LAND USE AND LAND COVER ANALYSIS FOR VARIABLE BUFFER SCALES IN THE CANYON TRIBUTARIES

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ABSTRACT

A GIS analysis was performed to evaluate the relationship between water chemistry data from 32 City of Austin Canyon Study sites and riparian zone quality and quantity. Riparian zone quantity was set at three different spatial scales, or buffer widths: 50-foot, 300-foot, and whole watershed. Riparian zone quality was measured in two different ways: 1) City of Austin land use data was utilized to compile traditional categories of zoning and land use planning (residential, commercial, industrial, etc…) in buffers, and 2) a newer methodology that uses classification software and color infrared aerial photography to delineate buffer vegetative or "land cover" categories (Deciduous tree, Tall Grass, lawn/golf course, etc…). These two types of spatial data were used as independent variables in a multiple regression analysis to evaluate their abilities to predict water quality and quantity variables.

Regression analysis shows that among the three spatial scales, the 300-foot buffer is as or more important to water quality than the whole watershed scale. Both the 300-foot buffer and watershed scales were more important than the 50-foot buffer. The classification method of measuring "land cover" showed better overall results in predicting water quality variables than the traditional land use categories.

Within the land use categories, the amount of undeveloped land was the best predictor of water quality, while in the land cover groupings, the lawn/golf course category was the best predictor of water quality. These results may be put to use in evaluating the beneficial effects of the City of Austin regulatory setbacks from creeks and determining the most effective buffer width.

INTRODUCTION

The Canyon Study is a City of Austin monitoring program that has been evaluating water chemistry in tributaries in West Austin for the past nine years in an effort to characterize water quality in tributaries with different land use types. Initially, this study was designed to evaluate three major categories of land use: golf courses, high density and low density residential (COA-ERM/1997). However, as better spatial data was made available through geographical information systems (GIS) and more tributaries were added to the study, it became evident that land use distribution was more complex than anticipated and called for further analysis.

The City of Austin has been instituting water quality protection measures within "Critical Water Quality Zones" or buffers along stream corridors since 1986 with the Comprehensive Watershed Ordinance. These measures vary depending on size and location of the watershed, but generally protect from development a 50- to 400-foot buffer on either side of the centerline of a given stream. How and if these buffers actually affect water chemistry in streams has been a concern since their institution both in Austin and virtually anywhere buffers are controlled by watershed ordinances.

Historically, the application of water quality ordinances was irregular and spatially inconsistent, and state grandfathering laws have limited their utility. Watersheds in the Austin area have had varying levels of protection for different lengths of time. Therefore, analysis of buffer effects on water quality is difficult due to the extreme variation in buffer quantity and quality on both a watershed and citywide scale.

A GIS analysis was undertaken which utilized the water chemistry data set generated by the Canyon Study as a measure of water quality and vegetative classification, and land use categories as measures of buffer quantity and quality. Buffers were quantified using GIS tools and analyzed within three scales: 50-foot buffer, 300-foot buffer, and the whole watershed. (In this analysis, a buffer is the distance measured from the centerline of the stream and extending its entire length, not necessarily an undeveloped riparian zone.) The purpose of this analysis is to measure the quality and quantity of the land cover within these fixed buffer areas. Each of these scales represents three general levels of protection that are enforced within the City of Austin's ordinances and in other states and municipalities in the country (Schultz et al 1993, Wissmar and Bechta 1998, Connecticut River Joint Commission 2000). A 50-foot buffer is considered the minimum to protect basic aspects of riparian function, while a 300-foot buffer is considered adequate for larger scale ecological and wildlife benefits. The whole watershed scale represents the maximum protection possible and assumes that any land draining to a stream contributes to its water chemistry. In addition, this analysis would determine those specific types of land cover and land use within the three scales which most impact stream water chemistry and which could facilitate improved development and application of water quality ordinances.

The hypothesis of this analysis is that the full watershed scale predicts water quality variables most accurately, and that the smaller buffer scales are proportionately less important to overall water chemistry.

METHODS

The water chemistry data set for this analysis was compiled from nine years of monthly sampling in 38 tributaries. Sites with inconsistent data sets or a limited number of data points (<3 per constituent) and sites that did not have land use or land cover data available were ignored. This reduced the number of sites to 32 (see Figure 1).

Water quality constituents that had the most variation among sites and were common in municipal and state water quality assessment programs were selected. The mean for each constituent was calculated after removing data influenced by storm flows (COA Standard Operating Procedures). The mean value was used to represent each site in the analyses in this report (see Appendix 1). Non-detected values in this data set were used at their detection level in calculating means.

Two sources of data were used to evaluate buffer quantity and quality; 1) color infrared aerial photography collected in October of 2000 was used to quantify vegetative land cover using ERDAS Imagine software, and 2) the classification system shown in Table 1.

Figure 1. Location of 32 Canyon sampling sites within Austin area watersheds, primarily Barton Creek.

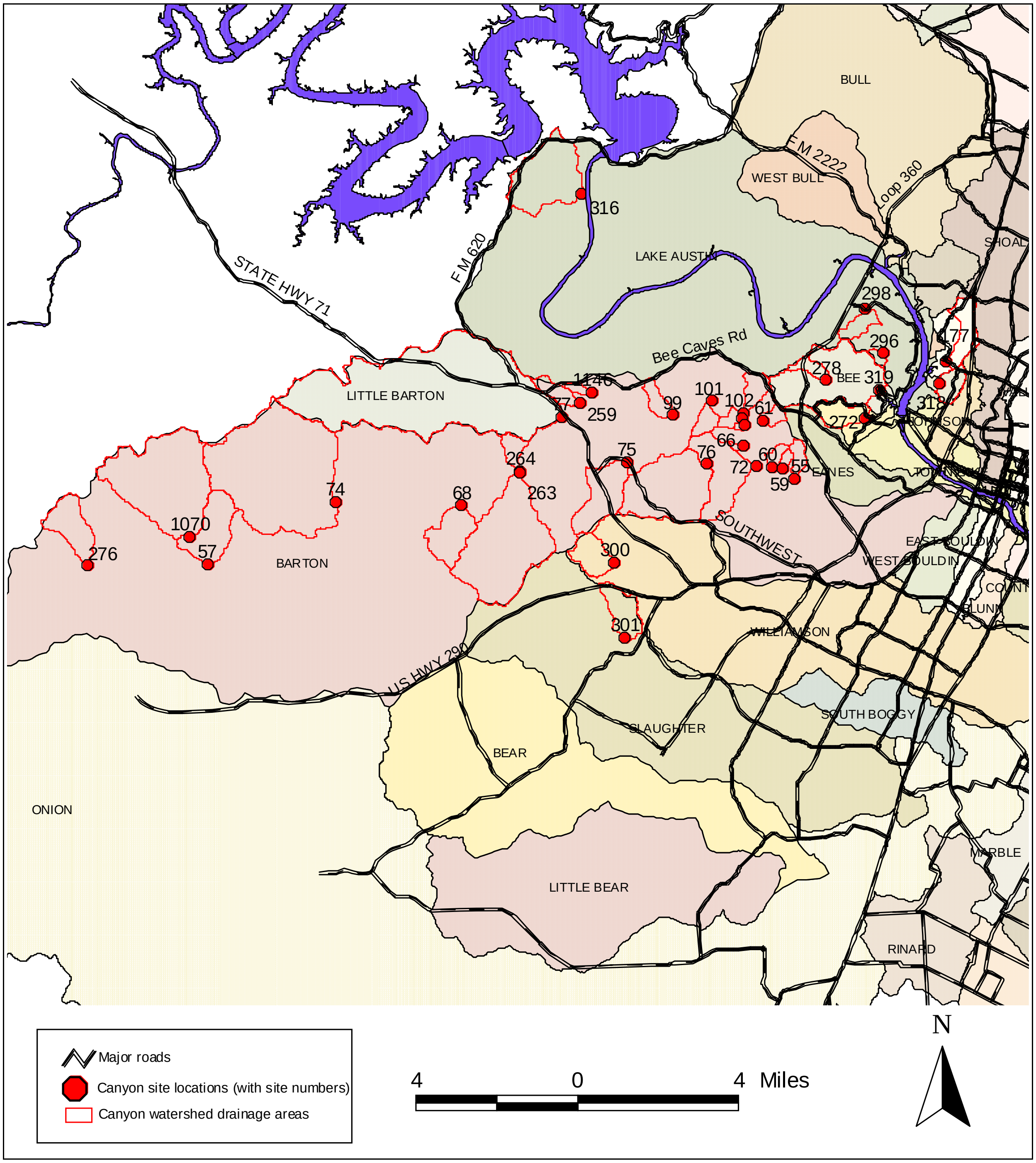
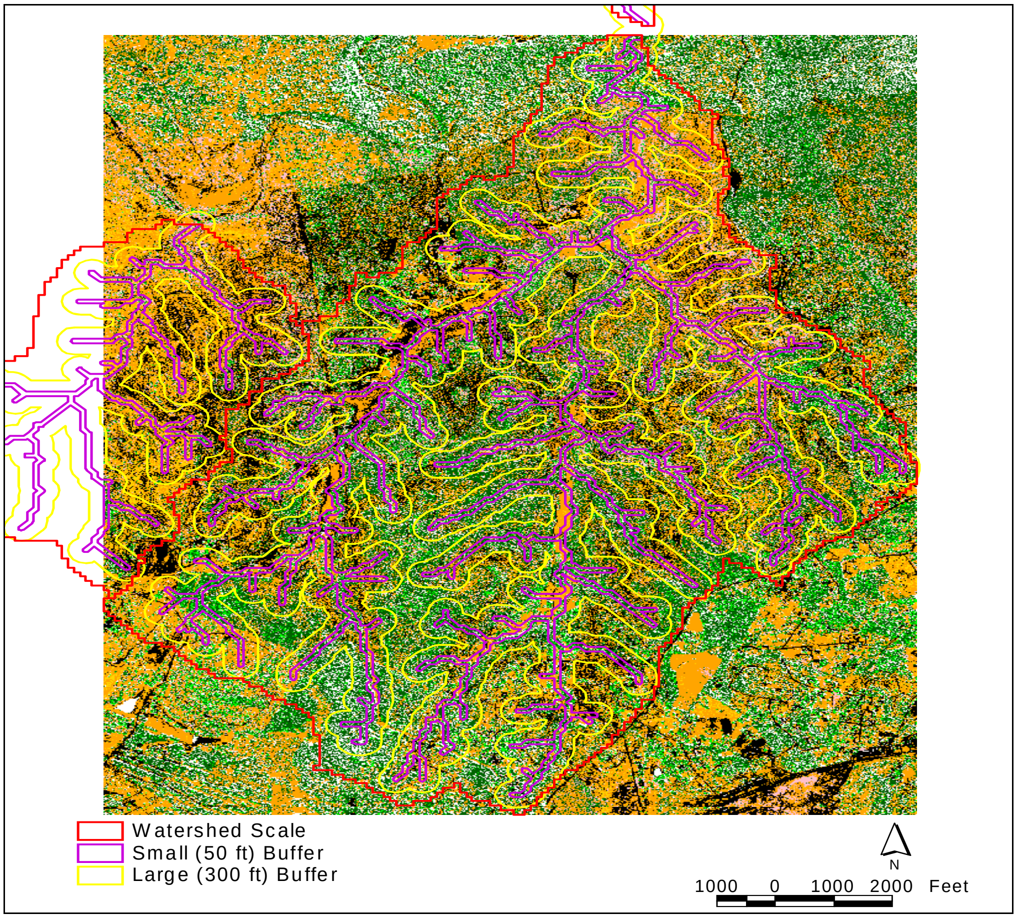


Table 1. Vegetative Classification categories (Land Cover).
(Shaded categories are calculations made from raw data categories.)

	Category	Description	Abbreviation
1	Short Grass	Less established meadows/fields	short_gr
2	Tall Grass	More established meadows/fields	tall_gr
3	Ashe Juniper	Evergreen, dominant species.	ajun
4	Deciduous/Live Oak	All deciduous trees including Live Oak	decid_lo
5	Impervious cover	Roads, buildings etc., as well as limestone.	concrete
6	Hot/Forbes/Lawns	Disturbed, fertilized, irrigated vegetation.	hot_forb
7	Natural Area	Summation of Category 1, 2, 3, and 4	Nat_%
8	Forested Area	Summation of Category 3, and 4	For_%
9	Road Crossings/km	Number of roads crossing stream per km	xing_km

A 50-foot buffer, a 300-foot buffer and whole watershed areas were delineated with GIS and used to quantify the distribution of each category associated with each site from the classified images (see Figure 2 for an example image and Appendix 2 for the raw land cover and land use data). In addition to the percentage that each vegetative group contributed to each buffer scale, several categories were grouped together to estimate “Total Natural Area” (Short Grass, Tall Grass, Ashe Juniper and Deciduous) and “Total Forested Area” (Ashe Juniper and Deciduous). The number of road crossings per km was also added to the land cover group as a measure of buffer continuity.

Figure 2. Example of three scales of analysis for one site. The background image has been classified to indicate coverage of selected vegetative groups.



The other measure of buffer quality was the City of Austin Land Use coverage, which uses zoning and manual interpretation of aerial photography to spatially locate categories of land use (see Table 2):

Table 2. City of Austin Land Use categories.

	Category	**Description**	**Abbreviation**
1	Civic	Wide range of municipal/state uses	CIVIC
2	Commercial	Commercial use	COMM
3	Industrial	Industrial use	IND
4	Low-Density Single Family	At least one acre lot residential use	LLSF
5	Multi-Family	Multi-family residential, high-density	MF
6	Office	Office use	OFF
7	Park	Park or open green space.	PARK
8	Single Family	Single family residential use	SF
9	Transportation	Paved roads of any size	TRAN
10	Undeveloped	Undeveloped land use	UNDEV
11	Area	Total drainage area	AREA
12	Impervious Cover	Total impevious area	IC
13	%Developed	Sum of categories 1-9 without parks	%Dev

These two methods of measuring land cover were used as independent variables in the prediction of the dependent water quality variables. The infrared aerial photography is based exclusively on what is "on the ground" and not on prior knowledge of the constructed environment. Note that photographs were taken during leaf-on conditions in October of 2000, potentially obscuring impervious cover below canopy or vegetative cover.

The City of Austin Land Use coverage has no measure of vegetative quantity or quality and therefore cannot assess buffers of streams; it may, however, show more accurate measurements of development and impervious cover that is obscured by vegetation. It also classifies development by type, as opposed to the land cover, which identifies impervious areas. These land use categories (Commercial, Civic, Park, etc.) are generally thought to have differing effects on stream water quality constituents (Tam et al. 1998, Pitt et al. 1993). In addition to the above categories, total drainage area and impervious cover (as calculated from City of Austin Land Use) were included in this group as potentially important variables.

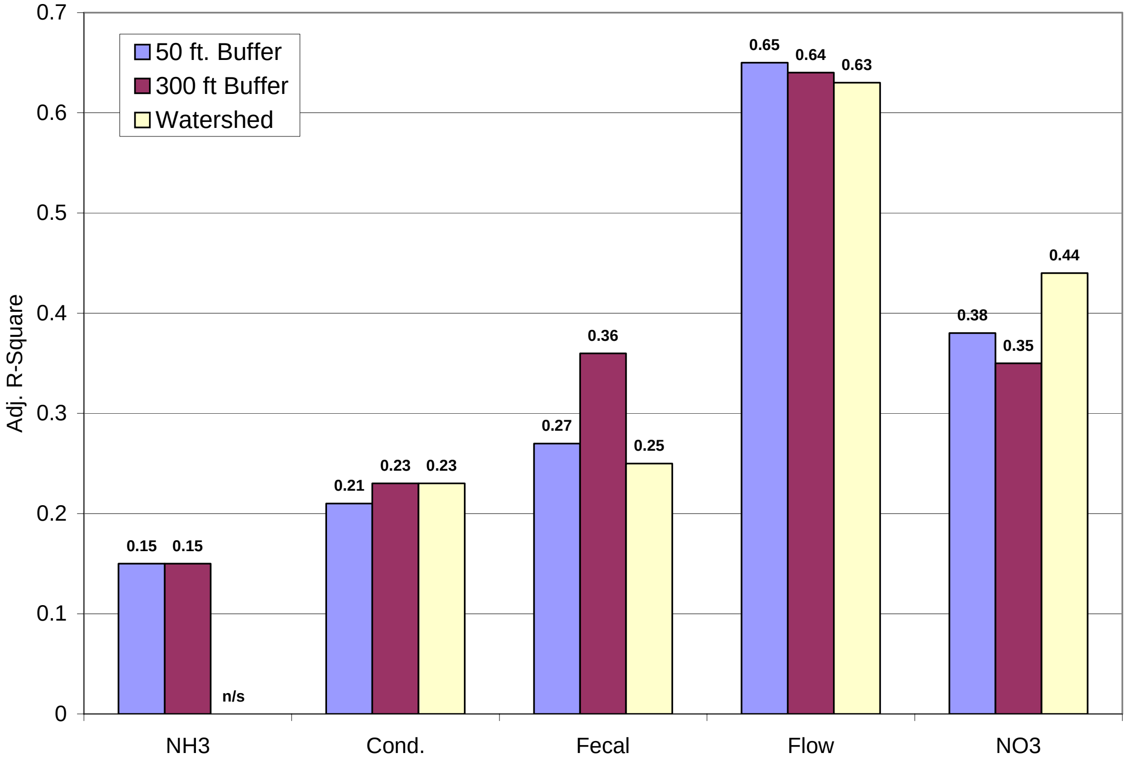
Forward stepwise multiple regression analysis was used to evaluate the ability of these spatial measures to predict water quality variables in the 32 selected Canyon Study watersheds at three different scales. Each dependent water quality variable was regressed against the two groups of independent land cover variables separately and as a composite (land use and land cover variables together). Following this initial analysis, another series of regressions was performed using only the significant independent variables and ridge analysis (Statistica, 1998), which compensates for correlated independent variables. The resulting adjusted coefficients of correlations (R^2) were used to evaluate the relationships between dependent and independent variables.

RESULTS

City of Austin Land Use

In all three buffer categories, all water quality variables (except Ammonia at the watershed scale) had significant relationships to some combination of land use categories. Forward stepwise regression removes those variables that do not contribute to the predictive ability of the model, leaving only those that are important (Snedecor and Cochran 1989). In some cases several of the independent variables were significant ($p<0.10$), while in others, only one of the variables was used in the final regression equation. The ability of these land use categories to explain the main water quality variables ranged from adjusted R^2 values of 0.15-0.65 (see Figure 3). Flow had the highest R^2, similar for all three scales, due primarily to the presence of the Total Drainage Area variable in the Land Use group (generally, Flow is closely correlated to Drainage Area).

Figure 3. Adjusted R^2 values from multiple regression analyses of Land Use categories at three different buffer scales vs. five water quality variables. NH3 (ammonia) was non-significant at the watershed scale.



Of the water chemistry constituents, Nitrate was the variable best explained by land use, with the whole watershed being slightly more important to mean Nitrate values than the 300- or 50-foot buffers. After nitrates, Fecal coliform was the next variable best explained by land use variables, and particularly the 300-foot buffer, which had a higher R^2 value than either of the other two scales ($R^2 = 0.36$ vs. 0.27 for the 50-foot buffer and 0.25 for the watershed). Conductivity was similarly explained by all three buffer scales with R^2 ranging from 0.21 – 0.23 while Ammonia (NH_3) had low R^2 values (0.15) with the whole watershed having an insignificant overall regression. In general, the three buffers were similar in their inability to explain the water chemistry variables at the Canyon Study sites, with the exception of the higher correlation between Fecal coliform and the 300-foot buffer.

The Land Use categories that were best at explaining the water quality variables were generally the same at the three buffer scales, with a few exceptions (see Table 3). Ammonia was significantly (positively) related to Civic land use but not at the watershed scale. Conductivity and Fecal coliform were both explained primarily by the amount of undeveloped land at all three scales (negatively) except fecal coliform values in the 300-foot buffer, which were more related to Transportation and Multi-Family residential (positively). Not surprisingly, Flow was closely related (positively) to drainage area and Low-Density Single Family residential (LLSF). Nitrate concentrations were explained by different land use variables at each scale, with Percent Developed being most important at the 50-foot buffer (positively), Undeveloped at the 300-foot buffer (negatively) and Impervious Cover at the watershed scale (positively).

Table 3. Land Use categories with significant relationships to water quality constituents at three spatial scales (listed in order of importance). *

WQ Variable	50 ft Buffer	300 ft Buffer	Watershed
NH3	Civic (+), Park (+)	Civic (+)	n/s
Cond.	Und (-)	Und (-)	Und(-)
Fecal	Und (-)	Trans (+), MF (+)	Und(-)
Flow	Area (+) , LLSF (+)	Area (+), LLSF (+)	Area(+), LLSF(+)
NO3	%Dev (+), MF(+)	Und(-), MF (+)	IC(+), Off(+), Und(-)

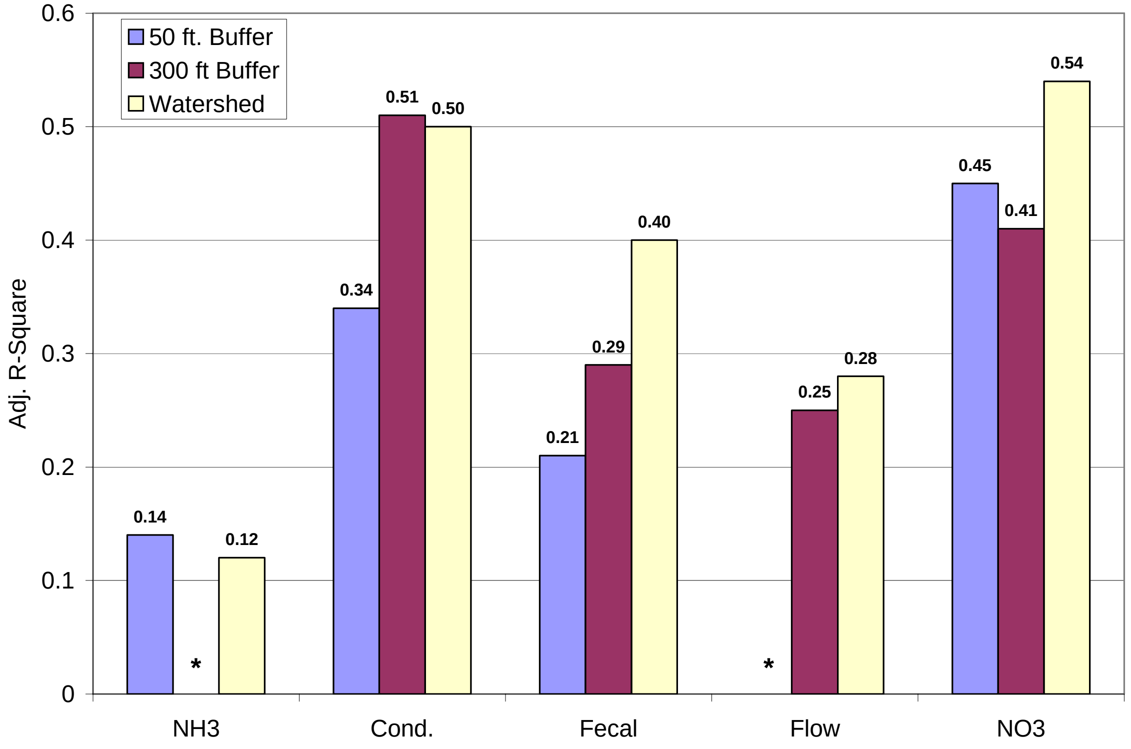
* Positive or negative relationships between land use and water quality constituents are indicated in parenthesis after each land use variable.

Land cover from infrared classification

All water quality variables, except Ammonia and Flow, had a significant relationship to some combination of land cover variables in all three spatial scales, with R^2 values ranging from 0.12 – 0.54 (see Figure 4). The land cover variables were related to Conductivity and Nitrate values at the Canyon Study sites better than the other water quality constituents, with R^2 ranging from 0.34 – 0.54. Conductivity was closely correlated to land cover at the 300-foot buffer and watershed scales while Nitrates were more closely related to the watershed scale than either of the buffer scales. Fecal coliform was closely related to the watershed scale ($R^2 = 0.40$) with weaker relationships to smaller buffers. Flow did not have a significant relationship with the 50-foot buffer, but correlated better to both the 300-foot and watershed scales (R^2 of 0.25 and 0.28 respectively). Ammonia had the weakest relationship to land cover variables with the 50-foot and watershed scale having similar R^2 (0.14 and 0.12) while the 300-foot buffer had no significant model.

Overall, the 50-foot buffer did not explain variation in water chemistry values as well as the larger 300-foot buffer and watershed scales of land cover data. Except for Conductivity and Ammonia, the largest (watershed) scale was the best group for relating water quality variables using land cover.

Figure 4. Adjusted R^2 values from multiple regression analyses of Land Cover categories at three different buffer scales vs. five water quality variables. The asterisk indicates a non-significant regression.



Some land cover variables are better than others at predicting water chemistry at the Canyon Study sites, but there was only minimal variation between the three spatial scales (see Table 4). Ammonia had no significant regression at the 300-foot buffer scale and the best land cover variables were different at the 50-foot and watershed scales (Hot/Forbes and Percent Natural, respectively). Deciduous tree cover was the most important land cover variable, being the most significant one in all three scales for Nitrates and Fecal coliform and a secondary variable for Conductivity (all positively correlated). Hot/Forbes, which includes lawns and golf courses, was also an important land cover variable, primarily in conductivity and secondarily in nitrates (positively correlated). Flow did not have a significant regression at the 50-foot buffer. Percent natural cover was the best land cover variable at the 300-foot and watershed scales for Flow (positively correlated). The number of road crossings per kilometer (xing_km) and Ashe Juniper (Ajun) were the only other land cover variables with significant relationships to these water quality variables, but they were of secondary or tertiary importance.

Table 4. Land Cover categories that had significant relationships with water quality constituents at three spatial scales: 50-foot, 300-foot and whole watershed. *

WQ Variable	50-foot Buffer	300-foot Buffer	Watershed
NH3	Hot_Forb (+)	n/s	%Natural
Cond.	Hot_Forb (+), Decid (+)	Hot_Forb (+), Decid (+)	Hot_Forb (+), Decid (+)
Fecal	Decid (+)	Decid (+), Ajun(-)	Decid (+), Hot_Forb (+), Ajun (-)
Flow	n/s	%Natural (+), Xings_km(+)	%Natural (+)
NO3	Decid (+), Xing_km (+), Hot_Forb (+)	Decid (+), Hot_Forb (+)	Decid (+), Hot_Forb (+), Xing_km (+)

* Positive or negative relationships between land use and water quality constituents are indicated in parenthesis after each land use variable.

Combination of Land Use and Land Cover variables

All Land Use and Land Cover variables were combined into one group of independent variables to provide the best possible regression equation for each water quality variable at each spatial scale (see Figure 5). This series of regressions resulted in improved explanatory power over the individual land use and land cover regressions for only the Fecal coliform variable (see Figure 6). Land cover by itself was generally better at explaining both Nitrates and Conductivity, while land use explained Flow and Ammoniathe best. The 300-foot buffer was the strongest predictor of water quality for conductivity, fecal coliform and flow in these regressions. There were no obvious differences in the individual land use and land cover regressions between the 300-foot and watershed scales in their predictive abilities.

Figure 5. R^2 values from multiple regression of Land Cover and Land Use categories (grouped together) at three different buffer scales vs. five water quality variables.

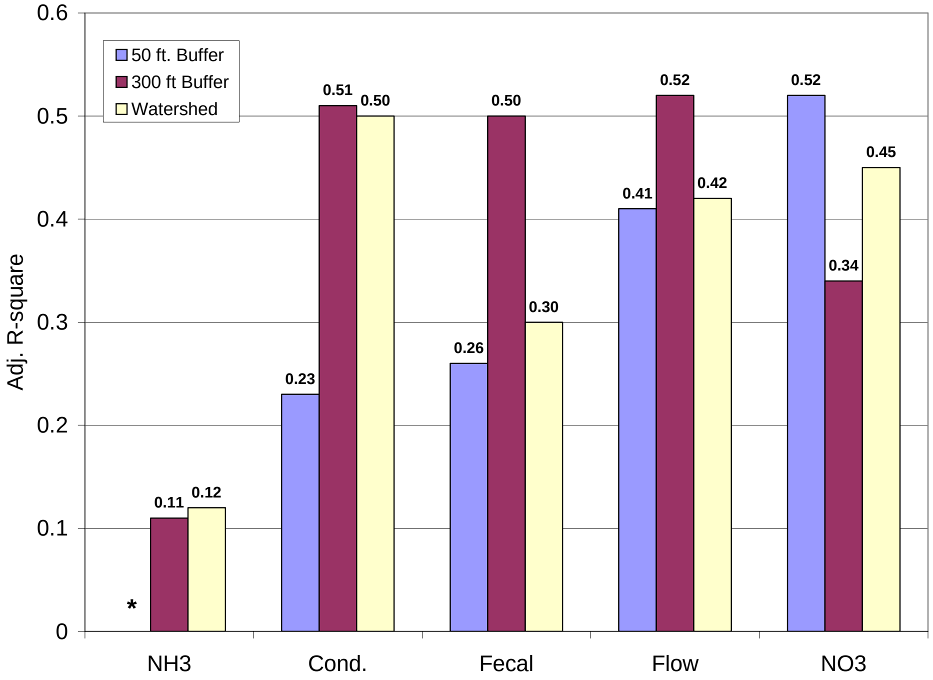
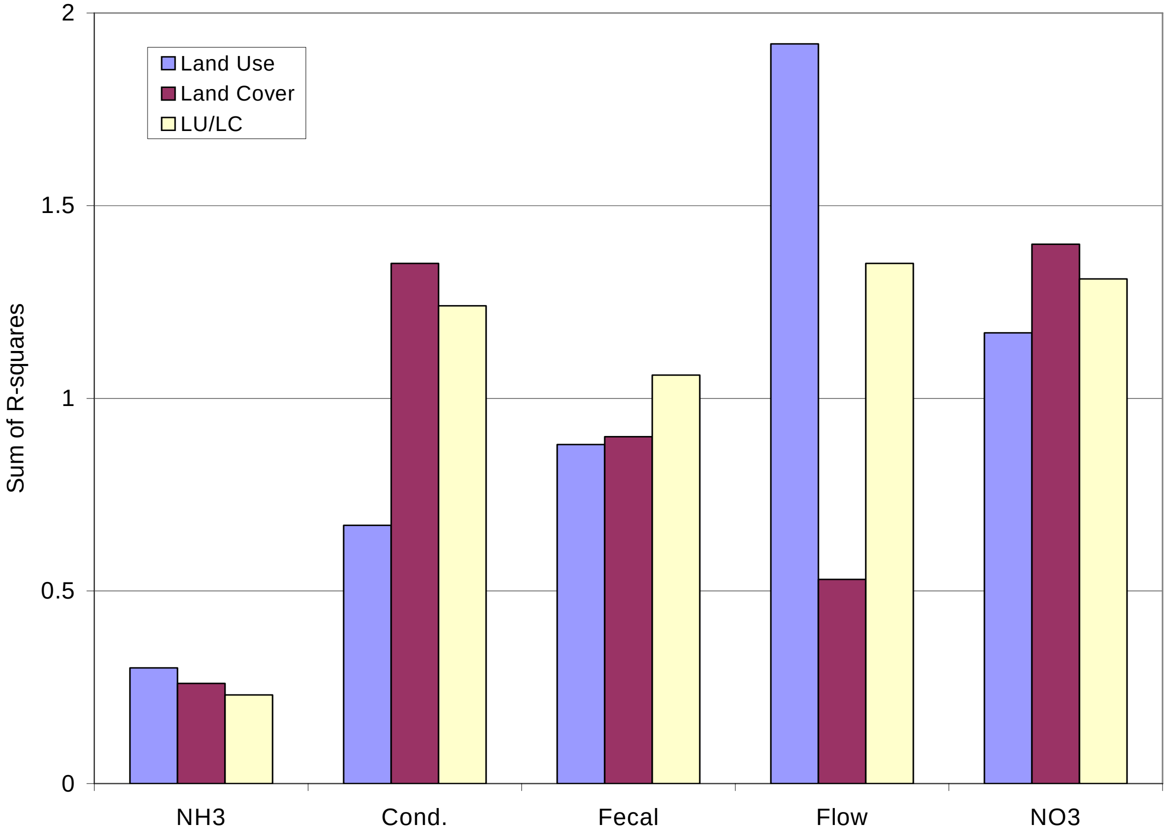


Figure 6. Sum of R^2 values for each of the three spatial scales (50-foot, 300-foot and watershed) to quantify overall ability of the land use and land cover characteristics to predict water quality/quantity.



When Land Cover and Land Use variables were grouped together, certain variables provided the best explanation of a given water quality constituent in a given buffer scale (also see Table 5):

- There was no significant regression for Ammonia in the 50-foot buffer while in the 300-foot buffer Civic land use was most important.
- At the watershed scale the land cover characteristic Percent Natural was the most significant.
- Conductivity was most closely related to the Hot/Forbes category at all three scales with the addition of industrial land use at the 50-foot buffer and Deciduous at the 300-foot and watershed scales (all positively correlated).
- Fecal coliform was most closely related to land cover variables (Deciduous and Ashe Juniper) with the addition of Transportation and Multi-family land use in the 300-foot buffer. In these regressions, Area was not included as one of the independent variables to evaluate how strongly anthropogenic variables correlate to Flow.
- Flow was dominated by the effects of Low-Level Single Family development (positively correlated) and to a lesser degree by Short Grass and Road Crossings/km (both also positive).
- Nitrate concentrations at the study sites were related to a diverse mix of land cover and land use variables, usually including Hot/Forbes and Concrete land covers and Industrial land use.

- Ashe Juniper, Concrete and Industrial were the only variables that were negatively correlated to water quality variables.

Table 5. Land Cover and Land Use categories that had significant relationships with water quality constituents at three spatial scales: 50-foot, 300-foot and whole watershed. *

WQ Variable	50-foot buffer	300-foot buffer	Watershed
NH3	n/s	Civic(+)	%Natural
Cond.	Hot_Forb(+), Indust(+)	Hot_Forb(+), Decid(+)	Hot_Forb(+), Decid(+)
Fecal	Decid(+), Ajun(-)	Trans(+), Hot_Forb(+), MF(+)	Decid(+), Ajun(-)
Flow	LLSF(+), Sh_Gr(+), Xing_km(+)	LLSF(+), Sh_Gr(+) , Xing_km(+), Concrete(-)	%Natural(+), LLSF(+)
NO3	Dev_%(+), Hot_Forb(+), Indust(-) Concrete(-)	MF(+), Concrete(-)	Xing_km(+), Hot_Forb(+), Indust(-), Concrete(-)

* Positive or negative relationships between land cover and water quality constituent are indicated in parenthesis after each land use variable.

DISCUSSION

Land Use variables

The land use overlay used in this analysis, composed of the common land use categories used by planners around the country (Richards and Host 1994, Anderson et al 1976), was fairly successful at predicting water quality variables in the 32 Canyon Study sites. Some variables, such as Nitrates (average $R^2 = 0.46$) and Fecal coliform (average $R^2 = 0.36$), were more closely related to land use than others, such as ammonia ($R^2 = 0.14$). Multiple regression, the statistical tool used to explore these relationships, can be artificially skewed by independent variables that are correlated (Snedecor and Cochran 1989), which was the case with many of the Land Use and Land Cover variables. The ridge regression technique (Lambda = 0.10) was utilized for these calculations and, although it reduces the additive effect that correlation plays, the resulting R^2 values should be considered carefully. It is possible that some of the relationships presented in this paper have been artificially elevated by the correlation of independent variables or by the use of a large number of independent variables.

The effect of the three scale levels (50-foot buffer, 300-foot buffer and watershed) on the results of the land use analysis was minimal. Except in the case of Fecal coliform values, where the 300-foot buffer showed more significance than the other two, there appears to be no significant difference between analyzing land use at the local 50-foot buffer or farther out in the watershed (see Figure 2). The fact that Fecal coliform is distinct from the other water quality variables in this analysis indicates that there is at least some benefit of buffering for land use planning efforts. Apparently, land use in the 300foot buffer range plays some role in distribution of Fecal coliform values in baseflow water quality. However, the land use variables most closely tied to Fecal coliform, Transportation and Multi-family, are not likely to generate human or animal waste products, which are generally the source for this indicator variable. It is likely that they are correlated to some other unmeasured variable, such as sewer lines or pet ownership, which could be providing baseflow inputs of fecal coliform to these tributaries.

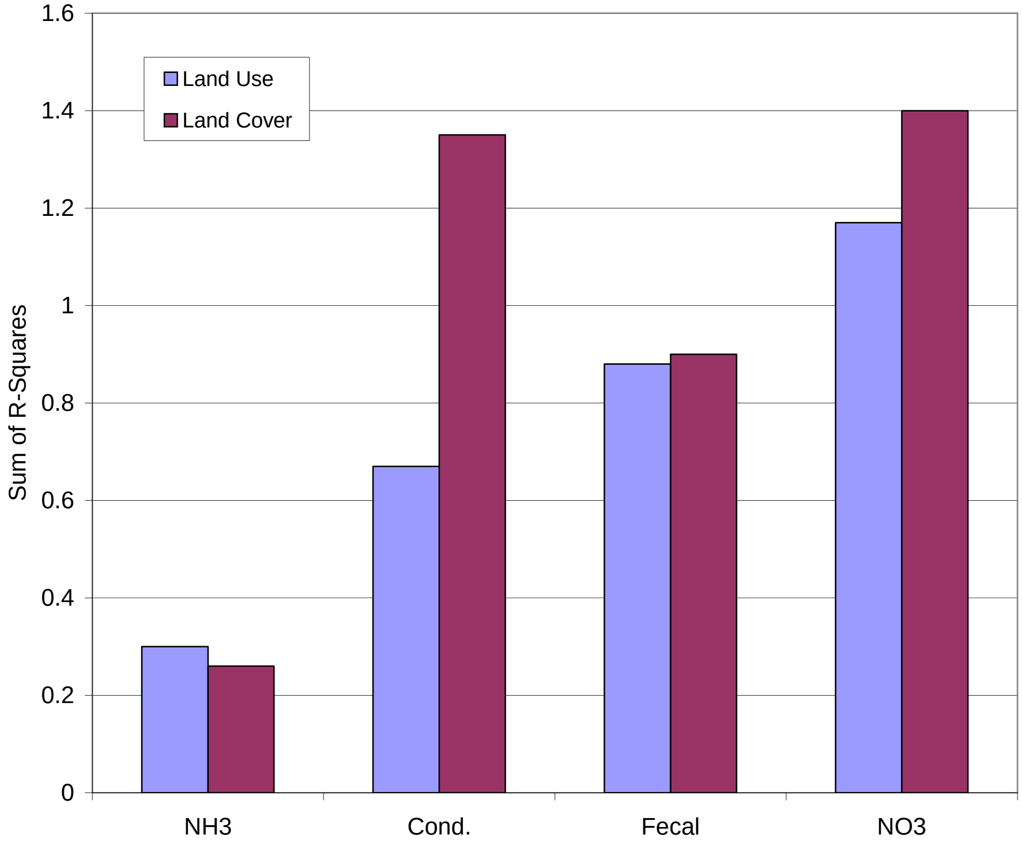
Among the land use variables, the Percent of Undeveloped land within the three buffer scales appeared to be the most important predictor of water quality, consistently showing a negative relationship to several water quality variables. This is particularly true of Conductivity and Fecal coliform.

No single measure of development, such as residential or commercial land use, was as important as the lack of development within the three buffer scales. This could be due to the fact that the Canyon watersheds had a wide range of development conditions and that no single land use was consistent across enough watersheds or dense enough in several watersheds to provide a significant signal. This indicates that there is a difference in the way developed versus undeveloped land, as measured by City of Austin Land Use classification, reflects baseflow water quality, and that it may be more important to limit quantity of development over quality of development.

Land Cover variables

Land Cover variables, as measured by classification of aerial photography, are possibly better predictors of water quality variables than land use. When R^2 values from each of the three buffer scales were averaged for each water quality variable, land cover regression models were stronger than land use models for Conductivity and Nitrate (see Figure 7). Fecal coliform and Ammonia didn't show significant differences between land use and land cover. These findings have management level implications since all of the City of Austin's watershed ordinances and planning tools are based on zoning, land use and impervious cover (which is a land use based measure). Apparently, "on the ground" measures such as those utilized in the development of the land cover categories (mainly vegetative), are as important to baseflow water chemistry as the more theoretical land use categories.

Figure 7. Average R^2 values from three buffer scales for the two different types of spatial data, land use and land cover for each water quality variable.



With regards to the three buffer scales, land cover appeared to be more important in the large scales (300--foot and watershed) than at the 50-foot scale. Land cover within the 50-foot buffer in the Canyon watersheds either does not provide sufficient variation to predict water quality variables or larger scale land cover drives water quality in these streams. Hot/Forbes and Deciduous cover were the dominant variables in all three scales of analysis, so it is unlikely that the land cover variation in the 50-foot buffers was much different than in the rest of the watershed.

The Hot/Forbes category of land cover includes lawns, golf courses and other highly manipulated or disturbed areas where irrigation and fertilization are common. This category is consistently correlated (positively) to the water chemistry variables and therefore it seems likely that it is both a source and possibly a surrogate for other influences on water quality.

A strong positive correlation was found between Deciduous cover, which includes all non-coniferous trees and shrubs, and each of the water quality constituents except Ammonia. The Deciduous category isolates Ashe Juniper cover from the rest of the tree cover. This is significant since Ashe Juniper is considered a nuisance species and is being singled out as a priority in land management practices in the Hill Country. It is important to note that if Ashe Juniper had a consistent negative or positive influence on water quality, it would have appeared as an important variable in this analysis, which it did not. Generally, Ashe Juniper comprises a large majority of the forest cover in the Canyon watersheds. However, deciduous trees can dominate in riparian zones and are considered to have deeper root systems with denser vegetated under-stories.

It is of particular interest that Deciduous tree cover was positively correlated to Conductivity, Fecal coliform and Nitrates, three important water quality variables. This suggests that the more broadleaf trees are present in a given stream corridor or watershed, the worse the water quality. This contradicts the findings of many studies of riparian zone function (Peterson et al 2001, Mulholland 1992, Wissmar and Beschta 1998, Horner and Mays 1999), which have shown that forested stream corridors and watersheds generally produce lower in-stream nutrient concentrations and higher soil filtration abilities, which would lower conductivity and fecal coliform concentrations. This apparent contradiction calls for further research on riparian function in this area and a closer look at unmeasured variables that may be correlated with deciduous tree cover. It is possible that more managed and developed areas have more deciduous trees and that this is a better predictor of water quality influences than Impervious cover or Percent Undeveloped.

Combined Land Use and Land Cover

When the land use and land cover variables were combined together and regressed against the water quality variables at the three buffer scales, one notable change was that the 300-foot buffer became more important in the Fecal coliform and Flow water quality parameters. Also, except for Nitrate, the whole watershed was not a better predictor of water quality than the 300-foot buffer.

From a management perspective, this is an important distinction. There is an ongoing effort to define not only how much development can occur in a watershed and how big a buffer zone is needed to protect streams, but also how to manage existing conditions to maintain and improve water quality. It is not surprising that the mid-size buffer is more closely tied to water quality variables than the small buffer. It is useful to document this relationship and to see that limiting development quantity and quality in the small buffer does not necessarily protect stream health. The City of Austin uses a 50-foot buffer as the default, which is probably not adequate, particularly for headwater streams.

The original hypothesis of this paper is that larger buffers have stronger relationships to water quality. This hypothesis was rejected since the mid-size buffer had similar or stronger relationships to most of the important water quality variables (Conductivity, Fecal coliform, Nitrates, Flow) than the watershed scale analysis. These results suggest that more stringent management efforts within the mid-size buffer should result in water quality improvement, and that stricter development control within this area may be the most efficient way to protect water quality. For example, regulating land use within the whole watershed of the Granada Hills Tributary applies to more than 556 acres, while the 300-foot buffer of this stream is only 305 acres. It is important to note that the difference between these two values is larger when the watershed in question is larger.

The Land Cover group, which is primarily vegetative cover types, appears to be an excellent tool in watershed management, in addition to the more traditional Land Use categories. When these two types of data are grouped together, the Land Cover variables tend to have the strongest relationships in these regressions (see Table 5), supporting the results found when both groups were analyzed separately. In fact, land cover variables are the most important independent variables in 8 of the 12 regression analyses. An important aspect of this work is that the independent variables in the land cover data set were automatically generated using aerial photography and classification software. This is a much less expensive method than generating land use data from zoning and manual interpretation of aerial photography, and is less prone to error. Further exploration of the predictive ability of these Land Cover variables is merited, particularly within biological communities that are closely tied to vegetative distribution in the riparian zones, and that are better overall indicators of stream health.

APPENDICES

Appendix 1. Mean water chemistry value and number of data points (n) for selected constituents at 32 Canyon Study sites.

Site Number	NH3 (mg/l)	N	Cond. (us/cm)	N	Fecal Coli. (col/100ml)	N	Discharge (cfs)	N	NO3 (mg/l)	n
55	0.02	54	732.1	33	232	48	0.13	42	0.66	43
56	0.02	77	637.4	48	307	70	0.10	47	0.41	59
57	0.02	47	537.0	32	117	43	3.26	43	0.10	46
59	0.03	62	769.9	30	1436	54	0.28	52	1.52	57
60	0.06	15	647.3	3	202	5	2.33	2	0.16	16
61	0.02	27	743.0	21	99	24	0.17	25	1.21	23
66	0.07	27	1066.5	19	430	18	0.16	16	0.34	21
67	0.02	51	999.3	46	92	41	0.22	41	1.89	36
68	0.01	17	505.8	12	34	11	0.82	11	0.08	14
72	0.04	69	1136.2	25	1523	42	0.13	38	1.25	66
74	0.02	13	680.2	12	22	11	2.01	10	0.09	10
75	0.01	25	583.8	23	88	24	2.01	29	0.08	19
76	0.03	70	687.3	47	181	59	1.33	64	0.27	51
99	0.01	81	850.0	64	102	69	0.34	70	0.23	59
101	0.04	97	596.0	92	52	71	0.24	80	0.12	88
102	0.02	23	729.7	18	19	15	0.38	13	0.13	20
177	0.03	23	643.4	15	384	20	0.17	24	0.48	18
259	0.02	13	635.9	15	84	10	0.16	13	0.08	6
263	0.01	11	556.5	10	121	10	3.67	10	0.16	10
264	0.01	7	590.0	5	272	7	0.10	7	0.09	6
272	0.02	21	810.8	15	196	21	0.91	24	1.91	15
276	0.01	13	564.2	10	173	9	0.18	8	0.09	13
278	0.01	17	749.8	12	143	16	0.31	21	0.32	13
296	0.01	24	865.9	17	454	21	0.16	23	1.26	19
298	0.02	71	723.0	54	357	64	0.24	68	0.30	53
300	0.02	25	840.2	20	246	24	0.84	26	0.23	18
301	0.02	31	1188.7	28	402	28	0.77	37	0.68	25
316	0.01	50	635.3	43	152	47	1.30	55	0.22	39
318	0.03	68	816.7	53	983	56	0.07	67	2.36	51
319	0.03	35	670.2	34	49	34	1.56	33	0.45	18
1070	0.02	9	637.0	12	120	8	1.82	11	0.10	1
1146	0.02	19	724.3	24	57	19	0.07	22	0.06	9

Appendix 2a. Land use and land cover distribution for the 50-foot buffer at each of the 32 Canyon Study sites. Unavailable data are indicated by an asterisk.

Site #	LU600	LU300	LU500	LU50	LU200	LU400	LU700	LU100	LU800	LU900	Impervious Cover	%Developed	# Road Crossing	Xings/km	Short grass/field	Unclassified/shadow	Ajun	Hot/forbes/lawn	Tall grass/meadow	concrete/asphalt/soil	Decid/liveoak	% Natural	% Forested
55	0%	0%	0%	0%	0%	0%	90%	5%	0%	5%	2.5	5%	0	0.00	0.2%	18.0%	49.4%	10.0%	3.6%	2.8%	16.0%	69.2%	65.4%
56	0%	0%	0%	0%	0%	0%	44%	53%	2%	1%	8.4	55%	0	0.00	0.3%	16.1%	44.4%	6.7%	4.1%	7.2%	21.2%	70.1%	65.7%
57	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	1.5	0%	7	0.42	14.2%	7.4%	15.8%	10.3%	36.0%	9.5%	6.8%	72.8%	22.6%
59	0%	0%	0%	0%	0%	0%	20%	72%	8%	0%	13.6	80%	2	1.14	0.2%	19.0%	40.4%	7.4%	3.5%	4.4%	25.2%	69.2%	65.6%
60	0%	0%	0%	0%	0%	0%	30%	12%	1%	57%	2.8	13%	4	0.22	1.0%	12.6%	36.8%	15.9%	16.4%	6.3%	11.1%	65.3%	47.9%
61	0%	0%	0%	0%	0%	0%	0%	54%	0%	46%	6.9	54%	0	0.00	0.2%	10.8%	52.0%	20.9%	5.5%	2.0%	8.5%	66.3%	60.6%
66	23%	0%	0%	0%	0%	0%	65%	0%	0%	12%	5.1	23%	0	0.00	0.7%	7.3%	18.3%	30.2%	22.5%	10.0%	11.0%	52.5%	29.4%
67	29%	0%	0%	0%	0%	0%	14%	0%	0%	57%	6.4	29%	0	0.00	1.8%	10.8%	25.0%	24.6%	20.0%	5.1%	12.8%	59.5%	37.7%
68	0%	0%	0%	0%	0%	0%	0%	1%	0%	99%	0.6	1%	0	0.00	8.0%	4.3%	15.0%	12.1%	44.9%	11.1%	4.5%	72.4%	19.5%
72	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	1.1	0%	0	0.00	0.4%	11.7%	30.3%	28.0%	14.0%	3.8%	11.8%	56.5%	42.1%
74	0%	0%	0%	0%	0%	0%	1%	1%	0%	98%	1.7	1%	26	0.33	6.8%	11.6%	23.4%	7.7%	35.0%	11.0%	4.6%	69.8%	27.9%
75	0%	0%	0%	0%	0%	0%	74%	6%	0%	19%	2.1	7%	5	0.33	1.0%	14.4%	40.4%	17.0%	16.1%	5.3%	5.8%	63.3%	46.2%
76	0%	0%	0%	1%	0%	0%	31%	7%	1%	59%	2.6	9%	15	0.51	1.1%	14.3%	39.6%	15.3%	14.4%	6.2%	9.0%	64.2%	48.7%
77	1%	1%	1%	1%	0%	0%	0%	6%	3%	86%	4.2	13%	33	0.29	*	*	*	*	*	*	*	0.0%	0.0%
99	0%	0%	0%	0%	0%	0%	0%	1%	1%	98%	1.5	2%	1	0.27	2.4%	6.2%	30.9%	22.6%	17.7%	11.0%	9.2%	60.2%	40.1%
101	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	1.3	0%	0	0.00	1.8%	11.6%	36.3%	14.6%	16.8%	10.8%	8.1%	63.1%	44.5%
102	0%	0%	0%	0%	0%	0%	0%	32%	7%	60%	8.5	40%	2	0.39	0.6%	12.2%	51.1%	11.1%	9.3%	5.3%	10.4%	71.4%	61.5%
177	37%	3%	0%	0%	1%	1%	4%	32%	22%	1%	28.8	95%	20	1.92	0.9%	17.1%	21.4%	9.4%	16.0%	22.9%	12.2%	50.6%	33.6%
259	0%	22%	0%	0%	0%	0%	23%	0%	3%	51%	11.5	25%	4	1.04	4.7%	7.9%	20.8%	13.1%	27.8%	20.3%	5.3%	58.6%	26.1%
263	0%	0%	0%	7%	0%	0%	0%	2%	0%	91%	1.3	9%	4	0.08	1.7%	10.0%	35.1%	13.4%	23.0%	8.7%	8.1%	67.9%	43.2%
264	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	1.5	0%	0	0.00	9.2%	11.6%	24.0%	7.9%	32.2%	6.4%	8.7%	74.0%	32.7%
272	0%	0%	0%	0%	0%	0%	0%	67%	8%	26%	17.7	74%	13	2.19	0.3%	15.7%	43.7%	13.8%	4.3%	5.3%	16.9%	65.2%	60.6%
276	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	1.5	0%	5	0.40	12.5%	4.8%	14.1%	3.6%	50.5%	10.4%	4.1%	81.3%	18.2%
278	0%	0%	0%	0%	0%	0%	66%	7%	17%	10%	11.4	24%	1	0.35	1.8%	8.6%	37.3%	19.8%	16.2%	6.5%	9.9%	65.1%	47.2%
296	0%	0%	0%	0%	0%	0%	0%	93%	4%	4%	20.6	96%	2	2.07	0.2%	20.8%	54.1%	2.2%	2.1%	4.1%	16.5%	72.9%	70.7%
298	0%	0%	0%	0%	0%	0%	10%	6%	5%	79%	5.1	11%	3	0.76	0.3%	26.0%	36.6%	6.8%	5.0%	8.2%	17.1%	59.0%	53.7%
300	0%	2%	4%	0%	0%	0%	0%	58%	9%	28%	13.6	72%	14	2.03	3.8%	10.6%	27.3%	14.3%	22.2%	9.7%	12.1%	65.4%	39.5%
301	0%	0%	1%	0%	0%	0%	0%	60%	6%	33%	10.9	67%	12	1.47	3.3%	7.9%	27.9%	10.4%	29.7%	8.5%	12.2%	73.1%	40.2%
316	0%	0%	0%	0%	0%	0%	0%	4%	4%	92%	4.5	8%	36	1.56	1.3%	20.0%	32.5%	16.4%	12.9%	11.8%	5.1%	51.8%	37.7%
318	24%	2%	0%	0%	2%	0%	3%	48%	20%	1%	30.1	96%	18	3.64	1.1%	6.7%	16.3%	28.7%	14.8%	24.0%	8.4%	40.5%	24.7%
319	0%	0%	0%	0%	1%	2%	20%	27%	6%	45%	10.1	35%	25	0.82	0.6%	15.4%	43.1%	16.6%	8.8%	5.5%	9.9%	62.5%	53.0%
1070	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	1.5	0%	9	0.17	7.1%	11.5%	21.4%	6.3%	37.7%	11.5%	4.6%	70.8%	25.9%
1146	0%	0%	0%	0%	0%	0%	30%	0%	0%	70%	1.1	0%	2	1.68	3.0%	4.5%	18.5%	21.8%	23.4%	23.0%	5.8%	50.7%	24.4%

Appendix 2b. Land use and land cover for the 300-foot buffer at each of the 32 Canyon Study sites. Unavailable data are indicated by an asterisk.

Site	LU50	LU100	LU113	LU200	LU300	LU400	LU500	LU600	LU700	LU800	LU870	LU900	Imp.Cov.	% Developed	Xings/km	# Road Crossing	Short grass/field	ajun	Hot/forbes/lawn	Tall grass/meadow	concrete/asphalt/soil	Decid/liveoak	% Natural	% Forested
55	0.0%	23.6%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	69.7%	2.0%	0.0%	4.6%	5.4	25.7%	0.00	0	1.2%	43.5%	9.6%	10.8%	8.7%	11.7%	67.1%	55.2%
56	0.0%	68.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.9%	11.5%	0.0%	2.5%	14.9	79.6%	0.42	0	0.9%	28.4%	9.8%	10.3%	23.7%	14.3%	54.0%	42.8%
57	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	1.14	7	17.2%	15.1%	10.2%	35.1%	9.8%	6.9%	74.3%	22.0%
59	0.0%	78.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	11.6%	3.0%	0.0%	17.6	93.3%	0.22	2	0.9%	28.1%	9.9%	9.9%	18.9%	17.9%	56.8%	46.0%
60	0.0%	11.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	24.8%	2.4%	0.0%	60.9%	3.6	14.3%	0.00	4	2.0%	35.4%	13.7%	19.7%	10.2%	7.5%	64.6%	42.9%
61	0.0%	59.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.2%	0.0%	35.5%	10.3	64.5%	0.00	0	0.8%	41.7%	20.5%	12.2%	7.8%	8.4%	63.1%	50.1%
66	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	24.6%	49.1%	4.4%	0.0%	21.3%	7.8	29.6%	0.00	0	0.9%	15.4%	30.5%	22.4%	15.7%	8.5%	47.2%	23.9%
67	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.2%	29.2%	0.0%	0.0%	49.6%	4.8	21.2%	0.00	0	1.6%	24.1%	30.5%	17.1%	6.0%	11.9%	54.7%	36.0%
68	0.3%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.0%	0.7	2.0%	0.00	0	9.5%	10.5%	8.4%	43.2%	23.7%	2.6%	65.8%	13.0%
72	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	1.1	0.0%	0.33	0	0.5%	17.0%	45.9%	15.7%	4.7%	9.4%	42.6%	26.4%
74	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	97.9%	1.7	1.3%	0.33	26	9.2%	19.4%	6.2%	36.9%	16.1%	3.4%	68.8%	22.7%
75	0.0%	7.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	73.3%	0.9%	0.0%	18.6%	2.5	8.1%	0.51	5	2.5%	33.5%	15.0%	23.6%	9.4%	4.1%	63.6%	37.5%
76	2.0%	6.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	31.1%	2.0%	0.0%	58.4%	2.9	10.5%	0.29	15	2.3%	37.0%	12.5%	18.8%	10.1%	7.0%	65.1%	43.9%
77	1.2%	7.1%	0.1%	0.0%	0.6%	0.1%	1.3%	1.2%	0.5%	2.3%	0.0%	85.7%	4.1	13.8%	0.27	33	*	*	*	*	*	*	0.0%	0.0%
99	0.0%	11.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.2%	0.0%	81.5%	6.1	18.5%	0.00	1	2.7%	24.9%	20.7%	20.5%	20.8%	6.0%	54.1%	30.9%
101	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.5%	97.5%	2.1	2.5%	0.39	0	2.7%	27.2%	12.6%	20.5%	24.7%	4.5%	55.0%	31.7%
102	0.0%	33.1%	0.0%	0.0%	0.0%	1.8%	0.0%	0.8%	0.0%	10.8%	0.6%	52.9%	11.7	47.1%	1.92	2	2.0%	35.0%	12.9%	17.5%	16.2%	8.5%	63.0%	43.5%
177	0.0%	31.6%	0.0%	1.1%	3.1%	2.1%	0.0%	39.1%	3.0%	19.3%	0.2%	0.4%	28.5	96.5%	1.04	20	1.1%	20.5%	8.7%	17.3%	26.0%	10.3%	49.2%	30.7%
259	0.0%	0.0%	0.0%	0.0%	13.0%	0.0%	0.0%	0.0%	21.7%	3.7%	0.0%	61.6%	8.1	16.7%	0.08	4	6.0%	16.0%	12.7%	31.5%	23.4%	4.4%	58.0%	20.5%
263	5.9%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	90.9%	1.5	9.1%	0.00	4	2.6%	31.9%	10.8%	27.5%	13.5%	5.5%	67.6%	37.4%
264	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	2.19	0	8.7%	23.6%	7.1%	31.4%	13.8%	6.2%	69.9%	29.8%
272	0.0%	63.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.8%	0.0%	28.0%	17.8	72.0%	0.40	13	0.6%	41.7%	13.2%	6.6%	8.0%	13.9%	62.8%	55.7%
276	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	0.35	5	12.3%	14.8%	3.9%	46.8%	13.6%	4.3%	78.3%	19.1%
278	0.0%	9.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	64.1%	13.8%	0.0%	12.8%	10.0	23.0%	2.07	1	3.9%	30.3%	19.1%	22.0%	11.3%	6.4%	62.6%	36.7%
296	0.0%	85.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.3%	0.0%	4.7%	22.7	95.3%	0.76	2	0.5%	44.6%	3.7%	4.4%	9.6%	15.7%	65.2%	60.3%
298	0.0%	14.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.1%	3.4%	0.2%	76.4%	5.9	18.5%	2.03	3	0.6%	33.3%	7.3%	7.4%	13.9%	13.2%	54.4%	46.4%
300	0.0%	53.8%	9.0%	0.0%	0.7%	0.0%	3.6%	0.4%	0.0%	7.9%	0.0%	24.6%	13.2	75.4%	1.47	14	4.2%	26.7%	14.3%	21.4%	12.4%	11.0%	63.3%	37.7%
301	0.0%	56.3%	1.2%	0.0%	0.1%	0.0%	0.9%	0.0%	0.0%	8.5%	0.2%	32.8%	12.2	67.2%	1.56	12	4.2%	22.9%	11.1%	29.6%	14.1%	10.7%	67.4%	33.5%
316	0.0%	3.9%	0.6%	0.0%	0.3%	0.0%	0.2%	0.0%	0.0%	6.8%	0.0%	85.7%	6.1	11.8%	3.64	36	2.5%	26.9%	13.7%	19.2%	18.9%	3.1%	51.8%	30.0%
318	0.0%	49.0%	0.0%	2.1%	1.5%	0.0%	0.0%	29.9%	0.9%	16.0%	0.0%	0.6%	29.5	98.5%	0.82	18	1.4%	14.7%	25.9%	16.8%	29.1%	6.2%	39.1%	20.9%
319	0.0%	30.4%	0.0%	0.2%	0.5%	2.2%	0.1%	0.3%	19.1%	7.5%	0.0%	39.6%	12.1	41.3%	0.17	25	1.4%	38.9%	15.2%	12.3%	10.3%	8.3%	60.9%	47.2%
1070	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	1.68	9	8.6%	20.2%	5.4%	37.4%	14.0%	4.1%	70.3%	24.3%
1146	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%	1.5%	0.0%	73.5%	1.9	1.5%	0.00	2	3.7%	13.0%	18.5%	27.3%	30.8%	3.3%	47.3%	16.3%

Appendix 2c. Land use and land cover distribution for the Watersheds of each of the 32Canyon sites. Unavailable data indicated by asterisk.

site	CIVIC	COMM	IND	LLSF	MF	OFF	PARK	SF	TRAN	UNDEV	shedIC	shed%dev	Short grass/field	Unclassified/shadow	ajun	Hot/forbes/lawn	Tall grass/meadow	concrete/asphalt/soil	Decid/liveoak	% Natural	% Forested
55	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	52.8%	31.0%	6.9%	8.7%	8.9	38.4%	1.3%	12.8%	38.6%	10.0%	11.1%	14.3%	11.8%	62.8%	50.4%
56	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.2%	71.6%	12.8%	2.4%	15.9	84.4%	1.0%	11.8%	25.5%	10.5%	10.9%	26.0%	14.3%	51.8%	39.8%
57	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	18.0%	5.1%	13.9%	9.4%	37.0%	10.3%	6.3%	75.1%	20.1%
59	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%	78.2%	17.6%	0.0%	19.1	95.7%	0.9%	12.6%	25.0%	10.7%	10.1%	23.6%	17.0%	53.0%	42.0%
60	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	19.6%	12.9%	4.1%	62.9%	4.7	17.5%	2.9%	10.4%	31.3%	13.1%	22.6%	13.5%	6.2%	63.0%	37.5%
61	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	56.6%	9.3%	32.5%	12.8	67.5%	1.0%	7.7%	37.6%	19.6%	13.0%	12.8%	8.3%	60.0%	46.0%
66	23.1%	0.0%	0.0%	0.0%	0.0%	0.0%	38.7%	3.9%	5.9%	28.5%	8.7	32.9%	1.0%	6.6%	14.4%	28.1%	20.9%	21.1%	7.9%	44.2%	22.3%
67	21.5%	0.0%	0.0%	0.0%	0.0%	0.0%	36.5%	0.0%	0.1%	42.0%	4.9	21.5%	2.2%	7.5%	20.8%	30.5%	17.2%	11.0%	10.7%	51.0%	31.5%
68	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	2.7%	0.0%	96.6%	0.9	3.4%	9.8%	1.8%	9.6%	7.7%	42.4%	26.4%	2.3%	64.1%	11.9%
72	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	97.1%	0.0%	0.0%	2.9%	1.1	0.0%	0.5%	6.7%	15.4%	46.0%	16.1%	5.9%	9.5%	41.5%	24.9%
74	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	1.4%	0.0%	98.1%	1.7	1.4%	9.4%	8.5%	19.1%	6.2%	36.2%	17.3%	3.2%	68.0%	22.3%
75	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	69.3%	8.2%	1.5%	21.0%	2.9	9.7%	3.0%	10.9%	31.1%	14.9%	25.7%	10.8%	3.6%	63.4%	34.7%
76	0.0%	0.0%	0.5%	2.6%	0.0%	0.0%	32.1%	7.3%	2.5%	55.0%	3.4	12.9%	3.2%	11.4%	34.2%	11.8%	21.7%	12.1%	5.6%	64.7%	39.8%
77	1.3%	0.5%	1.0%	1.4%	0.0%	0.1%	0.6%	7.9%	2.3%	85.0%	4.1	14.4%	*	*	*	*	*	*	*	0.0%	0.0%
99	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.6%	10.3%	71.5%	8.6	28.5%	2.7%	3.9%	20.6%	19.3%	22.1%	26.1%	5.3%	50.7%	26.0%
101	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	3.5%	95.8%	3.0	4.2%	2.9%	6.9%	22.4%	11.2%	20.5%	32.3%	3.9%	49.6%	26.3%
102	2.9%	0.0%	0.0%	0.0%	0.0%	4.4%	0.0%	29.3%	15.0%	48.5%	14.6	51.5%	2.4%	6.9%	28.8%	11.9%	19.2%	23.6%	7.3%	57.6%	36.0%
177	45.5%	2.5%	0.0%	0.0%	1.3%	2.4%	2.1%	30.0%	15.7%	0.4%	27.4	97.5%	1.1%	16.2%	20.5%	8.7%	17.3%	26.0%	10.3%	49.2%	30.7%
259	0.0%	8.7%	0.0%	0.0%	0.0%	0.0%	19.1%	0.0%	3.2%	69.0%	6.2	11.9%	8.2%	5.0%	13.7%	12.1%	31.3%	25.6%	4.2%	57.4%	17.8%
263	0.0%	0.1%	0.0%	5.4%	0.0%	0.0%	0.0%	4.0%	0.2%	90.3%	1.7	9.7%	2.8%	8.2%	31.7%	10.1%	27.2%	14.7%	5.3%	67.1%	37.1%
264	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	99.6%	1.5	0.4%	8.3%	8.3%	24.0%	7.1%	30.3%	16.6%	5.5%	68.1%	29.5%
272	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	66.4%	10.5%	22.6%	19.4	77.4%	0.6%	16.1%	39.7%	12.7%	7.2%	10.1%	13.7%	61.2%	53.4%
276	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	11.9%	4.6%	17.7%	4.3%	42.3%	14.6%	4.5%	76.5%	22.2%
278	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	66.6%	8.9%	11.3%	13.1%	8.5	20.3%	3.8%	7.4%	29.2%	18.3%	22.3%	12.6%	6.4%	61.7%	35.6%
296	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	76.3%	14.5%	9.2%	23.3	90.8%	0.6%	19.4%	39.6%	5.8%	7.1%	12.8%	14.7%	61.9%	54.3%
298	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%	19.3%	6.0%	71.2%	8.0	25.4%	0.7%	22.8%	30.9%	7.8%	8.7%	17.3%	11.9%	52.2%	42.8%
300	0.2%	0.7%	3.0%	0.0%	0.0%	0.0%	0.0%	63.6%	8.5%	24.0%	13.5	76.0%	3.7%	9.2%	25.8%	15.2%	20.8%	14.5%	10.9%	61.1%	36.6%
301	0.2%	0.3%	0.6%	0.0%	0.0%	0.0%	0.0%	55.1%	8.4%	35.5%	11.8	64.5%	4.2%	8.7%	23.5%	11.0%	27.2%	15.6%	9.8%	64.7%	33.3%
316	0.1%	0.3%	0.5%	0.0%	0.0%	0.0%	0.0%	6.7%	7.2%	85.2%	6.9	14.8%	2.9%	13.7%	24.0%	12.7%	20.5%	23.6%	2.6%	50.0%	26.6%
318	34.7%	1.6%	0.0%	0.0%	1.6%	0.0%	0.6%	45.6%	15.0%	0.9%	29.4	98.5%	1.4%	6.4%	14.0%	24.1%	17.0%	31.2%	6.0%	38.4%	20.0%
319	0.8%	0.8%	0.4%	0.0%	0.1%	2.4%	16.7%	35.4%	8.9%	34.4%	14.2	48.8%	1.7%	12.2%	35.5%	15.0%	14.3%	13.3%	8.0%	59.5%	43.5%
1070	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1.5	0.0%	9.4%	10.2%	20.3%	4.9%	36.0%	15.2%	3.9%	69.7%	24.2%
1146	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.4%	0.0%	4.5%	77.0%	3.5	4.5%	3.4%	3.1%	10.9%	16.4%	27.4%	35.9%	3.0%	44.6%	13.8%

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