Title

Monitoring erosion control strategies of vineyards in Napa County

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Abstract:

In 1991 Napa County adopted an erosion control ordinance that regulates alterations of landscapes with slopes greater than 5%. The objectives of the Hillside Ordinance are to reduce erosion from hillsides into streams and improve water quality. Vineyard development and management are regulated by this ordinance.

Little research has directly addressed the effectiveness of erosion control strategies as recommended by the Hillside Ordinance. The Napa Conservation District (RCD) initiated the first monitoring that will compare management techniques for erosion control. They are recording suspended sediment concentrations (SSC) flowing from two vineyard plots under different management. The RCD will conduct further data analysis in May of 2004.

Another study conducted by Lutrick (2000), a student in Landscape Architecture 222, focused on the impacts of vineyard development to a stream in Napa. After the plots were cleared Lutrick (2000) conducted basic stream surveys and pebble counts pre and post rains. She chose an adjacent watershed as an analogous control. Her findings indicate that the grain size of the stream changed similarly to the control. In both streams, grain size decreased after one winter (Lutrick 2000). Lutrick (2000) concluded that the development had no significant measured effects on the test stream.

In spring 2004 I resurveyed the streams. My objective was to analyze more long-term changes that might have occurred to Lutrick's (2000) study sites. My findings indicate that the pebble size D_{50} for cumulative percent finer in both streams seems to be decreasing. Increased sedimentation in both streams may be due to upstream human activity or natural phenomena.

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Introduction

In 1987, it was discovered that significant soil erosion from a hillside vineyard in Napa, California was contaminating Bell Canyon Municipal Reservoir. This stimulated the Napa County Board of Supervisors to enact an ordinance addressing anthropogenic stream degradation. The Hillside Ordinance of 1991 aims to reduce erosion into waterways, and maintain or improve water quality (RCD website).

The ordinance requires review and approval of all plans that would alter natural or pre-existing landscapes on hillsides with slopes greater than 5%. These include development projects and agricultural activities. The ordinance suggests several options for erosion control. Acceptable measures include cover crops, silt fences, drop inlets, sedimentation ponds, rock-lined drainage channels, and stream setbacks (Lutrick 2000; RCD website).

Developers submit their erosion control plan for review to either an approved private agency or to the non-regulatory Napa Resource Conservation District (RCD). The Napa County Conservation, Development and Planning Department (CDPD) approves projects that make sufficient efforts to curb erosion. The Planning Commission can deny permits for development or land use if they believe erosion control measures are insufficient.

The Sierra Club and other interested parties are lobbying for more strict regulations in the Hillside Ordinance. They contend that vineyard activities still threaten aquatic and terrestrial habitats by clearing the cover surrounding waterways and increasing fine sediment in streams (Malan 1999). To address the concerns of these parties a watershed task force reviewed the Hillside Ordinance in 1999. The task force recommended more strict enforcement, scientific monitoring, and an ongoing watershed alliance (Malan 1999).

Proposed changes by the task force to the Hillside Ordinance do not fully address the concerns of environmental groups. The predominance of agribusiness representatives and engineers on the task force overwhelmed their objectives. These groups still criticize the methods recommended by the ordinance for erosion control (Malan 1999).

Although erosion from vineyards is decreasing, the specific effects of erosion control methods have not been scientifically assessed. Regional studies have recorded less soil loss from hillside vineyards following the adoption of the Hillside Ordinance (Neal 1998). But no completed studies directly address vineyard management (Champion 2004).

In 2000, the RCD initiated the first study comparing vineyard erosion control methods. They are monitoring of suspended sediment concentrations (SSC) from vineyard runoff. Their project is located in the Spring Mountain District, northwestern Napa Valley. In 2003, the RCD improved their sampling equipment. They will analyze the first year of data collection in May 2004. The data analysis should help make informed decisions for the better management of vineyards on hillsides.

An initial effort to record the impacts of vineyard development was made by a LA222 student. Erin Lutrick surveyed a small, ephemeral stream. This stream drained plots recently cleared for vineyard development in 1999 (Lutrick 2000). Lutrick (2000) surveyed the stream in October 1999, before first winter rains, and again in April of 2000, after winter rains. She replicated the same survey on a control stream. Lutrick (2000) chose the control stream because it was largely unaffected by the vineyard development.

She measured longitudinal profiles, cross sections, and pebble counts for both streams (Lutrick 2000).

Lutrick's (2000) analysis did not compare changes in stream morphology due to difficulties with surveying accuracy. Pebble counts indicated a decrease of D_{50} for both the test and control streams. D_{50} is the pebble size class of a sample where 50% of the pebbles are of equal or smaller size. This decrease of D_{50} translates to a greater amount of small pebbles in both streams after one winter following the hillside clearing. Lutrick (2000) concluded that the development did not impact the test stream. She recommended that future surveys explain the long-term impacts of vineyard development on the test stream (Lutrick 2000).

In April 2004 I resurveyed all of Lutrick's (2000) sites. The objective of this study was to document any changes to Lutrick (2000) sites four years after the initial study.

Methods

Site identification at Atlas Peak

I located Lutrick's (2000) sites at Atlas Peak prior to conducting my own survey. Finding the precise site was a critical part of the resurvey. I relied on the documentation that Lutrick (2000) provided in her term paper. These consist of sketch maps, topographic maps, photographs, and written descriptions. Her written directions to the study sites include a street address on Atlas Peak Rd., which does not exist. The RCD helped me locate the correct address and property owners using a GIS program to identify the parcel in the topographic map that Lutrick (2000) included in her documentation.

The flagging left by Lutrick (2000) was gone. Nor could I locate other key features, such as a marked rock at site D (Lutrick 2000). Therefore, it is uncertain if I accurately relocated Lutrick's (2000) study sites. I recorded compass readings in the direction of every cross section and longitudinal profile to facilitate future resurveying.

Cross sections and longitudinal profiles

My measurements were made using a Topcon automatic level, a stadia rod, and a measuring tape. I measured cross sections from the left banks. My cross sections include the approximate bank height at each site. I tried to capture the most obvious variation in stream channel morphology.

I recorded longitudinal profiles that approximated the Lutrick (2000) reach. I measured the thalweg of the stream at site B. In the field I became confused by Lutrick's (2000) sketch map and decided to record the center of the channel instead of the thalweg for sites A, C, and D. In graphing the longitudinal profiles, I chose the point of intersection with the cross sections as an elevation of zero feet.

Pebble counts

My methods for conducting the pebble counts differed from Lutrick (2000). I sampled 100 pebbles from the beds alongside the riffles of the streams (Dunne and Leopold 1978) near the cross sections. I intended to conduct a standard and easily replicable sampling method. Lutrick (2000) sampled at six-inch intervals throughout the pools near the cross sections. It was proposed that sediment in the stream would most likely be deposited in the pools (Lutrick 2000).

I measured pebble size with a gravelometer whereas Lutrick (2000) used a tape measure. Therefore, size classes differ in between each study. To normalize Lutrick's

(2000) data with this study, I combined all small size classes as less than 4 mm and all large size classes as greater than 128 mm. Intermediary classes in Lutrick's (2000) survey encompass two of mine. Therefore, I condensed my intermediated classes to fit those of Lutrick (2000.).

I classified embedded pebbles as greater than 128 inches. In collecting data I mistakenly included bedrock and embedded pebbles as one category. My data cannot be separated for analysis. Lutrick (2000) recorded bedrock as a separate category, and did not include the bedrock category in her calculations (table 1).

I calculated a cumulative percentage finer, which is a size class' percent of the total sample divided by the sum percentage of all smaller size classes. I graphed cumulative percentage finer against size class to derive the D_{50} of the pebble count (figures 5a-d).

Results and Discussion

Site identification, cross sections, and longitudinal profiles at Atlas Peak

I did not locate all sites successfully at Atlas Peak. Significant topographic differences that I recorded for the control stream in comparison to previous surveys illustrate this (fig 3a-4b). Excluding any large flow events, the streambed probably changes slowly due to its composition of bedrock and large boulders, as well as the region's low annual precipitation (Champion 2004). Still, some similarities between all surveys indicate that I captured at the least parts of the study reaches from Lutrick (2000).

My surveys of the test stream replicated Lutrick's (2000) surveys more accurately. I located more markers on the test stream. The dimensions of the channel were roughly the same in both of our surveys.

Although I located sites A and B successfully, the longitudinal profiles and cross sections are not accurate enough to draw inferences about changing stream morphology over four years. Lutrick (2000) also concluded that topographic surveys from October 1999 and April 2000 were not accurate enough to compare. I concord with Lutrick (2000) that sites A and B have a complex topography of boulders. This may cause relatively large differences in topographic measurement depending on the placement of the stadia rod. Future surveys should consider using small measurement intervals. Also, triangulating locations using clear and permanent markers should be integrated into survey projects that expect follow-up work by other investigators.

Since I recorded the center of the channel instead of the thalweg for sites A, C, and D I anticipated that my longitudinal profiles would not correspond with Lutrick's (2000) survey. My longitudinal profile for site C (fig. 3b) is the most accurate of my longitudinal profiles. This is due to the more regular channel bed on the reference stream, as well as its narrowness.

Pebble counts

Lutrick (2000) classified her samples into smaller and larger size classes than I could with a gravelometer. Although her method was more accurate, using a gravelometer is much faster. This allowed me to complete my survey within a shorter time period. I did not compare the larger and smaller sediment classes recorded by Lutrick (2000). A less specific comparison of the data should not be impeded by the size class distinctions.

Lutrick's (2000) data indicate that the D_{50} for percentage finer decreased at all four sites. More small size class pebbles were collected after the rainy season than before the rainy season (Lutrick 2000). Changes in the test stream's pebble size were no different than for those of the reference stream (Lutrick 2000). Therefore, the hillside vineyard development did not impact the pebble size in the test stream after one rain (Lutrick 2000).

Lutrick (2000) suggested that some of the erosion control measures must have been successful. Otherwise, a greater increase in fine sediment would have occurred in the test stream than in the control stream. This conclusion assumes vineyard development without control measures would have increased erosion into the test stream.

My survey showed the same trend of decreasing D_{50} at sites A, B, and D. However, site C shows a slight increase to D_{50}. My data may indicate a change in sediment size for the surveyed streams. The magnitude of change for D_{50} at sites A, B, and D are similar. This shows that pebble size may not have differentially changed in four years following vineyard development. This does not explicitly prove that the vineyard development is responsible for erosion into the test creek. It may imply that upstream human activities are causing erosion into both streams. Or, human activity upstream may not be affecting natural sedimentation rates.

My pebble counts demonstrate a greater concentration of mid-range size classes in contrast to Lutrick's (2000) pebble counts with more fine and large sediment (tables 1a-d). Plotting percentage finer has resulted in convex lines of my percent finer versus Lutrick's (2000) concave lines (figures 5a-d). This suggests that pebble beds alongside streams may contain more intermediate sizes, and pools may contain both smaller and larger size classes.

Conclusion

Minimizing erosion from hillside vineyards in Napa County is an essential part of improving riparian and terrestrial habitat, as well as maintaining good water quality. The RCD has begun important survey that may improve specific management decisions on vineyards.

In contrast, traditional surveying is an important tool to understand changes occurring at the watershed scale. The experiences of both Lutrick (2000) and this study indicate that a greater accuracy is required to compare stream morphology. Replication of survey methods is also critical. Using identical surveying techniques and clear reference points when resurveying leads to meaningful results.

References

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Figure 1a. Cross section of site A on the test stream looking downstream with vertical exaggeration.

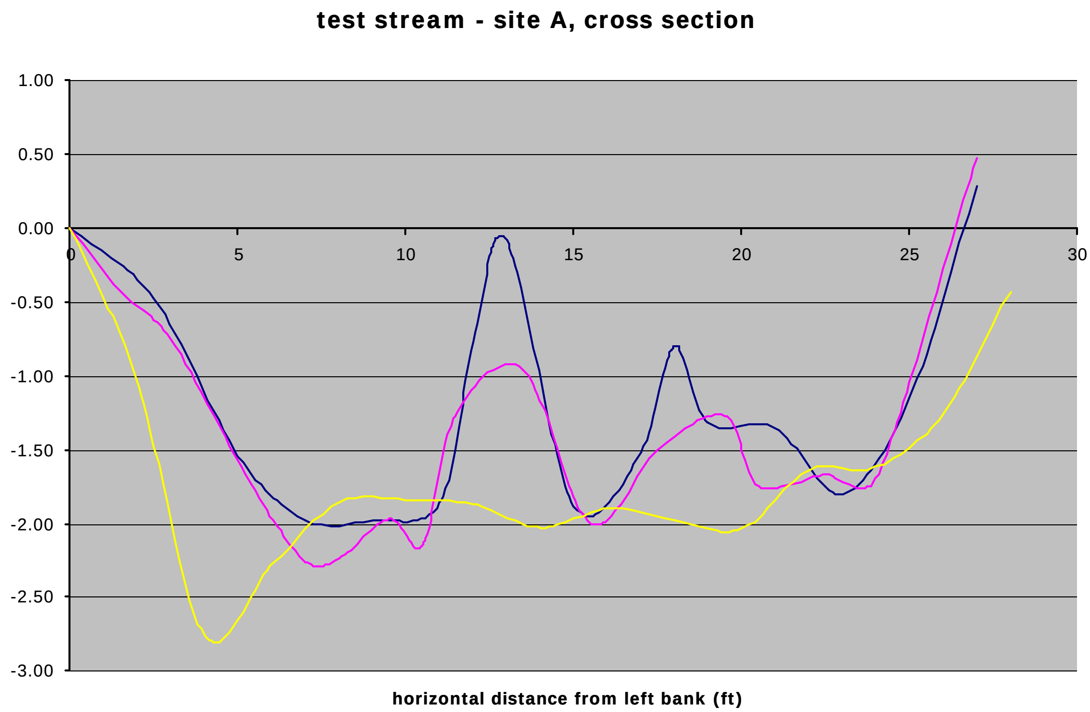

Figure 1b. Longitudinal profile of site A on the test stream with vertical exaggeration. The longitudinal profile crosses the cross section at zero feet.

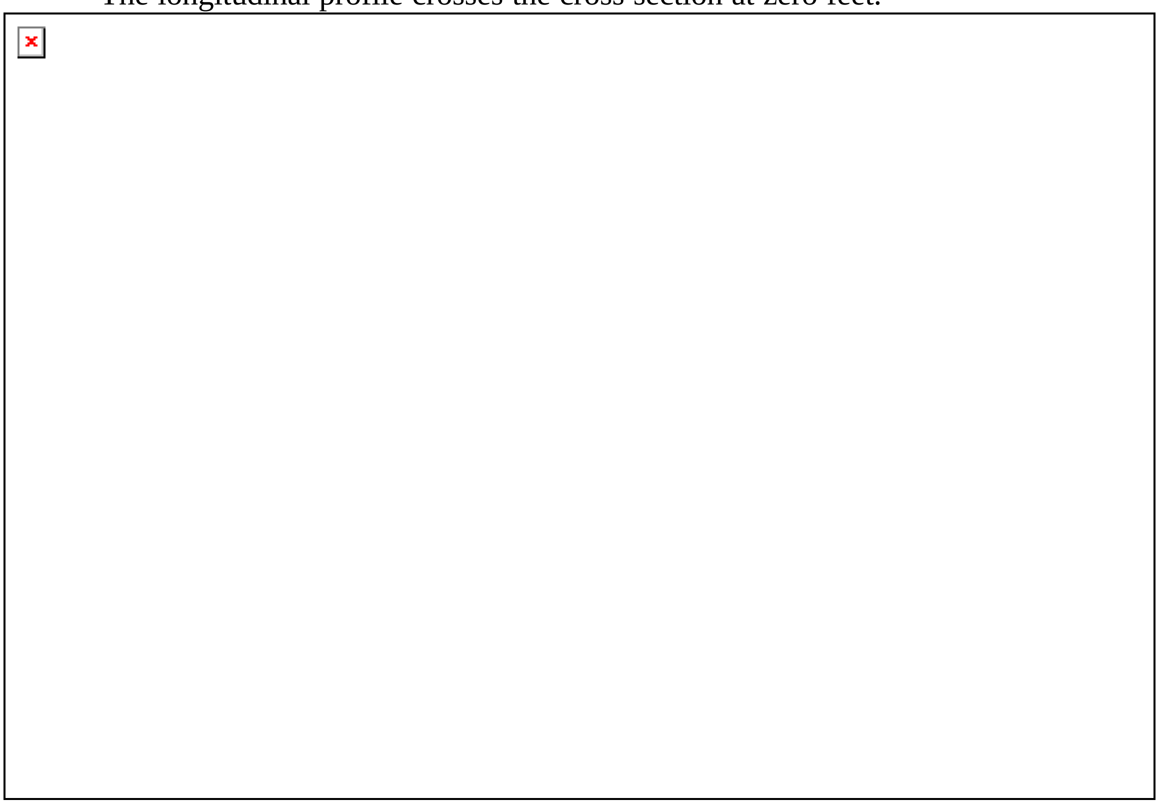

Figure 2a. Cross section of site B on the test stream looking downstream. Vertical exaggeration.

Figure 2b. Longitudinal profile of site B on the test stream. Vertical exaggeration. The longitudinal profile crosses the cross section at zero feet.

Figure 3a. Cross section of site C on the control stream looking downstream. Vertical exaggeration.

Figure 3b. Longitudinal profile of site C on the control stream with vertical exaggeration. The longitudinal profile crosses the cross section at zero feet.

Figure 4a. Cross section of site D on the control stream looking downstream. Vertical exaggeration.

Figure 4b. Longitudinal profile of site D on the control stream with vertical exaggeration. The longitudinal profile crosses the cross section at zero feet.

figure 5a.

Figure 5b.

Figure 5c.

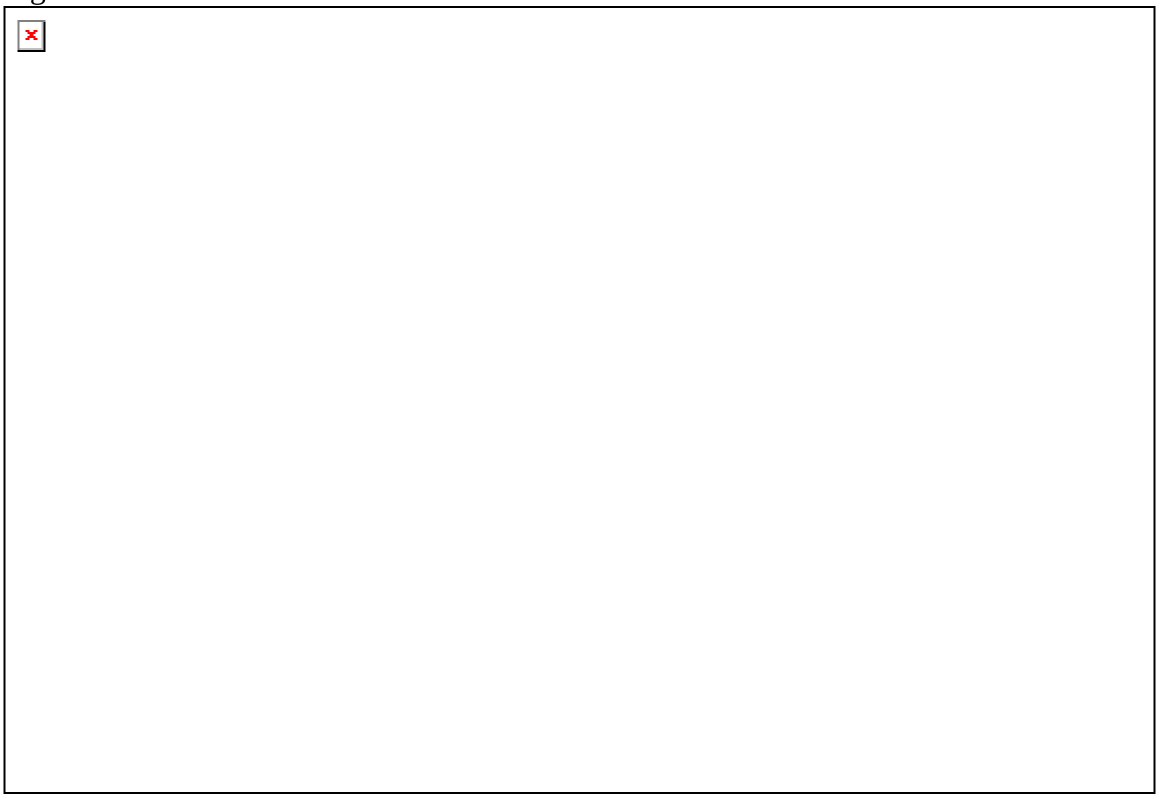

Figure 5d.

Table 1a. formatted pebble counts for site A on the test stream

October 1999 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	11	14.10	14.10
4-8	2	2.56	16.67
8-16	4	5.13	21.79
16-32	12	15.38	37.18
32-64	6	7.69	44.87
64-128	9	11.54	56.41
128-360	34	43.59	100.00
total	**78**		
bedrock	22		

April 2000 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	20	23.53	23.53
4-8	2	2.35	25.88
8-16	6	7.06	32.94
16-32	6	7.06	40.00
32-64	8	9.41	49.41
64-128	11	12.94	62.35
128-360	32	37.65	100.00
total	**85**		
bedrock	15		

April 2004 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	10	10.00	10.00
4-8	31	31.00	41.00
8-16	24	24.00	65.00
16-32	19	19.00	84.00
32-64	4	4.00	88.00
64-128	2	2.00	90.00
128-360	10	10.00	100.00
total	**100**		
bedrock	?		

Table 1b. formatted pebble counts for site B on the test stream

October 1999 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	7	9.46	9.46
4-8	5	6.76	16.22
8-16	6	8.11	24.32
16-32	16	21.62	45.95
32-64	8	10.81	56.76
64-128	8	10.81	67.57
128-360	24	32.43	100.00
total	**74**		
bedrock	26		

April 2000 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	19	20.43	20.43
4-8	5	5.38	25.81
8-16	8	8.60	34.41
16-32	10	10.75	45.16
32-64	5	5.38	50.54
64-128	9	9.68	60.22
128-360	37	39.78	100.00
total	**93**		
bedrock	7		

April 2004 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	19	19.00	19.00
4-8	26	26.00	45.00
8-16	33	33.00	78.00
16-32	11	11.00	89.00
32-64	2	2.00	91.00
64-128	2	2.00	93.00
128-360	7	7.00	100.00
total	**100**		
bedrock	?		

Table 1c. formatted pebble counts for site C on the control stream

October 1999 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	18	30.51	30.51
4-8	1	1.69	32.20
8-16	4	6.78	38.98
16-32	8	13.56	52.54
32-64	6	10.17	62.71
64-128	4	6.78	69.49
128-360	18	30.51	100.00
Total	**59**		
Bedrock	41		

April 2000 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	32	46.38	46.38
4-8	3	4.35	50.72
8-16	3	4.35	55.07
16-32	3	4.35	59.42
32-64	9	13.04	72.46
64-128	10	14.49	86.96
128-360	9	13.04	100.00
Total	**69**		
Bedrock	31		

April 2004 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	14	14.00	14.00
4-8	21	21.00	35.00
8-16	25	25.00	60.00
16-32	18	18.00	78.00
32-64	14	14.00	92.00
64-128	5	5.00	97.00
128-360	3	3.00	100.00
Total	**100**		
Bedrock	?		

Table 1d. formatted pebble counts for site D on the control stream

October 1999 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	15	21.13	21.13
4-8	7	9.86	30.99
8-16	4	5.63	36.62
16-32	5	7.04	43.66
32-64	10	14.08	57.75
64-128	9	12.68	70.42
128-360	21	29.58	100.00
Total	**71**		
Bedrock	29		

April 2000 survey			
size category (mm)	percent of total	fraction of total	cumulative percent finer
<4	21	29.58	29.58
4-8	0	0.00	29.58
8-16	0	0.00	29.58
16-32	0	0.00	29.58
32-64	3	4.23	33.80
64-128	15	21.13	54.93
128-360	32	45.07	100.00
Total	**71**		
Bedrock	29		

April 2004 survey			
size category (mm)	number counted	percent of total	cumulative percent finer
<4	14	13.73	13.73
4-8	33	32.35	46.08
8-16	31	30.39	76.47
16-32	5	4.90	81.37
32-64	3	2.94	84.31
64-128	1	0.98	85.29
128-360	15	14.71	100.00
Total	**102**		
Bedrock	?		

Appendix

data from Atlas Peak long profiles and cross sections
sketch maps from Atlas Peak
photographs from Atlas Peak surveys
directions to surveying locations in Atlas Peak

data from Atlas Peak long profiles and cross sections
site A

October 1999 survey   April 2000 survey site A   April 2004 survey site A xsec

dist. from left bank (ft)	elevation (ft)
0	0.00
2.5	-0.48
5	-1.54
7	-1.98
9	-1.98
11	-1.86
12	-0.77
13	-0.09
15	-1.88
17	-1.52
18	-0.80
19	-1.32
21	-1.35
23	-1.80
25	-1.16
27	0.28

October 1999 survey

xsec

dist. from left bank (ft)	elevation (ft)
0	
1.5	
3	
5.5	
7	
8	
9.5	
10.5	
11.5	
13.5	
15.5	
17.5	-1.50
19.5	-1.27
20.5	-1.75
22.5	-1.67
24	-1.70
27	0.48

site A

long profile thalweg

dist. from xsec (ft)	elevation (ft)
-13	0.57
-8	0.16
-3	0.33
0	0.00
2	-0.33
7	0.80
12	-1.73
17	-3.13
22	-3.49
27	-3.95

April 2000 survey

xsec 200 SW

dist. from left bank (ft)	elevation (ft)
22	
24	
26	
28	

site A

long profile thalweg

dist. from xsec (ft)	elevatic
-31	1.31
-26	0.96
-24	0.96
-21	1.06
-17	0.96
-14	0.66
-11	0.72
-9	0.16
-7.2	-0.18
-3	-0.21
-1	-0.64
0	0.00
2	0.04
5	-0.57
7	-1.44
8	-0.73
11	-1.80
18	-3.52
20	-4.01
25	-3.98
27	-3.89

April 2004 survey

data from Atlas Peak long profiles and cross sections
site B

October 1999 survey
site B
xsec

dist. from left bank (ft)	elevation (ft)
0	0.00

April 2000 survey
site B
xsec

dist. from left bank (f		
0		

2	-0.61
3	-0.9
4	-1.50
6	-1.61
8	-1.18

2	-0.76
4.6	-1.63
6.8	-1.69
9.1	-1.10
11.8	0.85

10	-1.00
11.2	0.20

5	0.54
8	-0.45
10	-0.06
15	-1.08
20	-0.98
25	-1.78
30	-1.16
35	-2.18
40	-2.62

-27.7	1.40
-23.5	1.52
-19.4	1.20
-16	0.96
-13	1.11
-8	0.58
-4.5	0.15
-1	0.25
0	0.00
5	-0.24
8	-0.51
12	-0.55
16.4	-1.98
21	-1.58
25	-1.97
28	-2.21
30	-1.34
33	-1.89
37	-2.06
40	-2.57

October 1999 survey
site B

long profile thalweg

dist. from xsec (ft)	elevation (ft)
0	0.00

April 2000 survey
site B

long profile thalweg

dist. from xsec (ft)	elevation (ft)
-32	1.66

April 2004 survey
site B
long profile thalweg
160 SE

dist. from xsec (ft)	elevation (ft)
-26	1.19

data from Atlas Peak long profiles and cross sections
site C

October 1999 survey
site C
xsec

dist. from left bank (ft)	elevation (ft)
0	0.00
1	-0.64
2	-1.02
3	-1.30

April 2000 survey
site C
xsec

dist. from left bank (f	
0	
2	
3	
4	-0.86

…04 survey
…5 SW

…om left bank (f	
5	-1.02

4	-1.41
5	-1.26
6	-2.19
7	-2.02
8	-2.14
9	-1.82
10	-0.89

5	-2.16
6	-2.12
7	-1.96
8	-1.60
9	-1.98
10	-0.90

-11	0.79
-15	1.34
-18	1.95
-20	2.16
-22	2.63
-27	2.31
-32	2.69
-37	3.21
-40	3.97

3	-0.45
5	-0.93
7	-1.20
11	-1.42
13	-1.60
14.5	-1.85
16	-2.15
18.5	-2.35
20	-2.57
22	-2.80
26.3	-3.59
28	-3.52
32	-3.65
35	-3.69
37	-3.97
39	-4.13
40	-4.37

October 1999 survey
site C
long profile
thalweg

dist. from xsec (ft)	elevation (ft)
0	0.00
-5	0.40
-8	0.90
-9	0.30

April 2000 survey
site C
long profile
thalweg

dist. from xsec (ft)	elevation (ft)
-6	0.55
-4	0.91
-2	0.12
0	0.00

April 2004 survey
site C

lp mid-channel 122 S

dist. from xsec (ft)	
-40	[illegible]
-35	2.82
-30	2.06
-27	1.48

data from Atlas Peak long profiles and cross sections
site D

October 1999 survey
site D
xsec

dist. from left bank (ft)	elevation (ft)
0	0.00
1	0.02
2	-0.46
3.4	-1.43
4	-1.37
5	-0.95
6.25	-1.71

April 2000 survey
site D
xsec

dist. from left bank (ft)	elevation (ft)
0	0.00
0.5	-1.36
3	-1.94
6	-2.24
9	-2.12
13	-2.60
15	-2.74

7	[illegible]
8.3	-1.56
10	[illegible]
11	-0.18

survey
site D

dist. from left bank (f
0
2
4
6
8

15.7	-4.46
16	-4.23
17	-4.36
17.5	-4.34
18.5	-4.26
19.5	-4.14
20.5	-3.90
21	-3.40
23	-3.10
26	-2.64
29	-2.60

-12	0.61
-9	0.38
-6	0.34
-3	0.10
0	0.00
3	-0.32
6	-1.09
9	-0.39

-18.7	2.04
-17	2.21
-13	0.75
-10	0.70
-8	0.46
-6	0.73
-5	0.65
-4	0.43
-2	0.47
0	0.00
1	-0.21
4	-0.03
6	-0.22
11	-0.68
16	-0.13
20	-0.57
25	-0.71
30	-0.91
33	-1.24

October 1999 survey
site D

long profile
thalweg

dist. from xsec (ft)	elevation (ft)
-32	3.04
-27	2.62
-24	2.13
-21	1.63
-18	2.08
-15	1.39

sketch maps from Atlas Peak test stream (Lutrick 2000)

April 2000 survey
site D

long profile
thalweg

dist. from xsec (ft)	elevation (ft)
-32	3.21
-30.5	2.99
-29	2.76
-26.5	2.59
-25	2.96
-23	1.97

April 2004 survey
site D

lp mid-channel 115 SE

dist. from xsec (ft)	elevation (ft)
-7	1.55
-4	0.10
0	0.00
4	-0.22
7	0.25

test stream (my sketch 2004)

sketch maps from Atlas Peak
control stream (Lutrick 2000)

control stream (my sketch 2004)

photographs from Atlas Peak surveys

site A

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

site B

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

photographs from Atlas Peak surveys

site C

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

site D

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

directions to study sites

test stream

To reach the test stream, go to 3189 Atlas Peak Rd. Park your car across the street on a dirt road. A silver gate blocks the dirt road. The easiest way to find sites A and B is to follow the test stream from where it passes through the culvert under Atlas Peak Road. Use the sketch maps to identify your position. Where the stream banks widen dramatically to 25 feet across is site A. Site B is about 55 feet downstream of site A, and is distinguishable by a deep pool. There are several trails that lead back to the dirt road where your car is parked.

Control stream

To find the control stream find 3189 Atlas Peak Rd. Then follow Atlas Peak Rd. south until you reach the next culverted stream under Atlas Peak Rd. The study reaches are highly inaccessible. The best route was found to the right of the stream through the brush. Eventually the brush clears around the stream. This is where sites C and D are located. The longitudinal profile for site C starts near the first exposed section of the stream. Use the data sets to determine where the cross section measurement should be made. All markers left by Lutrick (2000) were not identified.