ENVIRONMENTAL PROTECTION
June 15, 1999
Stream File 2.21.0
Stream Code 10378

SUBJECT: Aquatic Biological Investigation
Big Spring Creek
Cumberland County
May 11 and 13, 1998,
And September 1 and 2, 1998

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EXECUTIVE SUMMARY

In August 1997 a report, "An Ecological Survey of Big Spring Creek with Emphasis on the Effects of Fish Hatchery Effluent," by John J. Black, Ph.D. and Eugene Macri, was presented to the Pennsylvania Fish and Boat Commission (PFBC). The report concluded that the NPDES discharge from the PFBC Big Spring Fish Hatchery was adversely impacting the trout fishery and the macroinvertebrate community in Big Spring Creek. The Department monitors the PFBC Big Spring Hatchery discharge and they have consistently complied with their NPDES permit limits for at least the last 5 years. However, the evidence presented by this report was compelling and prompted the Department to initiate a study of Big Spring Creek to determine if the discharge from the Big Spring Hatchery was impacting the stream.

Big Spring Creek is a very unique stream. It originates from a large limestone spring that literally flows out of the ground to form a moderately sized stream. True limestone streams such as Big Spring Creek have macroinvertebrate communities that are different in composition and structure from other types of streams. This makes it difficult to find a reference condition or threshold for pollution detection to compare to Big Spring Creek. The PFBC Big Spring Hatchery discharge is also very close to the origin of the stream making it impossible to collect an upstream sample. Because of these circumstances the Department felt it was important to develop a PA Modified Rapid Bioassessment Protocol (RBP) metric analysis system specifically designed to evaluate true limestone streams. RBP sample data from non-impaired limestone streams were used as the reference condition. Metrics that respond well to these unique macroinvertebrate communities were selected and pollution thresholds were established. The Department developed these analytical methods to assure that there was a fair evaluation of the hatchery discharge.

The RBP metric comparison generated scores for the three Big Spring Creek sample stations and placed each station in an overall rating classification category. Stations 1 and 2 were placed in the severely impaired category and station 3 was placed in the non-impaired category. The RBP biological samples indicated the discharge from the PFBC Big Spring

Hatchery was severely impacting Big Spring Creek. The impairment at station 1 and 2 was due to a very abnormally high density of pollution-tolerant organisms compared to the number of pollution-sensitive organisms. This type of macroinvertebrate community generally indicates organic pollution. The aquatic survey also indicated the current NPDES permit is not adequate to protect the aquatic life in the Big Spring Creek.

The PFBC contracted consulting firms to review the effluent situation at the Big Spring Hatchery. The PFBC is currently developing plans to upgrade their NPDES treatment facility. The Department has only been peripherally involved in this project. Considering that the PBFC hatchery discharge has severely impaired a Chapter 93 designated Exceptional Value stream and the discharge has resulted in Big Spring Creek being placed on the 303d list the Department needs to be an integral part of this proposed upgrade.

METHODS

Three sample sites were established on Big Spring Creek (Figure 1, Table 1). Reference sample sites were also established on Letort Spring Run and Falling Spring Branch. Macroinvertebrate samples and water chemistry samples were collected on May 11 & 13, 1998, and September 1 & 2, 1998.

Water samples were collected at each site, iced and returned to the laboratory for chemical analysis (Table 2 & 3). Temperature, pH, flow, specific conductance and dissolved oxygen were measured and recorded in the field. Additional water chemistry samples were collected from Big Spring Creek on January 26, 1998 (Table 4).

The RBP habitat assessment field data sheets were completed at each site (Table 5). Each macroinvertebrate sample was collected with a D-Frame net, disturbing a minimum area of 1 x .3 meters at two-selected representative riffle areas. Each sample consisted of two kicking efforts, one collected from a fast riffle/run habitat and one from a slow riffle/run habitat. The two kicking efforts were composited, fixed in a solution of 95% ethanol alcohol and returned to the laboratory for processing. The samples were floated and sorted removing all the macroinvertebrates. All the organisms were placed in a gridded pan containing enough water to allow complete dispersion of the sample. An individual square was randomly selected and all the organisms in that square were removed. The process of selecting squares continued until a subsample of at least 100 organisms was removed. Organisms in the subsample were identified and enumerated (Table 6 & 7). The complete samples were also identified and enumerated (Table 8 & 9). Table 10 contains the reference station macroinvertebrate data. The midges were identified to the family level. Flatworms and aquatic earthworms were identified to the class level. Proboscis worms and roundworms were identified to the phylum level and all other macoinvertebrates were identified to the genus level. The data from the subsamples were used in the computation of benthic metrics.

REFERENCE CONDITION & METRIC ANALYSIS DEVELOPMENT

Big Spring Creek originates from a large, karstic spring that discharges 30 to 40 million gallons per day making it a true limestone stream. Limestone streams have a fairly consistent temperature, low gradient and are highly productive. These unique physical and chemical characteristics produce a unique macroinvertebrate community. In order to measure an impact to a limestone stream using RBP metric analysis the Department needed to find comparable reference stations and develop pollution threshold values specific to

limestone streams. Sample stations needed to meet certain criteria to be used as reference stations. High quality limestone streams often have large populations of a pollution-sensitive mayfly, *Ephemerella*. The nymphs of this mayfly can only be collected from mid-winter to May. The presence or absence of this mayfly could have a big influence on the metrics. Big Spring Creek samples and reference samples could only be collected from January to May. The Department collected samples May 11 & 13, 1999 and September 1 & 2, 1998. The September data was not used in determining possible impacts on Big Spring Creek, but the data is presented for comparison. Reference stations also needed to have alkalinity greater than 180 mg/l and have a drainage area less than 12.5 sq. miles. The May samples collected from Falling Spring Branch and Letort Spring Run that were part of this survey were used as reference stations. RBP samples collected during other surveys conducted by the Department from Licking Run, Falling Spring Branch and the Letort Spring Run were also used as reference stations. This provided 8 reference stations. The macroinvertebrate data collected were used to establish an expected reference condition for limestone streams.

The first step in this process was the selection of the metrics. Twelve metrics were evaluated to see how well they reacted with the macroinvertebrate communities at the reference stations. Quartile calculations were performed on each metric for the 8 reference stations in order to find the 25^{th} percentile and the 75^{th} percentile (Table 11). The detection limits or pollution threshold values for impairment were the 25^{th} percentile for metrics that decrease with pollution and the 75^{th} percentile for metrics that increase with pollution. The metrics that were most sensitive to changes in limestone macroinvertebrate communities were chosen: total taxa, EPT taxa, % intolerant, % tolerant, % EPT, HBI, and % Isopoda. The pollution threshold values for the seven selected metrics were used to develop a scoring criteria (Table 12). The scoring criteria was established by giving the highest score (5) to metric values equal to or higher than the pollution-detection threshold value for metrics that decrease with pollution or equal to or lower than the pollution-detection threshold value for metrics that increase with pollution. The pollution-detection limit for the total taxa metric was 11 taxa. A sample containing 11 or more taxa would be considered unaffected by pollution and receive a score of 5. The range below the threshold value for decreasing metrics or above the threshold value for increasing metrics was then divided into two equal parts. The resulting three scoring ranges were assigned a score: 5 for non-impaired, 3 for slightly impaired and 1 for severely impaired. The eight reference samples and the three Big Spring Creek samples were scored for each metric and totaled (Tables 13). Quartile calculations were performed on the total scores for the 8 reference samples to establish rating classifications. The classification categories for the bioassessment indices were: non-impaired 35 to 29, slightly impaired 28 to 22, moderately impaired 21 to 14, and severely impaired 13 to 0. In Table 14 the total scores for the reference condition and the Big Spring Creek were assigned to their respective classification. This multimetric approach reduces the biological condition of each sample to a single rating classification number. This allows for a quick and easy comparison of sample stations to the reference condition.

RESULTS

Station 1. Approximately 20 meters upstream from the Big Spring Road Bridge.

This sample station was located downstream of the area known as the "ditch" and about 200 meters downstream of the PFBC Big Spring Hatchery discharge. The riparian

zone was marginal. One side of the stream had mowed grass to the edge of the stream and the other side had low bushes. The stream banks were moderately stable. Fish habitat improvement devices were installed within the last 5 years. The substrate was dominated by gravel, but there was an abundant growth of periphyton covering large areas of the gravel. Embeddedness was estimated to be about 60% and the substrate seemed to be cemented together at a depth of 2 to 4 inches. The field habitat assessment yielded a score of 154 out of a possible 240. This indicated the habitat for macroinvertebrates was in the sub-optimal category. The instream habitat, which is most critical to the macroinvertebrates, was poor due to a high percentage of embeddedness and the cementing in the hyporheic zone. However, with the exception of the cementing the habitat at station 1 was fairly typical of limestone streams and consistent with the habitat at the reference sites.

The biological sampling resulted in a rating classification score of 7 out of a possible 35, placing it in the severely impaired category. The only reason this site was able to score 7 was because the minimum score for each metric was 1 and there were 7 metrics. *Lirceus* (sowbugs) and *Gammarus* (scuds) completely dominated the macroinvertebrate community. Together they accounted for 94% of the organisms. In a limestone stream sample there should normally be a high percentage of Crustacea, but there should still be some pollution-sensitive organisms and the dominant Crustacea should not be the most pollution-tolerant Crustacea, *Lirceus*. The whole sample was also identified and enumerated and there were 9,522 organisms collected. The very high density of organisms and the dominance (55%) of the community by a pollution-tolerant organism indicated organic enrichment at this sample location.

Station 2. Approximately 10 meters downstream from the Nealy Road Bridge.

This sample station was located about 1.5 miles downstream from the PFBC Big Spring Hatchery discharge. The riparian zone was suboptimal with low to moderately high bushes and small trees lining the stream banks. The riparian zone was impacted by a road and a parking area. The stream banks were moderately stable. The sample site was just downstream of the bridge. The bridge channeled the stream flow through a pipe increasing the velocity and creating a moderately deep riffle. This was the best macroinvertebrate habitat in the area. The substrate had a fairly good mixture of cobble and gravel, but the embeddedness was about 60%. The upper layer of stones were easy to dislodge, but the lower levels of stones were hard to kick loose. However, the substrate was not cemented like station 1. The field habitat assessment yielded a score of 154 out of a possible 240. This indicated the habitat for macroinvertebrates was in the sub-optimal category. The high percentage of embeddedness was bad enough to impact the macroinvertebrates. The habitat was fairly typical of limestone streams and consistent with the habitat at the reference sites.

The biological sampling resulted in a rating classification score of 7 out of a possible 35, placing it in the severely impaired category. The only reason this site was able to score 7 was because the minimum score for each metric was 1 and there were 7 metrics. *Lirceus* (sowbugs) completely dominated the macroinvertebrate community. *Lirceus* accounted for 91% of the organisms. There were no pollution-sensitive organisms collected. The complete dominance of the macroinvertebrate community by a pollution-tolerant organism indicated organic enrichment at this sample location.

Station 3. Approximately 30 meters downstream from the Route 641 Bridge.

Station 3 was about 3.4 miles downstream of the PFBC Big Spring Hatchery discharge. This site was located in the town of Newville. The stream seemed to be fairly well buffered from the town. Urban runoff did not appear to be a problem. The riparian zone was poor and the stream banks were fairly stable. Just upstream was a dam that formed a long impoundment on the stream. The substrate had a fair mixture of cobble and gravel. There was a small area of good rock substrate to sample, but overall the riffle was poorly developed and moderately to severely embedded (50% to 70%). The field habitat assessment yielded a score of 124 out of a possible 240. This indicated the habitat for macroinvertebrates was marginal. The embeddedness problem was severe enough to impact the macroinvertebrate community. Overall station 3 had the lowest quality habitat.

The biological sampling resulted in a rating classification score of 29, placing it in the non-impaired category. The macroinvertebrate community at station 3 was very different from stations 2 and 3. The macroinvertebrate community was dominated by Chironomidae (midges) not *Lirceus*. There was an increase in diversity including several EPT taxa. Taxa richness was good with 11 taxa collected and scored 5. There were 4 EPT taxa for a score of 5. Percent tolerant organisms was low and scored 5. The percent Isopoda, the percent intolerant and percent EPT organisms were fair and scored 3 for each metric.

Based on a limestone-stream type metric analysis this sample site showed good water quality. This could be due to the station being downstream of the PFBC discharge impact zone. The impoundment may also have helped to negate the impact from the PFBC discharge. The impoundment may have consumed any remaining organic material from the PFBC discharge and the overflow from the impoundment, about an eight-foot drop, would add oxygen to the water. However, there could be an additional reason for the change in the macroinvertebrate community. A review of all the sample data indicates the community at station 3 may not be a pure limestone community. The impoundment exposes the water to greater temperature changes. An increase in the range of temperatures at station 3 would increase the diversity of the macroinvertebrate community and improve the metric scores.

WATER CHEMISTRY RESULTS

Water chemistry samples collected on May 11 & 13, 1998, and September 1 & 2, 1998, showed no results above normal. Samples collected January 26, 1998, compared upstream water chemistry results to the PFBC discharge results and downstream results. There were noticeable increases in BOD and total phosphorus downstream of the PFBC discharge.

CONCLUSIONS

The RBP metric comparison generated scores for the 3 sample stations and placed each station in an overall rating classification category. The maximum rating classification score for a sample was 35. Stations 1 and 2 each scored 7 and were placed in the severely impaired category. Station 3 had a score of 29 and was placed in the non-impaired category. The RBP biological samples indicated the PFBC Big Spring Hatchery discharge severely impacted Big Spring Creek for 1.5 miles and the impact probably extends approximately another 1.0 mile to the impounded area. The impairment at stations 1 and 2 was due to an abnormally high-density of pollution-tolerant organisms compared to the

number of pollution-sensitive organisms. This type of macroinvertebrate community is usually found where there is organic enrichment.

The upper part of Big Spring Creek known as the "ditch" has a Chapter 93 designation of Exceptional Value. The remainder of the stream is a Cold Water Fishery. The impairment caused by the PFBC discharge has resulted in Big Spring Creek being unable to meet its designated use placing it on the 303d list. The Department found the PFBC Big Spring treatment facility has generally complied with their NPDES permit. The current NPDES permit does not appear to be adequate to protect the aquatic life in the stream. The PFBC is developing a plan to upgrade their waste treatment facility. The Department needs to be part of the proposed upgrade to assure that the aquatic life in Big Spring Creek is protected in the future.

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Stream File 2.21.0 (Big Spring Creek)

FIGURE 1. Sample station locations for an aquatic biological investigation of Big Spring Creek, Cumberland County, May 11 & 13, 1998. Reproduced from the Newville USGS Quad.

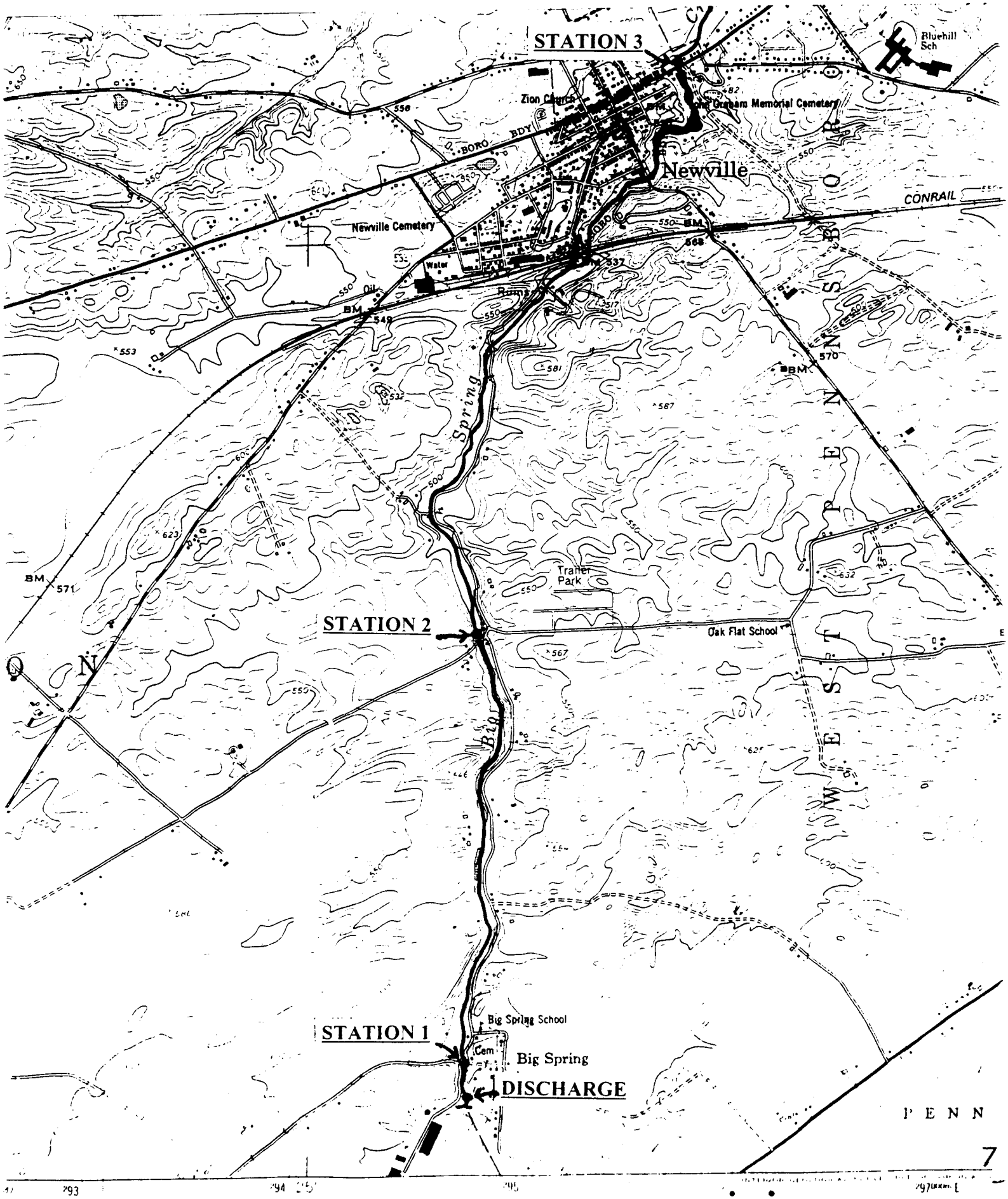

TABLE 1

Big Spring Creek
May 11, 1998 and September 1, 1998
Sampling Station Locations

STATION	RIVER MILES	TOWNSHIP	COUNTY	USGS QUAD.	INCHES NORTH	INCHES WEST
1	4.61	North Newton	Cumberland	Newville	0.94	4.56
2	3.25	North Newton	Cumberland	Newville	4.38	4.44
3	1.20	North Newton	Cumberland	Newville	9.00	2.88

TABLE 2

Big Spring Creek
Water Chemistry

PARAMETER	May 11, 1998			Big Spring Creek		
	Station 1	Station 2	Station 3	Station 1	Station 2	Station 3
Flows Ft.3/sec.	51.95	65.78	75.42	41.99	39.71	36.04
Specific Conductance (umhos/cm)	315	339	350	315	328	342
Temperature (Field) Deg. C	11.0	10.8	11.0	11.7	12.2	14.5
Dissolved Oxygen (Field) mg/l	10.9	11.4	12.4	9.9	10.8	11.0
pH (Field)	7.15	7.37	7.62	7.41	7.49	7.51
pH (Lab.)	7.10	7.30	7.60	7.30	7.60	7.90
Alkalinity Total (CACO3) mg/l	200	208	228	184	186	192
Total Dissolved Solids mg/l	300	316	604	382	236	336
Residue Total Solids Nonfilt. mg/l	14.0	22.0	12.0	<2.0	<2.0	8.0
NH3-N mg/l	0.07	0.05	0.03	0.04	0.03	<0.02
NO2-N mg/l	0.01	0.02	0.03	<0.01	0.03	0.04
NO3-N mg/l	5.51	5.33	5.05	5.51	5.40	5.03
Total Phosphorus mg/l	0.02	0.03	0.02	0.02	0.02	0.02
Total Organic Carbon mg/l	1.0	1.0	1.1	<1.0	<1.0	1.1
Total Hardness CACO3 mg/l	85	99	95	149	111	192
Sulfate Total mg/l	20.0	23.0	17.0	11.0	<10.0	<10.0
Copper Total ug/l	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Iron Total ug/l	<50.0	138.0	120.0	27.0	136.0	111.0
Lead Total ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Manganese Total ug/l	<10.0	<10.0	<10.0	<10.0	<10.0	10.0
Nickel Total ug/l	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Zinc Total ug/l	<10.0	<10.0	<10.0	<13.0	<10.0	<10.0
Aluminum Total ug/l	<200.0	<200.0	<200.0	<200.0	<200.0	<200.0

TABLE 3

Reference Stations
Water Chemistry

PARAMETER	Letort Spring Run				Falling Spring Branch			Lick Run		
	May-98	Sept.-98	May-96 #1	May-96 #2	May-98	Sept.-98	Apr.-91	Apr.91 #1	Jan.-93 #1	Jan.-93 #2
Flows Ft.3/sec.	40.13	23.8	-	-	20.55	16.47	-	-	-	-
Specific Conductance (umhos/cm)	361	391	-	-	385	439	-	-	-	-
Temperature (Field) Deg. C	11.5	10.1	-	-	12.1	12.1	-	-	-	-
Dissolved Oxygen (Field) mg/l	11.8	9.4	-	-	12	9.9	-	-	-	-
pH (Field)	7.30	7.63	7.60	7.70	7.31	7.15	8.10	8.15	7.90	8.20
pH (Lab.)	7.30	7.30	-	-	7.5	7.3	-	-	-	-
Alkalinity Total (CACO3) mg/l	226	228	216	224	242	244	228	218	206	240
Total Dissolved Solids mg/l	-	404	366	398	380	453	1194	336	336	332
Residue Total Solids Nonfilt. mg/l	<2.0	<2.0	-	-	<2.0	15.0	-	-	-	-
NH3-N mg/l	0.02	<0.02	-	-	<0.02	<0.02	-	-	-	-
NO2-N mg/l	<0.01	0.01	-	-	<0.01	<0.01	-	-	-	-
NO3-N mg/l	6.19	6.84	6.99	6.33	8.85	8.95	8.70	4.48	4.36	6.33
Total Phosphorus mg/l	0.02	<0.02	0.02	0.02	<0.02	0.012	0.02	0.03	0.02	0.04
Total Organic Carbon mg/l	1.5	<1.0	-	-	1.2	-	-	-	-	-
Total Hardness CACO3 mg/l	88	337	-	-	188	97	-	-	-	-
Sulfate Total mg/l	19.0	12.0	23.0	29.0	20.0	24.4	31.0	34.0	39.0	29.0
Copper Total ug/l	<10.0	<10.0	-	-	<10.0	<4.0	-	-	-	-
Iron Total ug/l	150.0	78.0	125.0	122.0	<20.0	115.0	100.0	271.0	97.0	203.0
Lead Total ug/l	<1.0	<1.0	-	-	<1.0	<1.0	-	-	-	-
Manganese Total ug/l	44.0	<10.0	-	-	<10.0	3.9	-	-	-	-
Nickel Total ug/l	<50.0	<50.0	-	-	<50.0	<4.0	-	-	-	-
Zinc Total ug/l	<10.0	<10.0	-	-	<10.0	<5.0	-	-	-	-
Aluminum Total ug/l	<200.0	<200.0	-	-	<200.0	32.4	-	-	-	-

TABLE 4

Big Spring Creek
Water Chemistry
January 26, 1998

PARAMETER	West Side of Spring	East Side of Spring	Hatchery Discharge	Big Spring Rd. Bridge	Cold Fish Barrier	Private Rd. Bridge
Specific Conductance (umhos/cm)	-	-	-	-	-	-
Temperature (Field) Deg. C	10.8	10.7	10.3	10.8	10.7	10.9
Dissolved Oxygen (Field) mg/l	8.7	8.3	8.4	8.8	8.6	8.8
pH (Field)	-	-	7.48	-	-	-
BOD 5 Day mg/l	0.3	0.4	11.5	**2.6**	**2.8**	**1.8**
COD	<10.0	<10.0	-	<10.0	<10.0	<10.0
Total Suspended Solids mg/l	6.0	<20.0	18.0	10.0	16.0	4.0
NH3-N mg/l	<0.02	<0.02	0.5	0.02	0.21	0.14
NO2-N mg/l	<0.01	<0.01	-	0.02	0.01	0.02
NO3-N mg/l	5.14	5.28	-	5.22	5.24	5.30
Phosphorus Total mg/l	<0.02	<0.02	0.36	**0.08**	**0.08**	**0.06**

Elevated concentrations in bold type

TABLE 5

Big SpringCreek, Falling Spring Branch
and Letort Spring Run
May 11 & 13, 1998
Habitat Assessment Summary

HABITAT PARAMETER	Big Spring Creek			Letort Spring	Falling Spring
	Station 1	Station 2	Station 3		
1. Instream Cover	11	8	7	18	15
2. Epifaunal Substrate	10	12	8	8	8
3. Embeddedness	8	7	5	6	14
4. Velocity/Depth Regimes	18	19	17	18	16
5. Channel Alterations	17	19	15	20	20
6. Sediment Deposits	10	7	6	4	15
7. Frequency of Riffles	8	6	8	5	8
8. Channel Flow Status	20	20	20	20	20
9. Condition of Banks	13	16	15	18	18
10. Bank Vegetative Protection	17	16	15	18	18
11. Bank Vegetative Disruption	12	12	4	14	8
12. Riparian Zone	10	12	6	13	5
TOTAL SCORE	**154**	**154**	**126**	**162**	**165**

Maximum Score 240

TABLE 6

Big Spring Creek
Reference Streams-Falling Spring Branch & Letort Spring Run
RBP Subsamples, May 11 & 13, 1998
Semi-Quantitative Macroinvertebrate Data

TAXA	MOD. HBI	Big Spring-May 98			Letort Spring	Falling Spring
		#1	#2	#3		
ANNELIDA (Earthworms,Leeches)						
Oligochaeta	10	1	-	1	-	1
Helobdella	6	-	-	-	-	-
PODOCOPA (Seed Shrmp)		-	-	-	-	-
ISOPODA (Sowbugs)						
Caecidotea	6	-	-	-	-	1
Lirceus	8	158	144	9	16	-
AMPHIPODA (Scud)						
Gammarus	6	113	13	13	42	157
DECAPODA (Crayfish)						
Cambarus	6	-	-	1	-	-
EPHEMEROPTERA (Mayflies)						
Baetis	6	-	-	3	5	9
Ephemerella	1	-	-	27	98	8
Paraleptophlebia	1	-	-	-	-	11
TRICHOPTERA (Caddisflies)						
Cheumatopsyche	5	-	-	1	-	-
Glossosoma	0	1	-	-	-	-
Hydropsyche	4	-	-	2	-	-
Lepidostoma	1	-	-	-	-	-
Micrasema	2	-	-	-	-	1
COLEOPTERA (Beetles)						
Optioservus	4	-	-	1	3	-
DIPTERA (Midges, Flies)						
Chironomidae spp.	6	15	1	69	3	5
Simulium	6	-	-	4	2	-
GASTOPODA (Snails)						
Physidae	8	-	-	-	-	2
TOTAL TAXA		5	3	11	7	9
TOTAL ORGANISMS		288	158	131	169	195
EPT		1	0	4	2	4

TABLE 7

Big Spring Creek
Reference Streams-Falling Spring Branch & Letort Spring Run
RBP Subsamples, September 1 & 2, 1998
Semi-Quantitative Macroinvertebrate Data

TAXA	MOD. HBI	Big Spring			Falling Spring	Letort Spring
		#1	#2	#3		
TURBELLARIA (Flatworm)	7	1	-	1	2	-
NEMATODA (Roundworm)	9	-	-	1	-	-
ANNELIDA (Earthworms)						
Oligochaeta	10	6	3	2	2	3
ISOPODA (Sowbugs)						
Lirceus	8	279	124	41	-	26
AMPHIPODA (Scud)						
Gammarus	6	44	25	29	178	50
EPHEMEROPTERA (Mayflies)						
Baetis	6	-	-	6	-	9
Ephemerella	1	-	-	-	-	4
Paraleptophlebia	1	-	-	-	5	-
Stenonema	3	-	-	1	-	-
TRICHOPTERA (Caddisflies)						
Cheumatopsyche	5	-	-	8	-	-
Chimarra	4	-	-	1	-	-
Glossosoma	0	13	-	-	-	-
Goera	0	-	-	1	1	-
Hydropsyche	4	-	-	6	-	-
Hydroptila	6	-	-	-	-	1
COLEOPTERA (Beetles)						
Optioservus	4	-	-	10	5	20
DIPTERA (Midges, Flies)						
Antocha	3	-	-	1	4	-
Chironomidae spp.	6	44	8	14	12	15
Simulium	6	-	-	-	2	7
GASTOPODA (Snails)						
Fossaria	7	-	-	-	6	-
Physidae	8	7	-	-	21	2
TOTAL TAXA		7	4	13	11	10
TOTAL ORGANISMS		393	160	120	236	137
EPT		1	0	6	2	3

TABLE 8

Big Spring Creek
Reference Streams-Falling Spring Branch & Letort Spring Run
RBP Complete Samples
May 11 & 13, 1998

TAXA	MOD. HBI	Big Spring			Letort Spring	Falling Spring
		#1	#2	#3		
TURBELLARIA (Flatworms)	7	6	-	-	2	1
NEMATODA (Roundworms)	9	3	-	-	-	2
ANNELIDA (Earthworms, Leeches)						
Helobdella	6	-	-	-	-	2
Oligochaeta	10	18	-	7	10	19
HYDRACHNIDIA (Water Mites)	-	5	-	-	1	6
PODOCODA (Seed Shrimp)	-	-	-	-	-	4
ISOPODA (Sow Bugs)						
Caecidotea	6	-	-	-	-	34
Lirceus	8	5456	3215	52	281	-
AMPHIPODA (Scud)						
Gammarus	6	3300	476	91	585	2603
DECAPODA (Crayfish)						
Cambarus	6	-	-	1	-	1
EPHEMEROPTERA (Mayflies)						
Attenella	2	-	-	1	-	-
Baetis	6	1	-	20	44	86
Ephemerella	1	-	1	147	1388	83
Paraleptophlebia	1	-	-	-	-	161
Stenonema	3	-	-	1	-	-
MEGALOPTERA (Alderflies)						
Sialis	4	-	-	-	-	1
COLEOPTERA (Beetles)						
Agabus	5	-	-	-	-	1
Optioservus	4	-	1	5	45	1
Stenelmis	5	-	-	2	-	-

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TABLE 8

TAXA	MOD. HBI	Big Spring			Letort Spring	Falling Spring
		#1	#2	#3		
TRICHOPTERA (Caddisflies)						
Brachycentrus	1	-	-	2	-	-
Cheumatopsyche	5	-	1	14	5	-
Chimarra	4	-	-	1	-	-
Glossosoma	0	14	-	-	8	-
Geora	0	-	-	-	-	-
Hydropsyche	4	-	24	13	1	-
Hydroptila	6	-	-	-	1	19
Lepidostoma	1	-	-	-	-	7
Limnephilus	3	-	-	-	-	-
Micrasema	2	-	-	-	-	6
Neophylax	3	-	-	-	2	-
Ochrotrichia	4	-	-	-	3	1
Oxyethira	3	-	-	-	-	1
Polycentropus	6	-	-	-	-	8
DIPTERA (Midges, Flies)						
Antocha	3	-	-	-	-	4
Bezzia	6	-	-	-	-	-
Chelifera	6	-	-	-	-	-
Chironomidae spp.	6	668	23	357	84	230
Hemerodromia	6	-	-	-	-	-
Muscidae	6	-	-	-	-	1
Pedicia	6	-		-	-	1
Pseudolimnophila	2	-		-	-	1
Simulium	6	18	-	14	22	12
Stratiomyidae	8	2	3	-	-	1
BIVALVIA (Clams)						
Pisidium	8	-	1	-	-	-
Sphaerium	8	-	-	-	-	1
GASTOPODA (Snails)						
Fossaria	7	-	-	-	-	8
Gyraulus	6	-	-	-	-	1
Hydrobiidae	8	-	-	1	-	-
Physidae	8	31	-	-	2	31
TOTAL TAXA		12	9	17	17	32
TOTAL ORGANISMS		9522	3745	729	2484	3338
EPT		2	3	8	9	9

TABLE 9

Big Spring Creek
Reference Streams-Falling Spring Branch & Letort Spring Run
RBP Complete Samples
September 1 & 2, 1998

TAXA	MOD. HBI	Big Spring			Falling Spring	Letort Spring
		#1	#2	#3		
TURBELLARIA (Flatworms)	7	17	-	4	11	-
NEMATODA (Roundworms)	9	6	-	2	-	-
NEMERTEA (Proboscis)	5	-	-	1	-	
ANNELIDA (Earthworms, Leeches)						
Helobdella	6	-	-	-	1	-
Oligochaeta	10	158	8	10	14	34
HYDRACHNIDIA (Water Mites)	-	1	-	-	3	1
PODOCODA (Seed Shrimp)	-	-	-	-	5	-
ISOPODA (Sow Bugs)						
Caecidotea	6	-	-	-	15	-
Lirceus	8	7253	2913	199	-	290
AMPHIPODA (Scud)						
Gammarus	6	1485	908	186	2985	696
DECAPODA (Crayfish)						
Cambarus	6	-	-	-	-	2
Orconectes	6	-	-	2	-	-
EPHEMEROPTERA (Mayflies)						
Baetis	6	-	6	69	50	121
Ephemerella	1	-	-	12	2	46
Paraleptophlebia	1	-	-	-	99	3
Stenonema	3	-	-	2	-	-

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TABLE 9

TAXA	MOD. HBI	Big Spring			Falling Spring	Letort Spring
		#1	#2	#3		
TRICHOPTERA (Caddisflies)						
Cheumatopsyche	5	-	5	132	-	2
Chimarra	4	-	-	4	-	-
Dolophilodes	0	-	-	-	-	1
Glossosoma	0	154	-	-	-	12
Goera	0	-	-	3	11	-
Hydropsyche	4	-	3	69	-	-
Hydroptila	6	-	-	-	-	12
Limnephilus	3	1	1	-	-	2
Micrasema	2	-	-	-	1	-
Oxyethira	3	-	-	-	1	3
Polycentropus	6	-	1	1	3	1
COLEOPTERA (Beetles)						
Optioservus	4	1	-	40	35	160
Oulimnius	5	-	-	-	-	1
Peltodytes	5	-	-	-	1	-
Stenelmis	5	-	-	1	-	-
DIPTERA (Midges, Flies)						
Antocha	3	-	-	4	9	-
Chelifera	6	-	-	-	2	-
Chironomidae spp.	6	1429	222	115	117	193
Hemerodromia	6	-	-	2	1	-
Muscidae	6	1	-	1	1	-
Simulium	6	5	5	1	37	87
BIVALVIA (Clams)						
Pisidium	8	-	1	-	-	-
GASTOPODA (Snails)						
Fossaria	7	-	-	-	65	2
Physidae	8	205	-	-	260	16
TOTAL TAXA		13	11	22	24	21
TOTAL ORGANISMS		10716	4073	860	3729	1685
EPT		2	4	8	7	10

TABLE 10

Spring Reference Streams

RBP Subsamples

Semi-Quantitative Macroinvertebrate Data

TAXA	MOD HBI	Letort 1 May-96	Letort 2 May-96	Letort May-98	Lick Apr.-91	Lick 1 Jan.-93	Lick 2 Jan.-93	Ealling Apr.-91	Falling May-98
TURBELLARIA (Flatworms)	7	-	-	-	1	-	-	-	-
ANNELIDA (Earthworms)									
Oligochaeta	10	-	-	-	-	10	2	30	1
HYDRACHNIDAE (Water Mites)		-	-	-	-	-	1	-	-
ISOPODA (Sowbugs)									
Caecidotea	6	-	-	-	-	-	-	-	1
Lirceus	8	5	18	16	-	-	-	-	-
AMPHIPODA (Scud)									
Gammarus	6	37	21	42	62	74	41	49	157
DECAPODA (Crayfish)									
Cambarus	6	-	-	-	1	-	-	1	-
EPHEMEROPTERA (Mayflies)									
Baetis	6	3	1	5	36	5	19	2	9
Ephemerella	1	67	47	98	33	82	1	15	8
Drunella	0	-	-	-	10	-	8	-	-
Paraleptophlebia	1	-	-	-	-	-	-	-	11
PLECOPTERA (Stoneflies)									
Capniidae	3	-	-	-	-	-	2	-	-
Leuctra	2	-	-	-	16	-	10	-	-
Perlidae	3	-	-	-	1	-	-	-	-
Sweltsa	0	-	-	-	-	1	-	-	-
MEGALOPTERA (Alderflies)									
Sialis	4	-	-	-	-	-	-	1	-
TRICHOPTERA (Caddisflies)									
Cheumatopsyche	5	-	3	-	-	-	-	1	-
Hydropsyche	4	-	8	-	3	-	-	-	-
Hydroptila	6	-	-	-	-	-	2	-	-
Leucotrichia	6	1	4	-	-	-	-	-	-
Micrasema	2	-	-	-	-	-	-	1	1
Neophlax	3	-	-	-	-	1	-	-	-
Ochrotrichia	4	-	-	-	-	-	4	-	-
Pycnopsyche	4	-	-	-	-	2	-	-	-
Rhyacophila	1	-	-	-	3	-	1	-	-

Continued on the Next Page

TABLE 10

TAXA	MOD HBI	Letort 1 May-96	Letort 2 May-96	Letort May-98	Lick Apr.-91	Lick 1 Jan.-93	Lick 2 Jan.-93	Falling Apr.-91	Falling May-98
COLEOPTERA (Beetles)									
Optioservus	4	17	2	3	8	7	-	-	-
Promoresia	2	-	-	-	-	22	-	-	-
DIPTERA (Midges, Flies)									
Antocha	3	-	-	-	2	1	-	-	-
Chelifera	6	-	-	-	1	-	4	-	-
Chironomidae spp.	6	6	-	3	29	15	44	10	5
Chrysops	7	-	-	-	-	-	-	1	-
Muscidae	6	-	-	-	-	1	-	-	-
Simulium	6	4	43	2	17	1	-	-	-
Tipula	4	-	-	-	1	1	-	-	-
GASTOPODA (Snails)									
Fossaria	7	1	-	-	-	-	-	4	-
Gyraulus	6	2	4	-	-	-	-	1	-
Physidae	8	1	1	-	-	-	-	3	2
BIVALVIA (Clams)									
Sphaeriidae	8	-	-	-	-	-	3	-	-
TOTAL TAXA		11	11	7	16	14	14	13	9
TOTAL ORGANISMS		144	152	169	224	223	142	119	195
EPT		3	5	2	7	5	8	4	4

TABLE 11

Reference Condition Metric Selection
Quartile Analysis of 12 Possible Metrics

NAME	DATE	Intolerant % (HBI< 4)	%Tolerant (HBI >6)	Taxa Rich	EPT	Mod EPT	HBI	% Dom	%Mod May	% EPT	%Mod EPT	% Amp-hipoda	% Iso-poda	DOMINANT TAXA
Falling Spring Br.	980513	10	2	9	4	3	5.53	81	10	15	10	81	0	Gammarus
Falling Spring Br.	910424	29	13	13	4	2	6.41	41	13	17	13	41	0	Gammarus
Letort Spring Run	980511	58	9	7	2	1	3.25	58	58	61	58	25	9	Ephemerella
Letort Spring Run 1	960514	47	5	11	3	1	3.53	47	47	49	47	26	3	Ephemerella
Letort Spring Run 2	960514	31	13	11	5	2	4.55	31	31	41	36	14	12	Ephemerella
Lick Run	910424	29	0	16	7	6	4.50	28	19	46	29	28	0	Gammarus
Lick Run 1	930127	48	3	14	5	4	3.58	37	37	41	39	33	0	Ephemerella
Lick Run 2	930127	15	4	14	8	6	5.42	32	6	33	19	29	0	Chironomidae
Minimum		10	0	7	2	1	3.25	28	6	15	10	14	0	
1st Quartale		25.5 X	2.75	10.5 X	3.75 X	1.75 X	3.57	31.75	12.25 X	29 X	17.5 X	25.75 X	0	
Median		30	4.5	12	4.5	2.5	4.53	39	25	41	32.5	28.5	0	
3rd Quartale		47.25	10 X	14	5.5	4.5	5.45 X	49.75 X	39.5	46.75	41	35	4.5 X	
Maximum		58	13	16	8	6	6.41	81	58	61	58	81	12	

X-Indicates Selected Metrics

Reference Stations: Drainage Area = <12.5 sq. mi.
Alkalinity = >180 mg/l
Sample Period = Jan. to May

TABLE 12

Metric Scoring Criteria
Based on the Reference Condition

Metric	Scope for Detecting Impairment	Scoring Criteria		
		5	3	1
Total Taxa	<25th	≥11	10-6	<6
EPT	<25th	≥4	3-2	<2
% Intolerant	<25th	≥ 25.5	25.4-12.7	<12.7
% Tolerant	>75th	≤ 10	11-40	>40
% EPT	<25th	≥ 29	28.9-14.5	<14.5
HBI	>75th	≤ 5.45	5.46-6.96	>6.96
% Isopoda	>75th	≤ 4.5	4.6-52.2	>52.2

Used a top range of 70% for % Tolerant
Used a top range of 8.5 for HBI

TABLE 13

Big Spring Creek
Reference Streams
Macroinvertbrate Metric Scores

							Reference Stations															
	Big Spring						Falling		Falling		Letort		1 Letort		2 Letort		Lick		1 Lick		2 Lick	
METRIC	#1		#2		#3		Spr. 98		Spr. 91		Spr. 98		Spr. 96		Spr. 96		Run 91		Run 93		Run 93	
Total Taxa	5	1	3	1	11	5	9	3	13	5	7	3	11	5	11	5	16	5	14	5	14	5
EPT Taxa	1	1	0	1	4	5	4	5	4	5	2	3	3	3	5	5	7	5	5	5	8	5
% Intolerant	1	1	0	1	21	3	10	1	29	5	58	5	47	5	31	5	29	5	48	5	15	3
% Tolerant	55	1	91	1	8	5	2	5	13	3	9	5	5	5	13	3	0	5	3	5	4	5
% EPT	0	1	0	1	25	3	15	3	17	3	61	5	49	5	41	5	46	5	41	5	33	5
HBI	7.04	1	7.28	1	5.08	5	5.53	3	6.41	3	3.25	5	3.53	5	4.55	5	4.50	5	3.58	5	5.42	5
% Isopoda	55	1	91	1	7	3	0	5	0	5	9	3	3	5	12	3	0	5	0	5	0	5
Total Score		7		7		29		25		29		29		33		31		35		35		33

Maximum Score = 35
1st Quartile = 29

TABLE 14

Big Spring Creek
May 11 & 13, 1998
Rating Classifications for Bioassessment Indices

Station	Not Impaired	Slightly Impaired	Moderately Impaired	Severely Impaired
	>64	50-64	27-49	<27
Big Spring Run #1				7
Big Spring Run #2				7
Big Spring Run #3	29			
Falling Spring Br. 98		25		
Falling Spring Br. 91	29			
Letort Spring Run 98	29			
Letort Spring Run 96 #1	33			
Letort Spring Run 96 #2	31			
Lick Run 91	35			
Lick Run 93 #1	35			
Lick Run 93 #2	33			

Maximum Score 35