Hydrological Monitoring in the Lower Klamath Basin

Water Year 2005

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I. Introduction

This report summarizes hydrological monitoring conducted by the Yurok Tribe Environmental Program (YTEP) during Water Year 2005 (WY05), which covers October 1, 2004 through September 30, 2005. YTEP operates real-time gaging stations in McGarvey Creek, Turwar Creek, Blue Creek, Tully Creek, and the Klamath River estuary (Figure 1). Hourly data from real-time sites can be accessed through YTEP's website at: http://exchange.yuroktribe.nsn.us/lrgsclient/stations/stations.html (all data is provisional and not to be cited or used for analysis until published in our annual Water Year Report).

YTEP's goal in operating gaging stations in tributaries to the Lower Klamath is to obtain a continuous record of streamflow, which can be estimated by creating a relationship, or rating curve, between gage height at the gaging station and discharge measurements taken at a range of water levels. In addition, data such as suspended sediment concentration (SSC) and turbidity are also monitored during the winter months, when most sediment transport occurs in watersheds. Watersheds can be impaired by excessive sediment loads, which can lead to changes in channel morphology, habitat degradation, loss of spawning habitat, and may influence salmonid migration. The objectives for conducting this monitoring are: 1) establish baseline conditions and long-term trends, 2) provide a basis for comparing inter-annual flow regimes as they related to fisheries studies, and 3) to monitor long-term progress of restoration projects.

The gaging station in the Klamath River estuary is unique in that it is not used to monitor streamflow. Gage height in the estuary varies both seasonally and daily and is greatly influenced by tidal activity during periods of low flow. YTEP's goal in operating this gaging station is to increase our knowledge of the estuary and investigate how tidal stage, river flow, and the location of the mouth affect the physical, chemical, and biological characteristics of the estuary.

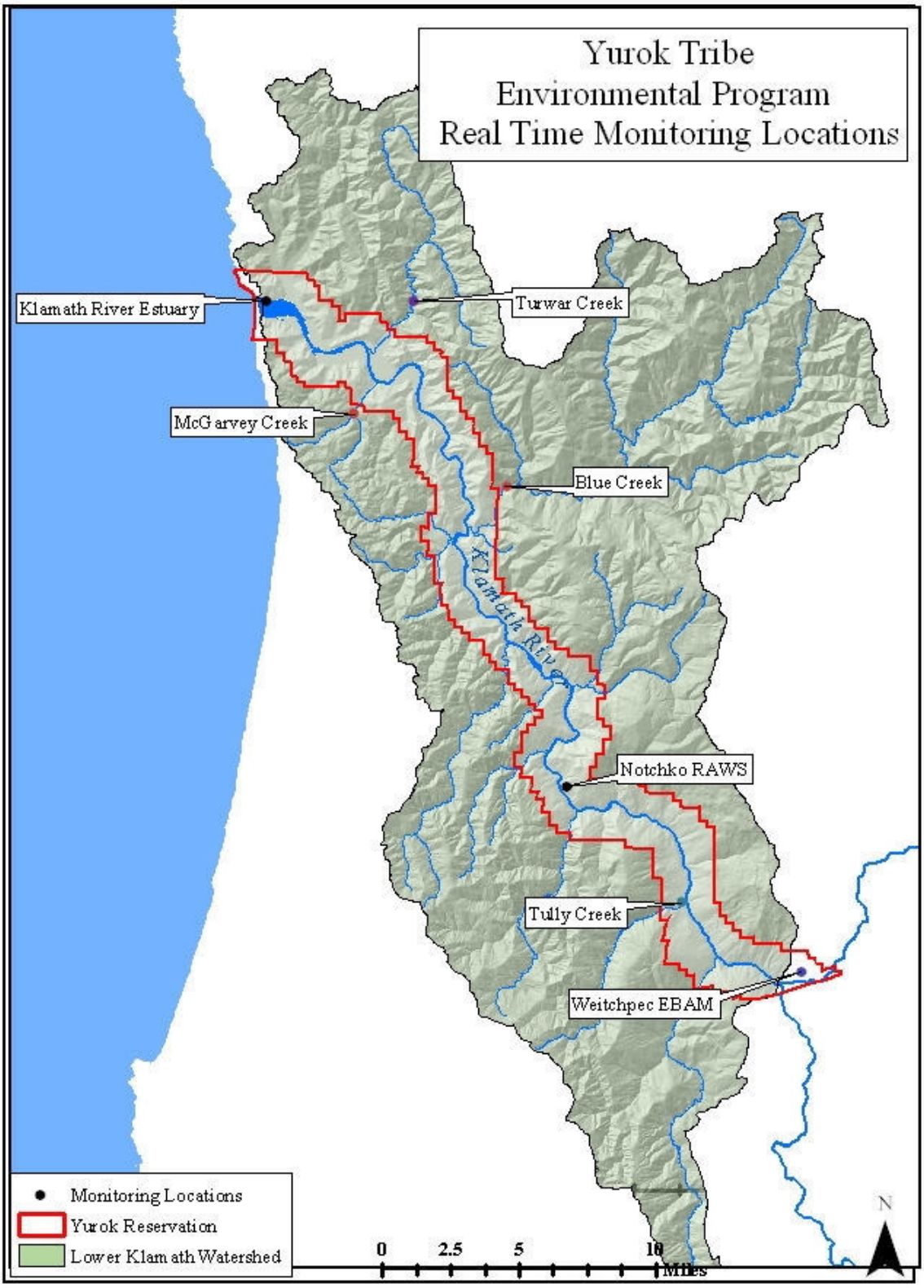

Figure 1. Locations of real-time monitoring stations operated by the Yurok Tribe Environmental Program during WY05 (EBAM station measures air quality and RAWS station collects meteorological data).

II. Quality Assurance

Data collected for this project is managed under quality assurance (QA) and quality control (QC) procedures that have been approved by the USEPA. YTEP's Quality Assurance Program Plan (QAPP) was finalized and has been implemented since 2001 (Yurok Tribe Environmental Program, 2001) and is overseen by YTEP's Program Director. The QAPP details the quality assurance and quality control procedures used to ensure and document that data is accurate, precise, complete, and representative of actual field conditions. The QAPP additionally describes the planning, implementation, and assessment criteria required for projects performed by YTEP for the generation, acquisition, and use of environmental data. Changes to the QAPP are approved by the Environmental Program Director.

In order to ensure comparability and accuracy of data, YTEP uses Standard Operating Procedures (SOP's) and follows USGS approved methods of data collection. YTEP also operates under an EPA approved Sampling and Analysis Plan (SAP) for bedload and suspended sediment (Yurok Tribe Environmental Program, 2003). Where an SOP does not exist for a certain instrument or procedure, YTEP follows the manufacturer's suggested procedures. Detailed logs are kept in waterproof field notebooks at each gaging station location and waterproof datasheets are used during data collection. In these records, any malfunctions, unusual circumstances, alteration of gage height, and/or other variations are noted.

III. Gaging Station Locations

Site selection criteria for gaging stations include spatial distribution, watershed restoration activities, proposed future development, and fisheries monitoring. Sites were located in the lower reaches of watersheds that characterize water quality and watershed health condition throughout the lower Klamath. All tributaries currently monitored vary in size, geology, and geographic location and can potentially be used in the future to make inferences to neighboring watersheds. YTEP is in the process of developing baseline conditions to document the magnitude and duration of water quality impacts. The following reasons were used as selection criteria for gaging station locations:

1. *Spatial Distribution* – Sites located in the lower reaches of watersheds that characterize the water quality and watershed health condition throughout the lower Klamath.

2. *Activity Specific* – Sites located above and/or below activities that may potentially impact water quality.

3. *Watershed Restoration Activities* – Sites located in watersheds that have active or proposed restoration activities.

4. *Proposed Future Development* – Sites near locations of resource and proposed resource development.

Table 1. Selection criteria priority matrix for gaging station locations.

Stream	Watershed	Primary Criteria	Secondary Criteria	Other
Blue	Blue	1	3	2
McGarvey	McGarvey	3	1	
Tully	Tully	4	1	2
Turwar	Turwar	1	3	2

The McGarvey Creek gaging station has been in operation since December 1, 2001. The station is located at 41° 29' 11.29" north latitude, 124° 00' 34.46" west longitude, approximately 100 ft downstream of the confluence of the West Fork McGarvey and the mainstem. The total drainage area of the watershed is 5,667 acres (Figure 2, Figure 3). During winter storm events, flows are taken from a bridge crossing McGarvey Creek approximately ¼ mile downstream of the gaging station. Den Creek flows into McGarvey Creek directly upstream of the bridge, so flow measurements were taken in Den Creek and subtracted from the mainstem measurement during these events. McGarvey Creek was the first gaging station installed by the Yurok Tribe Environmental Program due to the widespread logging that had occurred in the watershed and planned restoration that has since occurred. The Yurok Tribal Fisheries Program (YTFP) operates an outmigrant trap just downstream of the McGarvey Creek Bridge and has also implemented a passive integrated transponder (PIT) monitoring project.

The Blue Creek gaging station has been in operation since April 2003 and is located at 41° 27' 00" north latitude, 123° 53' 40" west longitude, approximately ¼ mile downstream of the confluence of the West Fork of Blue Creek with the mainstem. During storm events, flows are taken from the B10 Bridge approximately ½ mile downstream of the gaging station. Blue Creek was targeted because it is a unique watershed and is a major tributary to the Lower Klamath River with a total drainage area of 80,321 acres (Figure 2, Figure 4). Extensive logging activities have and continue to occur in the Blue Creek watershed, along with restoration projects. YTFP also monitors outmigrating salmonids in Lower Blue Creek and conducts extensive spawner surveys during the fall and winter months in the mainstem, West Fork of Blue Creek, and Crescent City Fork of Blue Creek.

The Turwar gaging station has been in operation since October 9th, 2003. The station is located at 41° 32' 6" north latitude, 123° 58' 43" west longitude. The gaging station is located several miles upstream of the mouth due to subsurface flows during summer months in the lower reach. YTEP plans on installing a gaging station on Turwar Creek at the Highway 169 Bridge to investigate the difference in discharge during winter and

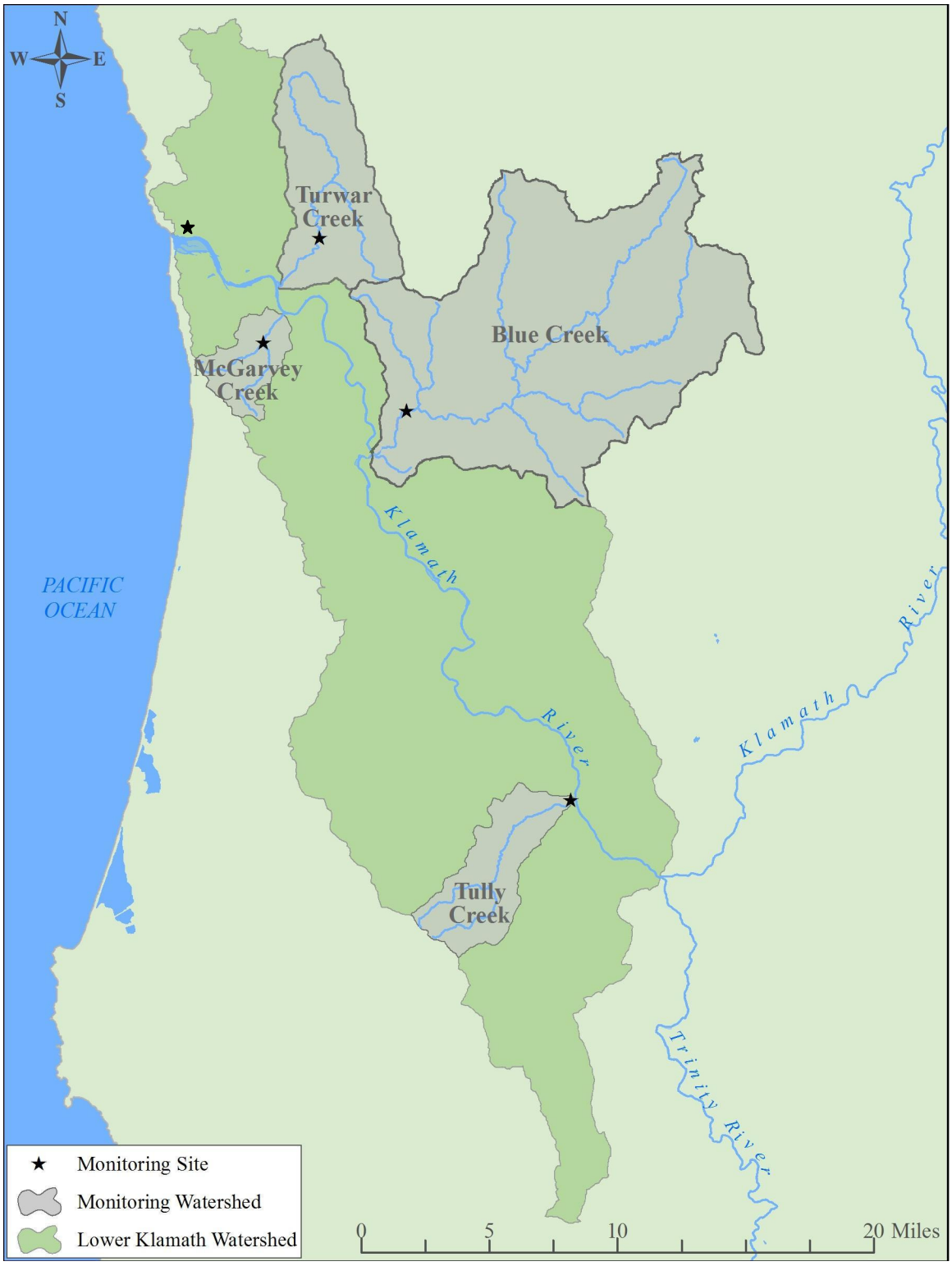

Figure 2. Watershed boundaries of Blue, McGarvey, Turwar, and Tully creeks and the location of YTEP gaging stations within these watersheds and the Klamath River estuary.

Figure 3. McGarvey Creek looking upstream from the gaging station location at the confluence of the West Fork (right) and mainstem (left).

Figure 4. Blue Creek looking downstream at staff plate at gaging station location.

spring months when the creek is flowing. The total drainage area of the watershed is 20,380 acres (Figure 2, Figure 5).

The Tully Creek gaging station has been in operation since February 11, 2005. The station is located at 41° 13' 42" north latitude, 123° 46' 32" west longitude and encompasses a drainage area of 11,267 acres (Figure 2, Figure 6). The site location is approximately ¼ mile upstream of the mouth and was selected to monitor the impacts of development adjacent to Tully Creek. During storm events, flows are taken from the Tully Creek Rd. Bridge approximately 200 ft. downstream of the gaging station.

YTEP also installed a gaging station in the Klamath River estuary on September 29, 2005 at 41° 32' 45" north latitude, 124° 04' 21" west longitude. The site is located approximately ½ mile inland from the Pacific Ocean at Requa. Water levels are recorded at this site; however, they are not used to calculate discharge. Gage height varies in the estuary seasonally as well as daily depending on many factors including river flow, tidal stage and location of the river mouth. The goal of operating this site is to increase the knowledge about the estuary and investigate how tidal stage, river flow, and the location of the mouth affect the physical, chemical, and biological characteristics of the estuary. Data from the estuary gaging station will not be included in this report since it was only in operation for one day before the end of the water year (Figure 2, Figure 7).

Figure 5. Turwar Creek gaging station looking upstream at staff plate (left) and cableway.

Figure 6. Tully Creek looking downstream at gaging station site (staff plate is on left bank).

Figure 7. Gaging station located in the Klamath River estuary at Requa Resort.

IV. Methods

Gage height was measured at computerized gaging stations with WaterLog® Pressure Transducer/Data Collection Platforms. Datalogger models differ among sites, with H-350XL models installed at McGarvey, Blue, and Tully Creeks and in the Klamath River estuary. An H-350 model was installed at the Turwar Creek gaging station until it was removed on 12/20/04 due to technical difficulties. A new H-350XL was then installed at Turwar Creek and began logging on 1/26/05. The following parameters are measured at each site on a fifteen-minute time interval throughout the year: date, time, stage, air temperature (inside the gaging box), and battery voltage. Data was downloaded from the gaging station using either a SanDisk Compact Flash Memory Card (for H-350XL models) or by exchanging linear datacards (H-350 model). During site visits, gage height was compared visually to water level on a fixed, graduated staff plate and adjusted accordingly when a difference greater than 5% was observed. If gage height was

adjusted during site visits, it was noted in the site field notebook and the data file was flagged accordingly.

Flow measurements were collected at or near the gaging station periodically, especially during high flow events during winter months. Stream discharge was measured by wading, with a bridge crane, or with a bank operated cableway using USGS methodology (Buchanan and Somers 1969, Nolan and Sultz 2001). Discharge was measured using either a Price AA® or Pygmy® flow meter, depending on stream depth, and an AquaCalc® flow computer. During high flow measurements in Turwar Creek, measurements were taken at a cableway installed at the gage site. In McGarvey and Blue Creeks, however, non-wadable flow measurements were taken from bridges downstream of the gage site using a sounding weight, crane, and B-reel. At Blue Creek, the distance between the gage site and the bridge on the B-10 road is approximately one kilometer, with no measurable surface inputs between the two points. In McGarvey Creek the bridge is approximately ½ kilometer downstream of the gaging station, with Den Creek flowing into McGarvey Creek directly upstream of the bridge. During high flow measurements, a flow is also taken from Den Creek and subtracted from the total McGarvey flow so that discharge at the bridge is comparable with flow at the gaging station.

Flow measurements taken at each site were used to create a rating curve based on USGS methodology (Kennedy 1984). To increase our confidence in the rating curves and ensure that they encompass as much of the variability in flow as possible, flow measurements between the installation of the sites and January 2006 were used. Although flows taken after the end of WY05 are used to compute rating curves, it increases the accuracy and precision of the data since several high flows were taken during WY06. To estimate a continuous flow record at each gaging station, the rating curve equation was applied to gage height datum. Minimum, maximum, and average daily streamflow were calculated, and total monthly discharge in acre feet was calculated using the following formula:

Acre Feet / Month = $\left\{\frac{(x)\text{cf}}{\text{sec}} * \frac{60\,\text{sec}}{\text{min}} * \frac{60\,\text{min}}{\text{hr}} * \frac{24\text{hr}}{\text{day}} * \frac{\#\text{days}}{\text{month}}\right\} * \frac{1\text{acrefoot}}{43{,}560\,\text{cf}}$

YTEP also periodically collected suspended sediment samples at gaging stations during WY05. Depth integrated samples were collected using either a US-D-48 wadable sediment sampler or US-D-74 sampler attached to either a bank operated cableway or crane for non-wadable sampling. YTEP followed Equal Discharge Increment (EDI) and Equal Width Increment (EWI) methodology developed by USGS (Edwards and Glysson 1998). Sediment samples were analyzed by Graham Mathews and Associates (Arcata, California) following all USGS protocols to determine suspended sediment concentrations (SSC).

Turbidity was also periodically monitored in McGarvey, Blue, and Turwar creeks using two different methodologies. In McGarvey and Blue creeks, Hydrolab Datasondes (sensor 4a) were deployed and programmed to collect water temperature (°C), turbidity (NTU), and specific conductivity (µS/cm) at 15-minute intervals. Two deployments were conducted in McGarvey Creek (12/27/04 – 1/11/05; 3/23/05 – 4/08/05) and one in Blue Creek (11/24/04 – 12/10/04). In Turwar Creek, a DTS-12 SDI turbidity sensor (Forest Technology Systems, Inc.) was deployed at the gaging station on 11/10/04 until high flows damaged the instrument on 12/09/04 and it was removed for repairs.

V. Results and Discussion

McGarvey Creek

Discharge

The rating curve for WY05 was generated using flow measurements taken between 12/07/01 - 3/16/2006 (N = 38) and produced the following formula (Figure 8):

$y = 2.0792x^{3.9962}$, where y = discharge in cfs and x = gage height

Datapoints on the McGarvey Creek rating curve are the most scattered of all YTEP gaging stations due to changing streambed characteristics at the site. The highest flow measurement taken at McGarvey Creek during the water year was 60.3 cfs (Figure 9);

however, a flow measurement of 270 cfs was taken on 12/29/03 and is included in the rating curve that discharge is calculated from. The highest estimated flow in McGarvey Creek was 233.8 cfs on 4/08/05 at 20:15 (Figure 9). The lowest flow measured in McGarvey Creek was 1.62 cfs on 8/04/05 during summertime low flows (Figure 9). The lowest estimated flows based on the rating curve equation were 0.73 cfs at the beginning of the water year on 10/08/04 (Table 2).

Data is missing from the gaging record between 04/13/05 – 6/06/05 due to an error in data transfer. During this time, there were several small storms that produced peaks in gaging records from other stations. Rainfall recorded at the CDEC/DWR rain gage totaled 8.68 inches during this time, with scattered small storms and two notable storms. The first storm event occurred between 5/03/05 – 5/10/05 and resulted in 4.24 inches of rain while the second storm (5/15/05 – 5/22/05) produced 2.64 inches of additional rainfall. Total acre feet discharged from McGarvey Creek was estimated to be 8,121; however, this is a low estimate since 53 days of data are missing, including significant rainfall events (Table 4).

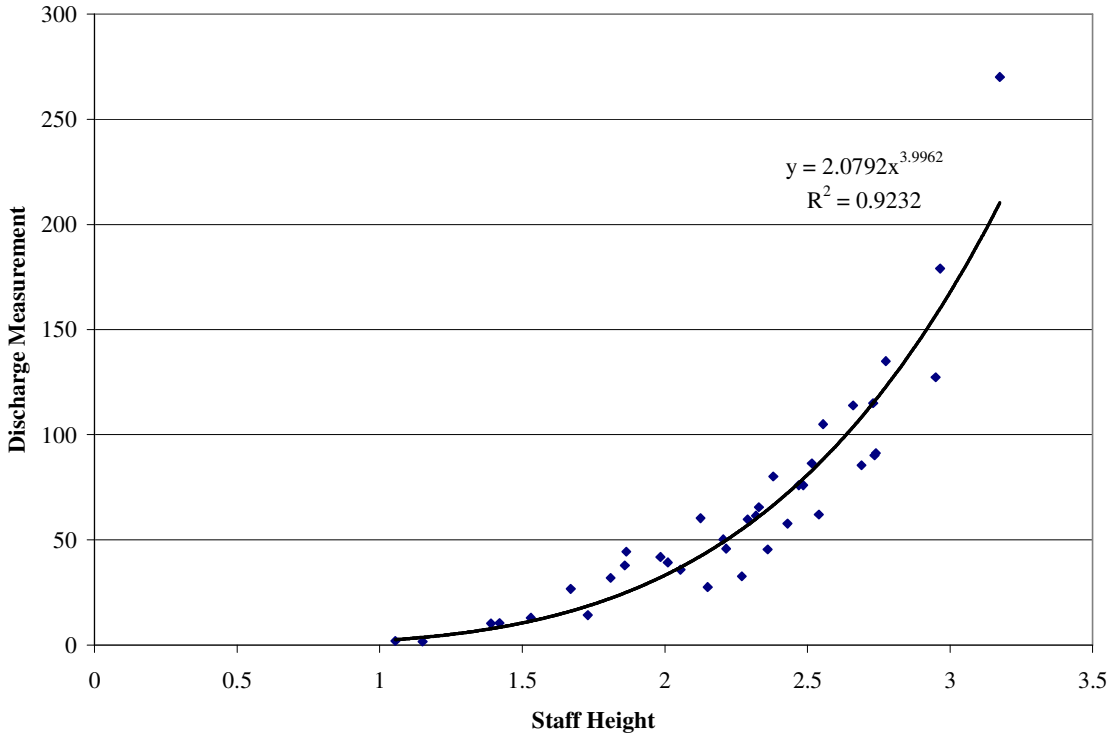

Figure 8. Discharge rating curve for McGarvey Creek using flow measurements taken between 12/07/01 – 3/16/06.

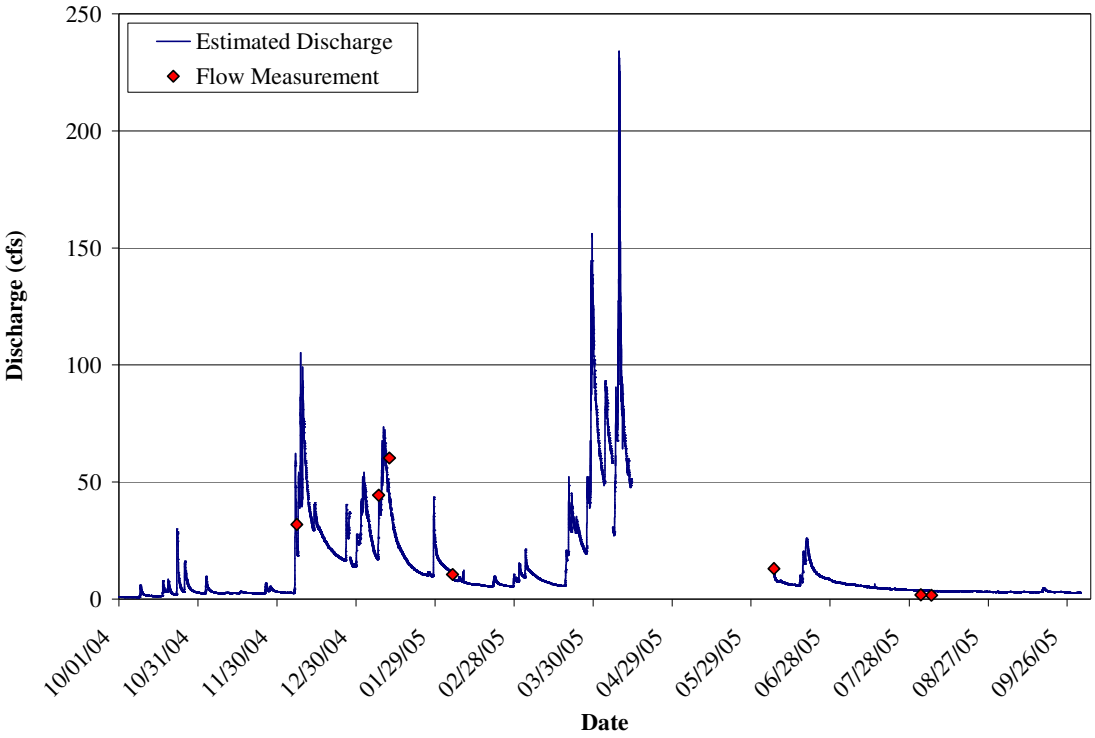

Figure 9. McGarvey Creek hydrograph and flow measurements for WY05.

Table 2. Minimum daily discharge (cfs) values for McGarvey Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	Aug	Sept
1	0.90	2.43	2.83	35.91	13.27	7.32	57.00			6.90	3.63	2.72
2	0.85	2.34	2.72	35.91	12.29	9.96	49.45			6.50	3.51	2.72
3	0.81	4.17	2.62	30.61	11.68	9.18	48.56			6.31	3.39	2.83
4	0.81	3.27	2.62	24.30	8.21	9.18	67.62			6.12	3.39	2.93
5	0.81	2.83	2.62	19.46	7.98	11.68	62.14			6.12	3.27	2.83
6	0.77	2.62	2.53	17.33	7.53	10.79	27.03		8.93	5.93	3.27	2.83
7	0.73	2.53	18.59	16.93	7.75	9.96	27.60		7.53	5.75	3.27	2.72
8	0.73	2.53	24.83	35.91	7.10	8.93	67.62		7.32	5.58	3.27	2.72
9	2.16	2.43	39.56	48.56	6.90	8.21	78.38		7.10	5.40	3.16	2.93
10	1.62	2.53	54.07	45.97	6.50	7.75	64.29		6.70	5.40	3.16	2.93
11	1.43	2.53	40.32	41.10	6.31	7.32	54.07		6.31	5.07	3.16	2.83
12	1.31	2.53	33.85	31.24	6.12	6.90	48.56		6.12	5.07	3.16	2.83
13	1.19	2.62	29.38	26.47	6.12	6.50	47.68		5.93	4.91	3.04	2.83
14	1.19	2.53	32.52	22.27	5.93	6.31			5.75	4.76	3.16	2.83
15	1.14	2.53	29.99	20.83	5.75	5.93			5.75	4.60	3.27	2.83
16	1.19	2.83	27.60	18.59	5.58	5.75			5.75	4.45	3.27	2.93
17	1.25	2.72	24.83	16.53	5.40	5.58			7.10	4.31	3.27	3.51
18	3.04	2.62	23.27	15.01	5.40	5.58			15.01	4.31	3.27	3.16
19	2.93	2.62	21.30	13.60	5.40	5.58			17.74	4.31	3.27	3.04
20	2.43	2.53	20.36	12.61	6.31	16.53			13.60	4.17	3.27	2.83
21	1.92	2.53	19.02	11.98	6.70	28.78			11.98	4.17	3.39	2.83
22	1.77	2.43	18.16	11.38	6.12	29.99			10.79	4.17	3.16	2.93
23	6.31	2.43	17.33	10.79	5.75	28.19			9.69	4.03	3.04	2.93
24	3.51	2.43	16.93	10.23	5.58	25.91			9.43	4.03	3.04	2.83
25	2.93	2.43	16.53	9.96	5.58	22.27			8.93	3.89	3.04	2.72
26	6.50	3.27	16.53	9.96	5.40	19.91			8.68	3.76	3.04	2.72
27	4.31	3.63	16.14	9.69	5.24	19.46			8.21	3.76	2.93	2.62
28	3.39	3.39	13.60	9.69	7.75	38.81			7.53	3.76	2.83	2.62
29	2.93	3.16	13.60	17.33		45.97			7.10	3.63	2.83	2.62
30	2.83	2.93	14.65	15.38		84.89			6.90	3.63	2.83	2.62
31	2.53		23.78	14.29		68.75				3.63	2.72	
Monthly Statistics												
Total	66.22	82.37	622.68	659.82	195.63	577.82	700.00		215.90	148.44	98.30	85.26
Mean	2.14	2.75	20.09	21.28	6.99	18.64	53.85		8.64	4.79	3.17	2.84
Max	6.50	4.17	54.07	48.56	13.27	84.89	78.38		17.74	6.90	3.63	3.51
Min	0.73	2.34	2.53	9.69	5.24	5.58	27.03		5.75	3.63	2.72	2.62

Table 3. Maximum daily discharge (cfs) values for McGarvey Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	0.94	2.53	2.93	54.07	14.29	15.38	68.75			7.10	3.76	2.93
2	0.94	8.21	2.83	52.19	13.27	14.65	58.00			6.90	3.76	2.93
3	0.90	9.69	2.72	40.32	12.29	9.96	93.22			6.70	3.63	3.04
4	0.85	4.17	2.72	31.24	11.68	21.30	90.38			6.50	3.63	3.16
5	0.90	3.27	2.72	24.30	8.21	13.27	69.91			6.31	3.51	3.04
6	0.85	2.83	62.14	19.91	8.93	11.68	62.14		11.38	6.12	3.51	2.93
7	0.81	2.62	59.02	42.67	9.43	10.79	90.38		8.68	6.12	3.51	3.04
8	4.60	2.62	105.27	67.62	12.29	9.96	233.78		7.98	5.75	3.51	3.04
9	5.93	2.62	99.11	73.45	7.10	9.18	228.11		7.98	5.75	3.39	3.16
10	2.16	2.72	83.56	67.62	6.90	8.21	91.79		7.10	5.58	3.39	3.16
11	1.62	2.72	55.04	51.26	6.50	7.98	69.91		6.90	5.40	3.39	3.04
12	1.43	2.62	40.32	41.10	6.31	7.32	60.04		6.50	5.24	3.27	2.93
13	1.84	2.62	33.18	31.87	6.50	7.10	51.26		6.12	5.07	3.27	2.93
14	1.25	2.62	41.10	26.47	6.12	6.70			6.12	6.50	3.27	2.93
15	1.19	2.93	32.52	22.76	5.93	6.31			5.93	4.91	3.39	3.04
16	1.25	3.27	29.99	20.83	5.75	5.93			10.23	4.76	3.39	4.60
17	7.75	2.83	27.03	18.59	5.58	5.93			20.36	4.76	3.39	4.60
18	4.45	2.72	24.83	16.93	5.58	5.75			24.83	4.60	3.39	3.39
19	8.44	2.62	23.27	15.01	6.31	20.83			25.91	4.45	3.39	3.16
20	5.58	2.62	21.30	13.94	9.69	52.19			17.74	4.45	3.39	3.04
21	2.43	2.53	20.36	12.94	7.98	45.13			13.94	4.31	3.39	2.93
22	23.78	2.53	19.02	11.98	6.70	44.30			11.98	4.45	3.39	3.04
23	29.99	2.43	18.16	11.38	6.12	35.21			10.79	4.31	3.39	3.16
24	6.31	2.43	17.74	10.79	5.75	31.87			9.69	4.17	3.16	2.93
25	15.76	6.70	16.93	10.51	5.58	26.47			9.43	4.17	3.16	2.83
26	16.14	4.60	40.32	11.68	5.58	22.76			8.93	4.03	3.27	2.72
27	6.50	5.24	37.34	10.51	10.51	52.19			8.68	3.89	3.16	2.72
28	4.31	4.17	16.14	43.48	9.18	52.19			8.21	3.89	3.04	2.62
29	3.39	3.39	15.01	23.27		154.71			7.75	3.89	3.04	2.72
30	2.93	3.16	27.60	17.33		127.30			7.32	3.76	3.39	2.72
31	2.83		41.88	15.38		87.60				3.76	2.93	
Monthly Statistics												
Total	168.05	106.06	1022.10	911.37	226.03	930.12	1267.67		270.49	157.60	104.45	92.54
Mean	5.42	3.54	32.97	29.40	8.07	30.00	97.51		10.82	5.08	3.37	3.08
Max	29.99	9.69	105.27	73.45	14.29	154.71	233.78		25.91	7.10	3.76	4.60
Min	0.81	2.43	2.72	10.51	5.58	5.75	51.26		5.93	3.76	2.93	2.62

Table 4. Average daily discharge (cfs) values for McGarvey Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	0.93	2.49	2.86	43.13	13.84	8.42	62.65			6.99	3.70	2.78
2	0.91	2.83	2.75	44.48	12.88	11.51	53.76			6.77	3.70	2.83
3	0.87	5.75	2.68	34.95	12.10	9.62	65.72			6.50	3.58	2.99
4	0.84	3.61	2.68	27.12	10.31	14.09	78.38			6.33	3.48	3.06
5	0.85	3.01	2.66	21.55	8.08	12.35	65.51			6.23	3.45	2.91
6	0.83	2.73	6.03	18.24	7.90	11.32	39.82		9.87	6.11	3.39	2.88
7	0.78	2.60	27.51	26.75	8.42	10.30	53.21		8.03	5.97	3.38	2.87
8	1.01	2.53	49.69	43.54	7.50	9.45	108.02		7.47	5.68	3.35	2.93
9	3.39	2.44	65.22	63.75	6.99	8.69	118.47		7.47	5.64	3.31	3.08
10	1.86	2.65	65.60	56.72	6.69	8.12	76.97		6.96	5.51	3.28	3.00
11	1.53	2.65	47.03	45.59	6.47	7.65	62.44		6.61	5.30	3.26	2.93
12	1.38	2.53	36.53	35.97	6.24	7.22	54.07		6.26	5.15	3.22	2.87
13	1.27	2.62	30.87	28.92	6.23	6.83	49.43		6.06	5.01	3.18	2.89
14	1.19	2.61	36.34	24.48	6.06	6.44			5.99	4.89	3.20	2.89
15	1.19	2.62	30.78	21.76	5.88	6.11			5.84	4.73	3.29	2.95
16	1.21	3.05	28.69	19.63	5.72	5.89			7.33	4.65	3.35	3.52
17	2.87	2.77	26.09	17.56	5.55	5.75			11.11	4.54	3.34	4.04
18	3.28	2.65	24.15	15.79	5.41	5.59			18.08	4.42	3.32	3.31
19	4.86	2.62	22.27	14.42	5.47	9.72			21.37	4.37	3.34	3.13
20	3.35	2.57	21.00	13.32	8.33	25.35			15.49	4.31	3.37	3.00
21	2.11	2.53	19.78	12.38	7.14	32.75			12.89	4.28	3.39	2.92
22	2.36	2.49	18.72	11.67	6.34	34.48			11.34	4.28	3.34	3.00
23	15.92	2.43	17.91	11.04	5.98	30.66			10.32	4.14	3.24	3.04
24	4.52	2.43	17.15	10.59	5.74	28.86			9.60	4.09	3.11	2.91
25	4.17	3.95	16.60	10.31	5.58	24.26			9.17	4.01	3.10	2.81
26	9.57	3.68	27.94	10.89	5.45	21.23			8.85	3.91	3.14	2.72
27	5.17	4.59	26.06	9.94	6.28	27.75			8.47	3.83	3.05	2.64
28	3.77	3.70	14.56	21.39	8.43	44.20			7.96	3.82	2.98	2.62
29	3.16	3.24	14.31	19.50		104.83			7.49	3.77	2.98	2.66
30	2.86	3.02	23.25	16.38		100.59			7.14	3.70	2.95	2.72
31	2.67		27.22	14.92		76.76				3.70	2.86	
Monthly Statistics												
Total	90.71	89.41	754.92	766.67	207.01	716.76	888.45		237.17	152.65	101.63	88.90
Mean	2.93	2.98	24.35	24.73	7.39	23.12	68.34		9.49	4.92	3.28	2.96
Max	15.92	5.75	65.60	63.75	13.84	104.83	118.47		21.37	6.99	3.70	4.04
Min	0.78	2.43	2.66	9.94	5.41	5.59	39.82		5.84	3.70	2.86	2.62
Acre Feet	179.92	177.34	1497.36	1520.68	410.59	1421.67	1762.21		470.42	302.78	201.59	176.33
Total Acre Feet for WY05			8120.89									

Turbidity

Turbidity ranged from 3.6 – 1363 NTU between 12/27/04 – 1/11/05 and 7.7 – 371.8 NTU between 3/23/05 and 4/08/05 (Figure 10).

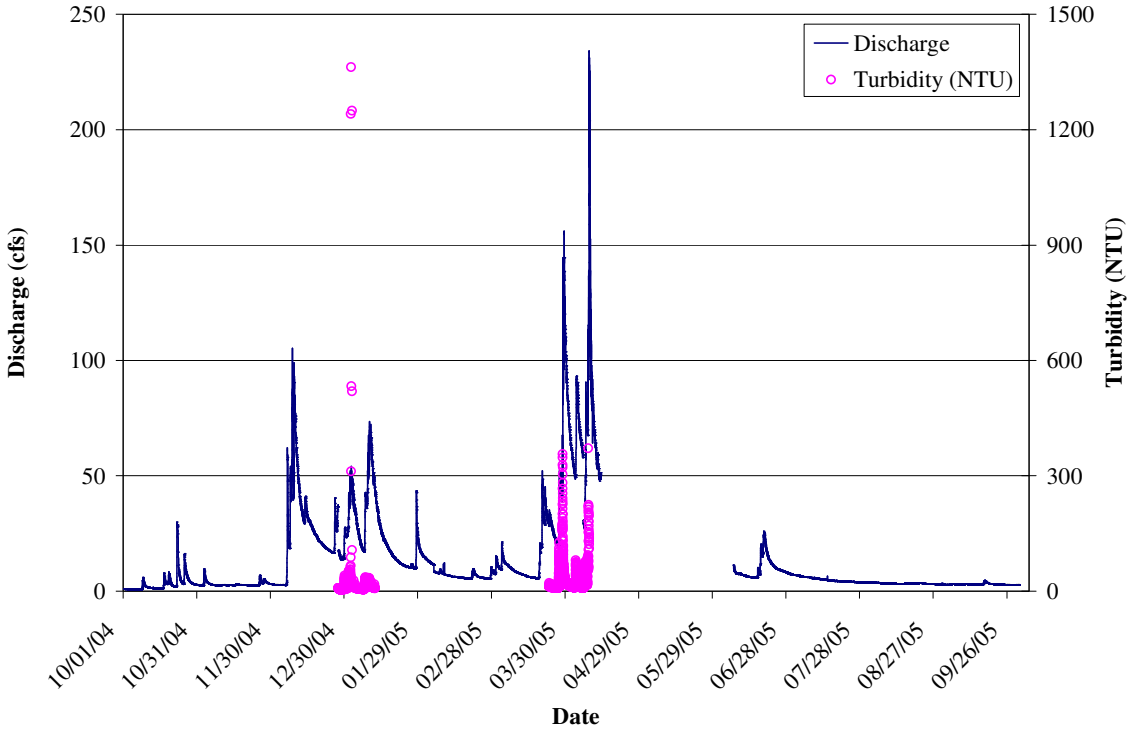

Figure 10. McGarvey Creek hydrograph and fifteen minute turbidity data for WY05.

Specific Conductivity

Specific conductivity ranged between 54.7 – 63.7 µS/cm between 3/23/05 and 4/08/05.

Water Temperature

Temperature ranged between 7.31 – 9.39°C during monitoring from 12/27/04 – 1/11/05 and 8.71 – 10.86°C between 3/23/05 – 4/08/05.

Suspended Sediment

Table 5. Suspended sediment samples taken in McGarvey Creek during WY05.

Sample ID	Bottle Number	Date	Time	SSC (mg/L)	Turbidity (NTU) Lab	Turbidity (NTU) Datasonde	Gage Height (ft)	Hydraulic Position	Flow Est (cfs)
McG120704		12/7/2004	12:38	10.7	6.5	N/A	1.82	F	31.9**
McG010705	a	1/7/2005	12:45	27.6	10.0	26.0	1.98	R	44.4**
McG010705*	b	1/7/2005	12:49	28.5	9.7	26.0	1.98	R	44.4**
McG032905	a	3/29/2005	15:46	74.2	25.0	44.2	2.9	F	146.46
McG032905	b	3/29/2005	15:46	58.6	28.0	44.2	2.9	F	146.46
McG032905	c	3/29/2005	15:46	61.5	22.0	44.2	2.9	F	146.46
McG032905	d	3/29/2005	15:46	61.8	26.0	44.2	2.9	F	146.46
McG032905	e	3/29/2005	15:46	58.5	25.0	44.2	2.9	F	146.46

*Replicate Sample
**Actual Flow Measurement Taken
Hydraulic Position: F = Falling, R = Rising, P = Peak

Gage Height was read from the gaging station.
Flow Estimate (cfs) was calculated from flow rating curve Q = 2.0792*(stage height)^3.9962

Blue Creek

Discharge

The rating curve for WY05 was produced using data collected between 5/23/02 – 1/20/06 (N = 16) and produced the following formula (Figure 11):

$$y = 118.02x^{2.0499}, \text{ where } y = \text{discharge in cfs and } x = \text{gage height}$$

The highest flow measurement taken in Blue Creek during the water year was 2,160 cfs on 3/28/05 (Figure 12). The highest flow measurement on the rating curve used to estimate discharge is 3,794 cfs, taken on 12/22/2005. Two storm events exceeded measured flows, and the estimates of these discharges should be considered with caution because they are only as robust as the rating curve is. The maximum estimated flow in Blue Creek was 13,212 cfs during a storm event on 12/08/2004, corresponding with a gage height of 9.98 ft (Figure 13). The lowest estimated flow was 34.56 cfs and occurred at the end of the water year during summer base flows (9/29/2005, Figure 12). Total acre feet discharged from Blue Creek was estimated to be 395,113 (Table 8).

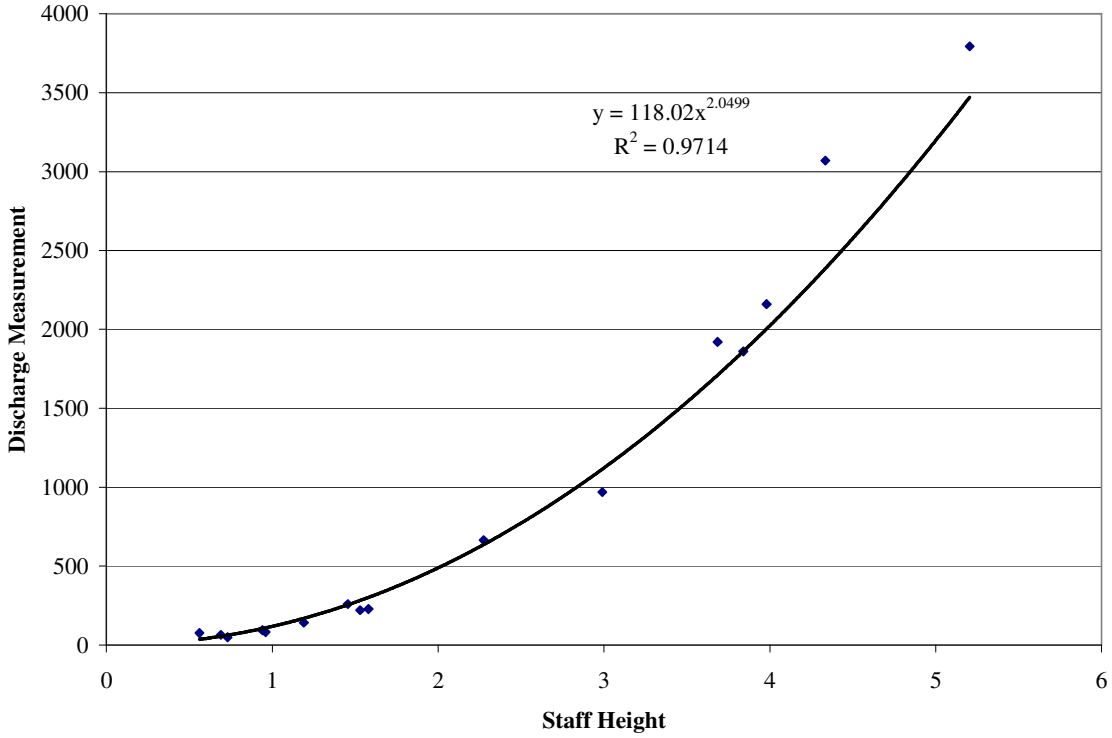

Figure 11. Discharge rating curve for Blue Creek using flow measurements taken between 5/23/02 – 1/20/06.

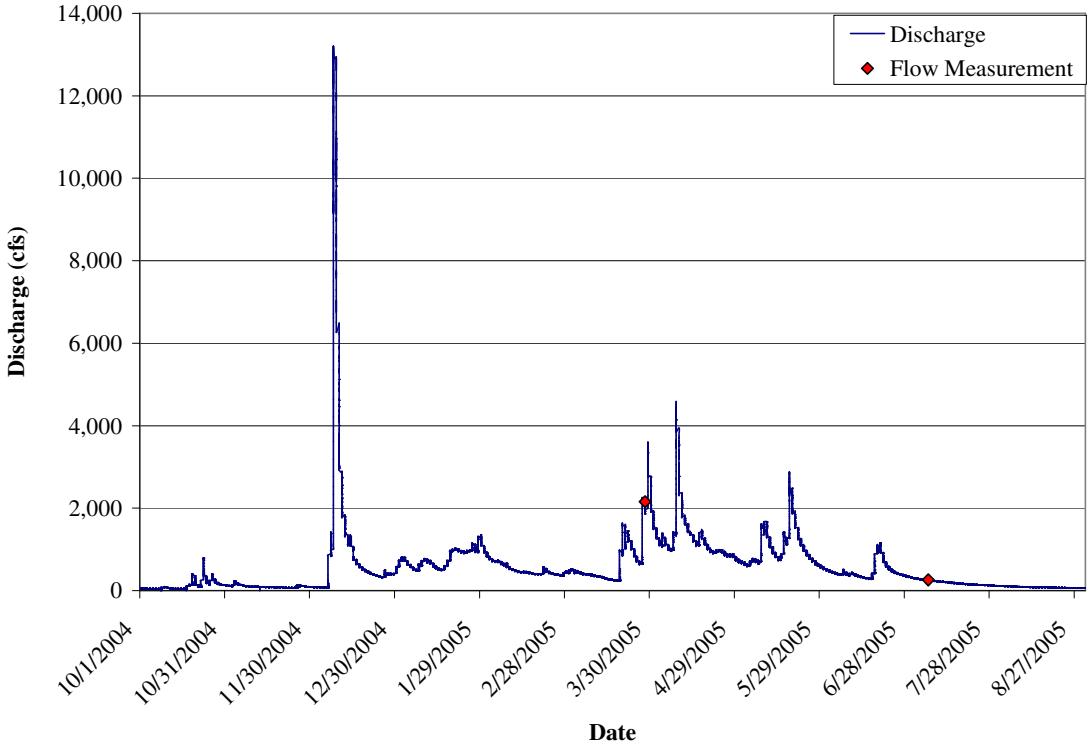

Figure 12. Blue Creek hydrograph and flow measurements for WY05.

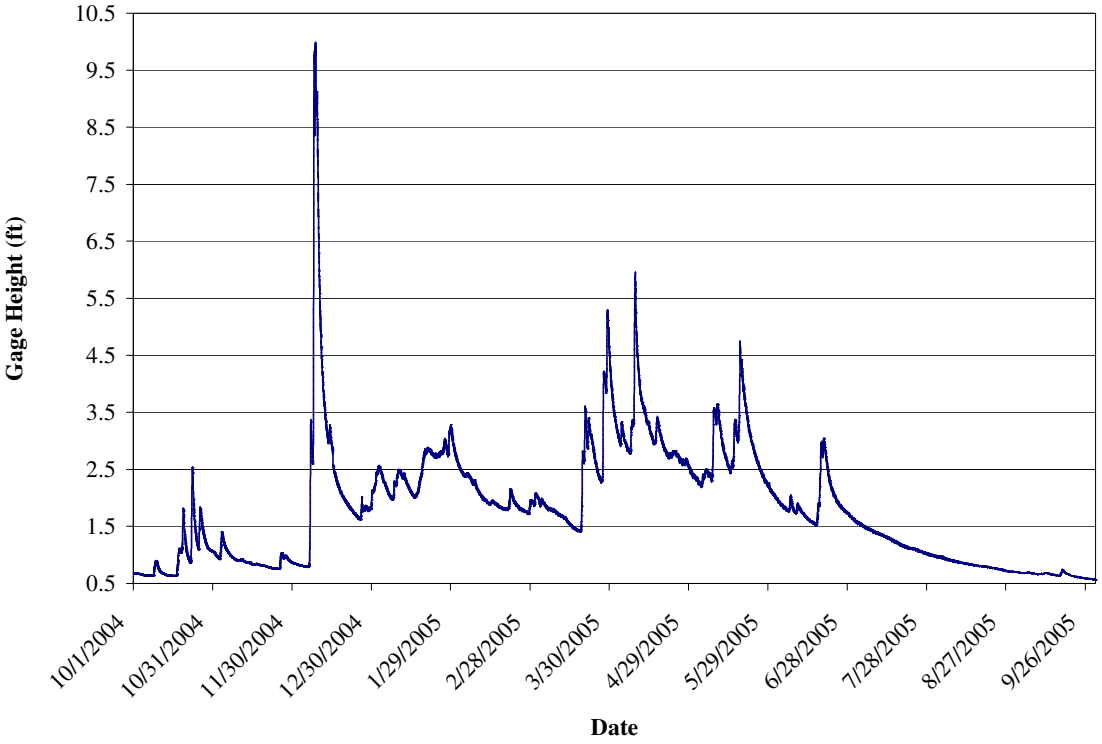

Figure 13. Blue Creek gage height data for WY05.

Table 6. Minimum daily discharge (cfs) values for Blue Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	Aug	Sept
1	50.35	106.24	80.55	710.15	747.02	416.52	1256.25	650.82	449.46	282.20	106.24	51.93
2	50.35	99.48	76.62	710.15	698.07	483.70	1091.58	610.87	425.80	274.69	103.96	51.93
3	48.80	143.48	74.70	627.83	686.10	411.91	1046.71	583.12	398.26	267.28	99.48	51.93
4	47.28	146.17	72.79	561.40	680.15	421.14	1084.04	594.14	384.85	252.78	97.27	53.53
5	47.28	125.39	72.79	498.76	633.54	411.91	988.37	698.07	371.67	245.69	92.94	50.35
6	45.77	113.23	70.92	473.79	605.26	384.85	952.78	686.10	380.43	242.18	90.81	50.35
7	45.77	103.96	830.19	468.87	556.03	376.04	988.37	639.27	371.67	228.40	88.71	48.80
8	45.77	95.09	1002.80	594.14	514.07	371.67	1322.10	692.07	354.47	225.02	86.63	48.80
9	74.70	92.94	6261.21	716.23	488.69	358.73	2302.41	1347.24	389.30	221.66	84.58	48.80
10	58.49	92.94	2915.51	668.34	463.98	341.84	1772.81	1280.74	358.73	215.03	82.55	50.35
11	51.93	90.81	1772.81	650.82	439.92	333.55	1593.58	1046.71	337.68	205.28	80.55	50.35
12	48.80	86.63	1305.48	577.65	425.80	321.31	1415.46	897.23	317.28	198.91	78.57	48.80
13	47.28	84.58	1084.04	534.84	435.19	301.43	1338.83	804.12	301.43	192.64	76.62	47.28
14	45.77	80.55	1076.52	498.76	430.48	282.20	1176.36	728.47	289.81	180.41	74.70	45.77
15	45.77	78.57	734.63	483.70	411.91	263.62	1069.02	728.47	274.69	171.50	74.70	44.30
16	45.77	80.55	633.54	503.84	402.79	252.78	1076.52	890.41	274.69	171.50	72.79	45.77
17	45.77	78.57	556.03	588.62	389.30	242.18	1240.06	1099.16	411.91	159.99	72.79	56.81
18	110.88	74.70	503.84	722.34	384.85	238.69	1106.76	1264.39	897.23	154.38	70.92	50.35
19	125.39	74.70	459.11	938.74	384.85	238.69	995.57	1861.13	917.86	148.88	70.92	47.28
20	140.82	70.92	425.80	981.20	407.34	836.78	924.79	1512.09	686.10	143.48	69.07	44.30
21	97.27	69.07	398.26	945.75	444.68	1017.33	890.41	1232.00	561.40	143.48	67.24	42.85
22	84.58	67.24	376.04	904.08	416.52	1184.23	904.08	1076.52	498.76	140.82	67.24	42.85
23	263.62	67.24	350.23	897.23	393.77	988.37	938.74	952.78	454.28	135.58	63.66	41.42
24	177.41	65.44	321.31	910.96	376.04	823.64	924.79	843.39	421.14	130.43	61.91	40.02
25	140.82	65.44	313.28	945.75	371.67	692.07	843.39	765.82	393.77	127.90	60.19	38.64
26	249.22	103.96	321.31	952.78	358.73	627.83	817.10	692.07	371.67	122.91	58.49	37.28
27	192.64	106.24	376.04	924.79	354.47	639.27	817.10	627.83	358.73	120.45	56.81	37.28
28	151.62	92.94	376.04	917.86	425.80	1861.13	804.12	594.14	337.68	115.61	56.81	35.96
29	138.19	86.63	384.85	1084.04		1992.58	716.23	545.38	317.28	113.23	55.16	34.65
30	130.43	82.55	421.14	917.86		1901.09	674.23	514.07	305.35	110.88	55.16	34.65
31	120.45		566.79	810.60		1476.57		478.73		106.24	53.53	
Monthly Statistics												
Total	2969.03	2726.29	24215.16	22721.88	13327.00	20493.63	33072.60	26937.35	12613.38	5549.46	2331.02	1373.40
Mean	95.78	90.88	781.13	732.96	475.96	661.08	1102.42	868.95	420.45	179.01	75.19	45.78
Max	263.62	146.17	6261.21	1084.04	747.02	1992.58	2302.41	1861.13	917.86	282.20	106.24	56.81
Min	45.77	65.44	70.92	468.87	354.47	238.69	674.23	478.73	274.69	106.24	53.53	34.65

Table 7. Maximum daily discharge (cfs) values for Blue Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	53.53	120.45	84.58	810.60	830.19	498.76	1521.03	716.23	493.72	309.30	113.23	56.81
2	51.93	140.82	80.55	817.10	772.13	529.61	1280.74	692.07	463.98	301.43	110.88	55.16
3	51.93	238.69	78.57	722.34	728.47	498.76	1389.68	645.03	439.92	289.81	113.23	55.16
4	50.35	186.47	74.70	627.83	734.63	483.70	1297.21	716.23	416.52	278.43	106.24	58.49
5	48.80	146.17	74.70	566.79	704.10	459.11	1122.04	778.48	398.26	267.28	101.71	55.16
6	48.80	125.39	863.38	514.07	662.47	425.80	1024.63	772.13	514.07	259.98	97.27	53.53
7	47.28	113.23	1424.11	650.82	662.47	407.34	1424.11	734.63	444.68	249.22	97.27	53.53
8	74.70	103.96	13211.89	728.47	577.65	398.26	4582.82	1611.98	416.52	242.18	92.94	51.93
9	95.09	97.27	12942.21	772.13	529.61	393.77	3945.27	1667.85	444.68	235.24	90.81	53.53
10	80.55	101.71	6485.16	765.82	498.76	376.04	2369.37	1677.26	407.34	228.40	88.71	55.16
11	58.49	101.71	2890.56	728.47	473.79	358.73	1831.44	1297.21	367.33	221.66	86.63	55.16
12	53.53	92.94	1841.31	662.47	454.28	350.23	1621.23	1061.56	346.02	211.76	84.58	53.53
13	50.35	88.71	1355.67	605.26	468.87	337.68	1432.79	924.79	325.36	208.51	82.55	50.35
14	48.80	90.81	1347.24	545.38	463.98	309.30	1355.67	823.64	309.30	198.91	82.55	50.35
15	47.28	82.55	1069.02	514.07	444.68	289.81	1207.99	883.61	301.43	192.64	80.55	48.80
16	47.28	84.58	753.26	599.69	425.80	270.97	1406.84	1424.11	416.52	186.47	78.57	56.81
17	108.55	82.55	650.82	734.63	411.91	259.98	1476.57	1288.96	890.41	177.41	76.62	65.44
18	146.17	78.57	572.21	974.06	407.34	249.22	1272.55	2878.13	1114.38	168.59	76.62	58.49
19	402.79	76.62	514.07	1017.33	411.91	988.37	1122.04	2483.17	1152.92	162.83	76.62	51.93
20	363.02	74.70	473.79	1031.96	572.21	1639.80	1024.63	1931.34	924.79	159.99	74.70	48.80
21	140.82	72.79	435.19	1017.33	540.10	1602.77	966.94	1530.01	698.07	151.62	72.79	45.77
22	245.69	70.92	407.34	966.94	463.98	1450.22	981.20	1264.39	588.62	151.62	70.92	44.30
23	797.67	69.07	380.43	966.94	430.48	1207.99	995.57	1114.38	529.61	148.88	69.07	44.30
24	354.47	67.24	354.47	974.06	407.34	1017.33	988.37	974.06	473.79	140.82	67.24	42.85
25	249.22	122.91	337.68	995.57	398.26	836.78	952.78	876.84	435.19	138.19	65.44	41.42
26	411.91	125.39	498.76	1152.92	384.85	710.15	897.23	784.85	411.91	132.99	63.66	40.02
27	274.69	115.61	425.80	1129.72	430.48	2258.31	890.41	716.23	384.85	130.43	61.91	40.02
28	189.54	108.55	421.14	1322.10	468.87	2247.35	897.23	662.47	371.67	125.39	60.19	38.64
29	154.38	95.09	416.52	1347.24		3602.87	830.19	633.54	346.02	122.91	60.19	38.64
30	138.19	86.63	577.65	1091.58		2779.64	759.53	566.79	325.36	120.45	58.49	37.28
31	132.99		734.63	938.74		1931.34		529.61		115.61	58.49	
Monthly Statistics												
Total	5018.80	3162.14	51777.39	26292.42	14759.60	29169.99	42868.13	34661.58	15153.21	6028.96	2520.70	1501.35
Mean	161.90	105.40	1670.24	848.14	527.13	940.97	1428.94	1118.12	505.11	194.48	81.31	50.05
Max	797.67	238.69	13211.89	1347.24	830.19	3602.87	4582.82	2878.13	1152.92	309.30	113.23	65.44
Min	47.28	67.24	74.70	514.07	384.85	249.22	759.53	529.61	301.43	115.61	58.49	37.28

Table 8. Average daily discharge (cfs) values for Blue Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	52.10	113.03	82.22	763.52	790.11	444.93	1376.34	685.48	474.25	302.53	110.00	54.27
2	51.28	107.80	79.03	757.37	731.99	508.67	1177.92	648.83	447.02	289.93	108.28	53.73
3	50.09	200.03	76.20	661.74	707.94	458.20	1202.61	613.62	422.89	279.02	105.07	54.27
4	48.85	162.44	74.44	594.77	713.50	456.69	1181.44	670.55	402.36	268.09	101.08	55.53
5	47.99	134.63	73.49	530.04	675.28	433.03	1049.79	747.15	386.93	258.21	98.10	53.33
6	47.20	118.47	132.73	491.31	626.11	405.77	987.10	722.34	449.51	250.81	95.30	52.11
7	46.98	107.75	1064.82	547.43	607.94	394.84	1274.94	684.24	401.94	243.56	93.30	51.25
8	51.37	99.85	8514.56	644.01	547.21	386.10	2498.43	1263.12	375.58	233.77	90.48	50.58
9	88.15	94.76	9745.20	753.59	509.69	377.73	2872.05	1497.98	416.18	228.65	88.30	51.53
10	67.70	96.93	4173.30	711.23	480.18	357.84	2026.92	1470.70	381.67	222.08	86.25	52.70
11	55.45	95.32	2273.42	686.97	459.82	346.81	1699.31	1156.16	354.91	215.38	84.18	53.30
12	51.06	89.24	1543.99	620.91	441.80	335.82	1535.72	974.43	332.60	206.66	82.20	51.45
13	48.26	86.50	1184.89	565.55	450.86	322.87	1383.00	857.87	314.19	200.36	80.59	49.37
14	47.13	83.42	1203.44	520.19	446.02	296.72	1251.43	771.01	302.45	191.96	78.78	47.78
15	46.33	80.68	895.38	500.03	432.04	277.06	1135.81	813.85	289.81	184.37	77.33	46.79
16	45.81	82.47	690.45	543.29	412.58	262.78	1165.91	1258.62	316.73	178.07	76.16	49.20
17	63.91	79.91	600.62	662.66	402.36	251.18	1370.76	1184.23	525.27	170.92	75.08	61.14
18	135.31	77.17	536.92	840.56	397.47	243.82	1183.57	2124.76	995.87	163.60	74.08	54.31
19	208.54	75.22	488.49	975.47	399.06	402.46	1050.64	2115.24	1058.22	157.76	72.79	50.22
20	217.51	73.13	451.67	1004.91	503.36	1066.45	975.02	1682.66	798.61	152.57	71.11	46.74
21	113.85	70.80	418.63	982.32	491.15	1213.48	931.10	1375.63	635.75	148.26	69.85	44.79
22	101.38	68.95	389.99	942.68	440.31	1304.53	946.19	1172.93	546.43	146.45	69.09	43.54
23	542.02	67.70	363.42	930.59	414.69	1113.51	972.28	1025.39	490.68	143.15	66.85	42.46
24	241.12	66.92	341.18	939.32	396.01	908.31	950.44	906.73	447.02	137.75	64.99	41.45
25	164.02	89.65	324.01	967.01	385.40	758.28	892.40	816.22	416.61	133.61	63.48	40.09
26	333.16	114.92	403.92	1059.46	373.35	672.08	855.16	740.10	392.55	129.38	61.77	39.15
27	228.29	112.00	401.32	1018.69	372.62	1019.15	856.34	679.35	374.12	125.00	59.49	38.61
28	169.52	100.50	396.48	1123.47	455.89	2053.06	850.30	628.90	354.91	121.45	58.20	37.48
29	144.41	90.22	400.90	1215.14		3019.47	769.70	582.03	333.85	118.20	57.92	36.89
30	135.17	85.18	528.47	995.95		2263.00	714.14	540.76	317.70	115.34	57.61	36.22
31	127.59		628.25	866.10		1672.55		508.19		112.27	56.07	
Monthly Statistics												
Total	3771.54	2925.58	38481.80	24416.29	14064.78	24027.18	37136.77	30919.07	13756.61	5829.14	2433.78	1440.30
Mean	121.66	97.52	1241.35	787.62	502.31	775.07	1237.89	997.39	458.55	188.04	78.51	48.01
Max	542.02	200.03	9745.20	1215.14	790.11	3019.47	2872.05	2124.76	1058.22	302.53	110.00	61.14
Min	45.81	66.92	73.49	491.31	372.62	243.82	714.14	508.19	289.81	112.27	56.07	36.22
Acre Feet	7480.73	5802.80	76327.54	48429.00	27897.07	47657.22	73659.71	61327.08	27285.84	11561.94	4827.33	2856.79
Total Acre Feet for WY05			395113.07									

Turbidity

Turbidity ranged between 1 – 1100 NTU between 11/24/04 and 12/10/04 (Figure 14).

Specific Conductivity

Specific conductivity was not monitored in Blue Creek during WY05.

Water Temperature

Water temperature ranged between 6.74 – 10.33°C during monitoring from 11/24/04 – 12/10/04.

Suspended Sediment

No suspended sediment samples were collected from Blue Creek during WY05.

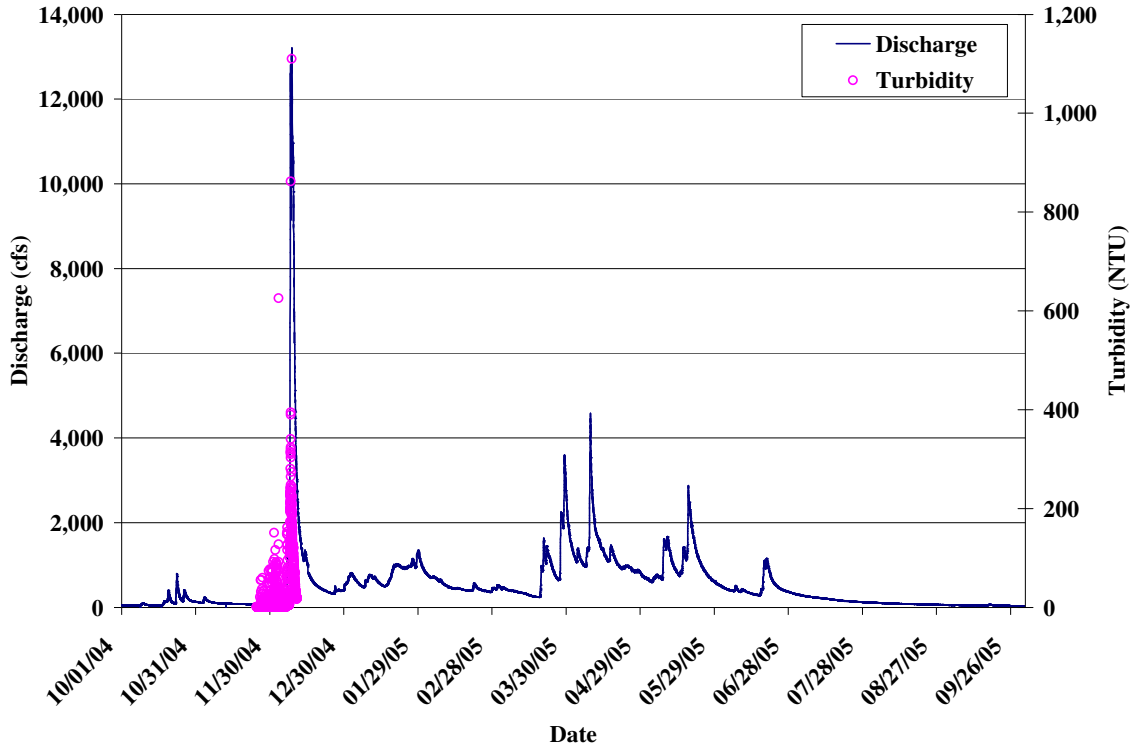

Figure 14. Blue Creek hydrograph and fifteen minute turbidity data for WY05.

Turwar Creek

Discharge

The rating curve for WY05 was generated using flow measurements taken between 1/27/05 – 5/18/06 (N = 8). Due to damage to the previous staff plate during a storm event, it had to be relocated and a new rating curve established. Although it only includes 8 data points to date, it will be built on for future discharge estimation. The new rating curve produced the following formula (Figure 15):

$y = 34.003x^{3.0503}$, where y = discharge in cfs and x = gage height

The highest flow measurement taken in Turwar Creek during the water year was 1,320 cfs on 4/08/05 (Figure 15). The highest flow measurement on the rating curve used to estimate discharge is 2,000 cfs, taken on 2/01/06.

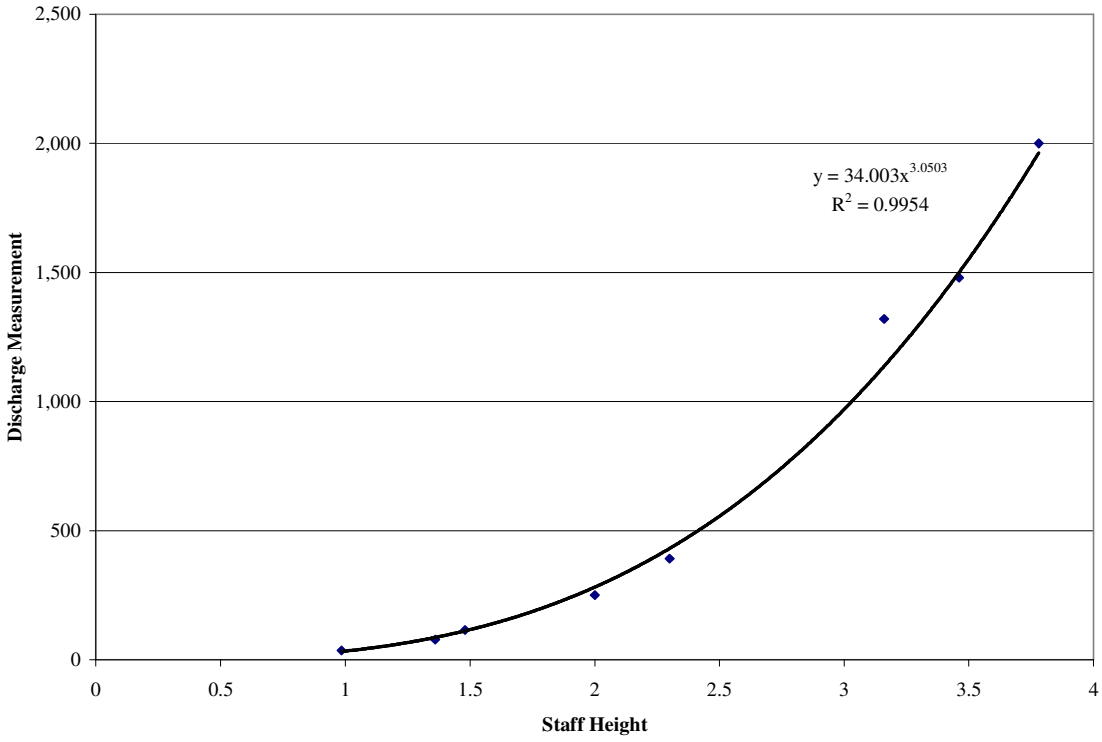

Figure 15. Discharge rating curve for Turwar Creek using flow measurements taken between 1/27/05 – 5/18/06.

Total rain accumulation during WY05 was 64.72 inches according to the California Data Exchange Center's data from a precipitation gage on the Klamath River near Klamath at Turwar (http://cdec.water.ca.gov, Figure 16). The highest flow event of the water year occurred on 12/09/04 and was a response to a storm that began on 12/06/04 and ended on 12/10/04, resulting in 7.92 inches of rainfall. The estimated maximum discharge peaked at 9,250 cfs, but should not be regarded as accurate since estimated discharge exceeds measured flows by >100% (Figure 17). Two other notable storm events are evident in the hydrograph; one between 3/29/05 – 3/30/05 which peaked at 1,663 cfs on 03/29/05 and the other between 4/06/05 – 4/09/05 which peaked at 2,688 cfs on 4/08/05 (Figure 16). These peaks in flow were the result of 2.44 inches and 5.12 inches of rain during each storm (respectively, Figure 16).

The lowest estimated flow in Turwar Creek was 13.57 cfs and occurred at the end of the water year (from 9/26/05) during summer base flows (Figure 17). During this time, the datalogger was turned off because the orifice line measuring water level was out of water. During this time, estimated flow was based on staff height observations. Data is also missing between 12/20/04 at 15:30 until 1/26/05 at 15:30 due to equipment failure. Two small storms occurred during this period, the first between 12/25/04 – 1/02/05 resulting in 5.4 inches of precipitation and the second between 1/07/05 – 1/11/05 that produced 4.12 inches of rain (Figure 16). Neither storm event produced a substantial storm peak in the Blue Creek hydrograph, which is the watershed that neighbors Turwar Creek (Figure 1, Figure 12). Total acre feet discharged from Turwar Creek was estimated to be 103,556; however, this is a low estimate since 37 days of data are missing during the winter months (Table 11).

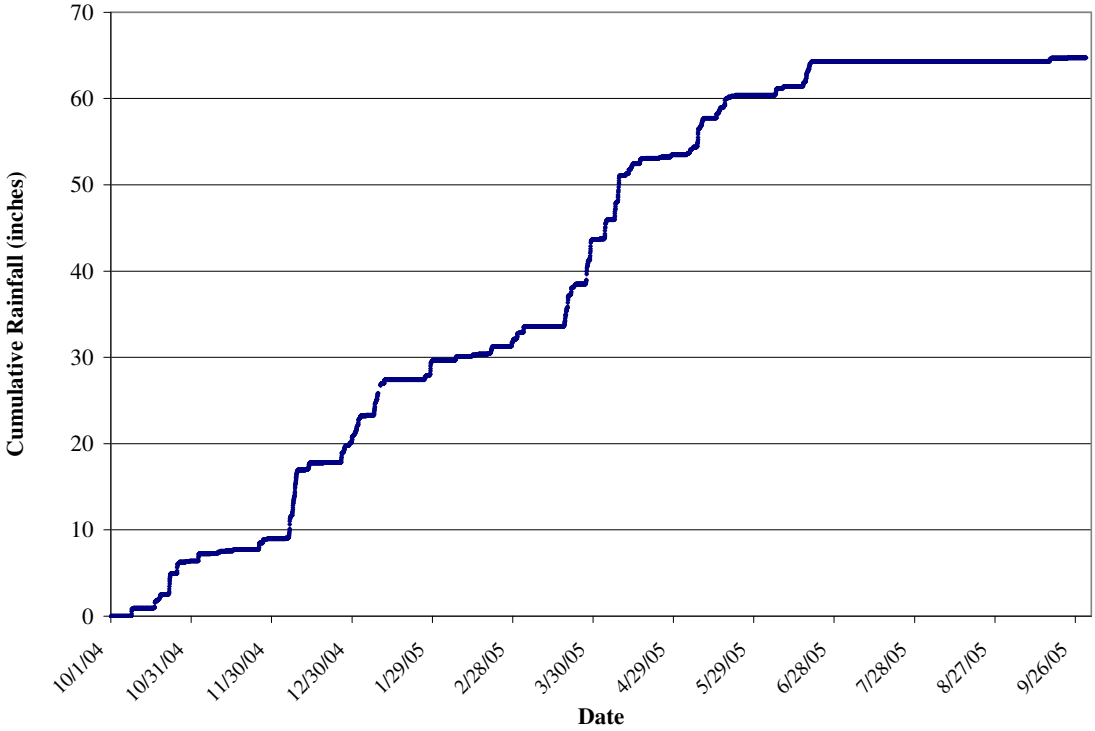

Figure 16. Cumulative precipitation data from the Klamath River near Klamath (Turwar Creek) for WY05 from the California Data Exchange Center (http://cdec.water.ca.gov).

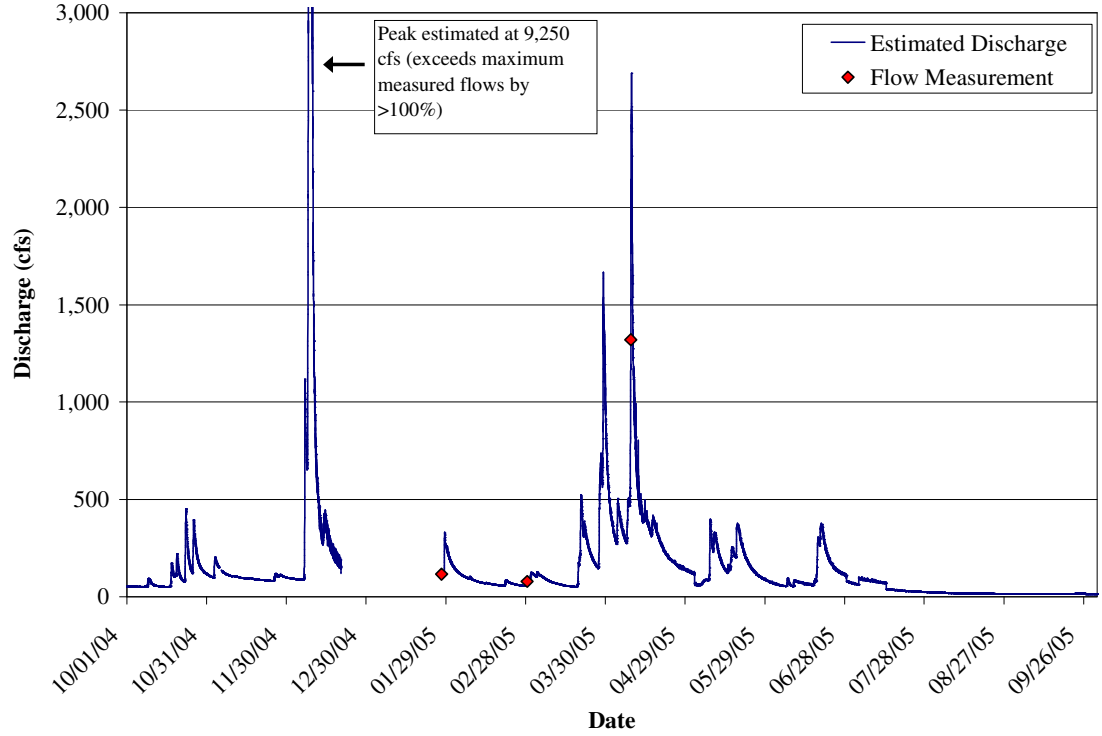

Figure 17. Turwar Creek hydrograph and flow measurements for WY05.

Table 9. Minimum daily discharge (cfs) values for Turwar Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	Aug	Sept
1	52.49	101.89	93.46		132.01	77.49	341.33	117.12	62.36	62.36	21.46	14.72
2	52.49	97.61	91.43		119.52	114.76	281.68	57.80	59.30	59.30	20.71	14.72
3	52.49	163.40	89.42		110.12	101.24	268.98	54.89	56.34	59.30	19.98	14.72
4	51.12	148.95	89.42		103.41	101.24	361.26	57.80	53.47	83.03	19.26	14.72
5	51.12	127.67	87.45		94.90	103.41	312.84	63.94	52.08	79.31	18.56	14.72
6	51.12	117.84	87.45		90.82	94.90	273.17	75.70	52.08	81.15	18.56	14.72
7	51.12	110.81	651.66		86.87	86.87	273.17	81.15	54.89	75.70	17.88	14.72
8	51.12	106.29	788.68		81.15	77.49	466.67	94.90	50.71	75.70	17.88	14.72
9	72.72	104.07	2356.56		77.49	73.93	884.16	229.46	54.89	73.93	17.22	14.72
10	59.75	104.07	763.22		73.93	70.49	583.96	268.98	70.49	70.49	17.22	14.72
11	55.32	99.73	486.86		70.49	65.54	442.96	200.81	68.81	70.49	16.57	14.72
12	53.90	97.61	333.09		68.81	62.36	387.26	162.51	62.36	67.16	15.94	14.72
13	52.49	95.52	266.08		67.16	59.30	376.71	137.24	60.82	37.21	15.94	14.72
14	51.12	93.46	305.07		63.94	56.34	371.51	119.52	59.30	36.12	15.94	14.72
15	51.12	91.43	261.97		62.36	54.89	322.15	121.95	54.89	34.00	15.94	14.72
16	49.77	93.46	219.51		60.82	52.08	308.25	145.34	54.89	32.98	15.94	14.72
17	52.49	89.42	188.42		59.30	50.71	346.24	204.26	75.70	31.97	15.32	14.72
18	104.07	89.42	169.43		57.80	50.71	299.21	200.81	260.74	30.02	15.32	14.72
19	106.29	87.45	148.95		56.34	50.71	264.84	281.68	312.84	29.08	15.32	14.72
20	104.07	85.51	120.25		59.30	156.64	233.23	225.74	229.46	28.15	15.32	14.72
21	83.60	83.60			70.49	308.25	214.82	194.05	190.72	28.15	15.32	14.72
22	78.03	83.60			67.16	294.76	194.05	162.51	165.49	28.15	14.72	14.72
23	181.94	81.71			62.36	237.03	184.19	142.61	145.34	27.25	14.72	15.94
24	140.71	81.71			60.82	197.41	174.67	124.42	132.01	25.50	14.72	15.94
25	120.25	81.71			59.30	168.52	159.56	110.12	121.95	25.50	14.72	15.94
26	238.18	101.89		119.52	56.34	150.92	145.34	101.24	114.76	23.83	14.72	13.57
27	169.43	106.29		107.86	54.89	145.34	139.91	90.82	107.86	23.02	14.72	13.57
28	140.71	101.89		107.86	67.16	563.17	137.24	84.93	75.70	23.02	14.72	13.57
29	125.16	97.61		211.26		612.46	126.91	79.31	70.49	22.23	14.72	13.57
30	117.84	95.52		171.58		612.46	121.95	72.20	65.54	22.23	14.72	13.57
31	106.29			150.92		425.72		67.16		21.46	14.72	
Monthly Statistics												
Total	2728.32	3021.12	7598.38	868.99	2095.08	5277.15	8998.23		2996.30	1387.84	508.80	439.55
Mean	88.01	100.70	379.92	144.83	74.82	170.23	299.94		99.88	44.77	16.41	14.65
Max	238.18	163.40	2356.56	211.26	132.01	612.46	884.16		312.84	83.03	21.46	15.94
Min	49.77	81.71	87.45	107.86	54.89	50.71	121.95		50.71	21.46	14.72	13.57

Table 10. Maximum daily discharge (cfs) values for Turwar Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	53.90	106.29	95.52		150.92	119.52	437.16	134.61	73.93	73.93	23.02	14.72
2	53.90	166.40	93.46		134.61	124.42	346.24	129.45	72.20	68.81	23.02	14.72
3	52.49	201.84	91.43		121.95	114.76	503.81	73.93	63.94	99.09	21.46	14.72
4	52.49	163.40	89.42		110.12	126.91	460.67	65.54	59.30	101.24	20.71	14.72
5	52.49	135.39	89.42		103.41	114.76	376.71	83.03	57.80	96.98	19.98	14.72
6	52.49	127.67	1064.94		103.41	105.62	322.15	88.83	96.98	94.90	19.98	14.72
7	52.49	117.84	1118.32		103.41	94.90	510.19	90.82	70.49	88.83	19.26	14.72
8	83.60	110.81	8008.77		88.83	86.87	2688.17	398.00	75.70	88.83	18.56	14.72
9	93.46	106.29	9250.52		81.15	79.31	2297.95	317.47	84.93	88.83	18.56	14.72
10	72.72	106.29	2268.14		77.49	73.93	1020.42	331.65	81.15	81.15	17.88	14.72
11	59.75	104.07	814.71		73.93	70.49	803.36	264.84	77.49	79.31	17.88	14.72
12	55.32	99.73	544.90		70.49	65.54	529.65	204.26	73.93	75.70	17.22	14.72
13	53.90	97.61	388.85		72.20	62.36	497.49	165.49	70.49	73.93	17.22	14.72
14	52.49	95.52	444.71		67.16	59.30	442.96	142.61	68.81	38.32	16.57	14.72
15	51.12	97.61	405.08		65.54	56.34	392.60	165.49	67.16	37.21	16.57	14.72
16	52.49	97.61	333.09		62.36	54.89	420.07	256.68	90.82	36.12	16.57	14.72
17	172.50	93.46	270.24		60.82	53.47	408.93	248.70	303.71	35.05	16.57	14.72
18	151.77	91.43	249.88		59.30	52.08	376.71	376.71	351.20	32.98	15.94	14.72
19	219.51	89.42	230.59		59.30	174.67	308.25	361.26	376.71	31.97	15.94	14.72
20	191.72	87.45	201.84		86.87	523.11	273.17	285.99	322.15	30.99	15.94	14.72
21	101.89	85.51			79.31	516.62	240.88	233.23	244.77	30.02	15.94	14.72
22	172.50	83.60			72.20	387.26	222.06	204.26	200.81	30.02	15.94	15.94
23	450.58	83.60			67.16	294.76	200.81	168.52	174.67	29.08	15.32	15.94
24	223.16	81.71			63.94	240.88	187.44	148.12	156.64	28.15	14.72	15.94
25	305.07	117.84			60.82	200.81	187.44	134.61	142.61	27.25	14.72	15.94
26	394.21	117.84		124.42	59.30	171.58	165.49	117.12	132.01	26.37	14.72	15.94
27	238.18	113.12		119.52	73.93	576.97	162.51	105.62	126.91	25.50	14.72	13.57
28	169.43	110.81		331.65	90.82	735.85	159.56	96.98	119.52	24.66	14.72	13.57
29	140.71	101.89		268.98		1663.51	145.34	94.90	81.15	23.83	14.72	13.57
30	125.16	97.61		211.26		1072.30	142.61	83.03	73.93	23.83	14.72	13.57
31	117.84			174.67		627.06		81.15		23.02	14.72	
Monthly Statistics												
Total	4119.35	3289.65	26053.83	1230.50	2320.77	8700.86	15230.81	5652.88	3991.96	1645.91	533.80	443.13
Mean	132.88	109.65	1302.69	205.08	82.88	280.67	507.69	182.35	133.07	53.09	17.22	14.77
Max	450.58	201.84	9250.52	331.65	150.92	1663.51	2688.17	398.00	376.71	101.24	23.02	15.94
Min	51.12	81.71	89.42	119.52	59.30	52.08	142.61	65.54	57.80	23.02	14.72	13.57

Table 11. Average daily discharge (cfs) values for Turwar Creek WY05.

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	53.25	104.21	94.94		142.01	84.87	387.87	123.75	67.35	67.38	21.90	14.72
2	52.58	106.36	92.78		126.52	119.07	312.02	95.16	63.46	64.12	21.73	14.72
3	52.49	180.54	90.71		115.27	107.36	357.94	61.59	59.68	79.67	20.96	14.72
4	51.98	155.90	89.42		106.41	116.41	409.51	61.60	56.40	91.47	20.17	14.72
5	51.50	130.64	88.74		99.09	109.32	341.33	71.36	55.00	87.25	19.57	14.72
6	51.15	122.87	137.46		94.34	99.80	295.22	83.84	71.40	86.12	19.06	14.72
7	51.55	114.88	801.08		93.63	90.55	412.11	85.84	61.52	83.32	18.81	14.72
8	56.01	108.82	3549.10		84.67	82.81	1043.87	258.20	54.80	82.48	18.29	14.72
9	84.53	106.10	4772.60		79.52	76.83	1354.13	263.94	78.35	81.44	17.94	14.72
10	65.15	105.54	1255.07		75.46	71.90	764.20	306.64	76.57	76.94	17.52	14.72
11	57.89	102.41	629.43		72.06	68.14	538.18	231.42	74.12	74.54	17.15	14.72
12	54.78	98.54	423.00		69.62	64.57	437.70	182.51	69.65	71.93	16.70	14.72
13	52.60	96.87	314.51		69.58	61.41	402.70	151.51	66.16	60.55	16.40	14.72
14	51.69	94.16	384.42		66.24	58.35	397.38	130.96	64.58	37.60	16.18	14.72
15	51.12	93.16	329.20		63.74	55.82	352.24	143.15	61.88	36.06	16.17	14.72
16	51.19	95.86	267.37		61.90	53.96	343.83	215.94	69.28	34.78	16.15	14.72
17	84.65	91.70	229.96		59.99	52.45	376.17	219.36	128.84	33.54	16.01	14.72
18	115.54	89.47	201.95		58.49	50.87	325.49	302.82	290.13	31.91	15.74	14.72
19	136.68	88.57	179.05		57.40	76.31	285.63	321.37	350.53	30.92	15.66	14.72
20	133.16	86.92	161.72		76.03	265.27	254.63	259.93	275.10	29.99	15.56	14.72
21	91.09	85.11			74.85	382.67	226.86	211.96	219.21	28.99	15.46	14.72
22	86.27	83.60			69.07	335.36	207.59	181.25	184.05	29.08	15.31	15.12
23	331.24	83.16			65.02	262.62	192.07	155.47	161.27	28.44	14.77	15.94
24	172.53	81.71			61.81	217.48	180.12	137.43	143.69	27.24	14.72	15.94
25	140.66	98.98			59.82	183.85	168.04	121.62	132.87	26.33	14.72	15.94
26	309.86	107.80		122.31	57.63	160.47	156.07	108.58	124.19	25.34	14.72	14.72
27	198.36	110.50		113.66	59.13	239.51	151.19	99.27	117.80	24.28	14.72	13.57
28	154.35	105.96		192.66	79.46	638.39	146.52	91.72	104.44	23.93	14.72	13.57
29	133.33	100.42		238.63		1168.59	137.74	84.47	75.96	23.35	14.72	13.57
30	121.21	97.50		189.59		778.02	130.64	77.77	70.72	22.82	14.72	13.57
31	111.77			160.69		512.39		72.31		22.39	14.72	
Monthly Statistics												
Total	3210.17	3128.24	14092.52	1017.54	2198.76	6645.43	11088.99	4912.75	3428.99	1524.22	521.00	441.09
Mean	103.55	104.27	704.63	169.59	78.53	214.37	369.63	158.48	114.30	49.17	16.81	14.70
Max	331.24	180.54	4772.60	238.63	142.01	1168.59	1354.13	321.37	350.53	91.47	21.90	15.94
Min	51.12	81.71	88.74	113.66	57.40	50.87	130.64	61.59	54.80	22.39	14.72	13.57
Acre Feet	6367.28	6204.78	27952.10	2018.27	4361.18	13181.01	21994.68	9744.29	6801.31	3023.26	1033.38	874.90
Total Acre Feet for WY05			103,556.44									

Turbidity

Turbidity ranged between 0.01 – 2,060 NTU between 11/10/04 and 12/09/04 (Figure 18).

Water Temperature

Water temperature ranged between 6.3 – 11.3°C during monitoring from 11/10/04 – 12/20/04.

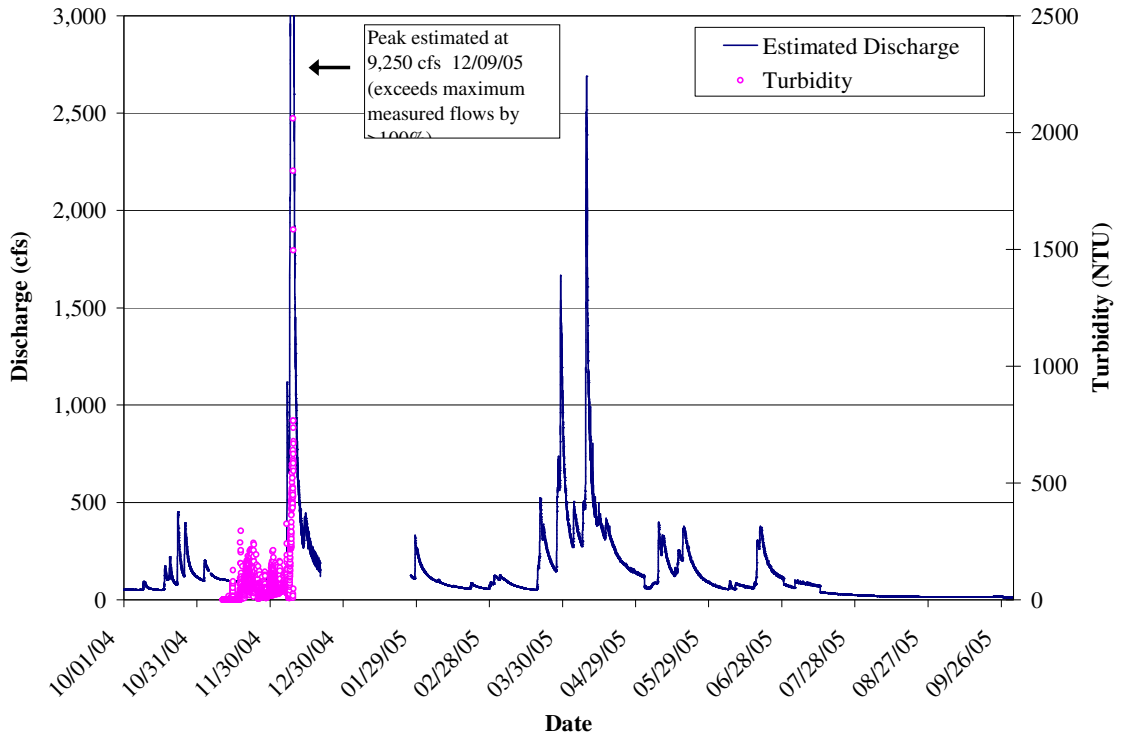

Figure 18. Turwar Creek hydrograph and fifteen minute turbidity data for WY05.

Suspended Sediment

Table 12. Suspended sediment samples taken in Turwar Creek during WY05.

Sample ID	Bottle Number	Date	Time	SSC (mg/L)	Turbidity (NTU) Lab	Turbidity (NTU) Datasonde	Gage Height (ft)	Hydraulic Position	Flow Est (cfs)
Tu120704		12/7/2004	1435	10.9	6.6	9.4	2.51	F	374**
Tu2120804***	a - d*	12/8/2004	1450	783	245	N/A	4.77	R	1910**
Tu1120904	a - d*	12/9/2004	1224	1299	455	551.93	4.59	F	3550.13
Tur040805	a - d*	4/8/2005	1155	248	17.0	N/A	2.75	R	1320**
Tur040805	e - k*	4/8/2005	1455	697	80.0	N/A	3.5	R	1552.70

*Composite Sample
**Actual Flow Measurement Taken
Hydraulic Position: F = Falling, R = Rising, P = Peak
***Sample taken from Turwar Bridge (downstream of gage)

Gage Height was read from the gaging station.
Flow Estimate (cfs) was calculated from flow rating curve Q = 34.003*(stage height)^3.0503

Tully Creek

Discharge

The rating curve for WY05 was generated using only four flow measurements taken between 7/08/05 – 1/13/06. Although it only includes four data points to date, it will be built on for future discharge estimation. Flow measurements that create the curve range between 9.49 – 274 cfs and include stage heights between 4.19 – 6.54 ft (Figure 17). The rating curve produced the following formula (Figure 19):

$y = 0.0002x^{7.5234}$, where y = discharge in cfs and x = gage height

Data is only available for Tully Creek from 7/08/05 at 13:45 through the end of the water year (9/30/05 at 23:45). Gage height for the available records ranged from 3.84 – 4.65 ft during summertime base flows, and estimation based on our rating curve is probably fairly accurate since it is almost entirely included in the range of flow measurements taken manually. Estimated flows during this period ranged from 4.98 – 21.02 cfs (Figure 20). Minimum, maximum, and average daily discharge were not calculated due to lack of substantial data. Turbidity, specific conductivity, water temperature, and suspended sediment were not monitored.

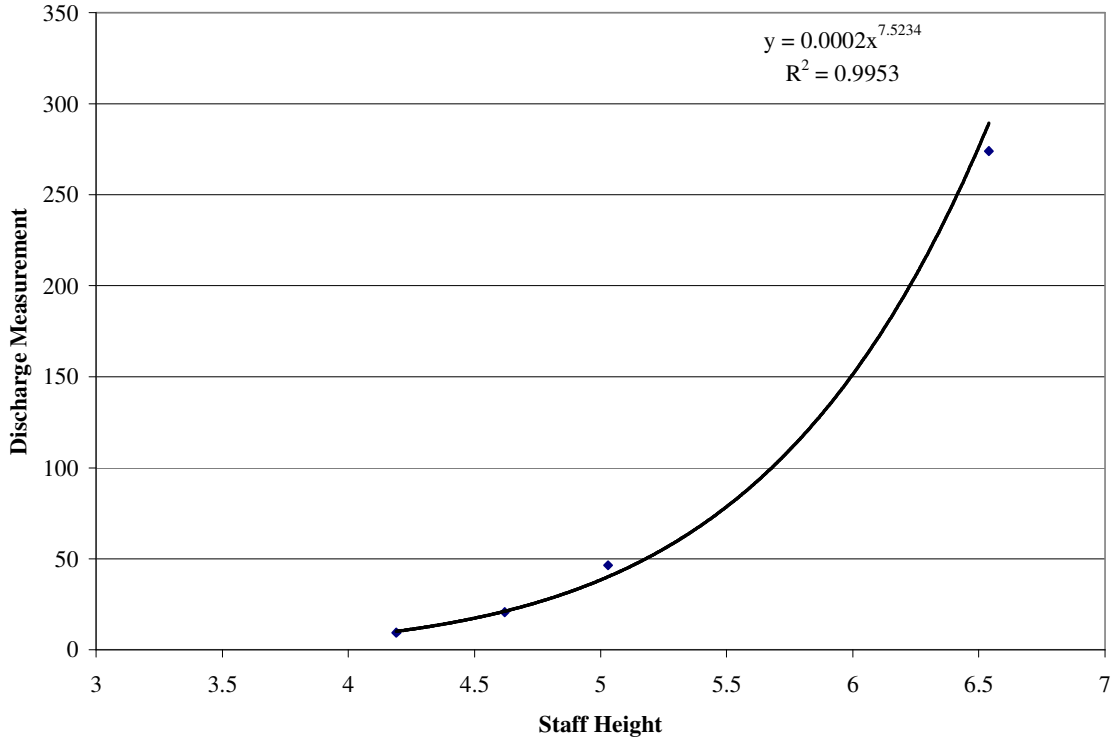

Figure 19. Discharge rating curve for Tully Creek using flow measurements taken between 7/08/05 – 1/13/06.

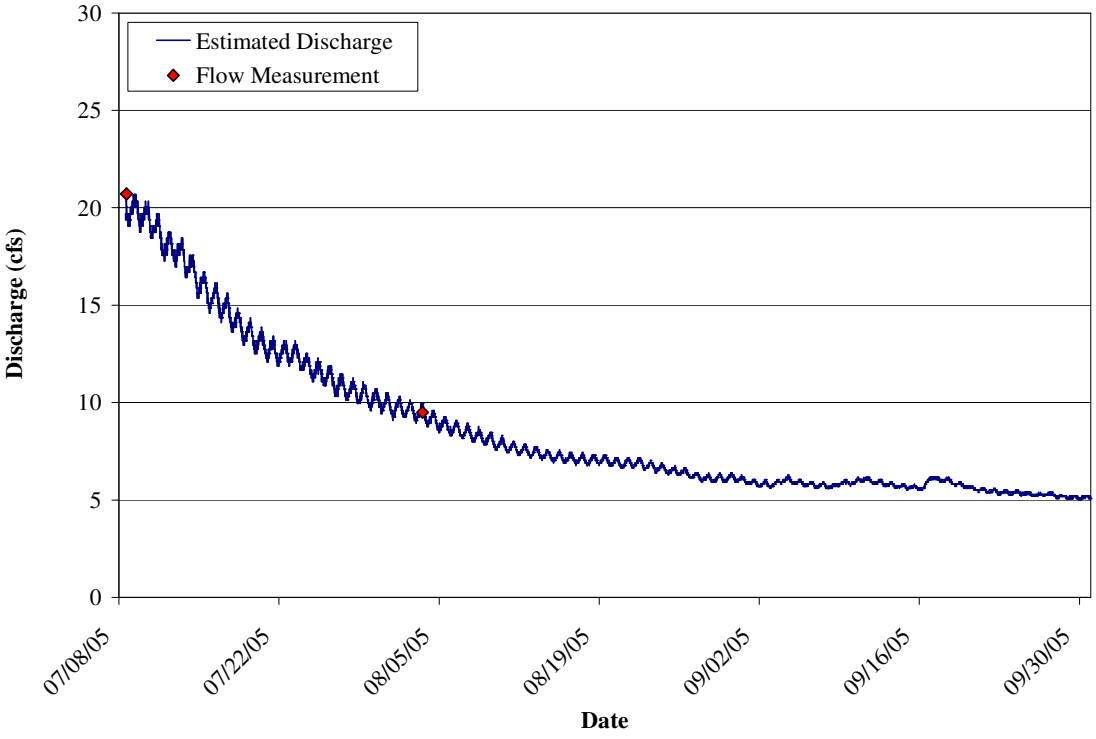

Figure 20. Tully Creek hydrograph and flow measurements for available gage data during WY05.

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