Relicensing Study 3.3.2

Evaluate Upstream and Downstream Passage of Adult American Shad

ADDENDUM 1

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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LIST OF ABBREVIATIONS

AIC	Akaike information criterion
CRASC	Connecticut River Atlantic Salmon Commission
CRWC	Connecticut River Watershed Council
FERC	Federal Energy Regulatory Commission
FirstLight or FL	FirstLight Hydro Generating Company
h	hour
HR	hazard ratio
LR	likelihood ratio
MADFW	Massachusetts Department of Fisheries and Wildlife
NMFS	National Marine Fisheries Service
MSM	Multi-State Markov model
RM	river mile
RM/h	river mile per hour
TFI	Turners Falls Impoundment
USFWS	United States Fish and Wildlife Service

1 INTRODUCTION

On October 14, 2016, FirstLight (FL) filed with the Federal Energy Regulatory Commission (FERC) Study Report No. 3.3.2 *Evaluate Upstream and Downstream Passage of Adult American Shad.* On October 31 and November 1, 2016, FL held its study report meeting in which Study No. 3.3.2 was discussed on October 31. On January 17, 2017, FL filed its responsiveness summary and agreed to file an addendum (Addendum 1) to the Study No. 3.3.2 report to address the commenters concerns. Section 2 of this addendum includes FL's responses to those items identified in its responsiveness summary.

On February 17, 2017 FERC issued its Determination on Requests for Study Modifications and New Studies. In its Determination FERC addressed the following comments: a) Additional Year of Study, b) Post-Mortality Drift, c) Effects of Flow on Adult Shad Migrating Upstream and d) Autocorrelation of Downstream Movements. In all cases, FERC did not recommend conducting further analysis of these issues.

FL used several statistical analyses to quantify the amount of delay that occurred at different locations within the project area and to identify locations of migratory bottlenecks that prevented some shad from completing their upstream or downstream migration. However, prolonged, intermittent problems with some PIT-tag readers and radio antennas limited the extent of the analyses in certain parts of the project area (e.g., in the bypassed reach and the spillway fish ladder). To address these problems and other stakeholder comments, FirstLight states that it will provide additional analyses and data summaries in an addendum to the study report by April 30, 2017. Since April 30, 2017 falls on a weekend, the addendum was filed with FERC on May 1, 2017.

Due to comments ranging from the simplification of analysis via grouping of receivers into representative reaches rather than receiver - receiver, to the removal of fallback fish and other false positives, and separating fish into their migration and emigration phases, the analyses in this addendum supersedes previous work. Therefore, these statistics are conditional on a fish having been detected within the initial state of the model and that all fish are in the correct migratory phase. Therefore, if the model is assessing migratory movement from the Montague receiver to the Cabot tailrace, a fish must first be detected at Montague (T3) and it must be in its migratory phase. If a fish moved through this region without being detected at Montague, it was not considered for analysis. Further if a fish passed through the Cabot powerhouse during its emigration only to swim back upstream into the tailrace, it was not used in this analysis because the fish was emigrating. FL employed Therneau's (2016) competing risks assessment methods to understand the rates at which animals move from Montague into one of the competing migratory routes. Entrance criteria for the competing risks assessment is stricter than the Multi-State Model (MSM) modeling previously used where fish could start from one of the migratory routes and move into the initial location. Fish must start from the initial state, if a fish was not detected in the initial state, then they were not included in the model. Therefore, the competing risk assessment uses fewer fish. However, appropriate sample sizes remained for calculating the expected number of attempts at each passage route and assessing time-to-event. We have addressed uncertainty with confidence intervals, and/or interquartile ranges when appropriate.

FirstLight organized the addendum per the previous report sections. Often, stakeholder comments prompted a new set of analyses, and rather than answering each individual stakeholder question, the new analysis and report sections are meant to supersede the previous analysis efforts. Therefore, the response section below is organized using report headers from the study report filed with FERC on October 14, 2016.

2 RESPONSES TO STAKEHOLDER COMMENTS

2.1 Glossary

This section addresses the following agency comment: USFWS-1(1)

Attempt: an attempt is any directed movement from one telemetered reach to another

Cormack Jolly Seber: open population mark recapture model that estimates the apparent survival (arrival) rate between telemetered reaches and the recapture rate at a reach. The model uses only live recapture data, therefore survival rate is apparent because we do not know if a fish has died or simply emigrated from the system.

Event: outcome variable in survival analysis, in our application events are movements from one telemetered reach into another. The event-time is the exact moment passage occurs, therefore with Cox proportional hazards we are regressing on the time-to-event and attempting to understand what increases or decreases the rate at which these events occur (hazard rate).

Hazard rate: rate of passage for a fish that has yet to pass a structure at time (t). It is the likelihood that a fish will experience an event at time (t) conditional on surviving until just prior to time (t)

Hazard Ratio: ratio of the hazard rates corresponding to conditions described by two levels of an explanatory variable. Often times the denominator is the baseline hazard rate that occurs at the median covariate value.

Kaplan Meier: non-parametric estimator of the survival function and is simply the number of fish that have yet to pass a structure at time (t) divided by the number of fish that had yet to pass just prior to the time (t).

Nelson Aalen: non-parametric estimator of the cumulative hazard function and estimates the probability of a fish passing into a particular route at the time (t). It is calculated as the number of fish to experience the event at time (t) divided by the number of animals at risk of experiencing the event just prior to time (t) summed over all event times.

Recapture: synonymous with detection, terminology comes from mark recapture literature, and is meant to convey that an animal was detected within a telemetered reach.

Survival: terminology comes from mark recapture theory. In terms of the CJS model , survival is meant to convey the probability that animal will arrive at the next upstream or downstream set of recievers. For the live recapture dead recovery model, survival is the actual survival. In survival analysis (time-to-event) survival refers to the probability that an animal still has yet to pass a structure (see Kaplan Meier).

Transition: in multi-state mark recapture, multi-state Markov, and competing risks analysis, transition simply means to move from one state to another. In terms of telemetry, it is simply directed movement from one telemetered reach to the next.

2.2 False Positive Reduction

This section addresses the following agency comments: USFWS-11 and USFWS-12

FirstLight developed a query that counted the number of detections per receiver. This query identified fish with sparse detection histories, which could indicate false positives. Fish that were detected at four or fewer receivers were further analyzed. FirstLight found false positives associated with KA-SHD-0006, KA-SHD-0018, KA-SHD-0021, KA-SHD-0080, KA-SHD-0176, KA-SHD-0178, KA-SHD-0530, KA-SHD-0543, KA-SHD-0545, KA-SHD-0763, KA-SHD-0806, NA-SHD-0959, and NA-SHD-1025. FirstLight also identified hits from KA-SHD-0163 at T19 (spillway) as false positive. FirstLight also identified and removed 'cross-chatter' where a fish makes rapid transitions between receivers and appears to be in two locations at once. This occurred between the impoundment and the intake. FirstLight has removed detections from these fish from the recaptures database.

2.3 Assessment of Dual vs PIT Tag Only Performance

This response addresses the whole or part of the following agency comments: CRWC-1(2), CRWC-10, MADFW-3, USFWS-15(1), USFWS-16, USFWS-21

FL assessed the performance of dual and PIT tagged only fish using two different methods. The first compared the proportion of fish expected to arrive at the next subsequent upstream PIT array using a CJS model, and the second used a test of proportions to assess survival within each ladder. The CJS model found that PIT tagged only fish were expected to arrive at the first PIT array at a proportion of 0.34 (0.28, 0.41) vs 0.27 (0.23, 0.31) for dual tagged fish (Table 2.3-1). Recapture probabilities are shown in Table 2.3-2. There was no difference between the proportions expected to arrive at the next subsequent PIT array (Gatehouse Ladder).

The second method assessed the proportion of fish entering versus exiting project areas with a simple test of proportions. We calculated confidence intervals using a normal approximation to the binomial, compared proportions and confidence intervals of Dual vs PIT, then performed a 2-sample test for equality of proportions with continuity correction in R using a two-sided alternative hypothesis. For project arrival, the denominator included all released fish from Holyoke while the numerator was the number that arrived at either the Cabot Ladder or Spillway Ladder. Out of 215 dual tagged fish, 50 arrived at one of the two ladders (23.3%) while out of 218 PIT tagged only fish, 67 arrived at one of the two ladders (30.7%). The results of test were significant ($p = 0.01$), PIT tagged only fish arrived in greater proportions to the ladders from Holyoke. For Cabot Ladder, while PIT tagged fish had a larger proportion of successful passage (0.17 v 0.13), the confidence intervals demonstrated a large amount of overlap (Table 2.3-3). The passage rate for dual tagged shad was 0.13 (0.03-0.23) and the passage rate for PIT tagged only fish was 0.17 (0.08-0.27). Out of 45 dual tagged fish, 6 successfully passed (19.8%) while out of 58 pit tagged only fish, 10 successfully passed (17.2%). However, the results of test were not significant ($p = 0.788$), there was no difference between proportions. For the Spillway Ladder, out of 11 dual tagged fish entering, 5 successfully passed (45.5%) while 11 of the 24 PIT tagged only fish entering successfully passed (45.8%). The results of test were not significant ($p = 1$), meaning there was no difference between proportions. For Canal Passage, out of 56 dual tagged fish, 14 made it to Gatehouse (25%) while out of 60 PIT tagged only fish, 35 made it to gatehouse (58%). The results of test were significant ($p < 0.001$), PIT tagged only fish arrived in greater proportions. For the Gatehouse Ladder, out of 19 dual tagged fish, 16 successfully passed (0.84) and out of 46 PIT tagged only fish, 42 successfully passed (0.91). The results of test were not significant ($p = 0.6897$), meaning there was no difference in performance of tags.

We should expect differences in performance of PIT vs Dual tagged fish up until the initial recapture location as evident with significant results for fish released from Holyoke and arriving at the first set of ladders, and for Cabot Canal as they arrive at the Gatehouse Ladder. However, by the time they make it to the ladders, the fish that would have dropped out due to handling and tagging stress have already done so, and the fish that are minimally affected are still making attempts. Once in the ladders, the performance between fish tagged with the two methods does not appear to differ. While PIT tagged only fish had greater proportions passing the ladders, they were not significantly different. There is an initial tagging and handling effect, but by the time fish arrive at the ladders and use them, there appears to be no difference in the performance of fish.

Table 2.3-1: Survival (Arrival) estimates for dual and PIT tagged only fish released at Holyoke.

Tag Plan	Parameter	Φ	SE	Lower	Upper
Dual	Release – 1st ladder	0.27	0.02	0.23	0.31
	1st ladder – Gatehouse ladder	0.26	0.04	0.19	0.35
	Gatehouse Ladder - Vernon	0.71	67.66	0.00	1.00
PIT only	Release – 1st ladder	0.34	0.03	0.28	0.41
	1st ladder – Gatehouse ladder	0.28	0.05	0.19	0.39
	Gatehouse Ladder - Vernon	0.62	55.35	0.00	1.00

Table 2.3-2: Recapture estimates for dual and PIT tagged only fish released at Holyoke.

Tag Plan	Parameter	p	SE	Lower	Upper
Dual	1st ladder	1.00	0.00	1.00	1.00
	Gatehouse ladder	1.00	0.00	1.00	1.00
	Vernon	0.71	67.65	0.00	1.00
PIT Only	1st ladder	1.00	0.00	0.00	1.00
	Gatehouse ladder	1.00	0.00	1.00	1.00
	Vernon	0.62	55.35	0.00	1.00

Table 2.3-3: Comparison of passage efficiencies between dual and PIT tagged only fish.

Reach	PIT Passage Efficiency (%)	Dual Passage Efficiency (%)	P
Holyoke- Project	23.3 (17.6-28.9)	30.7(24.6-36.9)	0.01
Cabot Ladder	17.2 (7.5-27.0)	13.3 (3.4-23.3)	0.79
Spillway Ladder	45.8 (25.9-65.8)	45.5 (16.0-74.9	1
Canal - Gatehouse	58.3 (45.9-70.8)	25.0 (13.7-36.3)	<0.001
Gatehouse Ladder	91.3 (83.2-99.4)	84.2 (60.6-97.3)	0.69

2.4 Assessment of Fallback

This section addresses the following agency comments: *CRWC-16(3), MADFW-5(1), USFWS-1(3&4), USFWS-7(1), USFWS-22(5), USFWS-26(4)*

Fish that exhibit irregular downstream movement after tagging and release are considered fallback fish (Frank et al. 2009). The behavior of these fish may indicate potential adverse effects from handling and tagging, therefore these fish were removed from all upstream migration analyses. Fallback fish were identified differently for each release cohort. Fish that were released at Holyoke and were not detected at any upstream telemetry stations were identified as fallback fish. Fish that were released in the Canal and were detected anywhere in the Bypass Reach, Cabot Tailrace, or any other downstream stations before being detected at stations upstream of their release site in the canal were identified as fallback fish. Fish that were released in TFI and were detected anywhere in the Canal or downstream of Turners Falls Dam before being detected at or upstream of Gill Bank were identified as fallback fish. Figure 2.4-1 shows an example of an impoundment-released fish identified as a fallback fish. Approximately 47% of Holyoke-released shad, 26% of Canal-released shad, and 66% of Impoundment-released shad were identified as fallback fish (Table 2.4-1). Although all fallback fish were removed from upstream analyses, fallback fish that were not detected downstream of their release site until at least 24 hours after their release were included in downstream analyses (*Pugh, Personal Comm.*).

Table 2.4-1: Fallback fish by release cohort.

Release Site	Total Number of Fish Released	Number of Fallback Fish	Percent Fallback
Holyoke	433	203	47%
Canal	100	26	26%
Impoundment	260	171	66%

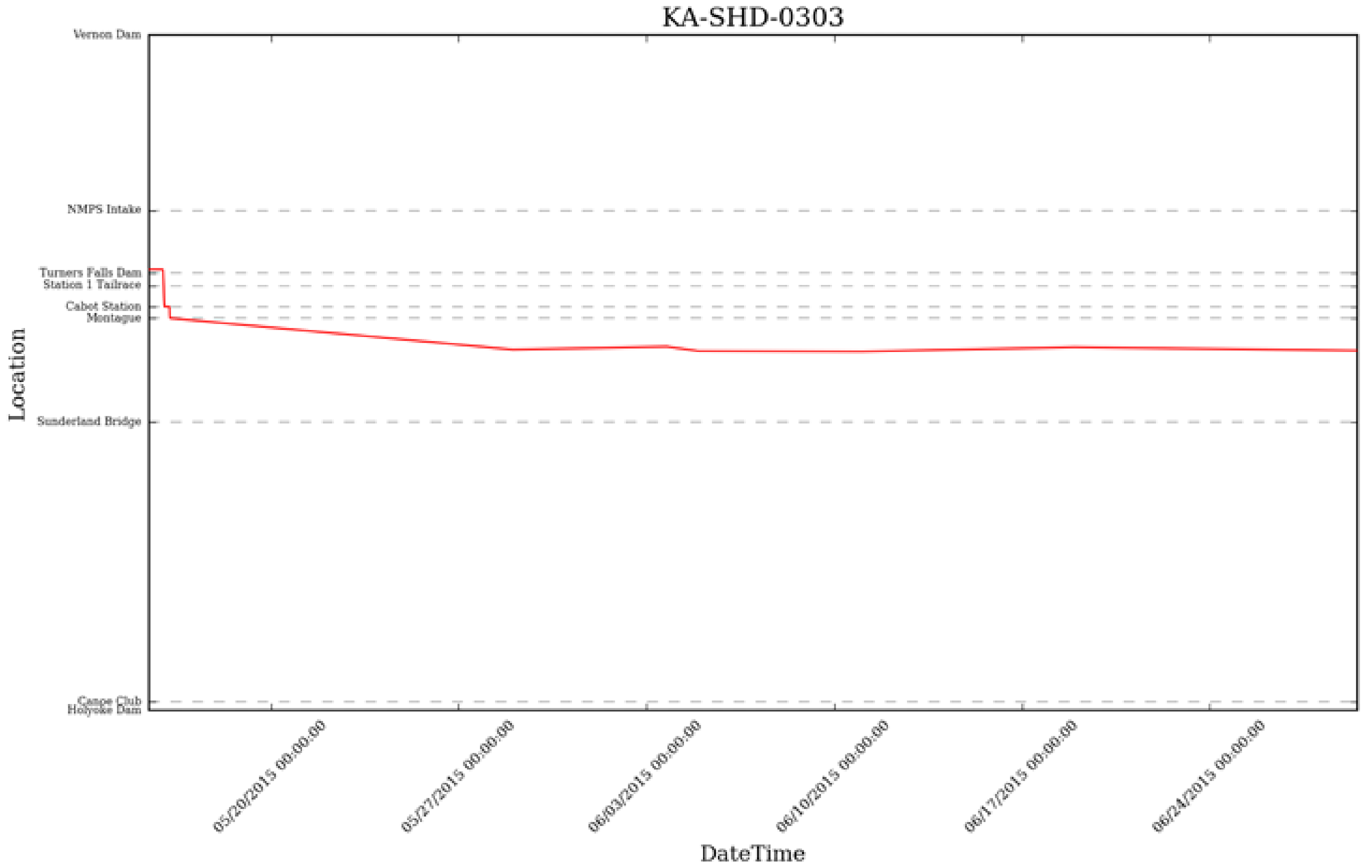


Figure 2.4-1: 2D detection history of a fallback fish released in TFI. Within hours of its release, the fish moved out of TFI, through the Canal, into Cabot Tailrace, and finally into the Deerfield River.

2.5 Assessment of Tag Loss

This section addresses the following agency comments: USFWS-7(2)

FirstLight developed a two-part MS Access query to quantify tag loss of dual-tagged Holyoke-released fish. In the first part, a crosstab query counted the number of detections at each receiver type (radio vs. PIT) by fish. The second part of the query identified the dual-tagged fish that were detected at PIT receivers without being detected at any radio receiver during the study period. The query identified two of the 164 non-fallback fish released at Holyoke as fish that instantaneously lost their tags. Both fish had strong detections at the Cabot Ladder entrance PIT stations (33 and 38 detections) without any detections at radio stations leading up to the project from their release site at Holyoke Dam. A QAQC procedure using the 2D detection history plots revealed that KA-SHD-0519 was indeed only detected at the Cabot Ladder entrance (Figure 2.5-1), however KA-SHD-0003 was also detected during mobile tracking upstream of Redcliff Canoe Club (Figure 2.5-2). It is likely that KA-SHD-0003 shed its tag early during its upstream migration and that mobile detections only represent the location of the shed tag, not the fish itself.

Because not all fish reached the project area and tag loss may not have been instantaneous, FirstLight developed a series of follow up queries to identify fish that may have lost their as they moved up in the system. For each point of interest, the original two-part query was modified to remove all detections from receivers downstream of that location (Table 2.5-1). In this way, only fish that were confirmed to have reached at least the point of interest would be in the analysis pool for that location. The downstream-most PIT receiver was located at the Cabot Ladder Entrance, therefore the most complete estimate of tag loss for fish in this study, approximately 2%, was derived from the pool of fish that were recaptured at least as far upstream as Cabot Tailrace (Table 2.5-1). Aside from the two fish that lost their tags instantaneously after release at Holyoke, only one other fish was deemed to have lost its tag during the study. KA-SHD-0166 ascended Cabot Ladder and then Gatehouse Ladder, but there were no records for the fish as it passed through radio stations in the Canal.

Table 2.5-1: Tag loss as calculated from Holyoke-released shad.

Area of Interest	Stations Removed	Number of Fish Recaptured at or Above Area of Interest	Number of Fish with Lost Radio Tags	Percent Tag Loss
Overall	None	164	2*	1.2%
Project	T1, T2	109	2*	1.8%
Cabot Tailrace	T1, T2, T3, T33	106	2*	1.9%
Canal	T1, T2, T3, T33, T11, T5, T6, T11, T29, T7, T15, T12E, T12W, T16, T19, T20, T30, P21, P22, P23SL, P23TP, P24, P25, P111, P112	35	1	2.9%
Bypass	T1, T2, T3, T33, T11, T5, T6, T29, T7, T8, T9, T14, T13, T18, T21, T22, P12, P111, P112	58	0	0

*The same two fish were identified as having lost tags in the Overall, Project, and Cabot Tailrace queries.

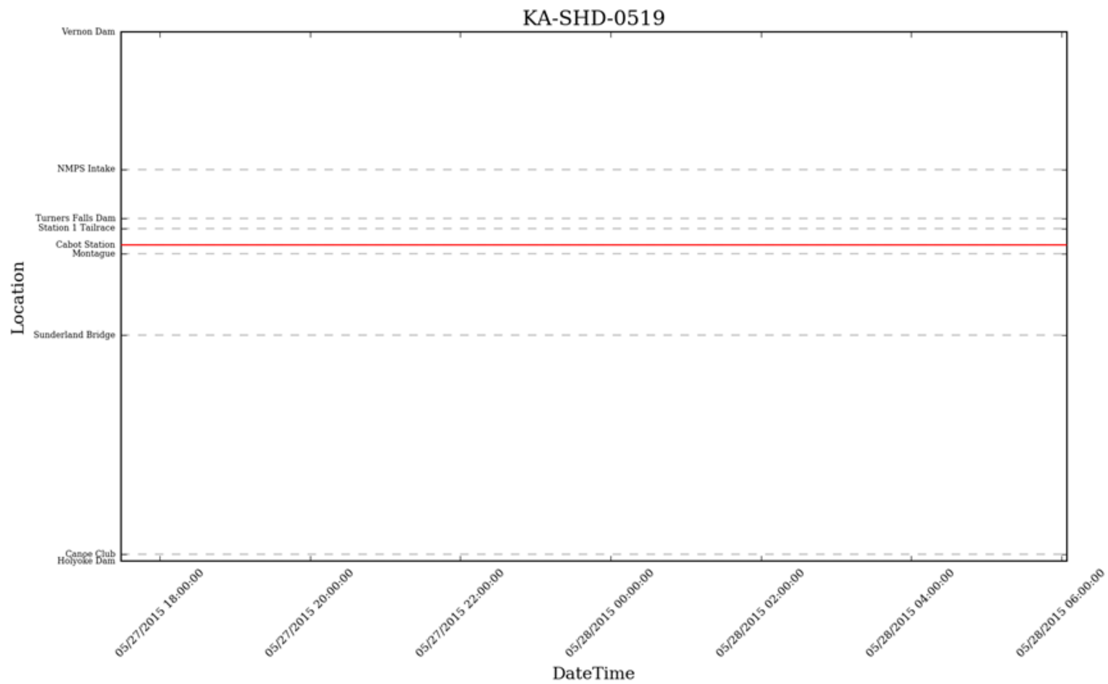


Figure 2.5-1: 2D Plot of KA-SHD-0519's detection history.

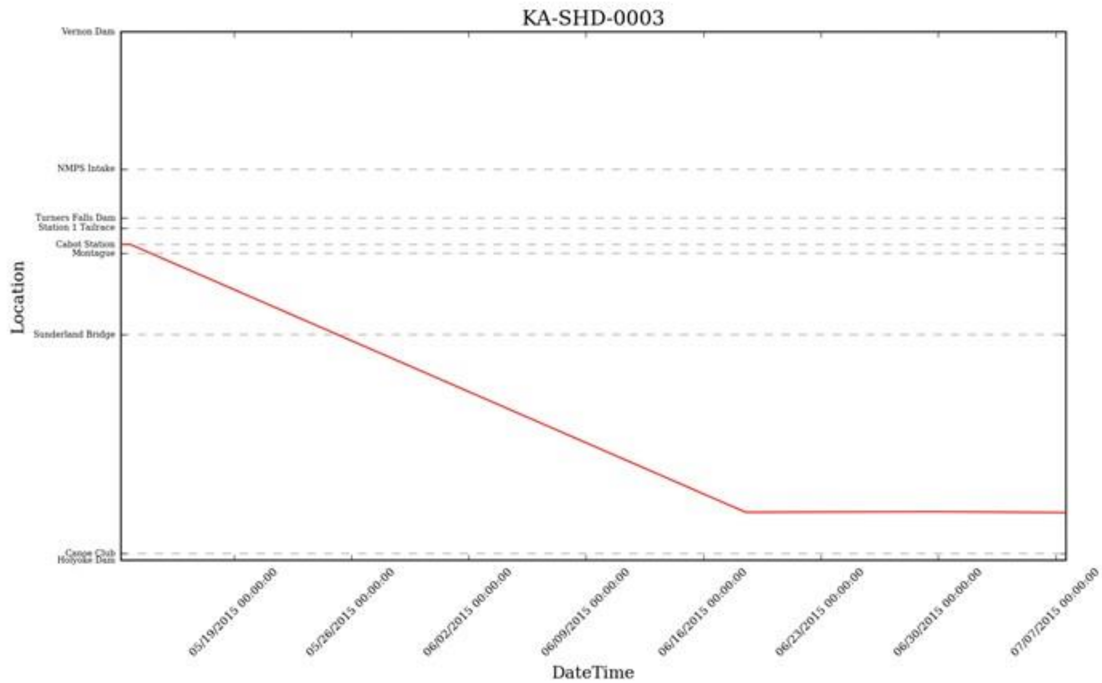


Figure 2.5-2: 2D Plot of KA-SHD-0003's detection history.

2.6 Assessment of Mortality

This section addresses the following agency comments: CRWC-4(1&2). USFWS-1(6), USFWS-10(1&2), USFWS-23(3), USFWS-24(3), USFWS-26(3)

FirstLight assessed mortality using simple counts and proportions as well as a live recapture dead recovery mark-recapture model that assesses true rather than apparent mortality. Prior to quantifying these rates, fish must be either classified into alive or dead status.

The radio tags used in this study were equipped with a mortality sensor. Active tags on live fish were set to pulse every 2 seconds, however if the tags remained stationary for more than 24 hours, a mortality sensor was engaged, reducing the tag pulse rate to once every 11 seconds. Fish that died near Orion receivers showed a clear transition between live and mortality pulse rates (Figure 2.6-1). Unlike Orion receivers, Lotek receivers are not able to monitor multiple frequencies at once, therefore they must scan through each channel individually. In this study, Lotek receivers were set with a scan time of 2.2 seconds per frequency to ensure that all live fish within detection range of each receiver would be detected at least once per scan cycle. Unfortunately, with 5 study frequencies, each channel was only monitored for 2.2 seconds of every 11 second cycle (Table 2.6-1). This lead to irregular detection lags, making it is impossible to reliably differentiate between live and dead detections on these units (Figure 2.6-2). Fish that died outside of the range of Orion receivers, but in the study area, could have been identified during mobile tracking surveys. Mobile tracking was not conducted in the upper Bypass Reach, however some fish remained in the range of Lotek receivers located below Turners Falls Dam for several weeks after passing via spill. Fish emigrating from the study area generally did so over the period of a few days, therefore fish that remained below the dam for several weeks after downstream passage were determined to have died as they transitioned over the dam. FirstLight considered all detections after a fish's first mortality detection to be mortality detections and were removed from competing risks analysis and from the CJS models.

FirstLight classified all migration mortalities as those fish that were found dead during mobile tracking further upstream than the most upstream stationary receiver. If a fish was detected with a mortality signal during mobile tracking downstream of the upstream most stationary receiver, than the fish died during emigration. If a fish with a mortality signal was found at a stationary downstream of the most upstream stationary receiver, than it died during emigration. FirstLight found most of the moralities occur during emigration, with the most attrition occurring within the Project to Holyoke reach. Mortalities from the Holyoke release cohort could include fish that did not pass the Turners Falls Project yet died during their emigration, however mortalities from the Canal and Impoundment release cohorts within this reach reflect mortalities after downstream passage. Thus, downstream passage may be responsible for upwards of 31% (15/49) and 17% (15/89) of the mortality from these two release cohorts (Table 2.6-2). A complete history on each fish mortality can be found in Table 2.6-3.

To assess for mortality of a fish after passing a structure, FirstLight used a live recaptures dead recovery mark recapture model. Live recapture information came from alive recaptures at telemetry receivers, while dead recoveries came from dead mobile tracking events. This type of modeling differs from the classic CJS model because it incorporates direct mortality information, thus we have a true estimate of survival rather than an apparent rate of survival. This is because the CJS model does not know that a fish has died, it only knows that it was not recaptured at a telemetry station. Emigrating fish passing through the Cabot Powerhouse or sluiceway were assessed in this manner because the mobile tracking survey sampled up to the Cabot Tailrace area. For survival through the powerhouse, 100% of the shad passing through the powerhouse were detected, and none were found dead in tailrace. However, this survival rate drops to 80% to Montague and 47% between Montague and the Lower River. Sluiceway survival was not better, with 97% of the fish expected to survive immediate passage into the tailrace, 75% expected to survive to Montague and only 46% are expected to survive to the lower river. The limitation that exists at the last recapture occasion with the CJS still exists at the last recapture occasion in the live recapture dead recovery model. We cannot differentiate between survival and recapture at the last station. If a fish was not detected at a telemetry receiver, nor was it detected during mobile tracking we do not know its fate. Therefore, one should exercise caution while interpreting the results of the last survival estimate. While immediate mortality through either route was low, latent mortality occurred within the tailrace – Montague reach. It should be noted that a certain degree of latent mortality would also be expected post-migration and after spawning, due to depletion of an individual fish's energy reserves. Unfortunately, mobile tracking was not conducted in the bypass reach, so the best estimate of mortality for fish that pass via bascule gates and into the bypass reach comes from the overall downstream passage model. Here, 80.7% of the fish known to pass downstream via the bypass reach are expected to arrive at the Cabot tailrace. That aside, the survival estimate generated by the live recapture dead recovery model at the first recapture station (immediate downstream passage survival) are in line with the raw proportions by release cohorts. The median raw mortality rate within the Project to Holyoke reach ((0.31 + 0.17)/2) ~ 24% validates the mark recapture estimate of survival to Montague 0.20 (1-0.80) and 0.25 (1 – 0.75) for the powerhouse and sluiceway respectively.

Table 2.6-1: Monitoring period for each study frequency within the 11 second channel cycle of Lotek receivers.

Frequency	Range of Seconds
149.740	0 - 2.2
149.780	2.2 - 4.4
149.800	4.4 - 6.6
150.440	6.6 - 8.8
150.540	8.8 - 11

Table 2.6-2: Counts of mortalities by reach and release cohort. Fall back fish may contain those released into the canal or impoundment that fell back immediately upon release.

Phase	n	Release Location	Number of Mortalities by Reach			
			Holyoke to Project	Project to Bypass	Canal	TFI
Migration	155	Holyoke	2	0	0	0
	49	Canal	0	0	0	0
	89	Impoundment	0	0	0	4
Emigration	155	Holyoke	19	2	1	2
	49	Canal	15	8	2	1
	89	Impoundment	15	12	4	15
Fallback	104	All	12	4	1	2

Table 2.6-3: Summary of shad mortality as detected by fixed monitoring stations.

Fish ID	Release Location	Release Date	Date/Time of Death	Station of Death	Reach of Death	History
KA-0065	Holyoke	5/6/2015	6/12/2015 2:55	T8	Cabot Forebay	Through Cabot Ladder (5/16/2015 9:38:47 PM), up canal as far as T18, back to forebay and died
KA-0166	Holyoke	5/12/2015	5/29/2015 11:39	T12E	Lower Bypass	Made it to Cabot Ladder (5/16/2015 12:55:31 PM) and Gatehouse Ladder (5/22/2015 3:30:31 PM), did not pass but up to P33, back to bypass and died
KA-0244	Cabot	5/13/2015	5/31/2015 6:39	T5	Cabot Tailrace	Made it as far as T18, back down to forebay for some time, through bypass sluice and died in Tailrace
KA-0245	Cabot	5/13/2015	5/20/2015 13:48	T8	Cabot Forebay	Never moved out of the Forebay (only nosed up to T14)
KA-0295	TFI	5/15/2015	6/1/2015 19:06	T11	Lower Bypass	Moved up to Gill, back down and over the Dam, down to Cabot Tailrace, back to Lower Bypass and died
KA-0323	TFI	5/15/2015	6/10/2015 10:17	T13	Canal	Made it to Shearer Farm, down into Canal, died in lower canal before Forebay
KA-0354	TFI	5/16/2015	6/20/2015 3:48	T8	Cabot Forebay	Made it to Shearer Farm, down into Canal, died in Cabot Forebay
KA-0359	TFI	5/16/2015	6/5/2015 3:18	T5	Cabot Tailrace	Made it to Shearer Farm, down into Canal, possibly through station 1 and died in Cabot Tailrace
KA-0369	TFI	5/16/2015	6/6/2015 3:21	T5	Cabot Tailrace	Made it to Shearer Farm, down into Canal (6/5/2015 10:10:48 AM), through the bypass sluice (6/6/2015 3:18:46 AM) and died in the Cabot Tailrace
KA-0372	TFI	5/16/2015	6/13/2015 21:12	T2	Downstream	Made it to Shearer Farm, down into Canal, through Powerhouse, to Montague and died in Sunderland
KA-0373	TFI	5/16/2015	6/11/2015 12:33	T8	Cabot Forebay	Made it to Shearer Farm, down into canal (6/11/2015 11:53:11 AM), and died in the Cabot Forebay
KA-0378	TFI	5/16/2015	6/6/2015 7:43	T5	Cabot Tailrace	Made it to Shearer Farm, passed down over the dam (6/1/2015 5:46:32 PM), and moved into the Cabot Tailrace where it died
KA-0379	TFI	5/16/2015	6/10/2015 8:45	T6	Cabot Tailrace	Made it to Shearer Farm, down into the canal, through the bypass sluice, down to Montague and back to Cabot Tailrace where it died
KA-0383	TFI	5/16/2015	6/3/2015 16:31	T12E	Lower Bypass	Made it up to Shearer Farm, passed down over the dam, and died in the Lower Bypass
KA-0539	Holyoke	5/19/2015	6/11/2015 8:32	T1	Downstream	Made it to Sunderland, moved back to Canoe Club where it died
KA-0601	Cabot	5/19/2015	6/23/2015 11:16	T5	Cabot Tailrace	Never made it out of the canal, only as far as T13, died in the Cabot Tailrace
KA-0607	Cabot	5/19/2015	5/30/2015 14:47	T5	Cabot Tailrace	Never made it out of the canal, only as far as T13, died in the Cabot Tailrace

Fish ID	Release Location	Release Date	Date/Time of Death	Station of Death	Reach of Death	History
KA-0614	Cabot	5/19/2015	6/10/2015 8:49	T5	Cabot Tailrace	Made it through canal into TFI, up to Shearer Farm, back into the Canal and through Cabot where it died in the Tailrace immediate after passage
KA-0624	Cabot	5/19/2015	5/23/2015 10:47	T8	Cabot Forebay	Never made it out of the canal, stayed in lower portion, mostly Cabot Forebay where it died
KA-0628	TFI	5/22/2015	6/2/2015 0:02	T20	Upper Bypass	Never made it passed Boat Barrier, fell over the dam and died in the Spillway
KA-0654	TFI	5/22/2015	6/2/2015 0:10	T20	Upper Bypass	Never made it passed Boat Barrier, fell over the dam and died in the Spillway
KA-0692	TFI	5/23/2015	6/14/2015 4:02	T5	Cabot Tailrace	Never moved up passed T23, dropped over the dam and moved into Cabot Tailrace where it died
KA-0708	TFI	5/23/2015	6/2/2015 2:11	T8	Cabot Forebay	Made it to Shearer Farms, passed back down through the Canal and died in the Cabot Forebay
KA-0719	TFI	5/23/2015	5/28/2015 6:26	T21	Canal	Did not move upstream of release, back through the Canal where it died
NA-0450	TFI	5/28/2015	6/13/2015 3:46	T21	Canal	Made it to mid-canal where it died
NA-0453	TFI	5/28/2015	6/20/2015 19:27	T25	NFM Intake	Moved down from Shearer and died in the Intake
NA-0903	Northfield Boat Ramp	5/10/2015	5/13/2015 3:31	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-0908	Northfield Boat Ramp	5/10/2015	5/13/2015 11:23	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-0910	Northfield Boat Ramp	5/10/2015	6/13/2015 1:33	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-0914	Northfield Boat Ramp	5/10/2015	5/17/2015 11:46	T9	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-0918	Northfield Boat Ramp	5/10/2015	6/8/2015 12:01	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-0920	Northfield Boat Ramp	5/10/2015	5/14/2015 6:40	T9	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-0950	Northfield Boat Ramp	5/14/2015	5/23/2015 16:54	T21	Canal	Moved down into Canal where it died
NA-1011	Brattleboro	5/24/2015	6/23/2015 20:08	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-1013	Brattleboro	5/24/2015	6/10/2015 12:12	T12E	Lower Bypass	Moved down over the Dam and died in the Lower Bypass

Fish ID	Release Location	Release Date	Date/Time of Death	Station of Death	Reach of Death	History
NA-1017	Brattleboro	5/24/2015	6/11/2015 6:49	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-1024	Northfield	5/28/2015	6/11/2015 22:21	T8	Cabot Forebay	Moved down into Canal and died in the Cabot Forebay
NA-1027	Northfield	5/28/2015	7/11/2015 13:40	T22	Canal	Moved down into Canal where it died

ReceiverID	timeStamp	UniversalID	Reach	lag	Mortality
T8	5/23/2015 10:46:26 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:46:28 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:46:30 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:46:32 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:46:34 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:46:37 AM	KA-SHD-0624	Cabot Forebay	3	
T8	5/23/2015 10:46:47 AM	KA-SHD-0624	Cabot Forebay	10	
T8	5/23/2015 10:46:49 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:46:57 AM	KA-SHD-0624	Cabot Forebay	8	
T8	5/23/2015 10:46:59 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:47:01 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:47:03 AM	KA-SHD-0624	Cabot Forebay	2	
T8	5/23/2015 10:47:14 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:47:25 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:47:36 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:47:58 AM	KA-SHD-0624	Cabot Forebay	22	1
T8	5/23/2015 10:48:09 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:48:20 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:48:31 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:48:42 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:48:53 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:49:04 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:49:15 AM	KA-SHD-0624	Cabot Forebay	11	1
T8	5/23/2015 10:49:26 AM	KA-SHD-0624	Cabot Forebay	11	1

Figure 2.6-1: Screenshot of a tag (Fish ID KA-SHD-0624) displaying a typical transition from a live signal to a mortality signal.

Above the red line are the relatively consistent 2 second lags of a tag emitting a live signal, while below the red line are the 11 second lags of a tag emitting a mortality signal.

ReceiverID	timeStamp	Reach	lag
T6	5/11/2015 7:19:33 PM	Cabot Powerhc	10
T6	5/11/2015 7:19:44 PM	Cabot Powerhc	11
T6	5/11/2015 7:19:56 PM	Cabot Powerhc	12
T6	5/11/2015 7:20:06 PM	Cabot Powerhc	10
T6	5/11/2015 7:20:39 PM	Cabot Powerhc	33
T6	5/11/2015 7:20:50 PM	Cabot Powerhc	11
T6	5/11/2015 7:21:01 PM	Cabot Powerhc	11
T6	5/11/2015 7:21:11 PM	Cabot Powerhc	10
T6	5/11/2015 7:21:24 PM	Cabot Powerhc	13
T6	5/11/2015 7:21:36 PM	Cabot Powerhc	12
T6	5/11/2015 7:21:45 PM	Cabot Powerhc	9
T6	5/11/2015 7:21:57 PM	Cabot Powerhc	12
T6	5/11/2015 7:22:19 PM	Cabot Powerhc	22
T6	5/11/2015 7:22:30 PM	Cabot Powerhc	11
T6	5/11/2015 7:22:52 PM	Cabot Powerhc	22
T6	5/11/2015 7:23:13 PM	Cabot Powerhc	21
T6	5/11/2015 7:23:24 PM	Cabot Powerhc	11
T6	5/11/2015 7:23:36 PM	Cabot Powerhc	12
T6	5/11/2015 7:23:58 PM	Cabot Powerhc	22
T6	5/11/2015 7:24:08 PM	Cabot Powerhc	10

Figure 2.6-2: Screenshot of a typical series of irregular lags exhibited by detections of live a fish at a Lotek receiver.

2.7 Classifying Fish into the Migration and Emigration Phase

FirstLight classified each detection as belonging to either the migration or emigration phase. To accomplish this, FL used a combination of GIS techniques and MS Access queries. The approximate distance from the mouth of the Connecticut River to each fixed telemetry station was calculated in RKM using ArcGIS's linear referencing toolset. Linear referencing is a method for referencing the relative location of features along a line, in this case the National Hydrography Dataset (NHD) flowline for the Connecticut River. Receiver positions were assigned the distance of their closest point along the NHD flowline (Table 2.7-1). The same procedure was used to calculate distances for individual mobile tracking observations. Then, a series of MS Access queries were developed to identify the maximum upstream distance of each fish using a combination of fixed station and mobile tracking data that linked each detection with a receiver and its related river distance measurement. First, an aggregate query identified the maximum upstream distance for each fish recorded in the fixed-station recaptures dataset. A similar query identified the maximum upstream distance for each fish observed during mobile tracking. The two queries were combined via union. Then, a final aggregate query found the maximum upstream distance for each fish. The average migration distance from Holyoke was 43.51 RKM for dual-tagged Holyoke-released fish (Figure 2.7-1), 3.71 RKM for dual-tagged Cabot-released fish (Figure 2.7-2), and 11.15 RKM for dual-tagged impoundment-released fish (Figure 2.7-3). All detections leading up to and including the last detection at each fish's upstream-most location were used in the migration analyses. All subsequent detections were used in the emigration analyses.

FirstLight assessed the point of turn around with the Optimized Hotspot Analysis tool in ArcGIS to determine if there were any hotspots where Holyoke-released shad reached their migration limits. The Optimized Hotstpot Analysis tool requires a certain degree of spatial variation between point locations in order to compute hot and cold spots. Many fixed telemetry stations represented the upstream migration limits of two or more shad, therefore FirstLight used the RANDBETWEEN function in Microsoft Excel to randomly move the location of each fish's migration limit up to +/-200ft in both x and y space. Despite the forced randomization, there was still not enough spatial variation in migration limits to compute hot and cold spots with the Optimized Hotspot Analysis tool. It appears as though congregations of upstream limits exist at the tailrace, within the bypass reach, at the spillway and within the canal. Figure 2.7-4 shows the randomized turn around locations of all Holyoke-released shad.

Table 2.7-1: Mainstem Connecticut River receiver distances from Long Island Sound calculated using the Linear Referencing toolset in ArcGIS.

Station	Reciever ID	Distance (RKM)
Redcliffe Canoe Club	T1	137.42
Sunderland Bridge	T2	176.1
Montague Wastewater	T3	190.47
Smead Island	T11	191.61
Cabot Tailrace	T5	191.98
Cabot Farfield	T6	192.08
Conte Discharge	T15	192.7
Rawson Island	T12E/W	193.21
Station 1 Tailrace	T16	194.93
Dam River Right	T19	196.45
Dam River Left	T20	196.62
Impoundment	T23	197.19
Gill Bank	T24	204.62
NMPS Intake	T25	205.51
Shearer Farm	T26/T27	206.24

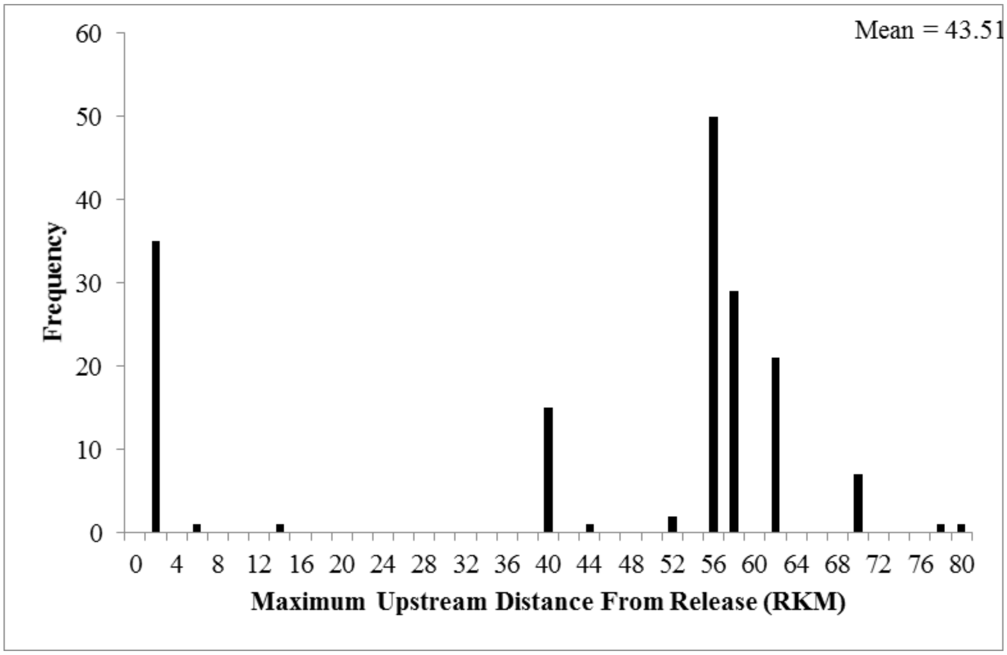


Figure 2.7-1: Maximum upstream displacement observed for dual-tagged Holyoke-released shad.

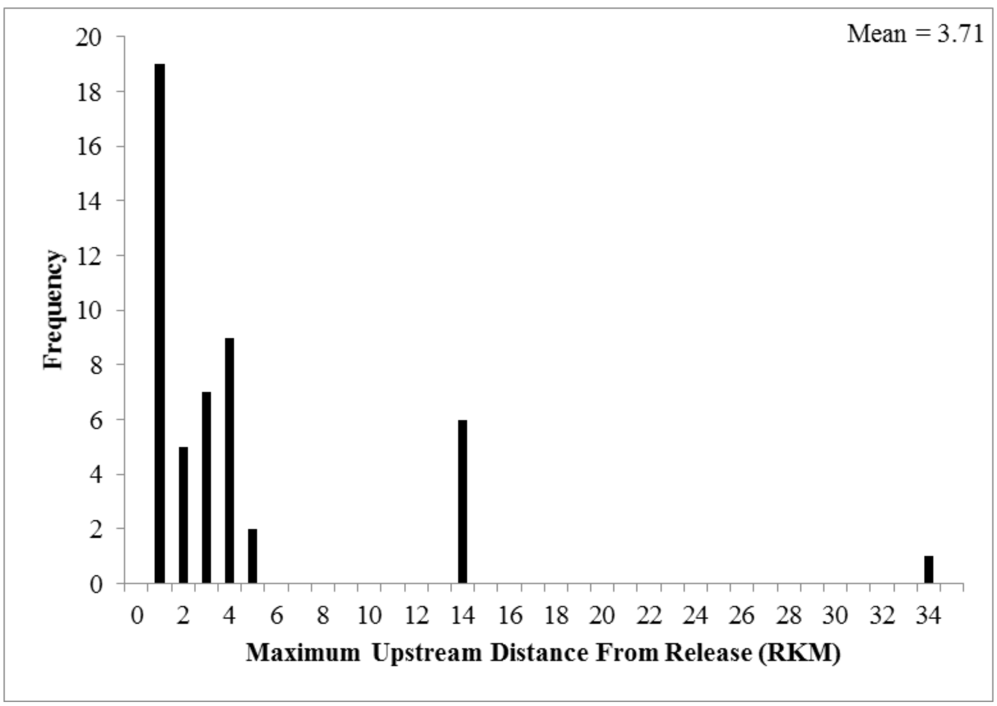


Figure 2.7-2: Maximum upstream displacement observed for dual-tagged Canal-released shad.

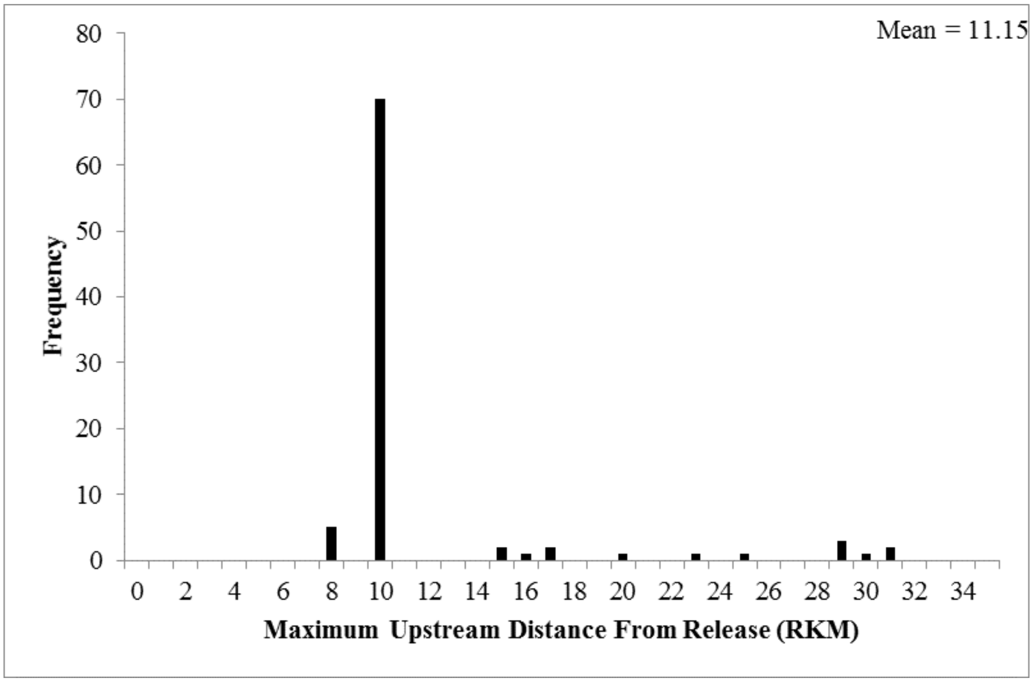
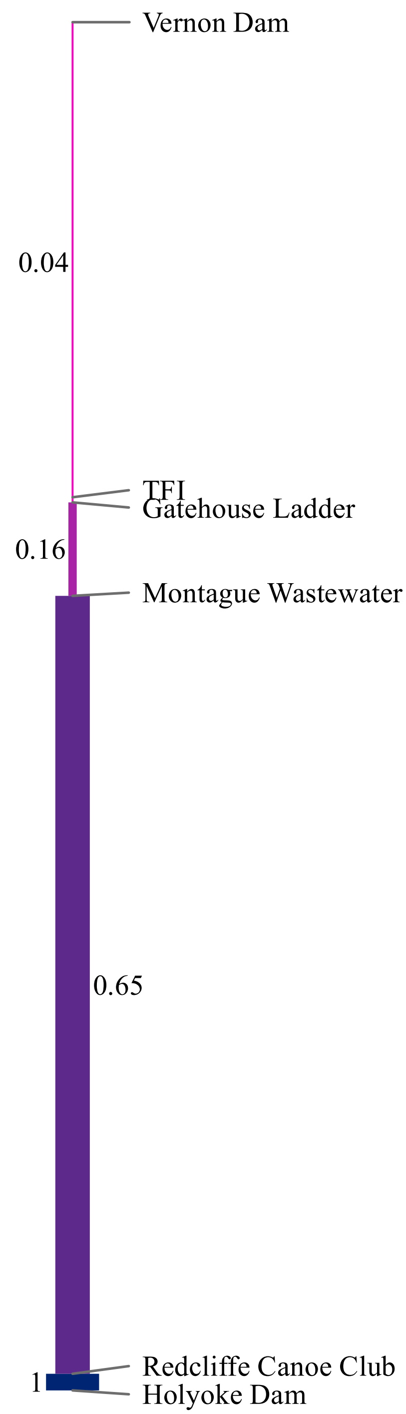


Figure 2.7-3: Maximum upstream displacement for dual-tagged Impoundment-released shad.



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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Relicensing Study 3.3.2

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Figure 2.8.7-4: Overall probability of upstream project passage by reach (n=5) for all release cohorts combined

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2.8 Adult Shad Migration and Emigration with the Connecticut River – Holyoke to Vernon

2.8.1 4.6.2 Montague Spoke:

This analysis supersedes previous work and is meant to replace section 4.6.2 Montague Spoke.

As a result, this section addresses the following agency comments: CRWC-1(2&5), CRWC-6(1), CRWC-7, MADFW-11, MADFW-12, MADFW-13, NMFS-2(2), USFWS-5, USFWS-13(4), USFWS-15(3,4,&5), USFWS-14(1&2), USFWS-20(3), USFWS-26(1)

Fish traveling upstream that reach Montague (T3) have several potential migratory routes to continue their upstream migration including:

- into the Deerfield River (T33),
- enter the Bypass Reach (T11, T15),
- enter the Cabot Tailrace (T5, T6),
- return downstream to the Lower River or (T1, T2),
- enter an unknown state (T3 at their last detection).

Fish transition into the "unknown state" if they are last detected at Montague. This count represents the number of fish that die, are lost track of, or start their emigration from this location. Fish can transition into any of these reaches (states) and can make multiple attempts between the initial state (Montague) and a migratory route (Deerfield, Bypass Reach, Cabot Tailrace, Lower River and an unknown state). Fish can transition directly into the Bypass Reach from Montague by traveling around Smead Island (T11) or by migrating through the Cabot Tailrace undetected.

In total, there were 68 dual tagged migrating fish from five (5) Holyoke release cohorts (May 6th, May 12th, May 19th, May 26th, and June 8th, 2015) (Table 2.8.1-1) that were recaptured at and made at least one (1) movement from Montague. Figure 2.8.1-1 show the raw recaptures within each state (Montague, Lower River, Deerfield, Bypass Reach, Cabot Tailrace, and an unknown state) and Table 2.8.1-1 contains the raw recaptures by cohort. Placing a fish into the unknown state has an important benefit, rather than censoring individuals that remain within the lower impoundment up until their last detection in the model, we placed them into an 'unknown' state so they remain in the denominator and not bias statistics in favor of upstream migration or movement into the intake. Fish may remain at Montague until their last detection in the model and transition into the unknown state because we are only considering their migratory phase. Since we are not considering movement during the emigration phase for this model, Montague may have been their most upstream location. Therefore, the Nelson-Aalen cumulative incidence plots (Figure 2.8.1-2) will match empirical expectations. In other words, if 25% of the movements from the initial location are directed towards the bypass reach, than the cumulative incidence plot will show 25% probability of movement into the bypass reach.

Table 2.8.1-2 is similar to the state table produced by the MSM and counts the number of transitions made by all 68 fish in this model from and to various states. It also contains the number of fish present within a reach or that made a movement and describes the expected number of movements between reaches. It is clear that most fish move from Montague to the Cabot tailrace (m = 44 transitions) and to the bypass reach (m = 34 transitions). It is important to note that this table only counts the transitions of tagged fish conditional on having been detected initially at Montague. This does not reflect movements made by fish that were not detected at Montague (T3) during their migration. Once in the Tailrace, fish made m = 49 movements into the bypass reach, and once in the bypass reach, fish made m = 31 movements back into the Cabot tailrace. This is indicative of heavy back and forth movement between these two reaches, which warrants additional modeling to understand what drives movement of the fish in this region (See response section 2.8.2). Table 2.8.1-2 describes the frequency of the number of attempts per fish. This table is important because it describes the expected number of attempts that a fish will make at a structure or migratory route. These statistics are based on the movements of individual fish, so the maximum of 6 towards the bypass reach means that one fish made 6 attempts from Montague to the bypass reach, however the median count was only two (2) suggesting that most of the population made fewer attempts. Figure 2.8.1-3 displays the histogram for each possible movement within the Montague spoke and graphs the frequency of the number of attempts made by each fish.

Table 2.8.1-3 describes the amount of time (days) it took fish to transition from Montague to adjacent states. It is important to note that once a fish moves into any other state (lower river, Deerfield, bypass reach, Cabot tailrace, or unknown), the time is recorded and the clock is reset. Thus, the time to a movement event is reflective of the time spent within the Montague state. Median event times indicate that fish had the slowest transition times from Montague to the lower river (0.26 days) and the fastest median transition time from Montague to the Deerfield River (0.09 days). It is also important to note that this analysis only includes those fish that are in the upstream phase of their migration. So, fish that move to the lower river can make another attempt at the project. The median transition time of 0.26 days could reflect the time-to-recover as these fish are known to make another attempt at the project from attempted passage. Fish transitioning from Montague to the Cabot Tailrace or to the Bypass Reach did so in a median time of 0.11 and 0.18 days, respectively.

A series of Cox Proportional Hazard regression models were fit to time-to-bypass passage and time-to-Cabot tailrace passage from Montague to understand the effects of project operations and other factors in regards to movement. For the movement between Montague and the bypass reach, fish transitioned throughout the day Figure 2.8.1-4 (top left panel). However, it appears the largest concentration of fish moved in the early morning hours. It appears fish approached the bypass reach while Cabot discharge (kcfs) was low (Figure 2.8.1-4 - bottom left panel) and bypass discharge (kcfs) high (Figure 2.8.1-4 – bottom right). The top right panel counts the number of times fish transitioned during a particular Cabot/Bypass combination. It appears the highest number of movements occurred when Cabot discharge ~ 5 – 7 cfs and Bypass Discharge was ~ 4 – 5000 cfs. The best time-to-Bypass model (AIC = 232.04) was complex and included main effects of diurnal cues, bypass flow (kcfs), Cabot discharge (kcfs) and an interaction effect between bypass flows and Cabot discharge (Table 2.8.1-4). The model was highly significant (robust $p = 0.001$). The estimated hazard ratio for the main effect of daytime was not significant 1.14 ($p = 0.71$. Both main effects of bypass flow (HR = 2.31, $p < 0.001$) and Cabot discharge (HR = 1.39, $p < 0.001$) suggest that fish are more likely to move into the bypass reach from Montague if either source of flow increases by 1,000 cfs. However, if both the bypass flow and Cabot discharge increases by 1,000 cfs simultaneously (interaction effect), fish are less likely to move into the bypass reach (HR = 0.94, $p < 0.001$).

For the movement between Montague and the tailrace reach, fish transitioned throughout the day Figure 2.8.1-5 (top left panel). However, it appears the largest concentration of fish moved very early in morning. It appears fish approached the tailrace throughout all Cabot discharges (Figure 2.8.1-4 - bottom left panel). However, there was limited movement along this route over 6000 cfs (Figure 2.8.1-5 – bottom right). The top right panel counts the number of times fish transitioned during a particular Cabot / Bypass combination. The majority of transitions occurred when both Cabot and bypass discharge was low, or when Cabot discharge was at 10,000 cfs and bypass flow was low (< 3,000 cfs). The best model for the time-to-Cabot Tailrace incorporated Montague flow (kcfs) (AIC = 303.10) (Table 2.8.1-5). The model was significant at the $a = 0.10$ (robust $p < 0.07$). The estimated hazard ratio Montague flow was 0.95 (0.65, 1.10). Models incorporating Cabot discharge and bypass flow were not significant, but the estimated hazard ratios were 1.001 and 0.76. There appears to be evidence that fish are more likely to move to the tailrace race when Cabot discharge increases and less likely to move when it increases. However caution should be taken while interpreting these results. Regardless, the estimated hazard ratio associated with Montague means that as flow in the river increases the likelihood a shad will move up into the tailrace decreases. Figure 2.8.1-5 shows fish approaching the tailrace at all Cabot discharges, but very sparse movement above 6000 cfs in the bypass reach. Movement into this reach may be sensitive to bypass flow.

Table 2.8.1-1: Total number of detections within each state by release cohort for the Montague Spoke

Holyoke Release Date	Montague	Lower River	Deerfield	Bypass Reach	Tailrace	Unknown State
5/6/2015	34	1	1	29	16	3
5/12/2015	18	4	1	14	11	2
5/19/2015	10	1	0	7	10	0
5/26/2015	3	1	0	3	3	1
6/8/2015	3	0	0	1	2	1
Total	**68**	**7**	**2**	**54**	**42**	**7**

Table 2.8.1-2: describes the total number of movements (m) by all fish between reaches, the number of fish (n) that made those movements and describes the expected number of movements that a fish will make for each transition among states in the Cabot Tailrace model. The diagonal counts the number of fish detected within each reach.

To->	Montague	Lower River	Deerfield	Bypass Reach	Tailrace	Unknown
From						
Montague	n: 68	n: 1 m: 5 Min: 1 Median: 1 Max: 1	n: 1 m: 1 Min: 1 Median: 1 Max: 1	n: 29 m: 34 Min: 1 Median: 1 Max: 2	n: 37 m: 44 Min: 1 Median: 1 Max: 2	n: 7 m: 7 Min: 1 Median: 1 Max: 1
Lower River	n: 3 m: 3 Min: 1 Median: 1 Max:1	n: 7	n: 0 m: 0 Min: 0 Median: 0 Max:0	n: 0 m: 0 Min: 0 Median: 0 Max:0	n: 1 m: 1 Min: 1 Median: 1 Max:1	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Deerfield	n: 1 m: 1 Min: 1 Median: 1 Max: 1	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 2	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Bypass	n: 5 m: 6 Min: 1 Median: 1 Max: 2	n: 1 m: 1 Min: 1 Median: 1 Max: 1	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 54	n: 17 m: 31 Min: 1 Median: 1 Max: 6	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Tailrace	n: 12 m: 13 Min: 1 Median: 1 Max: 2	n: 1 m: 1 Min: 1 Median: 1 Max: 1	n: 1 m: 1 Min: 1 Median: 1 Max: 1	n: 31 m: 49 Min: 1 Median: 1 Max: 6	n: 42	n: 0 m: 0 Min: 0 Median: 0 Max: 0

Table 2.8.1-3: Descriptive statistics of event times (days) from the Montague to an absorbing state

Event	Min	25%	Median	75%	Max
Lower River	0.17	0.20	0.26	1.28	3.37
Deerfield	0.09	0.09	0.09	0.09	0.09
Bypass Reach	0.03	0.07	0.18	0.53	7.27
Tailrace	0.03	0.06	0.11	1.47	21.63
Unknown	0.01	0.05	0.11	0.89	3.04

Table 2.8.1-4: Cox Proportional Hazards output for time-to-Bypass passage

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	P	(+/-)
1	Diurnal (Day)	243.61	0.69	1.17	0.39	0.69	(0.55, 2.49)
2	Montague Flow (kcfs)	242.08	0.02	1.04	0.02	0.06	(0.99, 1.08)
3	Cabot Flow (kcfs)	243.72	0.77	1.01	0.03	0.78	(0.95, 1.08)
4	Bypass Flow_(kcfs)	238.78	0.003	1.15	0.06	0.01	(1.03, 1.29)
5	Diurnal (Day)	241.40	0.03	0.69	0.92	0.66	(0.11, 4.17)
	Bypass Flow (kcfs)			1.10	0.07	0.19	(0.95, 1.28)
	Diurnal (Day): Bypass Flow (kcfs)			1.14	0.19	0.50	(0.79, 1.63)
6	Diurnal (Day)	**232.04**	0.001	1.14	0.36	0.71	(0.57, 2.29)
	Bypass Flow (kcfs)			2.31	0.08	<0.001	(1.67, 3.21)
	Cabot Flow (kcfs)			1.39	0.08	<0.001	(1.17, 1.64)
	Bypass Flow (kcfs):Cabot Flow (kcfs)			0.94	0.02	<0.001	(0.91, 0.97)

Table 2.8.1-5: Cox Proportional Hazards output for time-to-Tailrace passage

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	P	(+/-)
1	Diurnal (Day)	313.04	0.31	1.36	0.31	0.31	(0.75, 2.50)
2	Montague Flow (kcfs)	**303.10**	0.07	0.95	0.03	0.08	(0.89, 1.01)
3	Cabot Flow (kcfs)	313.80	0.83	1.01	0.03	0.83	(0.94, 1.08)
4	Bypass Flow (kcfs)	305.59	0.002	0.76	0.10	0.008	(0.62, 0.93)
5	Diurnal (Day)	309.13	0.02	1.01	0.66	0.99	(0.27, 3.72)
	Bypass Flow (kcfs)			0.73	0.17	0.07	(0.52, 1.03)
	Diurnal (Day): Bypass Flow (kcfs)			1.06	0.20	0.77	(0.72, 1.57)
6	Diurnal (Day)	315.76	0.63	0.78	0.56	0.66	(0.26, 2.35)
	Cabot Flow (kcfs)			0.93	0.09	0.41	(0.79, 1.10)
	Diurnal (Day): Cabot Flow (kcfs)			1.10	0.10	0.32	(0.92, 1.34)
7	Diurnal (Day)	303.87	0.13	0.34	0.86	0.12	(0.08, 1.32)
	Montague Flow (kcfs)			0.86	0.07	0.02	(0.76, 0.98)
	Diurnal (Day): Montague Flow (kcfs)			1.14	0.07	0.07	(0.99, 1.32)

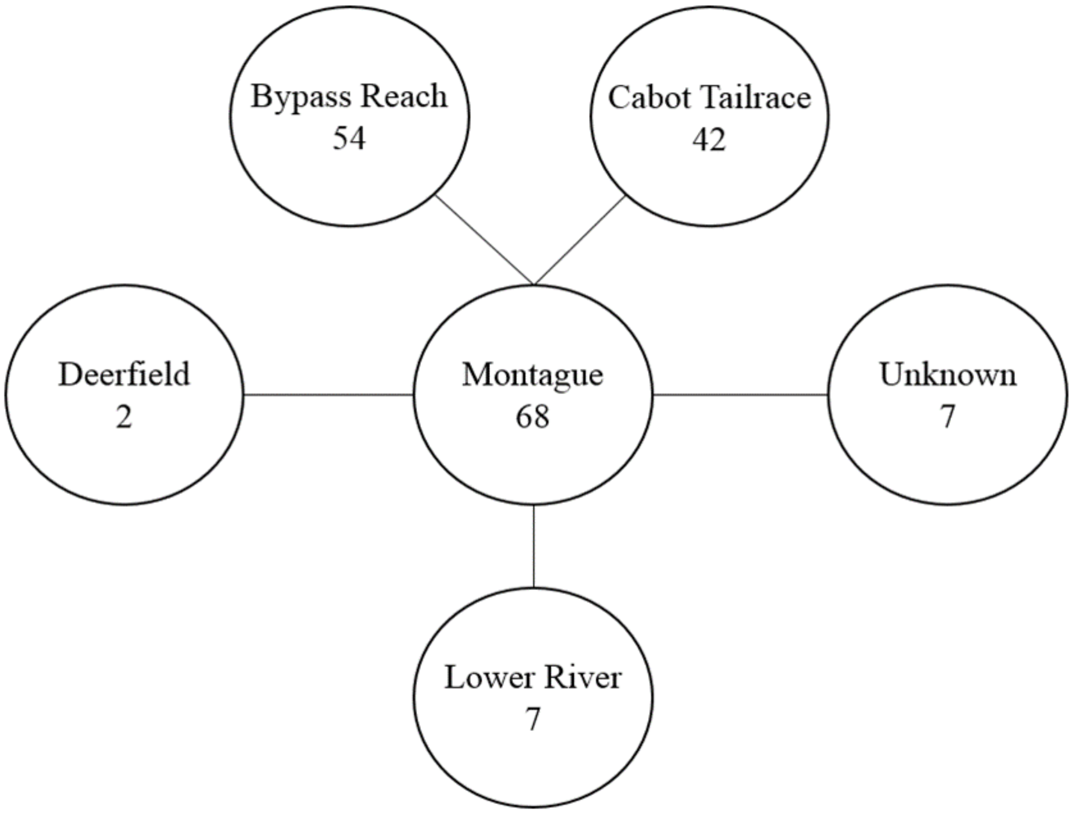

Figure 2.8.1-1: Unique number of fish per state in the Montague Spoke model.

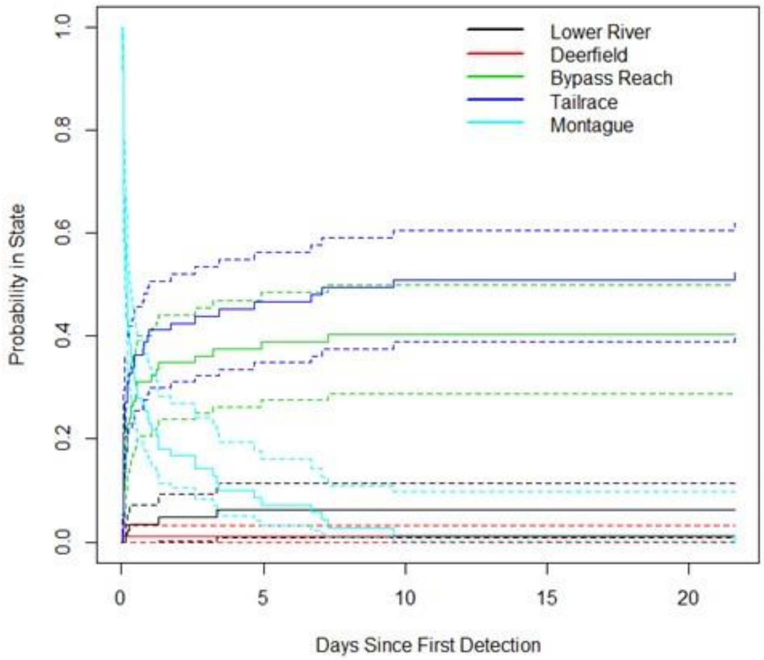

Figure 2.8.1-2: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that move from the Montague Spoke to the Lower River, Deerfield River, Bypass Reach or Cabot Tailrace. Note Kaplan-Meier curve is superimposed to show that probabilities sum to 1.0 at all event times.

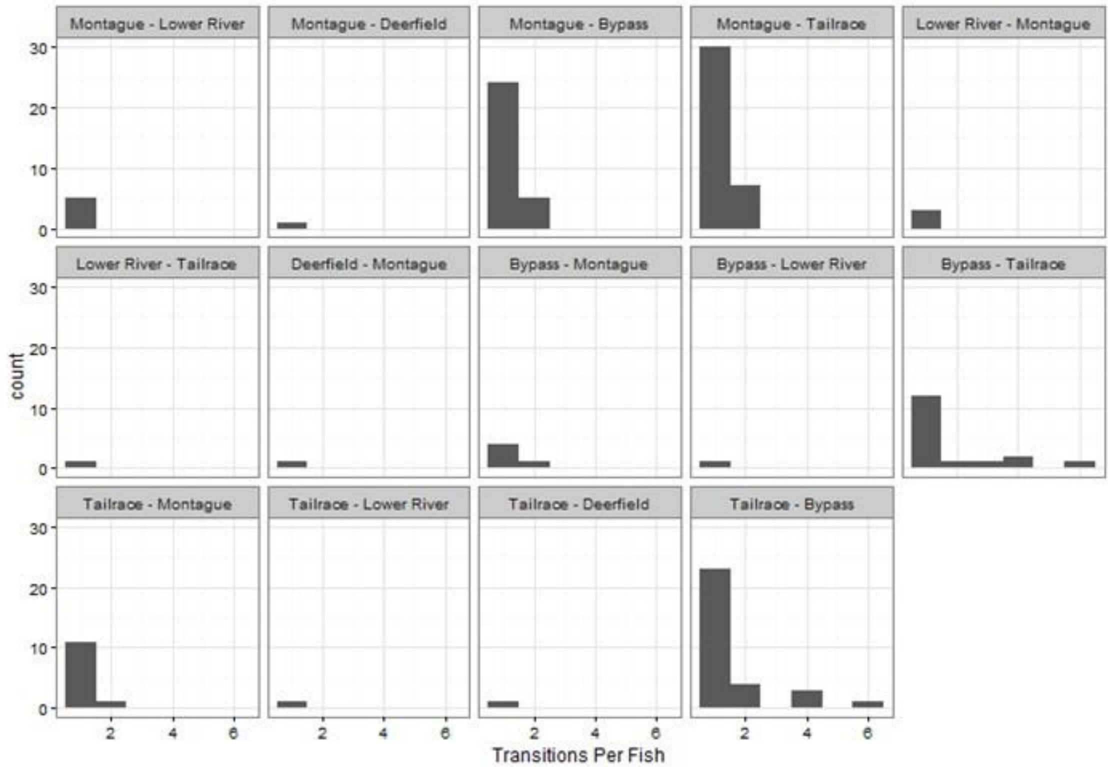

Figure 2.8.1-3: Histograms of the frequency of movement between passage routes for the 75 fish used in the Montague Spoke model. The most amount of movement per fish occurred between the bypass reach and Cabot tailrace, with some fish making that movement up to 6 times. Thirty fish made the movement from Montague to the tailrace once.

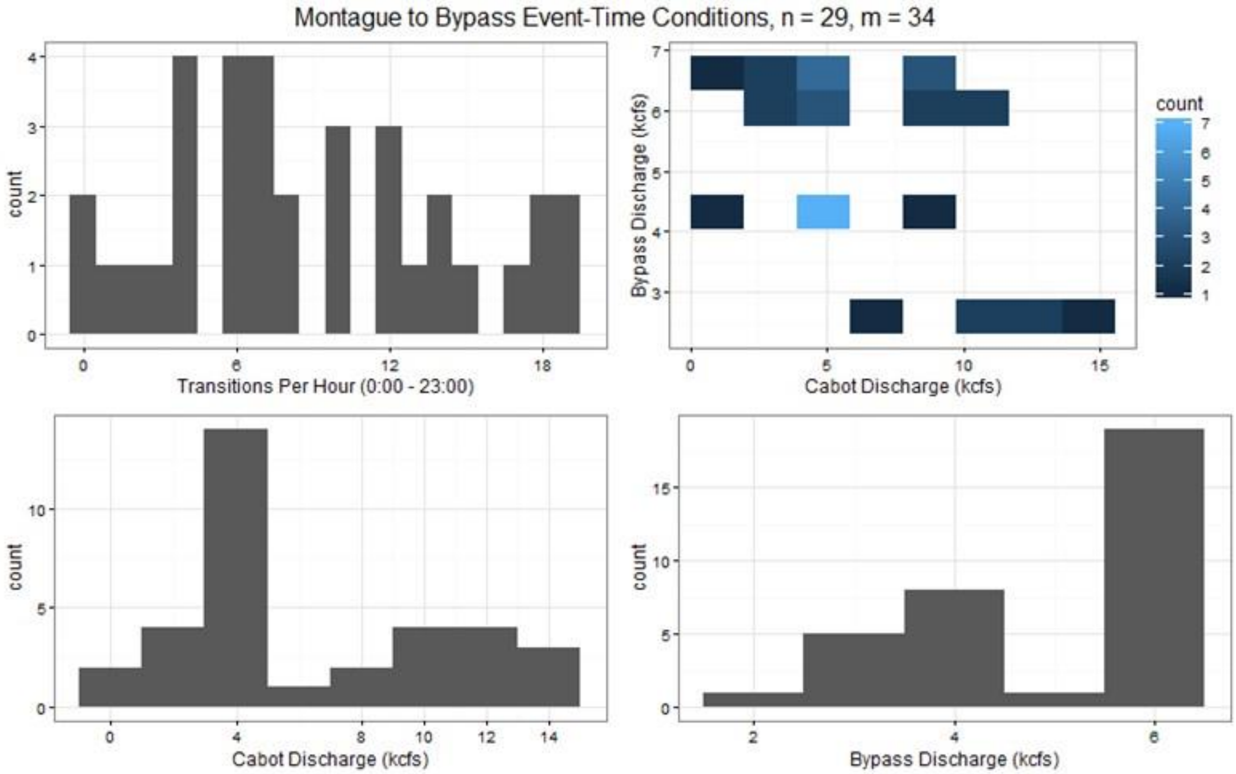

Figure 2.8.1-4: The environmental conditions at event time for fish (n = 29) moving between Montague and the Bypass Reach (m = 34).

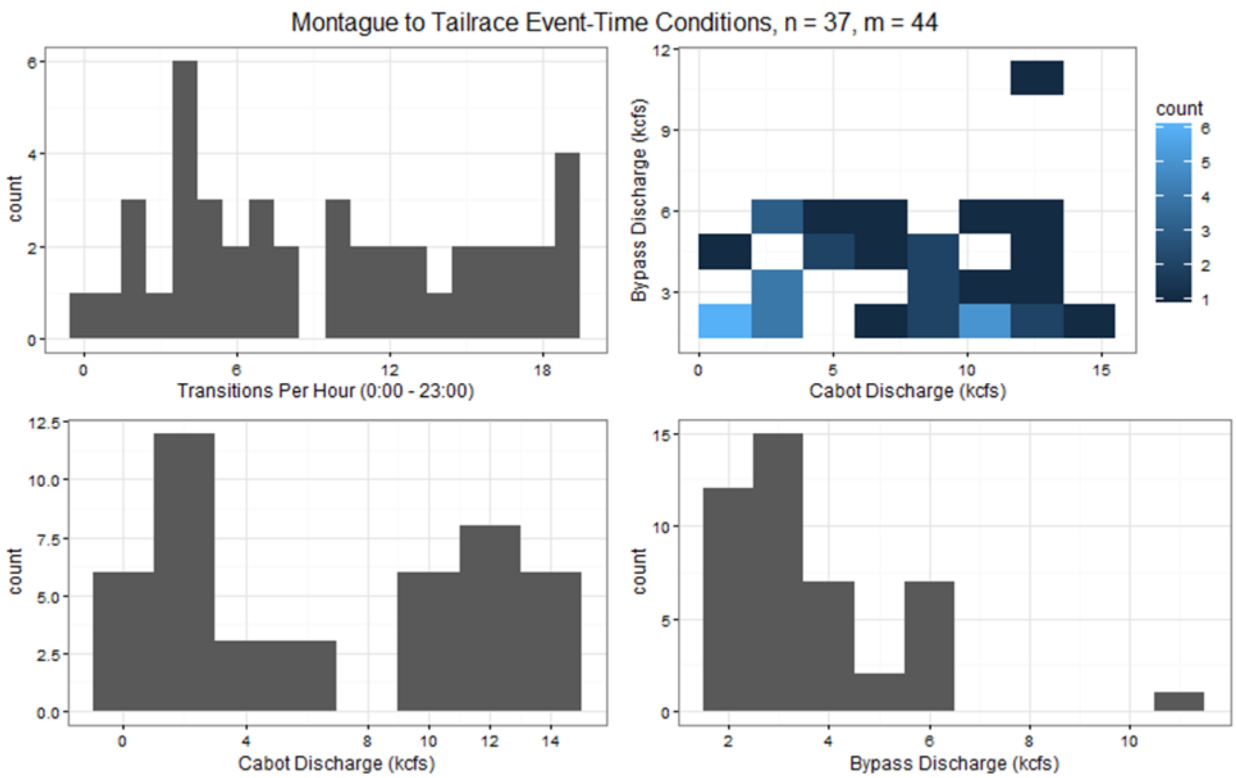

Figure 2.8.1-5: The environmental conditions at event time for fish (n = 37) moving between Montague and the Bypass Reach (m = 44).

2.8.2 4.6.3 Cabot Ladder Attraction

This analysis supersedes previous work and is meant to replace section 4.6.3 Cabot Ladder Attraction. As a result, this section addresses the following agency comments: CRWC-1(2), CRWC-8, MADFW-11, MADFW-12, MADFW-15, MADFW-16, USFWS-5, USFWS-20(3), USFWS-27(3&6)

Fish traveling upstream may arrive at the Cabot Station Tailrace (T5, T6). Once in the tailrace, they have the option of entering the Cabot Fish Ladder (T7, P111, P112, T29 or P12), moving upstream through the Bypass Reach (T11, T15, T12W, T12E, T19 or T20), or turning back downstream (T1, T2, T3, T33). Downstream locations (Lower River), for this model, were comprised of every receiver downstream of the tailrace and consisted of the Deerfield River, Montague, and T2 and T1. Fish transition into the unknown state if their last location is within the Cabot tailrace. This means that the fish was either lost and was last detected here, died in the tailrace, or started their emigration from the tailrace. Fish can transition into any of these reaches (states) and they can make multiple attempts back and forth between the initial state (Cabot tailrace) and a competing risk state (Cabot fish ladder, bypass reach, lower river). However, once fish move into the unknown state they cannot re-enter the model.

In total, 79 fish from five release cohorts (Table 2.8.2-1) were detected within, and made at least one movement attempt from the Cabot tailrace during their migration. Figure 2.8.2-1 shows the raw recaptures within each state (Cabot tailrace, lower river, Cabot ladder, the bypass reach and an unknown state) and Table 2.8.2-1 contains the raw recaptures by release cohort. Fish are placed into the unknown state if they remain within the tailrace until the end of the study (i.e. their last detection is within the tailrace). The unknown state means a fish has had one of three fates: they have died, become lost, or have started their emigration from the tailrace. The probability that a fish will end up choosing one of the routes available at Cabot tailrace is the Nelson-Aalen cumulative incidence probability. The cumulative probability for the unknown state is the joint probability that a fish will die, become lost or start their emigration from the tailrace. Placing a fish into the unknown state has an important benefit, rather than censoring individuals that remain within the lower impoundment up until their last detection in the model, we placed them into an 'unknown' state so they remain in the denominator and not bias statistics in favor of upstream migration or movement into the intake. Fish may remain in the tailrace until their last detection in the model and transition into the unknown state because we are only considering their migratory phase. Since we are not considering movement during the emigration phase for this model, the tailrace may have been their most upstream location.

Table 2.8.2-2 is similar to the state table produced by the MSM model and describes the number of movements between reaches. However, these statistics are conditional on a fish having first been detected within the tailrace during their migratory phase. There were 126 total attempts (m) from the Cabot tailrace towards the Cabot ladder by all fish included in this analysis. For movement towards the ladder, 31 fish (n) made 126 attempts (m), and the most a single fish made was 13 while the median was only three (3). Table 2.8.2-2 describes the expected number of attempts per fish at each migratory route. Figure 2.8.2-2 shows the frequency of attempts made by fish within the Cabot ladder, and counts the number of times a fish made a transition (movement between reaches).

Table 2.8.2-3 describes the amount of time (days) it took fish to transition from the Cabot tailrace into adjacent states. Fish quickly move from the Cabot tailrace into the Cabot ladder (minimum = 0.007 days, maximum = 1.87). In addition, the amount of transitions made by an individual fish is greatest (n=13) from the tailrace to the ladder, and the amount of total transitions made (n=126) is greater than any other state transition. The median time fish abandon the ladder for the tailrace is only 0.0004 days, though a fish spent upwards of 24 days within the ladder before falling back into the tailrace. Fish in the bypass reach spend a median of 0.8 days there before returning to the tailrace while some spend as much as 17 days within the bypass reach. Disregarding the fish that move from the tailrace into the unknown state, movements to the lower river take the longest amount of time (median = 0.02 days, maximum = 20.5 days). This may reflect a recovery time as fish drift back to the lower river only to make another attempt at the tailrace. We know these fish will make another attempt at tailrace because the model only includes fish in their migratory phase, meaning the lower river cannot be their last state.

The Kaplan-Meier survival curve (Figure 2.8.2-3) shows the proportion of fish remaining within the Cabot tailrace from the time they were initially detected (t=days). Nearly 80% of the fish transition out of the Cabot tailrace after their first day of being there, however a few fish remain in the Tailrace for as many as 25 days. Figure 2.8.2-4 shows the Nelson-Aalen cause-specific cumulative incidence curves, which represents the probability that a fish will migrate into a state at time (t) from the Cabot tailrace. The Kaplan-Meier curve is superimposed on this figure (light blue) to show that probabilities sum to 1.0 at all event times. This figure shows where and when fish are transitioning to surrounding states after being detected in the Cabot tailrace. Of the 320 movements from the tailrace, 126 were directed towards the Cabot ladder (126/320 ~ 39%) while only 61 (61/320 ~ 19%) were directed towards the bypass reach. Thirty-six fish enter the unknown state, this means that (36/320 ~ 11%) of the fish that arrive in the tailrace either die, become lost, or start their emigration from this location. Fish also appear to transition to the lower river after spending quite a bit of time in the tailrace only to make another attempt at the project. After 3 days, fish no longer appear to attempt Cabot ladder, but some fish are still making attempts at the bypass reach after 5 days.

A series of Cox Proportional hazards regression models were fit to time-to-Cabot ladder from the tailrace, time-to-bypass reach from the tailrace, and time-to-tailrace from the bypass reach to understand the effects of project operations and other factors in regards to movement. For the movement between the tailrace and Cabot ladder, fish transitioned throughout the day Figure 2.8.2-5 (top left panel). There appears to be multiple peaks occurring in the morning, mid and late day. It appears fish approached the ladder throughout all Cabot discharges (Figure 2.8.2-5 - bottom left panel). The top right panel counts the number of times fish transitioned during a particular Cabot / Bypass bin. The majority of transitions occurred when both Cabot discharge was high 10 – 12,000 cfs, and when bypass flow was low ~ 3000 cfs. The best model time to Cabot ladder model (AIC = 1243.37) incorporated main effects of diurnal cues, Cabot discharge (kcfs), bypass flows in kcfs, and an interaction effect between Cabot and bypass operations (Table 2.8.2-4). The model was significant (robust p = 0.04), and the main effects of daytime (HR = 1.62, p = 0.099) and Cabot discharge (HR = 1.15, p = 0.05) were significant at the a = 0.10, while bypass flow (HR = 1.30, p = 0.15) was not. The interaction effect was also significant (HR = 0.96, p = 0.04). These results suggest that fish are 1.62 times more likely to move into Cabot ladder during the day, and when Cabot discharge increases by 1000 cfs a fish is 1.15 times more likely to move into the ladder. However, when both Cabot discharge and bypass discharge increase by 1000 cfs each, a fish is 1.04 times less likely (HR = 0.96, p = 0.01) to move into the ladder. Therefore, during high flow events when discharge through Cabot station and the bypass reach is high, fish are less likely to move into Cabot Ladder.

For the movement between the tailrace and bypass, fish transitioned throughout the day Figure 2.8.2-6 (top left panel). There appears to be a peak occurring later on in the day. It appears fish approached the bypass throughout all Cabot discharges (Figure 2.2-6- bottom left panel) with peak movement occurring when Cabot discharge over 12,000 cfs. The top right panel counts the number of times fish transitioned during a particular Cabot / Bypass bin. The majority of transitions occurred when both Cabot discharge was high 10 – 12,000 cfs, and when bypass flow was low ~ 3000 cfs. For time-to-bypass reach from the tailrace, neither model was significant. FirstLight assessed time-to-tailrace movement from the bypass reach as well. Fish spend a median of 0.80 days within the bypass reach, with one spending as many as 17 days with the bypass before returning to the tailrace. Only 53 fish made this movement and the models suffered from a high standard error. The best model (robust p = 0.02, AIC = 342.40) included the main effects of bypass flow (HR = 0.83, p = 0.02) (Table 2.8.2-5). The results suggest that movement back into the tailrace is delayed when bypass flow increases. When bypass flows increase, fish appear to be motivated to stay within the bypass reach.

Table 2.8.2-1: Raw recaptures within each state from the Cabot Tailrace by Holyoke release date

Holyoke Release Date	Cabot Tailrace	Lower River	Cabot Ladder	Bypass Reach	Unknown
5/6/2015	35	27	14	18	9
5/12/2015	22	15	9	10	8
5/19/2015	14	11	4	8	7
5/26/2015	5	4	3	3	2
6/8/2015	3	1	1	1	2
Total	**79**	**58**	**31**	**40**	**28**

Table 2.8.2-2: describes the total number of movements (m) by all fish between reaches, the number of fish (n) that made those movements and describes the expected number of movements that a fish will make for each transition among states in the Cabot Tailrace model. The diagonal counts the number of fish detected within each reach.

To->	Cabot Tailrace	Lower River	Cabot Ladder	Bypass Reach	Unknown state
From					
Cabot Tailrace	n: 79	n: 53 m: 105 Min: 1 Median: 1 Max: 34	n: 31 m: 126 Min: 1 Median: 3 Max: 13	n: 37 m: 61 Min: 1 Median: 1 Max: 8	n: 28 m: 28 Min: 1 Median: 1 Max: 1
Lower River	n: 22 m: 61 Min: 1 Median: 1 Max: 33	n: 58	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 7 m: 9 Min: 1 Median: 1 Max: 2	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Cabot Ladder	n: 31 m: 127 Min: 1 Median: 1 Max: 13	n: 0 m: 0 n: 0 Min: 0 Median: 0 Max: 0	n: 31	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Bypass Reach	n: 31 m: 53 Min: 1 Median: 1 Max: 9	n: 11 m: 13 Min: 1 Median: 1 Max: 2	n: 1 m: 1 Min: 1 Median: 1 Max: 1	n: 40	n: 0 m: 0 Min: 0 Median: 0 Max: 0

Table 2.8.2-3: Descriptive statistics of event times (days) from the Cabot Tailrace to an absorbing state

Event	Min	25%	Median	75%	Max
Lower River	0.00	0.00	0.03	0.14	20.51
Cabot Ladder	0.007	0.02	0.05	0.11	1.87
Bypass Reach	0.007	0.03	0.06	0.25	26.5
Unknown State	0.0002	0.01	0.24	3.21	22.2

Table 2.8.2-4: Cox Proportional Hazards output for time-to-ladder passage

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	P	(+/-)
1	Diurnal (Day)	1244.98	1.56	1.46	0.33	0.25	(0.77, 2.78)
2	Cabot Flow (kcfs)	1246.42	0.58	1.02	0.03	0.57	(0.96, 1.08)
3	Bypass Flow (kcfs)	1246.98	0.78	0.97	0.10	0.79	(0.79, 1.18)
4	Diurnal (Day)	1246.39	0.45	1.44	0.32	0.26	(0.76, 2.72)
	Cabot Flow (kcfs)			1.02	0.03	0.62	(0.95, 1.08)
5	Diurnal (Day)	1246.89	0.46	1.45	0.32	0.24	(0.77, 2.72)
	Bypass Flow (kcfs)			0.98	0.10	0.85	(0.81, 1.20)
6	Diurnal (Day)	**1243.37**	0.04	1.62	0.29	0.10	(0.91, 2.87)
	Cabot Flow (kcfs)			1.16	0.07	0.05	(0.998, 1.34)
	Bypass Flow (kcfs)			1.30	0.19	0.15	(0.91, 1.88)
	Bypass Flow: Cabot Flow			0.96	0.02	0.04	(0.92, 0.99)

Table 2.8.2-5: Cox Proportional Hazards output for time-to-Bypass passage

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal (Day)	774.80	0.83	0.93	0.34	0.83	(0.48, 1.80)
2	Cabot Ops (kcfs)	773.59	0.24	1.03	0.02	0.22	(0.98, 1.07)
3	Bypass Ops (kcfs)	**770.69**	0.10	1.11	0.06	0.08	(0.98, 1.24)

Table 2.8.2-6: Cox Proportional Hazards output for time-to-Tailrace passage from the Bypass Reach

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal (Day)	349.99	0.74	0.91	0.29	0.74	(0.52, 1.60)
2	Cabot Ops (kcfs)	349.44	0.40	1.02	0.03	0.4	(0.97, 1.08)
3	Bypass Ops (kcfs)	**342.40**	0.02	0.83	0.08	0.02	(0.71, 0.97)
4	Day	353.22	0.76	1.12	0.49	0.82	(0.43, 2.92)
	Cabot Ops (kcfs)			1.04	0.05	0.28	(0.97, 1.12)
	Day: Cabot Ops			0.98	0.05	0.64	(0.88, 1.08)
5	Cabot Flow (kcfs)	346.26	0.16	0.70	0.53	0.63	(0.27, 2.19)
	Bypass Flow (kcfs)			0.80	0.10	0.03	(0.65, 0.98)
	Cabot Flow: Bypass Flow			1.06	0.12	0.66	(0.83, 1.34)

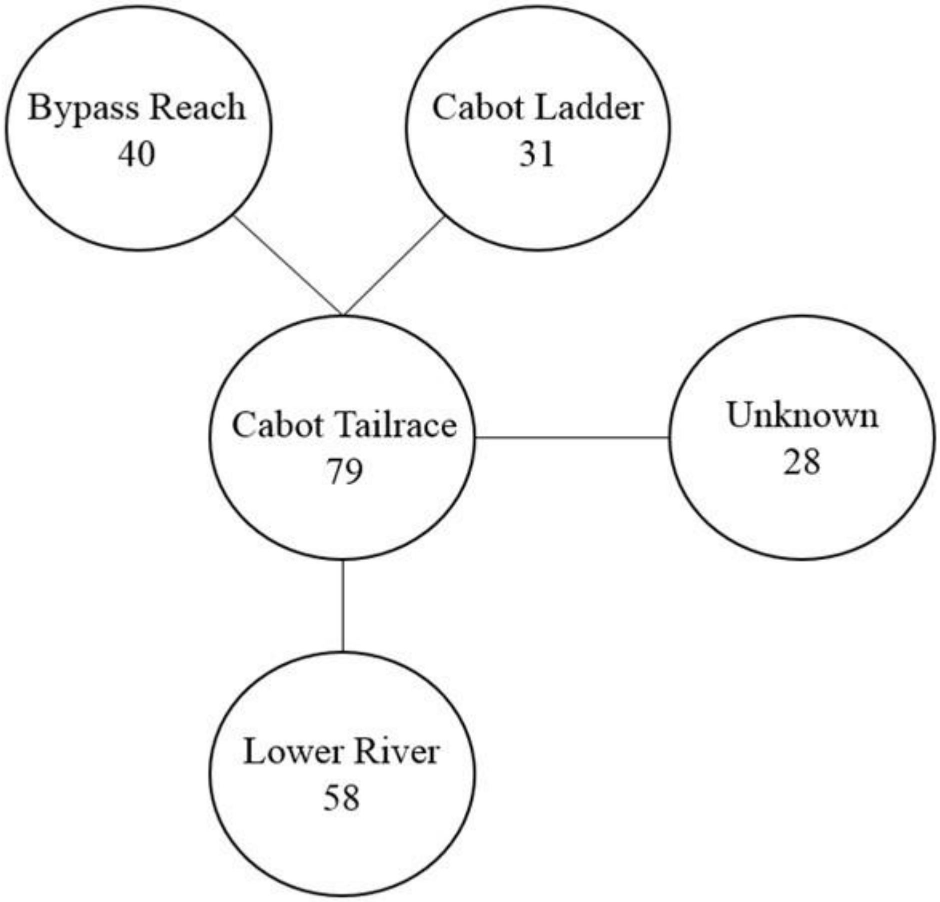

Figure 2.8.2-1: Unique number of fish per state in the Cabot Tailrace model.

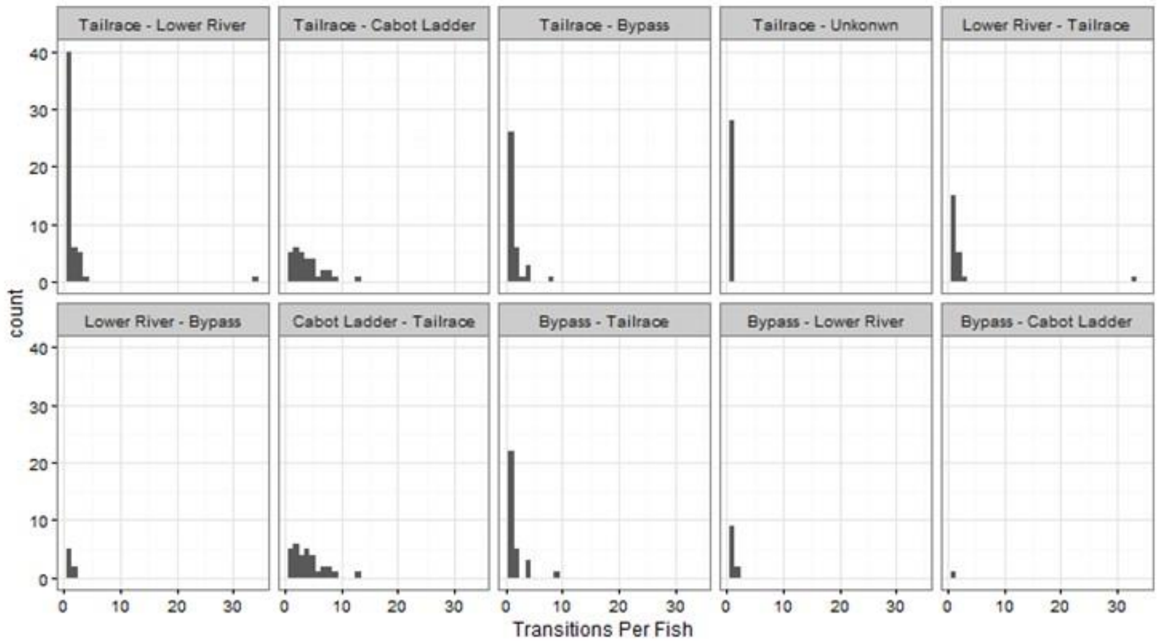

Figure 2.8.2-2: counts the number of movements per fish between reaches used within the Cabot Tailrace model. Forty fish made at least 1 movement from the tailrace towards the lower river. However, the highest number of expected movements (median = 3) occur between the tailrace and Cabot ladder.

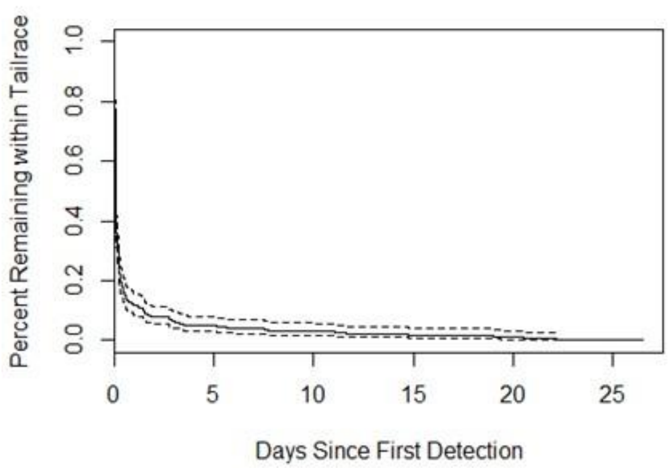

Figure 2.8.2-3: Kaplan-Meier survival curve for fish remaining in the Cabot Tailrace. A majority of the fish will leave the tailrace after only 1 day, however there are fish that remain for greater than 25 days.

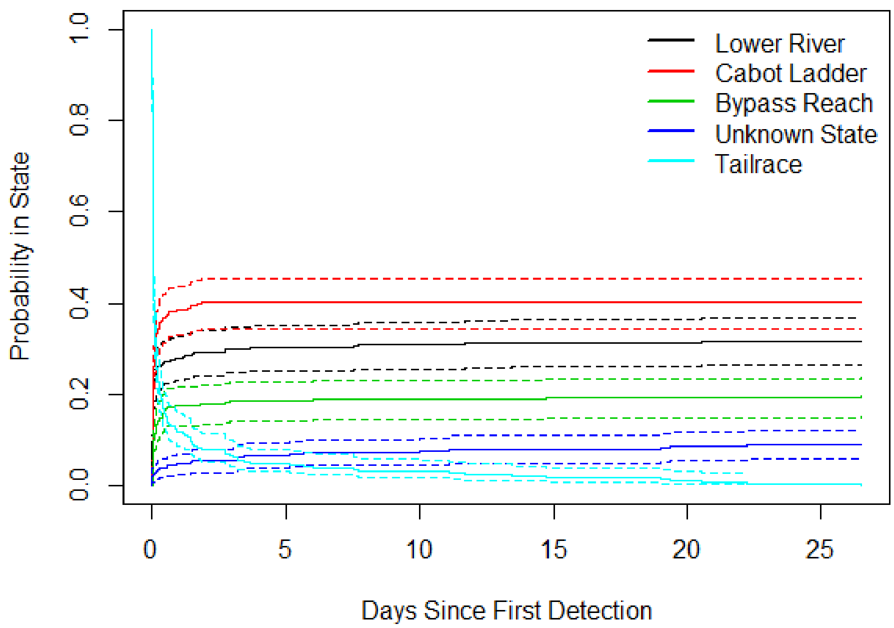

Figure 2.8.2-4: Nelson-Aalen cause-specific cumulative incidence curves showing probability of moving into a state at time (t) for the fish that move from the Cabot Tailrace to the lower river, the Cabot Ladder, or the Bypass reach. Fish are either lost, die, or start their emigration from the tailrace up to 20 days after first detection. Note Kaplan-Meier curve for Cabot Tailrace is superimposed to show that probabilities sum to 1.0 at all event times.

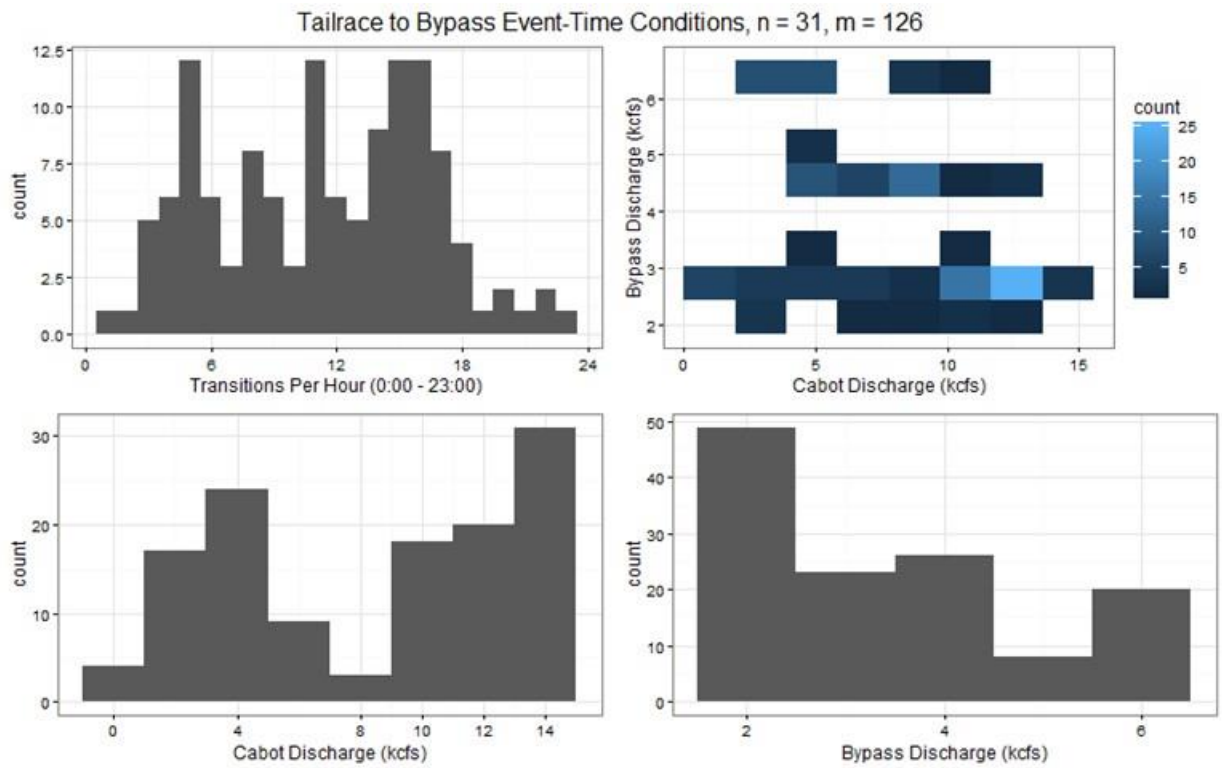

Figure 2.8.2-5: The environmental conditions at event time for fish (n = 31) moving between the tailrace and Cabot Ladder (m = 126).

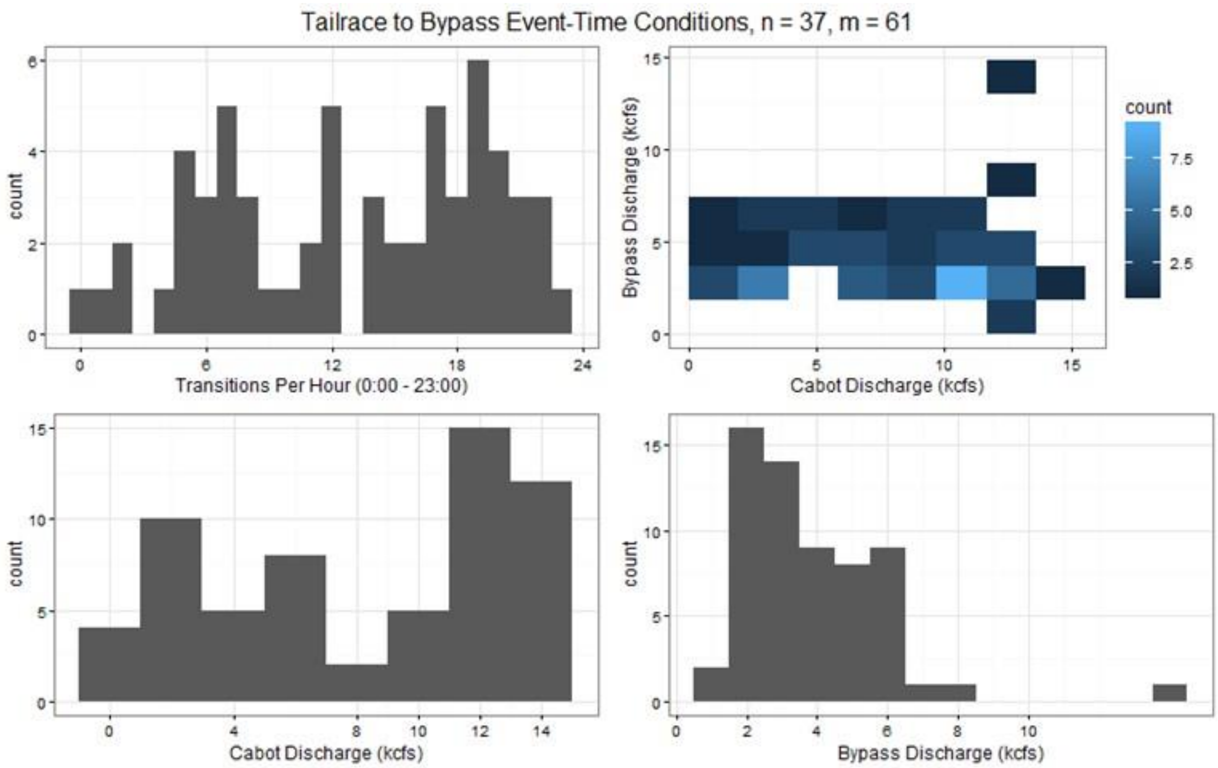

Figure 2.8.2-6: The environmental conditions at event time for fish (n = 37) moving between the tailrace and the bypass reach (m = 61).

2.8.3 4.6.5 Bypass Reach

This analysis supersedes previous work and is meant to replace section 4.6.5 Bypass Reach.

As a result, this section addresses the following agency comments: CRWC-1(2), CRWC-9 MADFW-11, MADFW-12, NMFS-7, USFWS-5, USFWS-17(2,3,&4), USFWS-20(3)

When fish enter the greater bypass reach, described as the area encompassing the detection zones around receivers between Montague and Rawson Island (T3, T11, T15, T5, T6, T12E, T12W), they have several routes available. They can continue moving upstream toward the spillway (T19 or T20), move back downstream toward the lower river (T1, T2), or go unaccounted for and enter an unknown state within the greater bypass reach. Fish can transition into any of these reaches once detected in the greater bypass reach and may make multiple attempts back and forth between the initial state (greater bypass reach) and a competing risk state (spillway, lower river). Fish that enter the unknown state can have one of four fates, they can die, go unaccounted for, pass the Cabot ladder and into the canal, or start their emigration. For fish attempting Cabot ladder please see the 4.6.3 Cabot Tailrace section.

In total, there were 93 fish from five release cohorts (May 6th, 12th, 19th, 26th, June 8th, 2015) (Table 2.6-1) that were recaptured in the greater bypass reach. Table 2.8.3-1 and Figure 2.8.3-1 counts the number of movements between states per fish (greater bypass reach, spillway, lower river and unknown state). If we lost track of a fish before the end of the monitoring period, it was placed into an unknown state. Placing a fish into the unknown state has an important benefit, rather than censoring individuals that remain within the lower impoundment up until their last detection in the model, we placed them into an 'unknown' state so they remain in the denominator and not bias statistics in favor of upstream migration or movement into the intake. Fish may remain in the greater bypass reach until their last detection in the model and transition into the unknown state because we are only considering their migratory phase. Since we are not considering movement during the emigration phase for this model, the bypass may have been their most upstream location.

Table 2.8.3-2 shows the transitions from and to various states (state table) along with the number of fish making those transitions and their expected number of movements. This table is similar to the state table produced by the MSM, except for the fact that these counts are conditional on a fish first making it to the bypass reach while it is still within its migratory phase. For example, there were 25 movements from the bypass reach to spillway and 10 from the bypass reach to the lower river. There were 69 movements from the bypass reach into the unknown state, therefore it appears that a majority of fish in this model either died, went unaccounted for, passed Cabot ladder or started their emigration (69/93 ~ 74%) from the bypass reach area. Of those 69 fish that pass into the unknown state, 6 were known to have passed Cabot ladder and continue their migration through the canal, a majority of the remainder started their emigration. Table 2.8.3-2 describes the expected number of attempts toward each passage route based on the movements of the 93-migrating fish recaptured in the bypass reach. These statistics are based on the movement of individual fish, so the maximum of 2 towards spillway simply means that one fish made two movements from the initial state (bypass) to the spillway. The low number of attempts at the spillway means that there was not much back and forth movement from the bypass to the spillway or from the bypass back down to the lower river. These movements are reflected in the frequency histograms in each state in Figure 2.8.2-2.

Table 2.8.3-3 describes the time in days that fish took to migrate from the bypass reach towards the spillway, lower river and unknown state. The Kaplan Meier survival curve shows that fish spend quite a bit of time in the bypass reach, with about 10% remaining after 10 days (Figure 2.8.3-3). It is important to note that once a fish moves into any other state, the clock is reset. The fastest transition time in this reach is from the bypass to an unknown state with a median time of 0.89 days. This unknown state means that the fish went unaccounted for and either remained in the bypass, died, passed into Cabot ladder, or started its emigration. Transitions from the greater bypass reach to the Spillway took a median time of 1.18 days, and transitions from the greater bypass reach to the lower river took a median time of 3.27 days. After falling back to the lower river, these fish are ensured to make another attempt at the bypass reach because we are only concerned with fish in their migratory phase. Thus, the lower river cannot be their last state.

A series of Cox Proportional Hazard regression models were fit to the greater bypass movement data to assess time-to-spillway movement. For the movement between the bypass and spillway, fish transitioned primarily in the morning with few movements occurring after noon Figure 2.8.3-5 (top left panel). It appears fish approached the spillway during discharges less than 8,000 cfs (Figure 2.8.3-5 - bottom left panel) with peak movement occurring when the spill flow was 4,000 cfs. The top right panel counts the number of times fish transitioned during a particular Spill / Station No. 1 discharge bin. The majority of transitions occurred when both the spillway was under 5,000 cfs and station No. at or near 0. The best model (AIC = 178.23) for time-to-spillway attraction incorporated diurnal cues and total bypass flow (kcfs) (Table 2.8.3-4). The model was highly significant (LR = 0.002). The estimated hazard ratio for daytime was very large (HR = 0.41, $p < 0.01$) suggesting fish less likely to move to the spillway during the day. When bypass flows increase, fish are 1.22 times more likely to move to the spillway.

Table 2.8.3-1: Raw recaptures within each state from the Bypass Migration by Holyoke release date

Holyoke Release Date	Bypass Reach	Spillway	Lower River	Unknown State
5/6/2015	43	16	1	26
5/12/2015	28	4	6	24
5/19/2015	13	1	2	11
5/26/2015	5	0	1	4
6/8/2015	4	0	0	4
Total	**93**	**21**	**10**	**69**

Table 2.8.3-2: describes the total number of movements (m) by all fish between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach.

To->	**Greater Bypass**	**Spillway**	**Lower River**	**Unknown**
From				
Greater Bypass	n: 93	n: 21 m: 25 Min: 1 Median: 1 Max: 2	n: 10 m: 10 Min: 1 Median: 1 Max: 1	n: 69 m: 69 Min: 1 Median: 1 Max: 1
Spillway	n: 4 m: 4 Min: 1 Median: 1 Max: 1	n: 21	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Lower River	n: 7 m: 7 Min: 1 Median: 1 Max: 1	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 10	n: 0 m: 0 Min: 0 Median: 0 Max:0

Table 2.8.3-3: Descriptive statistics of event times (days) from the Bypass Reach to an adjacent state

Event	Min	25%	Median	75%	Max
Spillway	0.16	0.51	1.18	1.96	48.23
Lower River	0.09	1.05	3.27	4.54	25.13
Unknown State	0.00002	0.21	0.89	3.89	29.01

Table 2.8.3-4: Cox Proportional Hazards output for time-to-spillway

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	P	(+/-)
1	Diurnal (Day)	185.02	0.06	0.41	0.42	0.03	(0.18, 0.94)
2	Cabot (kcfs)	188.81	0.93	1.00	0.04	0.93	(0.93, 1.08)
3	Bypass (kcfs)	180.02	0.02	1.22	0.06	<0.001	(1.09, 1.36)
4	Sta No. 1 (kcfs)	188.25	0.40	0.80	0.30	0.46	(0.45, 1.43)
5	Sta No. 1 (kcfs)	181.37	0.02	1.05	0.65	0.94	(0.30, 3.76)
	TF Spill (kcfs)			1.37	2.48	0.01	(1.07, 1.75)
	Sta No. 1: TF Spill			0.95	0.08	0.51	(0.81, 1.11)
6	Diurnal (Day)	**178.23**	0.03	0.41	0.42	0.03	(0.18, 0.93
	Bypass (kcfs)			1.22	0.05	<0.001	(1.09, 1.36)

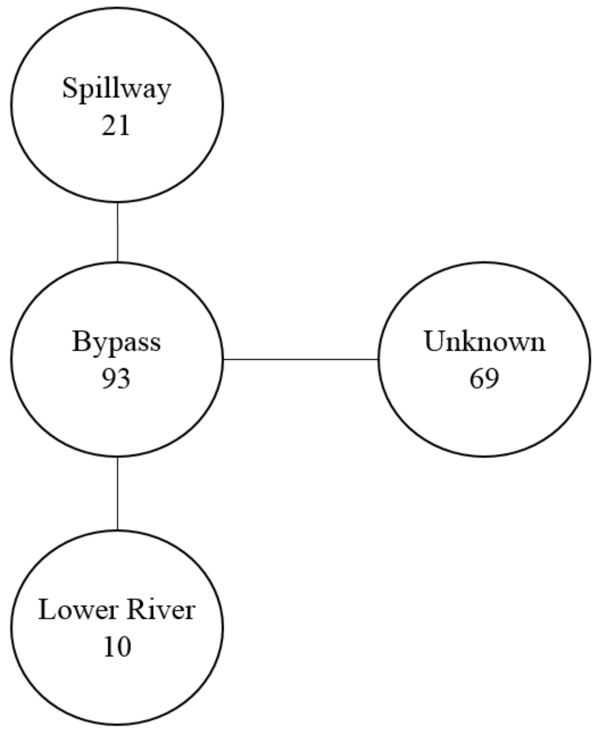

Figure 2.8.3-1: Unique number of fish per state in the Bypass migration model.

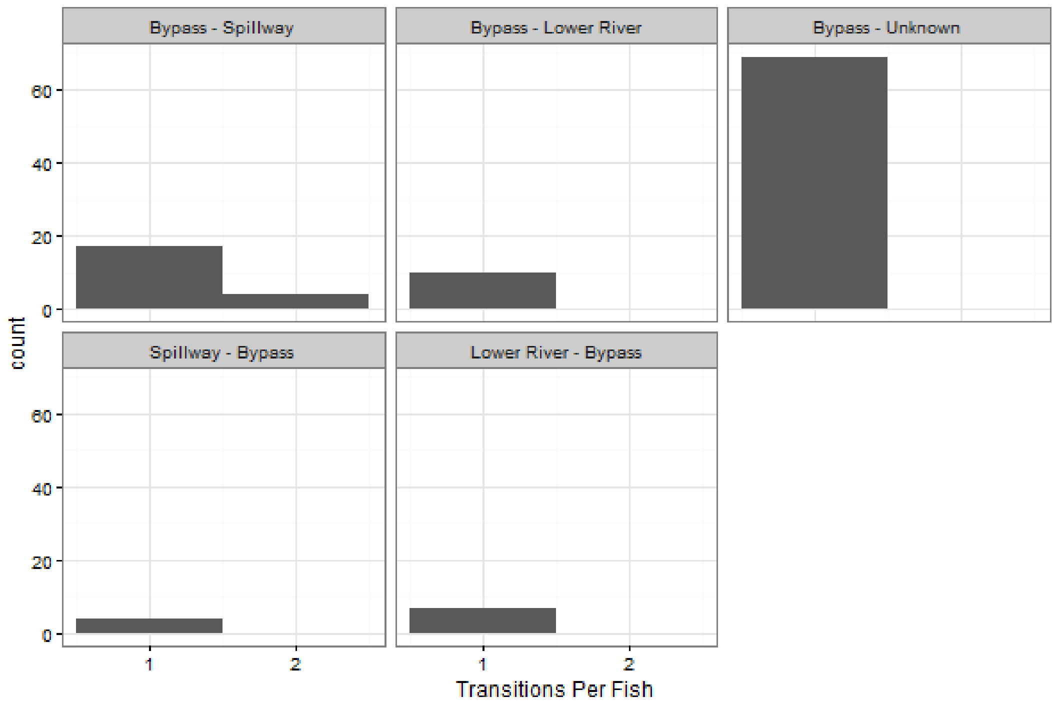

Figure 2.8.3-2: counts the number of movements per fish between reaches used within the greater bypass migration model. Nearly 70 fish made at least 1 movement from the unknown state indicating many fish either die in or begin their emigration from the greater bypass reach.

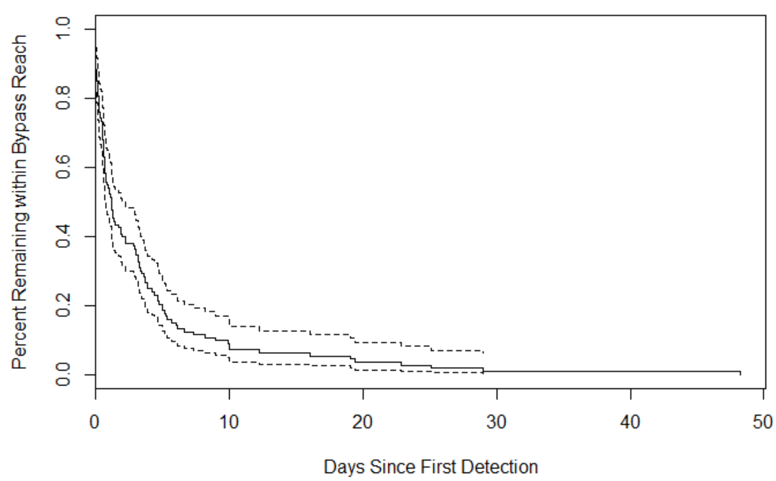

Figure 2.8.3-3: Kaplan-Meier survival curve for fish remaining in the Bypass

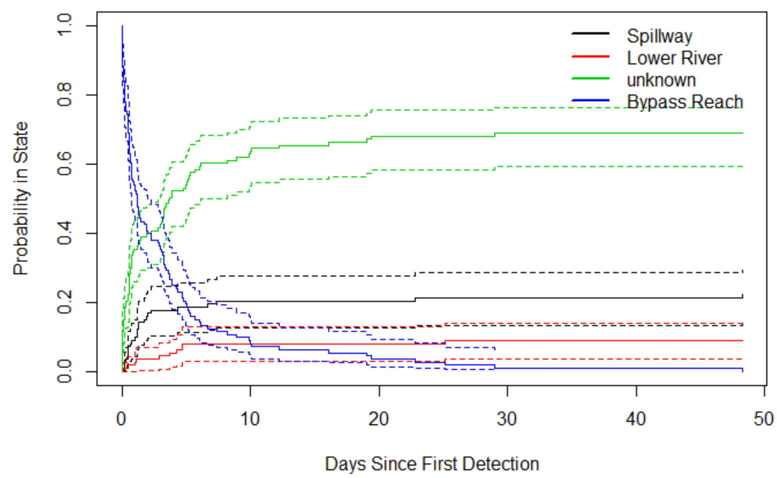

Figure 2.8.3-4: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that move from the Bypass Reach to the Spillway, Lower River, or the an unknown state. Note Kaplan-Meier curve for Cabot Tailrace is superimposed to show that probabilities sum to 1.0 at all event times.

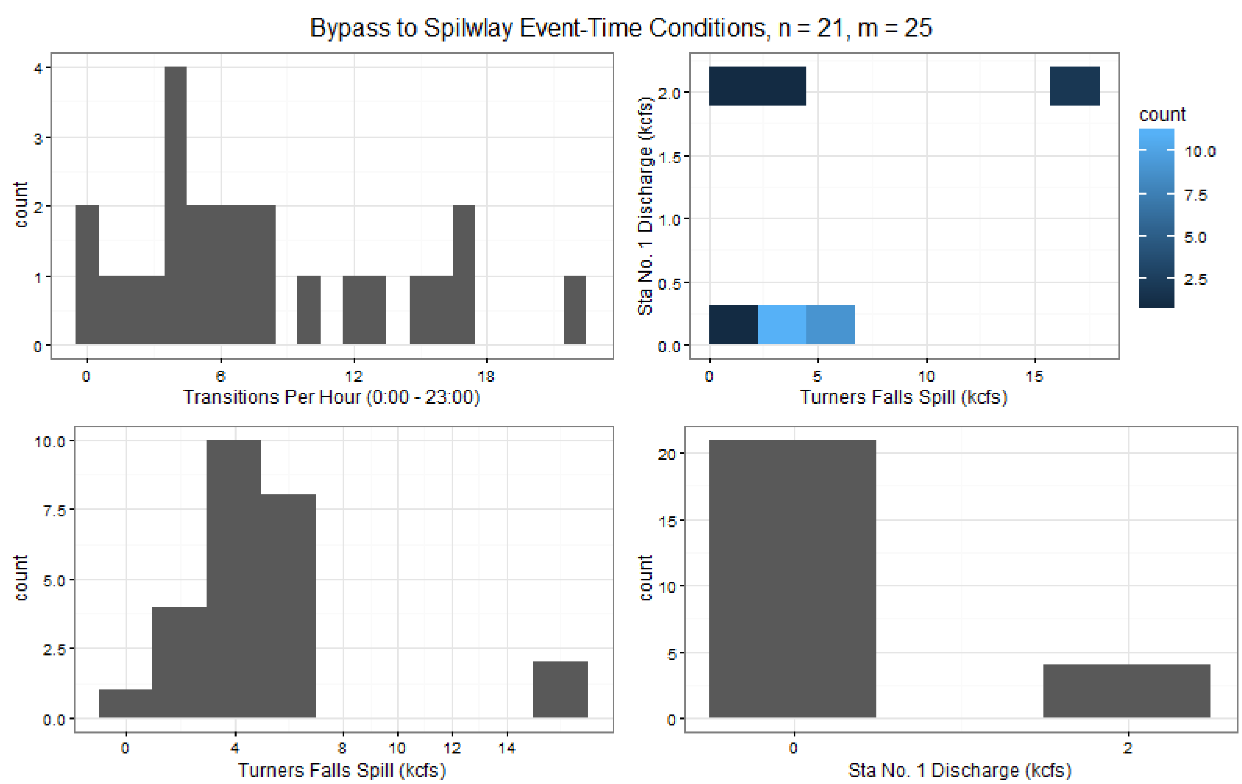

Figure 2.8.3-5: The environmental conditions at event time for fish (n = 21) moving between the bypass and spillway (m = 25).

2.8.4 4.6.6 Spillway Ladder Attraction

This analysis supersedes previous work and is meant to replace section 4.6.3 Cabot Ladder Attraction. FirstLight has also conducted an analysis of receiver downtimes and assessed the impact of those downtimes on our ability to quantify attraction. These statistics are conditional on a dual tagged fish released from Holyoke, and having been detected first within Turners Falls spillway (T20 and T19).

As a result, this section addresses the following agency comments: CRWC-1(2), MADFW-11, MADFW-12, MADFW-15, NMFS-12(3), USFWS-5, USFWS-18, USFWS-20(3), USFWS-27(3), MADFW-19, USFWS-6, USFWS-19, NMFS-3

Migrating shad located in the spillway (T20 and T19) can be attracted into the spillway ladder, move back downstream to the bypass, or transition into an unknown state if they are last detected within the spillway. Fish can transition into any of these states and can make multiple attempts back and forth between the initial state (spillway) and a competing risk (spillway ladder, bypass, unknown state).

In total, there were 21 fish from 3 cohorts (May 6th, 12th, and 19th) detected in the spillway during their migration. Table 2.8.4-1 and Figure 2.8.4-1 contain the raw recaptures within in each state (spillway, spillway ladder, bypass, and unknown state). If we lost track of a fish before the end of the monitoring period, it was placed into an unknown state. Placing a fish into an unknown state has two important benefits. First, the Nelson-Aalen cumulative incidence plots (Figure 2.8.4-2) will match empirical expectations. Second, rather than censoring individuals that remain within the spillway until their last detection in the model, we placed them into an 'unknown' state so they remain in the denominator and not bias statistics in favor of attraction to the spillway ladder or movement downstream into the bypass. Fish may remain in the spillway state until the end of the model because this analysis only considers their upstream migration phase.

Table 2.8.4-2 shows the transitions to and from various states (state table) and is analogous to the state table produced by the MSM procedure. However, these movement statistics are conditional on a fish first arriving at the spillway. If a fish moves through this region undetected, or was never detected at the spillway, then its movements are not included in Table 2.8.4-2. There were 13 transitions from the spillway into the Spillway Ladder. All but one of the dual tagged fish known to pass Spillway ladder are included in this model. The fish 'KA-SHD-0170' was not detected within the spillway (T19 or T20) and therefore was not included in this model, however it was known to have passed via Spillway Ladder. The fish 'KA-SHD-0032', 'KA-SHD-0065', 'KA-SHD-0066' and 'KA-SHD-0067' attempted Spillway Ladder and failed, and only 'KA-SHD-0065' was successful at passing Cabot Ladder in a later attempt. The frequency of movements made by individual fish from the spillway into adjacent states are plotted on Figure 2.8.4-3, which simply counts the number of attempts made by a fish from one location to another. Of the 21 fish detected in the spillway, 13 moved into the unknown state, meaning they either died, were lost or began their emigration from this location. Further, the fish that move into the unknown state do so at a faster rate than fish attempt the spillway ladder (Figure 2.8.4-3). In other words, fish are turning around faster than they are finding the entrance to the ladder. All fish that moved from the spillway to the bypass did so once, while all fish that moved from the spillway to the spillway ladder made the transition at least twice. Table 2.8.4-2 describes these movements and provides statistics for the number of expected attempts into each reach. These statistics are based off the movement of individual fish, so the maximum of 3 towards the spillway ladder means that one fish made 3 attempts from the spillway to the spillway ladder.

Table 2.8.4-3 describes the amount of time (days) it took fish to transition from the spillway to the spillway ladder and the bypass. It is important to note that once a fish moves into any other state, the time is recorded and the clock is reset. The median time (days) it takes fish to move from the spillway to the spillway ladder is 0.81 days. The median time it takes for fish to move from the spillway to the bypass is 2.45 days. The movements from the spillway into the adjacent states is reflected in Figures 2.8.4-2 and 2.8.4-4. Figure 2.8.4-4 indicates the percent of fish remaining in the spillway over time (days) and Figure 2.4-2 is the cumulative incidence plot and represents the probability that a fish will move into a state at time (t).

Two Cox Proportional Hazards regression models were fit to the spillway movements to assess time-to-spillway ladder. Neither model for spillway attraction was significant. An examination of the conditions at event time (Table 2.8.4-5) indicated that fish arrive in the morning (median hour: 9 AM) and enter the ladder at spill flows around 4,000 cfs.

FirstLight performed an in-depth assessment of the antenna outages at the entrance of spillway ladder. In the original report, we note that the two PIT readers (P21 and P22) only had detections on 9 out of the 61 days of the study period. The dropper antenna at the entrance (T30) was also not operational during two time periods for 5 and 10 days respectively. We originally noted that these outages could have repercussions when assessing the entrance efficiency of the spillway ladder. It was proposed by the USGS to develop a multi-state mark recapture model where antenna status (operational vs malfunctioning) was a state. However, with only 21 dual tagged fish known to use the spillway during their migration and making only 13 attempts at the ladder, there is not enough information for the data-intensive multi-state mark recapture model. As a result, FirstLight compared the performance of both receiver technologies and noted when they were malfunctioning. We also looked for outage overlaps where both receiver technologies were down and identified the number of fish present during outage events. Then, we attempted to see if there was a correlation between times of high discharge and low antenna performance.

Of the 13 known attempts towards spillway ladder from the Turners Falls spillway, dual tagged fish were recaptured at T30 and not P21 or P22 eight times (8/13 ~ 62%). In other words, the PIT antennas at the entrance were not functioning for 62% of the attempts. Between 5/6/2015 and 5/11/2015 and on 5/31/2015 and 6/3/2015 both technologies were malfunctioning. FirstLight focused on the dates where both receiver technologies were down and found that fish were present in the spillway (Figure 2.8.4-5). Meaning that some attempts towards the ladder could have gone unnoticed. On 5/10/2015 and 6/3/2015 there were 8 and 6 fish present in the spillway when both antennas were down. The first known attempt at the Spillway Ladder from a dual tagged fish occurred on 5/12/2015, a day after both antenna technologies were down (Table 2.8.4-6). The only known attempt at the ladder to occur when both antennas were down was on 5/31/2015 where a PIT tagged only fish was recaptured after the entrance but before the turning pool at P23SL. For dual tagged fish, only one attempt missed all entrance antennas when they were functioning, KA-SHD-0001 was recaptured at P23SL on 5/17/2015 at 11:37 AM, Table 2.8.4-6. However, the entrance antennas were operational on this day and time. Of the 5 known ladder attempt failures (noted as a Ladder to Spillway transition in Table 2.8.4-6), only one started at P23SL, all other failures originated from T30. Given that ladder failures start from T30 it is conceivable that attempts were missed during receiver downtimes.

FirstLight performed a logistic regression to determine if an increase in spill flow (kcfs) increases the probability of the entrance receivers malfunctioning. The intercept was highly significant and the estimated log odds ratio of -3.1920 ($p < 0.001$). This means that the baseline probability that the receivers will malfunction was 4%. Spill flow was significant at the $a = 0.10$ level ($p = 0.07$). The log odds ratio increases by 0.1866 times for every 1000 cfs. Figure 2.4-6 visualizes the effect, note at large spill flows the probability of malfunction is highest. However, these high flow events were sporadic rain events that did not coincide with a large number of fish present in the spillway (Figure 2.8.4-5).

In conclusion, with the exception of one attempt at the ladder, the remaining 12 attempts were first detected at the entrance dipole T30. There was a period of time early on in the study where both receiver technologies were down. During this period of time (between 5/6/2015 and 5/11/2015) fish were present in the spillway. Fish were detected in the spillway ladder as early as 5/12/2015, one day after receiver malfunctions. Further, most failed attempts started from T30 and not further up the ladder. Given that fish were present in the spillway and that failed attempts generally started from T30, it is likely that there were attempts unaccounted for. Therefore, we have likely underestimated the number of attempts at the ladder. However, there were periods of time when many more fish were present in the spillway and the receivers were operational. While the count may be underestimated, the effect of receiver downtime should be minimal considering some combination of the entrance receivers were operational for 64 out of the 70 days while fish were known to be in the spillway. Both receivers were down only once during a high flow event, and 6 fish were present within the spillway during this time, but that number reduced from 12 fish present the day before.

Table 2.8.4-1: Raw recaptures within each state from the Spillway by Holyoke release date

Release Date	Upper Bypass	Spillway Ladder	Lower Bypass Downstream	Unknown State
5/6/2015	16	8	4	8
5/12/2015	4	0	0	4
5/19/2015	1	0	0	1
Total	**21**	8	4	13

Table 2.8.4-2: describes the total number of movements (m) by all fish between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach.

To->	**Spillway**	**Spillway Ladder**	**Bypass**	**Unknown**
From				
Spillway	n: 21	n: 8 m: 13 Min: 1 Median: 1.5 Max: 3	n: 4 m: 4 Min: 1 Median: 1 Max: 1	n: 13 m: 13 Min: 1 Median: 1 Max: 1
Spillway Ladder	n: 4 m: 5 Min: 1 Median: 1 Max: 2	n: 8	n: 0 m:0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Bypass	n: 4 m: 4 Min: 1 Median: 1 Max: 1	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 4	n: 0 m: 0 Min: 0 Median: 0 Max:0

Table 2.8.4-3: Descriptive statistics of event times (days) from the Spillway to an absorbing state

Event	Min	25%	Median	75%	Max
Spillway Ladder	0.04	0.27	0.81	1.60	6.21
Lower Bypass	0.43	1.75	2.45	2.87	3.33
Unknown	0.0001	0.08	0.17	0.70	3.76

Table 2.8.4-4: Cox Proportional Hazards output for time-to-Spillway Ladder transition

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal (Day)	NA	NA	NA	NA	NA	NA
2	Spill (kcfs)	62.47	0.15	0.74	0.21	0.16	(0.49, 1.13)

Table 2.8.4-5: Conditions at event time for time-to-spillway ladder.

Universal ID	Hour	Spill Flow (kcfs)	Day/Night
KA-SHD-0001	11	6.30	Day
KA-SHD-0001	16	6.38	Day
KA-SHD-0022	16	4.43	Day
KA-SHD-0026	16	4.54	Day
KA-SHD-0026	18	4.40	Day
KA-SHD-0032	7	2.45	Day
KA-SHD-0065	7	2.54	Day
KA-SHD-0066	4	4.29	Day
KA-SHD-0066	5	2.53	Day
KA-SHD-0067	8	4.43	Day
KA-SHD-0071	18	6.32	Day
KA-SHD-0071	16	4.48	Day
KA-SHD-0071	9	4.49	Day
Min	4	2.301	
Median	9	4.427	
Max	18	6.382	

Table 2.8.4-6: Movement history for dual tagged fish known to be within the Turners Falls Spillway and attempting the Spillway Ladder.

Universal ID	Start Receiver	End Receiver	Time	Transition	Successful Attempt?
KA-SHD-0001	T20	T30	5/16/2015 16:15	Spillway to Ladder	
KA-SHD-0001	T30	T20	5/16/2015 16:15	Ladder to Spillway	
KA-SHD-0001	T20	P23SL	5/17/2015 11:37	Spillway to Ladder	Yes
KA-SHD-0022	T20	T30	5/12/2015 16:28	Spillway to Ladder	Yes
KA-SHD-0026	T20	T30	5/12/2015 16:52	Spillway to Ladder	
KA-SHD-0026	T30	T20	5/12/2015 16:52	Ladder to Spillway	
KA-SHD-0026	T20	T30	5/12/2015 18:17	Spillway to Ladder	Yes
KA-SHD-0032	T20	T30	5/13/2015 5:16	Spillway to Ladder	
KA-SHD-0065	T20	T30	5/15/2015 12:08	Spillway to Ladder	
KA-SHD-0066	T20	T30	5/12/2015 16:17	Spillway to Ladder	
KA-SHD-0066	P23SL	T20	5/13/2015 5:14	Ladder to Spillway	
KA-SHD-0066	T20	T30	5/13/2015 6:08	Spillway to Ladder	
KA-SHD-0067	T20	T30	5/12/2015 14:57	Spillway to Ladder	
KA-SHD-0071	T20	T30	5/17/2015 16:13	Spillway to Ladder	
KA-SHD-0071	T30	T20	5/17/2015 16:13	Ladder to Spillway	
KA-SHD-0071	T20	T30	5/19/2015 6:35	Spillway to Ladder	
KA-SHD-0071	T30	T20	5/19/2015 6:43	Ladder to Spillway	
KA-SHD-0071	T20	T30	5/19/2015 9:21	Spillway to Ladder	Yes

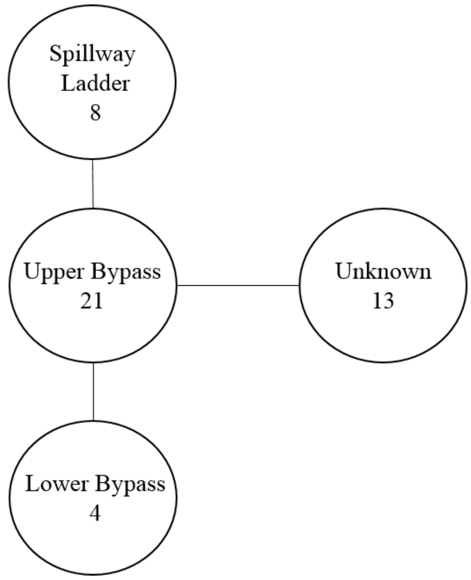

Figure 2.8.4-1: Unique number of fish per state in the Spillway Ladder Attraction model.

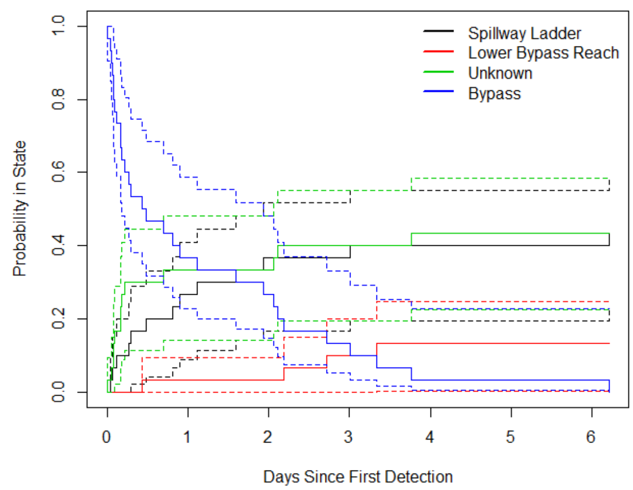

Figure 2.8.4-2: Nelson-Aalen cause-specific cumulative incidence curves showing the probability of being in state at time (t) for fish that move from the spillway to spillway ladder, the bypass, or an unknown state.

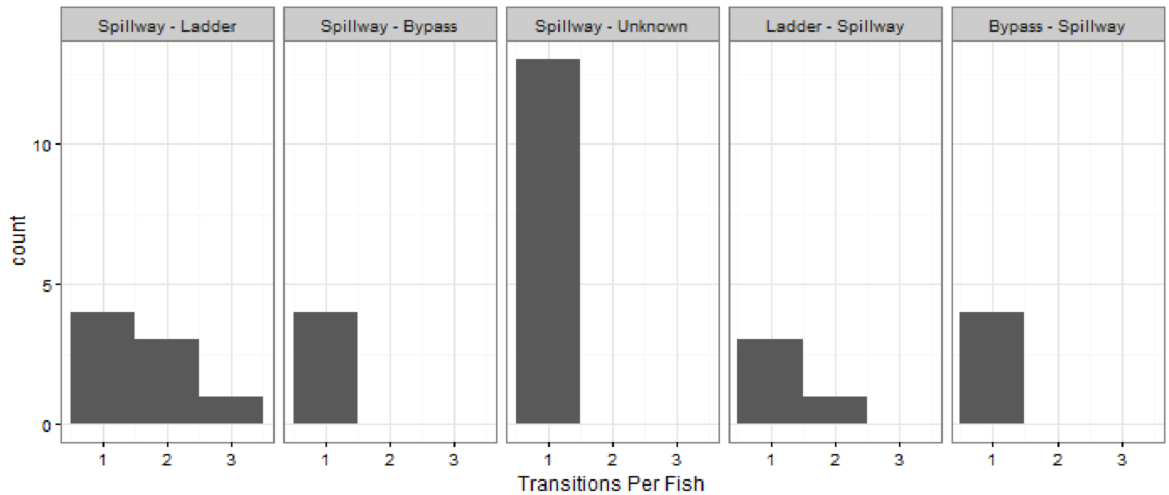

Figure 2.8.4-3: counts the number of movements per fish between reaches used within the greater bypass migration model.

Thirteen ***fish made at least 1 movement from the unknown state indicating more fish either die in or begin their emigration from the spillway than find the ladder.***

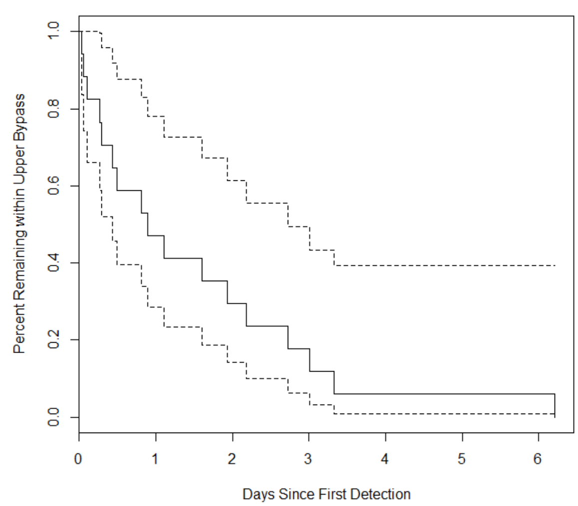

Figure 2.8.4-4: Kaplan-Meier survival curve for fish remaining in the Upper Bypass

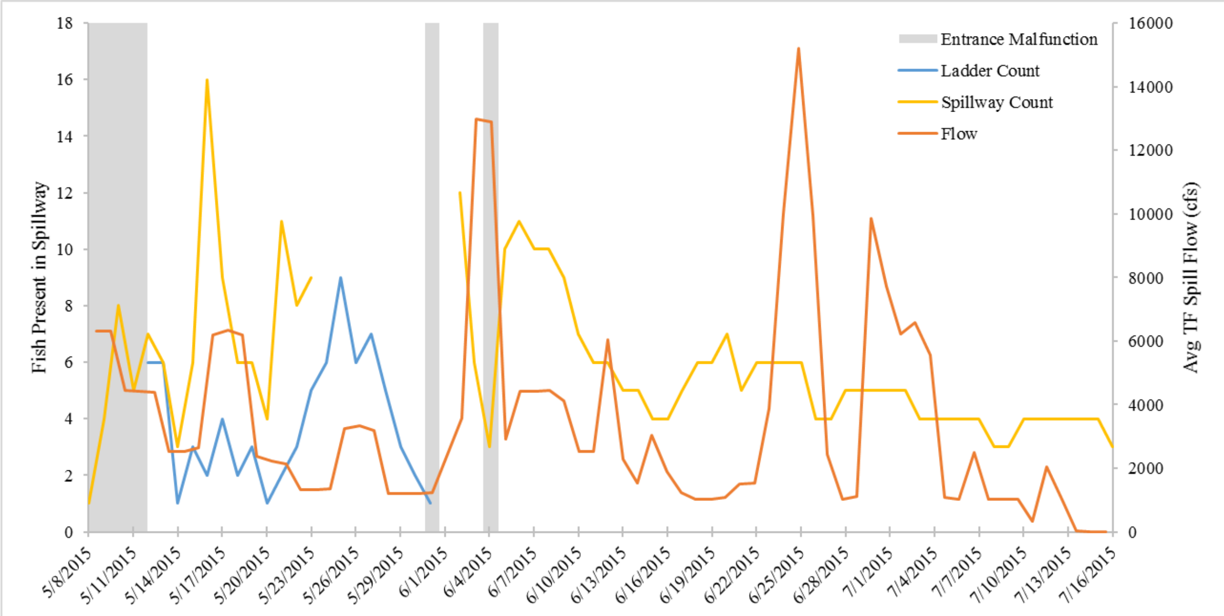

Figure 2.8.4-5: shows fish per day in the spillway and spillway ladder, and the average daily spill at Turners Falls Dam.

The vertical bars represent days when both entry receivers (PIT and dropper) were down.

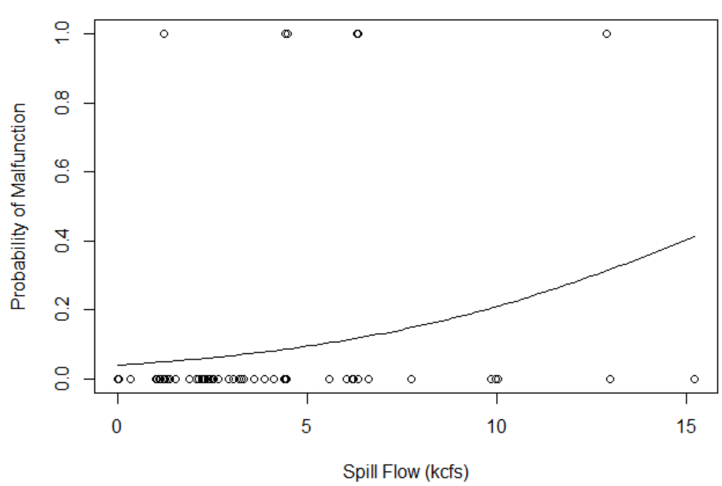

Figure 2.8.4-6: shows the effect of spill flow on the probability that both entrance antennas will malfunction.

Note that as discharge increases the probability increases.

2.8.5 4.6.8 Upstream Migration through the Canal

This analysis supersedes previous work and is meant to replace section 4.6.8 Upstream Migration through Canal. The statistics for the competing risks assessment are conditional on a dual tagged fish released from Holyoke or into the Canal, and having migrated up until the mid-canal where it narrows (T13).

As a result, this section addresses the following agency comments: CRWC-1(2), MADFW-11, MADFW-12, NMFS-9, USFWS-5, USFWS-20, MADFW-20

The movements assessed with this competing risks model is conditional on a dual tagged fish released from Holyoke or into the canal having migrated up until at least mid-canal (T13) where it narrows. Fish that fell back after being released into the Cabot canal were removed from analysis. If a fish was not detected in the initial state (T13), then they were not included in the model. Competing risks analysis allows us to assess the effect of project operations on migration rates in the canal, while a Cormack-Jolly-Seber live recapture mark recapture assessed the overall arrival rate to the next upstream set of receivers. Coupled together, these models provide a complete picture of movement through the canal.

Fish moving upstream through the canal have multiple routes available. They can transition to the head of the canal and enter the Gatehouse ladder, they can drop back and enter the Cabot Forebay, they can move toward the Station No.1 Forebay, or they can enter an unknown state within the canal. Fish can transition into any or all of these reaches, and may make multiple attempts back and forth between the initial state (canal) and a competing risk state (Gatehouse Ladder, Cabot Forebay, Station No.1 Forebay). The unknown canal state was absorbing. The cumulative probability of a fish moving into this state is the joint probability of dying, becoming unaccounted for, and starting its emigration from the canal. The competing risks model only included fish that reached station T13 within the canal during their upstream migration.

In total, there were 34 fish from multiple release cohorts (May 6th, 12th, 13th, 19th, and June 8th, 2015) that were detected at T13 in the canal during their upstream migration. These dates represent fish from two different release locations: Cabot and Holyoke. Cabot released fish accounted for 88% of fish used in this analysis (n = 30 fish). Table 2.8.5-1 and Figure 2.8.5-1 contain the raw recaptures within each state (canal, Gatehouse Ladder, Cabot Forebay, Station No.1 Forebay and the unknown canal state). If we lost track of a fish before the end of a monitoring period, it was placed into the unknown state. Placing a fish into an unknown state has multiple benefits. First, the Nelson-Aalen cumulative incidence plots (Figure 2.8.5-2) will match empirical expectations. Second, by placing fish into an unknown state, we can quantify the probability that a fish will die, go missing within, or start their emigration from the canal. If we do not put fish into this state, then we risk biasing passage in favor of passage.

Table 2.8.5-2 describes the expected amount of passage attempts a fish will make. These statistics are based off the movement of individual fish, therefore the maximum of 11 movements towards the Cabot Forebay simply means one fish made 11 attempts. However, the median number of movements downstream in the canal are only 3. This is an important finding, and shows that fish will make multiple attempts in the canal, falling back all the way to the Forebay before they make another attempt. The unknown state minimum, maximum and median remain at 1 because the unknown state is treated as an absorbing state. Figure 2.8.5-3 shows the frequency of attempts between each state. The total number of movements between states are displayed in Table 2.8.5-2. The state table is similar to that produced by the MSM with the exception that these counts are conditional on the fish arriving at receiver T13 in its migratory phase. In total, 13 of the 34 fish available to pass in the canal made 21 attempts from the canal to the gatehouse ladder. There were 76 total attempts from the canal to the Cabot forebay. In other words, fish rejected the canal in favor of the forebay 76 times, while only making 21 attempts at the gatehouse ladder. This table also tells us that 8 attempts at the Gatehouse Ladder were unsuccessful.

Table 2.8.5-3 describes the amount of time (days) it took fish to transition from the canal (T13) to adjacent states. It is important to note that once a fish moves into any other state, the time is recorded, and the clock is reset. The 21 fish that attempted the gatehouse ladder took a median time of 0.92 days to arrive at the ladder once they had been detected in the canal at T13. Fish detected in the canal that were subsequently detected in the Cabot Forebay took a median time of 0.74 days to do so. Some fish moved to the Forebay quickly (0.0006 hours) while one spent as much as 163.6 hours in the main canal segment before falling back to the forebay. The same is true for the amount of time it took some fish to get from the canal (T13) to the gatehouse ladder. The quickest fish arrived in only 0.20 hours, while the slowest did so in 194.6 hours. At least one fish took roughly 8.1 days to traverse up through the canal to the gatehouse ladder.

A series of Cox Proportional Hazard regression models were fit to the upstream canal movement data to assess time-to-Gatehouse Ladder and the factors that may be contributing or inhibiting movement. For the movement between the canal and Gatehouse ladder, fish transitioned throughout the day with a peak in the late afternoon Figure 2.8.5-4 (top left panel). It appears fish approached the ladder at canal flows that range between 0 and 14,000 cfs (Figure 2.2-6 - bottom left panel) with peak movement occurring when the spill flow was 4,000 cfs. The top right panel counts the number of times fish transitioned during a particular Canal / Cabot Station discharge bin. The majority of transitions occurred when both the flows were around 5,000 cfs. The top right panel shows strong correlation between either flows, therefore we only used Canal flow (kcfs) for this analysis. The best model (AIC = 154.34) incorporated diurnal cues, canal flow (kcfs), and the interaction between diurnal cues and canal flow (kcfs) (Table 2.8.5-4). The model was not significant (robust $p < 0.22$). The main effects of diurnal cues were not significant ($p=0.13$), but Canal discharge ($p = 0.01$) was. The interaction between the two was significant ($p=0.01$). The model suggest that fish are 1.62 times more likely to move up to the Gatehouse Ladder as canal flow increases by 1,000 cfs, but the interaction effect suggests that fish are 1.13 less likely to move to the Gatehouse Ladder during the day as discharges increase.

Aside from the competing risks assessment, FirstLight also constructed a CJS live recapture model to assess the cumulative impoundment arrival rate for those fish that migrated through the canal. The model assesses the proportion of tagged adult shad that successfully pass upstream of the project (or released into) and utilizing the Turners Falls Power Canal. The model incorporated recapture histories from 54 tagged, non-fallback fish that entered or were released into the canal and assessed recapture at six locations subsequent to release including mid canal (T13), downstream (d/s) of Station No. 1 (T18), canal (T20, T21), downstream of gatehouse (T22), Gatehouse Ladder, and the impoundment (T23, T24, T25, T26 and T27). This model used more fish because the initial location was the Conte Intake (T14). Entrance to the canal was afforded via the Cabot Station Ladder, or direct release. Project passage was assumed to occur when fish arrived in the Impoundment. For all release cohorts combined, the CJS model estimated recapture probabilities (p) and arrival (survival in Mark-Recapture literature) probabilities (ϕ) for each of the locations described above.

Results of the CJS estimates of recapture probability (including 95% confidence intervals) per reach (n=6) for each of the five release cohorts is summarized in Table 2.8.5-5 and arrival (or survival) probabilities are summarized in Table 2.8.5-6.

Overall passage through the canal was estimated as 21.4% (Table 2.8.5-7). Arrival probabilities appeared to decrease between the lower and mid-canal reaches, as well as from downstream of Gatehouse to Gatehouse Ladder. Figure 2.8.5-5 depicts upstream arrival probabilities for all cohorts combined and provides an indication of potential bottlenecks to upstream passage in the canal. The stretches of the canal between the lower and mid-canal, as well as between downstream of Gatehouse and the Gatehouse Ladder depict decreases in arrival probabilities that could be representative of bottlenecks.

Table 2.8.5-1: Raw recaptures within each state from the upstream canal migration by release date

Release Date	Release Location	Canal	Gatehouse Ladder	Cabot Forebay	Station No.1 Forebay	Unknown
5/6/2015	Holyoke	1	1	0	0	0
5/12/2015	Holyoke	1	1	0	0	0
5/13/2015	Cabot	14	6	12	2	7
5/19/2015	Cabot	16	3	12	1	12
5/19/2015	Holyoke	1	1	0	0	0
6/8/2015	Holyoke	1	1	0	0	0
Total		**34**	**13**	**24**	**3**	**19**

Table 2.8.5-2: describes the total number of movements by all fish (m) between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach.

To->	Canal	Gatehouse Ladder	Cabot Forebay	Station No.1 Forebay	Unknown
From					
Canal	n: 34	n: 13 m: 21 Min: 1 Median: 1 Max: 4	n: 24 m: 76 Min: 1 Median: 3 Max: 10	n: 3 m: 3 Min: 1 Median: 1 Max: 1	n: 19 m: 19 Min: 1 Median: 1 Max: 1
Gatehouse Ladder	n: 5 m: 8 Min: 1 Median: 1 Max: 3	n: 13	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Cabot Forebay	n: 23 m: 75 Min: 1 Median: 3 Max: 10	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 24	n: 0 m: 0 Min: 0 Median: 0 Max:0	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Station No.1 Forebay	n: 2 m: 2 Min: 1 Median: 1 Max: 1	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 0 m: 0 Min: 0 Median: 0 Max: 0	n: 3	n: 0 m: 0 Min: 0 Median: 0 Max: 0

Table 2.8.5-3: Descriptive Statistics of event times (days) from the Canal into an adjacent state

Event	Min	25%	Median	75%	Max
Gatehouse Ladder	0.008	0.32	0.92	2.26	8.11
Cabot Forebay	0.00002	0.28	0.74	2.63	6.82
Station No. 1 Forebay	0.98	1.41	1.84	2.19	2.54
Unknown	0.06	0.43	0.77	1.79	4.14

Table 2.8.5-4: Cox Proportional Hazards output for time-to-Gatehouse Ladder

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal	160.28	0.56	0.68	0.58	0.50	(0.21, 2.13)
2	Canal (kcfs)	160.71	0.99	1.001	0.08	0.99	(0.95, 1.18)
3	Diurnal	**154.34**	0.22	28.2	2.21	0.13	(0.37, 2125.42)
	Canal (kcfs)			1.62	0.19	0.01	(1.11, 2.36)
	Diurnal: Canal			0.57	0.23	0.01	(0.36, 0.89)
4	Diurnal (day)	159.95	0.31	58.83	2.49	0.10	(0.43, 7500.0)
	Canal (kcfs)			1.81	0.22	0.008	(1.17, 2.82)
	delta Canal (ft^3/s^2)			0.07	1.04	0.01	(0.009, 0.59)
	Diurnal: Canal			0.51	0.26	0.009	(0.31, 0.85)
	Diurnal: delta Canal			40.22	1.08	<0.001	(4.82, 335.46)
	Canal: delta Canal			1.17	0.14	0.24	(0.89, 1.53)
	Diurnal: Canal: delta Canal			0.77	0.13	0.04	(0.59, 0.99)

Table 2.8.5-5: CJS estimated recapture probability (p) and 95% confidence intervals for shad migrating upstream through the Power Canal.

Reach	p	Lower 95%	Upper 95%
Lower Canal (T14)	1.00	0.96	1.00
Mid Canal (T13)	0.97	0.86	0.99
d/s Station No. 1 (T18)	0.96	0.83	0.99
Upper Canal (T21)	1.00	1.00	1.00
d/s Gatehouse (T22)	1.00	1.00	1.00
Gatehouse Ladder	0.90	0.63	0.99
Impoundment	0.87	0.47	1.00

Table 2.8.5-6: CJS estimated survival between canal reaches (ϕ) and 95% confidence intervals for shad migrating upstream through the Power Canal.

Reach	ϕ	Lower 95%	Upper 95%
Release: Lower Canal	1.00	0.96	1.00
Lower Canal: Mid Canal	0.64	0.51	0.76
Mid Canal: d/s Station No. 1	0.85	0.71	0.95
d/s Station No. 1: Upper Canal	0.82	0.65	0.93
Upper Canal: d/s Gatehouse	0.92	0.76	0.99
d/s Gatehouse: Gatehouse Ladder	0.91	0.39	0.81
Gatehouse Ladder: Impoundment	0.87	0.47	1.00

Table 2.8.5-7: CJS estimated cumulative arrival probability (ϕ) for shad moving upstream through the Power Canal (all cohorts combined).

Site	Cumulative Arrival Probability
Release: Lower Canal	1.000
Lower Canal: Mid Canal	0.633
Mid Canal: d/s Station No. 1	0.541
d/s Station No. 1: Upper Canal	0.444
Upper Canal : d/s Gatehouse	0.407
d/s Gatehouse: Gatehouse Ladder	0.247
Gatehouse Ladder: Impoundment	0.214

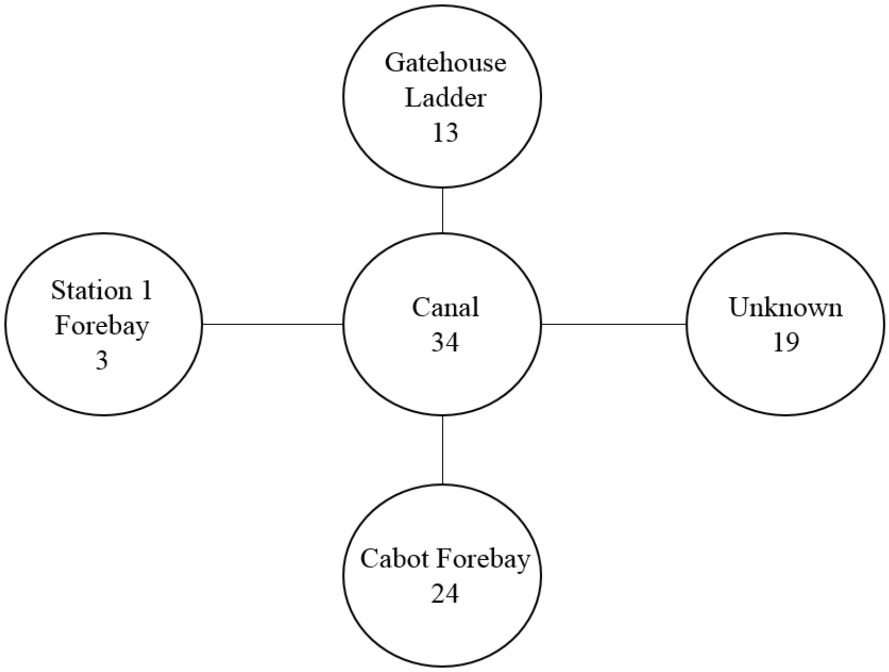

Figure 2.8.5-1: Unique number of fish per state in the Upstream Canal model.

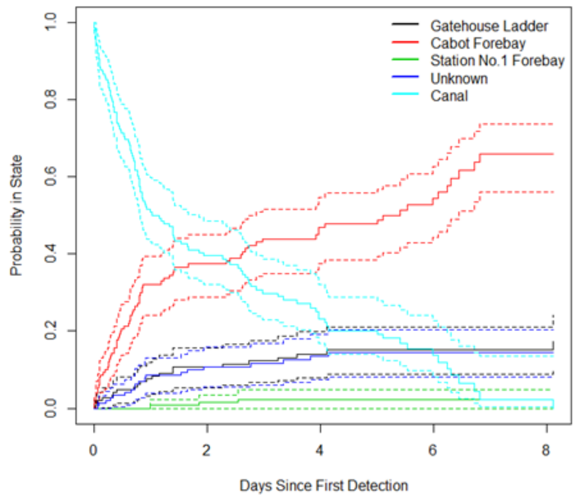

Figure 2.8.5-2: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that move from the Canal (T13) to the Gatehouse Ladder, Cabot Forebay, Station No.1 Forebay and an unknown state. Note Kaplan-Meier curve for the Impoundment is superimposed to show that probabilities sum to 1.0 at all event times.

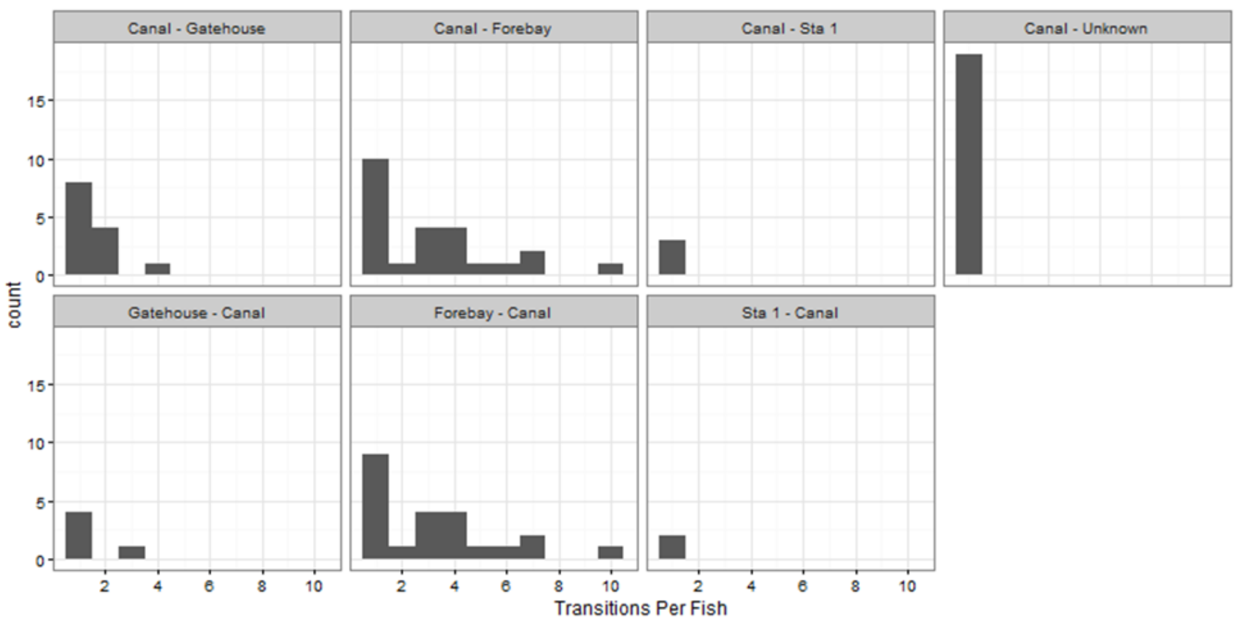

Figure 2.8.5-3: counts the number of movements per fish between reaches used within the canal migration model. Many more fish dropped back to the Cabot Forebay than advanced on to the Gatehouse ladder and one fish remained within the Station No. 1 forebay.

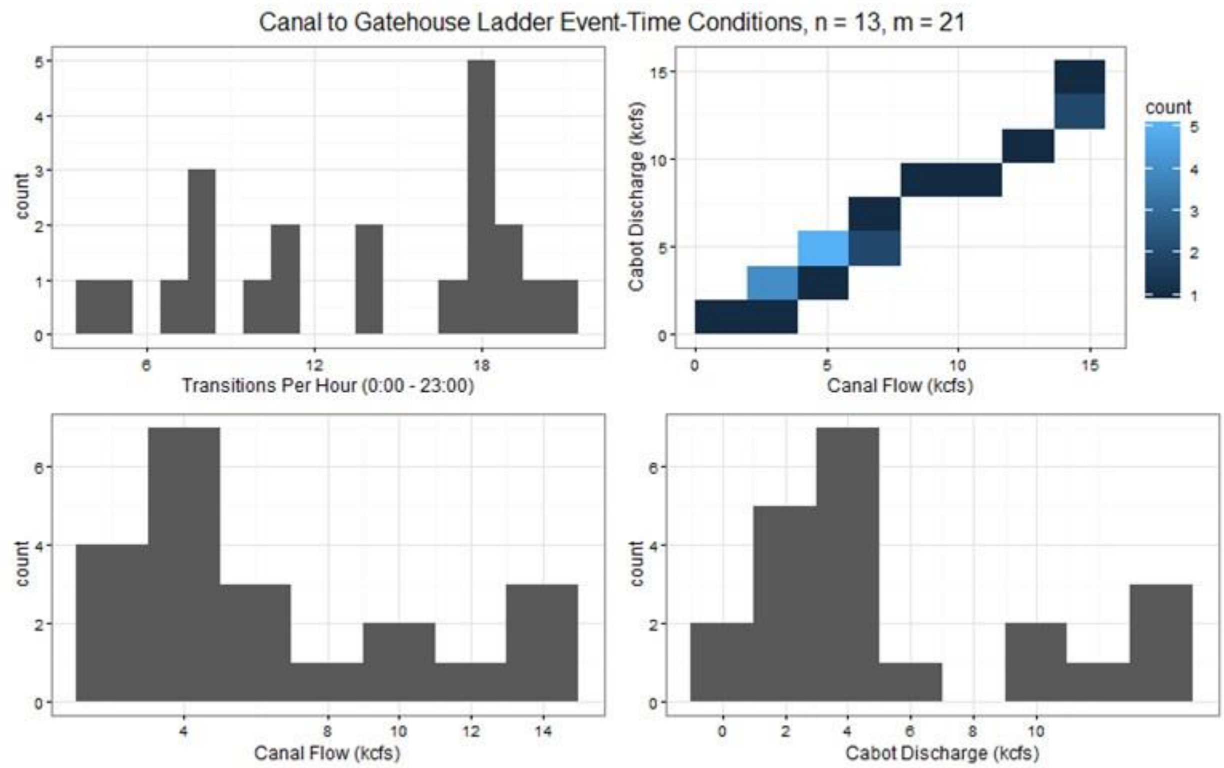

Figure 2.8.5-4: The environmental conditions at event time for fish (n = 13) moving between the Canal and Gatehouse Ladder (m = 21).

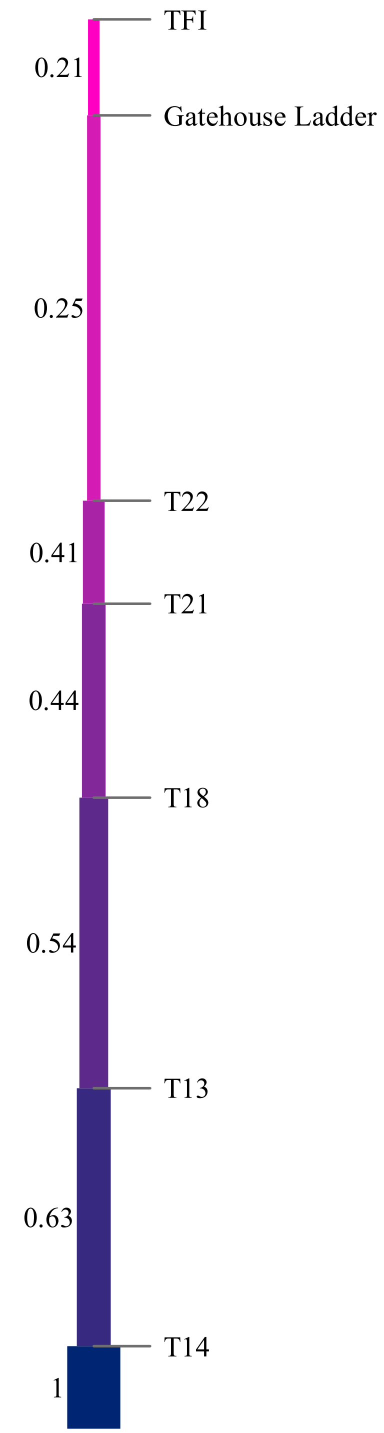

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Figure 2.8.5-5: Overall probability of upstream passage through the Power Canal for all release cohorts combined

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2.8.6 4.6.10 Upstream Migration Through the TFI

This analysis supersedes previous work and is meant to replace section 4.6.10 Upstream Migration through the TFI.

As a result, this section addresses the following agency comments: CRWC-1(2), CRWC-14 MADFW-11, MADFW-12, NMFS-12(4), USFWS-5, USFWS-20(3), USFWS-22(1,2,3,&4)

Fish migrating through the lower Turners Falls Impoundment (TFI) (T23, T24) can be attracted to the NMPS Intake (T25) area or continue upstream towards Shearer Farms (T26, T27). Fish can transition into any or all of these reaches and may make multiple attempts back and forth between the initial state (impoundment) and a competing migratory route (NMPS Intake or Shearer Farms). The model included only those fish known to be in their migration phase and removed fish that fell back from analysis.

In total, there were 105 migrating non-fallback fish from multiple release cohorts (May 6th, 12th, 13th, 15th, 16th, 19th, 22nd, 23rd and June 8th, 2015) that were detected within the TFI (Table 2.8.6-1). The fish recaptured within the impoundment were from three different release locations: Holyoke, Cabot Canal and the TFI. Table 2.8.6-1 indicates that 84.8% (n = 89 fish) analyzed in this model were from Impoundment released fish. In contrast, only 8.6% (n = 9 fish) used in this model were Holyoke released fish and all nine of those fish made it up to Shearer Farms. Fish release in the Cabot Canal accounted for 6.6% (n = 7 fish) of recaptures used in this analysis. Table 2.8.6-1 and Figure 2.8.6-1 contain the number of dual tagged fish detected within each state (Impoundment, NMPS Intake, Shearer Farms and an unknown state). If we lost track of a fish, it died, or started its emigration it was placed into an unknown state. Placing a fish into an unknown state has two important benefits. First, the Nelson-Aalen cumulative incidence plots (Figure 2.8.6-2) will match empirical expectations. Second, rather than censoring individuals that remain within the lower impoundment up until their last detection in the model, we placed them into an 'unknown' state so they remain in the denominator and not bias statistics in favor of upstream migration or movement into the intake. Fish may remain in the lower TFI state until the end of the model and transition into the unknown state because we are only considering their migratory phase. Since we are not considering movement during the emigration phase for this model, the lower impoundment may have been their most upstream location.

Table 2.8.6-2 counts the number of transitions from and to states within the model, the number of fish to make those movements and describes the expected number of attempts. This table is important because it describes the expected number of movements a fish will make between states. The state table presented here (Table 2.8.6-2) is similar to the state table produced by MSM, except that the counts are conditional on a fish being detected and moving from the lower impoundment and not being a fall back fish. There were 29 movements from the lower TFI to the NMPS Intake and 219 movements from the lower TFI to Shearer farms. The frequency of these movements made by individual fish from the lower TFI to adjacent states is plotted in the histograms of Figure 2.8.6-3, which simply counts the number of movements made by fish between locations. Eighteen fish from 9 release cohorts were recaptured at the NMPS Intake (Table 2.8.6-1). Those 18-fish made a total of 47 transitions into the NMPS Intake from the Impoundment or from Shearer Farms (Table 2.8.6-2). Sixty-two of the 100 fish at Shearer Farms made movements to the lower TFI, which means that those fish must make a repeat trip back up to Shearer Farms because this model only includes those fish known to be emigrating. Sixteen of the fish in the lower TFI transitioned into the unknown state, meaning that 15% (16/105) of the fish failed to migrate further than the lower TFI. The histograms in Figure 2.8.6-3 indicates that most fish moving into the NMPS Intake made only 2 back and forth movements between those states.

Table 2.8.6-3 describes the amount of time (days) it took fish to move from the lower TFI into the adjacent states. It is important to note that once a fish moves into any other state the clock is reset. The median time (days) it takes fish to transition from the Impoundment to the NMPS Intake is 0.26 days. In contrast, the median transition time from the lower TFI to Shearer Farms is 0.90 days. Graphical representation of the percent of fish remaining in the lower TFI over time (Kaplan-Meier) is plotted in Figure 2.8.6-4. The cumulative incidence plot (Figure 2.8.6-5) represents the probability that a fish will move into a state at time (t), for fish that move from the lower TFI to the NMPS Intake, Shearer Farms, or into the unknown state. It is important to note that the unknown state here simply means that fish were last detected at one of the stations within the lower TFI. Those fish could have begun their emigration, become lost, or they could have died.

A series of Cox Proportional Hazard models were fit to the lower TFI migration data to assess the effects of covariates on time-to-Shearer Farms and time-to-intake passage from the lower TFI, and time-to-lower TFI from the intake. Flow variables in the CT River that were used in this analysis were extracted from the Turners Falls Impoundment hydraulic model at Shearer Farms, across the width of the river at NMPS, and at Gill Bank (Figure 2.8.6-6). For the movement between the lower TFI and Shearer Farms, fish transitioned throughout the day, however the overwhelming majority did so between 06:00 and 12:00 (Figure 2.8.6-6 top left panel). It appears fish transition to Shearer farms when NMPS operations were around 5000 cfs (Figure 2.8.6-6 **-** bottom left panel). The top right panel counts the number of times fish transitioned during a particular river flow at NMPS and Shearer Farms discharge bin. Note that there is a high amount of correlation between these flow variables, therefore there is no need to include both of them in a model. That being said, the majority of transitions occurred when both the flows were around 10,000 cfs. The best time-to-shearer model (AIC = 1988.23) was complex and incorporated main effects of diurnal cues, the change in river flow at NMPS (ft^3/s^2), NMPS generation (kcfs) and an interaction effect between day/night and the change in river flow (Table 2.8.6-4). The main effect of diurnal cues was not significant (HR = 0.69, p = 0.06), however evidence suggests that fish are less likely transition at night. When river flow at NMPS accelerates, fish are 2.49 times more likely to move up to Shearer Farms (p = 0.02), however when discharge at NMPS increases by 1000 cfs fish are less likely to move (HR = 0.93, p = 0.009). The interaction effect was also significant suggesting that as flow in the river accelerates at night, fish are much less likely to move upstream (HR = 0.44, p = 0.04). The results show that ramping flows in the river cause shad to move, just not at night. However as discharge increases at NMPS, fish are delayed.

For the movement between the lower TFI and the NMPS intake, fish transitioned throughout the day, however the majority did so between 06:00 and 12:00 (Figure 2.8.6-7 top left panel). It appears fish move into the intake when NMPS operations were around 10,000 cfs (Figure 2.8.6-7 **-** bottom left panel). The top right panel counts the number of times fish transitioned during a particular river flow at NMPS and Shearer Farms discharge bin. Note that there is a high amount of correlation between these flow variables, therefore there is no need to include both of them in a model. That being said, the majority of transitions occurred when both the flows were around 10,000 cfs. The best time-to-intake model (AIC = 268.59) incorporated the main effects NMPS pumping (kcfs) and NMPS generation (kcfs) (Table 2.8.6-5). The model was significant (LR = 0.03). The main effect of pumping was significant (HR = 1.16, p < 0.001). The main effect of NMPS generation (kcfs) was not significant (HR = 0.86, p = 0.15). As NMPS pumping operations increase by 1000 cfs fish more likely to transition into the intake. These results suggest that fish are more likely to move into the intake as pumping increases in magnitude.

Table 2.8.6-1: counts the number of dual tagged fish detected within each state by release date

Release Date	Release Location	Lower Impoundment	NMPS Intake	Shearer Farms	Unknown Impoundment
5/6/2015	Holyoke	5		5	1
5/12/2015	Holyoke	2	1	2	
5/13/2015	Cabot	5		5	1
5/15/2015	Impoundment	22	4	22	3
5/16/2015	Impoundment	20	5	19	2
5/19/2015	Cabot	2	1	2	
5/19/2015	Holyoke	1		1	
5/22/2015	Impoundment	23	1	20	6
5/23/2015	Impoundment	24	6	23	3
6/8/2015	Holyoke	1		1	
Total		**105**	**18**	**100**	**16**

Table 2.8.6-2: describes the total number of movements (m) by all fish between reaches, the number of fish (n) that made those movements and describes the expected number of movements that a fish will make for each transition. The diagonal counts the number of fish detected within each reach.

To->	**Lower Impoundment**	**NMPS Intake**	**Shearer Farms**	**Unknown Impoundment**
From				
Impoundment	n: 105	n: 16 m: 29 Min: 1 Median: 1.5 Max: 5	n: 99 m: 219 Min: 1 Median: 2 Max: 11	n: 16 m: 16 Min: 1 Median: 1 Max: 1
NMPS Intake	n: 14 m: 28 Min: 1 Median: 2 Max: 4	n: 18	n: 14 m: 19 Min: 1 Median: 1 Max: 4	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Shearer Farms	n: 62 m: 131 Min: 1 Median: 2 Max: 8	n: 9 m: 18 Min: 1 Median: 2 Max: 4	n: 100	n: 0 m: 0 Min: 0 Median: 0 Max: 0

Table 2.8.6-3: describes the amount of time (days) it took a dual tagged fish to migrate from the lower TFI into one of the competing routes.

Event	Min	25%	Median	75%	Max
NMPS Intake	0.003	0.03	0.50	0.89	19.15
Shearer Farms	0.006	0.13	0.91	1.89	34.14
Unknown Impoundment	0.001	0.83	1.38	2.8	4.13

Table 2.8.6-4: Cox Proportional Hazards output for time-to-Shearer Farms from impoundment

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal	1996.47	0.01	0.62	0.19	0.01	(0.43, 0.89)
2	NMPS pump (kcfs)	2004.08	0.90	1.00	0.02	0.90	(0.95, 1.05)
3	NMPS gen (kcfs)	1993.756	<0.001	0.92	0.03	0.002	(0.87, 0.97)
4	Delta NMPS ops (ft^3/s^2)	2003.71	0.98	1.002	0.08	0.98	(0.86, 1.17)
5	River at NMPS (kcfs)	2004.01	0.01	1.003	0.01	0.76	(0.98, 1.03)
6	Delta NMPS river (ft^3/s^2)	2000.63	0.006	1.24	0.08	0.006	(1.06, 1.46)
7	Diurnal	1993.86	0.001	0.66	0.20	0.03	(0.45, 0.97)
	Delta NMPS river (ft^3/s^2)			2.54	0.38	0.01	(1.21, 5.33)
	Diurnal: Delta NMPS			0.45	0.38	0.04	(0.21, 0.96)
8	Diurnal	1988.23	<0.001	0.69	0.20	0.06	(0.46, 1.02)
	Delta NMPS river (ft^3/s^2)			2.49	0.39	0.02	(1.15, 5.39)
	NMPS gen (kcfs)			0.93	0.03	0.01	(0.88, 0.98)
	Diurnal: Delta NMPS			0.44	0.40	0.04	(0.20, 0.95)

Table 2.8.6-5: Cox Proportional Hazards output for time-to-Intake from impoundment

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal	282.62	0.46	0.65	0.52	0.42	(0.24, 1.82)
2	NMPS pump (kcfs)	268.356	0.03	1.19	0.04	<0.001	(1.10, 1.29)
3	NMPS gen (kcfs)	276.35	0.01	0.77	0.12	0.03	(0.61, 0.97)
4	Delta NFM Ops (ft^3/s^2)	282.72	0.39	1.19	0.17	0.32	(0.84, 1.67)
5	NMPS river (kcfs)	280.98	0.11	1.05	0.02	0.06	(0.998, 1.10)
6	Delta NFM river (ft^2/s^2)	281.70	0.03	1.49	0.17	0.02	(1.07, 2.08)
7	NMPS pump (kcfs)	268.59	0.03	1.16	0.04	<0.001	(1.06, 1.26)
	NMPS gen (kcfs)			0.86	0.10	0.15	(0.71, 1.05)

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Figure 2.8.6-6: Cross-sections from which Hydraulic Model Flow Data were extracted

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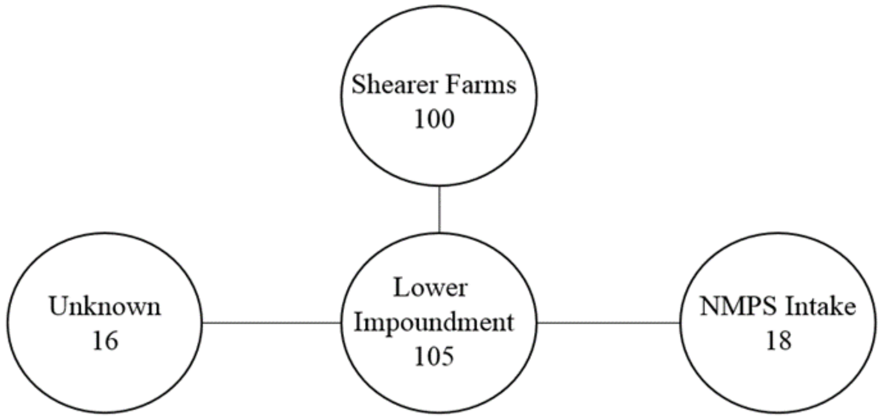

Figure 2.8.6-1: Unique number of fish per state in the TFI upstream migration model.

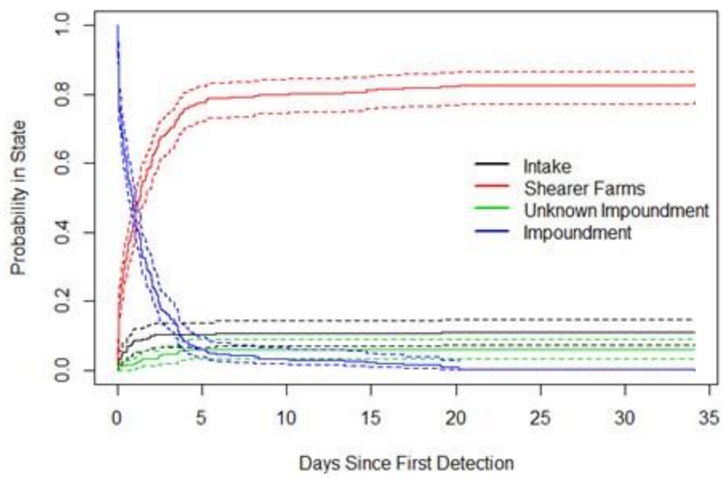

Figure 2.8.6-2: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that move from the Impoundment to the NMPS Intake, Shearer Farms, or the an unknown state in the Impoundment. Note Kaplan-Meier curve for the Impoundment is superimposed to show that probabilities sum to 1.0 at all event times.

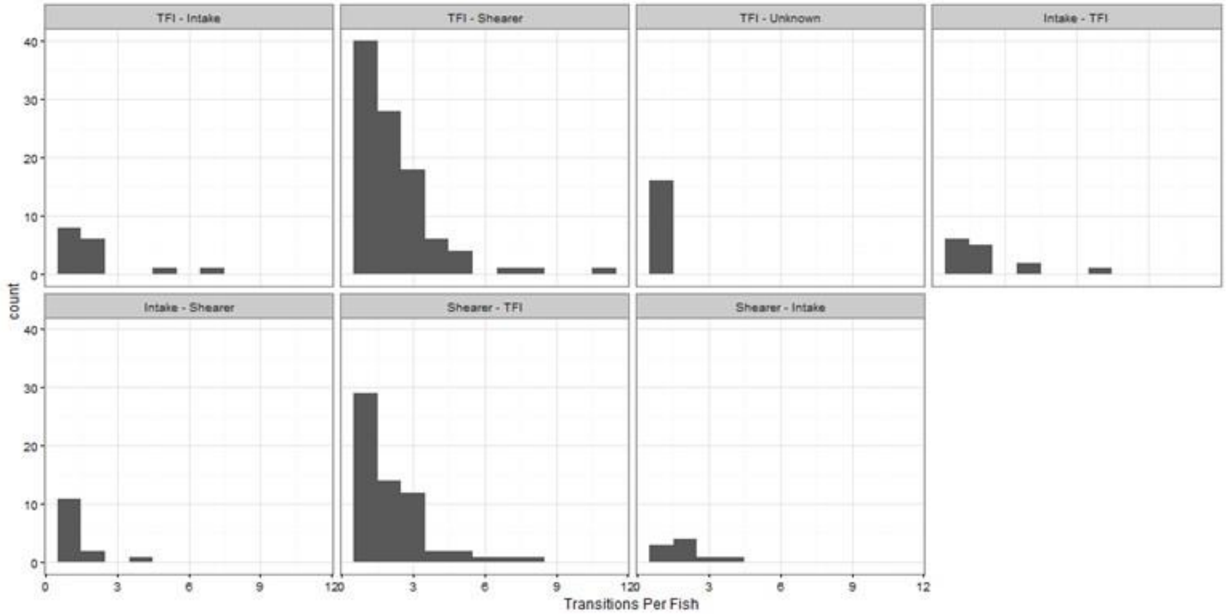

Figure 2.8.6-3: counts the number of movements per fish between reaches used within the Impoundment Migration model. Forty fish made at least 1 movement from the lower TFI towards the Shearer Farms.

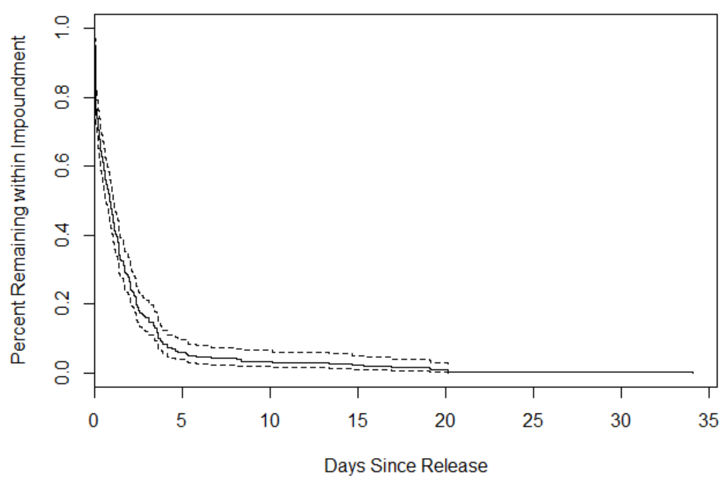

Figure 2.8.6-4: Kaplan-Meier survival curve for fish remaining in the Impoundment

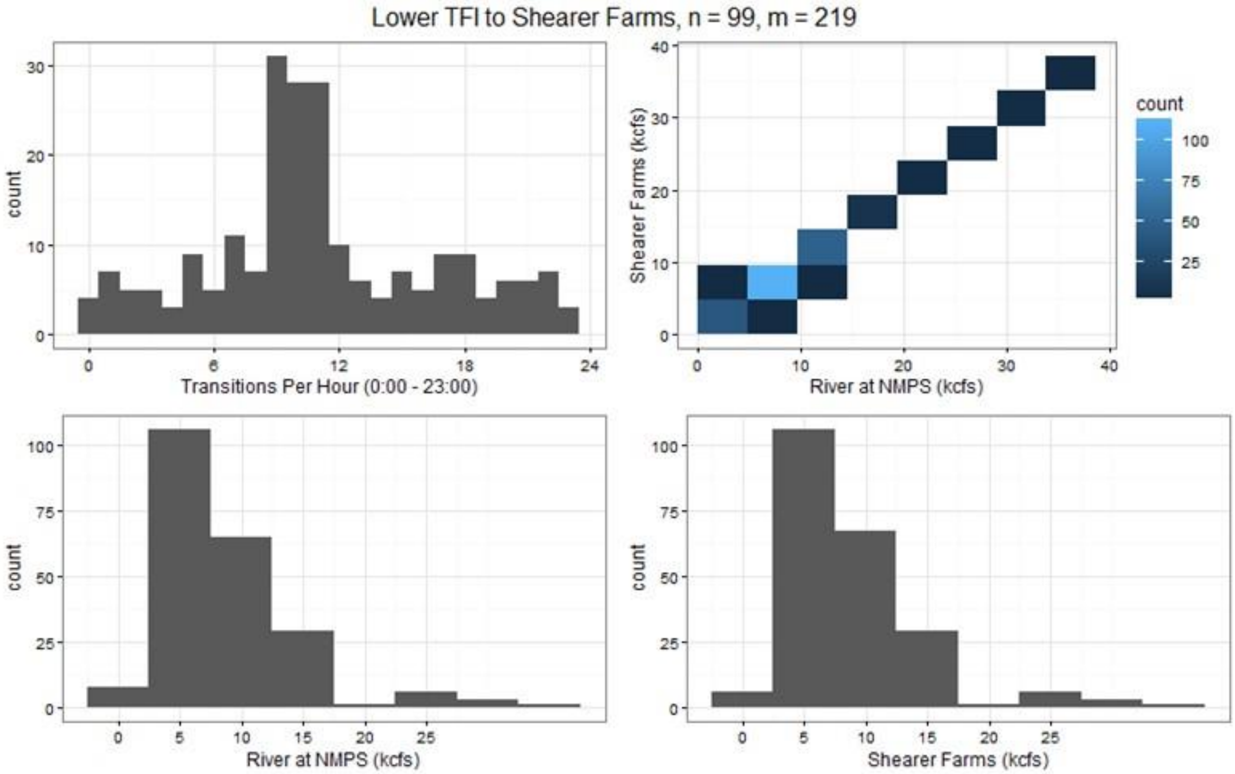

Figure 2.8.6-5: The environmental conditions at event time for fish (n = 99) moving between the tailrace and the bypass reach (m = 219).

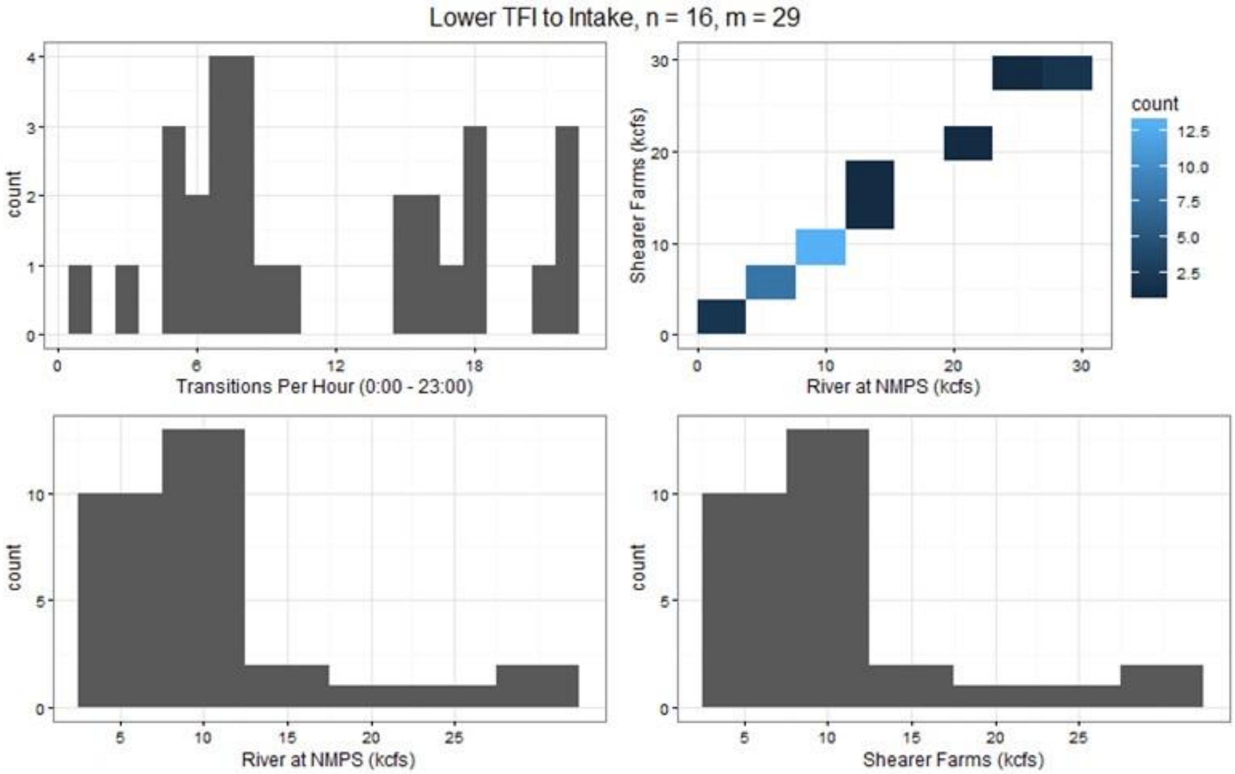

Figure 2.8.6-7: The environmental conditions at event time for fish (n = 16) moving between the tailrace and the bypass reach (m = 29).

2.8.7 Overall Probability of Arrival at Vernon

This section addresses the following agency comments: CRWC-1(1&2), CRWC-3, CRWC-6(2), CRWC-19, MADFW-8, USFWS-8, USFWS-14(1), MADFW-5(2), MADFW-7, MADFW-24, NMFS-1, NMFS-2(1,3,&4), USFWS-13(2), USFWS-17(1), USFWS-25

FirstLight fit two Cormack-Jolly-Seber (CJS) open population mark recapture models to assess the probability that a fish released at Holyoke will eventually arrive at Vernon Dam. The first model followed a fish as it passed every major receiver group through the project and up the bypass reach. The second model was more general, simplified receiver groups into major reaches, and included fish that used both the bypass reach and power canal on their upstream migration. The section does not supersede any previous model, but given the logical progression of upstream to downstream movement models, this is the most logical location for discussion of the overall probability of upstream arrival.

The first model assessed the proportion of marked American Shad that successfully move through the project (Holyoke to Vernon) by utilizing the Bypassed Reach. In total, the CJS model incorporated recapture histories from 152 tagged American Shad from five release cohorts (releases occurred May 6, 12, 19, 26, and June 8 at Holyoke) at 11 recapture locations: Red Cliff Canoe Club, Sunderland (Route 116 Bridge), Montague, Cabot Tailrace, lower Bypassed Reach, Rawson Island, upper Bypassed Reach, Spillway Ladder, Gatehouse Ladder, impoundment, and Vernon Dam area. Recapture at a receiver within any of the project reaches means recapture within the entire reach. The impoundment recapture location consisted of all receivers within the TFI including Gill Bank, NMPS Intake, and Shearer Farms. In addition, the TransCanada study team provided detection data for receivers located upstream of the FL study area (i.e., near Stebbins Island and Vernon Dam). For each release cohort, the CJS model estimated recapture probabilities (p) and arrival (or survival) probabilities (ϕ) for each of the 11 locations described above.

The CJS model reduces bias associated with low recapture rates and provides confidence intervals around the estimate. The CJS model assumes arrival at each recapture occasion is independent; therefore, the overall project passage is simply the product of the individual reach arrivals. Results of the CJS estimates of recapture probability (including 95% confidence intervals) per reach for each of the five release cohorts is summarized in Table 2.8.7-1 and arrival (or survival) probabilities are summarized in Figure 2.8.7-1. Recapture probabilities are based on the actual detections of fish, such that a zero entry followed by a probability greater than zero at a subsequent receiver suggests fish avoided detection or receiver malfunction. In general, it appeared fish released earlier in the season were more likely to be recaptured at Vernon than those released later in May, although 5.3% of the June-released fish were estimated to be recaptured in the area of Vernon Dam (Table 2.8.7-1).

Based on these data, the overall project passage (from Release to Vernon Dam via the Bypass Reach and Spillway Ladder) for all cohorts combined was estimated as about 4.0%. Arrival probabilities appeared to decrease sharply between Sunderland and Montague, as well as from Cabot Tailrace to the lower Bypass Reach (Figure 2.8.7-1). It should be noted that shad spawning has been documented downstream of the Montague site, as well as in the vicinity of Rock Dam, which is located in the lower Bypass Reach. Figure 2.8.7-2 depicts upstream arrival probabilities for all cohorts combined and provides an indication of potential bottlenecks to upstream passage through the project. The large bottleneck associated with the reach between the Tailrace and anywhere upstream can be attributed to the large number of fish that start their emigration from this location. The stretches of river between Sunderland and Montague; the Cabot Tailrace and lower Bypass Reach; and the upper Bypass Reach and Spillway Ladder depict decreases in arrival probabilities that could be representative of bottlenecks.

The second and more general and simplified CJS model, assessed the proportion of marked American Shad (n=156) that successfully move through the project (Holyoke to Vernon) for each release cohort and based on five recapture locations within the study area: Lower River, Project, Gatehouse Ladder, Impoundment (or TFI), and Vernon Dam area. Recapture at a receiver anywhere within these reaches means recapture within the entire reach. The Lower River recapture site included the receivers downstream of Montague.

Recapture at the Project was indicated by detections at and all receivers between Montague and Gatehouse Ladder. The impoundment recapture location consisted of all receivers within the TFI including Gill Bank, NMPS Intake, and Shearer Farms. In addition, the TransCanada study team provided detection data for receivers located upstream of the FL study area (i.e., near Stebbins Island and Vernon Dam). For each release cohort, the CJS model estimated recapture probabilities (p) and arrival (or survival) probabilities (ϕ) for each of the 5 locations described above.

Results of the CJS estimates of recapture probability (including 95% confidence intervals) per reach (n=5) for each of the five release cohorts is summarized in Table 2.8.7-3 and arrival (or survival) probabilities are summarized in Table 2.8.7-4. Recapture probabilities are based on the actual detections of fish, such that a zero entry followed by a probability greater than zero at a subsequent receiver suggests fish avoided detection or receiver malfunction. In general, recapture probabilities were lower for the fish moving from the Project to Gatehouse Ladder, with the exception of fish released on May 19 (Figure 2.8.7-3).

Based on the simplified reach assessment, the overall project passage (from the Lower River to Vernon Dam area) for each release cohort ranged from 0 to 9% (Figure 2.8.7-3). Arrival probabilities appeared to decrease between Lower River and the Project, as well as from the Project to Gatehouse Ladder. It should be noted that shad spawning has been documented downstream of the Montague site, as well as in the vicinity of Rock Dam, which is located in the lower Bypass Reach. Figure 2.8.7-4 depicts upstream arrival probabilities for all cohorts combined and provides an indication of potential bottlenecks to upstream passage through the project. The stretch of river between the Project (Montague) and Gatehouse Ladder depicts a decrease in arrival probabilities that could be representative of bottlenecks. Note this stretch of river represents both the Bypass Reach and Power Canal pathways for upstream passage of adults.

Table 2.8.7-1: CJS estimates of upstream recapture probability (p) and 95% confidence intervals per reach (n=11) for each of the five release cohorts.

(p) Reach	Release Cohort				
	6-May	12-May	19-May	26-May	8-Jun
Canoe Club	0.51 (0.33-0.69)	0.43 (0.23-0.66)	0.59 (0.33-0.80)	0.95 (0.53-1.00)	0.58 (0.46-0.68)
Sunderland	0.88 (0.67-0.97)	0.64 (0.38-0.84)	0.79 (0.38-0.96)	0.60 (0.11-0.95)	0.7 (0.46-0.87)
Montague	0.80 (0.57-0.92)	0.65 (0.38-0.84)	0.71 (0.33-0.93)	0.60 (0.11-0.95)	0.73 (0.63-0.87)
Cabot Tailrace	0.86 (0.59-0.97)	0.76 (0.46-0.92)	1.00 (1.000-1.00)	1.00 (1.00-1.00)	0.84 (0.70-0.92)
Lower Bypass	1.000 (1.000-1.000)	0.89 (0.30-0.99)	1.00 (1.000-1.00)	1.00 (1.00-1.00)	0.95 (0.71-0.99)
Rawson Island	0.71 (0.36-0.91)	0.36 (0.07-0.80)	0.46 (0.02-0.98)	1.00 (1.00-1.00)	0.59 (0.33-0.80)
Upper Bypass	0.89 (0.30-0.99)	0.54 (0.13-0.91)	0.15 (0.00-0.88)	0.00 (0.00-0.00)	0.63 (0.29-0.87)
Spillway Ladder	0.800 (0.15-0.99)	0.38 (0.02-0.94)	0.00 (0.00-0.00)	1.00 (1.00-1.00)	0.50 (0.15-0.85)
Gatehouse Ladder	1.000 (1.000-1.000)	1.000 (1.000-1.000)	0.1.00 (0.00-1.00)	0.00 (0.00-0.00)	0.875 (0.27-0.99)
Impoundment	1.000 (1.000-1.000)	1.000 (1.000-1.000)	0.000 (0.00-0.00)	0.07 (0.07-0.07)	1.000 (1.000-1.000)
Vernon	1.000 (1.000-1.000)	1.000 (1.000-1.000)	0.03 (0.03-0.03)	0.28 (0.28-0.28)	1.000 (1.000-1.000)

Table 2.8.7-2: CJS estimates of upstream arrival (or survival) probability (Φ) and 95% confidence intervals per reach for each of the five release cohorts.

(Φ) Reach	Release Cohort				
	6-May	12-May	19-May	26-May	8-Jun
Release: Canoe Club	1.000 (0.02-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.000 (0.02-1.00)	1.000 (1.00-1.00)
Canoe Club: Sunderland	0.91 (0.70-0.98)	0.89 (0.56-0.98)	0.70 (0.38-0.90)	0.67 (0.12-0.97)	0.79 (0.66-0.88)
Sunderland: Montague	0.88 (0.64-0.97)	0.94 (0.34-1.00)	0.69 (0.33-0.91)	0.37 (0.07-0.82)	0.81 (0.66-0.90)
Montague: Cabot Tailrace	0.96 (0.39-0.99)	1.00 (1.00-1.00)	1.00 (0.02-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Cabot Tailrace: Lower Bypass	0.69 (0.46-0.86)	0.58 (0.29-0.82)	0.57 (0.23-0.86)	0.800 0.15-0.99)	0.63 (0.47-0.76)
Lower Bypass: Rawson Island	0.78 (0.42-0.95)	0.66 (0.16-0.95)	0.82 (0.00-1.00)	0.50 (0.06-0.94)	0.77 (0.44-0.91)
Rawson Island: Upper Bypass	0.79 (0.32-0.97)	1.00 (0.00-1.00)	1.00 (0.02-1.00)	0.50 (0.50-0.50)	0.83 (0.20-0.99)
Upper Bypass: Spillway Ladder	0.56 (0.18-0.88)	0.54 (0.02-0.99)	0.16 (0.00-1.00)	0.99 (0.99-0.99)	0.47 (0.14-0.92)
Spillway Ladder: Gatehouse Ladder	0.50 (0.12-0.88)	0.50 (0.02-0.99)	0.99 (0.00-1.00)	0.00 (0.00-0.95)	0.47 (0.14-0.83)
Gatehouse Ladder: Impoundment	1.00 (1.00-1.00)	0.67 (0.06-0.98)	0.00 (0.00-0.97)	0.01 (0.01-0.01)	0.78 (0.28-0.97)
Impoundment: Vernon	1.00	1.00	0.021	0.28	1.000

	(1.00-1.00)	(1.00-1.00)	(0.021-0.021)	(0.28-0.28)	(1.00-1.00)

Table 2.8.7-3: CJS estimates of upstream recapture probability (p) and 95% confidence intervals per reach (n=5) for each of the five release cohorts.

(p) **Reach**	**Release Cohort**				
	6-May	**12-May**	**19-May**	**26-May**	**8-Jun**
Lower River	0.91 (0.90-0.96)	0.81 (0.66-0.90)	0.90 (0.74-0.97)	0.95 (0.72-0.99)	0.89 (0.83-0.93)
Project	1.00 (1.00-1.00)	1.00 (0-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Gatehouse Ladder	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.06 (0.01-0.33)	0.00 (0.00-1.00)	0.78 (0.42-0.94)
Impoundment	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (0.07-1.00)	0.001 (0.00-1.00)	1.00 (1.00-1.00)
Vernon	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.00 (0.00-0.00)	0.07 (0.00-1.00)	0.943 (0.00-1.00)

Table 2.8.7-4: CJS estimates of upstream arrival (or survival) probability (ϕ) and 95% confidence intervals per reach (n=5) for each of the five release cohorts.

(ϕ) Reach	**Release Cohort**				
	6-May	**12-May**	**19-May**	**26-May**	**8-Jun**
Release- Lower River	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Lower River - Project	0.79 (0.66-0.87)	0.81 (0.65-0.90)	0.52 (0.35-0.68)	0.25 (0.25-0.25)	0.63 (0.55-0.70)
Project - Gatehouse Ladder	0.11 (0.05-0.25)	0.10 (0.03-0.28)	1.00 (1.00-1.00)	0.00 (0.00-0.00	0.12 (0.07-0.20)
Gatehouse Ladder - Impoundment	1.00 (1.00-1.00)	0.67 (0.15-0.96)	0.06 (0.01-0.34)	0.00 (0.00-1.00)	0.78 (0.42-0.94)
Impoundment - Vernon	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.00 (0.00-0.00)	0.07 (0.00-1.00)	0.94 (0.00-1.00)

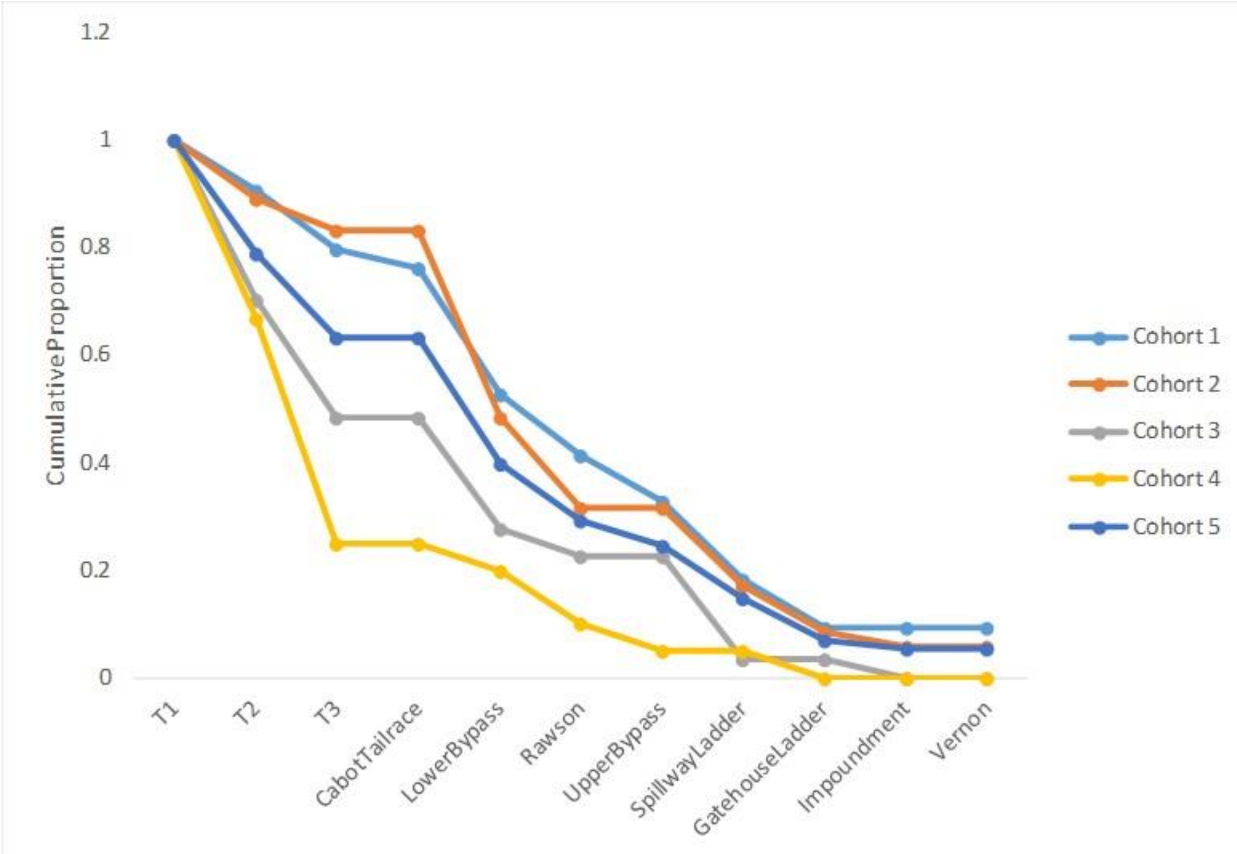

Figure 2.8.7-1: Upstream cumulative arrival probability (Φ) for five release cohorts as they utilize the Bypass Reach to move through the Project area.

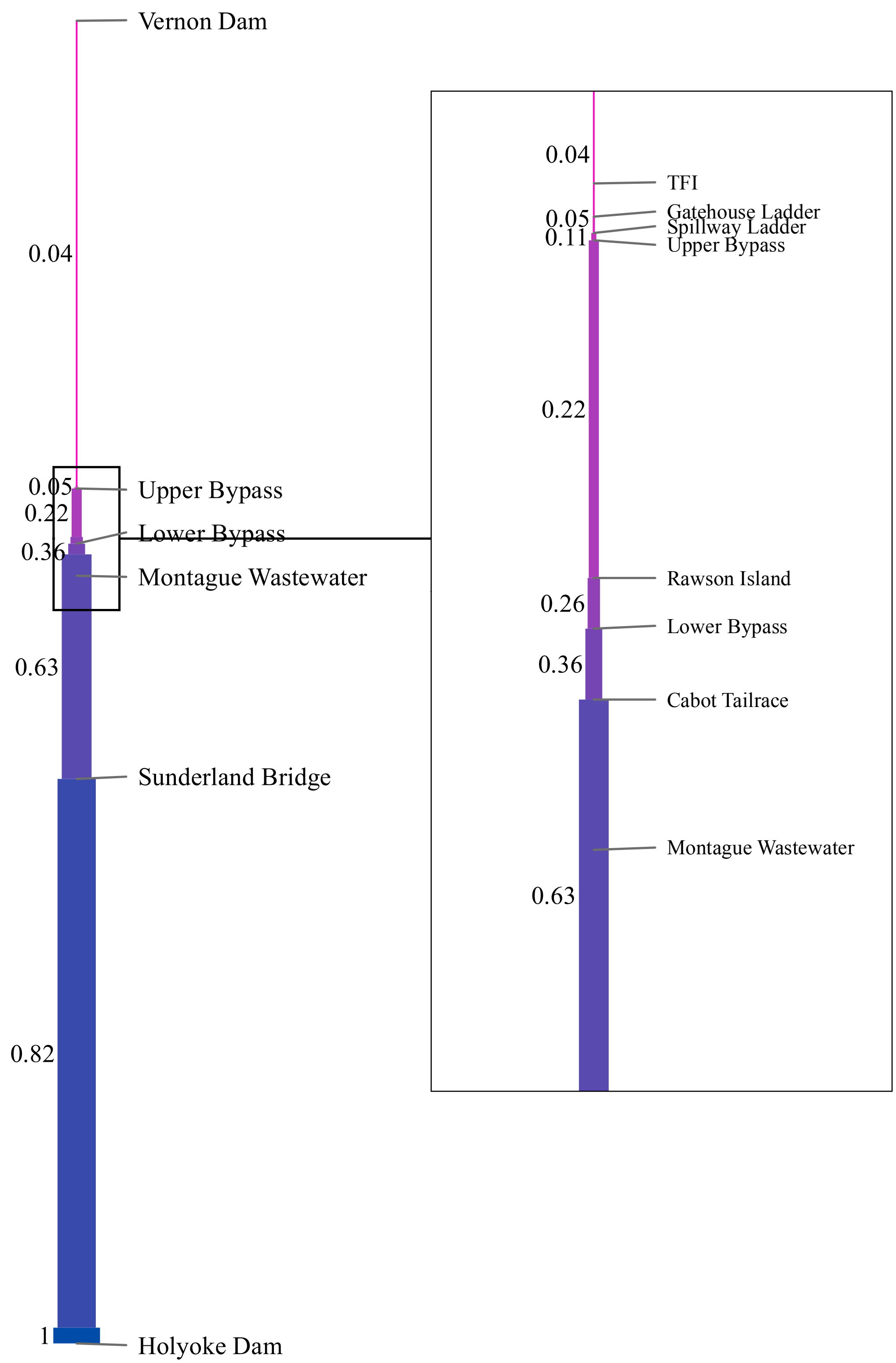

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Figure 2.8.7-2: Overall probability of upstream project passage by reach (n=11) for all release cohorts combined

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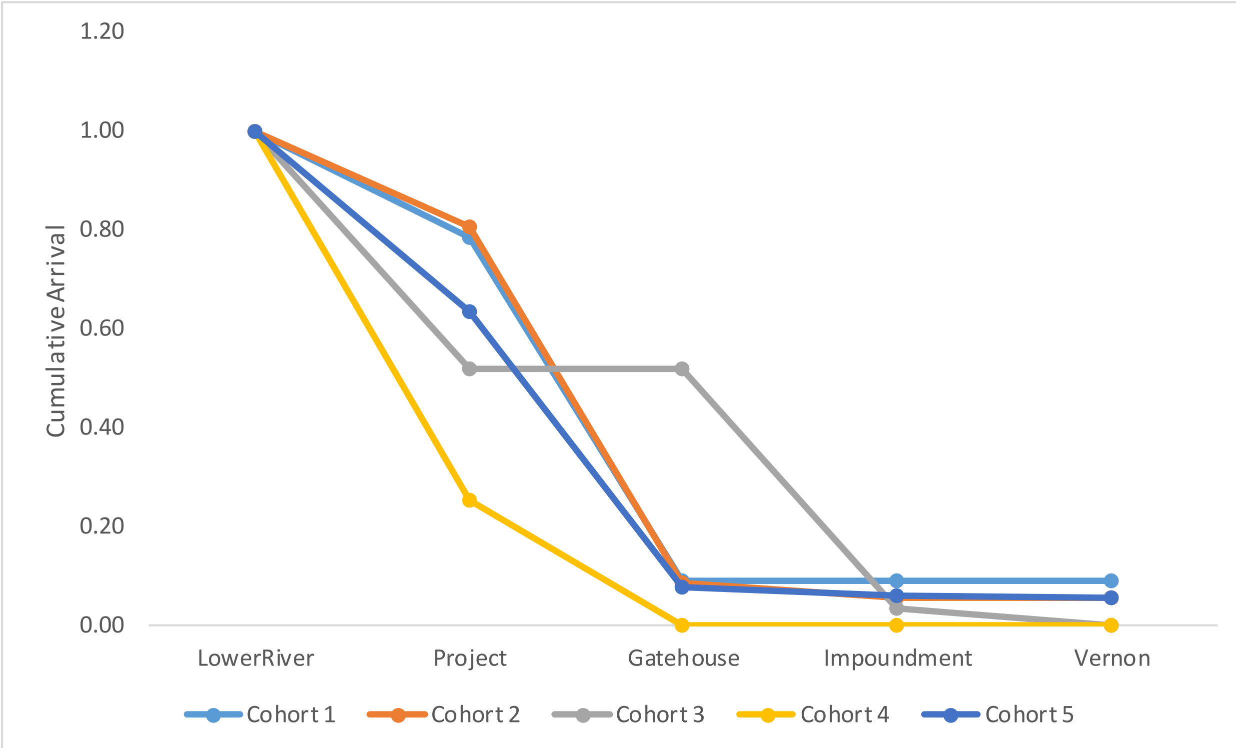

Figure 2.8.7-3: Upstream cumulative arrival probability for five release cohorts as they move through the Project area divided into five reaches

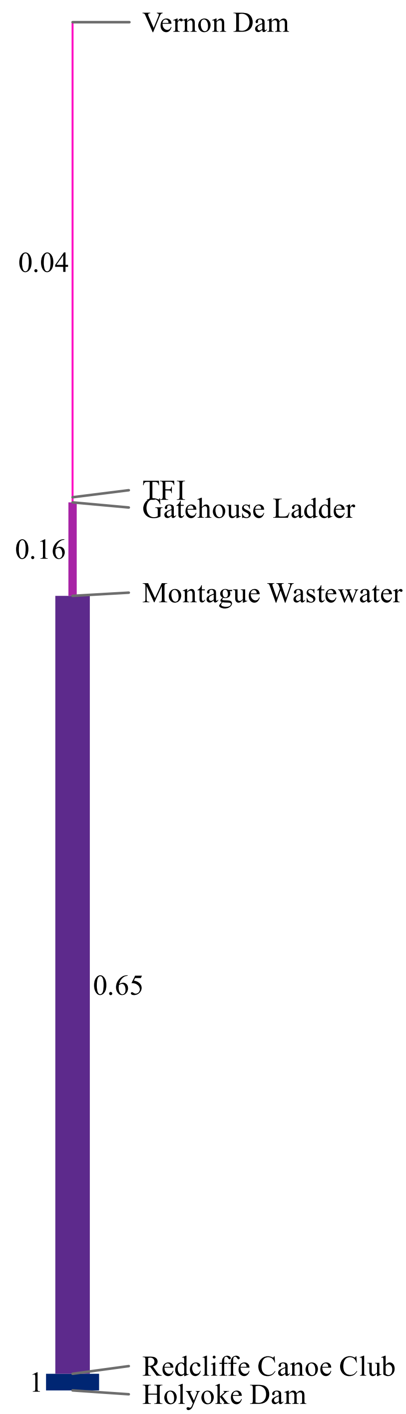

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Figure 2.8.7-4: Overall probability of upstream project passage by reach (n=5) for all release cohorts combined

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2.8.8 4.6.11 Emigration through the Turners Falls Impoundment

This analysis supersedes previous work and is meant to replace section 4.6.10 Upstream Migration through the TFI.

As a result, this section addresses the following agency comments: CRWC-1(2), CRWC-15(2) MADFW-11, MADFW-12, NMFS-4, USFWS-5, USFWS-20(3), USFWS-23(1)

Fish emigrating downstream through the Turners Falls Impoundment (TFI) can continue down river toward the lower impoundment (T23, T24), be attracted to the NMPS Intake (T25), or remain in the upper TFI at Shearer Farms (T26, T27). Fish can transition into any of these reaches (states) and they can make multiple attempts back and forth between the initial state (Shearer Farms) and a competing route (lower TFI, NMPS Intake). If a fish remains at Shearer Farms until their last detection, they transition into the unknown state.

In total, there were 65 fish detected in the upper impoundment (Shearer Farms) during their downstream emigration from 9 release cohorts (May 6th, 12th, 13th, 15th, 16th, 19th, 22nd, 23nd, 2015). Table 2.8.8-1 and Figure 2.8.8-1 shows the raw recaptures within each state (Impoundment, Lower impoundment, NMPS intake, Unknown impoundment) and Table 2.8.8-1 contains the raw recaptures by release cohort (Holyoke, Cabot, or TFI). If we lost track of a fish before the end of a monitoring period, it was placed into an unknown state. Placing a fish into an unknown state has two important benefits. First, the Nelson-Aalen cumulative incidence plots will match empirical expectations (Figure 3.8.8-2). Second, rather than censoring individuals that remain within the upper impoundment up until their last detection in the model, we placed them into an ‘unknown’ state so they remain in the denominator and not bias statistics in favor of downstream migration or movement into the intake. Since we are not considering movement during the migration phase for this model, the upper impoundment may have been the most downstream location for fish in an unknown state.

Table 2.8.8-2 describes the total number of movements by all fish (m) between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach. In total, there were 62 transitions from Shearer Farms to the lower TFI. Interestingly, there were 13 transitions from the impoundment to the NMPS Intake and 31 transitions from the lower TFI to the NMPS intake. The frequency of these movements made by individual fish from Shearer Farms to adjacent states is plotted in the histograms of Figure 2.8.8-3, which simply counts the number of movements made by a fish between locations. Note that 50 fish moved from Shearer Farms to the lower TFI once, while three fish made upwards of 5 of these movements. Sixty-three fish from 9 release cohorts were recaptured in the lower TFI (Table 2.8.8-1). The histograms in Figure 2.8.8-3 indicate that the majority of those fish moving into the NMPS Intake made only 1 back and forth transition between those states. Two fish transitioned into the unknown intake state from the intake, meaning they are at risk of entrainment.

Table 2.8.8-3 describes the amount of time (days) it took fish to transition from Shearer Farms to the lower TFI and the NMPS Intake. It is important to note that once a fish moves into any other state, the clock is reset. The median time (days) it takes fish to transition from Shearer Farms to the NMPS intake is 0.016 days. The median time it takes for fish to transition from Shearer Farms to the lower TFI is 0.19 days a distance of 1.62 rkm. Conversely emigrating fish take from 0.45 days to 15.05 days (median 1.02) to travel from the Cabot Tailrace (T5) to the Canoe Club (T1), a distance of 54.56 rkm. Fish are finding their way downstream to the lower impoundment quickly during their emigration phase, suggesting the fish are motivated to move downstream. This fast transition from the impoundment into the downstream areas is reflected in Figure 2.8.8-2. Figure 2.8.8-2 indicates the percent of fish remaining in the Impoundment over time (days) and Figure 2.8.8-3 is the cumulative incidence plot and represents the probability that a fish will move into a state at time (t). It is evident that fish do not spend a lot of time at Shearer Farms with a majority gone after a day.

A series of Cox Proportional Hazards regression models were fit to the impoundment emigration movements to assess time-to-lower TFI, time-to-Intake from Shearer and time-to-intake from the lower TFI. For the movement between the Shearer Farms and lower TFI, fish transitioned throughout the day Figure 2.8.8-4 (top left panel). However, it appears most of the transition occurred early morning and late afternoon and into the evening. It appears fish approached the lower TFI at river flows that range between 0 and 30,000 cfs (Figure 2.8.8-4 - bottom left panel) with peak movement occurring when the spill flow was 10,000 cfs. The top right panel counts the number of times fish transitioned during a particular NMPS / Gill Banks discharge bin. The majority of transitions occurred when both the flows were around 10,000 cfs. The top right panel shows strong correlation between either flow, therefore we only used Canal flow (kcfs) for this analysis. The best model for time to-lower TFI (AIC = 394.79) incorporated river flow at NMPS (kcfs) (Table 2.8.8-4). The model was significant (LR = 0.003), and the main effect of river flow at NMPS found that fish were more likely (HR = 1.05) to transition.

For the movement between the Shearer Farms and the intake, fish transitioned primarily during the early morning hours Figure 2.8.8-5 (top left panel). It appears fish approached the intake when NMPS was pumping (Figure 2.8.8-5 - bottom right panel) with peak movement occurring when the pumping flow was 9,000 cfs. The top right panel counts the number of times fish transitioned during a particular Generation / NMPS Pumping discharge bin. The majority of transitions occurred when pumping was hight. The best model for time-to-intake passage incorporated NMPS pumping operations and the change in river flow at NMPS (AIC = 89.94). The model was highly significant ($p < 0.001$), and the main effect of changing river flow (ft^3/s^2) (HR = 0.58, p = 0.008) and pumping operations (HR = 1.16, p = 0.04). In other words, as pumping flow increases, fish are more likely attracted to the intake, however as river flow accelerates, the likelihood of movement decreases.

Table 2.8.8-1: Raw recaptures within each state from the Impoundment by release date

Release Date	Release Location	Upper Impoundment	Lower Impoundment	NMPS Intake	Unknown Intake
5/6/2015	Holyoke	2	2	1	
5/12/2015	Holyoke	1	1		
5/13/2015	Cabot	2	2	2	
5/15/2015	Impoundment	15	15	4	
5/16/2015	Impoundment	14	14	3	
5/19/2015	Cabot	1	1		
5/19/2015	Holyoke	1	1		
5/22/2015	Impoundment	13	12	2	1
5/23/2015	Impoundment	16	15	6	1
Total		**65**	**63**	**18**	**2**

Table 2.8.8-2: describes the total number of movements by all fish (m) between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach.

To->	**Shearer**	**Lower TFI**	**NMPS Intake**	**Unknown Intake**
From				
Shearer	n: 65	n: 53 m: 62 Min: 1 Median: 1 Max: 5	n: 13 m: 13 Min: 1 Median: 1 Max: 1	n: 0 m: 0 Min: 0 Median: 0 Max: 0
Lower TFI	n: 3 m: 8 Min: 1 Median: 3 Max: 4	n: 63	n: 9 m: 31 Min: 1 Median: 3 Max: 11	n: 0 m: 0 Min: 0 Median: 0 Max: 0
NMPS Intake	n: 2 m: 2 Min: 1 Median: 1 Max: 1	n: 15 m: 40 Min: 1 Median: 2 Max: 12	n: 18	n: 2 m: 2 Min: 1 Median: 1 Max: 1

Table 2.8.8-3: Descriptive statistics of event times (days) from the Impoundment to an adjacent state

Event	Min	25%	Median	75%	Max
Lower Impoundment	0.000046	0.0427	0.19	0.50	30.67
NMPS Intake	0.0087	0.015	0.016	0.084	0.22

Table 2.8.8-4: Cox Proportional Hazards output for time-to-Lower Impoundment from Shearer

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	P	(+/-)
1	Diurnal (Day)	402.87	0.83	0.95	0.24	0.83	(0.60, 1.51)
2	River at NMPS (kcfs)	**394.80**	0.003	1.05	0.01	0.001	(1.02, 1.09)
3	NMPS gen (kcfs)	402.88	0.83	0.99	0.05	0.83	(0.92, 1.07)
4	NMPS pump (kcfs)	402.74	0.04	0.98	0.04	0.67	(0.92, 1.06)
5	Gill Banks (kcfs)	396.17	0.01	1.04	0.01	0.009	(1.01, 1.08)
6	River at NMPS (kcfs)	396.52	0.01	1.04	0.02	0.105	(0.99, 1.09)
	Gill Banks (kcfs)			1.02	0.03	0.57	(0.96, 1.07)

Table 2.8.8-5: Cox Proportional Hazards output for time-to-Intake passage from Shearer

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal (day)	104.61	0.59	1.34	0.54	0.59	(0.46, 3.88)
2	River at NMPS (kcfs)	104.47	0.37	1.03	0.03	0.33	(0.97, 1.08)
3	NMPS gen (kcfs)	102.84	0.03	0.74	0.19	0.10	(0.51, 1.06)
4	NMPS pump (kcfs)	94.69	0.02	1.22	0.06	<0.001	(1.10, 1.36)
5	Delta NMPS (ft^3/s^2)	91.72	0.02	0.48	0.13	<0.001	(0.37, 0.62)
6	NMPS pump (kcfs)	**89.94**	0.04	0.58	0.14	<0.001	(0.44, 0.77)
	Delta NMPS (ft^3/s^2)			1.16	0.07	0.04	(1.01, 1.33)

Table 2.8.8-6: Cox Proportional Hazards output for time-to-escape from the Intake

Model ID	Covariates	AIC	Robust	Hazard Ratio	SE	p	(+/-)
1	Diurnal (day)	11812.79	0.78	1.004	0.01	0.78	(0.98, 1.03)
2	River at NMPS (kcfs)	11812.68	0.30	1.001	0.00	0.331	(0.99, 1.003)
3	NMPS gen (kcfs)	11804.48	0.95	1.00	0.00	0.95	(0.999,1.002)
4	NFM pump (kcfs)	**11804.4**	0.02	0.99	0.00	0.05	(0.99, 1.00)
5	Delta NMPS (ft^3/s^2)	11796.15	0.32	1.003	0.003	0.29	(0.99, 1.01)

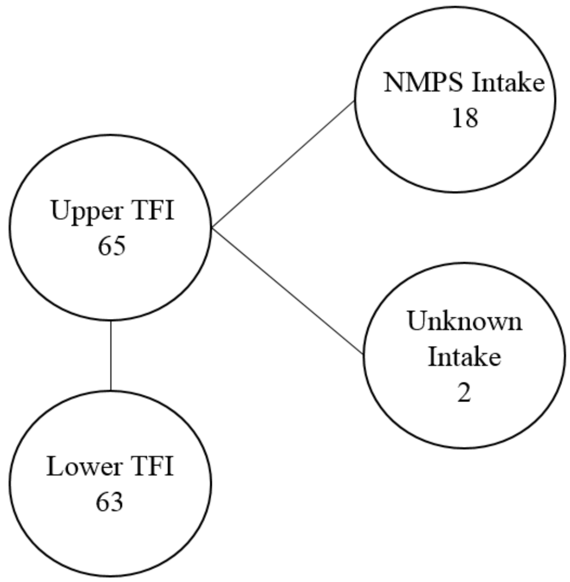


Figure 2.8.8-1: Unique number of fish per state in the TFI emigration model.

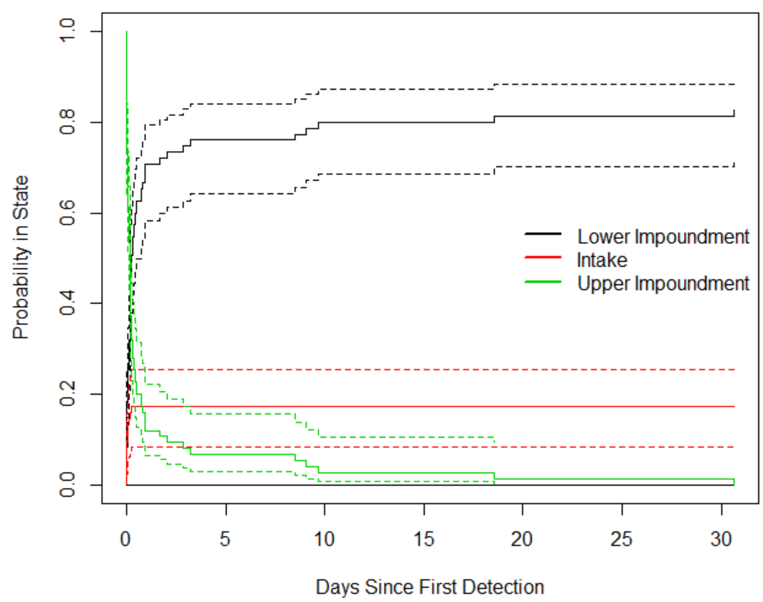


Figure 2.8.8-2: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that move from the upper Impoundment to the Lower Impoundment, or NMPS Intake. Note Kaplan-Meier curve for the Impoundment is superimposed to show that probabilities sum to 1.0 at all event times.

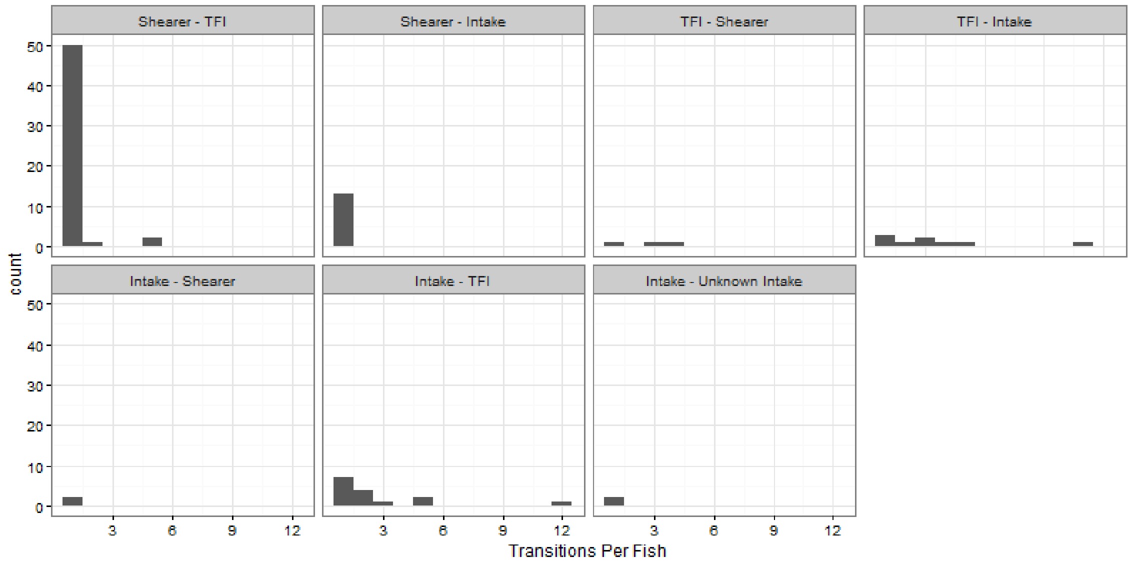


Figure 2.8.8-3: counts the number of movements per fish between reaches used within the Impoundment Emigration model. Fifty fish made at least 1 movement from Shearer Farms to the lower TFI.

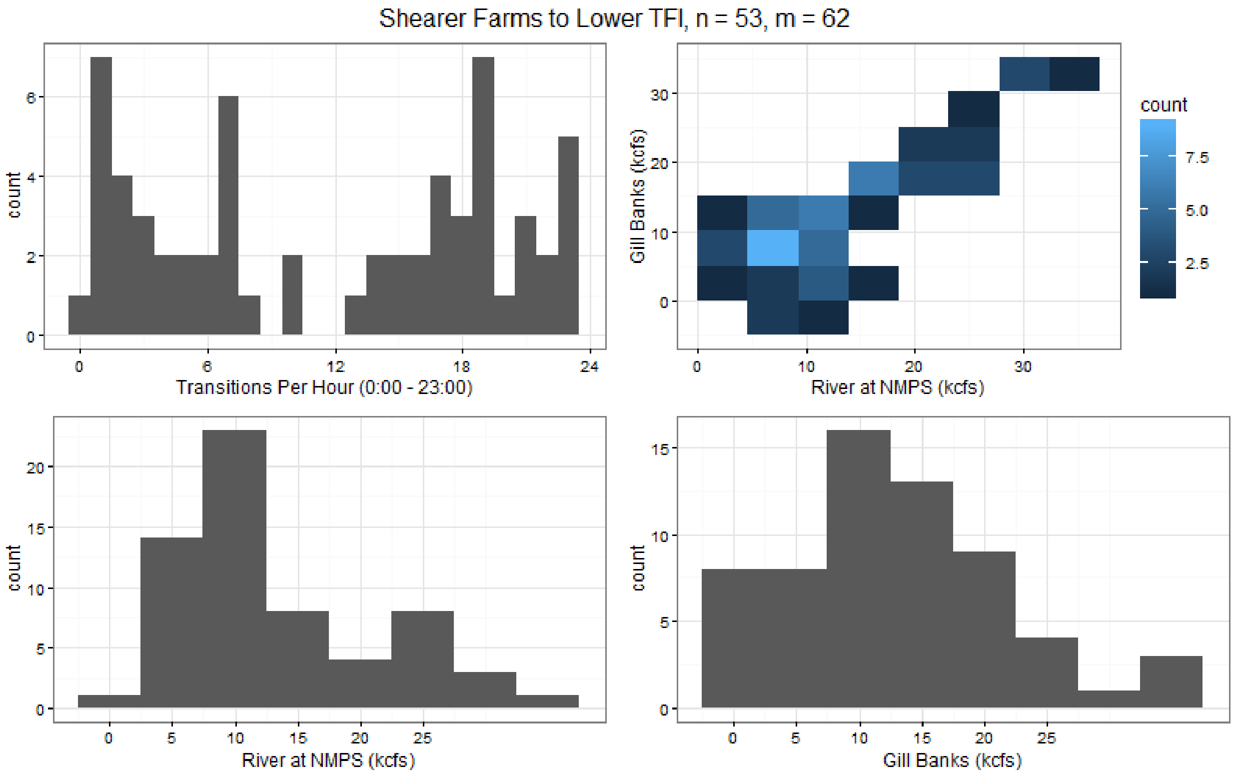


Figure 2.8.8-4: The environmental conditions at event time for fish (n = 53) moving between the Shearer Farms and the lower TFI (m = 62).

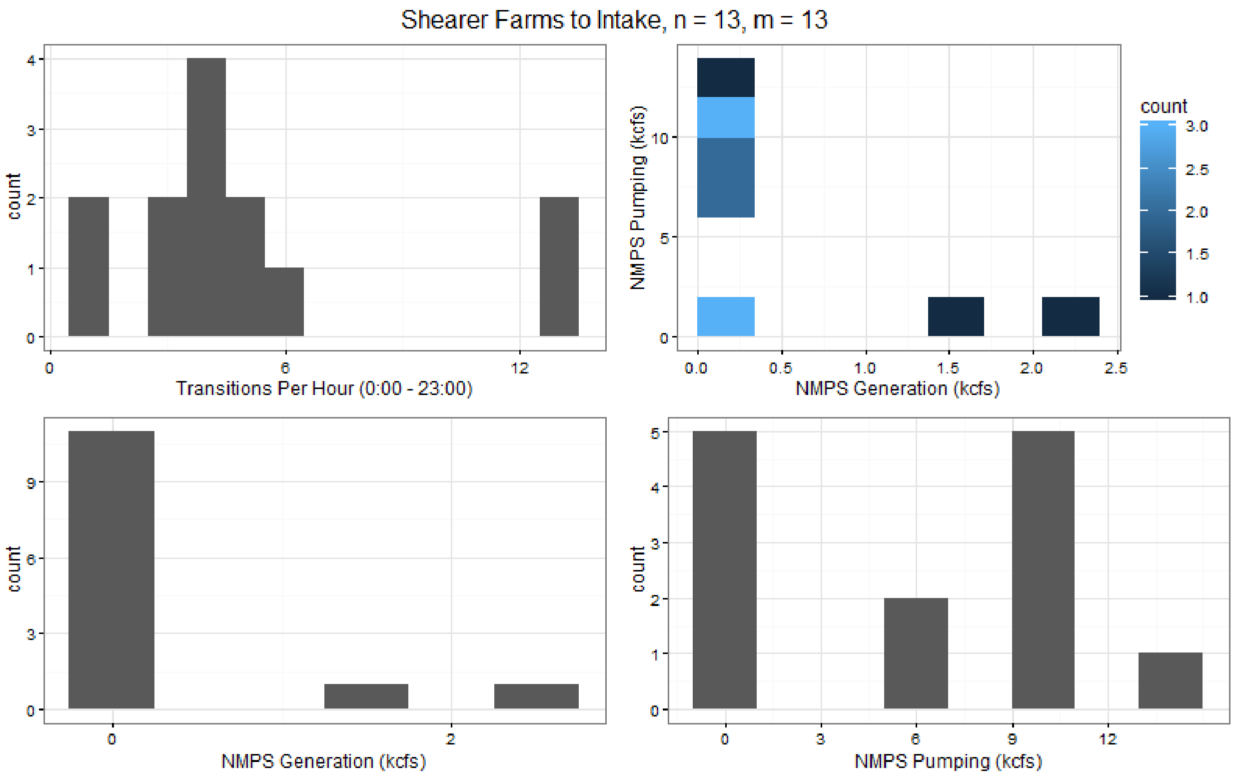


Figure 2.8.8-5: The environmental conditions at event time for fish (n = 13) moving between the Shearer Farms and the intake (m = 13).

2.8.9 4.6.12 Downstream Migratory Route Choice at Turners Falls Dam

This analysis supersedes previous work and is meant to replace section 4.6.12 Downstream Migratory Route Choice at Turners Falls Dam

As a result, this section addresses the following agency comments: CRWC-1(2), CRWC-16(1&2), MADFW-11, MADFW-12, MADFW-21, NMFS-6, NMFS-11, USFWS-5, USFWS-20(3), USFWS-24(1&2), USFWS-27(3)

Fish entering the lower impoundment (TFI) that approach Turners Falls Dam (TFD) can either pass via the Canal, into the Bypass Reach or not pass the dam and remain in the Impoundment. The route choice at Turners Falls Dam is the ideal platform for a competing risks analysis. Each route is absorbing, therefore there is no back and forth between the states. In other words, once they pass the Dam via the canal or the Bypass, they cannot return to the initial state (TFI).

In total, there were 68 emigrating fish detected in the lower Impoundment from 8 release cohorts (May 6th, 12th, 13th, 15th, 16th, 19th, 22nd, and 23rd, 2015). These fish are released from either: Holyoke, Cabot, the TFI and upstream at the Vernon project. Fish released in the TFI represent 90% of the fish analyzed in this model (n=61 fish). Table 2.8.9-1 and Figure 2.8.9-1 contain the raw recaptures within each state (TFI, Canal, Bypass and fish that did not pass). All fish that were detected in the initial state (TFI), made only one subsequent transition via a route of passage through the TFD (Table 2.8.9-2).

Table 2.8.9-2 describes the number of transitions from one state to the other. Passage through the canal accounted for 39 fish (~57%), followed by 12 fish (~18%) that passed over the dam into the Bypass and 17 fish (25%) that did not pass and remained in the Impoundment.

Table 2.8.9-3 shows the descriptive statistics of the event times (days) from the lower impoundment to an absorbing state of passage at TFD (Canal, Bypass or did not pass). The median time for passage via the canal was 0.53 days and the median time for passage into the bypass was much longer at 3.31 days.

We fit a series of Cox Proportional Hazards regression models to assess time-to-canal and time-to-bypass route selection. In both cases, 4 models were fit to each route. For the movement between the lower TFI and the canal, fish transitioned throughout the day Figure 2.8.9-3 (top left panel). However, it appears most of the transition occurred early morning and late afternoon and into the evening. It appears fish approached the canal when Canal flows range between 0 and 15,000 cfs (Figure 2.8.9-3 - bottom left panel) with peak movement occurring when the canal flow was 10,000 cfs. The top right panel counts the number of times fish transitioned during a particular Canal/Spill discharge bin. The majority of transitions occurred when both the flows were around 5 - 10,000 cfs. The best model incorporated canal flow (Table 2.8.9-4) and was highly significant (AIC = 264.09, LR = 0.001). An increase in 1000 cfs in Canal flow menas that fish are 1.1 times more likely to transition into the canal. The fish appear to follow the flow and are cued into the flow through the Gatehouse.

For the movement between the lower TFI and the canal, fish transitioned throughout the day Figure 2.8.9-3 (top left panel). It appears fish approached the bypass when canal flows range between 0 and 15,000 cfs (Figure 2.8.9-4 - bottom left panel) with peak movement occurring when the canal flow was 10,000 cfs. The top right panel counts the number of times fish transitioned during a particular Canal/Spill discharge bin. The majority of transitions occurred when both the flows were around 10,000 cfs. Turners Falls Spill (kcfs) was the only significant model for time-to-bypass route selection (Table 2.8.9-5). The model was significant (LR = 0.01) and the estimated hazard ratio (1.17) was greater than 1, suggesting that as spill flow increases by 1000 cfs fish are 1.13 times more likely to choose the spill route.

Table 2.8.9-1: Raw recaptures within each state from the Route Choice at TFD by release date

Release Date	Release Location	Lower Impoundment	Canal	Bypass	Did Not Pass
5/6/2015	Holyoke	2	2	0	0
5/12/2015	Holyoke	1	0	1	0
5/13/2015	Cabot	2	1	0	1
5/15/2015	Impoundment	15	8	3	4
5/16/2015	Impoundment	16	13	1	2
5/19/2015	Cabot	1	1	0	0
5/19/2015	Holyoke	1	0	1	0
5/22/2015	Impoundment	15	6	3	6
5/23/2015	Impoundment	15	8	3	4
Total		**68**	**39**	**12**	**17**

Table 2.8.9-2: describes the total number of movements by all fish (m) between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach.

To->	TFI	Canal	Bypass	Did Not Pass
From				
TFI	n: 68	n: 39 m: 39 Min: 1 Median: 1 Max: 1	n: 12 m: 12 Min: 1 Median: 1 Max: 1	n: 17 m: 17 Min: 1 Median: 1 Max: 1

Table 2.8.9-3: Descriptive Statistics of event times (days) from the Canal into an adjacent state

Event	Min	25%	Median	75%	Max
Canal	0.01	0.17	0.53	1.28	20.60
Bypass	0.23	0.55	3.31	5.97	33.54
Did Not Pass	0.01	0.08	1.36	3.08	14.77

Table 2.8.9-4: Cox Proportional Hazards output for Time-to-Canal route selection

Model ID	Covariates	AIC	LR Test	Hazard Ratio	SE	p	(+/-)
1	Diurnal (day)	274.69	0.86	0.95	0.33	0.865	(0.49, 1.80)
2	Canal Flow (kcfs)	264.09	0.001	1.10	0.03	0.001	(1.04, 1.16)
3	TF Spill (kcfs)	274.51	0.64	1.02	0.04	0.64	(0.94, 1.10)

Table 2.8.9-5: Cox Proportional Hazards output for Time-to-Bypass route selection

Model ID	Covariates	AIC	LR Test	Hazard Ratio	SE	p	(+/-)
1	Diurnal (day)	63.58	0.07	3.10	0.68	0.10	(0.82, 11.75)
2	TF Spill (kcfs)	59.78	0.006	1.18	0.06	0.006	(1.05, 1.32)
3	Canal Flow (kcfs)	65.15	0.21	1.07	0.06	0.22	(0.96, 1.20)

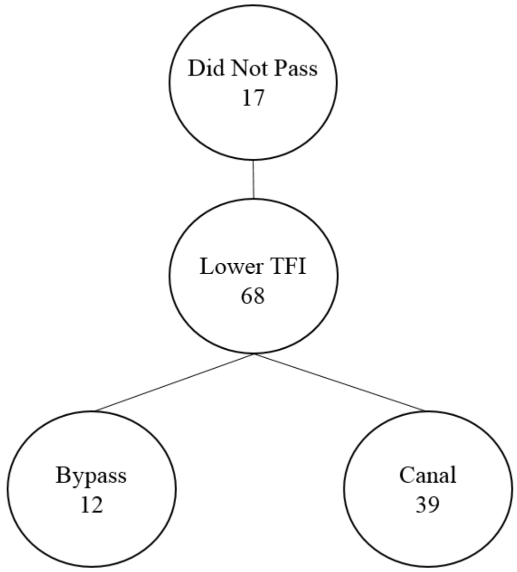


Figure 2.8.9-1: Unique number of fish per state in the Route Choice at TFD model.

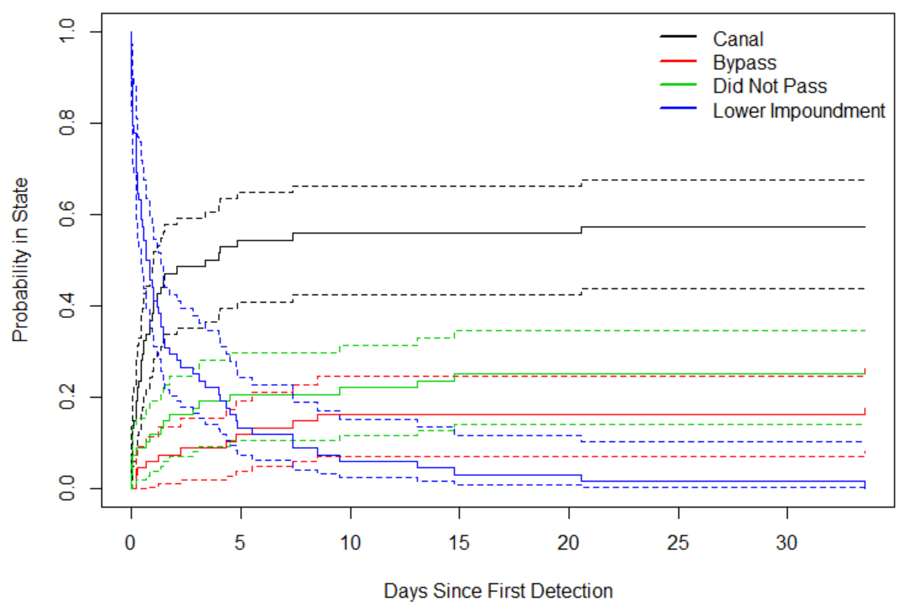


Figure 2.8.9-2: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that move from the Lower Impoundment to the Bypass, Canal, or do not pass the Dam. Note Kaplan-Meier curve for the Impoundment is superimposed to show that probabilities sum to 1.0 at all event times.

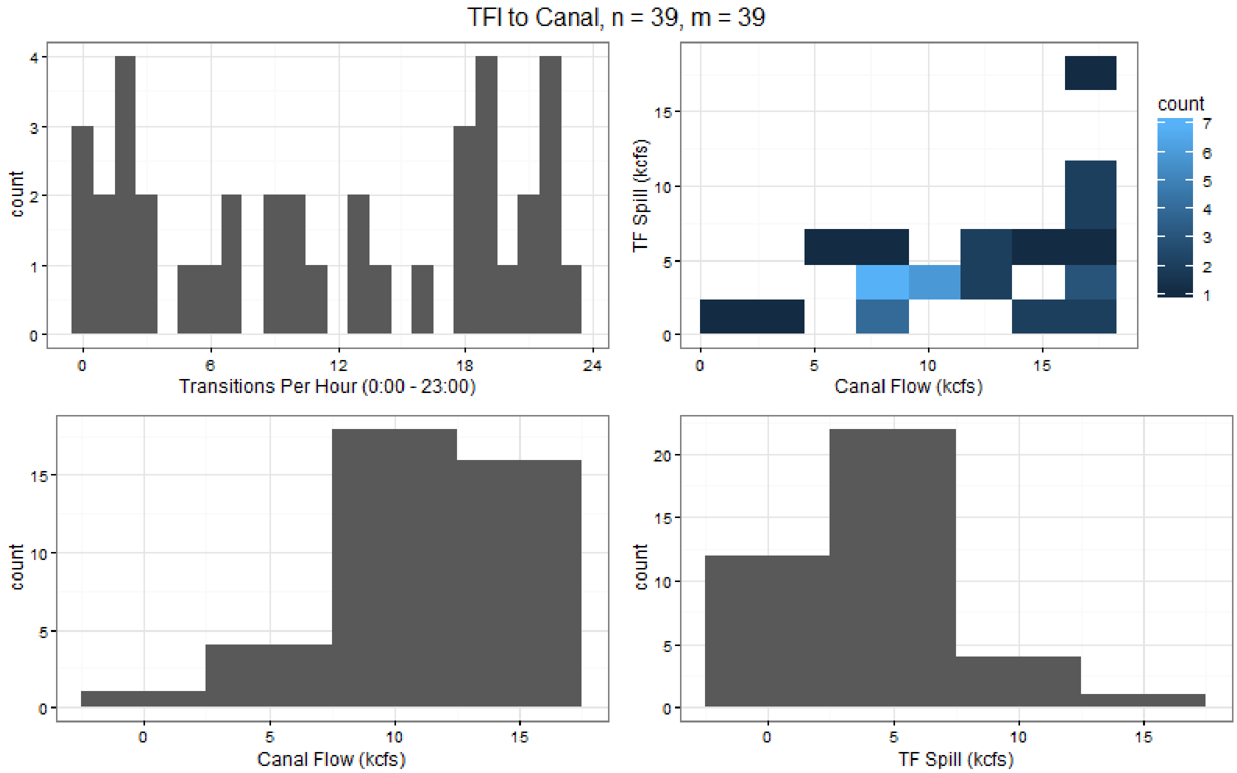


Figure 2.8.9-3: The environmental conditions at event time for fish (n = 39) moving between the TFI and the Canal (m = 39).

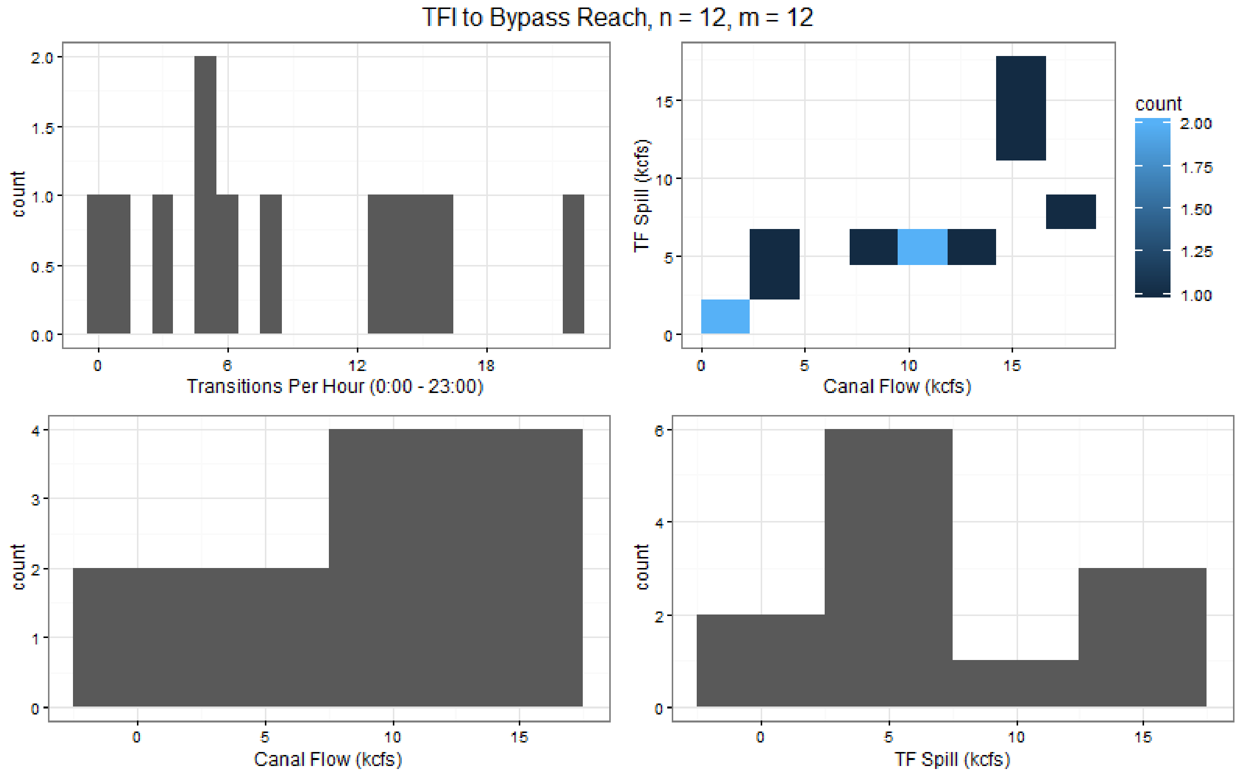


Figure 2.8.9-4: The environmental conditions at event time for fish (n = 12) moving between TFI and the Bypass Reach (m = 12).

2.8.10 4.6.13 Canal Emigration

This analysis supersedes previous work and is meant to replace section 4.6.13 Canal Emigration. These statistics are conditional on a dual tagged fish released from Holyoke, into the canal, into the TFI, or released at Vernon and having been detected at the Gatehouse Yagi (T22).

As a result, this section addresses the following agency comments: CRWC-1(2), CRWC-17, MADFW-2, MADFW-11, MADFW-12, MADFW-15, MADFW-22, USFWS-5, USFWS-10(4), USFWS-20(3&4), USFWS-24, USFWS-27(3&8)

Emigrating fish that are detected in the canal have multiple avenues of escapement. They can escape via the Cabot powerhouse, through the bypass sluice, they can remain in the canal or they escape with the route being unknown. Fish can also escape via Station No. 1, however no fish did this and therefore Station No. 1 was not added to this analysis. The model only included fish known to be emigrating. This model supersedes the previous Multi-State Markov model of movement through the canal based on comments from stakeholders as described above.

In total, there were 83 emigrating fish detected in the canal from 7 release cohorts (May 6th, 13th, 15th, 16th, 19th, 22nd and 23rd, 2015) (Table 2.8.10-1). These release dates represent fish from three release locations: Holyoke, Cabot and the TFI. The majority of fish recaptured in the canal (~51%) and analyzed in this model came from Cabot releases (n = 42 fish), with Impoundment releases representing (44%, n = 37) and only 5% (n = 4) coming from Holyoke releases. Table 2.8.10-1 and Figure 2.8.10-1 contain the raw recaptures within each state (canal, powerhouse, bypass sluice, fish remaining in the canal and unknown escapement fish). The downstream canal escapement data is the ideal platform for a competing risk analysis. We configured the model so that it did not capture milling between the Cabot Forebay and sluiceway entrance and simplified model reaches of previous version. For the new analysis, a fish is in the canal state until it is known to pass through one of the competing exit routes. Therefore, all the fish that were detected in the initial state (canal), made only one subsequent movement to the route of passage (Table 2.8.10-2).

Table 2.8.10-2 describes the number of transitions from one state to another and is similar to the state table produced by the MSM. We simplified the modeling of emigration through the canal, movement only occurred when the fish was in a passing state. A fish passed via the sluiceway from the canal if subsequent detections after the canal state were followed by detections at T9, P13 and then the tailrace (T5, T6). Passage through the powerhouse occurred when a fish was detected in the Cabot Forebay (T8) followed by subsequent detections in the tailrace (T5 or T6). The modeling did not incorporate milling between the Forebay (T8) and sluiceway entrance (T9). Table 2.8-2 describes the exact fate of all 83 fish analyzed in the model. Escapement through the bypass sluice accounted for 41 fish (~49%), followed by 30 fish (~36%) that escaped via the Cabot Station powerhouse, 8 fish (~10%) escaped via unknown avenues and 4 fish (~5%) remained in the canal.

Table 2.8.10-3 describes the time to passage event in (days), from the canal into a passage route. The max times for escapement through the powerhouse, bypass sluice and unknown escapement were 23.63, 18.84 and 29.51 days respectively meaning some emigrating fish were present for nearly a month in the canl before finding an escaping route. This means the slowest emigrating fish spent weeks in the canal before finally finding their escape routes. The fastest fish moved through the canal very quickly with minimum escapement times of 0.03, 0.01 and 0.03 days for the powerhouse, bypass sluice and unknown escapement, respectively. Fish KA-SHD-0022 (149.720 33) escaped the canal via the powerhouse in roughly 43 minutes (~0.03 days) and was recaptured at all receivers in the canal (T22, T21, T18, T13, T14, T8). This progressive string of downstream detections confirms full detection history from the upper to lower canal but also how quickly fish can move out of the canal when motivated.

A series of Cox Proportional Hazards regression models were fit to the canal escapement to describe time-to-passage through the powerhouse and the bypass sluice. The best model to assess time-to-passage at the Cabot Powerhouse incorporated Cabot Operations (kcfs) (AIC = 203.72, Table 2.8.10-4). The model was ot significant (LR <0.002). The estimated hazard ratio suggests that fish are 1.18 times more likely to pass through the powerhouse when discharge increases by 1000 cfs.

The best model to assess time-to-passage at the Bypass Sluiceway incorporated the rate of change in Cabot discharge (AIC = 289.61, Table 2.8.10-5). The model was very close to being significant (LR = 0.08) and the effect of increased rate of flow (p = 0.03) found that fish are less likely to use the spillway when the rate of discharge increased.

Aside from the competing risks assessment, FirstLight also constructed a CJS model to assess the proportion of tagged adult shad that successfully pass downstream of the project utilizing the Turners Falls Power Canal. The model incorporated recapture histories from 83 tagged emigrating fish that entered the canal and assessed recapture at eight locations subsequent to release including downstream of Gatehouse, Upper Canal, downstream of Station No. 1, Mid-Canal, Lower Canal, Cabot Station Forebay, Cabot Station Tailrace, and the lower river. The lower river location represents any receiver downstream of the Cabot Tailrace. Project passage was assumed to occur when fish arrived in the lower river. For all fish combined, regardless of route selected, the CJS model estimated recapture probabilities (p) and arrival (or survival) probabilities (ϕ) for each of the locations described above.

Results of the CJS estimates of recapture probability (including 95% confidence intervals) per location is summarized in Table 2.8.10-6 and arrival (or survival) probabilities are summarized in Table 2.8.10-7. Overall passage for fish that enter the canal and successfully move downstream past the Cabot Tailrace was estimated as 88% (Table 2.8.10-7). Figure 2.8.10-4 depicts arrival probabilities for downstream migrating fish in the Power Canal and provides an indication of potential bottlenecks to downstream passage in the canal. The greatest difference in arrival probability occurs between the Cabot Tailrace and Lower River, suggesting minimal impacts to downstream migrating shad that use the Power Canal.

Table 2.8.10-1: Raw recaptures within each state from the Canal by release date

Release	Release Location	Canal	Powerhouse	Bypass Sluice	Remained in canal	Unknown Escapement
5/6/2015	Holyoke	3	1	1	0	1
5/13/2015	Cabot	21	5	14	1	1
5/15/2015	Impoundment	9	5	2	1	1
5/16/2015	Impoundment	14	6	3	2	3
5/19/2015	Cabot	21	7	13	0	1
5/19/2015	Holyoke	1	0	1	0	0
5/22/2015	Impoundment	6	3	3	0	0
5/23/2015	Impoundment	8	3	4	0	1
Total		**83**	**30**	**41**	**4**	**8**

Table 2.8.10-2: escribes the total number of movements by all fish (m) between reaches, the number of fish (n) that made those movements and descriptive statistics of the number of times those fish made a transition. The diagonal counts the number of fish detected within each reach.

To->	**Canal**	**Powerhouse**	**Bypass Sluice**	**Remained in canal**	**Unknown Escapement**
From					
Canal	n: 83	n: 30 m: 30 Min: 1 Median: 1 Max: 1	n: 41 m: 41 Min: 1 Median: 1 Max: 1	n: 4 m: 4 Min: 1 Median: 1 Max: 1	n: 8 m: 8 Min: 1 Median: 1 Max: 1

Table 2.8.10-3: **Descriptive statistics of event times (days) from the Canal to an absorbing state**

Event	Min	25%	Median	75%	Max
Powerhouse	0.03	0.16	0.32	1.49	23.63
Bypass Sluice	0.01	0.11	0.42	2.68	18.84
Remained in Canal	0.02	0.03	1.53	10.10	31.32
Unknown Escapement	0.03	0.27	1.03	13.39	29.51

Table 2.8.10-4: **Cox Proportional Hazards output for time-to-Powerhouse passage**

Model ID	Covariates	AIC	LR Test	Hazard Ratio	SE	p	(+/-)
1	Diurnal (Day)	214.55	0.61	1.22	0.40	0.61	(0.55, 2.68)
2	Cabot Ops (kcfs)	203.72	<0.001	1.17	0.05	0.002	(1.06, 1.29)
3	Canal (kcfs)	201.85	<0.001	1.16	0.04	0.001	(1.07,1.27)
4	Delta Cabot Ops (ft^3/s^2)	204.32	0.48	0.81	0.29	0.47	(0.46, 1.43)

Table 2.8.10-5: Cox Proportional Hazards output for time-to-Sluiceway passage

Model ID	Covariates	AIC	LR Test	Hazard Ratio	SE	p	(+/-)
1	Diurnal (Day)	291.16	0.22	0.68	0.32	0.22	(0.37, 1.26)
2	Cabot Ops (kcfs)	292.32	0.58	1.02	0.03	0.58	(0.95, 1.10)
3	Canal (kcfs)	292.25	0.56	1.02	0.03	0.56	(0.96, 1.10)
4	Delta Cabot Ops (ft^3/s^2)	289.61	0.08	0.74	0.14	0.04	(0.56, 0.98)

Table 2.8.10-6: CJS estimated recapture probabilities (p) and 95% confidence intervals for shad migrating downstream through the Power Canal past the Cabot Tailrace.

Reach	p	Lower 95%	Upper 95%
d/s of Gatehouse	0.614	0.425	0.775
Upper Canal	0.530	0.347	0.705
d/s Station No. 1	0.614	0.425	0.775
Mid-Canal	0.735	0.543	0.866
Lower Canal	0.890	0.708	0.964
Cabot Forebay	0.975	0.775	0.998
Cabot Tailrace	0.768	0.575	0.890
Lower River	0.890	0.890	0.890

Table 2.8.10-7: CJS estimated arrival probability (Φ) and 95% confidence intervals for shad migrating downstream through the Power Canal past the Cabot Tailrace.

Reach	Φ	Lower 95%	Upper 95%
Release: d/s of Gatehouse	1.00	1.00	1.00
d/s of Gatehouse: Upper Canal	1.00	1.00	1.00
Upper Canal: d/s Station No. 1	1.00	1.00	1.00
d/s Station No. 1: Mid-Canal	1.00	1.00	1.00
Mid-Canal: Lower Canal	0.99	0.720	1.00
Lower Canal: Cabot Forebay	1.00	1.00	1.00
Cabot Forebay: Cabot Tailrace	1.00	1.00	1.00
Cabot Tailrace: Lower River	0.890	0.890	0.890

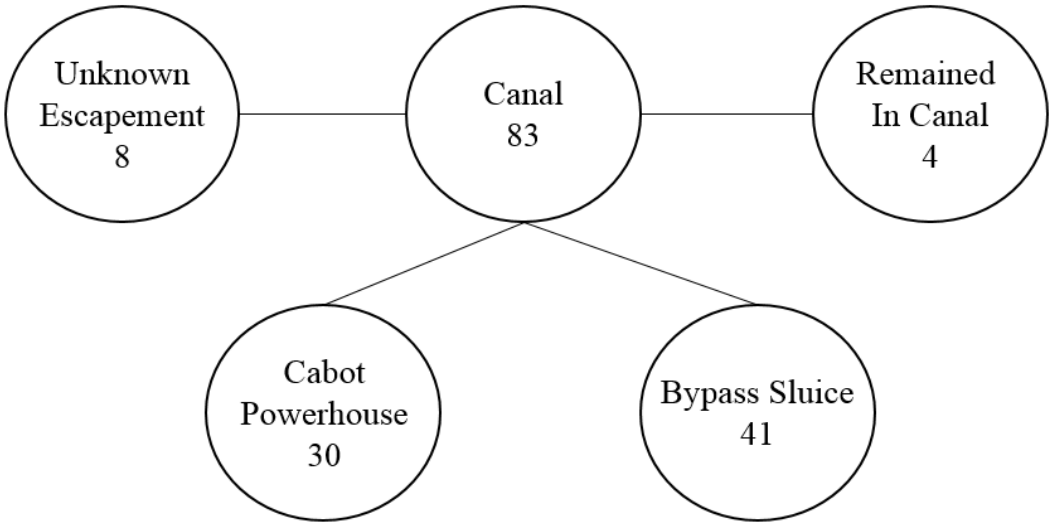


Figure 2.8.10-1: Unique number of fish per state in the Canal Escapement model.

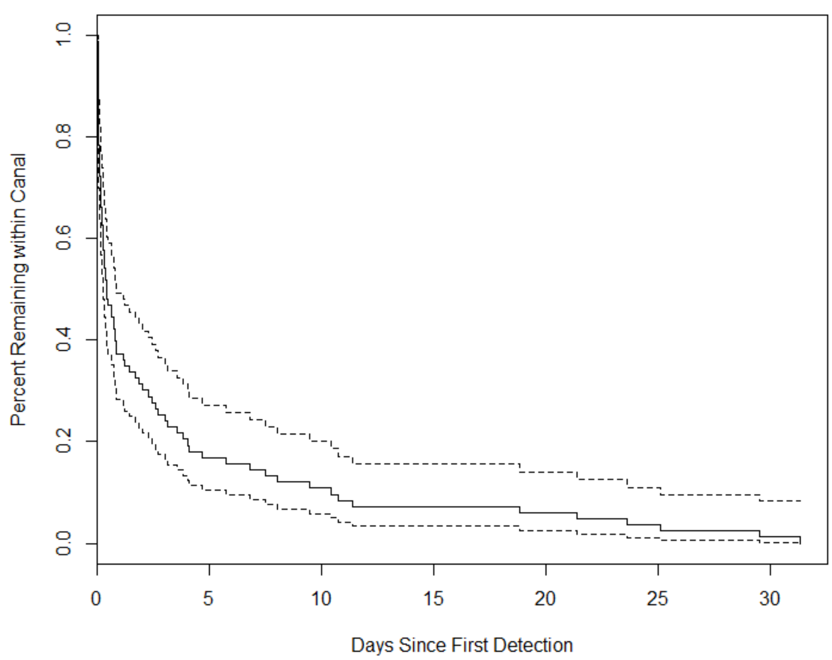


Figure 2.8.10-2: Kaplan-Meier survival curve for fish remaining in the Canal

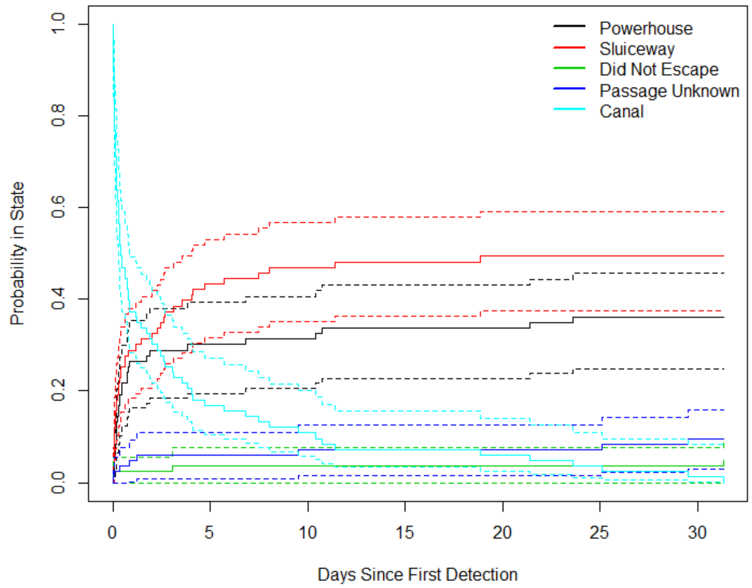
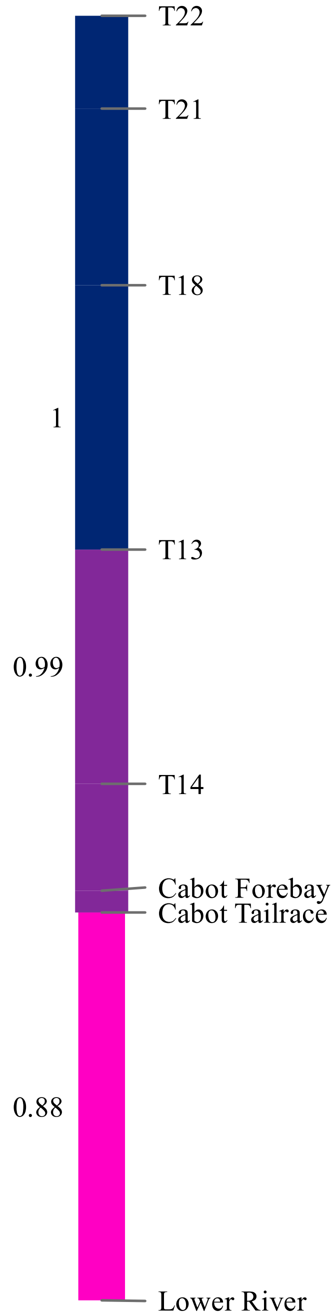


Figure 2.8.10-3: Nelson-Aalen cause-specific cumulative incidence curves showing probability of in state at time (t) for the fish that pass from the Canal through the powerhouse, sluiceway, did not escape the canal or passage unknown. Note Kaplan-Meier curve for Cabot Tailrace is superimposed to show that probabilities sum to 1.0 at all event times.



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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Relicensing Study 3.3.2

Figure 2.8.10-4: Overall probability of downstream passage through the Power Canal and past Cabot Tailrace

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2.9 Meta-Analysis of past studies at Turners Falls

This section is meant to place the results of the 2015 study in context with previous efforts to understand fish passage at Turners Falls per stakeholder comment.

This section addresses the following agency comments: CRWC-1(2), CRWC-11, CRWC-13, MADFW-4, NMFS-12(1&2), USFWS-1(2), USFWS-15(2)

Upstream fish passage facilities were operational at the Turners Falls Project by 1980. Although American Shad were immediately present when the facilities began operating, they were not passing the Project in the numbers expected (expected 50-60% of those that passed at Holyoke) (Figure 2.9-1). Various modifications were made to both fish ladders as well as the Gatehouse entrance (Exhibit E). Passage rates increased, but were still a fraction of the number of shad passing the Holyoke Fish Lift (a maximum of 14% in 2015). From 1981 to 2015, Holyoke passed as few as 117,000 shad in 2005, to as many as 722,000 shad in 1992 (Figure 2.9-1). In contrast, the greatest number of shad that passed the Gatehouse Fish Ladder in Turners Falls was 60,000 in 1992 (Figure 2.9-1), which represented only 8% of the fish that had passed Holyoke that year. In turn, Vernon Dam passes up to 86% of the fish that pass Turners Falls.

Comparing the number of fish passing the Turners Falls Project to the number of fish passing Holyoke tells only part of the story. The proportions discussed above do not illustrate the number of shad that attempt to pass the Turners Falls Project and fall back downstream, nor do they account for the shad that spawn downstream of the Turners Falls Project. Thirty-five river miles lie between the Holyoke and Turners Falls Projects and previous studies have documented shad spawning in that reach. Shad that use habitat downstream of the Turners Falls Project for spawning have no need to pass upstream of the Turner Falls Project.

Many studies have monitored shad migration from Holyoke through the Turners Falls Project since the fish ladders were installed in 1980. Tracking techniques varied depending on the goal of each study, but each used some combination of PIT tags and/or radio tags. Some studies focused on the Holyoke-to-Turners Falls reach only, while others assessed the entire river. The results of these studies have led to various modifications to the fish ladders throughout the years (Exhibit E). Four studies that include data from seven years were identified for comparison with the findings from FirstLight (2016b)[1]. Each of these studies examined fish passage through the Turners Falls Project, and included detailed data from each passage section. These studies included 1) a radio telemetry study conducted by Northeast Utilities in conjunction with the USFWS evaluating the migration between Holyoke and Turners Falls (Stira & Kuzmeskus 2000)[2]; 2) a four-year master's thesis spanning 1999 to 2002, conducted by Timothy Sullivan in conjunction with the Massachusetts Department of Wildlife and Fisheries Conservation that evaluated passage through the Turners Falls Project with the use of PIT tags (Sullivan 2004); 3) a study by the USGS Conte Anadromous Fish Lab monitoring fish passage through the Turners Falls Project, specifically the efficiency of the Gatehouse entrance (Castro-Santos & Haro 2005)[3]; and 4) a study conducted by the USGS Conte Anadromous Fish Lab in 2011 monitoring passage throughout the Turners Falls Project (Castro-Santos & Haro 2011)[4]. Tagging methods, number of fish tagged, and the area of concern for each study are summarized in Table 2.9-1.

[1] FirstLight (2016b) is referred to as FirstLight 2015 to clarify data is from 2015 migration season.
[2] Stira & Kuzmeskus (2000) is referred to as Northeast Utilities (2000).
[3] Castro-Santos & Haro (2005) is referred to as USGS (2005).
[4] Castro –Santos & Haro (2011) is referred to as USGS (2011).

Table 2.9-1: Summary of past studies used for comparison with 2015 results.

Author (Year)	Year(s) of Study	Tagging Technique	Total Number Fish Tagged	Area of Concern	Passage Efficiency		
					Cabot	Spillway	Gatehouse
Northeast Utilities (2000)	1993	Radio	155	Holyoke – Turners Falls	Yes	No	No
Sullivan (2004)	1999-2002	PIT	3,196	Holyoke – Turners Falls	Yes	Yes	Yes
USGS (2005)	2005	PIT & Radio	740	Holyoke-Turners Falls	Yes	Yes	Yes
USGS (2011)	2011	PIT & Radio	493	Lower River (Below Holyoke)-Turners Falls	Yes	Yes	Yes
Kleinschmidt (2016)	2015	PIT & Radio	793	Holyoke - Vernon	Yes	Yes	Yes

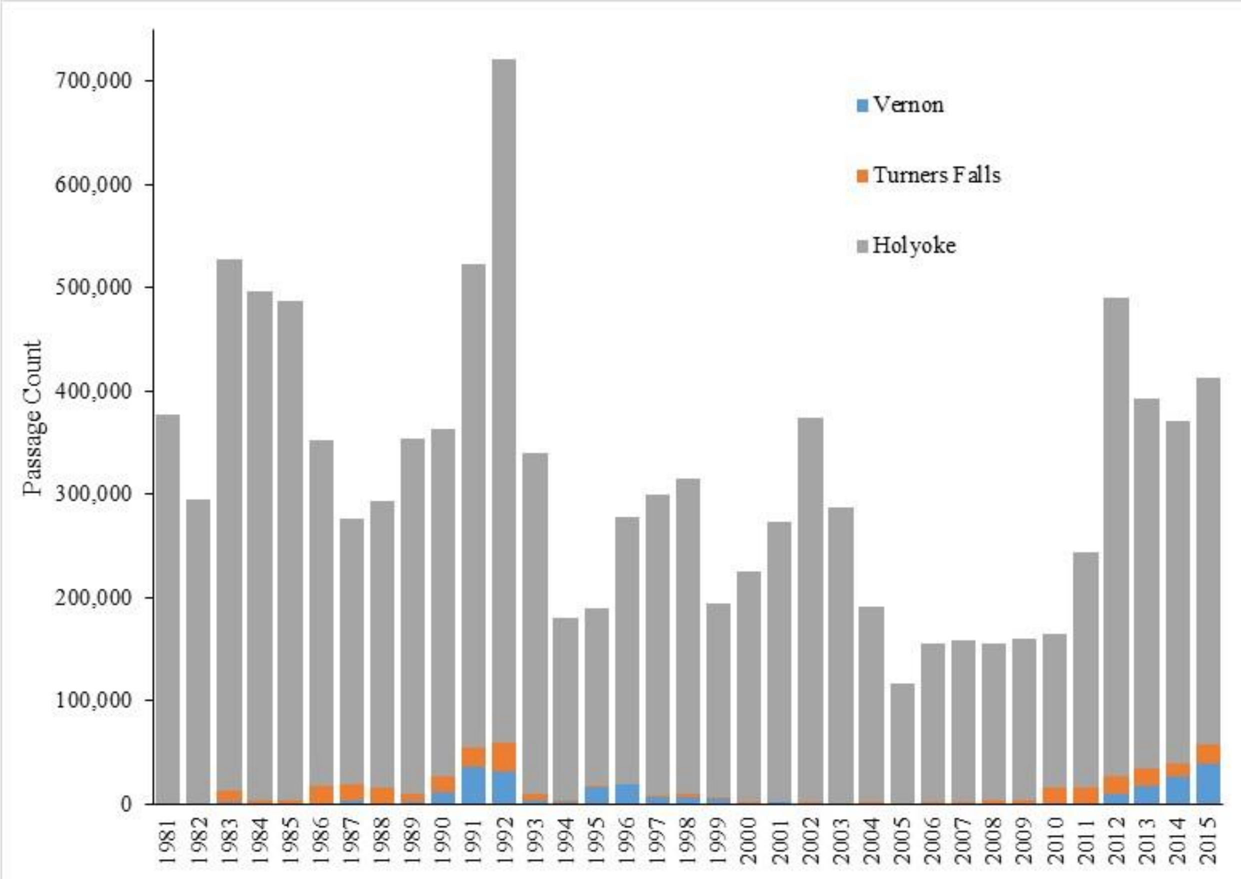

Figure 2.9-1: Window counts of shad passage at the Holyoke, Turners Falls, and Vernon Projects from 1981 to 2015.

Methods

Each of these studies divided the fish passage route into five sections: Holyoke to Turners Falls Project, Cabot Fish Ladder, Spillway Fish Ladder, the Turners Falls Power Canal, and the Gatehouse Fish Ladder. Percent passage and transition time through each section was determined by the detections of tagged shad. Percent passage for each of the five sections was calculated using the number of tagged shad observed entering a section and the number of tagged shad observed exiting the section, or entering the next section. The 95% confidence intervals (CI) were estimated for the binomial proportions by approximating a normal distribution. This was done for the 2015 raw recapture data, and data from the historical studies that did not provide CI. Transit time was defined as the time it took for a fish to move through a passage segment. Besides the recent FirstLight study, Sullivan (2004) was the only study that provided transition times for each section. Although locations of the "entrance" and "exit" to a section may have varied between studies, we attempted to use similar boundaries for each of the passage segments.

Since tagging methods for each study varied, we also compared the passage rate and transition time for fish tagged with PIT tags only, and fish tagged with both a PIT tag and a radio tag.

Results

Holyoke to Turners Falls

All five studies examined the passage of shad between the Holyoke and Turners Falls dams. The radio telemetry study conducted by the USFWS and Northeast Utilities Service Company in 1993 observed 14% of the 154 tagged fish released at Holyoke Dam reached Cabot Station (Table 2.9-2). Sullivan (2004) released 767 PIT tagged shad above the Holyoke Fish lift from 1999 to 2002. He estimated 30 to 46%[5] of fish that passed the Holyoke Fish Lift proceeded upstream and attempted to pass the Turners Falls Project via the Cabot or Spillway Fish Ladders (Table 2.9-2). Studies conducted by USGS in 2005 and 2011 observed 26% and 24% of PIT tagged fish, respectively, passed from Holyoke to one of the two Turners Falls fish ladders (Table 2.9-2). According to the CJS model resulting from the telemetry study conducted in 2015, 60% of fish released at Holyoke reach the Turners Falls Project (Table 2.9-2). This estimate was significantly higher than past studies, but it is important to note this calculation did not include any fish that fell back below the Holyoke Dam after being released. When fall back fish are included in the number of fish "entering" that passage segment, which was the case in past studies, an estimated 29% of fish passed from Holyoke to the Turners Falls Project (Table 2.9-2). This estimation is within the confidence interval of these past studies (24-33%) (Figure 2.9-2).

Sullivan (2004) reported that 78% (189 of 242) of the tagged fish recaptured at the Turners Falls Project were observed attempting to pass the Cabot Fish Ladder, while 15% attempted to pass the Spillway Fish Ladder. Seventeen of these tagged fish entered both fish ladders. In the FirstLight 2015 study, 71% (89 of 124) of the tagged fish that reached the Turners Falls Project attempted to ascend the Cabot Station Fish Ladder, 17% (21 of 124) attempted to pass the Spillway Fish Ladder, and 11% (14 of 124) entered both ladders. Both studies concluded flow conditions though the Bypass Reach influenced which ladder fish where more likely to enter (Sullivan 2004; FirstLight 2016b).

There was a significant difference in the passage efficiency of dual tagged fish (PIT and radio tagged) and PIT tagged fish in 2015. About 23% of dual tagged fish released at Holyoke made their way to the Turners Falls Project, while 31% of PIT tagged fish traveled to the Project (Table 2.9-3).

[5] Of the fish tagged and released at Holyoke Fishlift, 30% migrated upstream and attempted to ascend the Turners Falls Project by entering the Cabot or Spillway Fish Ladders. But when using the observed percent passage and window counts at each of these ladders to back-calculate, an estimated 46% of fish that successfully passed Holyoke attempted to pass the Turners Falls Project.

Sullivan (2004) defined transition time through the Holyoke-to-Turners Falls reach as the difference between the time of release and the time of first detection in either of the two fish ladders at the Turners Falls Project (Cabot or Spillway). Overall, he found the median time for fish to travel through this passage segment was 5.8 days, ranging from a minimum of 23 hours to a maximum of 32 days (Table 2.9-4). Fish tagged in 2015 took a median of 5.9 days to travel this section (Table 2.9-4). PIT tagged fish appeared to reach the Turners Falls Project slightly faster than dual tagged fish following release at Holyoke in 2015 (Table 2.9-3). The minimum transition time for a PIT tagged fish was about 29 hours, whereas the minimum transition time for a dual tagged fish was 42 hours (Table 2.9-2). This is similar to the passage rate of Sullivan's (2004) PIT tagged fish. The study conducted by Northeast Utilities in 1993 examined the difference in passage time for fish tagged at different times of the season. They observed faster rates of movement for fish tagged later in the season (mean transition time 4.9 days) than fish tagged earlier in the season (mean transition time 10.4 days) (Stira & Kuzmeskus 2000). The transition time for this study was defined as the time of departure from the Redcliffe Canoe Club to the time of arrival at the Cabot Tailrace, thus it could not be readily compared to Sullivan (2004) nor FirstLight (2016b) studies.

Table 2.9-2: Passage efficiency from Holyoke Fish Lift to the Turners Falls Project (Cabot Fish Ladder or Spillway Fish Ladder). Note FirstLight studies were the only ones to remove fallback fish from analysis.

Study	ID	Year	% Passage	95% CI	N enter	N exit
Northeast Utilities (2000)	A	1993	13.6	8.2-19.1	154	21
Sullivan (2004)	B	1999	37.4	28.7-47.7	99	37
	C	2000	25.9	20.7-32	232	60
	D	2001	25.1	19.7-31.8	199	50
	E	2002	34.6	28.9-41.1	237	82
	F	Overall (1999-2002)	29.9	26.7-33.3	767	229
USGS	G	2005	25.9	22.3-29.6	552	143
	H	2011	23.6	17.2-30.1	165	39
FirstLight (2016b)	I	2015	28.6	24.4-32.9	433	124
	J	2015 (CJS Model)*	59.8	49.1-59.8		
	K	2015 Dual tagged**	23.3	17.6-28.9	215	50
	L	2015 PIT Tagged Only**	30.7	24.6-36.9	218	67

*: fallback fish removed from analysis, project arrival is proportion arriving at Montague (T3)
**: fallback fish included in denominator

Table 2.9-3: Passage efficiency (%) and transition time (hours) for dual tagged and PIT tagged fish released above Holyoke Dam in the 2015 FirstLight study.

	Dual Tagged	PIT Tag ONLY
Passage Efficiency		
% Passage	23.3	30.7
95% CI	17.6-28.9	24.6-36.9
N enter	215	218
N exit	50	67
Transition Time		
Median	148.9	135.0
Min	42.3	28.9
Max	531.9	531.8
N	49	75

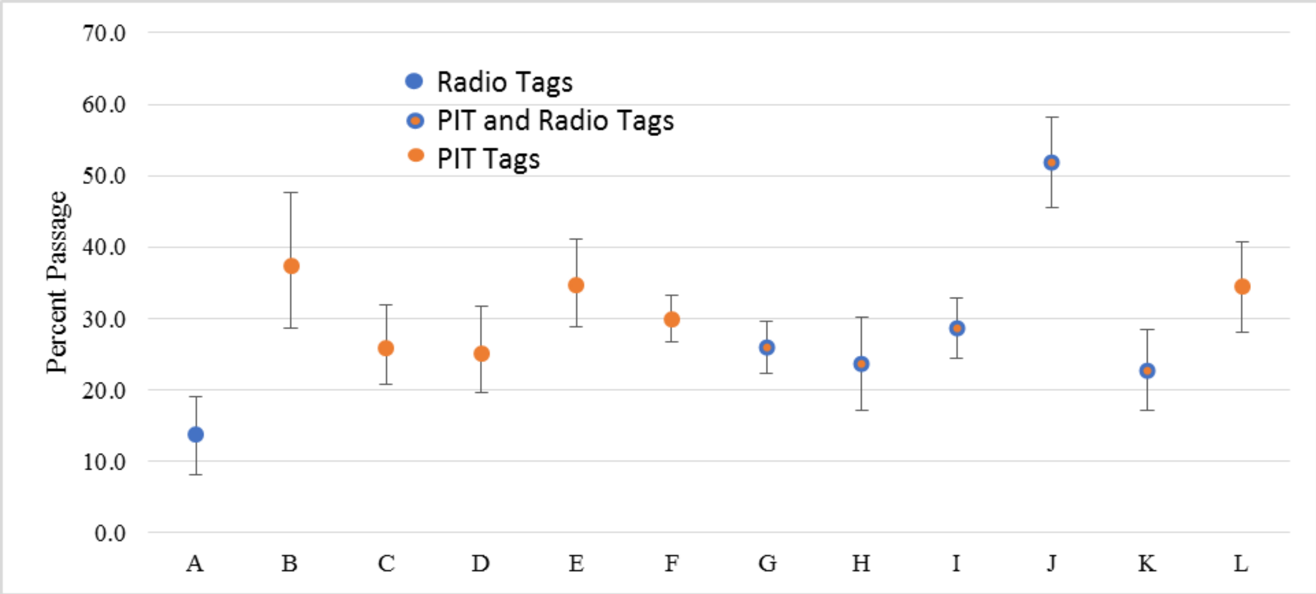

Figure 2.9-2: Holyoke Fish Lift to Turners Falls Project passage, with 95% CI, from studies (A-L, see Table 2.9-2) using PIT tags and/or radio tags.

Cabot Fish Ladder

All five studies examined the passage efficiency of Cabot Fish Ladder. Passage efficiency was calculated by the number of fish entering the ladder and the number of fish that successfully passed. Passage efficiency at the Cabot Fish Ladder was about 16% during the 2015 study period (Table 2.9-5). This estimate fell directly in line with passage from previous studies (Figure 2.9-3). In 1993, 13 radio tagged shad attempted to ascend the Cabot Fish Ladder, and of these, only one successfully passed (Table 2.9-5). Sullivan (2004) observed 13% (71 of 575 tagged shad) passage efficiency at Cabot Station Fish Ladder overall, ranging from 16-19% between 1999 and 2001, but in 2002 passage efficiency dropped to 2%. Cause for this decline was not evident. When calculations excluded the outlying 2002 passage rate (2%), overall passage of 1999, 2000, and 2001 combined was 17%. Although the highest observed passage efficiency occurred during the USGS 2011 study (25%), the low number of tagged fish entering the Cabot ladder was cause for a large CI (8-42%). Aside from Northeast Utilities (1993), and Sullivan (2004) data from 2002, observed passage efficiencies from previous studies were similar (Table 2.9-5).

Similar to the Holyoke-to-Turners Falls reach, the Cabot Ladder passed more PIT tagged shad than dual tagged shad. Although the median transition time of PIT tagged fish (7.8 hours) was longer than that of dual tagged fish (4.0 hours), the maximum transition time for PIT tagged fish (25.4 hours) was much lower (Table 2.9-6). Three fish from each tagging group had to be removed the transition time analysis since they were not detected at the exit of the fish ladder. These fish were included in the passage efficiency analysis because they were detected at monitoring stations upstream of the Cabot Ladder. Overall, the median transition time for the remaining 10 tagged shad in 2015 was about 8 hours (Table 2.9-7). This was similar to Sullivan (2004) which observed an overall median transition time of 10 hours, ranging from 6 hours in 2002 to 25 hours in 1999 (Table 2.9-7).

Table 2.9-4: Transition time (hours) for tagged fish that successfully passed from Holyoke Fish Lift to the Turners Falls Project.

Study	Year	Median	Min	Max	N
Sullivan (2004)	Overall	138.6	23.2	764	229
	1999	95.7	23.2	280.3	37
	2000	167.1	40.1	720.7	60
	2001	171.1	39.4	353.5	50
	2002	99.2	27.4	764	82
FirstLight (2016b)	2015	140.5	28.9	531.9	124

Table 2.9-5: Passage efficiency through Cabot Fish Ladder.

Study	ID	Year	% Passage	95% CI	N enter	N exit
Northeast Utilities (2000)	A	1993	7.7	0-22.2	13	1
Sullivan (2004)	B	1999	19.2	12.7-28.4	99	19
	C	2000	17.5	12.4-24.5	154	27
	D	2001	15.7	10.7-22.9	140	22
	E	2002	2	0.7-5.7	152	3
	F	Overall (1999-2002)	13	10.4-16.2	545	71
USGS	G	2005	17.2	10.5-23.9	122	21
	H	2011	25	7.7-42.3	24	6
FirstLight (2016)	I	2015	15.5	8.5-22.5	103	16
	J	2015 (CJS Model)	15.3	5.4-23		
	K	2015 Dual tagged	13.3	3.4-23.3	45	6
	L	2015 PIT Tagged Only	17.2	7.5-27.0	58	10

Table 2.9-6: Passage efficiency (%) and transition time (hours) for dual tagged and PIT tagged fish that successfully passed Cabot Fish Ladder in 2015 FirstLight study.

	Dual Tagged	PIT Tag ONLY
Passage Efficiency		
% Passage	13.3	17.2
95% CI	3.4-23.3	7.5-27.0
N enter	45	58
N exit	6	10
Transition Time		
Median	4.1	7.8
Min	3.08	3.99
Max	35.18	25.42
N	3	7

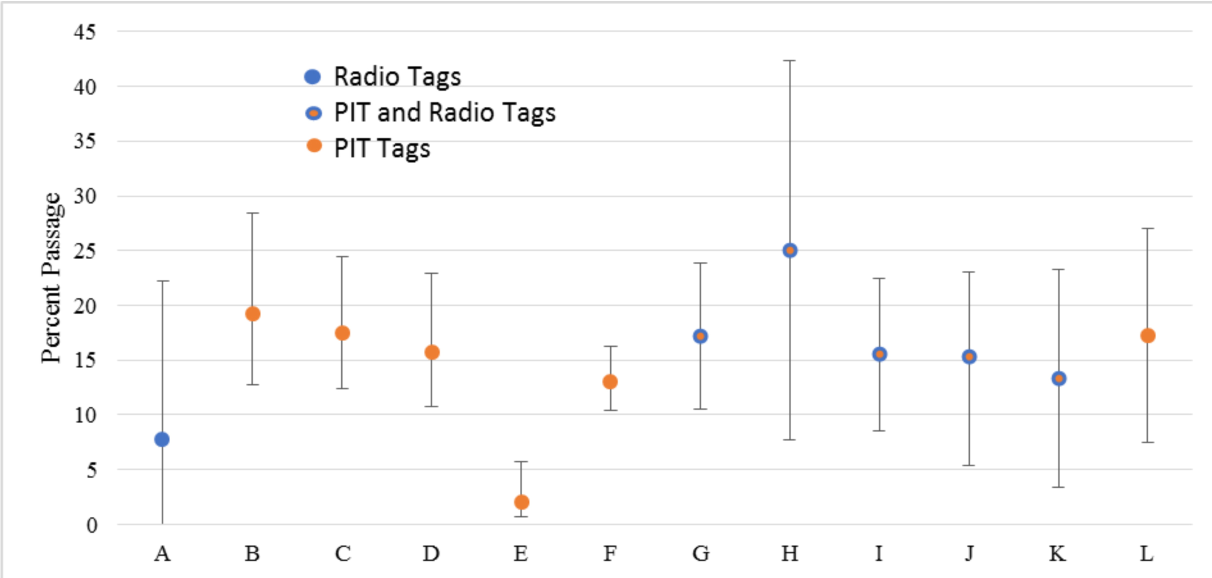

Figure 2.9-2: Passage efficiency through Cabot Fish Ladder, with 95% CI, from studies (A-L, see Table 2.9-5) using PIT tags and/or radio tags.

Spillway Fish Ladder

Sullivan (2004), USGS (2005), and USGS (2011) included passage data through the Spillway Fish Ladder. Passage efficiencies varied wildly between these studies (Table 2.9-8). Both calculations from raw counts and the CJS model revealed the highest passage (46-55%) in 2015. Observed passage was lowest in 2011 when no tagged shad passed the ladder (Table 2.9-8). The next highest passage efficiency, aside from 2015, occurred in 2001 with 32% passage. Although the passage estimates from 2015 data are higher than in past years, the 95% CI overlap with past studies' findings (Figure 2.9-4). As seen in other passage segments, PIT tagged shad were more likely to pass the Spillway Ladder than dual tagged fish (Table 2.9-8).

Sullivan (2004) estimated a median residency time of 7.0 hours within the Spillway Fish Ladder and noted that residency time was confounded by an inability to determine if fish observed at the entrance were indeed entering the ladder or exiting. In 2015, transit time up the Spillway Fish Ladder was evaluated using only dual tagged fish. Malfunctioning PIT tag readers at the entrance and the exit of the fish ladder made it impossible to determine the transition time of fish tagged with a PIT tag only. Only 4 fish were detected at the dipole radio antenna at the entrance of the ladder, and at one of the three PIT receivers in the gallery of the Gatehouse Fish Ladder (P34Z, P31, or P32). Transition time for these four fish through the Spillway Ladder ranged from 4 hours to 7 days (Table 2.9-9). This was slower compared to Sullivan's (2004) times which ranged from 2 hours to 2 days (Table 2.9-10).

Table 2.9-7: Transition Time (hours) for tagged fish that successfully passed Cabot Fish Ladder.

Study	Year	Median	Min	Max	N
Sullivan (2004)	Overall	10.2	2.2	92.5	55
	1999	24.6	8.5	30.1	9
	2000	9.3	2.2	92.5	24
	2001	10	4.9	38.4	19
	2002	6.3	6	46.8	3
FirstLight (2016b)	2015	7.8	4.0	35.2	9

Table 2.9-8: Passage efficiency through Spillway Fish Ladder.

Study	ID	Year	% Passage	95% CI	N enter	N exit
Sullivan (2004)	B	1999	16.7	8.6-31.4	42	7
	C	2000	8.2	3.9-17.1	73	6
	D	2001	31.9	20.8-47.2	47	15
	E	2002	14.3	7.8-25.4	63	9
	F	Overall (1999-2002)	16.4	12.2-22	225	37
USGS	G	2005	11.5	0-23.8	26	3
	H	2011	0	n/a	15	0
FirstLight (2016b)	I	2015	45.7	29.2-62.2	35	16
	J	2015 (CJS Model)	55.2	20.8-82.2		
	K	2015 Dual tagged	45.5	16.0-74.9	11	5
	L	2015 PIT Tagged Only	45.8	25.9-65.8	24	11

Table 2.9-9: Passage efficiency for PIT tagged shad and dual tagged shad that successfully passed Spillway Fish Ladder in 2015 FirstLight study.

	Dual Tagged	PIT Tag ONLY
% Passage	45.5	45.8
95% CI	16.0-74.9	25.9-65.8
N enter	11	24
N exit	5	11

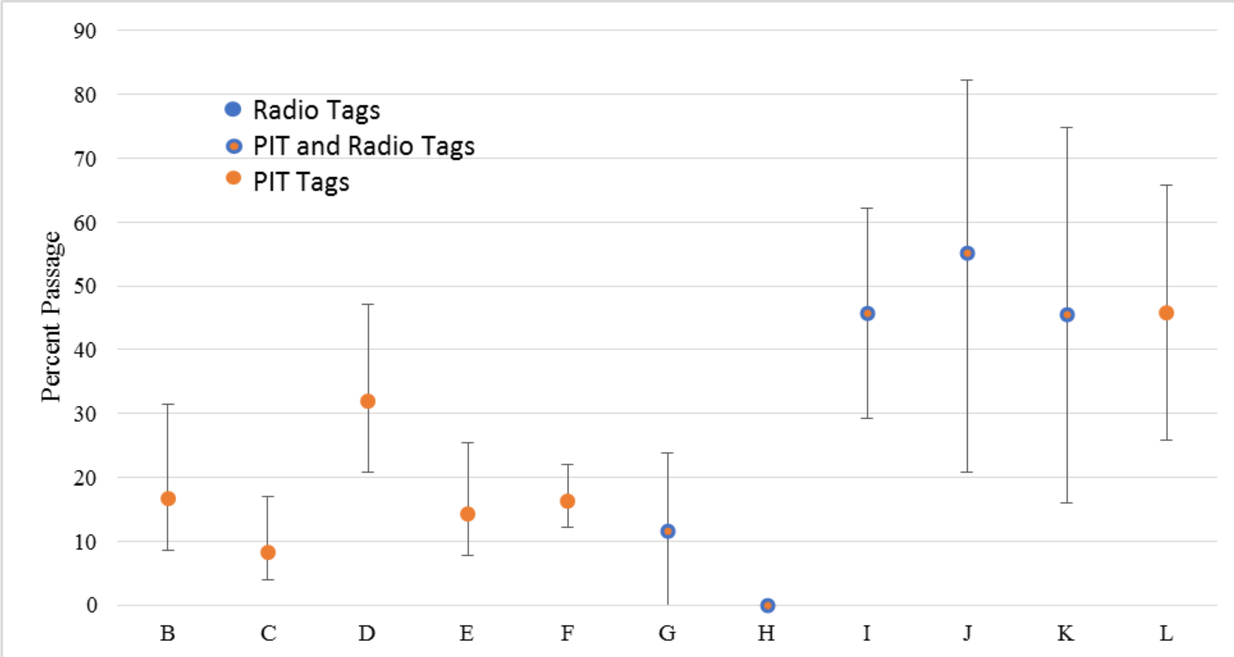

Figure 2.9-3: Passage efficiency at the Spillway Fish Ladder, with 95% CI, from studies (B-L, see Table 2.9-8) using PIT tags and/or radio tags.

Power Canal

Passage through the Power Canal started with fish exiting the Cabot Fish Ladder or fish directly released into the canal above the ladder exit. Passage was considered complete for fish that exited the canal via the Gatehouse Fish Ladder entrance. The ability to find the Gatehouse Ladder entrance has long been suspected as the limiting factor for fish successfully passing through the Power Canal. From 1999 to 2002 Sullivan (2004) observed 19% of tagged fish successfully navigating the Power Canal (Table 2.9-11, Figure 2.9-5). But he notes that 35% of the fish entering the Power Canal via the Cabot Fish Ladder passed the canal, whereas only 18% of the fish tagged and released above the Cabot Ladder navigated through the power canal and entered the Gatehouse Fish Ladder (Sullivan 2004). We saw a similar trend in 2015, although our overall passage efficiency was much greater (42%) (Table 2.9-11). Ninety-three percent of fish that were released at Holyoke and successfully passed the Cabot Ladder were able to pass through the Power Canal, whereas 34% of fish that were released in the canal above the Cabot Ladder found their way to the Gatehouse Ladder (Table 2.9-11). The lower passage of fish released at Cabot during both studies may indicate negative effects from tagging and handling.

In 2005, the USGS conducted a study evaluating the entry rate of a Mock Entrance to the Gatehouse Ladder located along the river-side bank of the canal. Of the 210 PIT tagged fish in the canal (21 from Cabot Ladder, 188 released directly into the canal above the Cabot Ladder, and 1 fish that passed the Spillway Ladder and fell back into the canal), 14% entered the Gatehouse Ladder through the existing entrance, and 49% entered via the Mock Entrance (Table 2.9-11). The second Gatehouse entrance was installed at the location of the Mock Entrance in 2008 (Exhibit E). By 2011, USGS observed a passage efficiency through the Power Canal of 45% (Table 2.9-11). Adjustments to the operating protocol of the canal head gate were made in 2012. The operational changes reduced eddies downstream of the ladder entrances, and improved the rate of entrance into the Gatehouse Ladder. In 2015, entrance into the Gatehouse Ladder from the canal was 42%, closer to the observations seen at the Mock Entrance during the USGS 2005 study (Table 2.9-11).

More fish tagged with a PIT tag only passed through the Power Canal in 2015 (58%). Only 25% of available dual tagged fish passed the canal (Table 2.9-12). Both PIT tagged and dual tagged fish released above Cabot Ladder had a much lower passage efficiency (50% and 18% respectively) than those released at Holyoke Dam. All 10 PIT tagged fish that traveled from Holyoke Dam and successfully passed the Cabot Ladder made their way to the end of the Power Canal and entered the Gatehouse Fish Ladder (Table 2.9-12). Only one dual tagged shad that passed Cabot did not make it to the Gatehouse. The passage time of PIT tagged fish was similar, regardless of release location (Table 2.9-12). Dual tagged fish released at Holyoke and Cabot passed through the canal within a median of 7 days, but the minimum time for a Cabot released, dual tagged fish was 2.7 days, while the minimum time for a Holyoke released fish was 5 days (Table 2.9-12).

The comparison of transition times from Sullivan (2004) and FirstLight (2016b) is, in some ways, misleading. Many changes have been made to both structures and operations in the years since Sullivan's study. Overall the transition time through the Power Canal for fish tagged in 2015 was much shorter than those tagged between 1999 and 2002 (Table 2.9-13). The median transit time for fish in 2015 was about 7 days (Table 2.9-13). Sullivan (2004) observed a median transit time of 13 days for all four years of the study. The difference in travel time through the canal from one study to the next may be attributed to the changes to the Gatehouse Entrances and operation of the head gates.

Table 2.9-10: Transition time (hours) for tagged fish that successfully passed Spillway Fish Ladder.

Study	Year	Median	Min	Max	N
Sullivan (2004)	Overall	7	1.6	53.7	31
	1999	4.5	3.1	31.2	5
	2000	6.4	4.5	10.3	3
	2001	7.8	1.6	53.7	14
	2002	8.8	2.4	14.7	9
FirstLight (2016b)	2015	15.5	4.1	168.1	4

Table 2.9-11: Passage Efficiency through the Turners Falls Power Canal.

Study	ID	Year		% Passage	95% CI	Nenter	Nexit
Sullivan (2004)	B	1999		34.4	28.8-40.8	244	84
	C	2000		27.6	22.5-33.6	250	69
	D	2001		11.1	8.2-14.9	343	38
	E	2002		7.2	4.8-10.7	307	22
	F	Overall (1999-2002)		18.6	16.4-21	1,144	213
USGS	G-1	2005	Gatehouse Entrance	13.8	9.1-18.5	210	29
	G-2		Mock Entrance	49	42.3-55.8	210	103
	H	2011		44.6	39.3-49.9	334	149
FirstLight (2016b)	I-1	2015	Holyoke Release	93.8	81.9-100	16	15
	I-2		Cabot Release	34.0	24.7-43.3	100	34
	I-3		Total Release	42.2	33.3-51.2	116	49
	K-1	2015 Dual tagged	Holyoke Release	83.3	53.5-113.2	6	5
	K-2		Cabot Release	18.0	7.4-28.6	50	9
	K-3		Total Release	25.0	13.7-36.3	56	14
	L-1	2015 PIT Tagged Only	Holyoke Release	100.0	n/a	10	10
	L-2		Cabot Release	50.0	36.1-63.9	50	25
	L-3		Total Release	58.3	45.9-70.8	60	35

Table 2.9-12: Passage efficiency (%) and transition time (hours) for dual tagged and PIT tagged shad that successfully passed the Turners Falls Power Canal in 2015 FirstLight study.

	Dual Tagged			PIT Tag ONLY		
Passage Efficiency	**Holyoke Release**	**Cabot Release**	**Total Release**	**Holyoke Release**	**Cabot Release**	**Total Release**
% Passage	83.3	18.0	25.0	100.0	50.0	58.3
95% CI	53.5-113.2	7.4-28.6	13.7-36.3	n/a	36.1-63.9	45.9-70.8
Nenter	6	50	56	10	50	60
Nexit	5	9	14	10	25	35
Transition Time						
Median	175.2	168.2	171.7	146.3	145.8	145.8
Min	120.9	64.9	64.9	53.0	42.6	42.6
Max	312.1	281.8	312.1	439.3	500.3	500.3
N	5	9	14	10	25	35

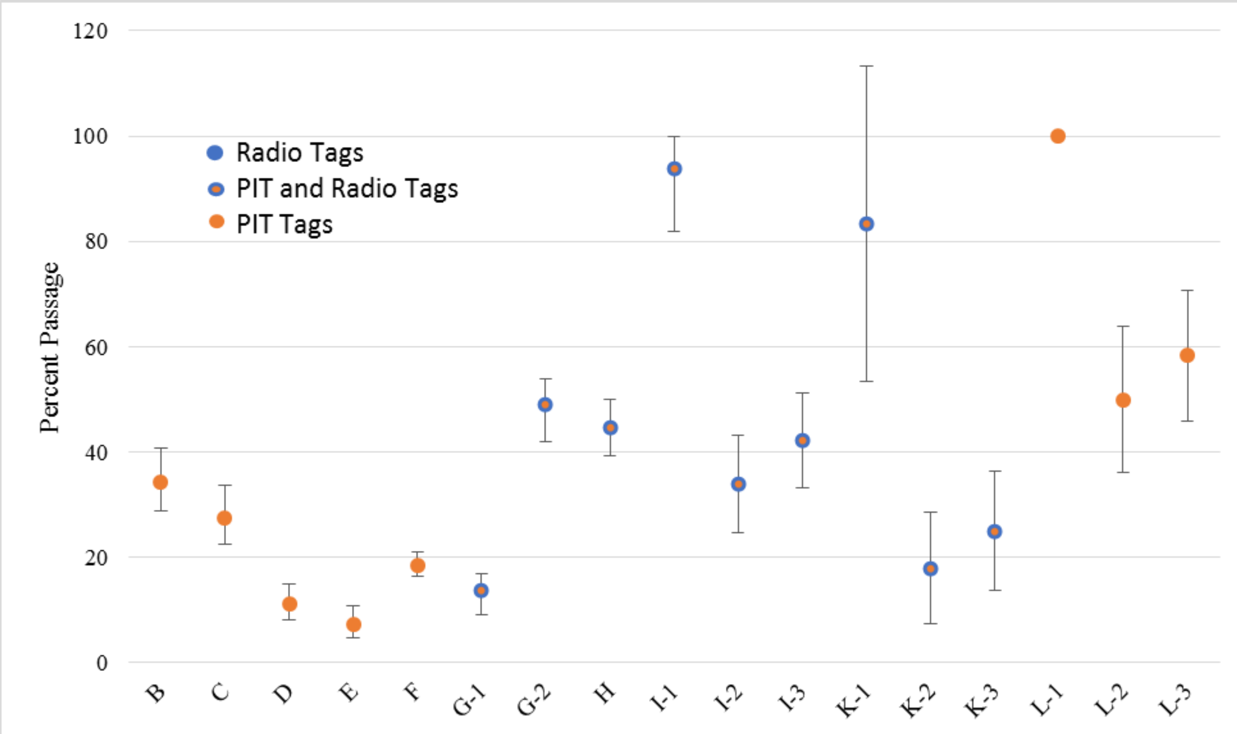

Figure 2.9-4: Passage Efficiency through the Turners Fall Power Canal, with 95% CI, from studies (B-L3, see Table 2.9-11) using PIT tags and/or radio tags

Gatehouse Fish Ladder

Passage efficiency at the Gatehouse Fish Ladder has been consistently high since its installation, ranging from 63% in 2005 to 88% in 2015 (Table 2.9-14, Figure 2.9-6). The Gatehouse Ladder is much smaller in both length and gradient than the other two fish ladders at the Project. In 2015, Fish released at Holyoke were more likely to pass than fish tagged and released above the Cabot Fish Ladder. Ninety percent of the 31 fish that entered the Gatehouse Ladder after making their way from the Holyoke release site successfully passed the Gatehouse Ladder. All 16 shad that entered the Gatehouse Ladder via the Spillway Fish Ladder successfully passed. In turn, 15 of the 16 fish that successfully passed the Cabot Fish Ladder entered the Gatehouse Ladder, and of these, 12 passed. Thirty-four of the 100 fish released into the Power Canal, above Cabot Ladder, entered the Gatehouse Fish Ladder, and 85% of these successfully passed (Table 2.9-14).

As seen in other passage sections, PIT tagged fish had a much higher passage efficiency, and shorter passage time than dual tagged fish in 2015, but 95% CI's show little difference between the two (Table 2.9-15; Figure 2.9-6). There was a slight difference in the transition time between fish released at Holyoke and fish released above Cabot Ladder. Fish that made their way from Holyoke navigated the Gatehouse Ladder in 0.06 to 3.89 hours with a median of 0.41 hours (Table 2.9-16). Fish that were released directly in the canal passed the Gatehouse Ladder in 0.17 to 2.28 hours with a median of 0.71 hours (Table 2.9-16).

Table 2.9-13: Transition Times (hours) of tagged shad that successfully passed through the Turners Falls Power Canal.

Study	Year		Median	Min	Max	N
Sullivan (2004)	Overall		308.7	2.1	1,069	140
	1999		667.4	74.3	913.7	14
	2000		261.5	2.1	579.4	66
	2001		580.8	170.7	1,068.80	38
	2002		423.3	26.9	885.8	22
FirstLight (2016b)	2015	Holyoke Release	164.9	53.0	439.3	15
		Cabot Release	157.0	42.6	500.3	34
		Total Release	164.9	42.6	500.3	49

Table 2.9-14: Passage efficiency at Gatehouse Fish Ladder

Study	ID	Year		% Passage	95% CI	N enter	N exit
Sullivan (2004)	B	1999		86.8	79.3-93	91	79
	C	2000		80.8	71.4-89.1	73	59
	D	2001		83.7	72.7-92.7	49	41
	E	2002		76	59.2-90.7	25	19
	F	Overall (1999-2002)		83.2	78.2-87.8	238	198
USGS	G	2005		62.5	45.7-79.3	32	20
	H	2011		81	74.9-87.5	149	121
FirstLight (2016b)	I-1	2015	Holyoke Release	90.3	84.9-100	31	28
	I-2		Cabot Release	85.3	73.4-97.2	34	29
	I-3		Total Release	87.7	81.7-96.8	65	57
	J	2015 (CJS Model)		90.7	75.1-97.6		
	K-1	2015 Dual tagged	Holyoke Release	90.0	68.4-100	10	9
	K-2		Cabot Release	77.8	50.6-100	9	7
	K-3		Total Release	84.2	60.6-97.3	19	16
	L-1	2015 PIT Tagged Only	Holyoke Release	95.2	86.1-100	21	20
	L-2		Cabot Release	88.0	75.3-100	25	22
	L-3		Total Release	91.3	83.2-99.4	46	42

Table 2.9-15: Passage efficiency (%) and transition time (hours) for dual tagged and PIT tagged shad that successfully passed the Gatehouse Fish Ladder in 2015 FirstLight study.

	Dual Tagged			PIT Tag ONLY		
Passage Efficiency	**Holyoke Release**	**Cabot Release**	**Total Release**	**Holyoke Release**	**Cabot Release**	**Total Release**
% Passage	90.0	77.8	84.2	95.2	88.0	91.3
95% CI	68.4-109.4	50.6-104.9	60.6-97.3	86.1-104.3	75.3-100.7	83.2-99.4
Nenter	10	9	19	21	25	46
Nexit	9	7	16	20	22	42
Transition Time	**Holyoke Release**	**Cabot Release**	**Total Release**	**Holyoke Release**	**Cabot Release**	**Total Release**
Median	0.80	0.89	0.88	0.40	0.69	0.52
Min	0.36	0.26	0.26	0.06	0.17	0.06
Max	3.89	1.37	3.89	3.80	2.28	3.80
N	8	7	15	20	22	42

Table 2.9-16: Transition time (hours) through Gatehouse Fish Ladder.

Study	Year		Median	Min	Max	N
Sullivan (2004)	Overall		0.05	0.01	10.54	198
	1999		0.12	0.01	10.54	79
	2000		0.03	0.01	0.61	59
	2001		0.06	0.01	0.95	41
	2002		0.05	0.01	0.73	19
FirstLight (2016b)	2015	Holyoke Release	0.41	0.06	3.89	28.00
		Cabot Release	0.71	0.17	2.28	29.00
		Total Release	0.51	0.06	3.89	28.00

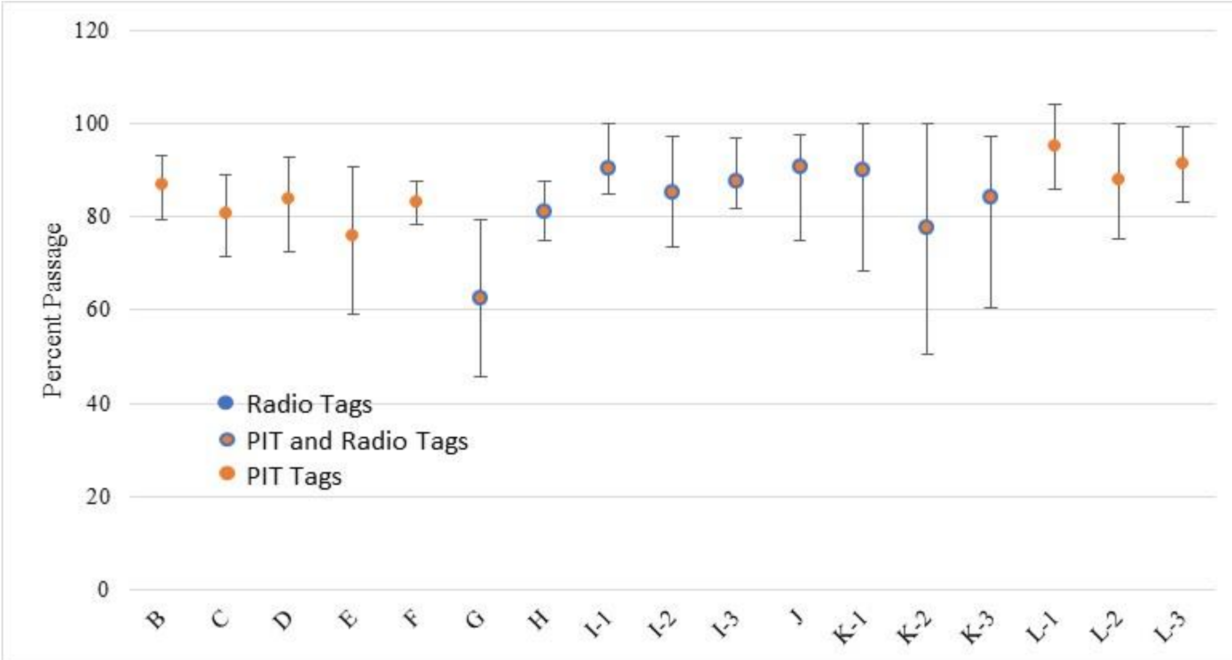

Figure 2.9-5: Passage efficiency at Gatehouse Fish Ladder, with 95% CI, from studies (B-L3, see Table 2.9-14) using PIT tags and/or radio tags.

Conclusion and Discussion

We compared our findings with those of past studies including the study conducted by Northeast Utilities in partnership with USFWS in 1993 (Stira & Kuzmeskus 2000); Tim Sullivan's work from 1999 to 2002 (Sullivan 2004); and the continued work by the USGS, specifically the studies conducted in 2005 (Castro-Santos & Haro 2005) and 2011 (Casto-Santos & Haro 2011). Each of these studies used some combination of PIT and radio tags to track the migration of shad from Holyoke to the Turners Falls Project, and in most cases, through the project itself.

Overall the 2015 data was comparable to trends observed in past years. Percent passage between Holyoke and the Turners Falls Project, and through Cabot and Gatehouse Fish Ladders was well within the range of passage seen in the previous studies. We observed much higher passage efficiency at the Spillway Ladder and through the Power Canal than what was reported in past years. Passage efficiency through the Power Canal, according to the previous studies, was mostly dependent on a fish's ability to locate the entrance to the Gatehouse Ladder. Many modifications were made to the Gatehouse entrance and the flows around the entrance between 2008 and 2012. These changes made comparing results from different studies difficult, but we were able to observe a noticeable difference in passage efficiency through the Power Canal in studies conducted before and after these changes.

Sullivan (2004) found that flow conditions at the bypass reach influenced whether fish entered the Cabot Fish Ladder or the Spillway Fish Ladder. At higher flows, around 5,000 cfs or 46% of the canal flow, fish were more likely to enter the Spillway Ladder. Whereas, at lower flows through the bypass reach, around 800 cfs or 8% of the canal flow, fish were more likely to enter the Cabot Fish Ladder. Flows through the Power Canal also appeared to influence the ability to find the Gatehouse Fish Ladder entrance. At the time of Sullivan's (2004) study, a maximum of 687 cfs was used as attraction flow to the Gatehouse Fish Ladder entrance. Sullivan (2004) noted entry to the ladder was the highest when canal flows were less than 4,000 cfs, but canal flows can reach a maximum of 16,000 cfs. Sullivan (2004) suggests the higher flows may inhibit fish from finding the entrance, or prevent fish from entering the ladder. Since then, various flow parameters have been examined and automated gates have been installed to adjust attraction flow depending on the Turners Falls Impoundment elevations.

Transition times through each passage segment were fairly consistent from year to year. Only Sullivan (2004) had data to compare the 2015 transition times. Median passage time through the Holyoke impoundment and Cabot Fish Ladder were similar between the two studies. Passage through the Spillway Fish Ladder appeared to be much slower in 2015 than what was observed from 1999 to 2002, Timing of entrance and exit of the ladder was difficult to determine in 2015 due to malfunctioning PIT readers. Four dual tagged fish were used to determine a medial transit time between monitoring station T30 (dipole antennae at the entrance of the ladder) and P34Z, P31, and P32 (PIT readers in the Gatehouse Ladder gallery). Transition time through the Power Canal was also faster compared to Sullivan's (2004) findings. Changes to the Gatehouse Ladder entrance could be the cause for this difference in transition time and passage efficiency.

Overall passage efficiency through the Turners Falls Project has been historically lower than the goal of 40-60% (CRASC 1992). Passage efficiency has been defined as the percent of Holyoke-passed fish that pass the Turners Falls Gatehouse Fish Ladder and was historically determined by window counts. Since the ladders have been operational, Turners Falls has only passed an average of 4% of shad passed over the Holyoke Dam (1-14%) according to fish counts at the respective windows. In comparison, Vernon Dam passes an average of 36% (0.27- over 100%) of available shad. Sullivan (2004) suggested that the limitation of window counts could skew the estimated passage efficiency at the Project. He recommended taking into account the percent of Holyoke-passed fish that attempt to pass the Turners Falls Project. With this consideration, passage efficiency through the Project is improved a bit, but not to the extent to reach the goal of 40-60%. Figure 2.9-7 illustrates how percent passage through the Turners Falls Project (dotted lines) is impacted by adjusting for the proportion of fish that attempt the ascent. The percentages indicated in the legend represent the estimated proportion of Holyoke-passed fish that attempted to ascend the Project during the indicated study year(s). In 2015, 28 (6.5%) of the 433 fish tagged and released at Holyoke successfully passed the Gatehouse ladder. But considering only 124 (28.6%) of the 433 fish attempted to pass the Turners Fall Project, this suggest 22.6% passage efficiency through the Project. Although these adjusted passage efficiencies are more optimistic than the original calculations, they still do not reach the goal of 40-60%.

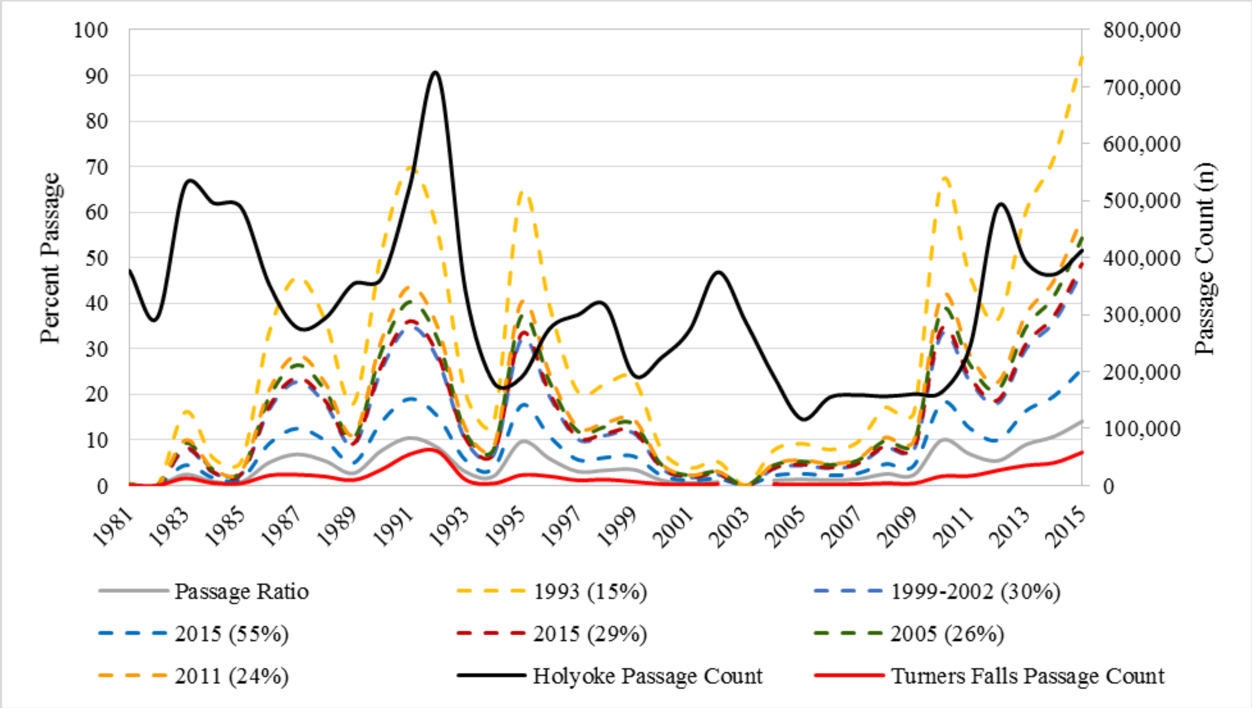

Figure 2.9-6: Passage efficiency (green line) adjusted for estimated proportion of Holyoke-passed shad that attempt to ascend the Turners Falls Project. Each dotted line represents a year in which a study estimated the percent of attempted ascent.

2.10 Flow Time Series

This response addresses the whole or part of the following agency comments: MADFW-9, USFWS-9 and USFWS-14(4).

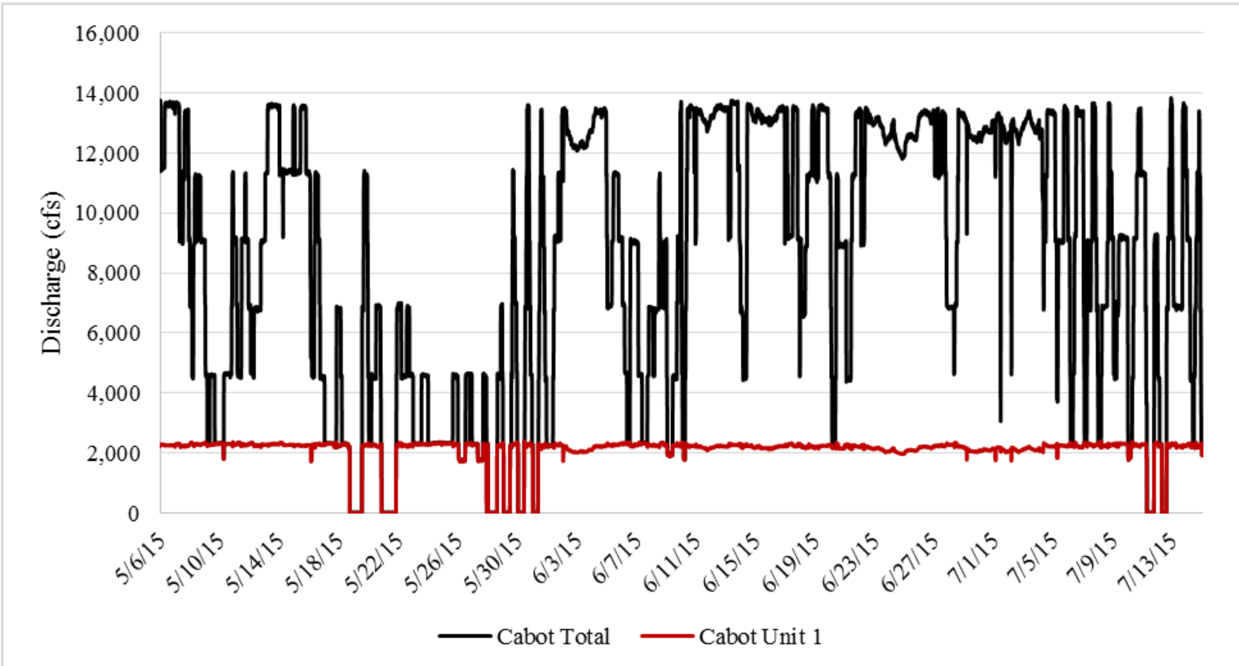

Figure 2.10-1: Cabot Station discharge during the adult shad study.

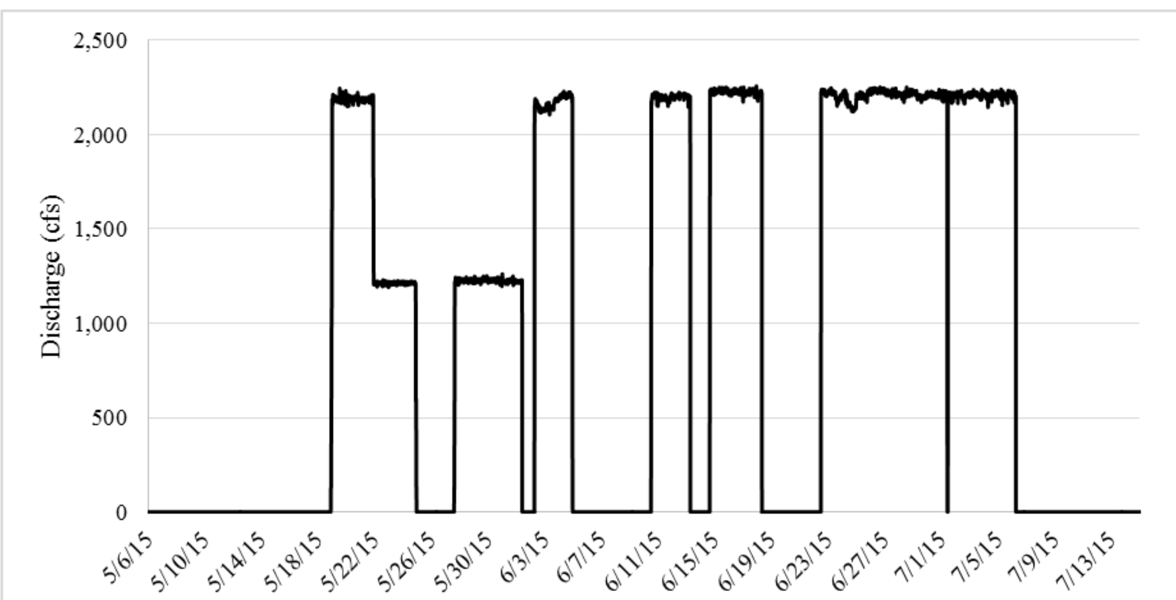

Figure 2.10-2: Station No.1 discharge during the adult shad study.

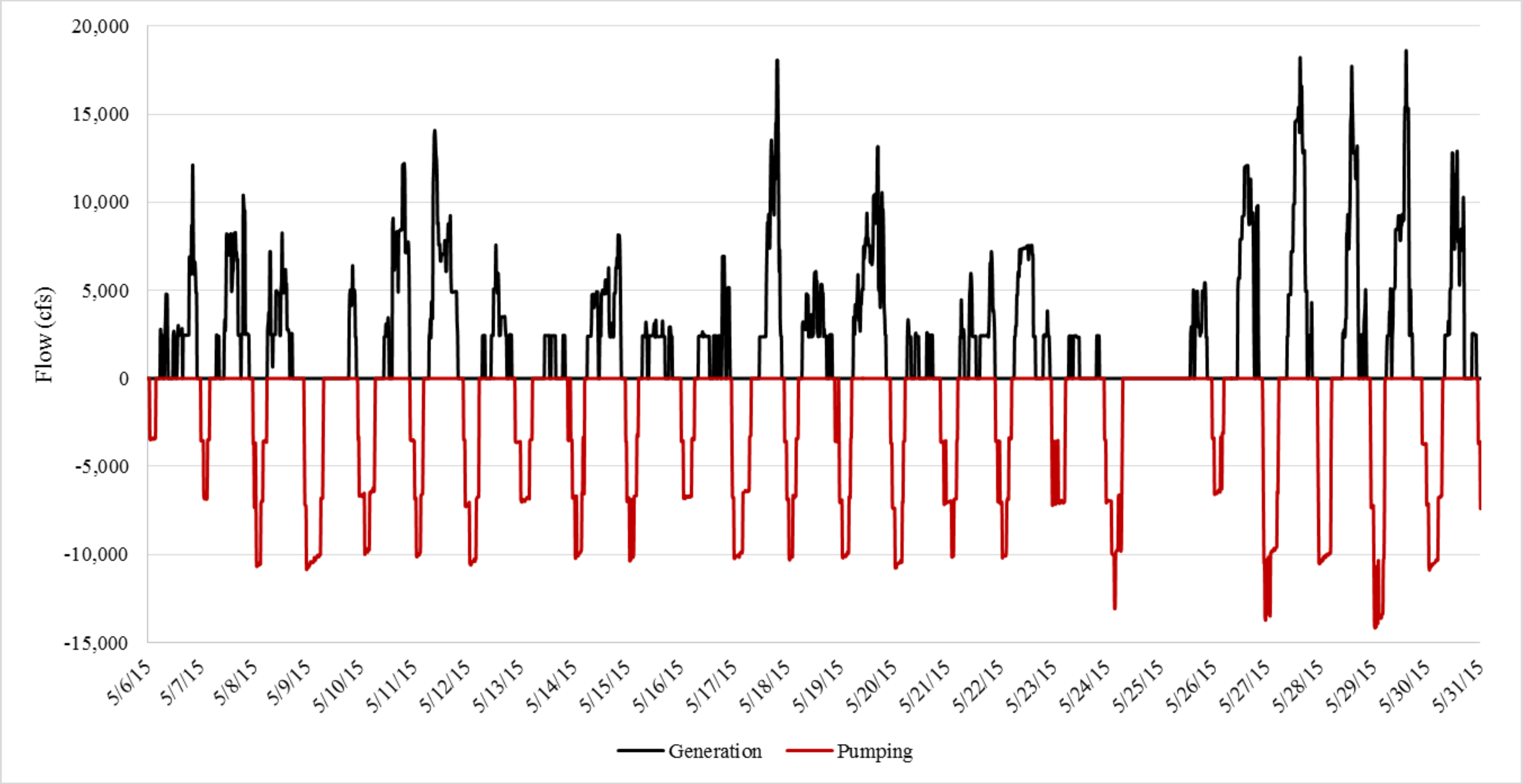

Figure 2.10-3: NMPS flow in May 2015 during the adult shad study.

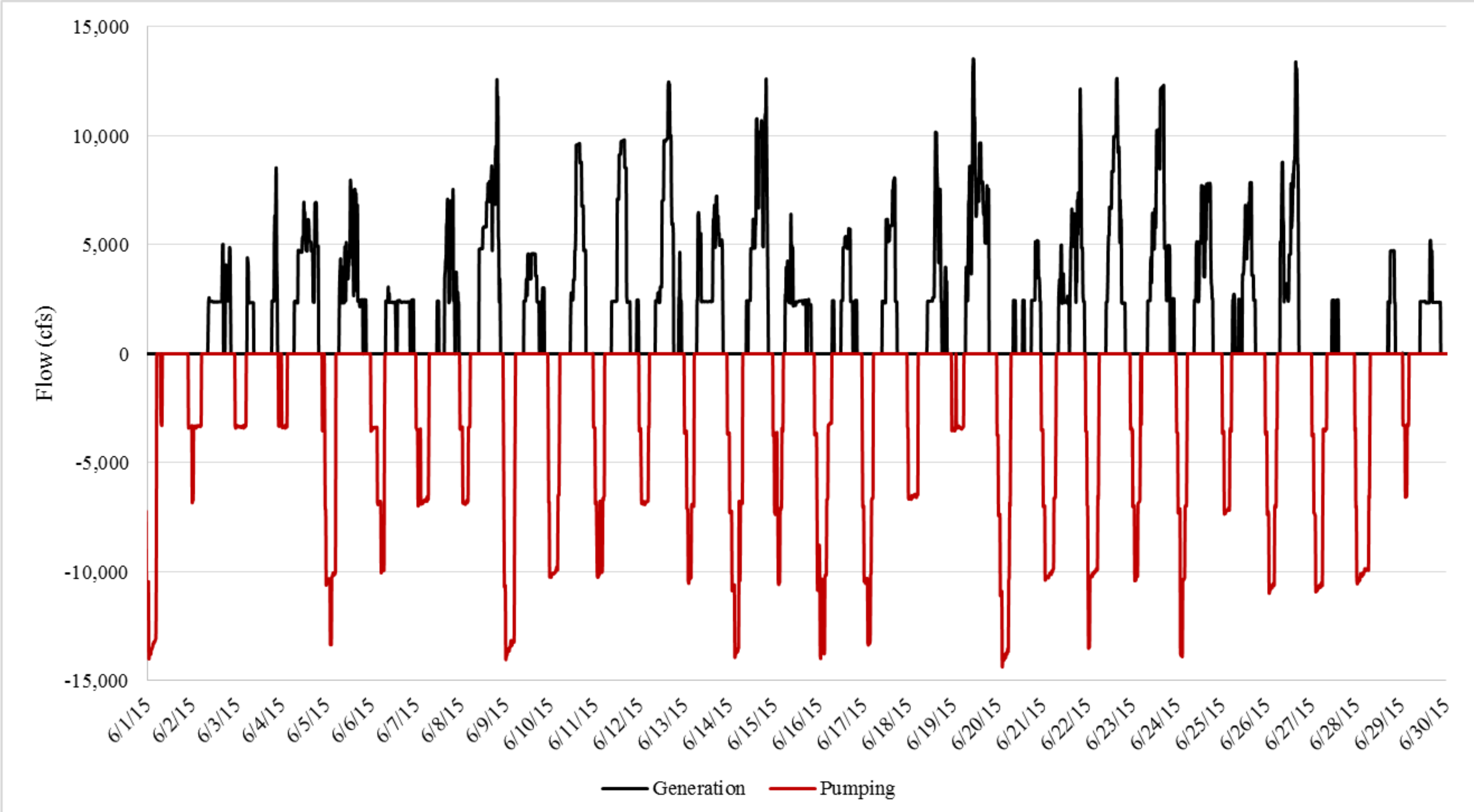

Figure 2.10-4: NMPS flow in June 2015 during the adult shad study.

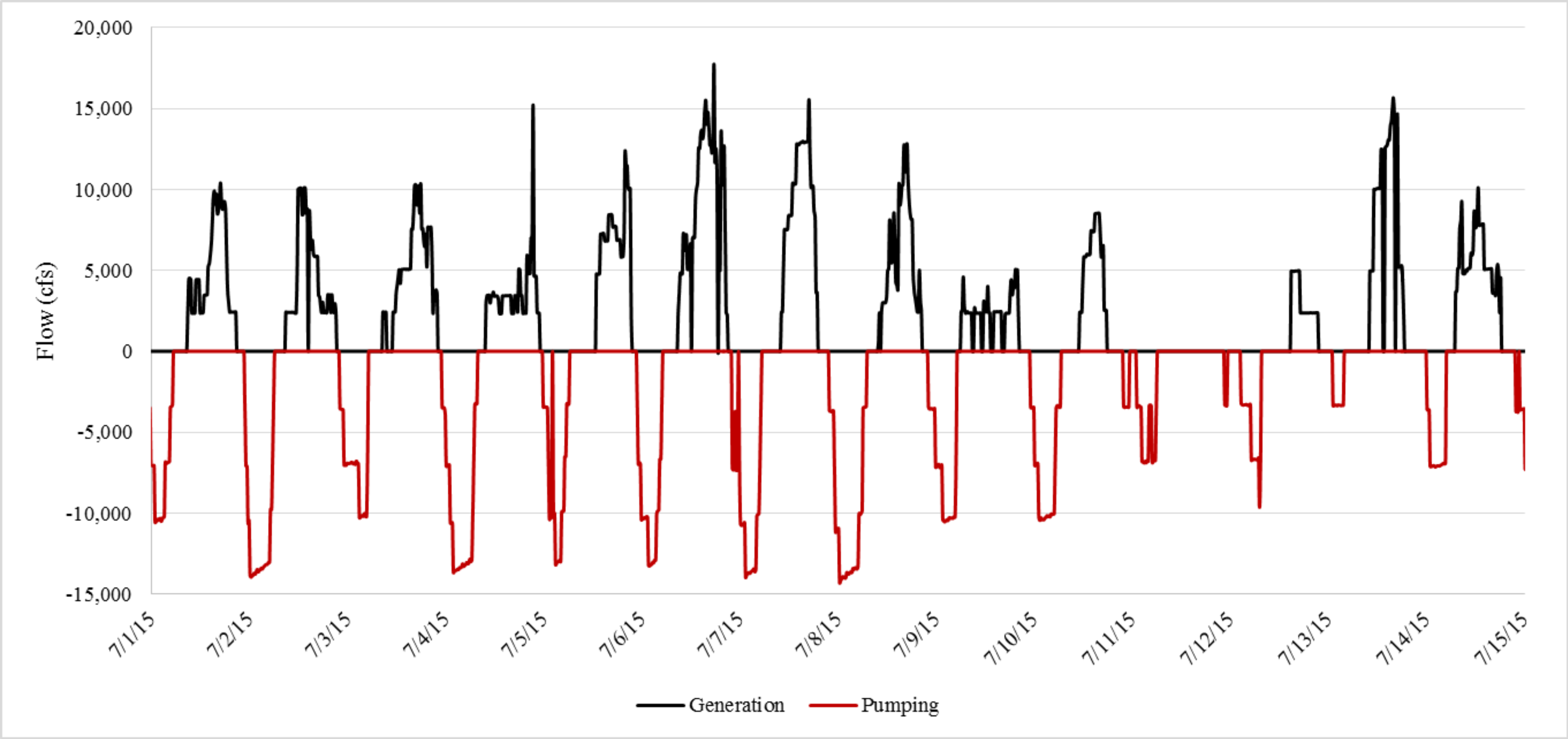

Figure 2.10-5: NMPS flow in July 2015 during the adult shad study.

2.11 Detection History Plots

This section is addresses the following agency comments: *MADFW-10 USFWS-1(5), and USFWS-13(5).*

See Attachment A

2.12 Flow Histograms and Quantiles

This section addresses the following agency comments: USFWS-13(3).

Flow in the Turners Falls Impoundment (Gill Bank, NMPS Intake and Shearer Farms) was assessed using a HEC-RAS model which calculated hourly total flow at these particular cross sections of the river using WSEL and average channel velocities. These cross sectional areas are in close proximity to NMPS, therefore operations at Northfield can have varying effects on flow data. For example, during pumping at NMPS and low river flows, flow values and velocities at the Gill Bank location may be negative. During higher river flows and the same amount of pumping, there is only a decrease in the flows and velocities. Upstream of NMPS at the Shearer Farms location, flow reversals are caused by generation at NMPS. The following histograms (Figures 2.12-1 to 2.12-9) display frequency of flows throughout the 2015 adult shad study and the descriptive statistics are shown in Table 2.12-1.

Table 2.12-1: Descriptive statistics of Flow (cfs) at various locations throughout the 2015 adult shad study

Flow Quantile	25%	50%	75%	100%
Location				
Gill Bank	4134.19	9048.29	14494.66	38205.2
NMPS Intake	4462.73	8667.67	13744.58	34541.43
Shearer Farms	4511.25	8654.62	13727.30	34364.64
Cabot Canal	4008	8966	13969	18691
Cabot Powerhouse	2346.84	8889.21	12467.03	13841.92
Montague	6745	12200	17900	39300
Station No.1	0	0	2179.12	2256.95
TF Dam	0	1357.5	4386	20818
Vernon	5069.11	9724.56	14548.28	42859.58

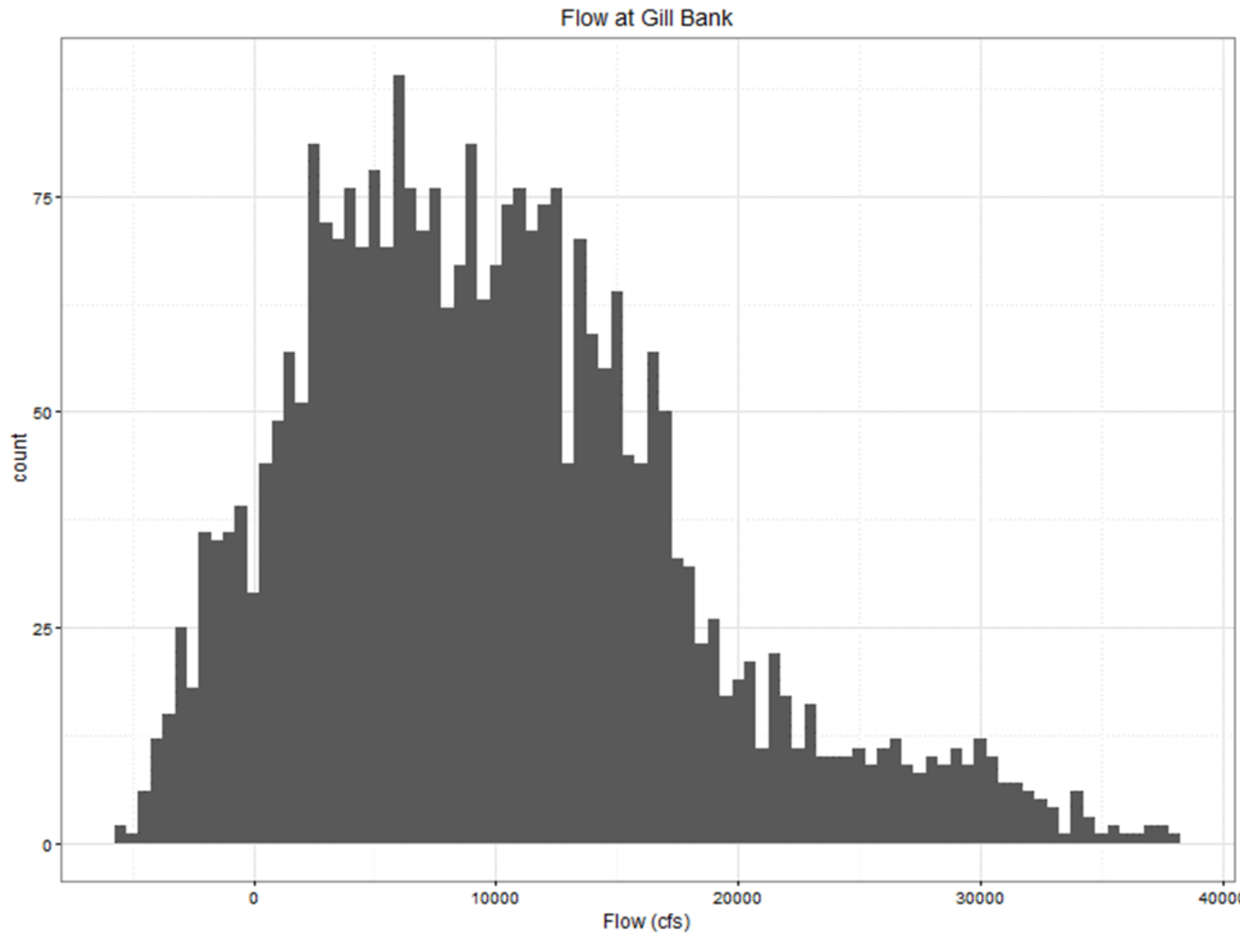

Figure 2.12-1: Flow at Gill Bank (cfs); frequency during the 2015 Adult Shad Telemetry study

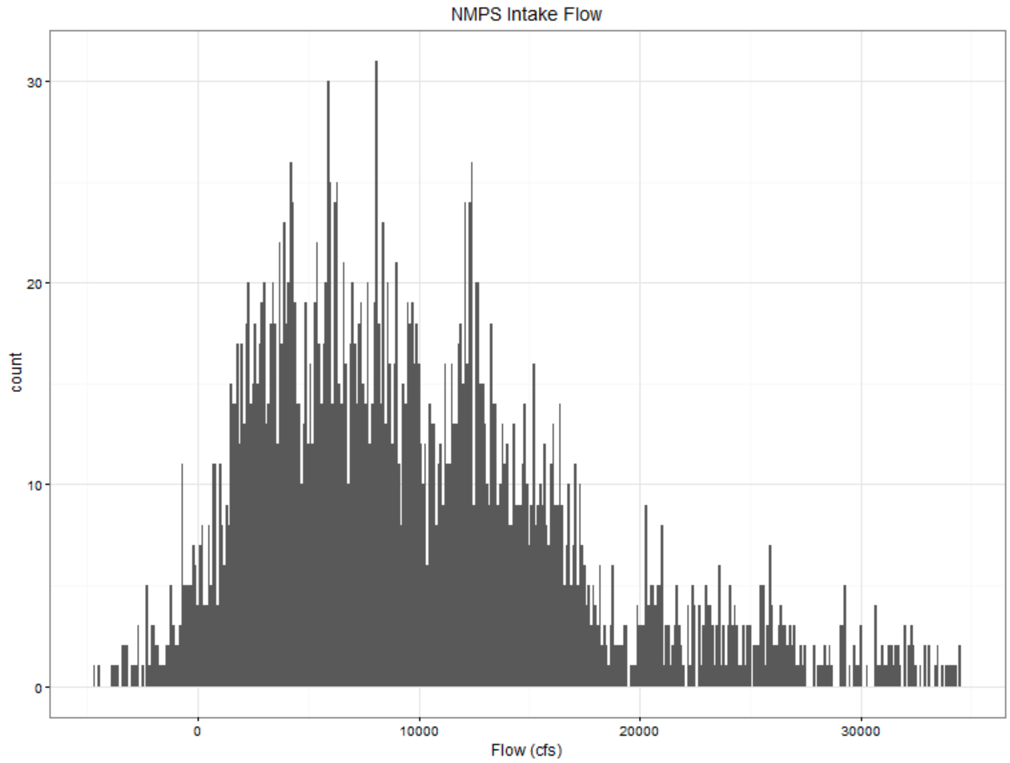

Figure 2.12-2: Flow at NMPS Intake (cfs); frequency during the 2015 Adult Shad Telemetry study

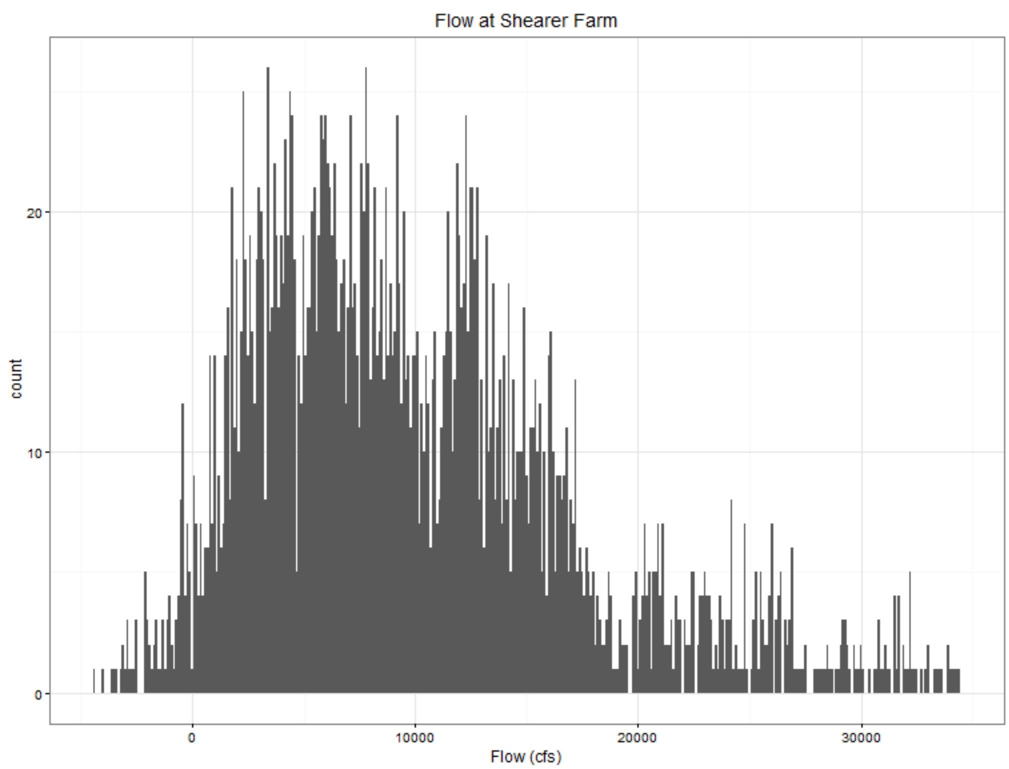

Figure 2.12-3: Flow at Shearer Farms (cfs); frequency during the 2015 Adult Shad Telemetry study

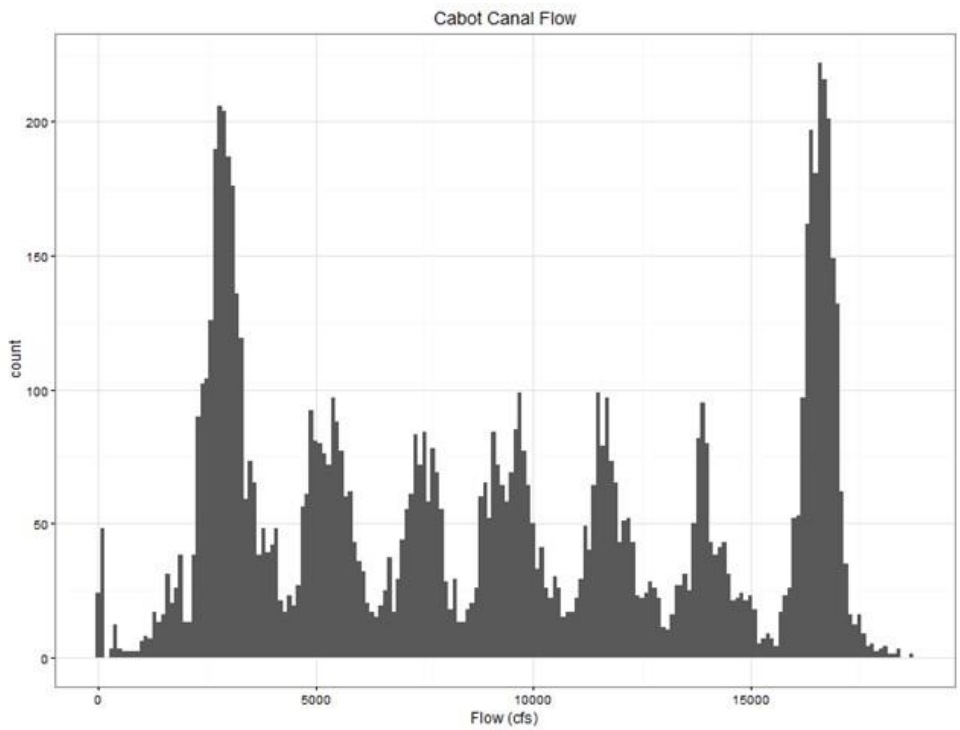

Figure 2.12-4: Flow at Cabot Canal (cfs); frequency during the 2015 Adult Shad Telemetry study

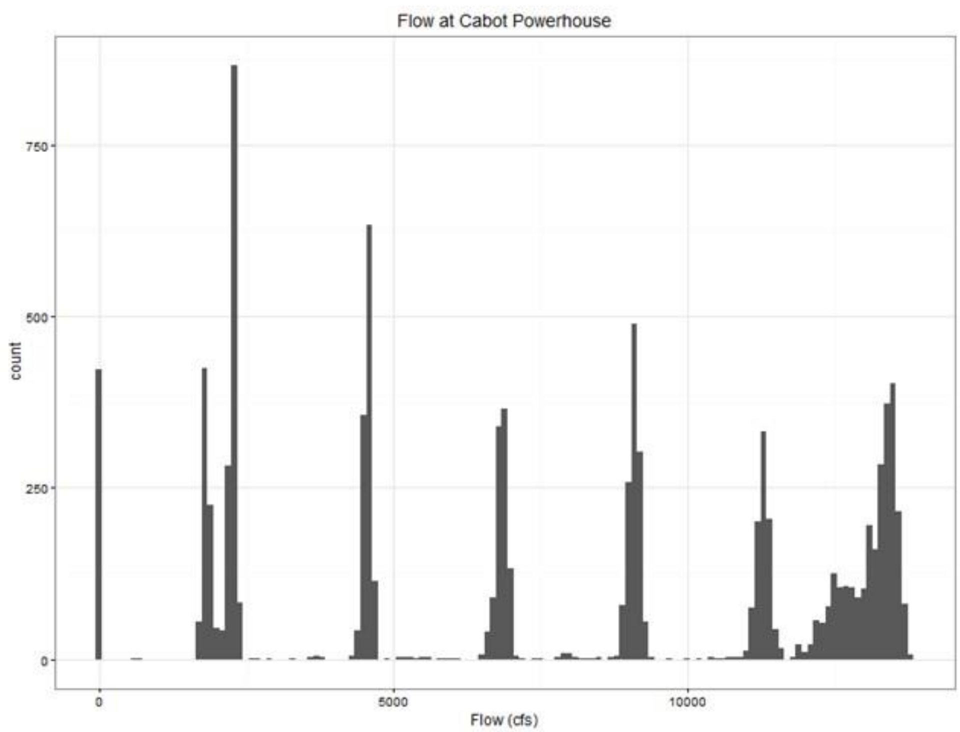

Figure 2.12-5: Flow at Cabot Powerhouse (cfs); frequency during the 2015 Adult Shad Telemetry study

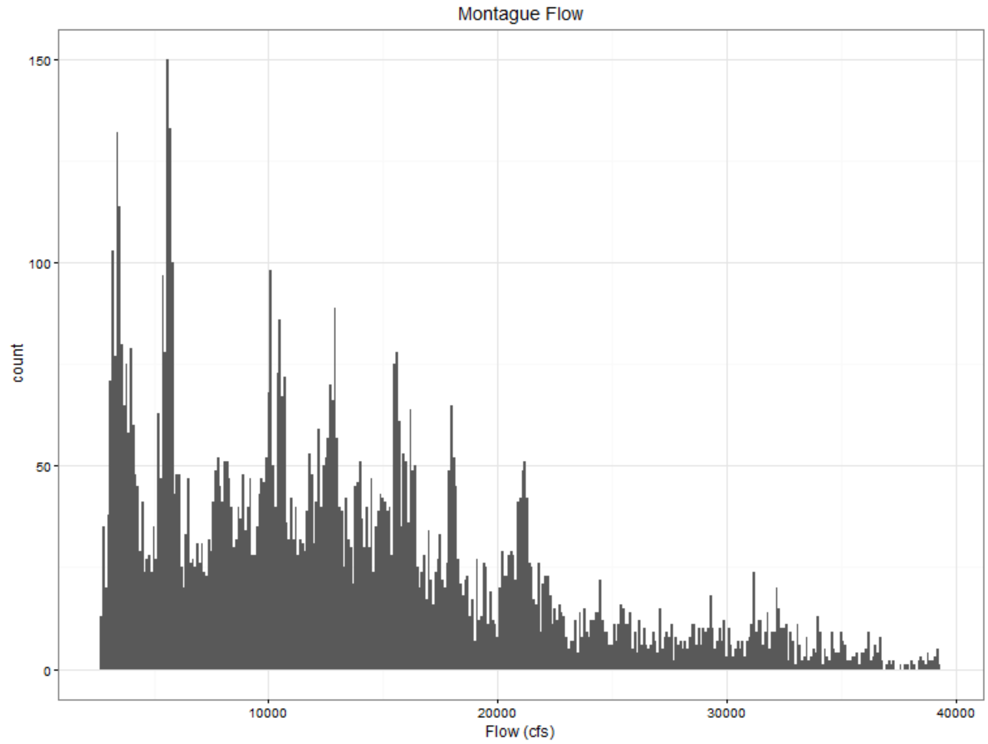

Figure 2.12-6: Montague Flow (cfs); frequency during the 2015 Adult Shad Telemetry study

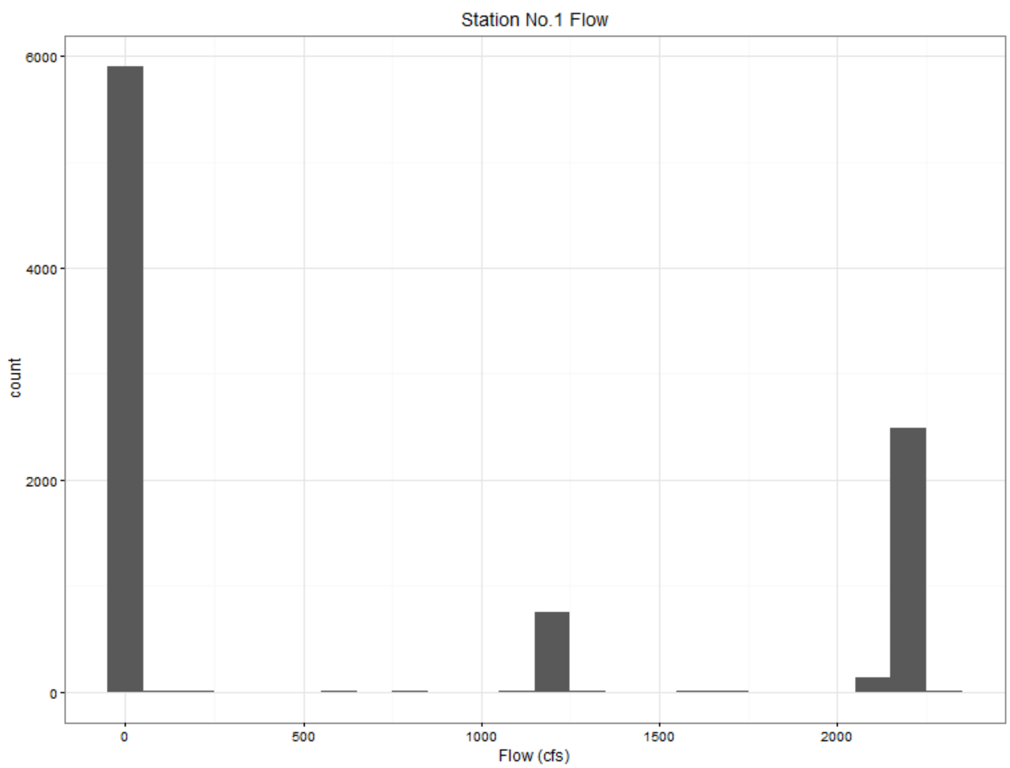

Figure 2.12-7: Station No.1 Flow (cfs); frequency during the 2015 Adult Shad Telemetry study

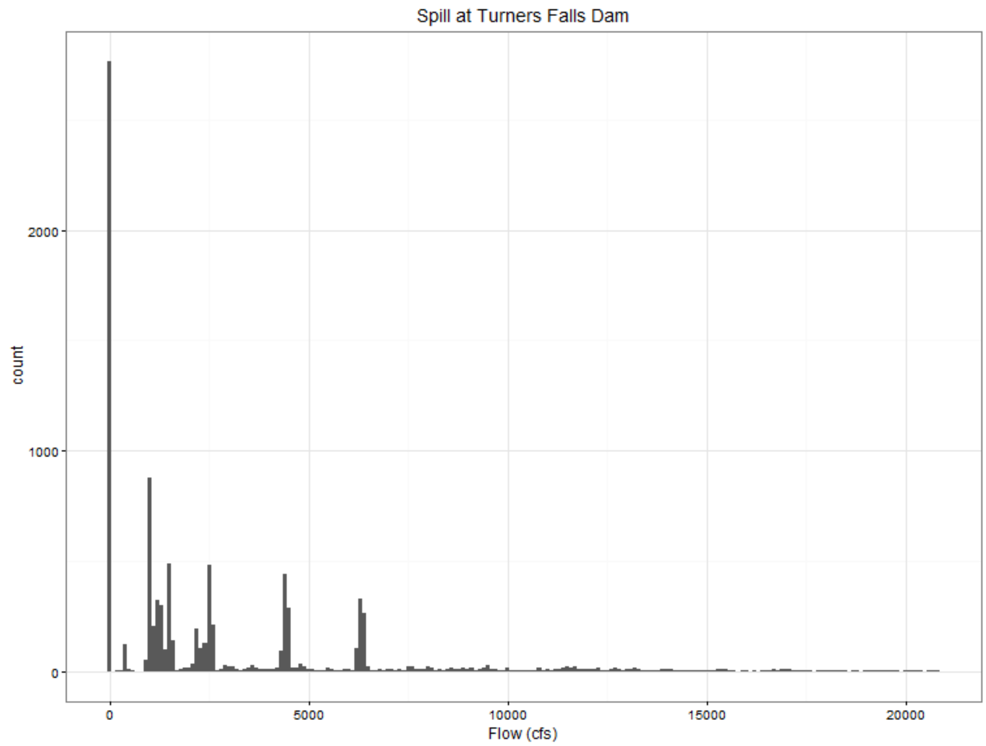

Figure 2.12-8: Spill at TFD (cfs); frequency during the 2015 Adult Shad Telemetry study

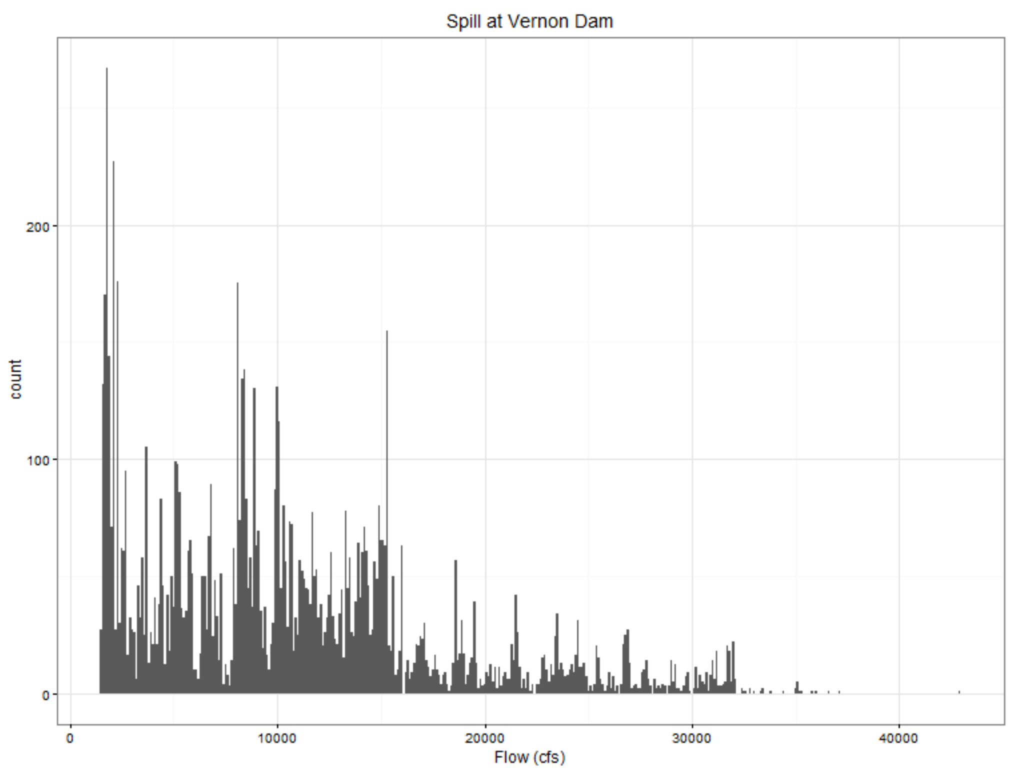

Figure 2.12-9: Spill at Vernon (cfs); frequency during the 2015 Adult Shad Telemetry study

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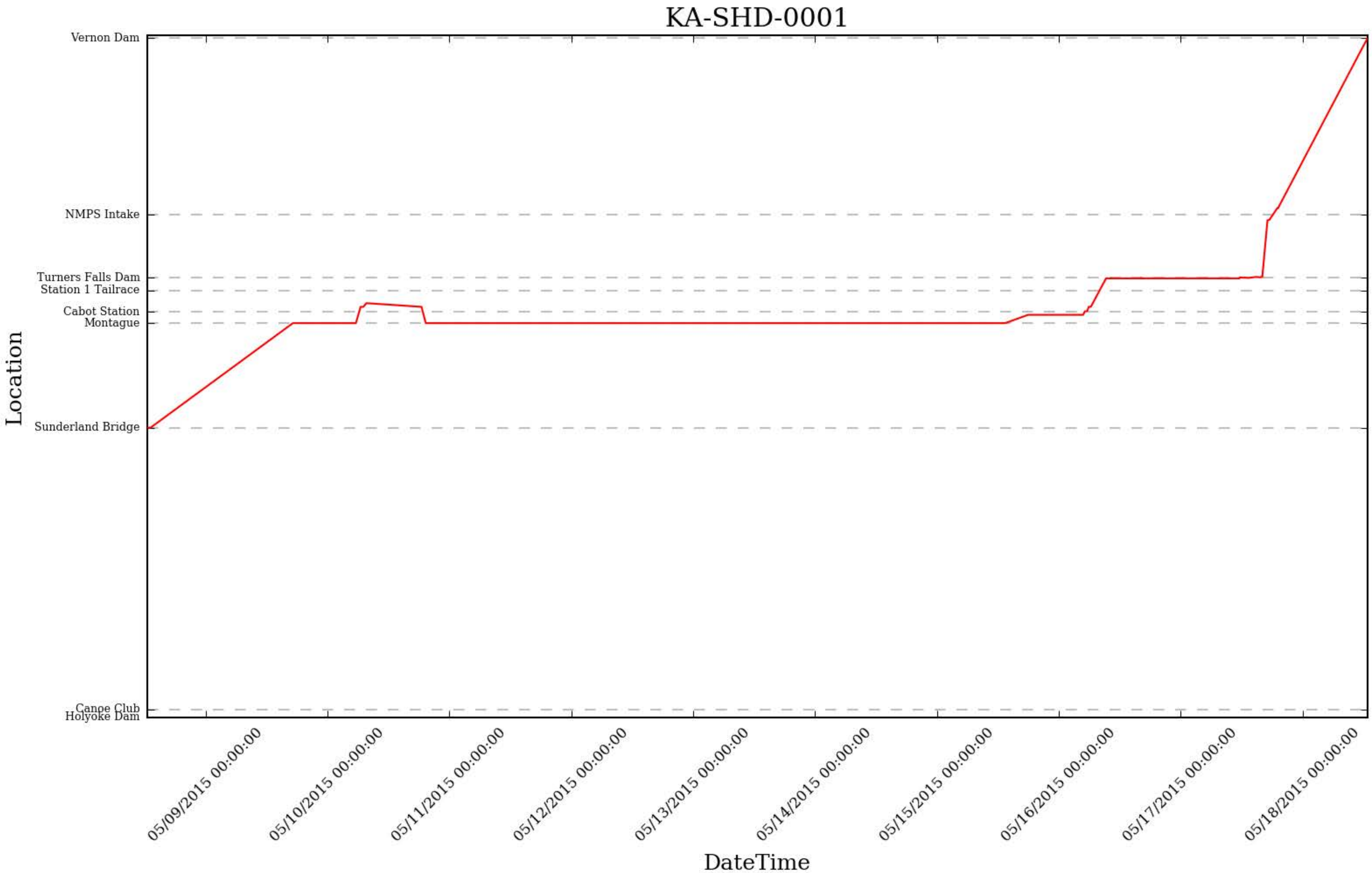
ATTACHMENT A:
DETECTION HISTORY PLOTS



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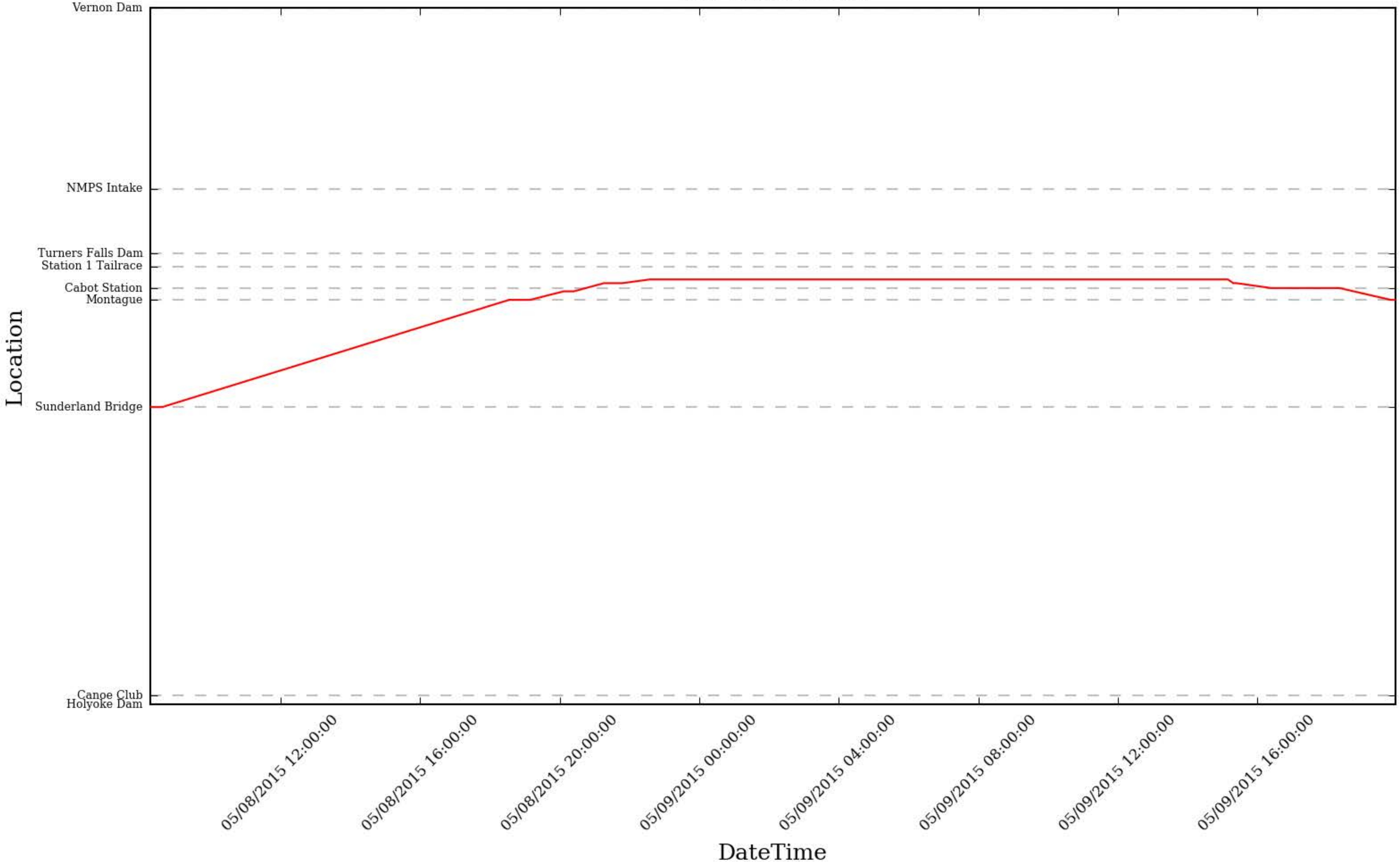
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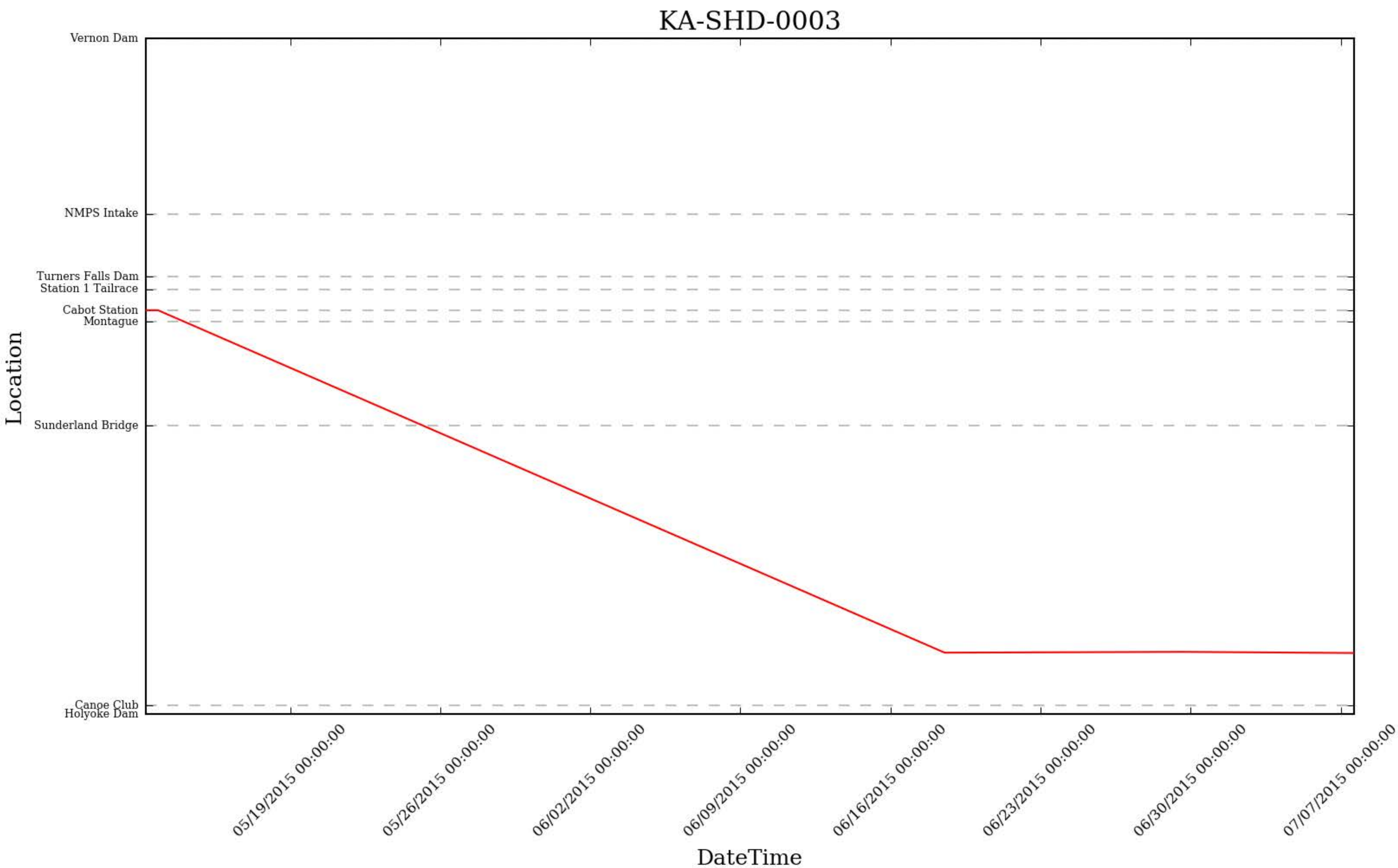

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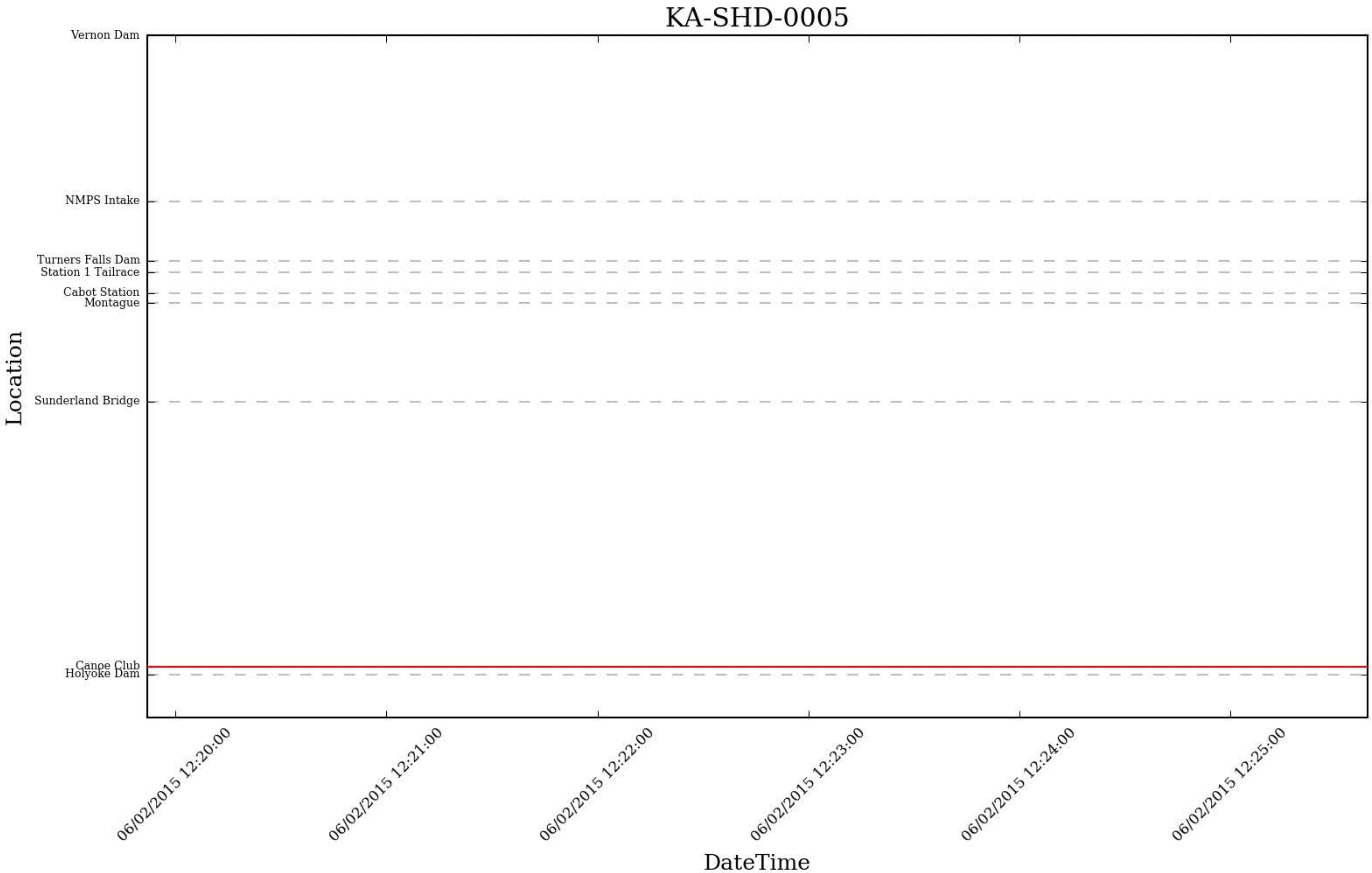
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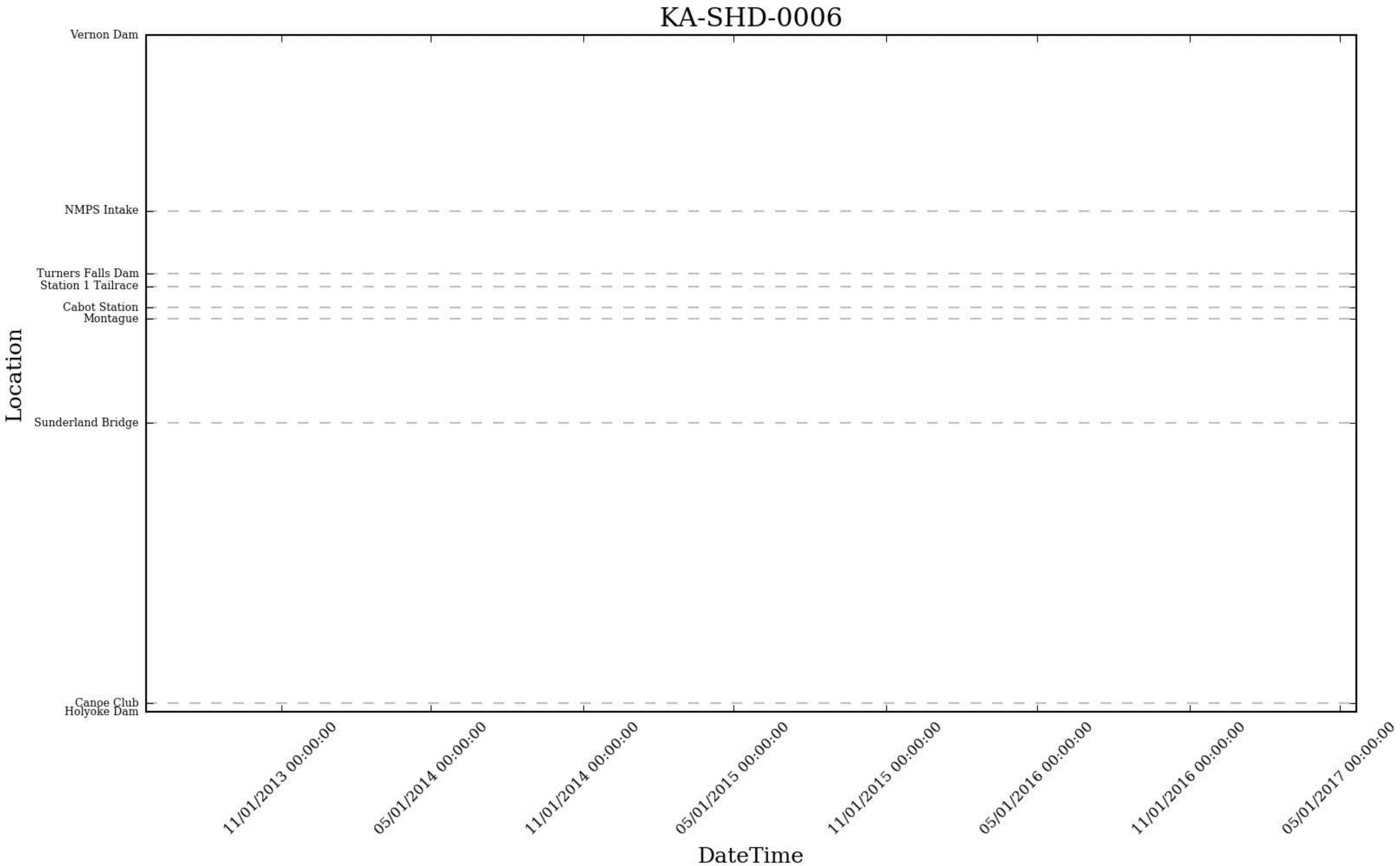
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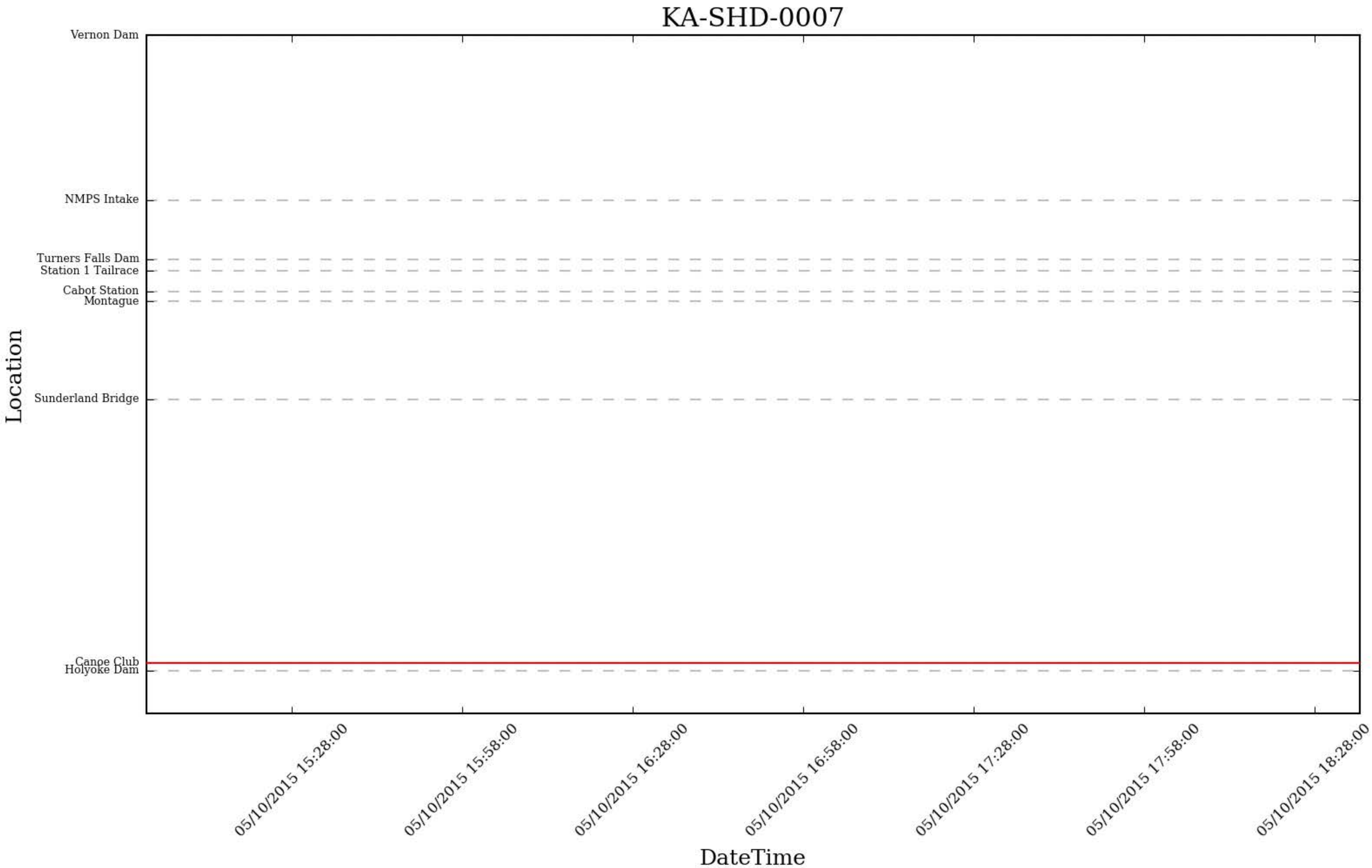
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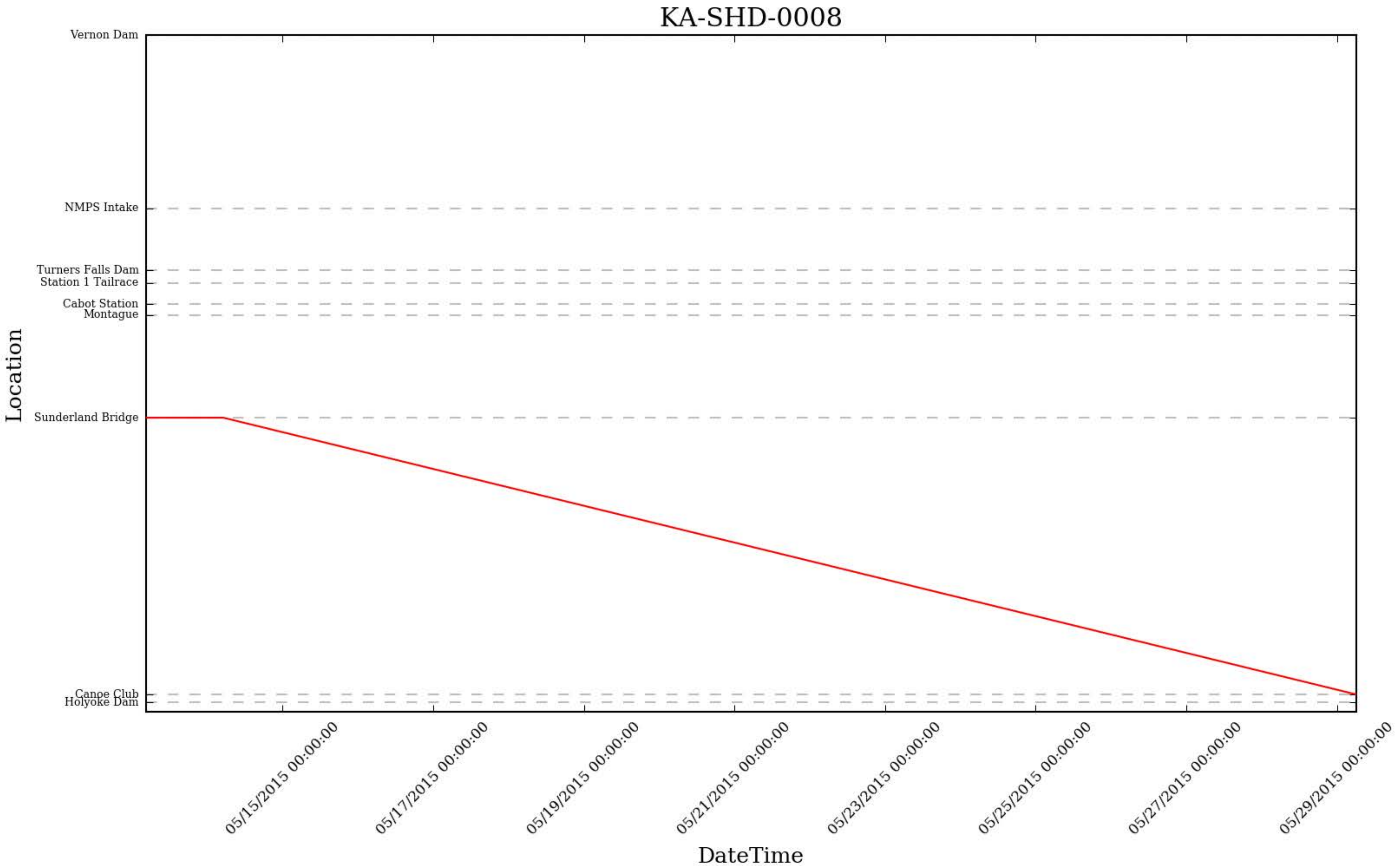
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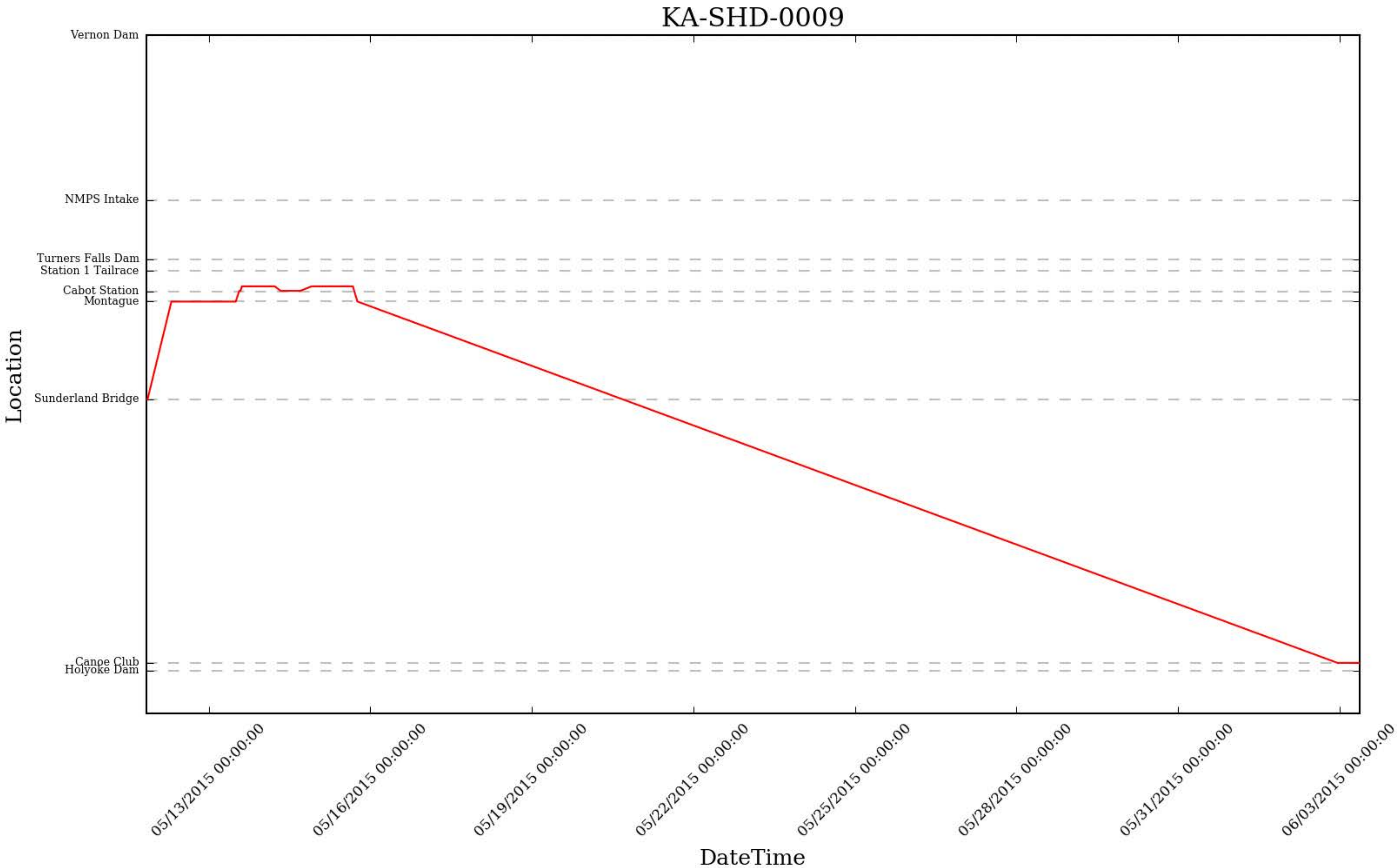
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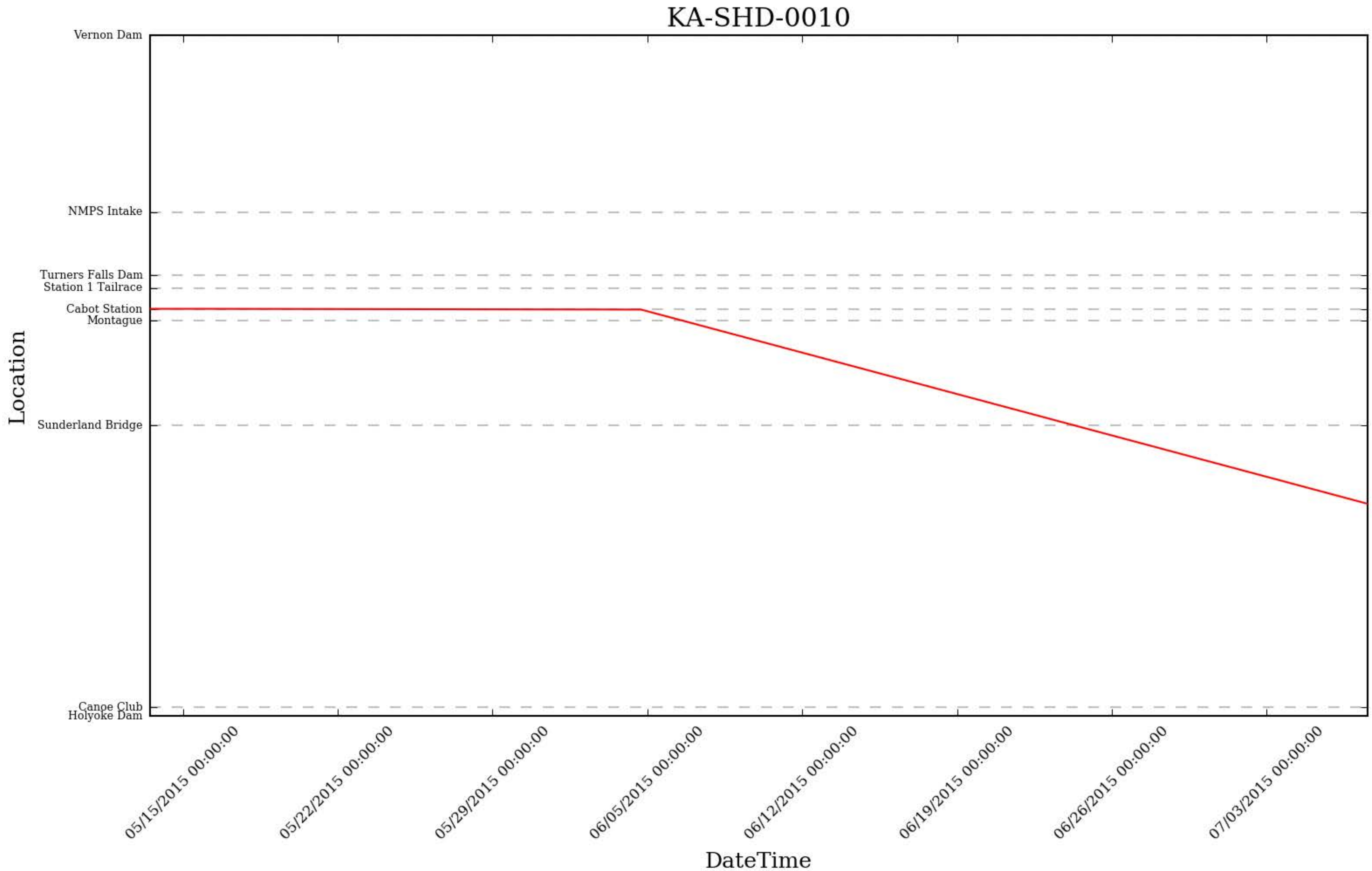

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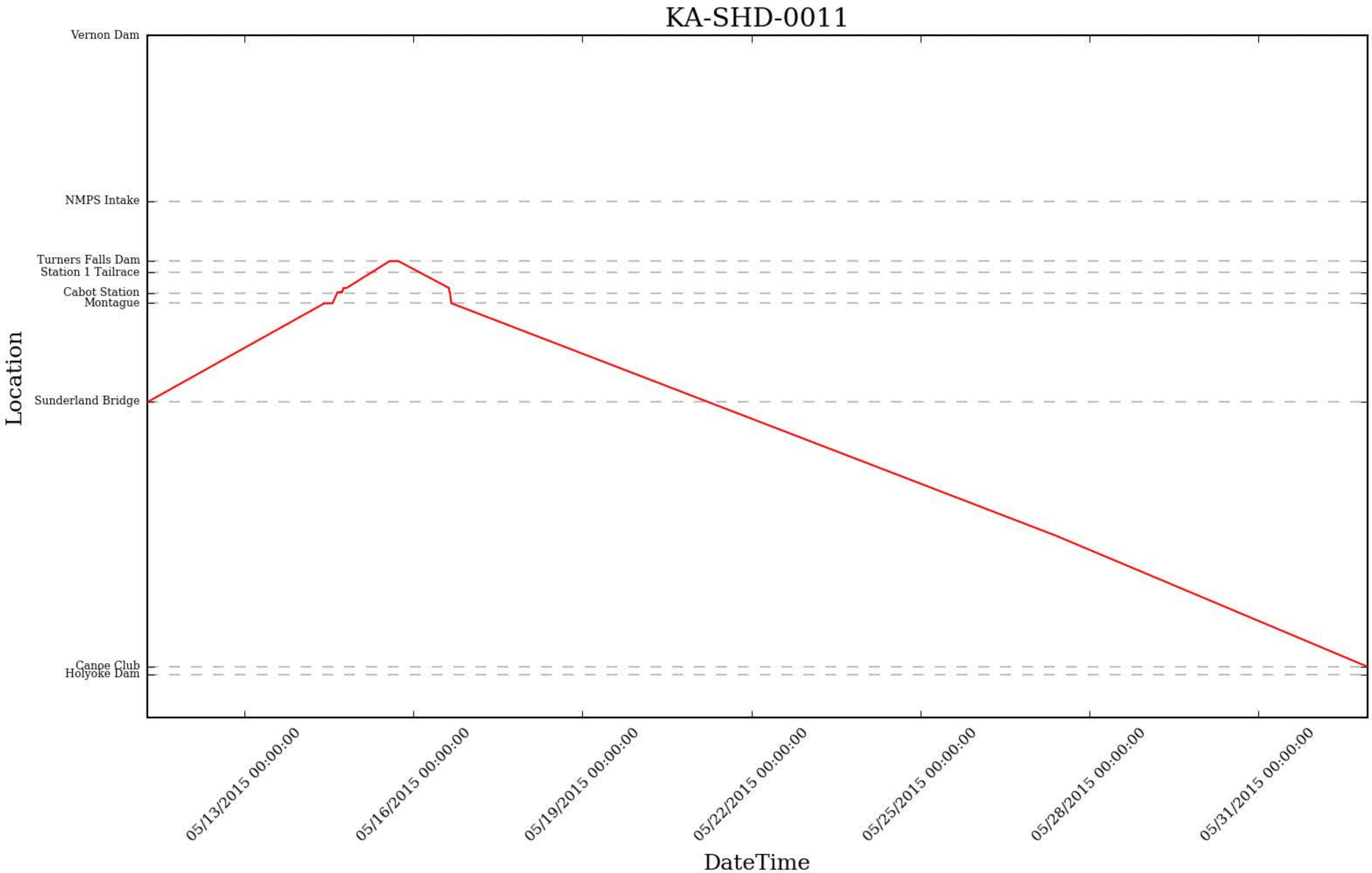

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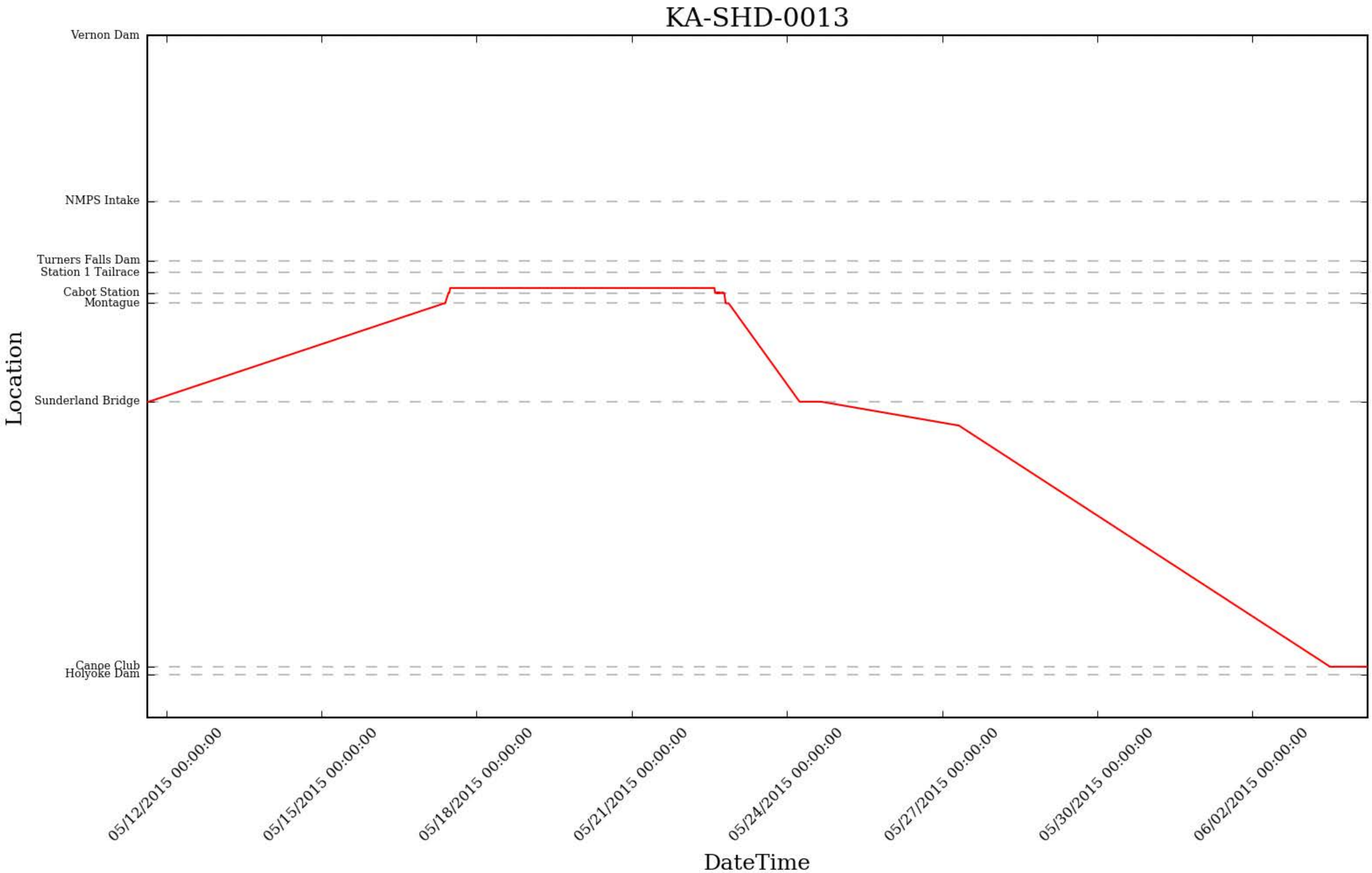

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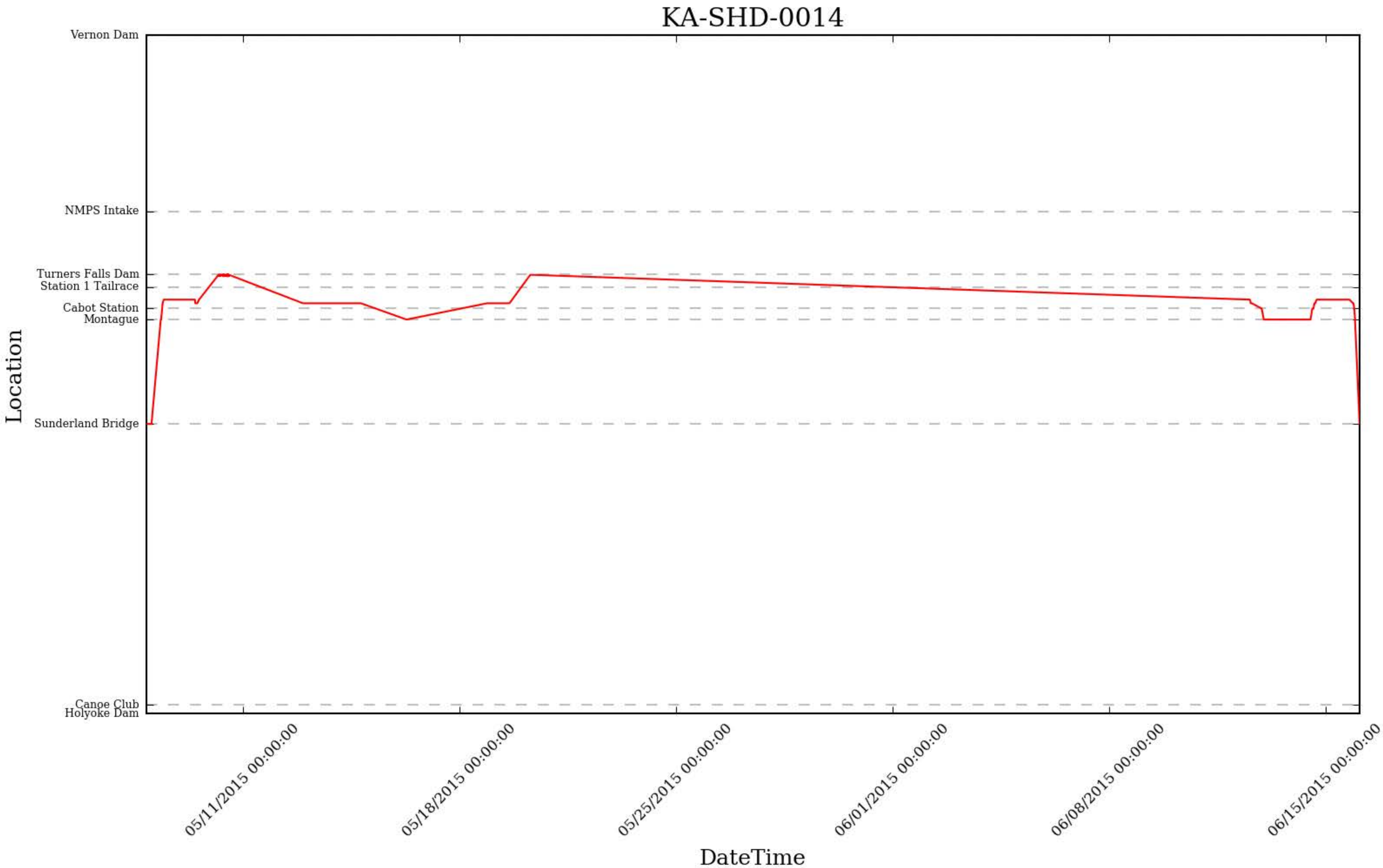

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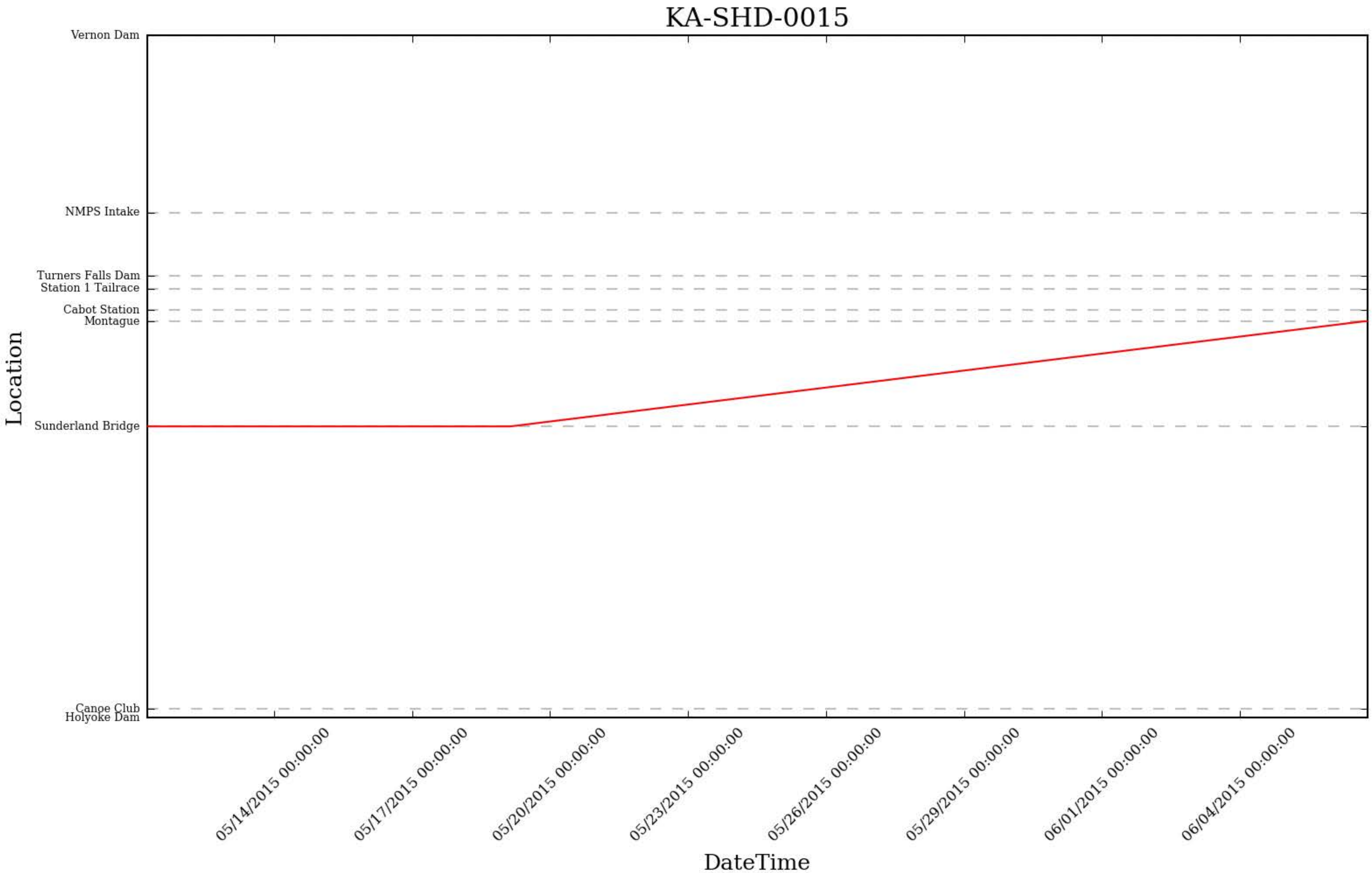

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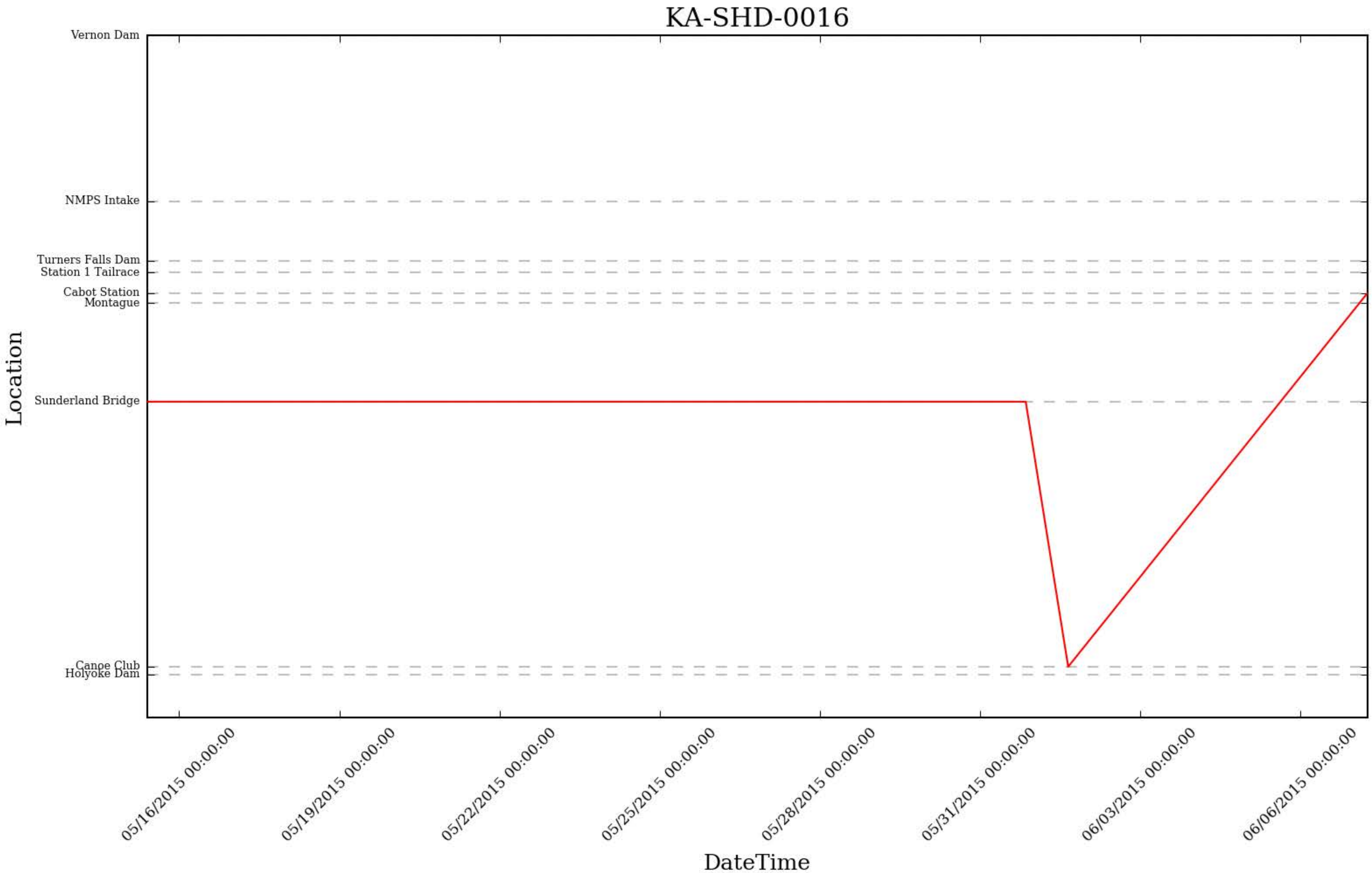

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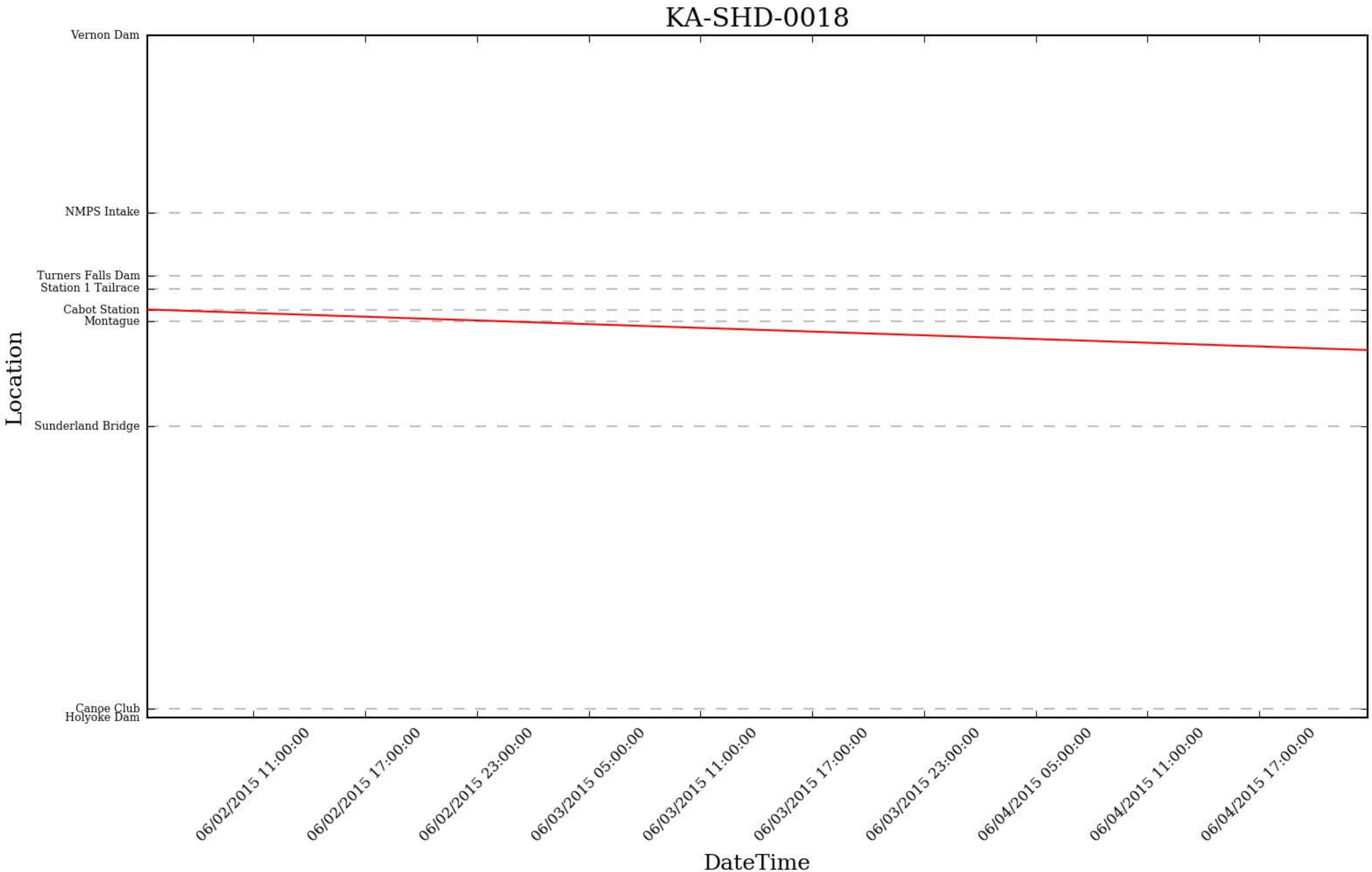
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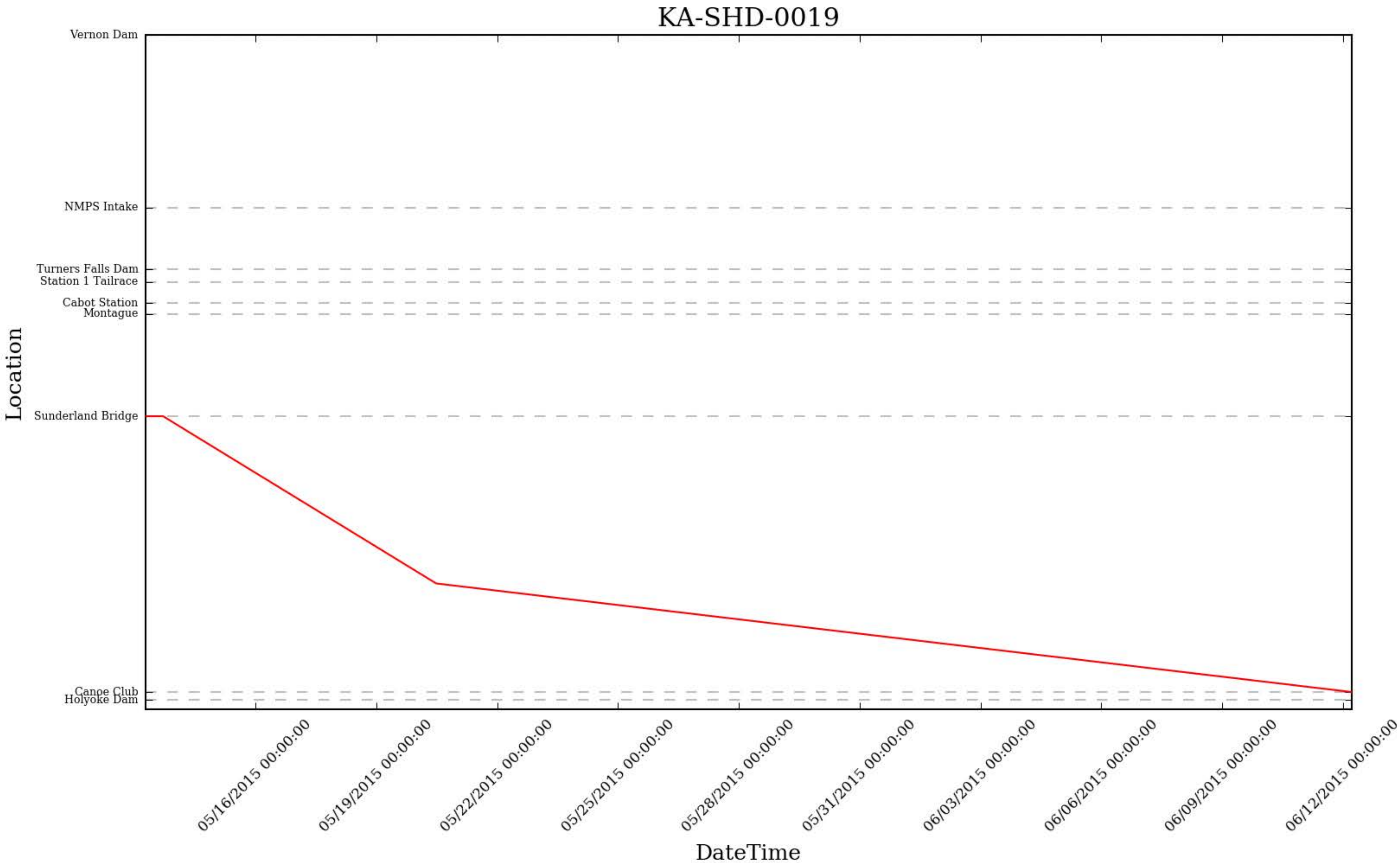

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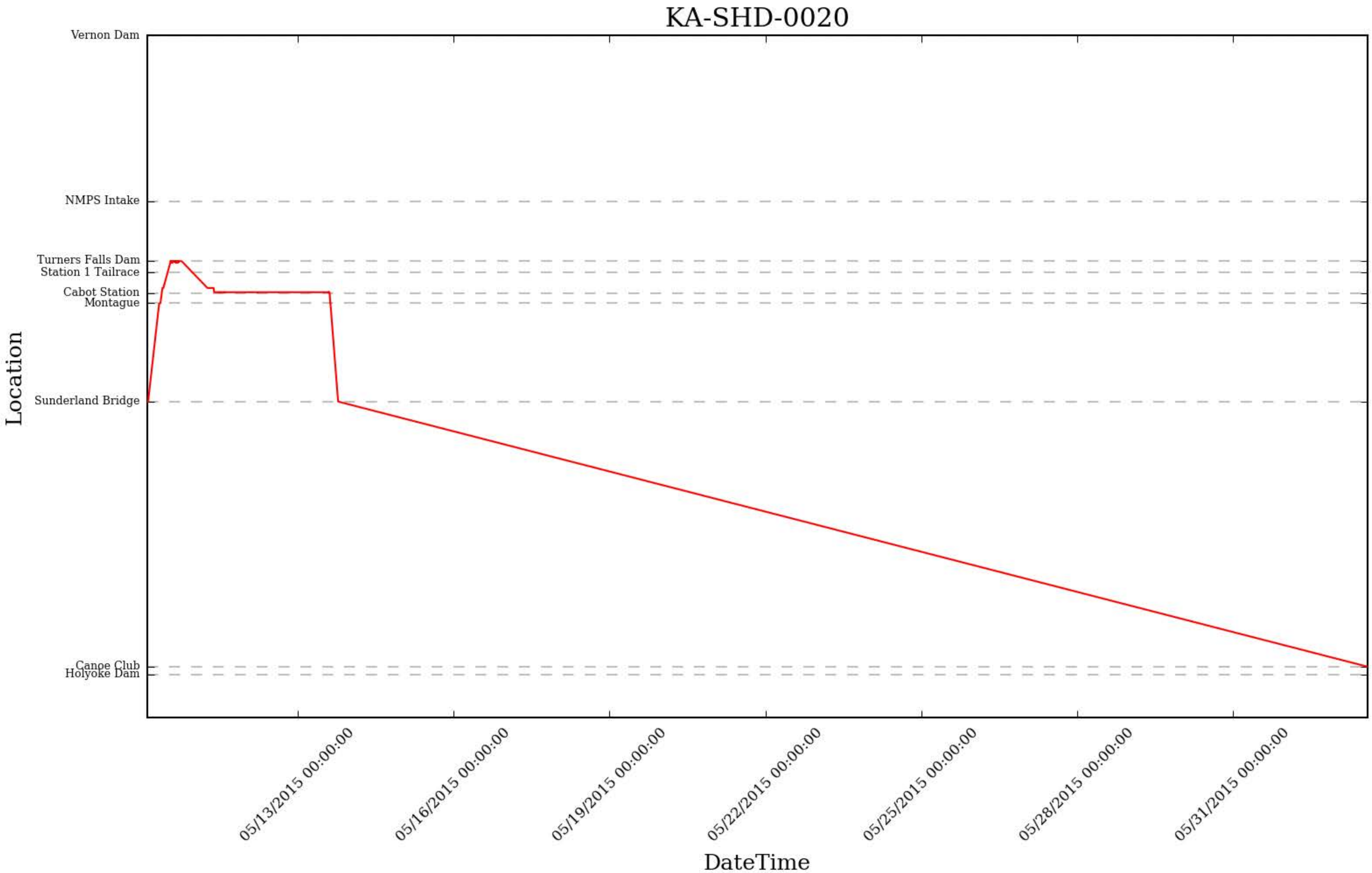
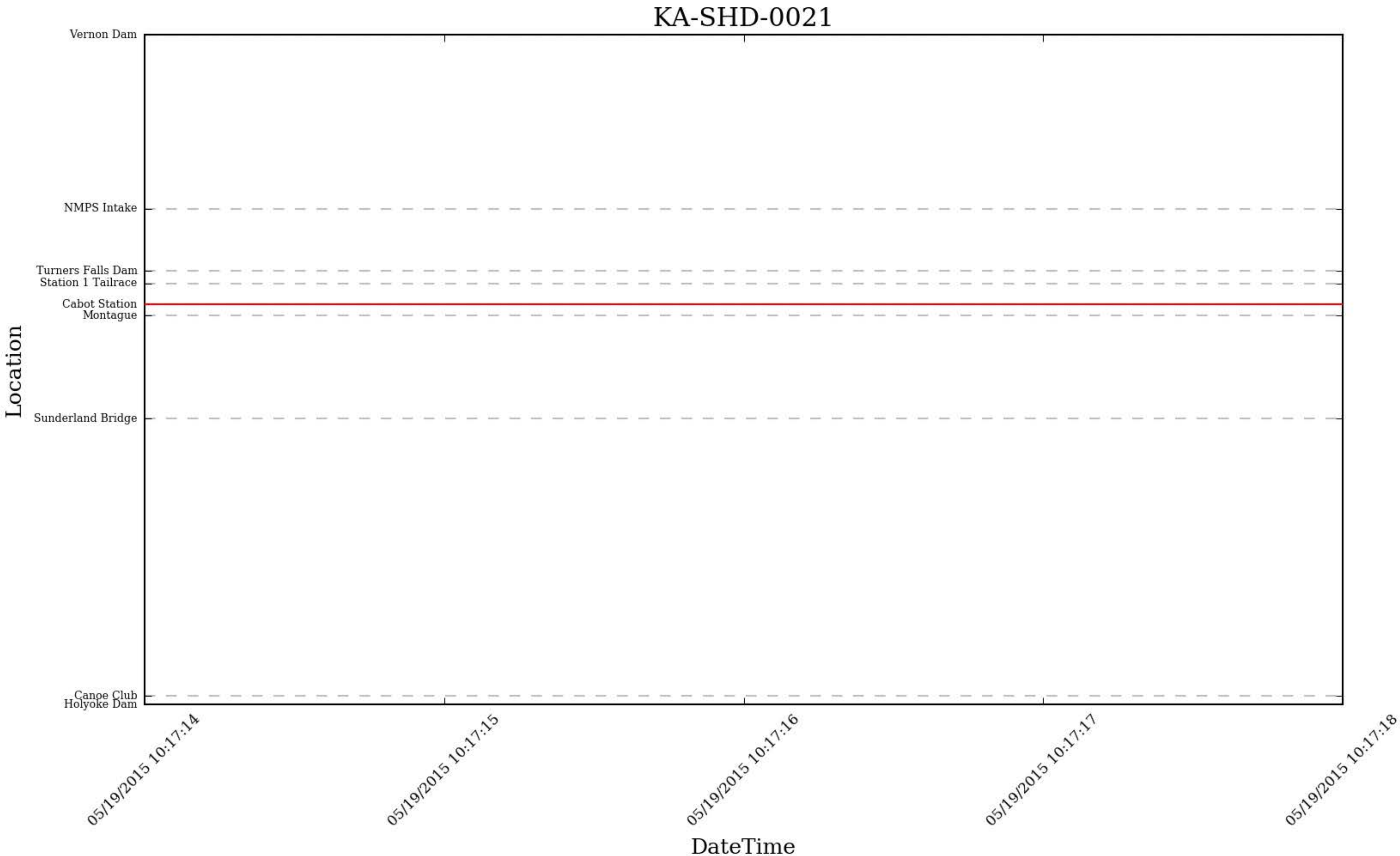
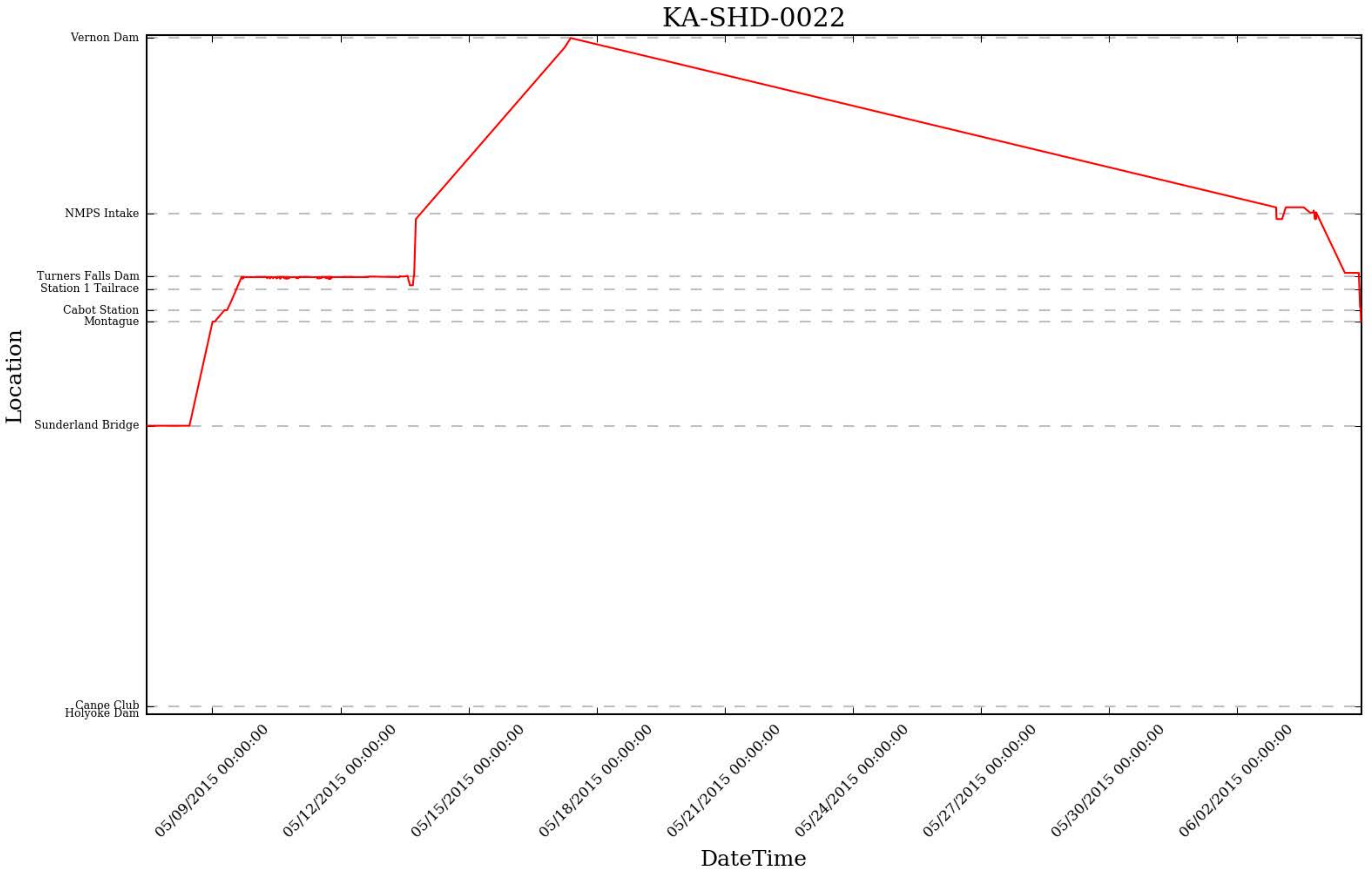
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
06/12/2015 00:00:00
DateTime

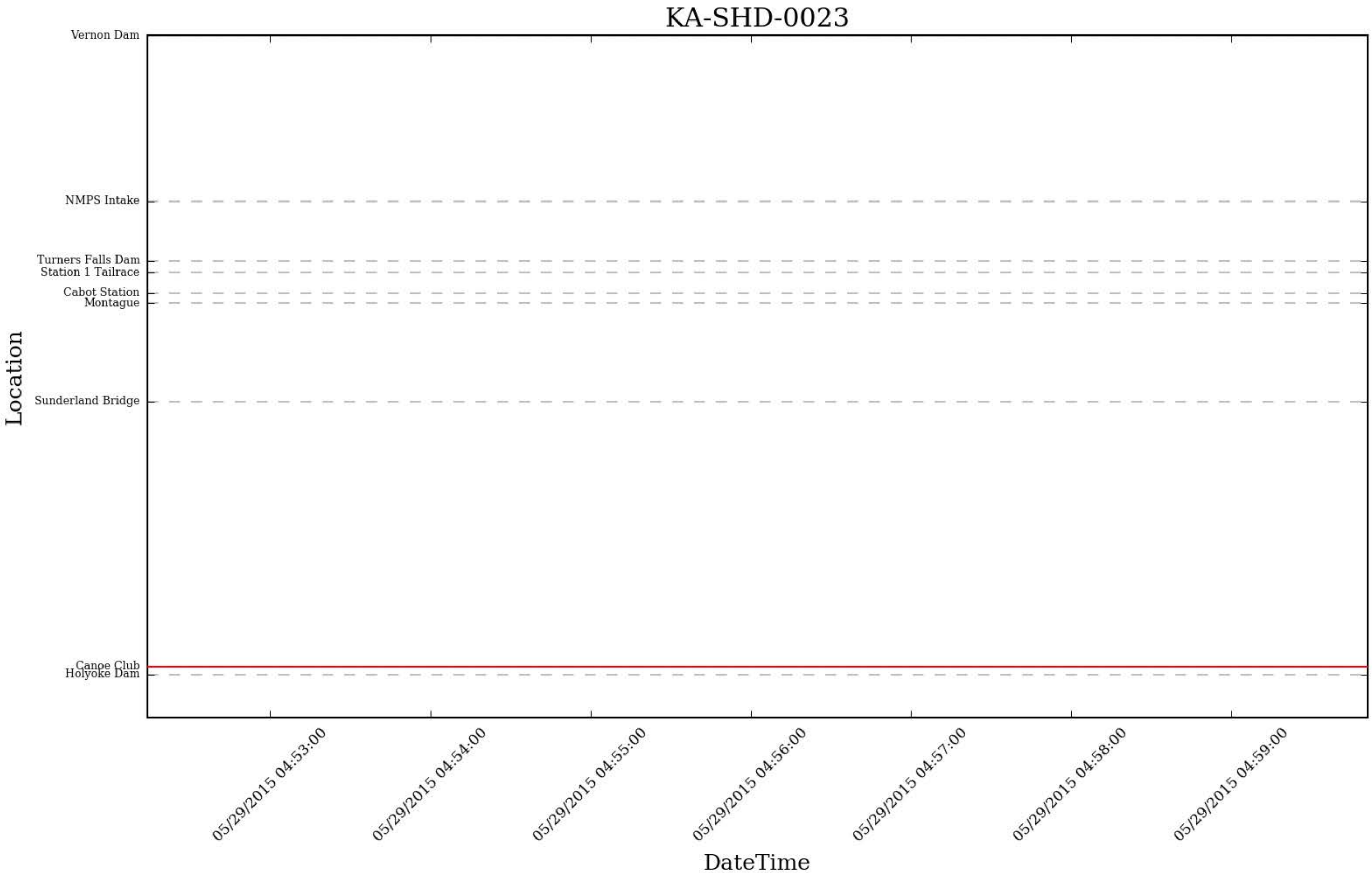


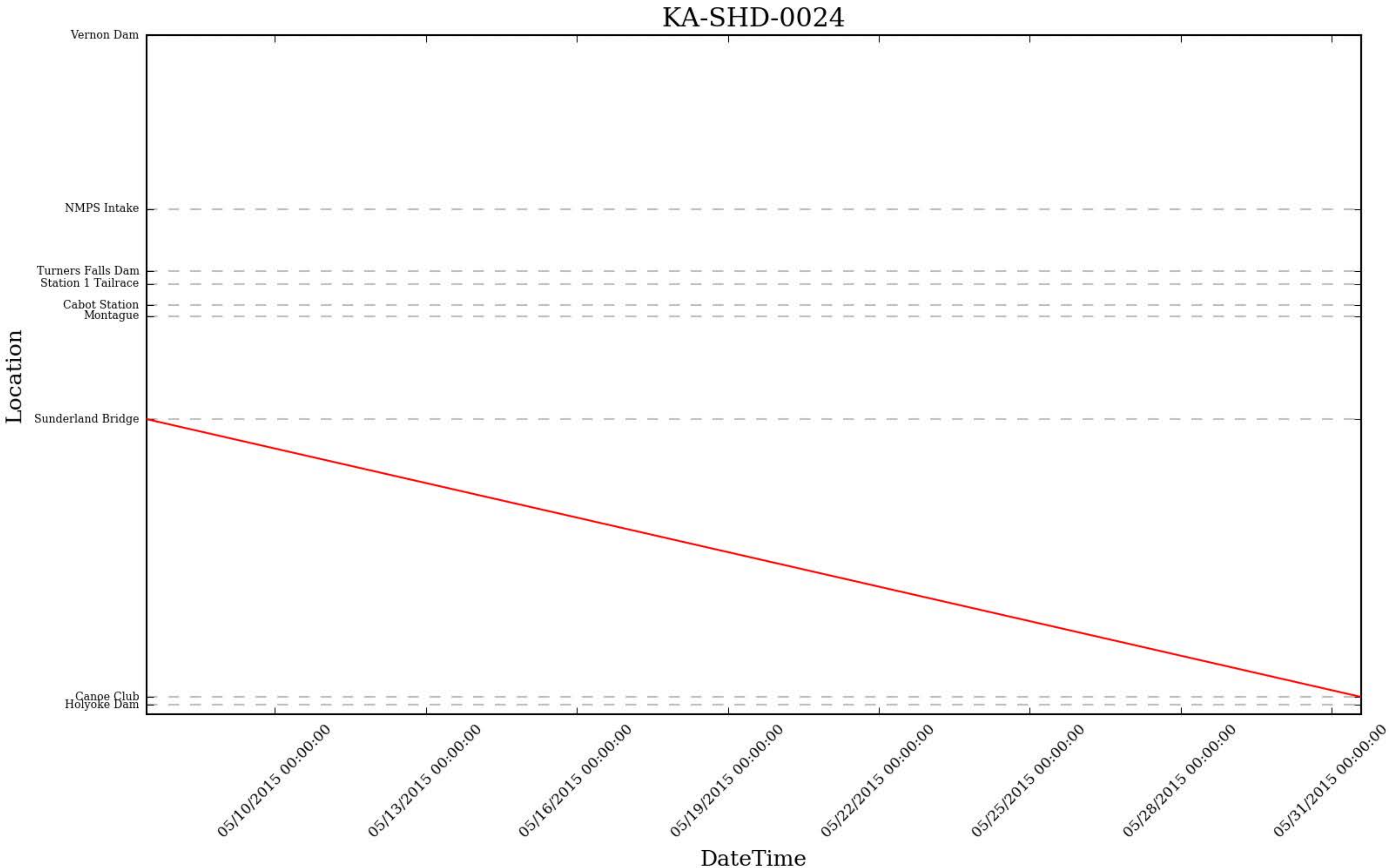
KA-SHD-0020
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 00:00:00
05/16/2015 00:00:00
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
DateTime

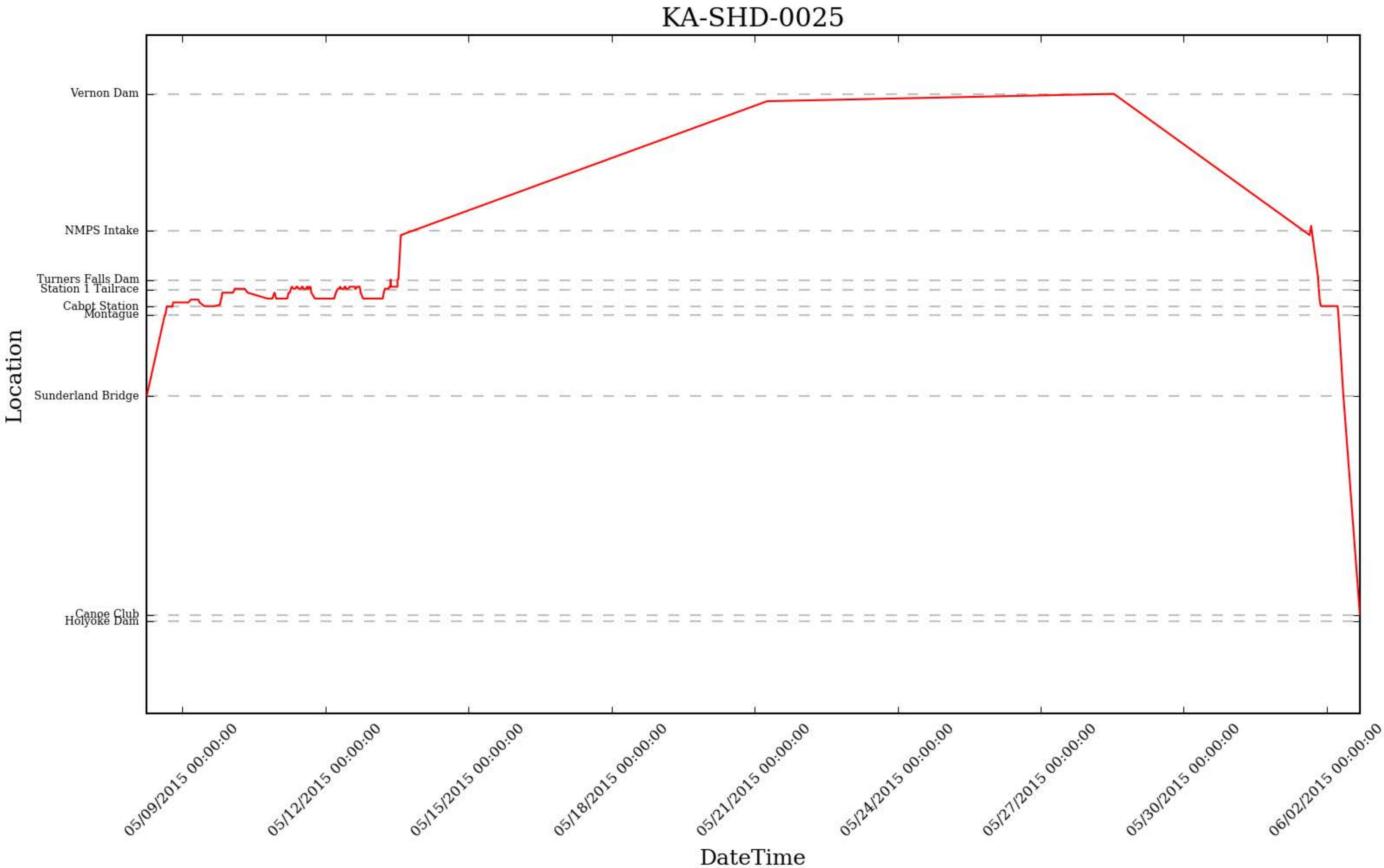

KA-SHD-0021
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 10:17:14
05/19/2015 10:17:15
05/19/2015 10:17:16
05/19/2015 10:17:17
05/19/2015 10:17:18
DateTime

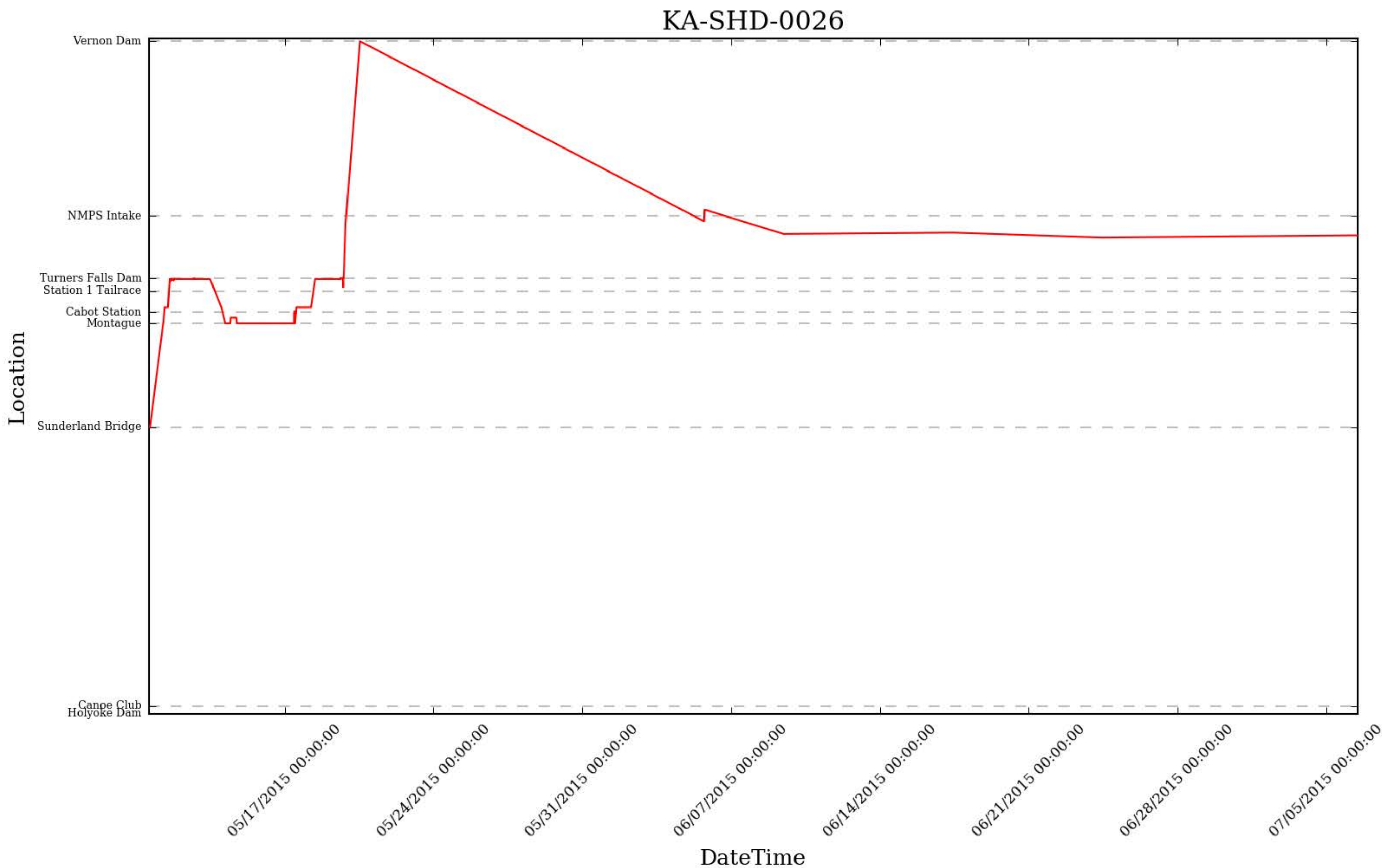


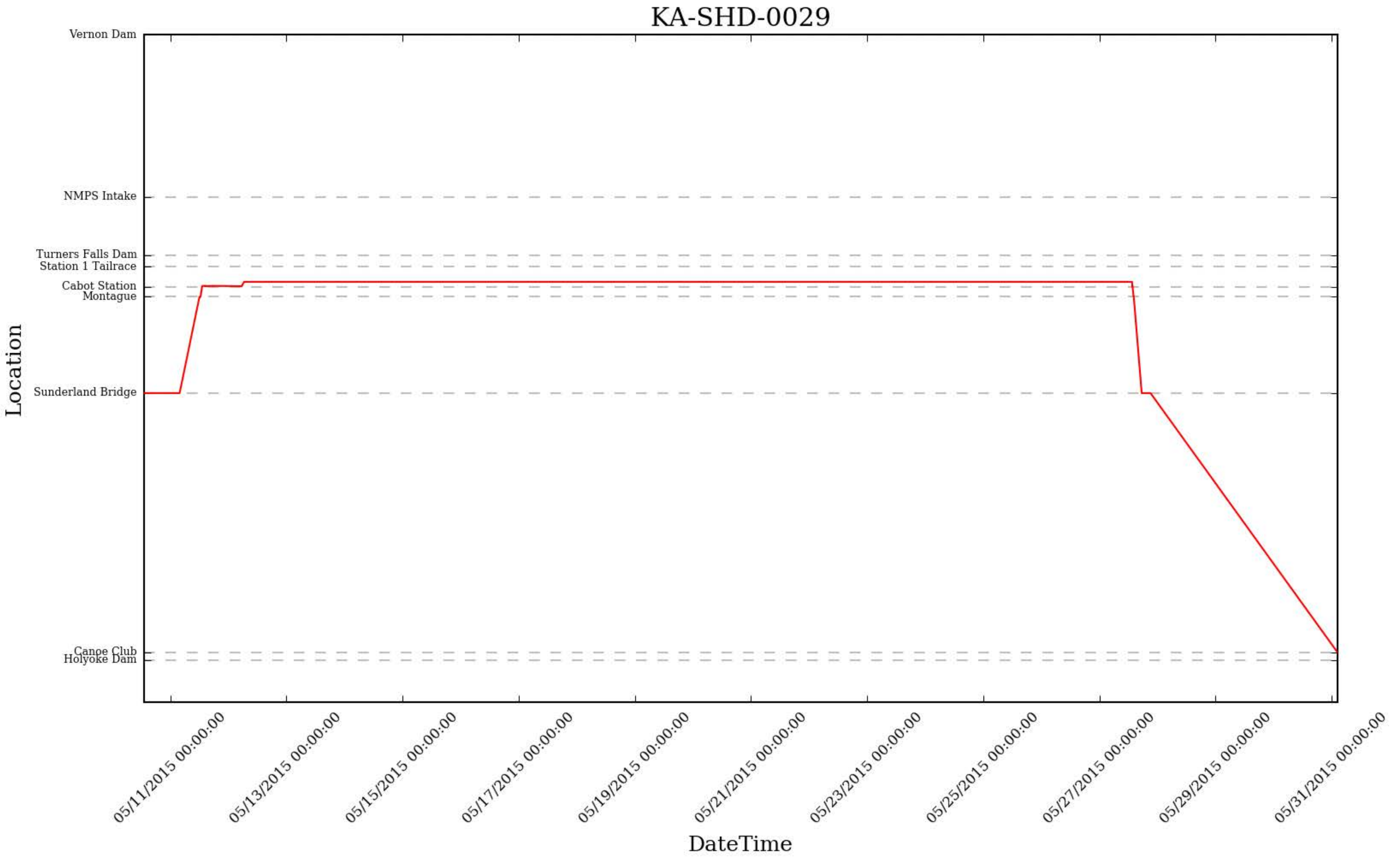
KA-SHD-0022
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/09/2015 00:00:00
05/12/2015 00:00:00
05/15/2015 00:00:00
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
DateTime


KA-SHD-0023
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/29/2015 04:53:00
05/29/2015 04:54:00
05/29/2015 04:55:00
05/29/2015 04:56:00
05/29/2015 04:57:00
05/29/2015 04:58:00
05/29/2015 04:59:00
DateTime

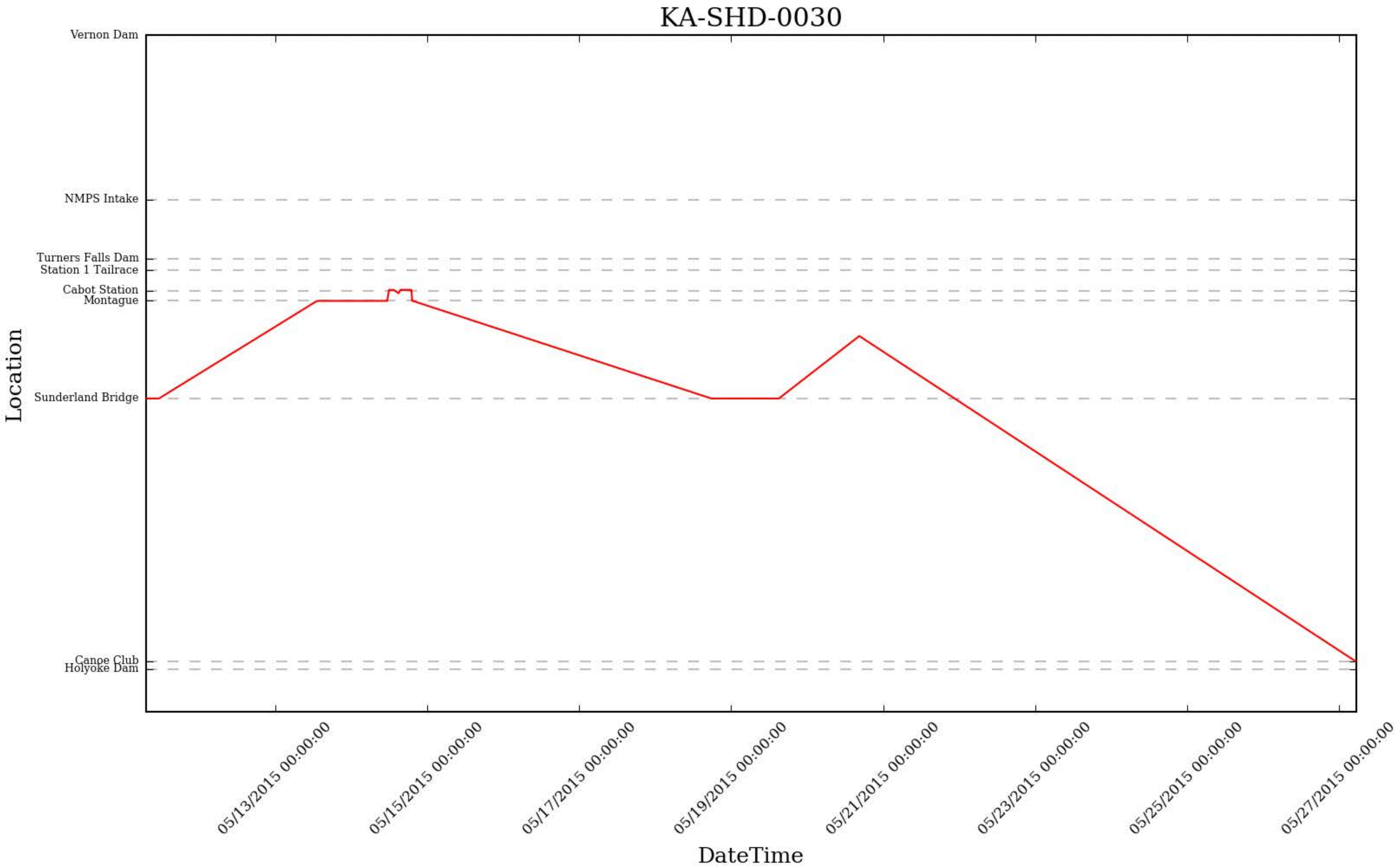

KA-SHD-0024
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/13/2015 00:00:00
05/16/2015 00:00:00
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
DateTime


KA-SHD-0025
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/09/2015 00:00:00
05/12/2015 00:00:00
05/15/2015 00:00:00
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
DateTime

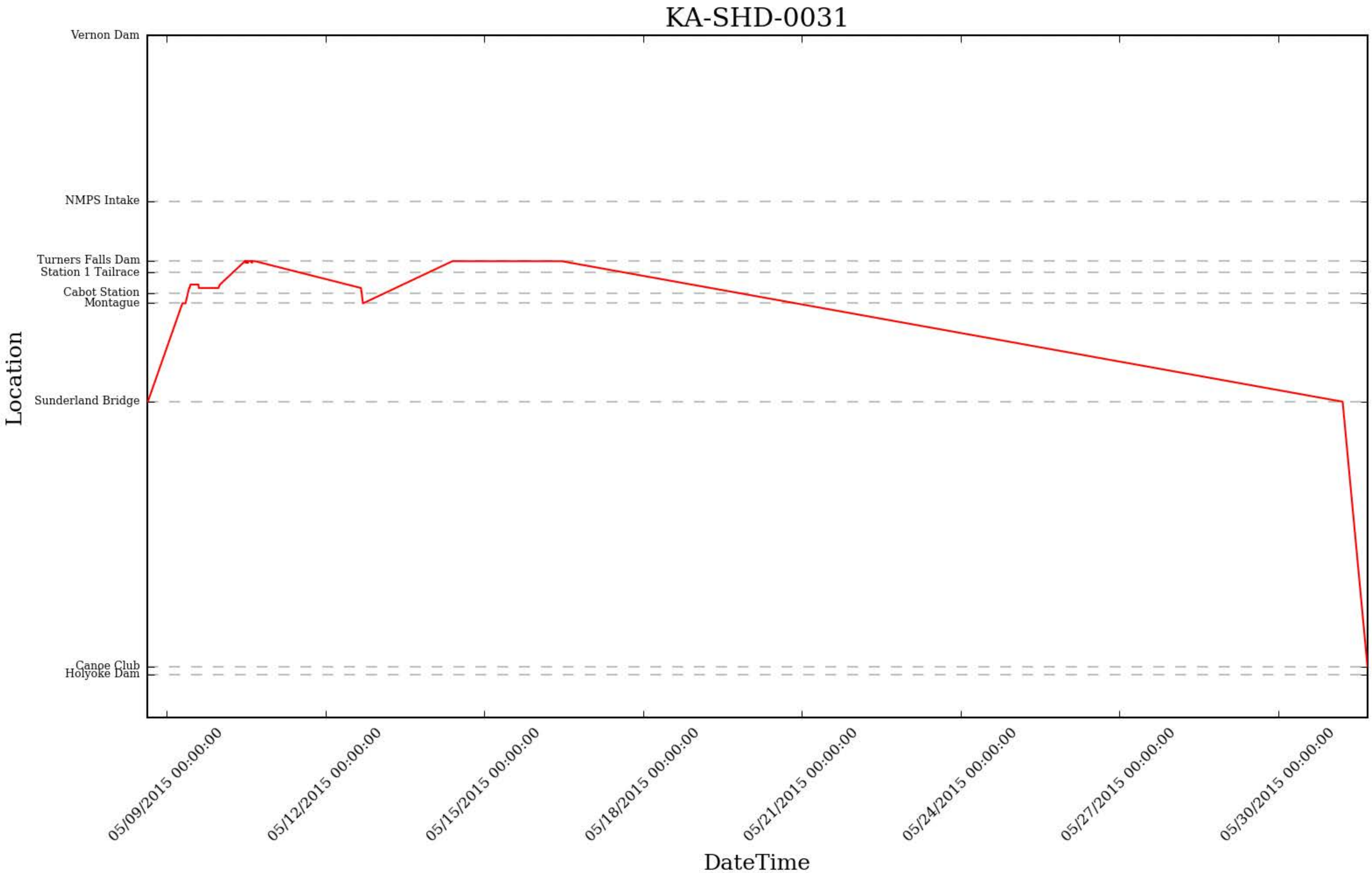

KA-SHD-0026
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
DateTime

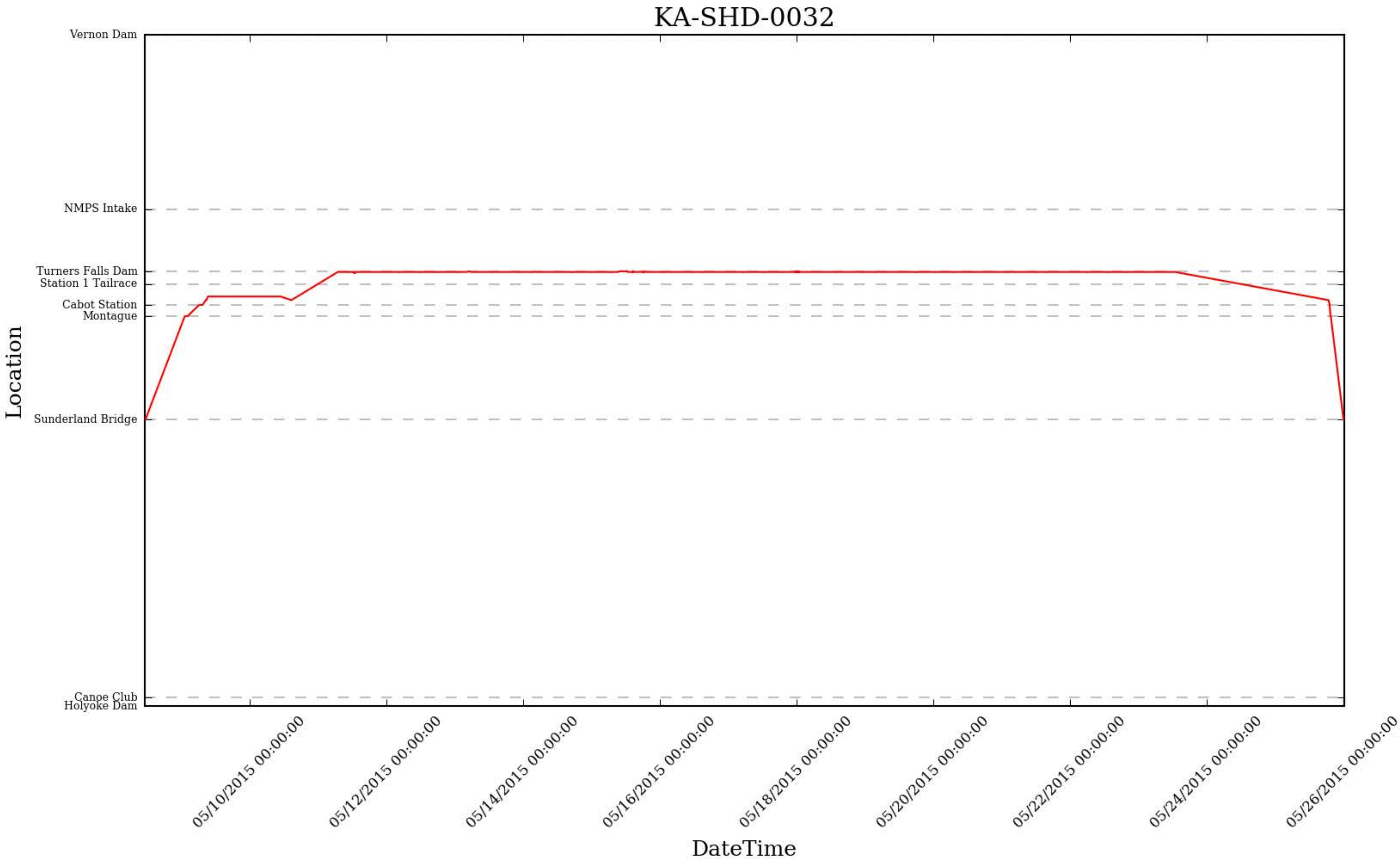


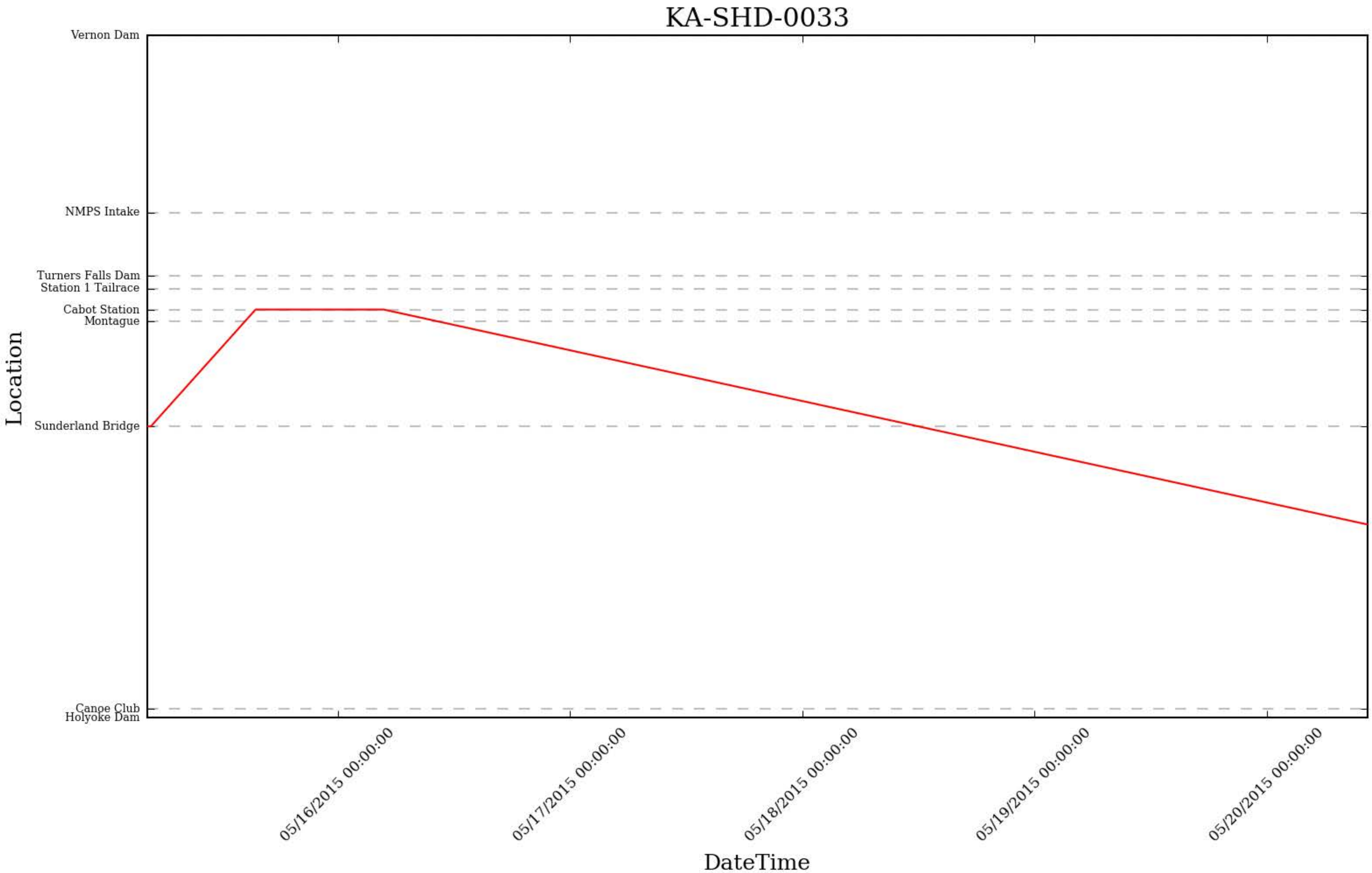
KA-SHD-0029
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 00:00:00
05/13/2015 00:00:00
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
DateTime

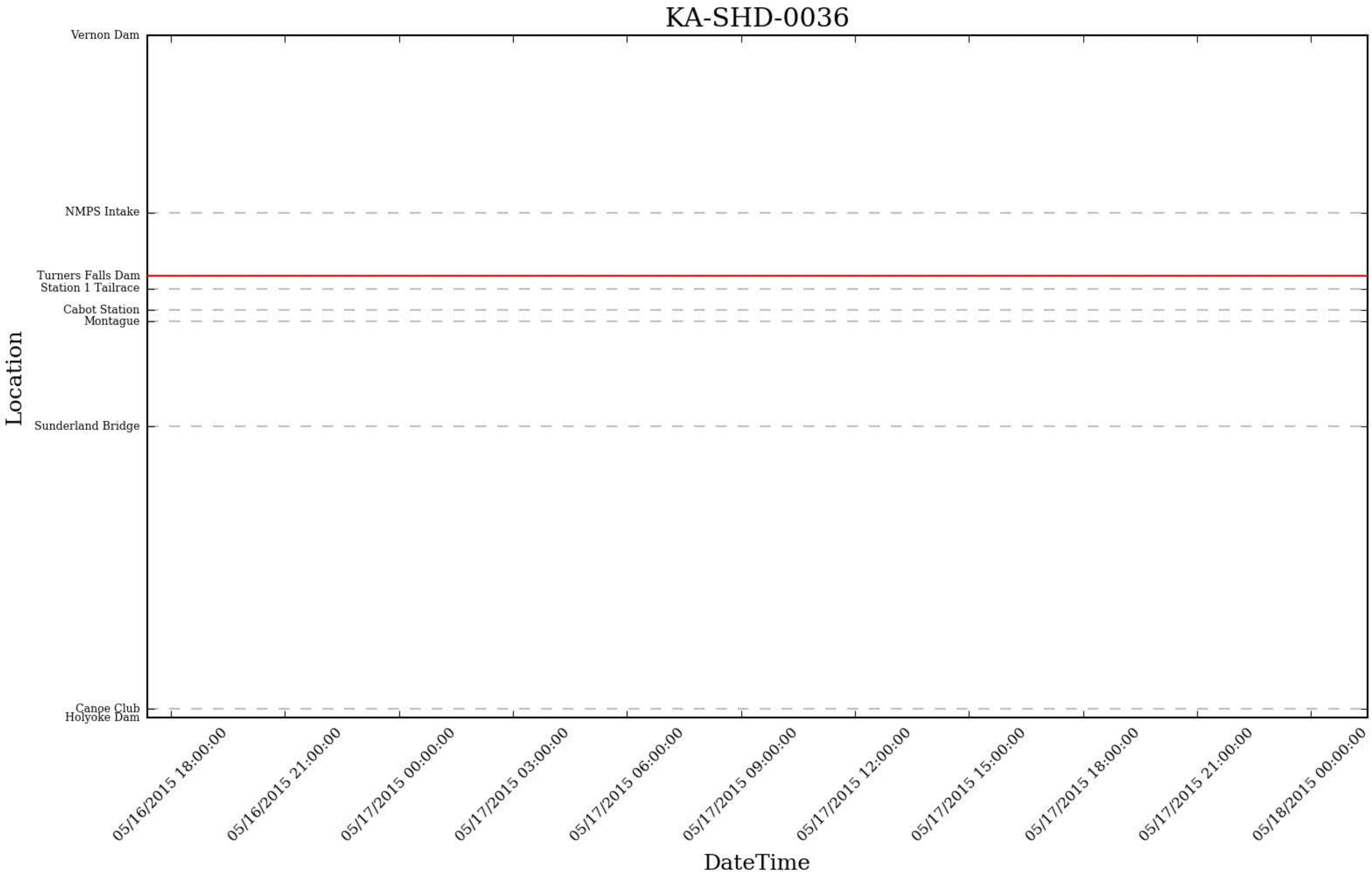


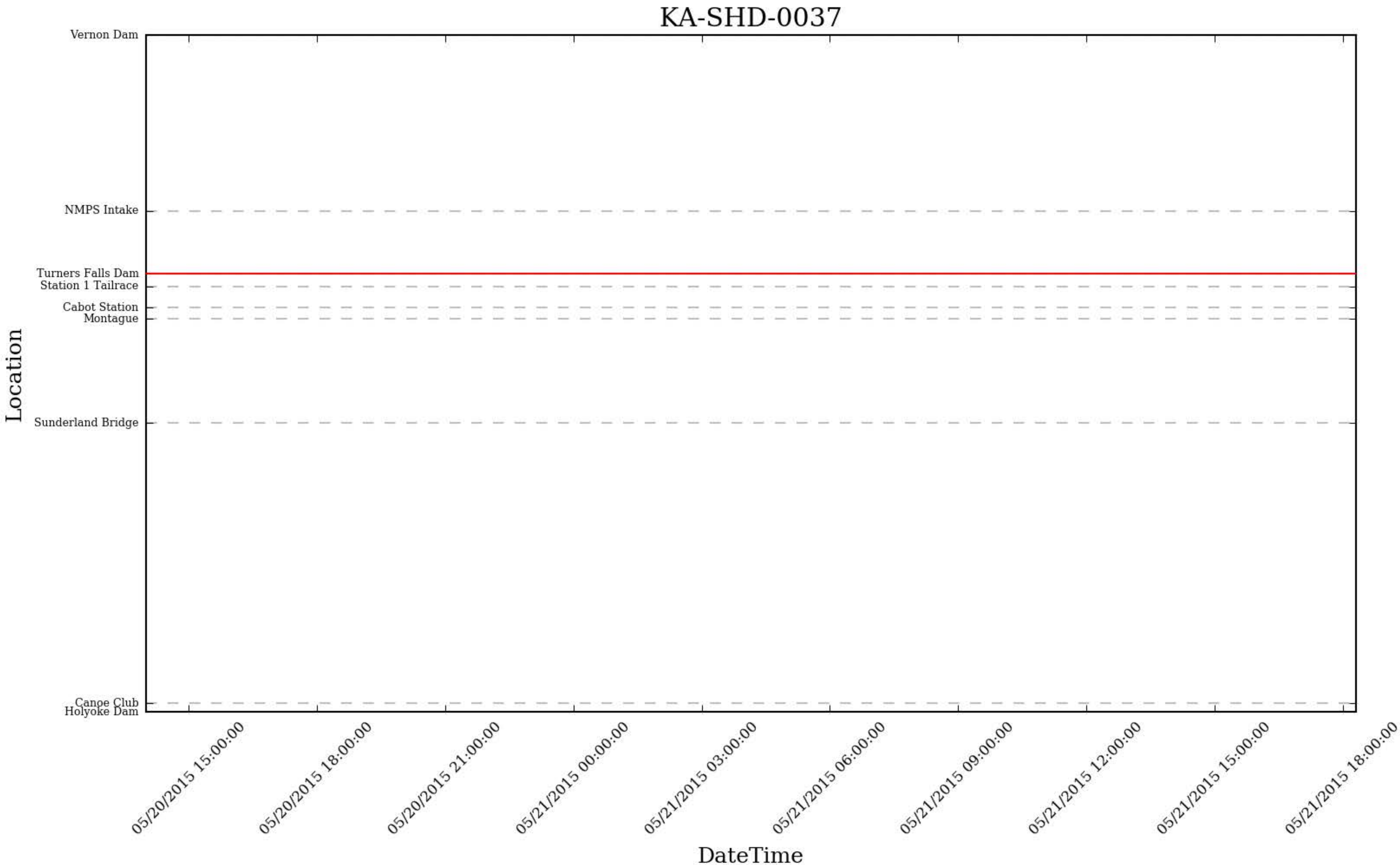
KA-SHD-0030
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/13/2015 00:00:00
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
DateTime

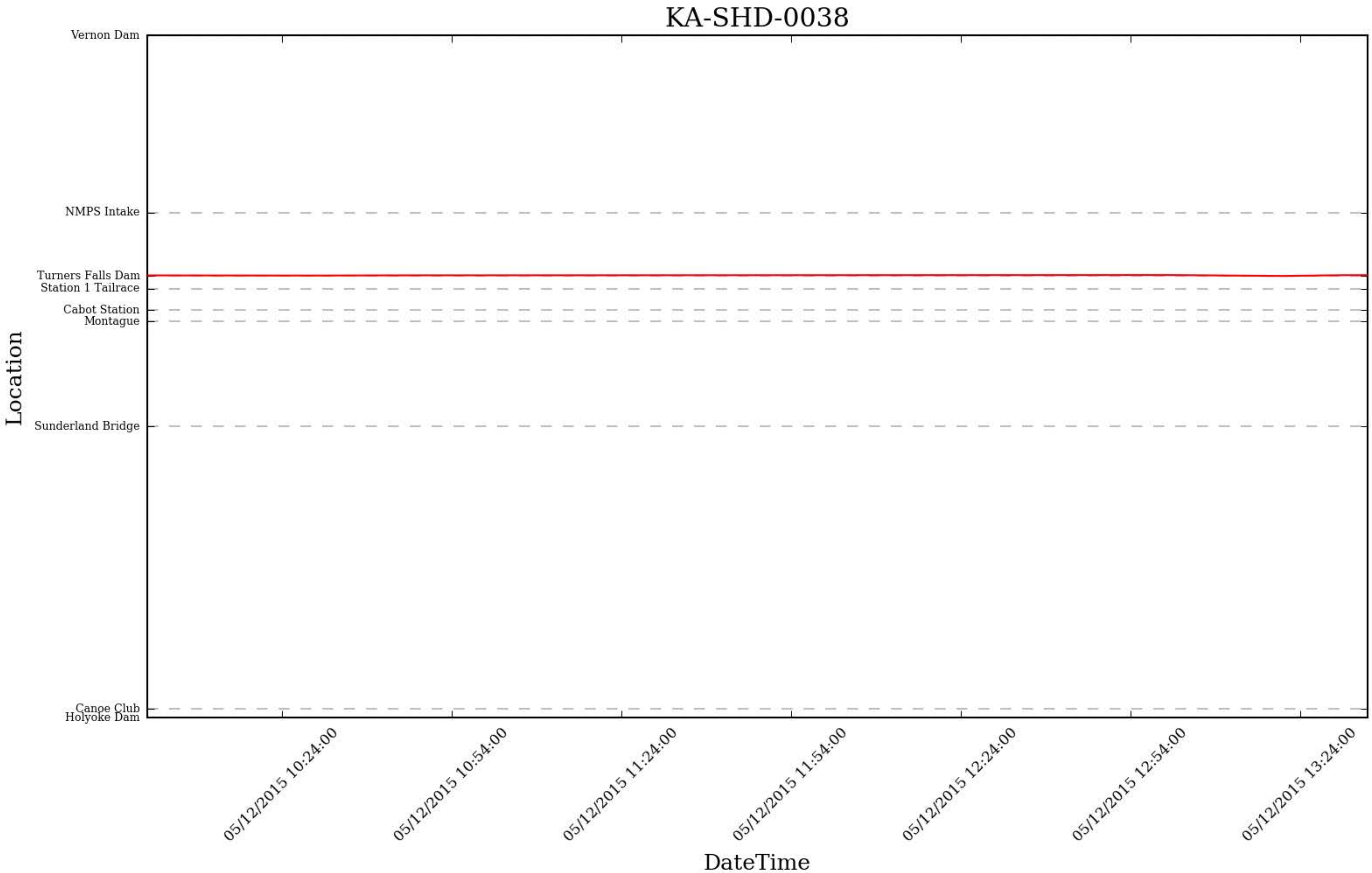

KA-SHD-0031
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/09/2015 00:00:00
05/12/2015 00:00:00
05/15/2015 00:00:00
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
DateTime

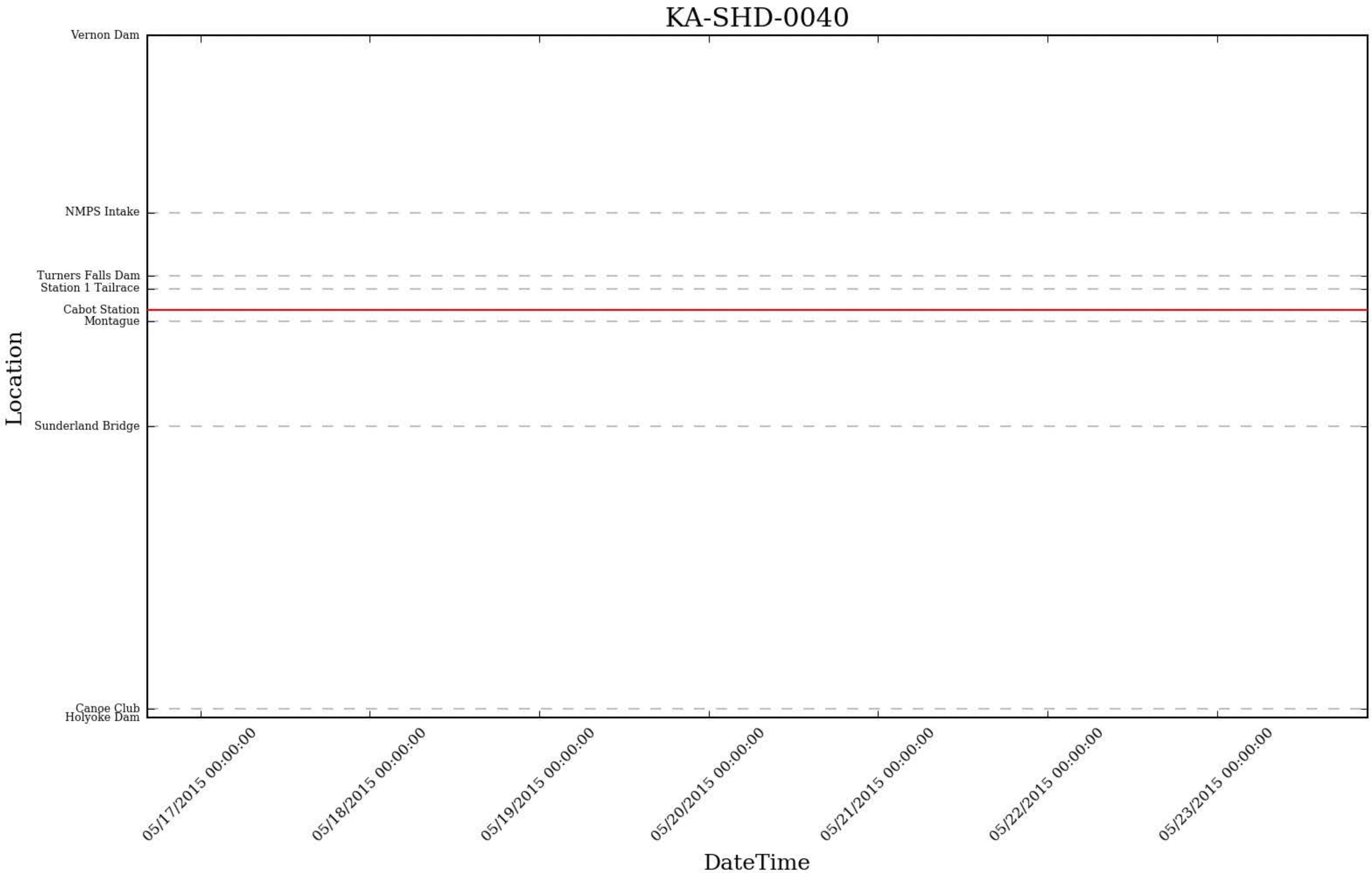

KA-SHD-0032
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/12/2015 00:00:00
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
DateTime


KA-SHD-0033
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
DateTime

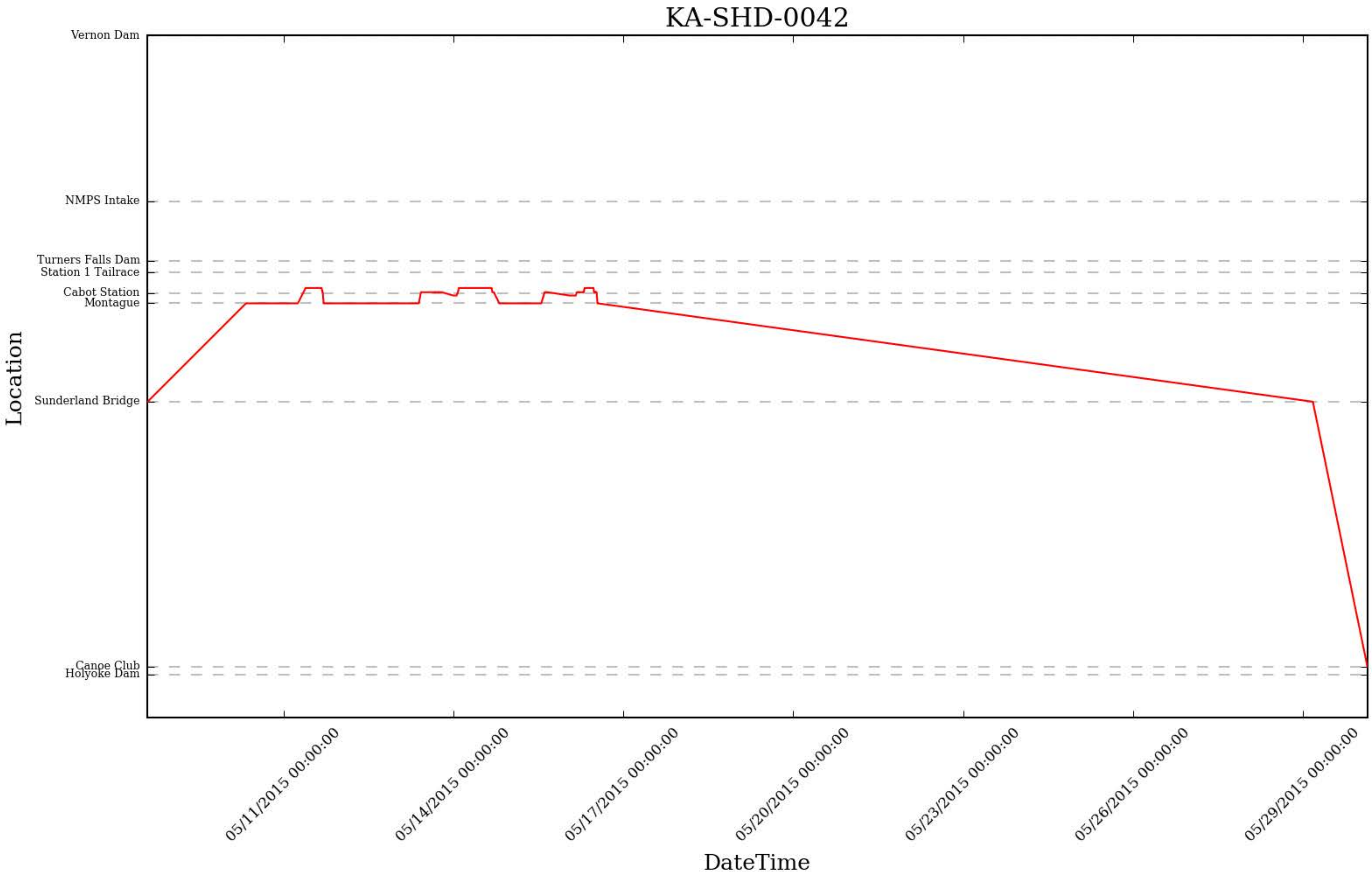

KA-SHD-0036
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 18:00:00
05/16/2015 21:00:00
05/17/2015 00:00:00
05/17/2015 03:00:00
05/17/2015 06:00:00
05/17/2015 09:00:00
05/17/2015 12:00:00
05/17/2015 15:00:00
05/17/2015 18:00:00
05/17/2015 21:00:00
05/18/2015 00:00:00
DateTime

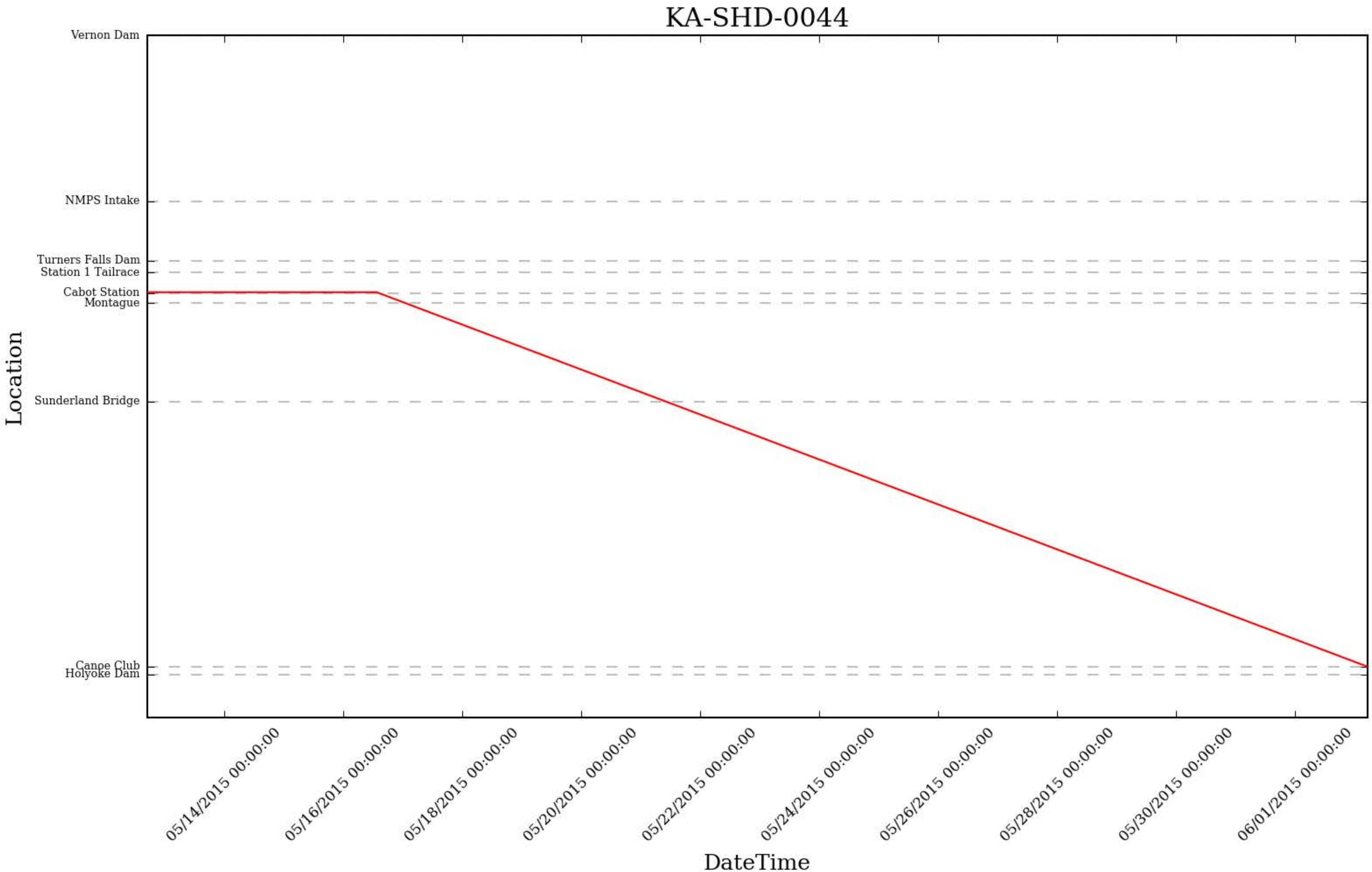

KA-SHD-0037
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 15:00:00
05/20/2015 18:00:00
05/20/2015 21:00:00
05/21/2015 00:00:00
05/21/2015 03:00:00
05/21/2015 06:00:00
05/21/2015 09:00:00
05/21/2015 12:00:00
05/21/2015 15:00:00
05/21/2015 18:00:00
DateTime


KA-SHD-0038
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/12/2015 10:24:00
05/12/2015 10:54:00
05/12/2015 11:24:00
05/12/2015 11:54:00
05/12/2015 12:24:00
05/12/2015 12:54:00
05/12/2015 13:24:00
DateTime

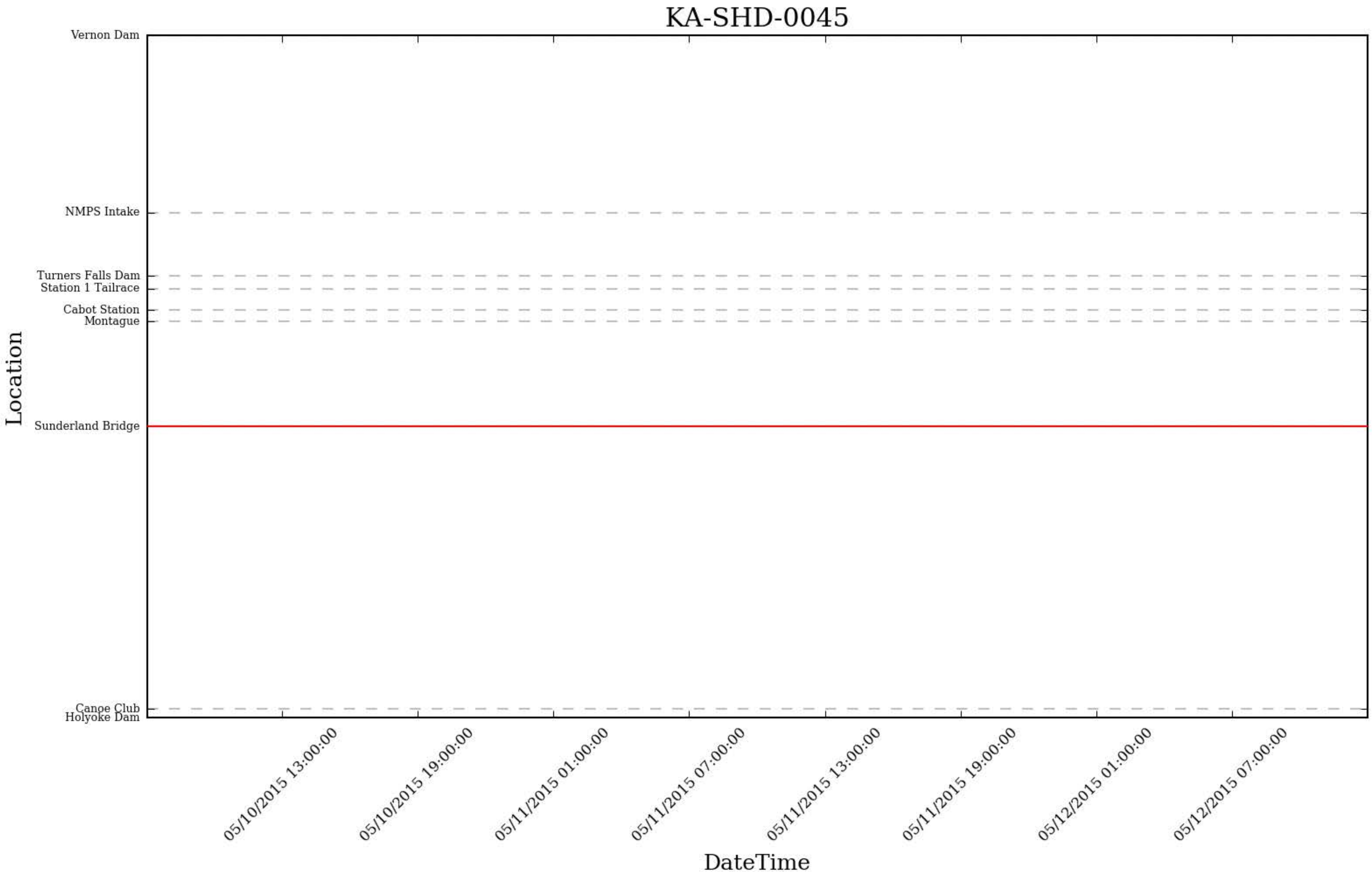


KA-SHD-0040
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
DateTime

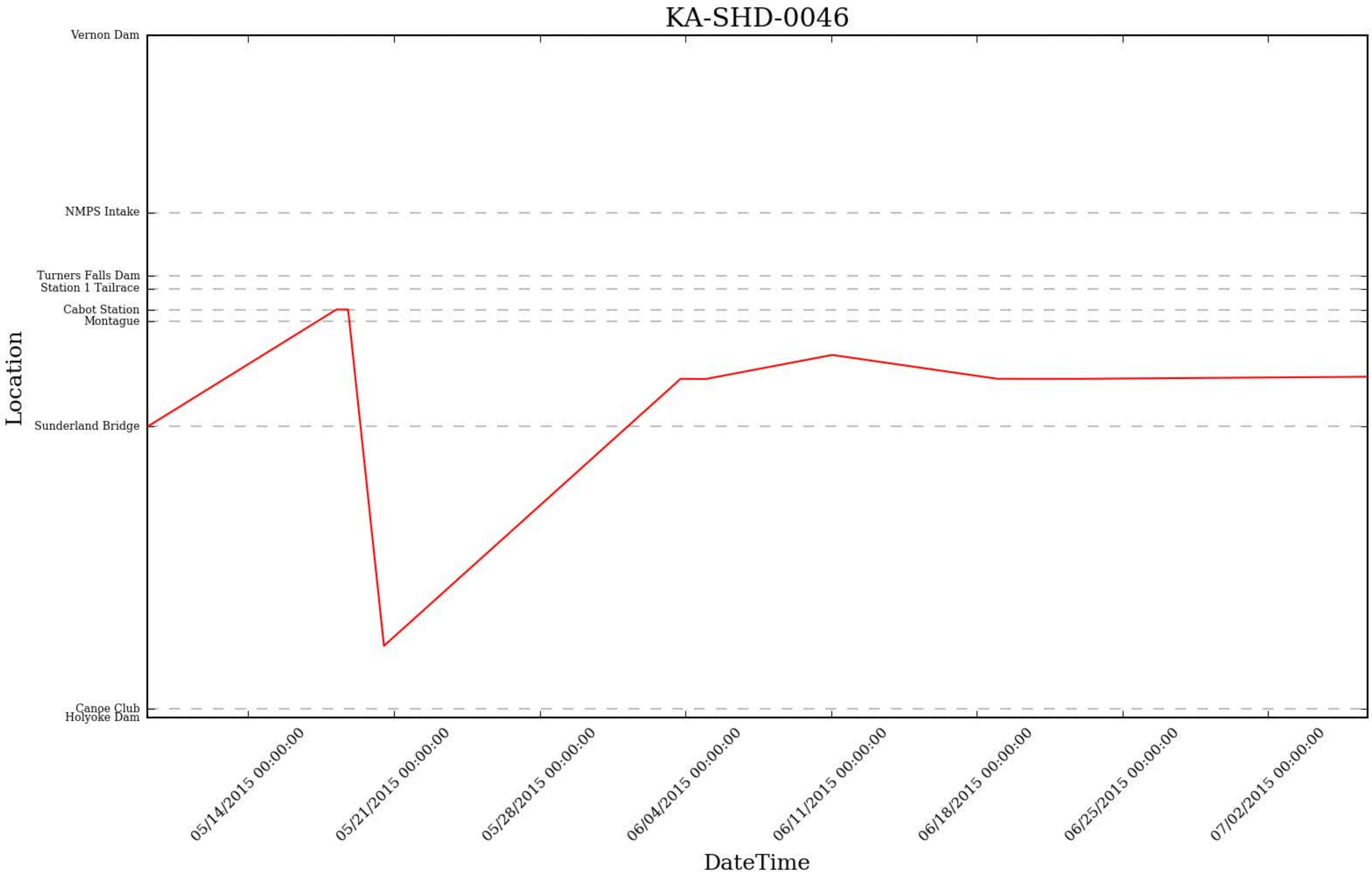

KA-SHD-0042
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/11/2015 00:00:00
05/14/2015 00:00:00
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
DateTime



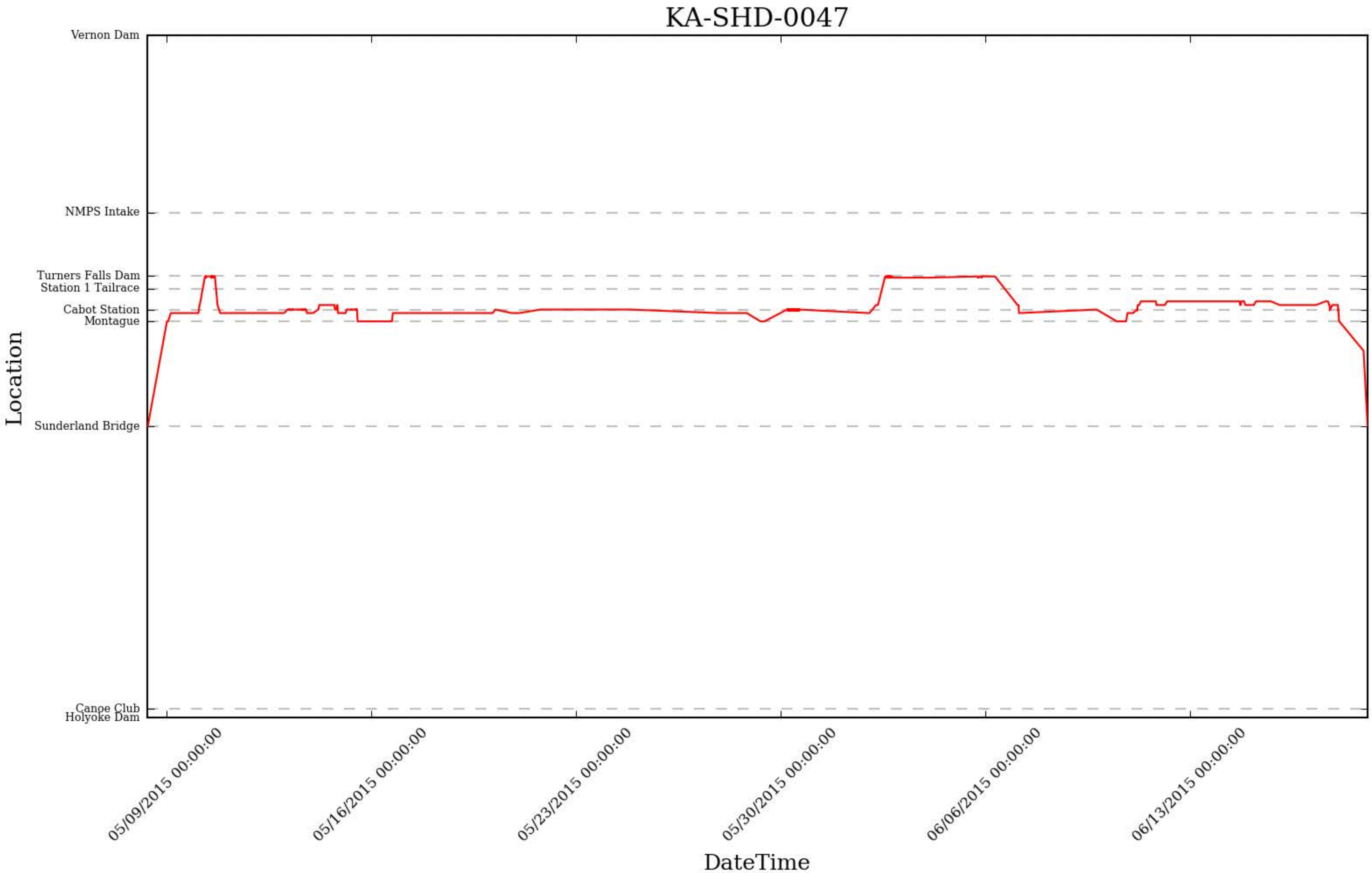
KA-SHD-0044
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
DateTime

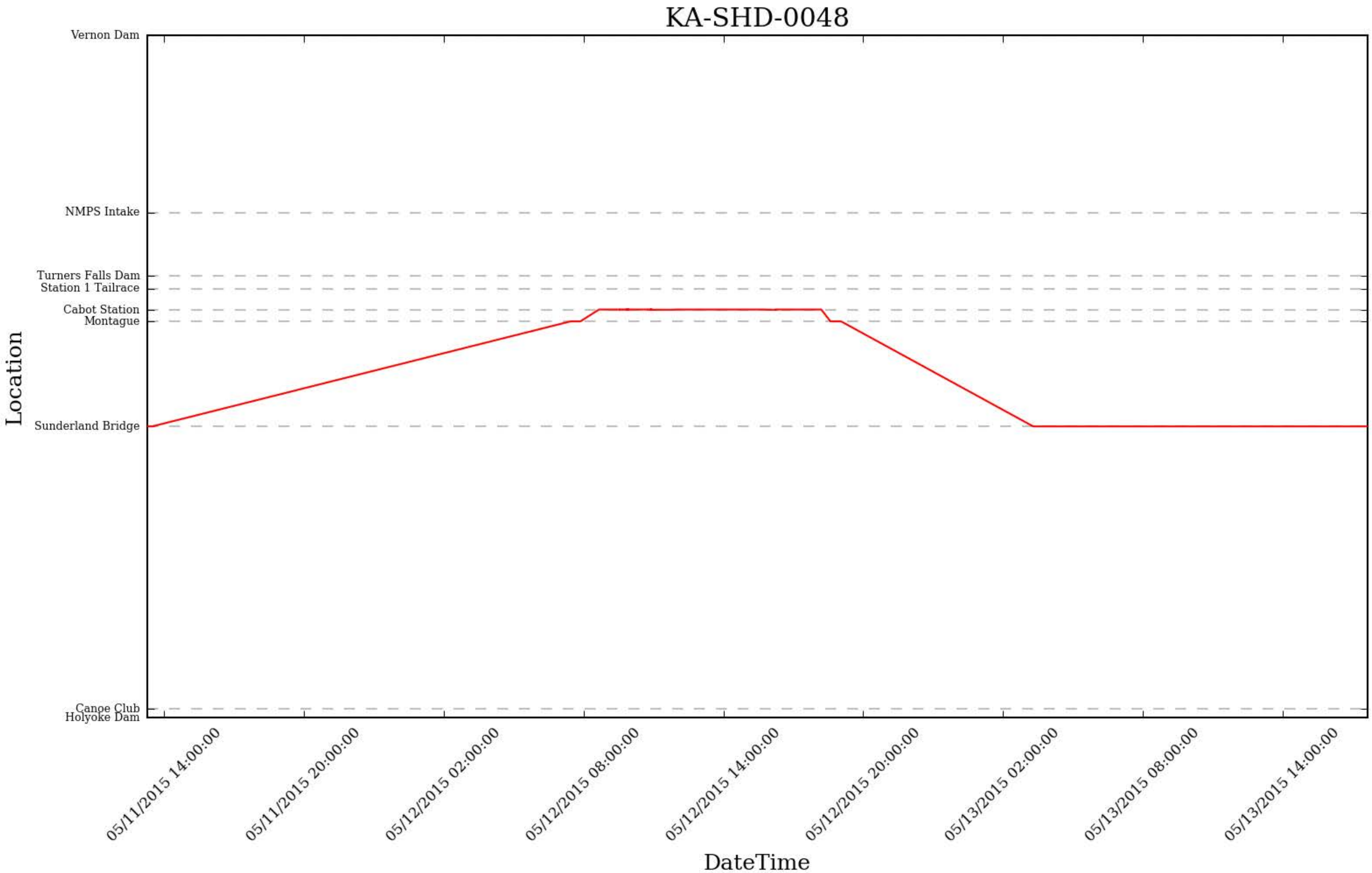


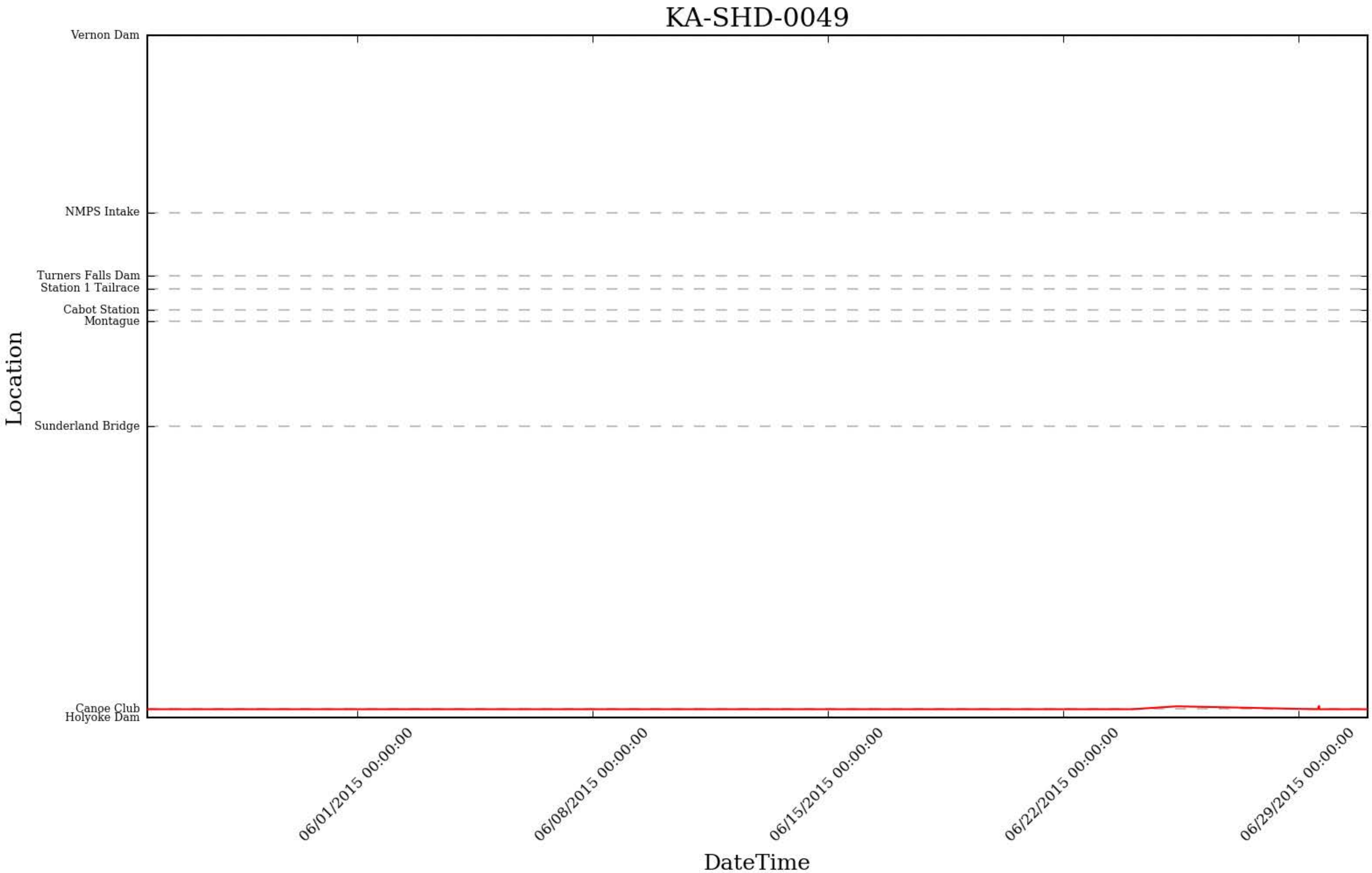
KA-SHD-0045
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 13:00:00
05/10/2015 19:00:00
05/11/2015 01:00:00
05/11/2015 07:00:00
05/11/2015 13:00:00
05/11/2015 19:00:00
05/12/2015 01:00:00
05/12/2015 07:00:00
DateTime

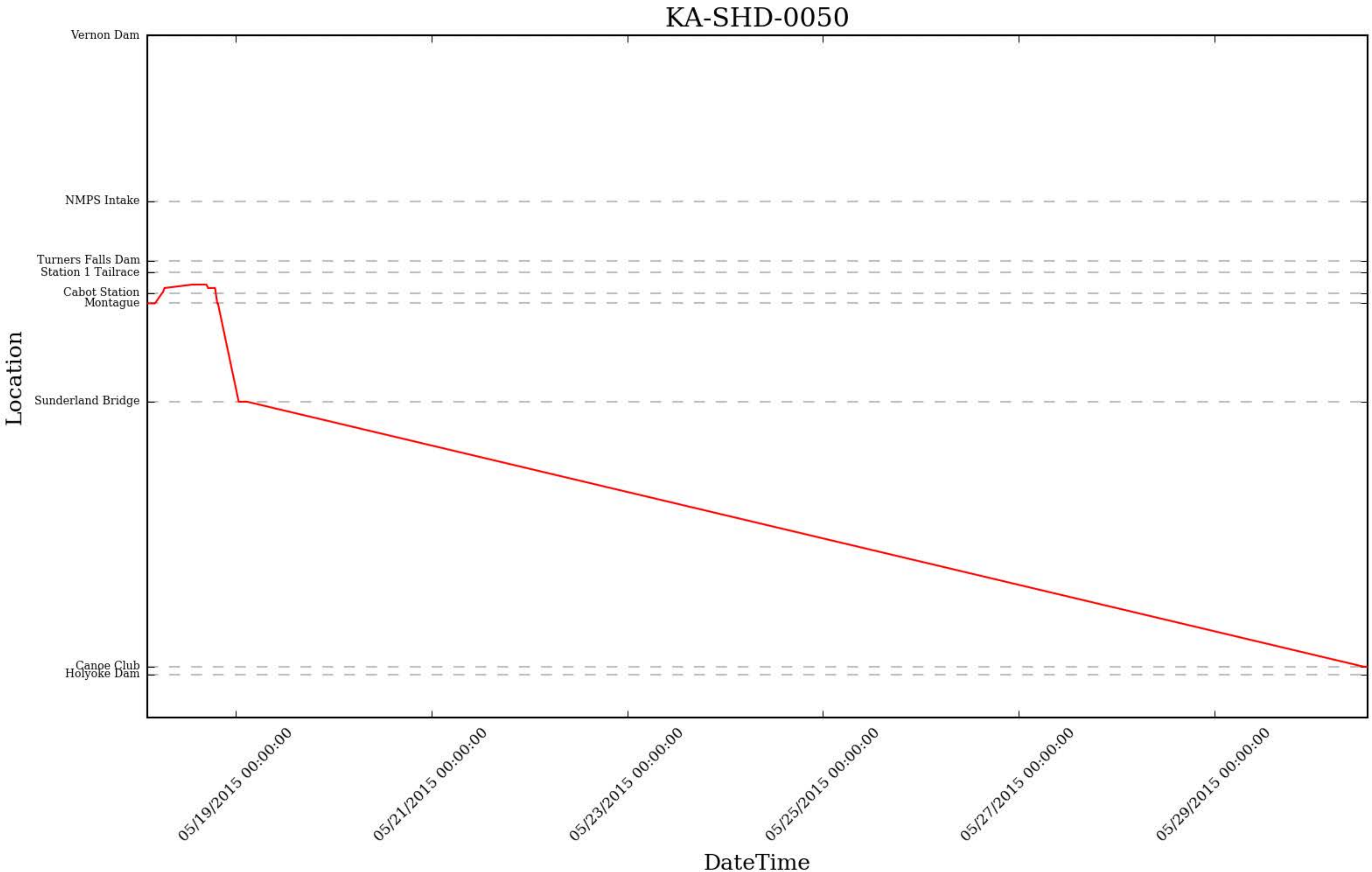


KA-SHD-0046
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

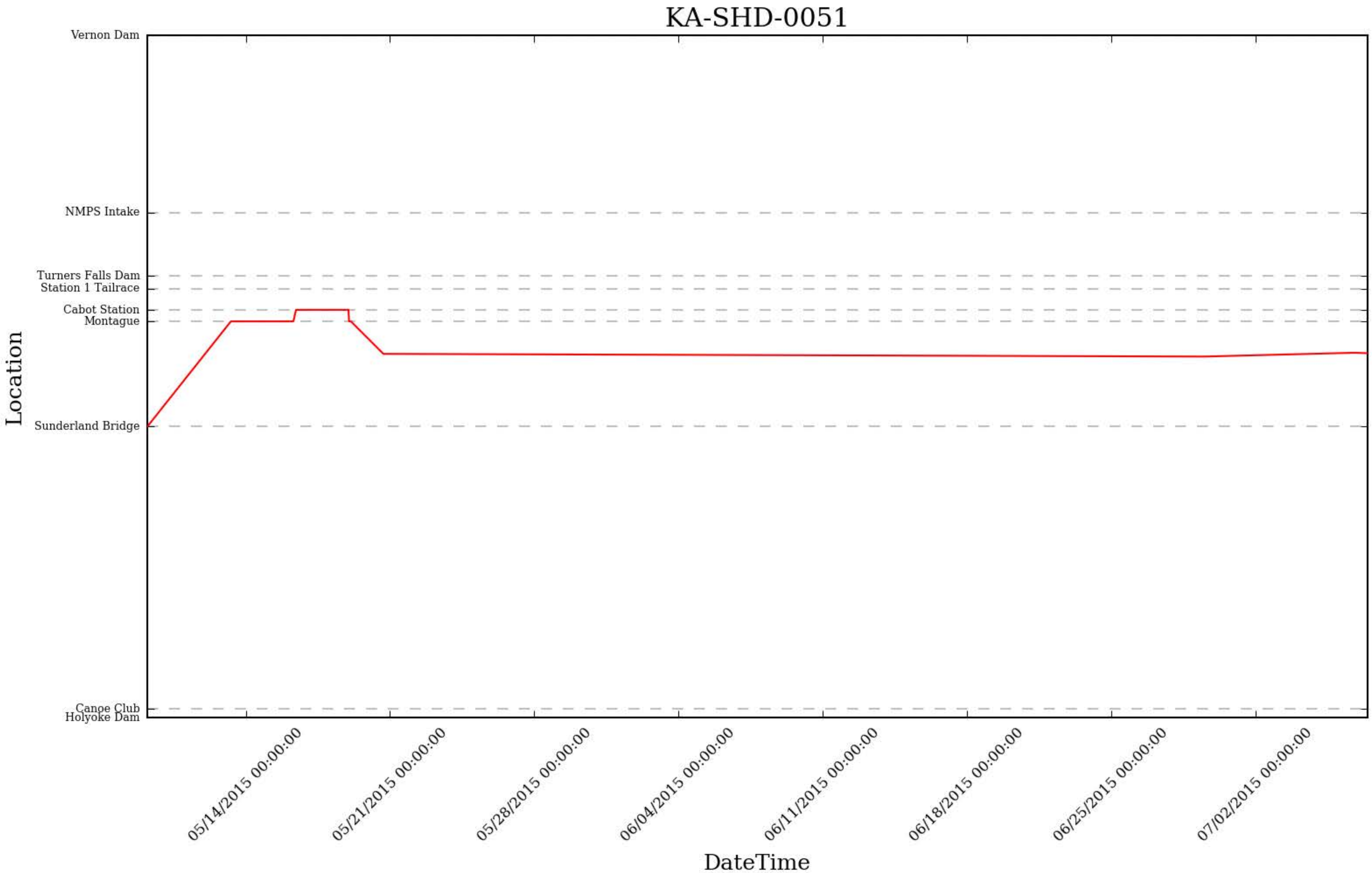

KA-SHD-0047
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/09/2015 00:00:00
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
DateTime

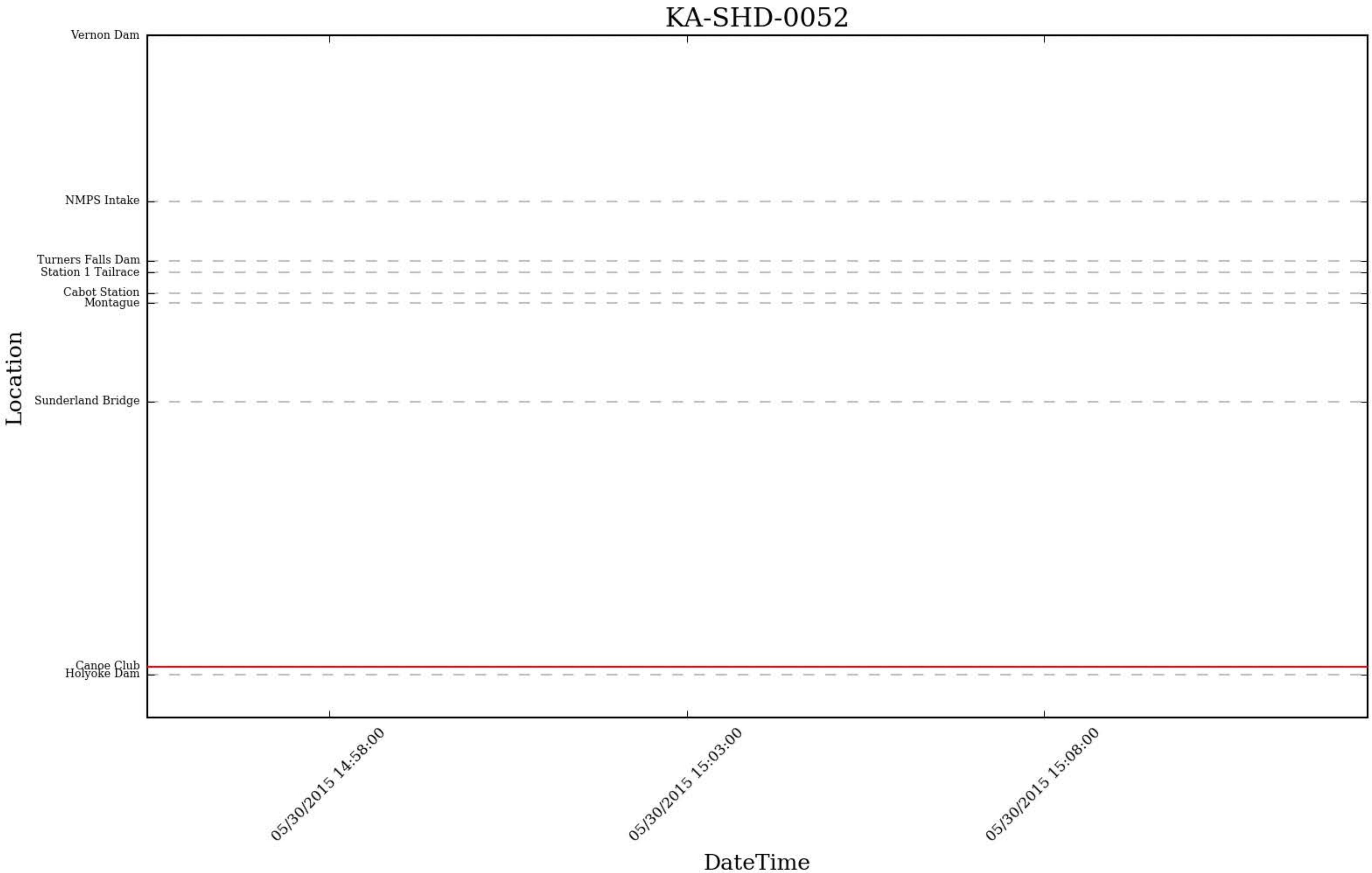

KA-SHD-0048
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 14:00:00
05/11/2015 20:00:00
05/12/2015 02:00:00
05/12/2015 08:00:00
05/12/2015 14:00:00
05/12/2015 20:00:00
05/13/2015 02:00:00
05/13/2015 08:00:00
05/13/2015 14:00:00
DateTime

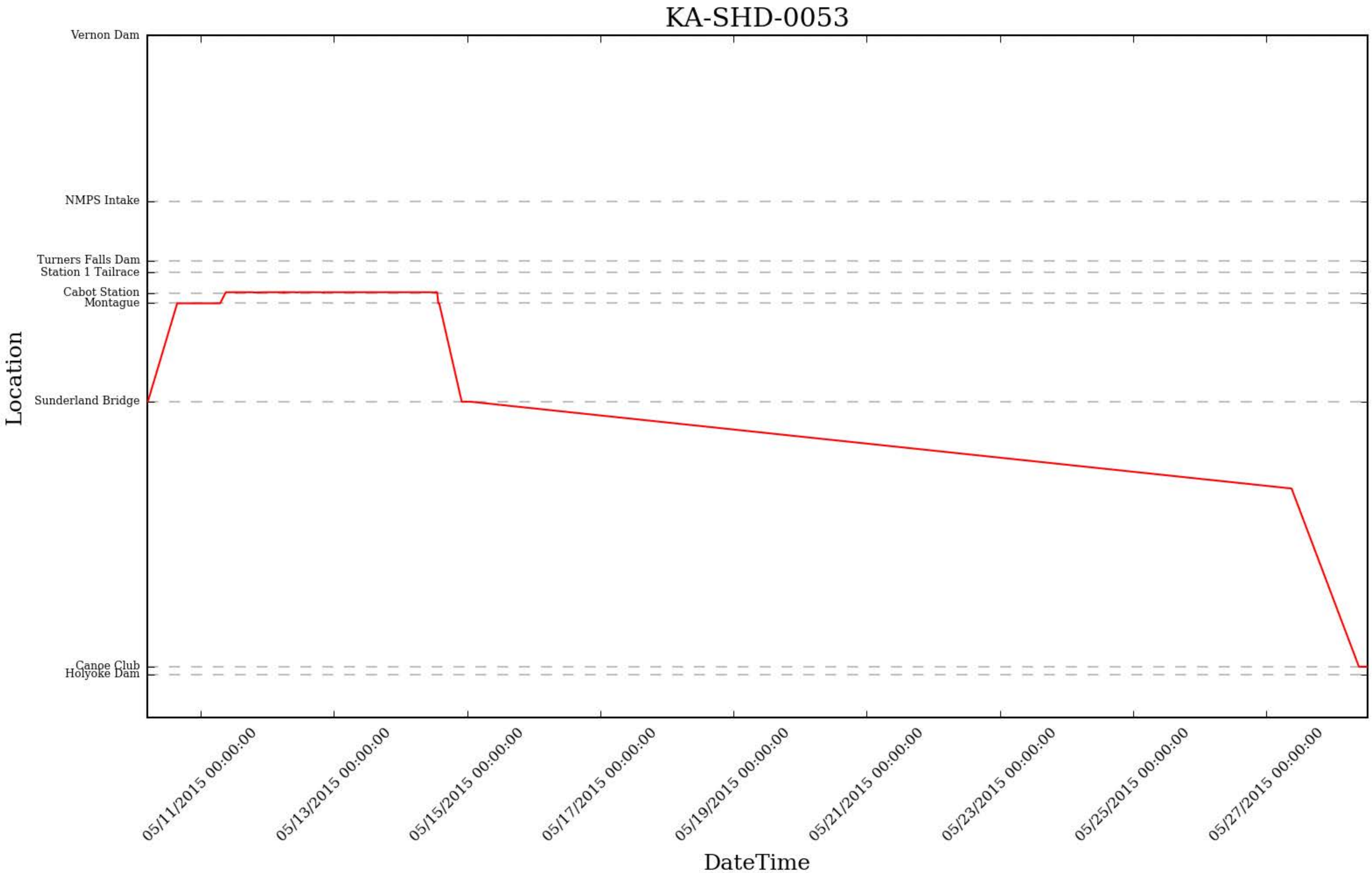

KA-SHD-0049
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
06/29/2015 00:00:00
DateTime

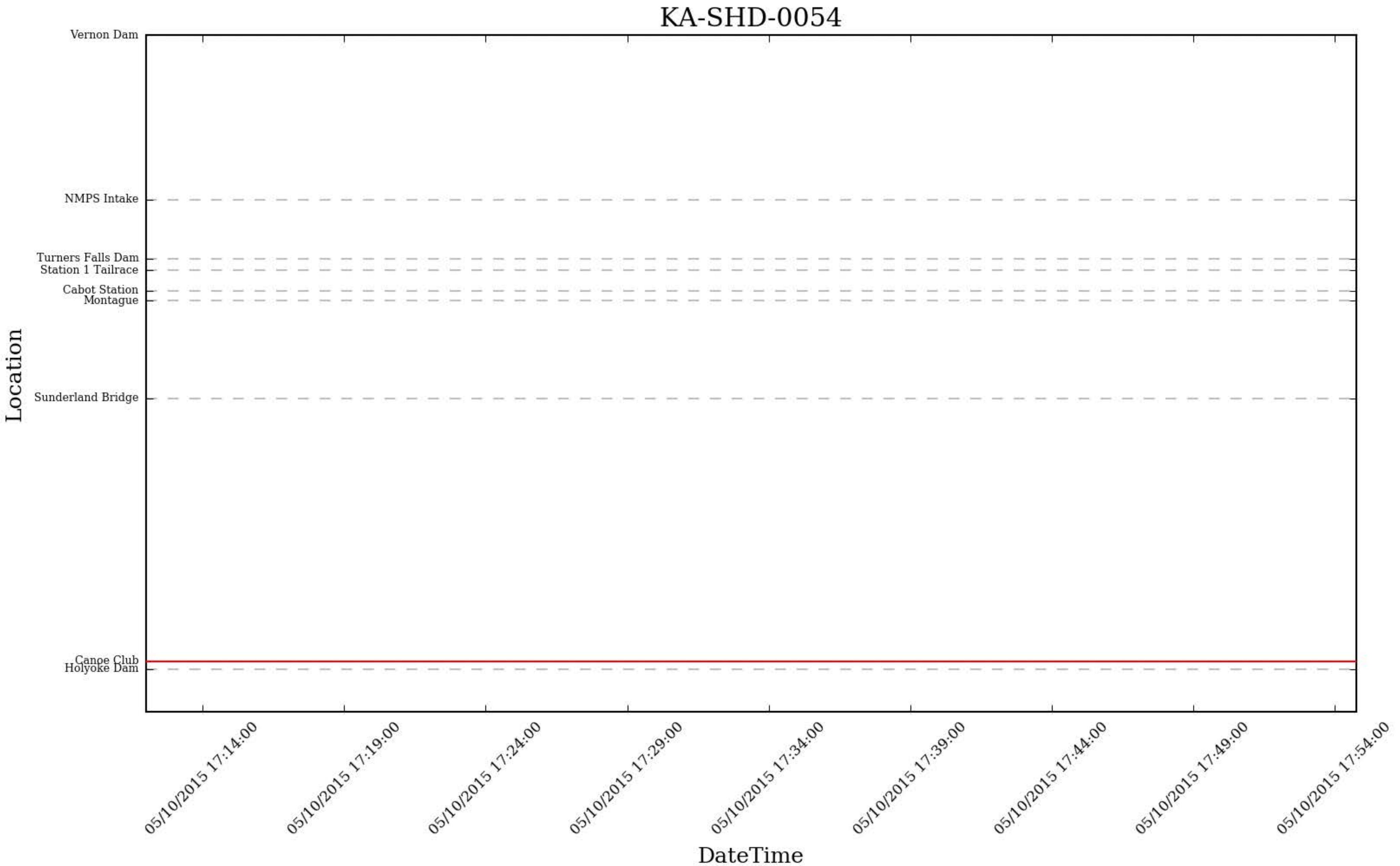


KA-SHD-0050
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
DateTime


KA-SHD-0051
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

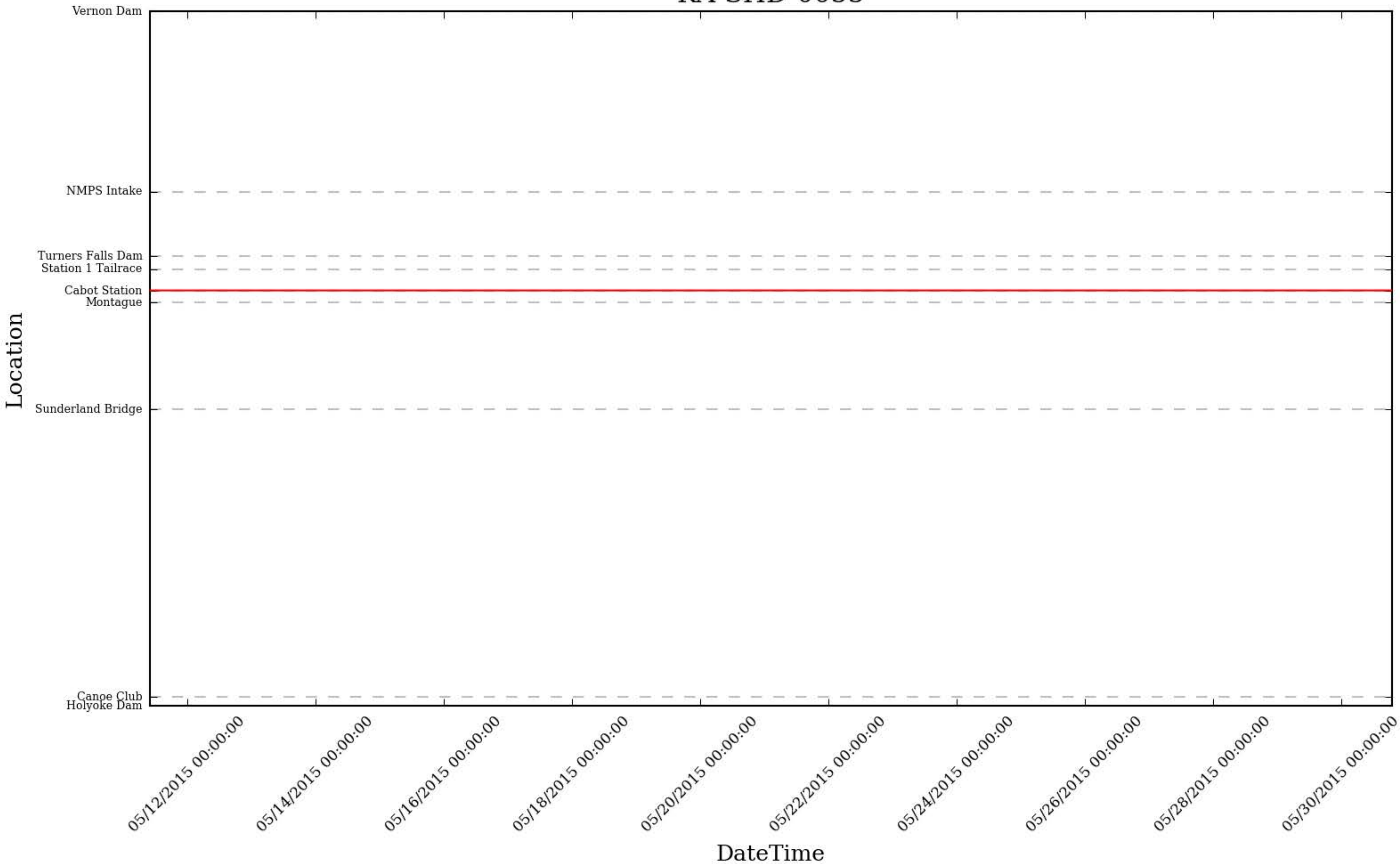

KA-SHD-0052
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 14:58:00
05/30/2015 15:03:00
05/30/2015 15:08:00
DateTime

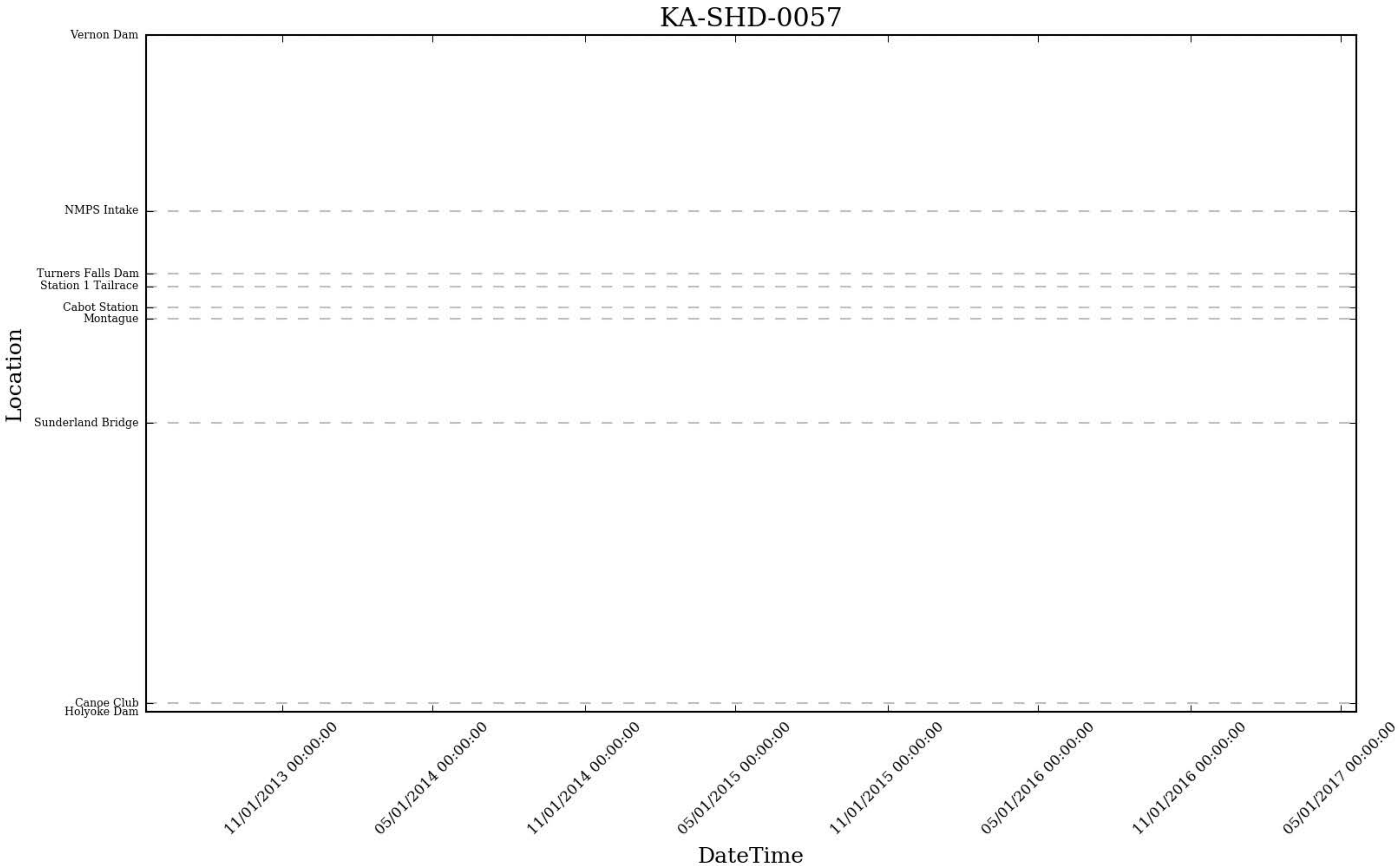

KA-SHD-0053
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 00:00:00
05/13/2015 00:00:00
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
DateTime

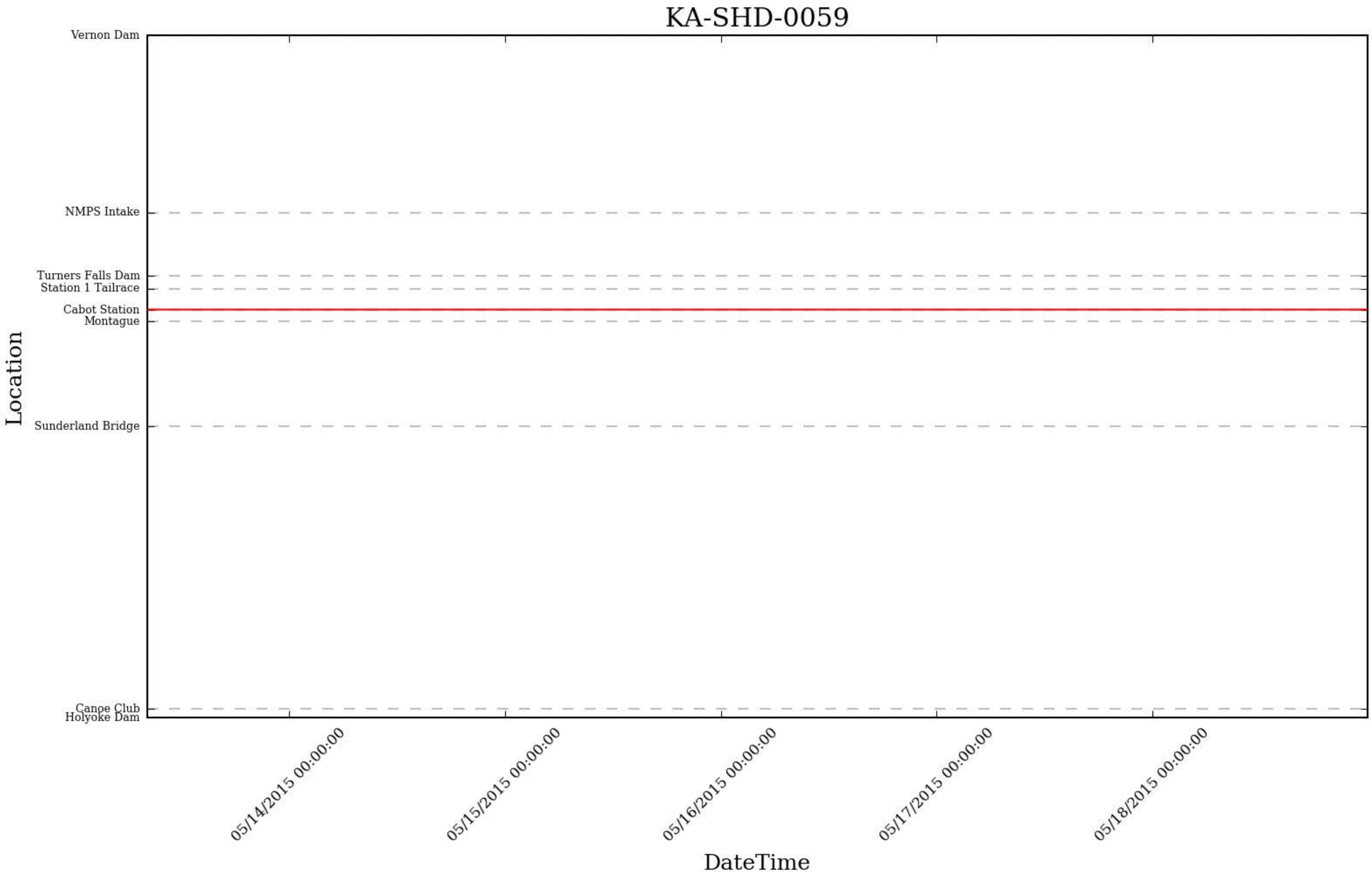


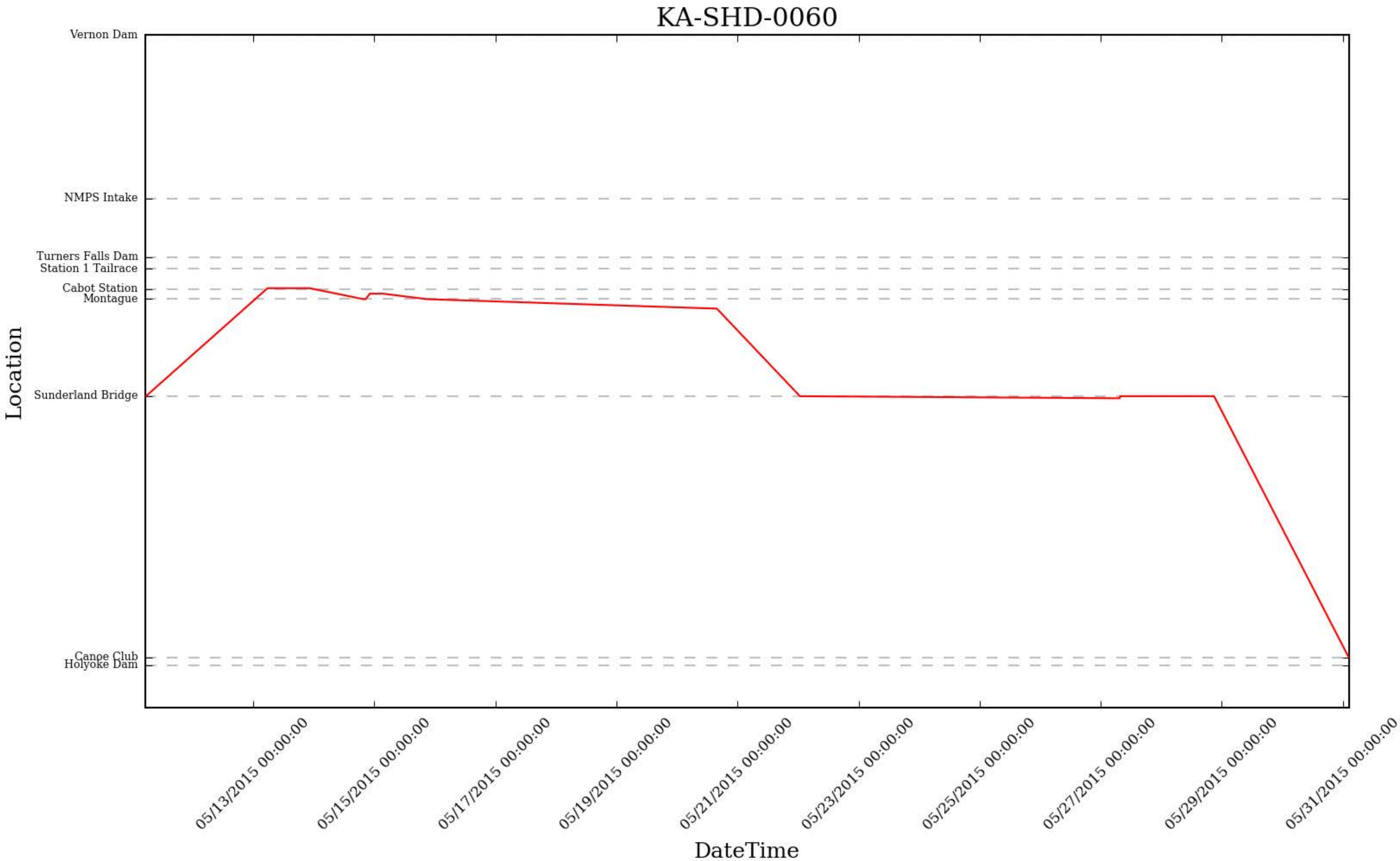
KA-SHD-0054
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 17:14:00
05/10/2015 17:19:00
05/10/2015 17:24:00
05/10/2015 17:29:00
05/10/2015 17:34:00
05/10/2015 17:39:00
05/10/2015 17:44:00
05/10/2015 17:49:00
05/10/2015 17:54:00
DateTime

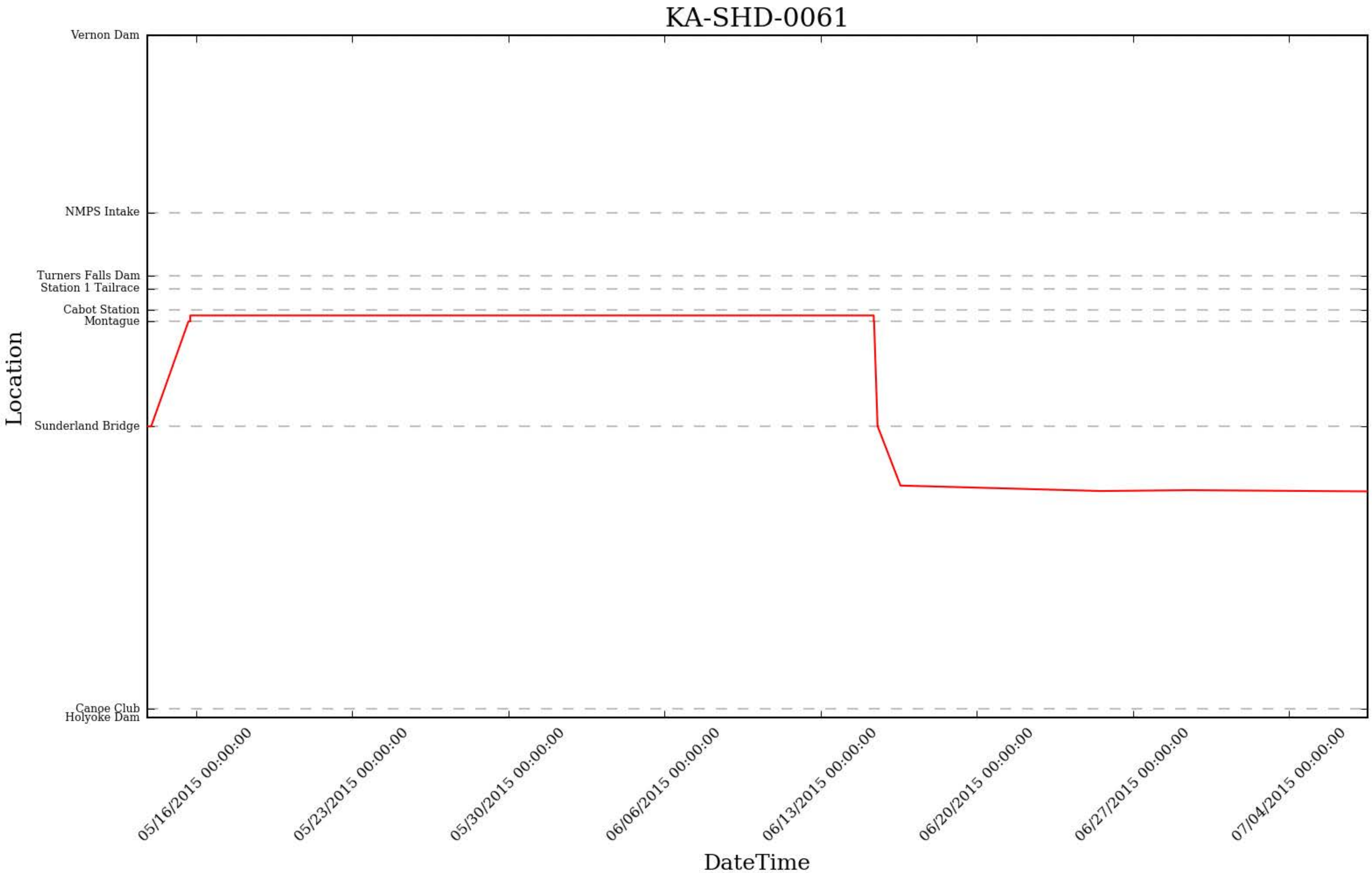
KA-SHD-0055

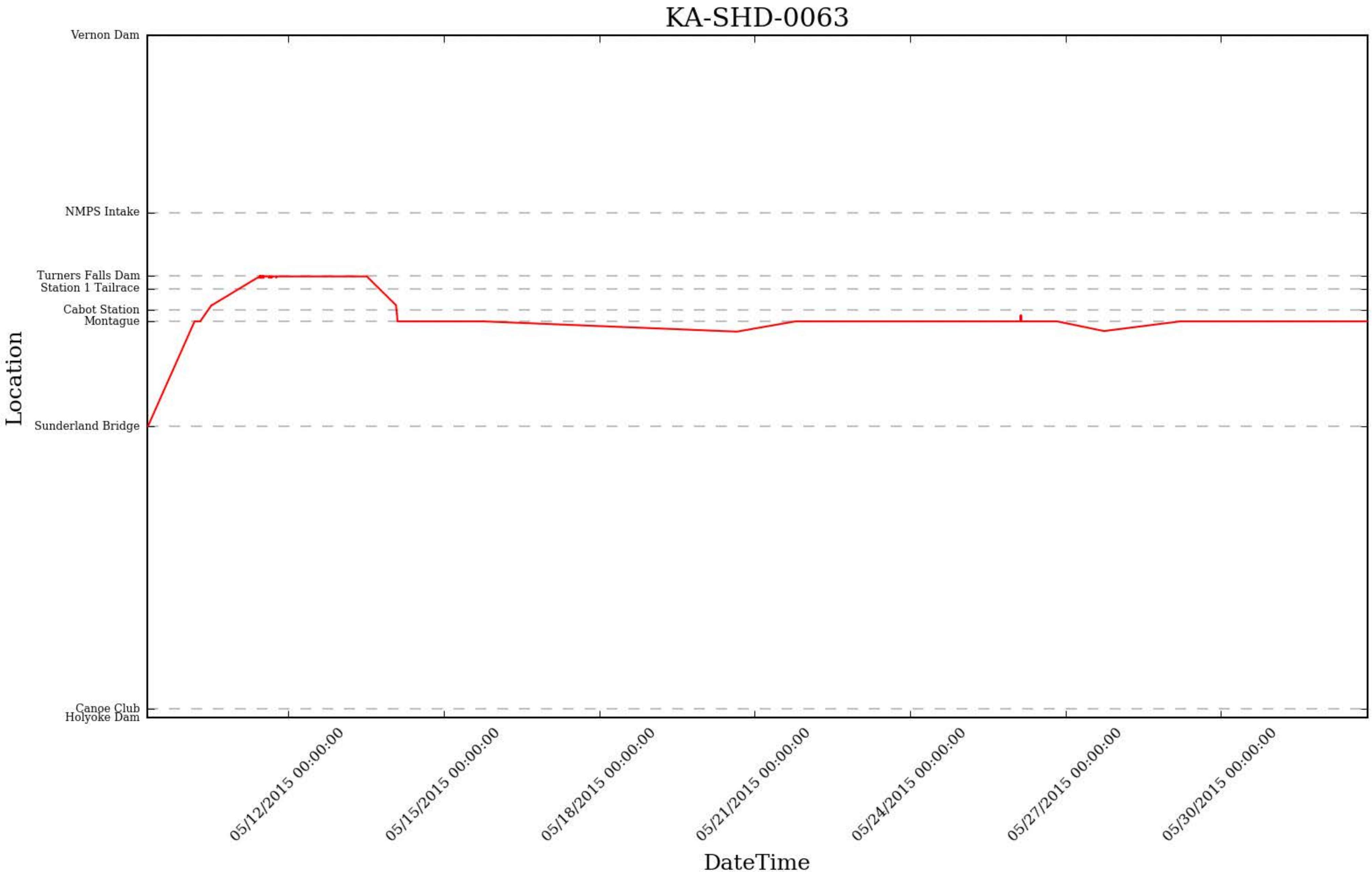

Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/12/2015 00:00:00
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
DateTime

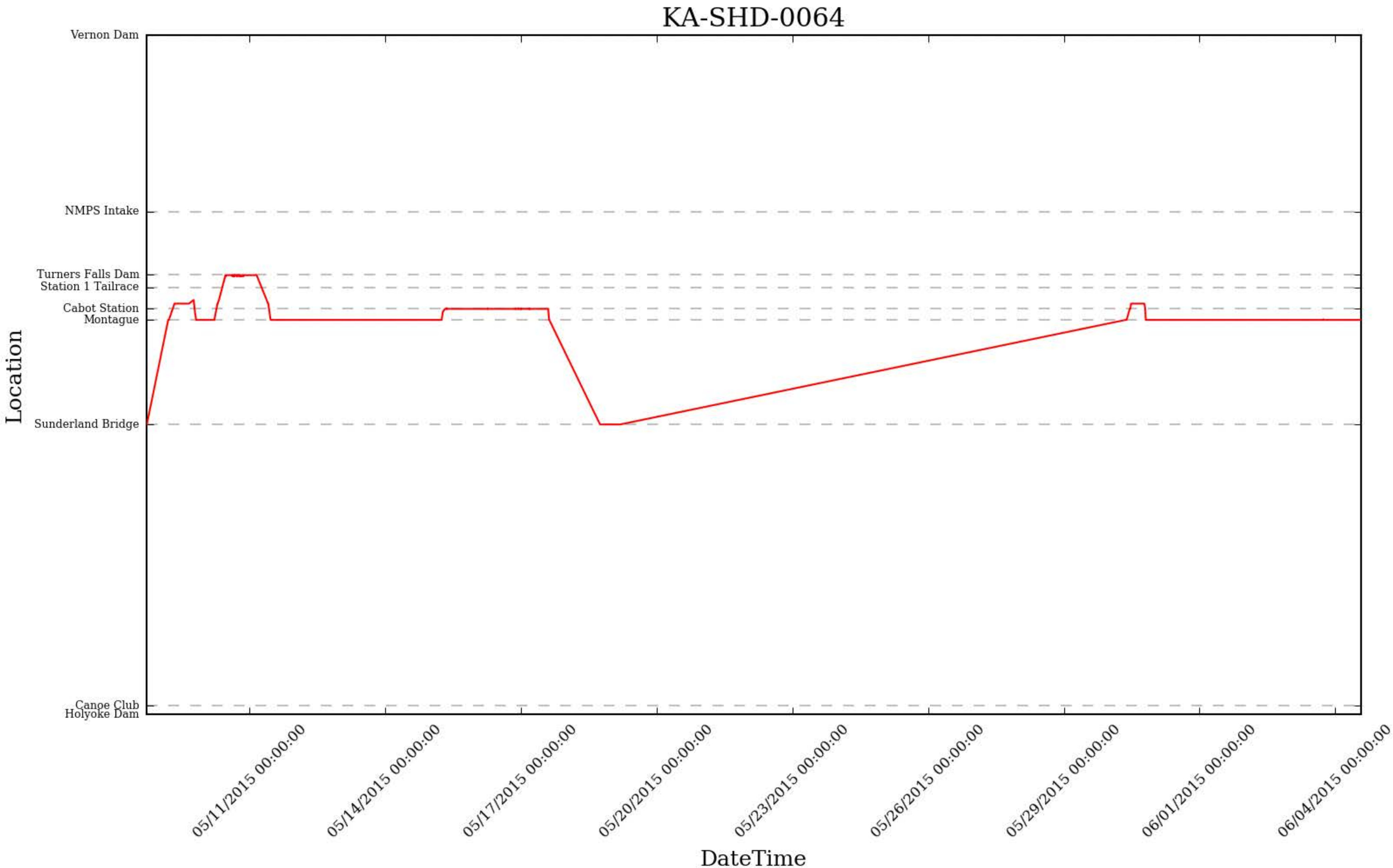

KA-SHD-0057
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

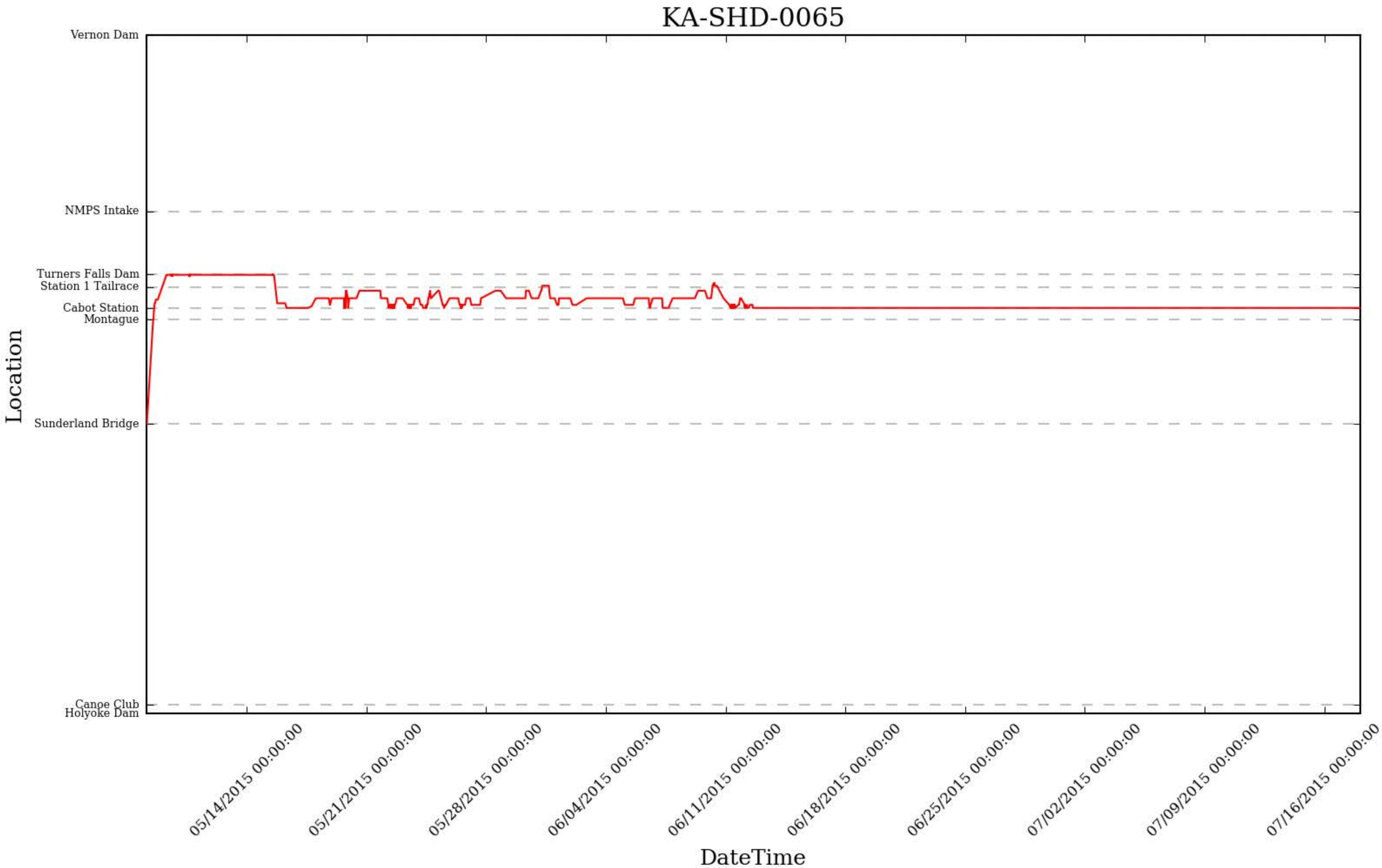

KA-SHD-0059
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
DateTime

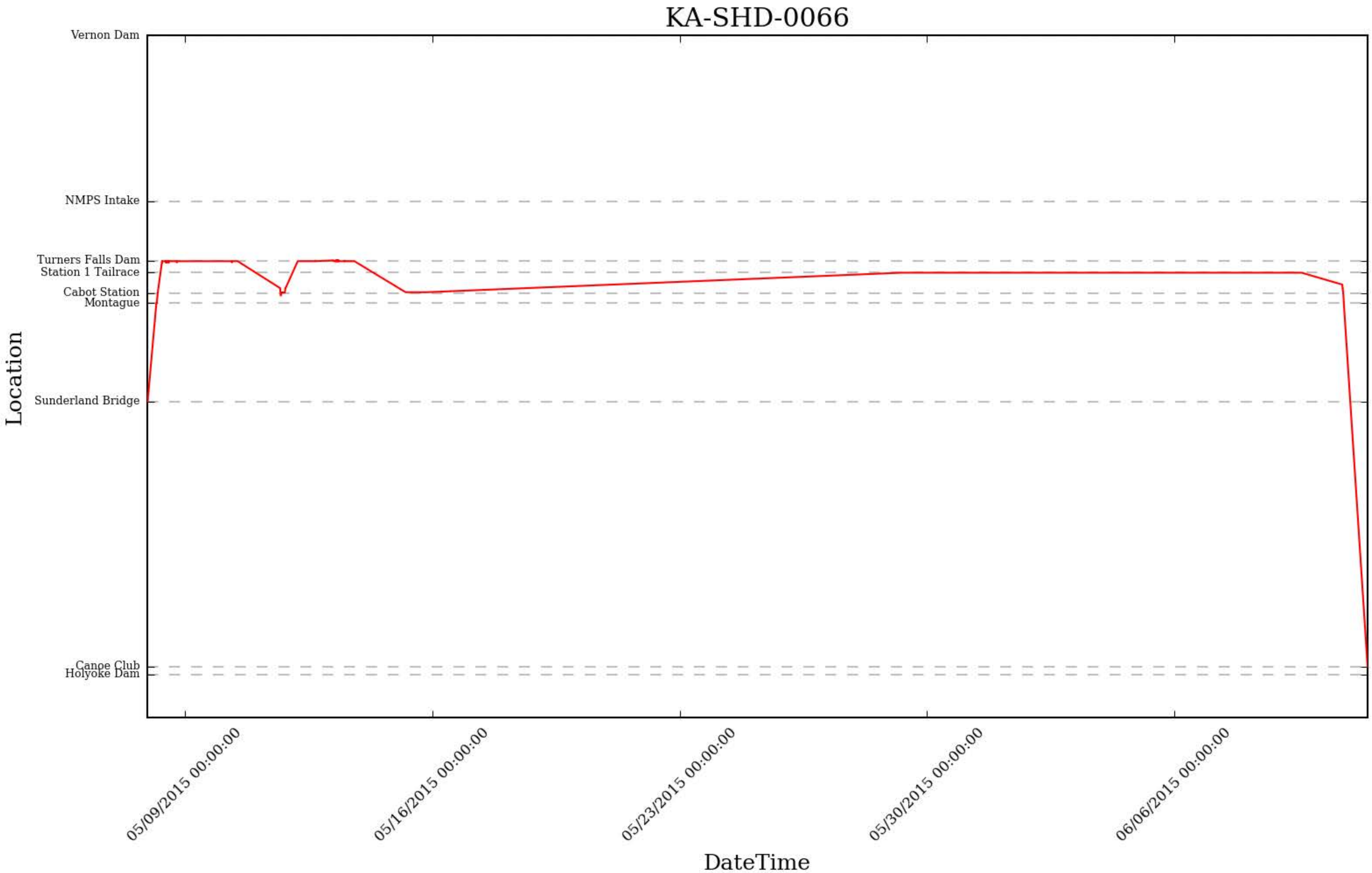

KA-SHD-0060
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 00:00:00
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
DateTime


KA-SHD-0061
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
DateTime

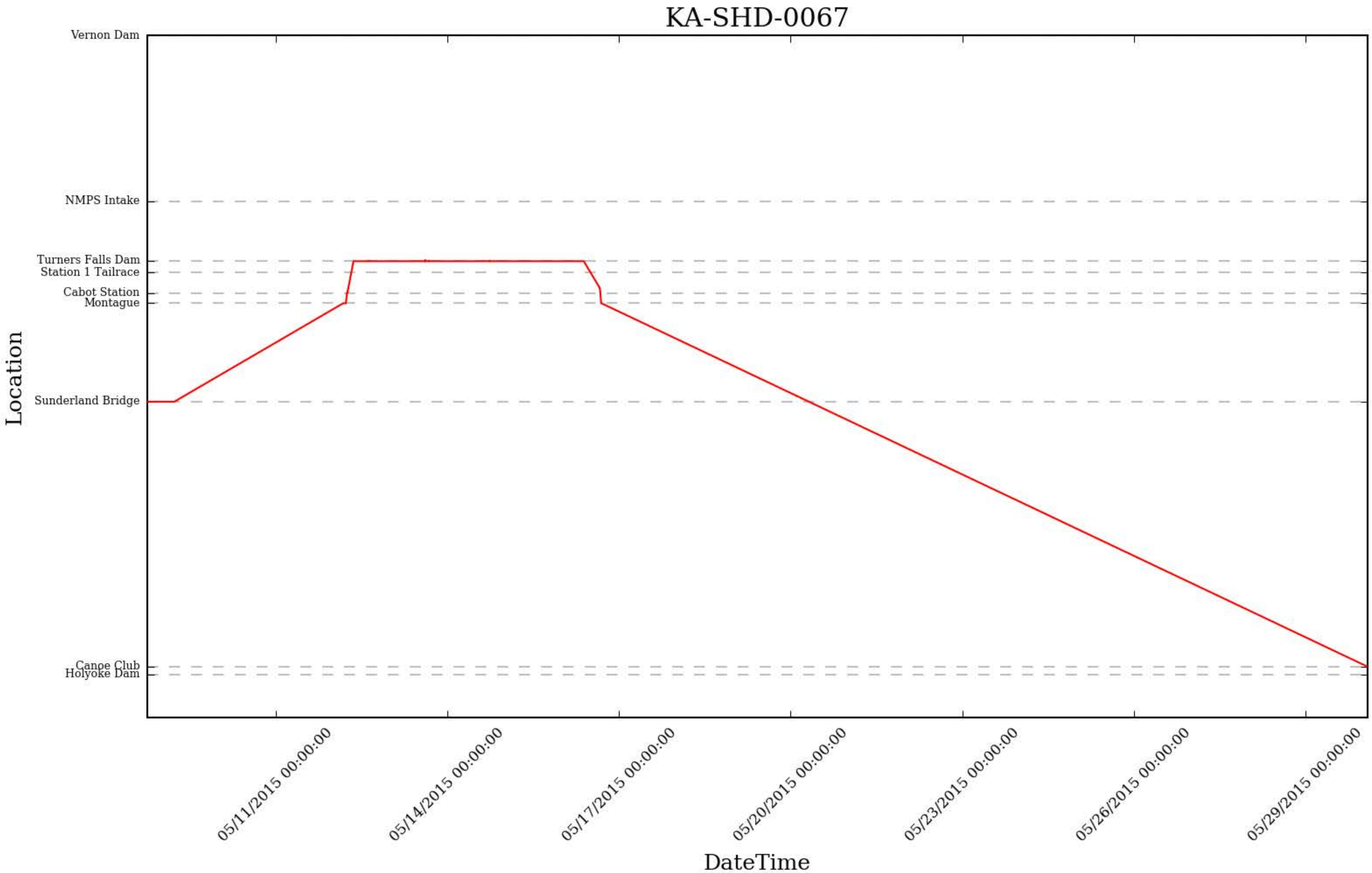

KA-SHD-0063
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/12/2015 00:00:00
05/15/2015 00:00:00
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
DateTime


KA-SHD-0064
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 00:00:00
05/14/2015 00:00:00
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
DateTime

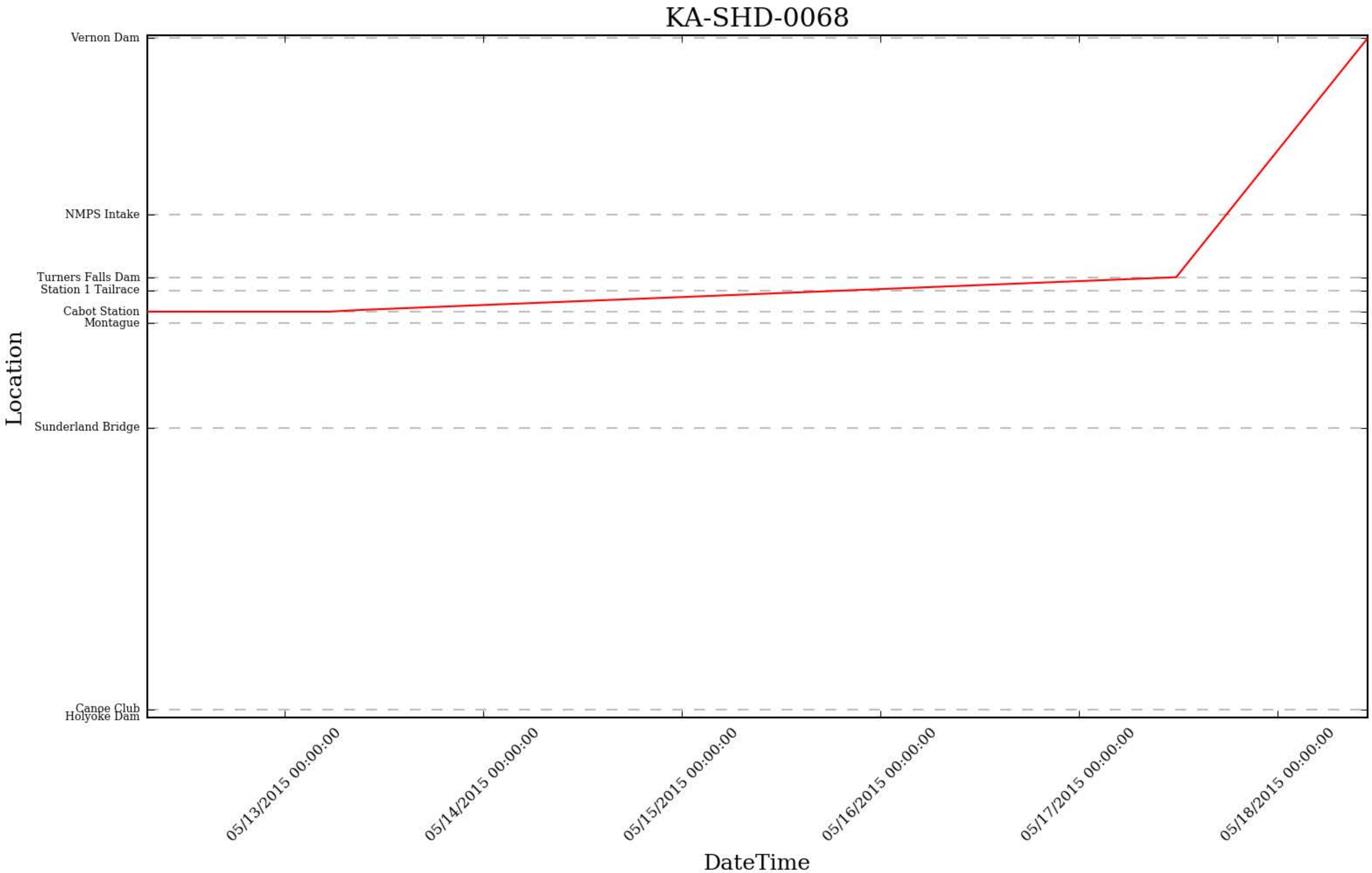

KA-SHD-0065
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/14/2015 00:00:00
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
07/09/2015 00:00:00
07/16/2015 00:00:00
DateTime



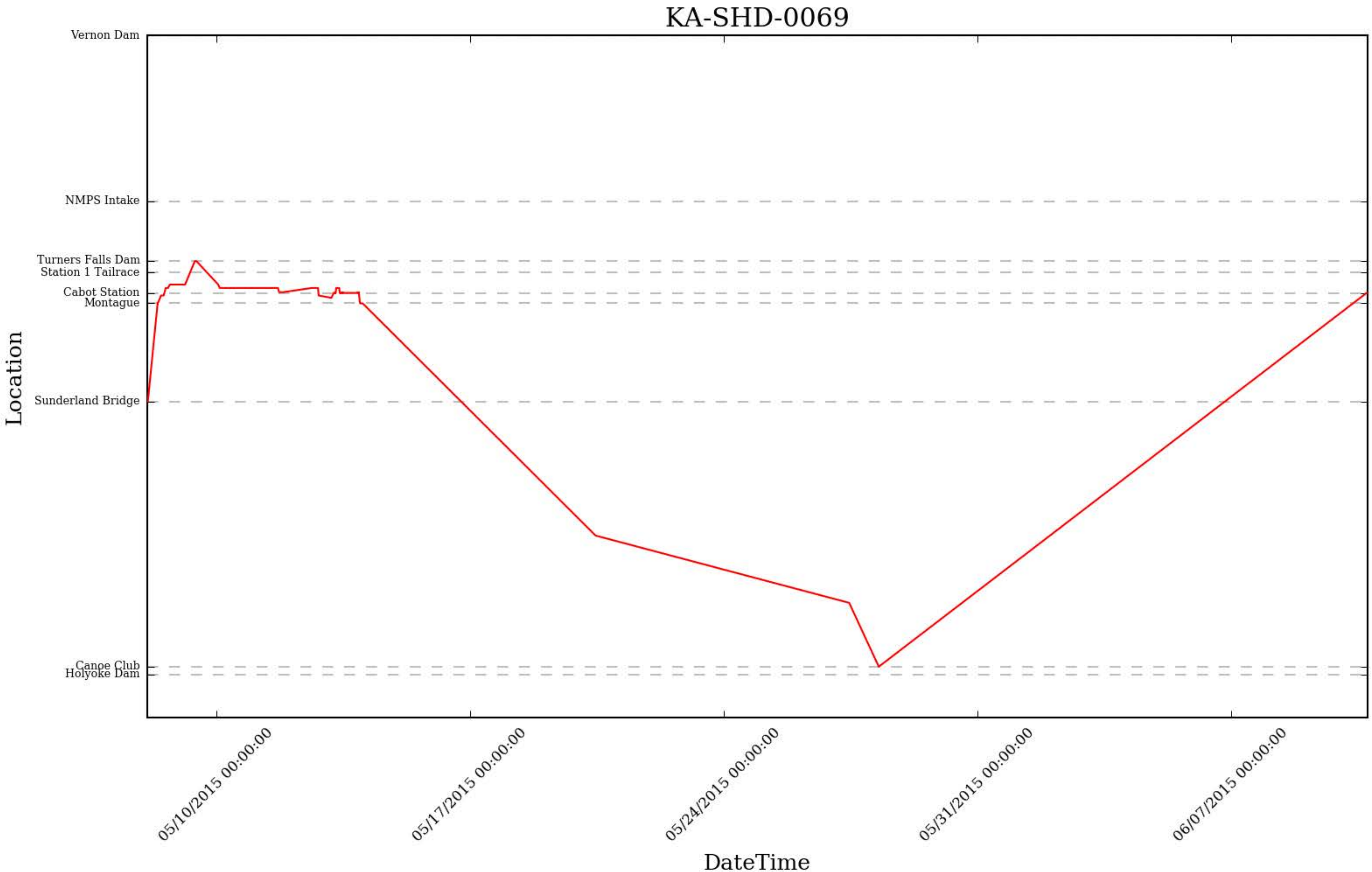
KA-SHD-0066
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/09/2015 00:00:00
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
DateTime

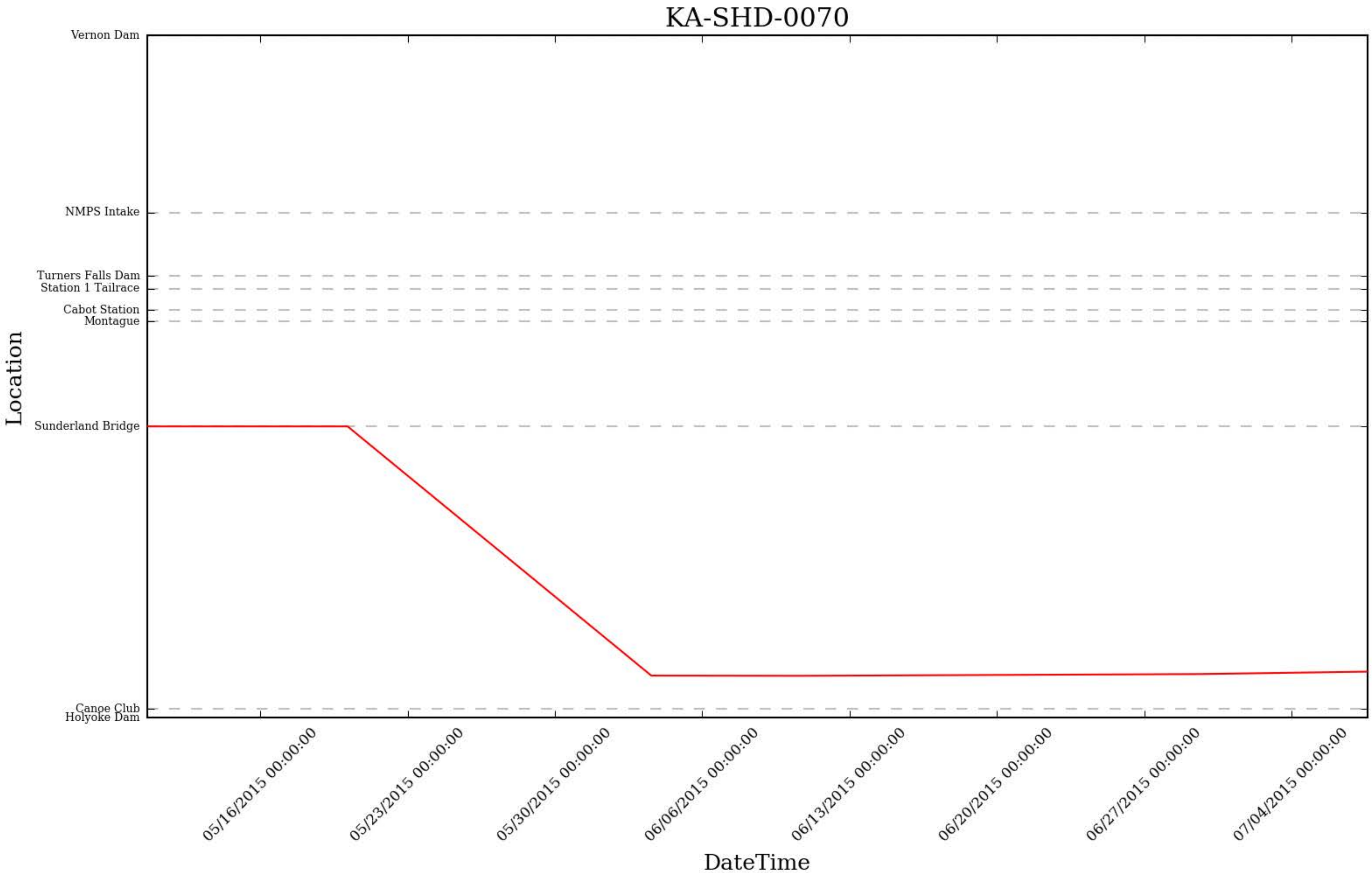


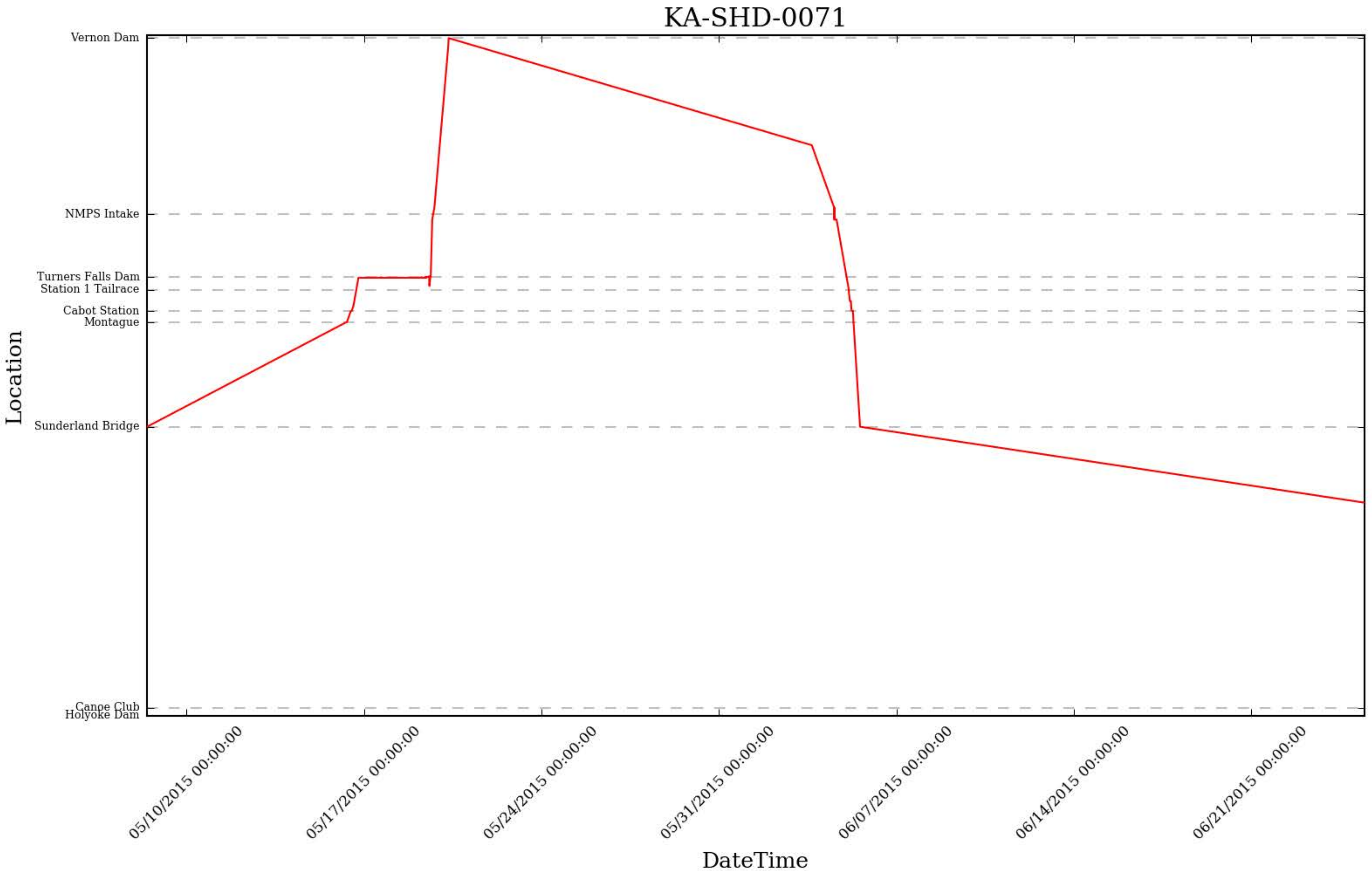
KA-SHD-0067
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 00:00:00
05/14/2015 00:00:00
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
DateTime

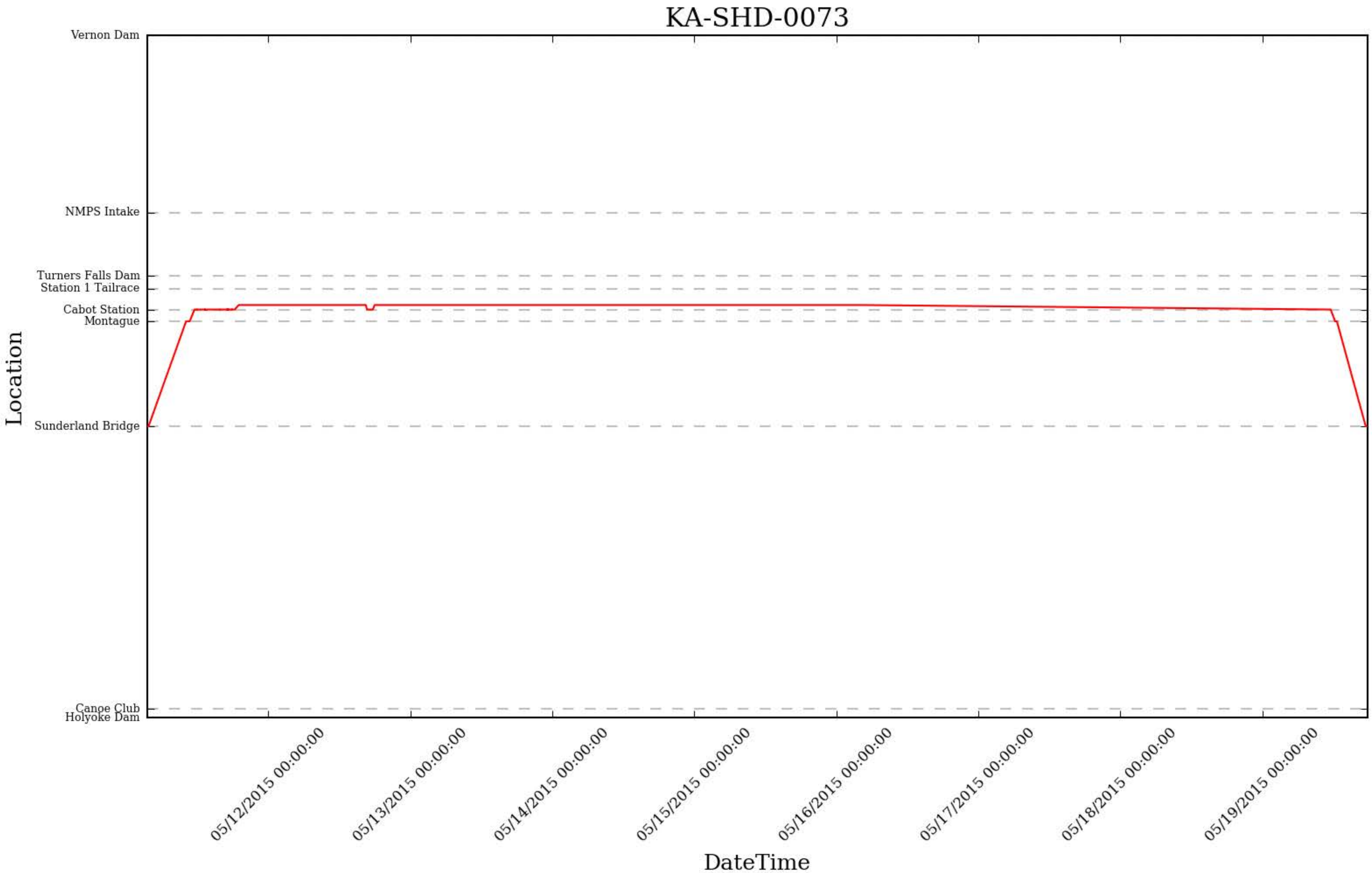


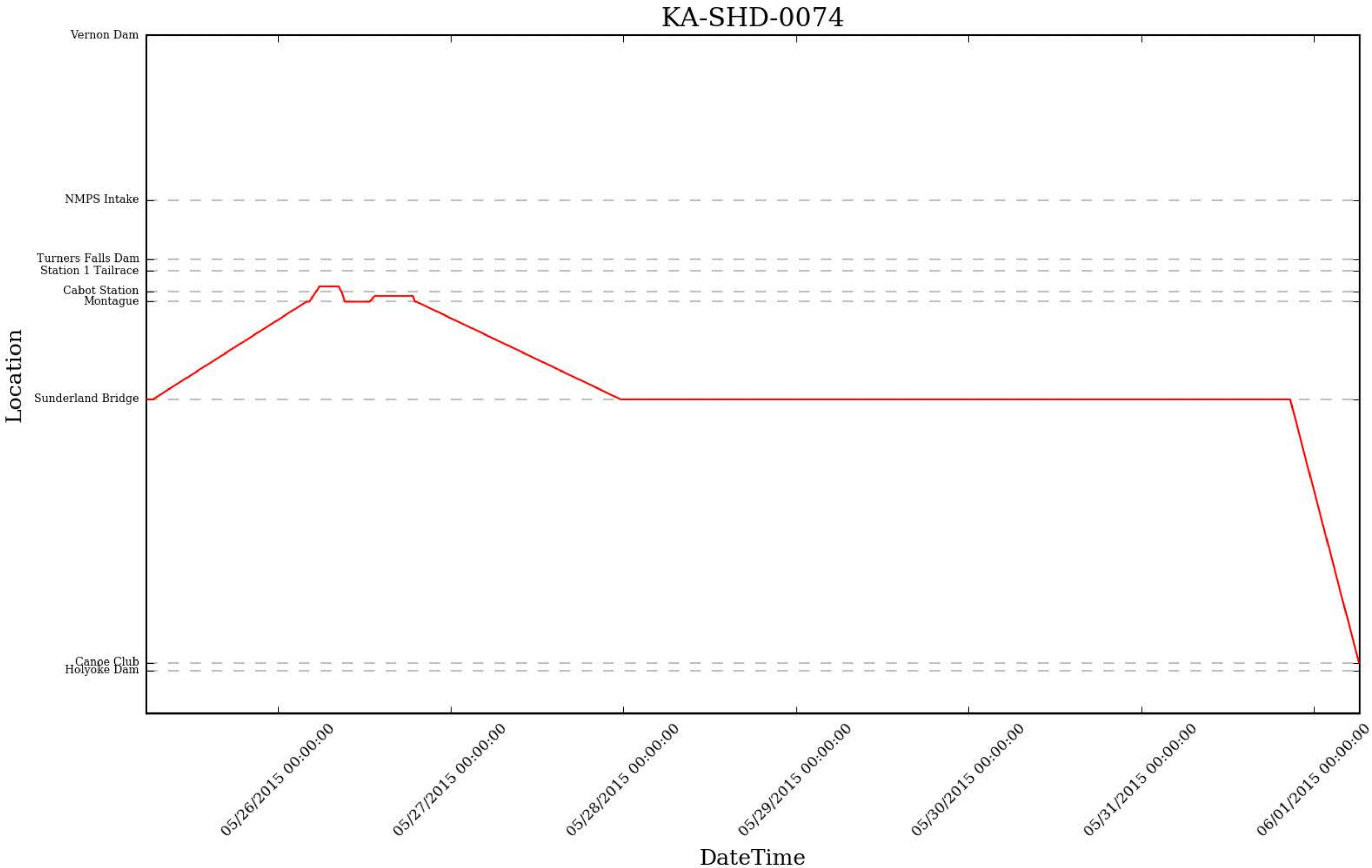
KA-SHD-0068
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 00:00:00
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
DateTime


KA-SHD-0069
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/10/2015 00:00:00
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
DateTime

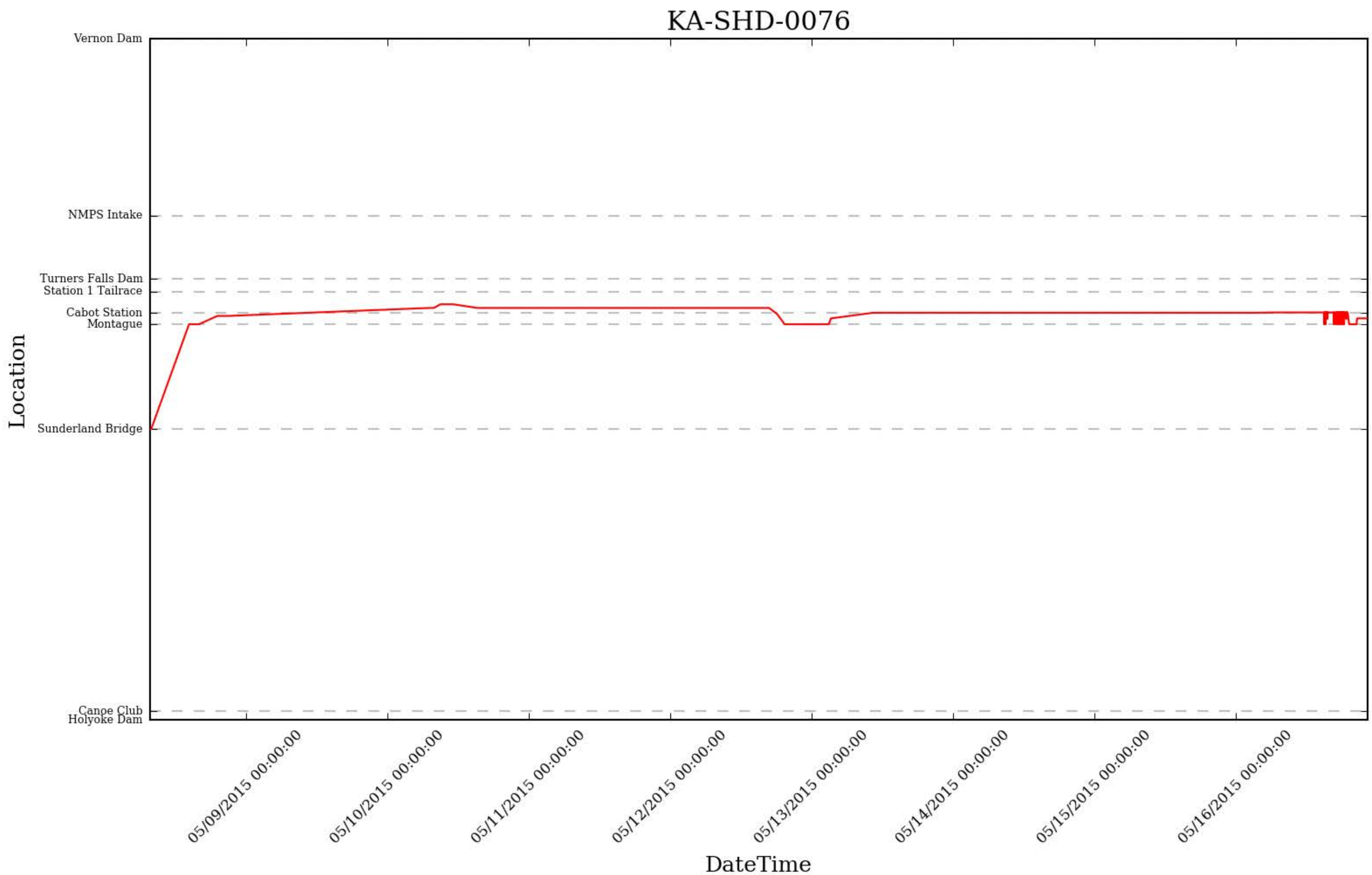

KA-SHD-0070
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
DateTime

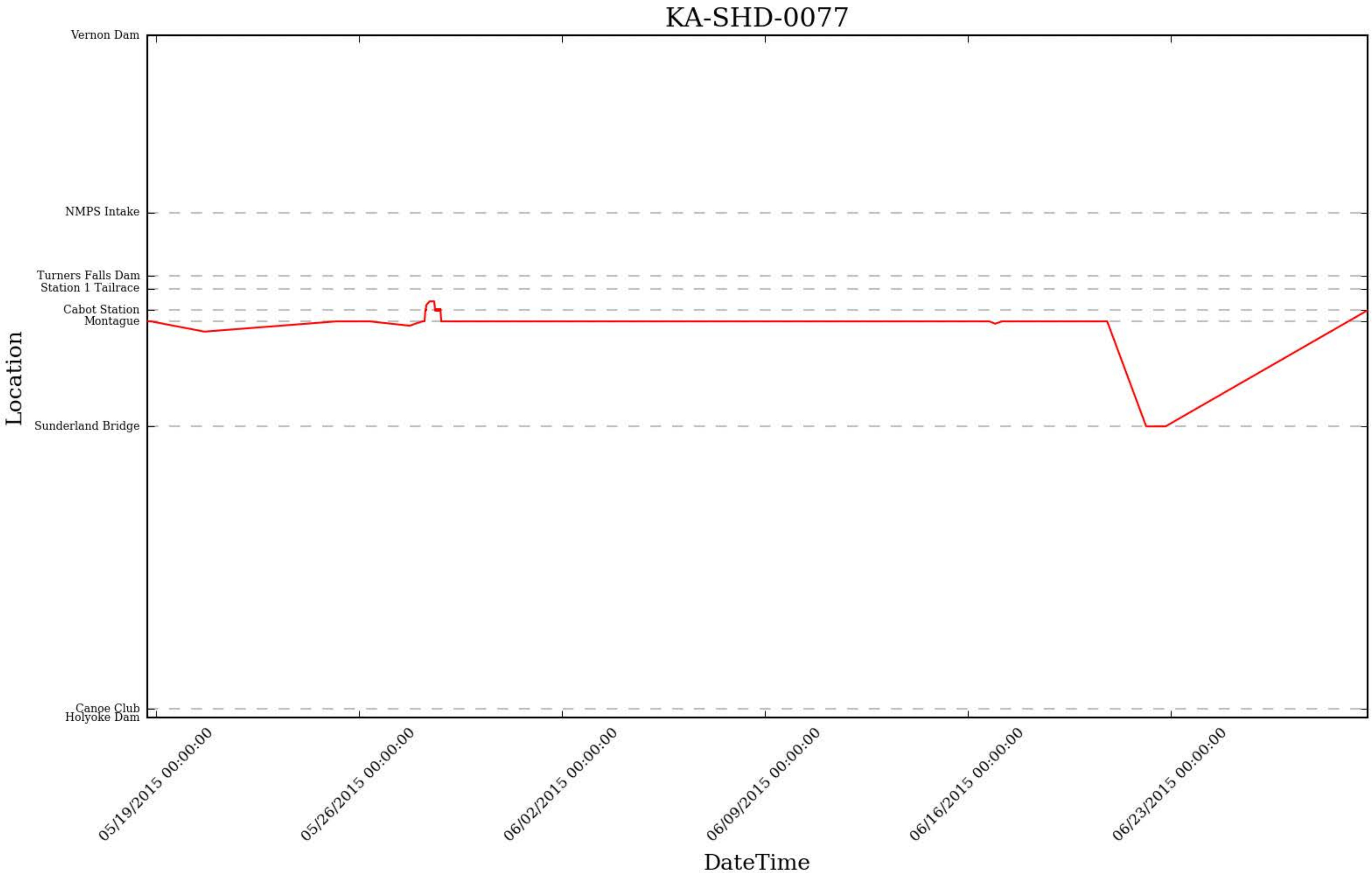

KA-SHD-0071
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
DateTime


KA-SHD-0073
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/12/2015 00:00:00
05/13/2015 00:00:00
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
DateTime

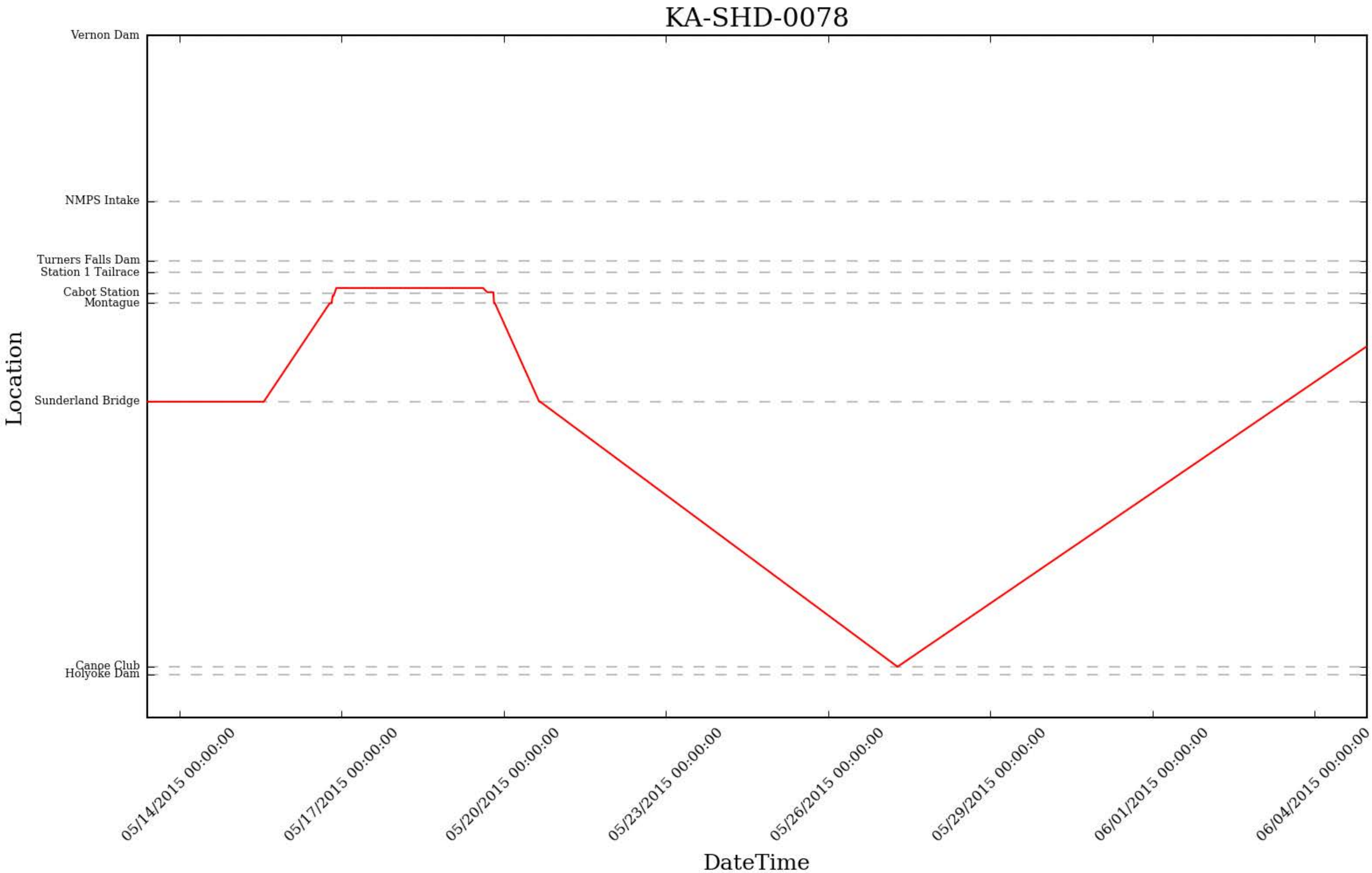


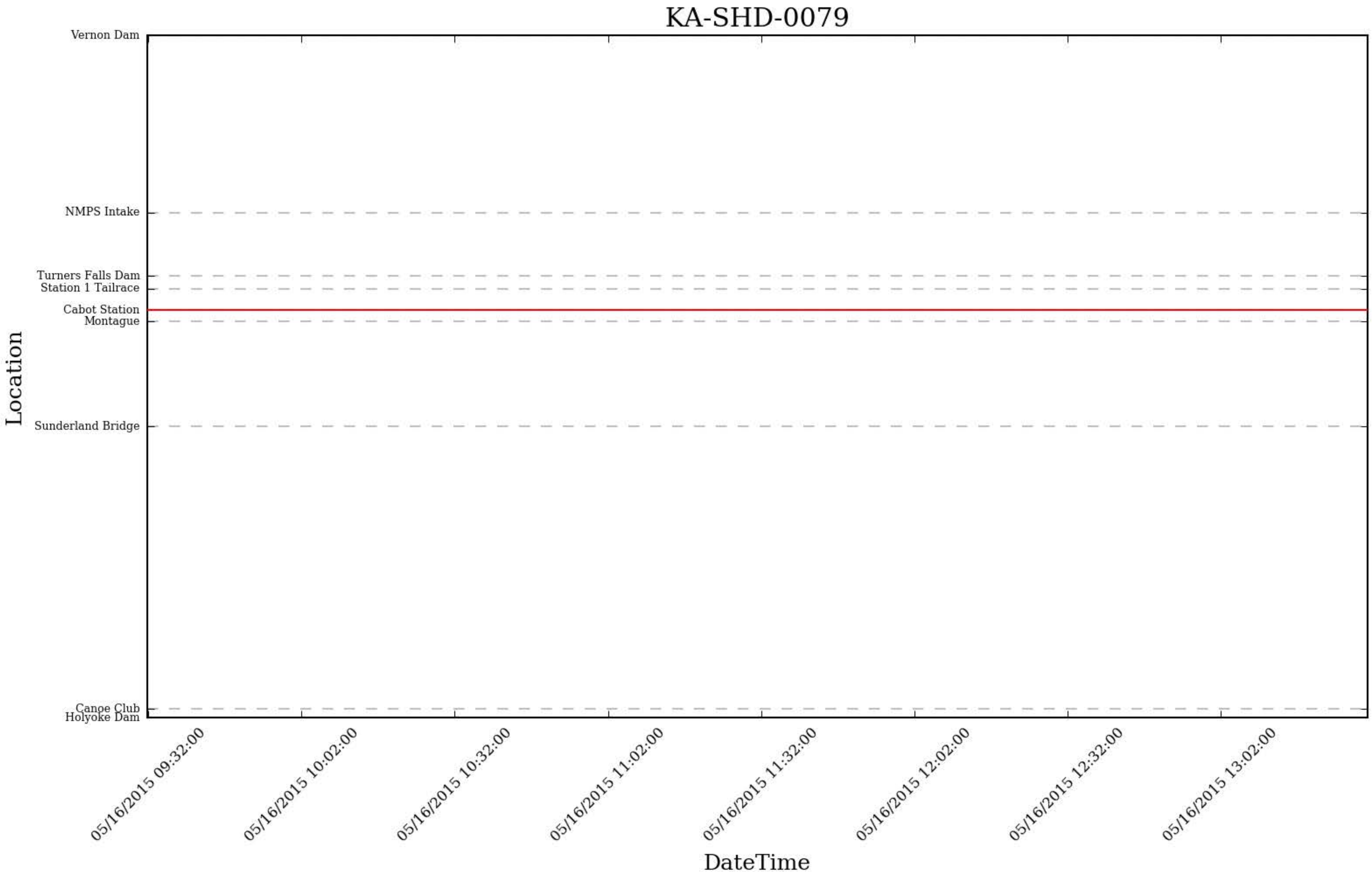
KA-SHD-0074
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
DateTime

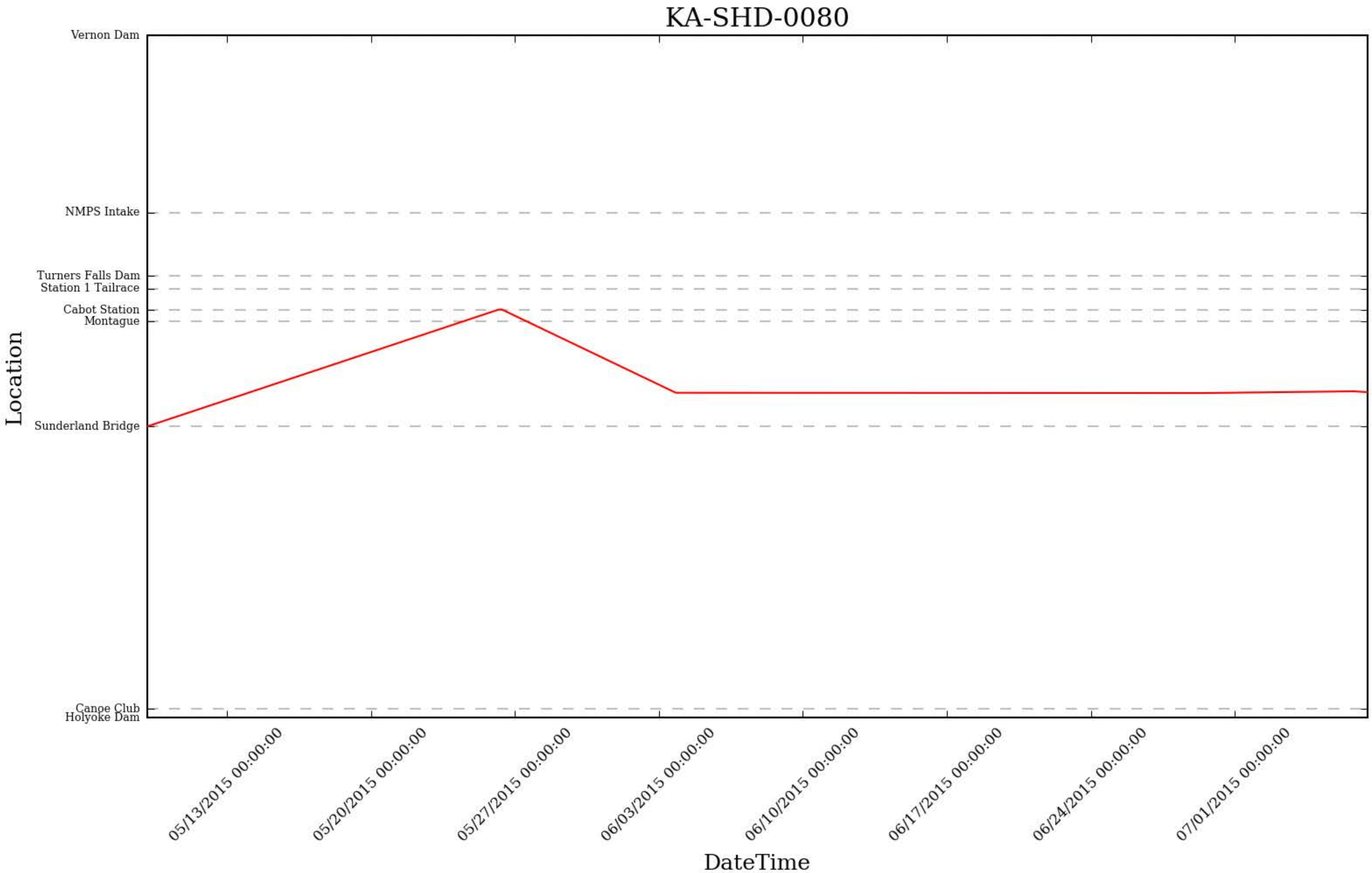

KA-SHD-0076
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/09/2015 00:00:00
05/10/2015 00:00:00
05/11/2015 00:00:00
05/12/2015 00:00:00
05/13/2015 00:00:00
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
DateTime

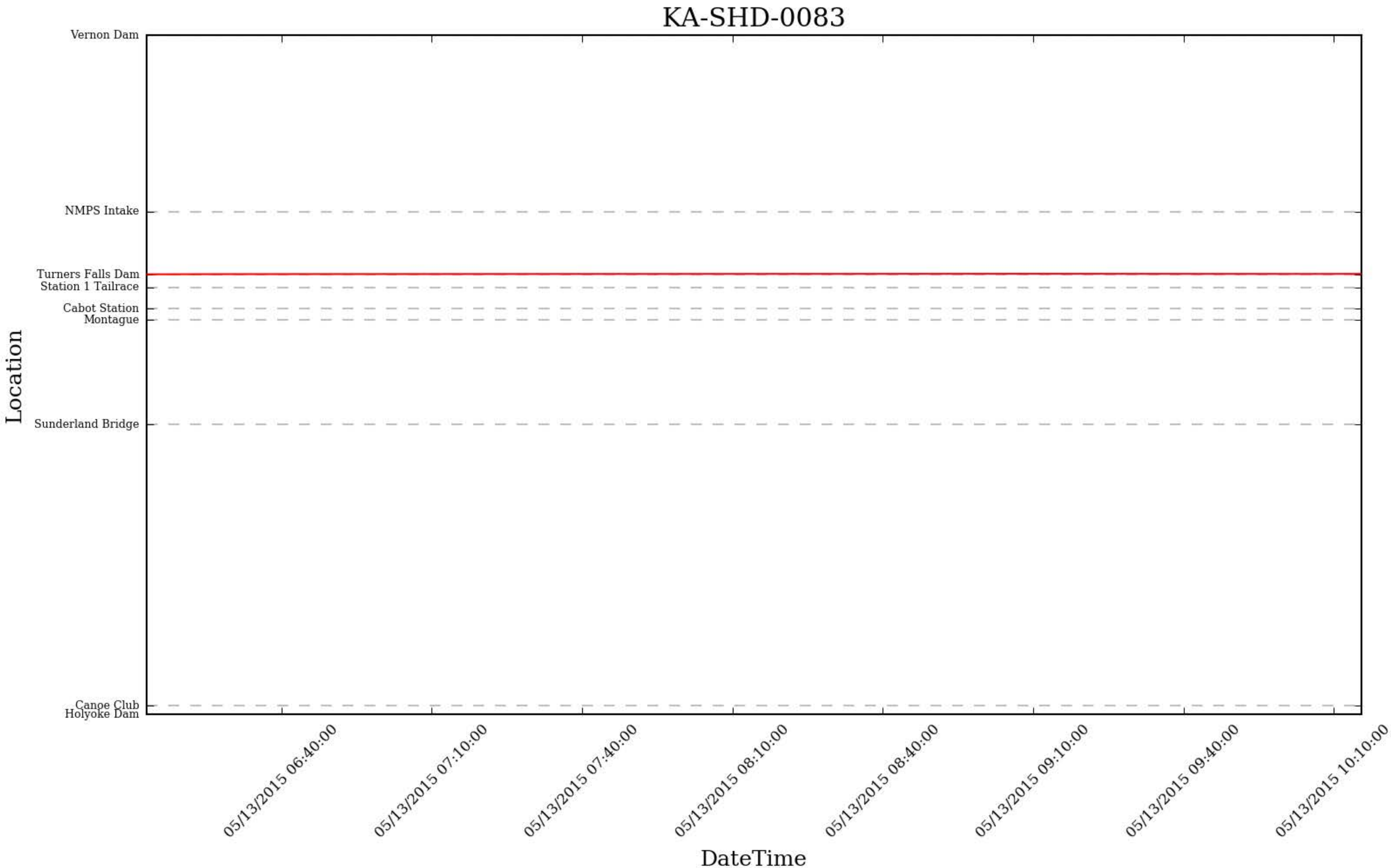


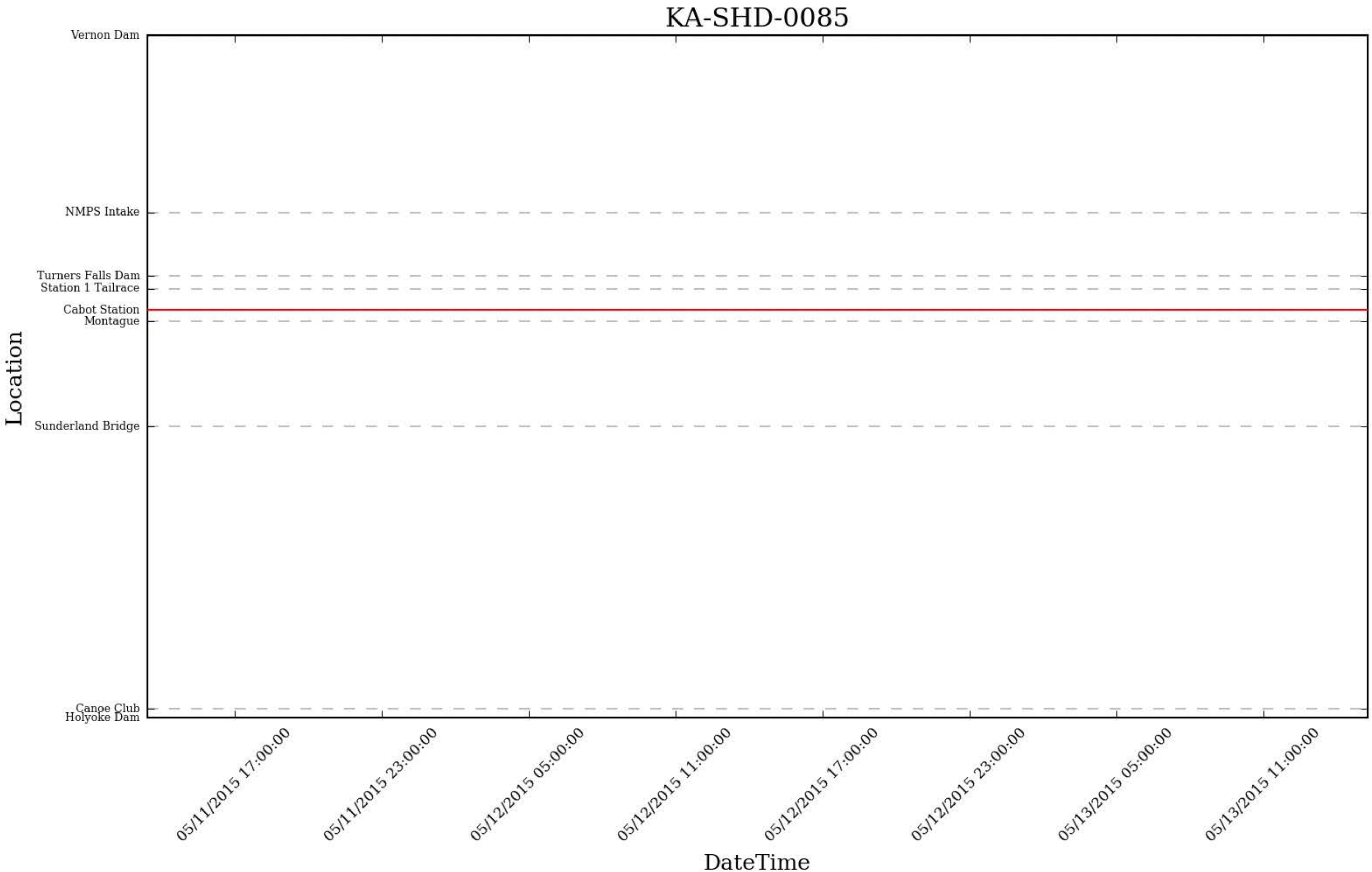
KA-SHD-0077
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
DateTime

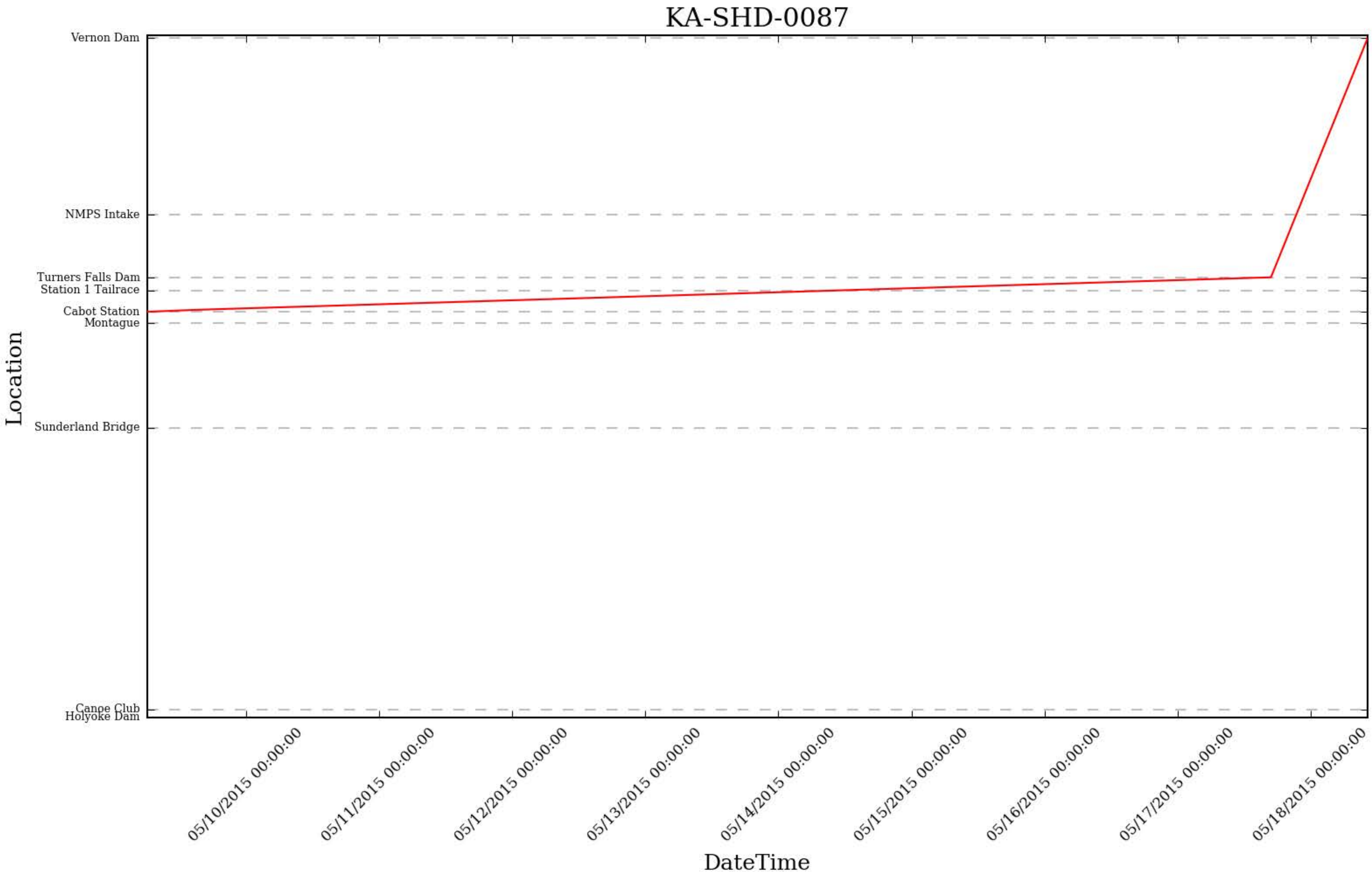

KA-SHD-0078
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
DateTime

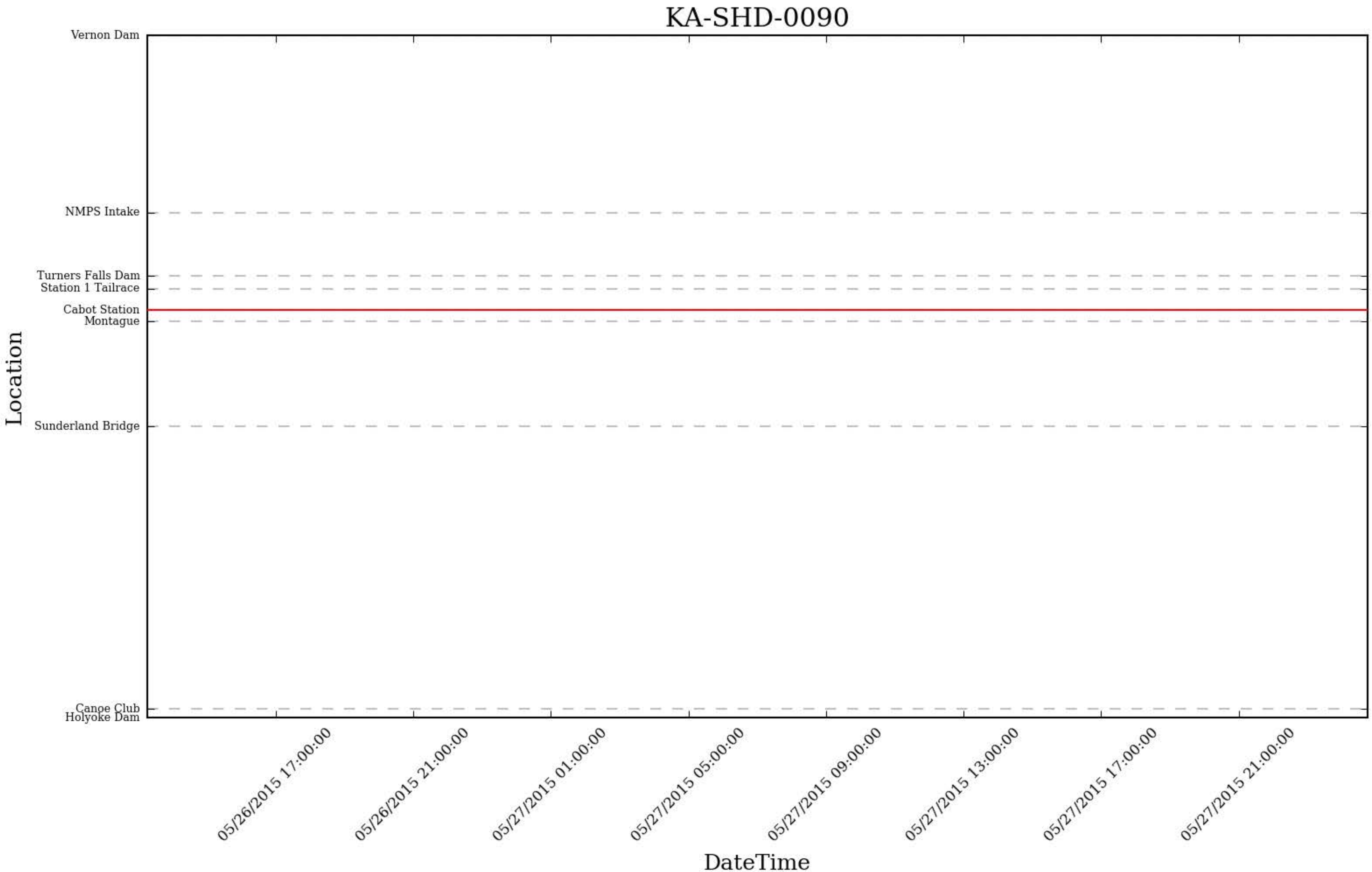

KA-SHD-0079
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 09:32:00
05/16/2015 10:02:00
05/16/2015 10:32:00
05/16/2015 11:02:00
05/16/2015 11:32:00
05/16/2015 12:02:00
05/16/2015 12:32:00
05/16/2015 13:02:00
DateTime

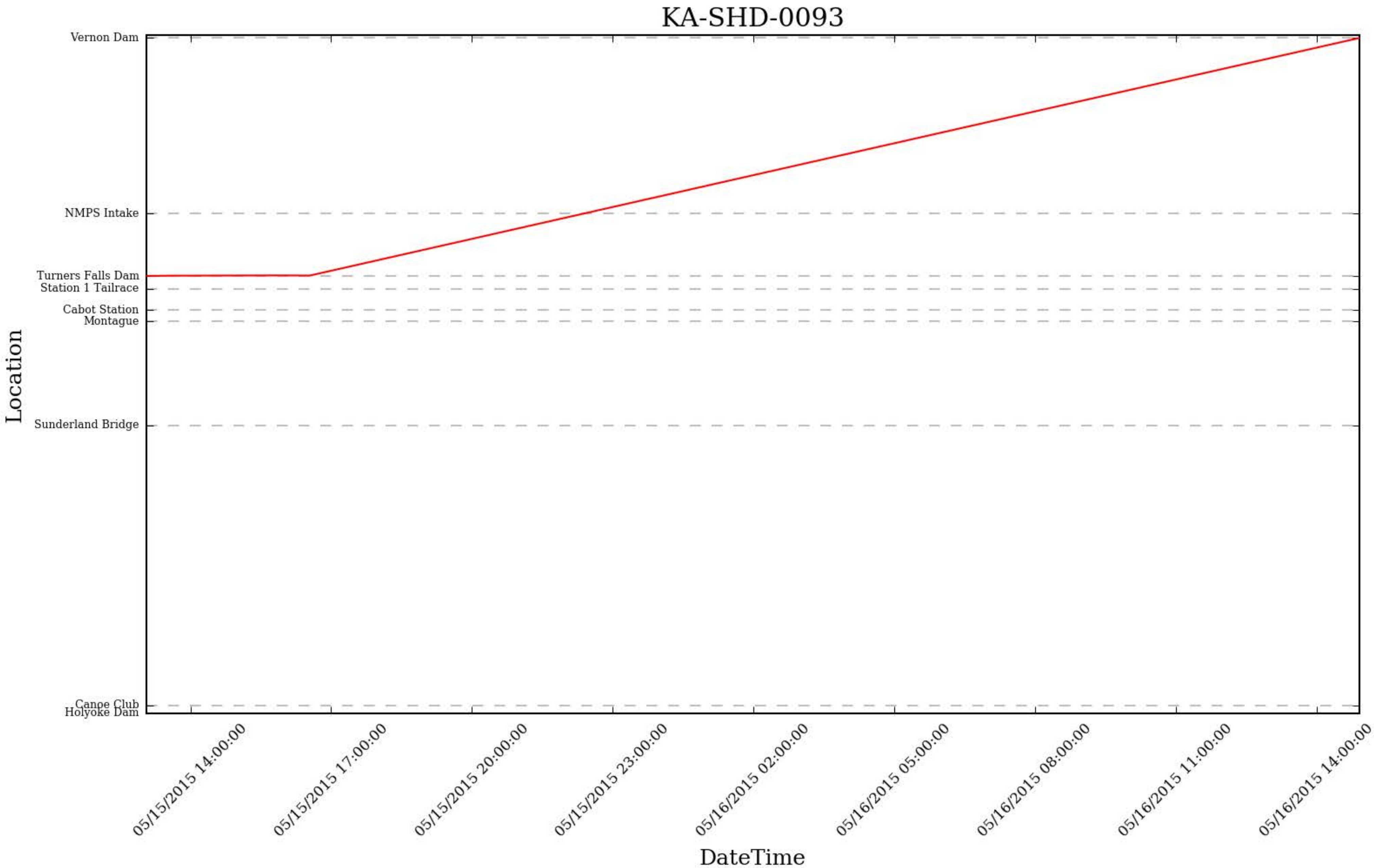

KA-SHD-0080
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 00:00:00
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

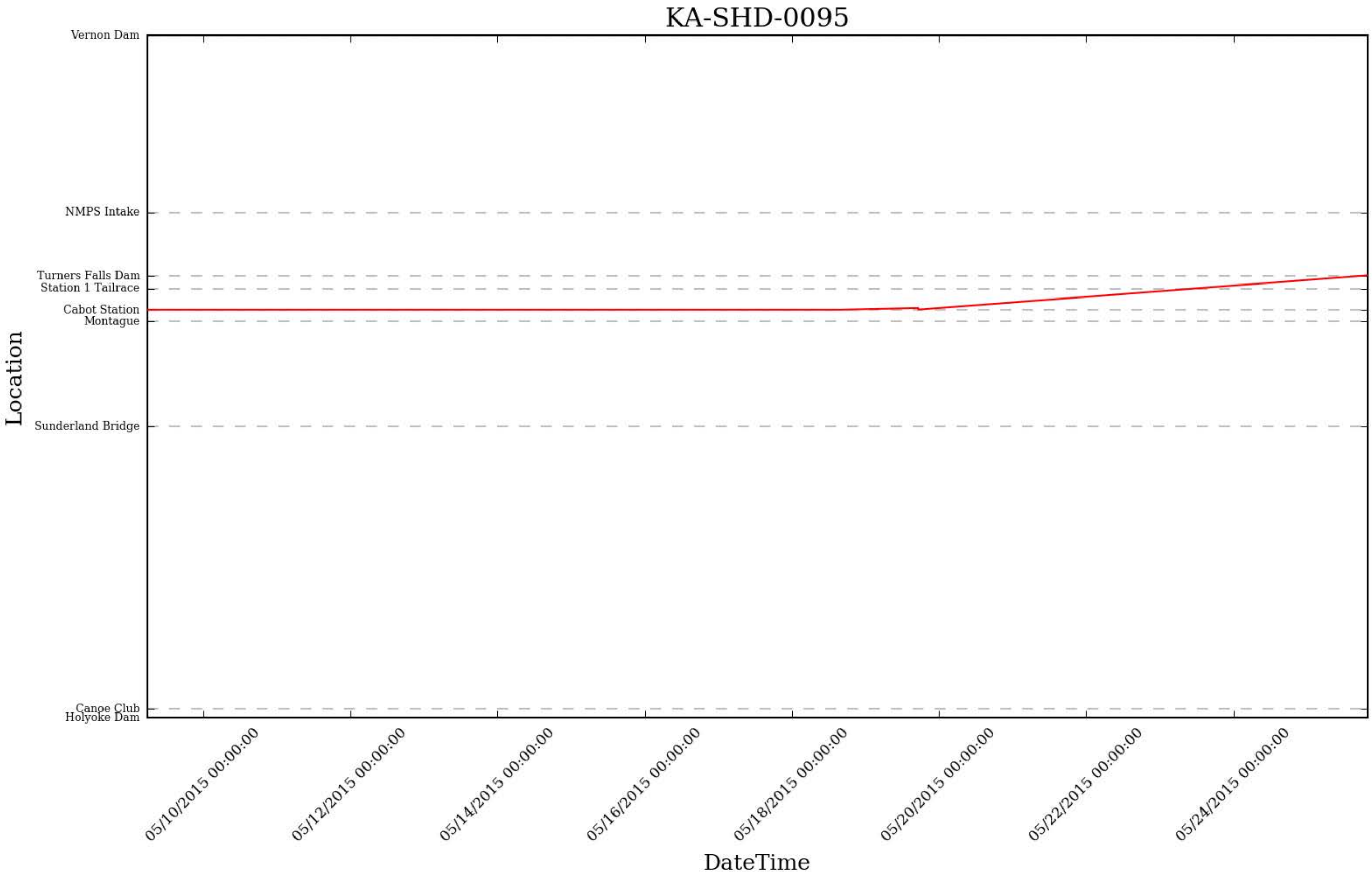

KA-SHD-0083
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 06:40:00
05/13/2015 07:10:00
05/13/2015 07:40:00
05/13/2015 08:10:00
05/13/2015 08:40:00
05/13/2015 09:10:00
05/13/2015 09:40:00
05/13/2015 10:10:00
DateTime

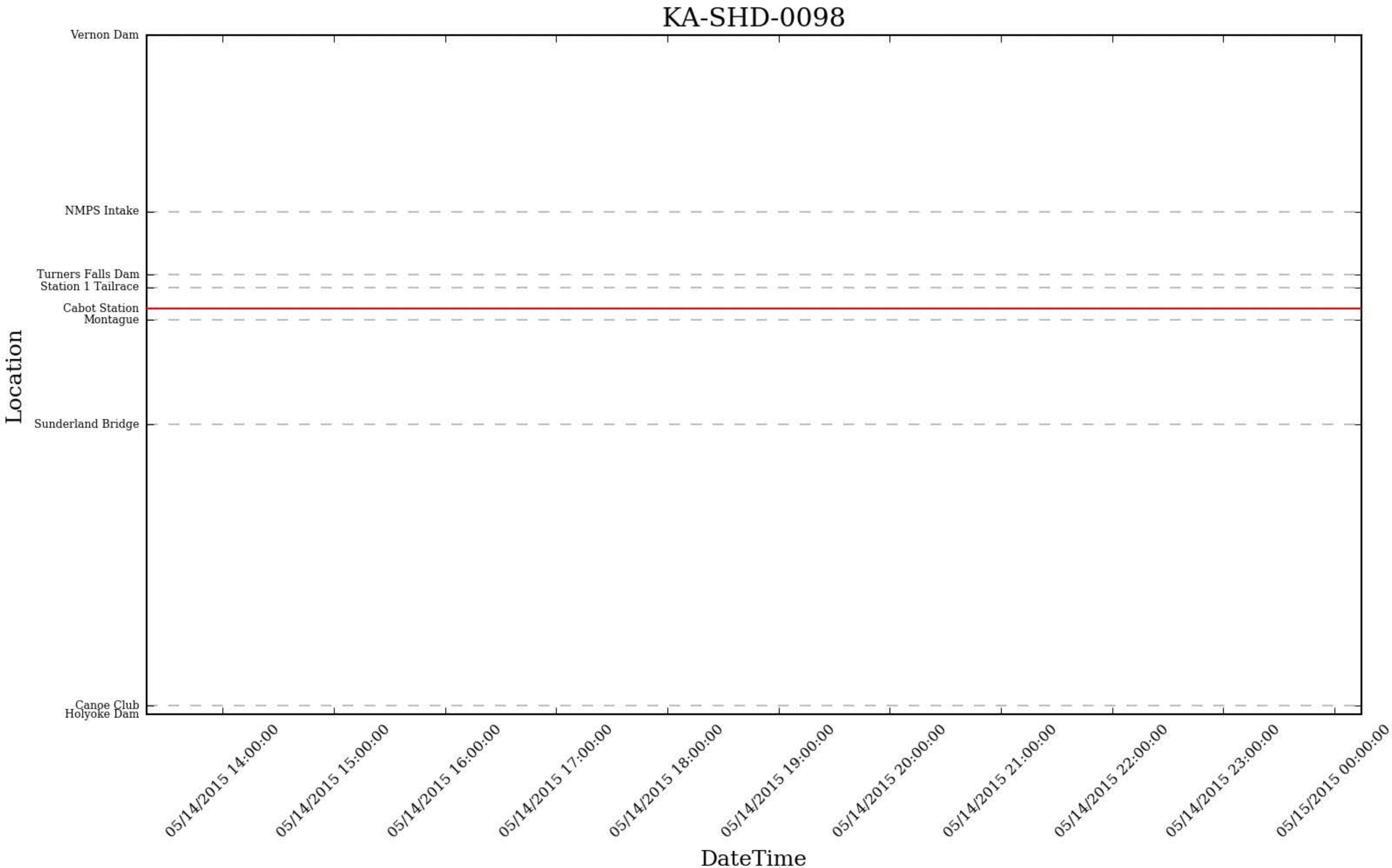

KA-SHD-0085
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 17:00:00
05/11/2015 23:00:00
05/12/2015 05:00:00
05/12/2015 11:00:00
05/12/2015 17:00:00
05/12/2015 23:00:00
05/13/2015 05:00:00
05/13/2015 11:00:00
DateTime


KA-SHD-0087
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/11/2015 00:00:00
05/12/2015 00:00:00
05/13/2015 00:00:00
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
DateTime

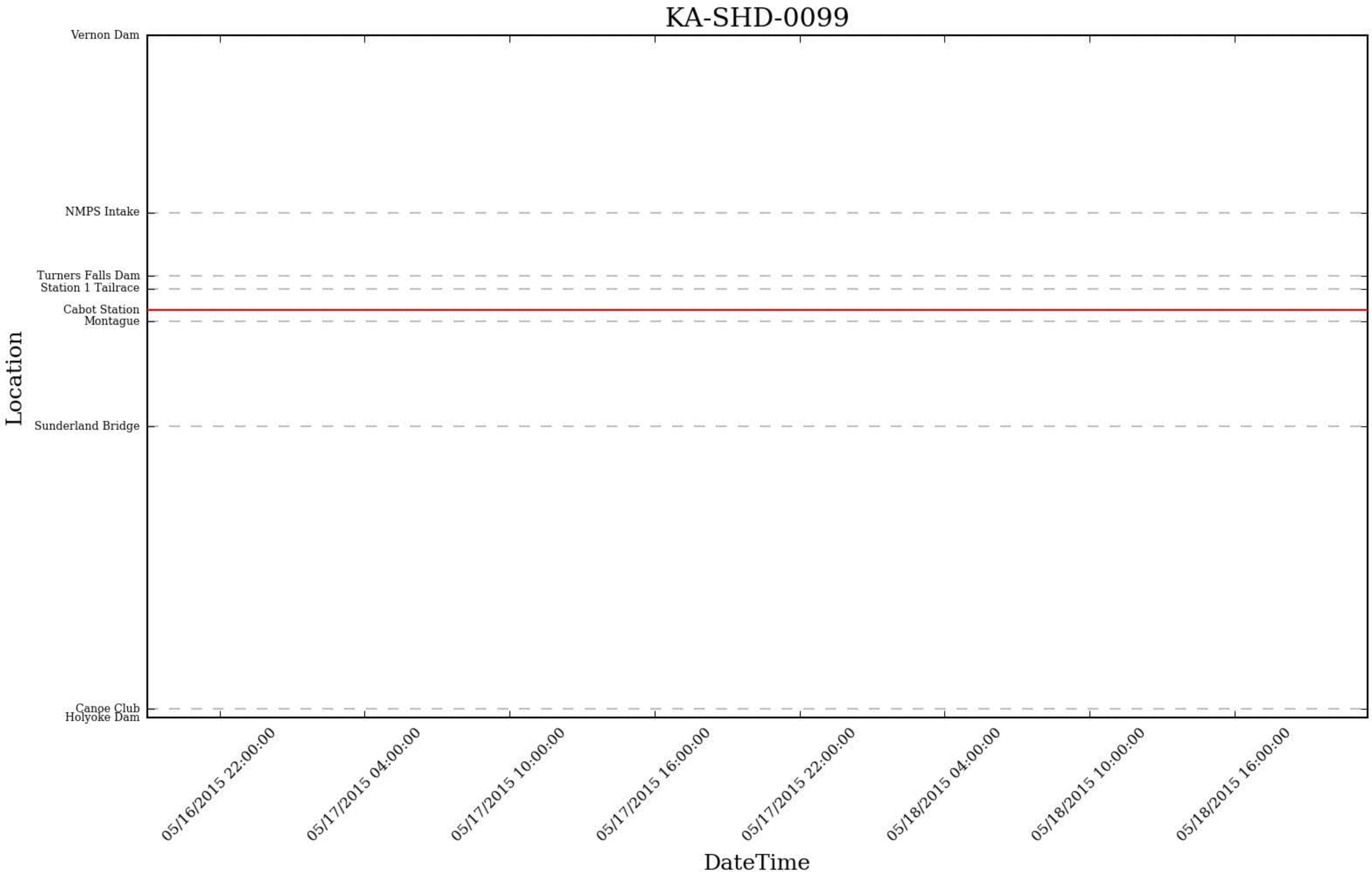

KA-SHD-0090
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 17:00:00
05/26/2015 21:00:00
05/27/2015 01:00:00
05/27/2015 05:00:00
05/27/2015 09:00:00
05/27/2015 13:00:00
05/27/2015 17:00:00
05/27/2015 21:00:00
DateTime


KA-SHD-0093
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 14:00:00
05/15/2015 17:00:00
05/15/2015 20:00:00
05/15/2015 23:00:00
05/16/2015 02:00:00
05/16/2015 05:00:00
05/16/2015 08:00:00
05/16/2015 11:00:00
05/16/2015 14:00:00
DateTime

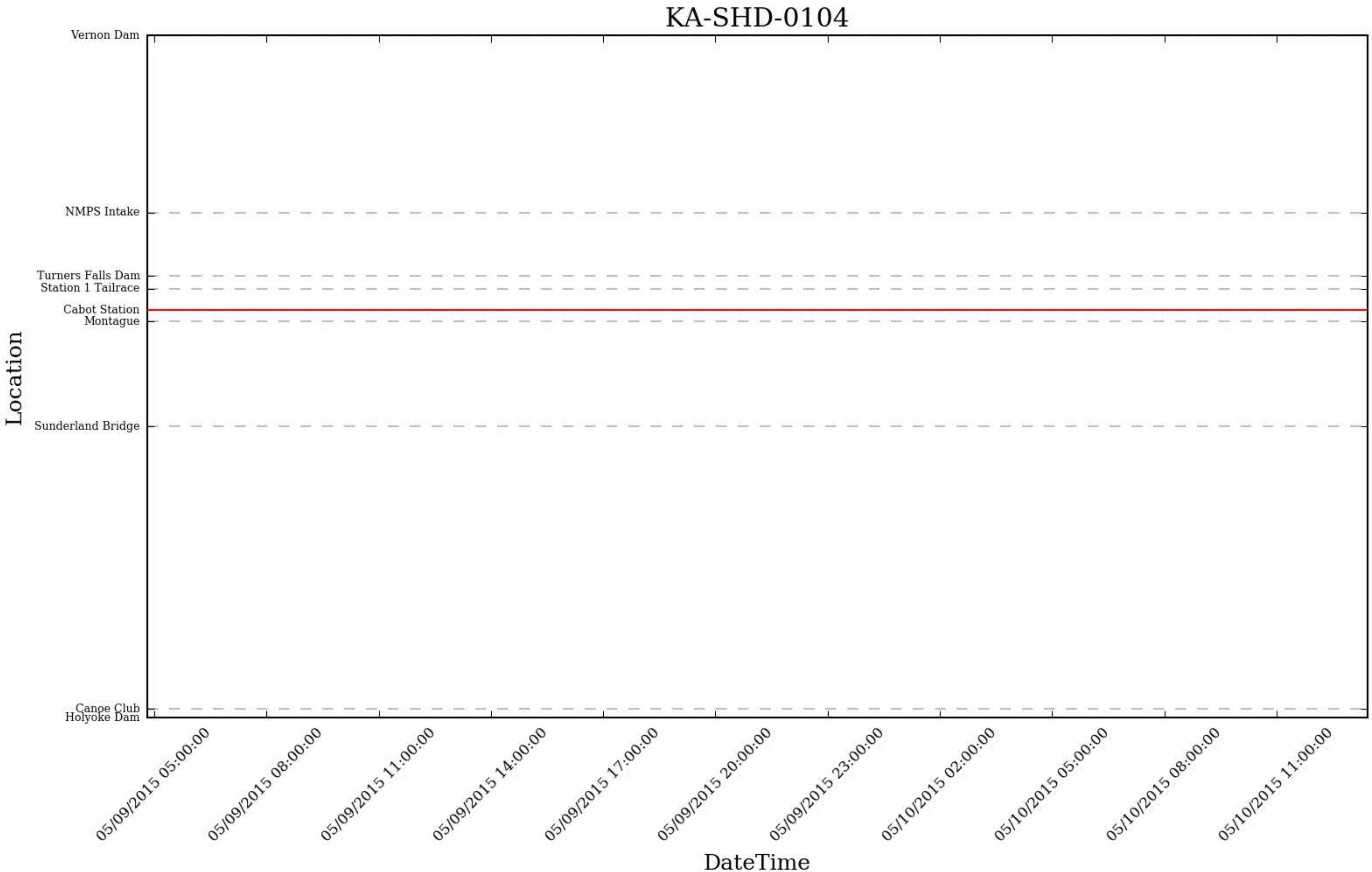

KA-SHD-0095
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/12/2015 00:00:00
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
DateTime

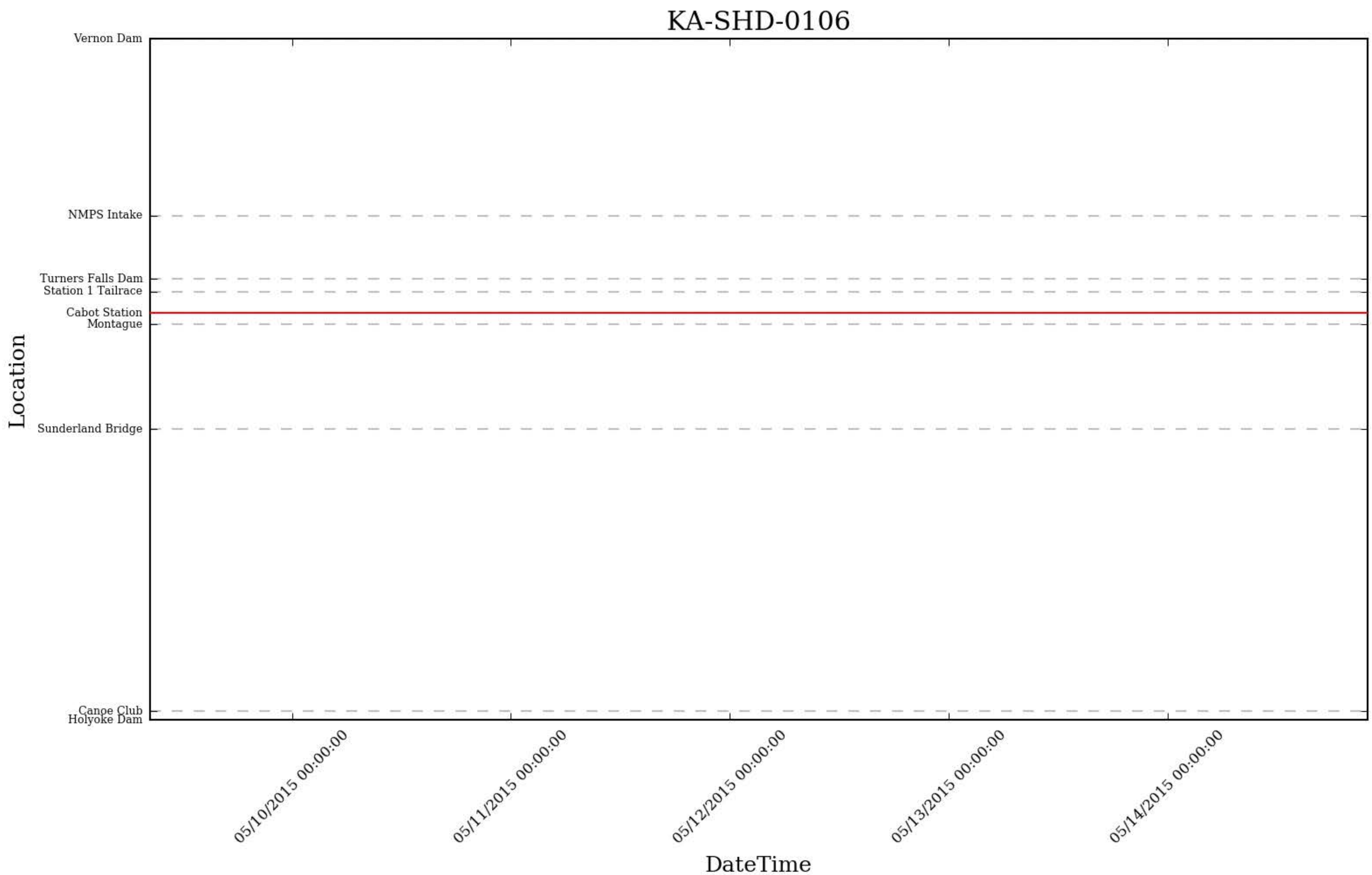


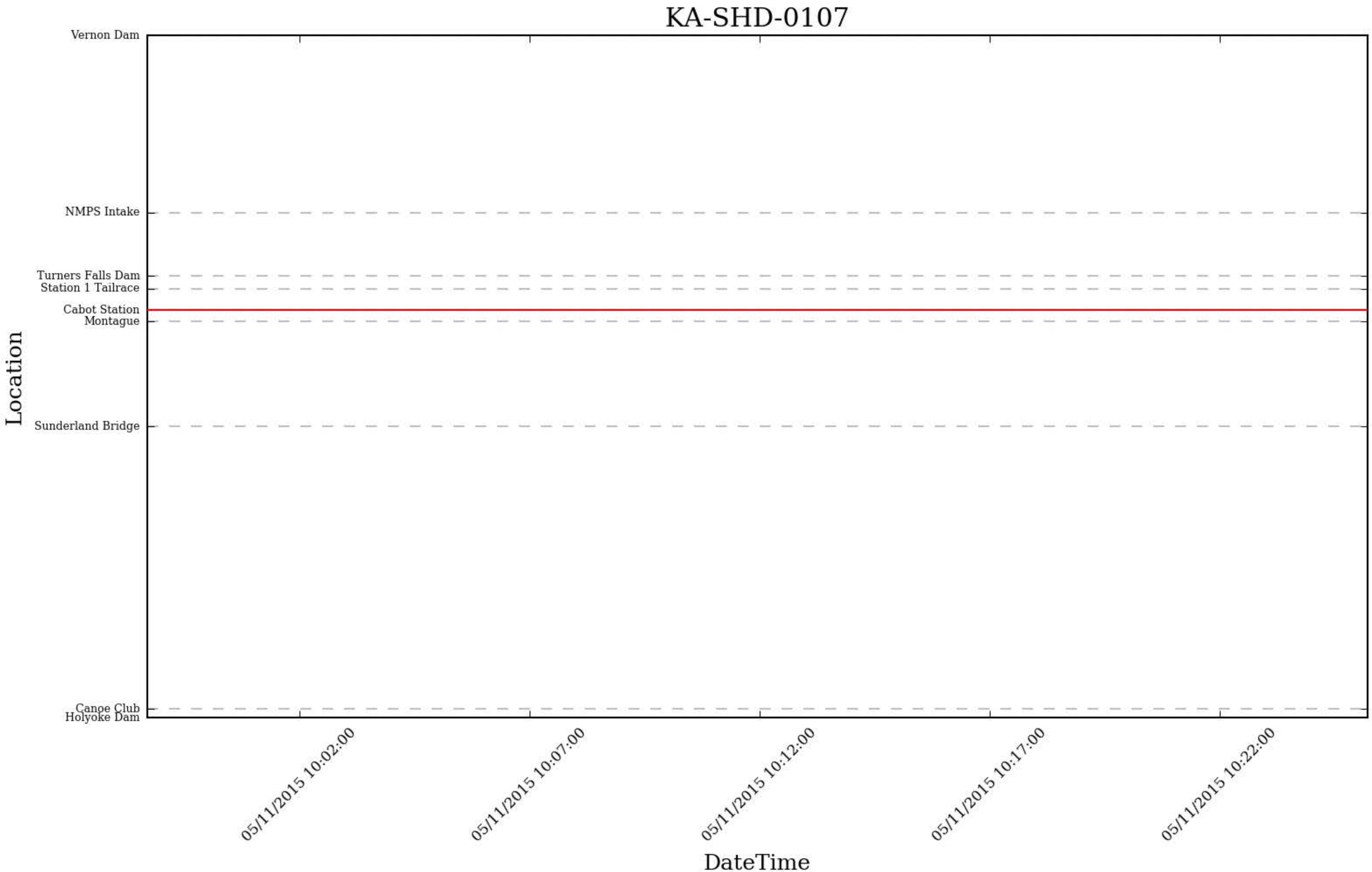
KA-SHD-0098
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 14:00:00
05/14/2015 15:00:00
05/14/2015 16:00:00
05/14/2015 17:00:00
05/14/2015 18:00:00
05/14/2015 19:00:00
05/14/2015 20:00:00
05/14/2015 21:00:00
05/14/2015 22:00:00
05/14/2015 23:00:00
05/15/2015 00:00:00
DateTime



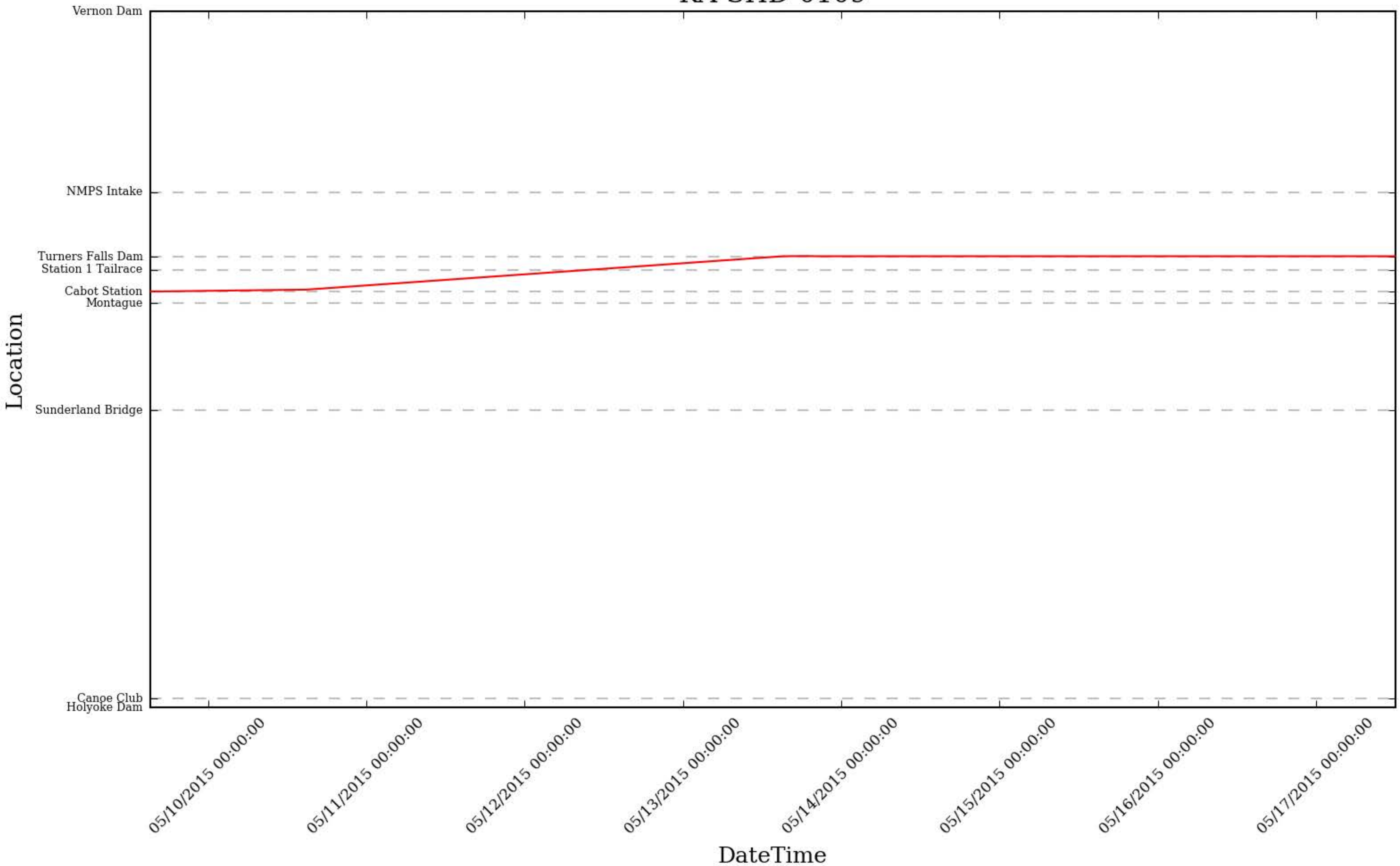
KA-SHD-0099
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 22:00:00
05/17/2015 04:00:00
05/17/2015 10:00:00
05/17/2015 16:00:00
05/17/2015 22:00:00
05/18/2015 04:00:00
05/18/2015 10:00:00
05/18/2015 16:00:00
DateTime


KA-SHD-0104
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/09/2015 05:00:00
05/09/2015 08:00:00
05/09/2015 11:00:00
05/09/2015 14:00:00
05/09/2015 17:00:00
05/09/2015 20:00:00
05/09/2015 23:00:00
05/10/2015 02:00:00
05/10/2015 05:00:00
05/10/2015 08:00:00
05/10/2015 11:00:00
DateTime

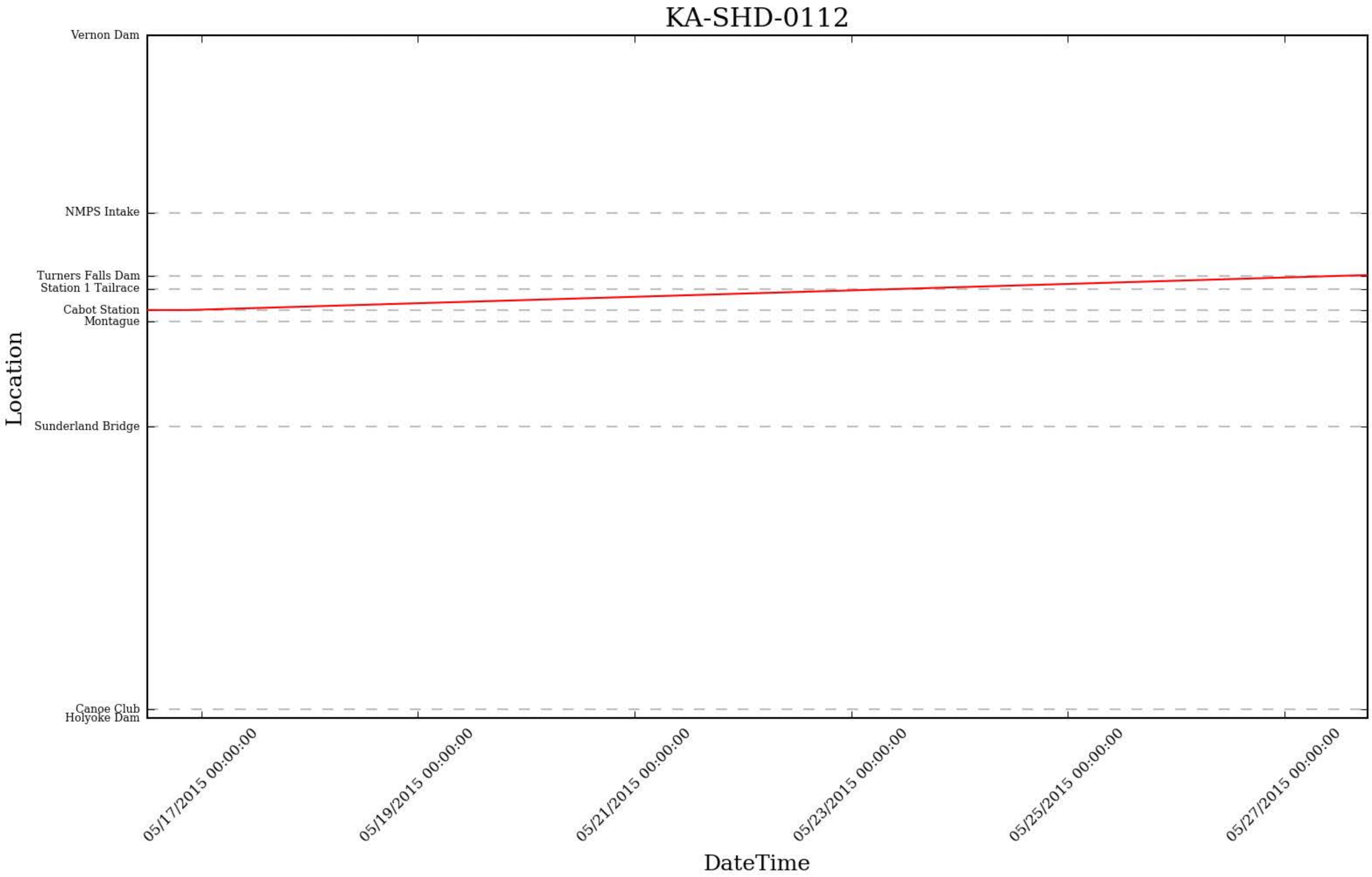

KA-SHD-0106
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/11/2015 00:00:00
05/12/2015 00:00:00
05/13/2015 00:00:00
05/14/2015 00:00:00
DateTime


KA-SHD-0107
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 10:02:00
05/11/2015 10:07:00
05/11/2015 10:12:00
05/11/2015 10:17:00
05/11/2015 10:22:00
DateTime

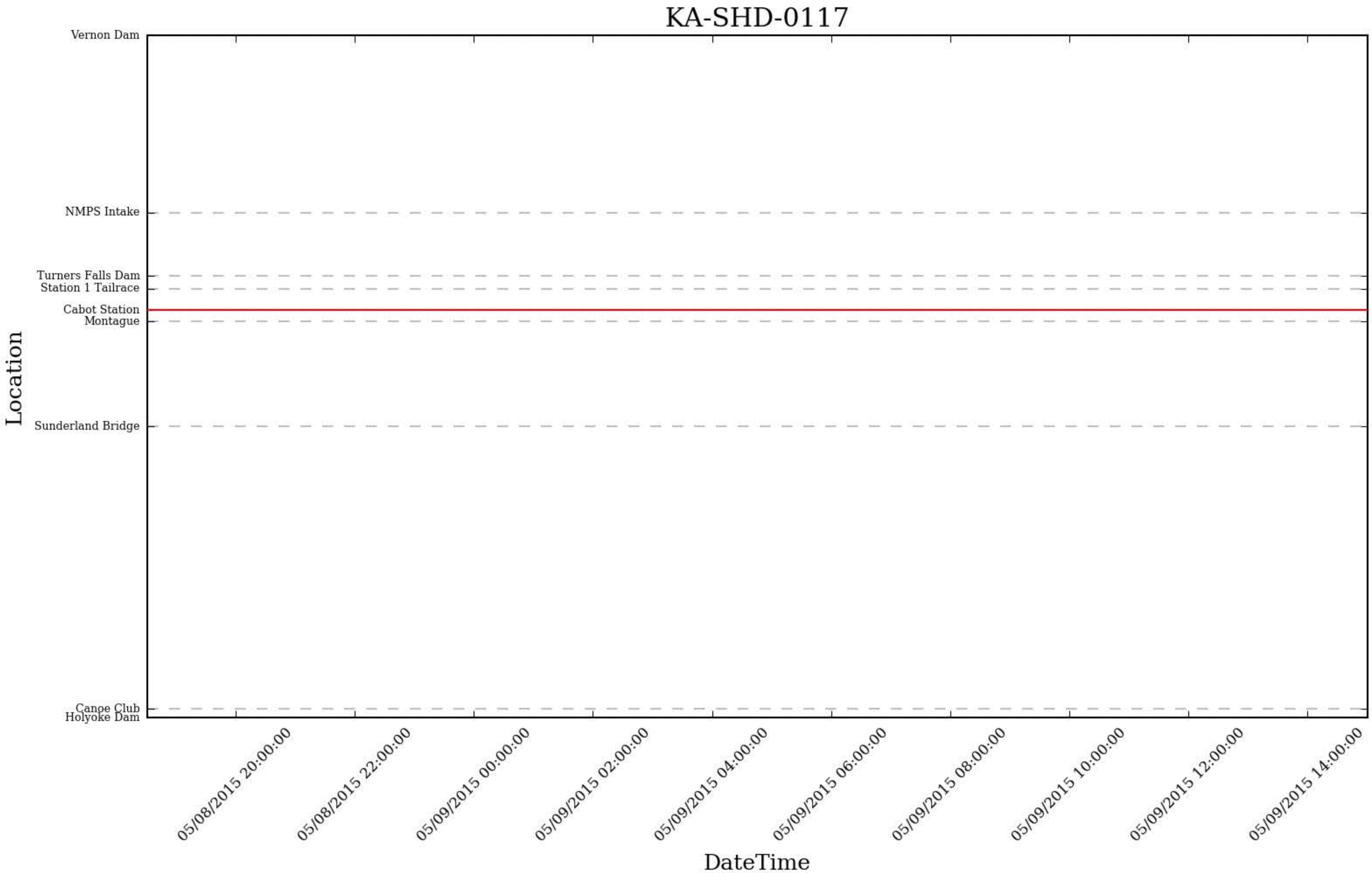
KA-SHD-0109



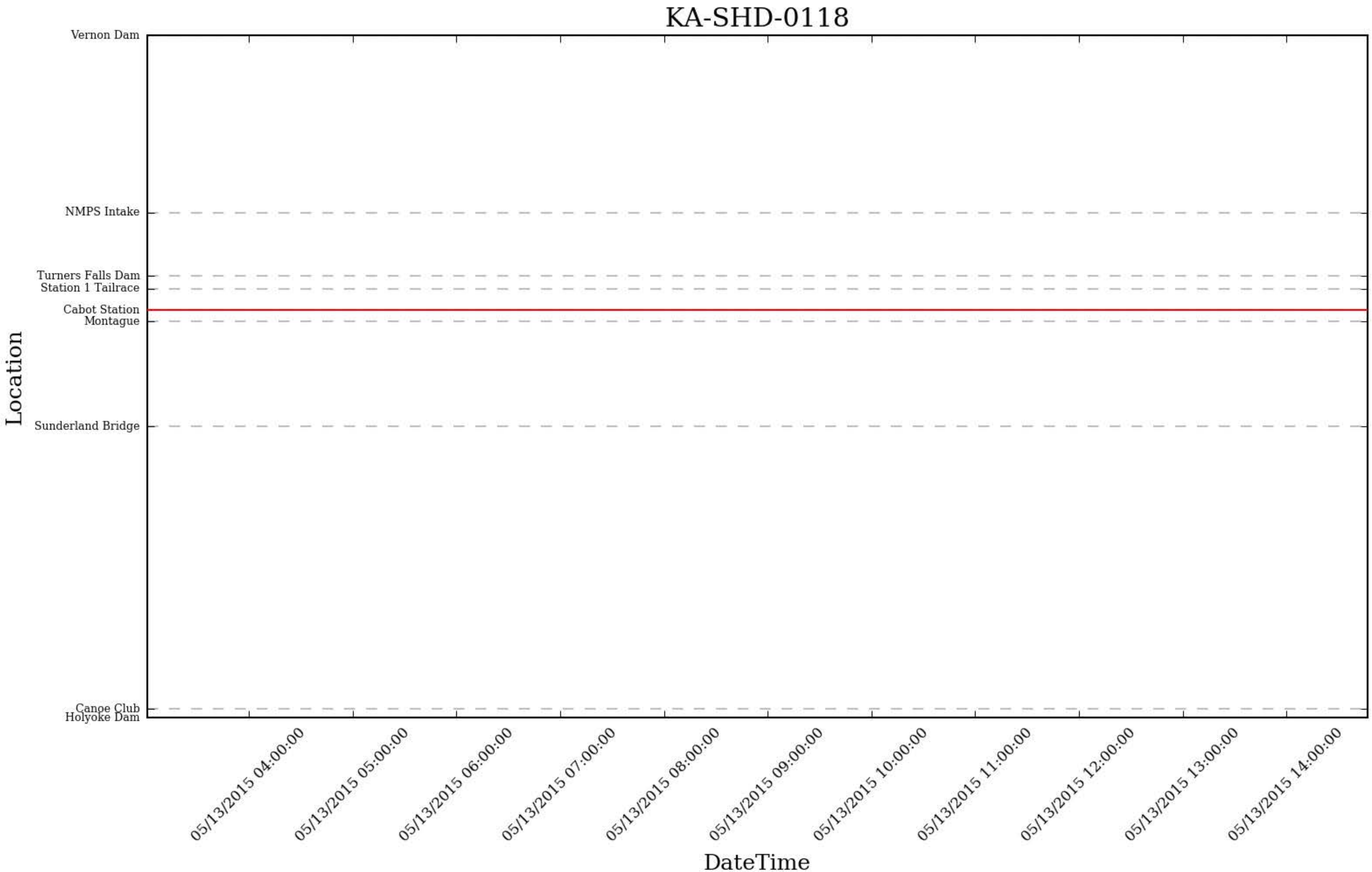
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 00:00:00
05/11/2015 00:00:00
05/12/2015 00:00:00
05/13/2015 00:00:00
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
DateTime

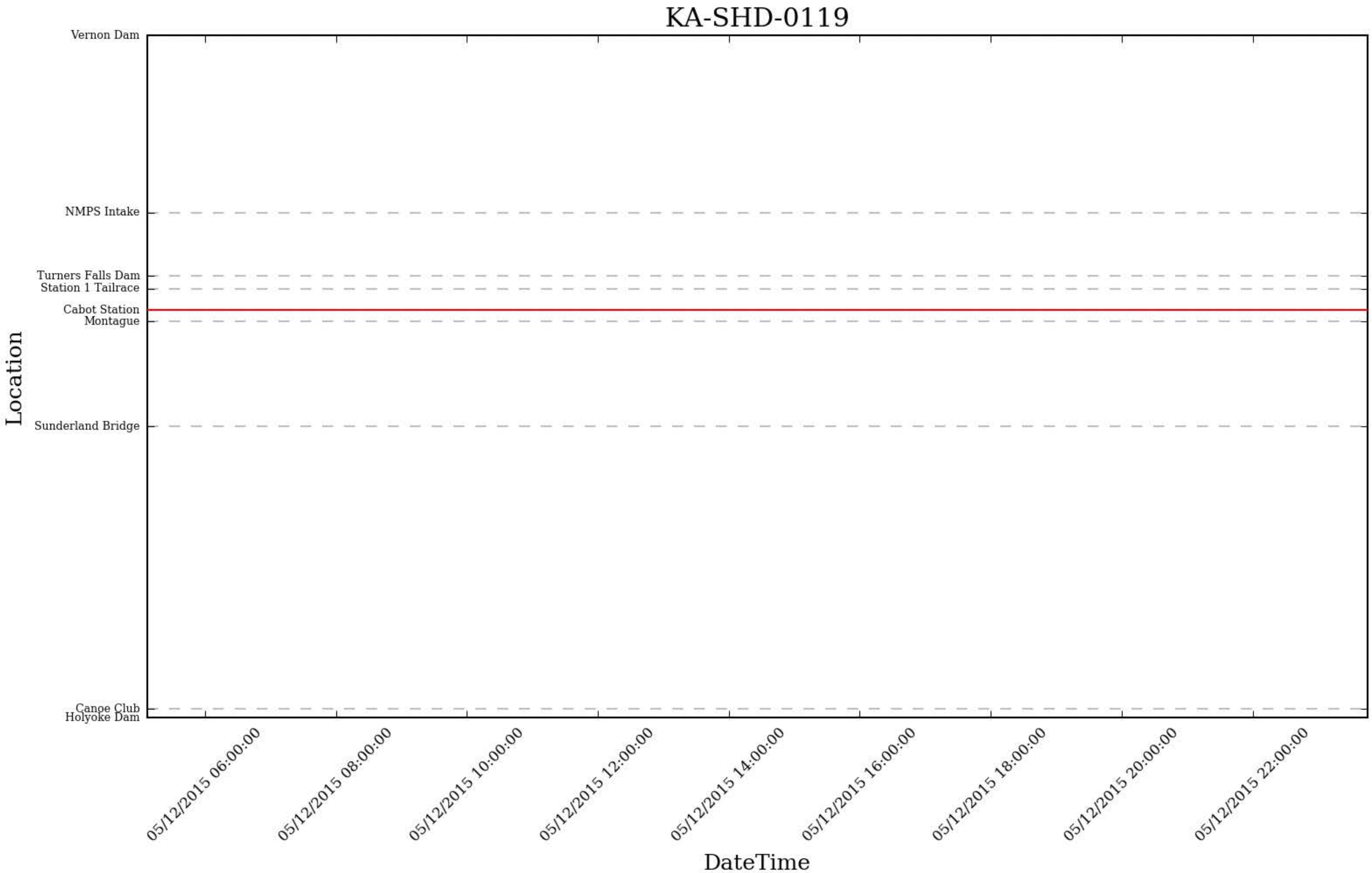


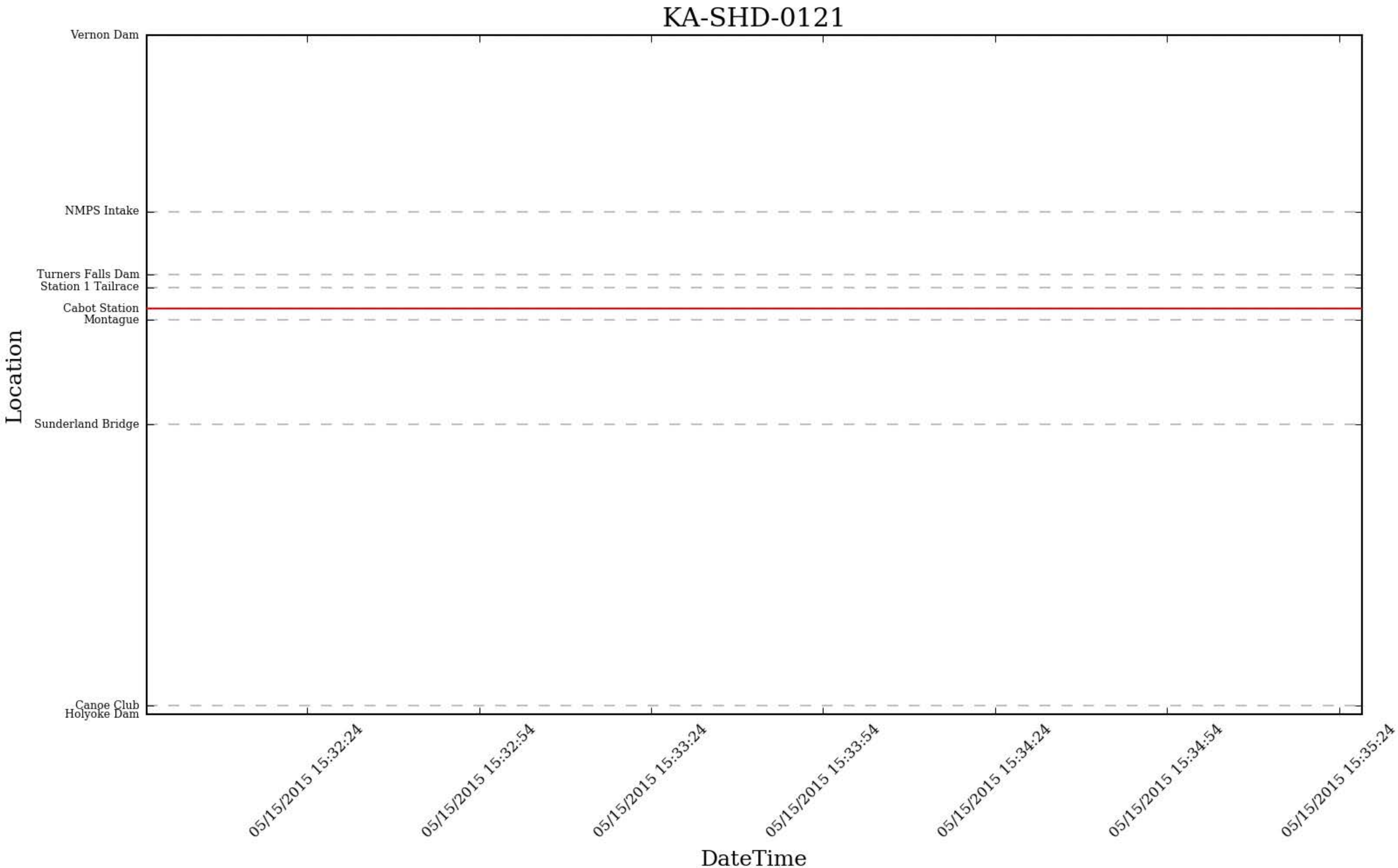
KA-SHD-0112
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
DateTime

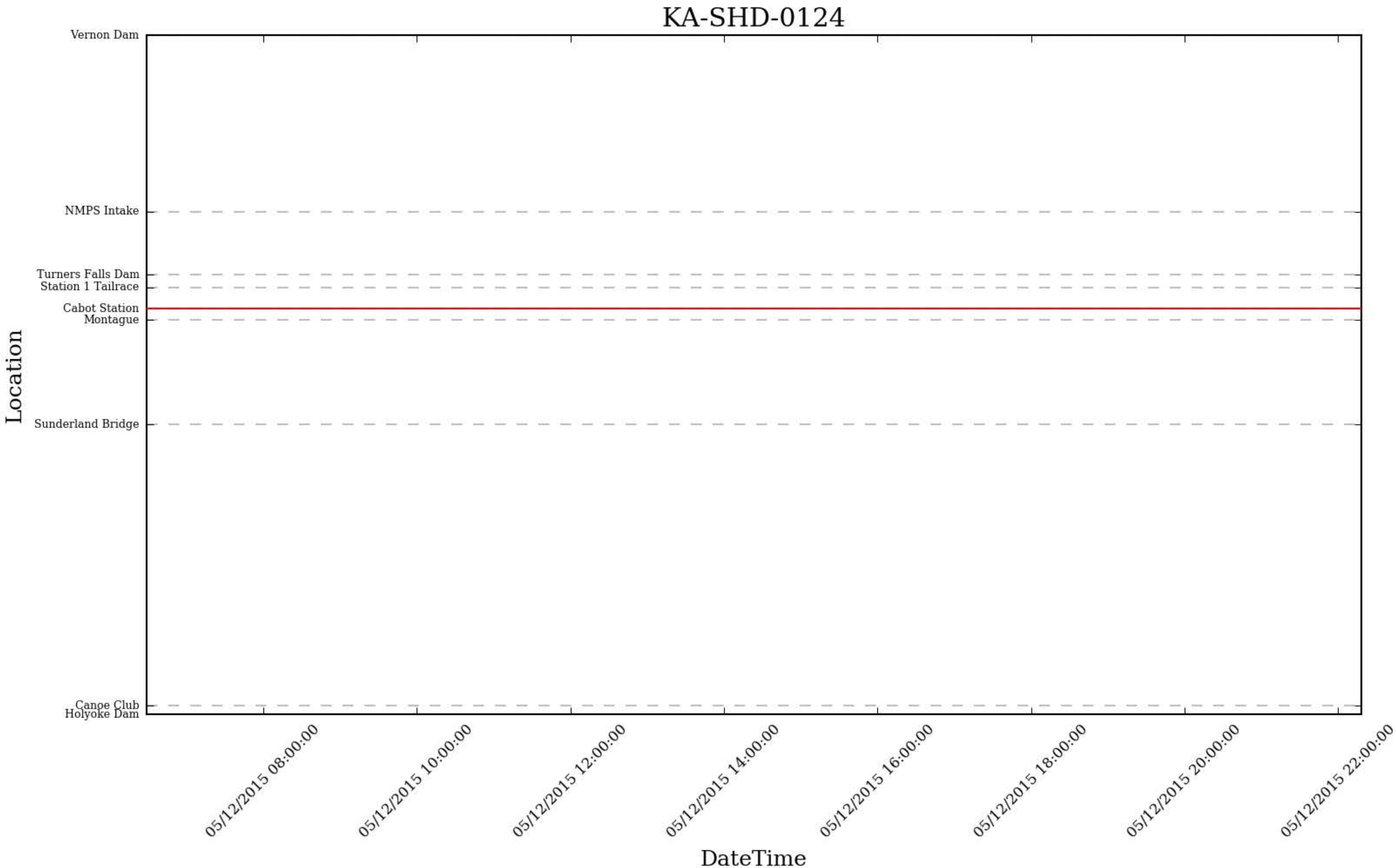


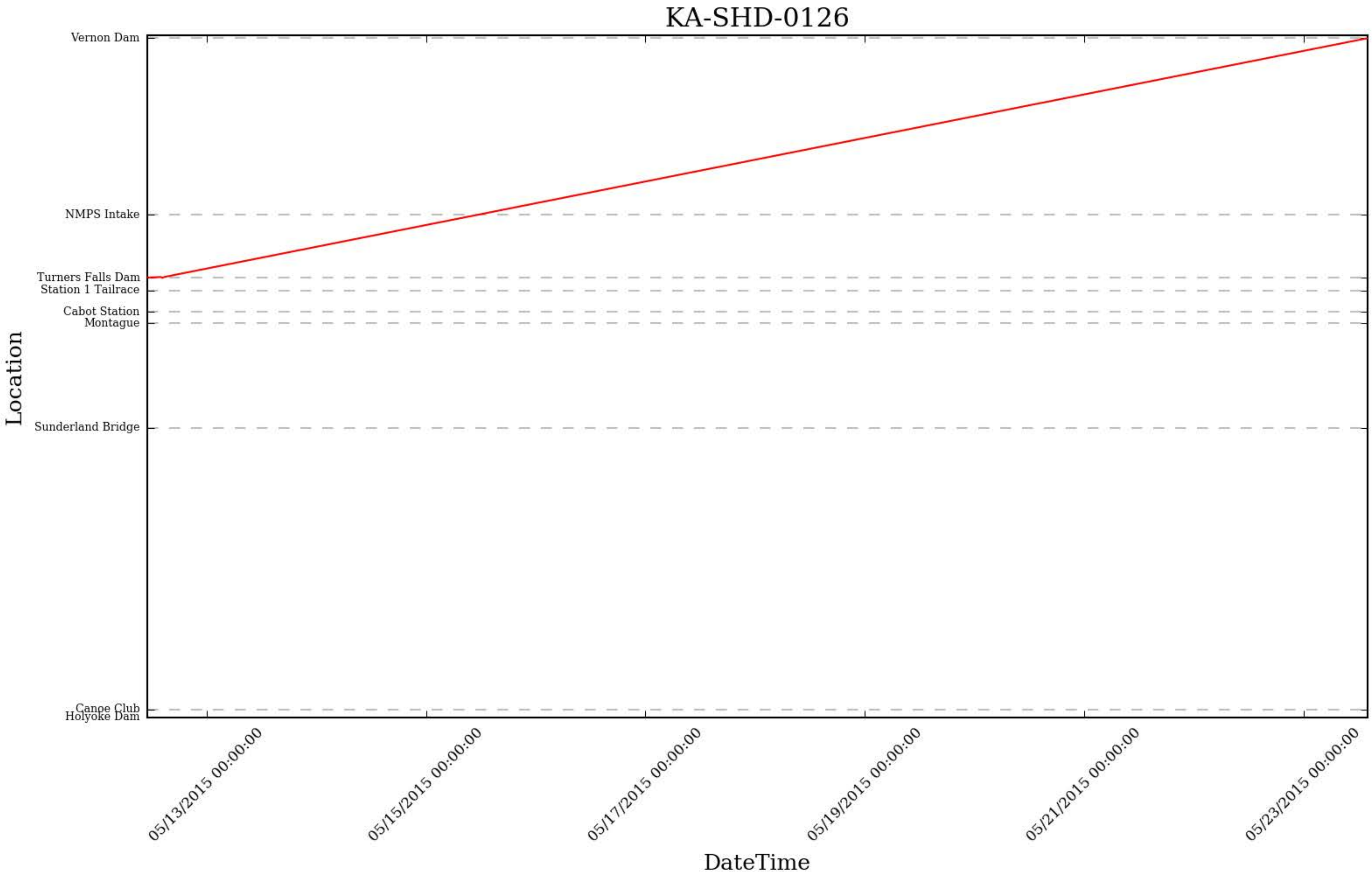
KA-SHD-0117
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/08/2015 20:00:00
05/08/2015 22:00:00
05/09/2015 00:00:00
05/09/2015 02:00:00
05/09/2015 04:00:00
05/09/2015 06:00:00
05/09/2015 08:00:00
05/09/2015 10:00:00
05/09/2015 12:00:00
05/09/2015 14:00:00
DateTime

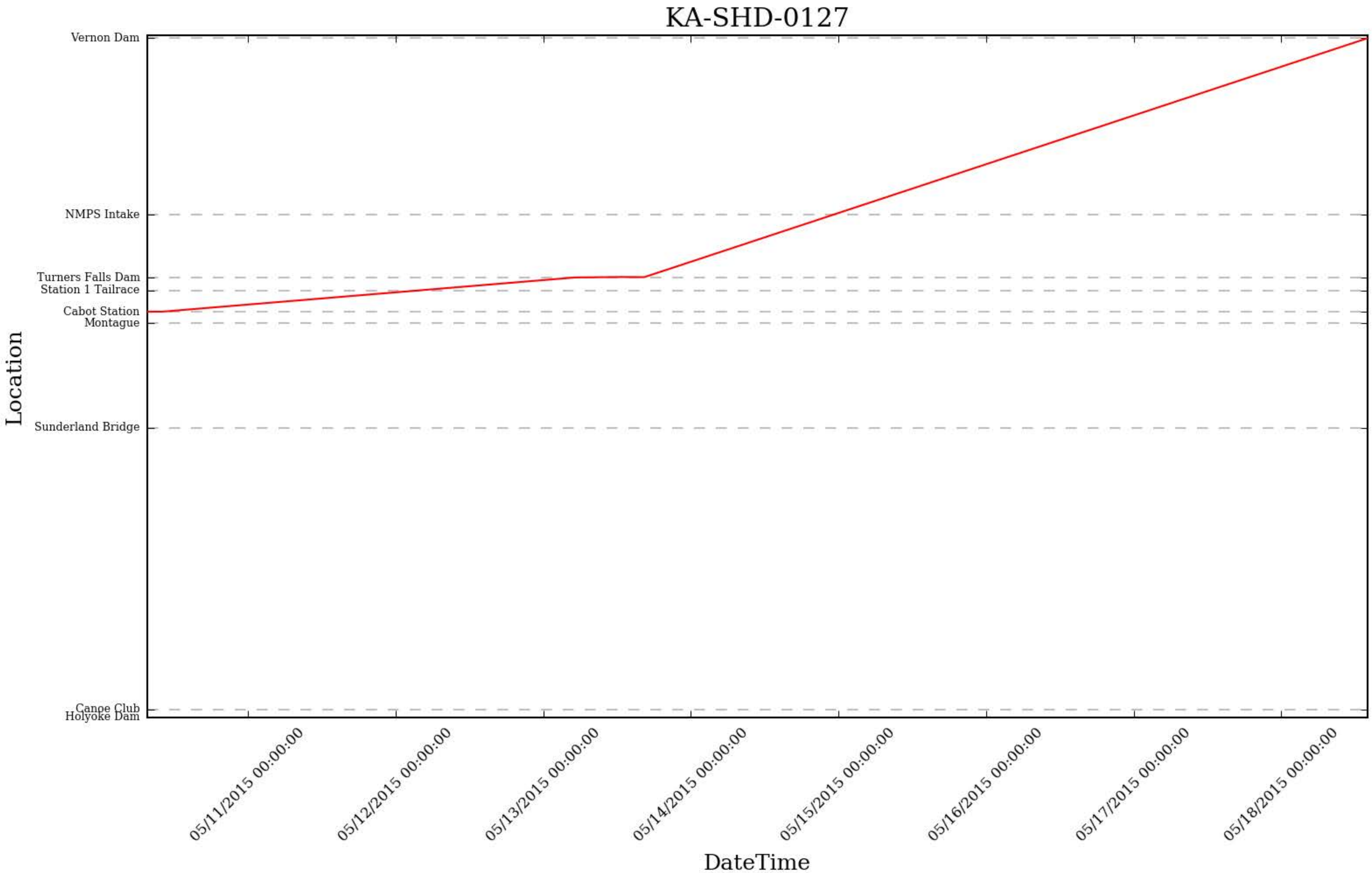

KA-SHD-0118
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 04:00:00
05/13/2015 05:00:00
05/13/2015 06:00:00
05/13/2015 07:00:00
05/13/2015 08:00:00
05/13/2015 09:00:00
05/13/2015 10:00:00
05/13/2015 11:00:00
05/13/2015 12:00:00
05/13/2015 13:00:00
05/13/2015 14:00:00
DateTime

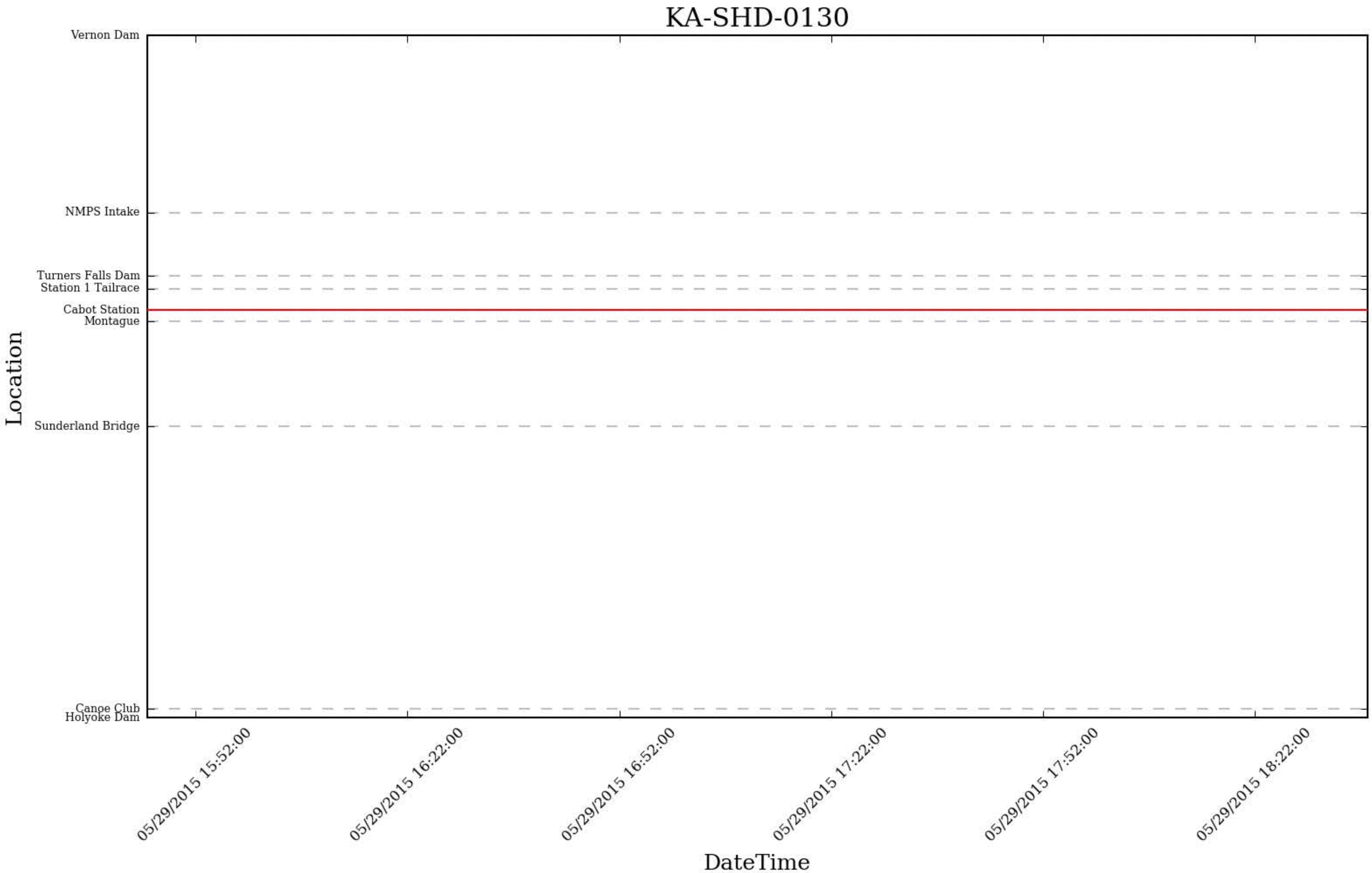

KA-SHD-0119
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/12/2015 06:00:00
05/12/2015 08:00:00
05/12/2015 10:00:00
05/12/2015 12:00:00
05/12/2015 14:00:00
05/12/2015 16:00:00
05/12/2015 18:00:00
05/12/2015 20:00:00
05/12/2015 22:00:00
DateTime

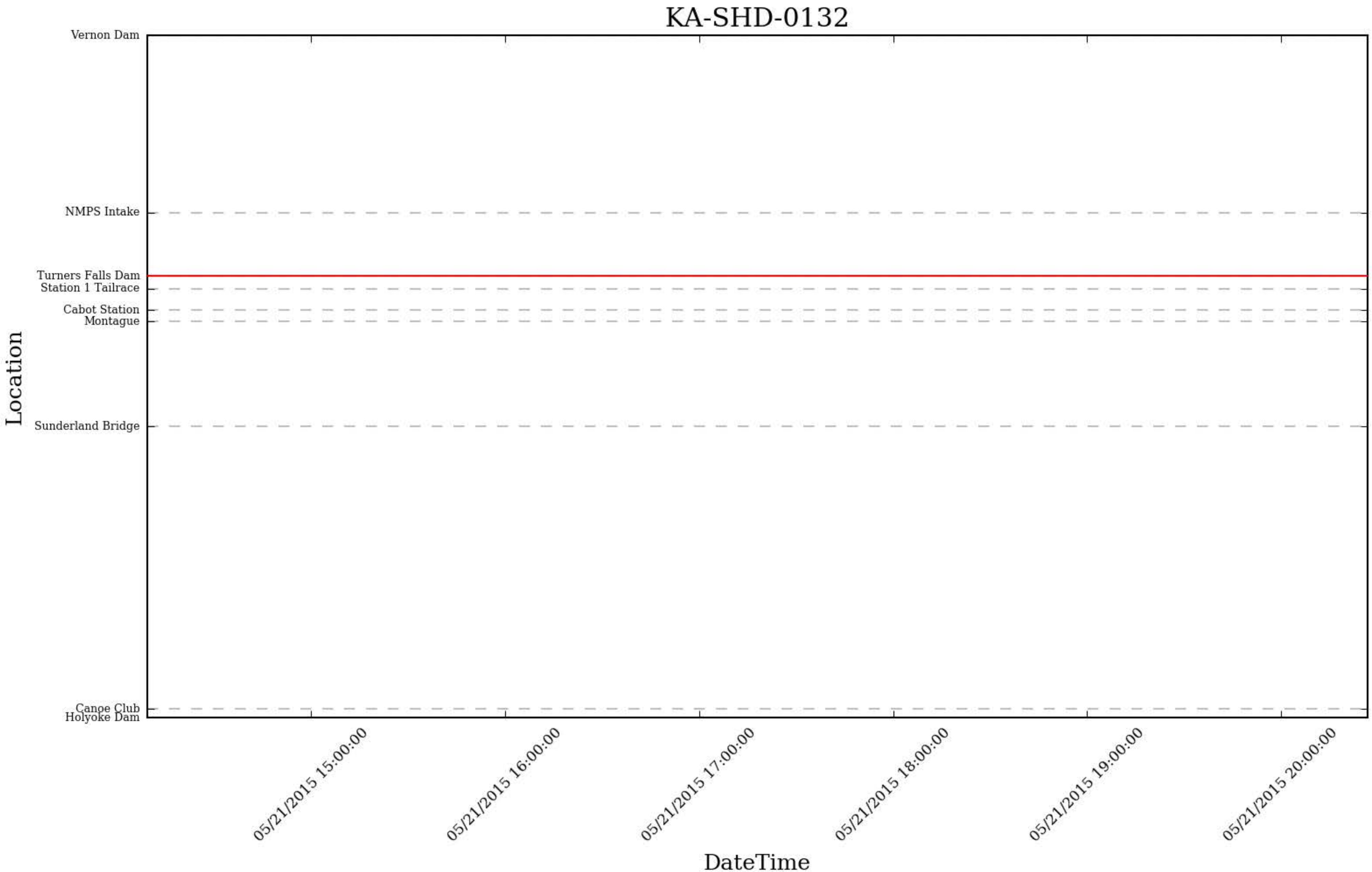

KA-SHD-0121
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 15:32:24
05/15/2015 15:32:54
05/15/2015 15:33:24
05/15/2015 15:33:54
05/15/2015 15:34:24
05/15/2015 15:34:54
05/15/2015 15:35:24
DateTime


KA-SHD-0124
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/12/2015 08:00:00
05/12/2015 10:00:00
05/12/2015 12:00:00
05/12/2015 14:00:00
05/12/2015 16:00:00
05/12/2015 18:00:00
05/12/2015 20:00:00
05/12/2015 22:00:00
DateTime

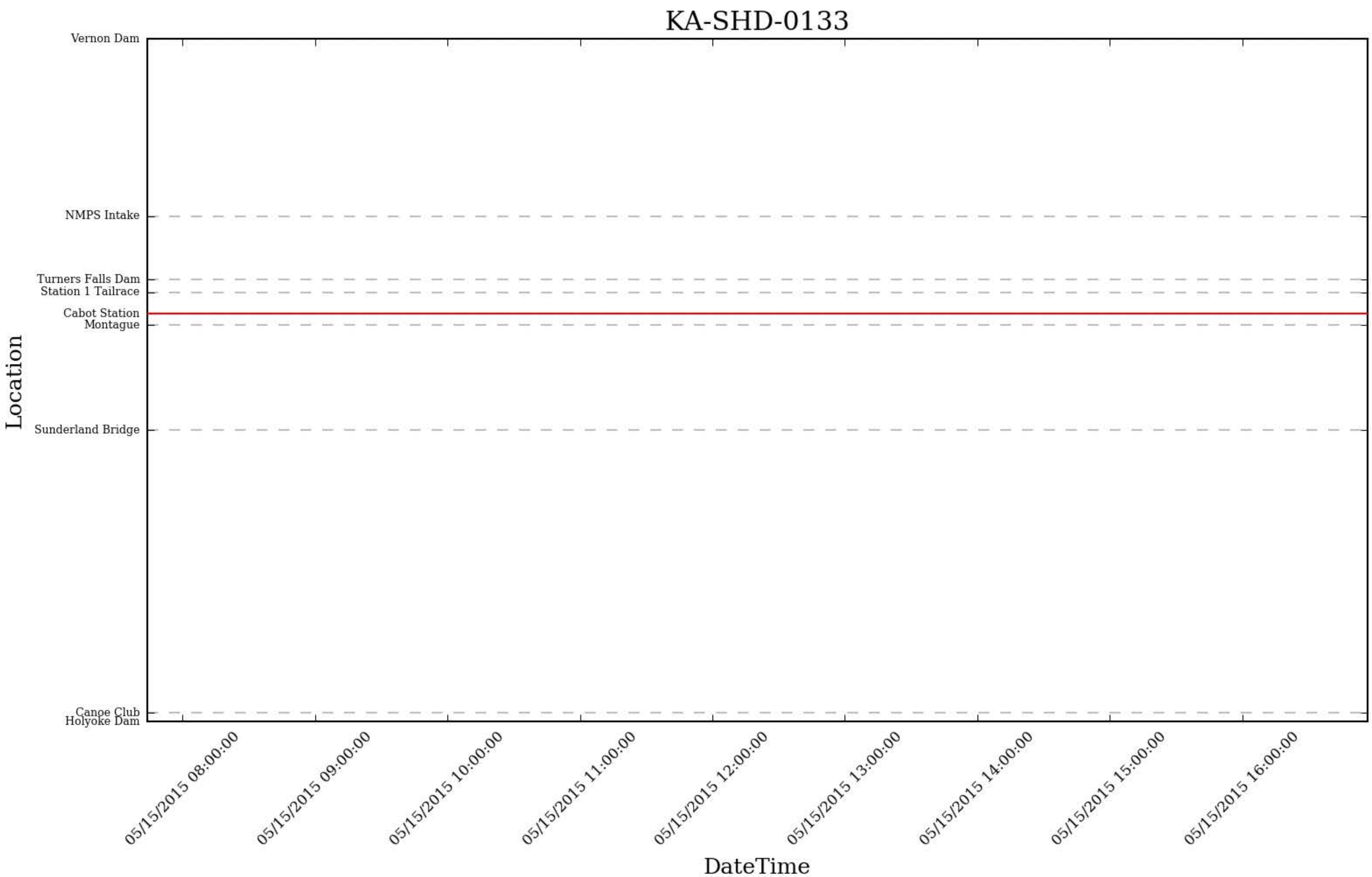

KA-SHD-0126
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 00:00:00
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
DateTime

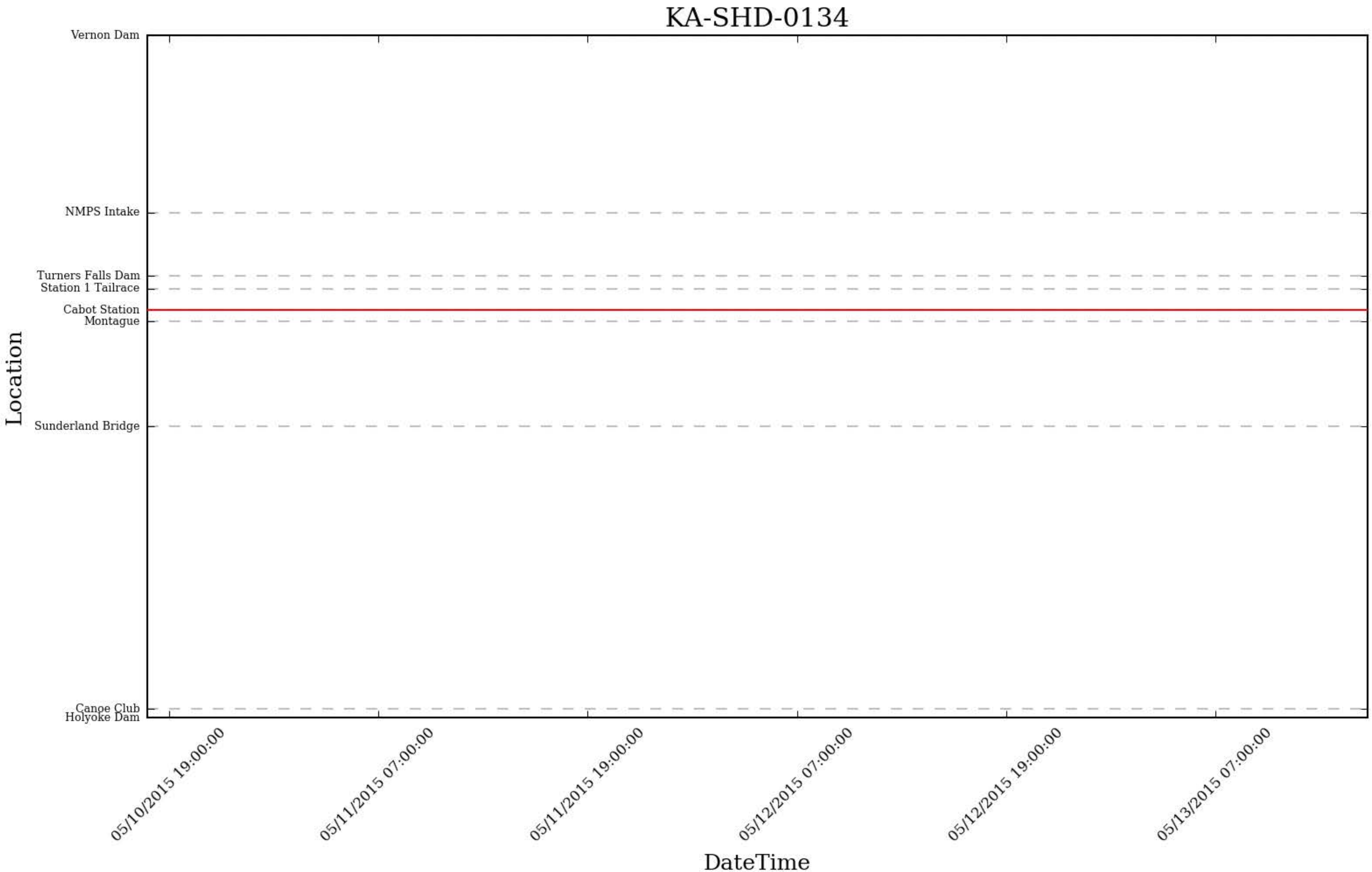

KA-SHD-0127
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 00:00:00
05/12/2015 00:00:00
05/13/2015 00:00:00
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
DateTime

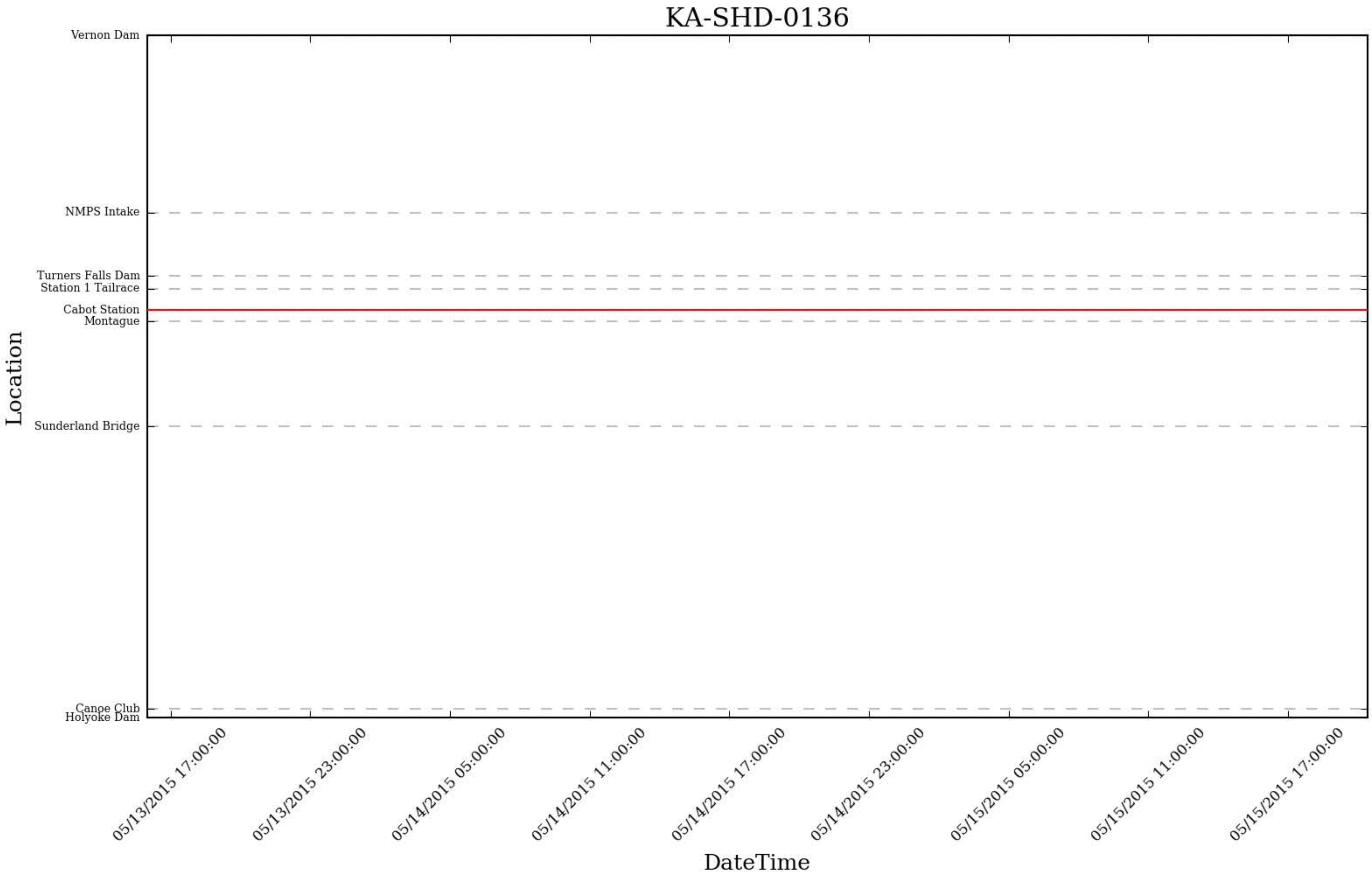

KA-SHD-0130
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 15:52:00
05/29/2015 16:22:00
05/29/2015 16:52:00
05/29/2015 17:22:00
05/29/2015 17:52:00
05/29/2015 18:22:00
DateTime

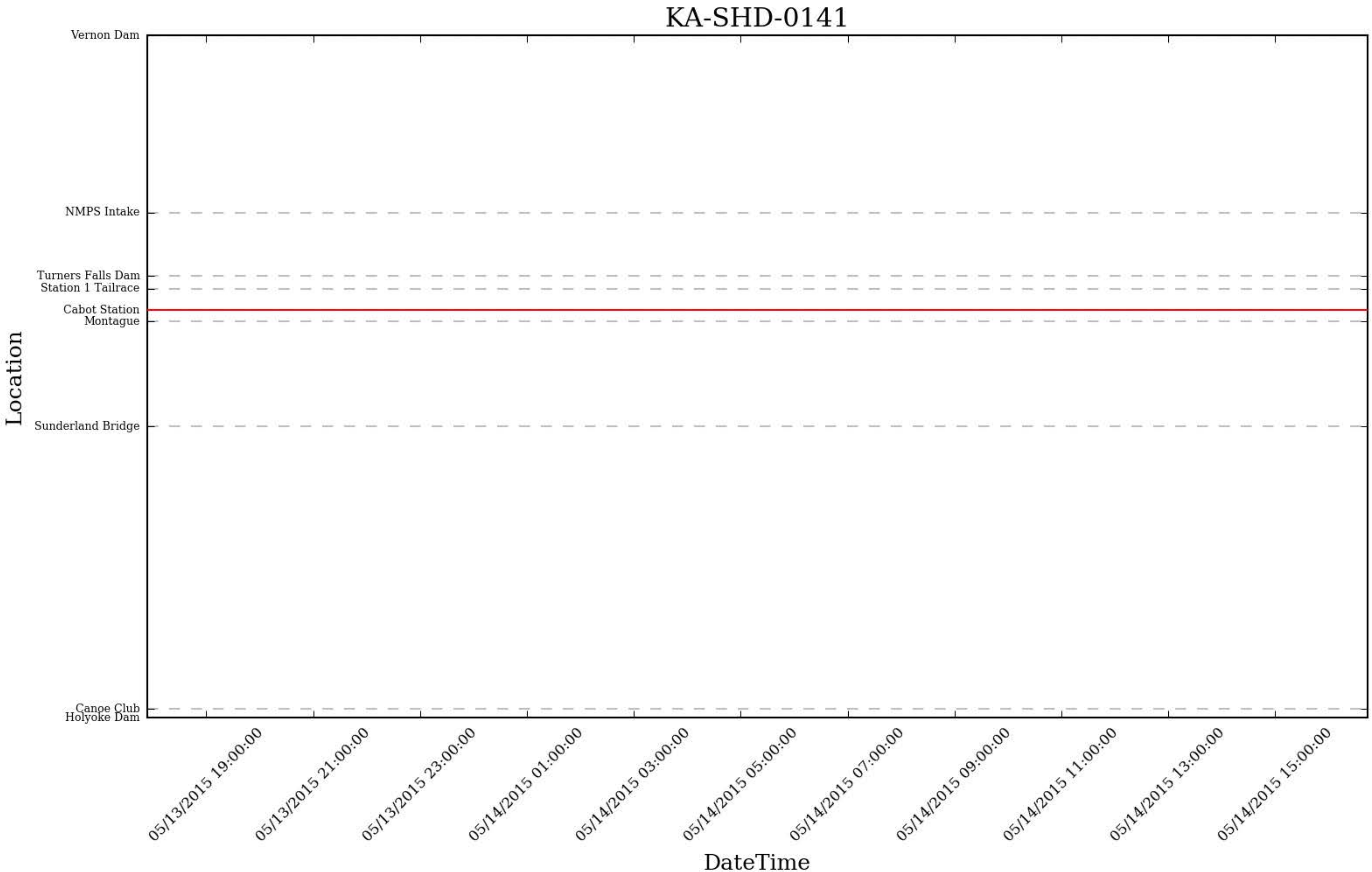


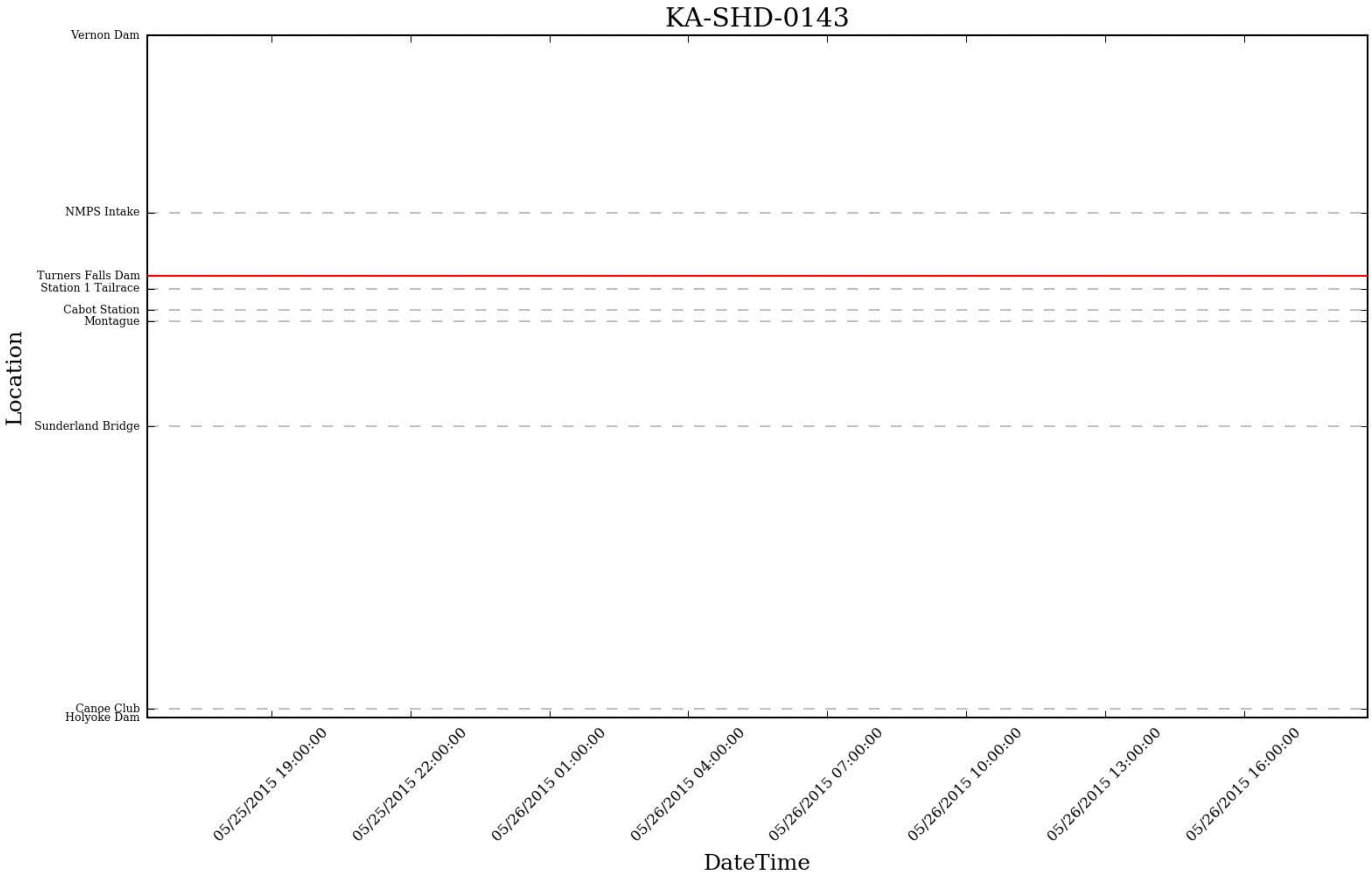
KA-SHD-0132
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 15:00:00
05/21/2015 16:00:00
05/21/2015 17:00:00
05/21/2015 18:00:00
05/21/2015 19:00:00
05/21/2015 20:00:00
DateTime


KA-SHD-0133
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 08:00:00
05/15/2015 09:00:00
05/15/2015 10:00:00
05/15/2015 11:00:00
05/15/2015 12:00:00
05/15/2015 13:00:00
05/15/2015 14:00:00
05/15/2015 15:00:00
05/15/2015 16:00:00
DateTime

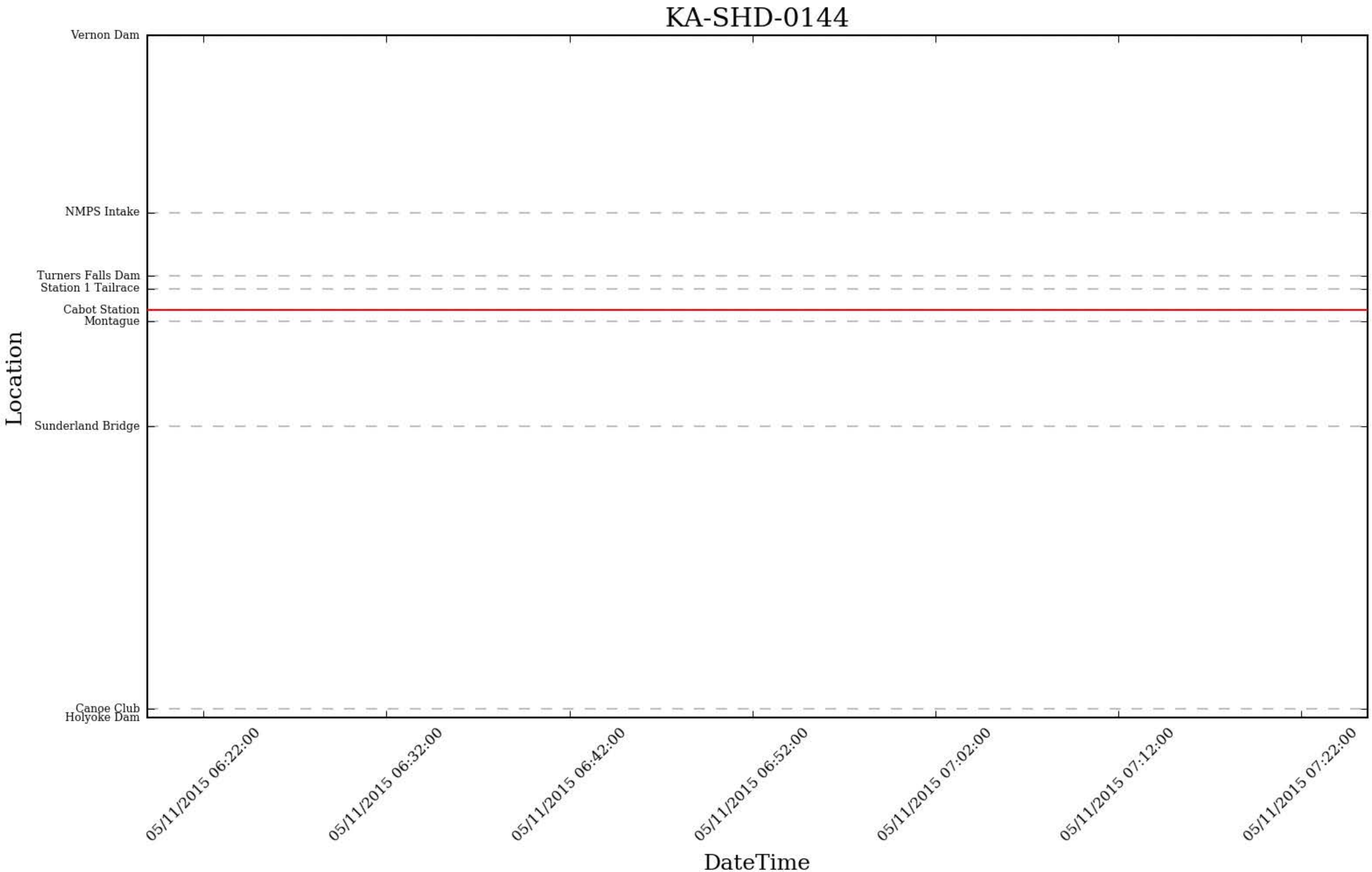

KA-SHD-0134
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/10/2015 19:00:00
05/11/2015 07:00:00
05/11/2015 19:00:00
05/12/2015 07:00:00
05/12/2015 19:00:00
05/13/2015 07:00:00
DateTime


KA-SHD-0136
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 17:00:00
05/13/2015 23:00:00
05/14/2015 05:00:00
05/14/2015 11:00:00
05/14/2015 17:00:00
05/14/2015 23:00:00
05/15/2015 05:00:00
05/15/2015 11:00:00
05/15/2015 17:00:00
DateTime

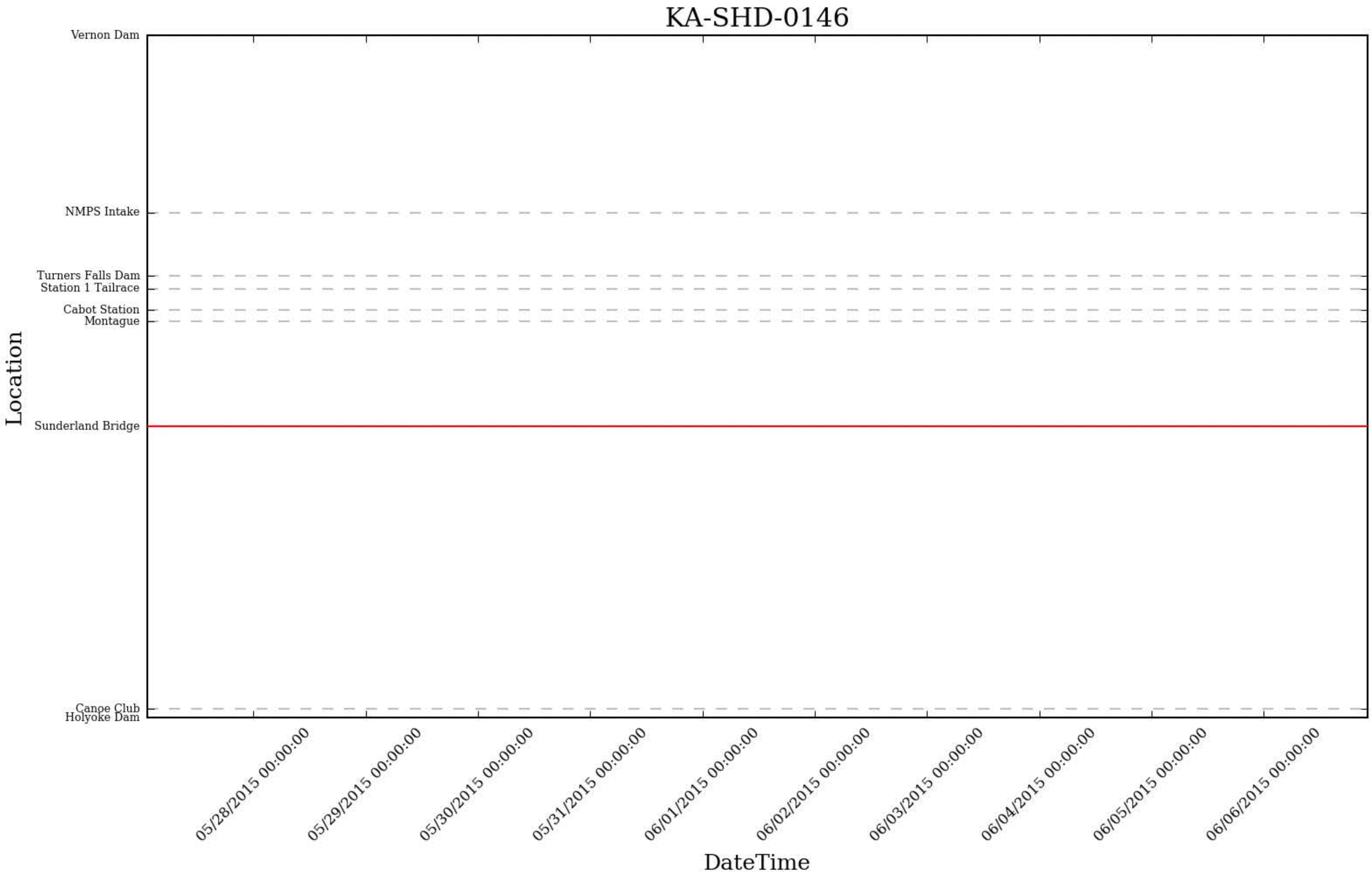

KA-SHD-0141
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 19:00:00
05/13/2015 21:00:00
05/13/2015 23:00:00
05/14/2015 01:00:00
05/14/2015 03:00:00
05/14/2015 05:00:00
05/14/2015 07:00:00
05/14/2015 09:00:00
05/14/2015 11:00:00
05/14/2015 13:00:00
05/14/2015 15:00:00
DateTime



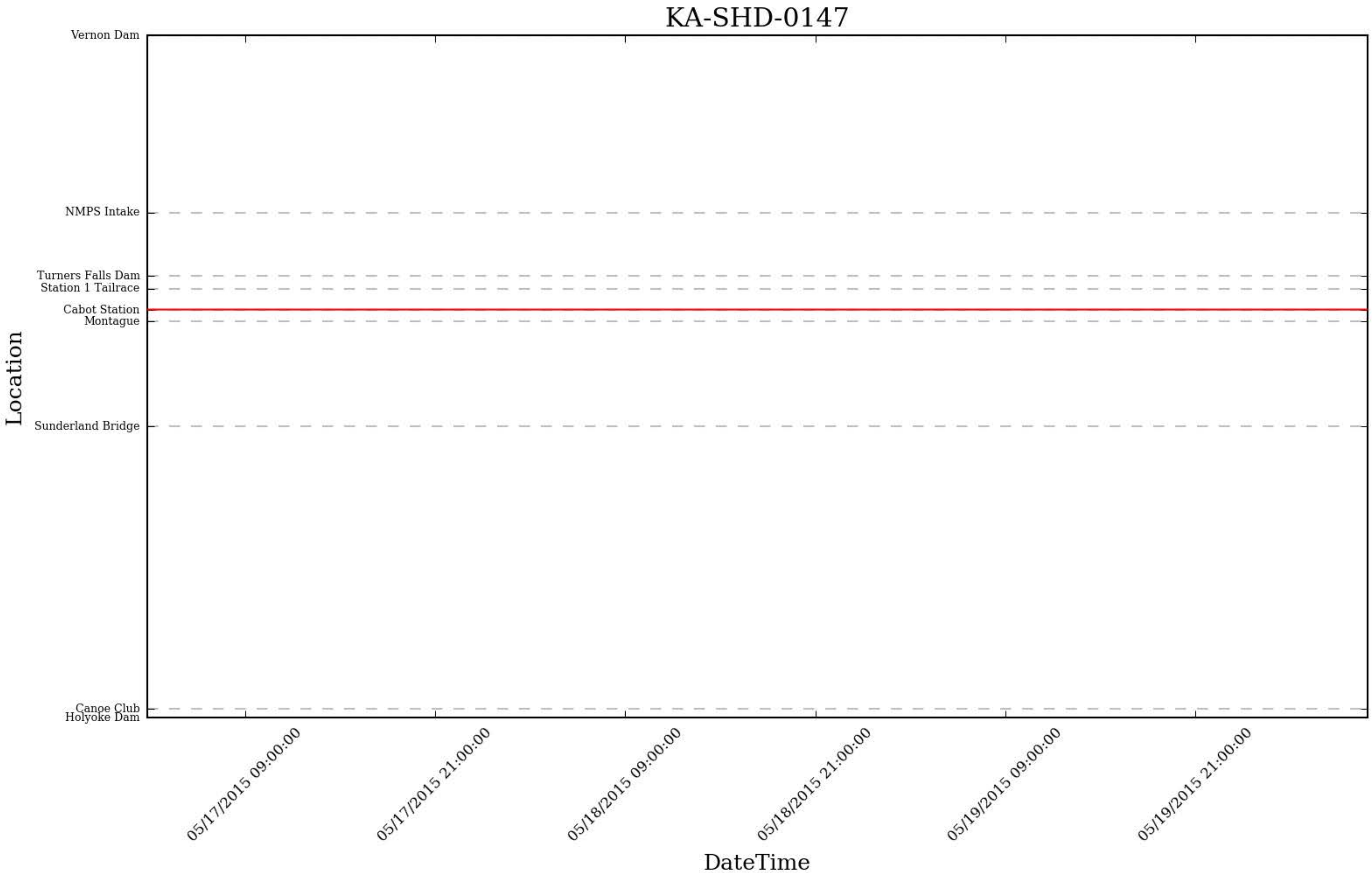
KA-SHD-0143
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 19:00:00
05/25/2015 22:00:00
05/26/2015 01:00:00
05/26/2015 04:00:00
05/26/2015 07:00:00
05/26/2015 10:00:00
05/26/2015 13:00:00
05/26/2015 16:00:00
DateTime

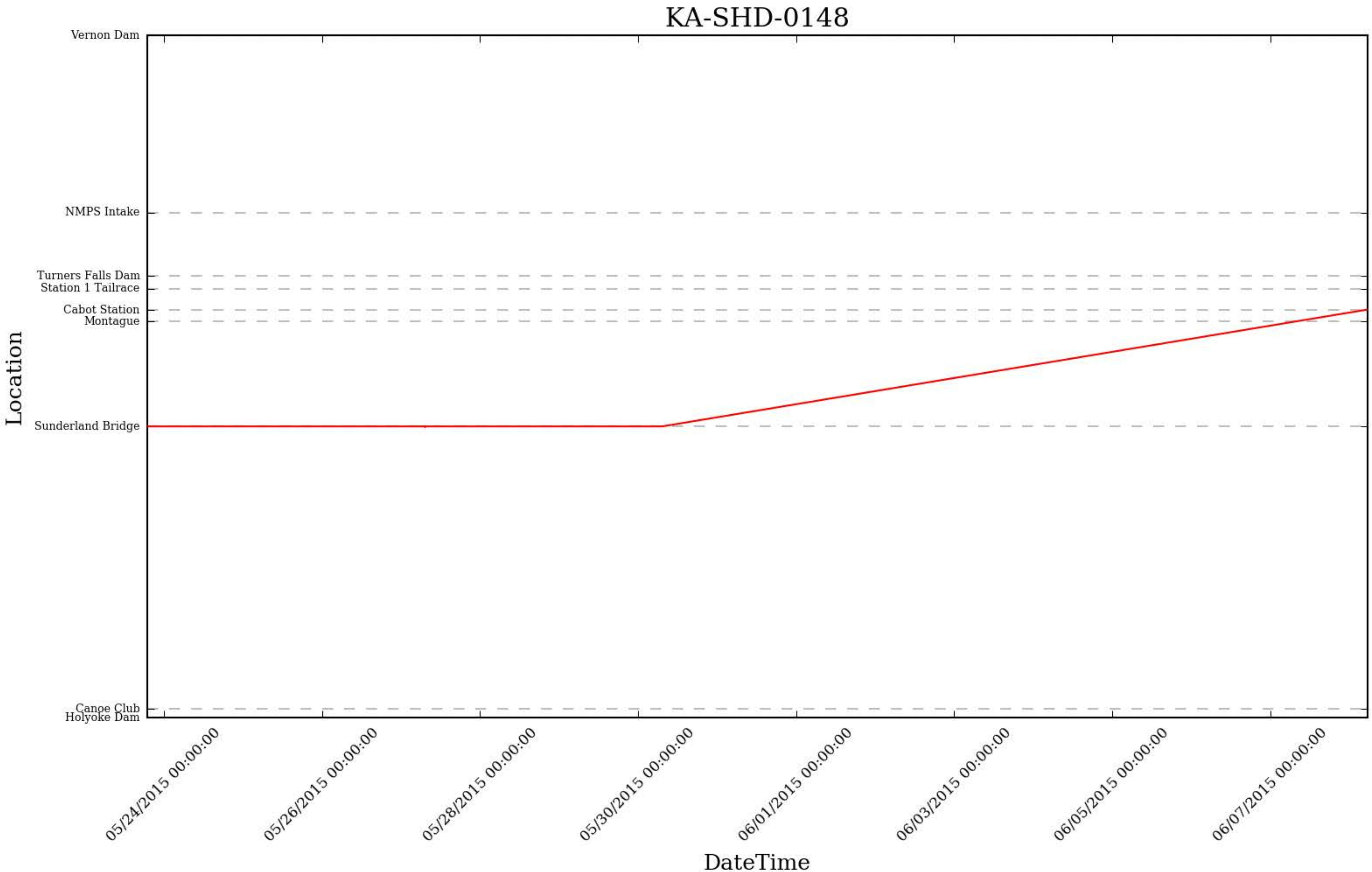


KA-SHD-0144
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/11/2015 06:22:00
05/11/2015 06:32:00
05/11/2015 06:42:00
05/11/2015 06:52:00
05/11/2015 07:02:00
05/11/2015 07:12:00
05/11/2015 07:22:00
DateTime

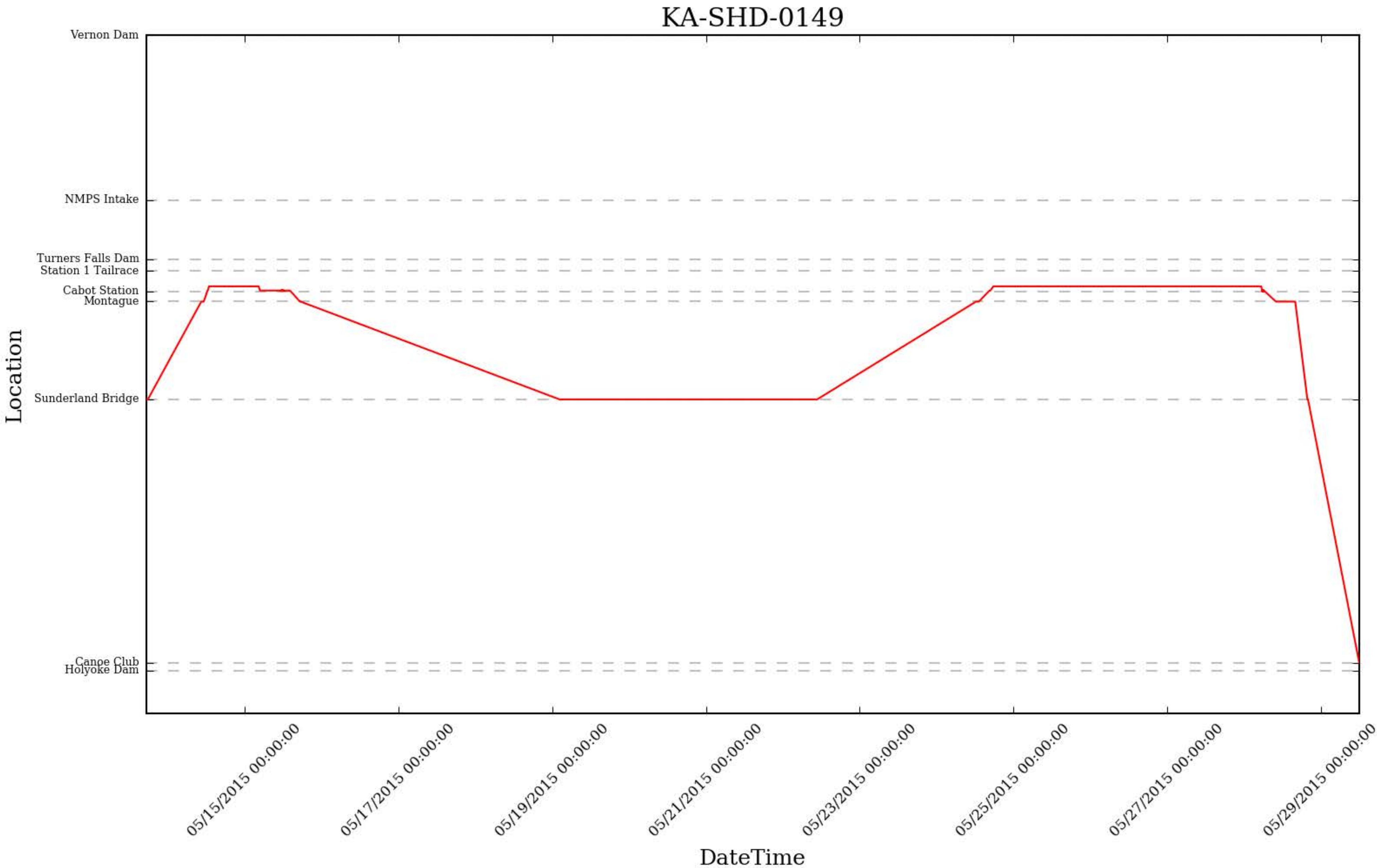


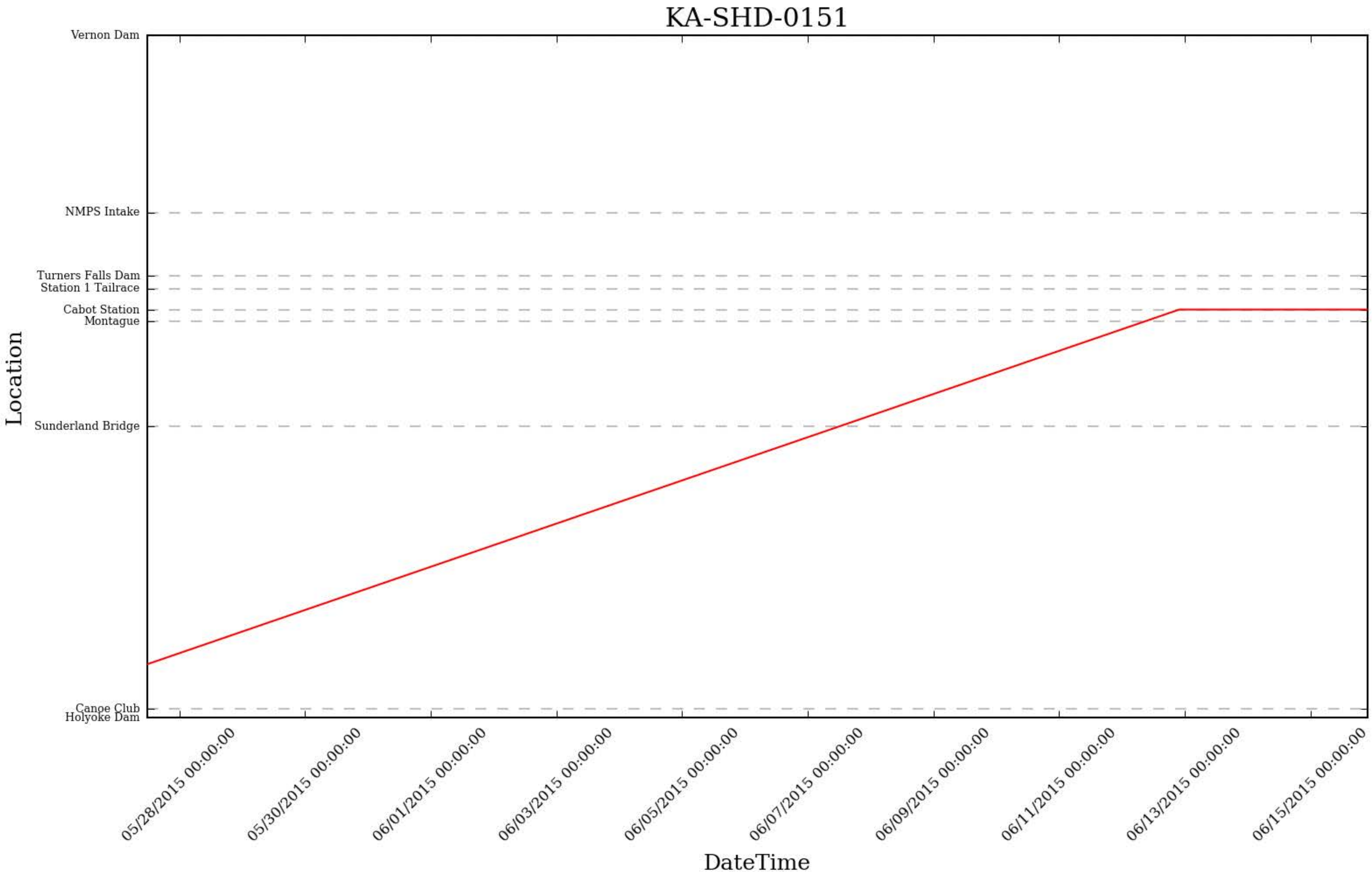
KA-SHD-0146
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
06/04/2015 00:00:00
06/05/2015 00:00:00
06/06/2015 00:00:00
DateTime

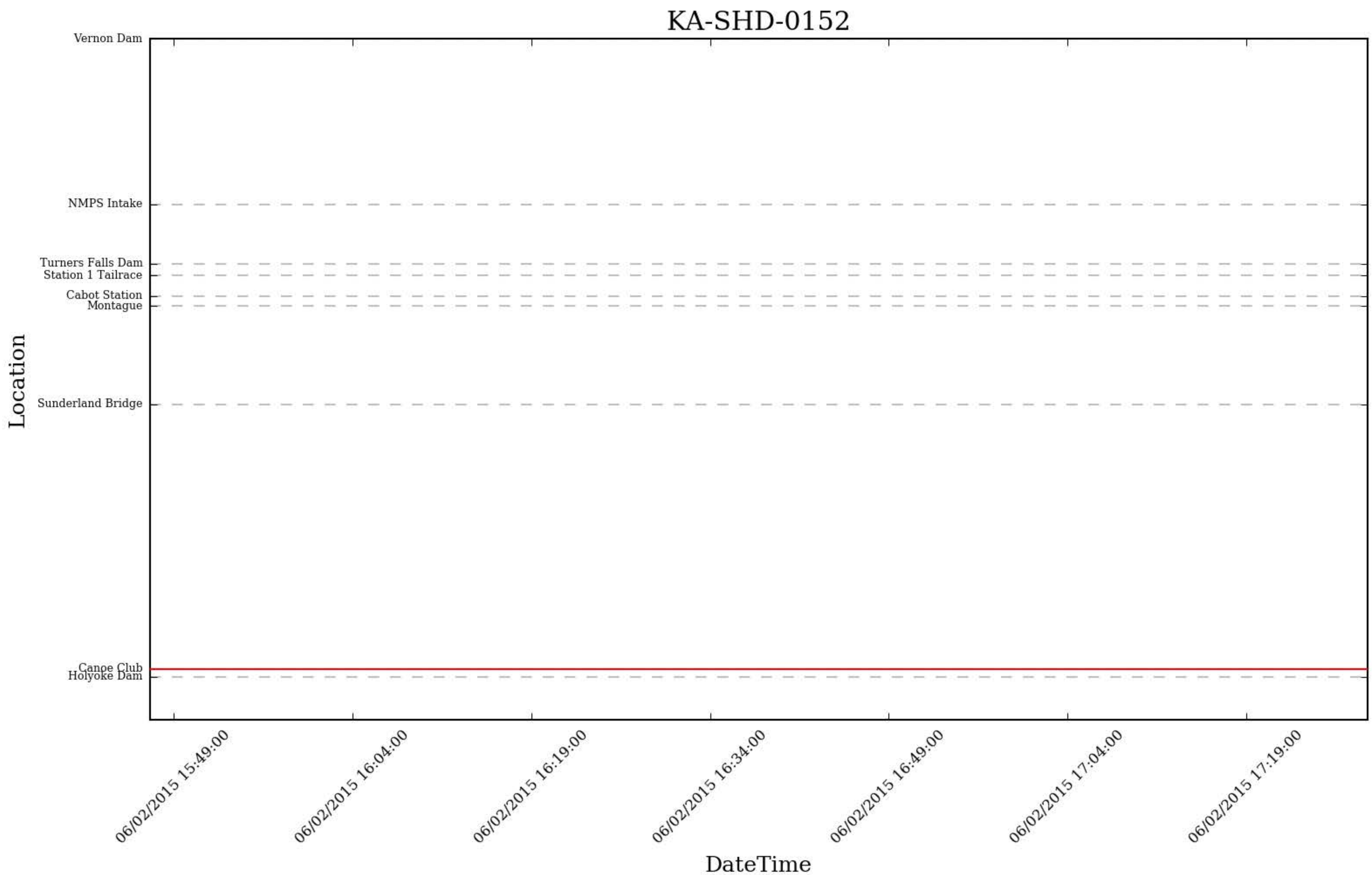

KA-SHD-0147
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 09:00:00
05/17/2015 21:00:00
05/18/2015 09:00:00
05/18/2015 21:00:00
05/19/2015 09:00:00
05/19/2015 21:00:00
DateTime



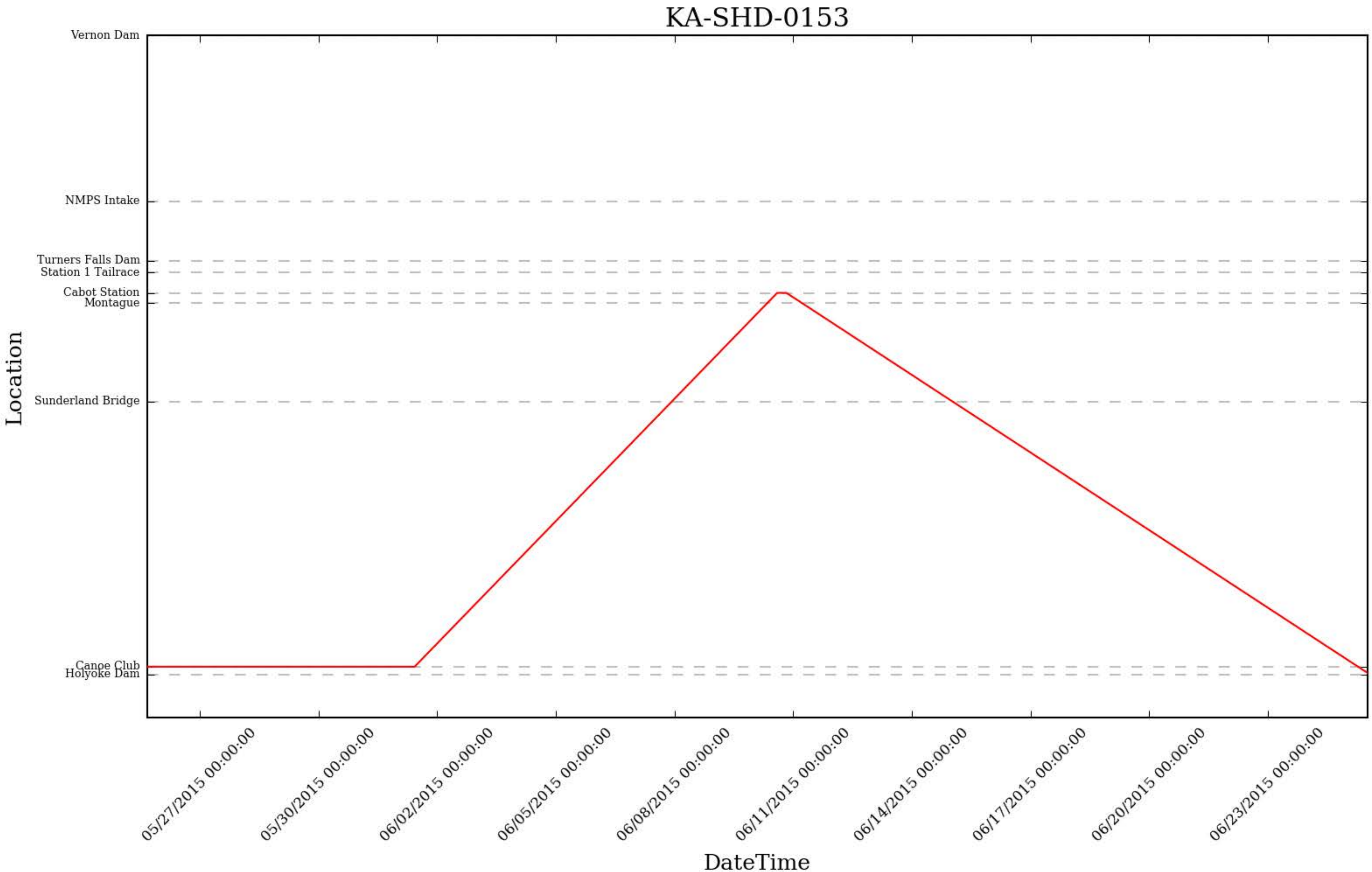
KA-SHD-0148
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
DateTime


KA-SHD-0149
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
DateTime

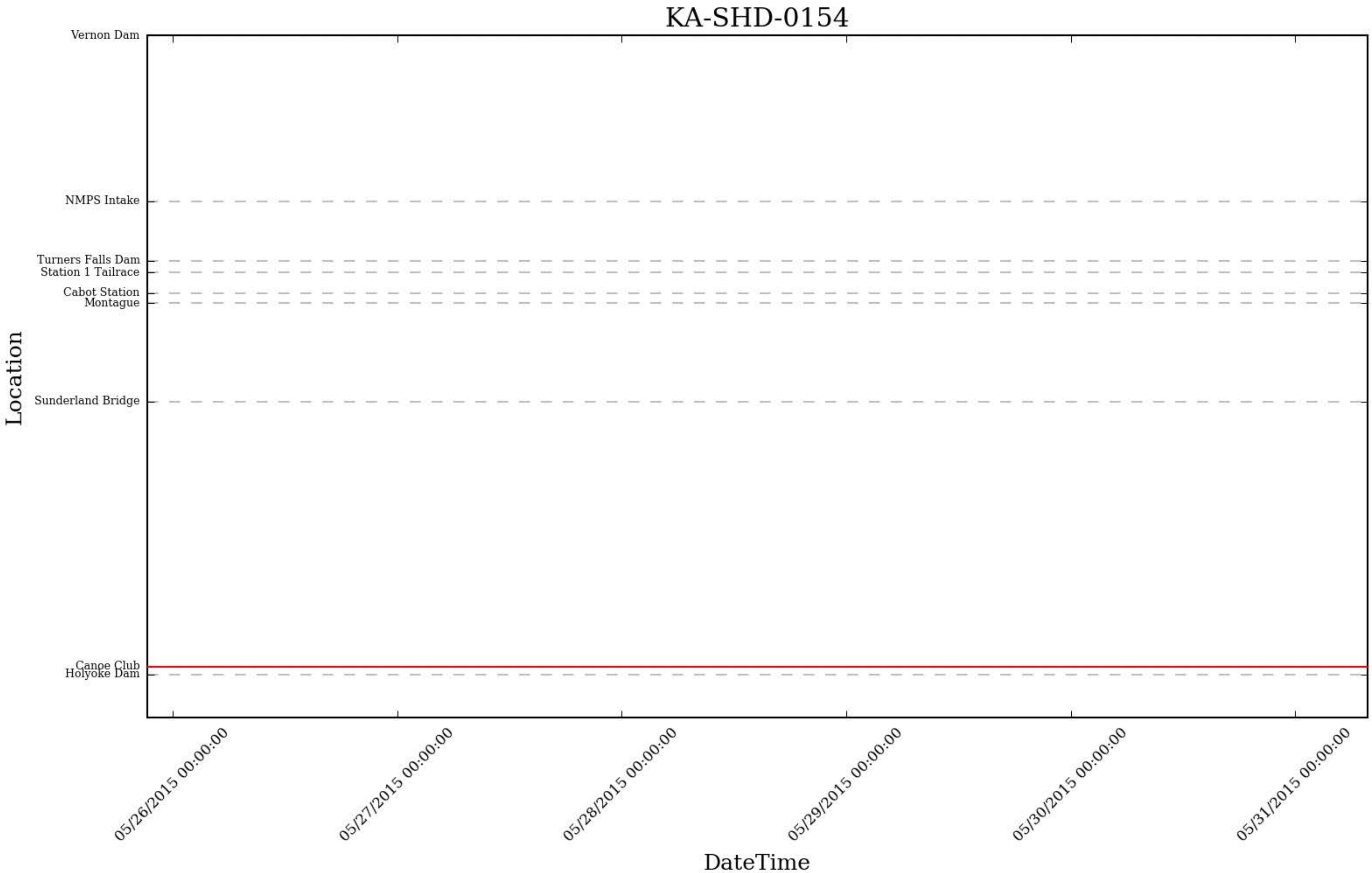

KA-SHD-0151
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
06/13/2015 00:00:00
06/15/2015 00:00:00
DateTime

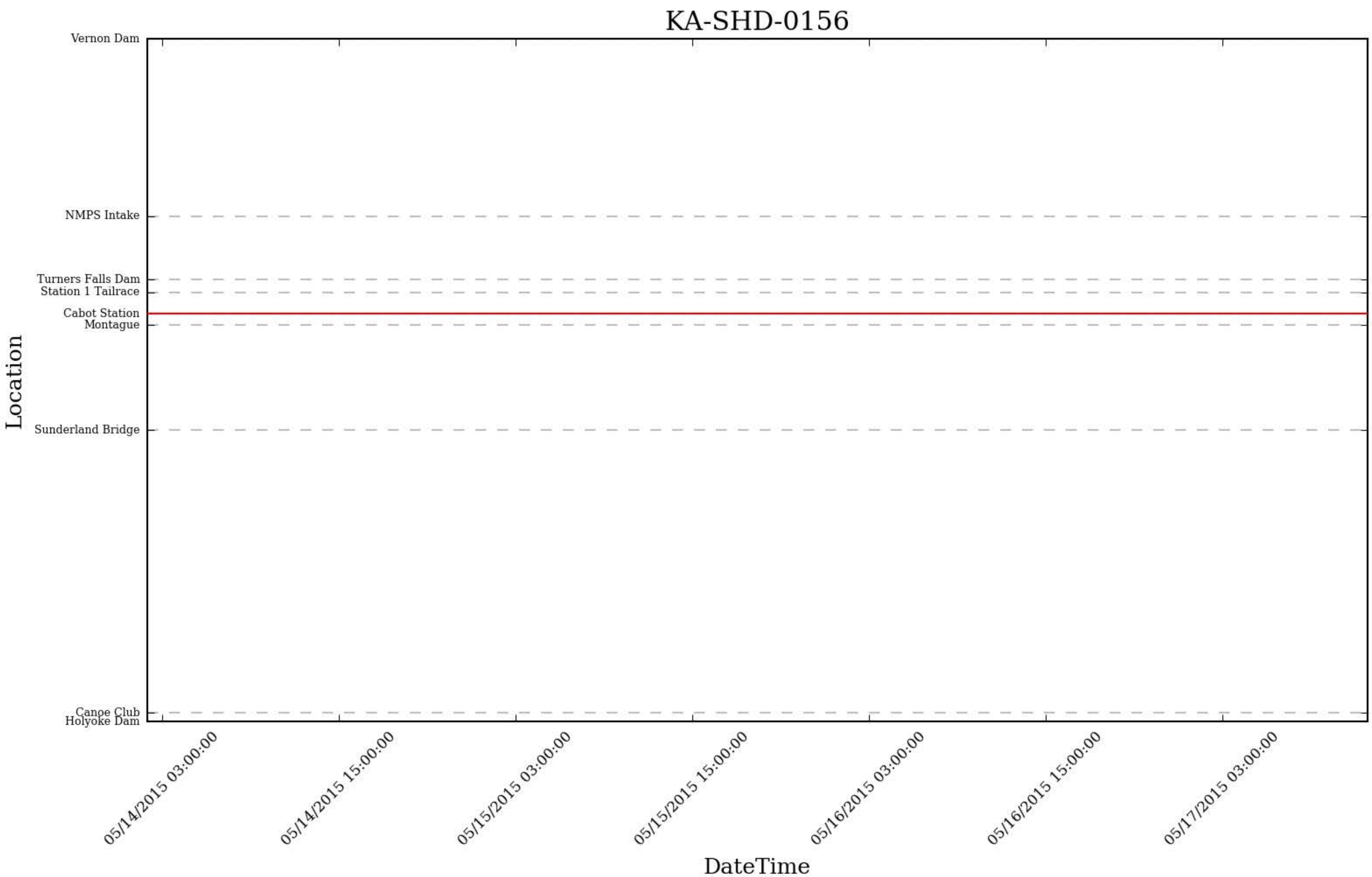


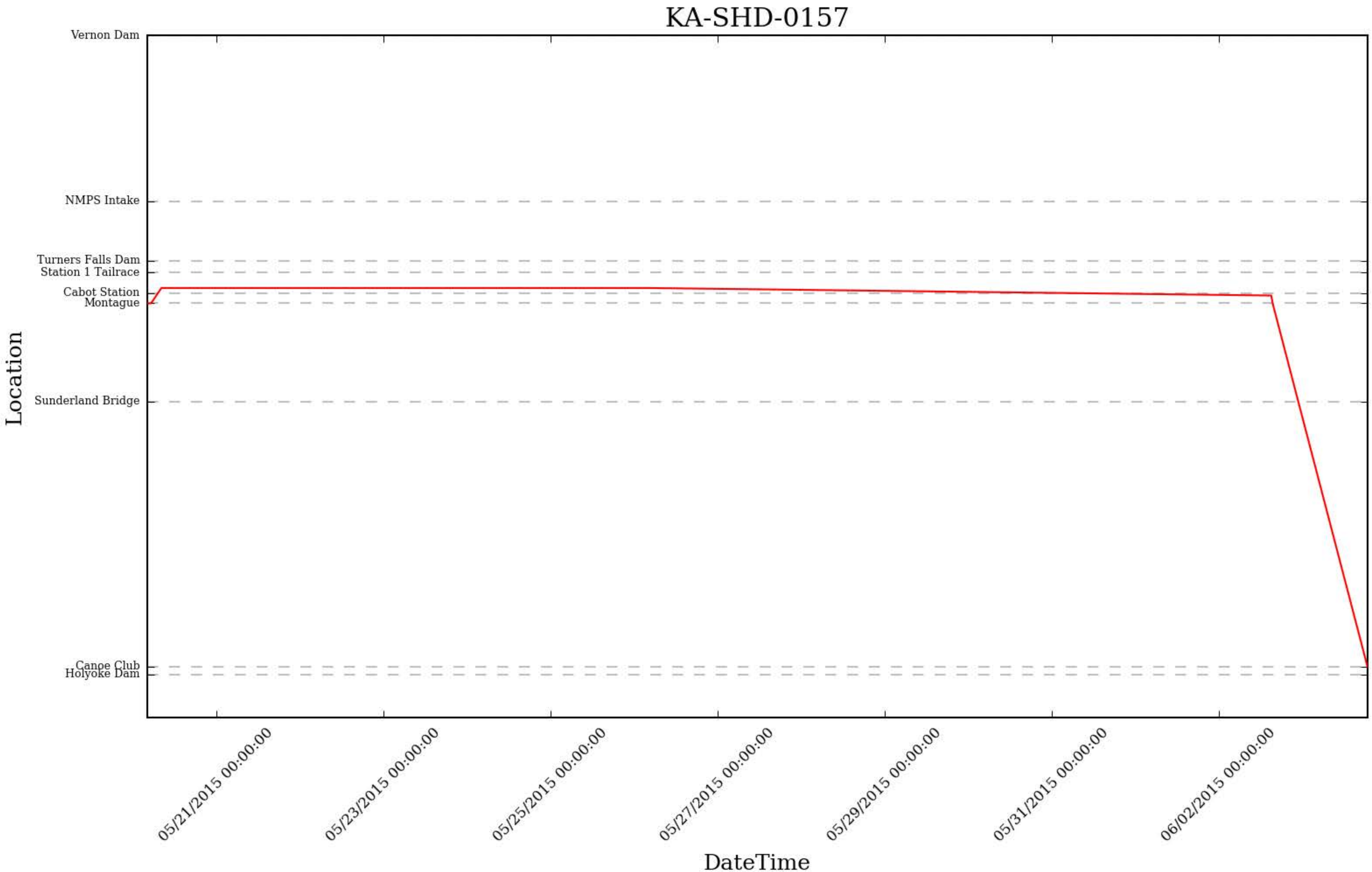
KA-SHD-0152
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/02/2015 15:49:00
06/02/2015 16:04:00
06/02/2015 16:19:00
06/02/2015 16:34:00
06/02/2015 16:49:00
06/02/2015 17:04:00
06/02/2015 17:19:00
DateTime

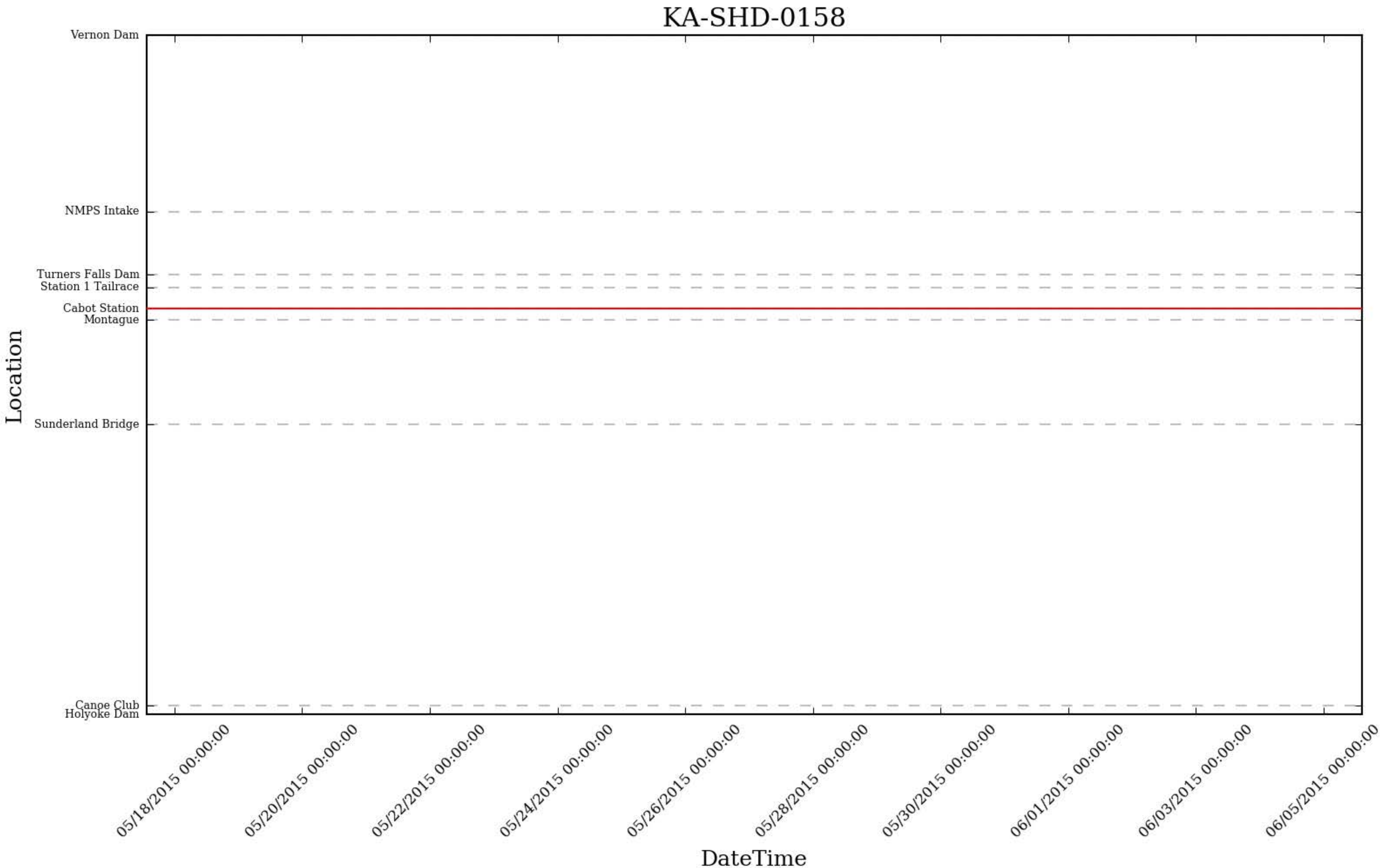


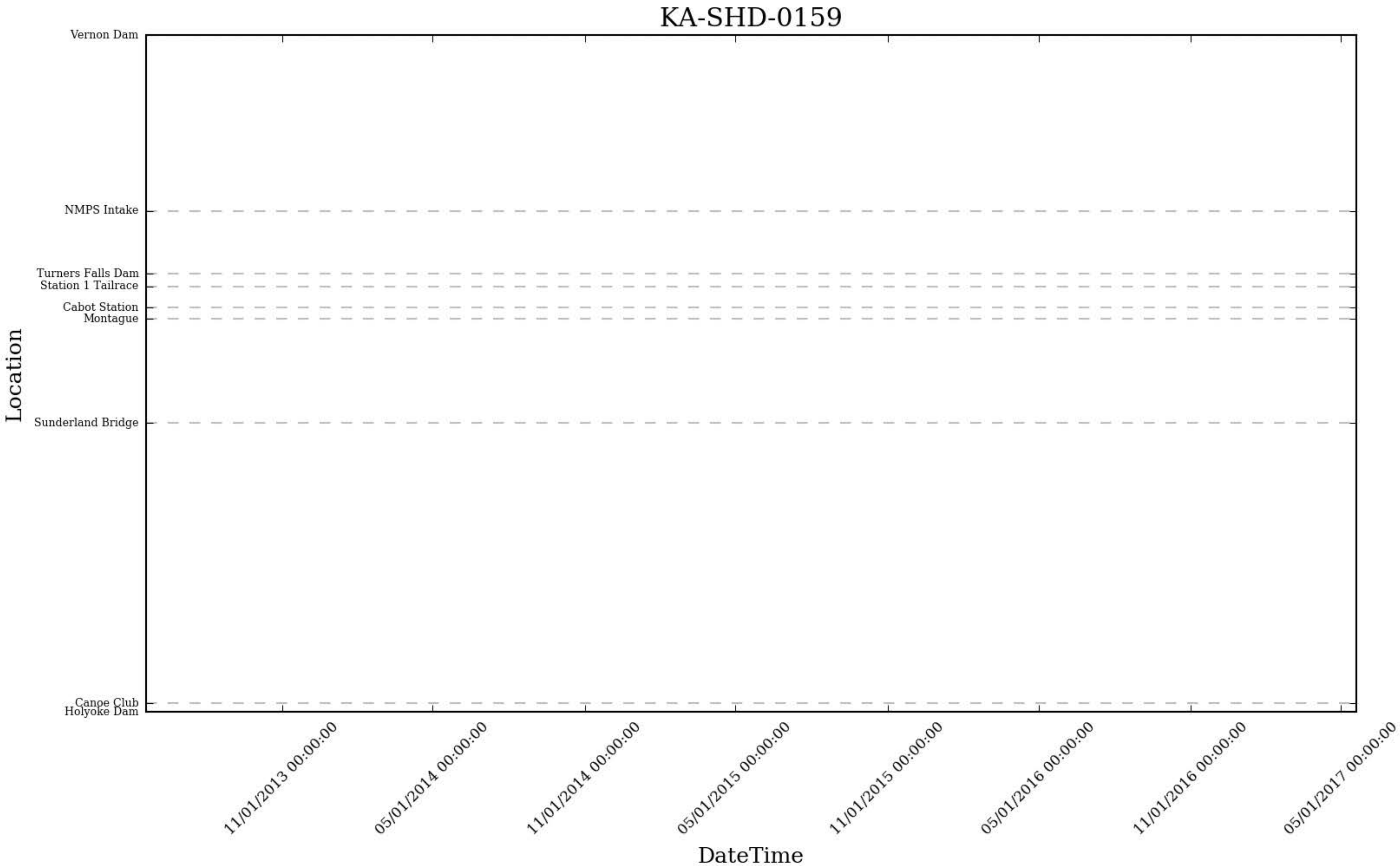
KA-SHD-0153
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
06/14/2015 00:00:00
06/17/2015 00:00:00
06/20/2015 00:00:00
06/23/2015 00:00:00
DateTime


KA-SHD-0154
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
DateTime

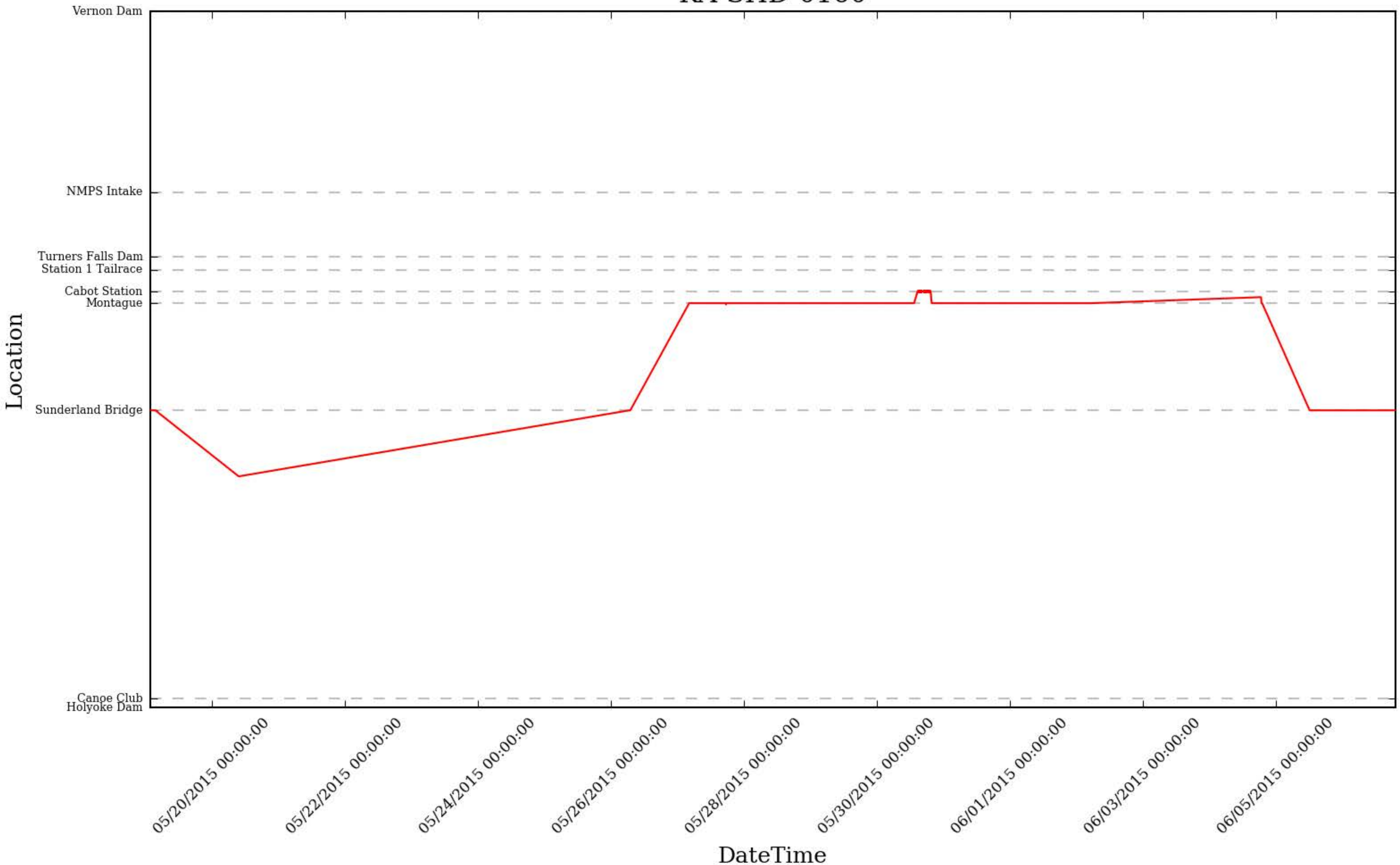

KA-SHD-0156
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 03:00:00
05/14/2015 15:00:00
05/15/2015 03:00:00
05/15/2015 15:00:00
05/16/2015 03:00:00
05/16/2015 15:00:00
05/17/2015 03:00:00
DateTime


KA-SHD-0157
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
DateTime

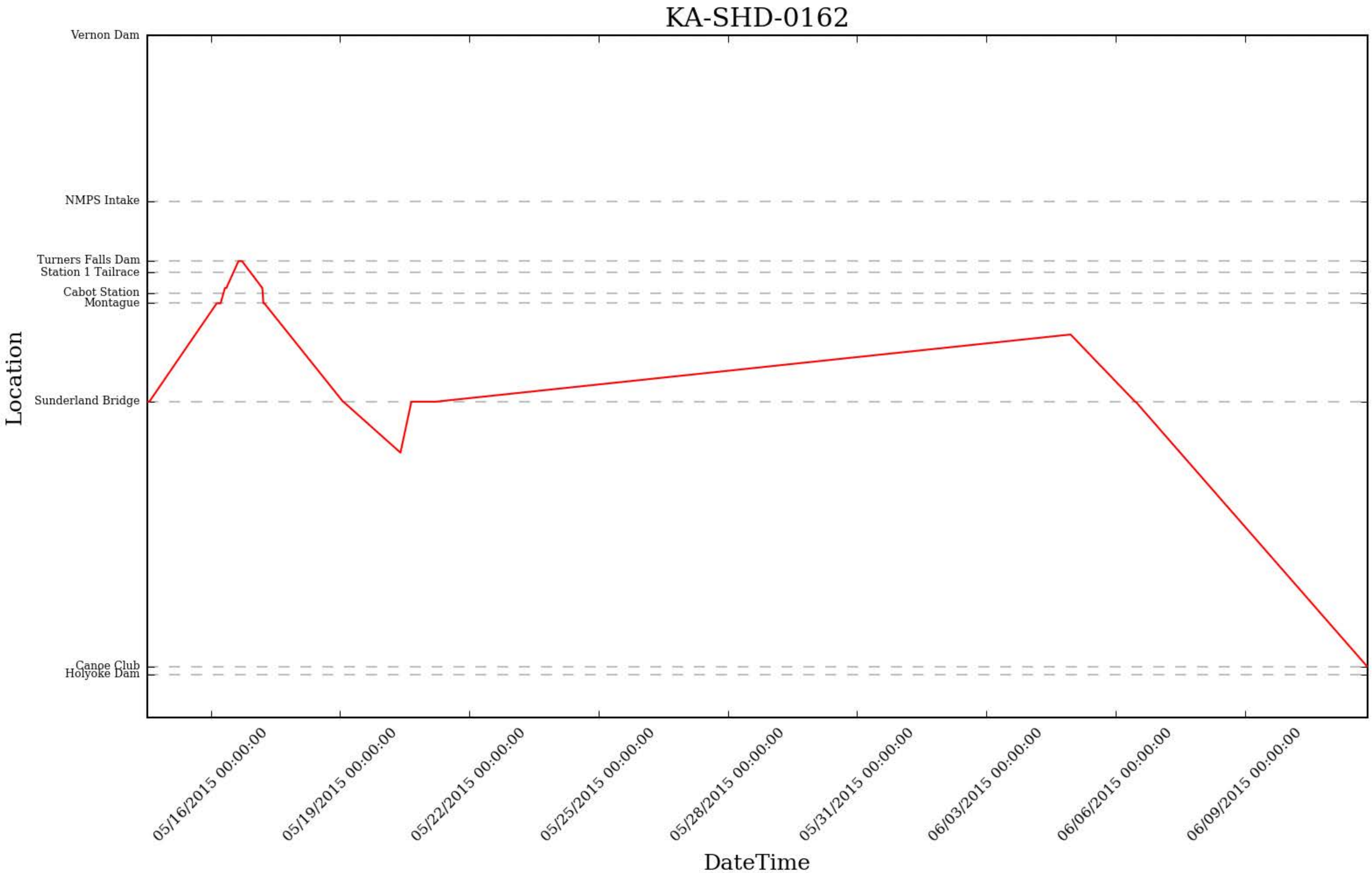

KA-SHD-0158
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime


KA-SHD-0159
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

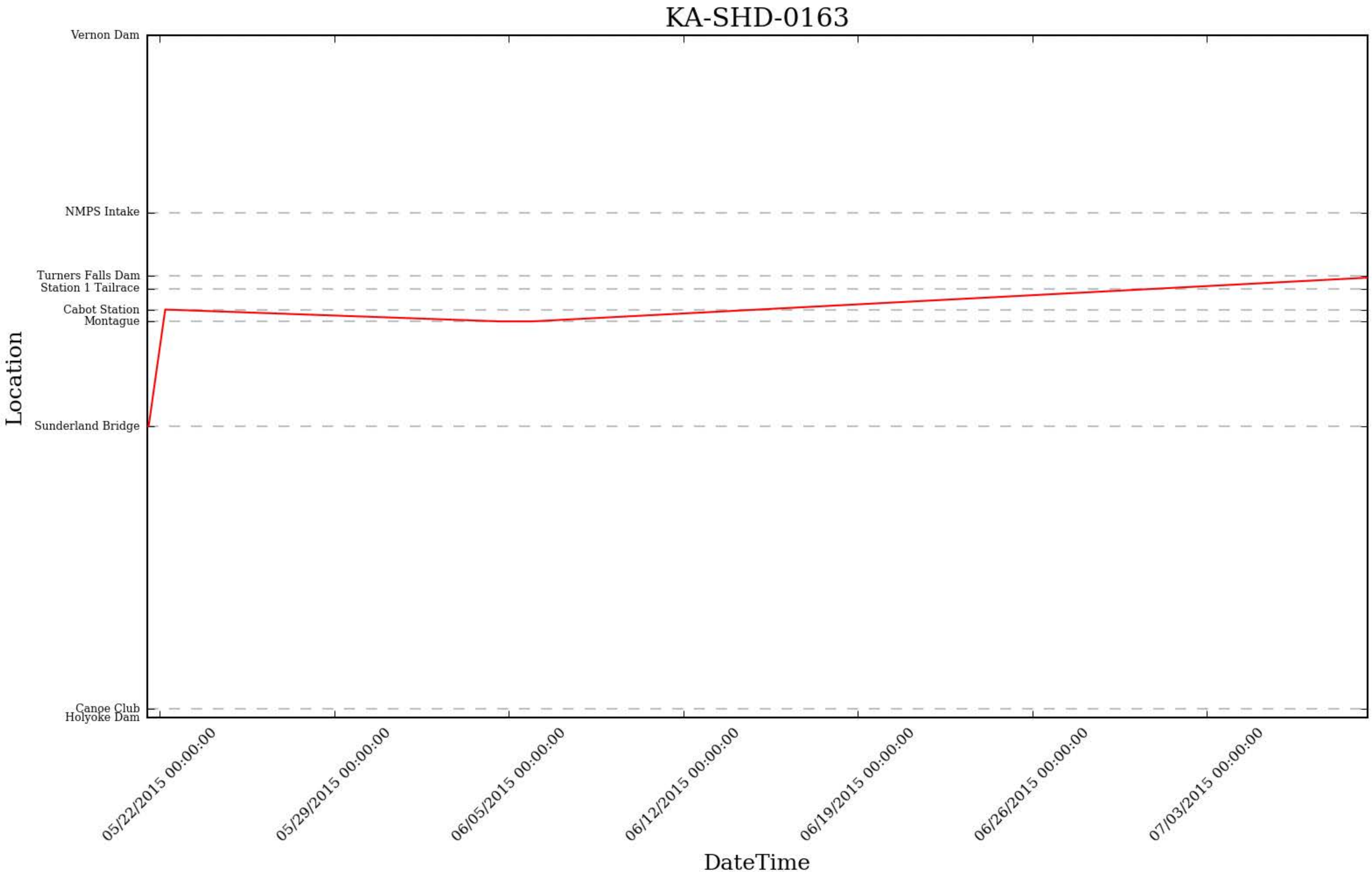
KA-SHD-0160

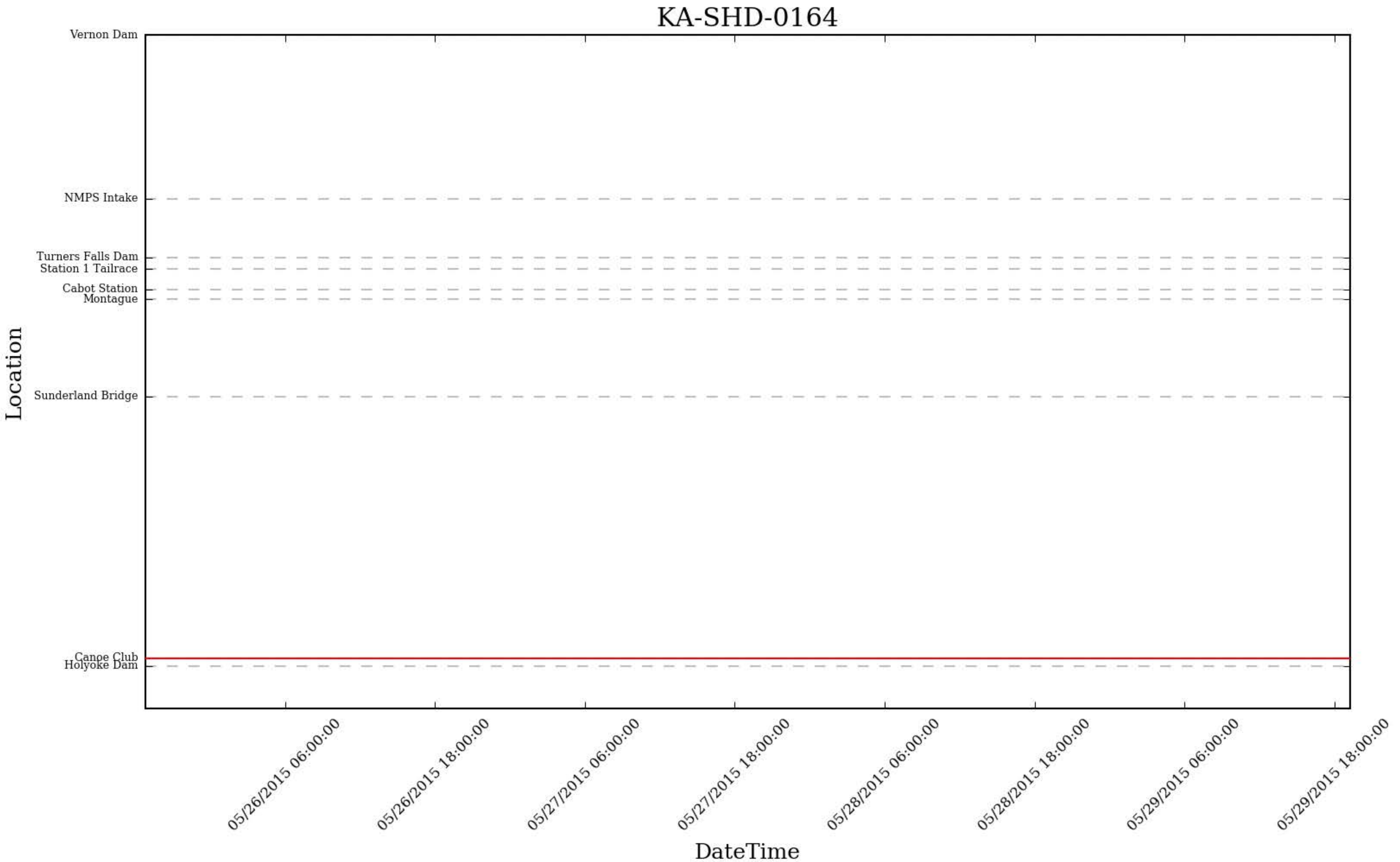


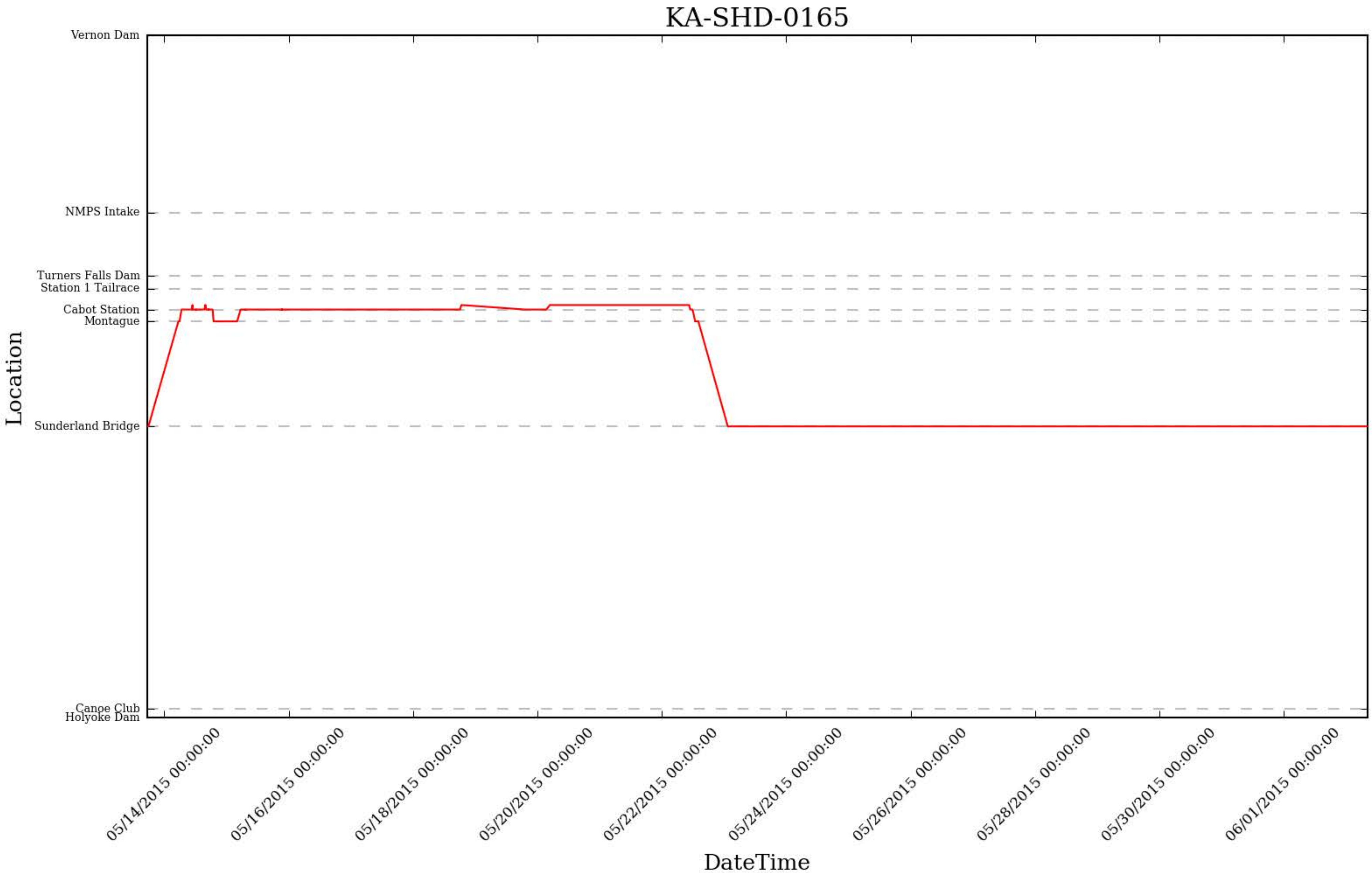
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime

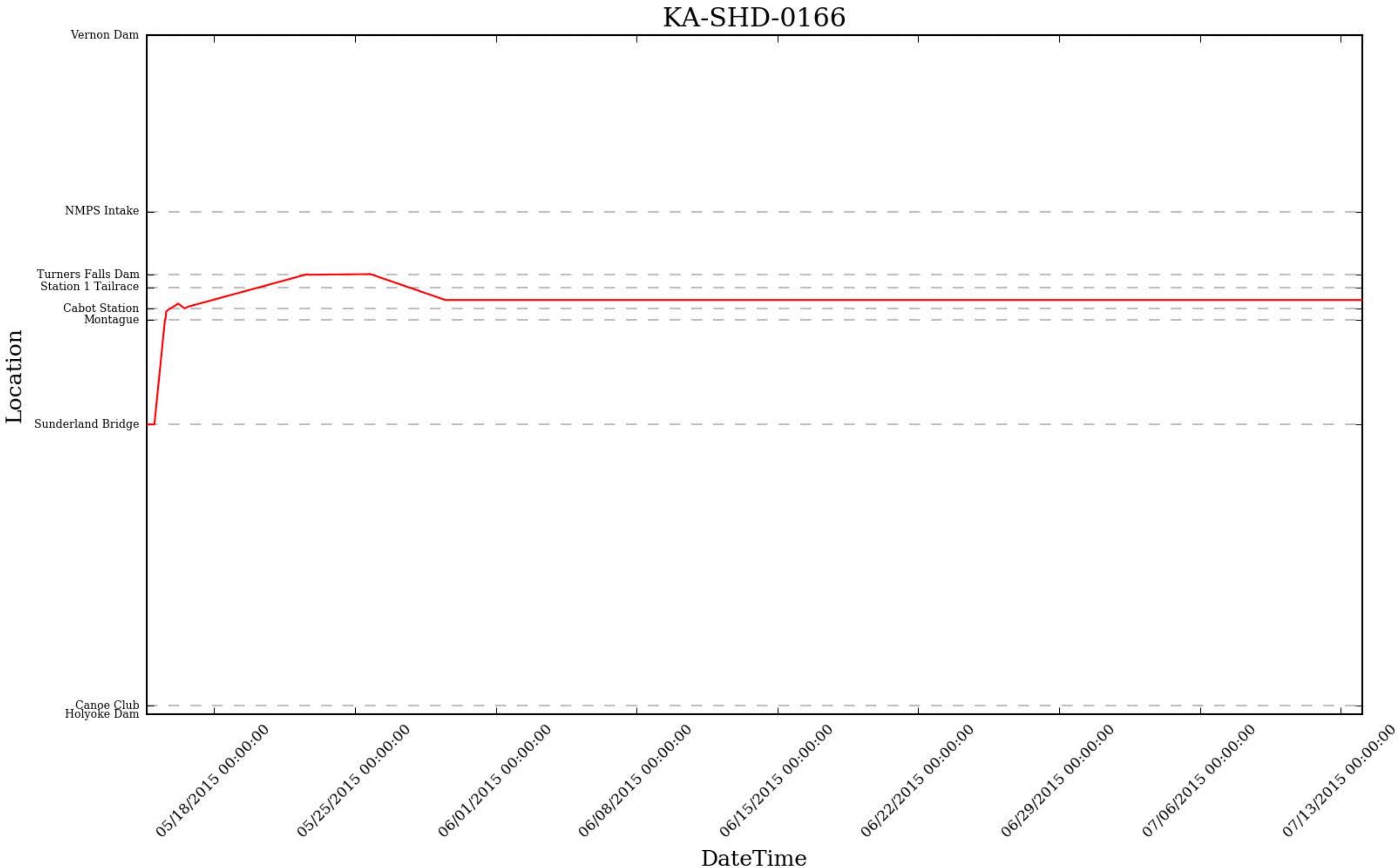


KA-SHD-0162
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
DateTime

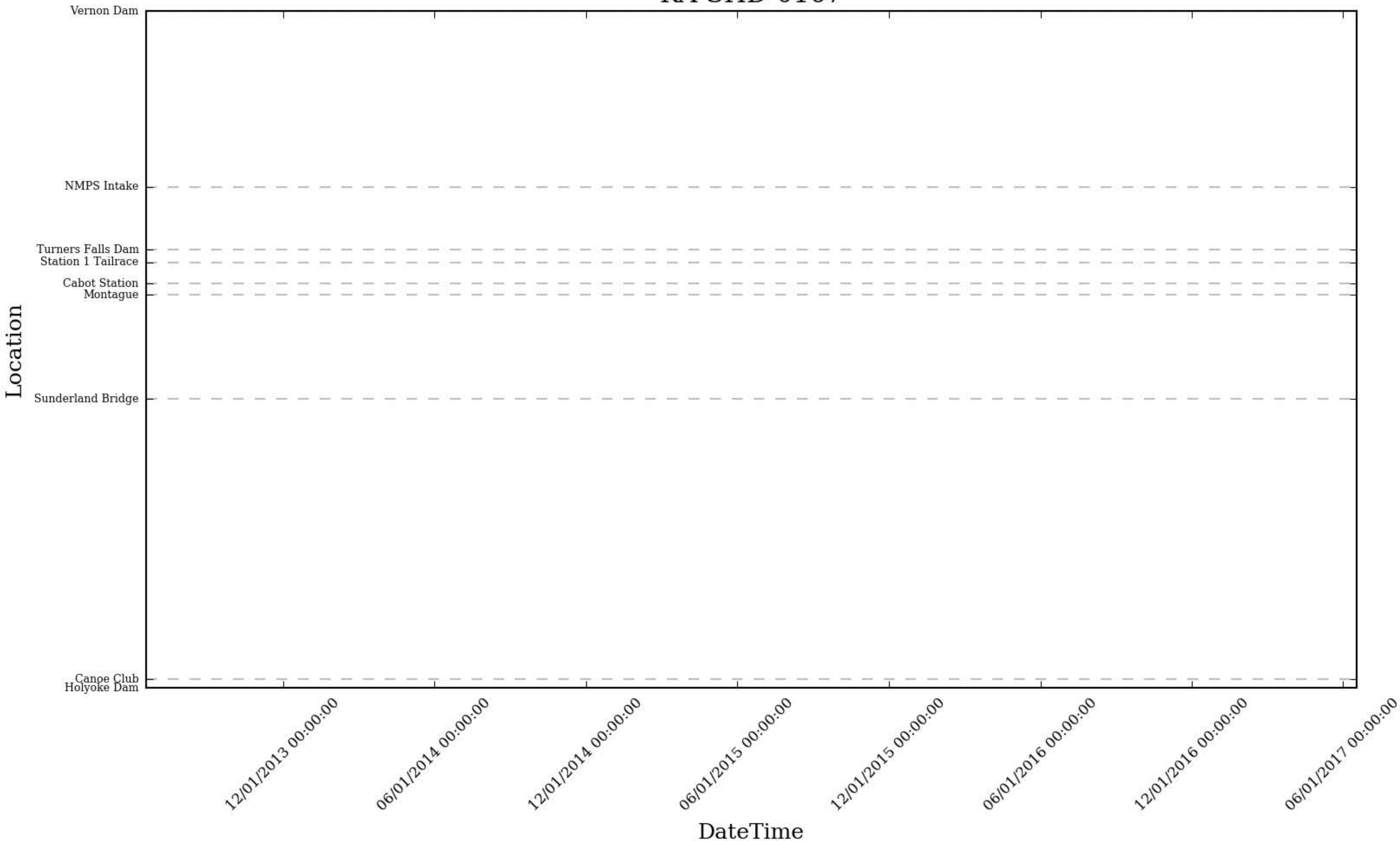

KA-SHD-0163
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime


KA-SHD-0164
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 06:00:00
05/26/2015 18:00:00
05/27/2015 06:00:00
05/27/2015 18:00:00
05/28/2015 06:00:00
05/28/2015 18:00:00
05/29/2015 06:00:00
05/29/2015 18:00:00
DateTime

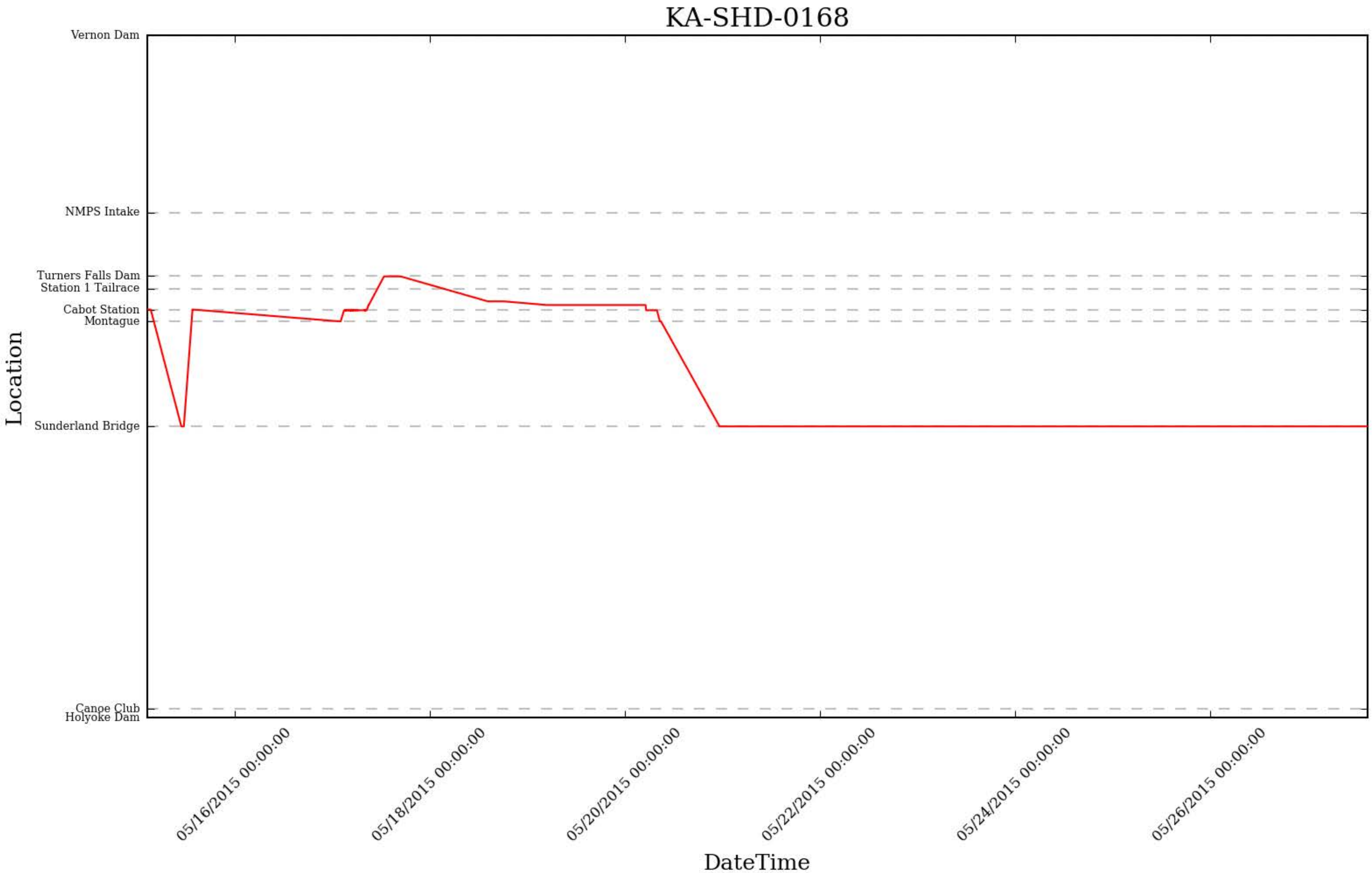

KA-SHD-0165
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
DateTime

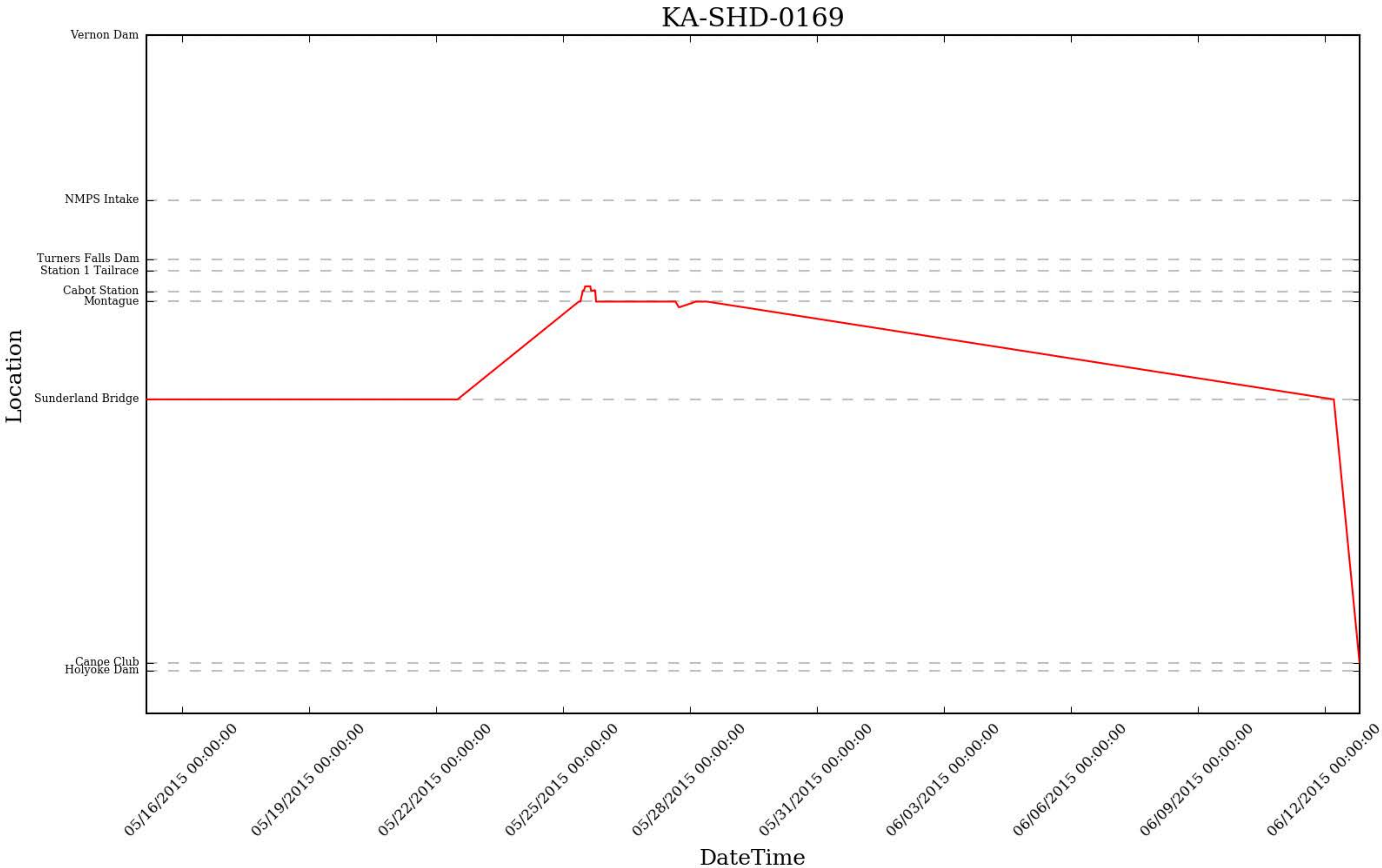

KA-SHD-0166
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/25/2015 00:00:00
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
06/29/2015 00:00:00
07/06/2015 00:00:00
07/13/2015 00:00:00
DateTime

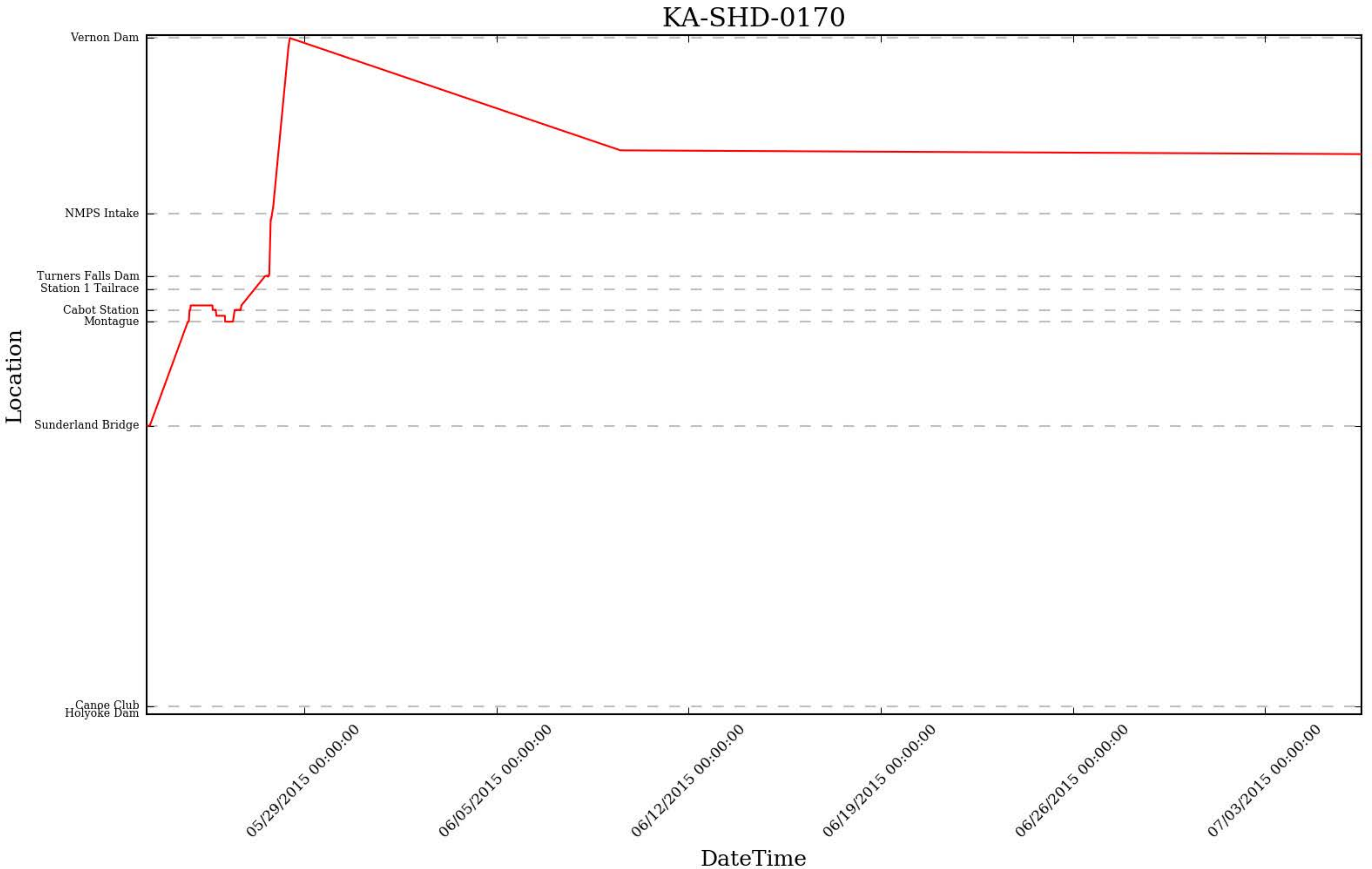
KA-SHD-0167

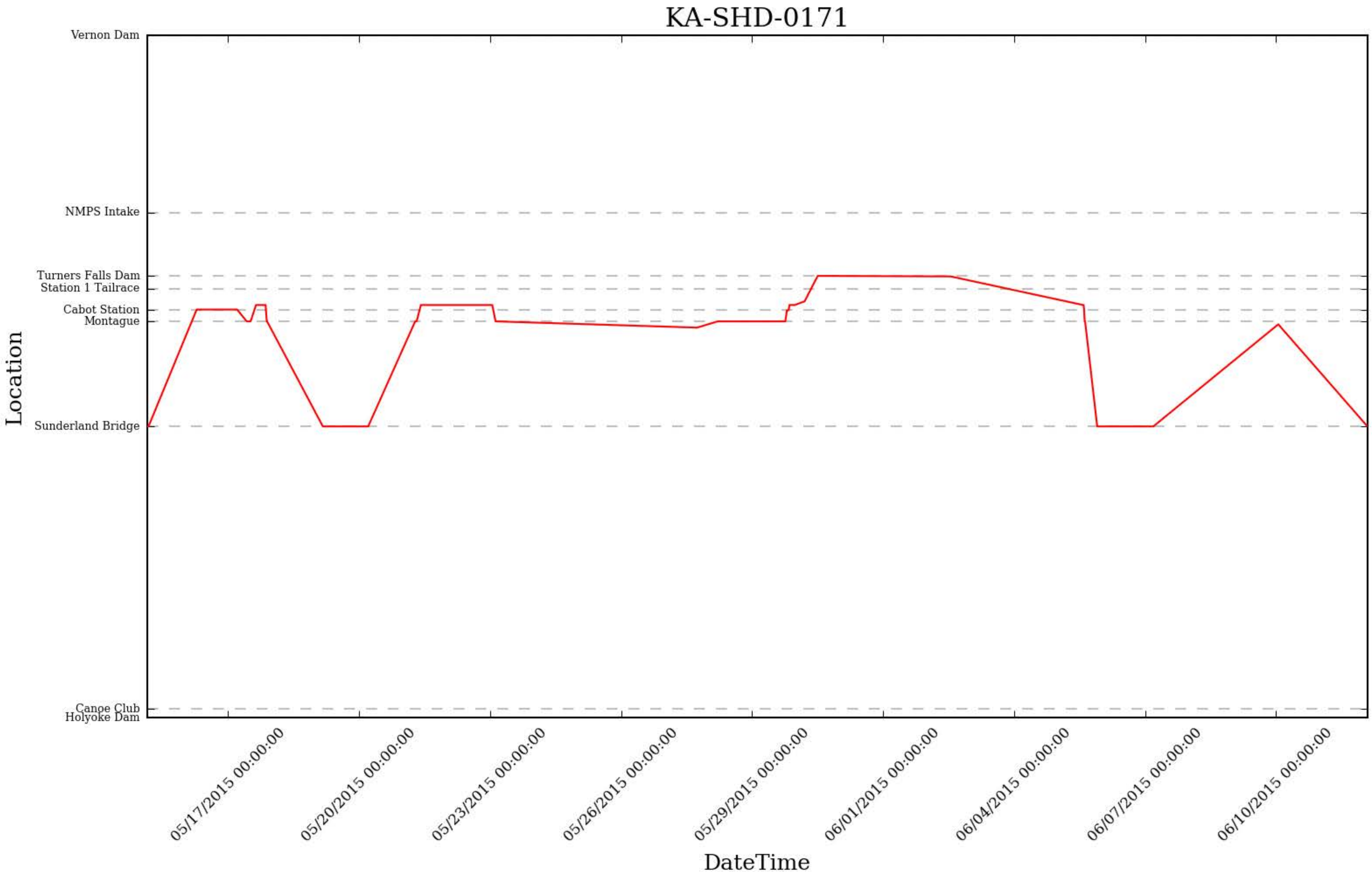


Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime

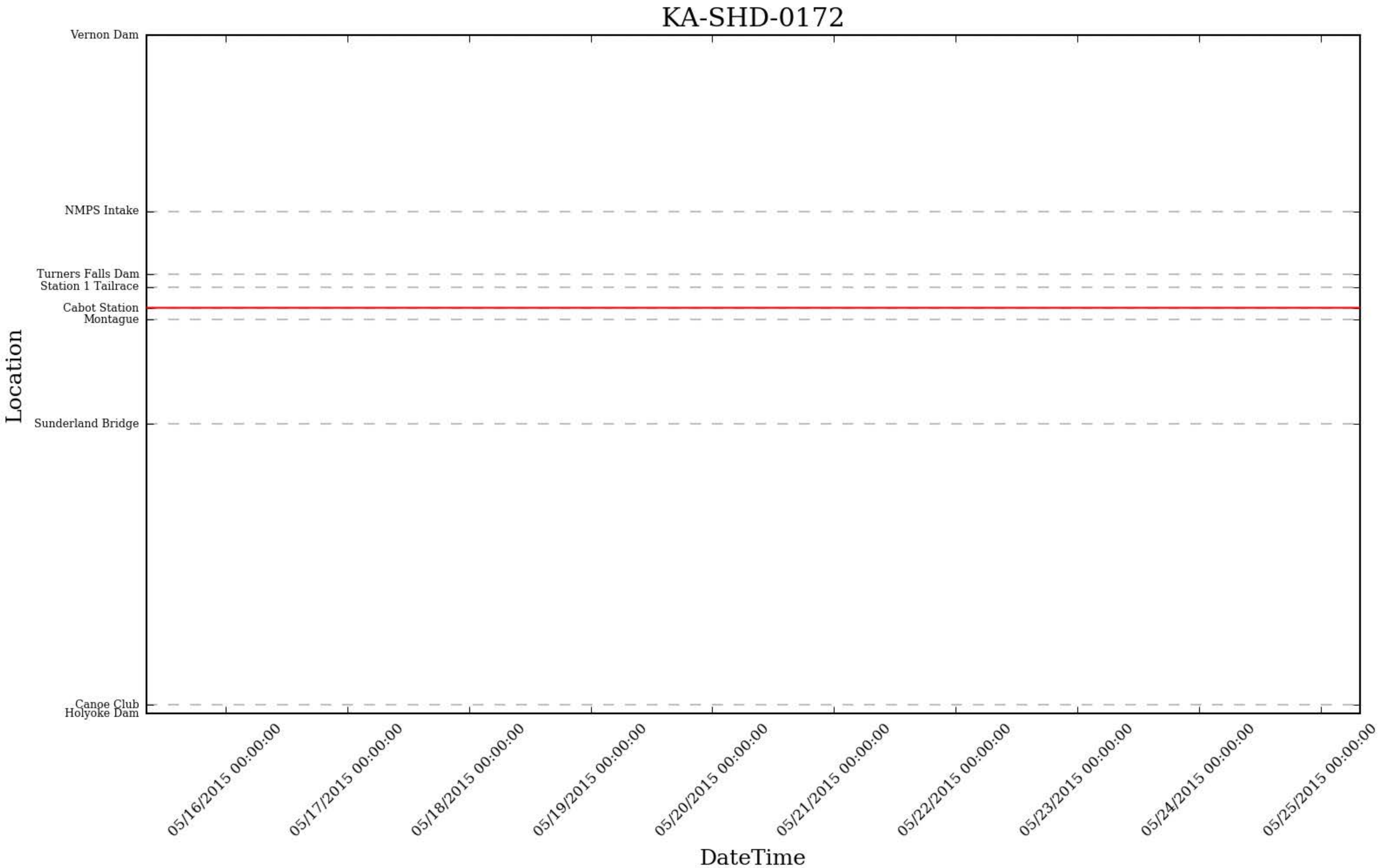

KA-SHD-0168
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
DateTime


KA-SHD-0169
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
06/12/2015 00:00:00
DateTime

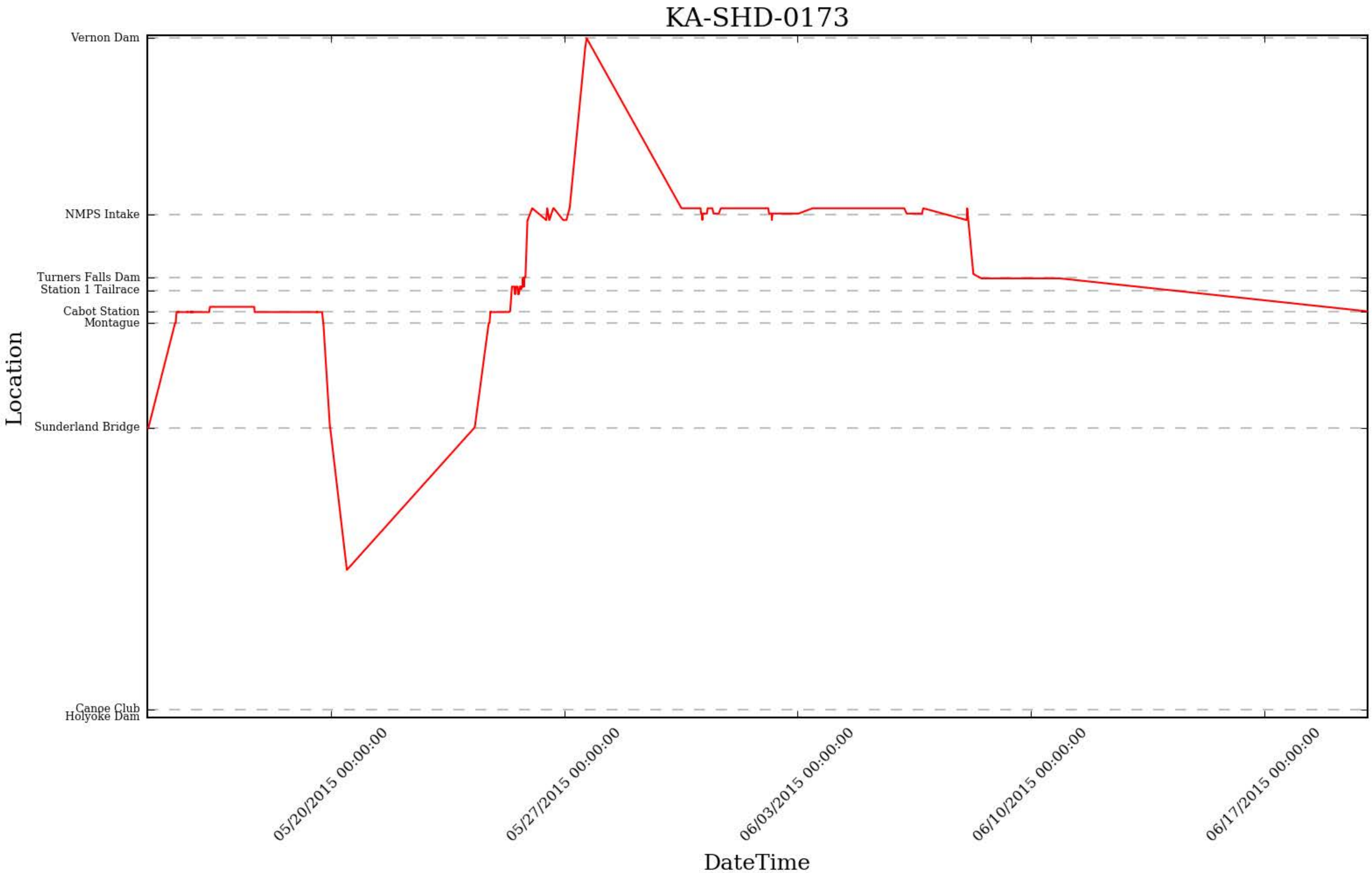

KA-SHD-0170
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime



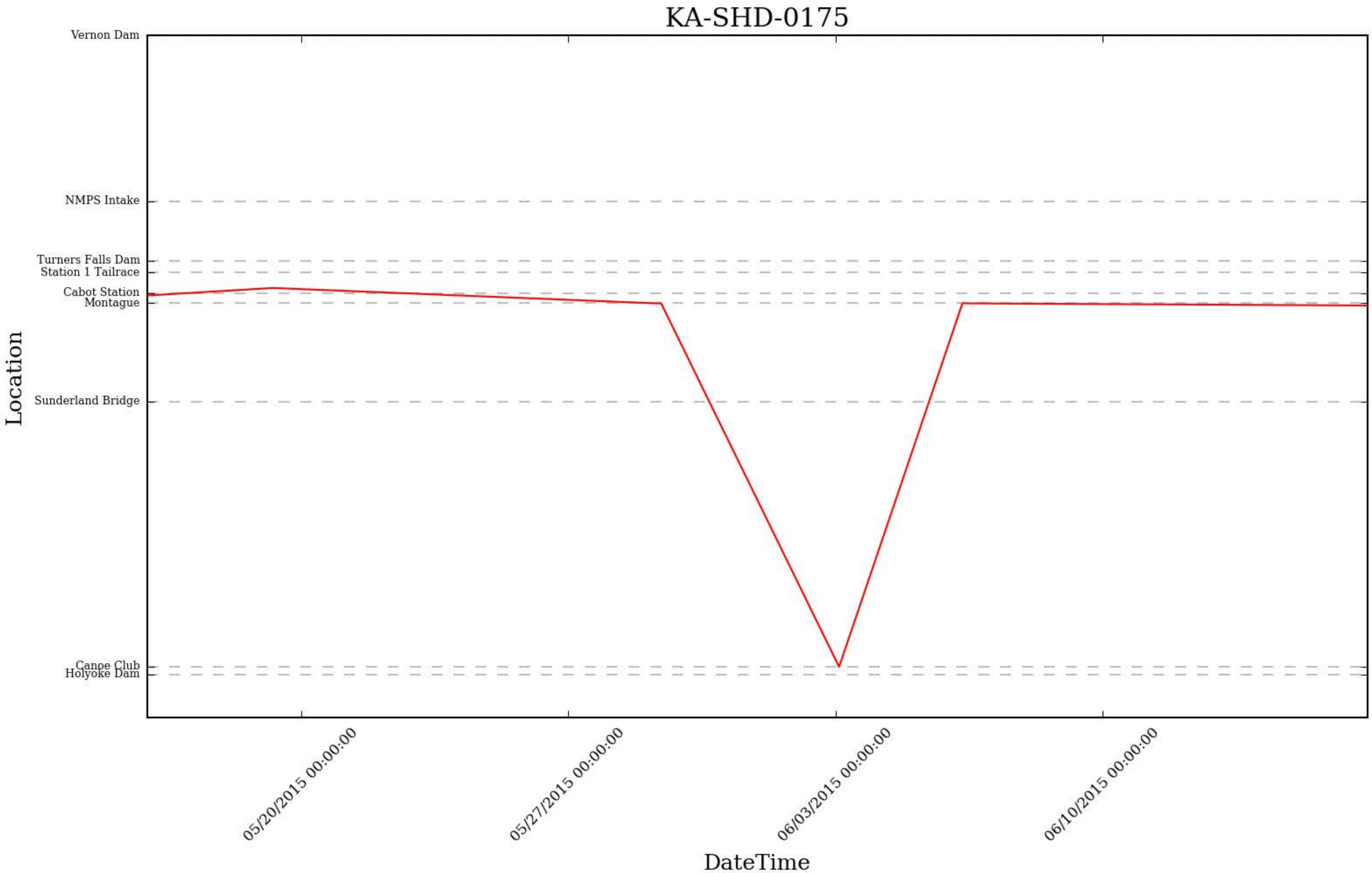
KA-SHD-0171
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
DateTime

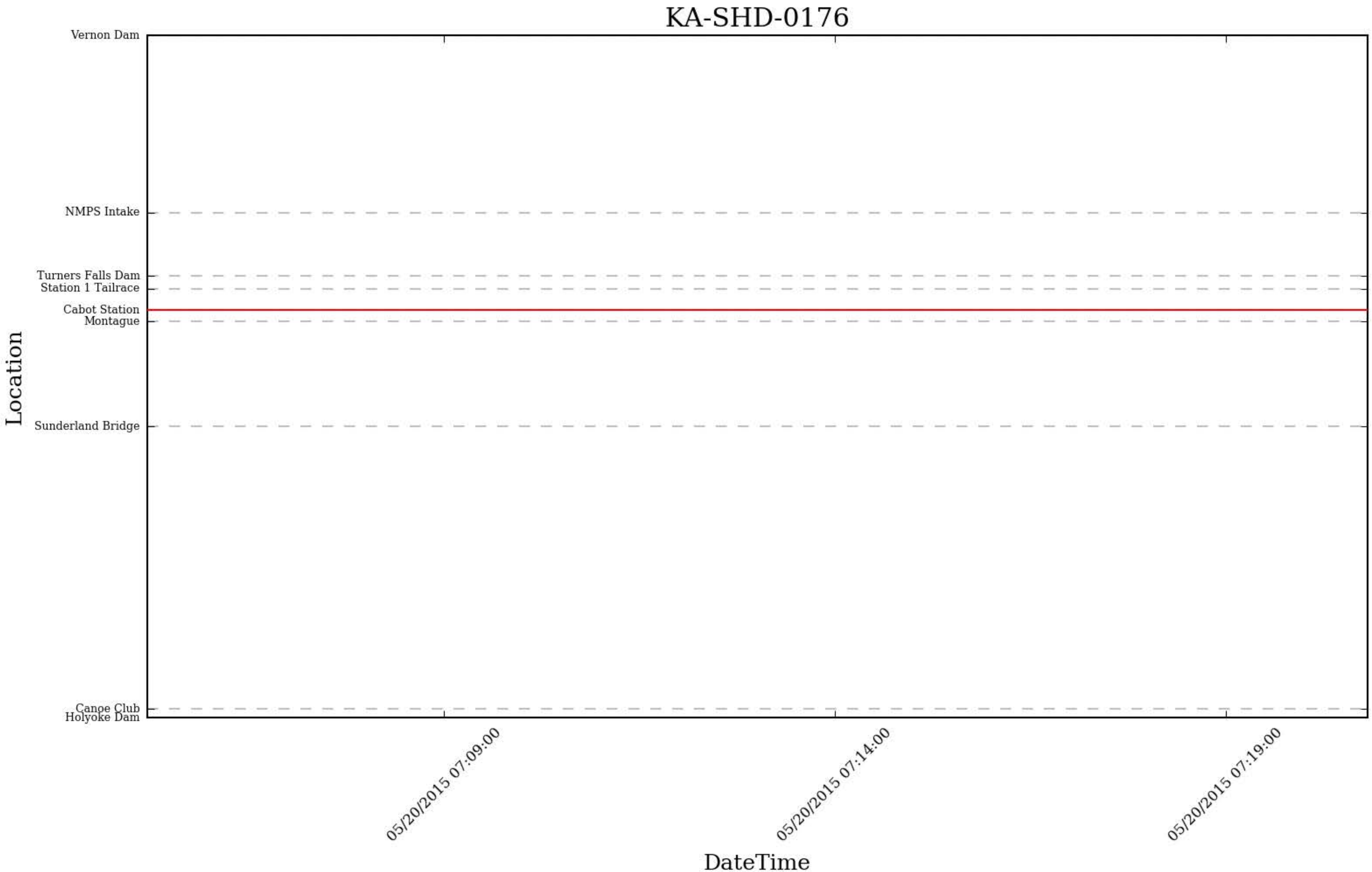


KA-SHD-0172
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
DateTime

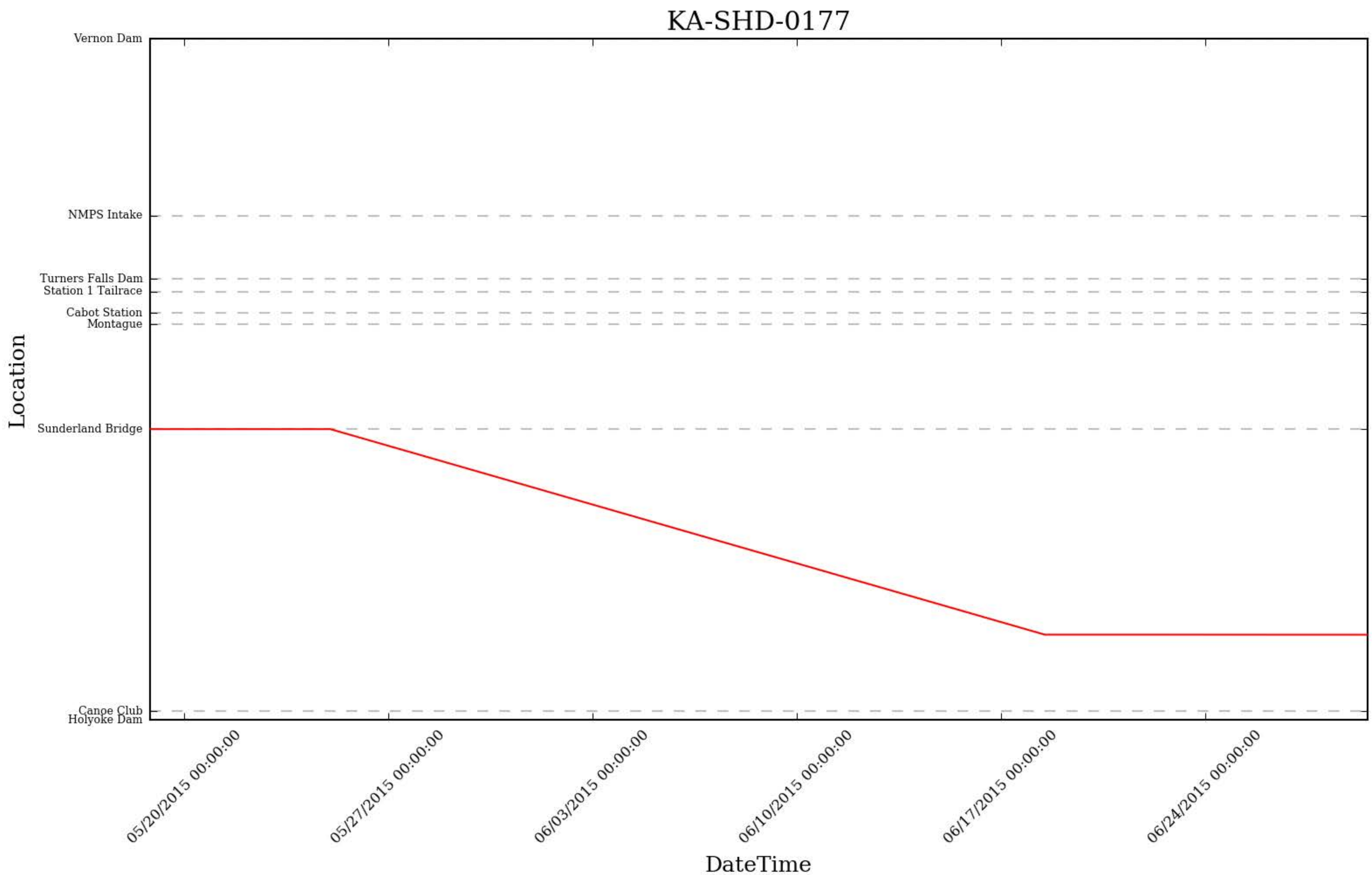


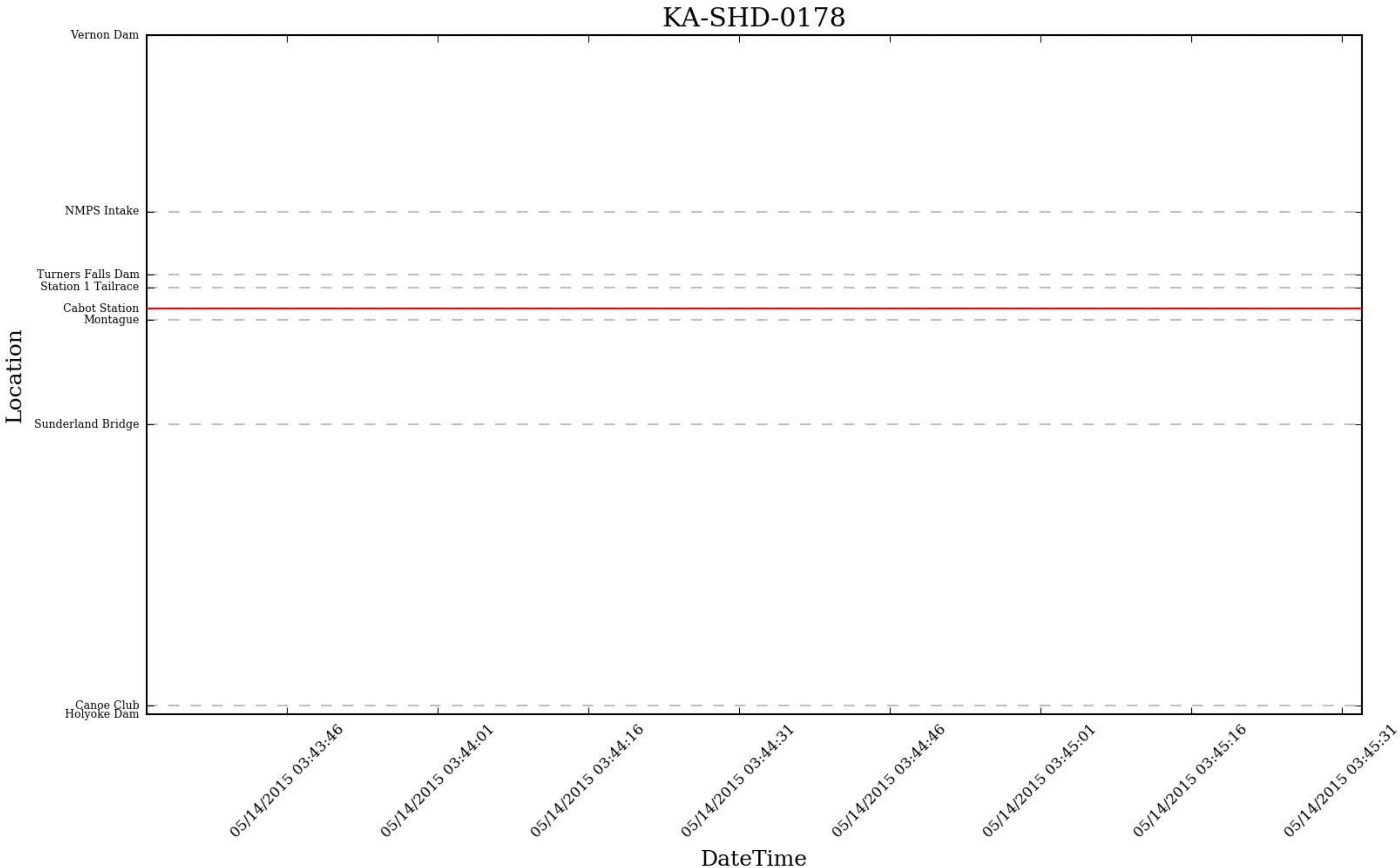
KA-SHD-0173
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
DateTime

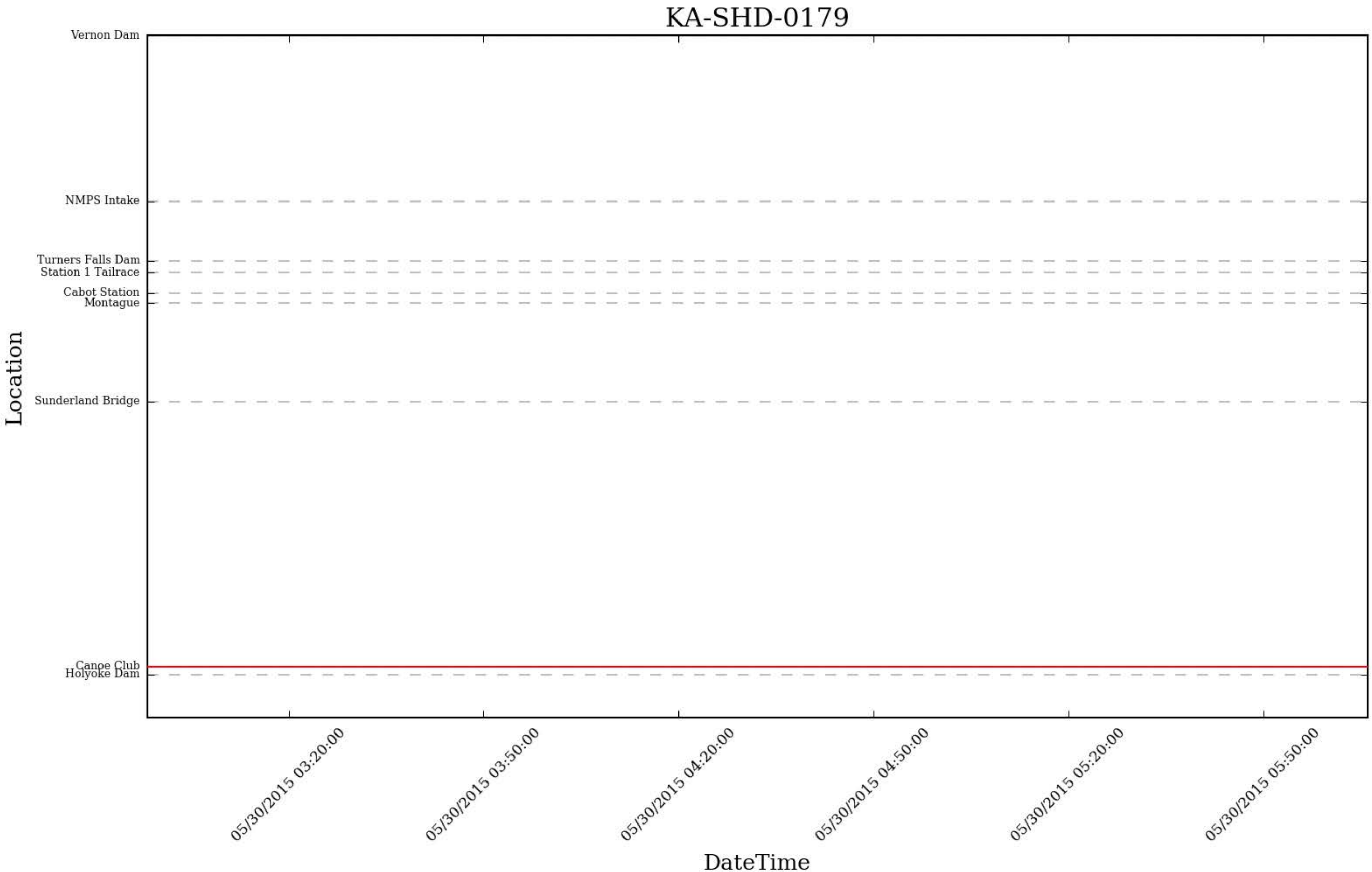

KA-SHD-0175
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
DateTime



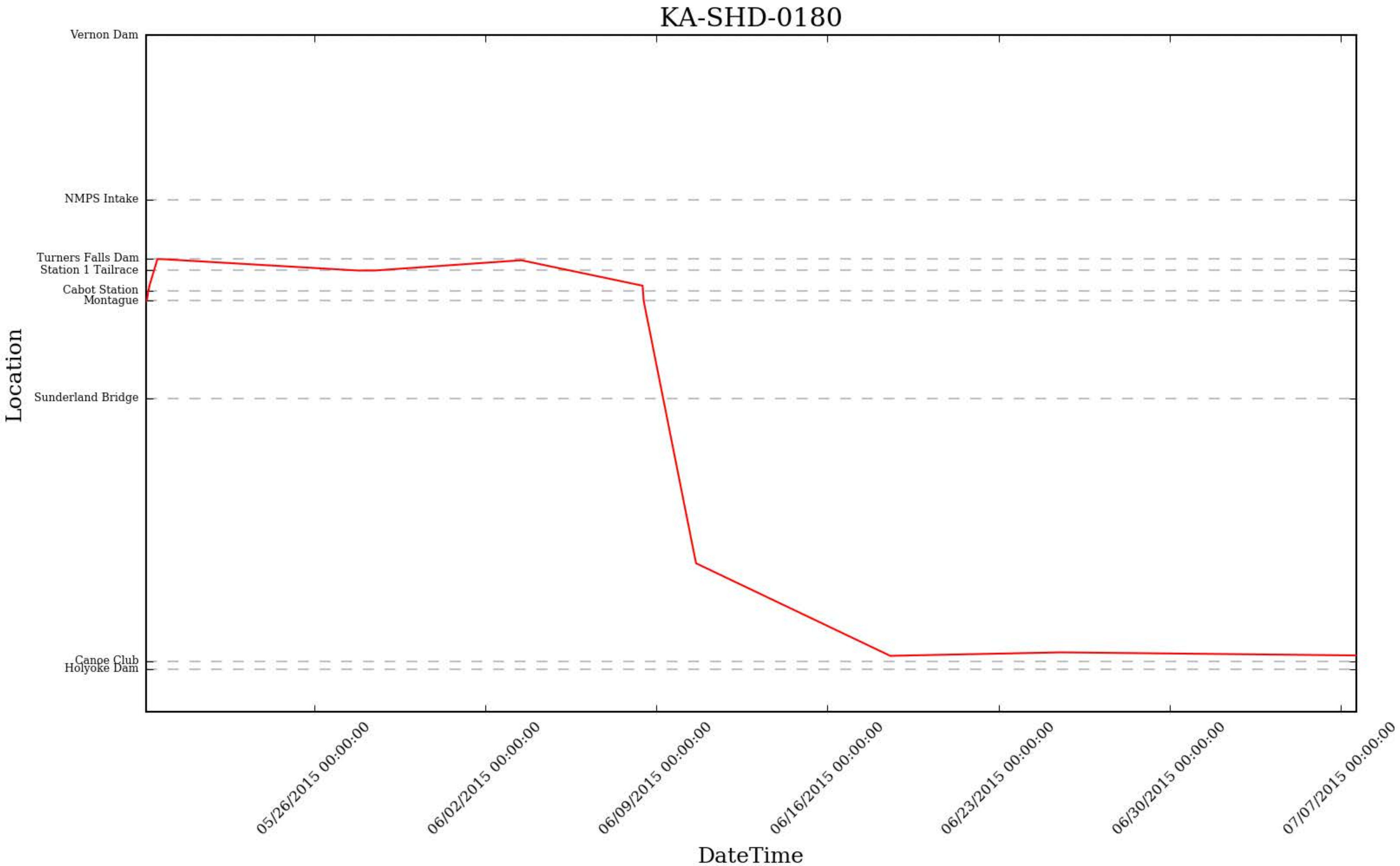
KA-SHD-0176
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 07:09:00
05/20/2015 07:14:00
05/20/2015 07:19:00
DateTime

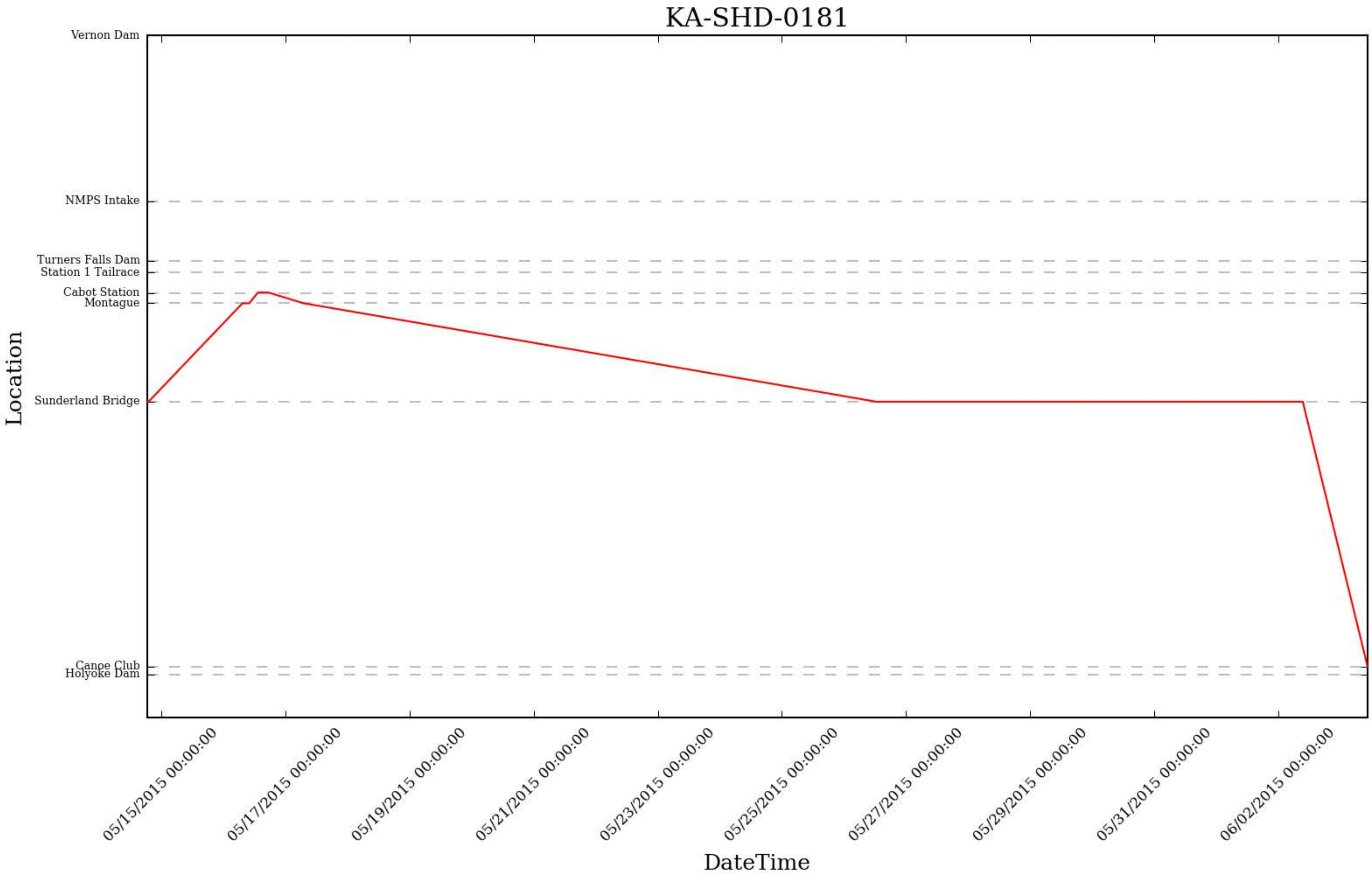

KA-SHD-0177
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
DateTime


KA-SHD-0178
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 03:43:46
05/14/2015 03:44:01
05/14/2015 03:44:16
05/14/2015 03:44:31
05/14/2015 03:44:46
05/14/2015 03:45:01
05/14/2015 03:45:16
05/14/2015 03:45:31
DateTime

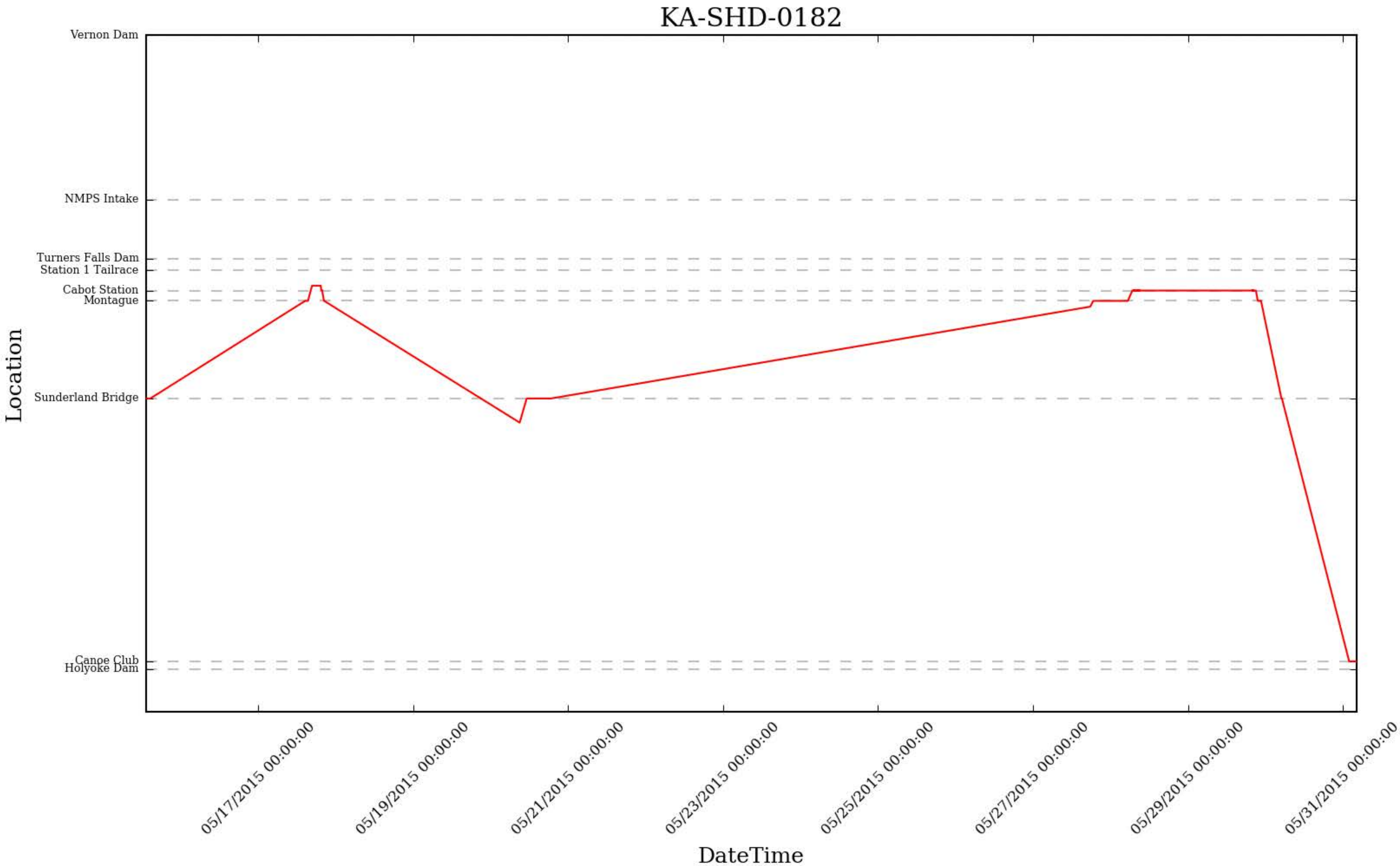


KA-SHD-0179
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 03:20:00
05/30/2015 03:50:00
05/30/2015 04:20:00
05/30/2015 04:50:00
05/30/2015 05:20:00
05/30/2015 05:50:00
DateTime

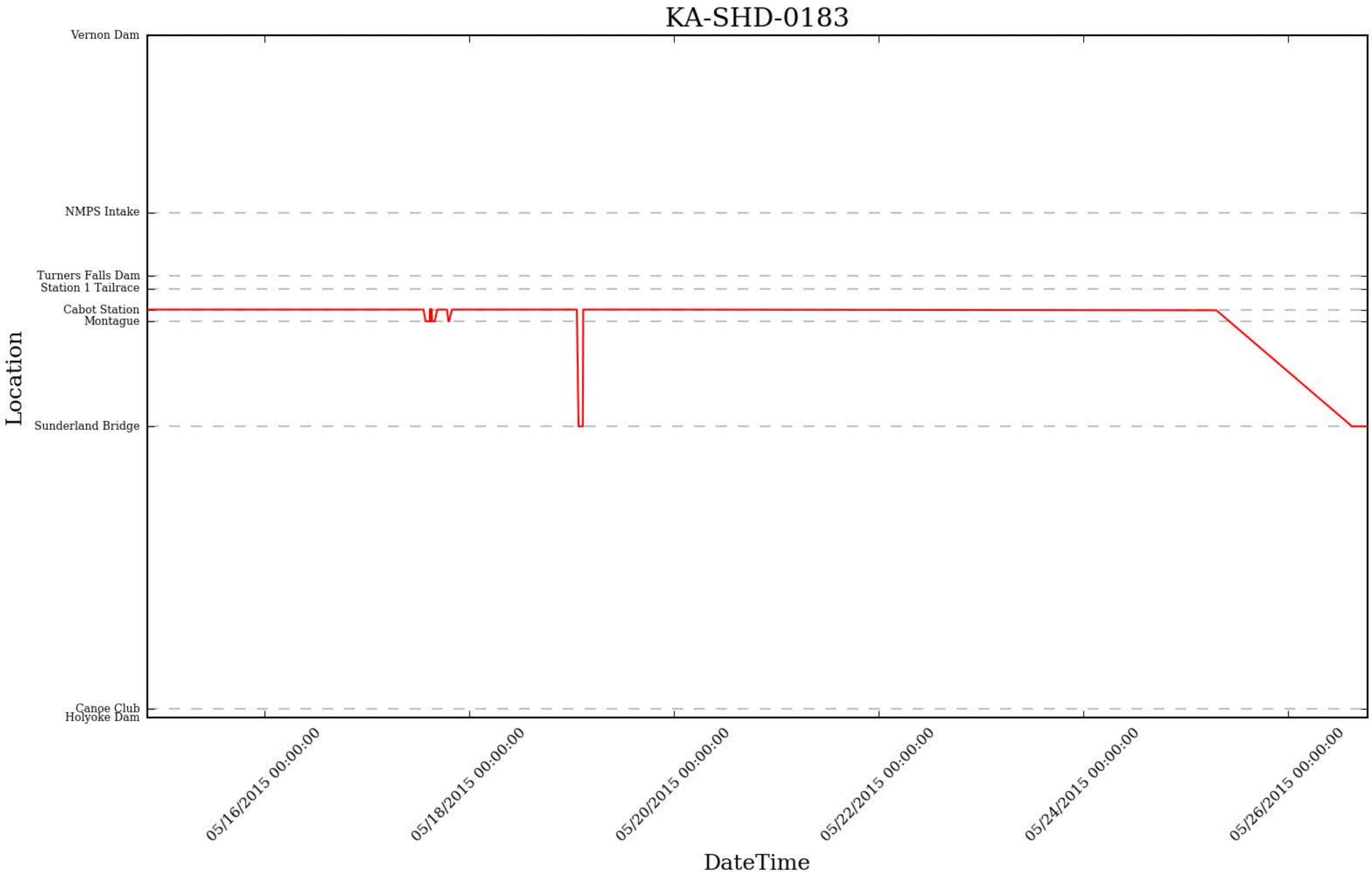

KA-SHD-0180
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime

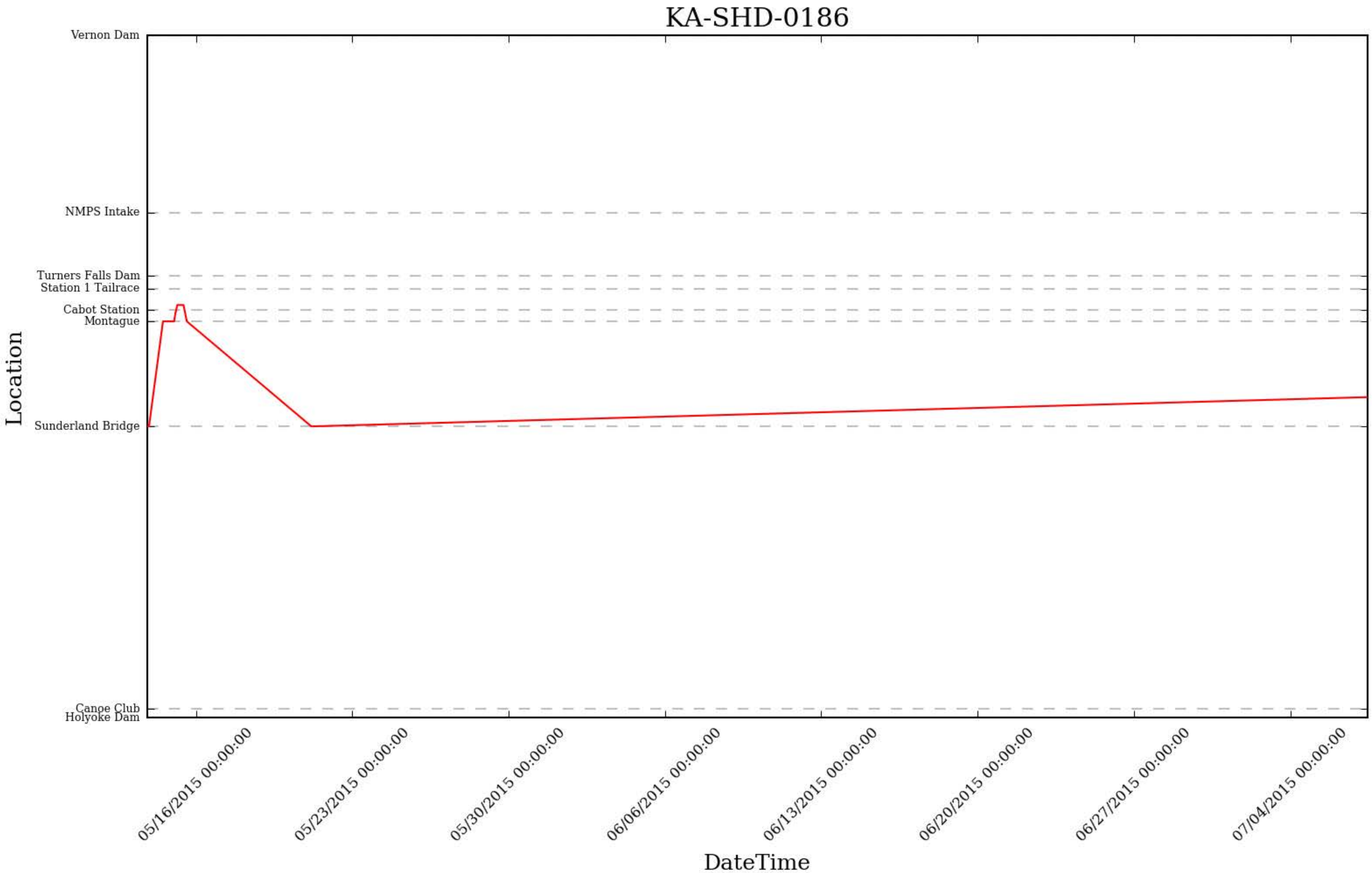


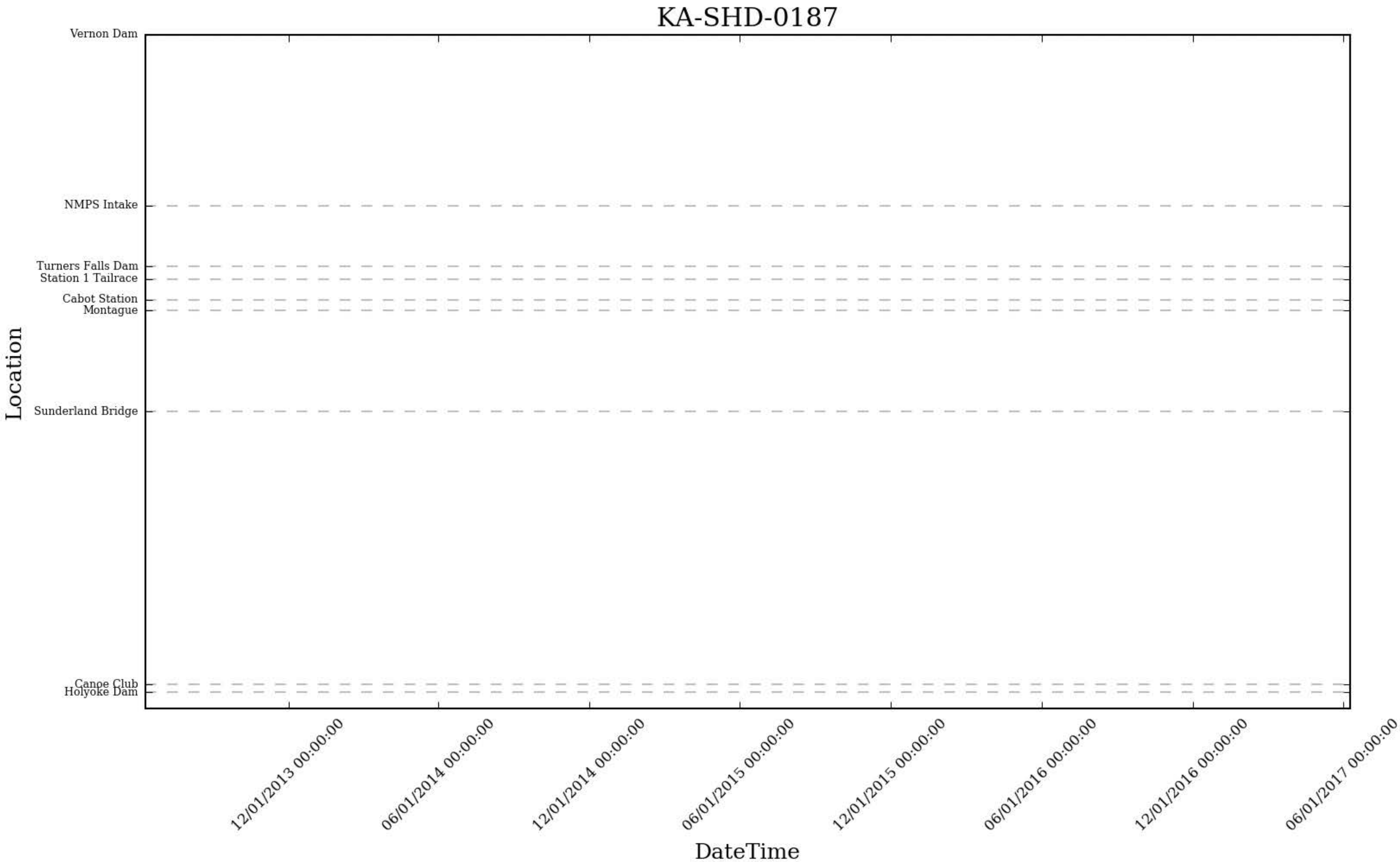
KA-SHD-0181
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
DateTime

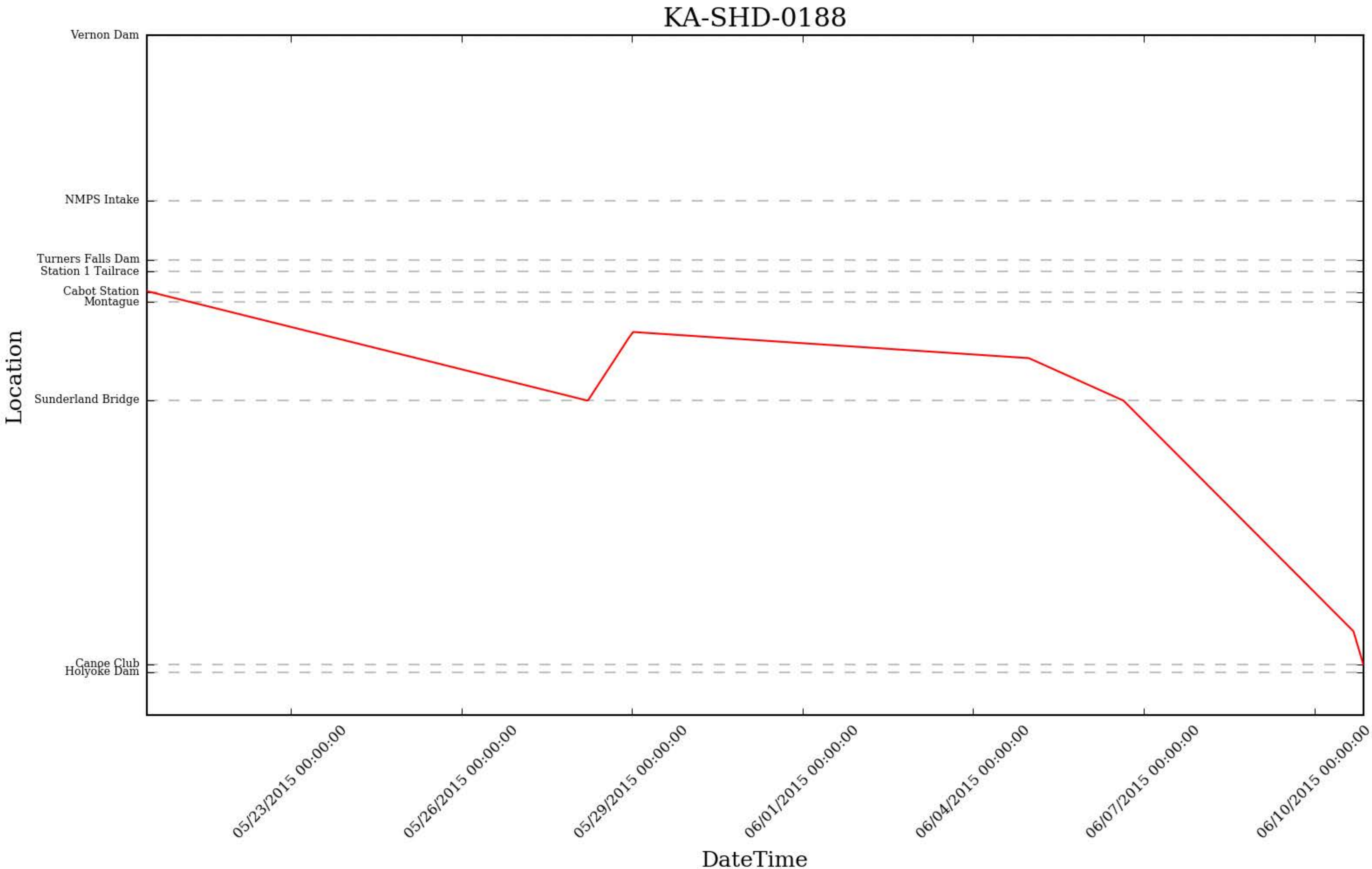


KA-SHD-0182
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
DateTime

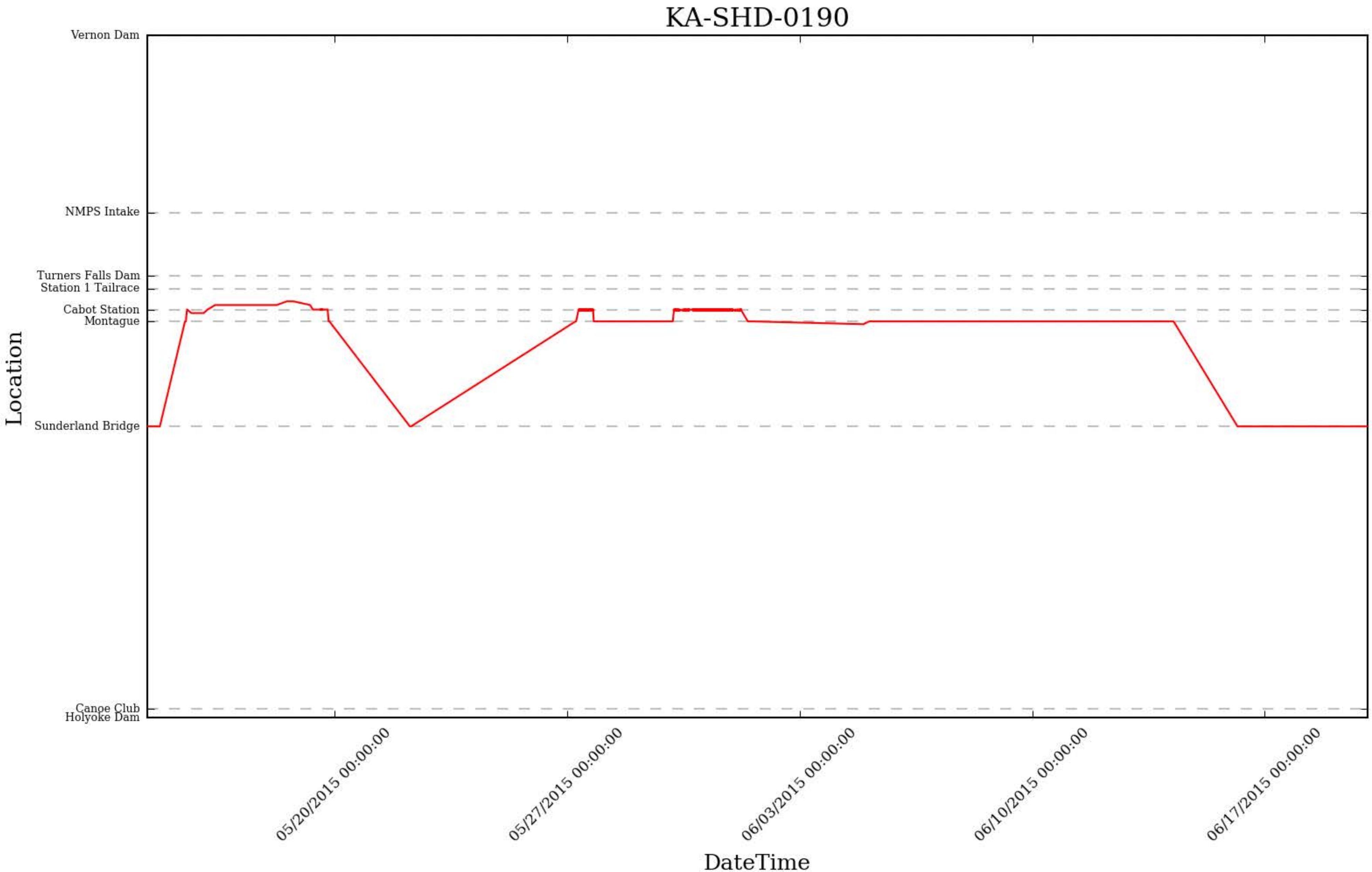

KA-SHD-0183
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
DateTime

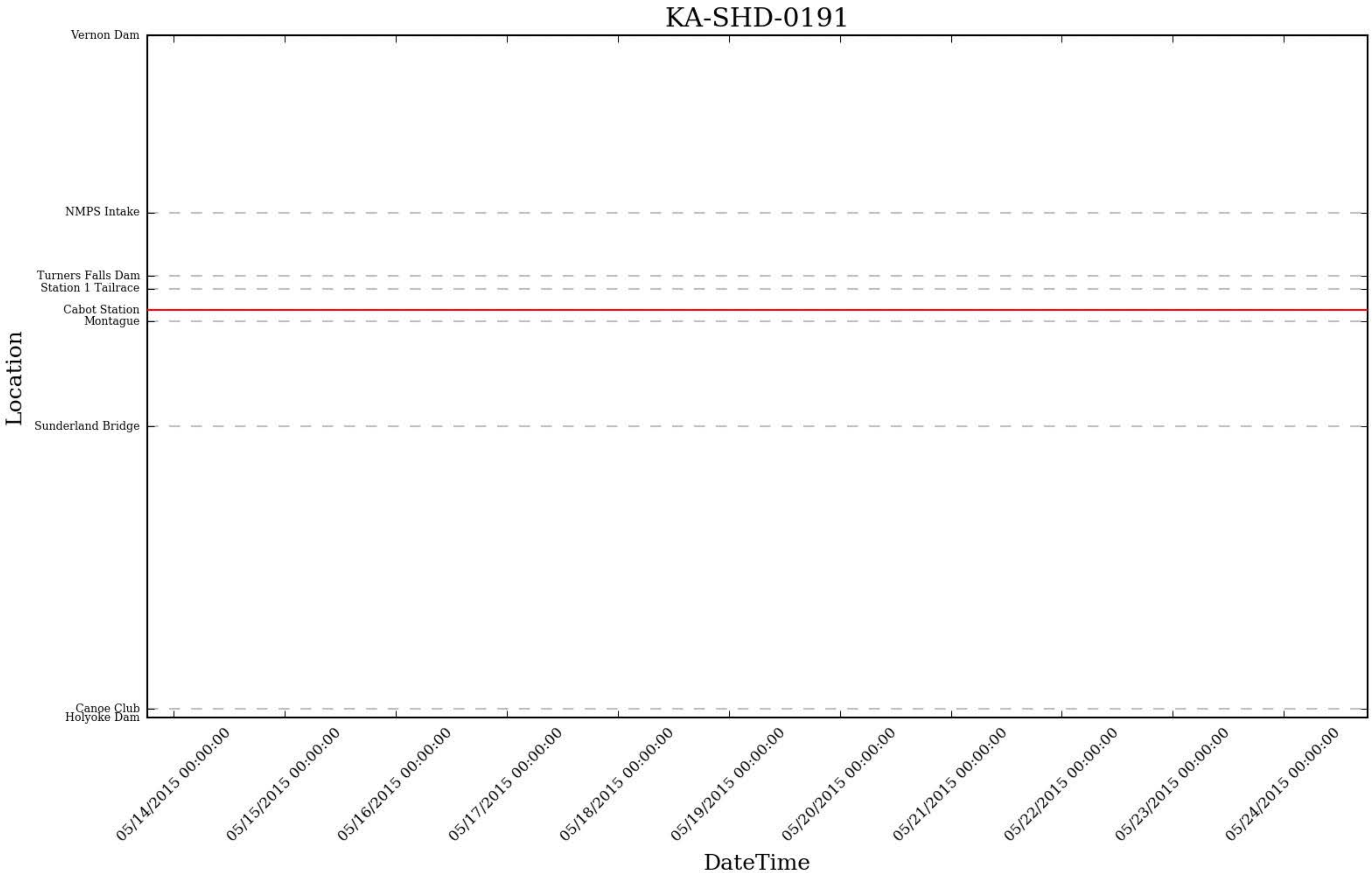

KA-SHD-0186
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
DateTime

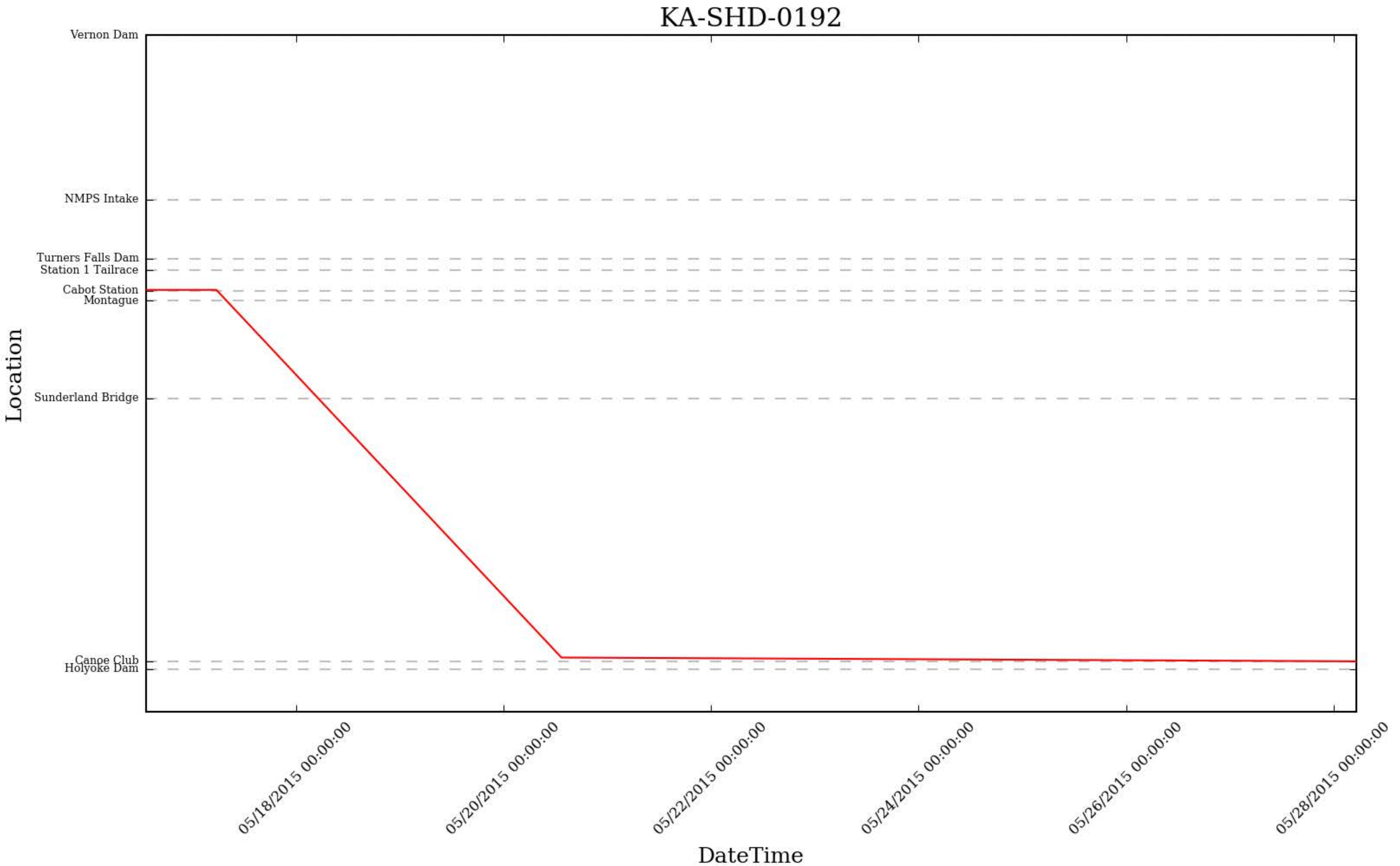

KA-SHD-0187
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime

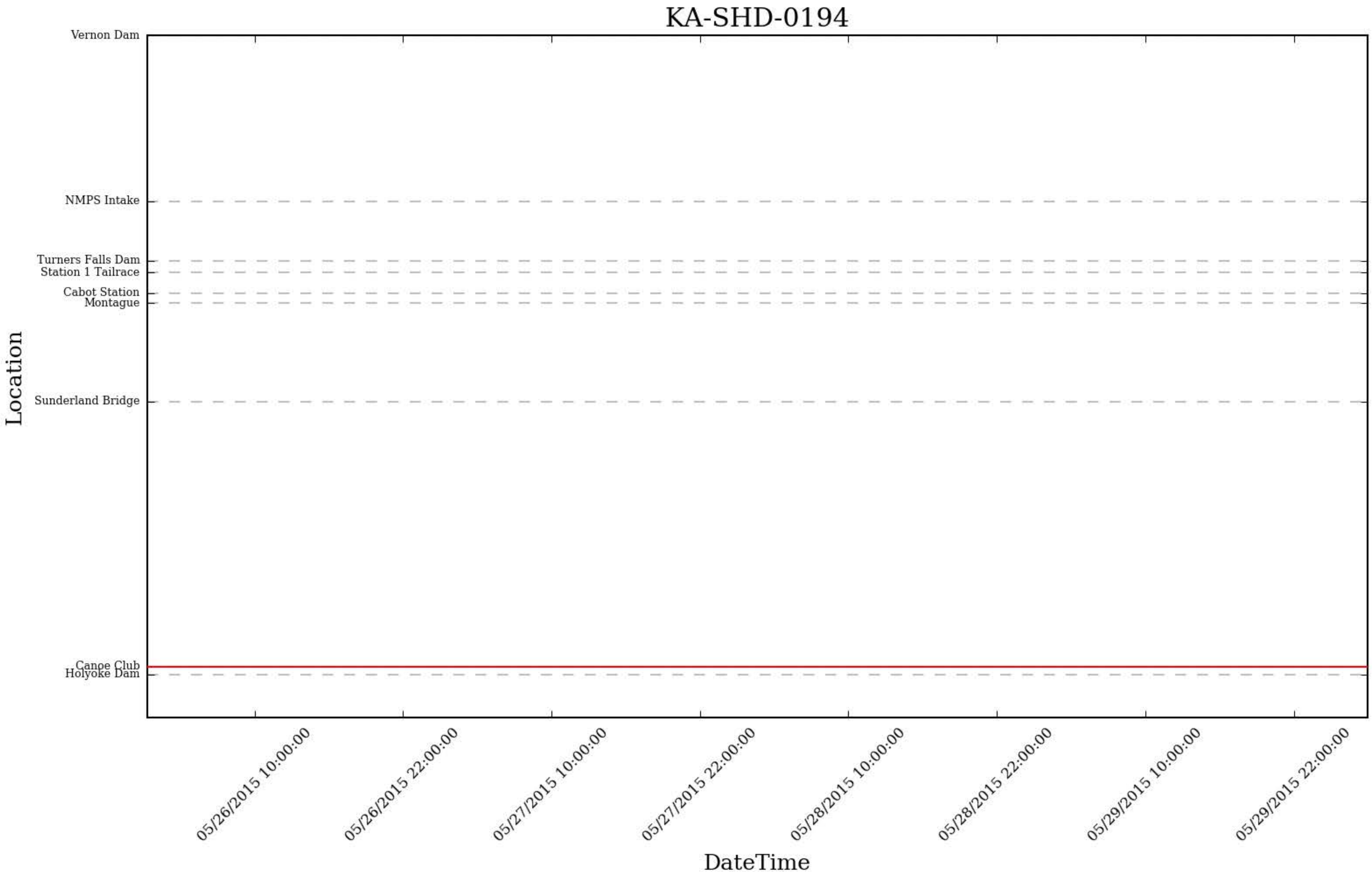


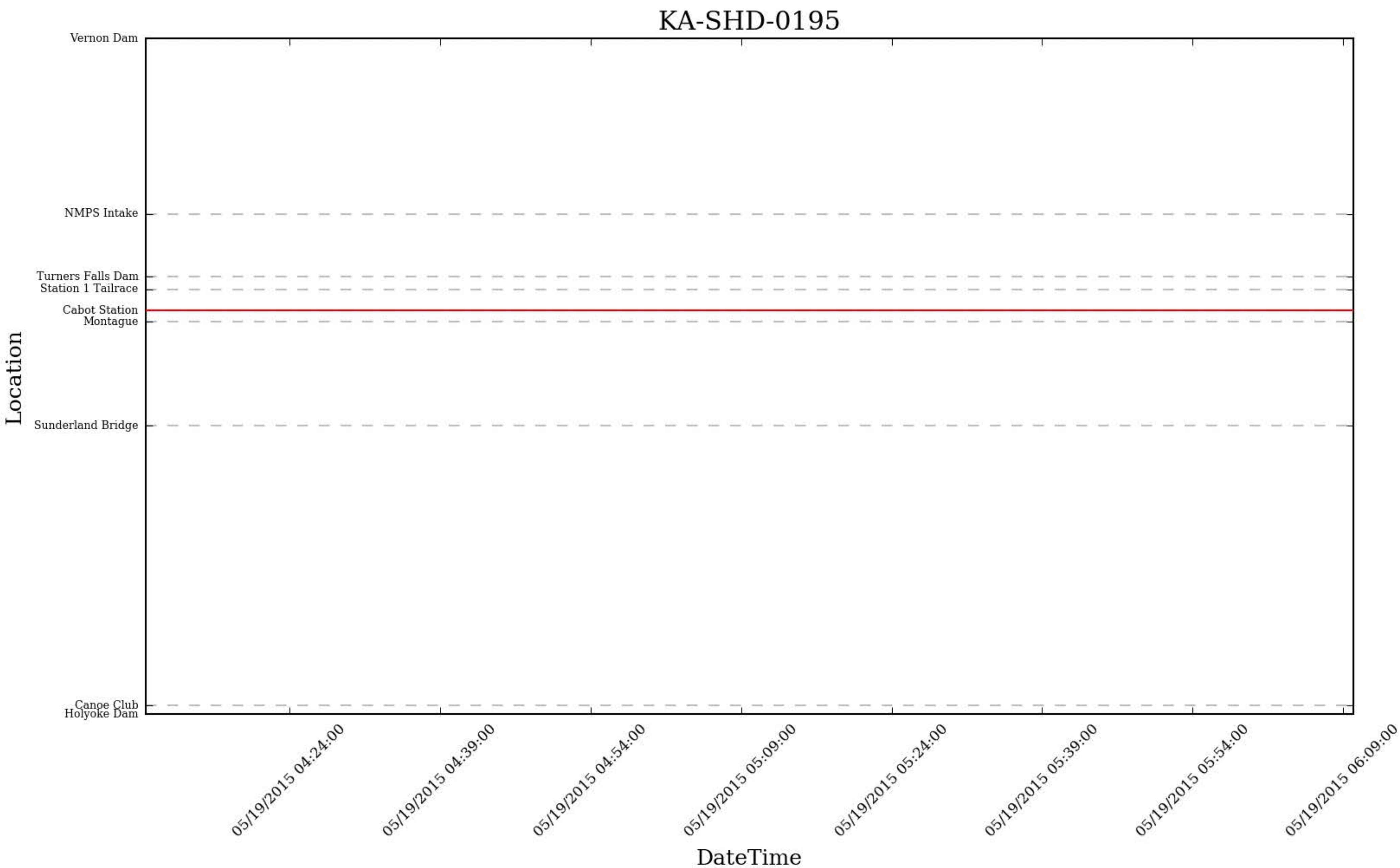
KA-SHD-0188
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
DateTime

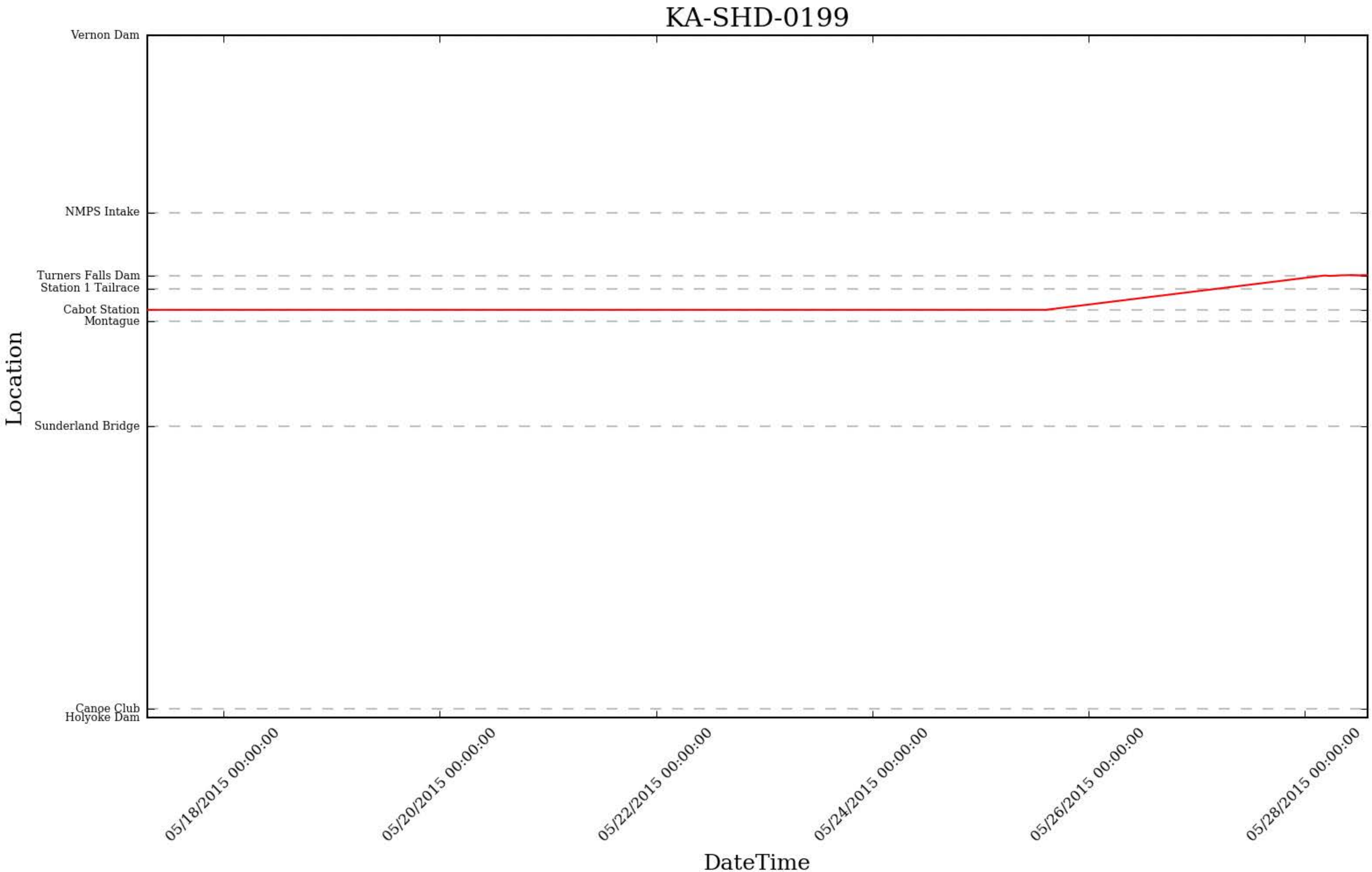

KA-SHD-0190
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
DateTime

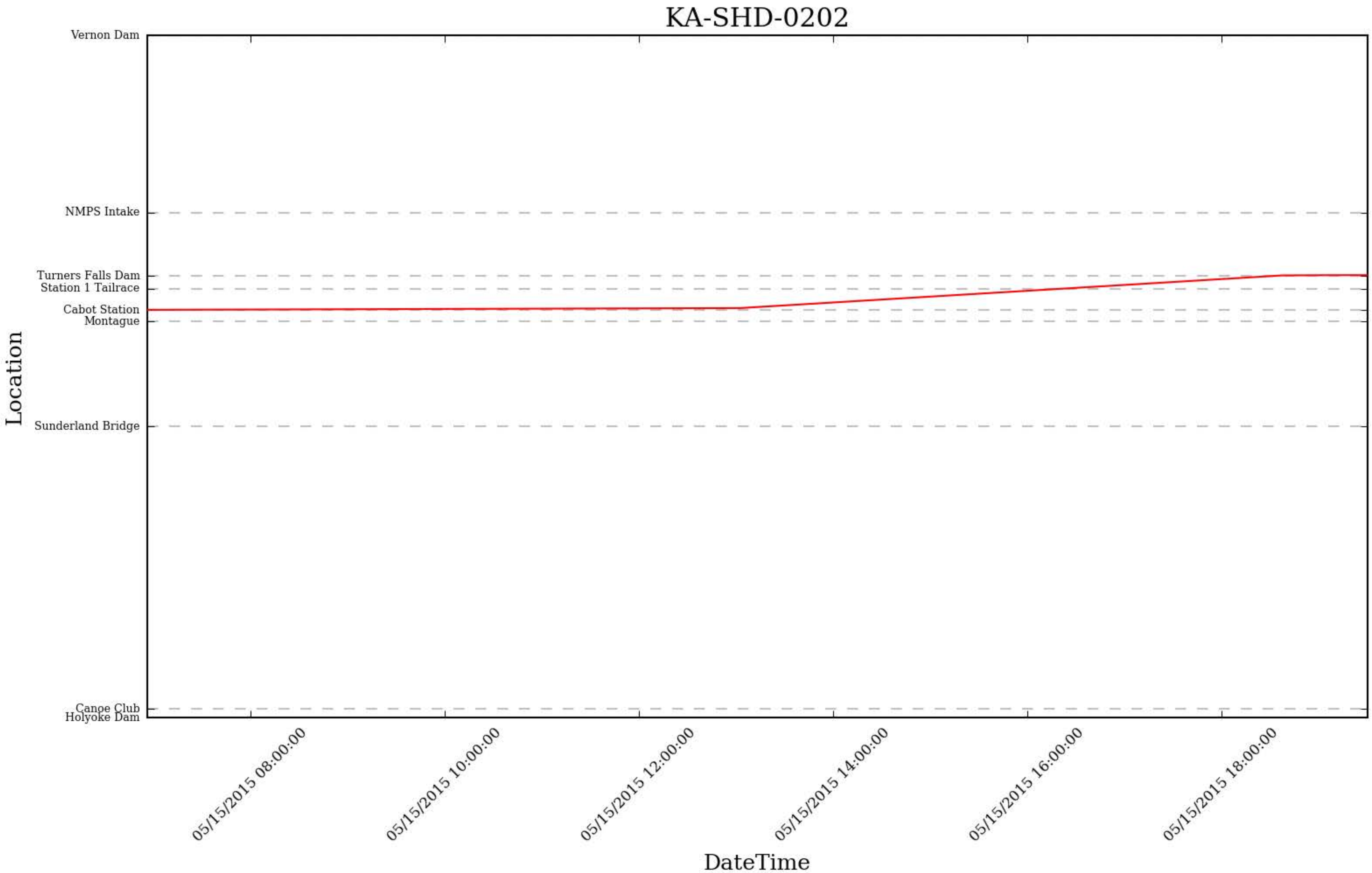

KA-SHD-0191
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
DateTime


KA-SHD-0192
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
DateTime

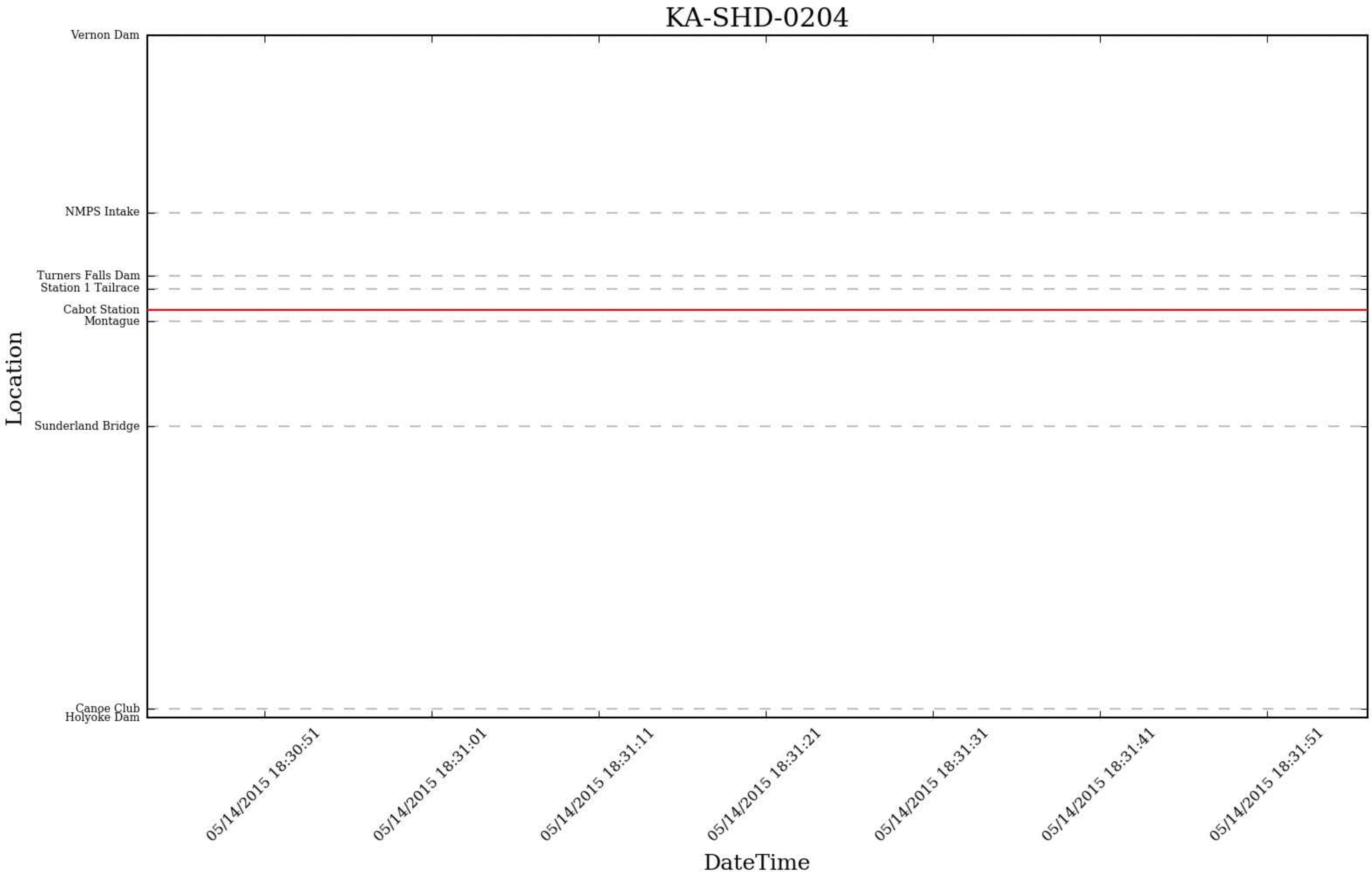

KA-SHD-0194
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 10:00:00
05/26/2015 22:00:00
05/27/2015 10:00:00
05/27/2015 22:00:00
05/28/2015 10:00:00
05/28/2015 22:00:00
05/29/2015 10:00:00
05/29/2015 22:00:00
DateTime


KA-SHD-0195
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 04:24:00
05/19/2015 04:39:00
05/19/2015 04:54:00
05/19/2015 05:09:00
05/19/2015 05:24:00
05/19/2015 05:39:00
05/19/2015 05:54:00
05/19/2015 06:09:00
DateTime

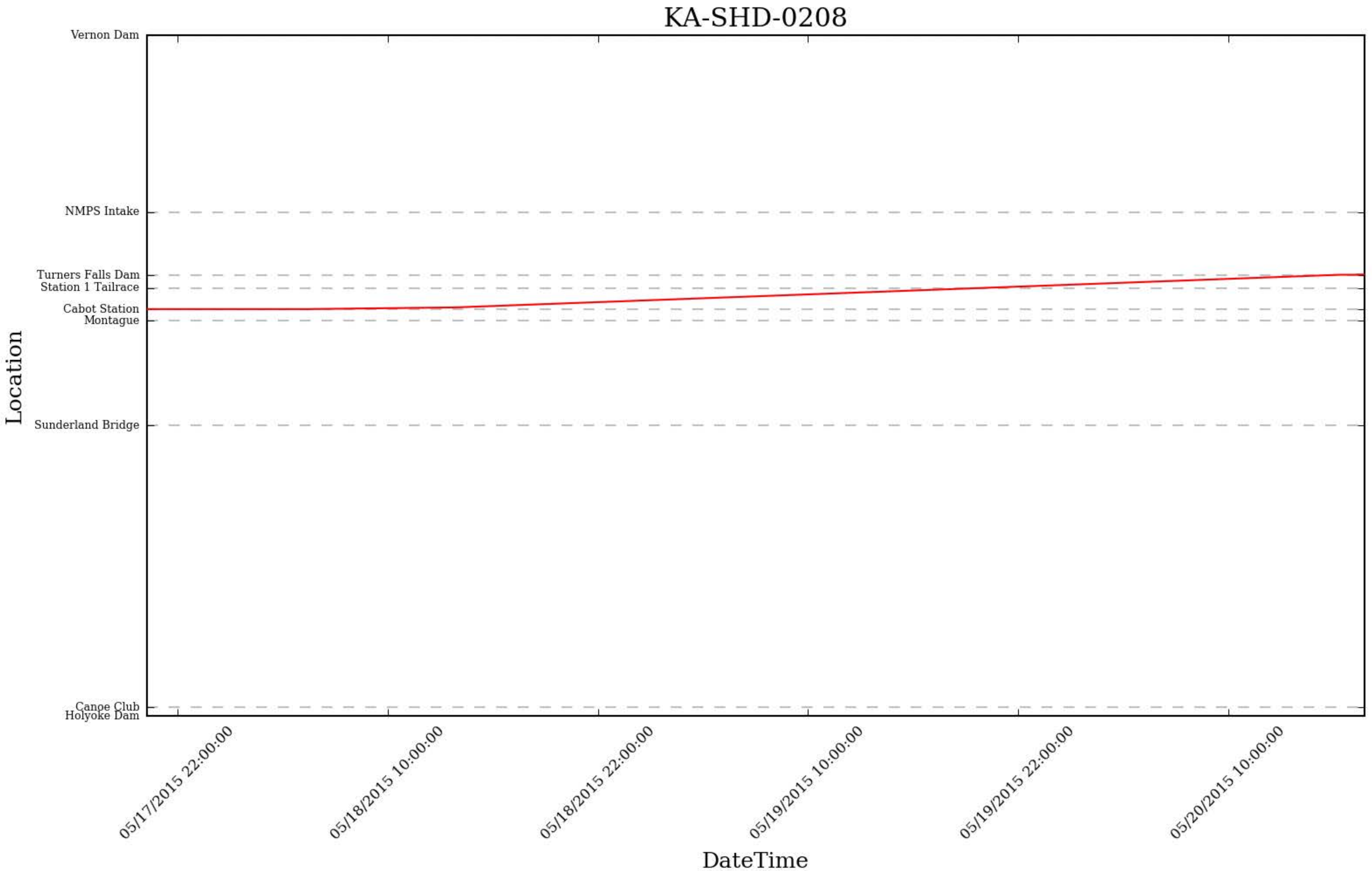

KA-SHD-0199
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
DateTime



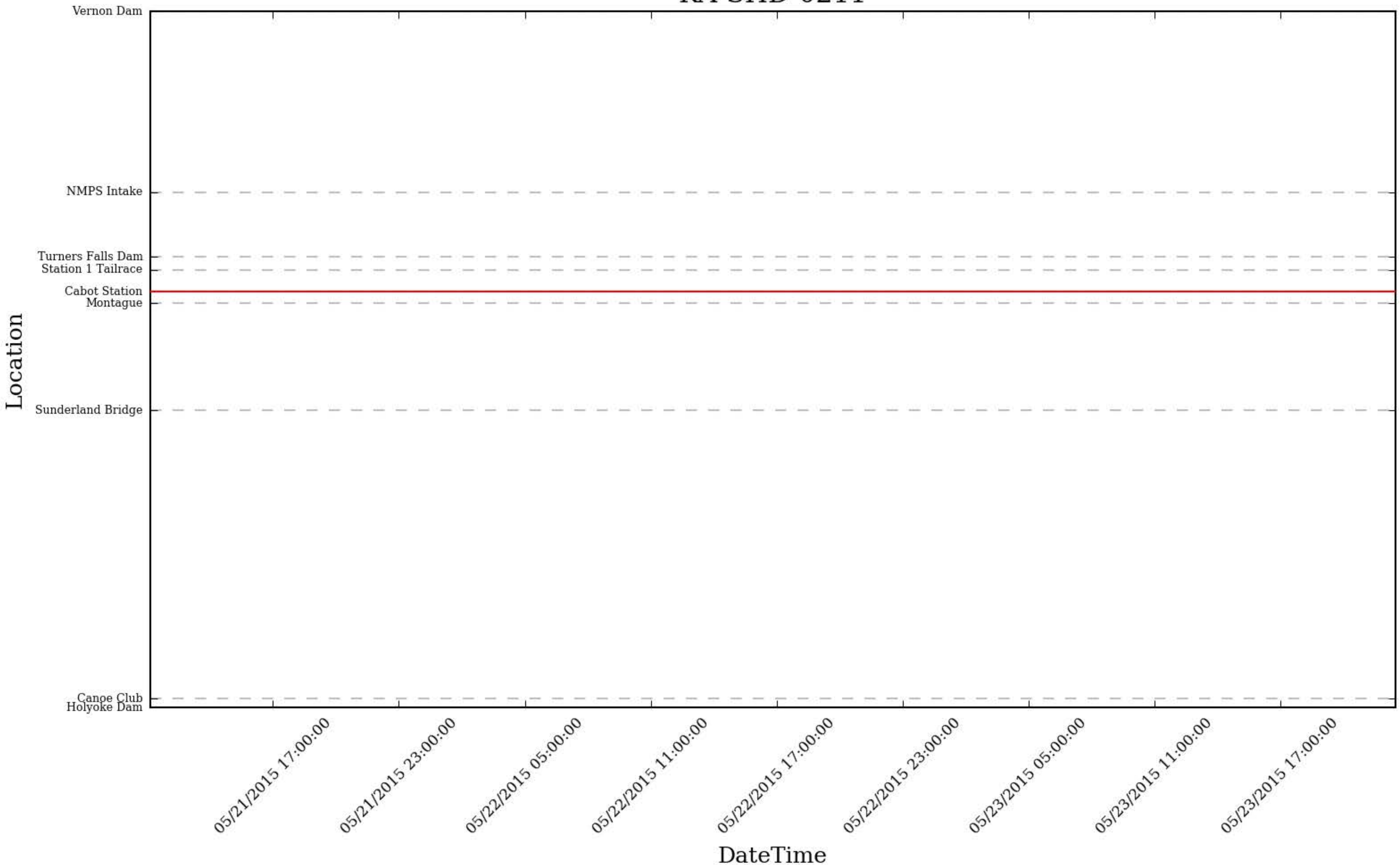
KA-SHD-0202
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 08:00:00
05/15/2015 10:00:00
05/15/2015 12:00:00
05/15/2015 14:00:00
05/15/2015 16:00:00
05/15/2015 18:00:00
DateTime



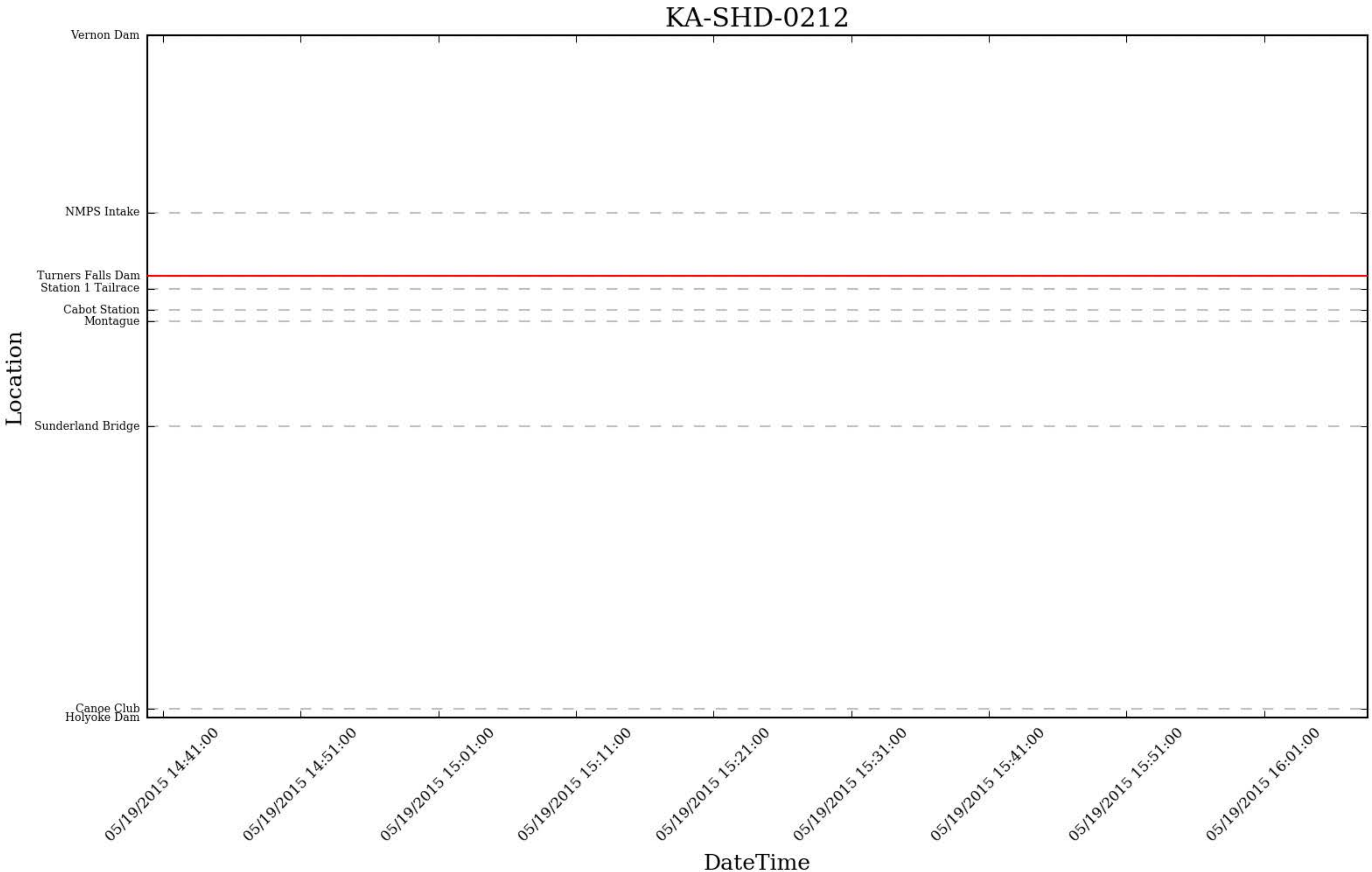
KA-SHD-0204
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 18:30:51
05/14/2015 18:31:01
05/14/2015 18:31:11
05/14/2015 18:31:21
05/14/2015 18:31:31
05/14/2015 18:31:41
05/14/2015 18:31:51
DateTime

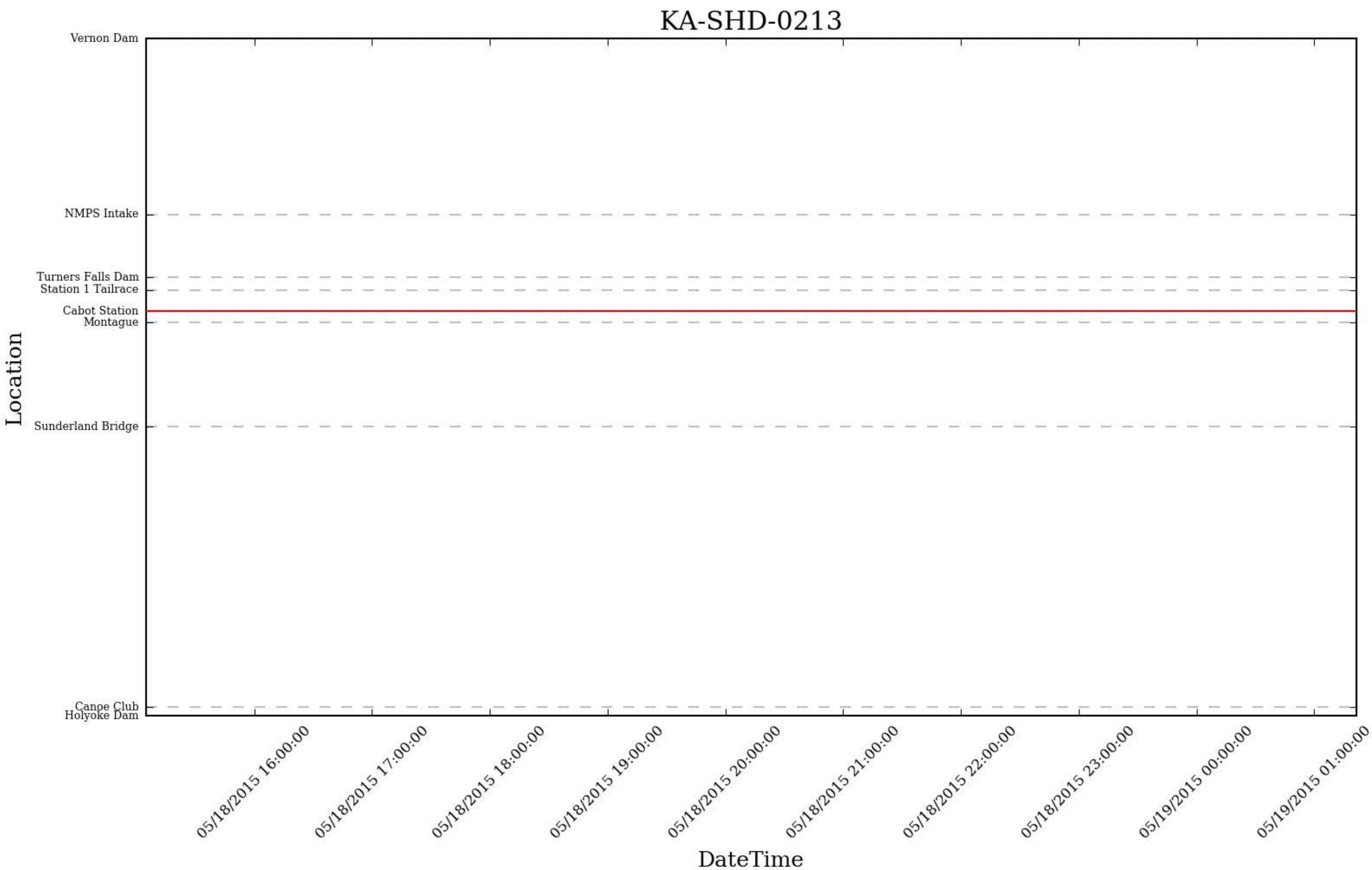

KA-SHD-0208
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 22:00:00
05/18/2015 10:00:00
05/18/2015 22:00:00
05/19/2015 10:00:00
05/19/2015 22:00:00
05/20/2015 10:00:00
DateTime

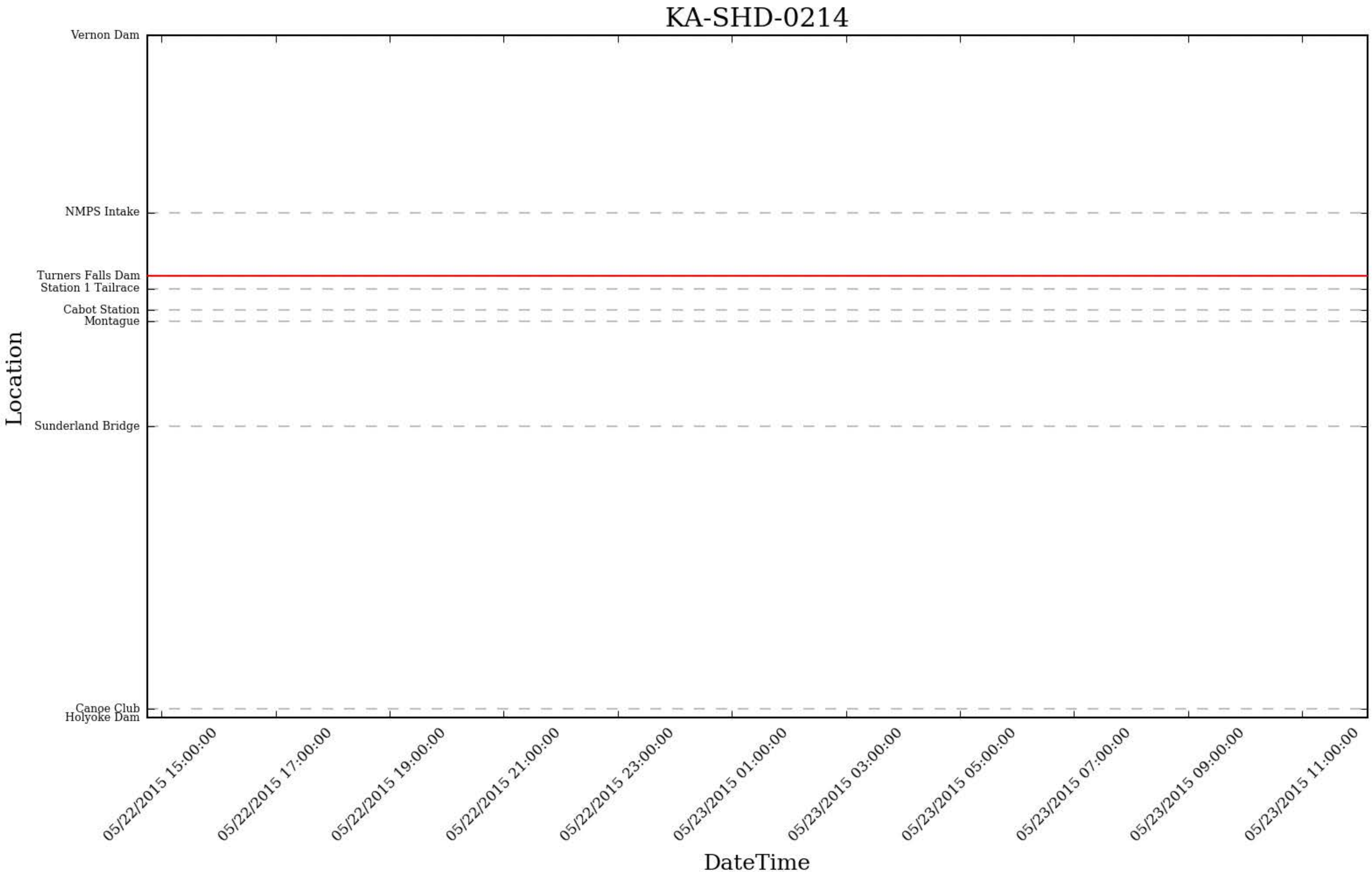
KA-SHD-0211

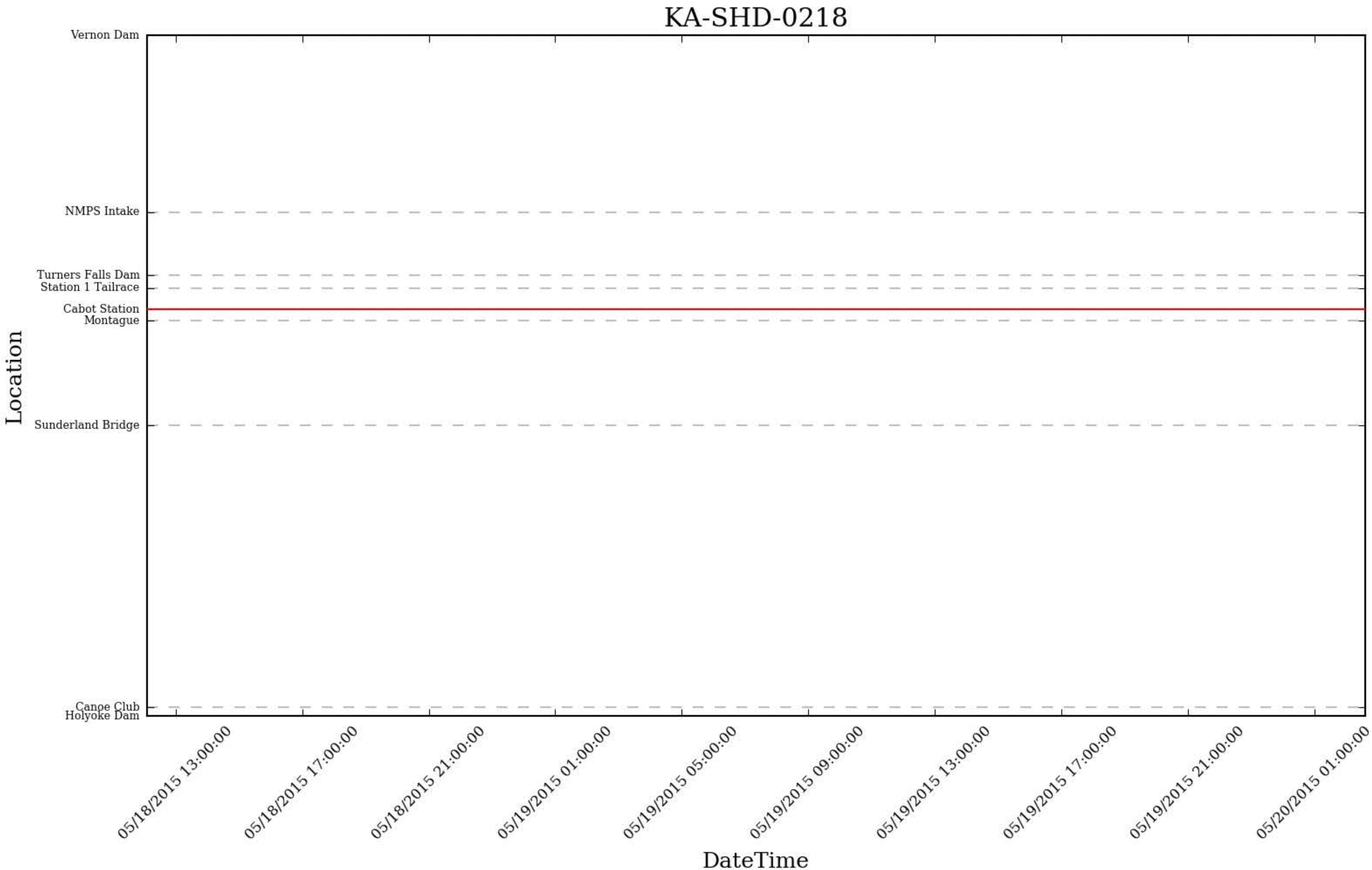


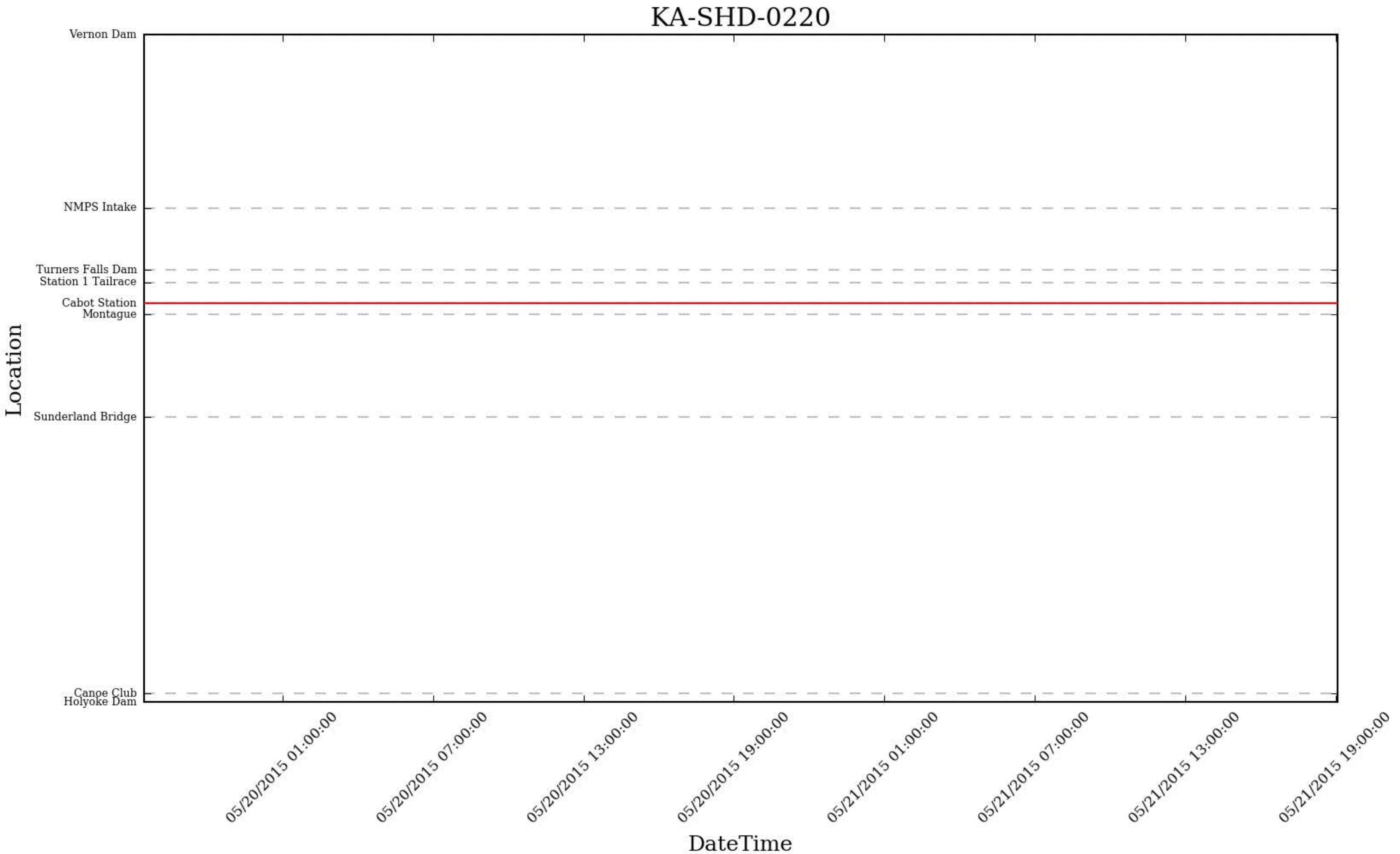
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 17:00:00
05/21/2015 23:00:00
05/22/2015 05:00:00
05/22/2015 11:00:00
05/22/2015 17:00:00
05/22/2015 23:00:00
05/23/2015 05:00:00
05/23/2015 11:00:00
05/23/2015 17:00:00
DateTime


KA-SHD-0212
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 14:41:00
05/19/2015 14:51:00
05/19/2015 15:01:00
05/19/2015 15:11:00
05/19/2015 15:21:00
05/19/2015 15:31:00
05/19/2015 15:41:00
05/19/2015 15:51:00
05/19/2015 16:01:00
DateTime

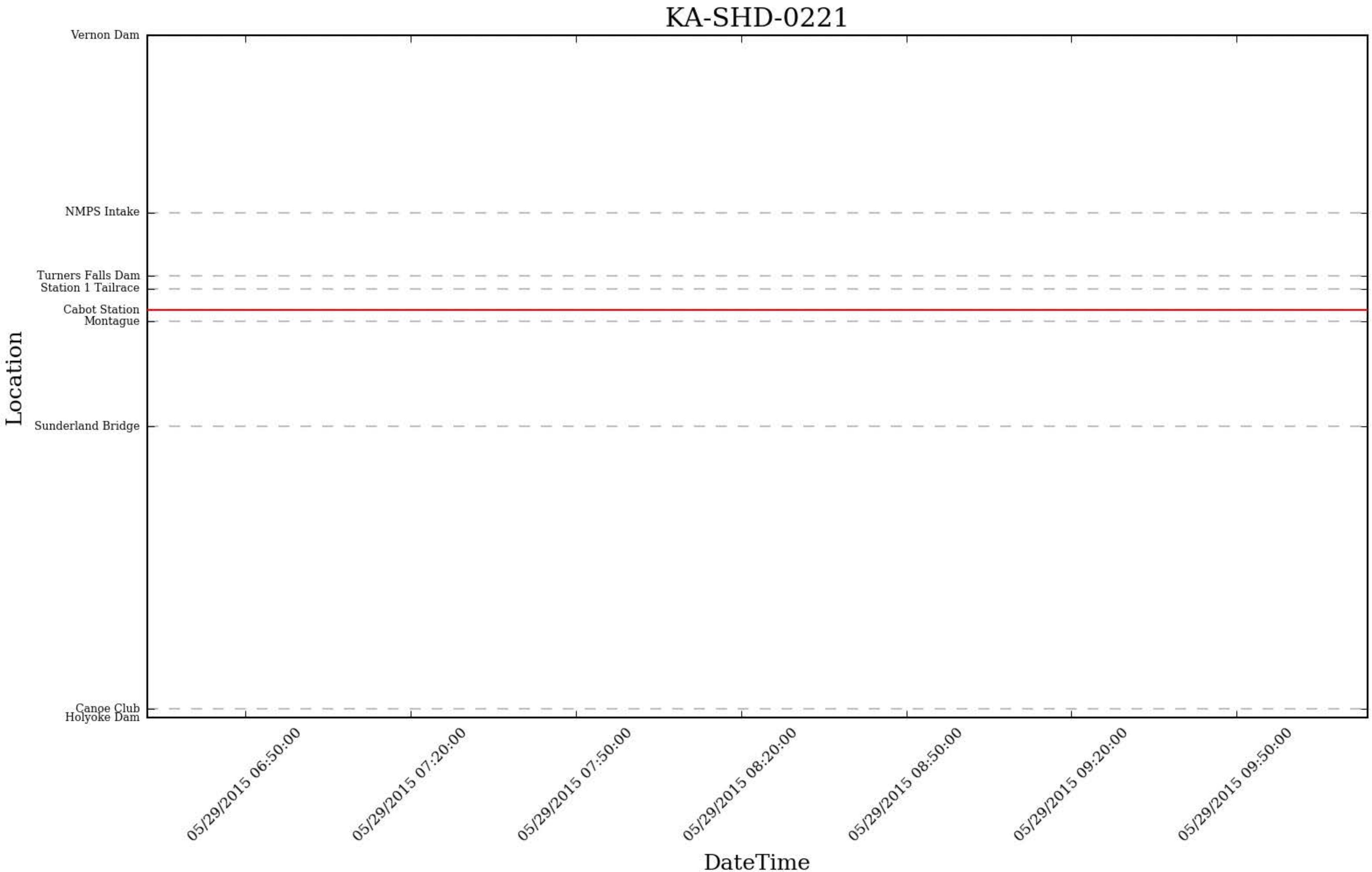

KA-SHD-0213
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/18/2015 16:00:00
05/18/2015 17:00:00
05/18/2015 18:00:00
05/18/2015 19:00:00
05/18/2015 20:00:00
05/18/2015 21:00:00
05/18/2015 22:00:00
05/18/2015 23:00:00
05/19/2015 00:00:00
05/19/2015 01:00:00
DateTime

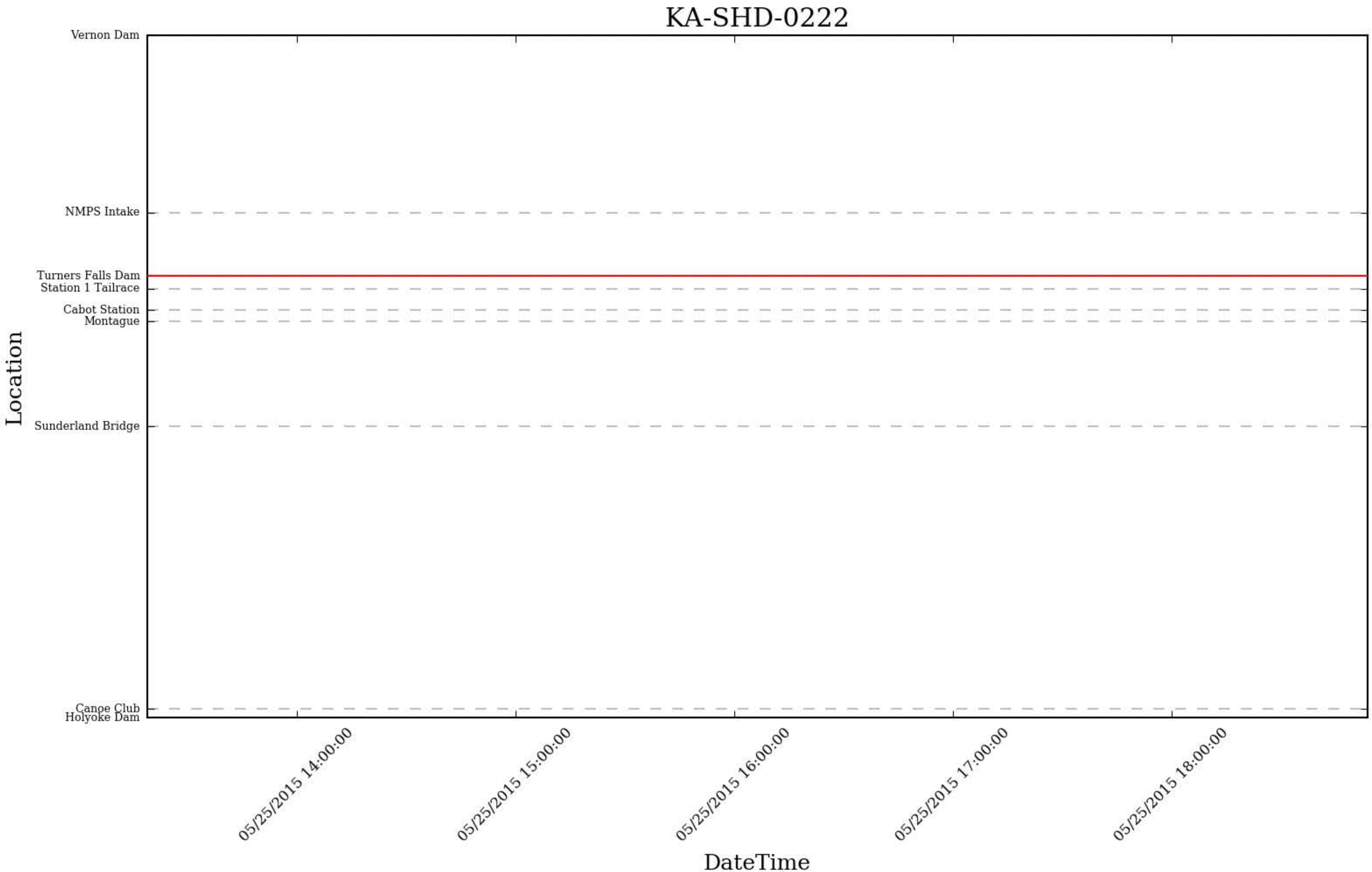

KA-SHD-0214
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/22/2015 15:00:00
05/22/2015 17:00:00
05/22/2015 19:00:00
05/22/2015 21:00:00
05/22/2015 23:00:00
05/23/2015 01:00:00
05/23/2015 03:00:00
05/23/2015 05:00:00
05/23/2015 07:00:00
05/23/2015 09:00:00
05/23/2015 11:00:00
DateTime

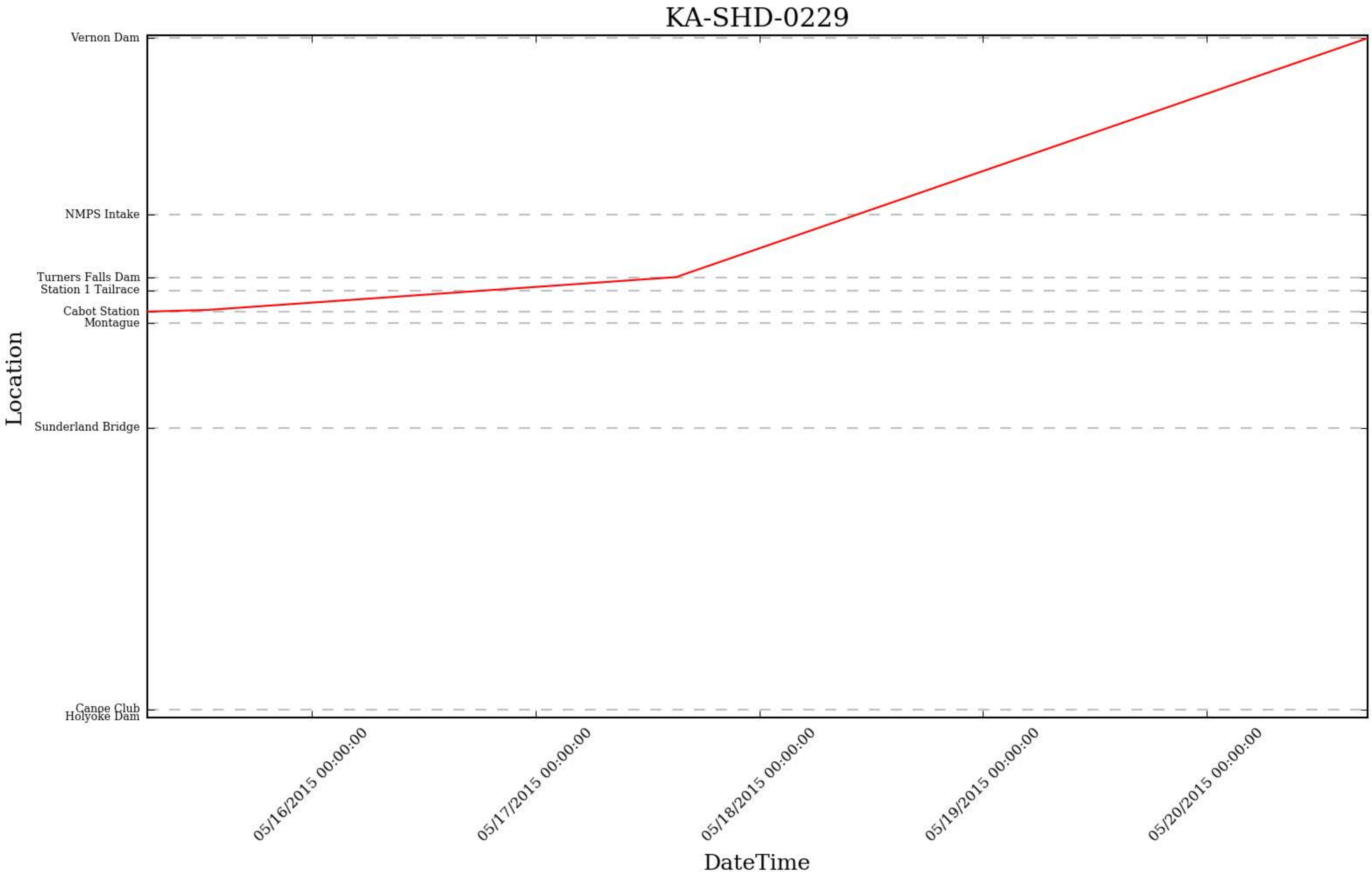

KA-SHD-0218
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 13:00:00
05/18/2015 17:00:00
05/18/2015 21:00:00
05/19/2015 01:00:00
05/19/2015 05:00:00
05/19/2015 09:00:00
05/19/2015 13:00:00
05/19/2015 17:00:00
05/19/2015 21:00:00
05/20/2015 01:00:00
DateTime



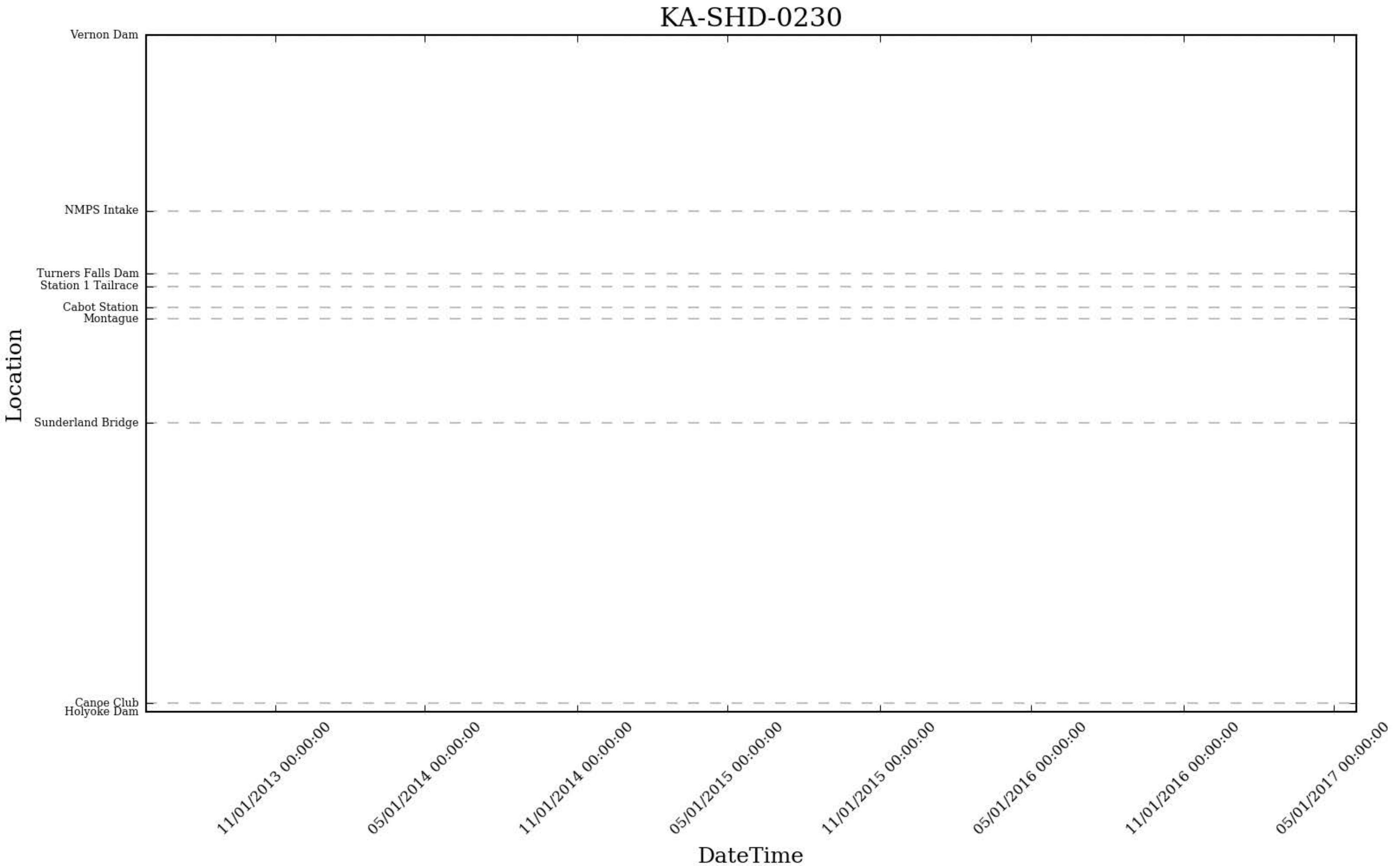
KA-SHD-0220
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 01:00:00
05/20/2015 07:00:00
05/20/2015 13:00:00
05/20/2015 19:00:00
05/21/2015 01:00:00
05/21/2015 07:00:00
05/21/2015 13:00:00
05/21/2015 19:00:00
DateTime


KA-SHD-0221
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 06:50:00
05/29/2015 07:20:00
05/29/2015 07:50:00
05/29/2015 08:20:00
05/29/2015 08:50:00
05/29/2015 09:20:00
05/29/2015 09:50:00
DateTime

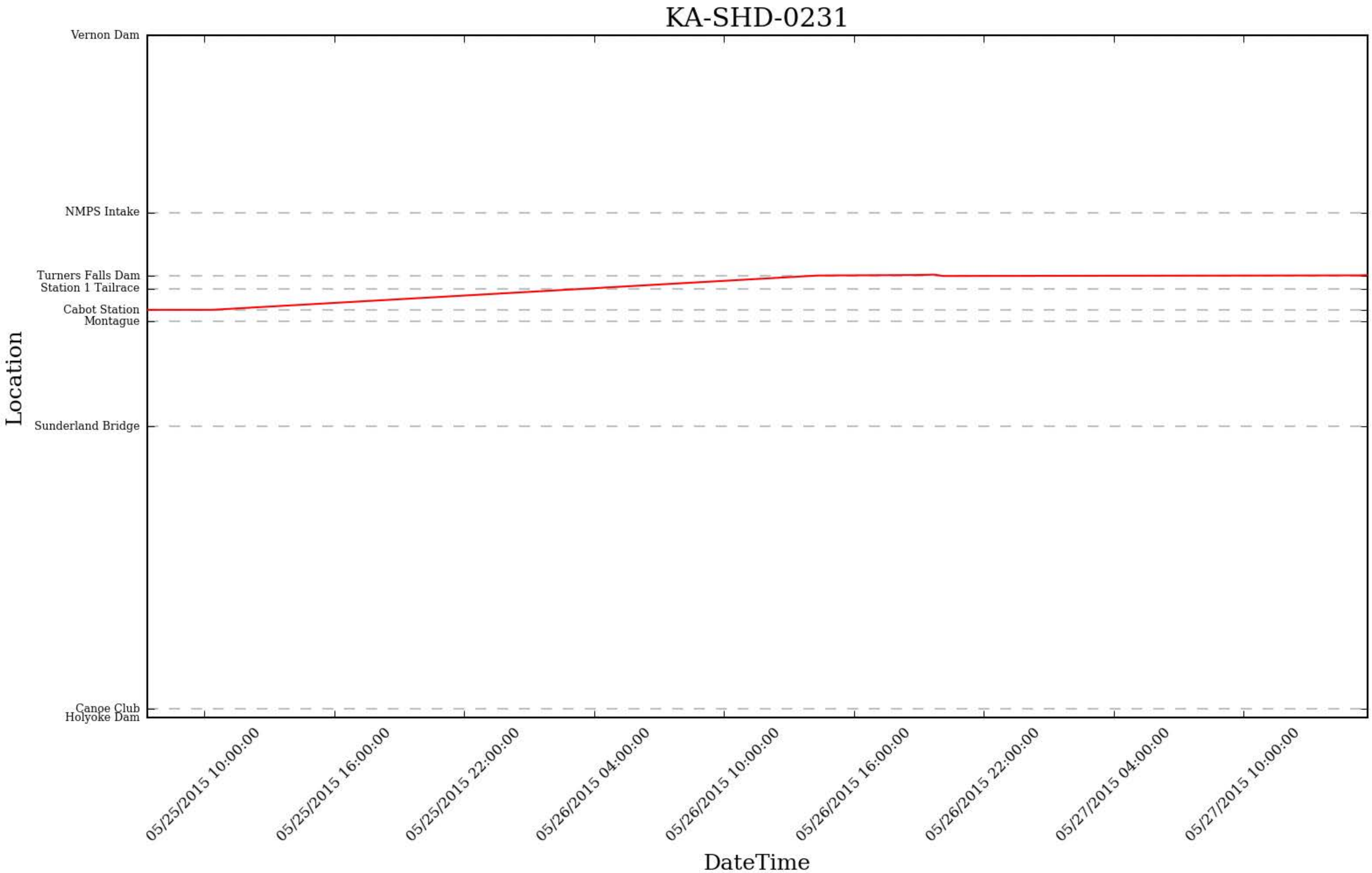

KA-SHD-0222
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 14:00:00
05/25/2015 15:00:00
05/25/2015 16:00:00
05/25/2015 17:00:00
05/25/2015 18:00:00
DateTime



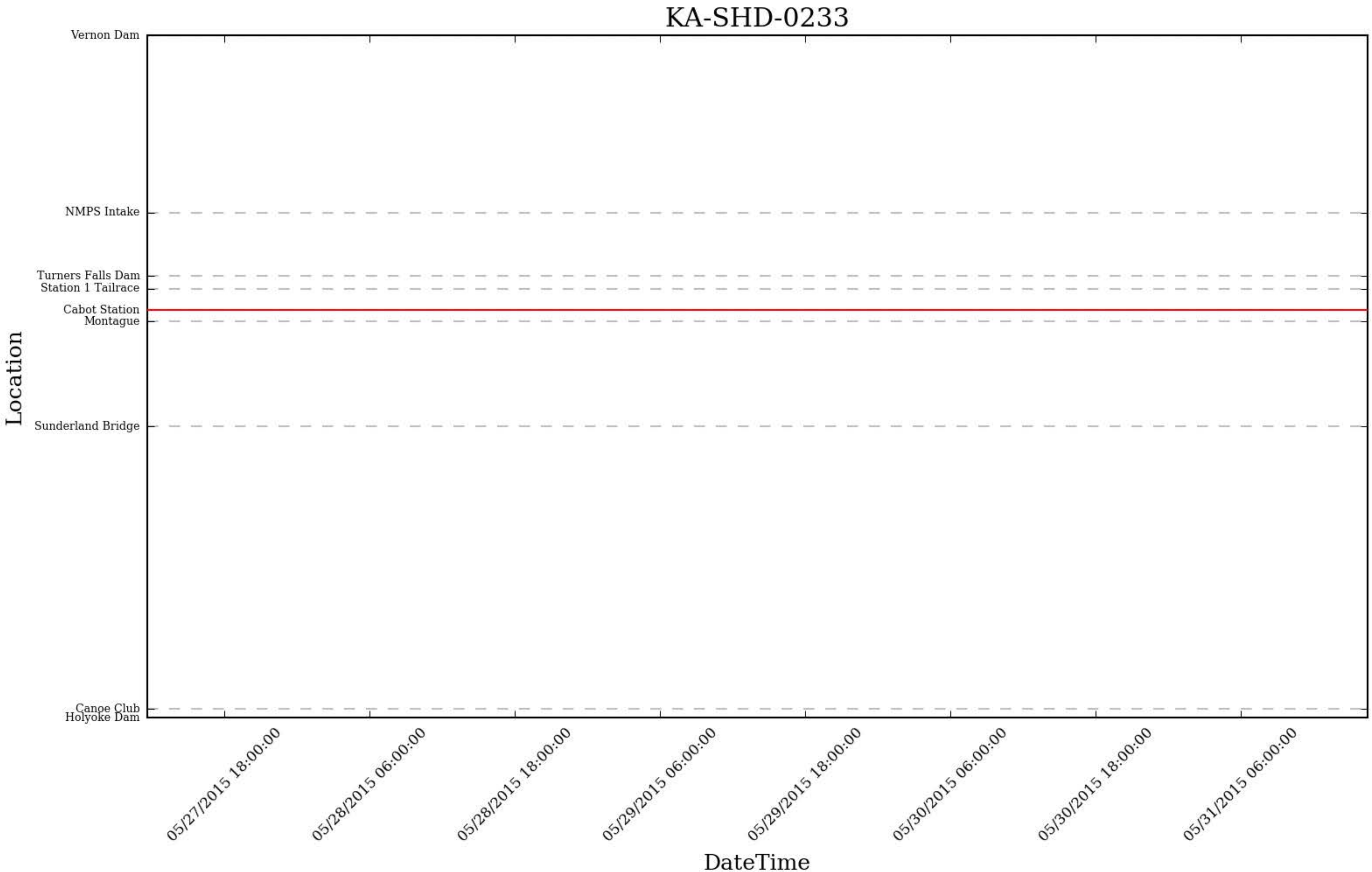
KA-SHD-0229
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
DateTime

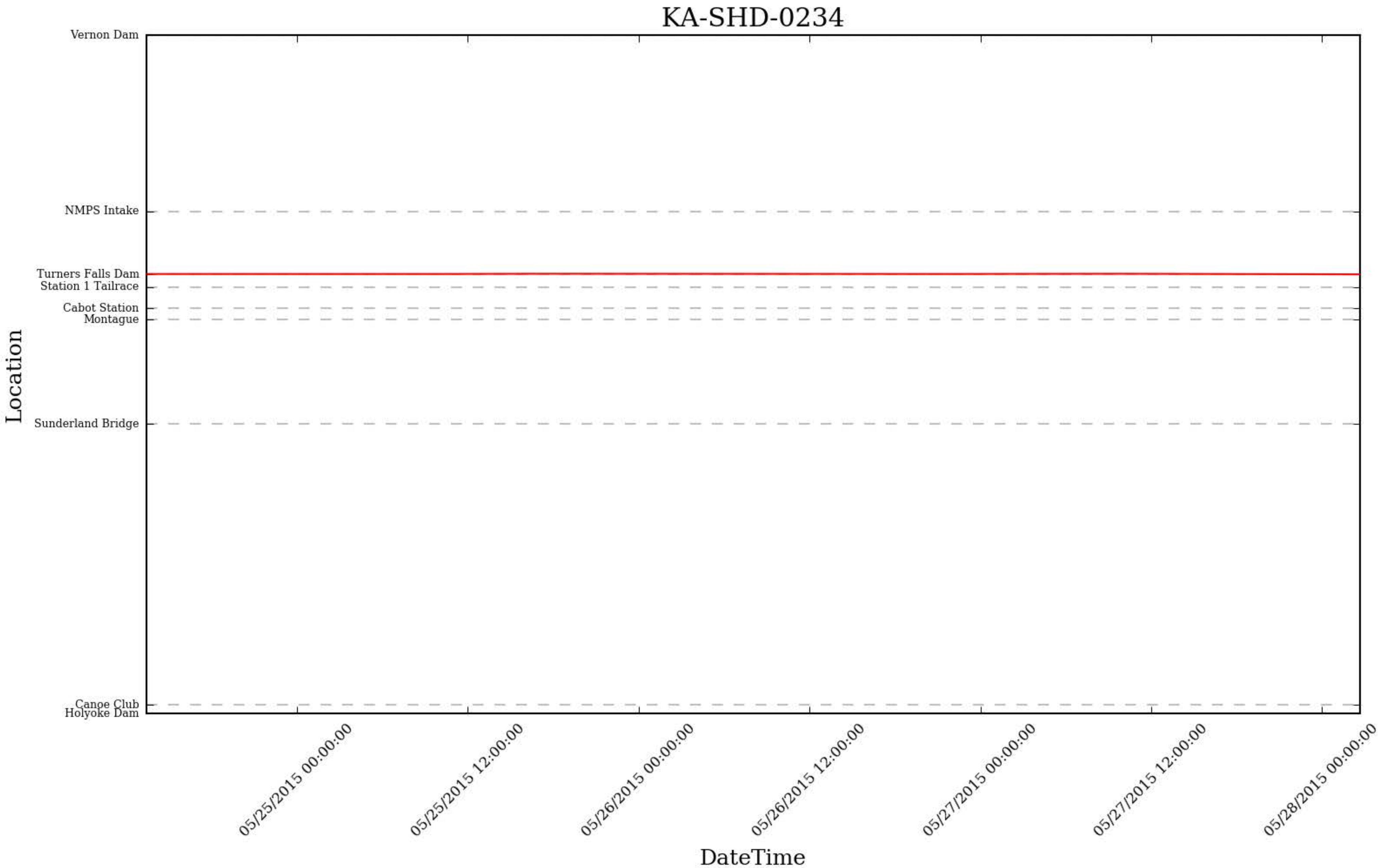


KA-SHD-0230
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

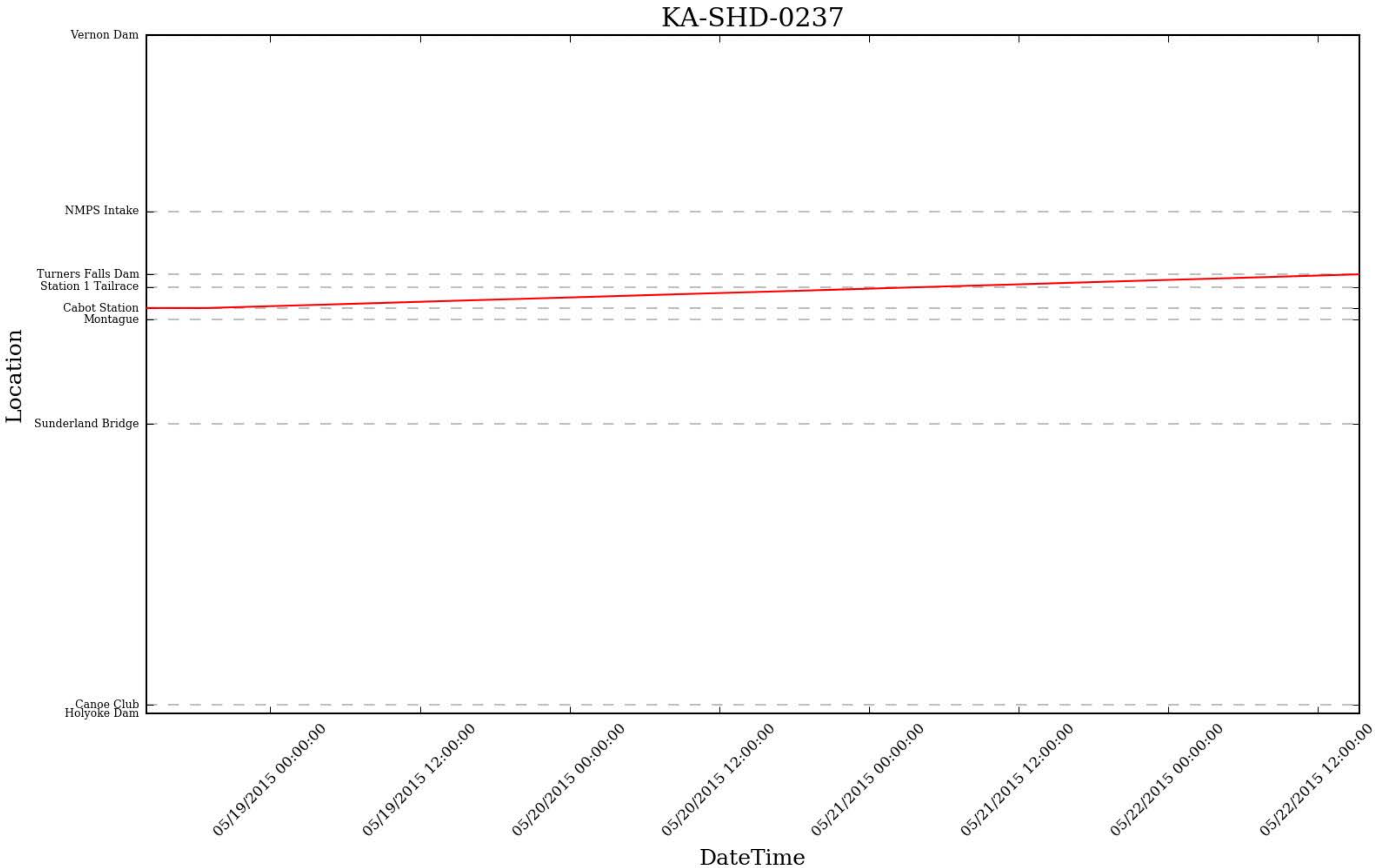


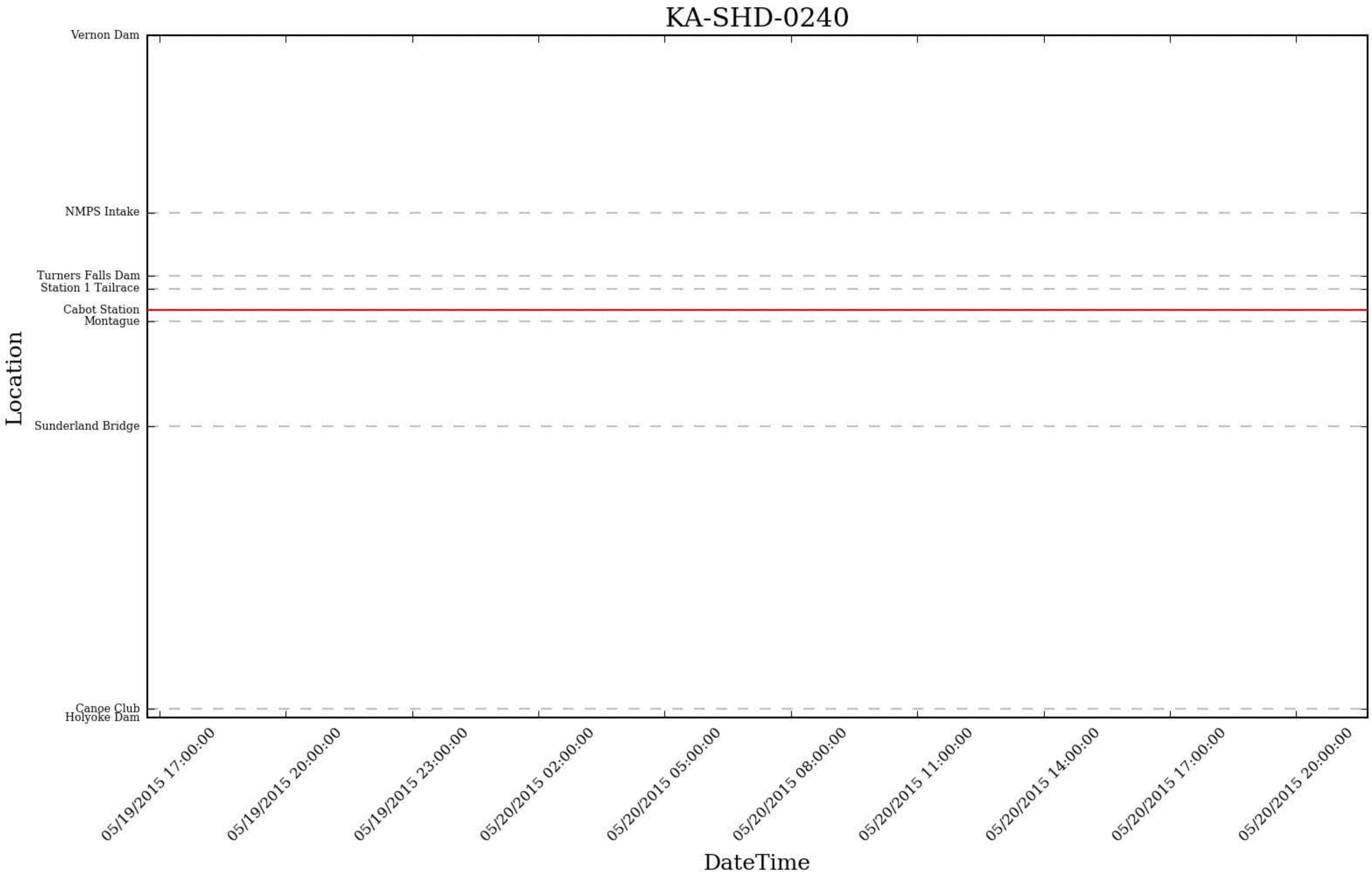
KA-SHD-0231
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 10:00:00
05/25/2015 16:00:00
05/25/2015 22:00:00
05/26/2015 04:00:00
05/26/2015 10:00:00
05/26/2015 16:00:00
05/26/2015 22:00:00
05/27/2015 04:00:00
05/27/2015 10:00:00
DateTime


KA-SHD-0233
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 18:00:00
05/28/2015 06:00:00
05/28/2015 18:00:00
05/29/2015 06:00:00
05/29/2015 18:00:00
05/30/2015 06:00:00
05/30/2015 18:00:00
05/31/2015 06:00:00
DateTime

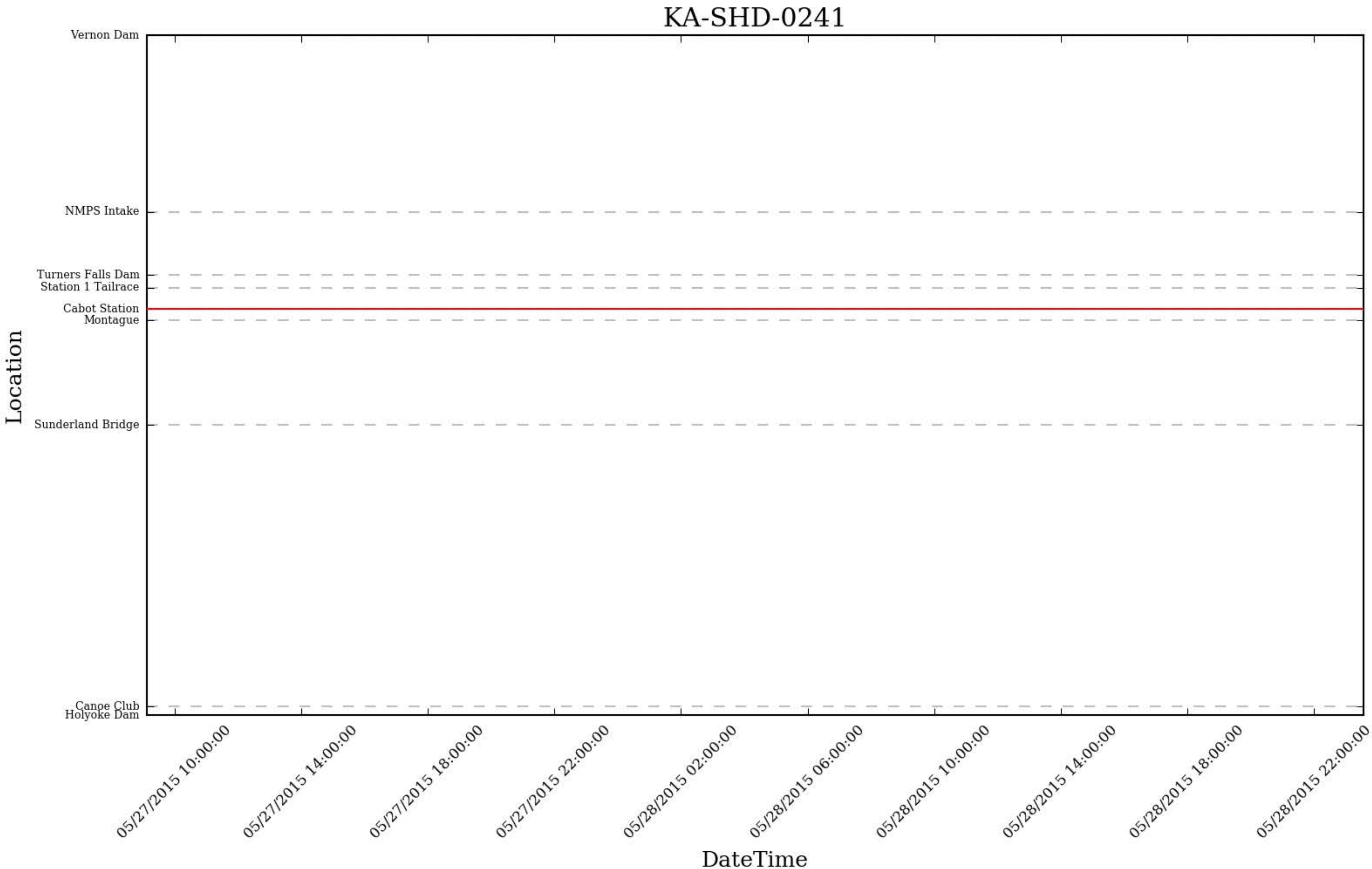


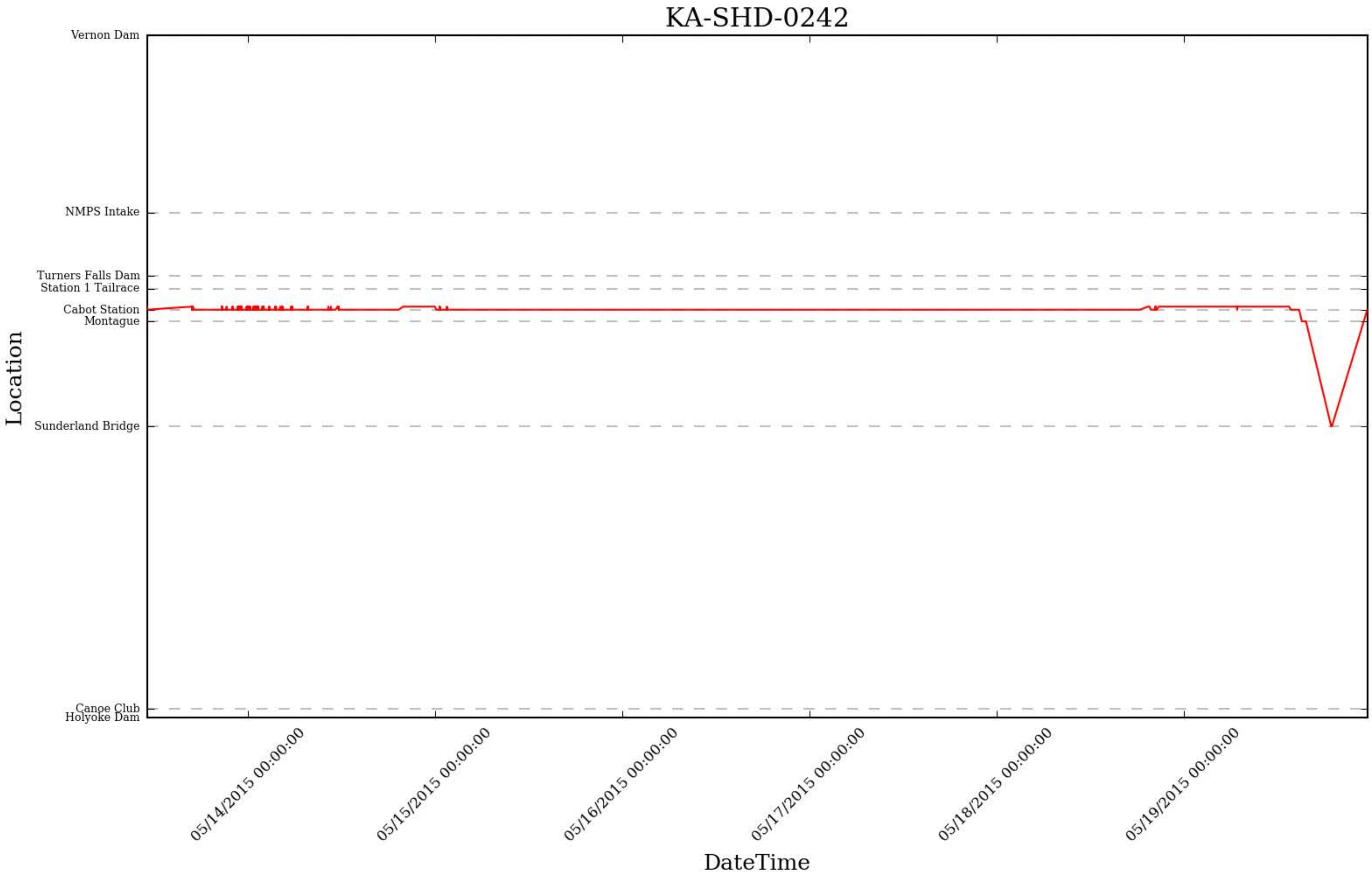
KA-SHD-0234
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 00:00:00
05/25/2015 12:00:00
05/26/2015 00:00:00
05/26/2015 12:00:00
05/27/2015 00:00:00
05/27/2015 12:00:00
05/28/2015 00:00:00
DateTime


KA-SHD-0237
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/19/2015 12:00:00
05/20/2015 00:00:00
05/20/2015 12:00:00
05/21/2015 00:00:00
05/21/2015 12:00:00
05/22/2015 00:00:00
05/22/2015 12:00:00
DateTime

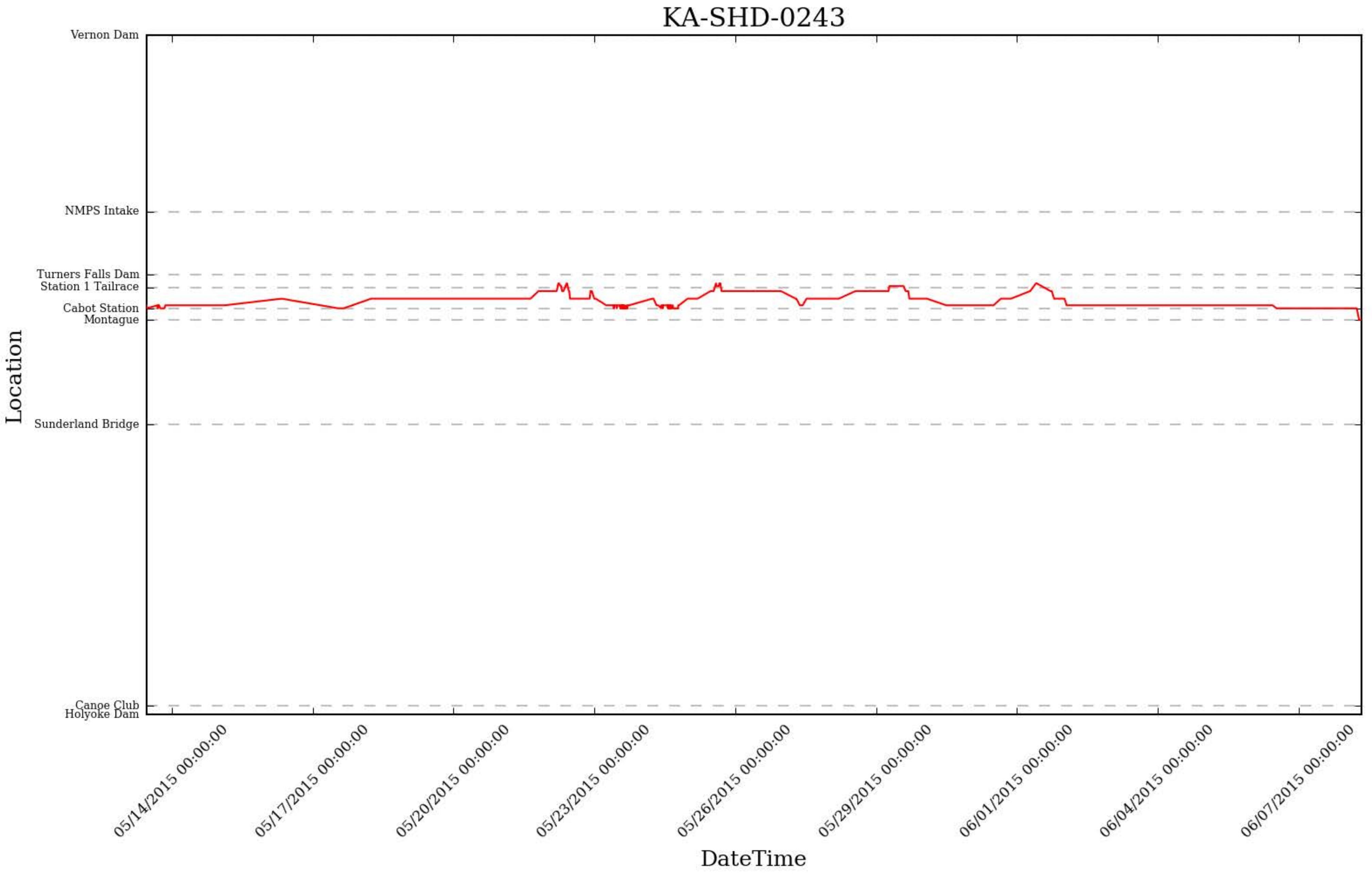


KA-SHD-0240
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 17:00:00
05/19/2015 20:00:00
05/19/2015 23:00:00
05/20/2015 02:00:00
05/20/2015 05:00:00
05/20/2015 08:00:00
05/20/2015 11:00:00
05/20/2015 14:00:00
05/20/2015 17:00:00
05/20/2015 20:00:00
DateTime


KA-SHD-0241
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/27/2015 10:00:00
05/27/2015 14:00:00
05/27/2015 18:00:00
05/27/2015 22:00:00
05/28/2015 02:00:00
05/28/2015 06:00:00
05/28/2015 10:00:00
05/28/2015 14:00:00
05/28/2015 18:00:00
05/28/2015 22:00:00
DateTime



KA-SHD-0242
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/15/2015 00:00:00
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
DateTime


KA-SHD-0243
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
DateTime
05/14/2015 00:00:00
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
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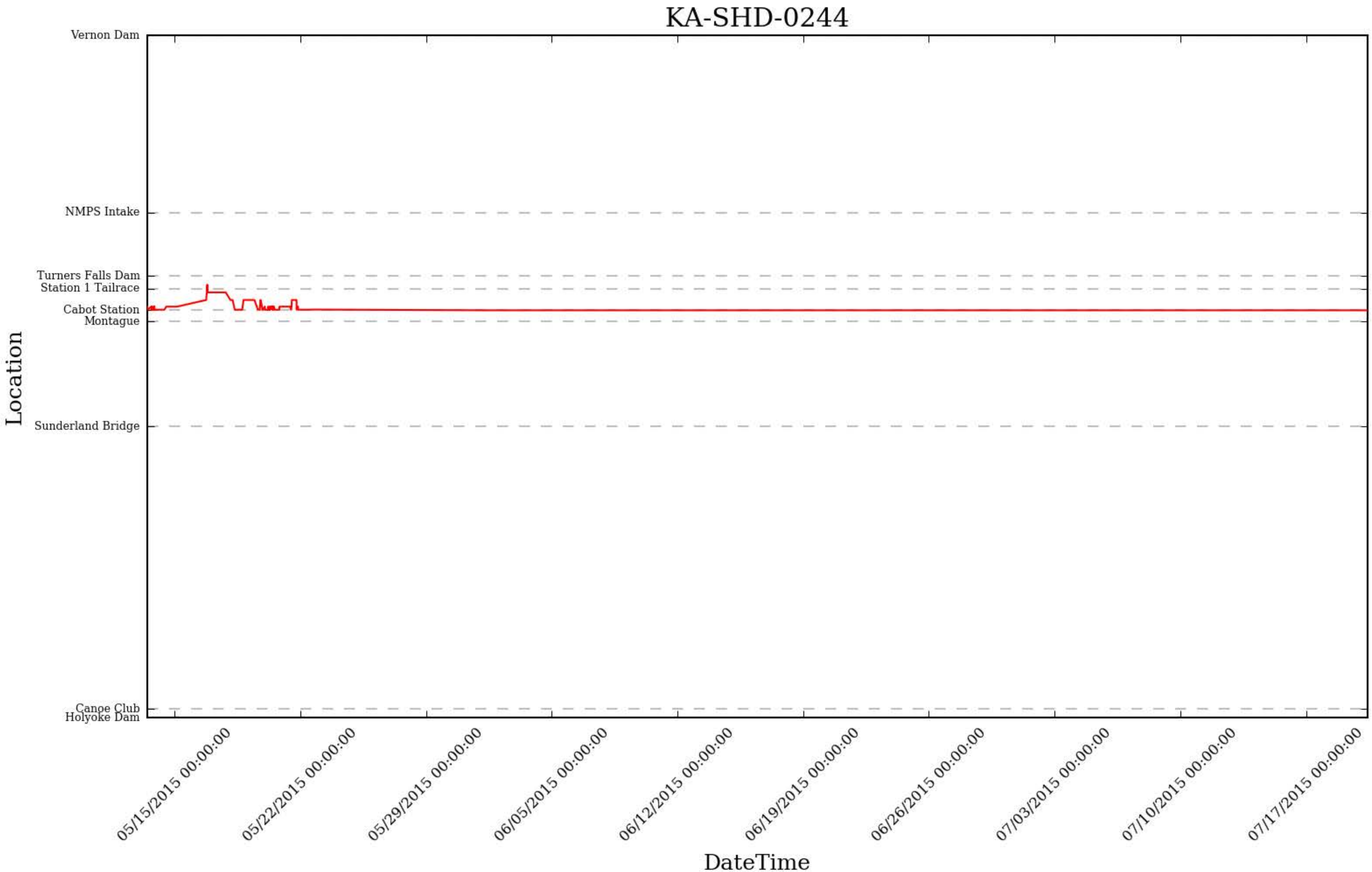
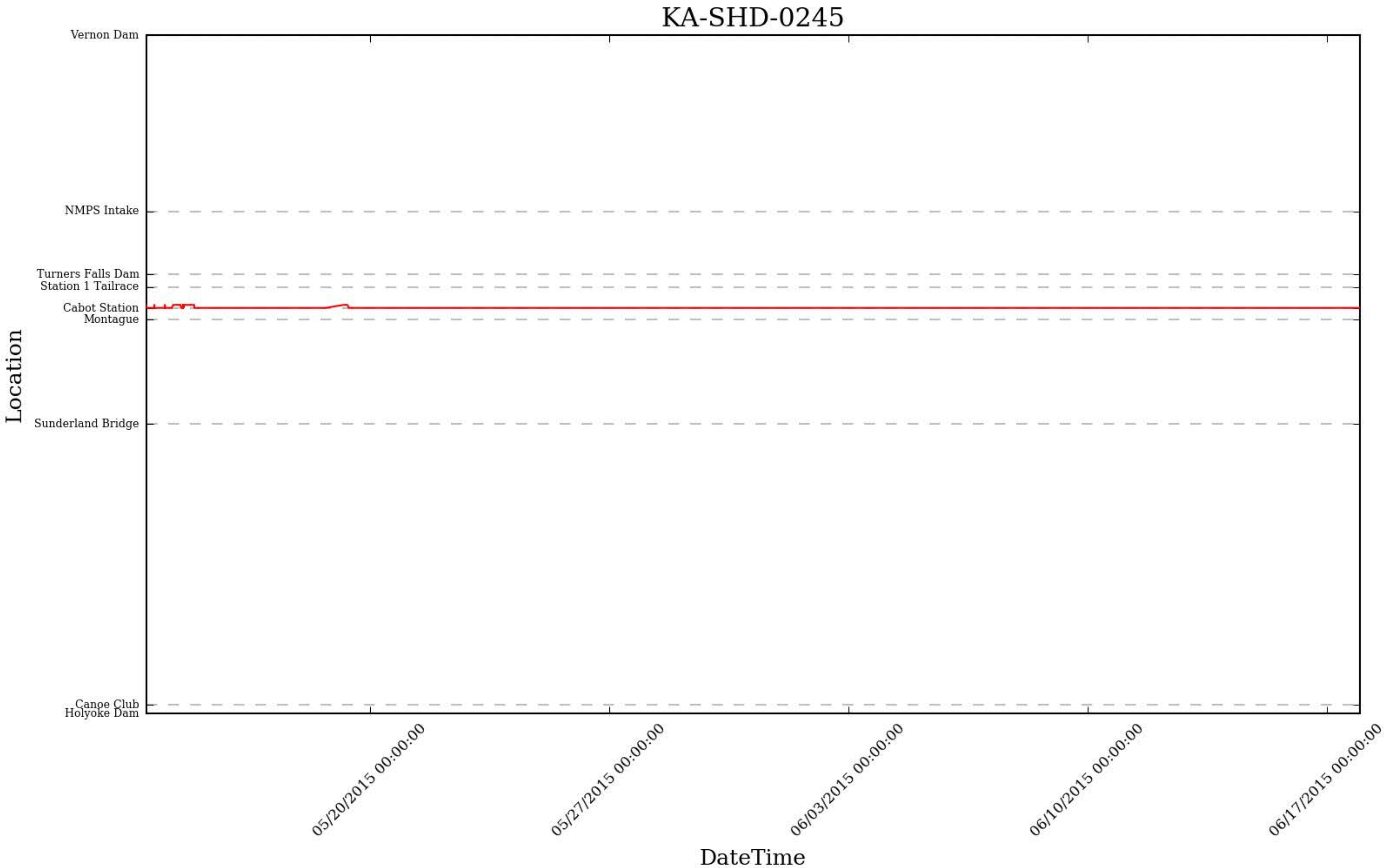
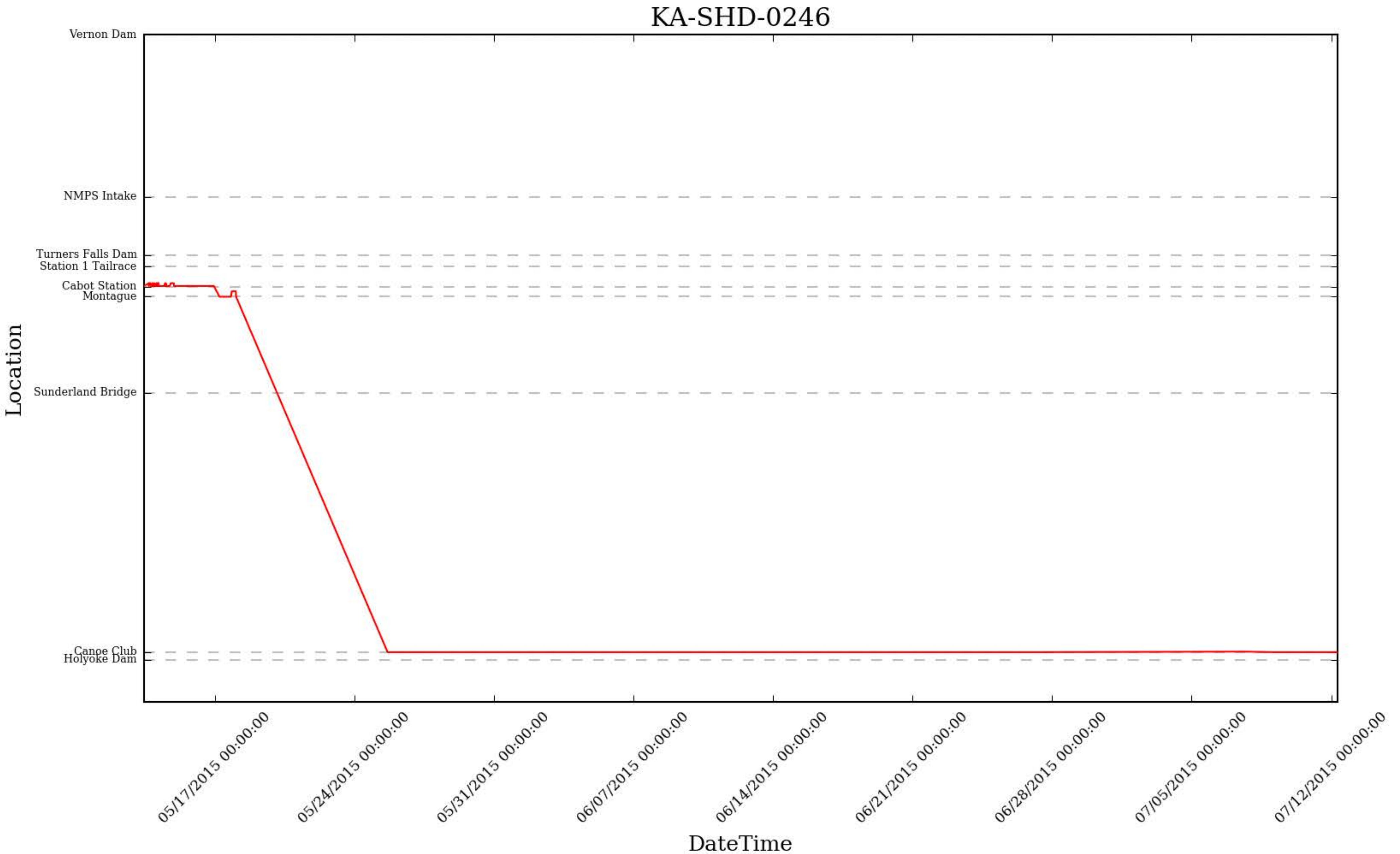
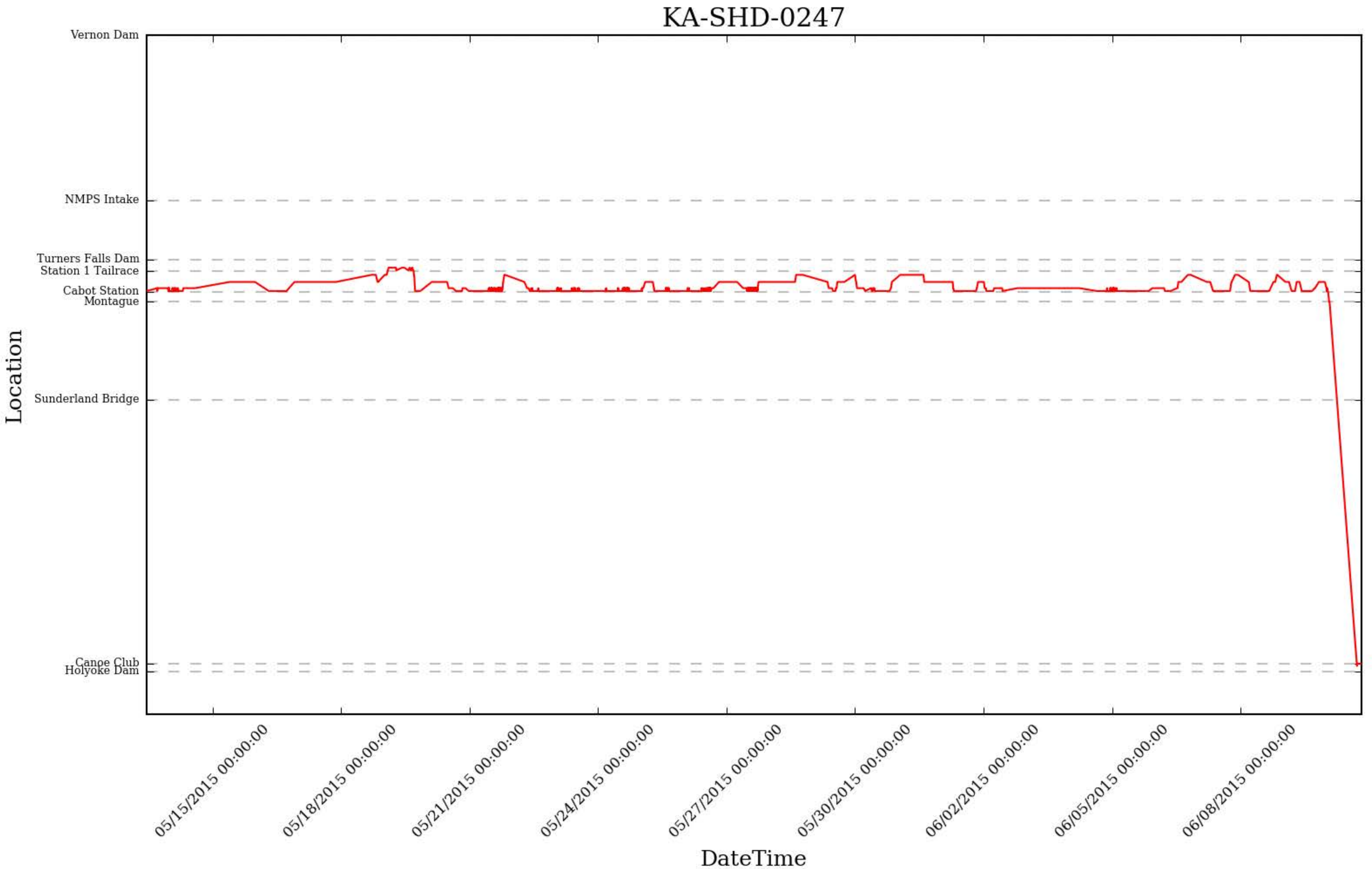
06/04/2015 00:00:00
06/07/2015 00:00:00



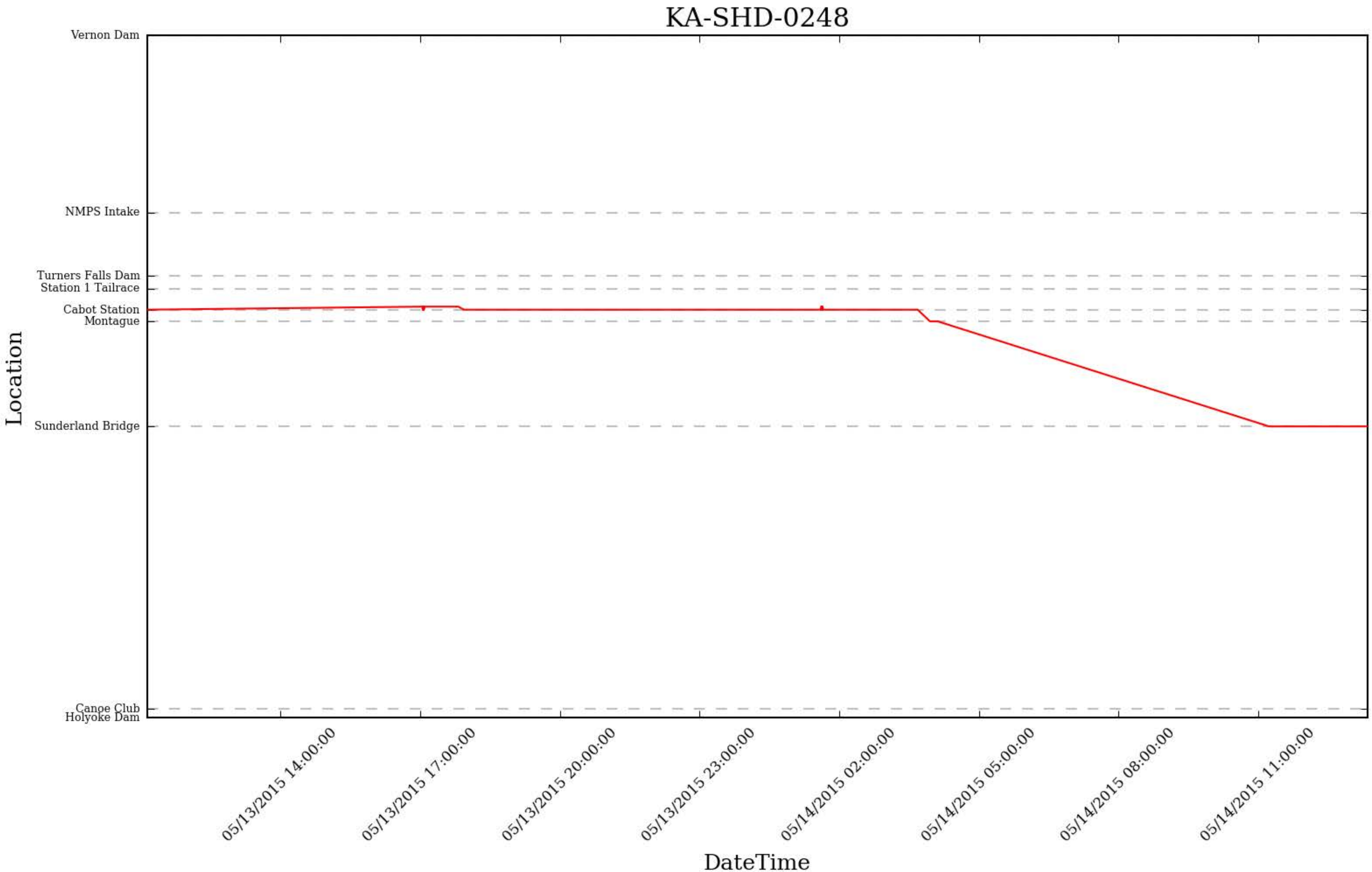
KA-SHD-0244
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
07/10/2015 00:00:00
07/17/2015 00:00:00
DateTime


KA-SHD-0245
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
DateTime

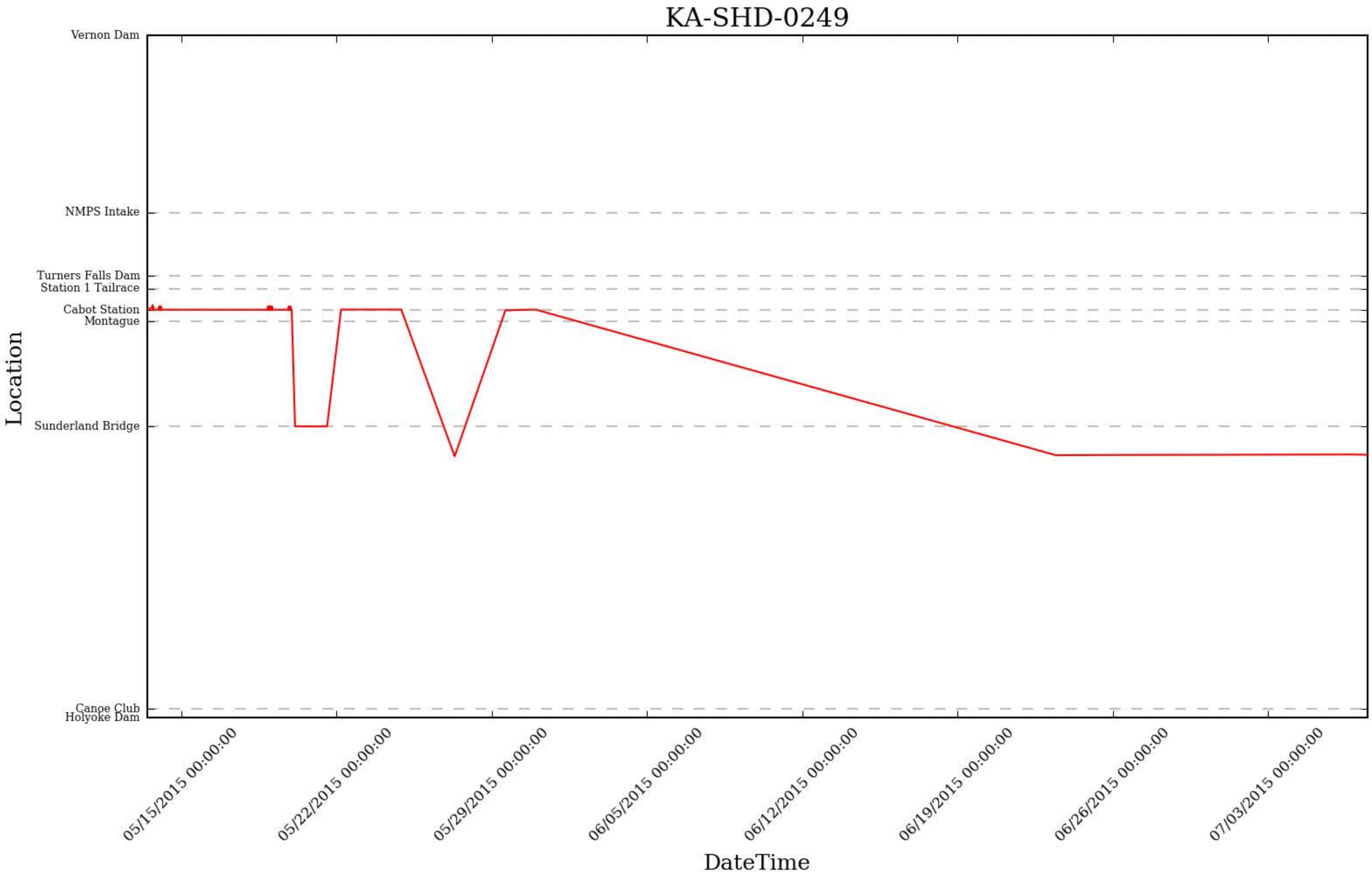

KA-SHD-0246
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
07/12/2015 00:00:00
DateTime

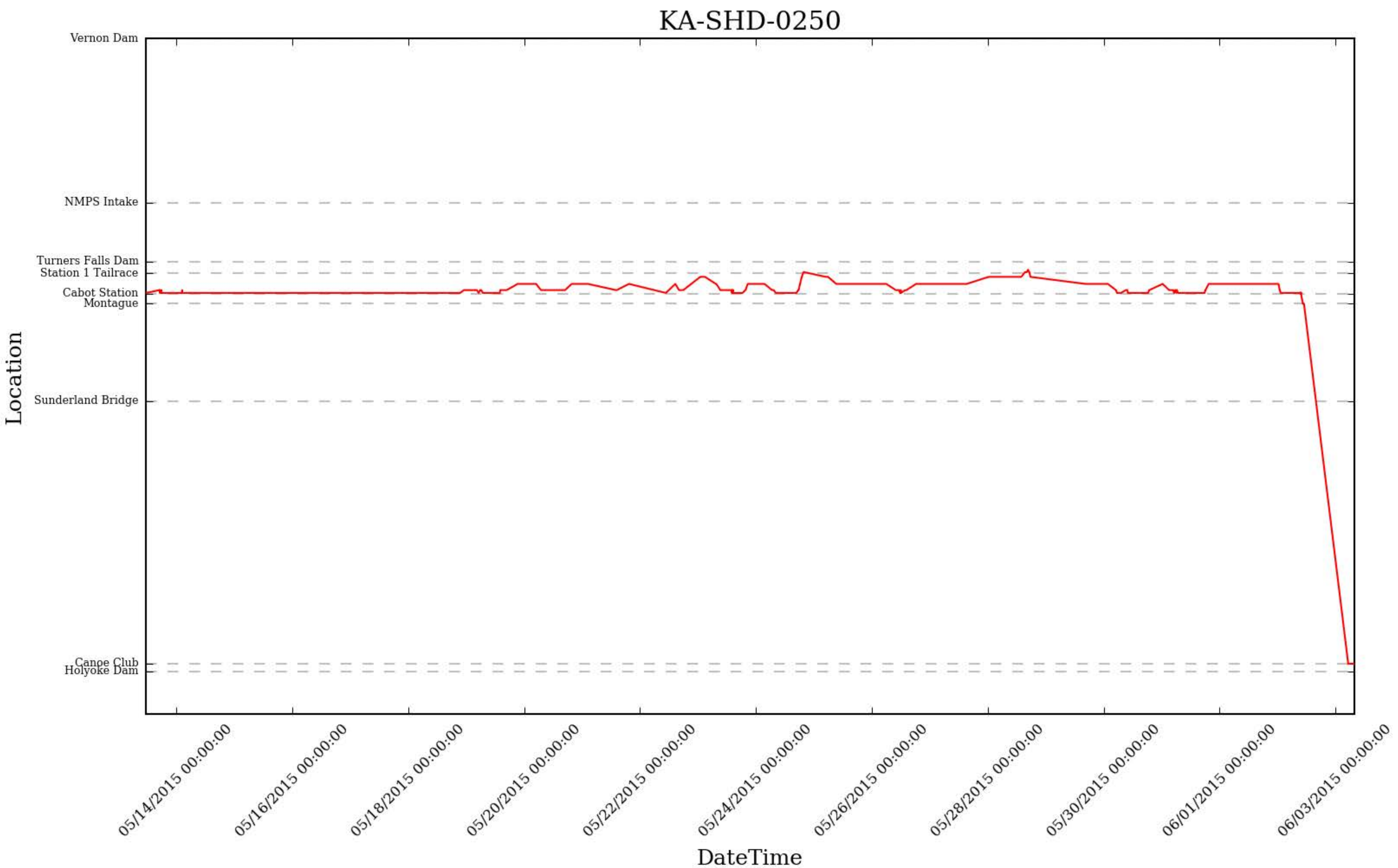


KA-SHD-0247
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
DateTime

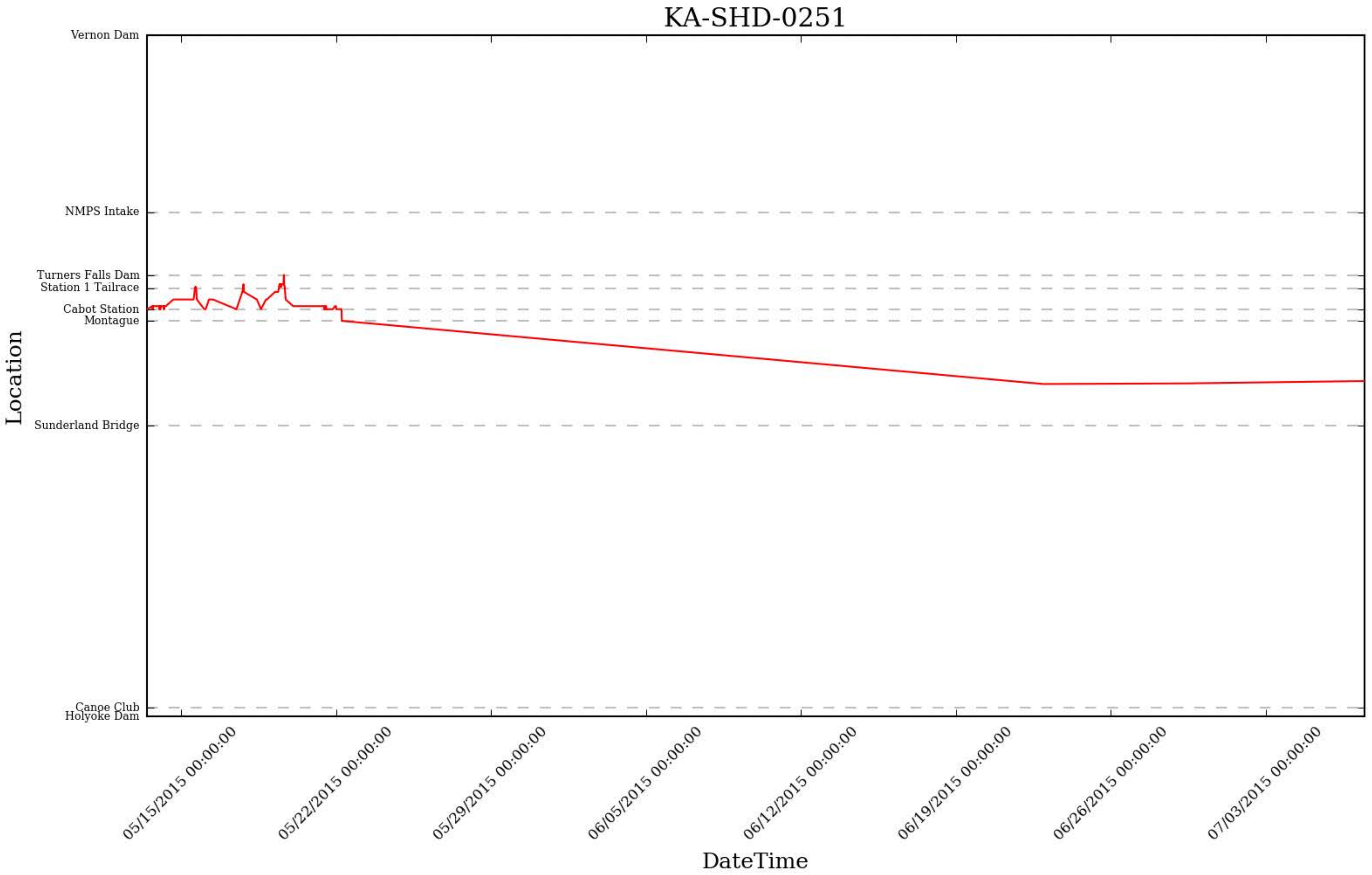


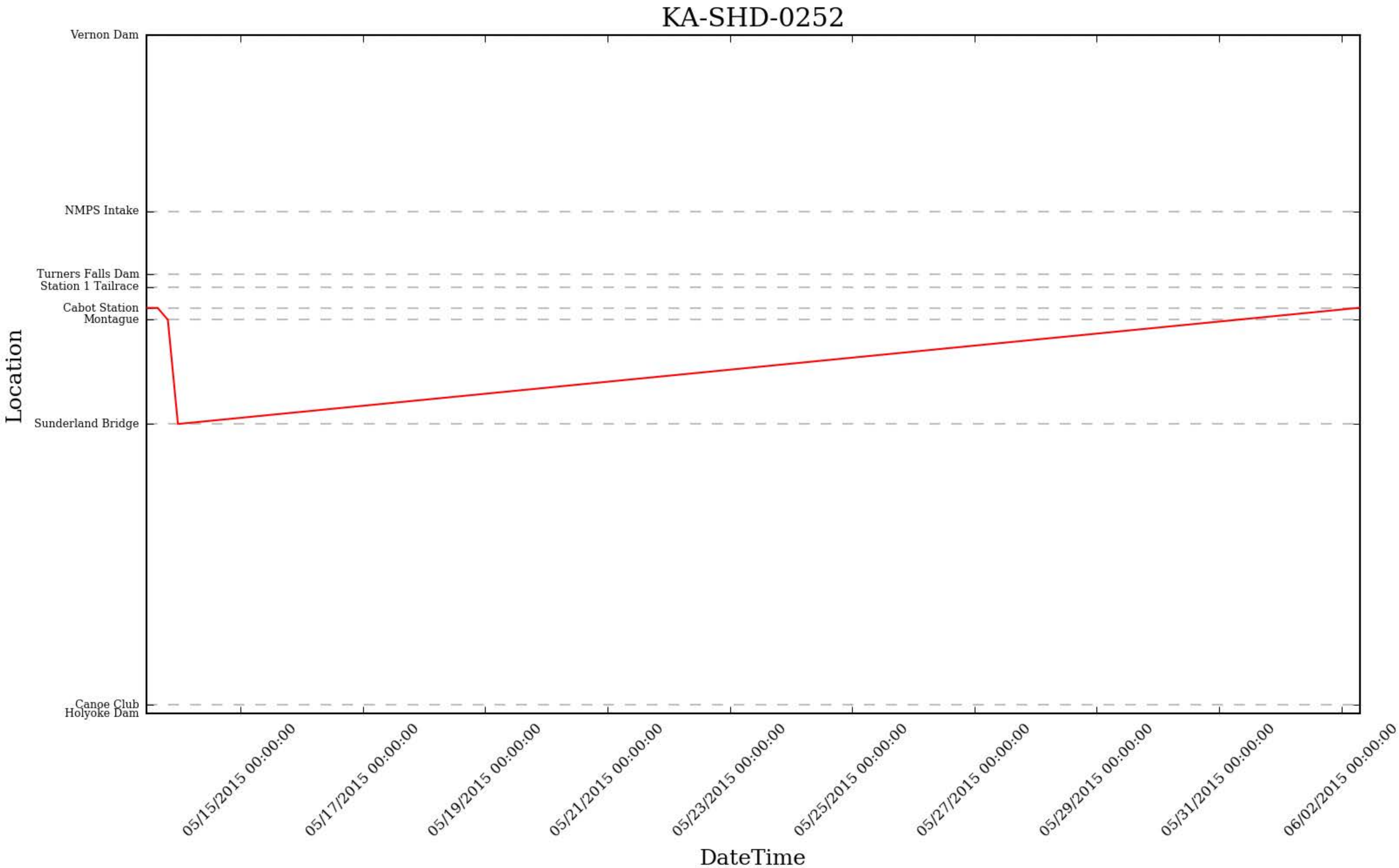
KA-SHD-0248
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 14:00:00
05/13/2015 17:00:00
05/13/2015 20:00:00
05/13/2015 23:00:00
05/14/2015 02:00:00
05/14/2015 05:00:00
05/14/2015 08:00:00
05/14/2015 11:00:00
DateTime


KA-SHD-0249
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime



KA-SHD-0250
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
DateTime


KA-SHD-0251
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime



KA-SHD-0252
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
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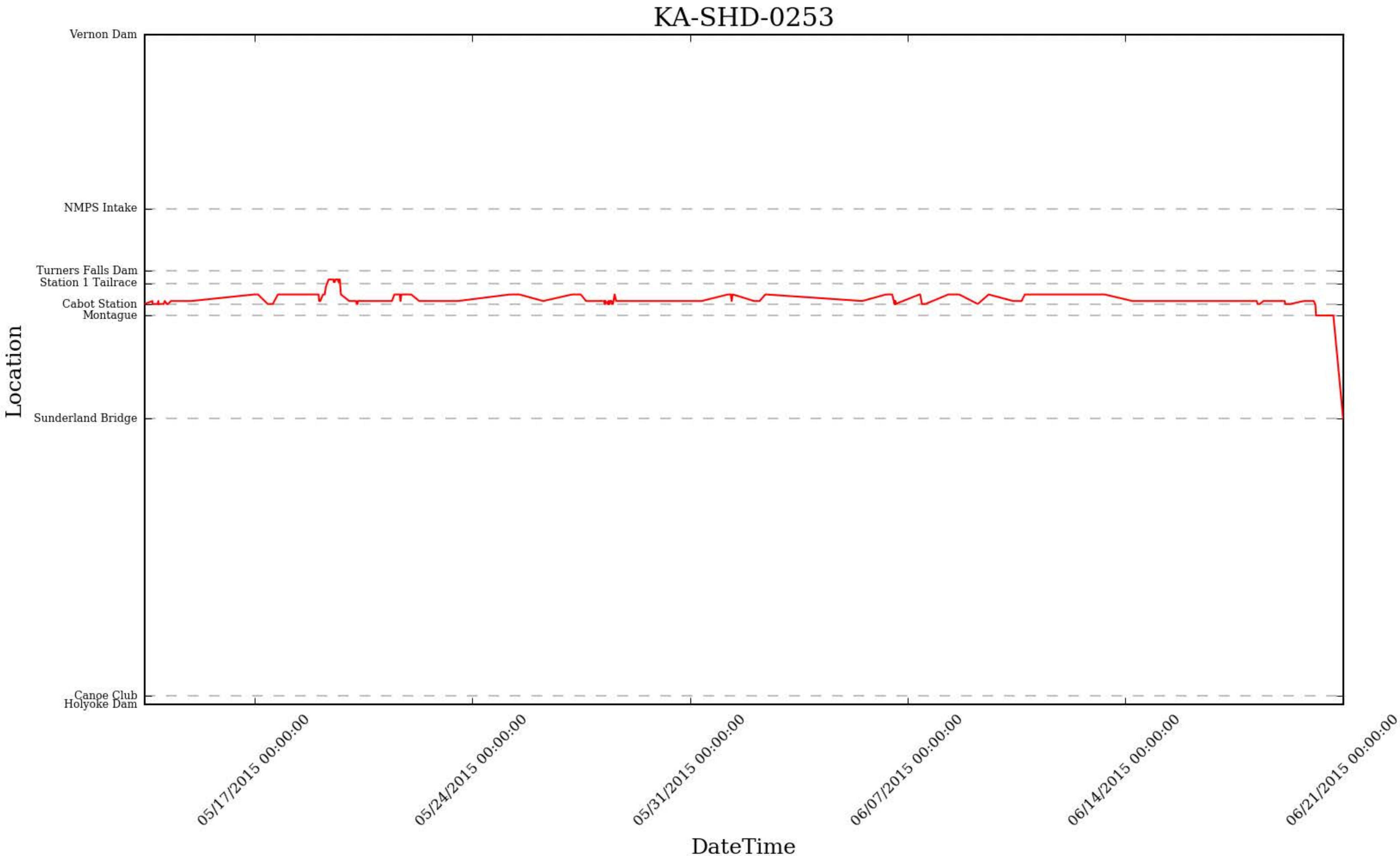
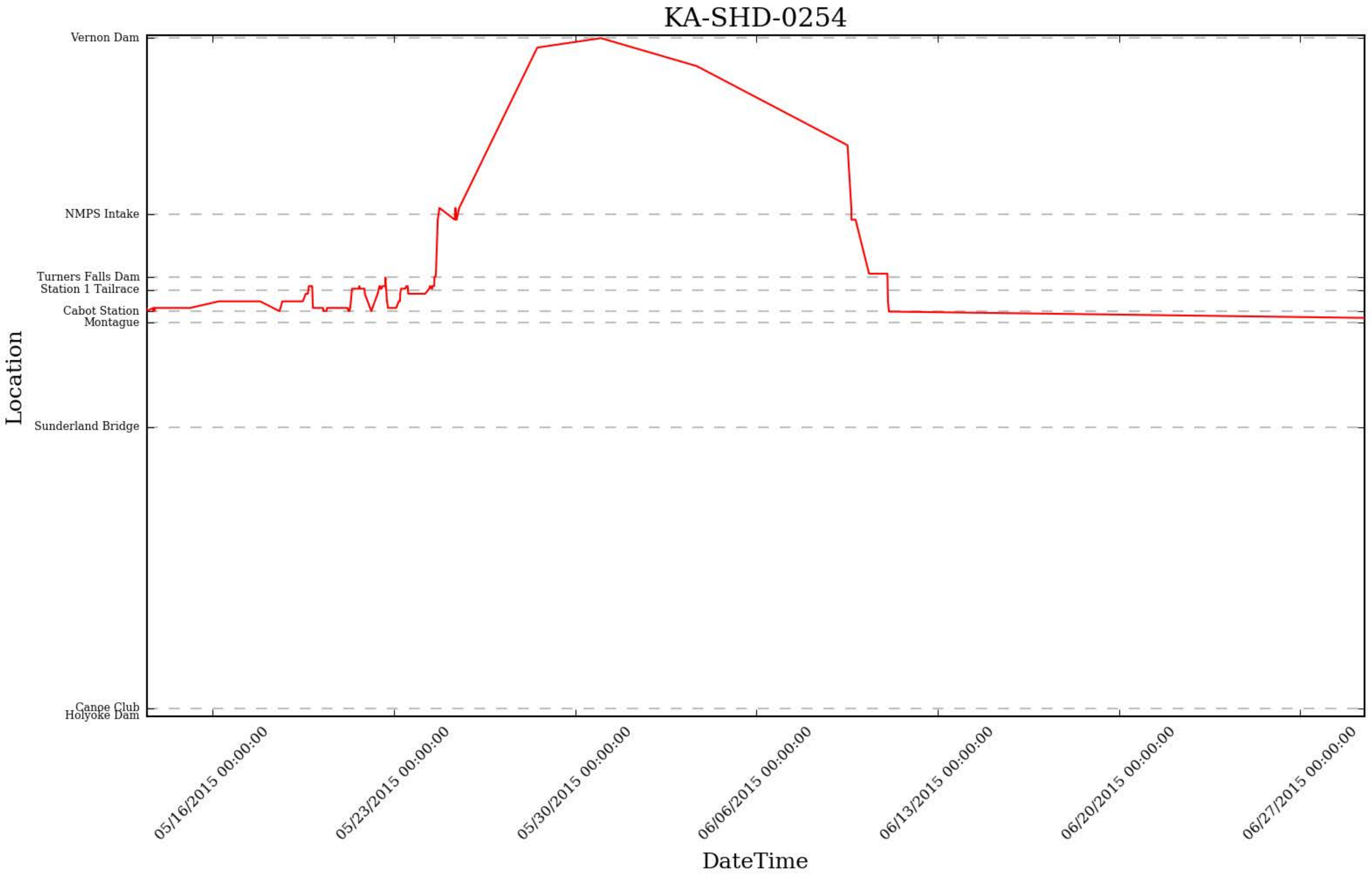
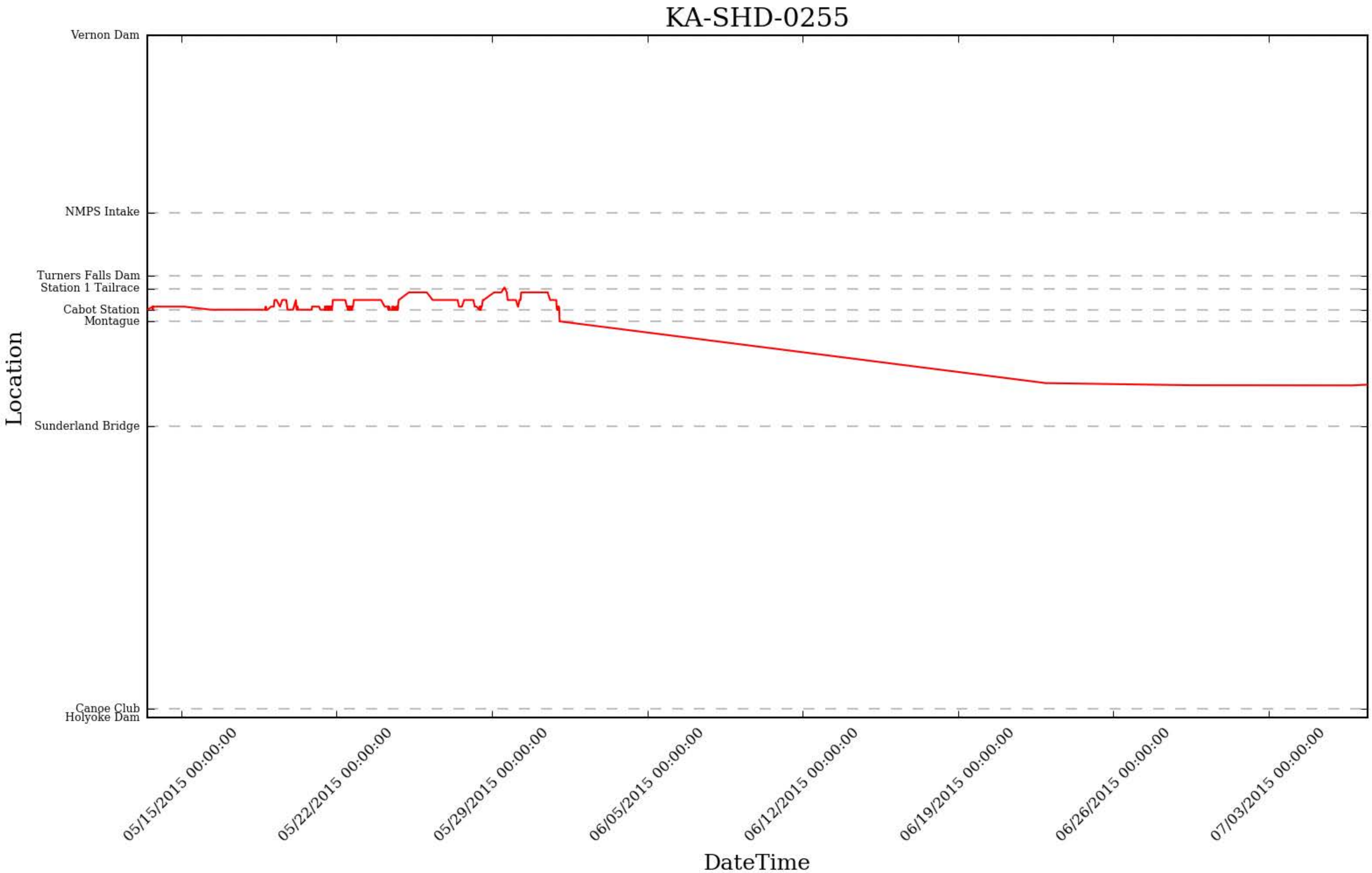
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
DateTime

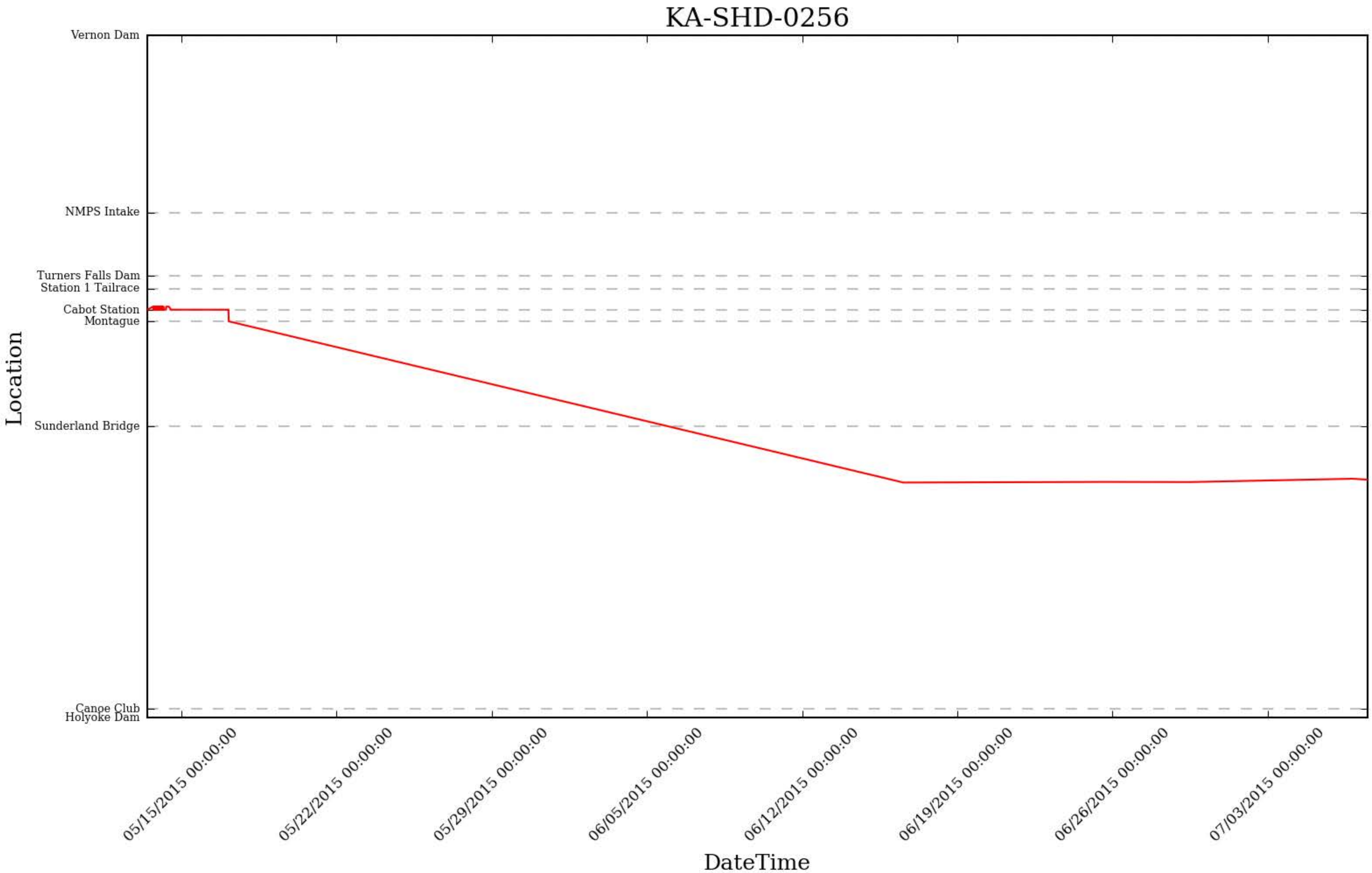


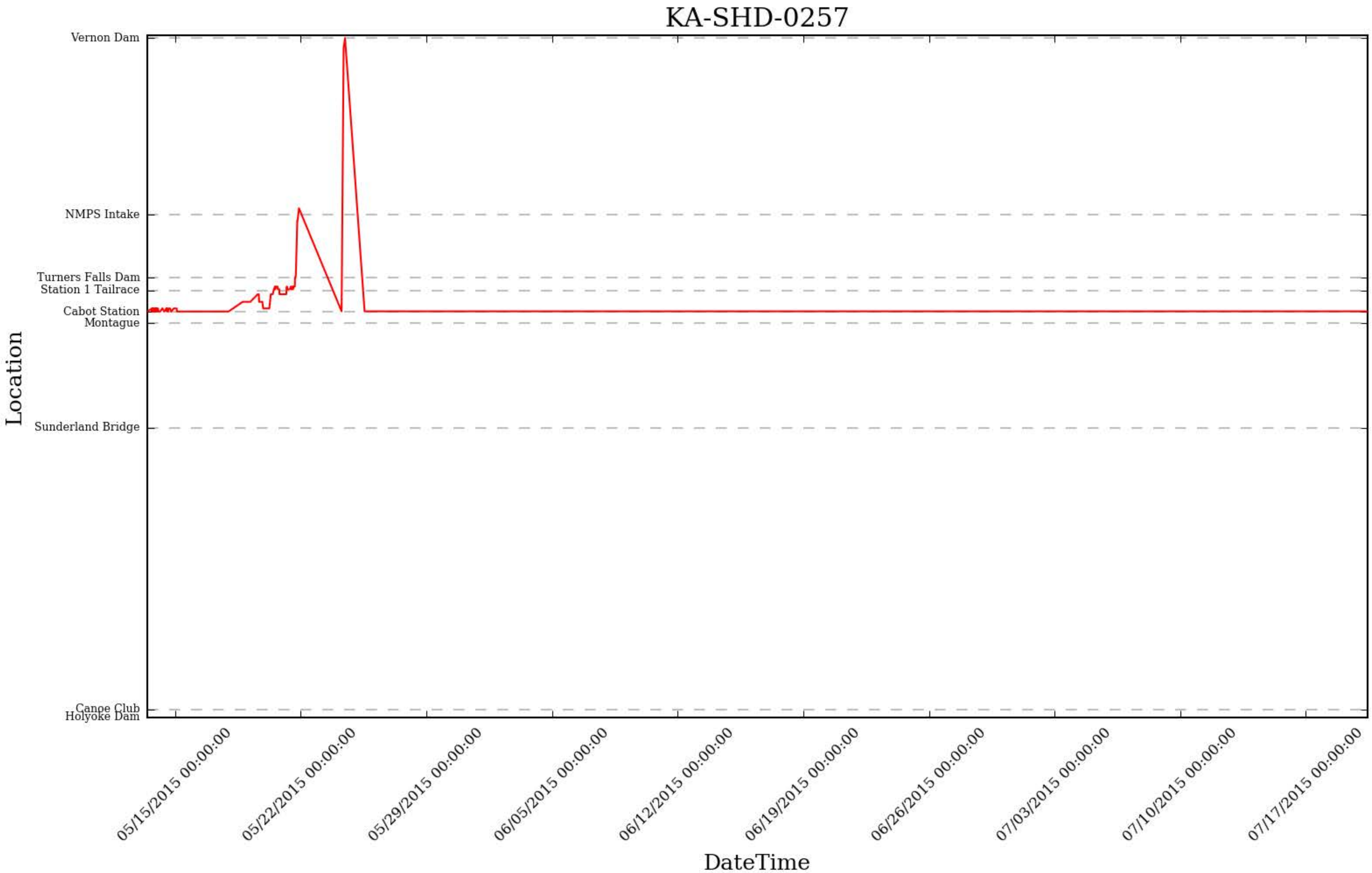
KA-SHD-0253
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
DateTime



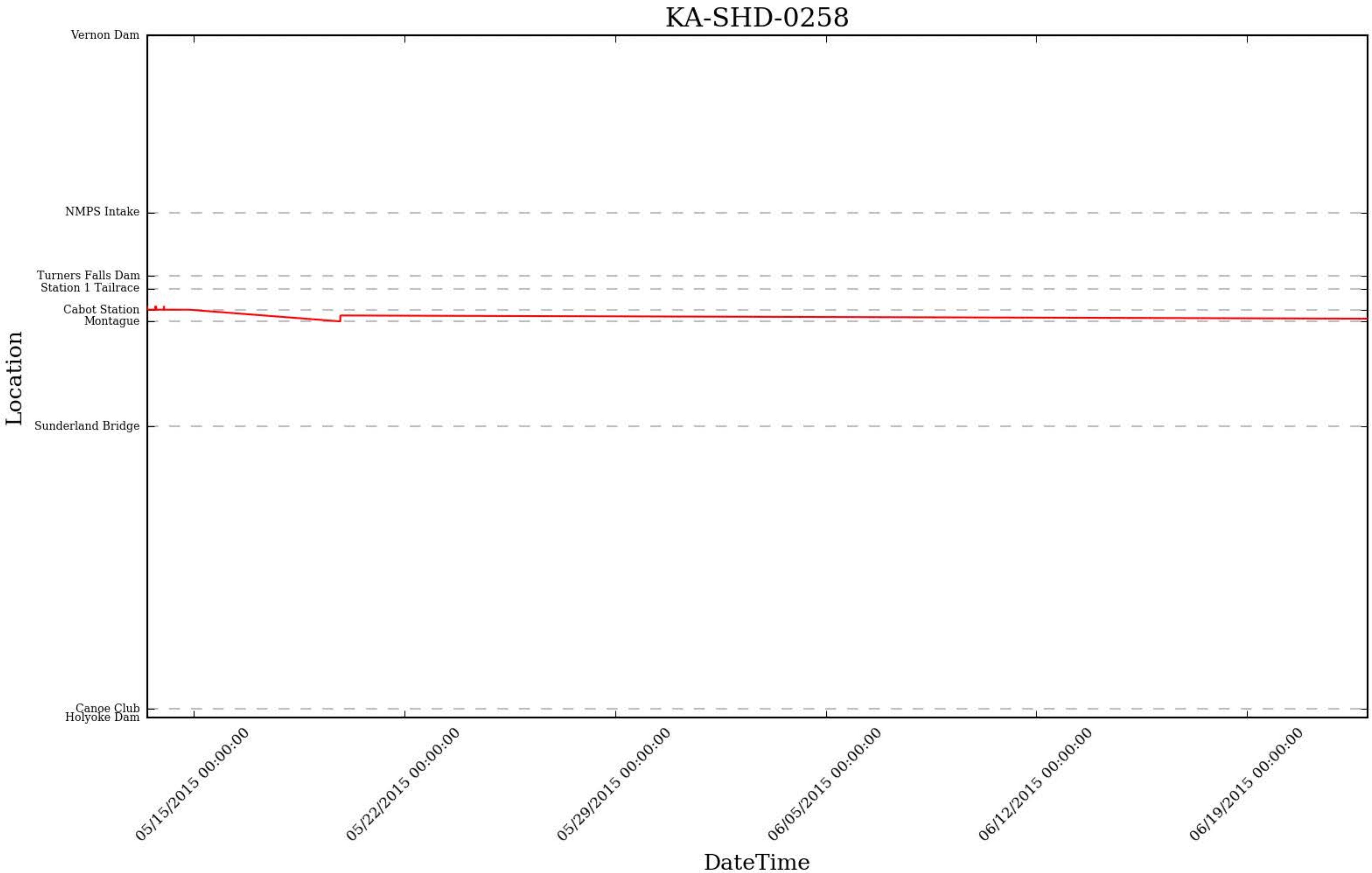
KA-SHD-0254
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
DateTime

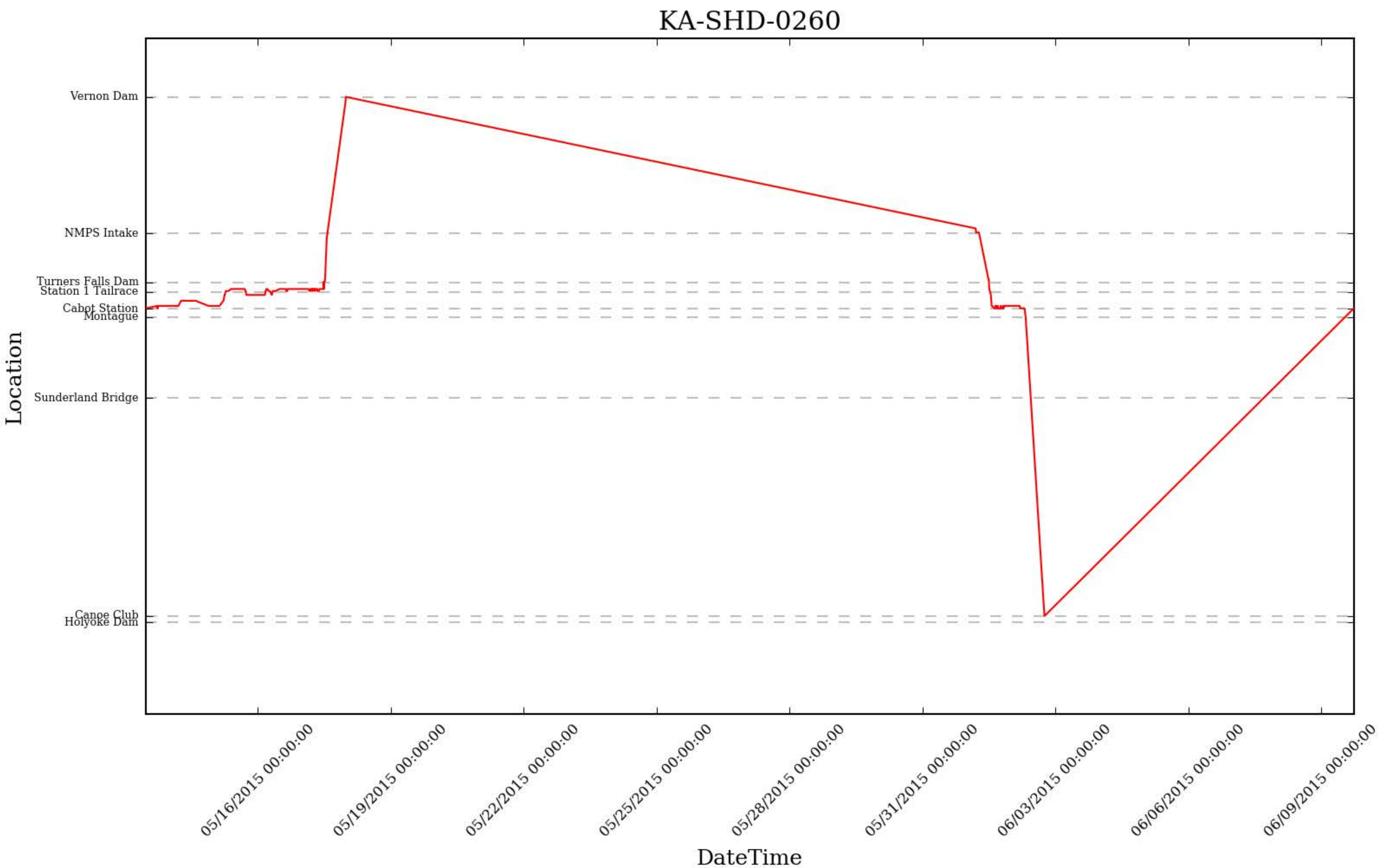

KA-SHD-0255
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime


KA-SHD-0256
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime

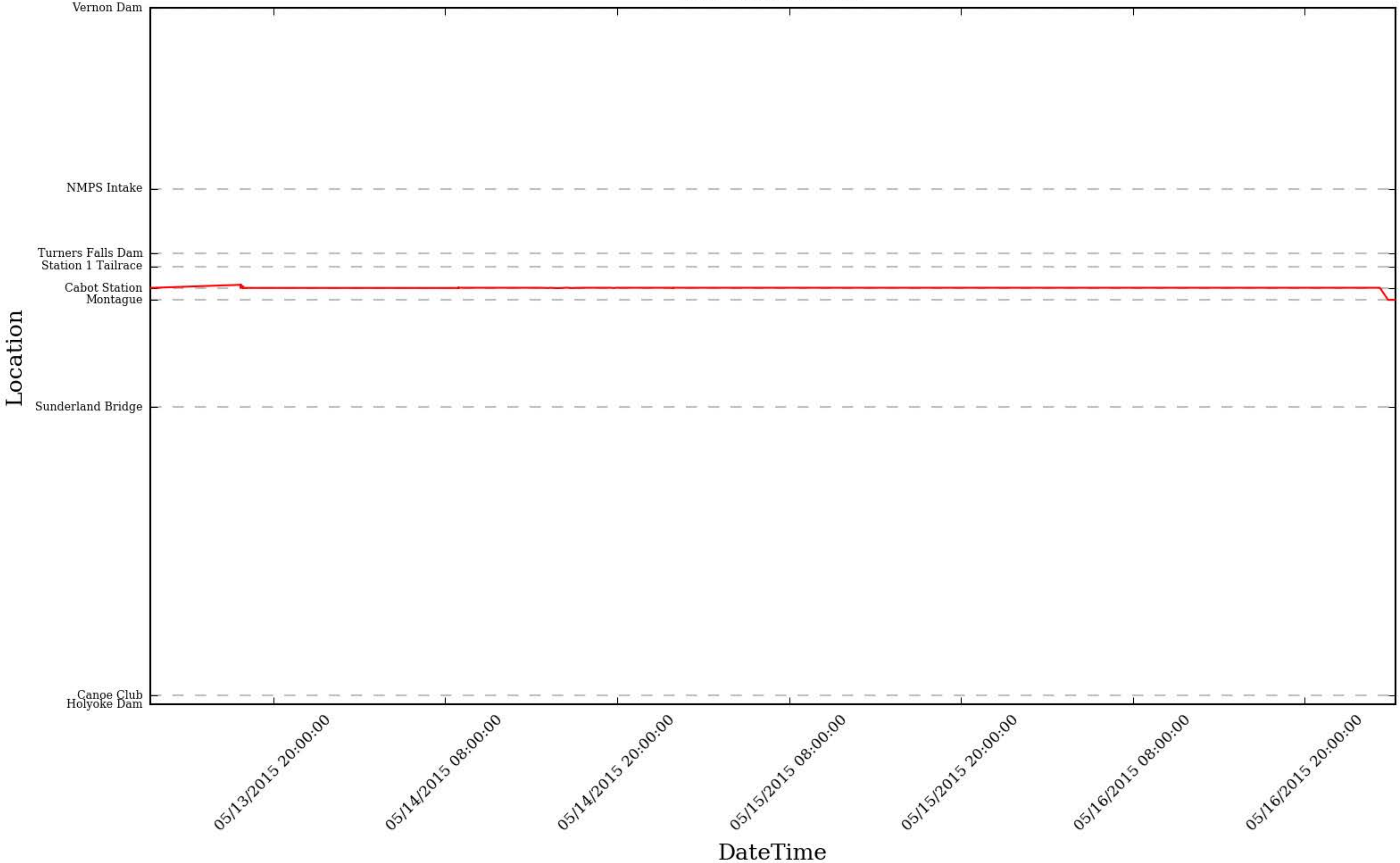


KA-SHD-0257
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
07/10/2015 00:00:00
07/17/2015 00:00:00
DateTime

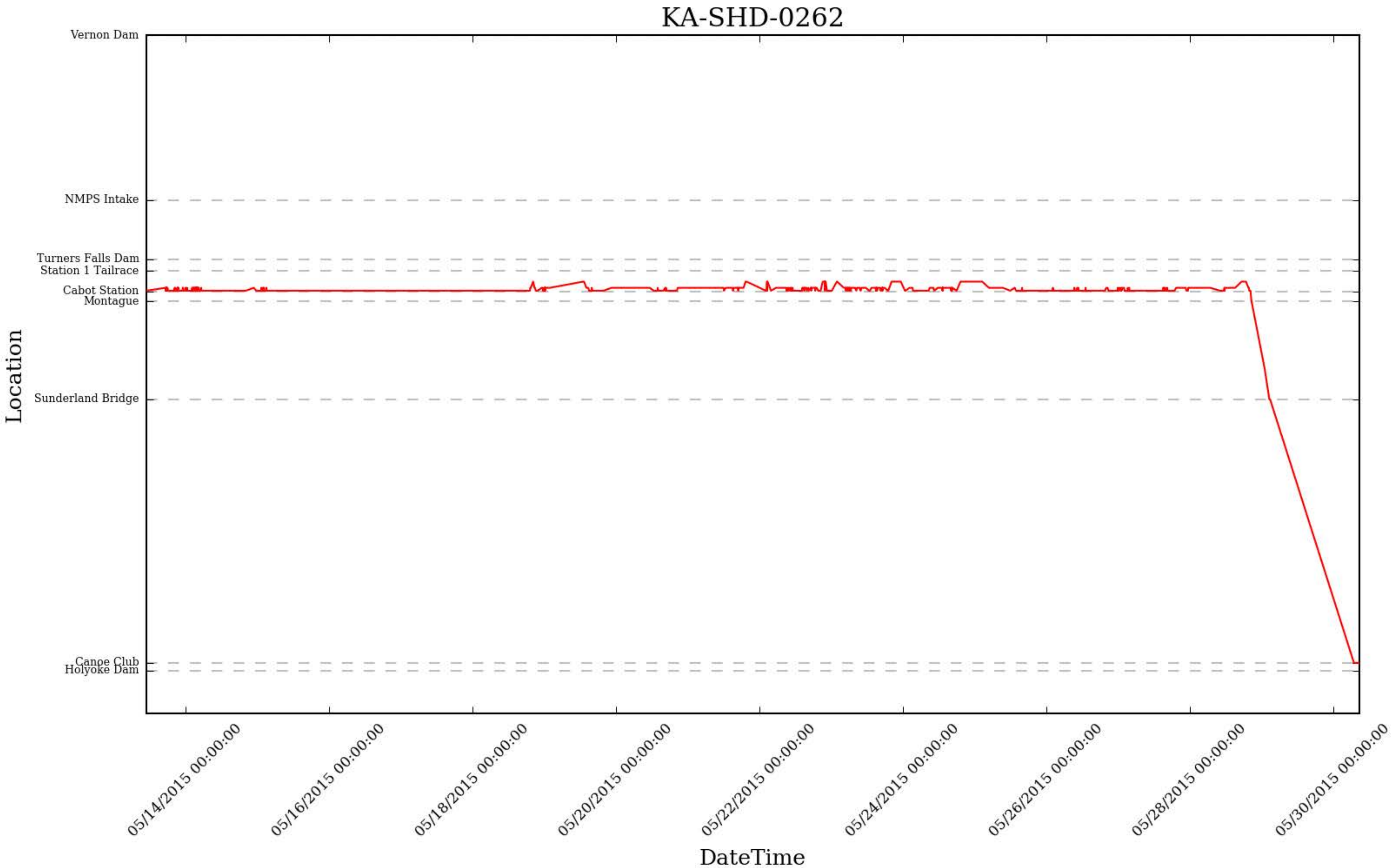

KA-SHD-0258
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
DateTime

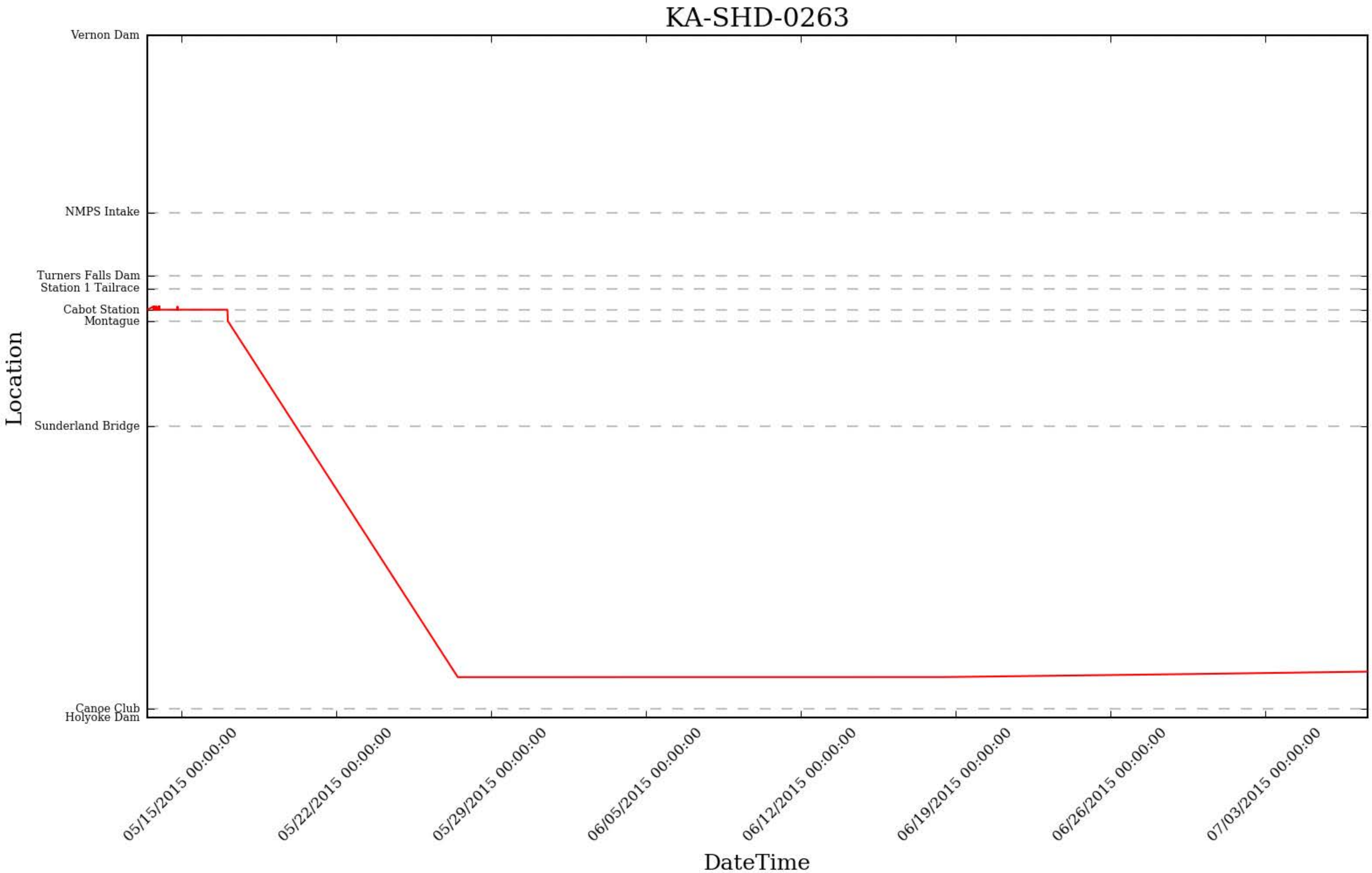

KA-SHD-0260
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
DateTime

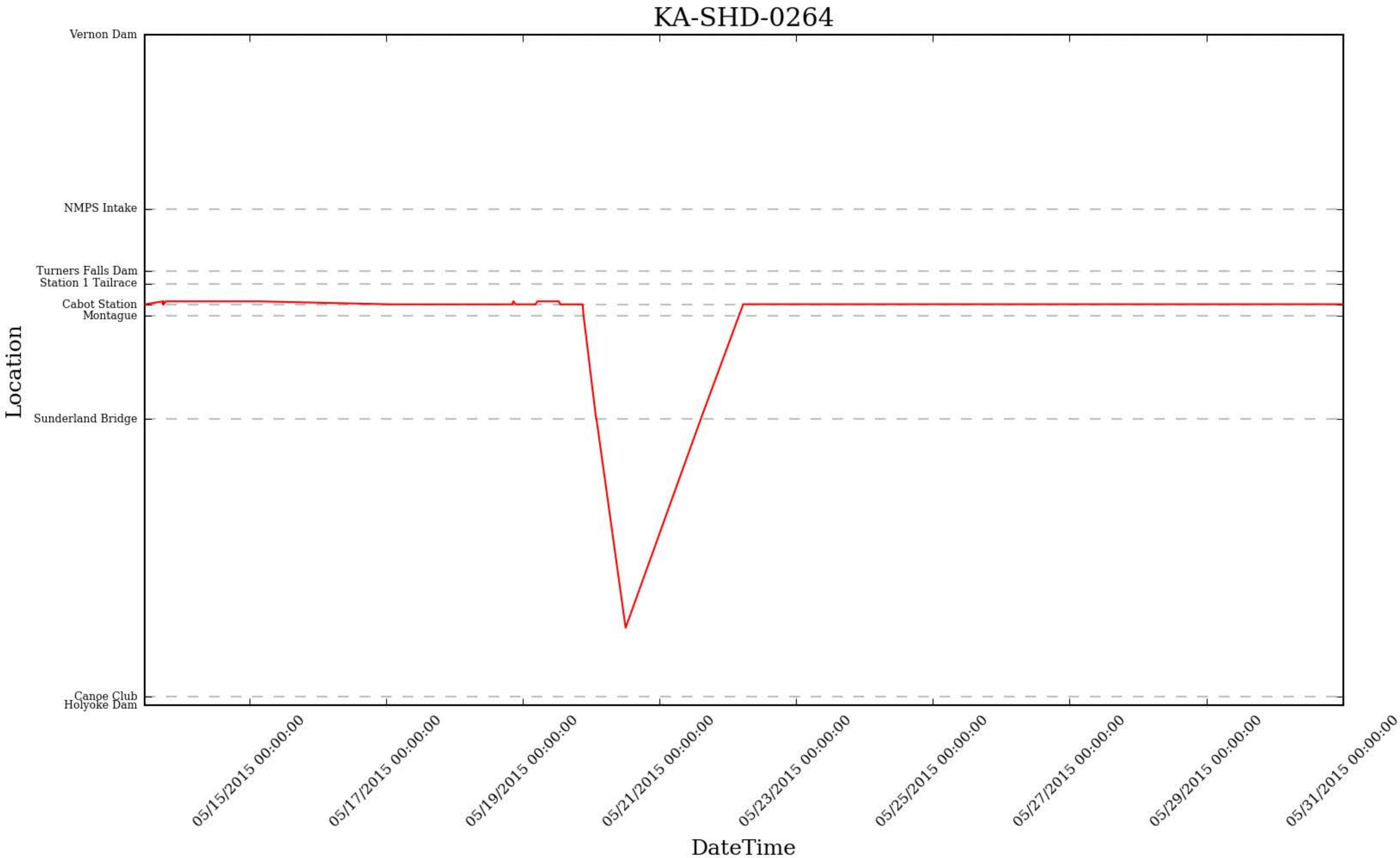
KA-SHD-0261

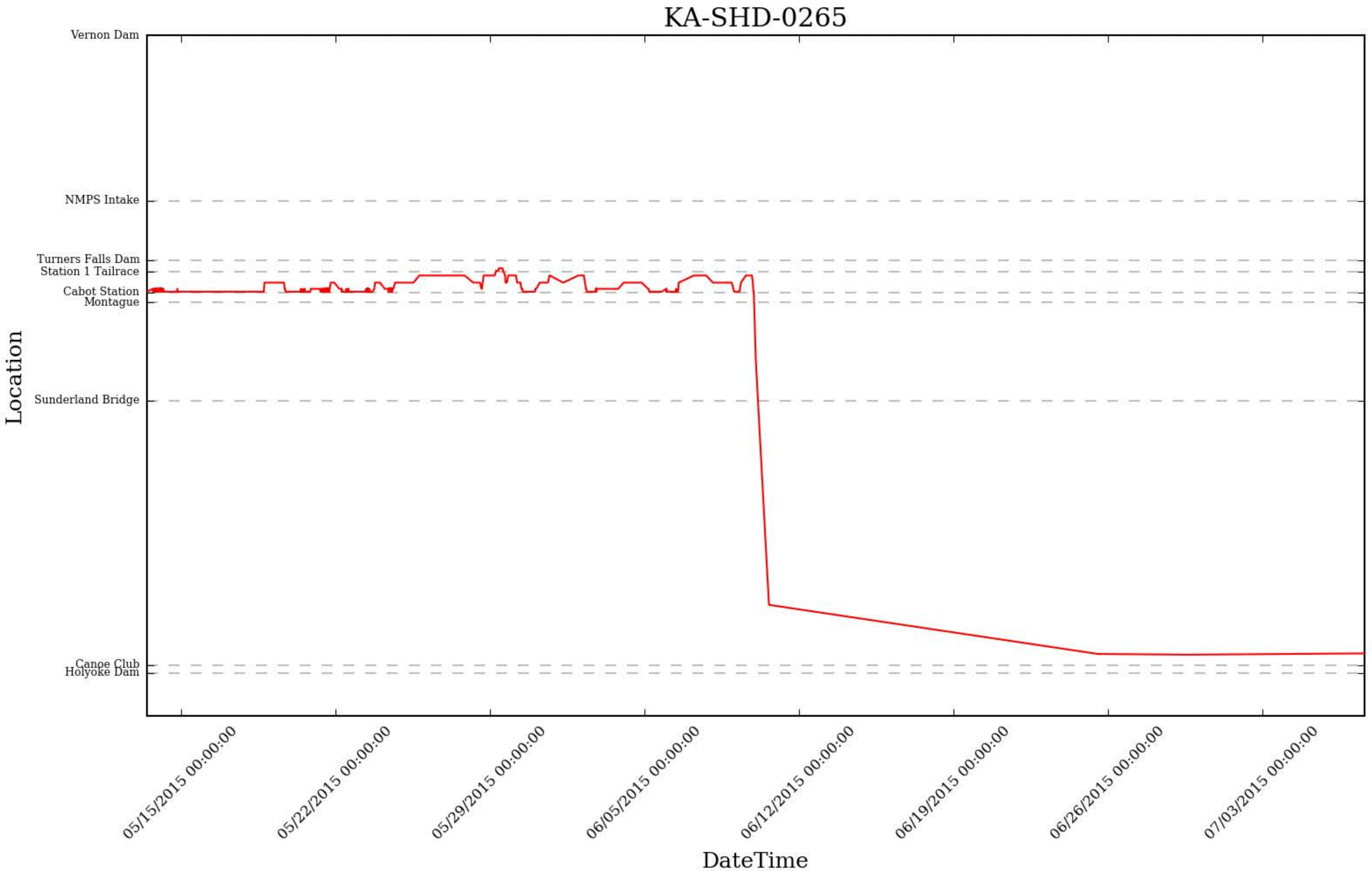


Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/13/2015 20:00:00
05/14/2015 08:00:00
05/14/2015 20:00:00
05/15/2015 08:00:00
05/15/2015 20:00:00
05/16/2015 08:00:00
05/16/2015 20:00:00
DateTime

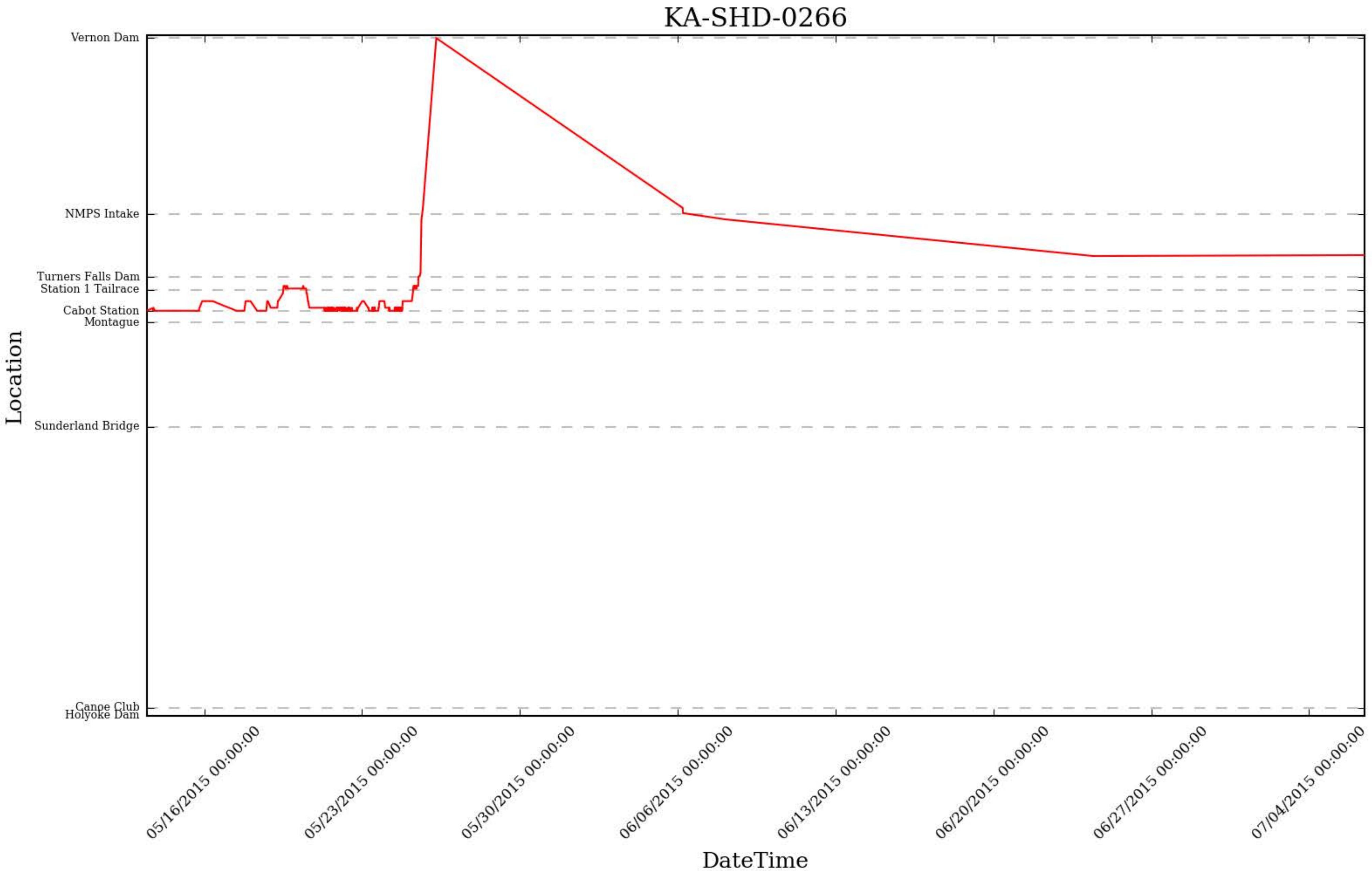

KA-SHD-0262
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/14/2015 00:00:00
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
DateTime


KA-SHD-0263
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime

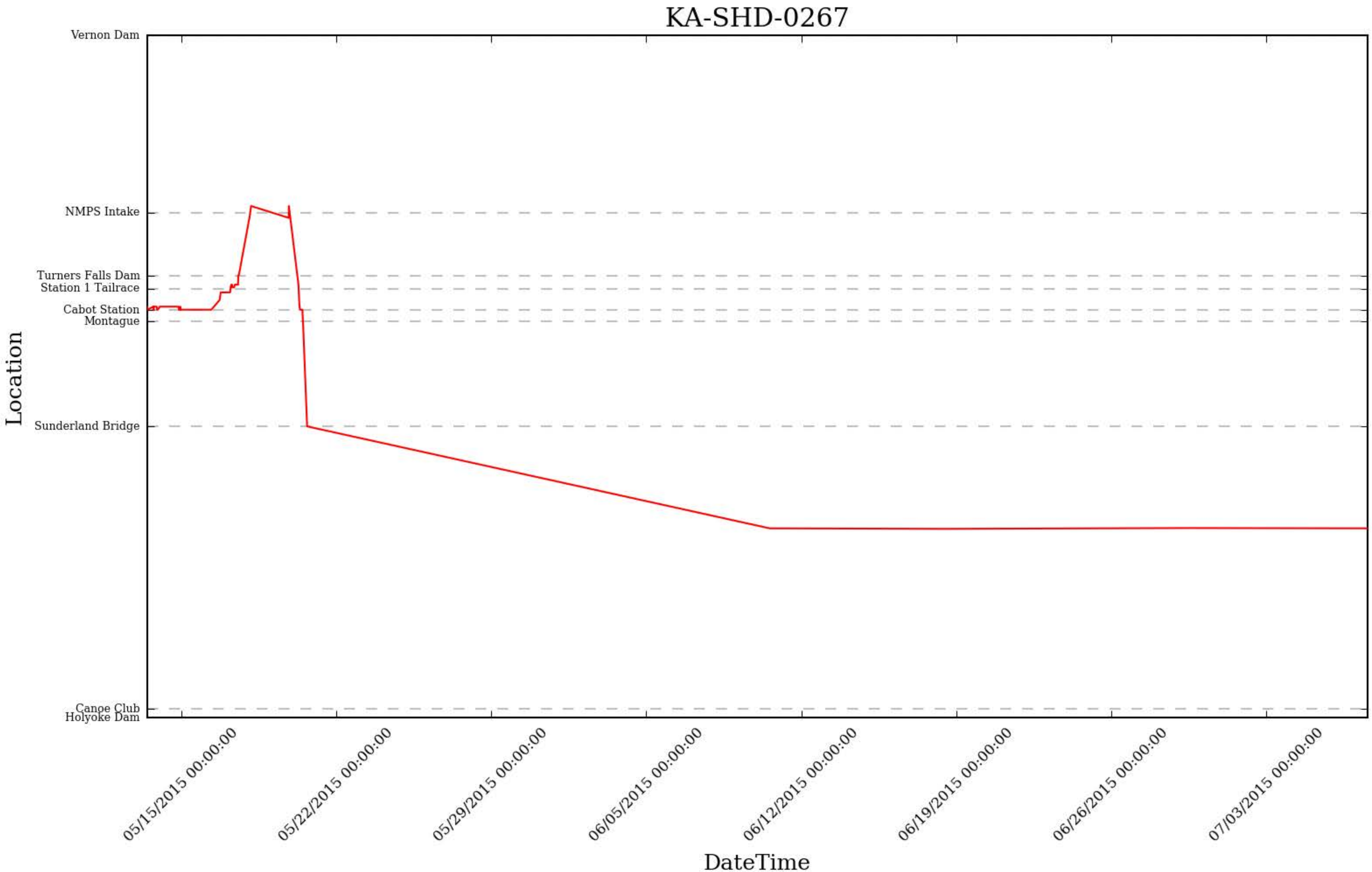

KA-SHD-0264
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
DateTime

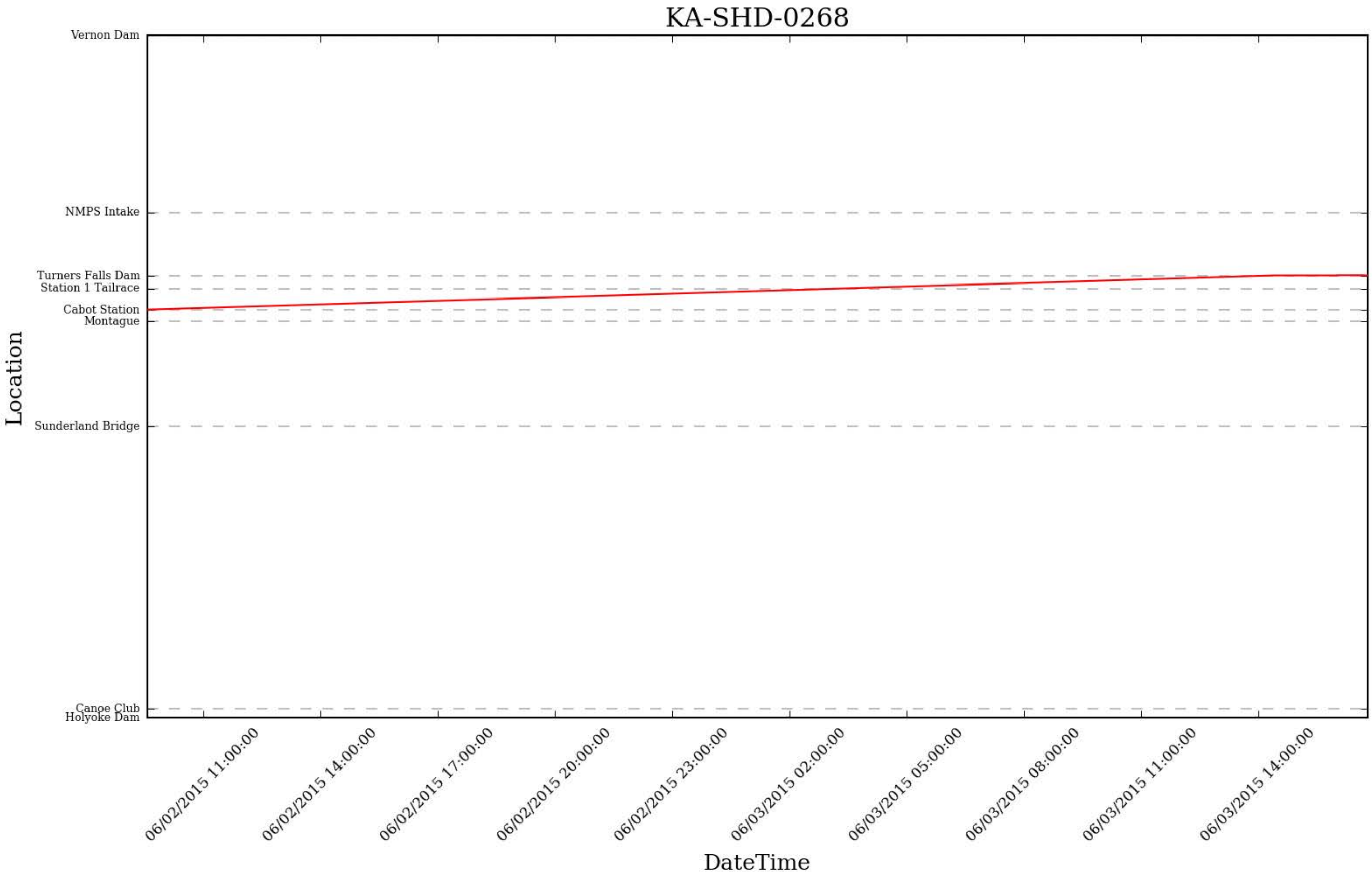


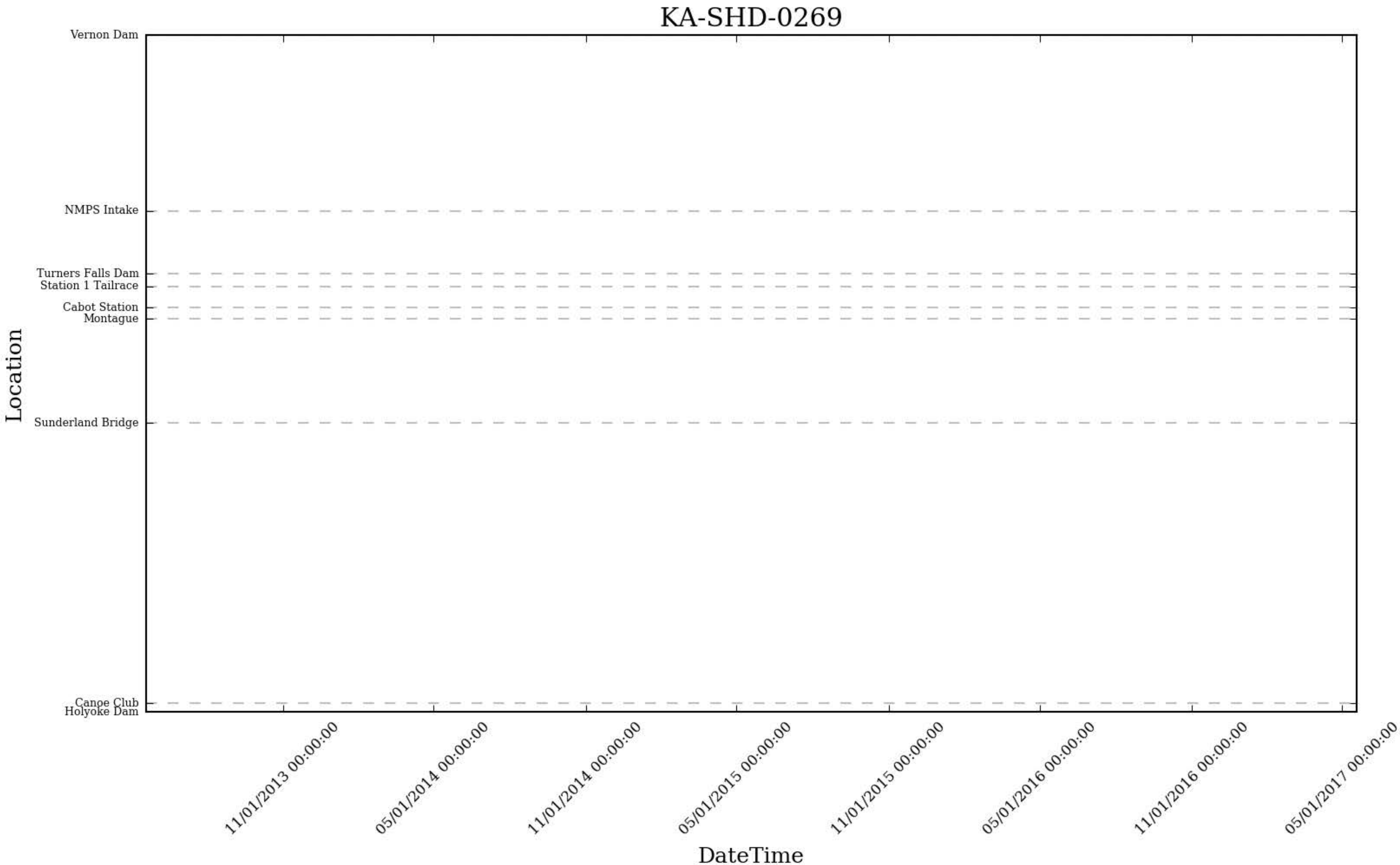
KA-SHD-0265
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime

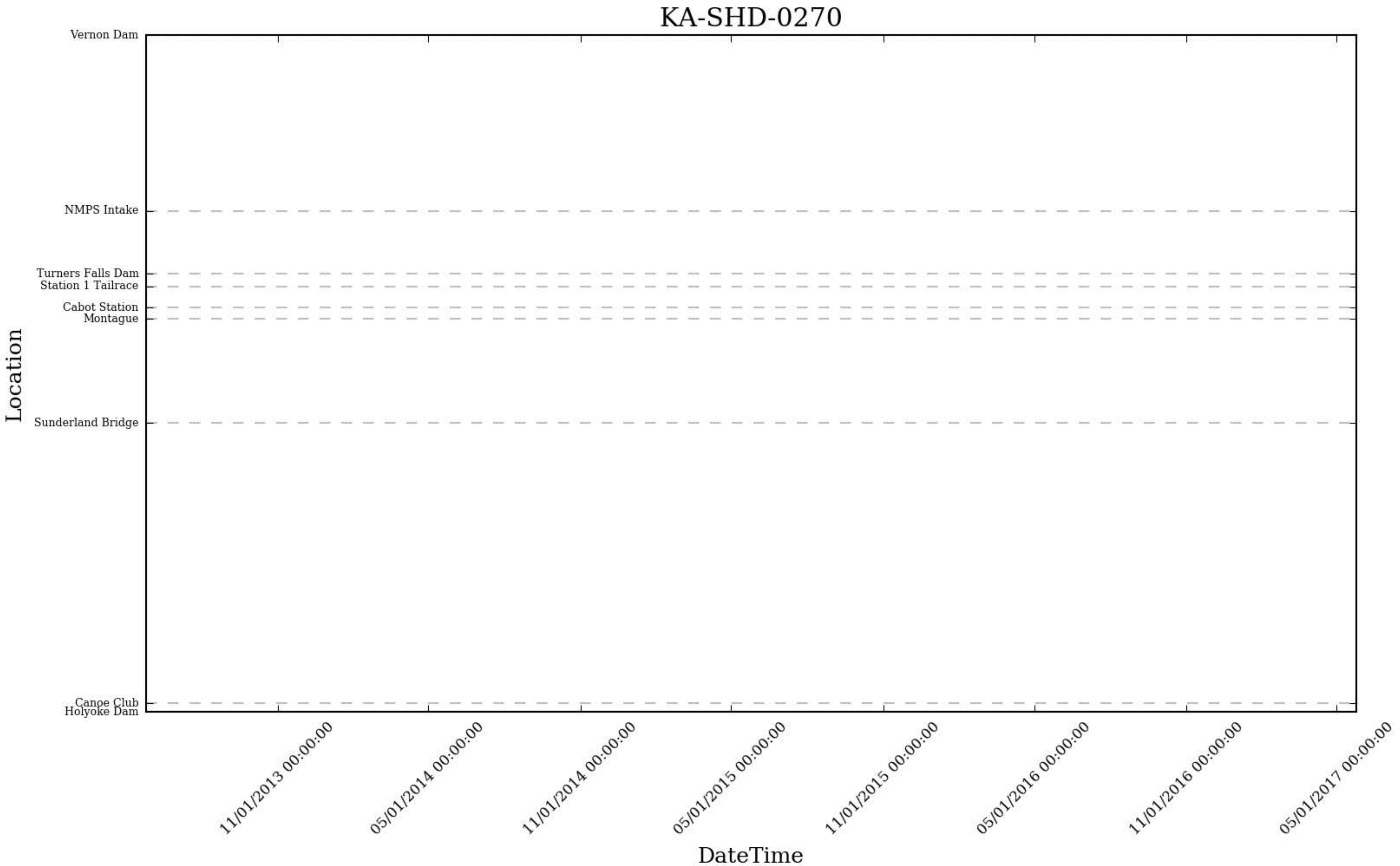


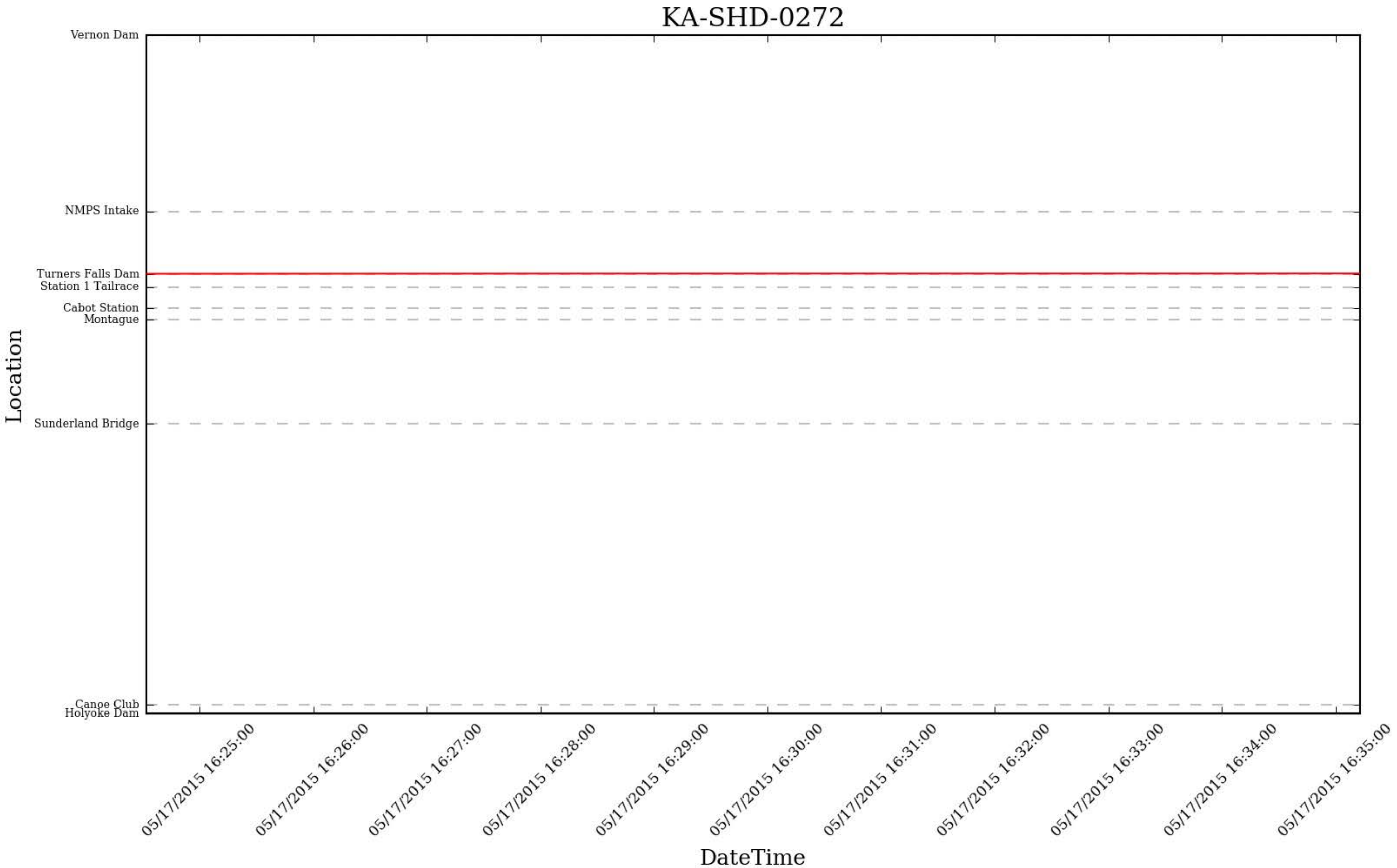
KA-SHD-0266
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
DateTime

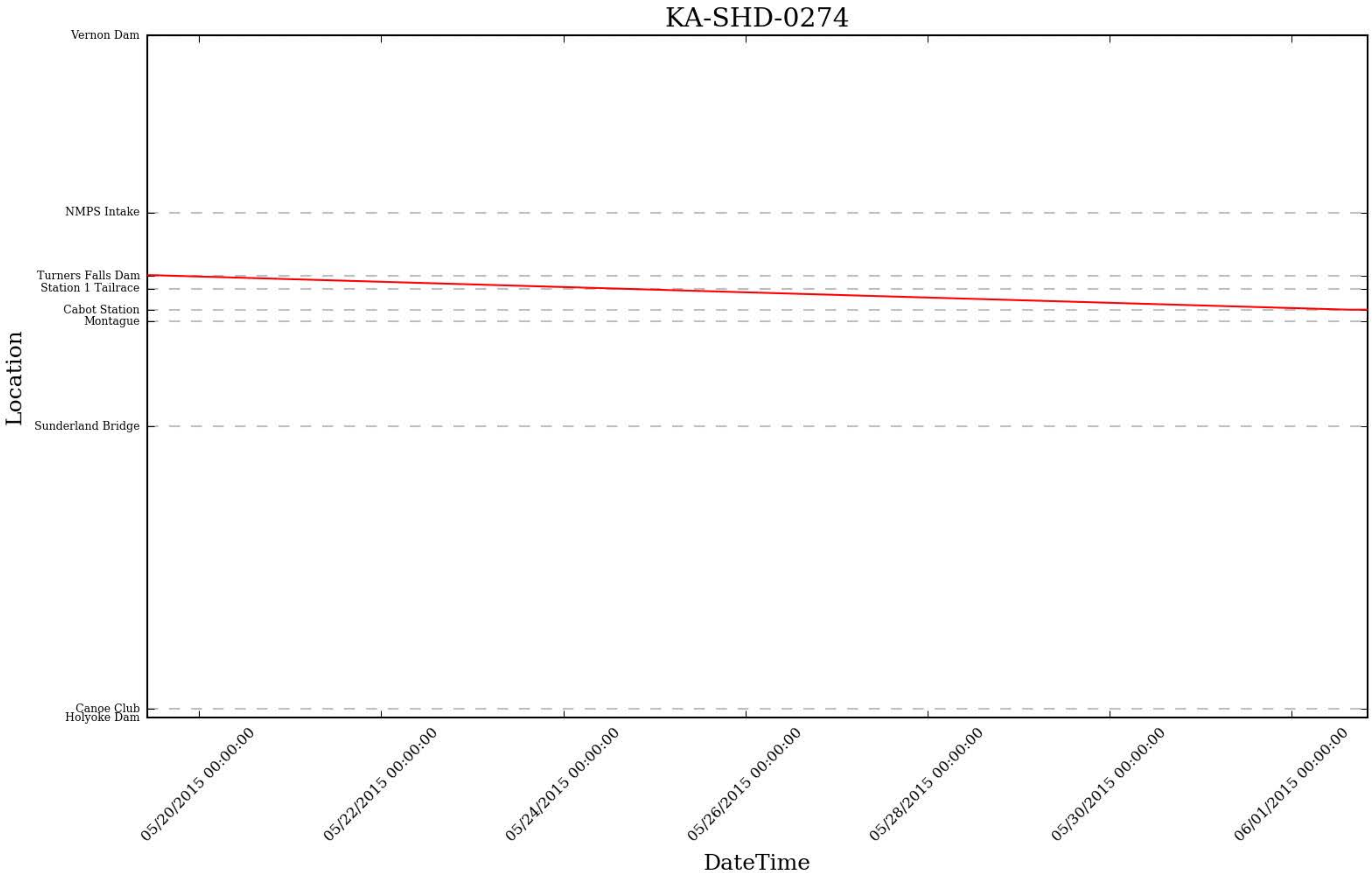

KA-SHD-0267
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/15/2015 00:00:00
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime

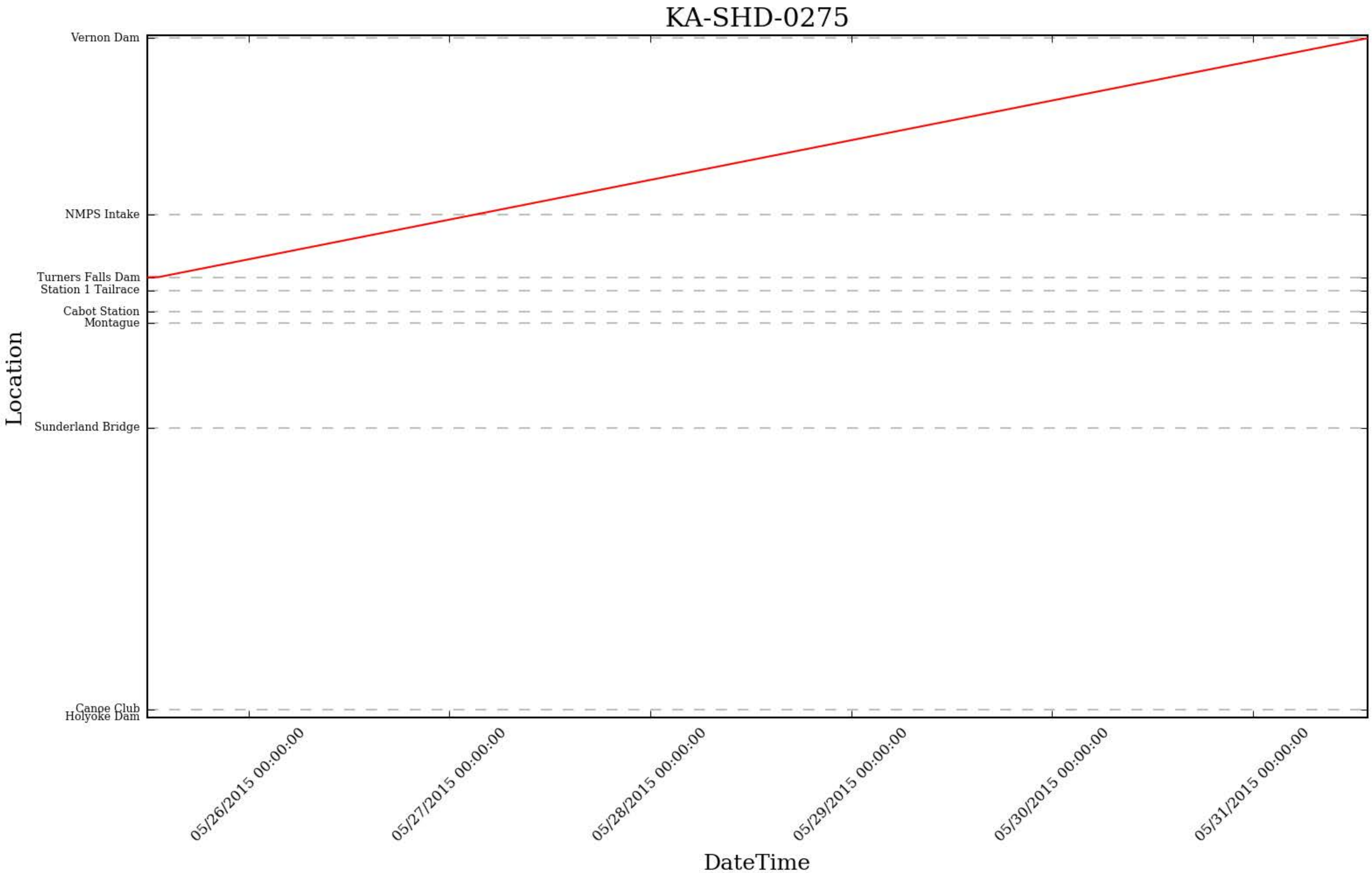

KA-SHD-0268
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/02/2015 11:00:00
06/02/2015 14:00:00
06/02/2015 17:00:00
06/02/2015 20:00:00
06/02/2015 23:00:00
06/03/2015 02:00:00
06/03/2015 05:00:00
06/03/2015 08:00:00
06/03/2015 11:00:00
06/03/2015 14:00:00
DateTime

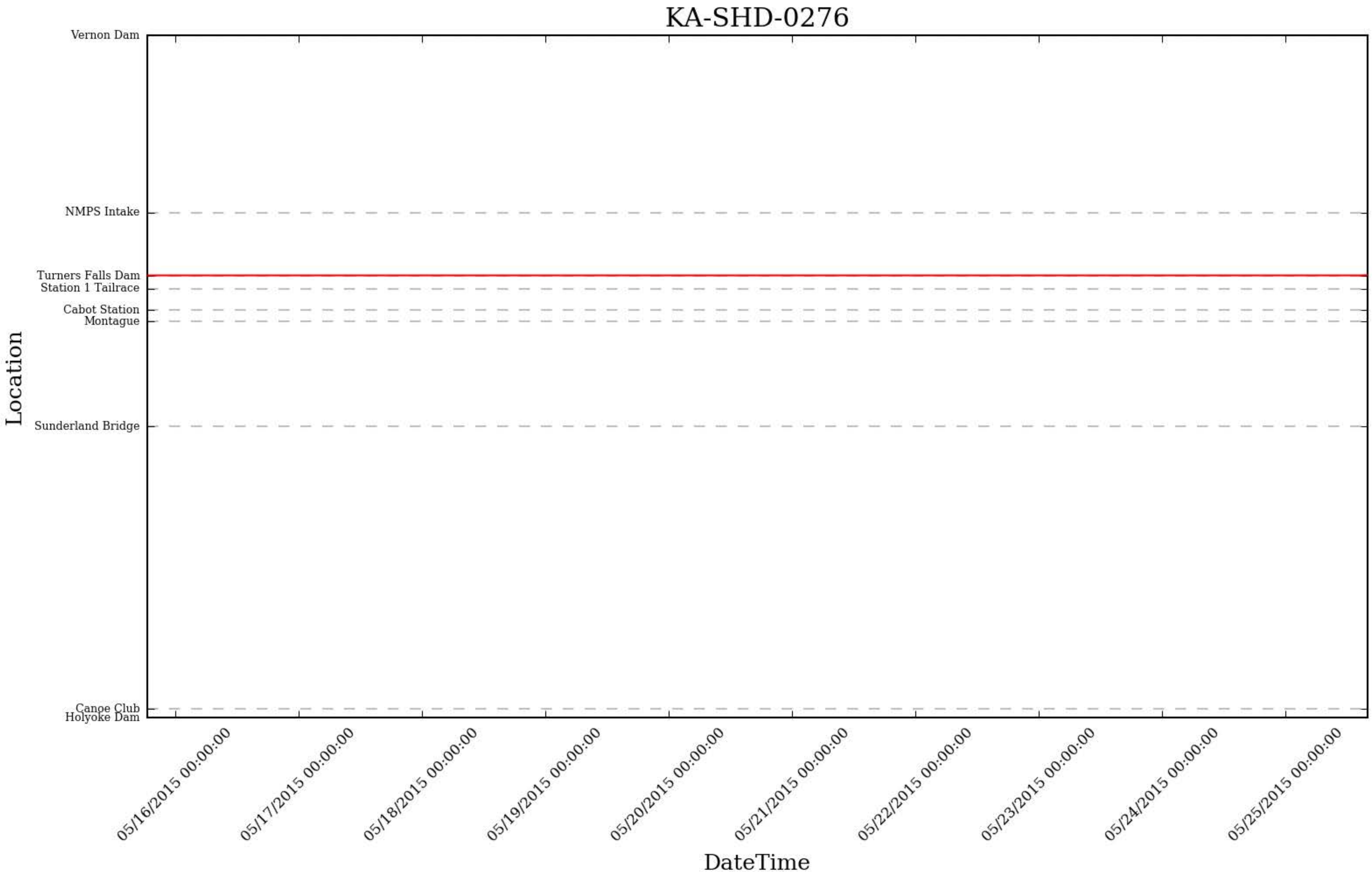

KA-SHD-0269
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0270
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

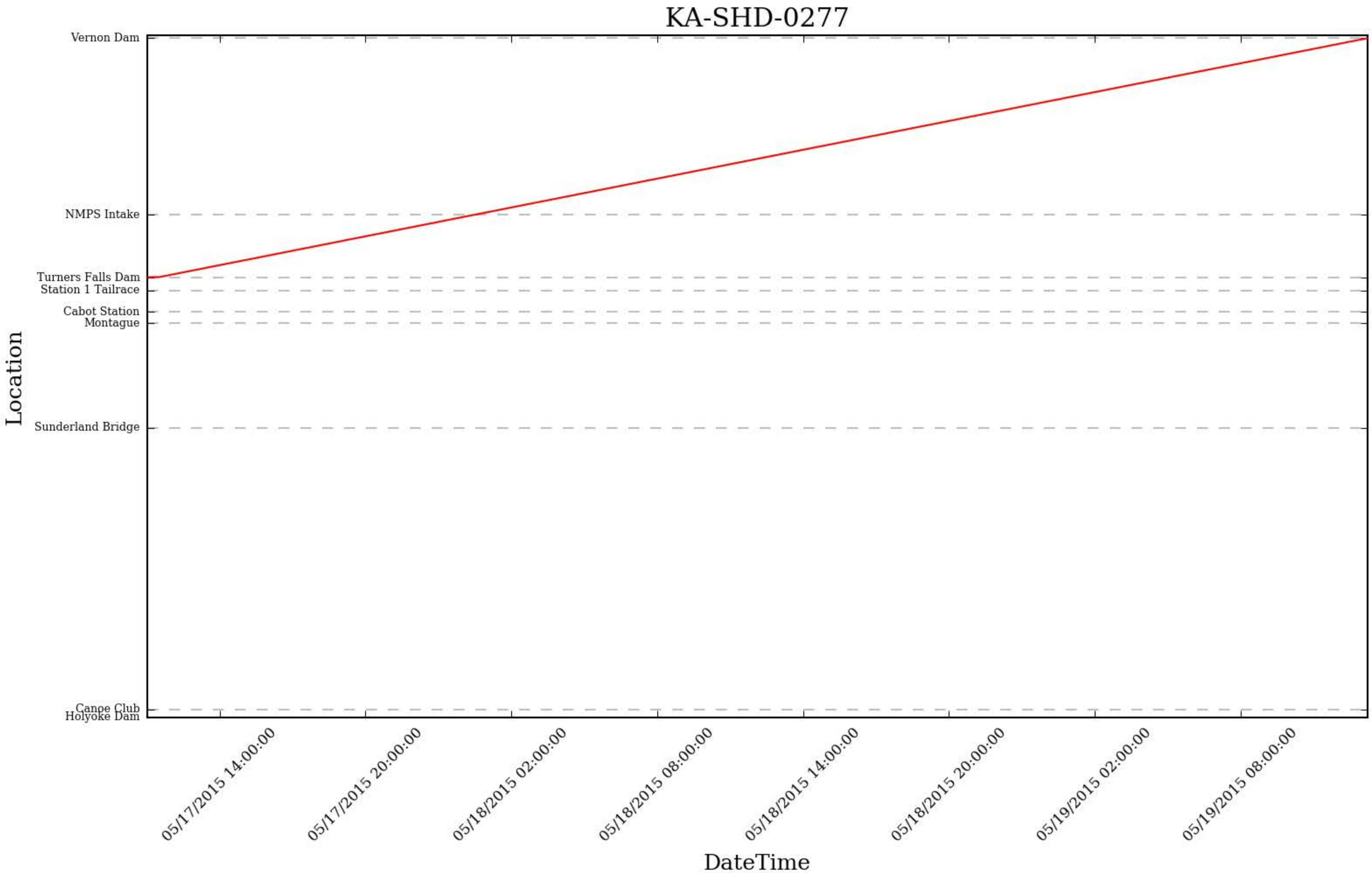

KA-SHD-0272
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 16:25:00
05/17/2015 16:26:00
05/17/2015 16:27:00
05/17/2015 16:28:00
05/17/2015 16:29:00
05/17/2015 16:30:00
05/17/2015 16:31:00
05/17/2015 16:32:00
05/17/2015 16:33:00
05/17/2015 16:34:00
05/17/2015 16:35:00
DateTime


KA-SHD-0274
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
DateTime


KA-SHD-0275
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
DateTime

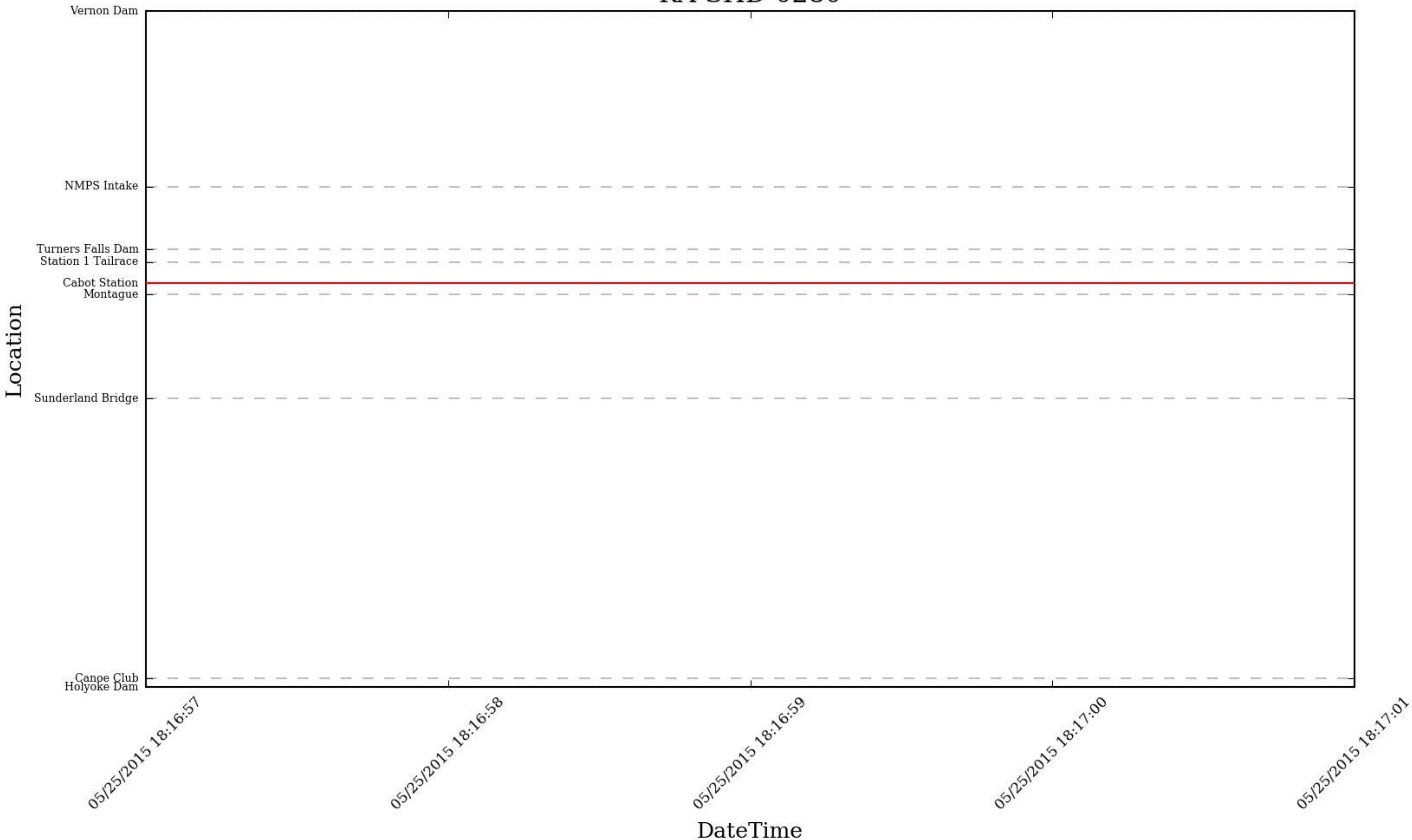


KA-SHD-0276
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
DateTime



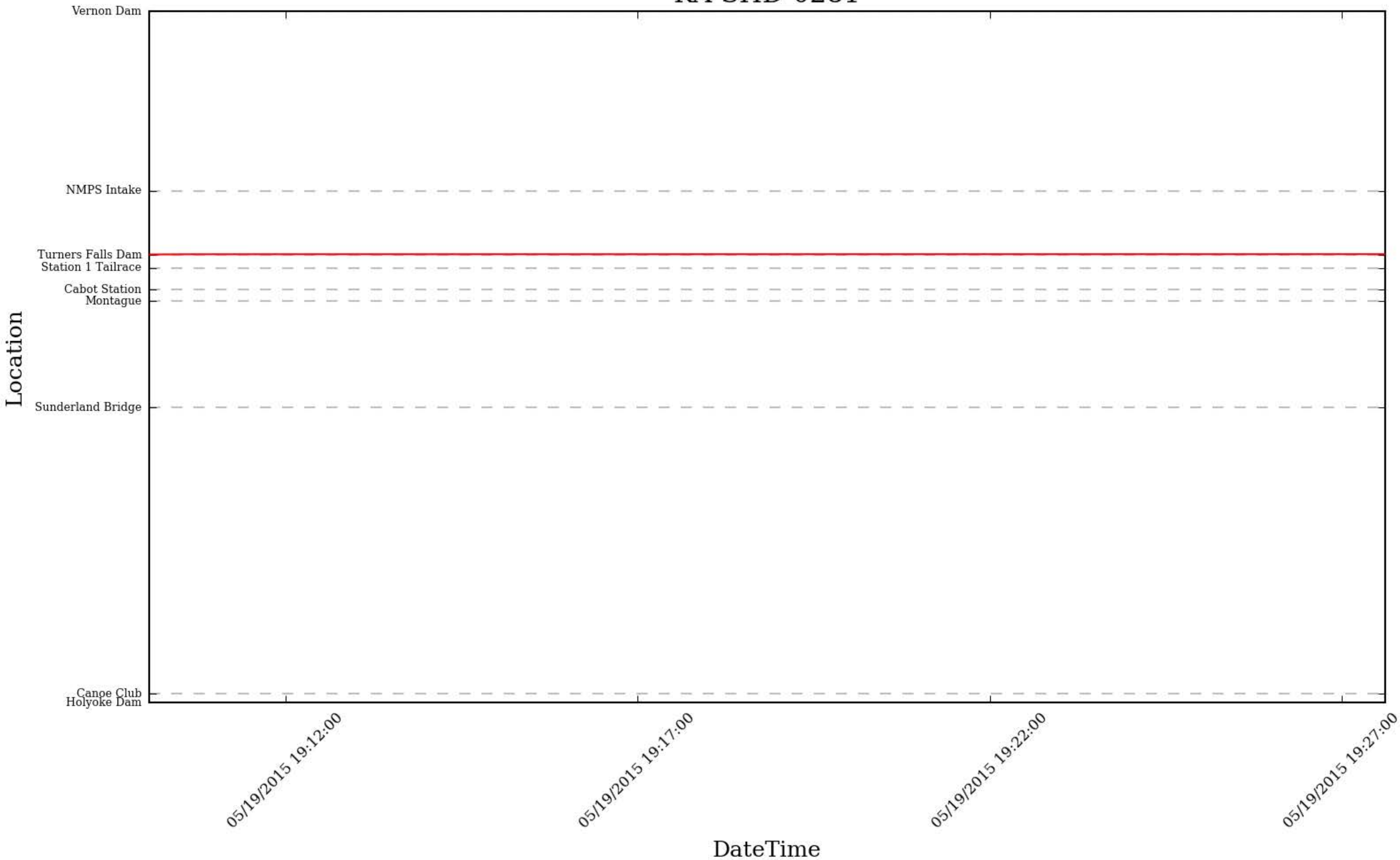
KA-SHD-0277
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 14:00:00
05/17/2015 20:00:00
05/18/2015 02:00:00
05/18/2015 08:00:00
05/18/2015 14:00:00
05/18/2015 20:00:00
05/19/2015 02:00:00
05/19/2015 08:00:00
DateTime

KA-SHD-0280

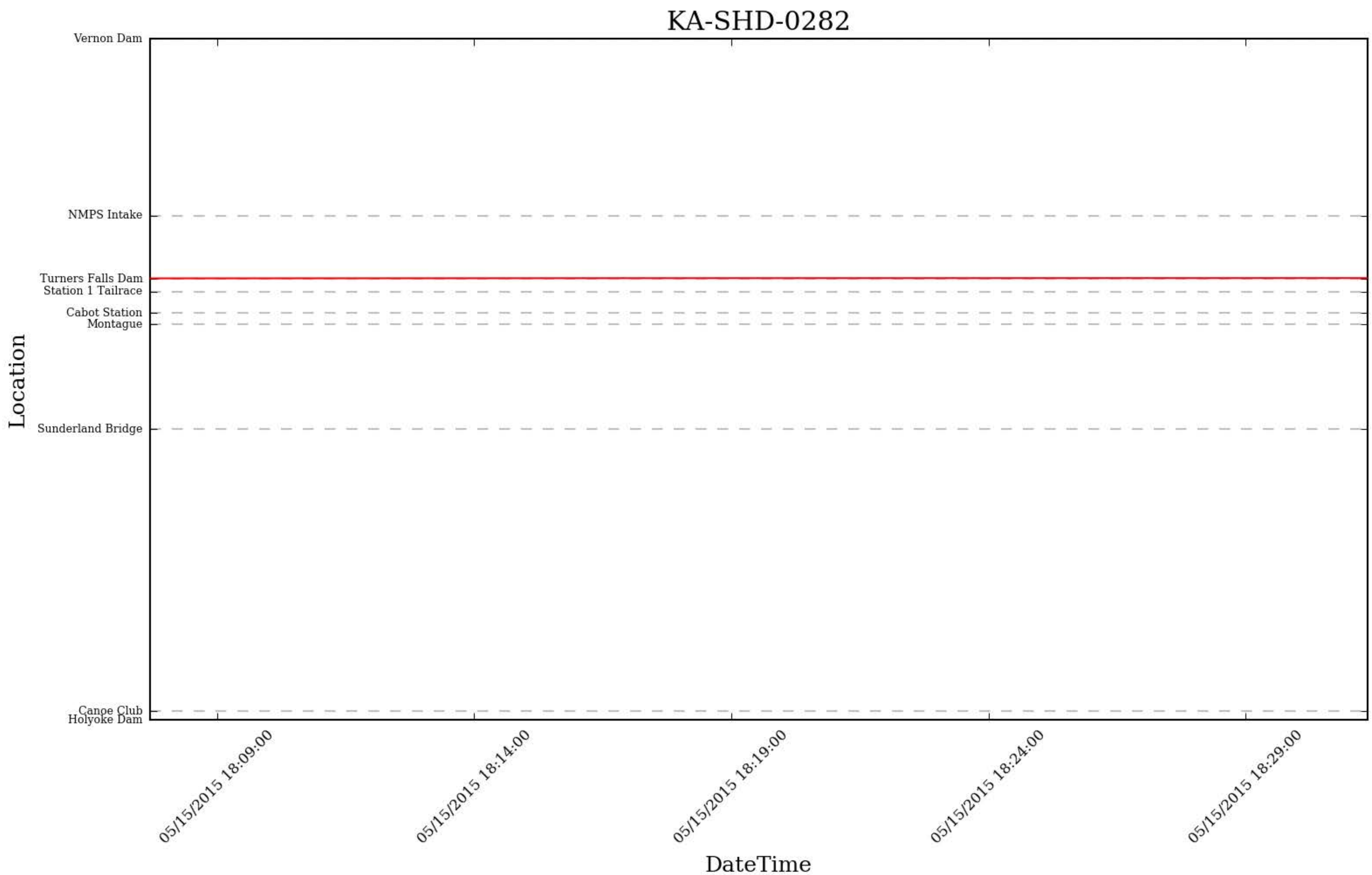


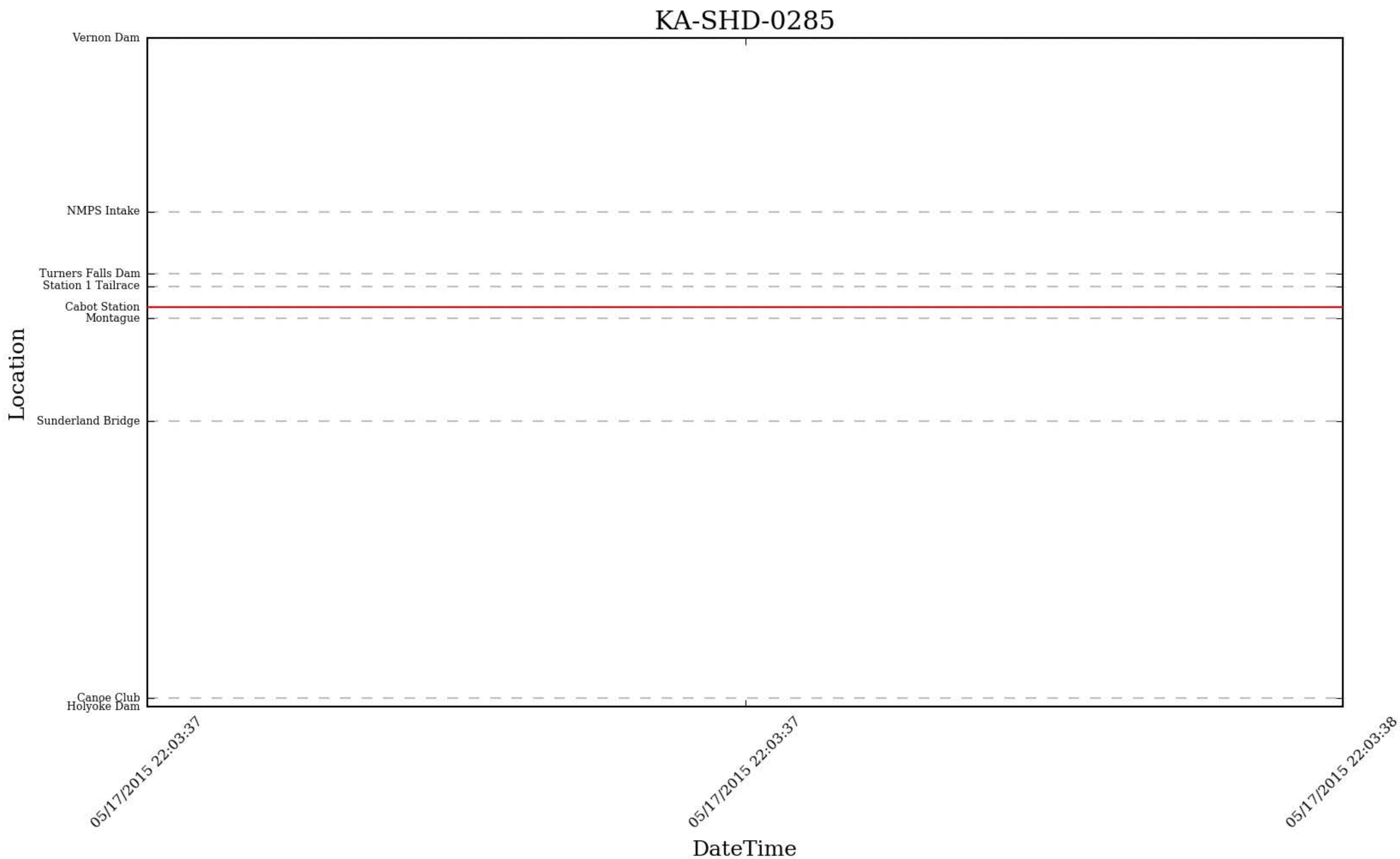
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 18:16:57
05/25/2015 18:16:58
05/25/2015 18:16:59
05/25/2015 18:17:00
05/25/2015 18:17:01
DateTime

KA-SHD-0281



Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/19/2015 19:12:00
05/19/2015 19:17:00
05/19/2015 19:22:00
05/19/2015 19:27:00
DateTime


KA-SHD-0282
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 18:09:00
05/15/2015 18:14:00
05/15/2015 18:19:00
05/15/2015 18:24:00
05/15/2015 18:29:00
DateTime


KA-SHD-0285
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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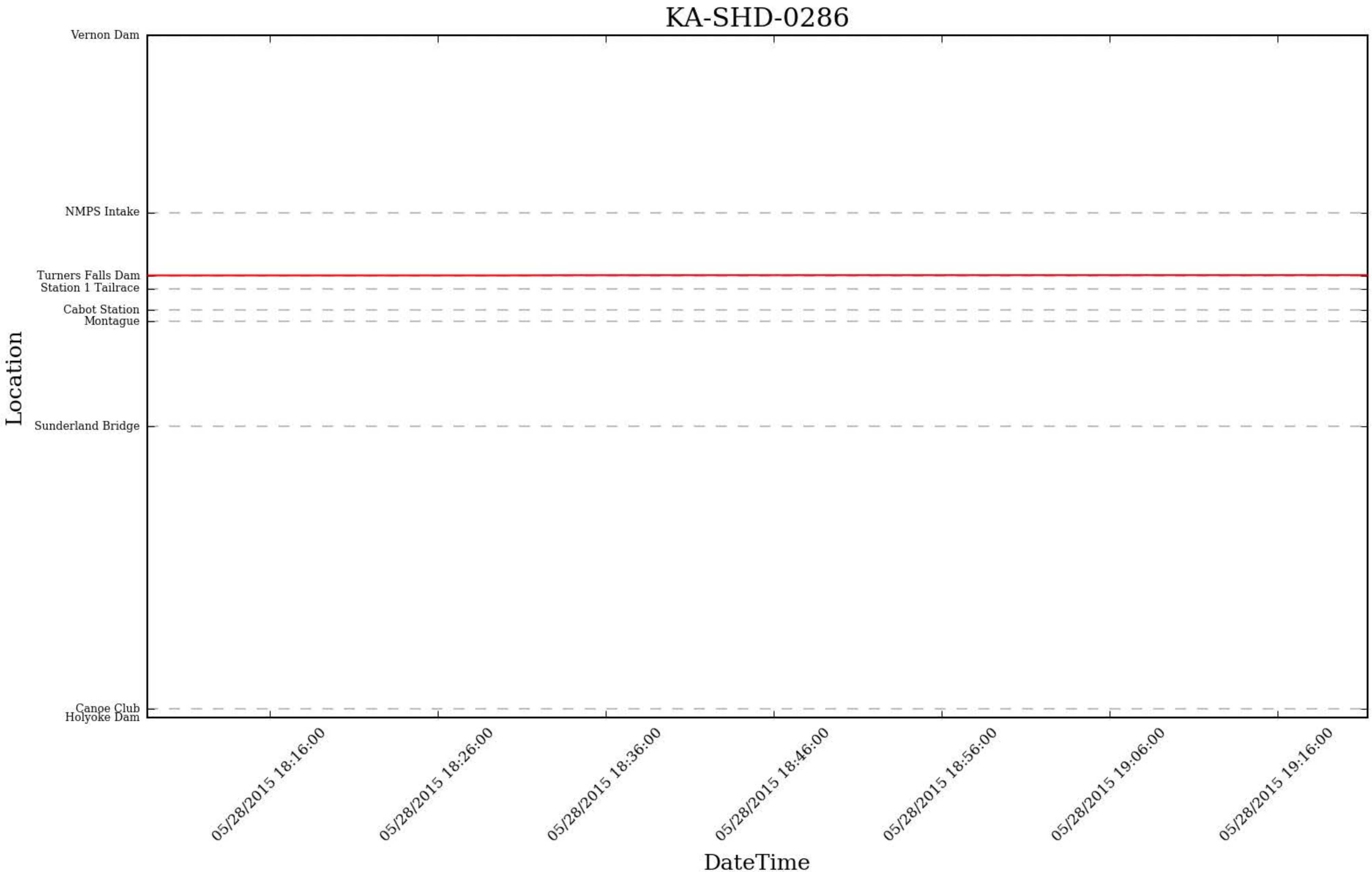
05/17/2015 22:03:37
05/17/2015 22:03:38
DateTime


KA-SHD-0286
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 18:16:00
05/28/2015 18:26:00
05/28/2015 18:36:00
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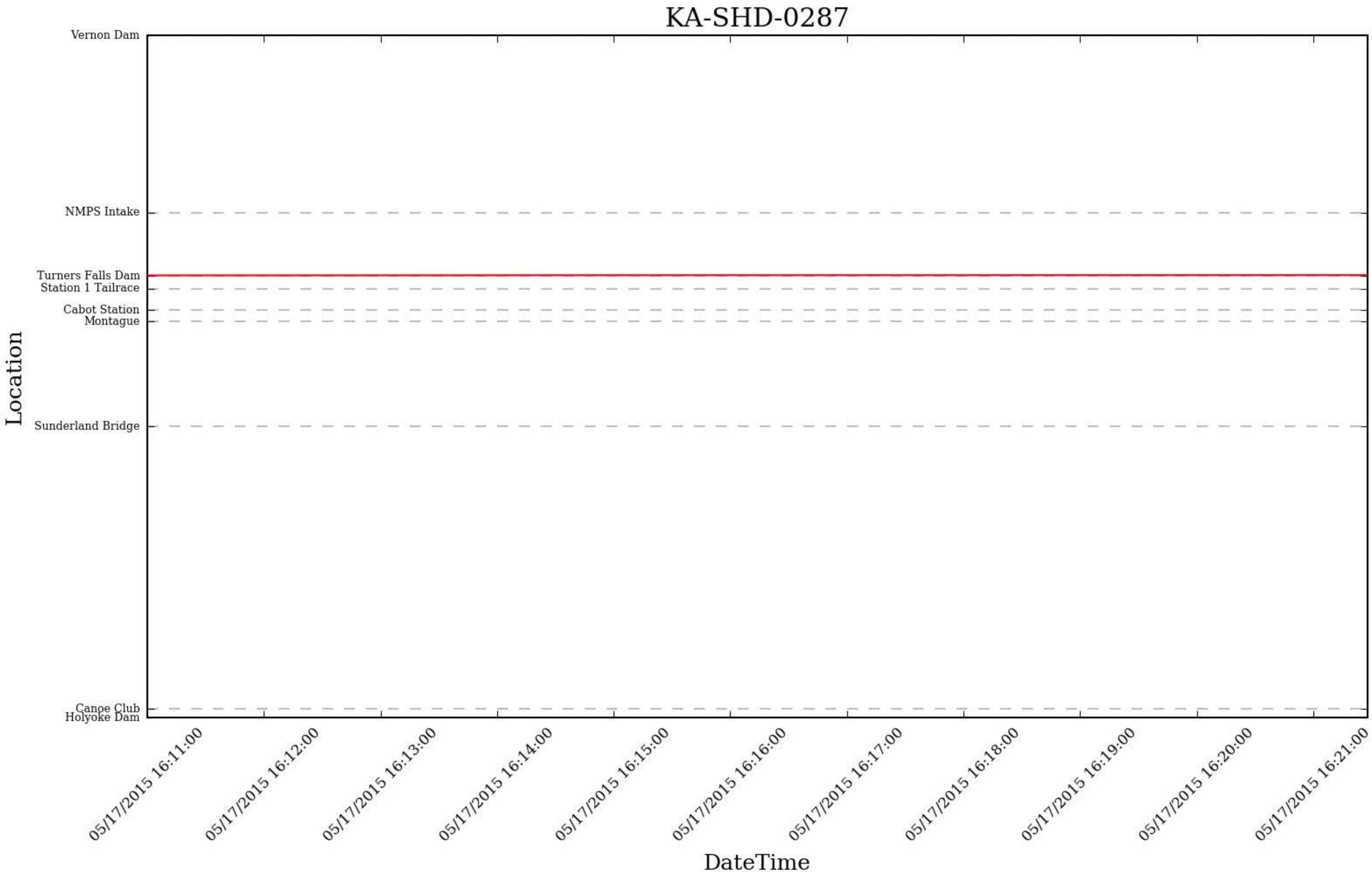
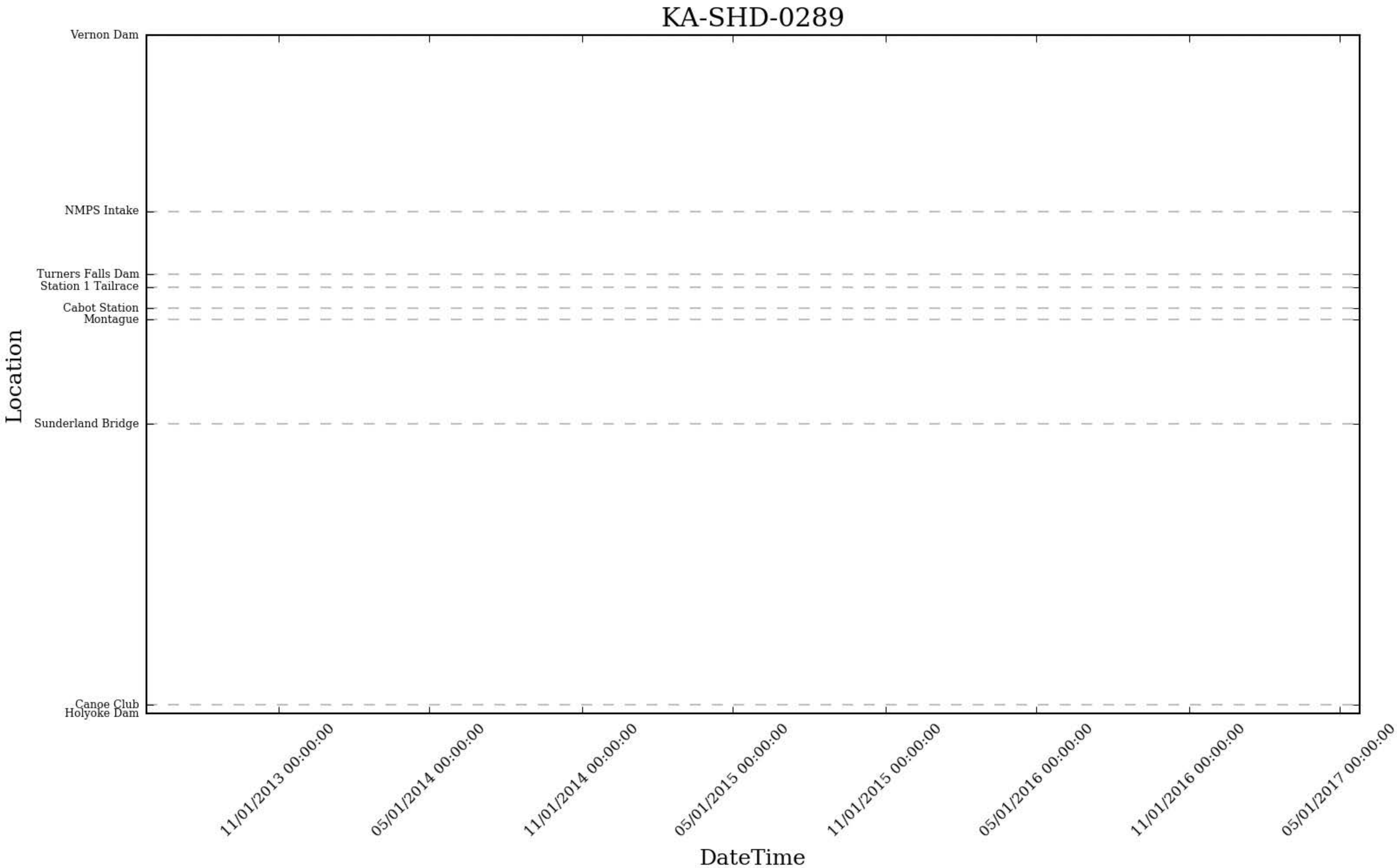
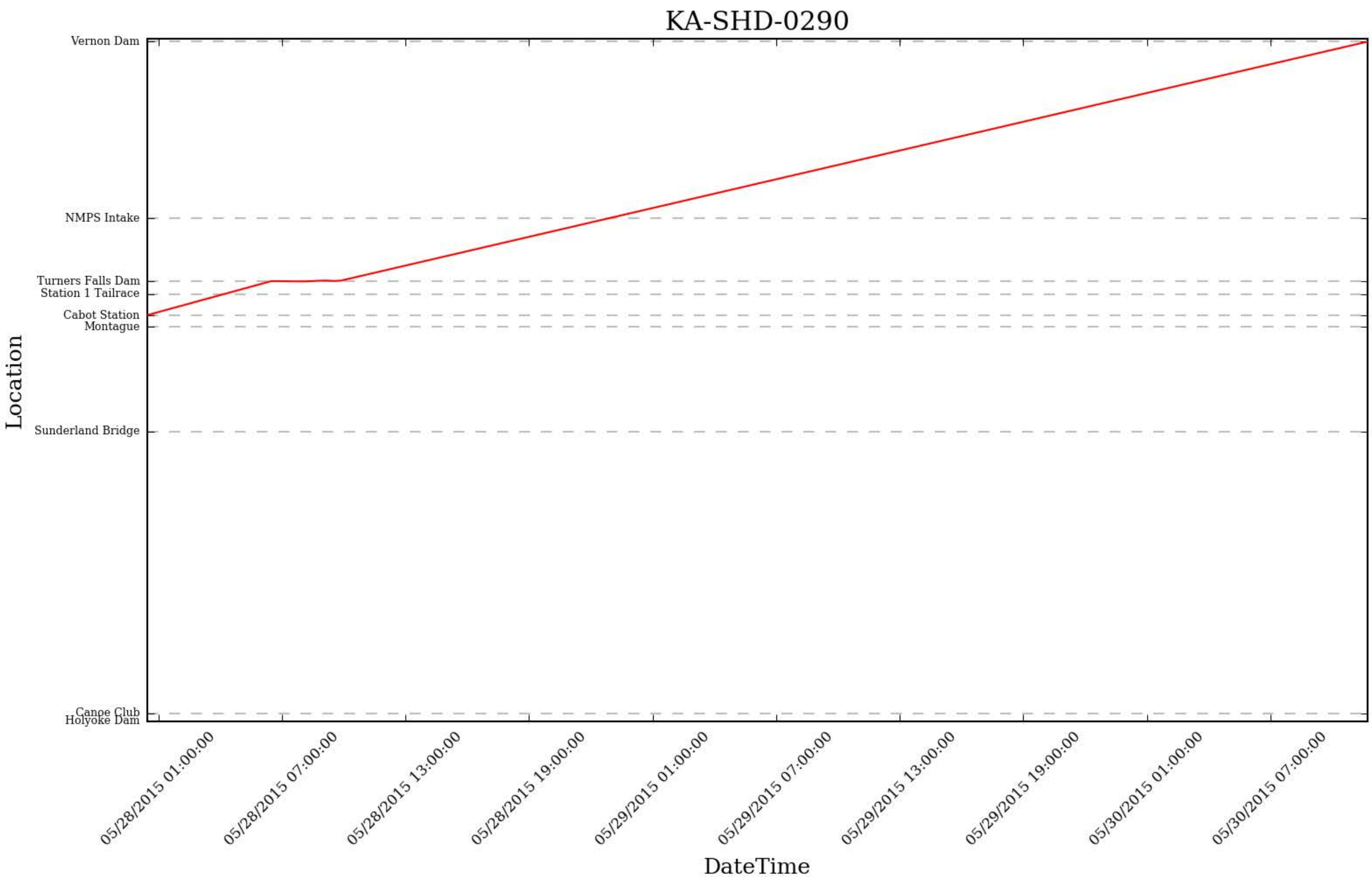
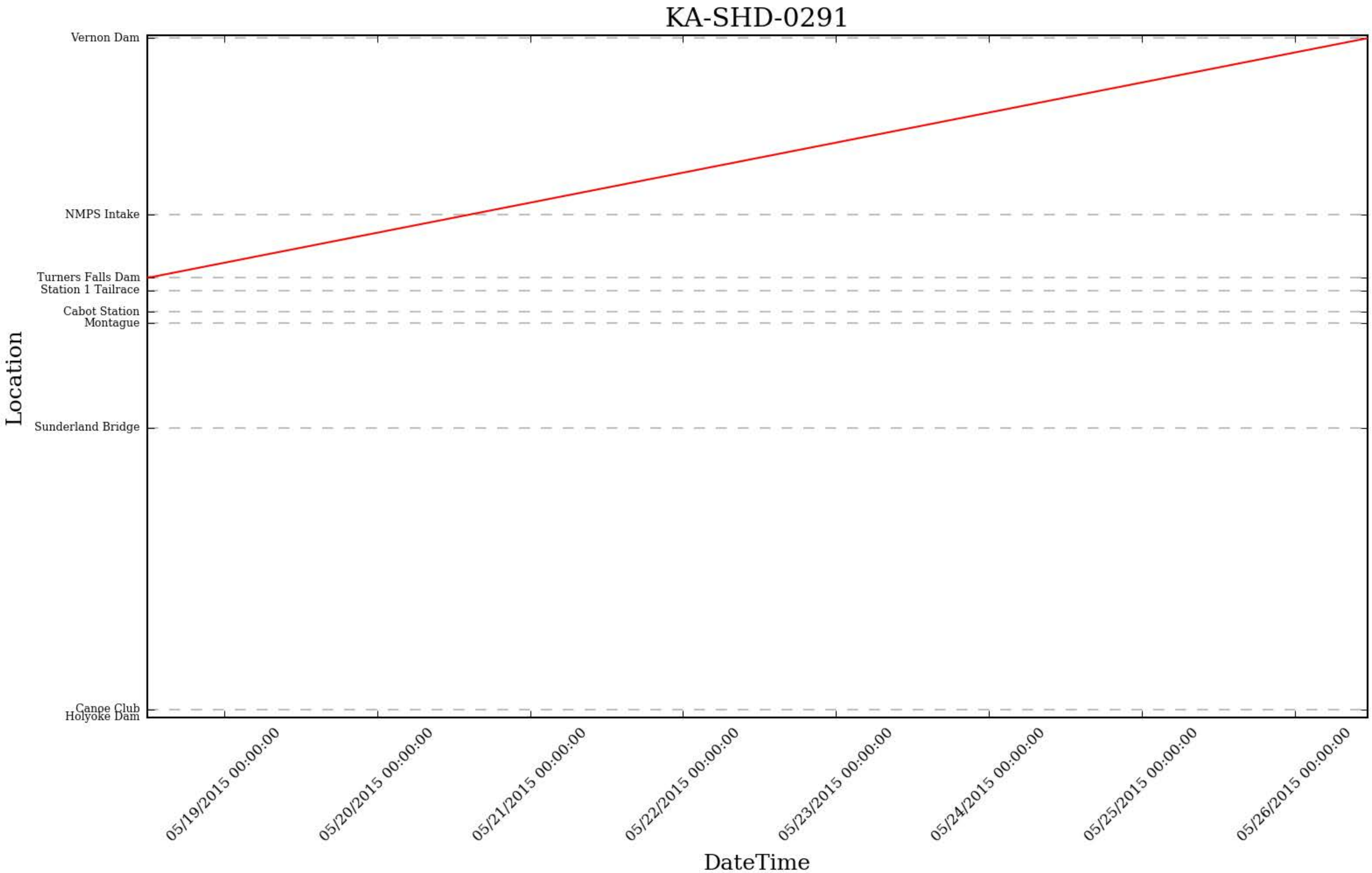
05/28/2015 18:56:00
05/28/2015 19:06:00
05/28/2015 19:16:00
DateTime


KA-SHD-0287
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 16:11:00
05/17/2015 16:12:00
05/17/2015 16:13:00
05/17/2015 16:14:00
05/17/2015 16:15:00
05/17/2015 16:16:00
05/17/2015 16:17:00
05/17/2015 16:18:00
05/17/2015 16:19:00
05/17/2015 16:20:00
05/17/2015 16:21:00
DateTime

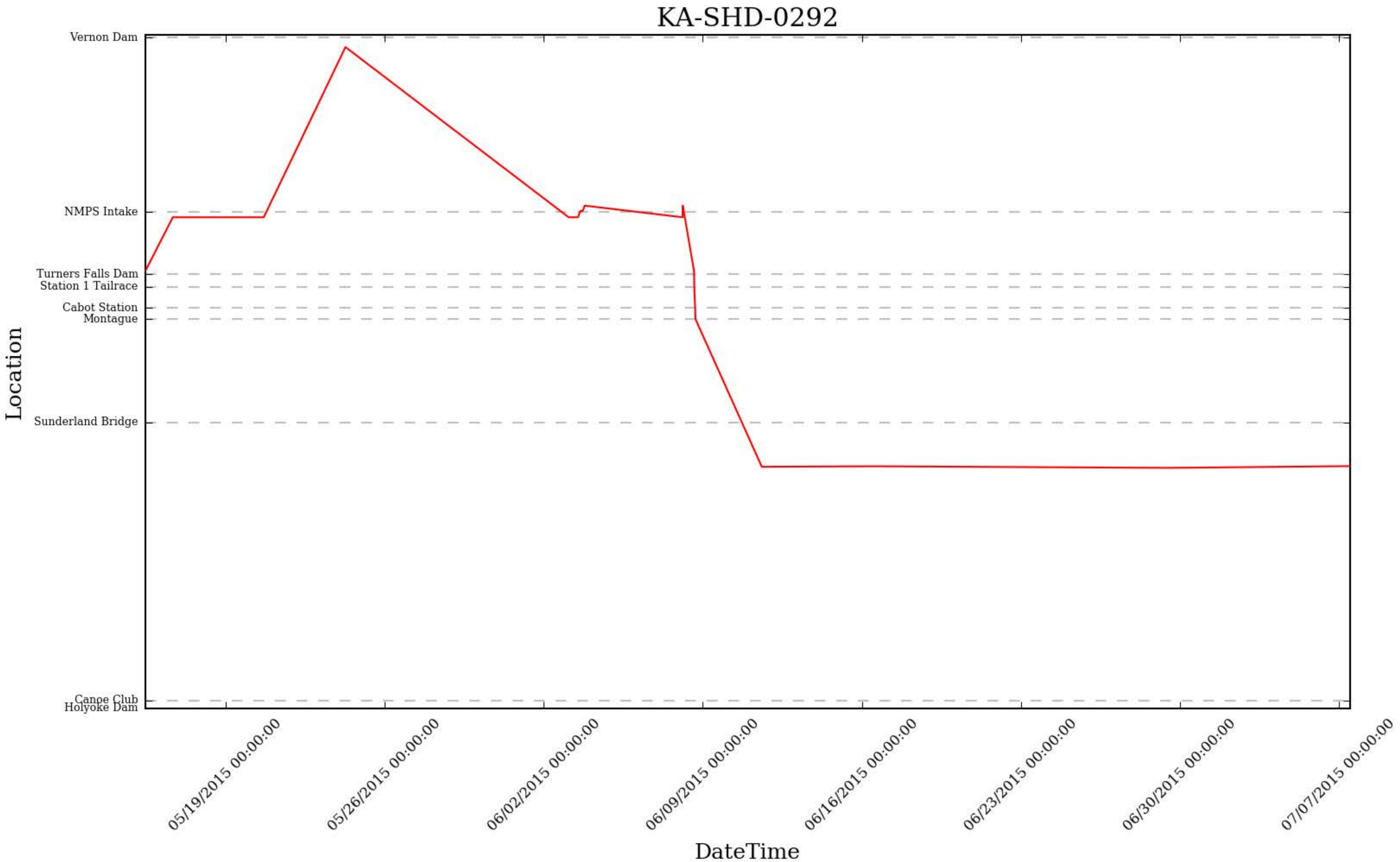

KA-SHD-0289
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime



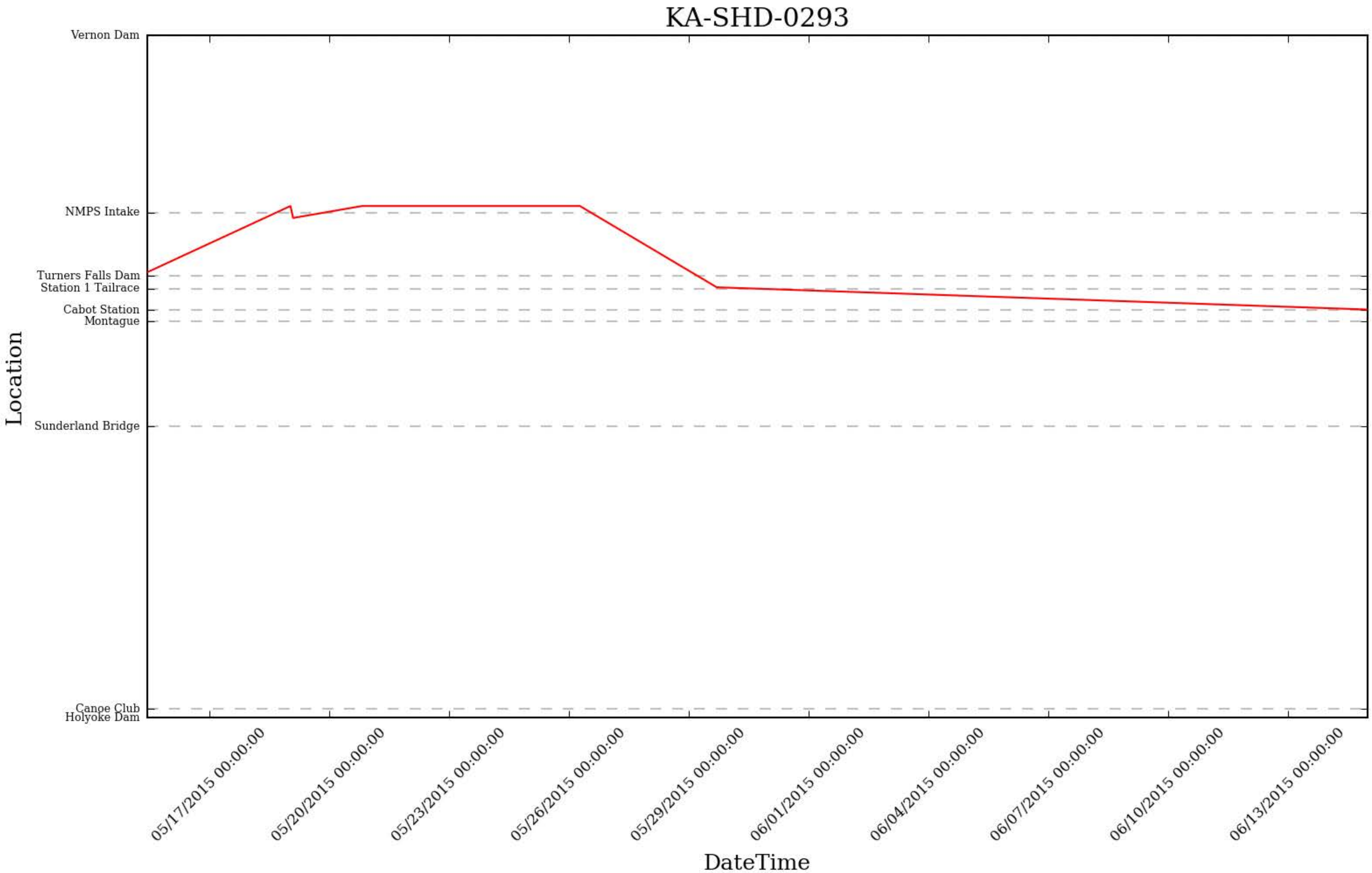
KA-SHD-0290
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 01:00:00
05/28/2015 07:00:00
05/28/2015 13:00:00
05/28/2015 19:00:00
05/29/2015 01:00:00
05/29/2015 07:00:00
05/29/2015 13:00:00
05/29/2015 19:00:00
05/30/2015 01:00:00
05/30/2015 07:00:00
DateTime



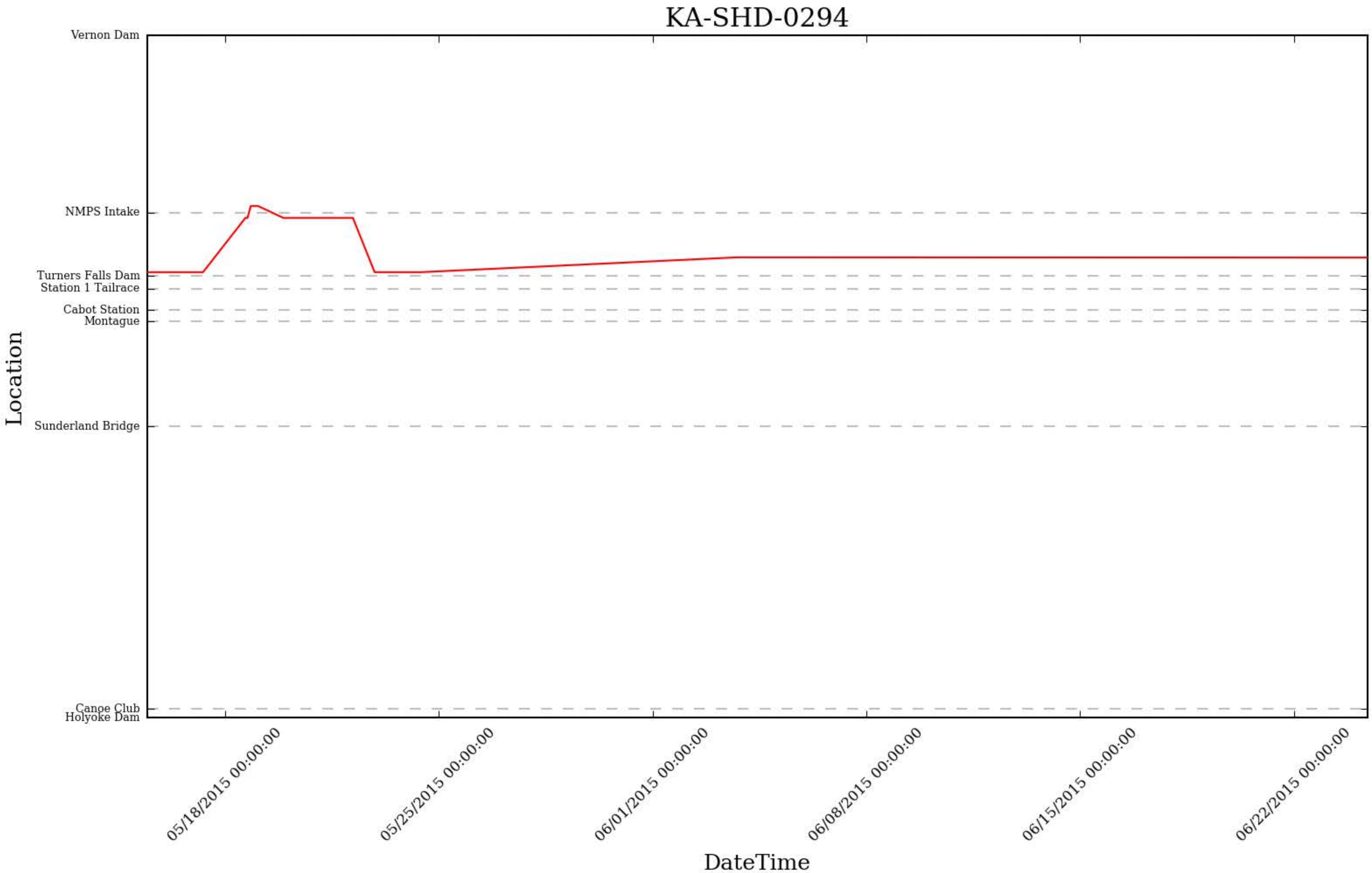
KA-SHD-0291
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
DateTime



KA-SHD-0292
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime



KA-SHD-0293
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
06/13/2015 00:00:00
DateTime


KA-SHD-0294
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/25/2015 00:00:00
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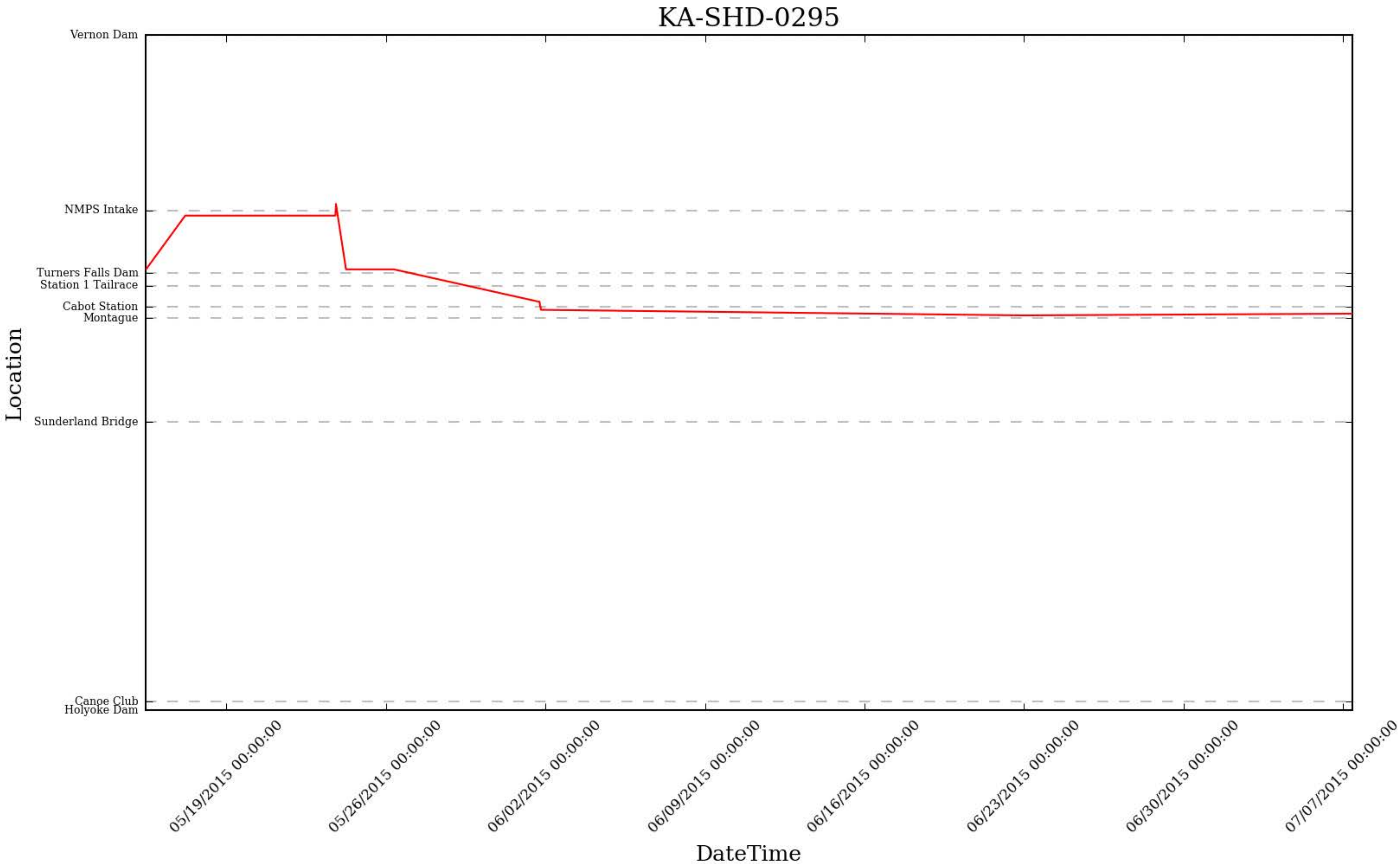
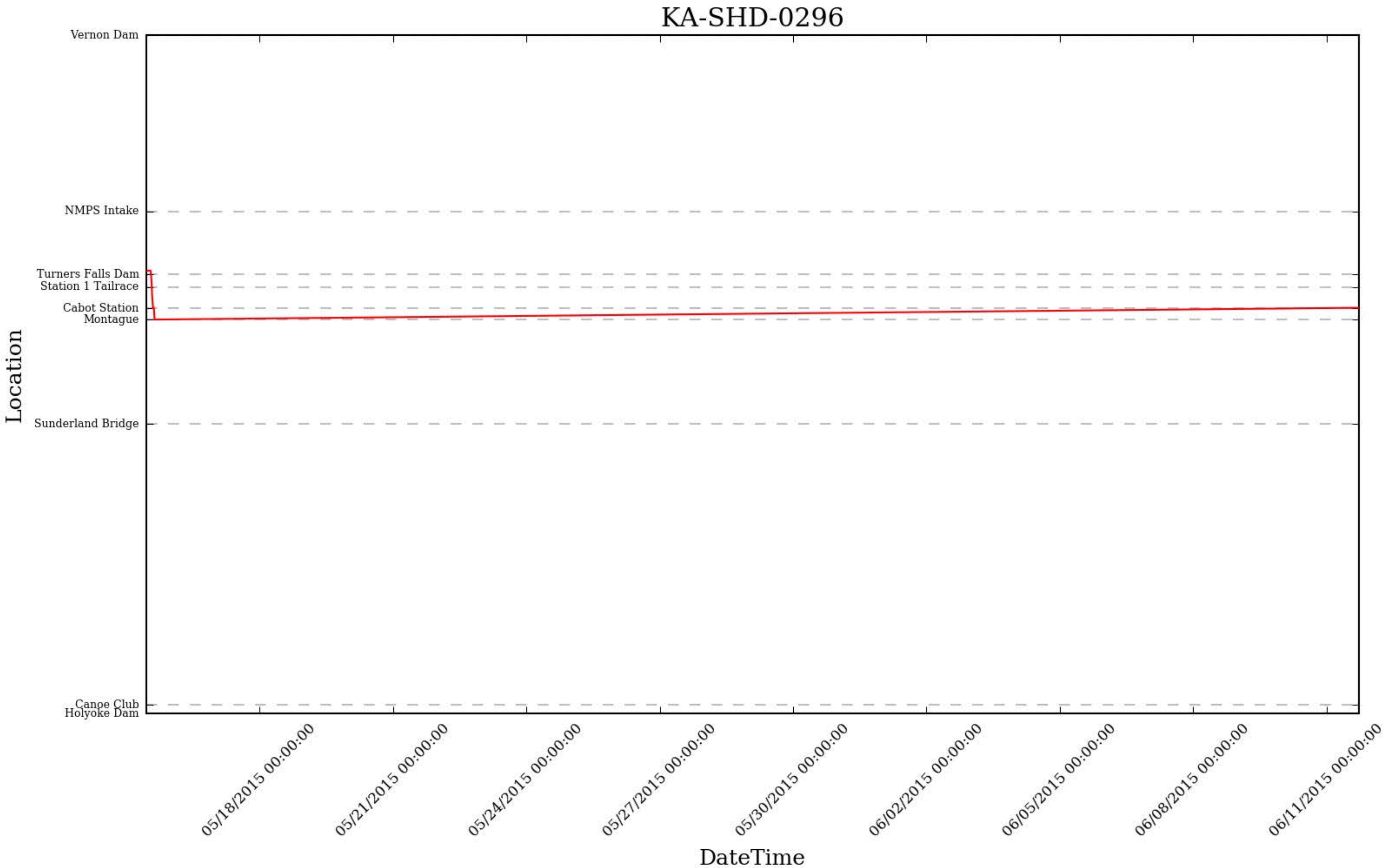
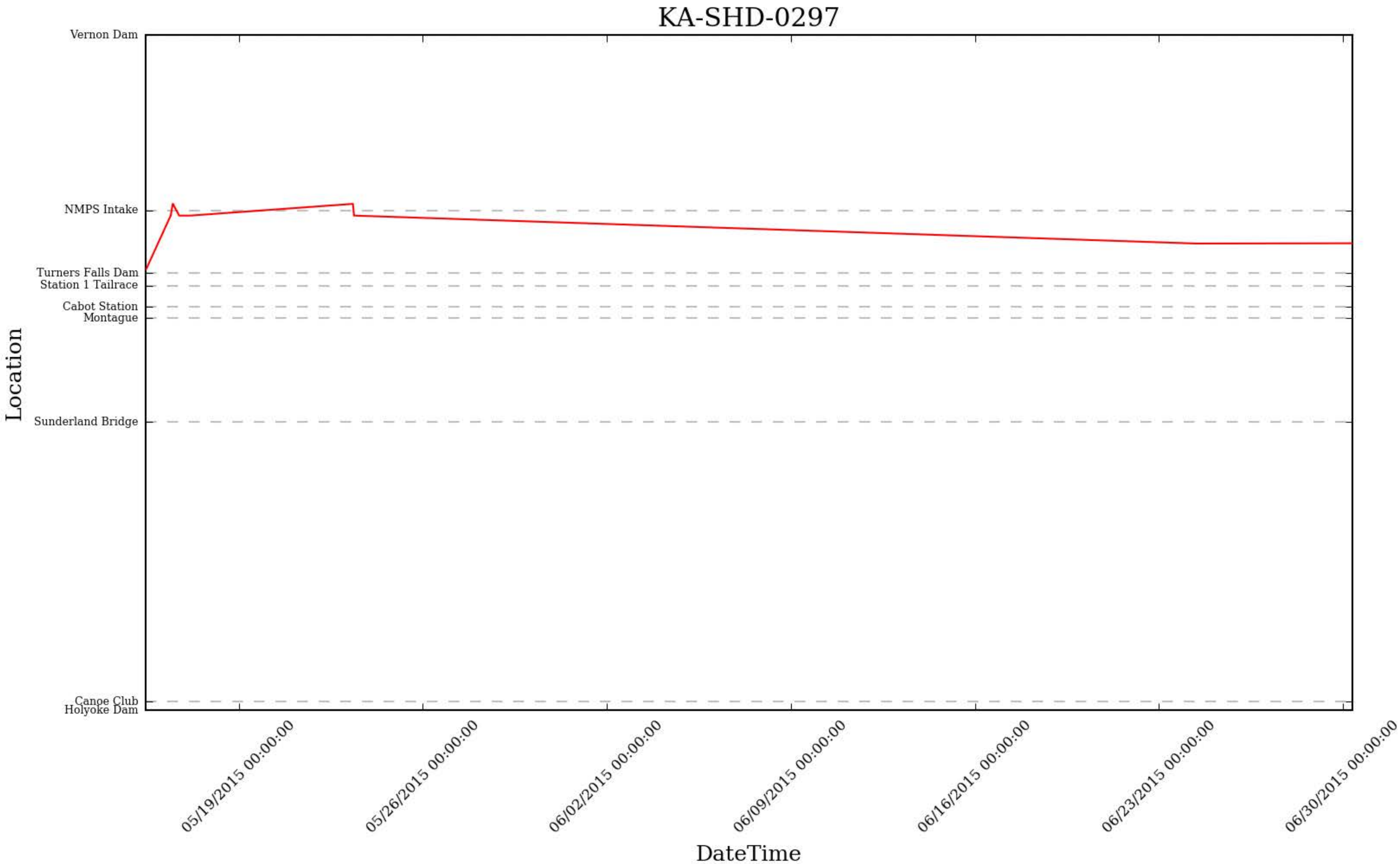
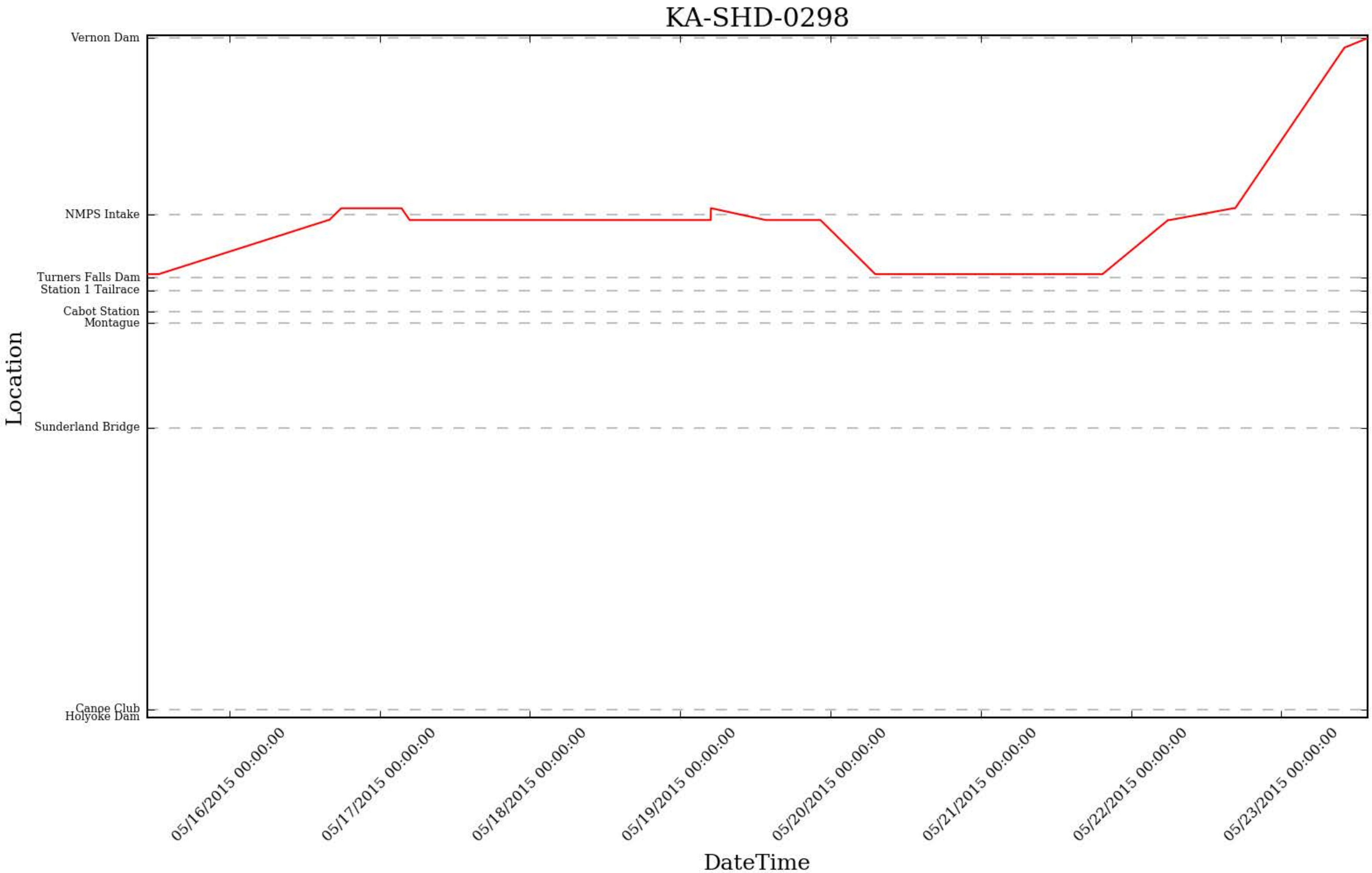
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
DateTime

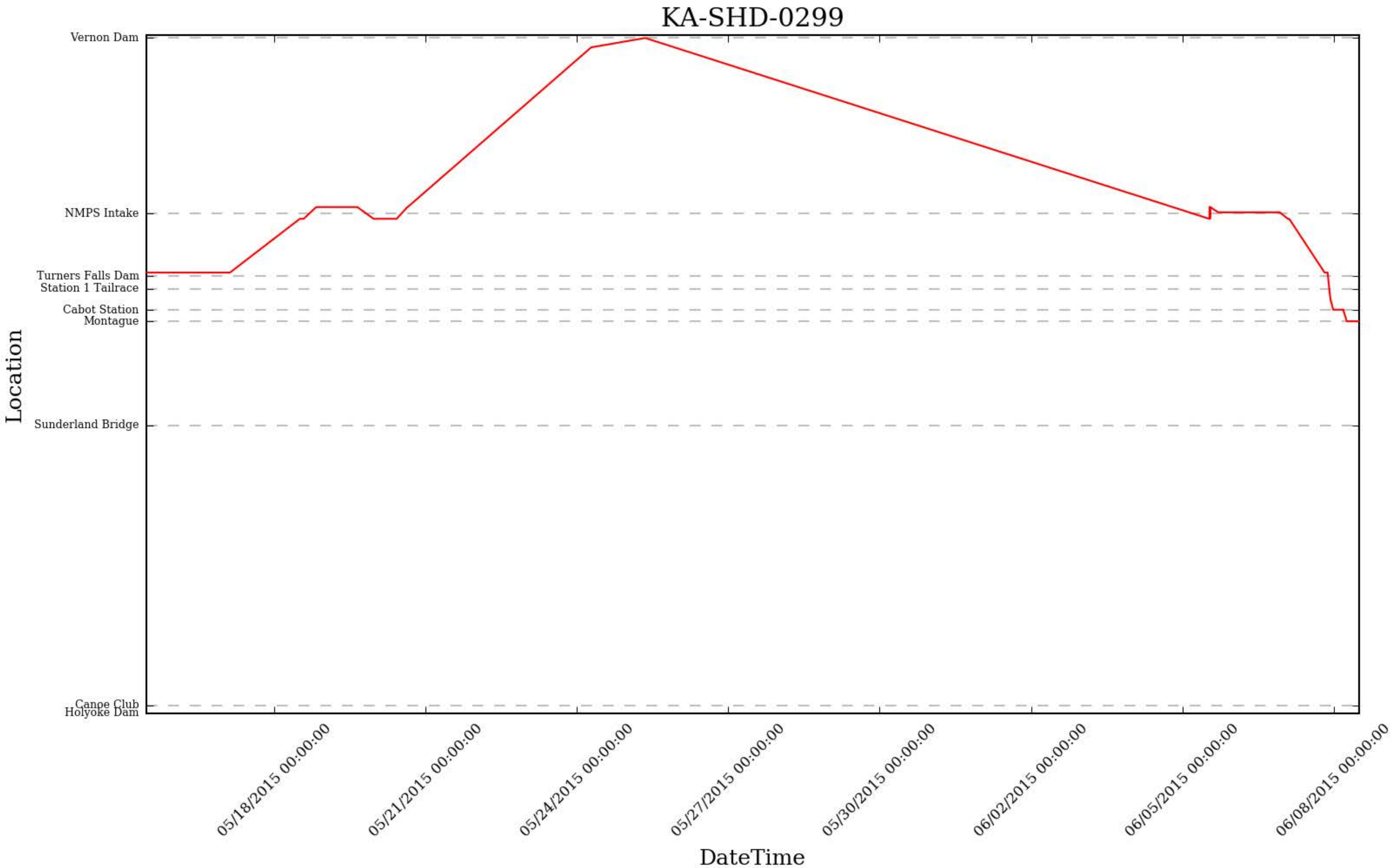

KA-SHD-0295
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime

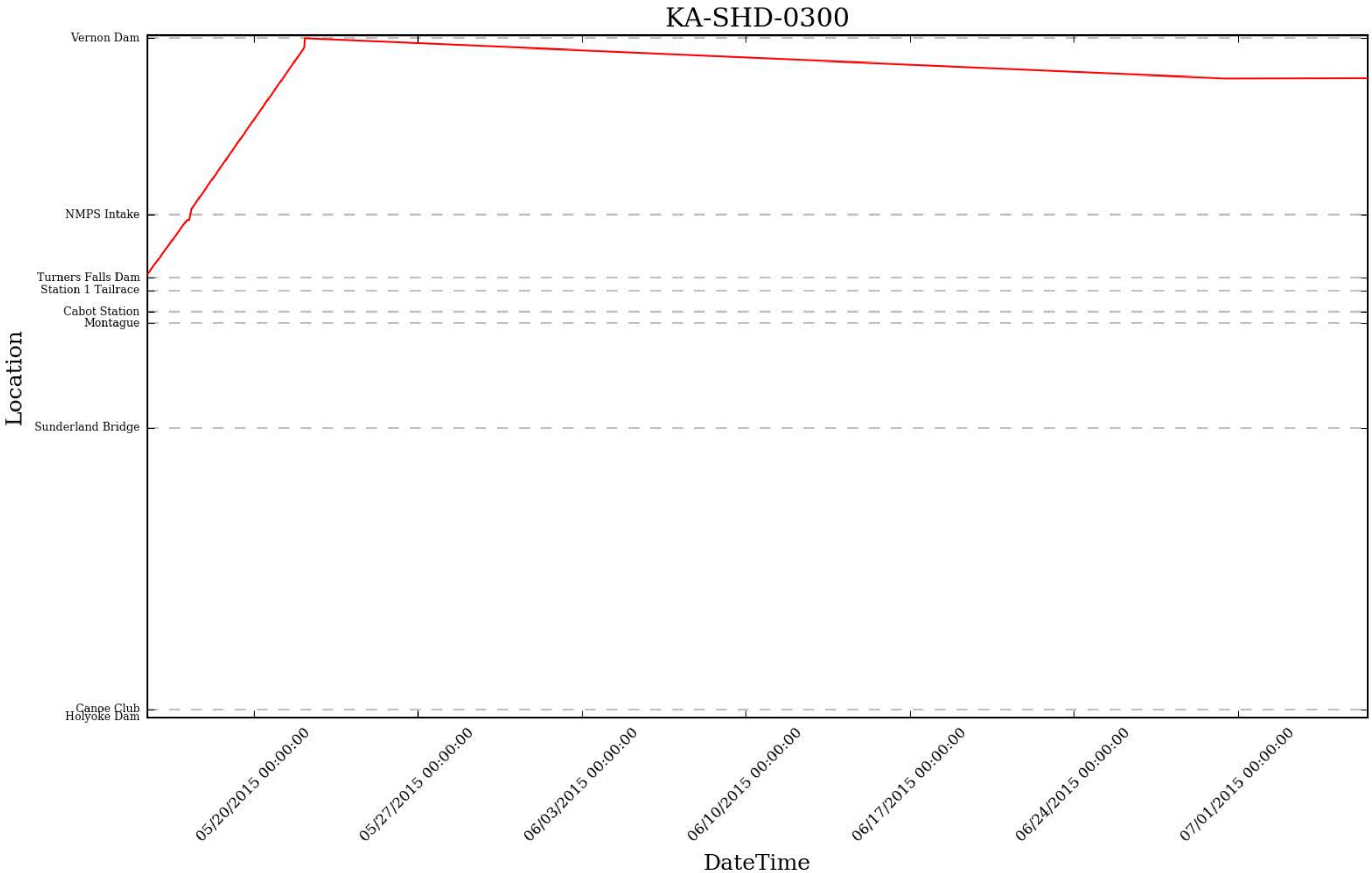

KA-SHD-0296
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
DateTime

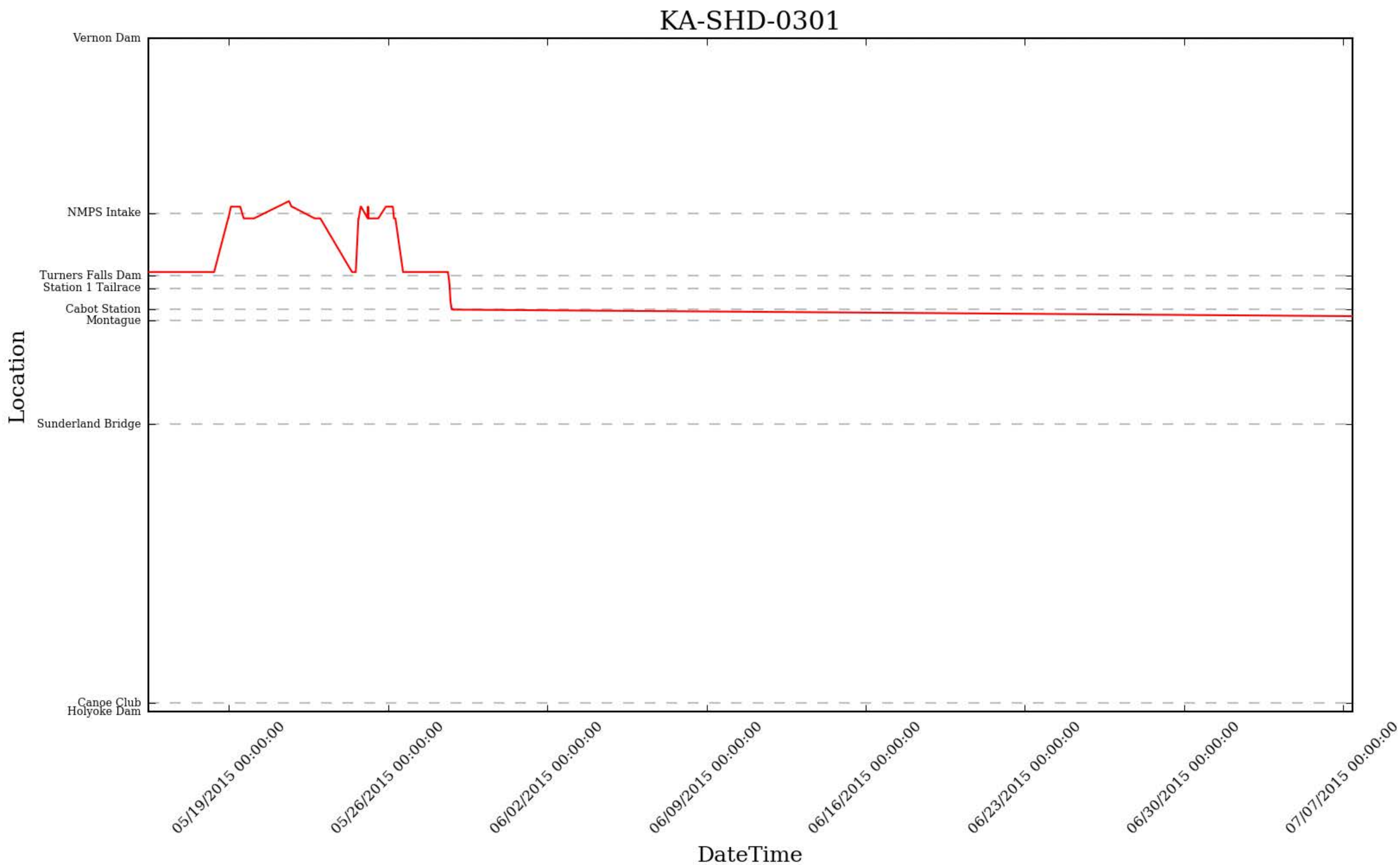

KA-SHD-0297
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
DateTime



KA-SHD-0298
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
DateTime


KA-SHD-0299
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
DateTime


KA-SHD-0300
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime


KA-SHD-0301
Location
Vernon Dam
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Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
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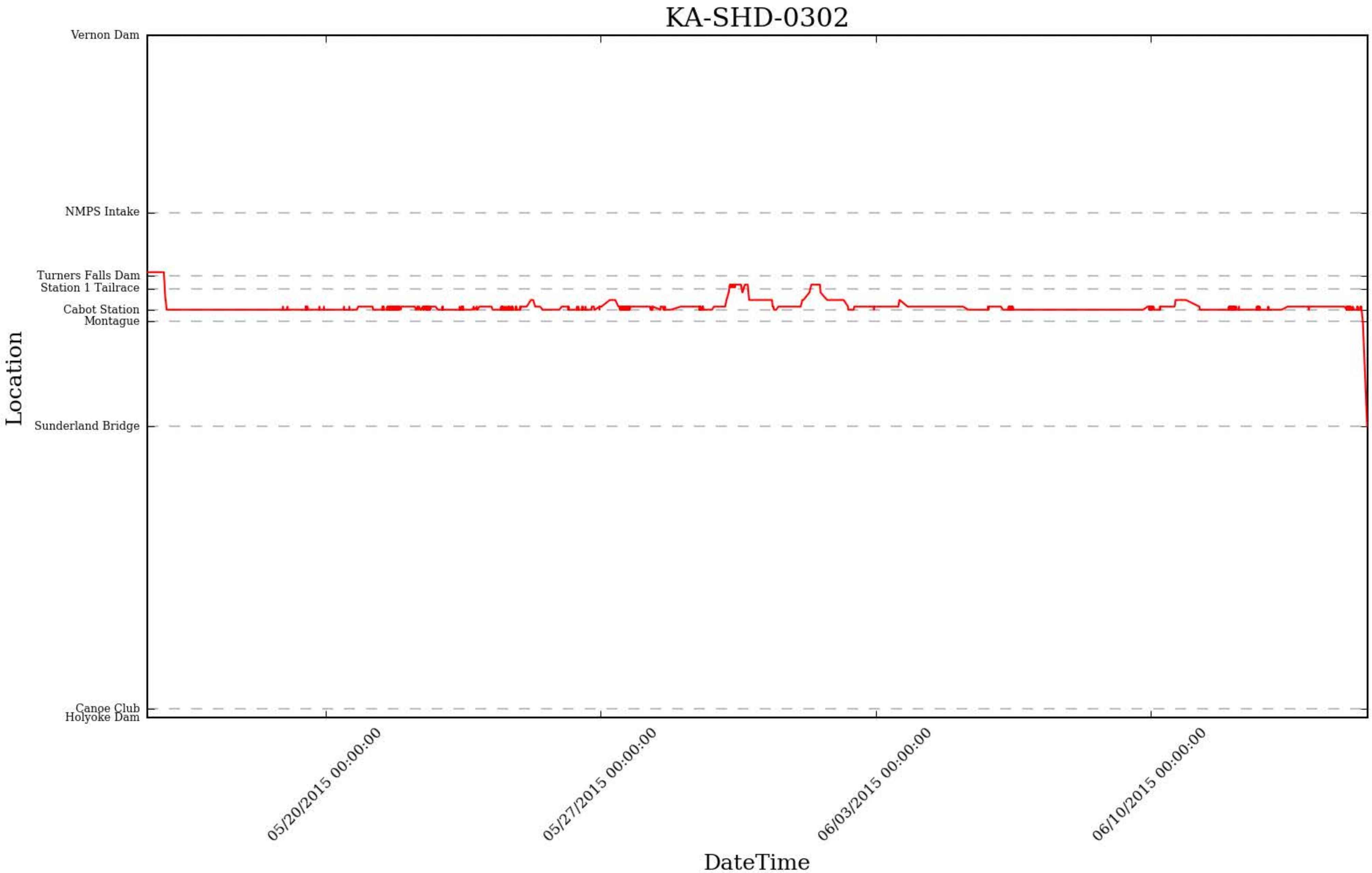
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime


KA-SHD-0302
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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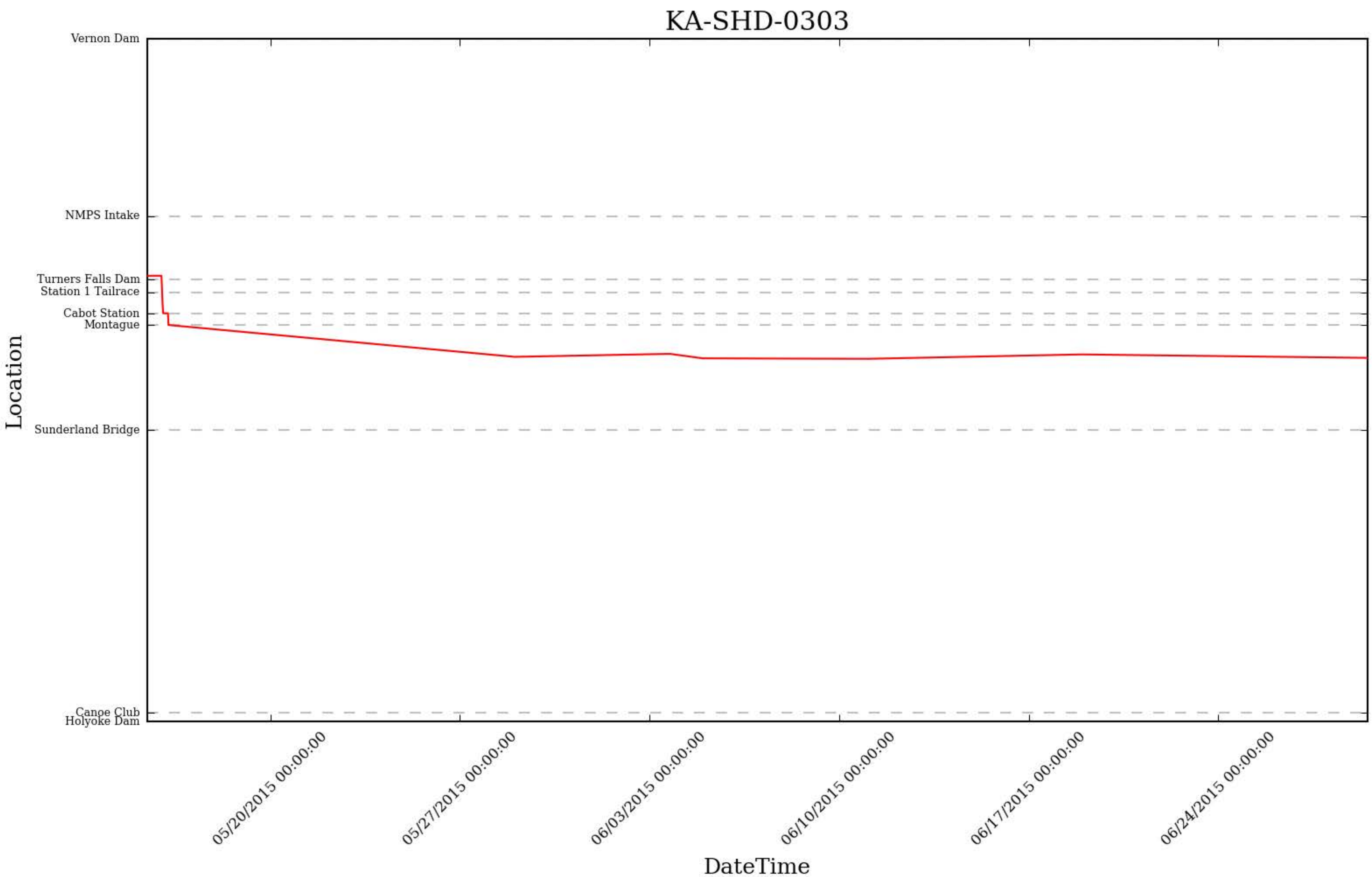
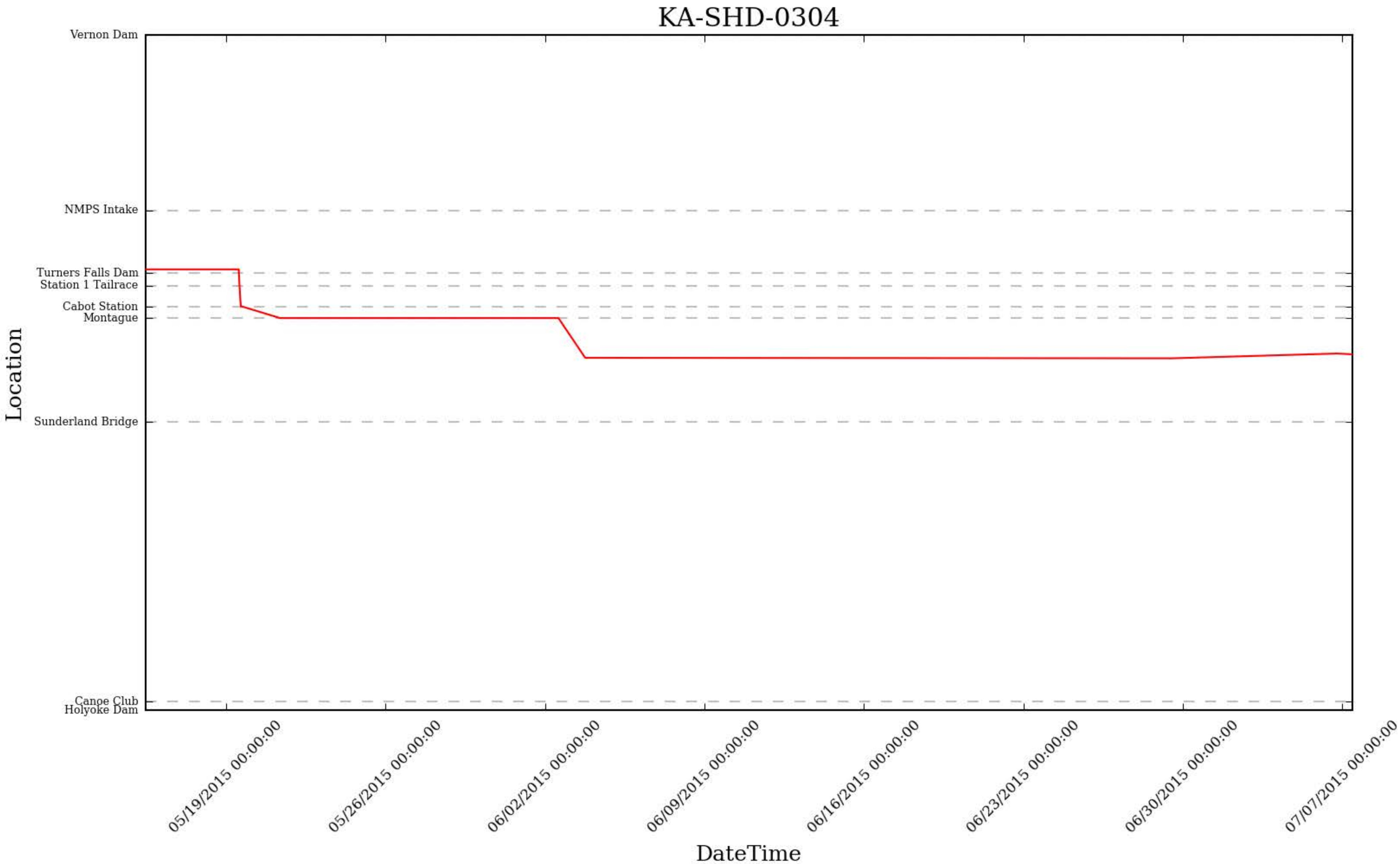
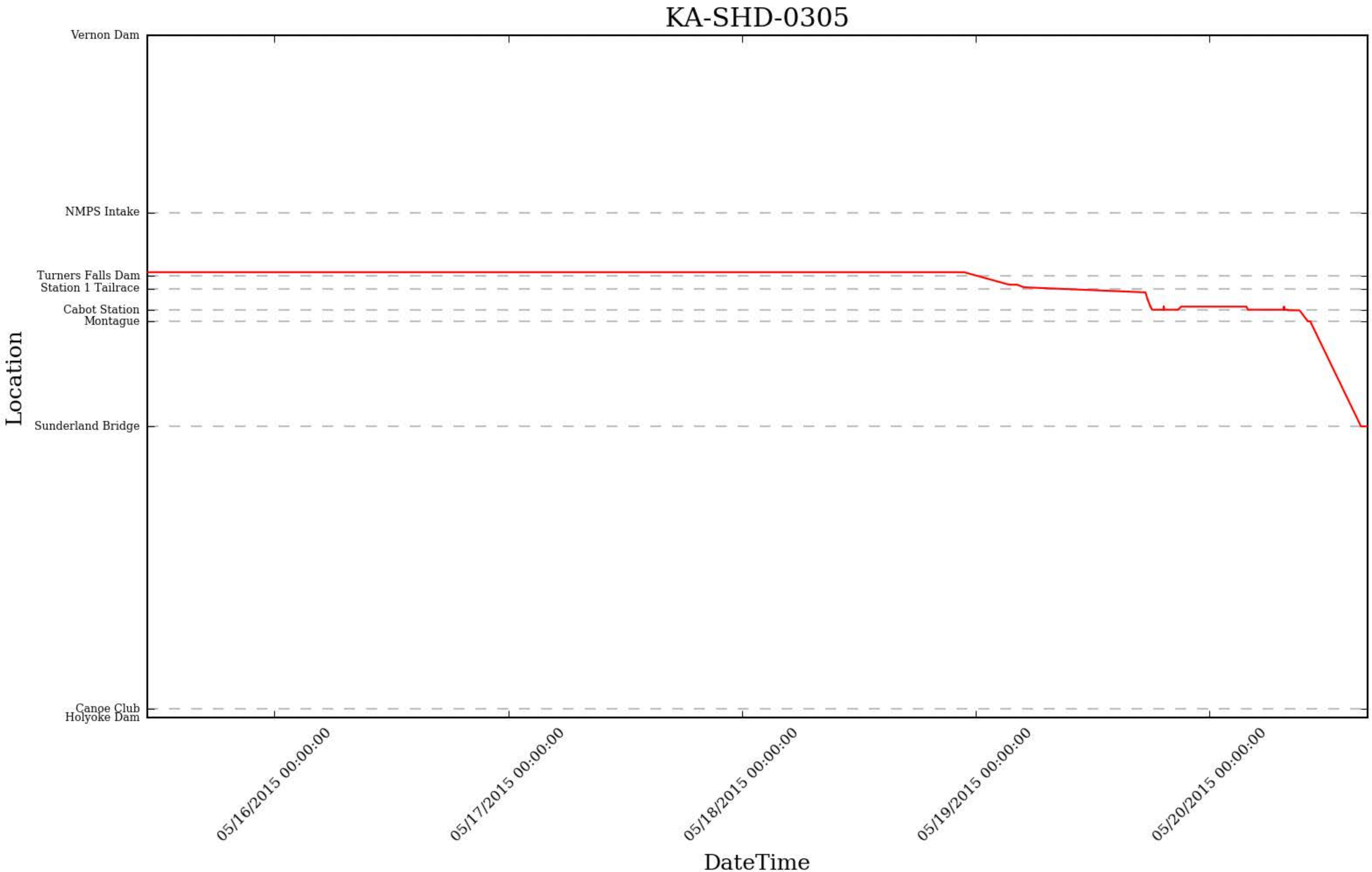
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
DateTime


KA-SHD-0303
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
DateTime


KA-SHD-0304
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime


KA-SHD-0305
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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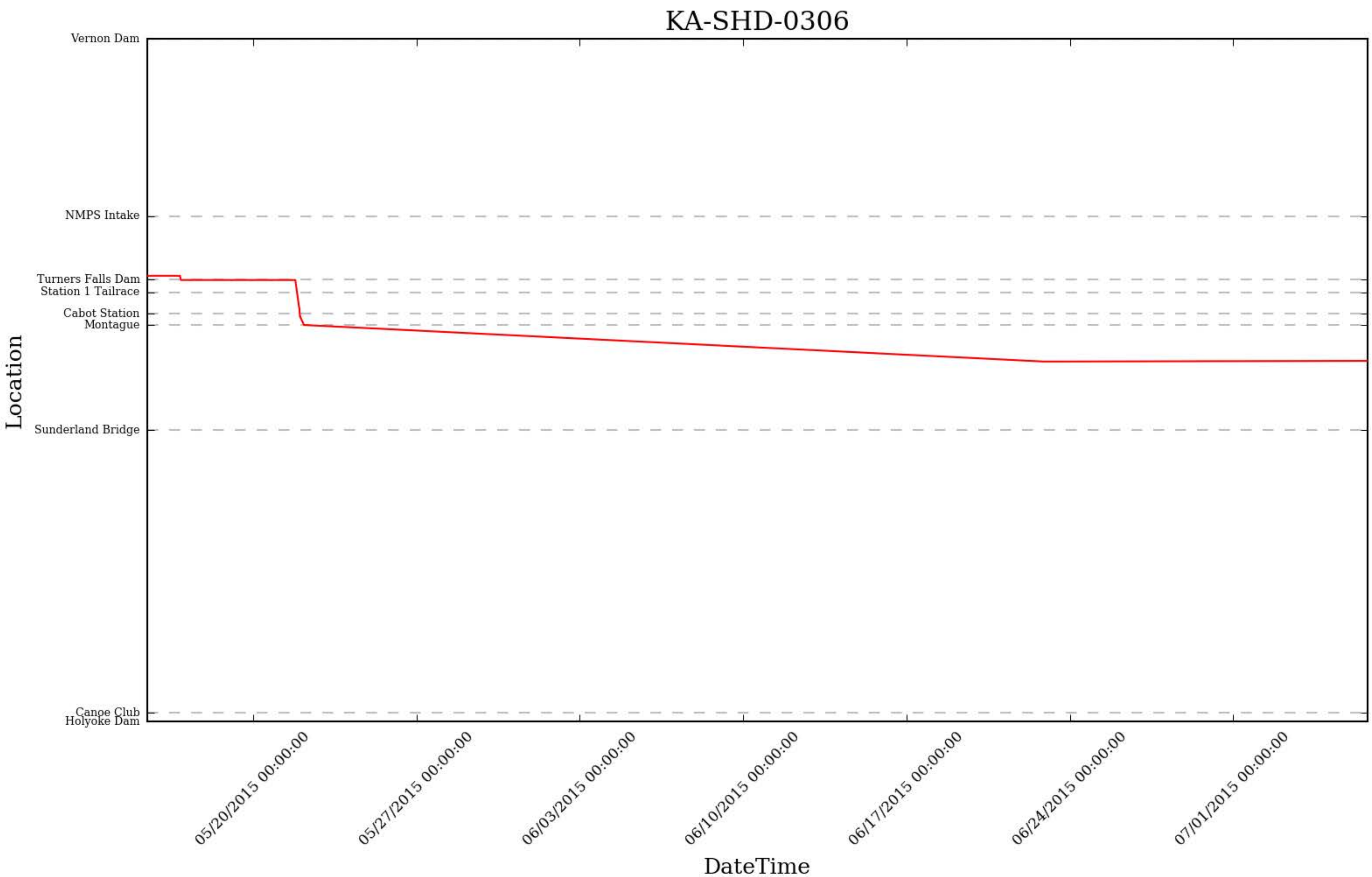
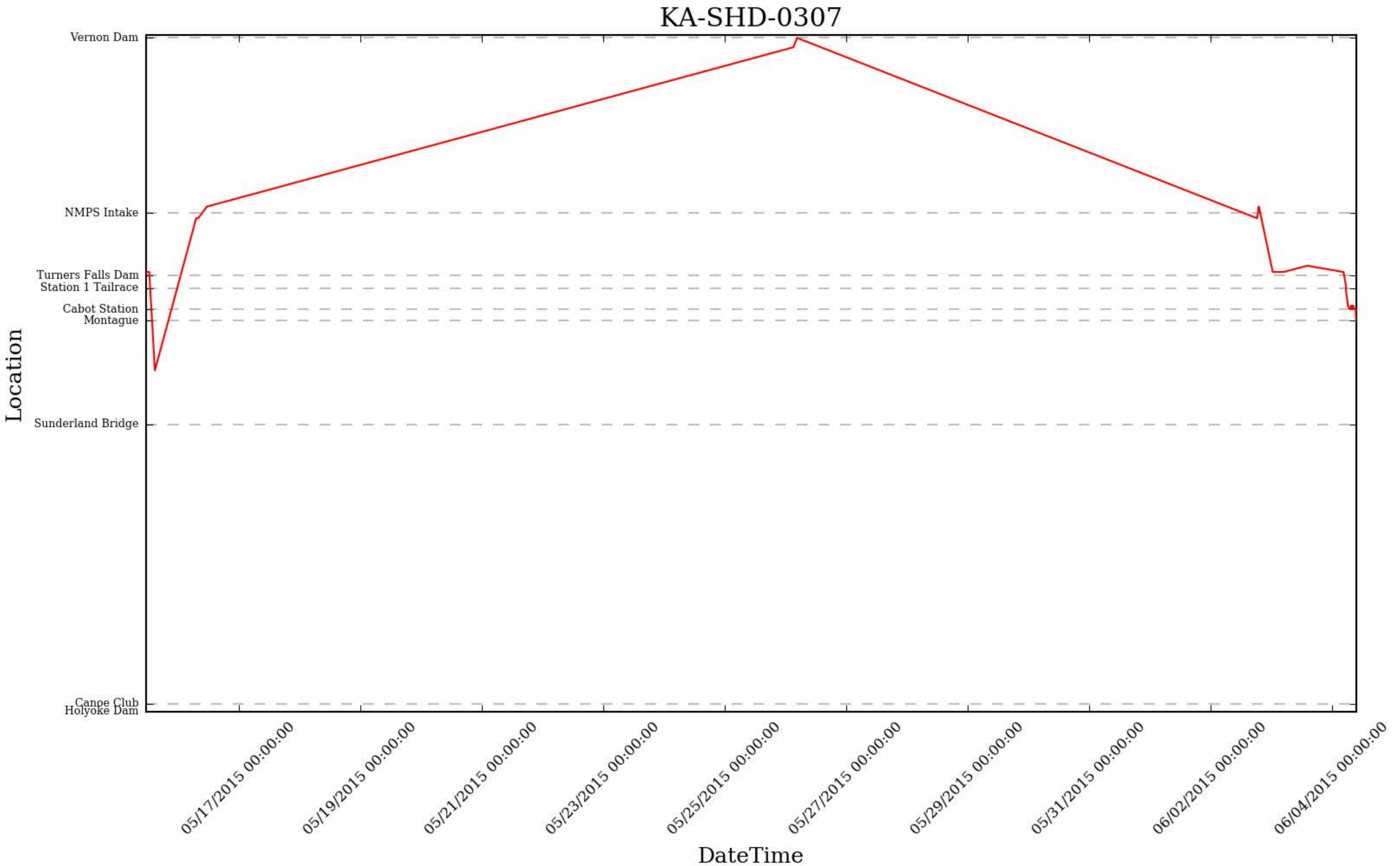
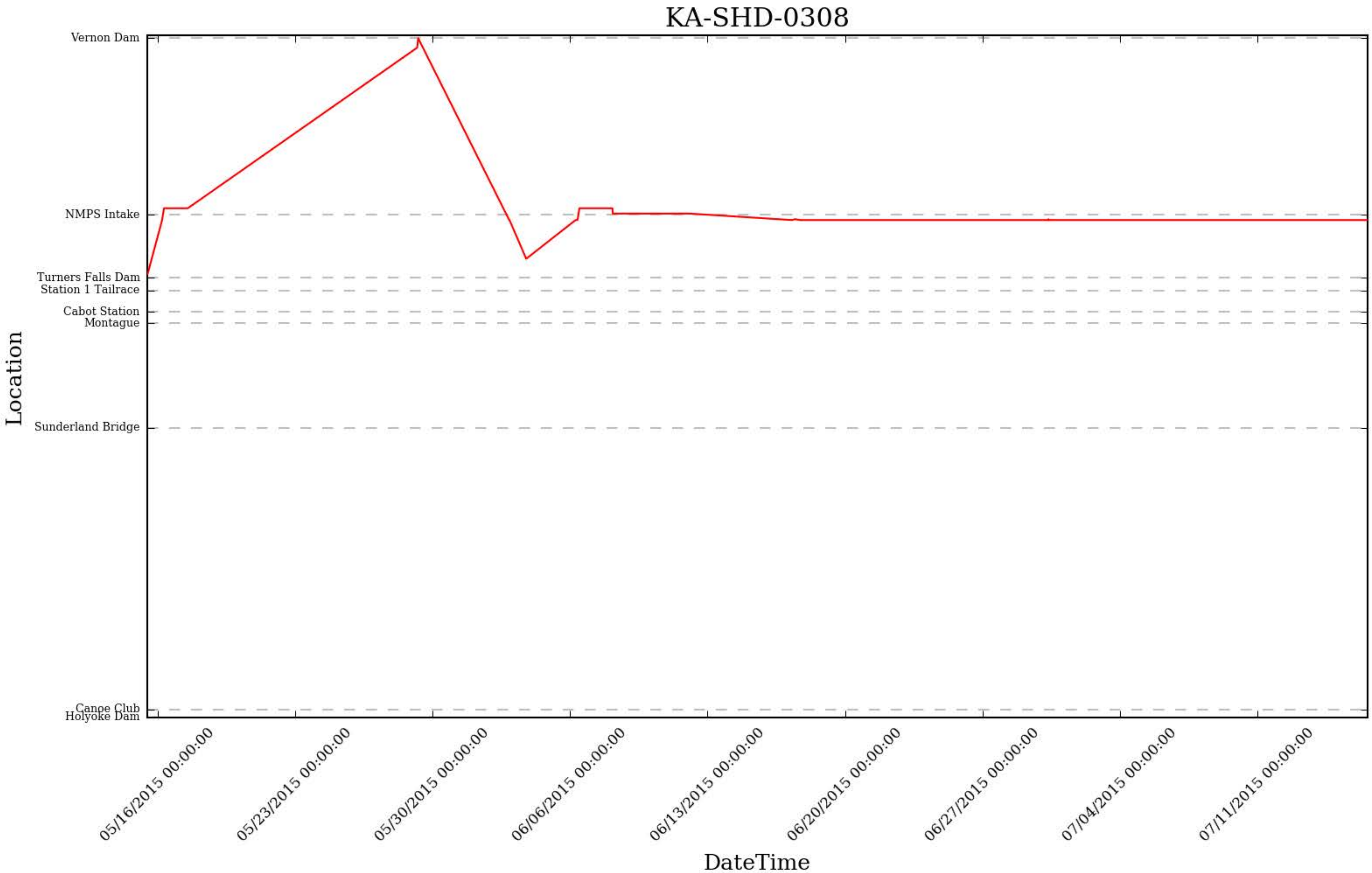
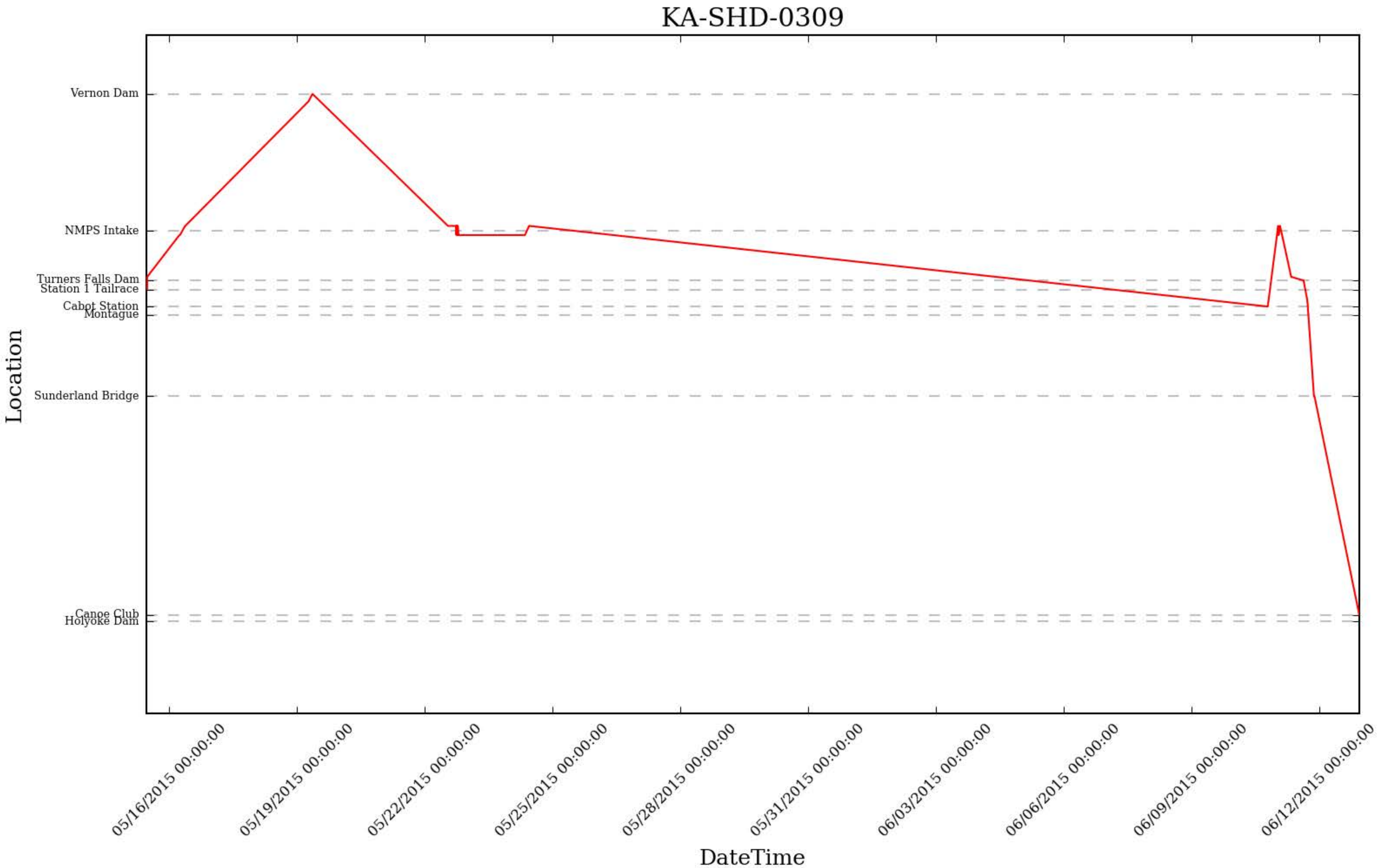
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
DateTime

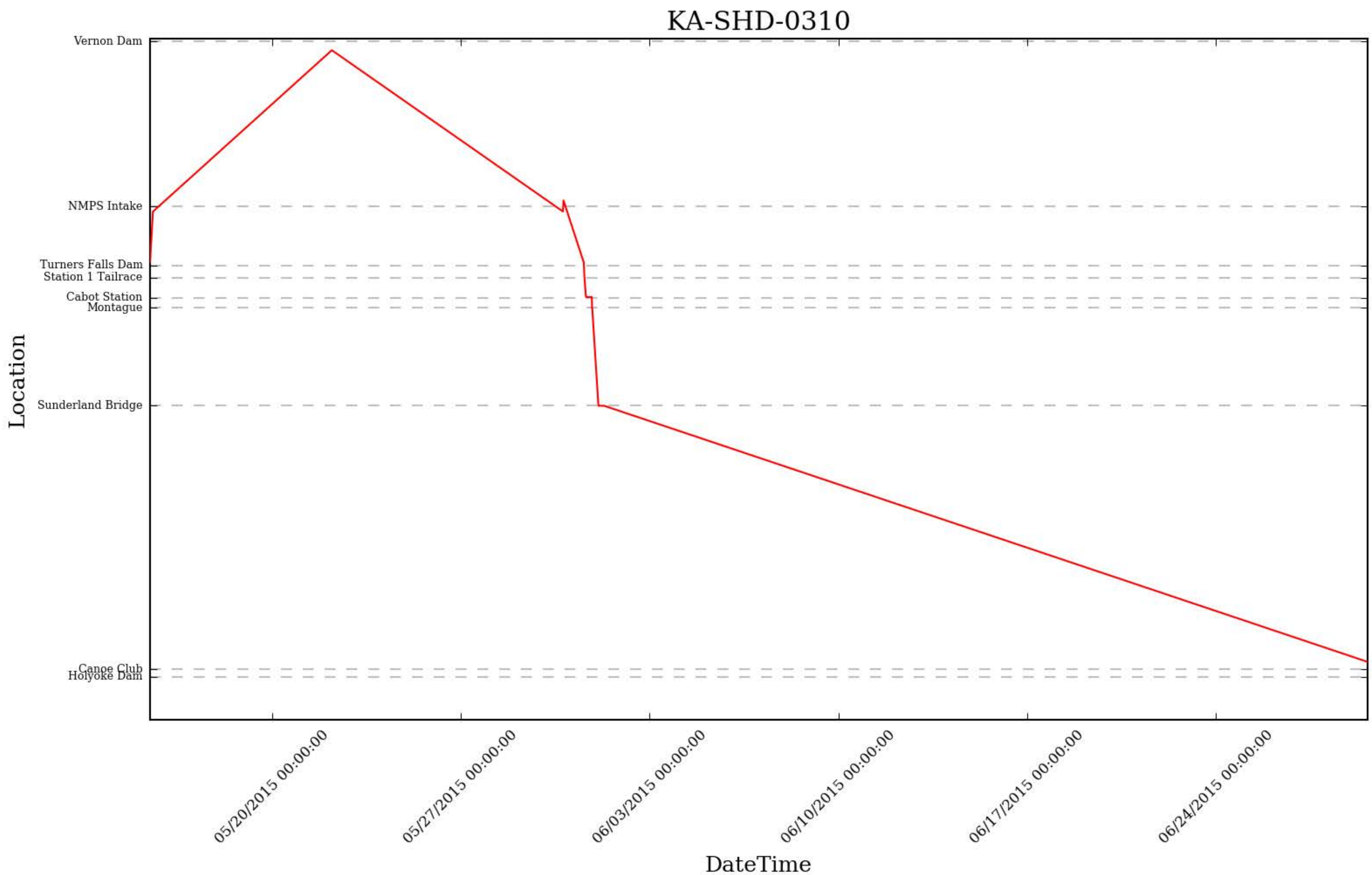

KA-SHD-0306
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime


KA-SHD-0307
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
DateTime


KA-SHD-0308
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
07/11/2015 00:00:00
DateTime



KA-SHD-0309
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/16/2015 00:00:00
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
06/12/2015 00:00:00
DateTime


KA-SHD-0310
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
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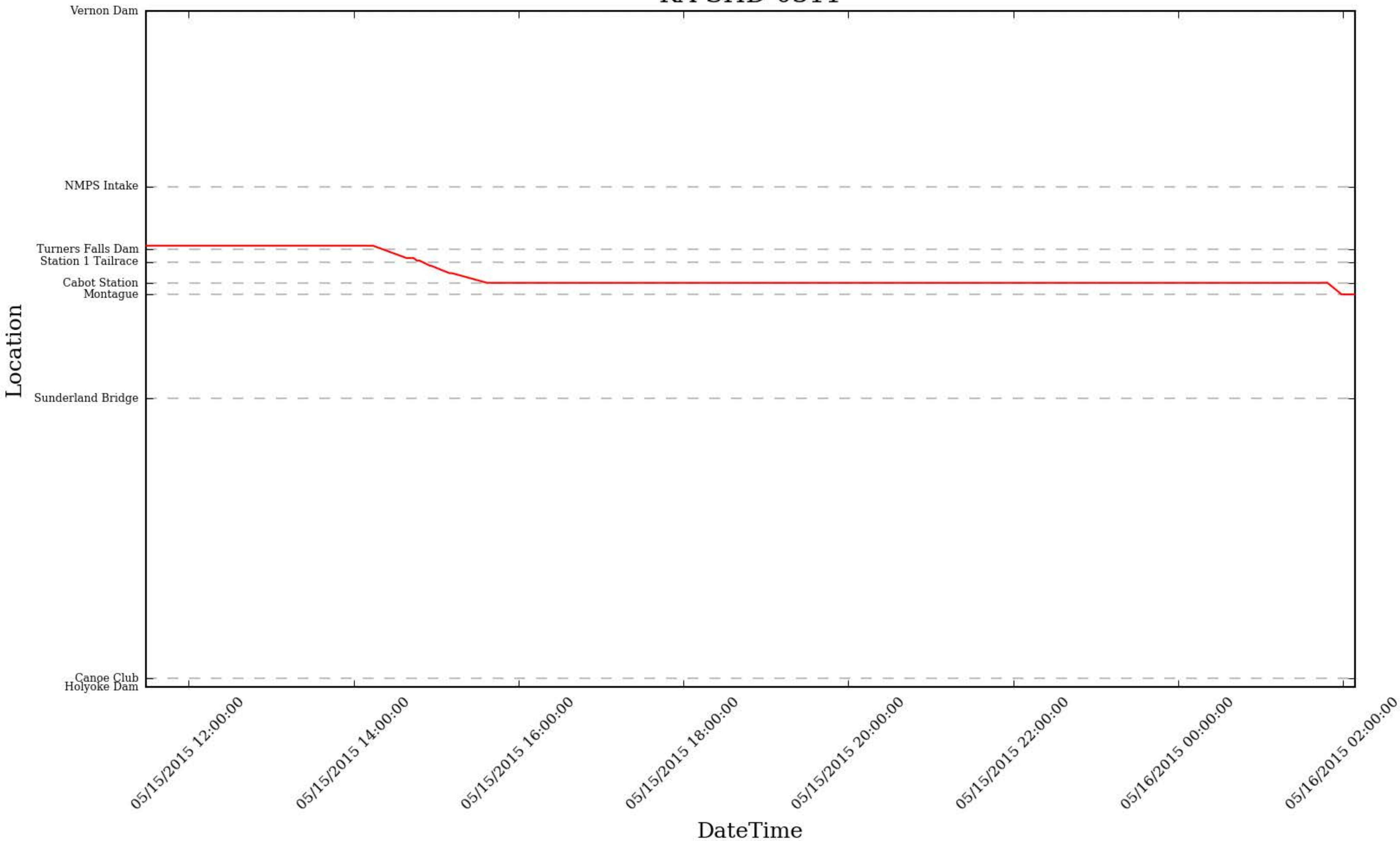
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
DateTime

KA-SHD-0311



Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/15/2015 12:00:00
05/15/2015 14:00:00
05/15/2015 16:00:00
05/15/2015 18:00:00
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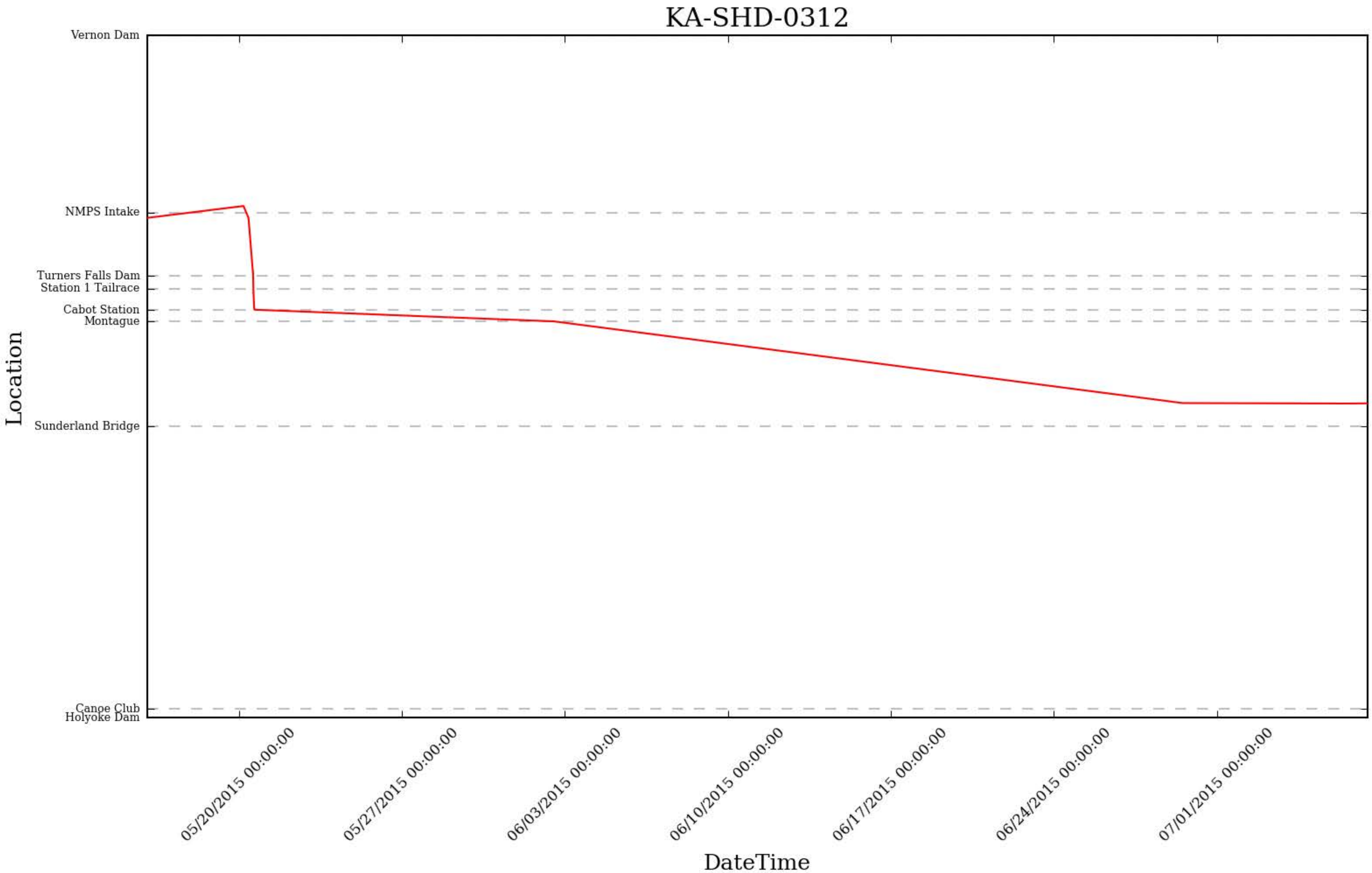
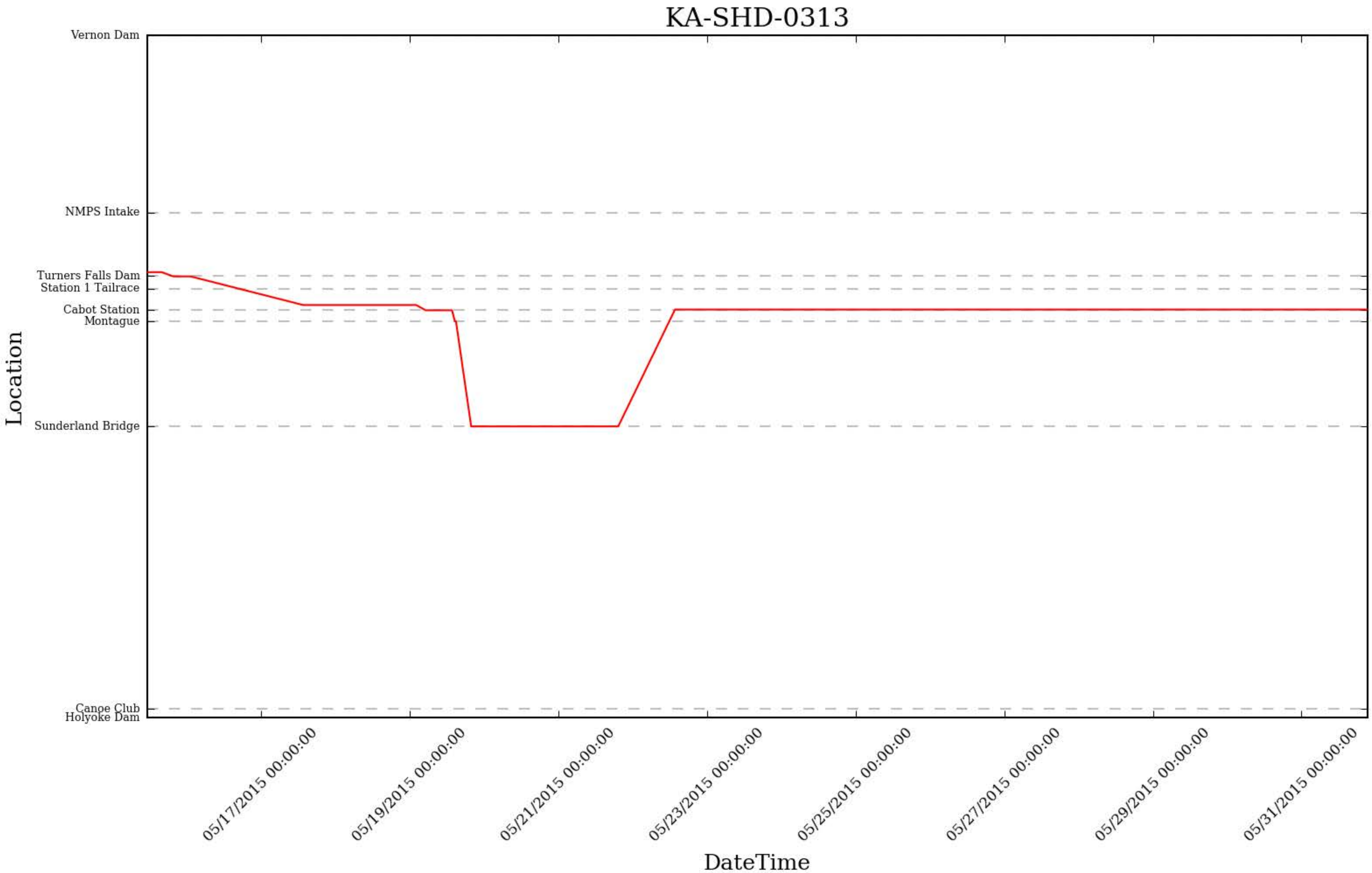
05/15/2015 22:00:00
05/16/2015 00:00:00
05/16/2015 02:00:00
DateTime


KA-SHD-0312
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime


KA-SHD-0313
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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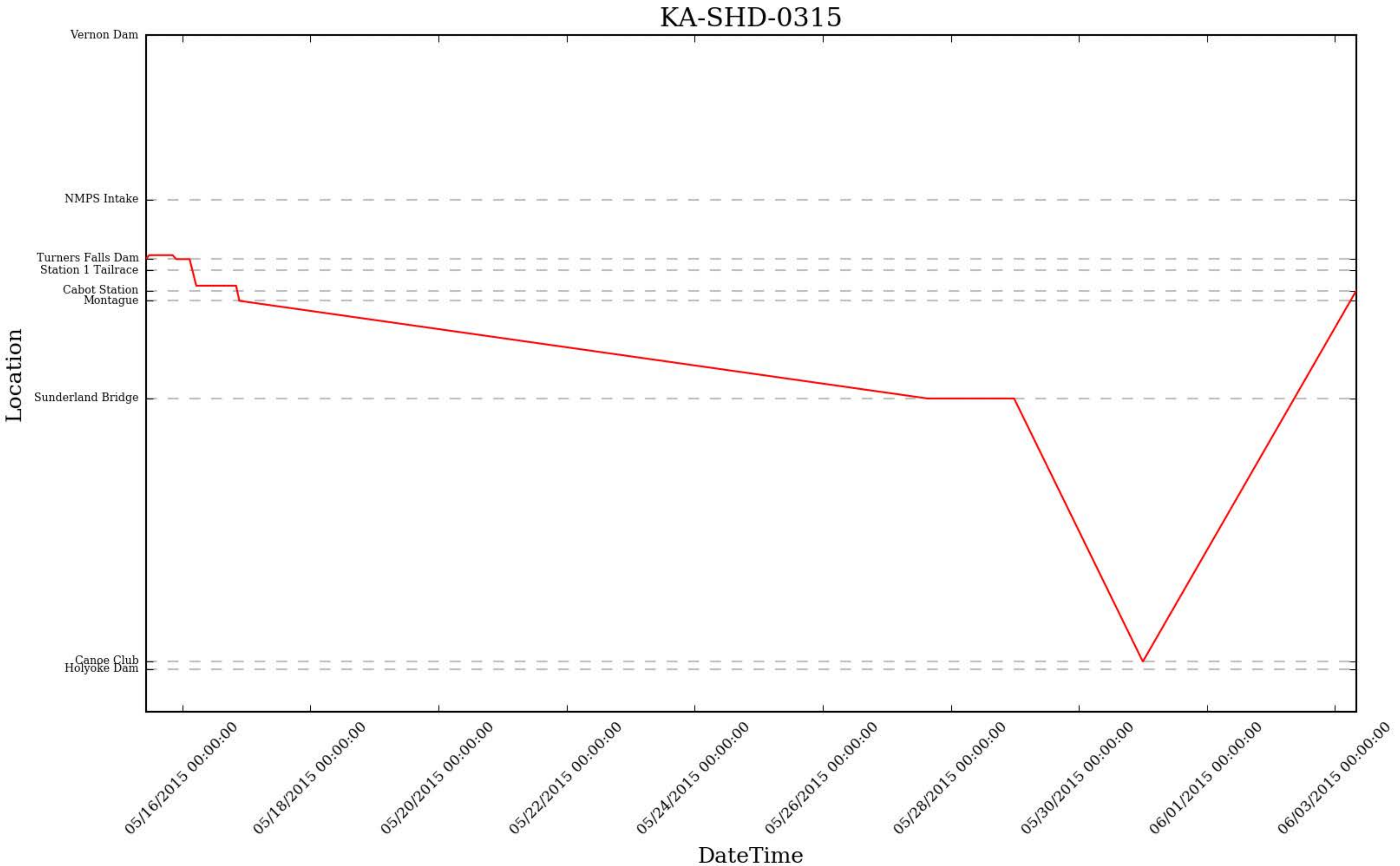
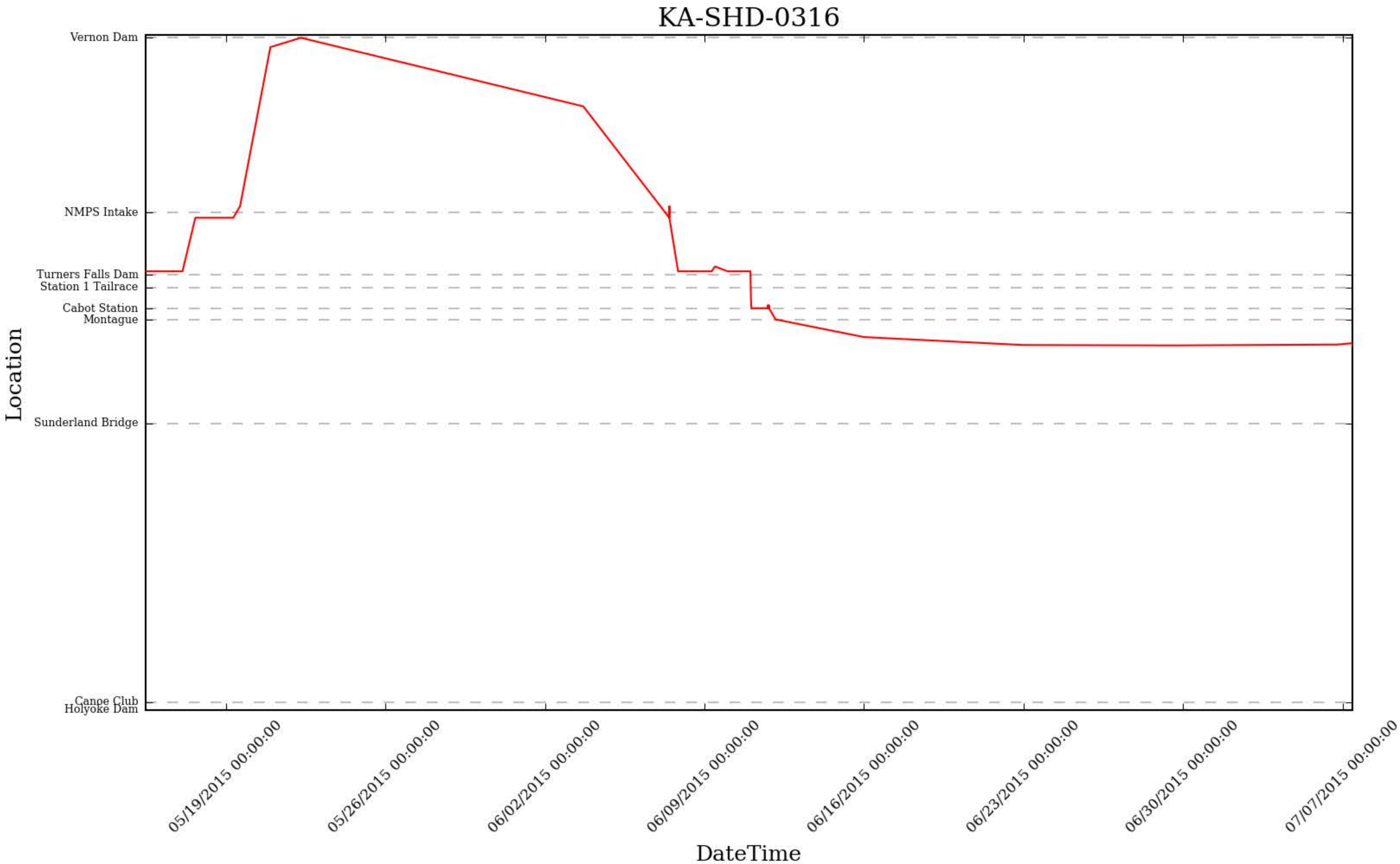
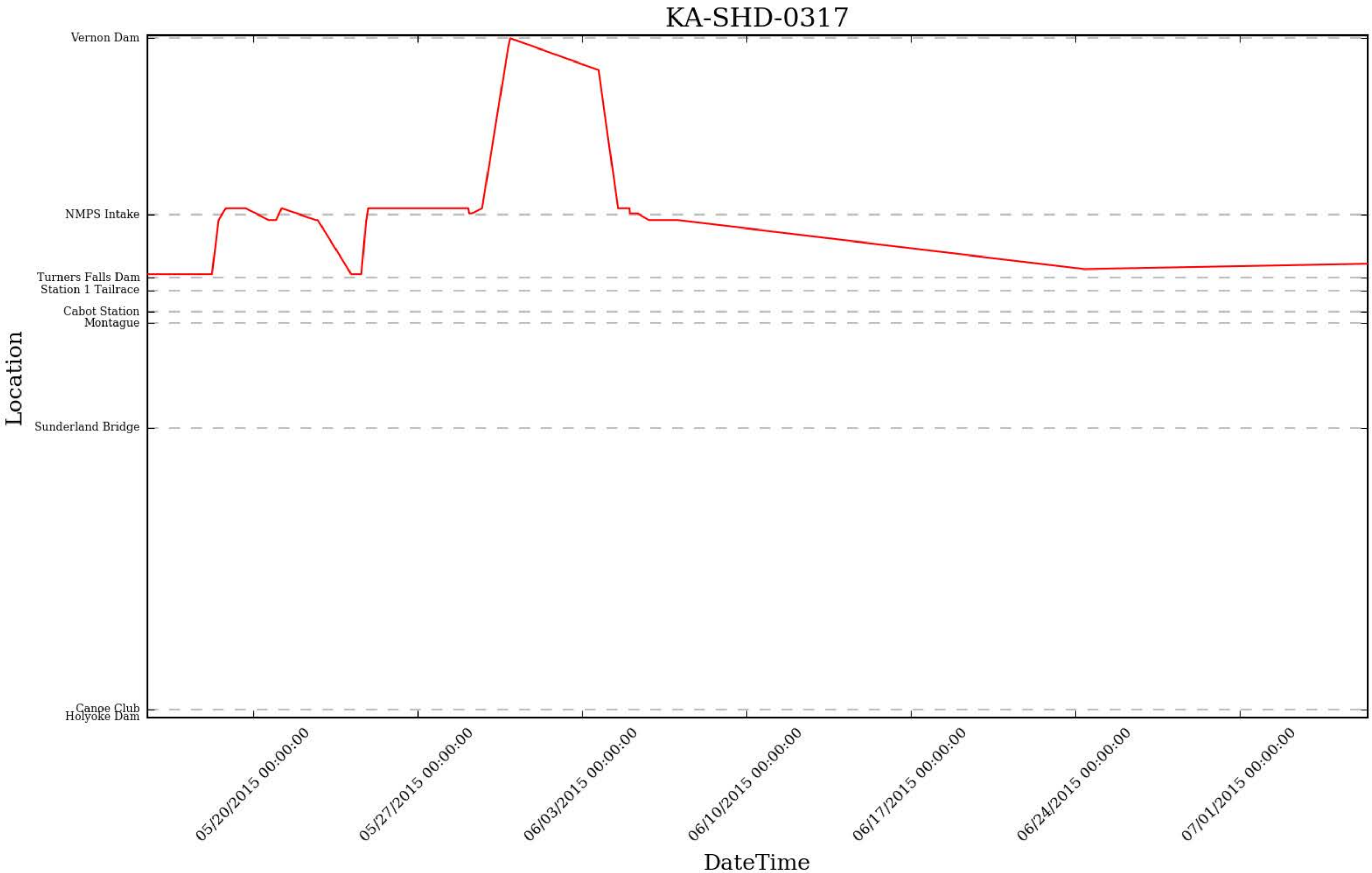
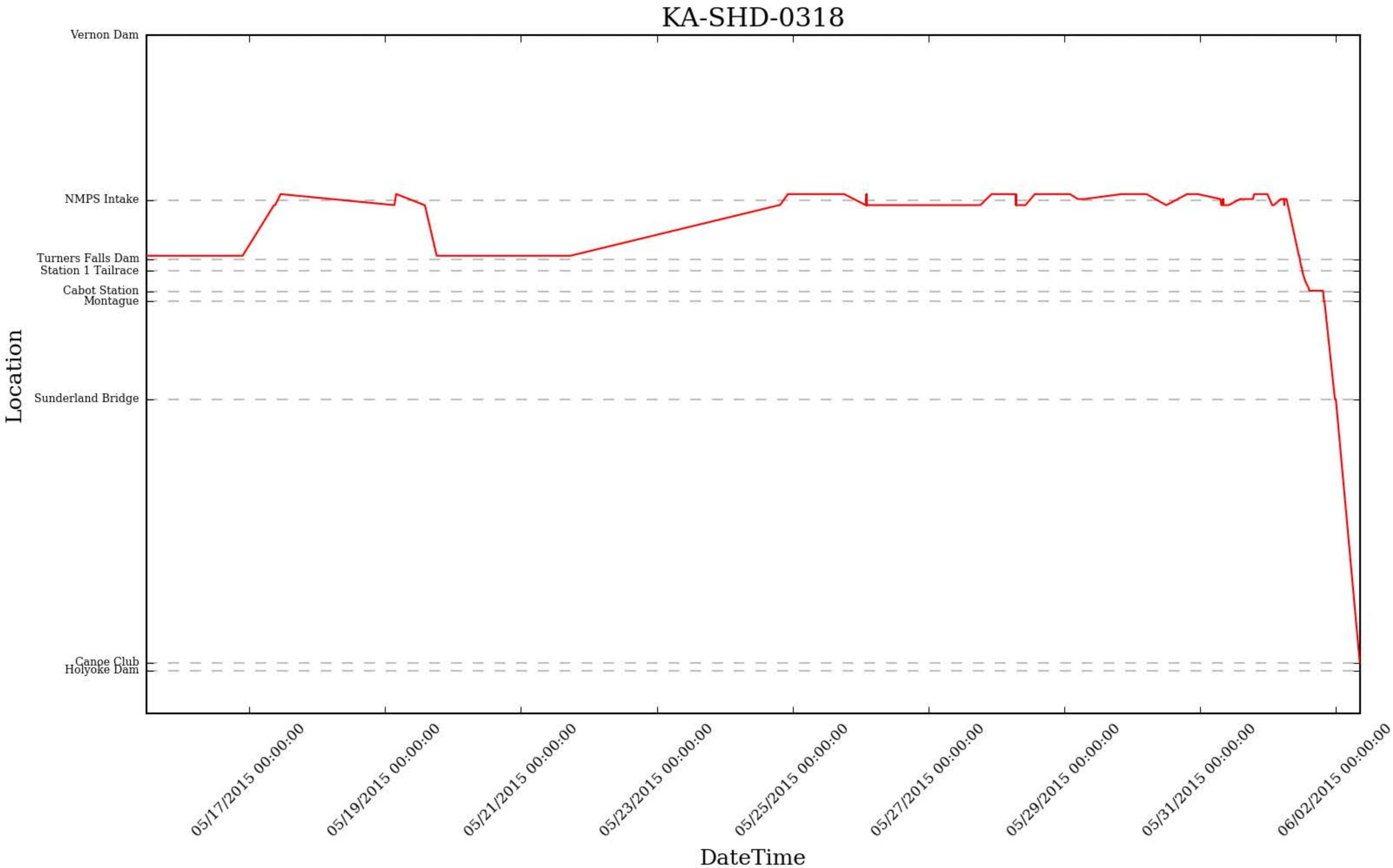
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
DateTime

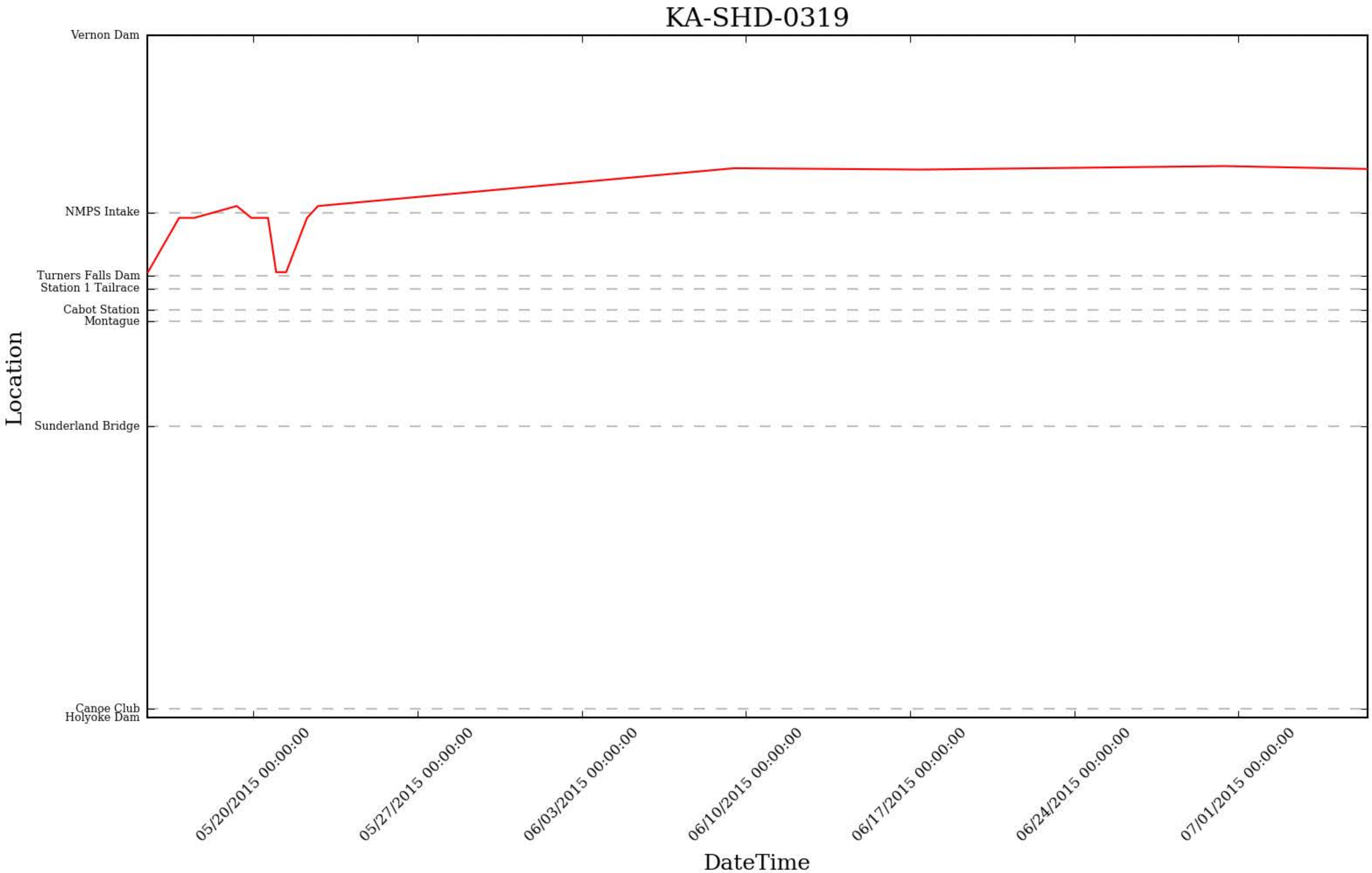

KA-SHD-0315
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
DateTime

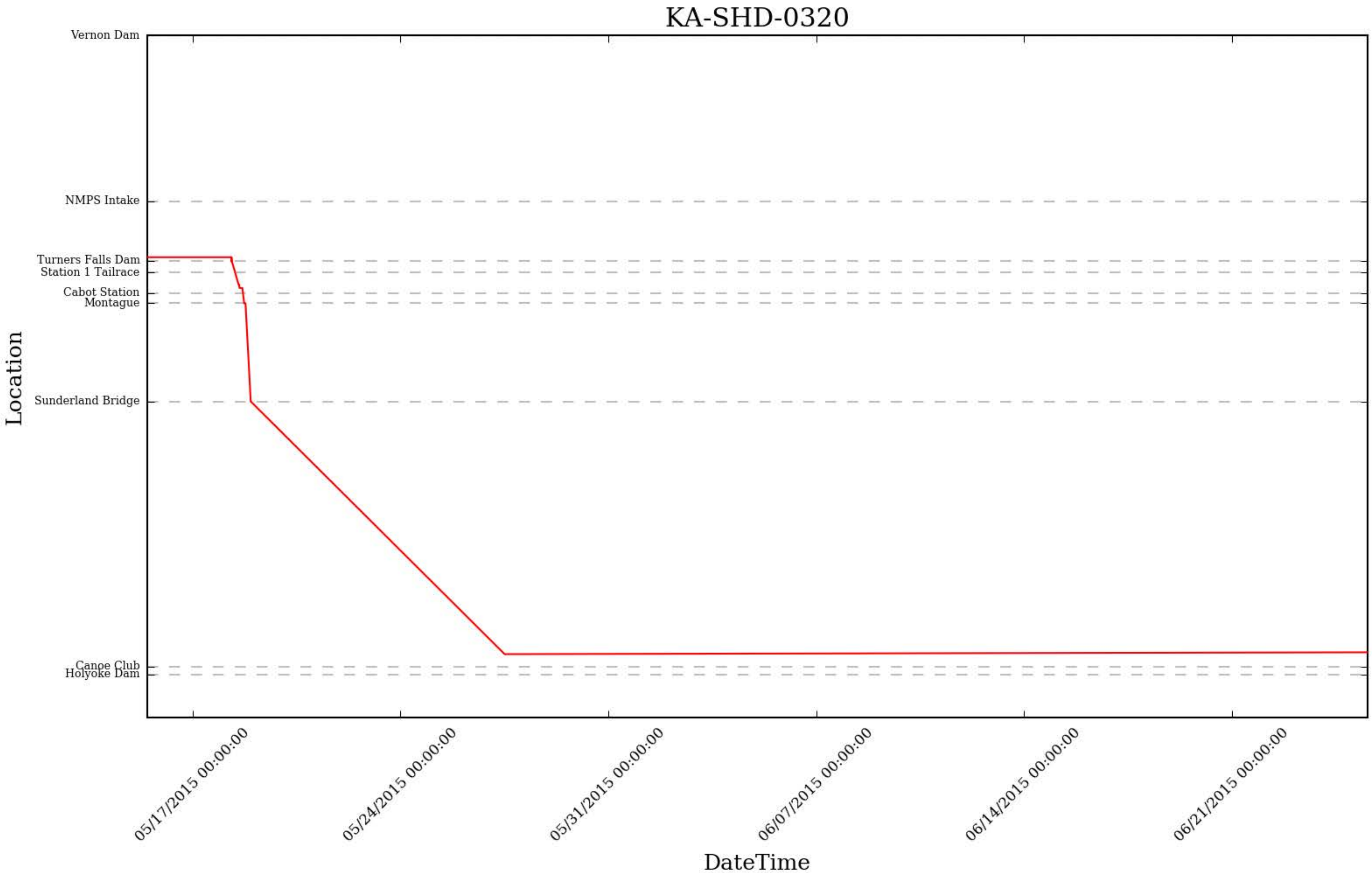

KA-SHD-0316
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/19/2015 00:00:00
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime


KA-SHD-0317
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime



KA-SHD-0318
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
DateTime


KA-SHD-0319
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime


KA-SHD-0320
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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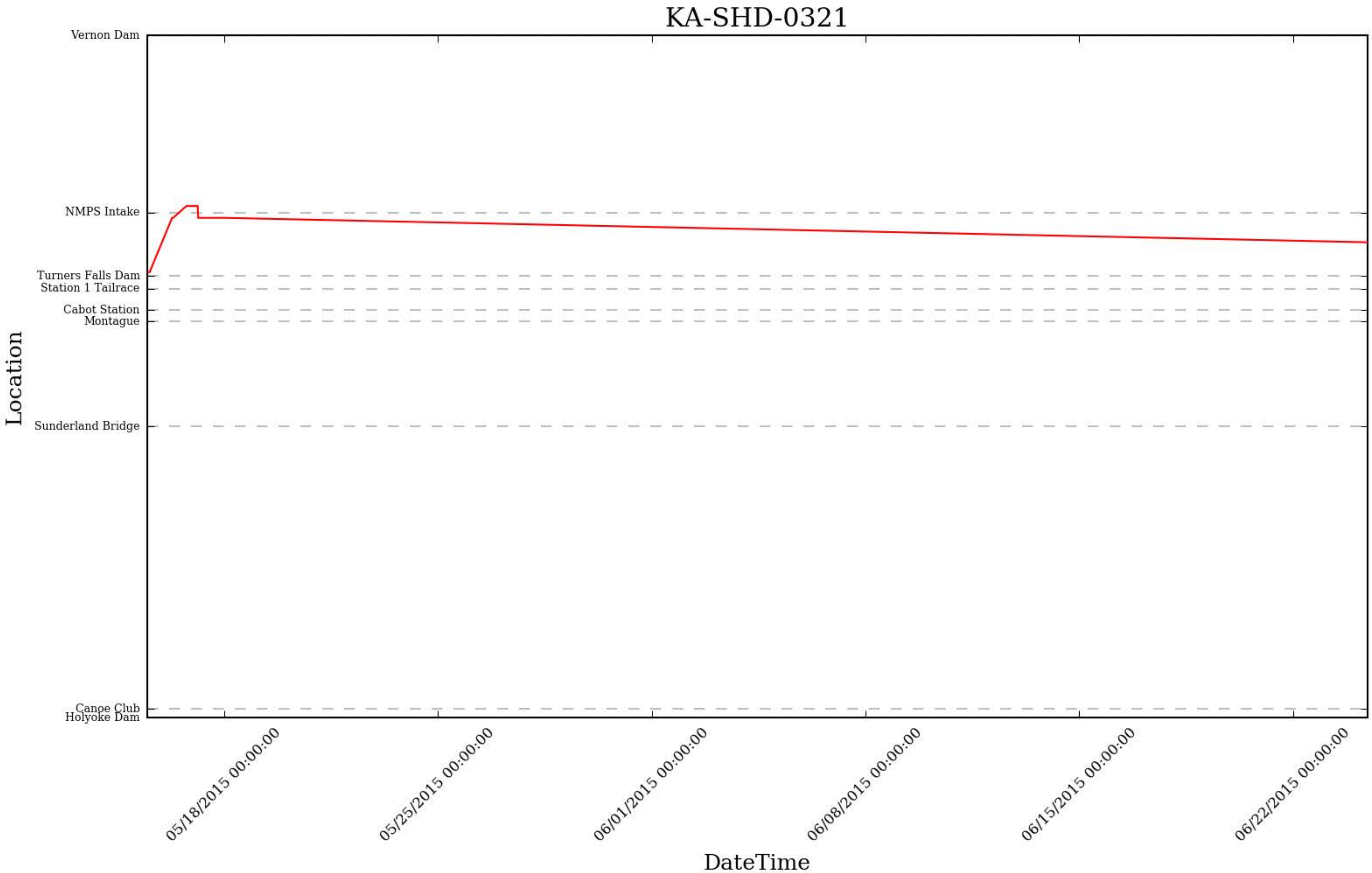
06/14/2015 00:00:00
06/21/2015 00:00:00
DateTime


KA-SHD-0321
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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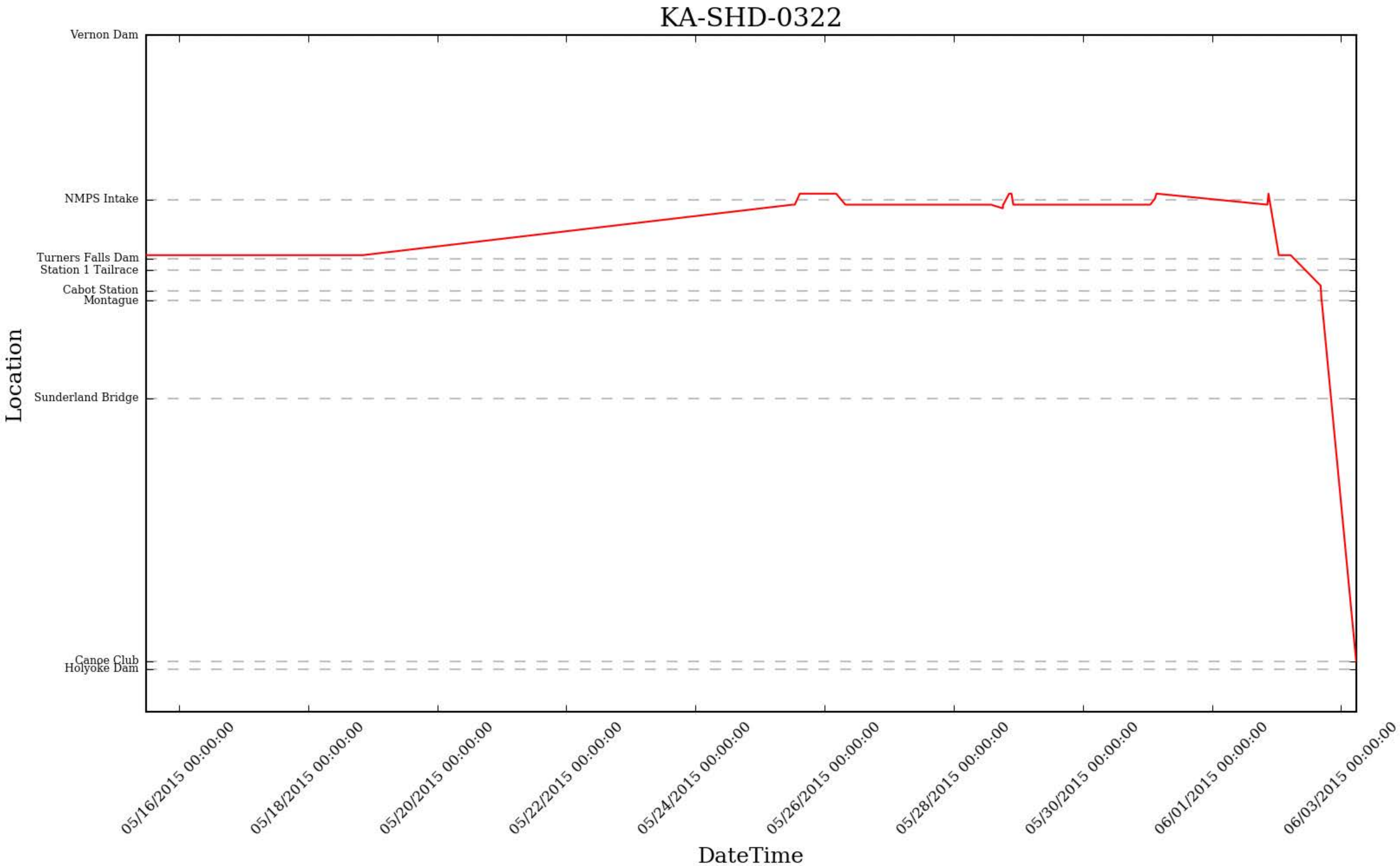
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
DateTime


KA-SHD-0322
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 00:00:00
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
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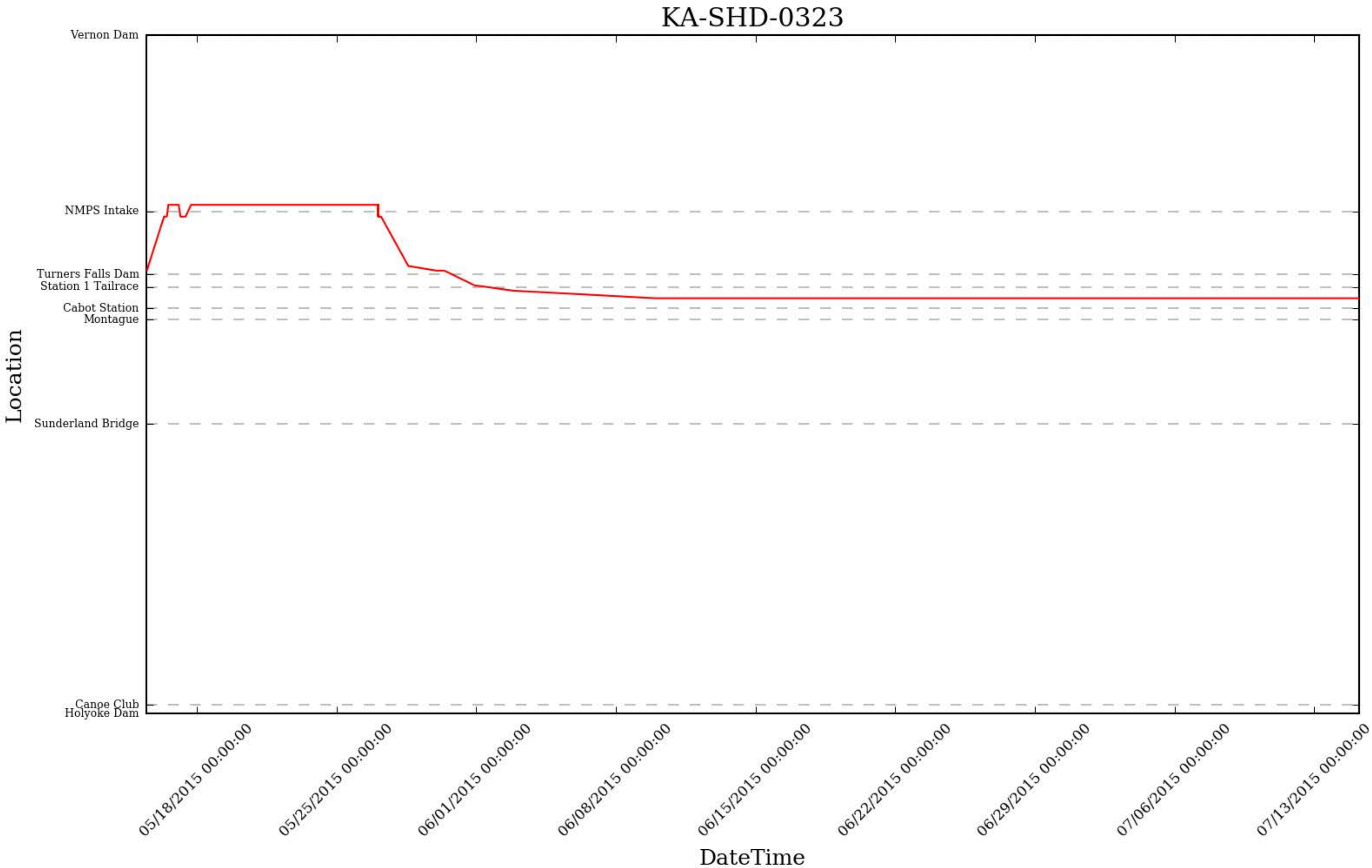
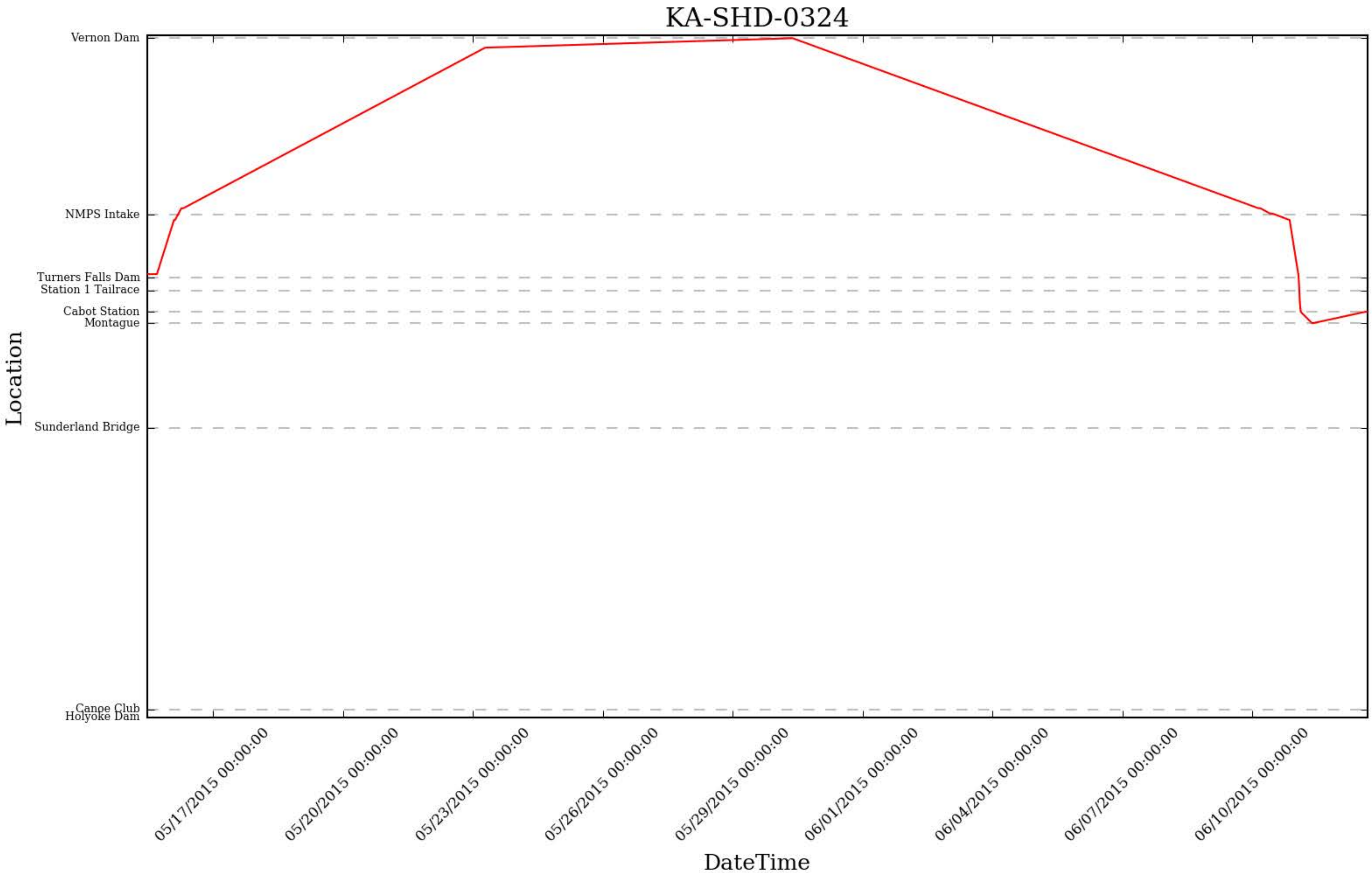
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
DateTime


KA-SHD-0323
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/25/2015 00:00:00
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
06/29/2015 00:00:00
07/06/2015 00:00:00
07/13/2015 00:00:00
DateTime


KA-SHD-0324
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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05/23/2015 00:00:00
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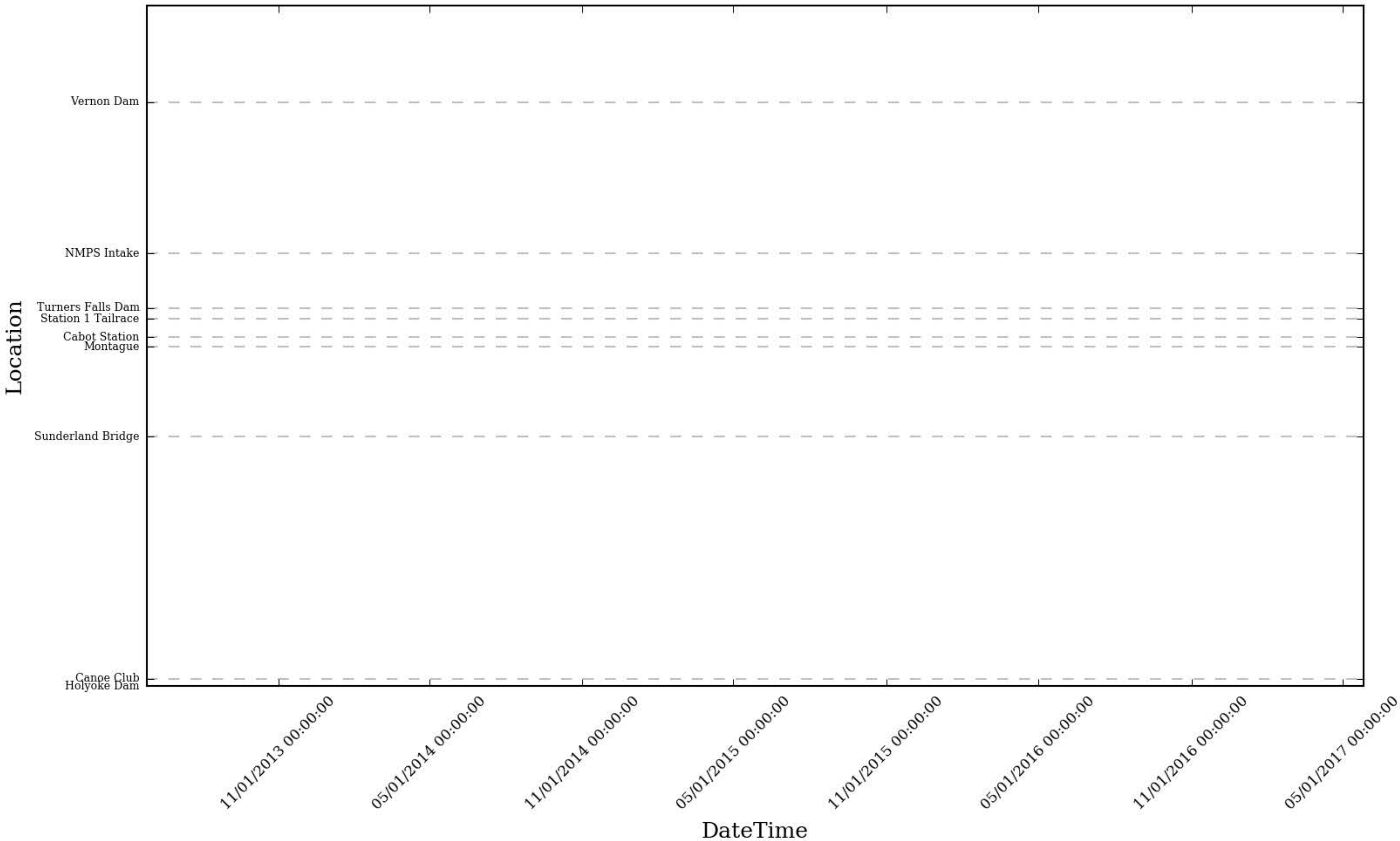
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
DateTime

KA-SHD-0328


Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
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05/01/2015 00:00:00
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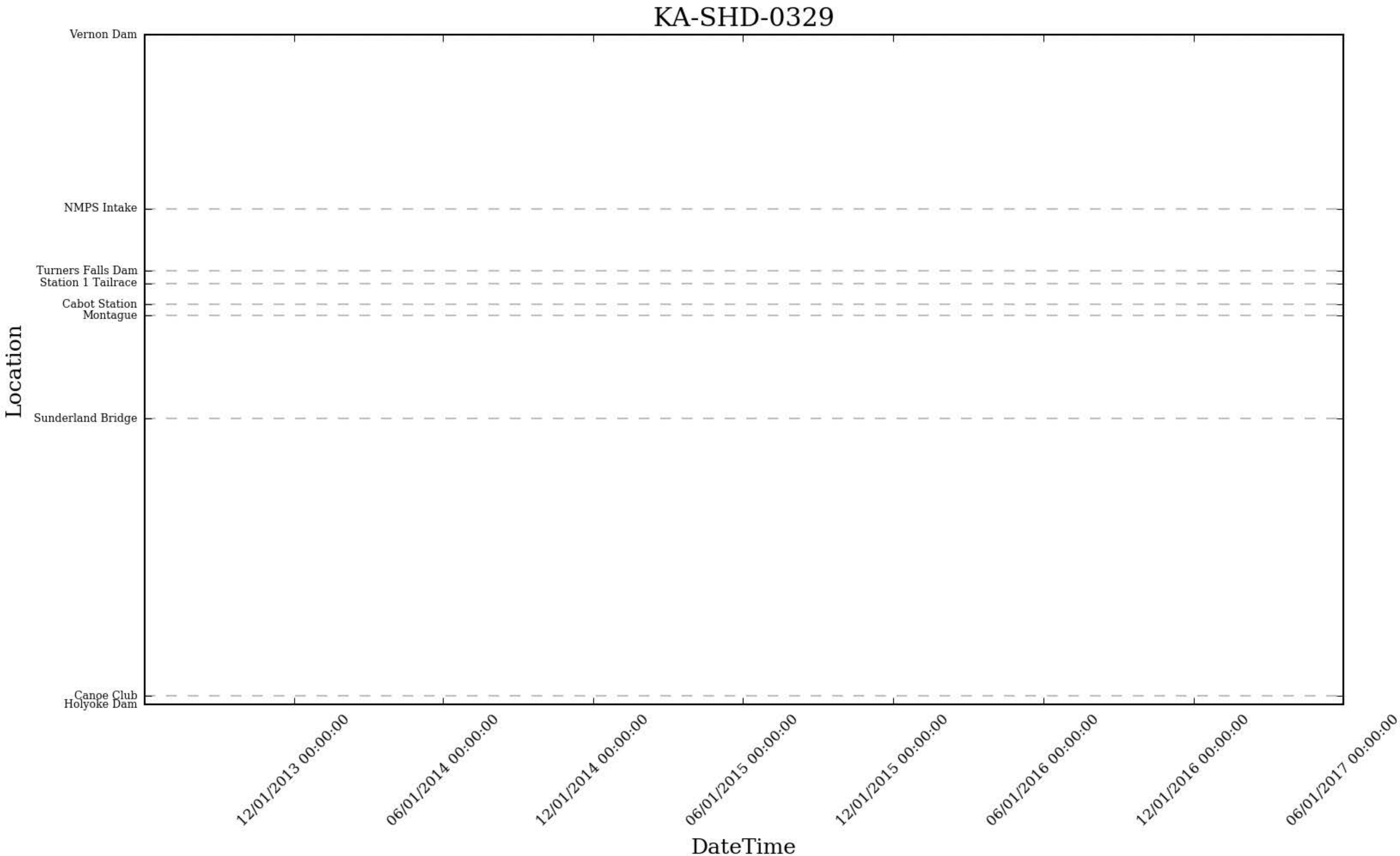
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0329
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
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12/01/2014 00:00:00
06/01/2015 00:00:00
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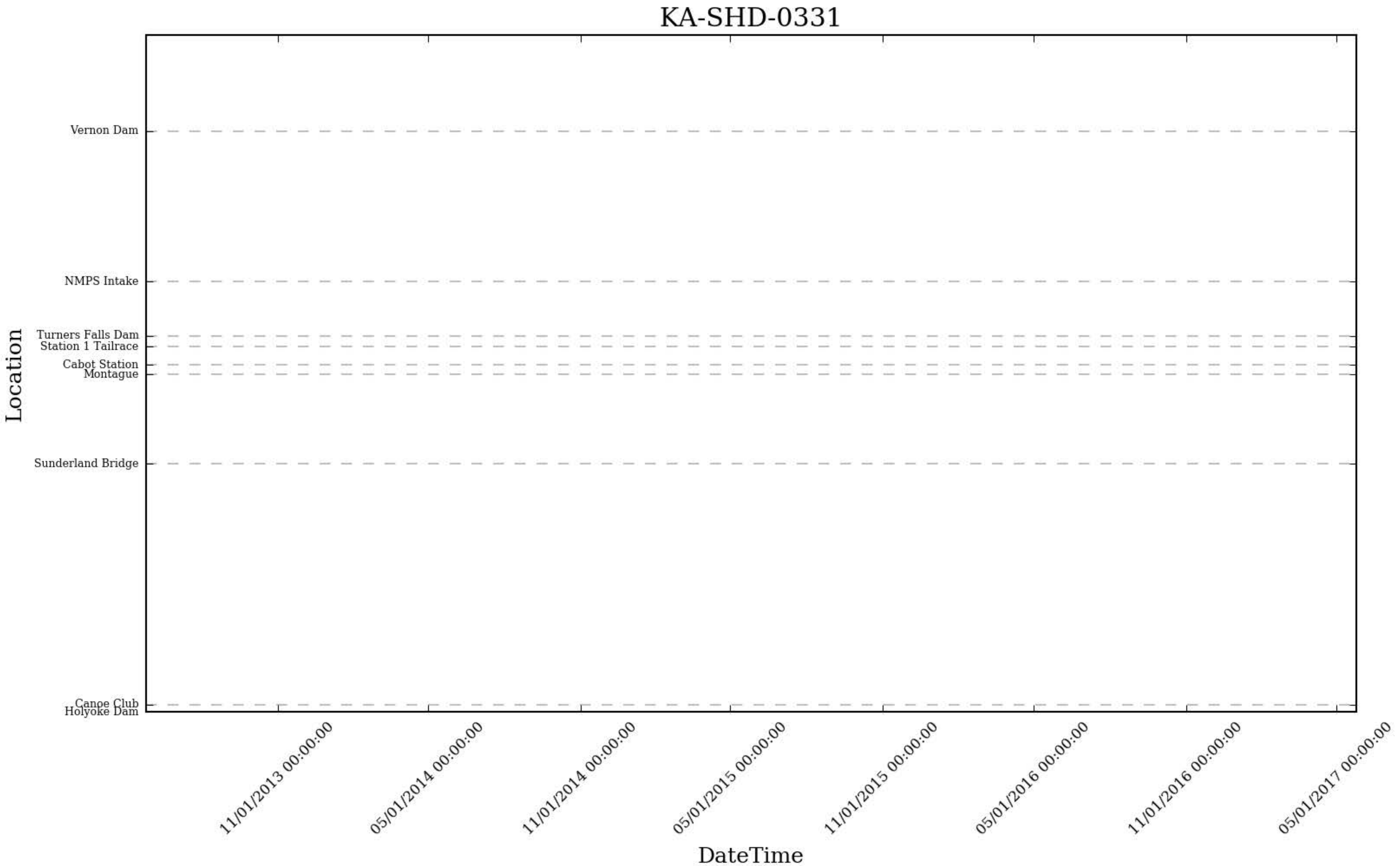
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime


KA-SHD-0331
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
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05/01/2015 00:00:00
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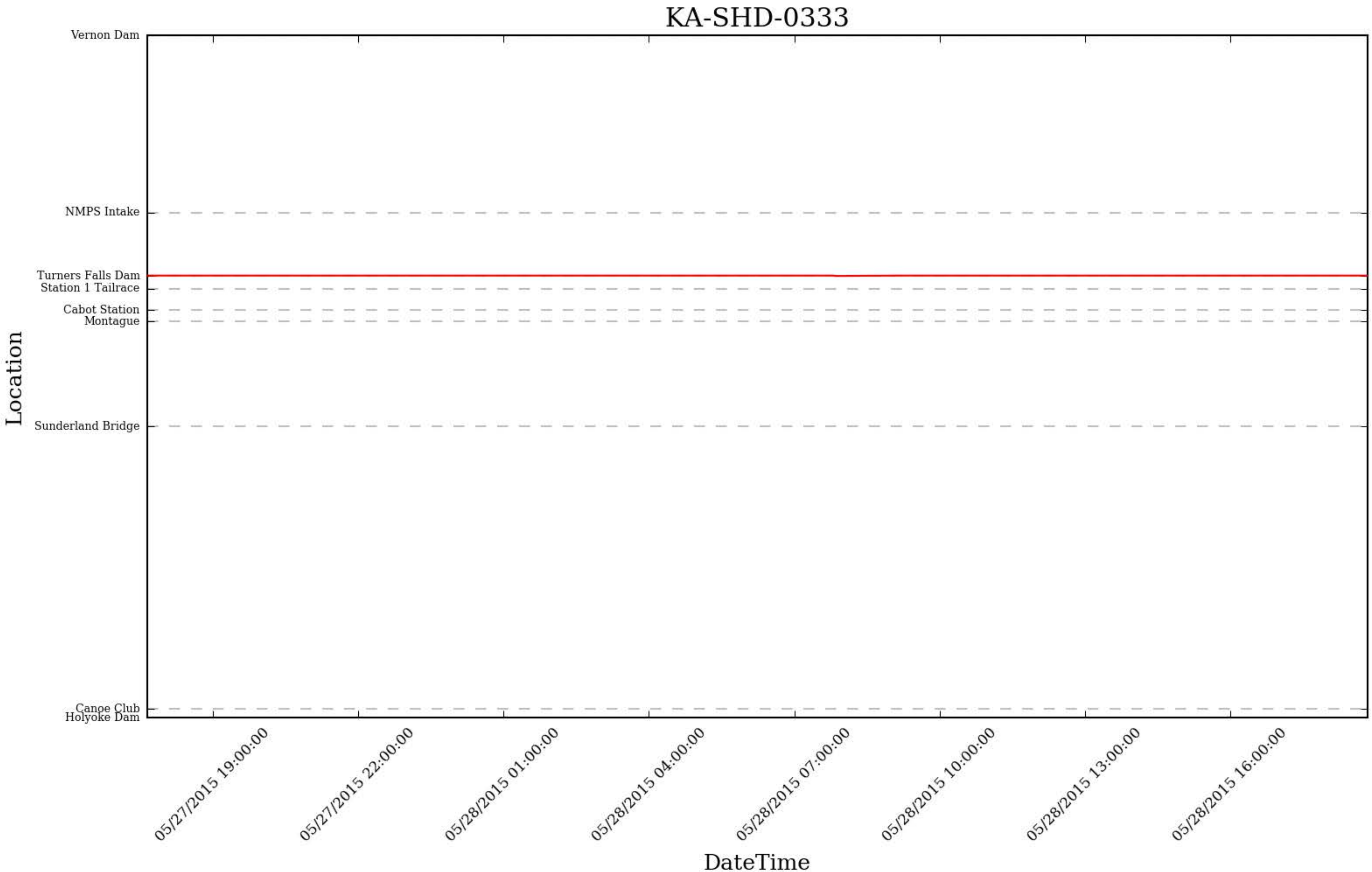
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0333
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 19:00:00
05/27/2015 22:00:00
05/28/2015 01:00:00
05/28/2015 04:00:00
05/28/2015 07:00:00
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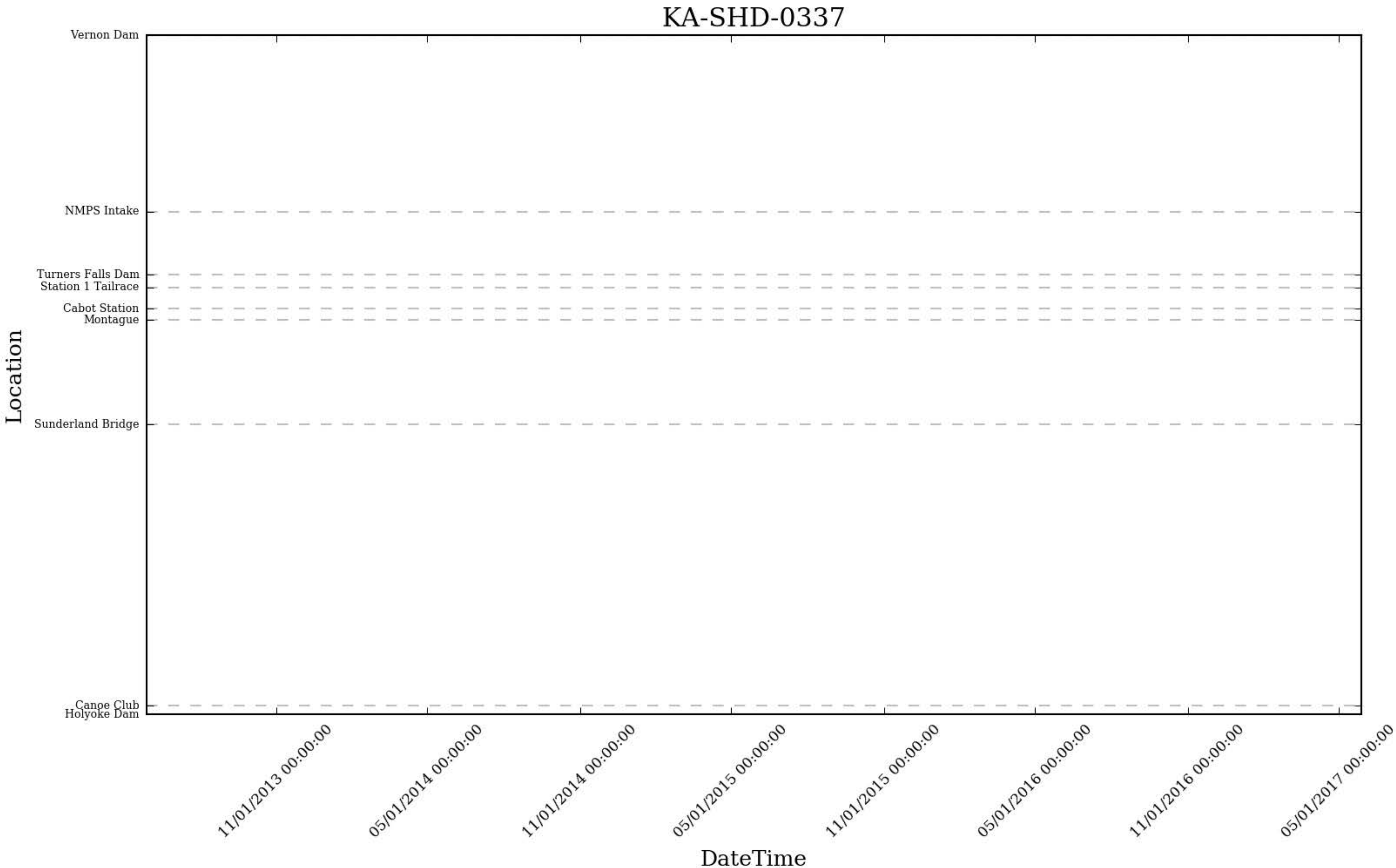
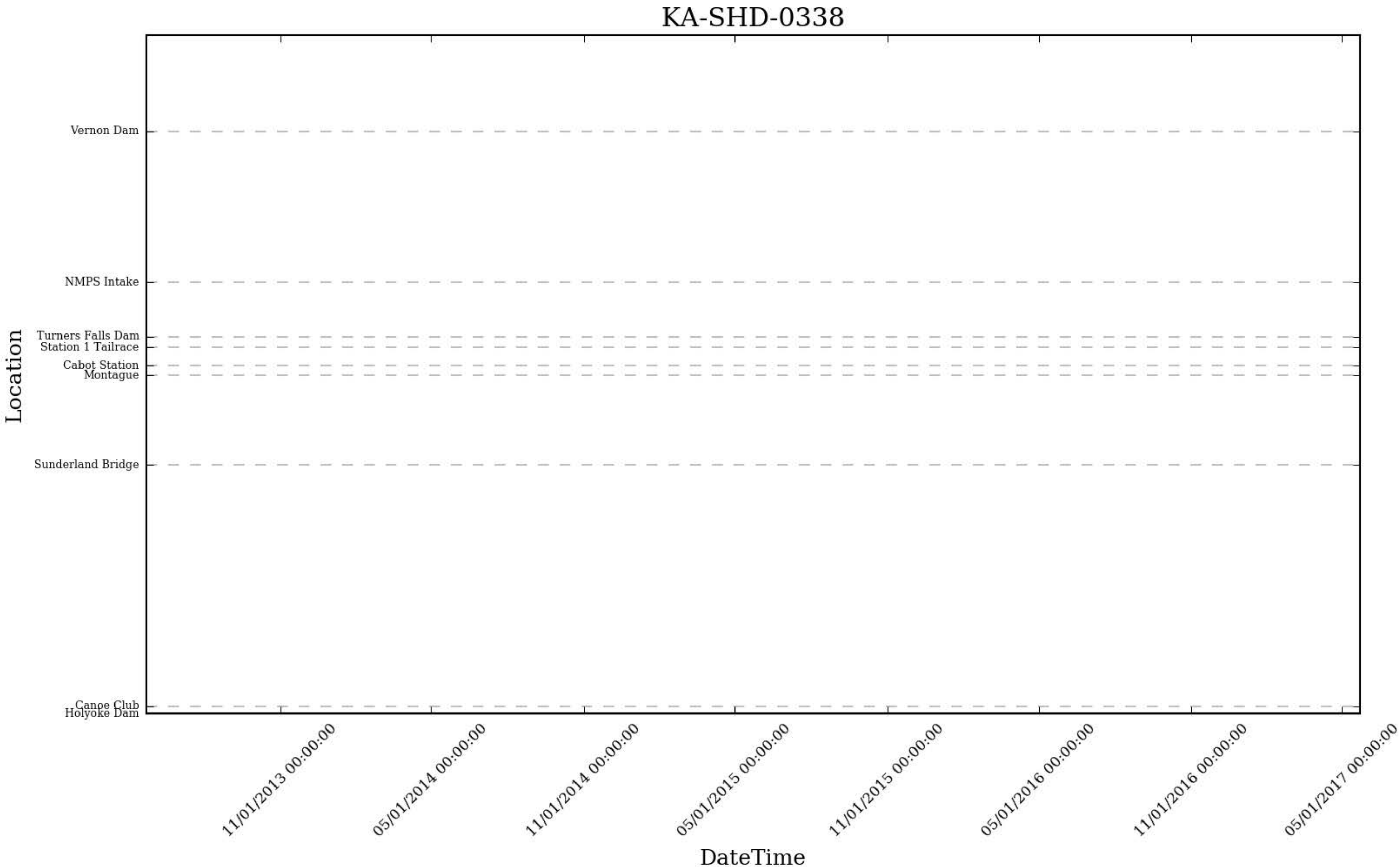
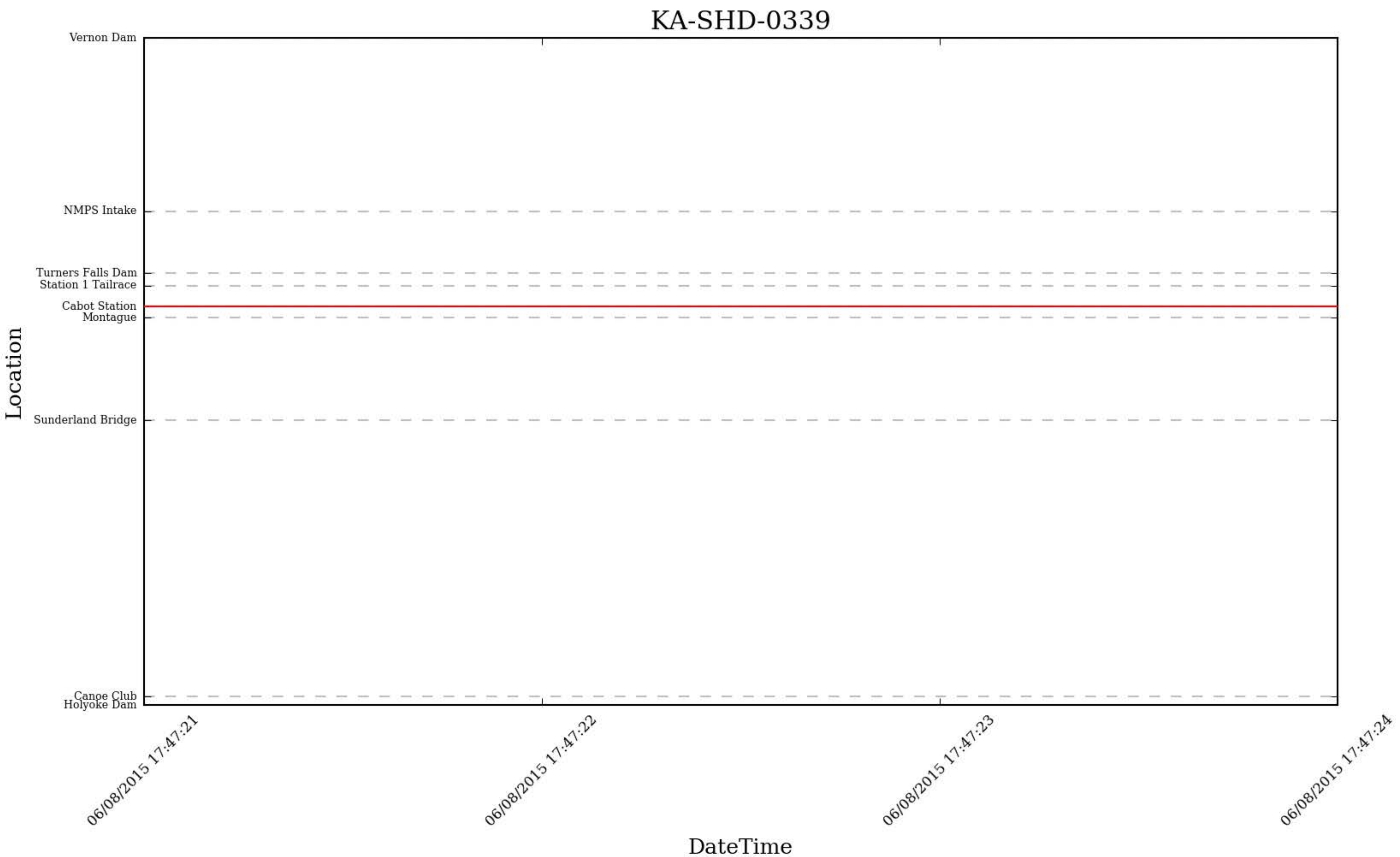
05/28/2015 16:00:00
DateTime


KA-SHD-0337
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0338
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0339
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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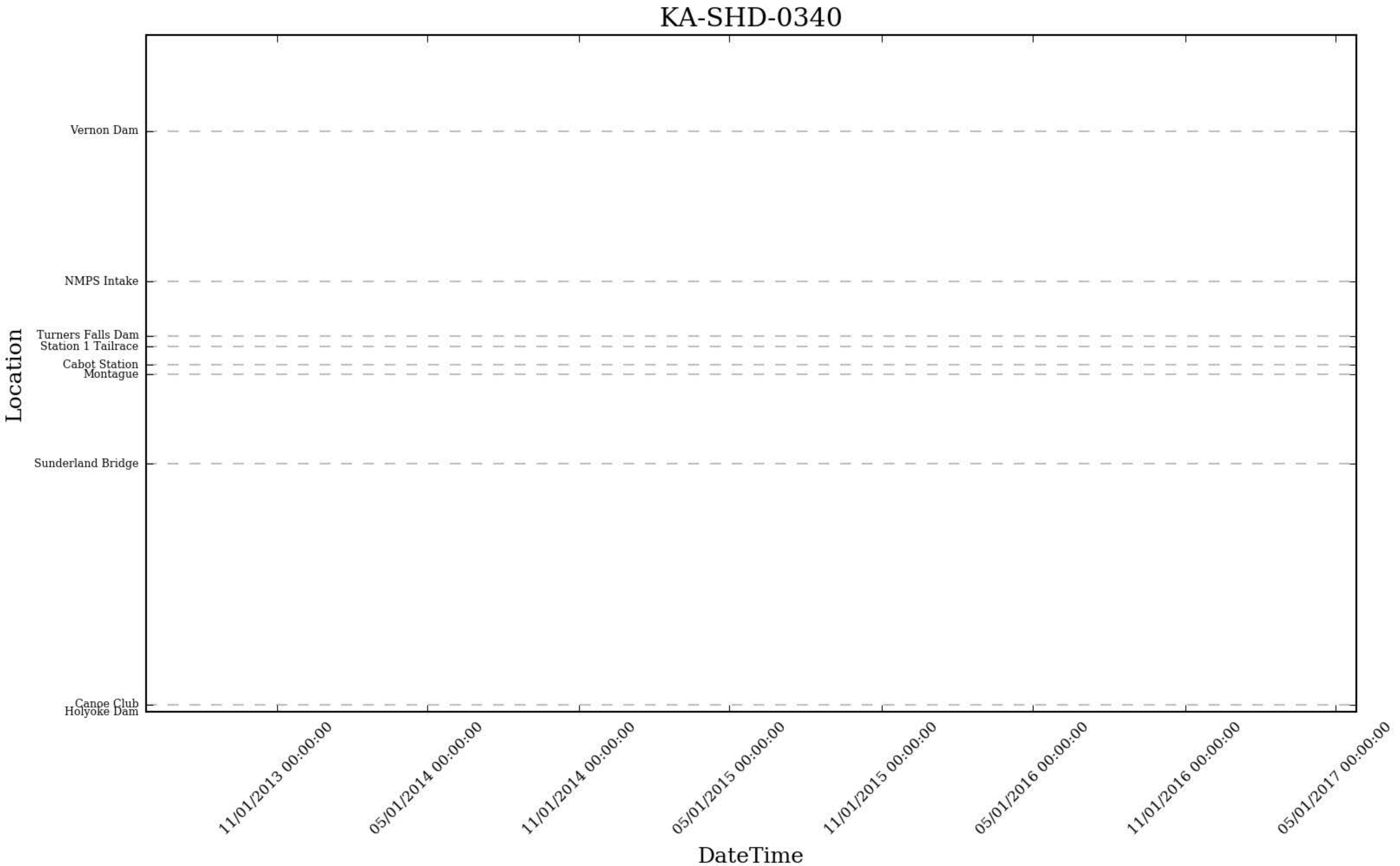
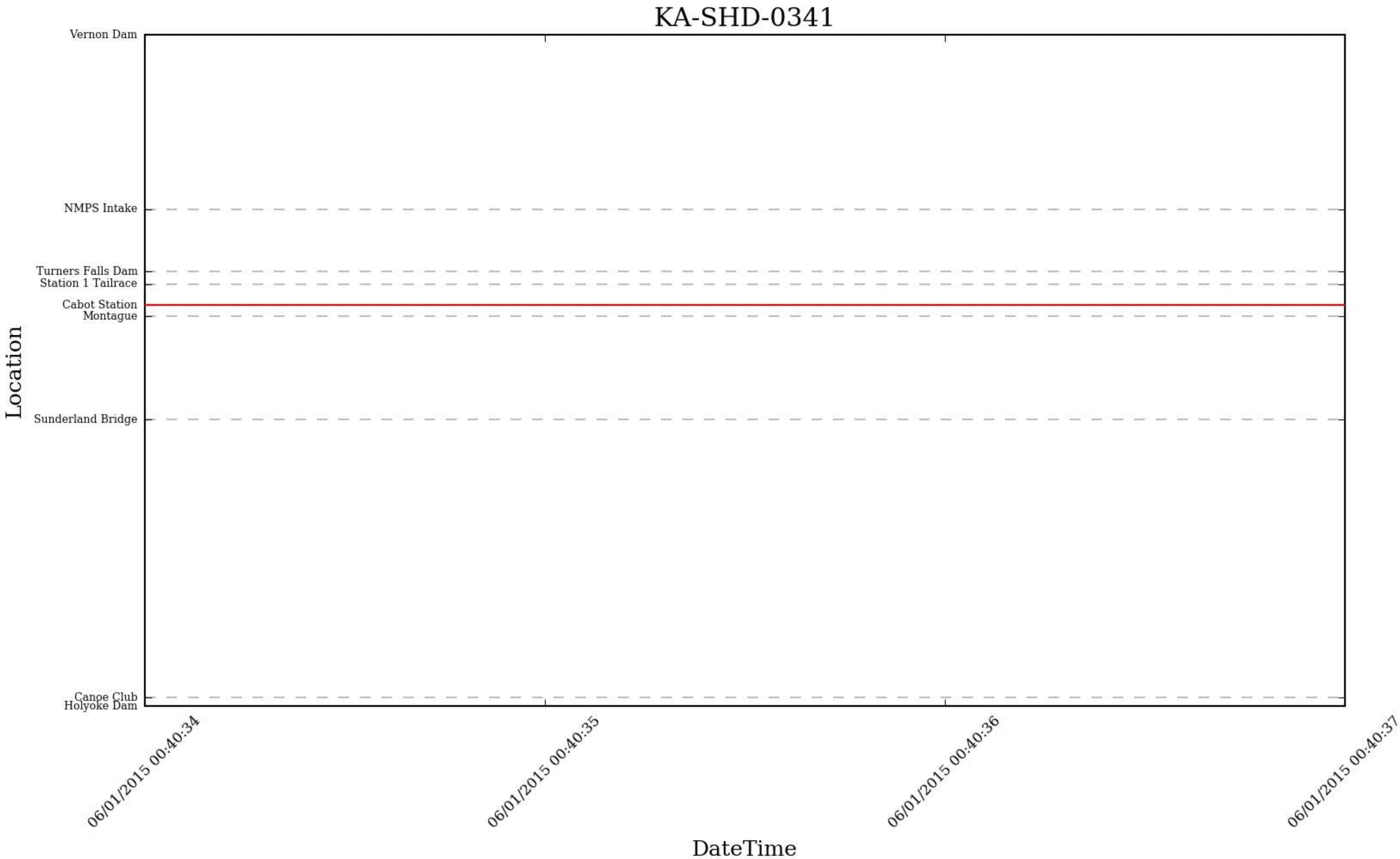
06/08/2015 17:47:22
06/08/2015 17:47:23
06/08/2015 17:47:24
DateTime



KA-SHD-0340
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0341
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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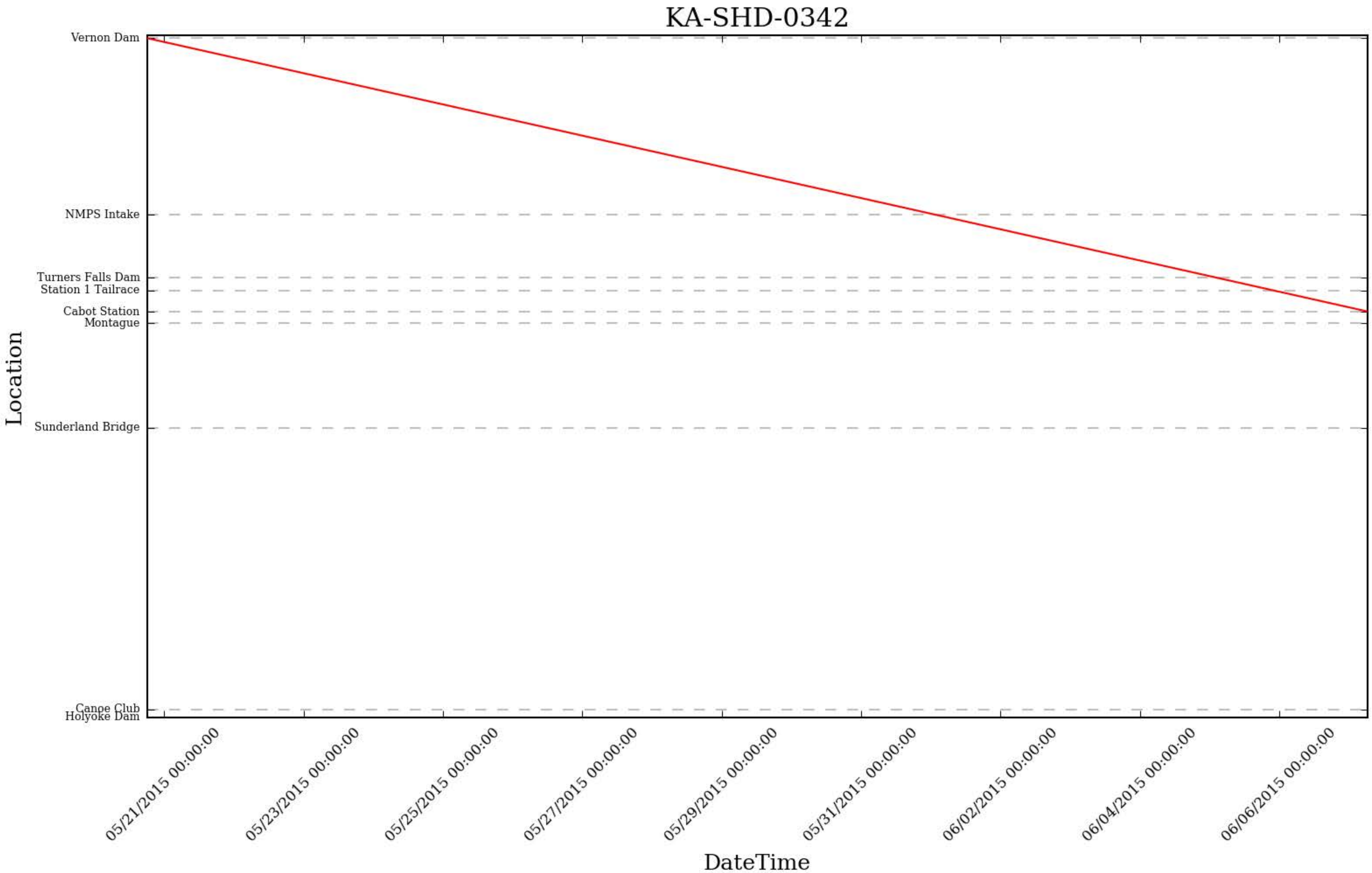
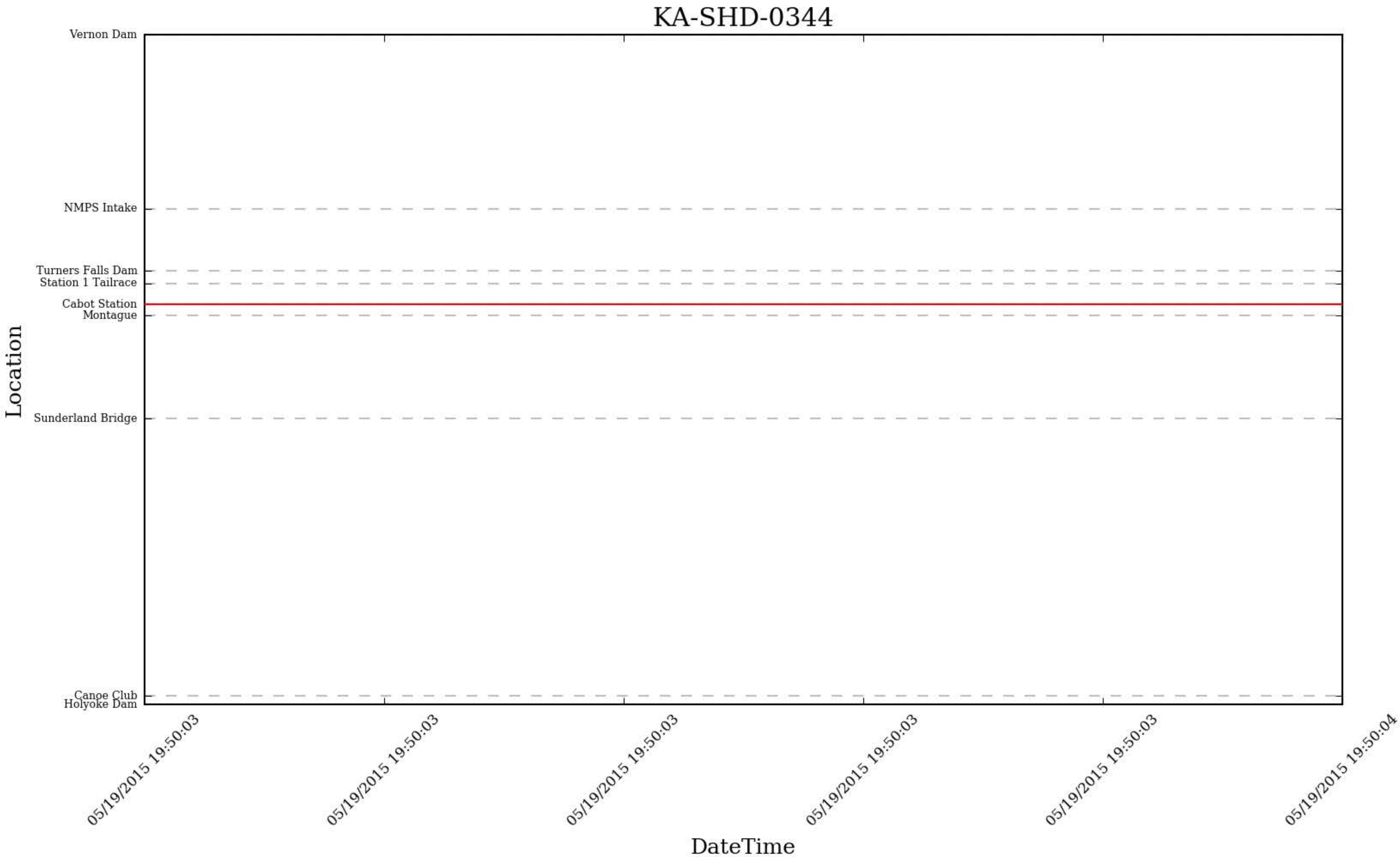
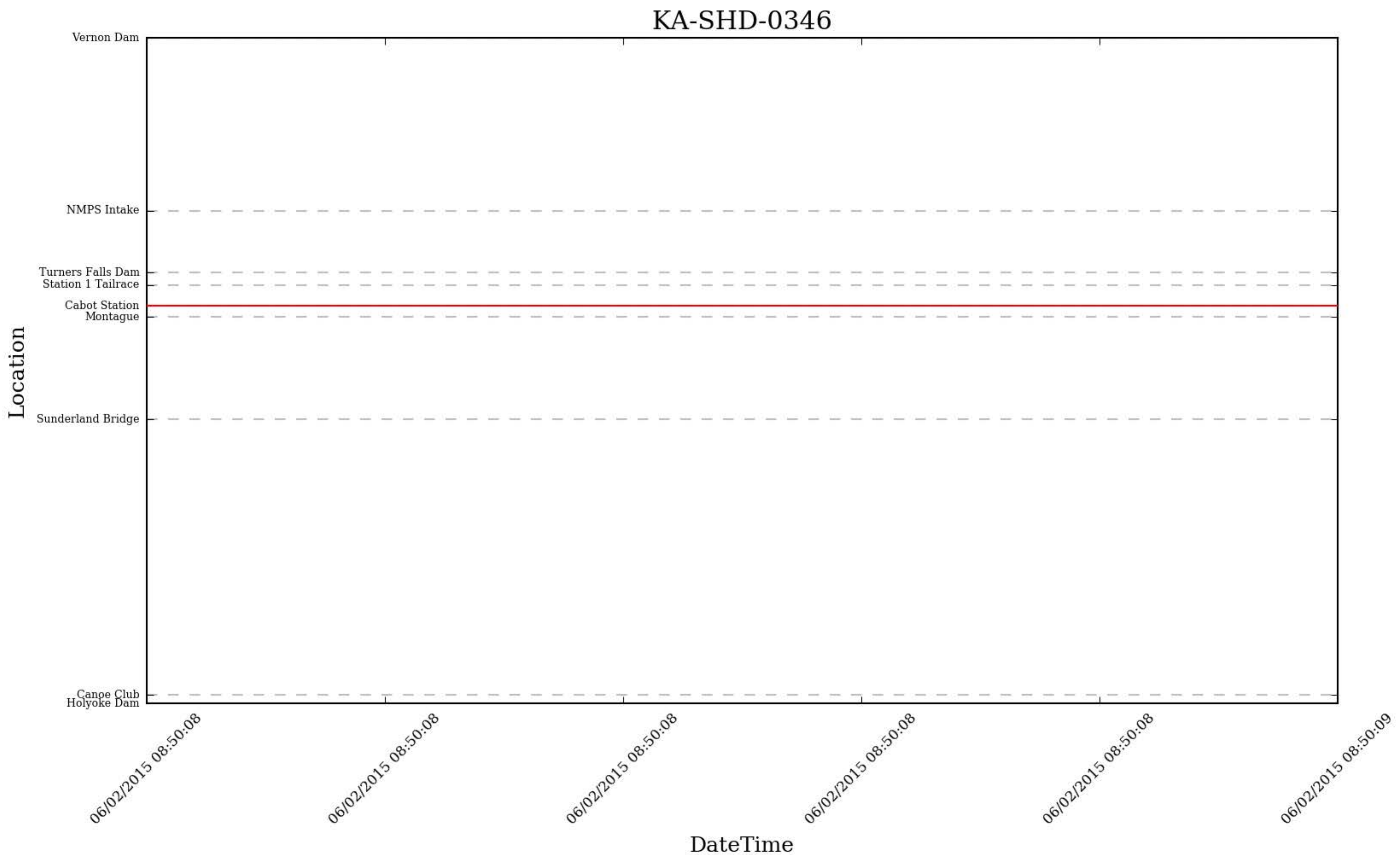
06/01/2015 00:40:35
06/01/2015 00:40:36
06/01/2015 00:40:37
DateTime



KA-SHD-0342
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
06/06/2015 00:00:00
DateTime


KA-SHD-0344
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/19/2015 19:50:03
05/19/2015 19:50:03
05/19/2015 19:50:03
05/19/2015 19:50:03
05/19/2015 19:50:03
05/19/2015 19:50:04
DateTime


KA-SHD-0346
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/02/2015 08:50:08
06/02/2015 08:50:08
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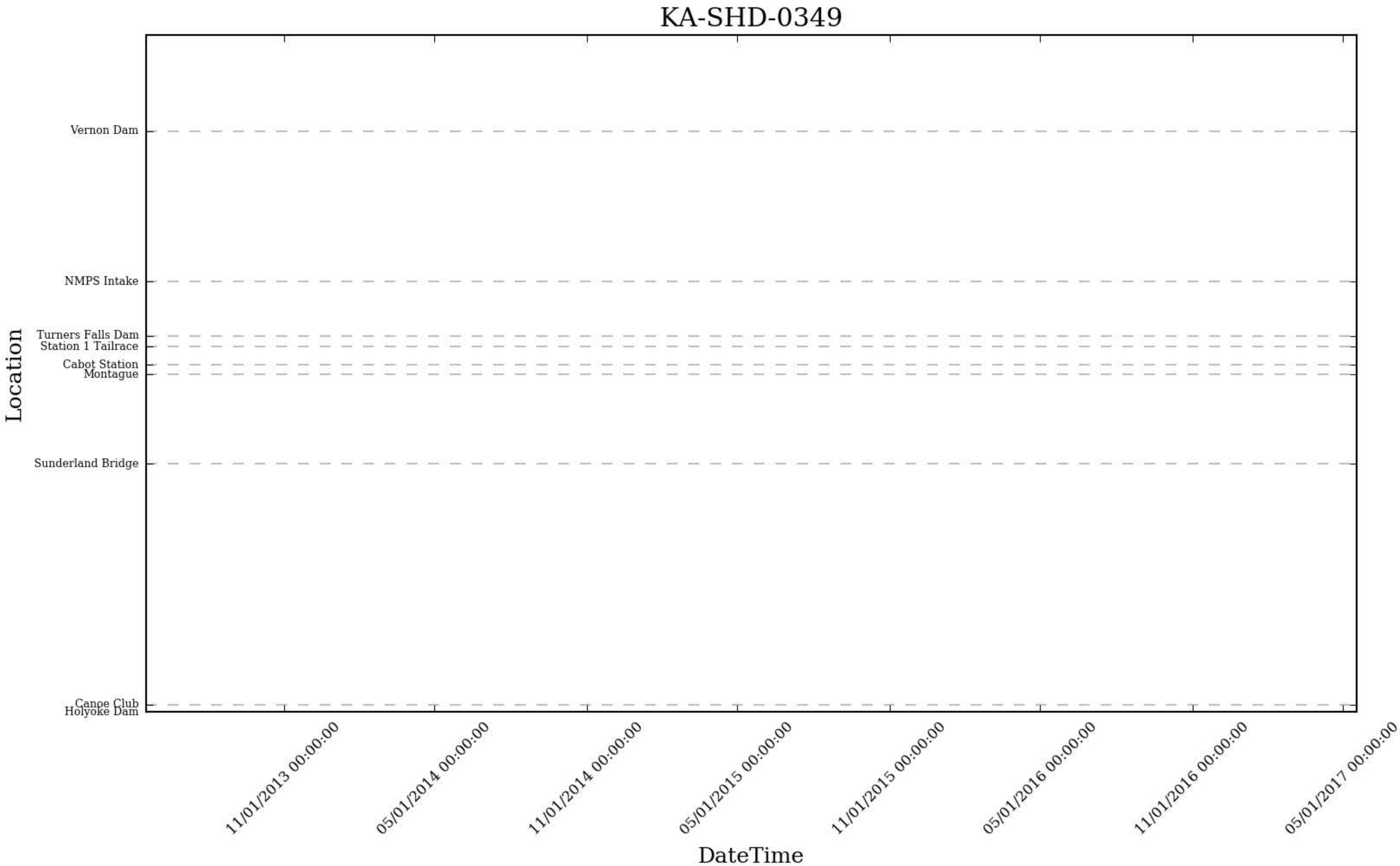
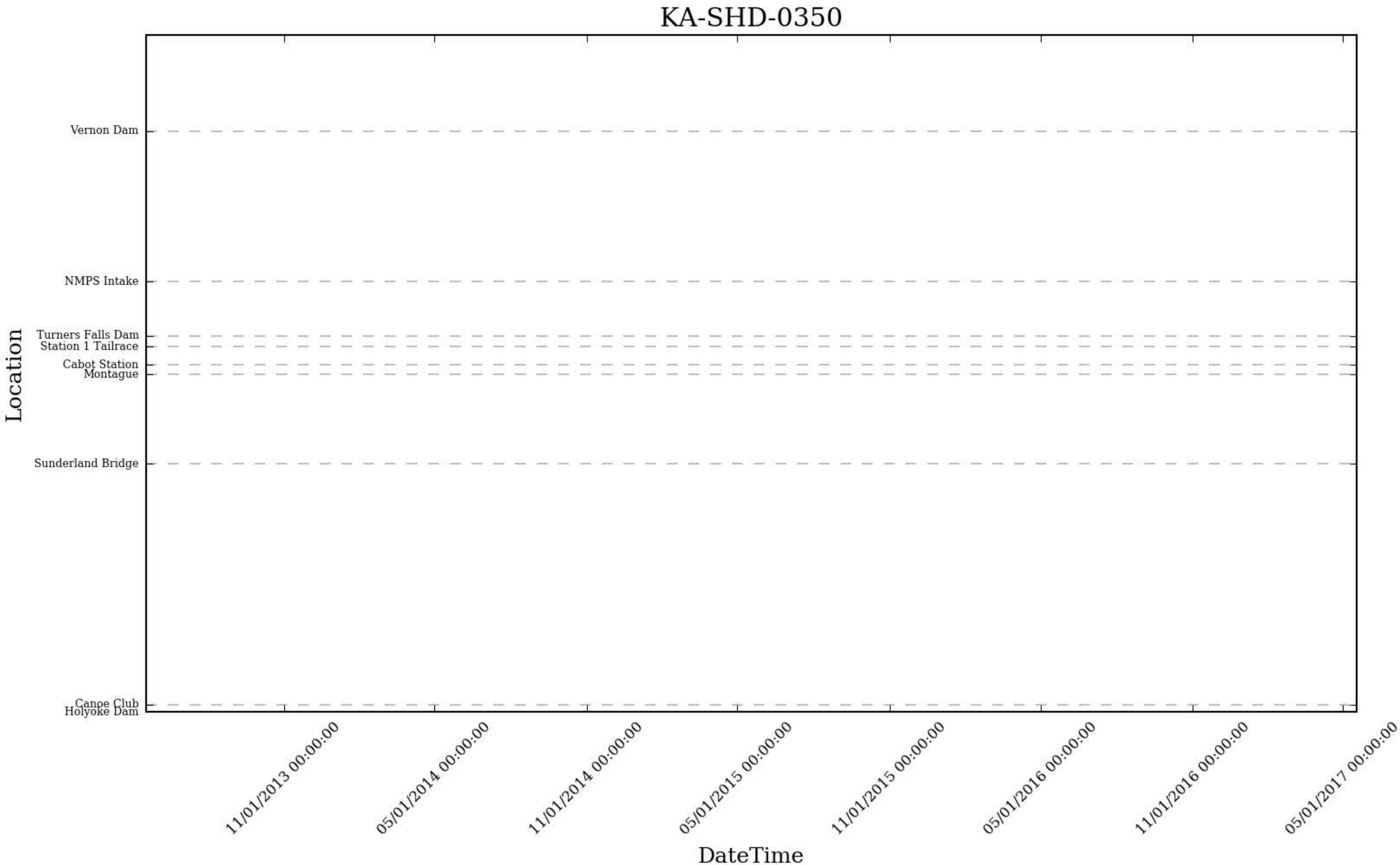
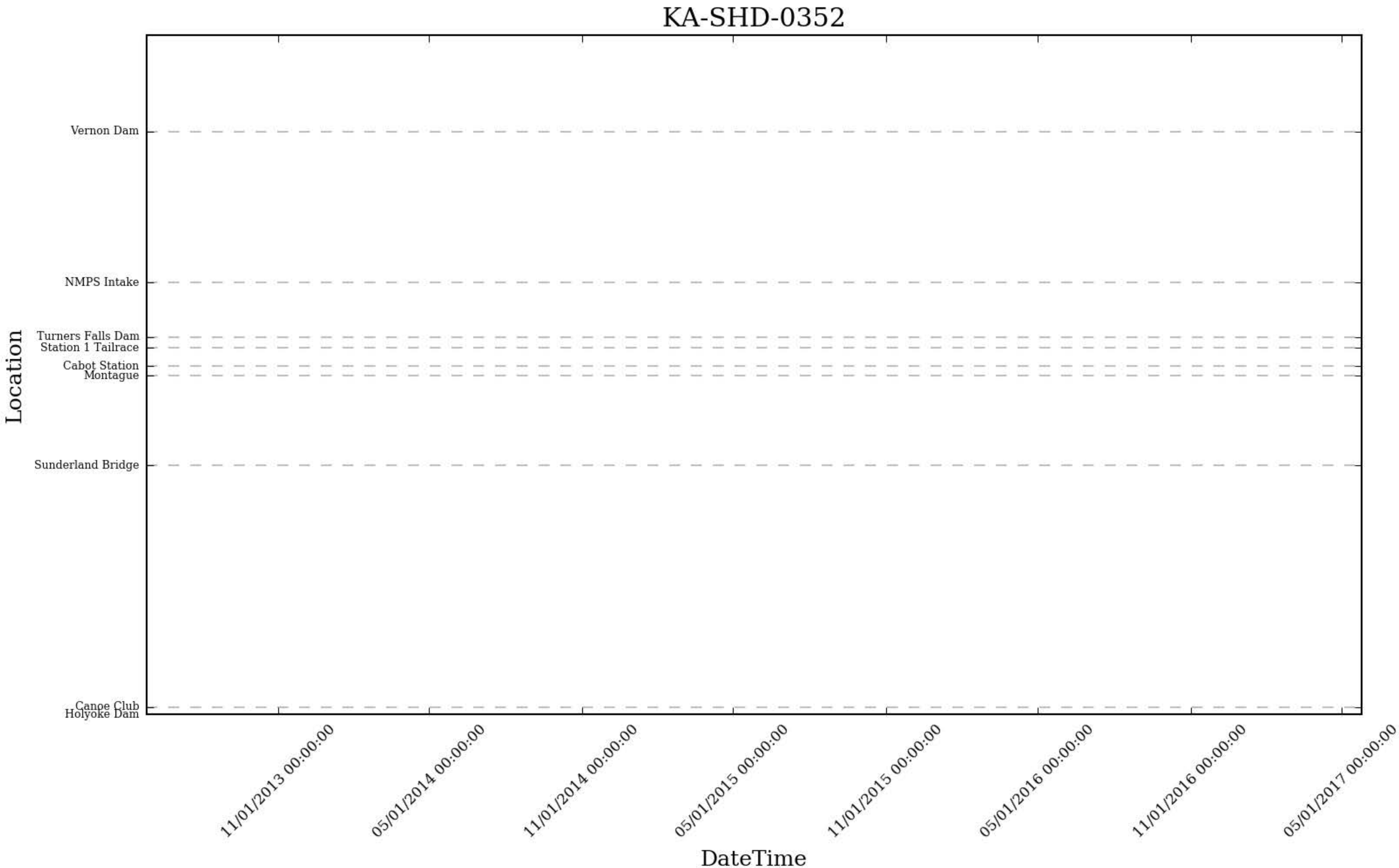
06/02/2015 08:50:08
06/02/2015 08:50:08
06/02/2015 08:50:09
DateTime


KA-SHD-0349
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0350
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0352
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
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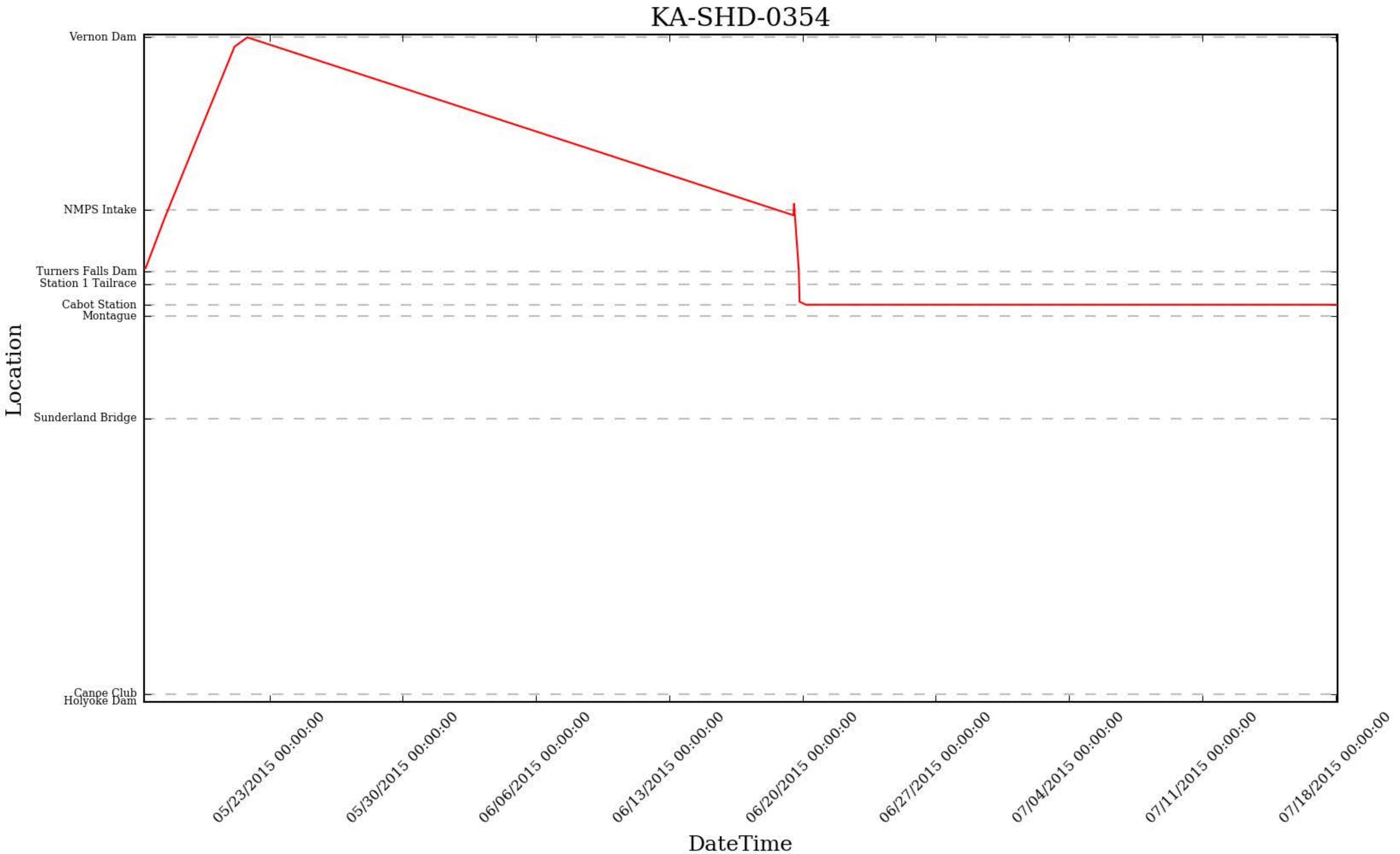
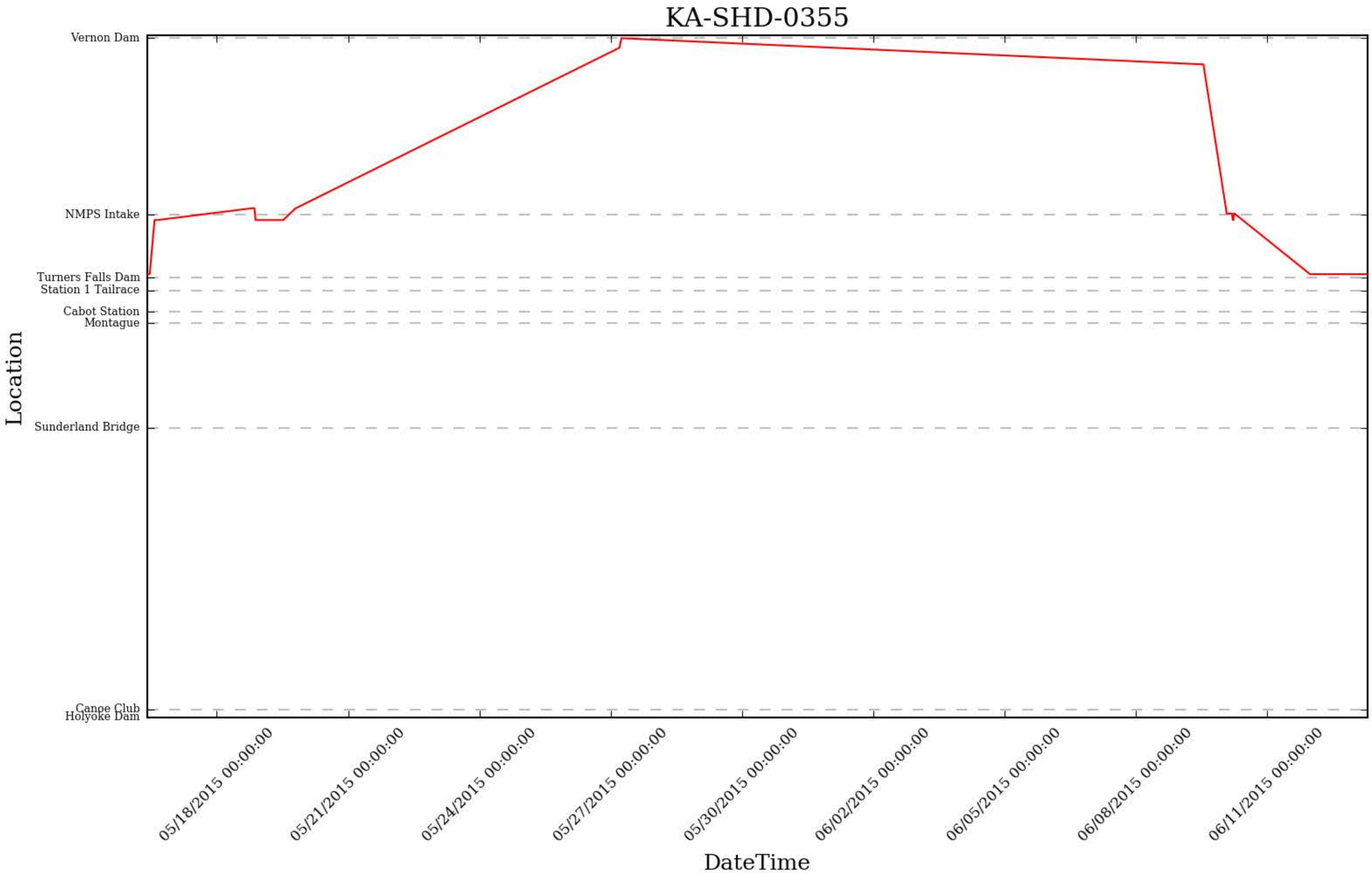
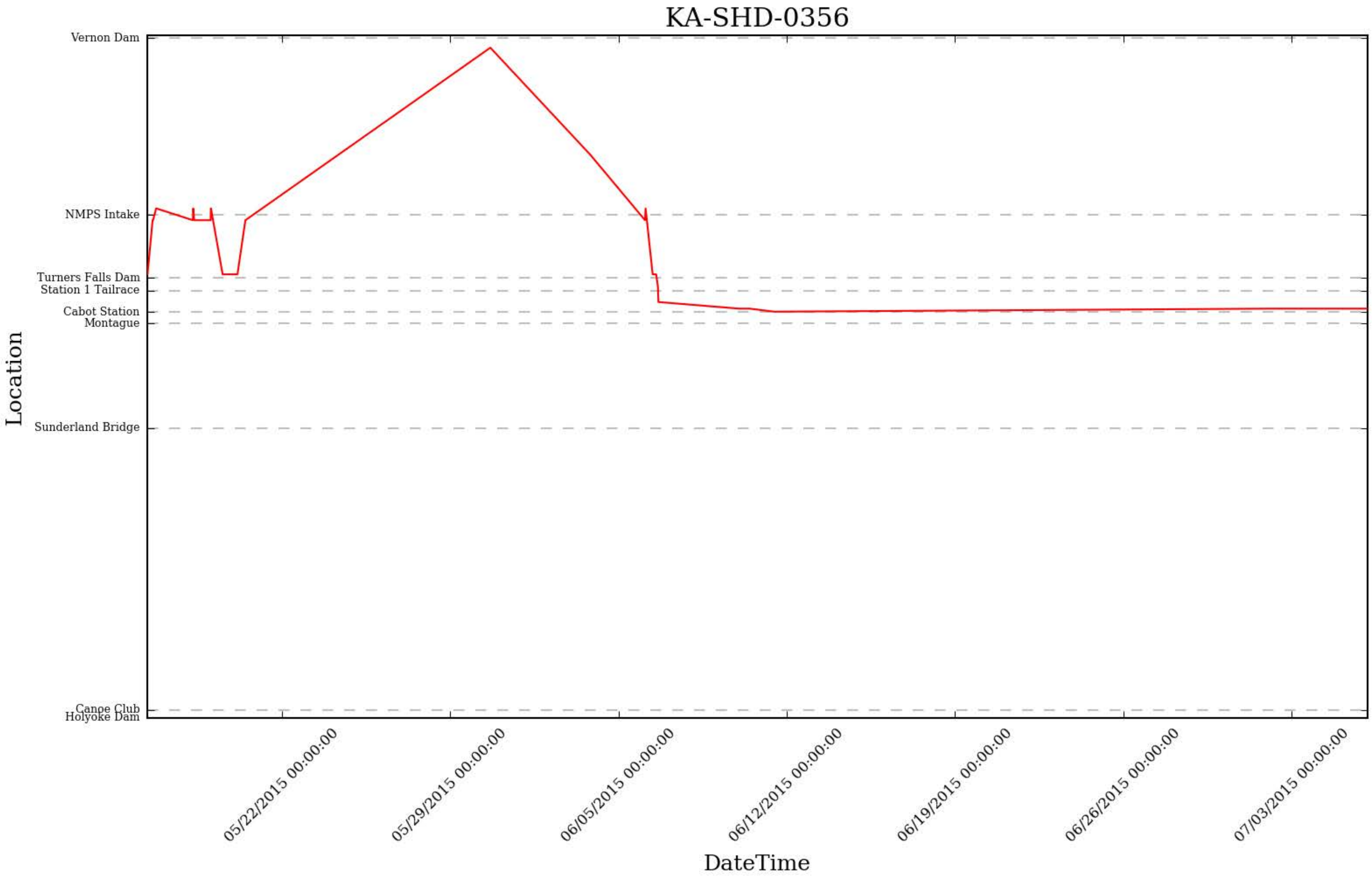
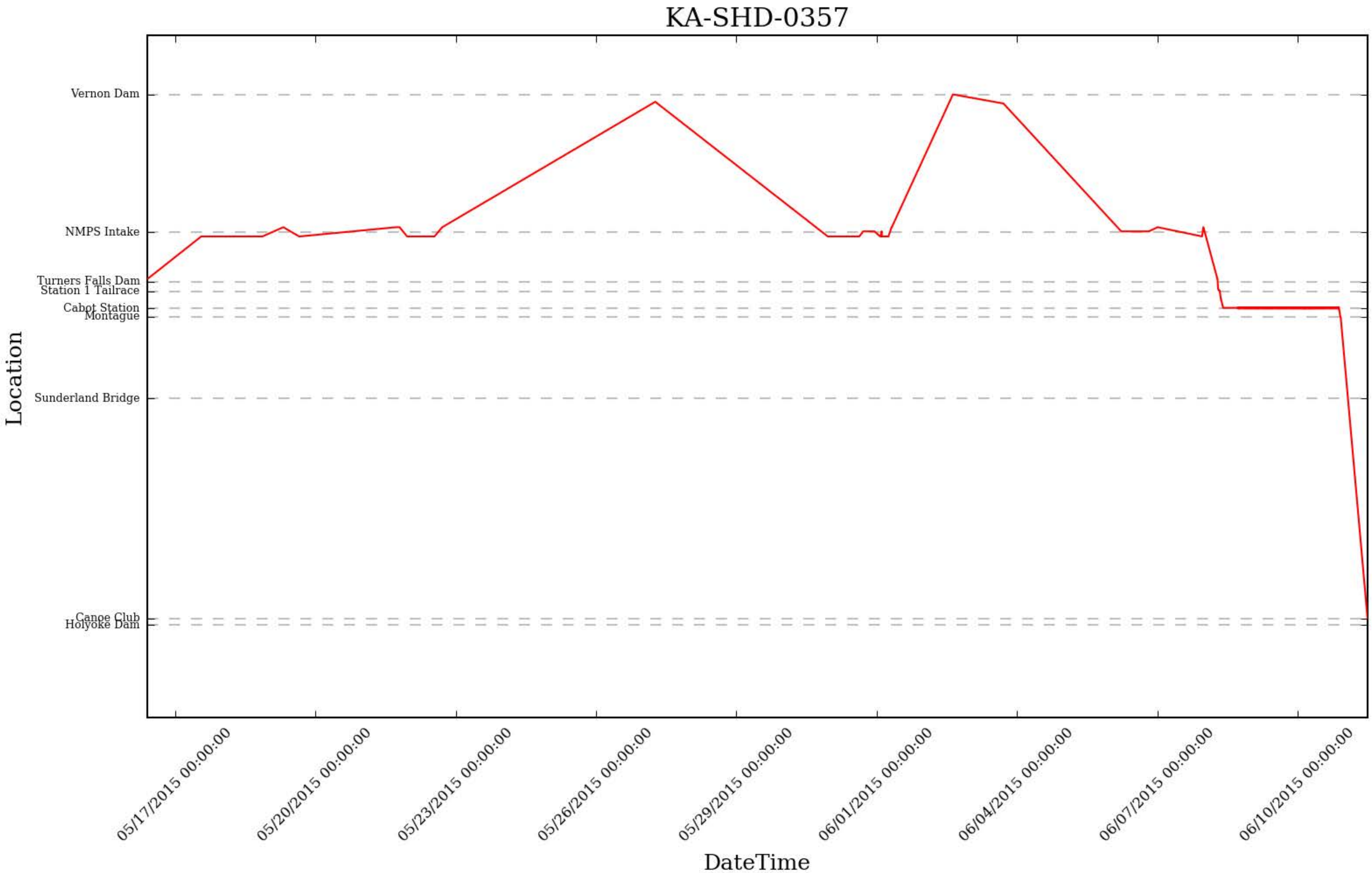
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime



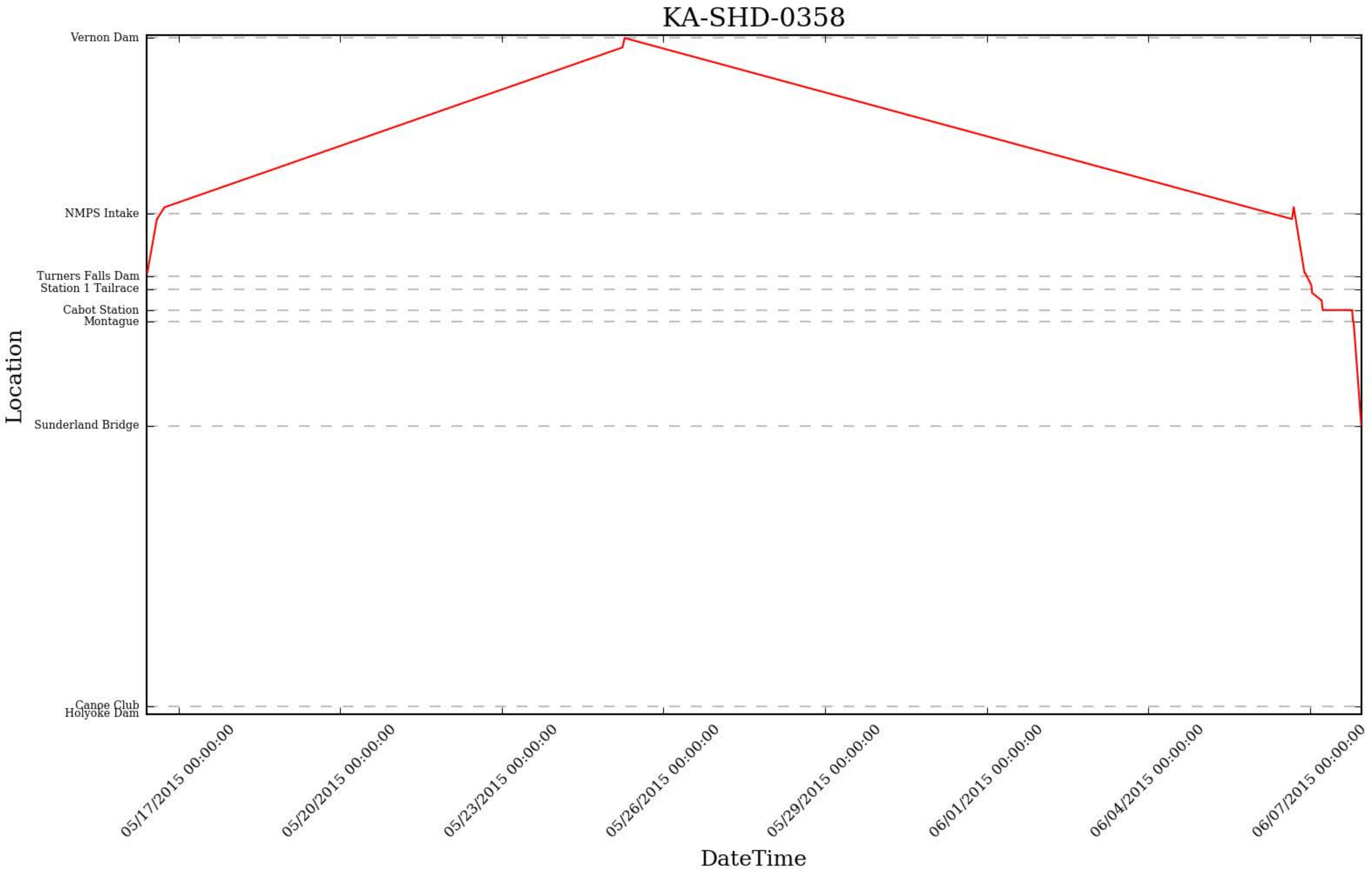
KA-SHD-0354
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
07/11/2015 00:00:00
07/18/2015 00:00:00
DateTime


KA-SHD-0355
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
DateTime

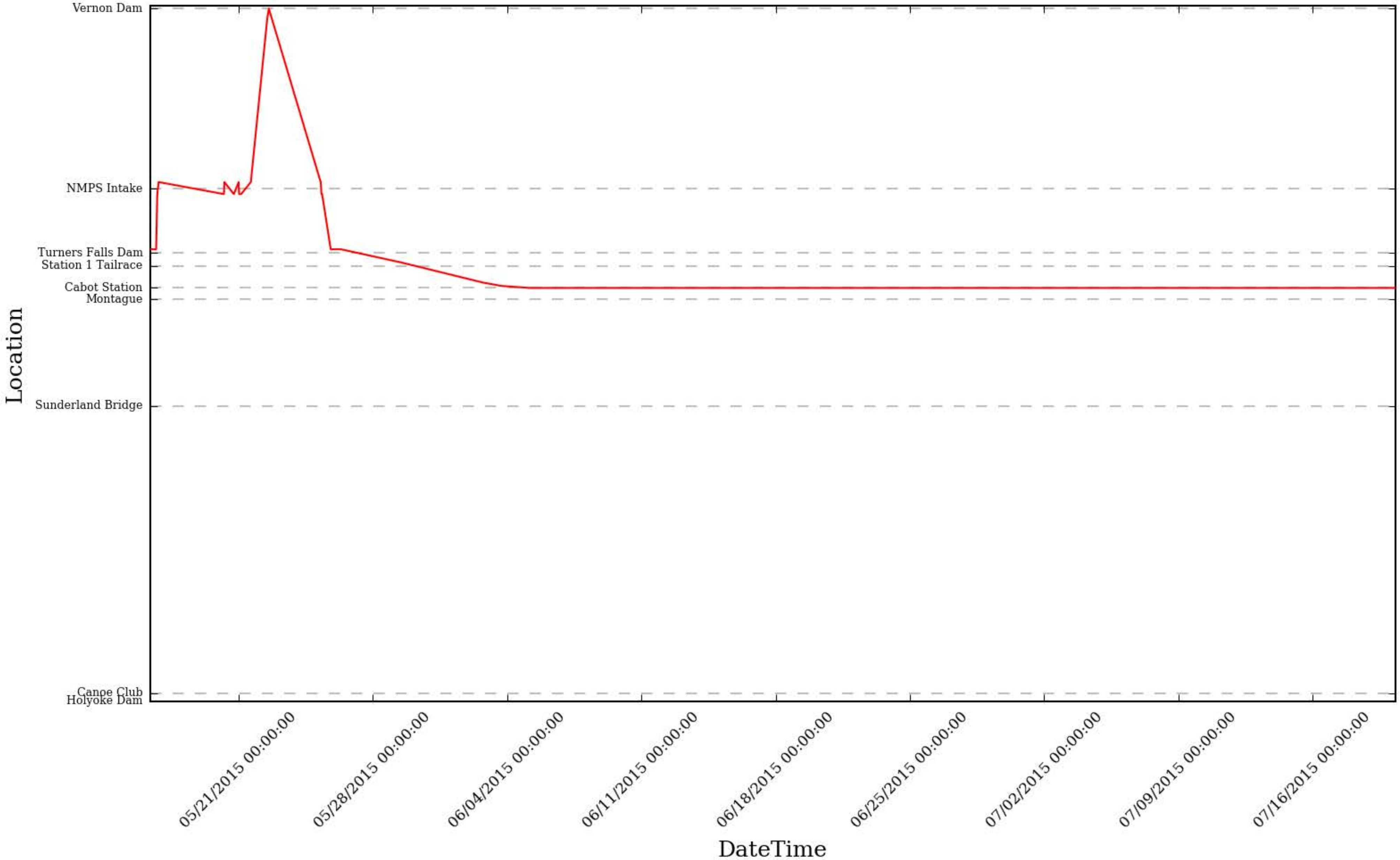

KA-SHD-0356
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime



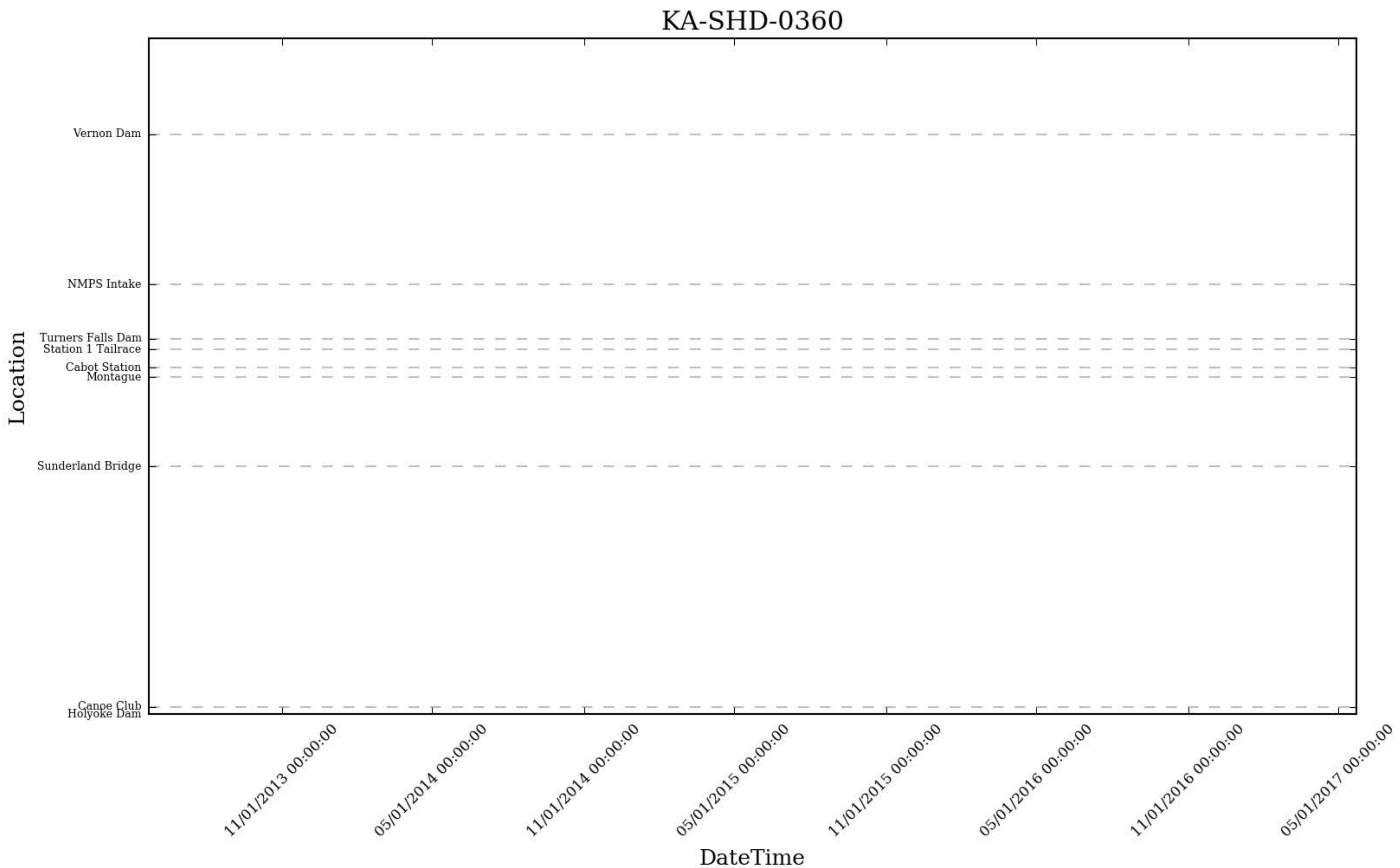
KA-SHD-0357
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
DateTime

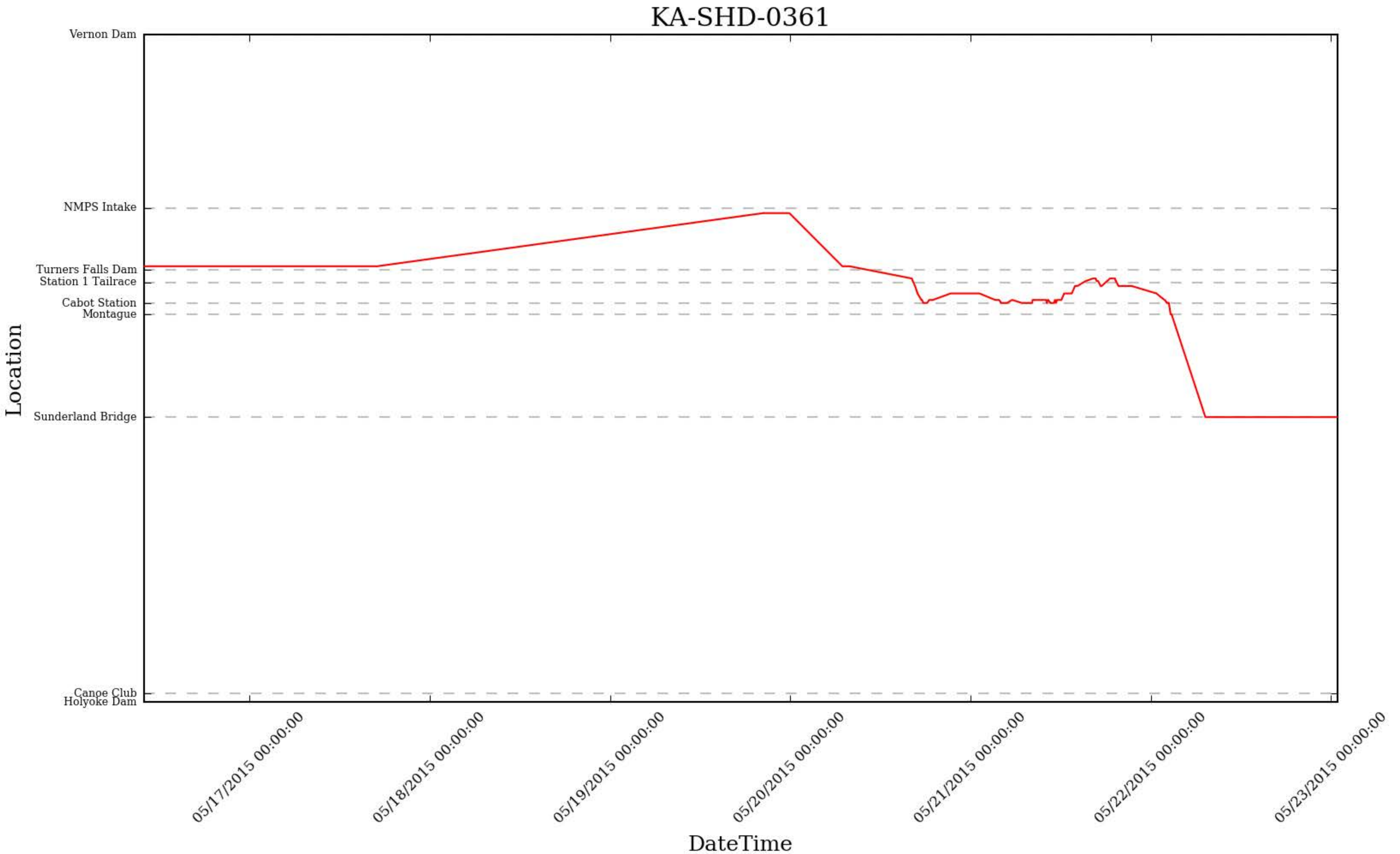

KA-SHD-0358
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
DateTime

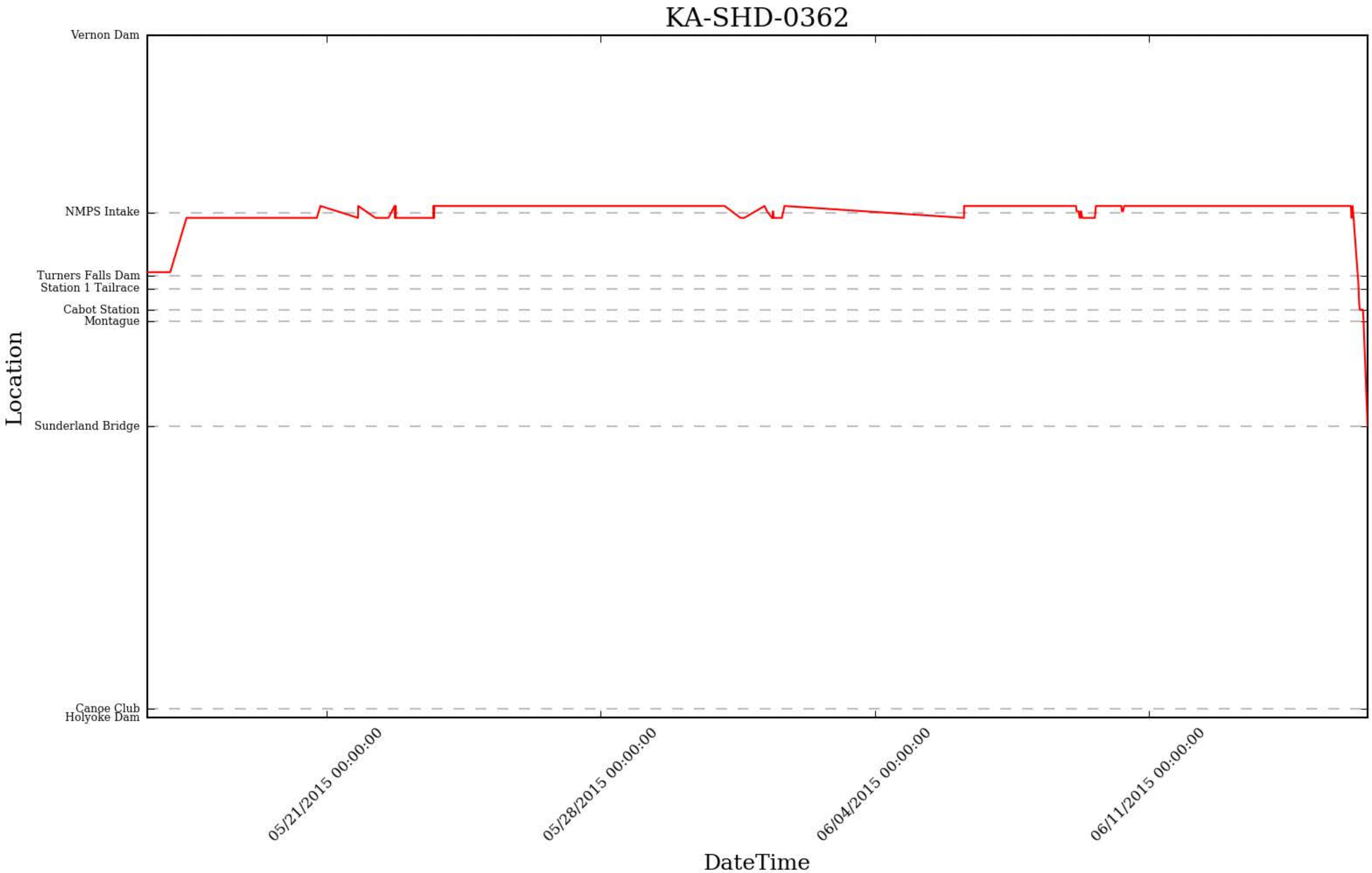
KA-SHD-0359

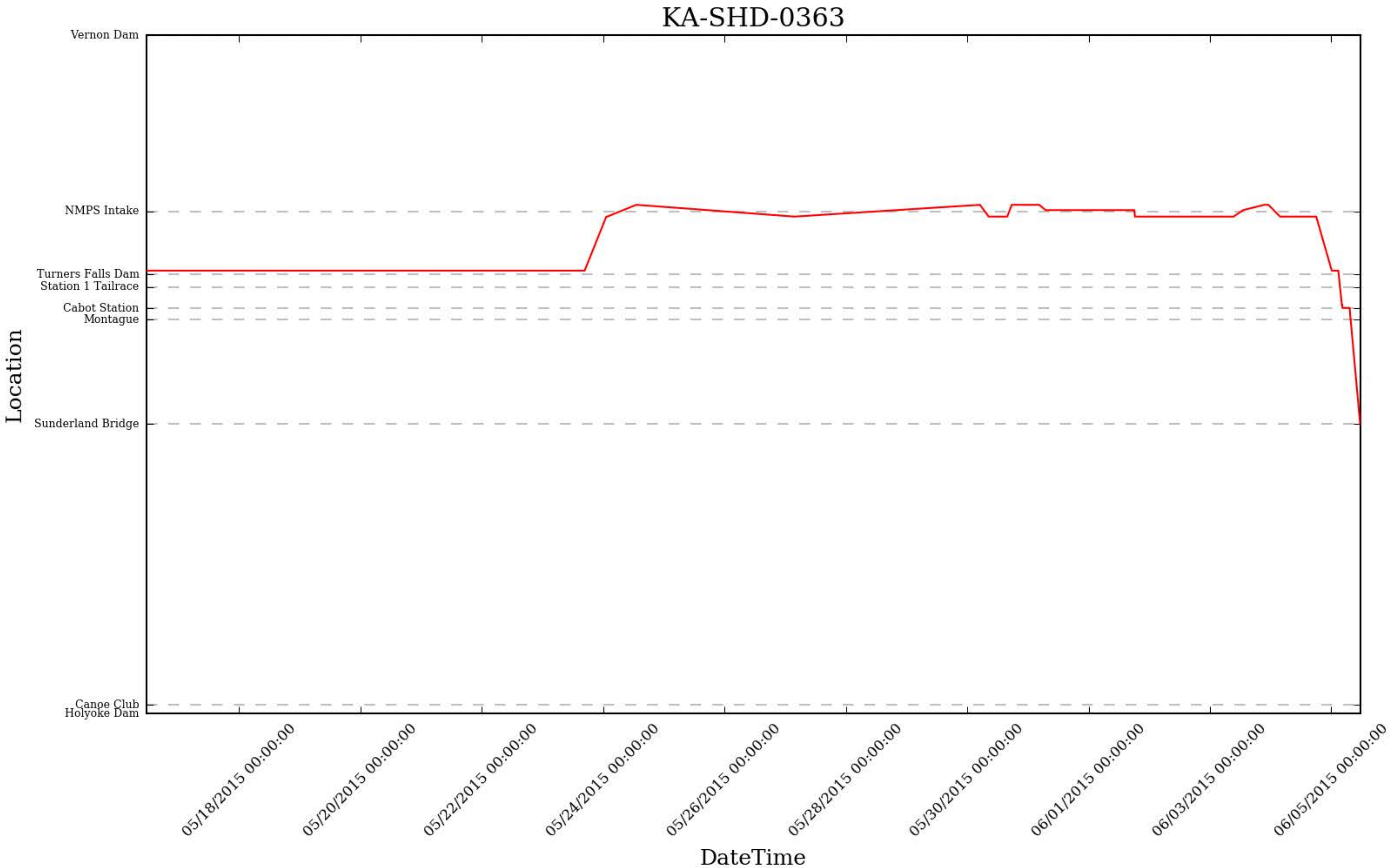


Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
07/09/2015 00:00:00
07/16/2015 00:00:00
DateTime

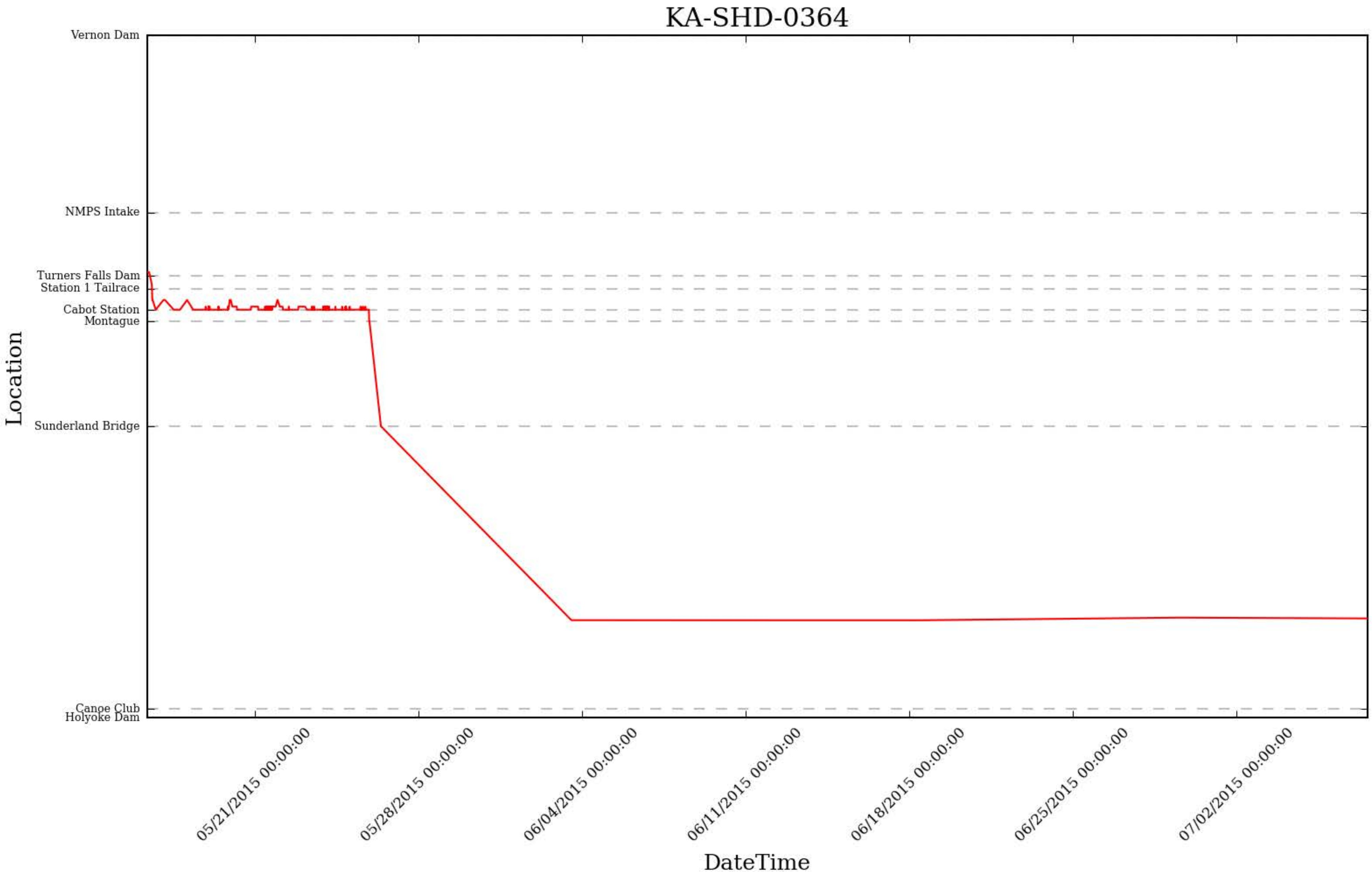

KA-SHD-0360
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

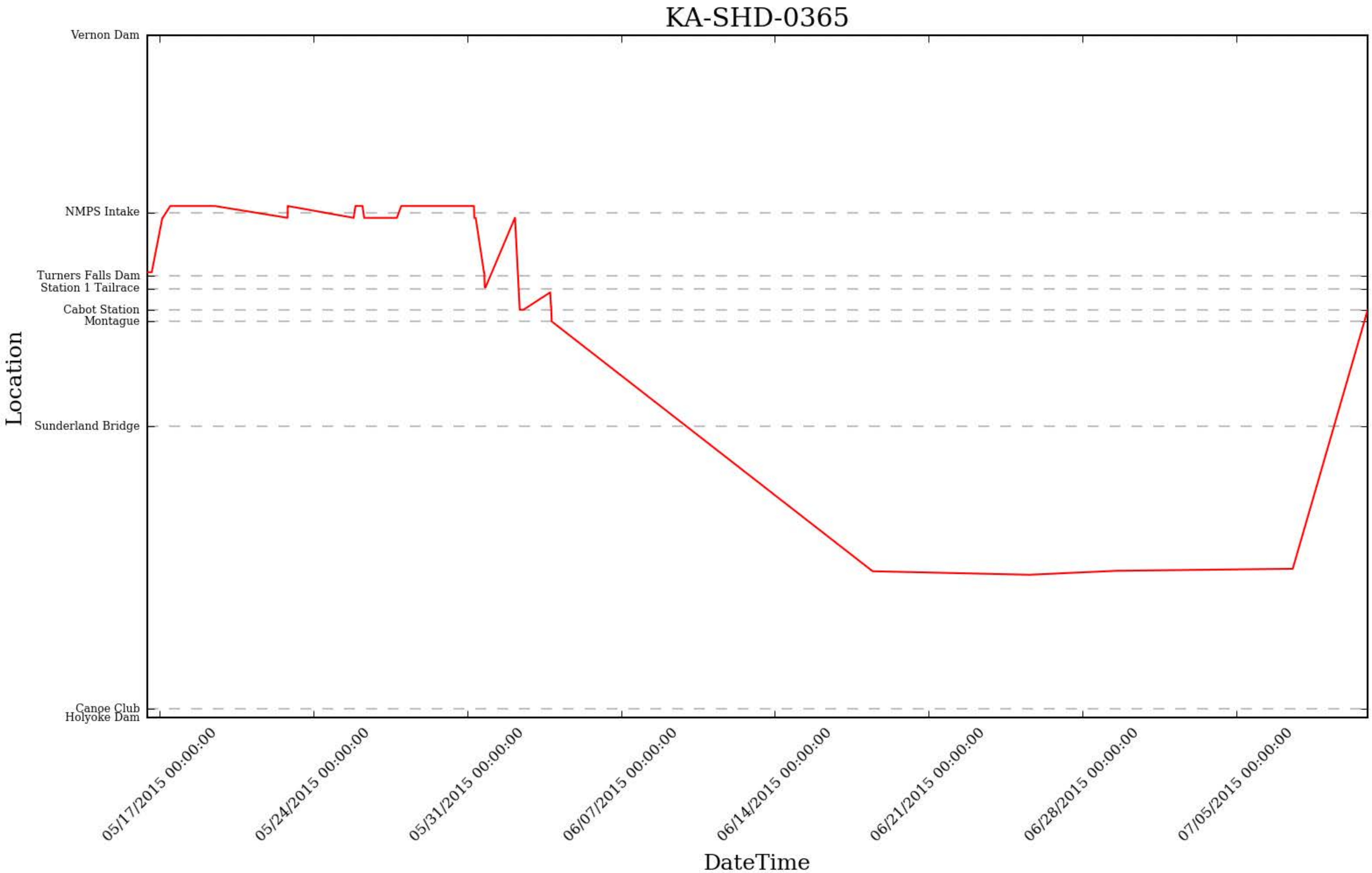

KA-SHD-0361
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
DateTime

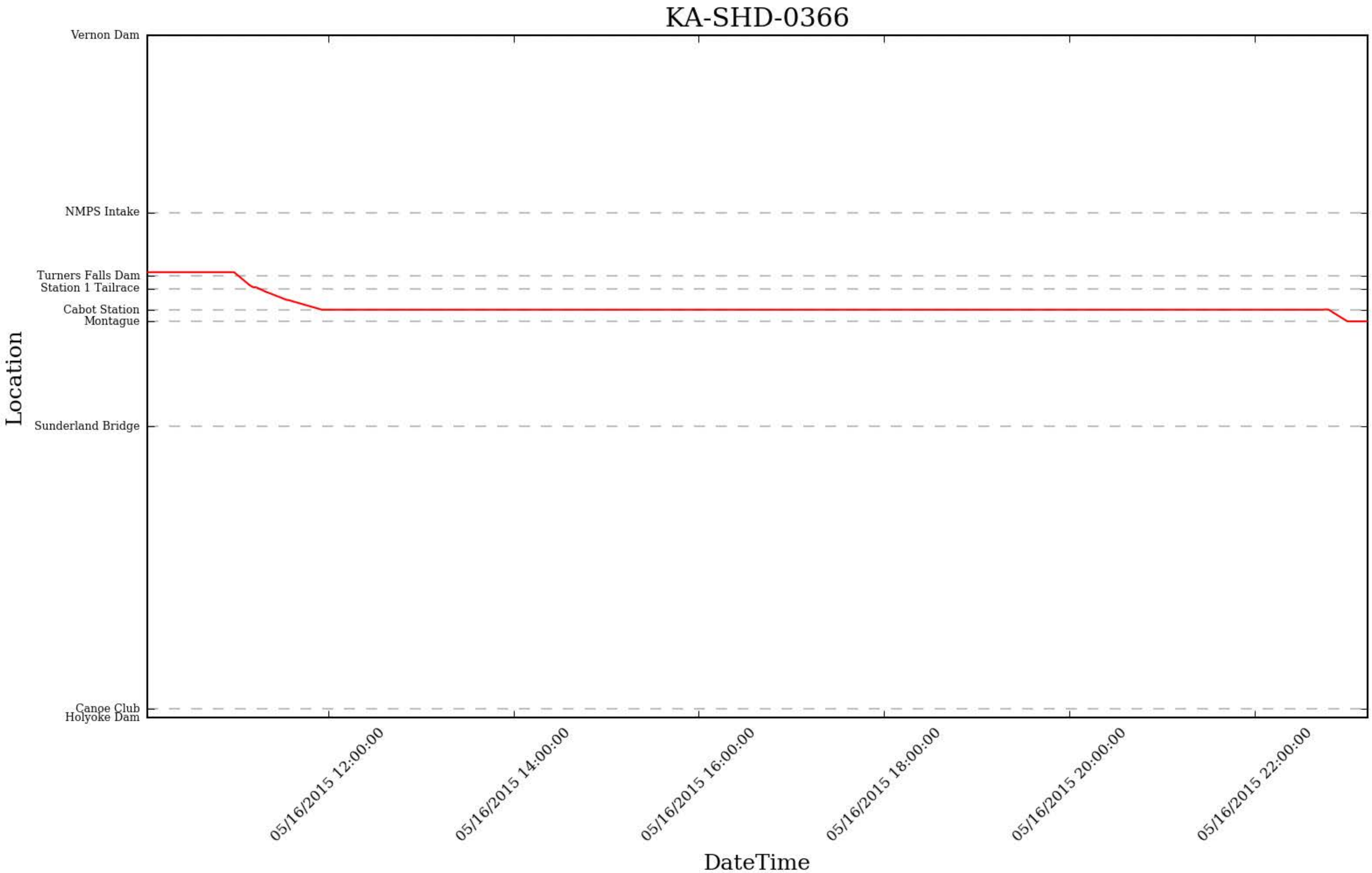

KA-SHD-0362
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
DateTime



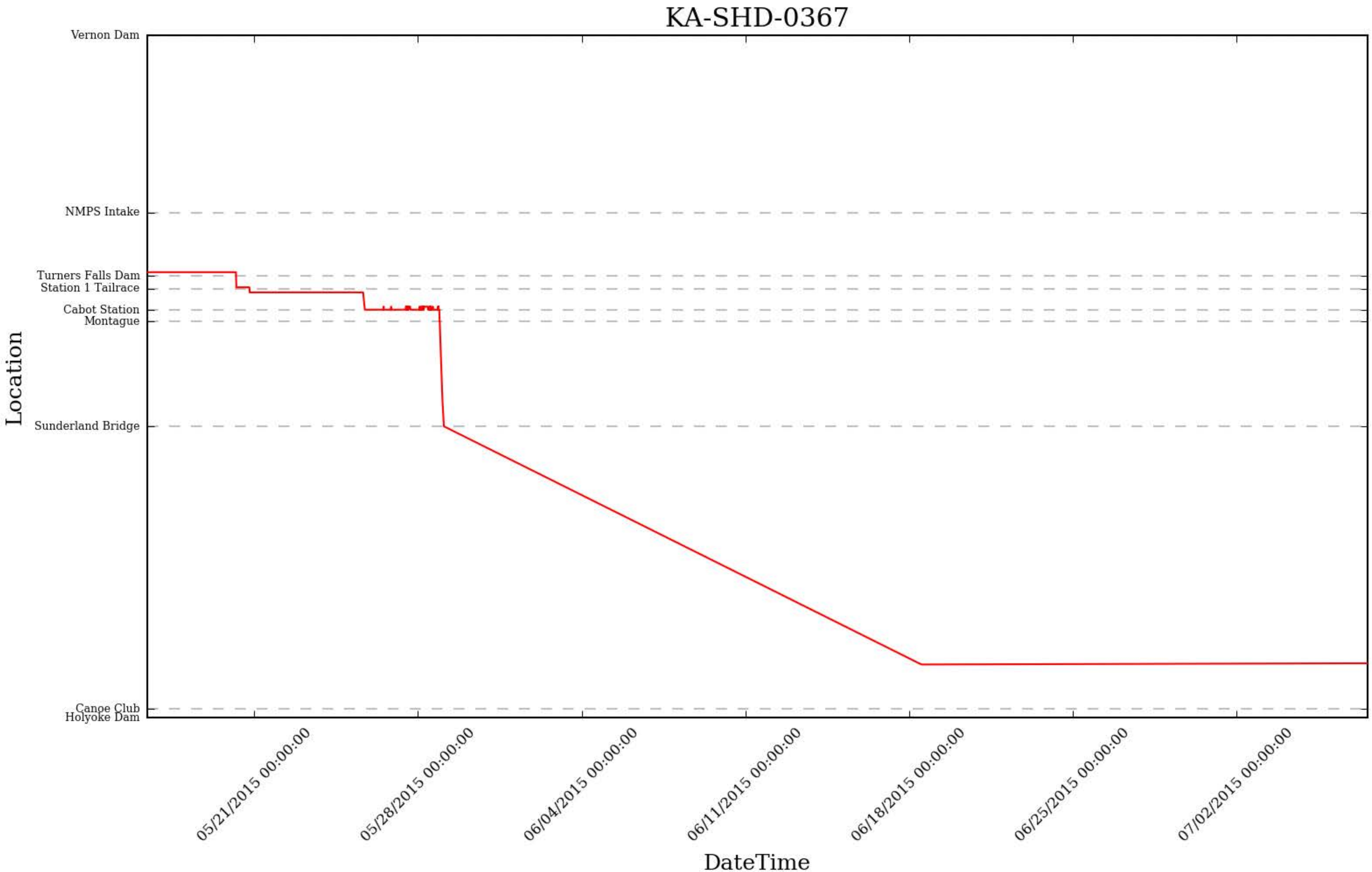
KA-SHD-0363
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime

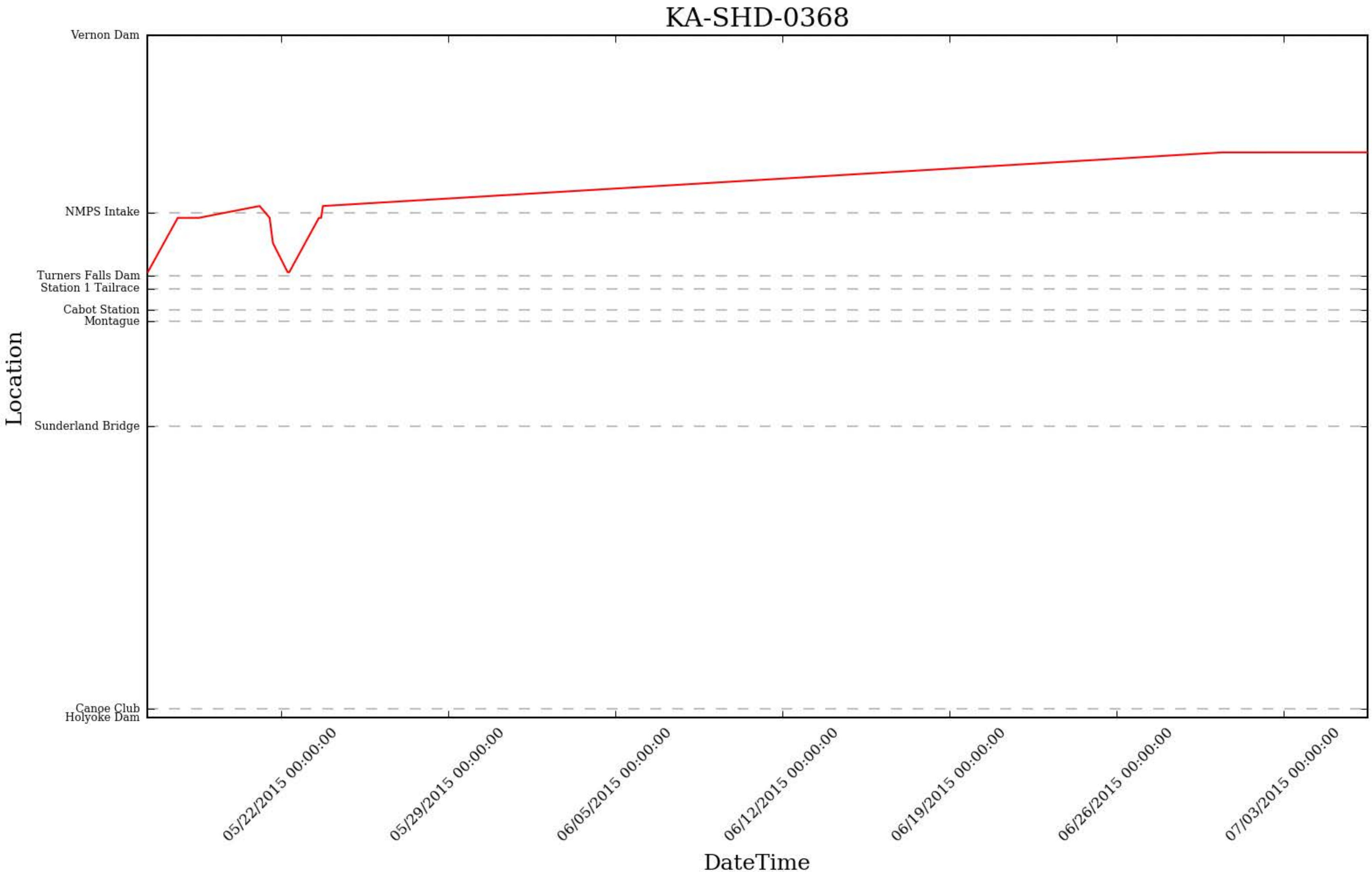

KA-SHD-0364
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

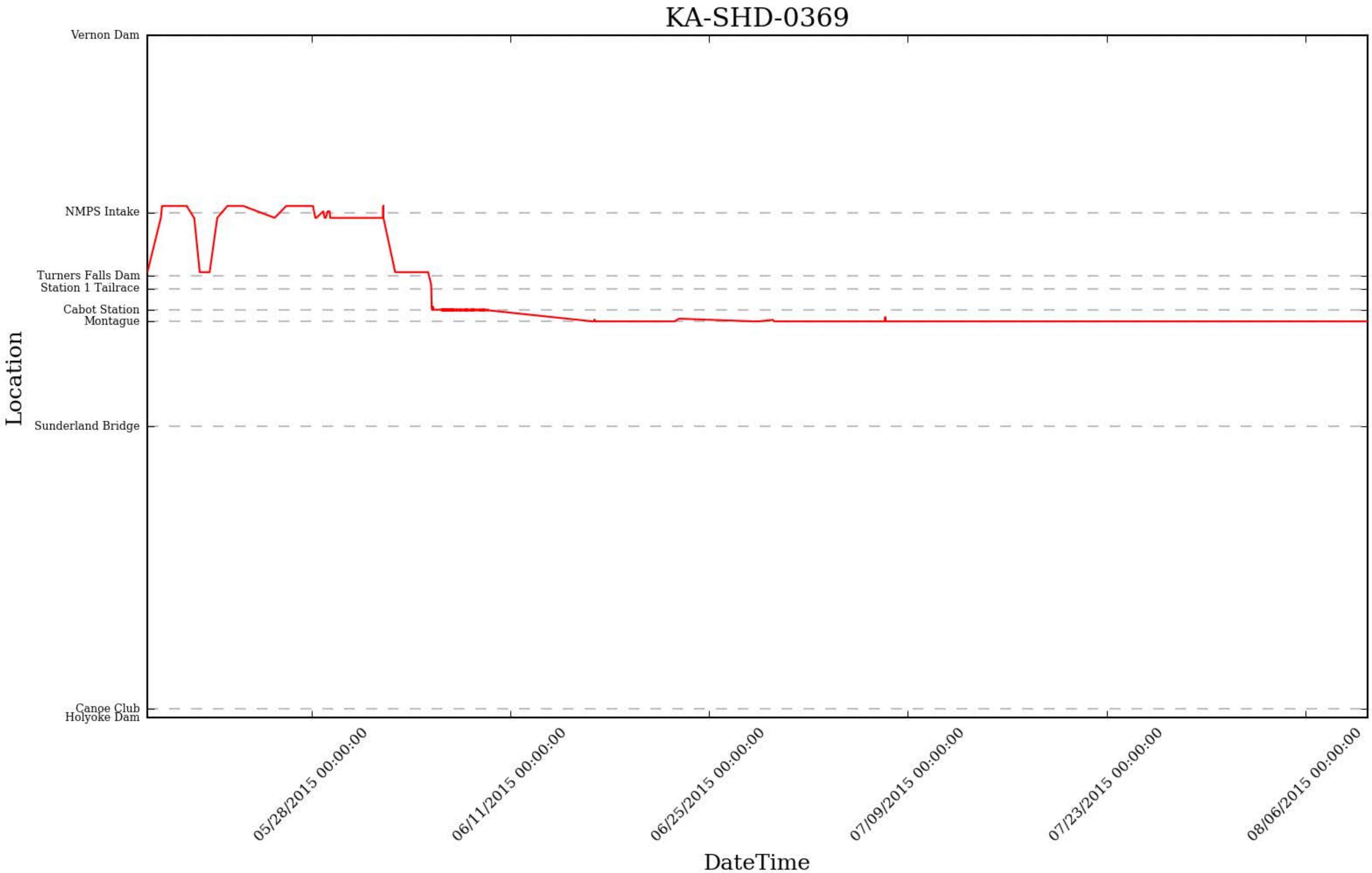

KA-SHD-0365
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
DateTime

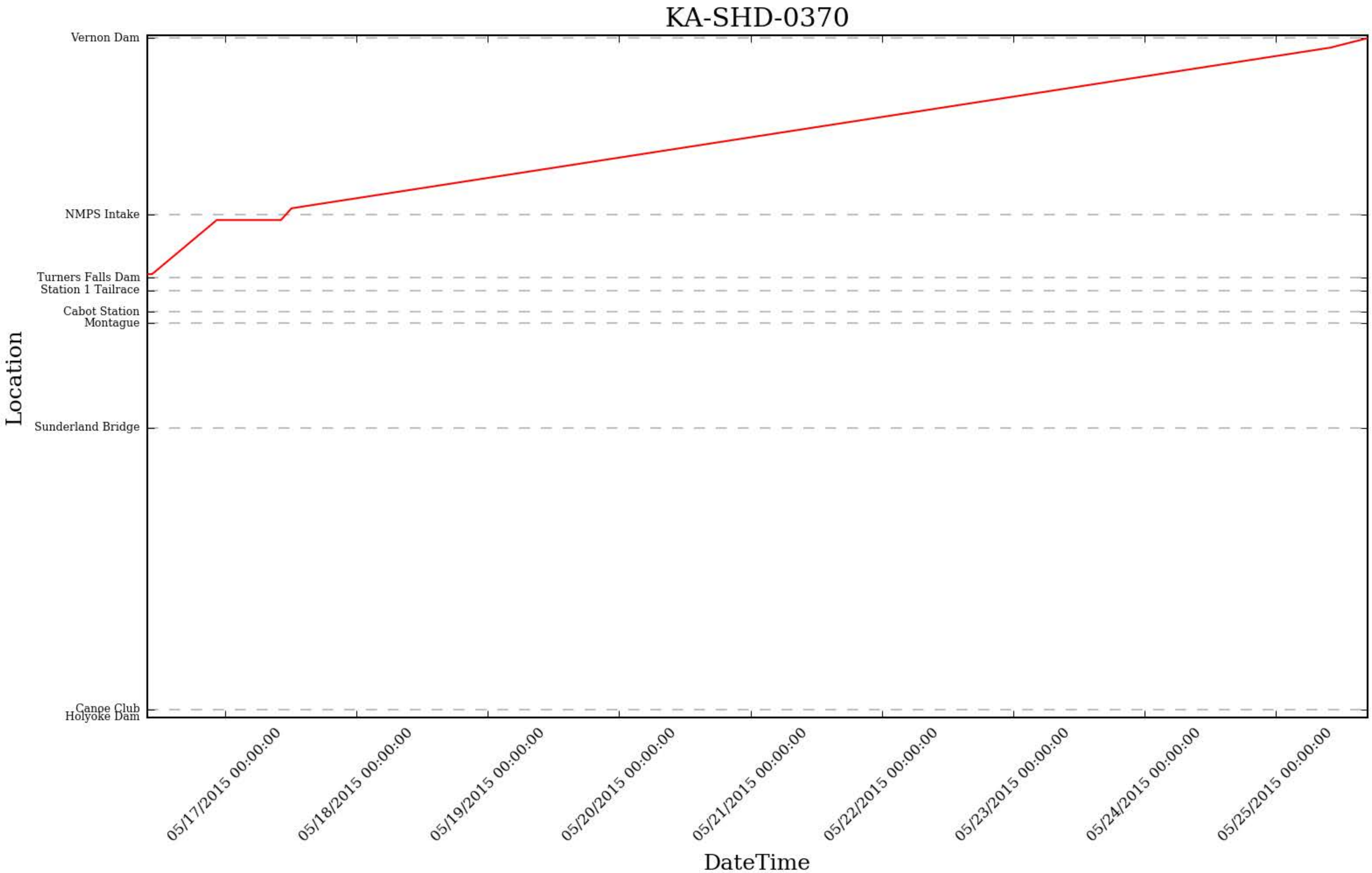


KA-SHD-0366
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 12:00:00
05/16/2015 14:00:00
05/16/2015 16:00:00
05/16/2015 18:00:00
05/16/2015 20:00:00
05/16/2015 22:00:00
DateTime

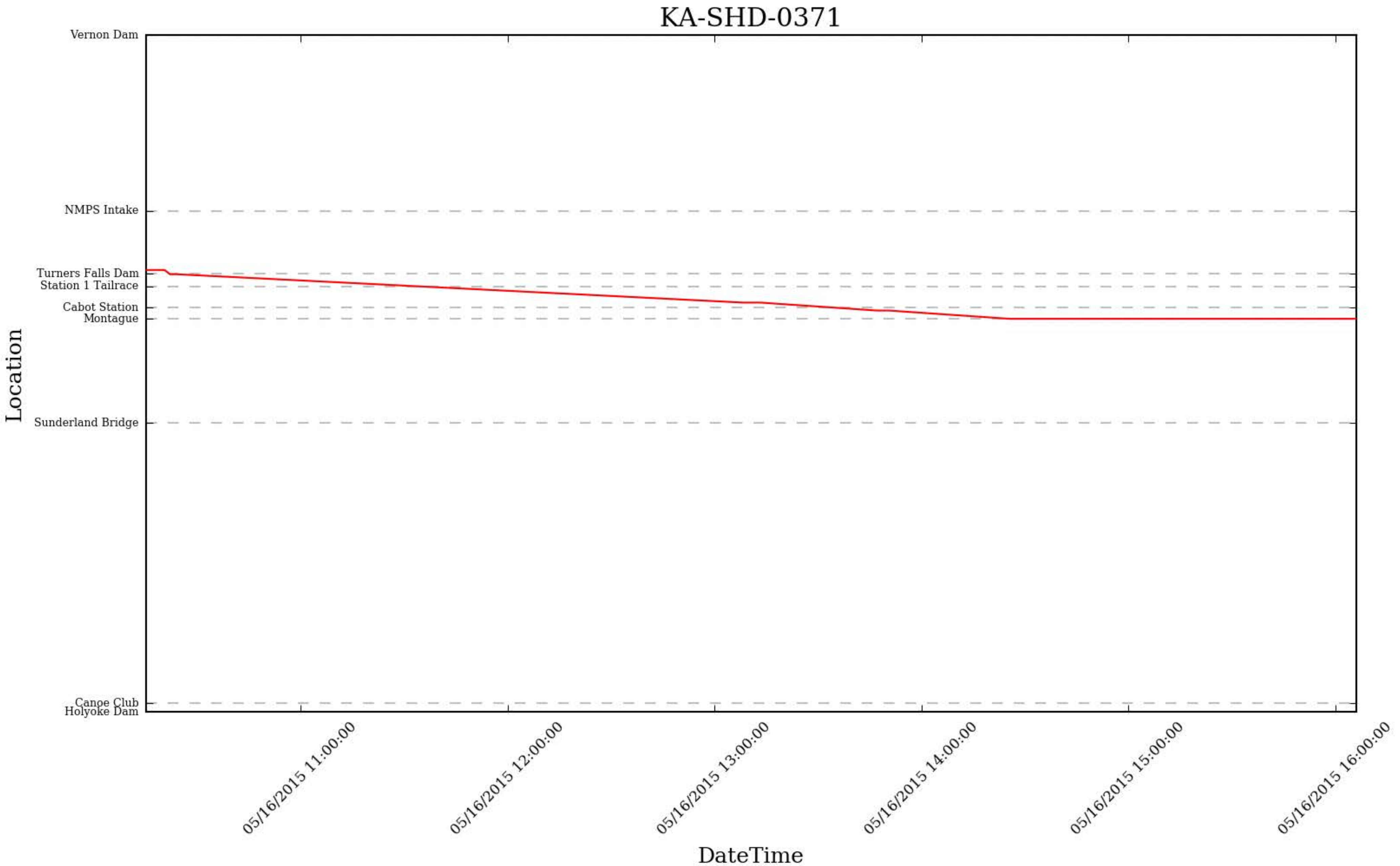

KA-SHD-0367
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

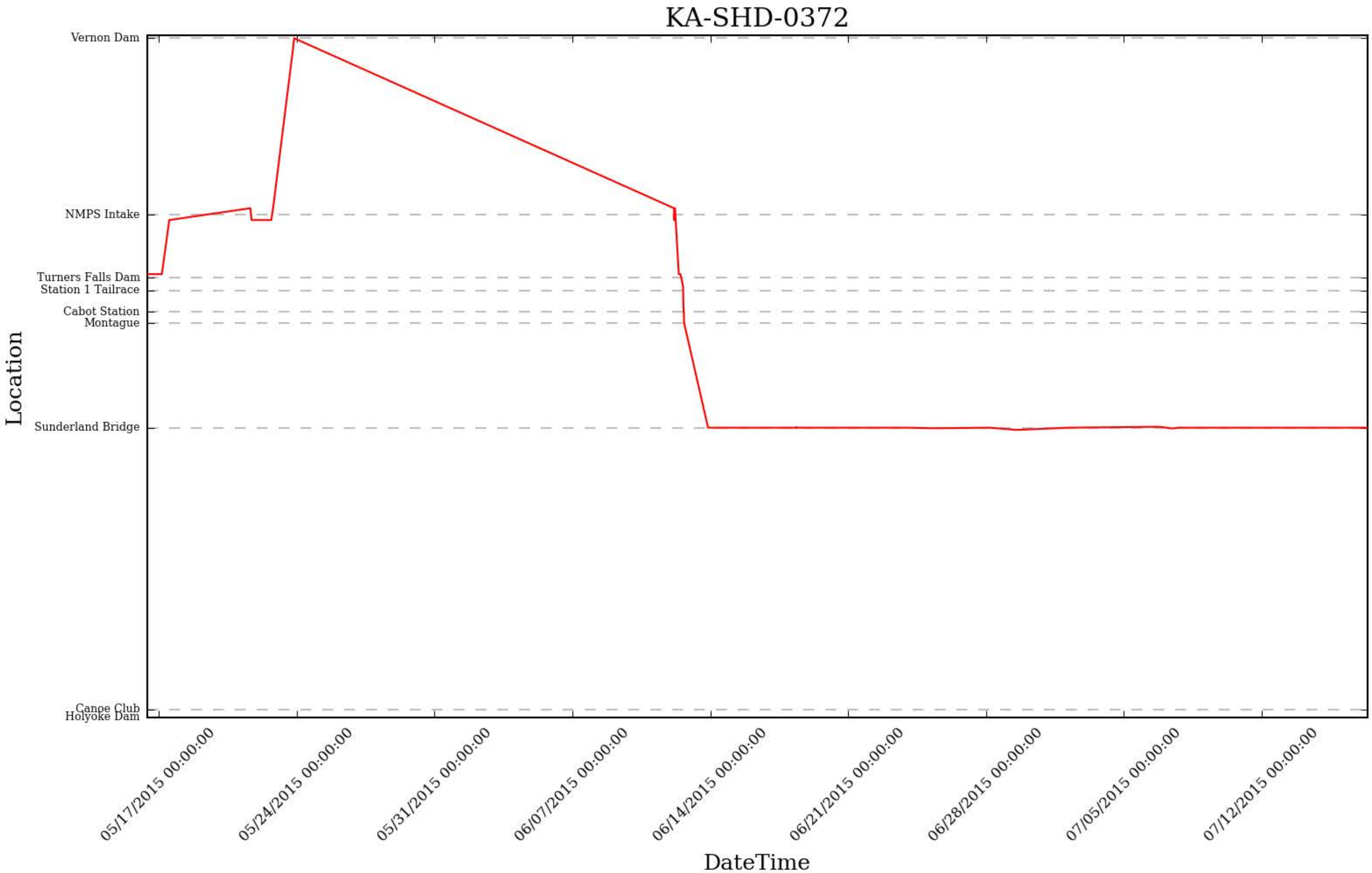

KA-SHD-0368
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime


KA-SHD-0369
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/11/2015 00:00:00
06/25/2015 00:00:00
07/09/2015 00:00:00
07/23/2015 00:00:00
08/06/2015 00:00:00
DateTime

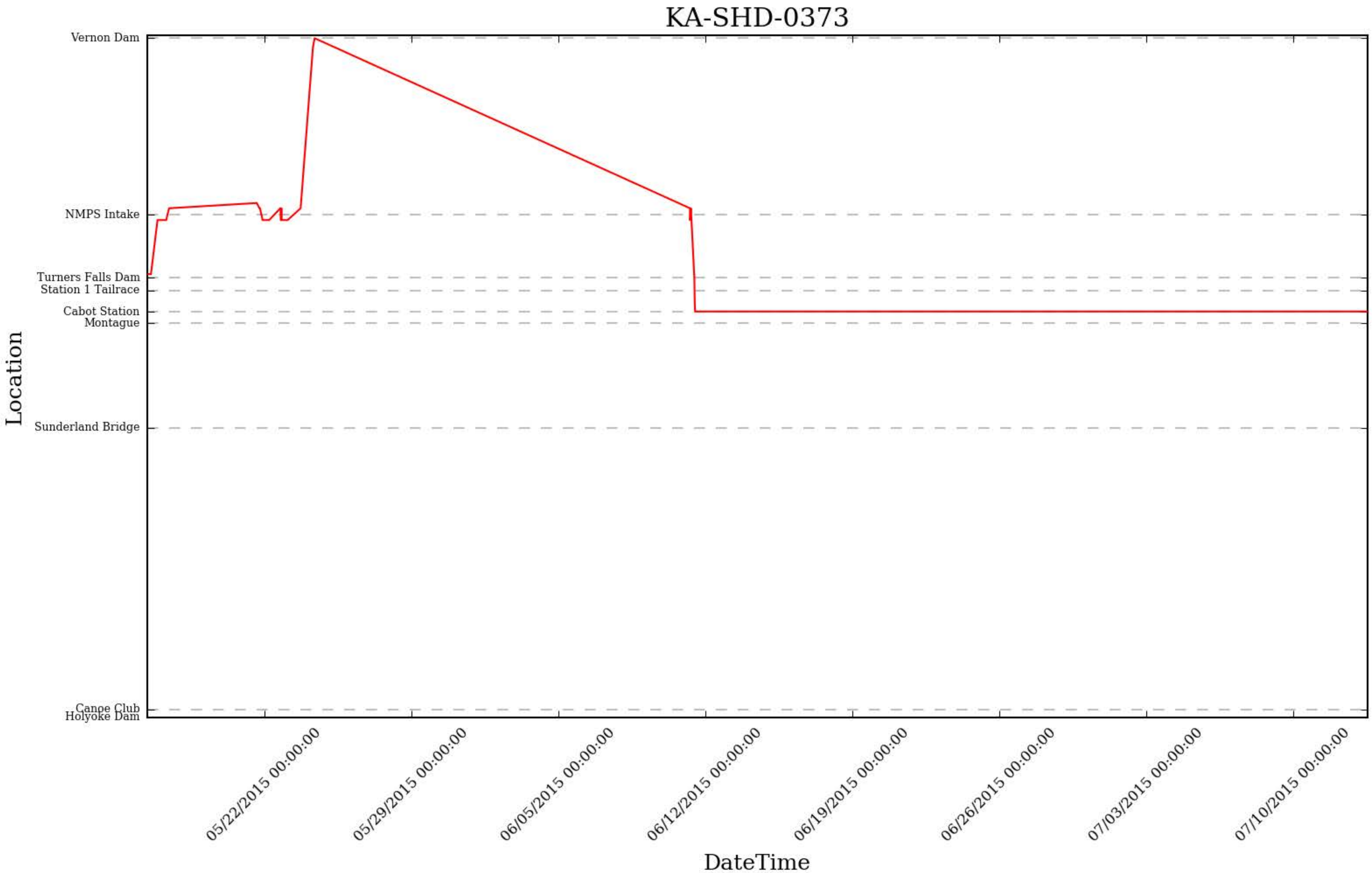


KA-SHD-0370
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
DateTime

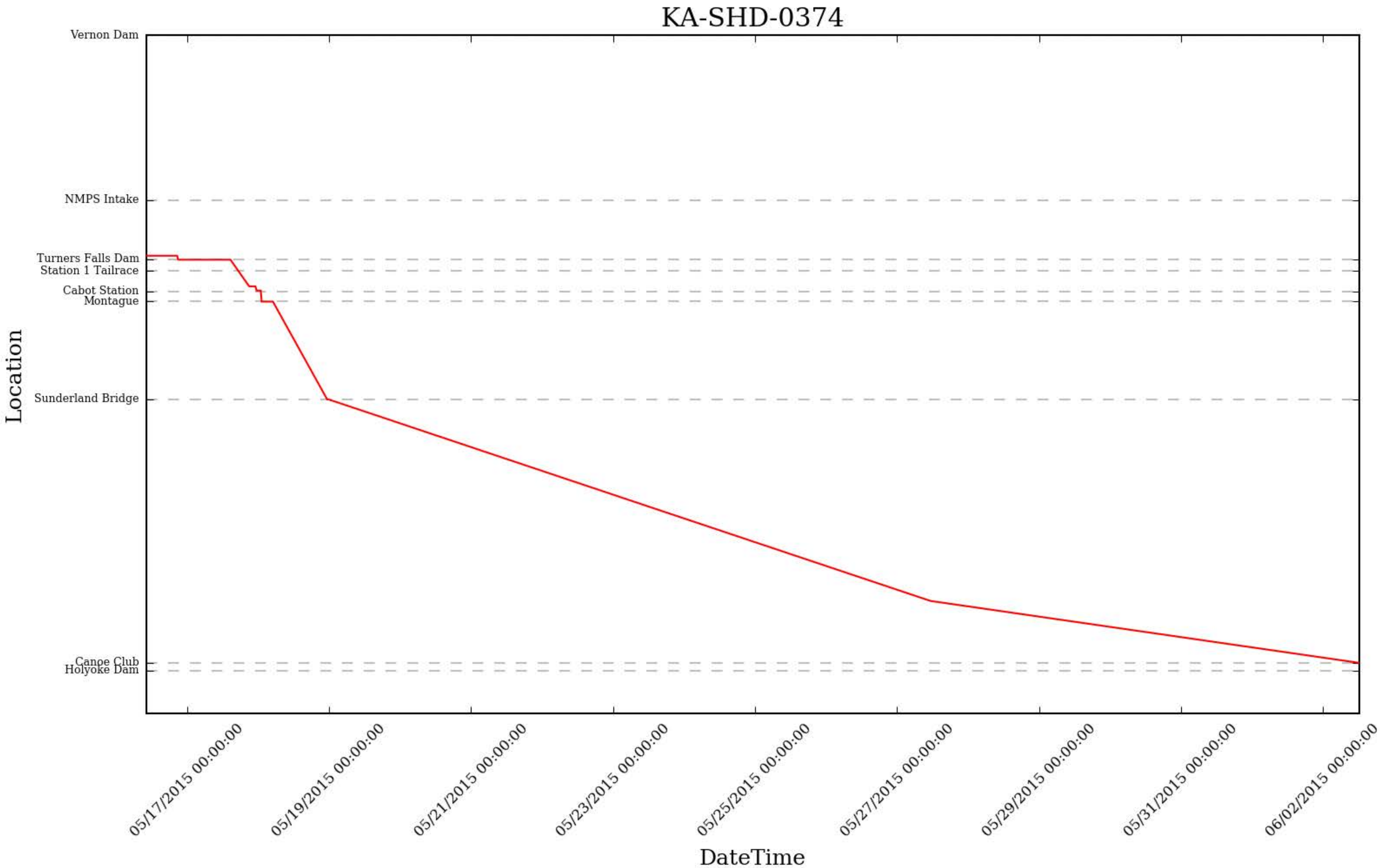

KA-SHD-0371
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 11:00:00
05/16/2015 12:00:00
05/16/2015 13:00:00
05/16/2015 14:00:00
05/16/2015 15:00:00
05/16/2015 16:00:00
DateTime

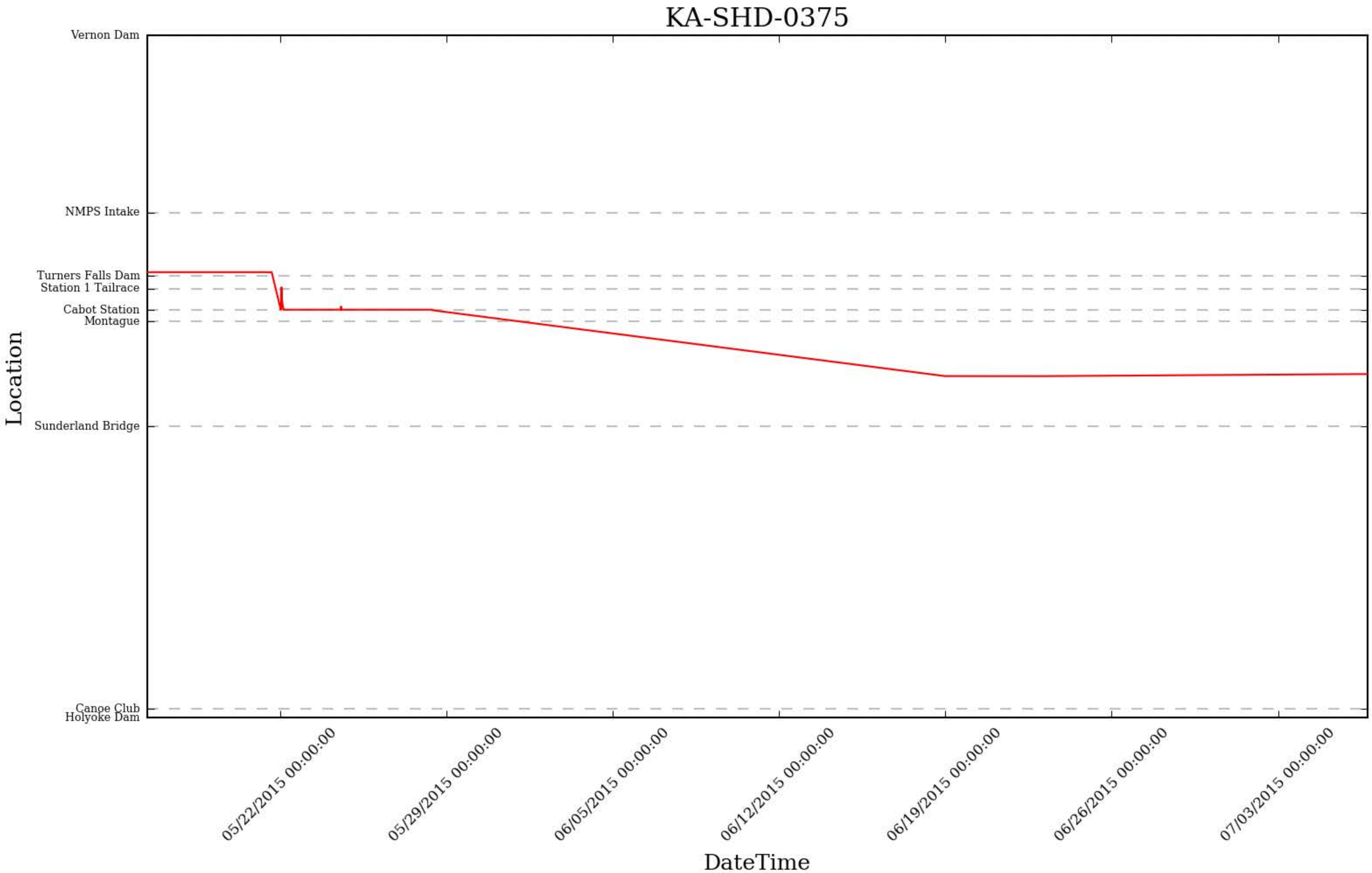


KA-SHD-0372
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
07/12/2015 00:00:00
DateTime

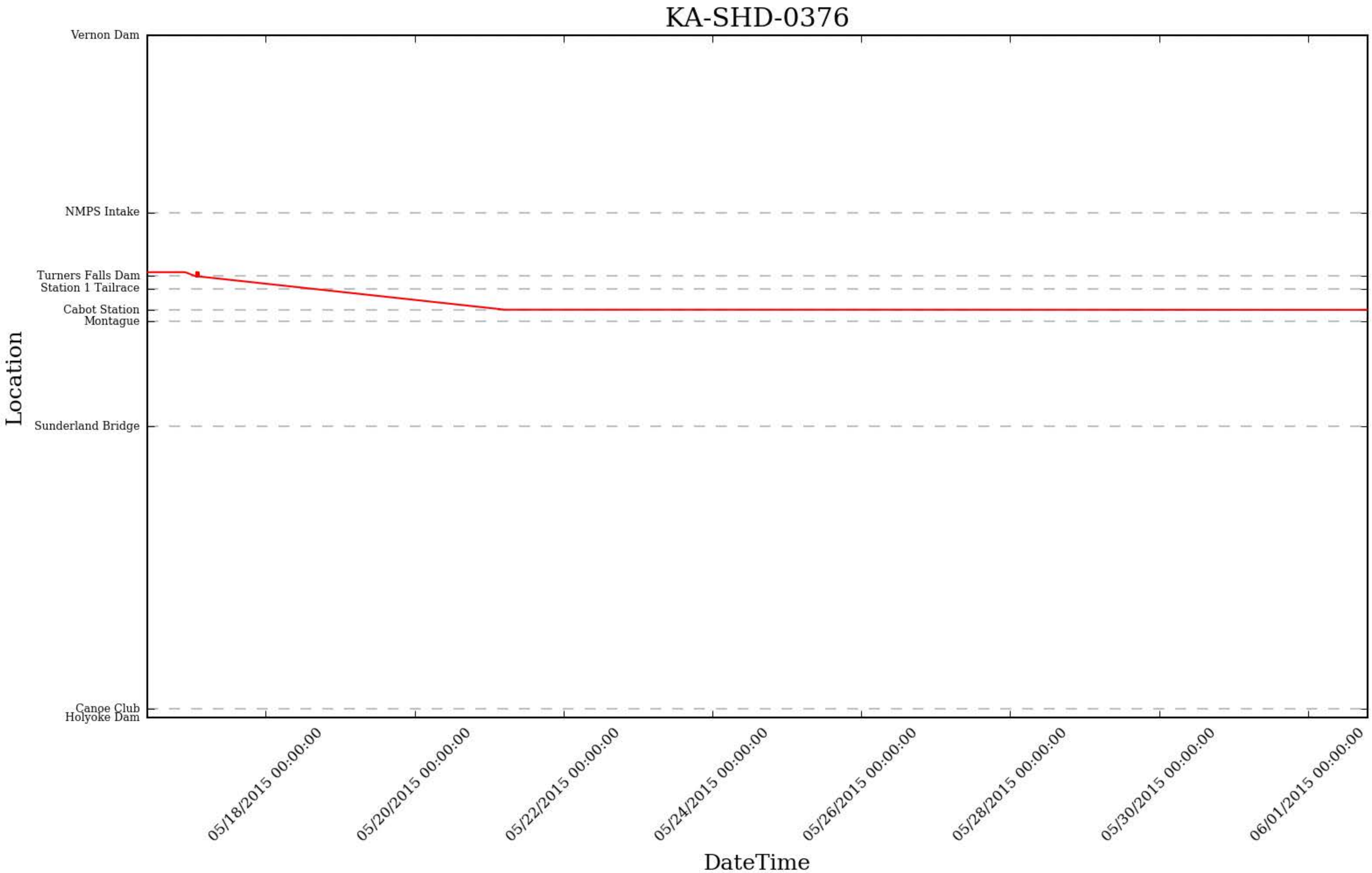


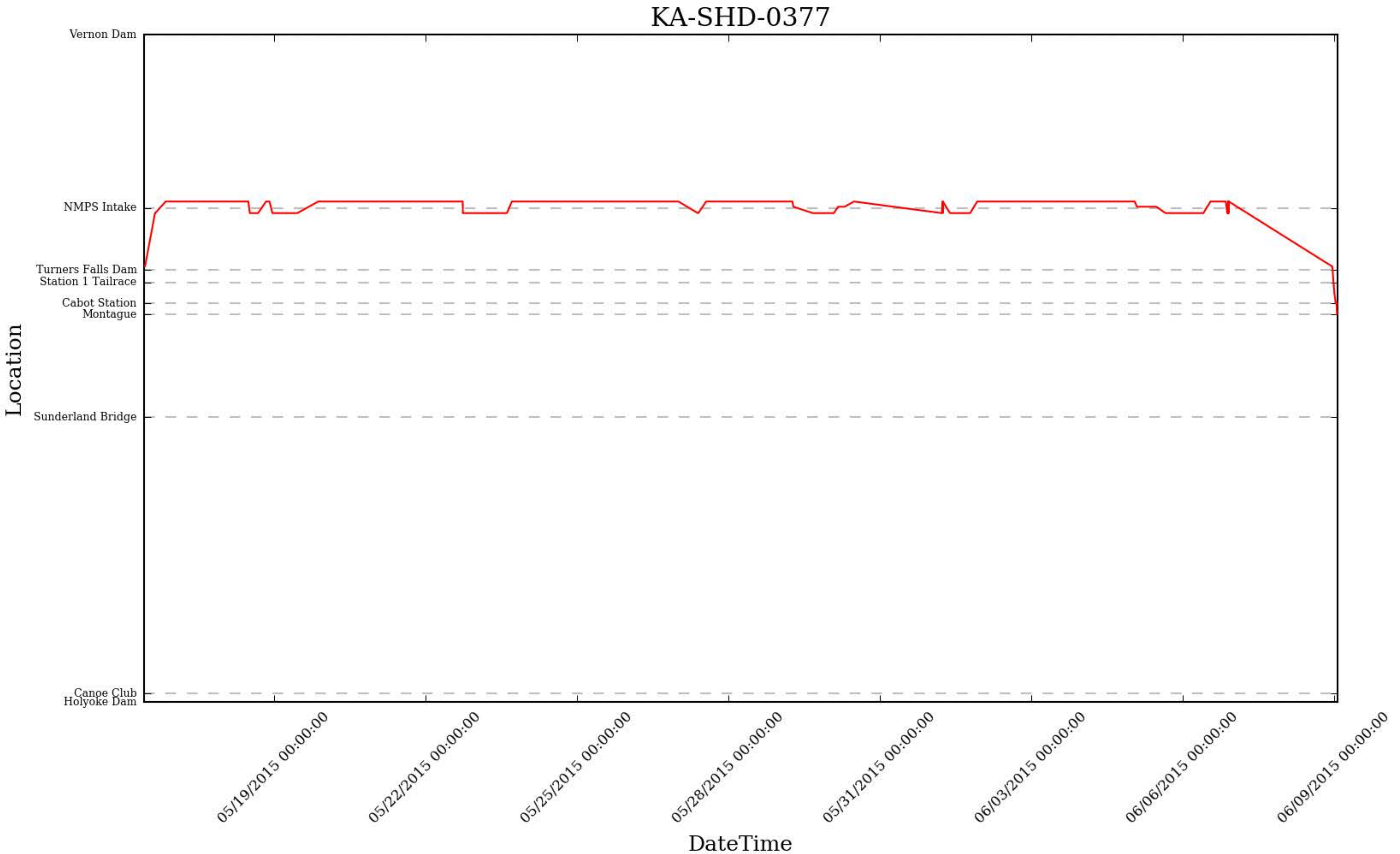
KA-SHD-0373
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
07/10/2015 00:00:00
DateTime

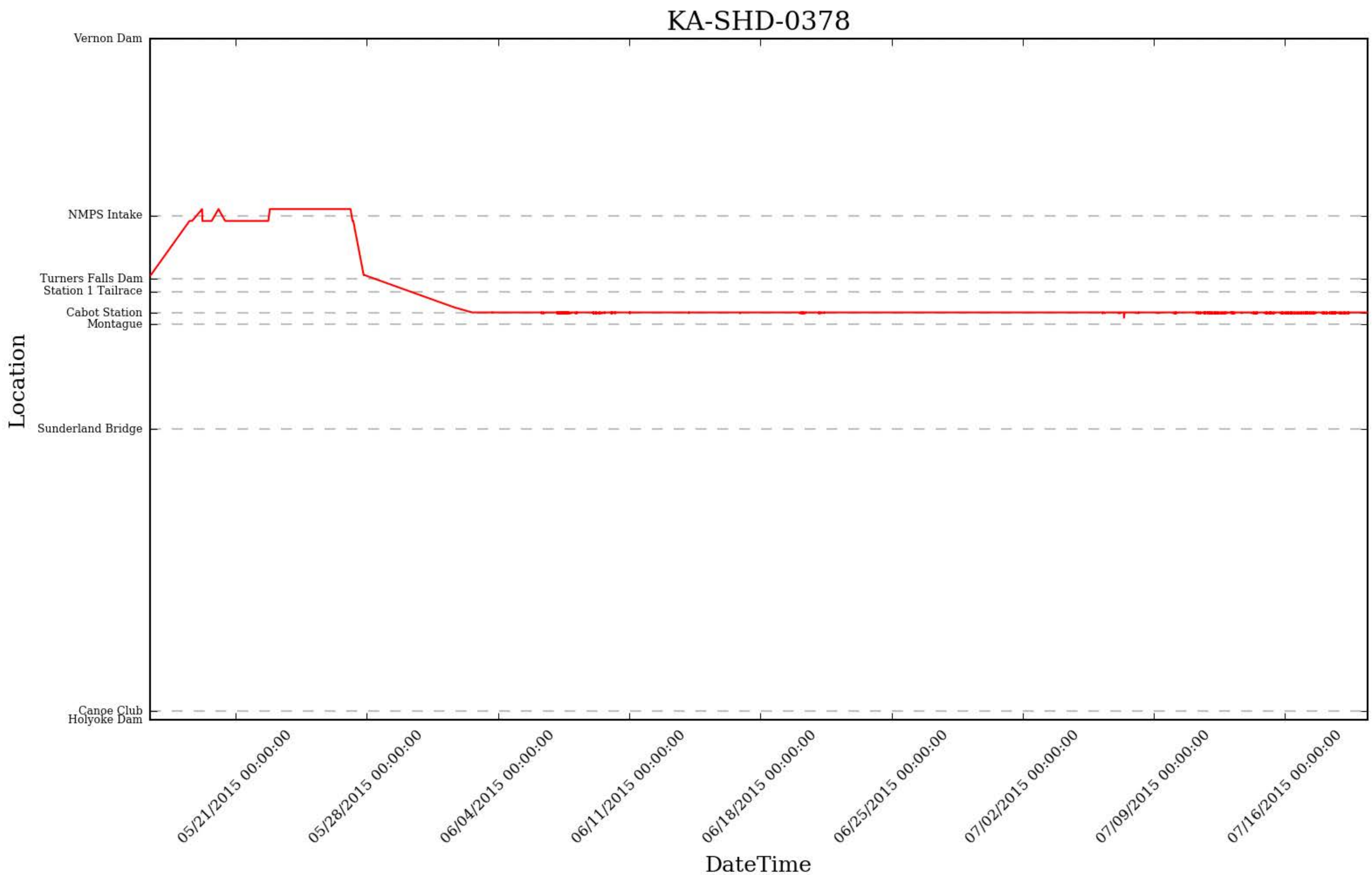

KA-SHD-0374
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/19/2015 00:00:00
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
DateTime



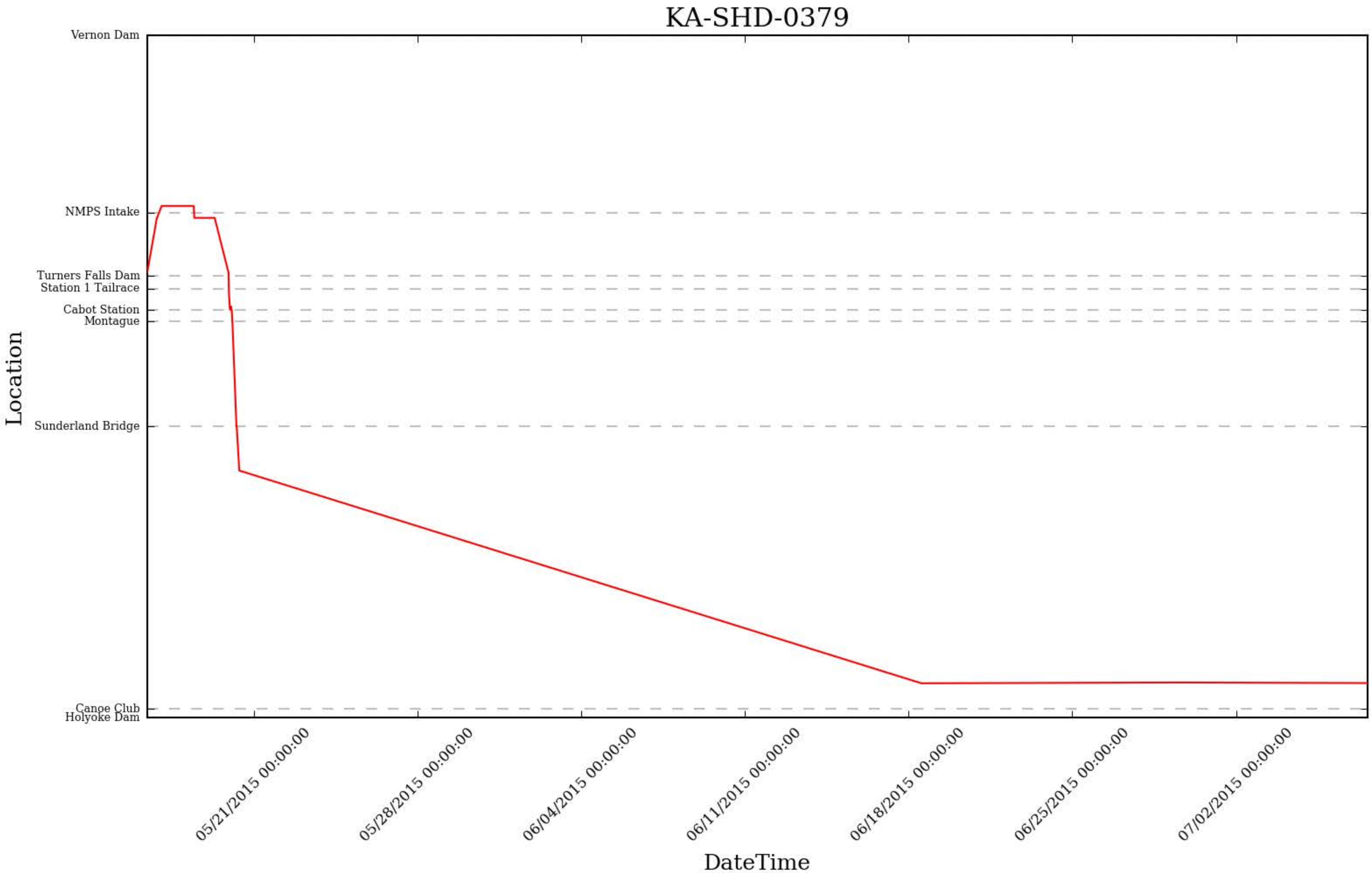
KA-SHD-0375
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime

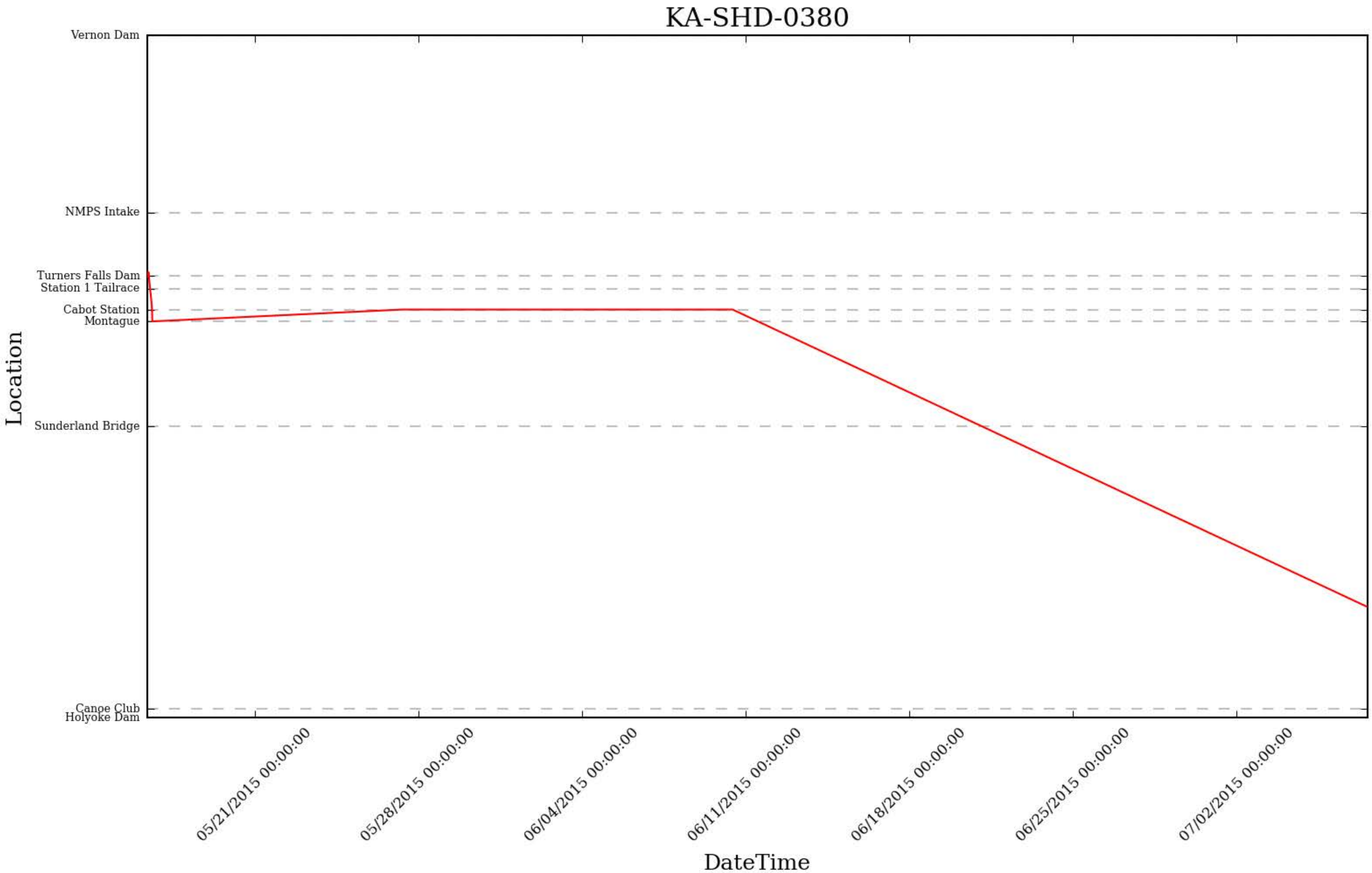

KA-SHD-0376
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
DateTime

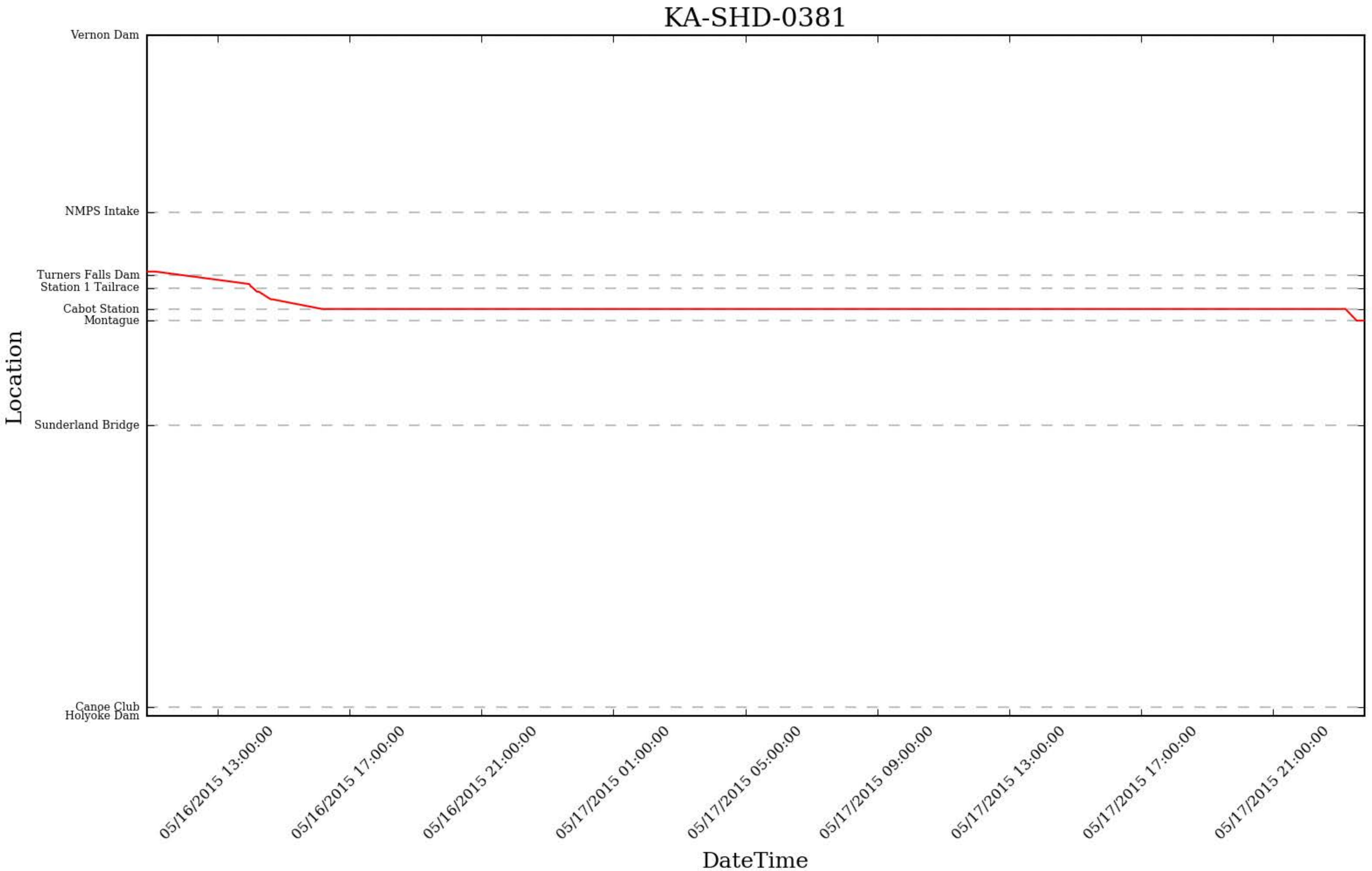

KA-SHD-0377
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 00:00:00
05/22/2015 00:00:00
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
DateTime

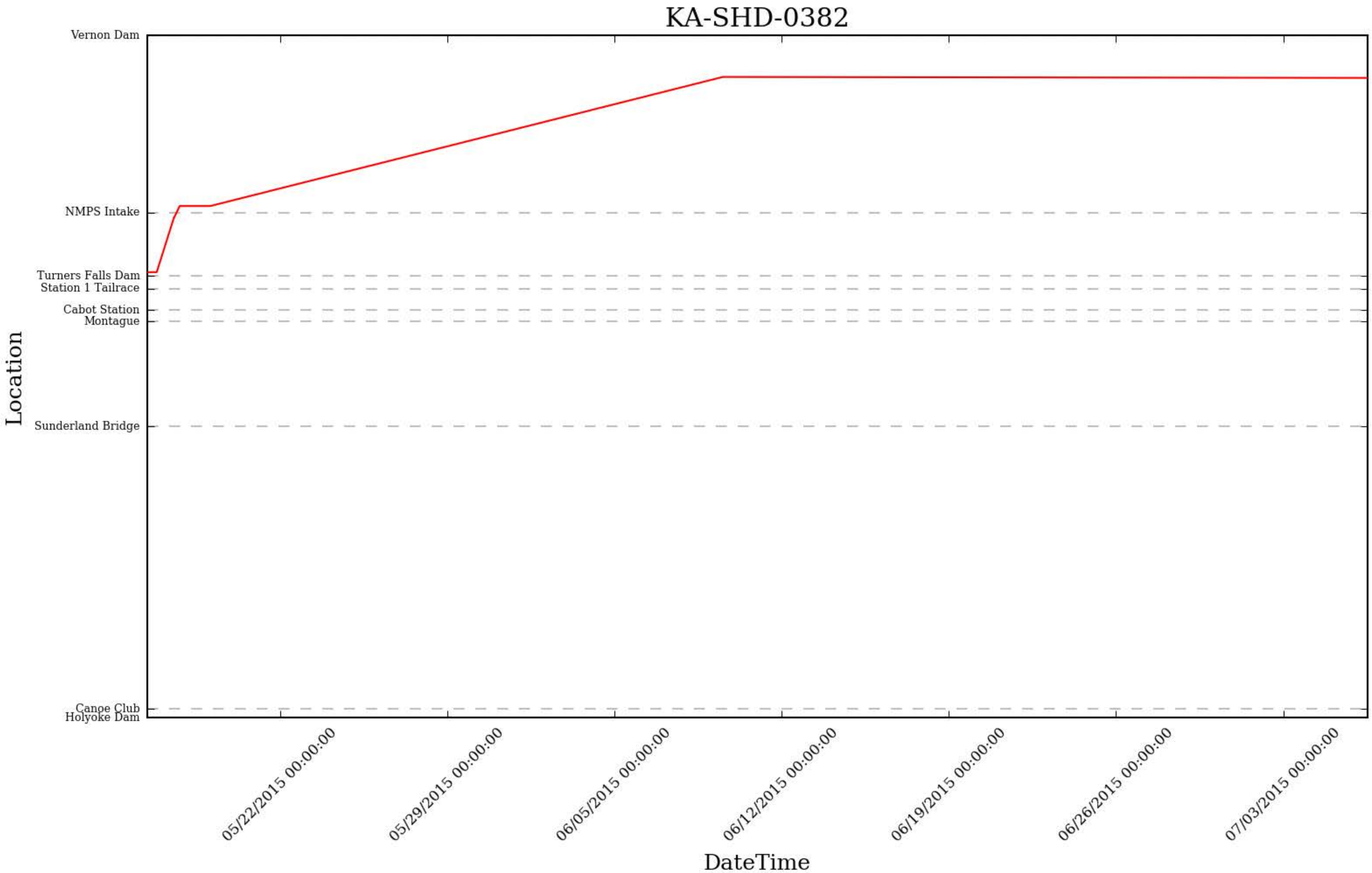


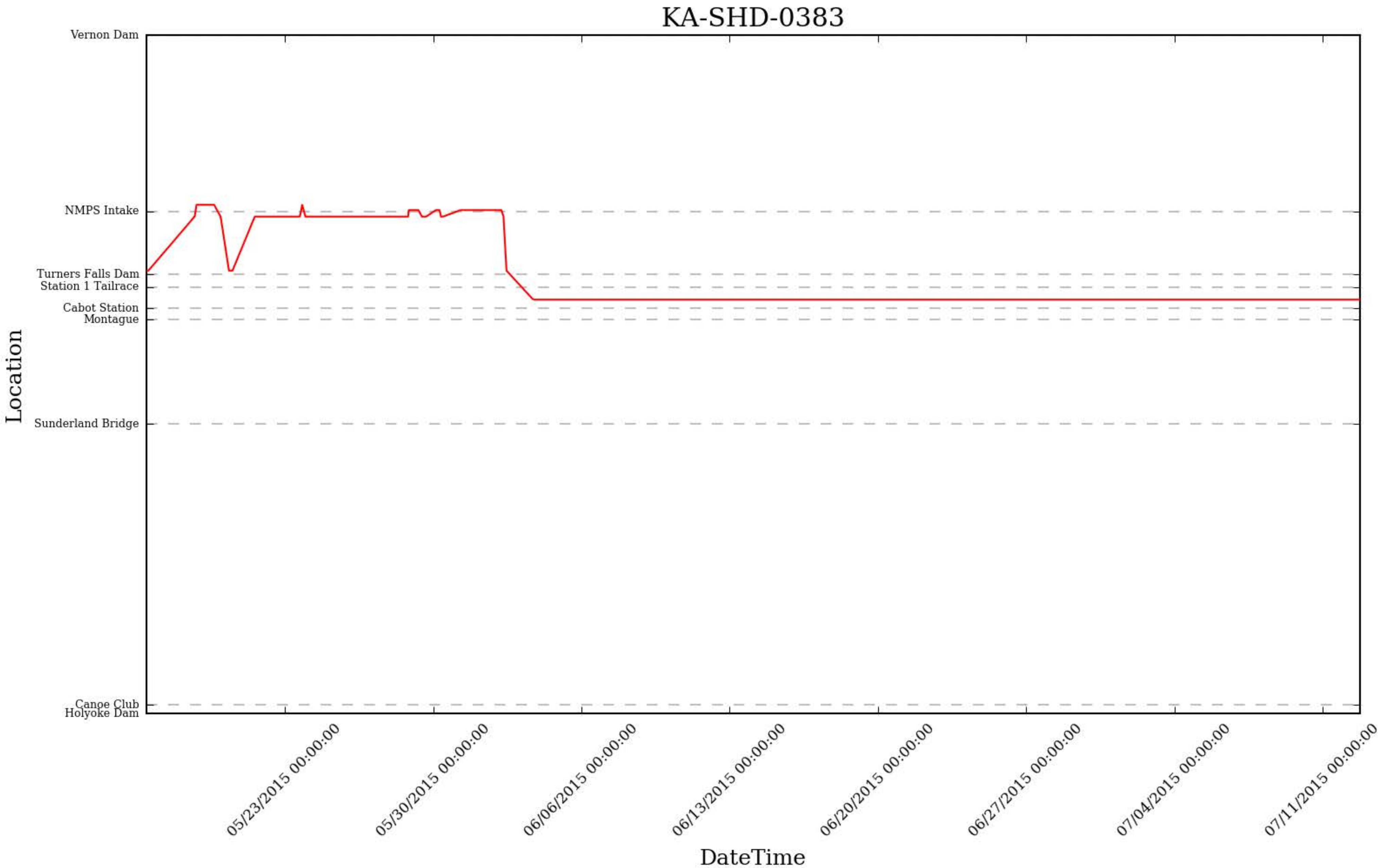
KA-SHD-0378
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
07/09/2015 00:00:00
07/16/2015 00:00:00
DateTime


KA-SHD-0379
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

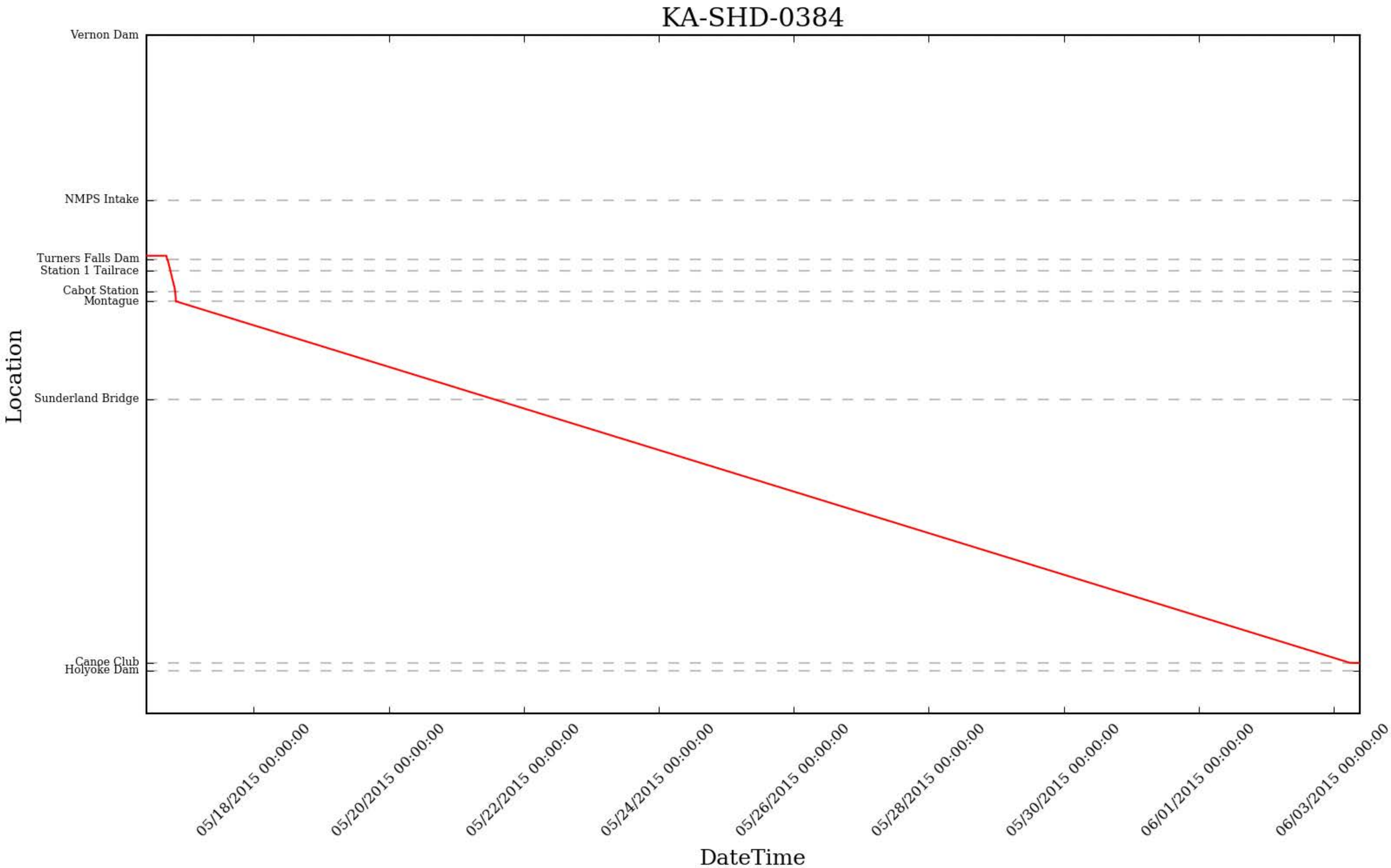

KA-SHD-0380
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

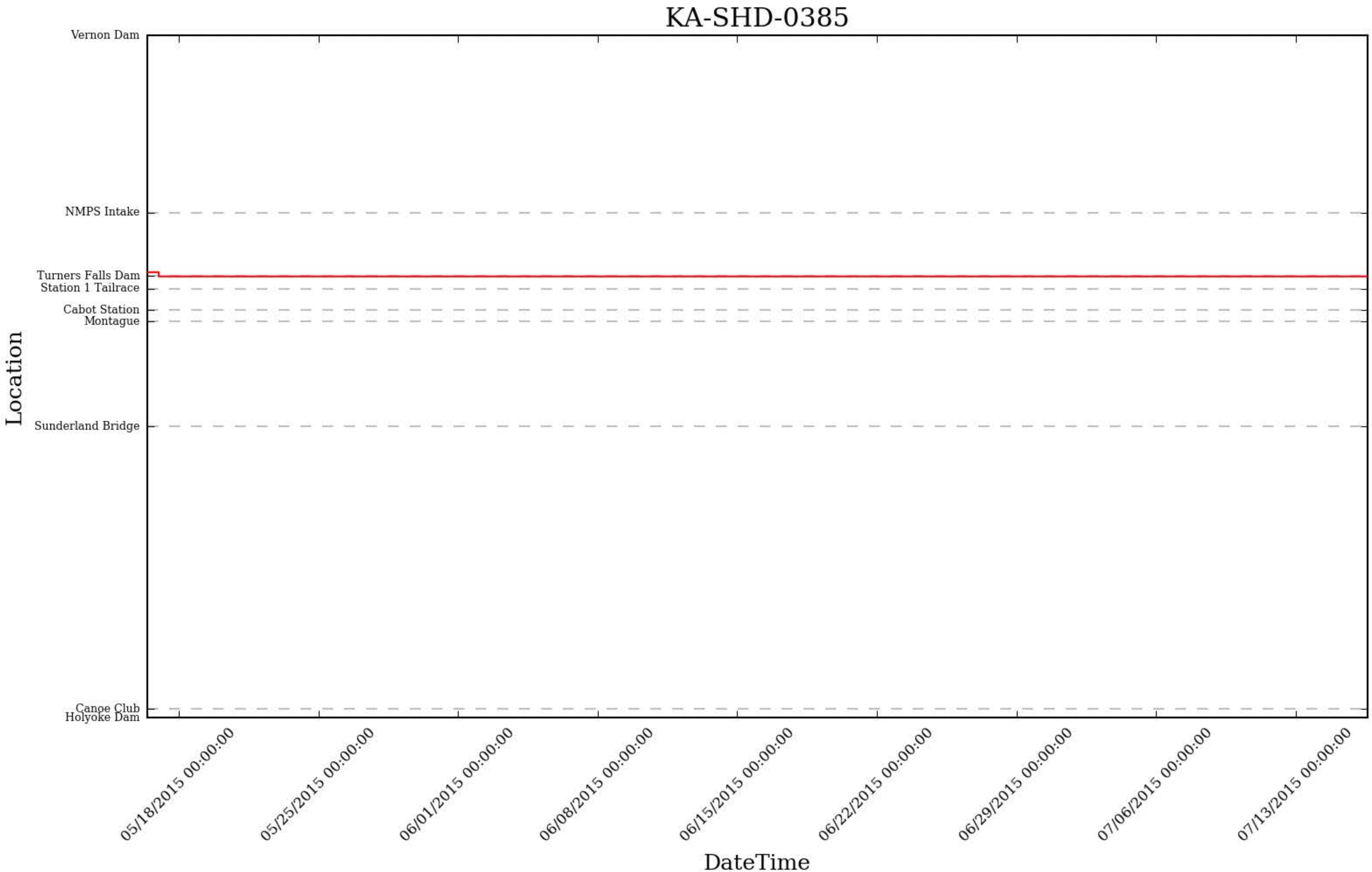

KA-SHD-0381
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 13:00:00
05/16/2015 17:00:00
05/16/2015 21:00:00
05/17/2015 01:00:00
05/17/2015 05:00:00
05/17/2015 09:00:00
05/17/2015 13:00:00
05/17/2015 17:00:00
05/17/2015 21:00:00
DateTime

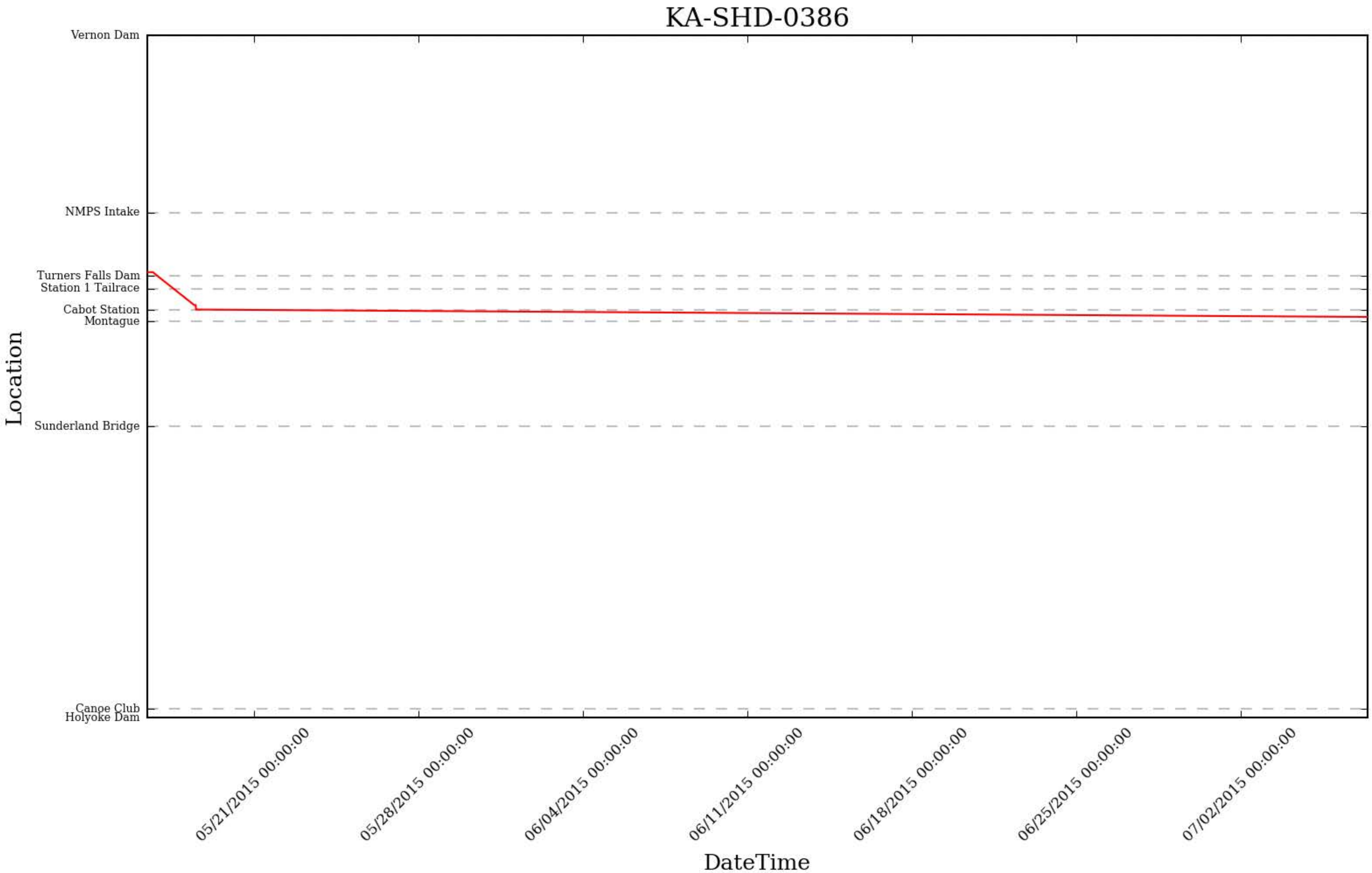

KA-SHD-0382
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 00:00:00
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime



KA-SHD-0383
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
07/11/2015 00:00:00
DateTime

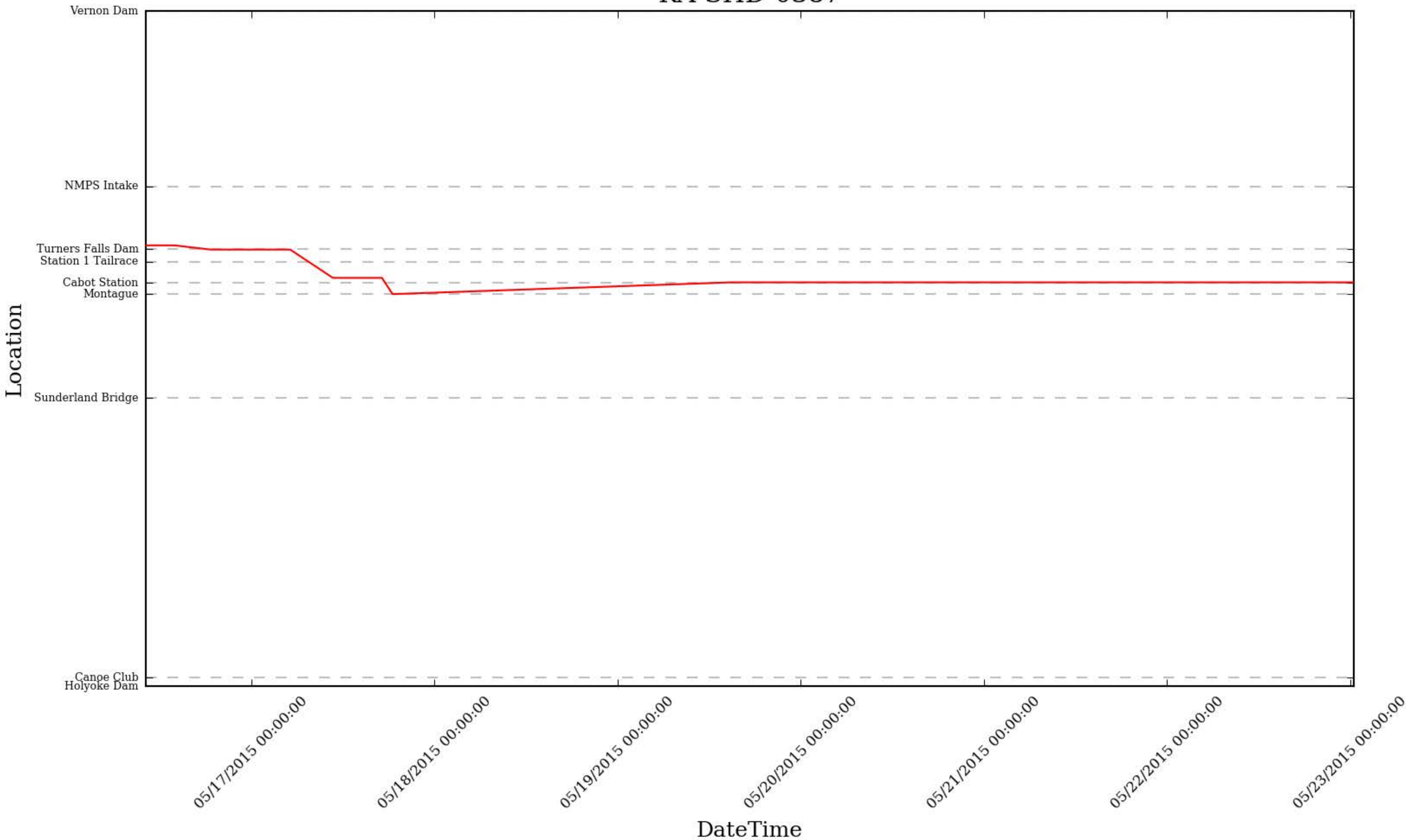

KA-SHD-0384
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
DateTime


KA-SHD-0385
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/18/2015 00:00:00
05/25/2015 00:00:00
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
06/29/2015 00:00:00
07/06/2015 00:00:00
07/13/2015 00:00:00
DateTime



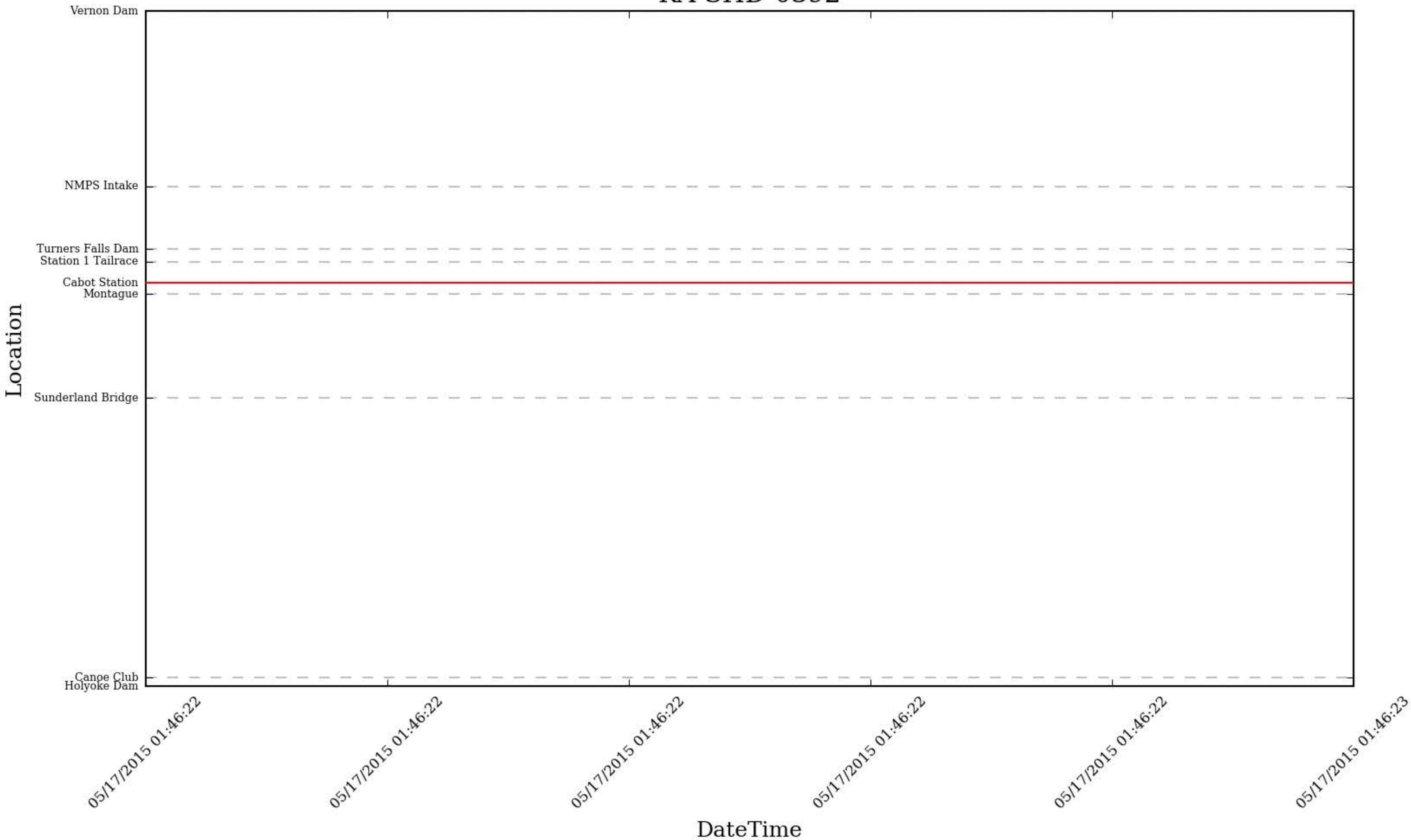
KA-SHD-0386
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

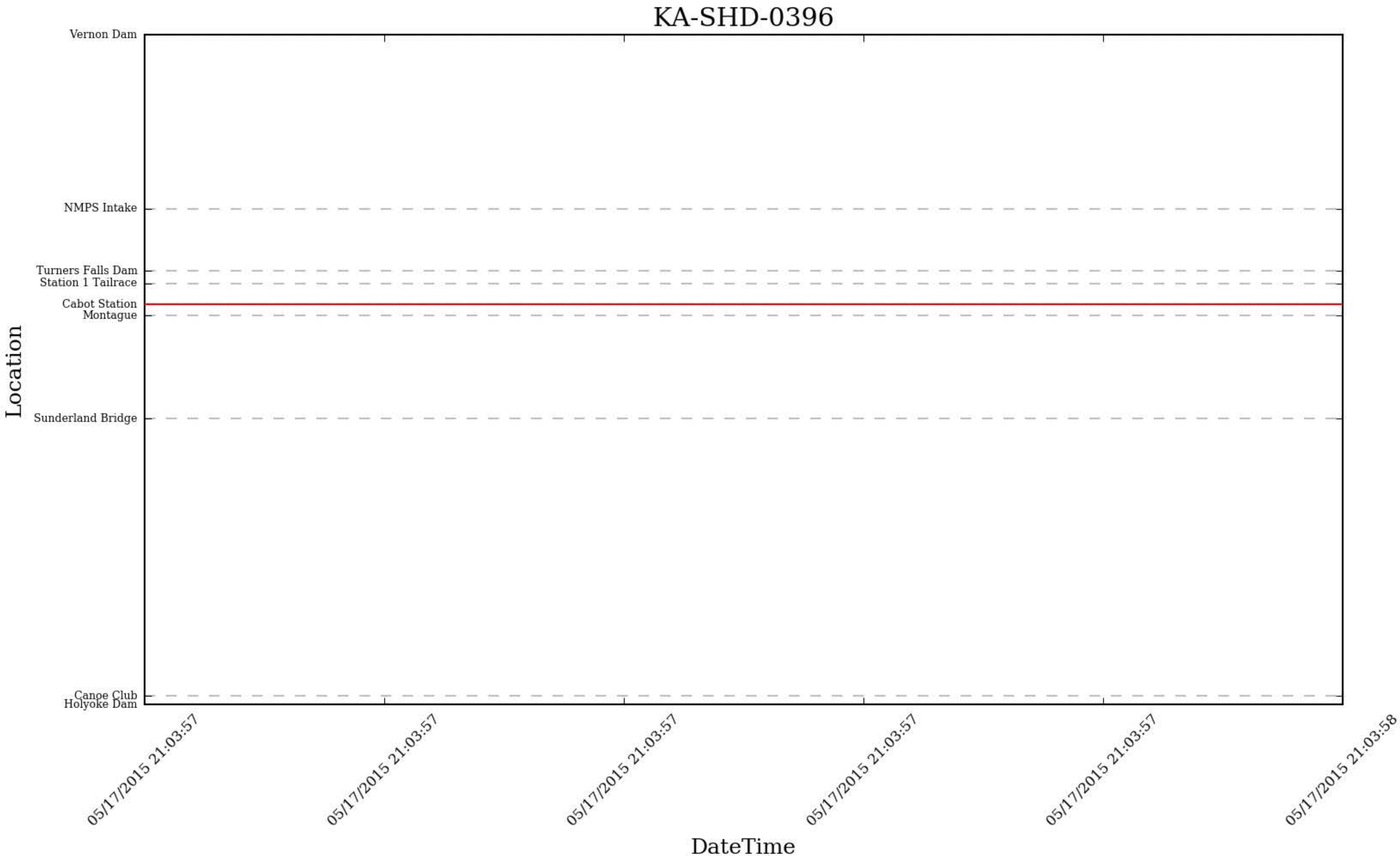
KA-SHD-0387



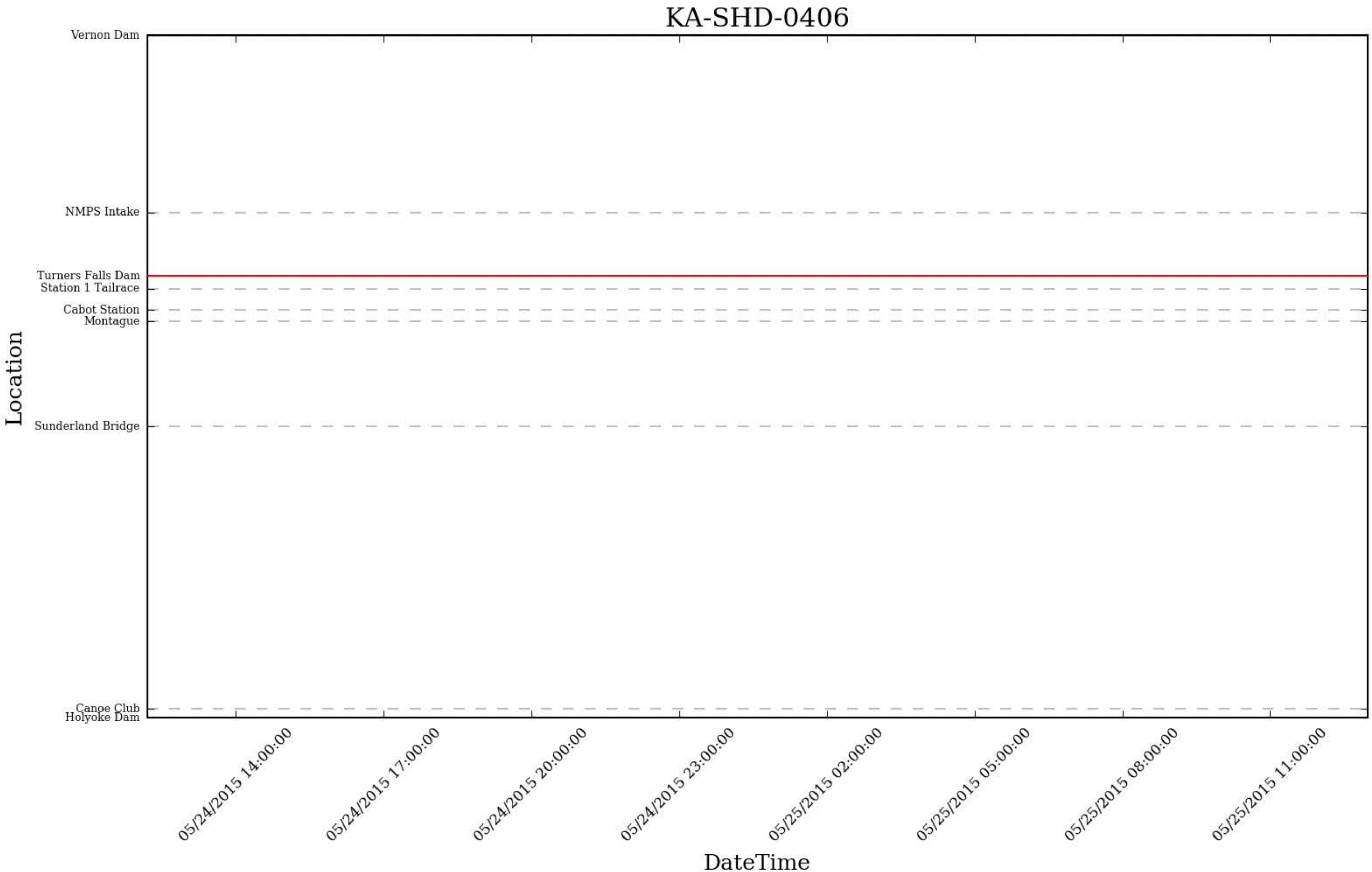
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 00:00:00
05/18/2015 00:00:00
05/19/2015 00:00:00
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
DateTime

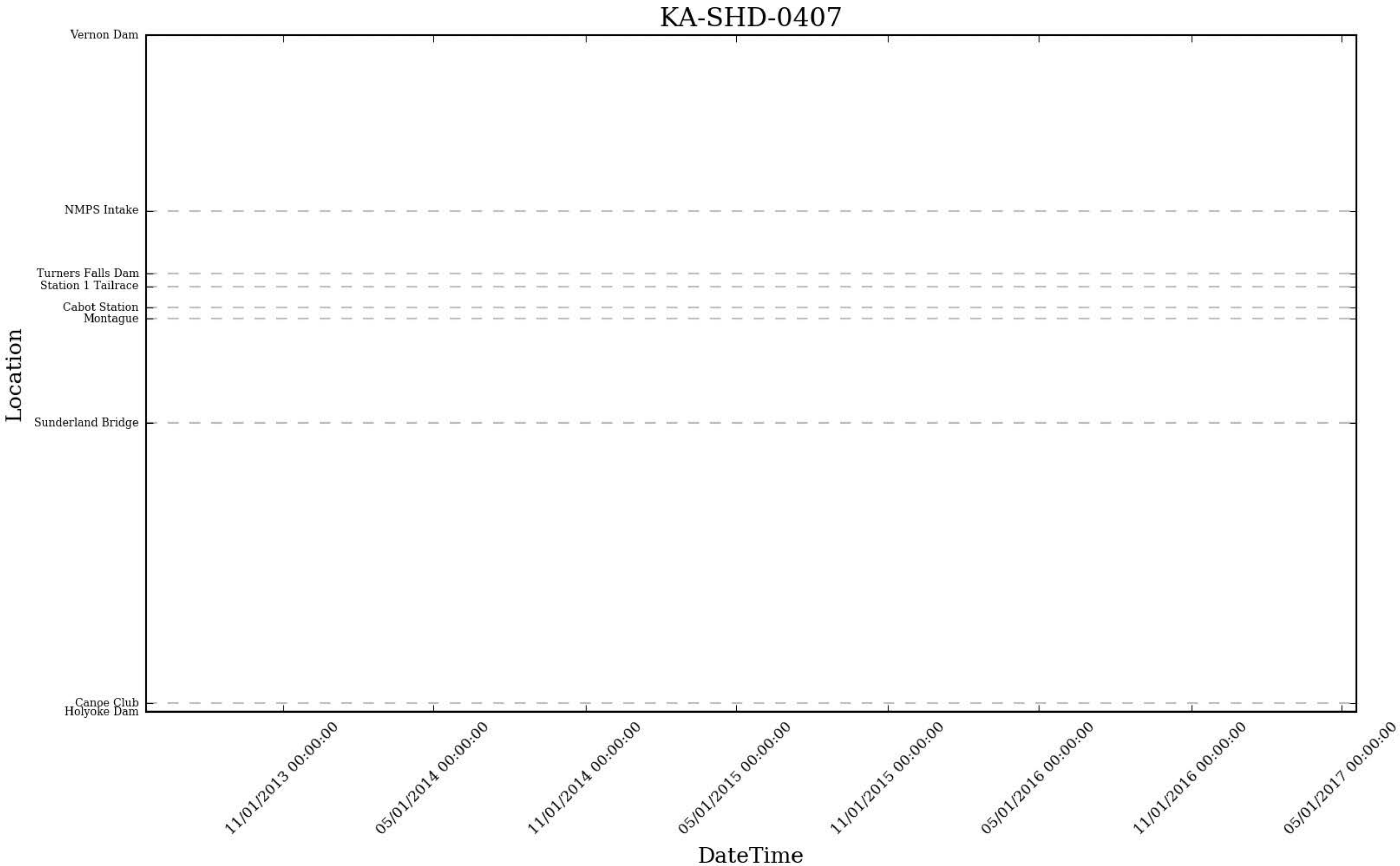
KA-SHD-0392


Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 01:46:22
05/17/2015 01:46:22
05/17/2015 01:46:22
05/17/2015 01:46:22
05/17/2015 01:46:22
05/17/2015 01:46:23
DateTime

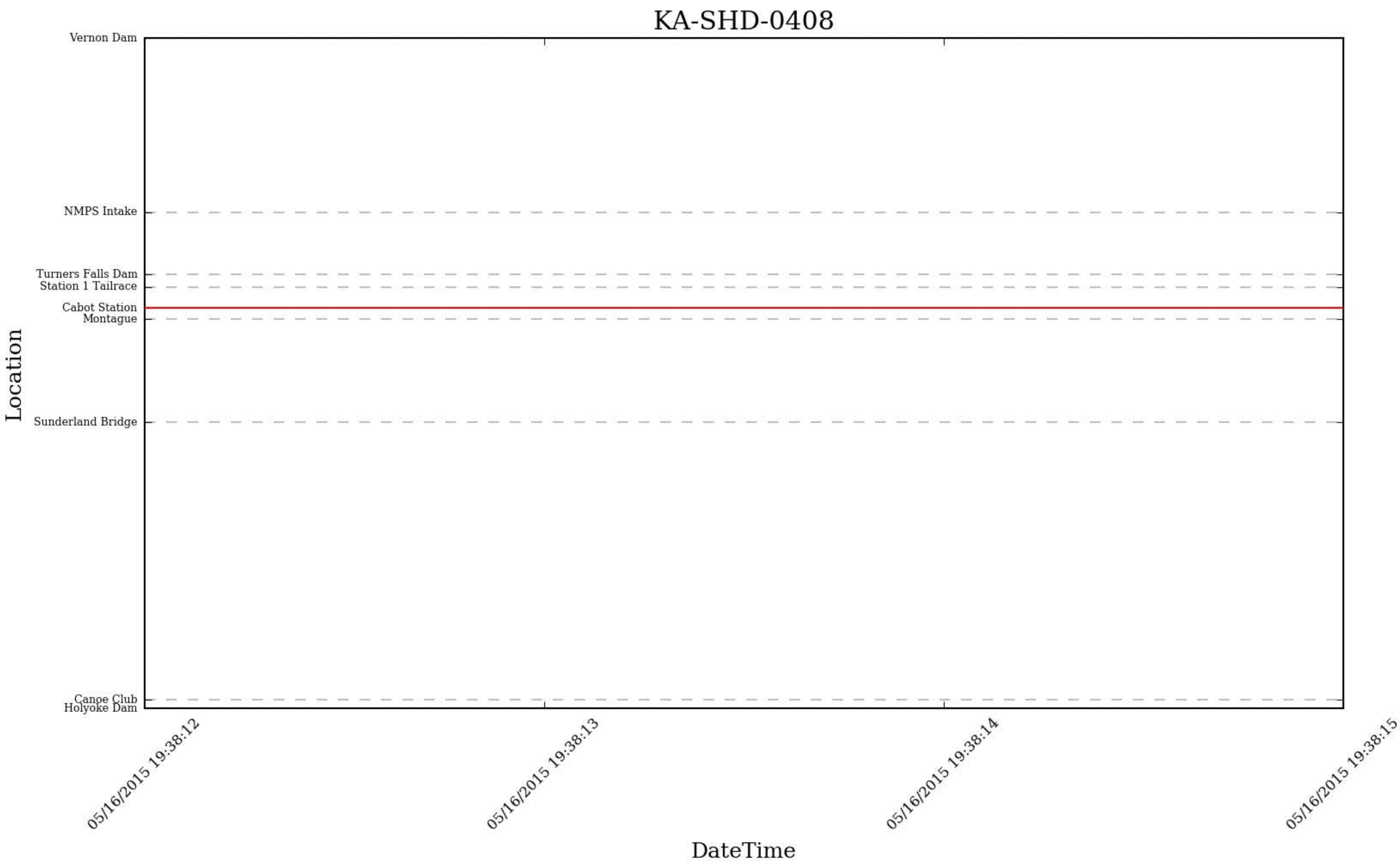


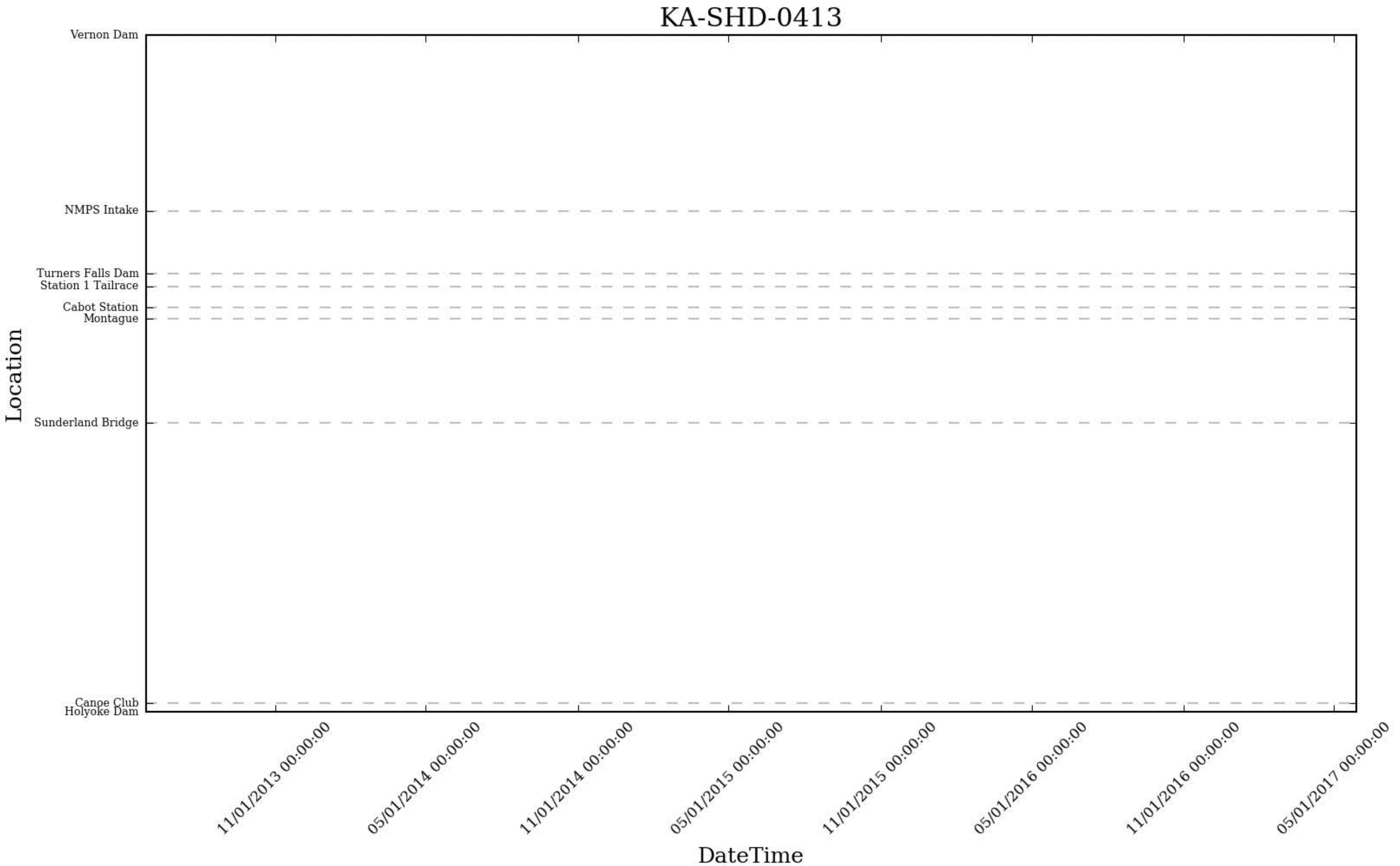
KA-SHD-0396
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/17/2015 21:03:57
05/17/2015 21:03:57
05/17/2015 21:03:57
05/17/2015 21:03:57
05/17/2015 21:03:57
05/17/2015 21:03:58
DateTime

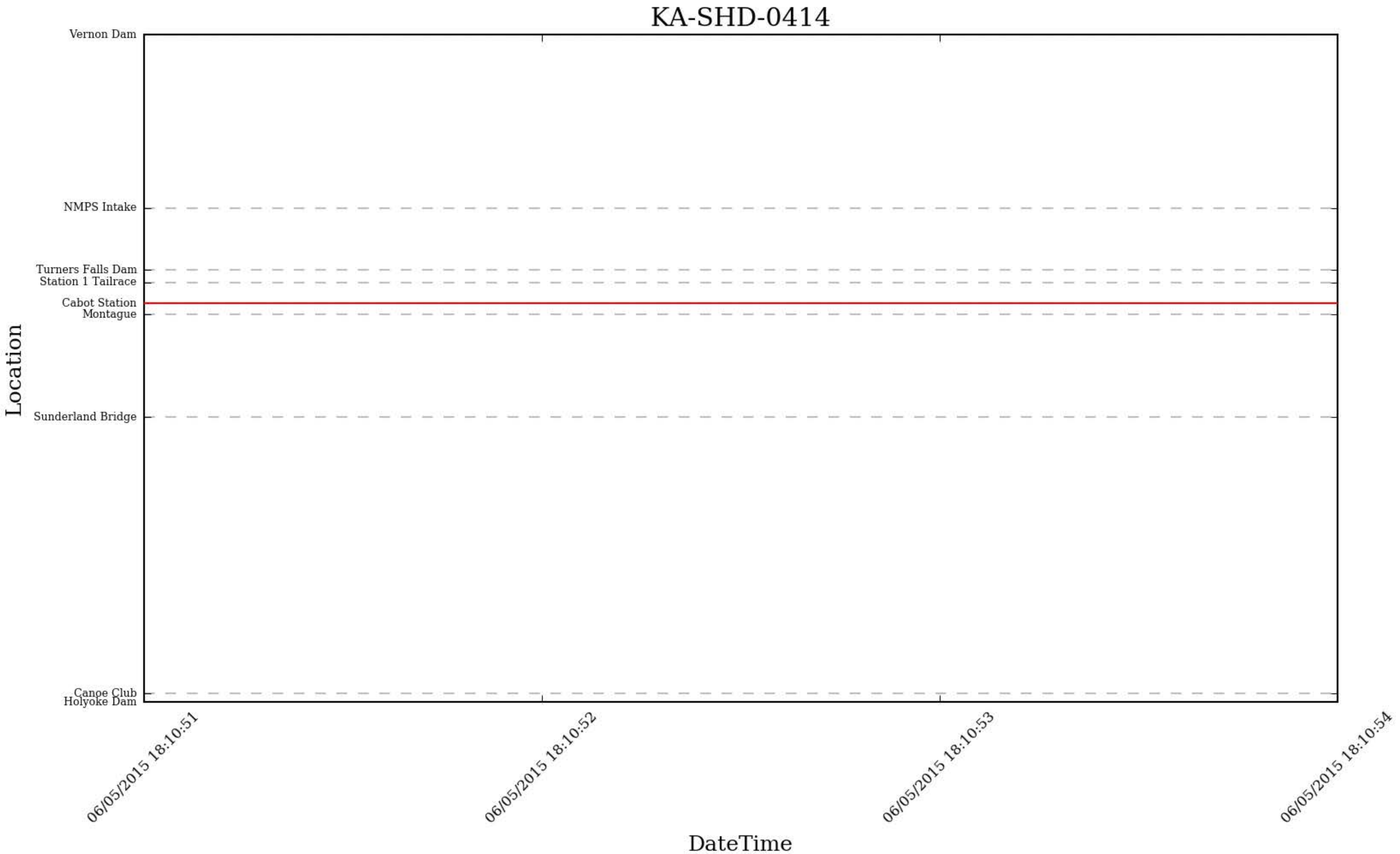

KA-SHD-0406
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 14:00:00
05/24/2015 17:00:00
05/24/2015 20:00:00
05/24/2015 23:00:00
05/25/2015 02:00:00
05/25/2015 05:00:00
05/25/2015 08:00:00
05/25/2015 11:00:00
DateTime

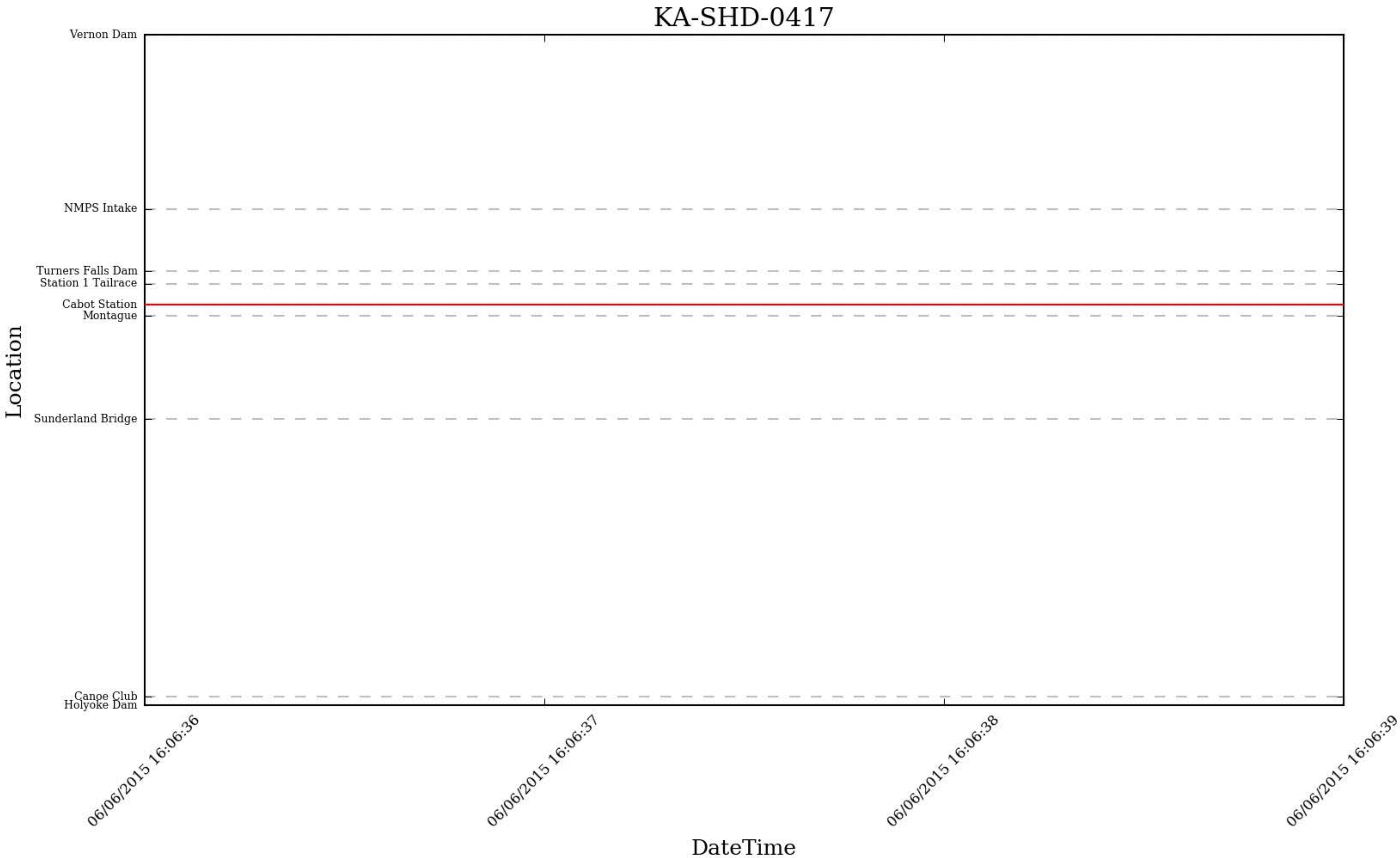


KA-SHD-0407
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0408
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/16/2015 19:38:12
05/16/2015 19:38:13
05/16/2015 19:38:14
05/16/2015 19:38:15
DateTime


KA-SHD-0413
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0414
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/05/2015 18:10:51
06/05/2015 18:10:52
06/05/2015 18:10:53
06/05/2015 18:10:54
DateTime



KA-SHD-0417
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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06/06/2015 16:06:37
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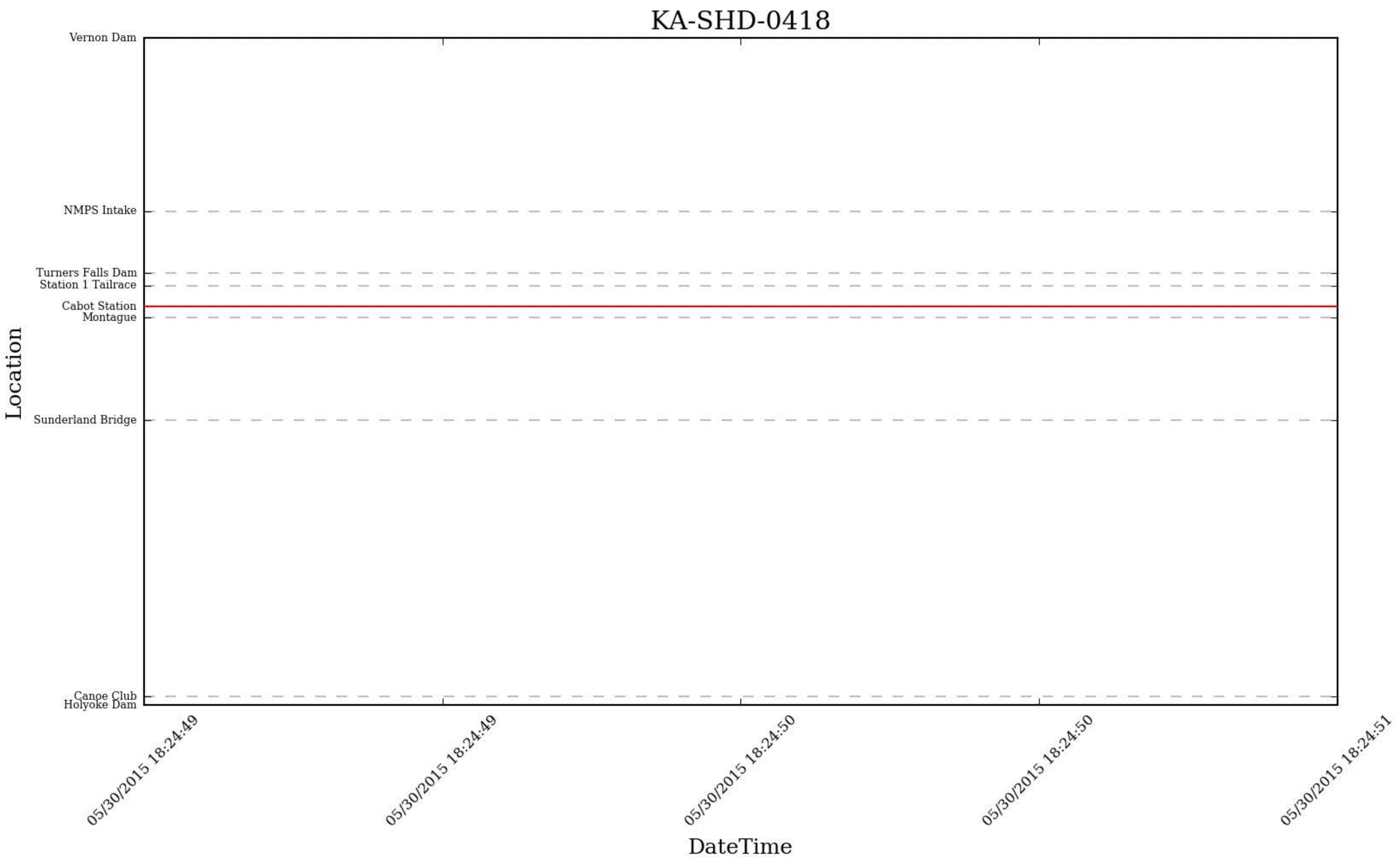
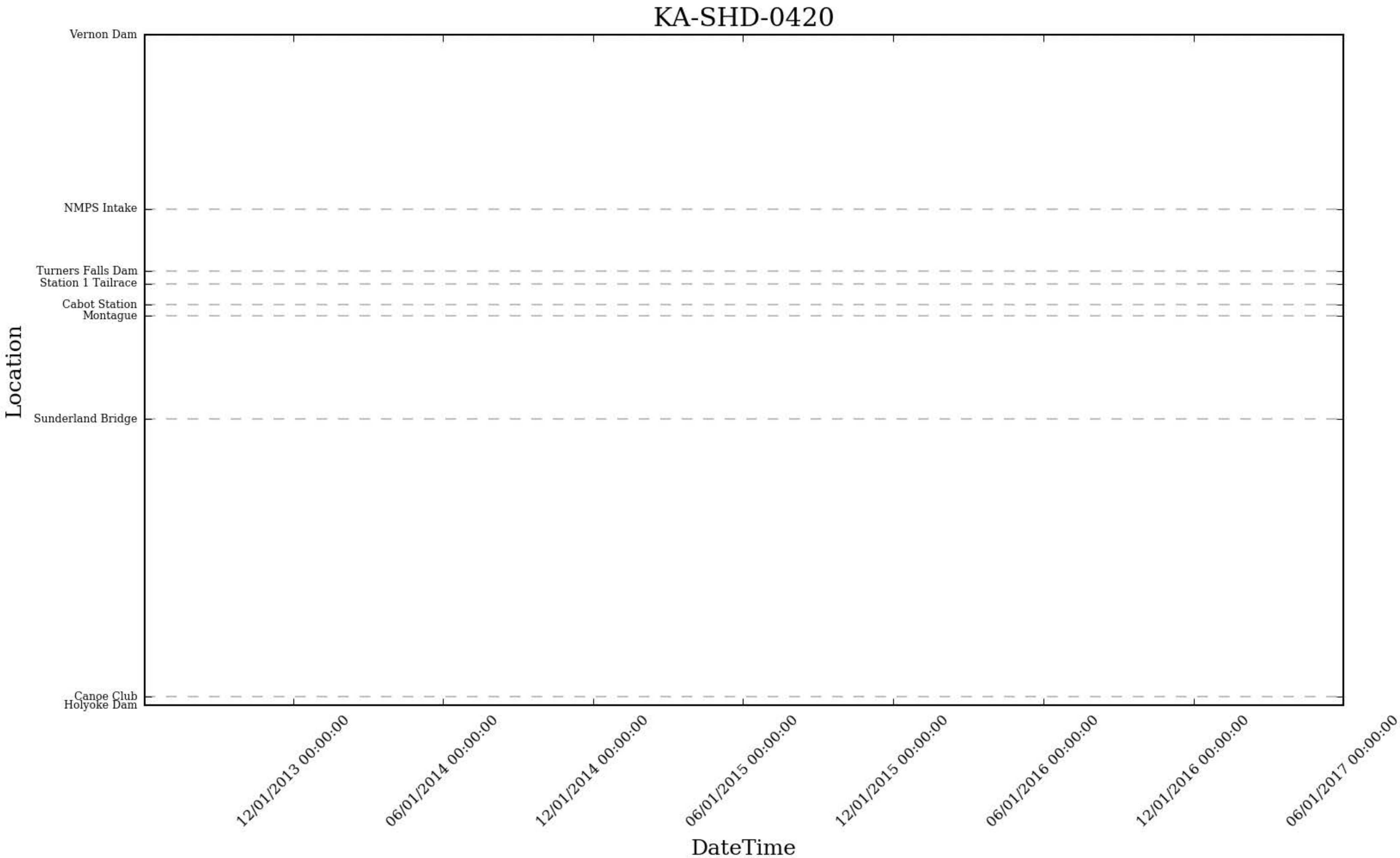
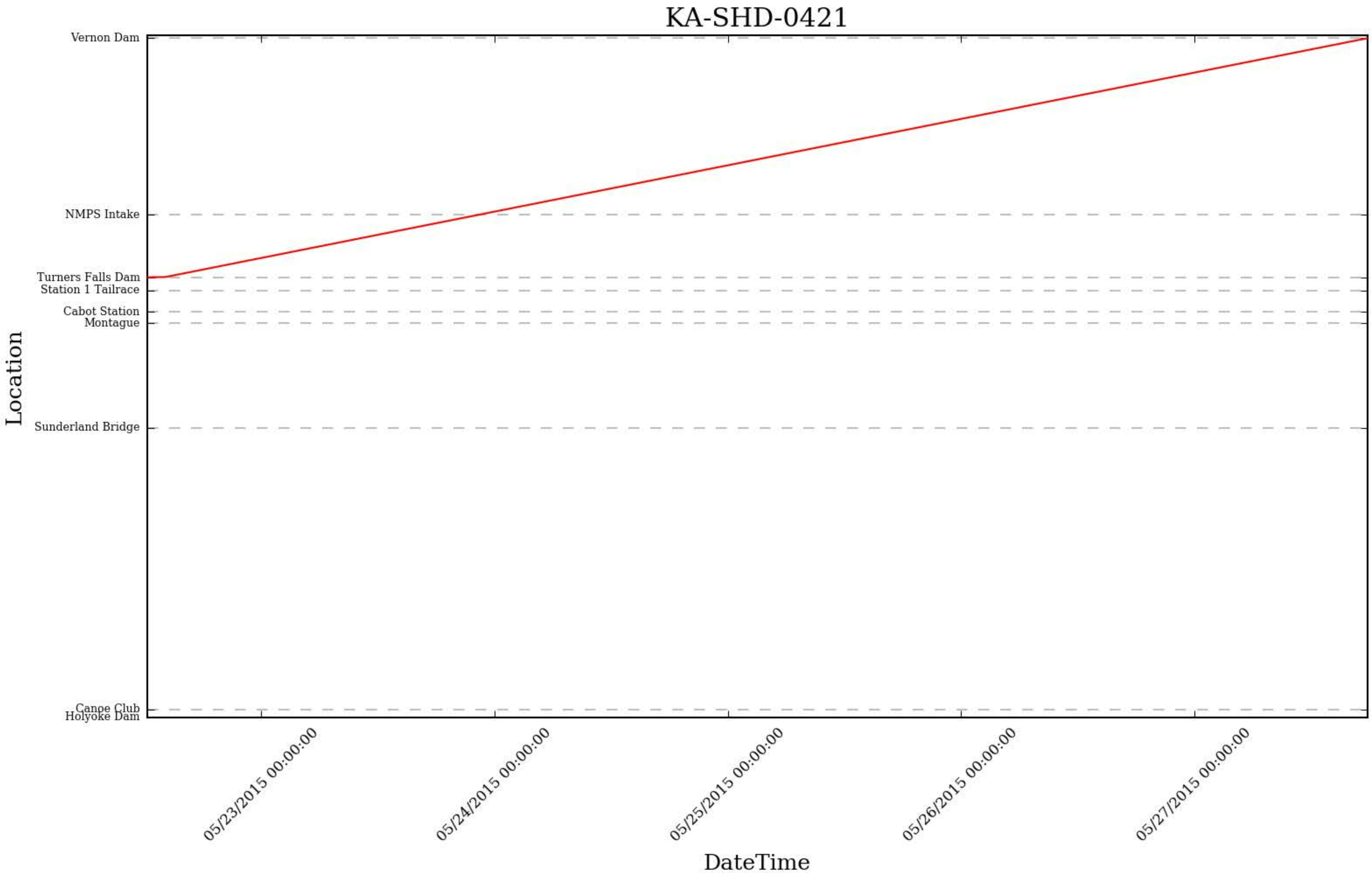
06/06/2015 16:06:39
DateTime

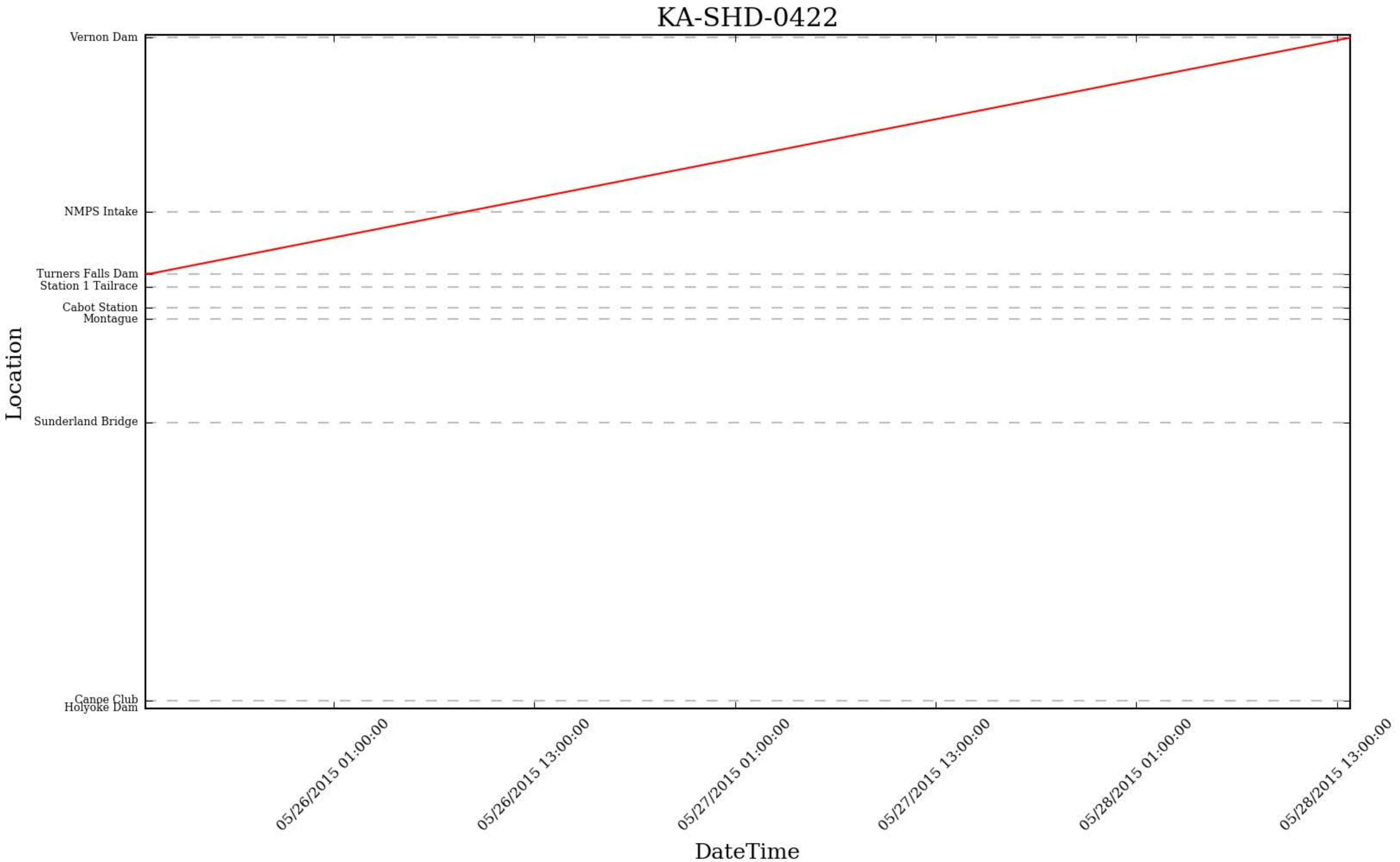

KA-SHD-0418
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 18:24:49
05/30/2015 18:24:49
05/30/2015 18:24:50
05/30/2015 18:24:50
05/30/2015 18:24:51
DateTime

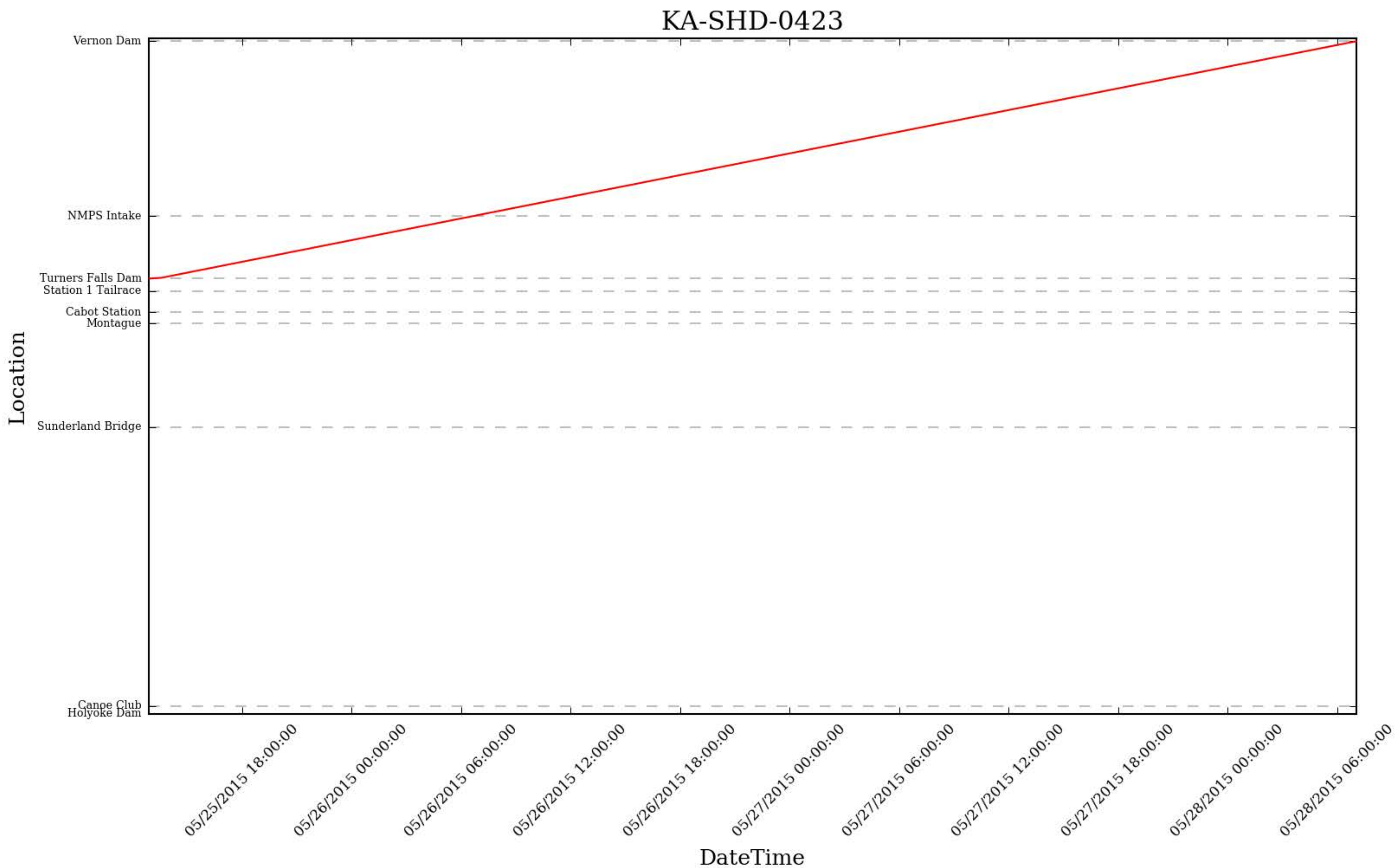


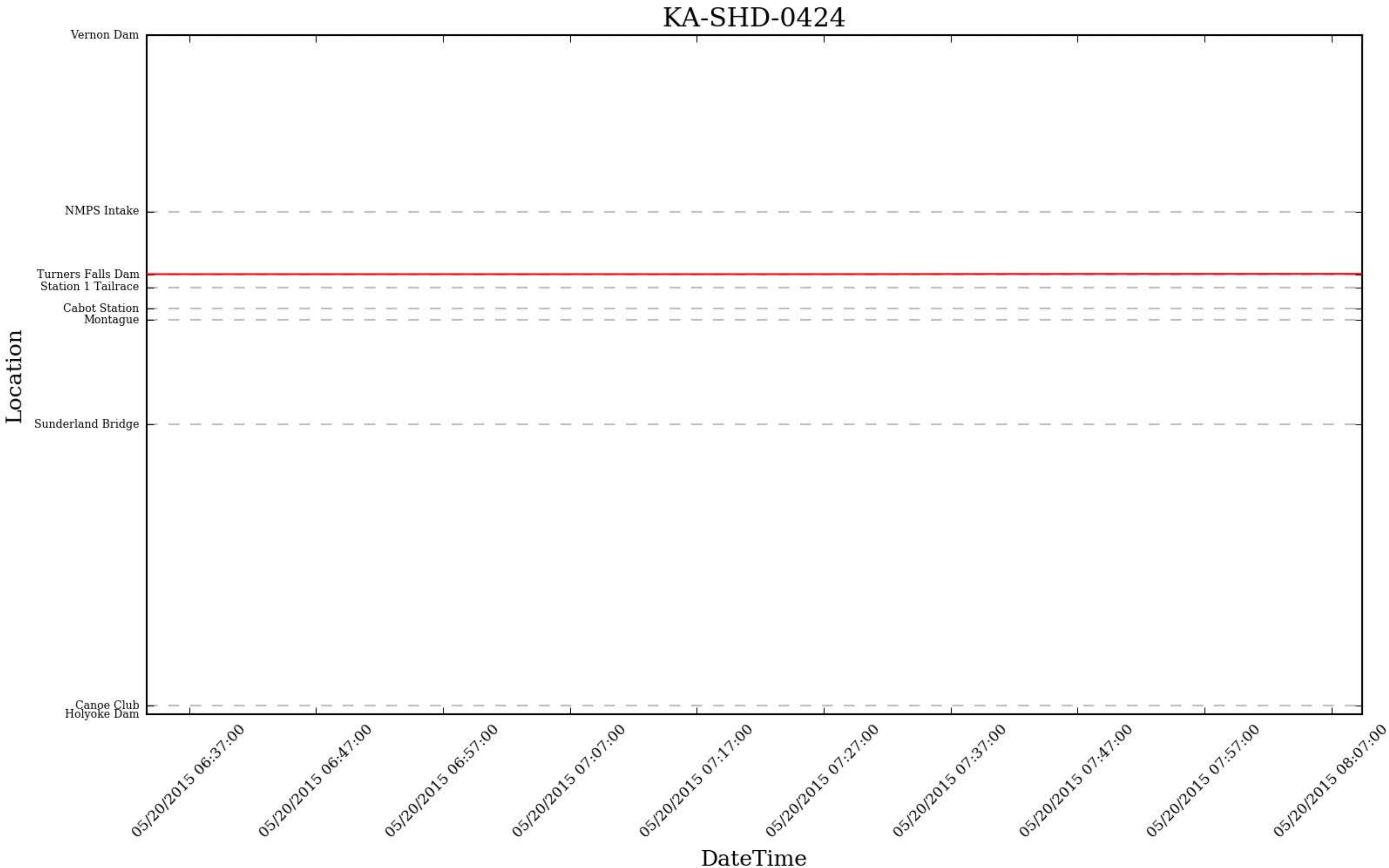
KA-SHD-0420
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime

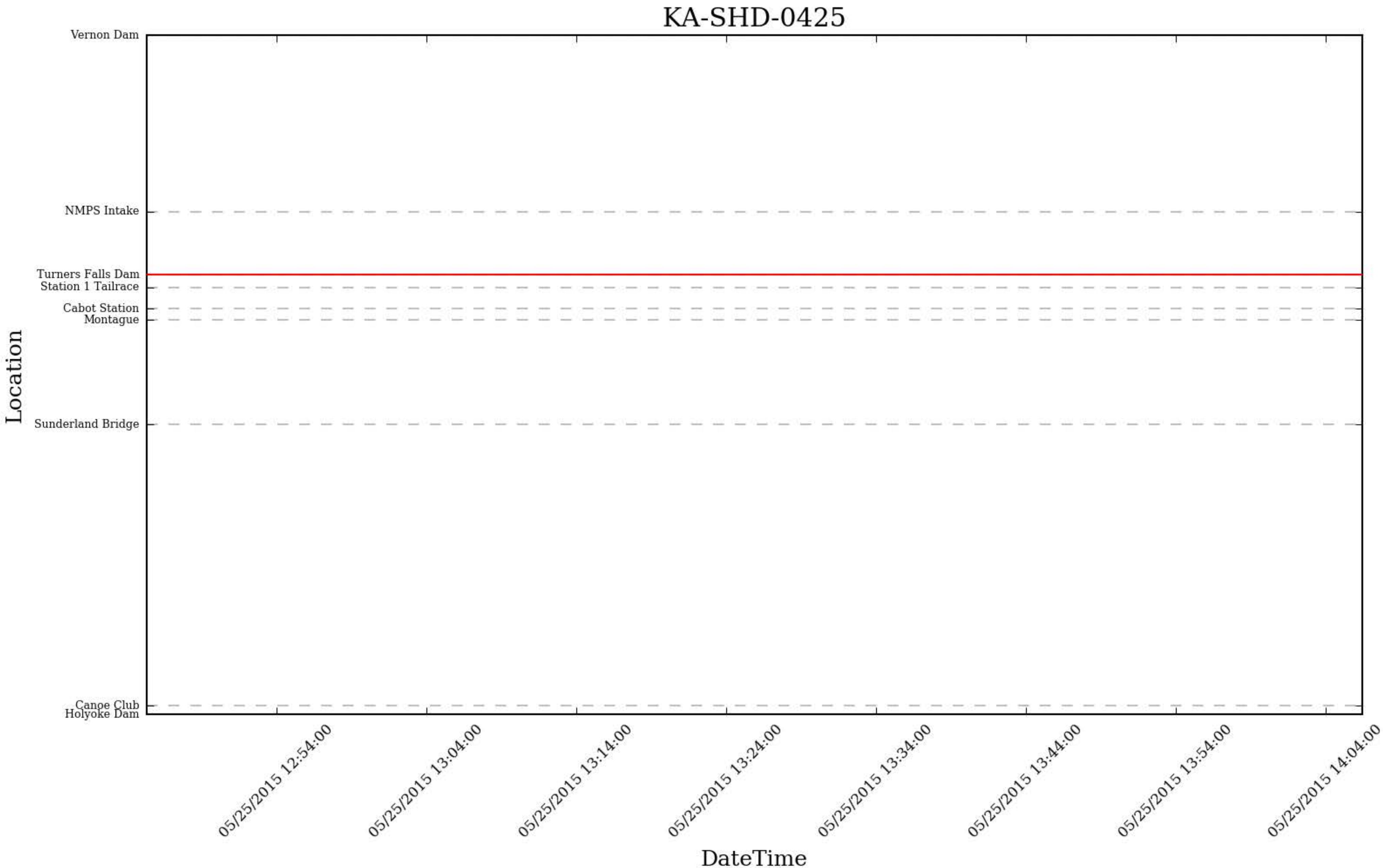


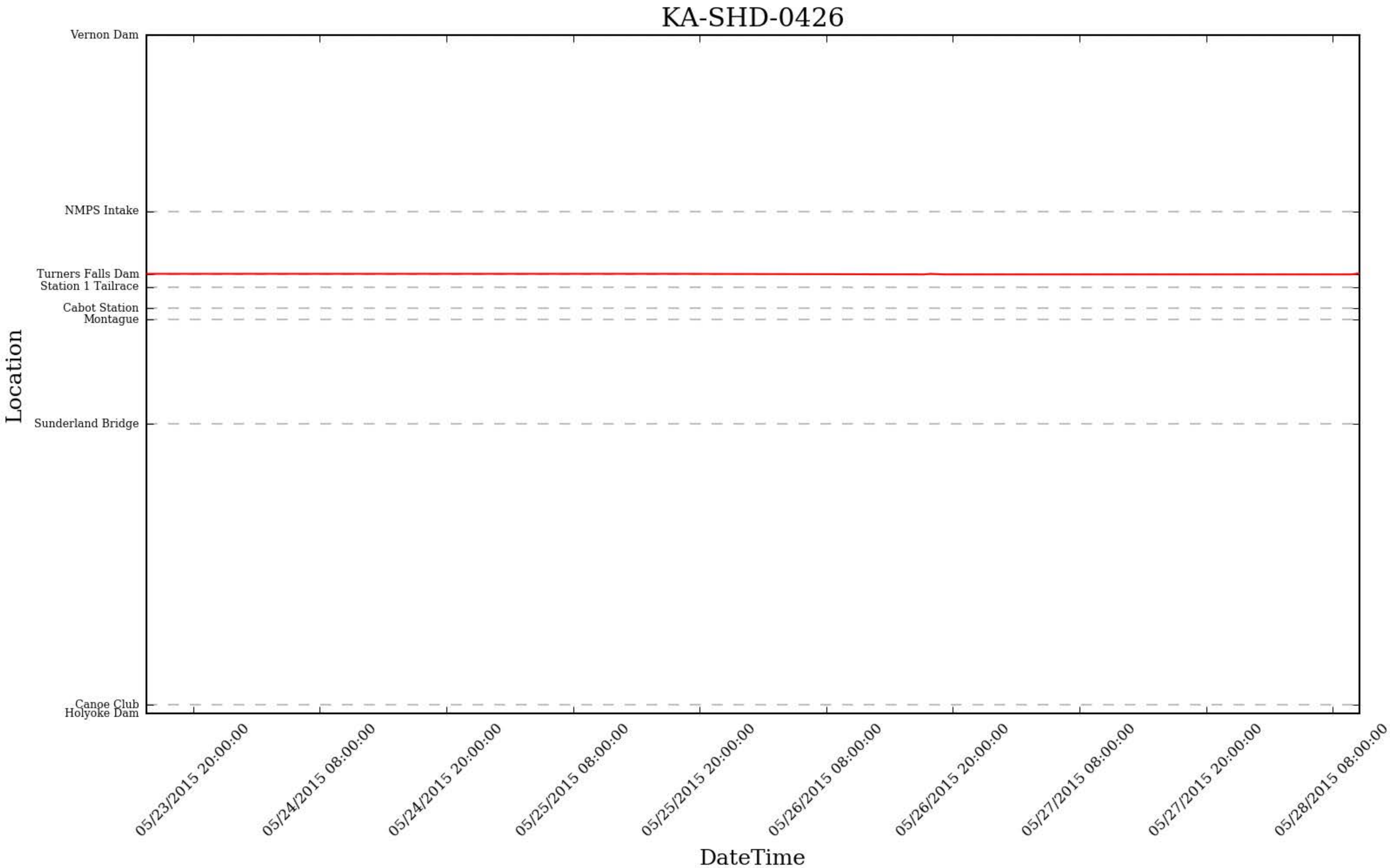
KA-SHD-0421
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
DateTime

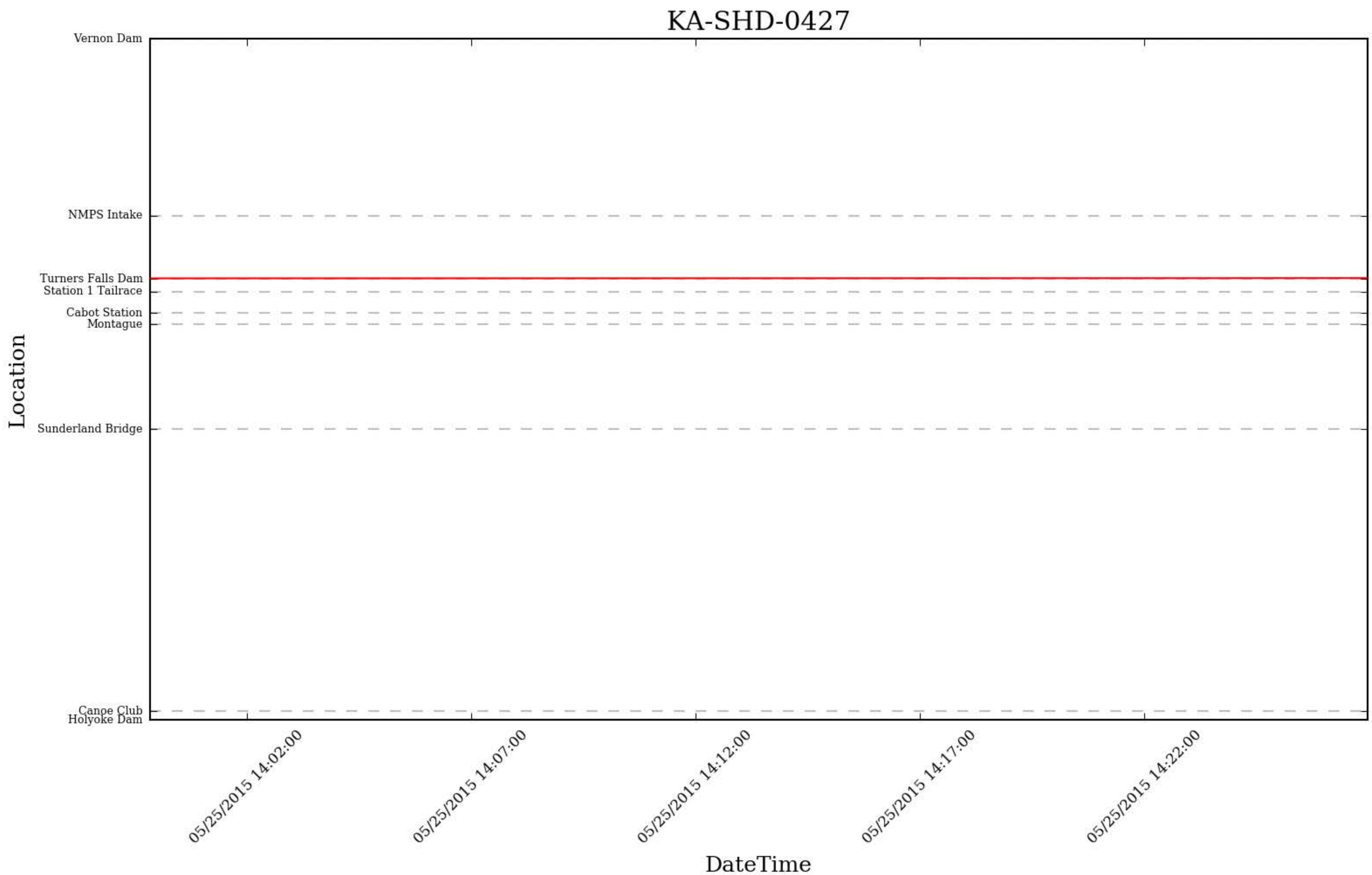

KA-SHD-0422
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 01:00:00
05/26/2015 13:00:00
05/27/2015 01:00:00
05/27/2015 13:00:00
05/28/2015 01:00:00
05/28/2015 13:00:00
DateTime

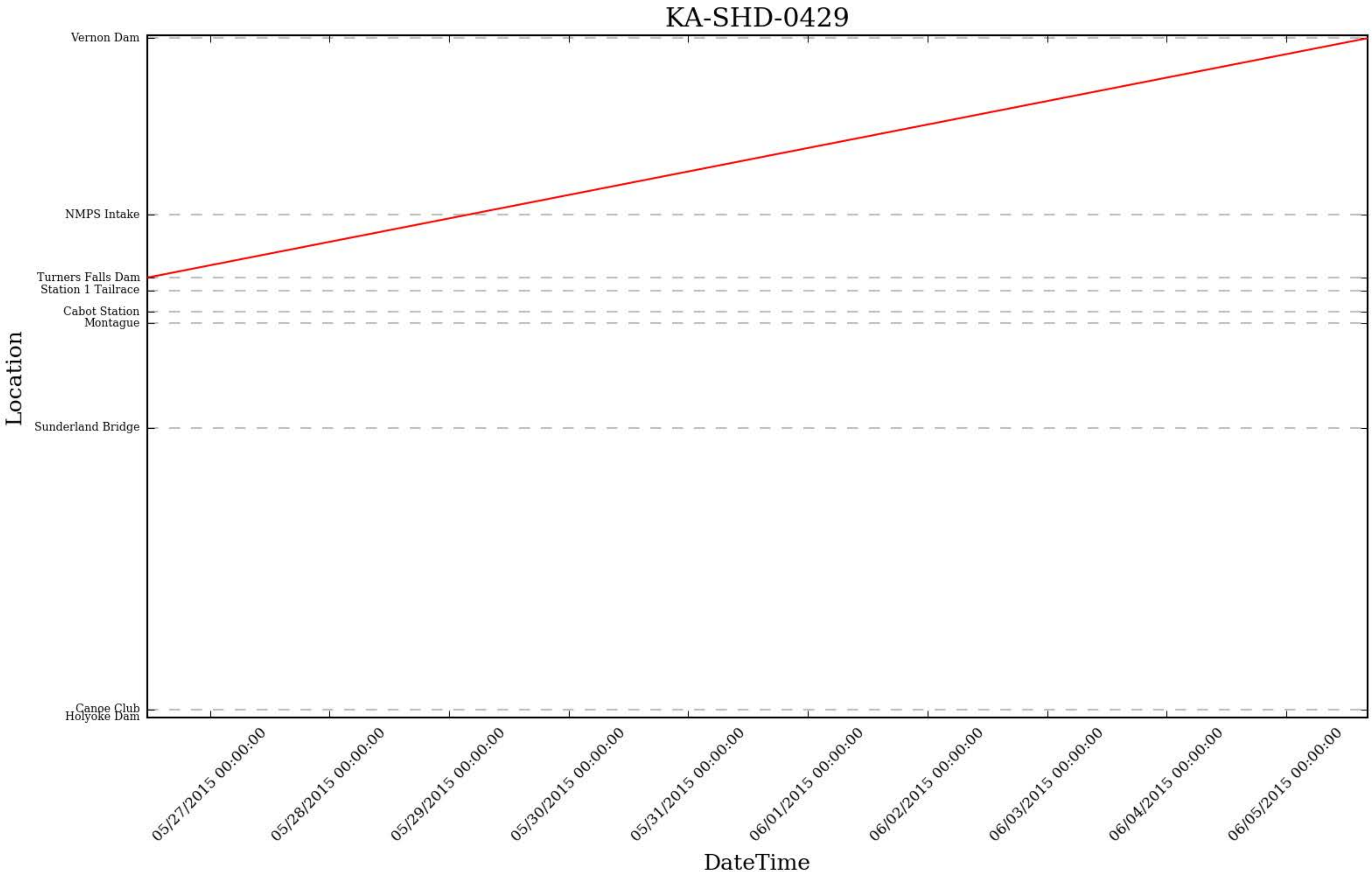

KA-SHD-0423
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 18:00:00
05/26/2015 00:00:00
05/26/2015 06:00:00
05/26/2015 12:00:00
05/26/2015 18:00:00
05/27/2015 00:00:00
05/27/2015 06:00:00
05/27/2015 12:00:00
05/27/2015 18:00:00
05/28/2015 00:00:00
05/28/2015 06:00:00
DateTime

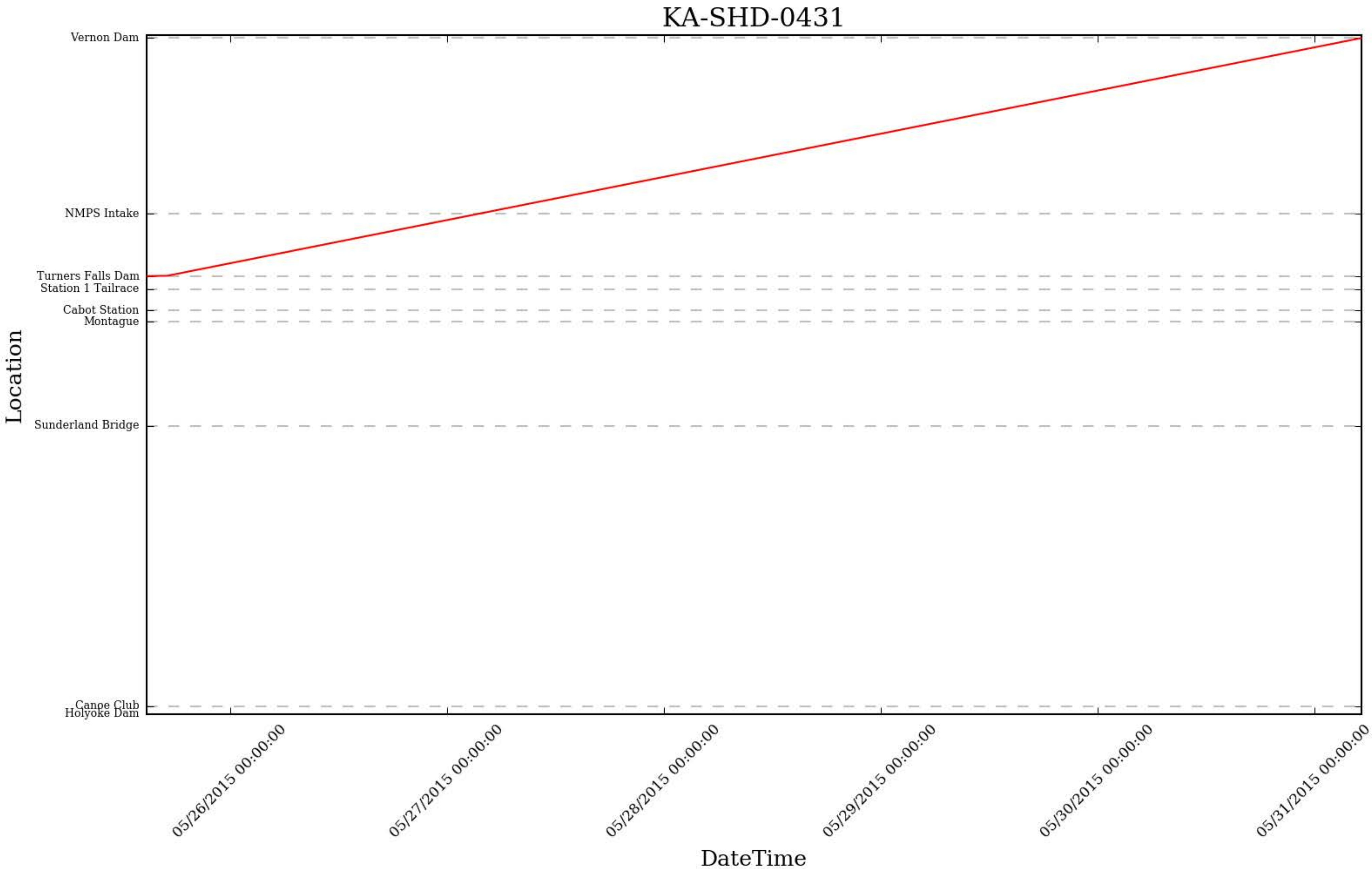

KA-SHD-0424
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 06:37:00
05/20/2015 06:47:00
05/20/2015 06:57:00
05/20/2015 07:07:00
05/20/2015 07:17:00
05/20/2015 07:27:00
05/20/2015 07:37:00
05/20/2015 07:47:00
05/20/2015 07:57:00
05/20/2015 08:07:00
DateTime

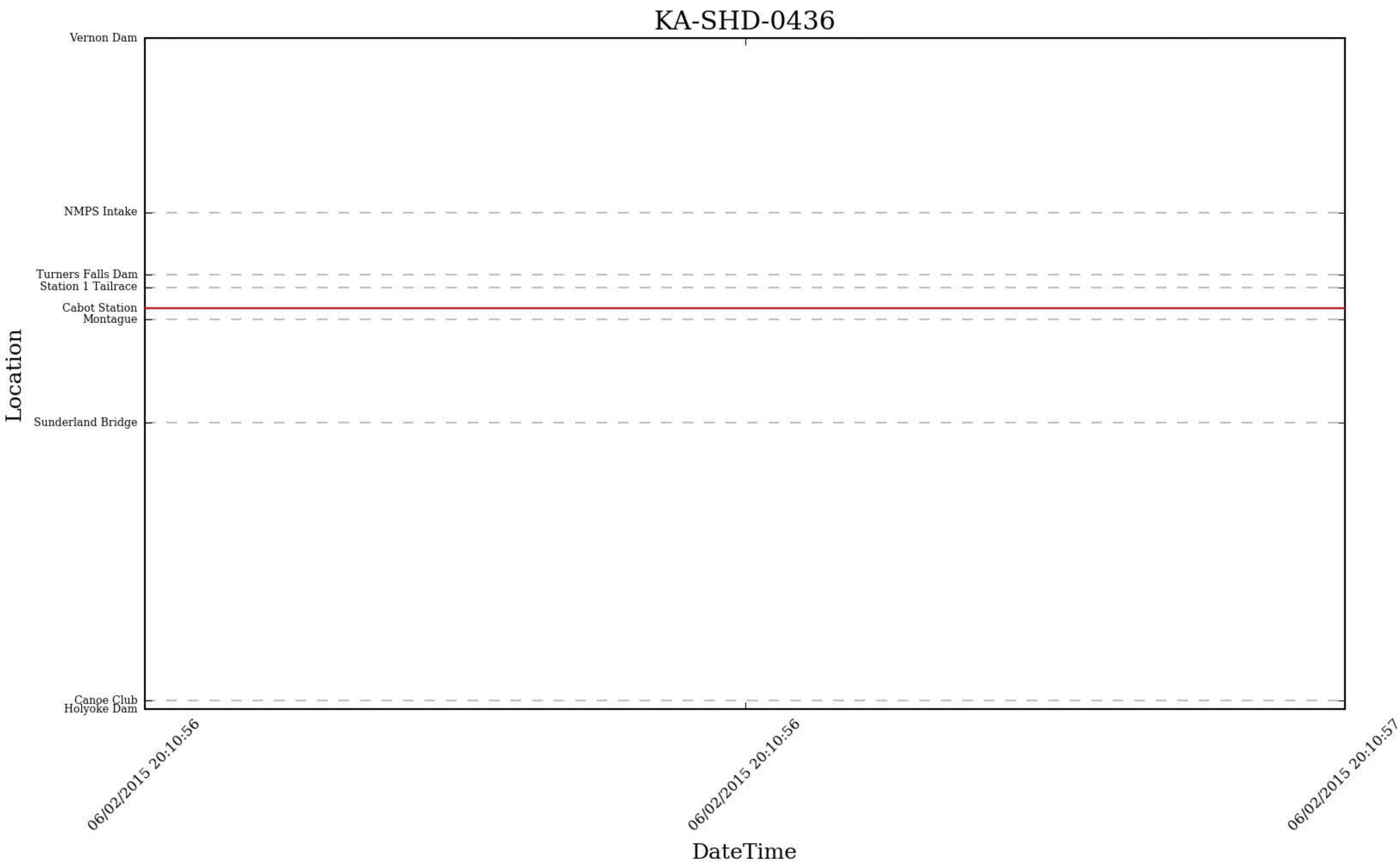

KA-SHD-0425
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 12:54:00
05/25/2015 13:04:00
05/25/2015 13:14:00
05/25/2015 13:24:00
05/25/2015 13:34:00
05/25/2015 13:44:00
05/25/2015 13:54:00
05/25/2015 14:04:00
DateTime

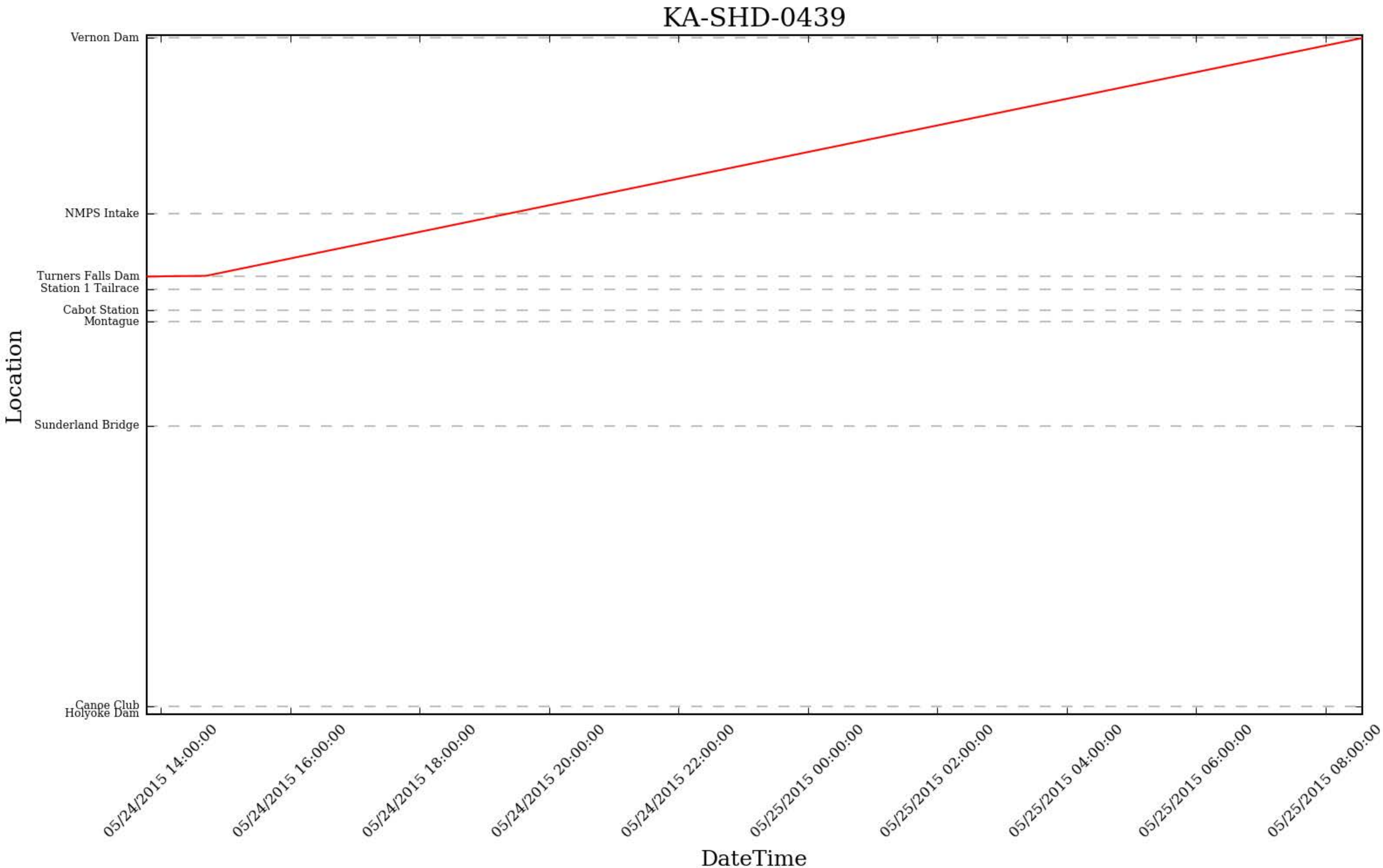

KA-SHD-0426
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 20:00:00
05/24/2015 08:00:00
05/24/2015 20:00:00
05/25/2015 08:00:00
05/25/2015 20:00:00
05/26/2015 08:00:00
05/26/2015 20:00:00
05/27/2015 08:00:00
05/27/2015 20:00:00
05/28/2015 08:00:00
DateTime


KA-SHD-0427
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 14:02:00
05/25/2015 14:07:00
05/25/2015 14:12:00
05/25/2015 14:17:00
05/25/2015 14:22:00
DateTime

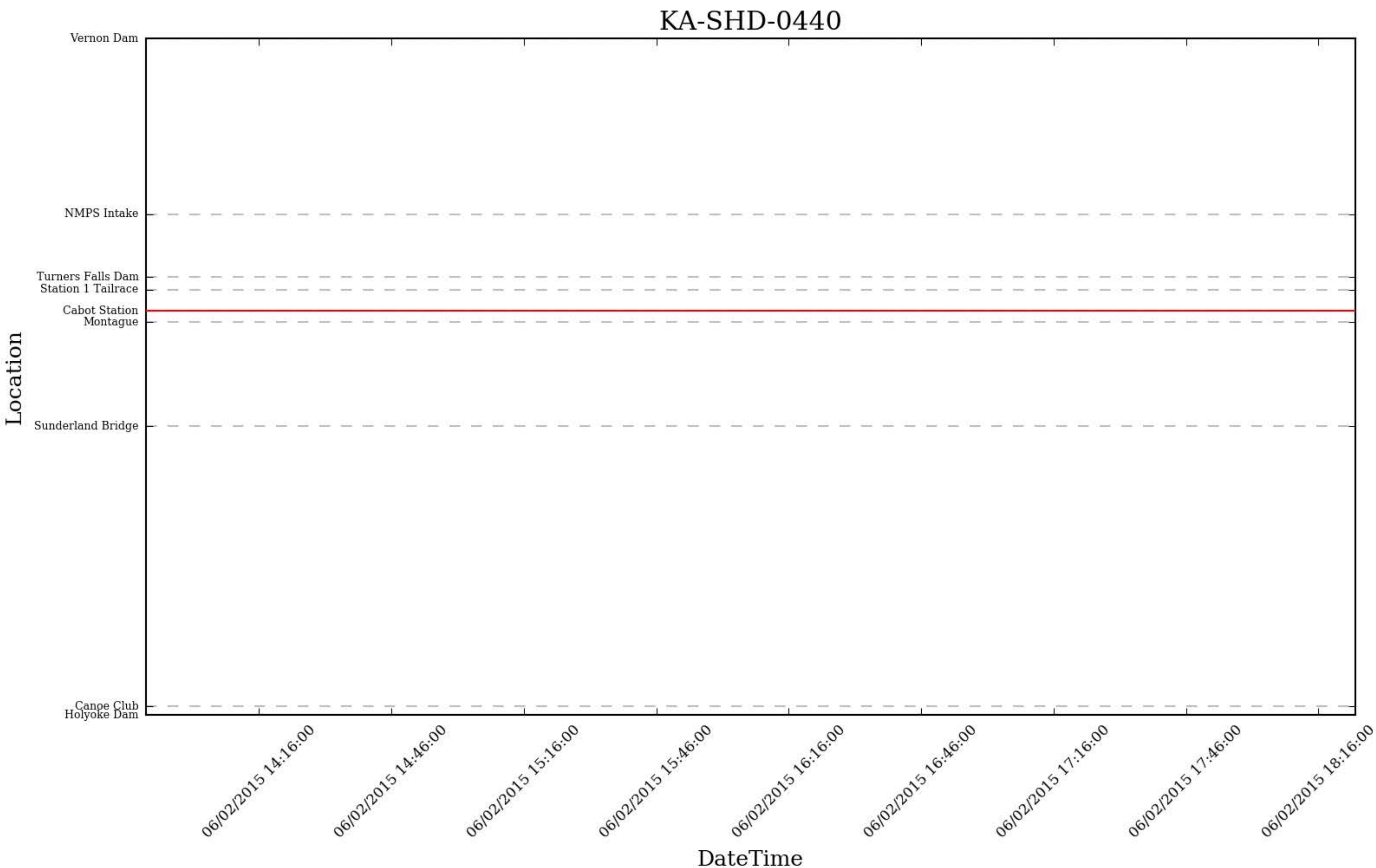

KA-SHD-0429
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
06/04/2015 00:00:00
06/05/2015 00:00:00
DateTime


KA-SHD-0431
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
DateTime

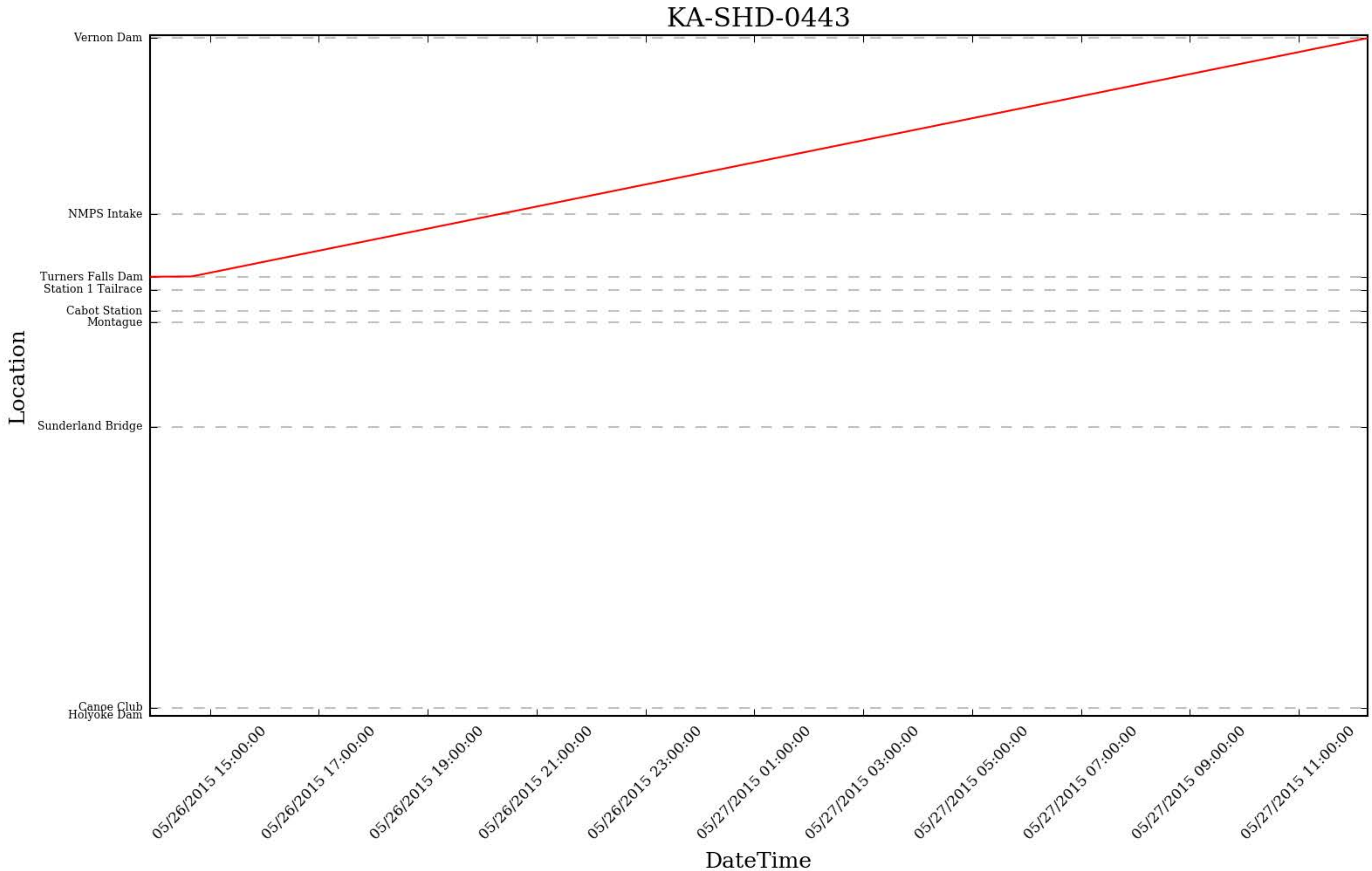

KA-SHD-0436
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/02/2015 20:10:56
06/02/2015 20:10:56
06/02/2015 20:10:57
DateTime



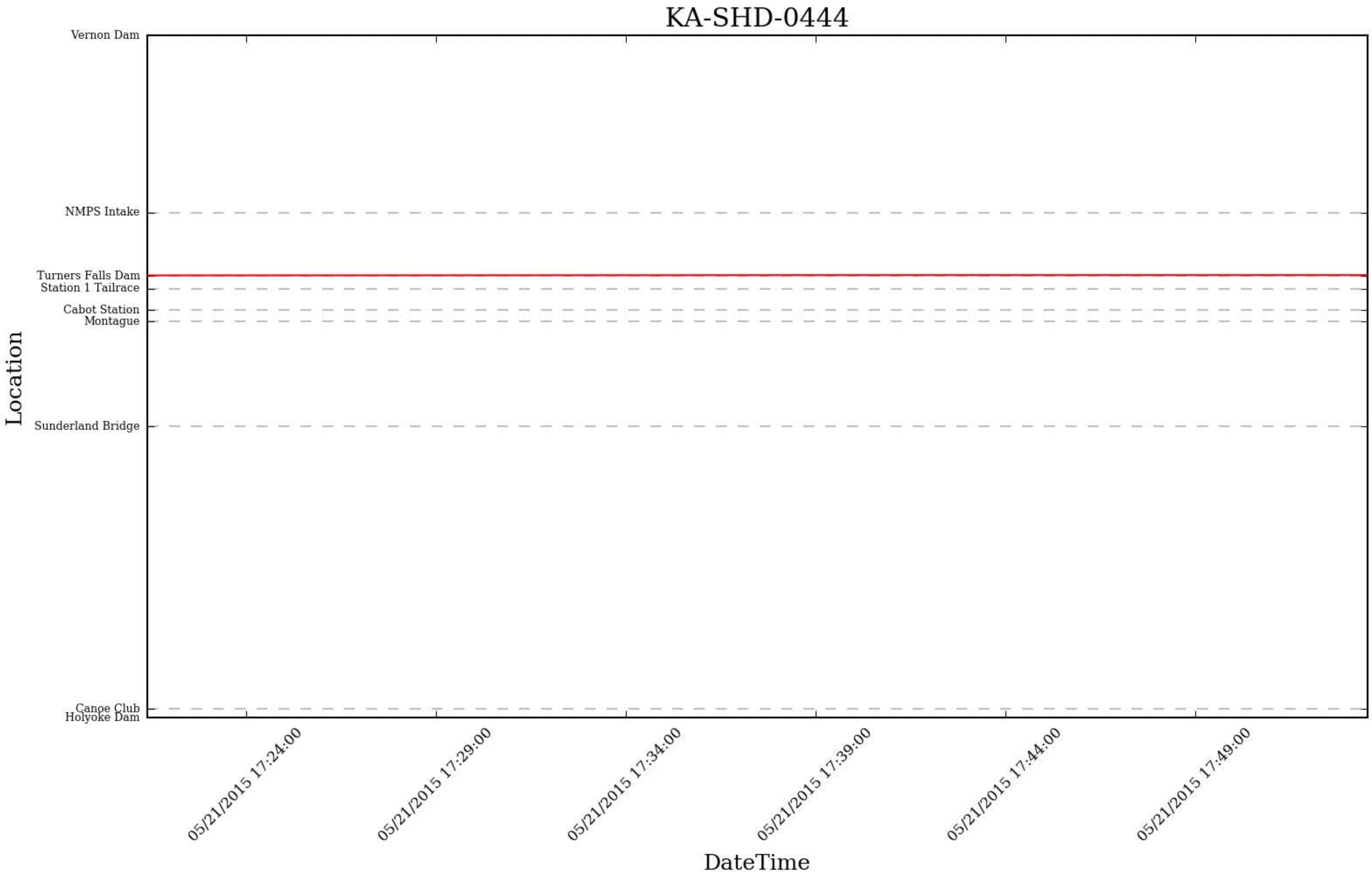
KA-SHD-0439
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 14:00:00
05/24/2015 16:00:00
05/24/2015 18:00:00
05/24/2015 20:00:00
05/24/2015 22:00:00
05/25/2015 00:00:00
05/25/2015 02:00:00
05/25/2015 04:00:00
05/25/2015 06:00:00
05/25/2015 08:00:00
DateTime

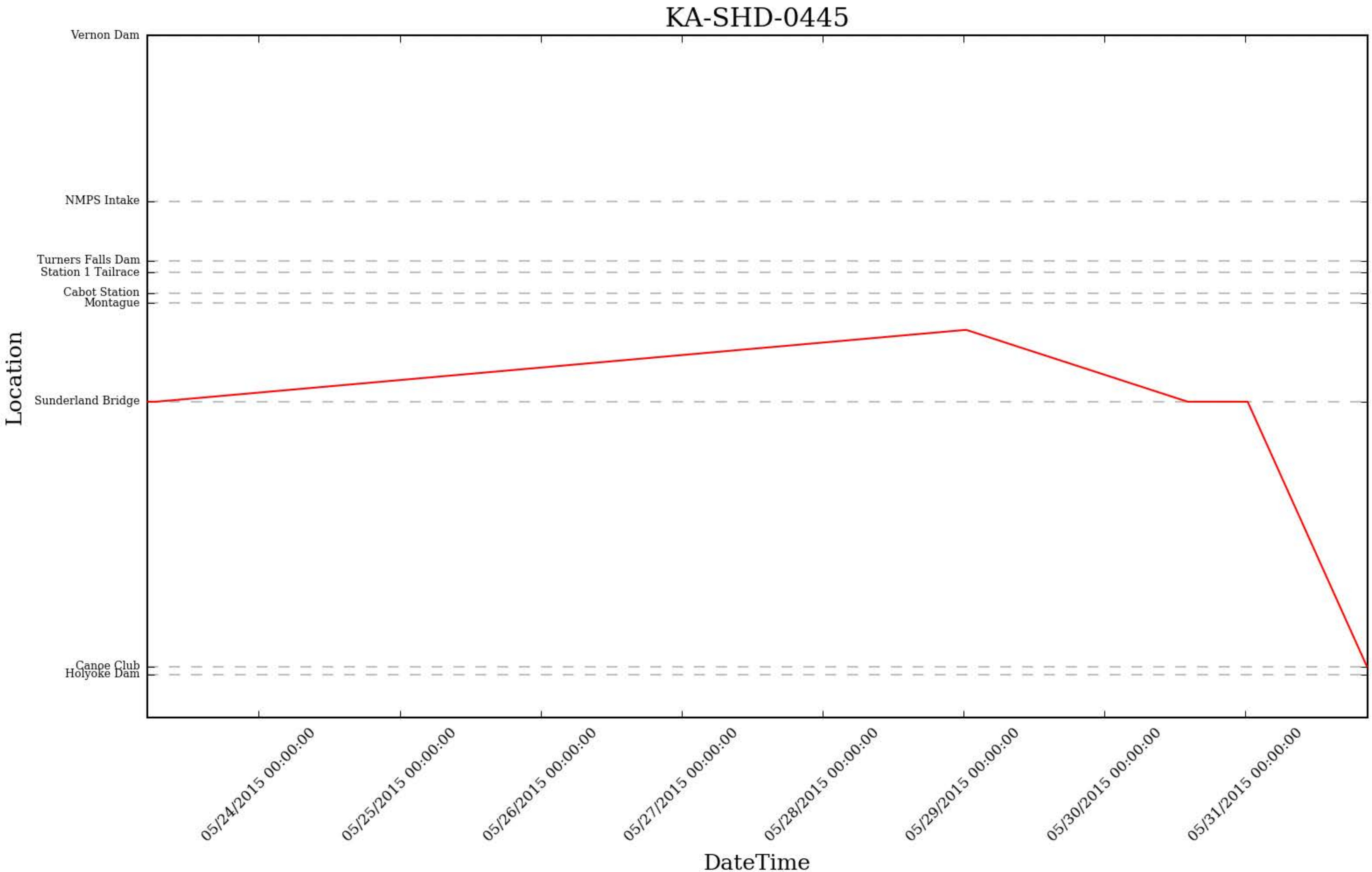


KA-SHD-0440
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/02/2015 14:16:00
06/02/2015 14:46:00
06/02/2015 15:16:00
06/02/2015 15:46:00
06/02/2015 16:16:00
06/02/2015 16:46:00
06/02/2015 17:16:00
06/02/2015 17:46:00
06/02/2015 18:16:00
DateTime

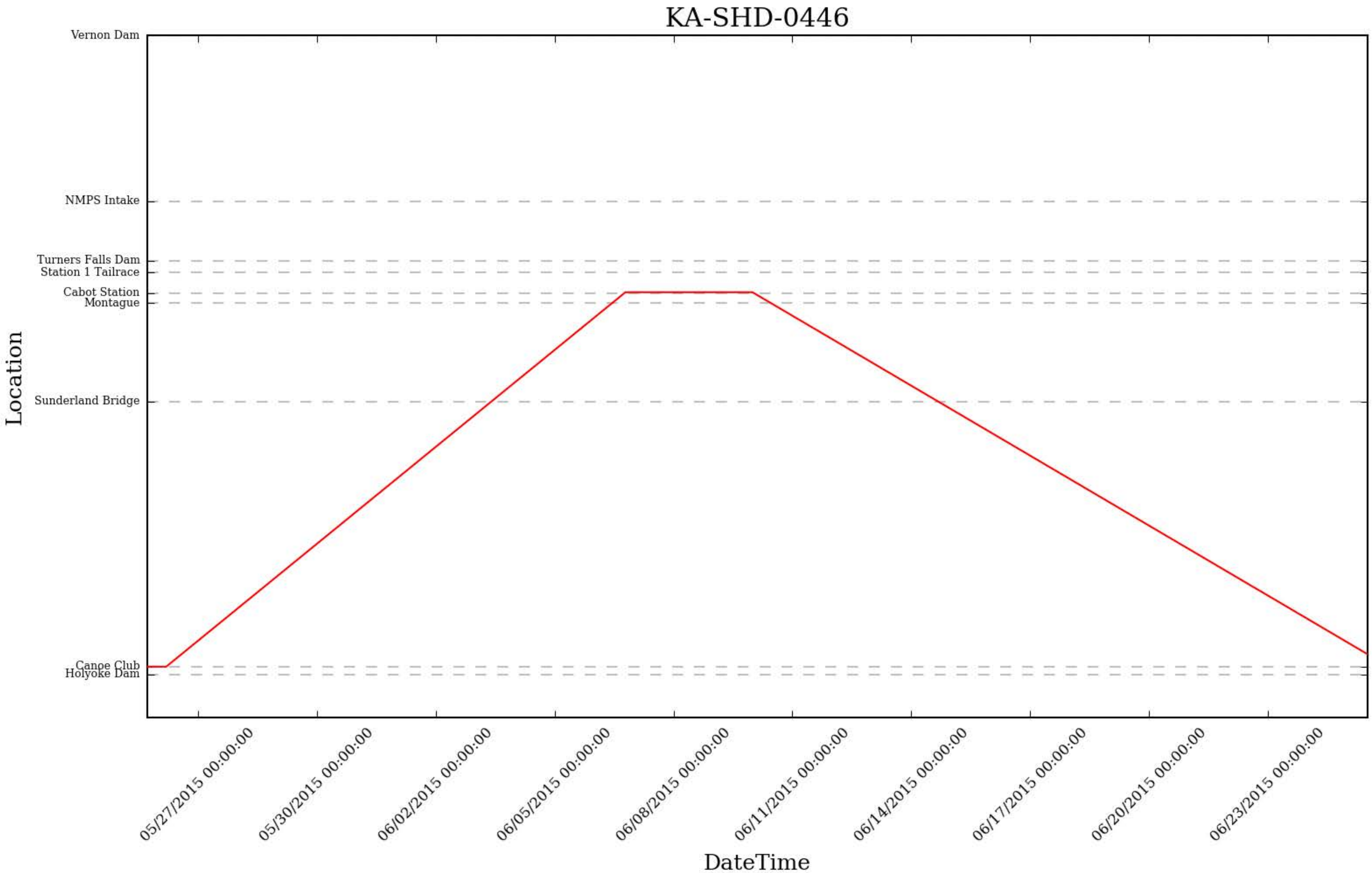


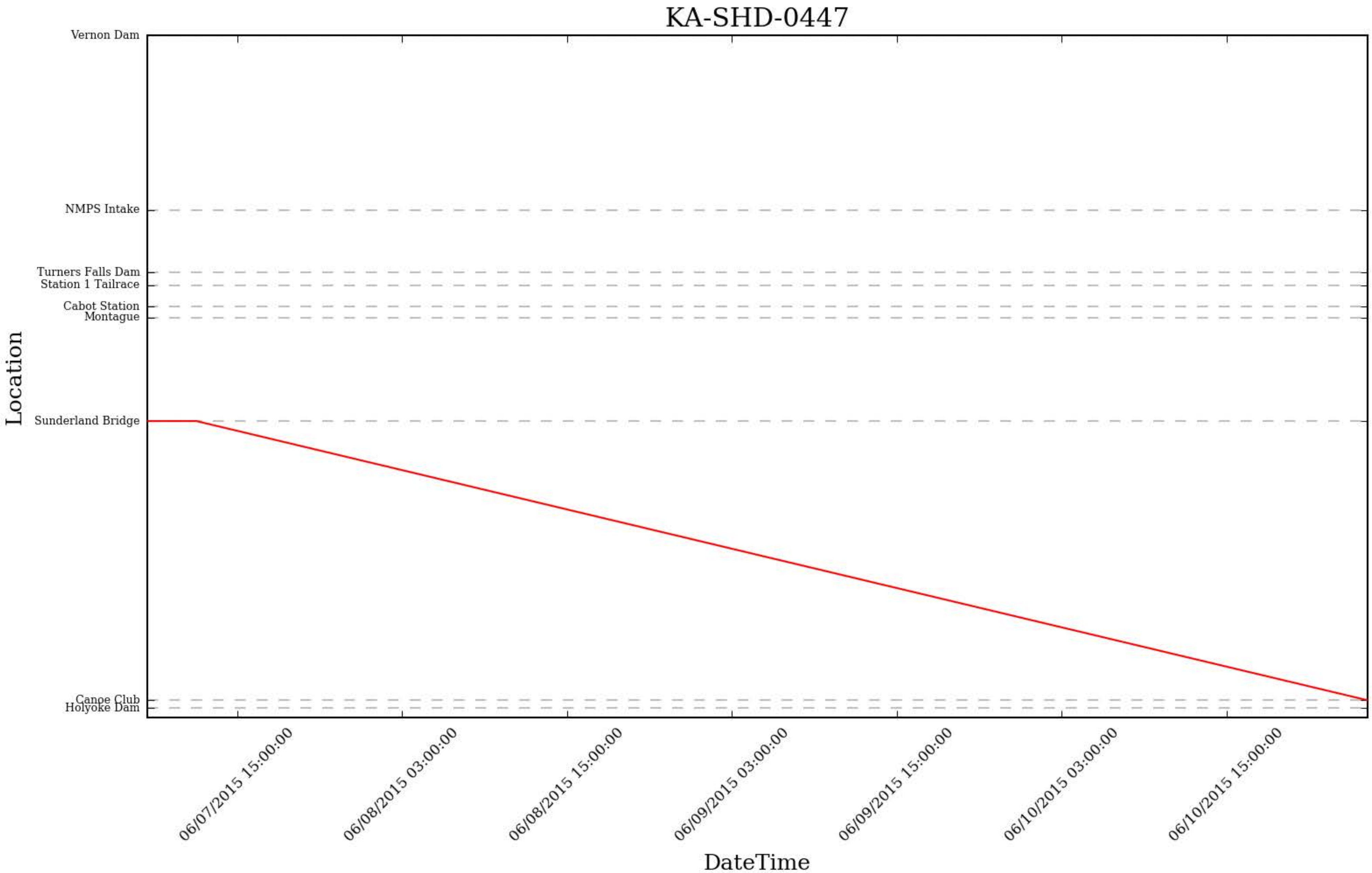
KA-SHD-0443
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 15:00:00
05/26/2015 17:00:00
05/26/2015 19:00:00
05/26/2015 21:00:00
05/26/2015 23:00:00
05/27/2015 01:00:00
05/27/2015 03:00:00
05/27/2015 05:00:00
05/27/2015 07:00:00
05/27/2015 09:00:00
05/27/2015 11:00:00
DateTime

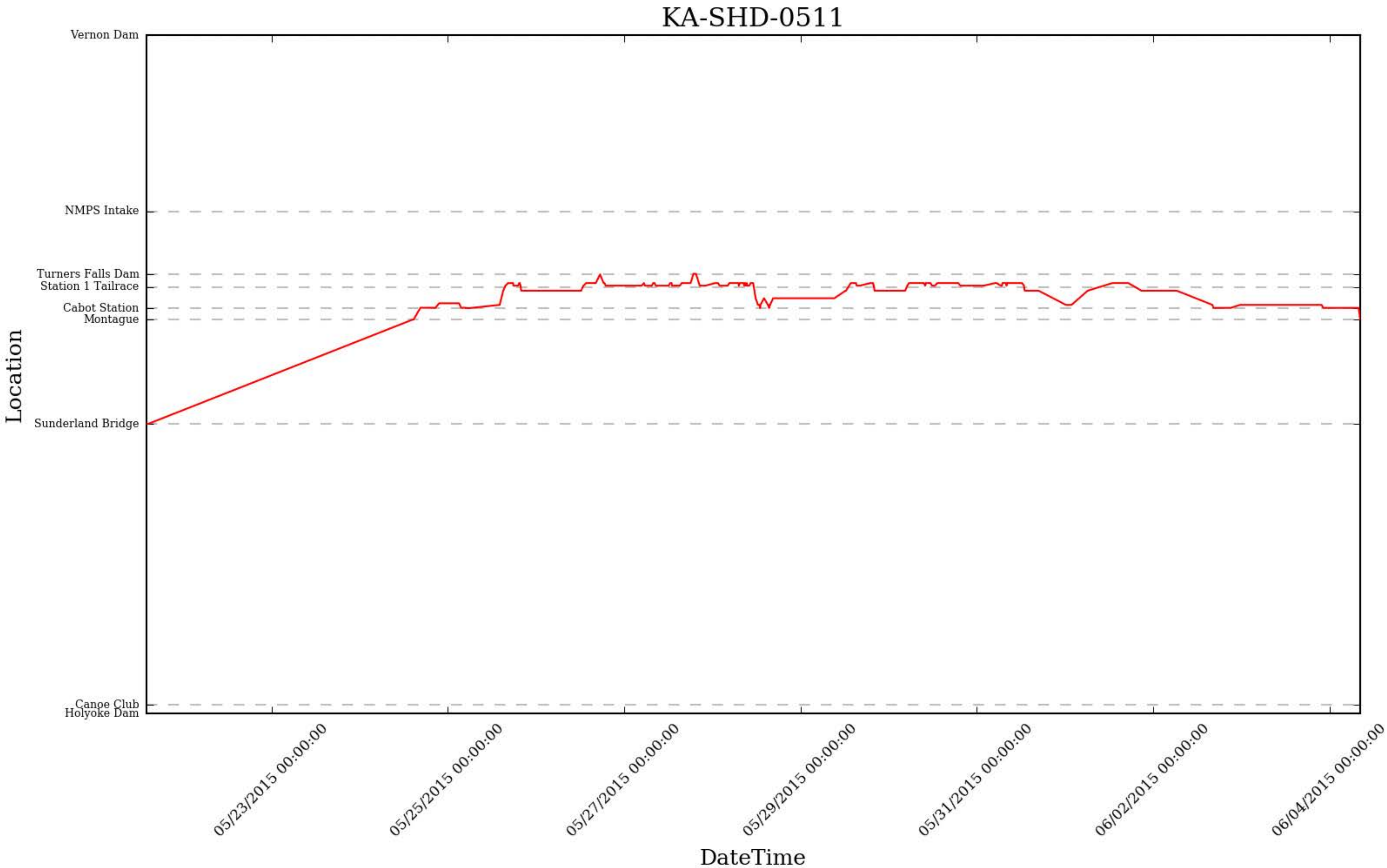

KA-SHD-0444
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 17:24:00
05/21/2015 17:29:00
05/21/2015 17:34:00
05/21/2015 17:39:00
05/21/2015 17:44:00
05/21/2015 17:49:00
DateTime

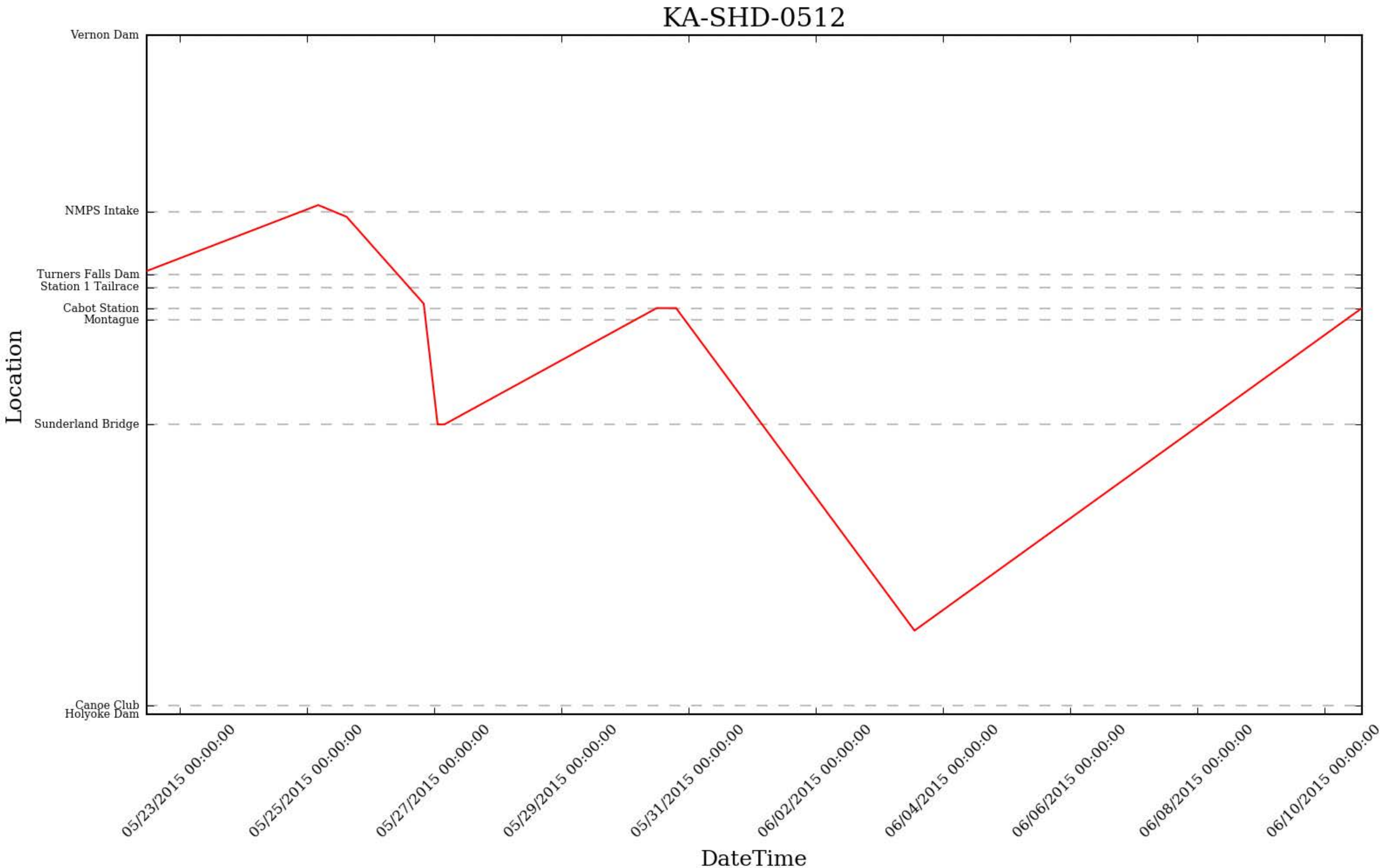


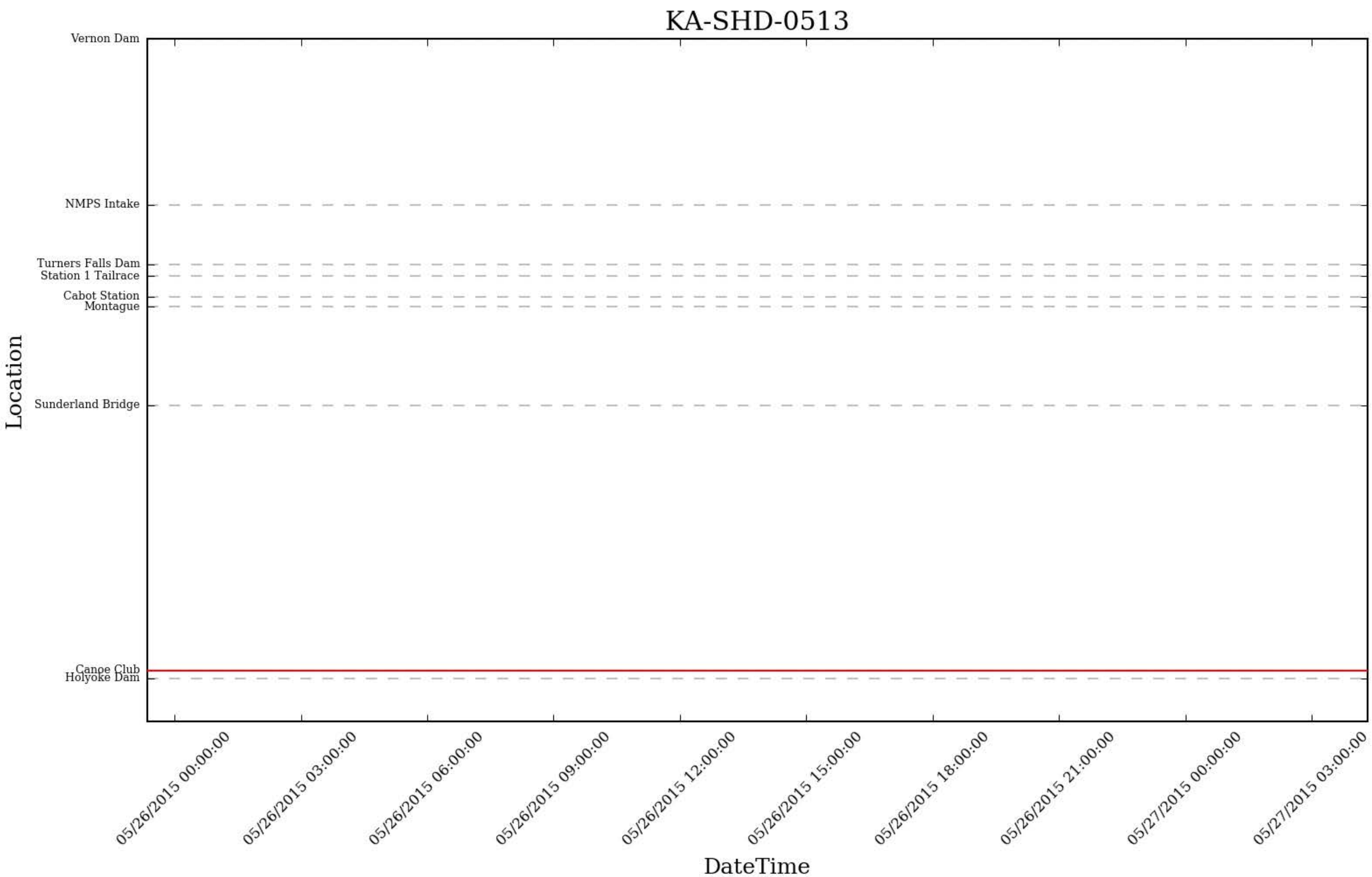
KA-SHD-0445
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
DateTime

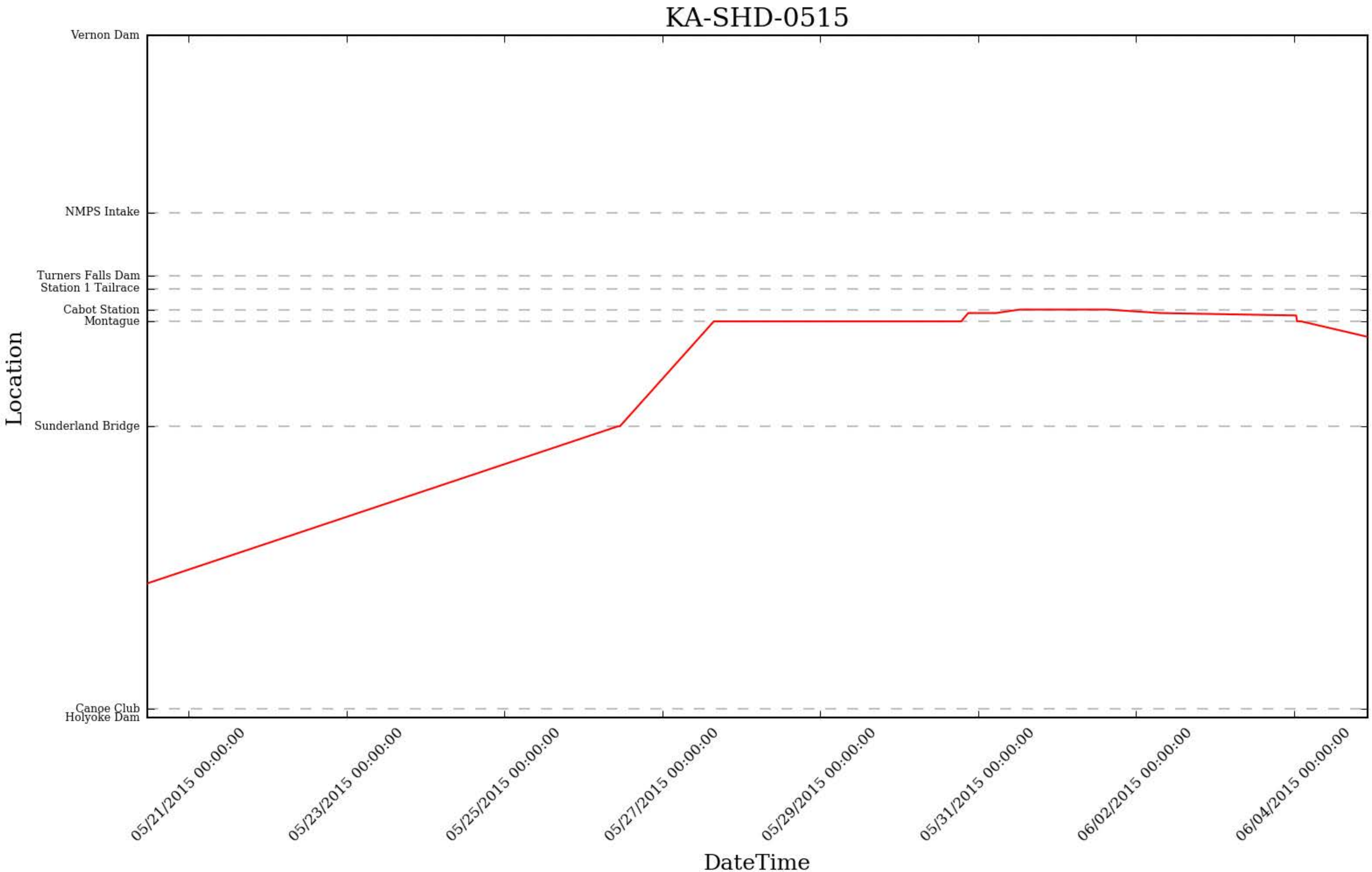

KA-SHD-0446
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
06/14/2015 00:00:00
06/17/2015 00:00:00
06/20/2015 00:00:00
06/23/2015 00:00:00
DateTime

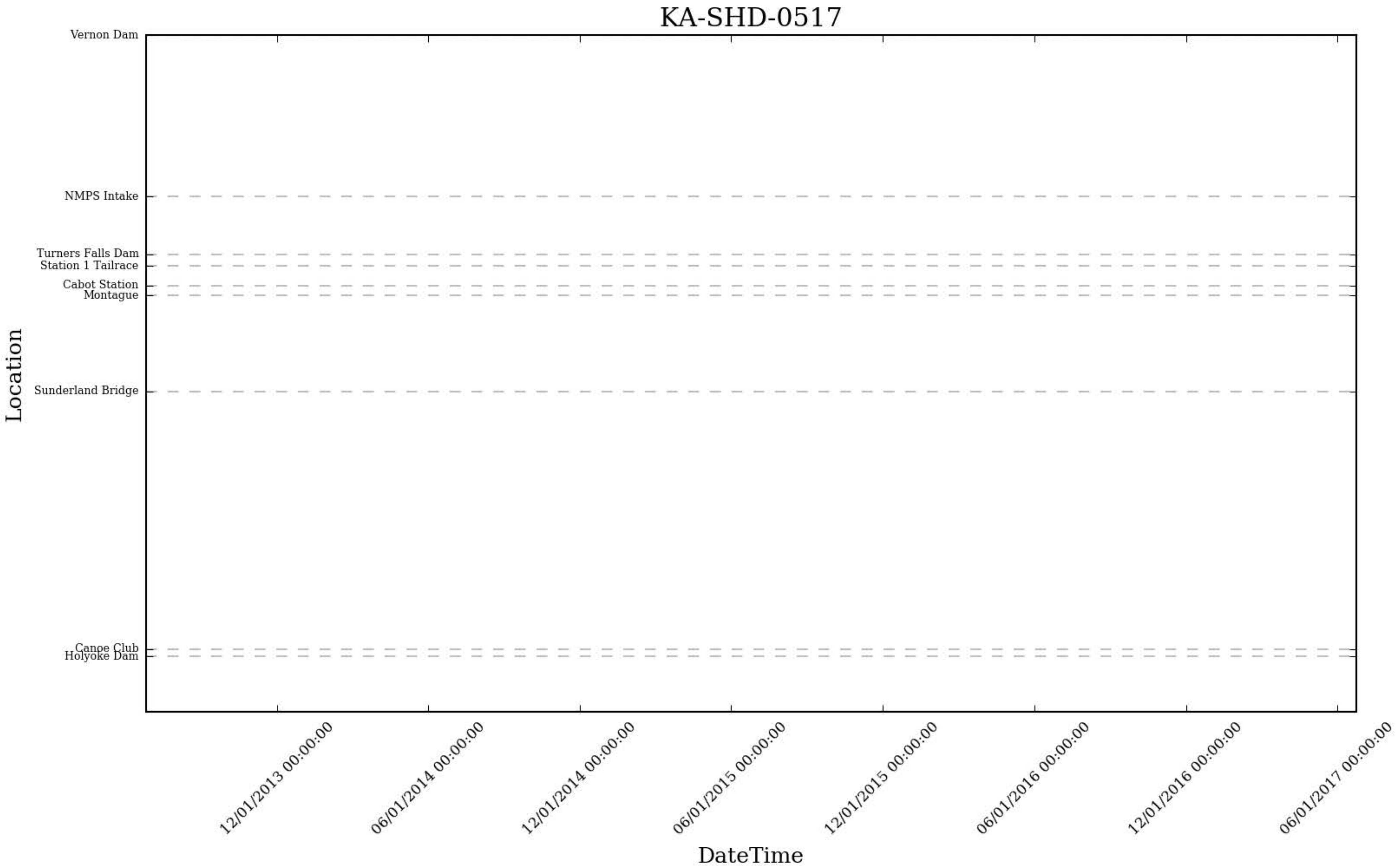

KA-SHD-0447
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/07/2015 15:00:00
06/08/2015 03:00:00
06/08/2015 15:00:00
06/09/2015 03:00:00
06/09/2015 15:00:00
06/10/2015 03:00:00
06/10/2015 15:00:00
DateTime

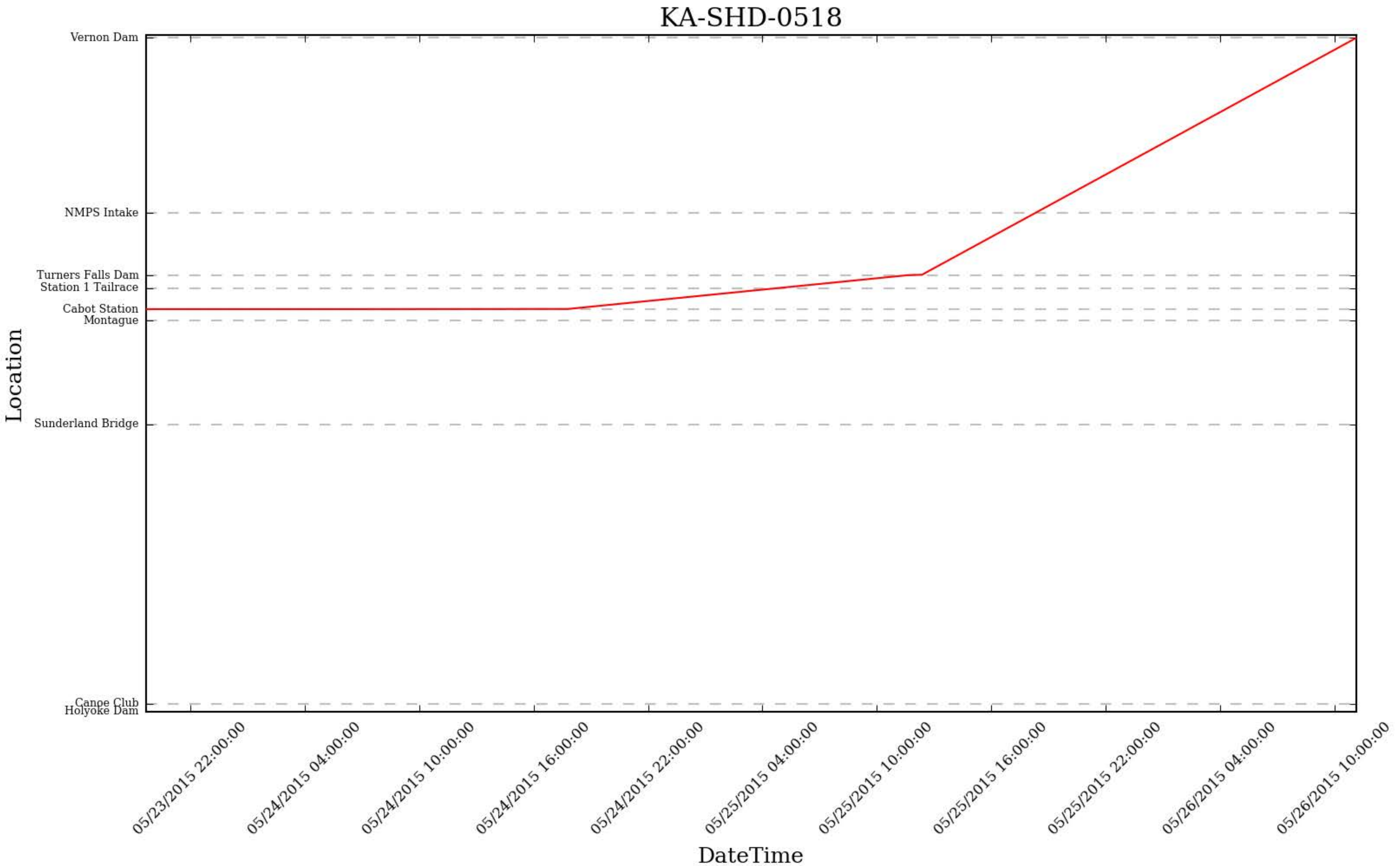

KA-SHD-0511
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
DateTime


KA-SHD-0512
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
06/06/2015 00:00:00
06/08/2015 00:00:00
06/10/2015 00:00:00
DateTime


KA-SHD-0513
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/26/2015 03:00:00
05/26/2015 06:00:00
05/26/2015 09:00:00
05/26/2015 12:00:00
05/26/2015 15:00:00
05/26/2015 18:00:00
05/26/2015 21:00:00
05/27/2015 00:00:00
05/27/2015 03:00:00
DateTime

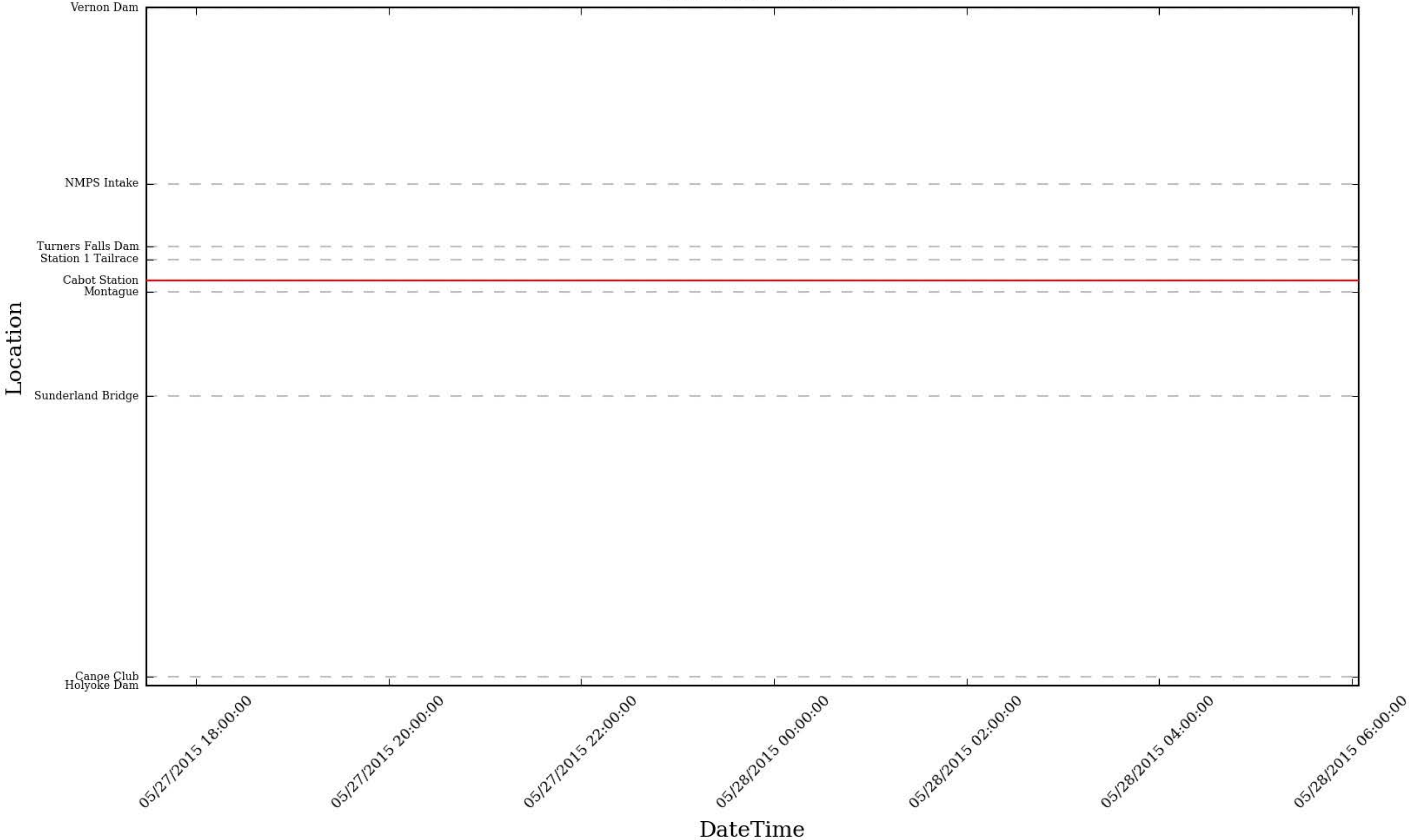

KA-SHD-0515
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
DateTime

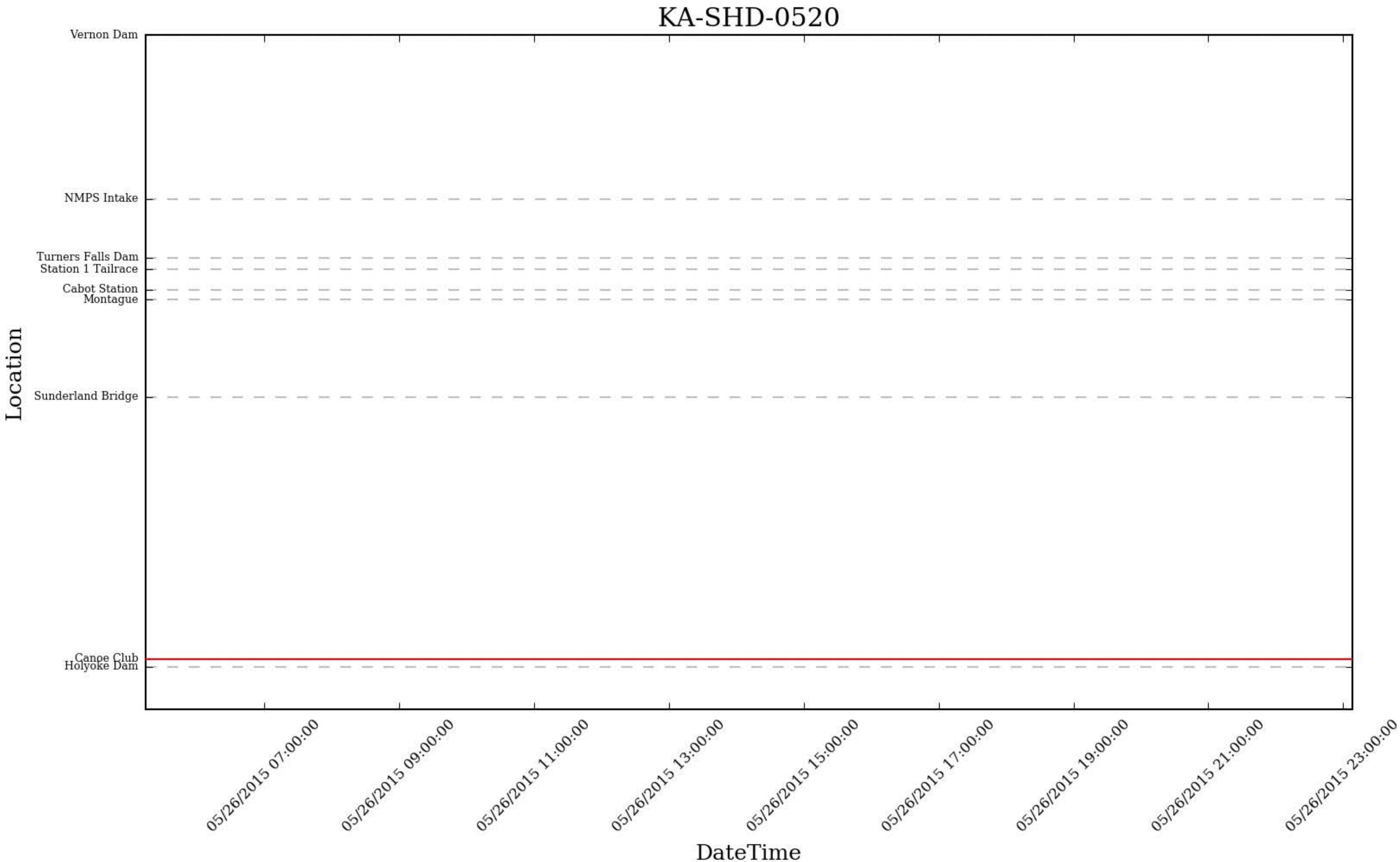

KA-SHD-0517
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime

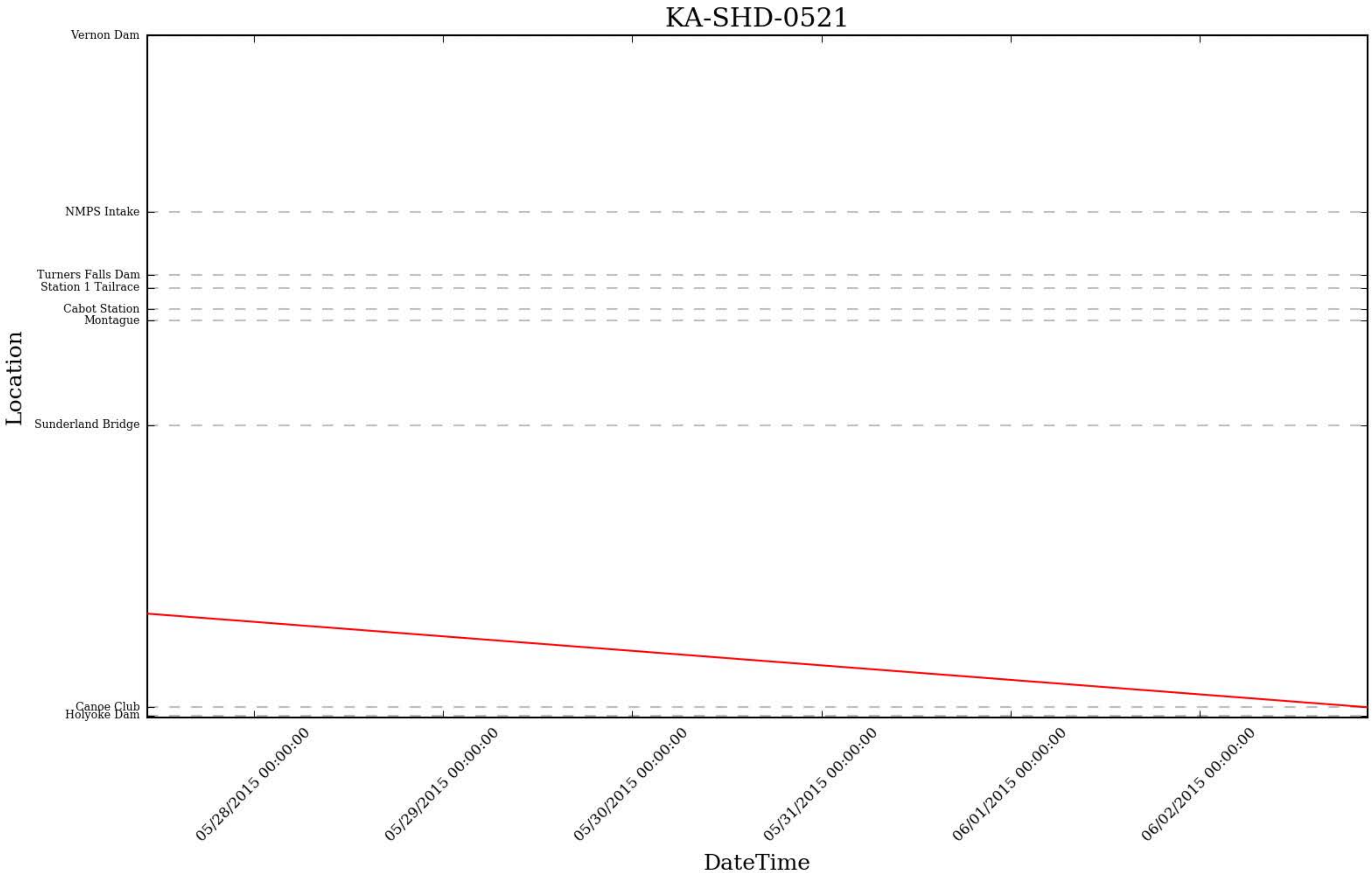


KA-SHD-0518
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 22:00:00
05/24/2015 04:00:00
05/24/2015 10:00:00
05/24/2015 16:00:00
05/24/2015 22:00:00
05/25/2015 04:00:00
05/25/2015 10:00:00
05/25/2015 16:00:00
05/25/2015 22:00:00
05/26/2015 04:00:00
05/26/2015 10:00:00
DateTime

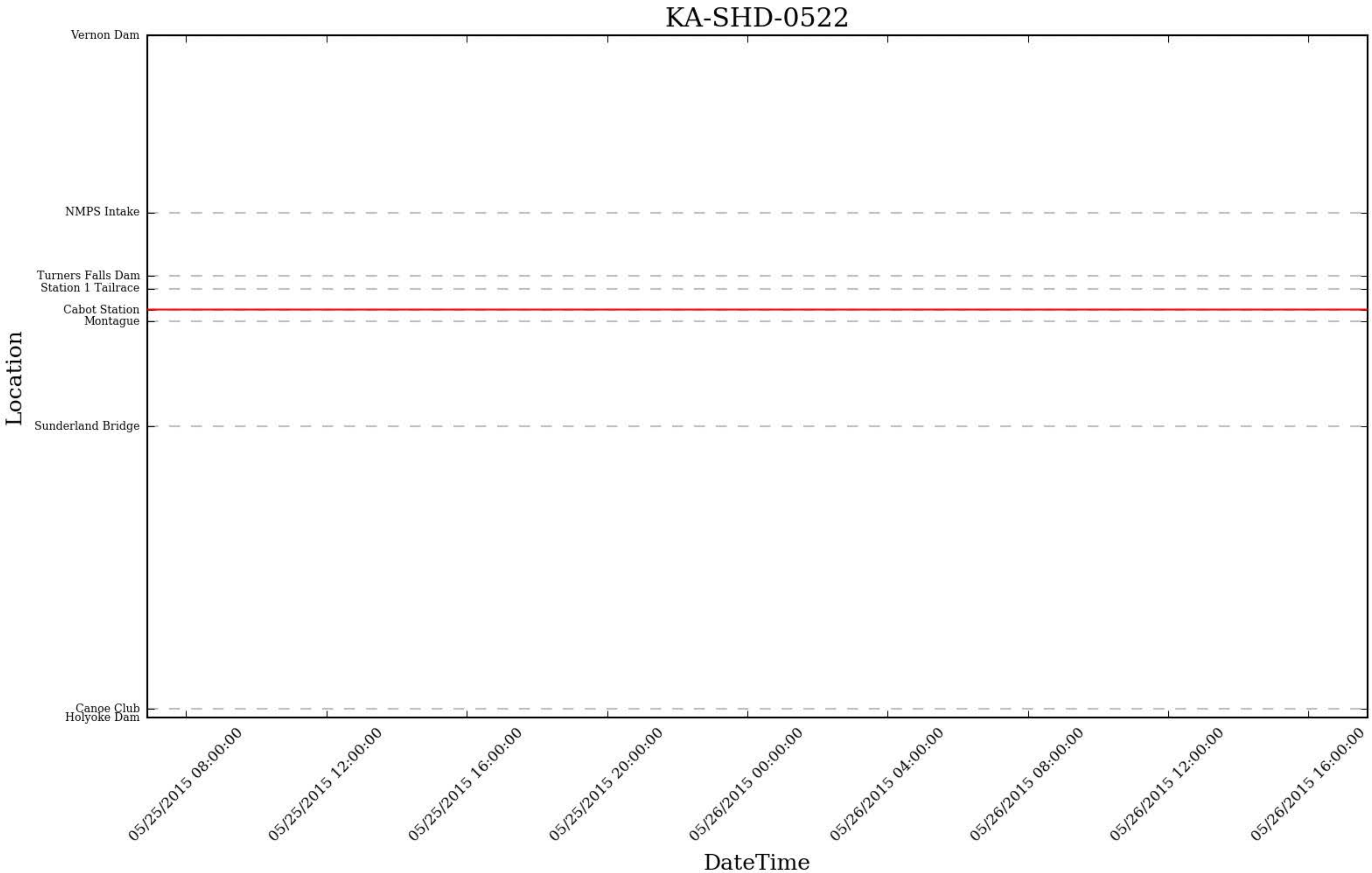
KA-SHD-0519

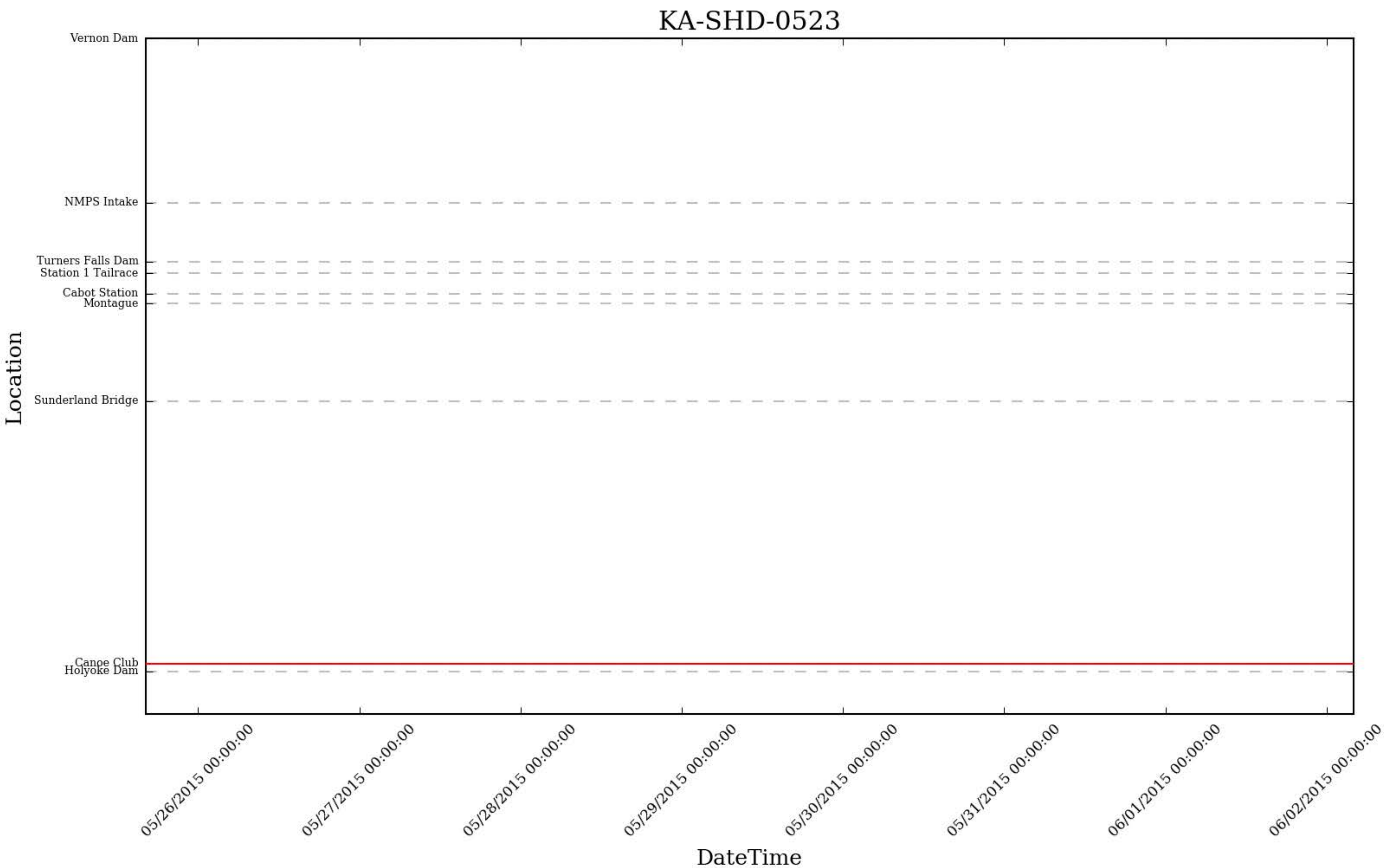

Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 18:00:00
05/27/2015 20:00:00
05/27/2015 22:00:00
05/28/2015 00:00:00
05/28/2015 02:00:00
05/28/2015 04:00:00
05/28/2015 06:00:00
DateTime

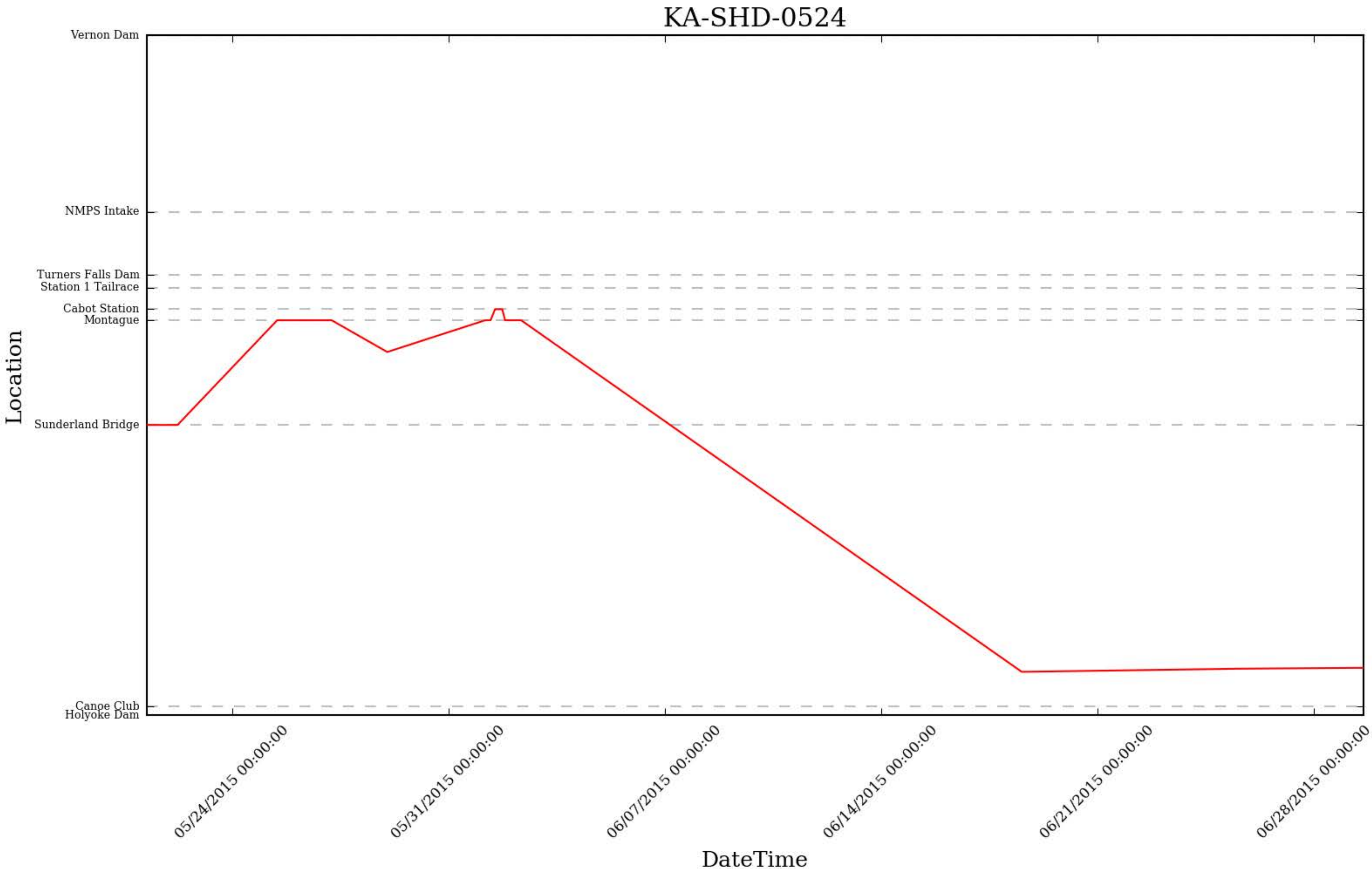

KA-SHD-0520
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/26/2015 07:00:00
05/26/2015 09:00:00
05/26/2015 11:00:00
05/26/2015 13:00:00
05/26/2015 15:00:00
05/26/2015 17:00:00
05/26/2015 19:00:00
05/26/2015 21:00:00
05/26/2015 23:00:00
DateTime



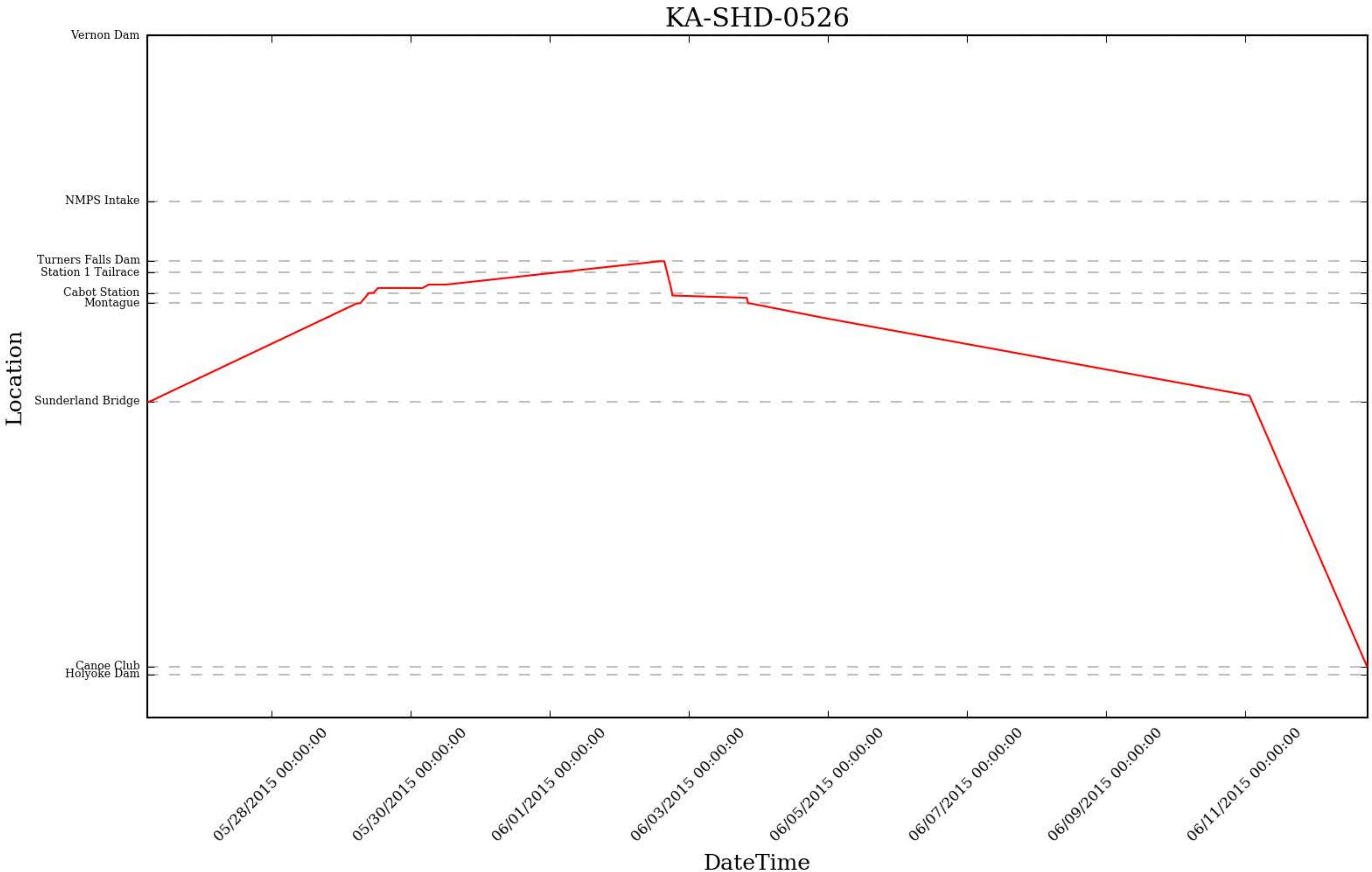
KA-SHD-0521
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
DateTime


KA-SHD-0522
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 08:00:00
05/25/2015 12:00:00
05/25/2015 16:00:00
05/25/2015 20:00:00
05/26/2015 00:00:00
05/26/2015 04:00:00
05/26/2015 08:00:00
05/26/2015 12:00:00
05/26/2015 16:00:00
DateTime

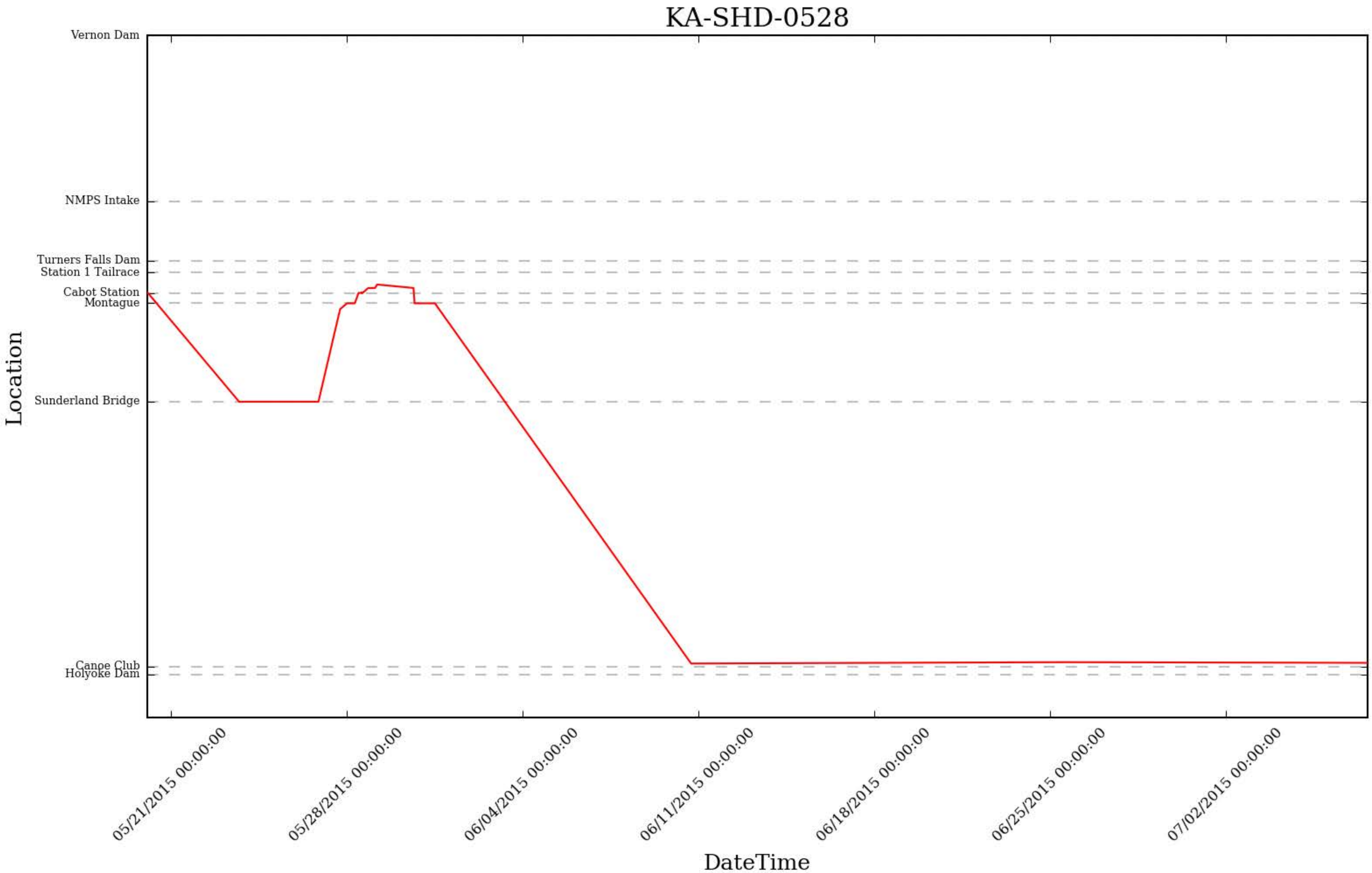

KA-SHD-0523
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
DateTime



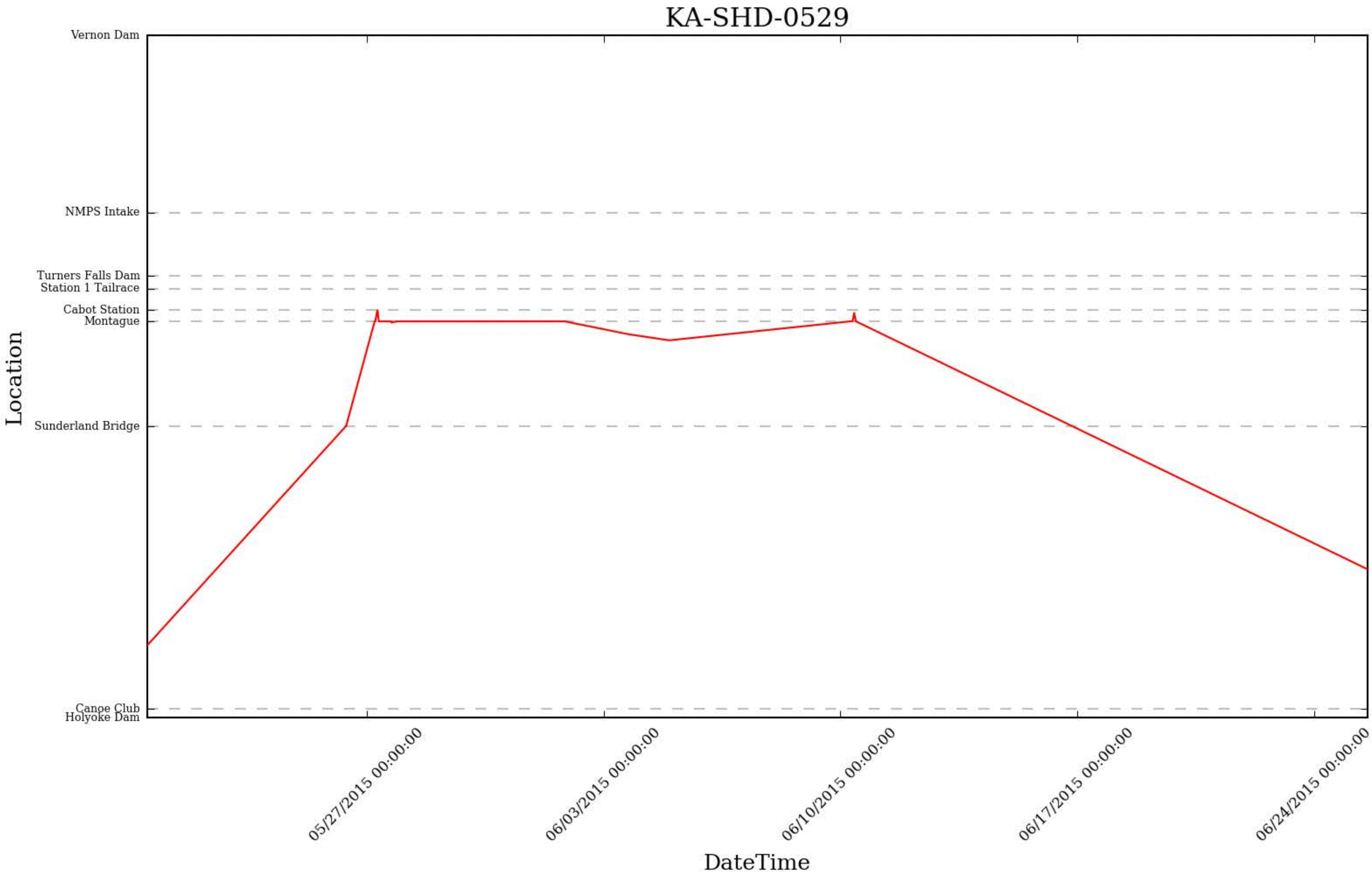
KA-SHD-0524
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
DateTime



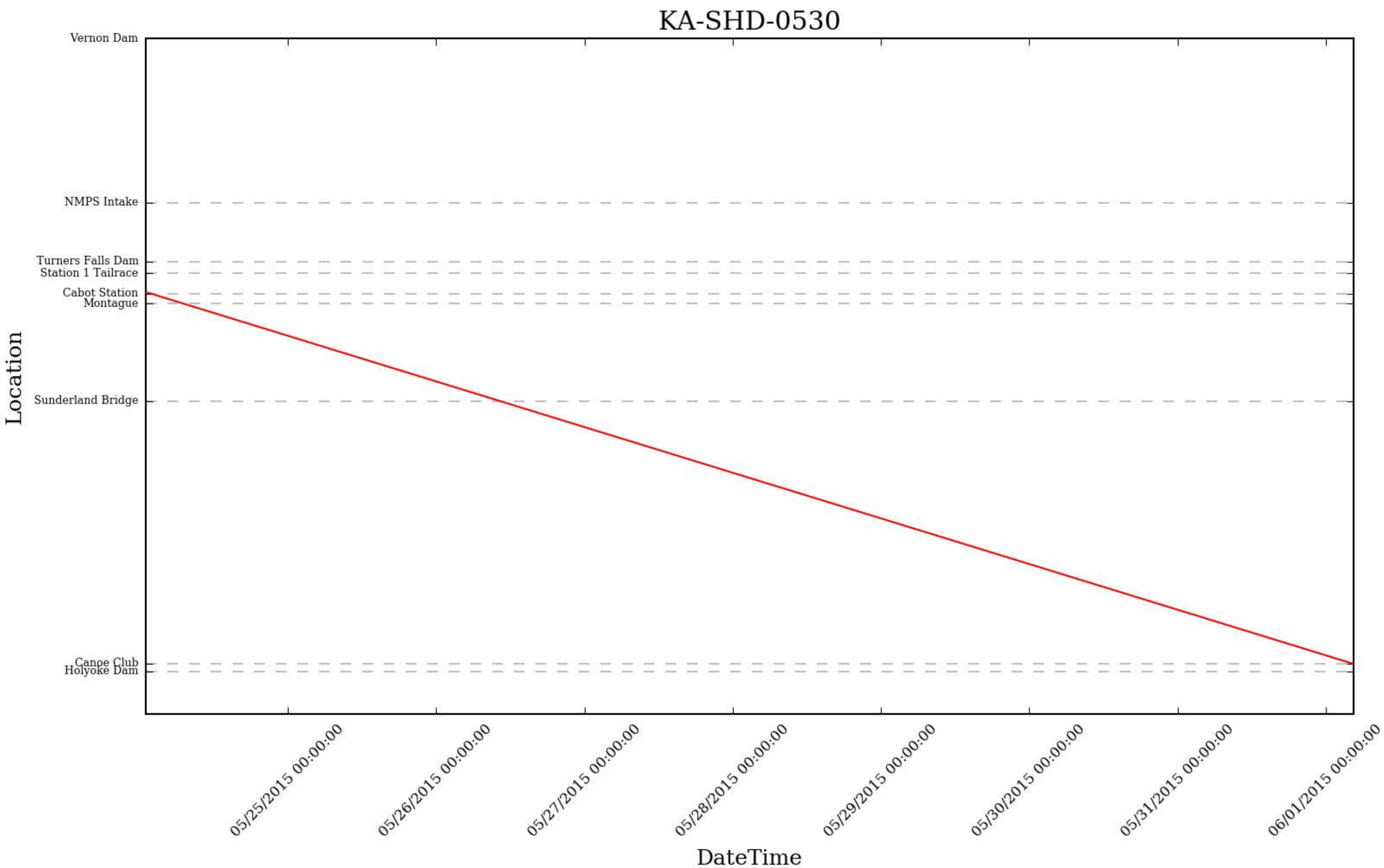
KA-SHD-0526
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
DateTime

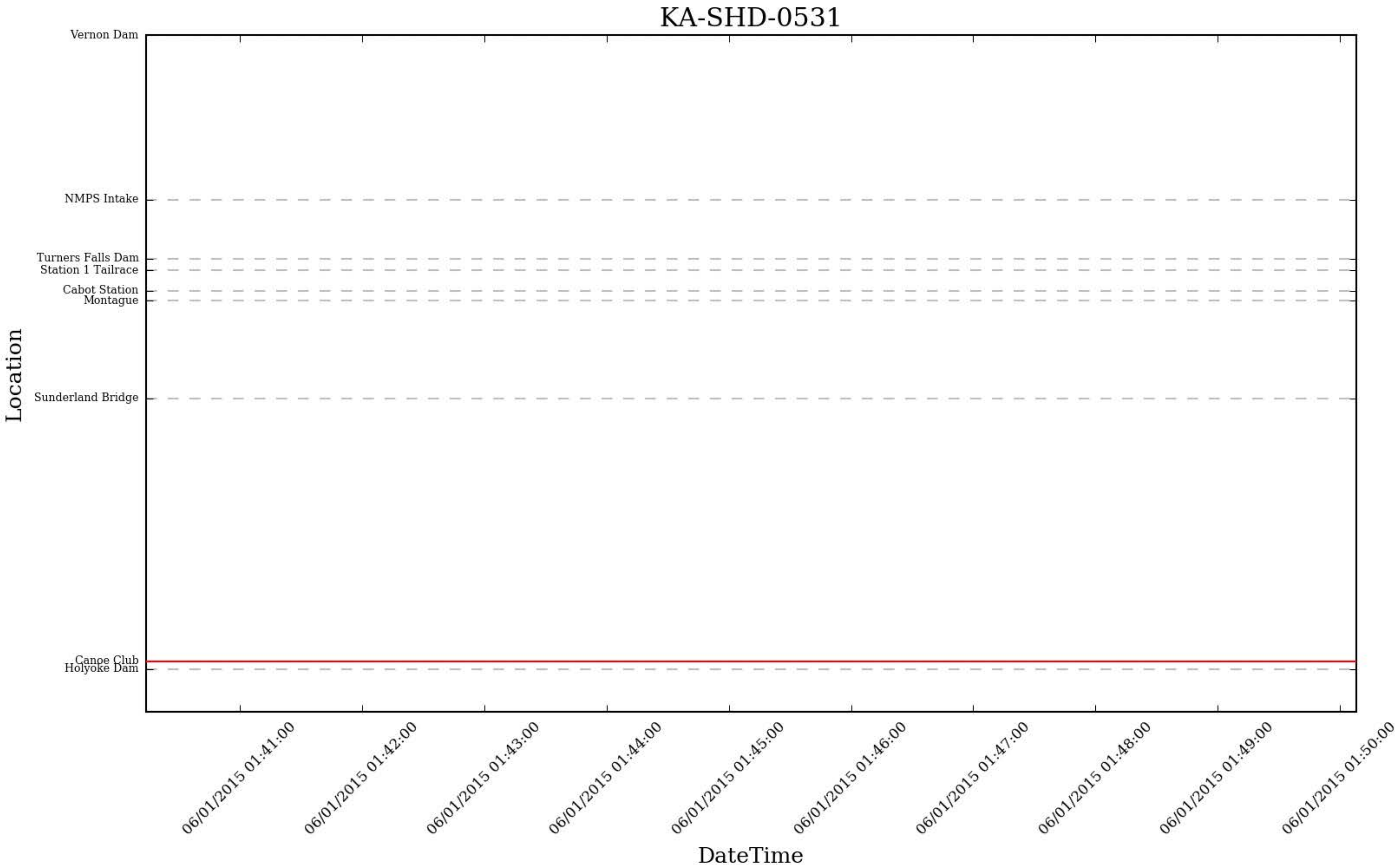


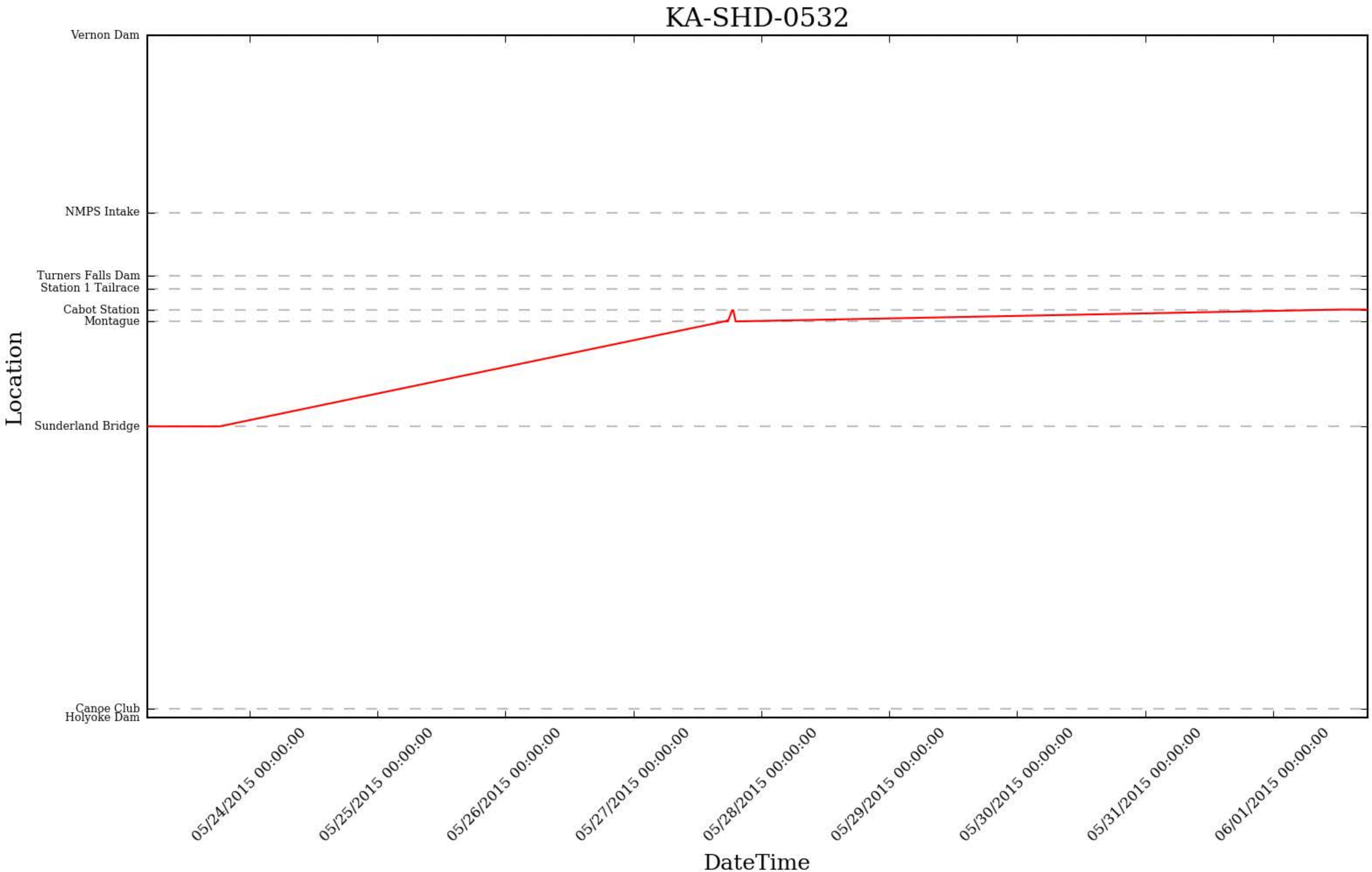
KA-SHD-0528
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime



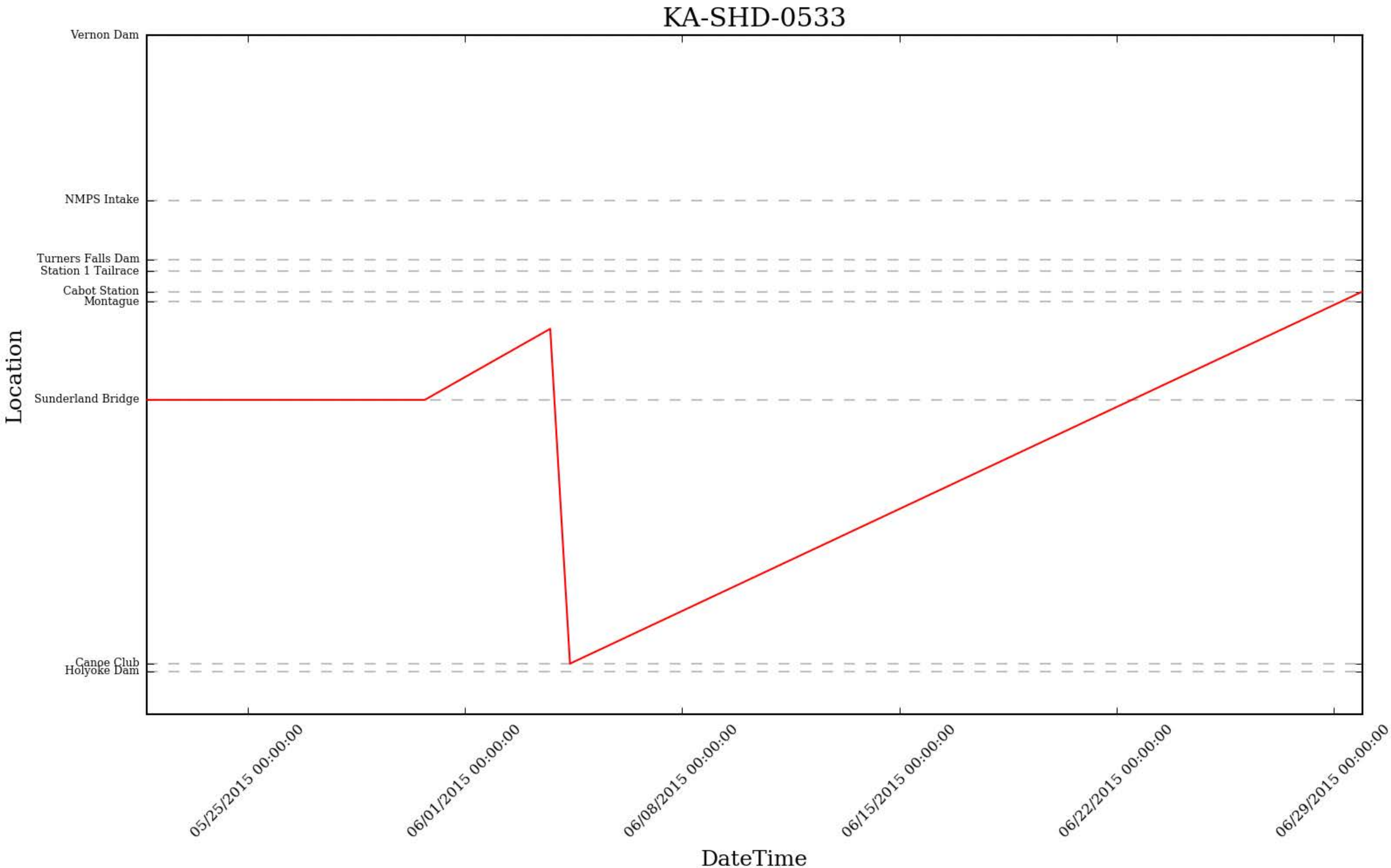
KA-SHD-0529
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
DateTime

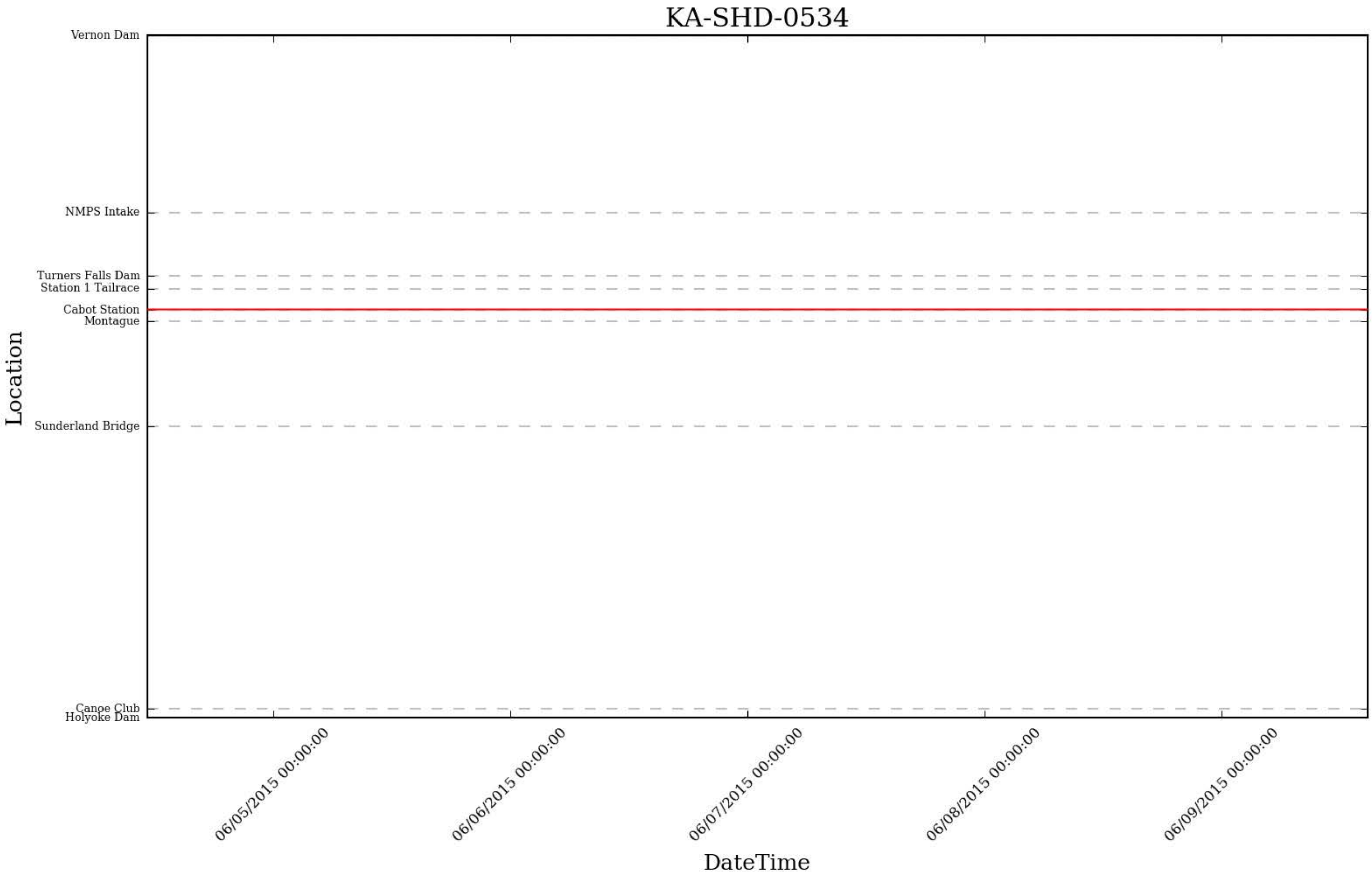

KA-SHD-0530
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
DateTime


KA-SHD-0531
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/01/2015 01:41:00
06/01/2015 01:42:00
06/01/2015 01:43:00
06/01/2015 01:44:00
06/01/2015 01:45:00
06/01/2015 01:46:00
06/01/2015 01:47:00
06/01/2015 01:48:00
06/01/2015 01:49:00
06/01/2015 01:50:00
DateTime



KA-SHD-0532
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
DateTime


KA-SHD-0533
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 00:00:00
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
06/29/2015 00:00:00
DateTime


KA-SHD-0534
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/05/2015 00:00:00
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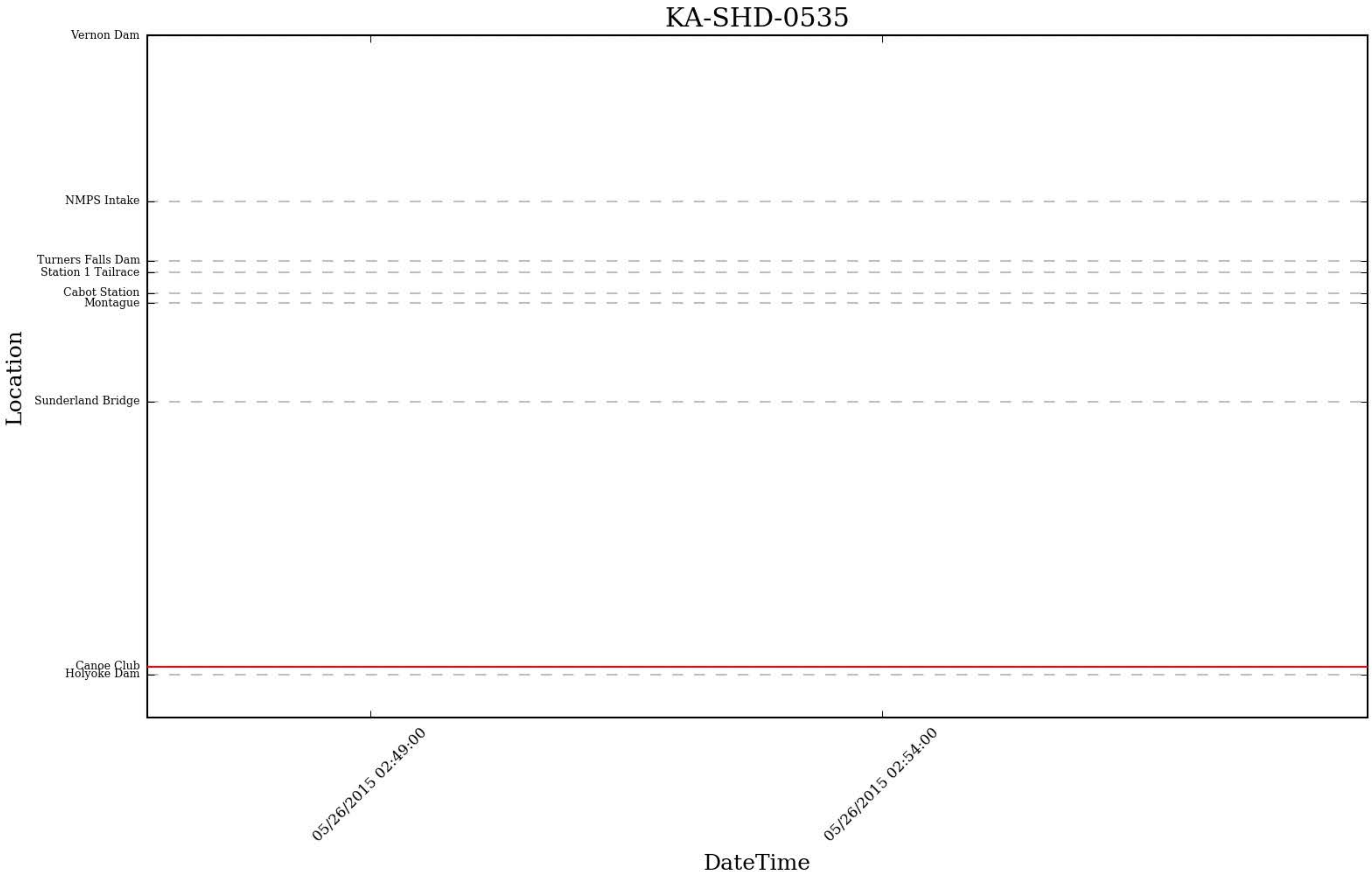
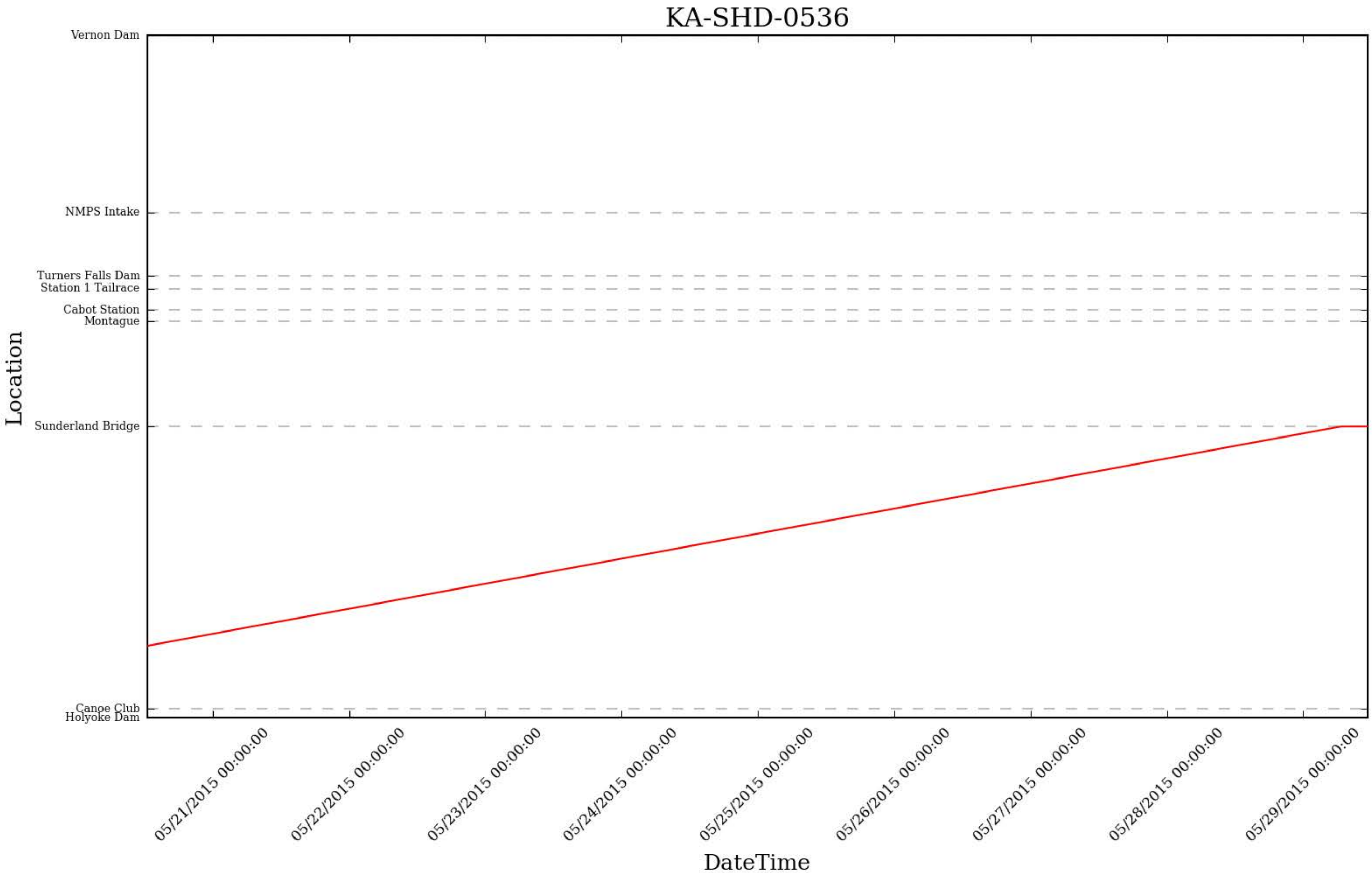
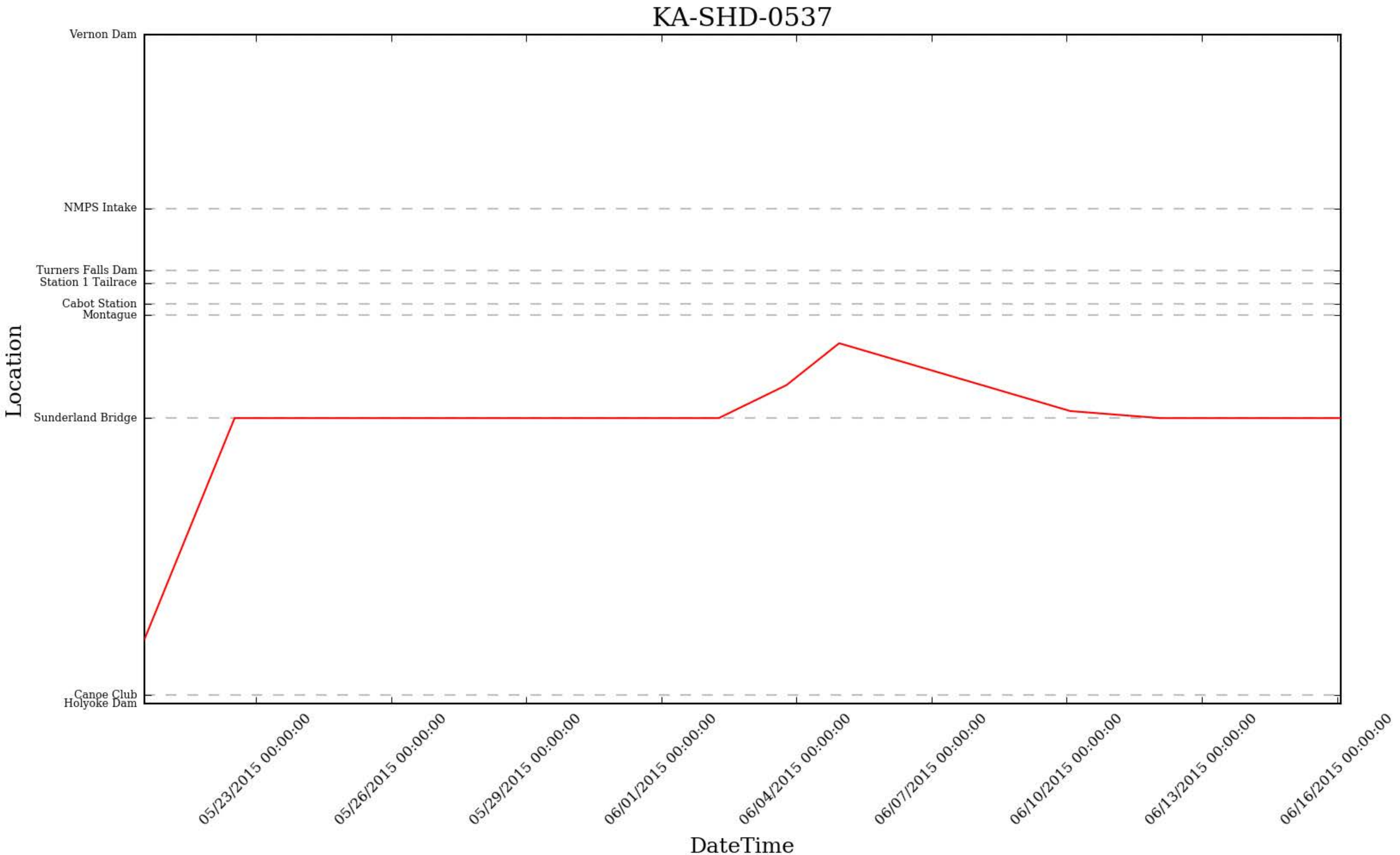
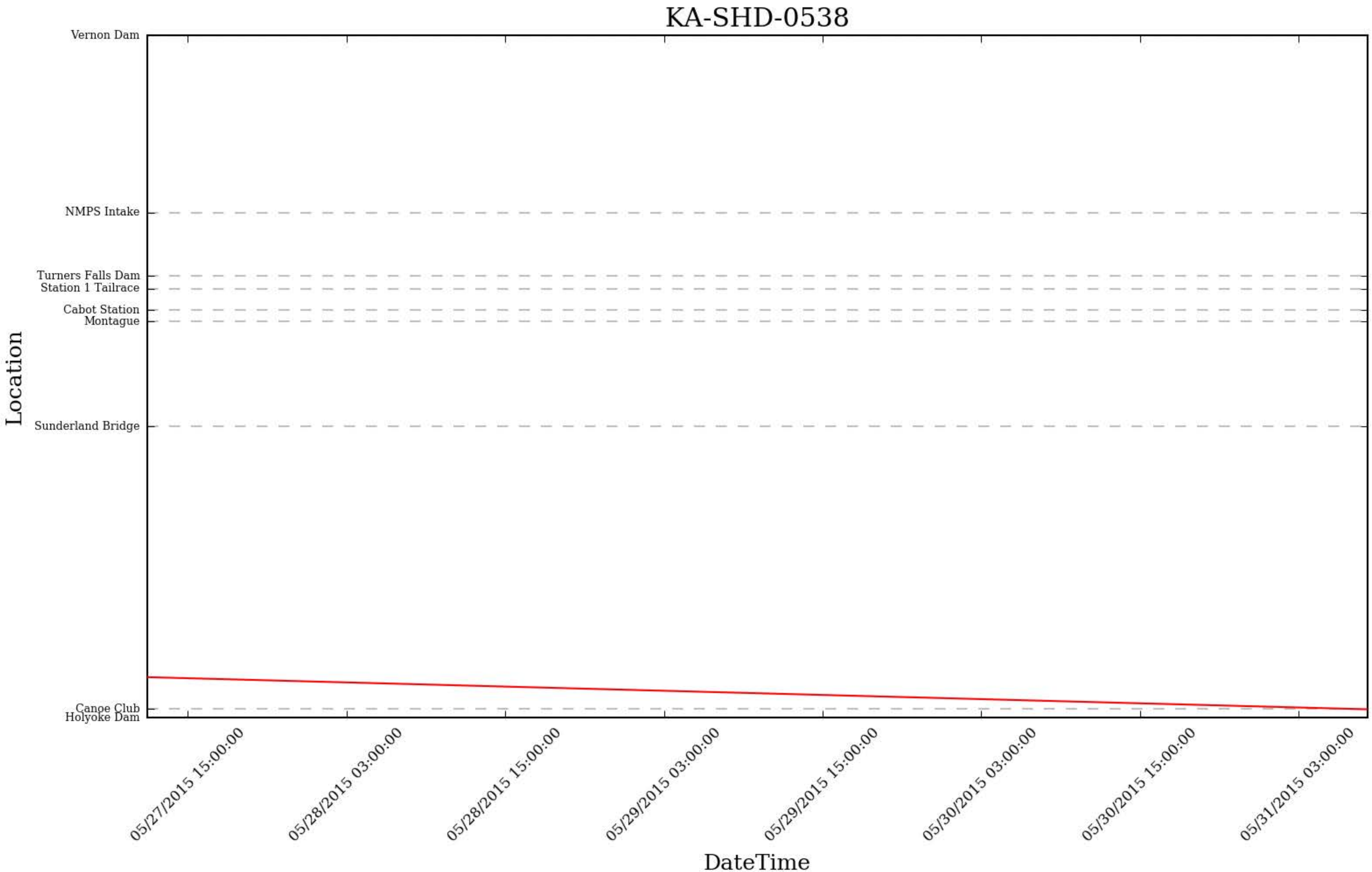
06/07/2015 00:00:00
06/08/2015 00:00:00
06/09/2015 00:00:00
DateTime

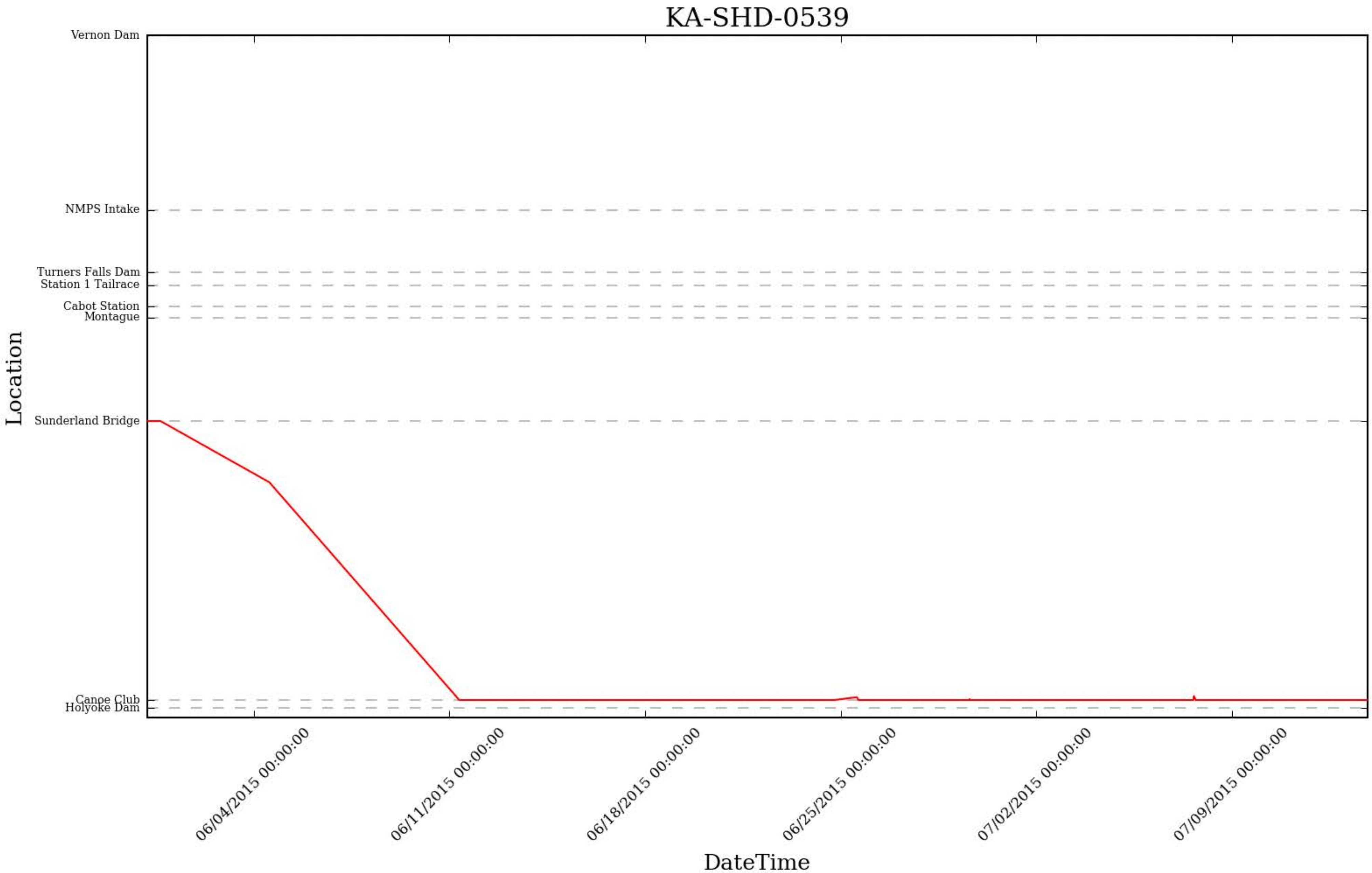

KA-SHD-0535
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 02:49:00
05/26/2015 02:54:00
DateTime



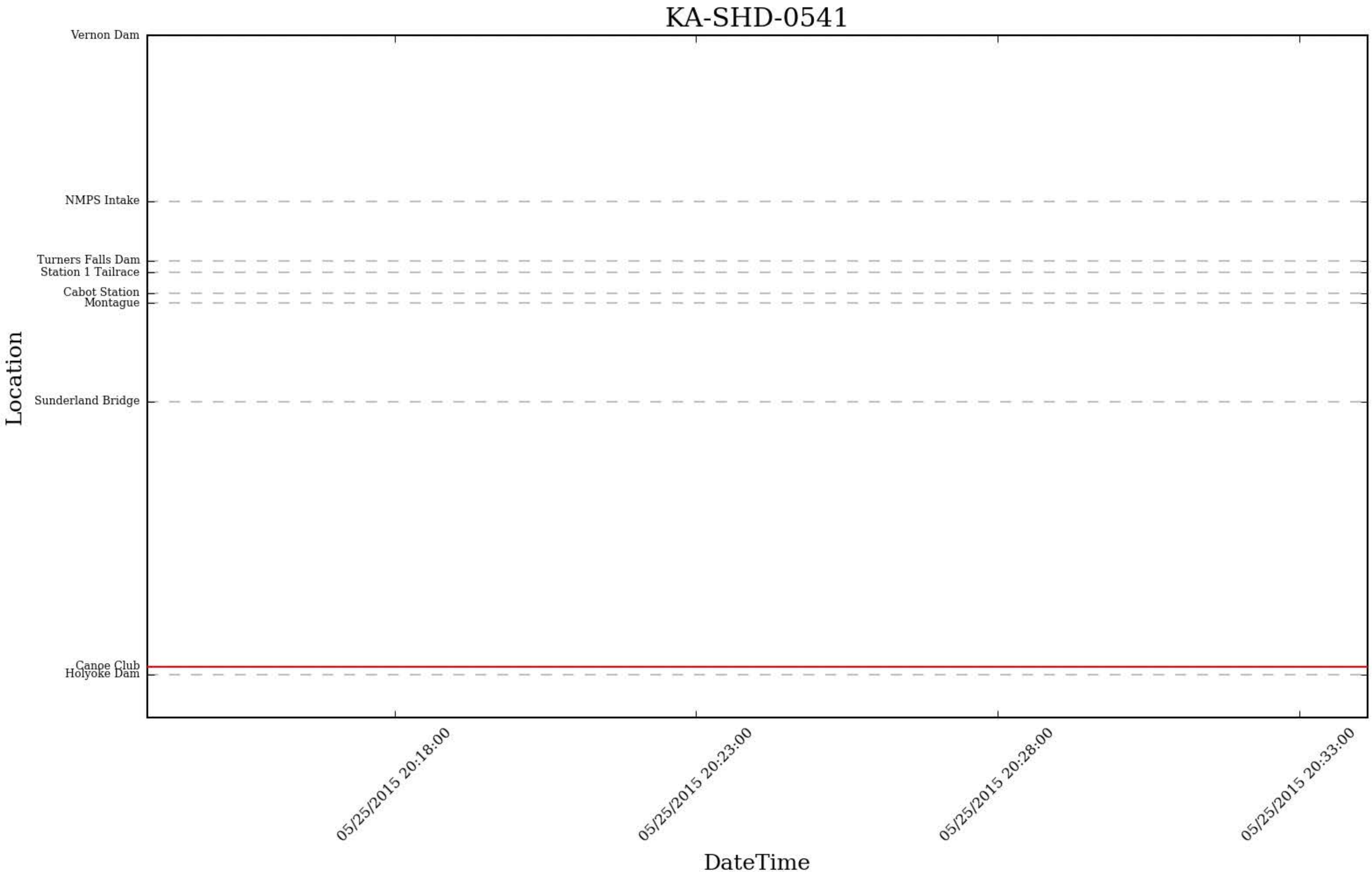
KA-SHD-0536
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
DateTime


KA-SHD-0537
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
06/13/2015 00:00:00
06/16/2015 00:00:00
DateTime

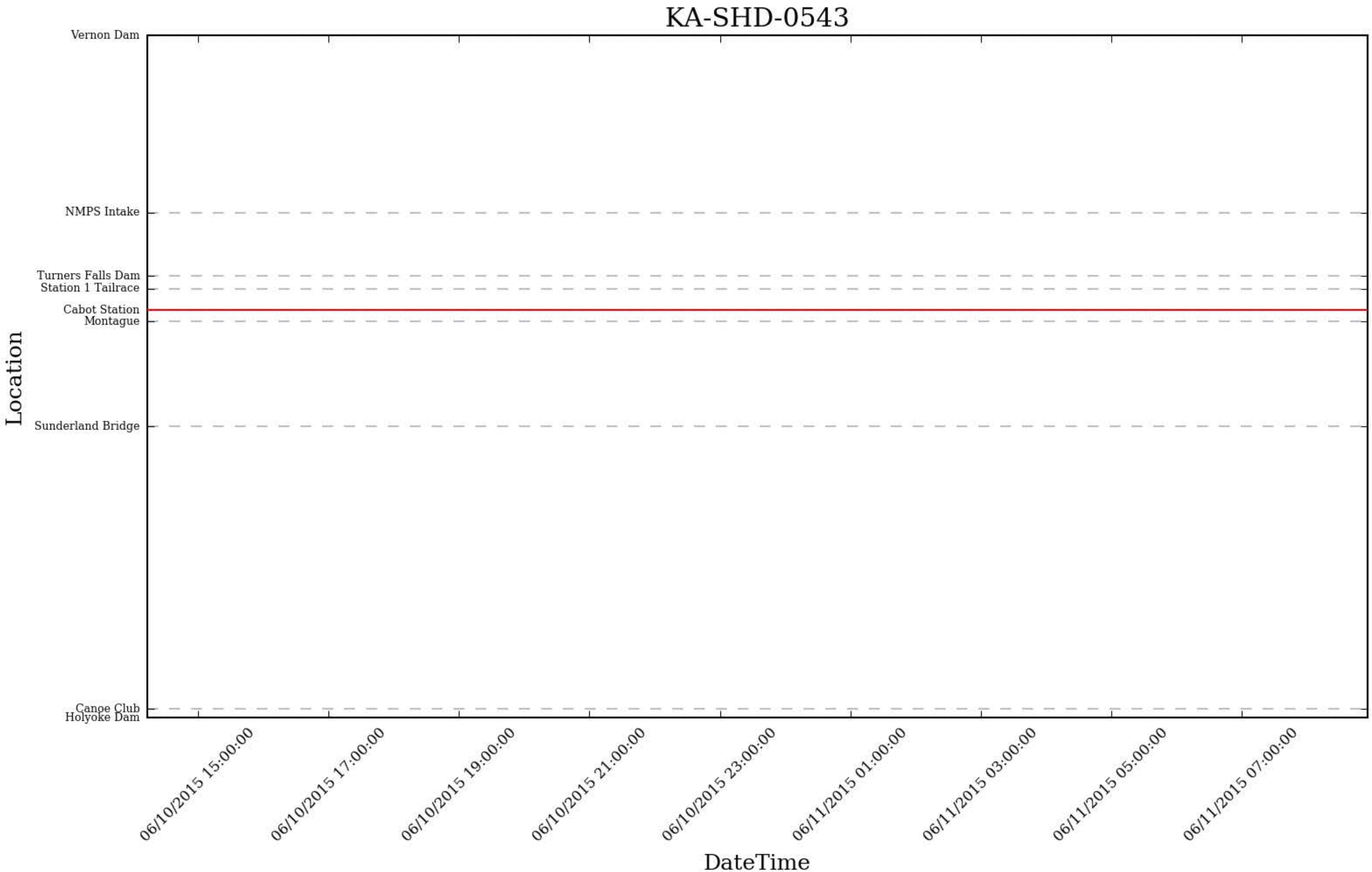

KA-SHD-0538
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 15:00:00
05/28/2015 03:00:00
05/28/2015 15:00:00
05/29/2015 03:00:00
05/29/2015 15:00:00
05/30/2015 03:00:00
05/30/2015 15:00:00
05/31/2015 03:00:00
DateTime

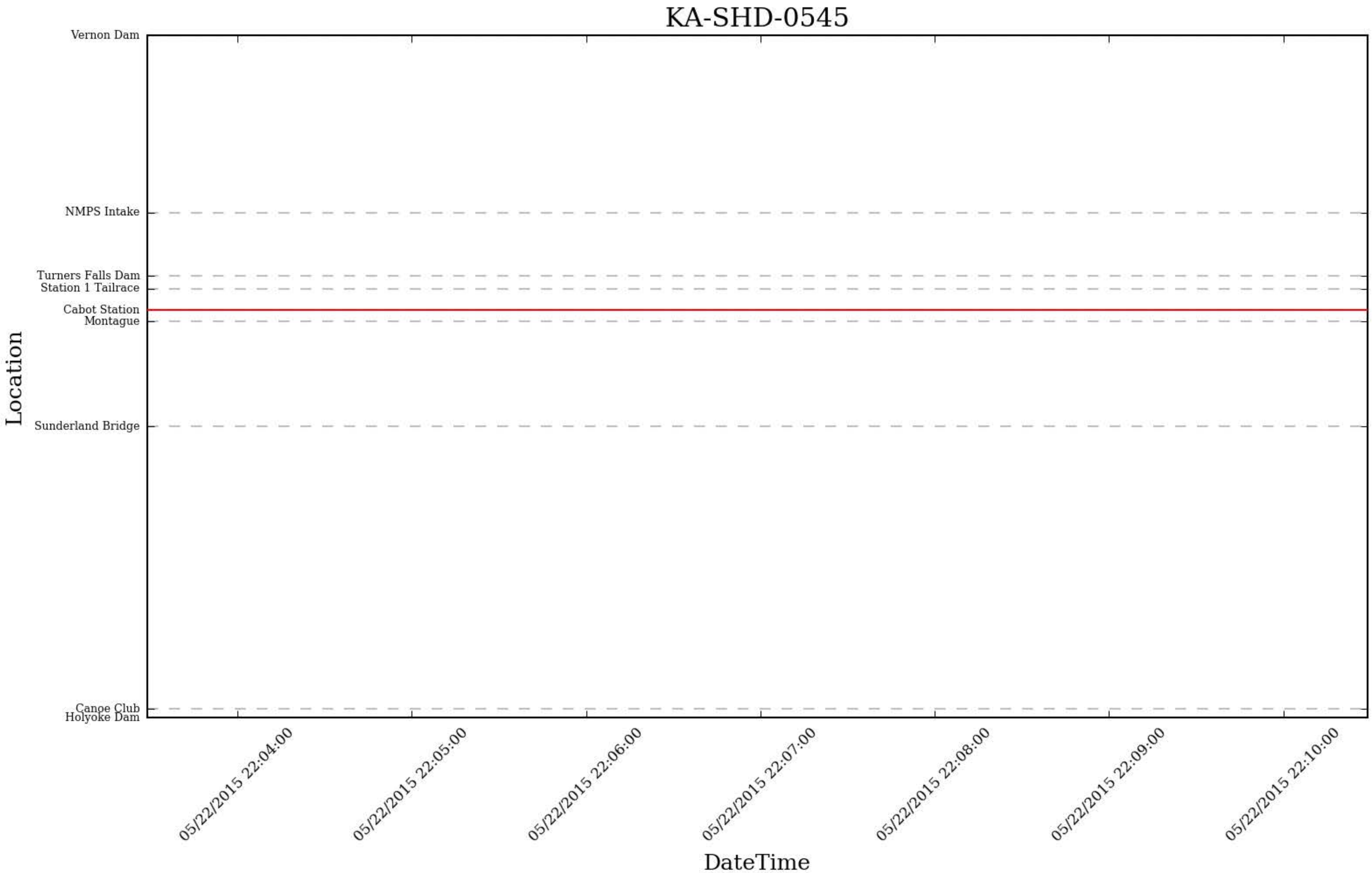


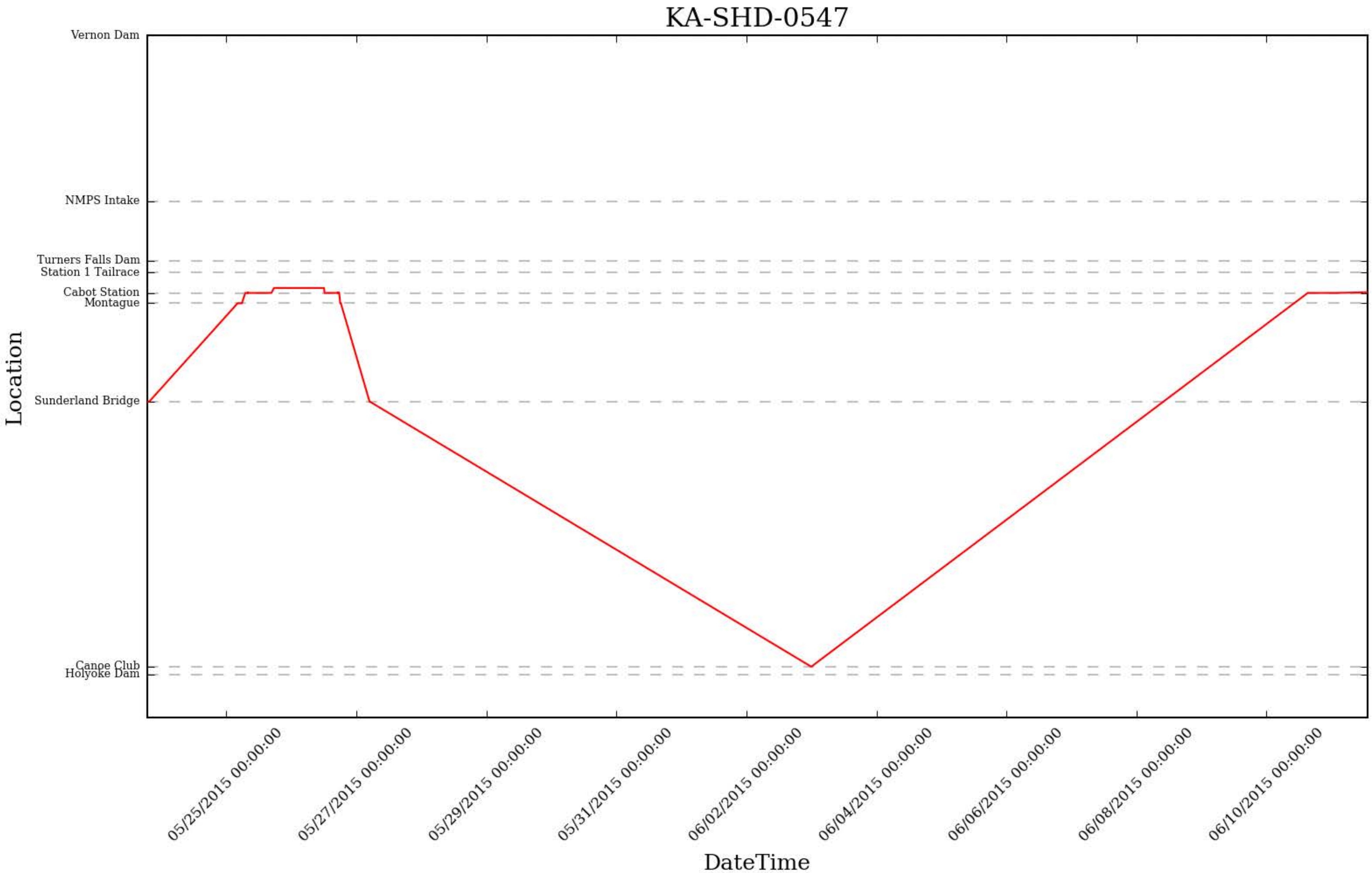
KA-SHD-0539
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
07/09/2015 00:00:00
DateTime

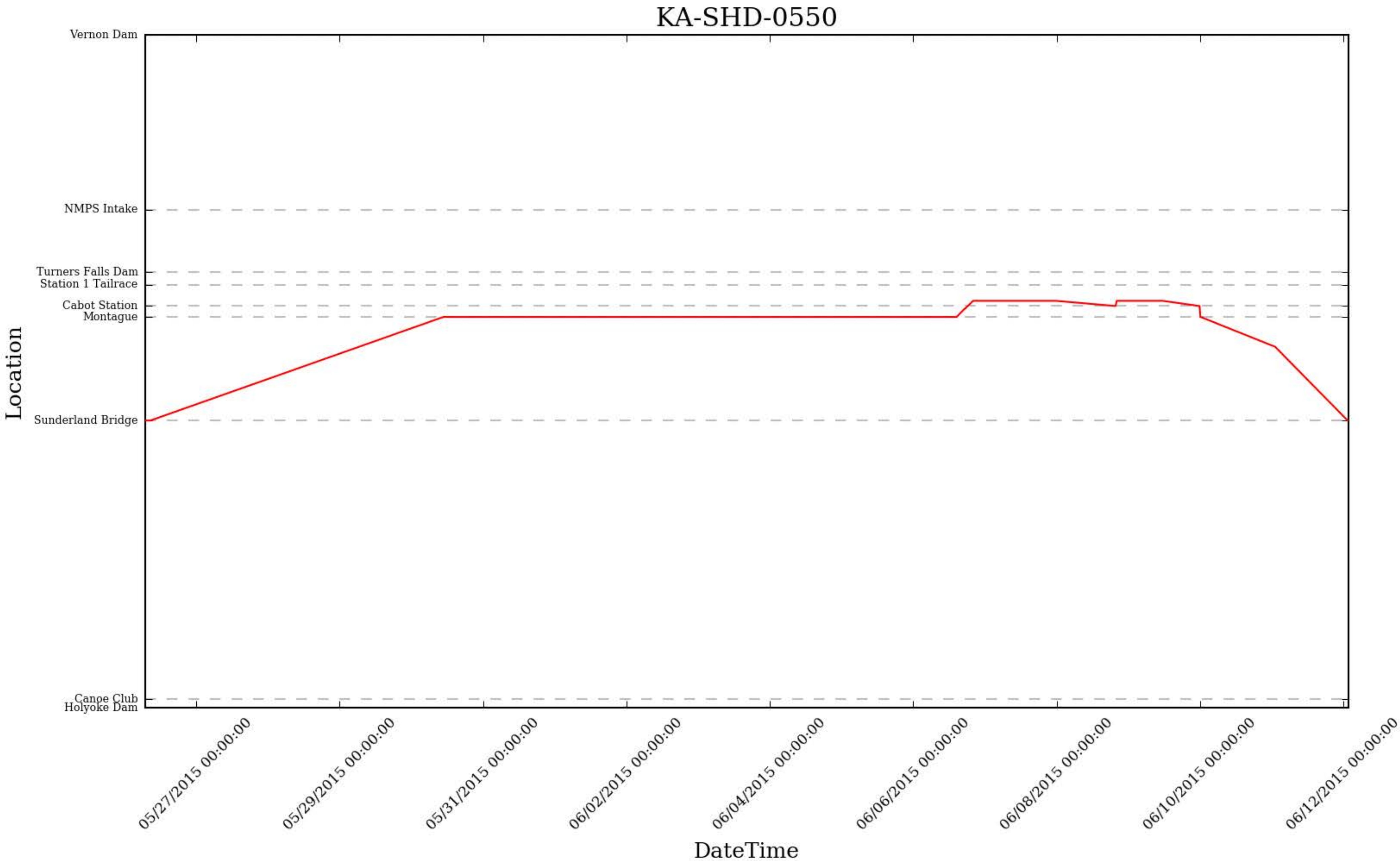


KA-SHD-0541
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 20:18:00
05/25/2015 20:23:00
05/25/2015 20:28:00
05/25/2015 20:33:00
DateTime

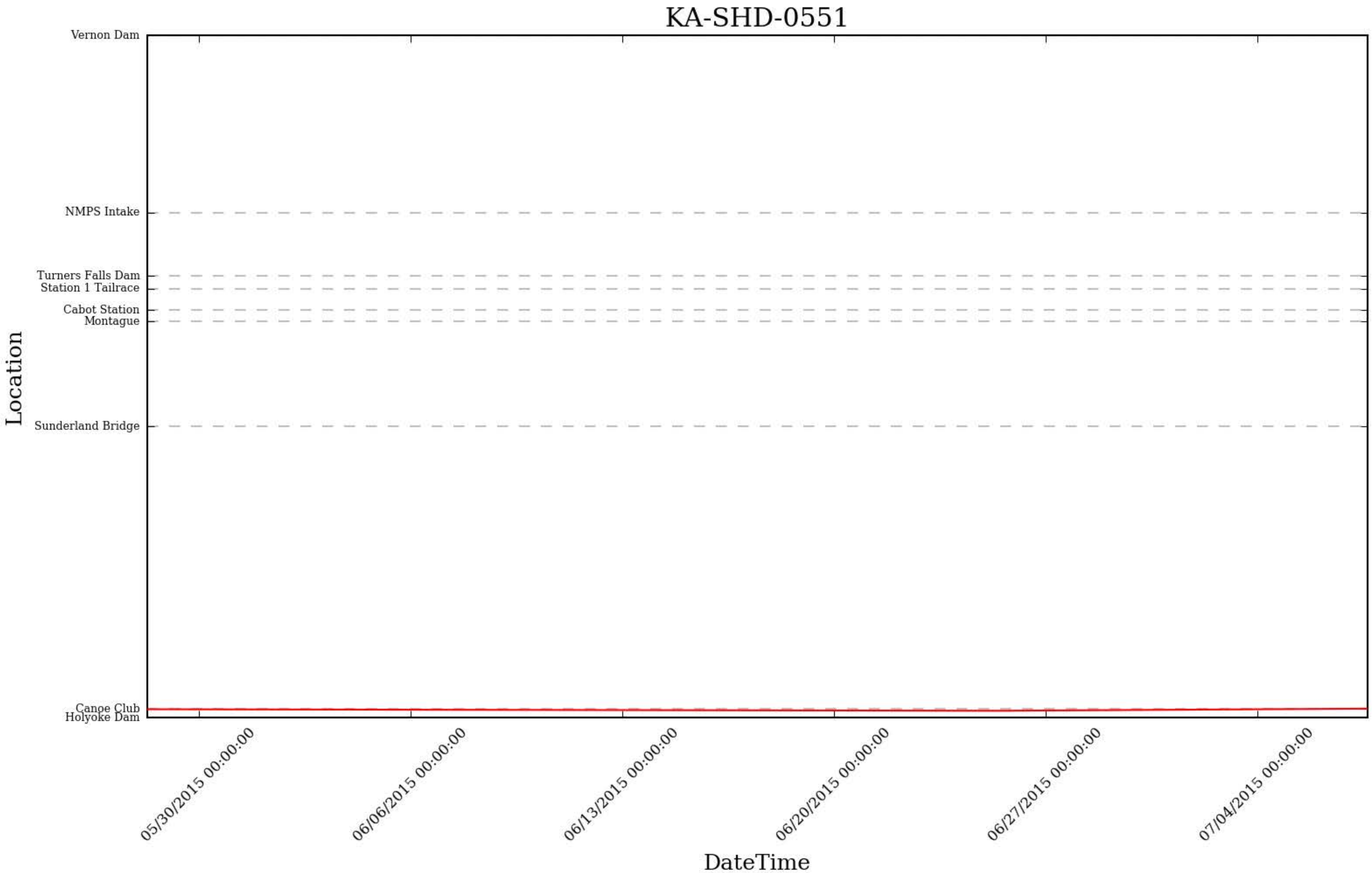

KA-SHD-0543
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/10/2015 15:00:00
06/10/2015 17:00:00
06/10/2015 19:00:00
06/10/2015 21:00:00
06/10/2015 23:00:00
06/11/2015 01:00:00
06/11/2015 03:00:00
06/11/2015 05:00:00
06/11/2015 07:00:00
DateTime


KA-SHD-0545
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 22:04:00
05/22/2015 22:05:00
05/22/2015 22:06:00
05/22/2015 22:07:00
05/22/2015 22:08:00
05/22/2015 22:09:00
05/22/2015 22:10:00
DateTime

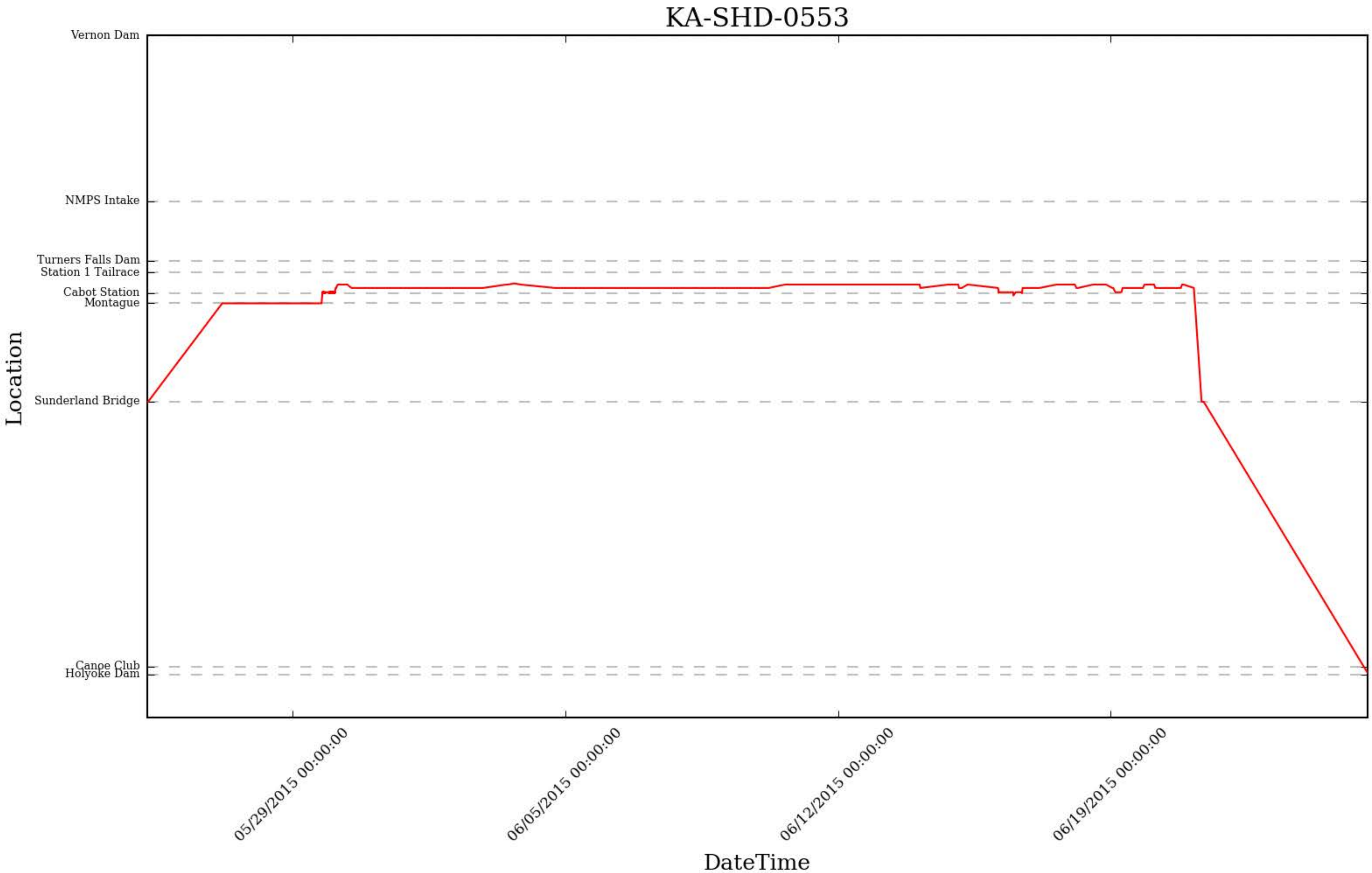

KA-SHD-0547
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
06/06/2015 00:00:00
06/08/2015 00:00:00
06/10/2015 00:00:00
DateTime

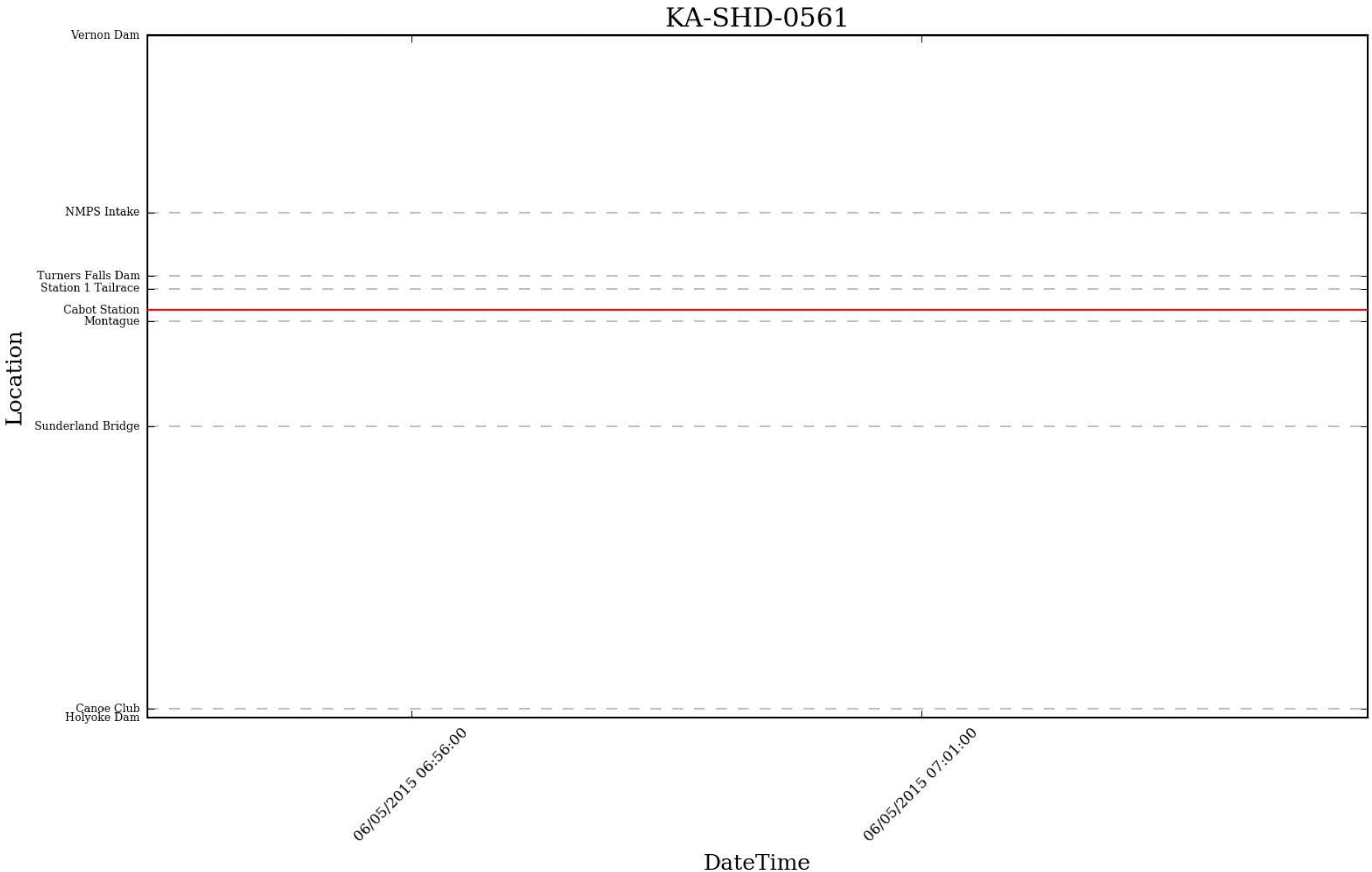


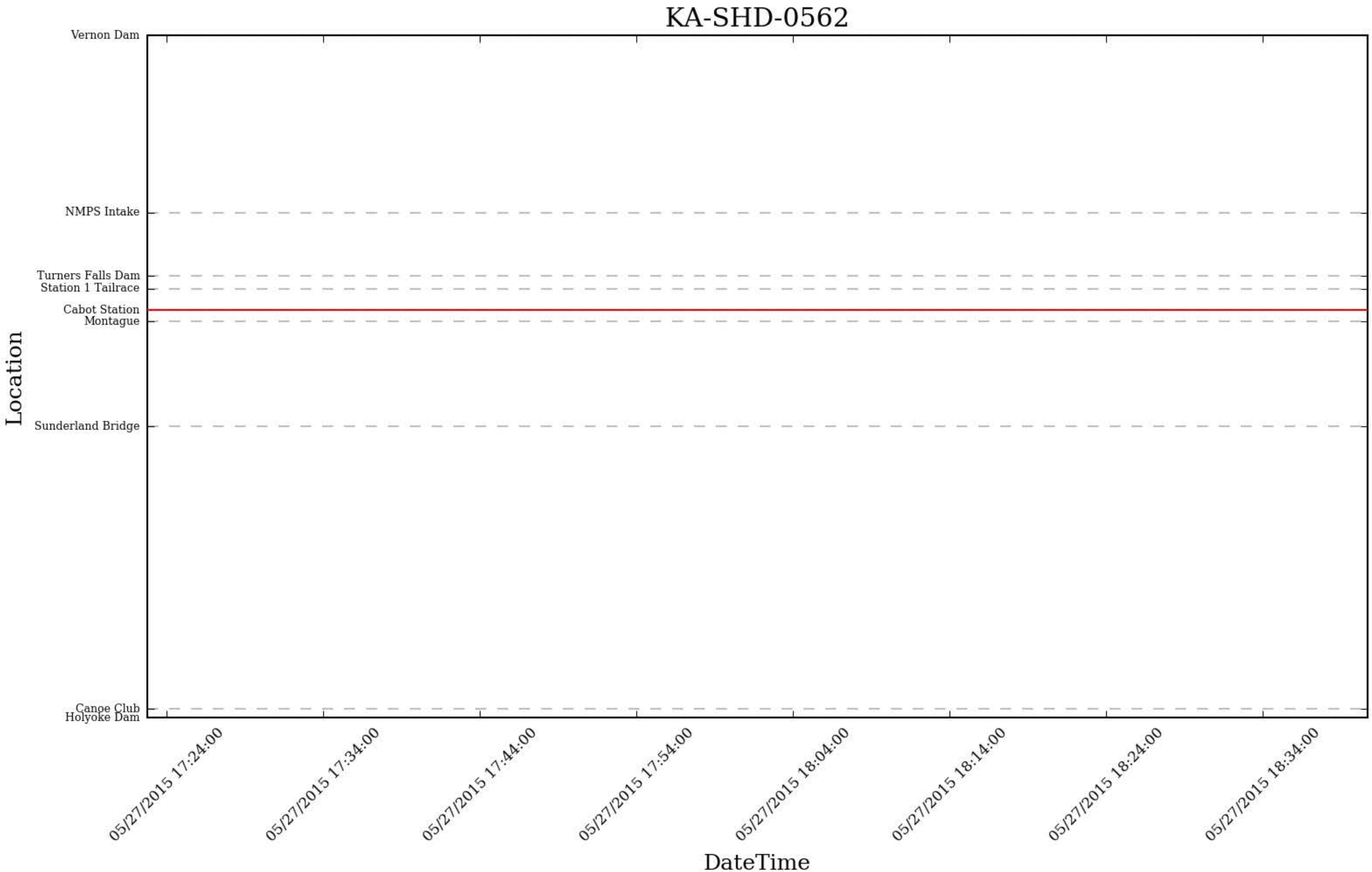
KA-SHD-0550
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
06/06/2015 00:00:00
06/08/2015 00:00:00
06/10/2015 00:00:00
06/12/2015 00:00:00
DateTime

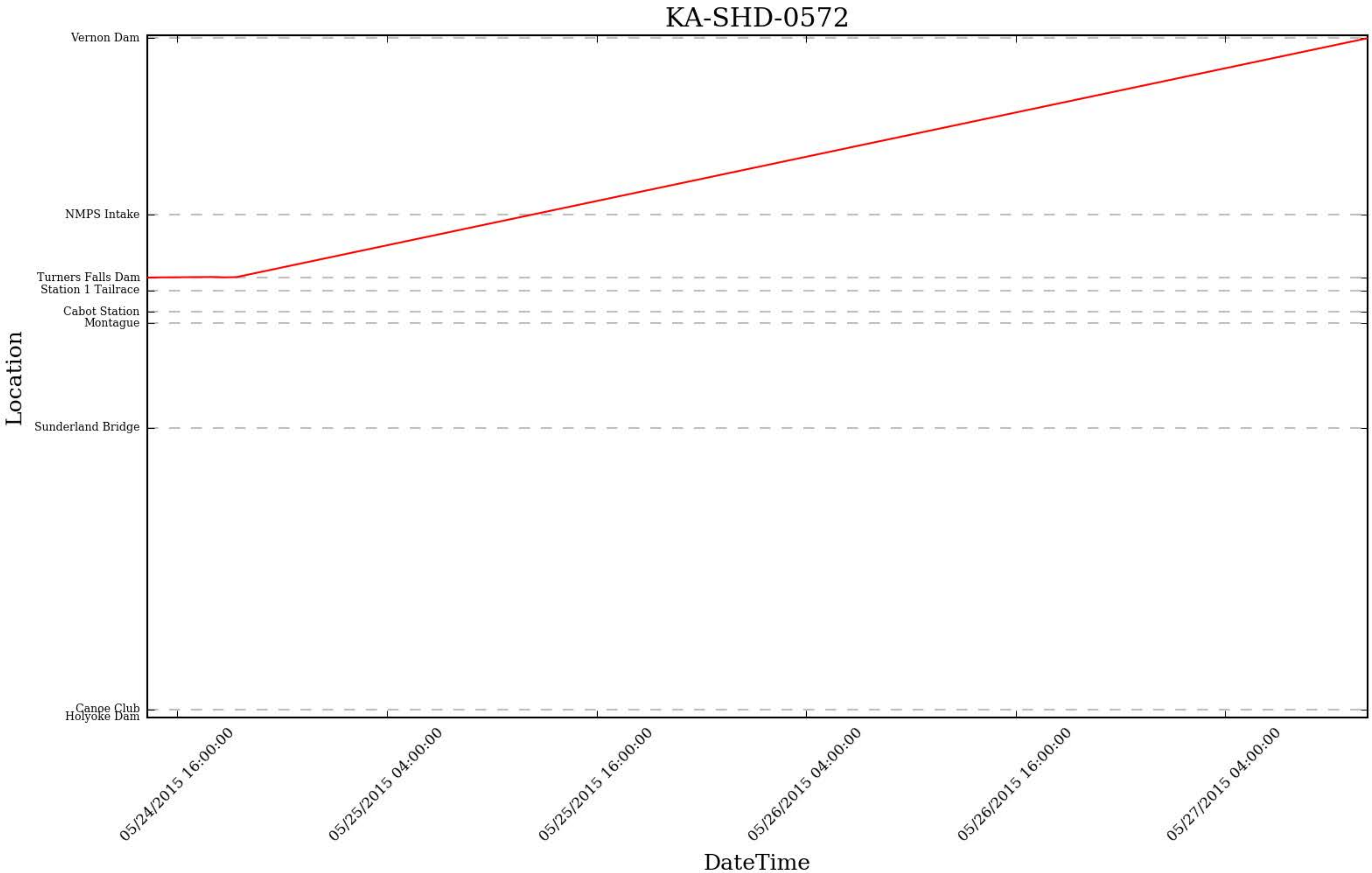


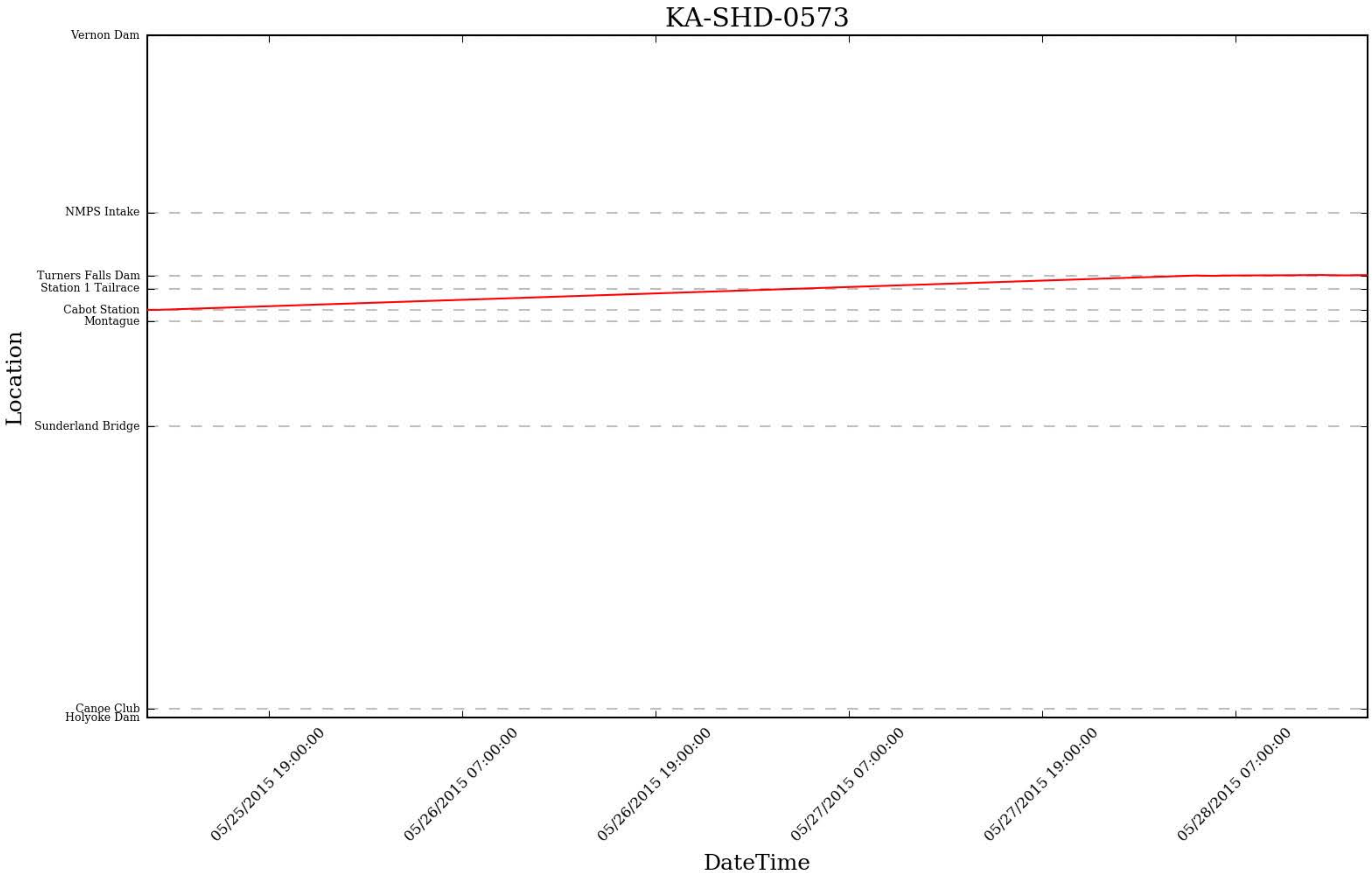
KA-SHD-0551
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 00:00:00
06/06/2015 00:00:00
06/13/2015 00:00:00
06/20/2015 00:00:00
06/27/2015 00:00:00
07/04/2015 00:00:00
DateTime

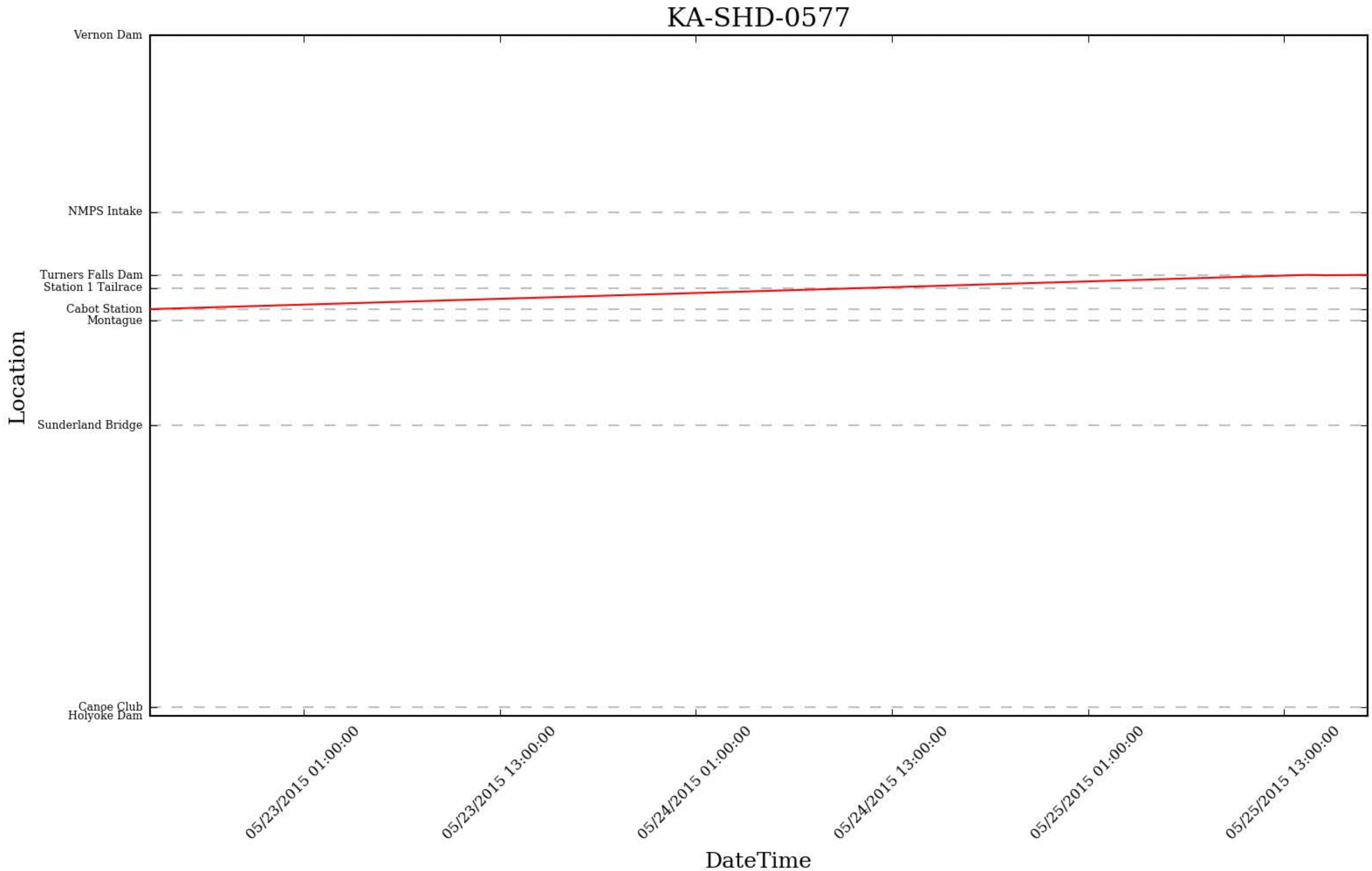

KA-SHD-0553
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
DateTime

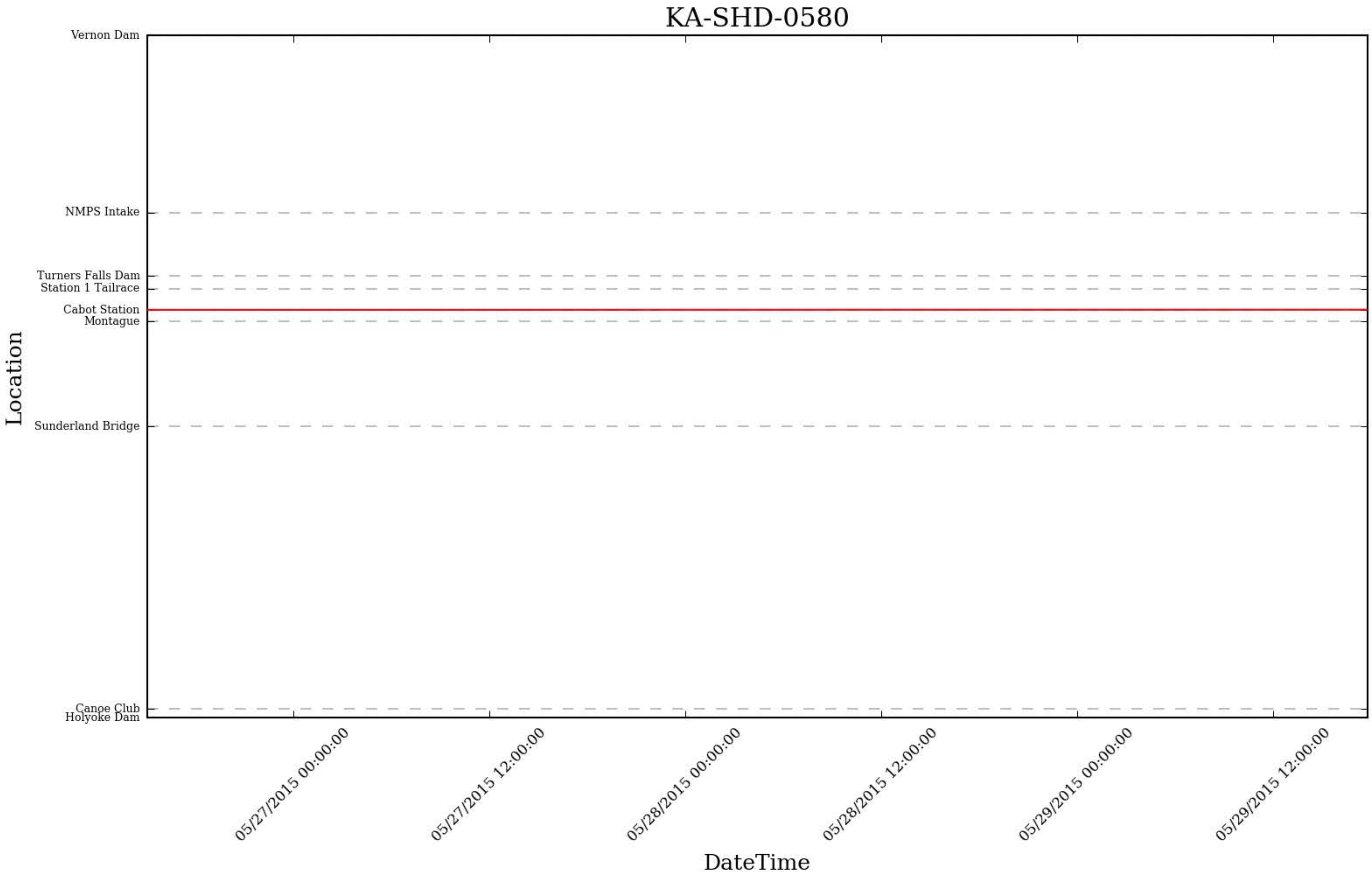

KA-SHD-0561
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/05/2015 06:56:00
06/05/2015 07:01:00
DateTime

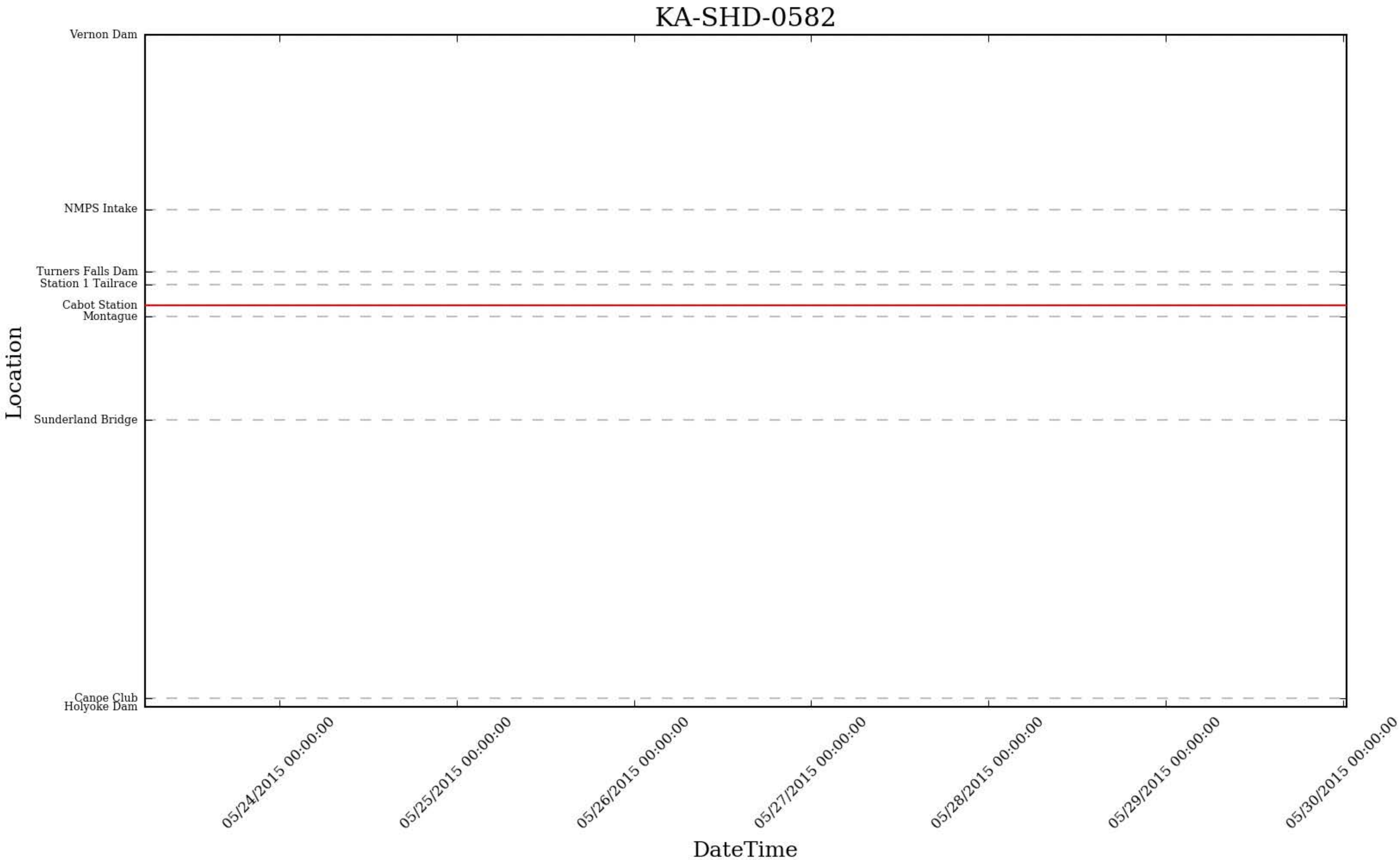

KA-SHD-0562
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 17:24:00
05/27/2015 17:34:00
05/27/2015 17:44:00
05/27/2015 17:54:00
05/27/2015 18:04:00
05/27/2015 18:14:00
05/27/2015 18:24:00
05/27/2015 18:34:00
DateTime

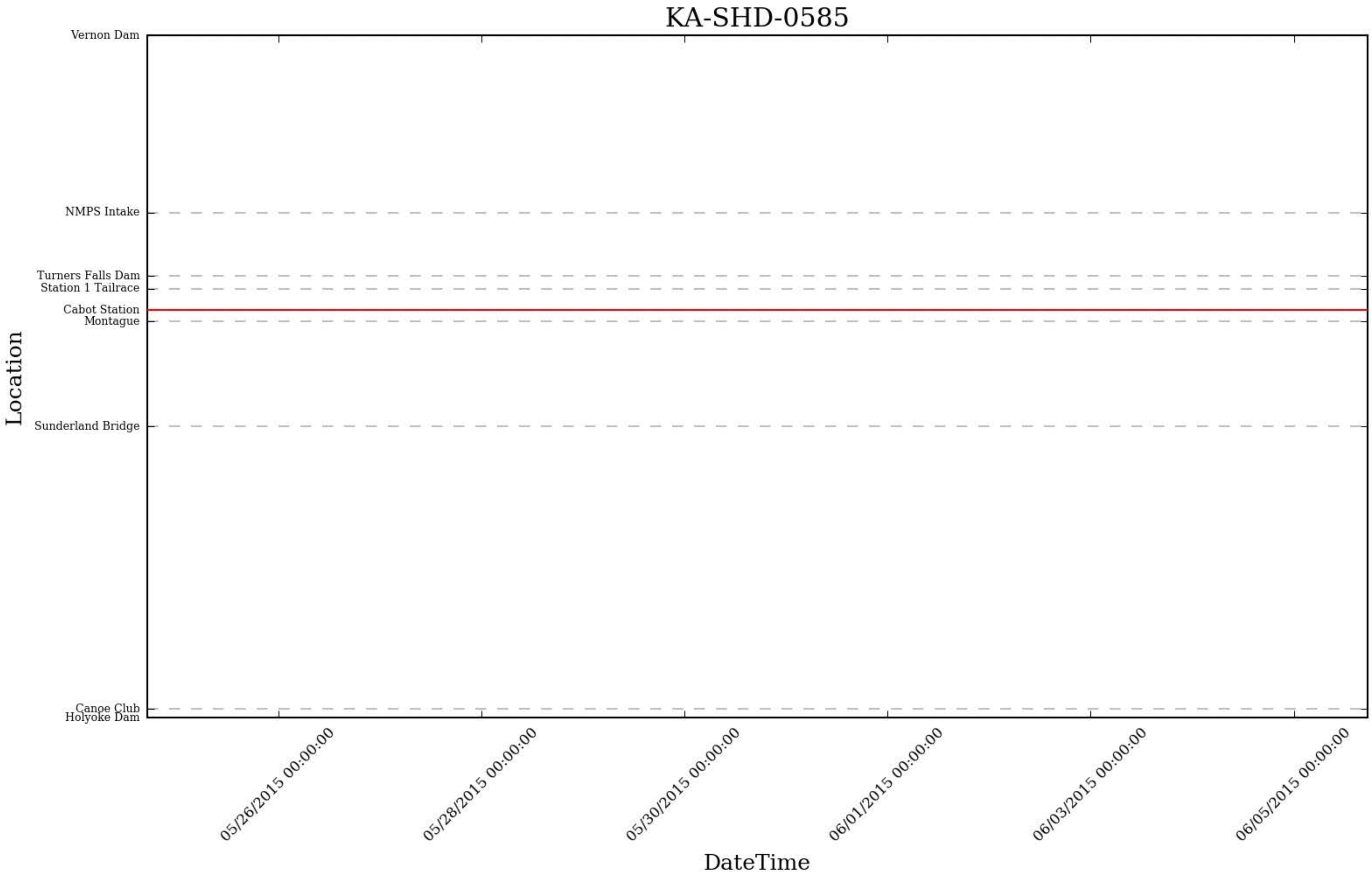

KA-SHD-0572
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/24/2015 16:00:00
05/25/2015 04:00:00
05/25/2015 16:00:00
05/26/2015 04:00:00
05/26/2015 16:00:00
05/27/2015 04:00:00
DateTime


KA-SHD-0573
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 19:00:00
05/26/2015 07:00:00
05/26/2015 19:00:00
05/27/2015 07:00:00
05/27/2015 19:00:00
05/28/2015 07:00:00
DateTime

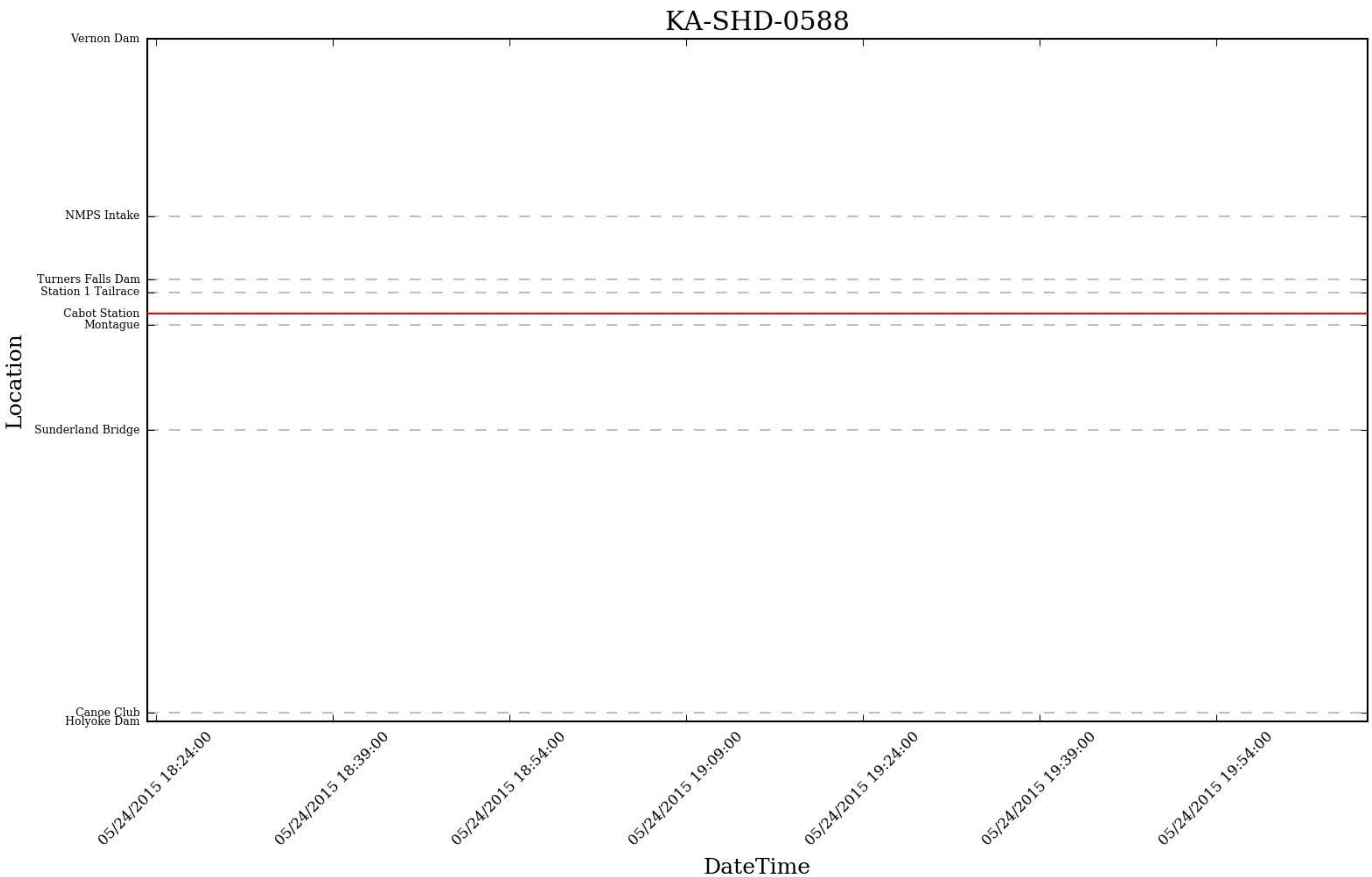

KA-SHD-0577
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 01:00:00
05/23/2015 13:00:00
05/24/2015 01:00:00
05/24/2015 13:00:00
05/25/2015 01:00:00
05/25/2015 13:00:00
DateTime

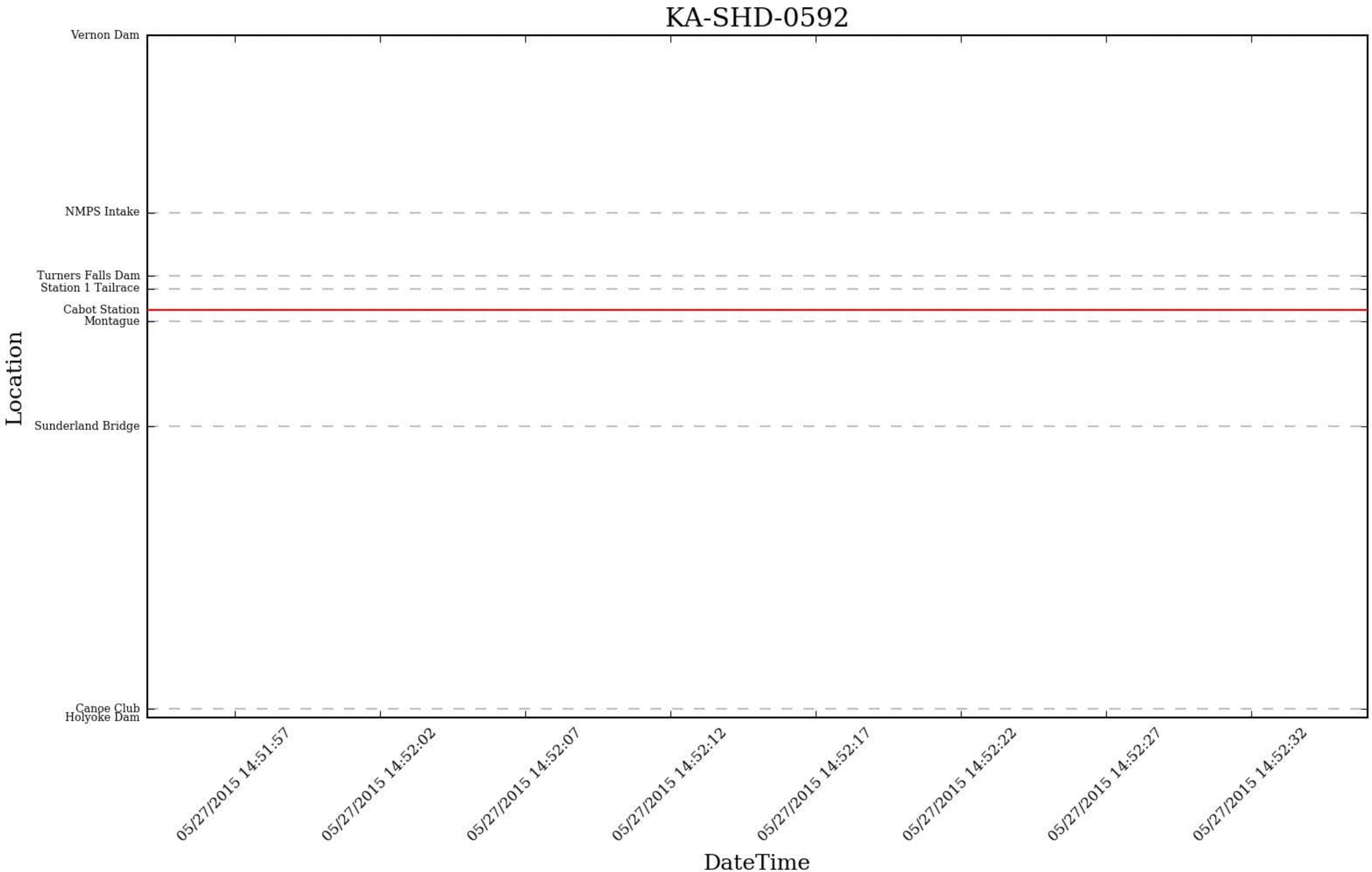

KA-SHD-0580
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/27/2015 12:00:00
05/28/2015 00:00:00
05/28/2015 12:00:00
05/29/2015 00:00:00
05/29/2015 12:00:00
DateTime


KA-SHD-0582
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
DateTime

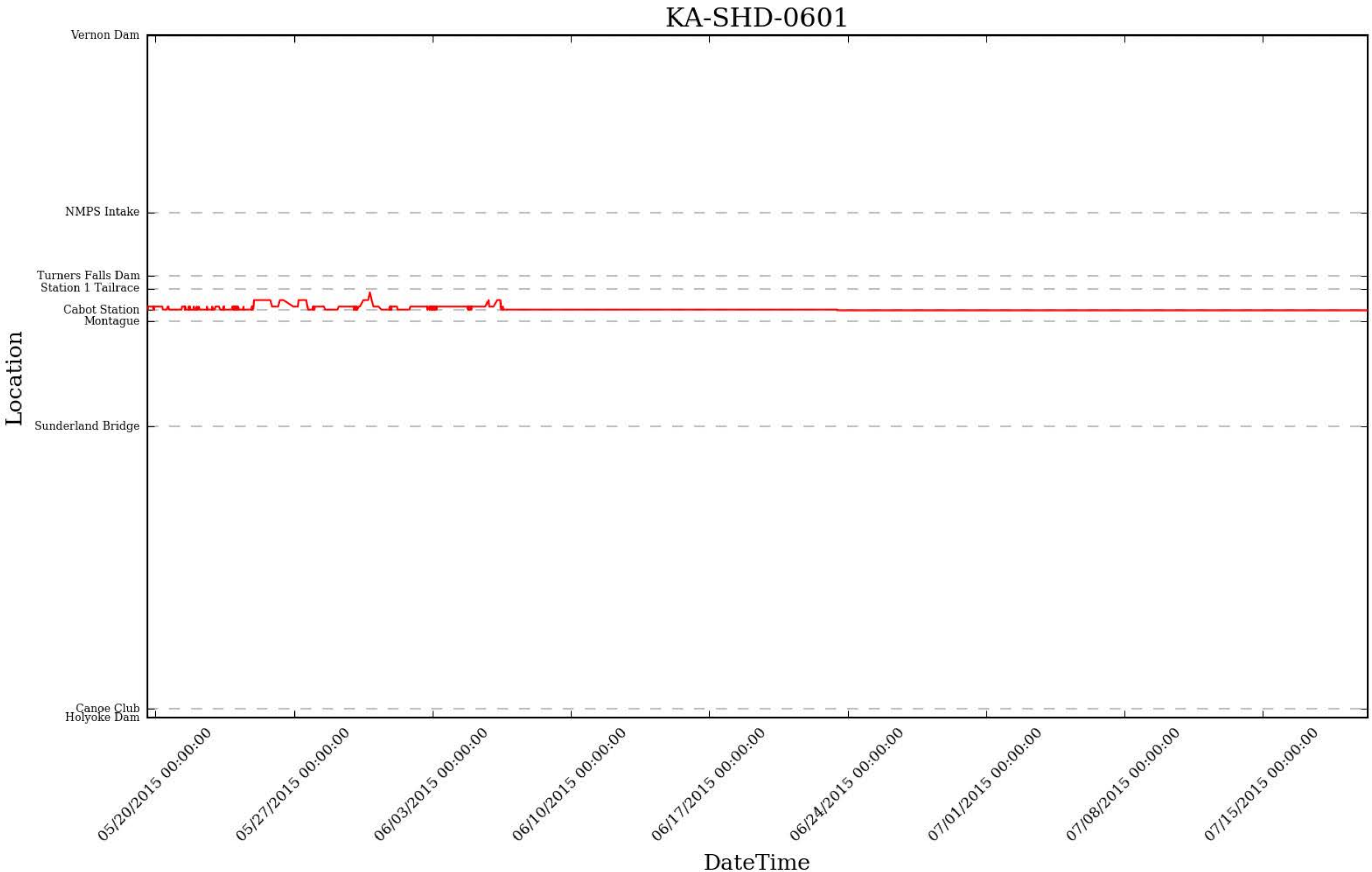


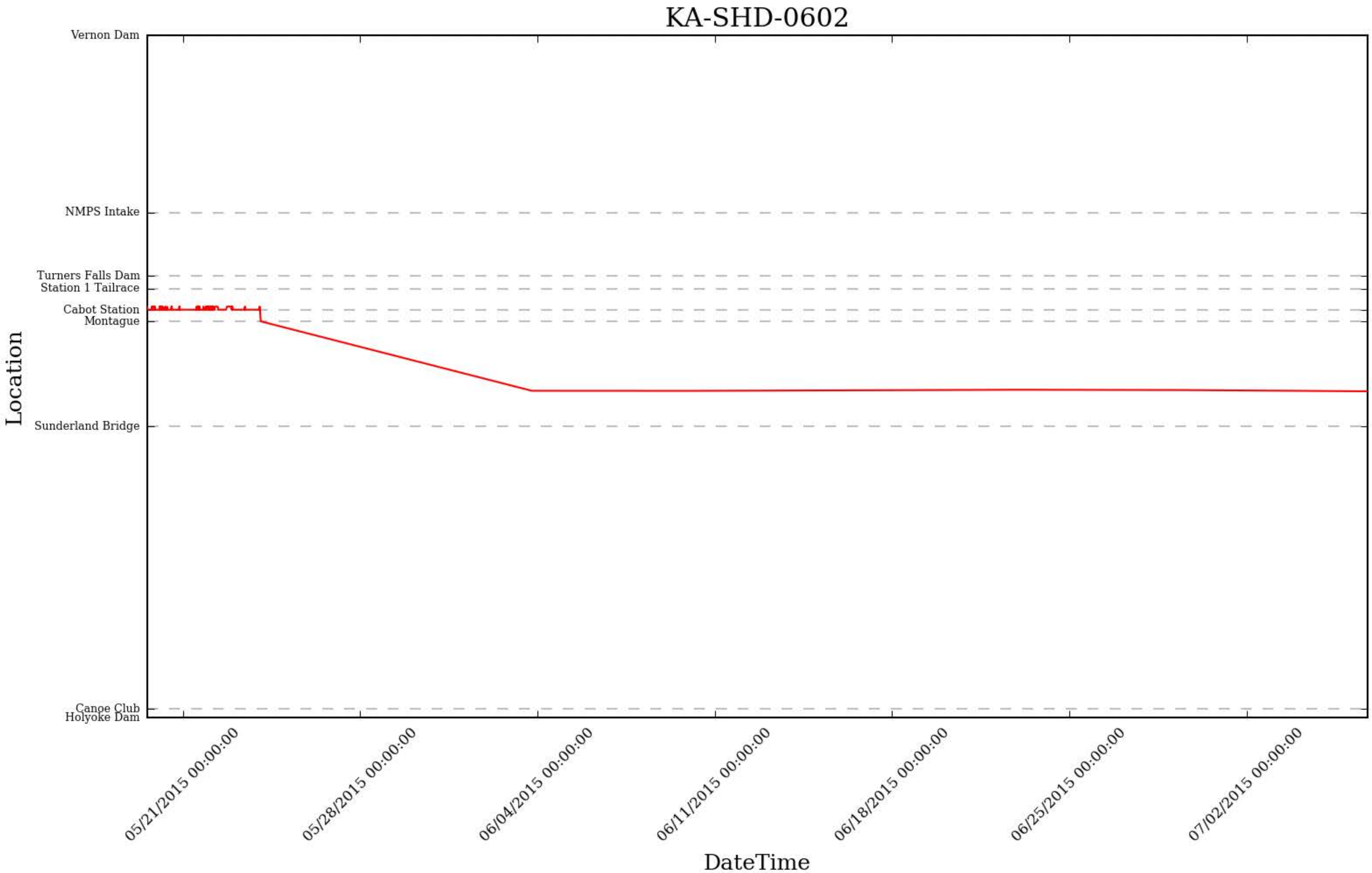
KA-SHD-0585
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime

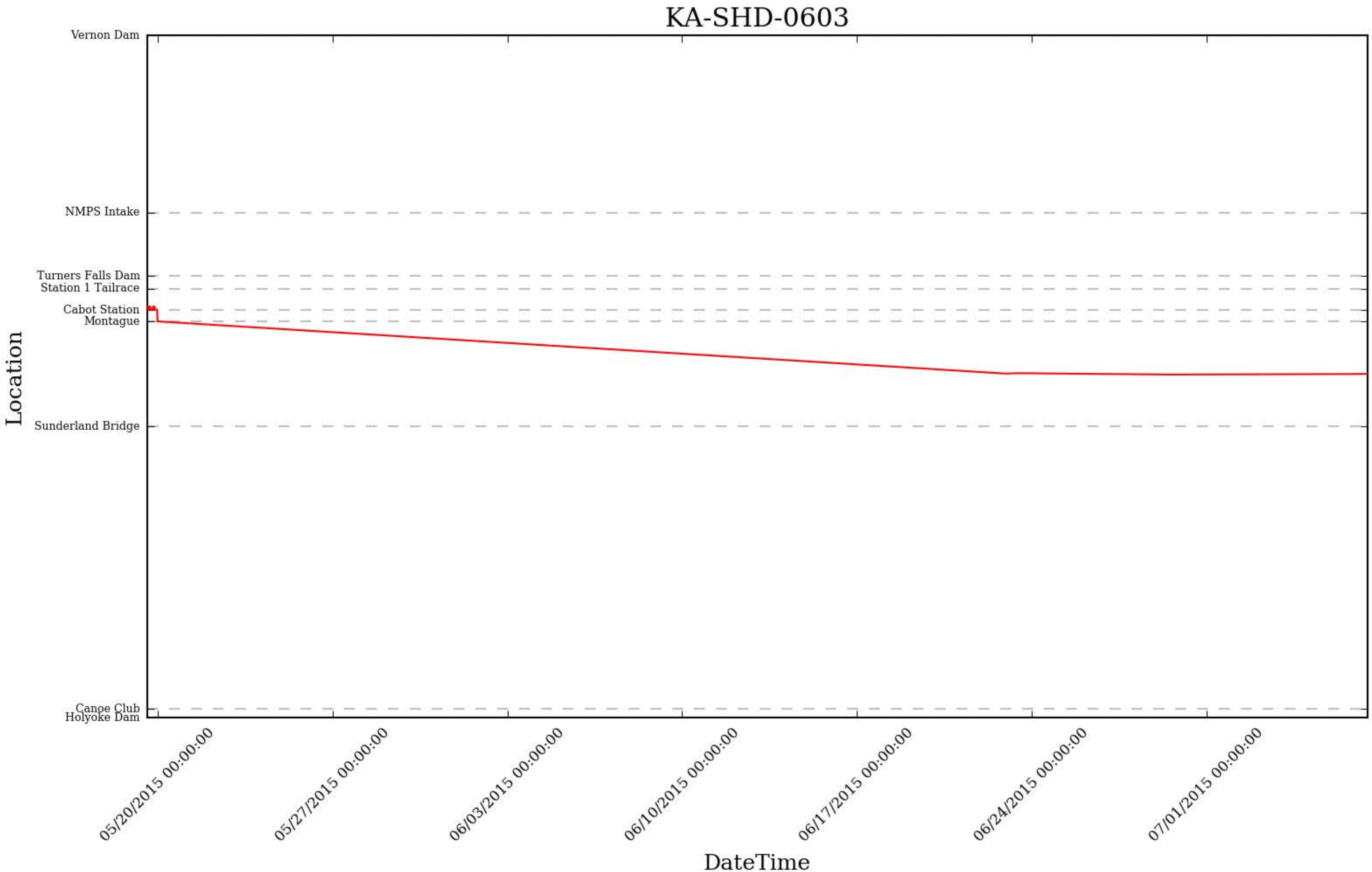

KA-SHD-0588
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 18:24:00
05/24/2015 18:39:00
05/24/2015 18:54:00
05/24/2015 19:09:00
05/24/2015 19:24:00
05/24/2015 19:39:00
05/24/2015 19:54:00
DateTime



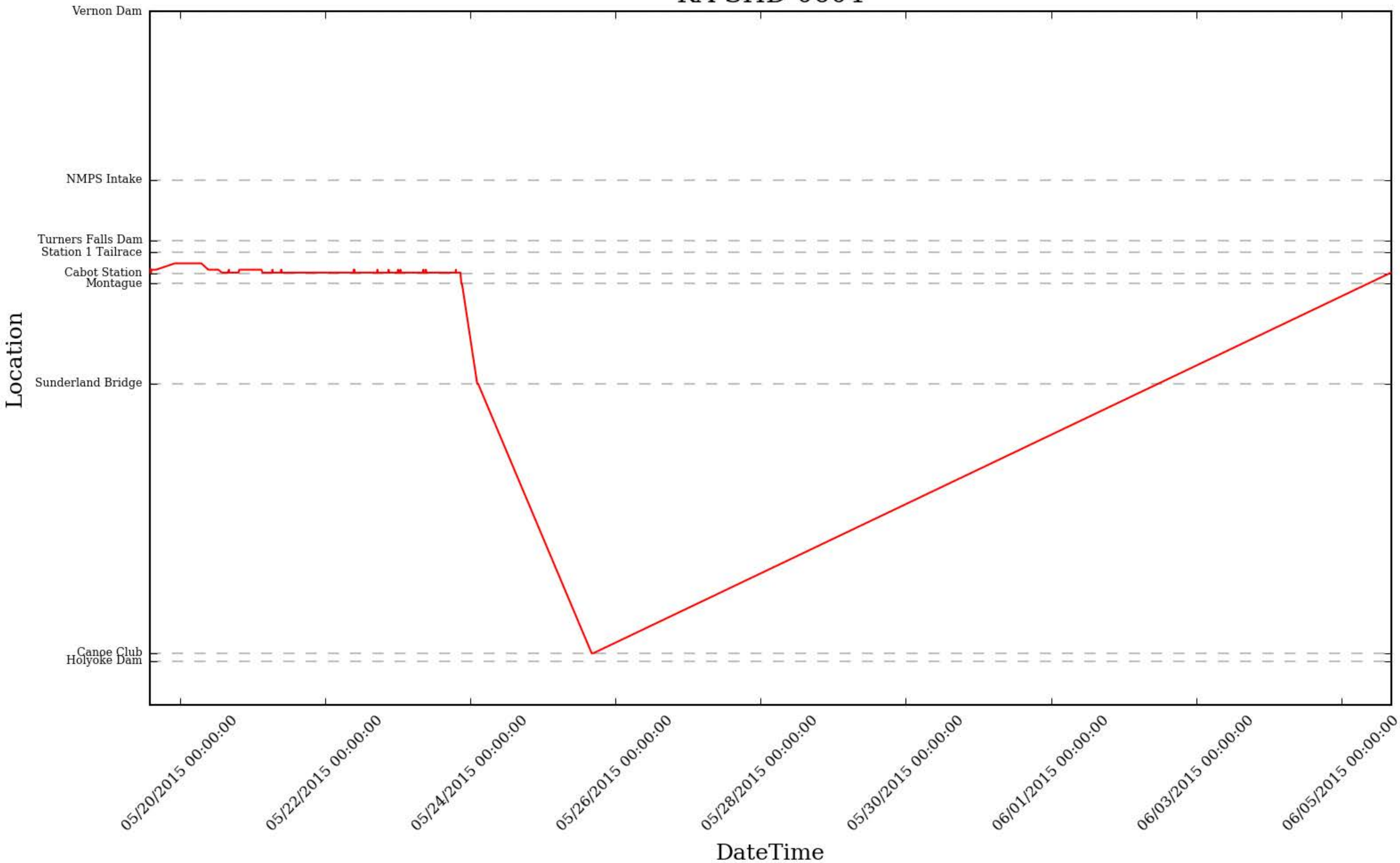
KA-SHD-0592
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 14:51:57
05/27/2015 14:52:02
05/27/2015 14:52:07
05/27/2015 14:52:12
05/27/2015 14:52:17
05/27/2015 14:52:22
05/27/2015 14:52:27
05/27/2015 14:52:32
DateTime


KA-SHD-0601
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
07/08/2015 00:00:00
07/15/2015 00:00:00
DateTime

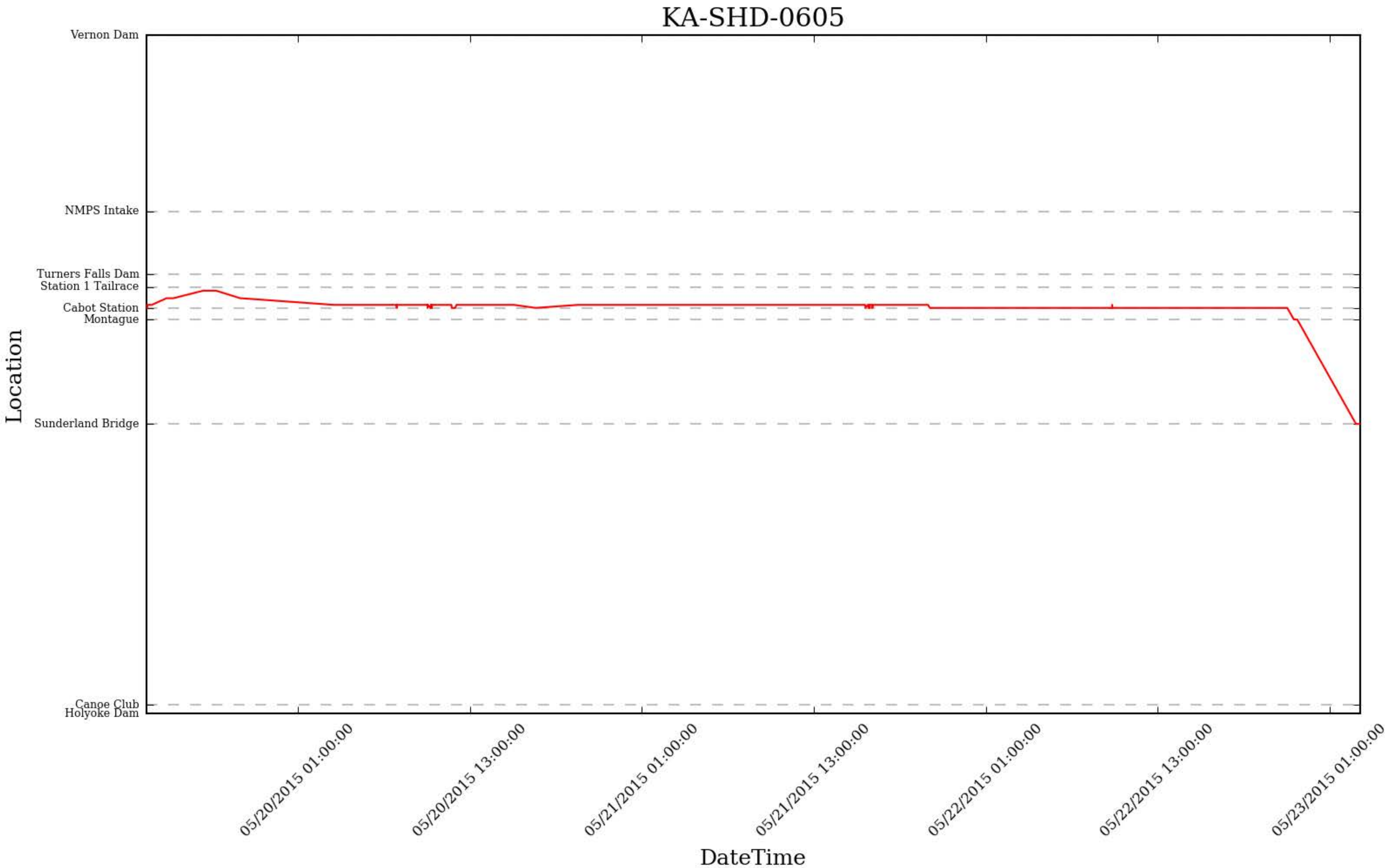

KA-SHD-0602
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

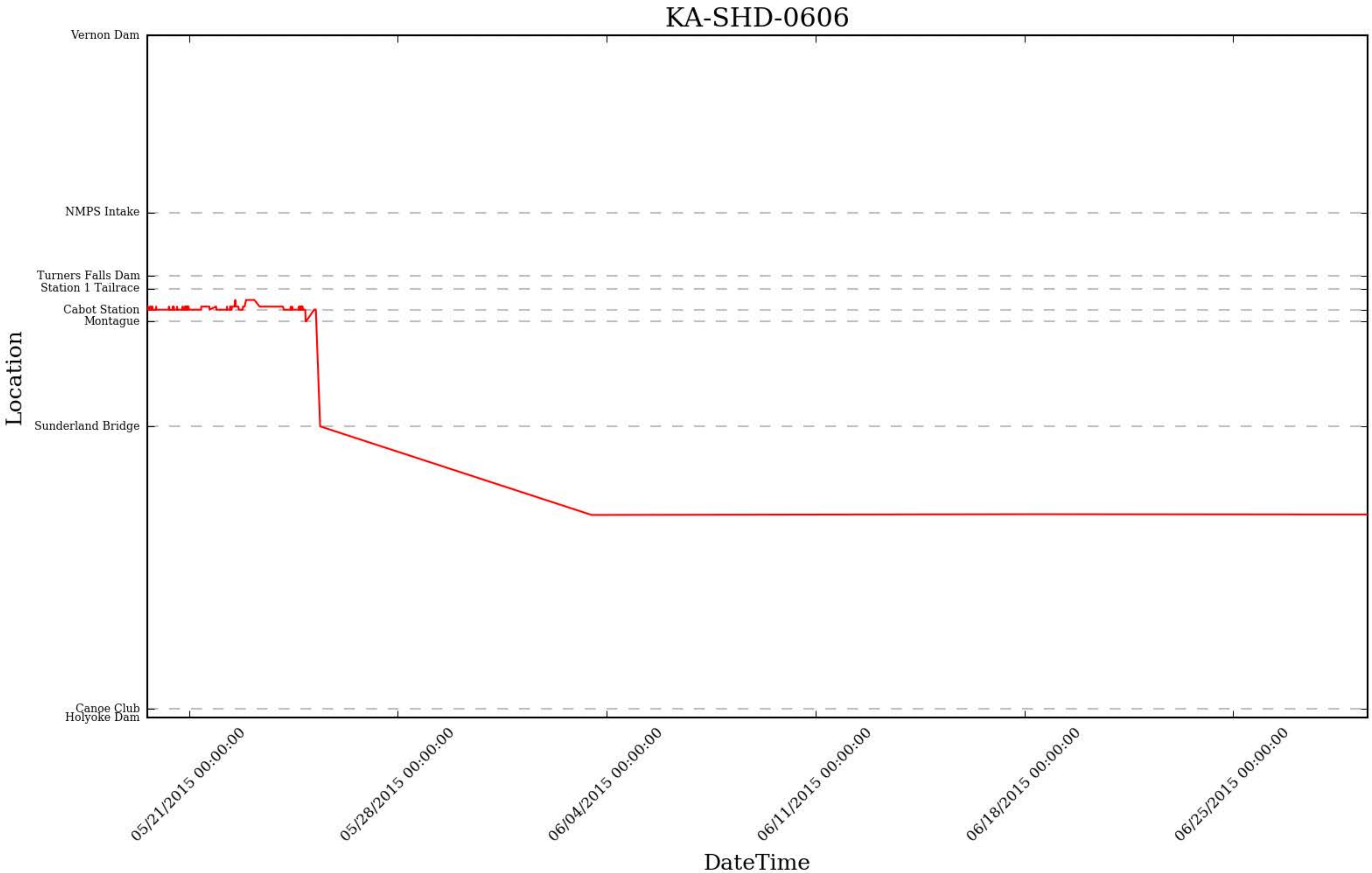

KA-SHD-0603
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

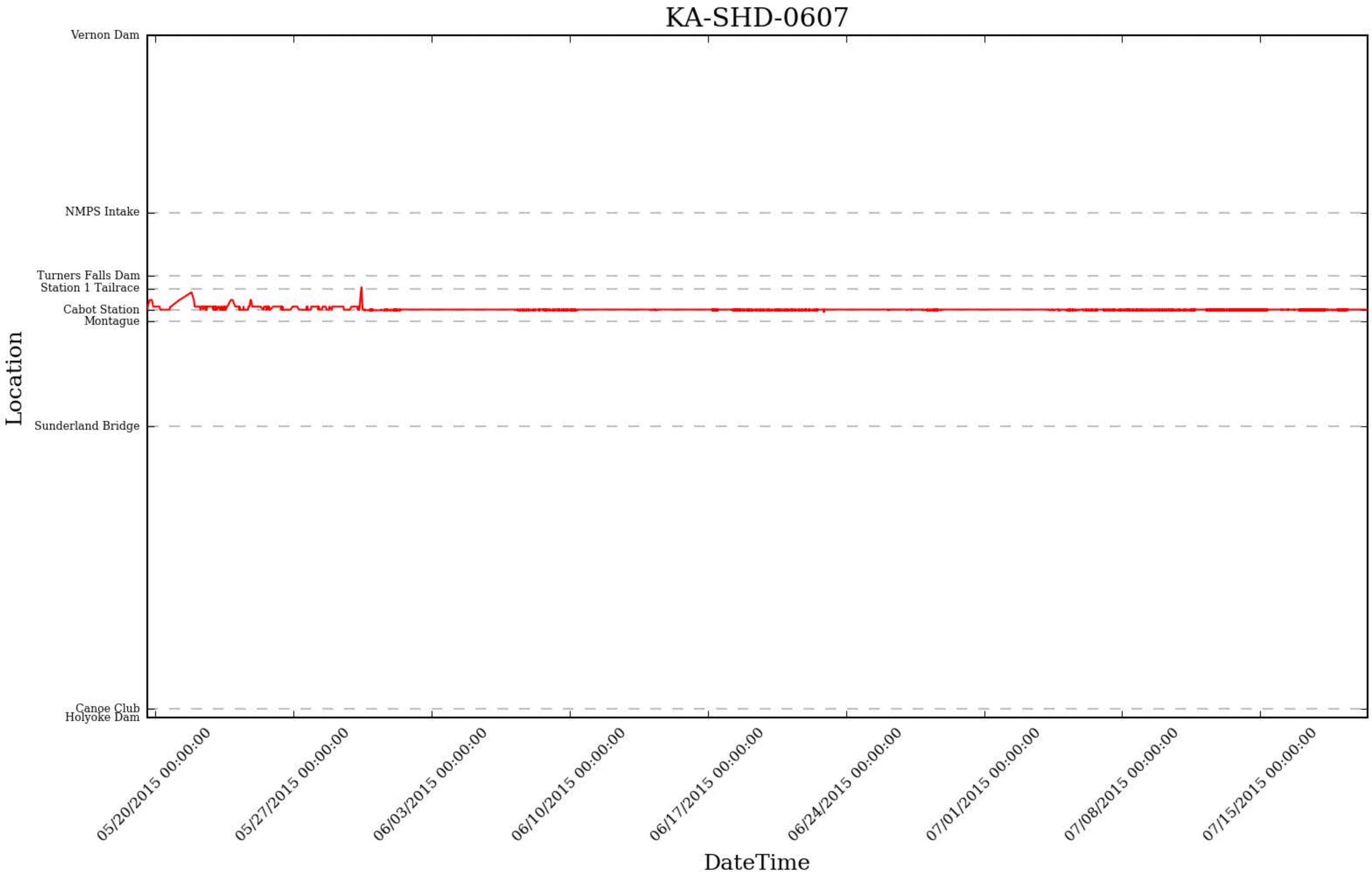
KA-SHD-0604

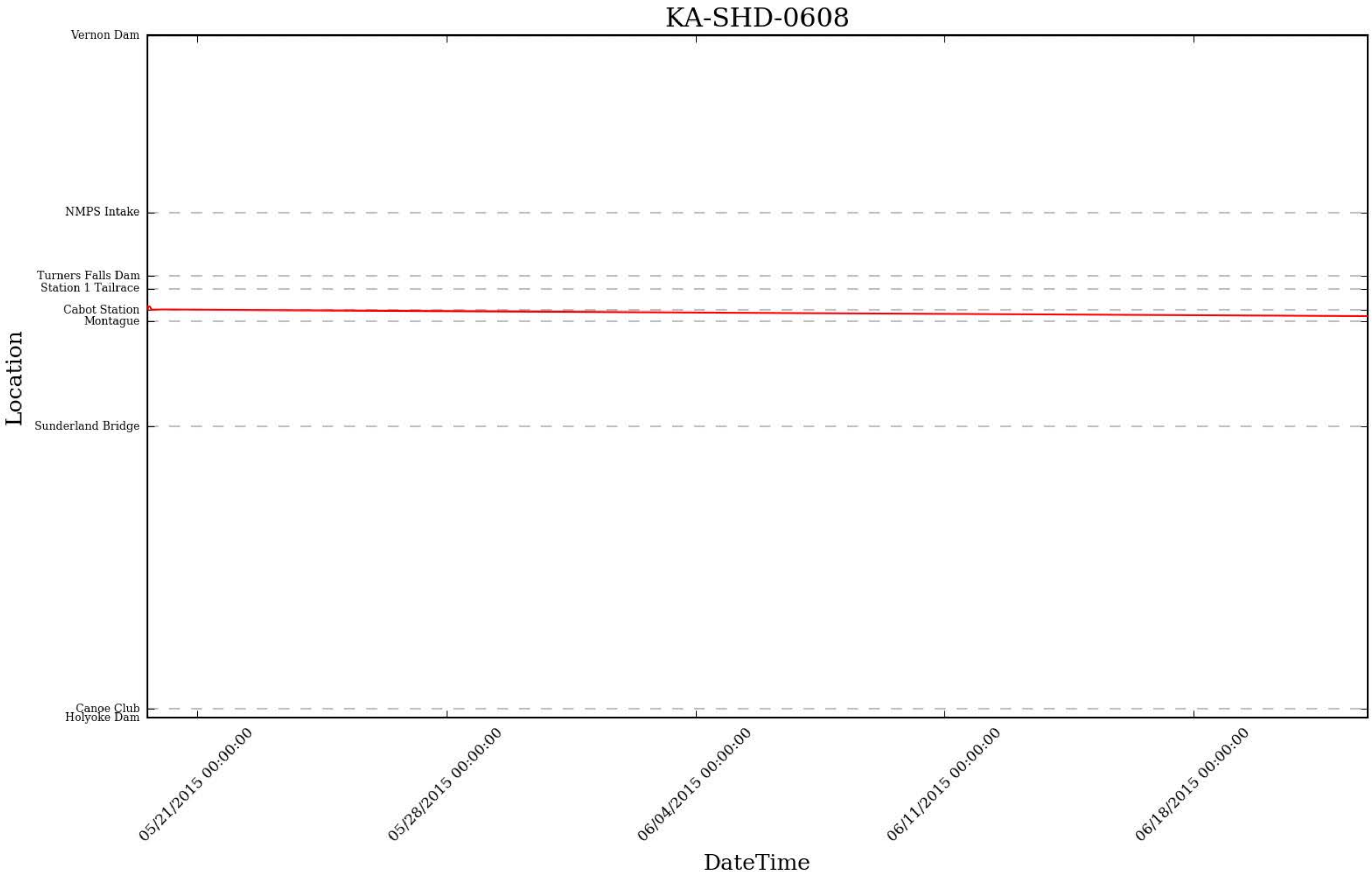


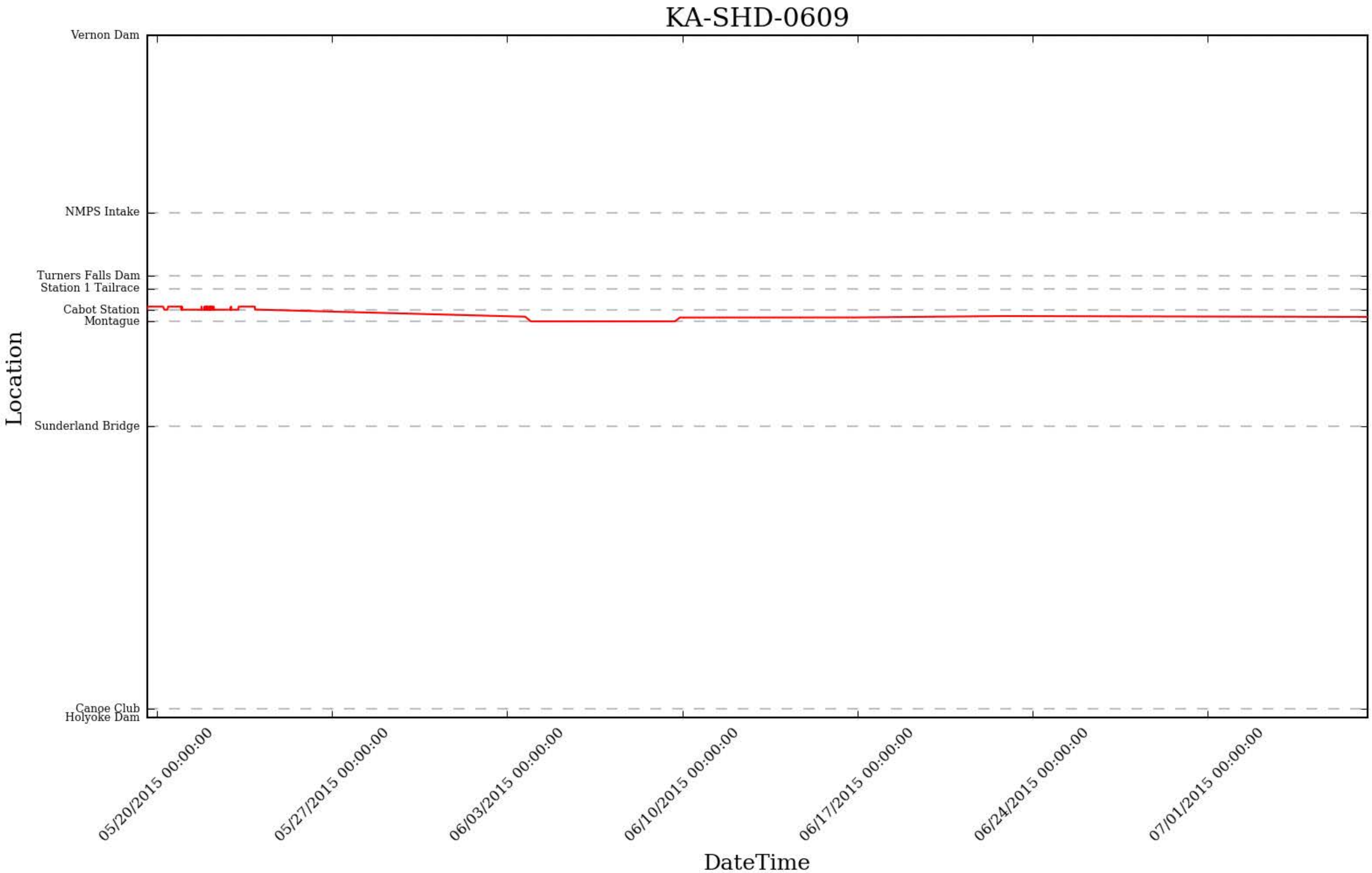
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime

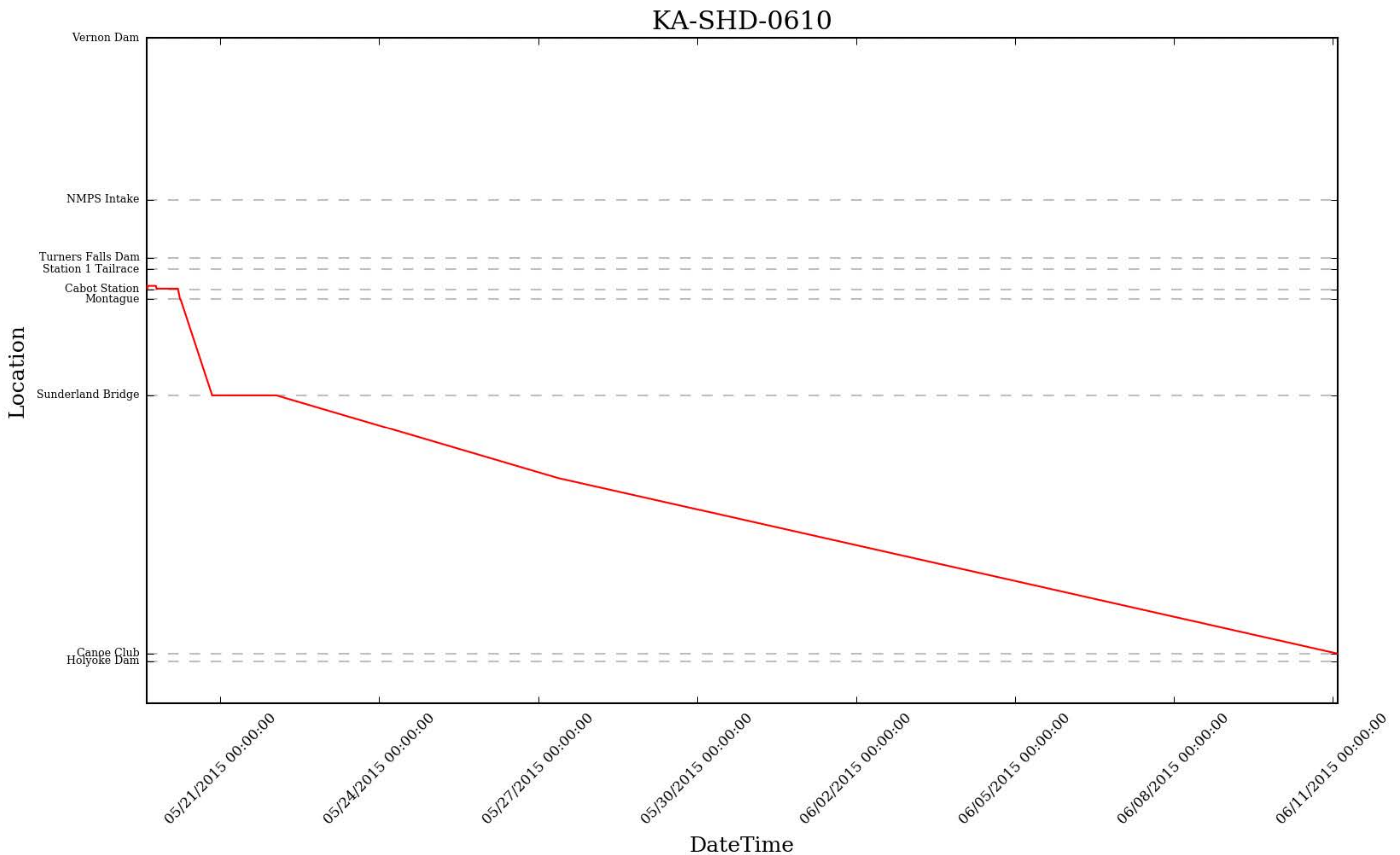

KA-SHD-0605
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 01:00:00
05/20/2015 13:00:00
05/21/2015 01:00:00
05/21/2015 13:00:00
05/22/2015 01:00:00
05/22/2015 13:00:00
05/23/2015 01:00:00
DateTime

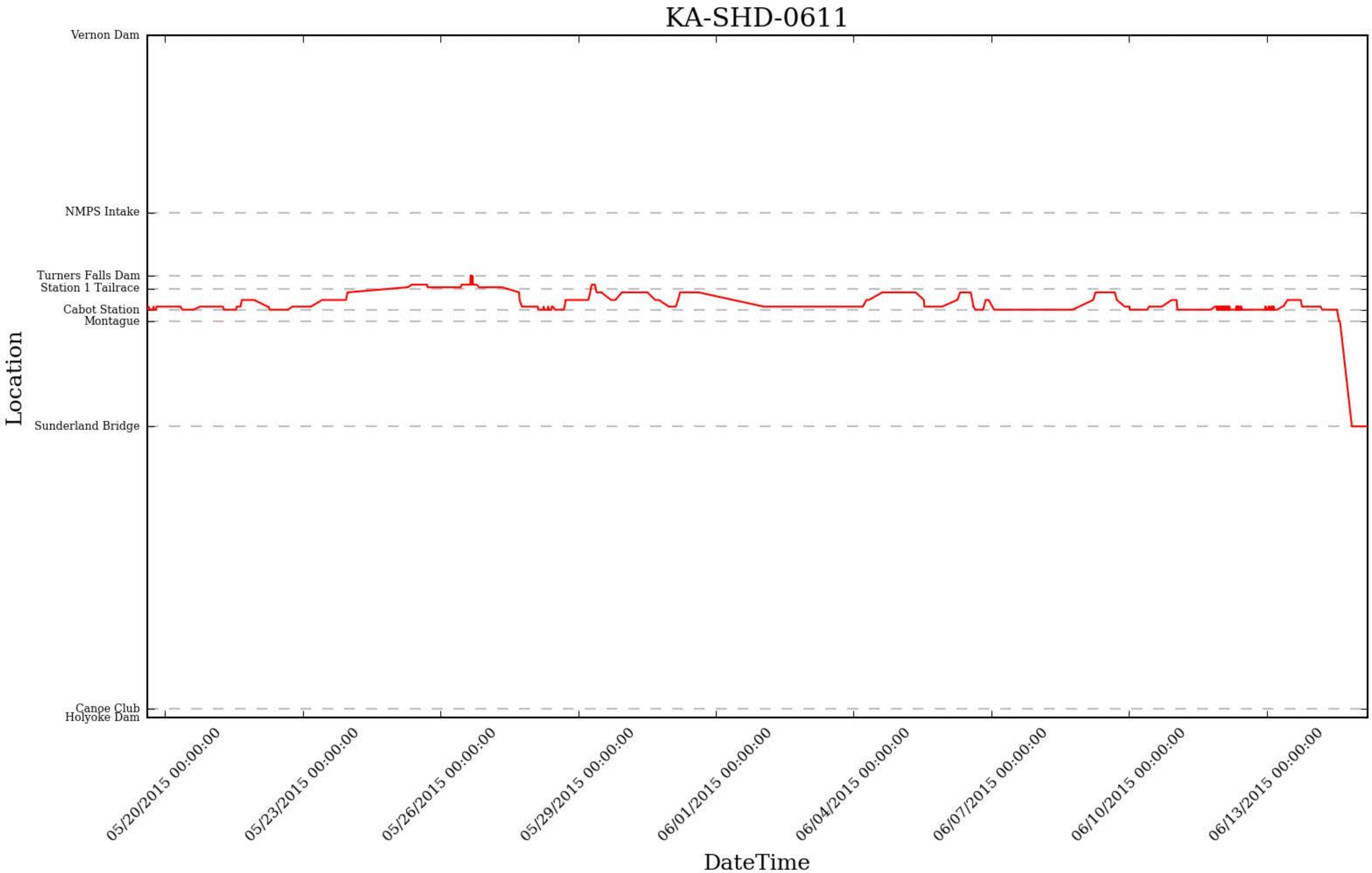

KA-SHD-0606
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
DateTime

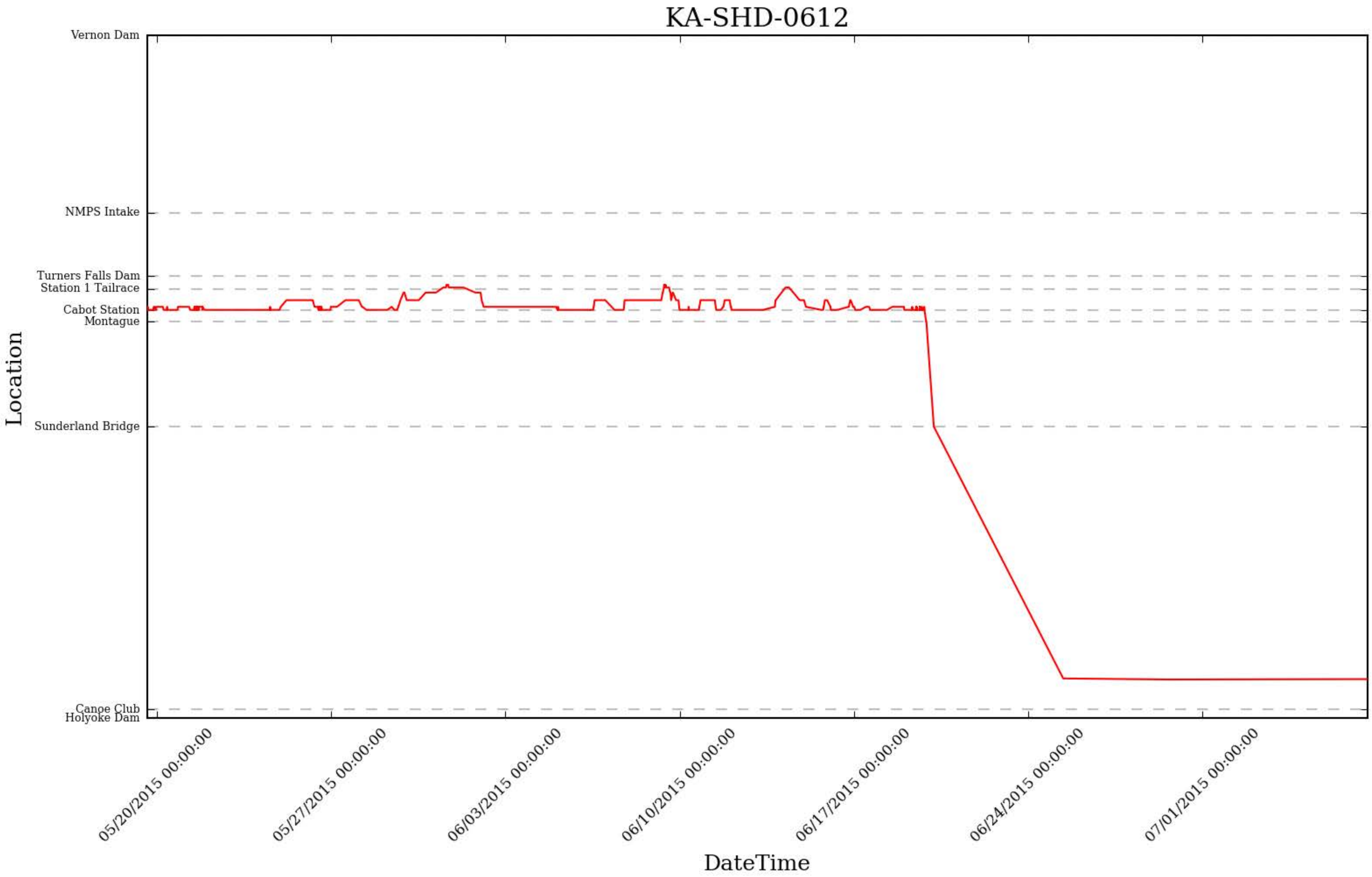

KA-SHD-0607
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
07/08/2015 00:00:00
07/15/2015 00:00:00
DateTime

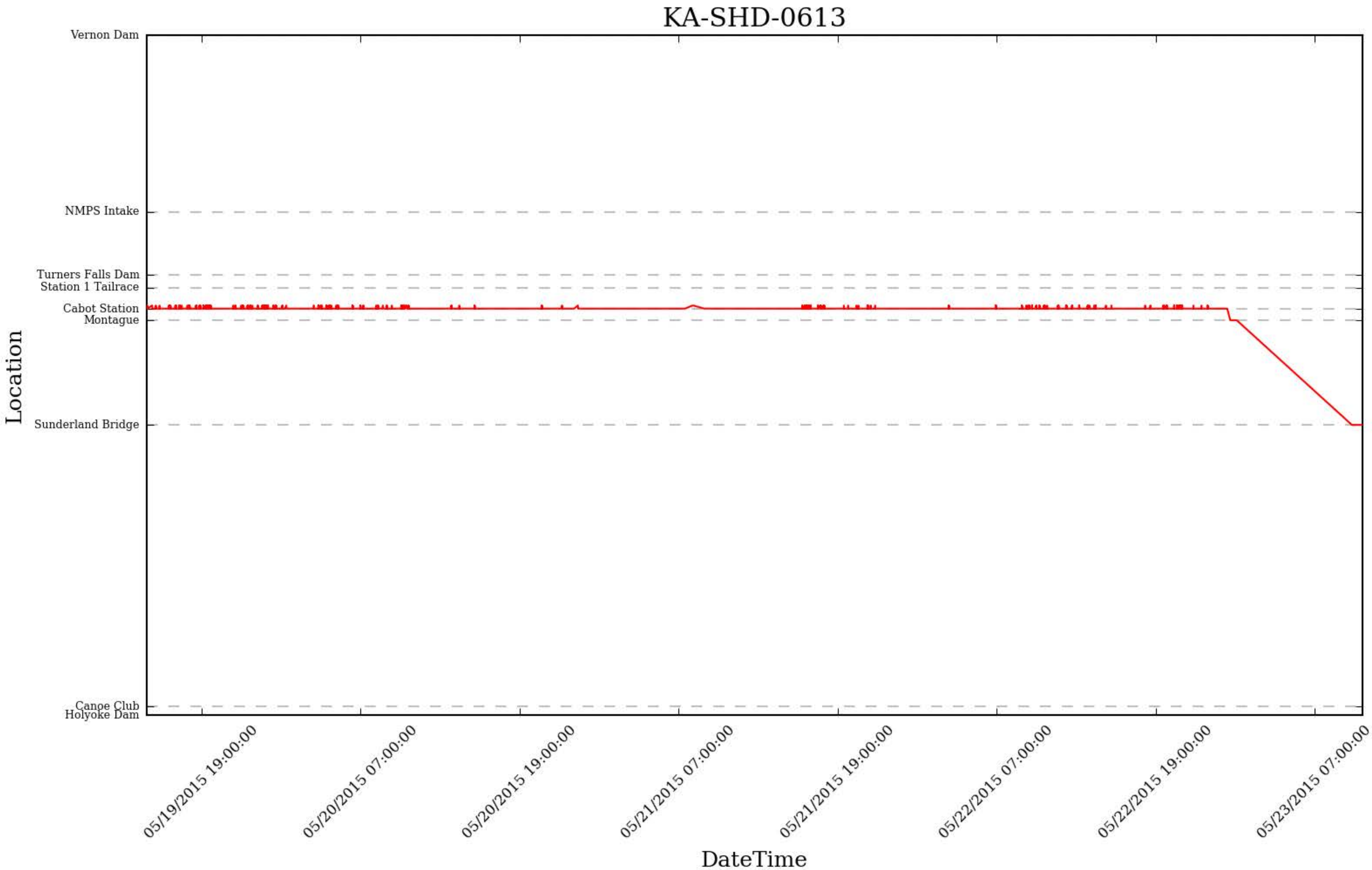

KA-SHD-0608
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
DateTime


KA-SHD-0609
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

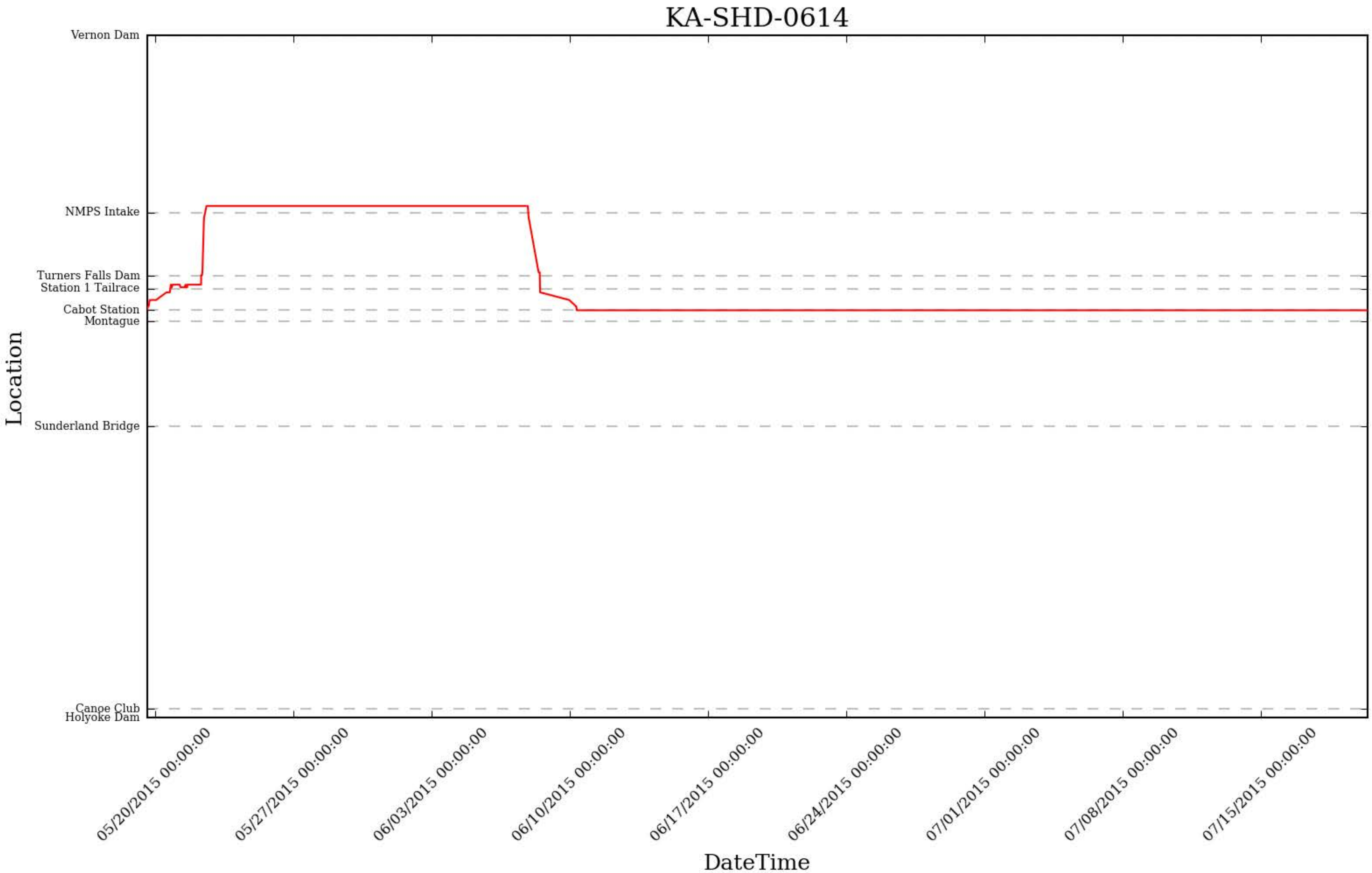

KA-SHD-0610
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
DateTime


KA-SHD-0611
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/23/2015 00:00:00
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
06/13/2015 00:00:00
DateTime

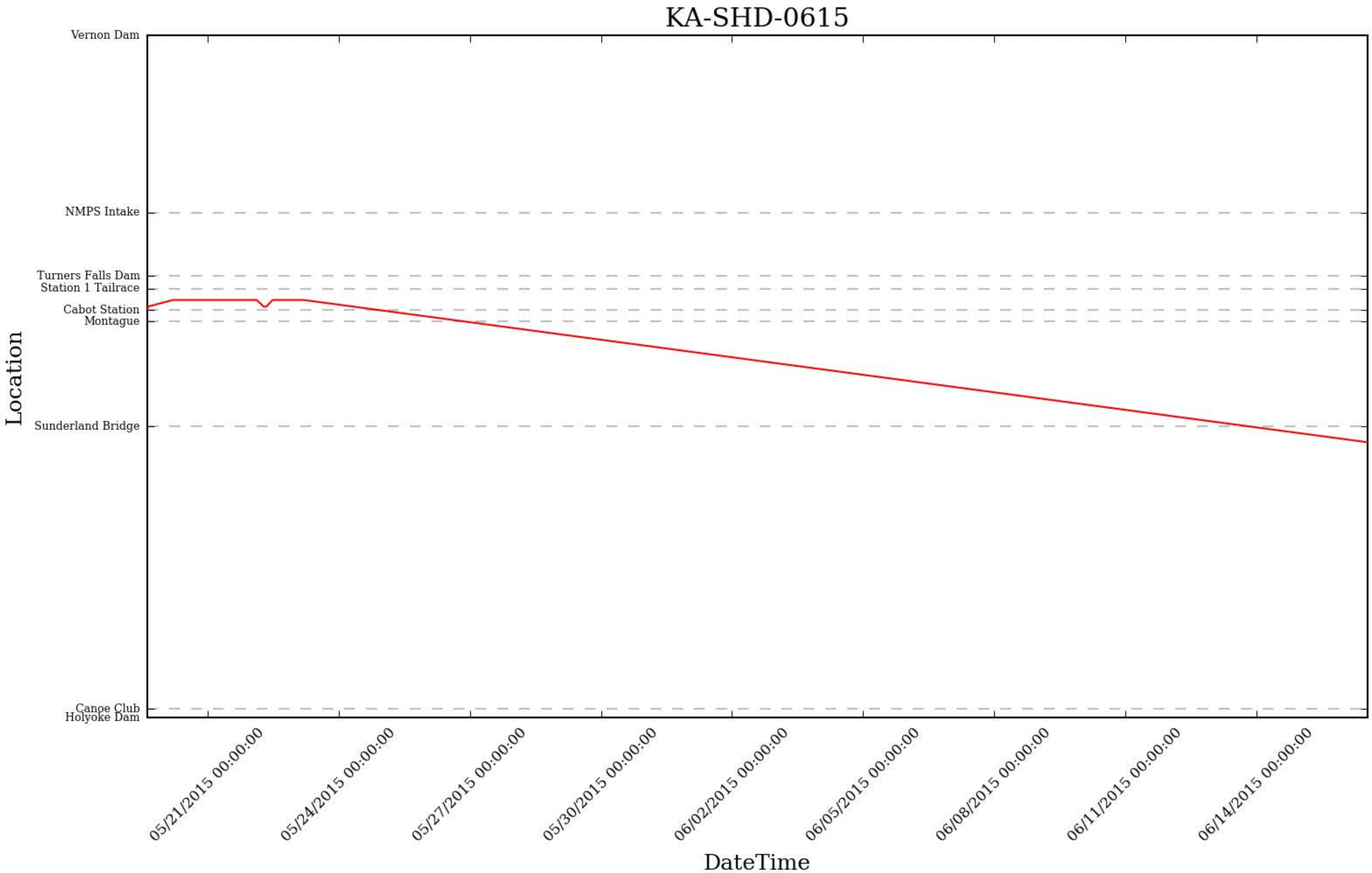

KA-SHD-0612
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

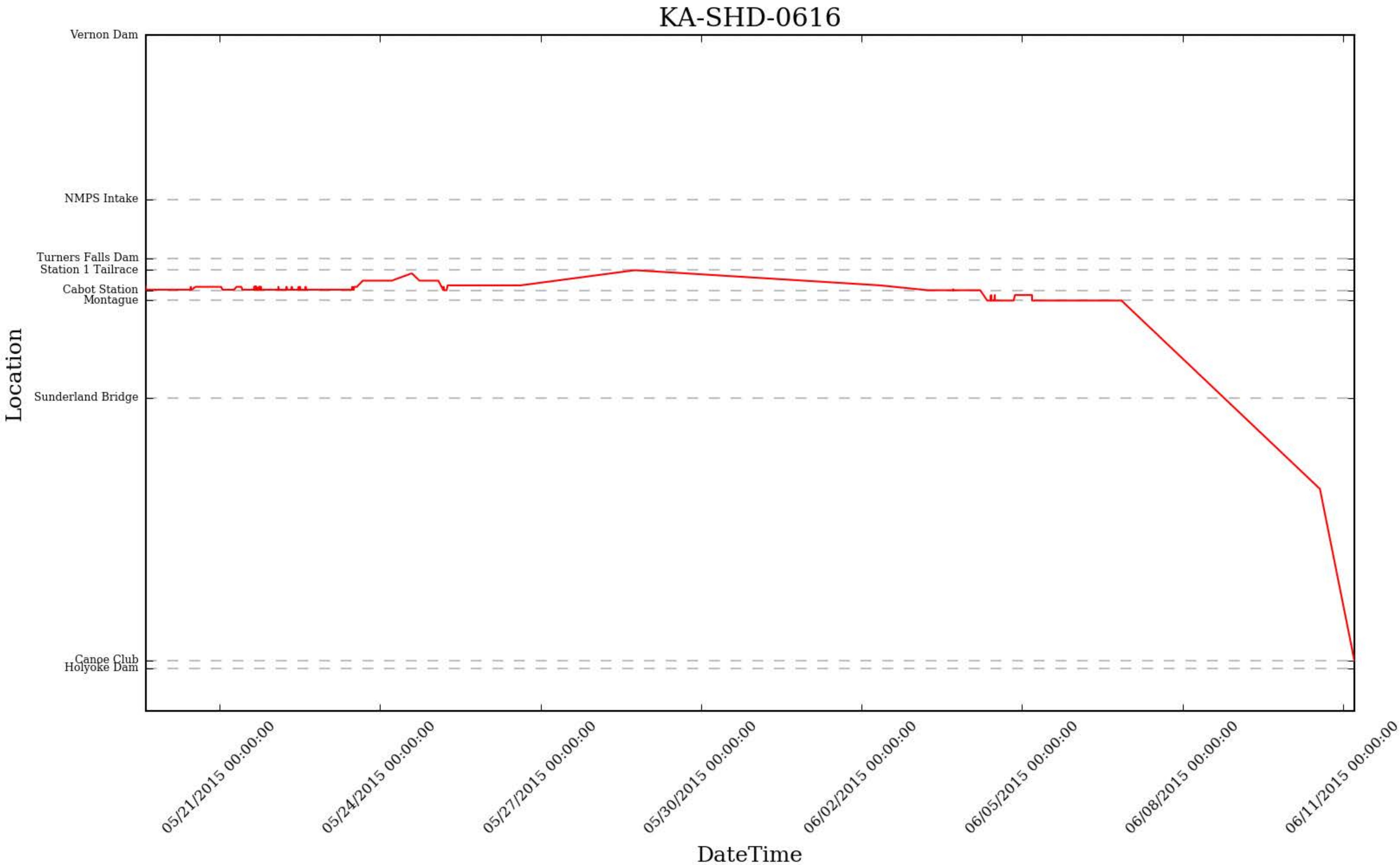


KA-SHD-0613
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/19/2015 19:00:00
05/20/2015 07:00:00
05/20/2015 19:00:00
05/21/2015 07:00:00
05/21/2015 19:00:00
05/22/2015 07:00:00
05/22/2015 19:00:00
05/23/2015 07:00:00
DateTime



KA-SHD-0614
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
07/08/2015 00:00:00
07/15/2015 00:00:00
DateTime


KA-SHD-0615
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
06/14/2015 00:00:00
DateTime


KA-SHD-0616
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
DateTime
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
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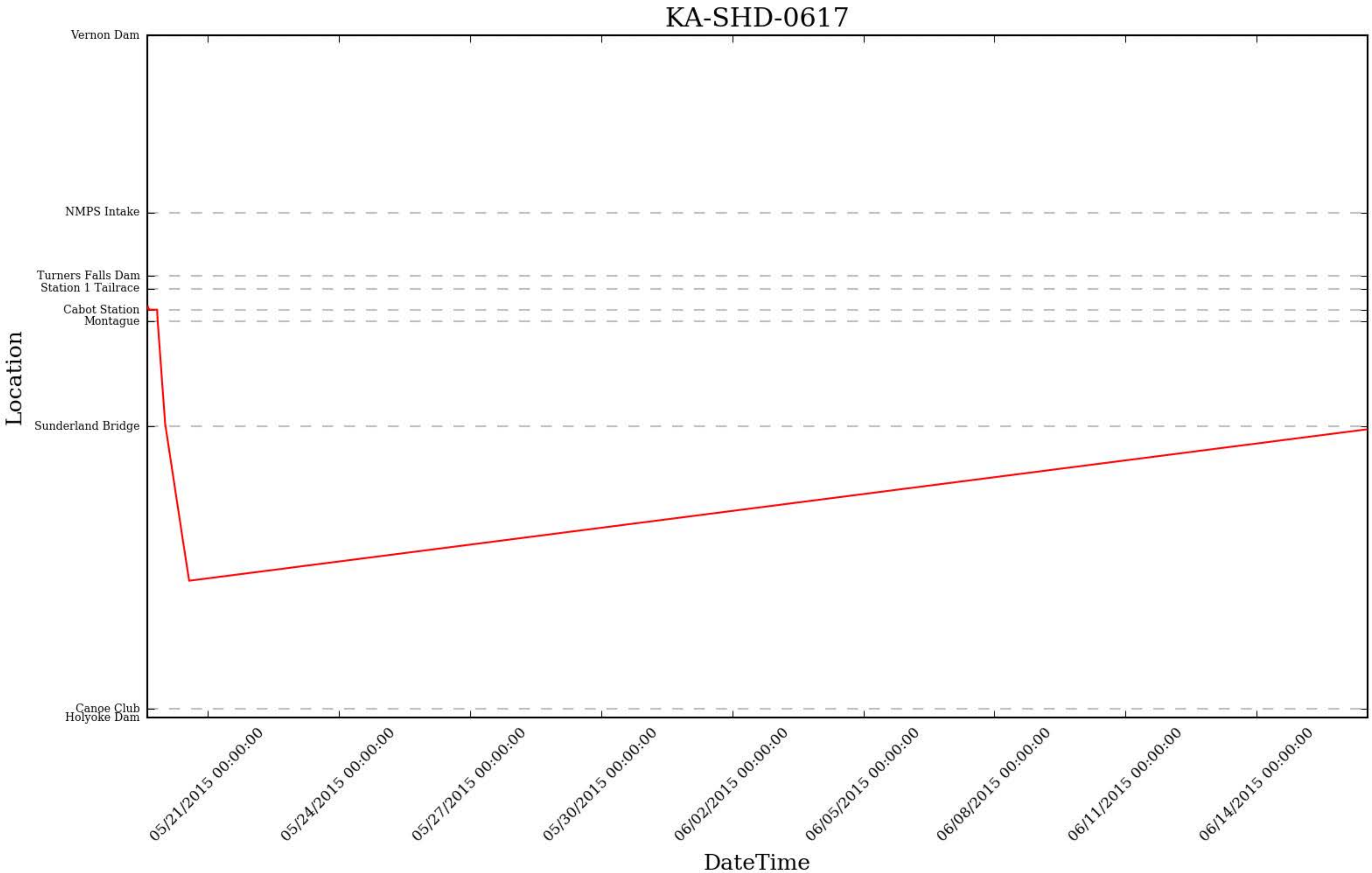
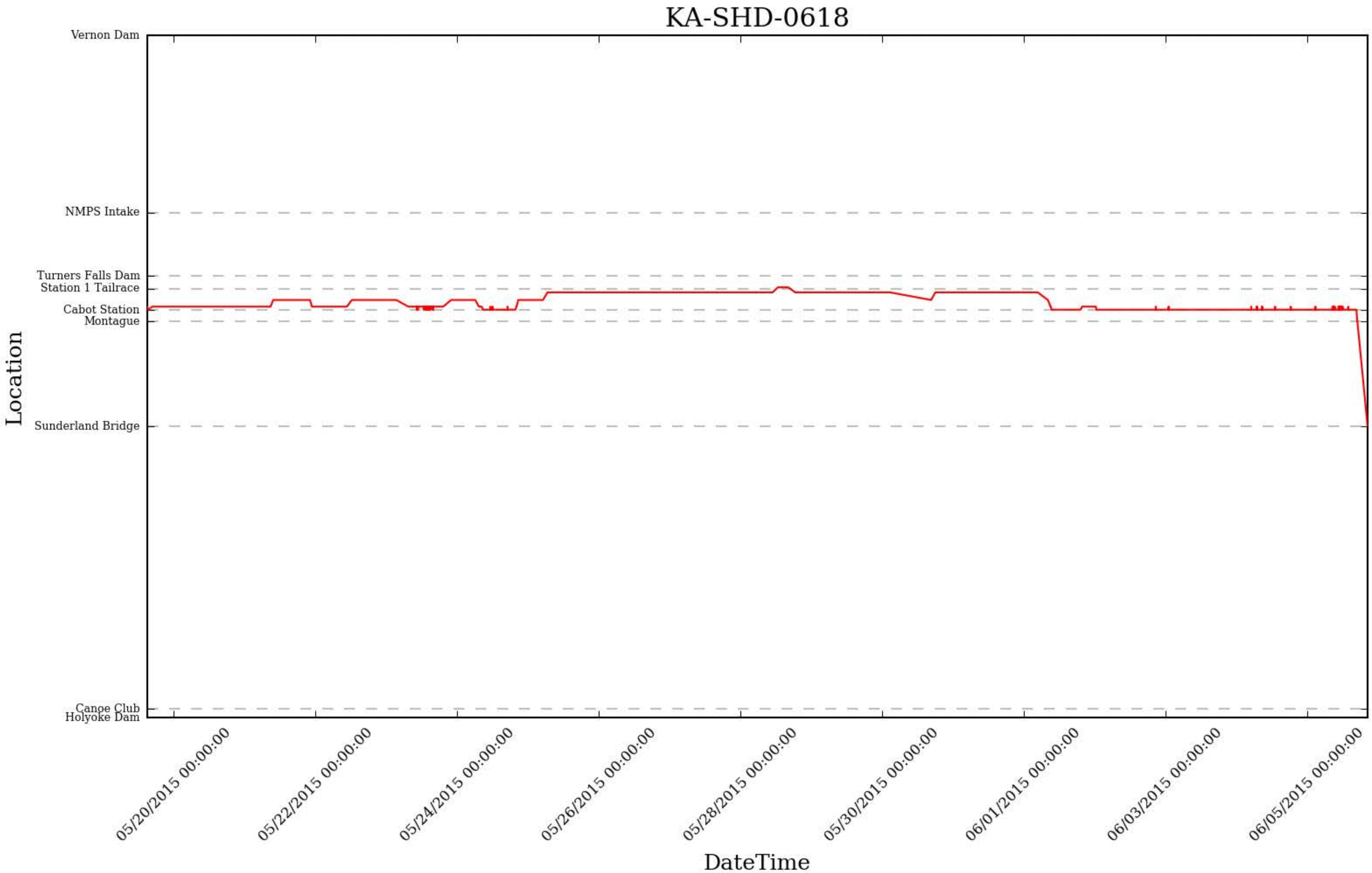
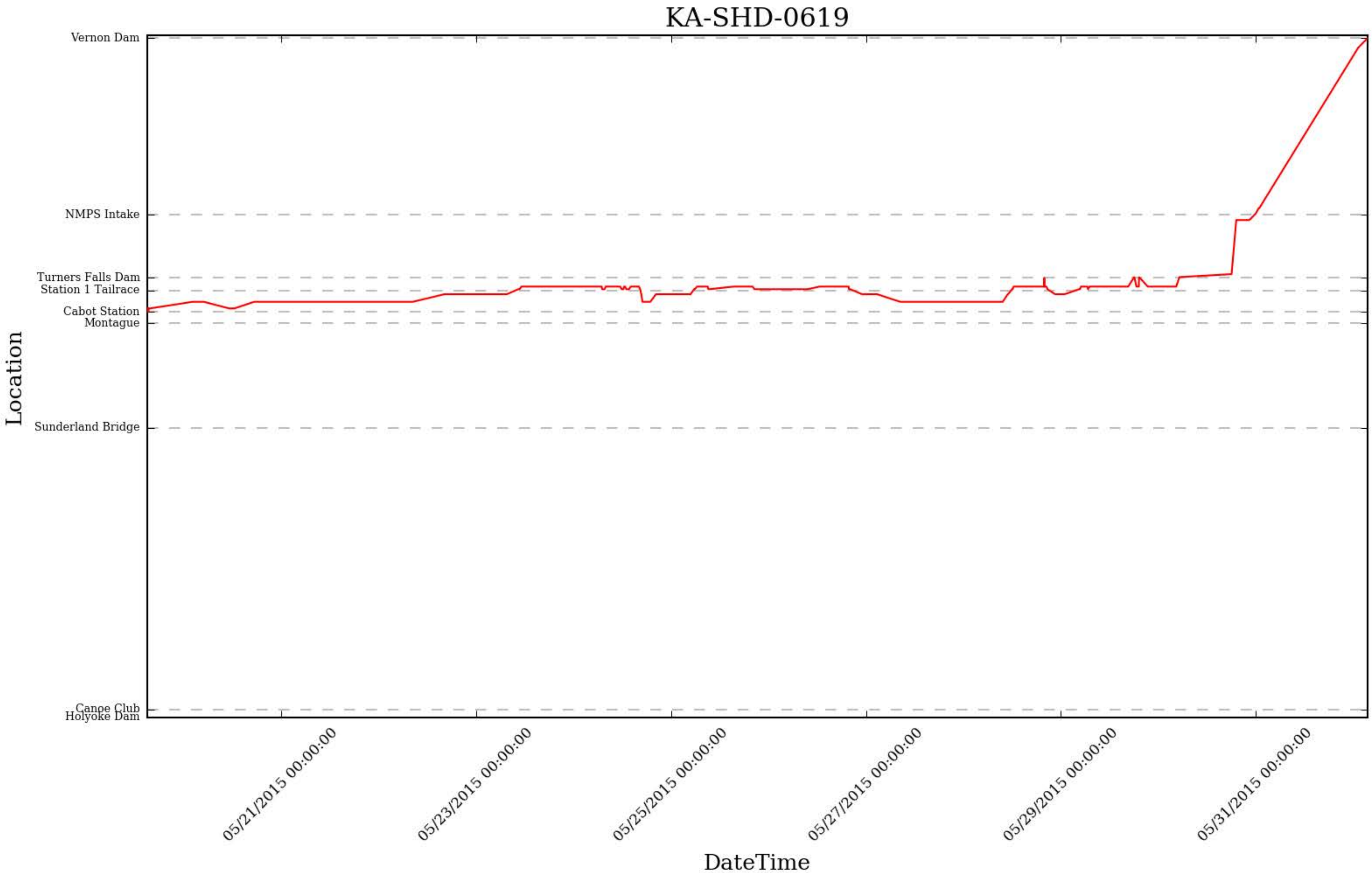
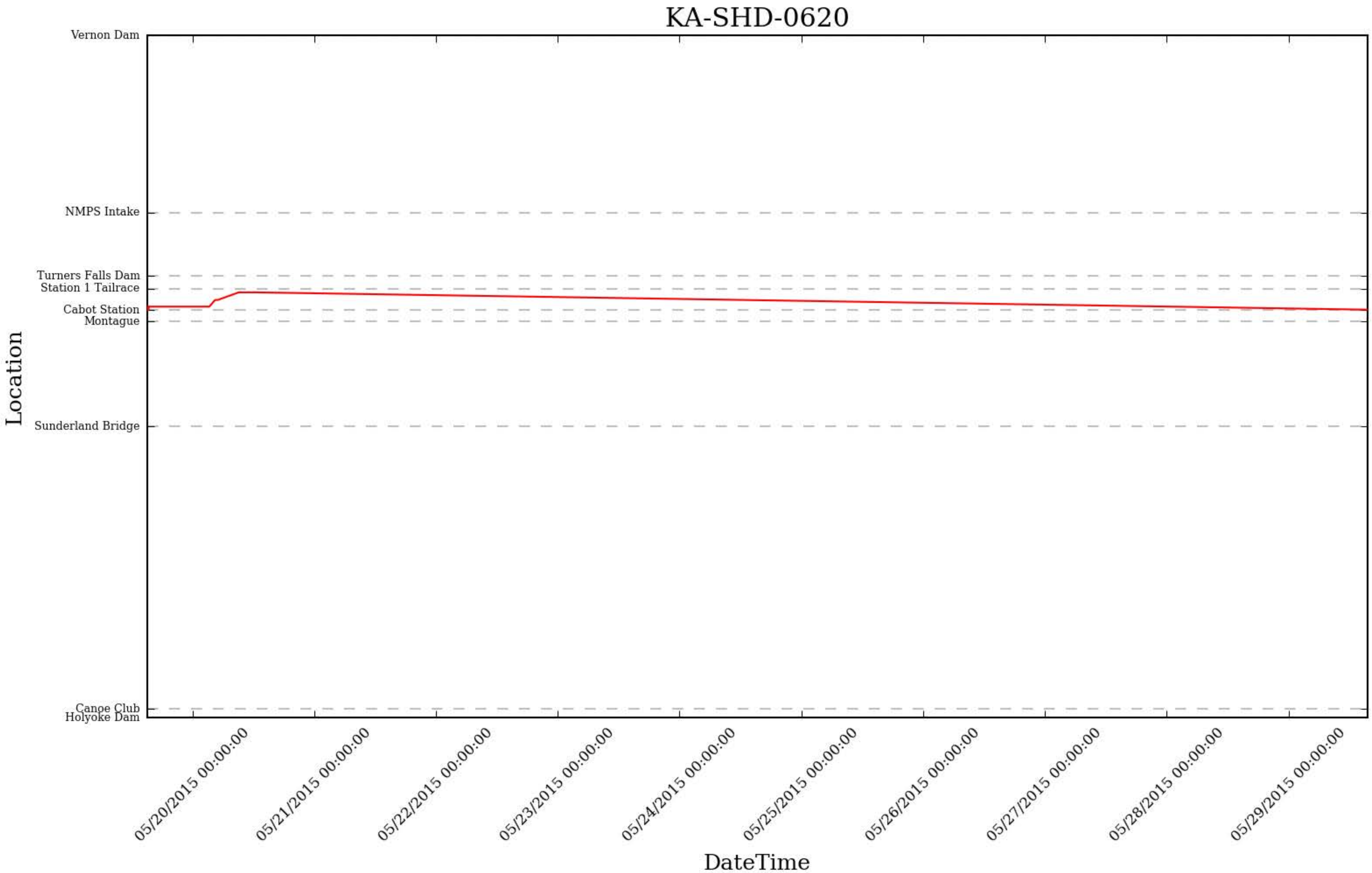
06/08/2015 00:00:00
06/11/2015 00:00:00

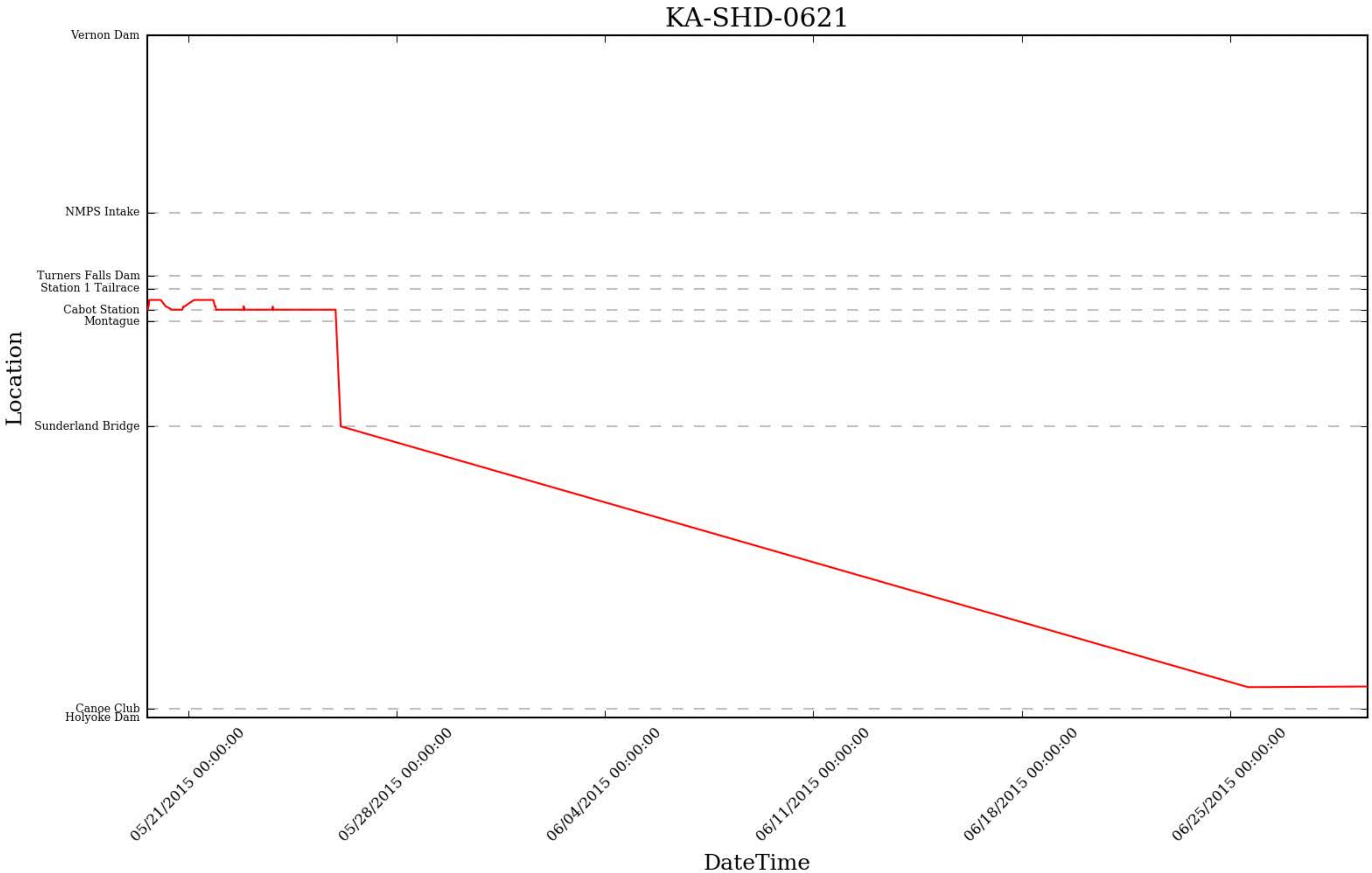


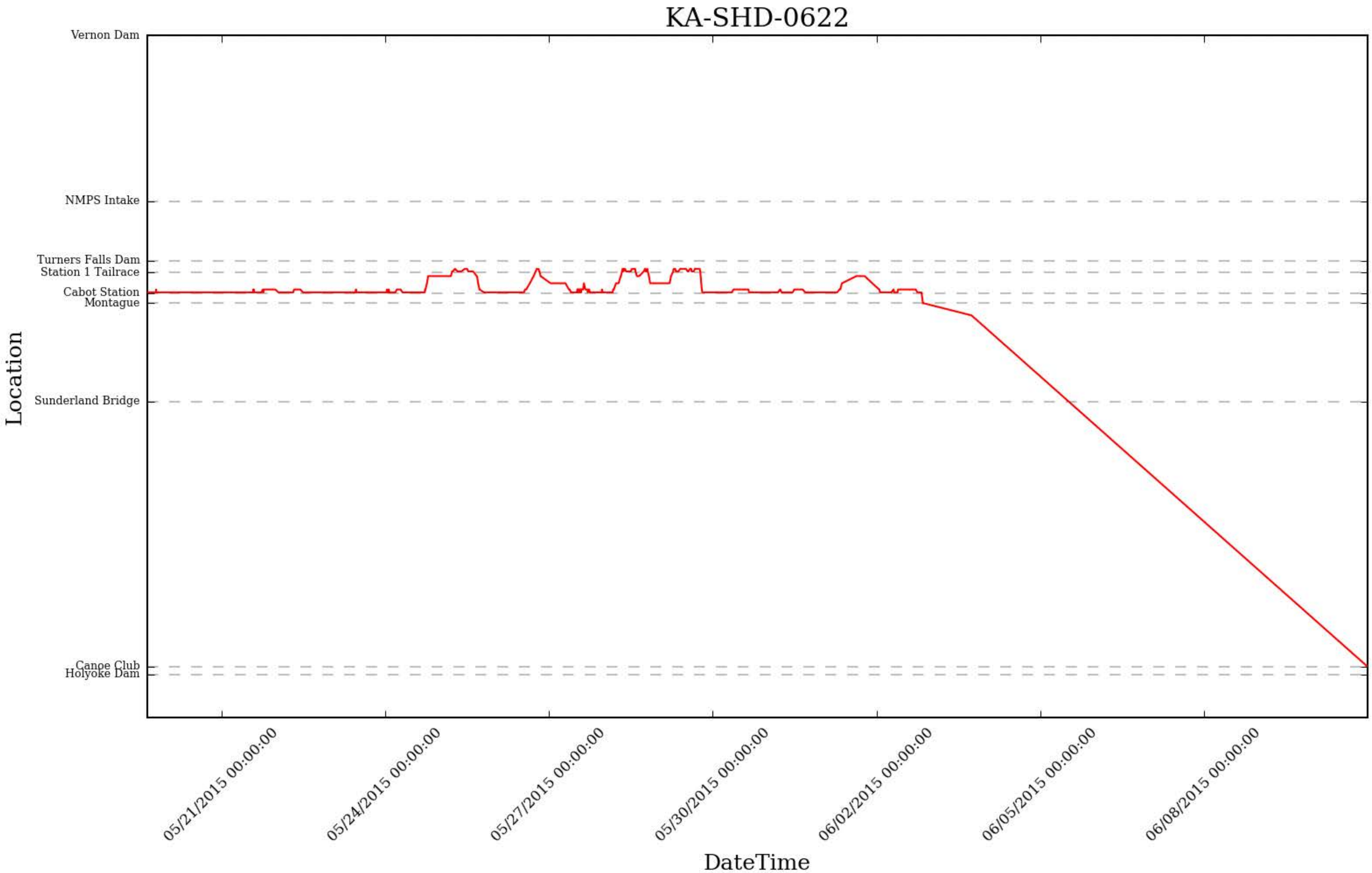
KA-SHD-0617
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
06/14/2015 00:00:00
DateTime

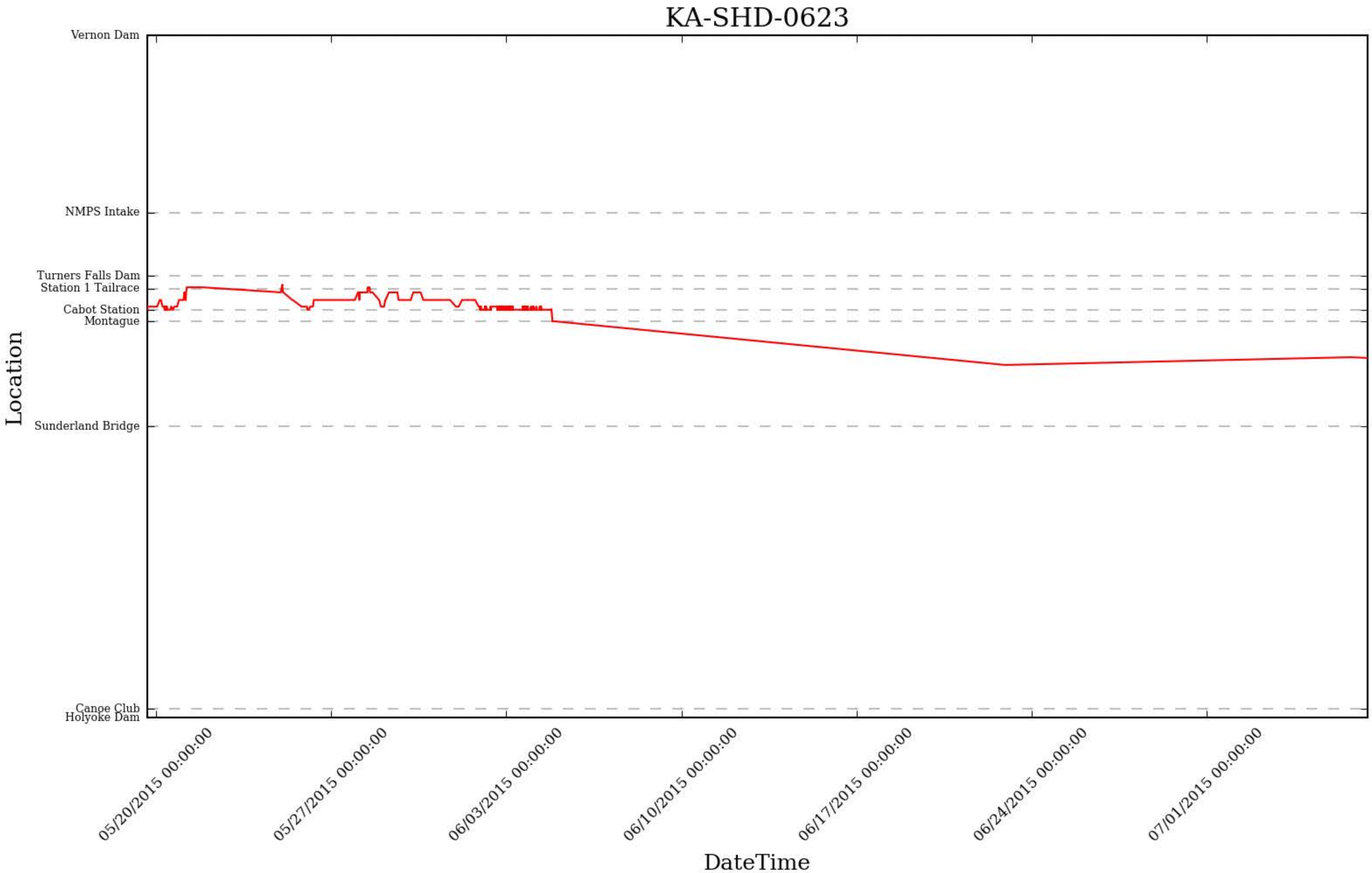

KA-SHD-0618
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/22/2015 00:00:00
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime


KA-SHD-0619
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
DateTime


KA-SHD-0620
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/21/2015 00:00:00
05/22/2015 00:00:00
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
DateTime


KA-SHD-0621
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
DateTime


KA-SHD-0622
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/21/2015 00:00:00
05/24/2015 00:00:00
05/27/2015 00:00:00
05/30/2015 00:00:00
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
DateTime



KA-SHD-0623
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
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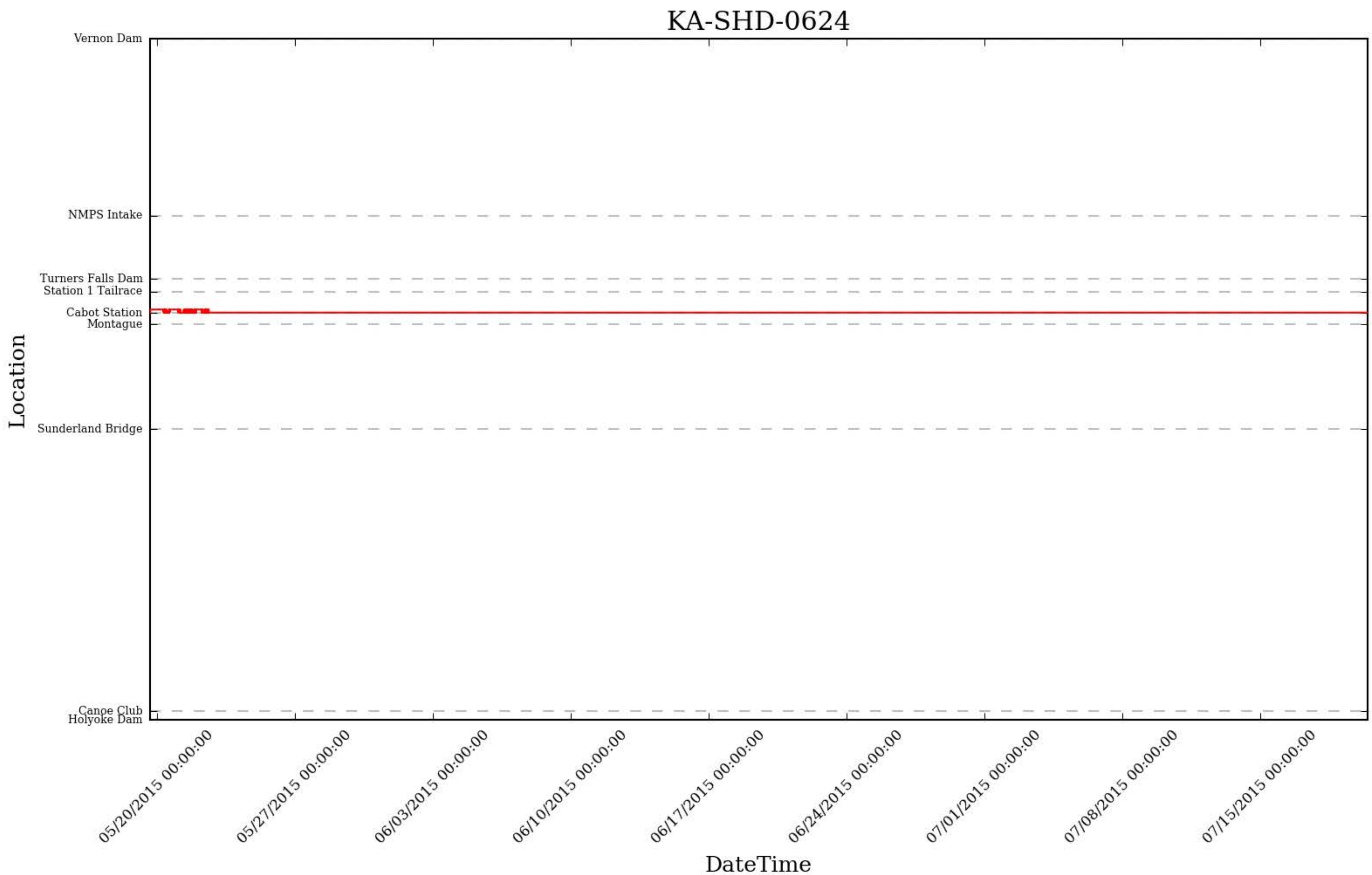
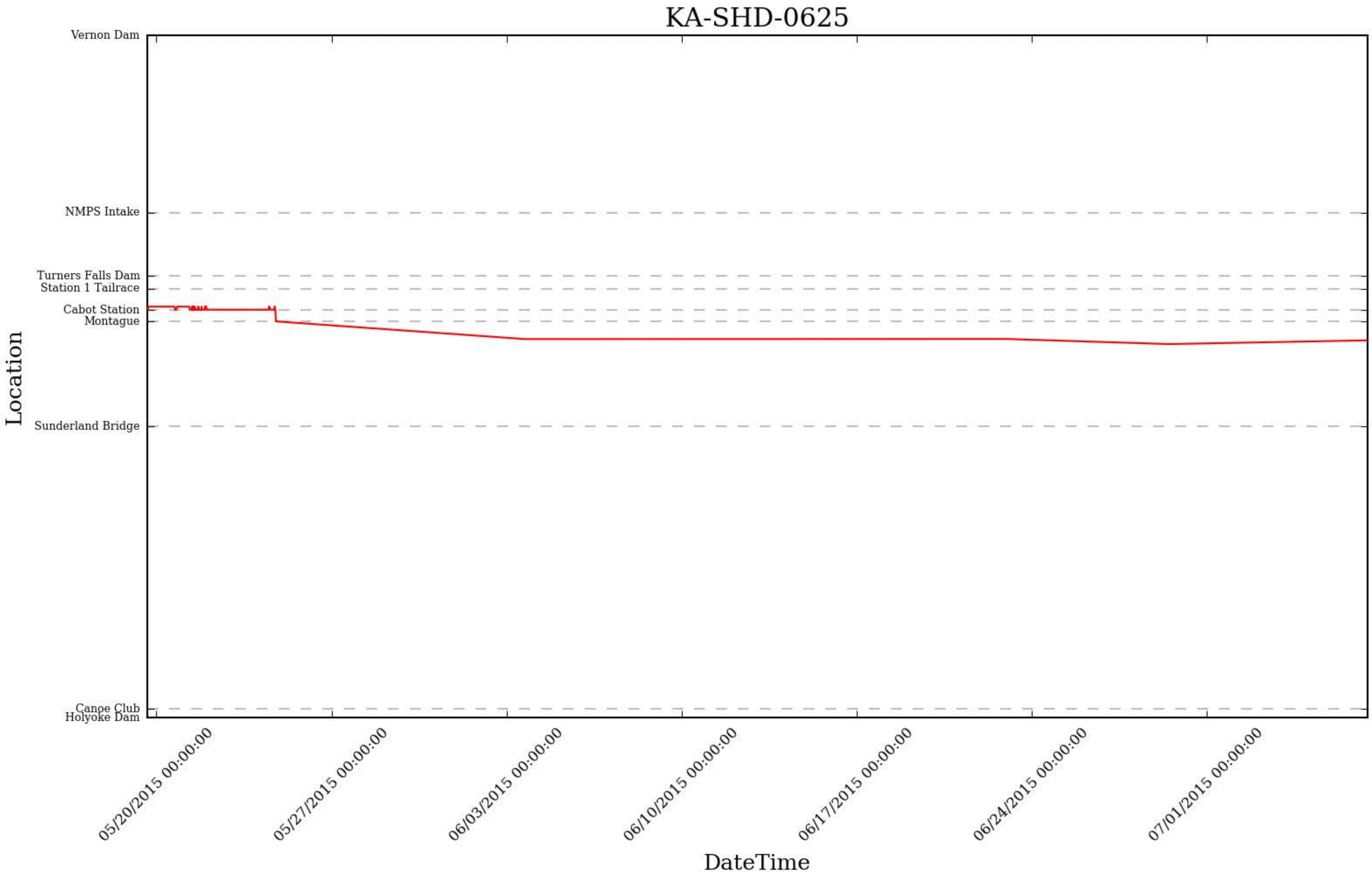
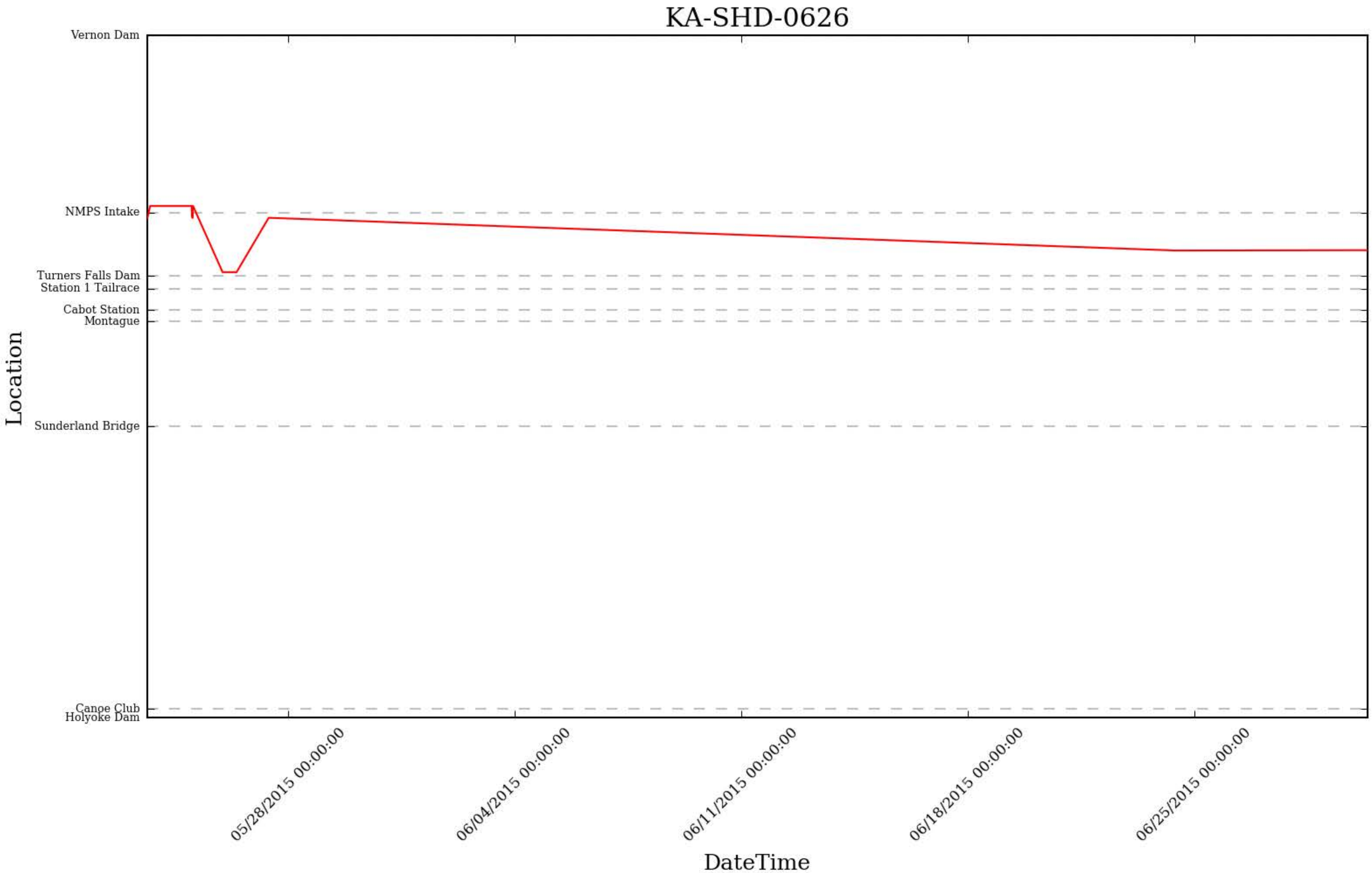
07/01/2015 00:00:00
DateTime



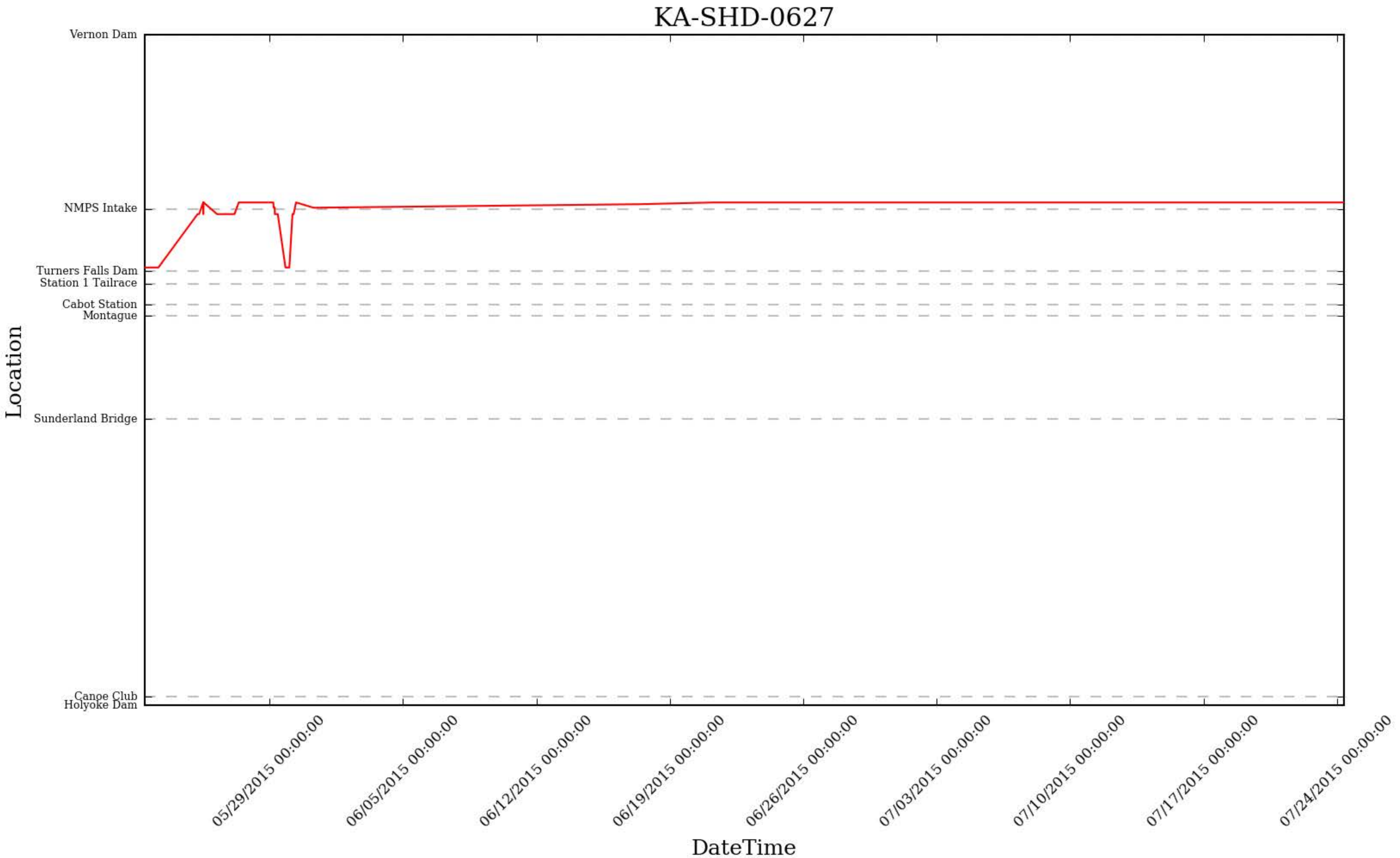
KA-SHD-0624
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
07/08/2015 00:00:00
07/15/2015 00:00:00
DateTime

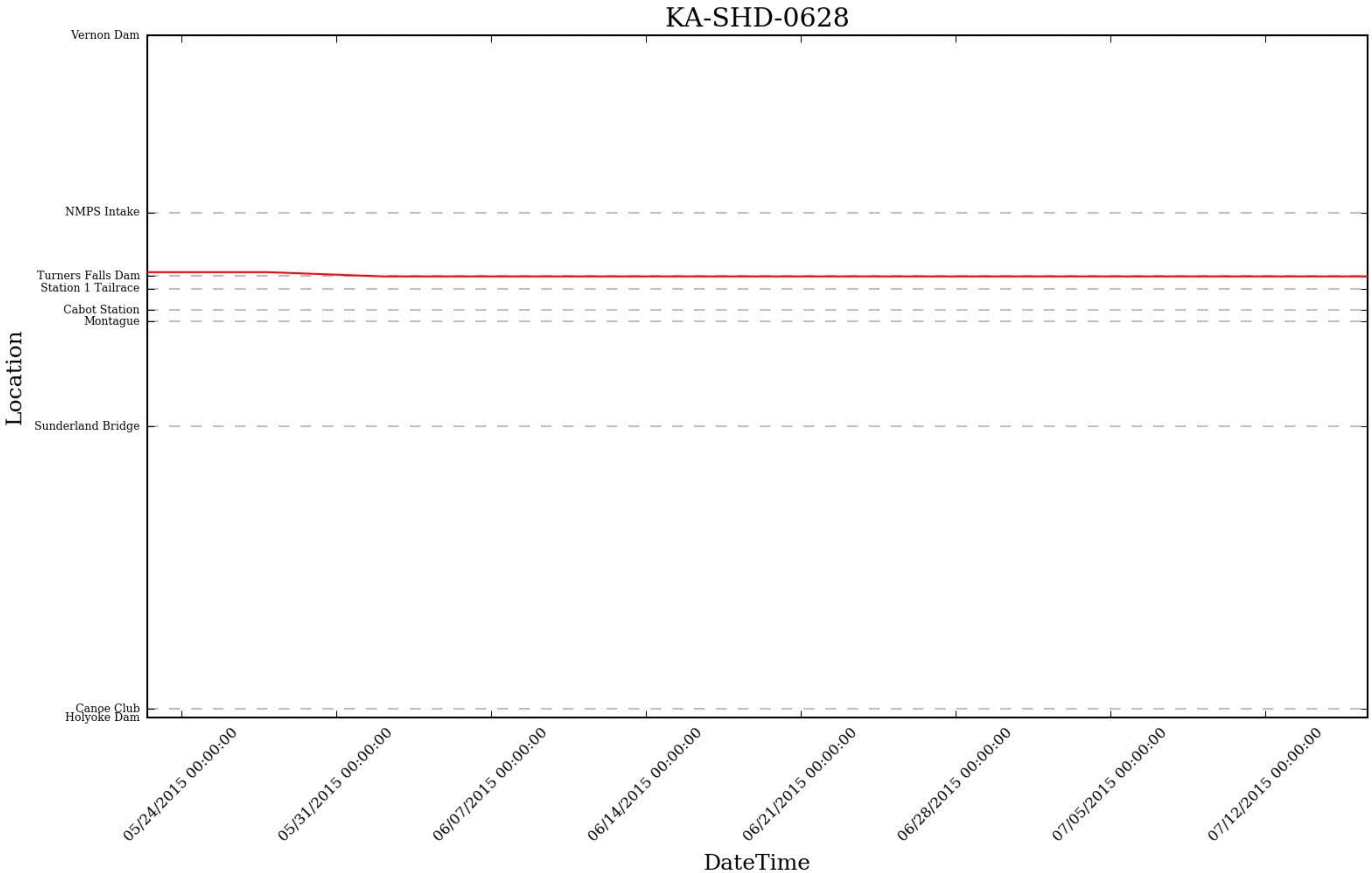


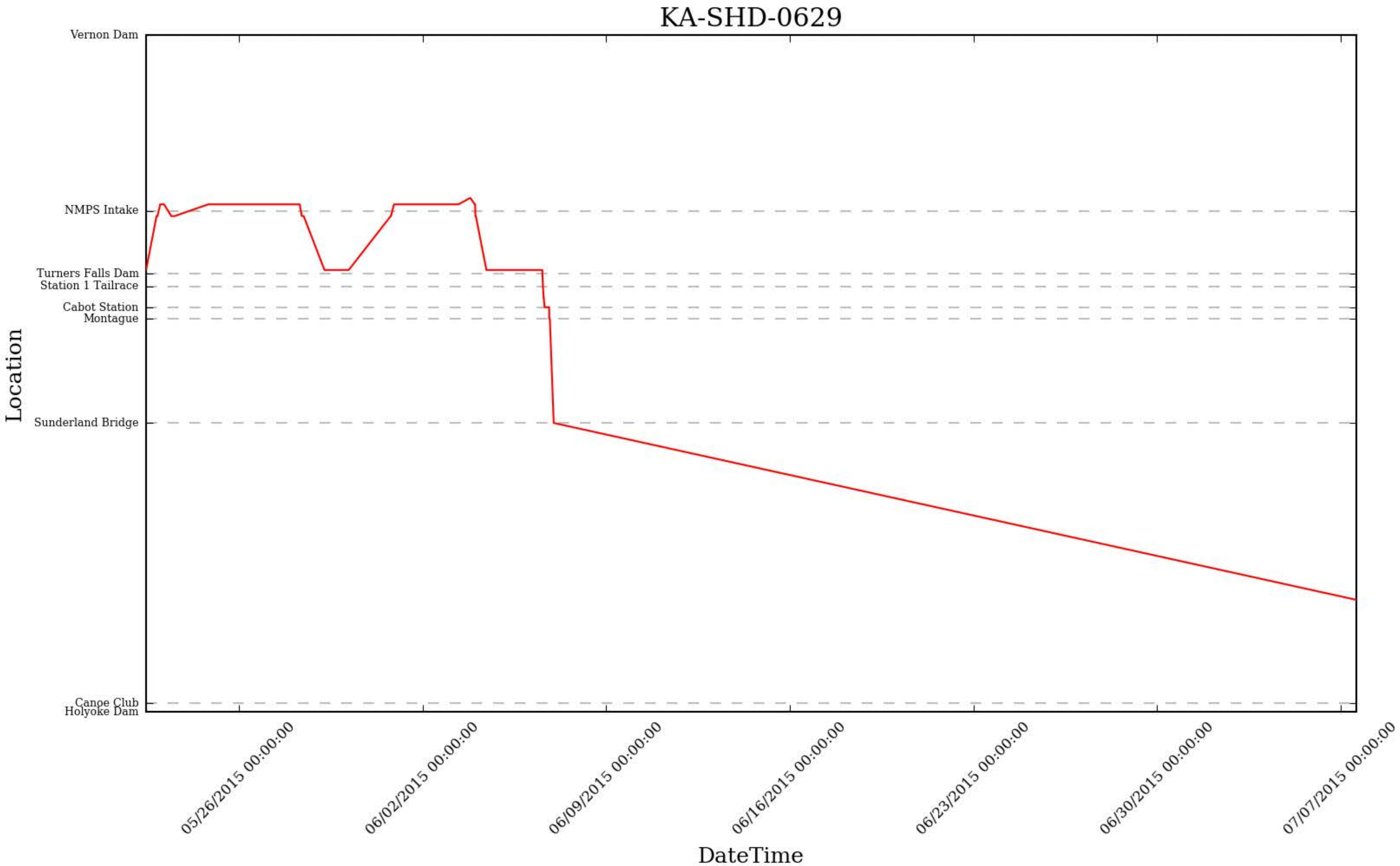
KA-SHD-0625
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/20/2015 00:00:00
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

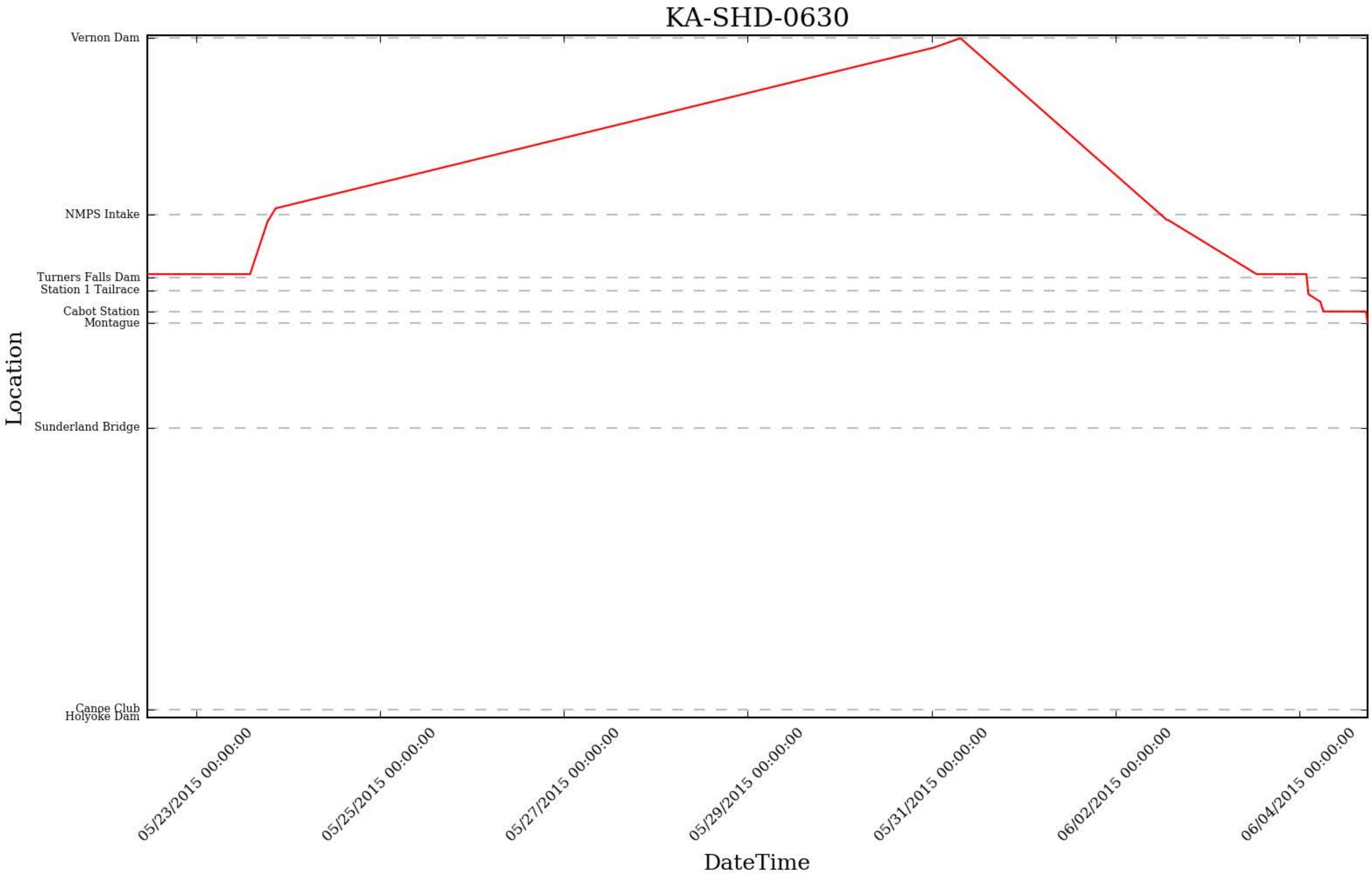


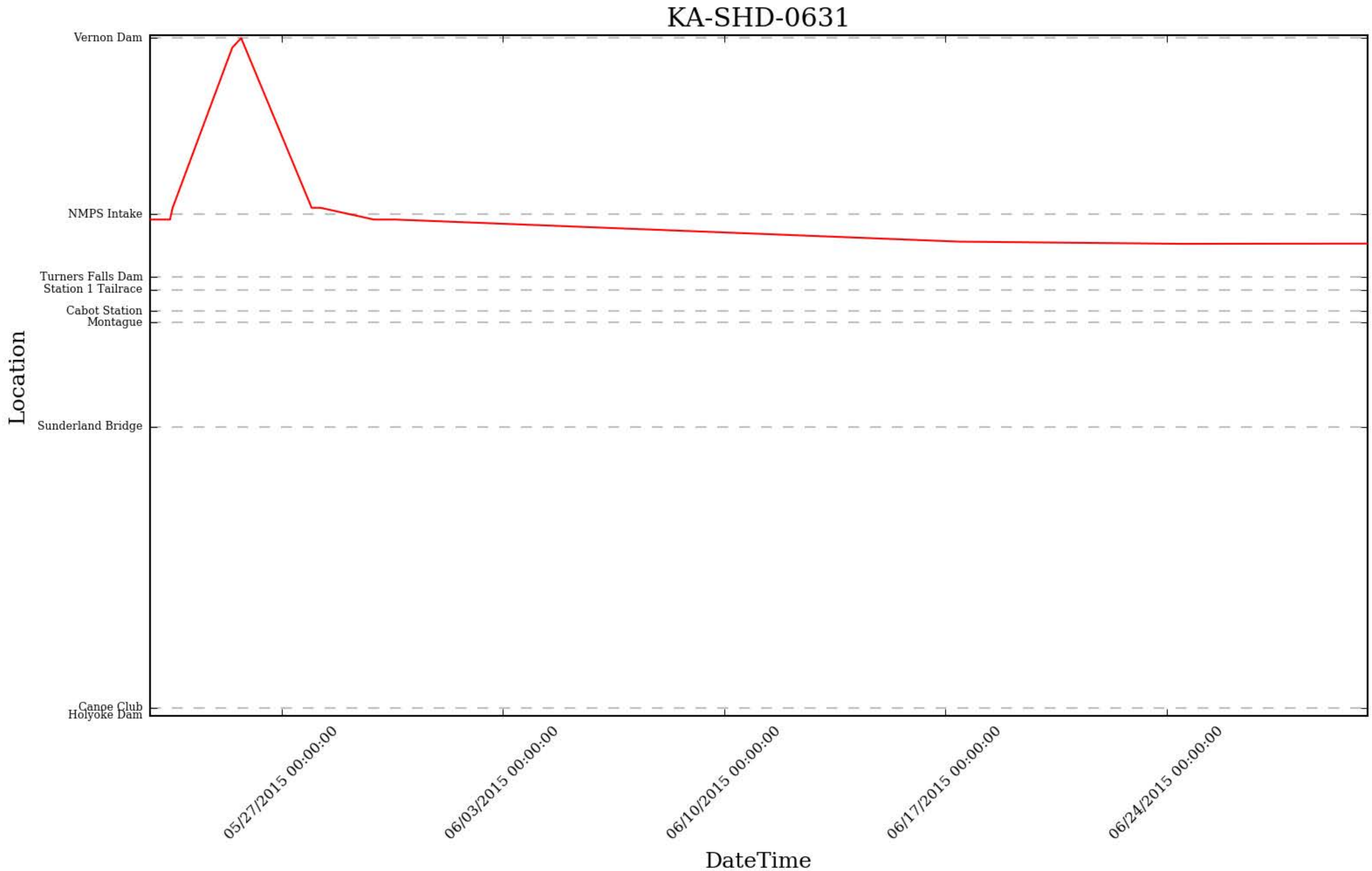
KA-SHD-0626
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
DateTime


KA-SHD-0627
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
07/10/2015 00:00:00
07/17/2015 00:00:00
07/24/2015 00:00:00
DateTime


KA-SHD-0628
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
07/12/2015 00:00:00
DateTime


KA-SHD-0629
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime


KA-SHD-0630
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
DateTime


KA-SHD-0631
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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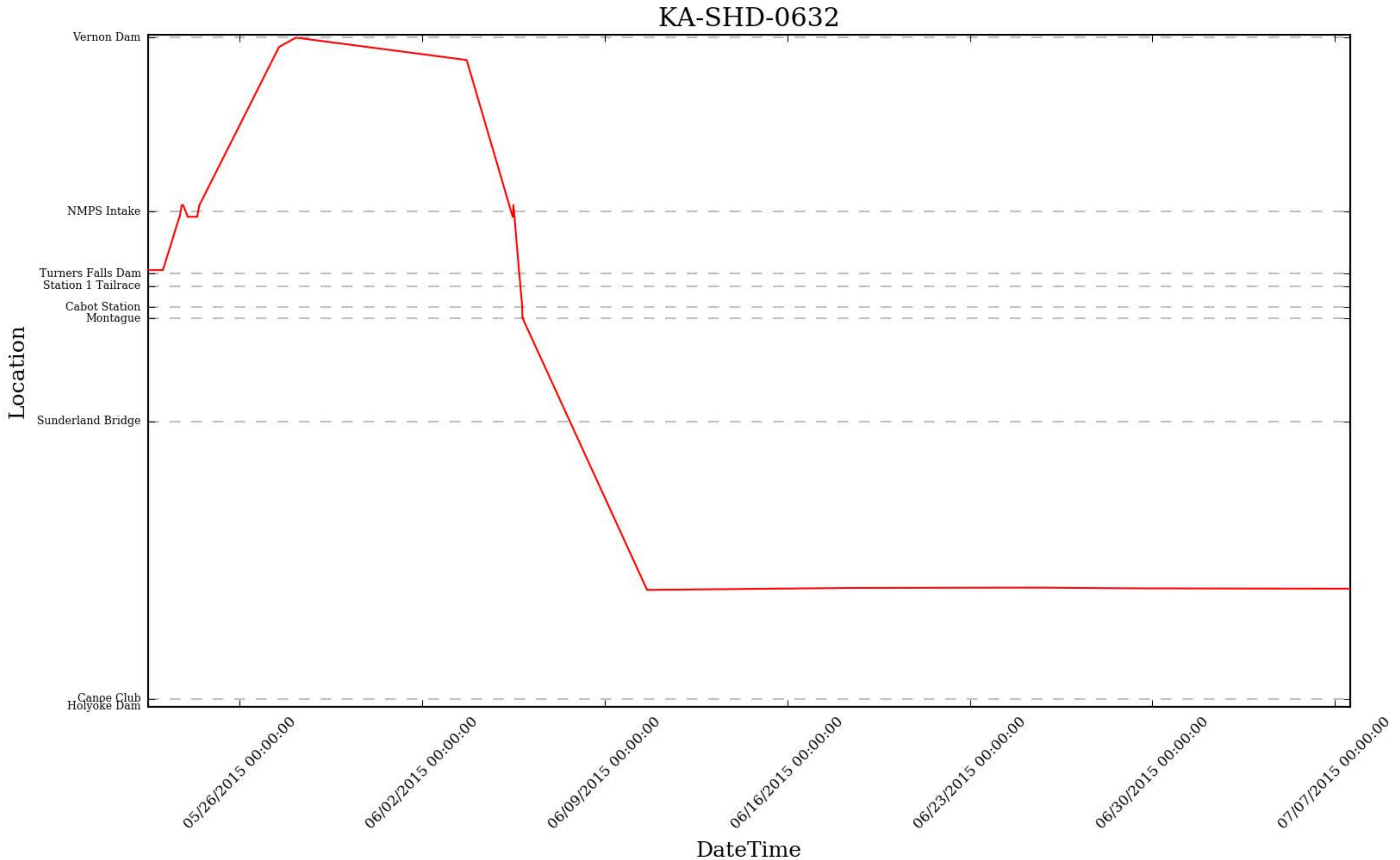
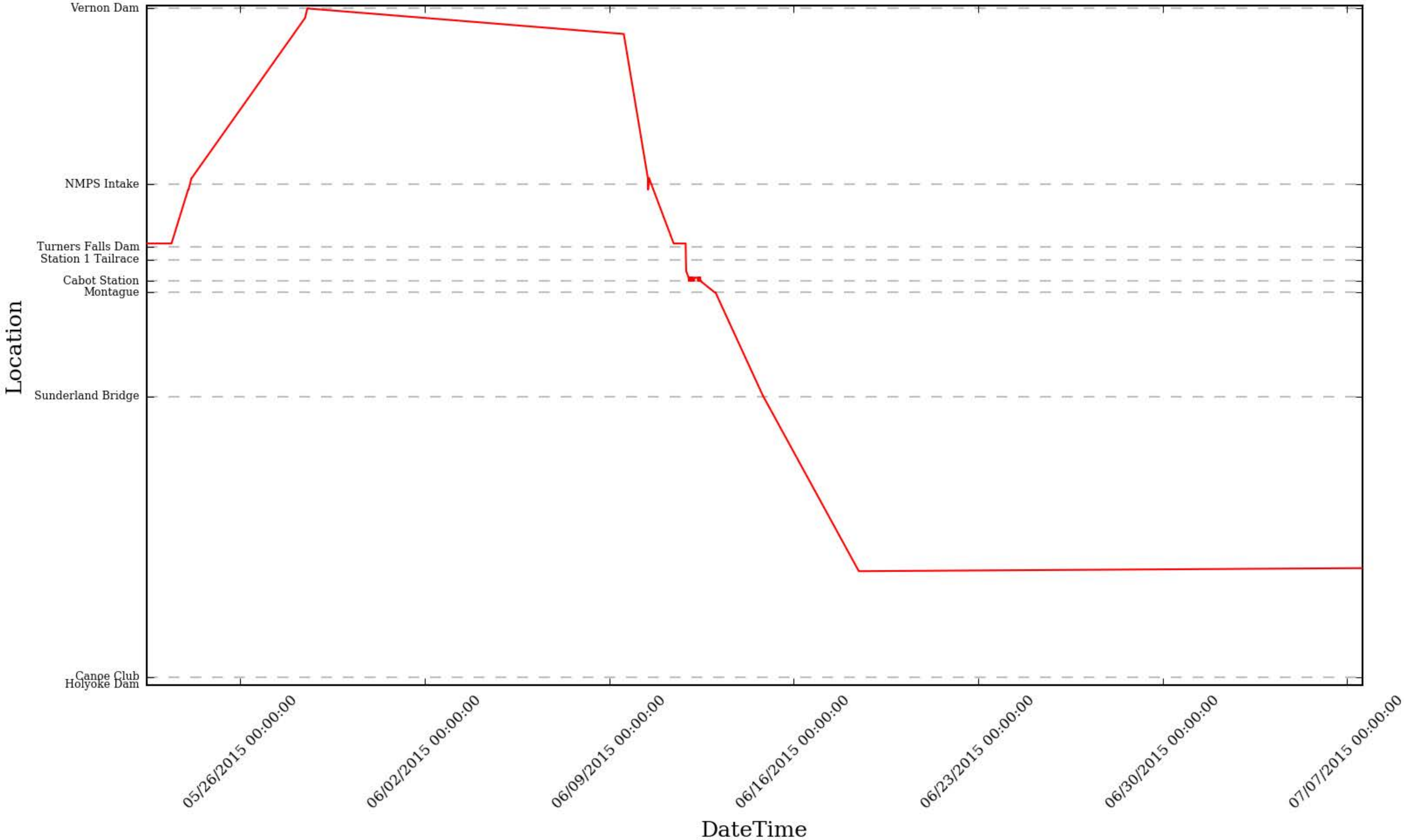
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
DateTime



KA-SHD-0632
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
DateTime
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00

KA-SHD-0634



Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
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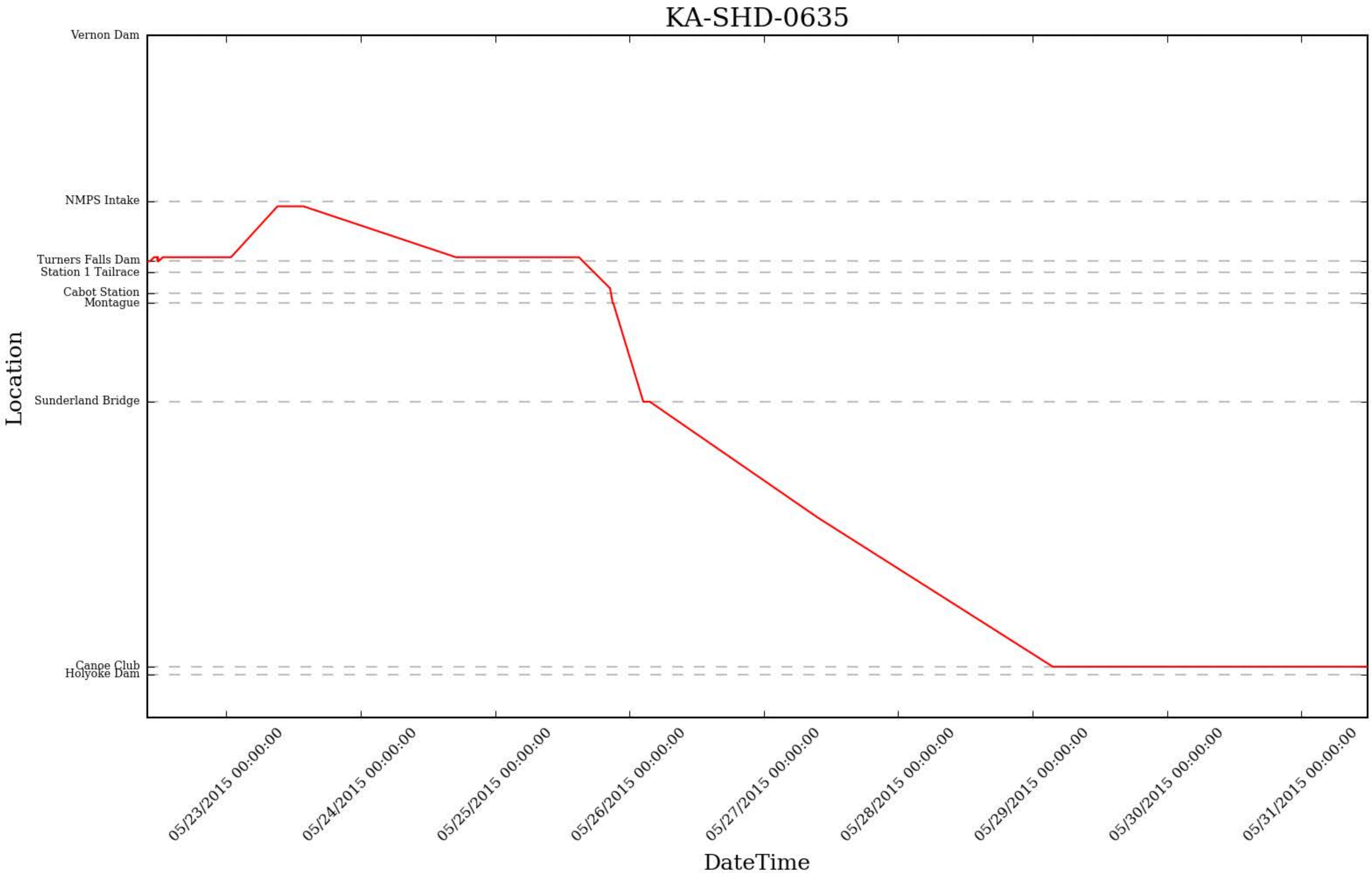
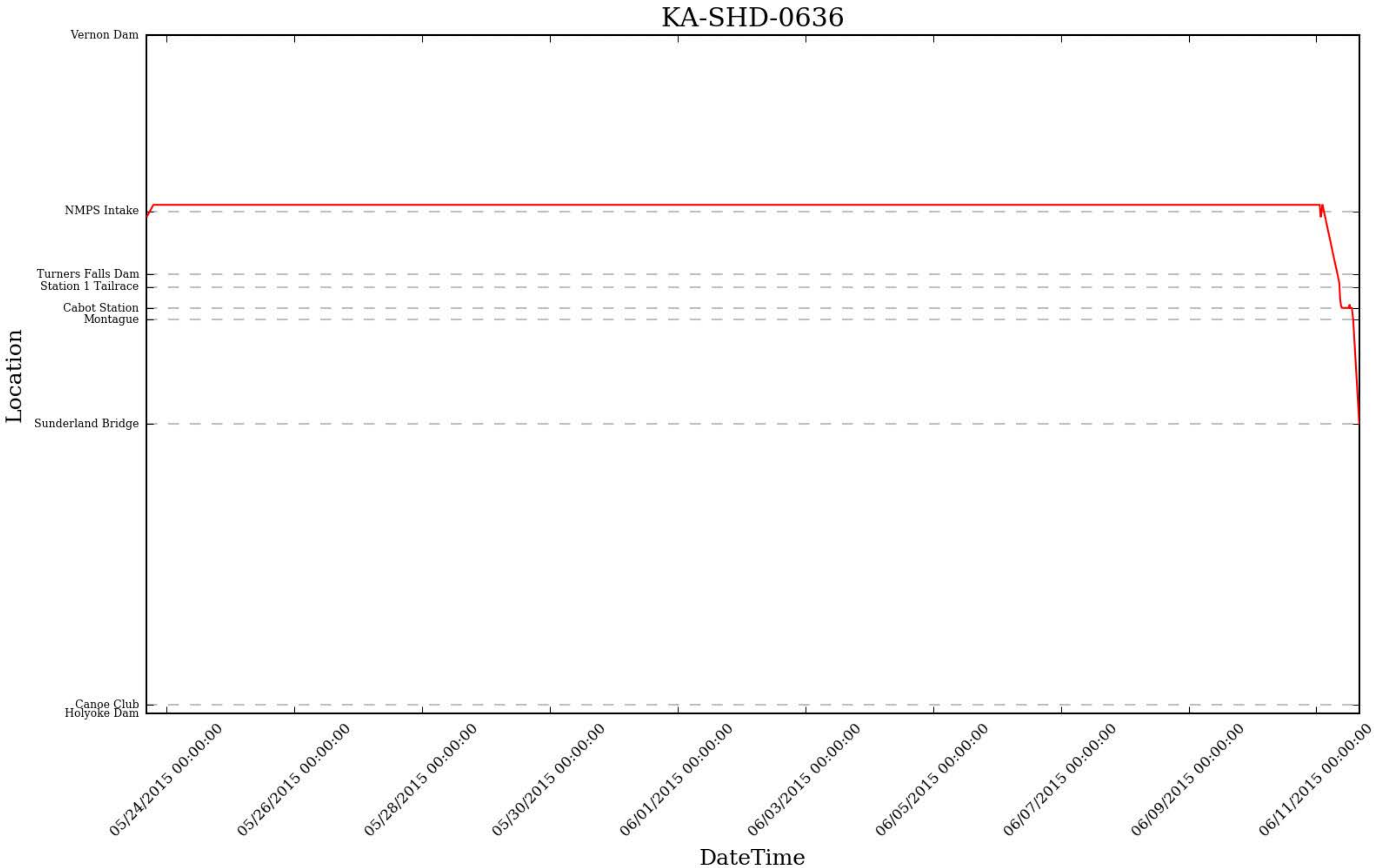
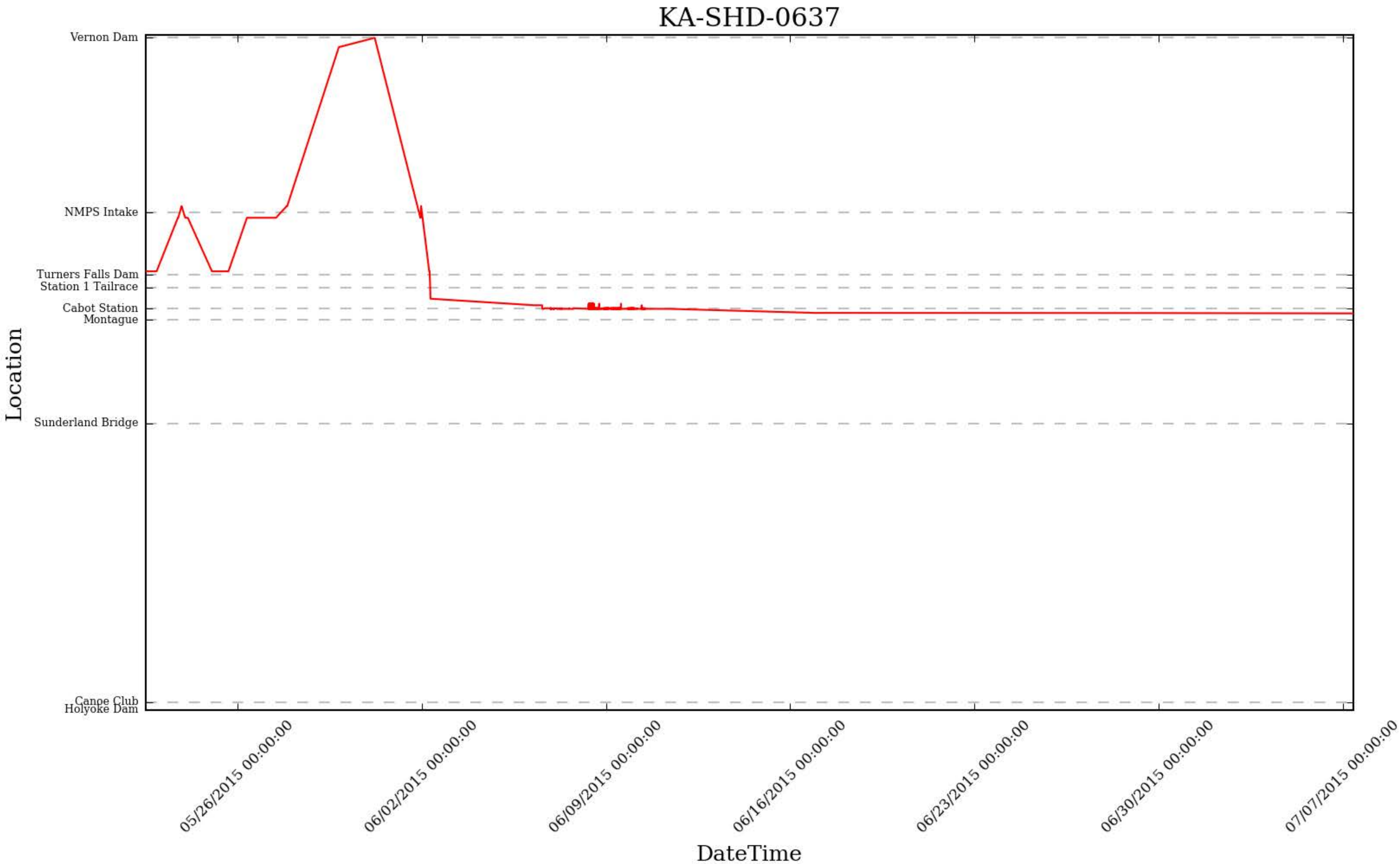
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime

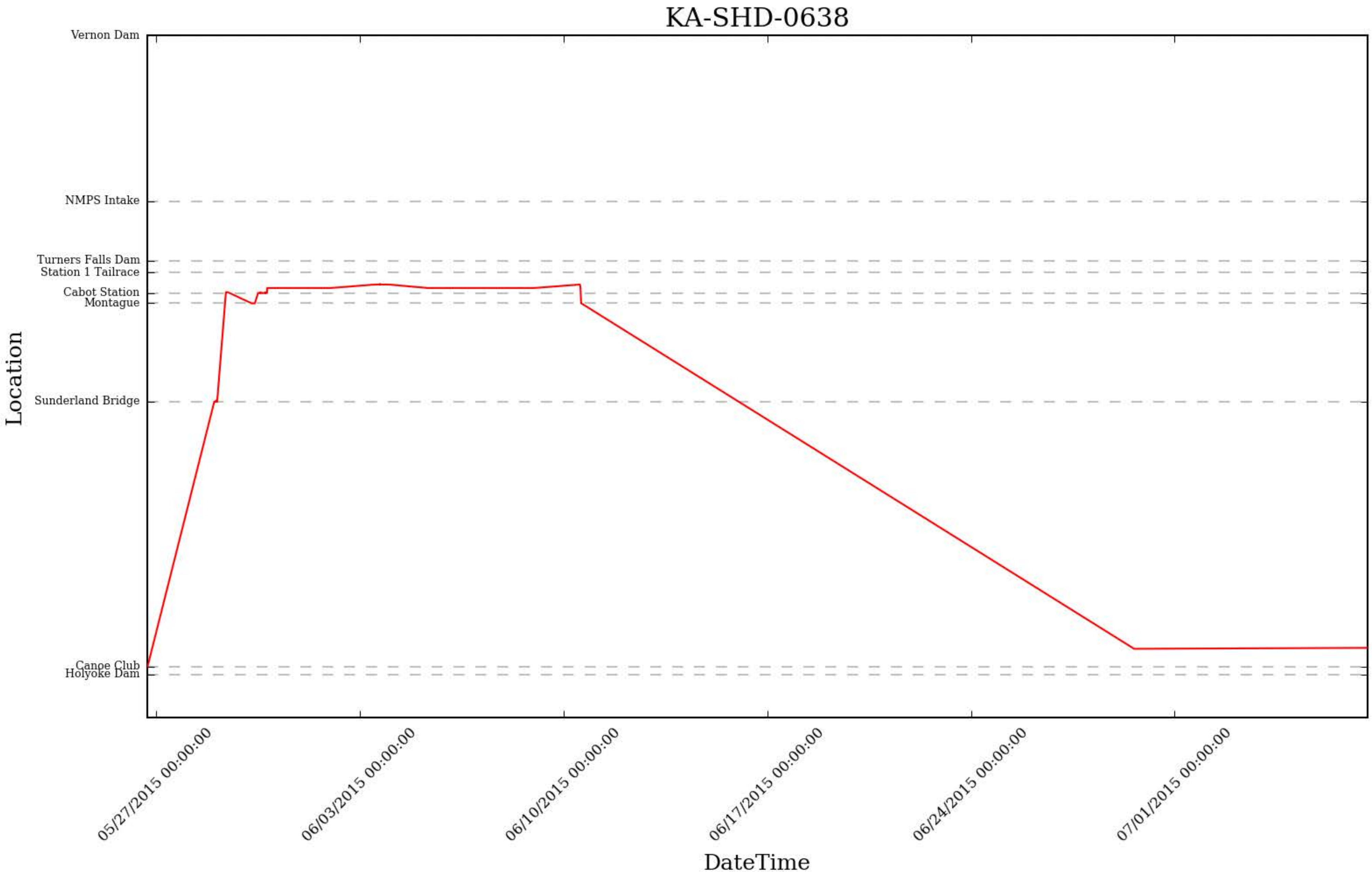

KA-SHD-0635
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
DateTime

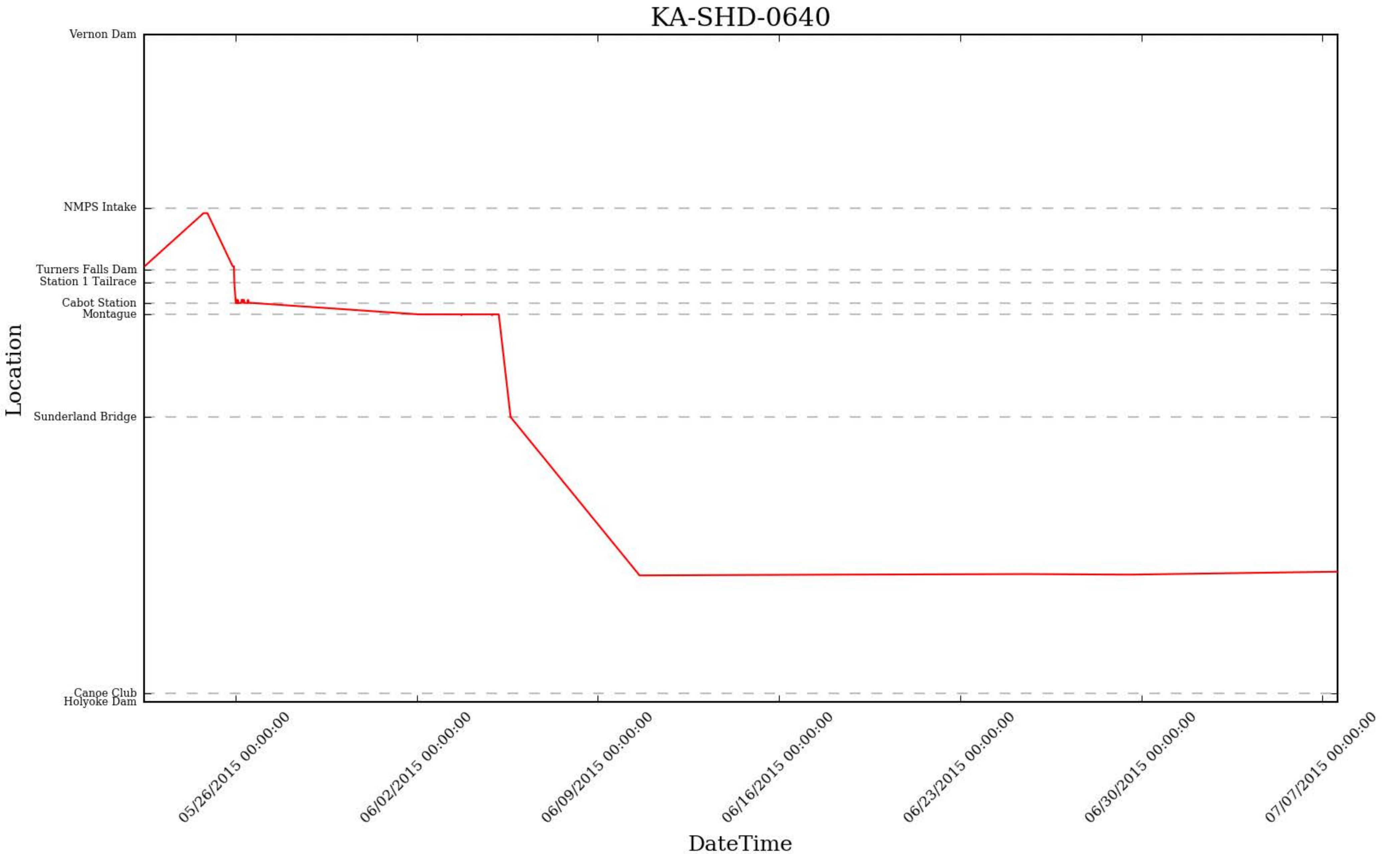


KA-SHD-0636
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
DateTime

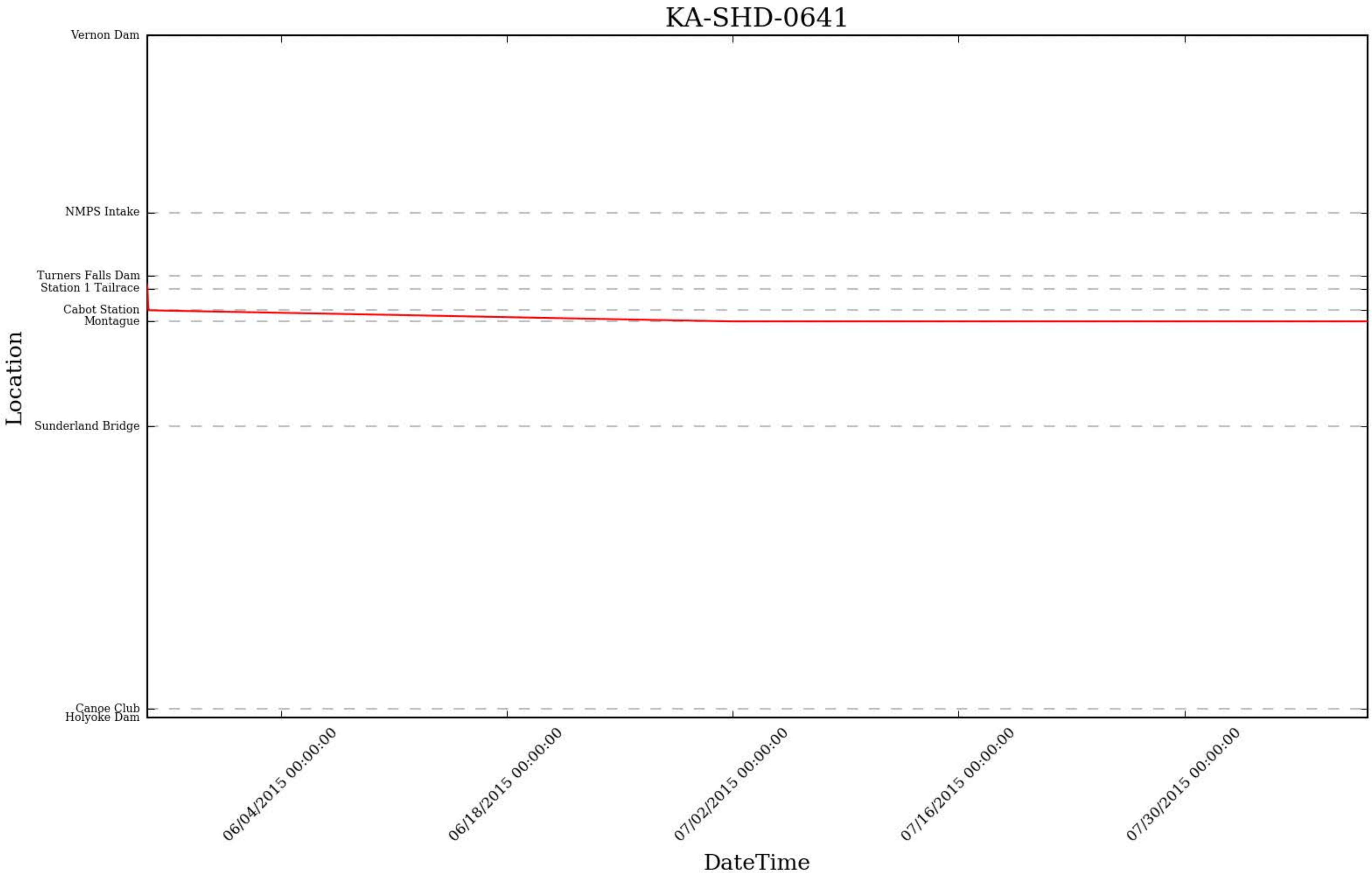


KA-SHD-0637
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime

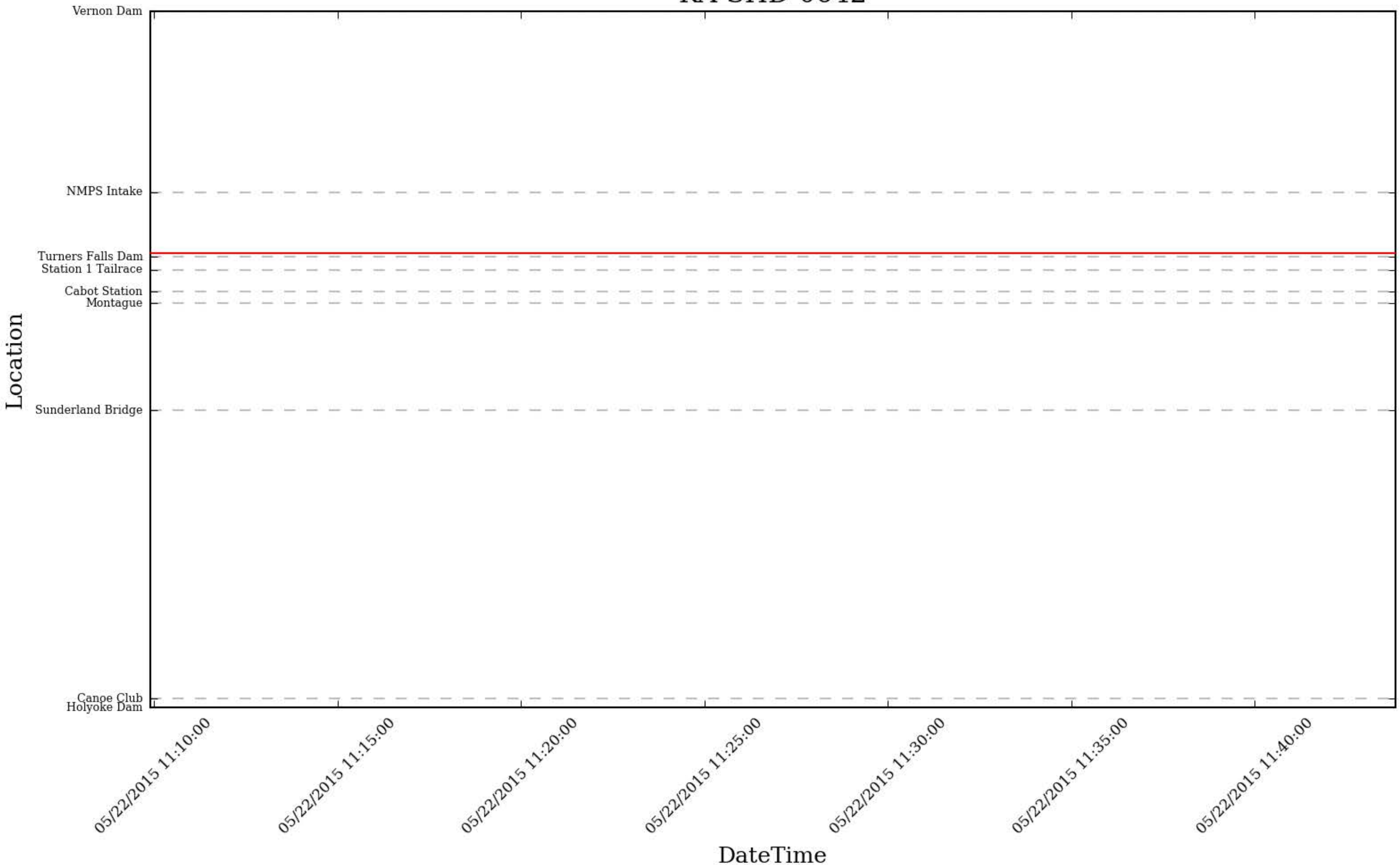

KA-SHD-0638
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

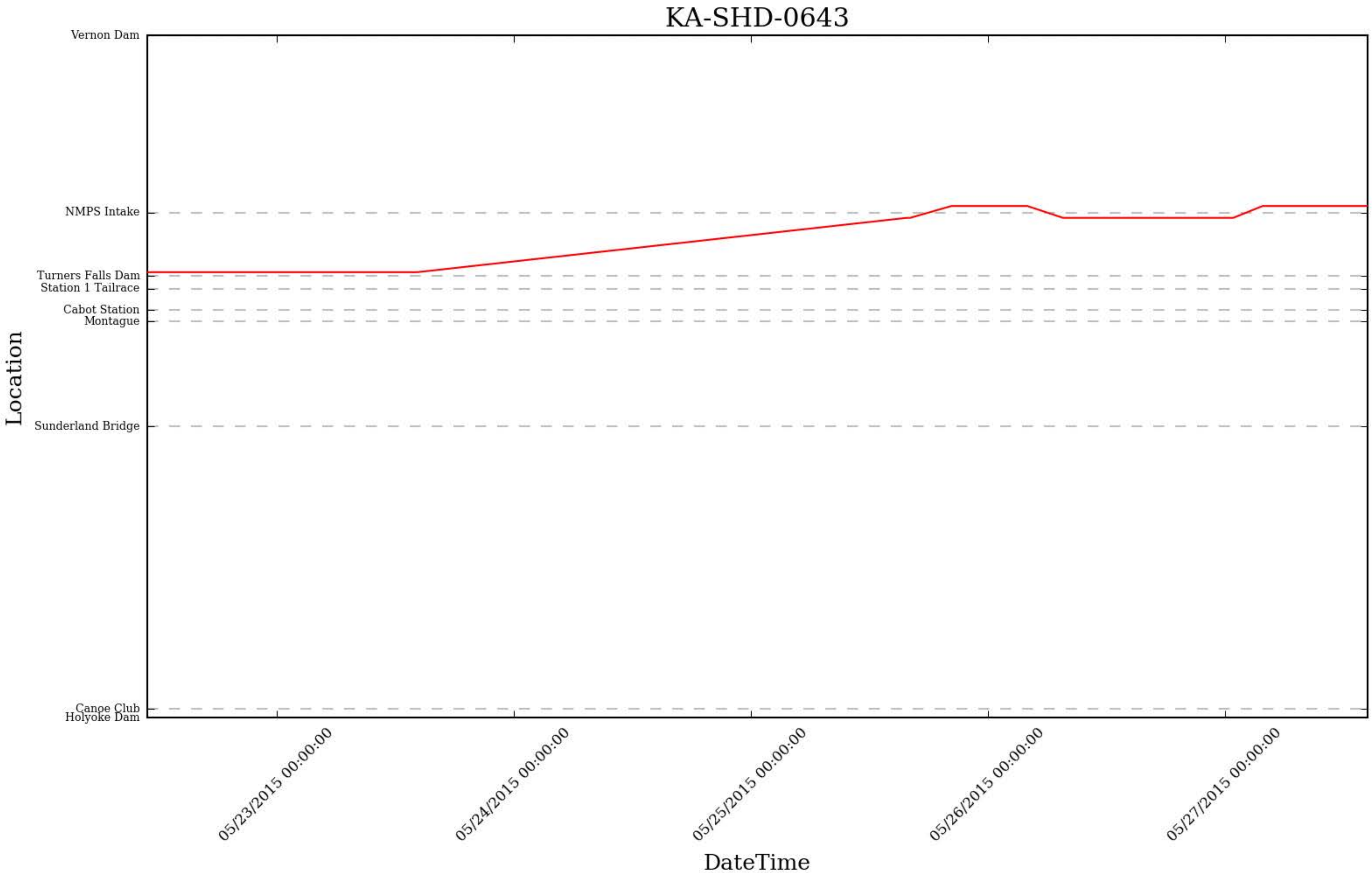


KA-SHD-0640
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime


KA-SHD-0641
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/04/2015 00:00:00
06/18/2015 00:00:00
07/02/2015 00:00:00
07/16/2015 00:00:00
07/30/2015 00:00:00
DateTime

KA-SHD-0642


Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 11:10:00
05/22/2015 11:15:00
05/22/2015 11:20:00
05/22/2015 11:25:00
05/22/2015 11:30:00
05/22/2015 11:35:00
05/22/2015 11:40:00
DateTime


KA-SHD-0643
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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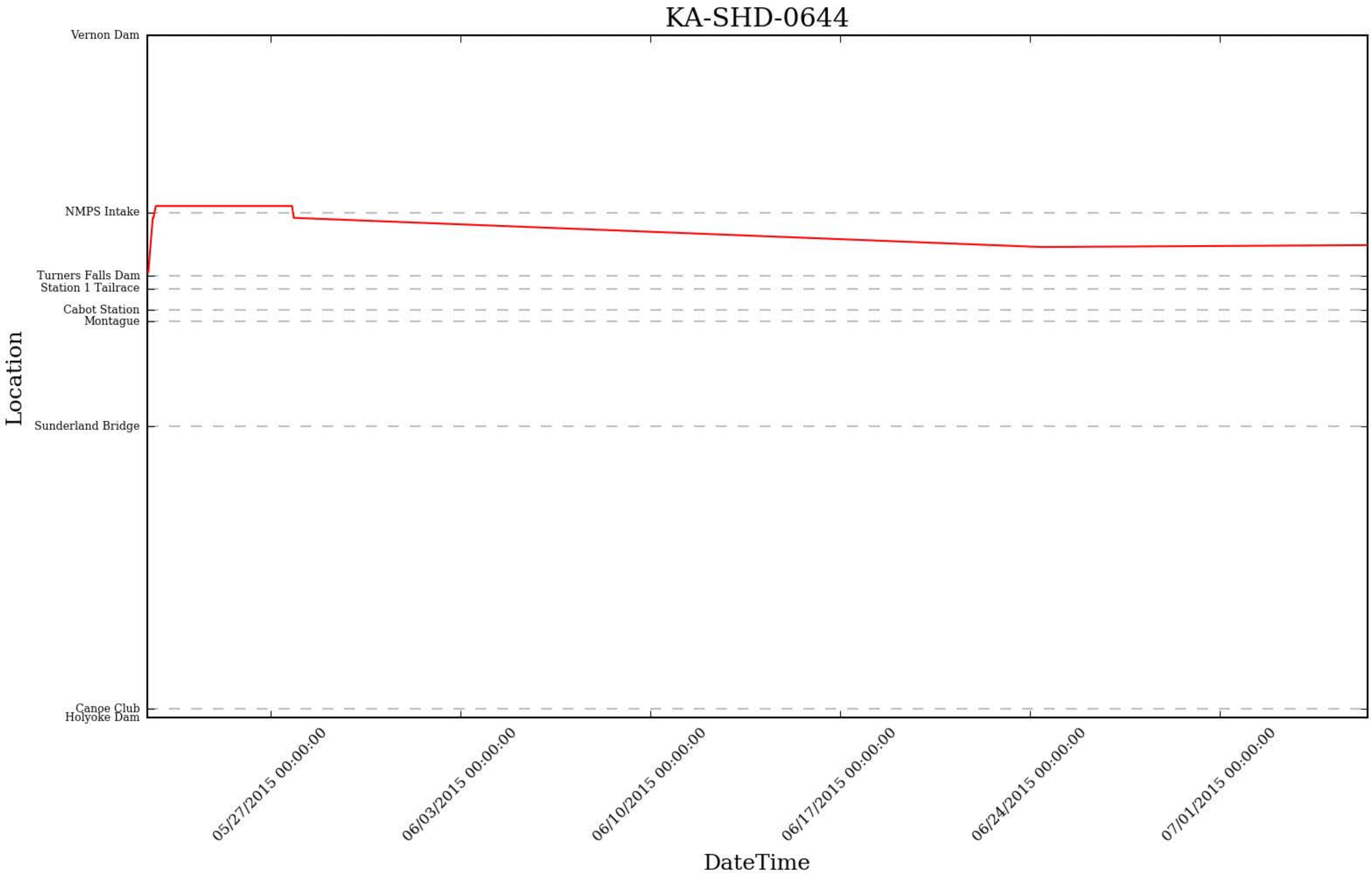
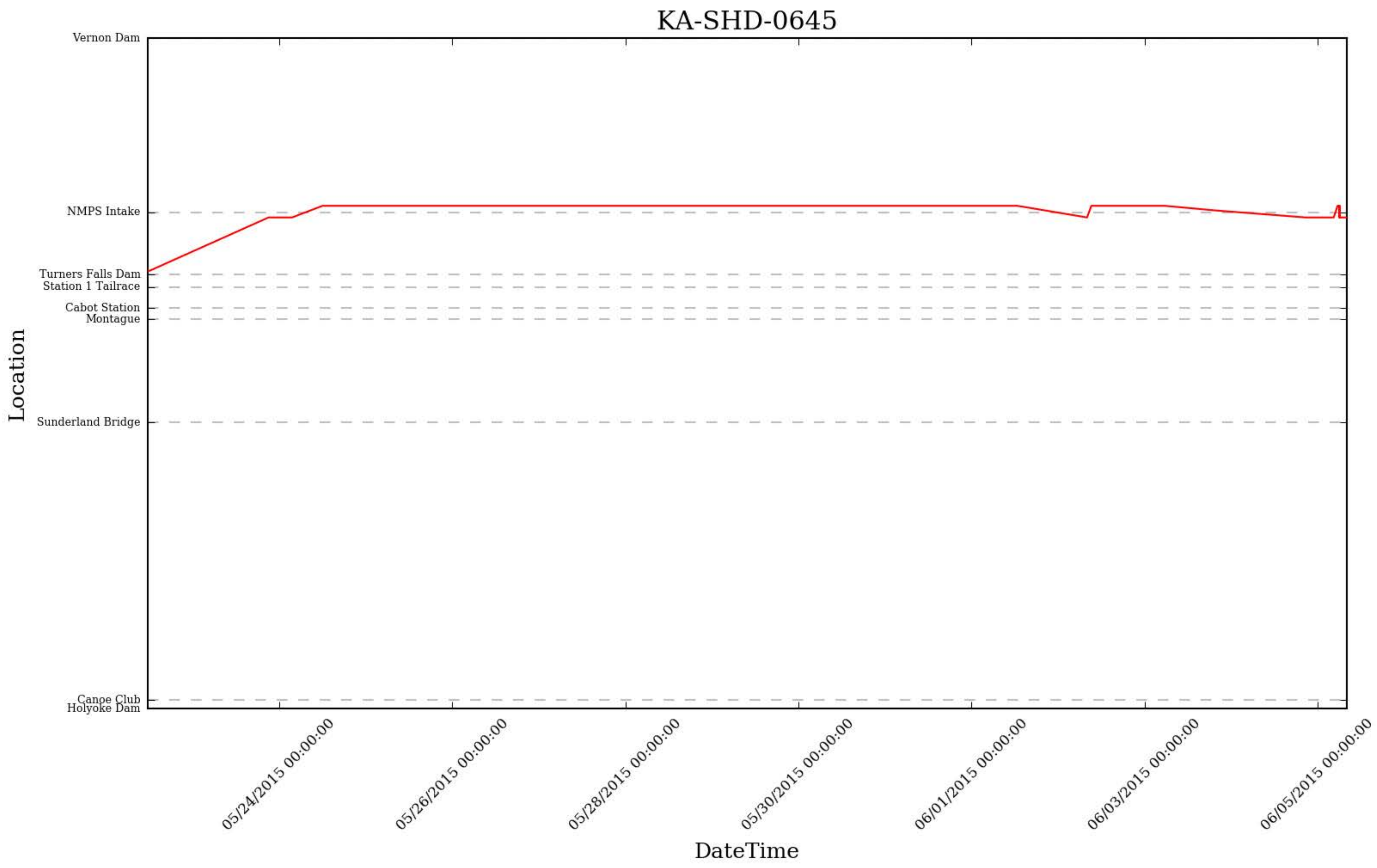
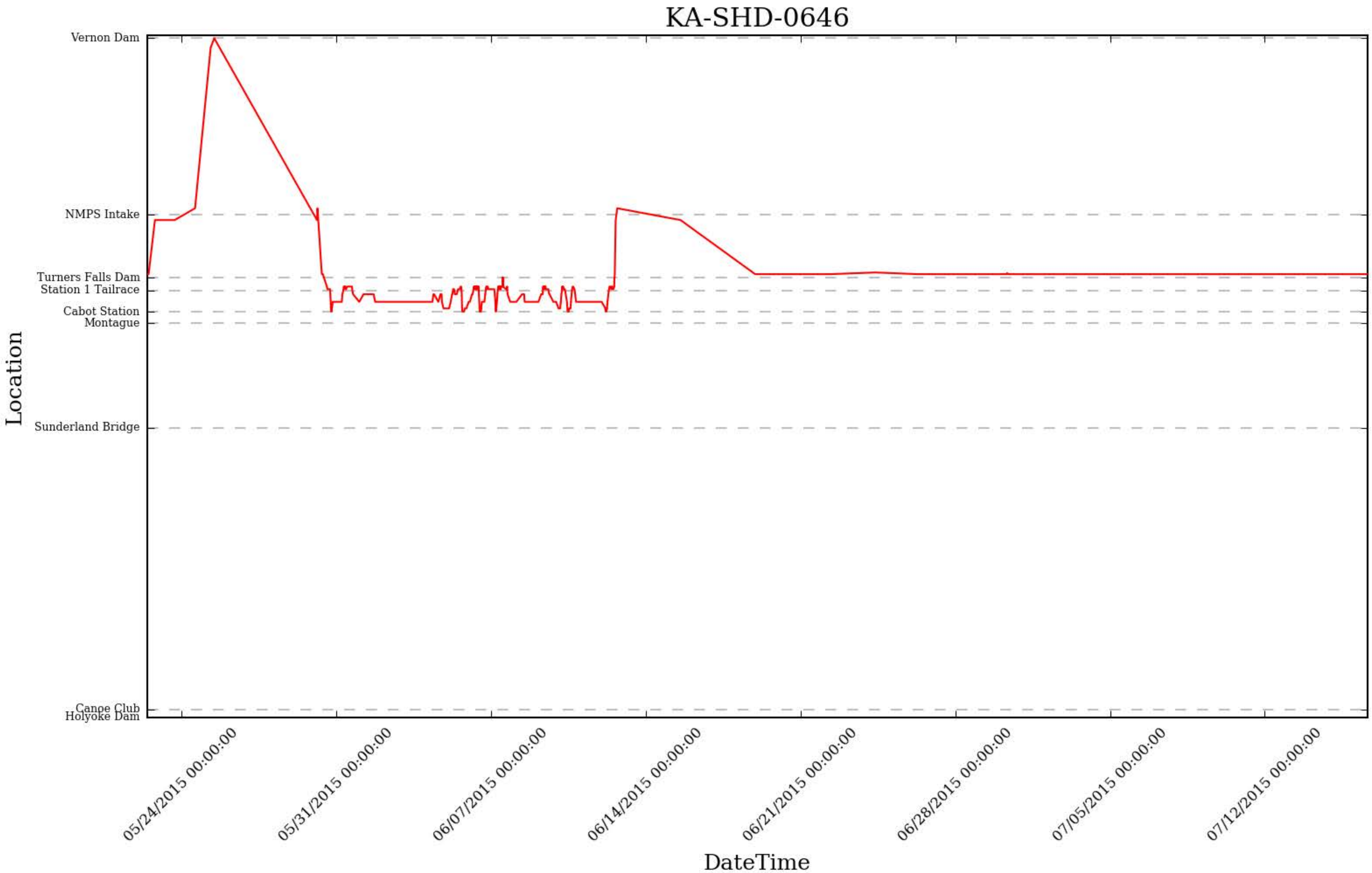
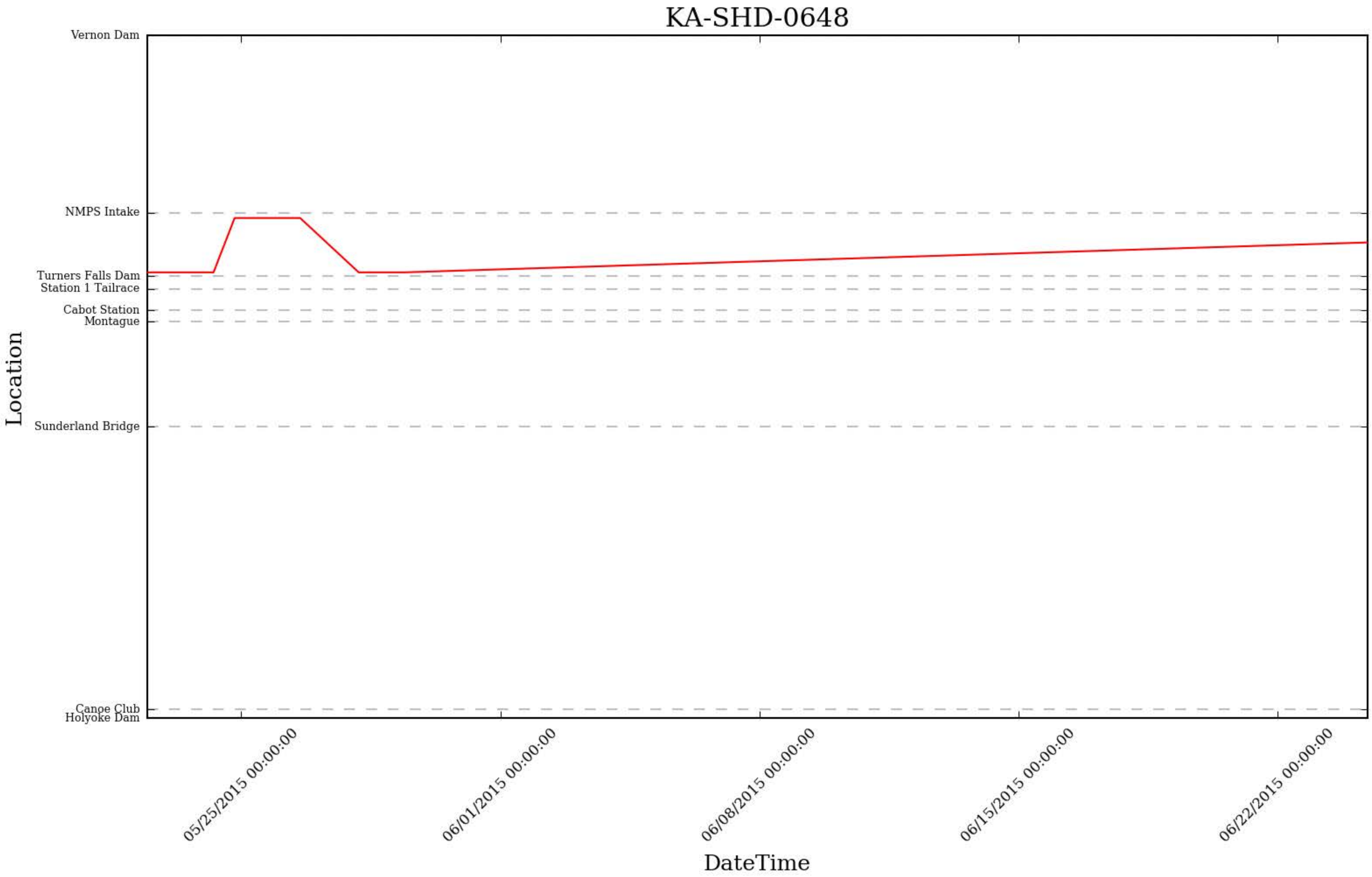
05/27/2015 00:00:00
DateTime

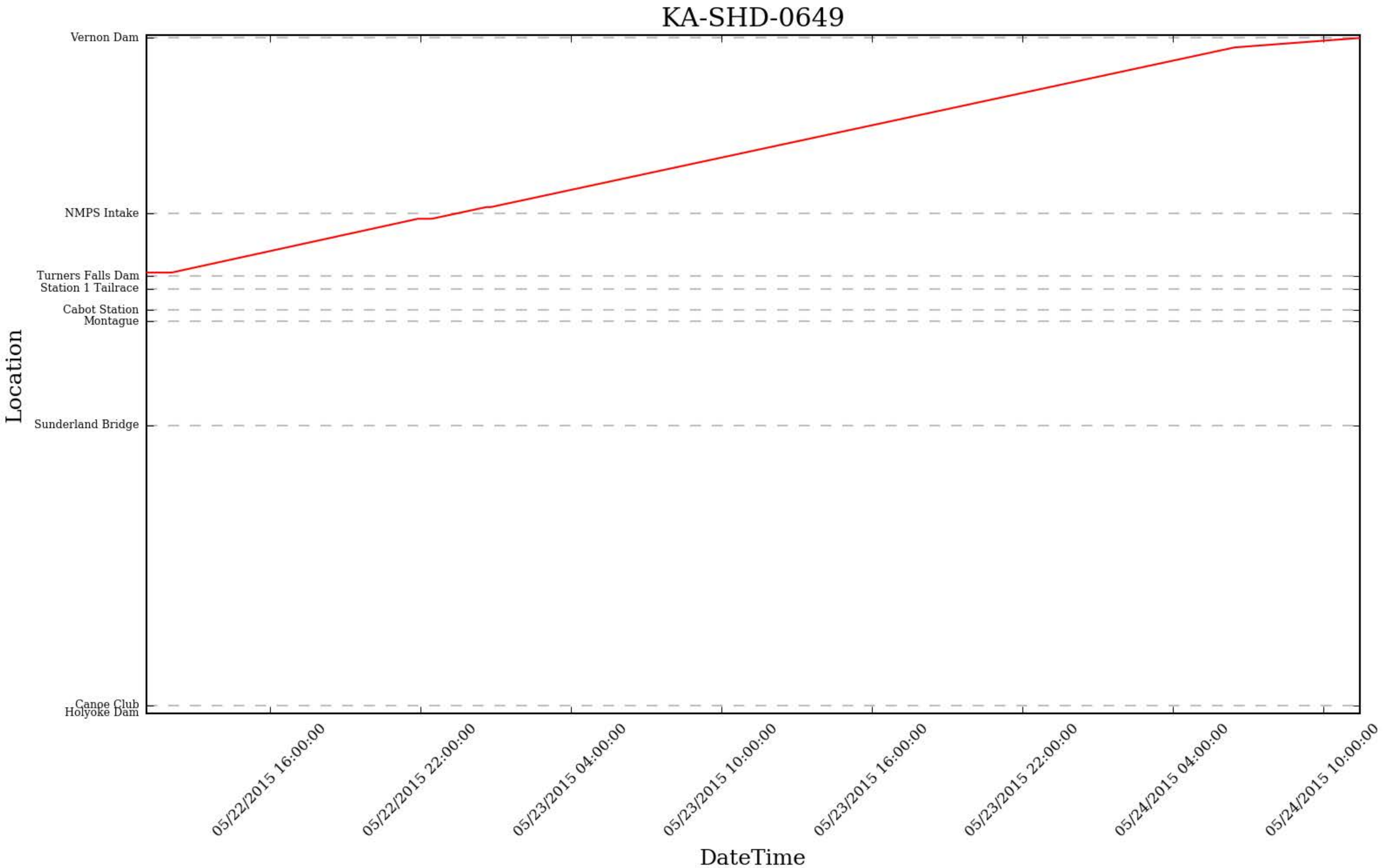


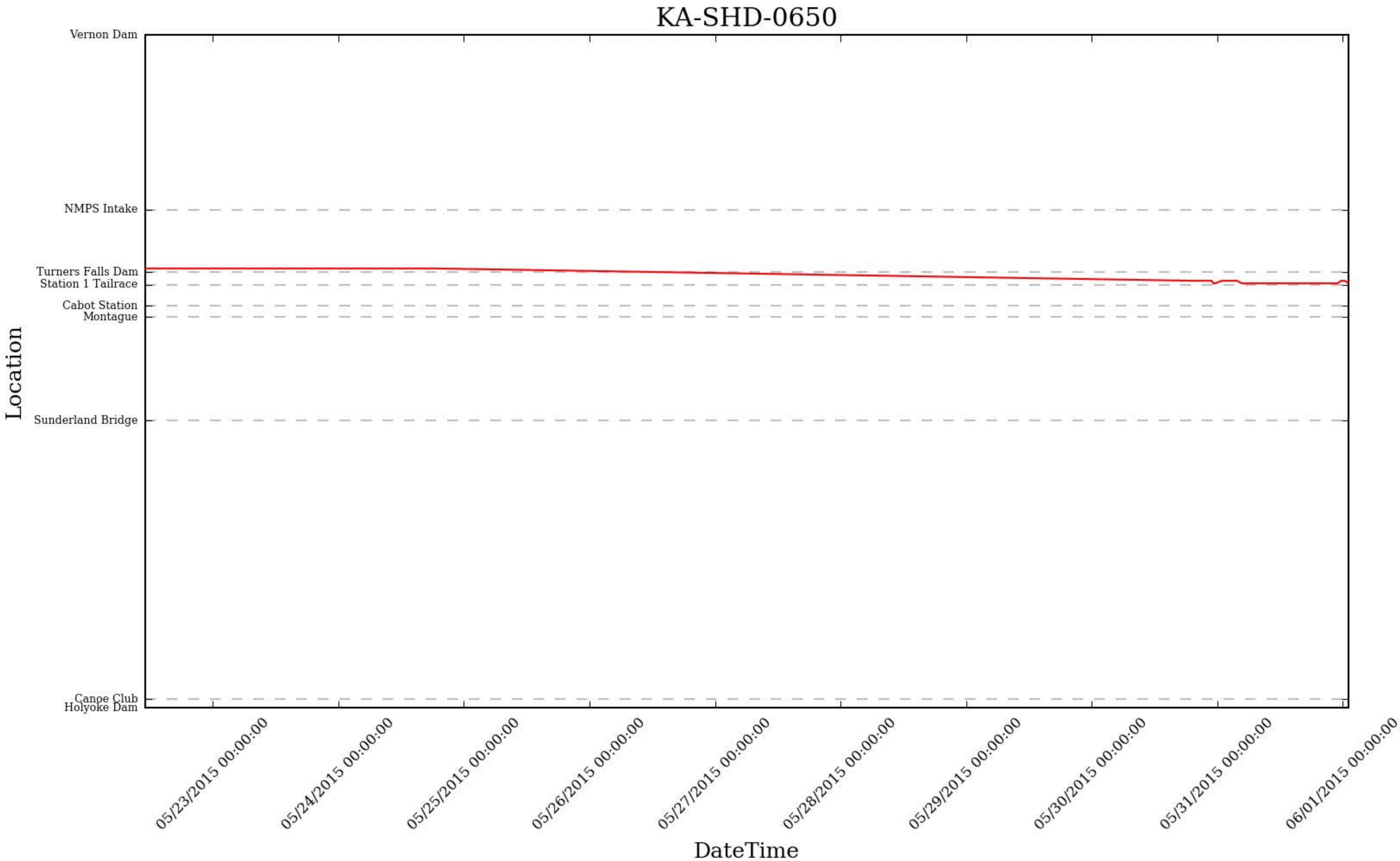
KA-SHD-0644
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

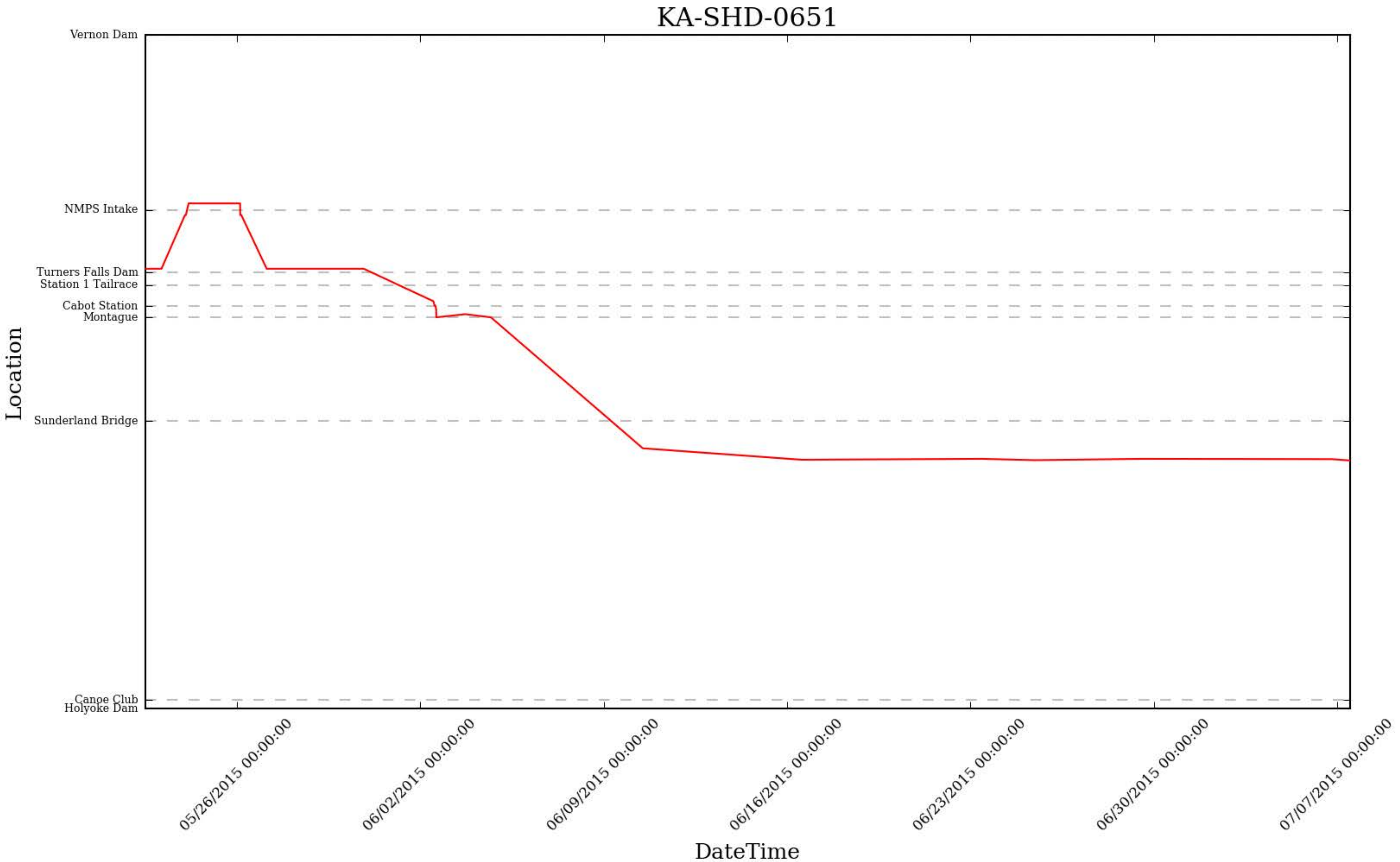

KA-SHD-0645
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime

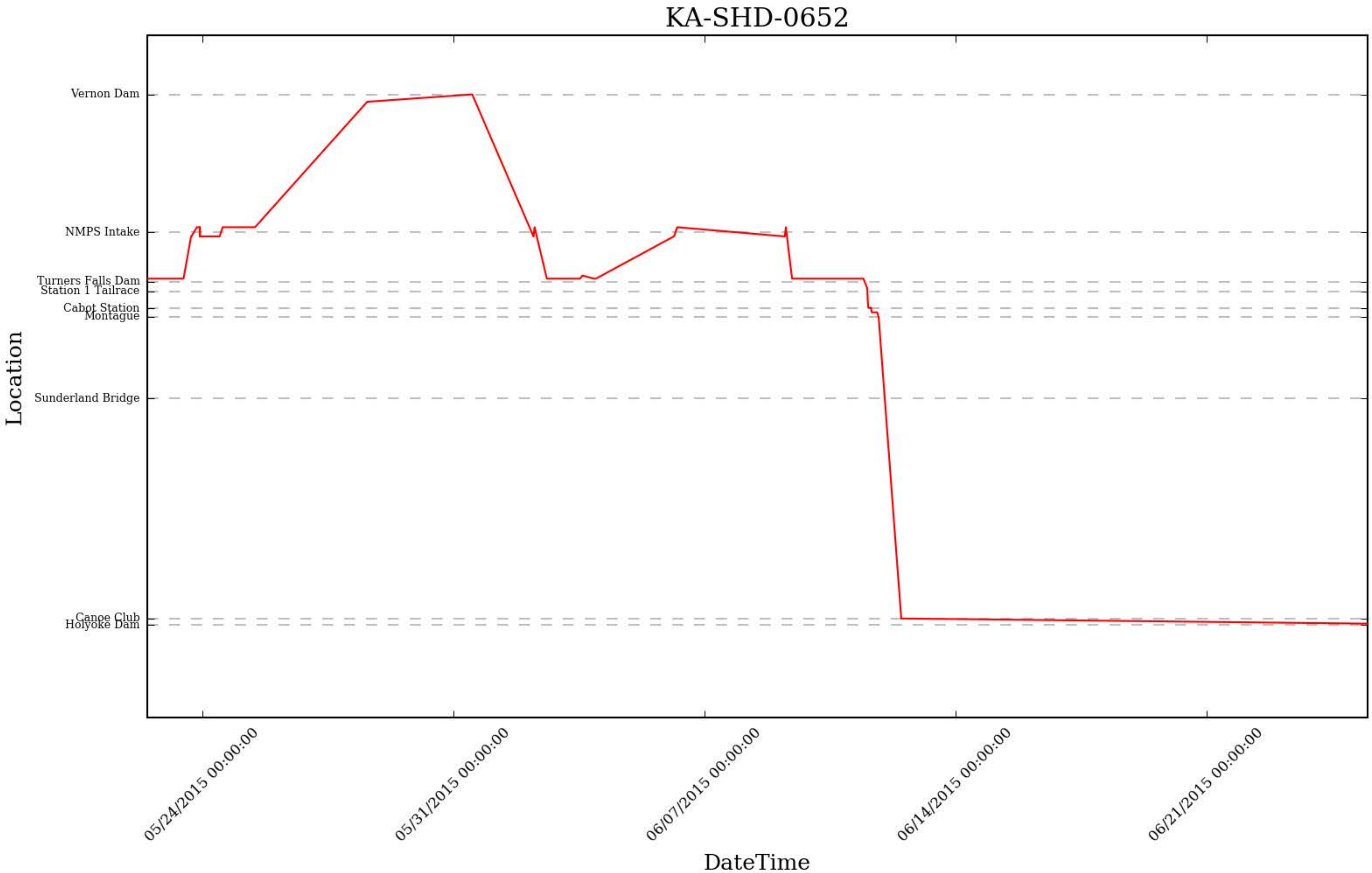

KA-SHD-0646
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
07/12/2015 00:00:00
DateTime

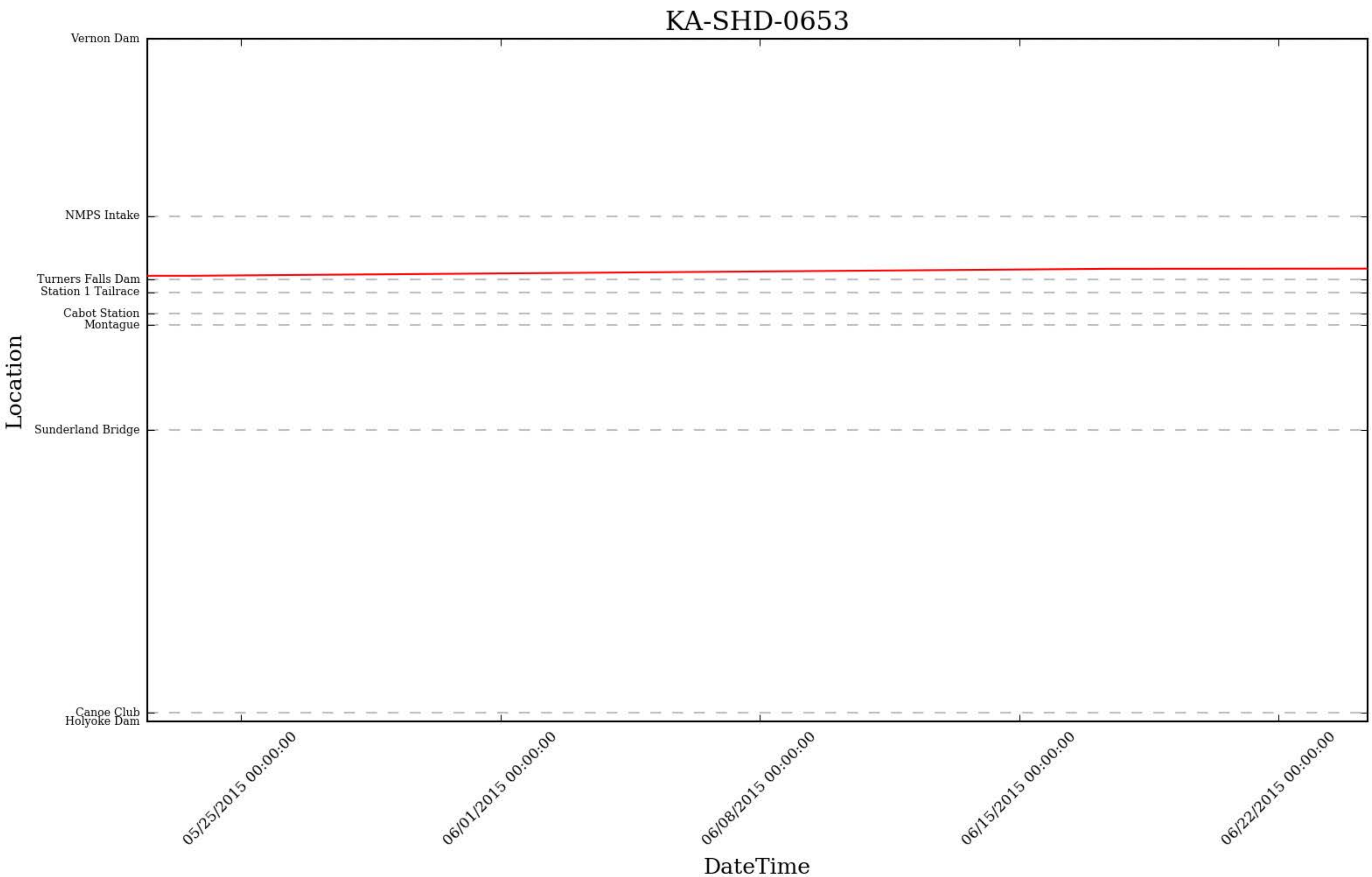

KA-SHD-0648
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 00:00:00
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
DateTime


KA-SHD-0649
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/22/2015 16:00:00
05/22/2015 22:00:00
05/23/2015 04:00:00
05/23/2015 10:00:00
05/23/2015 16:00:00
05/23/2015 22:00:00
05/24/2015 04:00:00
05/24/2015 10:00:00
DateTime

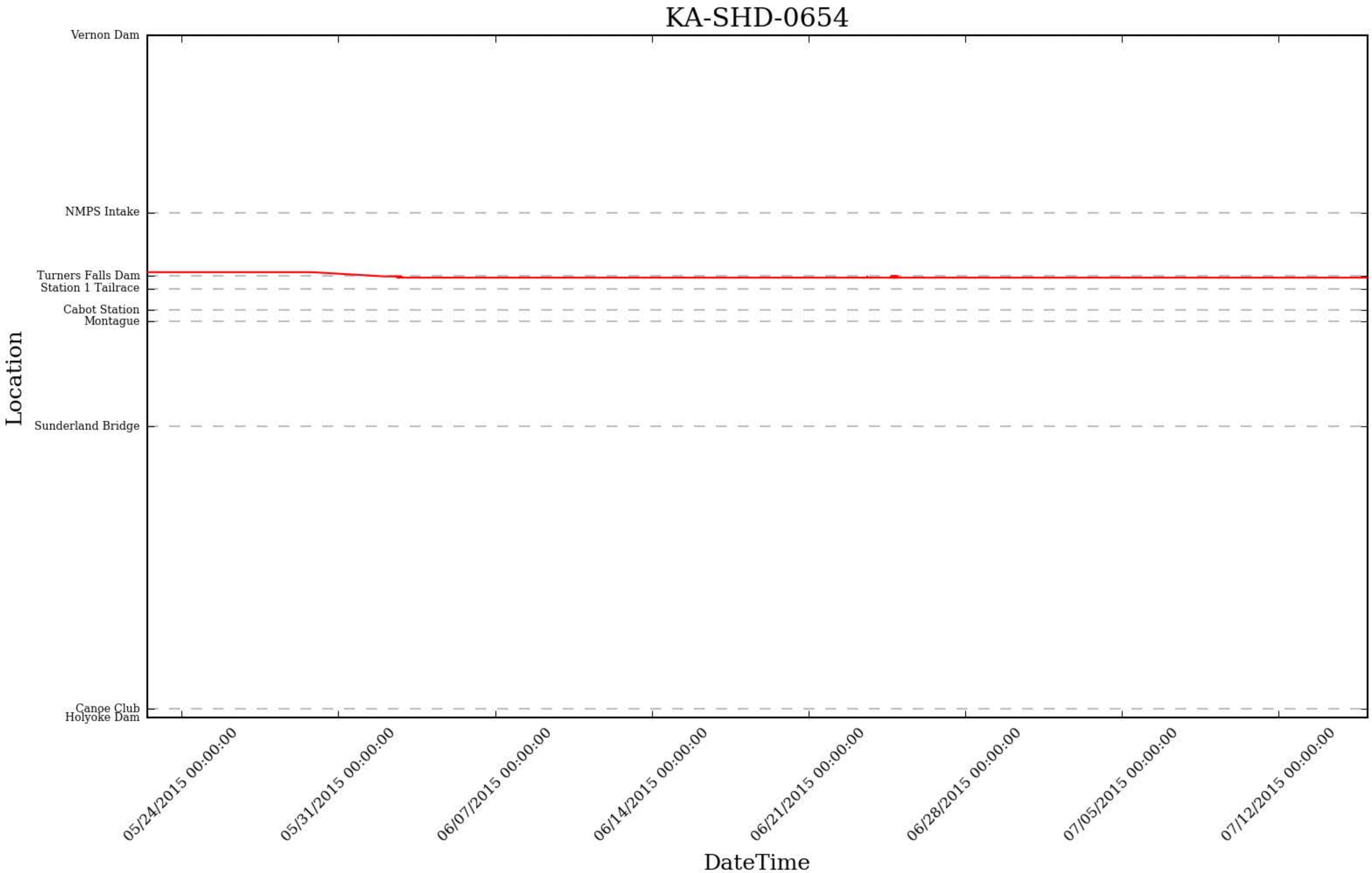

KA-SHD-0650
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
DateTime

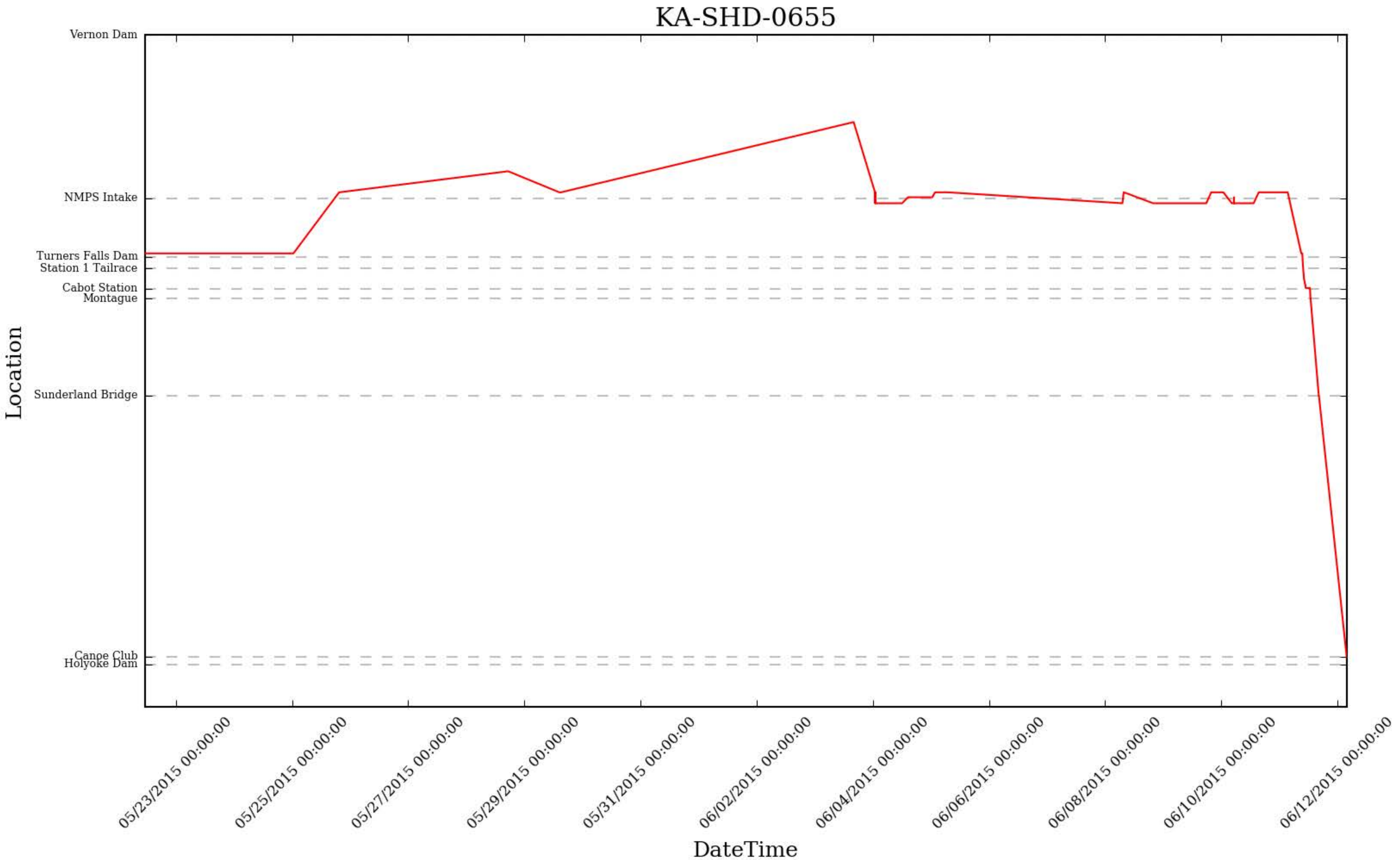

KA-SHD-0651
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime

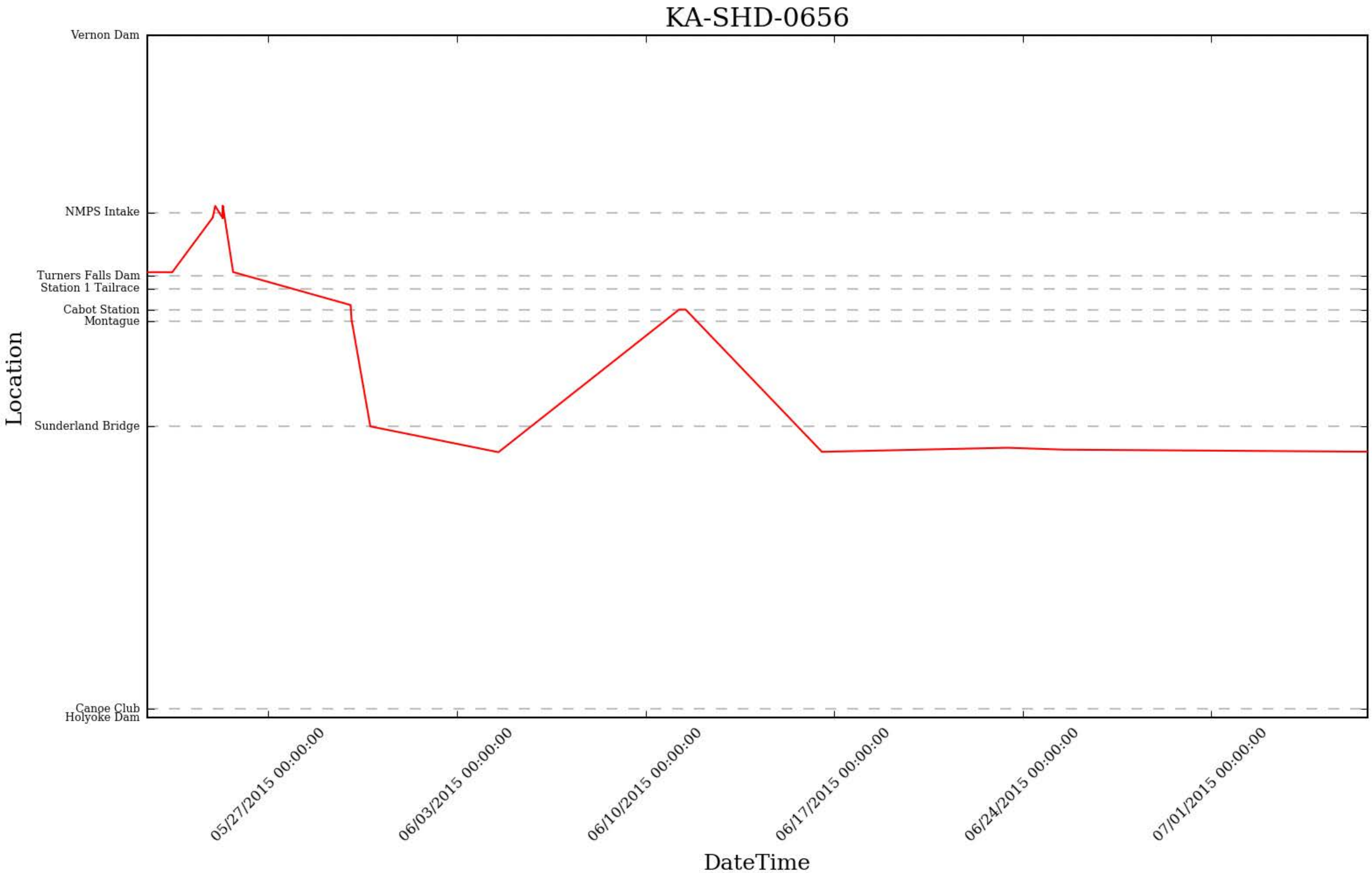

KA-SHD-0652
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
DateTime

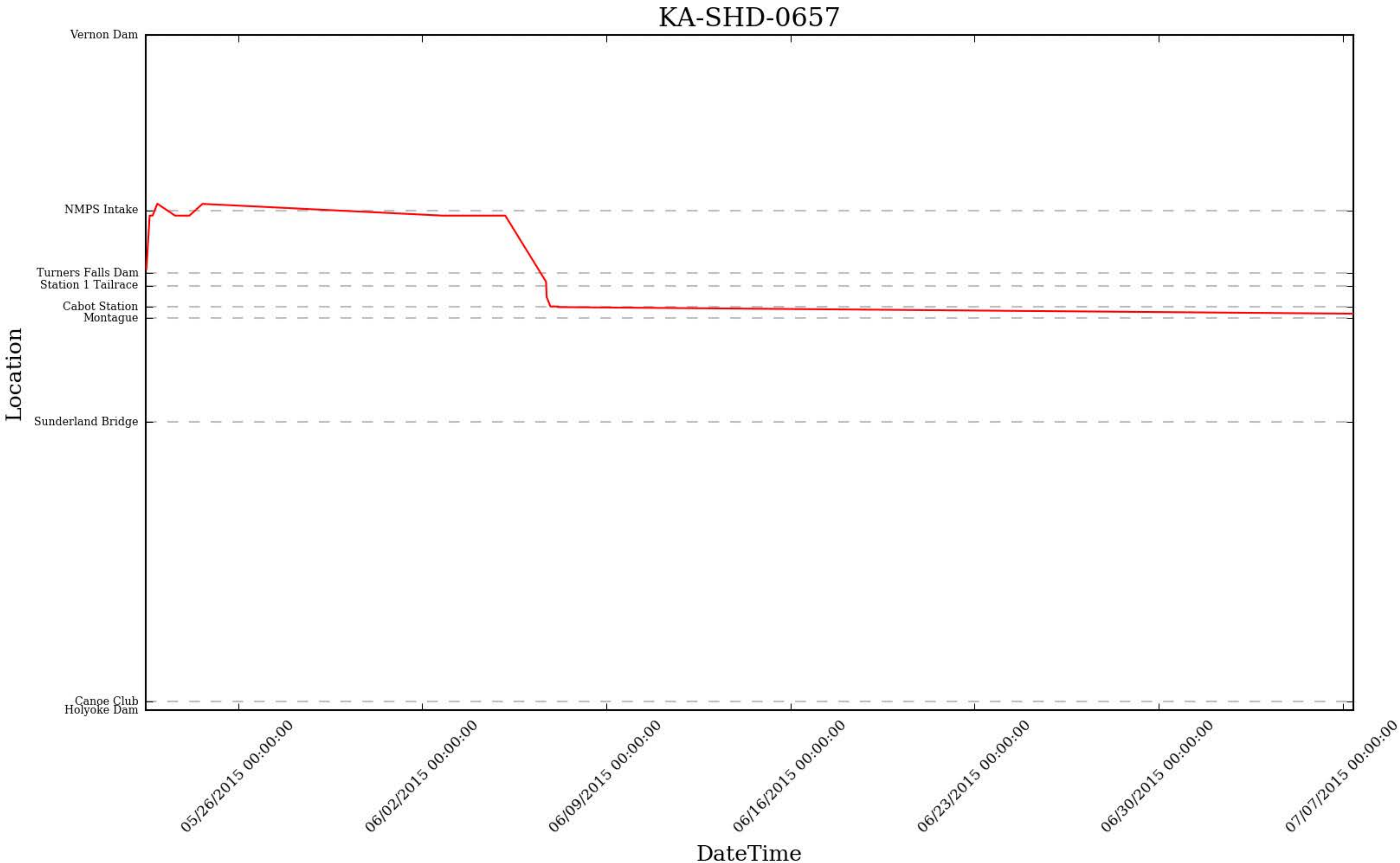


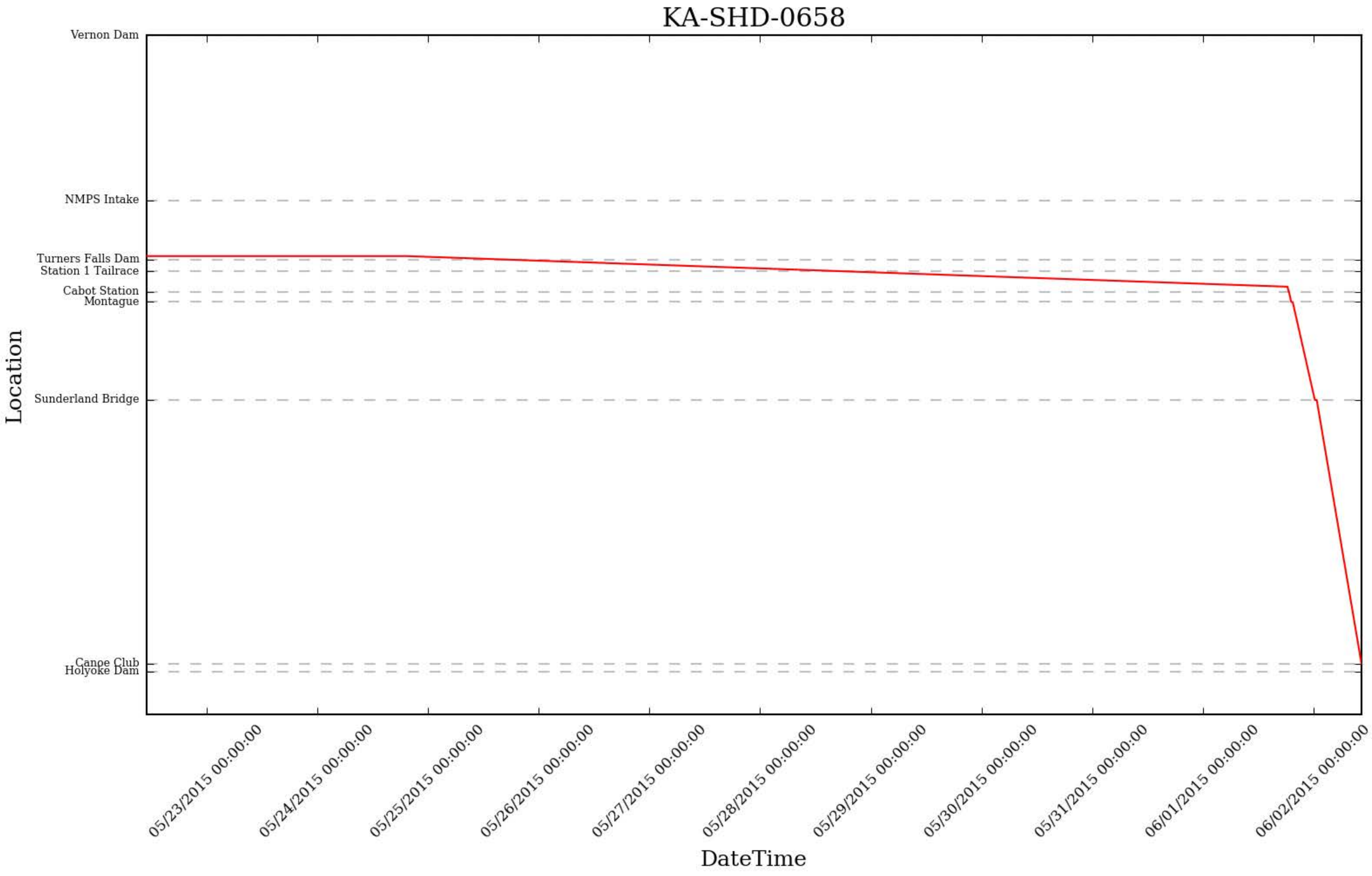
KA-SHD-0653
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 00:00:00
06/01/2015 00:00:00
06/08/2015 00:00:00
06/15/2015 00:00:00
06/22/2015 00:00:00
DateTime


KA-SHD-0654
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
07/12/2015 00:00:00
DateTime

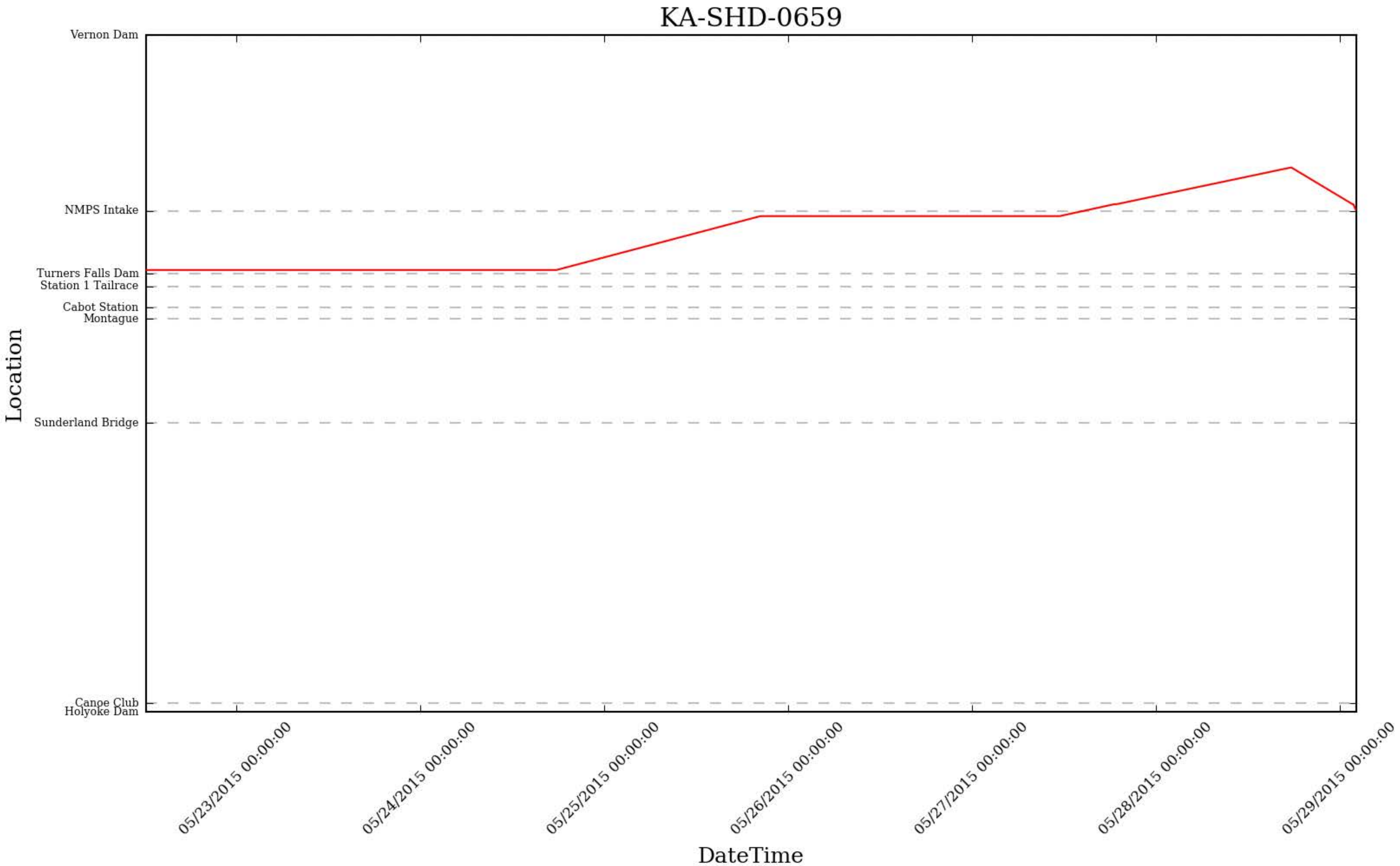

KA-SHD-0655
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
DateTime
05/23/2015 00:00:00
05/25/2015 00:00:00
05/27/2015 00:00:00
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
06/06/2015 00:00:00
06/08/2015 00:00:00
06/10/2015 00:00:00
06/12/2015 00:00:00


KA-SHD-0656
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

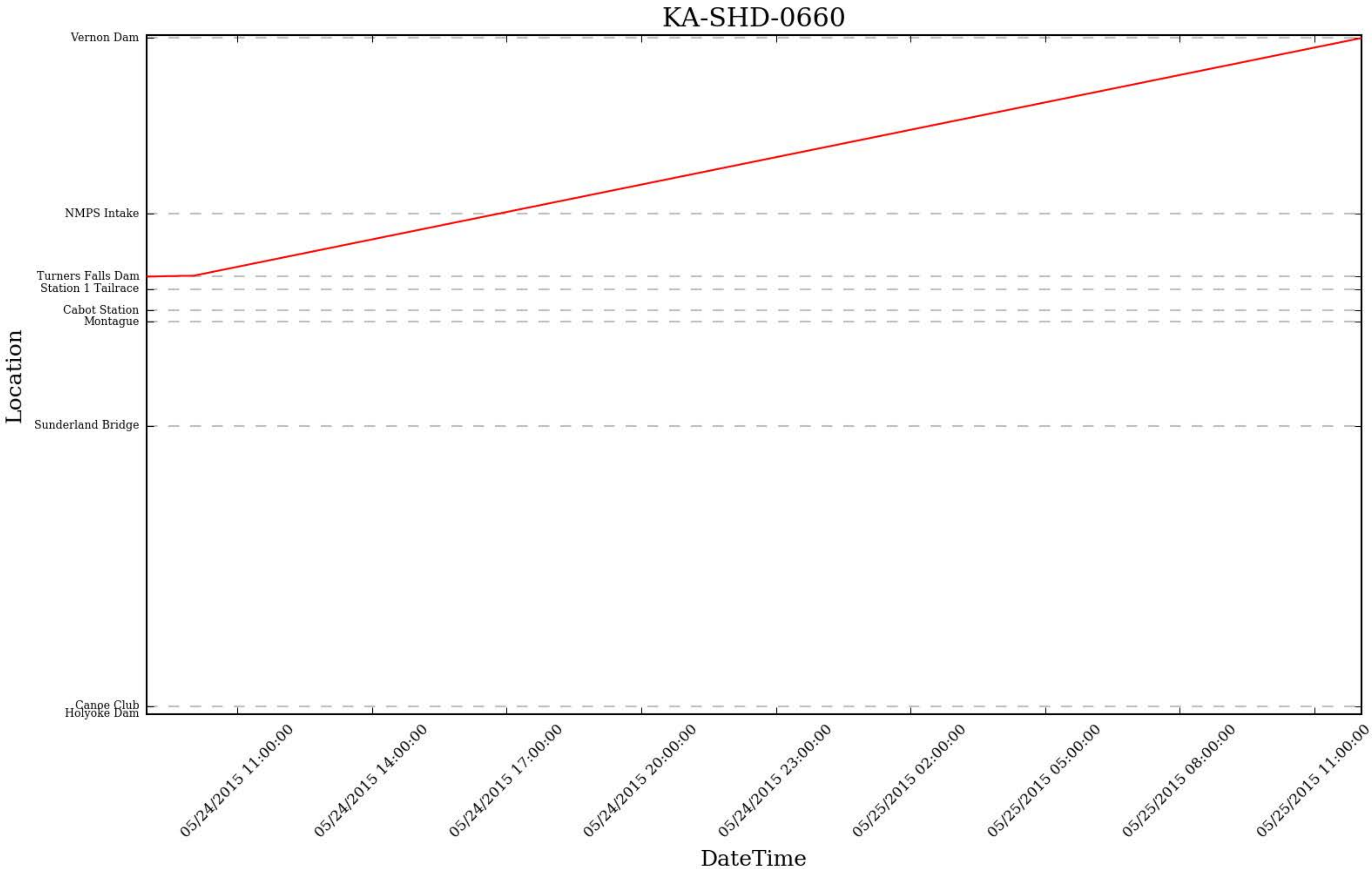

KA-SHD-0657
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
DateTime

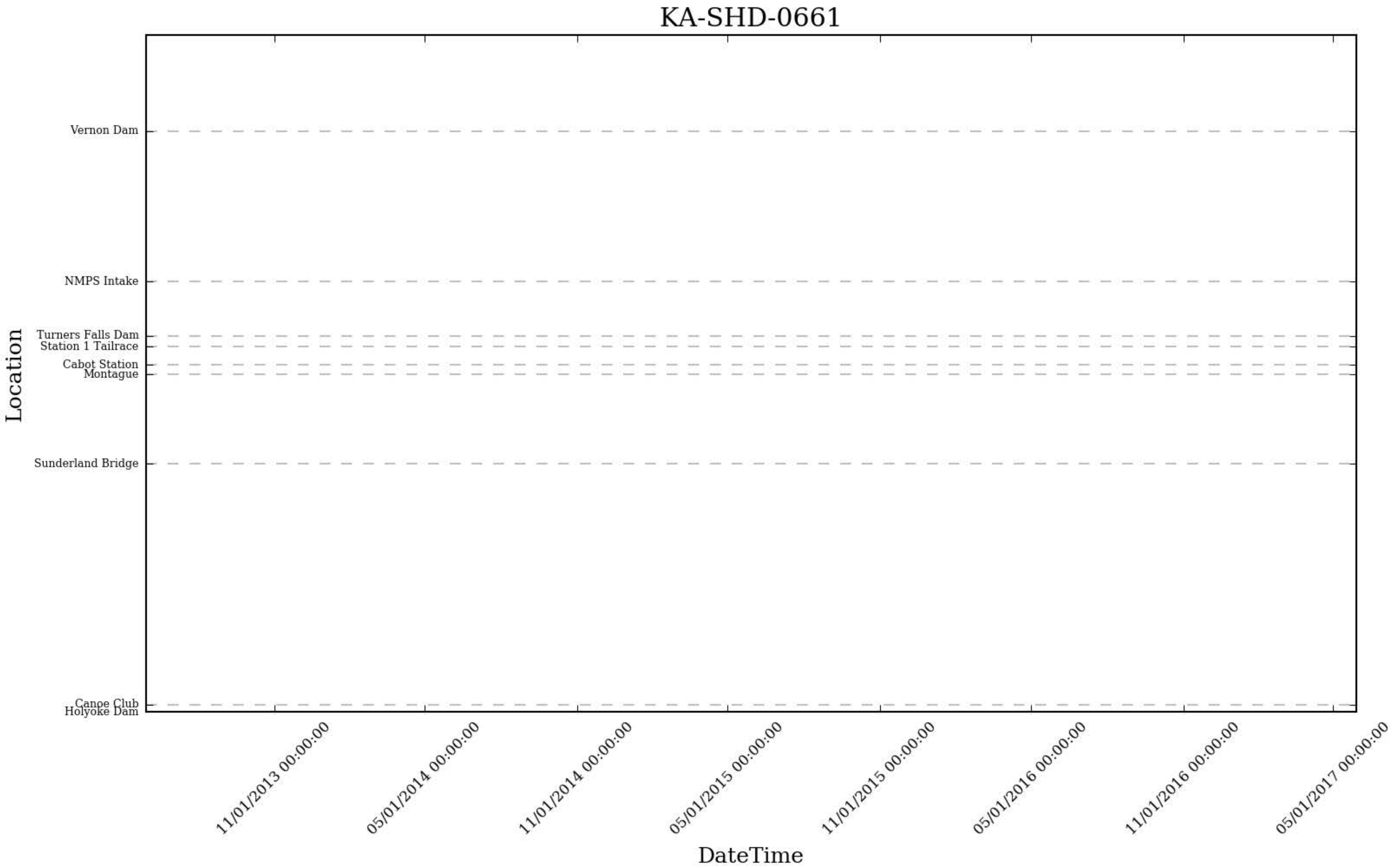


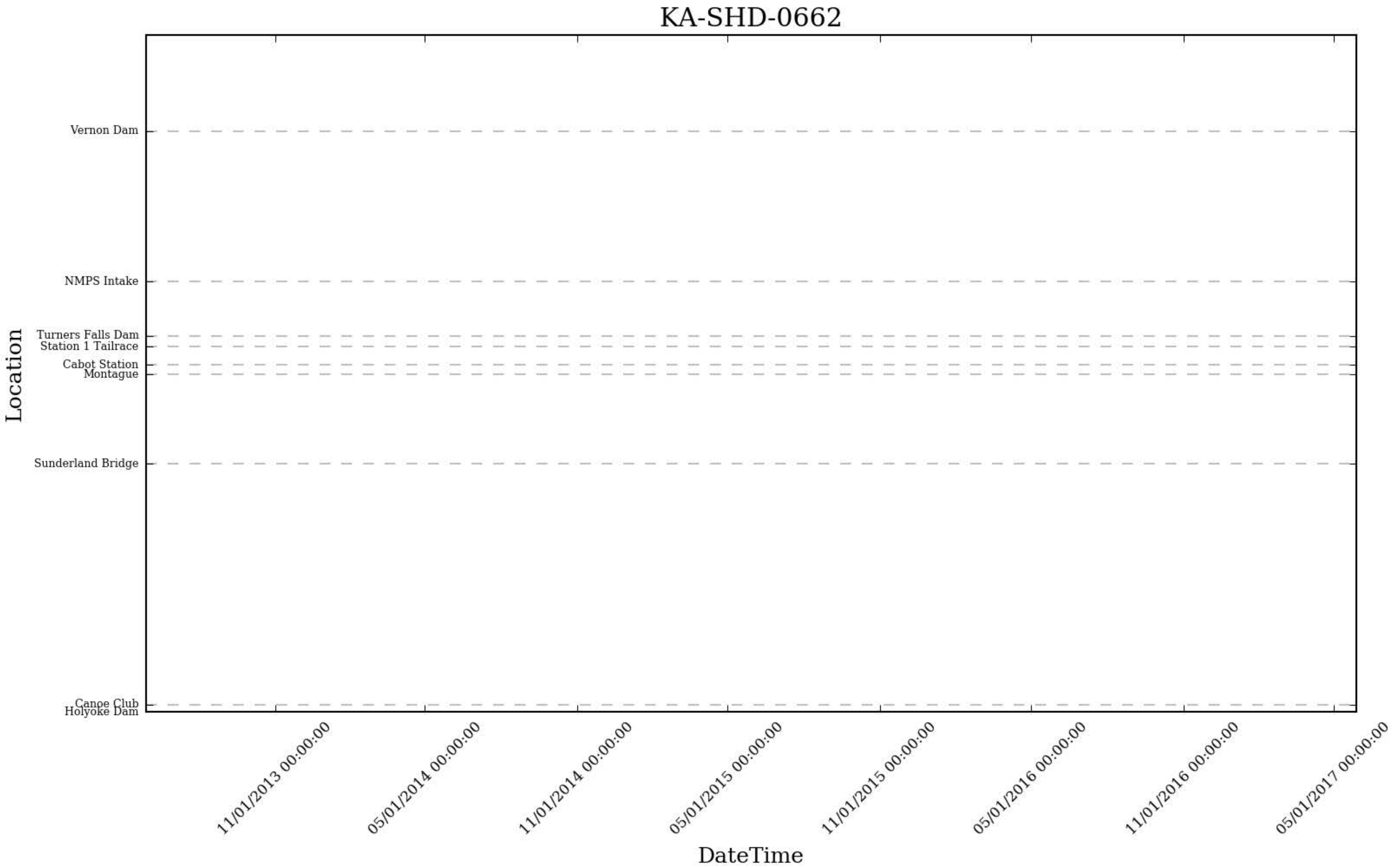
KA-SHD-0658
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
DateTime

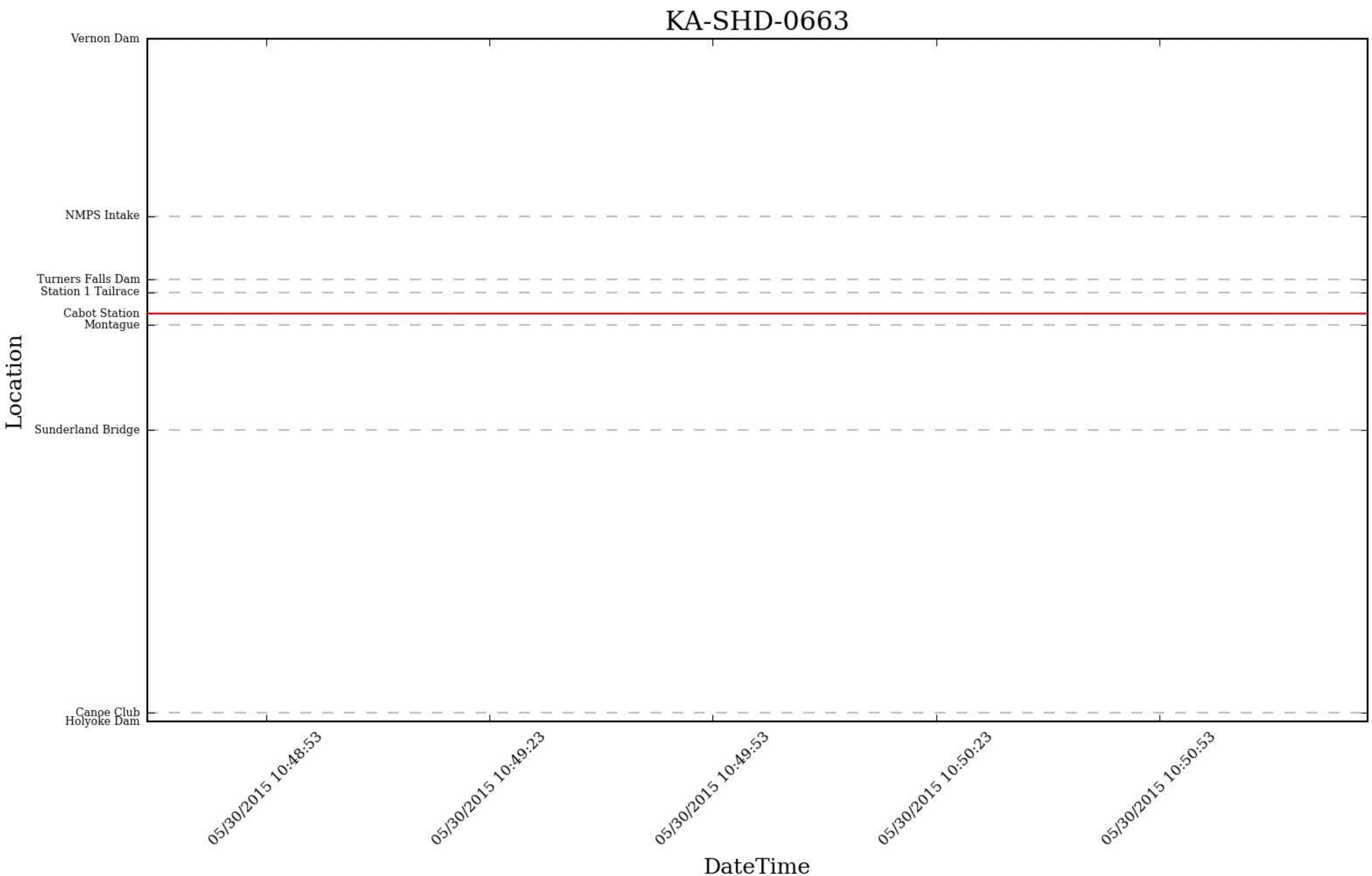


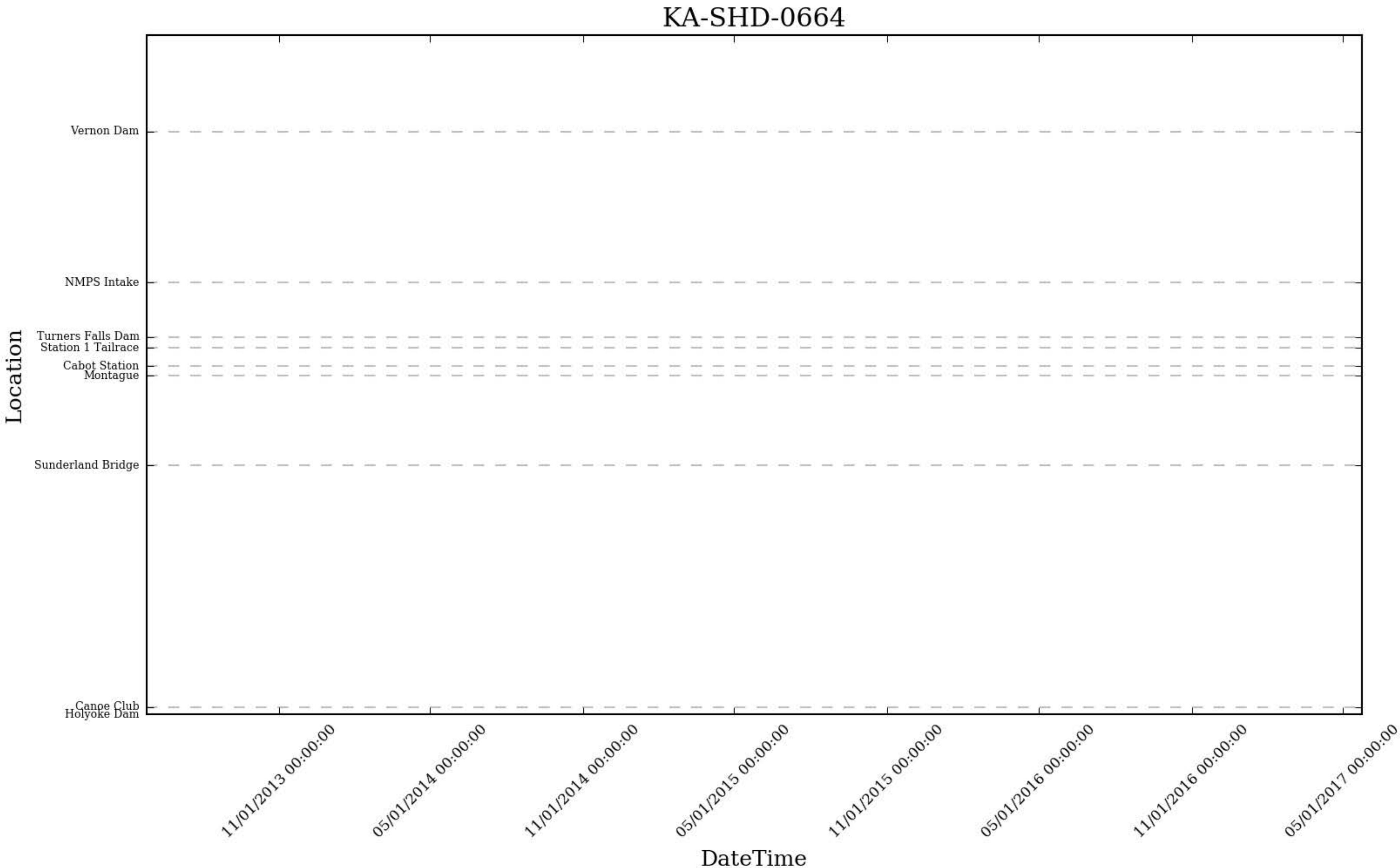
KA-SHD-0659
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 00:00:00
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
DateTime


KA-SHD-0660
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/24/2015 11:00:00
05/24/2015 14:00:00
05/24/2015 17:00:00
05/24/2015 20:00:00
05/24/2015 23:00:00
05/25/2015 02:00:00
05/25/2015 05:00:00
05/25/2015 08:00:00
05/25/2015 11:00:00
DateTime

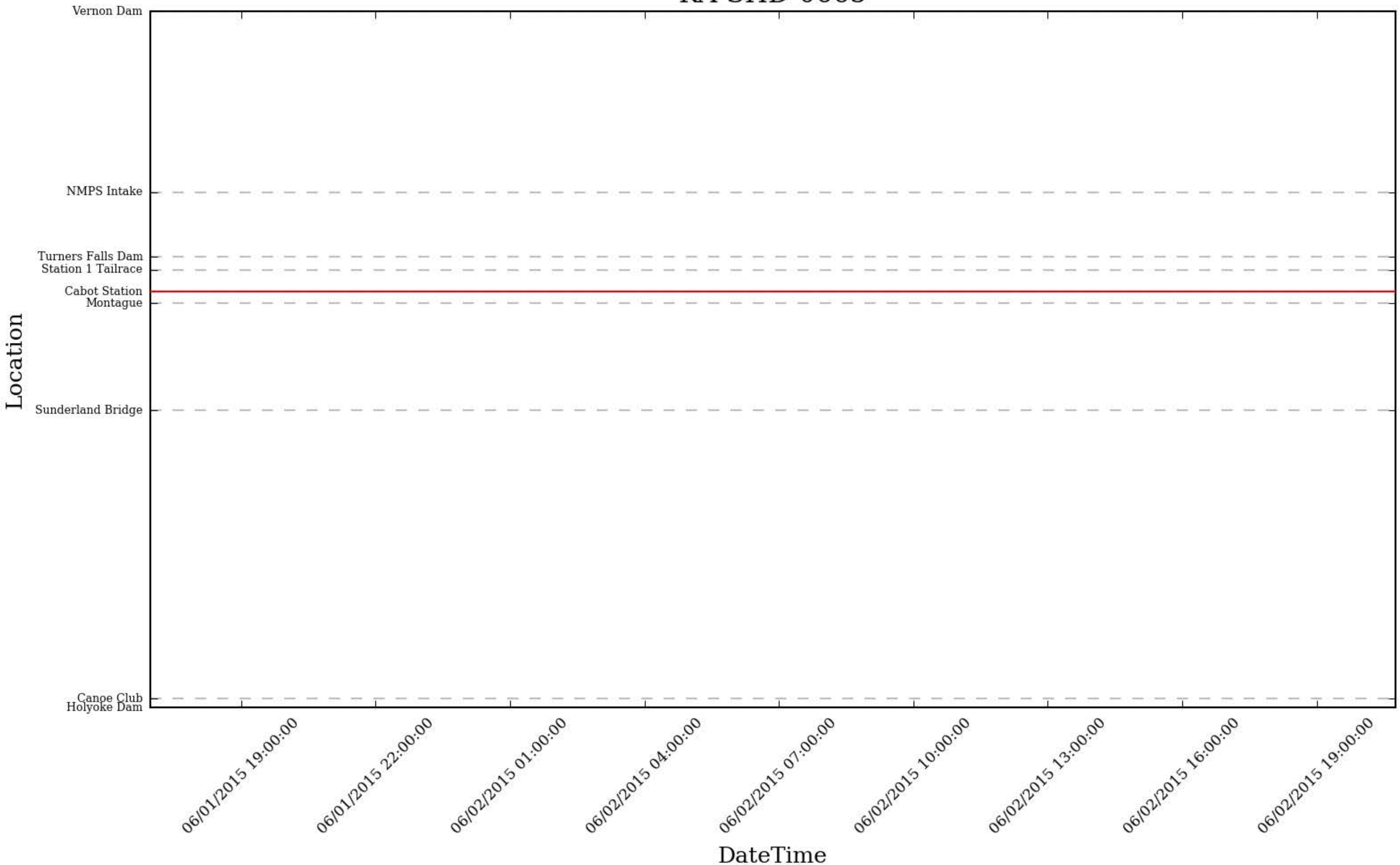

KA-SHD-0661
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0662
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

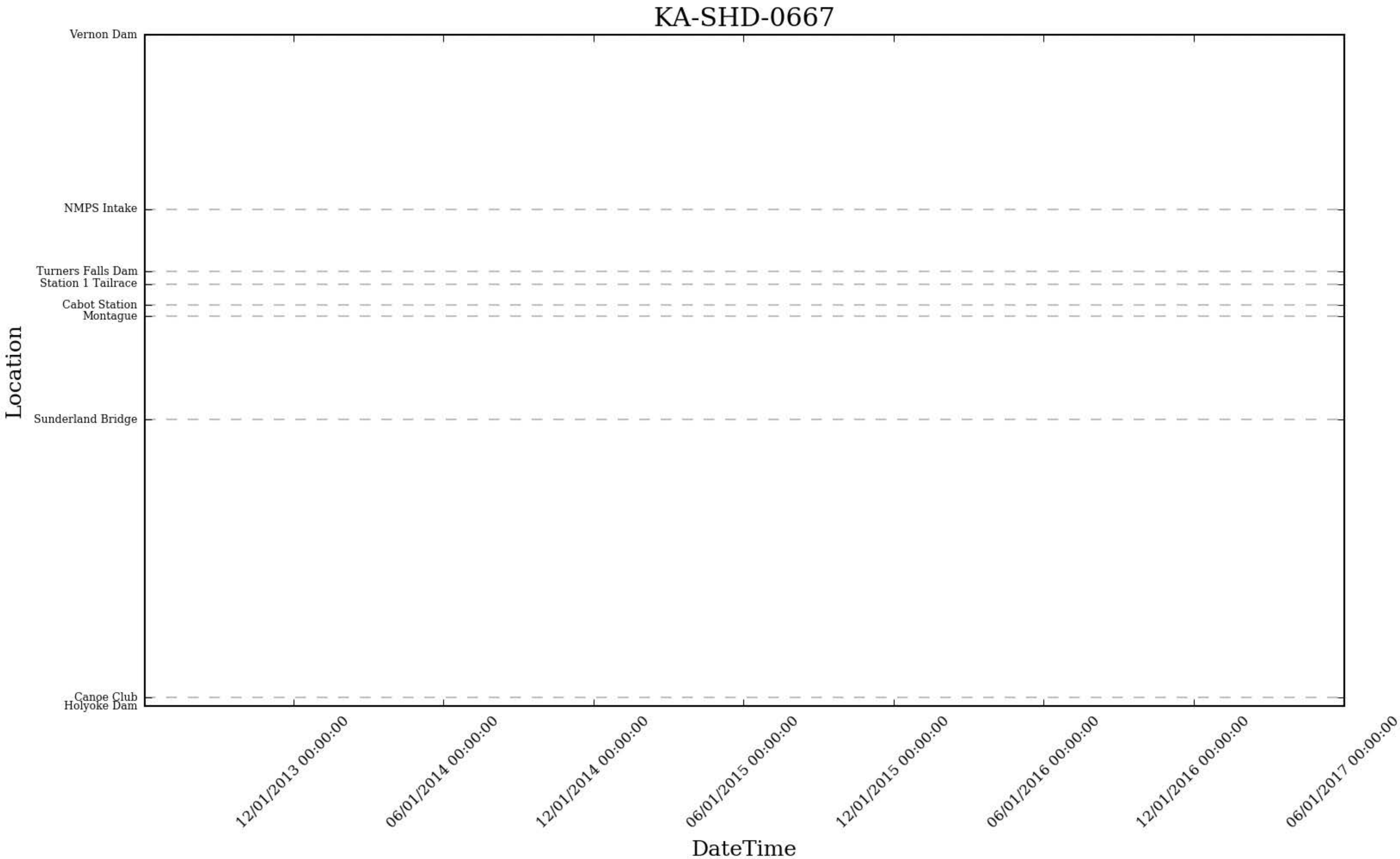

KA-SHD-0663
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 10:48:53
05/30/2015 10:49:23
05/30/2015 10:49:53
05/30/2015 10:50:23
05/30/2015 10:50:53
DateTime

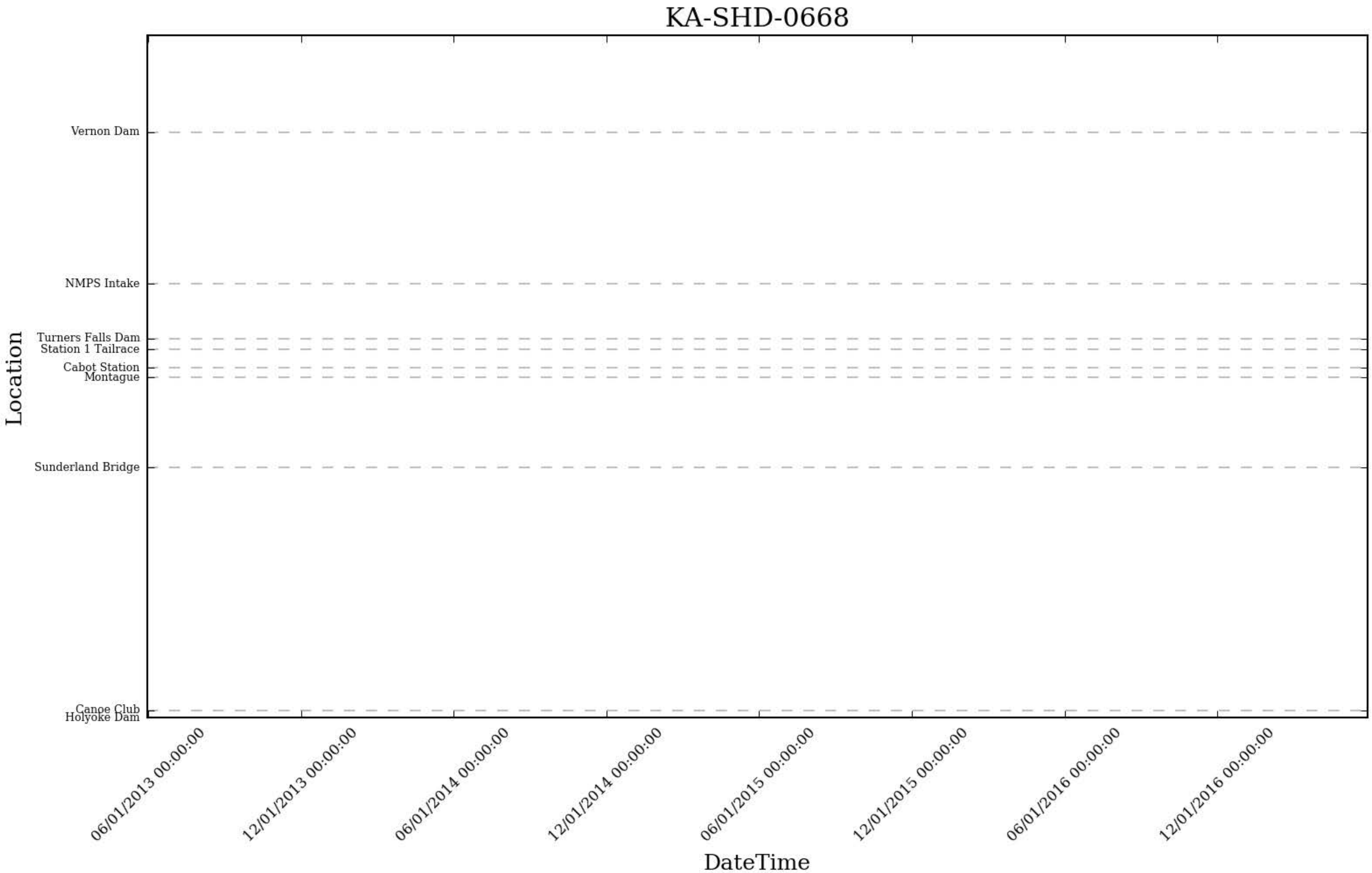

KA-SHD-0664
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

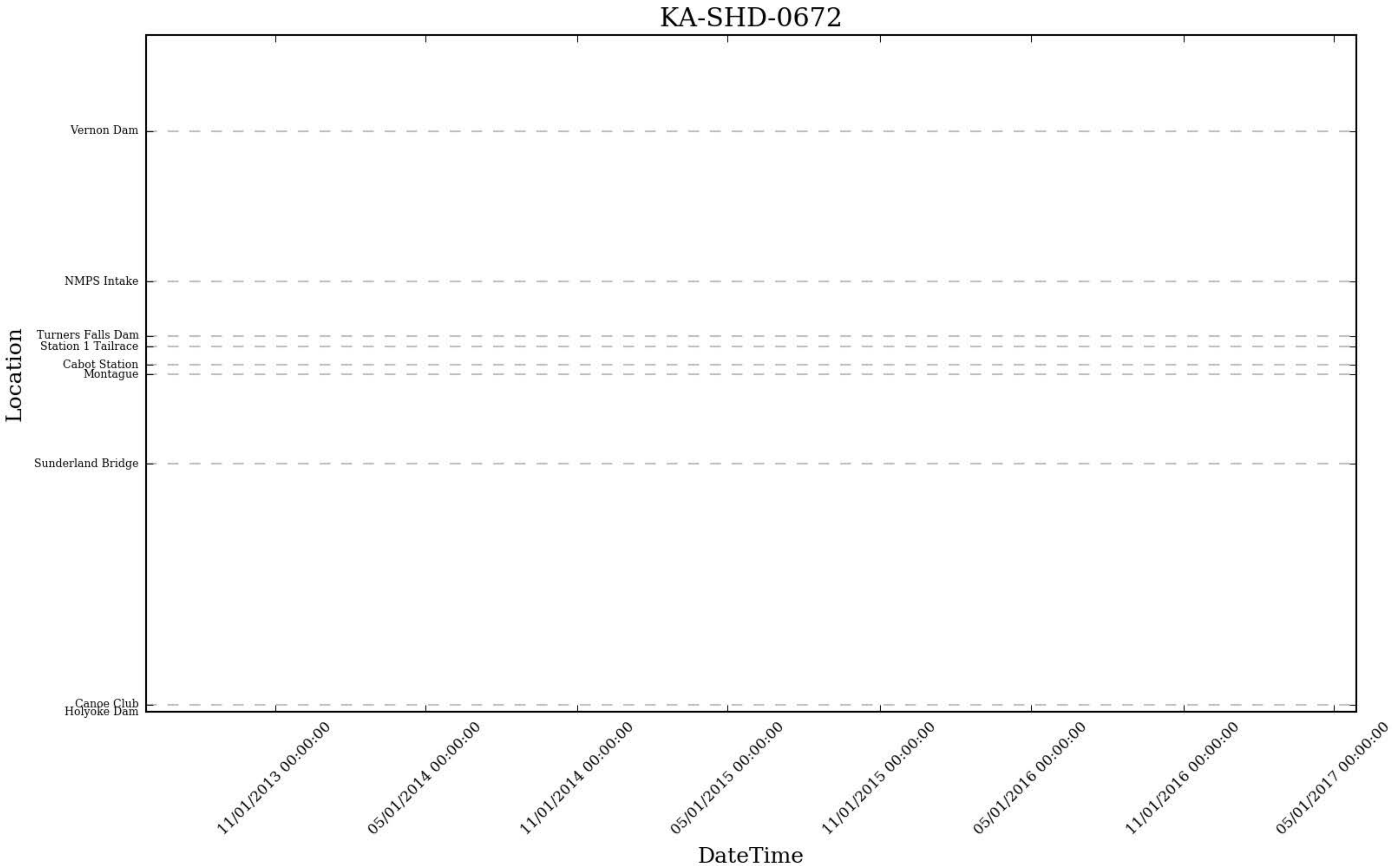
KA-SHD-0665

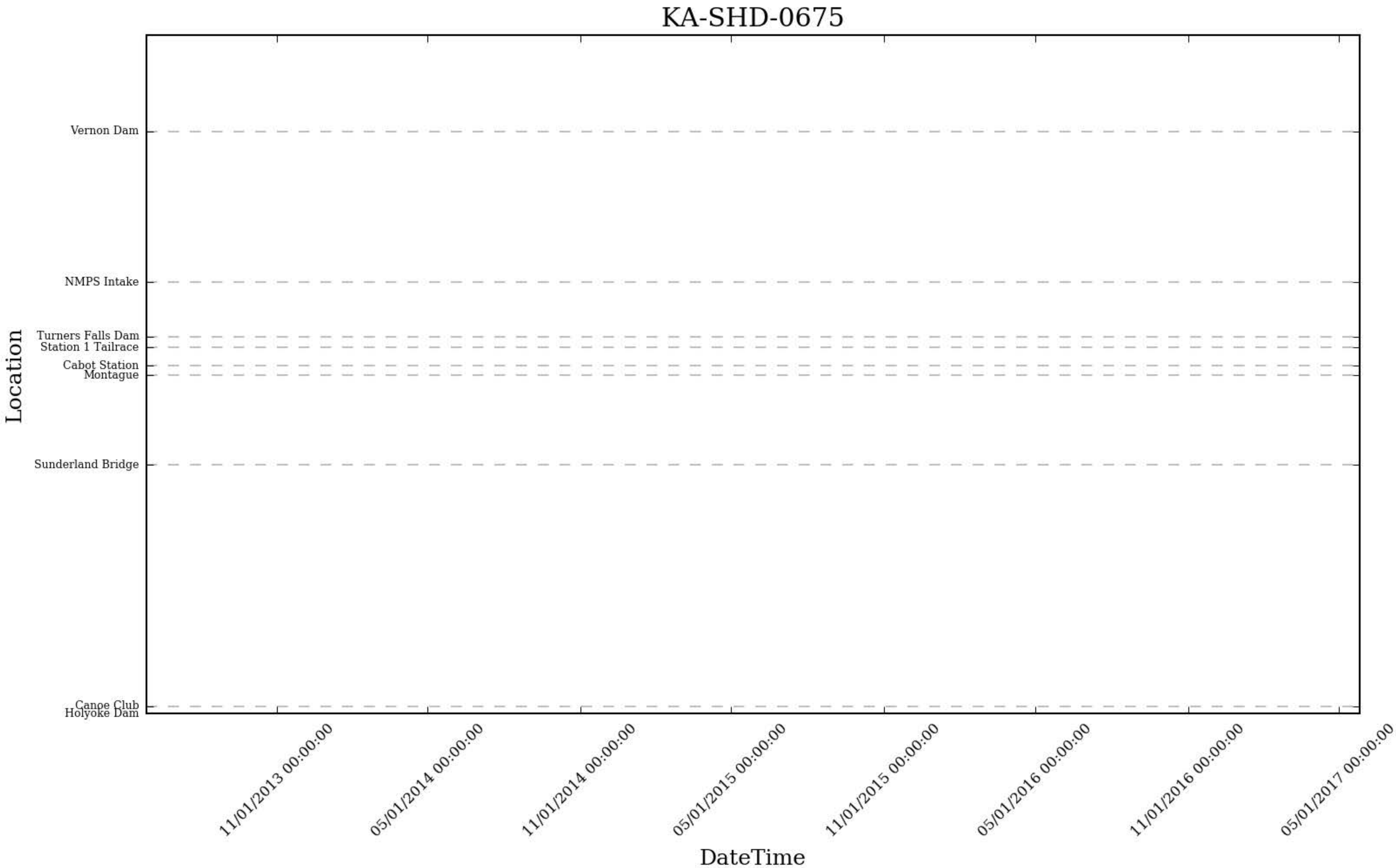


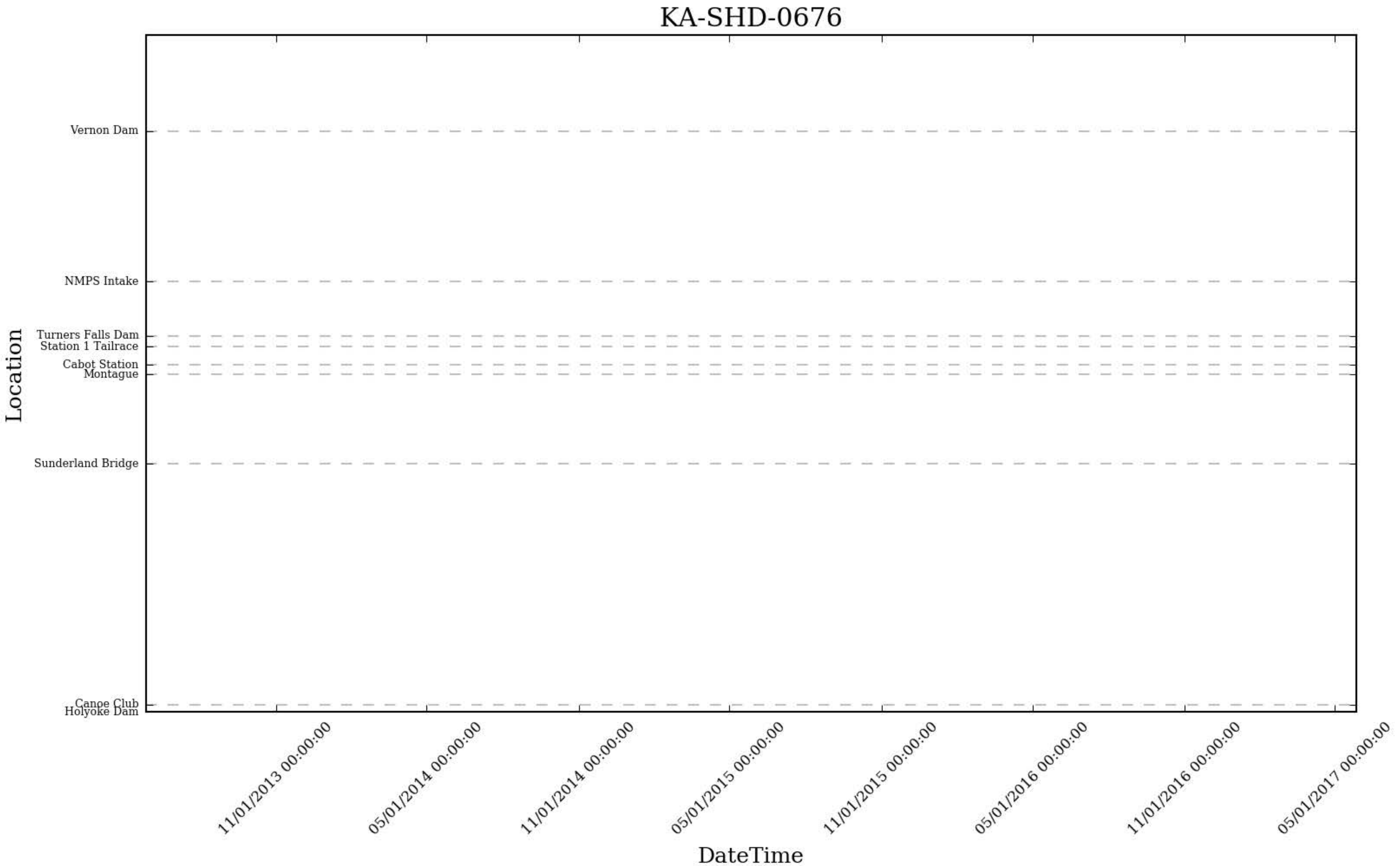
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/01/2015 19:00:00
06/01/2015 22:00:00
06/02/2015 01:00:00
06/02/2015 04:00:00
06/02/2015 07:00:00
06/02/2015 10:00:00
06/02/2015 13:00:00
06/02/2015 16:00:00
06/02/2015 19:00:00
DateTime

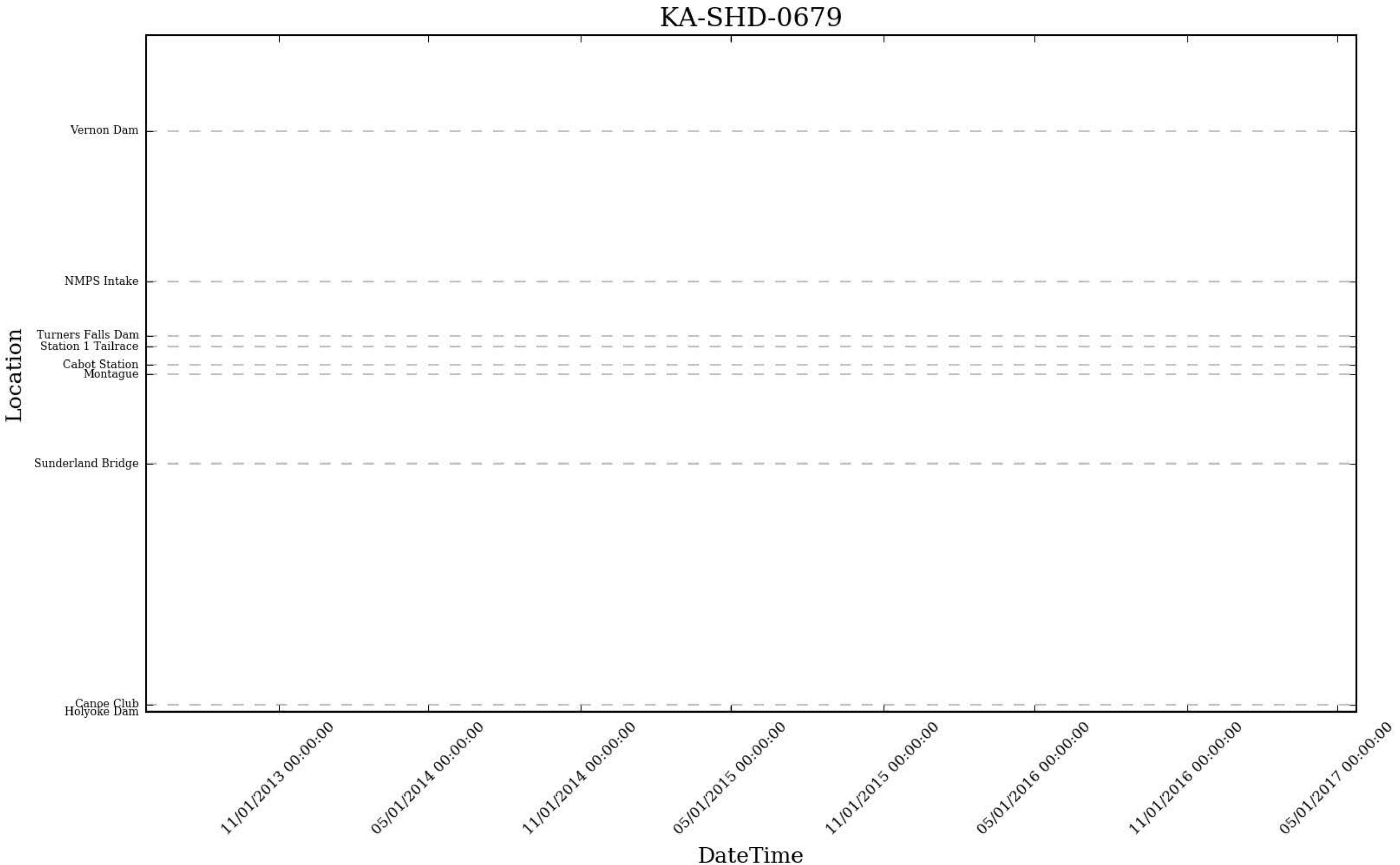

KA-SHD-0667
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime

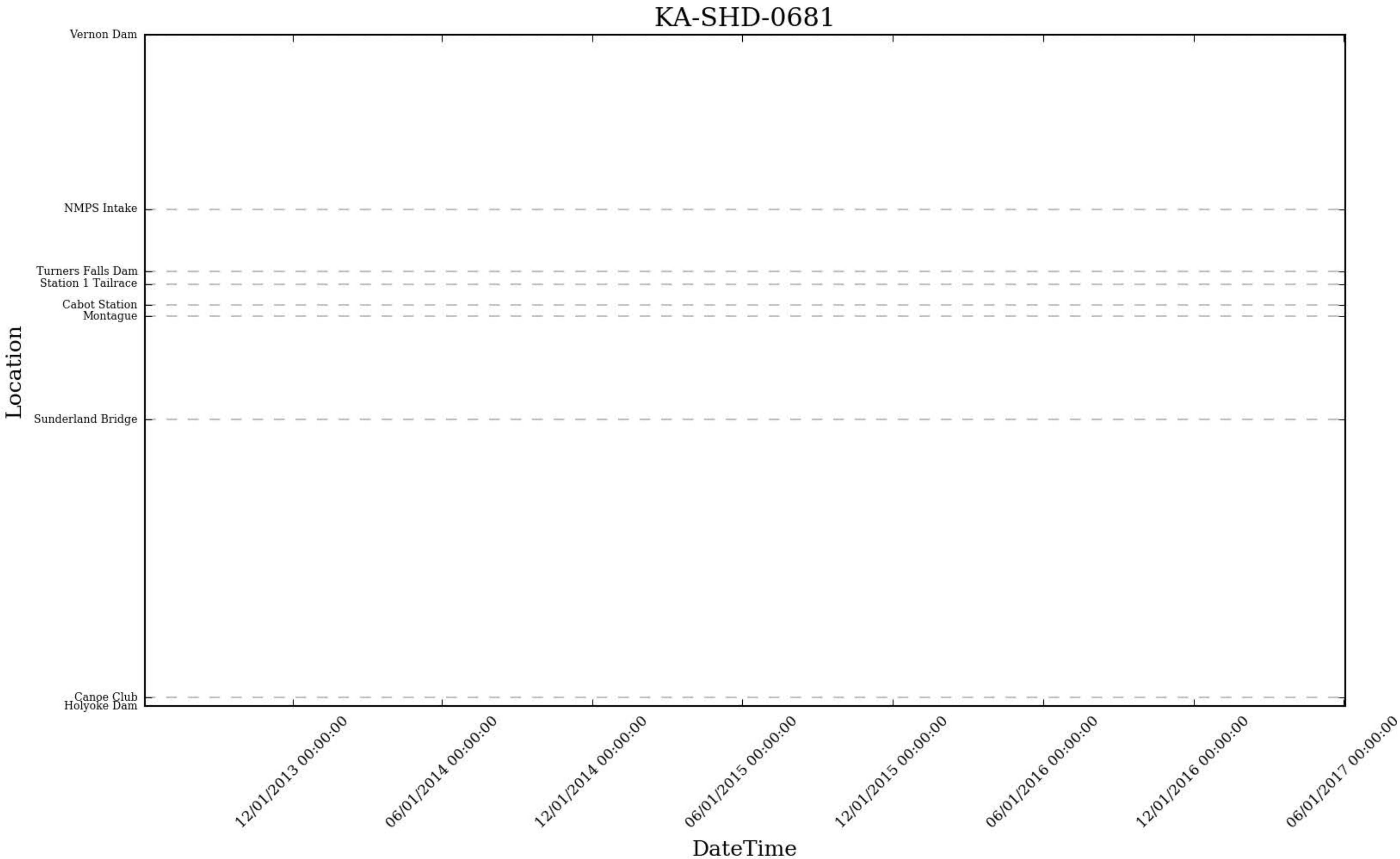

KA-SHD-0668
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
06/01/2013 00:00:00
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
DateTime

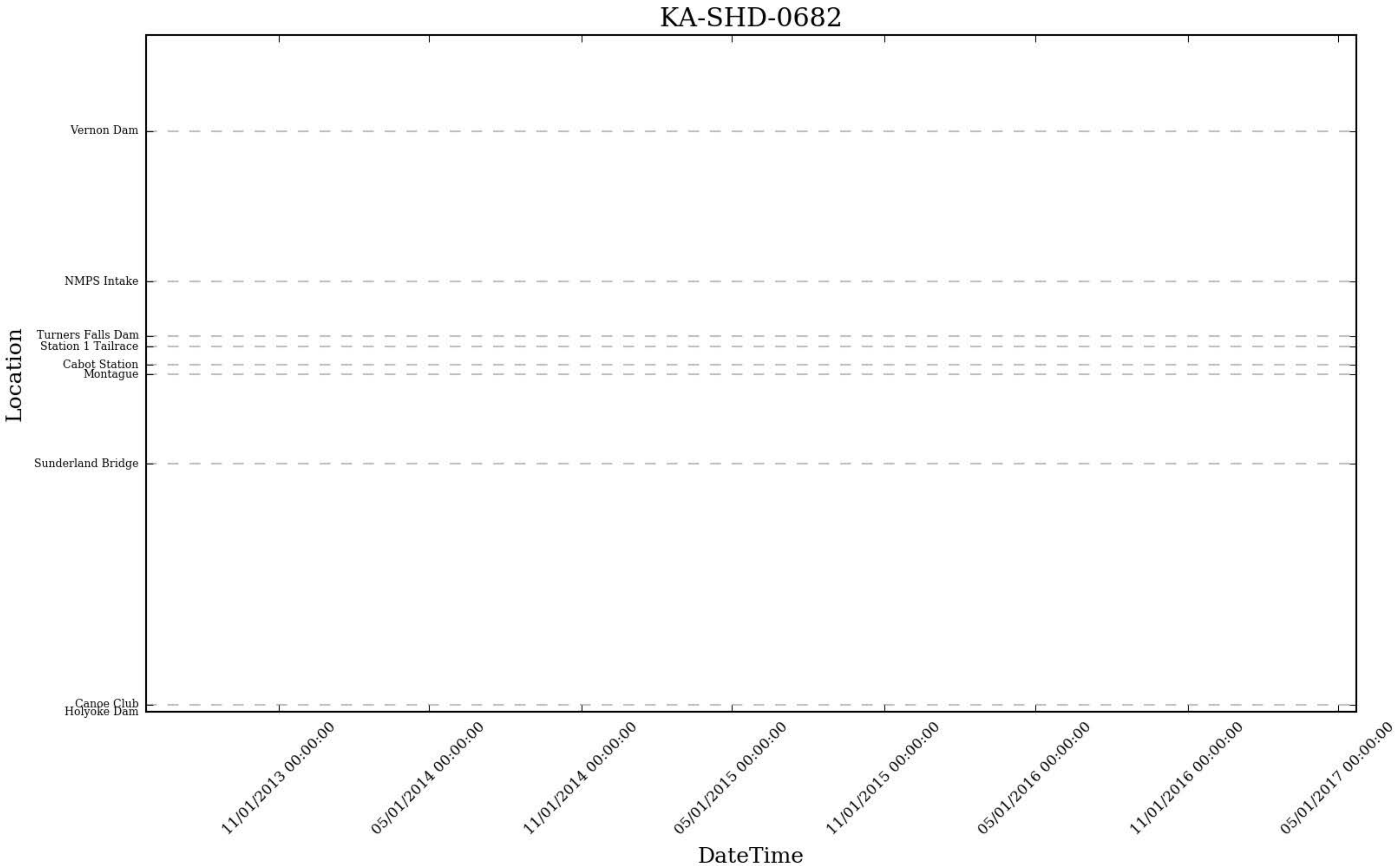

KA-SHD-0672
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

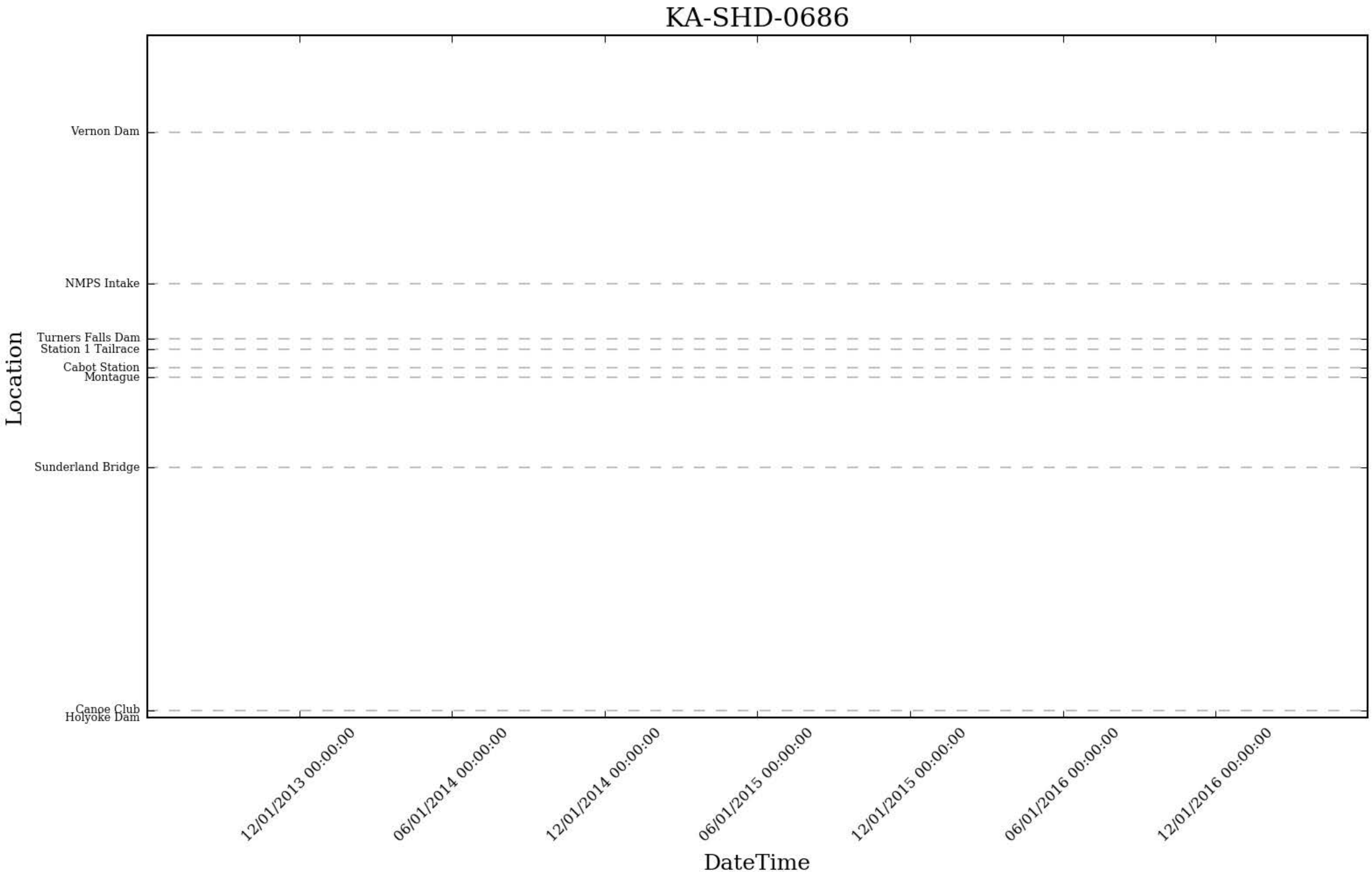

KA-SHD-0675
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

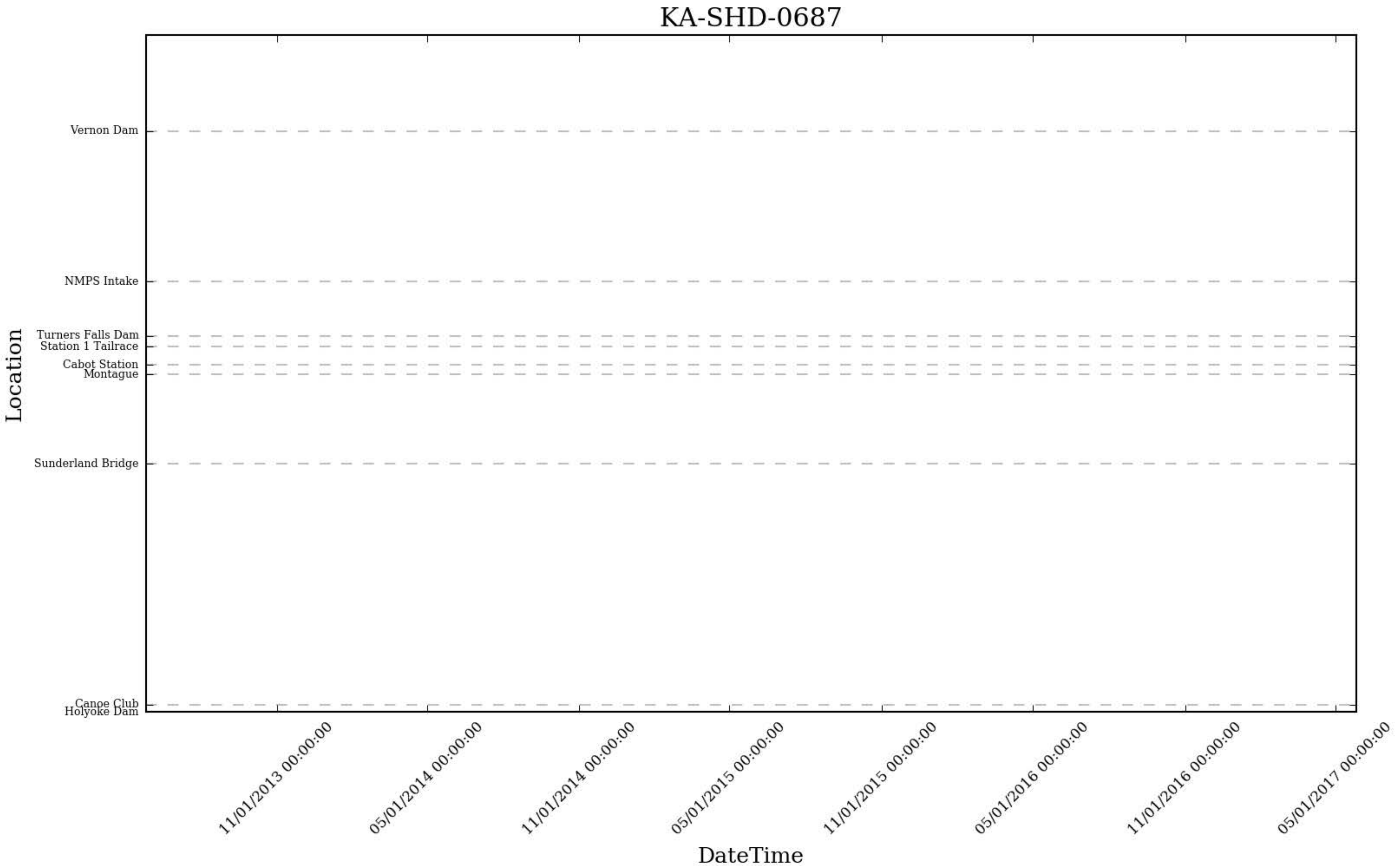

KA-SHD-0676
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

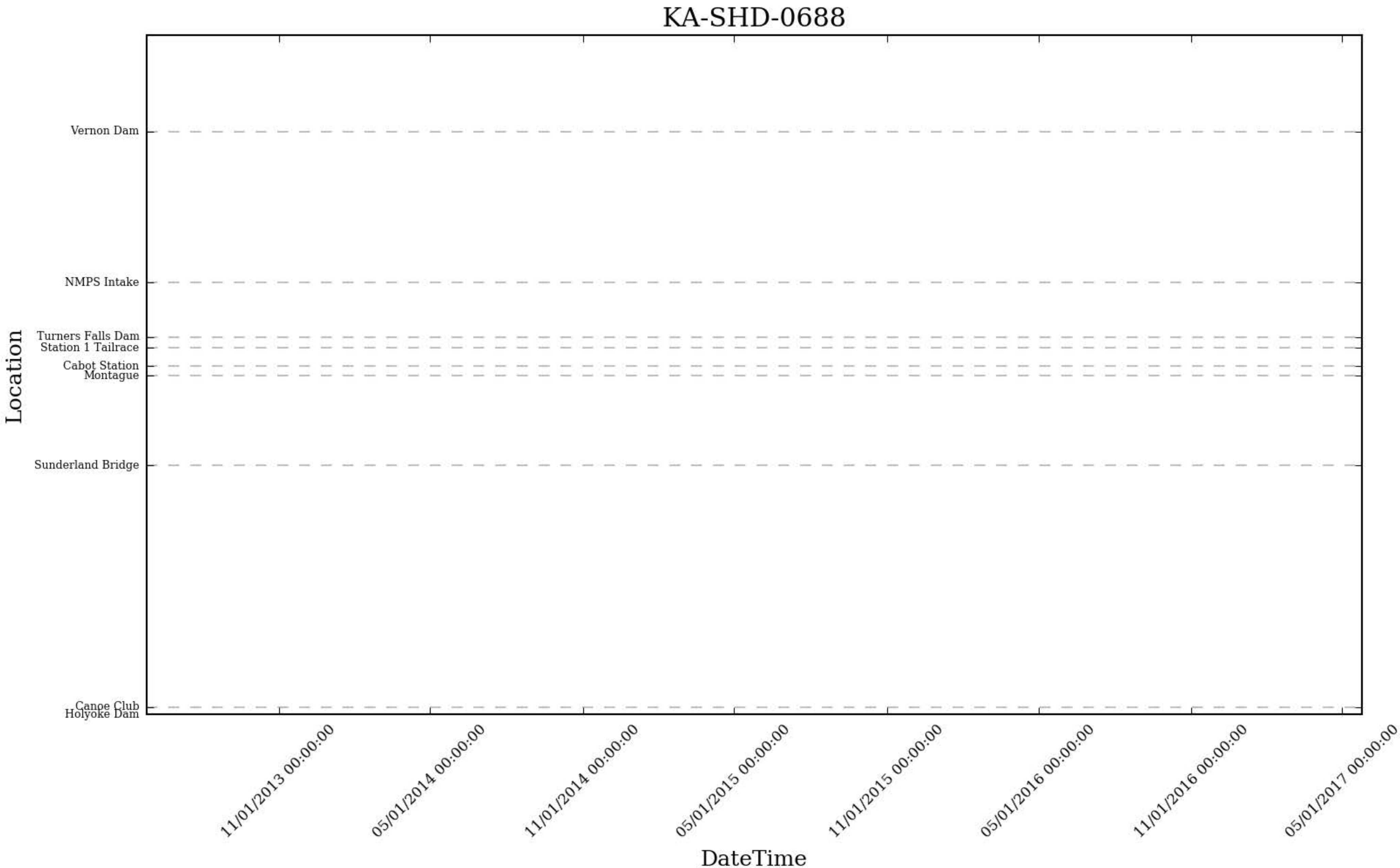

KA-SHD-0679
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

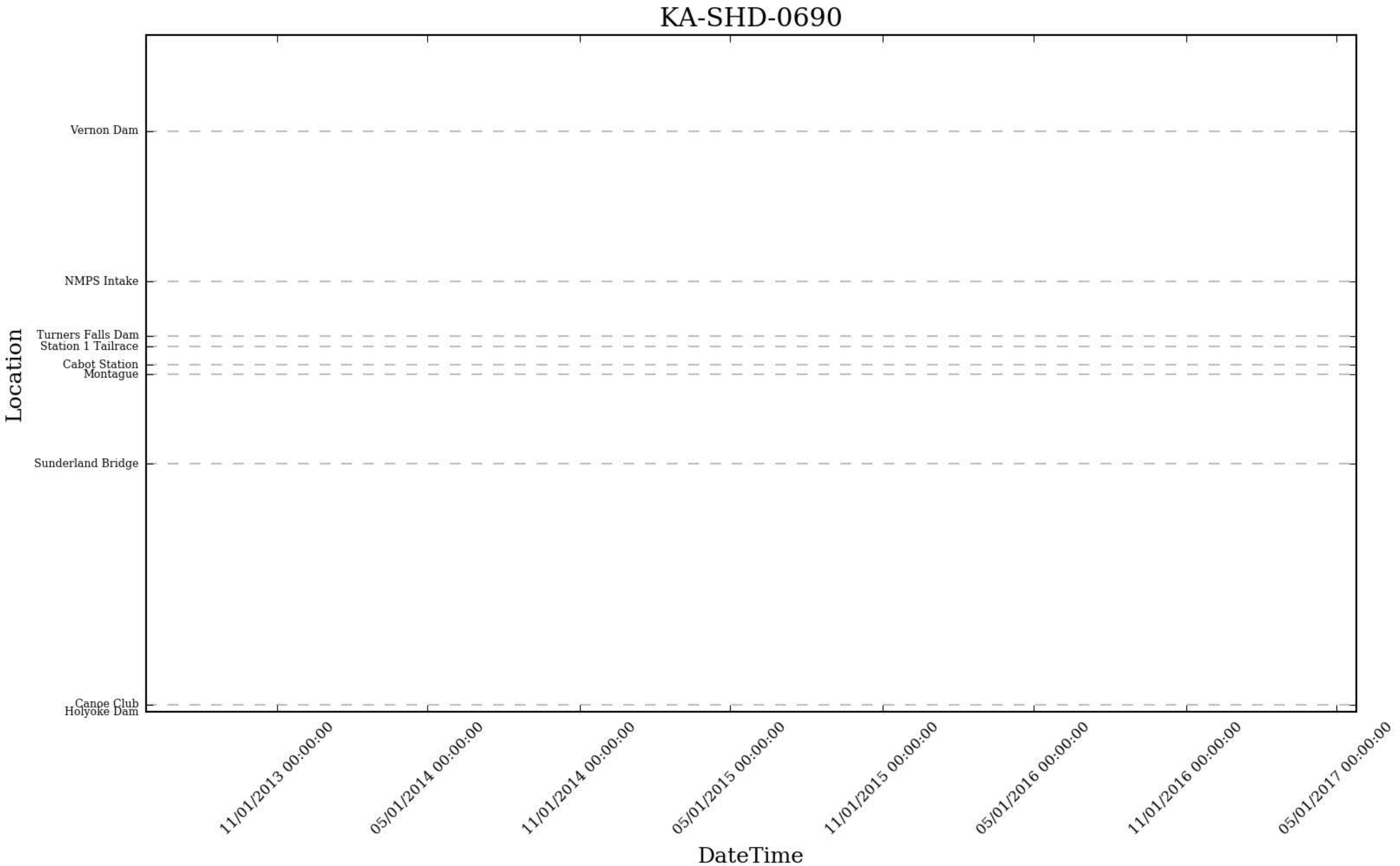

KA-SHD-0681
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
06/01/2017 00:00:00
DateTime


KA-SHD-0682
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0686
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
06/01/2015 00:00:00
12/01/2015 00:00:00
06/01/2016 00:00:00
12/01/2016 00:00:00
DateTime


KA-SHD-0687
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0688
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime



KA-SHD-0690
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
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05/01/2016 00:00:00
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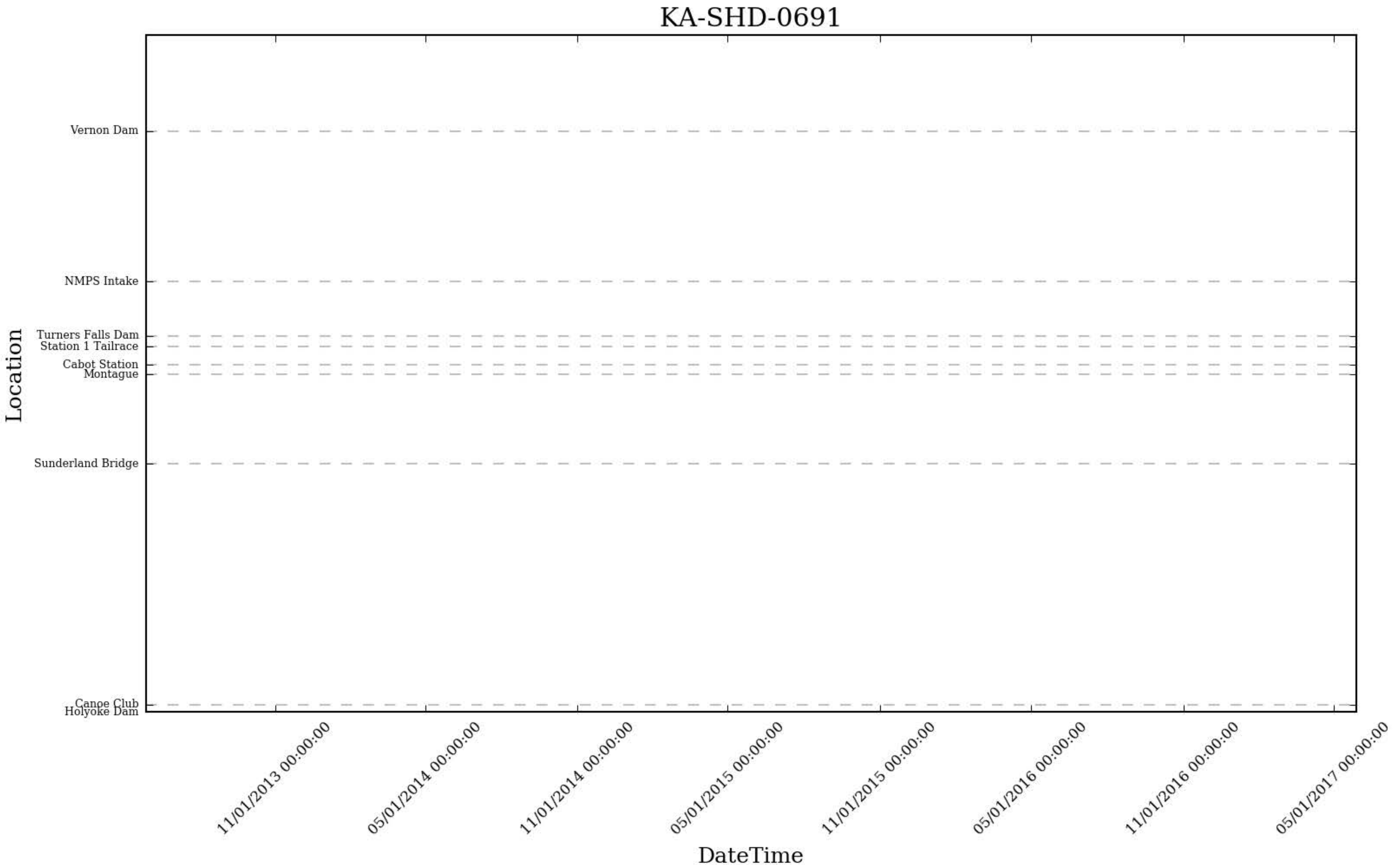
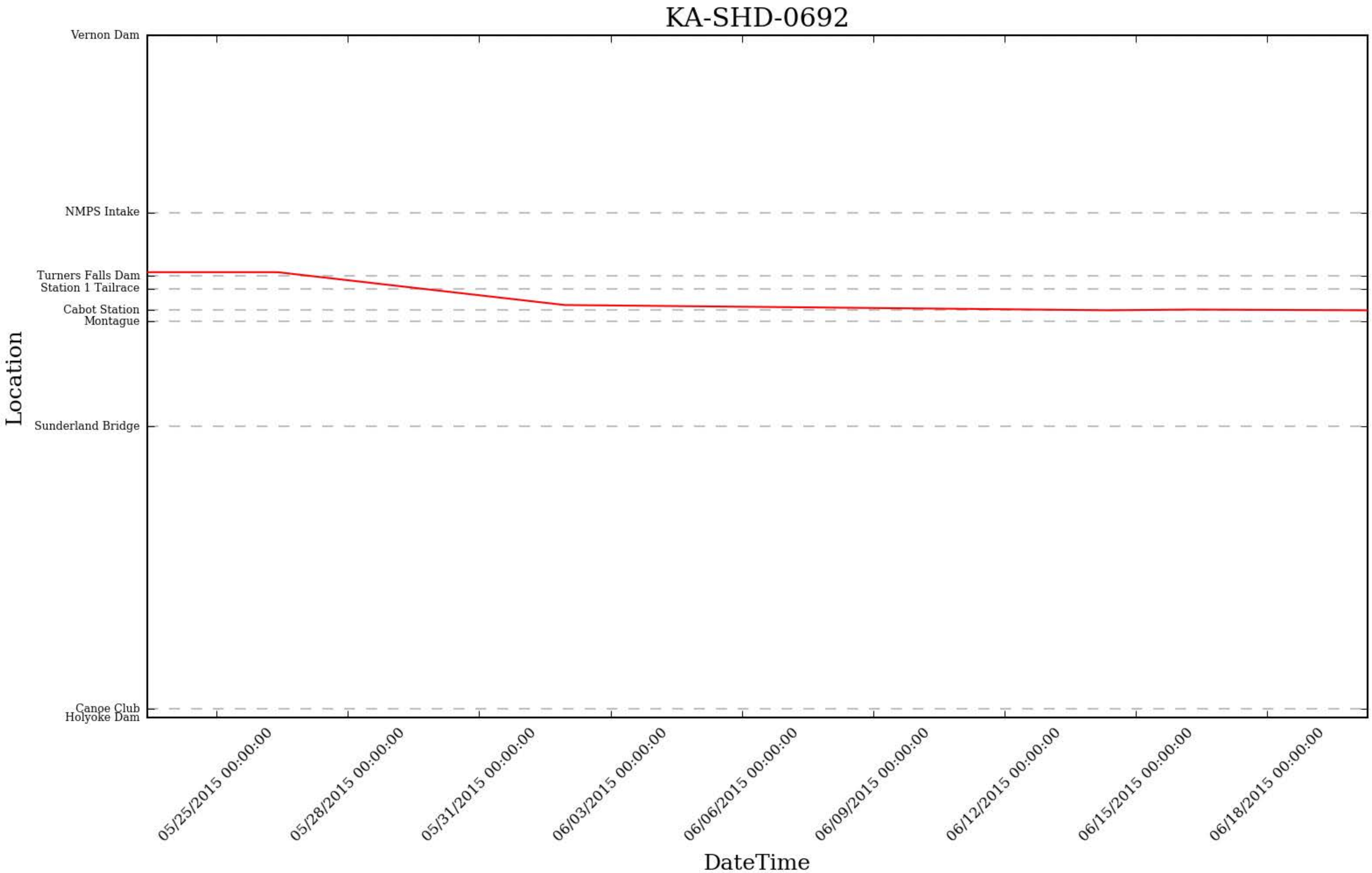
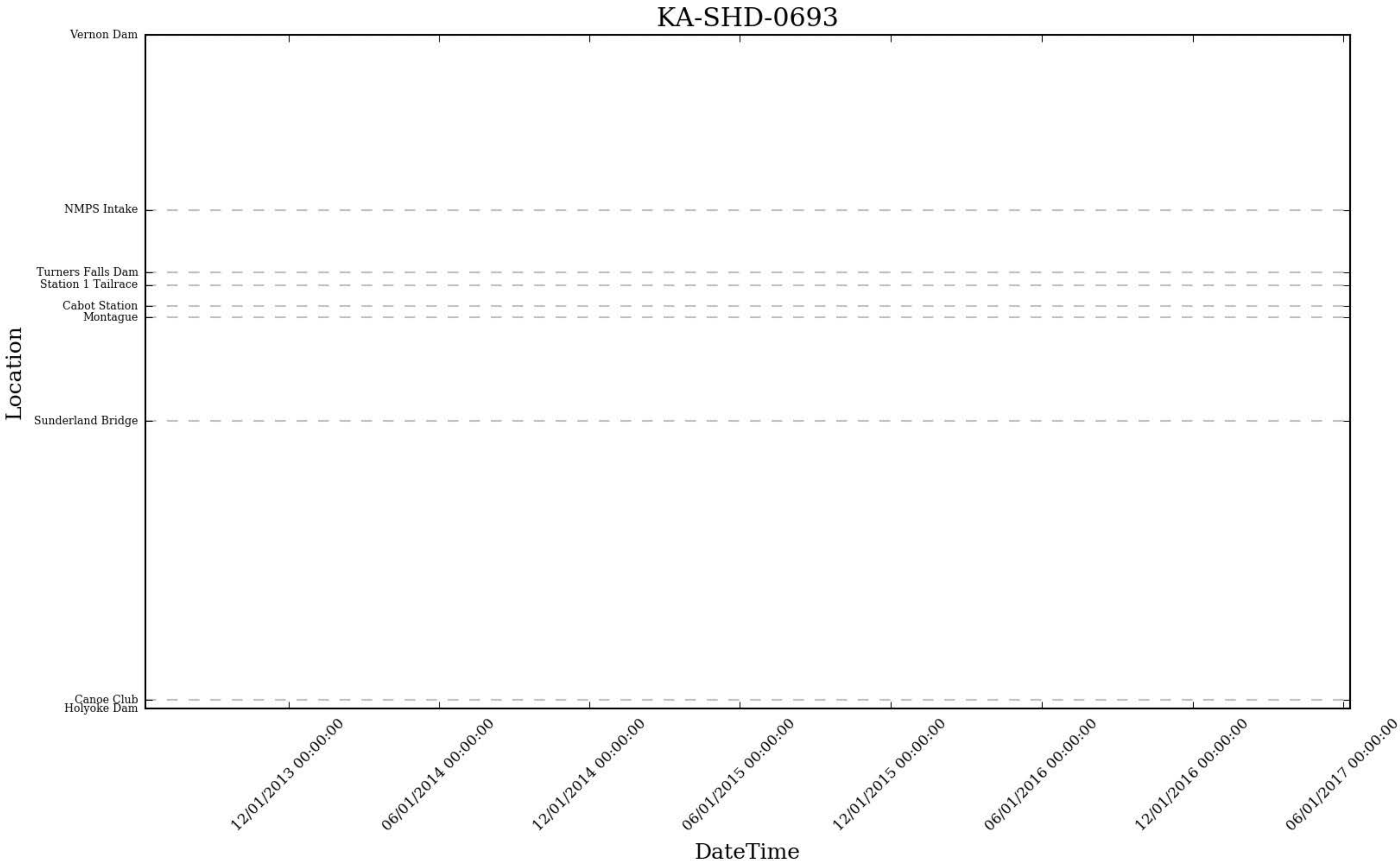
05/01/2017 00:00:00
DateTime



KA-SHD-0691
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0692
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/25/2015 00:00:00
05/28/2015 00:00:00
05/31/2015 00:00:00
06/03/2015 00:00:00
06/06/2015 00:00:00
06/09/2015 00:00:00
06/12/2015 00:00:00
06/15/2015 00:00:00
06/18/2015 00:00:00
DateTime


KA-SHD-0693
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
12/01/2013 00:00:00
06/01/2014 00:00:00
12/01/2014 00:00:00
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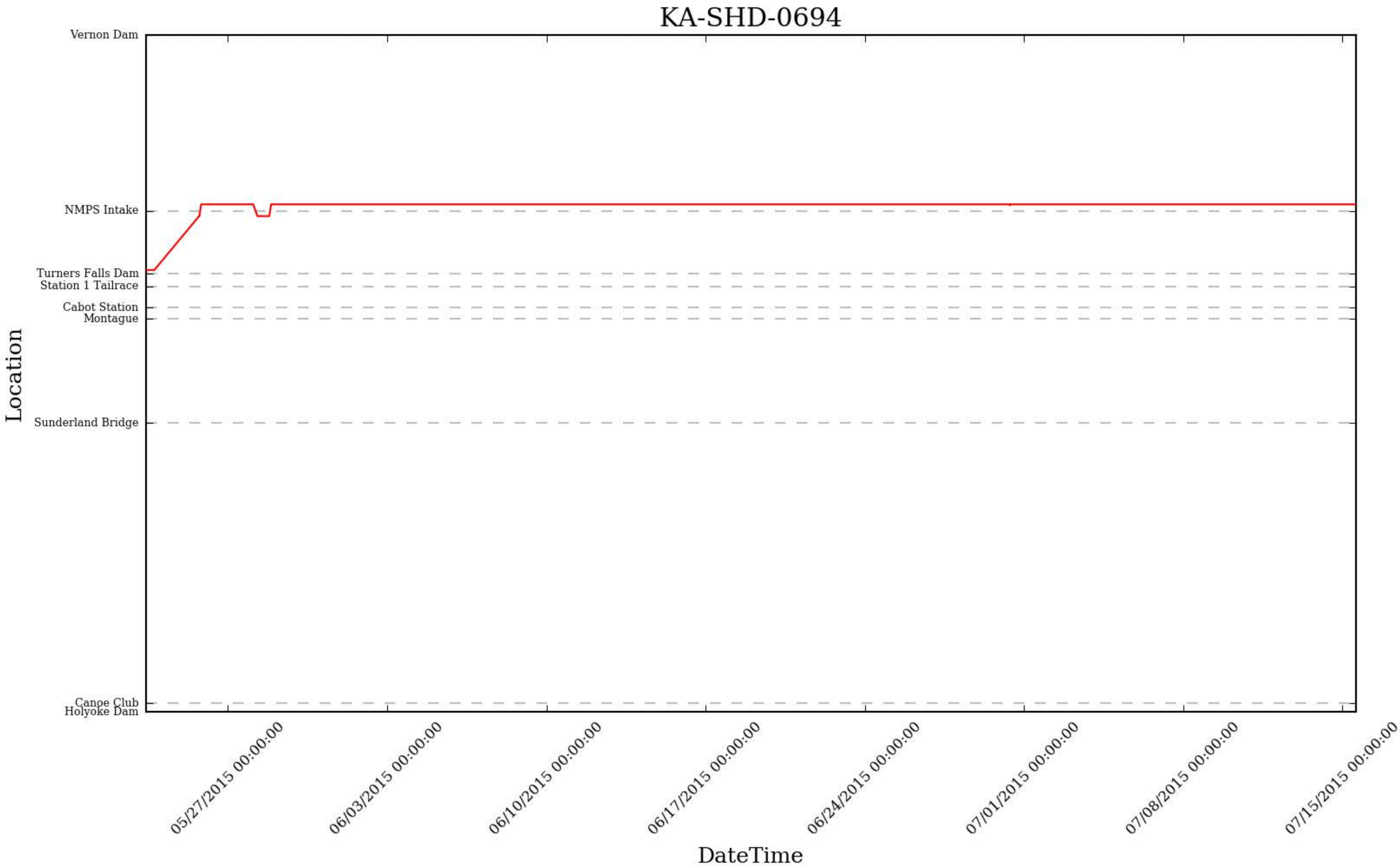
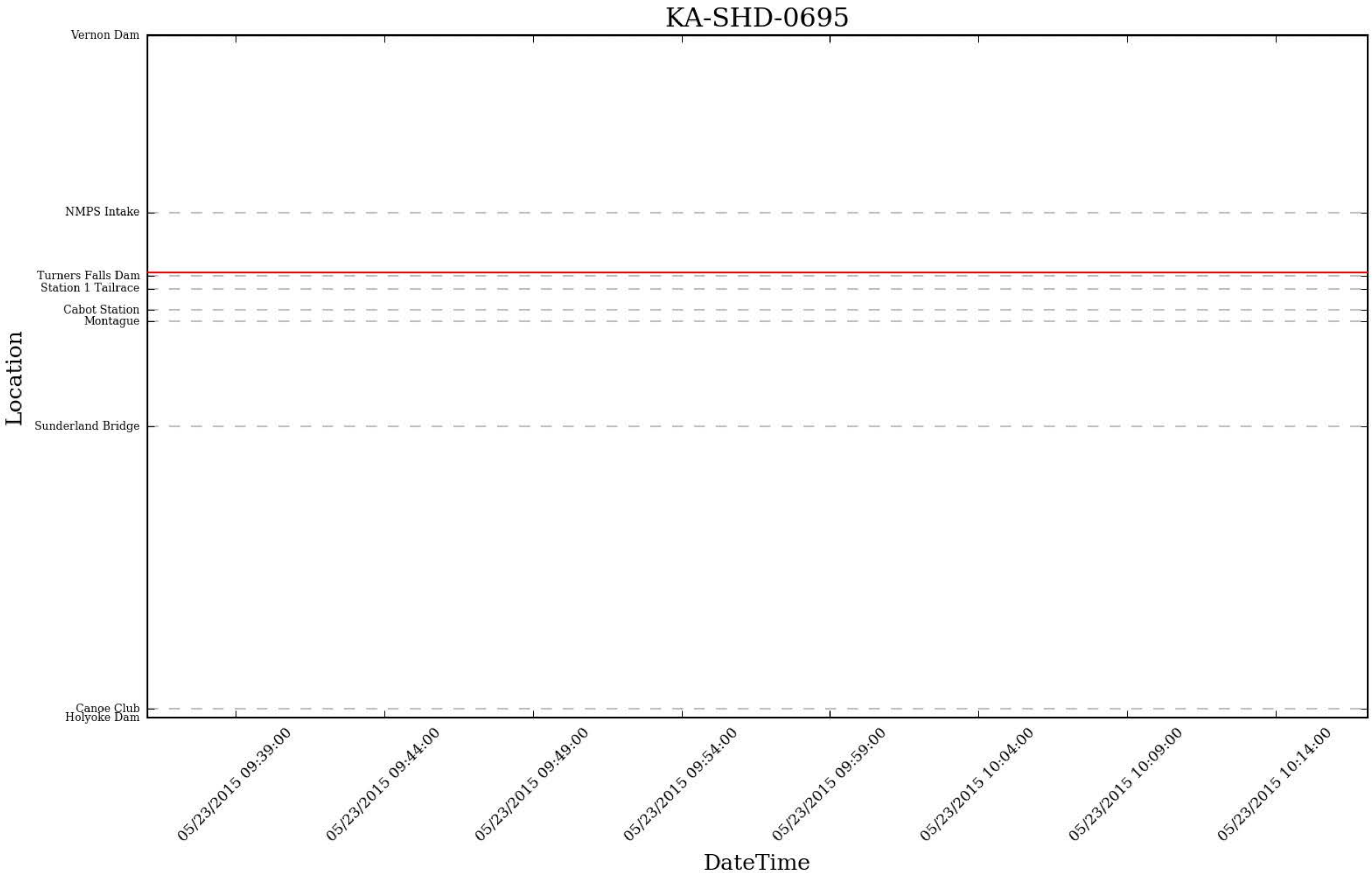
06/01/2017 00:00:00
DateTime


KA-SHD-0694
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
07/08/2015 00:00:00
07/15/2015 00:00:00
DateTime



KA-SHD-0695
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Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/23/2015 09:39:00
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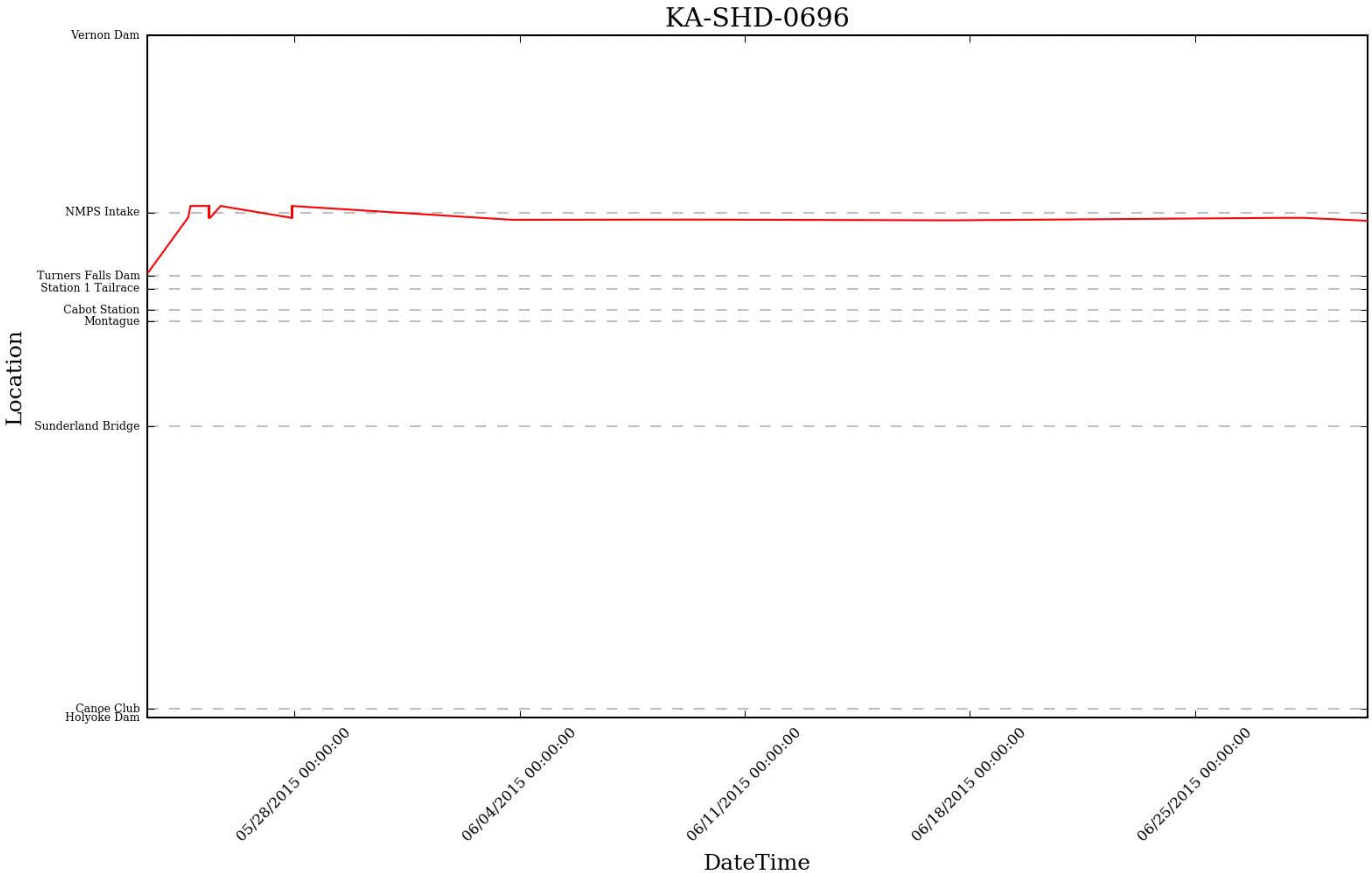
05/23/2015 09:49:00
05/23/2015 09:54:00
05/23/2015 09:59:00
05/23/2015 10:04:00
05/23/2015 10:09:00
05/23/2015 10:14:00
DateTime


KA-SHD-0696
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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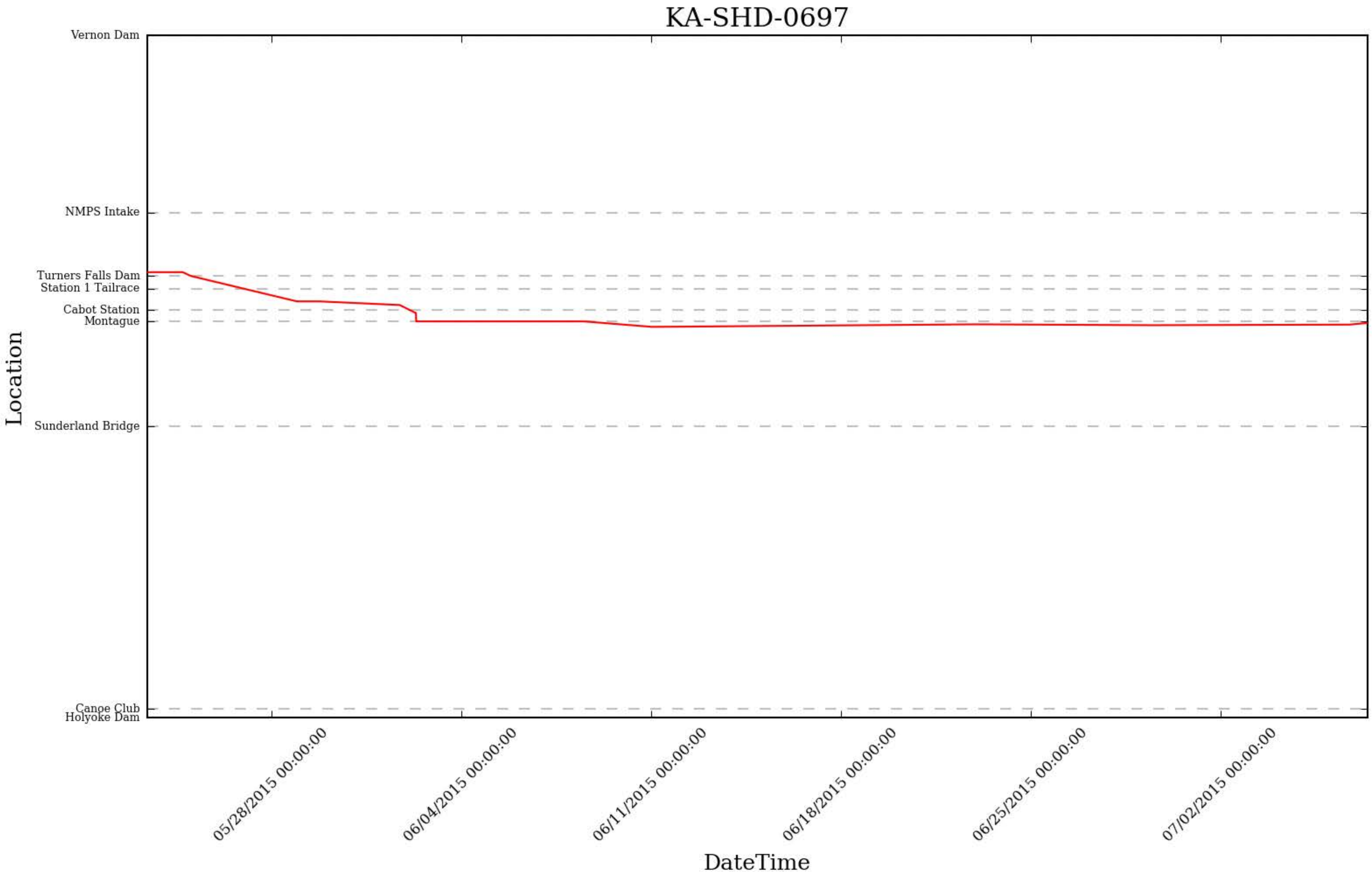
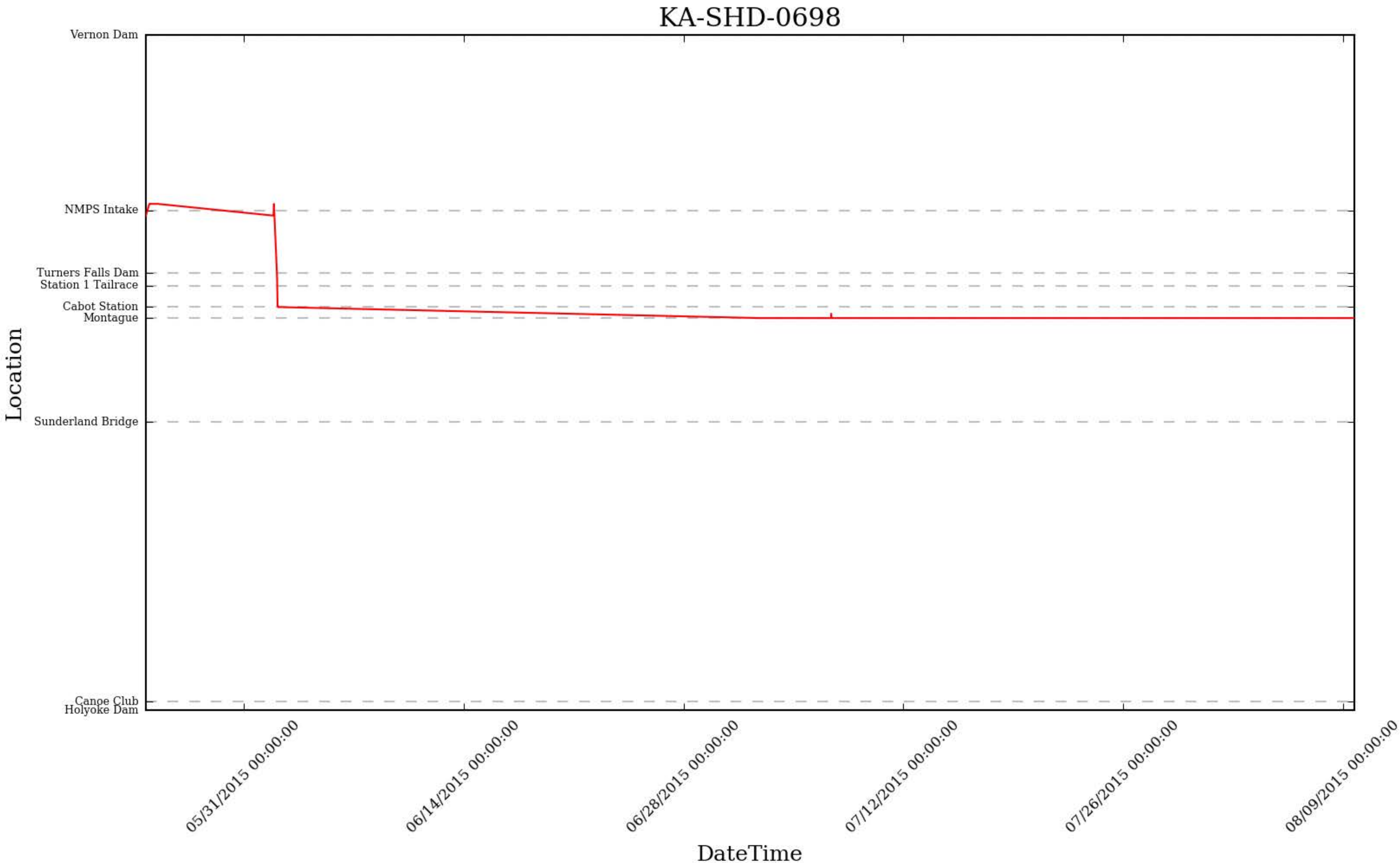
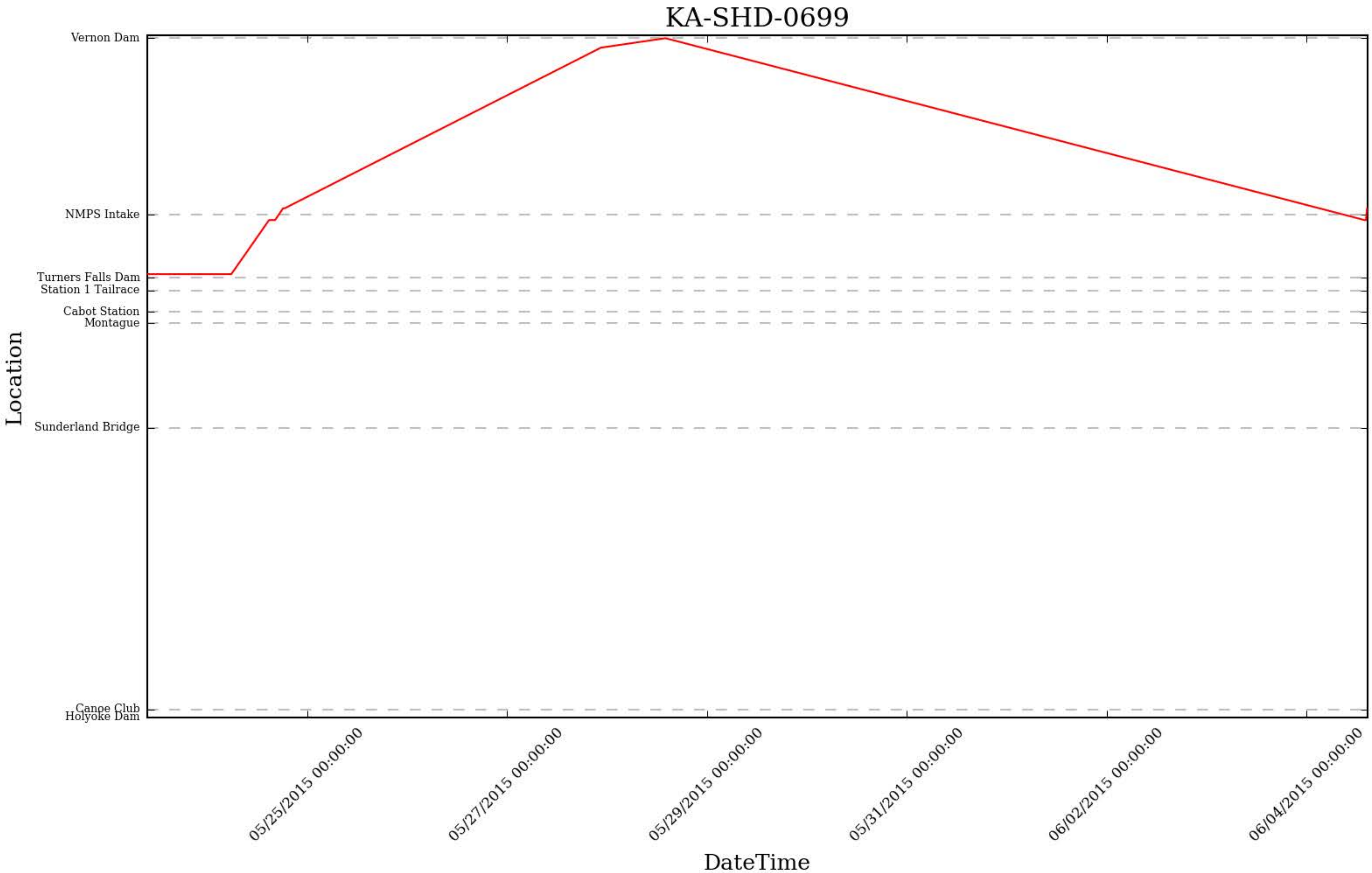
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
DateTime


KA-SHD-0697
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime


KA-SHD-0698
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/31/2015 00:00:00
06/14/2015 00:00:00
06/28/2015 00:00:00
07/12/2015 00:00:00
07/26/2015 00:00:00
08/09/2015 00:00:00
DateTime


KA-SHD-0699
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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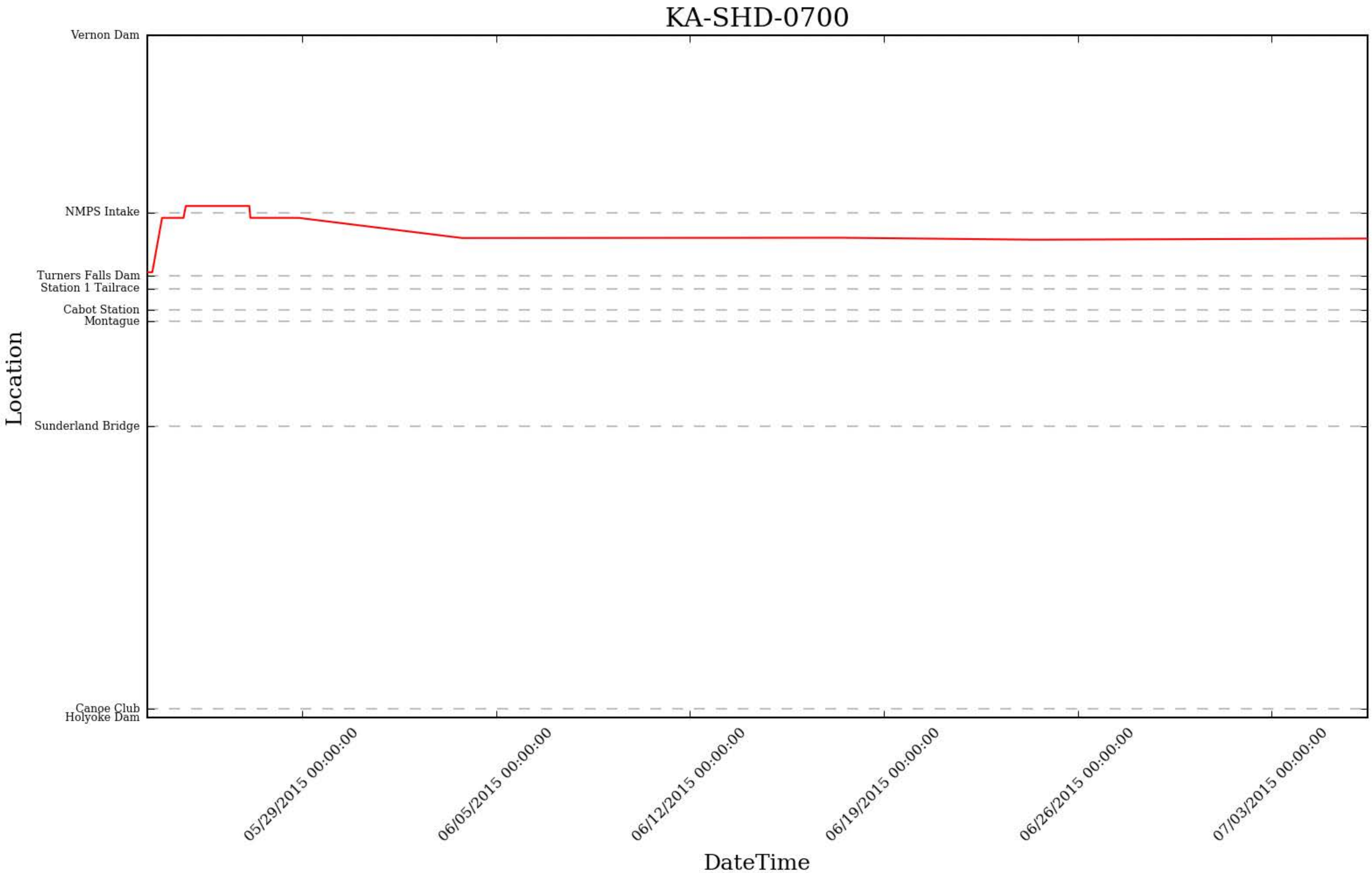
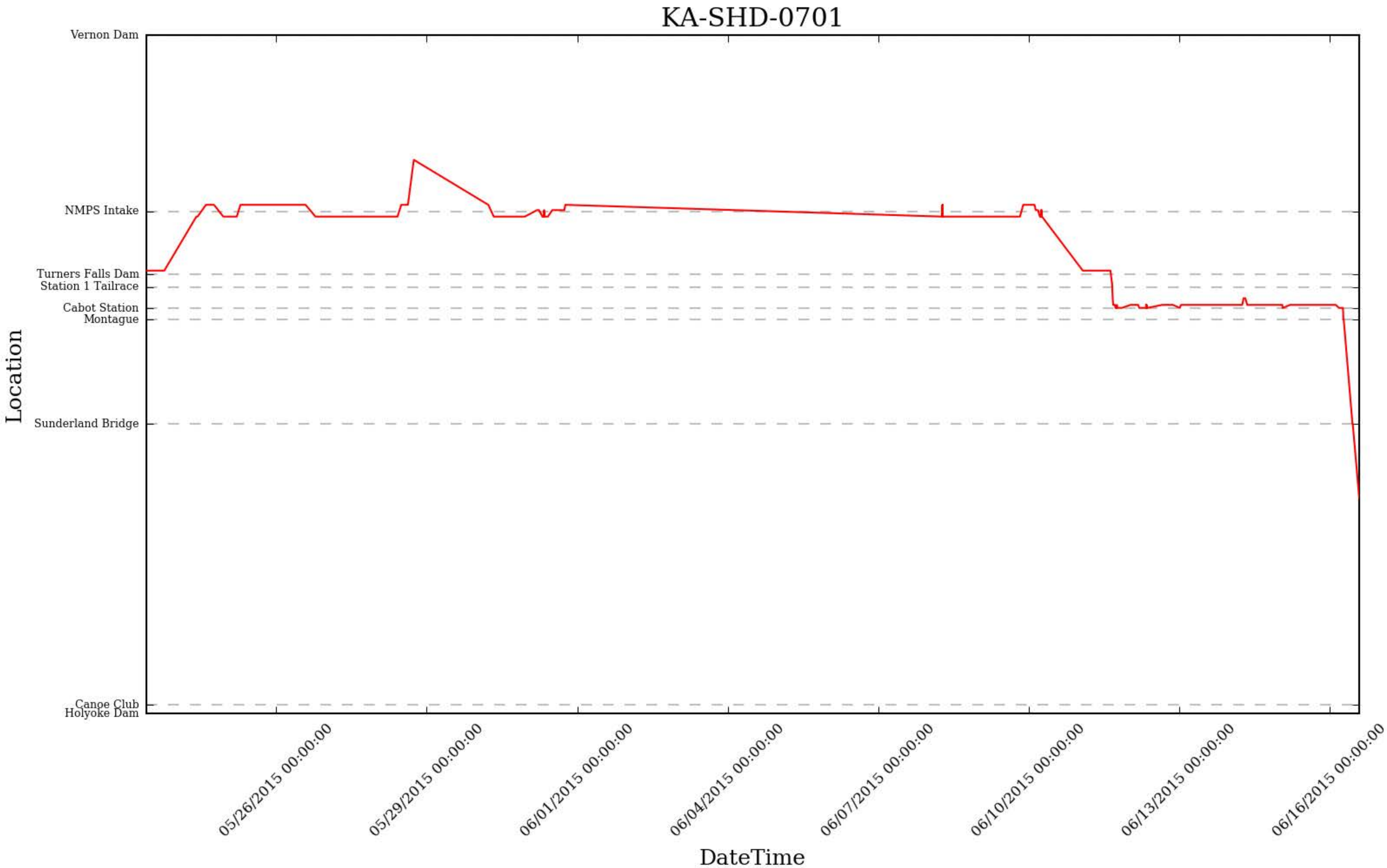
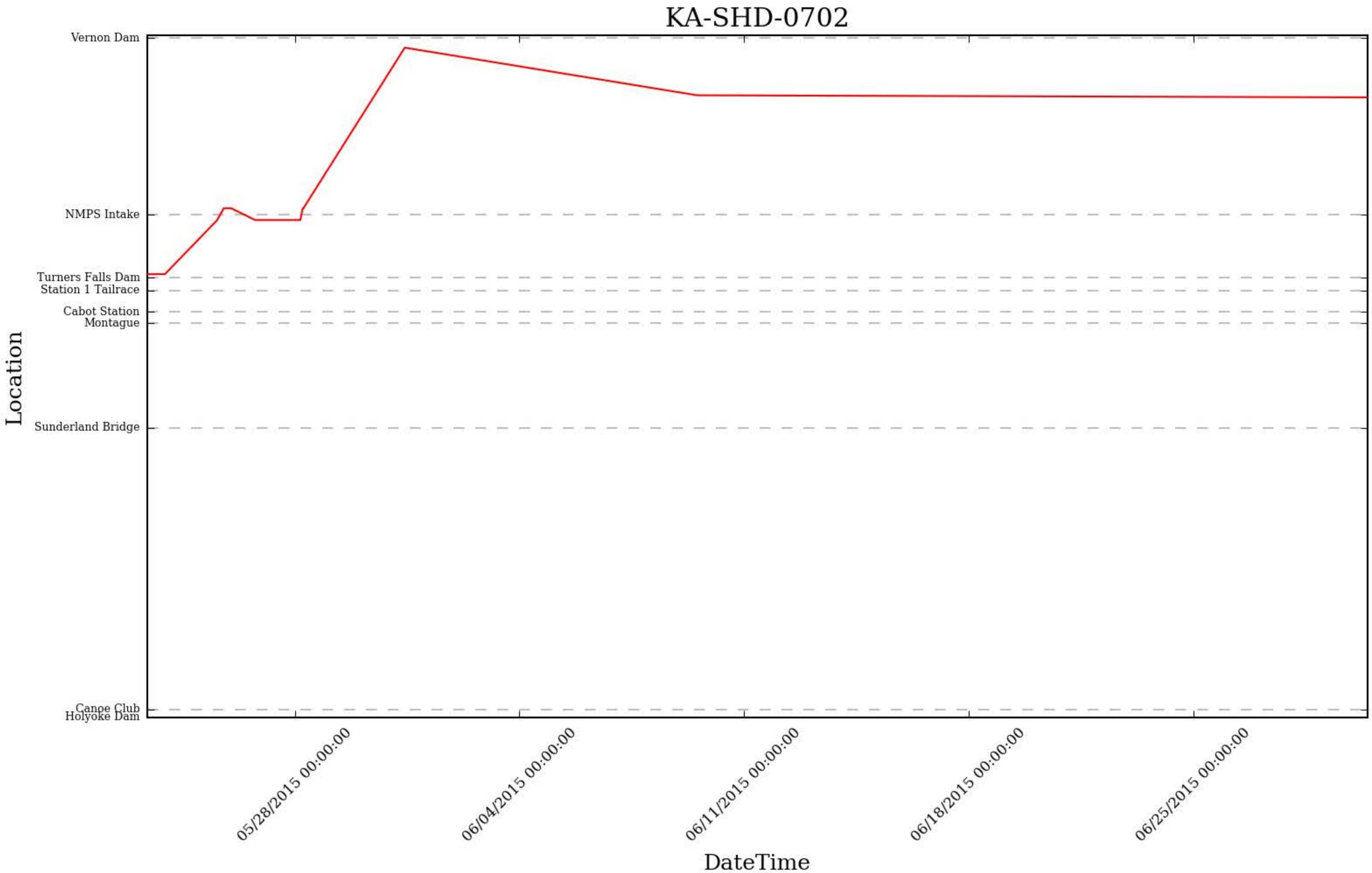
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
DateTime


KA-SHD-0700
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
DateTime



KA-SHD-0701
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
05/29/2015 00:00:00
06/01/2015 00:00:00
06/04/2015 00:00:00
06/07/2015 00:00:00
06/10/2015 00:00:00
06/13/2015 00:00:00
06/16/2015 00:00:00
DateTime


KA-SHD-0702
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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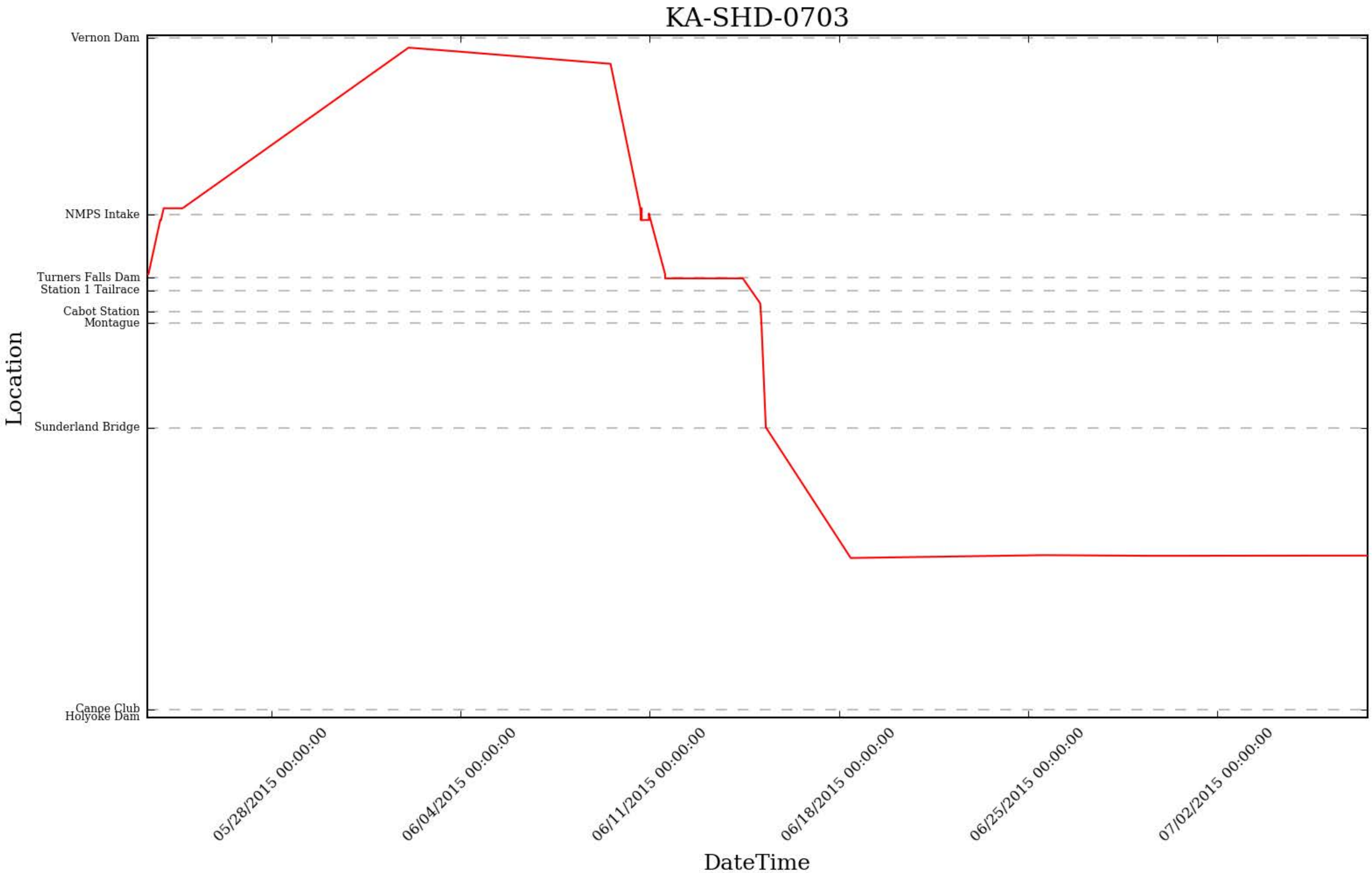
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
DateTime


KA-SHD-0703
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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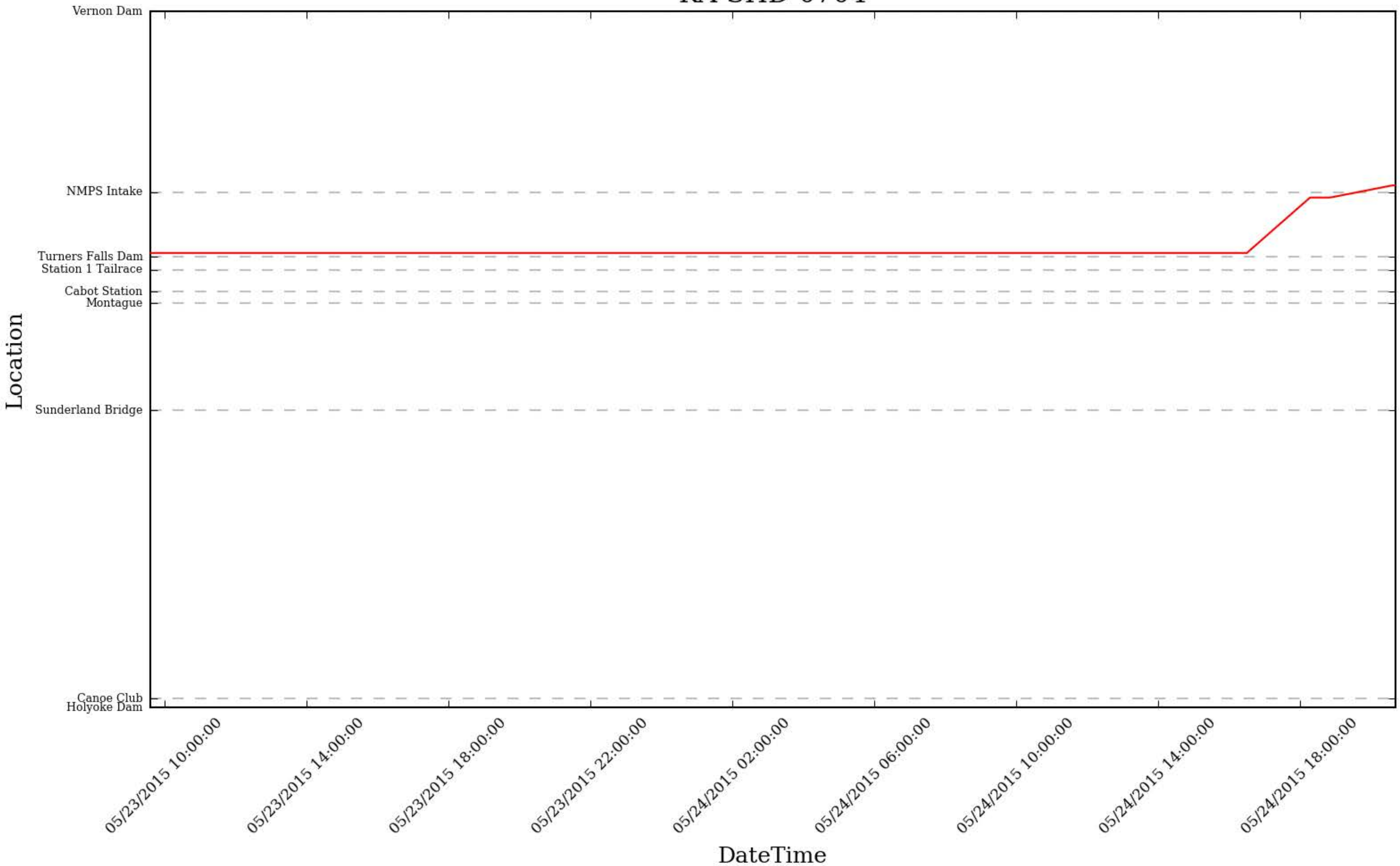
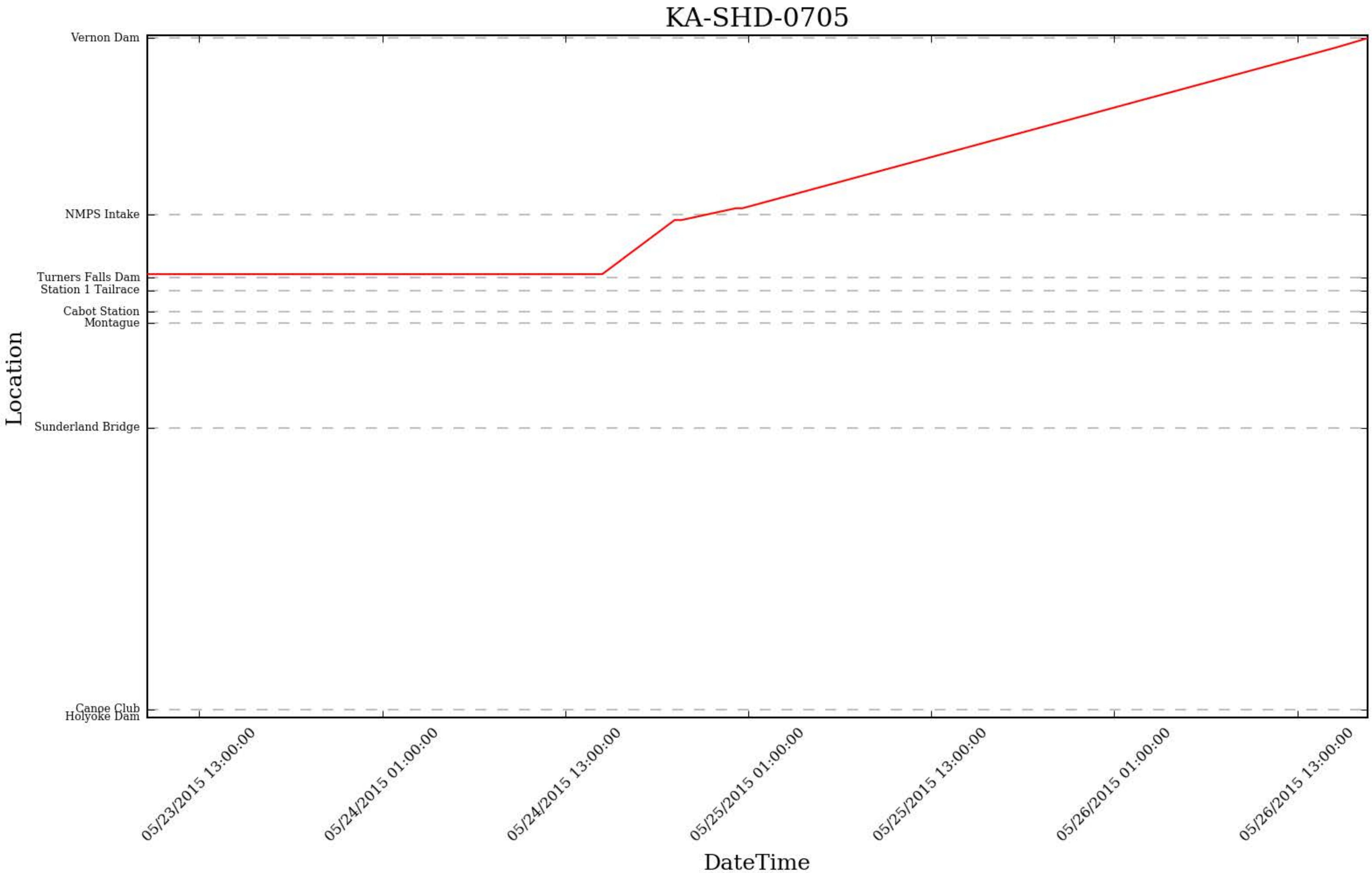
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime

KA-SHD-0704


Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 10:00:00
05/23/2015 14:00:00
05/23/2015 18:00:00
05/23/2015 22:00:00
05/24/2015 02:00:00
05/24/2015 06:00:00
05/24/2015 10:00:00
05/24/2015 14:00:00
05/24/2015 18:00:00
DateTime


KA-SHD-0705
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/23/2015 13:00:00
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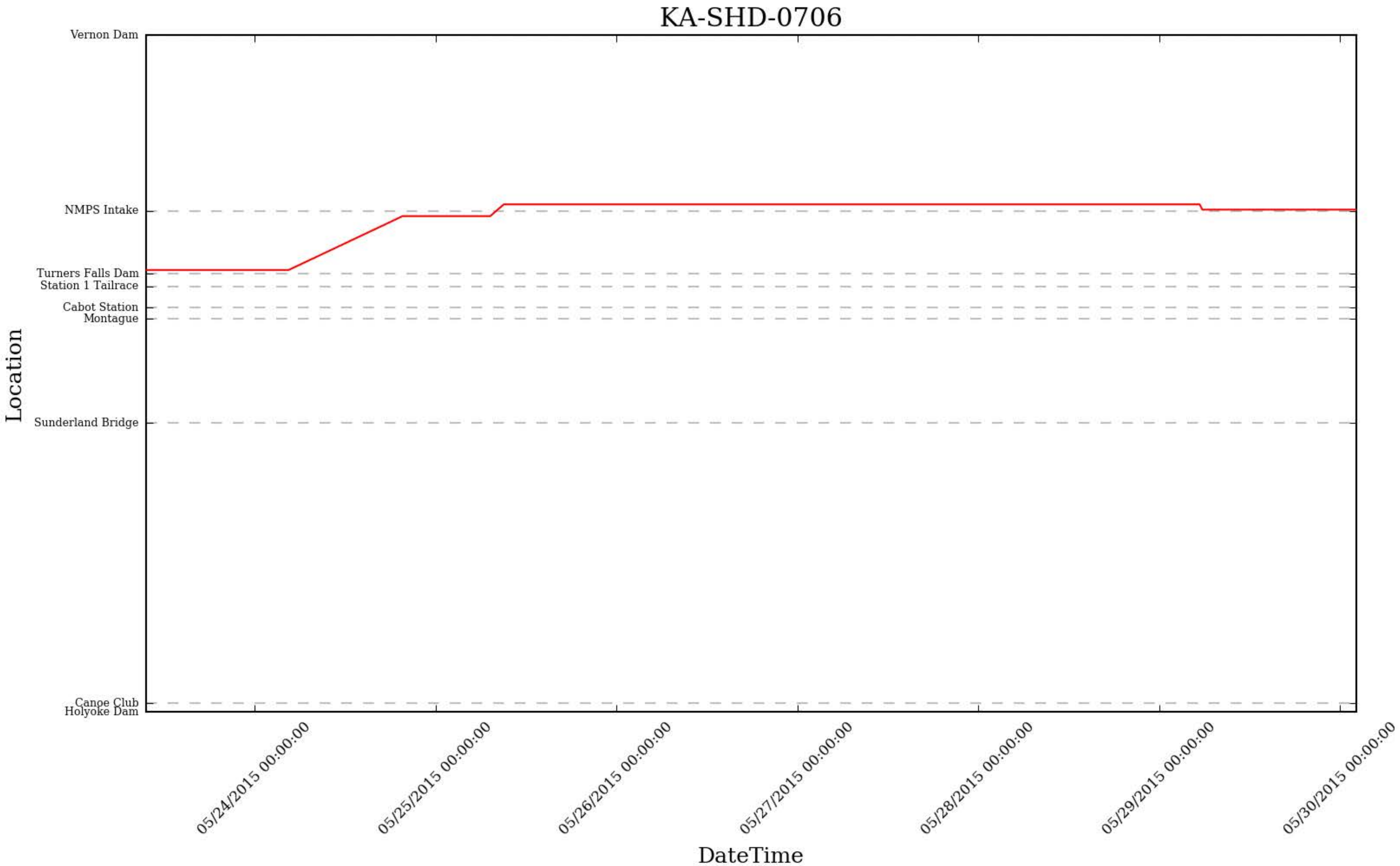
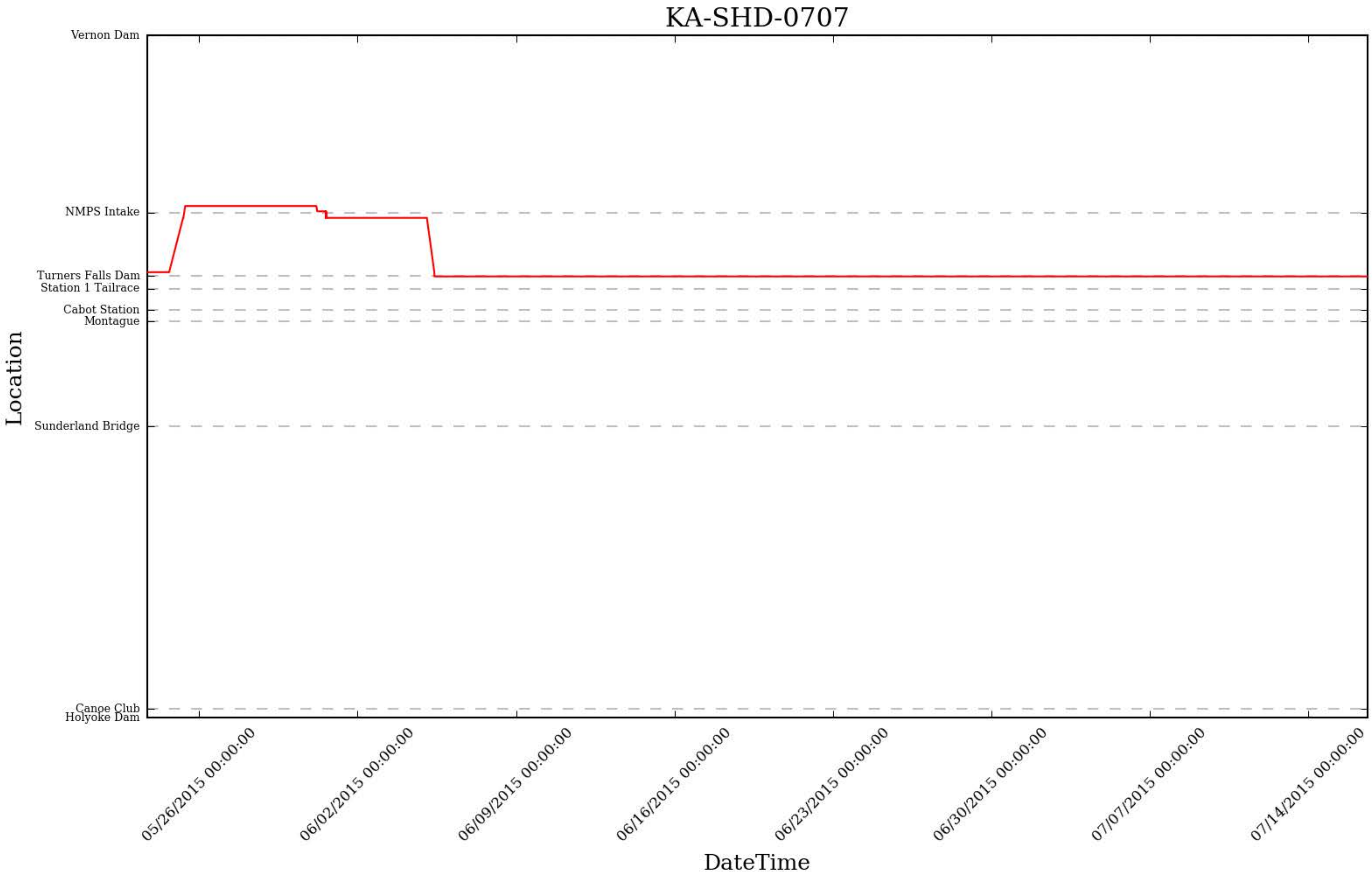
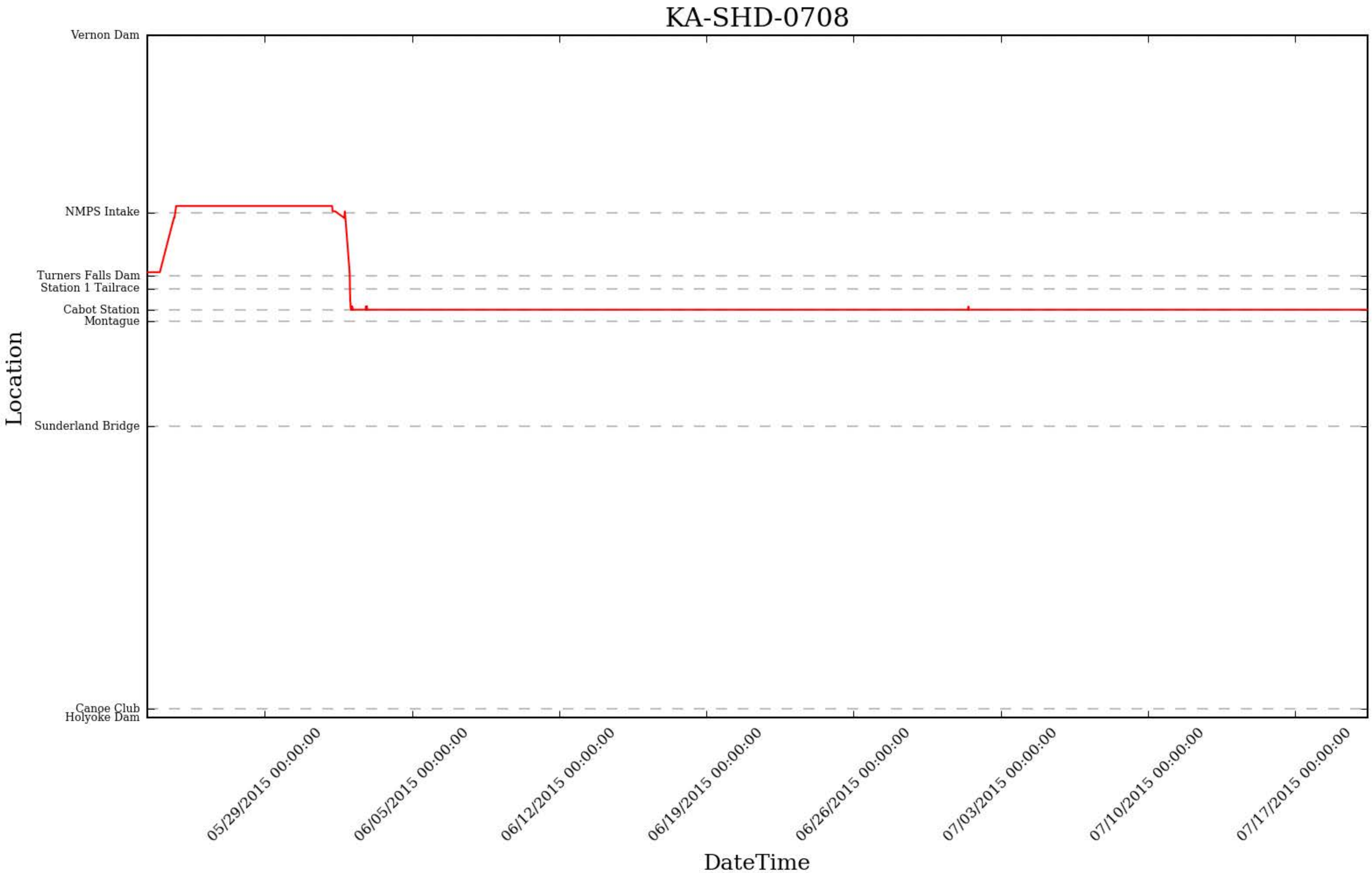
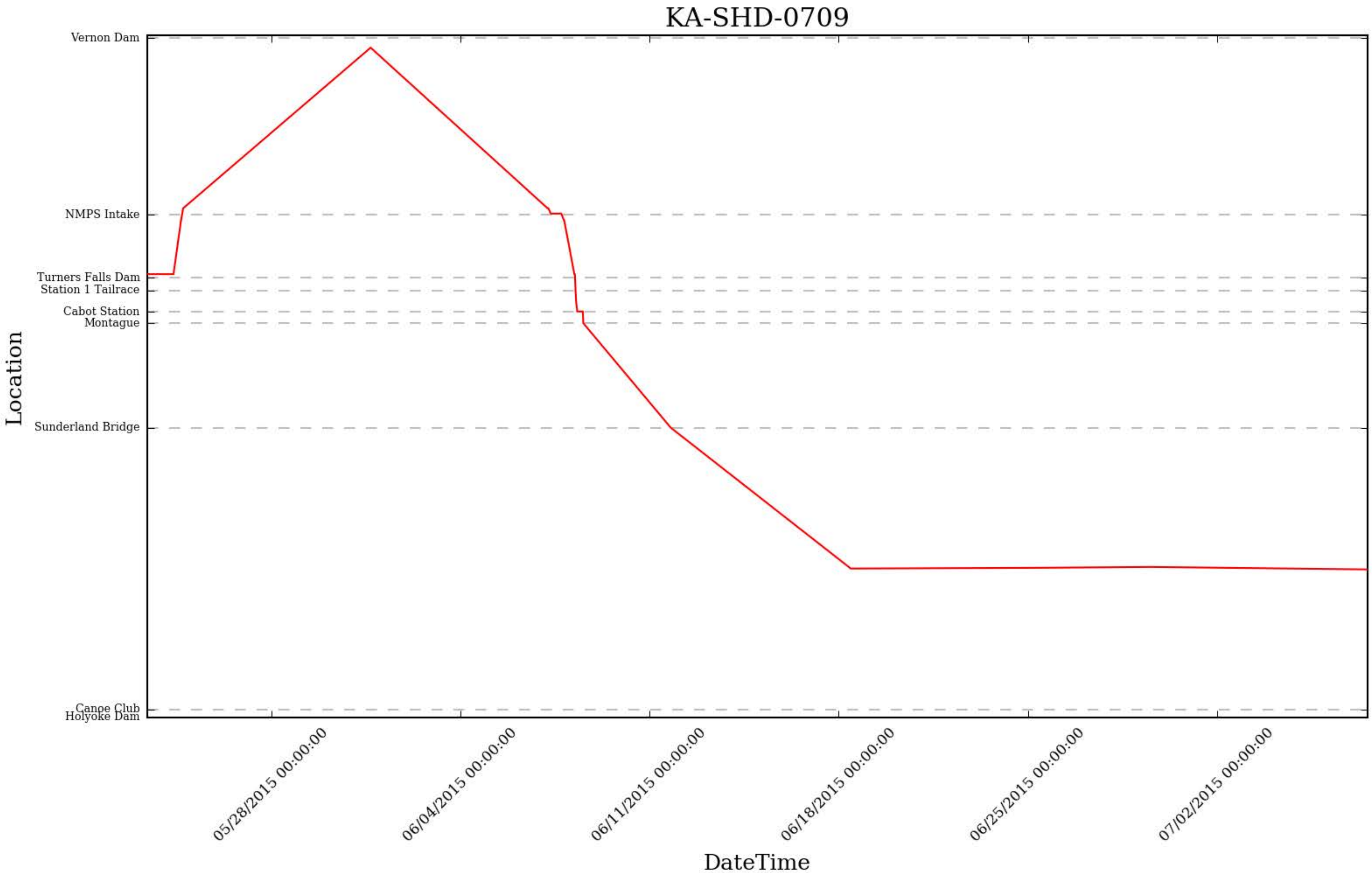
05/24/2015 13:00:00
05/25/2015 01:00:00
05/25/2015 13:00:00
05/26/2015 01:00:00
05/26/2015 13:00:00
DateTime

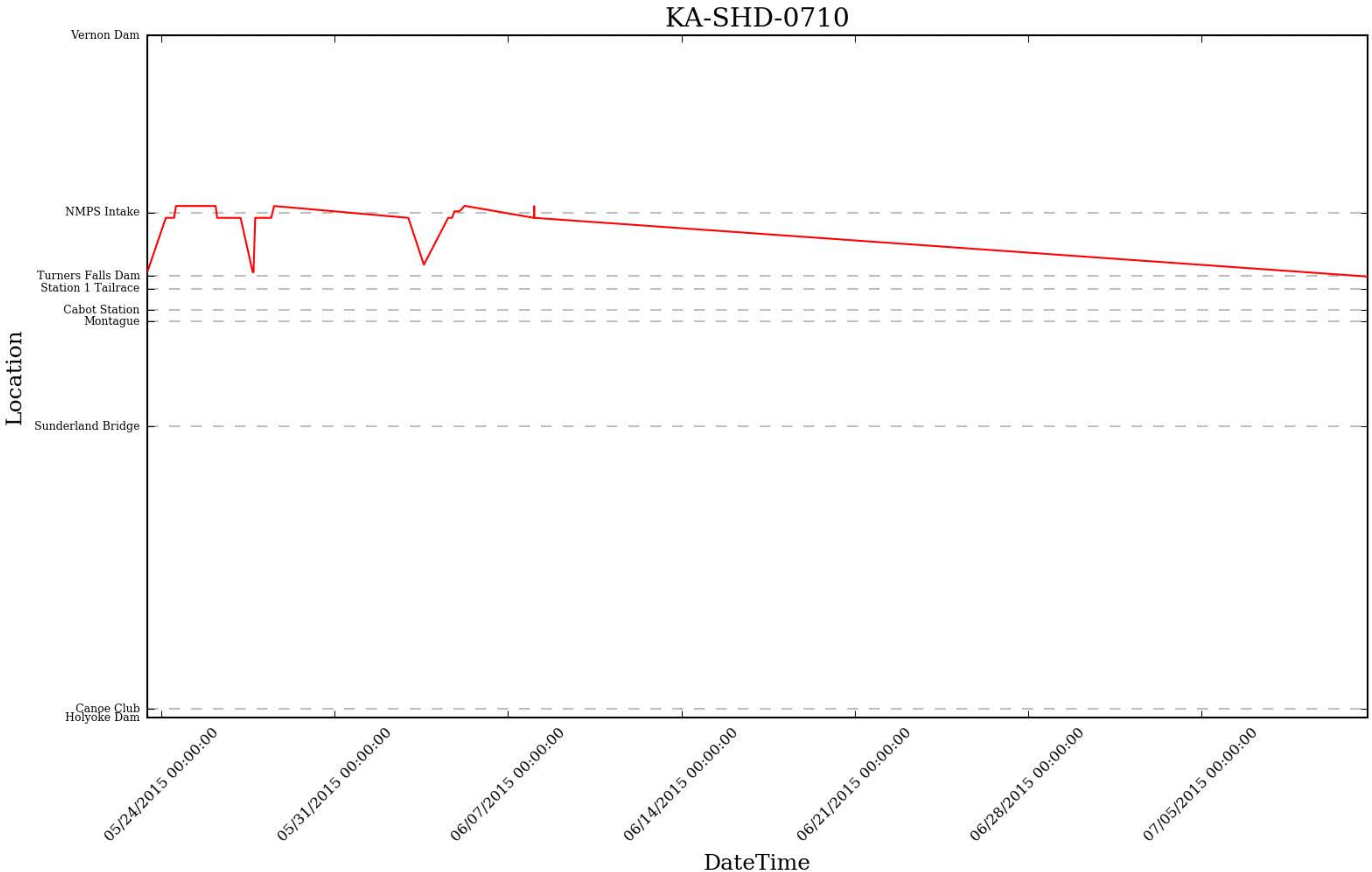

KA-SHD-0706
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
DateTime

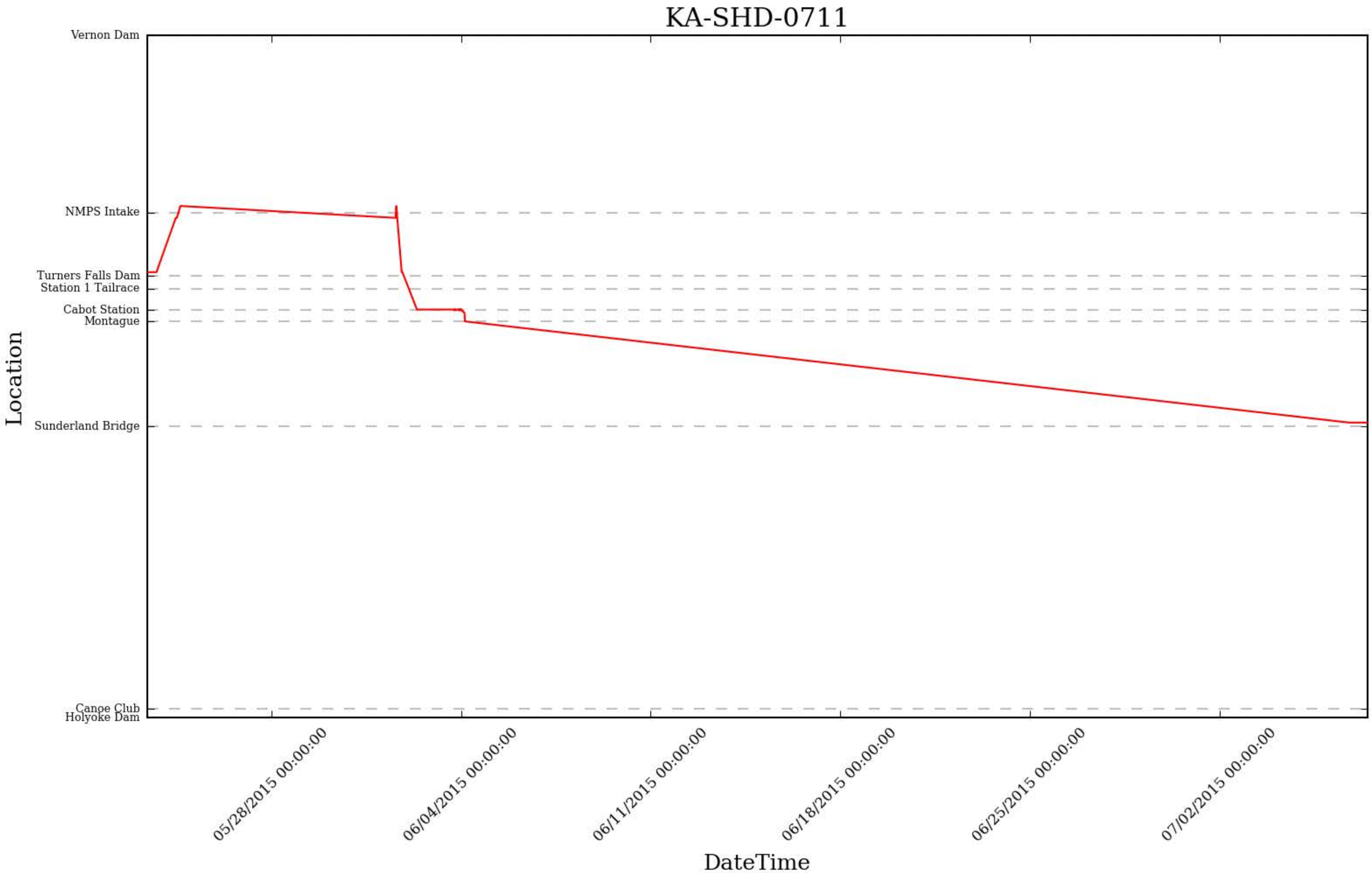


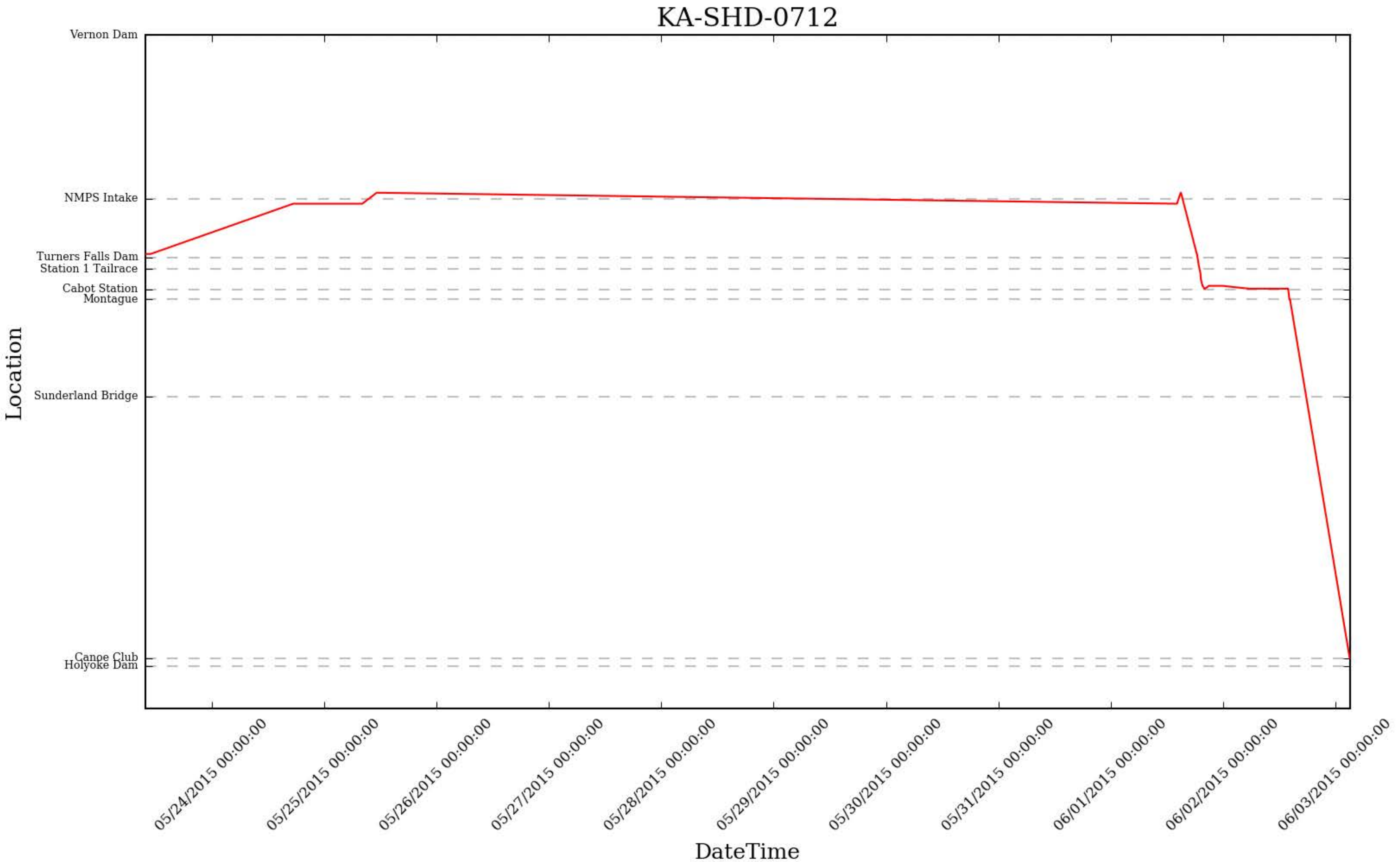
KA-SHD-0707
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 00:00:00
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
06/30/2015 00:00:00
07/07/2015 00:00:00
07/14/2015 00:00:00
DateTime

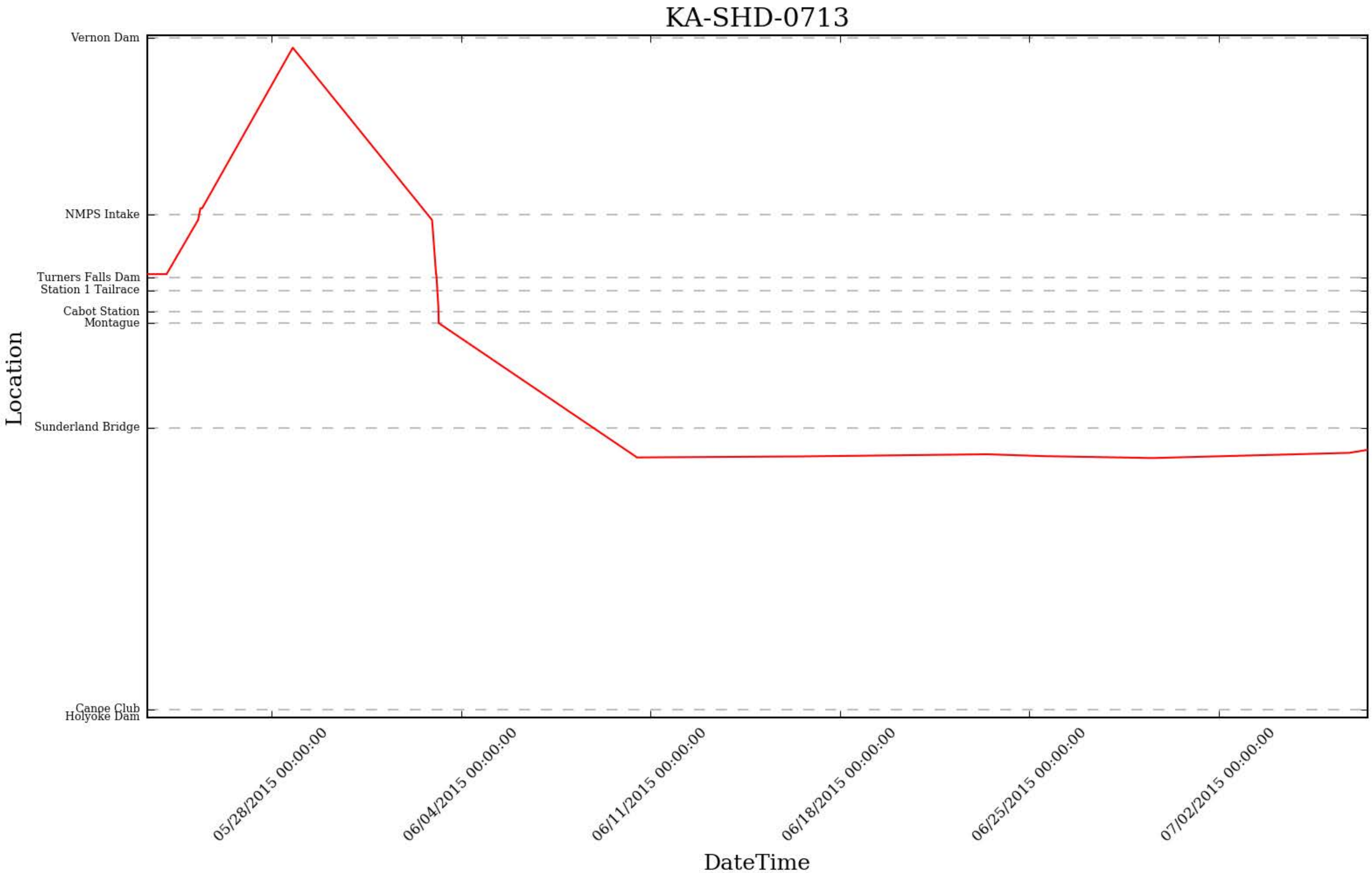

KA-SHD-0708
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
06/05/2015 00:00:00
06/12/2015 00:00:00
06/19/2015 00:00:00
06/26/2015 00:00:00
07/03/2015 00:00:00
07/10/2015 00:00:00
07/17/2015 00:00:00
DateTime

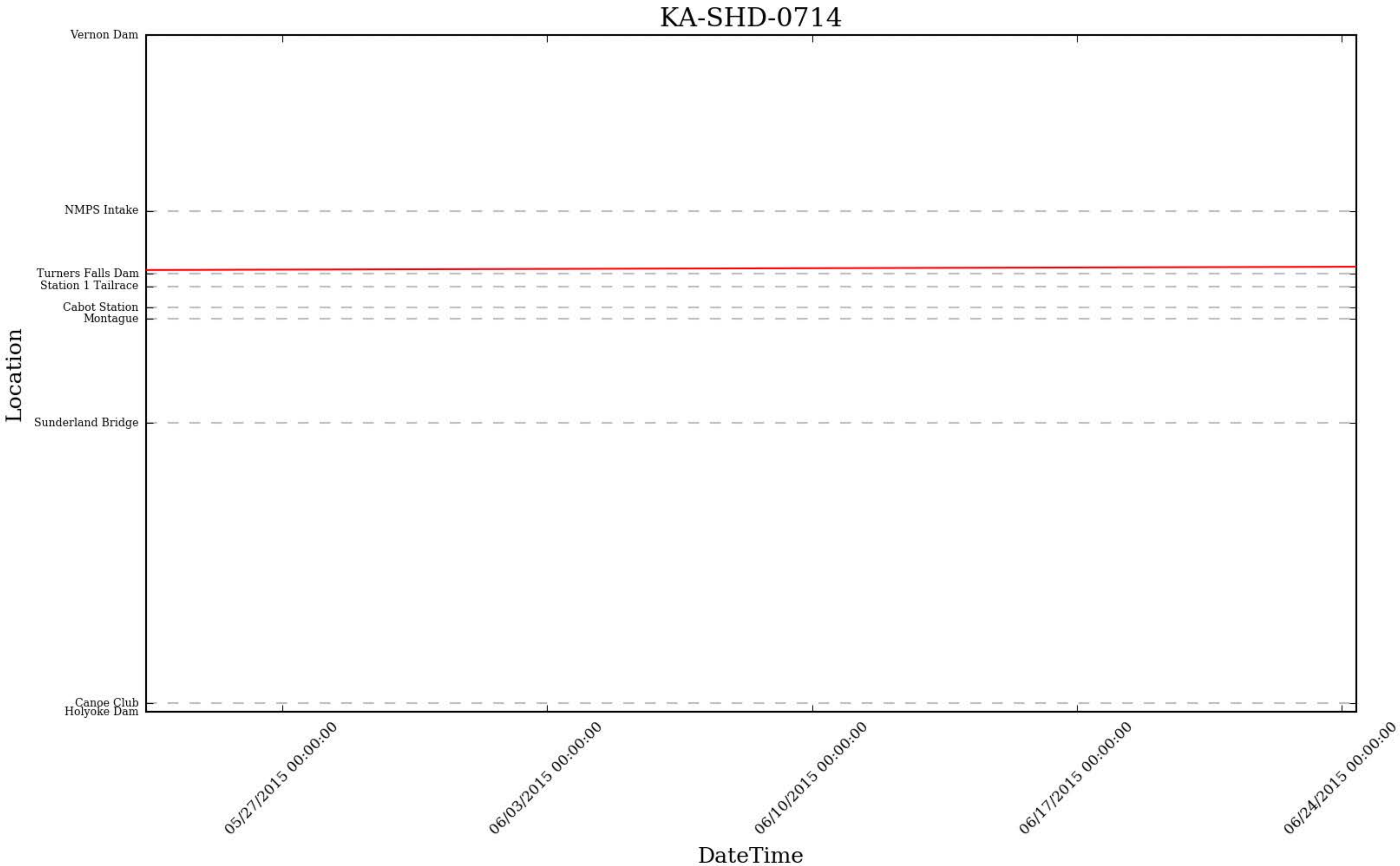

KA-SHD-0709
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime


KA-SHD-0710
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/31/2015 00:00:00
06/07/2015 00:00:00
06/14/2015 00:00:00
06/21/2015 00:00:00
06/28/2015 00:00:00
07/05/2015 00:00:00
DateTime


KA-SHD-0711
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime


KA-SHD-0712
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
DateTime


KA-SHD-0713
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime


KA-SHD-0714
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
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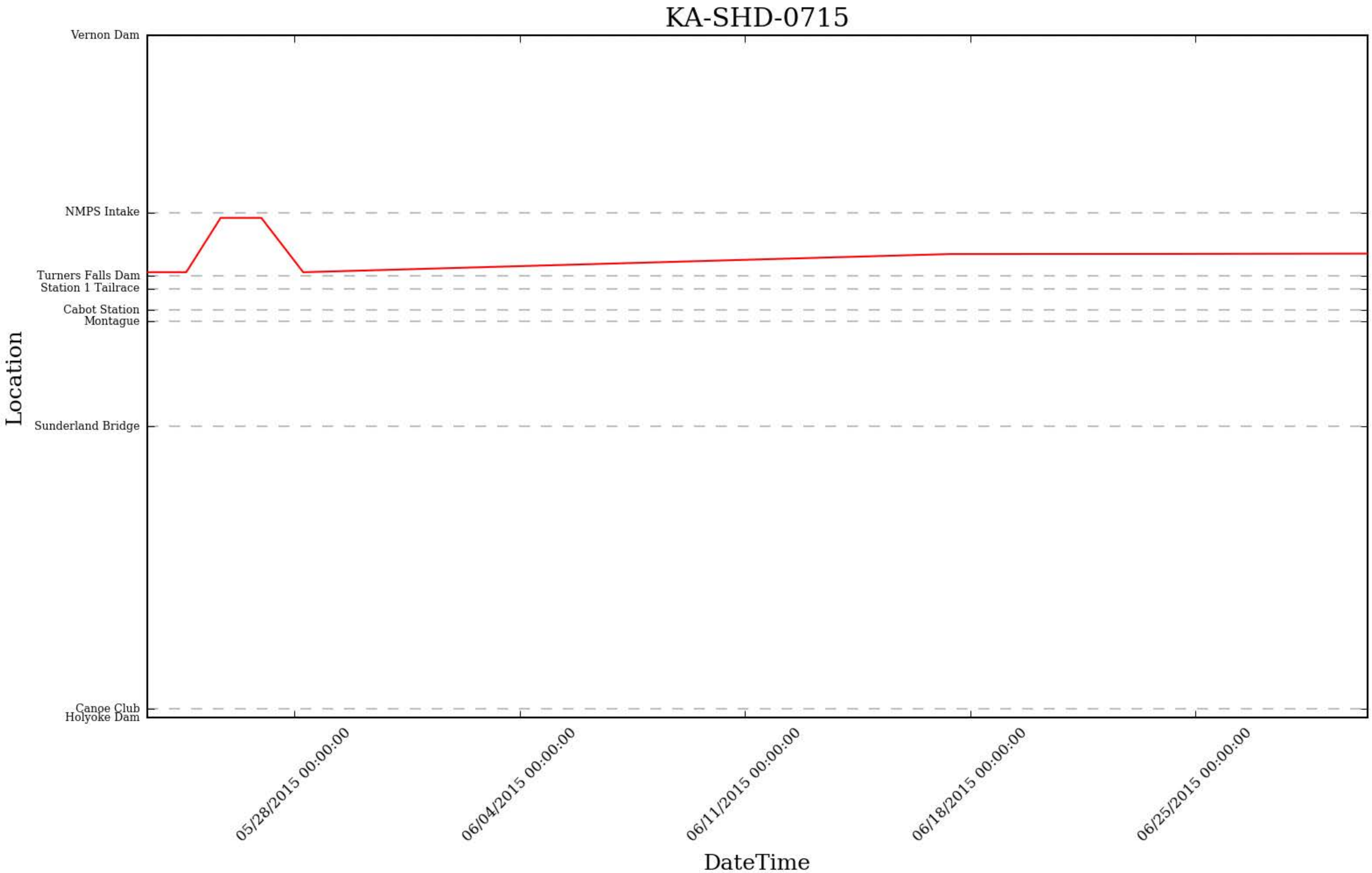
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
DateTime


KA-SHD-0715
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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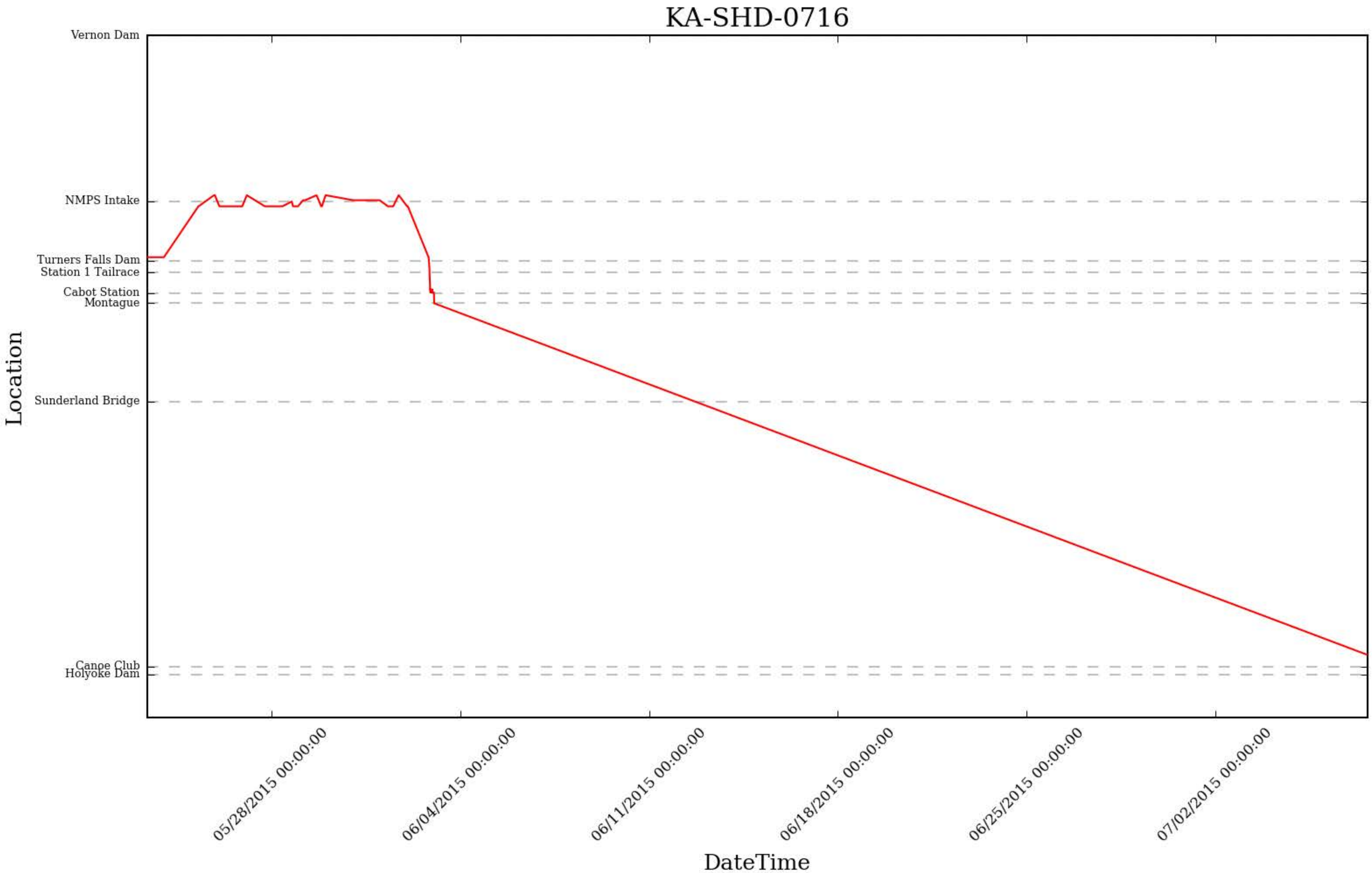
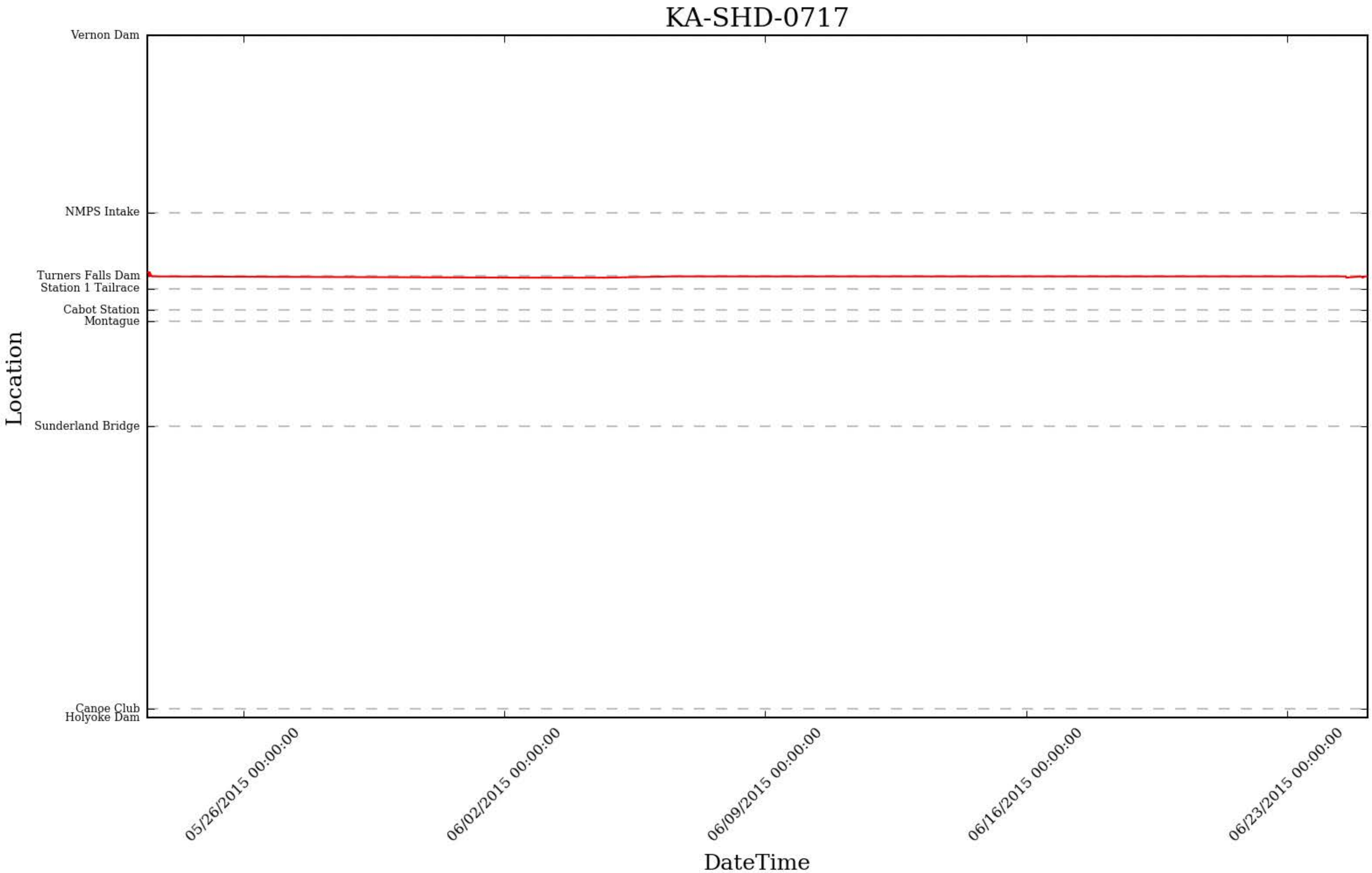
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
DateTime


KA-SHD-0716
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
06/04/2015 00:00:00
06/11/2015 00:00:00
06/18/2015 00:00:00
06/25/2015 00:00:00
07/02/2015 00:00:00
DateTime


KA-SHD-0717
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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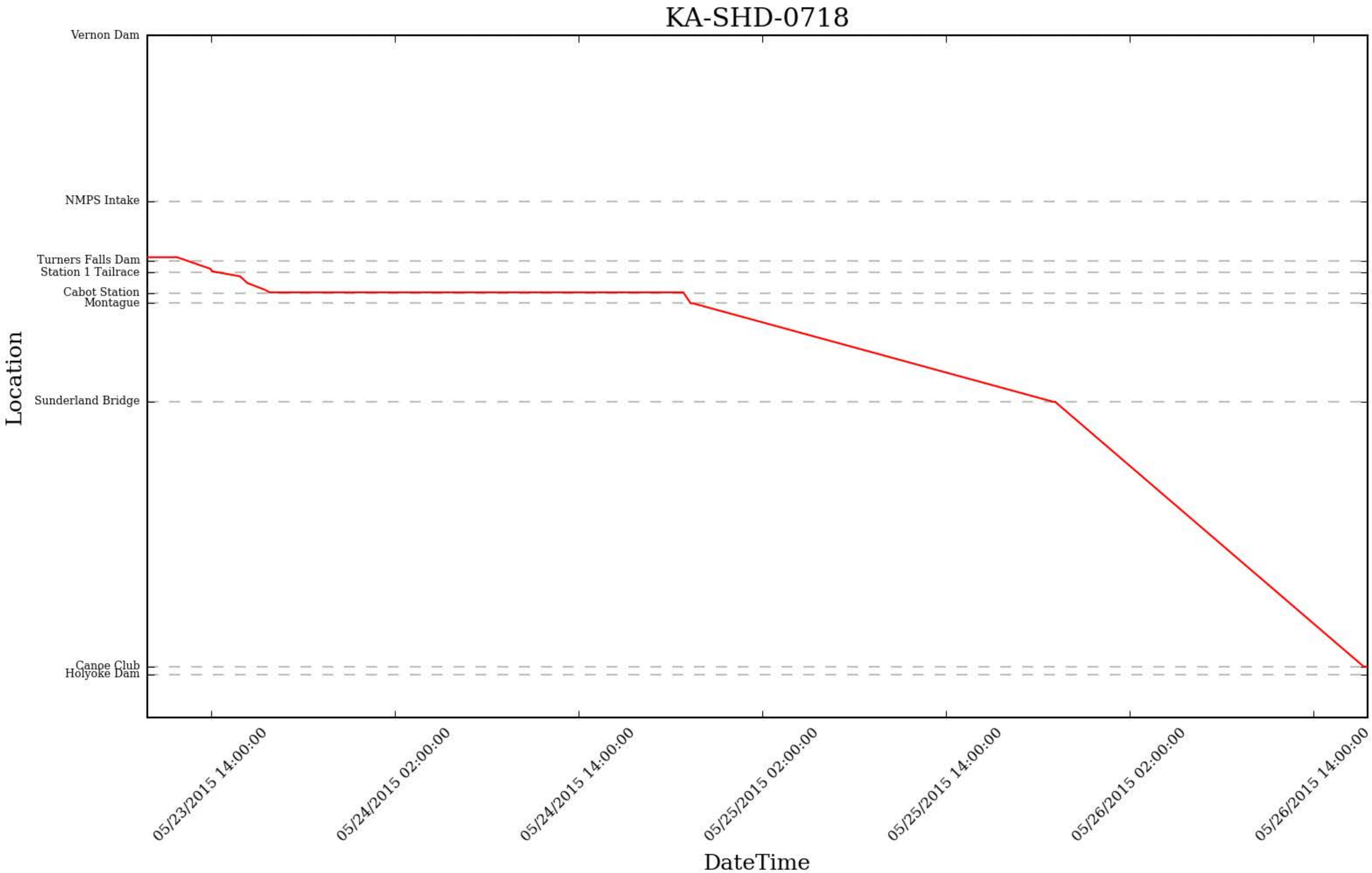
06/02/2015 00:00:00
06/09/2015 00:00:00
06/16/2015 00:00:00
06/23/2015 00:00:00
DateTime



KA-SHD-0718
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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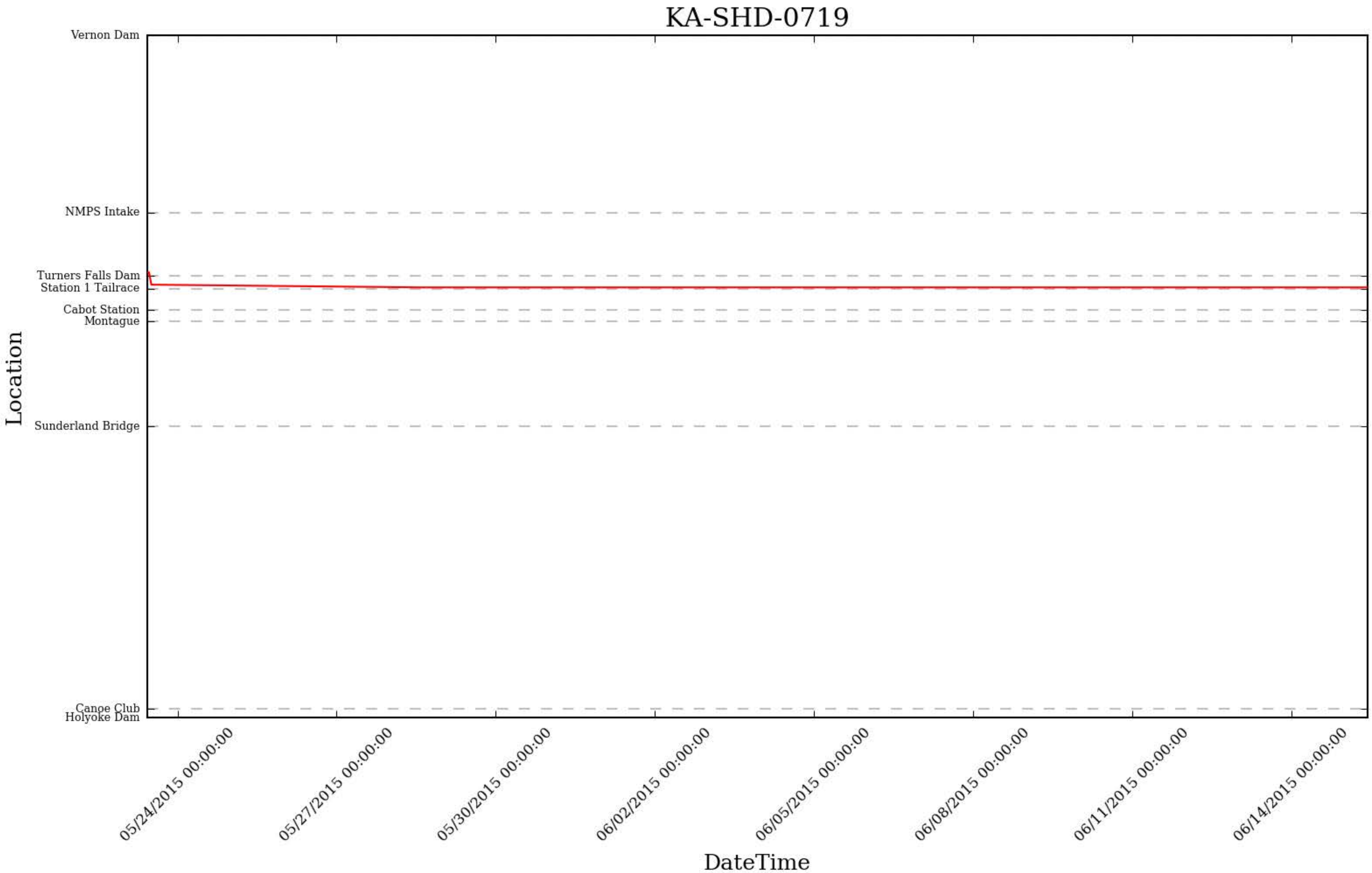
05/26/2015 14:00:00
DateTime


KA-SHD-0719
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/27/2015 00:00:00
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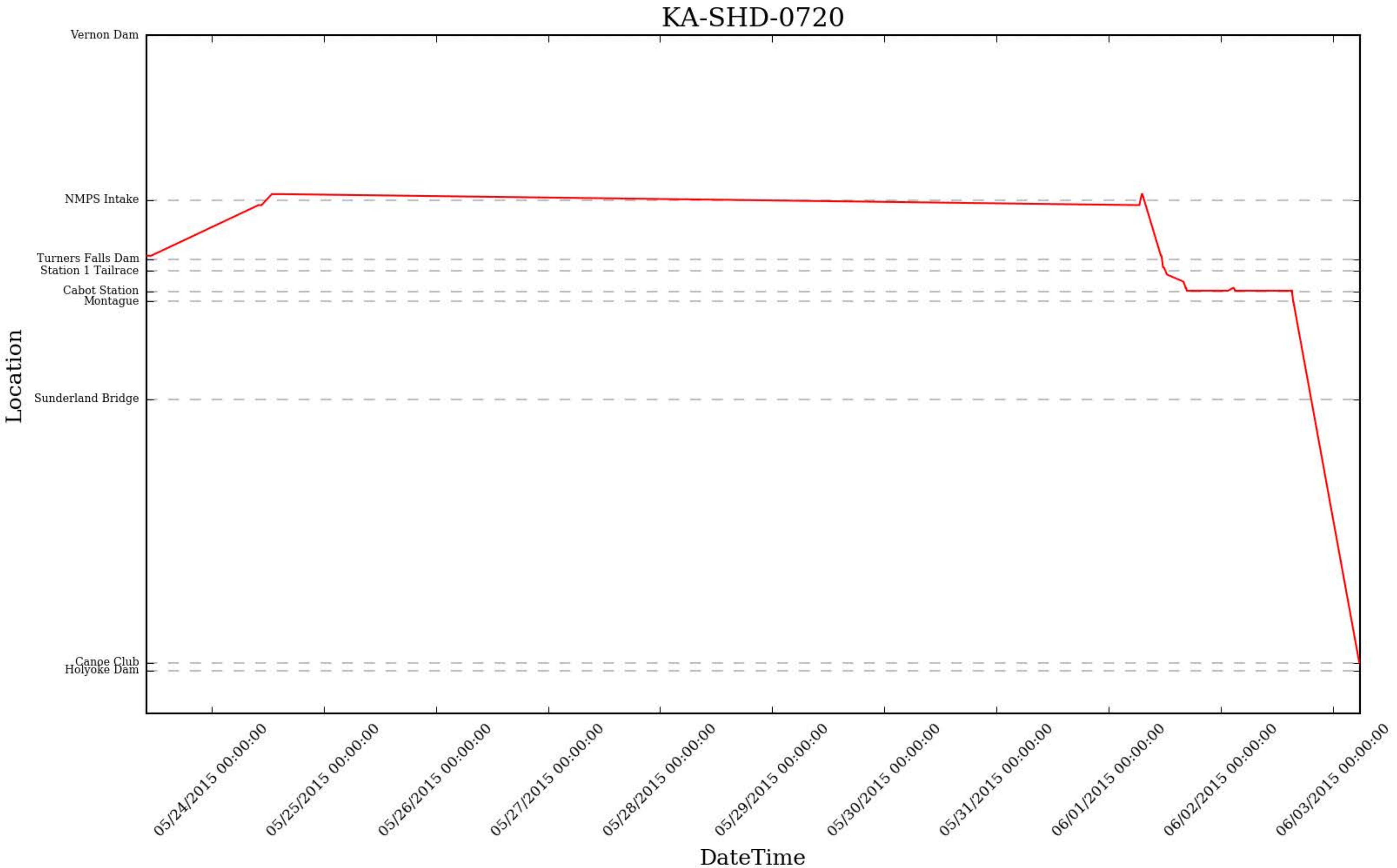
06/02/2015 00:00:00
06/05/2015 00:00:00
06/08/2015 00:00:00
06/11/2015 00:00:00
06/14/2015 00:00:00
DateTime


KA-SHD-0720
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
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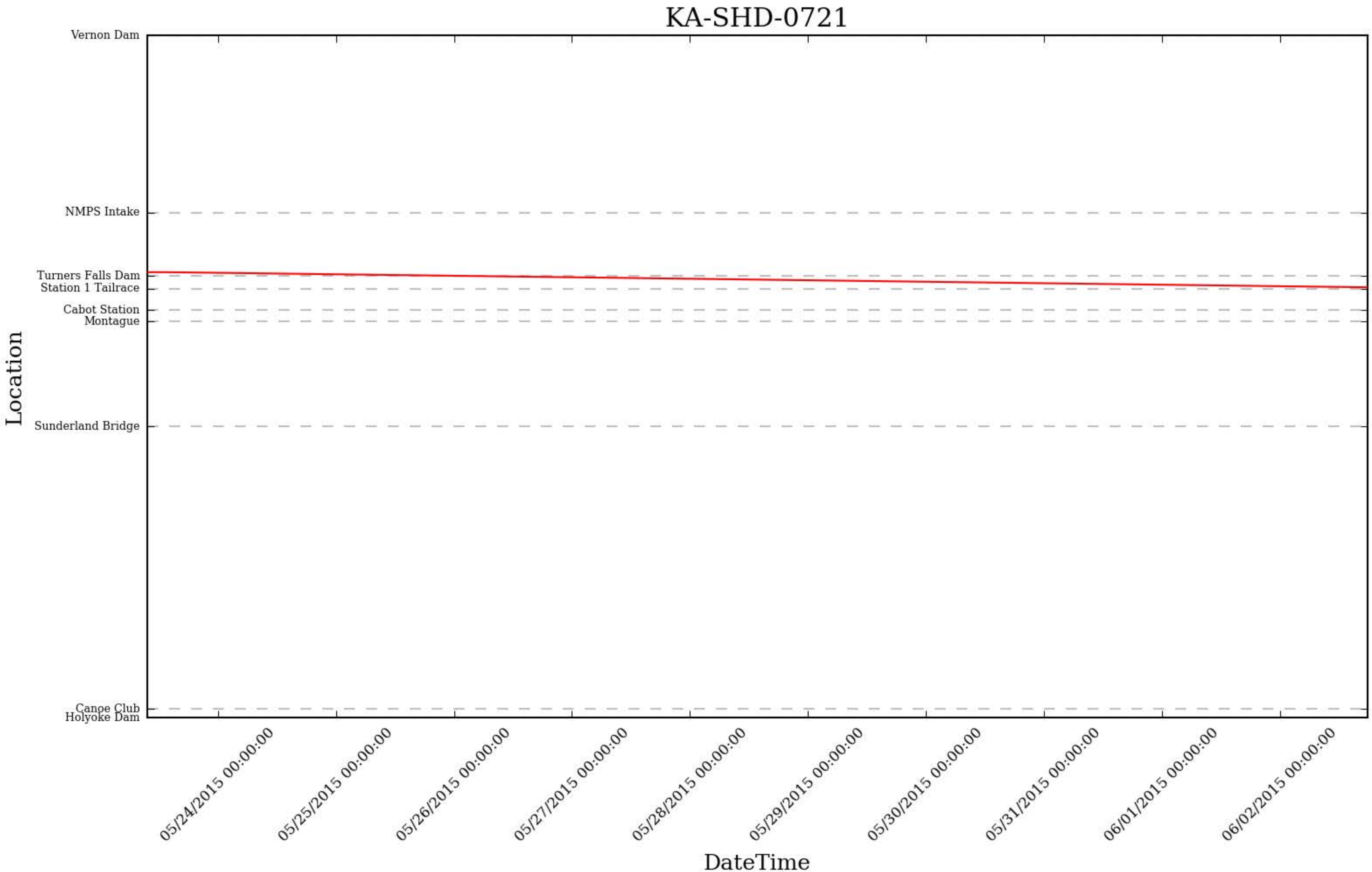
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
DateTime


KA-SHD-0721
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/25/2015 00:00:00
05/26/2015 00:00:00
05/27/2015 00:00:00
05/28/2015 00:00:00
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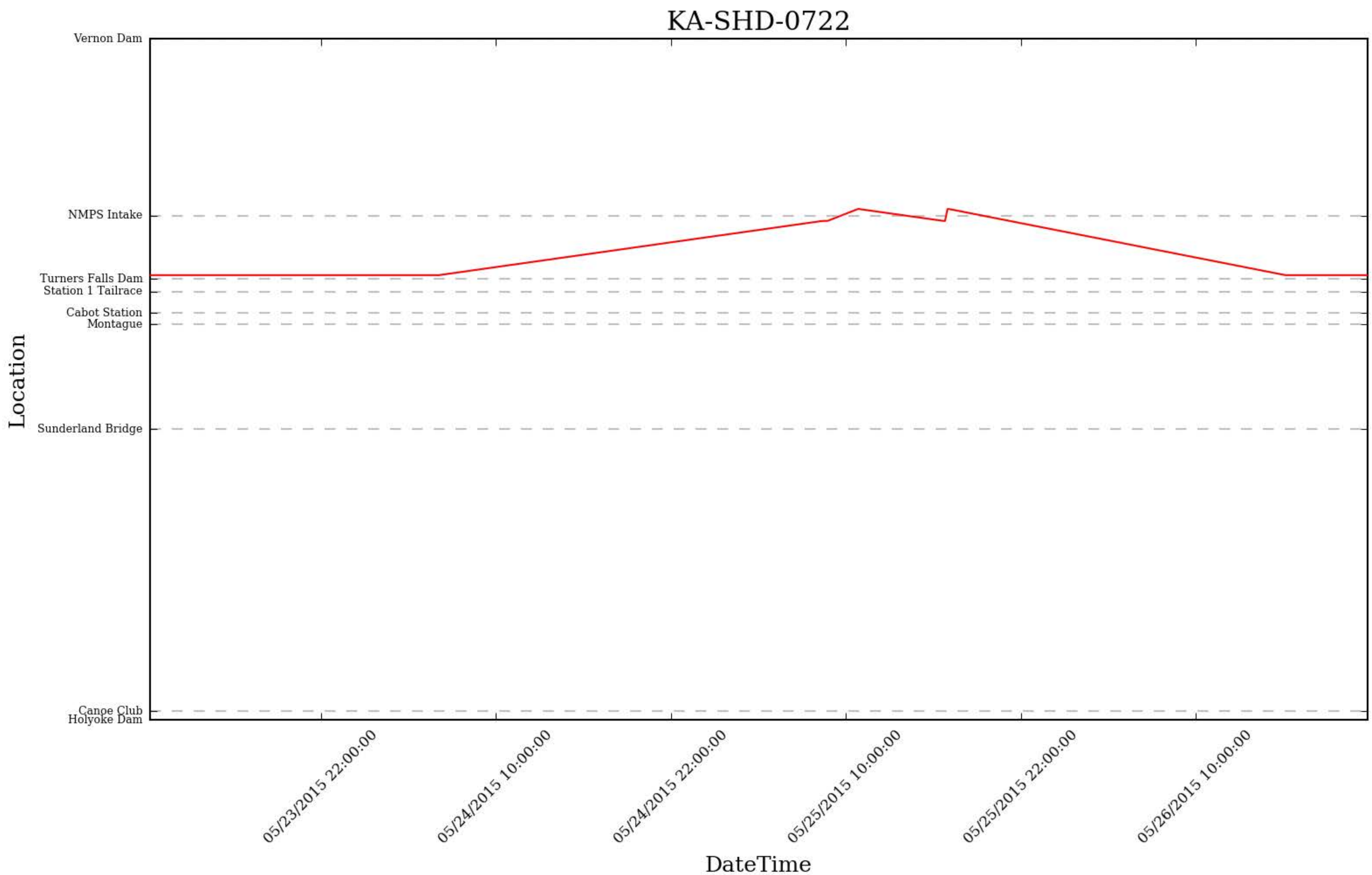
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
DateTime



KA-SHD-0722
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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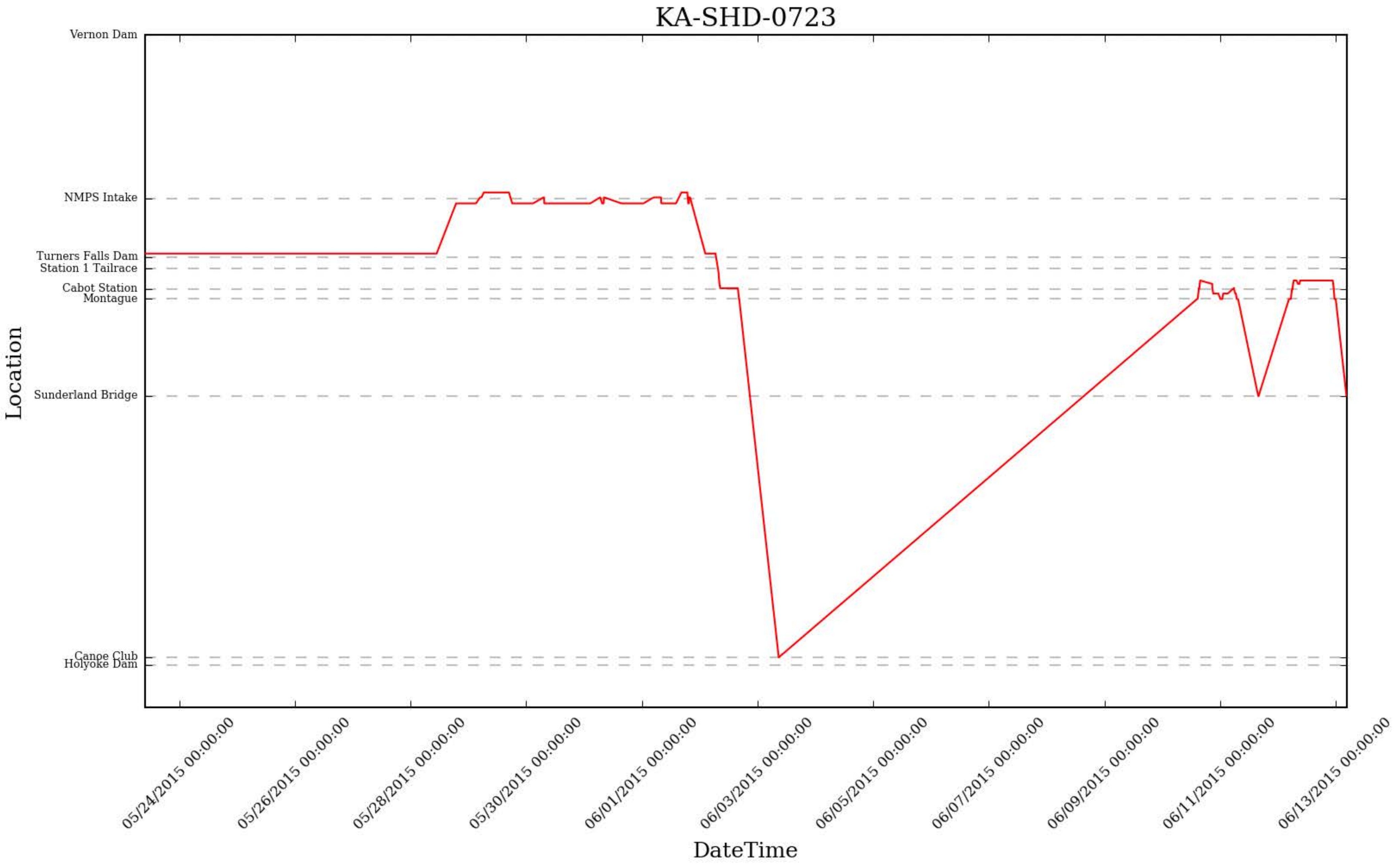
05/26/2015 10:00:00
DateTime


KA-SHD-0723
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
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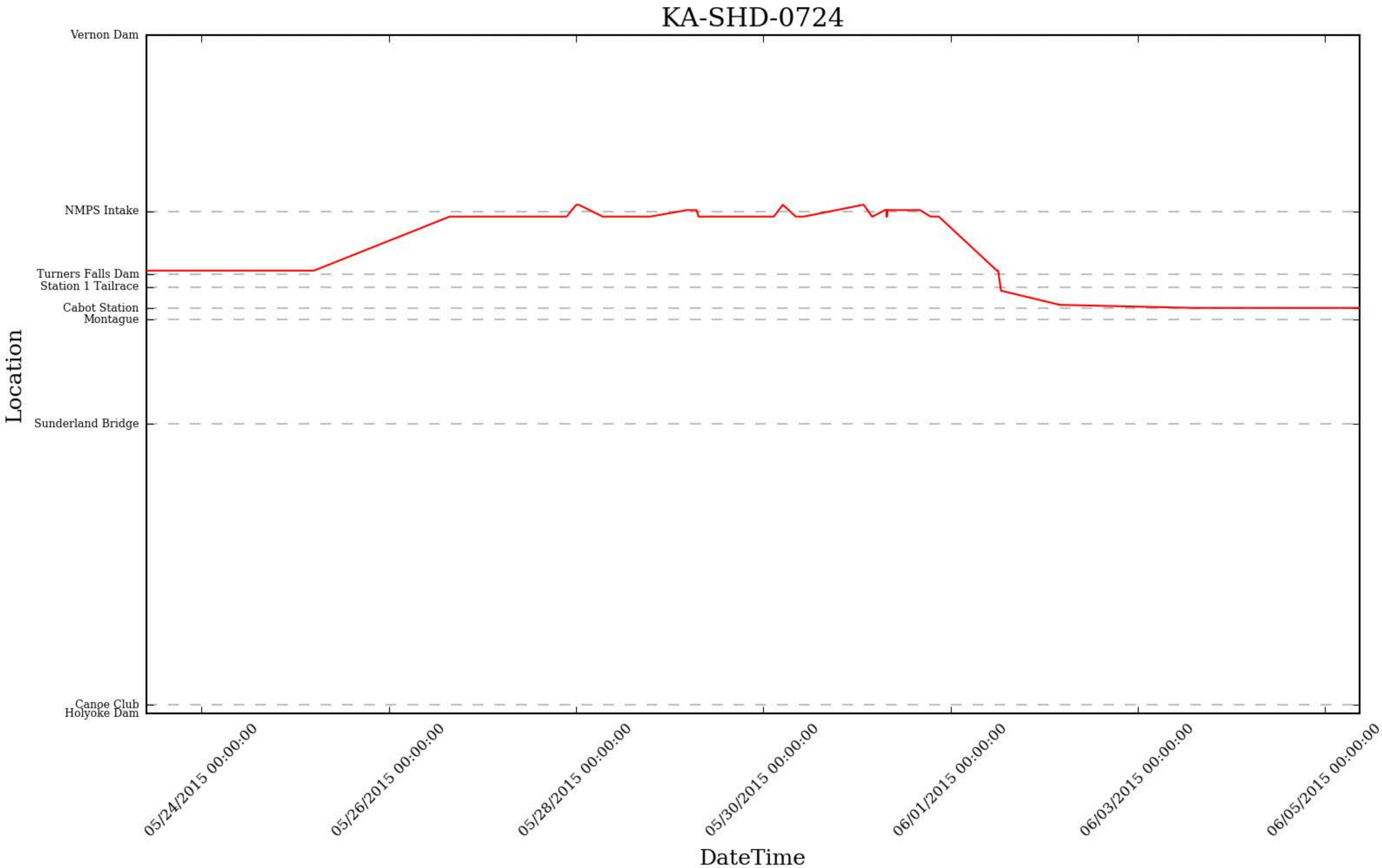
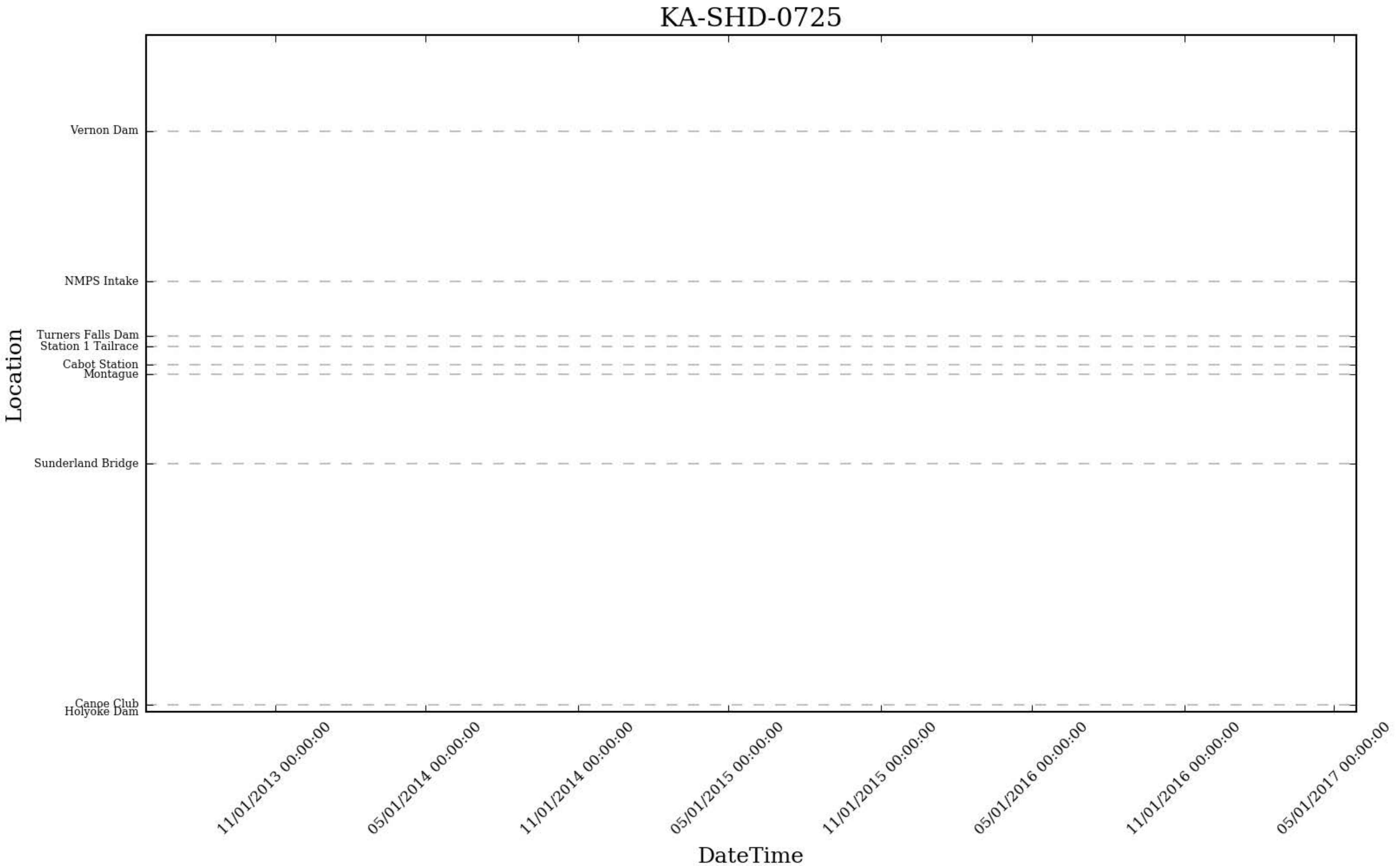
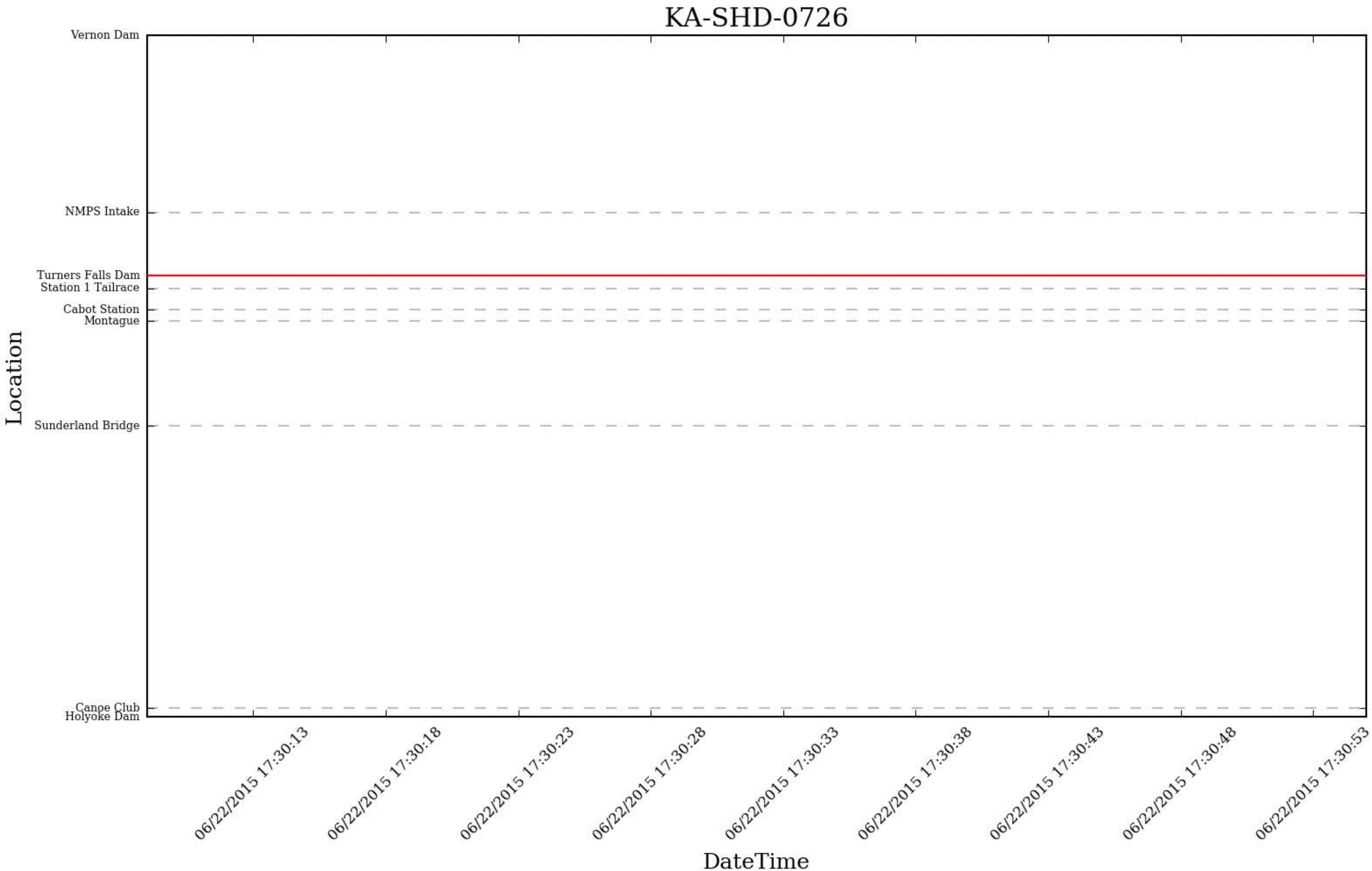
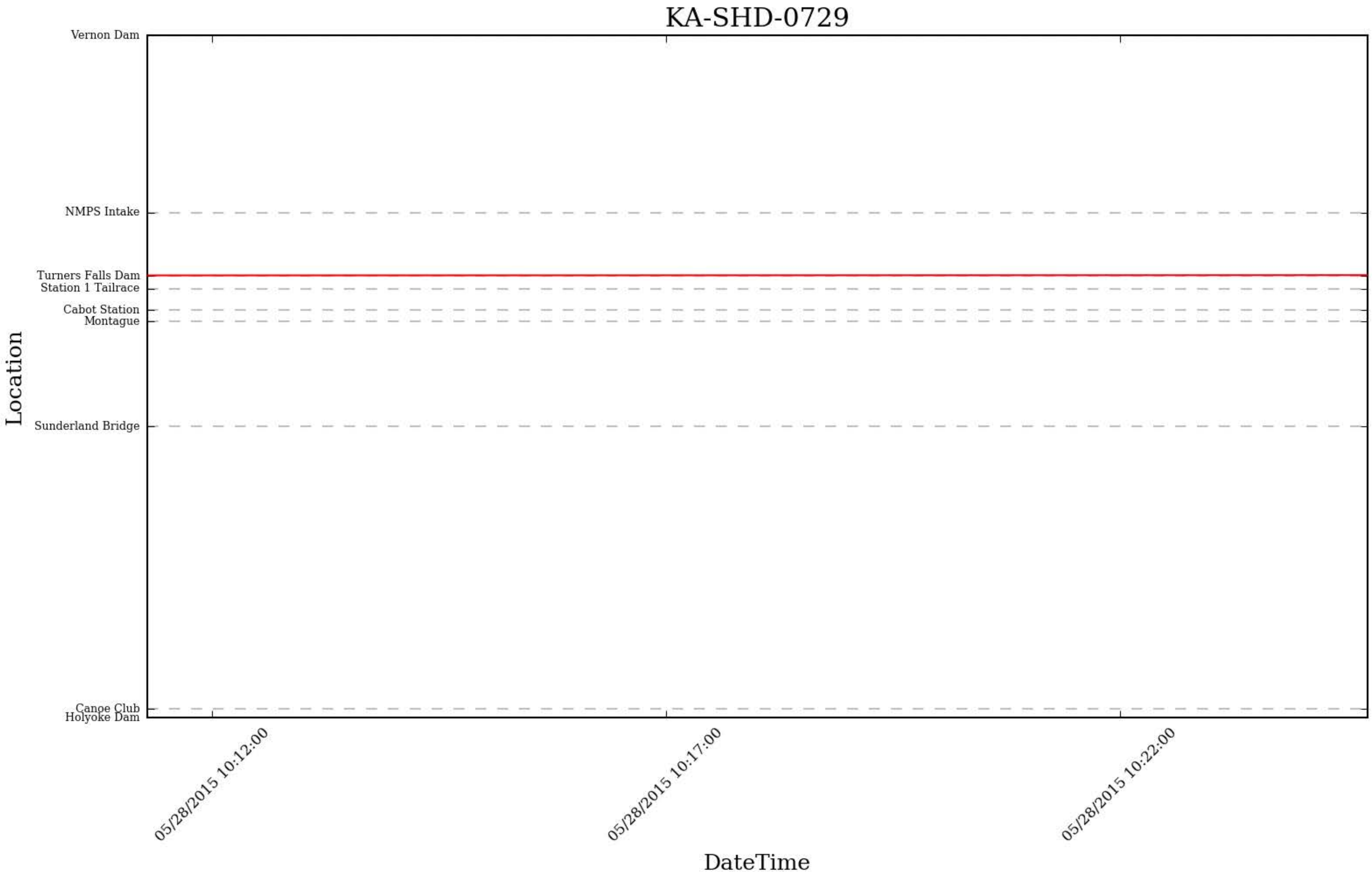
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
06/13/2015 00:00:00
DateTime

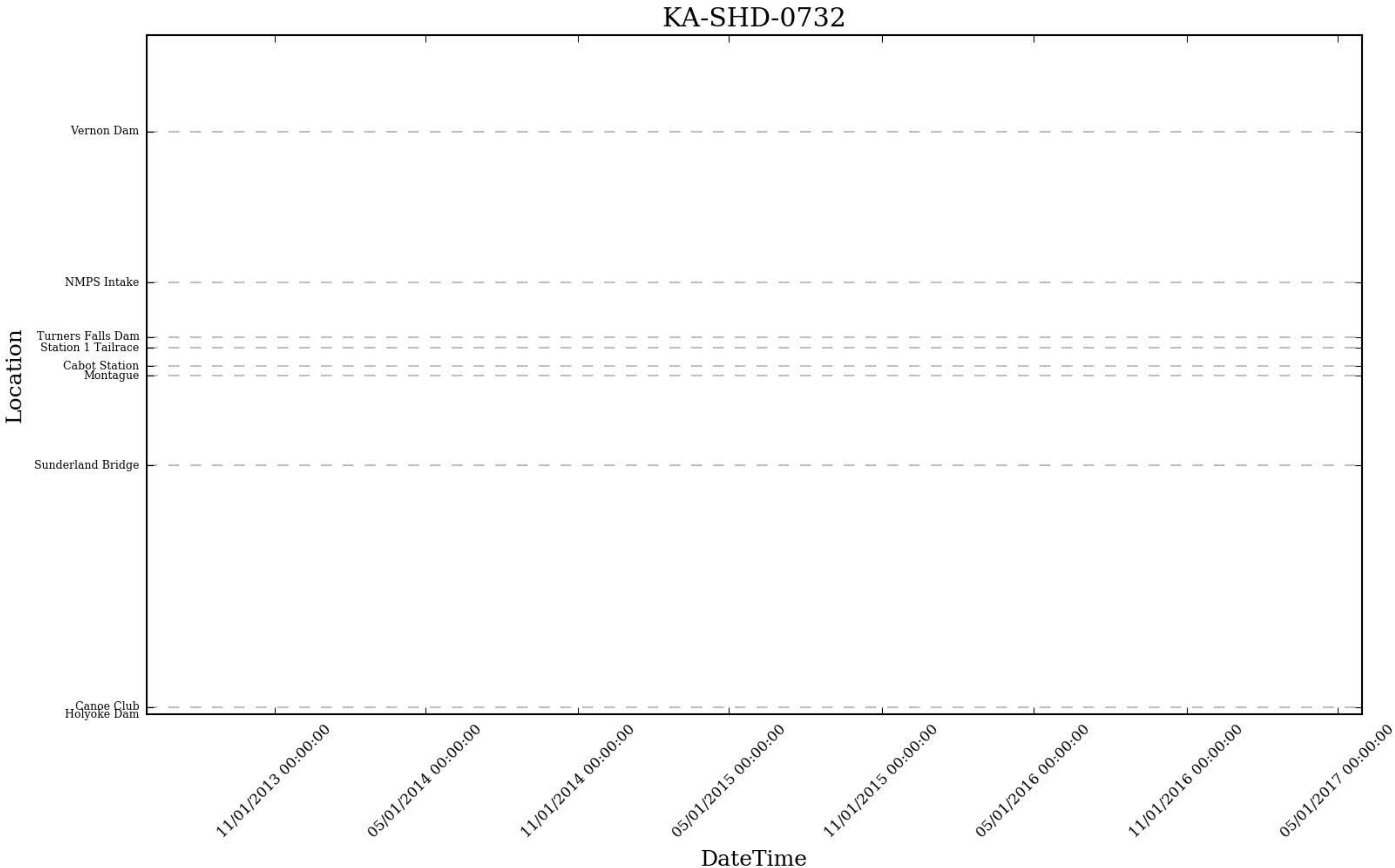

KA-SHD-0724
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/24/2015 00:00:00
05/26/2015 00:00:00
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
DateTime

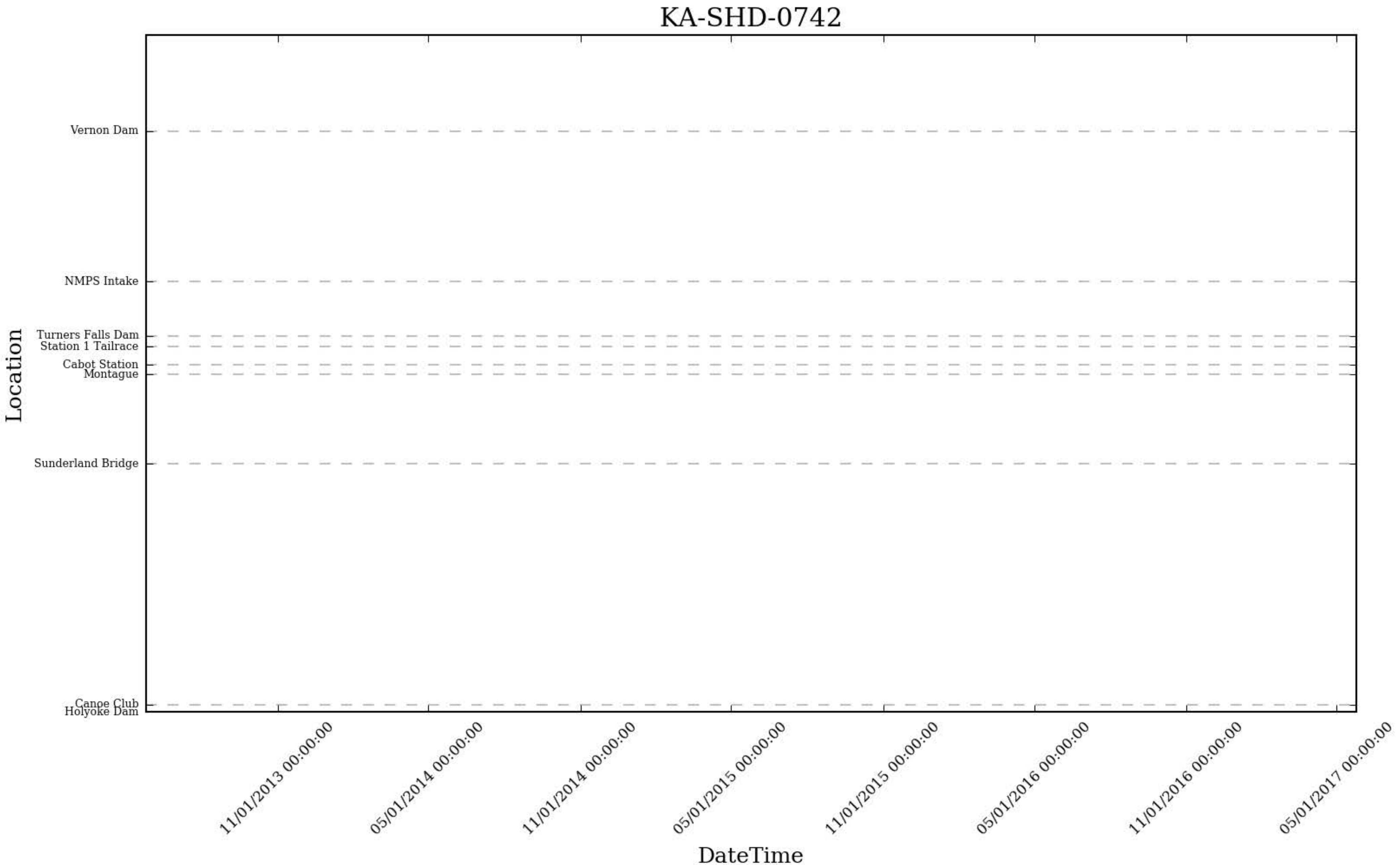

KA-SHD-0725
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

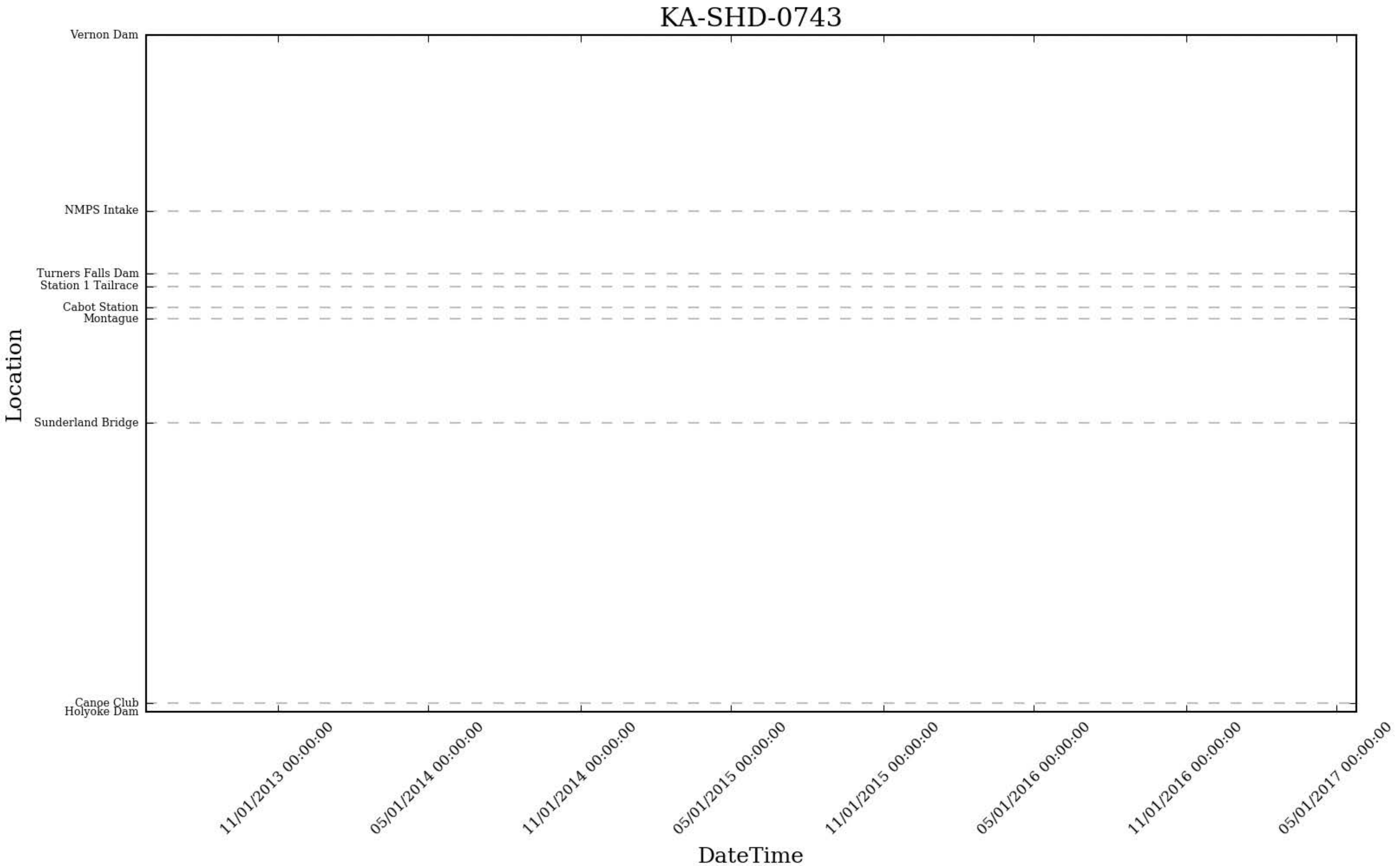


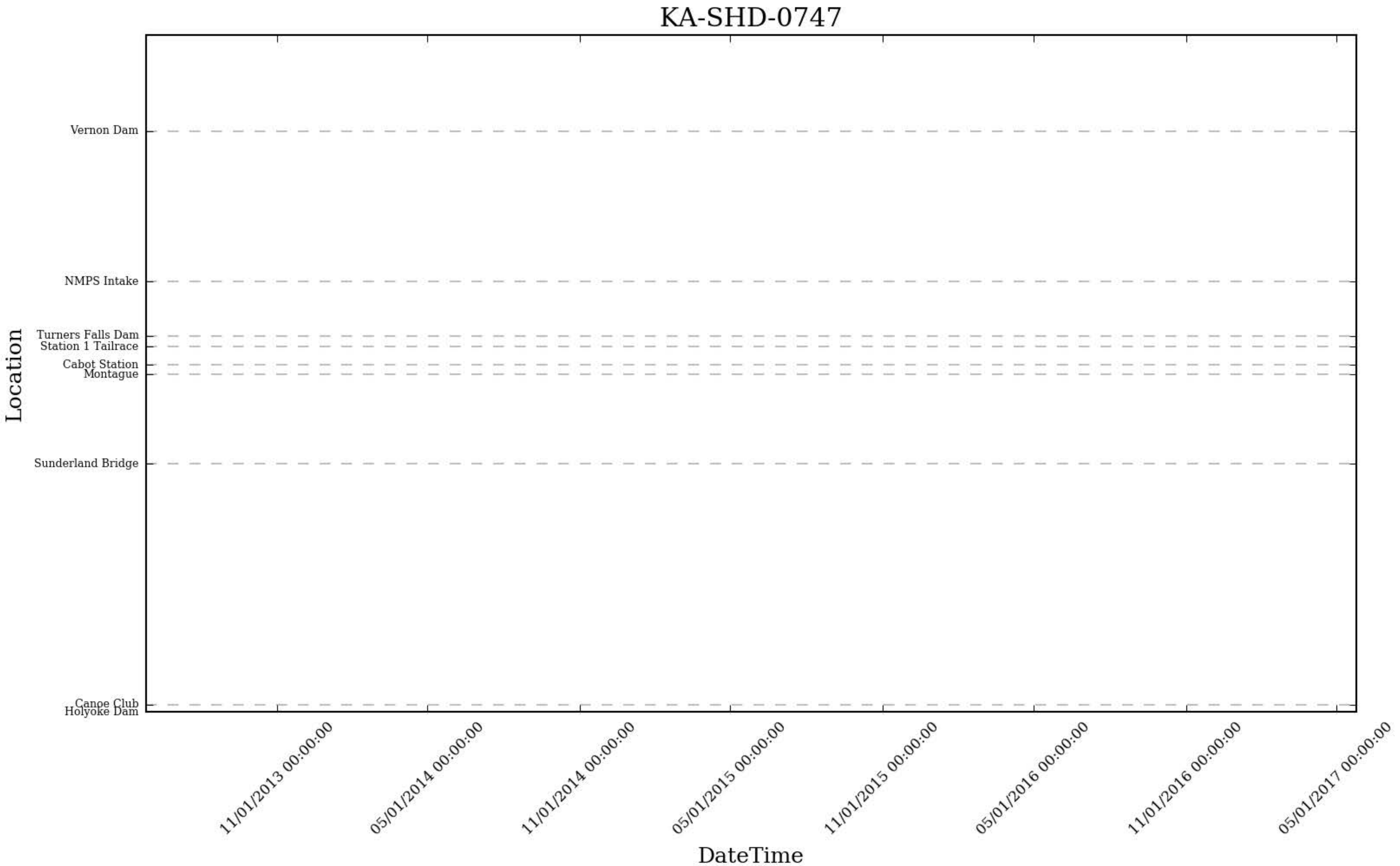
KA-SHD-0726
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/22/2015 17:30:13
06/22/2015 17:30:18
06/22/2015 17:30:23
06/22/2015 17:30:28
06/22/2015 17:30:33
06/22/2015 17:30:38
06/22/2015 17:30:43
06/22/2015 17:30:48
06/22/2015 17:30:53
DateTime

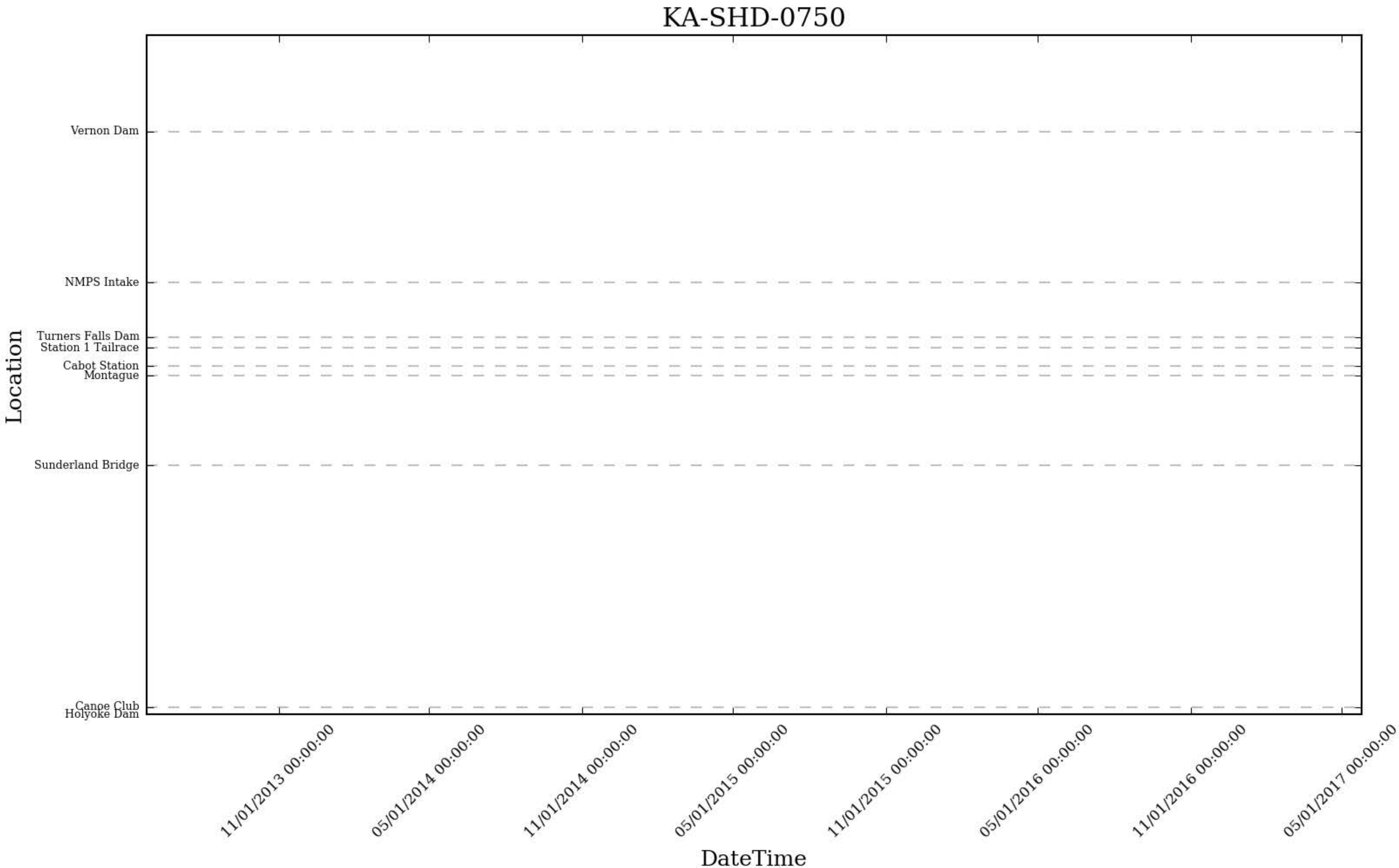

KA-SHD-0729
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 10:12:00
05/28/2015 10:17:00
05/28/2015 10:22:00
DateTime

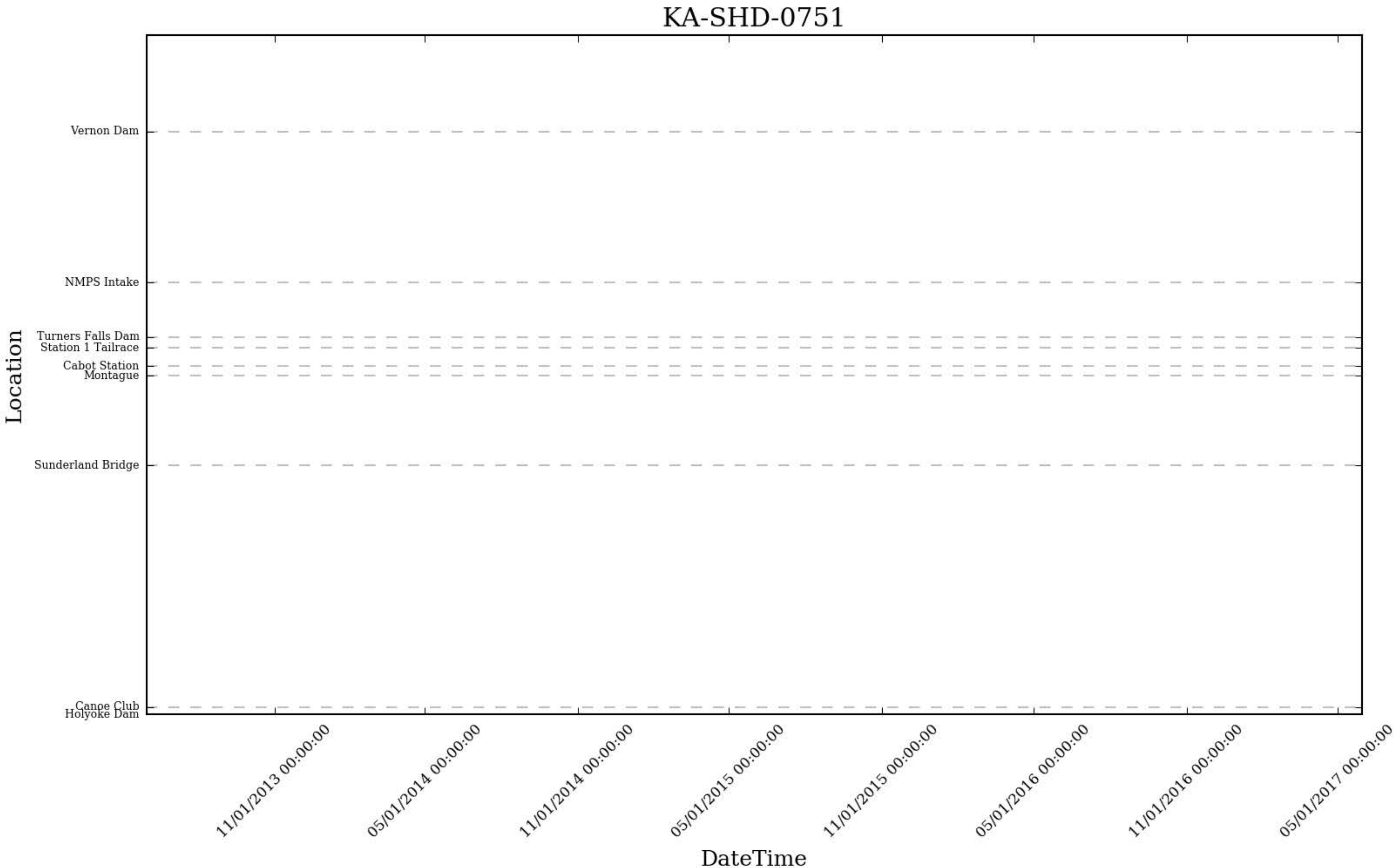

KA-SHD-0732
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

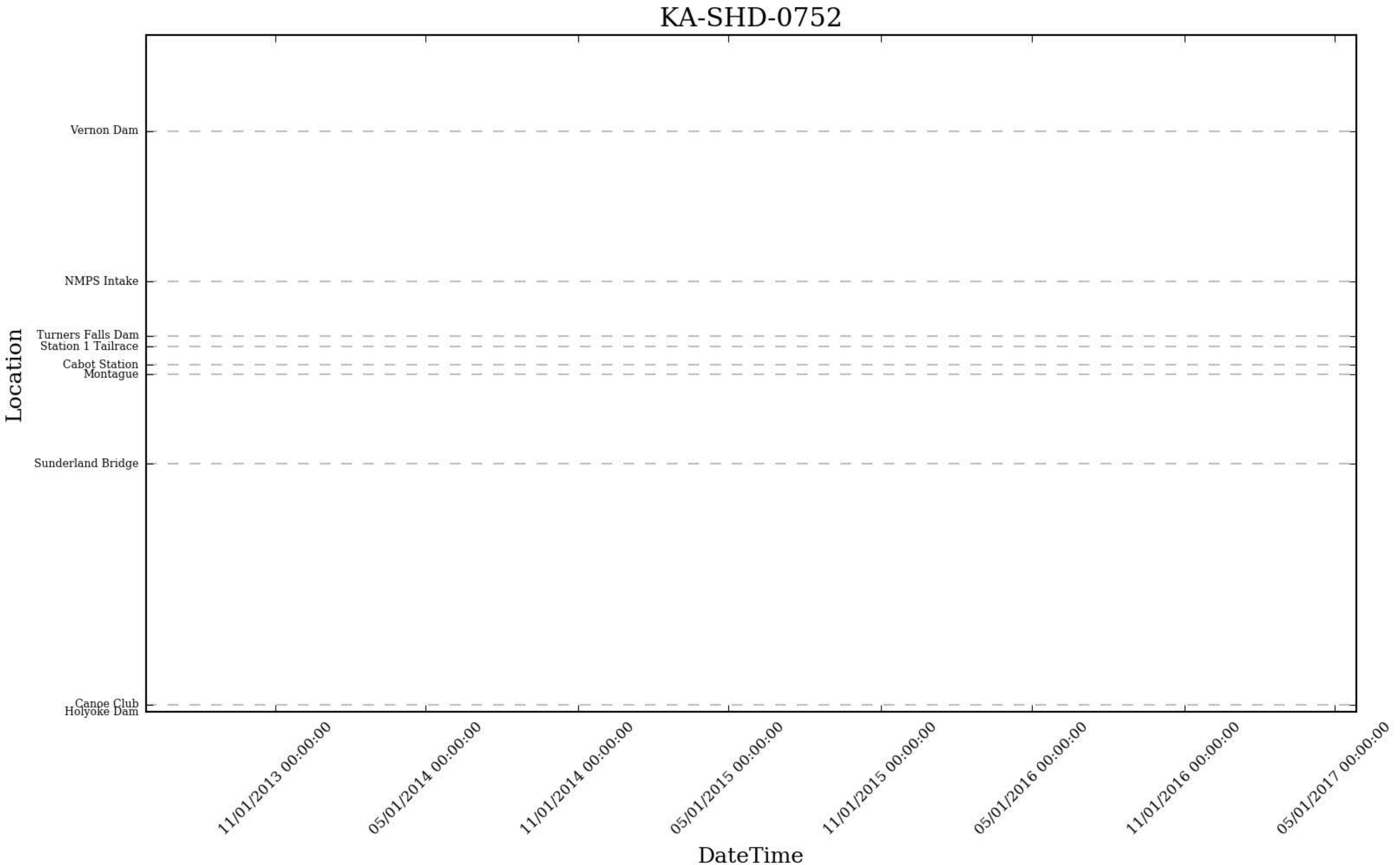

KA-SHD-0742
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

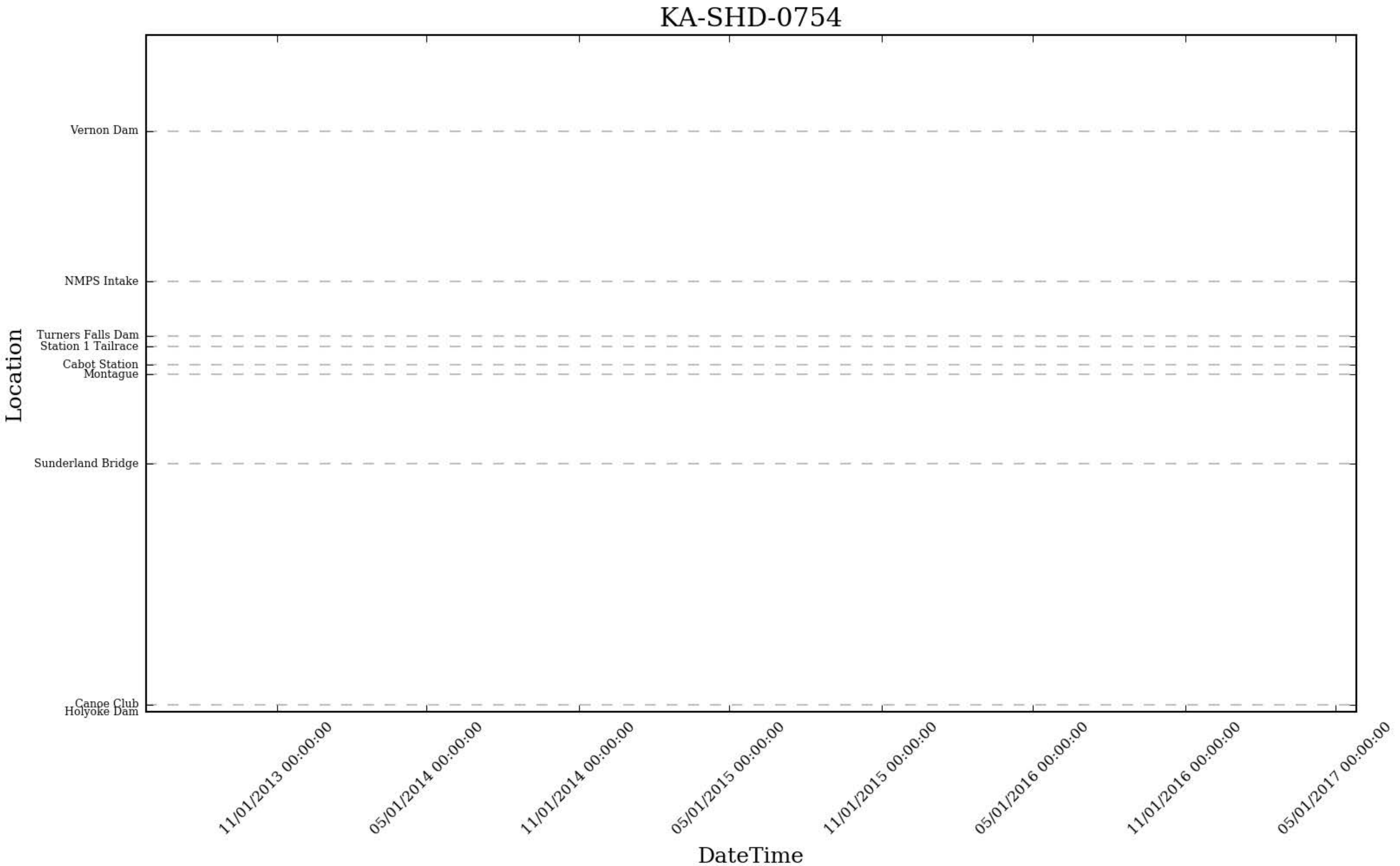

KA-SHD-0743
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

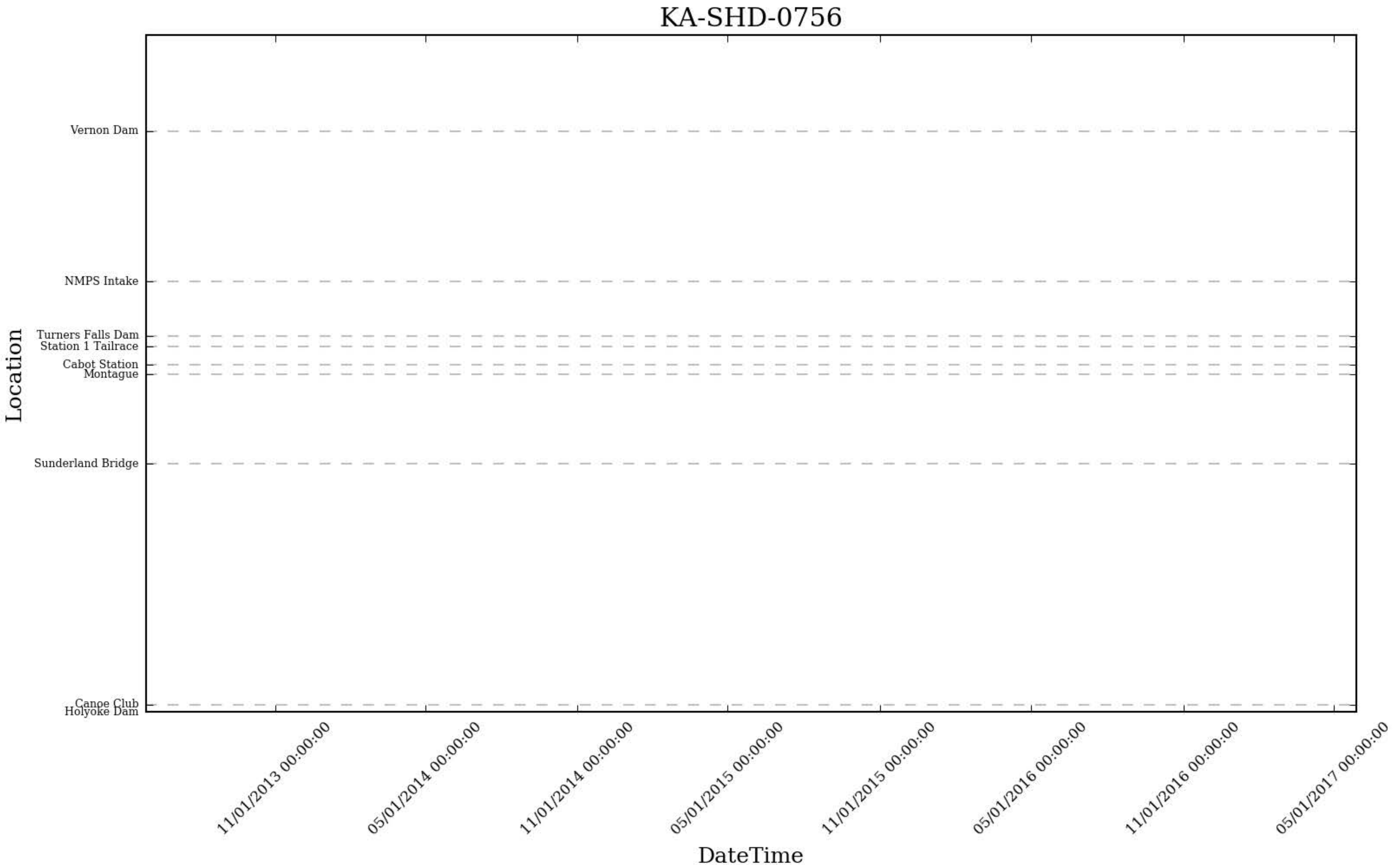

KA-SHD-0747
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

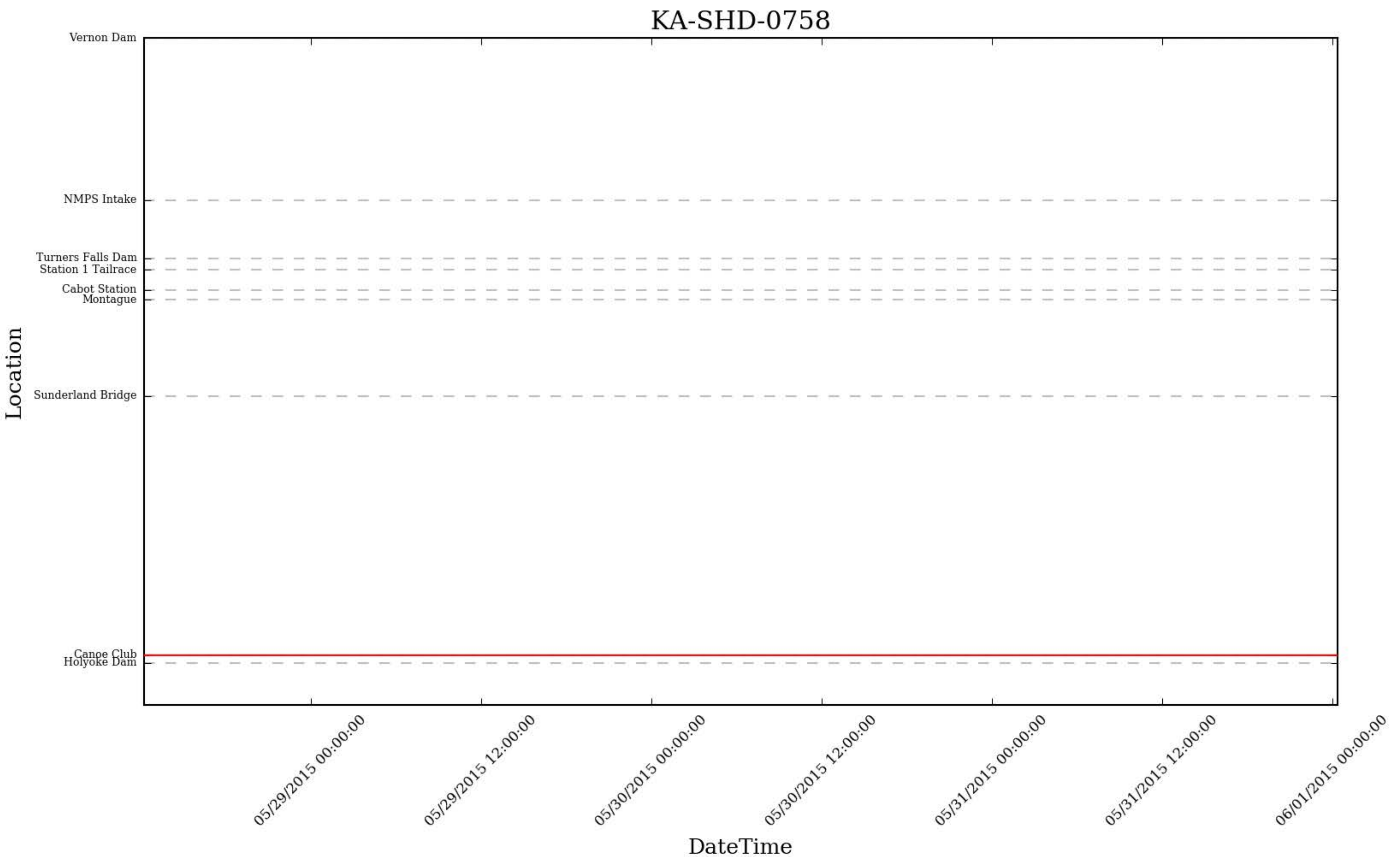

KA-SHD-0750
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0751
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

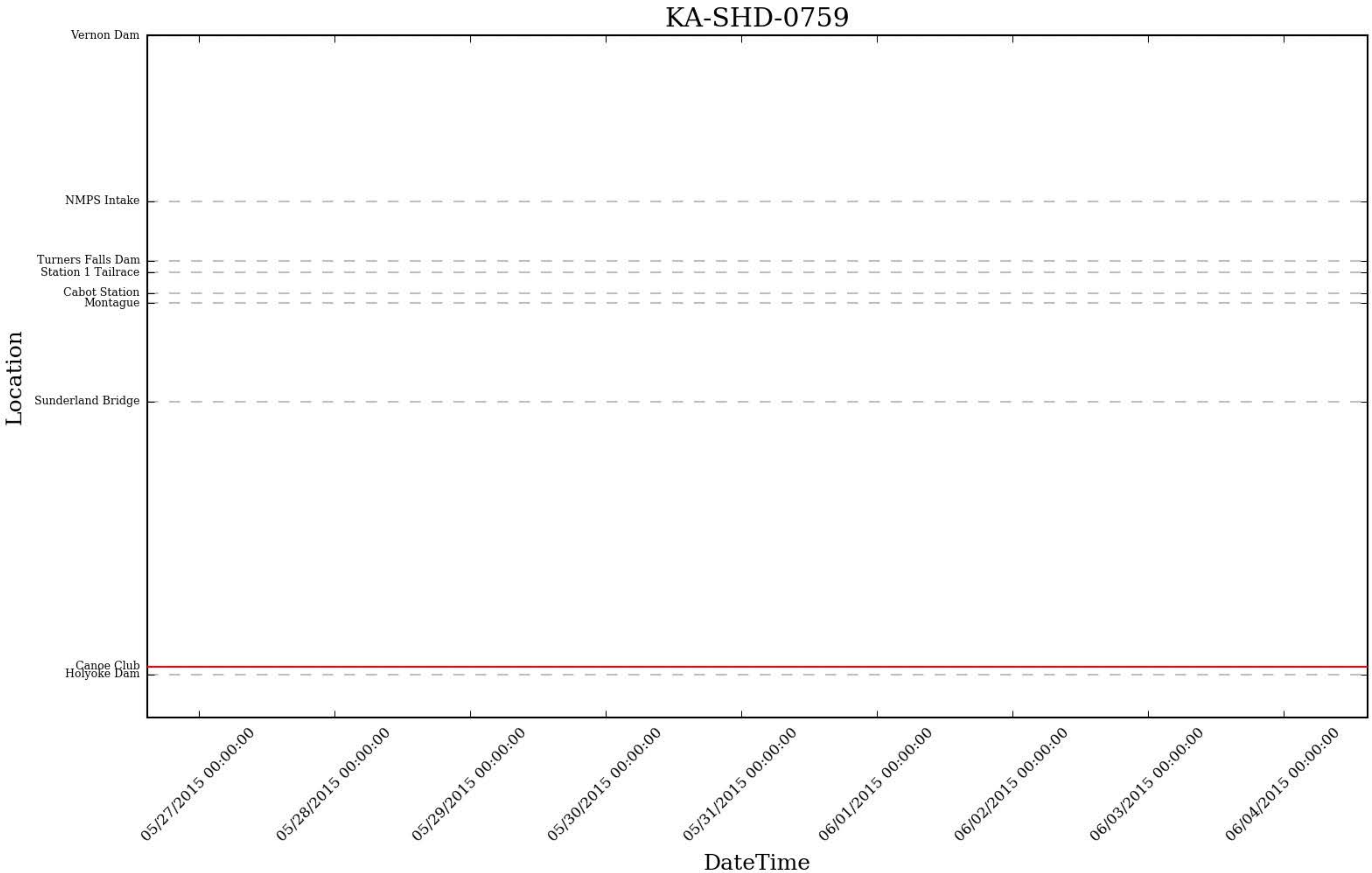

KA-SHD-0752
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

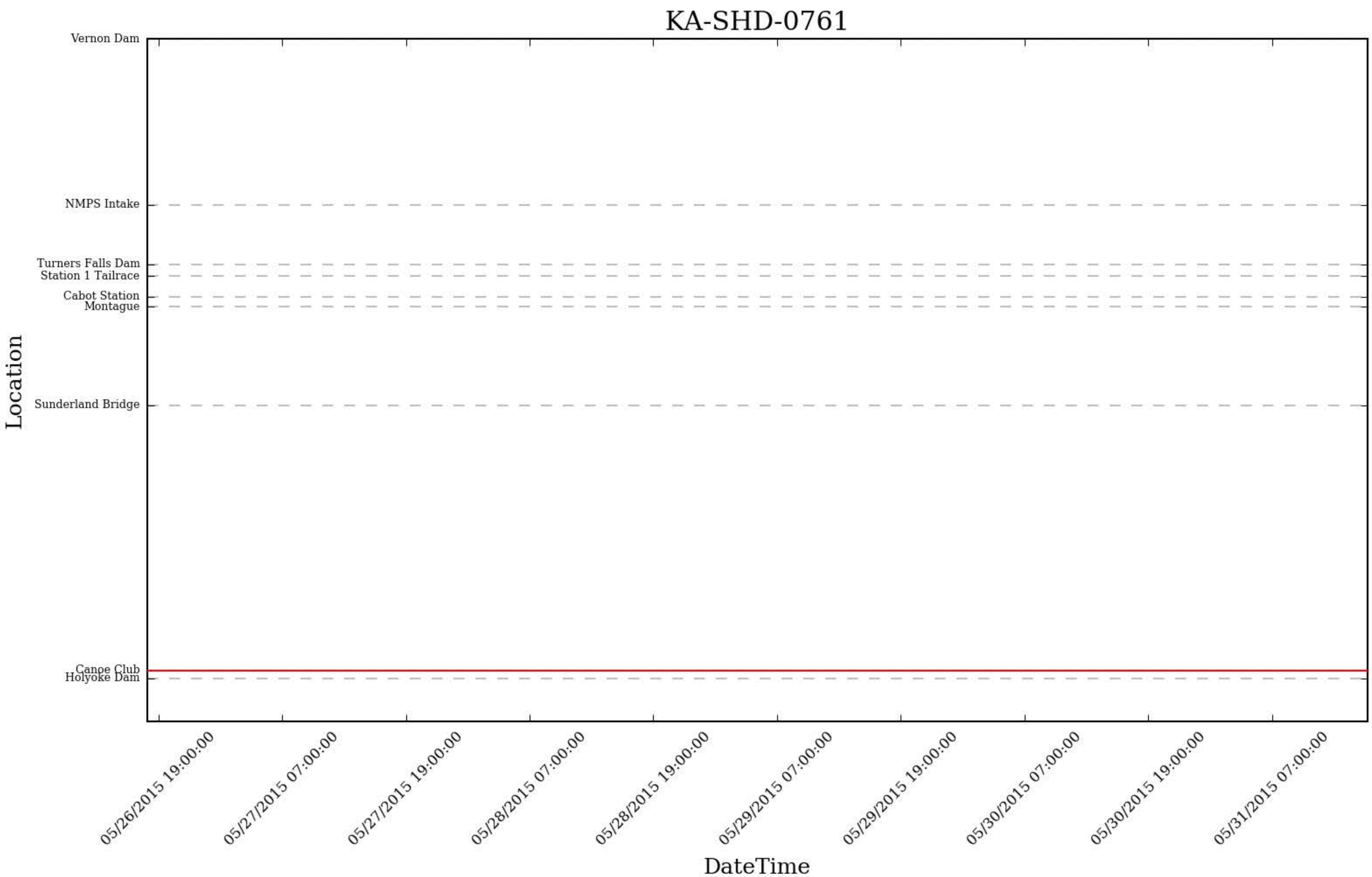

KA-SHD-0754
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime


KA-SHD-0756
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
11/01/2013 00:00:00
05/01/2014 00:00:00
11/01/2014 00:00:00
05/01/2015 00:00:00
11/01/2015 00:00:00
05/01/2016 00:00:00
11/01/2016 00:00:00
05/01/2017 00:00:00
DateTime

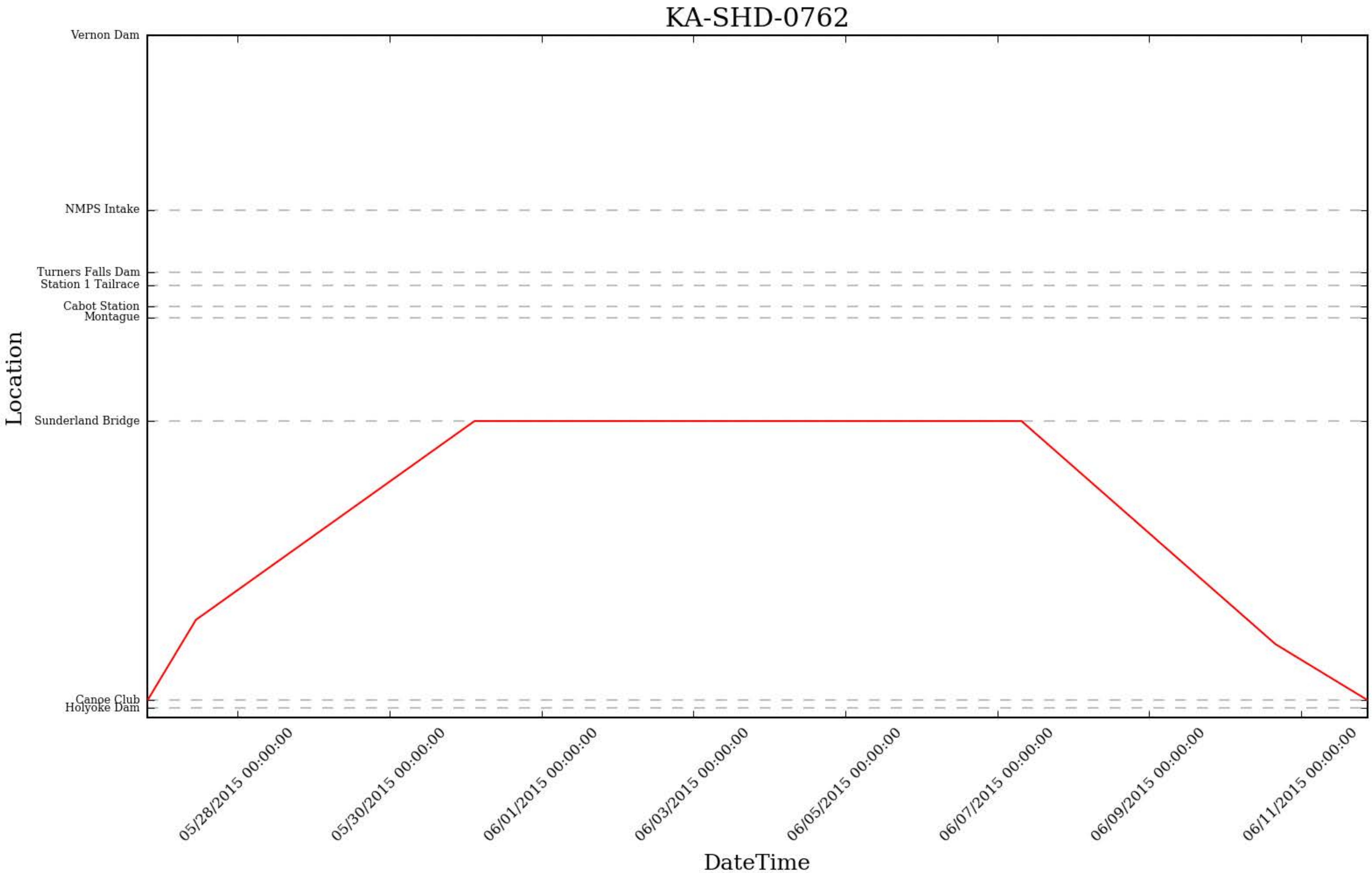


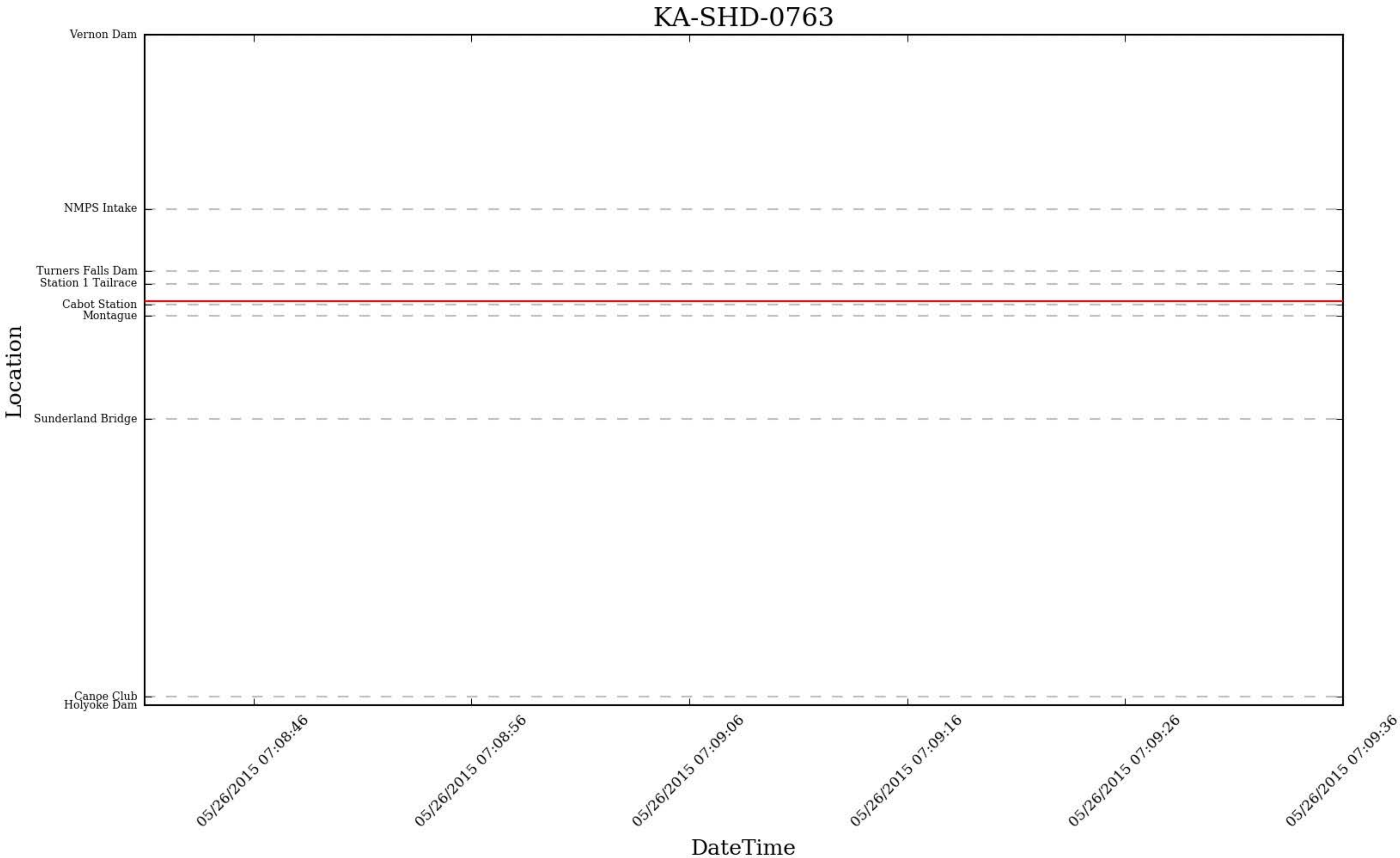
KA-SHD-0758
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
05/29/2015 12:00:00
05/30/2015 00:00:00
05/30/2015 12:00:00
05/31/2015 00:00:00
05/31/2015 12:00:00
06/01/2015 00:00:00
DateTime

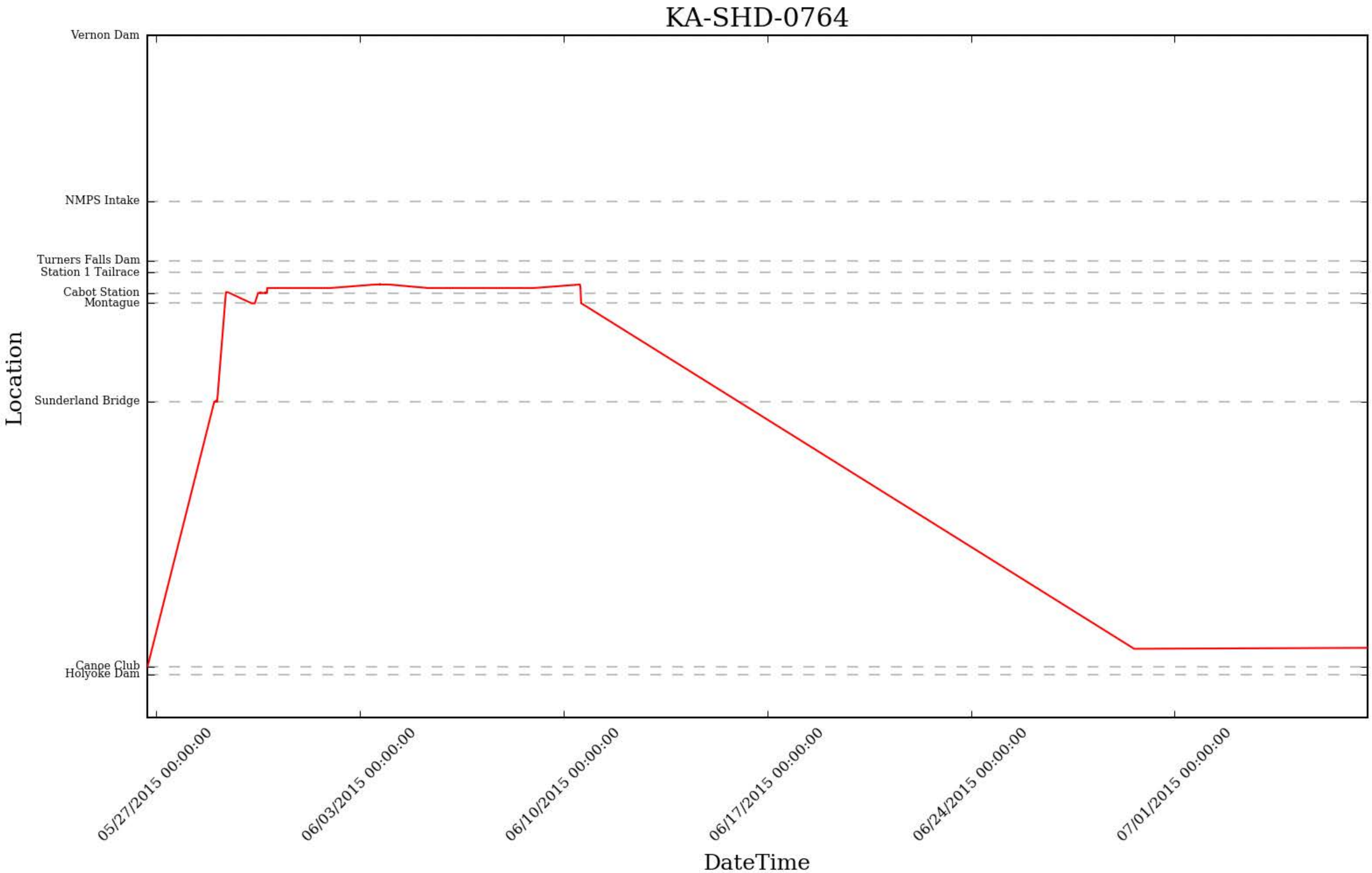

KA-SHD-0759
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
06/04/2015 00:00:00
DateTime

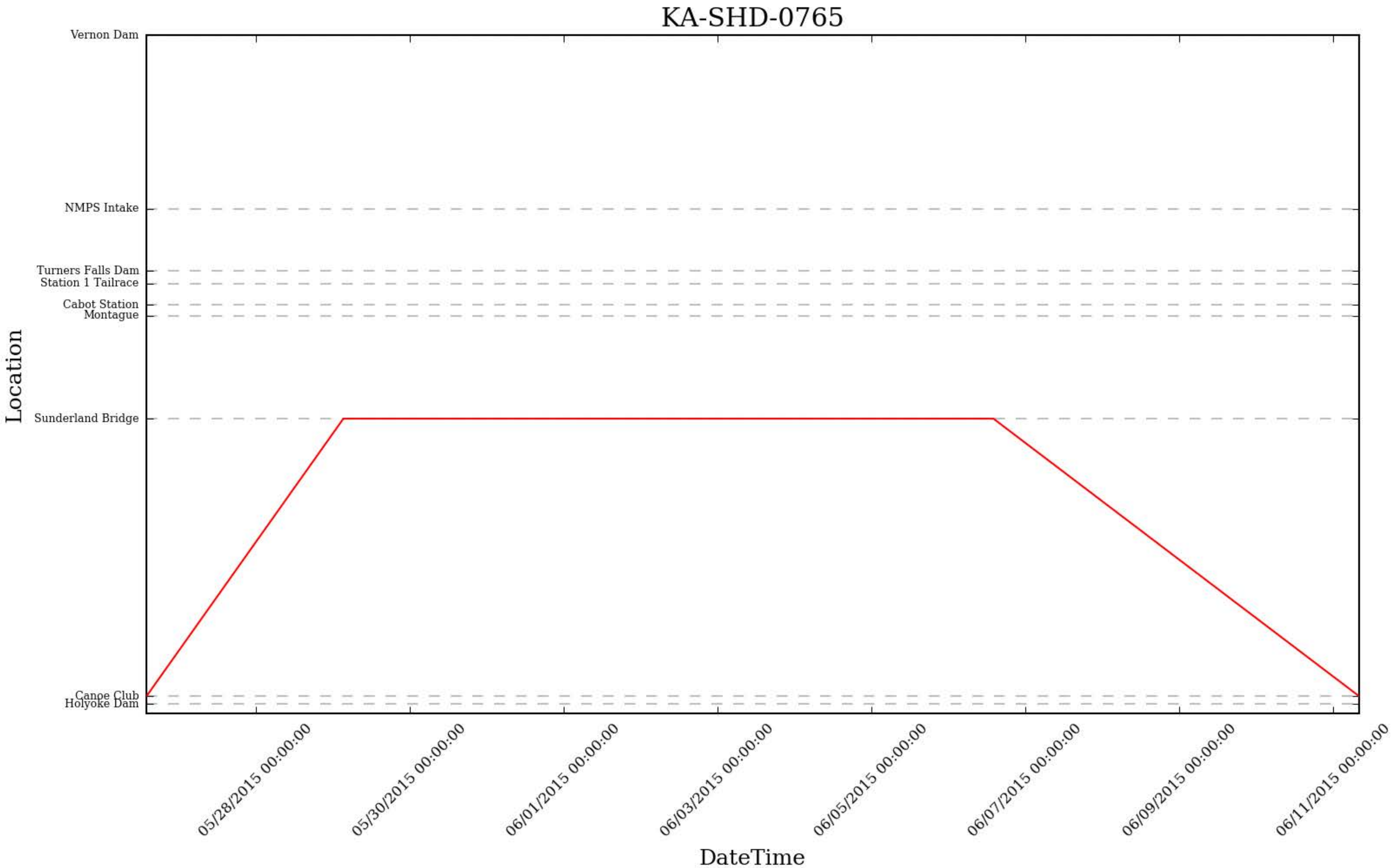


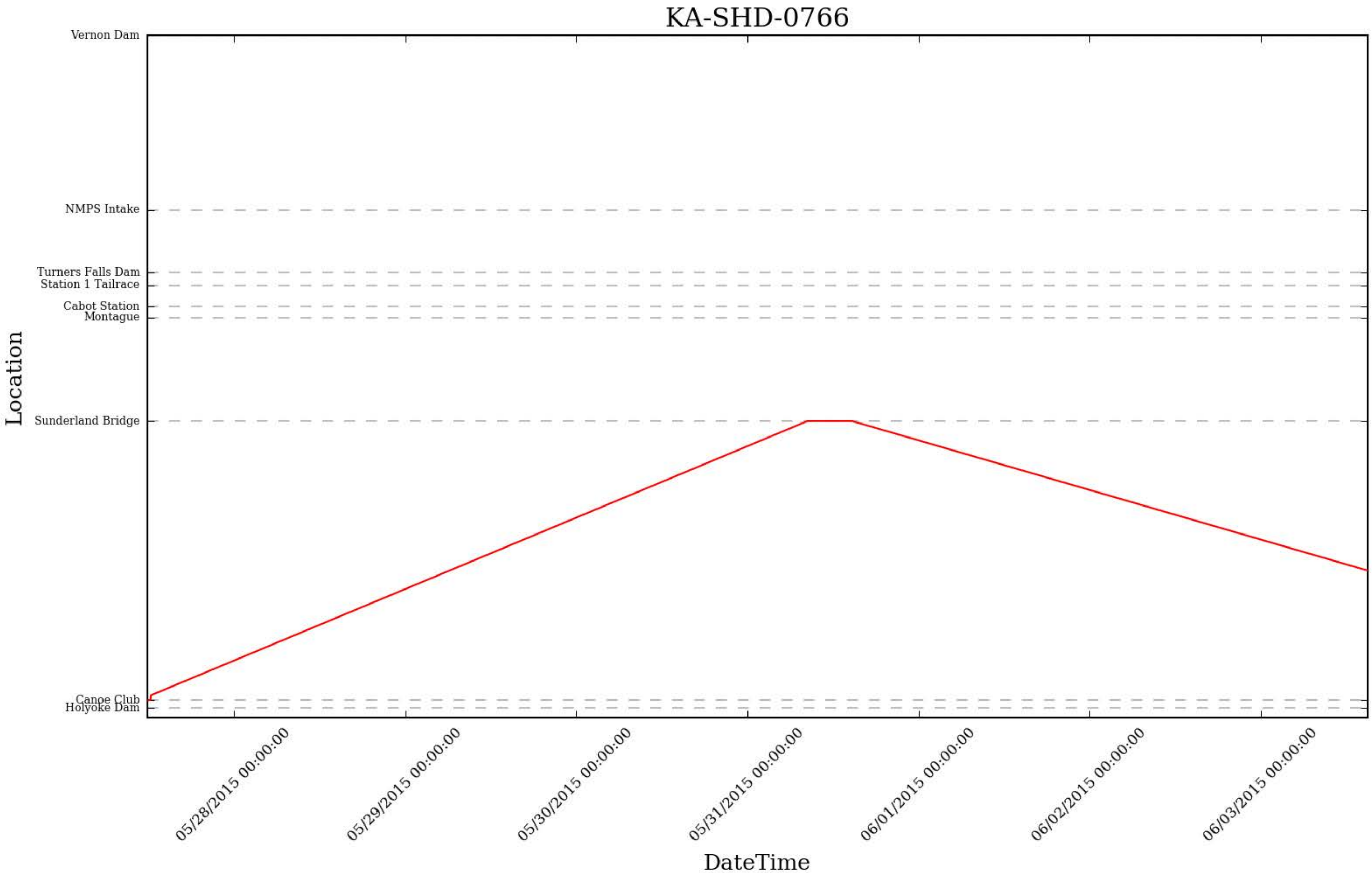
KA-SHD-0761
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 19:00:00
05/27/2015 07:00:00
05/27/2015 19:00:00
05/28/2015 07:00:00
05/28/2015 19:00:00
05/29/2015 07:00:00
05/29/2015 19:00:00
05/30/2015 07:00:00
05/30/2015 19:00:00
05/31/2015 07:00:00
DateTime


KA-SHD-0762
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
DateTime


KA-SHD-0763
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 07:08:46
05/26/2015 07:08:56
05/26/2015 07:09:06
05/26/2015 07:09:16
05/26/2015 07:09:26
05/26/2015 07:09:36
DateTime

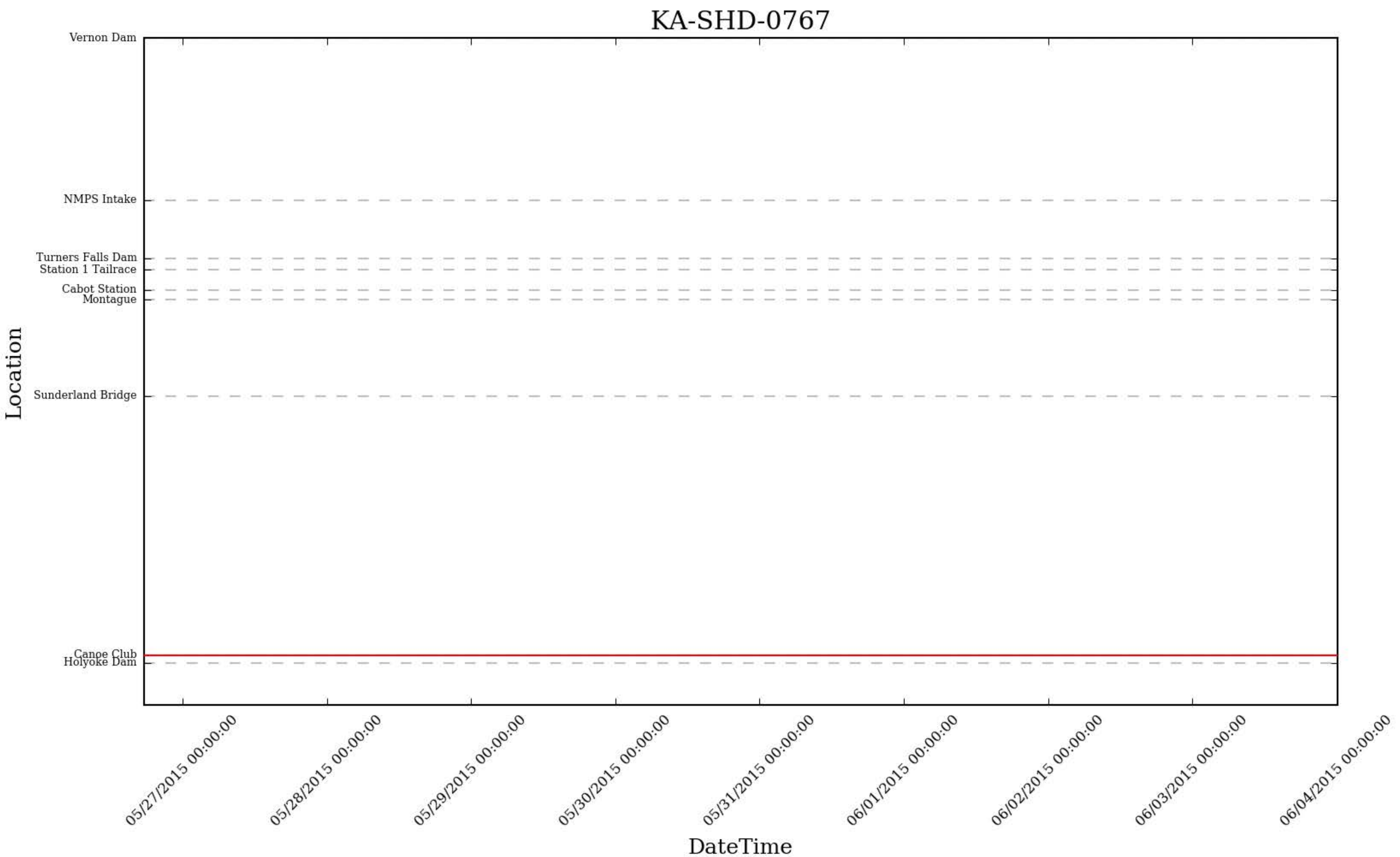

KA-SHD-0764
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime


KA-SHD-0765
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
DateTime

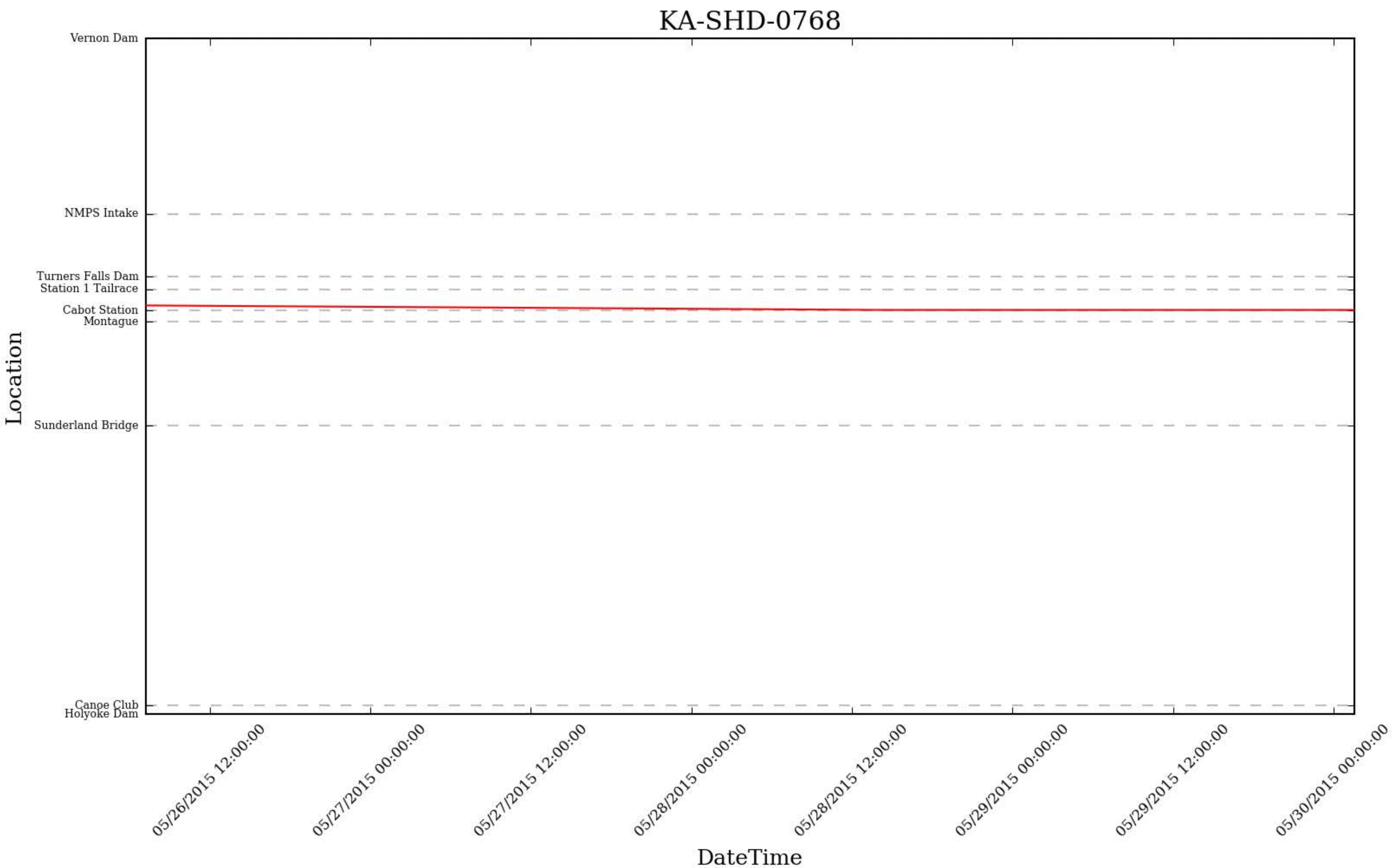


KA-SHD-0766
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
DateTime

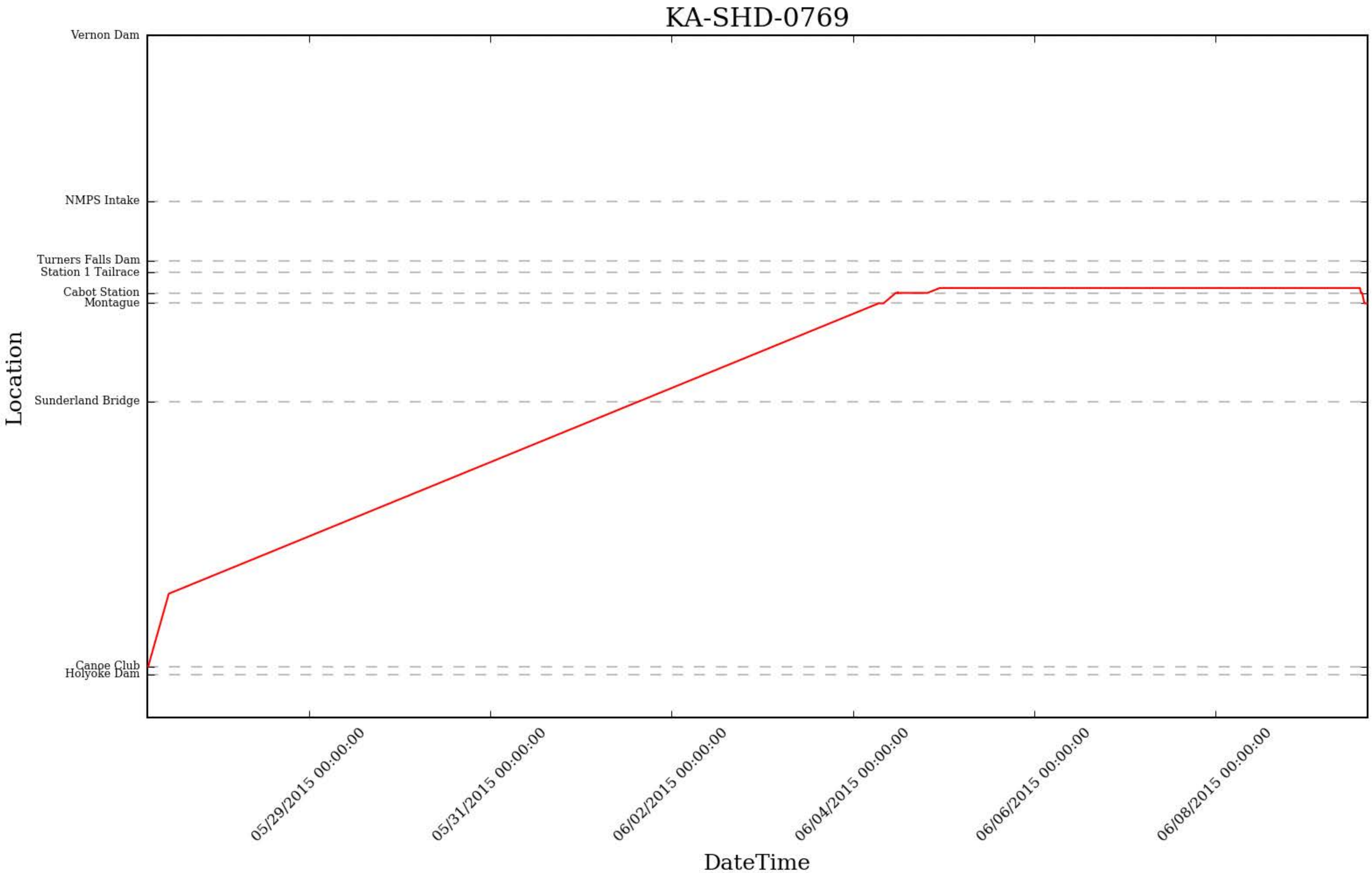
KA-SHD-0767

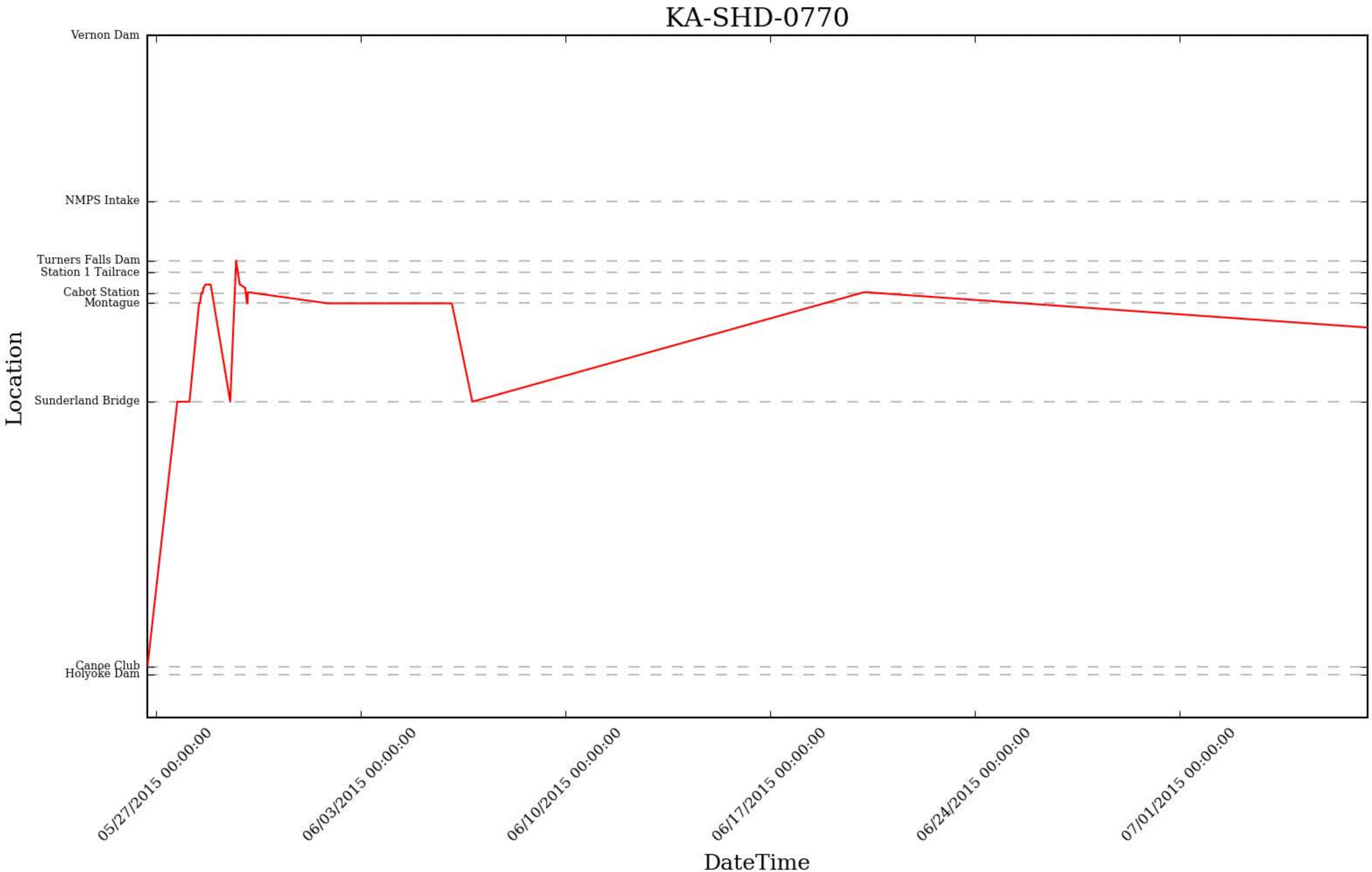


KA-SHD-0767
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
06/04/2015 00:00:00
DateTime

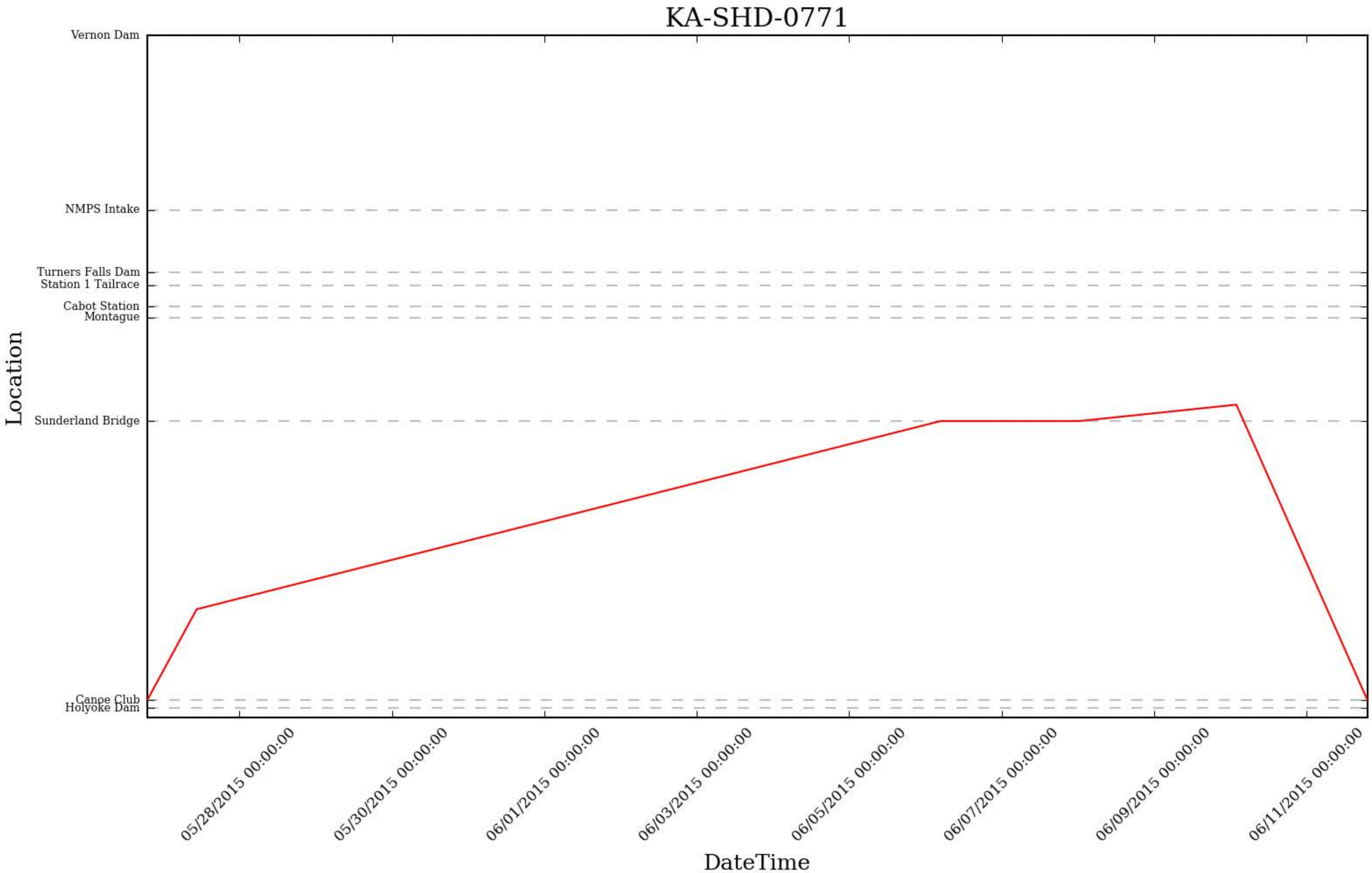


KA-SHD-0768
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/26/2015 12:00:00
05/27/2015 00:00:00
05/27/2015 12:00:00
05/28/2015 00:00:00
05/28/2015 12:00:00
05/29/2015 00:00:00
05/29/2015 12:00:00
05/30/2015 00:00:00
DateTime

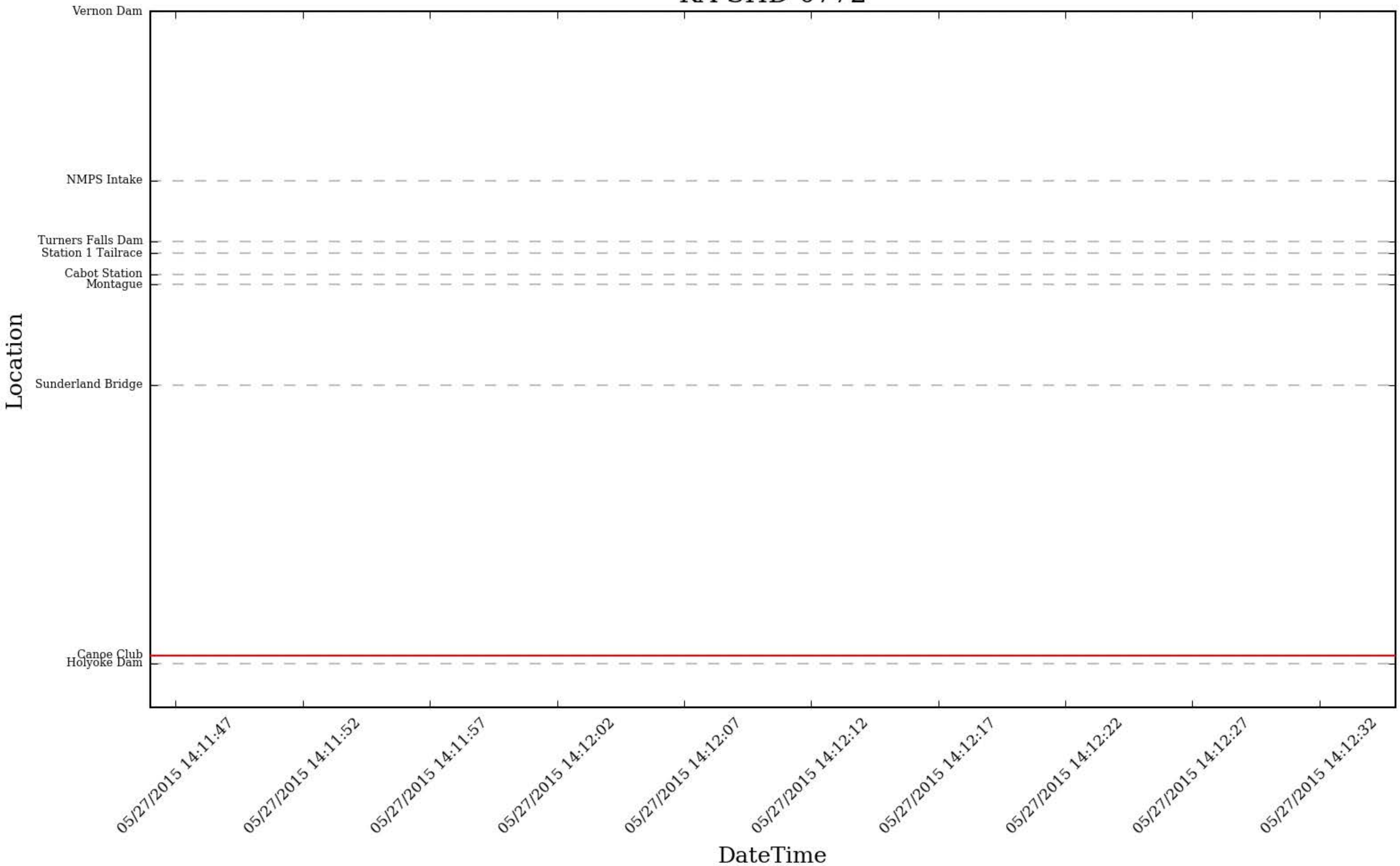

KA-SHD-0769
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
05/31/2015 00:00:00
06/02/2015 00:00:00
06/04/2015 00:00:00
06/06/2015 00:00:00
06/08/2015 00:00:00
DateTime



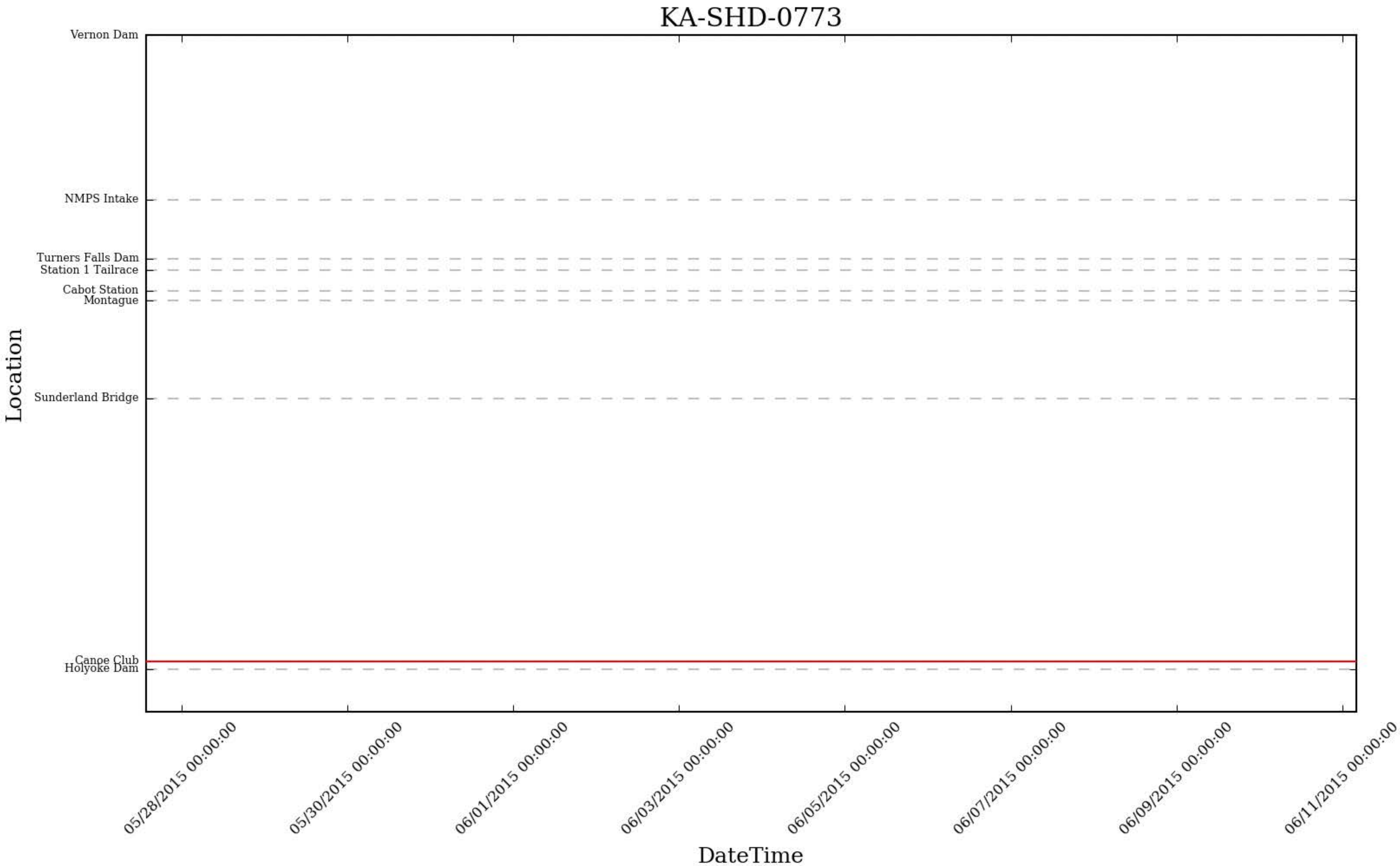
KA-SHD-0770
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

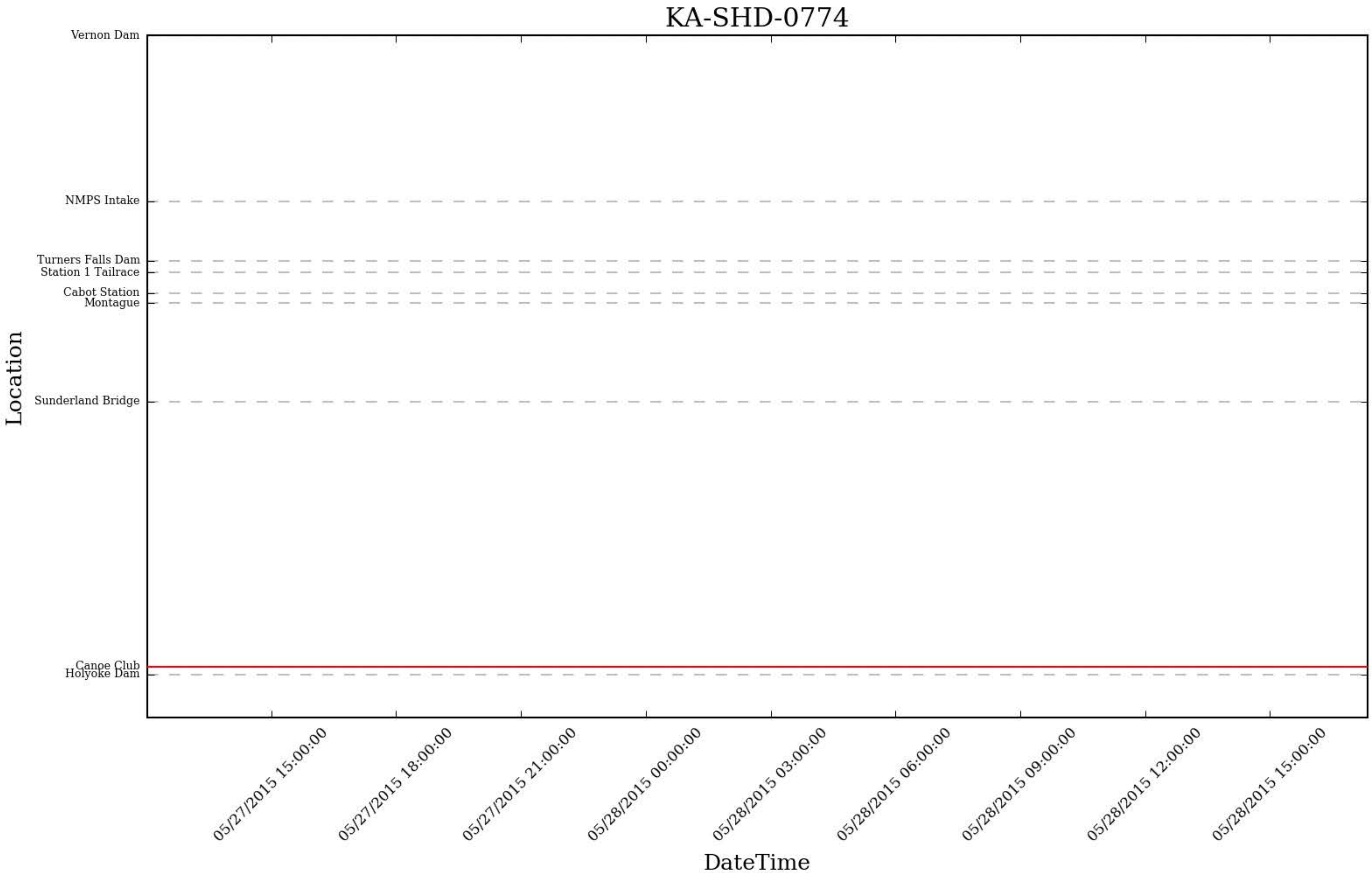

KA-SHD-0771
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
DateTime

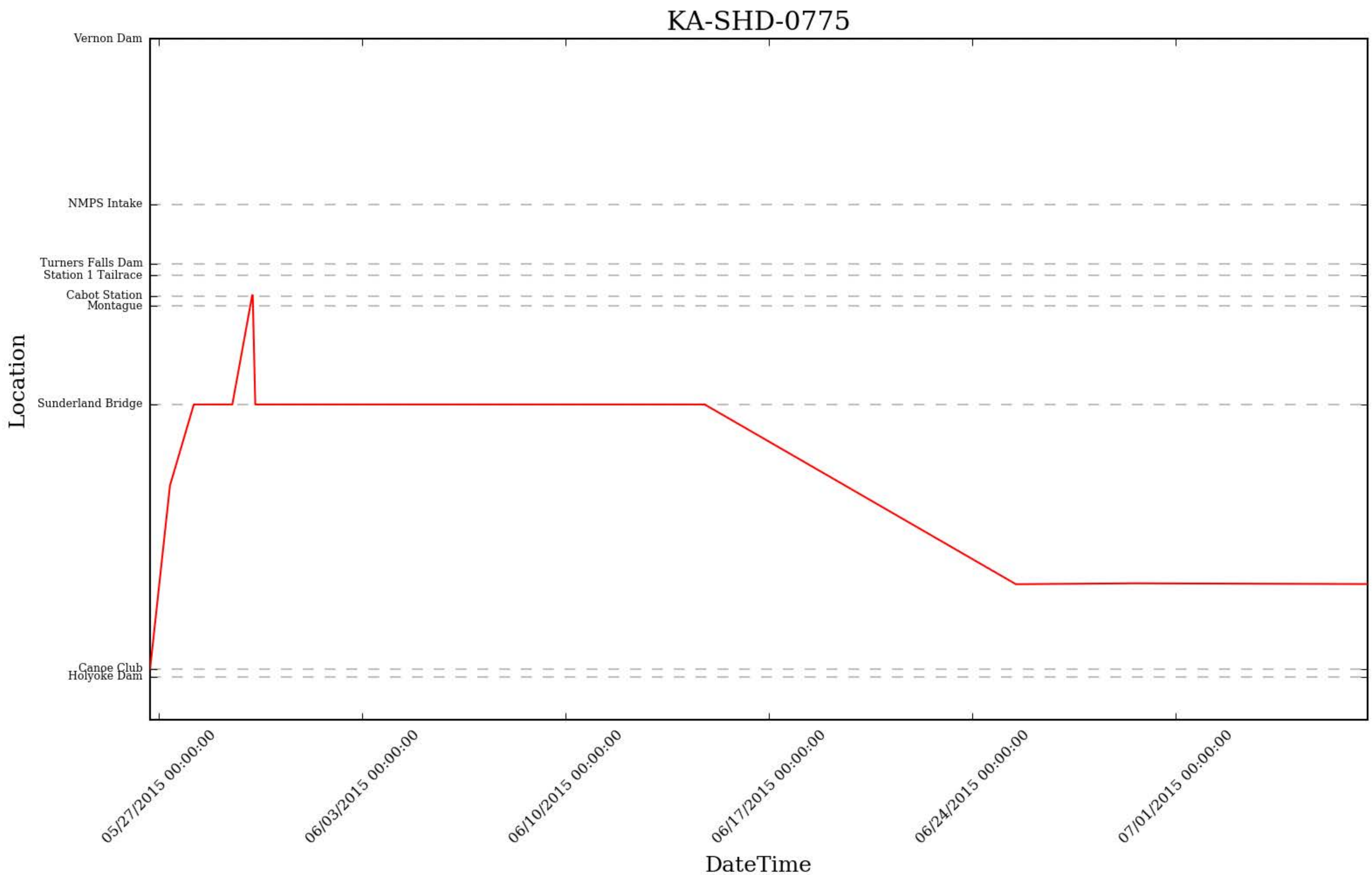
KA-SHD-0772

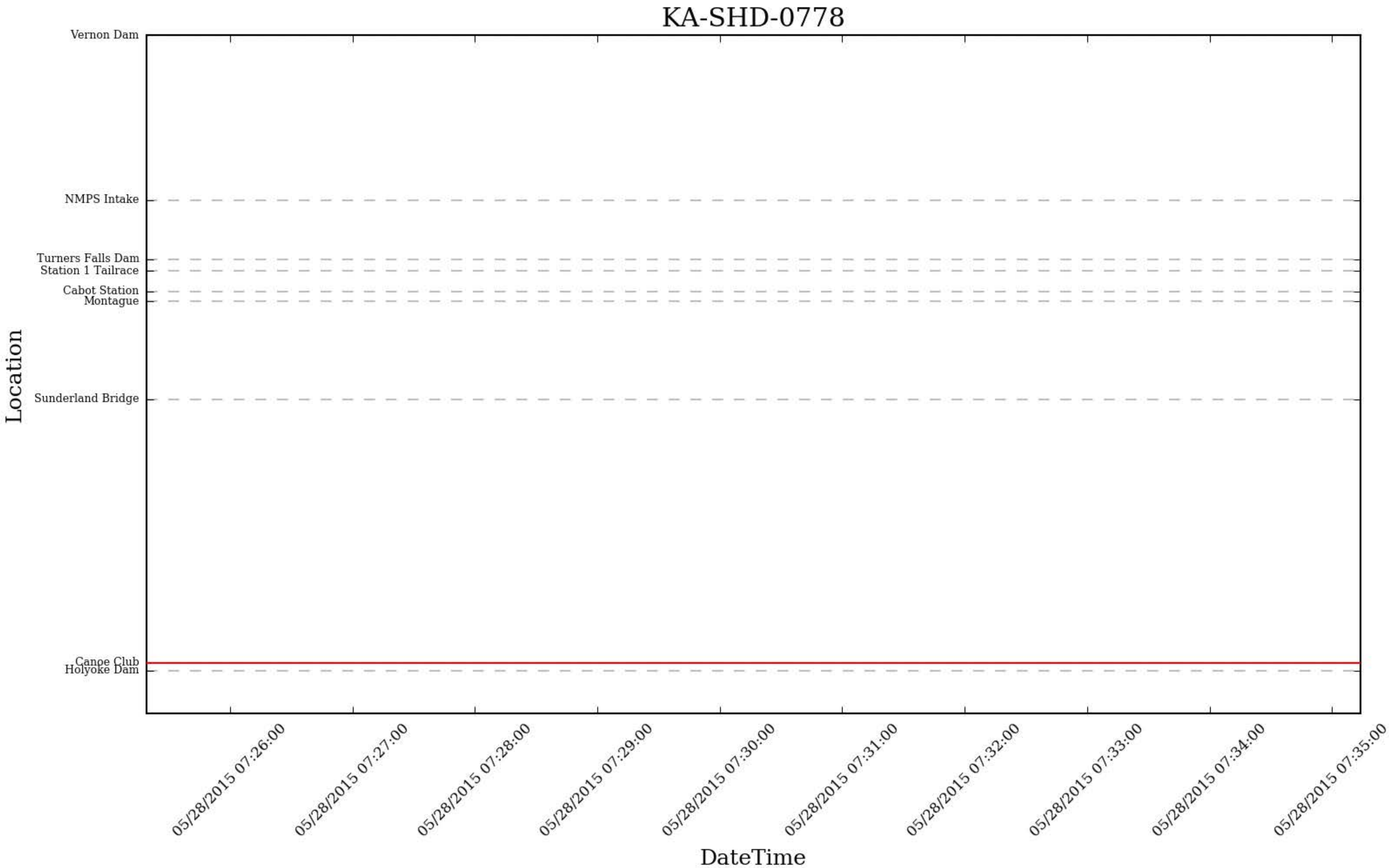


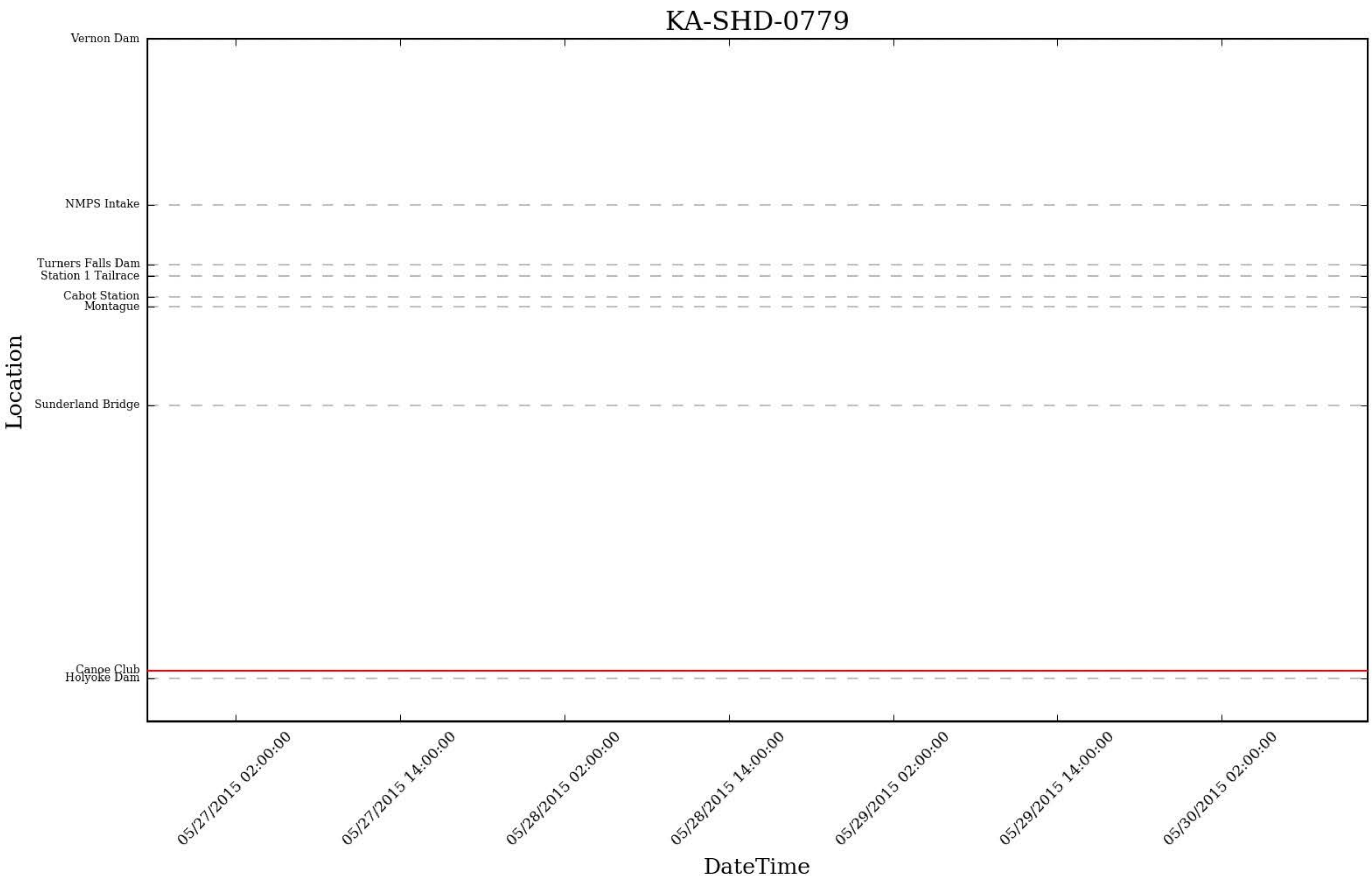
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 14:11:47
05/27/2015 14:11:52
05/27/2015 14:11:57
05/27/2015 14:12:02
05/27/2015 14:12:07
05/27/2015 14:12:12
05/27/2015 14:12:17
05/27/2015 14:12:22
05/27/2015 14:12:27
05/27/2015 14:12:32
DateTime


KA-SHD-0773
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/28/2015 00:00:00
05/30/2015 00:00:00
06/01/2015 00:00:00
06/03/2015 00:00:00
06/05/2015 00:00:00
06/07/2015 00:00:00
06/09/2015 00:00:00
06/11/2015 00:00:00
DateTime

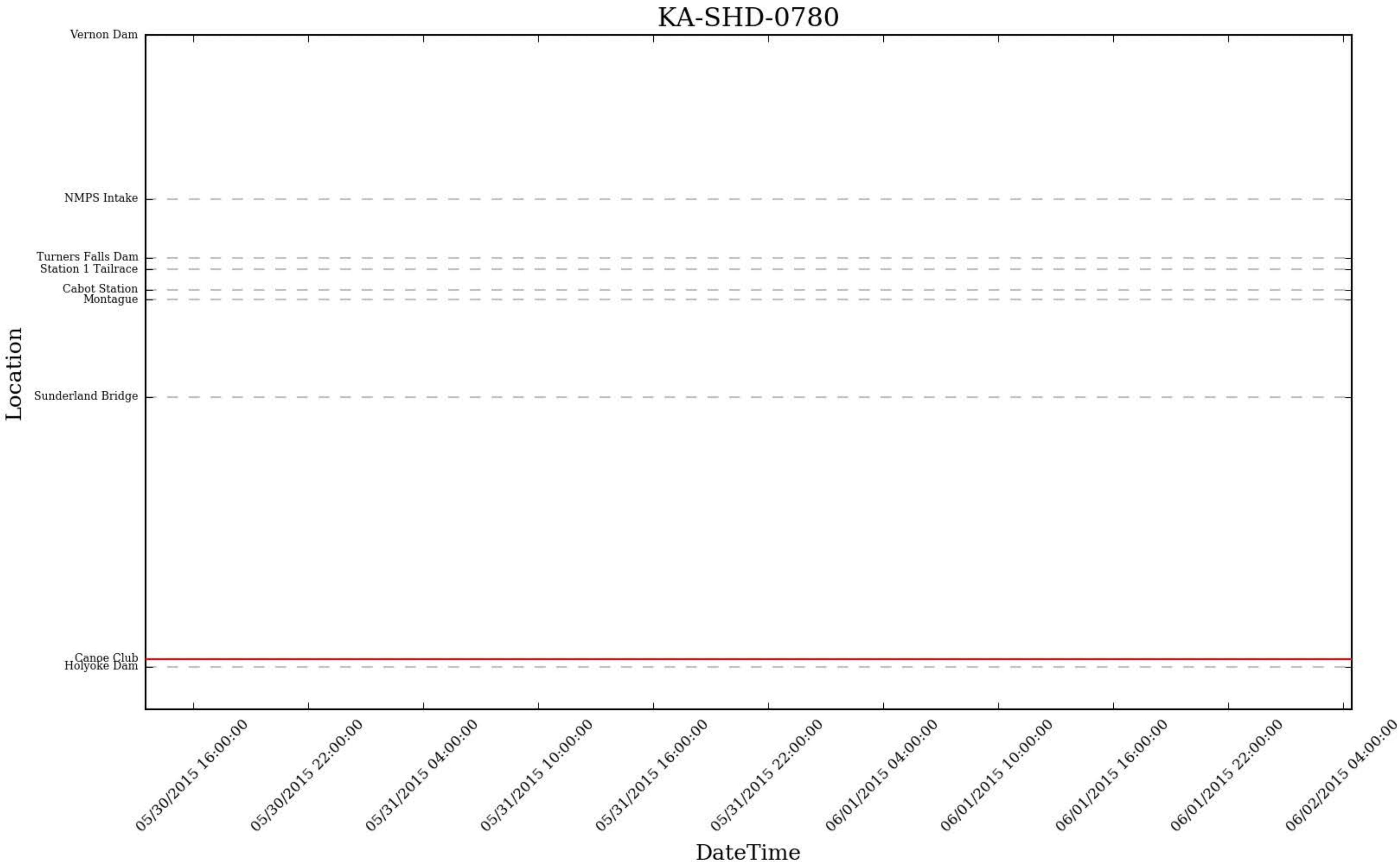

KA-SHD-0774
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 15:00:00
05/27/2015 18:00:00
05/27/2015 21:00:00
05/28/2015 00:00:00
05/28/2015 03:00:00
05/28/2015 06:00:00
05/28/2015 09:00:00
05/28/2015 12:00:00
05/28/2015 15:00:00
DateTime

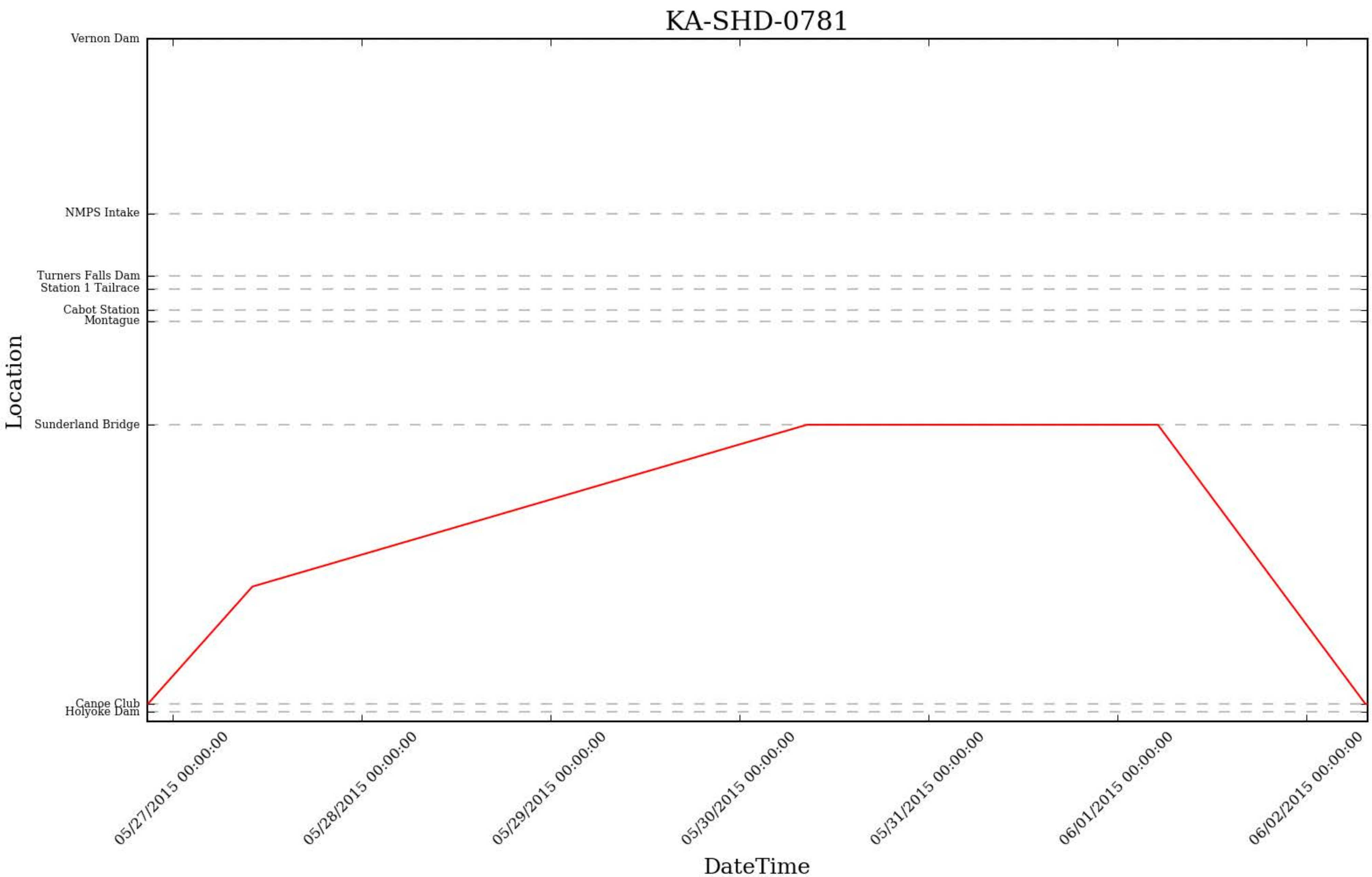

KA-SHD-0775
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
06/03/2015 00:00:00
06/10/2015 00:00:00
06/17/2015 00:00:00
06/24/2015 00:00:00
07/01/2015 00:00:00
DateTime

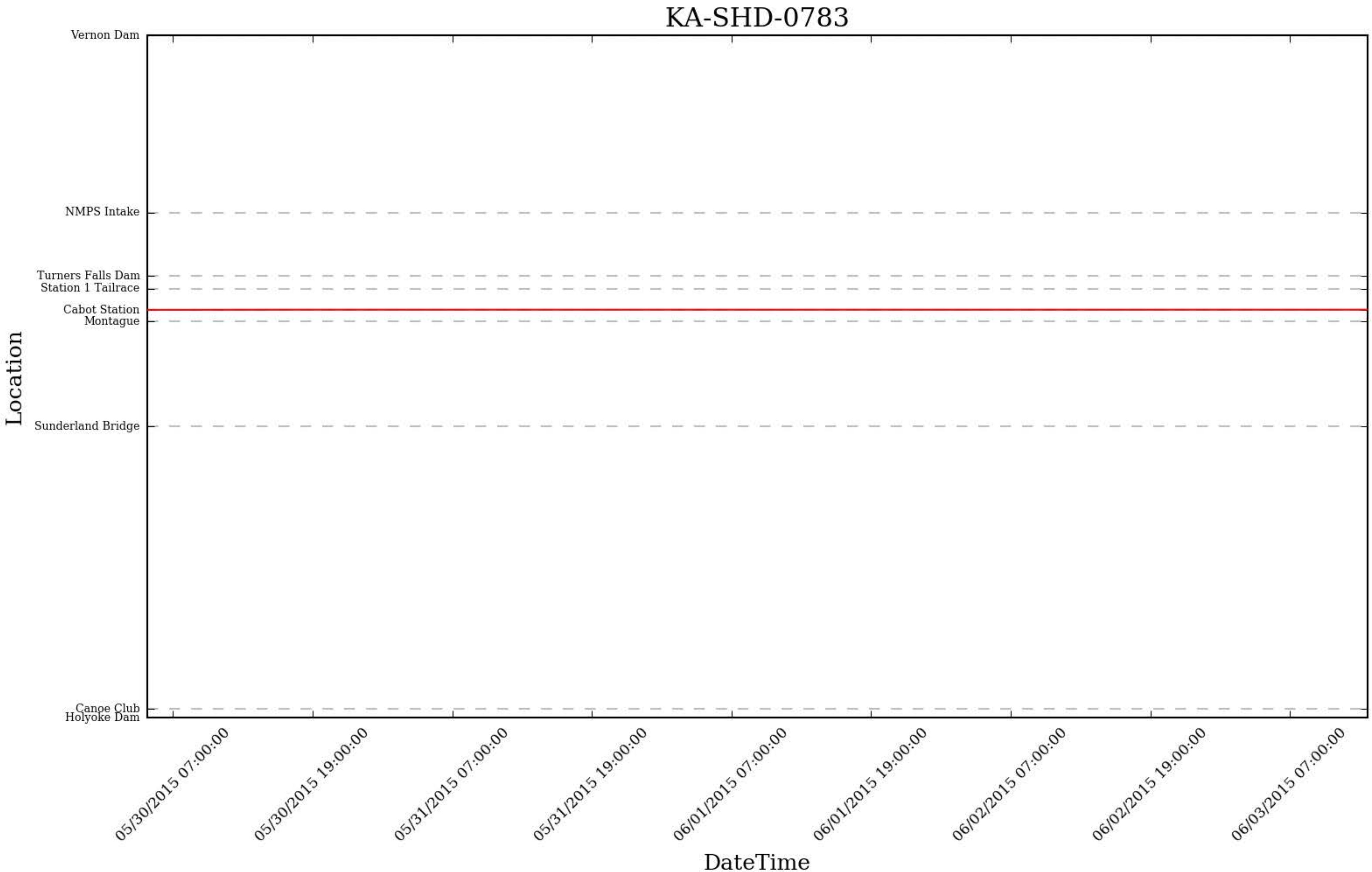

KA-SHD-0778
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/28/2015 07:26:00
05/28/2015 07:27:00
05/28/2015 07:28:00
05/28/2015 07:29:00
05/28/2015 07:30:00
05/28/2015 07:31:00
05/28/2015 07:32:00
05/28/2015 07:33:00
05/28/2015 07:34:00
05/28/2015 07:35:00
DateTime

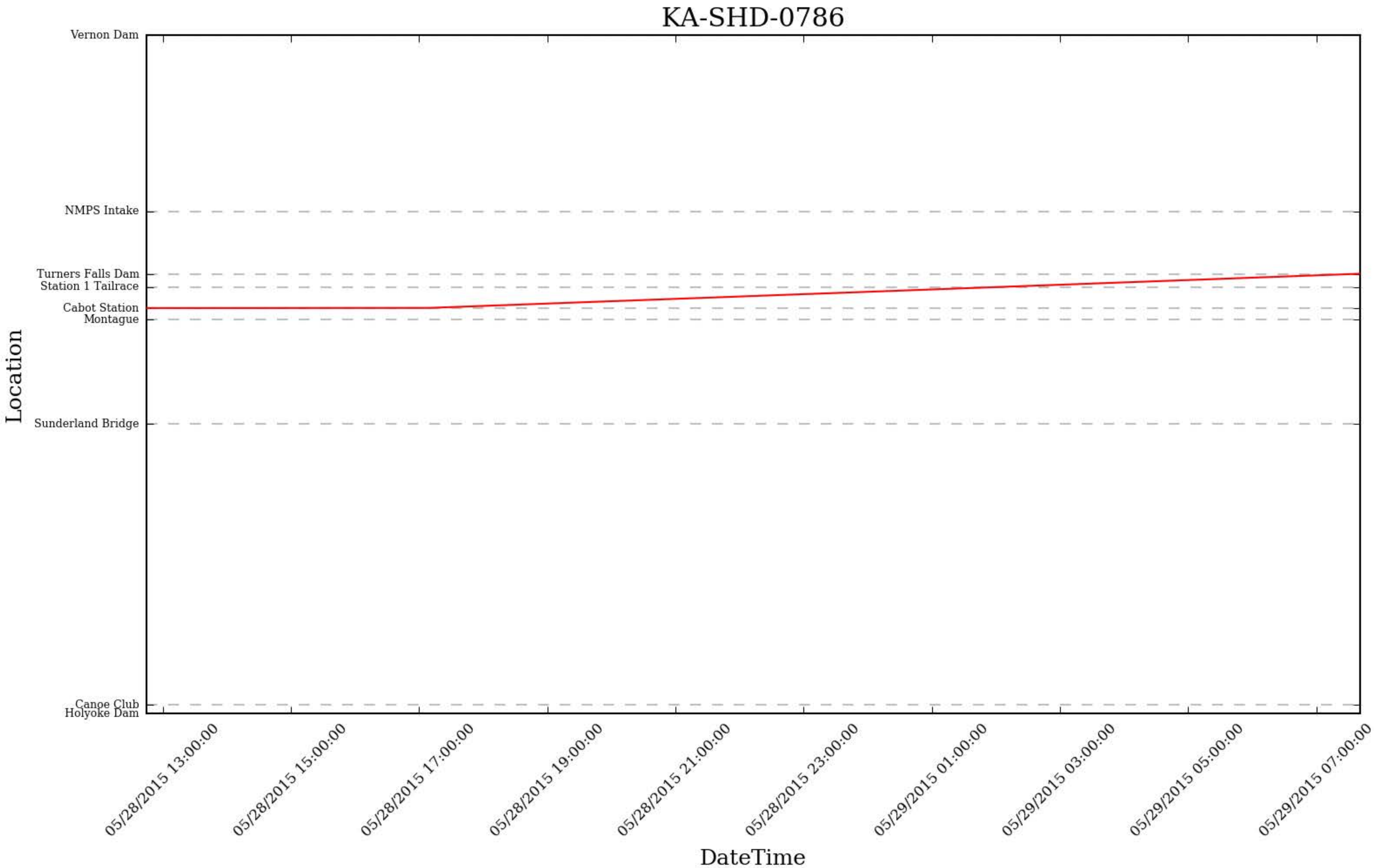


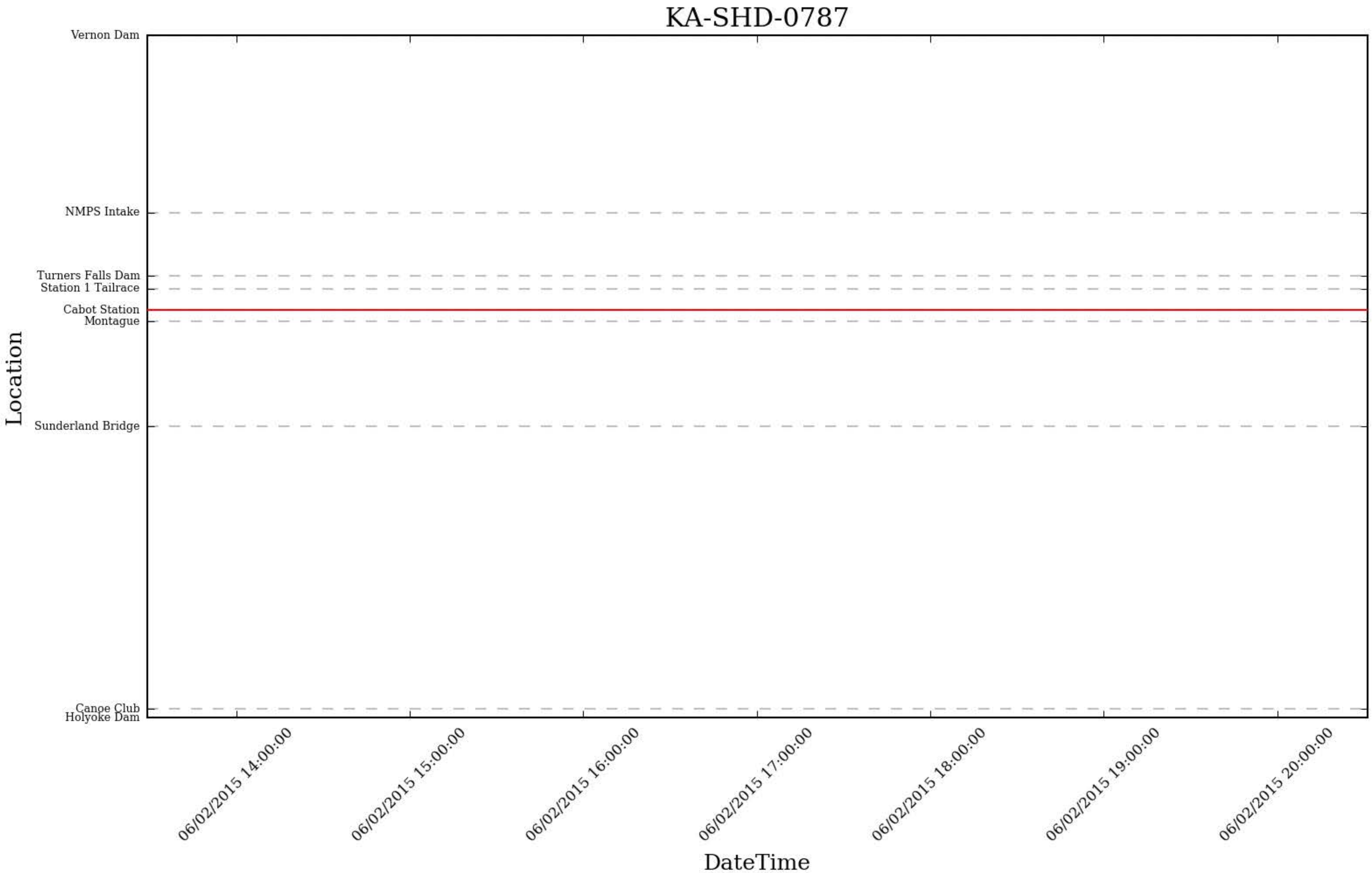
KA-SHD-0779
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 02:00:00
05/27/2015 14:00:00
05/28/2015 02:00:00
05/28/2015 14:00:00
05/29/2015 02:00:00
05/29/2015 14:00:00
05/30/2015 02:00:00
DateTime


KA-SHD-0780
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 16:00:00
05/30/2015 22:00:00
05/31/2015 04:00:00
05/31/2015 10:00:00
05/31/2015 16:00:00
05/31/2015 22:00:00
06/01/2015 04:00:00
06/01/2015 10:00:00
06/01/2015 16:00:00
06/01/2015 22:00:00
06/02/2015 04:00:00
DateTime

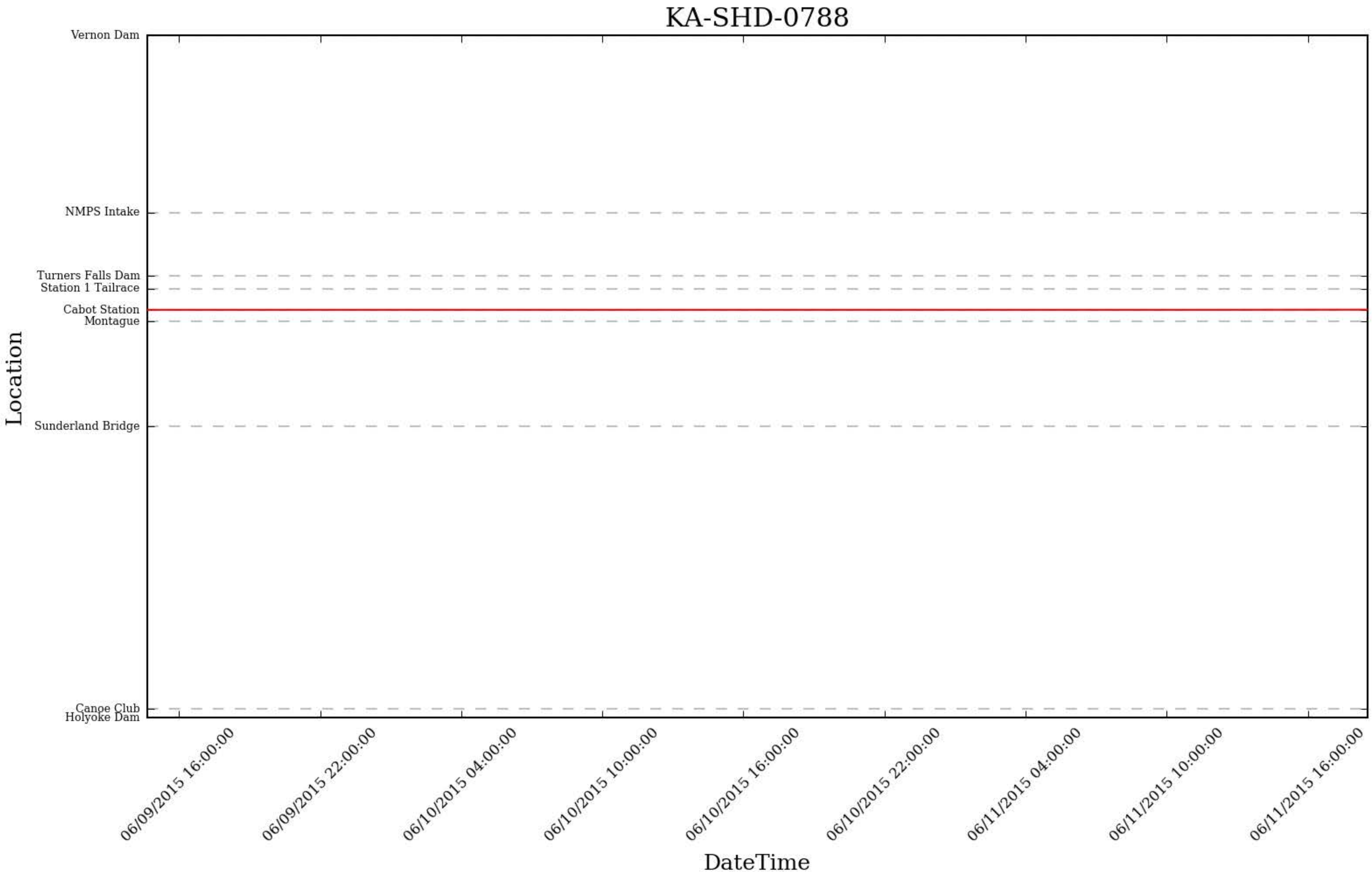

KA-SHD-0781
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/27/2015 00:00:00
05/28/2015 00:00:00
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
DateTime

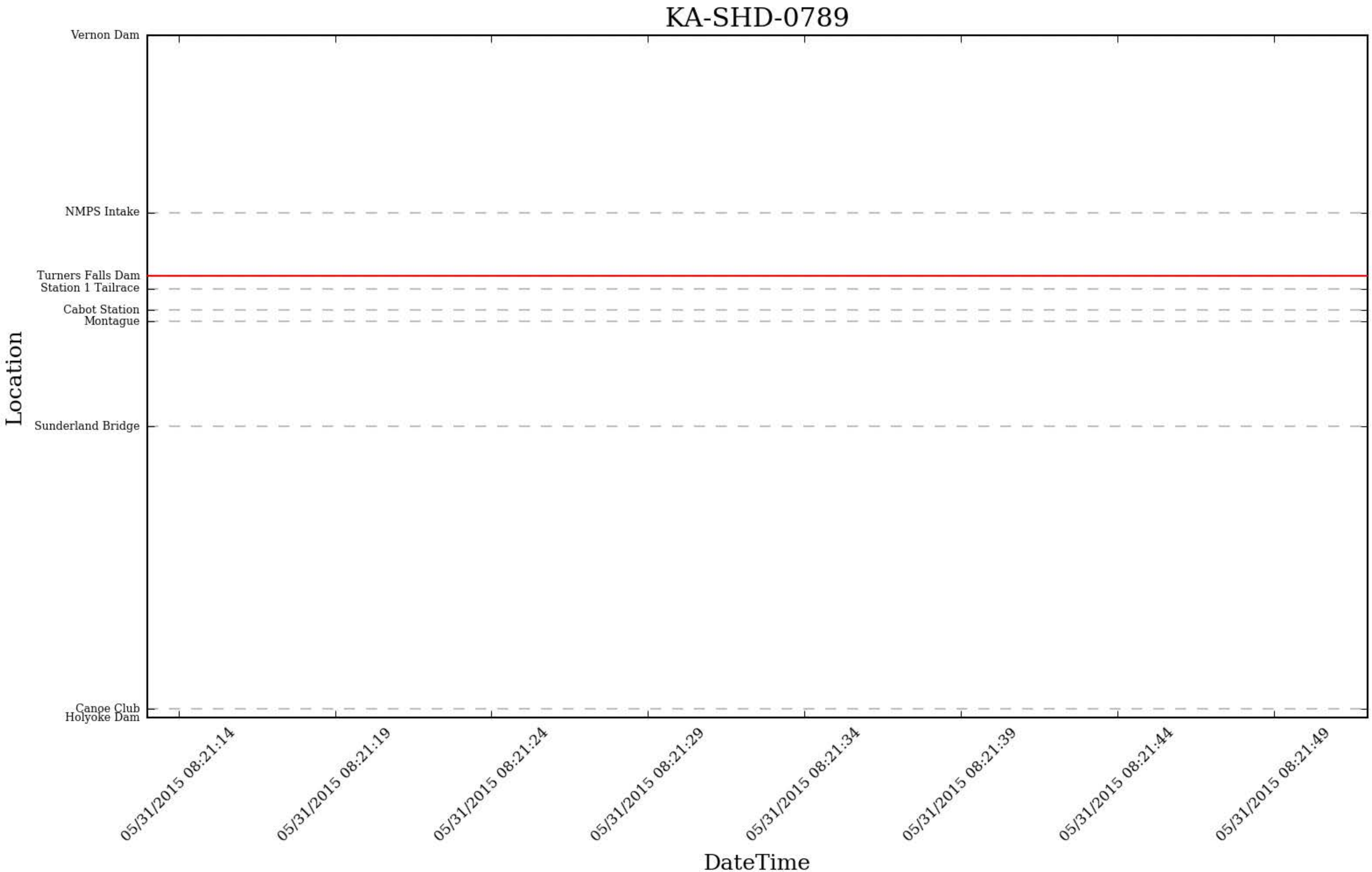

KA-SHD-0783
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/30/2015 07:00:00
05/30/2015 19:00:00
05/31/2015 07:00:00
05/31/2015 19:00:00
06/01/2015 07:00:00
06/01/2015 19:00:00
06/02/2015 07:00:00
06/02/2015 19:00:00
06/03/2015 07:00:00
DateTime

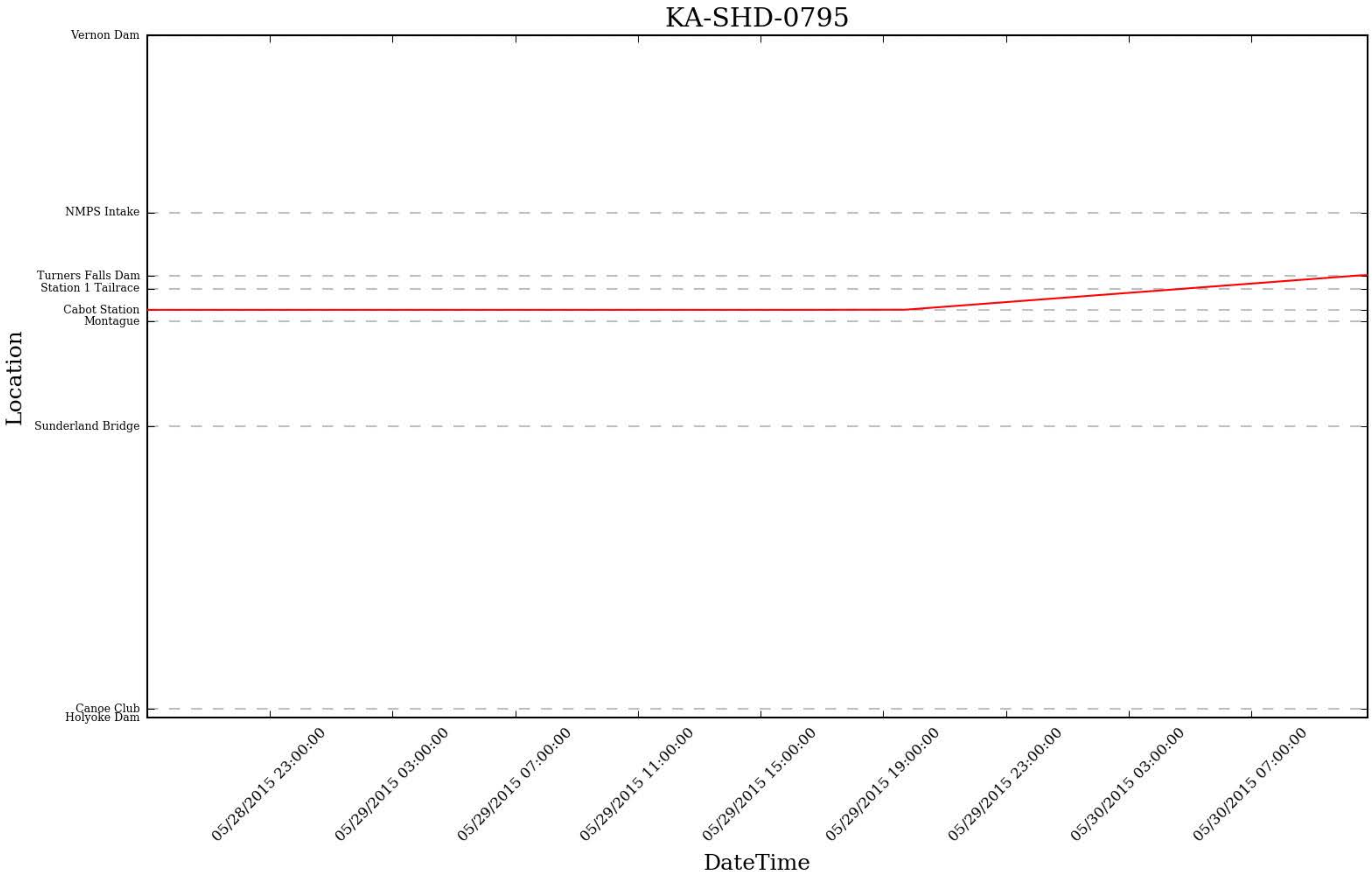

KA-SHD-0786
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/28/2015 13:00:00
05/28/2015 15:00:00
05/28/2015 17:00:00
05/28/2015 19:00:00
05/28/2015 21:00:00
05/28/2015 23:00:00
05/29/2015 01:00:00
05/29/2015 03:00:00
05/29/2015 05:00:00
05/29/2015 07:00:00
DateTime

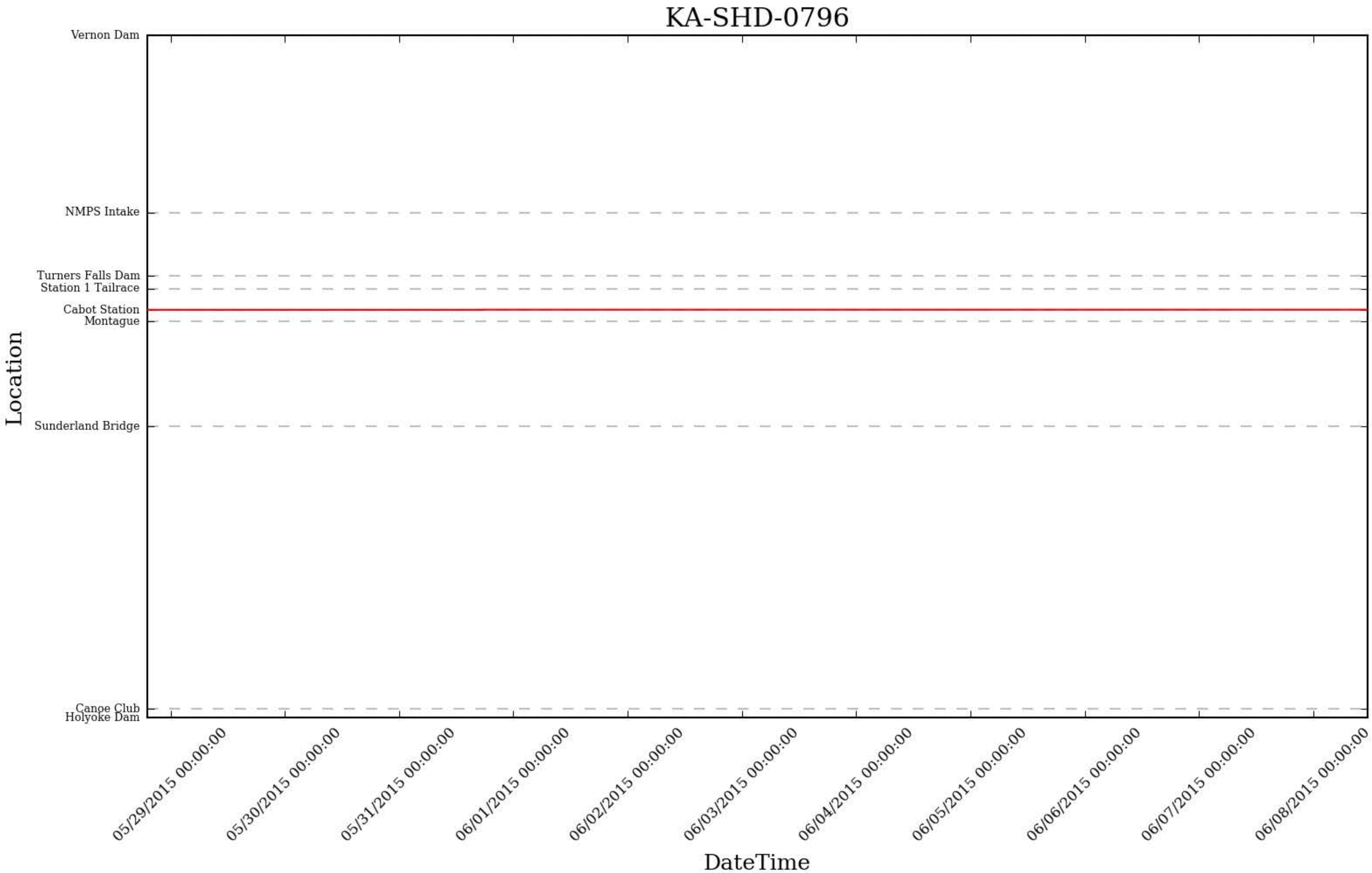


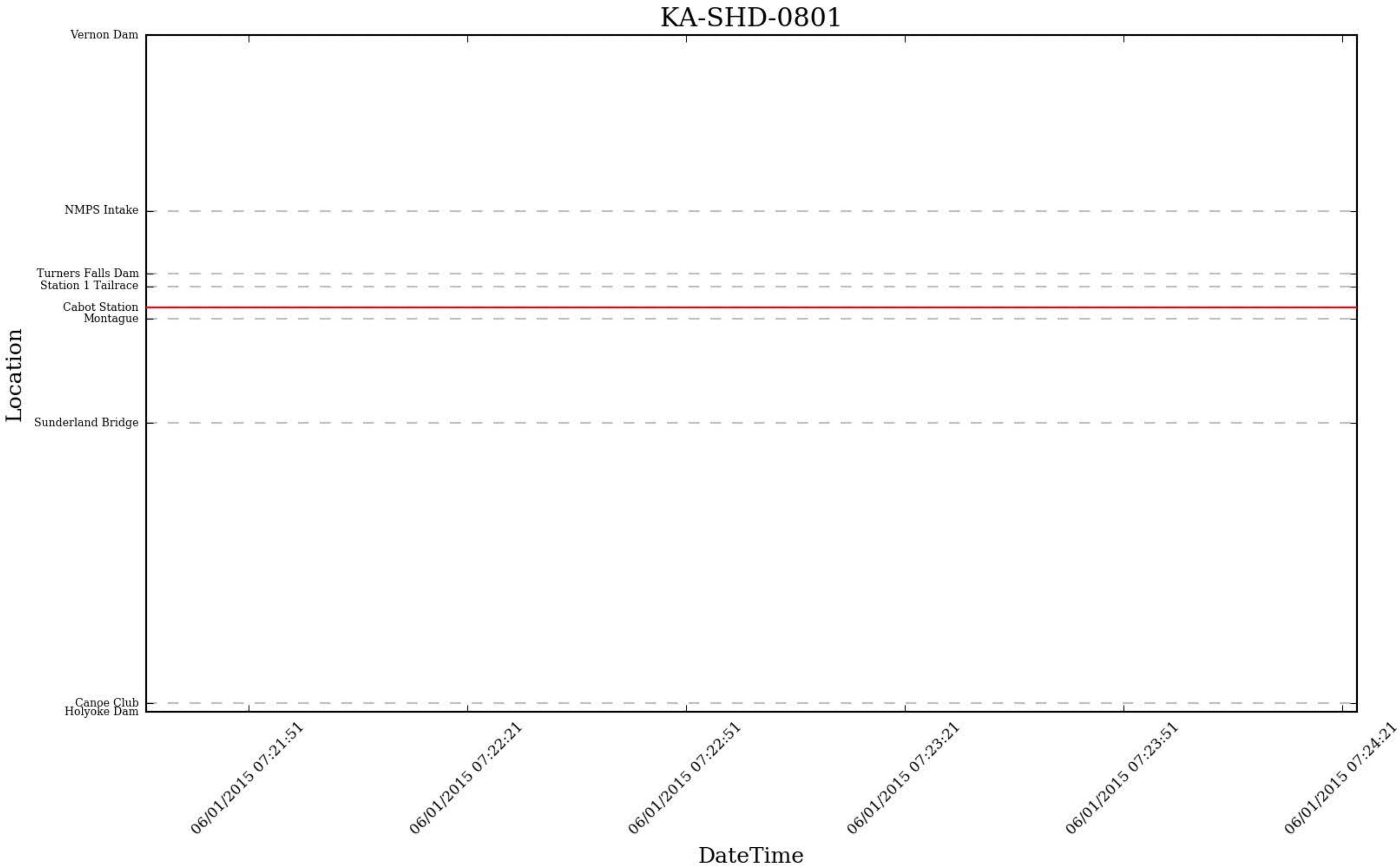
KA-SHD-0787
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/02/2015 14:00:00
06/02/2015 15:00:00
06/02/2015 16:00:00
06/02/2015 17:00:00
06/02/2015 18:00:00
06/02/2015 19:00:00
06/02/2015 20:00:00
DateTime


KA-SHD-0788
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/09/2015 16:00:00
06/09/2015 22:00:00
06/10/2015 04:00:00
06/10/2015 10:00:00
06/10/2015 16:00:00
06/10/2015 22:00:00
06/11/2015 04:00:00
06/11/2015 10:00:00
06/11/2015 16:00:00
DateTime


KA-SHD-0789
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/31/2015 08:21:14
05/31/2015 08:21:19
05/31/2015 08:21:24
05/31/2015 08:21:29
05/31/2015 08:21:34
05/31/2015 08:21:39
05/31/2015 08:21:44
05/31/2015 08:21:49
DateTime


KA-SHD-0795
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
05/28/2015 23:00:00
05/29/2015 03:00:00
05/29/2015 07:00:00
05/29/2015 11:00:00
05/29/2015 15:00:00
05/29/2015 19:00:00
05/29/2015 23:00:00
05/30/2015 03:00:00
05/30/2015 07:00:00
DateTime


KA-SHD-0796
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/29/2015 00:00:00
05/30/2015 00:00:00
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
06/04/2015 00:00:00
06/05/2015 00:00:00
06/06/2015 00:00:00
06/07/2015 00:00:00
06/08/2015 00:00:00
DateTime



KA-SHD-0801
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/01/2015 07:21:51
06/01/2015 07:22:21
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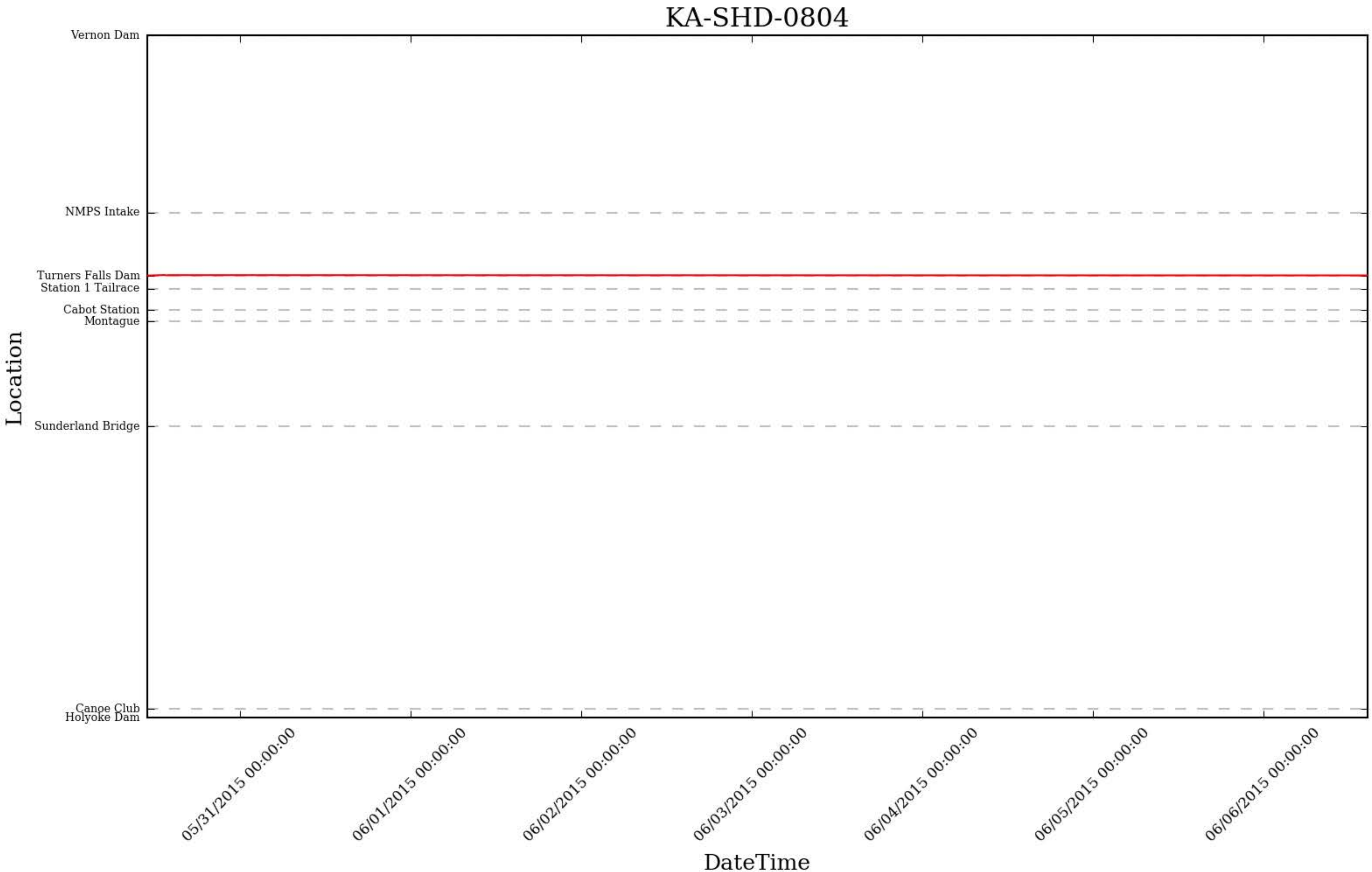
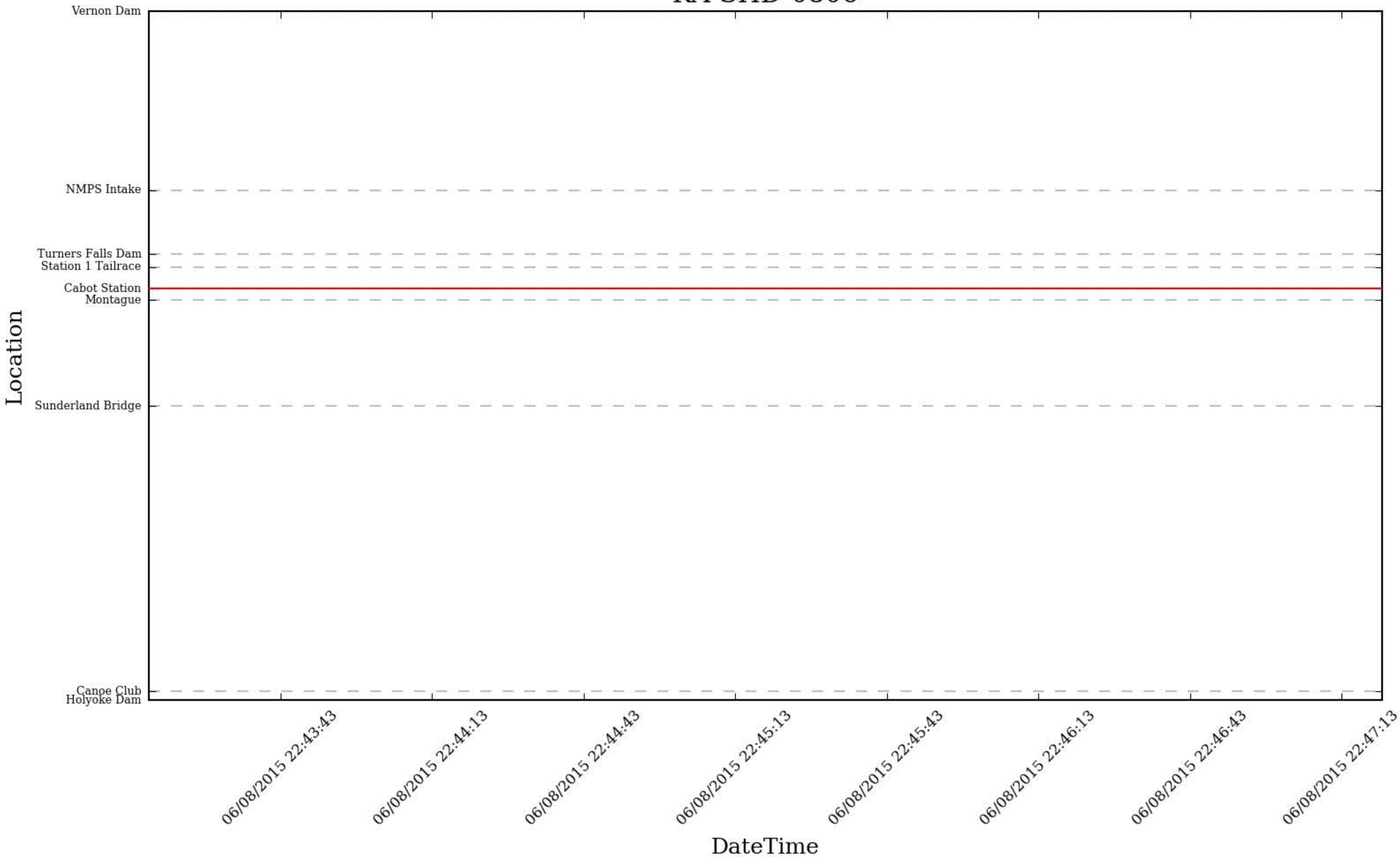
06/01/2015 07:24:21
DateTime

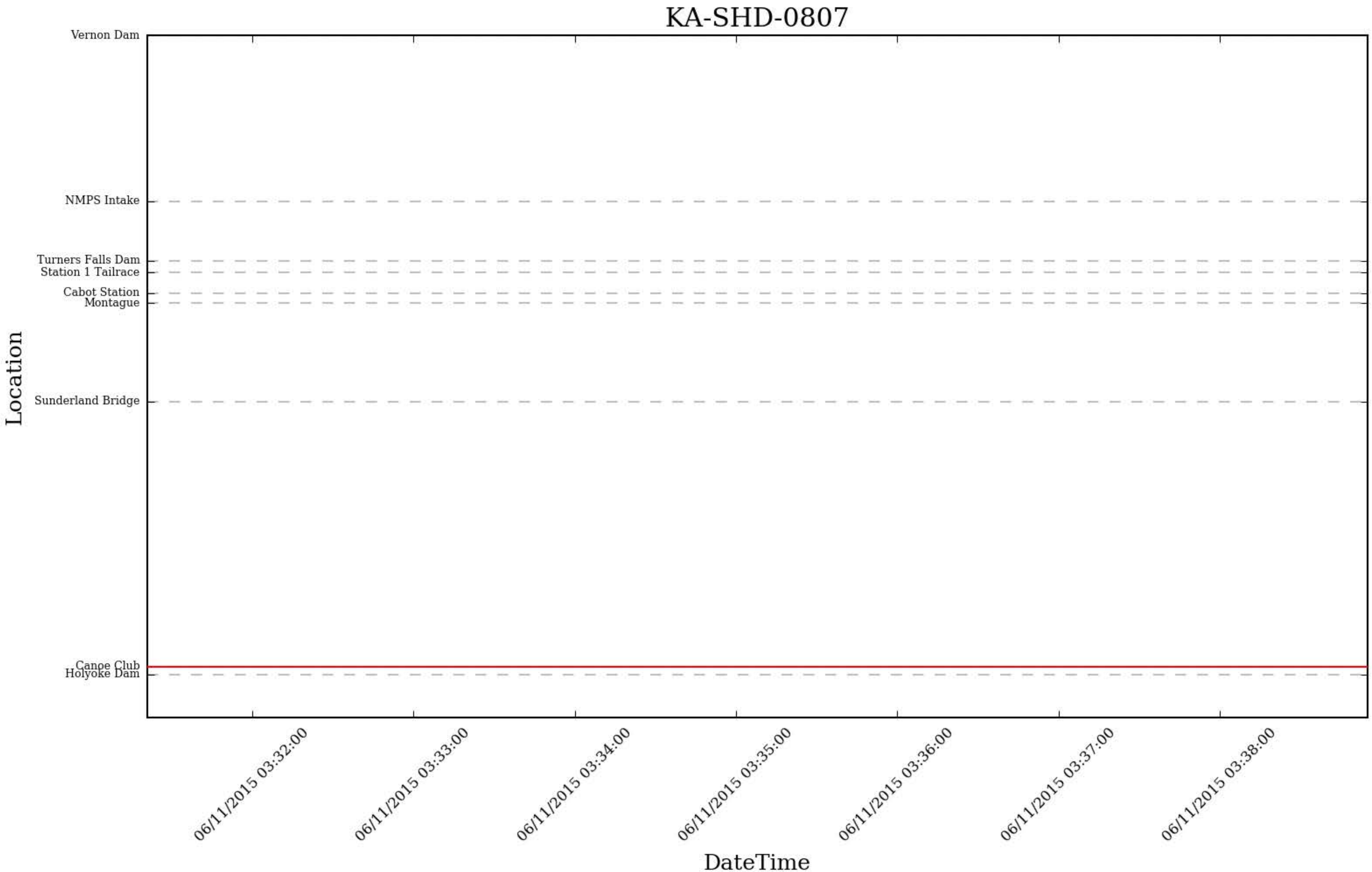


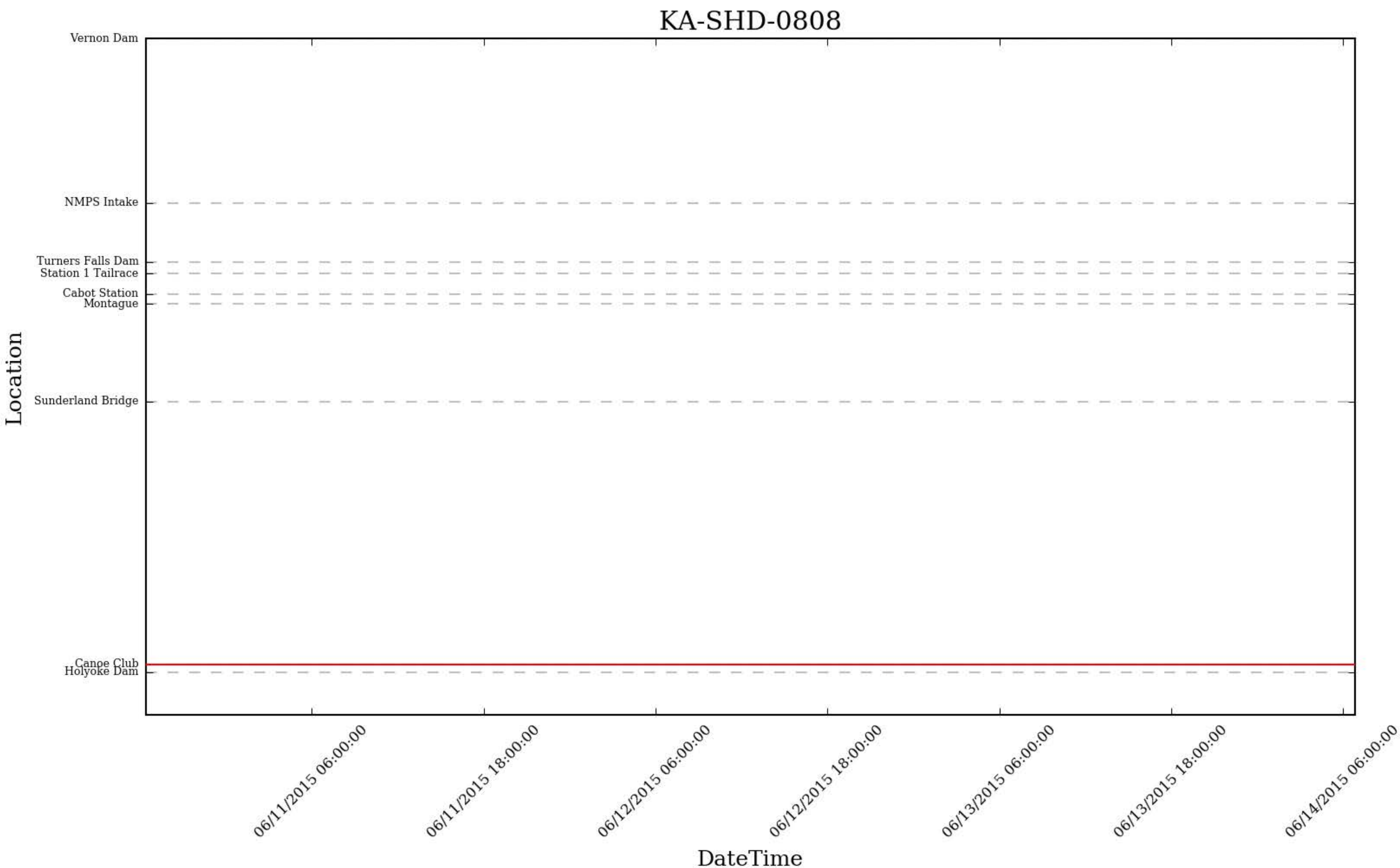
KA-SHD-0804
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
05/31/2015 00:00:00
06/01/2015 00:00:00
06/02/2015 00:00:00
06/03/2015 00:00:00
06/04/2015 00:00:00
06/05/2015 00:00:00
06/06/2015 00:00:00
DateTime

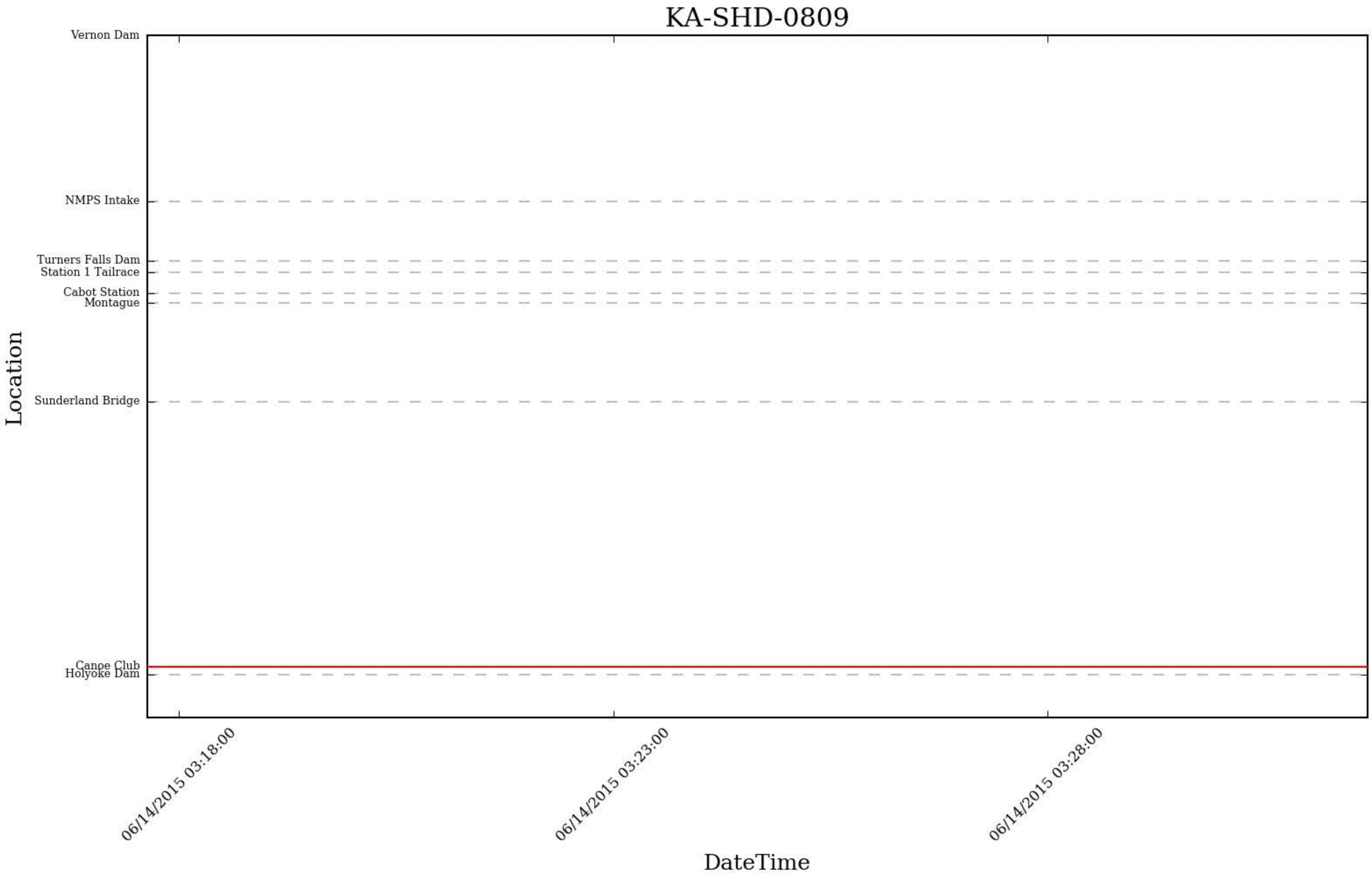
KA-SHD-0806

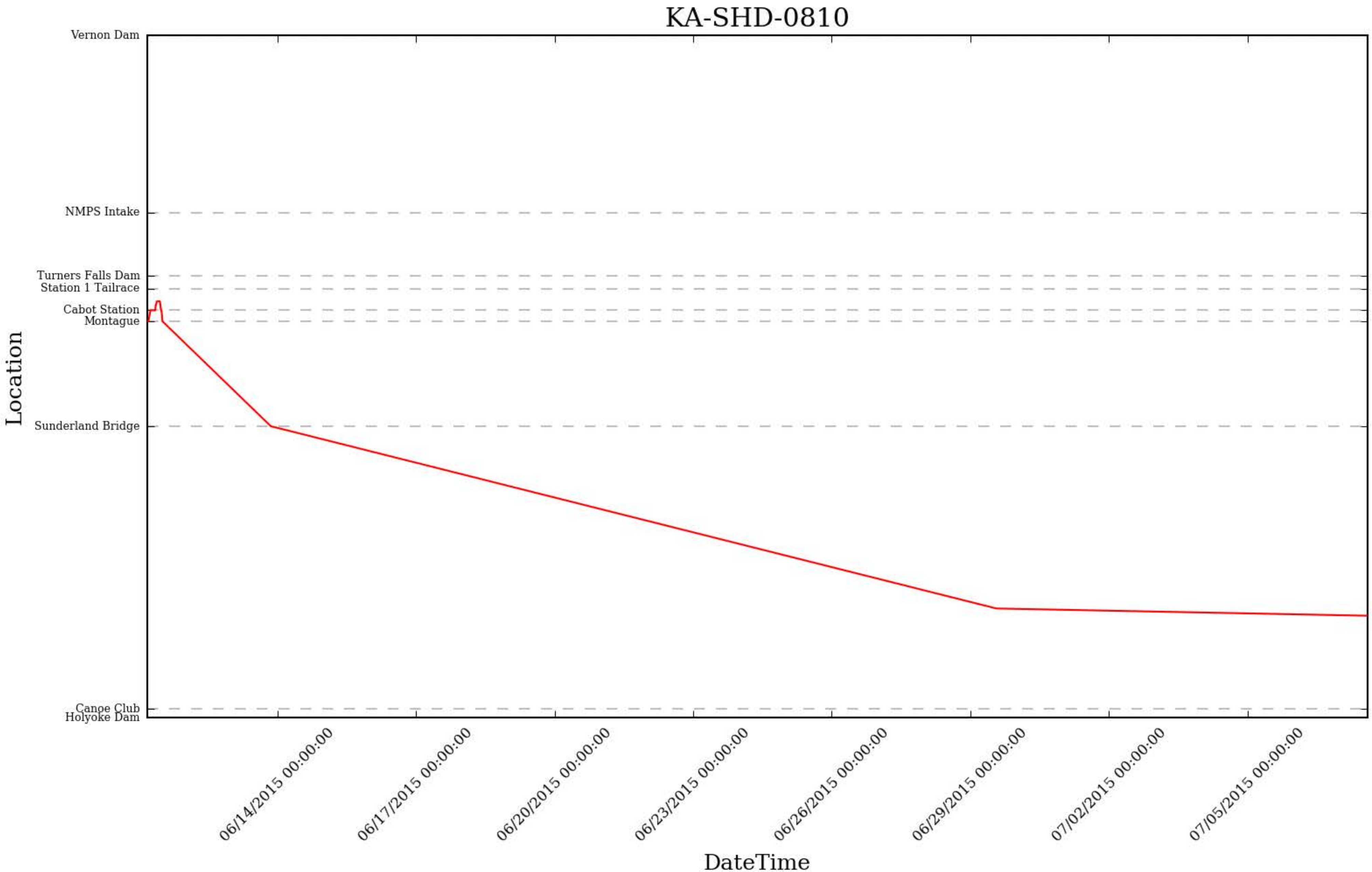


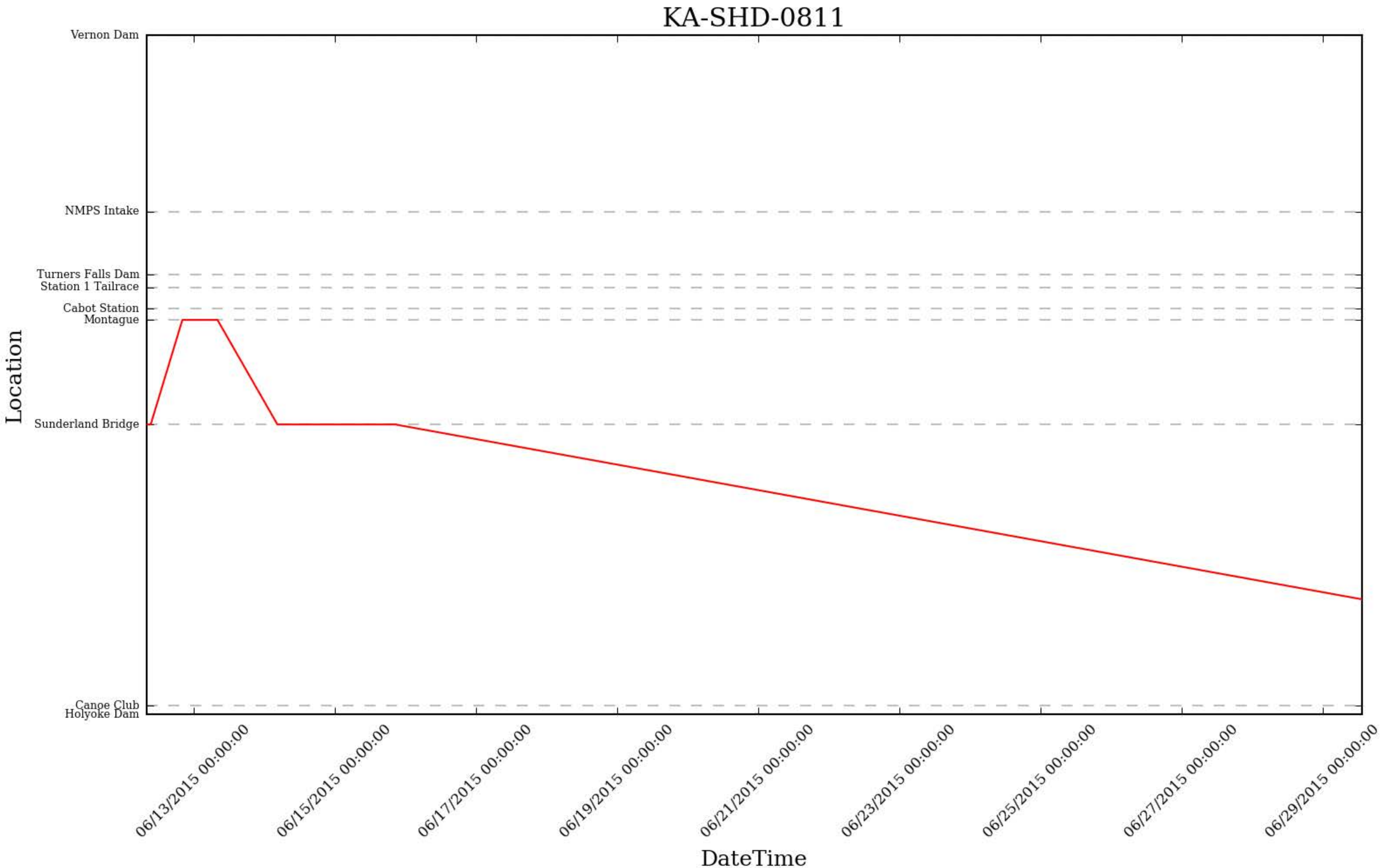
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/08/2015 22:43:43
06/08/2015 22:44:13
06/08/2015 22:44:43
06/08/2015 22:45:13
06/08/2015 22:45:43
06/08/2015 22:46:13
06/08/2015 22:46:43
06/08/2015 22:47:13
DateTime


KA-SHD-0807
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 03:32:00
06/11/2015 03:33:00
06/11/2015 03:34:00
06/11/2015 03:35:00
06/11/2015 03:36:00
06/11/2015 03:37:00
06/11/2015 03:38:00
DateTime

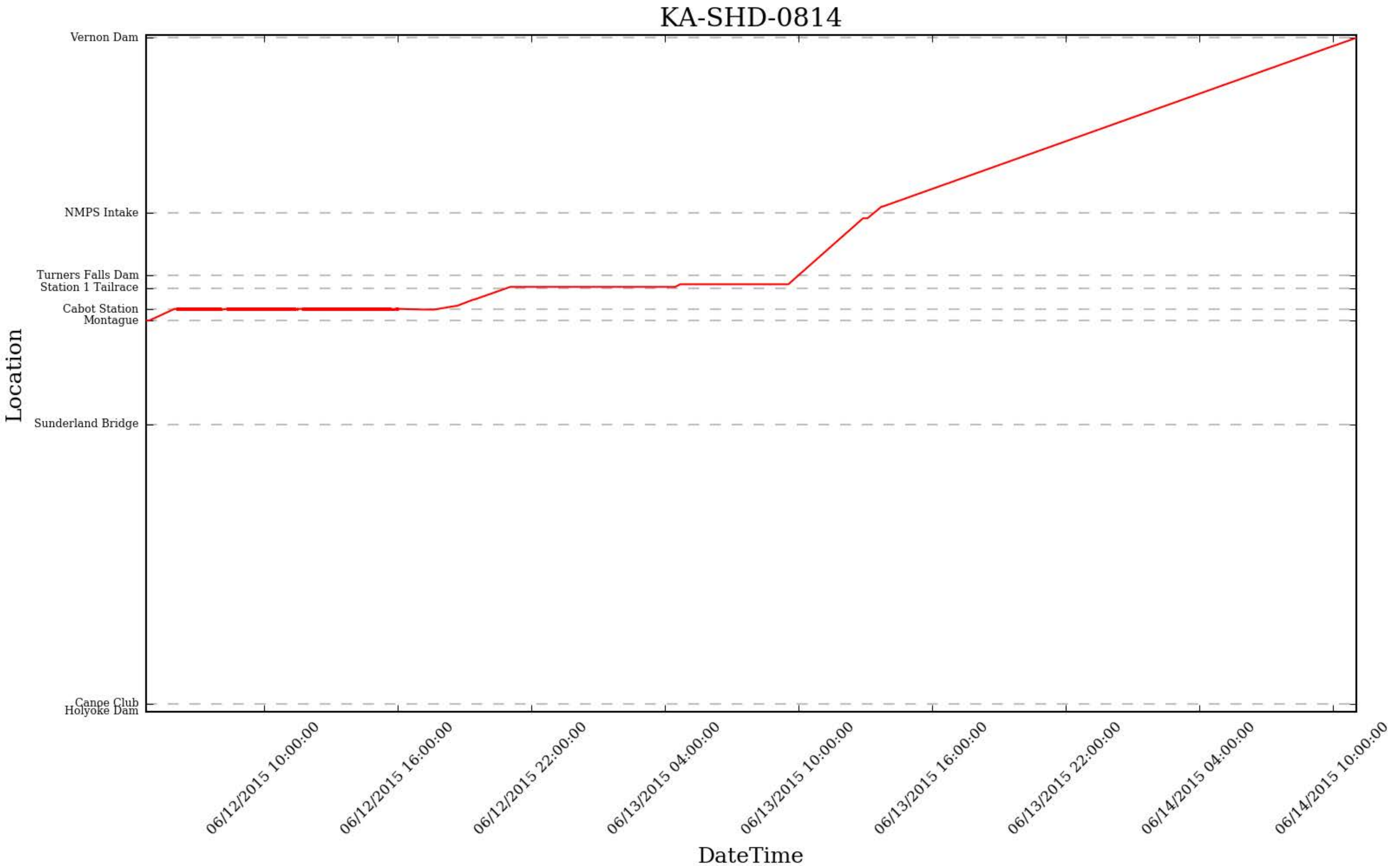

KA-SHD-0808
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 06:00:00
06/11/2015 18:00:00
06/12/2015 06:00:00
06/12/2015 18:00:00
06/13/2015 06:00:00
06/13/2015 18:00:00
06/14/2015 06:00:00
DateTime

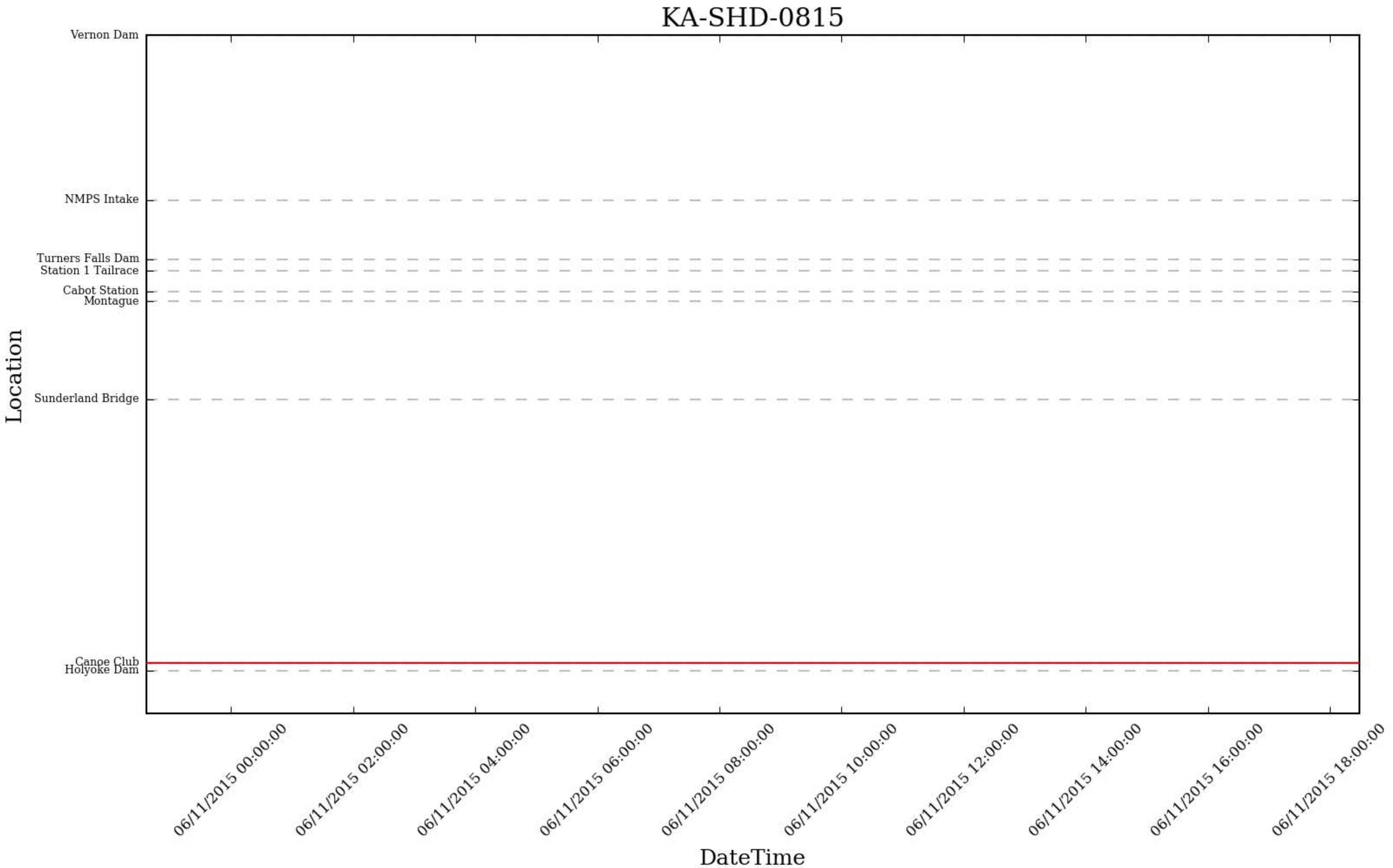

KA-SHD-0809
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/14/2015 03:18:00
06/14/2015 03:23:00
06/14/2015 03:28:00
DateTime

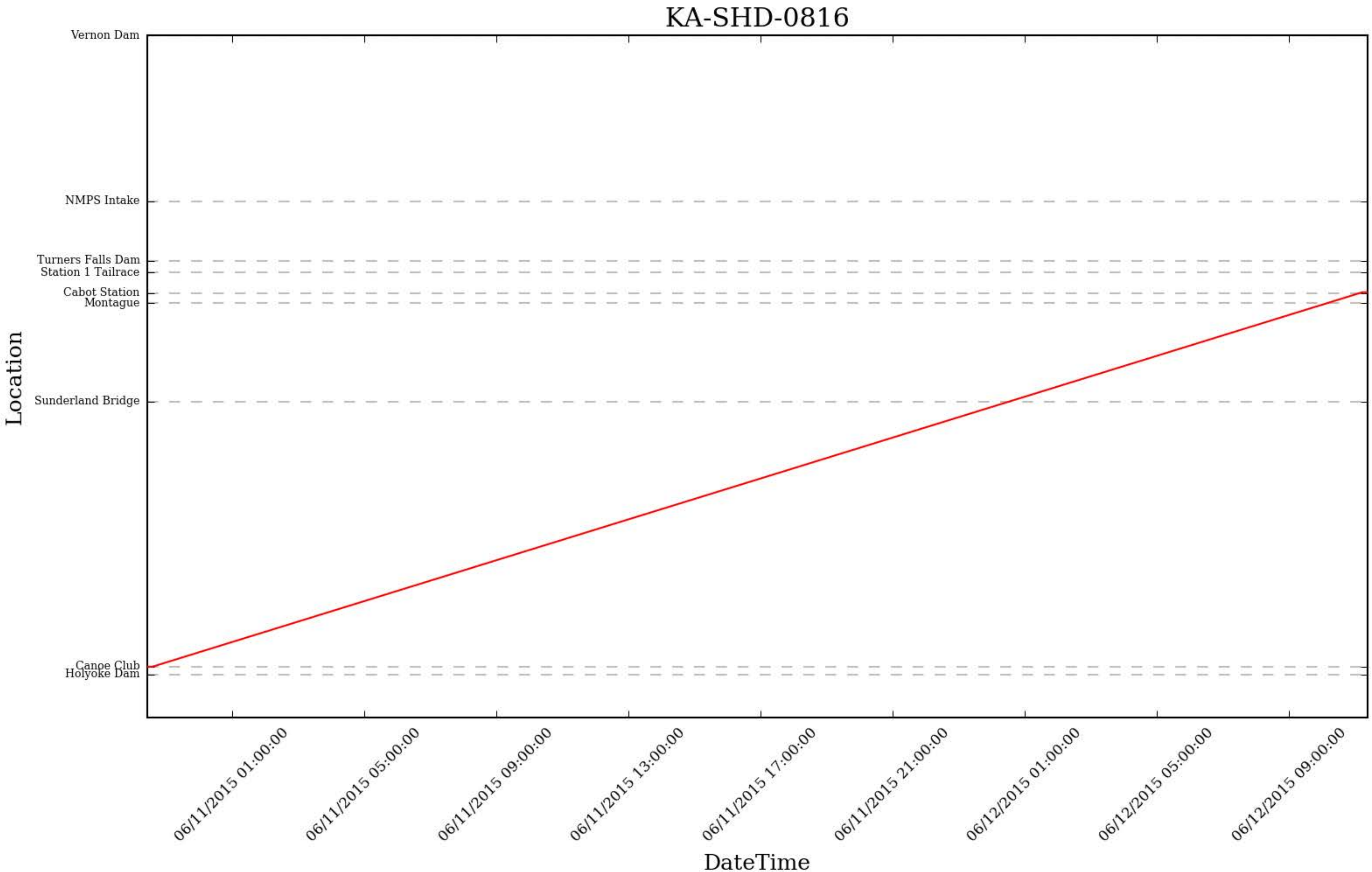

KA-SHD-0810
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/14/2015 00:00:00
06/17/2015 00:00:00
06/20/2015 00:00:00
06/23/2015 00:00:00
06/26/2015 00:00:00
06/29/2015 00:00:00
07/02/2015 00:00:00
07/05/2015 00:00:00
DateTime



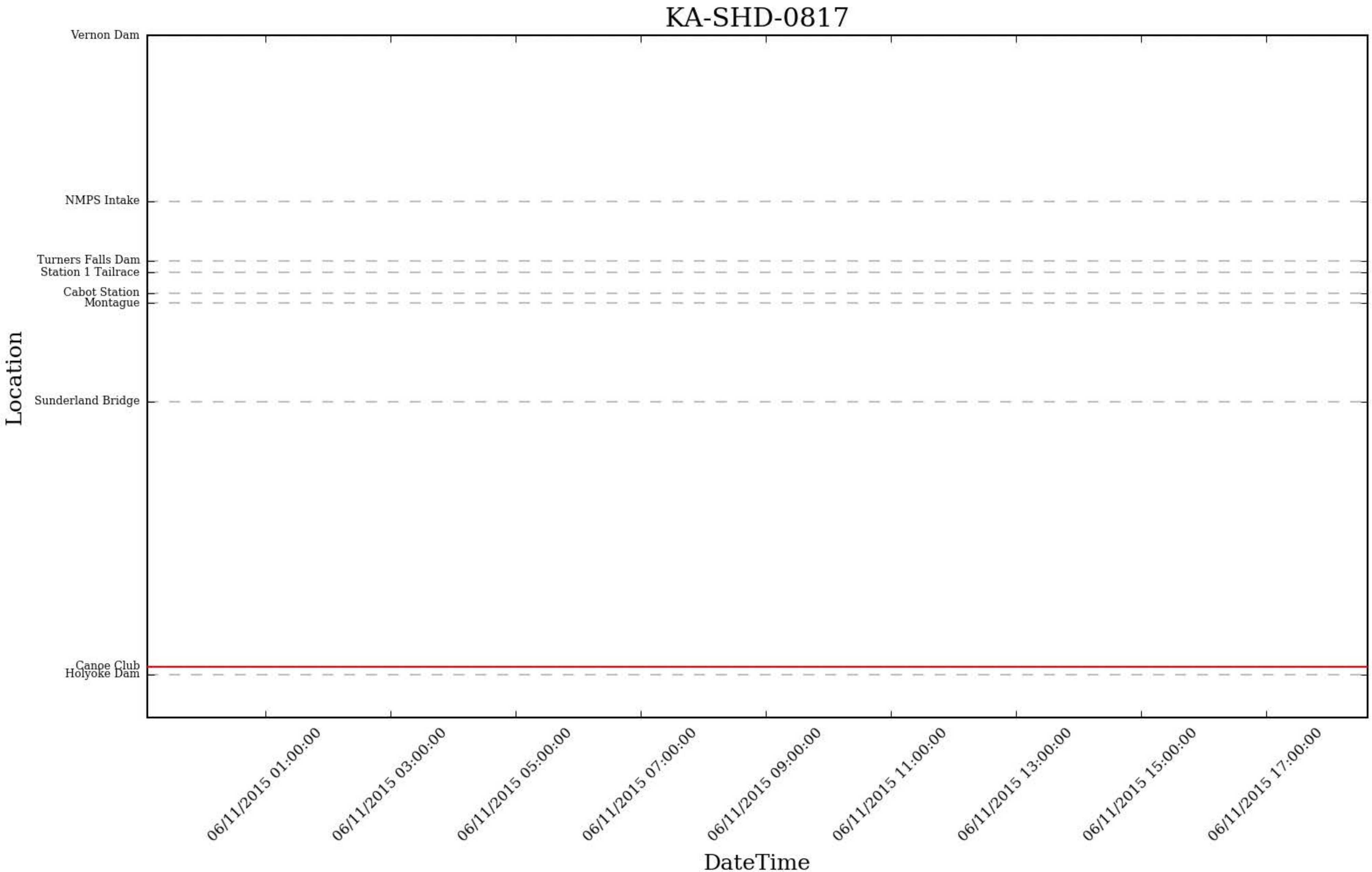
KA-SHD-0811
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/13/2015 00:00:00
06/15/2015 00:00:00
06/17/2015 00:00:00
06/19/2015 00:00:00
06/21/2015 00:00:00
06/23/2015 00:00:00
06/25/2015 00:00:00
06/27/2015 00:00:00
06/29/2015 00:00:00
DateTime


KA-SHD-0814
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/12/2015 10:00:00
06/12/2015 16:00:00
06/12/2015 22:00:00
06/13/2015 04:00:00
06/13/2015 10:00:00
06/13/2015 16:00:00
06/13/2015 22:00:00
06/14/2015 04:00:00
06/14/2015 10:00:00
DateTime

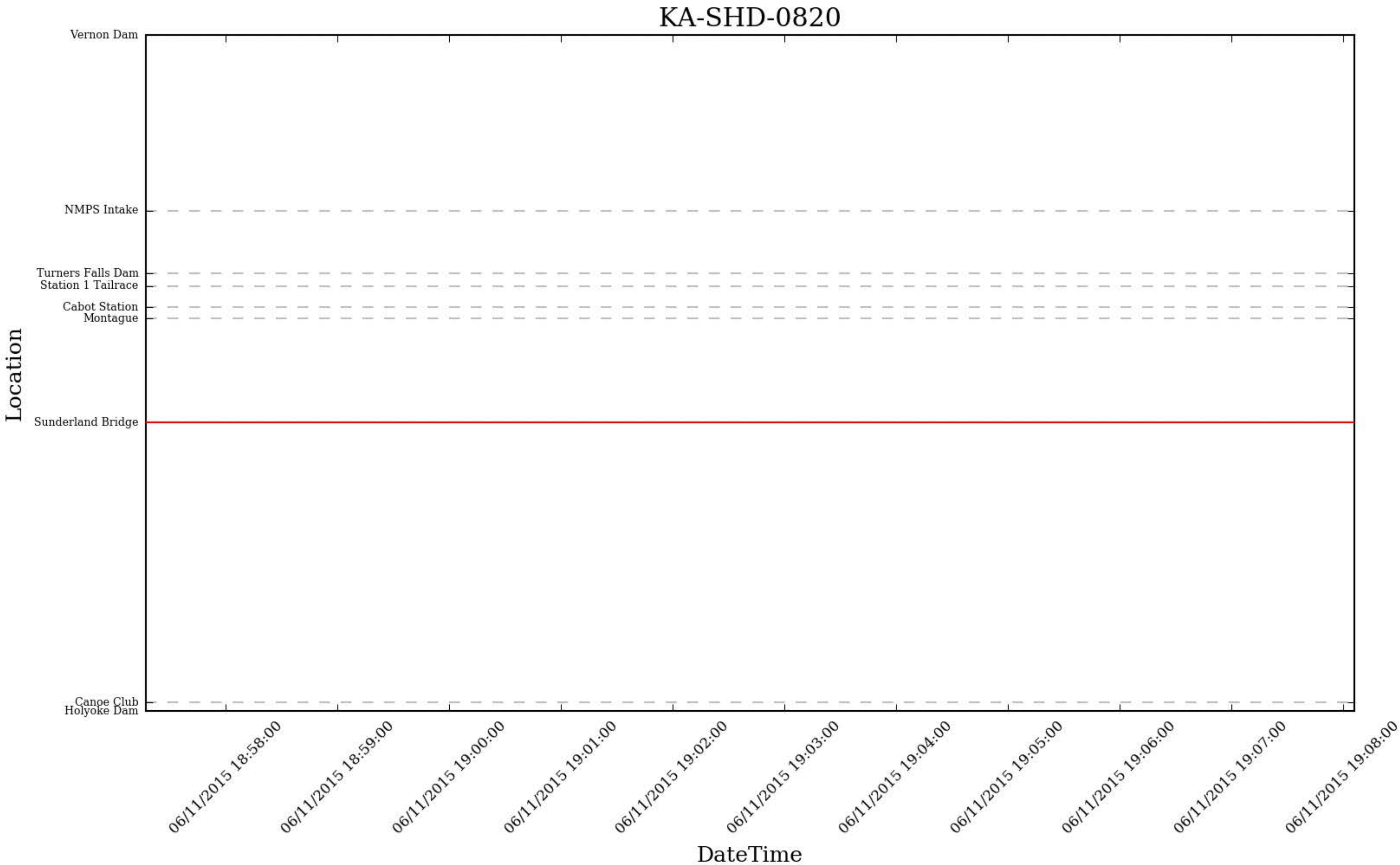

KA-SHD-0815
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 00:00:00
06/11/2015 02:00:00
06/11/2015 04:00:00
06/11/2015 06:00:00
06/11/2015 08:00:00
06/11/2015 10:00:00
06/11/2015 12:00:00
06/11/2015 14:00:00
06/11/2015 16:00:00
06/11/2015 18:00:00
DateTime

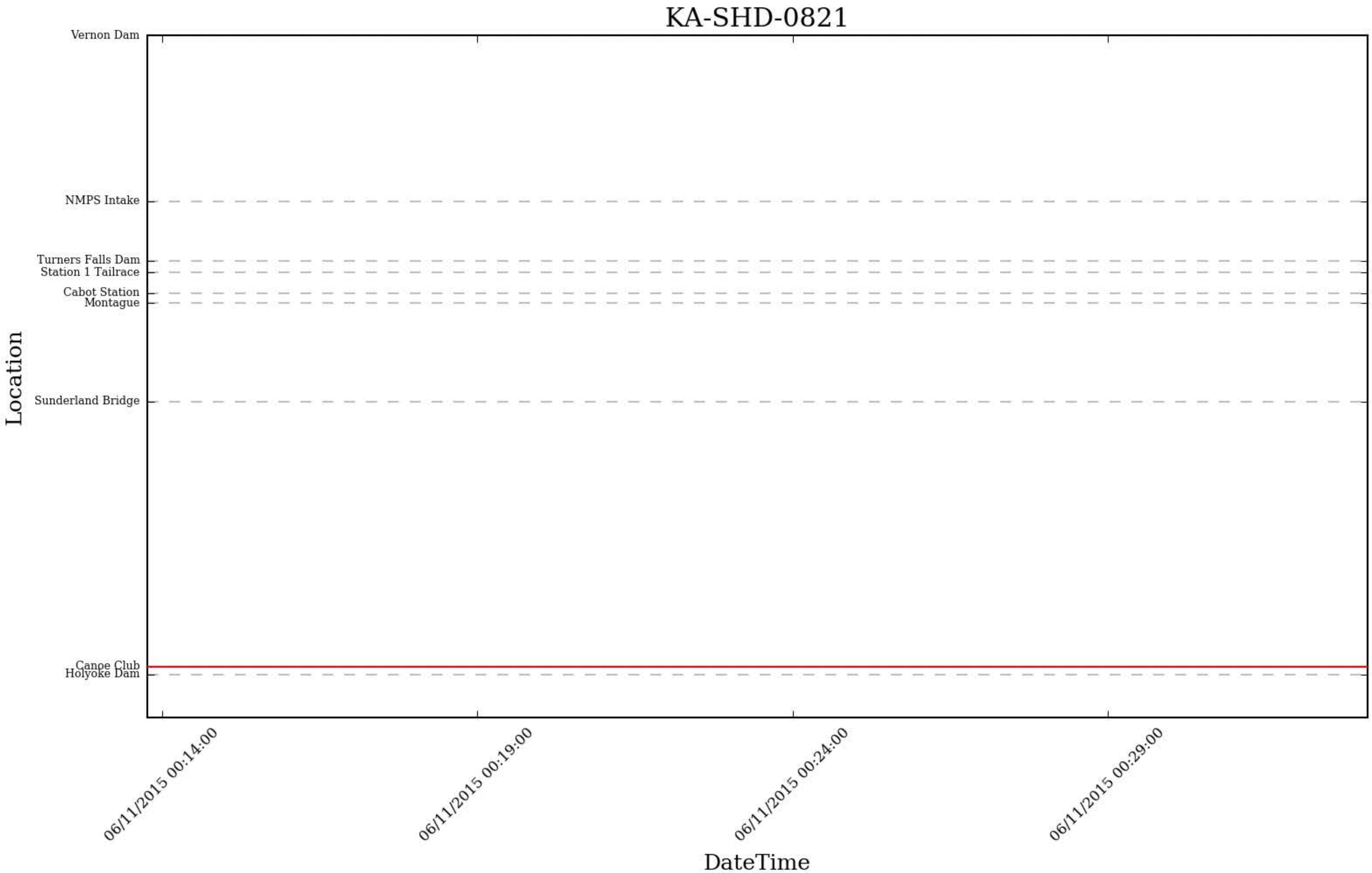


KA-SHD-0816
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 01:00:00
06/11/2015 05:00:00
06/11/2015 09:00:00
06/11/2015 13:00:00
06/11/2015 17:00:00
06/11/2015 21:00:00
06/12/2015 01:00:00
06/12/2015 05:00:00
06/12/2015 09:00:00
DateTime

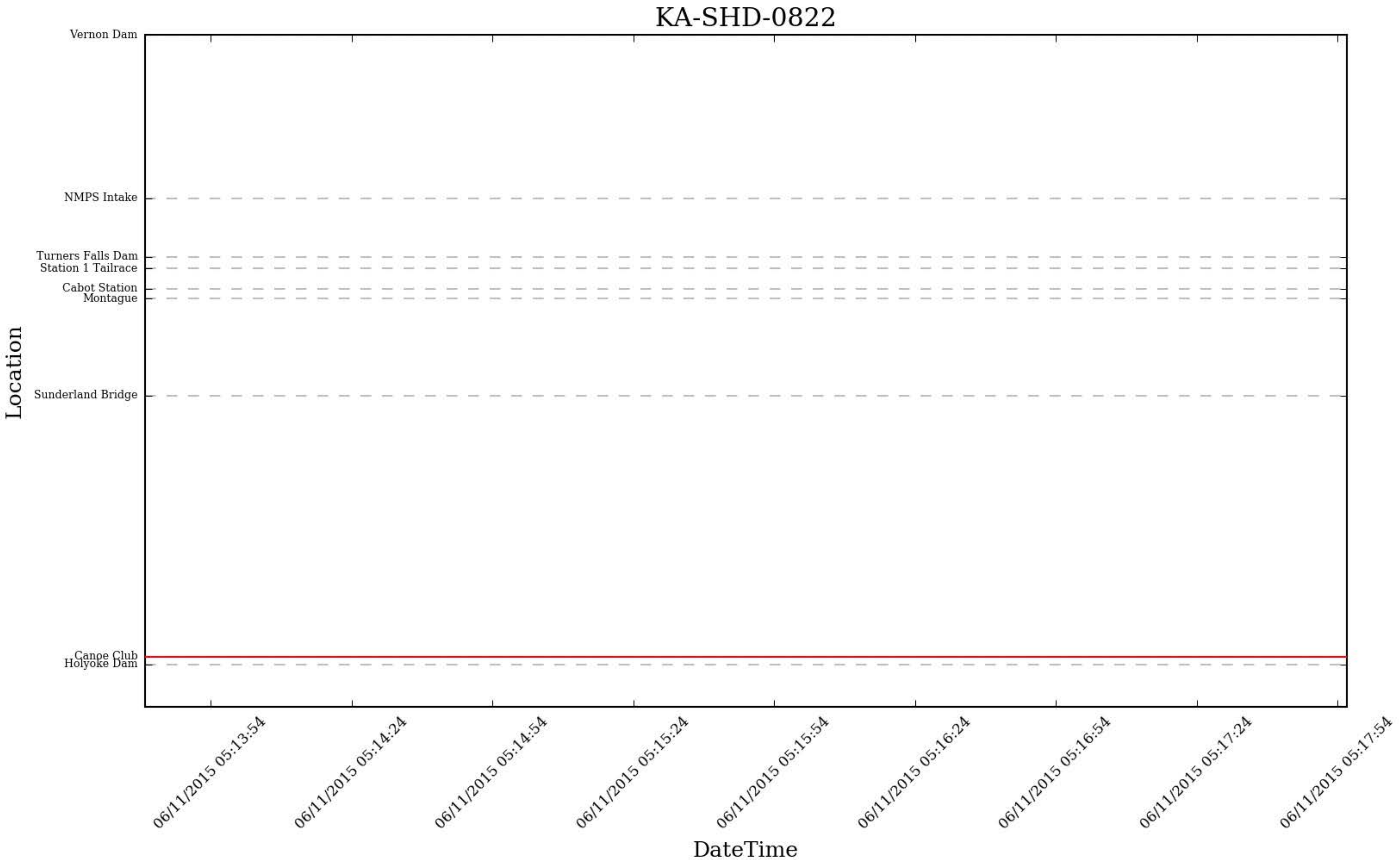


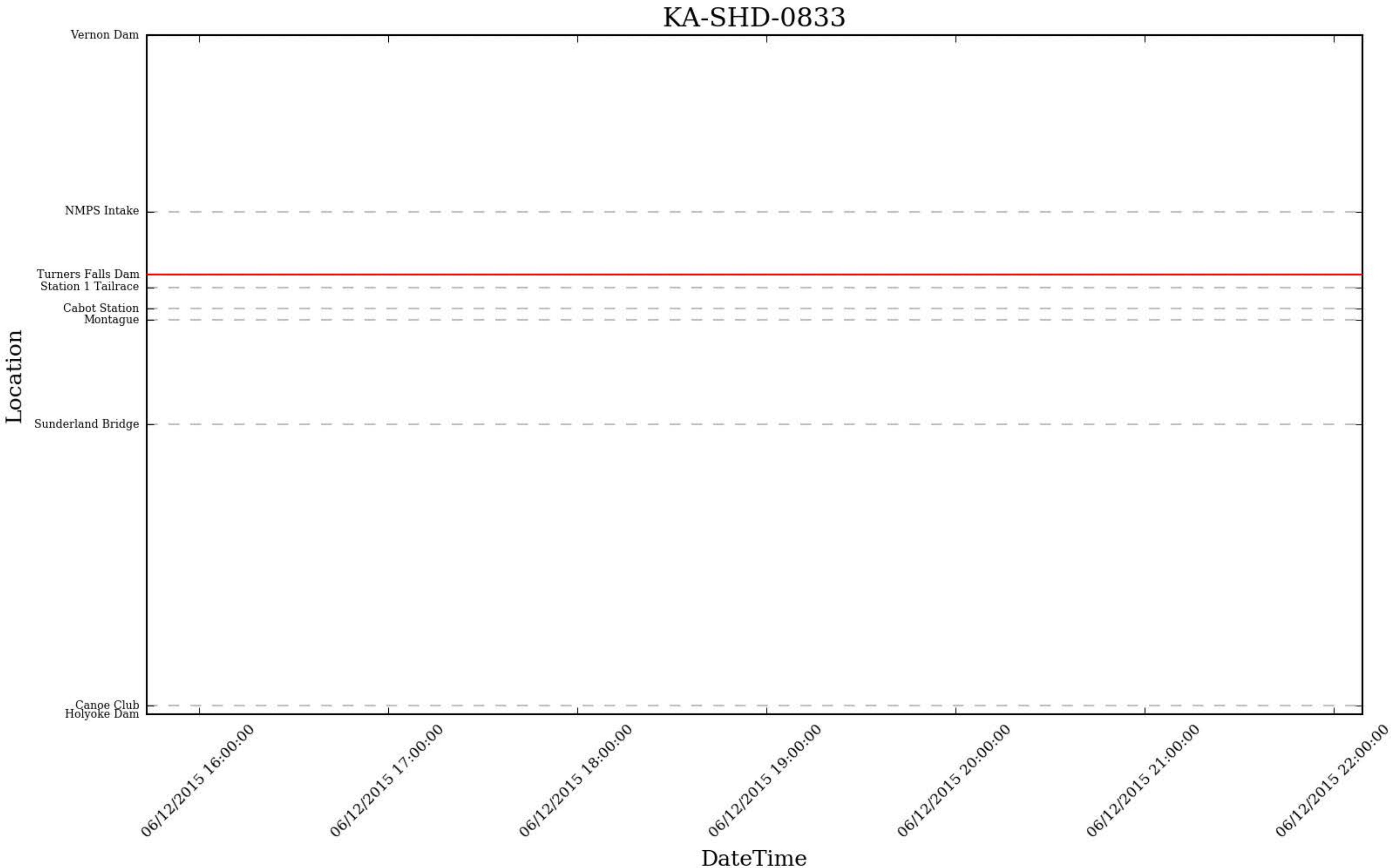
KA-SHD-0817
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 01:00:00
06/11/2015 03:00:00
06/11/2015 05:00:00
06/11/2015 07:00:00
06/11/2015 09:00:00
06/11/2015 11:00:00
06/11/2015 13:00:00
06/11/2015 15:00:00
06/11/2015 17:00:00
DateTime


KA-SHD-0820
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 18:58:00
06/11/2015 18:59:00
06/11/2015 19:00:00
06/11/2015 19:01:00
06/11/2015 19:02:00
06/11/2015 19:03:00
06/11/2015 19:04:00
06/11/2015 19:05:00
06/11/2015 19:06:00
06/11/2015 19:07:00
06/11/2015 19:08:00
DateTime



KA-SHD-0821
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 00:14:00
06/11/2015 00:19:00
06/11/2015 00:24:00
06/11/2015 00:29:00
DateTime


KA-SHD-0822
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
Location
06/11/2015 05:13:54
06/11/2015 05:14:24
06/11/2015 05:14:54
06/11/2015 05:15:24
06/11/2015 05:15:54
06/11/2015 05:16:24
06/11/2015 05:16:54
06/11/2015 05:17:24
06/11/2015 05:17:54
DateTime


KA-SHD-0833
Location
Vernon Dam
NMPS Intake
Turners Falls Dam
Station 1 Tailrace
Cabot Station
Montague
Sunderland Bridge
Canoe Club
Holyoke Dam
06/12/2015 16:00:00
06/12/2015 17:00:00
06/12/2015 18:00:00
06/12/2015 19:00:00
06/12/2015 20:00:00
06/12/2015 21:00:00
06/12/2015 22:00:00
DateTime