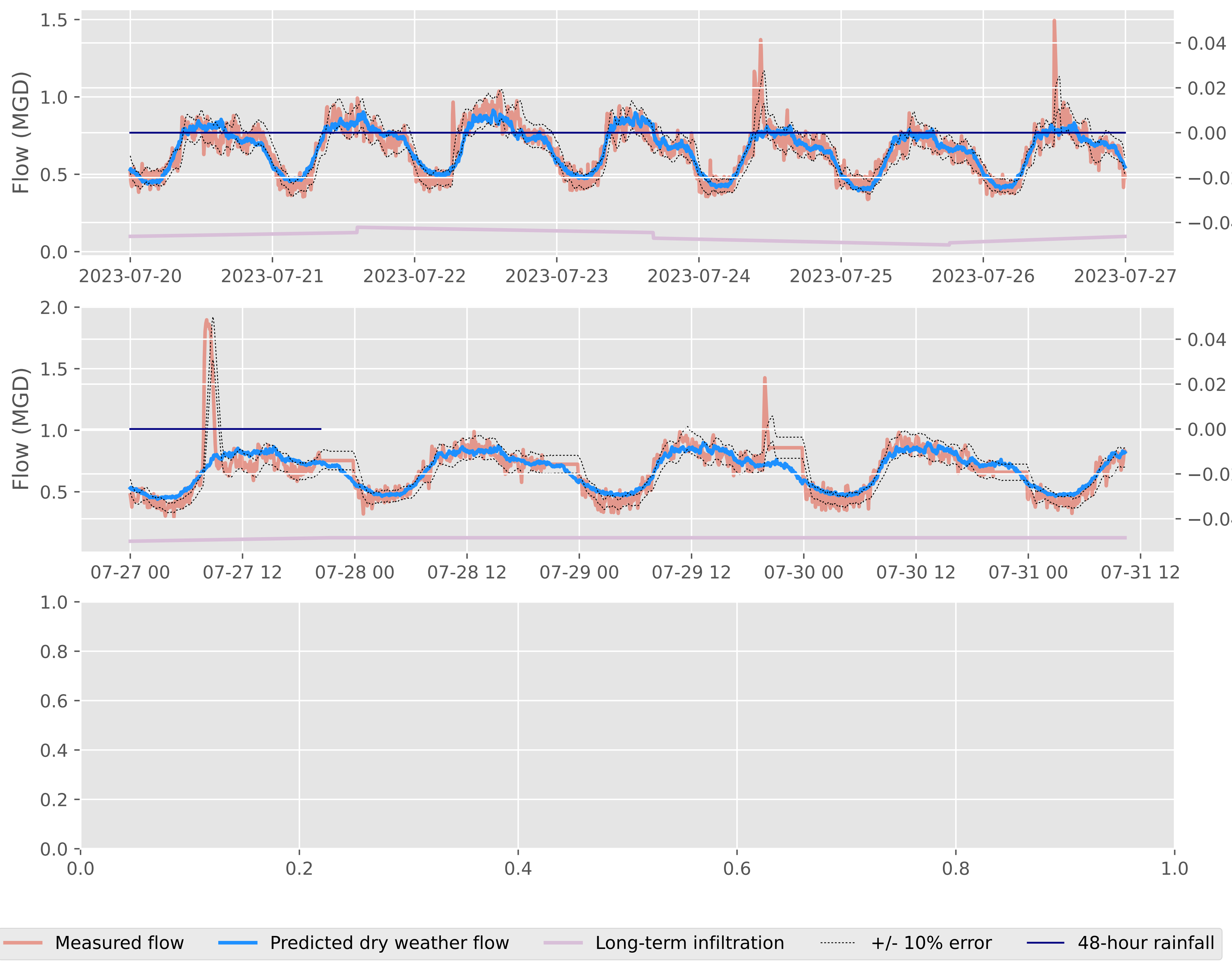


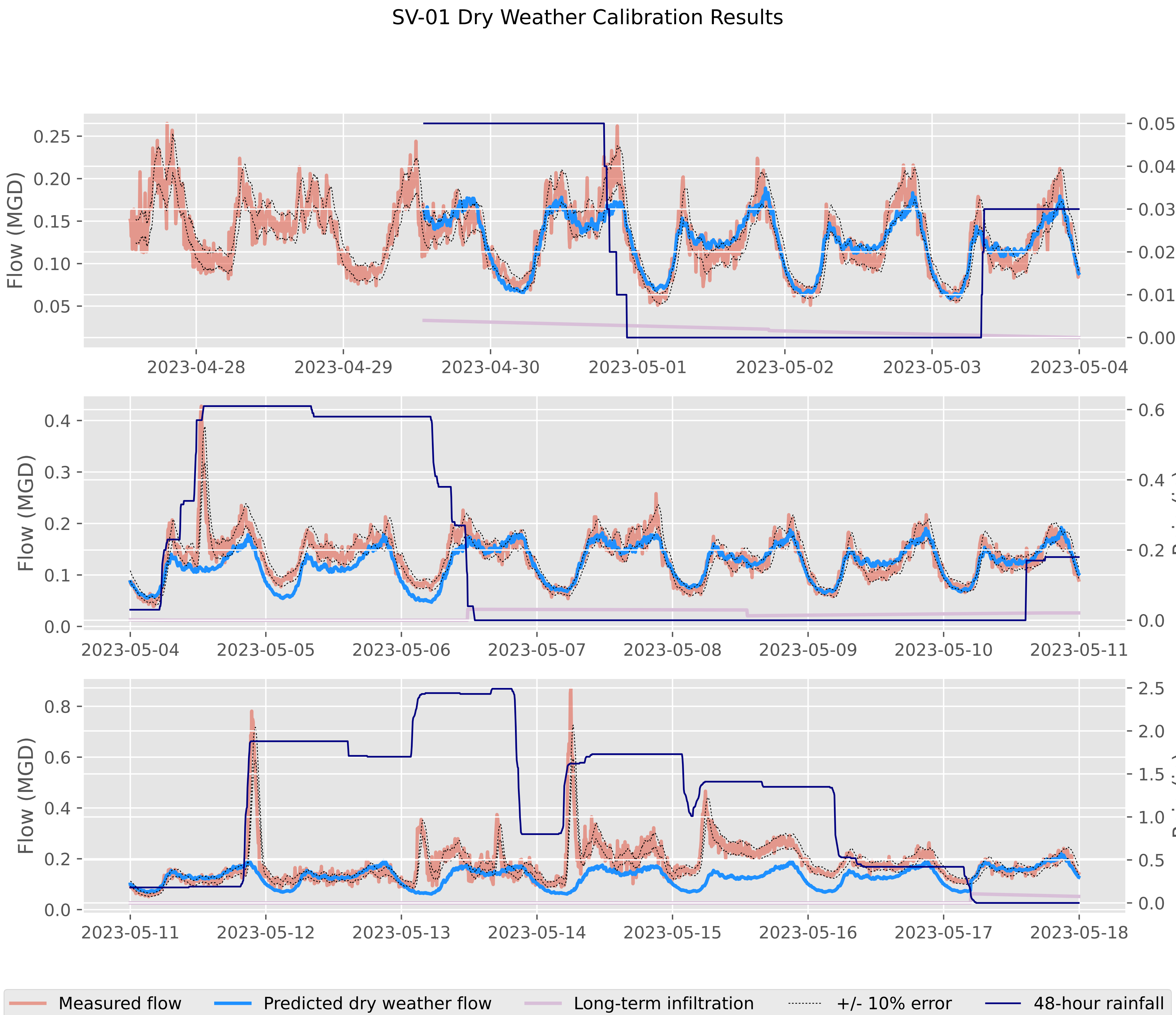

ND-09 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
1.25
1.00
0.75
0.50
0.25
0.8
0.6
0.4
0.2
0.0
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
1.5
1.0
0.5
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

ND-09 Dry Weather Calibration Results

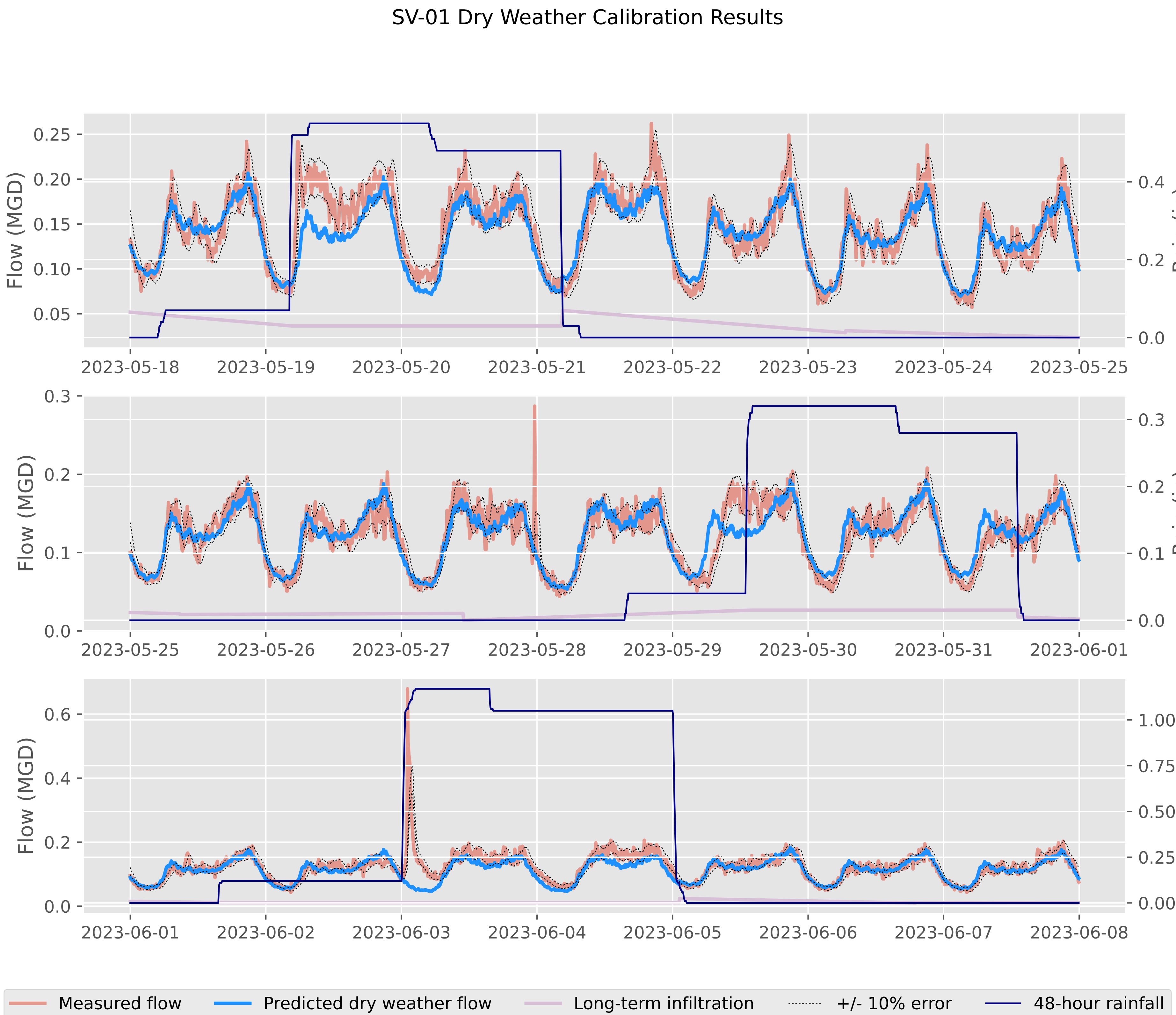


ND-09 Dry Weather Calibration Results



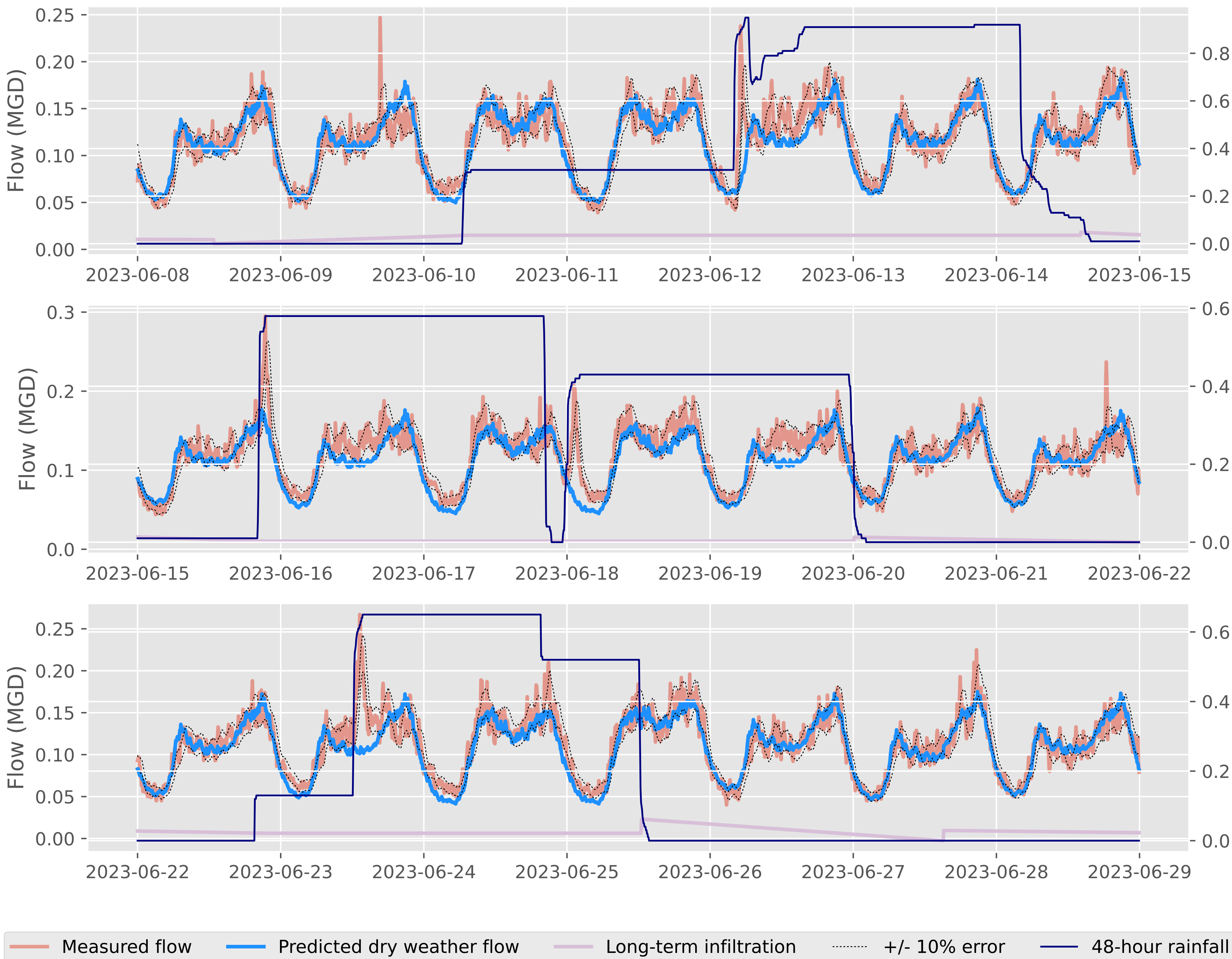


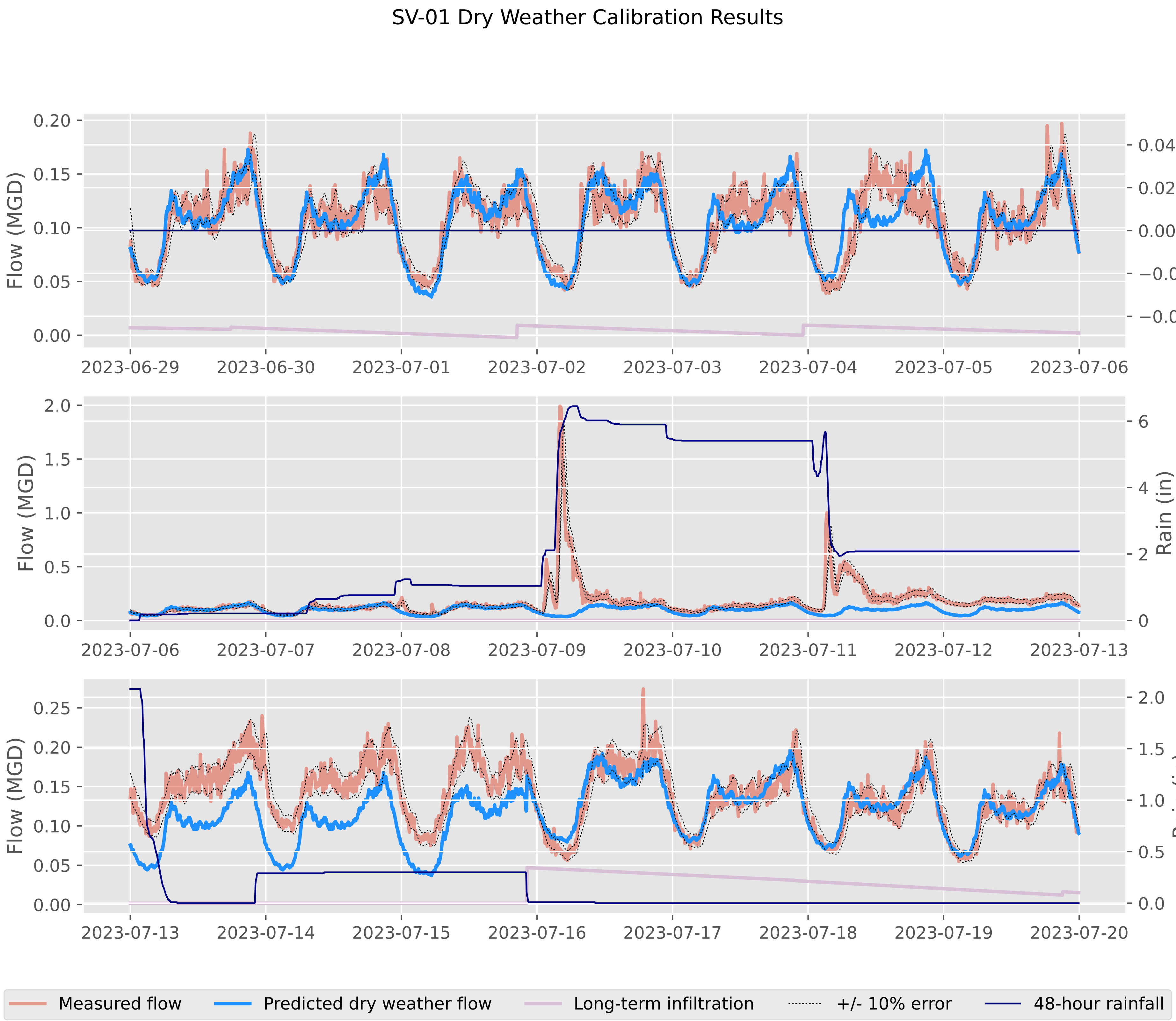
SV-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall



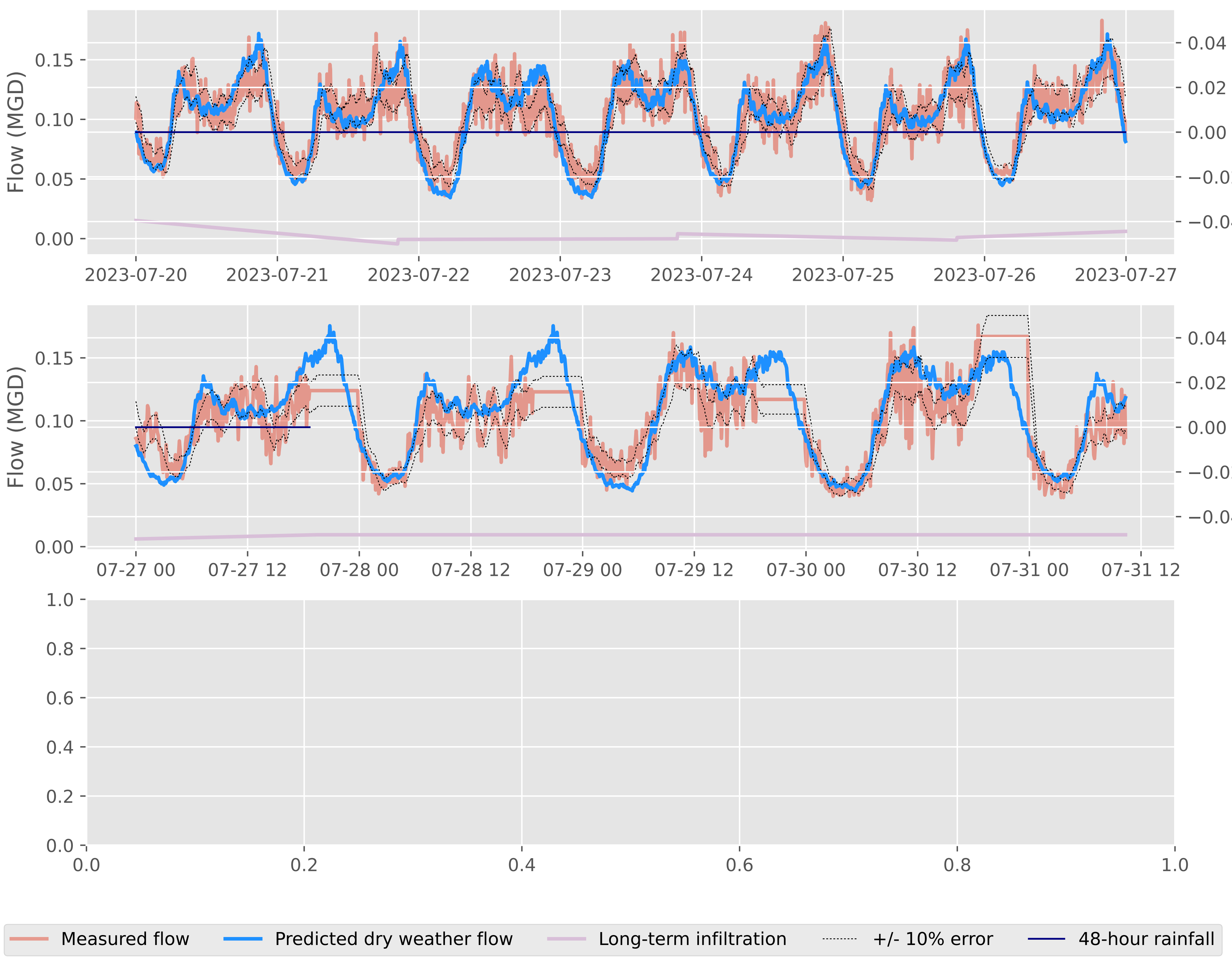
SV-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.25
0.20
0.15
0.10
0.05
0.4
0.2
0.0
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
0.3
0.2
0.1
0.0
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
0.6
0.4
0.2
0.0
1.00
0.75
0.50
0.25
0.00
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

SV-01 Dry Weather Calibration Results

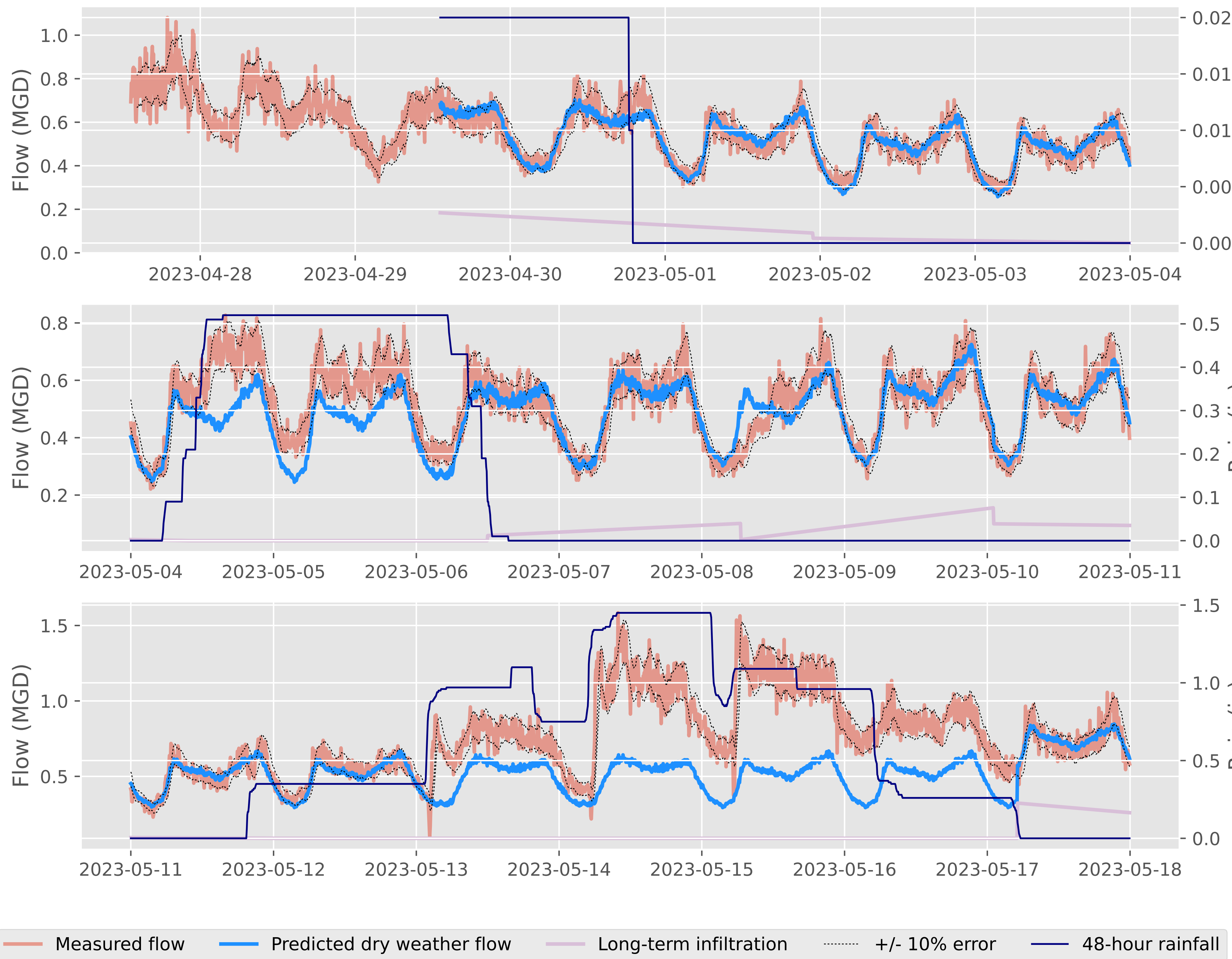


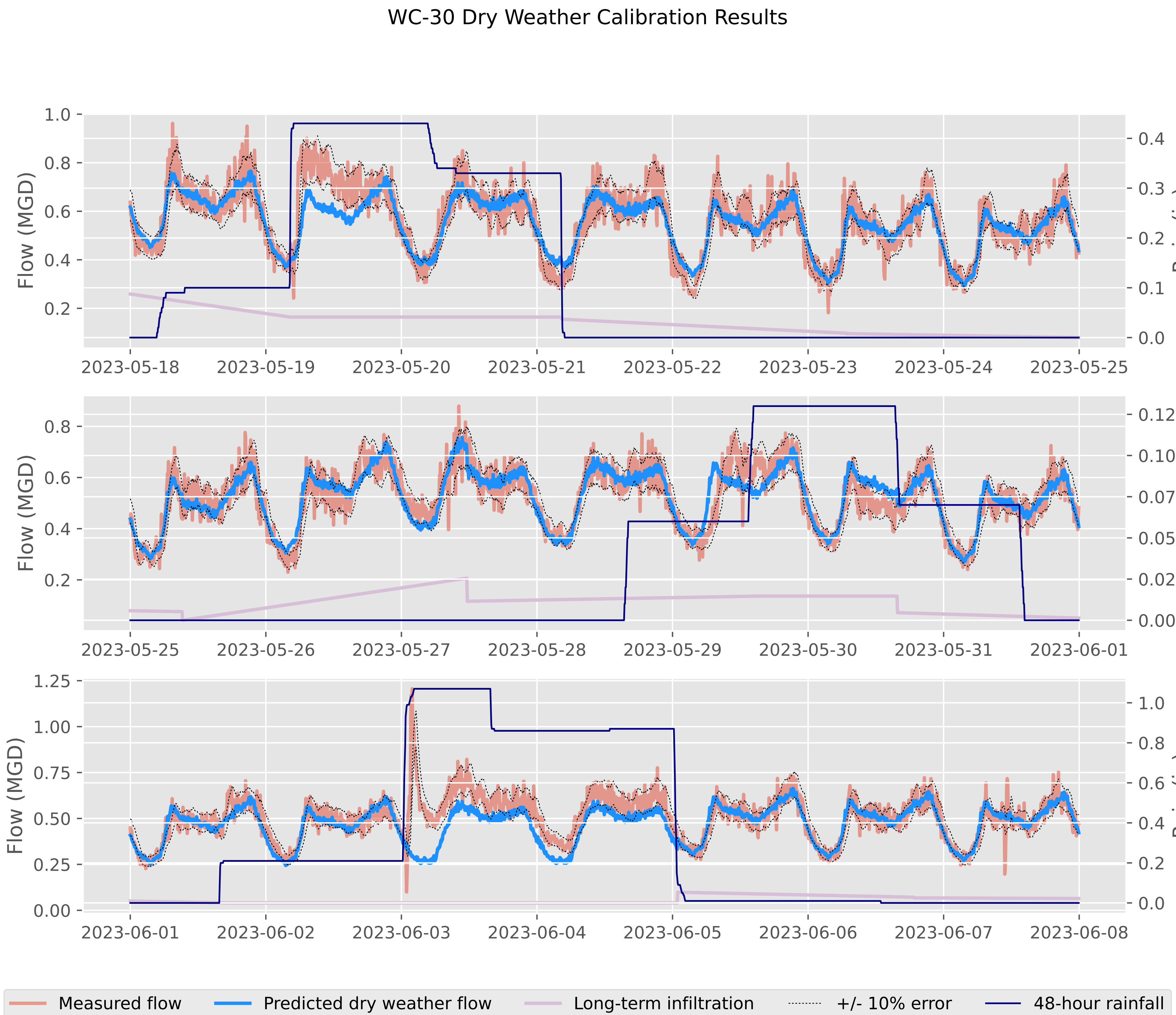

SV-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.00
0.05
0.10
0.15
0.20
−0.04
−0.02
0.00
0.02
0.04
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
0.0
0.5
1.0
1.5
2.0
0
2
4
6
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
0.25
0.5
1.0
1.5
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

SV-01 Dry Weather Calibration Results



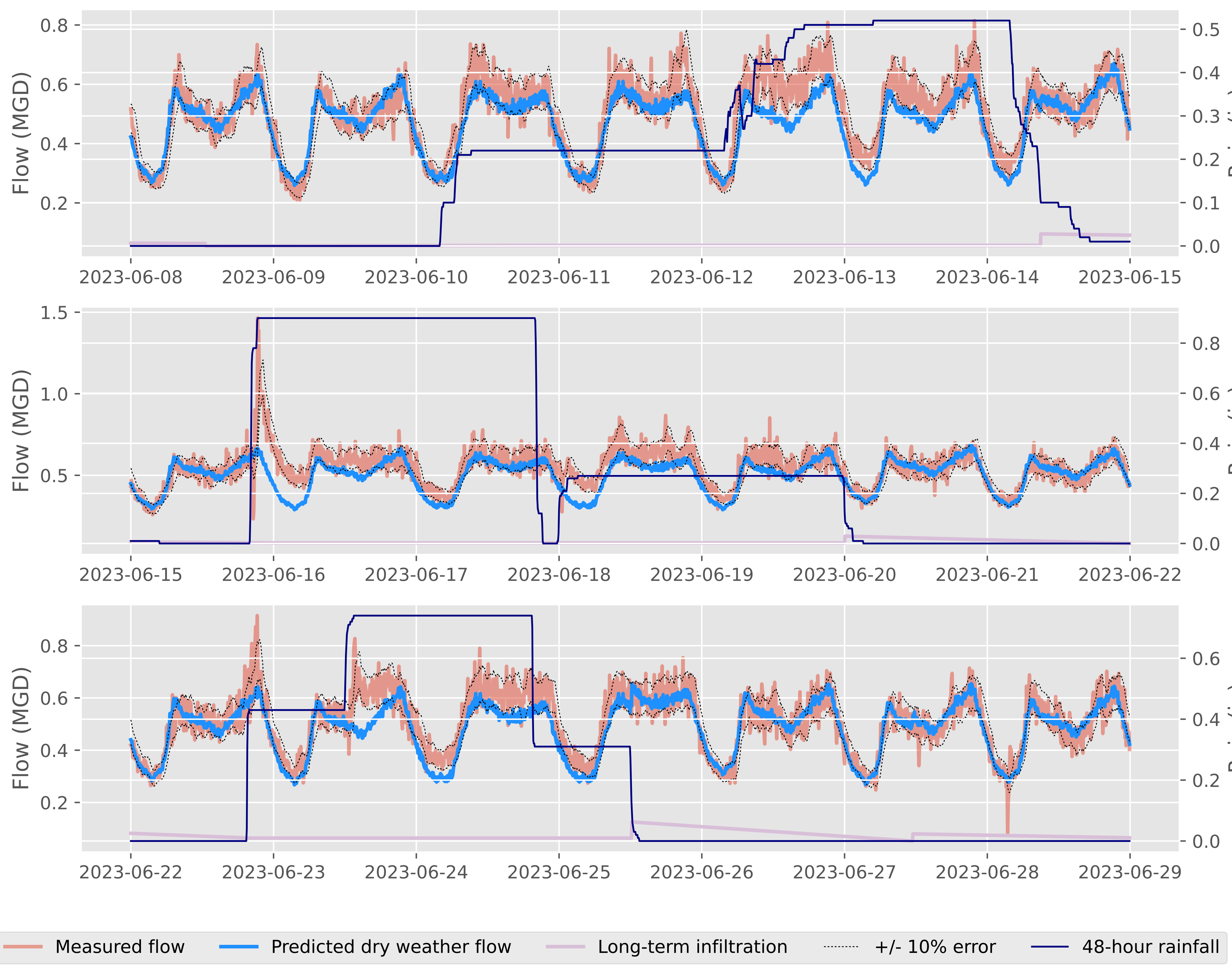
WC-30 Dry Weather Calibration Results



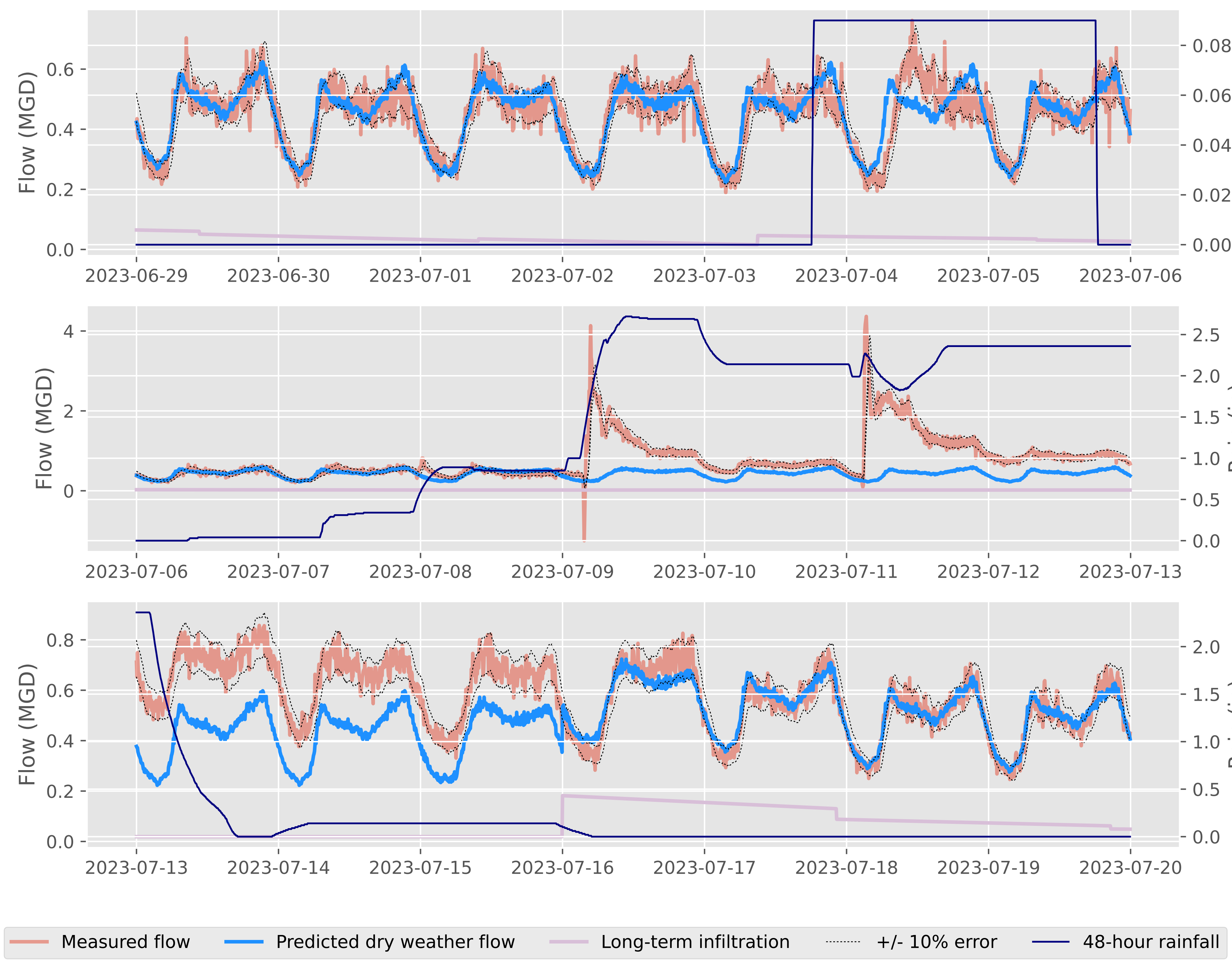


WC-30 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

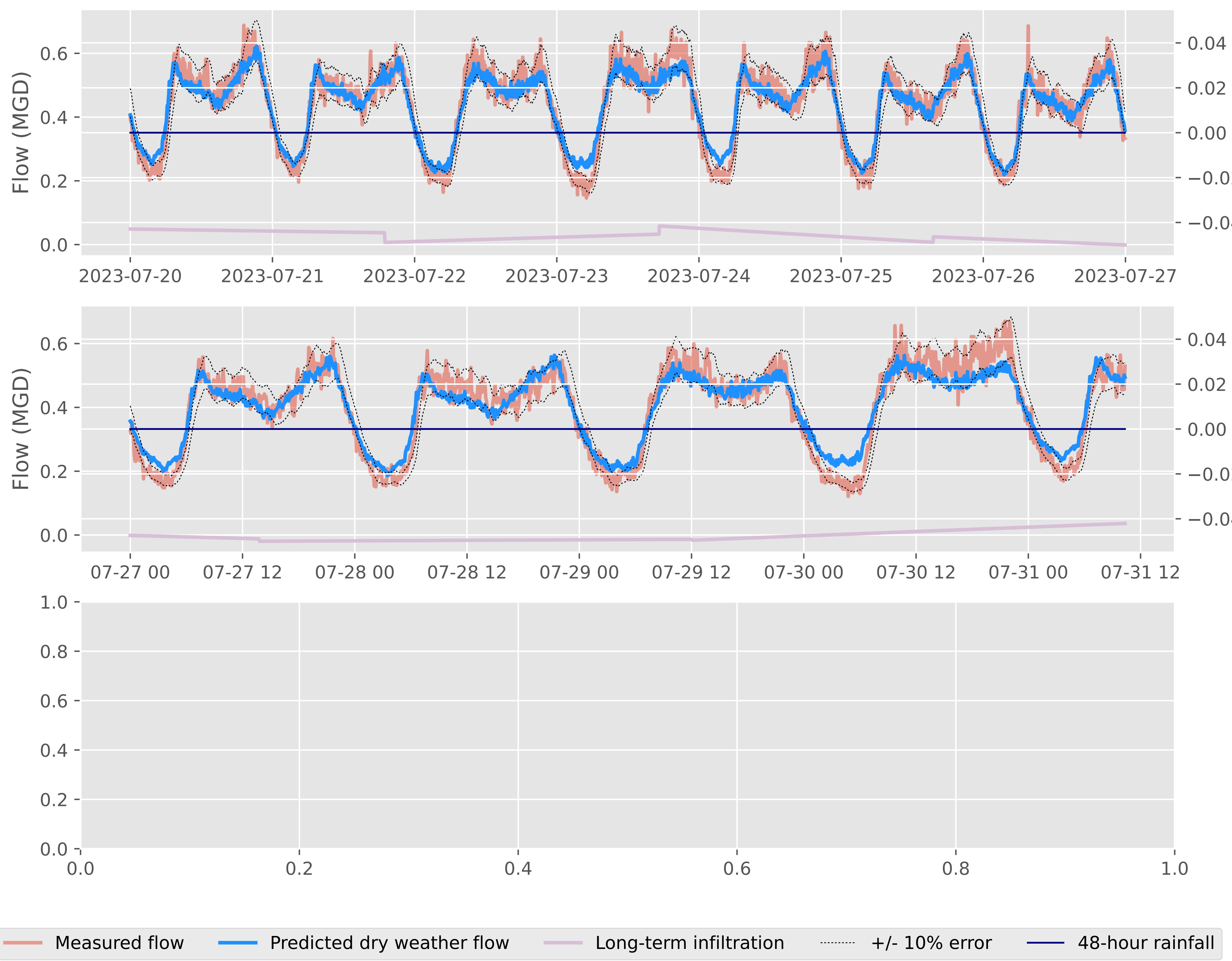
WC-30 Dry Weather Calibration Results

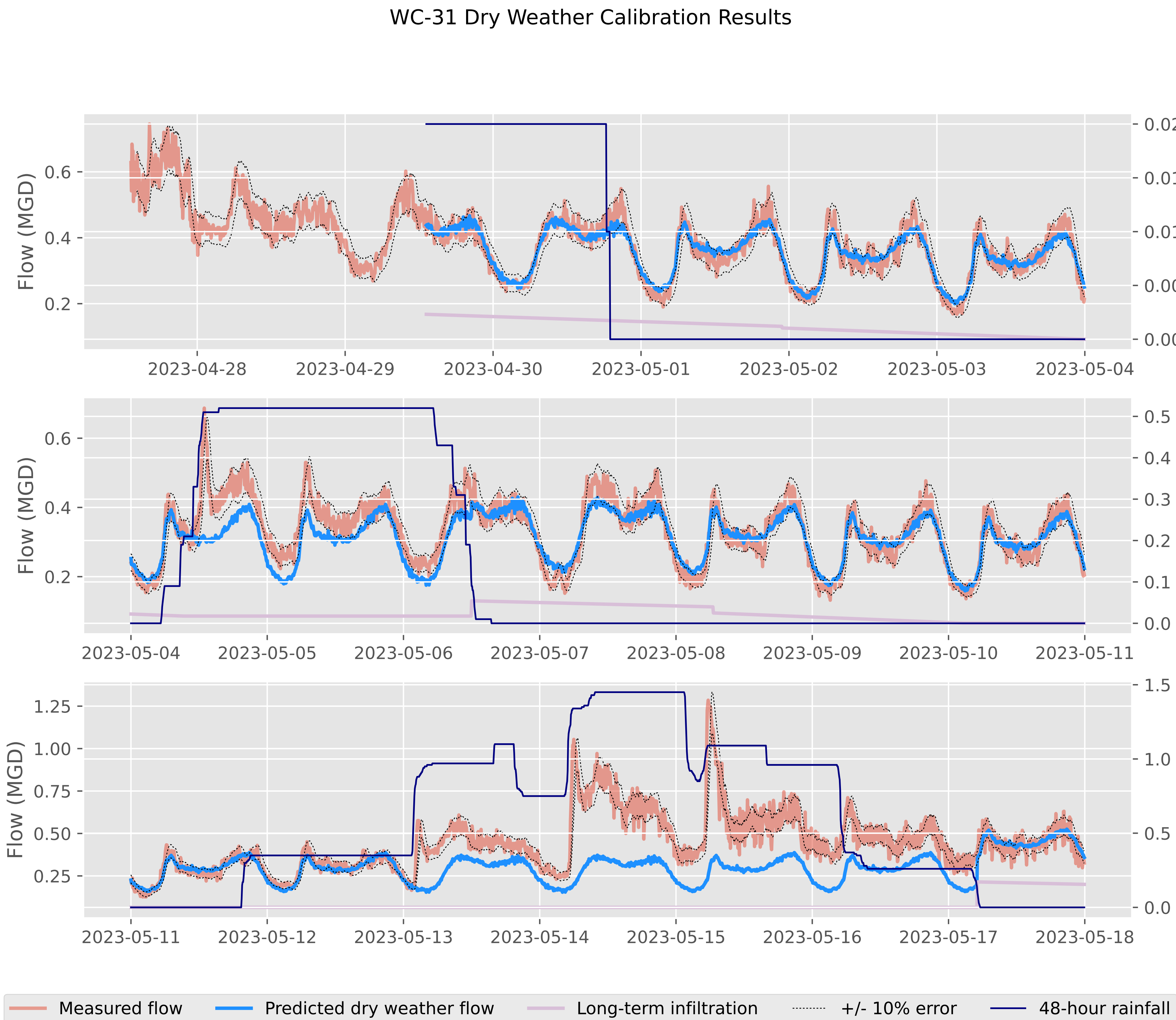


WC-30 Dry Weather Calibration Results

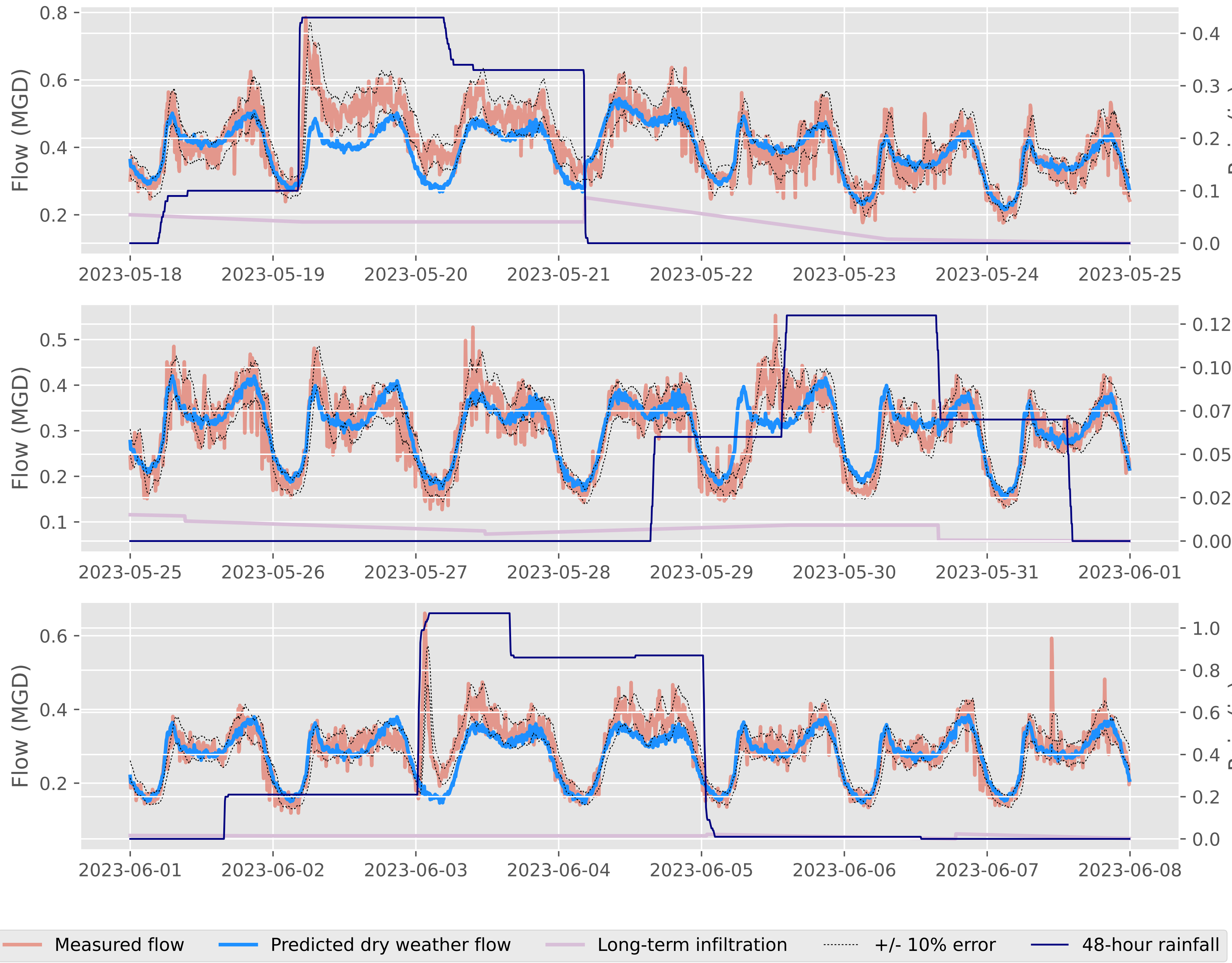


WC-30 Dry Weather Calibration Results

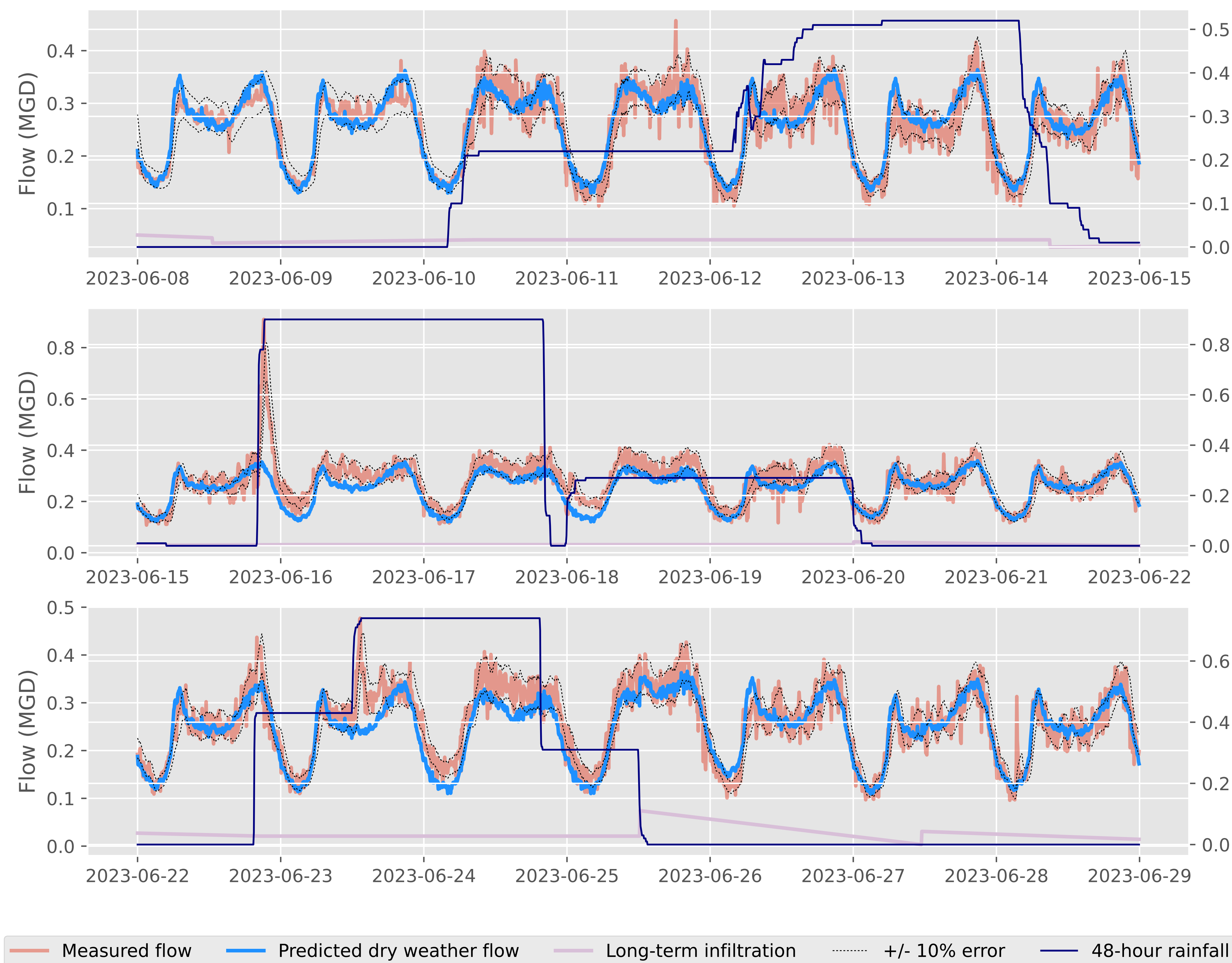


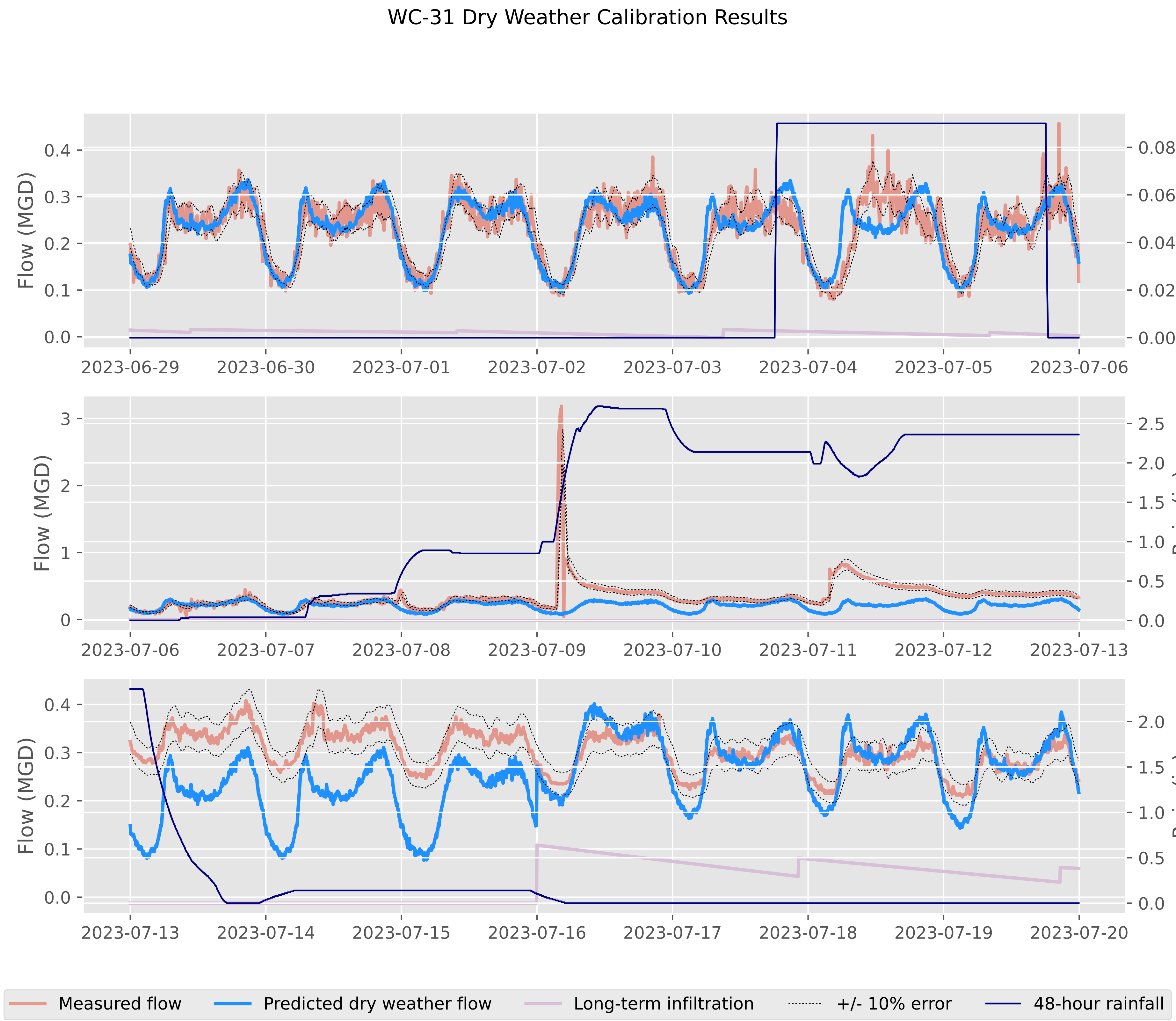

WC-31 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

WC-31 Dry Weather Calibration Results



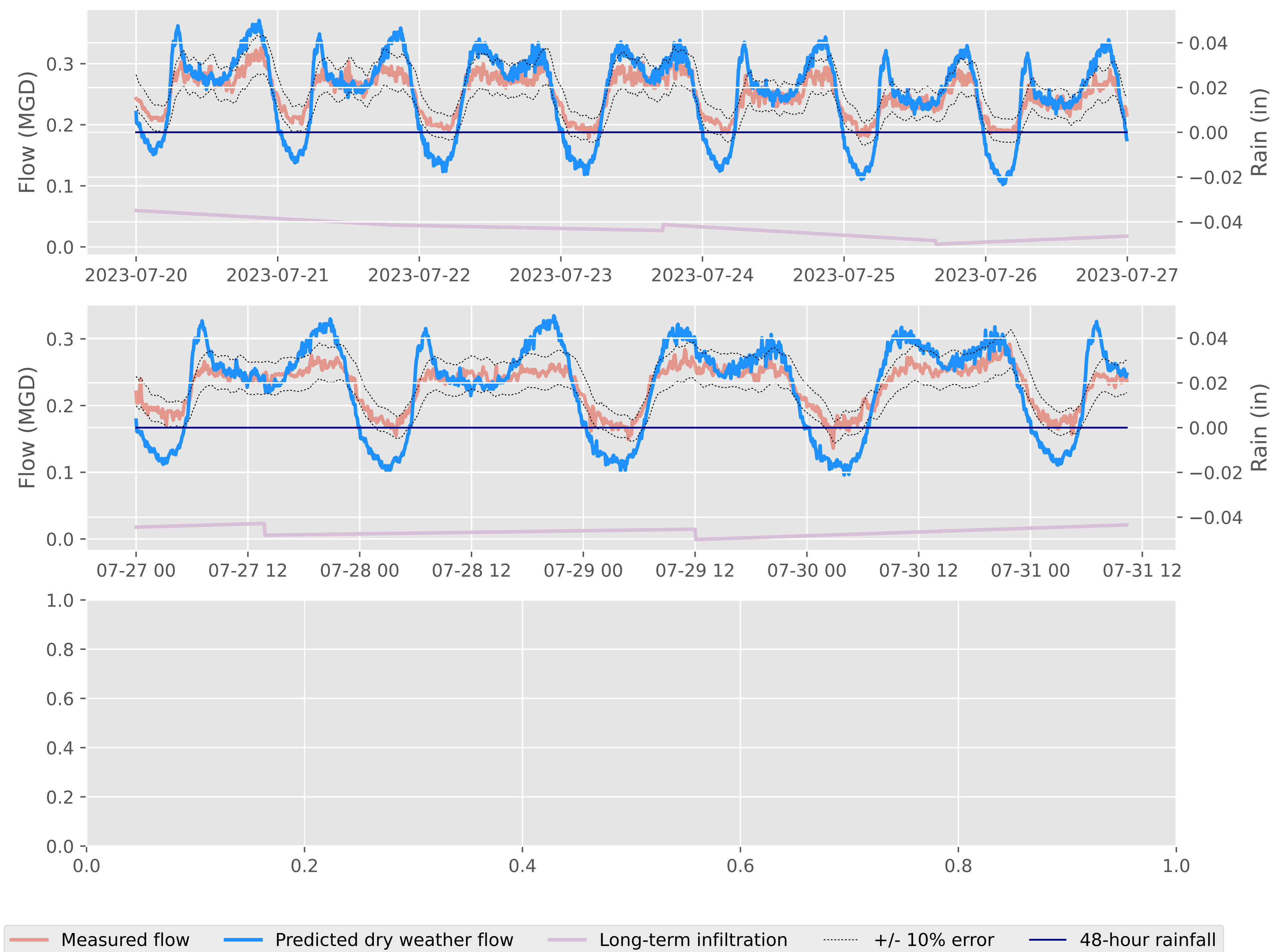
WC-31 Dry Weather Calibration Results

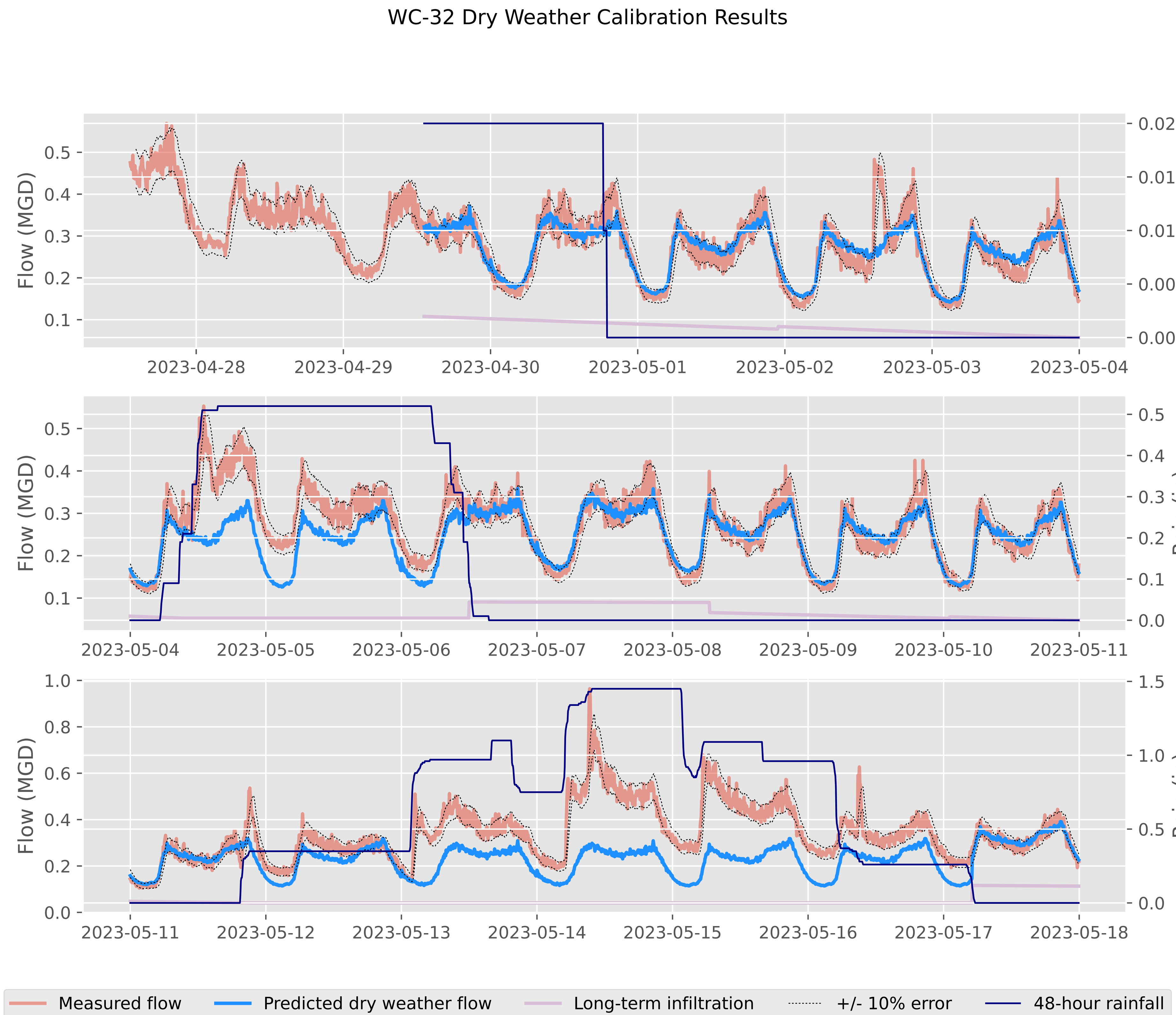




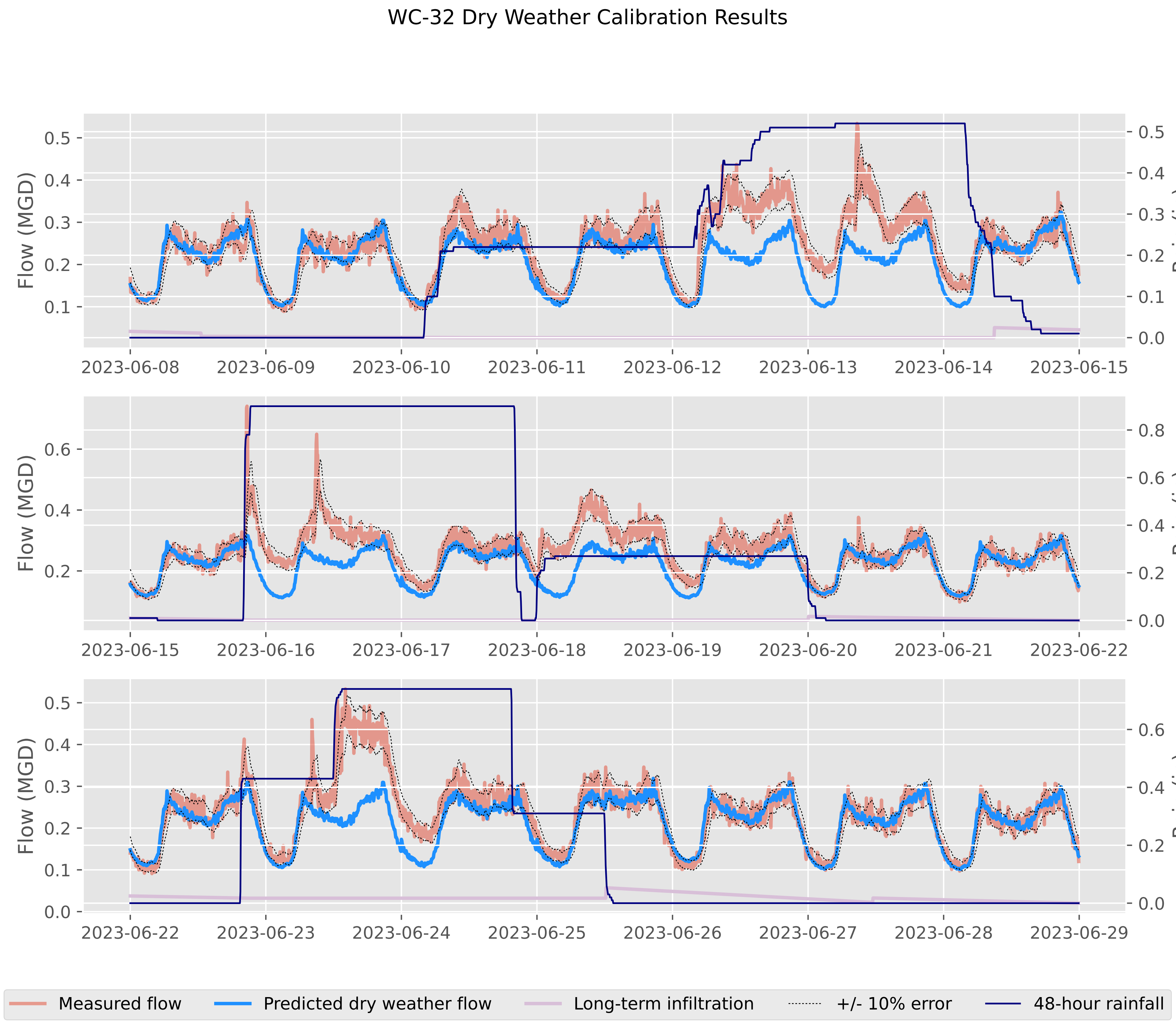
WC-31 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

WC-31 Dry Weather Calibration Results



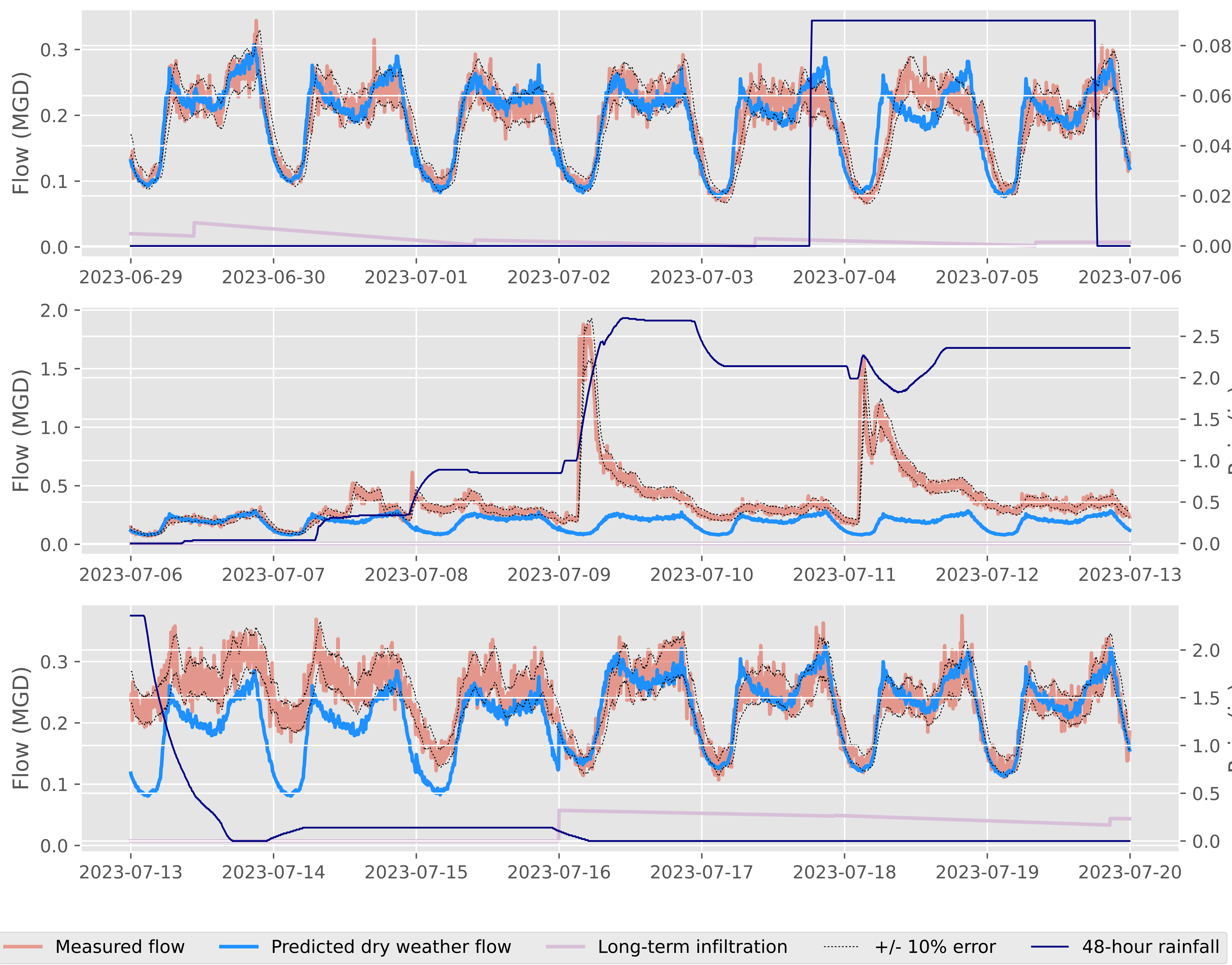

WC-32 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

WC-32 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

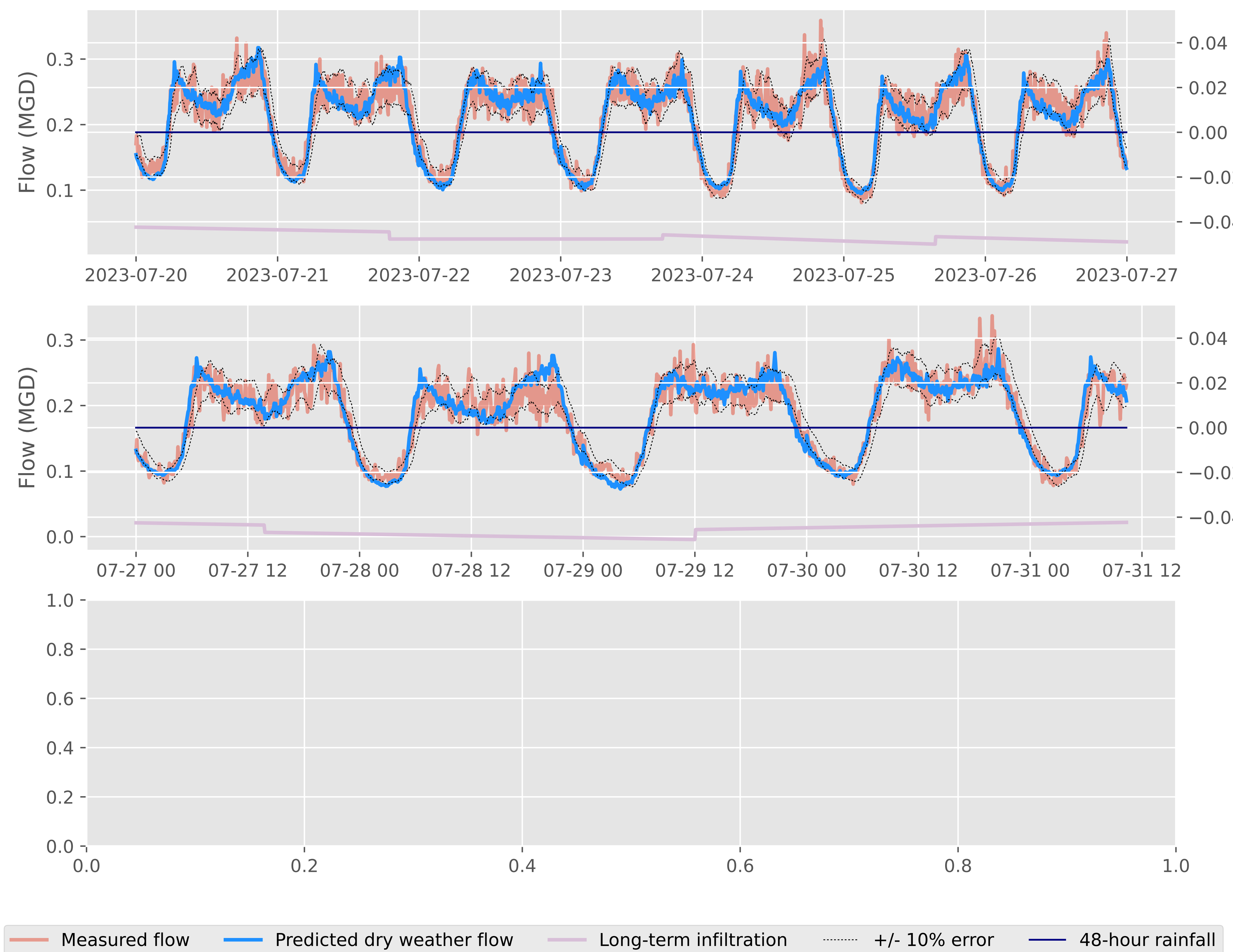


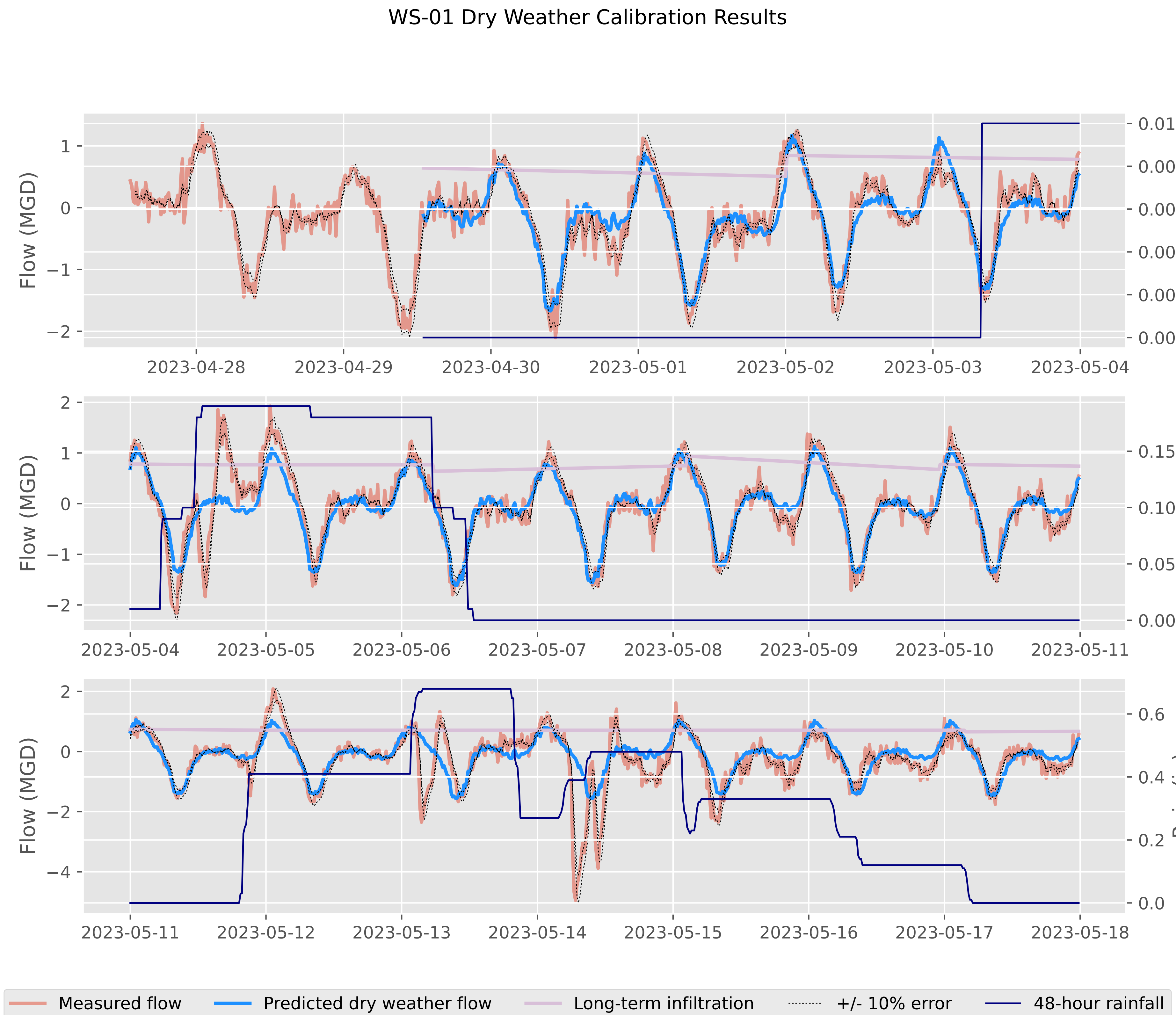
WC-32 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

WC-32 Dry Weather Calibration Results

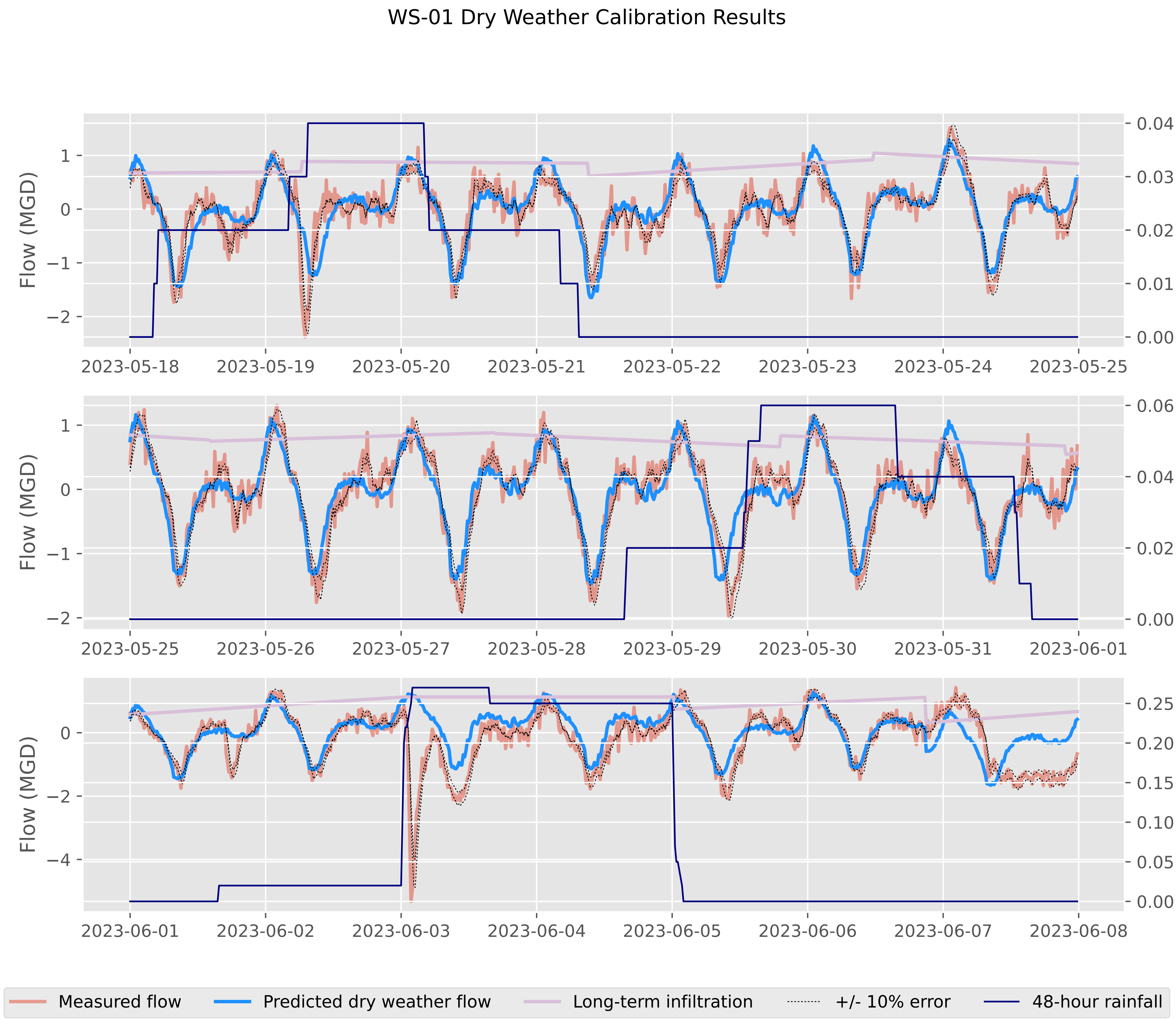


WC-32 Dry Weather Calibration Results

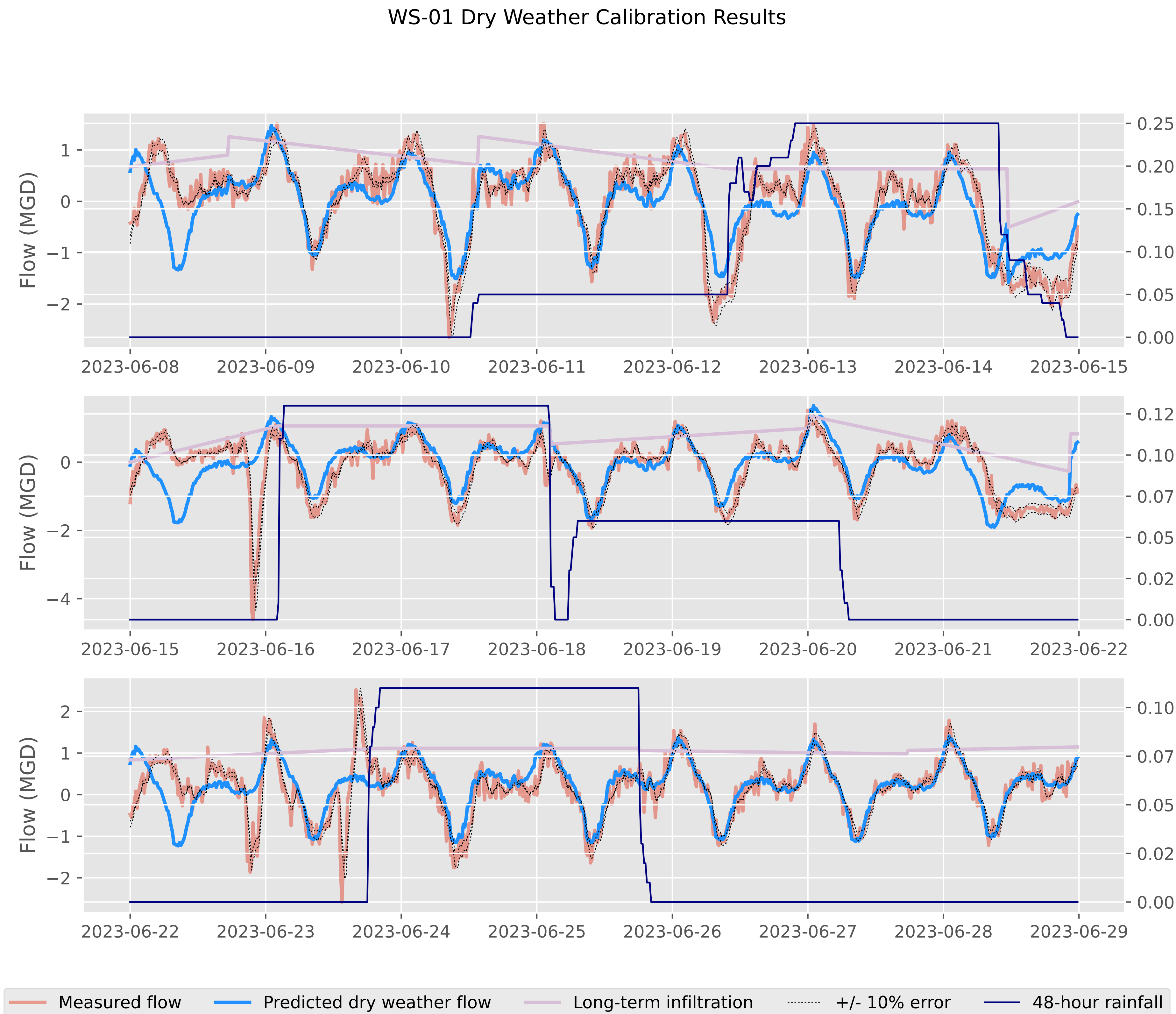




WS-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

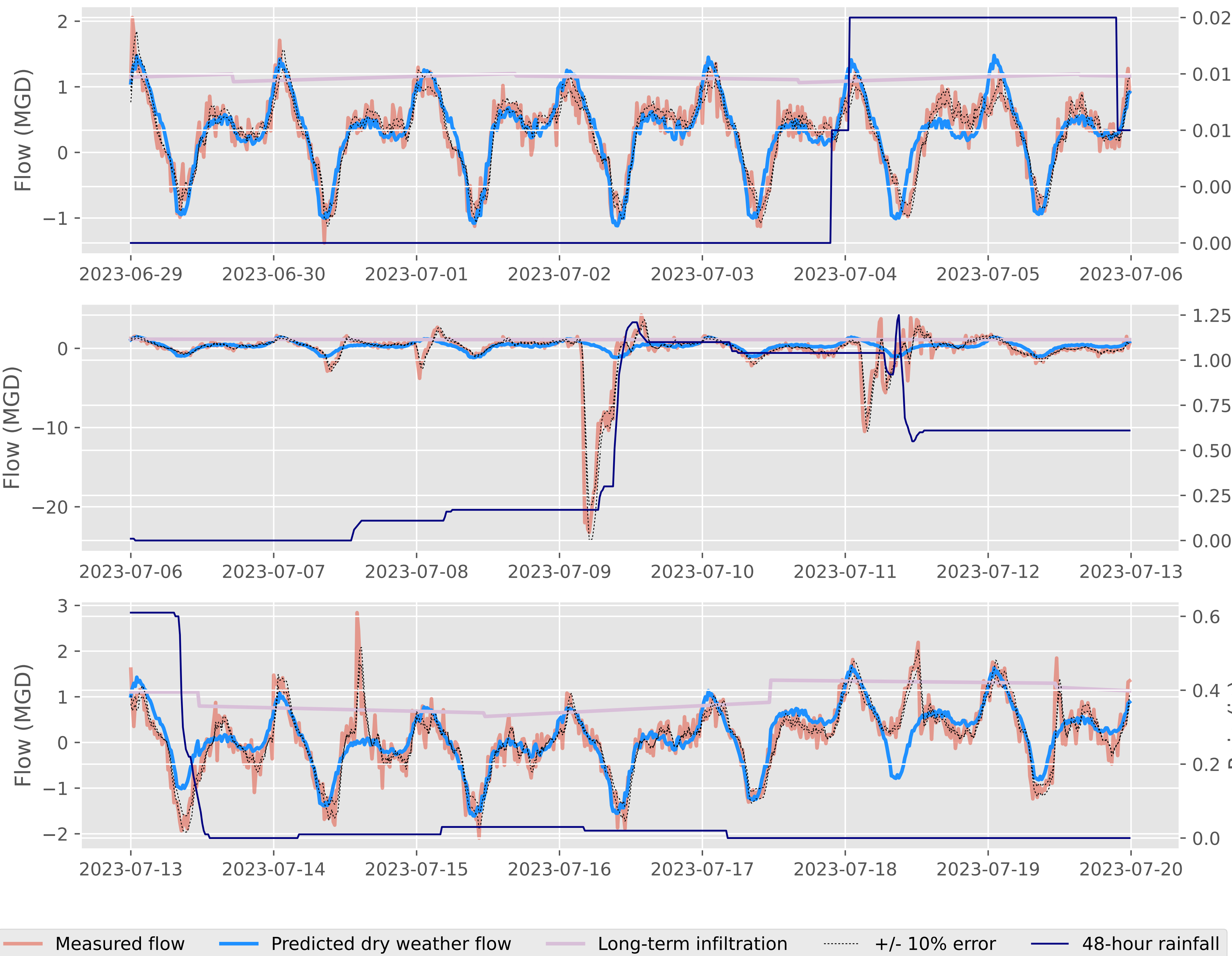


WS-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

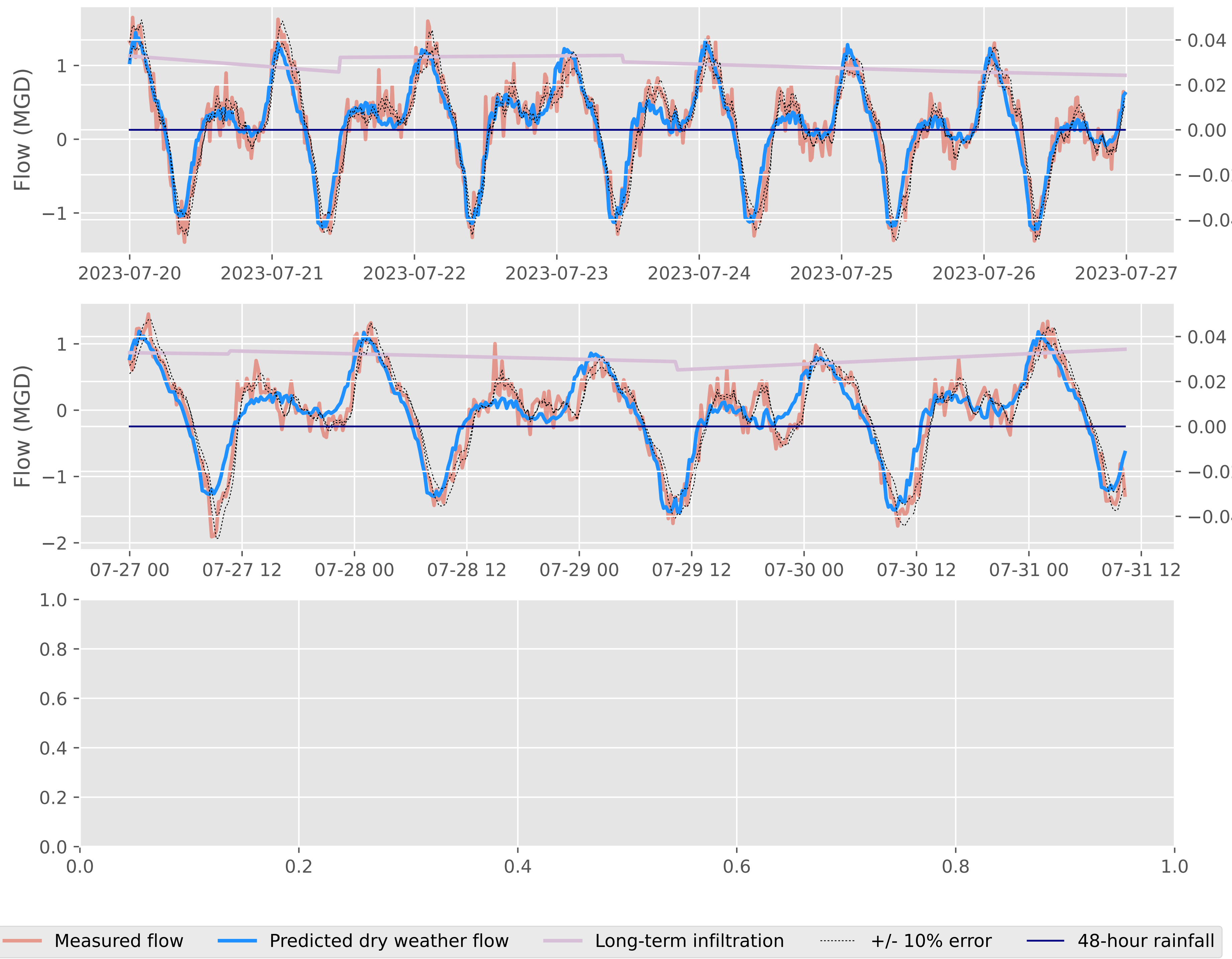


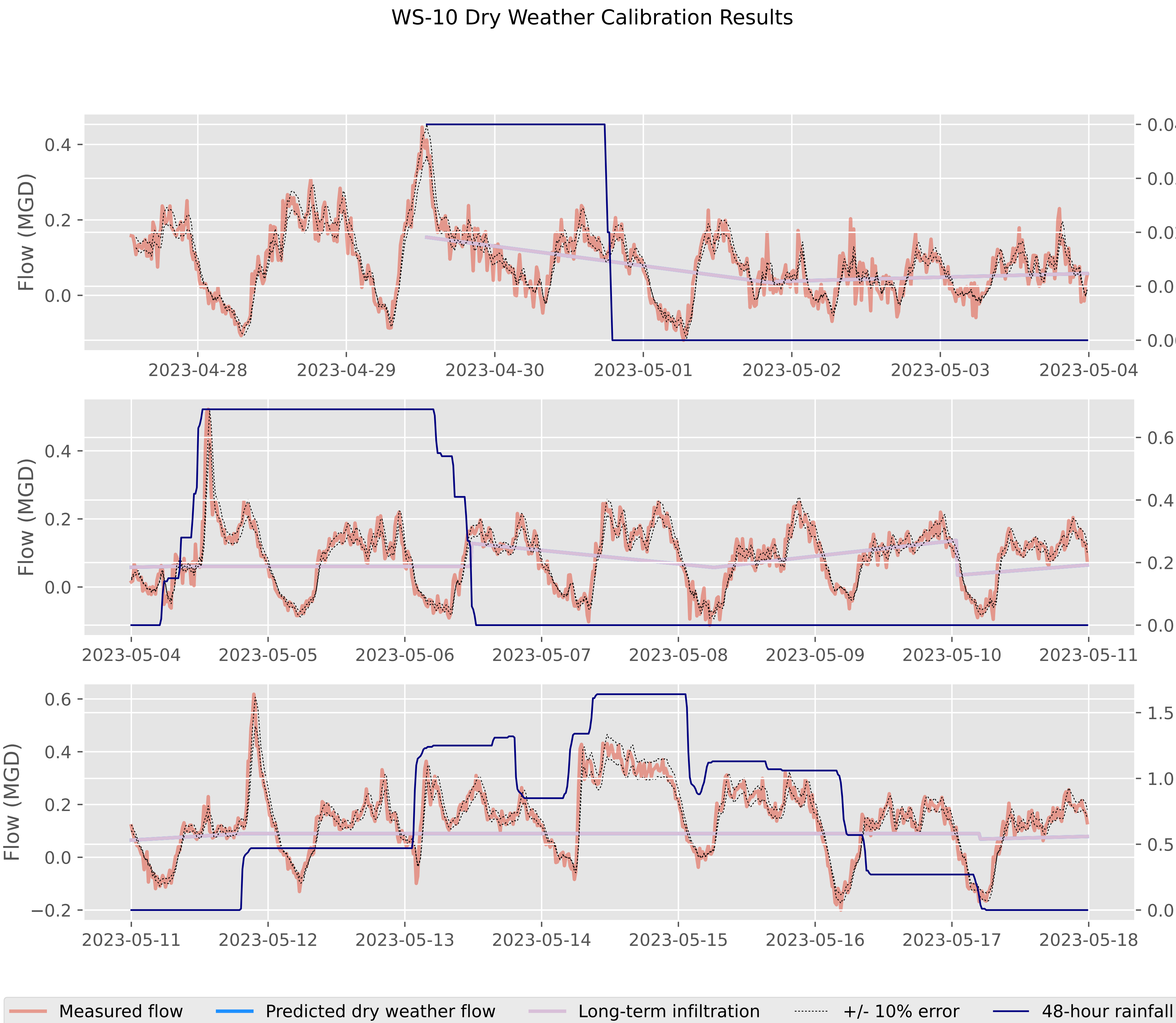
WS-01 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

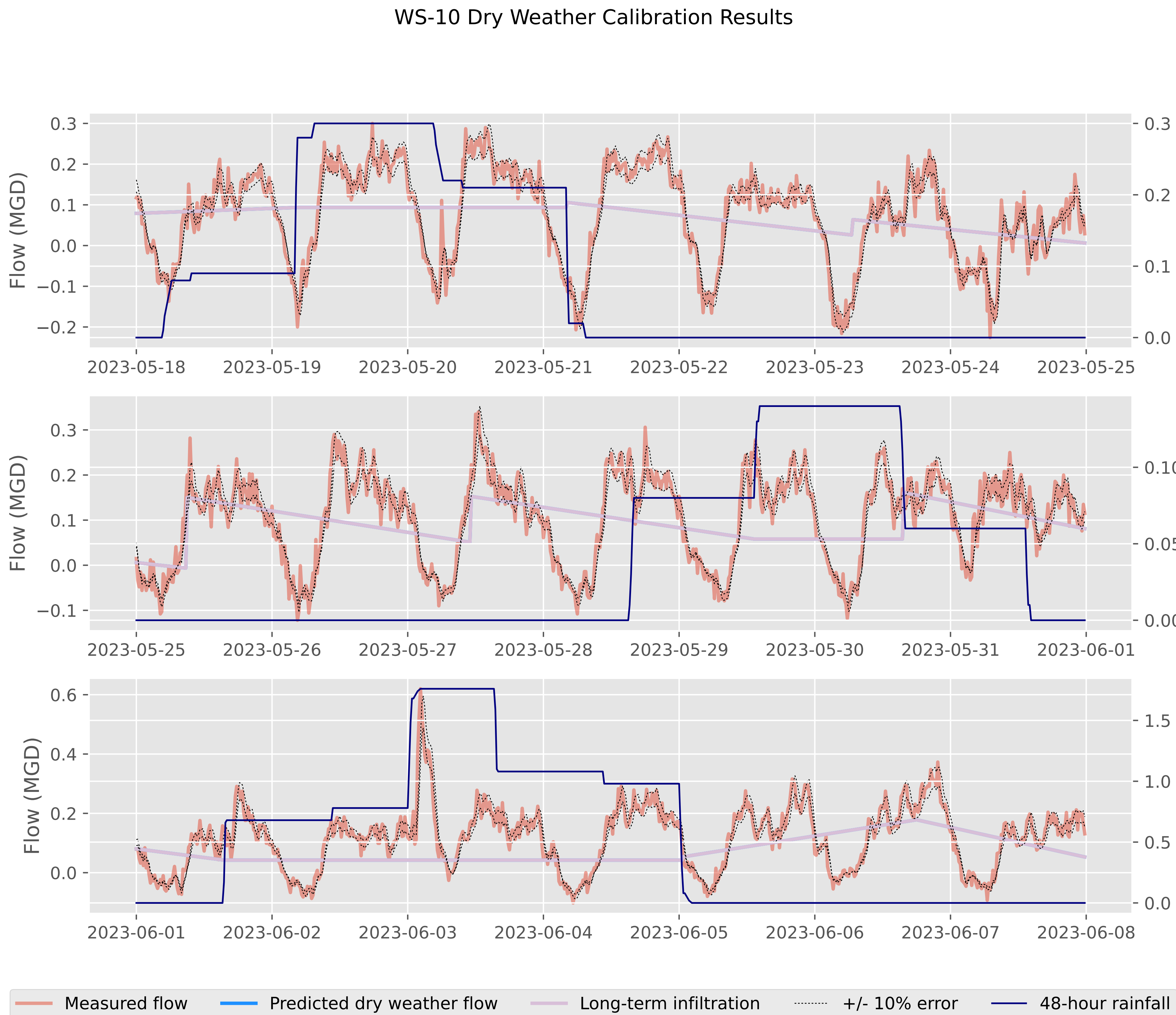
WS-01 Dry Weather Calibration Results



WS-01 Dry Weather Calibration Results

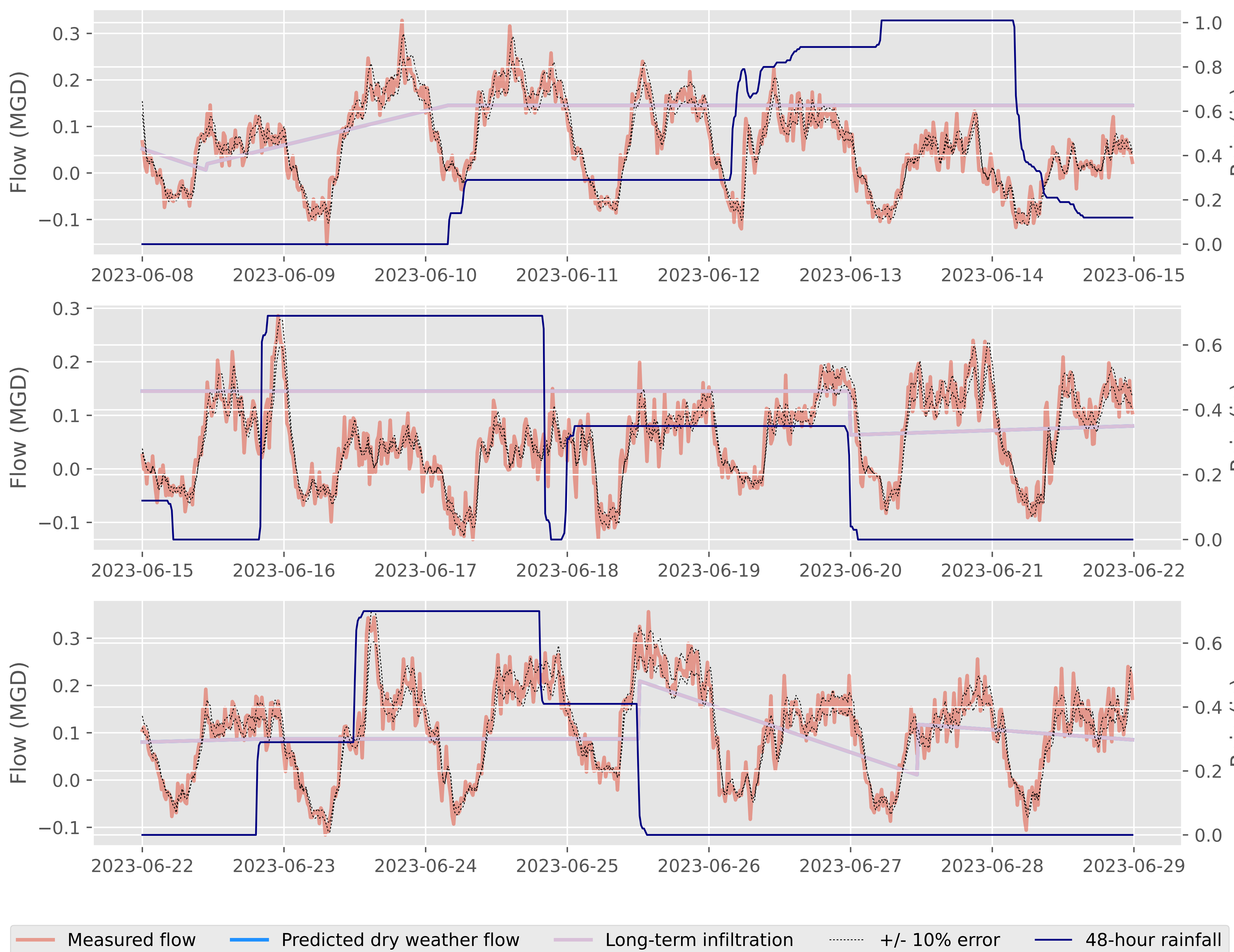


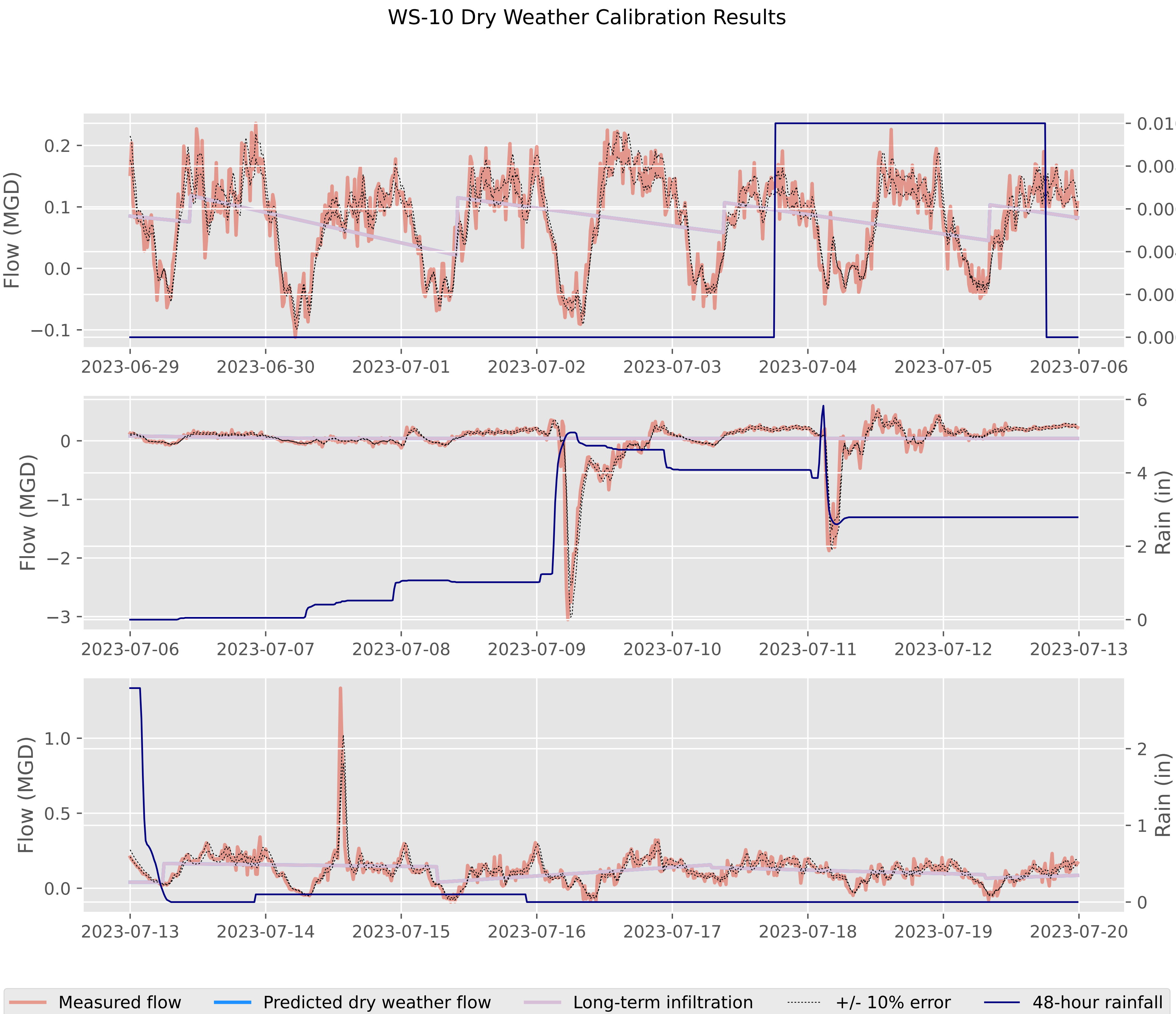

WS-10 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall



WS-10 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

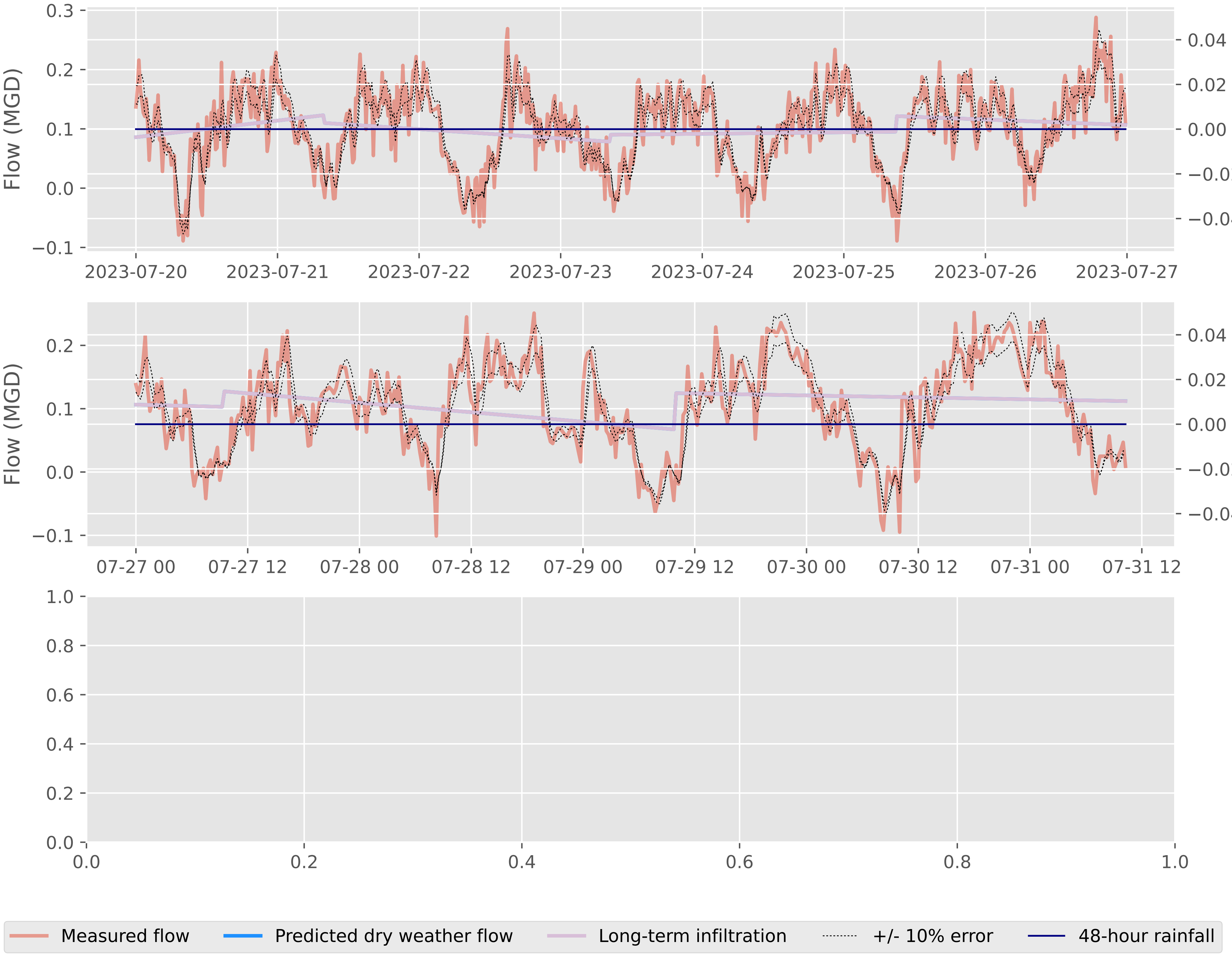
WS-10 Dry Weather Calibration Results

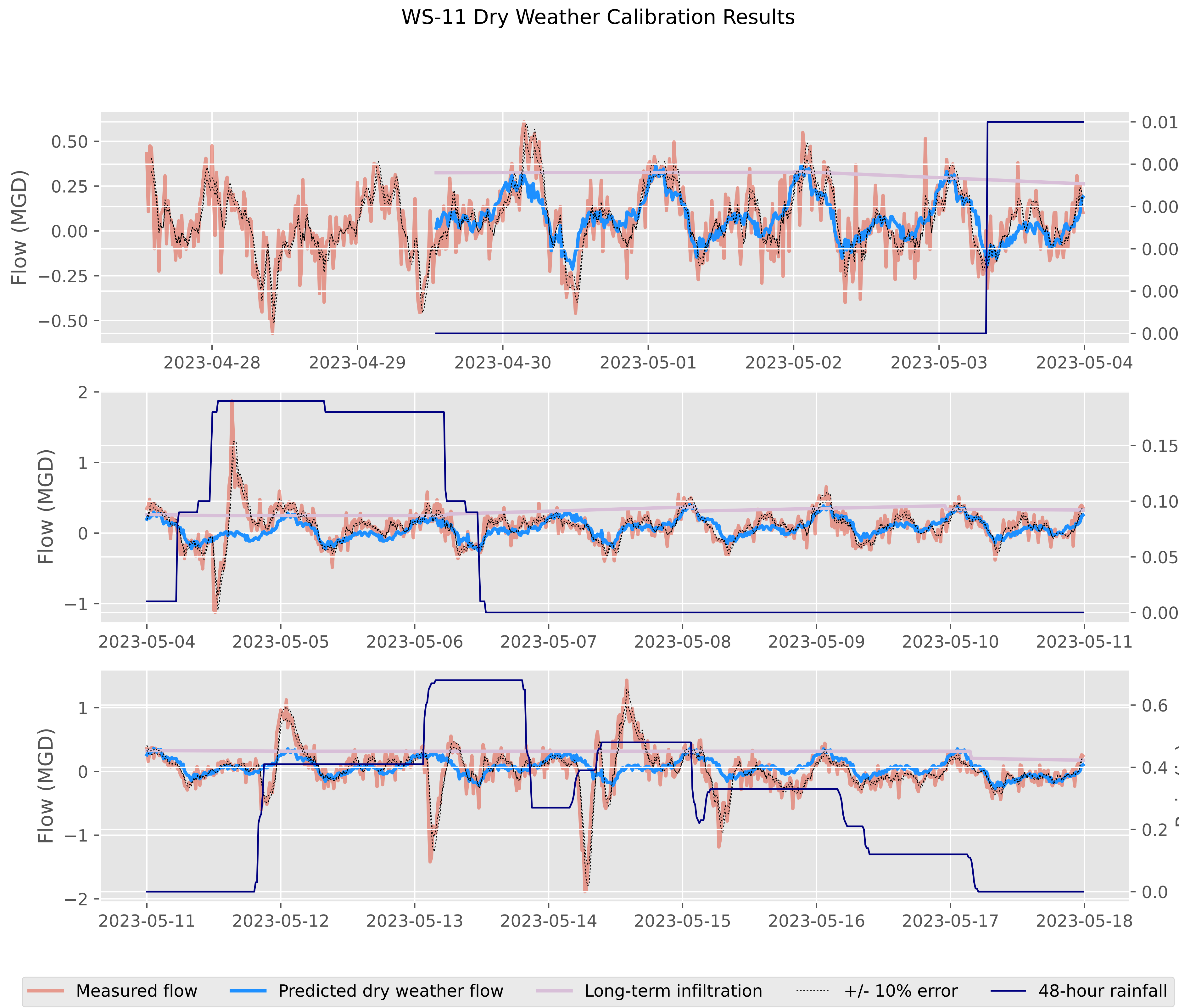




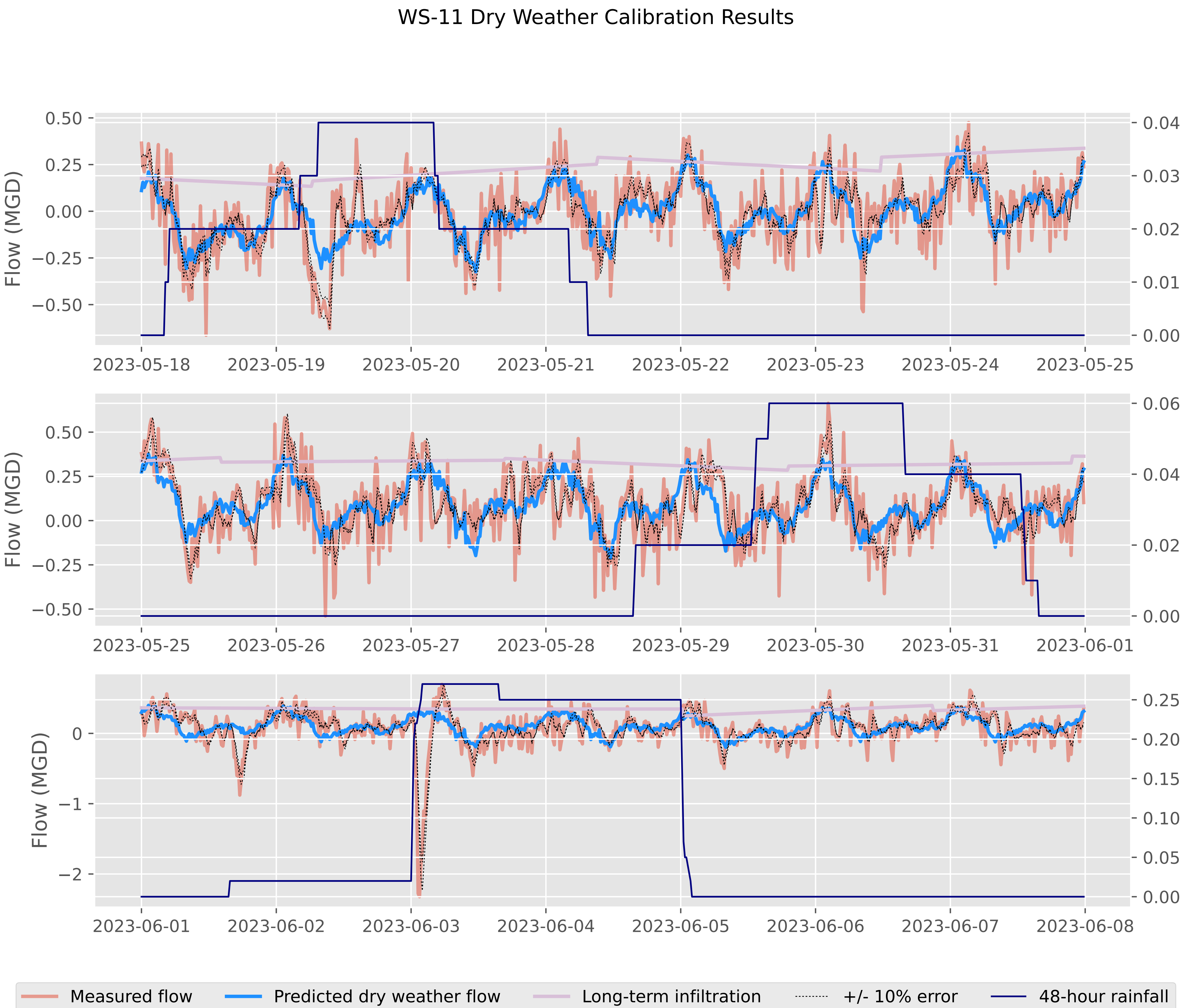
WS-10 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.2
0.1
0.0
−0.1
0.010
0.008
0.006
0.004
0.002
0.000
2023-06-29
2023-06-30
2023-07-01
2023-07-02
2023-07-03
2023-07-04
2023-07-05
2023-07-06
0
−1
−2
−3
6
4
2
0
2023-07-06
2023-07-07
2023-07-08
2023-07-09
2023-07-10
2023-07-11
2023-07-12
2023-07-13
1.0
0.5
0.0
2
1
0
2023-07-13
2023-07-14
2023-07-15
2023-07-16
2023-07-17
2023-07-18
2023-07-19
2023-07-20
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

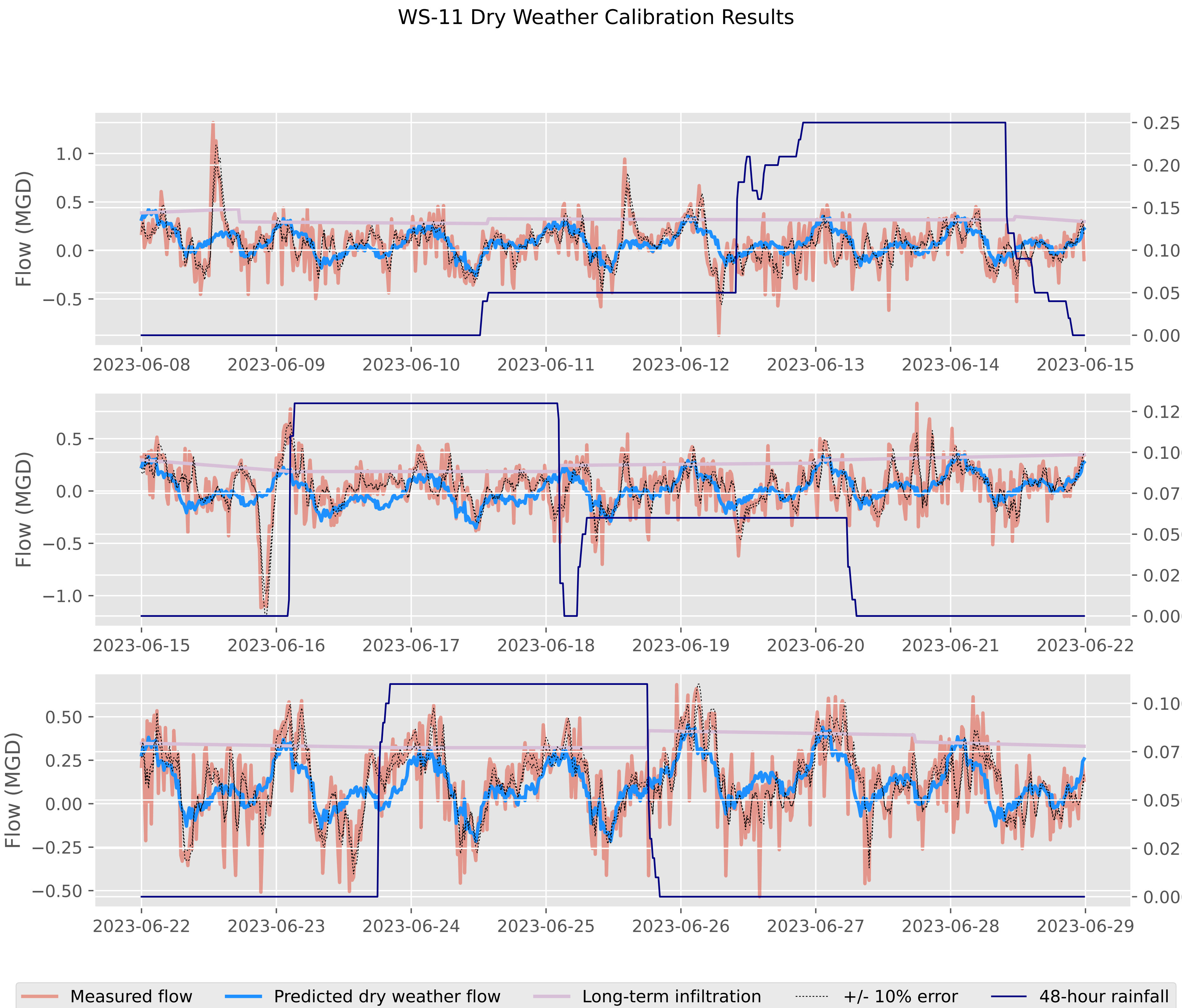
WS-10 Dry Weather Calibration Results



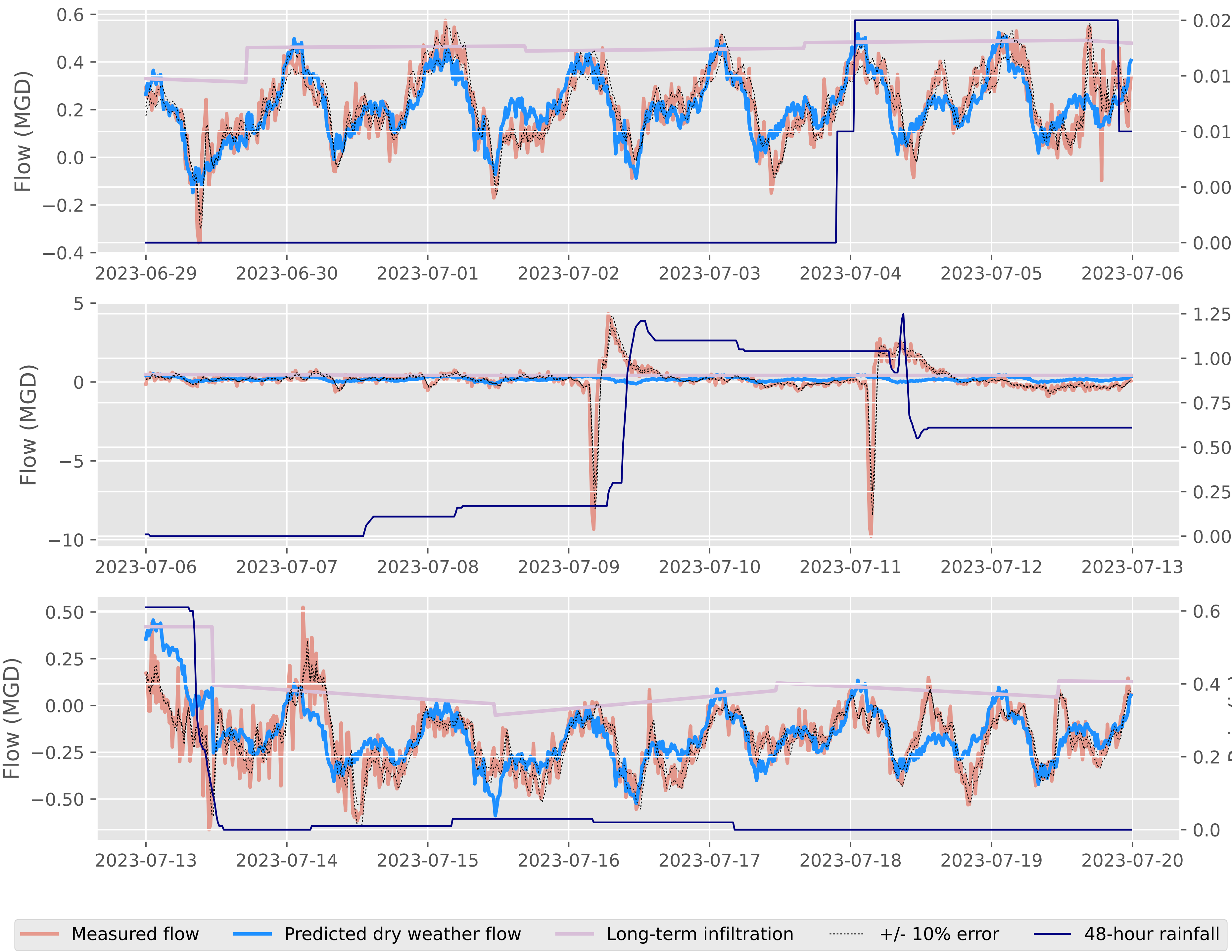


WS-11 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-04-28
2023-04-29
2023-04-30
2023-05-01
2023-05-02
2023-05-03
2023-05-04
2023-05-05
2023-05-06
2023-05-07
2023-05-08
2023-05-09
2023-05-10
2023-05-11
2023-05-12
2023-05-13
2023-05-14
2023-05-15
2023-05-16
2023-05-17
2023-05-18
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

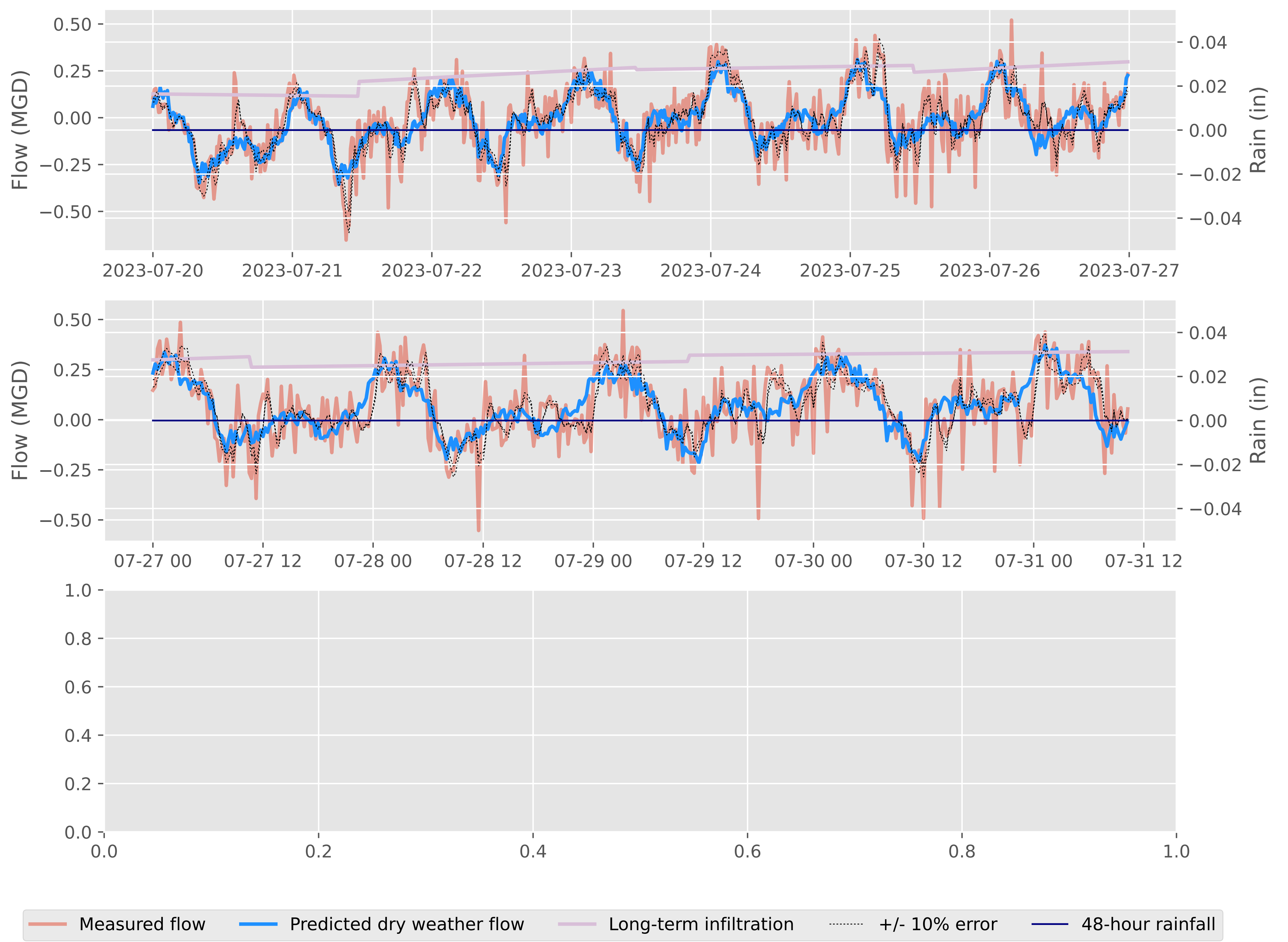

WS-11 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
0.50
0.25
0.00
−0.25
−0.50
0.04
0.03
0.02
0.01
0.00
2023-05-18
2023-05-19
2023-05-20
2023-05-21
2023-05-22
2023-05-23
2023-05-24
2023-05-25
0.06
2023-05-26
2023-05-27
2023-05-28
2023-05-29
2023-05-30
2023-05-31
2023-06-01
0
−1
−2
0.25
0.20
0.15
0.10
0.05
2023-06-02
2023-06-03
2023-06-04
2023-06-05
2023-06-06
2023-06-07
2023-06-08
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall


WS-11 Dry Weather Calibration Results
Flow (MGD)
Rain (in)
2023-06-08
2023-06-09
2023-06-10
2023-06-11
2023-06-12
2023-06-13
2023-06-14
2023-06-15
2023-06-16
2023-06-17
2023-06-18
2023-06-19
2023-06-20
2023-06-21
2023-06-22
2023-06-23
2023-06-24
2023-06-25
2023-06-26
2023-06-27
2023-06-28
2023-06-29
Measured flow
Predicted dry weather flow
Long-term infiltration
+/- 10% error
48-hour rainfall

WS-11 Dry Weather Calibration Results



WS-11 Dry Weather Calibration Results



APPENDIX G

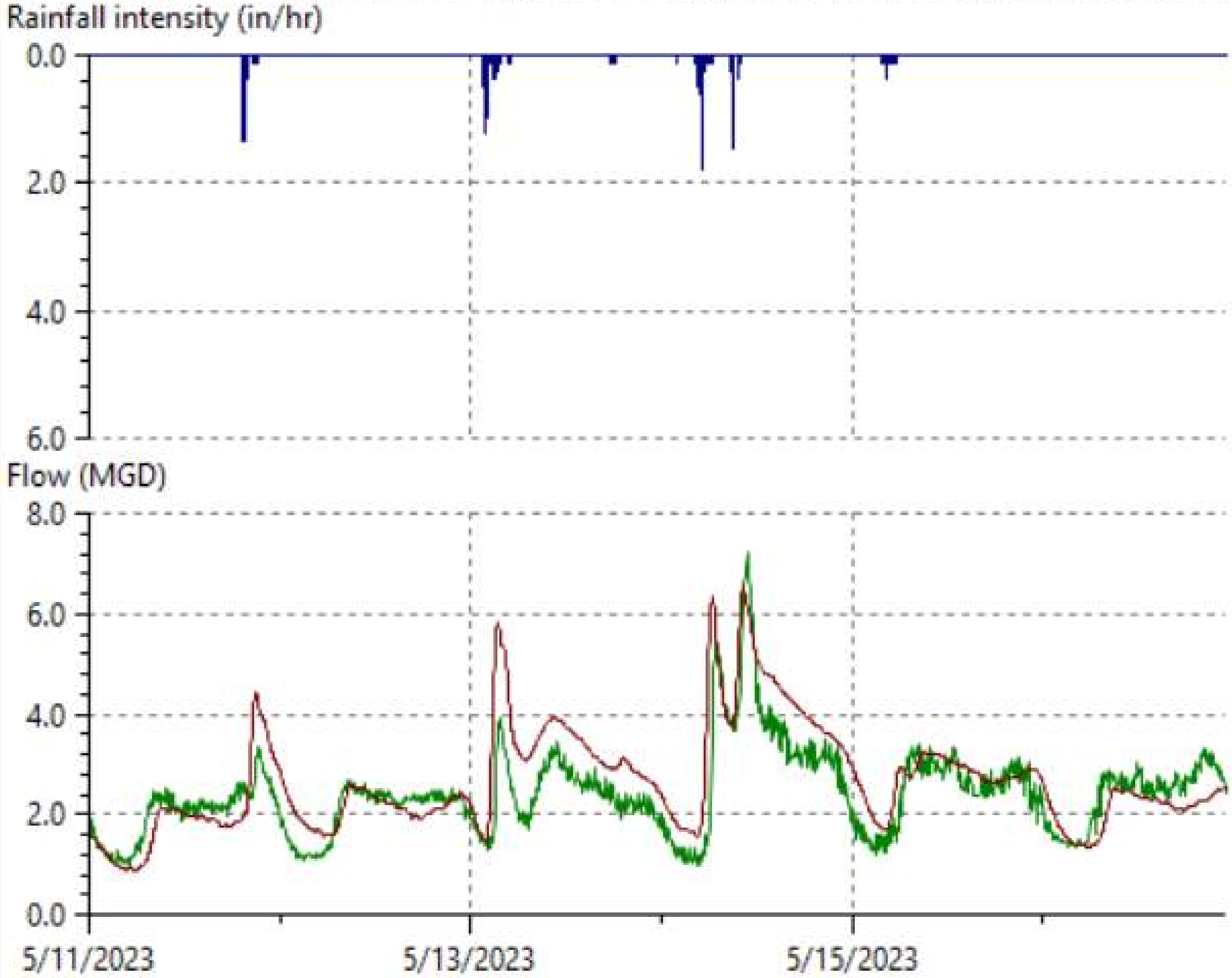
RTK PARAMETERS

RTK hydrograph ID	Response ratio R - short term	Time to peak T - short term	Recession limb ratio K - short term	Response ratio R - medium term	Time to peak T - medium term	Recession limb ratio K - medium	Response ratio R - long term	Time to peak T - long term	Recession limb ratio K - long term	Total response ratio R
BH-02	0.0299	0.32	4	0.0199	4.72	3	0.0473	7.00	2	**0.0970**
BH-03	0.0055	0.13	16	0.0016	4.38	5	0.0016	6.10	2	**0.0086**
BH-04	0.0096	0.80	5	0.0289	35.50	8	0.0395	37.60	1	**0.0780**
BH-05	0.0050	0.03	5	0.0100	1.00	10	0.0125	8.00	5	**0.0274**
BH-06	0.0094	0.40	2	0.0113	4.00	8	0.0226	12.00	8	**0.0433**
BP-20	0.0000	4.40	3	0.0000	15.00	10	0.0000	15.00	10	**0.0000**
BP-22	0.0088	0.30	1	0.0070	2.95	1	0.0140	5.83	6	**0.0298**
BP-24	0.0011	2.10	2	0.0002	6.00	1	0.0000	43.80	7	**0.0013**
BP-25	0.1317	1.80	6	0.1366	8.50	19	0.1106	57.80	5	**0.3789**
BP-27	0.0084	6.80	1	0.0142	8.80	6	0.0070	10.80	1	**0.0297**
BP-28	0.0004	1.12	4	0.0015	3.93	1	0.0000	2517.10	11	**0.0018**
BP-30	0.0031	0.15	2	0.0124	2.55	5	0.0187	3.45	8	**0.0342**
IH-13	0.0039	0.07	13	0.0313	2.83	13	0.0130	7.38	2	**0.0482**
IH-14	0.0012	0.80	1	0.0022	4.00	5	0.0015	12.00	4	**0.0048**
IH-15	0.0686	4.30	7	0.0338	4.50	1	0.0795	36.60	9	**0.1819**
IH-16	0.0169	0.40	5	0.0386	6.02	8	0.0193	9.23	7	**0.0749**
LD-02	0.0006	0.50	1	0.0017	1.77	3	0.0127	9.45	1	**0.0151**
LD-03	0.0033	0.50	2	0.0109	4.00	8	0.0176	9.00	8	**0.0318**
ND-08	0.0025	0.28	1	0.0083	4.22	2	0.0021	7.00	1	**0.0129**
ND-09	0.0061	0.18	2	0.0122	1.00	9	0.0610	6.88	10	**0.0793**
SV-01	0.0256	0.75	2	0.0396	5.00	5	0.0371	23.60	9	**0.1023**
WC-32	0.0146	0.58	5	0.0282	3.35	5	0.0171	4.85	3	**0.0599**
WS-01	0.0000	0.85	4	0.0000	3.10	2	0.0000	3.25	2	**0.0000**
BP-19	0.0803	0.58	9	0.0220	14.75	11	0.0156	24.17	5	**0.1179**
BH-07	0.0431	1.02	10	0.0216	7.15	8	0.0323	10.33	4	**0.0970**
WC-31	0.0047	0.13	2	0.0187	5.07	4	0.0257	8.00	7	**0.0490**
LD-01	0.0000	1.93	2	0.0210	4.93	4	0.0842	12.00	8	**0.1052**
BP-26	0.0170	0.75	2	0.0136	2.83	4	0.0746	7.00	10	**0.1052**
WC-30	0.0247	0.62	13	0.0513	9.18	6	0.0513	11.50	6	**0.1273**
IH-12	0.0004	0.02	1	0.0000	3.00	6	0.0004	7.38	4	**0.0008**
BP-23	0.0286	0.67	7	0.0715	5.33	6	0.1637	6.10	4	**0.2638**
BP-21	0.0734	2.00	3	0.0294	15.00	10	0.0184	36.40	10	**0.1211**
BP-17	0.2170	0.58	9	0.1628	3.00	5	0.1628	5.00	11	**0.5425**
WS-10	0.0183	0.58	5	0.0366	3.35	5	0.0183	4.85	3	**0.0733**
WS-11	0.0009	0.58	5	0.0018	3.35	5	0.0009	4.85	3	**0.0036**
Median Values	**0.0084**	**0.58**	**4**	**0.0142**	**4.22**	**5**	**0.0183**	**9.00**	**5**	**0.0490**

APPENDIX H

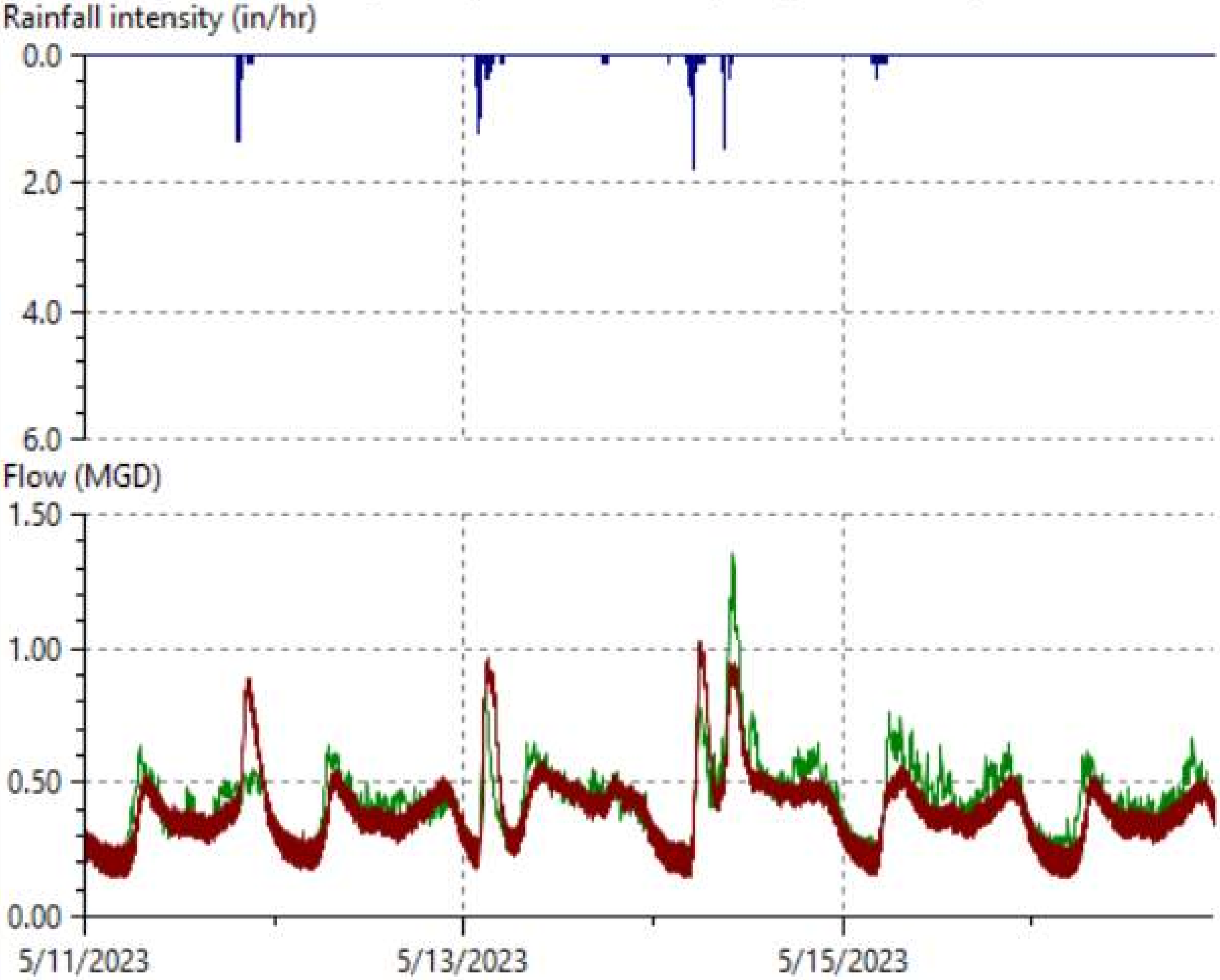
WET-WEATHER CALIBRATION RESULTS

Flow Survey Location (Obs.) BH-02, Model Location (Pred.) D/S 253006.1, Rainfall Profile: BH-02



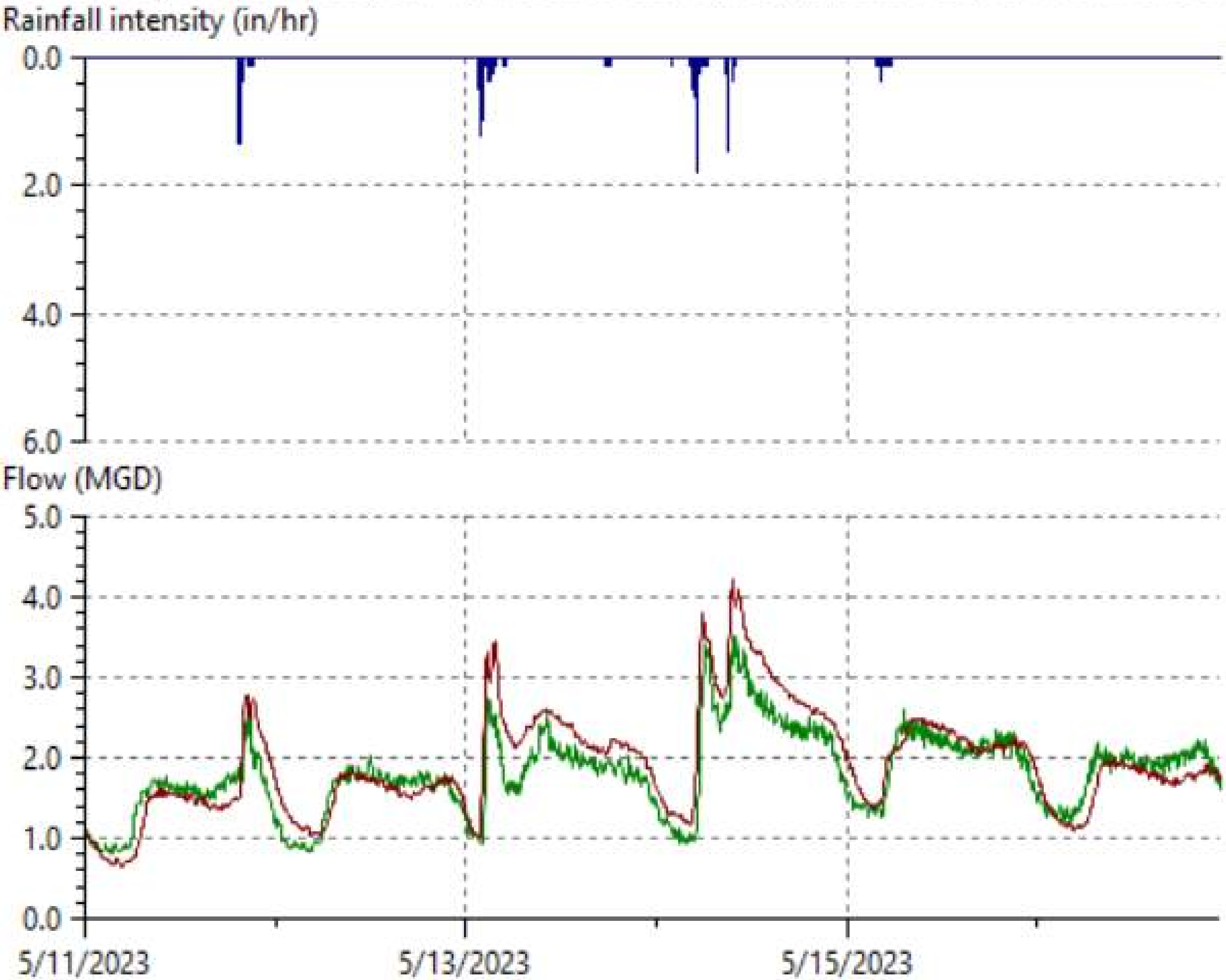
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.963	7.205	14.388
Predicted				0.873	6.568	15.870

Flow Survey Location (Obs.) BH-03, Model Location (Pred.) D/S 235001.1, Rainfall Profile: BH-03



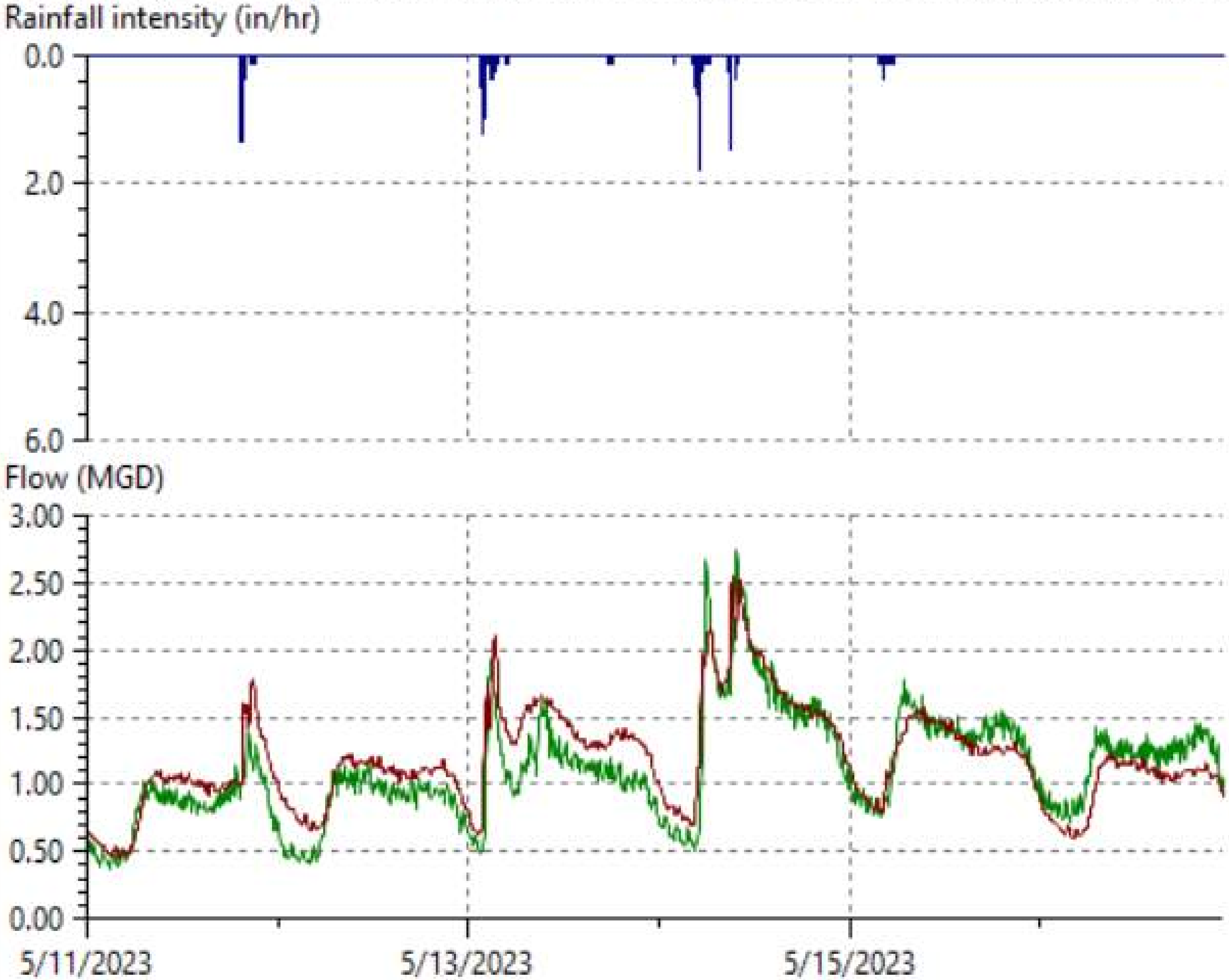
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.170	1.351	2.589
Predicted				0.142	1.028	2.391

Flow Survey Location (Obs.) BH-04, Model Location (Pred.) D/S 205049.1, Rainfall Profile: BH-04



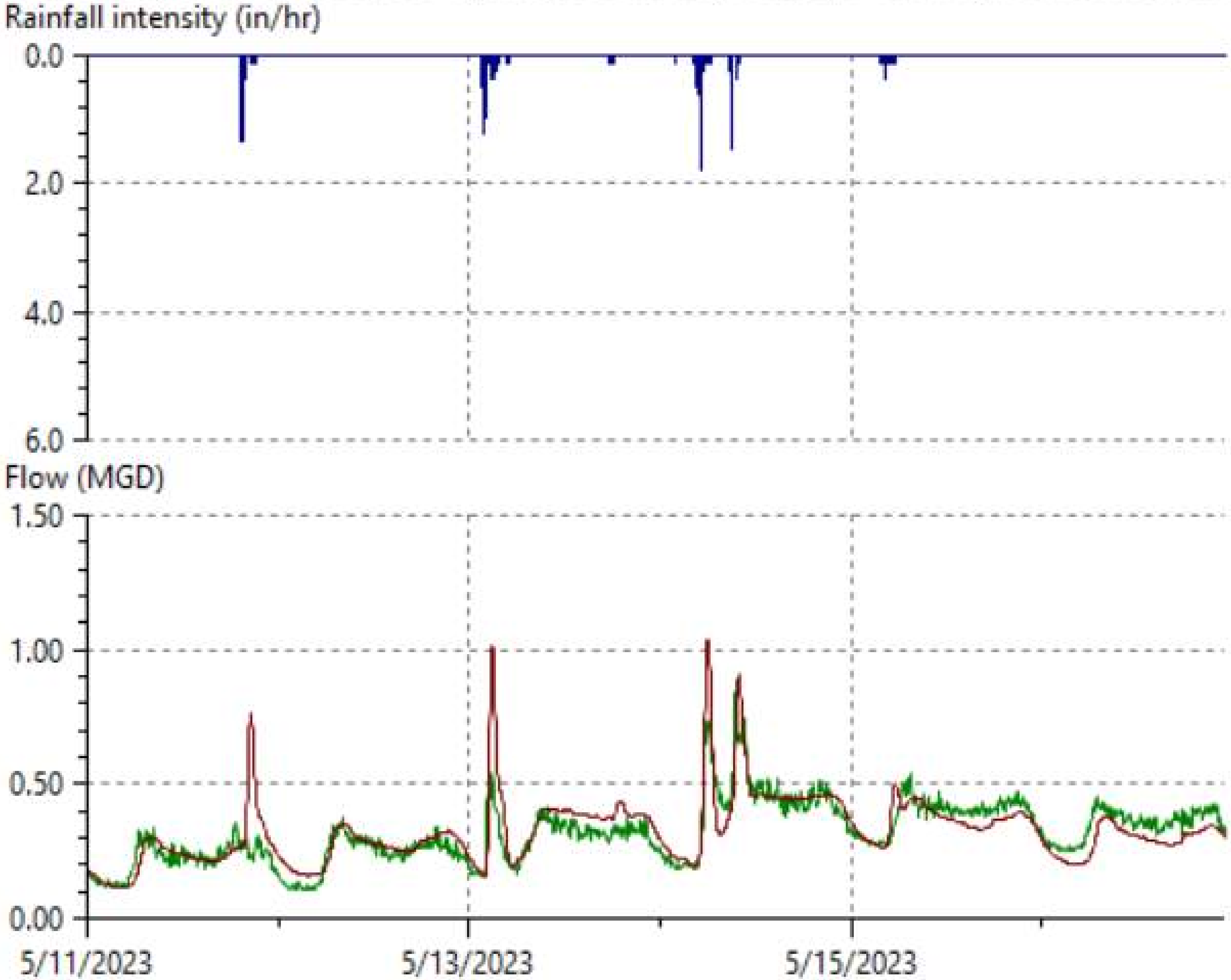
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.814	3.514	10.804
Predicted				0.638	4.211	11.469

Flow Survey Location (Obs.) BH-05, Model Location (Pred.) D/S 158106.1, Rainfall Profile: BH-05

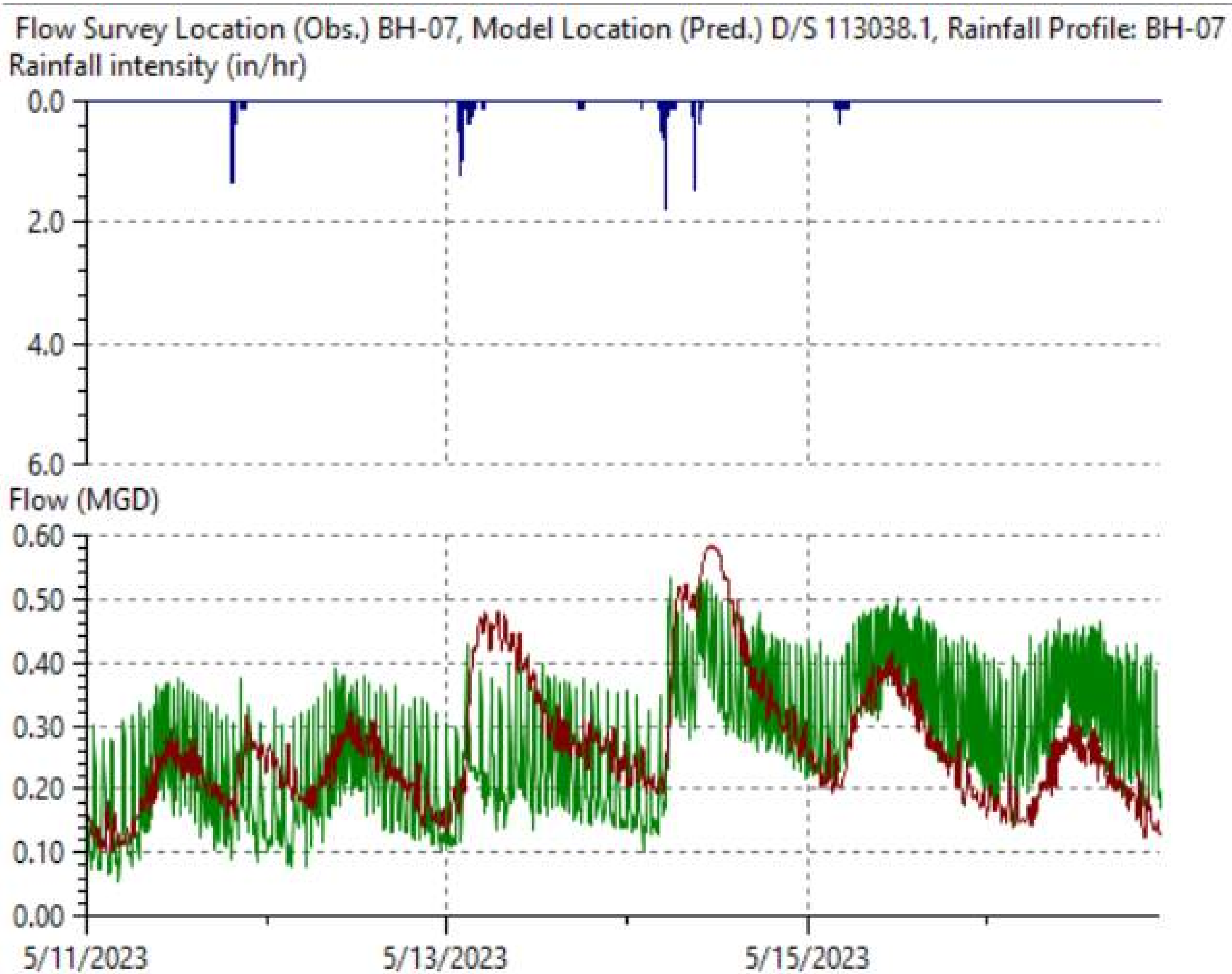


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.373	2.752	6.640
Predicted				0.440	2.549	7.047

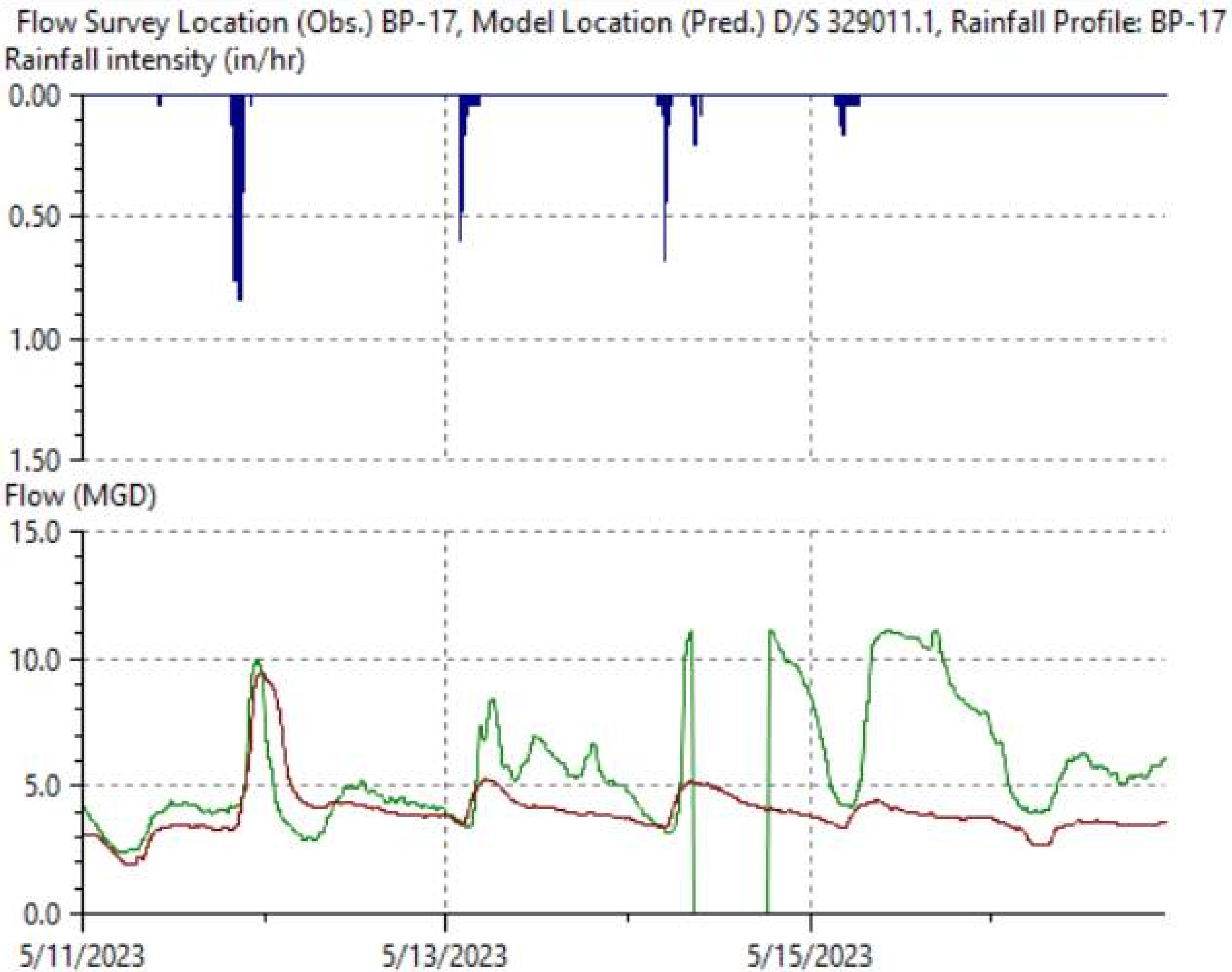
Flow Survey Location (Obs.) BH-06, Model Location (Pred.) D/S 143107.1, Rainfall Profile: BH-06



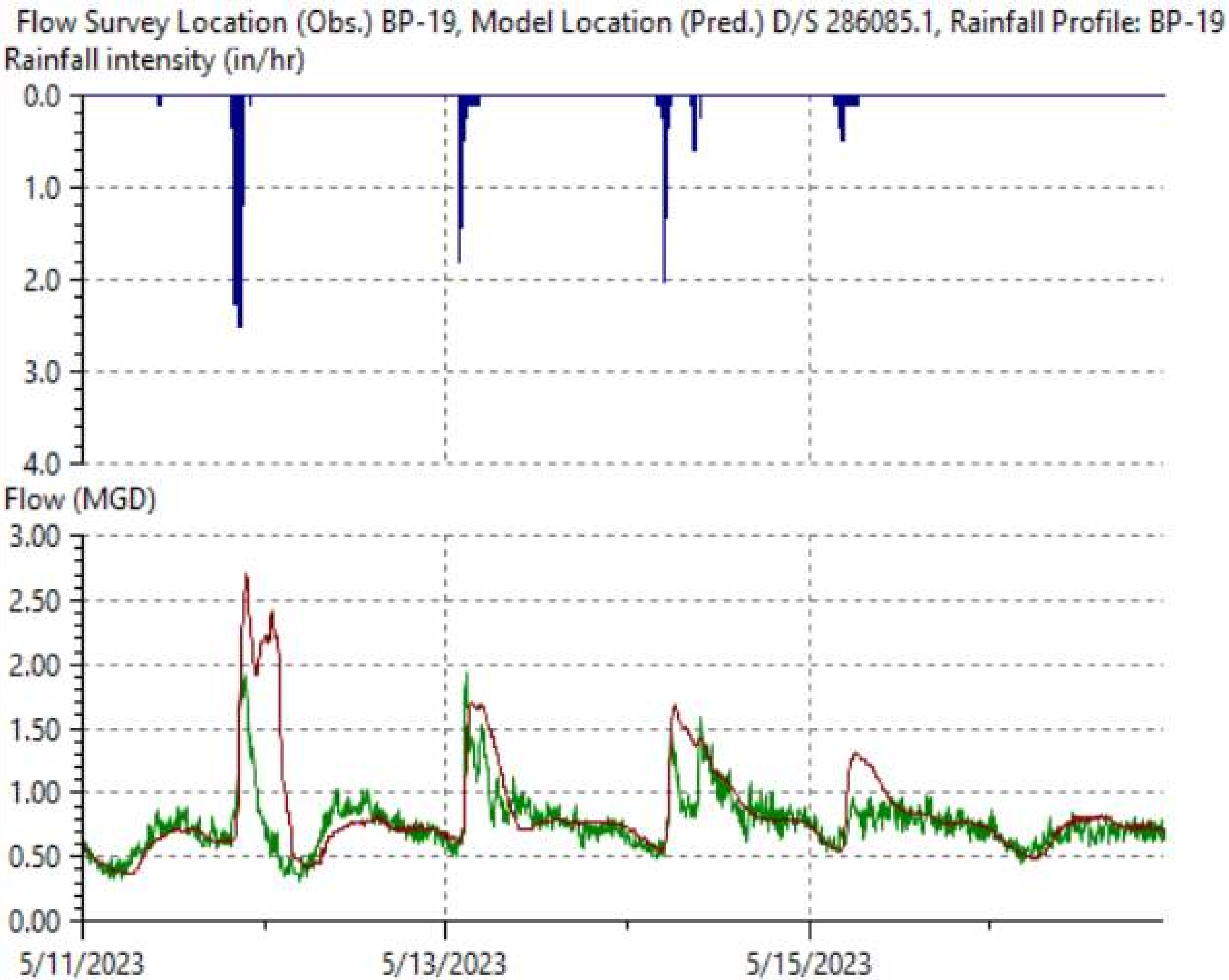
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.107	0.844	1.907
Predicted				0.114	1.037	1.943



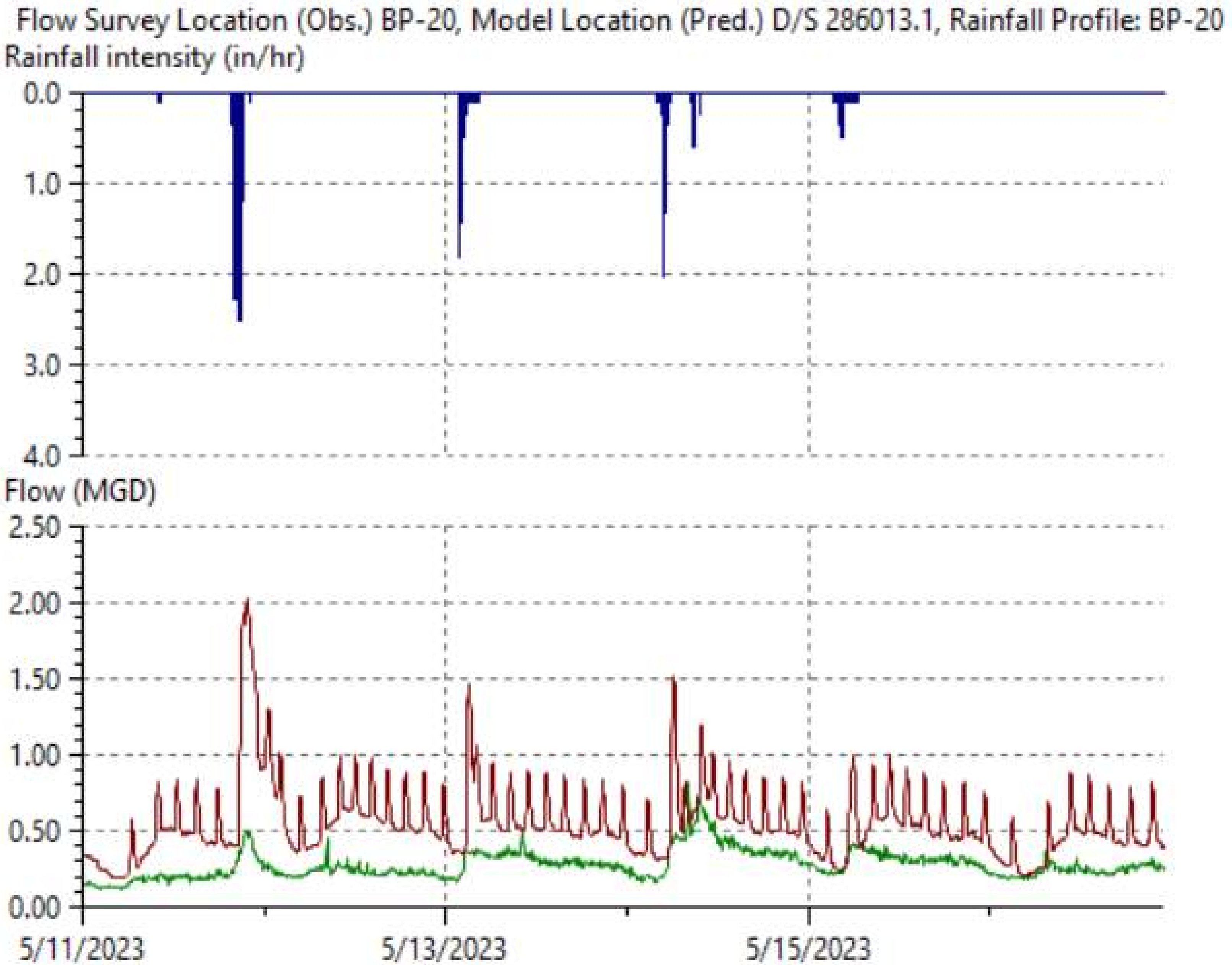
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.056	0.533	1.615
Predicted				0.099	0.584	1.602



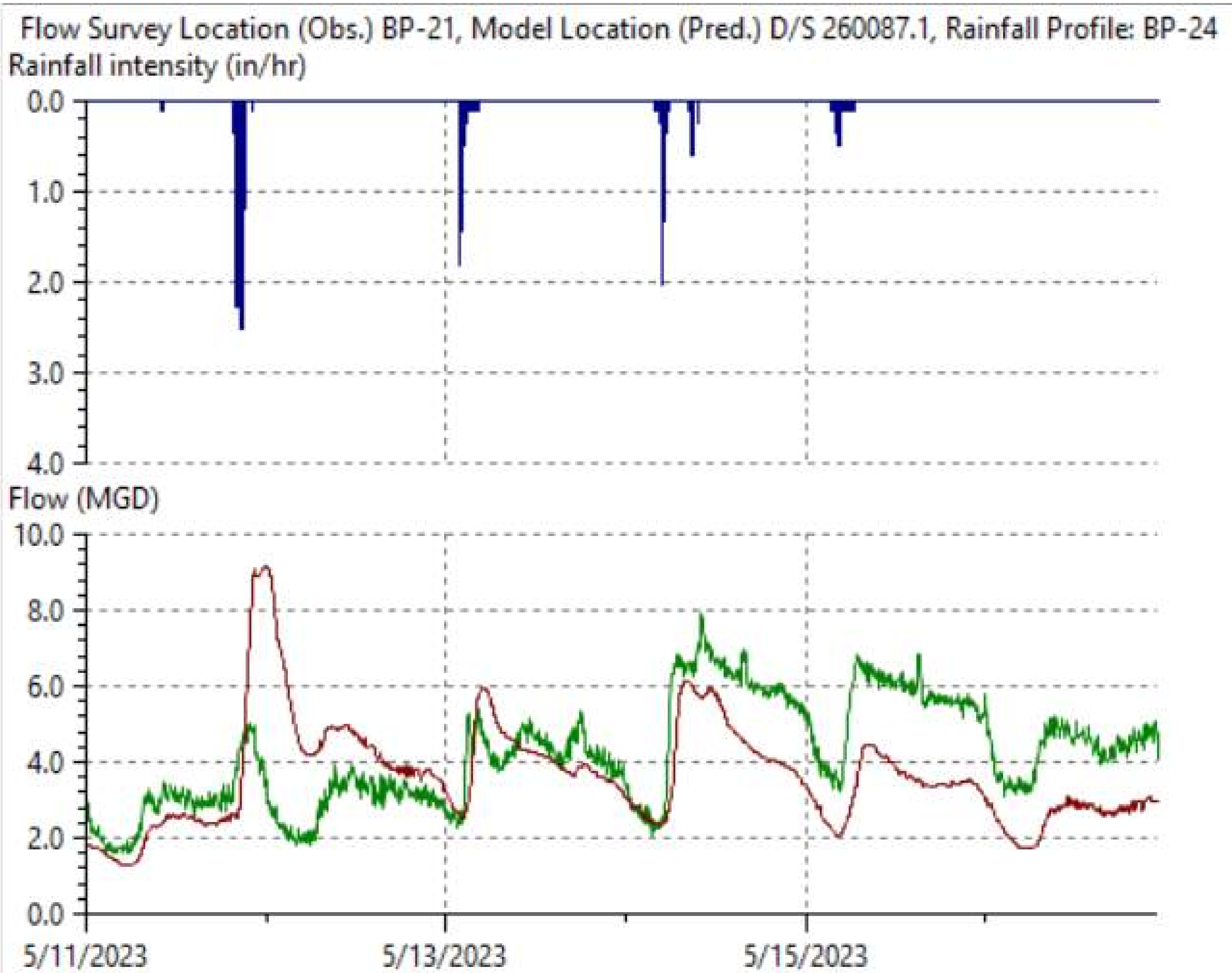
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.147	0.840	0.008			
Observed				0.000	11.152	31.776
Predicted				1.892	9.436	23.806



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.307	2.011	4.554
Predicted				0.359	2.706	5.024

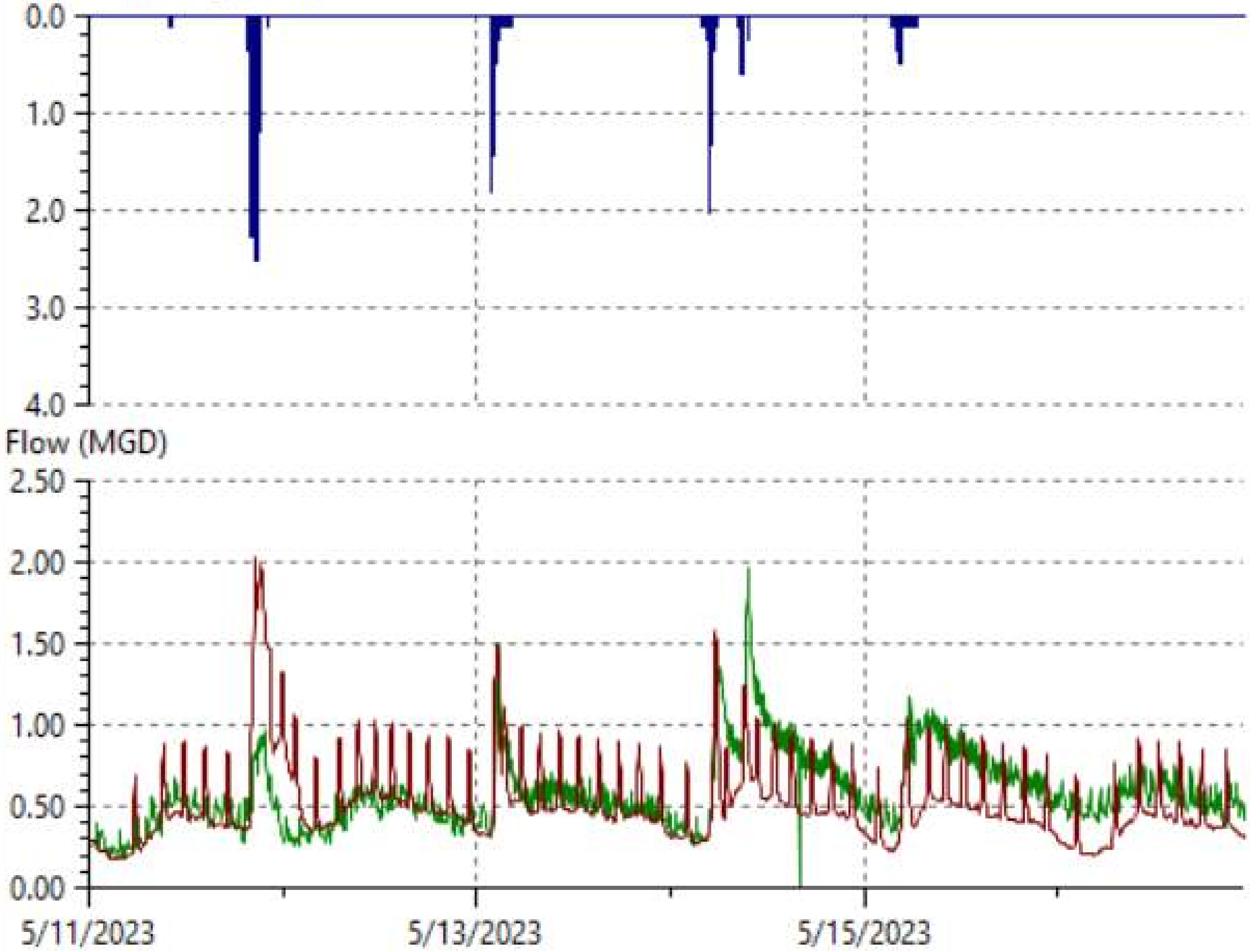


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.120	0.821	1.654
Predicted				0.190	2.029	3.322

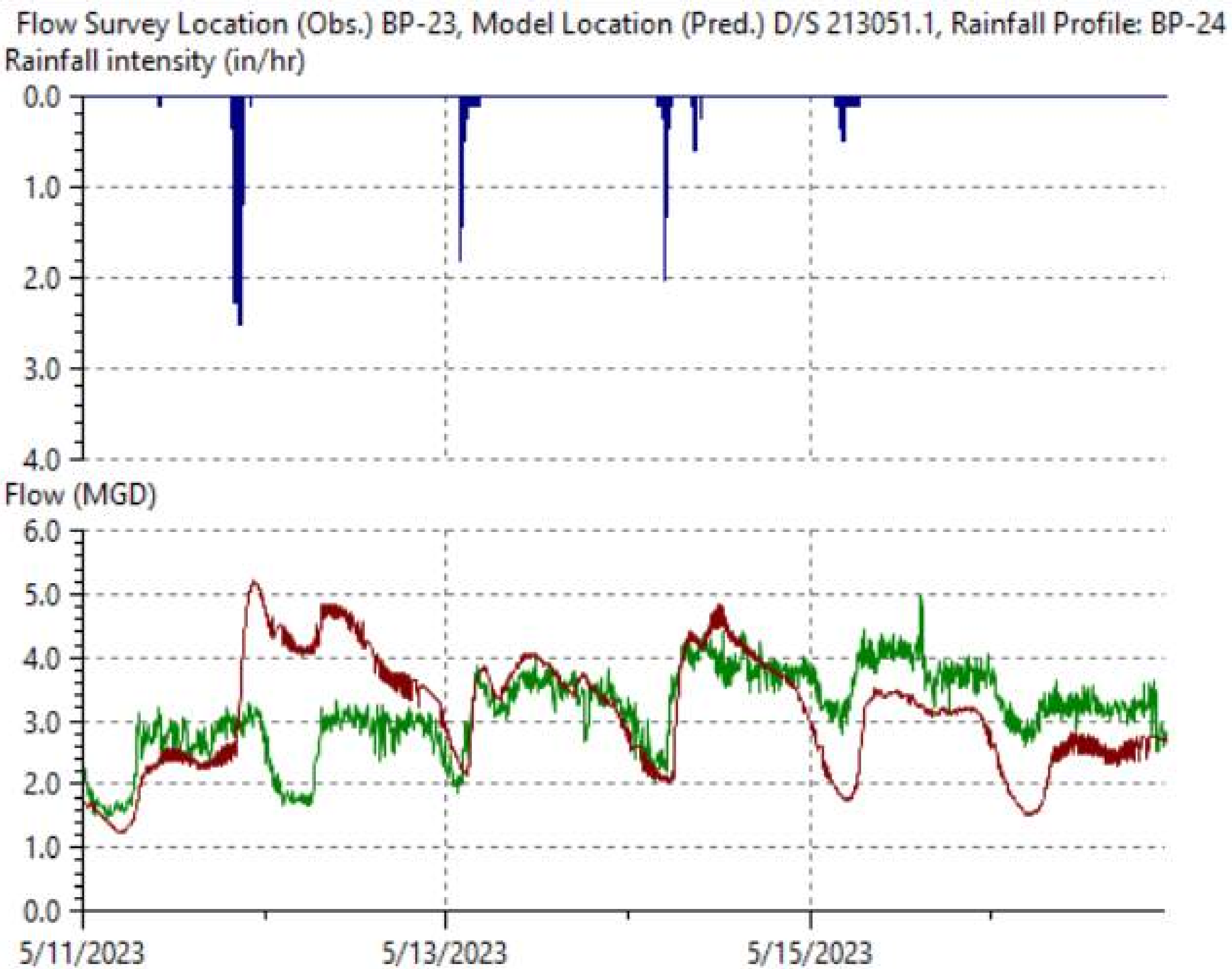


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				1.582	7.964	25.110
Predicted				1.271	9.138	21.654

Flow Survey Location (Obs.) BP-22, Model Location (Pred.) D/S 243054.1, Rainfall Profile: BP-22

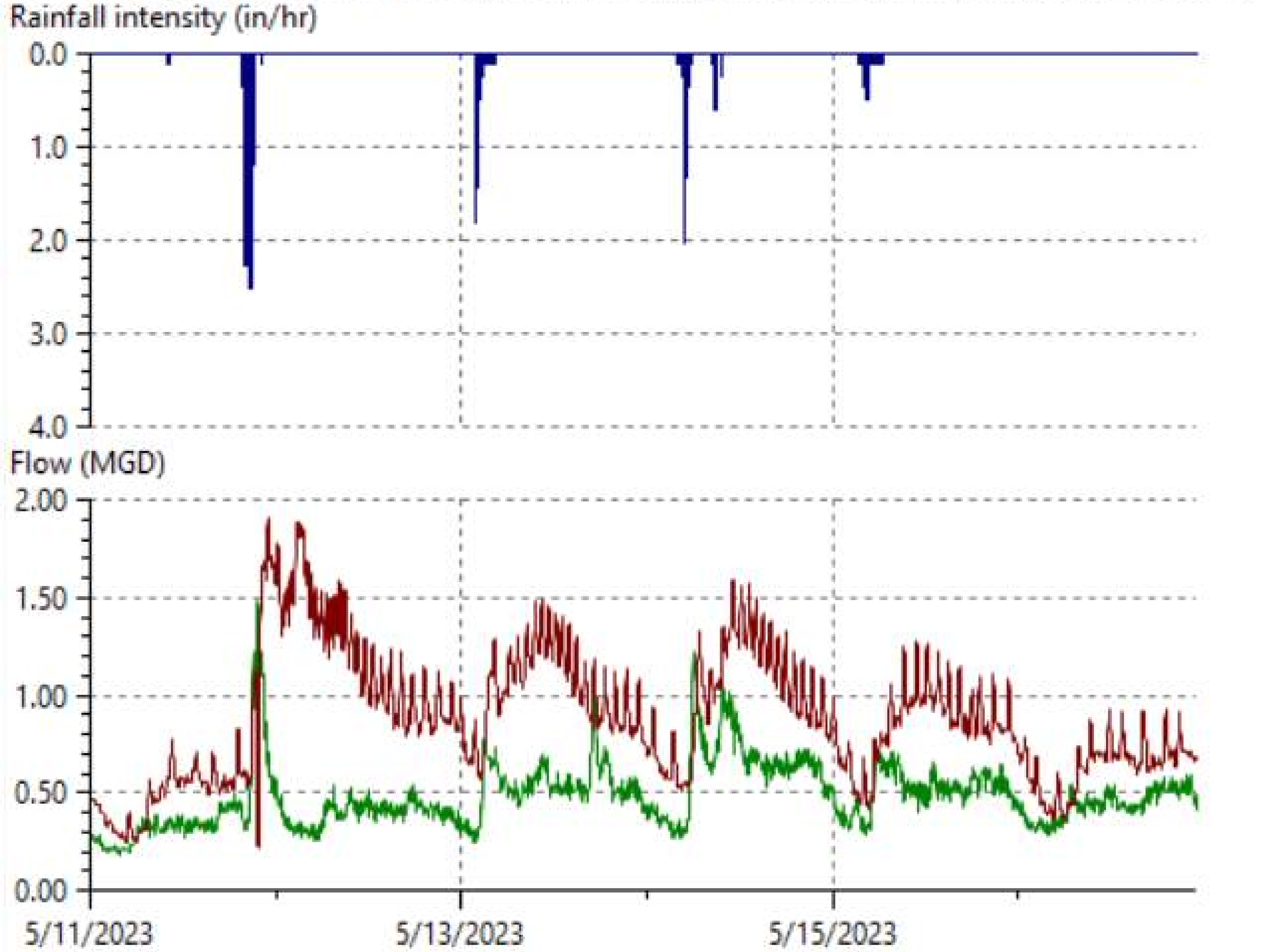


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.000	1.967	3.494
Predicted				0.180	2.033	3.113

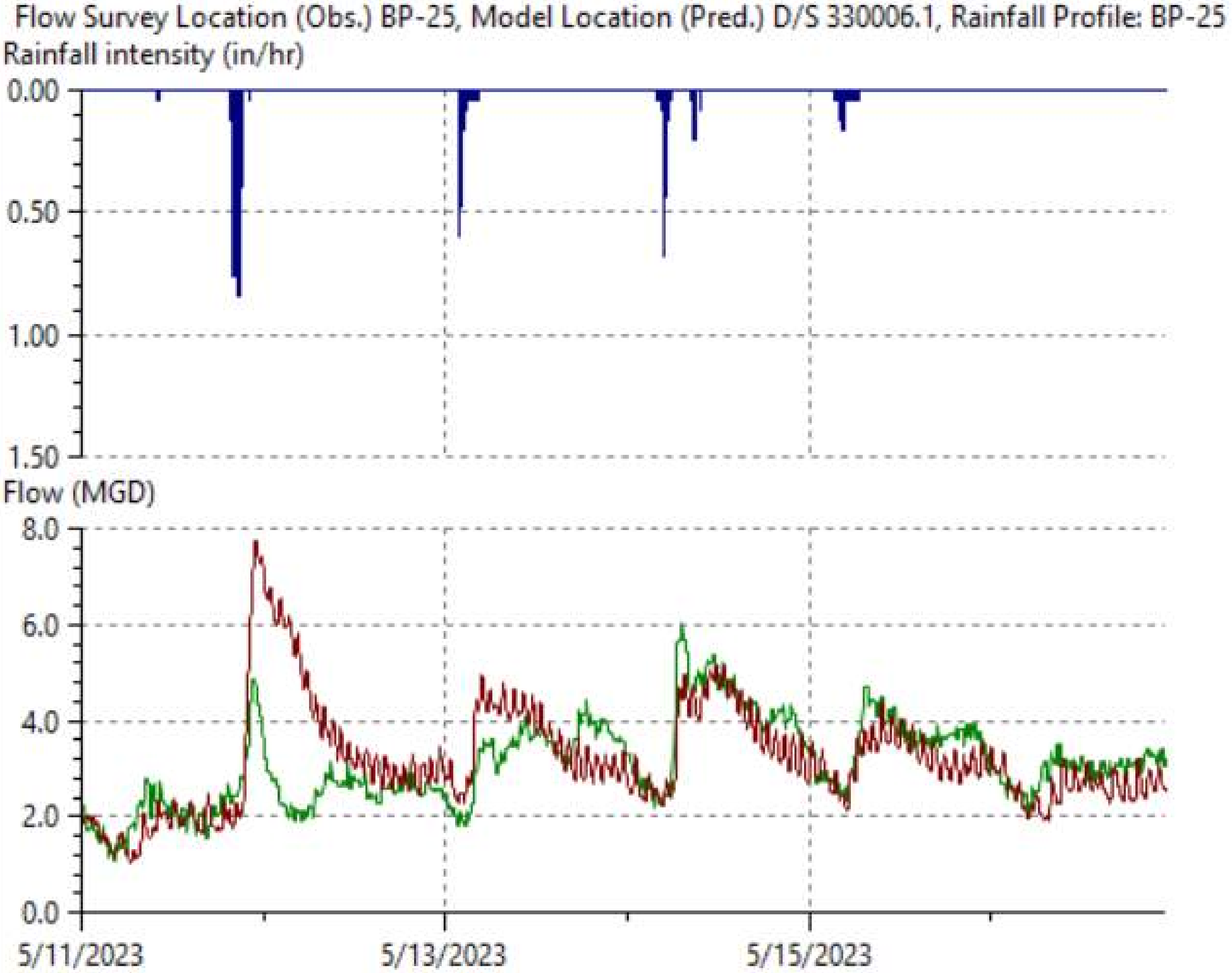


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				1.477	4.997	18.818
Predicted				1.232	5.215	18.667

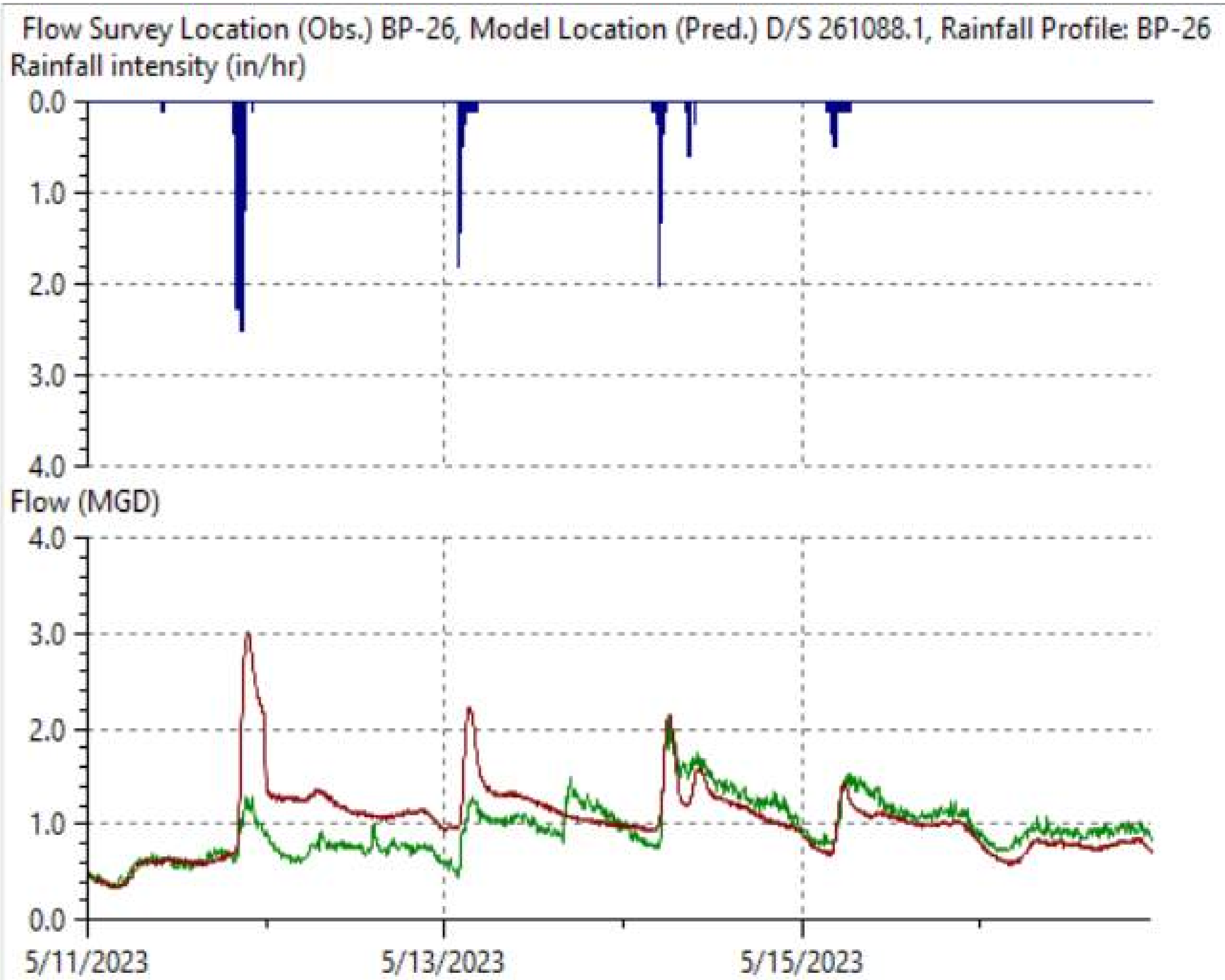
Flow Survey Location (Obs.) BP-24, Model Location (Pred.) D/S 297022.1, Rainfall Profile: BP-24



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.182	1.483	2.888
Predicted				0.225	1.911	5.258

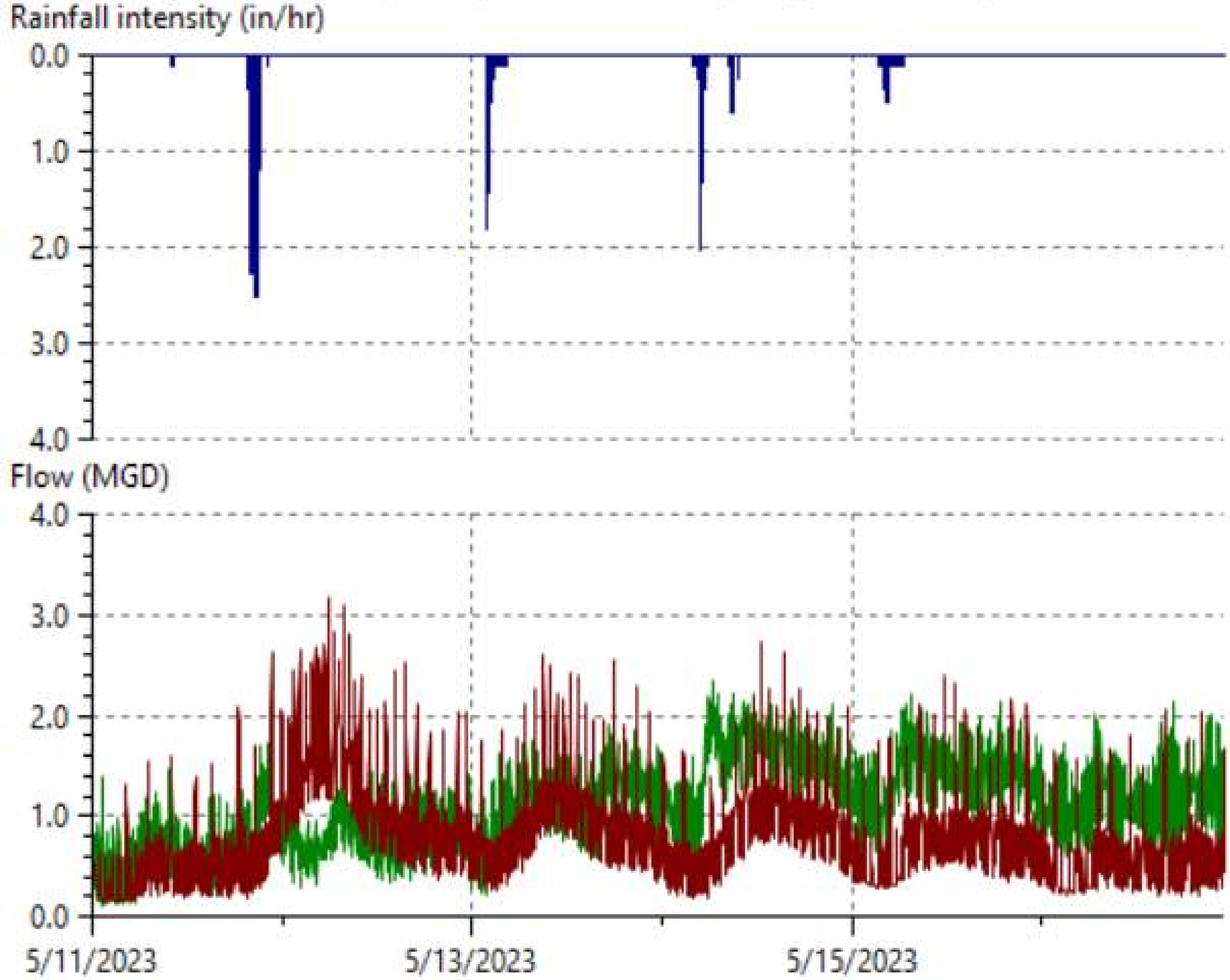


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.147	0.840	0.008			
Observed				1.091	6.037	18.507
Predicted				1.033	7.746	19.034



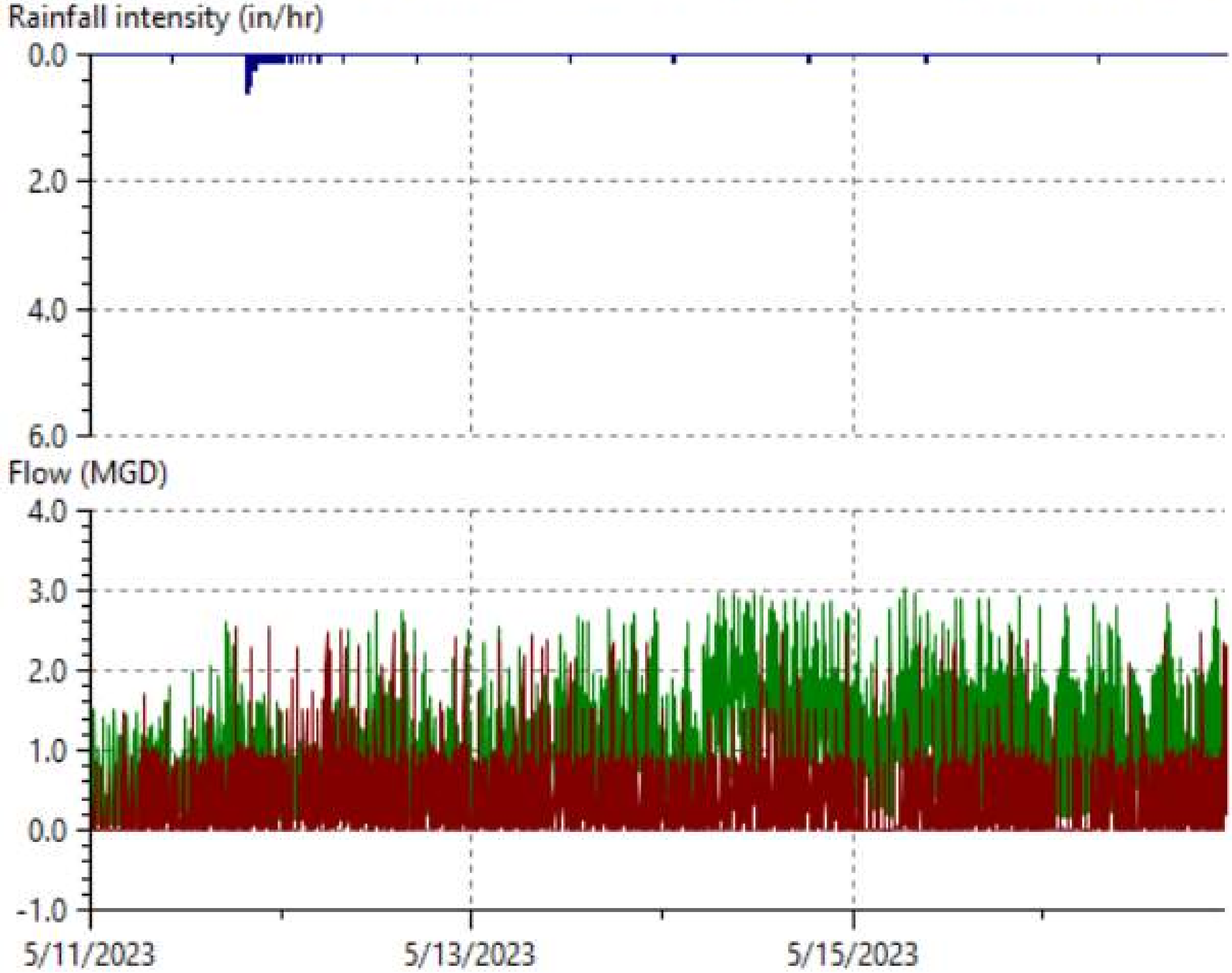
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.328	2.101	5.676
Predicted				0.331	3.015	6.151

Flow Survey Location (Obs.) BP-27, Model Location (Pred.) D/S 261092.1, Rainfall Profile: BP-24

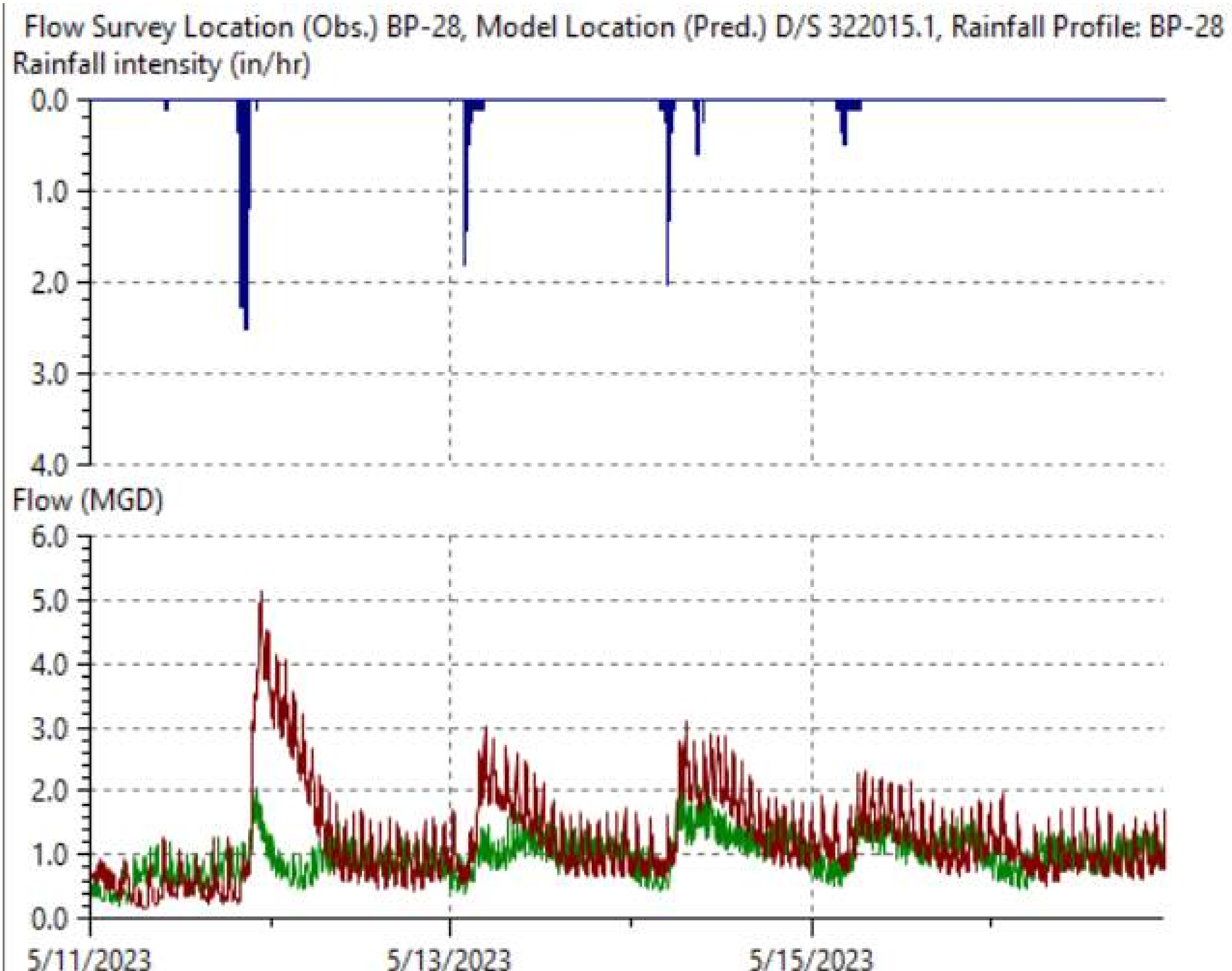


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.110	2.350	6.591
Predicted				0.134	3.172	4.798

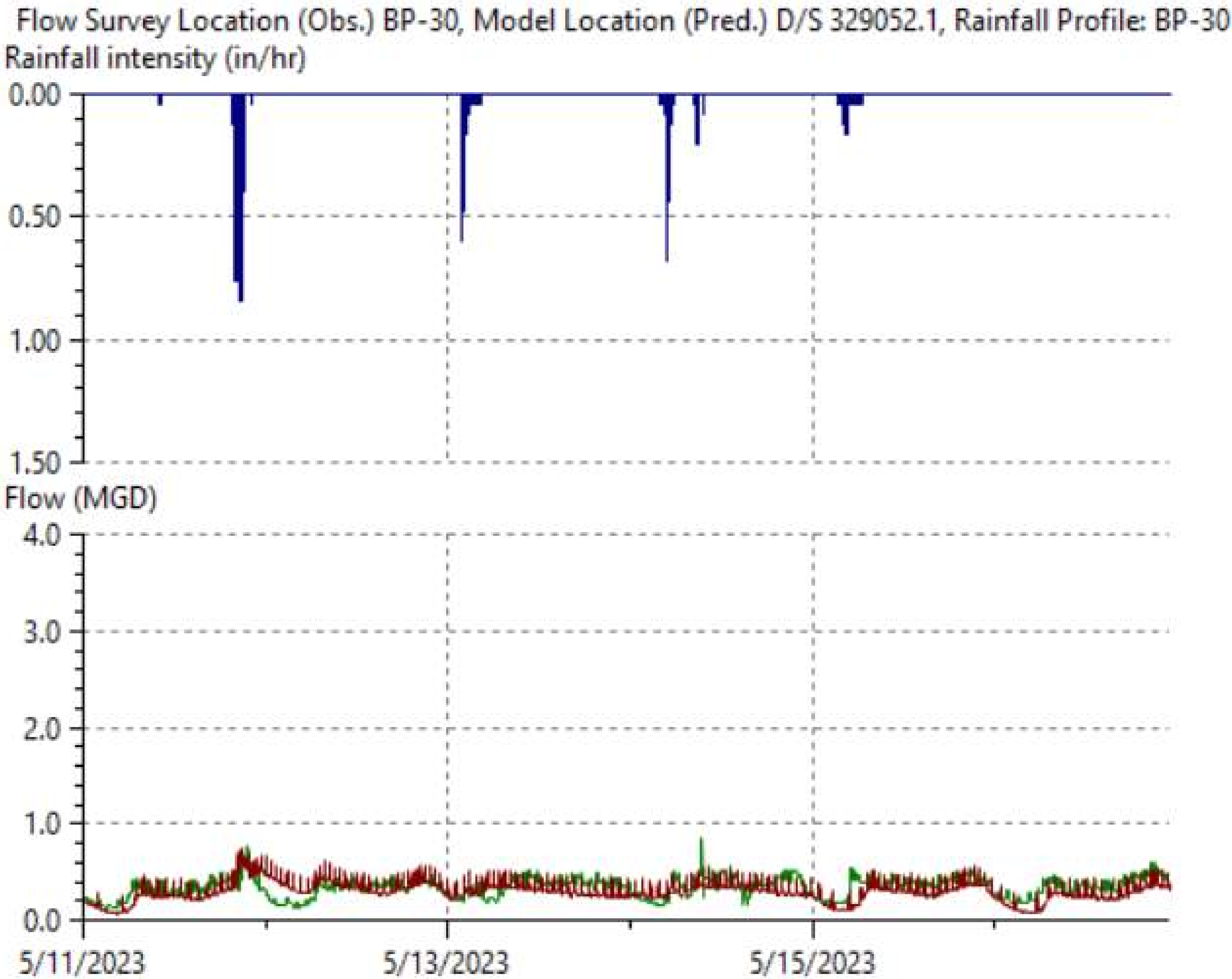
ow Survey Location (Obs.) BP-27-01, Model Location (Pred.) D/S 262078.1, Rainfall Profile: BP-27-



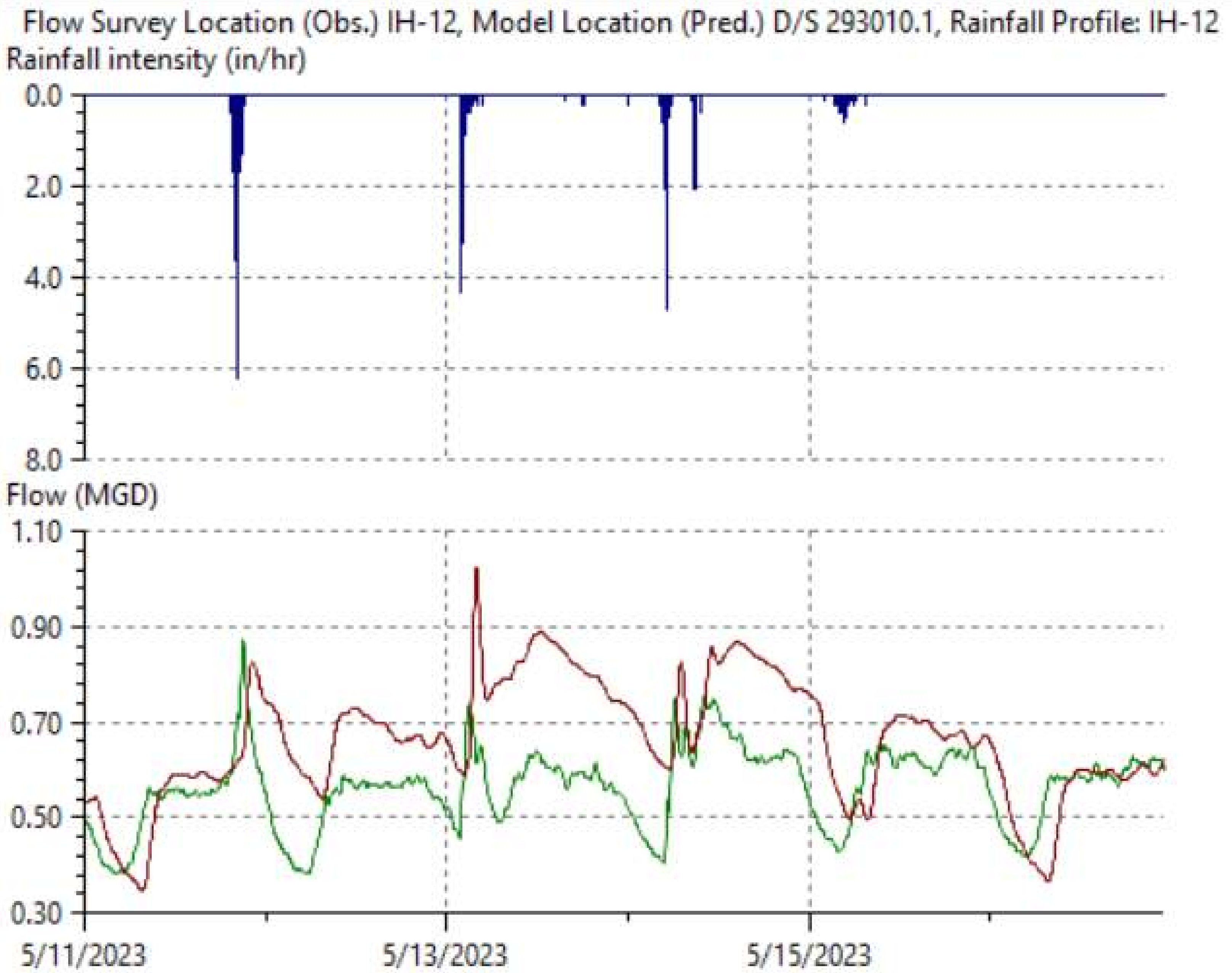
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	0.730	0.600	0.005			
Observed				0.044	3.046	5.693
Predicted				-0.000	2.557	2.248



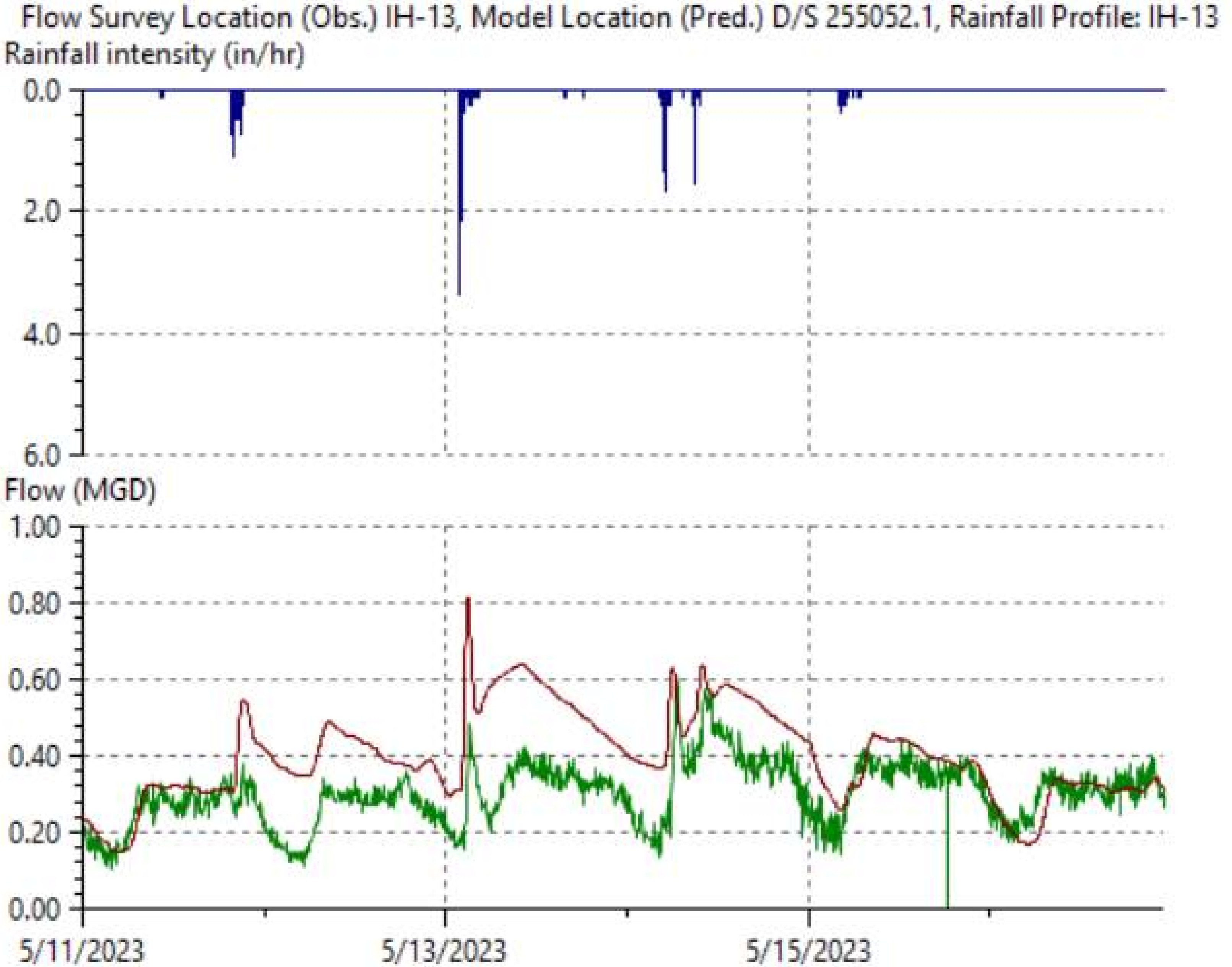
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.440	2.520	0.024			
Observed				0.209	2.198	5.894
Predicted				0.151	5.135	7.506



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.147	0.840	0.008			
Observed				0.117	0.860	2.045
Predicted				0.064	0.739	1.829

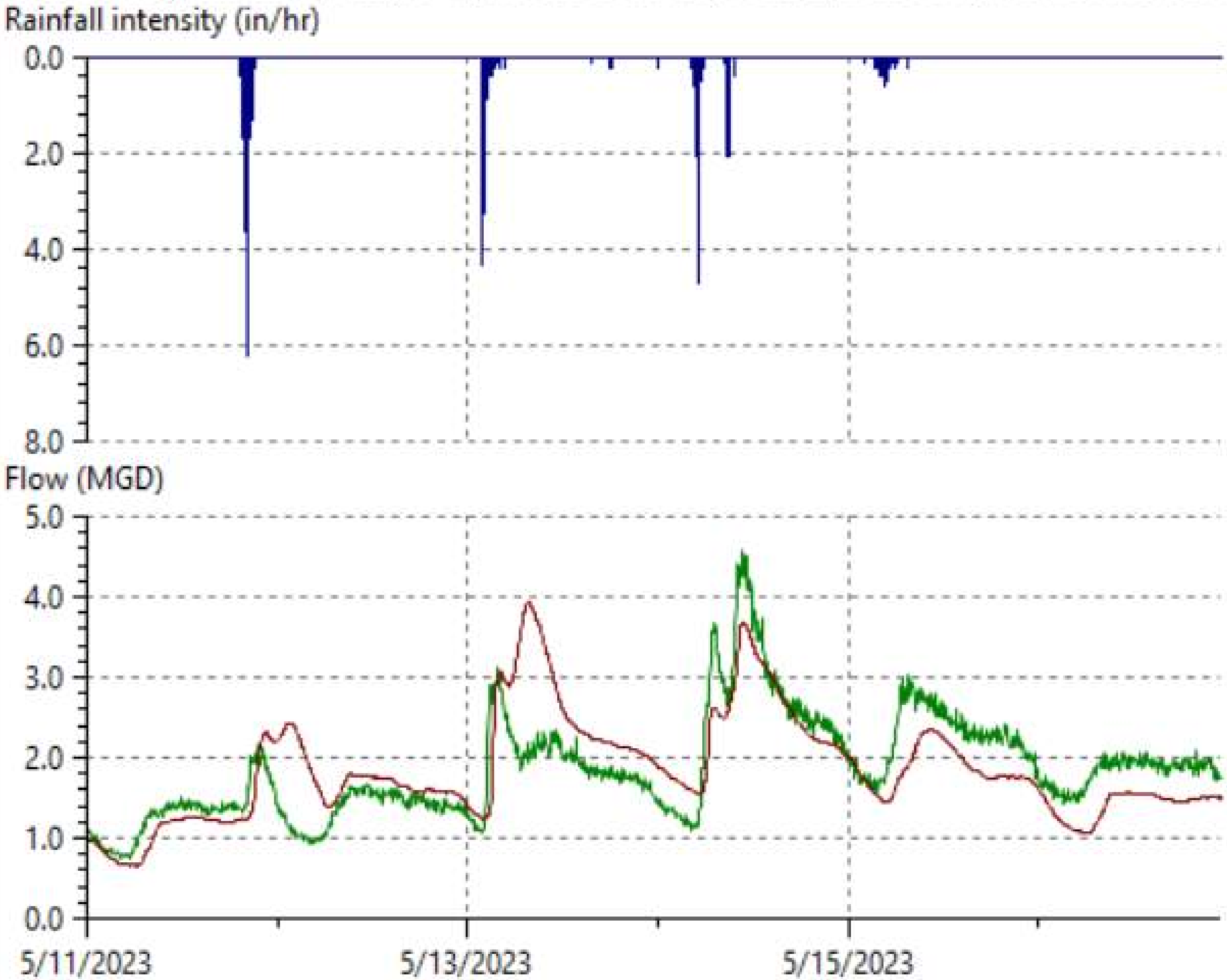


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	6.330	6.240	0.044			
Observed				0.381	0.874	3.353
Predicted				0.346	1.025	3.929



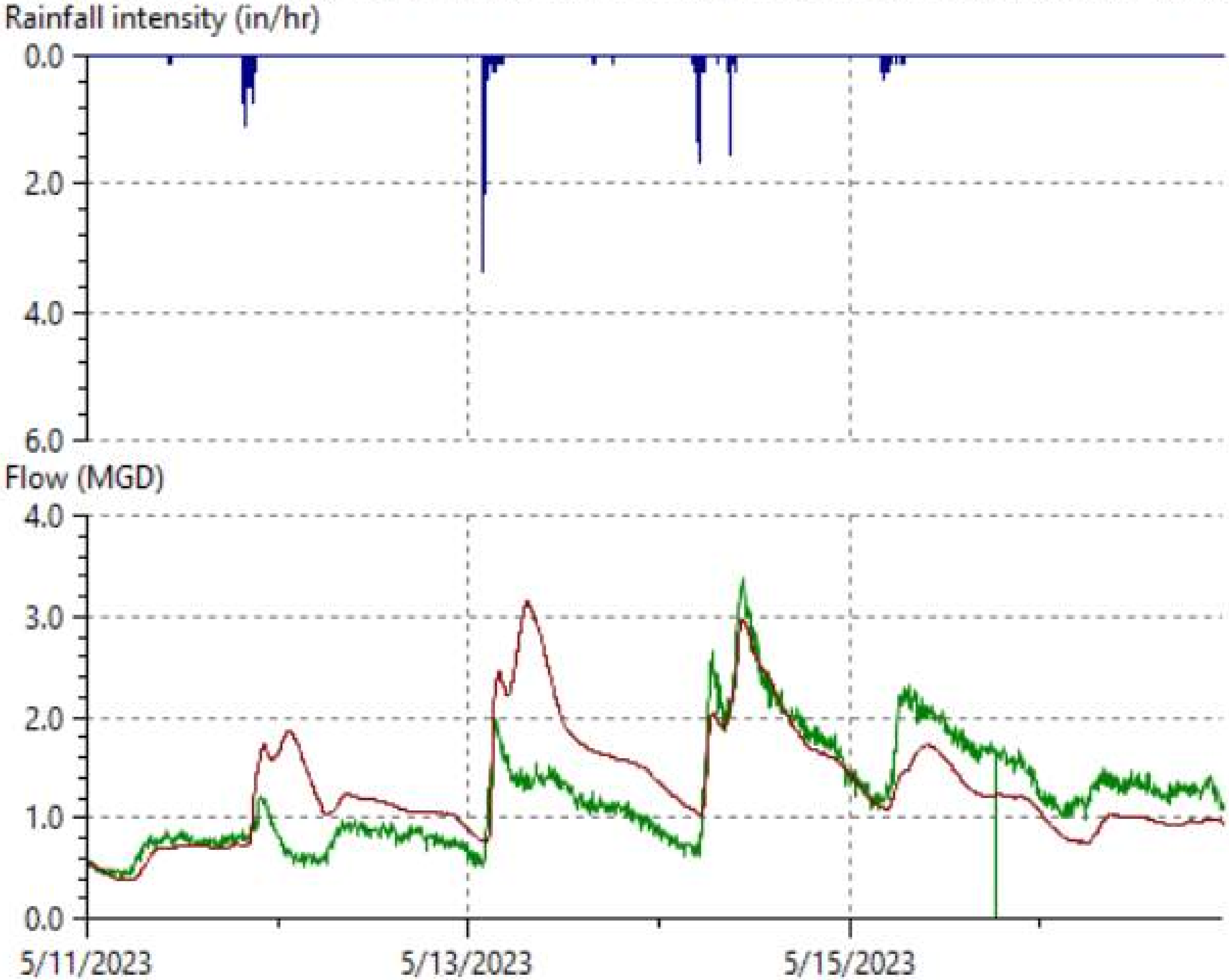
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.710	3.360	0.019			
Predicted				0.000	0.612	1.787
...w Meters				0.149	0.813	2.372

Flow Survey Location (Obs.) IH-14, Model Location (Pred.) D/S 283007.1, Rainfall Profile: IH-14

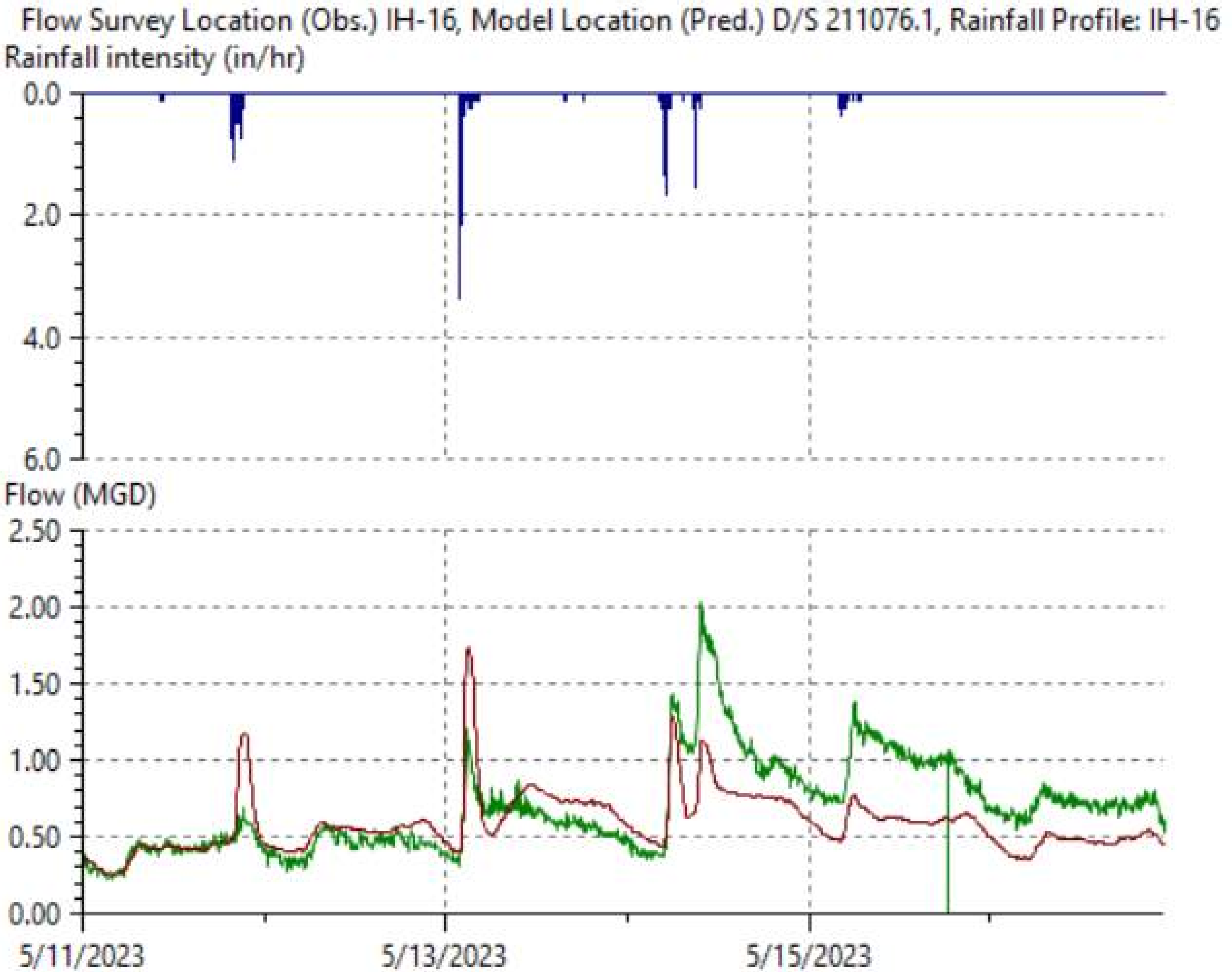


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	6.330	6.240	0.044			
Observed				0.746	4.596	11.169
Predicted				0.658	3.931	11.018

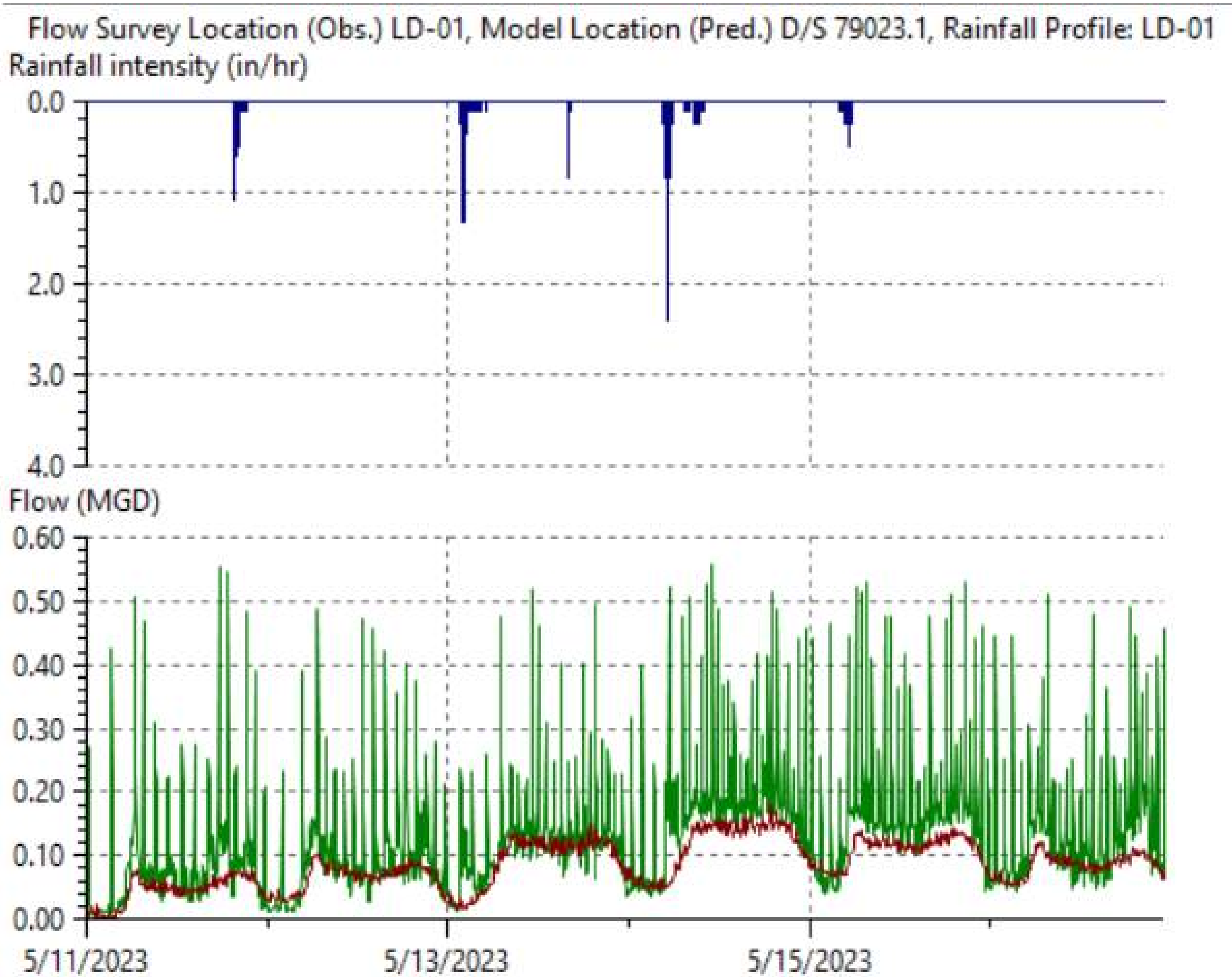
Flow Survey Location (Obs.) IH-15, Model Location (Pred.) D/S 241027.1, Rainfall Profile: IH-15



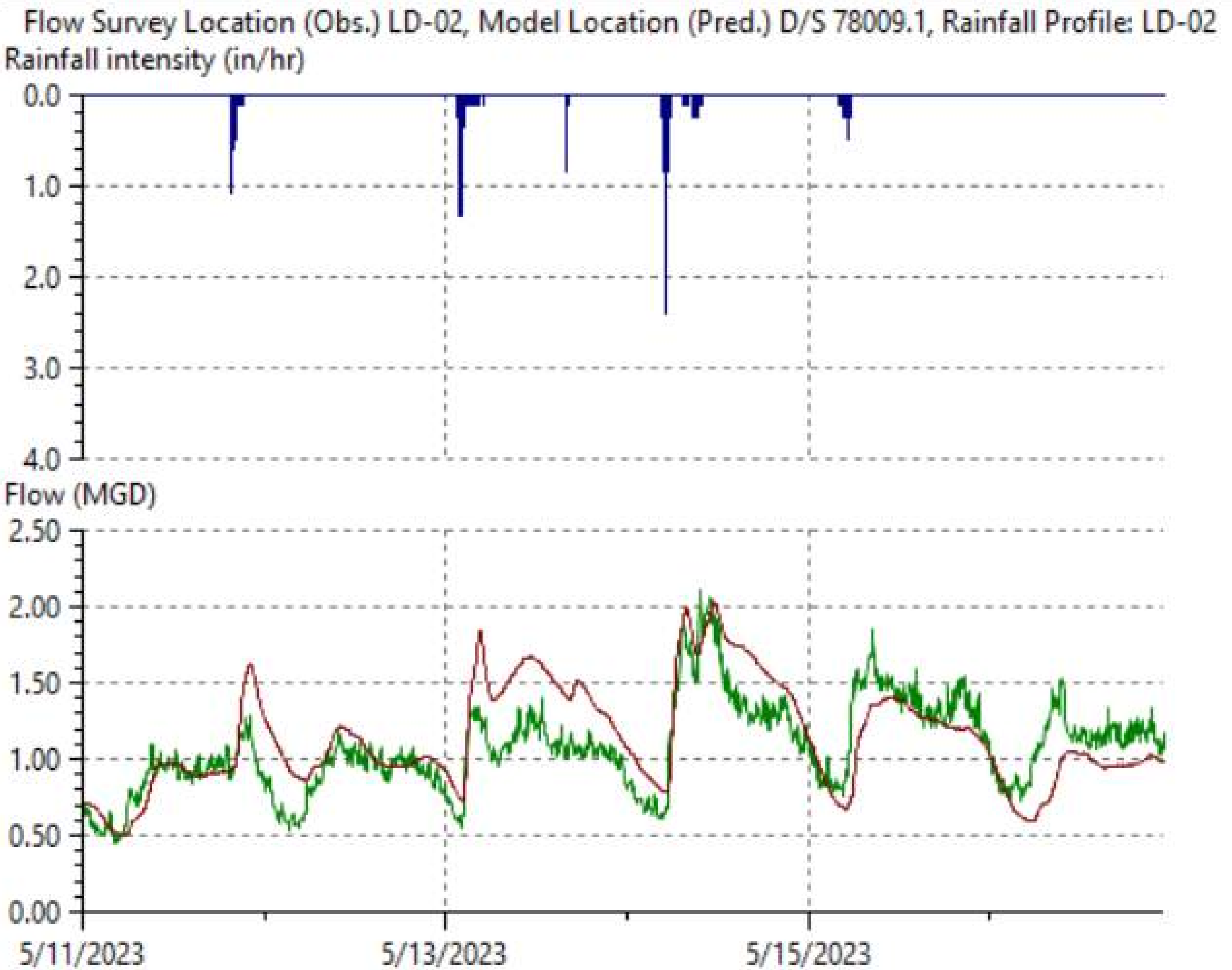
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.710	3.360	0.019			
Observed				0.000	3.380	7.383
Predicted				0.385	3.138	7.866



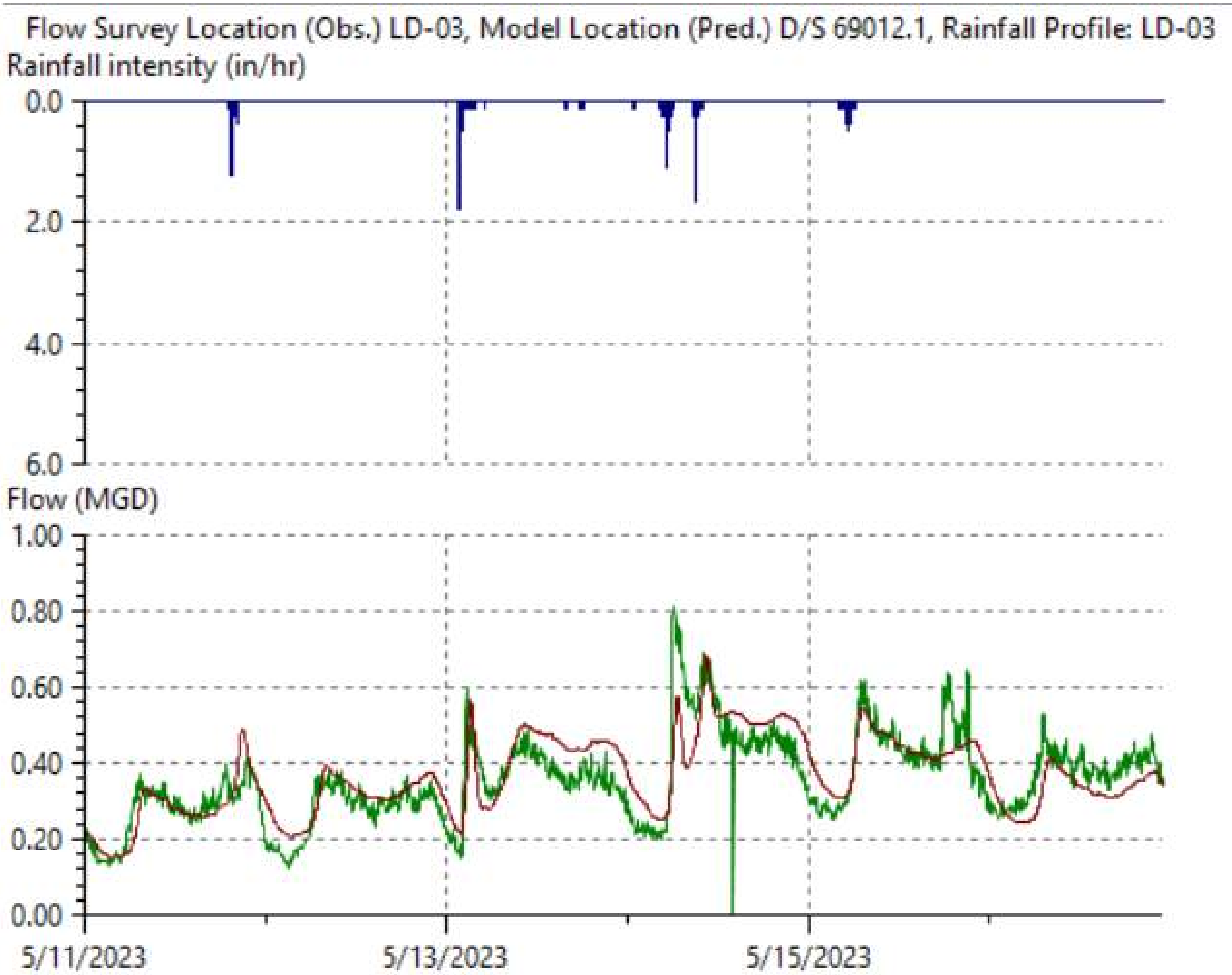
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.710	3.360	0.019			
Observed				0.000	2.027	4.126
Predicted				0.261	1.738	3.514



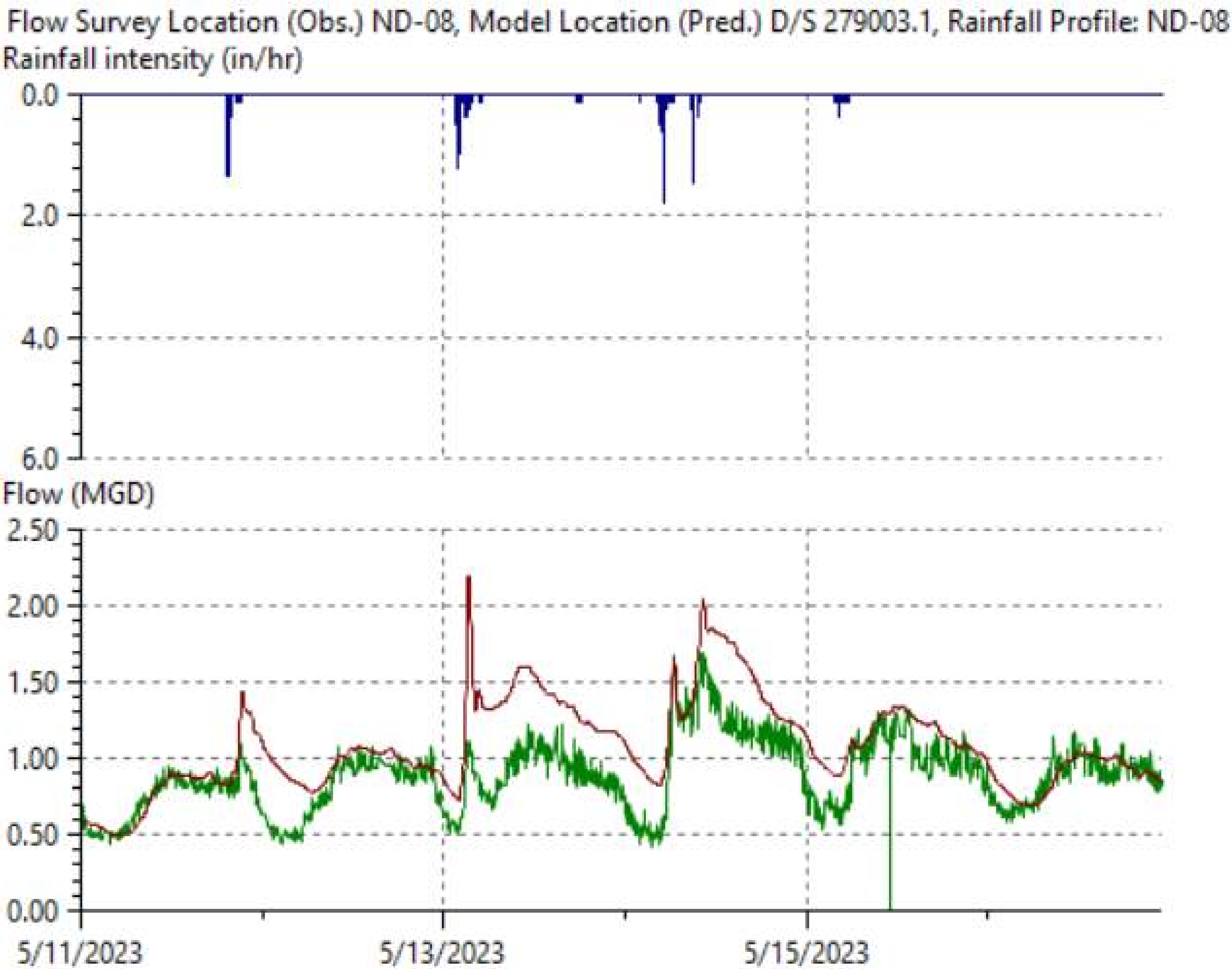
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.060	2.400	0.014			
Observed				0.005	0.557	0.795
Predicted				0.001	0.180	0.505



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.060	2.400	0.014			
Observed				0.445	2.120	6.432
Predicted				0.498	2.027	6.772

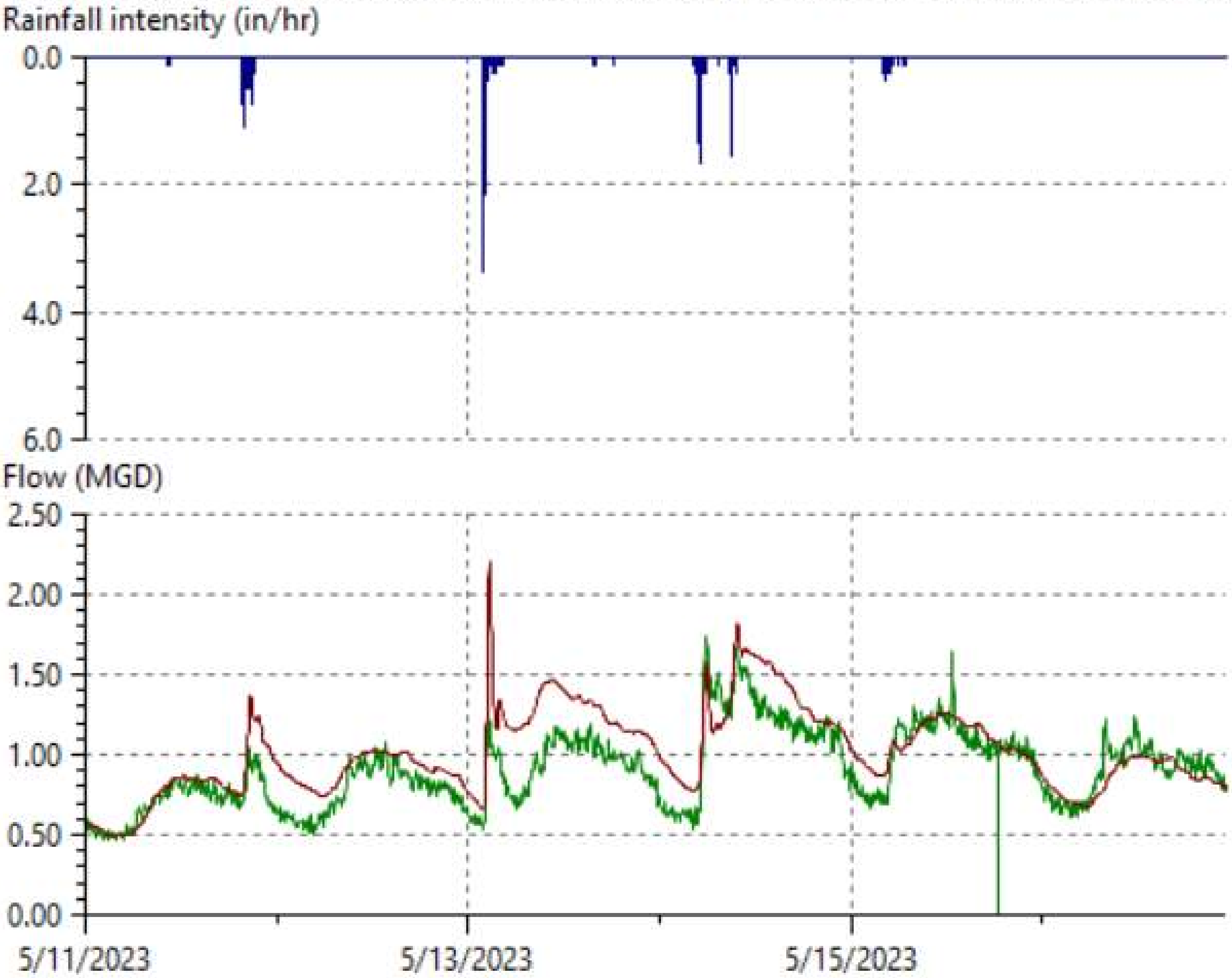


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.060	1.800	0.014			
Observed				0.000	0.815	2.124
Predicted				0.151	0.682	2.180



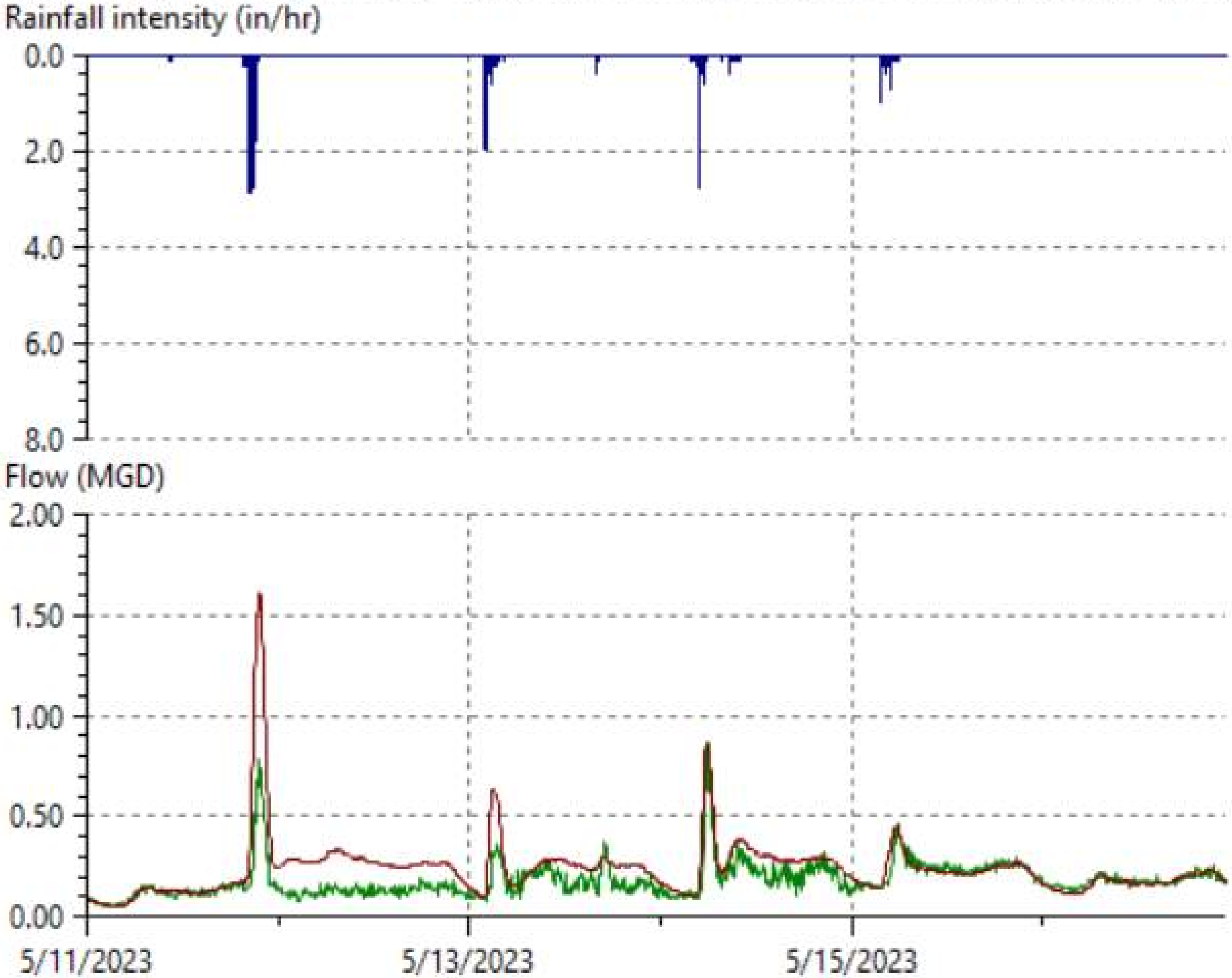
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.170	1.800	0.015			
Observed				0.000	1.697	5.273
Predicted				0.497	2.199	6.397

Flow Survey Location (Obs.) ND-09, Model Location (Pred.) D/S 208122.1, Rainfall Profile: ND-09



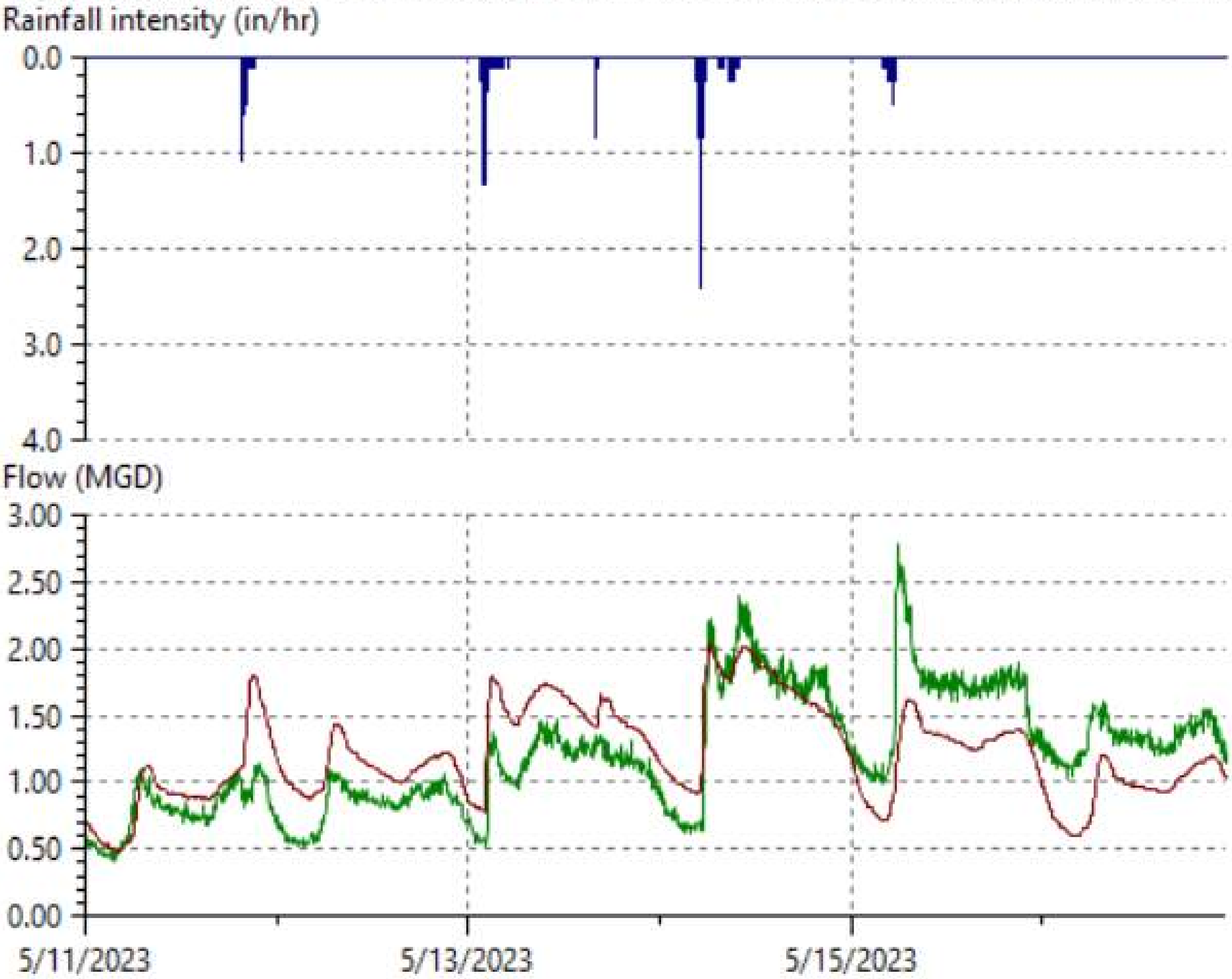
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.710	3.360	0.019			
Observed				0.000	1.744	5.410
Predicted				0.489	2.213	6.045

Flow Survey Location (Obs.) SV-01, Model Location (Pred.) D/S 301028.1, Rainfall Profile: SV-01



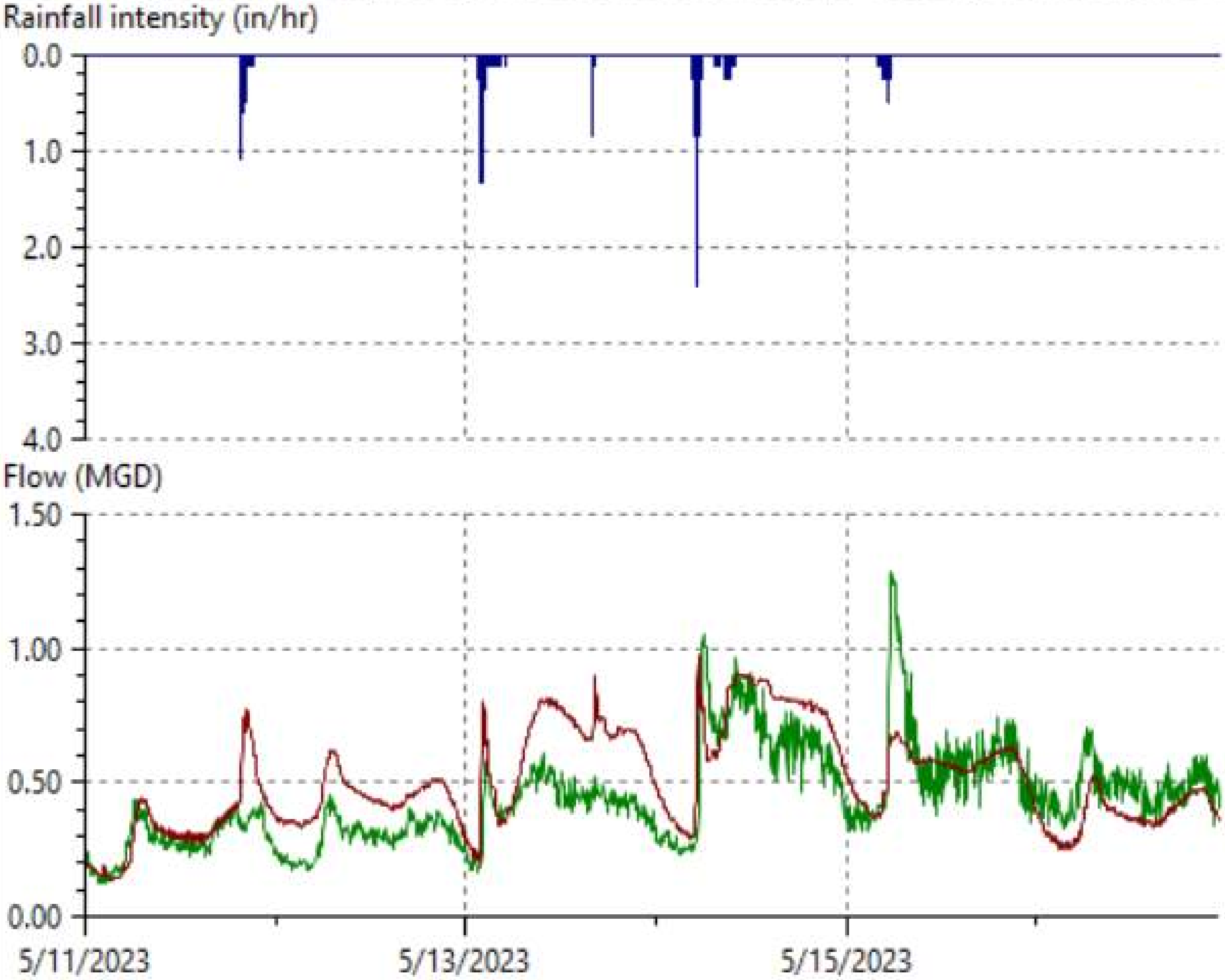
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	3.850	2.880	0.027			
Observed				0.051	0.869	1.082
Predicted				0.051	1.618	1.424

Flow Survey Location (Obs.) WC-30, Model Location (Pred.) D/S 79006.1, Rainfall Profile: WC-30

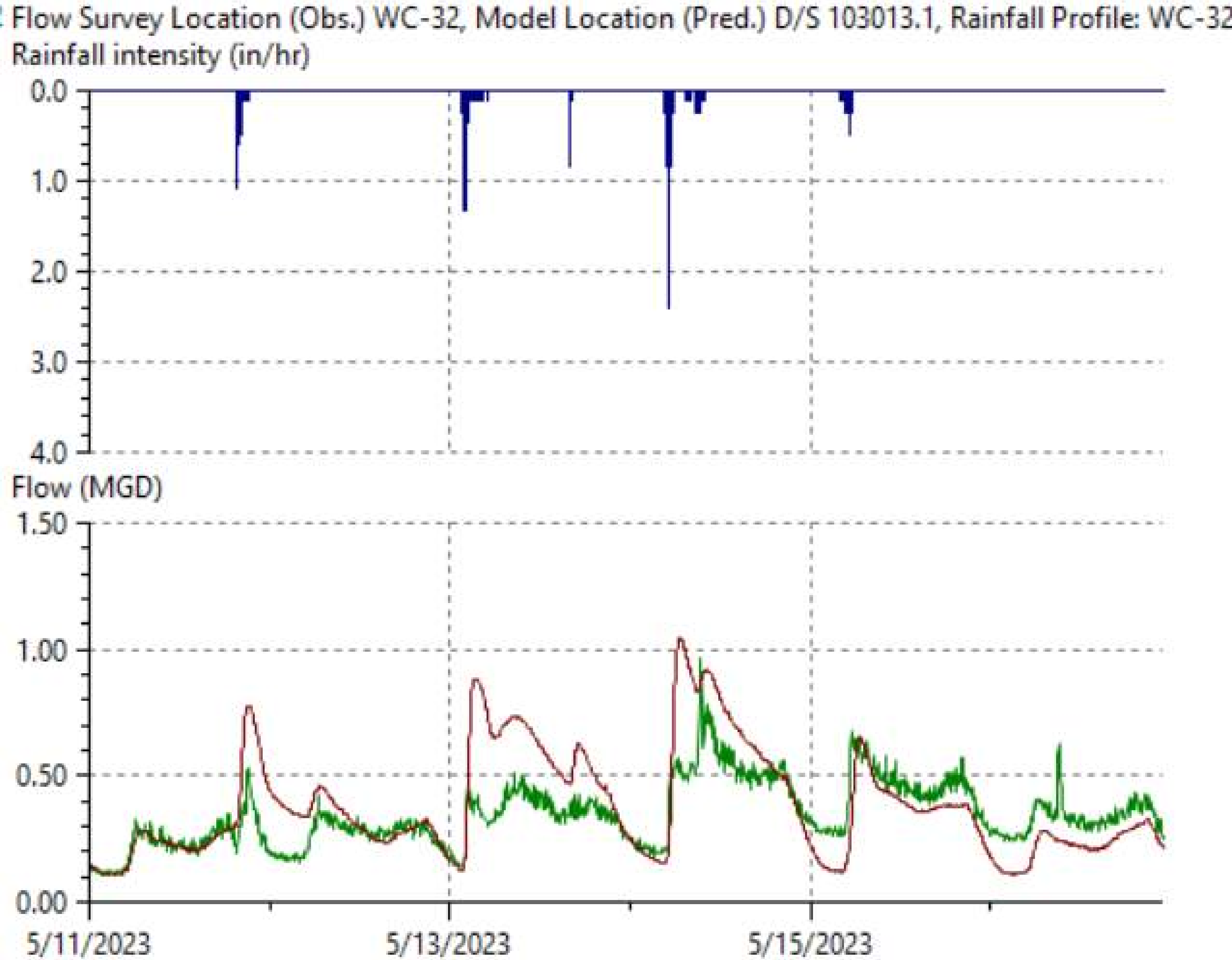


		Rainfall			Flow		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain		2.060	2.400	0.014			
Observed					0.409	2.789	7.197
Predicted					0.477	2.028	7.216

Flow Survey Location (Obs.) WC-31, Model Location (Pred.) D/S 105026.1, Rainfall Profile: WC-31

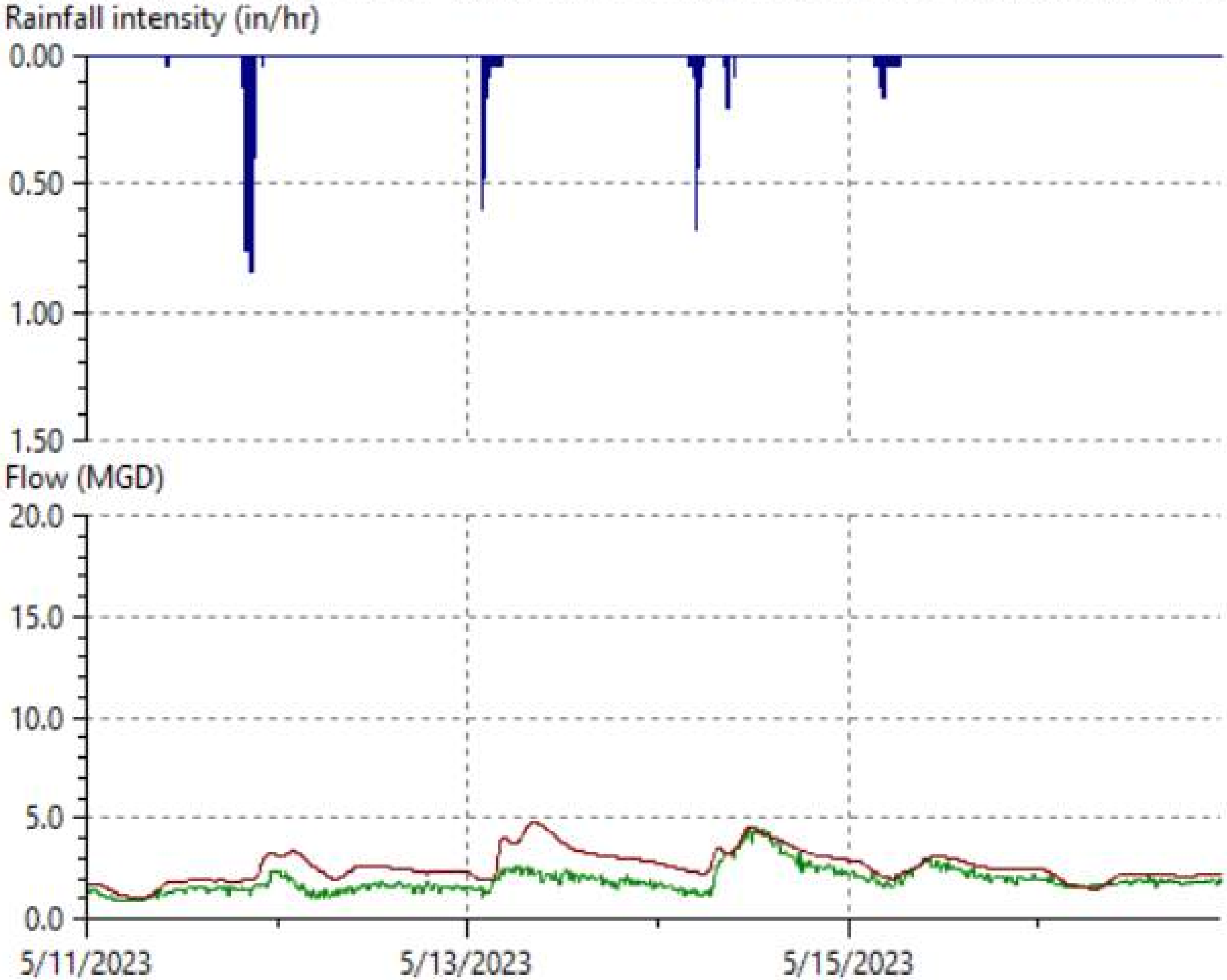


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	2.060	2.400	0.014			
Observed				0.126	1.285	2.640
Predicted				0.137	0.979	2.994

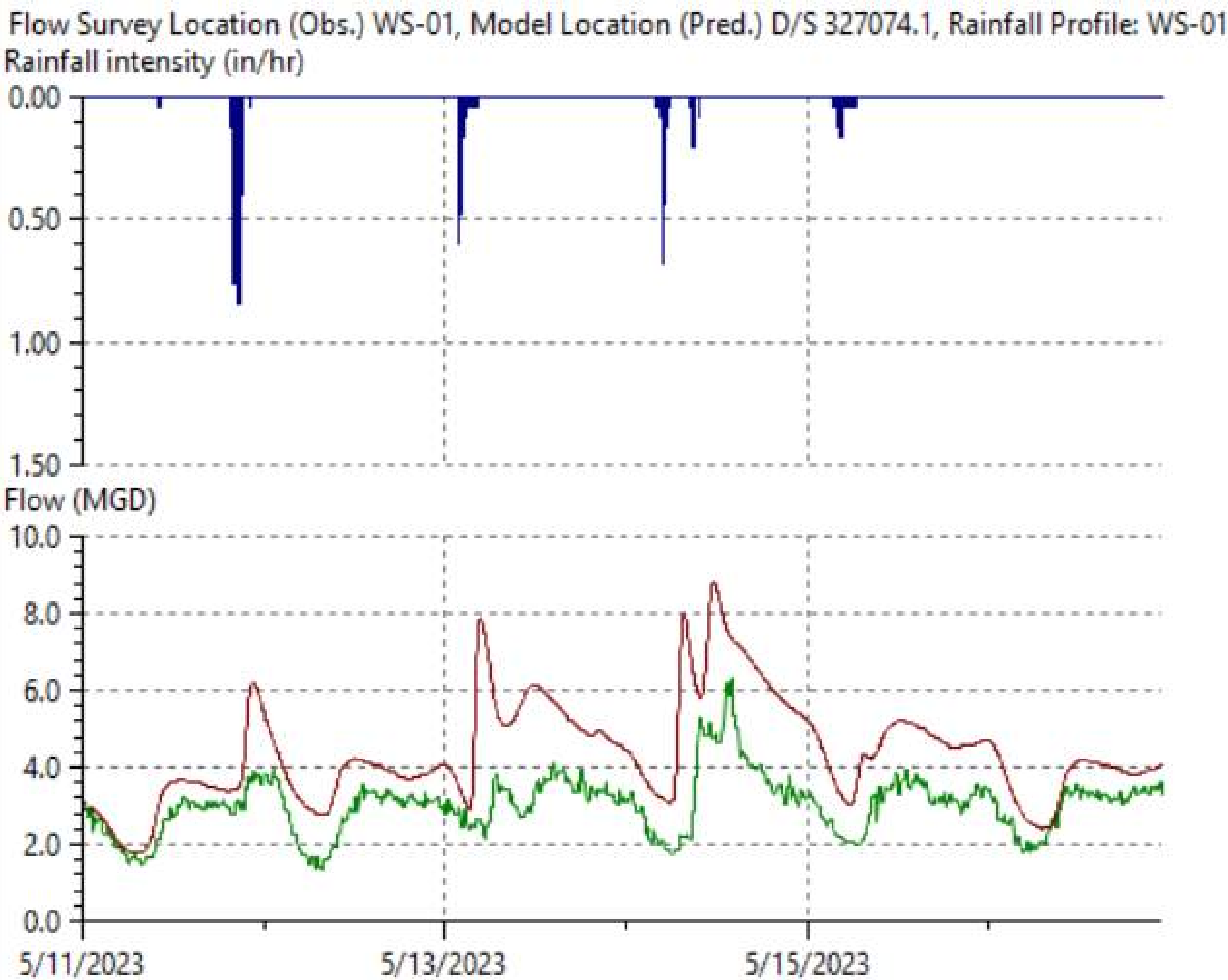


		Rainfall			Flow		
		Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain		2.060	2.400	0.014			
Observed					0.105	0.964	2.064
Predicted					0.110	1.049	2.271

Flow Survey Location (Obs.) WS-11, Model Location (Pred.) D/S 328046.1, Rainfall Profile: WS-11



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.147	0.840	0.008			
Observed				0.849	4.558	11.347
Predicted				1.032	4.760	15.311



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.147	0.840	0.008			
Observed				1.346	6.344	18.033
Predicted				1.774	8.813	26.001

APPENDIX I

WASTEWATER TREATMENT EVALUATION TECHNICAL MEMORANDUM

AIM NORMAN
AREA & INFRASTRUCTURE MASTER PLAN

WASTEWATER TREATMENT EVALUATION TECHNICAL MEMORANDUM

DRAFT

CITY OF NORMAN AND NORMAN UTILITIES AUTHORITY
NORMAN, OKLAHOMA

AIM NORMAN
AREA & INFRASTRUCTURE MASTER PLAN

Prepared by:

GARVER

In Partnership with:

RDG PLANNING • DESIGN

DRAFT
February 2025

Garver Project No. 22W02320
Norman Project No. WA0385

Engineer's Certification

I hereby certify that this Wastewater Treatment Evaluation Technical Memorandum for the City of Norman Area & Infrastructure Master Plan was prepared by Garver under my direct supervision for the City of Norman and Norman Utilities Authority.

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF MICHAEL C. NIBLETT PE#32400, NOVEMBER 2024. IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING, OR PERMITTING PURPOSES.

Cole Niblett, PE
State of Oklahoma PE License 32400

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Josef N. Dalaeli, PE
State of Oklahoma PE License 29918

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List of Acronyms

Acronym	Definition
ADF	average day flow
AIM	Area & Infrastructure Master
BNR	biological nutrient removal
BOD	biological oxygen demand
CIP	Capital Improvement Plan
City	City of Norman
IPR	indirect potable reuse
LCC	life cycle cost
LS	lift stations
MG	million gallons
MGD	million gallons per day
MMDF	max month daily flow
NPDES	National Pollution Discharge Elimination System
NUA	Norman Utilities Authority
O&M	operations and maintenance
ODEQ	Oklahoma Department of Environmental Quality
OPCC	opinion of probable construction costs
OTE	Oxygen Transfer Efficiency
PS	primary sludge
RAS	return activated sludge
SCFM	standard cubic feet per minute
SLR	solids loading rate
SOR	standard oxygen requirement
TM	Technical Memorandum
TPC	total project cost
TSS	total suspended solids
UV	ultraviolet
VSS	volatile suspended solids
WAS	waste activated sludge
WLR	wastewater loading rate
WRF	water reclamation facility

Executive Summary

The City of Norman and the Norman Utilities Authority (NUA) are creating a comprehensive plan called AIM Norman. This plan covers various aspects of city planning, such as land use, transportation, stormwater management, water and wastewater infrastructure, parks, and housing. AIM Norman will update existing plans for NUA's infrastructure.

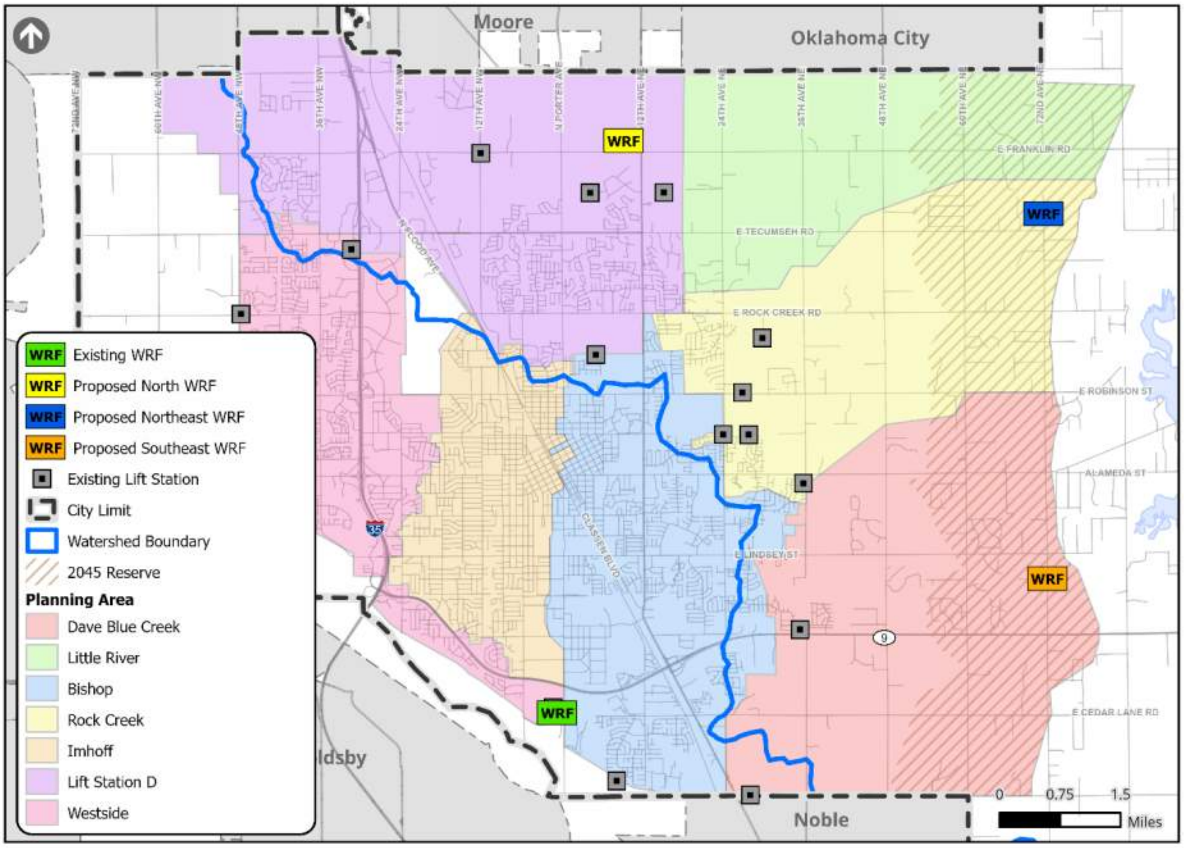
This technical memorandum will guide future tasks in the Wastewater Utility Master Plan. It looks at options for meeting future wastewater needs, identifies necessary improvements, and explores water reuse possibilities at current and new sites for a future water reclamation facility (WRF). It includes:

- Analysis of past wastewater flows and loads at the current WRF
- Criteria for future capacity needs
- Evaluation of the current WRF's capacity for future demands
- Options for future wastewater treatment
- Options for using treated wastewater as a water supply

These options are evaluated based on life cycle costs, including initial capital costs and ongoing operations and maintenance costs. The location of the WRF is important due to long-term costs related to building out the conveyance system. All costs are estimated over a 20-year period.

The project team conducted a thorough review of historical data spanning several years to establish the planning criteria for wastewater treatment evaluation and sizing of a potential new WRF. Using projected flows derived from previous baseline development efforts, it is anticipated that the entire system will generate a future average day flow (ADF) of 17.8 million gallons per day (MGD) of wastewater (including 10% reserve capacity). This TM evaluates the capacity to treat this flow either entirely at the existing WRF or through a combination of the existing facility and a new WRF in one of three potential locations, shown in Map ES-1. A gap analysis is performed to identify the necessary scope of improvements at the existing WRF, which is currently rated for 16 MGD but can be expanded to accommodate the projected 17.8 MGD annual average daily flow.

Map ES-1: Summary of WRF Alternatives

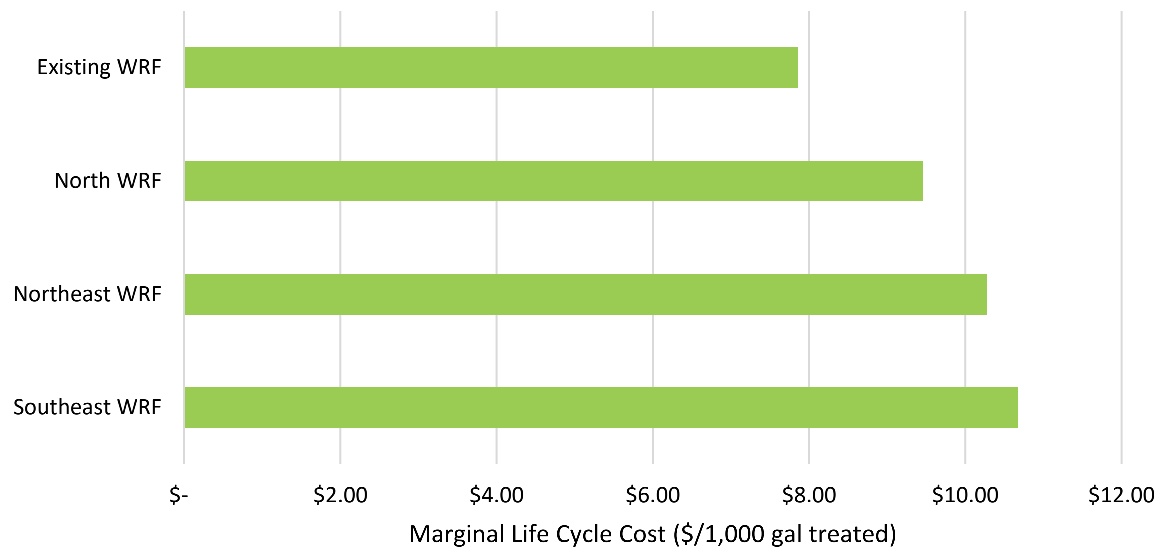


Detailed life cycle cost (LCC) comparisons support the conclusion that expanding the existing WRF is the most financially sound option for wastewater treatment, with a marginal LCC of $7.86 per thousand gallons (kgal) of wastewater treated. The costs of a new WRF are 20-40% higher, varying by location. Figure ES-1 shows the marginal LCC comparison of wastewater alternatives. Marginal LCC is calculated based on the anticipated marginal cost to upgrade, operate, and maintain the existing plant and conveyance system vs. build an additional one for the forecasted capacity need. The intention of marginal LCC is to provide a basis for comparing relative costs, not to capture all possible costs or serve as the basis for budgeting. Many of these costs would come in phases and will depend on the actual growth and flows experienced over time.

A new WRF could still be considered for future development. The majority of population growth is anticipated in the northern and eastern parts of the City, and significant collection system improvements will be required regardless of the selected option. A decision on constructing a new WRF can be made later, depending on how actual flows are realized within the system. Although not the most cost-effective solution, a new WRF could offer advantages by reducing the need for long-distance pumping from the northern and northeastern areas of the City to the existing WRF, which is located to the south.

Figure ES-1: Marginal LCC Comparison of Wastewater Alternatives

The marginal LCC is determined by comparing the expected marginal costs of upgrading, operating, and maintaining the existing plant and conveyance system versus constructing a new facility.



1.0 INTRODUCTION

The City of Norman (City) and the Norman Utilities Authority (NUA) are developing an Area & Infrastructure Master Plan (AIM Norman) that will cover a wide spectrum of city planning aspects including land use, transportation, stormwater management, water infrastructure, wastewater infrastructure, parks, and housing. The AIM Norman effort includes updates to related master plans for NUA's infrastructure including transportation, stormwater, water, and wastewater. This technical memorandum will serve as the basis for CIP development in forthcoming Wastewater Utility Master Plan Tasks. It evaluates alternatives for addressing NUA's future wastewater demands, identifies necessary capital improvements, and examines water reuse options at both existing sites and potential new locations for a future water reclamation facility (WRF). It includes:

- Analysis of historical wastewater flows and loadings entering the existing WRF
- Planning criteria for future required capacity
- Capacity evaluation of the existing WRF considering future needs
- Alternatives for meeting future wastewater treatment needs
- Alternatives for incorporating reuse as a possible water supply

Alternatives are evaluated based on marginal life cycle costs (LCC), considering both the estimated upfront capital expenditure required to implement each option as well as the operations and maintenance (O&M) cost projections. Because WRF location selection will have long-term cost impacts associated with conveyance buildout, conveyance capital costs are estimated for the buildout capacity. All other expenditures have been estimated over a 20-year horizon.

1.1 WASTEWATER SYSTEM OVERVIEW

The NUA wastewater system serves the urban area within the City limits. The wastewater system includes two primary components:

- Wastewater Collection System-The gravity sewers, lift stations, and force mains that collect sewage from each customer and convey it to the treatment facility.
- WRF-The treatment facility that treats sewage received from the collection system and returns highly treated water to the Canadian River.

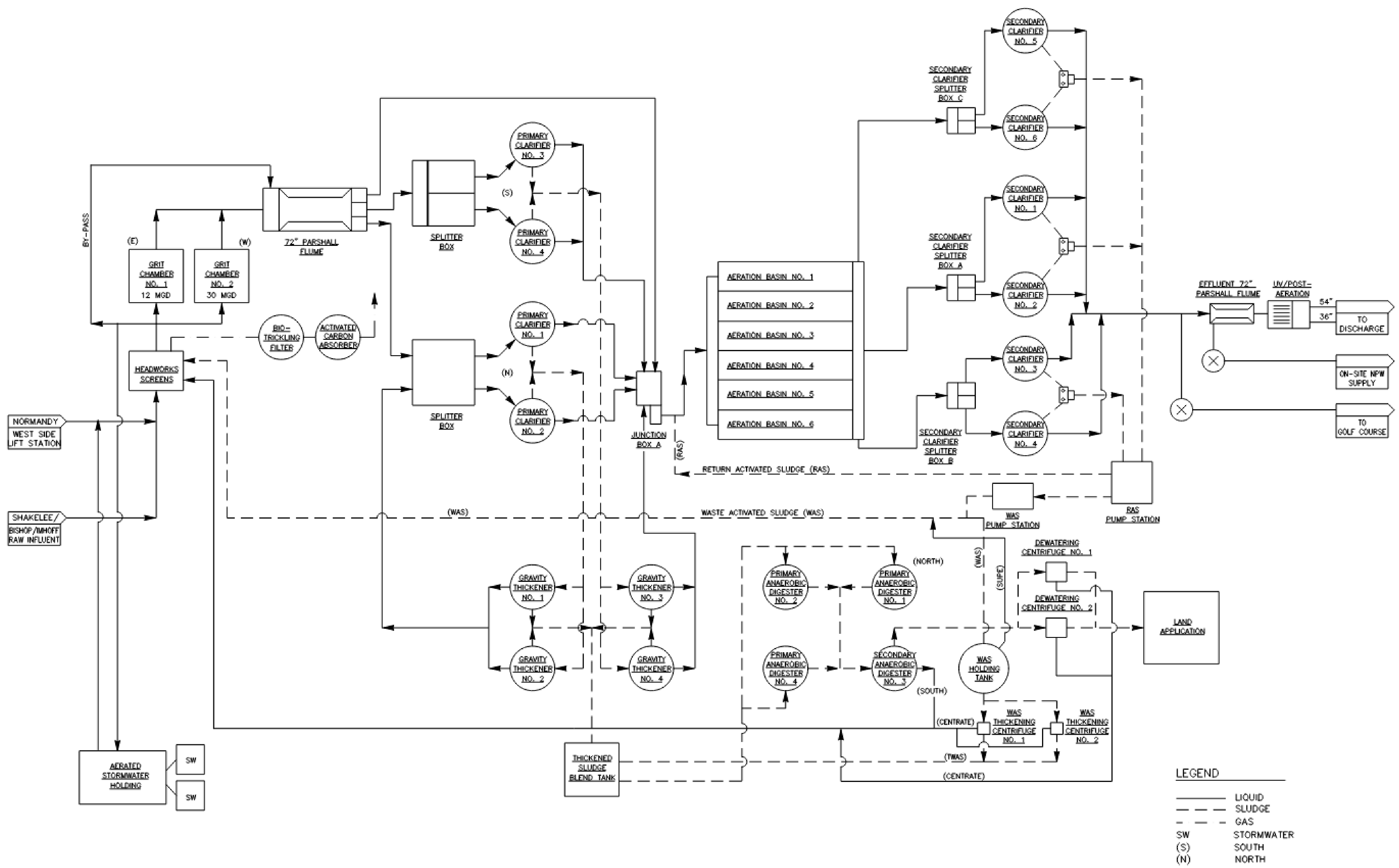
1.2 EXISTING WATER RECLAMATION FACILITY

NUA's single existing WRF is located south of Highway 9 off Jenkins Avenue in the southern portion of the wastewater service area. It is currently permitted for 16 million gallons per day (MGD) average day flow (ADF) by Oklahoma Department of Environmental Quality (ODEQ). A process flow diagram for the existing plant is shown in Figure 1-1. The plant consists of the following:

- Fine screens
- Grit removal

- Stormwater holding ponds
- Primary clarification with gravity thickeners
- Conventional activated sludge
- Secondary clarification with waste activated sludge (WAS) thickening centrifuges
- Ultraviolet (UV) disinfection
- Post-aeration
- Anaerobic digesters
- Dewatering centrifuges

Figure 1-1: Existing WRF Process Flow Diagram



NUA's WRF's National Pollution Discharge Elimination System (NPDES) permit requirements are provided in Table 1-1, with two added rows for anticipated total nitrogen and total phosphorous limits that could be implemented on new permits in the future. These limits maintain the quality of treated wastewater and regulatory compliance, and will therefore be used as a basis for evaluation of the existing WRF in this TM.

Table 1-1: Existing WRF NPDES Discharge Permit Limits

Effluent Characteristic		**Discharge Limitations**				**Monitoring Requirements**	
		Mass Loading (lbs/day)	**Concentrations (mg/L unless otherwise specified)**			**Frequency**	**Sample Type**
		Monthly Avg.	Monthly Avg.	Weekly Avg.	Daily Max.		
Flow	Year Round	---	Report	---	Report	Continuous	Totalized
Carbonaceous Biochemical Oxygen Demand - 5 Day (CBOD5)	Apr-May	1734.7	13.0	19.5	---	Daily	24-hr Composite
	Jun-Oct	1067.5	8.0	12.0	---		
	Nov-Mar	3336.0	25.0	37.5	---		
Total Suspended Solids	Jun-Oct	1334.4	10.0	15.0	---	Daily	24-hr Composite
	Nov-May	4003.2	30.0	45.0	---		
Ammonia (NH_3-N)	Jun-Oct	213.5	1.6	2.4	---	Daily	24-hr Composite
	Nov-May	547.1	4.1	6.2	---		
Total Nitrogen (NOT IN CURRENT PERMIT)	*Year Round*		*10*	*15*	---	*Daily*	*24-hr Composite*
Total Phosphorous (NOT IN CURRENT PERMIT)	*Year Round*		*1*	*1.5*	---	*Daily*	*24-hr Composite*
E. Coli (MPN/100mL)	Jun-Oct	---	126[b]	---	406	2/week	Grab
	Nov-May	---	630[b]	---	2030	1/week	
Dissolved Oxygen (DO)	Jun-Oct	---	6.5 (Minimum)			Daily	Grab
	Nov-May	---	5.0 (Minimum)				
pH (standard unit)	Year Round	---	6.5-9.0			Daily	Grab

[a] Ammonia analysis shall also be performed concurrently with and on all samples collected for WET testing at Outfall 001 (see WET testing requirements in Permit Part I.B). Results from concurrent ammonia analyses for Outfall TX1 may be used in partial fulfillment of ammonia monitoring requirements at Outfall 001.

[b] Monthly data for E. coli is reported as geometric mean of all samples in that month.

2.0 HISTORICAL DATA REVIEW

In this section, historical data is analyzed with the goal of finding data-supported planning criteria, which will be summarized in the following section.

2.1 HISTORICAL WATER RECLAMATION FACILITY FLOWS

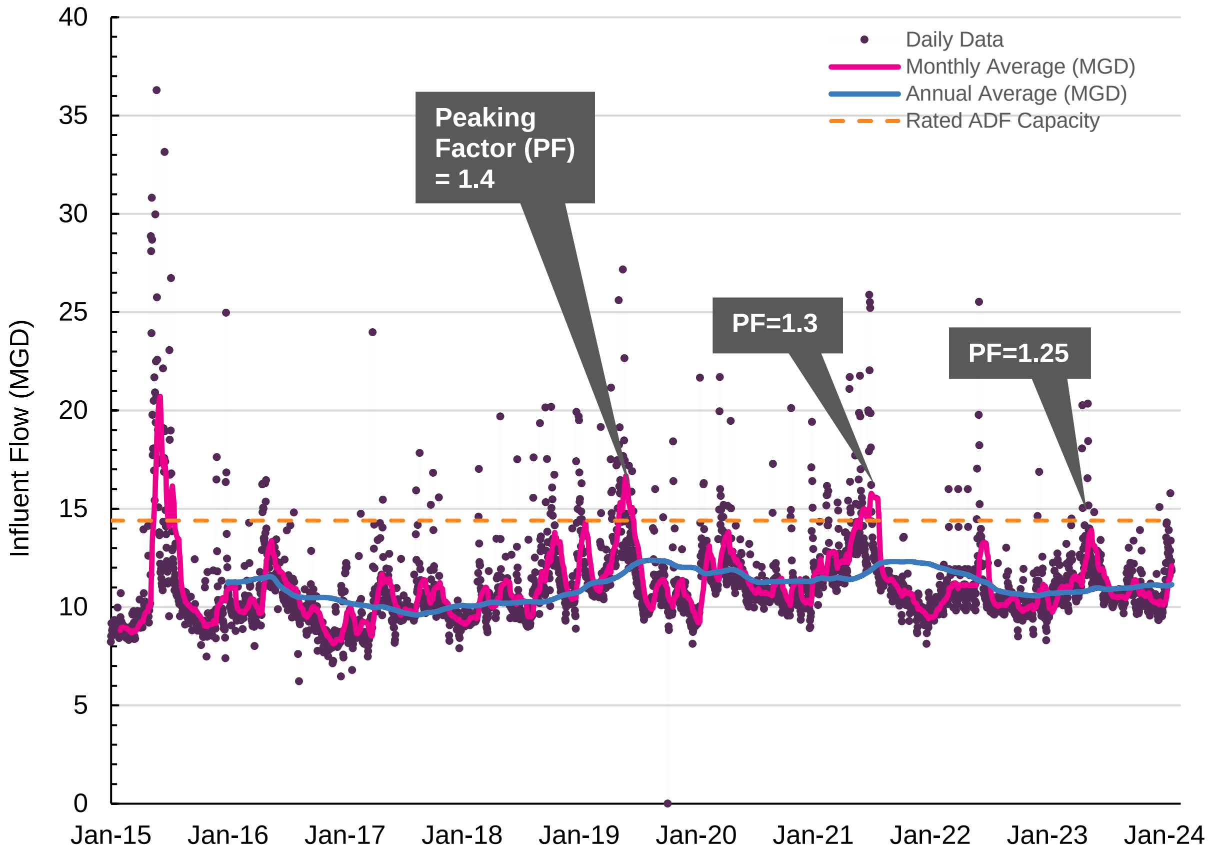
Figure 2-1 illustrates the historical influent flow to the WRF spanning from January 2015 to January 2024. This data as well as a special sampling period of collection system flow monitoring, is covered in more detail in the Wastewater Utility Master Plan. The figure includes daily data points along with lines representing the annual and monthly averages. Rolling averages are taken on a 30-day (monthly) and a 365-day (annual) basis for the influent flow data. Peaking factors are calculated according to the equation below. Here, the monthly average influent flow is divided by the annual average influent flow at a specific date to calculate the peaking factor. A peaking factor represents a peak month condition when the facility receives maximum flow and potentially maximum contaminant loadings over the course of a consecutive 30-day period. The identified peaking factor(s) can be used in establishing the proper maximum month conditions when the facility receives maximum levels of loadings over a month.

$$\textbf{Max Monthly Peaking Factor}(\textbf{Date}) = \frac{\textbf{30-day Average Flow }(\textbf{Date})}{\textbf{365-day Average Flow }(\textbf{Date})}$$

The data from 2015 indicates a period of elevated flows, with daily rates reaching up to 36 MGD. However, the subsequent time frame demonstrates a more consistent flow pattern. May 2015 experienced record rainfall (23.4 inches), leading to exceptionally high flows. While the methodology employed does not allow for an exact calculation of the mid-2015 annual average flow, it is estimated that the peak flow observed in 2015 had a peaking factor of nearly 2. This peak significantly exceeds the peaking factors recorded in subsequent years and surpasses the typical peaking factors for a municipal treatment facility of comparable size. summarizes the historical rainfall from 2002 to 2024 and showcases the level of intensity of the May 2015 rainfall relative to other years.

Between 2016 and January 2024, monthly average peaks fluctuated within an estimated range of 13.0 to 16.6 MGD. Although there has been a slight increase in the annual average flow since 2018, it has remained relatively stable, hovering around 11 to 12 MGD. A peaking factor of 1.4 is used for treatment capacity planning purposes within this project.

Figure 2-1: Historical Daily Influent Flows to WRF for January 2015 to January 2024



2.2 HISTORICAL INFLUENT LOADINGS

In this section, influent wastewater quality parameters biological oxygen demand (BOD), TSS, and ammonia (NH_3-N) are discussed in terms of contaminant loadings for the period of January 2019 through January 2024. For each parameter, loading is calculated using the equation below and daily influent flow values from the same dataset:

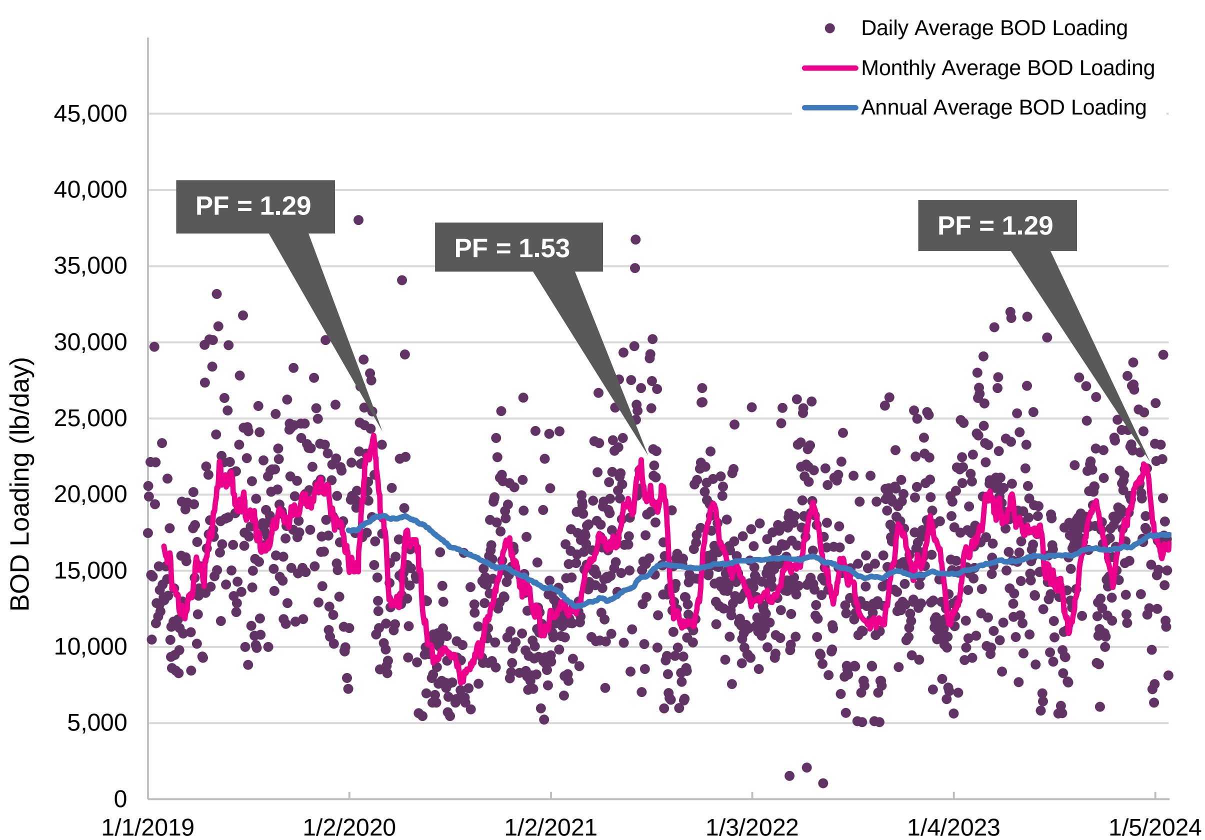
$$Load(lb/d) = Flow(MGD) \times Concentration(mg/L) \times 8.34$$

2.2.1 HISTORICAL BIOLOGICAL OXYGEN DEMAND LOADING

Figure 2-2 illustrates the historical influent BOD loading to the WRF spanning from January 2019 to January 2024. BOD is used to characterize the strength of the incoming wastewater with regards to how much metabolic load it brings to the plant. This is distinguished from the permitted *effluent* carbonaceous BOD (cBOD) in that BOD includes all sources of oxygen demand including nitrogen. The BOD loading in 2019 was elevated compared to the following four years, which were taken to be more representative. The average

BOD loading for the period is 15,879 pounds per day (lbs/day). The 91.7 percentile (11/12ths, a statistical method for evaluating max month) loading is 24,072 lbs/day. These values correspond to a peaking factor of 1.52. The highest peaking factor taken directly from the monthly and annual average data is 1.53, which has been chosen for the development of planning criteria. The previous phase of plant improvements design report listed a design BOD loading of 37,290 lb/day (17 MGD design ADF times max month loading), which is the basis for the loading triggers shown.

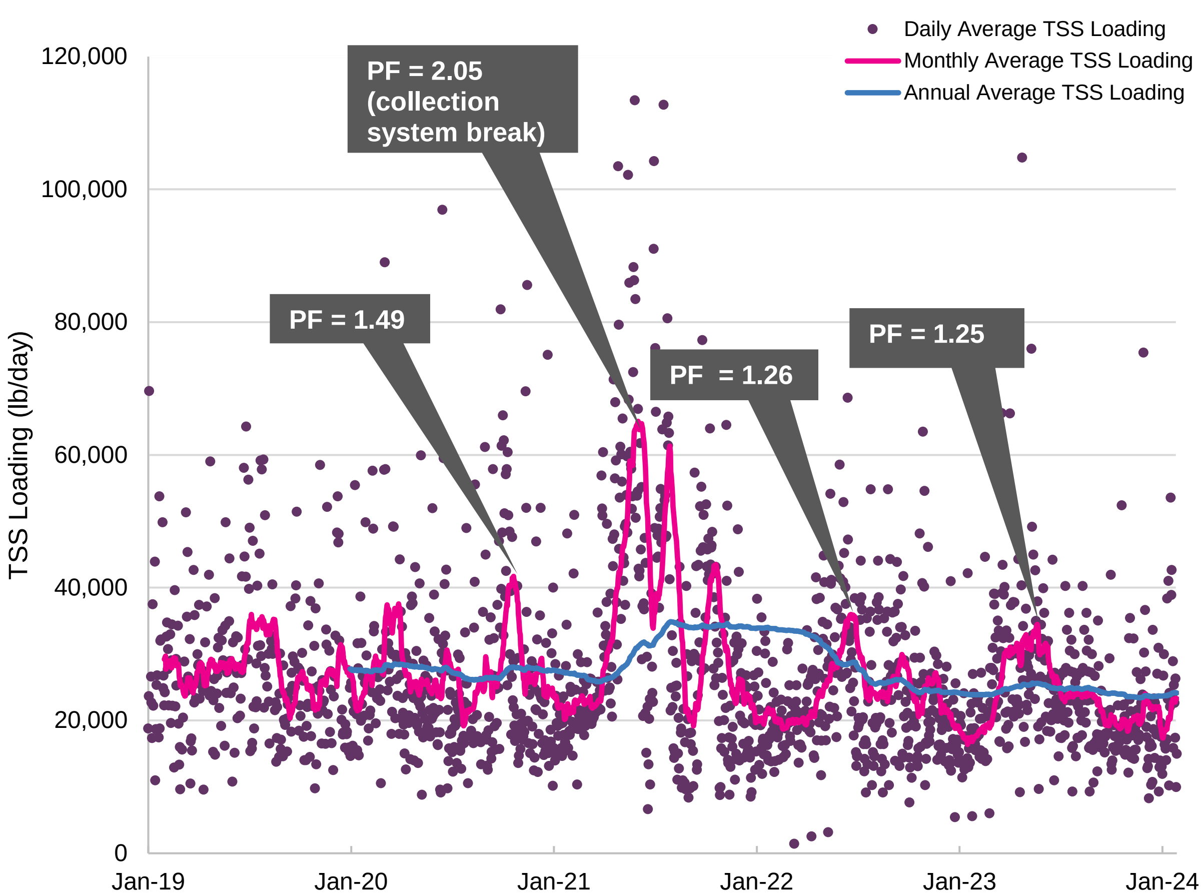
Figure 2-2: Historical Daily BOD Loading for January 2019 to January 2024



2.2.2 HISTORICAL TOTAL SUSPENDED SOLIDS LOADING

Figure 2-3 illustrates the historical influent TSS loading to the WRF spanning from January 2019 to January 2024. Interestingly, the elevated flow and BOD numbers from 2019 did not correlate with elevated TSS. The average TSS loading for the entire five-year period is 27,316 pounds per day. A fractured line in the collection system in 2021 swept large quantities of soil into the influent, resulting in elevated TSS that are not representative of typical conditions. This data artificially elevates the 91.7 percentile loading and resulting peaking factor to 48,682 lb/day and 1.78, respectively. Planning criteria uses the highest historical peaking factor of 1.49 instead. The engineering report for the previous phase of plant improvement listed a design TSS loading of 32,610 lb/day (17 MGD design ADF times max month loading), which is the basis for the loading triggers shown. Of note, TSS loading on average does exceed 75% of design loading, however, this is not a critical design parameter like flow or BOD in that the main processes that settle out TSS are primarily hydraulically limited, not solids-limited. The 2021 effluent TSS remains well within permit limits despite extended periods of extreme loading.

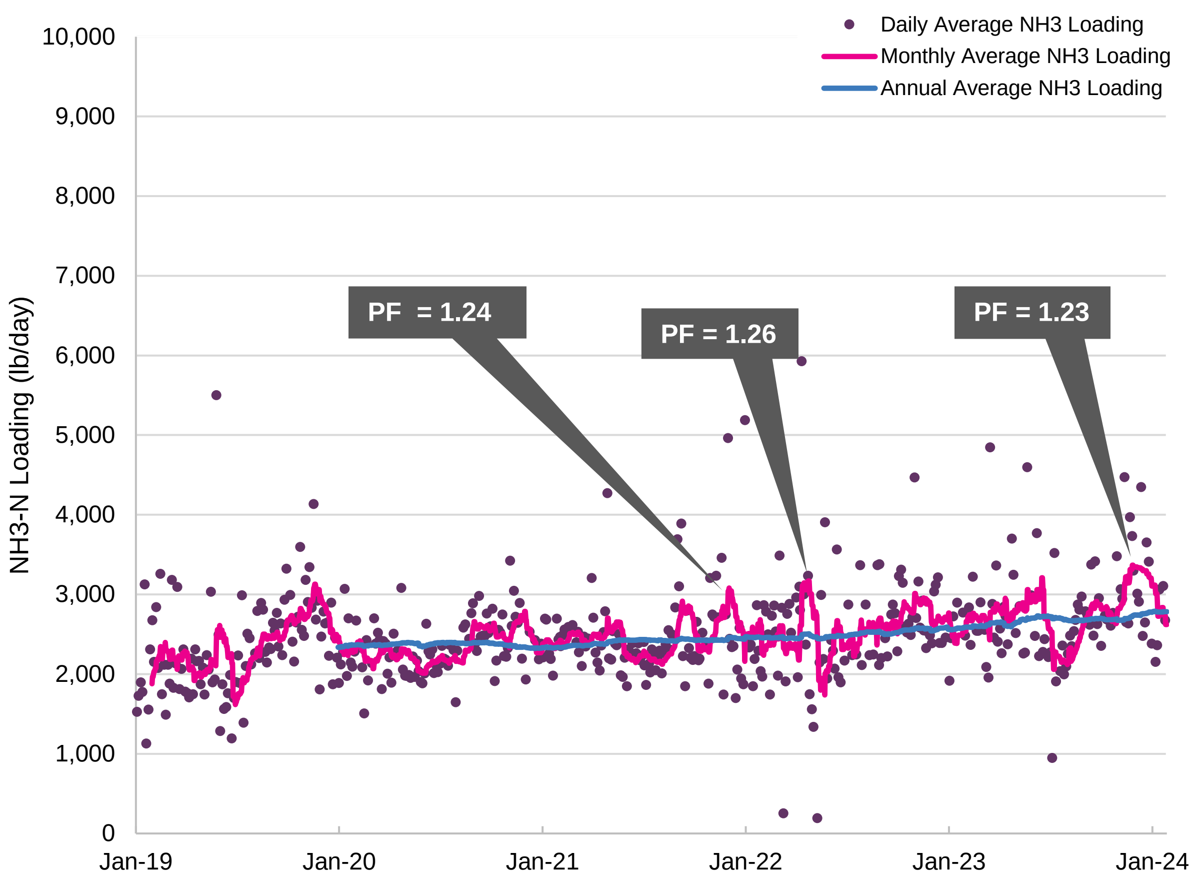
Figure 2-3: Historical Daily TSS Loading for January 2019 to January 2024



2.2.3 HISTORICAL AMMONIA-NITROGEN LOADING

Figure 2-4 illustrates the historical influent ammonia as nitrogen loading (commonly denoted as NH_3-N) to the WRF spanning from January 2019 to January 2024. The average NH_3-N loading for the period is 2,487 lb/day. The 91.7 percentile loading is 3,233 lb/day. These values correspond to a peaking factor of 1.29. Historical max peaking factors are very consistent, with a maximum of 1.26, which has been chosen for planning criteria development. The engineering report for the previous phase of plant improvement listed a design NH_3-N loading of 4,960 lb/day (17 MGD design ADF times max month loading).

Figure 2-4: Historical Daily NH_3-N Loading for January 2019 to January 2024



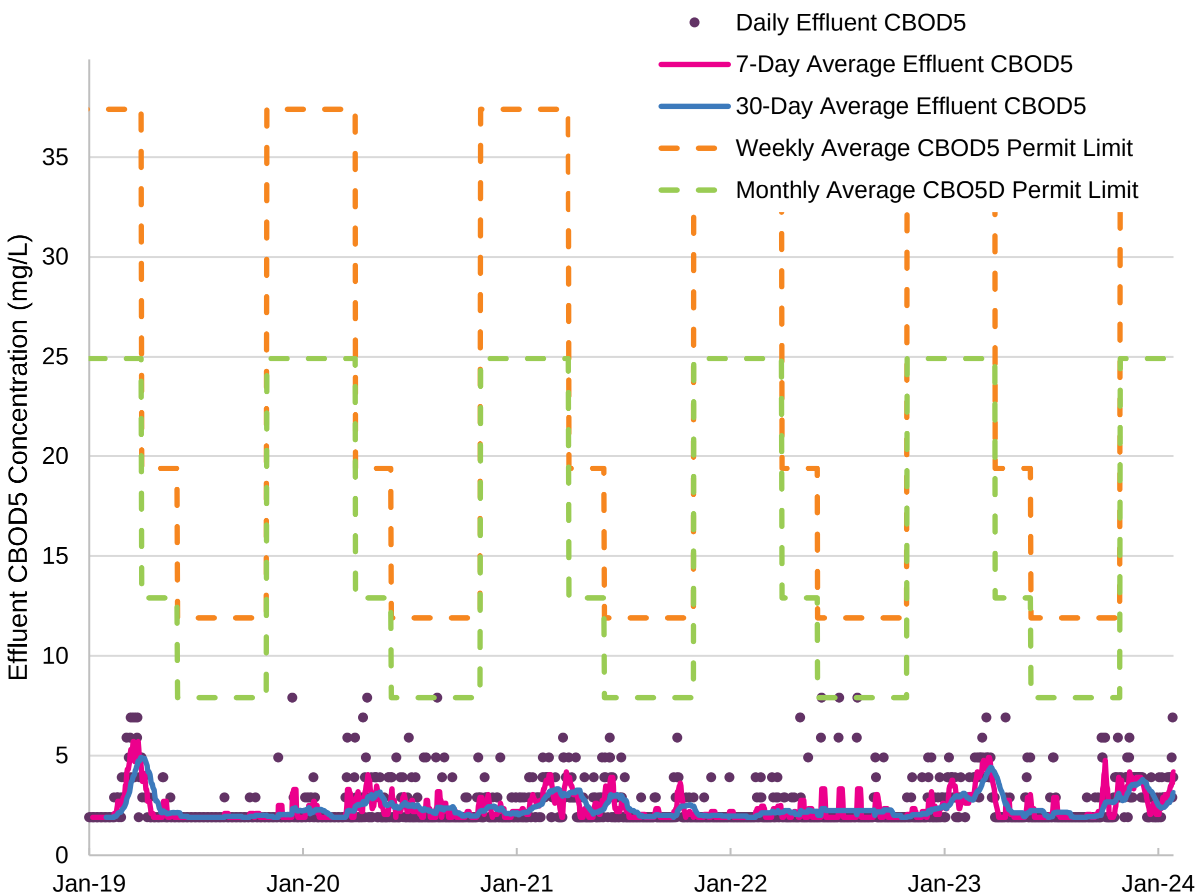
2.3 EFFLUENT WATER QUALITY

This section covers historical effluent quality parameters for the WRF during the study period. For each effluent characteristic pertaining to permitting, daily values are presented along with rolling 7-day average concentrations and rolling 30-day average concentrations. Weekly and monthly permit limits are presented as applicable. With respect to some parameters including NH_3-N and dissolved oxygen (DO), some exceedances were observed. However, these measurements may not have occurred within one calendar week or month and, therefore, may not constitute a failure to meet permit requirements.

2.3.1 EFFLUENT FIVE-DAY CARBONACEOUS BIOLOGICAL OXYGEN DEMAND

Figure 2-5 illustrates the historical effluent cBOD5 concentration. The 7-day average effluent cBOD5 concentration ranges from 2.0 to 5.8 mg/L. Monthly average effluent cBOD5 concentration ranges from 2.0 to 5.0 mg/L. As shown, during the study period, average effluent cBOD5 levels never exceeded permit limits.

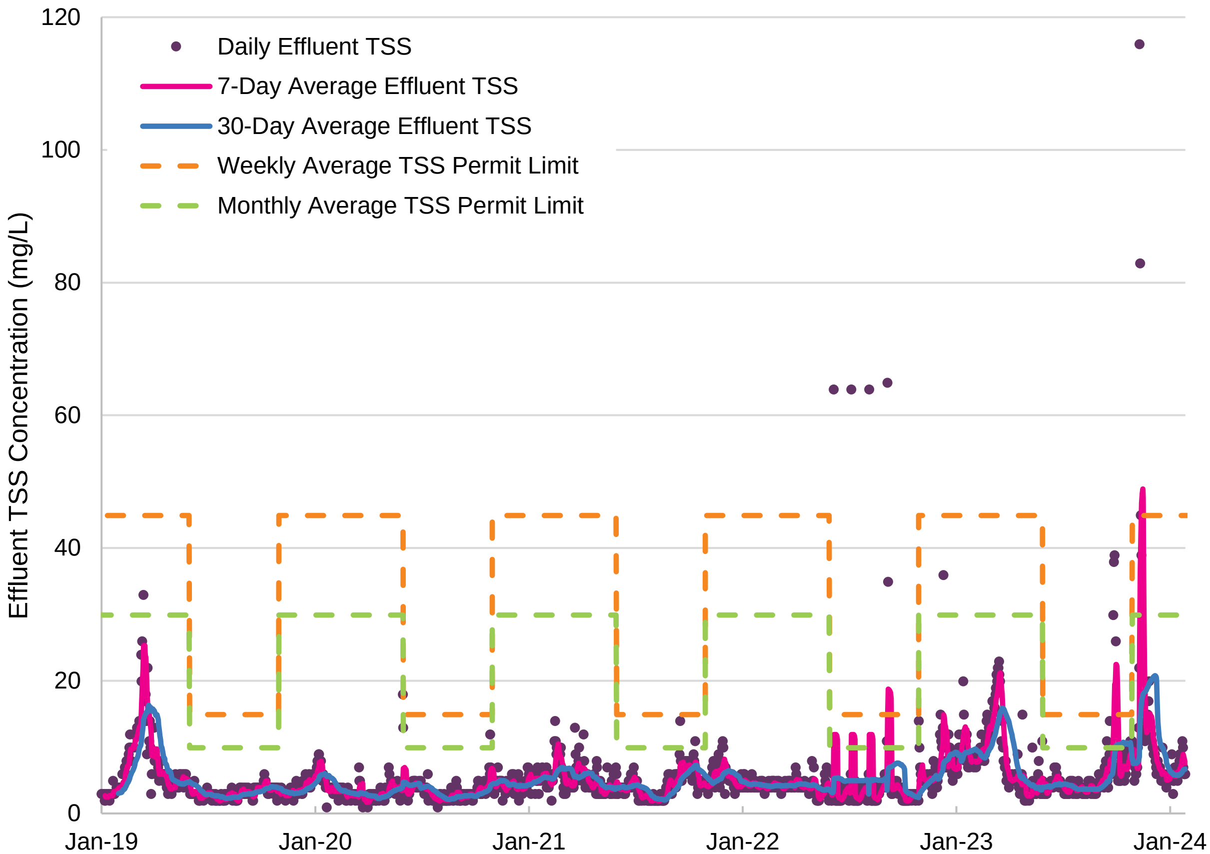
Figure 2-5: Historical Daily Effluent cBOD5 Concentration for January 2019 to January 2024



2.3.2 EFFLUENT TOTAL SUSPENDED SOLIDS

Figure 2-6 illustrates the historical effluent TSS concentration. The 7-day average effluent TSS concentration ranges from 1.8 to 49 mg/L. Monthly average effluent TSS concentration ranges from 2.1 to 20.9 mg/L. During September 2022 and November 2023, two brief exceedances in 7-day average effluent TSS concentration were observed. These align closely with effluent ammonia spikes and do not appear to correspond to extreme influent loading conditions. As such, they are likely related to process upsets and not reflective of the WRF's performance capabilities.

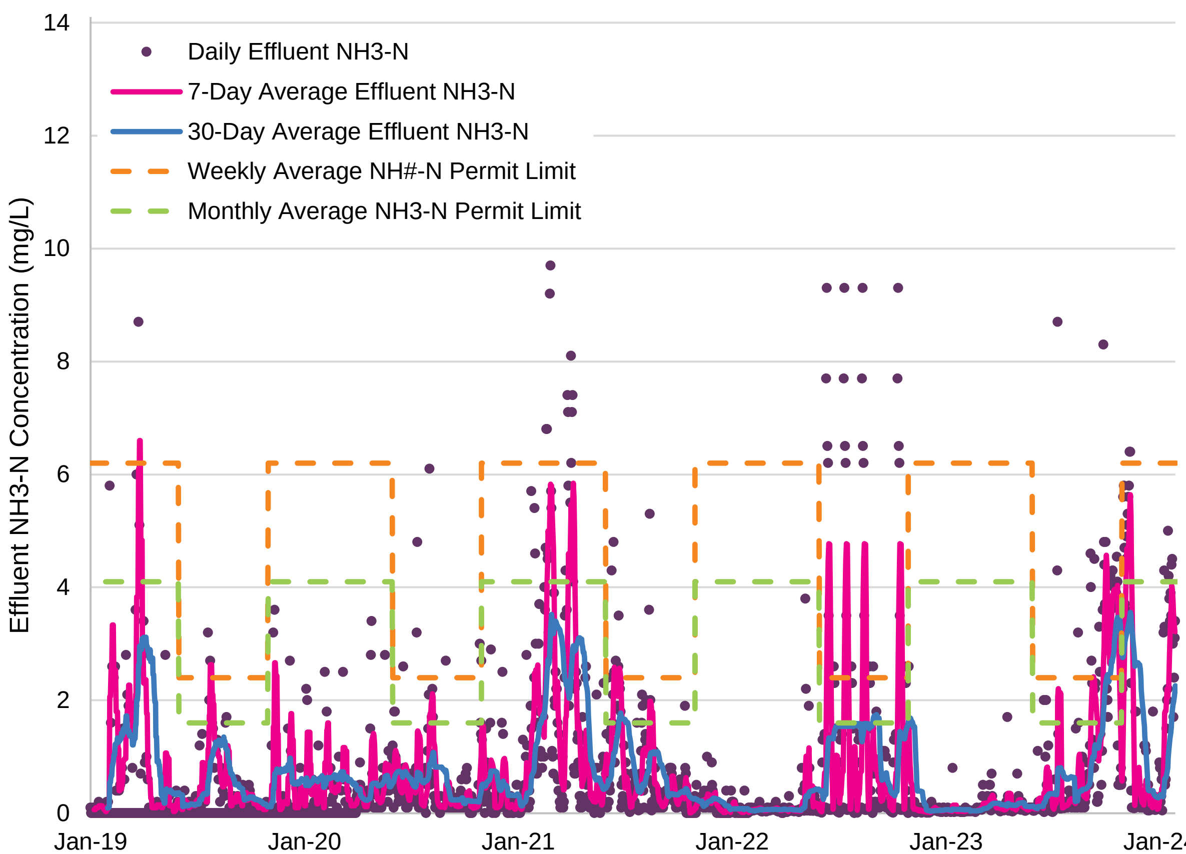
Figure 2-6: Historical Daily Effluent TSS Concentration for January 2019 to January 2024



2.3.3 EFFLUENT AMMONIA

Figure 2-7 illustrates the historical effluent NH_3-N concentration. The 7-day average effluent NH_3-N concentration ranges from 0.0 to 6.6 mg/L. Monthly average effluent NH_3-N concentration ranges from 0.04 to 3.6 mg/L. During summer 2022 and fall 2023, exceedances in 7-day average effluent NH_3-N concentration were observed, with the fall of 2023 also showing a period of monthly average exceedance. These align closely with effluent TSS spikes and do not appear to correspond to extreme influent loading conditions. As such, they are likely related to process upsets and not reflective of the WRF's performance capabilities.

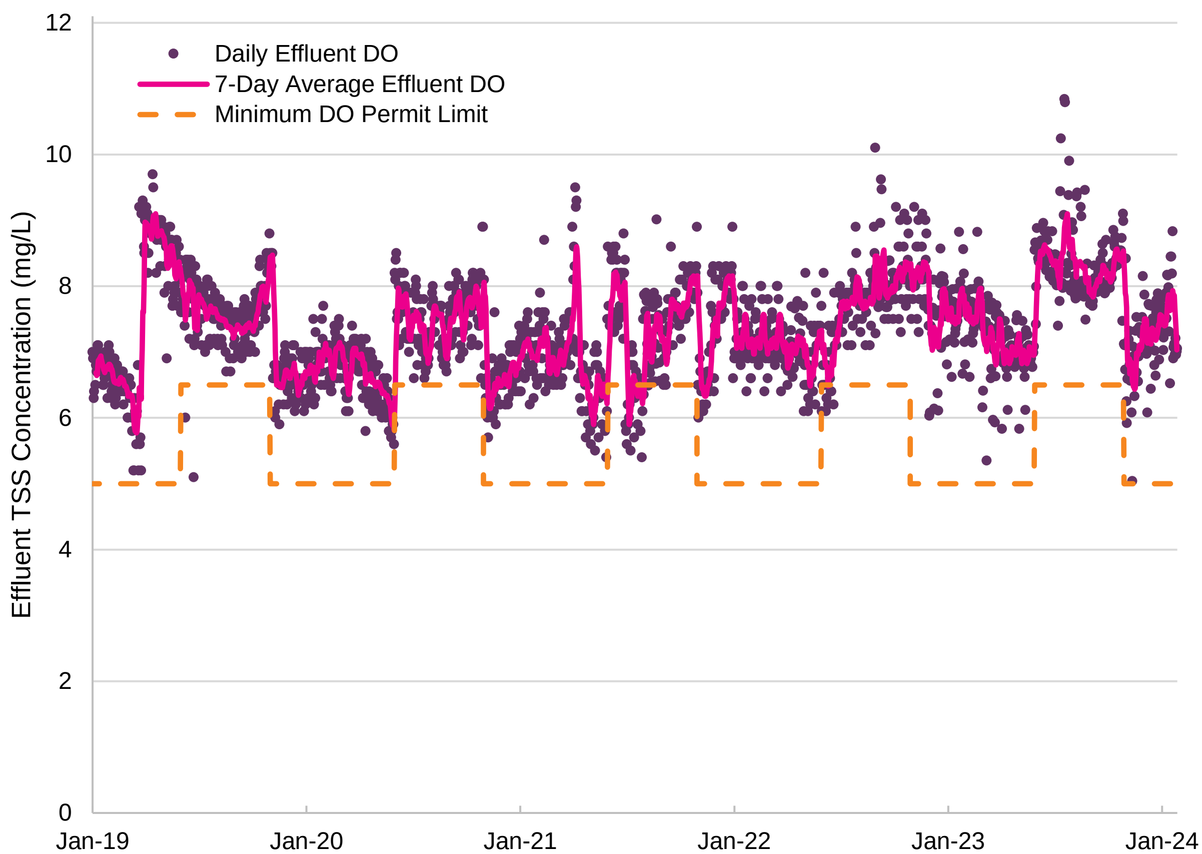
Figure 2-7: Historical Daily Effluent NH_3-N Concentration for January 2019 to January 2024



2.3.4 EFFLUENT DISSOLVED OXYGEN

Figure 2-8 illustrates the historical effluent DO concentration. The 7-day average effluent DO concentration ranges from 5.8 to 9.1 mg/L. Monthly average effluent DO concentration ranges from 6.2 to 8.9 mg/L. During late summer 2021, 7-day average effluent DO concentration fell below permit limits for approximately two weeks. This does not seem to be a particularly high flow period. Similar seasons in other years show good effluent DO, therefore post-aeration does not appear to present a pattern of poor performance.

Figure 2-8: Historical Daily Effluent DO Concentration for January 2019 to January 2024



3.0 BASIS OF EVALUATION & PLANNING CRITERIA

Design criteria and regulatory requirements from a variety of sources were assembled to develop the evaluation criteria for analysis of the wastewater treatment system. Specifically, documents from the following sources were reviewed and referenced:

- ODEQ
- 10 States Standards
- City of Norman 2023 Engineering Design Criteria and Standard Specifications (Norman EDC)
- Water Environment Federation's Manual of Practice 8

3.1 WASTEWATER TREATMENT

The assessment of the wastewater treatment system will be conducted in accordance with the ODEQ standards for the design of water pollution control facilities, alongside the treatment specifications required by the WRF to comply with the facility's Oklahoma Pollutant Discharge Elimination System permit limits. Additionally, the industry-recommended practices outlined in the Water Environment Federation's Manual of Practice 8 for municipal WRFs will also be taken into consideration. This assessment of the existing wastewater treatment system and further discussion of the WRF and CIP planning are detailed in the Wastewater Utility Master Plan.

Regarding capacity expansions, Garver's approach assumes that once the facility reaches 75% of its rated capacity, planning, and design phases for the next phase of capacity expansion must begin. This 75% capacity level acts as the trigger for initiating the planning and design process. Additionally, when the facility hits 90% of its rated capacity, construction to implement the designed improvements must be initiated. Anticipated construction timelines will be evaluated and considered in development of final triggers for recommended projects.

Historical data is used to establish flow and loading planning criteria by which current plant capacity and future gaps are assessed. Established planning and wastewater flow and loading planning criteria for treatment evaluation are provided in Table 3-1.

The 2045 ADF has been established in the Wastewater Utility Master Plan, estimated primarily as a function of population growth. A peaking factor of 1.4 has been established by historical data, which is applied to the 2045 ADF to establish 2045 max month daily flow (MMDF). Peaking factors are anticipated to remain constant over time as the service area and population expands.

ADF BOD mass loading is taken as the average from the entire 2019-2024 dataset of daily mass loadings. Max month BOD mass loading was taken as the 91.7 percentile of the dataset, corresponding to the peaking factor of 1.53. Concentrations were established for BOD by dividing these mass loadings by ADF and MMDF, respectively. 2045 mass loadings are calculated as the concentration times for ADF and MMDF, respectively.

ADF TSS mass loading is taken as the average from the entire 2019-2024 dataset of daily mass loadings. Max month TSS mass loading was calculated as the TSS peaking factor of 1.49 times ADF TSS mass loading. Concentrations were established for TSS by dividing these mass loadings by ADF and MMDF, respectively. The 2045 mass loadings are calculated as the concentration times for ADF and MMDF, respectively.

Current ADF NH_3-N mass loading is taken as the average from the entire 2019-2024 dataset of daily mass loadings. Current max month NH_3-N mass loading was calculated as the 91.7 percentile of the dataset. Concentrations were established for NH_3-N by dividing these mass loadings by ADF and MMDF, respectively. The 2045 mass loadings are calculated as the ADF concentration times projected flow rate, and the ADF mass loading times the peaking factor of 1.26.

Table 3-1: Historical Average and Projected Future Flows and Loadings

Description	Flow	BOD		TSS		NH_3-N	
	(MGD)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)
2019-2023 Historical Data							
ADF	11.4	167	15,879	287	27,316	26	2,487
MMDF	16.0	181	24,072	306	40,701	24	3,233
Peak Flow	45.6	--	--	--	--	--	--
2045							
ADF	17.8	167	24,766	287	42,604	26	3,879
MMDF	24.9	183	37,892	306	63,479	24	4,888
Peak Flow	71.1	--	--	--	--	--	--

Expected permit limits for a new WRF discharge to the Canadian River include all current WRF permit limits plus additional limits for total nitrogen and phosphorous, shown in Table 3-2. This is a conservative assumption based on the general trajectory of Environmental Protection Agency policy of managing macronutrients in receiving water bodies.

For expansion of the existing plant, it is assumed that the existing permit will remain unchanged. Should this not be the case, later reuse sections will include process and cost details for implementing biological nutrient removal and tertiary filtration to meet more restrictive nutrient limits.

Table 3-2: Speculative WRF NPDES Discharge Concentration Permit Limits

Parameter	Time Frame	Monthly Average	Weekly Average	Daily Max
Flow	Year round	Report	--	Report
$cBOD_5$ (mg/L)	Apr-May	13.0	19.5	--
	Jun-Oct	8.0	12.0	--
	Nov-Mar	25.0	37.5	--
Total Suspended Solids (mg/L)	Jun-Oct	10.0	15.0	--
	Nov-May	30.0	45.0	--
Ammonia (mg/L)	Jun-Oct	1.6	2.4	--
	Nov-May	4.1	6.2	--
Total Nitrogen (mg/L)	Year round	10.0	15.0	--
Total Phosphorus (mg/L)	Year round	1.0	1.5	--
E. Coli (MPN/100mL)	Jun-Oct	126	--	406
	Nov-May	630	--	2030
Dissolved Oxygen (mg/L)	Jun-Oct	6.5 (Minimum)		
	Nov-May	5.0 (Minimum)		
	Jun-Oct	6.5 (Minimum)		
pH (standard unit)	Year Round	6.5-9.0		

3.2 FLOW SPLIT

The City's topography includes four watersheds: the Canadian River, Little River, Rock Creek, and Dave Blue Creek watersheds. Force mains are required to unify these flows into a single WRF. All of these but the Canadian River drain to Lake Thunderbird, with a topographical divide roughly splitting Norman from northwest to southeast. A new WRF could simplify conveyance and eliminate the need to pump influent or effluent over this divide.

It is assumed that a new WRF will receive wastewater influent from the Little River and Rock Creek drainages to the east/northeast of the divide while the existing WRF would handle the Canadian (West/Southwest of divide) and Dave Blue Creek drainages. Little River and Rock Creek converge in the Development Reserve area, providing a prime location for a NE WRF. Extrapolating between the existing ADF and anticipated future flow as a function of current and projected future collection system area in each watershed yields the flow splits shown in Table 3-3. For the purposes of this evaluation, all new WRF alternatives have been considered to have the same flow split regardless of WRF location, which will be discussed further in Section 5.2. New WRFs are designed for 5 MGD ADF.

Table 3-3: Anticipated Flow Splits

Year	Little River ADF (MGD)	Rock Creek ADF (MGD)	NEW WRF ADF (MGD)	Canadian ADF (MGD)	Dave Blue Creek ADF (MGD)	Existing WRF ADF (MGD)	Total ADF (MGD)
2025	2.01	0.57	2.58	10.31	0.31	10.62	13.20
2026	2.08	0.62	2.70	10.35	0.37	10.73	13.43
2027	2.16	0.66	2.82	10.40	0.44	10.84	13.65
2028	2.23	0.71	2.94	10.44	0.50	10.94	13.88
2029	2.30	0.75	3.06	10.48	0.57	11.05	14.11
2030	2.38	0.80	3.18	10.53	0.63	11.16	14.33
2031	2.45	0.84	3.29	10.57	0.70	11.27	14.56
2032	2.52	0.89	3.41	10.61	0.76	11.37	14.79
2033	2.60	0.93	3.53	10.66	0.82	11.48	15.01
2034	2.67	0.98	3.65	10.70	0.89	11.59	15.24
2035	2.75	1.03	3.77	10.75	0.95	11.70	15.47
2036	2.82	1.07	3.89	10.79	1.02	11.81	15.69
2037	2.89	1.12	4.01	10.83	1.08	11.91	15.92
2038	2.97	1.16	4.13	10.88	1.15	12.02	16.15
2039	3.04	1.21	4.25	10.92	1.21	12.13	16.38
2040	3.11	1.25	4.37	10.96	1.27	12.24	16.60
2041	3.19	1.30	4.48	11.01	1.34	12.34	16.83
2042	3.26	1.34	4.60	11.05	1.40	12.45	17.06
2043	3.33	1.39	4.72	11.09	1.47	12.56	17.28
2044	3.40	1.43	4.84	11.14	1.53	12.67	17.51
2045	3.48	1.48	4.96	11.18	1.66	12.84	17.80

3.3 COST ESTIMATING CRITERIA

Opinion of probable construction costs (OPCC) were developed to allow NUA to compare the available alternatives on a monetary basis. In addition, LCCs were also developed to show a net present value of the alternatives over a lifespan of 20 years when considering O&M costs. The following items are used as a baseline for preparation of OPCCs:

- Actual cost estimates provided by equipment manufacturers and suppliers
- Previous cost estimates prepared by Garver
- Contractor bid tabulations from recent project deliveries

For most alternatives, costs are given as total project cost (TPC), which includes both the OPCC as well as an additional 25% to cover the cost of professional engineering, bidding, and construction management services.

Table 3-4 provides the contingencies, mobilization costs, conveyance cost assumptions, contractor overhead and profit, and professional services costs assumed in the development of the estimated OPCCs and TPCs.

Table 3-4: Preliminary Cost Estimate Criteria

Consideration	Assumption
Contingency	30%
Conveyance Pipelines	$25/inch-foot
Conveyance Easements & Property Acquisition	10%
Mobilization	5%
Contractor Overhead and Profit	25%
Engineering, Bidding, & Construction Services	25%

The LCC analysis is developed for a 20-year planning horizon and accounts for the flow and loading projections over that timeframe. The LCC considers the OPCC of the alternative as well as the yearly O&M costs associated with operating the equipment. O&M costs include electricity, chemical costs, replacement of filter media and other components that have life spans of less than 20-years, and labor required for maintenance. When comparing alternatives, some common elements have not been included like the base O&M cost to treat wastewater to current permit limits, since this cost will have to be paid regardless of where the treatment occurs. Marginal LCC costs, however, have been included, such as the additional energy and personnel required to open a new facility or treat effluent to higher reuse standards. Table 3-5 presents the key assumptions made for the basis of the LCCs developed in this TM.

Table 3-5: LCC Parameters

Parameter	Value
Period	20 years
Assumed Inflation	5%
Assumed Interest Rate	5%
Power Cost	$0.10 kWh

4.0 EXISTING SOUTH WRF TREATMENT CAPACITY EVALUATION AND GAP ANALYSIS

This section provides an evaluation of the major processes and facility capacities of the existing WRF. While the facility is permitted for an ADF of 16 MGD, many processes have capacity beyond this limit. Each process is compared against projected flows and loadings for the year 2045 to Identify potential capacity gaps that may need to be addressed.

The treatment capacity of each facility is defined either by hydraulic limits or constituent loading, depending on the specific process. The hydraulic capacity of the plant was thoroughly reviewed, with reference to the detailed analysis/design performed by Garver In 2014 as part of Phase II Improvements for the WRF. The plant's current hydraulic capacity Is limited to a flow of 36 MGD, and increasing this capacity would require significant modifications.

Peak flow shaving through the addition of peak flow storage basins has been considered as a feasible alternative to expanding the hydraulic capacity of processes downstream of the headworks. This approach would help manage peak flows without the need for extensive modifications to downstream processes.

This section evaluates treatment capacity for the following processes:

Liquid Processes:

- Westside LS
- WRF Screens
- Grit Removal
- Stormwater Holding Ponds
- Primary Clarifiers
- Aeration Basins
- Secondary Clarifiers
- Disinfection
- Post-Aeration

Solids Processes:

- Gravity Thickeners
- WAS Centrifuges
- Anaerobic Digesters
- Dewatering Centrifuges

A mass balance was created for determining capacities for solids-limited processes, based on previous design calculations and historical data. This mass balance was flow-adjusted to find the max month flow equivalent to each process's solids treatment capacity. Selected assumptions used in the mass balance are shown in Table 4-1. These include 60% primary clarifier TSS removal, 38% primary clarifier BOD removal, aeration basin sludge yield of 0.6, digester feed volatile suspended solids (VSS) fraction of 57%, and digester VSS reduction of 50%.

Table 4-1: Solids Mass Balance (Selected Assumptions and Outputs)

Parameter	Max Month	ADF	units
Influent + Recycle Streams			
Plant Flow Rate	24.9	17.8	MGD
Plant influent Max Month TSS	306	287	mg/L
Plant influent Max Month BOD	183	167	mg/L
Recycle Stream TSS	5,716	4,220	lb/d
Recycle Stream BOD	2,419	1,747	lb/d
Primary Clarification			
Flow to PCs	12.3	12.3	MGD
Flow Bypassing Primary Clarifiers	12.6	5.5	MGD
Primary Clarifiers % TSS Removal	60%	60%	
Primary Clarifiers % BOD Removal	38%	38%	
Primary Sludge Produced	20,528	19,386	lb/d
Primary Sludge Thickening			
Gravity Thickener Solids Capture	90%	90%	
Thickened Primary Sludge Solids	18,475	17,447	lb/d
Thickened Primary Sludge Solids Concentration	6.0%	6.0%	
Secondary Treatment			
WAS produced	35,143	19,281	lb/d
WAS Thickening			
Thickened WAS Centrifuge Solids Capture	95%	95%	
Thickened WAS Solids	33,386	18,317	lb/d
Thickened WAS Solids Concentration	5.0%	5.0%	
Anaerobic Digestion			
Combined Primary Sludge and WAS to Digesters	51,862	35,764	lb/d
Digester Feed VSS:TSS Ratio	0.53	0.53	
Digester Feed VSS	27,455	18,825	lb/d
Combined Digester Feed solids	5.4%	5.5%	
Digester %VSS Reduction	50%	50%	
Digested Sludge TSS	38,134	26,352	lb/d
Dewatering			
Dewatering Solids Capture	95%	95%	
Dewatered Solids	36,228	25,034	lb/d

4.1 WESTSIDE LIFT STATION

Located adjacent to the WRF, the Westside LS provides influent lift pumping and fine screening for the flows received from the portion of NUA along the Canadian River. Treatment capacities for the pumping and screening at Westside LS have been normalized to projected future flows in the Canadian River watershed, since most of the future growth areas are outside this watershed. Overall treatment capacity is limited by pumping and evaluated to be 13.5 MGD as shown in Table 4-2.

Table 4-2: Westside Lift Station Capacity

Parameter	Value
Peak Flows	
Maximum Westside LS Flow (observed)[1]	12.6 MGD
Average 2025 Estimated Canadian Watershed Flow	8.49 MGD
Factor	1.48
Average 2045 Estimated Canadian Watershed Flow	8.95 MGD
Projected 2045 Maximum Westside LS Flow	13.2 MGD
Westside LS-Pumps	
Quantity	3
Capacity (each)	6.8 MGD
Firm Pumping Capacity	13.5 MGD
Westside LS-Fine Screens	
Quantity	2
Capacity (each)	20 MGD
Firm Screening Capacity	20 MGD

Note:
From Wastewater Utility Master Plan

4.2 WRF SCREENS

For flows not coming from the Westside LS, screening is accomplished at the WRF itself. There are two fine screens installed, each with a capacity of 72 MGD. The firm screening capacity of the system, which accounts for redundancy (i.e., one duty and one standby unit), is also 72 MGD.

Table 4-3: WRF Fine Screen Capacity

Parameter	Value
Quantity	2
Capacity (each)	72 MGD
Firm Screening Capacity	72 MGD

4.3 GRIT REMOVAL

After screening, influent runs through grit removal at the WRF. Peak flows run through screening and grit removal (unless bypassed) before being diverted to the stormwater holding ponds during peak flow events. Grit removal capacity is manufacturer-rated at 42 MGD per Table 4-4. This is noticeably lower than screening capacity and will need to be augmented if future growth areas are routed to the existing WRF.

Table 4-4: WRF Grit Removal System Capacity

Parameter	Value
Quantity	2
Capacity (#1)	30 MGD
Capacity (#2)	12 MGD
Total Grit Capacity	42 MGD

4.4 STORMWATER HOLDING PONDS

Stormwater holding ponds provide flow equalization storage for peak flows more than the plant's design peak flow of 36 MGD. Total volume has been calculated at 10.9 million gallons (MG), shown in Table 4-5. Existing storage appears sufficient for current flows but is unlikely to suffice for 2045.

Table 4-5: Stormwater Holding Pond Capacity

Parameter	Value
Quantity	3
Volume (#1)	2.65 MG
Volume (#2)	2.65 MG
Volume (#3)	5.59 MG
Total Holding Volume	10.9 MG

4.5 PRIMARY CLARIFIERS

The WRF currently uses two primary clarifier pairs to physically separate heavier particulate matter from de-gritted influent. The surface overflow rate, based on the existing surface areas of each clarifier complex, was used to determine the capacity of the primary clarification facilities. These results are summarized in Table 4-6. Per ODEQ design regulations, primary clarifiers are rated hydraulically such that overall up-flow and weir velocities do not become high enough to overcome particle settling. ADF and peak flow ratings are 1,000 and 1,500 gallons per day per square foot (gpd/ft^2) of clarifier surface area, respectively. ADF weir loading rate is limited to 15,000 gallons per day per foot (gpd/ft) of weir length. The cumulative total primary clarification capacity using the above guidelines at the WRF is estimated at 12.3 MGD ADF and 20.1 MGD peak flow.

This is less than the current plant rating of 16 MGD ADF, which was made possibly with a variance granted for the ODEQ requirement that conventional activated sludge processes be preceded by primary clarification. The plant currently bypasses flows in excess of the primary clarifiers rating directly to the aeration basins. This approach has been continued in this evaluation, which is reflected in the mass balance. Based on the analysis performed in this study, the downstream aeration basins can handle the projected loadings even if the flow to primary clarifiers is limited to 12.3 MGD under maximum month conditions. Additionally, if future upgrades include biological nutrient removal, the biological process may benefit from reduced primary clarification which will lead to additional carbon availability for the biological nutrient removal process. Additional primary clarification capacity is, therefore, not recommended to meet the minimum treatment requirements under the planning horizon conditions.

Table 4-6: Primary Clarifier Capacity

Parameter	Value
Governing Criteria	
Surface Overflow Rate (ADF)[1]	1,000 gpd/ft^2
Surface Overflow Rate (peak hourly flow)[1]	1,500 gpd/ft^2
Weir Loading Rate (ADF)[1,2]	15,000 gpd/ft^2
Weir Loading Rate (peak hourly flow)[3]	30,000 gpd/ft^2
North Primary Clarifiers	
Quantity	2
Diameter	70 ft
Surface Area (total)	7,700 ft^2
Weir Length (total)	440 ft
ADF Treatment Capacity (Standard Oxygen Requirement [SOR]-limited)	7.7 MGD
ADF Treatment Capacity (Wastewater Loading Rate [WLR]-limited)	6.6 MGD
Peak Treatment Capacity (SOR-limited)	11.6 MGD
Peak Treatment Capacity (WLR-limited)	13.2 MGD
South Primary Clarifiers	
Quantity	2
Diameter	60 ft
Surface Area (total)	5,660 ft^2
Weir Length (total)	376 ft
ADF Treatment Capacity (WLR+SOR-limited)	5.7 MGD
Peak Treatment Flow Capacity (SOR-limited)	8.5 MGD
Peak Treatment Flow Capacity (WLR-limited)	11.3 MGD
Total Primary Clarification Capacity	
ADF Treatment Capacity	12.3 MGD
Peak Treatment Capacity (SOR- limited)	20.1 MGD

Notes:
1. Oklahoma Administrative Code 252:656 mandated
2. Interpreted to be at ADF

Parameter	Value
3. Industry standard	

4.6 AERATION BASINS

The suspended growth biological treatment system at the WRF consists of six rectangular aeration basins with fine-bubble diffusers. Each basin is 197 ft by 40 ft, with a side water depth of approximately 18 ft. Each aeration basin has a volume of approximately 139,000 ft^3 (1.04 MG), providing a total aeration volume of 833,000 ft^3 (6.23 MG). Four 6,550 standard cubic feet per minute (SCFM) multistage centrifugal blowers and two 5,640 SCFM turbo blowers will be operating after the current blower replacement project is complete. These will feed the existing grid with over 2,200 diffusers per basin.

The aeration basin capacity is evaluated using three main criteria:

- Volumetric organic loading rate (lb BOD per 1,000 ft^3 of basin volume)
- Aeration zone hydraulic retention time
- Biological process aeration requirements

The existing aeration basins have an organic loading capacity of 33,300 lb BOD_5/day using the volumetric organic loading rate of 40 lb BOD_5/1,000 ft^3 (ODEQ requirement for nitrifying systems). This organic loading capacity is equivalent to a maximum month capacity rating of 25.3 MGD which is greater than the established requirement for the planning horizon. Using the second criterion of 6-hour hydraulic retention time, the treatment capacity of the existing aeration basins is 24.9 MGD which is identical to the projected max month flow. From an aeration capacity standpoint, the rated capacity of the secondary treatment train is 25.2 MGD assuming one of the larger blowers as well as one aeration basin out of service for redundancy.

Based on these ratings, the existing aeration basins meet the volume and aeration capacity requirements of the planning criteria established for this master plan even with the primary clarifiers limited to 12.3 MGD and bypassed under average day and max month flows.

Table 4-7: Aeration Basin Capacity

Parameter	Value
Governing Criteria	
Maximum Organic Loading Rate[1]	40 lb BOD_5/1,000 ft^3
Aeration Retention Time	6-8 hr
Design Max Month BOD_5 to Aeration Basins[2]	124 mg/L
Design Max Month NH_3-N	24 mg/L
Diurnal Peaking Factor [3]	1.43
Minimum O_2 to BOD ratio	1.1 lb O_2/lb BOD_5

Parameter	Value
Minimum O_2 to NH_3-N ratio	4.6 lb O_2/lb NH_3-N
Aeration Basins-Volume	
Quantity	6
Dimensions	197 ft x 40 ft
Operating Depth (at MMDF)	17.62 ft
Volume (total)	6.23 MG
Maximum Loading Capacity	33,300 lb BOD_5/day
MM Aeration Basin Influent BOD (from mass balance)	158 mg/L
MMDF Treatment Capacity (loading rate-limited)	25.3 MGD
MMDF Treatment Capacity (hydraulic retention time-limited at 6 hours)	24.9 MGD
Aeration Basins-Blower Capacity	
Quantity	6
Capacity (each, two turbo blowers) [4,5]	5,640 SCFM
Capacity (each, four multistage blowers) [4,5]	6,550 SCFM
Blower Capacity (firm)	30,930 SCFM
Diffusers – installed per basin	2,267
Diffusers – firm (1 basin offline)	11,335
Diffuser Capacity @ 2 SCFM/each	22,670 SCFM
Effective Oxygen Transfer Efficiency (OTE) [6]	16.4%
Equivalent Required lb O_2/MGD [7]	3,400 lb O_2/MGD
Equivalent Required SCFM/MGD [8]	900 SCFM/MGD
Max Month Treatment Capacity (diffuser-limited)	25.2 MGD
Aeration Basins-Total Capacity	
Max Month Total Treatment Capacity (diffuser-limited) [5]	25.2 MGD
ADF Treatment Capacity (Hydraulic Retention Time-limited at 6 hours)	24.9 MGD

Notes:
1. Oklahoma Administrative Code 252:656 mandated
2. Assuming max month loadings, 60% TSS removal, and 38% BOD removal in primary clarifiers
3. From the Wastewater Utility Master Plan
4. From 2024 Norman Blower Replacement design documentation
5. Rated at 105 deg F inlet temperature and 8.75 pounds per square inch gauge header pressure
6. Based on OTE equation from Metcalf and Eddy, standard oxygen transfer efficiency (OTE) = 31%, $T_{water,max}$=20 deg C, α=0.7, FF=0.9, $DO_{avg,min}$=2.0mg/L
7. Calculated as the required oxygen per MGD assuming max month aeration basin influent concentrations of BOD and NH_3-N, multiplied by the diurnal peaking factor
8. Calculated as SCFM/MGD divided by OTE, 0.076 lb / SCFM, and 21% oxygen.

4.7 SECONDARY CLARIFIERS

Table 4-8 shows the capacity results for the existing final clarifiers at the WRF. There are six final clarifiers, each 125 ft in diameter. The total final clarifier surface area of this facility is 73,630 ft2 with a total weir length of 2,360 ft. The final clarification capacity of the facility is 35.4 MGD ADF, weir-limited.

Each final clarification facility has dedicated return sludge and waste sludge pumping capabilities. The recycle flow and volume of sludge to be wasted from each facility is determined each day by operations staff. Return activated sludge (RAS) is pumped to the head of the aeration basins while the WAS is pumped to the gravity thickeners.

Table 4-8: Secondary Clarifier Capacity

Parameter	Value
Governing Criteria	
Surface Overflow Rate (ADF)[1]	600 gpd/ft^2
Surface Overflow Rate (Peak Hourly Flow)[1]	1,200 gpd/ft^2
Solids Loading Rate (Peak Hourly Flow)[1,2]	40 lb/d/ft^2
Weir Loading Rate (ADF)[1,3]	15,000 gpd/ft^2
Design Mixed Liquor Suspended Solids	4,000 mg/L
Secondary Clarifiers	
Quantity	6
Diameter	125 ft
Surface Area (total)	73,630 ft^2
Weir Length (total)	2,360 ft
Treatment Capacity (ADF) (SOR-limited)	44.2 MGD
Treatment Capacity (Peak) (SOR-limited)	88.4 MGD
Treatment Capacity (Peak) (Solids Loading Rate [SLR]-limited)	88.5 MGD
Treatment Capacity (ADF) (WLR-limited)	35.4 MGD

Notes:
1. Oklahoma Administrative Code 252:656 mandated
2. SLR calculated assuming maximum 4,000 mg/L Mixed Liquor Suspended Solids is not limiting in any scenario
3. Interpreted to be at ADF

4.8 DISINFECTION CAPACITY

Disinfection is accomplished at the WRF using Trojan UV3000Plus UV systems. Secondary effluent is routed to a common header that evenly distributes flow to two UV channels, each with two banks per channel as detailed in Table 4-9. Each channel can disinfect a peak flow of 22 MGD, with a total disinfection capacity of 44 MGD with no redundancy. During the last round of improvements, peak flow disinfection capacity was considered 36 MGD, as the flow at which one entire bank could be lost in either channel with the resulting combined log removal of E. coli between the two channels remaining sufficient for permit compliance.

Table 4-9: Disinfection Capacity

Parameter	Value
UV Disinfection System-Layout	
Channels	2
Banks per Channel	2
Redundant Banks per Channels	0
Modules per Bank	24
Lamps per Module	8
Total Lamps per Channel	384
Design Criteria	
Peak Hour Flow (no redundancy)	44 MGD
Peak Flow (1+1 channel redundancy)	22 MGD
Delivered Dose (MS2 RED)[1]	30 mJ/cm^2
Minimum UV Transmittance	55%
Max TSS (30-day average)	15 mg/L
Max TSS (7-day average)	30 mg/L
Treatment Capacity	
Peak Flow (Max Day, combined)	36 MGD

Notes:

1. Estimated previously and accepted by ODEQ as the combined flow at which combined downstream permit compliance can be maintained with the loss of one UV bank.

4.9 RE-AERATION (POST-AERATION)

After disinfection, effluent is sent to two post-aeration basins, each with a dedicated blower and fine-bubble diffuser capacity sufficient to oxygenate the full plant peak flow of 36 MGD. Details of post-aeration capacity can be found in Table 4-10.

Table 4-10: Re-Aeration Capacity

Parameter	Value
Re-Aeration Basins	
Basins	2
Dimensions (each)	60 ft x 30 ft x 14 ft
Re-Aeration Basin Volume (Total)	0.377 MG
Treatment Capacity @ 10 min Hydraulic Retention Time	54.3 MGD
Re-Aeration Blowers/Diffusers	
Blowers	2
SCFM (each, 1+1)	875 SCFM
Worst-Case Temperature at Max Day Flow	20°C
DO in Secondary Effluent (assumed)	1.5 mg/L
Design avg DO in basins	6.5 mg/L
Diffuser Standard Oxygen Transfer Efficiency (OTE)	35%
α Factor	0.8
Fouling Factor	0.9
Oxygen Transfer Efficiency[1]	6.92%
Density of Air at Standard Temperature and Pressure	0.076 lbm/ft^3
Oxygen Mass Flow (from single blower)	1.06 lbm/ft^3
Treatment Capacity for Re-Aeration	36.7 MGD

Notes:

1. Based on OTE equation from Metcalf and Eddy, 35% SOTE, $T_{water,max}$=20 deg C, α=0.8, FF=0.9, $DO_{avg,min}$=6.5mg/L

4.10 GRAVITY THICKENERS

Primary sludge pulled from the bottom of the primary clarifiers is sent to four 18-ft-diameter gravity thickeners, which raise the solids percentage of the primary sludge sufficiently for anaerobic digestion. Gravity thickeners are neither hydraulically nor loading-limited at the rated primary clarification flow rate. As plant flow increases beyond the current rating, additional flow is modeled as being bypassed around primary clarification (and thus gravity thickeners). Thus, additional gravity thickener capacity is not anticipated to be necessary in the next 20 years. Table 4-11 details the capacity of the gravity thickeners.

Table 4-11: Gravity Thickener Capacity

Parameter	Value
Governing Criteria	
Surface Overflow Rate[1]	760 gpd/ft^2
Solids Loading Rate	29.5 lb/ft^2-d
Unthickened PS Solids	2.5%
Primary Sludge Gravity Thickeners	
Quantity	4
Diameter	18 ft
Surface Area (total)	1,018 ft^2
Maximum Primary Clarifier Flow	12.3 MGD
Assumed Outlet Solids	6%
Treatment Capacity (SOR-limited)	774,000 gpd
Treatment Capacity (SLR-limited)	30,037 lb/d
Calculated MMDF PS flow rate (mass balance)	161,000 gpd
Calculated MMDF PS solids Load (mass balance)	20,500 lb/d
Treatment Capacity	>12.3 MGD[3]

Notes:

1. Water Environment Federation's Manual of Practice 8 suggests designing primary sludge gravity thickeners for 380-760 gpd/ft2. This is the least conservative thickener capacity.
2. Water Environment Federation's Manual of Practice 8, 4-6 kg/m2-hr, 6 kg/m2-hr à 29.5 lb/ft2-d
3. Because primary clarifier flow is bypassed beyond 12.3 MGD plant flow, gravity thickener flow does not increase at higher plant flows.

4.11 WAS CENTRIFUGES

Waste activated sludge is sent to duty/standby WAS centrifuges for thickening before digestion. Assuming the operational parameters shown in Table 4-12, centrifuges are sufficient for 2045 anticipated loadings (25.7 MGD, solids-limited). This would require 12-hour-per-day operation to maintain full redundancy. Both centrifuges could be operated in parallel during normal operation, with additional man-hours only required while one of the units is down.

Table 4-12: WAS Thickening Centrifuge Capacity

Parameter	Value
Governing Criteria	
Solids Loading Capacity (each)[1]	1,504 lb/h
Hydraulic Loading Capacity (each)[1]	376 gallons per minute
Approximate WAS Solids Content	1%
Max Month Dewatering Hours Per Day	12 hours/day
WAS Centrifuges	
Quantity	2 (1+1)
Assumed outlet solids	5%
Minimum Solids Recovery	95%
Hydraulic Treatment Capacity (equivalent MMDF)	32.1 MGD
Solids Treatment Capacity (equivalent MMDF)	25.7 MGD
Treatment Capacity (equivalent MMDF)	25.7 MGD

4.12 ANAEROBIC DIGESTERS

The WRF has four 700,500-gallon digesters, three of which serve as active primary digesters and the fourth as a secondary digester for solids separation, digested solids storage, and additional biogas storage. Using the mass balance inputs and a 15-day retention time, total digestion capacity is estimated at 30.3 MGD as shown in Table 4-13.

Table 4-13: Total Digestion Capacity

Parameter	Value
Governing Criteria	
Minimum Solids Retention Time	15 days
Digester Feed Solids (MMDF)	5.7%
Anaerobic Digesters (Primary)	
Quantity	3
Volume (each)	700,500 gallons
Volume (total)	2,101,500 gallons
Sludge Treatment Capacity (MMDF)	140,100 gpd
Solids Treatment Capacity (MMDF)	66,560 pounds per day
Treatment Capacity (MMDF)	30.3 MGD

4.13 DEWATERING CENTRIFUGES

Digested sludge from the anaerobic digesters is sent to dewatering centrifuges once stabilization is achieved. The WRF has two Siemens (currently being replaced with GEA) centrifuges installed ca. 2015, capable of the performance shown in Table 4-14. Estimated dewatering capacity is 25.5 MGD (solids-limited) while maintaining full redundancy and 12-hour-per-day operation. As elaborated in Section 4.11, both centrifuges could be used during normal operation to allow for a shorter operating day until one of the units needs maintenance.

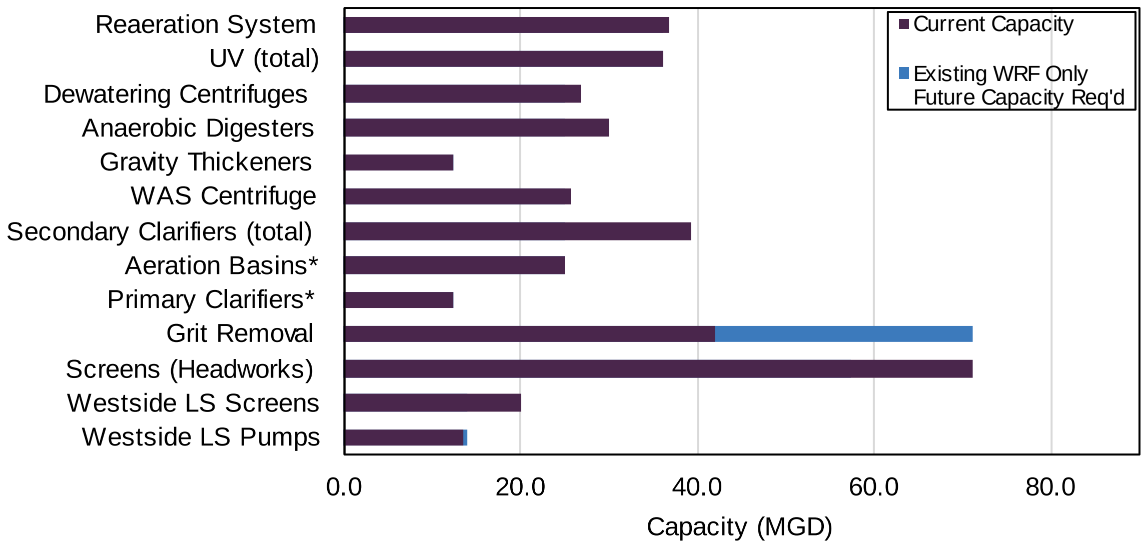
Table 4-14: Dewatering Centrifuge Capacity

Parameter	Value
Governing Criteria	
Centrifuge Solids Loading Capacity (each)	4,666 pph
Feed Pump Hydraulic Capacity (each)	205 gallons per minute
Centrifuge Feed Digested Solids (MMDF)	5.7%
Max Month Dewatering Hours per Day	12 hours/day
Dewatering Centrifuges	
Quantity	2 (1+1)
Minimum Solids Recovery	95%
Hydraulic Treatment Capacity (MMDF)	31.9 MGD
Solids Treatment Capacity (MMDF)	25.5 MGD
Treatment Capacity (MMDF)	25.5 MGD

4.14 SUMMARY OF TREATMENT CAPACITY EVALUATION FINDINGS

Figure 4-1 depicts a summary of the treatment capacity evaluation results for the existing liquid and solids treatment trains at the WRF. As discussed in previous subsections, additional treatment capacity is recommended for grit removal and stormwater holding/equalization basin storage (not shown). Processes downstream from primary clarification have sufficient capacity to treat the projected influent flow and loadings even if flow to the primary clarifiers is limited to 12.3 MGD and remaining flow bypassed. This is a conservative estimate because based on industry-common design criteria, the existing primary clarifiers are anticipated to be capable of handling more flow than the rated capacity of 12.3 MGD, which is governed by weir loading rate. It should also be noted that the secondary treatment train does not have any extra capacity beyond the projected maximum month loading conditions. Hence, if actual influent loadings exceed this master plan’s projections before 2045, additional treatment capacity will be required to meet the established design criteria.

Figure 4-1: Flow Capacity Summary for Existing WRF



5.0 WASTEWATER ALTERNATIVES

5.1 EXPAND EXISTING WRF

The existing WRF is rated at 16 MGD, less than 2 MGD below the anticipated 2045 ADF. A number of processes and facilities are already built to handle the future flows, thus getting the plant to 17.8 MGD would only be a matter of expanding a few bottlenecks. However, outside the boundaries of the plant, there are also considerations associated with pumping the various sewer sheds through force mains to the existing site as compared to a new WRF. The following subsections discuss this alternative and the high-level costs it would incur.

5.1.1 PROPOSED UPGRADES-WRF

For the base-case scenario, only EQ storage and grit removal facilities are recommended for capacity improvements, as shown in Figure 5-1.

Anticipated EQ storage required to shave storm event flows from the full projected 2045 service area to the existing WRF peak flow capacity of 36 MGD is estimated at roughly 25-30 MG, supporting the construction of 20 MG of new EQ storage capacity. This could be located north of the current WRF on City property as shown in Figure 5-1. A volume of 20 MG is achievable using two 10-MG pre-stressed concrete tanks of approximately 205' diameter and 40' deep each. A transfer pump station would likely be required to operate these tanks.

Ideally, all flows should be de-gritted before they are diverted to EQ storage to prevent loss of storage volume over time and minimize odor potential. Additional grit removal capacity is recommended and could be added at the site of the former trickling filters between the existing headworks and aeration basins, with road access near the aeration basins. A single 18-ft grit chamber would provide an additional 30 MGD worth of capacity.

Figure 5-1: Proposed Site Layout for Building Out Existing WRF for 2045 Flows

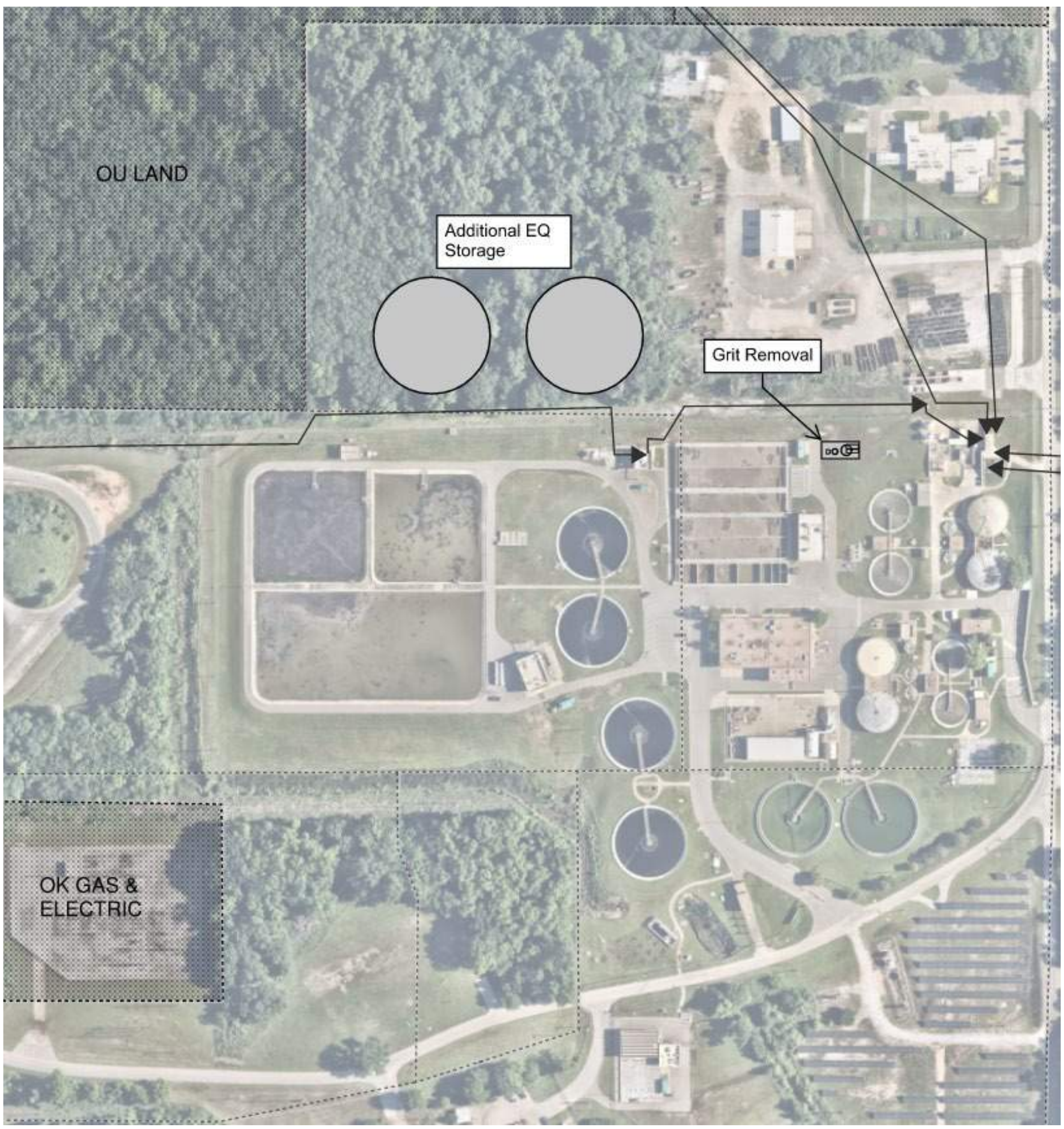
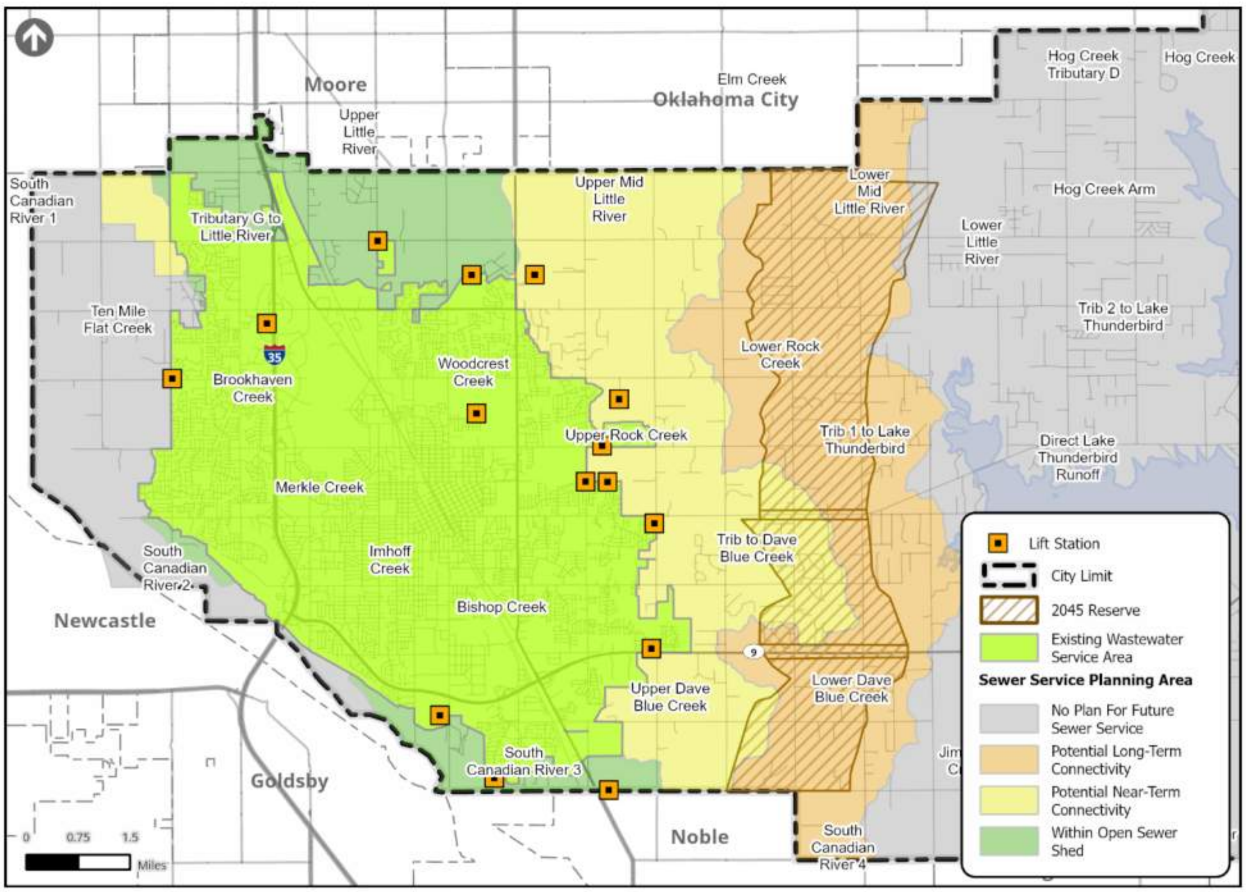


Figure 5-1 does not show various minor rehabilitations and/or replacements that would be required to maintain the existing WRF in good working order over the planning horizon.

5.1.2 COLLECTION SYSTEM IMPROVEMENTS

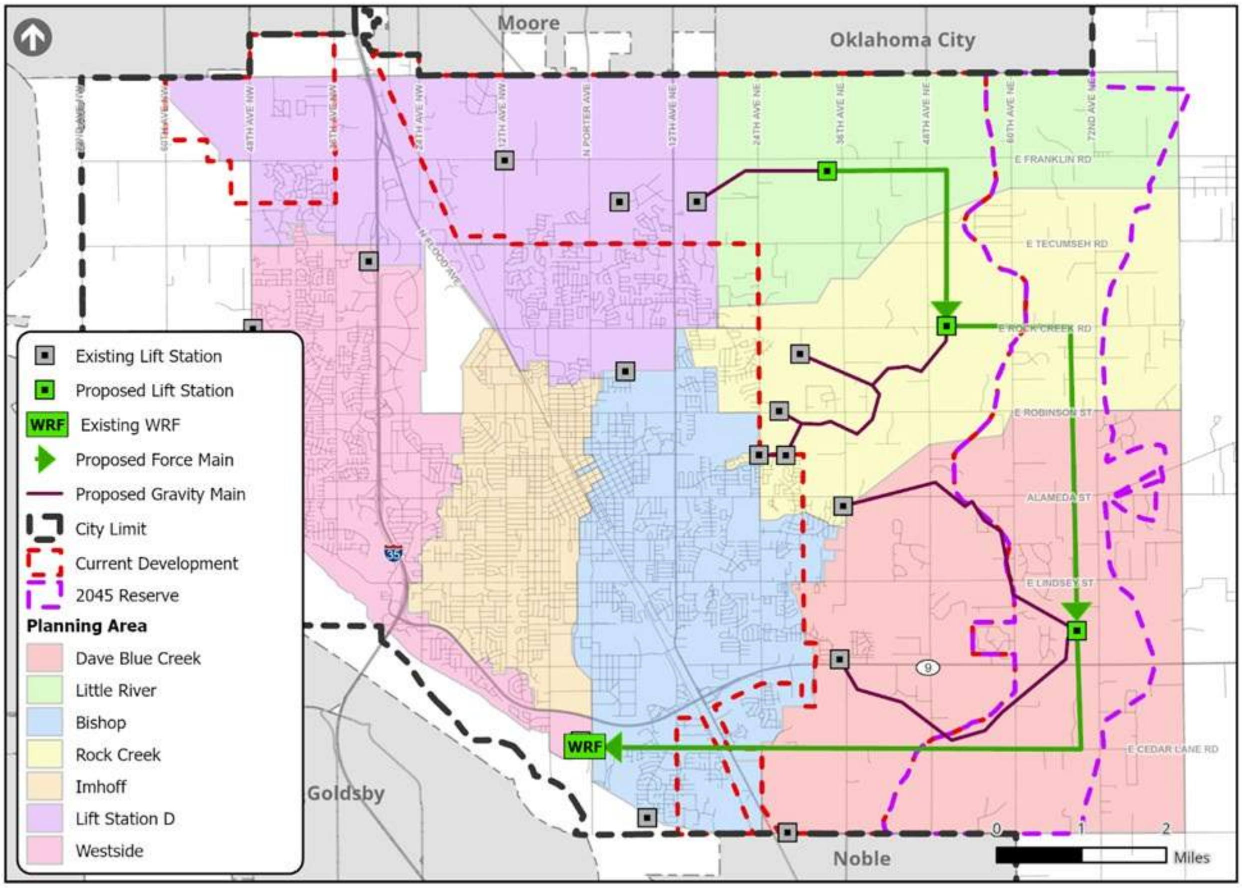
Given the geography and topography of anticipated future growth areas for the City (see Map 5-1), collecting and conveying future flows are largely tied to new service areas in the northern and eastern areas of the City. Most of these northern and eastern areas fall within the Little River, Rock Creek, and Dave Blue Creek watersheds, which results in the need to collect and pump these flows back over the central ridge to the south and west.

Map 5-1: Future Development Wastewater Service Area Overview



The existing collection system occasionally experiences minor surcharging (see Collection System Evaluation TM). Adding considerable service area and routing it through the same hydraulic bottlenecks is not tenable. Replacing major lines in already congested areas of the NUA wastewater service area is to be avoided where possible. Garver recommends building an eastern corridor for routing additional service area flows to the existing WRF. This would allow the bulk of these flows to be intercepted by gravity at the eastern edge of their respective watersheds and conveyed by three main lift stations around the southeast edge of the NUA wastewater service area to the existing WRF as shown in Map 5-2.

Map 5-2: Eastern Corridor Conveyance Improvements for Future Flows to Existing WRF



5.1.3 TOTAL PROJECT COST ESTIMATES

Recommended plant improvements are estimated at $62.5 million as shown in Table 5-1, the lowest cost out of all WRF alternatives. Included in these costs are additional EQ volume, additional grit removal (considered an operational improvement), and miscellaneous rehabilitation and equipment replacement at the existing WRF over the coming 20 years. The latter includes money for repairing the influent pipe from the Westside Lift Station, which is recommended to be repaired in the near term to restore the option to bypass pre-screened Westside flows around the WRF screens

Table 5-1: Existing WRF Improvements Plant OPCC

Facility	OPCC	Total Project Cost
Additional EQ	$23,842,000	$29,803,000
Additional Grit Removal	$6,174,000	$7,718,000
Existing WRF Rehabilitation and Equipment Replacement	$20,000,000	$25,000,000
Total	**$50,016,000**	**$62,521,000**

The conveyance infrastructure needed for this alternative is estimated at approximately $745 million as detailed in Table 5-2. This estimate is intended to capture the full buildout cost of infrastructure required to support this WRF location (as are the collection system costs for the new WRF alternatives) and include lift stations, interceptors, force mains, design, bidding, and construction services as well as easements and property acquisitions. Buildout costs are based on a roughly 33% increase in service area, mostly to the east, and zoned as low-density residential. It should be noted that much of this cost assumes parallel pipes for buildout flows.

Table 5-2: Existing WRF Improvements Conveyance OPCC

Description	Design Flow (MGD)	Length (ft)	Diameter (inch)	Cost
Little River Interceptor	35.7	45,511	54	$ 66,354,776
Upper Rock Creek Interceptor	6.2	7,250	30	$ 5,872,500
Lower Rock Creek Interceptor	15.5	10,875	48	$ 14,094,000
Upper Dave Blue Creek Interceptor	9.5	15,978	42	$ 18,119,052
Trib to Dave Blue Creek Interceptor	9.5	11,585	42	$ 13,137,390
Lower Dave Blue Creek Interceptor	28.5	24,220	66	$ 43,160,040
New East Regional LS	51.1	--	--	$ 26,128,046
New East Regional LS Force Main	51.1	26,240	42	$ 27,552,000
New Intermediate LS	56.1	--	--	$ 27,878,061
New Intermediate LS Force Main	56.1	26,240	48	$ 31,488,000
New Southeast Regional LS	84.6	--	--	$ 37,172,623
New Southeast Regional LS Force Main	84.6	78,902	54	$ 106,517,700

Description	Design Flow (MGD)	Length (ft)	Diameter (inch)	Cost
Existing WRF Influent LS	42.2	--	--	$ 22,833,401
New Influent LS Force Main	42.2	10,560	42	$ 11,088,000
			Subtotal	$ 451,395,590
			Contingency	$ 135,418,677
			Professional Service-Design, Bidding, Construction Services	$ 112,848,897
			Easements and Property Acquisition	$ 45,139,559
			Total	**$ 744,802,723**

5.2 BUILD NEW WRF

As growth continues to the east, the City's topography naturally lends itself to consideration of a new WRF in the Little River, Rock Creek, or Dave Blue Creek watersheds, where flow could be collected by gravity, treated, and discharged downstream. However, these drainages flow by gravity to Lake Thunderbird, where no new wastewater permits are to be issued due to its status as a sensitive water supply. The only exception to this may be under new indirect potable reuse (IPR) regulations, which are discussed in the Reuse Evaluation. However, even an IPR plant would require off-spec water to be able to be discharged somewhere other than the drinking water supply lake. Building a new WRF in one of these watersheds would require effluent to be piped back over the divide to the Canadian River watershed, which generally cancels out the geographical advantage of locating the plant downstream from new development, again with some caveats for reuse. While difficult to separate these issues, it has nonetheless been decided to evaluate wastewater treatment options on their own before layering the potential for reuse.

Considerations for optimal locations for a new WRF include conceptual environmental assessment requirements, geography, topography, "good neighbor" features, flood protection, access, and to a lesser extent, electrical utilities.

Three locations have been investigated. The first is a specific lot referred to in previous reports as the North WRF site, currently owned by NUA and located northwest of the corner of Franklin and 12th Avenue NE. The other locations are generalized and not tied to any particular property lines. The confluence of the Little River and Rock Creek provides an ideal location referred to as the Northeast WRF. Lastly, certain advantages may be had by locating the plant at the southern end of the 2045 Reserve area in the Dave Blue Creek drainage, referred to as the Southeast WRF. As discussed in Section 5.2 and in subsequent pages, the portion of the current and future NUA wastewater flows that a new WRF could treat is considered to remain the same for each alternative. Future analyses may decide to apportion flow differently. This assumption allows for a direct comparison of WRF costs in each of the three locations.

There are two main advantages of building a new WRF. As previously discussed, the existing WRF could be upgraded to handle the predicted future flows but would not have a large capacity margin overall as conceived. If a new WRF was built, those processes which would not be upgraded in section 8.1 would run at a lower percent of maximum capacity, offering additional flow equalization capacity and resistance to load shocks in the biological treatment. Additionally, building a new WRF closer to the newer service areas would reduce the amount of environmental risk associated with leaks, as this option would replace raw sewage force mains with treated effluent force mains.

5.2.1 PROPOSED UPGRADES

A new WRF would require a new NPDES permit, which would be likely to require increased nutrient removal from the existing permit (see Table 5-2). Accordingly, the new WRF design includes the mUCT biological nutrient removal process and tertiary filtration recommendations from the IPR Pilot Report, allowing for a modular discussion of IPR upgrades and costs. Otherwise, the process design reflects the current plant, including fine screens, grit removal, primary clarification with gravity thickening, mUCT process trains, secondary clarification, tertiary filtration, and UV disinfection. Solids would be treated to Class B standards and likely hauled to a landfill or the existing WRF instead of composted onsite, as it is unlikely NUA would build a second co-composting facility at the new WRF site and the complication to achieve Class A without composting is considered prohibitive. A proposed process flow diagram and site layout are shown in Figure 5-2.

Gravity thickeners are shown in series instead of parallel operation, which allows fermentation to release volatile fatty acids in the first stage that are routed from the supernatant of the second stage to process trains. The plant layout was developed to fit the North WRF site but is representative of either of the other sites. Future expansion needs will likely happen in phases according to actual growth; the proposed design is built of 2.5 MGD process modules, starting with 5 MGD with potential for expansion to 7.5 and 10 MGD possible. Flow enters one end of the plant and works in the same direction to discharge, while solids are processed back toward the plant entrance, minimizing solids hauling traffic across the plant.

Additional costs for a NE or SE property have not been included as a line item, as the City's current property could be sold. Proceeds from this sale should be able to cover a suitable acreage for these locations, which are likely less expensive further from the city center.

Figure 5-2: Proposed Process Flow Diagram for new WRF

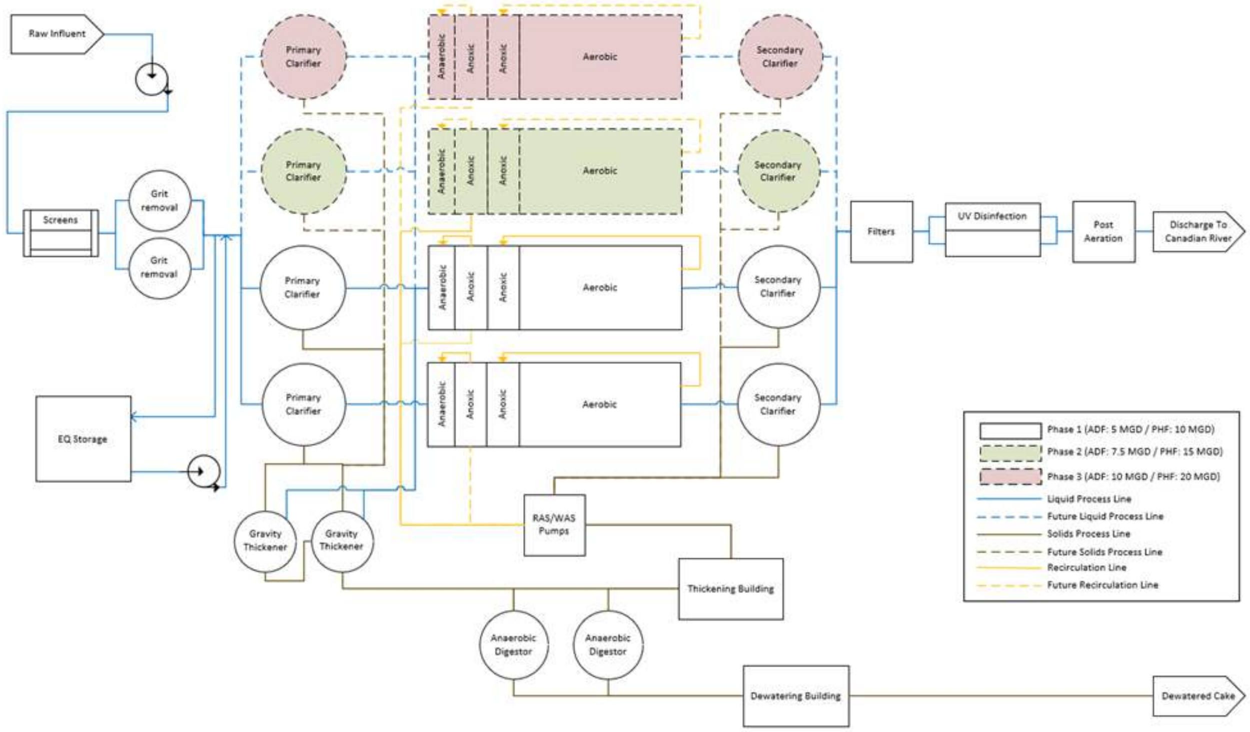
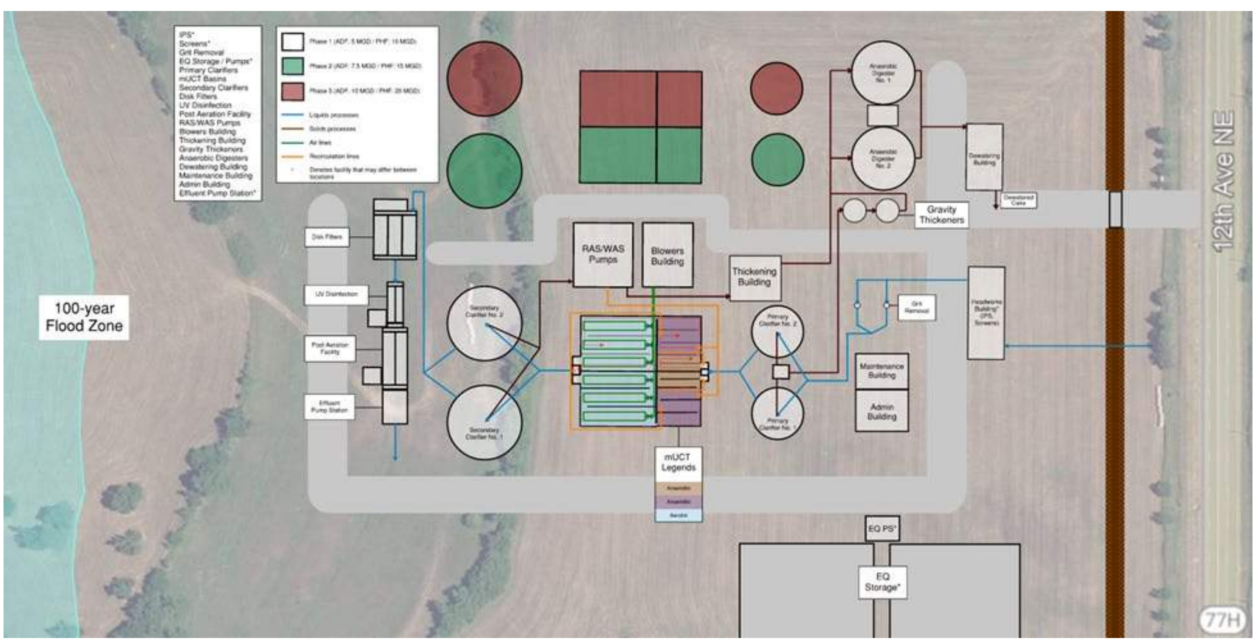


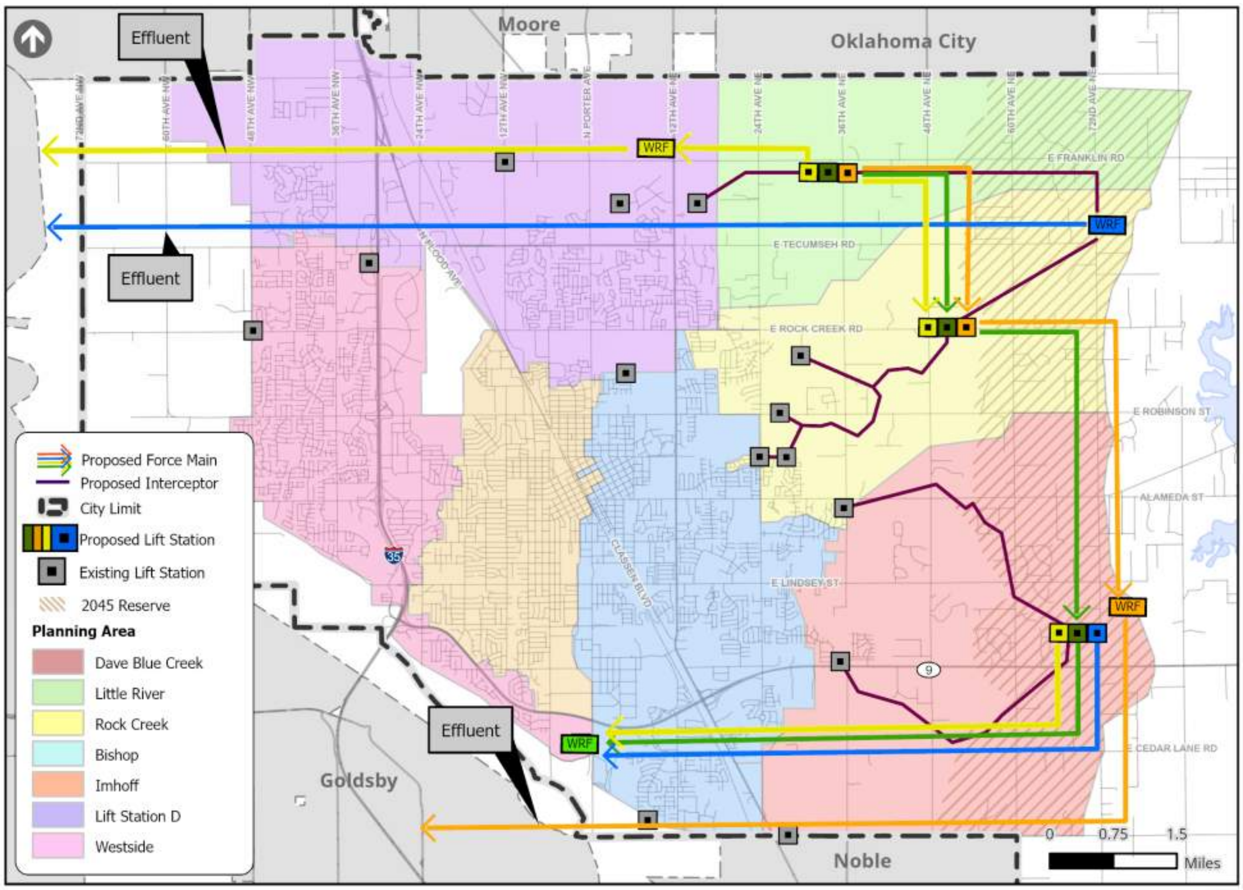
Figure 5-3: Proposed Site Layout for Building New WRF for 2045 Flows



5.2.2 NEW WRF SITE ALTERNATIVES

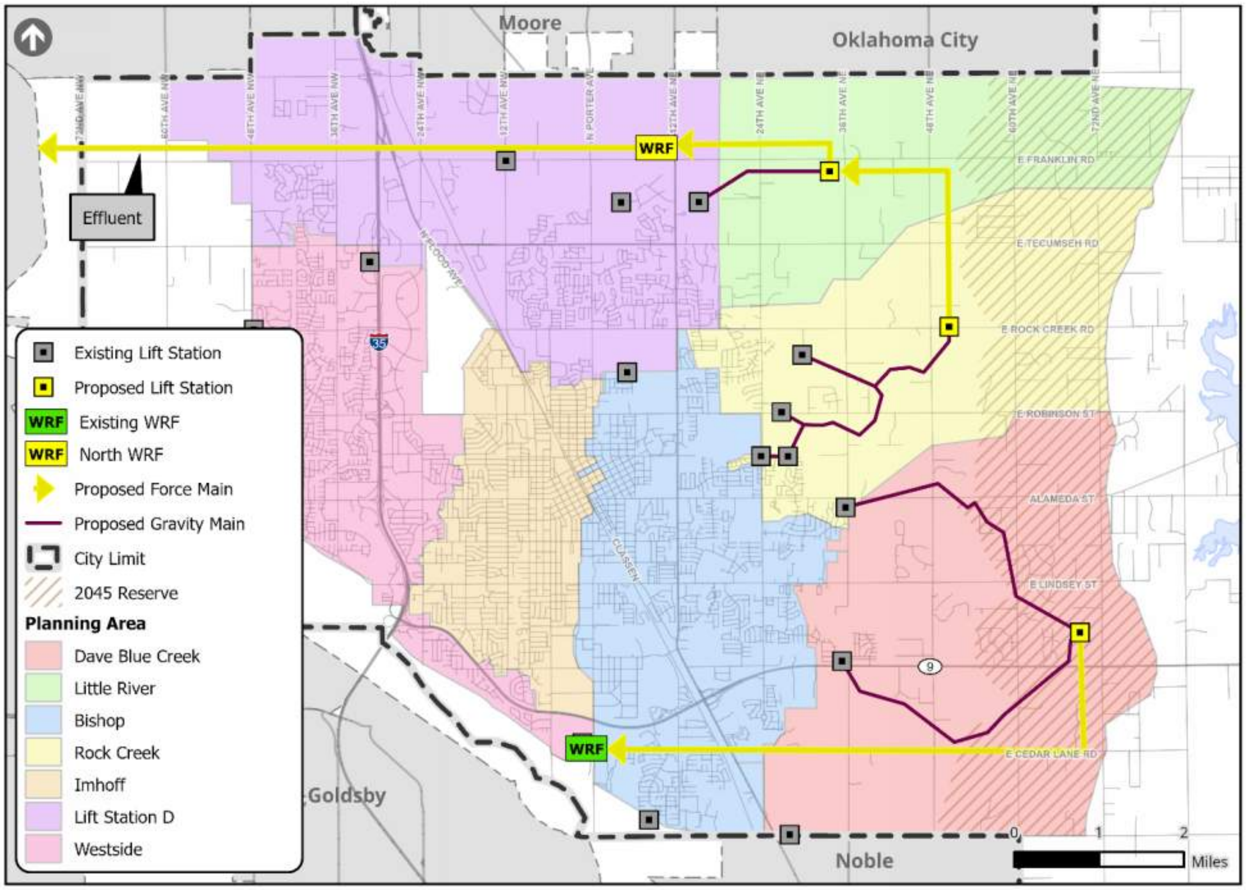
The relative locations of the three alternatives for a new WRF are shown in Map 5-3, along with their major conveyance differences. All alternatives require extensive influent and/or effluent pumping. This will translate to higher conveyance costs than the existing WRF buildout alternative would require and will be detailed in following subsections.

Map 5-3: Summary of Conveyance Differences Between WRF Alternatives

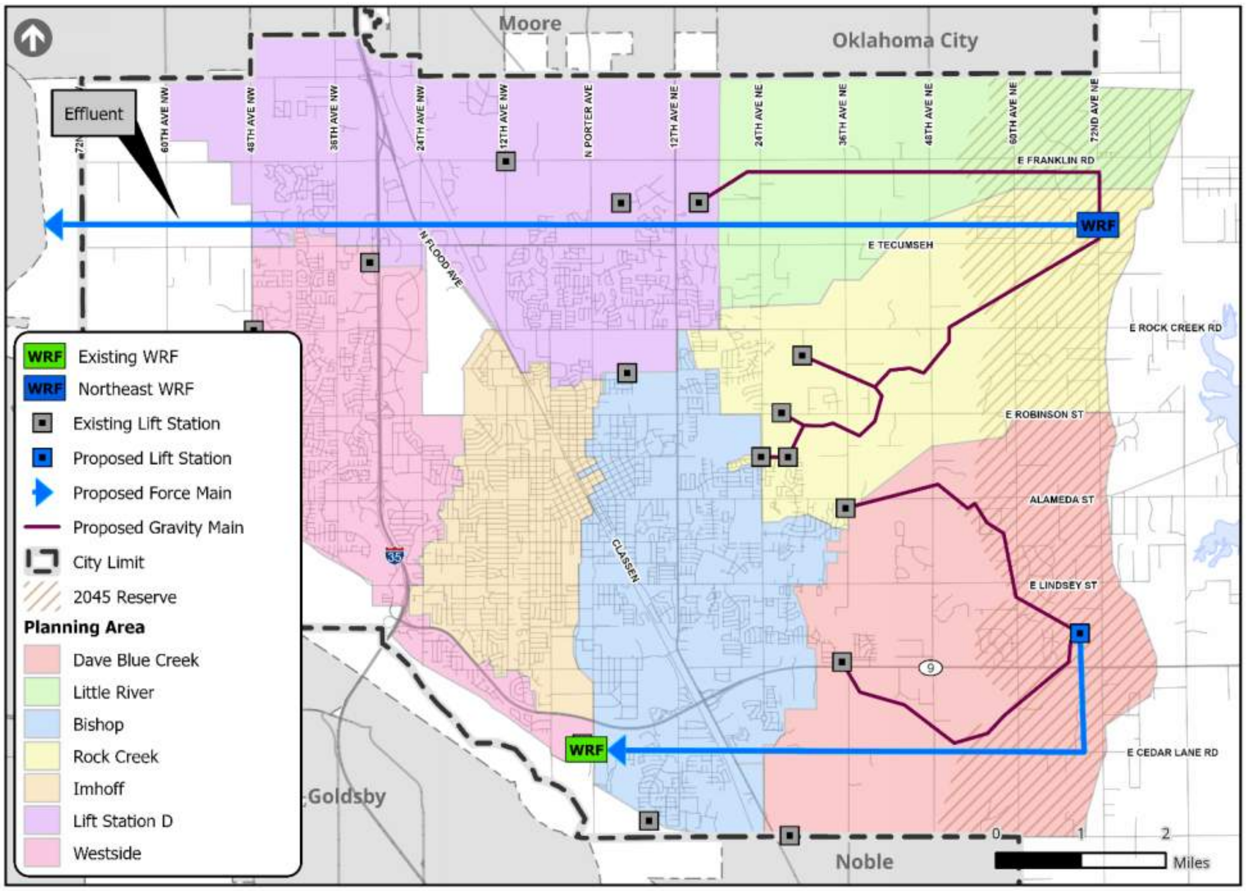


Looking at the North WRF location specifically (Map 5-4), it can be seen that flow from the lower portion of the Little River and Rock Creek watersheds flows by gravity to a regional LS, where it is pumped back westward to the WRF, located at the current Lift Station D. Dave Blue Creek is collected at another regional LS and routed to the existing WRF. Of note for this alternative alone is the screening and EQ capacity provided by Lift Station D. While this capacity would be usable for any of the alternatives, it would provide line-end performance of these functions at a North WRF instead of intermediate EQ and screening. This will impact detailed design and cost to some degree but is not considered significant enough to justify further complication of high-level cost estimation.

Map 5-4: North WRF Location

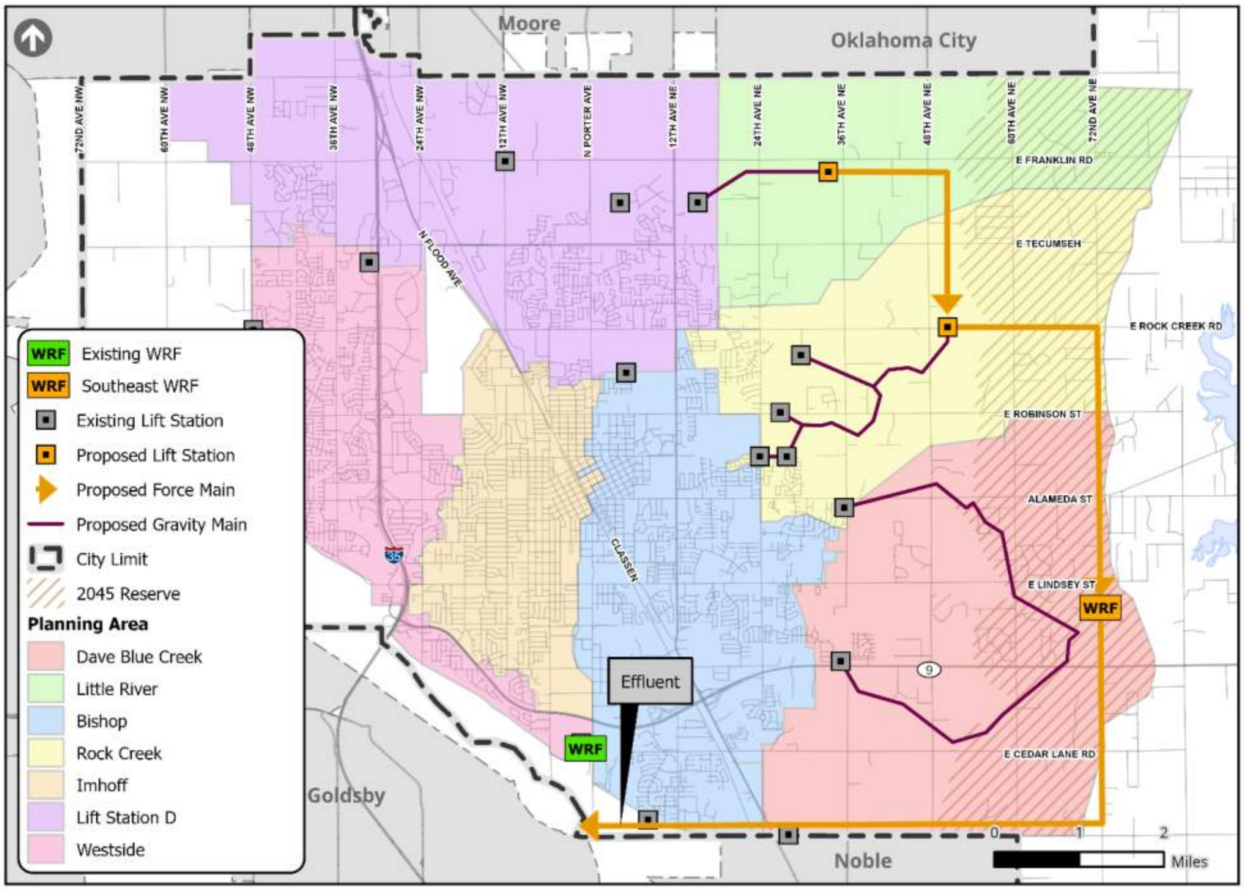


Map 5-5: Northeast WRF Location



The Southeast WRF location, shown on Map 5-6, takes on the flow from Dave Blue Creek watershed that is routed to the new WRF in other alternatives. The flow split is assumed to be maintained equal to the other alternatives by simply leaving Lift Station D (or portion of its flow) pumping to the existing WRF instead of re-routing the entire Little River watershed to the SE WRF. If this is not done, approximately 2 MGD of capacity would need to be built into the SE WRF. Effluent is routed to the south of the NUA WWSA to discharge near the current WRF's location. This is estimated as the most expensive alternative.

Map 5-6: Southeast WRF Location



5.2.3 TOTAL PROJECT COST

The new plant design, which is intended to handle an ADF of 5 MGD, has an estimated TPC of approximately $256 million. This total includes not only the costs associated with constructing the new facility but also accounts for a budget dedicated to replacing equipment at the existing WRF to maintain service. Incorporating the equipment replacement costs enables a more accurate and direct comparison of the alternatives, as these replacements are necessary regardless of the new plant's construction.

The breakdown of the estimated costs shown in Table 5-3 covers various essential components of the project, from the construction of administrative buildings and EQ (equalization) storage to critical treatment processes like the mUCT process, clarifiers, filters, sludge handling, and site improvements such as civil, electrical, and backup power systems. Additionally, the cost estimate includes provisions for side-stream treatment, which will be essential for the new WRF equipped with a biological nutrient removal (BNR) process (I.e., mUCT secondary treatment train). The side-stream treatment is designed to treat the recycle flow generated from the dewatering of anaerobically digested biosolids in the solids handling processes, capturing released phosphorus, and reducing nitrogen content before this flow is recycled back to the head of the plant. This treatment step is necessary to enable the BNR process to consistently remove nitrogen and phosphorus and meet the projected permit limits.

Table 5-3: New North/NE/SE WRF OPCC

Facility	OPCC	Total Project Cost
Admin Building	$5,840,000	$7,300,000
EQ Storage & Pump Station	$6,399,537	$8,000,000
Headworks	$9,660,000	$12,080,000
Overall Odor Control	$11,280,000	$14,100,000
Primary Clarifiers	$8,080,000	$10,100,000
Primary Sludge Pump Station	$2,130,000	$2,660,000
mUCT Process	$29,400,000	$36,800,000
Secondary Clarifiers	$15,190,000	$18,990,000
Filters	$8,280,000	$10,350,000
UV and Post-Aeration	$6,800,000	$8,500,000
RAS/WAS Pump Station	$6,380,000	$7,980,000
Gravity Thickeners	$4,590,000	$5,740,000
Anaerobic Digesters	$10,310,000	$12,370,000
Thickening and Dewatering Building	$17,590,000	$21,990,000
Side-Stream Treatment	$9,931,000	$11,918,000
Site Civil	$15,190,000	$18,990,000
Site Electrical and Backup Power	$22,780,000	$28,480,000
Existing WRF Equipment Replacement Budget	$20,000,000	$25,000,000
Total	**$209,830,537**	**$261,348,000**

In Table 5-4 through Table 5-6, conveyance improvement costs are estimated to accompany the three WRF locations shown and discussed above. These estimates are intended to capture the full buildout cost of infrastructure required to support these alternatives and include lift stations, interceptors, force mains, design, bidding, and construction services as well as easements and property acquisitions. Buildout costs are based on a roughly 33% increase in service area, mostly to the east, and zoned as low-density residential.

Table 5-4: New North WRF Conveyance Improvements OPCC

Description	Design Flow (MGD)	Length (ft)	Diameter (in)	Cost
Little River Interceptor	17.8	22,755	54	$ 33,177,388
Upper Rock Creek Interceptor	6.2	7,250	30	$ 5,872,500
Lower Rock Creek Interceptor	15.5	10,875	48	$ 14,094,000

Description	Design Flow (MGD)	Length (ft)	Diameter (in)	Cost
Upper Dave Blue Creek Interceptor	9.5	15,978	42	$ 18,119,052
Trib to Dave Blue Creek Interceptor	9.5	11,585	42	$ 13,137,390
Lower Dave Blue Creek Interceptor	28.5	24,220	66	$ 43,160,040
New East Regional LS	30.5	--	--	$ 18,209,968
New East Regional LS Force Main	30.5	64,060	36	$ 57,654,000
New Effluent LS	44.8	--	--	$ 23,846,550
New Effluent LS Force Main	44.8	73,726	36	$ 66,353,400
New Intermediate LS	1.0	--	--	$ 1,654,598
New Intermediate LS Force Main	1.0	13,120	10	$ 3,280,000
New Southeast Regional LS	28.5	--	--	$ 17,362,158
New Southeast Regional LS FM Force Main	28.5	78,902	36	$ 71,011,800
Existing WRF Influent LS	42.2	--	--	$ 22,833,401
New Influent LS FM Force Main	42.2	10,560	42	$ 11,088,000
			Subtotal	$ 420,854,245
			Contingency	$ 126,256,274
			Professional Service-Design, Bidding, Construction Services	$ 105,213,561
			Easements and Property Acquisition	$ 42,085,425
			Total	**$ 694,409,504**

Table 5-5: New NE WRF Conveyance Improvements OPCC

Description	Design Flow (MGD)	Length (ft)	Diameter (in)	Cost
Little River Interceptor	35.7	45,511	54	$ 66,354,776
Upper Rock Creek Interceptor	6.2	7,250	30	$ 5,872,500
Lower Rock Creek Interceptor	15.5	10,875	48	$ 14,094,000
Upper Dave Blue Creek Interceptor	9.5	15,978	42	$ 18,119,052
Trib to Dave Blue Creek Interceptor	9.5	11,585	42	$ 13,137,390
Lower Dave Blue Creek Interceptor	28.5	24,220	66	$ 43,160,040
New Influent LS	--	--	--	$ 26,128,046
New Influent LS Force Main	51.1	10,560	42	$ 11,088,000
New Effluent LS	44.8	--	--	$ 23,846,550
New Effluent LS Force Main	44.8	135,490	36	$ 121,941,000
New Intermediate LS	1.0	--	--	$ 1,654,598
New Intermediate LS Force Main	1.0	13,120	10	$ 3,280,000

Description	Design Flow (MGD)	Length (ft)	Diameter (in)		Cost
New Southeast Regional LS	28.5	--	--		$ 17,362,158
New Southeast Regional LS Force Main	28.5	78,902	36		$ 71,011,800
Existing WRF Influent LS	42.2	--	--		$ 22,833,401
New Influent LS Force Main	42.2	10,560	42		$ 11,088,000
				Subtotal	$ 470,971,311
				Contingency	$ 141,291,393
				Professional Service-Design, Bidding, Construction Services	$ 117,742,828
				Easements and Property Acquisition	$ 47,097,131
				Total	**$ 777,102,663**

Table 5-6: New SE WRF Conveyance Improvements OPCC

Description	Design Flow (MGD)	Length (ft)	Diameter (inch)		Cost
Little River Interceptor	35.7	45,511	54		$66,354,776
Upper Rock Creek Interceptor	6.2	7,250	30		$ 5,872,500
Lower Rock Creek Interceptor	15.5	10,875	48		$ 14,094,000
Upper Dave Blue Creek Interceptor	9.5	15,978	42		$ 18,119,052
Trib to Dave Blue Creek Interceptor	9.5	11,585	42		$ 13,137,390
Lower Dave Blue Creek Interceptor	28.5	24,220	66		$ 43,160,040
New East Regional LS	51.1	--	--		$ 26,128,046
New East Regional LS Force Main	51.1	26,240	42		$ 27,552,000
New Intermediate LS	56.1	--	--		$ 27,878,061
New Intermediate LS Force Main	56.1	26,240	48		$ 31,488,000
New Influent LS	28.5	--	--		$ 17,362,158
New Influent LS Force Main	28.5	10,560	36		$ 9,504,000
New Effluent LS	83.5	--	--		$ 36,850,817
New Effluent LS Force Main	83.5	91,920	54		$ 124,092,000
Existing WRF Influent LS	42.2	--	--		$ 22,833,401
New Influent LS Force Main	42.2	10,560	42		$ 11,088,000
				Subtotal	$ 495,514,242
				Contingency	$ 148,654,272
				Professional Service-Design, Bidding, Construction Services	$ 123,878,560
				Easements and Property Acquisition	$ 49,551,424
				Total	**$ 817,598,499**

5.3 LIFE CYCLE COST COMPARISON

In order to provide a better understanding of long-term cost implications, O&M costs were estimated for the four options and added to TPC for plant work and conveyance improvements to arrive at a total LCC for each in Table 5-7. LCC costs included considerations for those facilities or costs which could not be reasonably assumed to be similar across options, such as additional operators for a new plant and dewatered sludge hauling from the new WRF to the existing WRF or landfill. For the WRF comparison, since all alternatives move the same flows from the same drainages to the Canadian River (albeit via different routes), conveyance costs were assumed to be the same.

As expected, the existing WRF alternative shows a marked difference in LCC from the other options, coming in at $7.86 per kgal (thousand gallons) treated as compared to the $9.46-10.67/kgal shown by the new WRF alternatives.

Table 5-7: LCC Comparison of WRF Alternatives

	WRF TPC (million $)	WRF Conveyance TPC[1] (million $)	WRF O&M[1,2] (million $)	WRF Marginal LCC (million $)	WRF Marginal LCC ($/kgal)
Existing WRF	62.5	745		807	7.86
North WRF	261	694	16.99	972	9.46
NE WRF	261	777	16.99	1,055	10.27
SE WRF	261	818	16.99	1,096	10.67

Notes:
1. Excluding common elements
2. Includes eight additional full-time employees required to operate a new plant and sludge hauling from new plant to existing WRF

6.0 CONCLUSIONS

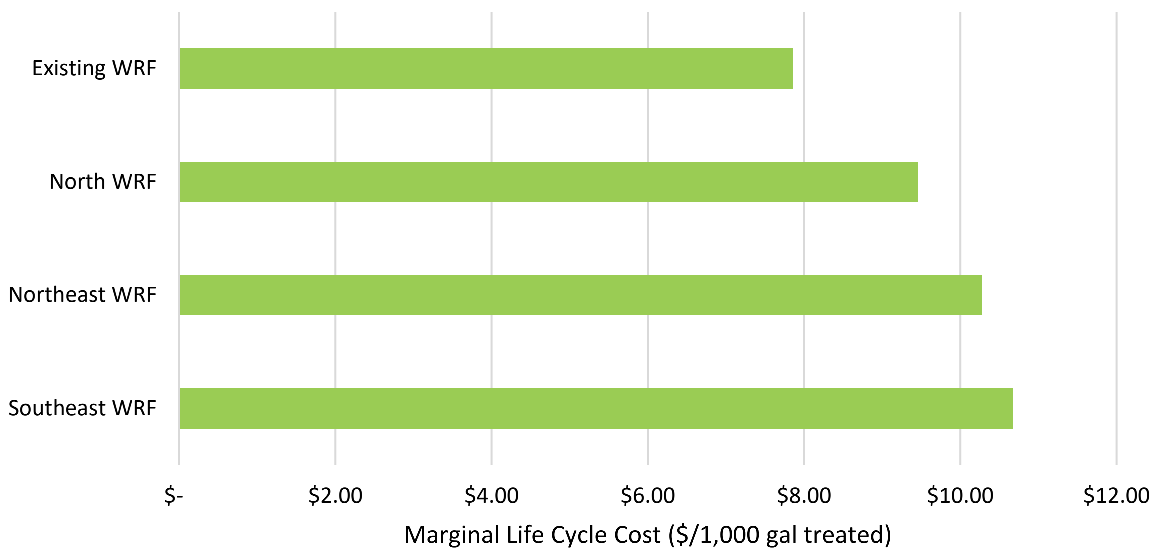
In preparing for NUA's continued growth, infrastructure needs must be balanced with financial prudence. The City's existing geography presents conveyance complications, but these have workable solutions. The existing WRF has extra capacity to handle much of the anticipated growth if only a few bottlenecks are improved. Garver recommends investing in the existing WRF in lieu of building a new WRF, as this will allow for a minimum of complication and expense. Life cycle costs for the four options discussed are duplicated for comparison in Table 6-1 and Figure 6-1.

In considering alternatives for meeting future anticipated flows and permits, the simplest base-case scenario is expanding the existing WRF as well as implementing the collection system improvements required to accomplish all treatment there. This is the most cost-effective solution due to the economy of scale associated with using existing infrastructure instead of duplicating it elsewhere. This alternative also best meets "good neighbor" considerations in that it does not propose any new treatment facility locations that could present nuisance odors to existing or future residents.

Table 6-1: Marginal LCC Comparison of Wastewater Alternatives

	WRF Marginal LCC (million $)	WRF Marginal LCC ($/kgal)
Existing WRF	807	7.86
North WRF	972	9.46
NE WRF	1,055	10.27
SE WRF	1,096	10.67

Figure 6-1: Marginal LCC Comparison of Wastewater Alternatives



APPENDIX J

20 YEAR CIP COSTS

Project 1: Lower Bishop Interceptor Upgrade				
Diameter (in)	**Description**	**Unit Cost ($/LF)**	**Length (LF)**	**Cost**
60	Gravity Main Installation	$ 1,620	3,500	$ 5,670,000
72	Gravity Main Installation	$ 1,944	4,500	$ 8,748,000
			Construction Subtotal	$ 14,418,000
			30% Contingency (Construction Subtotal)	$ 4,326,000
			20% Professional Services - Design, Bidding, and Construction Services	$ 3,749,000
			10% Easement Acquisition	$ -
			Total Project Cost with 30% Construction Cost Contingency	$ 22,493,000

Project 2: Upper Bishop Interceptor Upgrade				
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
30	Gravity Main Installation	$ 810	6,000	$ 4,860,000
36	Gravity Main Installation	$ 972	900	$ 875,000
42	Gravity Main Installation	$ 1,134	5,500	$ 6,237,000
48	Gravity Main Installation	$ 1,296	300	$ 389,000
54	Gravity Main Installation	$ 1,458	3,500	$ 5,103,000
			Construction Subtotal	$ 17,464,000
			30% Contingency (Construction Subtotal)	$ 5,240,000
			20% Professional Services - Design, Bidding, and Construction Services	$ 4,541,000
			10% Easement Acquisition	$ -
			Total Project Cost with 30% Construction Cost Contingency	$ 27,245,000

Project 3: Oak Tree Interceptor Upgrade				
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
42	Gravity Main Installation	$ 1,134	2,500	$ 2,835,000
Construction Subtotal				$ 2,835,000
30% Contingency (Construction Subtotal)				$ 851,000
20% Professional Services - Design, Bidding, and Construction Services				$ 738,000
10% Easement Acquisition				$ -
Total Project Cost with 30% Construction Cost Contingency				$ 4,424,000

Project 4: Constitution St Interceptor Upgrade				
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
24	Gravity Main Installation	$ 648	3,000	$ 1,944,000
			Construction Subtotal	$ 1,944,000
			30% Contingency (Construction Subtotal)	$ 584,000
			20% Professional Services - Design, Bidding, and Construction Services	$ 506,000
			10% Easement Acquisition	$ -
			Total Project Cost with 30% Construction Cost Contingency	$ 3,034,000

Project 5: Eagle Cliff Interceptor Upgrade				
Diameter (in)	**Description**	**Unit Cost ($/LF)**	**Length (LF)**	**Cost**
18	Gravity Main Installation	$ 486	3,000	$ 1,458,000
21	Gravity Main Installation	$ 567	2,500	$ 1,418,000
			Construction Subtotal	$ 2,876,000
			30% Contingency (Construction Subtotal)	$ 863,000
			20% Professional Services - Design, Bidding, and Construction Services	$ 748,000
			10% Easement Acquisition	
			Total Project Cost with 30% Construction Cost Contingency	$ 4,487,000

Project 6: Lift Station D Equalization Basin				
Description		Unit Cost	Quantity (MGD)	Cost
	Storage Installation	$ 1,500,000	3	$ 4,500,000
Construction Subtotal				$ 4,500,000
30% Contingency (Construction Subtotal)				$ 1,350,000
20% Professional Services - Design, Bidding, and Construction Services				$ 1,463,000
10% Easement Acquisition				$ -
Total Project Cost with 30% Construction Cost Contingency				$ 7,313,000

Project 7: Dave Blue Creek Eastern Conveyance Network				
Description		**Unit Cost**	**Quantity (MGD)**	**Cost**
Lift Station Installation		$ 677,491	20	$ 13,549,813
Diameter (in)	**Description**	**Unit Cost ($/LF)**	**Length (LF)**	**Cost**
33	Gravity Main Installation	$ 891	20,000	$ 17,820,000
36	Gravity Main Installation	$ 972	20,000	$ 19,440,000
36	Force Main Installation	$ 900	38,000	$ 37,260,000
			Construction Subtotal	$ 88,070,000
			30% Contingency (Construction Subtotal)	$ 26,421,000
			20% Professional Services - Design, Bidding, and Construction Services	$ 28,623,000
			10% Easement Acquisition	$ 11,450,000
			Total Project Cost with 30% Construction Cost Contingency	$ 154,564,000

Project 8: Rock Creek Eastern Conveyance Network				
Description		Unit Cost	Quantity (MGD)	Cost
Lift Station Installation		$ 875,763	8.5	$ 7,443,986
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
8	Gravity Main Installation	$ 216	2,000	$ 432,000
12	Gravity Main Installation	$ 324	2,500	$ 810,000
15	Gravity Main Installation	$ 405	2,000	$ 810,000
21	Gravity Main Installation	$ 567	5,000	$ 2,835,000
36	Gravity Main Installation	$ 972	7,500	$ 7,290,000
42	Gravity Main Installation	$ 1,134	7,000	$ 7,938,000
24	Force Main Installation	$ 600	27,000	$ 16,200,000
Construction Subtotal				$ 43,759,000
30% Contingency (Construction Subtotal)				$ 13,128,000
20% Professional Services - Design, Bidding, and Construction Services				$ 14,222,000
10% Easement Acquisition				$ 5,689,000
Total Project Cost with 30% Construction Cost Contingency				$ 76,798,000

Project 9: Little River Eastern Conveyance Network				
Description		Unit Cost	Quantity (MGD)	Cost
Lift Station Installation		$ 834,089	10	$ 8,340,888
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
12	Gravity Main Installation	$ 324	4,500	$ 1,458,000
15	Gravity Main Installation	$ 375	6,500	$ 2,438,000
36	Gravity Main Installation	$ 900	6,500	$ 5,850,000
42	Gravity Main Installation	$ 1,050	10,500	$ 11,025,000
24	Force Main Installation	$ 600	12,000	$ 7,200,000
Construction Subtotal				$ 36,311,888
30% Contingency (Construction Subtotal)				$ 10,894,000
20% Professional Services - Design, Bidding, and Construction Services				$ 11,802,000
10% Easement Acquisition				$ 4,721,000
Total Project Cost with 30% Construction Cost Contingency				$ 63,728,888

Project 10: Dave Blue Creek Expansion				
Description		Unit Cost	Quantity (MGD)	Cost
Lift Station Installation		$ 550,293	40	$ 22,011,736
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
36	Force Main Installation	$ 900	27,000	$ 24,300,000
Construction Subtotal				$ 46,312,000
30% Contingency (Construction Subtotal)				$ 13,894,000
20% Professional Services - Design, Bidding, and Construction Services				$ 15,052,000
10% Easement Acquisition				$ -
Total Project Cost with 30% Construction Cost Contingency				$ 75,258,000

Project 11: Rock Creek Expansion				
Description		Unit Cost	Quantity (MGD)	Cost
Lift Station Installation		$ 699,247	18	$ 12,586,444
Diameter (in)	Description	Unit Cost ($/LF)	Length (LF)	Cost
24	Force Main Installation	$ 600	12,000	$ 7,200,000
Construction Subtotal				$ 19,787,000
30% Contingency (Construction Subtotal)				$ 5,937,000
20% Professional Services - Design, Bidding, and Construction Services				$ 6,431,000
10% Easement Acquisition				$ -
Total Project Cost with 30% Construction Cost Contingency				$ 32,155,000

Project 12: Grit Removal			
Description	**Unit**	**Quantity**	**Cost**
Grit Removal	LS	1	$ 7,718,000

Project 13: WRF Equalization Storage			
Description	**Unit**	**Quantity**	**Cost**
WRF Equalization Storage	LS	1	$ 29,803,000
Construction Subtotal			$ 29,803,000

Project 14: 5-Year Existing WRF Rehabilitation and Equipment Replacement			
Description	**Unit**	**Quantity**	**Cost**
WRF Rehabilitation and Equipment Replacement	LS	1	$ 25,000,000