GEI Consultants

Geotechnical
Water Resources
Environmental and
Ecological Services

The Influence of Pet Recreation Areas on Soil and Water Quality at Cherry Creek State Park

Submitted to:
Cherry Creek State Park
Aurora, Colorado

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1.0 Introduction

At the request of the Cherry Creek State Park, GEI Consultants, Inc. completed a study to evaluate the potential influence of companion pets and their fecal wastes on soil microbes and stream water quality near the designated use area. Cherry Creek State Park maintains the 12-Mile Multi-Use Area located upstream of the reservoir, the western border of which is Cherry Creek. This area receives varying levels of pet recreational use depending upon the season. The potential effects of pet wastes on water quality is a common topic of many federal and state water quality brochures (SWWQ 2005, Washington State DOE, Wilmington NC), but few studies have specifically examined this relationship.

The most commonly cited water quality concern as related to pet waste is microbial contamination, typically related to fecal coliforms. Fecal coliform bacteria are a sub-group of the total coliform group found in the feces of warm-blooded animals such as people, livestock, wildlife, and pets. Excessive levels of fecal coliforms often indicate there is a greater risk of human pathogenic bacteria such as *Cryptosporidium* or *Campylobacter* that may result in gastroenteric illnesses. Other water quality concerns include increased nutrients and depleted oxygen levels related to microbial decomposition when heavy precipitation events wash fecal waste into nearby waters. Recreational use studies have shown that nearly 50 percent of all dog owners exercise their pets in public use areas; however, up to 40 percent of dog owners do not clean up their pets' waste. The total amount of waste can become substantial depending on the number of dog owners and their frequency of use of the area.

2.0 Methods

To evaluate the potential influence of companion pets on the microbial soil and water quality in the Cherry Creek State Park pet recreation area, GEI conducted this study in May 2008. Study site transects were established on May 22, 2008, with samples being collected on May 28, 2008. The colder temperature observed during the winter and early spring is not conducive to microbial activity and pet use is likely to be less. Therefore, estimates made during warmer months will conservatively estimate impacts during colder months. The study consisted of three main components, fecal waste surveys, microbial analysis of soil samples, and microbial analysis of water samples.

2.1 Fecal waste surveys

The first part of the study was to document pet usage and their fecal waste in the recreational use area with special reference to streamside activities. Multiple transects originating from waters edge of Cherry Creek and extending in a perpendicular manner for 100 m from the streambank were randomly established along each study area (Figure 1). Three transects were established upstream of the pet recreation area in an area designated as a habitat restoration area, and served as a reference area (Transects 1-3). Seven transects were established within the pet recreation area (Transects 4-10), and three transects were established downstream of the pet recreation area (Transects 11-13). During a pre-site evaluation visit, observations were made that pets would frequently mark their territory, either urinating or defacting or both, soon after arriving at the park's east entrance. Therefore, fecal samples were collected along two selected transects near the east parking lot entrance to the pet recreation area to characterize their territorial behavior (Transects P1 and P2). Visual inspections along a 2 m wide path for each transect, both outward and the return trip to the stream bank, documented the occurrence and location of fecal waste. Fecal wastes were collected along each transect and stored in separate Ziploc bags and weighed (dry weight, dw) to determine a total waste load for each transect.

2.2 Water microbial analyses

In combination with the transect surveys, microbial water quality samples were collected using sterile sampling techniques (i.e., new examination gloves for each transect site and sterile Whirl-Pak bags) from Cherry Creek, near the origin of each transect, for a total of 13 samples. Water samples were stored in a cooler and returned to the GEI Laboratory for analysis of fecal coliforms. The sample from Transect 1 was unable to be analyzed due to insufficient volume. Total and fecal coliform analyses were performed using Standard Method 9221E (APHA 2005). The detection limit was 2 coliforms per 100 ml.

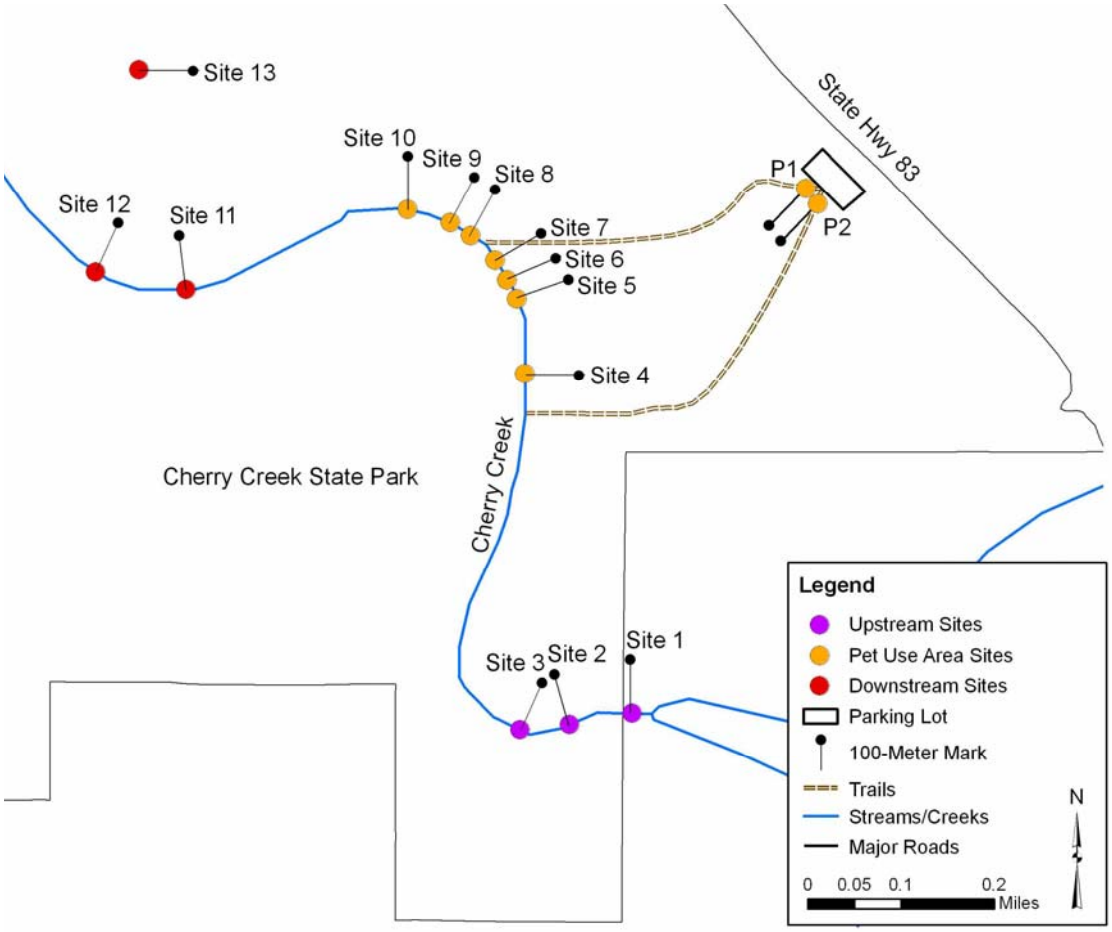

Figure 1: Sample site and transect locations in the Cherry Creek State Park pet recreation area.

Laboratory results were compared to the current numerical standard for fecal coliforms of 200 coliforms per 100 ml of sample for the stream segment immediately upstream of Cherry Creek Reservoir.

2.3 Soil microbial analyses

A combination of composite and "sample by chance" soil samples were collected along the established transects using clean sampling techniques (i.e., alcohol sterilization of metal putty knife between transects, and sterile Whirl-pac bags). Five soil samples were collected from randomly determined points along each transect, and combined to create one composite sample for each transect. A composite soil sample was collected from each of the three upstream transects (Transects 1-3) and the three downstream transects (Transects 11-13). At each point along the transect, the above ground vegetation was removed using shears, and a 9 square inch soil sample was defined using a 3 inch metal putty knife. Approximately 9 cubic inches of soil was removed by sliding the putty knife below the demarcated soil

sample. Each composite sample essentially represents a range of soil microbial conditions along their respective transect. Within the pet recreation area, composite soil samples were collected along transects 5, 6, 7, and 9, and "sample by chance" soil samples were collected along the three remaining transects (transects 4, 8, and 10). These "sample by chance" soil samples were collected beneath pet waste locations within their respective transects. Based on the number of observed dog waste per transect, between one and five direct contact soil samples were collected and combined to create one sample. These samples represent a worst case scenario for fecal contamination within the pet recreation area. Soil samples were stored in a separate cooler (i.e., not with water samples) and returned to the GEI Laboratory for analysis of total and fecal coliforms.

Soil was manually homogenized in the Whirl-Pak bag and 10 grams of soil was added to 100 ml diluent water to make a 10^{-1} dilution before inoculation. Fecal coliform analyses were performed using Standard Method 9221E (APHA 2005). The detection limit for this analysis was 20 coliforms per 100 ml (or 10g) sample.

3.0 Results

3.1 Fecal waste surveys

No dog waste was found in the three transects upstream of the recreation area. Within transects (4-10) of the pet recreation area and along side Cherry Creek, between one and five fecal samples were collected at each transect (Figure 2). At the downstream locations, between two and three samples were collected along each transect. The average number of fecal samples collected per transect (200 m^2 area) was 0 feces for the upstream area, 3.4 feces for the pet recreation area, and 2.3 feces for the downstream area. The transects sampled near the east parking lot entrance to the pet recreation area (P1 and P2), contained 9 and 27 fecal samples per 200m^2 area, respectively. These two transects are far removed from any stream side activities, but do characterize pet activities as they enter the pet recreation area.

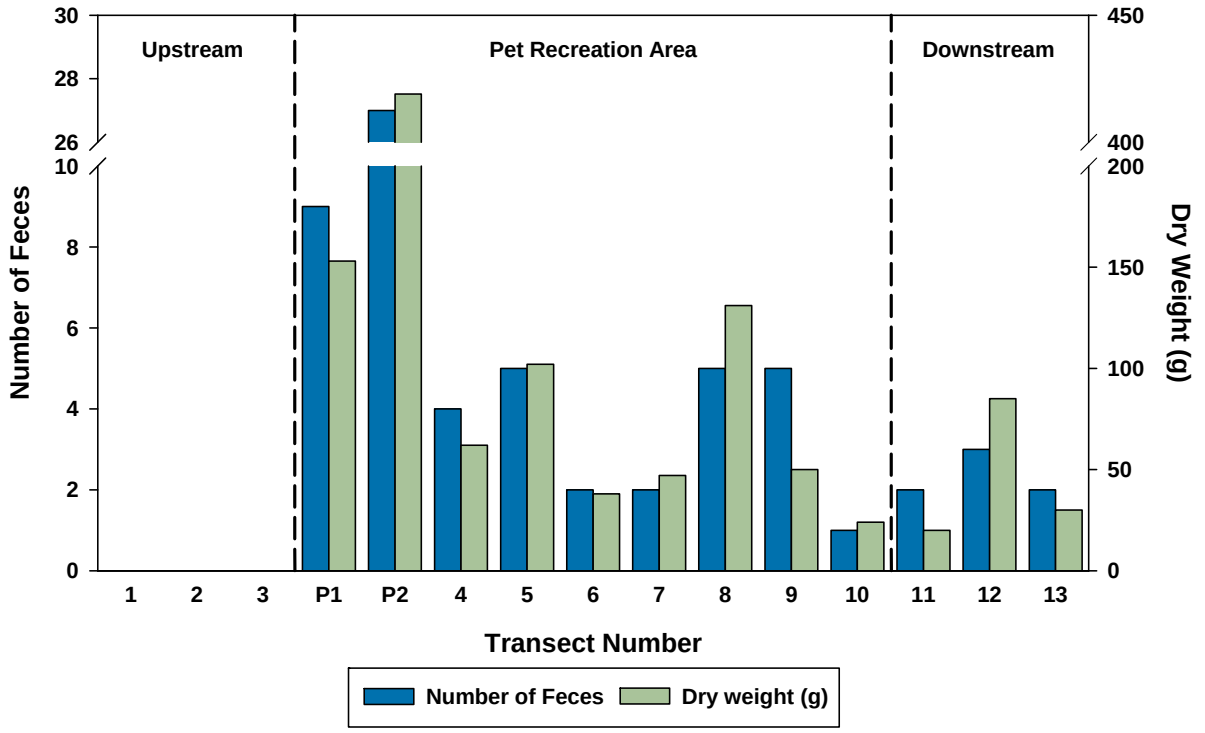

Figure 2: Number of feces and dry weight (g) for samples collected along each transect in the study area at Cherry Creek State Park.

Total dry weight of the fecal samples ranged from 24 to 419g, with an average of 65g per 200m^2 within the pet recreation area (Figure 2). In the downstream section, fecal dry weight ranged from 20 to 85g with an average of 45g per 200m^2. Fecal samples collected from transects P1 and P2, near the east parking lot entrance, weighed (dw) 153g and 419g per 200m^2, respectively.

3.2 Water microbial analyses

All fecal coliform analyses of water samples collected from transects upstream, downstream, and within the pet recreation area resulted in levels well below the numerical standard of 200 coliforms/100 ml (Figure 3). Fecal coliform levels upstream of the pet area were 11 and 13 coliforms/100 ml. The highest level detected in the study area was 23 coliforms/100 ml in the water sample collected at Transect 7, within the pet recreation area. However, fecal coliform concentrations in other transects within the pet area were not substantially different from the upstream sites, ranging from <2 to 13 coliforms/100 ml. Levels downstream of the pet area ranged from <2 to 11 coliforms/100 ml.

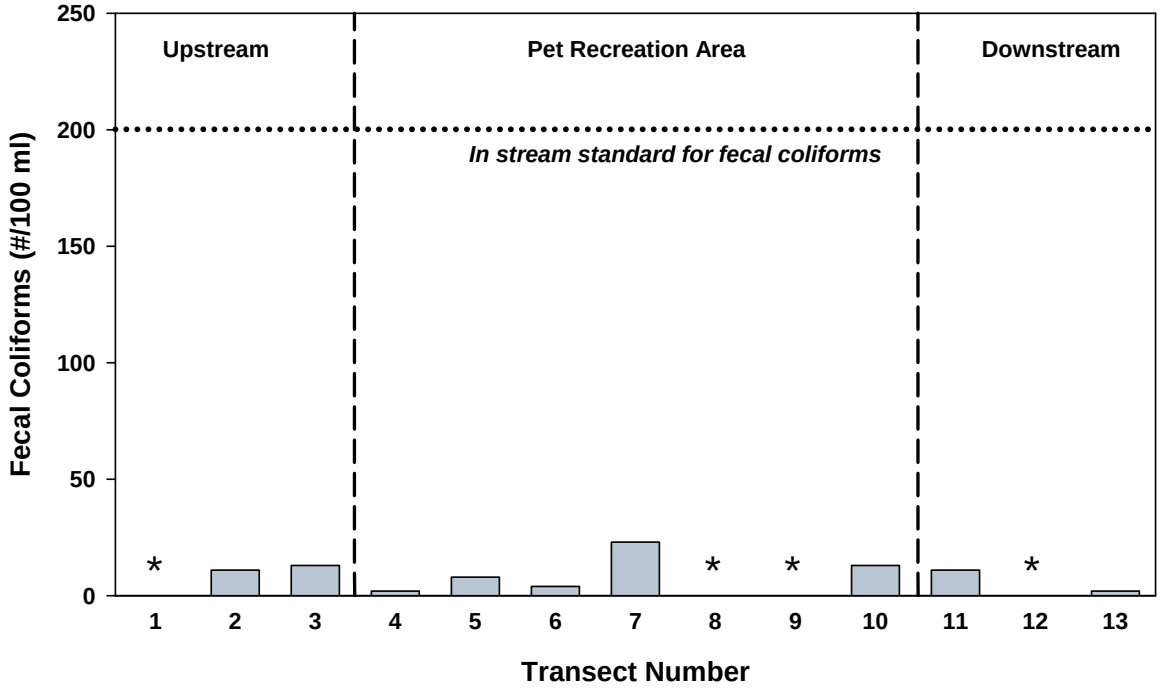

Figure 3: Number of fecal coliforms per 100 ml water sample for each stream side transect, compared to the in-stream numerical standard of 200 coliforms / 100 ml. Asterisk denotes result was less than method detection limit (<2 coliforms / 100 ml).

As part of the analytical method for fecal coliform bacteria, total coliform bacteria were also determined. Total and fecal coliform data for both water and soil samples are provided in Table 1. The results of the total coliform analyses were used as a quality control measure to validate the fecal coliform results. As expected, total coliform numbers are greater than fecal coliforms in water samples from all transects, ranging from 23 to 240 coliforms per 100 ml. This observation is not surprising given that coliform bacteria are commonly found in natural waters. Their presence does not necessarily indicate contamination (APHA 2005).

Table 1: Number of total and fecal coliforms in water and soil samples collected from each transect.

Transect	Water		Soil	
	Total Coliforms (#/100 ml)	Fecal Coliforms (#/100 ml)	Total Coliforms (#/100 ml)	Fecal Coliforms (#/100 ml)
1	no data	no data	230	<20
2	130	11	130	<20
3	23	13	230	<20
4	80	2	500	<20
5	50	8	500	<20
6	50	4	230	<20
7	30	23	230	<20
8	240	<2	>16,000	<20
9	110	<2	130	<20
10	30	13	<20	<20
11	80	11	500	<20
12	50	<2	<20	<20
13	130	2	230	<20

3.3 Soil microbial analyses

All fecal coliform analyses of soil samples collected from each transect upstream, downstream, and within the pet recreation area resulted in coliform levels less than the detection limit of 20 coliforms/100 ml. Soil samples were not collected from transects P1 and P2 due to the late addition of these sites.

As described in section 3.2, total coliform bacteria also were determined in soil samples. Similar to the results of the water quality samples, total coliform bacteria were greater than fecal coliform bacteria in all soil samples ranging from <20 to >16,000 coliforms per 100 ml (Table 1). Again, this does not indicate contamination; it does however confirm that the analytical method used in this study was appropriate for detecting coliform bacteria in soil.

4.0 Summary

The amount of fecal waste collected varied between the transect sites. No pet waste was observed in the upstream area, indicating this area was an appropriate reference area with no substantial pet use. The quantity of pet waste collected in the more active zone of the pet recreation area was slightly greater than in the downstream area, in both number of feces and dry weight. However, the transects near the east parking lot entrance contained substantially greater quantity and mass of pet wastes, approximately 2 and 5 times greater than any other transect sampled along Cherry Creek. This indicates that the territorial behavior of many pets' likely results in a greater fecal load near the east entrance rather than near the waters of Cherry Creek, which corroborates results found in other studies (SWWQ 2005). Management strategies for the pet recreation area may evaluate the effectiveness of confined entryways into the park and locate pet waste receptacles near these locations to encourage pet owners to help maintain the natural resource provided by the State Parks.

The results of the microbial water analyses collected from Cherry Creek indicate that pets are not greatly affecting the water quality in this area. The greatest fecal coliform level detected in any of the samples was 23 coliforms/100 ml, which is substantially less than the numerical standard of 200 coliforms/100 ml for the stream segment upstream of Cherry Creek Reservoir. Although the amount of pet waste did vary between the upstream, pet area, and downstream sample sites, fecal coliform levels did not vary substantially between the three areas, indicating the pet recreation area did not appear to contribute to the levels of fecal coliforms found in Cherry Creek during the study. During both the pre-site and sample collection visit, dogs were observed playing in the waters of Cherry Creek near many transects.

Analysis of soil samples randomly collected along the transects, as well as the direct contact "sample by chance" sample underneath fecal wastes indicated no fecal coliform contamination. It may be assumed that the fecal coliform bacteria were unable to persist under normal environmental conditions when not in an aquatic system. Survival of coliform bacteria has been shown to be negatively affected by increasing temperature and dessication (Zaleski, et al. 2005). Van Donsel et al. (1967) showed that fecal coliform bacteria numbers were reduced by 90 percent in soils within 3.3 days in the summer and within 13.4 days in the fall. Due to the short expected lifespan of fecal coliform bacteria in soil, it is unlikely that they would be easily transported to Cherry Creek in runoff situations.

Based on these data, the area that receives the greatest fecal load is the east parking lot entrance to the pet recreation area. Access areas to the pet recreation area should also be considered during the implementation of best management practices in pet recreation areas.

5.0 References

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