SAFE YIELD COMPUTATIONS AND IN-STREAM FLOW CONSIDERATIONS

Carroll County Water Authority
Carroll County, Georgia

Schnabel Reference 17C17107
January 4, 2018

Schnabel ENGINEERING

January 4, 2018

Mr. Matt Windom, PE
Executive Director
Carroll County Water Authority
PO Box 739
Carrollton, Georgia 30112

Subject: **Safe Yield Computations and In-Stream Flow Considerations**
Carroll County, Georgia (Schnabel Reference 17C17107)

Dear Mr. Windom:

SCHNABEL ENGINEERING, LLC (Schnabel) is pleased to submit this assessment of reservoir alternatives and safe yield analyses for the proposed Carroll County Reservoir. Also included is an assessment of the impact of the proposed reservoir on downstream flows. This study was performed in accordance with our proposal dated October 10, 2017, as authorized by you on October 24, 2017.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING, LLC

Melinda Dirdal

Melinda Dirdal, PE
Senior Engineer

J. Harrison

John Harrison, PE, D.WRE
Principal

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SAFE YIELD COMPUTATIONS AND IN-STREAM FLOW CONSIDERATIONS
CARROLL COUNTY WATER AUTHORITY
CARROLL COUNTY, GEORGIA

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1.0 SUMMARY

Schnabel was retained by the Carroll County Water Authority (CCWA) to perform safe yield analyses and to size reservoir sites for proposed reservoir alternatives. Safe yield analyses incorporated the requirements of the State of Georgia as well as that of the U.S. Army Corps of Engineers (USACE). A flow series from a nearby stream gage of long duration, incorporating the most severe droughts of record, was assessed in detail and was observed to demonstrate a gradual reduction in stream flow over time. Two additional nearby streams were similarly assessed and were found to exhibit comparable flow reductions. To address USACE resilience requirements, additional analyses were performed to sustainably size reservoirs to enable more reliable delivery of project safe yield for the duration of the planning period. All short-listed reservoir alternatives were pumped-diversion reservoirs, where river diversions and reservoir storage combinations were modeled to meet an unmet demand of 6 mgd for the duration of the planning period (8 mgd in 2017 corresponds to 6 mgd in 2065, as discussed in Section 2.3).

The preferred alternative (Indian Creek Reservoir) was then assessed in greater detail to characterize downstream flows. In-stream flows were based on the Monthly 7Q10 (M7Q10) for both the Little Tallapoosa River and Indian Creek. Pre- and post-project hydrographs of the Little Tallapoosa River and Indian Creek flows were developed to facilitate comparison of flows and allow assessment of impacts to stream habitat. The Little Tallapoosa River diversion location was considered to be in the vicinity of the Reavesville Road Bridge.

2.0 SAFE YIELD ANALYSES

2.1 Project Need

In 2016, the Georgia Environmental Protection Division (EPD) certified a 2065 unmet demand for CCWA's service area of 6 mgd. Reservoir safe yield is generally defined as the reliable withdrawal rate of water with acceptable quality that can be provided by reservoir storage through the critical drought period. The critical drought in the State of Georgia is often defined as the drought of record. Additionally, the USACE has mandated that public works projects incorporate resilience into their design to better serve communities. The safe yield analysis performed for the Carroll County water supply project incorporates both of these criteria. The discussion on resilience, flow change assessment, and reservoir sizing was included as part of the alternatives analysis and have been incorporated into this report for completeness.

2.2 Resilience

The USACE has mandated that resilience be built into all its infrastructure to better serve and support citizens and communities. Resilience is generally defined as the ability of a project to meet projected demand in spite of unanticipated conditions that could undermine the project purpose. From a water supply perspective, unanticipated conditions or factors that negatively impact or undermine a project include, but are not limited to, longer duration droughts and decreases in stream base flow from climate change (a supply consideration), and higher than anticipated population growth (a demand consideration). More specifically, relative to water supply reservoirs, resilience is indicated by the following factors:

- Diversion robustness is the ability of a project's diversion capacity to meet projected demand despite potential reductions in streamflow over the project planning period. Diversion robustness is defined by the proximity of a project's diversion rate relative to the point of diminishing returns beyond which additional pumping results in negligible additional yield.

- Expandability is the ability of the project to be expanded in the future should actual future events mandate its need, due to safe yield reduction from greater than anticipated supply source impacts and/or water demand growth greater than that projected. The presence of a greater level of expandability provides a counter measure to future conditions that undermine the project purpose. This, in turn, translates to avoidance of environmental impacts and significant cost savings to remedy a loss of functionality, given the opportunity to limit both environmental and facility impacts to an existing site, rather than requiring an additional reservoir.

- Storage superiority is the recognition that added storage is a buffer against climate variability.

Accordingly, resilience was incorporated into the safe yield analyses as described below.

2.3 Gage Selection and Flow Change Assessment

Safe yield analyses were based on Gaging Station # 02412000, Tallapoosa River near Heflin, Alabama, because it has a total record period of about 65 years (July 1, 1952, to the present). This gage is located downstream of the proposed project alternatives (drainage area at the Heflin gage of 448 sq mi). A more proximate, although shorter-term, gage is located on the Little Tallapoosa River at GA 100, near Bowdon, Georgia (Gaging Station # 02413210), which monitors flows from the upper 245 sq mi of the Little Tallapoosa River basin. The Bowdon gage has a total period of record of about 14 years (February 2000 to September 2004 and April 2008 to present). Assessments based on runoff per square mile indicated that the Heflin gage correlated well to the Bowdon gage without adjustments. Therefore, the Heflin gage data, converted to cfs per square mile, was used as the analysis basis due to its much longer available record.

To meet the project purpose, the supply facilities will need to provide 6 million gallons of water per day in the year 2065. In an effort to evaluate the stability of stream flow over time, a mass curve of stream flow (total volume sum over time) for the Tallapoosa River near Heflin, Alabama, was developed. Visual evaluation of the mass flow curve clearly indicates a gradual decrease in flow over time. This is exemplified by comparison of average flows prior and subsequent to July 2006. Average river discharge from July 1952 to July 2006 was computed to be 1.45 cfs per square mile (cfsm – unit discharge), while average river discharge from July 2006 to August 2017 was computed to be 1.00 cfsm, a 31% decrease in streamflow. This flow change is illustrated in **Error! Reference source not found.**.

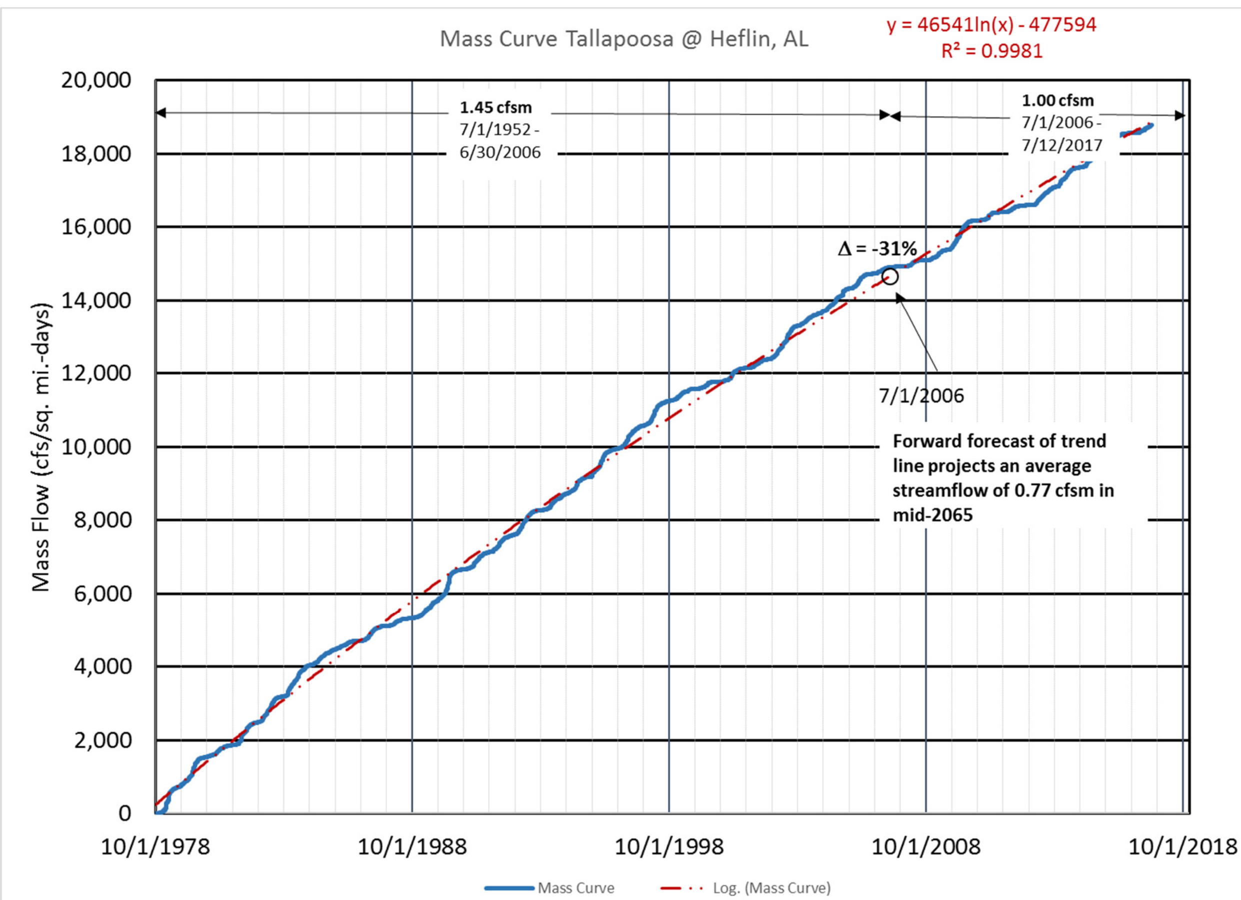


Figure 2.1: Tallapoosa River Mass Flow Curve

To confirm that the Tallapoosa stream flow behavior is not an isolated phenomenon, other nearby gages were reviewed and evaluated. The USGS stream gaging station near Bowdon, Georgia, went into operation in the year 2000, and therefore lacks the historical 20th Century flow data to contrast with more recent flows. The USGS stream gaging station at Carrollton, Georgia, has sufficient record, but its drainage area is less than 100 sq mi and flows are highly regulated/impacted by multiple upstream water supply reservoirs. Therefore, two Georgia stream flow gages located in relatively close proximity to the Carroll County Little Tallapoosa drainage area were selected for comparative evaluation. The search for stream flow gages was limited to those:

- With contributing drainage areas between 100 and 400 sq mi, because the mid-point of 250 sq mi is about equal to the sum of the diversion plus reservoir drainage area for the Carroll County project.
- Having at least 20 years of daily stream flow gaging records prior to 2006 (continuous daily flow measurements since 1985 or earlier).
- Located in the Piedmont Physiographic Province.

A gage located to the south of Carroll County on the New River in southern Heard County (at GA 100) was identified as meeting the above criteria. This gage has a drainage area of 127 sq mi and a continuous gage record starting in October 1978. The data from this gage also indicates a gradual decrease in flow with time. Calculations indicate that the average unit discharge from 1978 until February of 2006 was 1.16 cfsm, while the unit discharge from March 2006 to August 2017 was 0.89 cfsm, reflecting a reduction of 23 percent. This flow change is illustrated in Figure 2.2.

A second gage, located on Sweetwater Creek in northeast Douglas County (near the I-20 Bridge) with a drainage area of 238 sq mi and a continuous gage record starting in March 1937, also indicates a gradual reduction of flow with time. The data from this gage indicates that the average unit discharge from 1937 until June of 2006 was 1.50 cfsm, while the unit discharge from July 2006 to August 2017 was computed to be 1.14 cfsm, reflecting a reduction of 24 percent. This flow reduction is illustrated in Figure 2.3.

Use of a logarithmic function to model the stream flow for the selected gages provided an exceptional fit with the data, reflecting a gradual, but steady, decline in streamflow over the assessment period. A forward forecast of the trend lines suggests that future reduction in stream flow should be expected as indicated in Figures 2.1 through 2.3.

The Coefficient of Determination (R^2 value) for each trend line from the flow data was in excess of 0.995. R^2, which was originally developed to assess the forecasting quality of a mathematical relationship, is a measure of the quality of fit of a computed regression equation to the data (the proportion of the data values explained by the equation). The regression equations predict year 2065 unit discharge values for these three gaged streams will decrease from the current values by 31%, 23%, and 24%, in the order of the preceding discussions. The average reduction for the three streams is approximately 25%. A 25% reduction in stream flow would clearly result in the loss of safe yield of a greater magnitude (in part, because climate scientists cite increased flood flows and decreased drought flows, in addition to reduced overall flow volume). However, for the safe yield analysis, a 25% yield reduction was applied to retain 6 mgd in available yield in the year 2065. Therefore, a yield of 8 mgd was utilized to evaluate the preferred alternative using the current stream flow data.

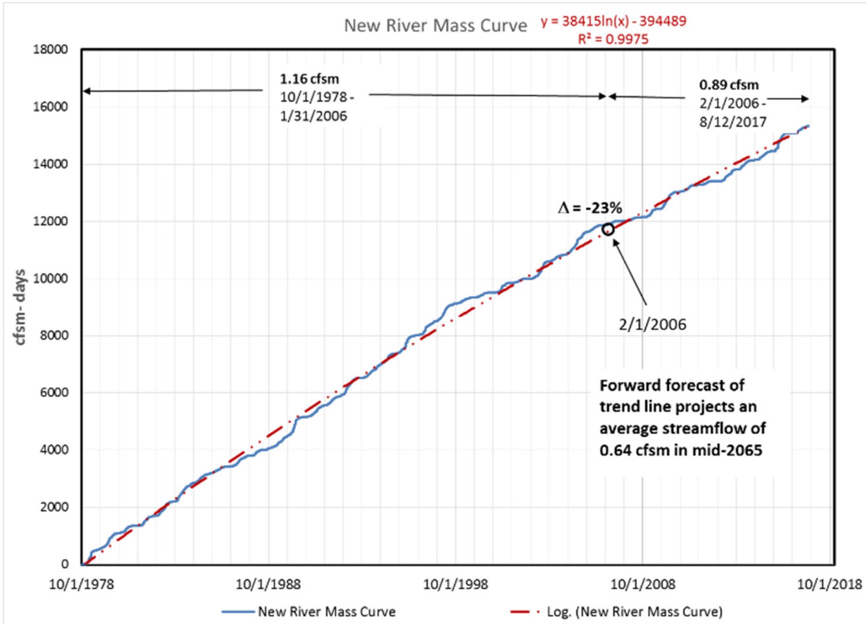


Figure 2.2: New River Mass Flow Curve

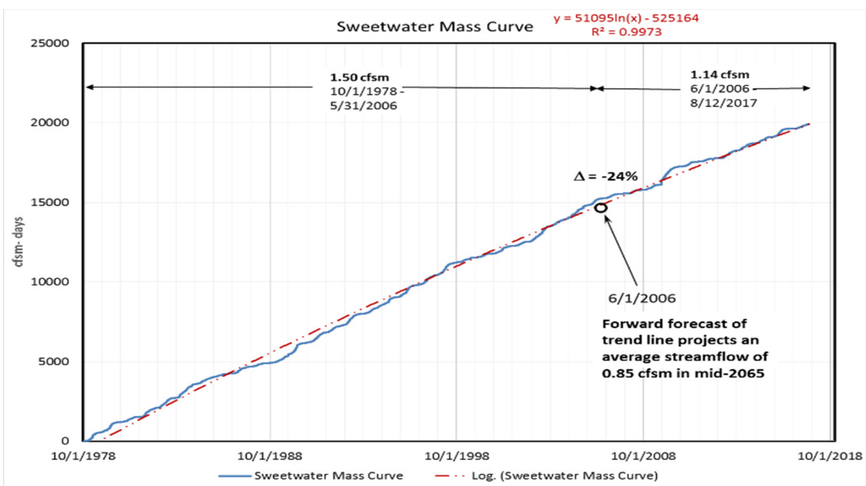


Figure 2.3: Sweetwater Creek Mass Flow Curve

2.4 Safe Yield Model

A spreadsheet model was programmed to perform daily flow iterations for three short-listed reservoir site alternatives (Figure 1, attached). For the calculation basis, each reservoir option and tested storage elevation was initially considered to be full, and the bottom 25% of the total reservoir volume was set aside as dead storage. The total elevation-storage relation was based on the integration of the elevation-area relationship data developed using 2010 Carroll County LiDAR data. Regression curves were then developed to relate storage values to both surface area and elevation for use in the spreadsheet. The dead storage set-aside allows for sediment deposition over the life of the reservoir and avoids use of the poorer quality benthic bottom waters of the reservoir. The Indian Creek Stage-Storage Curve is included as Figure 3, attached.

For each day of the synthesized 65 years of record, the spreadsheet accounted for losses due to net evaporation from the reservoir, additions due to natural runoff from the drainage area above the dam, withdrawals for water supply, maintenance of flows in the creeks downstream of the reservoirs, and diversions when needed for refilling. Withdrawals were simulated using a constant average annual demand; the justification for this is that while total water demands after declaration of a drought condition are usually less than normal, this situation is typically offset by higher than average demands prior to declaration of the drought condition. The daily mass balance equation was modeled as follows:

Ending storage =	initial storage – evaporation + basin runoff – water supply – minimum in-stream flow (dam) + diversions

If the reservoir is not full at the end of the day (without diversion pumping), the lesser of the following volumes was computed and delivered to the reservoir:

- The amount of pumping needed to refill the reservoir
- The designated diversion pumping capacity
- The diversion volume that can be accommodated after considering the minimum in-stream flow (MIF) maintenance requirements

Updated monthly 7Q10 values (M7Q10) were developed from the Heflin gage record period flows and applied as a direct proportion of drainage area to the Little Tallapoosa diversion location and the respective dam sites.

To assess net evaporation losses from the reservoir surface, a regression equation was developed to relate gross storage (in millions of gallons) to the surface area of the reservoir. Evaporation loss for each day in the computation was computed as the product of surface area and the average net daily evaporation rate (inches) as recorded at Experiment, Georgia (Station 181). It has been found that lake evaporation is typically about 70% of pan evaporation due to lake cooling effects.

The spreadsheet model takes into account MIF considerations for both the reservoir stream and for the diversion source. The model also considers a 10 mgd permitted withdraw on the Little Tallapoosa River upstream of the diversion by the City of Carrollton, and it considers a 2.5 mgd permitted withdraw upstream of the confluence of Indian Creek and Turkey Creek by the City of Bowdon.

2.5 Reservoir Sizing

Stage-storage relationships for each reservoir were developed using 2010 Carroll County LiDAR Data. Given the severity of the 1999, 2007, and 2010 droughts in the Tallapoosa River Basin, the monthly 7Q10 MIF values were recomputed as a percentage of mean annual flow (MAF) for the period of record through July 2017. The computation is shown in Figure 6. These values were subsequently used for MIF estimation at both the dam and diversion site for safe yield analyses.

Because of the short duration between the start of the two worst droughts of record (2007 and 2010 initiation of drawdowns), the safe yield analyses considered five conditions for the reservoir operations. Violation of any of these conditions could, with minor time shifts between these droughts, converge into one massive drought. The five conditions are:

1. Restricting drawdown within the limits of usable storage (i.e., 75% of total storage). The 25% dead storage allows for sediment storage and poor quality water in the lower strata of the reservoir.
2. Limiting the duration of the drought of record to three years (initial drawdown to full recovery).
3. Allowing the reservoir to refill to normal pool for a period of six months between the 2007 and 2010 droughts.
4. Not allowing usable storage to consistently remain below 50% for more than one year.
5. Requiring a pumping utilization rate (ratio of average pump rate on pumping days to maximum pump rate) of approximately 40%. This criteria is related to reservoir storage and provides resilience to meet the project purpose in spite of unanticipated conditions that could undermine the project purpose, such as longer duration droughts from climate variability or higher than anticipated population growth. For all sites, it was found that beyond a required diversion pump rate of 25 mgd, negligible additional yield could be attained for increases in pump capacity.

Incorporating the above criteria, the normal pool elevation was computed for each site based on iterative calculations of storage and required pumping to meet the required 8 mgd safe yield (corresponding to 6 mgd in 2065). By iterative analysis, it was determined that a reservoir storage of at least 5 billion gallons was necessary to meet the above criteria and provide adequate drought resilience. In the Alternatives Analysis, the top of dam elevation was assumed to be 10 ft above the identified normal pool elevation. However, during the preliminary evaluation of design alternatives for Indian Creek Dam, modifications to the geometry of the dam and spillway system were considered in an effort to reduce the overall project cost. For the preferred alternative, a top of dam elevation of 1181 ft (or 20 ft above the identified pool elevation) and a reduced spillway capacity were determined to be a more cost-effective solution for the Indian Creek project. We note that the geometry of the embankment and spillway system could be further modified during final dam design.

Findings of the yield analyses for the short-listed sites are presented in the table below. All are for an 8-mgd (corresponding to 6 mgd in 2065) safe yield using a MIF basis of the M7Q10 and 2010 Carroll County LiDAR data to assess storage and surface area.

Table 2.1: Summary of Short Listed Sites

Short-Listed Site	Reservoir Pool Level (EL)	Reservoir Storage (BG)	Diversion Location from Little Tallapoosa River(1)	Diversion Pumping Capacity (mgd)
Indian Creek	1161	5.1	Reavesville Road	19.4
Indian Branch Lower	1025.5	5.3	Reavesville Road	21.0
Indian Branch Upper	1052.5	5.2	Reavesville Road	21.0

(1)See Figure 2 (attached) for diversion location.

2.6 Pre- and Post-Project Hydrographs

The reservoir spreadsheet model was also used to develop daily flow hydrographs to compare pre- and post-project conditions for the preferred Indian Creek site and for the Little Tallapoosa River, based on a selected Indian Creek Reservoir operating pool at EL 1161. By simulating the natural addition of unregulated flows to downstream watershed areas on a unit discharge basis, stream flow recovery can be modeled by selecting a downstream location. Graphics are presented in Appendix A for an average year, a wet year, and a dry year at selected downstream locations for the recommended Indian Creek Reservoir. The flow assessment locations are presented in Figure 4, attached.

As anticipated, the most significant streamflow impacts occur immediately downstream of the dam; however, the pre-project flows at this location do not simulate the routing effects of the existing flood control dam, and therefore exaggerate reductions in stream flow. In addition, two small tributaries join Indian Creek within the first mile downstream of the dam, which will reduce project impact on flows. By the time Indian Creek joins Turkey Creek, roughly 4.5-miles downstream of the dam, the natural seasonal variability in flow is prominent and the long-term average flow in Indian Creek upstream of the confluence of Turkey Creek is only reduced by 25% compared to pre-project flows; immediately downstream of this confluence, long-term average flows are only reduced by about 6%. By the time Indian Creek joins the Little Tallapoosa River, record period post project flows only show about 4% reduction relative to pre-project flows. These flows indicate the relatively low impact of the dam on post-project flows.

In the Little Tallapoosa River, stream flow impacts are even less. Long-term average flows in the Little Tallapoosa River are only reduced by about 3% at the intake location due to diversion pumping. At the Georgia-Alabama state line, long-term average flows are also only reduced by about 3% due to the combined effects of the dam and pumped diversions. These effects on the Little Tallapoosa River are considered to be negligible.

3.0 CONCLUSIONS

The following conclusions were derived from the analyses described herein.

- To meet the reservoir operations criteria, and assuming use of the computed updated M7Q10 values, reservoir storage would need to be at least 5 BG. The Indian Creek Reservoir site, with an operating pool at EL 1161 and 19.4 mgd pumping, meets this criteria and is projected to adequately provide the required project demand of 6 mgd in 2065.

- Resilience considerations have been incorporated in the analysis. Due to the uncertainty regarding future conditions, consideration has been given to providing additional diversion capacities or reservoir expansion, given that drought conditions could persist longer or be more severe than are currently projected. Resilience considerations for the Indian Creek site enhance project economy and provide a reliable water supply to meet future demands.

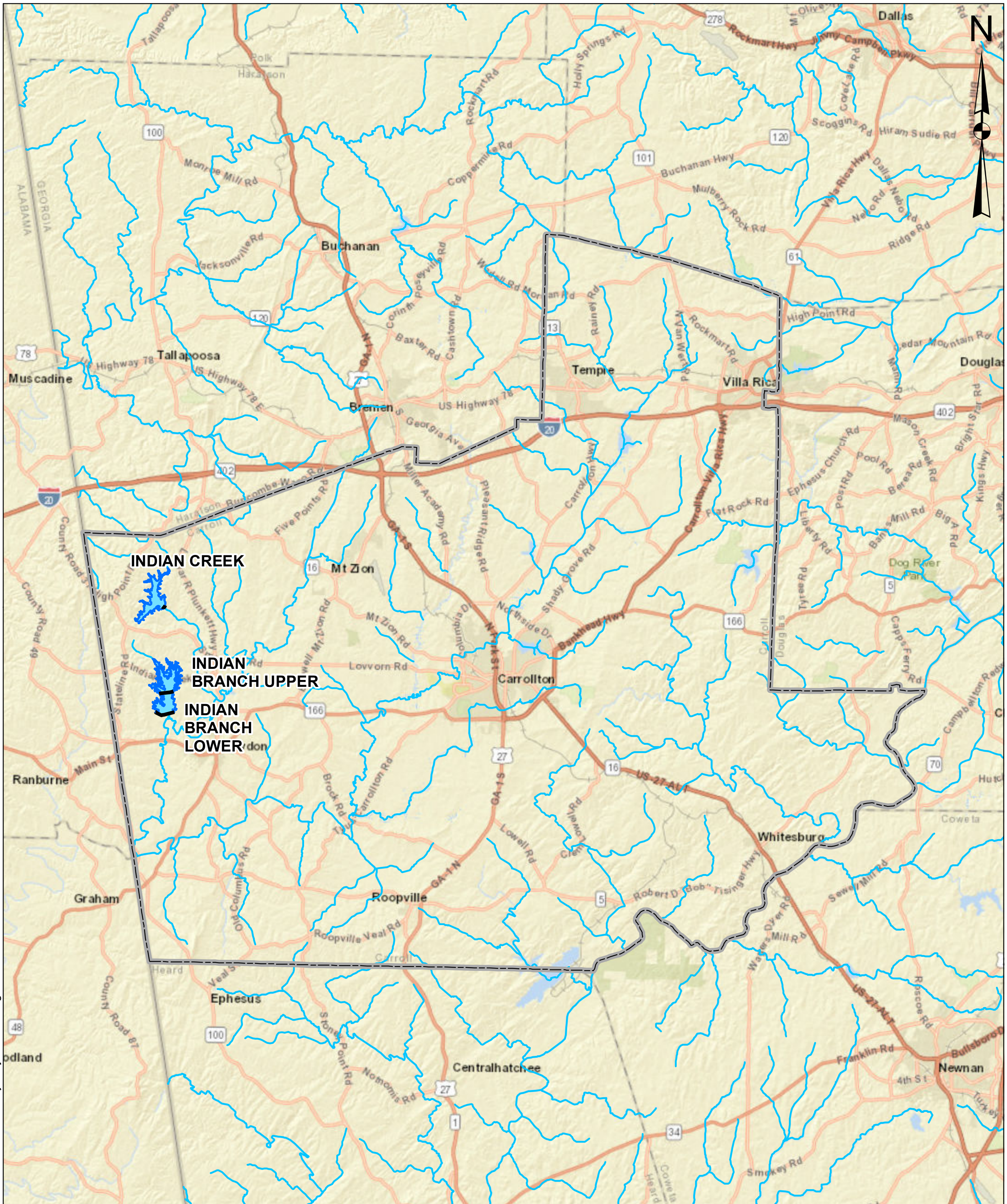
- Plots of pre- and post-project flows illustrate the anticipated impacts downstream of the dam and diversion location. The flows are considered to have a relatively low impact on Indian Creek and negligible impact on the Little Tallapoosa River as measured at the Georgia-Alabama state line. These plots can be used by project biologists to characterize the impacts of pre- and post-project flows on stream habitat.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Limitations

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report or any other instrument of service.

FIGURES



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Projection: NAD 1983 StatePlane Georgia West FIPS 1002 Feet

5 2.5 0 5
Miles

Scale: 1 in = 5 miles

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CARROLL COUNTY WATER SUPPLY
CARROLL COUNTY, GEORGIA

PROJECT NO. 17C17107.00

THREE SHORT-LISTED SITES

FIGURE 1

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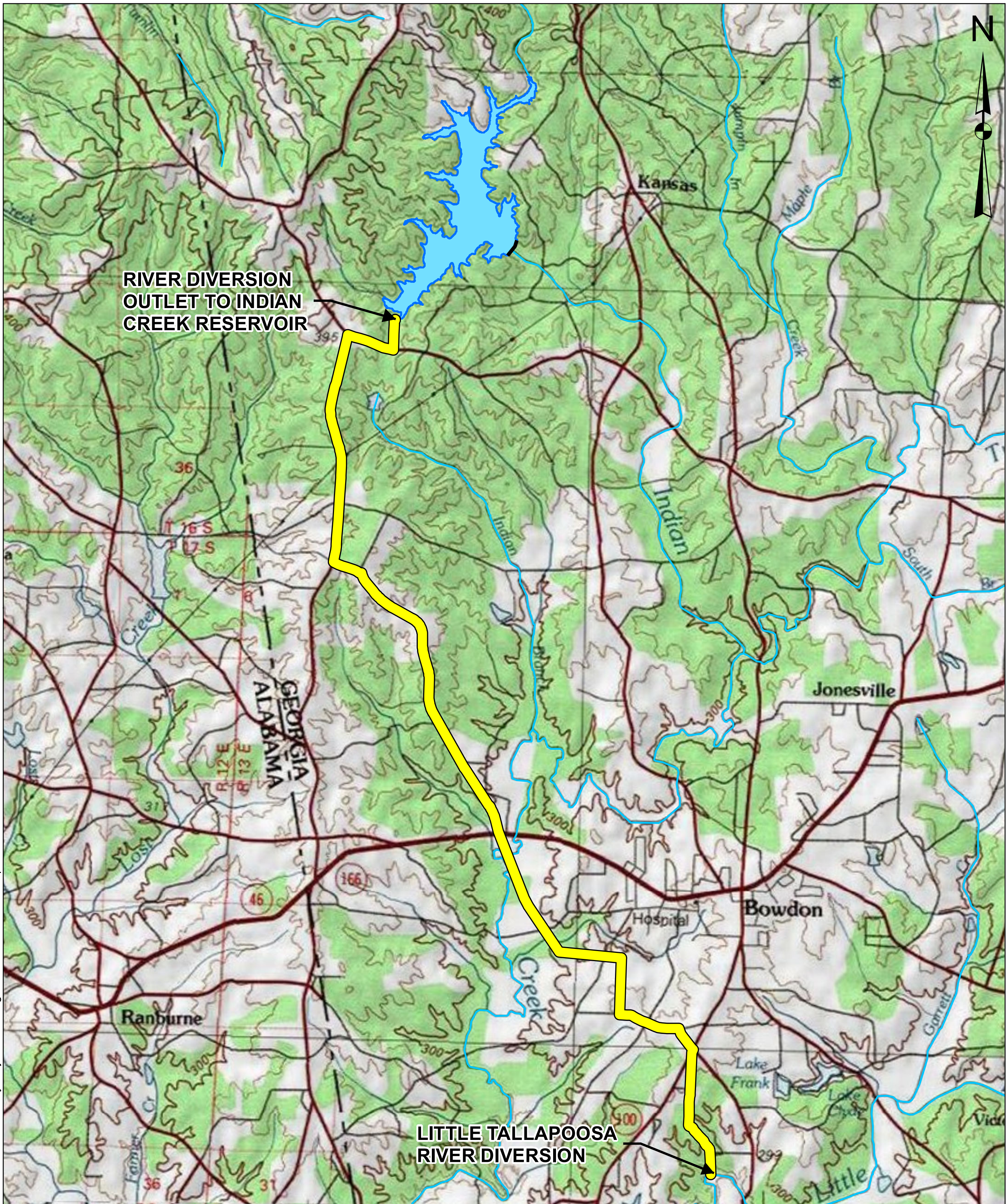
jhalligan



Source: Copyright:© 2013 National Geographic Society, i-cubed
Projection: NAD 1983 StatePlane Georgia West FIPS 1002 Feet

3,000 1,500 0 3,000 6,000 9,000
Feet

Scale: 1 in = 6,000 feet

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CARROLL COUNTY WATER SUPPLY
CARROLL COUNTY, GEORGIA

PROJECT NO. 17C17107.00

DIVERSION LOCATION
AND PIPELINE ROUTE

FIGURE 2

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jhalligan

Dam	Indian Creek	Figure 3: Stage-Storage Curve		
Project:	Carroll County Water Supply	By JTH	Date: 8/30/2017	Sheet 1 of 3
Client:	CCWA			
Location:	Carroll County Georgia	Checked MLD	Chk Date: 10/2/2017	Job No 17C17107.00

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Conic Method for Reservoir Volume
NAVD 88 Datum

EL	Area (sf)	Area (acre)	Area (mg/in)	DV (cf)	Vol (CF)	Vol (acre-ft)	Vol (MG)
1060	0	0.0	0.0	--	--	--	--
1084	1786380.6	41.0	1.1	14291045	14291045	328.1	106.9
1086	2097919.9	48.2	1.3	3880129	18171174	417.2	135.9
1088	2397202.8	55.0	1.5	4491798	22662972	520.3	169.5
1090	2622387.7	60.2	1.6	5017906	27680878	635.5	207.1
1092	2906084.4	66.7	1.8	5526044	33206922	762.3	248.4
1094	3219415.8	73.9	2.0	6122827	39329749	902.9	294.2
1096	3580208.1	82.2	2.2	6796431	46126180	1058.9	345.0
1098	3884905.7	89.2	2.4	7463040	53589220	1230.2	400.8
1100	4190445.5	96.2	2.6	8073424	61662644	1415.6	461.2
1102	4486905	103.0	2.8	8675662	70338306	1614.7	526.1
1104	4830299.5	110.9	3.0	9315094	79653400	1828.6	595.8
1106	5225692.1	120.0	3.3	10053400	89706800	2059.4	671.0
1108	5610462.6	128.8	3.5	10833877	100540677	2308.1	752.0
1110	5984966	137.4	3.7	11593412	112134089	2574.2	838.8
1112	6346546.6	145.7	4.0	12329745	124463834	2857.3	931.0
1114	6747790.7	154.9	4.2	13092288	137556122	3157.9	1028.9
1116	7120002.4	163.5	4.4	13866128	151422249	3476.2	1132.6
1118	7513771.3	172.5	4.7	14632007	166054257	3812.1	1242.1
1120	7883485.9	181.0	4.9	15395777	181450034	4165.5	1357.2
1122	8241241.3	189.2	5.1	16123404	197573439	4535.7	1477.8
1124	8596839.4	197.4	5.4	16836829	214410267	4922.2	1603.8
1126	8972345.6	206.0	5.6	17567847	231978115	5325.5	1735.2
1128	9365167.5	215.0	5.8	18336110	250314225	5746.4	1872.4
1130	9760897.7	224.1	6.1	19124700	269438926	6185.5	2015.4
1132	10172959	233.5	6.3	19932437	289371363	6643.1	2164.5
1134	10599870	243.3	6.6	20771367	310142730	7119.9	2319.9
1136	11013816	252.8	6.9	21612365	331755094	7616.0	2481.5
1138	11429824	262.4	7.1	22442356	354197450	8131.3	2649.4
1140	11875006	272.6	7.4	23303413	377500863	8666.2	2823.7
1142	12335507	283.2	7.7	24209053	401709916	9222.0	3004.8
1144	12811981	294.1	8.0	25145983	426855899	9799.3	3192.9
1146	13304984	305.4	8.3	26115414	452971312	10398.8	3388.2
1148	13827184	317.4	8.6	27130494	480101806	11021.6	3591.2
1150	14363731	329.7	9.0	28189213	508291019	11668.8	3802.0
1152	14906976	342.2	9.3	29269026	537560045	12340.7	4020.9
1154	15452930	354.8	9.6	30358270	567918314	13037.6	4248.0
1156	16005868	367.4	10.0	31457179	599375493	13759.8	4483.3
1158	16566744	380.3	10.3	32571002	631946495	14507.5	4727.0
1160	17173561	394.3	10.7	33738486	665684981	15282.0	4979.3
1162	17791418	408.4	11.1	34963159	700648140	16084.7	5240.8

Dam	Indian Creek	Figure 3: Stage-Storage Curve			
Project:	Carroll County Water Supply	By JTH	Date: 8/30/2017	Sheet 2 of 3	
Client:	CCWA	Checked MLD	Chk Date: 10/2/2017	Job No 17C17107.00	
Location:	Carroll County Georgia				

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Conic Method for Reservoir Volume
NAVD 88 Datum

EL	Area (sf)	Area (acre)	Area (mg/in)	DV (cf)	Vol (CF)	Vol (acre-ft)	Vol (MG)
1164	18414712	422.7	11.5	36204341	736852481	16915.8	5511.7
1166	19042238	437.1	11.9	37455198	774307679	17775.7	5791.8
1168	19685858	451.9	12.3	38726313	813033992	18664.7	6081.5
1170	20346209	467.1	12.7	40030252	853064245	19583.7	6380.9
1172	21057854	483.4	13.1	41402024	894466269	20534.1	6690.6
1174	21744656	499.2	13.6	42800673	937266942	21516.7	7010.8
1176	22569719	518.1	14.1	44311814	981578756	22533.9	7342.2
1178	23227757	533.2	14.5	45795900	1027374657	23585.3	7684.8
1180	23897576	548.6	14.9	47123746	1074498403	24667.1	8037.2
1182	24591701	564.5	15.3	48487620	1122986023	25780.2	8399.9
1184	25301981	580.9	15.8	49891997	1172878020	26925.6	8773.1
1186	26293158	603.6	16.4	51591966	1224469985	28110.0	9159.0
1188	27058550	621.2	16.9	53349878	1277819864	29334.7	9558.1
1190	27870472	639.8	17.4	54927023	1332746886	30595.7	9968.9
1192	28709663	659.1	17.9	56578061	1389324947	31894.5	10392.2
1194	29568957	678.8	18.4	58276508	1447601454	33232.4	10828.1
1196	30509992	700.4	19.0	60076492	1507677946	34611.5	11277.4
1198	31421035	721.3	19.6	61928793	1569606740	36033.2	11740.7
1200	32340899	742.4	20.2	63759722	1633366461	37496.9	12217.6
1202	33276120	763.9	20.7	65614797	1698981259	39003.2	12708.4
1204	34218997	785.6	21.3	67492922	1766474180	40552.7	13213.2
1206	35200279	808.1	21.9	69416964	1835891145	42146.3	13732.5
1208	36269037	832.6	22.6	71466653	1907357798	43786.9	14267.0
1210	37325296	856.9	23.3	73591806	1980949604	45476.3	14817.5
1212	38493370	883.7	24.0	75815667	2056765271	47216.8	15384.6
1214	39563426	908.3	24.7	78054351	2134819622	49008.7	15968.5

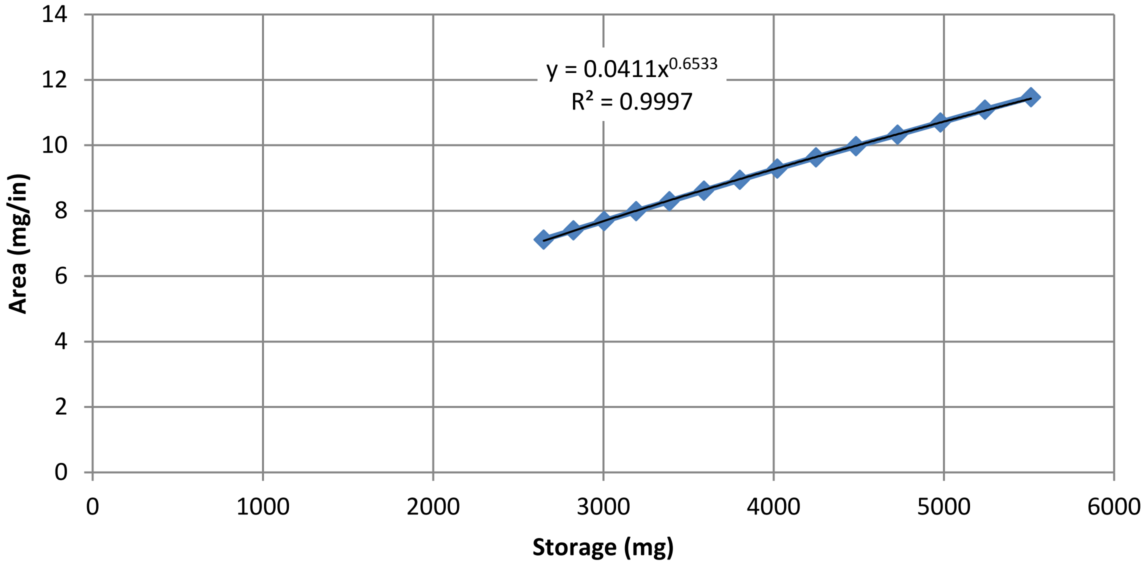
Area obtained from GIS.

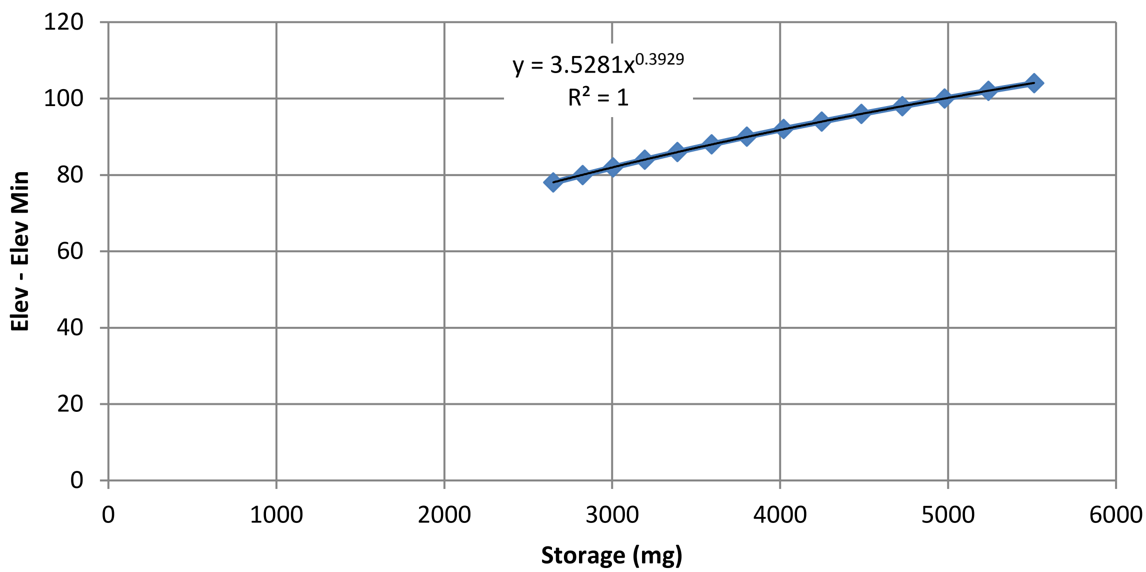
Dam	Indian Creek	**Figure 3: Stage-Storage Curve**		
Project:	Carroll County Water Supply	By JTH	Date: 8/30/2017	Sheet 3 of 3
Client:	CCWA	Checked MLD	Chk Date: 10/2/2017	Job No 17C17107.00
Location:	Carroll County Georgia			

Schnabel ENGINEERING

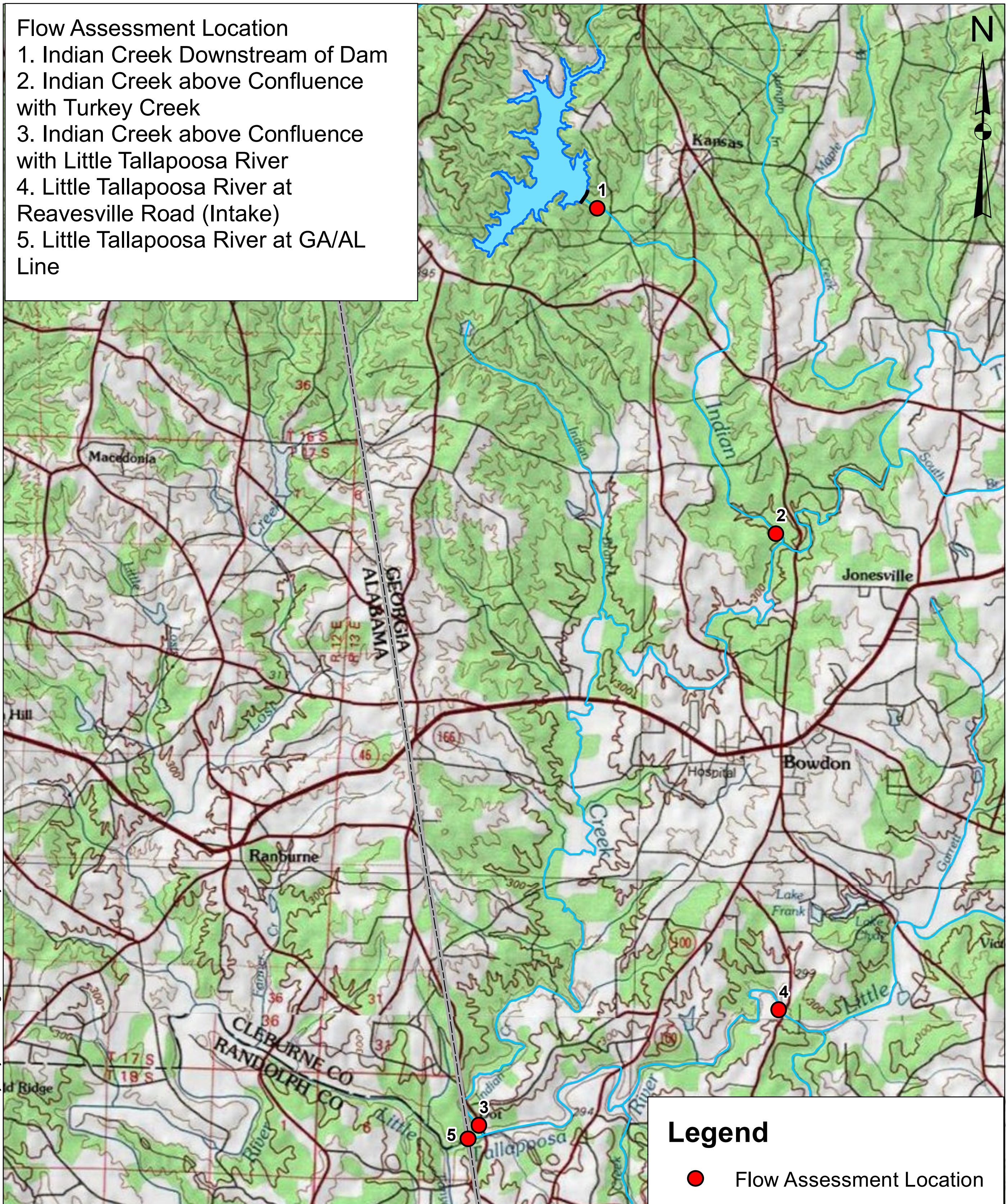
Conic Method for Reservoir Volume
NAVD 88 Datum

EL	Area (sf)	Area (acre)	Area (mg/in)	DV (cf)	Vol (CF)	Vol (acre-ft)	Vol (MG)





Definition: In statistics, the coefficient of determination, denoted R^2 or r^2 and pronounced R squared, is a number that indicates how well data fit a statistical model – sometimes simply a line or a curve. An R^2 of 1 indicates that the regression line perfectly fits the data, while an R^2 of 0 indicates that the line does not fit the data at all. (Oxford Statistics Dictionary)



Source: Copyright:© 2013 National Geographic Society, i-cubed
Projection: NAD 1983 StatePlane Georgia West FIPS 1002 Feet

7,000 3,500 0 7,000 Feet

Scale: 1 in = 7,000 feet

jhalligan

12/13/2017 B:\GIS_Data\2017\17C35006 - Carroll County\Projects\Working Folder\Pre Post Project Assessment Locations.mxd

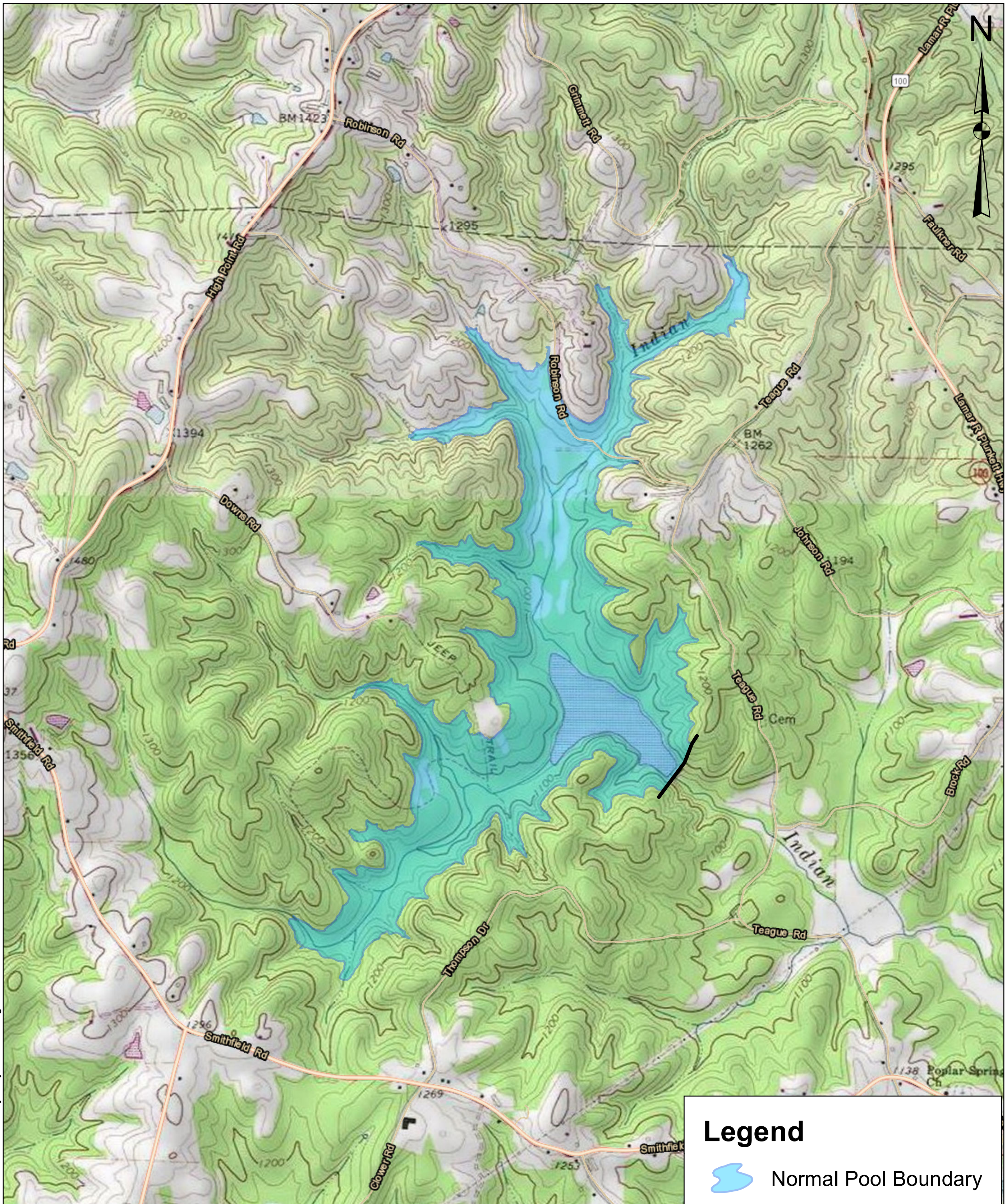
Schnabel ENGINEERING

CARROLL COUNTY WATER SUPPLY
CARROLL COUNTY, GEORGIA
PROJECT NO. 17C17107.00

PRE- AND POST-PROJECT ASSESSMENT LOCATIONS

FIGURE 4

jhalligan



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Projection: NAD 1983 StatePlane Georgia West FIPS 1002 Feet

2,000 1,000 0 2,000 Feet

Scale: 1 in = 2,000 ft

Schnabel ENGINEERING	CARROLL COUNTY RESERVOIR PROJECT CARROLL COUNTY, GEORGIA PROJECT NO. 17C17107.00	INDIAN CREEK RESERVOIR MAP NORMAL POOL EL. = 1161.0 FEET TOP OF DAM EL. = 1181.0 FEET FIGURE 5

1/2/2018 B:\GIS_Data\2017\17C35006 - Carroll County\Projects\Working Folder\Indian Creek SYR.mxd

Figure 6: Estimation of Monthly 7Q10 by Statistical Analysis
Using Log Pearson Type III Distribution

7-Day Low Flow Q (cfs)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1952							84.3	128.3	128.0	113.9	137.0	313.6
1953	713.9	530.7	741.0	603.4	423.0	267.6	176.7	102.3	55.9	98.4	109.9	382.1
1954	305.3	357.1	411.4	392.9	241.7	125.1	84.6	48.9	19.1	13.6	29.0	139.7
1955	309.4	514.6	461.4	545.6	317.1	206.4	184.7	78.3	35.1	62.4	86.0	156.6
1956	132.6	625.7	498.3	597.9	248.1	153.6	148.6	68.9	46.1	46.7	118.1	130.7
1957	319.1	374.0	567.1	640.9	314.4	236.4	147.0	74.0	54.4	277.3	270.3	640.0
1958	584.6	704.9	795.9	819.9	382.7	207.3	278.3	154.3	93.1	179.3	175.9	213.1
1959	318.4	515.7	590.0	561.7	331.6	308.4	157.1	113.9	117.4	99.1	205.7	242.3
1960	376.0	847.7	680.1	548.9	294.1	182.1	85.6	106.6	67.0	173.4	168.6	183.4
1961	237.0	303.9	734.7	768.0	560.4	389.0	248.1	131.7	99.7	83.9	110.0	173.7
1962	619.0	578.6	851.9	801.6	259.0	229.0	184.0	87.9	65.9	97.7	104.6	214.9
1963	322.9	544.6	933.1	462.4	424.7	229.9	427.6	240.7	151.9	131.3	142.7	284.1
1964	569.9	757.6	1282.1	1147.1	566.9	311.1	405.7	201.7	139.9	318.6	268.6	578.0
1965	613.6	975.6	1162.3	905.6	461.3	376.9	308.6	199.4	124.4	120.9	124.3	160.3
1966	335.1	392.1	713.7	558.6	688.3	357.6	178.1	204.0	165.7	202.9	455.3	385.6
1967	614.1	690.6	610.6	353.9	303.3	219.0	329.3	178.0	266.3	285.1	360.6	898.9
1968	1040.1	587.4	623.0	957.1	830.0	402.7	246.6	136.3	87.1	115.7	203.0	272.0
1969	289.0	590.7	548.0	654.0	525.9	251.1	168.1	129.3	96.7	124.3	140.0	180.4
1970	386.6	387.7	330.7	507.0	213.1	235.1	130.9	205.1	93.6	90.6	381.7	305.4
1971	590.7	907.6	1030.4	712.3	430.6	346.4	380.3	262.9	183.6	150.0	182.9	392.1
1972	820.3	754.6	792.0	585.1	454.9	257.3	236.1	124.3	94.9	135.3	208.6	449.3
1973	866.1	676.1	712.6	990.4	975.0	637.7	444.4	258.9	206.6	222.9	234.6	413.7
1974	821.9	963.7	606.4	710.0	445.6	267.7	215.4	277.7	235.9	185.7	221.4	434.0
1975	761.0	1085.7	845.9	711.3	546.7	349.1	312.1	278.6	240.0	609.0	554.1	578.6
1976	726.7	737.4	680.3	635.9	611.6	367.7	244.7	178.0	154.3	164.7	201.9	417.4
1977	584.4	432.0	1131.3	841.0	401.3	225.6	103.9	119.9	112.0	145.1	564.0	436.3
1978	544.4	504.7	539.1	443.1	444.7	364.3	164.7	119.3	76.7	68.4	77.1	194.7
1979	370.0	463.9	622.4	1042.7	533.7	343.0	270.1	178.3	177.4	325.6	541.0	431.4
1980	522.9	757.4	1127.4	1075.3	711.0	433.9	166.1	98.3	77.6	165.7	232.0	229.3
1981	214.4	484.6	405.9	379.4	253.3	174.1	96.3	92.4	74.9	45.1	123.4	176.3
1982	465.1	688.1	548.0	816.3	598.4	339.1	308.7	177.6	109.1	102.0	282.1	711.1
1983	617.3	781.4	759.4	1081.0	677.7	460.3	161.0	69.7	136.6	110.6	159.6	726.9
1984	763.0	742.6	748.1	877.4	754.7	350.6	338.9	362.1	182.1	155.1	199.9	288.1
1985	344.7	573.3	465.3	417.1	317.1	230.7	314.3	257.1	161.6	194.3	266.3	368.6
1986	308.7	360.7	315.7	254.4	157.0	82.2	41.9	30.4	59.9	47.3	106.1	346.7
1987	232.4	527.4	732.6	414.7	220.4	163.6	102.1	58.4	37.4	54.9	76.1	107.9
1988	251.7	284.9	267.9	265.6	159.3	38.6	44.1	43.6	69.9	66.6	204.4	152.0
1989	281.7	304.1	419.0	407.0	318.6	296.0	516.6	295.0	290.4	349.9	377.4	467.0
1990	670.4	1422.9	1292.9	749.3	411.6	213.9	126.6	68.1	43.3	58.9	118.0	192.4
1991	345.7	352.6	451.9	657.3	591.1	325.9	334.7	201.4	138.4	155.6	179.9	339.0
1992	490.3	457.4	757.3	612.0	291.1	223.4	180.9	160.3	189.6	165.0	426.3	590.1
1993	783.9	779.3	865.6	767.4	526.9	277.4	116.0	89.0	31.7	22.1	147.4	262.0
1994	350.6	406.9	454.0	528.3	284.6	232.1	401.9	276.9	235.3	315.6	279.3	370.9
1995	428.0	428.9	679.9	551.9	255.6	200.1	79.4	77.9	47.7	241.1	412.1	390.7
1996	586.0	737.6	1062.7	732.6	306.1	248.1	161.9	134.4	170.6	143.1	265.3	417.1
1997	751.3	1062.3	710.1	605.1	409.3	472.9	255.4	181.0	103.0	153.6	343.9	300.6
1998	785.3	864.1	769.3	868.6	376.3	222.3	169.4	191.4	99.7	107.9	108.3	175.4
1999	397.4	618.0	730.3	344.6	202.4	151.3	185.3	51.6	26.4	43.7	82.0	110.0
2000	157.3	190.7	368.9	309.7	157.3	70.6	17.1	29.4	18.7	27.0	35.3	150.1
2001	187.4	301.9	696.6	413.7	260.0	236.7	118.7	64.3	64.0	72.2	83.9	131.9
2002	181.3	291.1	324.9	227.9	194.1	84.8	101.6	51.0	27.8	264.1	525.7	921.9
2003	562.6	839.9	726.1	607.0	1067.7	668.0	580.0	335.7	186.4	180.3	189.6	407.6
2004	399.0	614.3	394.9	386.9	251.4	209.6	193.4	141.6	164.3	179.6	301.9	537.7
2005	451.9	561.7	711.3	611.4	328.6	332.0	524.7	364.9	156.6	141.4	144.6	380.1
2006	321.9	622.1	685.0	510.3	266.1	114.7	83.8	71.6	79.1	72.6	168.1	190.3
2007	336.4	302.1	260.0	202.4	71.3	22.6	19.3	9.9	7.2	3.8	9.5	32.9
2008	107.2	243.4	333.9	302.1	228.3	34.1	26.6	19.8	19.0	17.6	34.6	146.1
2009	225.7	187.4	334.0	365.4	443.0	84.3	67.5	81.2	127.4	510.3	508.0	1026.9
2010	648.9	1010.6	831.0	506.1	423.7	255.7	124.7	59.6	15.6	14.4	43.2	127.3
2011	185.7	200.6	465.1	364.3	114.7	42.3	61.9	11.9	19.7	24.9	42.6	144.6
2012	194.6	271.0	307.6	164.0	101.4	47.6	41.0	35.9	31.7	20.9	20.4	42.3
2013	236.6	500.9	503.3	490.9	321.7	293.0	353.0	350.4	194.6	168.0	164.6	555.9
2014	438.6	619.0	663.0	806.1	454.1	405.1	162.6	102.2	62.4	62.3	89.9	204.3
2015	424.6	408.4	530.9	975.1	355.4	223.0	138.3	64.6	54.8	79.8	366.1	377.7
2016	631.1	701.7	630.7	434.1	186.0	66.7	47.1	48.1	10.2	0.9	1.3	41.6
2017	118.1	215.3	290.9	277.0	193.1	247.3						

Log (7-Day Low Flow)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1952							1.926	2.108	2.107	2.056	2.137	2.496
1953	2.854	2.725	2.870	2.781	2.626	2.427	2.247	2.010	1.747	1.993	2.041	2.582
1954	2.485	2.553	2.614	2.594	2.383	2.097	1.927	1.689	1.282	1.133	1.462	2.145
1955	2.491	2.711	2.664	2.737	2.501	2.315	2.267	1.894	1.546	1.795	1.934	2.195
1956	2.122	2.796	2.697	2.777	2.395	2.186	2.172	1.838	1.664	1.669	2.072	2.116
1957	2.504	2.573	2.754	2.807	2.498	2.374	2.167	1.869	1.736	2.443	2.432	2.806
1958	2.767	2.848	2.901	2.914	2.583	2.317	2.444	2.188	1.969	2.254	2.245	2.329
1959	2.503	2.712	2.771	2.750	2.521	2.489	2.196	2.056	2.070	1.996	2.313	2.384
1960	2.575	2.928	2.833	2.739	2.469	2.260	1.932	2.028	1.826	2.239	2.227	2.263
1961	2.375	2.483	2.866	2.885	2.749	2.590	2.395	2.120	1.999	1.924	2.041	2.240
1962	2.792	2.762	2.930	2.904	2.413	2.360	2.265	1.944	1.819	1.990	2.019	2.332
1963	2.509	2.736	2.970	2.665	2.628	2.361	2.631	2.382	2.181	2.118	2.154	2.454
1964	2.756	2.879	3.108	3.060	2.753	2.493	2.608	2.305	2.146	2.503	2.429	2.762
1965	2.788	2.989	3.065	2.957	2.664	2.576	2.489	2.300	2.095	2.082	2.094	2.205
1966	2.525	2.593	2.854	2.747	2.838	2.553	2.251	2.310	2.219	2.307	2.658	2.586
1967	2.788	2.839	2.786	2.549	2.482	2.340	2.518	2.250	2.425	2.455	2.557	2.954
1968	3.017	2.769	2.794	2.981	2.919	2.605	2.392	2.134	1.940	2.063	2.307	2.435
1969	2.461	2.771	2.739	2.816	2.721	2.400	2.226	2.112	1.985	2.094	2.146	2.256
1970	2.587	2.589	2.519	2.705	2.329	2.371	2.117	2.312	1.971	1.957	2.582	2.485
1971	2.771	2.958	3.013	2.853	2.634	2.540	2.580	2.420	2.264	2.176	2.262	2.593
1972	2.914	2.878	2.899	2.767	2.658	2.410	2.373	2.094	1.977	2.131	2.319	2.653
1973	2.938	2.830	2.853	2.996	2.989	2.805	2.648	2.413	2.315	2.348	2.370	2.617
1974	2.915	2.984	2.783	2.851	2.649	2.428	2.333	2.444	2.373	2.269	2.345	2.637
1975	2.881	3.036	2.927	2.852	2.738	2.543	2.494	2.445	2.380	2.785	2.744	2.762
1976	2.861	2.868	2.833	2.803	2.786	2.566	2.389	2.250	2.188	2.217	2.305	2.621
1977	2.767	2.635	3.054	2.925	2.603	2.353	2.016	2.079	2.049	2.162	2.751	2.640
1978	2.736	2.703	2.732	2.647	2.648	2.561	2.217	2.077	1.885	1.835	1.887	2.289
1979	2.568	2.666	2.794	3.018	2.727	2.535	2.432	2.251	2.249	2.513	2.733	2.635
1980	2.718	2.879	3.052	3.032	2.852	2.637	2.220	1.992	1.890	2.219	2.365	2.360
1981	2.331	2.685	2.608	2.579	2.404	2.241	1.984	1.966	1.874	1.655	2.091	2.246
1982	2.668	2.838	2.739	2.912	2.777	2.530	2.490	2.249	2.038	2.009	2.450	2.852
1983	2.790	2.893	2.880	3.034	2.831	2.663	2.207	1.843	2.135	2.044	2.203	2.861
1984	2.883	2.871	2.874	2.943	2.878	2.545	2.530	2.559	2.260	2.191	2.301	2.460
1985	2.537	2.758	2.668	2.620	2.501	2.363	2.497	2.410	2.208	2.288	2.425	2.567
1986	2.490	2.557	2.499	2.406	2.196	1.915	1.622	1.483	1.778	1.675	2.026	2.540
1987	2.366	2.722	2.865	2.618	2.343	2.214	2.009	1.767	1.573	1.739	1.882	2.033
1988	2.401	2.455	2.428	2.424	2.202	1.586	1.645	1.639	1.844	1.823	2.311	2.182
1989	2.450	2.483	2.622	2.610	2.503	2.471	2.713	2.470	2.463	2.544	2.577	2.669
1990	2.826	3.153	3.112	2.875	2.614	2.330	2.102	1.833	1.636	1.770	2.072	2.284
1991	2.539	2.547	2.655	2.818	2.772	2.513	2.525	2.304	2.141	2.192	2.255	2.530
1992	2.690	2.660	2.879	2.787	2.464	2.349	2.257	2.205	2.278	2.217	2.630	2.771
1993	2.894	2.892	2.937	2.885	2.722	2.443	2.064	1.949	1.501	1.345	2.169	2.418
1994	2.545	2.609	2.657	2.723	2.454	2.366	2.604	2.442	2.372	2.499	2.446	2.569
1995	2.631	2.632	2.832	2.742	2.408	2.301	1.900	1.891	1.679	2.382	2.615	2.592
1996	2.768	2.868	3.026	2.865	2.486	2.395	2.209	2.128	2.232	2.156	2.424	2.620
1997	2.876	3.026	2.851	2.782	2.612	2.675	2.407	2.258	2.013	2.186	2.536	2.478
1998	2.895	2.937	2.886	2.939	2.576	2.347	2.229	2.282	1.999	2.033	2.035	2.244
1999	2.599	2.791	2.863	2.537	2.306	2.180	2.268	1.712	1.422	1.641	1.914	2.041
2000	2.197	2.280	2.567	2.491	2.197	1.849	1.234	1.469	1.272	1.431	1.548	2.177
2001	2.273	2.480	2.843	2.617	2.415	2.374	2.075	1.808	1.806	1.859	1.924	2.120
2002	2.258	2.464	2.512	2.358	2.288	1.928	2.007	1.707	1.444	2.422	2.721	2.965
2003	2.750	2.924	2.861	2.783	3.028	2.825	2.763	2.526	2.271	2.256	2.278	2.610
2004	2.601	2.788	2.596	2.588	2.400	2.321	2.287	2.151	2.216	2.254	2.480	2.731
2005	2.655	2.750	2.852	2.786	2.517	2.521	2.720	2.562	2.195	2.151	2.160	2.580
2006	2.508	2.794	2.836	2.708	2.425	2.060	1.923	1.855	1.898	1.861	2.226	2.279
2007	2.527	2.480	2.415	2.306	1.853	1.353	1.286	0.993	0.858	0.584	0.980	1.518
2008	2.030	2.386	2.524	2.480	2.358	1.533	1.425	1.296	1.278	1.244	1.539	2.165
2009	2.354	2.273	2.524	2.563	2.646	1.926	1.829	1.909	2.105	2.708	2.706	3.012
2010	2.812	3.005	2.920	2.704	2.627	2.408	2.096	1.776	1.194	1.158	1.635	2.105
2011	2.269	2.302	2.668	2.561	2.060	1.626	1.792	1.074	1.295	1.397	1.630	2.160
2012	2.289	2.433	2.488	2.215	2.006	1.677	1.612	1.555	1.502	1.320	1.310	1.627
2013	2.374	2.700	2.702	2.691	2.507	2.467	2.548	2.545	2.289	2.225	2.216	2.745
2014	2.642	2.792	2.822	2.906	2.657	2.608	2.211	2.010	1.795	1.795	1.954	2.310
2015	2.628	2.611	2.725	2.989	2.551	2.348	2.141	1.810	1.739	1.902	2.564	2.577
2016	2.800	2.846	2.800	2.638	2.270	1.824	1.673	1.682	1.007	-0.037	0.122	1.619
2017	2.072	2.333	2.464	2.442	2.286	2.393						

Gage No.: 02412000
Gage Name: Tallapoosa River near Heflin

Drainage Area: 448 sq. mi.
MAF: 634 cfs
1.41 cfsm

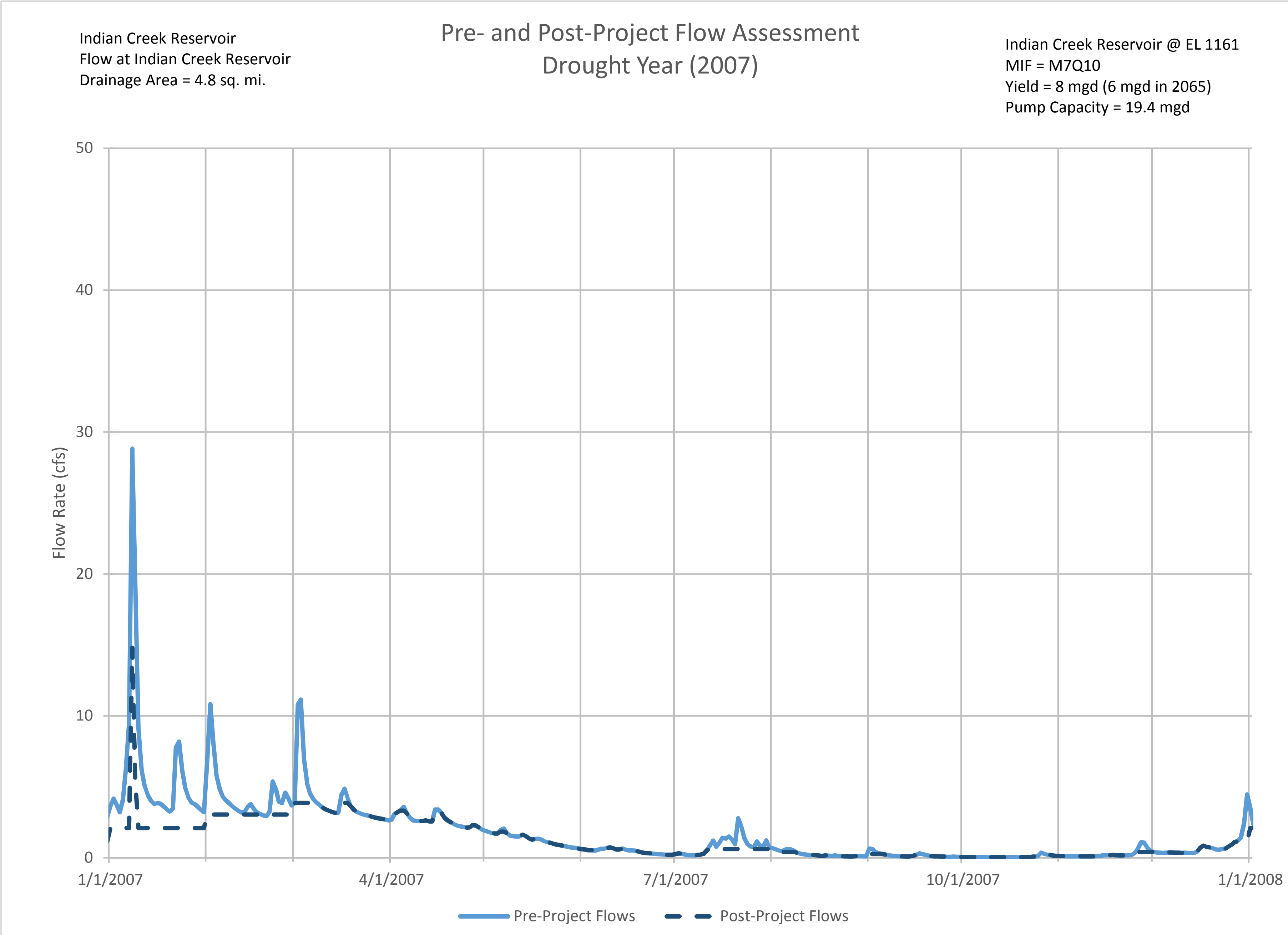
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of Years:	65	65	65	65	65	65	65	65	65	65	65	65
Ave Log Q:	2.603	2.719	2.780	2.739	2.537	2.323	2.196	2.037	1.906	1.979	2.174	2.432
Std Dev LogQ	0.231	0.200	0.171	0.190	0.230	0.304	0.340	0.344	0.365	0.476	0.442	0.306
Skew Coef:	-0.469	-0.372	-0.264	-0.548	-0.404	-1.319	-0.783	-0.806	-0.818	-1.691	-1.985	-0.701
Return Period (yrs)	10	10	10	10	10	10	10	10	10	10	10	10
Cumulative Probability	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Std Normal Deviate*	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28	-1.28
u*	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61
K**	-1.32	-1.31	-1.31	-1.32	-1.32	-1.33	-1.33	-1.33	-1.33	-1.31	-1.28	-1.33
7Q10 (cfs)	**199**	**286**	**360**	**307**	**171**	**82.8**	**55.4**	**37.9**	**26.3**	**22.7**	**40**	**106**
%MAF	**31%**	**45%**	**57%**	**49%**	**27%**	**13%**	**9%**	**6%**	**4%**	**4%**	**6%**	**17%**

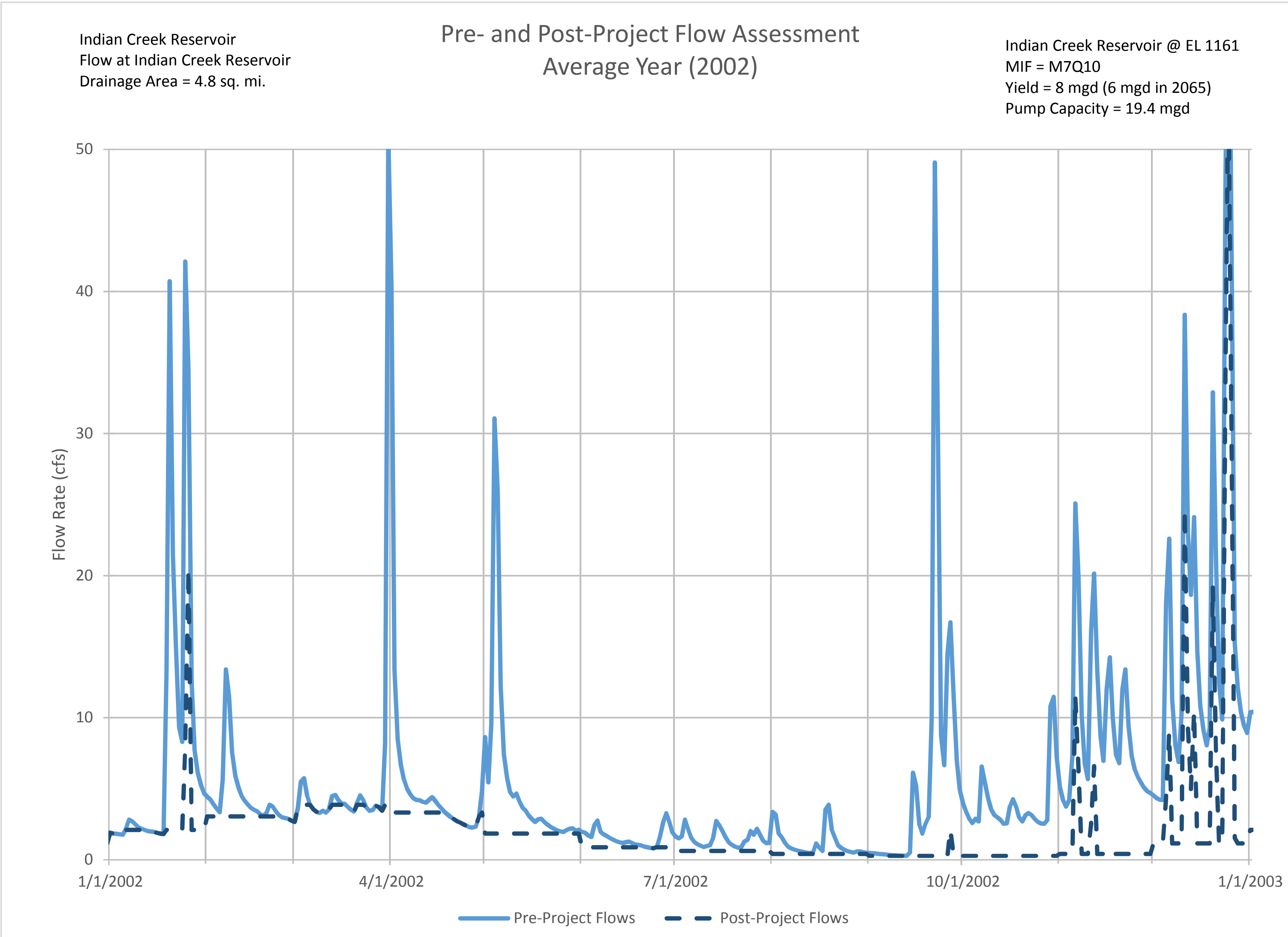
*Equation 18.2.3b, Handbook of Hydrology, Maidment
**Equation 18.2.29, ibid.

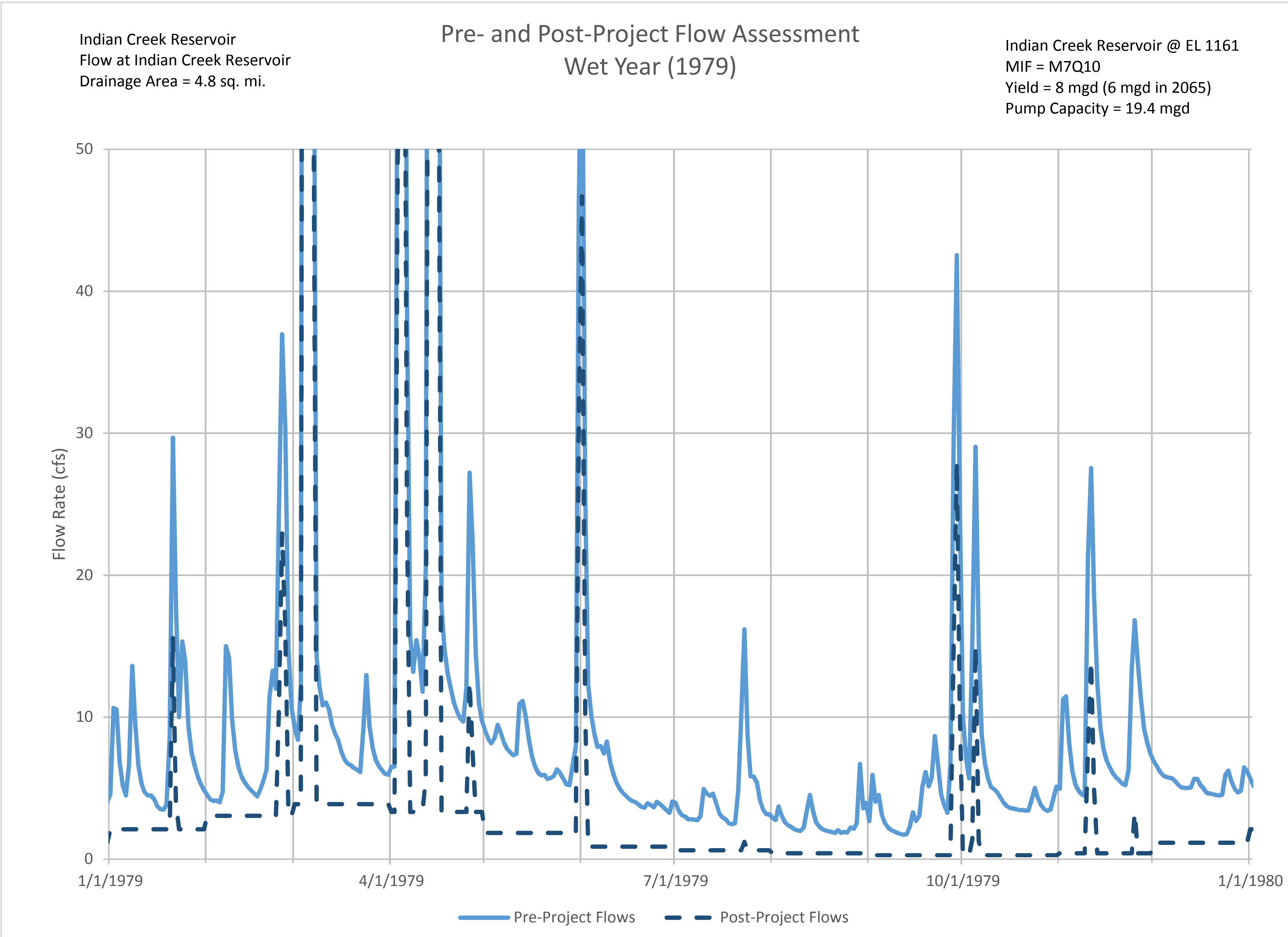
APPENDIX A

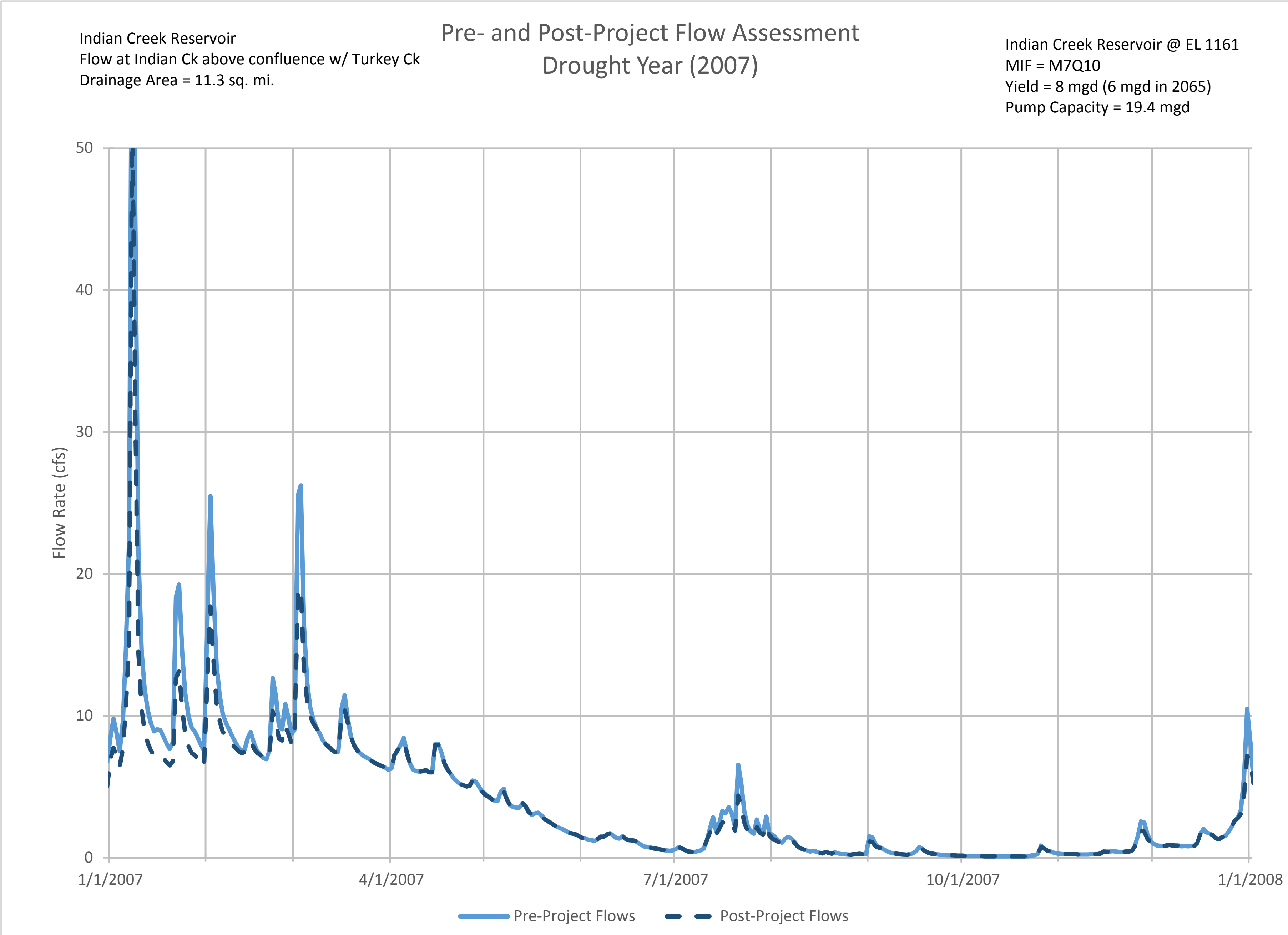
PRE- AND POST-PROJECT FLOWS

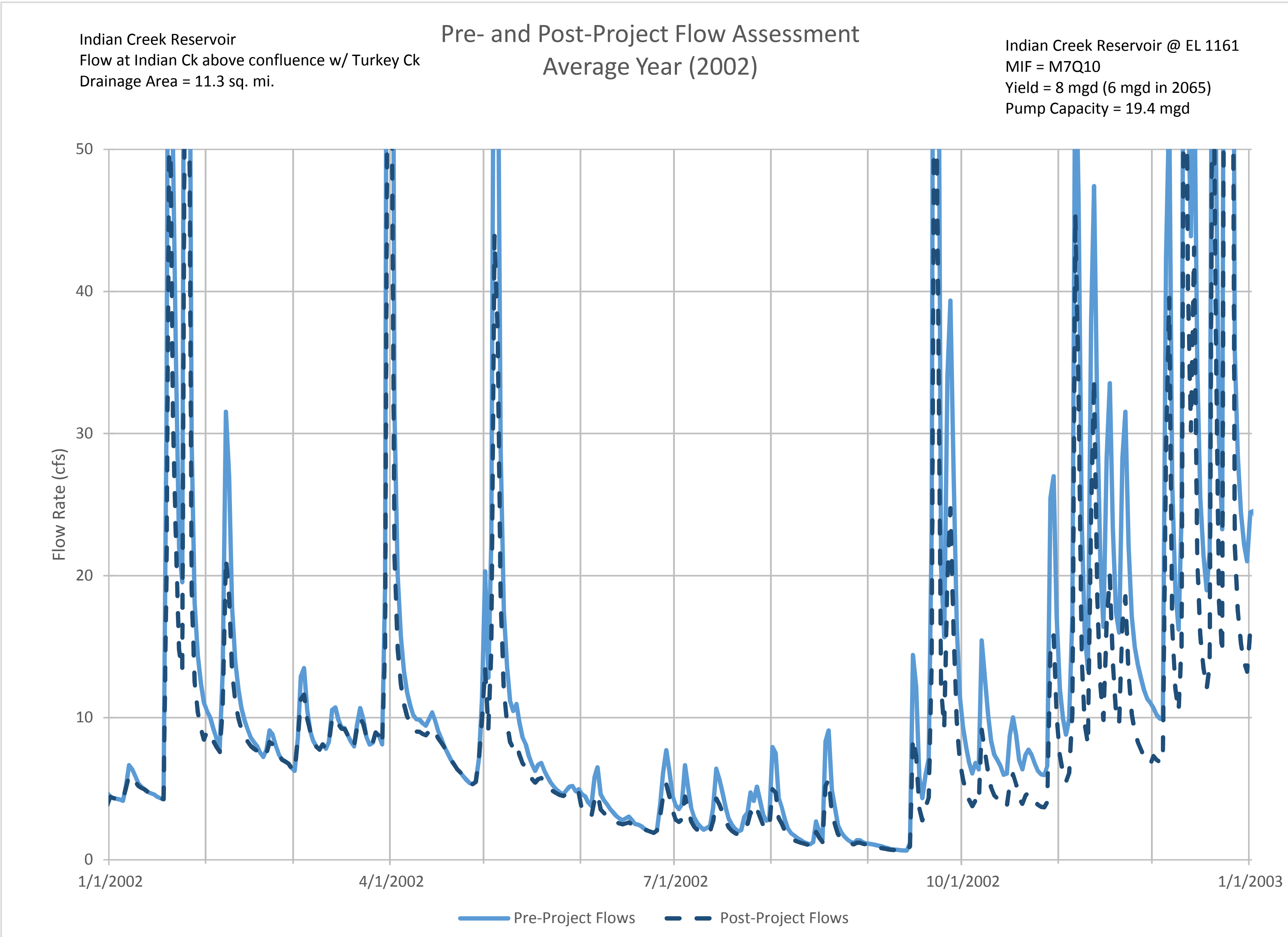
1.	Indian Creek Downstream of Dam	Wet, Dry, Average Years
2.	Indian Creek at Confluence with Turkey Creek	Wet, Dry, Average Years
3.	Indian Creek above Confluence with Little Tallapoosa River	Wet, Dry, Average Years
4.	Little Tallapoosa River at Reavesville Road (Intake)	Wet, Dry, Average Years
5.	Little Tallapoosa River at Georgia/ Alabama Line	Wet, Dry, Average Years

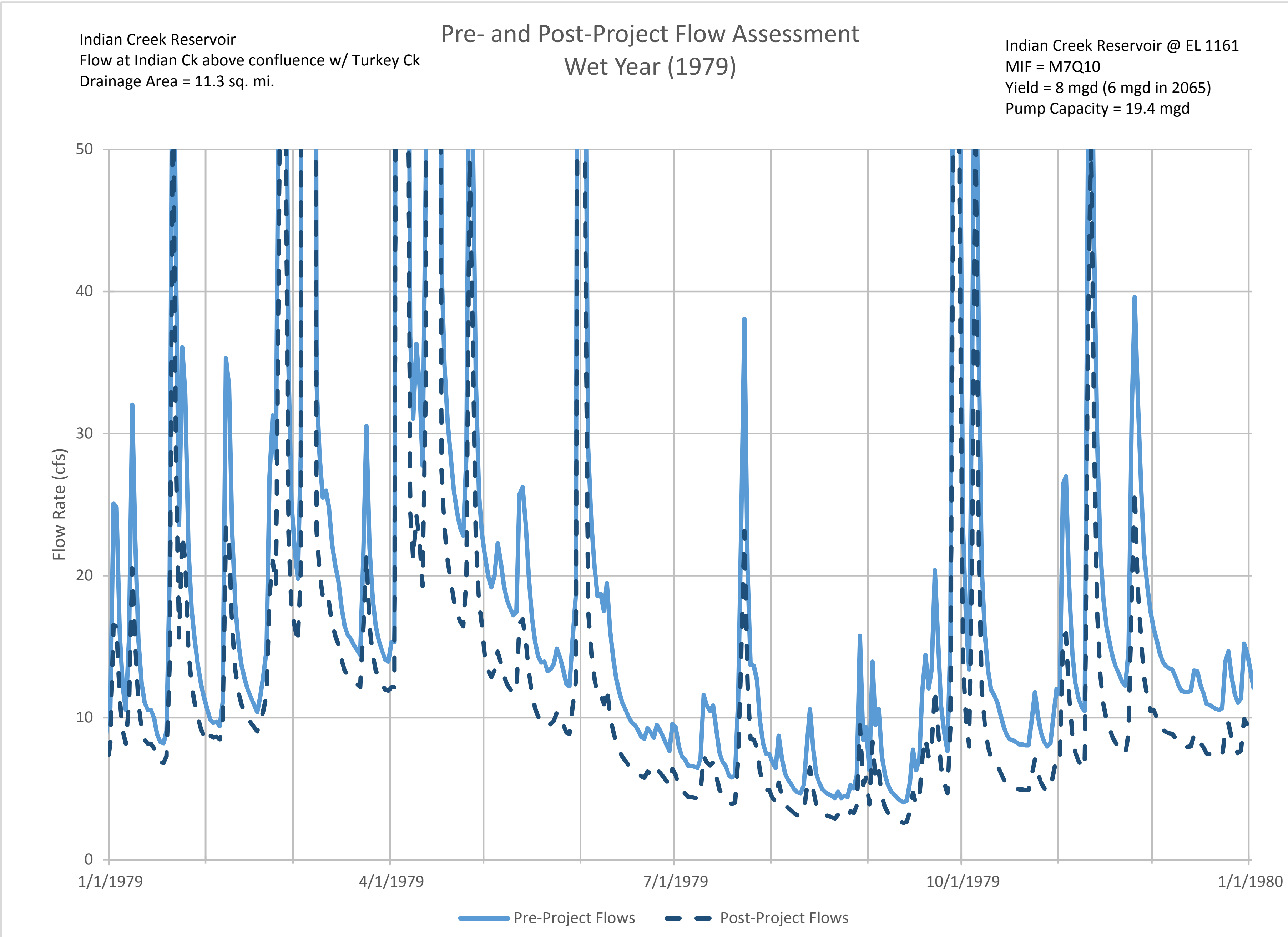

Indian Creek Reservoir
Flow at Indian Creek Reservoir
Drainage Area = 4.8 sq. mi.
Pre- and Post-Project Flow Assessment
Drought Year (2007)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
50
40
30
20
10
0
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
Pre-Project Flows
Post-Project Flows


Pre- and Post-Project Flow Assessment
Average Year (2002)
Indian Creek Reservoir
Flow at Indian Creek Reservoir
Drainage Area = 4.8 sq. mi.
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
50
40
30
20
10
0
1/1/2002
4/1/2002
7/1/2002
10/1/2002
1/1/2003
Pre-Project Flows
Post-Project Flows

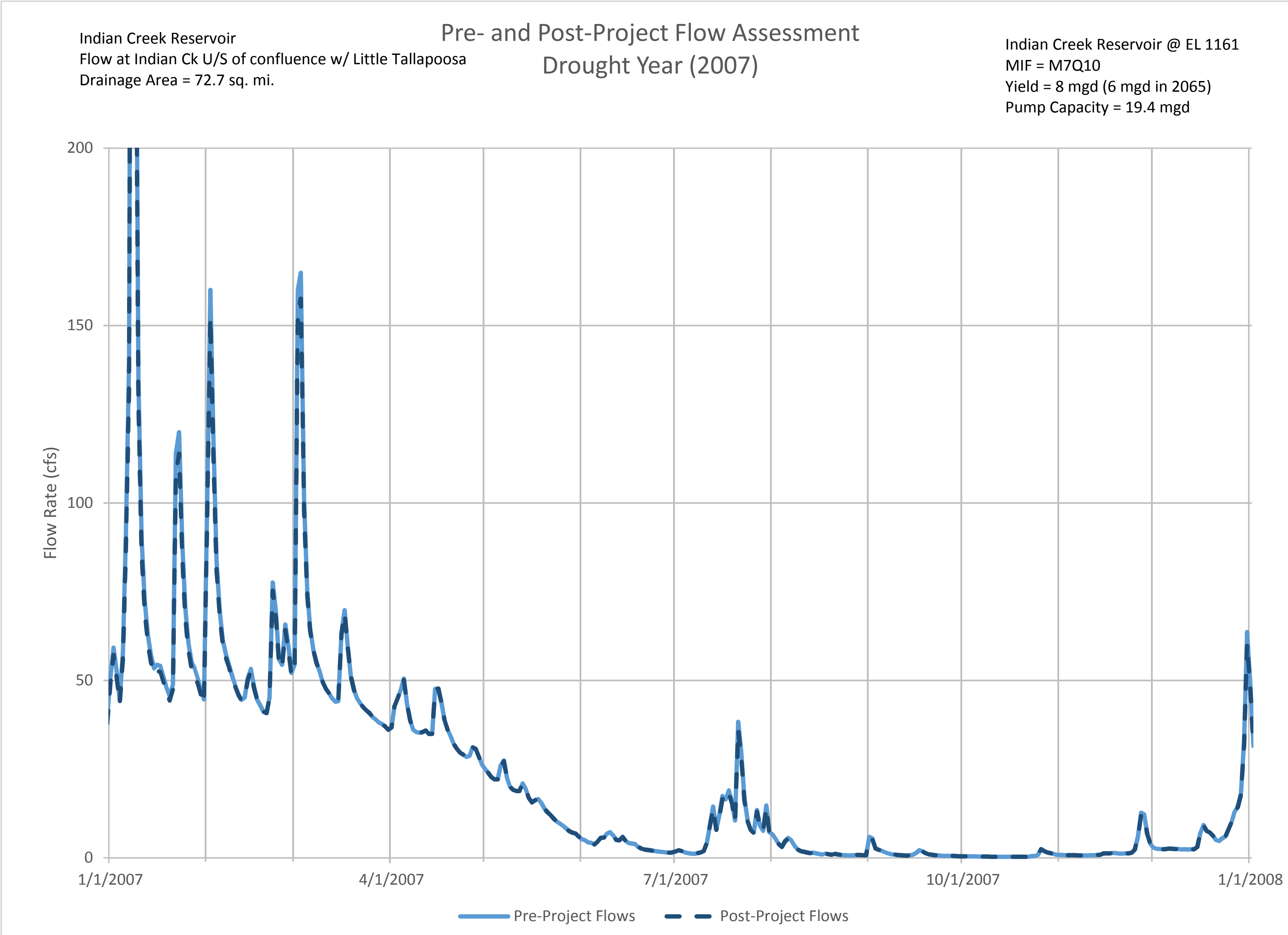

Indian Creek Reservoir
Flow at Indian Creek Reservoir
Drainage Area = 4.8 sq. mi.
Pre- and Post-Project Flow Assessment
Wet Year (1979)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
50
40
30
20
10
0
1/1/1979
4/1/1979
7/1/1979
10/1/1979
1/1/1980
Pre-Project Flows
Post-Project Flows

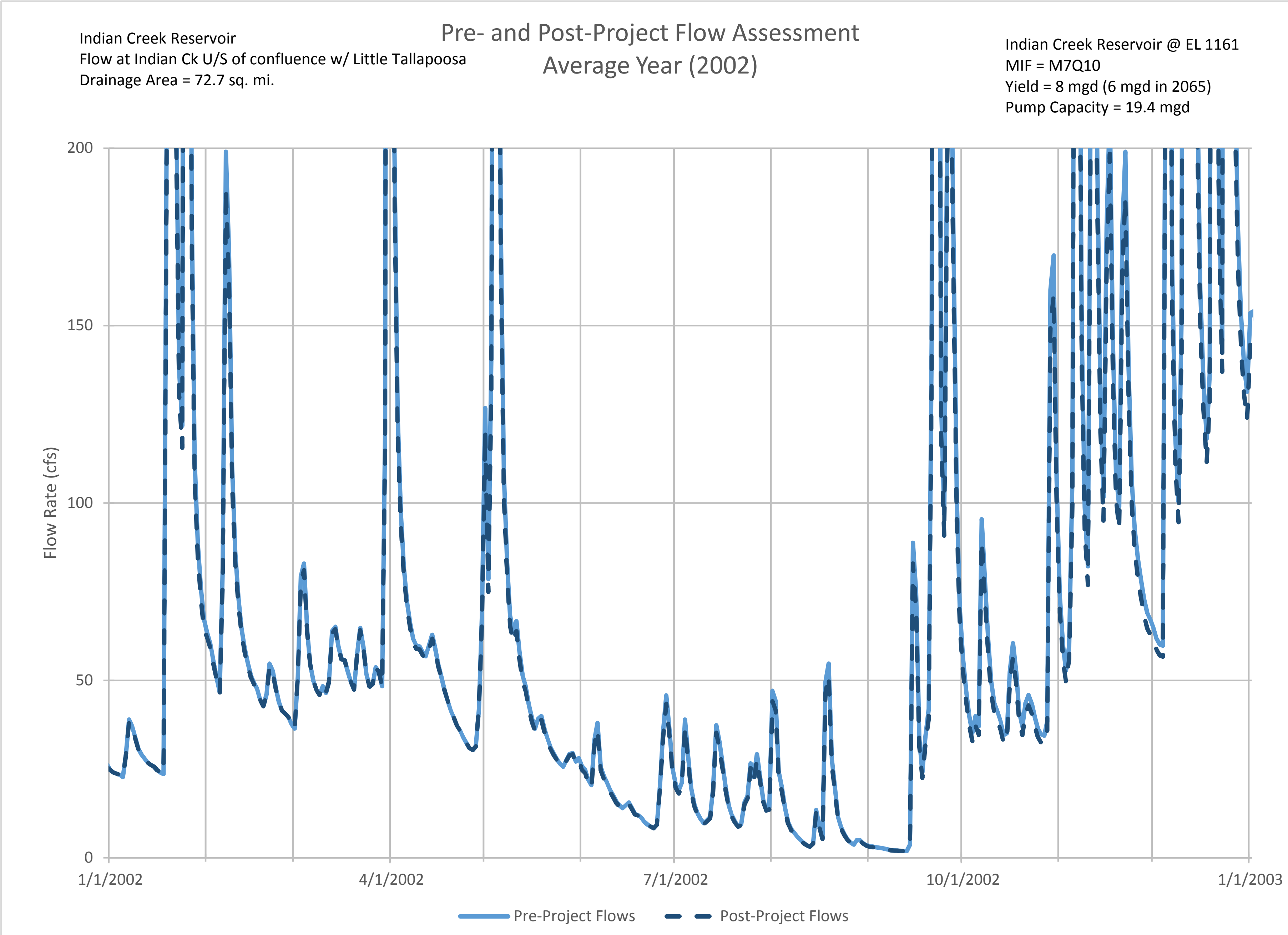

Indian Creek Reservoir
Flow at Indian Ck above confluence w/ Turkey Ck
Drainage Area = 11.3 sq. mi.
Pre- and Post-Project Flow Assessment
Drought Year (2007)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
50
40
30
20
10
0
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
Pre-Project Flows
Post-Project Flows


Indian Creek Reservoir
Flow at Indian Ck above confluence w/ Turkey Ck
Drainage Area = 11.3 sq. mi.
Pre- and Post-Project Flow Assessment
Average Year (2002)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
0
10
20
30
40
50
1/1/2002
4/1/2002
7/1/2002
10/1/2002
1/1/2003
Pre-Project Flows
Post-Project Flows

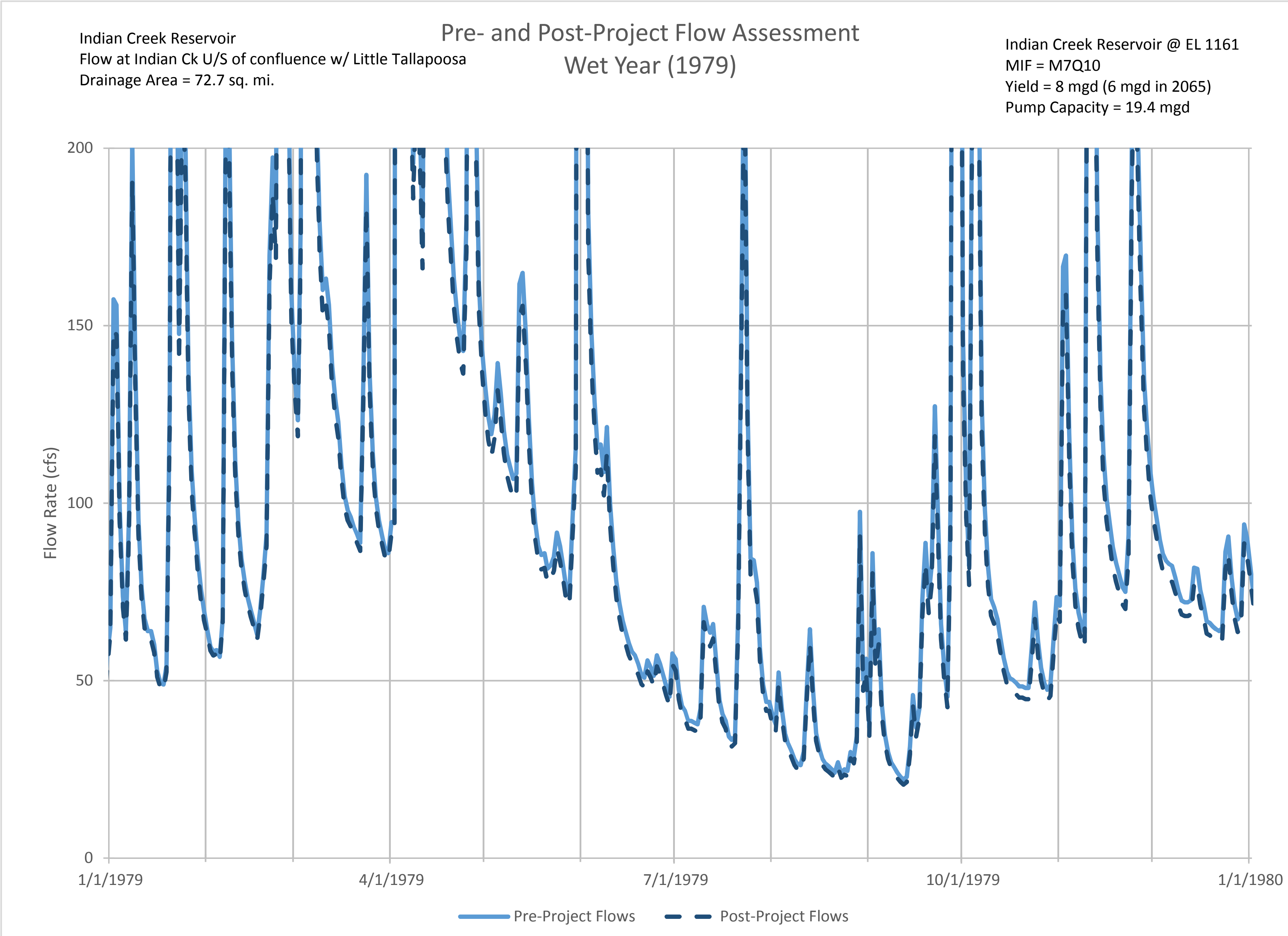


Indian Creek Reservoir
Flow at Indian Ck above confluence w/ Turkey Ck
Drainage Area = 11.3 sq. mi.
Pre- and Post-Project Flow Assessment
Wet Year (1979)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
0
10
20
30
40
50
1/1/1979
4/1/1979
7/1/1979
10/1/1979
1/1/1980
Pre-Project Flows
Post-Project Flows

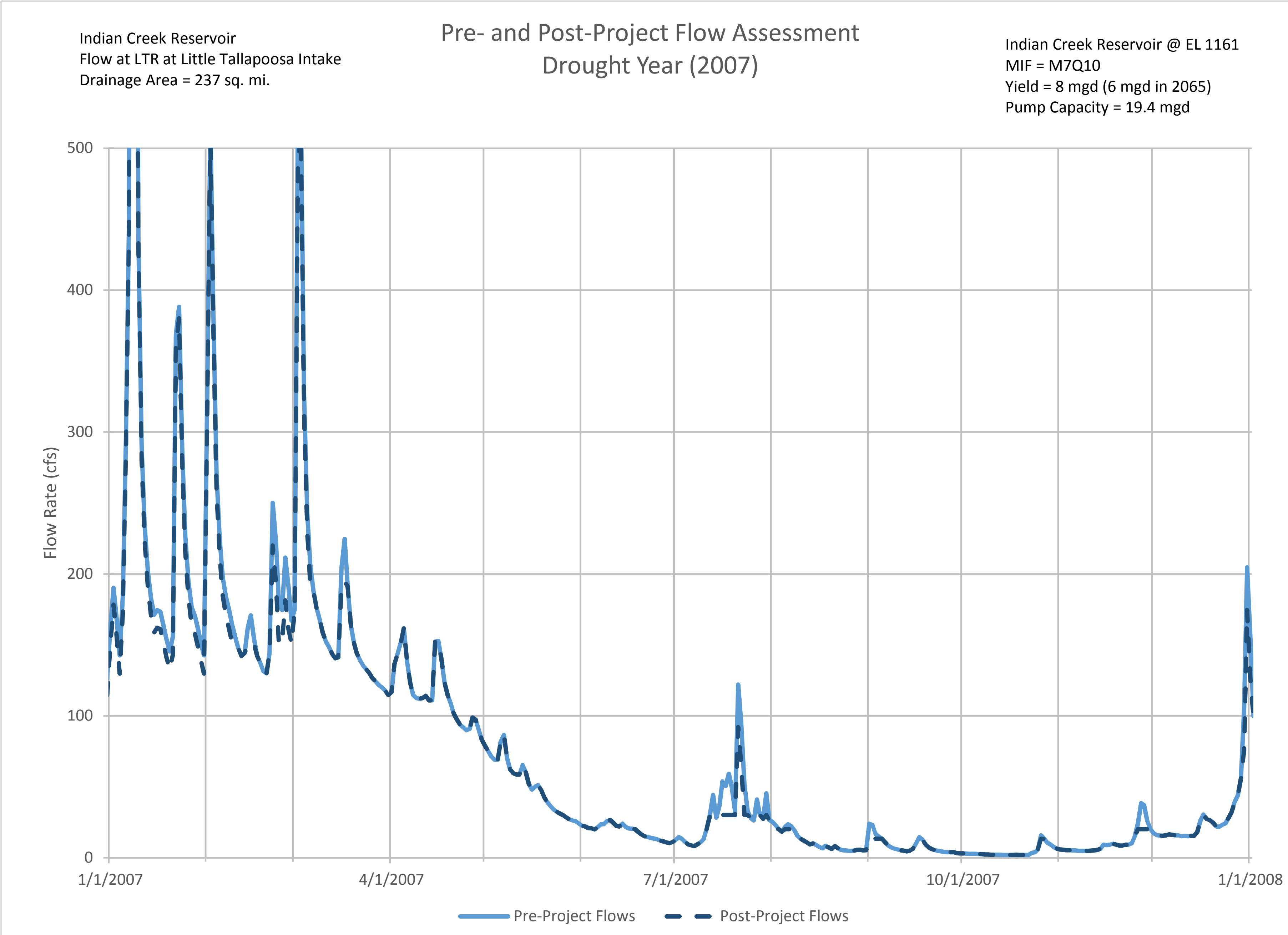

Indian Creek Reservoir
Flow at Indian Ck U/S of confluence w/ Little Tallapoosa
Drainage Area = 72.7 sq. mi.
Pre- and Post-Project Flow Assessment
Drought Year (2007)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
200
150
100
50
0
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
Pre-Project Flows
Post-Project Flows

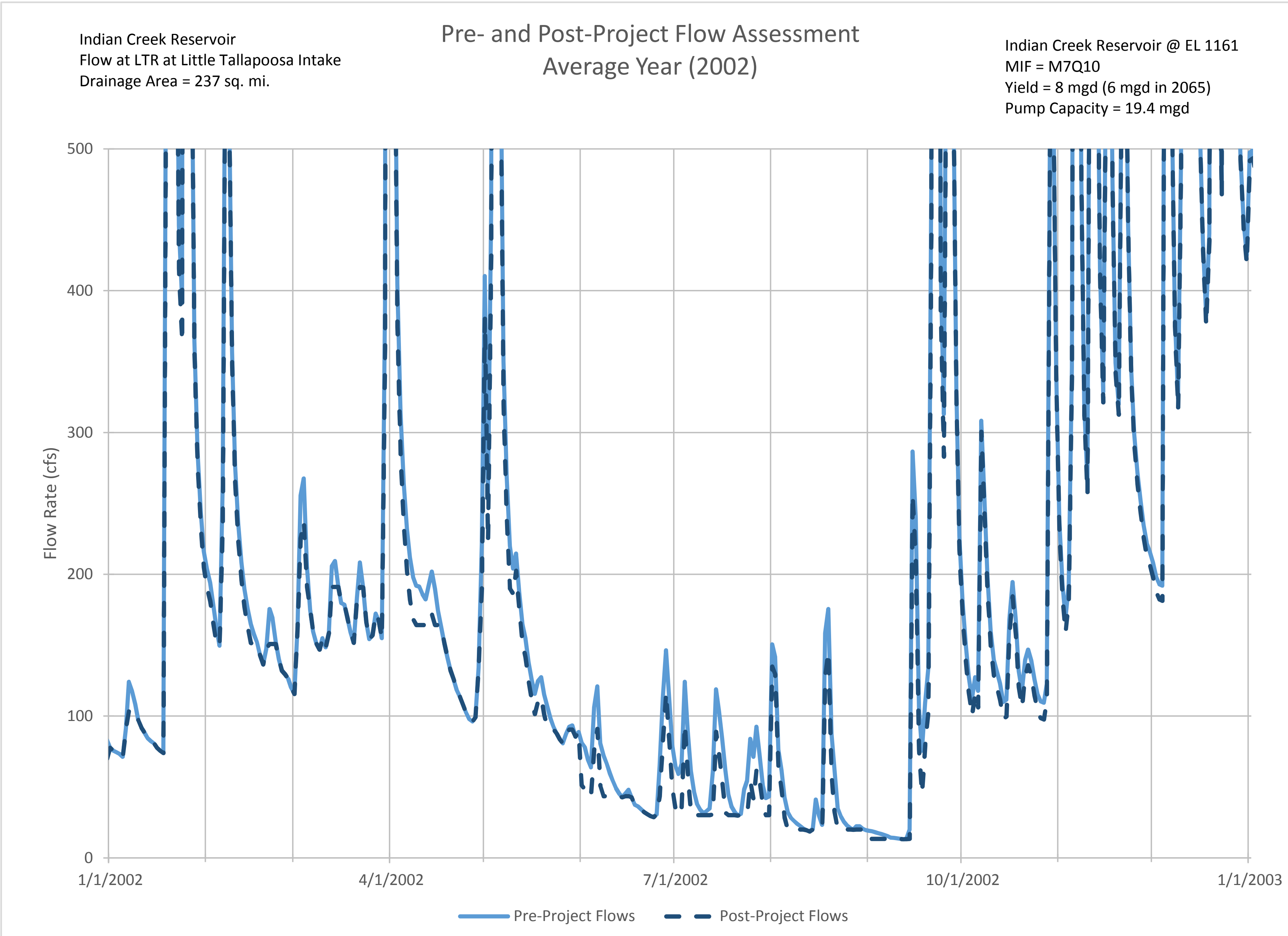


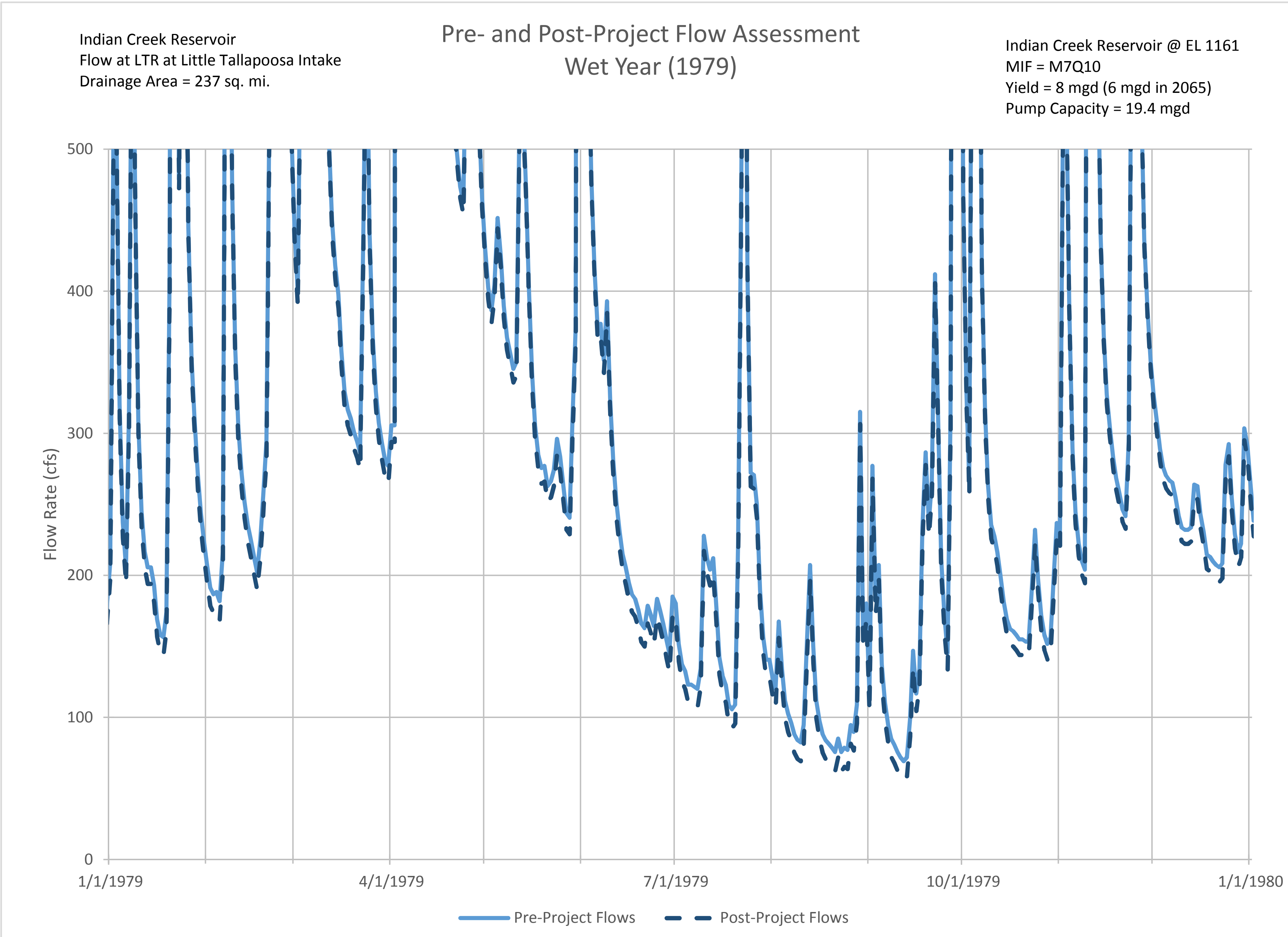
Indian Creek Reservoir
Flow at Indian Ck U/S of confluence w/ Little Tallapoosa
Drainage Area = 72.7 sq. mi.
Pre- and Post-Project Flow Assessment
Average Year (2002)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
200
150
100
50
0
1/1/2002
4/1/2002
7/1/2002
10/1/2002
1/1/2003
Pre-Project Flows
Post-Project Flows



Pre- and Post-Project Flow Assessment
Wet Year (1979)
Indian Creek Reservoir
Flow at Indian Ck U/S of confluence w/ Little Tallapoosa
Drainage Area = 72.7 sq. mi.
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
200
150
100
50
0
1/1/1979
4/1/1979
7/1/1979
10/1/1979
1/1/1980
Pre-Project Flows
Post-Project Flows


Pre- and Post-Project Flow Assessment
Drought Year (2007)
Indian Creek Reservoir
Flow at LTR at Little Tallapoosa Intake
Drainage Area = 237 sq. mi.
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
500
400
300
200
100
0
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
Pre-Project Flows
Post-Project Flows


Indian Creek Reservoir
Flow at LTR at Little Tallapoosa Intake
Drainage Area = 237 sq. mi.
Pre- and Post-Project Flow Assessment
Average Year (2002)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
500
400
300
200
100
0
1/1/2002
4/1/2002
7/1/2002
10/1/2002
1/1/2003
Pre-Project Flows
Post-Project Flows



Pre- and Post-Project Flow Assessment
Wet Year (1979)
Indian Creek Reservoir
Flow at LTR at Little Tallapoosa Intake
Drainage Area = 237 sq. mi.
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
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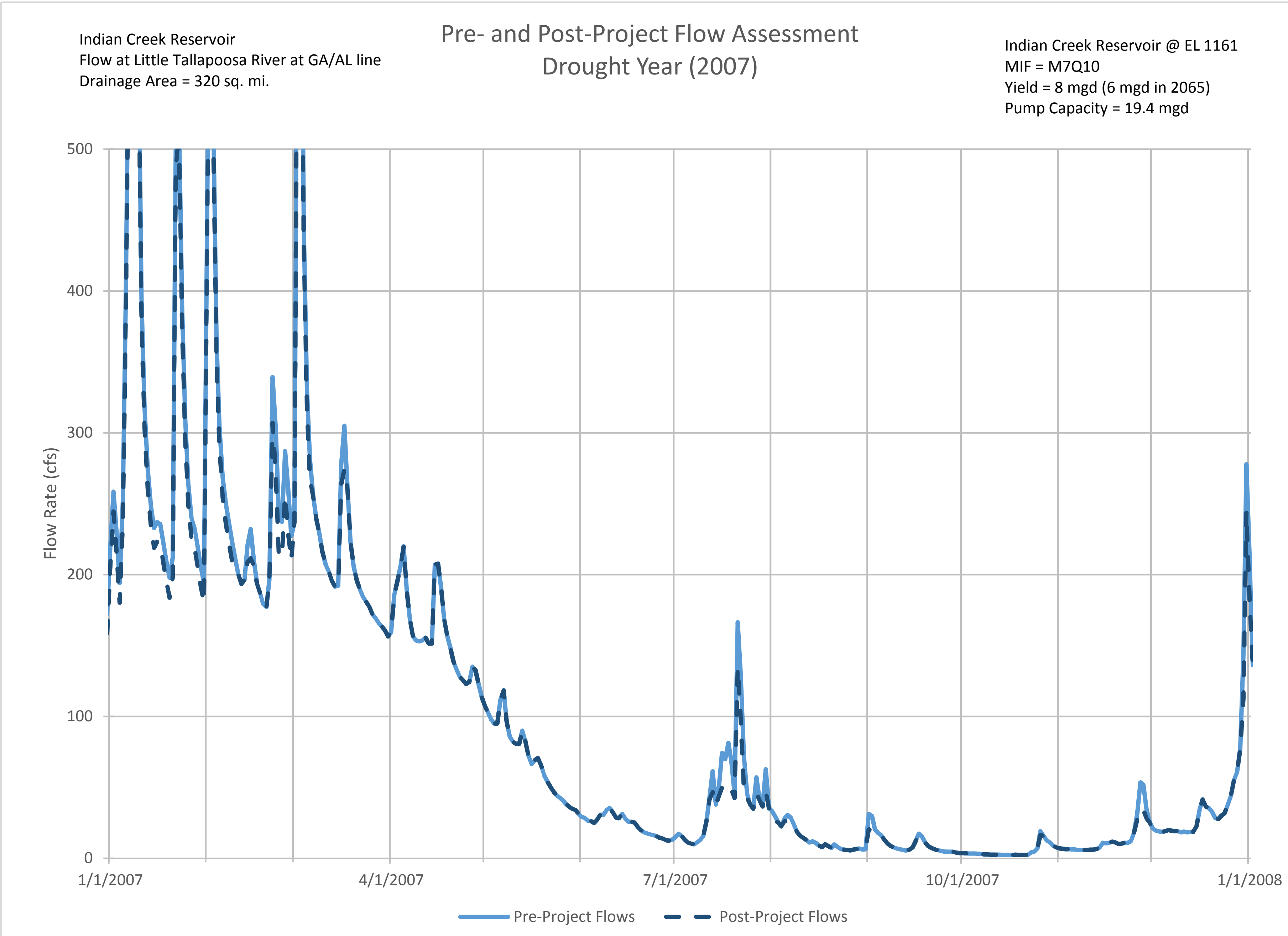
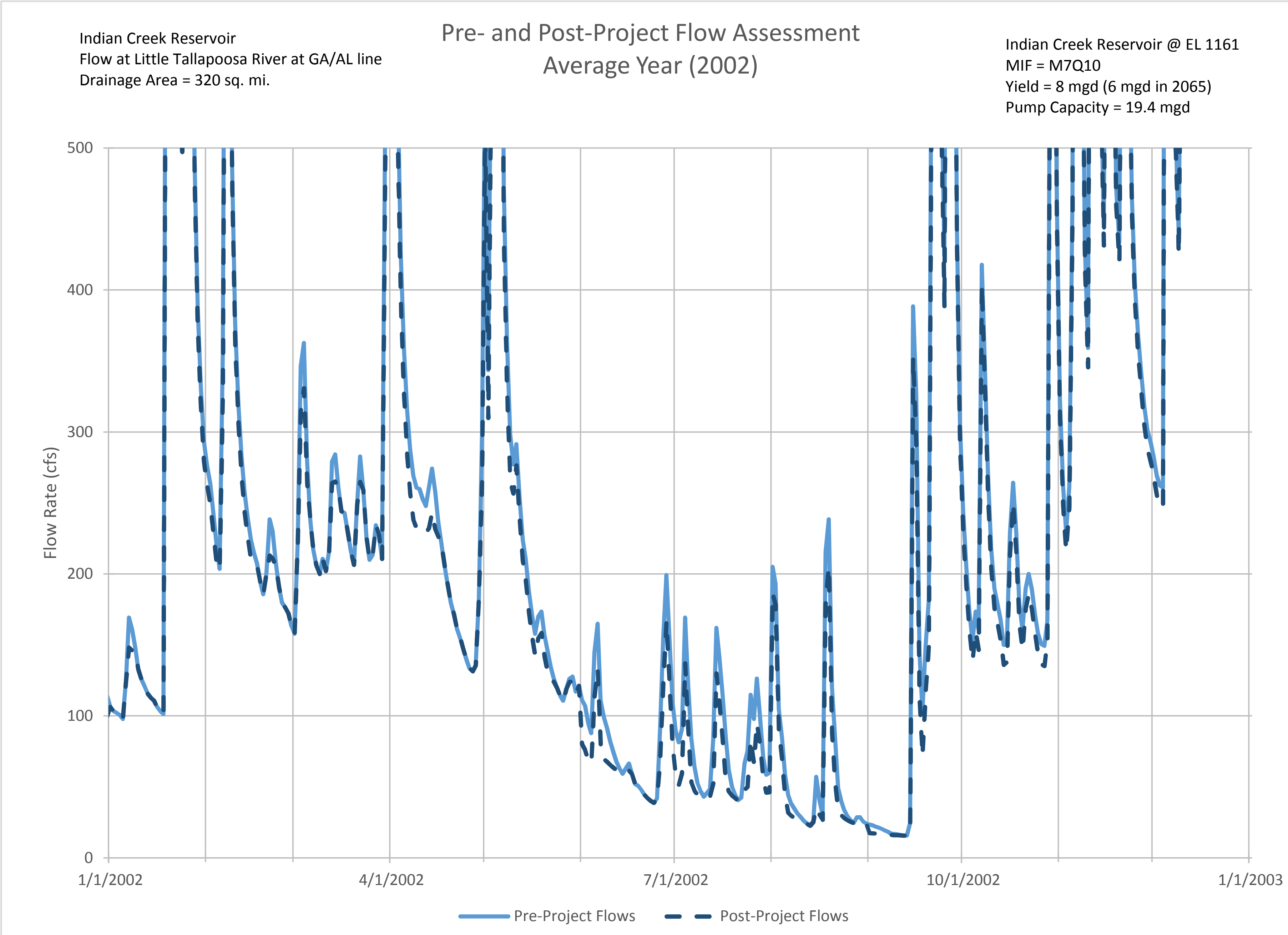
500
400
300
200
100
0
1/1/1979
4/1/1979
7/1/1979
10/1/1979
1/1/1980
Pre-Project Flows
Post-Project Flows



Indian Creek Reservoir
Flow at Little Tallapoosa River at GA/AL line
Drainage Area = 320 sq. mi.
Pre- and Post-Project Flow Assessment
Drought Year (2007)
Indian Creek Reservoir @ EL 1161
MIF = M7Q10
Yield = 8 mgd (6 mgd in 2065)
Pump Capacity = 19.4 mgd
Flow Rate (cfs)
500
400
300
200
100
0
1/1/2007
4/1/2007
7/1/2007
10/1/2007
1/1/2008
Pre-Project Flows
Post-Project Flows



Indian Creek Reservoir
Flow at Little Tallapoosa River at GA/AL line
Drainage Area = 320 sq. mi.
Pre- and Post-Project Flow Assessment
Average Year (2002)
Indian Creek Reservoir @ EL 1161
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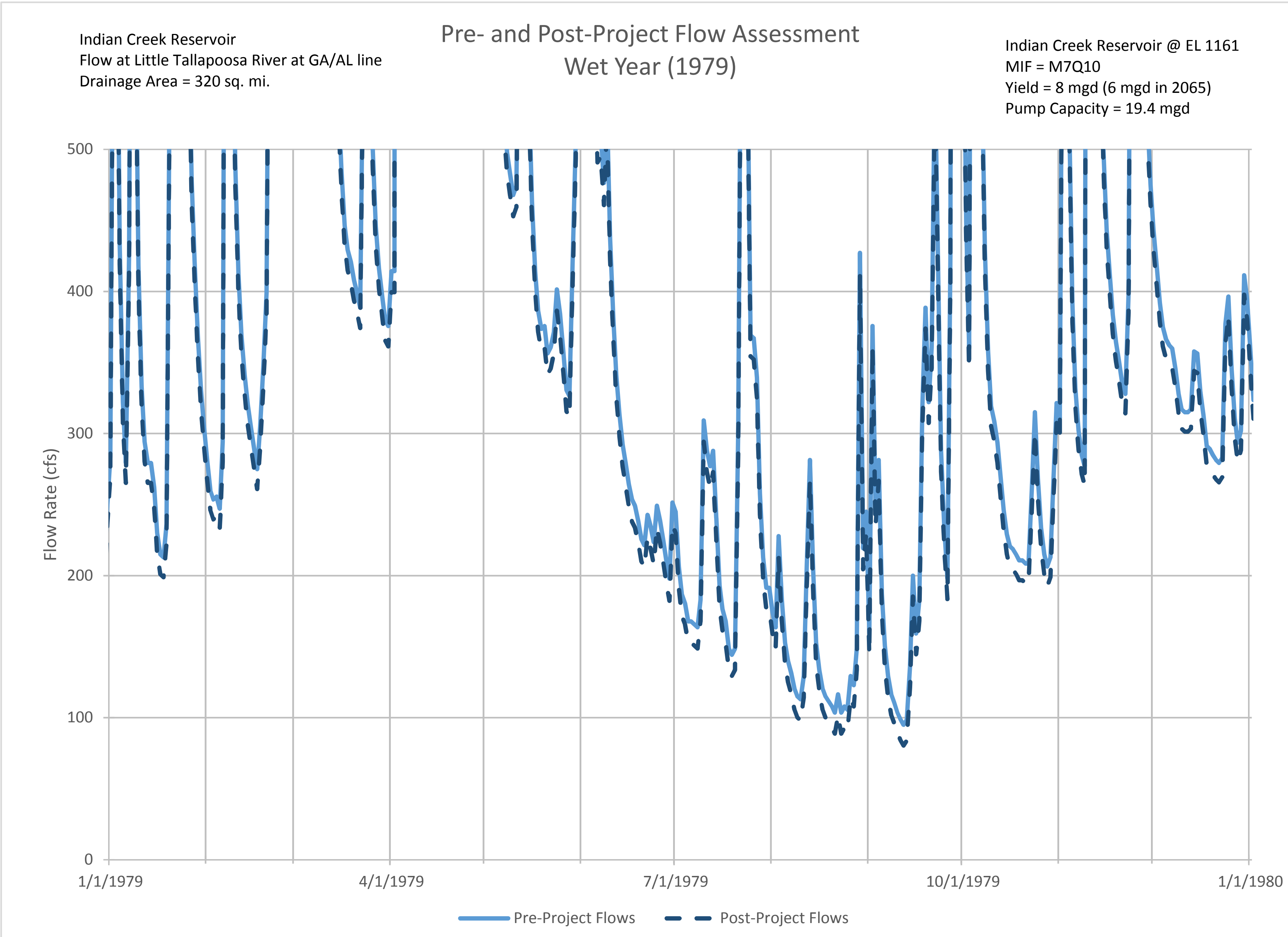
Flow Rate (cfs)
500
400
300
200
100
0
1/1/2002
4/1/2002
7/1/2002
10/1/2002
1/1/2003
Pre-Project Flows
Post-Project Flows



Indian Creek Reservoir
Flow at Little Tallapoosa River at GA/AL line
Drainage Area = 320 sq. mi.
Pre- and Post-Project Flow Assessment
Wet Year (1979)
Indian Creek Reservoir @ EL 1161
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400
300
200
100
0
1/1/1979
4/1/1979
7/1/1979
10/1/1979
1/1/1980
Pre-Project Flows
Post-Project Flows