Feasibility Report for Lawrence Brook Fish Ladders and Suggested Re-Operation Plan

New Brunswick Water Utility (NBWU)
Westons Arch Dam (NJ Dam No. 25-2)
Westons Mill Pond Dam (NJ Dam No. 25-3)
City of New Brunswick, Middlesex County, NJ

Prepared for / Funded by:

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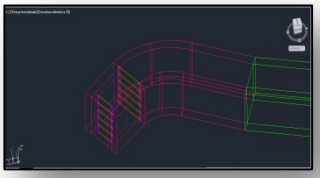

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New York - New Jersey
Harbor & Estuary Program
www.harborestuary.org

Conclusion from Previous Project Phase

This report summarizes Phase II of a feasibility study for fish passage over two water supply dams on the Lawrence Brook, a tributary to the Raritan River. Phase I can be found at **www.harborestuary.org/grants.htm**. During the initial phase of this project, Princeton Hydro determined preliminarily that fish passage via a fish ladder was feasible ("Lawrence Brook Fish Ladder Partial Feasibility Assessment") at the Westons Mill Pond Dam and Westons Arch Dam – dams used to supply drinking water to the City of New Brunswick, and operated by the New Brunswick Water Utility (NBWU). In particular, Princeton Hydro concluded that "despite water withdrawal operations which drop flows below the minimum passing flow requirement at times, minimum required fishway flows (for at least one proposed fishway design) are equaled or exceeded 92-99% of the migratory period." However, given the need to ensure feasibility of both the reliable provision of drinking water and fish passage, additional study focusing on water withdrawal was needed.

This subsequent feasibility report and suggested re-operation plan further investigates hydrologic and hydraulic data to affirm the feasibility of providing adequate passing flow for a fish ladder, presents more details on a fish ladder design, and proposes physical equipment upgrades and operational changes to the water withdrawal system to ensure compatibility with the current and future demands for water supply.

Target Species and the Migration Period

As stated in the previous report, the target migratory species included, and remain: alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), American shad (Alosa sapidissma), and American eel (Anguilla rostrata), as these species are native to the Raritan River basin and are believed to have formerly accessed Lawrence Brook for migration and breeding. Evidence exists, either anecdotal or confirmed, for all of these species at this site, including American eel and river herring, which were observed by project partners this past spring (2014). Further review of the available migration data confirmed that American Shad migration begins in April, peaks in mid-May, and extends, at diminishing rates, to the end of June. This period, April 1 through June 30, also spans the upstream migration periods of the other target species, and is considered to be all inclusive.

New Jersey Department of Environmental Protection (NJDEP) restrictions on in-stream work for the purpose of protecting migrating American shad provide a secondary justification for establishing the April through June migration period. The regulations (NJDEP Freshwater Wetlands Protection Act Rules) pertain specifically to the Delaware River, likely because it supports a sustaining American shad run. That the restrictions apply from the Delaware Bay to the New York border for the entire three month period serves as an additional rationale for a similar period within the Raritan River system, including Lawrence Brook. Thus the migration period for this project remains, as initially proposed in the earlier phase of this project, from April through June.

Upstream migration (and therefore, passage at fishways) of these species occurs during both day and night. Blueback herring tend to migrate during the day, whereas American shad migrate only during the day. However, alewife tend to migrate at night, and American eel migrate only at night. The potential for 24-hour upstream passage at the fish ladder during the migration period precludes the possibility for "non-migration" hours during which, for example, alternative operations or fish passage flow requirements could have been relaxed.

Hydrologic Analyses

Fish Passage Flows

Progression of the fish ladder design from the initial phase of this project has yielded more specific design criteria and flow requirements. In particular, the proposed fish ladders (at both Westons Mill Pond Dam and Westons Arch Dam) require a minimum water depth of 2 feet at the "exit" (i.e. the upstream end where water enters), which equates to a minimum flow through the fish ladder of 6 cubic feet per second (CFS). The current design of the fish ladder at Westons Mill Pond Dam, which accounts for the fluctuation in water surface elevation over the last 5 years, has established the invert of the fish ladder exit at 12.4' (NAVD 1988). Thus the minimum water stage for the proposed fish ladder at Westons Mill Pond Dam is 14.4' (NAVD 1988), which is approximately 0.9 feet below the dam crest. Minimum water stage for the proposed fish ladder at Westons Arch Dam is 17.8' (NAVD 1988). This recently established minimum fish ladder flow is lower than the required minimum passing flow of 8.7 CFS, and thus provides new flexibility in balancing the fish passage needs with water supply withdrawals, as compared to our initial findings. At high flows, when the fish ladder is "full" and water withdrawal is not a concern, it would divert 12 CFS. Additional fish ladder design details are presented in Appendix D.

Hydrographs of the migratory season from 2008 to the beginning of 2014 were updated with average daily withdrawal data provided by the NBWU (Appendix A). The hydrographs, which include instantaneous discharge from the USGS gage, depict the co-occurrence of withdrawal rates and low flows. (The gage, "USGS 01405030 Lawrence Brook at Westons Mills NJ," is located at the NBWU station, upstream of the Westons Mill Pond Dam and downstream of the Westons Arch Dam.) While daily mean discharges were generally above the passing flow requirement regardless of water withdrawal rates, instantaneous discharge records do not reveal an obvious trend. Withdrawal rates vary widely and irregularly. Higher withdrawals occurred in 2010, 2013, and 2014. While the instantaneous passing flows dropped below the required minimum on several occasions in 2013, the passing flow was met for the first part of 2014, partly because higher withdrawals were coincident with higher stream flows (i.e. storm events). In 2008, 2009, and 2011, water withdrawals were not as high, and yet the required minimum passing flow was occasionally not met. These observations indicate that fish passage can be accommodated most of the migration period in most years, but they also indicate that greater flexibility in pumping rate (i.e. the ability to pump out at slower, steadier rates) may be necessary to balance withdrawal demands during periods of conflict, such as unseasonably dry weather, during interruptions with the Raritan Canal Source, or when future demands are higher.

Flow Duration

To quantify the duration of time that low flows occurred during recent migratory periods, flow duration curves were updated with the latest available flow data (Appendix B). The period of record for flow data spans December 1988 to October 1994, and July 1995 to the present; however, this analysis pertains specifically to the migratory seasons (April 1 – June 30) of all the years on record (1988 – present, approximately). Typical performance standards for fish passage projects aim for functionality within the 5^{th} to 95^{th} percentile exceedance flows. (To restate, the 5^{th} percentile exceedance flow refers to the flow that is equaled or exceeded only 5 percent of the study period, likewise, the 95^{th} percentile exceedance flow refers to the flow that is equaled or exceeded 95 percent of the study period.) Fish are likely not migrating at the extreme low flows (95^{th} percentile or above) or extreme high flows (5^{th} percentile or below). The fish ladder, as designed, will be passable down to the 95^{th} percentile exceedance flow of the migratory period, thus meeting typical performance standards. However, if average daily withdrawal rates are increased to the amount permitted in the NJDEP Water Allocation

Permit (WAP) (10 million gallons per day, or 15.5 CFS on average), the fish ladder will be passable only down to the 80th percentile exceedance flow. In other words, at current average withdrawal rates, the fish ladders will be passable approximately 95% of the migratory season; if withdrawals increase to the maximum allowed by permit, the fish ladder will be passable approximately 80% of the migratory season.

Stage Fluctuation

In this second phase, stage data collected by the USGS gage (at Westons Mill Dam Pond) was also analyzed as it serves as a more accurate record of daily water level fluctuations due to water withdrawals (Appendix C). The USGS was able to provide 15-minute stage data from 2007 to 2013. Discharges are calculated from stage measurements; however, the discharge calculation assumes some seepage through the dam and thus may not accurately represent when water levels fall below the dam crest, particularly considering the undocumented operation of the sluice gates (described below) at Westons Mill Pond Dam. Stage records indicate water levels dropping below the crest of the dam on approximately seven occasions from 2007 through 2013, outside of the migration periods. For the majority of that seven-year period, stage tended to remain approximately 0.3 feet above the dam crest. Analysis of the stage data indicates that stage at the lower dam is above the dam crest for 99.9% of the period of record (10/2007 - 8/2014). This finding aided in establishing the invert of the fish ladder exit and further supports the feasibility of maintaining functional fish ladders.

Water Supply Operational Considerations

General

Since the Westons Mill Pond Dam and the Westons Arch Dam are both instrumental in providing water supply to the NBWU's water system, significant consideration was given during this second phase to assure that the operational feasibility of the fish passages for these dams would not adversely impact the critical and essential water supply and treatment requirements for the NBWU. Based on our understanding of water supply withdrawal operations, which we ascertained from examinations of water supply records and discussions with NBWU's operational and engineering officials, the fish ladders as designed will fully accommodate water supply withdrawals – the dams' sole purpose – while also providing efficient fish passage. Below are suggestions for possible changes to the equipment and operations of the NBWU that could enhance the effectiveness of the fish ladders and may even help in the cost effective operations of the water supply and treatment facilities.

Existing Operations

The NBWU receives its raw water from two sources, the Delaware and Raritan Canal (Canal) through a contract with the New Jersey Water Supply Authority (NJWSA) and the Lawrence Brook through their WAP. The contract with the NJWSA allows the NBWU to withdraw up to 10.5 MGD from the Canal, with the provision that they have to pay for the full 10.5 MGD withdrawal whether they take that much water or not. The WAP allows the withdrawal of up to 310 million gallons per month (MGM), an average of 10 MGD, from the Lawrence Brook. Currently, water is pumped from the Lawrence Brook to the treatment plant via four (4) pumps having pumping capacities of 4,200 gallons per minute ("GPM") or 6.0 MGD, 6,250 GPM or 9.0 MGD, 7,300 GPM or 10.5 MGD, and 10,100 GPM or 14.5 MGD. Some of these pumps are constant pressure pumps whose flow rate is not easily controlled while others have variable frequency drivers ("VFDs") that allow for flow control. Due to a relatively small amount of raw

and/or finished water storage in the City's system, the City uses the treatment plant to meet peaking flow rates, which are higher than the average daily flow rates. There is a passing flow requirement of 8.7 CFS (3,900 GPM or 5.6 MGD) in the Water Allocation Permit for the Lawrence Brook Intake. The City normally meets its passing flow requirement on a daily average basis, but not always. However this is common for similar stream intake facilities in New Jersey.

Since the NBWU has more total water available from its two water sources than it currently needs, it has choices of where to draw the raw water from to deliver to its water treatment plant and, ultimately, its distribution system. While the "take or pay" provision of the contract with the NJWSA provides some limited incentive for taking the full 10.5 MGD allowed withdrawal from the Canal, water quality considerations play a big role in deciding the best amount of water to take from each of the two water supply sources. According to NBWU officials, and evidenced by the historical pumping records from each water supply source, more water is being withdrawn from the Lawrence Brook in recent years to allow the provision of more efficient water treatment at the treatment plant.

Each of the two Westons Mill dams have sluice gates that can be manually opened and closed that allow water to be released from the bottom of the dams. Sluice gates typically are used such that the water level in dam impoundments can be reduced in anticipation of possible flooding conditions and for other dam maintenance needs. While the actual records of when sluice gates are being opened, or how far they are opened, are not available, water utility officials have indicated that they have been opened in the past.

The NBWU is preparing to go to bid on a project to change water pumping equipment at the Canal and at the Lawrence Brook intake (Pumping Project). After completion of the Pumping Project, the NBWU will have all constant pressure pumps. At the Canal, the pumping capacity will be 10.5 MGD and at Lawrence Brook there will be three pumps rated at 2 MGD, 8.5 MGD and 10.5 MGD. The purpose of the Pumping Project is to replace older pumping equipment at the two raw water pumping facilities to provide better flexibility in raw water pumping.

Re-Operation Suggestions to Enhance the Efficiency of the Proposed Fish Ladders

Of course, the overriding consideration of operations of the Lawrence Brook water intake is the provision of safe potable water to the customers of the NBWU. There are operational and water facility changes that may be feasible that would enhance the operational efficiency of the proposed fish ladders and, possibly, enhance the ease of operating the NBWU's treatment plant while maintaining the primacy of water supply and water quality for the NBWU. A discussion of these suggested changes follows.

As set forth above, the proposed fish ladders are being designed such that they can effectively allow fish passage over the dams while utilizing the minimum water flow through the ladders. Since the proposed fish ladders have a fish exit (water intake) near the top of each dam, the most efficient operation of these ladders requires adequate water elevation in the ponds to allow for sufficient water flow through the ladders. The following operational and facility suggestions are meant to provide the best tools for the NBWU to maintain an adequate water elevation behind both dams to accommodate the required flow through the ladders.

The most important consideration, and one that should be easy to accomplish, is to simply not open the sluice gates during the migratory period (April through June) except when needed for flood control (at

which time the flow in Lawrence Brook will either be high enough that opening the sluice gates will not lower the level to the point that there is insufficient flow in the ladders or there will be too high of a flow downstream to allow for natural fish passage even if the dams were not present). In the past, the sluice gates have been opened to provide some passing flow when water levels were low in Westons Mill Pond. However, the proposed fish ladders as designed would eliminate the need for that intermittent operation; flow should be preferentially directed through the fish ladders, which would in turn, provide adequate passing flow.

In addition, it is suggested that changes be made to the Pumping Project to enhance the operations of the fish ladders as well as providing additional tools to the NBWU for water supply operations. These changes are:

1. Provide a variable frequency drive (VFD) for the proposed 8.5 MGD pump at the Lawrence Brook Intake.
2. Provide a VFD for the 10.5 MGD pump at the Canal.
3. Connect the existing signal from the water level indicator of the USGS stream flow gaging station (No. 01405030) at the Westons Mill Pond Dam on the Lawrence Brook to the NBWU's supervisory control and data acquisition (SCADA) system.
4. Provide a water level indicator above the Westons Arch Dam on the Lawrence Brook that would be connected to the SCADA system to indicate a low water depth condition.

If the above changes were made to the Pumping Project, there would be much greater flexibility for operations of the NBWU water supply facilities. For instance, the operators could more easily control the amount of water flowing through the treatment plant by indicating how much water would be pumped from each of the two intake facilities. During times when the water quality is best in the Lawrence Brook, it would be easy to maximize flows from the Lawrence Brook without worrying about maintaining a passing flow. This could be accomplished by indicating the maximum flow (say 10.5 MGD) could be diverted from Lawrence Brook as long as the water level at the lower dam is set within the SCADA system to maintain the desired passing flow (the vast majority of the time being at least the 6.0 CFS required for efficient fish ladder operation, but could be lowered during low flow periods for water supply necessity reasons or increased to 8.7 CFS when feasible to maintain the required passing flow in the Water Allocation Permit). The SCADA system could then communicate to the 10.5 MGD pump at the Canal how much is needed to pump to maintain the optimum water flow through the treatment plant. Of course, the flow from the Lawrence Brook 8.5 MGD pump could not be lowered too far, perhaps to 50% of its capacity, such that the minimum flow would either be 2.0 MGD or 4.25 MGD depending on whether the 8.5 MGD pump was running or not. Also, it is understood that when the 8.5 MGD pump was out of service, this flexibility would be lost.

The amount of water flowing over the upper dam would normally be approximately equal to the amount of water flowing over the lower dam plus the amount of water diverted to the treatment plant. Nevertheless, if there was a water level indicator at the upper dam, an alarm can be sent when the water level drops to a low level due to the malfunction of some other aspect of the water control system.

There have been times in the past when the operations of the Lawrence Brook intake was such that large quantities of water were diverted for relatively short periods of time, causing wide variations in the water level behind the dams. As much as practical, therefore, withdrawal from the Lawrence Brook should be controlled such that as constant a flow as possible is maintained at the lowest rate needed for efficient operations of the treatment plant. This should provide better operation of the treatment plant

as opposed to having significant changes made in the pumping rate from the Lawrence Brook on a more frequent basis as has happened in the past.

While the need for some of these control features could be eliminated or reduced if there were additional raw or finished water storage added to the NBWU water system, the cost of adding such storage may be prohibitive and these operational suggestions are based on not adding additional storage.

It is likely that there will be a need to increase average water withdrawals from Lawrence Brook in the future due to water quality concerns or to meet higher usage demands from population growth or new industry. When these higher flows occur, perhaps to the full 310 MGM withdrawal allowed by the NJDEP, the suggested operational and facility changes will be more important to the efficacy of the fish ladder operations.

Summary of Minimum Fish Passage Needs and Suggested Re-Operation Steps

The following is a summary of the minimum fish passage needs to successfully operate the two proposed Denil fish ladders, as well as our suggested re-operation steps that will help ensure both successfully maintaining a reliable water supply and allowing for effective fish passage both now and into the future.

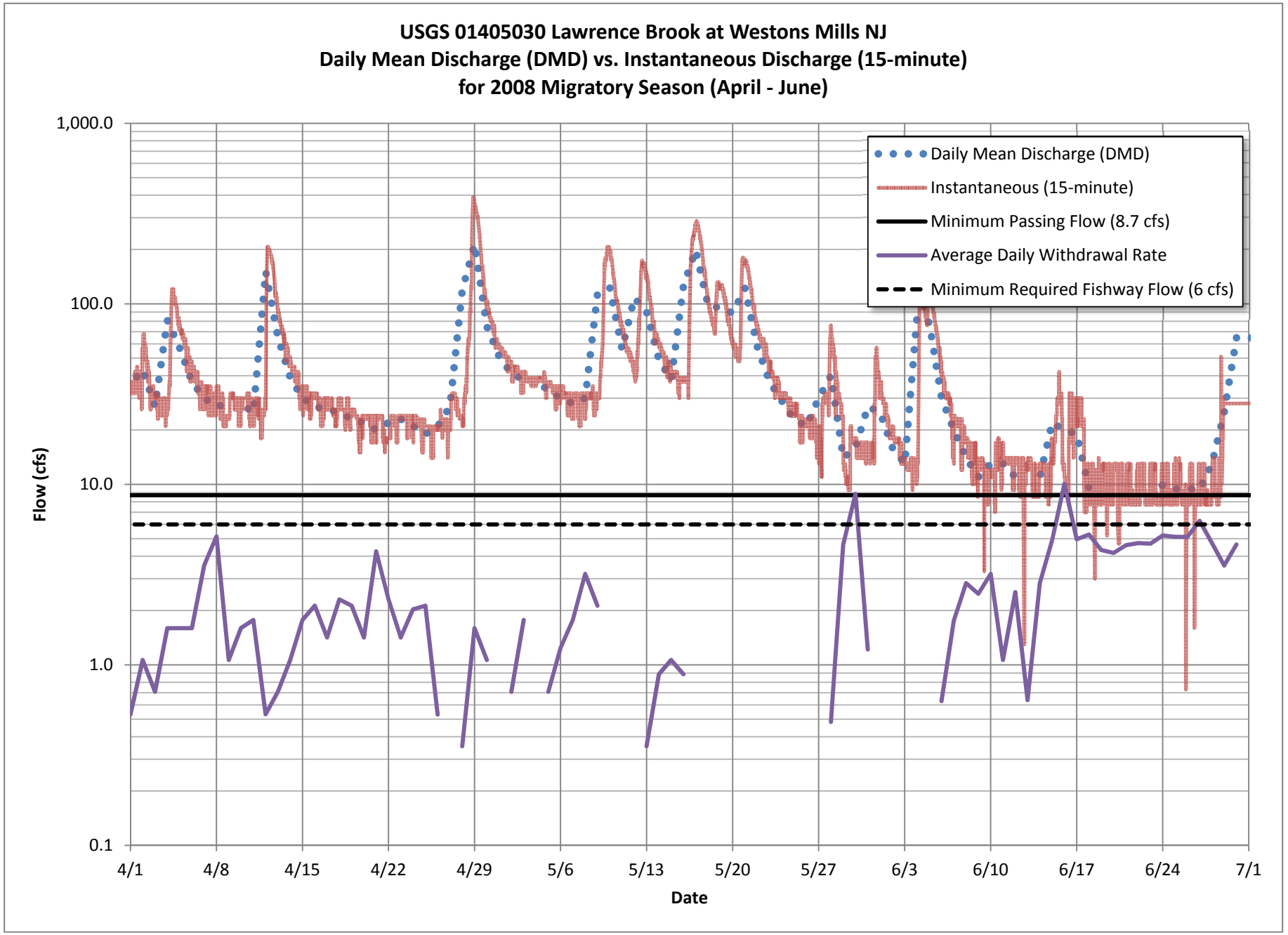
Minimum Fish Passage Needs:

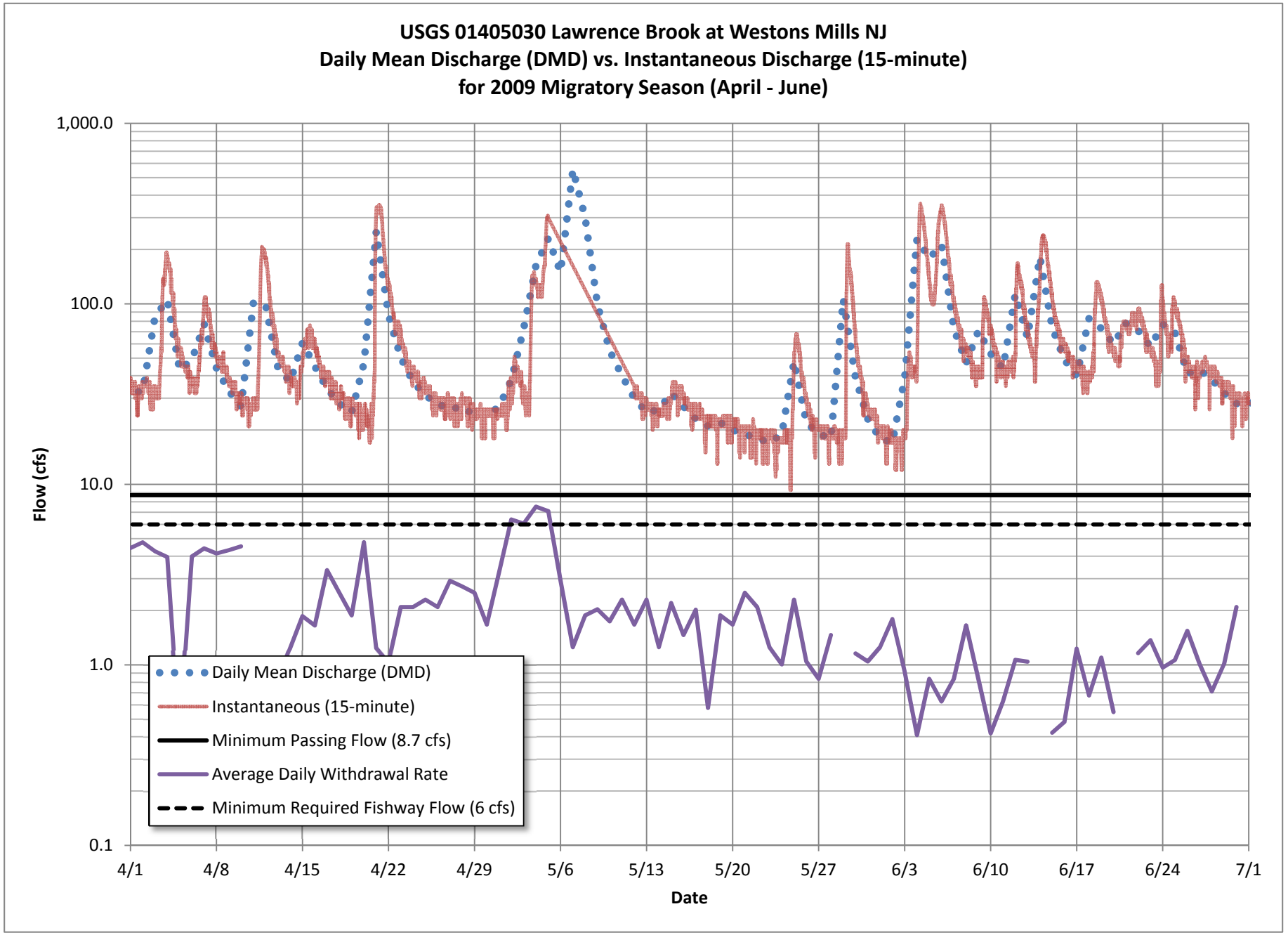
- Minimum required water elevation at Westons Mill Pond Dam: 14.4' (NAVD 1988)
- Minimum required water elevation at Westons Arch Dam: 17.8' (NAVD 1988)
- Minimum required flow for fish passage operation: 6 CFS (Note: the minimum passing flow required by NJDEP is 8.7 CFS.)
- Closure of the low-level sluice gates (on both dams) during the migratory period (except for periods of high flow in preparation for flood stages)

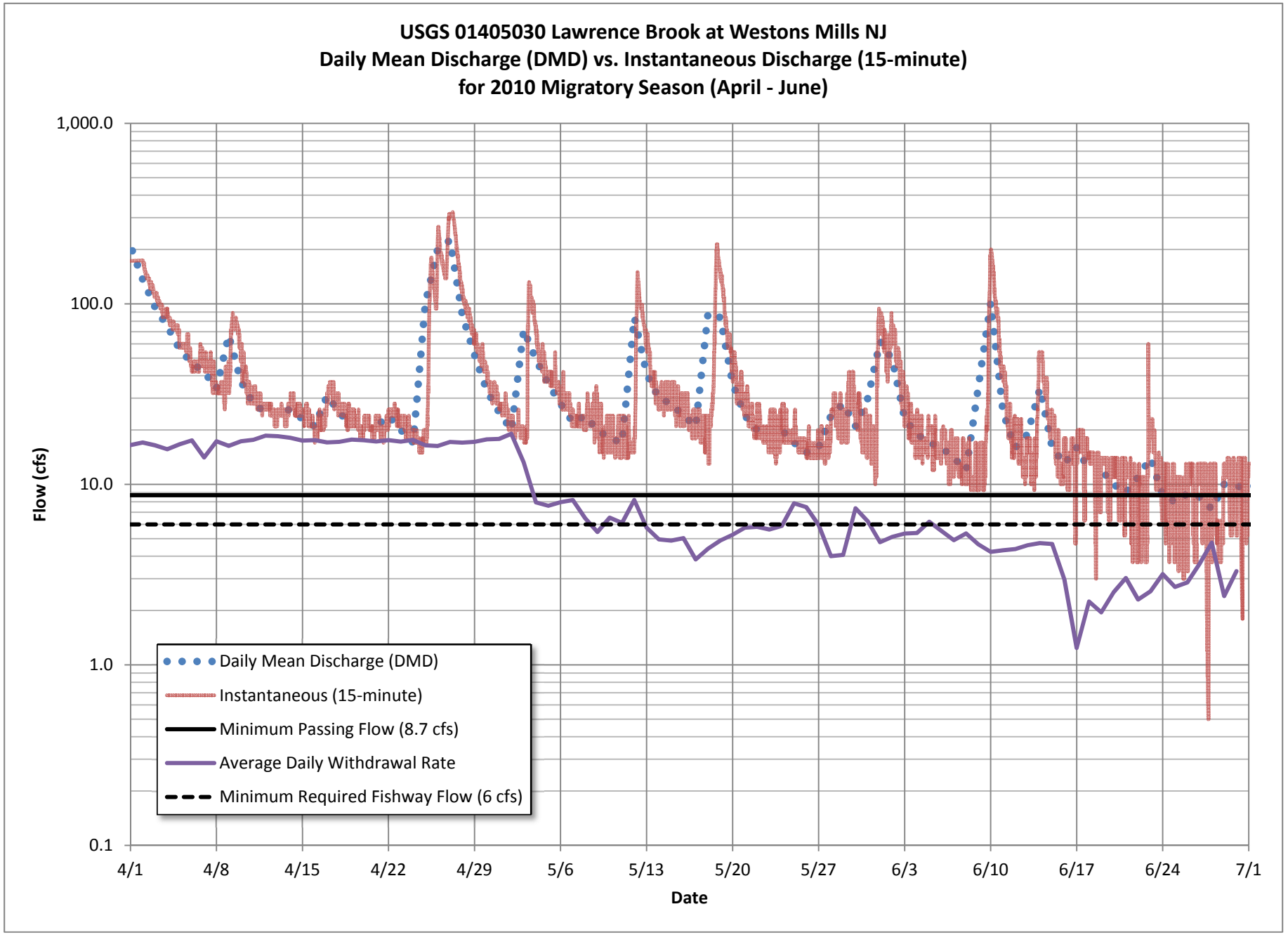
Suggested Re-Operation of the Water Withdrawal System

- Provide a variable frequency drive (VFD), instead of a constant flow pump, for the proposed 8.5 MGD pump at the Lawrence Brook Intake.
- Provide a VFD for the 10.5 MGD pump at the Canal.
- Connect the existing signal from the water level indicator of the USGS stream flow gaging station (No. 01405030) at the Westons Mill Pond Dam on the Lawrence Brook to the NBWU's supervisory control and data acquisition (SCADA) system.
- Provide a water level indicator above the Westons Arch Dam on the Lawrence Brook that would be connected to the SCADA system to indicate a low water depth condition.

Appendix A: Seasonal Hydrographs 2008 - 2014


USGS 01405030 Lawrence Brook at Westons Mills NJ
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2008 Migratory Season (April - June)
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)
Flow (cfs)
1,000.0
100.0
10.0
1.0
0.1
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date


USGS 01405030 Lawrence Brook at Westons Mills NJ
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2009 Migratory Season (April - June)
1,000.0
100.0
10.0
1.0
0.1
Flow (cfs)
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)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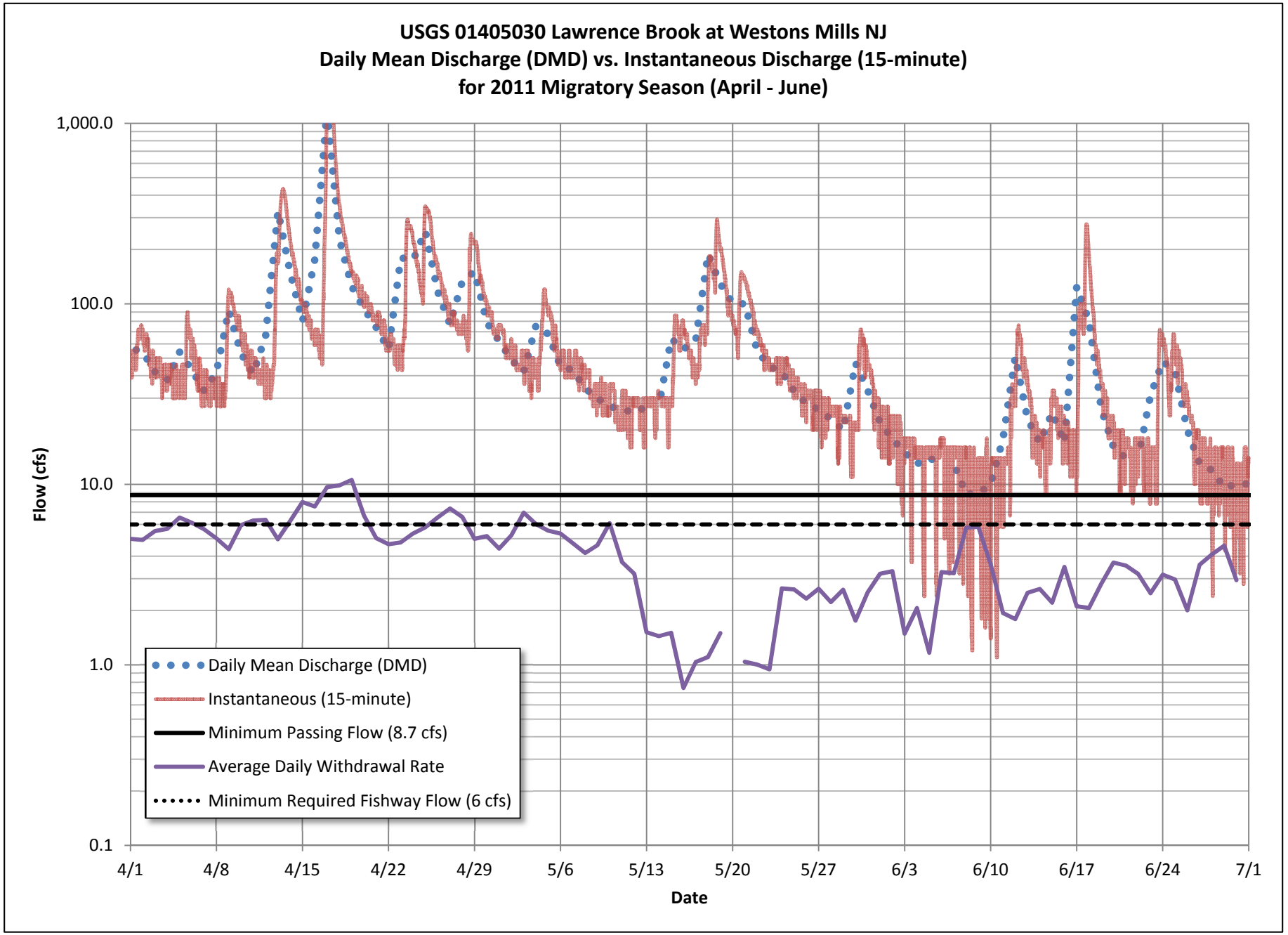
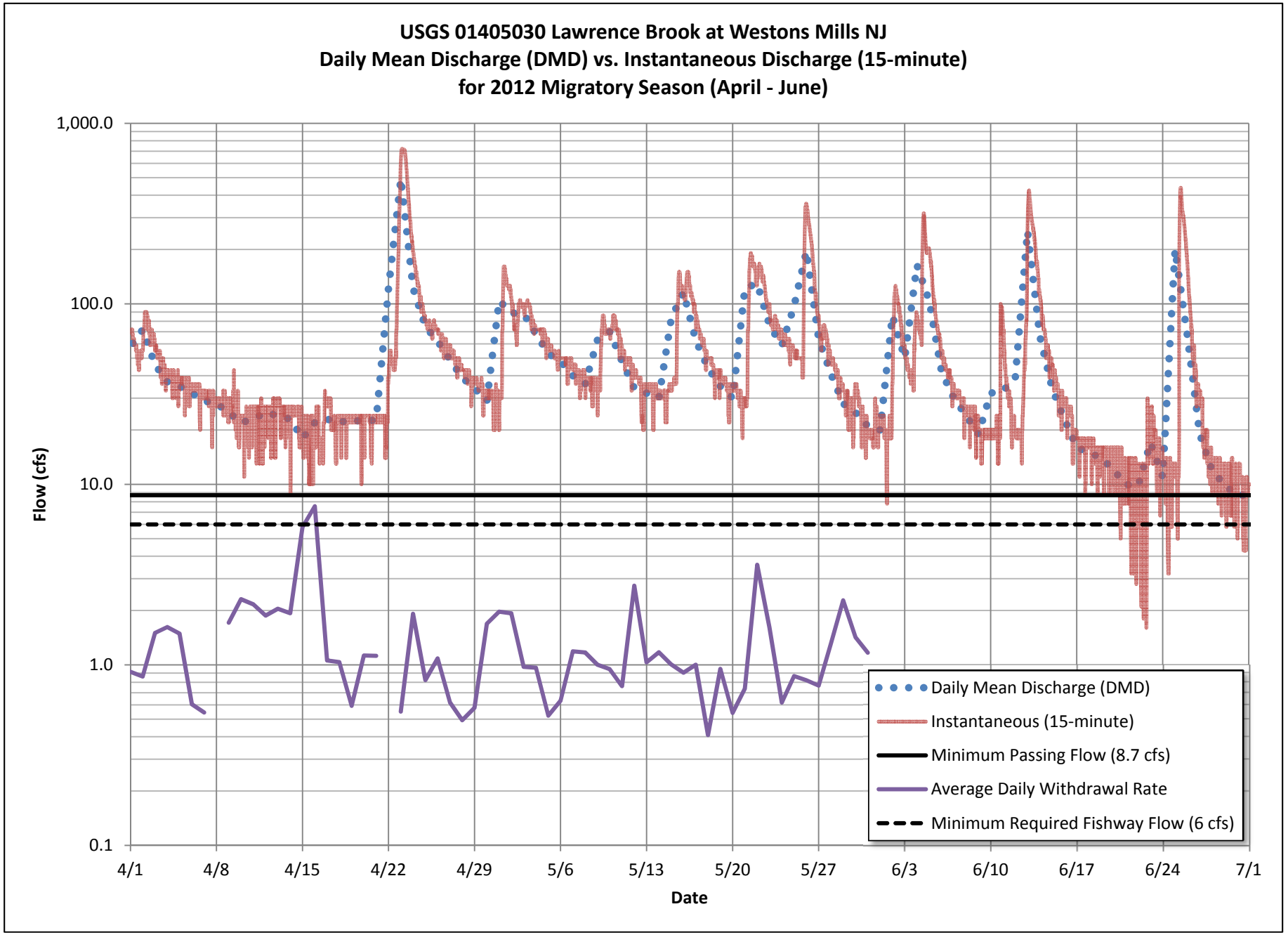
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2010 Migratory Season (April - June)
1,000.0
100.0
10.0
1.0
0.1
Flow (cfs)
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)


USGS 01405030 Lawrence Brook at Westons Mills NJ
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2011 Migratory Season (April - June)
1,000.0
100.0
10.0
1.0
0.1
Flow (cfs)
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)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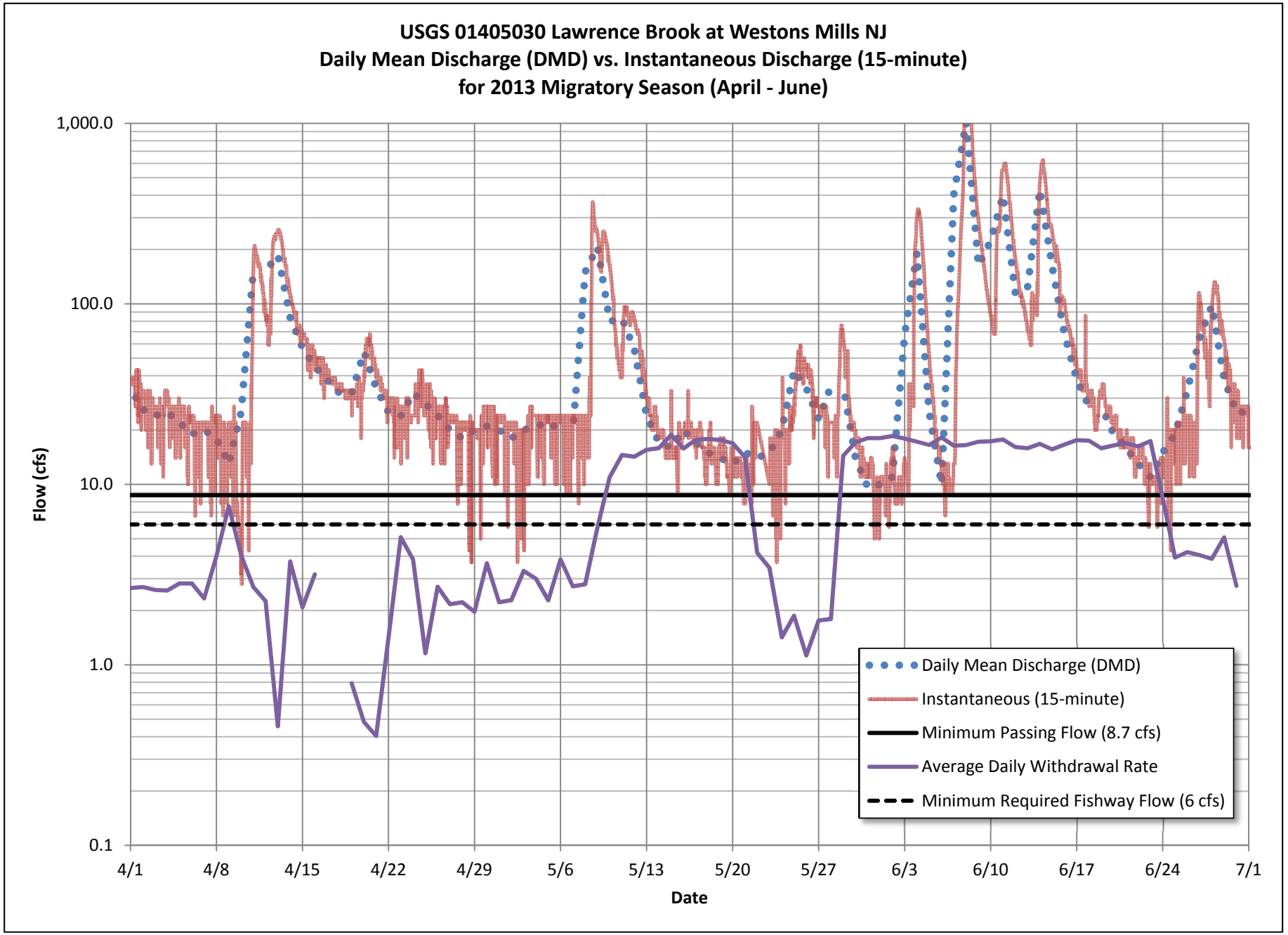
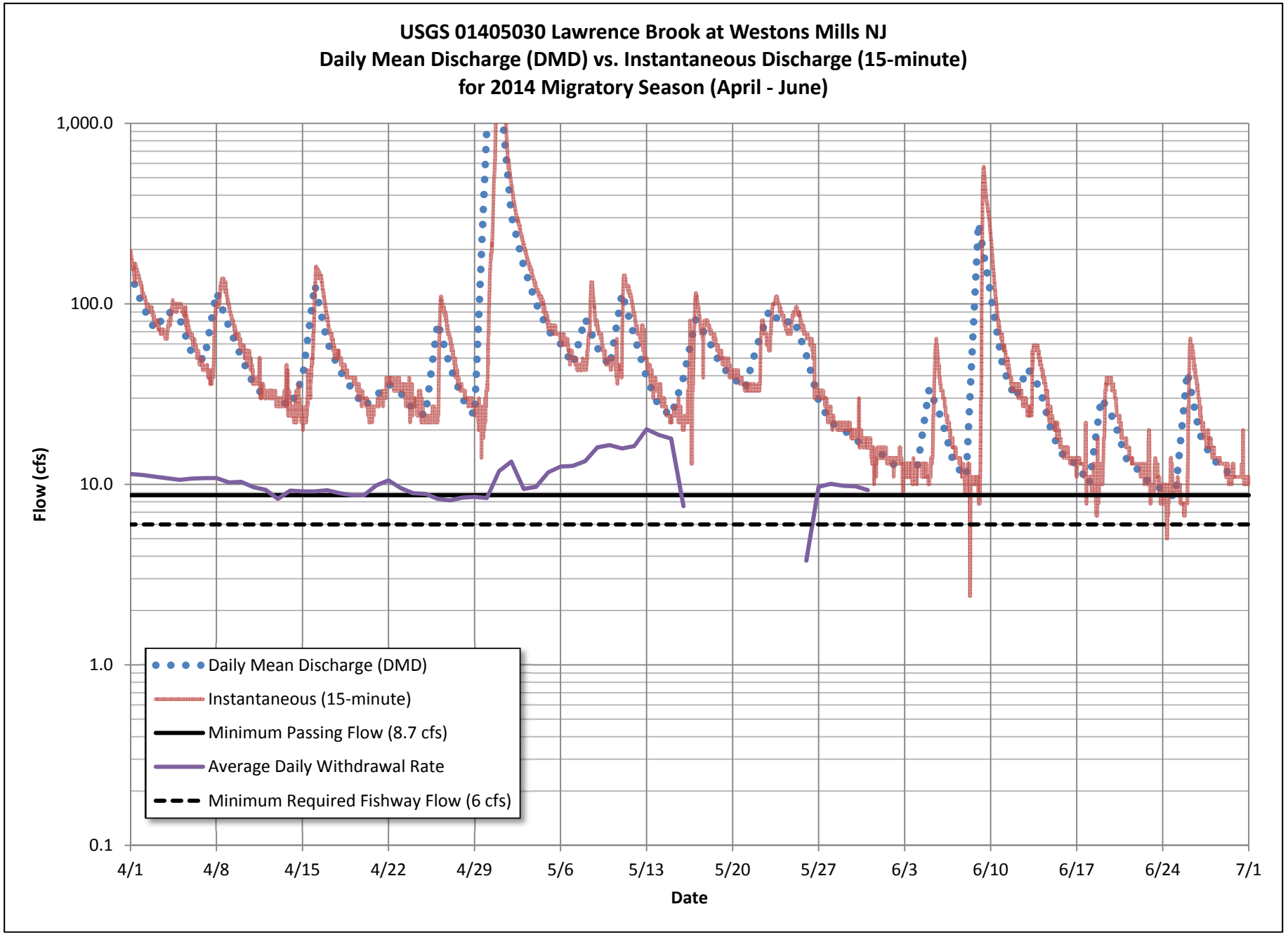
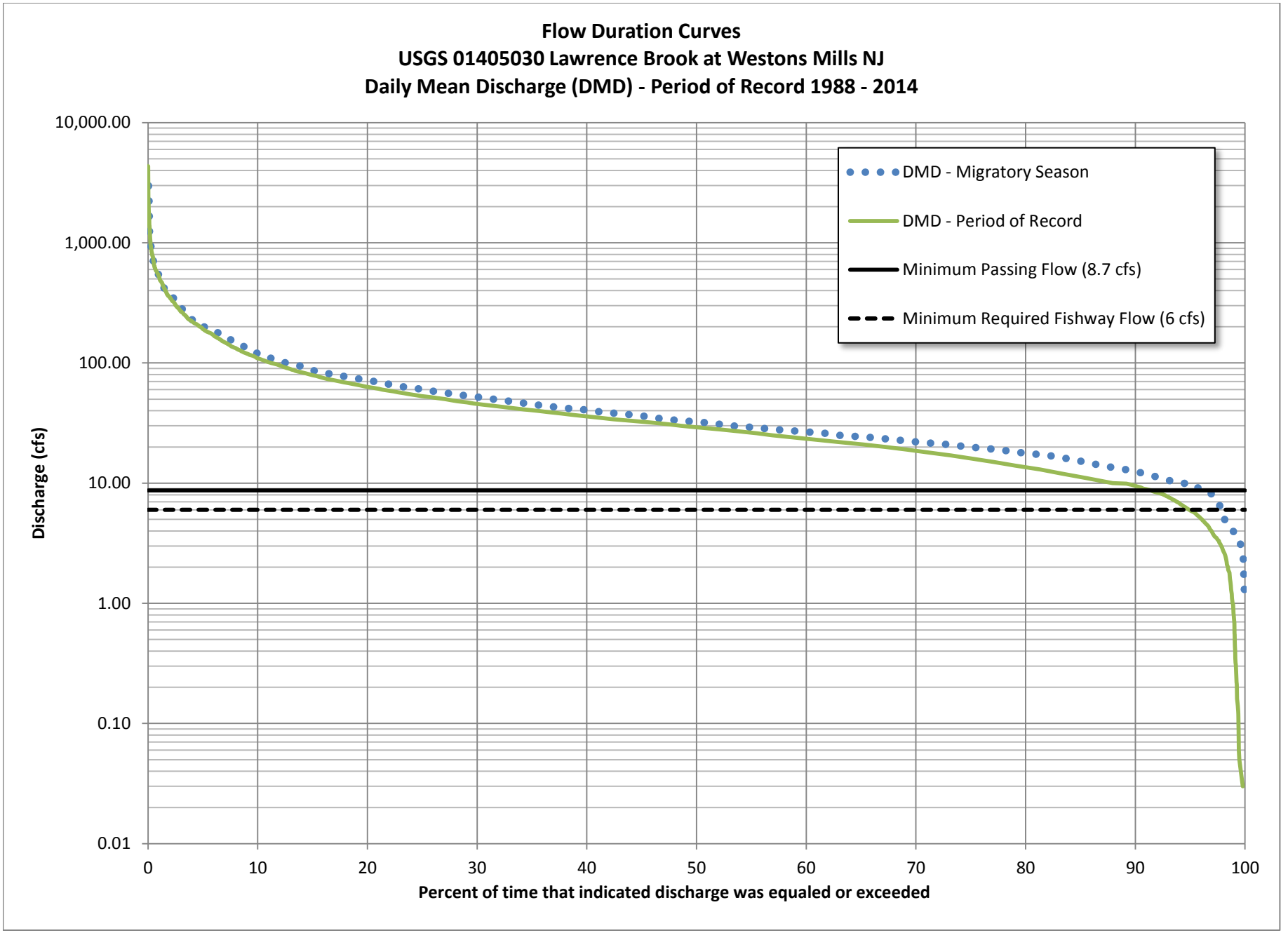
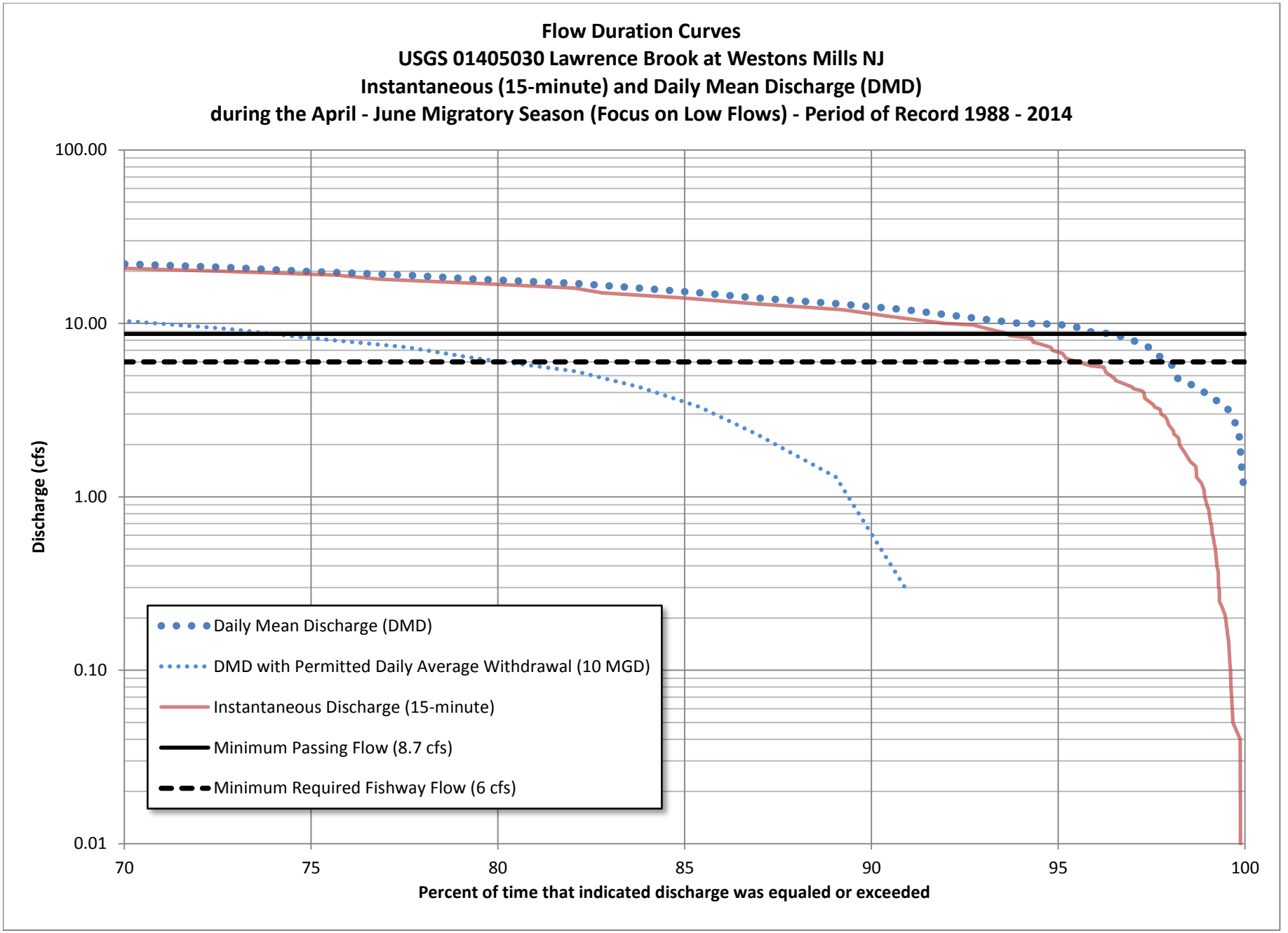
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2012 Migratory Season (April - June)
1,000.0
100.0
10.0
1.0
0.1
Flow (cfs)
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)


USGS 01405030 Lawrence Brook at Westons Mills NJ
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2013 Migratory Season (April - June)
1,000.0
100.0
10.0
1.0
0.1
Flow (cfs)
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)

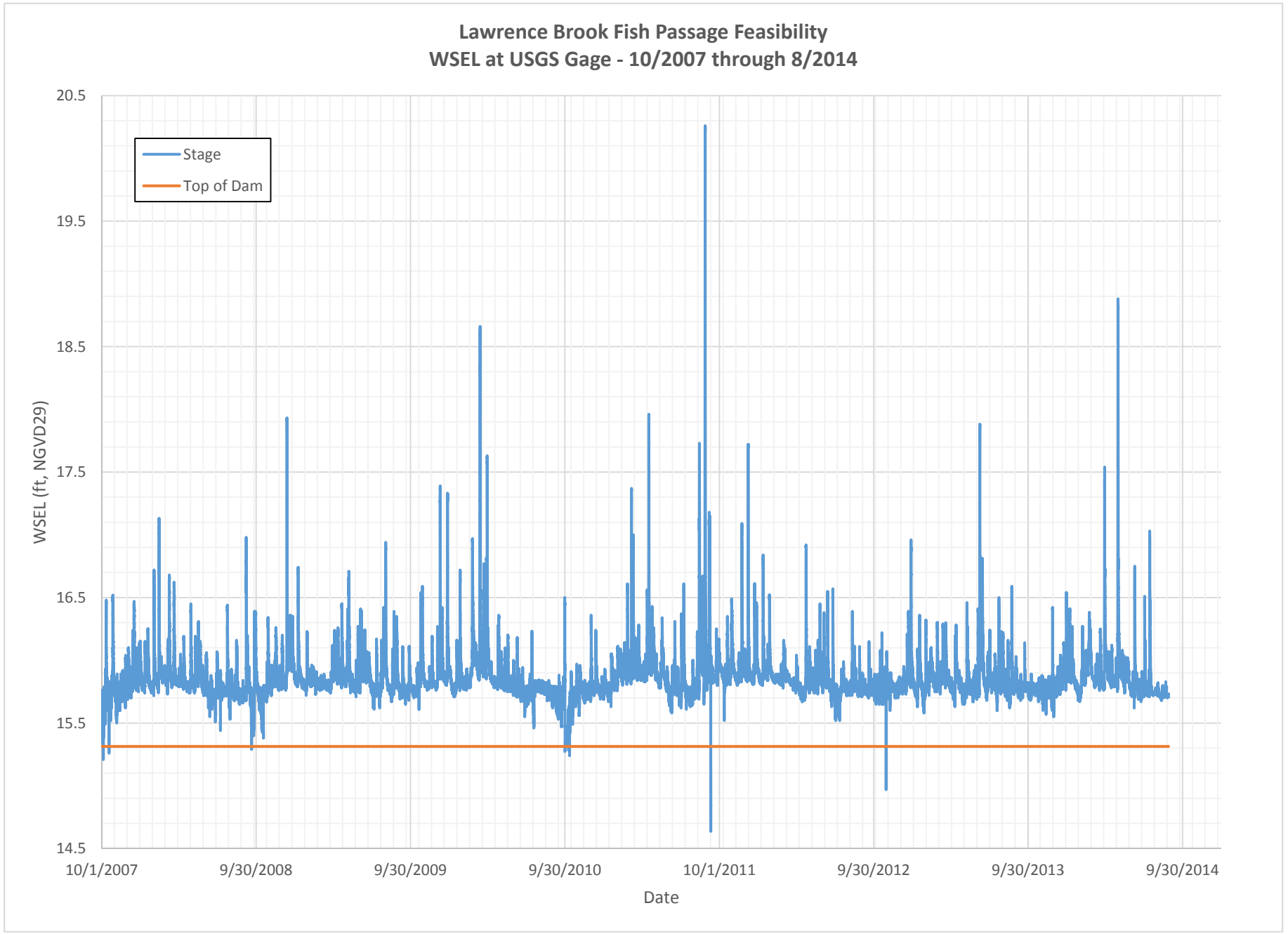

USGS 01405030 Lawrence Brook at Westons Mills NJ
Daily Mean Discharge (DMD) vs. Instantaneous Discharge (15-minute)
for 2014 Migratory Season (April - June)
1,000.0
100.0
10.0
1.0
0.1
Flow (cfs)
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
Date
Daily Mean Discharge (DMD)
Instantaneous (15-minute)
Minimum Passing Flow (8.7 cfs)
Average Daily Withdrawal Rate
Minimum Required Fishway Flow (6 cfs)

Appendix B: Flow Duration Curves

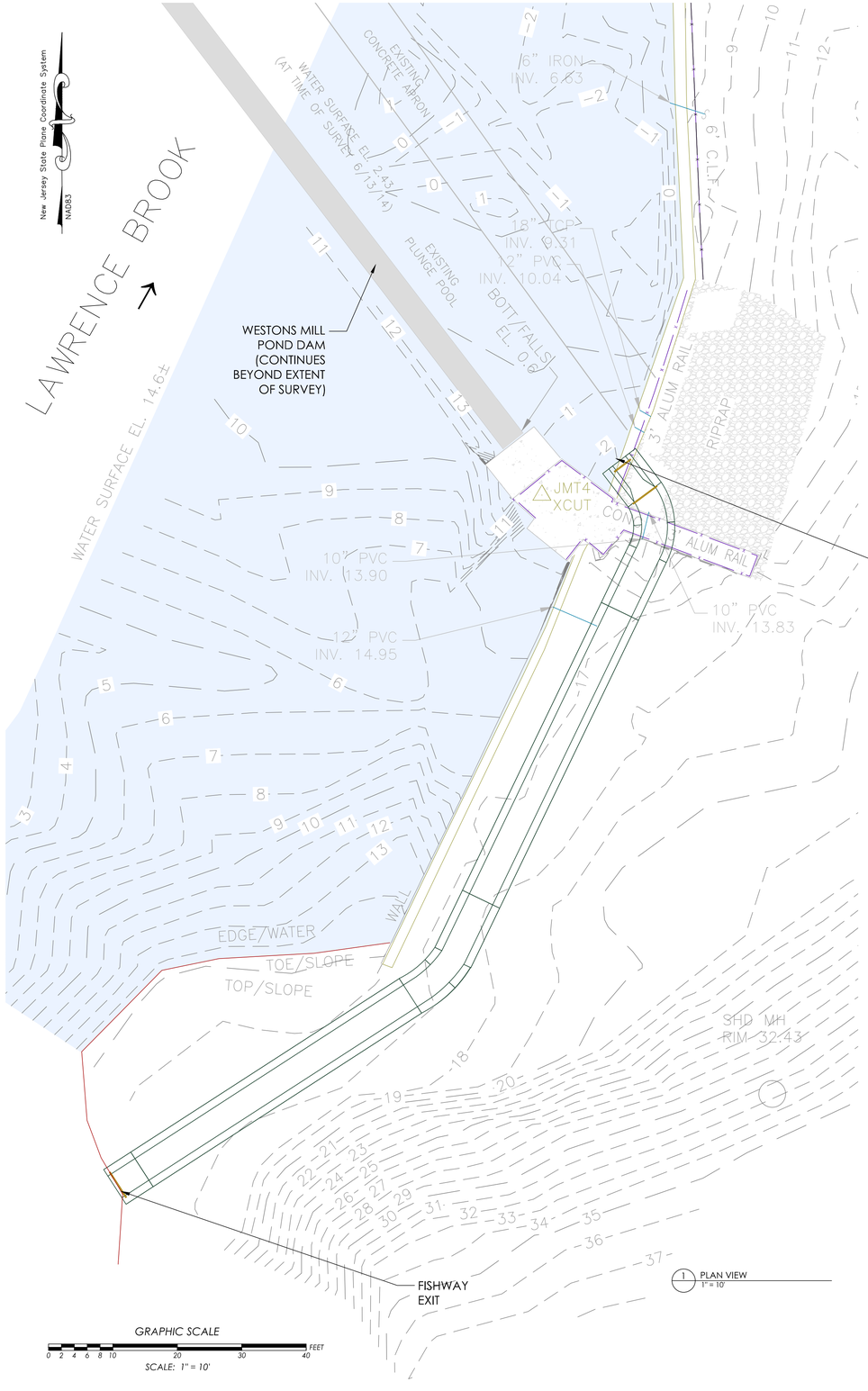

Flow Duration Curves
USGS 01405030 Lawrence Brook at Westons Mills NJ
Daily Mean Discharge (DMD) - Period of Record 1988 - 2014
10,000.00
1,000.00
100.00
10.00
1.00
0.10
0.01
Discharge (cfs)
0
10
20
30
40
50
60
70
80
90
100
Percent of time that indicated discharge was equaled or exceeded
DMD - Migratory Season
DMD - Period of Record
Minimum Passing Flow (8.7 cfs)
Minimum Required Fishway Flow (6 cfs)


Flow Duration Curves
USGS 01405030 Lawrence Brook at Westons Mills NJ
Instantaneous (15-minute) and Daily Mean Discharge (DMD)
during the April - June Migratory Season (Focus on Low Flows) - Period of Record 1988 - 2014
100.00
10.00
1.00
0.10
0.01
Discharge (cfs)
70
75
80
85
90
95
100
Percent of time that indicated discharge was equaled or exceeded
Daily Mean Discharge (DMD)
DMD with Permitted Daily Average Withdrawal (10 MGD)
Instantaneous Discharge (15-minute)
Minimum Passing Flow (8.7 cfs)
Minimum Required Fishway Flow (6 cfs)

Appendix C: Westons Mill Pond Dam Stage Data


Lawrence Brook Fish Passage Feasibility
WSEL at USGS Gage - 10/2007 through 8/2014
Stage
Top of Dam
WSEL (ft, NGVD29)
20.5
19.5
18.5
17.5
16.5
15.5
14.5
10/1/2007
9/30/2008
9/30/2009
9/30/2010
10/1/2011
9/30/2012
9/30/2013
9/30/2014
Date

Appendix D: Fish Ladder Layouts and Design Details



1 PLAN VIEW
1" = 10'

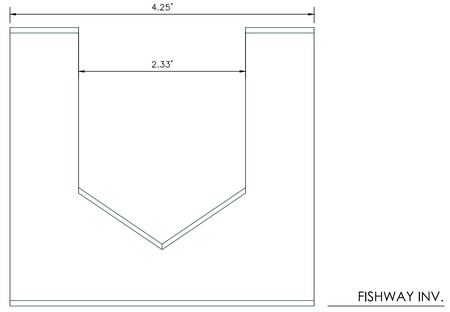
GRAPHIC SCALE
0 2 4 6 8 10 20 30 40 FEET
SCALE: 1" = 10'

FISHWAY ENTRANCE LOCATED IMMEDIATELY UPSTREAM OF CONCRETE APRON

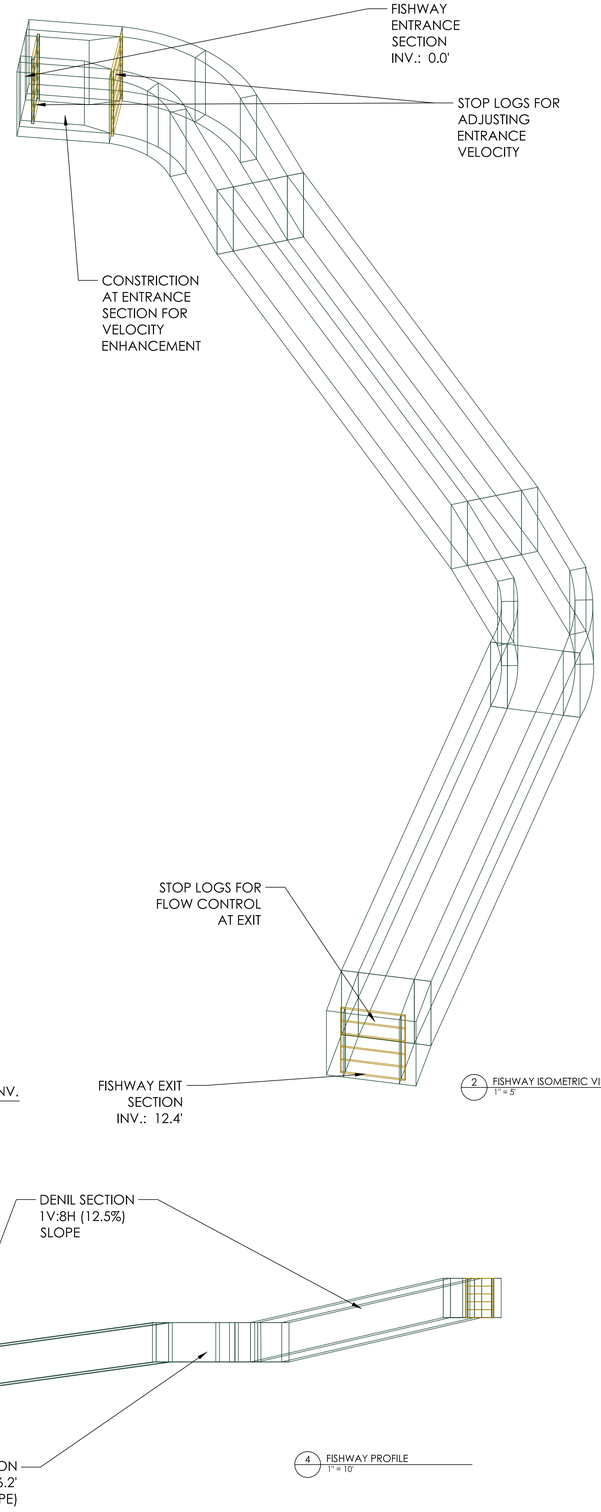
Lower Fish Ladder
(Westons Mill Pond Dam)

Total Length (Ft)	150.09
Slope	0.125
Width	4.00
Depth	5.50
# of Pools	1
# of Denil Sections	2
# of Baffles	21
Segment Lengths:	
Entrance	26.15
Section 1	50.00
Pool	18.94
Section 2	50.00
Exit	5.00

A DENIL FISH LADDER DIMENSIONS
PRELIMINARY LAYOUT



3 TYPICAL DENIL SECTION VIEW
1" = 1'



2 FISHWAY ISOMETRIC VIEW
1" = 5'

4 FISHWAY PROFILE
1" = 10'

CALL BEFORE YOU DIG!
NEW JERSEY LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE - STOP CALL NEW JERSEY ONE CALL SYSTEM, INC.
REFERENCE NEW JERSEY TITLE 48, CHPT. 2, ARTICLE 9
1-800-272-1000

PROJECT NOTES

1. SURVEY OBTAINED FROM JMT, INC., JULY 2014. HORIZONTAL DATUM NAD83 STATE PLANE NEW JERSEY, FEET. VERTICAL DATUM NAVD88, FEET.

PRELIMINARY NOT FOR CONSTRUCTION

DATE	DESCRIPTION

REVISIONS

STATE OF NEW JERSEY CERTIFICATE OF AUTHORIZATION NO.: 24GA27976800

DATE

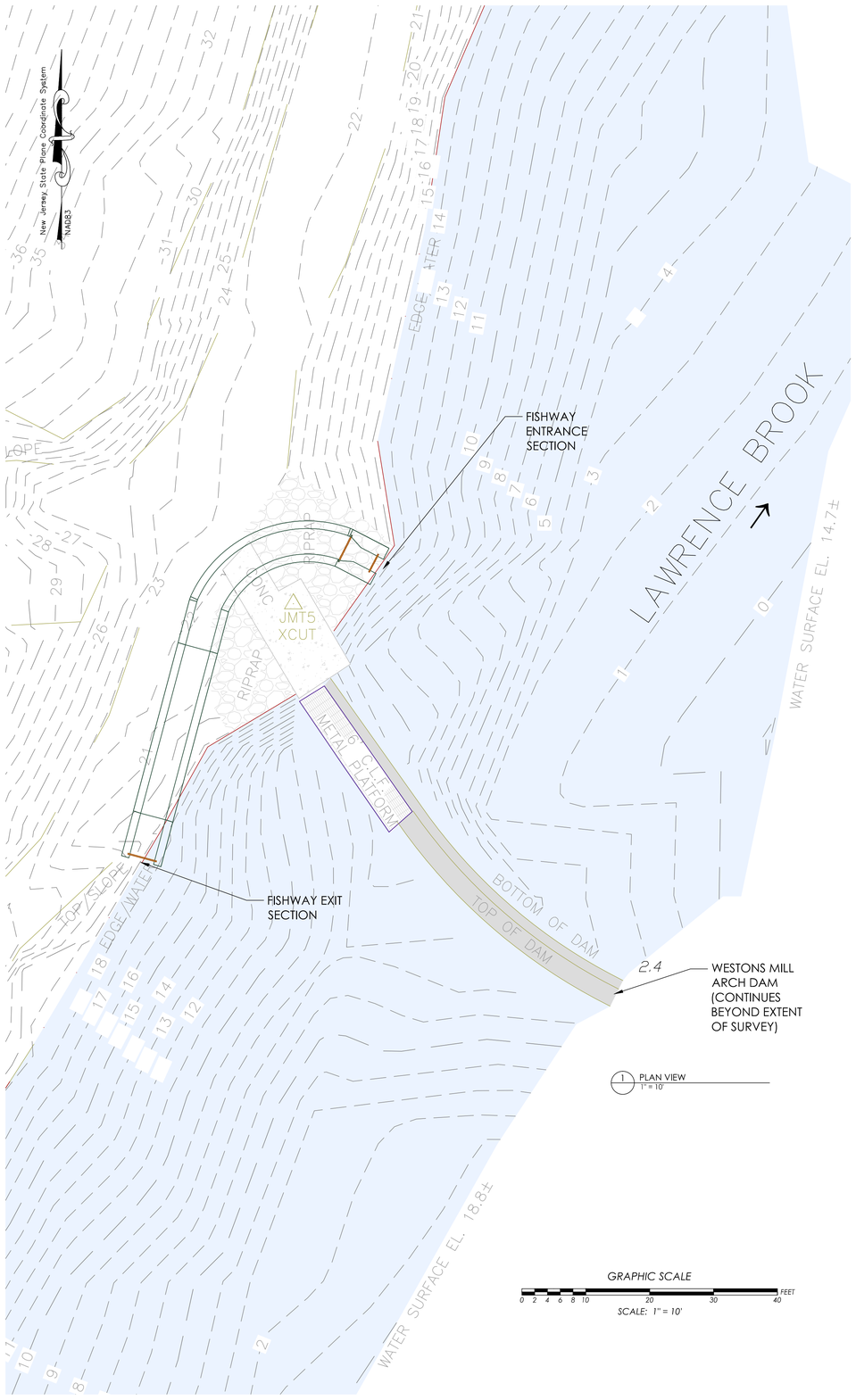
PRINCETON HYDRO, LLC
SCIENTISTS AND ENGINEERS
1108 OLD YORK ROAD, SUITE 1
P.O. BOX 720
RINGOES, NEW JERSEY 08551
PHONE. 908.237.5660
FAX. 908.237.5666
WWW.PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
LAWRENCE BROOK FISH LADDERS
PRELIMINARY LAYOUTS
CITY OF NEW BRUNSWICK
MIDDLESEX COUNTY, NEW JERSEY

DRAWING NAME:
WESTONS MILL POND DAM
(NJ DAM NO. 25-3)

DATE:	09/15/2014
PROJECT NO.:	1449.002
SCALE:	AS SHOWN
DRAWN BY:	PFG
CHECKED BY:	JEH

SHEET NO.
1 OF 2

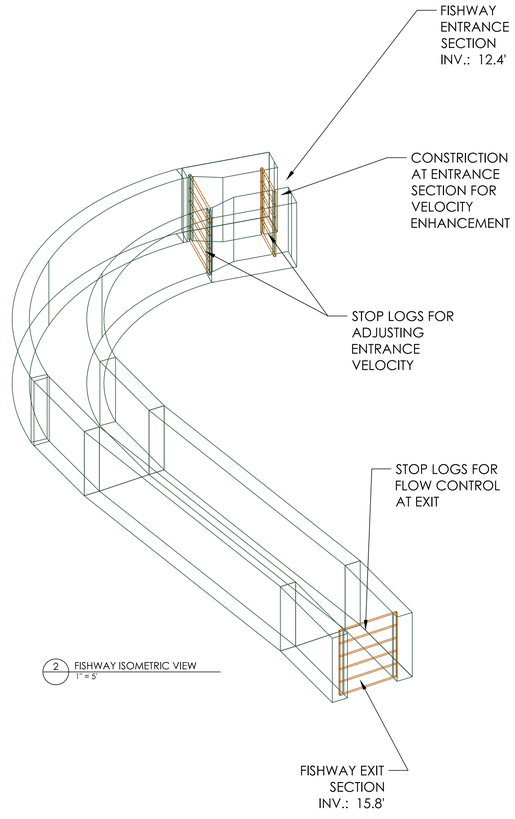


1 PLAN VIEW
1" = 10'

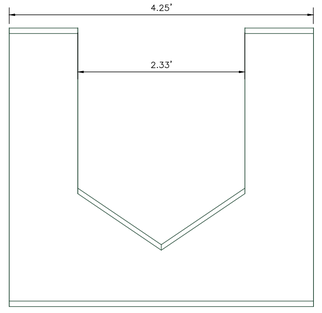
Upper Fish Ladder
(Westons Mill
Arch Dam)

Total Length (Ft)	73.23
Slope	0.125
Width	4.00
Depth	5.50
# of Pools	0
# of Denil Sections	1
# of Baffles	12
Segment Lengths:	
Entrance	38.50
Section 1	27.50
Pool	--
Section 2	--
Exit	7.23

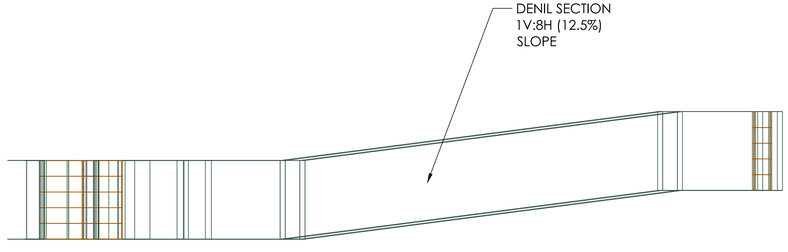
A DENIL FISH LADDER DIMENSIONS
PRELIMINARY LAYOUT



2 FISHWAY ISOMETRIC VIEW
1" = 5'



3 TYPICAL DENIL SECTION VIEW
1" = 1'



4 FISHWAY PROFILE
1" = 5'

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DAYS IN DESIGN STAGE - STOP CALL
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PROJECT NAME/LOCATION:
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PRELIMINARY LAYOUTS
CITY OF NEW BRUNSWICK
MIDDLESEX COUNTY, NEW JERSEY

DRAWING NAME:
WESTONS MILL ARCH DAM
(NJ DAM NO. 25-2)

DATE:	09/15/2014
PROJECT NO.:	1449.002
SCALE:	AS SHOWN
DRAWN BY:	PFG
CHECKED BY:	JEH

SHEET NO.
2 OF 2