Monitoring Infiltration of Atmospheric Chloride across the Land Surface in Central New Mexico

by

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1 Abstract

The objective of this study was to develop analytical methods and establish a field site to determine deposition rates of atmospheric chloride to the land surface in central New Mexico. I determined chloride deposition rates with a wet-dry precipitation collector, a standard precipitation collector, a dust collector 2.25 meters off the ground, and a set of 39 columns packed with leached sand to measure accumulation of chloride in artificial soil profiles. The monitoring project is scheduled to last for five years. After six months of monitoring, chloride deposition rates determined with the columns ranged from 19 to 190 mg Cl $m^{-2} yr^{-1}$. Chloride deposition rates determined with the precipitation collectors over the same timespans ranged from 14 to 44 mg Cl $m^{-2} yr^{-1}$. The average chloride deposition rate determined with the dust collector was 110 mg Cl $m^{-2} yr^{-1}$.

2 Introduction

2.1 Chloride cycle and groundwater recharge

2.1.1 Chloride cycle

The main source of atmospheric chloride is marine aerosol formed at the ocean surface. The splashing of raindrops and bursting of air bubbles introduce droplets of saltwater into the air. Droplets may evaporate and leave particulate NaCl in the air. Droplets and particulates are carried aloft by atmospheric turbulence and distributed across the globe. Atmospheric chloride is deposited on the land primarily by dry fallout or by scavenging by raindrops (Manahan, 1994).

In semiarid regions, defined as receiving an annual average precipitation of 200 to 500 mm (Lerner et al., 1990), rainwater often infiltrates a few cm into the ground, resulting in an influx of chloride across the ground surface. Then as some or all of the water returns to the atmosphere by evaporation, the chloride, which does not evaporate, remains in the soil. Chloride very close to the land surface, however, may subsequently be removed by eolian deflation. Water that escapes evaporation and infiltrates down as groundwater recharge removes dissolved chloride from the soil.

2.1.2 Groundwater recharge

Groundwater is recharged through a variety of pathways. In semiarid regions, surface water concentrated by runoff is the primary source of groundwater recharge. In contrast, there is also direct areal recharge, which is strictly vertical infiltration through the vadose zone to the water table, of precipitation that has fallen on a horizontal land surface. The rate of direct areal recharge in semiarid regions is very low relative to precipitation and evaporation rates, making quantification difficult. Various quantification methods have been compared by Knowlton et al. (1992).

The prospect of contamination from waste disposal sites in semiarid regions is one reason for the interest in accurate estimates of recharge rates. For risk assessment of possible nuclear waste disposal sites, regulations require a 10,000-year prediction of migration of waste with groundwater. On this time scale, a low recharge rate can result in significant flux of water and contaminant transport.

2.2 Use of chloride as a natural tracer

The chloride mass balance method uses atmospheric chloride as a natural tracer to estimate the amount of direct groundwater recharge in semiarid regions. The objective of this study was not to use the chloride mass balance method, but instead to attempt to measure the rate of chloride deposition, which is used in the mass balance equation.

The assumptions used in the chloride mass balance method are that :

1) The chloride deposition rate is constant over the time when chloride accumulates.
2) Water flow is vertical. The chloride mass balance method is therefore most applicable in areas with flat topography.
3) Atmospheric chloride is the only source of chloride.
4) Liquid water and dissolved chloride are transported at the same rate, i.e. chloride is a conservative tracer.

The chloride mass balance equation can be written as :

$$J_R = \frac{D_{Cl}}{C_{Cl}}$$

where :

(J_R) = residual soil-water flux at depth of measurement [$L\ T^{-1}$]

(D_{Cl}) = deposition rate of atmospheric chloride (both wet and dry) across the land surface [$M\ L^{-2}\ T^{-1}$]

(C_{Cl}) = chloride concentration in soil water at depth of measurement [$M\ L^{-3}$]

(Phillips, 1994).

2.3 Research objectives

The purpose of this project is to monitor accumulation of atmospheric chloride to reach the following objectives, which should provide valuable baseline information for other researchers using tracer methods.

1) To obtain estimates of the average annual deposition of chloride and bromide from the atmosphere to the land surface in central New Mexico.
2) To estimate the Cl:Br ratio of atmospheric deposition. The Cl:Br ratio is often used to identify the source of a tracer.
3) To estimate wet deposition of chloride so that the wet and dry components can be separated.

2.4 Experimental Design

The monitoring site is located on the Sevilleta National Wildlife Refuge, which is about 25 km north of Socorro, NM, as shown in Figure 1, the location map. The Sevilleta National Wildlife Refuge is administered by the U.S. Fish and Wildlife Service for research purposes. Appendix A includes information needed to access the wildlife refuge. The monitoring site is in an area within the wildlife refuge known as the Salado Grasslands. It is located south of the Rio Salado and west of Interstate highway 25 at 106 degrees 55' 34" W longitude and 34 degrees 17' 45 " N latitude. The elevation of the monitoring site is about 1520 m (USGS, 1979). The average slope of the land surface in the vicinity of the monitoring site is 0.05 (USGS, 1979). The slope within the monitoring site is flatter than the average slope. The ecosystem is classified as Colorado Plateau Shrub Steppe. The area is sparsely vegetated by creosote, forbs, and grasses.

The weather of the Sevilleta National Wildlife Refuge is monitored by seven meteorological stations established by the Long-Term Ecological Research (LTER) Program. For the study period 1989-1995, mean annual precipitation using all stations was 251 mm with an annual range varying from 144 mm in 1995 to 319 mm in 1991. The site is at the boundary between several major air mass trajectory zones which contribute to a dynamic local climate. The annual temperature/precipitation cycle of the Sevilleta is characterized by the dry, cold, winter months of December through February with a transition into the warmer, windy, but still generally dry, spring period of March through May. Spring is followed by a hot, dry June and then a hot but wetter summer "monsoon" period of July and August. Intense thunderstorms during the summer usually account for over half of the annual moisture. Subsequent to the monsoons, fall is characterized by moderate temperatures with drying from October through November (Moore, 1997).

The monitoring site includes five different types of collectors that are used to monitor accumulation of chloride. These collectors, described below, include soil columns, a dust collector, and three precipitation collectors that collect wet, dry, and bulk deposition. The LTER precipitation collectors were in use before I constructed the soil columns and dust collector for this project. The masses of chloride accumulated in each collector over known periods of time can be used to calculate deposition rates in terms of mg Cl m^{-2} yr^{-1} . It is assumed that the surface area of each collector is representative of the whole monitoring site, and that the monitoring site receives spatially homogeneous deposition. Samples are taken from each collector at the same time intervals. By comparing the deposition rates calculated with each collector, the wet, bulk, and dry components may be separated. The different elevations of the collectors in relation to the ground surface may cause variation in rates calculated from each collector. Comparison of these rates may help identify deposition of horizontally transported material. At the time of this writing, monitoring for this project has been done for six months, beginning when I emplaced the columns on November 2, 1996. The total timespan of monitoring is intended to be about five years. This may be adjusted depending on future results.

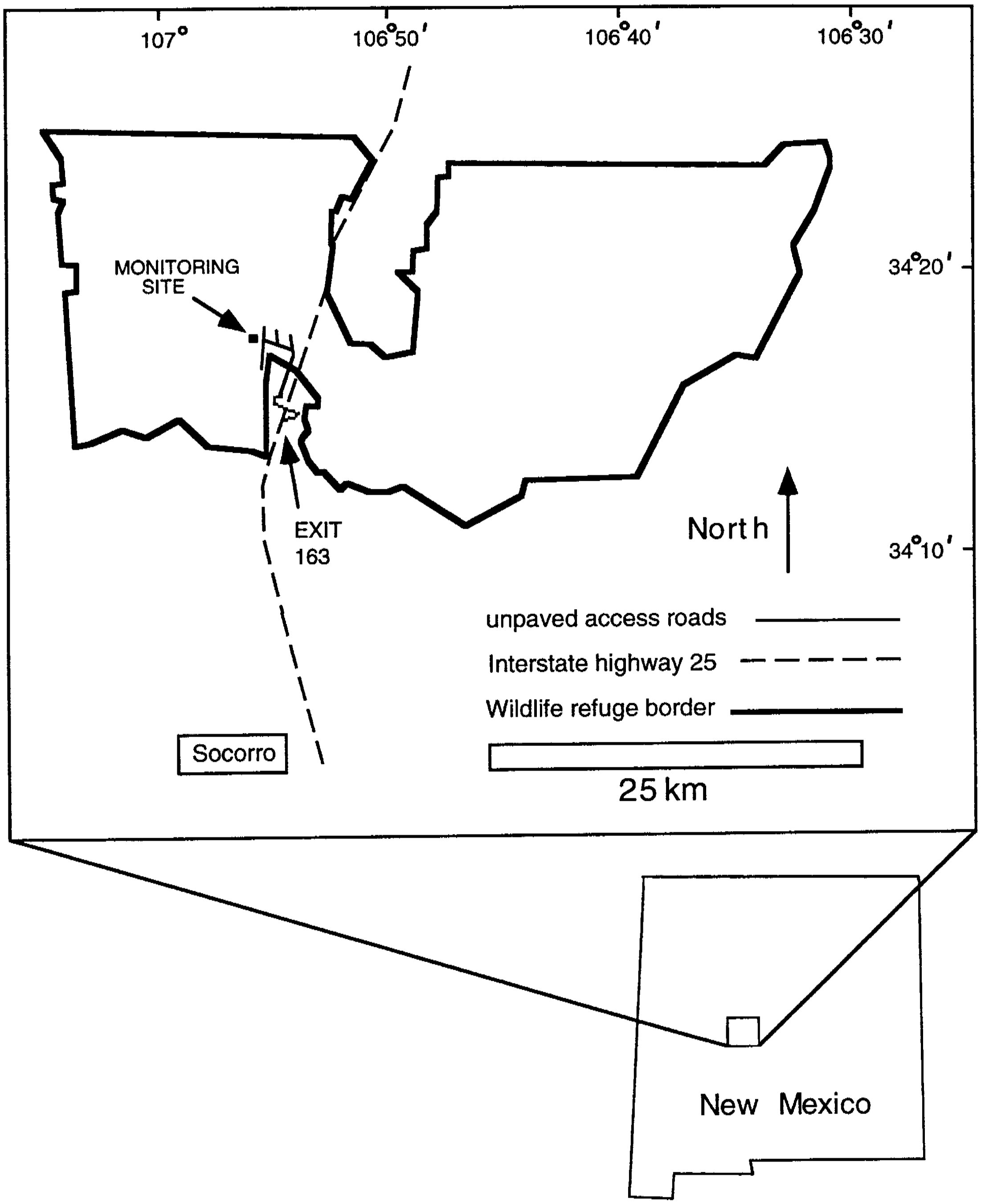


Figure 1. Map showing location of the monitoring site in the Sevilleta National Wildlife Refuge

2.4.1 Columns

To measure downward flux of chloride across the land surface, I packed 38 plastic pipes (referred to as columns in this paper) with pre-leached sand and buried them with their open tops approximately 1 cm below the land surface. I placed more pre-leached sand on top of them to form a surface level with the natural land surface. I sealed the bottoms of the columns with plastic caps to prevent water and chloride from being lost out the bottoms of the columns. The columns are made of ABS (acrylonitrilebutylstyrene) plastic. They are 60 cm (2 ft) long and have internal diameters of 10.16 cm (4 inches). The collection area of each opening is 0.0081 m^2. The design is shown in Figure 2. Details of the preparation of materials and the construction of the columns are described in Appendices B.2 and B.3.

The columns should trap any chloride deposited, by precipitation or dry fallout, by allowing infiltration and evaporation, but not allowing leakage out the bottoms. I packed the columns with sand pre-leached to an initially low chloride concentration, so that upon sampling, small increases in chloride concentration could be attributable to deposition. I extracted columns periodically to quantify accumulated chloride and to calculate chloride deposition rates (mg Cl m^{-2} yr^{-1}). I quantified the chloride in the columns by leaching the sand with a known volume of de-ionized water and measuring the concentration of chloride in the leachate by HPLC (High Performance Liquid Chromatography). All de-ionized water used for leaching sand was produced with a Milli-Q system.

The sampling schedule, which is listed in Appendix B.1, is expected to span a time of 5 years. During the first year, the sampling will be monthly and will include extraction of two columns every third month (i.e. duplicates removed at the same time). After the first year, the time intervals may be chosen based on results during the first year.

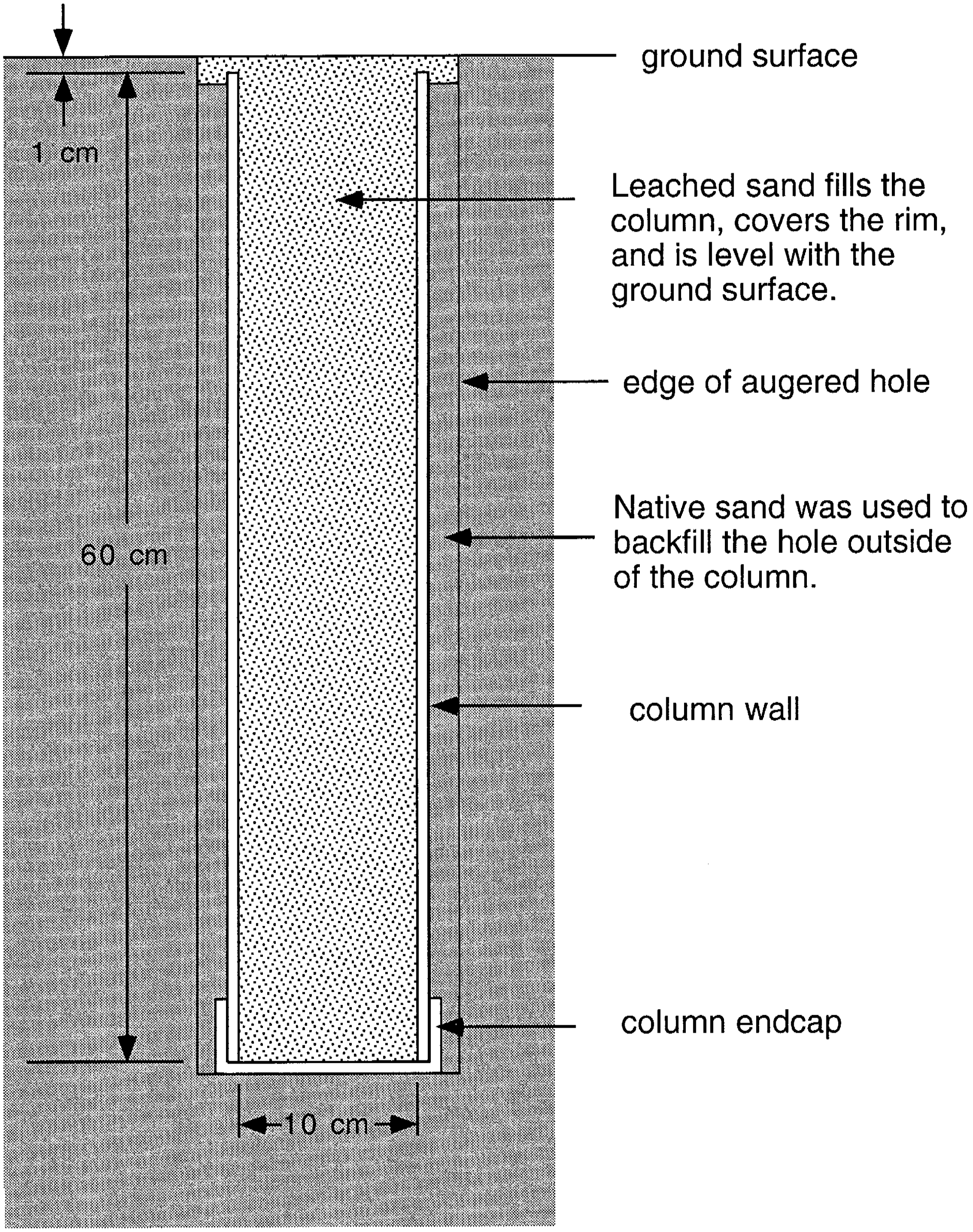


FIGURE 2 : Cross section of a column, showing column dimensions and leached sand level with the ground surface

2.4.2 Precipitation collectors

A set of precipitation collectors on the Sevilleta Wildlife Refuge has been established by the Long-Term Ecological Research (LTER) Program, funded by the National Science Foundation. The Biology Department of the University of New Mexico operates the collectors and has agreed to share data and samples with this project.

My columns are located near the LTER Meteorological Station 44, which includes a bulk precipitation collector and a wet-dry precipitation collector. The wet-dry precipitation collector has two 11.25-inch-diameter buckets, one of which is always covered. When an electronic sensor detects rain, a cover is automatically removed from the wet collector and placed over the dry collector. When the sensor stops detecting rain, the cover is returned to the wet collector. Rain samples are thus collected with minimal dry deposition, and dry deposition is collected with no rain. Although the cover inhibits evaporation from the wet collector, it does not completely prevent evaporation. This may cause the depth of precipitation indicated by the wet collector to be less than that indicated by the bulk collector, but the mass of chloride should not be affected by evaporation.

2.4.3 Dust collector

I set up a dust collector with a design based on that described by Reheis and Kihl (1995). Reheis and Kihl used multiple collectors to compare dust deposition rate and composition to climate and source lithology. I set up a single collector to quantify chloride deposition rates.

The collector consists of a 10.5 inch diameter angel food cake pan mounted 2.25 meters above the ground on a fence post. A circular piece of 1/2-inch-mesh galvanized metal screen is fitted into the pan so that it rests 3-4 cm below the rim, and glass marbles fill the upper part of the pan above the screen. The pan is Teflon-coated. This coating should be non reactive and should provide no chloride contamination. The 2.25-m height eliminates most saltating sand-sized particles. The marbles prevent dust that has filtered or washed into the bottom of the pan from being blown away. The empty space below the screen provides a reservoir that prevents water from overflowing the pan during large storms. To reduce contamination from birds perching on the collector, it is fitted with two metal straps looped over the pan in an inverted basket shape. The top surfaces of the straps are coated with Tanglefoot, a sticky material that never dries and discourages birds from roosting. A schematic diagram of the dust collector is shown in Figure 3.

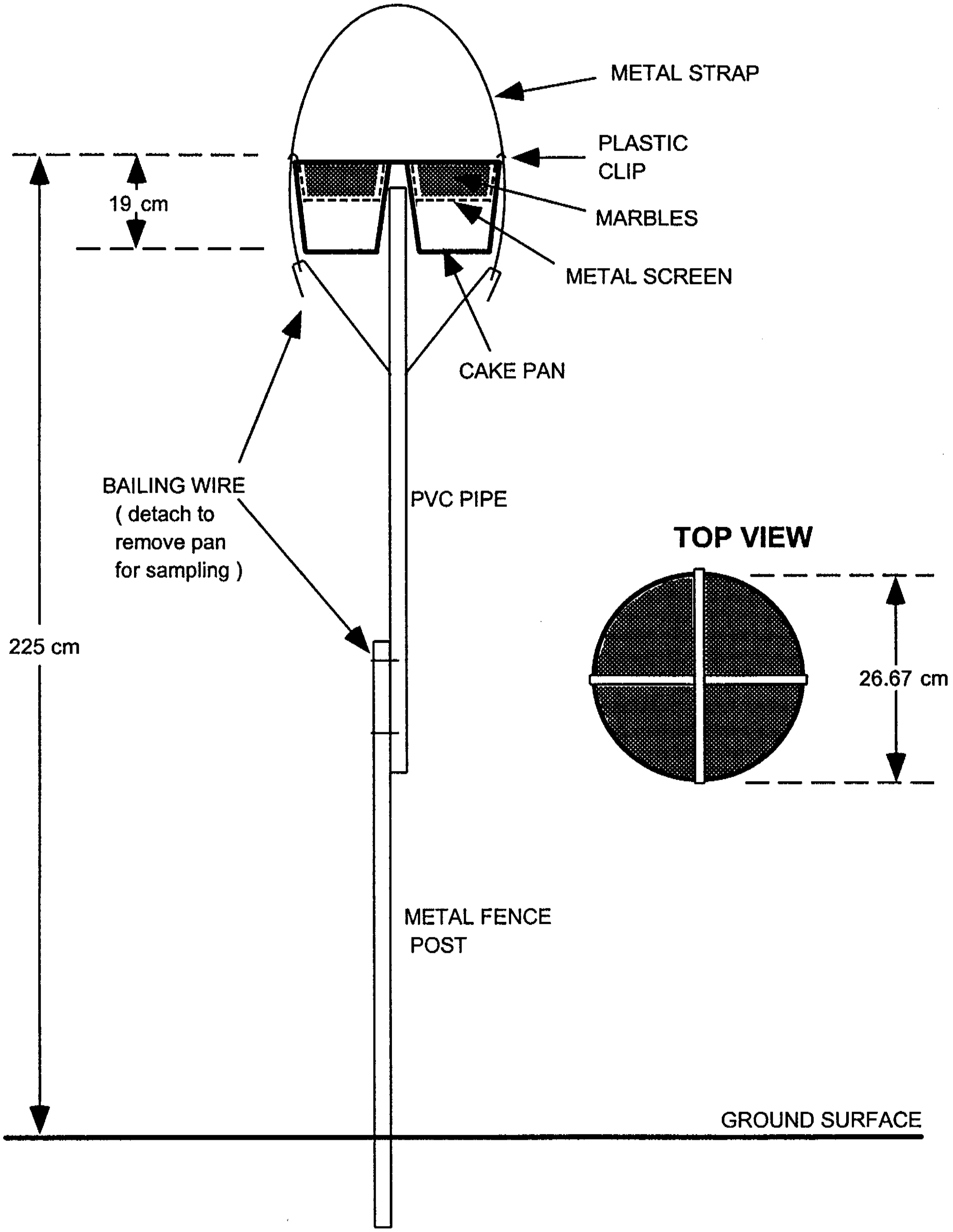


FIGURE 3 : DESIGN OF DUST COLLECTOR

3 Methods

3.1 Column sampling

3.1.1 Introduction of methods

Before I constructed the columns, I used bench-scale experiments to determine the suitability of the analytical methods, the suitability of the column material, and the minimum column depth. Details of these experiments are described in Appendix B. I obtained the sand used to pack the columns from a dune area with minimal vegetation. I selected the site for the columns based on proximity to the pre-existing precipitation collectors and on the slope of the land surface, which needed to be as level as possible.

Collecting the samples from the columns involves removing a column from the ground, dividing the sand into several depth intervals, and leaching the chloride from the sand of each interval with known volumes of de-ionized water (L). The chloride concentration (mg/L) of each leachate is determined by HPLC. Then the mass of chloride (mg) in the leachate = (volume of leachate) x (chloride concentration in leachate). Details of the leaching process are recorded in Appendix B.5 to allow backcalculation of the mass of chloride in each interval. The sum of the masses of chloride in each interval is used to determine the deposition rate of chloride to the column in terms of mg Cl m^{-2} yr^{-1}. The water content and chloride concentration are also plotted with depth. These distribution profiles may be compared to see if they reveal additional information. The column sampling schedule and details of the sampling methods are included in Appendix B.1 and Appendix B.4.

3.1.2 Control column

I began monitoring with the columns on November 2, 1996. After emplacing the 38 columns, I extracted a control column on the same day to determine the initial chloride concentration and to check for chloride introduced during packing, transport, and emplacement of the columns. The methods that I used for samples from the control column deviated from the standard methods described in Appendix B.4. I needed more preleached, dried sand to finish covering other columns, so I used some of the sand from the control column.

I divided the sand from the control column into five depth intervals. I handled interval 1, the surface sample, according to the standard method. I used the second interval, which consisted of about half of the sand in the column, to finish covering other columns and did not analyze it for water content or chloride concentration. For the third interval, which was taken from the middle depth, I followed the procedure in Appendix B.4. I handled the fourth interval the same way as the second. The fifth interval, which was from the bottom of the column, was handled as interval 3. For intervals 2 and 4, I used average values of water content and chloride concentration to estimate the total mass of chloride in the column, as shown in Appendix B.5.1.1.

3.1.3 Archive column

To check for contamination from the column materials over the total time of monitoring, I capped a column at both ends and buried it to expose it to the same conditions as other columns. This column will be extracted at the end of the experiment to test for contamination from the column materials.

3.1.4 Characterization of local sand

It is possible for chloride to reach the columns with eolian material. The most likely eolian material would be sand from the land surface within the experimental plot. To characterize this sand, I collected a sample and processed it the same way as a sample from the columns. I determined the chloride concentration of this sample in terms of mg Cl / g dry sand, as shown in Appendix B.5.2.1

To estimate a hypothetical influx of chloride from eolian sources, I calculated the mass of chloride that could be introduced to a column if sand from this source is transported to a column and accumulates to a depth of 1 mm. This mass is estimated as :

(1 mm sand) x (ratio of mass of dry sand to depth of sand) x (chloride concentration of sand)

where (ratio of mass of dry sand to depth of sand) is the ratio calculated from with data for the column extracted on December 2, 1996. This estimate assumes the two different sands have the same bulk density.

and (chloride concentration of sand) is calculated in Appendix B.5.2.1 in units of mg Cl / g dry sand

3.2 Precipitation data

3.2.1 Collection of precipitation data

I obtained precipitation data for the wet-dry precipitation collector and the standard, or bulk, precipitation collector from Doug Moore of the University of New Mexico Biology Department. The data includes the chloride concentrations, as determined by ion chromatography (IC) at UNM, and the amounts of precipitation, which may be expressed in terms of depth or in terms of volume collected. For consistency, I tabulated the data in terms of both in Appendix C and calculated the chloride deposition rates for each sample. Upon sampling, the volumes of precipitation in each collector are measured, then converted to depths of precipitation in mm by dividing by the area of each collector. I converted the depths back to volumes by multiplying by the areas of each collector.

The bulk precipitation collector, PW8, consists of a 10.5 inch plastic funnel connected to a storage bottle, which is emptied monthly. The volume of water is converted to depth of precipitation, and a sample is analyzed by IC for chloride and other constituents by the Biology Department at the University of New Mexico. The wet-only collector, PW11, is sampled monthly in the same way as the bulk collector. The dry-only collector, PW12, is sampled monthly by rinsing with a known volume of de-ionized water. A sample of this is analyzed for chloride by IC. In months with no rain, the collectors are rinsed with 250 ml of de-ionized water, which is collected and analyzed for chloride.

Because I compare data obtained by IC at UNM to data that I obtain by HPLC, I analyzed one of their standards by HPLC to confirm that results are comparable. My results for this standard, shown in Appendix F.4, indicate that our data are comparable. I obtained portions of some of the precipitation samples to analyze for chloride and bromide. The rain samples contain a preservative, phenyl mercuric acetate (PMA), which interfered with my analysis for chloride. Br analysis was also indeterminate. These samples are stored and archived for possible future analysis.

Records I have for the bulk collector begin with the sample taken on March 30, 1989. Records I have for the wet-dry collector begin with the samples taken on April 4, 1992. I began monitoring with the columns on November 2, 1996, and with the dust collector on January 3, 1997.

3.2.2 Analysis of precipitation data

I used the precipitation records for two purposes, which were to look for trends in the entire record predating my columns, and to compare the chloride deposition rates determined with the precipitation collectors to the rates determined with columns and the dust collector for the time span of my monitoring project. The raw data from the precipitation collectors is converted in Appendices C.1, C.2, and C.3 to chloride deposition rates for each of the three precipitation collectors. The rates are further sorted in Appendices C.4 and C.5 to examine long-term trends.

To look for long-term trends in the chloride deposition rates, I plotted the cumulative mass of chloride per m^2 for each of the precipitation collectors over the 5.1-year record from April 4, 1992, to April 30, 1997. This data is tabulated in Appendix C.4 and plotted in section 4. I then determined the monthly means and standard deviations of the precipitation rates and chloride deposition rates determined with the bulk precipitation collector, using the 7.8-year record from June 8, 1989, to April 30, 1997. The sorting of the data for statistical analysis is described and shown in Appendix C.5. The statistics are listed and summarized in section 4. Because these statistics indicate that both the monthly chloride deposition rates and the monthly precipitation rates may have lognormal distributions, I performed additional analysis to look for another characteristic of lognormally-distributed data, which is that the standard deviation of the natural logarithms of the data should not increase as the mean of the natural logarithm of the data increases. I calculated the statistics for the natural logarithms of the original rates in the same way that I calculated the statistics for the original rates in Appendix C.5. I plotted each set of twelve monthly means against the corresponding set of twelve monthly standard deviations. The slope of a regression line for the twelve data points in each plot indicates whether or not the standard deviations increase as the means increase.

3.3 Dust collector

I set up the dust collector on January 3, 1997, about two months after the columns were emplaced. The dust collector is sampled monthly on the same days as the other collectors. The dust collector is sampled by rinsing with de-ionized water, determining the volume of water (L), and determining the chloride concentration (mg/L) in the water by HPLC. Then the mass (mg) of chloride collected = (volume of water) x (chloride concentration). Details of the sampling procedure are outlined in Appendix D.1.

I assume that the metal straps above the pan do not block any precipitation or dry fallout, so the area of metal straps is not considered in calculating the collection area. The diameter of the pan is 250 mm. In the center of the pan there is a 35 mm diameter hole, which is not included in the collection area. Then the collection area = (area of whole pan) - (area of center hole) = 0.048 m^2. The calculations of chloride deposition rates are shown Appendix D.2.

4 Results

4.1 Temporal variability of rates indicated by precipitation collectors

4.1.1 Cumulative masses of chloride

Figure 4.1 displays the cumulative mass of chloride per m^2 collected in each of the three precipitation collectors from April 4, 1992, to April 30, 1997, as tabulated in Appendix C.4. It indicates an annual pattern with the highest increases in the summer months for each collector. The sum of values for the wet-only collector and the dry-only collector, shown by the dashed line in Figure 4.1, should theoretically be equal to the values for the bulk collector. Although there is some deviation, I consider the values for the bulk collector to be representative of all three precipitation collectors for the purposes stated in section 3.2.2. I therefore use data from the bulk collector for all analysis of precipitation data.

4.1.2 Statistical analysis of precipitation rates and chloride deposition rates

Table 4.1 lists the means and standard deviations of monthly precipitation rates and chloride deposition rates determined with the bulk precipitation collector. As shown in Appendix C.5, these statistics for each month are calculated by using the values for the respective months in eight different years. The means are plotted for each month of the year (January through December) in Figure 4.2 and Figure 4.3, with error bars showing one standard deviation for each month. Table 4.1 and figures 4.2 and 4.3 show that the standard deviations increase as means increase. This could indicate that the data have lognormal distributions.

4.1.3 Characterization of distributions of precipitation rates and chloride deposition rates

Table 4.2 lists the means and standard deviations of the natural logarithms of the of monthly precipitation rates and chloride deposition rates determined with the bulk precipitation collector. The data in Table 4.1 and Table 4.2 are plotted in Figure 4.4.a, Figure 4.4.b, Figure 4.5a, and Figure 4.5b to show correlations between the means and standard deviations.

The linear regression of the 12 points in Figure 4.4.a shows that the standard deviation of the monthly chloride deposition rates increases as the mean monthly chloride deposition rate increases. The linear regression of the 12 points in Figure 4.4.b shows that the standard deviation of natural logarithms of the monthly chloride deposition rates does not increase as the mean of the natural logarithms of the monthly chloride deposition rate increases. These two relationships both suggest that the monthly chloride deposition rates have a lognormal distribution.

The linear regression of the 12 points in Figure 4.5.a shows that the standard deviation of the monthly precipitation rates increases as the mean monthly precipitation rate increases. The linear regression of the 12 points in Figure 4.5.b shows that the standard deviation of natural logarithms of the monthly precipitation rates does not increase as the mean of the natural logarithms of the monthly precipitation rate increases. These two relationships both suggest that the monthly precipitation rates have a lognormal distribution.

Figure 4.1 Cumulative (mg Cl / m^2) collected in three precipitation collectors from 4-4-92 to 4-30-97

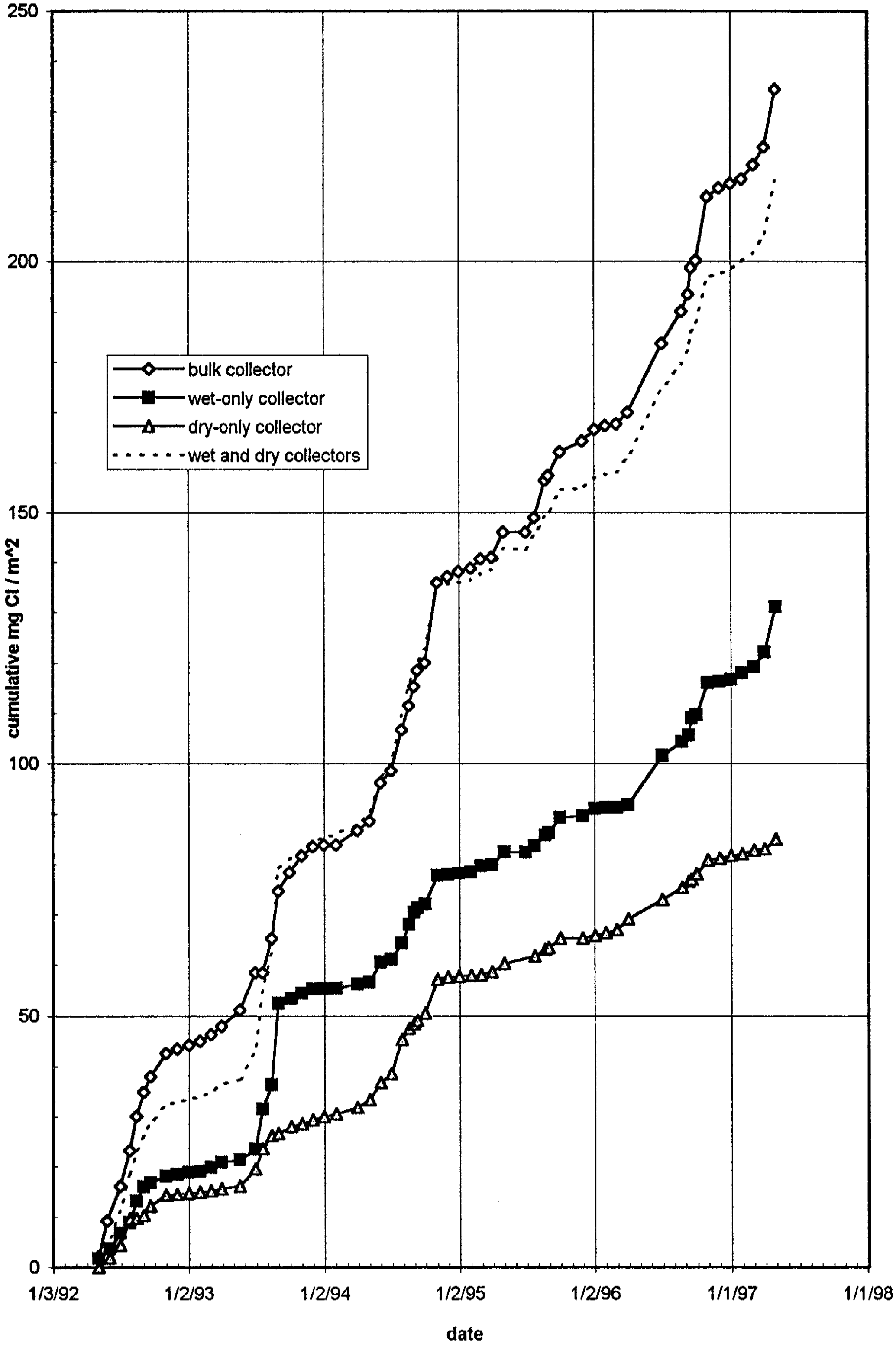


Table 4.1 Means and standard deviations of monthly* chloride deposition rates and precipitation rates determined with the bulk precipitation collector from June 8, 1989, to April 30, 1997.
Standard deviations increase as means increase.

	Chloride deposition rate (mg Cl m^{-2} $month^{-1}$)		Precipitation rate (mm $month^{-1}$)	
month	mean	standard deviation	mean	standard deviation
1	1.1	0.78	7.3	4.6
2	1.6	0.76	10	5.3
3	2.6	2.1	12	14
4	5.3	4.2	13	11
5	5.5	4.3	18	18
6	4.8	3.1	8	6.5
7	9.2	8.3	31	24
8	7.7	3.8	45	36
9	5.1	3.7	33	38
10	6.0	4.7	21	22
11	2.3	1.9	11	10
12	2.5	3.1	17	25

Table 4.2 Means and standard deviations of natural logarithms of monthly* chloride deposition rates and precipitation rates determined with the bulk precipitation collector from June 8, 1989, to April 30, 1997.
Standard deviations do not increase as means increase.

	ln (Chloride deposition rate)		ln (Precipitation rate)	
month	mean	standard deviation	mean	standard deviation
1	2.2	0.98	4.2	0.77
2	2.8	0.67	4.6	0.65
3	3.1	0.84	4.2	1.20
4	3.9	0.69	4.6	0.89
5	3.6	1.50	5.0	0.96
6	3.6	1.40	4.4	0.86
7	3.9	1.80	5.2	1.70
8	4.4	0.50	5.9	0.92
9	3.9	0.59	5.3	1.30
10	4.0	0.79	4.9	1.20
11	3.2	0.57	4.4	1.00
12	2.9	0.96	4.0	2.00

* The statistics for each month are calculated by using the values for the respective months in 8 different years.

Figure 4.2 Mean monthly chloride deposition rates from June 8, 1989, to April 30, 1997.
Error bars indicate one standard deviation.
Standard deviation increases as mean increases.

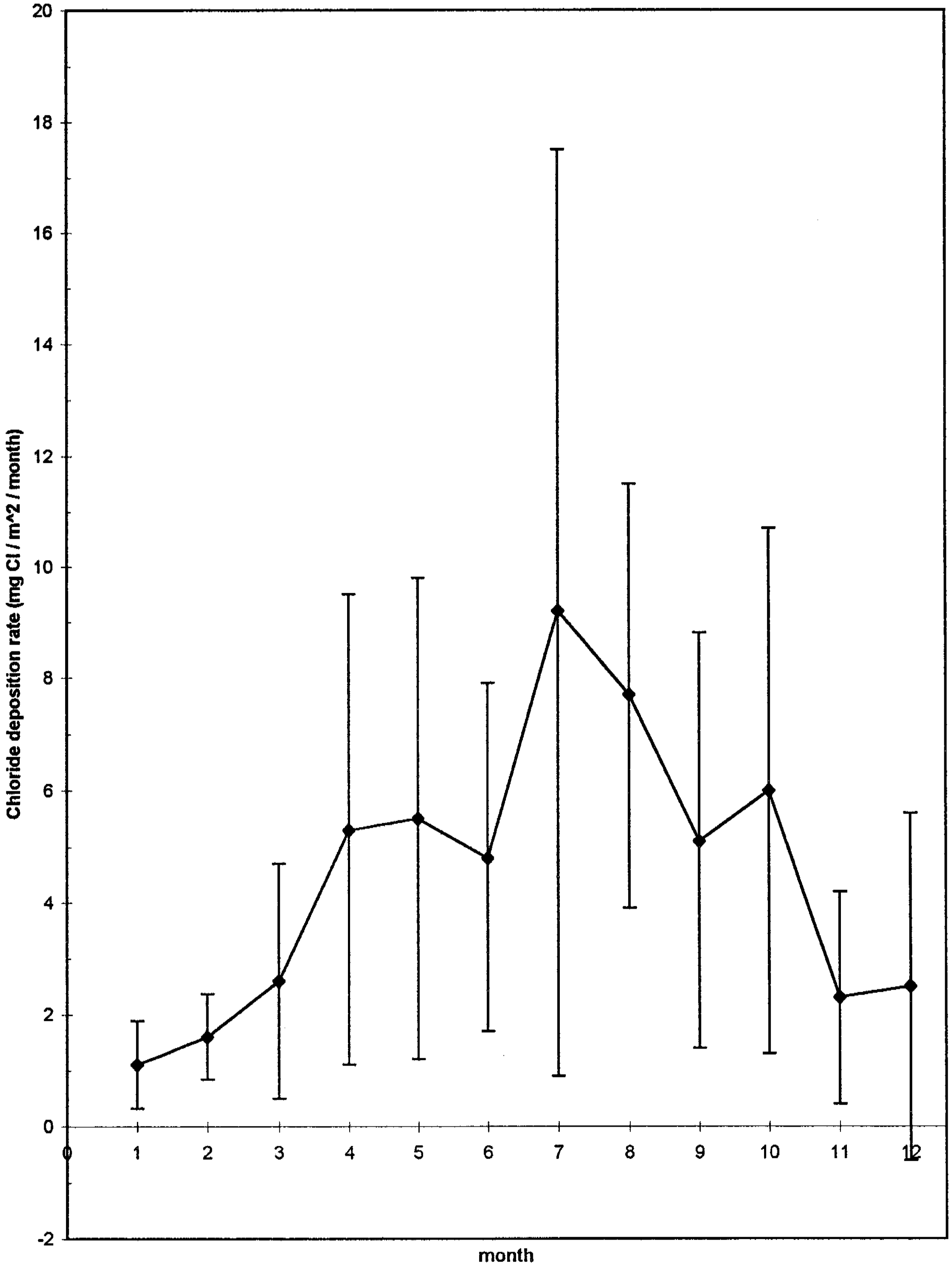


Figure 4.3 Mean monthly precipitation rates from June 8, 1989, to April 30, 1997.
Error bars indicate one standard deviation.
Standard deviation increases as mean increases.

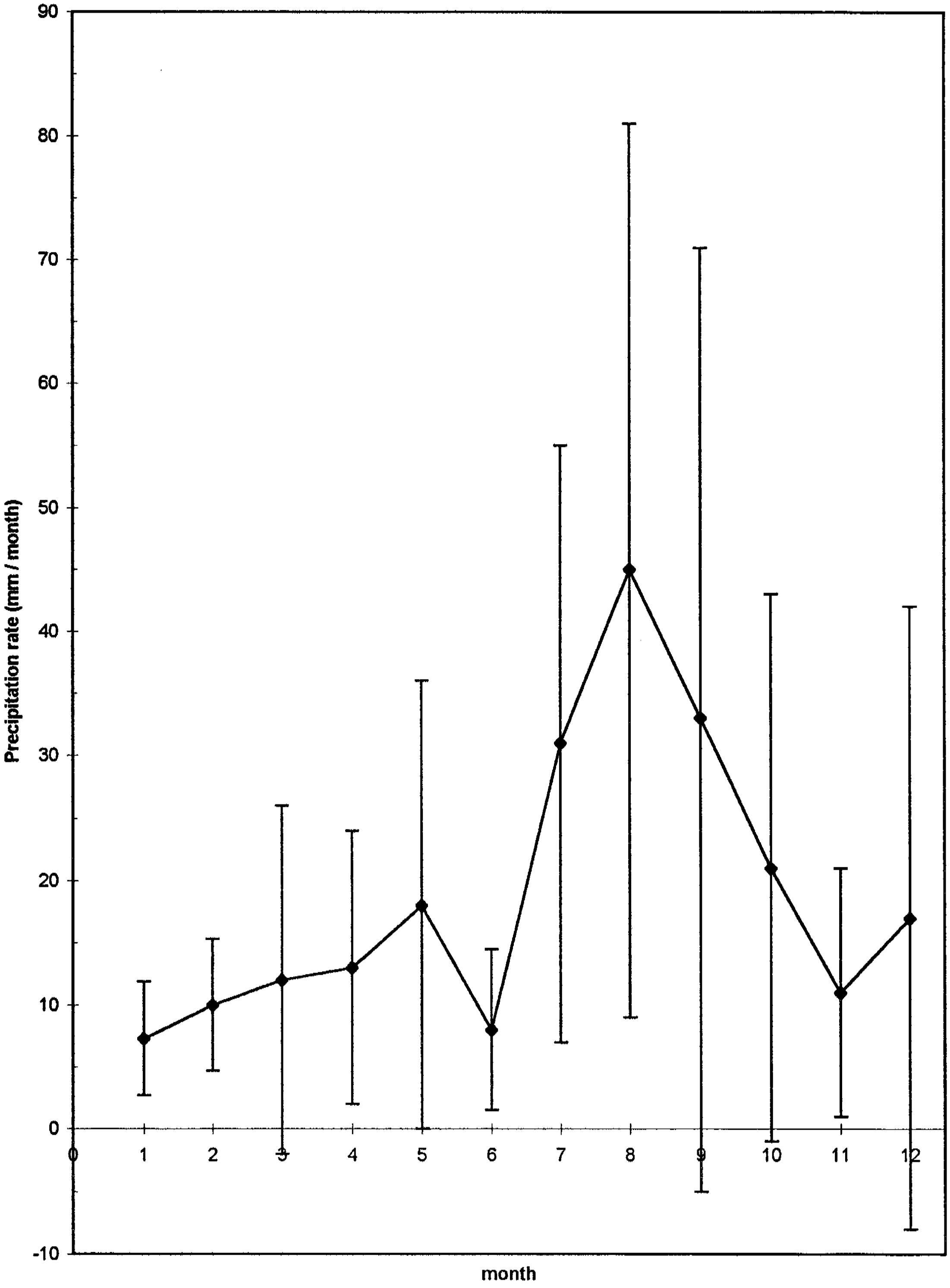


Figure 4.4.a Correlation of means and standard deviations of monthly chloride deposition rates.
Standard deviation increases as mean increases.

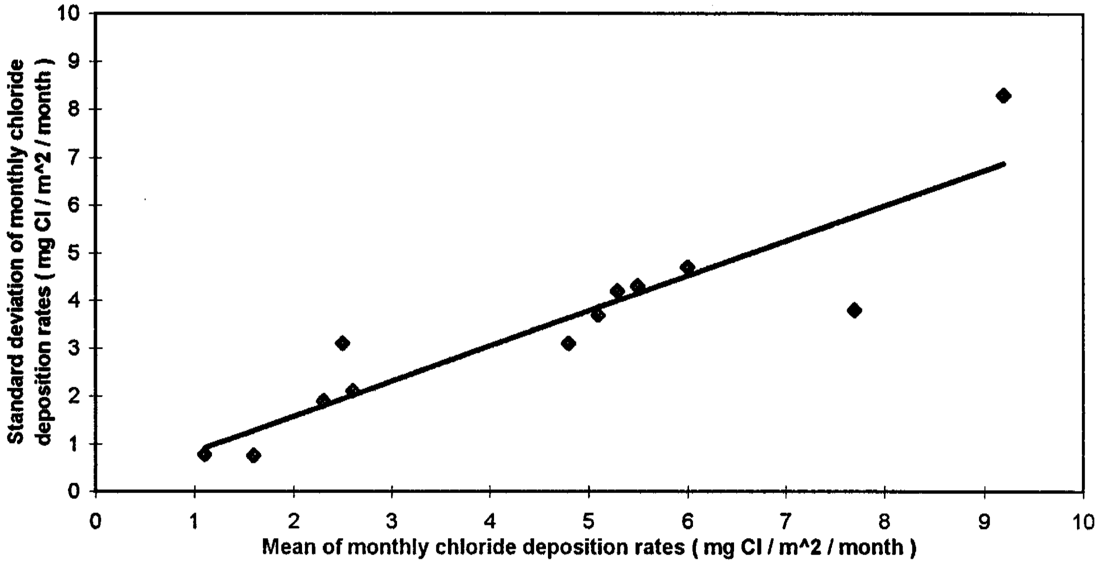
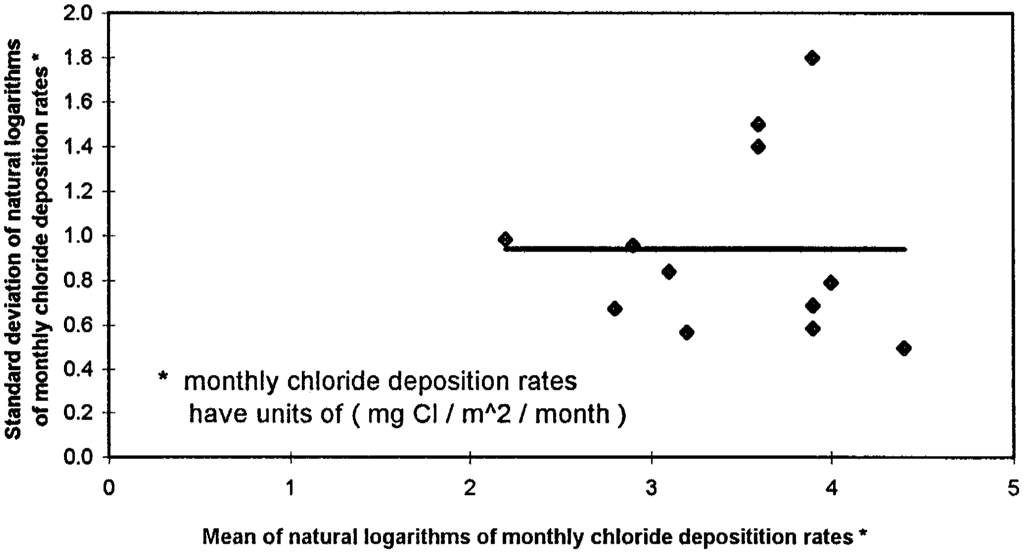


Figure 4.4b Correlation of means and standard deviations of natural logarithms of monthly chloride deposition rates.
Standard deviation does not increase as mean increases.



* monthly chloride deposition rates have units of (mg Cl / m^2 / month)

Figure 4.5a Correlation of means and standard deviations of monthly precipitation rates.
Standard deviation increases and mean increases.

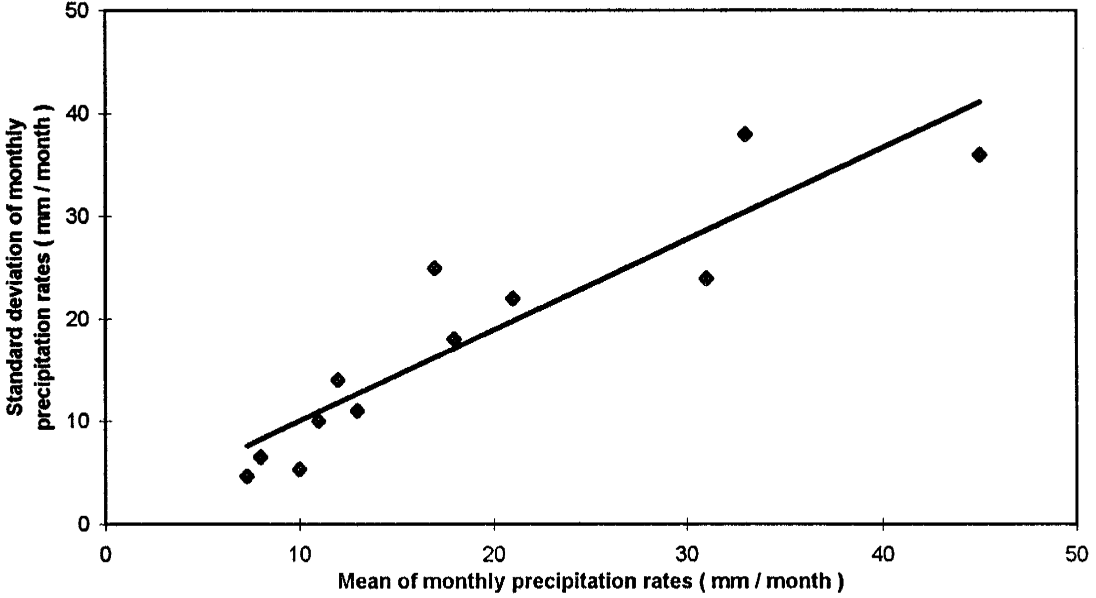
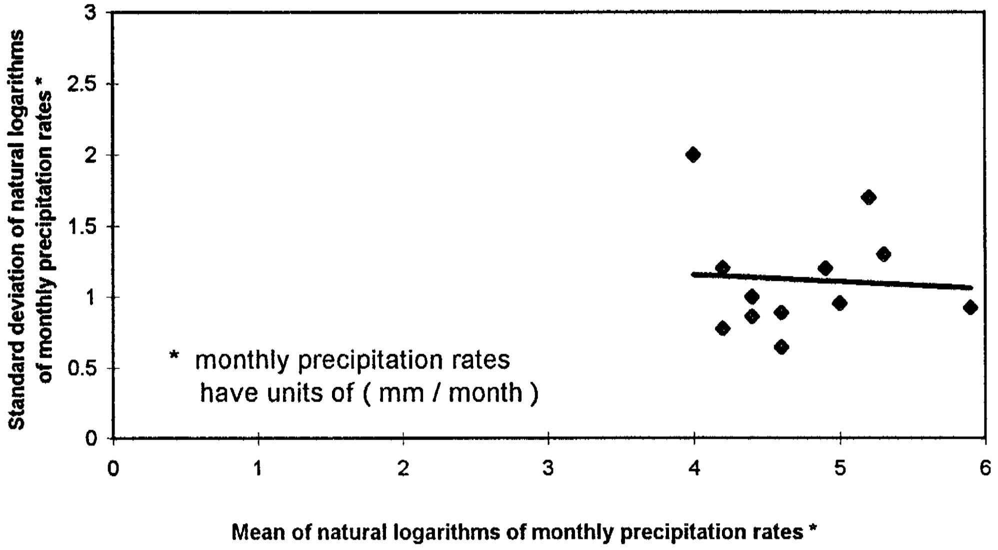


Figure 4.5b Correlation of means and standard deviations of natural logarithms of monthly precipitation rates.
Standard deviation does not increase as mean increases.



4.2 Calculation of chloride deposition rates to columns

4.2.1 Masses of chloride in columns

At the time of this writing, columns have been extracted monthly for six months, according to the sampling schedule in Appendix B.1. These columns include the control column extracted on the day the columns were emplaced, and two columns extracted on the third month. Figures 4.6.1 to 4.6.8 show the measured chloride concentration profiles and gravimetric water content profiles for each column, as calculated in Appendix B.5. The chloride concentration scale, in terms of nanograms Cl / gram dry sand, is at the bottom of each plot. The gravimetric water content scale is at the top of each plot.

The profiles indicate that the sand used to pack the columns contained detectable amounts of residual chloride that was not removed during the leaching process. Most of the profiles show an increase in chloride concentration due to deposition in the upper intervals and a uniform background concentration due to residual chloride in the lower intervals, below the depths of infiltration indicated by the water content profiles. Because the measured concentrations include both deposited chloride and residual chloride, using the measured concentrations to calculate the chloride deposition rates would result in overestimated rates.

I made corrections to determine what portion of the measured mass of chloride in each column is due to deposition. The mass of chloride in a column due to deposition is found by subtracting the mass of residual chloride from the total measured mass of chloride. The mass of residual chloride is determined by multiplying the total mass of sand in a column by the average background concentration, which can be determined where portions of the initial chloride profiles remain unchanged by infiltration. Calculations of the corrections are shown in Appendix B.6. Table 4.3 lists the measured masses of chloride in the columns and the masses of chloride in the columns due to deposition, as determined using the correction method. The columns extracted on March 3, 1997, and on April 30, 1997, are not amenable to this correction method because water infiltrated throughout the columns, redistributing the chloride so that initial background concentrations cannot be distinguished. The corrected masses are used in Appendix B.7 to calculate the chloride deposition rates to the columns. Deposition rates for all collectors are tabulated in Table 4.4 in section 4.3.

TABLE 4.3 Measured masses, background masses, and corrected masses of chloride in columns

time span of collection (months)	column location (row #, position #)	measured mass of chloride after column extraction (mg)	mass of background chloride (mg)	corrected mass of chloride deposited in time span of collection (mg)
0	(1 , 3)	0.137	0.137	0.00
1	(1 , 4)	0.415	0.376	0.039
2	(1 , 5)	0.137	0.104	0.033
3	(1 , 6)	0.393	0.331	0.062
3	(1 , 7)	0.120	0.077	0.043
4	(1 , 8)	0.297	NA	NA
5	(2 , 1)	0.715	0.685	0.030
6	(2 , 2)	0.274	NA	NA

Figure 4.6.1

Column extracted on November 2, 1996

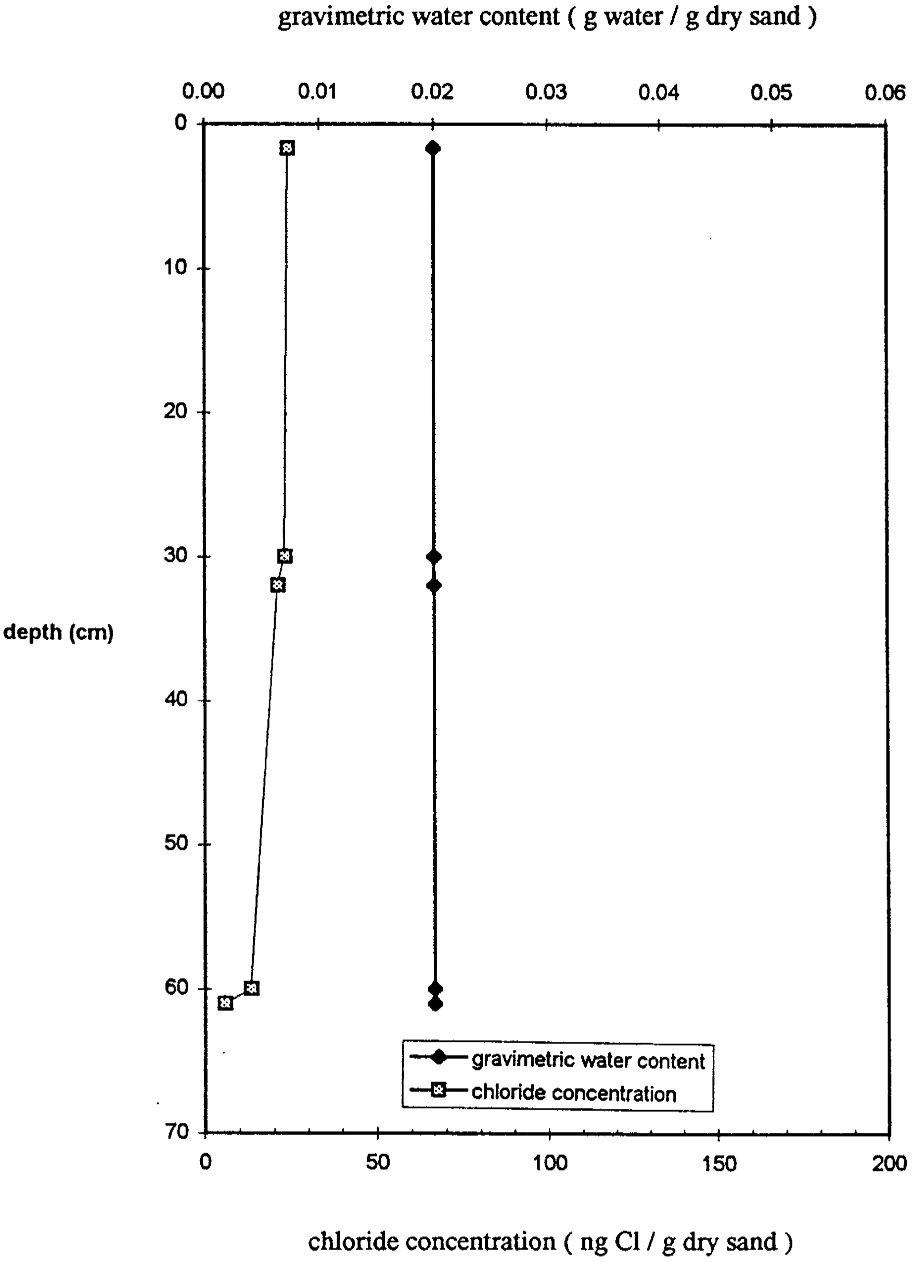


Figure 4.6.2

Column extracted on December 22, 1996

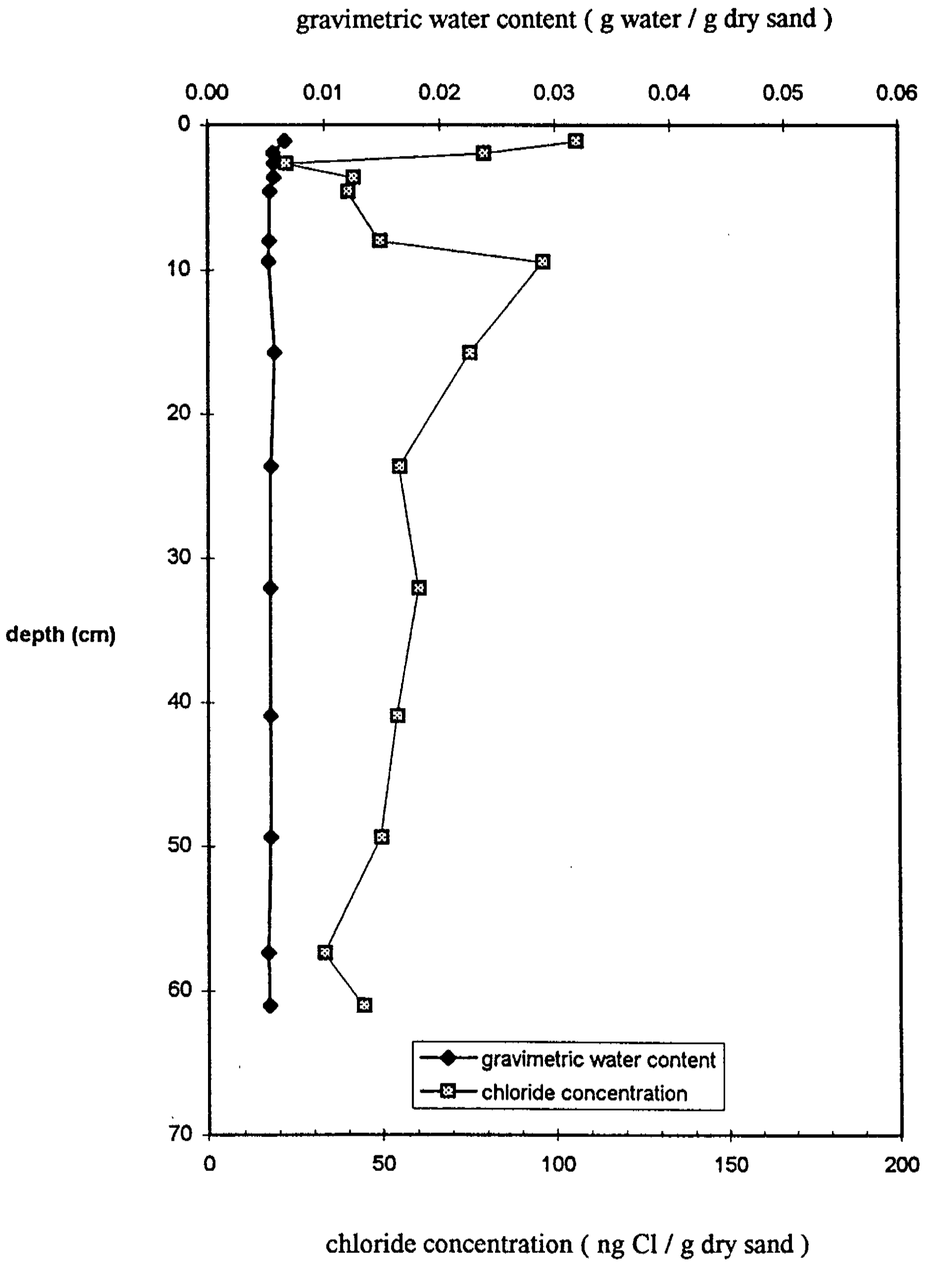


Figure 4.6.3

Column extracted on December 31, 1996

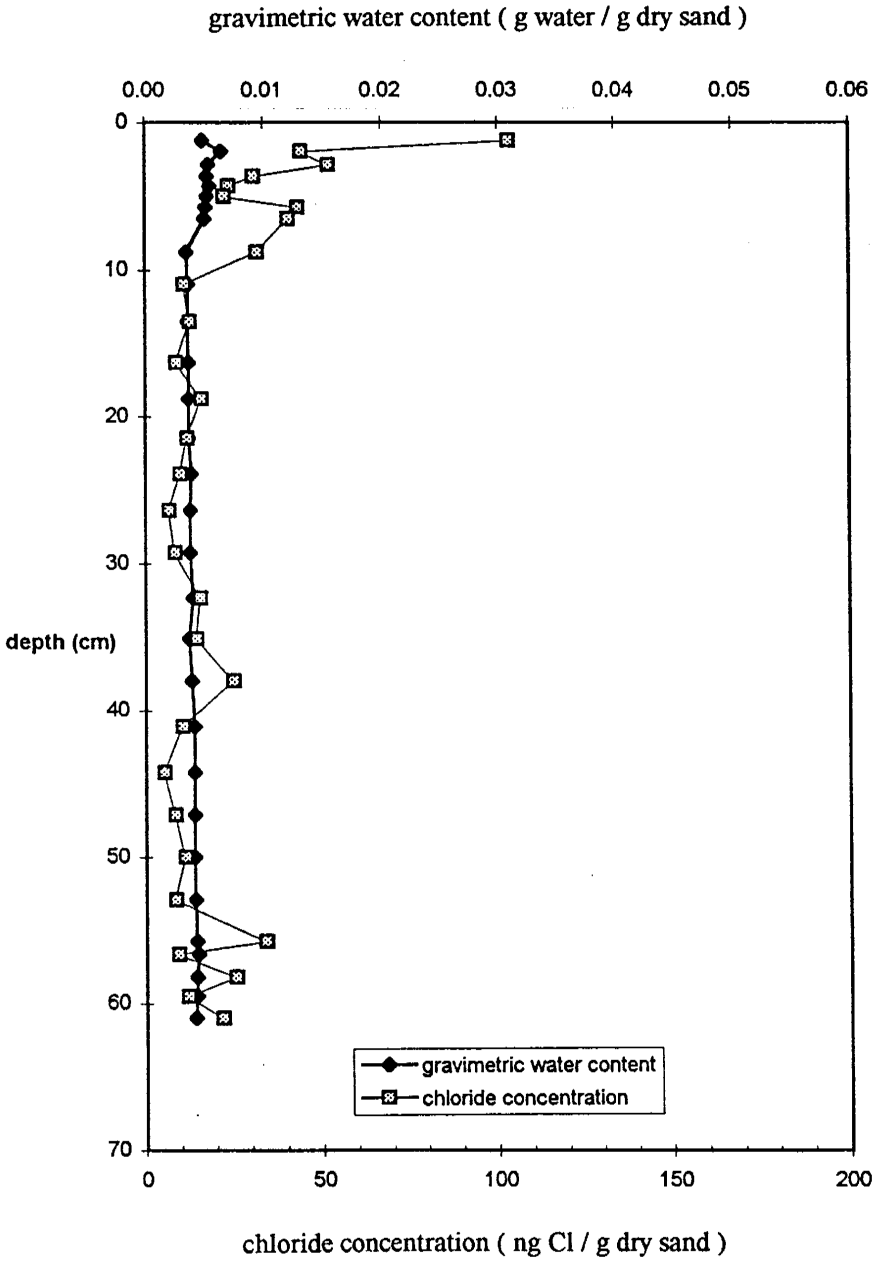


Figure 4.6.4

Column extracted on January 31, 1997,from position 6 of row 1

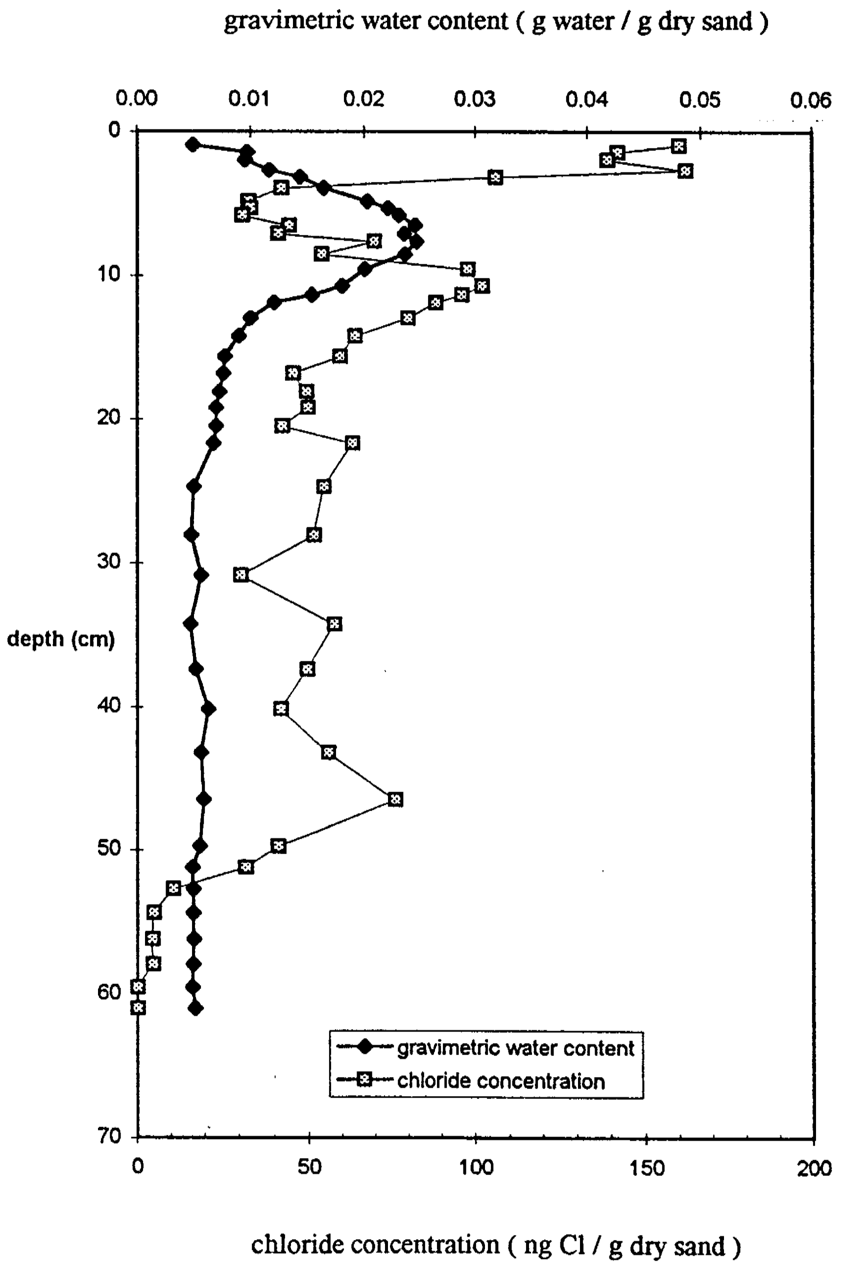


Figure 4.6.5

Column extracted on January 31, 1997, from position 7 of row 1

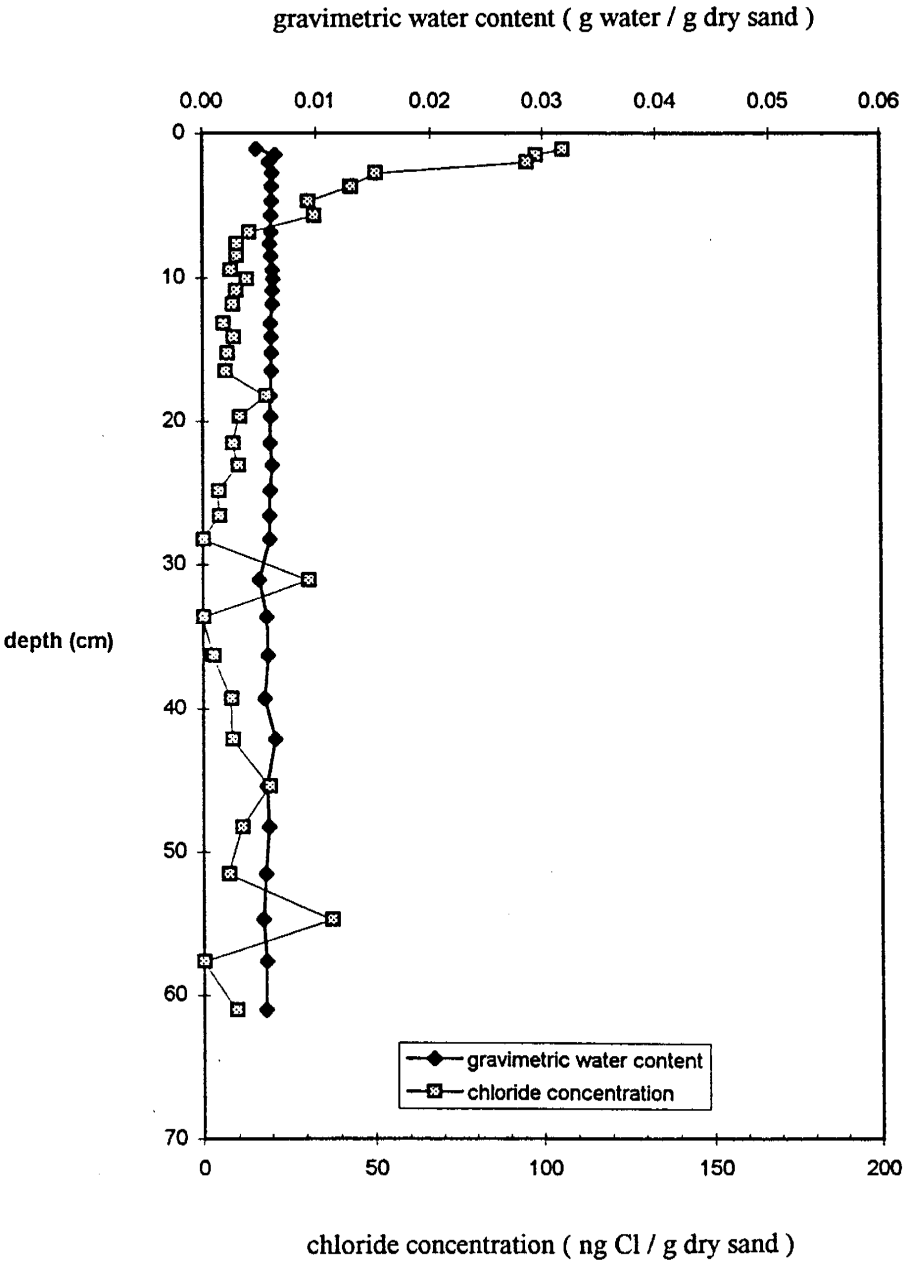


Figure 4.6.6

Column extracted on March 3, 1997

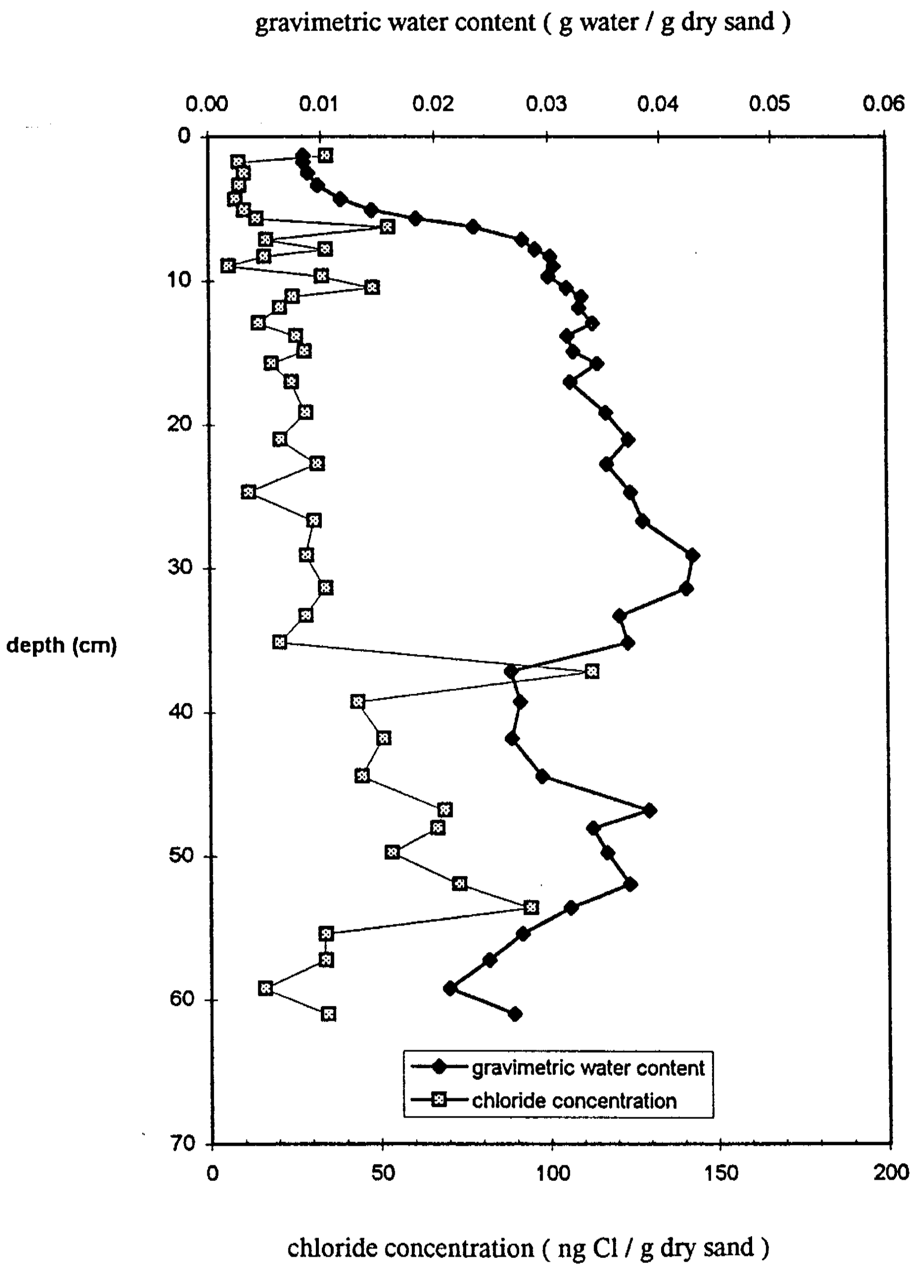


Figure 4.6.7

Column extracted on April 1, 1997

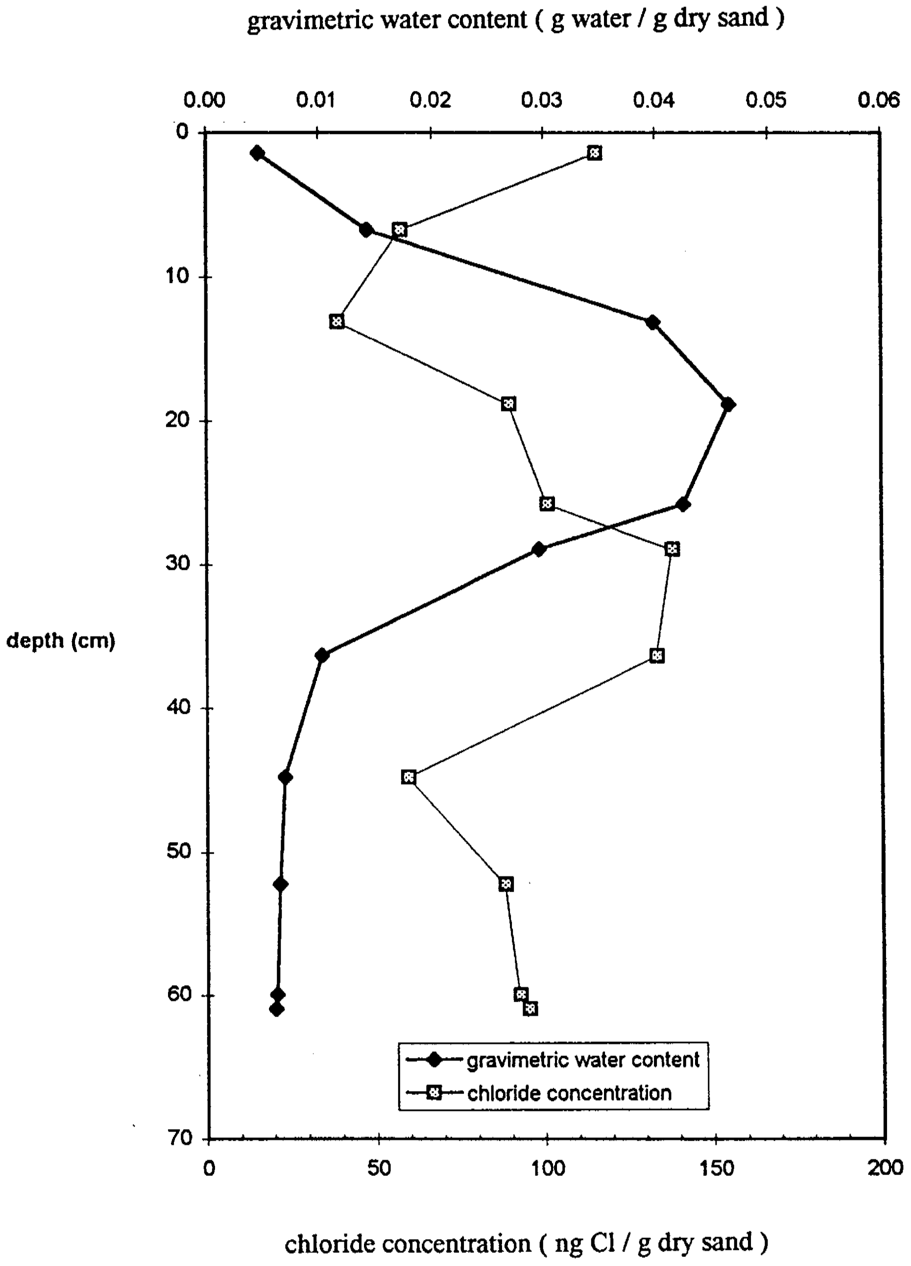
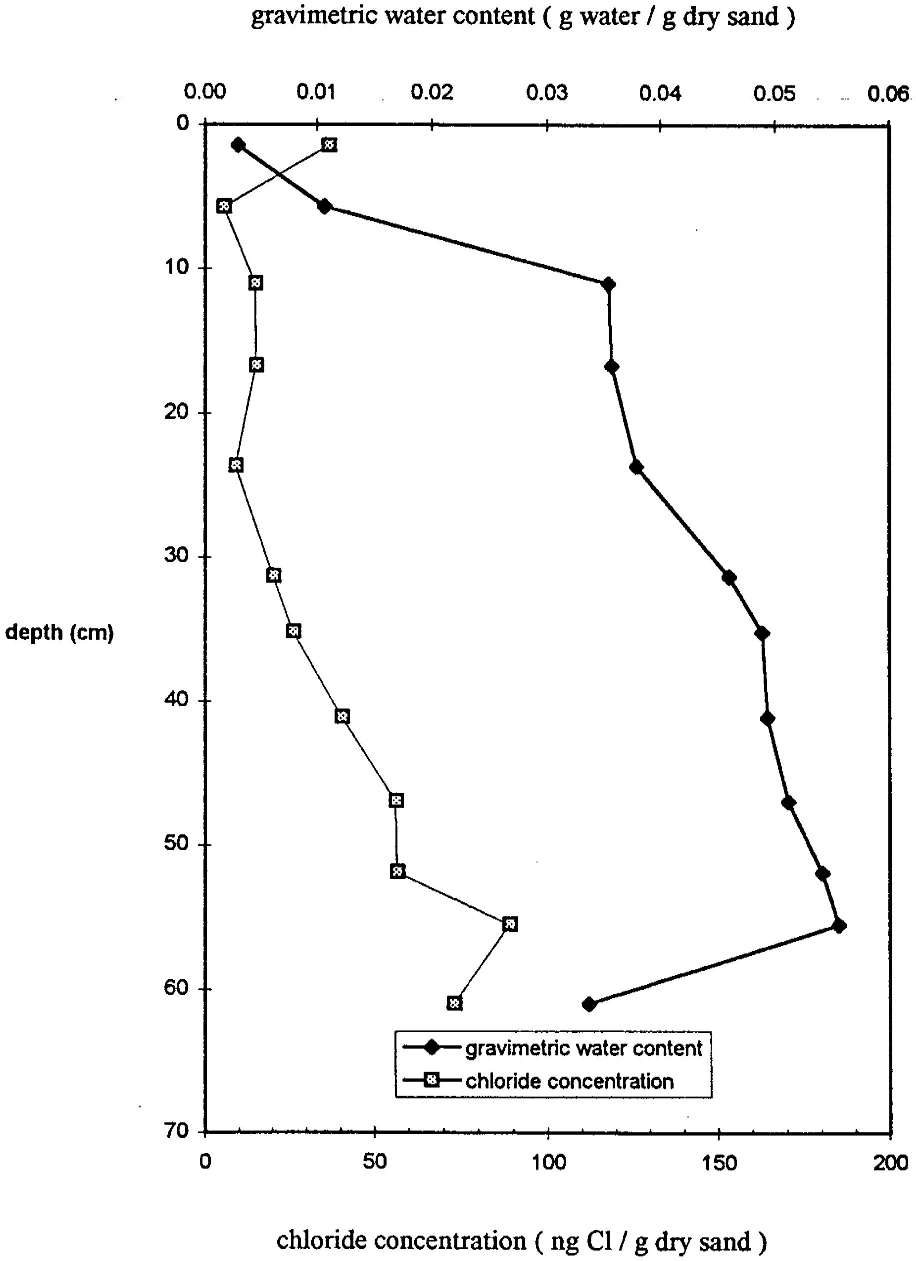


Figure 4.6.8

Column extracted on April 30, 1997



4.2.2 Characterization of local sand

If sand from the land surface within the experimental plot is transported by wind to the columns and accumulates to a depth of 1 mm, then the mass of chloride that could be introduced to a column is estimated as

$$(\text{mg Cl}) = (1\ \text{mm sand}) \times \left(\frac{\text{mass of dry sand}}{\text{depth of sand}}\right) \times \left(\frac{\text{mg Cl}}{\text{g dry sand}}\right)$$

where

$$\left(\frac{\text{mass of dry sand}}{\text{depth of sand}}\right) = \left(\frac{\text{mass of dry sand in column extracted at t} = 1\,\text{month}}{\text{depth of sand in column}}\right)$$

$$= \left(\frac{7630\ \text{g dry sand}}{61\ \text{cm sand}}\right)$$

$$= \left(\frac{12.5\ \text{g dry sand}}{\text{mm sand}}\right)$$

and

$$\left(\frac{\text{mg Cl}}{\text{g dry sand}}\right) = \left(\frac{0.000362\ \text{mg Cl}}{\text{g dry sand}}\right)$$, as calculated in Appendix B.5.2.1.

Then the mass of chloride = 0.00452 mg Cl. This is approximately one order of magnitude smaller than the masses of chloride deposited in the first five months, which are shown in Table 4.3.

4.3 Comparison of deposition rates indicated by different types of collectors

Table 4.4 lists the chloride deposition rates calculated for each collector in Appendices B, C, and D. In addition to the rates indicated by the monthly samples, Table 4.4 includes rates calculated as running averages for the bulk precipitation collector. These are calculated by averaging the monthly rates with each previous monthly rate, starting at the time when monitoring began with the columns, so the running average is mathematically analogous to rates determined for the columns. The precipitation data used in this section is for the sample dates coinciding with the sample dates of the other collectors. The data in Table 4.4 is graphed below in three separate figures.

Figure 4.7 compares the monthly chloride deposition rates determined with the bulk precipitation collector to the sum of those determined with the wet-only and dry-only precipitation collectors. Because the collectors indicate similar rates, I use only the rate determined with the bulk collector for comparison to the rates determined with the other collectors. The monthly chloride deposition rates determined with the dust collector are compared in Figure 4.8 to monthly rates determined with the bulk precipitation collector for corresponding dates. Deposition rates determined with the dust collector can be compared directly to rates determined with the precipitation collectors, because both are calculated on a monthly basis. Deposition rates determined with the dust collector can not be compared directly to rates determined with the columns because the dust collector was constructed two months after the columns, and calculations for the columns use the cumulative masses of chloride deposited since November 2, 1996. Figure 4.9 compares the chloride deposition rates determined with the columns to the chloride deposition rates determined with the bulk precipitation collector by averaging with each previous rate.

TABLE 4.4 Chloride deposition rates for all collectors

collector	date of sample collection	time span of collection (months)	chloride deposition rate (mg Cl m^{-2} yr^{-1})	chloride deposition rate (mg Cl m^{-2} $month^{-1}$)
column	12/2/96	1	58.6	4.88
column	12/31/96	2	25.2	2.10
column	1/31/97	3	31.0	2.58
column	1/31/97	3	21.5	1.79
column	3/3/97	4	NA	NA
column	4/1/97	5	9.0	0.8
column	4/30/97	6	NA	NA
average column		5	29.1	2.42
bulk precipitation	12/2/96	1	20	1.7
bulk precipitation	12/31/96	1	11	0.9
bulk precipitation	1/31/97	1	11	0.9
bulk precipitation	3/3/97	1	32	2.7
bulk precipitation	4/1/97	1	46	3.8
bulk precipitation	4/30/97	1	146	12.2
average bulk precip.		6	44	3.7
bulk precip., running ave.	12/2/96	1	20	1.7
bulk precip., running ave.	12/31/96	2	16	1.3
bulk precip., running ave.	1/31/97	3	14	1.2
bulk precip., running ave.	3/3/97	4	19	1.5
bulk precip., running ave.	4/1/97	5	24	2.0
bulk precip., running ave.	4/30/97	6	44	3.7
wet + dry precip.	12/2/96	1	6.8	0.57
wet + dry precip.	12/31/96	1	11	0.94
wet + dry precip.	1/31/97	1	19	1.6
wet + dry precip.	3/3/97	1	23	1.9
wet + dry precip.	4/1/97	1	41	3.4
wet + dry precip.	4/30/97	1	135	11.3
average wet + dry		6	39	3.3
dust collector	1/31/97	1	25.5	2.13
dust collector	3/3/97	1	66.0	5.50
dust collector	4/1/97	1	119	9.92
dust collector	4/30/97	1	233	19.4
average dust		4	111	9.24

FIGURE 4.7 Comparison of chloride deposition rates determined with different precipitation collectors

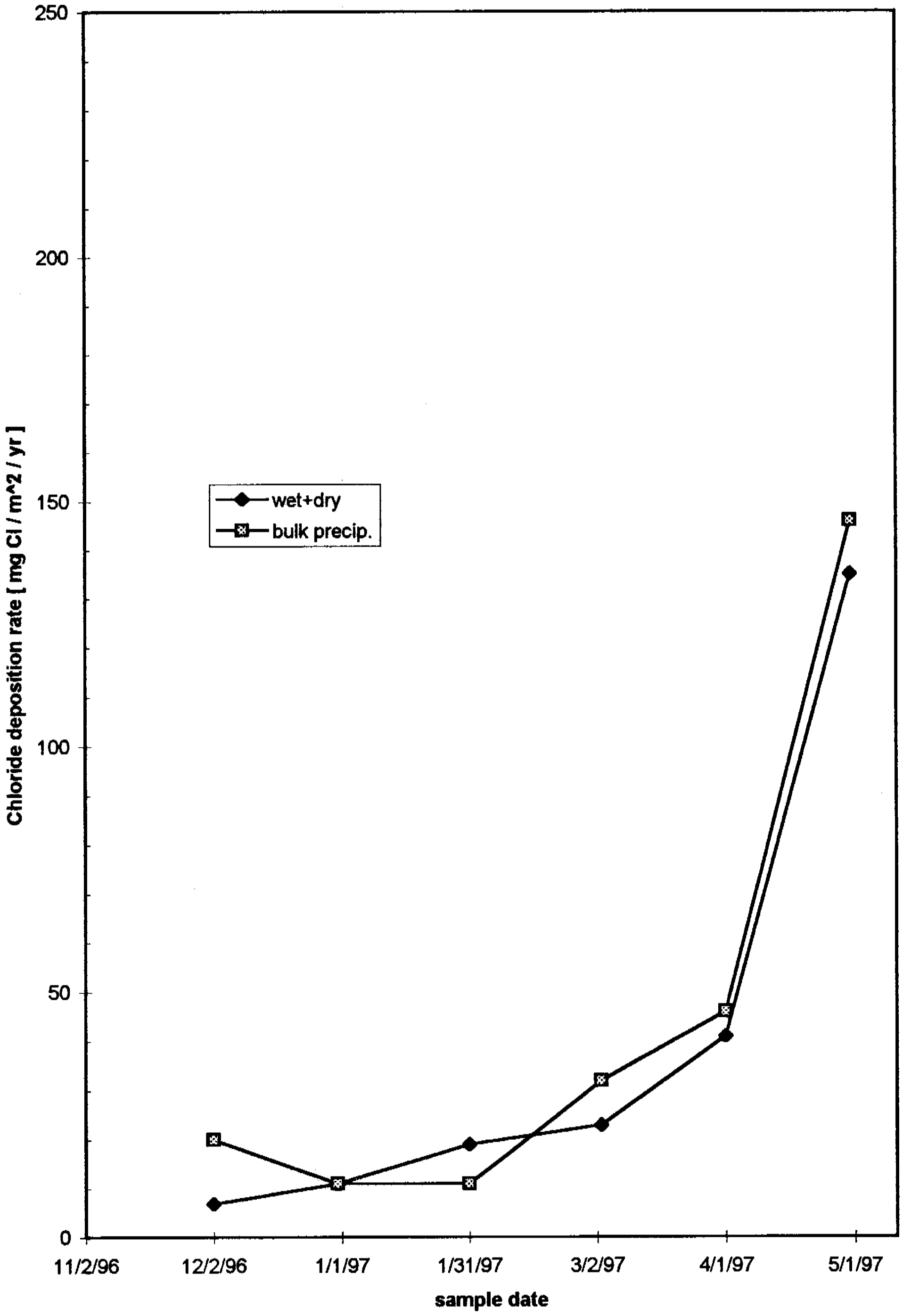


FIGURE 4.8 Comparison of monthly chloride deposition rates determined with dust collector and bulk precipitation collector

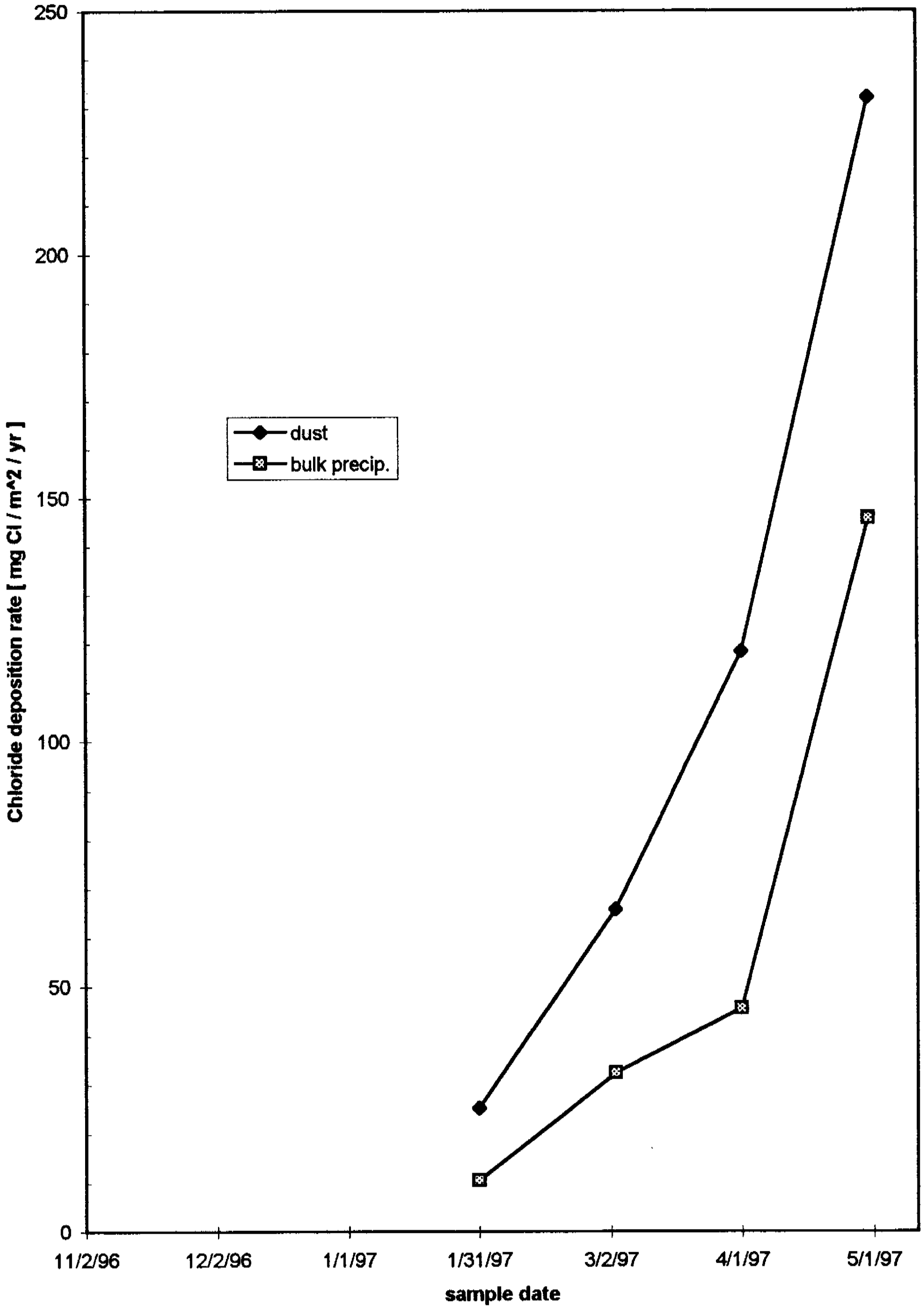
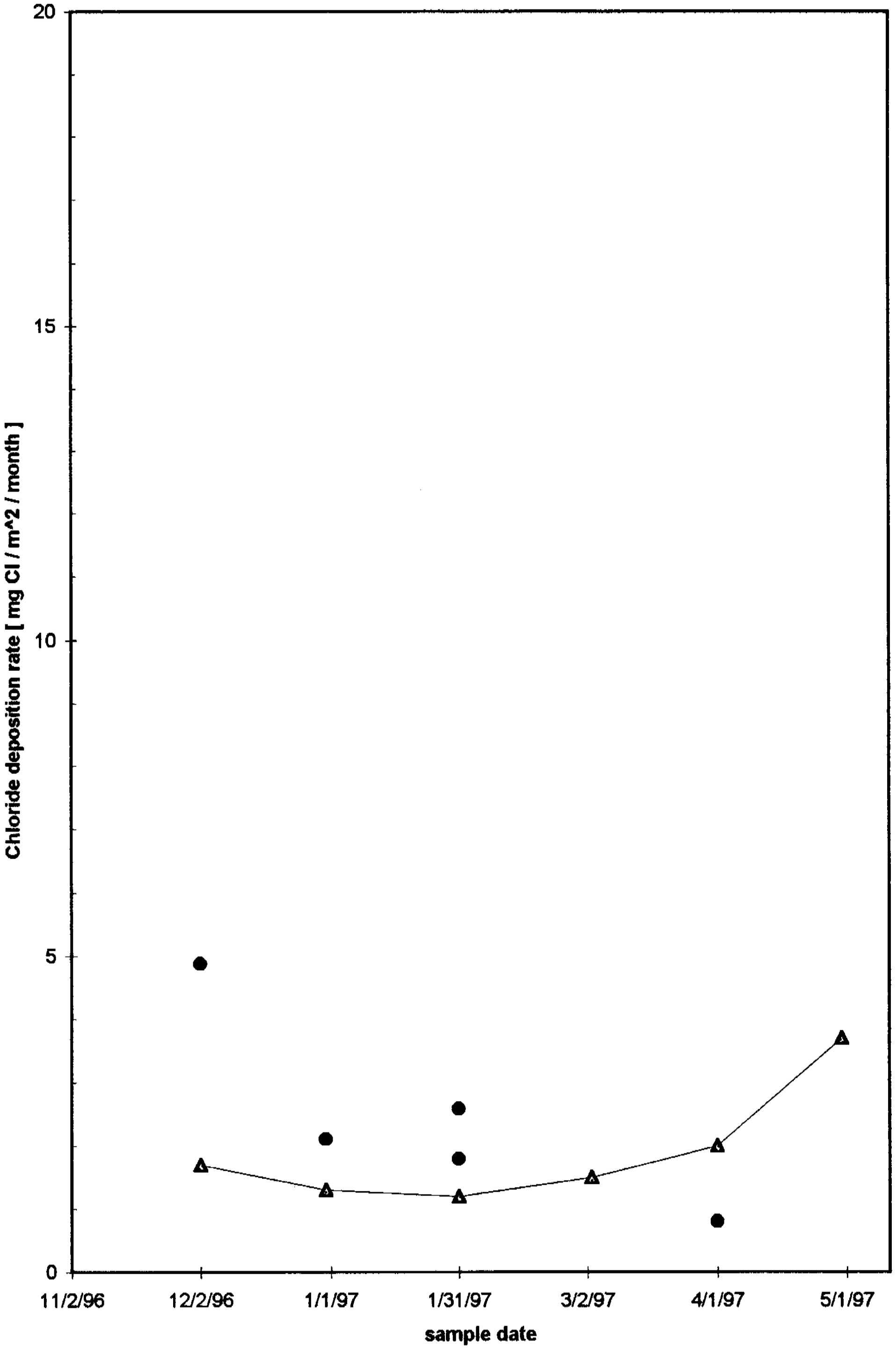


FIGURE 4.9 Comparison of chloride deposition rates determined with columns and bulk precipitation collector



5 Discussion

5.1 Research Goals

At this time, I have collected and analyzed samples for the first 6 months. The project is to be continued by another student using the same or similar methods. Of the three research goals stated previously, this early data is applicable mainly to the first goal, which is estimation of the deposition rate of atmospheric chloride to the land surface. The second and third goals will require chloride and bromide data for a longer monitoring time.

The third goal, which is to distinguish between wet and dry components of deposition, is not yet addressed for the columns, but can be partially addressed by comparing the chloride deposition rates in the wet-only and dry-only collectors. Because the deposition rates determined with the precipitation collectors are not well correlated with deposition rates determined with the columns, I have no basis for separation of the wet and dry components of deposition to the columns. Future analysis for bromide may help distinguish wet and dry components of deposition to the columns if different Cl:Br ratios can be distinguished for the different collectors. Comparison of the rates determined with the dust collector and precipitation collectors may also help with separation of the wet and dry components

5.2 Comparison of deposition rates determined with different collectors

The long-term record shows that there are seasonal trends in the chloride deposition rate and precipitation rate. As shown in Figures 4.2 and 4.3, the monthly rates can be expected to increase from January through July or August, then to decrease through January. Based on this trend , I expect the rates determined with all of the collectors to follow a similar trend during the six months that my monitoring project has existed.

The patterns of monthly rates determined with the bulk precipitation collector since I began monitoring has been similar to the historical pattern. All samples except two indicated chloride deposition rates within one standard deviation of the respective monthly mean rates. The sample taken on March 3, 1997, which was collected primarily in February, showed a chloride deposition rate of 1.4 standard deviations above the mean for February. The sample taken on April 30, 1997, showed a chloride deposition rate of 1.6 standard deviations above the mean for April.

The chloride deposition rates determined with the dust collector show an increasing trend, as expected for the months when the samples were taken. However, the magnitudes of these rates were higher than expected. The chloride deposition rates determined with the dust collector are greater than those determined with the bulk precipitation collector by factors of 1.6 to 2.6, as shown in Figure 4.8. This could be due to differences in collector designs. The dust collector probably retains solids better than the smooth, plastic funnels of the precipitation collectors, which may lose solids to the wind. Cl:Br ratios may be used to help determine whether or not this is true. The fact that the deposition rates are nearly proportional and are calculated with results from different chromatographs suggests the possibility that the HPLC and IC results are not comparable. Agreement of HPLC and IC results could be further investigated by exchanging more standards.

Figure 4.9 shows that the chloride deposition rates determined with the columns and with the bulk precipitation collector have similar ranges of magnitude. The average rate determined with the columns was 29.1 mg Cl m^{-2} yr^{-1}. The average rate determined with the bulk precipitation collector for the analogous timespan, from November 2, 1996, to April 1, 1997, was 23.9 mg Cl m^{-2} yr^{-1}. Due to the variability and the limited amount of data for the columns, it is difficult to tell how well the two collectors are correlated over a range of sampling times. The rates determined with the columns ranged from 38 percent to 299 percent of the rates determined with the bulk precipitation collector for the analogous timespans. Both columns extracted on January 31, 1997, differed in chloride content and water content, indicating that the influxes of both chloride and water were nonhomogeneous. The importance of this variability will not be known until more data is collected.

5.3 Factors affecting chloride deposition rate calculations for columns

The accuracy of the calculations of chloride deposition rates for the columns depends on several factors. The validity of the corrections that I made to account for residual chloride in the sand is probably the main factor affecting the rates calculated at this time. Analytical error could be a factor for the samples that I have taken, especially for the lower concentrations. As the total mass of chloride increases in the columns, analytical error should be less for future samples. Various sources of contamination and variability of infiltration are factors that could be more relevant to future calculations.

I made corrections to account for the masses of residual chloride in five of the columns based on background concentrations that I estimated using the profiles of measured concentrations. To assess the validity of the correction method, I compared the estimated background concentrations used in the five corrections to concentrations in two sets of samples of pre-leached, dried sand that were not subject to infiltration. One set consists of the six samples of dried sand that I analyzed before packing the columns, as described in Appendix B.3.2. The other set consists of the three samples taken from the control column extracted on the day the columns were emplaced. The concentrations, in terms of mg Cl / g sand, are tabulated in Table 5.1, which includes the means and standard deviations of the concentrations in each set. The mean estimated background concentration is higher than the means of the concentrations in the other two sets, but the concentrations vary over a similar range, which indicates that the estimated background concentrations used in the correction method are similar to concentrations in the samples of sand that were not subject to infiltration. This similarity supports the validity of the correction method for the samples which I used. For samples in the near future, the correction method may not be valid if the residual chloride in the columns is redistributed by infiltrating water and the initial background concentration profiles are not distinguishable. This was the case for the columns extracted on March 3, 1997, and April 30, 1997. As the total monitoring time increases, trends may emerge that allow other methods of interpretation to be applied. At later times, the amount of residual chloride will be insignificant relative to the amount of deposited chloride, so corrections may not be necessary.

TABLE 5.1 Comparison of estimated and measured residual chloride concentrations

estimate or sample	chloride concentration (mg Cl / g sand)
background in column from row 1, position 4	4.92E-05
background in column from row 1, position 5	1.40E-05
background in column from row 1, position 6	4.98E-05
background in column from row 1, position 7	1.10E-05
background in column from row 2, position 1	9.23E-06
mean	2.66E-05
standard deviation	2.09E-05
leachate of dried sand 1	7.80E-06
leachate of dried sand 2	1.68E-05
leachate of dried sand 3	1.53E-05
leachate of dried sand 4	6.90E-06
leachate of dried sand 5	4.05E-05
leachate of dried sand 6	1.96E-05
mean	1.78E-05
standard deviation	1.22E-05
control column, interval 1	2.40E-05
control column, interval 3	2.19E-05
control column, interval 5	5.80E-06
mean	1.72E-05
standard deviation	9.96E-06

The calculations of the mass of chloride in each column is subject to additive analytical error of HPLC results. The total mass of chloride in each column is the sum of the masses of chloride in each depth interval, many of which were based on measurements of concentrations near the detection limit of the HPLC. The columns were divided into different numbers of intervals, ranging from 11 to 43. Because leachates were made with approximately a 1:1 ratio of mass of water to mass of sand, the solid phase concentration (ng Cl / g dry sand) shown in the depth profiles in Figures 4.4.1 through 4.4.8 can be approximately converted to liquid phase concentration (mg Cl / L) by dividing by 1000. The certainty of HPLC results is highest for chloride concentrations above 0.04 mg/L. Many sample concentrations were below 0.04 mg/L and it is possible that many of them were overestimates.

Additive error for concentrations greater than 0.04 mg/L is also a possibility, although I think that it is less likely because a logical relation is evident between the chloride and water content profiles. This relation can be seen in the columns that have water content profiles that increase then decrease with depth. After the sand below the surface becomes wetted by precipitation, some water moves back up due to evaporation and some water moves down due to gravity and a matric potential gradient. As water is removed in both directions, chloride is also removed, resulting in a depression in the chloride concentration profile at the depth of the water bulge. The fact that this low point is distinguishable in several columns suggests that the chromatography is accurate.

The limiting factor of the detection limit of the HPLC was sinusoidal noise in the baseline with the same frequency as the pump pistons. Installation of a noise filter in the pump could remedy this. It may also be possible to use an extra chromatograph column between the pump and the injector to allow pressure fluctuations to dissipate so the mobile phase has a constant velocity.

Deposition of horizontally transported eolian material may contribute chloride to the columns. The mass of chloride that I estimated for a hypothetical influx of chloride from eolian sources is 0.00452 mg. This is an order of magnitude less than the masses of chloride deposited in the columns in the first five months, and I did not observe accumulation of native sand above the columns, so I consider contamination from eolian material to be zero for the columns that I extracted in the first five months of monitoring. If there is accumulation of eolian material above columns extracted in the future, it may be observed visually. Future analysis for bromide may help quantify this better. Chloride may also be lost from the columns to the wind, which may account for some of the variability in masses of chloride in the columns.

Biological activities, including deposition of waste and movement of native sand, could introduce chloride to the columns. Chloride may also enter the columns by solute transport. Even with no surface runoff, dissolved chloride may enter the collection areas of the columns horizontally. When the land surface is wetted, dissolved chloride may diffuse laterally from the native sand to the leached sand without advection. If solute transport is contaminating the columns, then it may level off in time.

6 Conclusions

The long-term record for the LTER precipitation collectors provides a useful background for comparing the deposition rates for the new collectors. Chloride deposition rates indicated by the precipitation collectors during my monitoring project were slightly higher than expected based on the long-term records.

The chloride deposition rates determined with the columns were similar in magnitude to those of the precipitation collectors, although variability was higher for the columns. The average chloride deposition rate determined with the columns was 29.1 mg Cl m^{-2} yr^{-1}. The average rate determined with the bulk precipitation collector for the analogous timespan was 23.9 mg Cl m^{-2} yr^{-1}.

The dust collector indicated the highest chloride deposition rates, which averaged 110.5 mg Cl m^{-2} yr^{-1} for January through April of 1997. The average rate for these months in the long-term precipitation records is 32 mg Cl m^{-2} yr^{-1}. Differences in collector designs and in analytical methods are possible explanations for the discrepancy.

The total monitoring time of this project will be about five years. The data that I have collected for the first six months is not enough to make conclusions about the magnitude of the chloride deposition rate. More data will be required to identify trends in deposition, to assess the variability of measurements for each collector, and to evaluate correlations between collectors.

7 Acknowledgments

I would like to thank my advisors, Dr. Fred Phillips, Dr. Robert Bowman, and Dr. Jan Hendrickx for giving me the opportunity to do this project. I would also like to thank and Doug Moore of the UNM Biology Department for his assistance with data collection and for sharing the resources of the Long Term Ecological Research Program. I would also like to thank Theodore Stans, the manager of the Sevilleta National Wildlife Refuge, for providing access to the site, and for his attention to security and safety.

8 References

Bowman, R.S. 1984. Analysis of Soil Extracts for Inorganic and Organic Tracer Anions via High-Performance Liquid Chromatography. Journal of Chromatography. 285. pages 467-477.

Knowlton, R. G., Jr., A.M. Parsons, and K.N. Gaithers. 1992. "Techniques for Quantifying the Recharge Rate Through Unsaturated Soils," Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118. David M. Nielsen and Martin N. Sara, Eds. American Society for Testing and Materials. Philadelphia.

Lerner, D., A. Isaar, and I. Simmers. 1990. Groundwater Recharge , A Guide to Understanding and Estimating Natural Recharge. Heise. Hannover. pages 4-5.

Manahan, S.E. 1994. Environmental Chemistry 6th edition. Lewis Publishers. Ann Arbor. pages 305-313.

Moore, D. 1997. http://sevilleta.unm.edu/overview/gen-meteor.html

Phillips, F.M. 1994. Environmental Tracers for Water Movement in Desert Soils of the American Southwest. Soil Science Society of America Journal. Vol. 58. No. 1. pages 15-24.

Reheis, M.C., and R. Kihl. 1995. Dust Deposition in Southern Nevada and California, 1984-1989: Relations to Climate, Source Area, and Source Lithology. Journal of Geophysical Research. Vol. 100. No. D5. pages 8893-8918.

Snyder, R.L., and J.J. Kirkland. 1979. Introduction to Modern Liquid Chromatography. Wiley. New York. pages 86-87.

Shalaby, S.W., and P. Moy. 1988. Thermal and Related Properties of Engineering Thermoplastics, Engineering Materials Handbook. Volume 2. ASM International. Metals Park, page 447.

1: 100 000 - Scale Metric Topographic Map of Socorro, New Mexico. USGS Map 34106-A1-TM-100. 1979.

Appendix A Sevilleta National Wildlife Refuge

The Sevilleta National Wildlife Refuge administered by the U.S. Fish and Wildlife Service to be used for research purposes. Permission to access the site is granted by the Refuge Manager, who is Theodore Stans at the time of this writing. The phone number of the U.S. Fish and Wildlife Service office on the refuge is 505-864-4021. The mailing address is :

Fish and Wildlife Service
Sevilleta National Wildlife Refuge
P.O. Box 1248
Socorro, NM 87801

Directions to the monitoring site :

Drive north from Socorro on I-25.

Take the San Acacia exit, exit 163.

Drive west over I-25, then turn north onto the service road parallel to I-25.

Drive about 2.5 miles to the locked gate.

The lock combination is provided when one obtains permission to enter the Sevilleta Wildlife Refuge from the Refuge Manager.

After passing through the gate, drive north about 0.2 miles and turn west onto the dirt road, which trends northwest. A four-wheel-drive vehicle is recommended for loose sand on this road.

Drive approximately 2.3 miles on this road until the road forks.

Take the left fork.

In approximately 0.2 miles the road intersects another road, which runs north-south, and which is under a power line.

Park in the turn-off at this intersection.

Proceed about 1/4 mile west on foot on the path to the monitoring site. Vehicles are no longer allowed to be driven on this path.

The LTER meteorological station is on the south side of the path.

The experimental plot with the columns and dust collector is on the north side of the path.

Appendix B Column information

Appendix B contents :

B.1 Column sampling schedule

The column sampling schedule is shown in Table B.1. Column locations are arranged in a grid at the monitoring site and are identified by row number and position number, as shown in Figure B.1.

Table B.1 Column sampling schedule

time span of collection (months)	date of collection	number of columns	column location (row #, position #)
0	11/2/96	1	(1,3)
1	12/2/96	1	(1,4)
2	12/31/96	1	(1,5)
3	1/31/97	2	(1,6) , (1,7)
4	3/3/97	1	(1,8)
5	4/1/97	1	(2,1)
6	4/30/97	1	(2,2)
7	6/2/97	2	(2,3) , (2,4)
8	pending	1	(2,5)
9	pending	2	(2,6) , (2,7)
10	pending	1	(2,8)
11	pending	1	(3,1)
12	pending	2	(3,2) , (3,3)
15	pending	2	(3,4) , (3,5)
18	pending	2	(3,6) , (3,7)
21	pending	2	(3,8) , (4,1)
24	pending	2	(4,2) , (4,3)
27	pending	2	(4,4) , (4,5)
30	pending	2	(4,6) , (4,7)
33	pending	2	(4,8) , (5,1)
36	pending	2	(5,2) , (5,3)
to be announced	pending	5	(5,4) , (5,5) , (5,6) , (5,7) , (5,8)

archive column at end of experiment	1	(1,3)

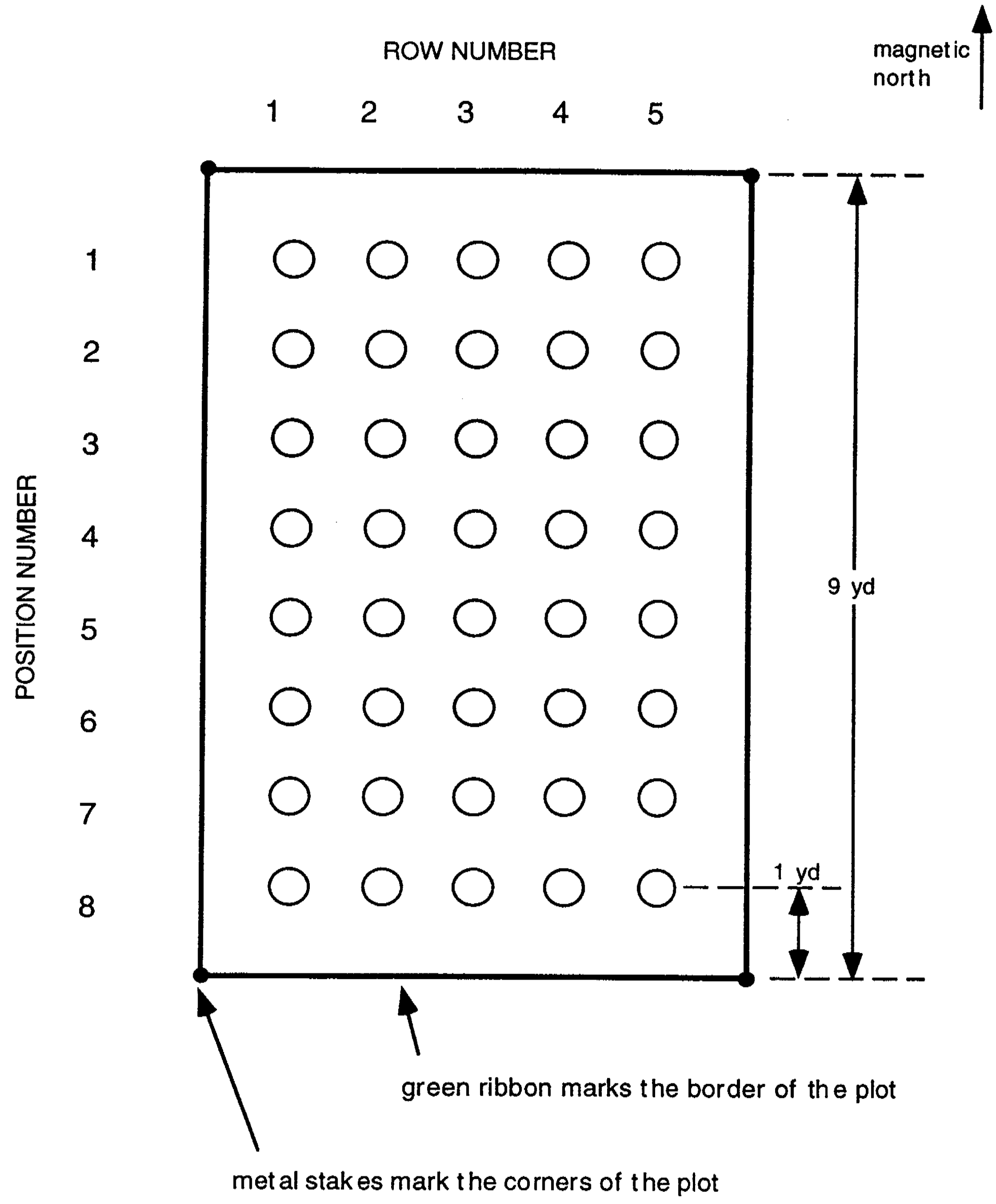


FIGURE B.1 Column locations within the experimental plot are identified by row number and position number

B.2 Preliminary design considerations

B.2.1 Suitability of analytical method

Before beginning the field work, I assessed the feasibility of quantifying monthly accumulation of chloride. To do this, I compared the sensitivity of the HPLC method used to the chloride concentration of leachate that would result from an estimated monthly accumulation.

The concentration of leachate that would result from an estimated monthly accumulation is calculated based on an earlier estimate by Dr. Fred Phillips that the chloride deposition rate is 100 mg m^{-2} yr^{-1} (personal communication with Dr. Fred Phillips). At this deposition rate, the mass of chloride that would enter a column in one month (through the surface area of 0.008107 m^2) is 0.0676 mg. The volume of water used to leach chloride from all sand in the column , using a 1:1 ratio of mass of sand to mass of water, is 7.78 L. The resulting concentration would then be (0.0676 mg Cl / 7.78 L) = 0.0087 mg / L. This is assuming all sand in the column is leached together. If the sand is sectioned into separate intervals and leached separately, the leachate from the upper intervals will likely have a chloride concentration greater than 0.0087 mg / L.

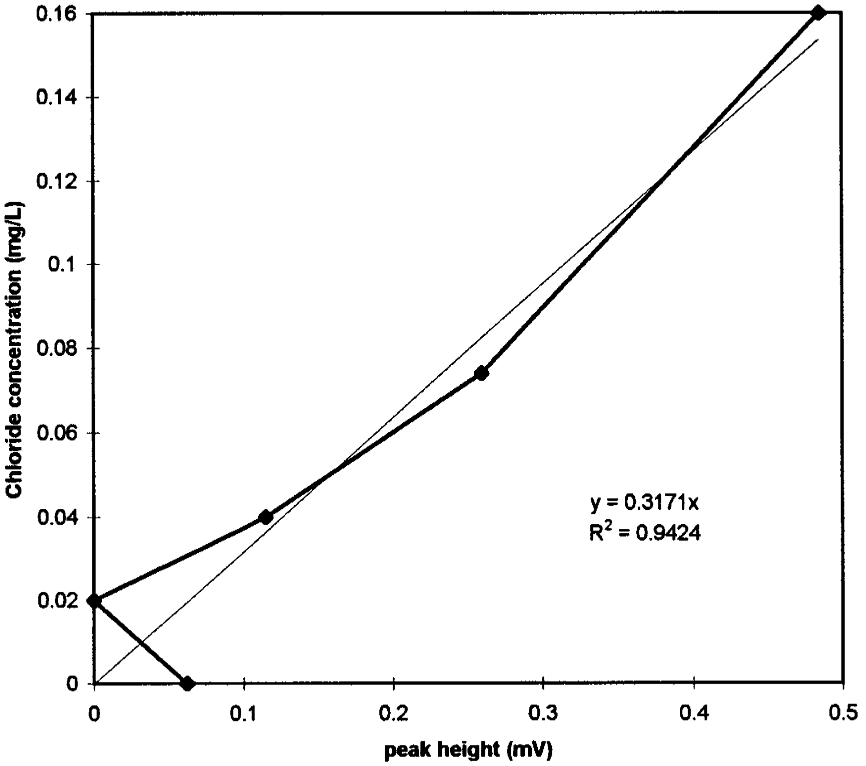
I determined the HPLC sensitivity, or detection limit, by analyzing chloride standards of decreasing concentrations until peaks could not be distinguished. I analyzed duplicates of each standard in order to check the variability in HPLC response (peak height). My interpretations of these peak heights are shown in Appendix F.5. Table B.2 shows the means and standard deviations of peak heights of the multiple injections of each standard.

The higher concentrations of this set are an order of magnitude above what is needed for the samples. The range of interest is from 0 to 0.16 mg/L. I plotted the standard curve for this range using the mean peak heights in Figure B.2. The coefficient of determination (r^2) of this standard curve shows that the response is near linear for a range of standards with concentrations as low as 0.04 ppm. I considered this to be sufficient to begin the field work.

Table B.2 Means and standard deviations of peak heights

chloride concentration (mg/L)	average of peak height (mV)	standard deviation of peak height
5.12	15.734	0.183
2.56	7.603	0.165
1.28	3.779	0.105
0.64	1.924	0.047
0.32	1.009	0.014
0.27	0.857	0.031
0.16	0.485	0.001
0.074	0.260	0.063
0.04	0.115	0.017
0.02	0.000	0.000
0	0.062	0.088

Figure B.2 Chloride standard curve used to check HPLC detection limit



B.2.2 Column material

Due to its availability, PVC (polyvinylchloride) plastic pipe was the first choice of column material. Under normal usage, PVC is usually considered inert. However, since water may pool on the plastic for years in this project, I was concerned that PVC may degrade and release chloride, so I considered ABS (acrylonitrilebutylstyrene) plastic pipe as an alternate material. To quantify the mass of chloride released per surface area of PVC and ABS, I shredded PVC and ABS plastic with a drill press, washed the shreds in detergent, rinsed the shreds several times with de-ionized water, and leached them in separate polyethylene bottles with 50 ml de-ionized water. HPLC analysis of the PVC leachate after one year showed a chloride concentration of 0.057 mg/L. There was no chloride detected in the ABS leachate. Conversion of chloride concentration and volume of leachate to mass of chloride shows that 0.00285 mg Cl were released from the unknown surface area of the PVC shreds.

I estimated the surface area of the PVC shreds by converting its mass to volume, and then converting volume to surface area. Using a density of 1.3 to 1.58 g/cm^3 (Shalaby and Moy, 1988), I converted the mass to a volume of 2 cm^3. To convert volume to surface area, I assumed the surface area of the shreds was the same as the surface area of 0.5 mm cubes. For a volume of 2 cm^3, this would be 240 cm^2 of surface area.

Then the mass of chloride released per cm^2 = [0.00285 mg Cl] / [240 cm^2]
= [0.0000119 mg Cl / cm^2]

For a 10 cm diameter , 50 cm deep column, the area of the sides is 3925 cm^2 and the area of the bottom is 78.5 cm^2. The mass of chloride released from this area would be 0.04764 mg. This indicates a potential for contamination from PVC, so I decided to use ABS plastic.

B.2.3 Minimum column depth

The columns needed to be deep enough so that if sand at the bottom the column should become saturated, capillary rise would not be sufficient to bring water directly to the surface. If capillary rise could reach the surface, it would allow a high percentage of the water to evaporate directly from the surface, leaving the chloride at the surface, where it would be more susceptible to being blown away .

To determine the capillary rise in the sand that would be used in the columns, I filled a clear plastic tube with sand and covered one end with a screen. I placed the screened end in a bucket of dyed water and observed the capillary rise of water into the sand. After three days, the approximate water table in the sand was 32.5 cm above the water level in the bucket. Based on this amount of capillary rise, I chose 60 cm (2 ft) for the depth of the columns.

B.2.4 Methods of leaching sand

B.2.4.1 Initial carbonate content

Local soils often contain carbonates, which are less soluble than chloride salts. It would be possible for a carbonate coating on sand particles to prevent soluble chloride from being removed during the pre-leaching process. This would be a problem because the carbonate could later dissolve and release chloride that was thought to be removed during the washing.

To analyze a sample of my sand supply for carbonate, I placed a sample of sand in a closed beaker equipped with a burette and manometer. I added a known volume of nitric acid through the burette. Addition of acid to carbonate releases carbon dioxide. The water level in the manometer indicated that the increase in volume in the closed system was very close to the volume of acid added, indicating negligible carbon dioxide evolved. This indicated that the carbonate-content of the sand supply was negligible. Therefore, de-ionized water should be a sufficient solute for removing chloride.

B.2.4.2 Amount of pre-leaching needed

To fill the 39 columns, 184 liters (48.5 gallons) of leached sand would be needed. Before beginning a full-scale leaching procedure I determined on a bench scale how much leaching would be necessary to reach a sufficiently low initial chloride concentration in the sand. I used the procedure outlined below to repeatedly leach sand six times and analyzed the leachates.

1) Add 200 g of sand and 200 ml de-ionized water (Milli - Q) to a 500 ml HDPE (high density polyethylene) centrifuge bottle.
2) Place the bottle on a shaker for 10 minutes, then centrifuge for 10 minutes at 10,000 rpm.
3) Before solid particles become resuspended, remove a water sample from the bottle with a syringe for HPLC analysis.
4) Pour out as much water as possible without pouring sand out. Complete drainage of water is not possible, so some residual water with dissolved chloride remains. The residual water was 26% of the total amount of water.
5) Add more de-ionized water to dilute the residual water to the initial volume.

The HPLC method used was identical to that in Appendix E, with the exception of the method of peak height quantification, which was done with Chromperfect. In the Analyze program of Chromperfect, I placed the INT+ event at the leading edge of the peak, so the reference level of the baseline was not subject to drift before the peak. The results of the chloride standards are listed and plotted in Table B.3 and Figure B.3.

Table B.4 lists the concentrations calculated for each leachate and the amount of dilution of each consecutive concentration. Each concentration was expected to be 26% of the previous concentration. The leachate concentrations are plotted in Figure B.4.

The results of this procedure showed that leaching six times, with a 1:1 ratio of mass of deionized water to mass of sand will dilute the chloride concentration of the residual water to a concentration below the detection limit. The last two concentrations were not decreasing as expected. This may be attributed to contamination during sample handling, or to loss of precision. Based on these results, I decided that six times should suffice for the large scale leaching.

TABLE B.3 HPLC results for chloride standards

chloride concentration (mg/L)	peak height
0.025	415
0.05	786
0.1	1361
0.2	2470

FIGURE B.3 Cl standards and regression line

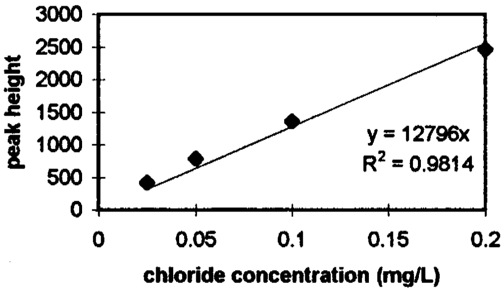
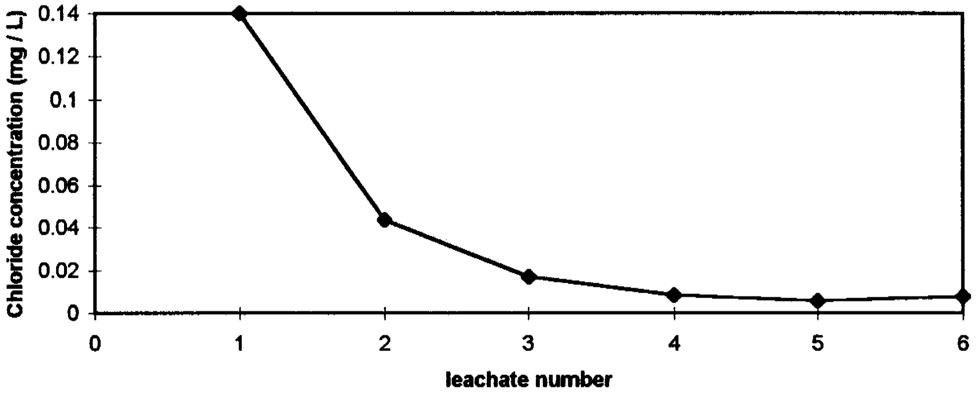


TABLE B.4 Chloride concentrations and dilution factors for consecutive leachates

leachate #	peak height	chloride concentration (= ht. / 12796)	percent of previous concentration
1	1790	0.140	
2	557	0.044	31.1
3	218	0.017	39.1
4	105	0.008	48.2
5	74	0.006	70.5
6	98	0.008	132.4

FIGURE B.4 Chloride concentrations in six consecutive leachates used to determine the amount of pre-leaching needed



B.3 Column construction

B.3.1 Leaching and drying of sand

To pre-leach sand for filling the 39 columns, I used a 55 gallon polyethylene drum to rinse sand in the same way that it was done in the bench scale test, i.e. six times with a 1:1 ratio of mass of sand to mass of de-ionized water (Milli - Q). I leached the sand in several loads of five gallons of sand at one time. I collected samples of the leachate to analyze by HPLC to confirm that the chloride concentration was low enough. The drum has a removable plastic lid, which can be held on tightly with a metal clamp that fits around the rim. The lid has a 2 $^{1/4}$ " diameter bung hole, which can be closed with a threaded plastic plug. To thoroughly mix the sand and water in the drum, I rotated the drum on four 3" diameter caster rollers mounted on a wood platform. I leached a maximum of 5 gallons of sand at one time, because with a larger amount, the combined weight of the sand and water would cause the drum wall to flex while resting on the rollers. The procedure that I used to leach five gallons of sand is outlined below.

1) With the empty drum upright and with the lid removed, add 5 gallons of sand .
2) Rinse sand from the rim of the drum with de-ionized water from a squirt bottle to allow a tight seal of the lid and to prevent scratching of the plastic by sand. Seal the lid with the metal clamp.
3) Place the drum on its side on the rollers.
4) Add 30.4 L of de-ionized water through the bunghole with a tube from a carboy, then close the bunghole. The water level can be seen through lid and marked for refilling.
5) Manually rotate the drum for 3 minutes. The metal clamp on the rim can be gripped by hand. The smooth plastic of the drum can be gripped with a rubber inner tube.
6) Pour water out of the drum in two stages. In the first stage, the lid is kept on and water is poured out the bung hole, which allows the high flow rate to be regulated and retains the sand.

<u>STAGE 1 of drainage :</u>

6a) Rotate the drum on the rollers until the bunghole is at its lowest position.
6)b) Open the bung and allow water to drain into buckets. Collect a sample in a rinsed polyethylene bottle for HPLC analysis.
6)c) When the water level becomes lower than the bung, flow stops.
Tilt the drum by lifting bottom (closed) end 6 to 8 inches with an overhead winch. The drum remains in contact with two of the rollers. Hold the drum in this tilted position until flow stops.

6)d) Lower the drum back onto all four rollers, rinse sand from threads of the bunghole with de-ionized water from a squirt bottle, and replace the bung. At this point, there is still more water in the drum to be removed in the second stage.

6)e) Place the drum upright on the floor. Shake the drum so wet sand clinging to the drum walls falls to the bottom.

6)f) Remove the lid. Use a squirt bottle to rinse any sand stuck on the rim of the drum back down into the drum.

STAGE 2 of drainage :

6)g) Place the plastic lid on the drum loosely without attaching the metal clamp.

6)h) Keeping the lid pressed on, lay the drum back down on the rollers
and lift the bottom about 6 inches with the winch.

6)i) Holding the lid on loosely prevents contamination and allows water to drain out.

Wait several minutes for water to drain from the sand.

6)j) Lower the drum back onto all four rollers. Keeping the lid pressed on, place the drum upright on the floor.

7) Repeat steps 2 through 6)j) until the same load of sand has been leached and drained six times.

8) After leaching 5 gallons of sand six times, spread the sand to dry on plastic sheet.
To avoid contamination, I isolated the drying sand in a small room. Due to lack of ventilation, I used electrical heaters to help dry the sand. After 2 days of drying, I oven dried samples at 98°C and found the gravimetric water content to be 0.02 g water / g dry sand.

9) Store the dried sand in clean buckets until it is packed into columns.

I filled five 500 ml PE bottles with dried sand from random loads for future analysis. I kept three bottles in storage and gave two to Doug Moore of the University of New Mexico Biology Department.

B.3.2 HPLC analysis

To determine whether or not the leaching process was successful, I analyzed some of the bottled leachate samples for chloride by HPLC. I interpreted results of the analyses described below twice, using different methods and obtaining different results. I made the first interpretation of each at the time of analysis, which was before I packed the columns and emplaced them at the field site. I made the second interpretation of the HPLC results after five months of monitoring. This second interpretation, which I believe was more accurate, showed more residual chloride in the columns than the first interpretation.

First Interpretation :

The HPLC method used was identical to that in Appendix E, with the exception of the method of peak height quantification, which was done with Chromperfect. In the Analyze program of Chromperfect, I placed the SBN event (Set Baseline Now) at the leading edge of the peak, so the reference level of the baseline was not subject to drift before the peak.

I began with samples labeled Water 18, 25, 32, and 38, which were the first leachates poured out of four different loads. I analyzed duplicates of each, except for Water 32, which I analyzed one time. I used a single-point calibration to determine the order of magnitude of the chloride concentration in each. The standard curve and sample results are shown in Appendix F.6.1. The chloride concentrations ranged from 0.114 to 0.235 mg/L and had an average value of 0.17 mg/L, which is at the expected order of magnitude, based on the results of the bench-scale leaching shown in Appendix B.2.4.2.

Then I analyzed samples of Water 6, 9, 12, 15, and 17, which were the second, third, fourth, fifth, and sixth leachates from the same load of sand. I analyzed duplicates the third and fourth leachates. I analyzed the others one time each. The sample results are shown in Appendix F.6.1., using the same standard curve as the previous samples. The chloride concentrations in these consecutive leachates are also shown in Table B.5 below. The concentration listed in the table as the first leachate is the average of concentrations of the set of first leachates described above. The concentrations of duplicate samples are listed together. The sequence of concentrations in Table B.5 indicates dilution to below the detection limit. I considered the variation among duplicates to be acceptable because they are in a range of uncertain quantitation.

Table B.5 Chloride concentrations in consecutive leachates

leachate number	chloride concentration (mg/L)
1	0.17
2	0.033
3	0.019, 0.000
4	0.012, 0.000
5	0.000
6	0.013

Then I analyzed samples of Water 24 and 31, which were the last (sixth) leachates poured out of two different loads. I detected no peaks for these samples. Appendix F.6.2 lists the filenames of the HPLC results. Based on these results, I concluded that the leaching process (not including the drying process) was sufficient.

Then I leached and analyzed six samples of dried sand from six different loads, referred to as dried sand 1 through dried sand 6. The standard curve and sample results are shown in Appendix F.6.3. The HPLC method used showed no chloride peaks for four of the six samples. The peaks in the other two samples indicated concentrations of 0.023 and 0.014 mg/L. These were near the detection limit. I considered them to be low enough to warrant beginning the field work. I proceeded to pack the columns with no distinctions of which loads of sand were used.

Second interpretation :

After sampling for five months, some results indicated higher amounts of chloride than expected in the columns. I reviewed the results of the analyses described above for the leachates of dried sand 1 through dried sand 6. At the time of the first analysis, I had interpreted the chromatography by using the peak height as evaluated by the software. For peaks near the detection limit, the software may or may not identify a change in voltage that could be considered to be a peak. I reviewed the results using a second method, which, as described in Appendix E, is to visually inspect the peaks magnified on the computer screen. I identified peaks that the computer didn't identify previously. The concentrations indicated by this second interpretation are shown in Appendix F.6.4. The first and second interpretations are compared in Table B.6, which shows the aqueous chloride concentrations of the leachates (mg Cl/L), solid phase chloride concentrations of the sand (mg Cl/g dry sand), and hypothetical masses of chloride that would be in columns packed with the sand leached for each sample.

Because I leached the sand using a 1:1 ratio of mass of de-ionized water to mass of sand, the following equation is used to convert the concentration units from (mg Cl/L) to (mg Cl /g sand)

$$\left(\frac{\text{mg Cl}}{\text{g sand}}\right)=\left(\frac{\text{mg Cl}}{\text{L water}}\right)\left(\frac{1\,\text{L water}}{1000\,\text{ml water}}\right)\left(\frac{1\,\text{ml water}}{1\,\text{g sand}}\right)$$

$$\left(\frac{\text{mg Cl}}{\text{g sand}}\right)=\left(\frac{\text{mg Cl}}{\text{L water}}\right)\left(10^{-3}\right)$$

Because the columns hold approximately 8000 g of sand, I multiplied the solid phase concentrations by 8000 g sand to estimate the hypothetical masses of residual chloride.

The second interpretation indicates that there is more residual chloride in the sand than I expected when I packed the columns. I used a correction method, shown in Appendix B.6, to distinguish between the masses of residual chloride in the columns and the masses of chloride deposited. The masses of residual chloride that I estimated with the correction method ranged from 0.077 to 0.376 mg. This range is comparable to the range shown for the second interpretation in Table B.6, which is from 0.055 to 0.324 mg.

B.3.3 Column packing

1) I cut 20-foot sections of ABS pipe with a radial arm saw into 2-ft lengths.
2) I washed the columns with detergent and rinsed them with de-ionized water.
3) The walls of the ABS pipe have a porous interior, which was exposed at the cut ends. I coated the top ends with solvent cement (Honest John ® 647, made by Rectorseal Corporation).
4) I glued one cap to each column with solvent cement.
5) When the glue dried, I rinsed the columns again with de-ionized water.
6) I filled 39 columns by scooping washed and dried sand from the storage buckets into a funnel held over the column. As I filled the columns, I tamped the sides of the column to cause the sand grains to settle compactly.
7) I secured sheets of plastic over 38 of the columns to prevent contamination and spilling during transport to the site.
8) I glued a plastic cap on the 39th column. This column will serve as a control column to test for contamination from the column materials at the end of the experiment.
9) I connected lengths of bailing wire around the bottoms of the columns with duct tape to use as handles when the columns are extracted from the ground..

B.3.4 Column emplacement

I chose the site for the columns based on proximity to pre-existing precipitation collectors and on levelness of topography. I used metal stakes to mark the corners of a 6 yard by 9 yard rectangular plot. The plot is 9 yards long in the north-south direction, aligned with magnetic north, and is 6 yards wide in the east-west direction. I attached a green ribbon to the metal stakes to mark the border of the plot. I placed a sign on the southwest stake to identify the plot.

Using a General 440 motorized auger with a 6" diameter bit, I dug 40 holes (5 rows of 8) , 2 feet deep. The holes are arranged in a 5 x 8 rectangular grid with one-yard spacing, and with a distance of 1 yard between the outer rows and the border, as shown in Figure B.1. Each column location is designated by a row number and a position number. I numbered the five north-south rows, with row 1 being the farthest west, and row 5 being the farthest east. The eight positions within each row are numbered starting with position 1 at the north end of each row and position 8 at the south end of each row.

I used a manual posthole digger to clear the holes to a depth such that the rim of each column would be 1 cm below the ground surface. A cemented layer at a depth of about 2 ft made adjustment of depths difficult, and prevented me from using positions 1 and 2 of row 1 for emplacement of columns. I refilled both of these holes, and later used the hole at position 1 for the dust collector.

On November 2, 1996, I placed the 38 uncapped columns, with the plastic covers still attached, in the other 38 holes. I then backfilled around the sides of the columns, using the native sand that had been dug from the holes, up to 1 cm below the column rims. I stored the unused native sand in a pile under burlap bags northeast of plot. This sand can be used to refill holes when columns are extracted. The ends of the bailing wire attached to each column protrude from the ground north and south of each column. A small marker flag marks the north end of each wire. After partially backfilling all holes with native sand, I removed the plastic covers, one at a time, and finished backfilling with leached sand above and beside the column rims, so the total depth of leached sand in each column is 61 cm.

I extracted the control column from position 3 of row 1 on November 2, 1996. As described in methods section 3.2, the sand from this column was handled differently than sand from other columns. I then used the same hole (at position 3 of row 1) to bury the archive column, which was capped at both ends.

Appendix B.4 Column sampling methods

B.4.1 General description
B.4.2 Field procedures
B.4.3 Lab procedures

B.4.1 General description

The samples from all collectors must be collected on the same day to provide data for the same time intervals. Coordinate the sampling schedule with UNM's sampling of precipitation collectors. As of May, 1997, for the foreseeable future, the person to contact is Doug Moore (dmoore@sevilleta.unm.edu). As explained in Appendix A, a permit is required for access to the Sevilleta National Wildlife Refuge. Appendix A includes directions to the monitoring site.

The total mass of chloride accumulated in the column is determined by removing the sand from the column in separate depth intervals, quantifying the mass of chloride in each interval, and summing the masses of chloride in each interval. The first interval (from the land surface above the column) is bottled at the monitoring site before extracting the column. Then the full column is sealed, extracted, and moved to the lab for further division into intervals and sample preparation.

Several 500 ml polyethylene bottles are needed for each column. One must be taken to the field site for the surface sample. Prepare the bottles by rinsing with de-ionized water, oven-drying , labeling with interval numbers, and recording the mass of each empty bottle.

After bottling each interval, sand from each interval is split into two subsamples. Subsample 1 of each interval is oven-dried to determine the gravimetric water content. Subsample 2 of each interval is leached to determine the chloride concentration in terms of mg Cl / g dry sand. Then the water content and chloride concentration for a whole interval are assumed to be equal to the values found for the subsamples.

Quantification of the mass of chloride in each interval is done by leaching subsample 2 with a known volume of de-ionized water in the polyethylene (PE) bottle and measuring the concentration in the leachate by HPLC. Then the mass of chloride (mg) in the leachate equals the product of the chloride concentration (mg/L) and the volume of the leachate (L).

Volume of leachate is determined by its mass (assuming its density is 1 g / ml.), and includes de-ionized water added in the lab and soil water already present in the sand. To determine these masses, it is necessary to record the mass with each step in the lab procedure outlined below.

B.4.2 Field procedures

Locations of individual columns are identified in Figure B.1. At the site, locate the appropriate column, as determined by the most up to date sampling schedule in Appendix B.1.

A marker flag is attached to the bailing wire, which is attached to the column. To locate the rim of the buried column, raise the bailing wire out of the sand without disturbing the sand directly above the column.

Without disturbing sand directly above the column, scrape away sand surrounding the rim with a rinsed scupula, so that the surface sample remains on top of the column. Dig around the outside of the column to expose the top 2 cm of the outside of the column so that a plastic cover may be held onto the column with a rubber band after the surface sample is removed.

Scoop the surface sample (interval 1) into a polyethylene bottle , collecting sand to a depth of about 0.5 cm below the rim and excluding sand from directly on top of the rim.

To minimize evaporation, which could skew the water content measurements, put the bottle in a cooler for shade.

Cover the top of the column with a small sheet of plastic, using a rubber band to hold it in place.

The column can be lifted out of the ground by attaching the bailing wire to a 2"x6" board used as a lever. Place a brick where it can be used as a fulcrum and lift the column out of the ground.

Refill the hole and transport the column back to the lab.

B.4.3 Lab procedures

Print a blank copy of the spreadsheet in Appendix B.5 and use it to record the information for the following procedures, which are repeated for each depth interval.

B.4.3.1) Whole interval

1) Record the mass of each PE bottle in column H of the spreadsheet.
2) Remove the sand from the column in separate layers with a plastic scoop and funnel into the PE bottles.
   To make a Plastic scoop, I cut a curved piece of HDPE (high density polyethylene) plastic from the bottom of a commercial 1 gallon water jug and attached it to the end of a PVC pipe, which served as a handle to reach inside the column.
3) Record the mass of the full PE bottle in Column I.

B.4.3.2 Preparation of subsample 1

1) Before separating a bottled layer into subsamples, shake the PE bottle to mix the sand inside so that the subsample removed for water content will be representative of sand in the whole interval.
2) Using a scale with four decimal places, measure the mass of an empty soil drying tin.
   Record each mass in column B.
3) Pour a subsample of about 20 g of sand from the polyethylene container into the drying tin.
4) Record the mass of full tin in column C.
5) The sand remaining in the PE bottle is subsample 2.
   Record the new mass of the bottle in column J.
6) Oven dry the soil tins at 100 degrees C overnight.
   Record the mass of each full tin (with dried contents) in column D.
7) The gravimetric water content (mass of water / mass of dry sand) of the sand in each tin is calculated in column G .

B.4.3.3 Preparation of subsample 2

Subsample 2 is leached with de-ionized water, using a 1:1 ratio of mass of water to mass of sand. This ratio does not have to be precisely achieved, because the actual mass of water will be recorded, so the dilution equations in Appendix B.5 will provide the desired result. The volume of water added is determined by its mass (using density of 1 g/ml). The bottle is placed on a scale and water is added until the desired mass is approximately reached.

1) The desired mass of the full bottle is calculated as :

[mass of empty bottle] + [(2) x (mass of sand in bottle)]

For this calculation, I ignored soil water and used the mass of undried sand in the bottle. This is calculated in column N of the spreadsheet, which is titled 'target mass'. The calculation may be done in the lab without a spreadsheet.

2) Place the open bottle and cap on the scale and add de-ionized water to the bottle until the digital scale shows near the target mass.
Record the actual mass in Column O .

3) Seal the bottle and shake for five minutes to dissolve chloride.

4) To prepare for HPLC analysis, the sample is centrifuged to avoid injecting suspended solids into the HPLC. I did not filter samples because filtering may risk contamination when low concentrations are being measured.
Pour some water from the PE bottle into a clean centrifuge tube,
then centrifuge at 10,000 rpm for 12 minutes.
Pour some water from the centrifuge tube into a second clean centrifuge tube,
then centrifuge at 10,000 rpm for 12 minutes.
Pour some water from the second centrifuge tube into a clean sample vial.

5) To analyze by HPLC, use a manual syringe to inject 250 ul of sample from the vial into the U6K injection port of the HPLC.

Appendix B.5 Calculations of water contents and chloride contents of columns

Appendix B.5.0	Explanation of equations
Appendix B.5.1.1	Column extracted on November 2, 1996
Appendix B.5.1.2	Column extracted on December 2, 1996
Appendix B.5.1.3	Column extracted on December 31, 1996
Appendix B.5.1.4	Column extracted on January 31, 1997, from position 6 of row 1
Appendix B.5.1.5	Column extracted on January 31, 1997, from position 7 of row 1
Appendix B.5.1.6	Column extracted on March 3, 1997
Appendix B.5.1.7	Column extracted on April 1, 1997
Appendix B.5.1.8	Column extracted on April 30, 1997
Appendix B.5.2.1	Sample of sand from the land surface within the experimental plot

Appendix B.5.0 Explanation of equations

The purpose of the spreadsheets in Appendix B.5 is to calculate, from experimental data recorded during sample preparation, the total mass of chloride present in each monitoring column. Data for each monitoring column is on a separate sheet. Each sheet consists of five or ten printed pages. The first page of each sheet includes a summary table showing the chloride deposition rate calculated with the total mass of chloride.

column A = depth interval number

column B = mass of empty soil drying tin (g)

column C = mass of soil drying tin and undried subsample 1 (g)

column D = mass of soil drying tin and subsample 1 after drying (g)

column E = mass of water in subsample 1 (g)

= (mass of soil drying tin and subsample 1 after drying)
- (mass of soil drying tin and subsample 1 after drying)

= (column C) - (column D)

column F = mass of dry sand in soil drying tin (g)

= (mass of soil drying tin and subsample 1 after drying) - (mass of empty soil drying tin)

= (column D) - (column B)

column G = gravimetric water content (θ) of subsample 1 (g water / g dry sand)

$$= \frac{(\text{column} E)}{(\text{column} F)}$$

column H = mass of polyethylene bottle (g)

column I = mass of polyethylene bottle and undried sand of whole interval (g)

column J = mass of polyethylene bottle and sand after removing subsample 1 (g)

column K = mass of sand and soil water in interval (g)

= (mass of polyethylene bottle and undried sand of whole interval)
-(mass of polyethylene bottle)

= (column I) - (column H)

column L = mass of dry sand in interval (g)

$$= \frac{(\text{mass of sand and soil water in interval})}{\left[1 + (\text{gravimetric water content})\right]}$$

$$= \frac{(\text{column K})}{\left[1 + (\text{column G})\right]}$$

column M = mass of sand and soil water in subsample 2 (g)

= (mass of polyethylene bottle and sand after removing subsample 1)
- (mass of polyethylene bottle)

= (column J) - (column H)

column N = hypothetical mass of bottle after adding a mass of de-ionized water equal to the mass of sand and soil water in subsample 2(g)

= (mass of polyethylene bottle and sand after removing subsample 1)
+ (mass of sand and soil water in subsample 2)

= (column J) + (column M)

column O = actual mass of bottle after adding de-ionized water (g)

column P = volume of water added (ml)

$$= \frac{\text{(actual mass of bottle after adding deionized water)} - \text{(mass of bottle and sand)}}{\text{(density of water)}}$$

$$= \frac{\text{(column O)} - \text{(column J)}}{1}$$

where density of water is assumed to be (1 g / ml)

column Q = total leachate volume in the bottle (ml)

$$= \left(\text{volume of water added}\right) + \left(\text{volume of soil water in bottle}\right)$$

$$= \left(\text{volume of water added}\right) + \left(\theta \times \left[\text{mass of dry sand in bottle}\right]\right)$$

$$= \left(\text{volume of water added}\right) + \left(\theta \times \left[\frac{\text{mass of sand and soil water in bottle}}{1+\theta}\right]\right)$$

$$= \left(\text{column P}\right) + \left(\text{(column G)} \times \left[\frac{\text{(column M)}}{1 + \text{(column G)}}\right]\right)$$

column R = Filename of HPLC results

This is included so that my interpretation of each may
be reviewed in Appendix F.

column S = peak height (mV)

column T = slope of standard curve ((mg/L) / mV) column U = chloride concentration in leachate (mg / L)

$$= (\text{peak height}) \times (\text{slope of standard curve})$$

$$= (\text{column S}) \times (\text{column T})$$

column V = mass of chloride in leachate (mg)

= (L leachate) x (chloride concentration in leachate)

$$= \left[(\text{ml leachate}) \left(\frac{1 \text{ L leachate}}{1000 \text{ ml leachate}} \right) \right] \times \left[\frac{\text{mg Cl}}{\text{L leachate}} \right]$$

$$= \left(\frac{\text{column Q}}{1000} \right) \times (\text{column U})$$

column W = mass of chloride in interval (mg)

$$= (\text{mass of Cl in leachate}) \times \left[\frac{(\text{mass of dry sand in interval})}{(\text{mass of dry sand in subsample 2})} \right]$$

$$= (\text{mass of Cl in leachate}) \times \left[\frac{\left[\frac{(\text{mass of sand and soil water in interval})}{(1 + \text{gravimetric water content})} \right]}{\left[\frac{(\text{mass of sand and soil water in subsample 2})}{(1 + \text{gravimetric water content})} \right]} \right]$$

$$= (\text{mass of Cl in leachate}) \times \left[\frac{(\text{mass of sand and soil water in interval})}{(\text{mass of sand and soil water in subsample 2})} \right]$$

$$= \left[\frac{(\text{column V}) \times (\text{column K})}{(\text{column M})} \right]$$

NOTE : The sum of values in column W is the total mass of chloride in the column.

The next four columns are used to produce the depth profile figures shown in the results section. The cumulative mass of dry sand is converted to a depth of 61 cm. The masses of dry sand for each interval have to be calculated and summed before the equation in (Column AB) can be written.

column AA = cumulative mass of dry sand in interval (g)

based on column L, mass of dry sand in interval

column AB = Depth in column (cm)

= 61 cm x (fraction of total mass of dry sand in column)

$$= 61 \times \left[\frac{\text{cumulative mass of dry sand in int ervals}}{\text{total mass of dry sand in column}} \right]$$

$$= 61 \times \left[\frac{\text{(Column AA)}}{\sum \text{(Column AA)}} \right]$$

column AC = gravimetric water content in interval before leaching (g water / g dry sand)

This column is a duplicate of column G.

column AD = chloride concentration in interval (ng Cl / dry sand)

$$= \frac{1000000 \times \text{(column W)}}{\text{(column L)}}$$

	A	B	C	D	E	F	G
1	Appendix B.5.1.1						
2	Calculation of results for column extracted on November 2, 1996,						
3	from position 3 of row 1						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1						0.02
10	2						0.02
11	3						0.02
12	4						0.02
13	5						0.02
14							
15							
16	SUM :						
17							
18							
19							
20	As described in section 3.1.2, not all samples were analyzed for this column,						
21	so average values are used.						
22							
23	For all five intervals in this column, water contents were assumed to be 0.02,						
24	which was the water content of samples that I analyzed during the drying process.						
25	(see Appendix B.3)						
26							
27	For intervals 2 and 4 :						
28		(mass of Cl in interval)=(mg Cl / g dry sand)x(mass of dry sand)					
29		(column W) = (column AD) x (column L)					
30							
31		The Cl concentrations (Column AD) are assumed to be the					
32			averages of those in the intervals above and below them.				
33							
34		I estimated the masses of dry sand by setting the total mass of					
35			dry sand in the column equal to the total mass of dry				
36			sand in the column extracted at t=1 month,				
37			then subtracting the masses of dry sand in intervals 1, 3, and 5.				
38							

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	69	275.6	275.6	210	210	210
10				0	3520	0
11	78	264.3	264.3	190	190	190
12				0	3520	0
13	78	237.7	237.7	160	160	160
14						
15						
16						
17						
18						
19						
20						
21						
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28						
29						
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31						
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33						
34						
35						
36						
37						
38						

	N	O	P	Q	R	S
1						
2						
3						
4						
5	mass of bottle of sand		volume			
6	with de-ionized water added		of water	total liquid		peak
7	target	actual	added	volume	filename of	height
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)
9	485.6	482.2	206.6	210.00	JWM10G96.09R	0.102
10	0		0	0.00		
11	454.3	445.2	180.9	180.00	JWM11A96.04R	0.096
12	0		0	0.00		
13	397.7	445.1	207.4	210.00	JWM11A96.03R	0.019
14						
15						
16						
17						
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21						
22						
23						
24						
25						
26						
27						
28						
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35						
36						
37						
38						

	T	U	V	W	X	Y	Z
1							
2							
3							
4							
5	slope of	chloride					
6	standard	concentration	mass of Cl	mass of Cl			
7	curve	in leachate	in leachate	in interval			
8	((mg/L)/mV)	(mg/L)	(mg)	(mg)			
9	0.2262	0.023	0.005	0.005			
10				0.081			
11	0.2262	0.022	0.004	0.004			
12				0.046			
13	0.2262	0.004	0.001	0.001			
14							
15							
16				0.137			
17							
18							
19							
20							
21							
22							
23							
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25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							

	AA	AB	AC	AD
1				
2				
3			gravimetric	
4	cumulative	depth in	water content	Cl concentration
5	mass of	column	in interval	in interval
6	dry sand		before leaching	
7	in interval			
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	210	1.7	0.02	24
10	3730	30	0.02	23
11	3920	32	0.02	21
12	7440	60	0.02	13
13	7600	61	0.02	5.6
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				

	A	B	C	D	E	F	G
1	Appendix B.5.1.2						
2	Calculation of results for column extracted on December 2, 1996,						
3	from position 4 of row 1						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.8400	35.8600	35.7300	0.1300	19.8900	0.0065
10	2	16.0416	32.6532	32.5627	0.0905	16.5211	0.0055
11	3	15.7608	33.7336	33.6339	0.0997	17.8731	0.0056
12	4	15.6166	37.8072	37.6846	0.1226	22.0680	0.0056
13	5	15.8446	37.6897	37.5759	0.1138	21.7313	0.0052
14	6						0.0052
15	7	15.5466	38.1359	38.0209	0.1150	22.4743	0.0051
16	8	15.9584	29.4558	29.3802	0.0756	13.4218	0.0056
17	9	15.9828	41.9279	41.7917	0.1362	25.8089	0.0053
18	10	15.6766	35.5940	35.4903	0.1037	19.8137	0.0052
19	11	15.7532	32.7881	32.6994	0.0887	16.9462	0.0052
20	12	15.4648	34.2198	34.1224	0.0974	18.6576	0.0052
21	13	15.5600	32.9284	32.8421	0.0863	17.2821	0.0050
22	14	15.4813	30.6606	30.5835	0.0771	15.1022	0.0051
23							
24							
25	SUM :						
26							
27							
28	The water content used for interval 6 is the average of those in intervals 5 and 7.						
29							

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	77.87	219.92	199.88	142.1	141.2	122.0
10	69.5	171.8	155.2	102	101	85.7
11	68.5	160.6	142.6	92.1	91.6	74.1
12	69.2	190.5	168.2	121	120	99.0
13	68.9	195.1	173.2	126	125	104
14	829.1	1257.2	1257.2	428.1	425.9	428.1
15	69.45	246.78	224.2	177.3	176.4	154.8
16	828.2	1618.3	1603.9	790.1	785.7	775.7
17	827.3	1818.1	1791.8	990.8	985.6	964.5
18	827.8	1895.4	1875.3	1068	1062	1048
19	827.8	1942.2	1924.9	1114	1108	1097
20	827.8	1887.2	1868.2	1059	1054	1040
21	827.6	1834.3	1816.7	1007	1002	989.1
22	827.9	1281.5	1265.8	453.6	451.3	437.9
23						
24						
25						
26						
27						
28						
29						

	N	O	P	Q	R	S
1						
2						
3						
4						
5	mass of bottle of sand		volume			
6	with de-ionized water added		of water	total liquid		peak
7	target	actual	added	volume	filename of	height
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)
9	321.88	314.15	114.27	115.1	JWM12G96.26R	0.164
10	240.9	236.4	81.2	81.7	JWM12G96.27R	0.125
11	216.7	224.0	81.4	81.80	JWM12G96.29R	0.040
12	267.2	259.0	90.8	91.4	JWM12G96.32R	0.069
13	277.2	278.4	105.2	106	JWM12G96.33R	0.057
14	1685.3	1671.7	414.5	416.7	JWM12G96.39R	0.076
15	379	367.4	143.2	144.0	JWM12G96.41R	0.160
16	2379.6	2397.7	793.8	798.1	JWM12G96.40R	0.110
17	2756.3	2708.2	916.4	921.5	JWM12G96.42R	0.086
18	2923.3	2877.7	1002.4	1008	JWM12G96.43R	0.094
19	3021.9	2804.2	879.3	885.0	JWM12G96.44R	0.100
20	2908.2	2829.2	961.0	966.4	JWM12G96.45R	0.080
21	2805.8	2804.7	988.0	992.9	JWM12G96.46R	0.049
22	1703.7	1620.5	354.7	356.9	JWM12G96.47R	0.079
23						
24						
25						
26						
27						
28						
29						

	T	U	V	W	X	Y	Z
1							
2							
3							
4							
5	slope of	chloride					
6	standard	concentration	mass of Cl	mass of Cl			
7	curve	in leachate	in leachate	in interval			
8	((mg/L)/mV)	(mg/L)	(mg)	(mg)			
9	0.6653	0.109	0.013	0.015			
10	0.6653	0.083	0.007	0.008			
11	0.6653	0.027	0.002	0.002			
12	0.6653	0.046	0.004	0.005			
13	0.6653	0.038	0.004	0.005			
14	0.6653	0.051	0.021	0.021			
15	0.6653	0.106	0.015	0.017			
16	0.6653	0.073	0.058	0.059			
17	0.6653	0.057	0.053	0.054			
18	0.6653	0.063	0.063	0.064			
19	0.6653	0.067	0.059	0.060			
20	0.6653	0.053	0.051	0.052			
21	0.6653	0.033	0.032	0.033			
22	0.6653	0.053	0.019	0.020			
23							
24							
25				0.415			
26							
27							
28							
29							

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	141	1.1	0.0065	106
10	242	1.9	0.0055	79.2
11	334	2.7	0.0056	21.8
12	454	3.6	0.0056	41.7
13	579	4.6	0.0052	40.0
14	1005	8.0	0.0052	49.3
15	1181	9.4	0.0051	96.4
16	1967	15.7	0.0056	75.1
17	2952	23.6	0.0053	54.8
18	4014	32.1	0.0052	60.3
19	5122	41.0	0.0052	54.2
20	6176	49.4	0.0052	49.3
21	7178	57.4	0.0050	32.9
22	7630	61.0	0.0051	44.3
23				
24				
25				
26				
27				
28				
29				

	A	B	C	D	E	F	G
1	Appendix B.5.1.3						
2	Calculation of results for column extracted on December 31, 1996,						
3	from position 5 of row 1						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.7556	33.3195	33.2340	0.0855	17.4784	0.0049
10	2	15.9820	23.3787	23.3307	0.0480	7.3487	0.0065
11	3	15.5592	27.0437	26.9820	0.0617	11.4228	0.0054
12	4	15.4818	29.4738	29.3994	0.0744	13.9176	0.0053
13	5	15.4248	26.9320	26.8692	0.0628	11.4444	0.0055
14	6	15.4667	26.8712	26.8108	0.0604	11.3441	0.0053
15	7	15.9597	30.0108	29.9378	0.0730	13.9781	0.0052
16	8	15.6802	33.6424	33.5514	0.0910	17.8712	0.0051
17	9	15.6815	48.2942	48.1812	0.1130	32.4997	0.0035
18	10	15.9670	53.4252	53.2922	0.1330	37.3252	0.0036
19	11	15.7271	46.8679	46.7552	0.1127	31.0281	0.0036
20	12	15.5633	47.1478	47.0310	0.1168	31.4677	0.0037
21	13	15.6319	42.3710	42.2716	0.0994	26.6397	0.0037
22	14	15.7284	50.9746	50.8457	0.1289	35.1173	0.0037
23	15	15.5945	44.7055	44.5927	0.1128	28.9982	0.0039
24	16	15.7414	50.2923	50.1620	0.1303	34.4206	0.0038
25	17	15.3490	51.0439	50.9088	0.1351	35.5598	0.0038
26	18	15.4279	42.6958	42.5873	0.1085	27.1594	0.0040
27	19	15.8101	56.9077	56.7561	0.1516	40.9460	0.0037
28	20	15.5547	52.1117	51.9682	0.1435	36.4135	0.0039
29	21	15.8918	47.9224	47.7915	0.1309	31.8997	0.0041
30	22	15.6364	45.1958	45.0760	0.1198	29.4396	0.0041
31	23	15.4166	47.9670	47.8332	0.1338	32.4166	0.0041
32	24	15.6332	47.2993	47.1691	0.1302	31.5359	0.0041
33	25	15.4511	46.2104	46.0821	0.1283	30.6310	0.0042
34	26	15.4695	43.1455	43.0266	0.1189	27.5571	0.0043
35	27	15.8103	34.7116	34.6282	0.0834	18.8179	0.0044
36	28	15.7896	48.4264	48.2878	0.1386	32.4982	0.0043
37	29	15.7020	40.5625	40.4564	0.1061	24.7544	0.0043
38	30	15.7855	52.1298	51.9792	0.1506	36.1937	0.0042
39							
40							

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	68.5	223.72	206.2	155	155	138
10	69.04	161.0	153.61	91.96	91.37	84.57
11	68.38	185.13	173.66	116.8	116.2	105.3
12	69.15	168.03	154.05	98.88	98.36	84.90
13	68.42	153.43	141.93	85.01	84.55	73.51
14	77.32	167.19	155.8	89.87	89.40	78.48
15	68.78	162.48	148.44	93.70	93.22	79.66
16	80.41	180.32	162.35	99.91	99.40	81.94
17	77.4	365.2	332.6	288	287	255
18	80.5	359.0	321.5	279	279	241
19	68.6	389.1	357.4	321	320	289
20	68.9	422.1	390.5	353	352	322
21	68.8	384.3	357.6	316	315	289
22	68.6	412.2	377.0	344	343	308
23	77.9	388.3	359.2	310	309	281
24	77.2	389.2	354.6	312	311	277
25	68.8	438.0	402.3	369	368	334
26	77.9	471.1	444.0	393	391	366
27	78.3	429.7	388.7	351	350	310
28	68.7	434.8	398.3	366	365	330
29	68.5	464.5	432.5	396	394	364
30	68.2	465.9	436.4	398	396	368
31	69.2	441.9	409.4	373	371	340
32	68.8	435.6	403.4	367	366	335
33	80.1	449.9	419.2	370	368	339
34	68.2	426.7	399.0	359	357	331
35	31.1	142.1	123.2	111	111	92.1
36	31.0	229.7	197.0	199	198	166
37	31.0	202.2	177.4	171	170	146
38	30.9	218.1	181.7	187	186	151
39						
40						

	N	O	P	Q	R	S
1						
2						
3						
4						
5	mass of bottle of sand		volume			
6	with de-ionized water added		of water	total liquid		peak
7	target	actual	added	volume	filename of	height
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)
9	344	348.68	142.5	143	JWM03B97.17R	0.250
10	238.2	238.85	85.24	85.79	JWM03B97.18R	0.130
11	279.0	277.91	104.25	104.80	JWM03B97.22R	0.110
12	239.0	237.98	83.93	84.38	JWM03B97.23R	0.078
13	215.4	214.99	73.06	73.46	JWM03B97.24R	0.080
14	234.3	233.7	77.9	78.3	JWM03B97.25R	0.055
15	228.1	227.41	78.97	79.38	JWM03B97.26R	0.106
16	244.3	243.15	80.80	81.22	JWM03B97.27R	0.081
17	588	552.6	220.0	221	JWM05B97.03R	0.058
18	563	552.6	231.1	232	JWM05B97.04R	0.020
19	646	600.1	242.7	244	JWM05B97.05R	0.029
20	713	656.1	265.6	267	JWM05B97.06R	0.017
21	647	600.1	242.5	244	JWM05B97.07R	0.036
22	685	656.1	279.1	280	JWM05B97.08R	0.024
23	640	601.2	242.0	243	JWM05B97.09R	0.020
24	632	601.2	246.6	248	JWM05B97.10R	0.010
25	736	616.1	213.8	215	JWM05B97.11R	0.020
26	810	632.6	188.6	190	JWM05B97.12R	0.050
27	699	630.7	242.0	243	JWM05B97.13R	0.029
28	728	616.1	217.8	219	JWM05B97.14R	0.056
29	797	632.6	200.1	202	JWM05B97.15R	0.030
30	804	713.5	277.1	279	JWM05B97.16R	0.012
31	749	618.6	209.2	211	JWM05B97.17R	0.020
32	738	574.7	171.3	173	JWM05B97.18R	0.040
33	758	670.4	251.2	253	JWM05B97.19R	0.019
34	730	630.7	231.7	233	JWM05B97.20R	0.075
35	215	193.0	69.8	70.2	JWM05B97.21R	0.020
36	363	295.8	98.8	100	JWM05B97.22R	0.070
37	323	301.4	124.0	125	JWM05B97.23R	0.030
38	333	294.5	112.8	113	JWM05B97.24R	0.040
39						
40						

	T	U	V	W	X	Y	Z
1							
2							
3							
4							
5	slope of	chloride					
6	standard	concentration	mass of Cl	mass of Cl			
7	curve	in leachate	in leachate	in interval			
8	((mg/L)/mV)	(mg/L)	(mg)	(mg)			
9	0.4013	0.100	0.014	0.016			
10	0.4013	0.052	0.004	0.004			
11	0.4013	0.044	0.005	0.006			
12	0.4013	0.031	0.003	0.003			
13	0.4013	0.032	0.002	0.002			
14	0.4013	0.022	0.002	0.002			
15	0.4013	0.043	0.003	0.004			
16	0.4013	0.033	0.003	0.004			
17	0.6179	0.036	0.008	0.009			
18	0.6179	0.012	0.003	0.003			
19	0.6179	0.018	0.004	0.004			
20	0.6179	0.011	0.003	0.003			
21	0.6179	0.022	0.005	0.005			
22	0.6179	0.015	0.004	0.004			
23	0.6179	0.012	0.003	0.003			
24	0.6179	0.006	0.002	0.002			
25	0.6179	0.012	0.003	0.003			
26	0.6179	0.031	0.006	0.006			
27	0.6179	0.018	0.004	0.005			
28	0.6179	0.035	0.008	0.009			
29	0.6179	0.019	0.004	0.004			
30	0.6179	0.007	0.002	0.002			
31	0.6179	0.012	0.003	0.003			
32	0.6179	0.025	0.004	0.004			
33	0.6179	0.012	0.003	0.003			
34	0.6179	0.046	0.011	0.012			
35	0.6179	0.012	0.001	0.001			
36	0.6179	0.043	0.004	0.005			
37	0.6179	0.019	0.002	0.002			
38	0.6179	0.025	0.003	0.004			
39							
40				0.137			

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	155	1.22	0.0049	103.00
10	246	1.94	0.0065	43.8
11	363	2.86	0.0054	51.6
12	461	3.64	0.0053	30.5
13	545	4.30	0.0055	23.7
14	635	5.01	0.0053	22.4
15	728	5.74	0.0052	42.9
16	828	6.53	0.0051	40.2
17	1115	8.79	0.0035	31.4
18	1394	11.0	0.0036	10.8
19	1714	13.5	0.0036	12.5
20	2066	16.3	0.0037	8.52
21	2381	18.8	0.0037	15.9
22	2724	21.5	0.0037	11.7
23	3033	23.9	0.0039	9.71
24	3344	26.4	0.0038	6.43
25	3712	29.3	0.0038	8.15
26	4103	32.4	0.0040	15.3
27	4453	35.1	0.0037	14.3
28	4818	38.0	0.0039	24.7
29	5212	41.1	0.0041	10.2
30	5608	44.2	0.0041	5.05
31	5979	47.1	0.0041	8.09
32	6345	50.0	0.0041	10.9
33	6713	52.9	0.0042	8.15
34	7070	55.8	0.0043	33.6
35	7181	56.6	0.0044	9.01
36	7379	58.2	0.0043	25.3
37	7549	59.5	0.0043	11.8
38	7735	61.0	0.0042	21.5
39				
40				

	A	B	C	D	E	F	G
1	Appendix B.5.1.4						
2	Calculation of results for column extracted on January 31, 1997,						
3	from position 6 of row 1						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.6768	31.8367	31.7569	0.0798	16.0801	0.0050
10	2	15.7554	24.5150	24.4308	0.0842	8.6754	0.0097
11	3	15.4823	26.2385	26.1368	0.1017	10.6545	0.0095
12	4	15.4246	26.1937	26.0703	0.1234	10.6457	0.0116
13	5	15.4698	26.2337	26.0826	0.1511	10.6128	0.0142
14	6	15.8330	27.0351	26.8551	0.1800	11.0221	0.0163
15	7	15.6505	31.7891	31.4682	0.3209	15.8177	0.0203
16	8	15.4654	25.7376	25.5152	0.2224	10.0498	0.0221
17	9	15.6773	27.6846	27.4126	0.2720	11.7353	0.0232
18	10	15.9594	26.4792	26.2264	0.2528	10.2670	0.0246
19	11	15.7240	37.3043	36.8064	0.4979	21.0824	0.0236
20	12	15.5600	24.8405	24.6166	0.2239	9.0566	0.0247
21	13	15.6284	26.7547	26.4975	0.2572	10.8691	0.0237
22	14	15.7274	23.9416	23.7802	0.1614	8.0528	0.0200
23	15	15.5870	24.6918	24.5311	0.1607	8.9441	0.0180
24	16	15.7340	20.9805	20.9015	0.0790	5.1675	0.0153
25	17	15.3470	27.7448	27.5981	0.1467	12.2511	0.0120
26	18	15.4153	37.7132	37.4921	0.2211	22.0768	0.0100
27	19	15.8044	31.9448	31.8010	0.1438	15.9966	0.0090
28	20	15.5345	48.5091	48.2559	0.2532	32.7214	0.0077
29	21	15.8872	38.0005	37.8327	0.1678	21.9455	0.0076
30	22	15.6102	39.3253	39.1534	0.1719	23.5432	0.0073
31	23	15.4058	34.7581	34.6237	0.1344	19.2179	0.0070
32	24	15.6058	29.7897	29.6913	0.0984	14.0855	0.0070
33	25	15.4480	33.6842	33.5617	0.1225	18.1137	0.0068
34	26	15.8406	49.5611	49.3930	0.1681	33.5524	0.0050
35	27	15.4277	48.7219	48.5633	0.1586	33.1356	0.0048
36	28	15.4525	48.6416	48.4555	0.1861	33.0030	0.0056
37	29	15.9776	48.4174	48.2650	0.1524	32.2874	0.0047
38	30	15.6484	49.2909	49.1174	0.1735	33.4690	0.0052
39	31	15.6597	43.2321	43.0605	0.1716	27.4008	0.0063
40	32	15.3676	47.8914	47.7092	0.1822	32.3416	0.0056
41	33	15.5027	43.2841	43.1213	0.1628	27.6186	0.0059
42	34	15.7990	49.4916	49.3073	0.1843	33.5083	0.0055
43	35	15.8117	40.1479	40.0294	0.1185	24.2177	0.0049
44	36	15.5811	40.8132	40.6888	0.1244	25.1077	0.0050
45	37	15.7037	46.6954	46.5438	0.1516	30.8401	0.0049
46	38	15.4819	52.2059	52.0242	0.1817	36.5423	0.0050
47	39	15.7931	48.9418	48.7792	0.1626	32.9861	0.0049
48	40	15.7115	46.7981	46.6468	0.1513	30.9353	0.0049
49	41	15.4989	42.5514	42.4140	0.1374	26.9151	0.0051
50							
51	SUM :						

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	69.2	189.5	173.3	120	119	104
10	31.5	95.7	86.8	64.2	63.6	55.3
11	31.8	104.6	93.9	72.8	72.1	62.1
12	31.4	118.8	108.1	87.4	86.4	76.7
13	31.3	98.4	87.7	67.1	66.2	56.4
14	31.2	128.2	117.0	97.0	95.4	85.8
15	32.2	158.5	142.3	126	123	110
16	31.2	92.9	82.6	61.7	60.4	51.4
17	31.2	97.7	85.8	66.5	65.0	54.6
18	31.3	124.4	113.7	93.1	90.9	82.4
19	31.1	106.2	84.5	75.1	73.4	53.4
20	31.2	104.9	95.6	73.7	71.9	64.4
21	31.3	145.9	134.7	115	112	103
22	31.2	167.4	159.2	136	133	128
23	32.1	182.3	173.3	150	147	141
24	31.0	115.7	110.6	84.7	83.4	79.6
25	31.2	100.0	87.5	68.8	68.0	56.3
26	31.0	169.7	147.5	139	138	117
27	30.9	188.8	172.8	158	157	142
28	31.1	218.1	185.2	187	186	154
29	31.1	187.5	165.5	156	155	134
30	31.5	195.3	171.7	164	163	140
31	31.1	173.4	154.1	142	141	123
32	31.4	197.9	177.5	167	166	146
33	31.4	191.2	173.1	160	159	142
34	78.9	467.5	433.8	389	387	355
35	69.0	499.9	466.7	431	429	398
36	78.5	443.7	410.5	365	363	332
37	69.1	507.3	474.9	438	436	406
38	69.1	477.2	443.6	408	406	375
39	69.6	431.4	403.8	362	360	334
40	69.4	466.9	434.3	398	396	365
41	78.0	501.9	474.1	424	422	396
42	81.1	499.2	465.4	418	416	384
43	31.1	220.9	196.5	190	189	165
44	31.5	227.7	197.5	196	195	166
45	31.3	246.1	215.0	215	214	184
46	31.7	263.3	226.5	232	231	195
47	31.2	257.5	224.3	226	225	193
48	32.2	241.6	210.4	209	208	178
49	31.3	222.5	195.4	191	190	164
50						
51						

	N	O	P	Q	R	S
1						
2						
3						
4						
5	mass of bottle of sand		volume			
6	with de-ionized water added		of water	total liquid		peak
7	target	actual	added	volume	filename of	height
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)
9	277	270.3	97.0	97.5	JWM03B97.37R	0.290
10	142	143.5	56.7	57.2	JWM03B97.38R	0.226
11	156	157.9	64.0	64.6	JWM03B97.39R	0.230
12	185	183.0	74.9	75.8	JWM03B97.42R	0.277
13	144	144.2	56.5	57.3	JWM03B97.43R	0.167
14	203	202.1	85.1	86.5	JWM03B97.44R	0.077
15	252	247.4	105.1	107	JWM03B97.45R	0.058
16	134	133.3	50.7	51.8	JWM03B97.46R	0.045
17	140	141.1	55.3	56.5	JWM03B97.47R	0.057
18	196	198.5	84.8	86.8	JWM03B97.48R	0.080
19	138	136.7	52.2	53.4	JWM03B97.49R	0.073
20	160	160.6	65.0	66.6	JWM03B97.50R	0.106
21	238	237.5	102.8	105.00	JWM03B97.51R	0.091
22	287	279.5	120.3	123.00	JWM03B97.52R	0.170
23	314	312.6	139.3	142.00	JWM03B97.53R	0.170
24	190	179.0	68.4	70.0	JWM03B97.54R	0.185
25	144	142.3	54.8	55.5	JWM03B97.55R	0.150
26	265	263.2	115.7	117	JWM03B97.56R	0.136
27	315	316.3	143.5	145	JWM03B97.57R	0.106
28	339	332.4	147.2	148	JWM03B97.58R	0.107
29	300	297.7	132.2	133	JWM03B97.59R	0.078
30	312	309.0	137.3	138	JWM03B97.60R	0.087
31	277	273.6	119.5	120	JWM03B97.61R	0.086
32	324	324.4	146.9	148	JWM03B97.62R	0.073
33	315	315.1	142.0	143	JWM03B97.63R	0.110
34	789	680.9	247.1	249	JWM03C97.61R	0.180
35	865	731.8	265.1	267	JWM03C97.62R	0.183
36	743	662.3	251.8	254	JWM03C97.63R	0.090
37	881	718.3	243.4	245	JWM03C97.64R	0.226
38	819	695.2	251.6	254	JWM03C97.65R	0.168
39	738	688.6	284.8	287	JWM03C97.66R	0.113
40	799	658.5	224.2	226	JWM03C97.67R	0.210
41	870	732.1	258.0	260	JWM03C97.68R	0.270
42	850	706.5	241.1	243	JWM03C97.70R	0.150
43	362	313.2	116.7	118	JWM03C97.71R	0.100
44	364	325.7	128.2	129	JWM03C97.73R	0.030
45	399	376.3	161.3	162	JWM03C97.74R	0.015
46	422	341.1	114.6	116	JWM03C97.76R	0.020
47	417	373.2	148.9	150	JWM03C97.78R	0.010
48	388	346.2	135.8	137	JWM03C97.80R	0.000
49	359	337.2	141.8	143	JWM03C97.81R	0.000
50						
51						

	T	U	V	W	X	Y	Z
1							
2							
3							
4							
5	slope of	chloride					
6	standard	concentration	mass of Cl	mass of Cl			
7	curve	in leachate	in leachate	in interval			
8	((mg/L)/mV)	(mg/L)	(mg)	(mg)			
9	0.5724	0.166	0.016	0.019			
10	0.5724	0.129	0.007	0.009			
11	0.5724	0.132	0.009	0.010			
12	0.5724	0.159	0.012	0.014			
13	0.5724	0.096	0.005	0.007			
14	0.5724	0.044	0.004	0.004			
15	0.5724	0.033	0.004	0.004			
16	0.5724	0.026	0.001	0.002			
17	0.5724	0.033	0.002	0.002			
18	0.5724	0.046	0.004	0.004			
19	0.5724	0.042	0.002	0.003			
20	0.5724	0.061	0.004	0.005			
21	0.5724	0.052	0.005	0.006			
22	0.5724	0.097	0.012	0.013			
23	0.5724	0.097	0.014	0.015			
24	0.5724	0.106	0.007	0.008			
25	0.5724	0.086	0.005	0.006			
26	0.5724	0.078	0.009	0.011			
27	0.5724	0.061	0.009	0.010			
28	0.5724	0.061	0.009	0.011			
29	0.5724	0.045	0.006	0.007			
30	0.5724	0.050	0.007	0.008			
31	0.5724	0.049	0.006	0.007			
32	0.5724	0.042	0.006	0.007			
33	0.5724	0.063	0.009	0.010			
34	0.4227	0.076	0.019	0.021			
35	0.4227	0.077	0.021	0.022			
36	0.4227	0.038	0.010	0.011			
37	0.4227	0.096	0.023	0.025			
38	0.4227	0.071	0.018	0.020			
39	0.4227	0.048	0.014	0.015			
40	0.4227	0.089	0.020	0.022			
41	0.4227	0.114	0.030	0.032			
42	0.4227	0.063	0.015	0.017			
43	0.4227	0.042	0.005	0.006			
44	0.4227	0.013	0.002	0.002			
45	0.4227	0.006	0.001	0.001			
46	0.4227	0.008	0.001	0.001			
47	0.4227	0.004	0.001	0.001			
48	0.4227	0.000	0.000	0.000			
49	0.4227	0.000	0.000	0.000			
50							
51				0.398			

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	119	0.9	0.0050	160
10	183	1.4	0.0097	142
11	255	2.0	0.0095	139
12	341	2.6	0.0116	162
13	407	3.2	0.0142	106
14	503	3.9	0.0163	41.9
15	626	4.9	0.0203	32.5
16	686	5.3	0.0221	33.1
17	751	5.8	0.0232	30.8
18	842	6.5	0.0246	44.0
19	915	7.1	0.0236	40.9
20	987	7.7	0.0247	69.5
21	1099	8.5	0.0237	53.6
22	1232	9.6	0.0200	97.7
23	1379	10.7	0.0180	102
24	1463	11.3	0.0153	95.9
25	1531	11.9	0.0120	88.2
26	1669	12.9	0.0100	79.7
27	1826	14.2	0.0090	63.7
28	2012	15.6	0.0077	59.1
29	2167	16.8	0.0076	45.2
30	2330	18.1	0.0073	49.1
31	2471	19.2	0.0070	49.6
32	2637	20.5	0.0070	42.2
33	2796	21.7	0.0068	62.9
34	3183	24.7	0.0050	54.3
35	3612	28.0	0.0048	51.3
36	3975	30.8	0.0056	30.3
37	4411	34.2	0.0047	57.3
38	4817	37.4	0.0052	49.3
39	5177	40.2	0.0063	41.7
40	5573	43.2	0.0056	55.6
41	5995	46.5	0.0059	75.8
42	6411	49.7	0.0055	40.9
43	6600	51.2	0.0049	31.7
44	6795	52.7	0.0050	10.3
45	7009	54.4	0.0049	4.67
46	7240	56.2	0.0050	4.33
47	7465	57.9	0.0049	4.44
48	7673	59.5	0.0049	0.00
49	7863	61.0	0.0051	0.00
50				
51				

	A	B	C	D	E	F	G
1	Appendix B.5.1.5						
2	Calculation of results for column extracted on January 31, 1997,						
3	from position 7 of row 1						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.7544	30.3824	30.3139	0.0685	14.5595	0.0047
10	2	15.7574	22.0580	22.0180	0.0400	6.2606	0.0064
11	3	15.4839	28.9012	28.8237	0.0775	13.3398	0.0058
12	4	15.4245	29.9577	29.8700	0.0877	14.4455	0.0061
13	5	15.4735	32.0821	31.9822	0.0999	16.5087	0.0061
14	6	15.8327	36.0988	35.9775	0.1213	20.1448	0.0060
15	7	15.6560	42.9403	42.7779	0.1624	27.1219	0.0060
16	8	15.4652	41.3543	41.2000	0.1543	25.7348	0.0060
17	9	15.6771	32.1034	32.0079	0.0955	16.3308	0.0058
18	10	15.9607	40.4932	40.3469	0.1463	24.3862	0.0060
19	11	15.7250	33.8149	33.7053	0.1096	17.9803	0.0061
20	12	15.5590	30.1745	30.0854	0.0891	14.5264	0.0061
21	13	15.6300	32.9530	32.8480	0.1050	17.2180	0.0061
22	14	15.7280	32.8171	32.7137	0.1034	16.9857	0.0061
23	15	15.5876	41.5051	41.3525	0.1526	25.7649	0.0059
24	16	15.7353	37.8640	37.7325	0.1315	21.9972	0.0060
25	17	15.3475	36.8591	36.7312	0.1279	21.3837	0.0060
26	18	15.4183	39.2833	39.1412	0.1421	23.7229	0.0060
27	19	15.8135	51.6789	51.4700	0.2089	35.6565	0.0059
28	20	15.5490	42.3942	42.2367	0.1575	26.6877	0.0059
29	21	15.8912	52.5877	52.3747	0.2130	36.4835	0.0058
30	22	15.6184	36.8272	36.6996	0.1276	21.0812	0.0061
31	23	15.4159	41.8644	41.7097	0.1547	26.2938	0.0059
32	24	15.6175	41.9988	41.8462	0.1526	26.2287	0.0058
33	25	15.4518	45.6928	45.5189	0.1739	30.0671	0.0058
34	26	15.4940	44.3516	44.2112	0.1404	28.7172	0.0049
35	27	15.4263	45.0175	44.8554	0.1621	29.4291	0.0055
36	28	15.4768	43.8501	43.6919	0.1582	28.2151	0.0056
37	29	15.8378	43.5085	43.3608	0.1477	27.5230	0.0054
38	30	15.6528	43.3977	43.2242	0.1735	27.5714	0.0063
39	31	15.4685	44.4685	44.3091	0.1594	28.8406	0.0055
40	32	15.6887	43.2645	43.1082	0.1563	27.4195	0.0057
41	33	15.6211	43.8053	43.6545	0.1508	28.0334	0.0054
42	34	15.6594	58.7256	58.5032	0.2224	42.8438	0.0052
43	35	15.7489	57.1387	56.9128	0.2259	41.1639	0.0055
44	36	15.8065	49.2783	49.0991	0.1792	33.2926	0.0054
45							
46	SUM :						

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	68.5	210.0	195.4	142	141.0	127
10	31.3	82.6	76.3	51.3	51.0	45.0
11	32.0	95.4	82.0	63.4	63.0	50.0
12	31.4	131.2	116.6	99.8	99.2	85.2
13	31.3	148.6	132.0	117	116	101
14	31.1	162.2	141.9	131	130	111
15	31.1	155.5	128.1	124	123	97.0
16	31.0	181.6	155.7	151	150	125
17	31.1	135.4	118.9	104	103	87.8
18	31.1	135.9	111.2	105	104	80.1
19	31.2	158.8	140.6	128	127	109
20	31.4	111.4	96.7	80.0	79.5	65.3
21	30.9	136.4	119.2	106	105	88.3
22	31.3	148.8	131.7	118	117	100
23	31.3	202.9	177.0	172	171	146
24	31.4	148.6	126.5	117	116	95.1
25	31.3	176.5	155.0	145	144	124
26	31.2	190.1	166.3	159	158	135
27	31.1	251.7	215.9	221	220	185
28	32.2	223.0	196.1	191	190	164
29	31.5	268.3	231.6	237	236	200
30	31.9	231.7	210.5	200	199	179
31	31.1	260.2	233.7	229	228	203
32	31.1	250.8	224.4	220	219	193
33	31.1	244.9	214.5	214	213	183
34	68.7	427.5	398.5	359	357	330
35	68.8	395.3	365.6	327	325	297
36	68.8	415.2	386.8	346	344	318
37	80.9	463.3	435.7	382	380	355
38	69.2	434.5	406.7	365	363	338
39	69.3	488.8	459.7	420	418	390
40	78.6	441.7	414.0	363	361	335
41	69.5	485.4	457.1	416	414	388
42	68.7	471.3	428.1	403	401	359
43	78.0	453.8	412.3	376	374	334
44	69.3	503.6	470.0	434	432	401
45						
46						

	N	O	P	Q	R	S	T
1							
2							
3							
4							
5	mass of bottle of sand		volume				slope of
6	with de-ionized water added		of water	total liquid		peak	standard
7	target	actual	added	volume	filename of	height	curve
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)	((mg/L)/mV)
9	322	315.2	119.8	120.00	JWM03B97.72R	0.220	0.5068
10	121	119.0	42.7	43.0	JWM03B97.73R	0.180	0.5068
11	132	131.7	49.7	50.0	JWM03B97.74R	0.180	0.5068
12	202	209.6	93.0	93.5	JWM03B97.75R	0.093	0.5068
13	233	232.5	100.5	101	JWM03B97.76R	0.070	0.5068
14	253	251.4	109.5	110	JWM03B97.77R	0.055	0.5068
15	225	223.5	95.4	96.0	JWM03B97.78R	0.060	0.5068
16	281	278.9	123.2	124	JWM03B97.79R	0.025	0.5068
17	207	216.8	97.9	98.4	JWM03B97.80R	0.024	0.5068
18	191	190.6	79.4	79.9	JWM03B97.81R	0.034	0.5068
19	250	250.1	109.5	110	JWM03B97.82R	0.025	0.5068
20	162	161.0	64.3	64.7	JWM03B97.83R	0.032	0.5068
21	208	205.1	85.9	86.4	JWM03B97.84R	0.023	0.5068
22	232	231.9	100.2	101	JWM03B97.85R	0.020	0.5068
23	323	316.2	139.2	140	JWM03B97.86R	0.018	0.5068
24	222	218.8	92.3	92.9	JWM03B97.87R	0.015	0.5068
25	279	274.4	119.4	120	JWM03B97.88R	0.009	0.5068
26	301	296.9	130.6	131	JWM03B97.89R	0.015	0.5068
27	401	397.0	181.1	182	JWM03B97.90R	0.030	0.5068
28	360	358.9	162.8	164	JWM03B97.91R	0.021	0.5068
29	432	427.8	196.2	197	JWM03B97.92R	0.018	0.5068
30	390	389.0	178.5	180	JWM03B97.94R	0.018	0.5068
31	437	439.2	205.5	207	JWM03B97.95R	0.010	0.5068
32	417	415.6	191.2	192	JWM03B97.96R	0.013	0.5068
33	398	392.7	178.2	179	JWM03B97.97R	0.000	0.5068
34	729	661.2	262.7	264	JWM03C97.86R	0.065	0.6083
35	663	648.8	283.2	285	JWM03C97.87R	0.000	0.6083
36	705	628.7	241.9	244	JWM03C97.88R	0.010	0.6083
37	791	658.9	223.2	225	JWM03C97.89R	0.020	0.6083
38	745	660.5	253.8	256	JWM03C97.90R	0.020	0.6083
39	850	647.0	187.3	189	JWM03C97.91R	0.064	0.6083
40	749	657.5	243.5	245	JWM03C97.92R	0.030	0.6083
41	845	684.4	227.3	229	JWM03C97.93R	0.020	0.6083
42	787	672.2	244.1	246	JWM03C97.94R	0.090	0.6083
43	746	681.0	268.7	271	JWM03C97.95R	0.000	0.6083
44	871	705.4	235.4	238	JWM03C97.96R	0.028	0.6083
45							
46							

	U	V	W	X	Y	Z
1						
2						
3						
4						
5	chloride					
6	concentration	mass of Cl	mass of Cl			
7	in leachate	in leachate	in interval			
8	(mg/L)	(mg)	(mg)			
9	0.111	0.013	0.015			
10	0.091	0.004	0.005			
11	0.091	0.005	0.006			
12	0.047	0.004	0.005			
13	0.035	0.004	0.005			
14	0.028	0.003	0.004			
15	0.030	0.003	0.004			
16	0.013	0.002	0.002			
17	0.012	0.001	0.001			
18	0.017	0.001	0.001			
19	0.013	0.001	0.001			
20	0.016	0.001	0.001			
21	0.012	0.001	0.001			
22	0.010	0.001	0.001			
23	0.009	0.001	0.001			
24	0.008	0.001	0.001			
25	0.005	0.001	0.001			
26	0.008	0.001	0.001			
27	0.015	0.003	0.004			
28	0.011	0.002	0.002			
29	0.009	0.002	0.002			
30	0.009	0.002	0.002			
31	0.005	0.001	0.001			
32	0.007	0.001	0.001			
33	0.000	0.000	0.000			
34	0.040	0.010	0.011			
35	0.000	0.000	0.000			
36	0.006	0.001	0.001			
37	0.012	0.003	0.003			
38	0.012	0.003	0.003			
39	0.039	0.007	0.008			
40	0.018	0.004	0.004			
41	0.012	0.003	0.003			
42	0.055	0.013	0.015			
43	0.000	0.000	0.000			
44	0.017	0.004	0.004			
45						
46			0.120			

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	141	1.1	0.0047	106
10	192	1.5	0.0064	98.0
11	255	2.0	0.0058	95.2
12	354.2	2.8	0.0061	50.4
13	470.2	3.7	0.0061	43.1
14	600.2	4.7	0.0060	30.8
15	723.2	5.7	0.0060	32.5
16	873.2	6.9	0.0060	13.3
17	976.2	7.7	0.0058	9.71
18	1080.2	8.5	0.0060	9.62
19	1207.2	9.5	0.0061	7.87
20	1286.7	10.1	0.0061	12.6
21	1391.7	10.9	0.0061	9.52
22	1508.7	11.8	0.0061	8.55
23	1679.7	13.2	0.0059	5.85
24	1795.7	14.1	0.0060	8.62
25	1939.7	15.2	0.0060	6.94
26	2097.7	16.5	0.0060	6.33
27	2317.7	18.2	0.0059	18.2
28	2507.7	19.7	0.0059	10.5
29	2743.7	21.5	0.0058	8.47
30	2942.7	23.1	0.0061	10.1
31	3170.7	24.9	0.0059	4.39
32	3389.7	26.6	0.0058	4.57
33	3602.7	28.3	0.0058	0.00
34	3959.7	31.1	0.0049	30.8
35	4284.7	33.6	0.0055	0.00
36	4628.7	36.3	0.0056	2.91
37	5008.7	39.3	0.0054	7.89
38	5371.7	42.2	0.0063	8.26
39	5789.7	45.4	0.0055	19.1
40	6150.7	48.3	0.0057	11.1
41	6564.7	51.5	0.0054	7.25
42	6965.7	54.7	0.0052	37.4
43	7339.7	57.6	0.0055	0.00
44	7771.7	61.0	0.0054	9.26
45				
46				

	A	B	C	D	E	F	G
1	Appendix B.5.1.6						
2	Calculation of results for column extracted on March 3, 1997,						
3	from position 8 of row 1						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.7560	27.6485	27.5493	0.0992	11.7933	0.0084
10	2	15.7560	27.6485	27.5493	0.0992	11.7933	0.0084
11	3	15.4846	37.5644	37.3710	0.1934	21.8864	0.0088
12	4	15.4246	35.8901	35.6940	0.1961	20.2694	0.0097
13	5	15.4725	32.0661	31.8740	0.1921	16.4015	0.0117
14	6	15.8345	33.6876	33.4337	0.2539	17.5992	0.0144
15	7	15.6524	29.0929	28.8506	0.2423	13.1982	0.0184
16	8	15.4652	26.9349	26.6720	0.2629	11.2068	0.0235
17	9	15.6770	25.7492	25.4776	0.2716	9.8006	0.0277
18	10	15.9593	26.4882	26.1927	0.2955	10.2334	0.0289
19	11	15.7264	30.4751	30.0424	0.4327	14.3160	0.0302
20	12	15.5590	25.8051	25.5022	0.3029	9.9432	0.0305
21	13	15.6282	37.7704	37.1248	0.6456	21.4966	0.0300
22	14	15.7280	33.0592	32.5277	0.5315	16.7997	0.0316
23	15	15.5868	24.4874	24.2034	0.2840	8.6166	0.0330
24	16	15.7354	26.7187	26.3704	0.3483	10.6350	0.0328
25	17	15.3467	24.8842	24.5708	0.3134	9.2241	0.0340
26	18	15.4170	27.0899	26.7312	0.3587	11.3142	0.0317
27	19	15.8124	37.2228	36.5543	0.6685	20.7419	0.0322
28	20	15.5428	31.2547	30.7324	0.5223	15.1896	0.0344
29	21	15.1900	27.3478	26.9714	0.3764	11.7814	0.0319
30	22	15.6166	30.5226	30.0166	0.5060	14.4000	0.0351
31	23	15.4134	29.6952	29.1840	0.5112	13.7706	0.0371
32	24	15.6174	34.1157	33.4874	0.6283	17.8700	0.0352
33	25	15.4500	32.9742	32.3440	0.6302	16.8940	0.0373
34	26	15.4682	34.3464	33.6487	0.6977	18.1805	0.0384
35	27	15.7955	29.6846	29.1138	0.5708	13.3183	0.0429
36	28	15.7810	30.1736	29.5897	0.5839	13.8087	0.0423
37	29	15.6977	38.6315	37.8284	0.8031	22.1307	0.0363
38	30	15.7844	34.6977	34.0229	0.6748	18.2385	0.0370
39	31	15.6806	35.2753	34.7680	0.5073	19.0874	0.0266
40	32	15.6193	32.5483	32.0974	0.4509	16.4781	0.0274
41	33	15.6593	34.6970	34.2030	0.4940	18.5437	0.0266
42	34	15.7480	35.9391	35.3652	0.5739	19.6172	0.0293
43	35	15.7938	33.5988	32.9324	0.6664	17.1386	0.0389
44	36	15.8417	37.0547	36.3610	0.6937	20.5193	0.0338
45	37	15.4143	33.1654	32.5646	0.6008	17.1503	0.0350
46	38	15.4514	44.2232	43.1942	1.0290	27.7428	0.0371
47	39	15.9426	34.9111	34.3275	0.5836	18.3849	0.0317
48	40	15.6474	32.8135	32.3545	0.4590	16.7071	0.0275
49	41	15.6587	34.5537	34.1009	0.4528	18.4422	0.0246
50	42	15.3531	30.1718	29.8671	0.3047	14.5140	0.0210
51	43	15.4870	31.6099	31.1900	0.4199	15.7030	0.0267
52							
53	SUM :						

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	69.0	243.3	243.2	174	173	174.2
10	30.7	89.0	77.0	58.3	57.8	46.3
11	31.3	129.6	107.3	98.3	97.4	76.0
12	31.5	144.7	124.1	113	112	92.6
13	32.0	161.7	144.9	130	129	112.9
14	31.3	130.9	113.0	99.6	98.2	81.7
15	34.0	107.0	93.4	73.0	71.7	59.4
16	31.1	108.8	97.3	77.7	75.9	66.2
17	31.1	152.9	142.9	122	119	111.8
18	30.9	120.4	91.9	89.5	87.0	61.0
19	31.2	95.0	80.1	63.8	61.9	48.9
20	31.1	122.5	112.3	91.4	88.7	81.2
21	31.3	124.2	101.7	92.9	90.2	70.4
22	31.3	138.5	121.3	107	104	90.0
23	31.4	115.4	106.4	84.0	81.3	75.0
24	31.0	130.2	119.3	99.2	96.1	88.3
25	31.1	175.5	165.9	144	139	134.8
26	31.2	152.5	140.9	121	117	109.7
27	31.1	177.9	155.9	147	142	124.8
28	31.4	144.1	128.3	113	109	96.9
29	31.3	201.6	190.1	170	165	158.8
30	77.4	367.9	352.8	291	281	275.4
31	69.1	318.4	304.1	249	240	235.0
32	68.8	297.1	278.6	228	220	209.8
33	68.8	340.5	323.0	272	262	254.2
34	77.1	345.7	326.9	269	259	249.8
35	31.5	361.3	347.5	330	316	316.0
36	68.9	374.1	359.7	305	293	290.8
37	68.5	325.4	302.4	257	248	233.9
38	81.2	335.1	316.1	254	245	234.9
39	78.1	342.7	323.0	265	258	244.9
40	78.6	363.5	346.5	285	277	267.9
41	70.0	413.3	394.3	343	334	324.3
42	69.6	416.9	396.6	347	337	327.0
43	69.2	387.0	369.5	318	306	300.3
44	81.5	252.9	231.6	171	165	150.1
45	69.5	303.3	285.6	234	226	216.1
46	69.2	368.5	339.6	299	288	270.4
47	79.2	299.5	280.4	220	213	201.2
48	69.1	312.8	295.6	244	237	226.5
49	69.2	311.9	292.9	243	237	223.7
50	69.0	330.9	316.1	262	257	247.1
51	79.7	319.8	303.7	240	234	224.0
52						
53						

	N	O	P	Q	R	S	T
1							
2							
3							
4							
5	mass of bottle of sand		volume				slope of
6	with de-ionized water added		of water	total liquid		peak	standard
7	target	actual	added	volume	filename of	height	curve
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)	((mg/L)/mV)
9		416.1	172.9	174.4	JWM03C97.04R	0.060	0.5381
10	123.3	121.3	44.3	44.7	JWM03C97.05R	0.017	0.5381
11	183.3	196.4	89.1	89.8	JWM03C97.06R	0.019	0.5381
12	216.7	211.9	87.8	88.7	JWM03C97.07R	0.020	0.5381
13	257.8	251.2	106.3	107.6	JWM03C97.08R	0.020	0.5381
14	194.7	191.9	78.9	80.1	JWM03C97.09R	0.015	0.5381
15	152.8	157.0	63.6	64.7	JWM03C97.11R	0.020	0.5381
16	163.5	169.8	72.5	74.0	JWM03C97.12R	0.070	0.5381
17	254.7	251.2	108.3	111.3	JWM03C97.13R	0.035	0.5381
18	152.9	149.6	57.7	59.4	JWM03C97.14R	0.050	0.5381
19	129.0	130.3	50.2	51.6	JWM03C97.15R	0.036	0.5381
20	193.5	191.5	79.2	81.6	JWM03C97.16R	0.010	0.5381
21	172.1	168.1	66.4	68.5	JWM03C97.17R	0.040	0.5381
22	211.3	218.6	97.3	100.1	JWM03C97.18R	0.066	0.5381
23	181.4	177.1	70.7	73.1	JWM03C97.19R	0.050	0.5381
24	207.6	212.6	93.3	96.1	JWM03C97.20R	0.034	0.5381
25	300.7	300.5	134.6	139.0	JWM03C97.21R	0.023	0.5381
26	250.6	247.6	106.7	110.1	JWM03C97.22R	0.055	0.5381
27	280.7	284.9	129.0	132.9	JWM03C97.23R	0.049	0.5381
28	225.2	232.7	104.4	108	JWM03C97.24R	0.037	0.5381
29	348.9	353.1	163.0	167.9	JWM03C97.25R	0.039	0.5381
30	628.2	617.5	264.7	274.0	JWM03C97.26R	0.053	0.5381
31	539.1	536.0	231.9	240.3	JWM03C97.27R	0.038	0.5381
32	488.4	480.3	201.7	208.8	JWM03C97.28R	0.050	0.5381
33	577.2	566.6	243.6	252.7	JWM03C97.29R	0.020	0.5381
34	576.7	562.8	235.9	245.1	JWM03C97.36R	0.055	0.5117
35	663.5	671.9	324.4	337.4	JWM03C97.37R	0.052	0.5117
36	650.5	638.4	278.7	290.5	JWM03C97.38R	0.070	0.5117
37	536.3	531.0	228.6	236.8	JWM03C97.39R	0.050	0.5117
38	551.0	555.2	239.1	247.5	JWM03C97.40R	0.038	0.5117
39	567.9	565.7	242.7	249.0	JWM03C97.41R	0.214	0.5117
40	614.4	633.6	287.1	294.2	JWM03C97.42R	0.074	0.5117
41	718.6	722.5	328.2	336.6	JWM03C97.43R	0.094	0.5117
42	723.6	715.2	318.6	327.9	JWM03C97.44R	0.086	0.5117
43	669.8	669.3	299.8	311.0	JWM03C97.45R	0.123	0.5117
44	381.7	375.8	144.2	149.1	JWM03C97.46R	0.130	0.5117
45	501.7	502.8	217.2	224.5	JWM03C97.47R	0.098	0.5117
46	610.0	612.4	272.8	282.5	JWM03C97.48R	0.130	0.5117
47	481.6	476.5	196.1	202.3	JWM03C97.49R	0.172	0.5117
48	522.1	526.0	230.4	236.5	JWM03C97.50R	0.059	0.5117
49	516.6	534.8	241.9	247.3	JWM03C97.51R	0.059	0.5117
50	563.2	557.5	241.4	246.5	JWM03C97.52R	0.030	0.5117
51	527.7	517.1	213.4	219.2	JWM03C97.53R	0.060	0.5117
52							
53							

	U	V	W	X	Y	Z
1						
2						
3						
4						
5	chloride					
6	concentration	mass of Cl	mass of Cl			
7	in leachate	in leachate	in interval			
8	(mg/L)	(mg)	(mg)			
9	0.032	0.006	0.006			
10	0.009	0.0004	0.0005			
11	0.010	0.001	0.001			
12	0.011	0.001	0.001			
13	0.011	0.001	0.001			
14	0.008	0.001	0.001			
15	0.011	0.001	0.001			
16	0.038	0.003	0.004			
17	0.019	0.002	0.002			
18	0.027	0.002	0.003			
19	0.019	0.001	0.001			
20	0.005	0.0004	0.0005			
21	0.022	0.002	0.003			
22	0.036	0.004	0.005			
23	0.027	0.002	0.002			
24	0.018	0.002	0.002			
25	0.012	0.002	0.002			
26	0.030	0.003	0.003			
27	0.026	0.003	0.004			
28	0.020	0.002	0.002			
29	0.021	0.004	0.004			
30	0.029	0.008	0.008			
31	0.020	0.005	0.005			
32	0.027	0.006	0.007			
33	0.011	0.003	0.003			
34	0.028	0.007	0.008			
35	0.027	0.009	0.009			
36	0.036	0.010	0.010			
37	0.026	0.006	0.007			
38	0.019	0.005	0.005			
39	0.110	0.027	0.029			
40	0.038	0.011	0.012			
41	0.048	0.016	0.017			
42	0.044	0.014	0.015			
43	0.063	0.020	0.021			
44	0.067	0.010	0.011			
45	0.050	0.011	0.012			
46	0.067	0.019	0.021			
47	0.088	0.018	0.020			
48	0.030	0.007	0.008			
49	0.030	0.007	0.008			
50	0.015	0.004	0.004			
51	0.031	0.007	0.008			
52						
53			0.297			

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	173	1.3	0.0084	34.7
10	231	1.8	0.0084	8.6
11	328	2.5	0.0088	10.3
12	440	3.4	0.0097	8.9
13	569	4.4	0.0117	7.8
14	667	5.1	0.0144	10.2
15	739	5.7	0.0184	14.0
16	815	6.3	0.0235	52.7
17	934	7.2	0.0277	16.8
18	1021	7.8	0.0289	34.5
19	1083	8.3	0.0302	16.1
20	1172	9.0	0.0305	5.6
21	1262	9.7	0.0300	33.3
22	1366	10.5	0.0316	48.1
23	1447	11.1	0.0330	24.6
24	1543	11.8	0.0328	20.8
25	1682	12.9	0.0340	14.4
26	1799	13.8	0.0317	25.6
27	1941	14.9	0.0322	28.2
28	2050	15.7	0.0344	18.3
29	2215	17.0	0.0319	24.2
30	2496	19.2	0.0351	28.5
31	2736	21.0	0.0371	20.8
32	2956	22.7	0.0352	31.8
33	3218	24.7	0.0373	11.5
34	3477	26.7	0.0384	30.9
35	3793	29.1	0.0429	28.5
36	4086	31.4	0.0423	34.1
37	4334	33.3	0.0363	28.2
38	4579	35.1	0.0370	20.4
39	4837	37.1	0.0266	112.4
40	5114	39.3	0.0274	43.3
41	5448	41.8	0.0266	50.9
42	5785	44.4	0.0293	44.5
43	6091	46.7	0.0389	68.6
44	6256	48.0	0.0338	66.7
45	6482	49.8	0.0350	53.1
46	6770	52.0	0.0371	72.9
47	6983	53.6	0.0317	93.9
48	7220	55.4	0.0275	33.8
49	7457	57.2	0.0246	33.8
50	7714	59.2	0.0210	15.6
51	7948	61.0	0.0267	34.2
52				
53				

	A	B	C	D	E	F	G
1	Appendix B.5.1.7						
2	Calculation of results for column extracted on April 1, 1997,						
3	from position 1 of row 2						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.76760	50.19770	50.03970	0.15800	34.27210	0.00461
10	2	15.76060	31.74080	31.51630	0.22450	15.75570	0.01425
11	3	15.48440	35.91850	35.13570	0.78280	19.65130	0.03983
12	4	15.42410	33.66590	32.85680	0.80910	17.43270	0.04641
13	5	15.47370	40.79560	39.76460	1.03100	24.29090	0.04244
14	6	15.83770	37.85180	37.22030	0.63150	21.38260	0.02953
15	7	15.65430	39.49600	39.25530	0.24070	23.60100	0.01020
16	8	15.46610	47.06620	46.85010	0.21610	31.38400	0.00689
17	9	15.67770	56.36030	56.10120	0.25910	40.42350	0.00641
18	10	15.96040	56.52970	56.28080	0.24890	40.32040	0.00617
19	11	15.72590	34.65510	34.54140	0.11370	18.81550	0.00604
20							
21	SUM						

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	69.3	261.0	226.5	191.7	190.8	157.2
10	100.8	828.3	812.3	727.5	717.3	711.5
11	101.0	986.8	966.3	885.8	851.9	865.3
12	101.0	908.7	889.9	807.7	771.9	788.9
13	101.8	1075.8	1050.4	974.0	934.3	948.6
14	103.7	536.2	514.2	432.5	420.1	410.5
15	101.5	1116.1	1092.2	1014.6	1004.4	990.7
16	102.2	1244.8	1213.2	1142.6	1134.8	1111
17	103.9	1111.1	1070.3	1007.2	1000.8	966.4
18	100.6	1147.8	1107.2	1047.2	1040.8	1006.6
19	68.5	206.4	187.5	137.9	137.1	119.0
20						
21						

	N	O	P	Q	R	S
1						
2						
3						
4						
5	mass of bottle of sand		volume			
6	with de-ionized water added		of water	total liquid		peak
7	target	actual	added	volume	filename of	height
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)
9	383.7	376.4	149.9	150.6	JWM03D97.18R	0.197
10	1523.8	1234.4	422.1	432.1	JWM03D97.07R	0.153
11	1831.6	1448.2	481.9	515.0	JWM03D97.08R	0.105
12	1678.8	1376.3	486.4	521.4	JWM03D97.09R	0.216
13	1999.0	1501.8	451.4	490.0	JWM03D97.10R	0.312
14	924.7	779.9	265.7	277.5	JWM03D97.11R	0.329
15	2082.9	1619.7	527.5	537.5	JWM03D97.12R	0.406
16	2324.2	1674.2	461.0	468.6	JWM03D97.13R	0.230
17	2036.7	1597.5	527.2	533.4	JWM03D97.14R	0.264
18	2113.8	1623.6	516.4	522.6	JWM03D97.15R	0.293
19	306.5	264.9	77.4	78.1	JWM03D97.16R	0.232
20						
21						

	T	U	V	W	X	Y	Z
1							
2							
3							
4							
5	slope of	chloride					
6	standard	concentration	mass of Cl	mass of Cl			
7	curve	in leachate	in leachate	in interval			
8	((mg/L)/mV)	(mg/L)	(mg)	(mg)			
9	0.5993	0.118	0.018	0.022			
10	0.5993	0.092	0.040	0.041			
11	0.5993	0.063	0.032	0.033			
12	0.5993	0.129	0.067	0.069			
13	0.5993	0.187	0.092	0.094			
14	0.5993	0.197	0.055	0.058			
15	0.5993	0.243	0.131	0.134			
16	0.5993	0.138	0.065	0.067			
17	0.5993	0.158	0.084	0.088			
18	0.5993	0.176	0.092	0.096			
19	0.5993	0.139	0.011	0.013			
20							
21				0.715			

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	190.8	1.4	0.0046	115.3
10	908.1	6.8	0.0142	57.2
11	1760	13.1	0.0398	38.7
12	2531.9	18.8	0.0464	89.4
13	3466.2	25.8	0.0424	100.6
14	3886.3	28.9	0.0295	138.1
15	4890.7	36.4	0.0102	133.4
16	6025.5	44.8	0.0069	59.0
17	7026.3	52.2	0.0064	87.9
18	8067.1	60.0	0.0062	92.2
19	8204.2	61.0	0.0060	94.8
20				
21				

	A	B	C	D	E	F	G
1	Appendix B.5.1.8						
2	Calculation of results for column extracted on April 30, 1997,						
3	from position 2 of row 2						
4							
5				mass of			
6		mass of	mass of	full tin	mass of	mass of	gravimetric
7	interval	empty tin	full tin	after drying	water	dry sand	water content
8		(g)	(g)	(g)	(g)	(g)	(g water / g dry sand)
9	1	15.6577	37.6170	37.5531	0.0639	21.8954	0.0029
10	2	15.7556	33.7848	33.5955	0.1893	17.8399	0.0106
11	3	15.4821	25.4339	25.0941	0.3398	9.6120	0.0354
12	4	15.4250	35.0470	34.3714	0.6756	18.9464	0.0357
13	5	15.4755	28.6094	28.1303	0.4791	12.6548	0.0379
14	6	15.8335	27.1274	26.6314	0.4960	10.7979	0.0459
15	7	15.6510	32.7006	31.9064	0.7942	16.2554	0.0489
16	8	15.4650	34.7367	33.8315	0.9052	18.3665	0.0493
17	9	15.6765	31.8258	31.0407	0.7851	15.3642	0.0511
18	10	15.9588	31.8705	31.0548	0.8157	15.0960	0.0540
19	11	15.7243	30.4756	29.7000	0.7756	13.9757	0.0555
20	12	15.5591	30.9194	30.4205	0.4989	14.8614	0.0336
21							
22							
23	SUM :						

	H	I	J	K	L	M
1						
2						
3						
4						
5			mass of full	mass of sand	mass of	mass of sand
6	mass of	mass of full	PE bottle	and soil water	dry sand	and soil water
7	PE bottle	PE bottle	less subsample	in **interval**	in interval	in **bottle**
8	(g)	(g)	(g)	(g)	(g)	(g)
9	76.5	268.6	246.6	192.1	191.5	170.1
10	101.2	654.4	636.4	553.2	547.4	535.2
11	104.0	806.4	796.5	702.4	678.4	692.5
12	102.3	863.1	843.5	760.8	734.6	741.2
13	103.7	1035.4	1022.3	931.7	897.7	918.6
14	100.1	1132.9	1121.6	1032.8	987.4	1021.5
15	102.4	623.7	606.7	521.3	497.0	504.3
16	99.6	904.7	885.3	805.1	767.3	785.7
17	101.5	889.3	873.0	787.8	749.5	771.5
18	102.1	774.5	758.5	672.4	637.9	656.4
19	101.3	588.5	573.7	487.2	461.6	472.4
20	101.9	840.7	825.3	738.8	714.8	723.4
21						
22						
23						

	N	O	P	Q	R	S
1						
2						
3						
4						
5	mass of bottle of sand		volume			
6	with de-ionized water added		of water	total liquid		peak
7	target	actual	added	volume	filename of	height
8	(g)	(g)	(ml)	(ml)	HPLC results	(mV)
9	416.7	398.0	151.4	151.9	JWM05A97.30R	0.080
10	1171.6	894.9	258.5	264.1	JWM05A97.16R	0.027
11	1489.0	1120.9	324.4	348.0	JWM05A97.19R	0.054
12	1584.7	1172.6	329.1	354.6	JWM05A97.20R	0.064
13	1940.9	1409.8	387.5	421.0	JWM05A97.21R	0.038
14	2143.1	1565.8	444.2	489.1	JWM05A97.22R	0.073
15	1111.0	901.9	295.2	318.7	JWM05A97.23R	0.080
16	1671.0	1220.0	334.7	371.6	JWM05A97.24R	0.145
17	1644.5	1205.1	332.1	369.6	JWM05A97.25R	0.204
18	1414.9	1072.2	313.7	347.3	JWM05A97.26R	0.180
19	1046.1	835.1	261.4	286.2	JWM05A97.27R	0.267
20	1548.7	1143.6	318.3	341.8	JWM05A97.28R	0.285
21						
22						
23						

	T	U	V	W	X	Y	Z
1							
2							
3							
4							
5	slope of	chloride					
6	standard	concentration	mass of Cl	mass of Cl			
7	curve	in leachate	in leachate	in interval			
8	((mg/L)/mV)	(mg/L)	(mg)	(mg)			
9	0.53	0.04	0.006	0.007			
10	0.53	0.01	0.003	0.003			
11	0.53	0.03	0.010	0.010			
12	0.53	0.03	0.011	0.011			
13	0.53	0.02	0.008	0.008			
14	0.53	0.04	0.020	0.020			
15	0.53	0.04	0.013	0.013			
16	0.53	0.08	0.030	0.031			
17	0.53	0.11	0.041	0.042			
18	0.53	0.10	0.035	0.036			
19	0.53	0.14	0.040	0.041			
20	0.53	0.15	0.051	0.052			
21							
22							
23				0.274			

	AA	AB	AC	AD
1				
2				
3				
4	cumulative	depth in	gravimetric	Cl concentration
5	mass of	column	water content	in interval
6	dry sand		in interval	
7	in interval		before leaching	
8	(g)	depth (cm)	(g water / g dry sand)	(ng Cl / g dry sand)
9	191.5	1.5	0.0029	36.6
10	738.9	5.7	0.0106	5.5
11	1417.3	11.0	0.0354	14.7
12	2151.9	16.7	0.0357	15.0
13	3049.6	23.7	0.0379	8.9
14	4037.0	31.3	0.0459	20.3
15	4534.0	35.2	0.0489	26.2
16	5301.3	41.1	0.0493	40.4
17	6050.8	46.9	0.0511	56.0
18	6688.7	51.9	0.0540	56.4
19	7150.3	55.5	0.0555	88.8
20	7865.1	61.0	0.0336	72.7
21				
22				
23				

AP B.5.2.1

mass calculations for surface sample from within plot

mass of empty tin (g)	mass of full tin (g)	mass of full tin after drying (g)	mass of water (g)	mass of dry sand (g)	gravimetric water content (g water / g dry sand)	mass of PE bottle (g)	mass of full PE bottle (g)
15.5594	26.5928	26.4186	0.1742	10.8592	0.01604	69.5	198.6

mass of full PE bottle less subsample	mass of sand and soil water in **interval**	mass of dry sand in interval	mass of sand and soil water in **bottle**	mass of bottle of sand with de-ionized water added		volume of water added	total liquid volume
(g)	(g)	(g)	(g)	target (g)	actual (g)	(ml)	(ml)
187.5	129.1	127.1	118.0	305.5	299.0	111.5	113.4

filename of HPLC results	peak height (mV)	slope of standard curve ((mg/L)/mV)	Cl conc in leachate (mg / L)	mass Cl in leachate (mg)	mass Cl in interval (mg)	mass of dry sand in interval (g)	(mg Cl / g dry sand)
JWM05E97.04R	0.754	0.487	0.367	0.042	0.046	127.1	3.62E-04

Appendix B.6 Corrections to account for residual chloride in columns

Because the masses of chloride in each column include residual chloride, corrections are made in this appendix to determine the masses of chloride attributable to deposition. Using information from Appendix B.5, the following equations are used to make the corrections. The variables used and the results are tabulated in Table B.7.

mass of Cl deposited (mg) = measured mass of Cl - mass of residual Cl

measured mass of Cl (mg) = sum of mass of Cl in each depth interval

mass of residual Cl (mg) = [mass of dry sand in column] x [background Cl concentration]

mass of dry sand in column (g) = sum of masses of dry sand in each depth interval

background Cl concentration (mg Cl / g sand) = average of concentrations in intervals below depth of infiltration

NOTE :
The ranges of intervals below the depths of infiltration are listed in the table.

NOTE :
The chloride profile of the column extracted from position 6 of row 1 at the time of three months has one background concentration in the lower intervals (36 to 41) and another background concentration in the middle intervals (25 to 35). This suggests that the column was packed with two different sources of sand having different amounts of residual chloride. To account for this in the correction, the (measured mass of chloride) and the (mass of dry sand in column) are calculated by summing the values for intervals 1 through 35, omitting intervals 36 through 41.

TABLE B.7 Corrections to account for residual chloride in columns					
date of column extraction	12/2/96	12/31/96	1/31/97	1/31/97	4/1/97
column location (row # , position #)	(1 , 4)	(1 , 5)	(1 , 6)	(1 , 7)	(2 , 1)
intervals averaged for background concentration	9 to 14	10 to 30	25 to 35	8 to 36	8 to 11
background concentration (mg Cl / g dry sand)	4.93E-05	1.34E-05	5.01E-05	9.97E-06	8.35E-05
mass of dry sand in column (g)	7630.0	7735.0	6599.7	7771.7	8204.2
mass of background chloride in column (mg)	0.376	0.104	0.331	0.077	0.685
measured mass of chloride in column (mg)	0.415	0.137	0.393	0.120	0.715
mass of chloride deposited	0.039	0.033	0.062	0.043	0.030

Appendix B.7 Calculation of chloride deposition rates using corrected masses of chloride

For the columns amenable to the correction method, the corrected masses of chloride deposited were calculated in Appendix B.6. The corrected masses are used in Table B.8 to calculate the chloride deposition rates.

Table B.8 Calculation of chloride deposition rates					
based on corrected masses of chloride					
date of column extraction	12/2/96	12/31/96	1/31/97	1/31/97	4/1/97
column location (row # , position #)	(1 , 4)	(1 , 5)	(1 , 6)	(1 , 7)	(2 , 1)
time span of collection (years)	0.082	0.162	0.247	0.247	0.411
mass of chloride deposited (mg)	0.039	0.033	0.062	0.043	0.030
area of collection (m^2)	0.0081	0.0081	0.0081	0.0081	0.0081
chloride deposition rate (mg Cl m^{-2} yr^{-1})	58.6	25.2	31.0	21.5	9.0

Appendix C Chloride deposition rate calculations for precipitation collectors

I obtained the data for the amounts of precipitation and the chloride concentrations in precipitation samples for monthly samples of the three precipitation collectors from Doug Moore of UNM. The tables in Appendices C.1, C.2, and C.3 are used to convert these records to monthly chloride deposition rates. These rates are sorted in Appendices C.4 and C.5 to characterize the temporal variability of the rates.

Appendix C.1	Bulk precipitation collector, PW8
Appendix C.2	Wet-only collector, PW11
Appendix C.3	Dry-only collector, PW12
Appendix C.4	Cumulative mg Cl m^{-2} collected in three precipitation collectors from April 4, 1992, to April 30, 1997
Appendix C.5	Statistical analysis of chloride deposition rates and precipitation rates determined with the bulk precipitation collector

APPENDIX C.1

Calculation of chloride deposition rates for bulk precipitation collector, PW8

collection area : 0.0559 m^2

sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
3/30/89	8.98	502.0	0.30	0.15		
6/8/89	0	0	0	0	70	0
7/7/89	1.66	92.8	2.20	0.20	29	46
7/25/89	48.32	2701.1	0.00	0.00	18	0.0
9/5/89	23.47	1312.0	0.24	0.31	42	49
10/3/89	3.97	221.9	0.59	0.13	28	31
10/17/89	36.12	2019.1	0.14	0.28	14	130
1/4/90	3.58	200.1	1.92	0.38	79	32
3/15/90	18.18	1016.3	0.32	0.33	70	30
4/5/90	28.96	1618.9	0.22	0.36	21	110
4/24/90	8.82	493.0	0.45	0.22	19	76
5/8/90	18.14	1014.0	0.54	0.55	14	260
7/3/90	6.69	374.0	1.41	0.53	56	62
7/13/90	11.88	664.1	0.32	0.21	10	140
7/24/90	15.13	845.8	0.29	0.25	11	150
8/2/90	21.81	1219.2	0.24	0.29	9	210
8/16/90	17.94	1002.8	0.26	0.26	14	120
9/3/90	3.52	196.8	0.48	0.09	18	34
10/4/90	61.97	3464.1	0.14	0.48	31	100
11/5/90	4.17	233.1	0.97	0.23	32	46
1/3/91	21.99	1229.2	0.20	0.25	59	27
2/4/91	10.18	569.1	0.20	0.11	32	23
4/2/91	5.78	323.1	0.53	0.17	57	20
6/4/91	9.46	528.8	1.27	0.67	63	70
7/1/91	6.39	357.2	1.56	0.56	27	140
8/1/91	35.21	1968.2	0.81	1.59	31	340
8/23/91	68.10	3806.8	0.11	0.42	22	120
9/12/91	47.44	2651.9	0.09	0.24	20	78
10/1/91	0.70	39.1	1.30	0.05	19	17
11/6/91	7.58	423.7	0.48	0.20	36	37
12/5/91	30.13	1684.3	0.18	0.30	29	68
12/28/91	66.99	3744.7	0.13	0.49	23	140
1/9/92	2.72	152.0	0.04	0.01	12	3.31
1/28/92	11.82	660.7	0.05	0.03	19	11
3/2/92	13.24	740.1	0.08	0.06	34	11
4/4/92	43.27	2418.8	0.10	0.24	33	48
5/4/92	10.91	609.9	0.20	0.12	30	27
5/26/92	43.72	2443.9	0.16	0.39	22	120

Bulk precipitation collector, PW8						
sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
7/1/92	22.97	1284.0	0.30	0.39	36	70
7/26/92	34.26	1915.1	0.21	0.40	25	110
8/14/92	68.05	3804.0	0.10	0.38	19	130
9/2/92	27.03	1511.0	0.18	0.27	19	94
9/21/92	27.66	1546.2	0.11	0.17	19	58
11/2/92	17.66	987.2	0.26	0.26	42	40
12/1/92	3.20	178.9	0.28	0.05	29	11
1/2/93	13.42	750.2	0.06	0.05	32	9
2/1/93	6.82	381.2	0.10	0.04	30	8.3
3/3/93	17.35	969.9	0.08	0.08	30	17
4/1/93	8.01	447.8	0.20	0.09	29	20
5/20/93	9.21	514.8	0.35	0.18	49	24
7/1/93	13.74	768.1	0.53	0.41	42	63
7/20/93	0	0	0	0	19	0
8/13/93	25.06	1400.9	0.27	0.38	24	100
8/31/93	67.75	3787.2	0.14	0.53	18	190
10/1/93	5.37	300.2	0.68	0.20	31	43
11/3/93	16.85	941.9	0.20	0.19	33	37
12/1/93	8.07	451.1	0.23	0.10	28	24
12/31/93	0.55	30.7	0.60	0.02	30	4.0
2/2/94	1.61	90.0	0.00	0.00	33	0.0
3/31/94	17.84	997.3	0.16	0.16	57	18
5/4/94	2.27	126.9	0.82	0.10	34	20
6/2/94	37.28	2084.0	0.20	0.42	29	94
7/1/94	1.55	86.6	1.57	0.14	29	31
7/30/94	28.18	1575.3	0.29	0.46	29	100
8/18/94	34.17	1910.1	0.14	0.27	19	92
9/1/94	17.55	981.0	0.22	0.22	14	100
9/9/94	44.20	2470.8	0.07	0.17	8	140
9/30/94	7.05	394.1	0.23	0.09	21	28
11/3/94	31.02	1734.0	0.51	0.88	34	170
12/1/94	23.18	1295.8	0.05	0.06	28	15
12/31/94	16.49	921.8	0.06	0.06	30	12
2/2/95	6.31	352.7	0.11	0.04	33	7.7
3/1/95	15.89	888.3	0.12	0.11	27	26
3/31/95	2.24	125.2	0.14	0.02	30	3.8
5/2/95	6.21	347.1	0.80	0.28	32	57
7/1/95	17.92	1001.7	0.00	0.00	60	0.0
7/25/95	9.73	543.9	0.31	0.17	24	46
8/22/95	13.47	753.0	0.55	0.41	28	97
9/1/95	2.70	150.9	0.39	0.06	10	38
10/2/95	35.46	1982.2	0.13	0.26	31	54
12/1/95	4.31	240.9	0.53	0.13	60	14
1/3/96	14.40	805.0	0.16	0.13	33	26
1/31/96	2.16	120.7	0.32	0.04	28	9.0

Bulk precipitation collector, PW8						
sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
3/1/96	3.01	168.3	0.12	0.02	30	4.4
4/1/96	1.00	55.9	2.24	0.13	31	26
7/2/96	44.49	2487.0	0.31	0.77	92	55
8/23/96	14.92	834.0	0.43	0.36	52	45
9/10/96	20.89	1167.8	0.16	0.19	18	68
9/18/96	31.11	1739.0	0.17	0.30	8	240
10/1/96	3.09	172.7	0.48	0.08	13	42
10/31/96	52.84	2953.8	0.24	0.71	30	150
12/2/96	6.87	384.0	0.25	0.10	32	20
12/31/96	0	500.0	0.10	0.05	29	11
1/31/97	8.20	458.4	0.11	0.05	31	11
3/3/97	10.20	570.0	0.27	0.15	31	32
4/1/97	1.61	90.0	2.25	0.20	29	46
4/30/97	28.23	1578.0	0.41	0.65	29	146

APPENDIX C.2

Calculation of chloride deposition rates for wet-only precipitation collector, PW11

collection area : 0.06413 m^2

sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
4/4/92	23.25	1491.0	0.07	0.10		
5/4/92	11.08	710.6	0.16	0.11	30	22
6/2/92	16.02	1027.4	0.12	0.12	29	24
7/1/92	9.44	605.4	0.33	0.20	29	39
7/26/92	15.64	1003.0	0.13	0.13	25	30
8/14/92	53.66	3441.2	0.08	0.28	19	82
9/2/92	25.52	1636.6	0.11	0.18	19	54
9/21/92	26.41	1693.7	0.03	0.05	19	15
11/2/92	16.08	1031.2	0.08	0.08	42	11
12/1/92	2.08	133.4	0.19	0.03	29	5.0
1/2/93	2.64	169.3	0.16	0.03	32	4.8
2/1/93	6.02	386.1	0.03	0.01	30	2.2
3/3/93	16.84	1079.9	0.05	0.05	30	10
4/1/93	7.47	479.1	0.13	0.06	29	12
5/20/93	7.98	511.8	0.06	0.03	49	3.6
7/1/93	11.31	725.3	0.19	0.14	42	19
7/20/93	50.53	3240.5	0.16	0.52	19	160
8/13/93	21.84	1400.6	0.22	0.31	24	73
8/31/93	48.88	3134.7	0.33	1.03	18	330
10/5/93	2.31	148.1	0.42	0.06	35	10
11/3/93	14.02	899.1	0.07	0.06	29	12
12/1/93	6.11	391.8	0.13	0.05	28	10
12/31/93	1.56	100.0	0.05	0.01	30	0.9
2/2/94	1.56	100.0	0.07	0.01	33	1.2
3/31/94	14.89	954.9	0.05	0.05	57	4.8
5/4/94	1.42	91.1	0.33	0.03	34	5.0
6/2/94	28.58	1832.8	0.14	0.26	29	50
7/1/94	0.43	27.6	1.25	0.03	29	6.8
7/30/94	26.44	1695.6	0.12	0.20	29	40
8/18/94	33.61	2155.4	0.11	0.24	19	71
9/1/94	15.16	972.2	0.16	0.16	14	63
9/9/94	16.66	1068.4	0.05	0.05	8	38
9/30/94	5.16	330.9	0.16	0.05	21	14
11/3/94	28.28	1813.6	0.20	0.36	34	61
12/1/94	23.73	1521.8	0.01	0.02	28	3.1
12/31/94	15.33	983.1	0.01	0.01	30	1.9
2/2/95	4.66	298.8	0.06	0.02	33	3.1
3/1/95	14.78	947.8	0.08	0.08	27	16
3/31/95	1.78	114.2	0.16	0.02	30	3.5

Wet-only precipitation collector, PW11						
sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
5/3/95	4.78	306.5	0.51	0.16	33	27
7/1/95	4.36	279.6	0.00	0.00	59	0.0
7/25/95	9.11	584.2	0.15	0.09	24	21
8/22/95	11.03	707.4	0.19	0.13	28	27
9/1/95	1.19	76.3	0.33	0.03	10	14
10/2/95	21.92	1405.7	0.14	0.20	31	36
12/1/95	3.86	247.5	0.08	0.02	60	1.9
1/3/96	13.19	845.9	0.11	0.09	33	16
1/31/96	0.42	26.9	0.41	0.01	28	2.2
3/1/96	3.91	250.7	0.01	0.00	30	0.5
4/1/96	3.91	250.7	0.15	0.04	31	6.9
7/2/96	46.48	2980.8	0.21	0.63	92	39
8/23/96	11.63	745.8	0.23	0.17	52	19
9/10/96	0.91	58.4	1.49	0.09	18	27
9/18/96	31.00	1988.0	0.11	0.22	8	160
10/1/96	1.72	110.3	0.39	0.04	13	19
10/31/96	48.73	3125.1	0.13	0.41	30	77
12/2/96	5.42	347.6	0.06	0.02	32	3.7
12/31/96	na	250.0	0.08	0.02	29	3.9
1/31/97	6.47	415.0	0.21	0.09	31	16
3/3/97	9.61	616.0	0.12	0.07	31	14
4/1/97	1.12	72.0	2.66	0.19	29	38
4/30/97	10.48	672.0	0.85	0.57	29	110

APPENDIX C.3

Calculation of chloride deposition rates for dry-only precipitation collector, PW12

collection area : 0.06413 m^2

sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
4/4/92	3.91	250.7	0.05	0.01		
5/4/92	0.00		0.00	0.00		
6/2/92	3.91	250.7	0.47	0.12	29	23
7/1/92	3.91	250.7	0.66	0.17	29	32
7/26/92	3.91	250.7	1.33	0.33	25	76
8/14/92	3.91	250.7	0.02	0.01	19	1.5
9/2/92	3.91	250.7	0.14	0.04	19	11
9/21/92	3.91	250.7	0.49	0.12	19	37
11/2/92	3.91	250.7	0.56	0.14	42	19
12/1/92	3.91	250.7	0.04	0.01	29	2.0
1/2/93	3.91	250.7	0.05	0.01	32	2.2
2/1/93	3.91	250.7	0.05	0.01	30	2.4
3/3/93	3.91	250.7	0.05	0.01	30	2.4
4/1/93	3.91	250.7	0.13	0.03	29	6.4
5/20/93	3.91	250.7	0.14	0.04	49	4.1
7/1/93	3.91	250.7	0.85	0.21	42	29
7/20/93	3.91	250.7	1.05	0.26	19	79
8/13/93	3.91	250.7	0.67	0.17	24	40
8/31/93	3.91	250.7	0.12	0.03	18	9.5
10/5/93	3.91	250.7	0.34	0.09	35	14
11/3/93	3.91	250.7	0.15	0.04	29	7.4
12/1/93	3.91	250.7	0.20	0.05	28	10
12/31/93	3.91	250.7	0.16	0.04	30	7.6
2/2/94	3.91	250.7	0.15	0.04	33	6.5
3/31/94	3.91	250.7	0.32	0.08	57	8.0
5/4/94	3.91	250.7	0.40	0.10	34	17
6/2/94	3.91	250.7	0.88	0.22	29	43
7/1/94	3.91	250.7	0.45	0.11	29	22
7/30/94	3.91	250.7	1.72	0.43	29	85
8/18/94	3.91	250.7	0.57	0.14	19	43
9/1/94	3.91	250.7	0.23	0.06	14	23
9/9/94	3.91	250.7	0.17	0.04	8	30
9/30/94	3.91	250.7	0.37	0.09	21	25
11/3/94	3.91	250.7	1.70	0.43	34	71
12/1/94	3.91	250.7	0.11	0.03	28	5.6
12/31/94	3.91	250.7	0.03	0.01	30	1.4
2/2/95	3.91	250.7	0.05	0.01	33	2.2
3/1/95	3.91	250.7	0.04	0.01	27	2.1

Dry-only precipitation collector, PW12

sample date	precip. depth (mm)	precip. volume (ml)	choride concentration (mg / L)	mass of chloride in sample (mg)	time span of collection (days)	chloride deposition rate (mg Cl m^{-2} yr^{-1})
3/31/95	3.91	250.7	0.14	0.04	30	6.7
5/3/95	3.91	250.7	0.41	0.10	33	18
7/25/95	3.91	250.7	0.40	0.10	83	6.9
8/22/95	3.91	250.7	0.34	0.09	28	17
9/1/95	3.91	250.7	0.06	0.02	10	8.6
10/2/95	3.91	250.7	0.48	0.12	31	22
12/1/95	0.00	0.0	0.00	0.00	60	0.0
1/3/96	3.91	250.7	0.16	0.04	33	6.9
1/31/96	3.91	250.7	0.14	0.04	28	7.1
3/1/96	3.91	250.7	0.12	0.03	30	5.7
4/1/96	3.91	250.7	0.57	0.14	31	26
7/2/96	3.91	250.7	0.99	0.25	92	15
8/23/96	3.91	250.7	0.61	0.15	52	17
9/10/96	3.91	250.7	0.31	0.08	18	25
9/18/96	3.91	250.7	0.12	0.03	8	21
10/1/96	3.91	250.7	0.28	0.07	13	31
10/31/96	3.91	250.7	0.70	0.18	30	33
12/2/96	3.91	250.7	0.07	0.02	32	3.1
12/31/96	3.91	250.0	0.15	0.04	29	7.4
1/31/97	3.91	250.0	0.07	0.02	31	3.2
3/3/97	3.90	250.0	0.19	0.05	31	8.7
4/1/97	3.90	250.0	0.06	0.02	29	2.9
4/30/97	3.90	250.0	0.51	0.13	29	25

	A	B	C	D	E
1	APPENDIX C.4				
2	Cumulative mg Cl m^{-2} collected in 3 precipitation collectors from 4-4-92 to 4-30-97				
3					
4	The plot of the data in this table is shown in Figure 4.1.				
5					
6					
7		cumulative	cumulative	cumulative	cumulative
8		mg Cl m^{-2}	mg Cl m^{-2}	mg Cl m^{-2}	mg Cl m^{-2}
9	sample	in PW8,	in PW11,	in PW12,	in PW11 and PW12,
10	dates	bulk collector	wet-only collector	dry-only collector	wet and dry collectors
11	5/4/92	2.18	1.77	0.00	1.77
12	5/26/92	9.18	N	N	N
13	6/2/92	NA	3.70	1.84	5.53
14	7/1/92	16.08	6.81	4.42	11.23
15	7/26/92	23.28	8.84	9.62	18.46
16	8/14/92	30.09	13.14	9.70	22.83
17	9/2/92	34.96	15.94	10.24	26.19
18	9/21/92	38.00	16.74	12.16	28.90
19	11/2/92	42.59	18.02	14.35	32.37
20	12/1/92	43.49	18.42	14.51	32.92
21	1/2/93	44.30	18.84	14.70	33.54
22	2/1/93	44.98	19.02	14.90	33.92
23	3/3/93	46.37	19.86	15.09	34.96
24	4/1/93	47.97	20.83	15.60	36.43
25	5/20/93	51.20	21.31	16.15	37.46
26	7/1/93	58.48	23.46	19.47	42.93
27	7/20/93	58.48	31.55	23.58	55.12
28	8/13/93	65.25	36.35	26.20	62.55
29	8/31/93	74.75	52.48	26.67	79.15
30	10/1/93	78.40	N	N	N
31	10/5/93	NA	53.45	28.00	81.45
32	11/3/93	81.77	54.43	28.58	83.02
33	12/1/93	83.63	55.23	29.36	84.59
34	12/31/93	83.96	55.31	29.99	85.29
35	2/2/94	83.96	55.41	30.58	85.99
36	3/31/94	86.82	56.16	31.83	87.99
37	5/4/94	88.68	56.63	33.39	90.02
38	6/2/94	96.14	60.63	36.83	97.46
39	7/1/94	98.57	61.17	38.59	99.76
40	7/30/94	106.75	64.34	45.32	109.66
41	8/18/94	111.54	68.04	47.55	115.58
42	9/1/94	115.40	70.46	48.44	118.91
43	9/9/94	118.50	71.29	49.11	120.40
44	9/30/94	120.12	72.12	50.56	122.68
45	11/3/94	135.95	77.78	57.20	134.98
46	12/1/94	137.11	78.01	57.63	135.65
47	12/31/94	138.10	78.17	57.75	135.92
48	2/2/95	138.80	78.45	57.95	136.39
49	3/1/95	140.70	79.63	58.10	137.73
50	3/31/95	141.02	79.91	58.65	138.56

	A	B	C	D	E
51	5/2/95	145.99	N	N	N
52	5/3/95	NA	82.35	60.25	142.60
53	7/1/95	145.99	82.35	0.00	82.35
54	7/25/95	149.01	83.72	61.82	145.54
55	8/22/95	156.42	85.81	63.15	148.96
56	9/1/95	157.47	86.21	63.38	149.59
57	10/2/95	162.09	89.28	65.26	154.53
58	12/1/95	164.37	89.58	65.26	154.84
59	1/3/96	166.68	91.03	65.88	156.92
60	1/31/96	167.37	91.21	66.43	157.64
61	3/1/96	167.73	91.25	66.90	158.15
62	4/1/96	169.97	91.83	69.13	160.96
63	7/2/96	183.77	101.59	73.00	174.59
64	8/23/96	190.19	104.27	75.38	179.65
65	9/10/96	193.54	105.62	76.60	182.22
66	9/18/96	198.83	109.03	77.07	186.10
67	10/1/96	200.31	109.71	78.16	187.87
68	10/31/96	213.00	116.04	80.90	196.94
69	12/2/96	214.72	116.37	81.17	197.54
70	12/31/96	215.62	116.68	81.76	198.43
71	1/31/97	216.52	118.04	82.03	200.07
72	3/3/97	219.27	119.19	82.77	201.96
73	4/1/97	222.90	122.18	83.00	205.18
74	4/30/97	234.48	131.08	84.99	216.07

Appendix C.5 Statistical analysis of chloride deposition rates and precipitation rates determined with the bulk precipitation collector

Table C.1 in this appendix is used to sort data from the bulk precipitation collector for statistical analysis. The precipitation rates and chloride deposition rates are grouped by month to calculate means and standard deviations of each rate for each of the twelve months of the year, using the eight-year record from March 30, 1989, to April 30, 1997. Each row represents one sampling interval, many of which include days from different months. A column for each month shows the number of days in each sampling interval that were in that month. The numbers of days are used to weight each rate in calculating the statistics with the following equations.

$$\text{standard deviation of chloride deposition rate for month i} = \sqrt{\frac{(\Sigma n_i)(\Sigma(n_i X_1^2)) - (\Sigma(n_i X_1))^2}{(\Sigma n_i)((\Sigma n_i) - 1))}}$$

$$\text{mean of chloride deposition rate for month i} = \frac{\Sigma(n_i X_1)}{\Sigma n_i}$$

$$\text{standard deviation of precipitation rate for month i} = \sqrt{\frac{(\Sigma n_i)(\Sigma(n_i X_2^2)) - (\Sigma(n_i X_2))^2}{(\Sigma n_i)((\Sigma n_i) - 1))}}$$

$$\text{mean of precipitation rate for month i} = \frac{\Sigma(n_i X_2)}{\Sigma n_i}$$

where n_i = number of days in month i, i =1 through 12 for January through December
X_1 = chloride deposition rate[mg Cl m^{-2} yr^{-1}]
X_2 = precipitation rate [mm yr^{-1}]

These statistics are tabulated and plotted in section 4.1.

	A	B	C	D
1	Table C.1 Grouping of Cl deposition rates and precipitation rates			
2	for calculation of monthly statistics			
3				
4		time span	chloride deposition	precipitation
5	sample	of collection	rate (mg Cl m^{-2} yr^{-1}),	rate (mm yr^{-1}),
6	date	(days)	X_1	X_2
7				
8				
9				
10	3/30/89			
11	6/8/89	70	0.0	0.0
12	7/7/89	29	46	21
13	7/25/89	18	0.0	980
14	9/5/89	42	49	200
15	10/3/89	28	31	52
16	10/17/89	14	130	940
17	1/4/90	79	32	17
18	3/15/90	70	30	95
19	4/5/90	21	110	500
20	4/24/90	19	76	170
21	5/8/90	14	260	470
22	7/3/90	56	62	44
23	7/13/90	10	140	430
24	7/24/90	11	150	500
25	8/2/90	9	210	890
26	8/16/90	14	120	470
27	9/3/90	18	34	71
28	10/4/90	31	100	730
29	11/5/90	32	46	48
30	1/3/91	59	27	140
31	2/4/91	32	23	120
32	4/2/91	57	20	37
33	6/4/91	63	70	55
34	7/1/91	27	140	86
35	8/1/91	31	340	420
36	8/23/91	22	120	1100
37	9/12/91	20	78	870
38	10/1/91	19	17	13
39	11/6/91	36	37	77
40	12/5/91	29	68	380
41	12/28/91	23	140	1100
42	1/9/92	12	3.3	83
43	1/28/92	19	11	230
44	3/2/92	34	11	140
45	4/4/92	33	48	480
46	5/4/92	30	27	130
47	5/26/92	22	120	730
48	7/1/92	36	70	230
49	7/26/92	25	110	500
50	8/14/92	19	130	1300
51	9/2/92	19	94	520
52	9/21/92	19	58	530
53	11/2/92	42	40	150
54	12/1/92	29	11	40
55	1/2/93	32	9.2	150
56	2/1/93	30	8.3	83
57	3/3/93	30	17	210
58	4/1/93	29	20	100
59	5/20/93	49	24	69

	A	B	C	D
60	7/1/93	42	63	120
61	7/20/93	19	0.0	0.0
62	8/13/93	24	100	380
63	8/31/93	18	190	1400
64	10/1/93	31	43	63
65	11/3/93	33	37	190
66	12/1/93	28	24	110
67	12/31/93	30	4.0	6.7
68	2/2/94	33	0.0	18
69	3/31/94	57	18	110
70	5/4/94	34	20	24
71	6/2/94	29	94	470
72	7/1/94	29	31	20
73	7/30/94	29	100	360
74	8/18/94	19	92	660
75	9/1/94	14	100	460
76	9/9/94	8	140	2000
77	9/30/94	21	28	120
78	11/3/94	34	170	330
79	12/1/94	28	15	300
80	12/31/94	30	12	200
81	2/2/95	33	7.7	70
82	3/1/95	27	26	220
83	3/31/95	30	3.8	27
84	5/2/95	32	57	71
85	7/1/95	60	0.0	110
86	7/25/95	24	46	150
87	8/22/95	28	97	180
88	9/1/95	10	38	99
89	10/2/95	31	54	420
90	12/1/95	60	14	26
91	1/3/96	33	26	160
92	1/31/96	28	9.0	28
93	3/1/96	30	4.4	37
94	4/1/96	31	26	12
95	7/2/96	92	55	180
96	8/23/96	52	45	110
97	9/10/96	18	68	420
98	9/18/96	8	240	1400
99	10/1/96	13	42	87
100	10/31/96	30	150	640
101	12/2/96	32	20	78
102	12/31/96	29	11	0.0
103	1/31/97	31	11	97
104	3/3/97	31	32	120
105	4/1/97	29	46	20
106	4/30/97	29	146	360

	E	F	G	H	I	J	K	L	M	N	O	P
1												
2												
3												
4	Number of days in each sample interval in each month											
5	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6	n_1	n_2	n_3	n_4	n_5	n_6	n_7	n_8	n_9	n_{10}	n_{11}	n_{12}
7												
8												
9												
10												
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	22	7	0	0	0	0	0
13	0	0	0	0	0	0	18	0	0	0	0	0
14	0	0	0	0	0	0	6	31	5	0	0	0
15	0	0	0	0	0	0	0	0	25	3	0	0
16	0	0	0	0	0	0	0	0	0	14	0	0
17	4	0	0	0	0	0	0	0	0	14	30	31
18	27	28	15	0	0	0	0	0	0	0	0	0
19	0	0	16	5	0	0	0	0	0	0	0	0
20	0	0	0	19	0	0	0	0	0	0	0	0
21	0	0	0	6	8	0	0	0	0	0	0	0
22	0	0	0	0	23	30	3	0	0	0	0	0
23	0	0	0	0	0	0	10	0	0	0	0	0
24	0	0	0	0	0	0	11	0	0	0	0	0
25	0	0	0	0	0	0	7	2	0	0	0	0
26	0	0	0	0	0	0	0	14	0	0	0	0
27	0	0	0	0	0	0	0	15	3	0	0	0
28	0	0	0	0	0	0	0	0	27	4	0	0
29	0	0	0	0	0	0	0	0	0	27	5	0
30	3	0	0	0	0	0	0	0	0	0	25	31
31	28	4	0	0	0	0	0	0	0	0	0	0
32	0	24	31	2	0	0	0	0	0	0	0	0
33	0	0	0	28	31	4	0	0	0	0	0	0
34	0	0	0	0	0	26	1	0	0	0	0	0
35	0	0	0	0	0	0	30	1	0	0	0	0
36	0	0	0	0	0	0	0	22	0	0	0	0
37	0	0	0	0	0	0	0	8	12	0	0	0
38	0	0	0	0	0	0	0	0	18	1	0	0
39	0	0	0	0	0	0	0	0	0	30	6	0
40	0	0	0	0	0	0	0	0	0	0	24	5
41	0	0	0	0	0	0	0	0	0	0	0	23
42	9	0	0	0	0	0	0	0	0	0	0	3
43	19	0	0	0	0	0	0	0	0	0	0	0
44	3	29	2	0	0	0	0	0	0	0	0	0
45	0	0	29	4	0	0	0	0	0	0	0	0
46	0	0	0	26	4	0	0	0	0	0	0	0
47	0	0	0	0	22	0	0	0	0	0	0	0
48	0	0	0	0	5	30	1	0	0	0	0	0
49	0	0	0	0	0	0	25	0	0	0	0	0
50	0	0	0	0	0	0	5	14	0	0	0	0
51	0	0	0	0	0	0	0	17	2	0	0	0
52	0	0	0	0	0	0	0	0	19	0	0	0
53	0	0	0	0	0	0	0	0	9	31	2	0
54	0	0	0	0	0	0	0	0	0	0	28	1
55	2	0	0	0	0	0	0	0	0	0	0	30
56	29	1	0	0	0	0	0	0	0	0	0	0
57	0	27	3	0	0	0	0	0	0	0	0	0
58	0	0	28	1	0	0	0	0	0	0	0	0
59	0	0	0	29	20	0	0	0	0	0	0	0

	E	F	G	H	I	J	K	L	M	N	O	P
60	0	0	0	0	11	30	1	0	0	0	0	0
61	0	0	0	0	0	0	19	0	0	0	0	0
62	0	0	0	0	0	0	11	13	0	0	0	0
63	0	0	0	0	0	0	0	18	0	0	0	0
64	0	0	0	0	0	0	0	0	30	1	0	0
65	0	0	0	0	0	0	0	0	0	30	3	0
66	0	0	0	0	0	0	0	0	0	0	27	1
67	0	0	0	0	0	0	0	0	0	0	0	30
68	31	2	0	0	0	0	0	0	0	0	0	0
69	0	26	31	0	0	0	0	0	0	0	0	0
70	0	0	0	30	4	0	0	0	0	0	0	0
71	0	0	0	0	27	2	0	0	0	0	0	0
72	0	0	0	0	0	28	1	0	0	0	0	0
73	0	0	0	0	0	0	29	0	0	0	0	0
74	0	0	0	0	0	0	1	18	0	0	0	0
75	0	0	0	0	0	0	0	13	1	0	0	0
76	0	0	0	0	0	0	0	0	8	0	0	0
77	0	0	0	0	0	0	0	0	21	0	0	0
78	0	0	0	0	0	0	0	0	0	31	3	0
79	0	0	0	0	0	0	0	0	0	0	27	1
80	0	0	0	0	0	0	0	0	0	0	0	30
81	31	2	0	0	0	0	0	0	0	0	0	0
82	0	26	1	0	0	0	0	0	0	0	0	0
83	0	0	30	0	0	0	0	0	0	0	0	0
84	0	0	0	30	2	0	0	0	0	0	0	0
85	0	0	0	0	29	30	1	0	0	0	0	0
86	0	0	0	0	0	0	24	0	0	0	0	0
87	0	0	0	0	0	0	6	22	0	0	0	0
88	0	0	0	0	0	0	0	9	1	0	0	0
89	0	0	0	0	0	0	0	0	29	2	0	0
90	0	0	0	0	0	0	0	0	0	29	30	1
91	3	0	0	0	0	0	0	0	0	0	0	30
92	28	0	0	0	0	0	0	0	0	0	0	0
93	0	29	1	0	0	0	0	0	0	0	0	0
94	0	0	30	1	0	0	0	0	0	0	0	0
95	0	0	0	29	31	30	2	0	0	0	0	0
96	0	0	0	0	0	0	29	23	0	0	0	0
97	0	0	0	0	0	0	0	8	10	0	0	0
98	0	0	0	0	0	0	0	0	8	0	0	0
99	0	0	0	0	0	0	0	0	12	1	0	0
100	0	0	0	0	0	0	0	0	0	30	0	0
101	0	0	0	0	0	0	0	0	0	0	30	2
102	0	0	0	0	0	0	0	0	0	0	0	29
103	31	0	0	0	0	0	0	0	0	0	0	0
104	0	28	3	0	0	0	0	0	0	0	0	0
105	0	0	28	1	0	0	0	0	0	0	0	0
106	0	0	0	29	0	0	0	0	0	0	0	0

Appendix D Dust collector

Appendix D contents :

Appendix D.1 Dust collector sampling methods

Take samples from the dust collector at the same time as columns are extracted. Before going to the site, prepare three 500 ml polyethylene bottles by rinsing, drying, labeling, and weighing. Record the masses in a duplicate of the spreadsheet in Appendix D.2.

At the site :

1) Remove the pan from the post and remove the metal straps.
2) Inspect the marbles for bird feces and discard any contaminated marbles.
3) Rinse the marbles, screen, and pan with about 1 L of de-ionized water from a squirt bottle. The squirt bottle may need to be refilled.
4) Lift the screen and marbles out of the pan and onto a plastic bag.
5) Pour the water from the pan into the pre-rinsed bottles.
7) Replace the collector.
8) Record the masses of the full bottles.
9) Record estimates of the masses of any solids in the bottles.
10) Determine the volumes of water in each bottle. This is done in the spreadsheet in Appendix D.2. by converting the mass of water to volume of water, assuming the density = 1 g / ml.
11) Analyze a sample from each bottle by HPLC and record the chloride concentration in the spreadsheet in Appendix D.2.
12) The mass of chloride (mg) collected in each bottle is determined by multiplying the chloride concentration (mg/L) by the volume of water (L). The chloride deposition rate is calculated by dividing the sum of masses of chloride by the collection area (0.048 m^2) and by the timespan of collection (based on sampling dates).
13) The samples are stored for future analysis.

Appendix D.2 Dust collector records and calculations

Calculations for each month of samples are shown on a separate spreadsheet pages following this explanation. Each page includes a summary table showing the deposition rate, and a table used to calculate masses of chloride from the sample data. The following equations are used in the spreadsheets.

Column A = sample bottle number

> Note:
> Samples may be contained in one or more bottles. Each row of the spreadsheet is for one bottle. Masses of chloride in each bottle are summed below the last row . The total mass is used to calculate the deposition rate.

Column B = mass of empty sample bottle (g)

Column C = mass of full sample bottle (g)

> Note :
> The sample bottle may contain solid material collected with the water.

Column D = mass of solid material (g)

> Note :
> There were small amounts of eolian material in some samples. Some bottles contained marbles that spilled during rinsing of the pan. All of these solids remained in the bottles. I used estimated masses of the solids in my calculations. The masses of eolian material are very small relative to the mass of water, so I considered them to be zero. I estimated the masses of the marbles by measuring the masses of dry marbles.

Column E = volume of leachate (ml)

= [mass of leachate] / [density of water]

= [(mass of full sample bottle) - (mass of empty sample bottle) - (mass of solid material)]

/ [1 g water / 1 ml water]

= (Column C) - (Column B) - (Column D)

Column F = chloride concentration in leachate (mg/L)

Column G = filename of HPLC results.

> Note :
> Results of HPLC analyses are tabulated in Appendix F.2.1 through Appendix F.2.4 so my interpretation may be reviewed.

Column H = mass of chloride in leachate (mg)

= [L leachate] x [mg Cl / L leachate]

= (Column E / 1000) x (Column F)

Appendix D.2.1 Calculation of chloride deposition rate based on dust collector sample

sample date	1/31/97
previous sample date	1/3/97
time span of collection (days)	28
mass of chloride collected (mg)	0.094
area of collection (m^2)	0.048
chloride deposition rate (mg Cl m^{-2} yr^{-1})	25.5

(A) bottle #	(B) mass of empty sample bottle (g)	(C) mass of full sample bottle (g)	(D) mass of solids in sample (g)	(E) water volume (ml)	(F) chloride conc. (mg / L)	(G) filename of HPLC results	(H) mass of chloride (mg)
1	77.4	400.2	0	322.8	0.290	JWM03B97.29R	0.094

Appendix D.2.2 Calculation of chloride deposition rate based on dust collector sample

sample date	3/3/97
previous sample date	1/31/97
time span of collection (days)	31
mass of chloride collected (mg)	0.269
area of collection (m^2)	0.048
chloride deposition rate (mg Cl m^{-2} yr^{-1})	66.0

(A) bottle #	(B) mass of empty sample bottle (g)	(C) mass of full sample bottle (g)	(D) mass of solids in sample (g)	(E) water volume (ml)	(F) chloride conc. (mg / L)	(G) filename of HPLC results	(H) mass of chloride (mg)
1	78	490.7	0	412.7	0.496	JWM03B97.31R	0.205
2	78	432.1	0	354.1	0.182	JWM03B97.33R	0.064
sum							0.269

Appendix D.2.3 Calculation of chloride deposition rate based on dust collector sample

sample date	4/1/97
previous sample date	3/3/97
time span of collection (days)	29
mass of chloride collected (mg)	0.452
area of collection (m^2)	0.048
chloride deposition rate (mg Cl m^{-2} yr^{-1})	119

(A) bottle #	(B) mass of empty sample bottle (g)	(C) mass of full sample bottle (g)	(D) mass of solids in sample (g)	(E) water volume (ml)	(F) chloride conc. (mg / L)	(G) filename of HPLC results	(H) mass of chloride (mg)
1	77.4	527.7	0	450.3	0.545	JWM05C97.13R	0.245
2	68.9	537.9	9.5	459.5	0.444	JWM05C97.14R	0.204
3	78	233.1	0	155.1	0.019	JWM05C97.15R	0.003
sum							0.452

Appendix D.2.4 Calculation of chloride deposition rate based on dust collector sample

sample date	4/30/97
previous sample date	4/1/97
time span of collection (days)	29
mass of chloride collected (mg)	0.888
area of collection (m^2)	0.048
chloride deposition rate (mg Cl m^{-2} yr^{-1})	233

(A) bottle #	(B) mass of empty sample bottle (g)	(C) mass of full sample bottle (g)	(D) mass of solids in sample (g)	(E) water volume (ml)	(F) chloride conc. (mg / L)	(G) filename of HPLC results	(H) mass of chloride (mg)
1	78.1	441.5	0	363.4	1.185	JWM05C97.16R	0.431
2	77.3	501.3	0	424	0.768	JWM05C97.17R	0.326
3	80.5	454	14.2	359.3	0.365	JWM05C97.18R	0.131
sum							0.888

Appendix E HPLC Methods

The components of the HPLC system used are listed below with descriptions of the methods.

1) mobile phase

The mobile phase used is 0.02 M potassium phosphate with pH of 3.8. It is made by dissolving 5.444 g potassium phosphate (KH_2PO_4, FW 136.09 , Fisher Scientific product #P286-1) in 2 L de-ionized water, vacuum filtering with 0.45 um filter, and adjusting the pH to 3.8 with concentrated phosphoric acid (H_3PO_4 , FW 98.00 , Aldrich catalog # 34,524 - 5). The mass of KH_2PO_4 used to make 2 L of a 0.02 Molar solution is calculated as :

$$\begin{aligned} &[\text{ mass of } KH_2PO_4] \\ &\quad = [2\ L] \times [0.02\ M / L] \times [136.09\ g / M] \\ &\quad = [5.444\ g\ KH_2PO_4] \end{aligned}$$

De-ionized water is obtained from 2 Millipore devices in series :

1) Milli - RO 10 Plus
2) Milli - Q Plus (Uses a carbon filter and exchange resin.)

2) pump

The pump used is a Waters 510. The flow rate used is 2 ml/min.

3) injector

Manual sample injection is done through a Waters Model U6K Universal Liquid Chromatograph Injector using a 250 microliter Hamilton gastight syringe. I found the peak size to increase linearly with injection volume, so using the relatively large injection volume of 250 ul gives an advantage when quantifying low concentrations (Bowman, 1984).

The injector is wired to the computer so the software begins recording the signal from the absorbance detector at the time of injection.

4) column

The chromatography column used is Vydac302IC4 S/N 940415-29-7 #037 951019.
A 2-micrometer filter is used between the injector and the column. The lengths of tubing between the injector and column and between the column and detector are kept to a minimum in order to minimize dispersion of the sample as it flows through the tubing. The sample should

flow through the first tubing as a compact plug and enter the column as instantaneously as possible. After the sample is separated into separate constituents in the column, minimizing dispersion in the second tubing will result in more distinct peaks (Snyder and Kirkland, 1979).

5) detector

The detector used is a Waters 486 Tunable Absorbance Detector. I found the optimal wavelength to be 190 nm for Cl analysis at low concentrations.

6) evaluation of peaks

The absorbance signal is converted to voltage for processing with a computer. The software I used is Chromperfect by Justice Innovations. Use of Chromperfect requires parameters to be chosen and stored in a Method File. The Method File that I used is included in this appendix.

Results of each analysis with Chromperfect are saved on disk and can be reviewed by selecting "Analyze" from the main menu.

For some samples, quantification of peak size by the software was inaccurate because either the baseline was sloping, or because background noise made the peaks unclear, especially for small peaks. For this reason, I used the software to magnify the peaks on the screen and determine the peak heights visually, by comparing the peaks to the mV axis of the plot, instead of using the peak heights determined by the software.

To visually evaluate a peak height, I displayed the chromatogram using the Analyze program and magnified the peak. I determined that a peak was chloride, judging as objectively as possible based on the retention time and peak width. Using the mouse, I placed the cursor at the base of the peak and recorded the millivolts value of this point. I did the same for the top of the peak, then calculated the peak height as the difference between these two values. The mV values that I recorded for each sample are tabulated in Appendix B. For peaks on a sloping baseline, the mV value at the peak base was measured at the point at the intersection of the sloping baseline and a vertical line passing through the peak .

7) chloride standards

I made a master standard of 2000 mg Cl / L and used dilutions of this for other standards.
I made the master standard with 1.648 g NaCl in 500 ml de-ionized water.
To calculate the amount of NaCl needed for 500 ml of a solution of 2000 mg Cl / L, I used

the ratio of molecular weights for NaCl and Cl, as shown below.

$$(0.5\text{ L}) \times \left(\frac{2000\text{ mg Cl}}{\text{L}}\right) \times \left(\frac{58.4428\text{ mg NaCl}}{35.453\text{ mg Cl}}\right) = 1648\text{ mg NaCl}$$

METHOD FILE C:\CPWIN\DATA3\JWM_CL.MET version # 53

Method date = 05-08-97, time = 01:02:39

Date printed = 05-29-1997, time = 04:44:53

ACQUISITION PARAMETERS

Run time = 60.000 minutes
Samples per second = 1.000
Low scale for real-time plot = -5.000 mV
High scale for real-time plot = 5.000 mV
Acquire from channel A

Options
[ ] Produce binary area files
[x] Produce bound raw data files
[ ] Autozero the real-time plot
[ ] Produce ASCII area files
[ ] Make raw files read-only

INTEGRATION PARAMETERS

Initial peak detect threshold = 1.

Initial peak width = 0.100 minutes

CALIBRATION FILE FOR THIS METHOD:

REPORT PARAMETERS

[x] Print page header
[ ] Print page footer
Number of copies = 1

[ ] Print fixed format report
[ ] Print custom format report

PLOTTING PARAMETERS

[x] Plot chromatogram
[ ] Page after plot
[ ] Force black and white printing
Plot Orientation: Horizontal
Label Options
Text:
[ ] Component name
[ ] Components found only
[ ] Name at peak top
[x] Timed events
[x] Axes labels
[ ] Axes units
[ ] Axes span
[x] Retention time
[ ] Retention time in seconds
[x] Sample name
[x] File name

Voltage Scaling: Automatic scaling
Time Scaling: Automatic scaling
Plot width = 6.000 inches, Plot height = 4.000 inches
Number of plot panels = 1

Drawing:
[ ] Search windows
[ ] Data Points as Dots
[x] Peak tic marks
[ ] Baselines
[x] Grid

MISCELLANEOUS METHOD PARAMETERS

Method description = for Cl and Br, duplicated from method
Method creator = Jim Moore
[ ] Run user program at end of analysis

TIMED EVENTS

#	Time	Event	Description
1	2.000	INT+	Turn on integration
2	9.900	INT-	Turn off integration

Appendix F HPLC results

This appendix documents my interpretations of peak heights for each sample analyzed. It lists the mV values that I selected to calculate peak heights as the difference between the mV values at the base of a peak and the top of a peak. Records of each analysis are stored on disk so they may be reviewed using Chromperfect. Each set of samples analyzed on the same day is shown on a separate page of this appendix.

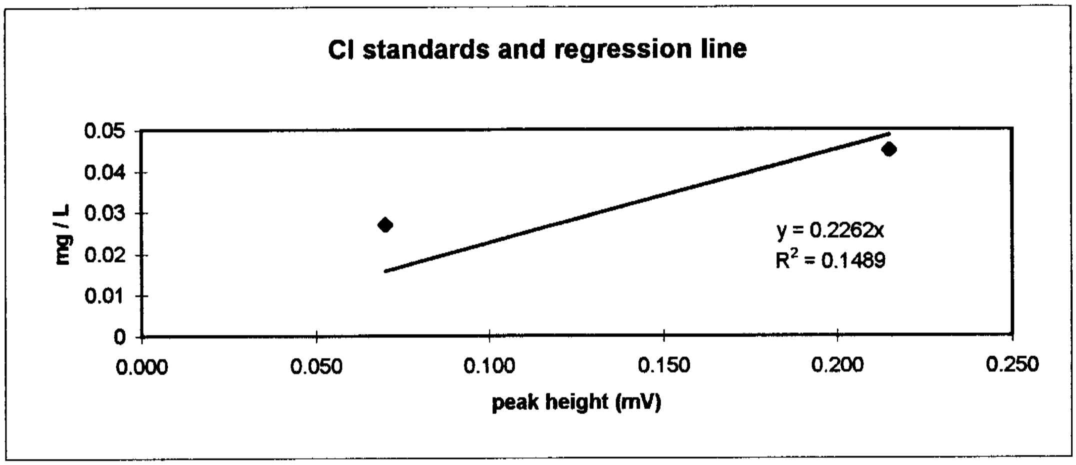
Each page includes a table of interpretations of peak heights of standards, a plot of standards, and a table of interpretations of peak heights of samples. The retention time of chloride is shown at the top of the first table. The plot of standards includes a linear regression line, which is forced through the origin, and displays the slope. The peak height calculations for each sample are shown in the second table, which includes the conversion to concentration.

Appendix F contents :

AP F.1.1-F.1.8	Columns
AP F.2	Dust collector
AP F.3	Local surface sand
AP F.4	Chloride standard from UNM
AP F.5	Chloride standards used to evaluate HPLC sensitivity
AP F.6.1 - F.6.4	Sand leachates from drum

AP F.1.1 HPLC results for Cl standards and samples for column extracted at t=0.

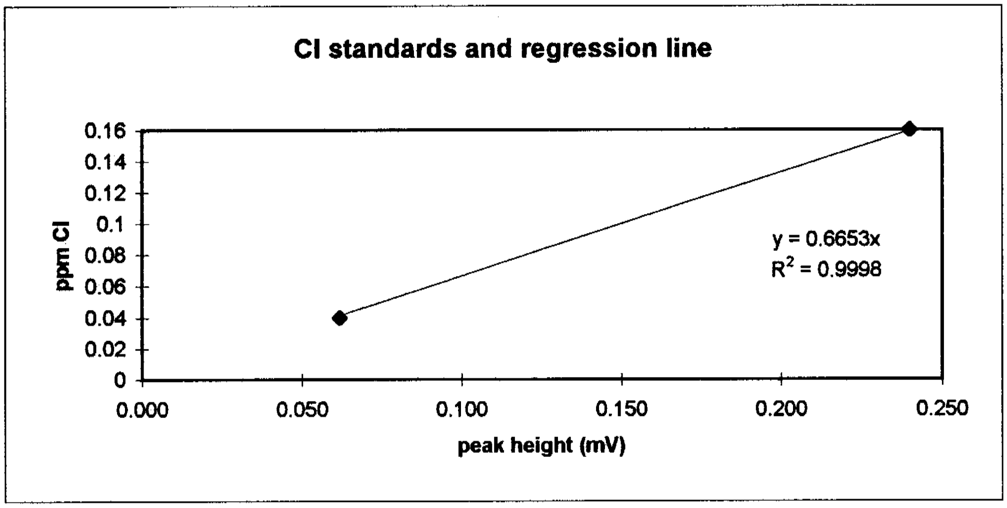
Cl standard results	retention time = 3.41 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM10G96.11R	0.045	0.350	0.565	0.215	0.045
JWM10G96.15R	0.027	0.500	0.570	0.070	0.027



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.2262
JWM10G96.07R	1	0.408	0.510	0.102	0.023
JWM11A96.04R	3	-0.383	-0.287	0.096	0.022
JWM11A96.03R	5	-0.485	-0.466	0.019	0.004

AP F.1.2 HPLC results for Cl standards and samples for column extracted at t = 1 month.

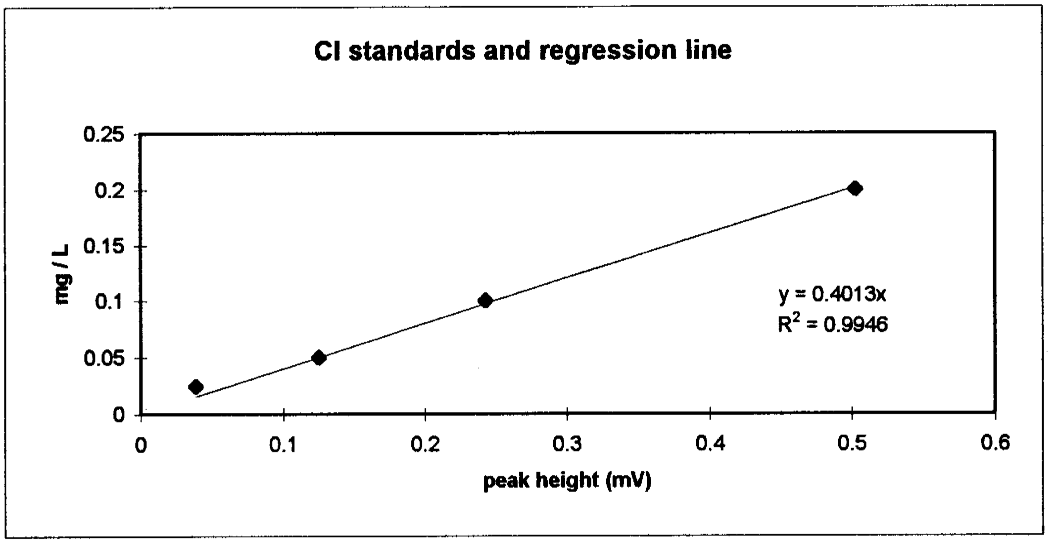
Cl standard results	retention time = 3.05 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM12G96.36R	0.02			0	0.02
JWM12G96.34R	0.04	0.620	0.682	0.062	0.04
JWM12G96.50R	0.16	0.160	0.400	0.240	0.16



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.6653
JWM12G96.26R	1	0.360	0.524	0.164	0.109
JWM12G96.27R	2	0.375	0.500	0.125	0.083
JWM12G96.29R	3	0.730	0.770	0.040	0.027
JWM12G96.32R	4	0.513	0.582	0.069	0.046
JWM12G96.33R	5	0.505	0.562	0.057	0.038
JWM12G96.39R	6	0.544	0.620	0.076	0.051
JWM12G96.41R	7	0.670	0.830	0.160	0.106
JWM12G96.40R	8	0.413	0.523	0.110	0.073
JWM12G96.42R	9	0.274	0.360	0.086	0.057
JWM12G96.43R	10	0.150	0.244	0.094	0.063
JWM12G96.44R	11	0.580	0.680	0.100	0.067
JWM12G96.45R	12	0.550	0.630	0.080	0.053
JWM12G96.46R	13	0.481	0.530	0.049	0.033
JWM12G96.47R	14	0.514	0.593	0.079	0.053

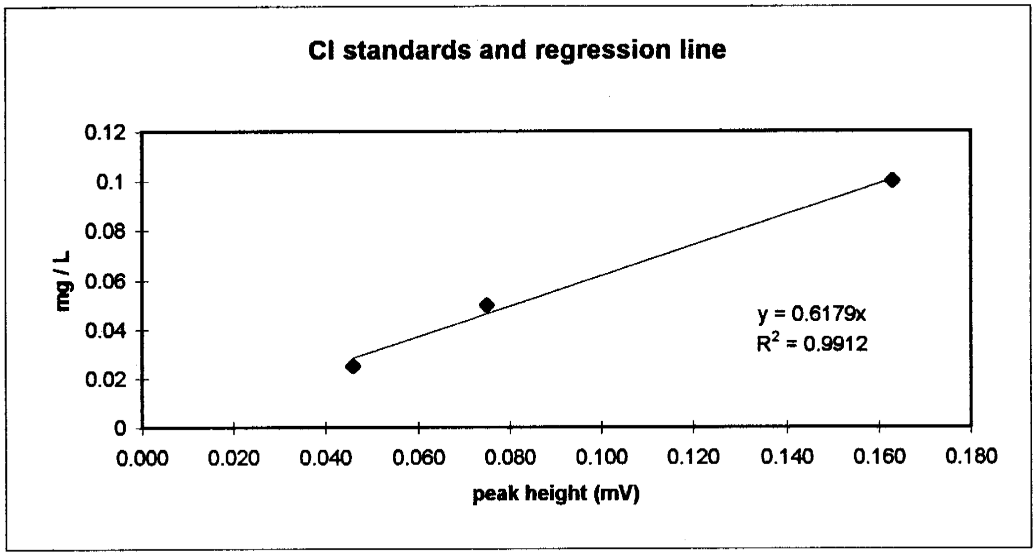
AP F.1.3 HPLC results for Cl standards and samples for column extracted at t = 2 months

Cl standard results	retention time = 5.76 min				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03B97.19R	0.2	1.192	1.695	0.503	0.2
JWM03B97.20R	0.1	0.592	0.835	0.243	0.1
JWM03B97.21R	0.05	0.889	1.014	0.125	0.05
JWM03B97.28R	0.025	0.538	0.577	0.039	0.025



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.4013
JWM03B97.17R	1	1.350	1.600	0.250	0.100
JWM03B97.18R	2	1.550	1.680	0.130	0.052
JWM03B97.22R	3	1.110	1.220	0.110	0.044
JWM03B97.23R	4	1.300	1.378	0.078	0.031
JWM03B97.24R	5	1.820	1.900	0.080	0.032
JWM03B97.25R	6	1.870	1.925	0.055	0.022
JWM03B97.26R	7	0.200	0.306	0.106	0.043
JWM03B97.27R	8	0.390	0.471	0.081	0.033

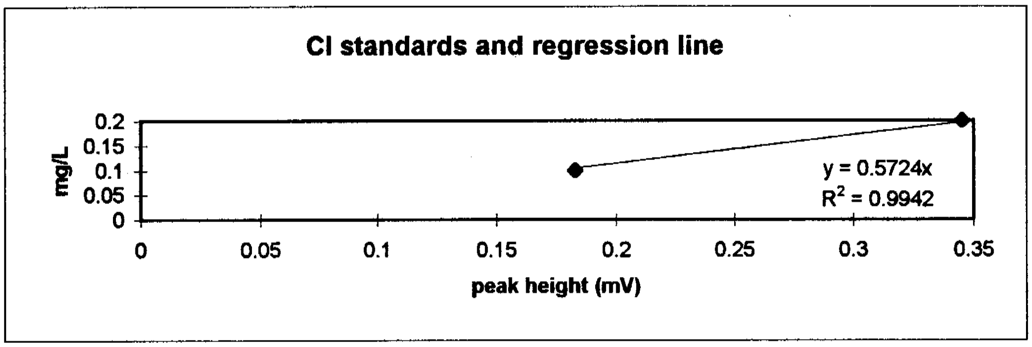
Cl standard results	retention time = 2.66 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM05B97.25R	0.1	-0.040	0.123	0.163	0.1
JWM05B97.26R	0.05	0.280	0.355	0.075	0.05
JWM05B97.27R	0.025	0.964	1.010	0.046	0.025



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.6179
JWM05B97.03R	9	0.298	0.356	0.058	0.036
JWM05B97.04R	10	1.480	1.500	0.020	0.012
JWM05B97.05R	11	-0.270	-0.241	0.029	0.018
JWM05B97.06R	12	1.200	1.217	0.017	0.011
JWM05B97.07R	13	0.964	1.000	0.036	0.022
JWM05B97.08R	14	-0.088	-0.064	0.024	0.015
JWM05B97.09R	15	1.450	1.470	0.020	0.012
JWM05B97.10R	16	0.027	0.037	0.010	0.006
JWM05B97.11R	17	0.462	0.482	0.020	0.012
JWM05B97.12R	18	1.437	1.487	0.050	0.031
JWM05B97.13R	19	-0.148	-0.119	0.029	0.018
JWM05B97.14R	20	1.600	1.656	0.056	0.035
JWM05B97.15R	21	0.320	0.350	0.030	0.019
JWM05B97.16R	22	0.337	0.349	0.012	0.007
JWM05B97.17R	23	0.660	0.680	0.020	0.012
JWM05B97.18R	24	-0.030	0.010	0.040	0.025
JWM05B97.19R	25	1.323	1.342	0.019	0.012
JWM05B97.20R	26	0.310	0.385	0.075	0.046
JWM05B97.21R	27	-0.070	-0.050	0.020	0.012
JWM05B97.22R	28	1.410	1.480	0.070	0.043
JWM05B97.23R	29	-0.470	-0.440	0.030	0.019
JWM05B97.24R	30	1.100	1.140	0.040	0.025

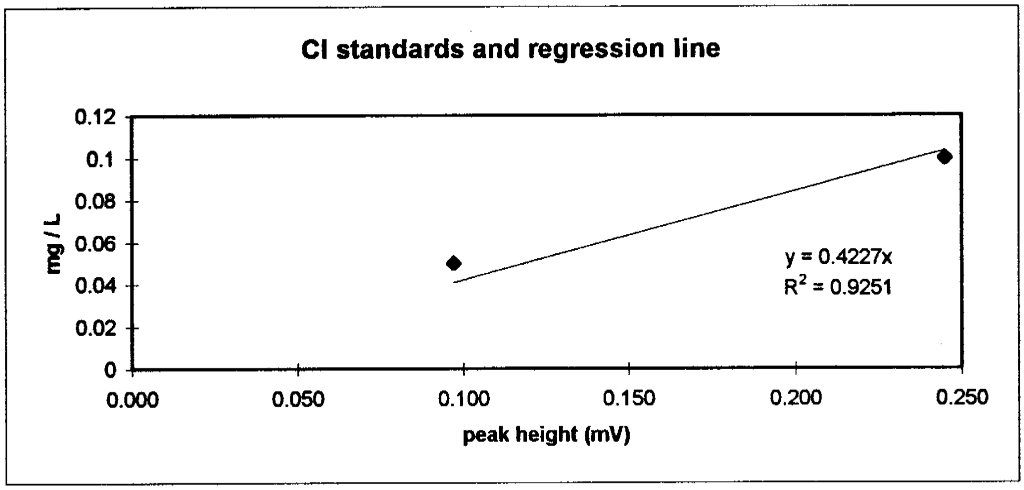
AP F.1.4 HPLC results for Cl standards and samples
for column extracted at t = 3 months
from position 6 of row 1

Cl standard results	retention time = 5.7 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03B97.36R	0.2	0.715	1.060	0.345	0.2
JWM03B97.41R	0.1	1.455	1.638	0.183	0.1



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5724
JWM03B97.37R	1	2.300	2.590	0.290	0.166
JWM03B97.38R	2	1.058	1.284	0.226	0.129
JWM03B97.39R	3	1.500	1.730	0.230	0.132
JWM03B97.42R	4	1.069	1.346	0.277	0.159
JWM03B97.43R	5	1.453	1.620	0.167	0.096
JWM03B97.44R	6	1.542	1.619	0.077	0.044
JWM03B97.45R	7	1.168	1.226	0.058	0.033
JWM03B97.46R	8	1.019	1.064	0.045	0.026
JWM03B97.47R	9	0.598	0.655	0.057	0.033
JWM03B97.48R	10	1.099	1.179	0.080	0.046
JWM03B97.49R	11	0.972	1.045	0.073	0.042
JWM03B97.50R	12	0.770	0.876	0.106	0.061
JWM03B97.51R	13	0.845	0.936	0.091	0.052
JWM03B97.52R	14	0.989	1.159	0.170	0.097
JWM03B97.53R	15	0.704	0.874	0.170	0.097
JWM03B97.54R	16	0.662	0.847	0.185	0.106
JWM03B97.55R	17	1.040	1.190	0.150	0.086
JWM03B97.56R	18	0.788	0.924	0.136	0.078
JWM03B97.57R	19	0.880	0.986	0.106	0.061
JWM03B97.58R	20	1.068	1.175	0.107	0.061
JWM03B97.59R	21	0.972	1.050	0.078	0.045
JWM03B97.60R	22	0.770	0.857	0.087	0.050
JWM03B97.61R	23	0.867	0.953	0.086	0.049
JWM03B97.62R	24	0.883	0.956	0.073	0.042
JWM03B97.63R	25	0.960	1.070	0.110	0.063

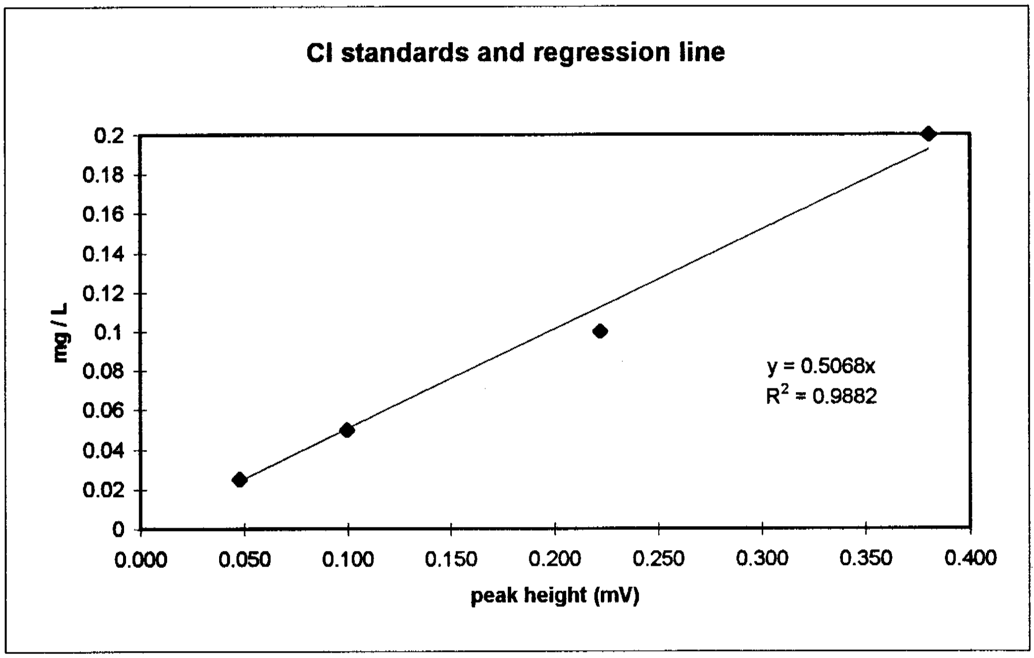
Cl standard results	retention time = 5.1 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03C97.59R	0.1	0.300	0.545	0.245	0.1
JWM03C97.60R	0.05	-0.100	-0.003	0.097	0.05
JWM03C97.79R	0	0.000	0.000	0.000	0



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.4227
JWM03C97.61R	26	0.546	0.726	0.180	0.076
JWM03C97.62R	27	0.652	0.835	0.183	0.077
JWM03C97.63R	28	0.070	0.160	0.090	0.038
JWM03C97.64R	29	0.730	0.956	0.226	0.096
JWM03C97.65R	30	0.617	0.785	0.168	0.071
JWM03C97.66R	31	0.812	0.925	0.113	0.048
JWM03C97.67R	32	1.020	1.230	0.210	0.089
JWM03C97.68R	33	1.240	1.510	0.270	0.114
JWM03C97.70R	34	1.090	1.240	0.150	0.063
JWM03C97.71R	35	0.700	0.800	0.100	0.042
JWM03C97.73R	36	0.050	0.080	0.030	0.013
JWM03C97.74R	37	0.495	0.510	0.015	0.006
JWM03C97.76R	38	0.880	0.900	0.020	0.008
JWM03C97.78R	39	0.940	0.950	0.010	0.004
JWM03C97.80R	40	0.000	0.000	0.000	0.000
JWM03C97.81R	41	0.000	0.000	0.000	0.000

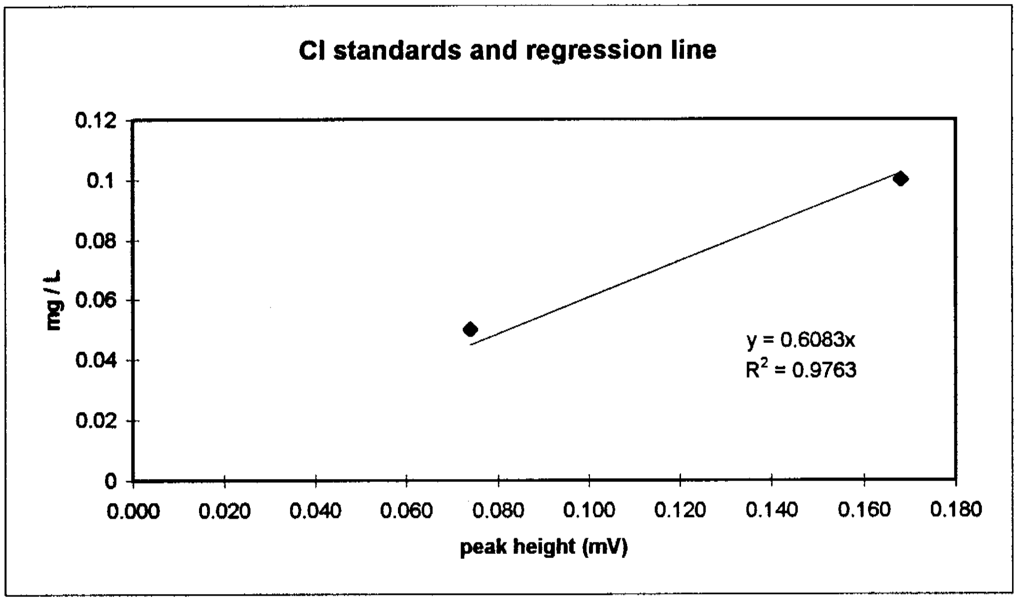
AP F.1.5 HPLC results for Cl standards and samples
for column extracted at t = 3 months
from position 7 of row 1

Cl standard results	retention time = 5.6 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03B97.68R	0.2	1.170	1.550	0.380	0.2
JWM03B97.71R	0.1	0.955	1.177	0.222	0.1
JWM03B97.70R	0.05	0.740	0.840	0.100	0.05
JWM03B97.93R	0.025	0.252	0.300	0.048	0.025



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5068
JWM03B97.72R	1	1.550	1.770	0.220	0.111
JWM03B97.73R	2	0.080	0.260	0.180	0.091
JWM03B97.74R	3	0.380	0.560	0.180	0.091
JWM03B97.75R	4	0.967	1.060	0.093	0.047
JWM03B97.76R	5	0.960	1.030	0.070	0.035
JWM03B97.77R	6	1.010	1.065	0.055	0.028
JWM03B97.78R	7	0.740	0.800	0.060	0.030
JWM03B97.79R	8	0.871	0.896	0.025	0.013
JWM03B97.80R	9	0.560	0.584	0.024	0.012
JWM03B97.81R	10	0.404	0.438	0.034	0.017
JWM03B97.82R	11	0.133	0.158	0.025	0.013
JWM03B97.83R	12	0.805	0.837	0.032	0.016
JWM03B97.84R	13	0.485	0.508	0.023	0.012
JWM03B97.85R	14	0.373	0.393	0.020	0.010
JWM03B97.86R	15	0.692	0.710	0.018	0.009
JWM03B97.87R	16	0.468	0.483	0.015	0.008
JWM03B97.88R	17	0.297	0.306	0.009	0.005
JWM03B97.89R	18	0.240	0.255	0.015	0.008
JWM03B97.90R	19	0.165	0.195	0.030	0.015
JWM03B97.91R	20	0.131	0.152	0.021	0.011
JWM03B97.92R	21	0.500	0.518	0.018	0.009
JWM03B97.94R	22	0.594	0.612	0.018	0.009
JWM03B97.95R	23	0.573	0.583	0.010	0.005
JWM03B97.96R	24	0.413	0.426	0.013	0.007
JWM03B97.97R	25	0.000	0.000	0.000	0.000

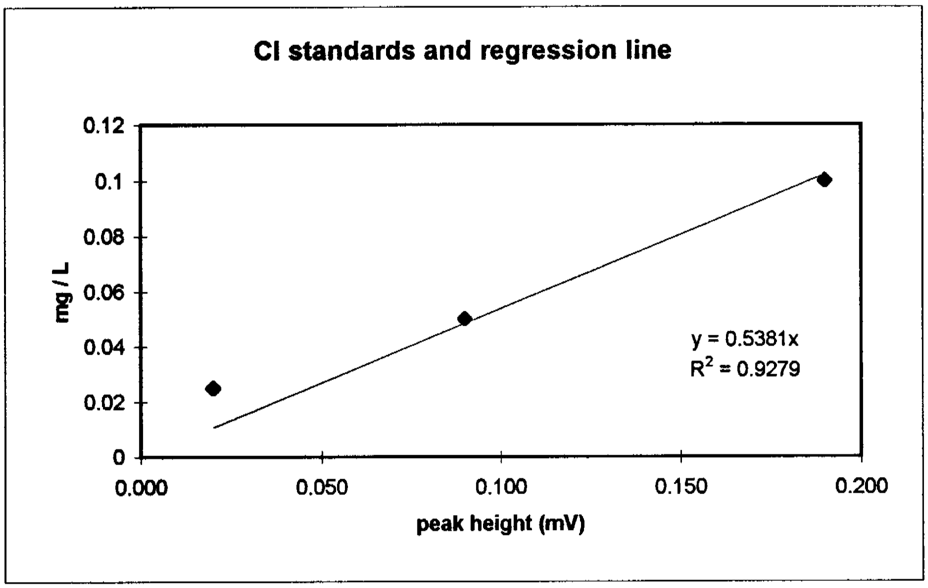
Cl standard results	retention time = 5.2 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03C97.84R	0.1	0.600	0.768	0.168	0.1
JWM03C97.85R	0.05	0.200	0.274	0.074	0.05



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5068
JWM03C97.86R	26	0.120	0.185	0.065	0.040
JWM03C97.87R	27	0.000	0.000	0.000	0.000
JWM03C97.88R	28	0.635	0.645	0.010	0.006
JWM03C97.89R	29	0.740	0.760	0.020	0.012
JWM03C97.90R	30	1.460	1.480	0.020	0.012
JWM03C97.91R	31	1.384	1.448	0.064	0.039
JWM03C97.92R	32	0.325	0.355	0.030	0.018
JWM03C97.93R	33	0.830	0.850	0.020	0.012
JWM03C97.94R	34	0.735	0.825	0.090	0.055
JWM03C97.95R	35	0.000	0.000	0.000	0.000
JWM03C97.96R	36	0.872	0.900	0.028	0.017

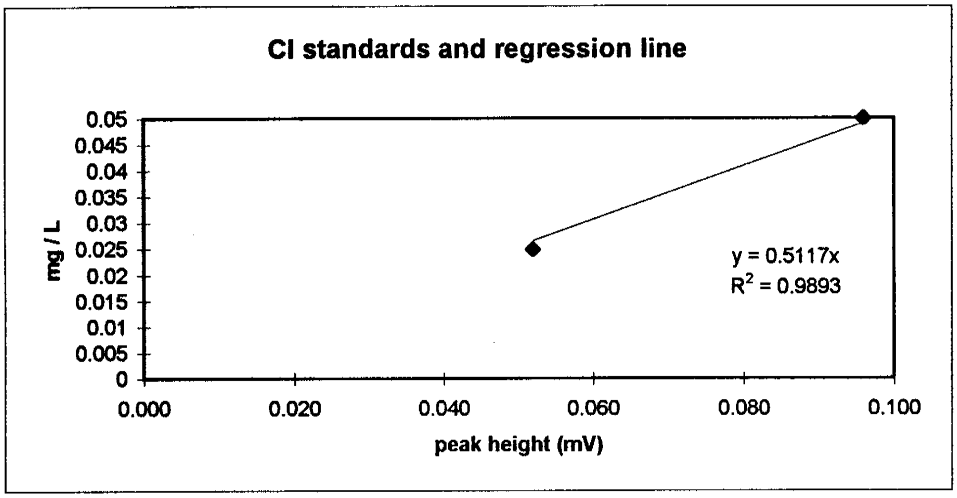
AP F.1.6 HPLC results for Cl standards and samples for column extracted at t = 4 months

Cl standard results	retention time = 5.2 minutes				
FILENAME	chloride concentra (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03C97.30R	0.025	0.207	0.227	0.020	0.025
JWM03C97.02R	0.05	0.470	0.560	0.090	0.05
JWM03C97.03R	0.1	0.950	1.140	0.190	0.1



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5724
JWM03C97.04R	1	1.110	1.170	0.060	0.032
JWM03C97.05R	2	1.368	1.385	0.017	0.009
JWM03C97.06R	3	0.778	0.797	0.019	0.010
JWM03C97.07R	4	1.090	1.110	0.020	0.011
JWM03C97.08R	5	0.760	0.780	0.020	0.011
JWM03C97.09R	6	0.840	0.855	0.015	0.008
JWM03C97.11R	7	0.655	0.675	0.020	0.011
JWM03C97.12R	8	0.440	0.510	0.070	0.038
JWM03C97.13R	9	0.630	0.665	0.035	0.019
JWM03C97.14R	10	0.365	0.415	0.050	0.027
JWM03C97.15R	11	0.411	0.447	0.036	0.019
JWM03C97.16R	12	0.390	0.400	0.010	0.005
JWM03C97.17R	13	0.560	0.600	0.040	0.022
JWM03C97.18R	14	0.411	0.477	0.066	0.036
JWM03C97.19R	15	0.390	0.440	0.050	0.027
JWM03C97.20R	16	0.350	0.384	0.034	0.018
JWM03C97.21R	17	0.282	0.305	0.023	0.012
JWM03C97.22R	18	0.510	0.565	0.055	0.030
JWM03C97.23R	19	0.295	0.344	0.049	0.026
JWM03C97.24R	20	0.648	0.685	0.037	0.020
JWM03C97.25R	21	0.076	0.115	0.039	0.021
JWM03C97.26R	22	0.613	0.666	0.053	0.029
JWM03C97.27R	23	0.124	0.162	0.038	0.020
JWM03C97.28R	24	0.160	0.210	0.050	0.027
JWM03C97.29R	25	0.640	0.660	0.020	0.011

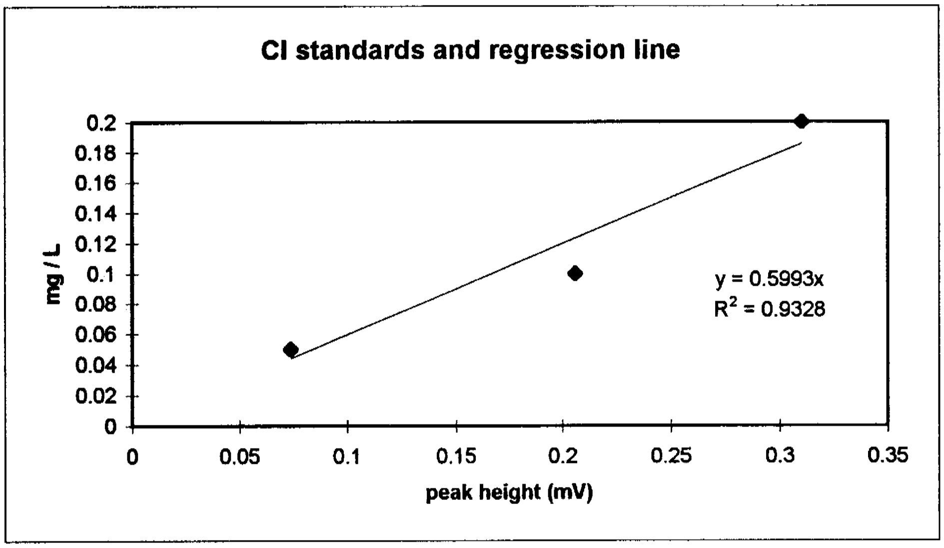
Cl standard results	retention time = 5.45 minutes				
FILENAME	chloride concentra (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03C97.34R	0.025	0.570	0.622	0.052	0.025
JWM03C97.35R	0.05	0.564	0.660	0.096	0.05



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5724
JWM03C97.36R	26	0.695	0.750	0.055	0.028
JWM03C97.37R	27	0.494	0.546	0.052	0.027
JWM03C97.38R	28	0.310	0.380	0.070	0.036
JWM03C97.39R	29	0.623	0.673	0.050	0.026
JWM03C97.40R	30	0.232	0.270	0.038	0.019
JWM03C97.41R	31	0.144	0.358	0.214	0.110
JWM03C97.42R	32	0.476	0.550	0.074	0.038
JWM03C97.43R	33	0.079	0.173	0.094	0.048
JWM03C97.44R	34	0.635	0.721	0.086	0.044
JWM03C97.45R	35	-0.010	0.113	0.123	0.063
JWM03C97.46R	36	0.270	0.400	0.130	0.067
JWM03C97.47R	37	-0.275	-0.177	0.098	0.050
JWM03C97.48R	38	0.610	0.740	0.130	0.067
JWM03C97.49R	39	0.558	0.730	0.172	0.088
JWM03C97.50R	40	0.308	0.367	0.059	0.030
JWM03C97.51R	41	1.038	1.097	0.059	0.030
JWM03C97.52R	42	0.010	0.040	0.030	0.015
JWM03C97.53R	43	0.410	0.470	0.060	0.031

AP F.1.7 HPLC results for Cl standards and samples for column extracted at t = 5 months

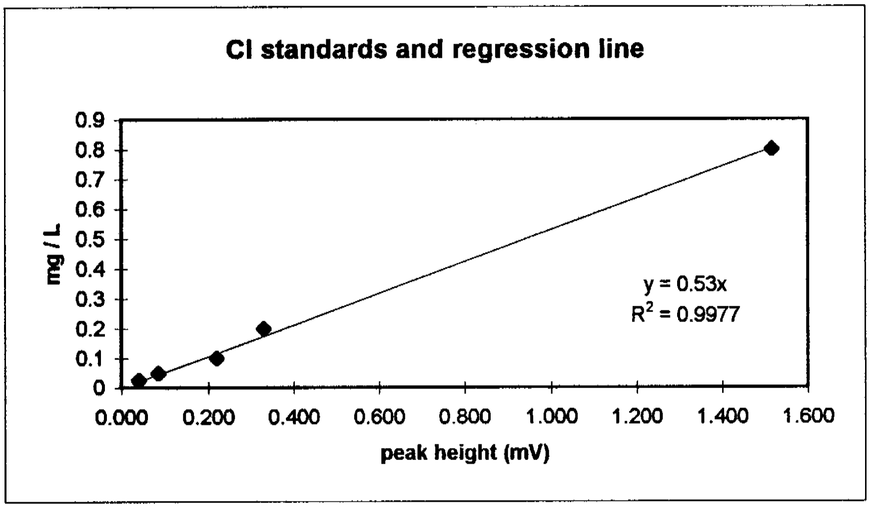
Cl standard results	retention time = 3.44 minutes				
FILENAME	chloride concentratio (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03D97.05R	0.05	0.404	0.478	0.074	0.05
JWM03D97.06R	0.1	0.312	0.518	0.206	0.1
JWM03D97.17R	0.2	1.130	1.440	0.310	0.2



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5724
JWM03D97.18R	1	0.631	0.828	0.197	0.118
JWM03D97.07R	2	0.797	0.950	0.153	0.092
JWM03D97.08R	3	0.292	0.397	0.105	0.063
JWM03D97.09R	4	0.483	0.699	0.216	0.129
JWM03D97.10R	5	0.228	0.540	0.312	0.187
JWM03D97.11R	6	0.971	1.300	0.329	0.197
JWM03D97.12R	7	0.794	1.200	0.406	0.243
JWM03D97.13R	8	0.850	1.080	0.230	0.138
JWM03D97.14R	9	1.418	1.682	0.264	0.158
JWM03D97.15R	10	0.080	0.373	0.293	0.176
JWM03D97.16R	11	0.688	0.920	0.232	0.139

AP F.1.8 HPLC results for Cl standards and samples for column extracted at t = 6 months

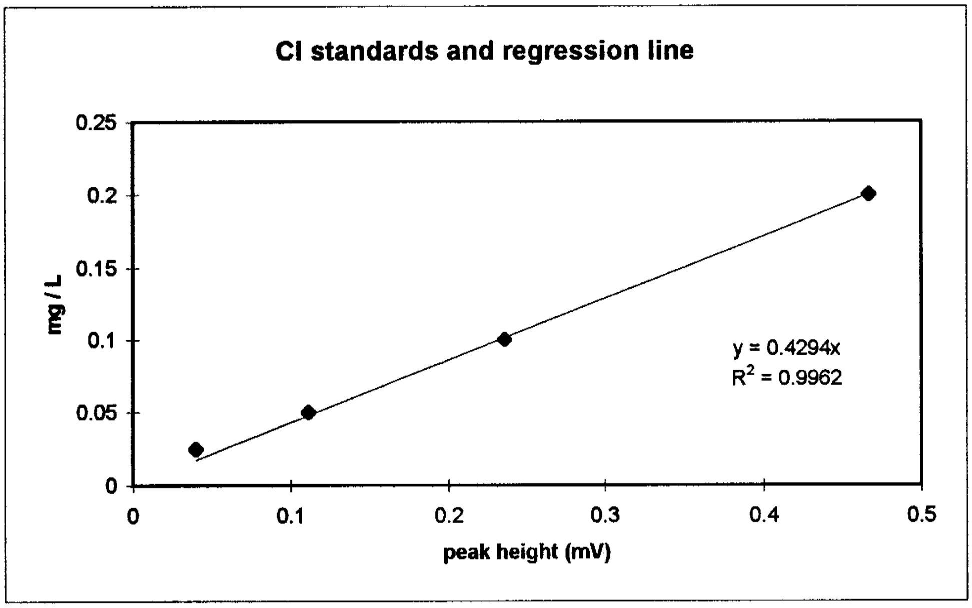
Cl standard resul	retention time = 2.65 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM05A97.11R	0.8	0.694	2.210	1.516	0.8
JWM05A97.12R	0.2	-0.110	0.220	0.330	0.2
JWM05A97.13R	0.1	1.150	1.370	0.220	0.1
JWM05A97.14R	0.05	-0.290	-0.204	0.086	0.05
JWM05A97.15R	0.025	1.770	1.810	0.040	0.025



sample results					
FILENAME	depth interval	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.53
JWM05A97.30R	1	1.520	1.600	0.080	0.042
JWM05A97.16R	2	0.250	0.277	0.027	0.014
JWM05A97.19R	3	0.120	0.174	0.054	0.029
JWM05A97.20R	4	-0.090	-0.026	0.064	0.034
JWM05A97.21R	5	0.826	0.864	0.038	0.020
JWM05A97.22R	6	-0.250	-0.177	0.073	0.039
JWM05A97.23R	7	0.950	1.030	0.080	0.042
JWM05A97.24R	8	0.586	0.731	0.145	0.077
JWM05A97.25R	9	0.100	0.304	0.204	0.108
JWM05A97.26R	10	1.360	1.540	0.180	0.095
JWM05A97.27R	11	-0.127	0.140	0.267	0.142
JWM05A97.28R	12	1.435	1.720	0.285	0.151

AP F.2.1 HPLC results for Cl standards and dust collector sample taken on January 31, 1997.

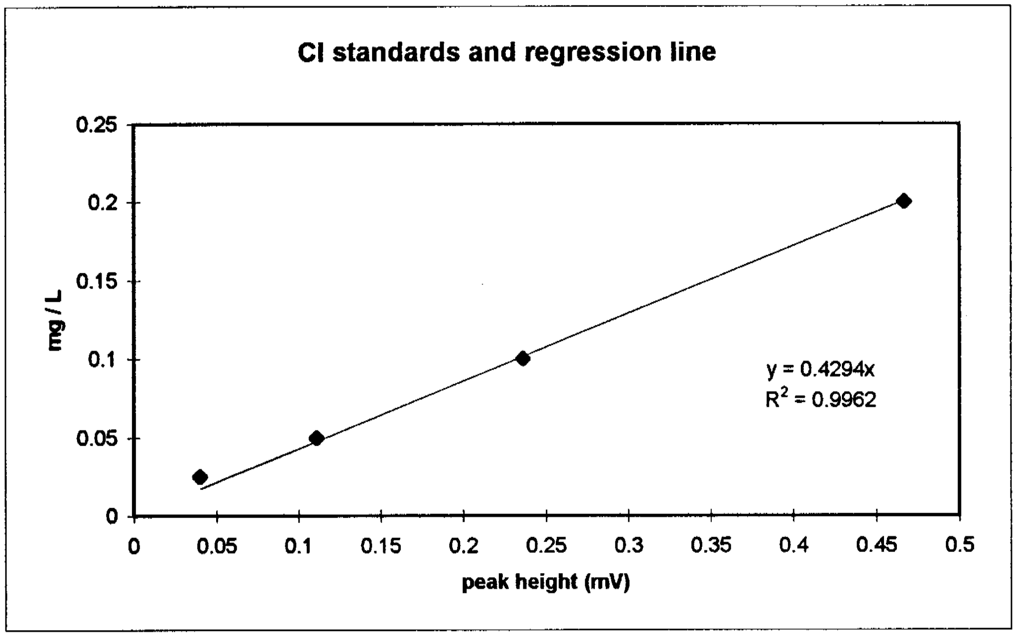
Cl standard results	retention time = 5.76 min				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03B97.19R	0.2	1.220	1.687	0.467	0.2
JWM03B97.20R	0.1	0.598	0.834	0.236	0.1
JWM03B97.21R	0.05	0.903	1.014	0.111	0.05
JWM03B97.28R	0.025	0.536	0.576	0.040	0.025



sample results					
FILENAME	sample	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.4294
JWM03B97.29R	bottle 1 of 1	6.025	6.700	0.675	0.290

AP F.2.2 HPLC results for Cl standards and dust collector sample taken on March 3, 1997.

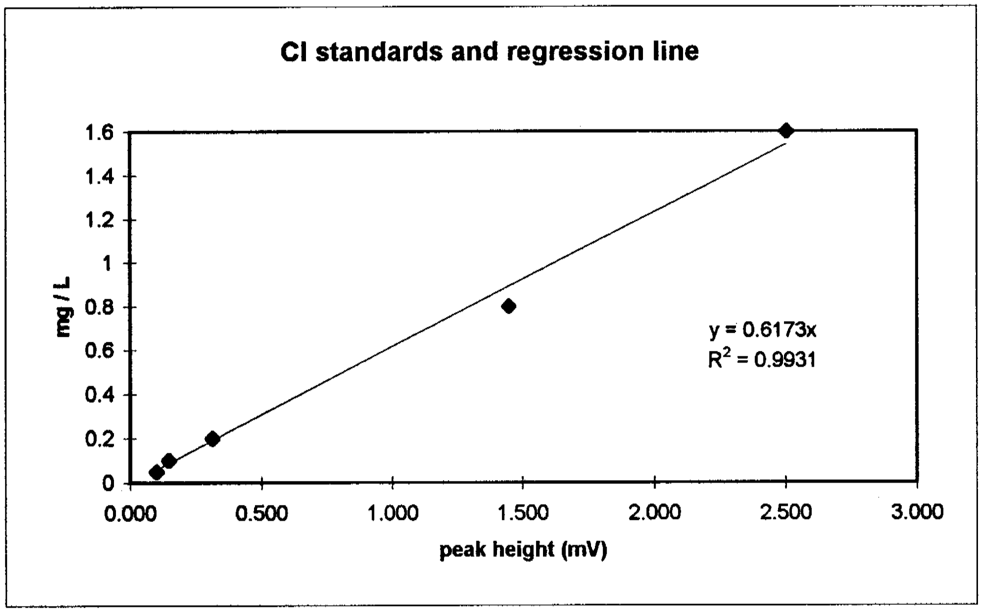
Cl standard results	retention time = 5.76 min				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM03B97.19R	0.2	1.220	1.687	0.467	0.2
JWM03B97.20R	0.1	0.598	0.834	0.236	0.1
JWM03B97.21R	0.05	0.903	1.014	0.111	0.05
JWM03B97.28R	0.025	0.536	0.576	0.040	0.025



sample results					
FILENAME	sample	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.4294
JWM03B97.31R	bottle 1 of 2	0.704	1.860	1.156	0.496
JWM03B97.33R	bottle 2 of 2	-0.964	-0.541	0.423	0.182

AP F.2.3 HPLC results for Cl standards and dust collector sample taken on April 1, 1997.

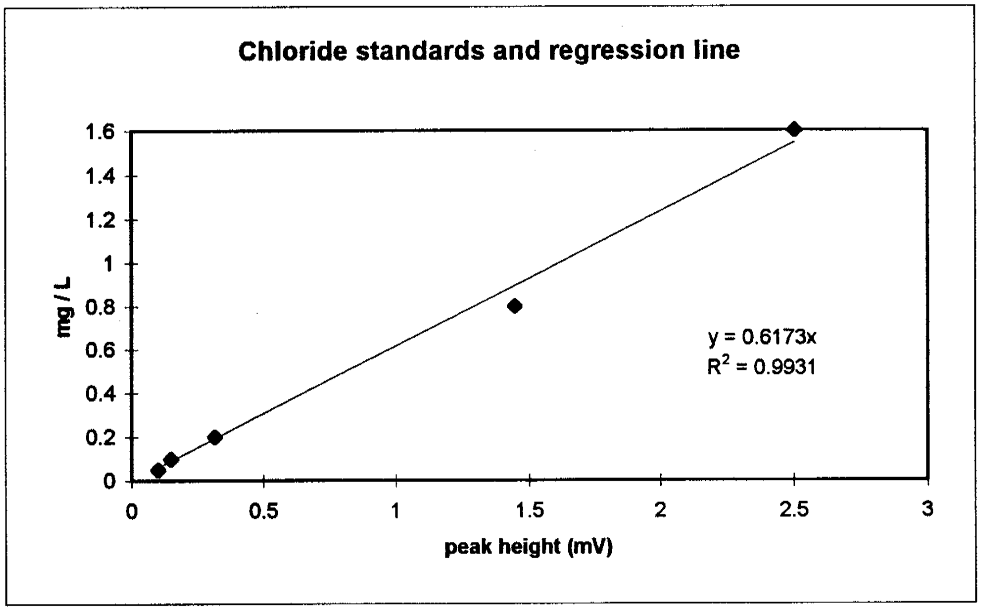
Cl standard results	retention time = 2.65 min				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM05C97.24R	1.60	1.102	3.607	2.505	1.6
JWM05C97.23R	0.80	0.655	2.103	1.448	0.8
JWM05C97.20R	0.20	0.147	0.462	0.315	0.2
JWM05C97.21R	0.10	1.352	1.500	0.148	0.1
JWM05C97.22R	0.05	0.432	0.532	0.100	0.05



sample results					
FILENAME	sample	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.6173
JWM05C97.13R	BOTTLE 1	0.212	1.095	0.883	0.545
JWM05C97.14R	BOTTLE 2	1.435	2.155	0.720	0.444
JWM05C97.15R	BOTTLE 3	0.133	0.163	0.030	0.019

AP F.2.4 HPLC results for Cl standards and dust collector sample taken on April 30, 1997.

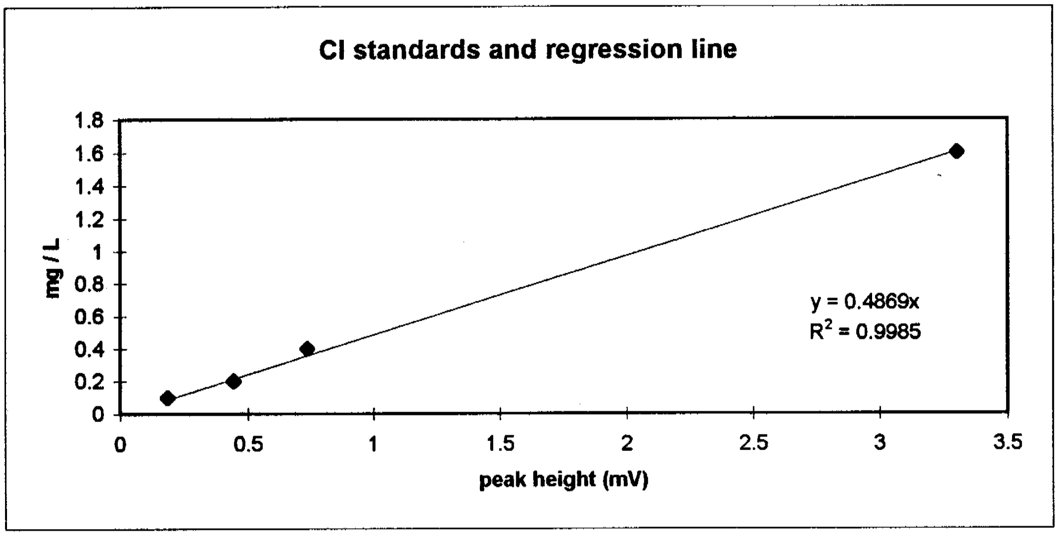
Cl standard results	retention time = 2.65 min				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM05C97.24R	1.60	1.102	3.607	2.505	1.6
JWM05C97.23R	0.80	0.655	2.103	1.448	0.8
JWM05C97.20R	0.20	0.147	0.462	0.315	0.2
JWM05C97.21R	0.10	1.352	1.500	0.148	0.1
JWM05C97.22R	0.05	0.432	0.532	0.100	0.05



sample results					
FILENAME	sample	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.6173
JWM05C97.16R	BOTTLE 1	0.921	2.84	1.919	1.185
JWM05C97.17R	BOTTLE 2	0.412	1.656	1.244	0.768
JWM05C97.18R	BOTTLE 3	1.146	1.738	0.592	0.365

AP F.3 HPLC results for Cl standards and samples for surface sample from within plot

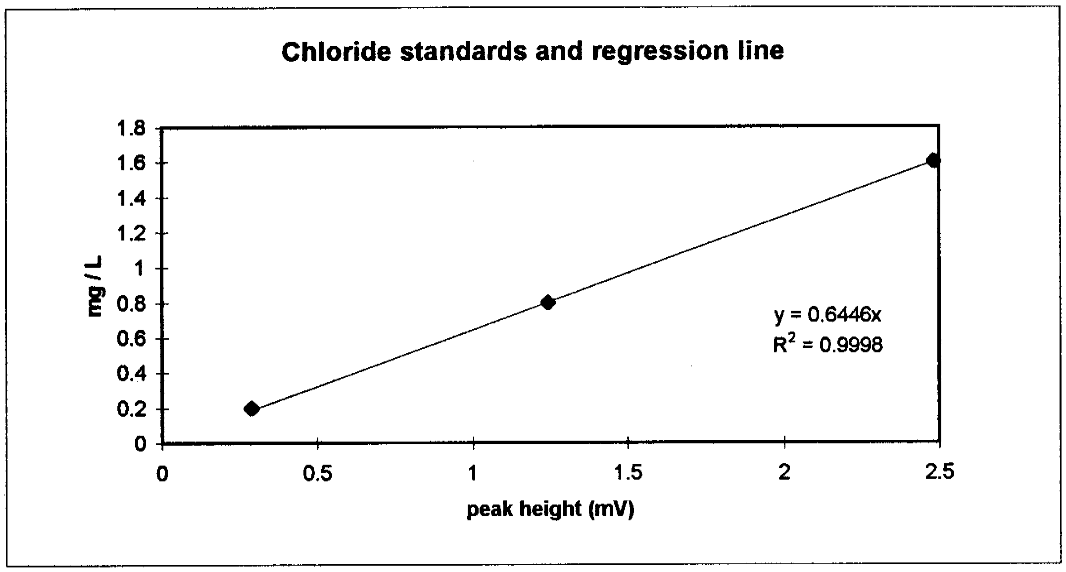
Cl standard results	retention time = 2.56 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM05E97.09R	0.1	0.150	0.336	0.186	0.1
JWM05E97.06R	0.2	0.860	1.305	0.445	0.2
JWM05E97.11R	0.4	0.795	1.530	0.735	0.4
KWM05D97.01R	1.6	0.416	3.718	3.302	1.6



sample results					
FILENAME	sample	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.5724
JWM05E97.04R	sand from land surface within experimental plot	3.379	4.133	0.754	0.367

AP F.4 HPLC results for my Cl standards and standard from UNM

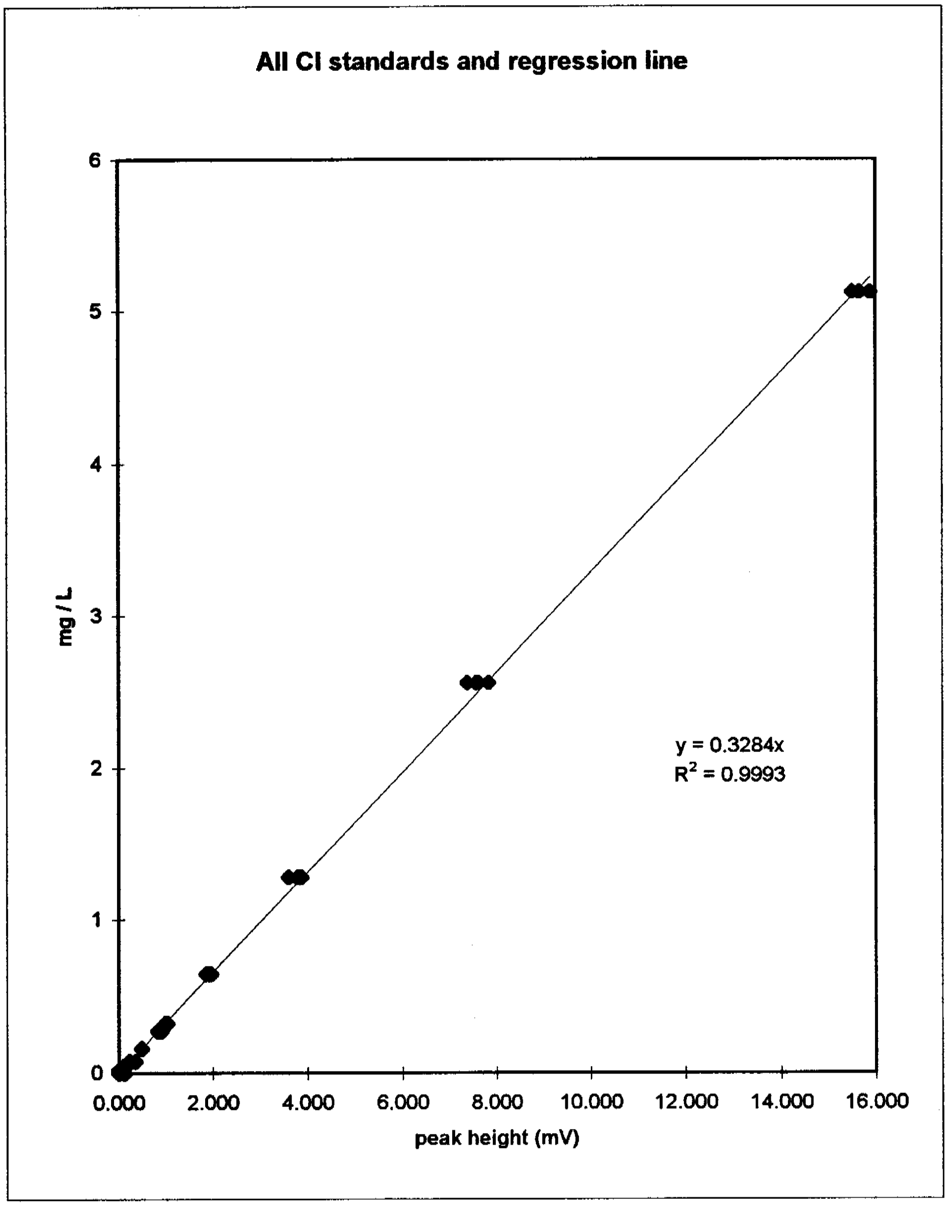
Cl standard results	retention time = 2.66 minutes				
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg/L)
JWM05D97.05R	0.2	1.240	1.530	0.290	0.2
JWM05D97.03R	0.8	0.050	1.294	1.244	0.8
JWM05D97.02R	1.6	0.327	2.810	2.483	1.6



sample results					
FILENAME	SAMPLE	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.6446
JWM05D97.04R	0.5 ppm Cl (UNM)	4.200	4.975	0.775	0.500

AP F.5 HPLC results for Cl standards
used for determination of detection limit.

Cl standard results	retention time = 3.54				
FILENAME	chloride concentration (mg / L)	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration (mg / L)
JWM10C96.01R	5.12	-0.271	15.238	15.509	5.12
JWM10C96.02R	5.12	-0.327	15.545	15.872	5.12
JWM10C96.03R	5.12	0.000	15.894	15.894	5.12
JWM10C96.04R	5.12	0.000	15.660	15.660	5.12
JWM10C96.05R	2.56	0.136	7.705	7.569	2.56
JWM10C96.06R	2.56	0.000	7.378	7.378	2.56
JWM10C96.07R	2.56	0.274	8.115	7.841	2.56
JWM10C96.10R	2.56	0.260	7.884	7.624	2.56
JWM10C96.11R	2.56	0.359	7.960	7.601	2.56
JWM10C96.12R	1.28	0.268	4.078	3.810	1.28
JWM10C96.13R	1.28	0.247	4.128	3.881	1.28
JWM10C96.14R	1.28	0.765	4.367	3.602	1.28
JWM10C96.15R	1.28	0.419	4.229	3.810	1.28
JWM10C96.16R	1.28	0.330	4.121	3.791	1.28
JWM10C96.17R	0.64	0.500	2.363	1.863	0.64
JWM10C96.18R	0.64	0.454	2.358	1.904	0.64
JWM10C96.19R	0.64	0.441	2.352	1.911	0.64
JWM10C96.20R	0.64	0.238	2.203	1.965	0.64
JWM10C96.21R	0.64	0.315	2.292	1.977	0.64
JWM10C96.22R	0.32	0.462	1.455	0.993	0.32
JWM10C96.23R	0.32	0.393	1.406	1.013	0.32
JWM10C96.24R	0.32	0.200	1.210	1.010	0.32
JWM10C96.25R	0.32	0.155	1.185	1.030	0.32
JWM10C96.32R	0.32	-0.289	0.710	0.999	0.32
JWM10C96.26R	0.27	0.445	1.282	0.837	0.27
JWM10C96.27R	0.27	0.425	1.256	0.831	0.27
JWM10C96.28R	0.27	0.328	1.190	0.862	0.27
JWM10C96.29R	0.27	0.229	1.067	0.838	0.27
JWM10C96.30R	0.27	0.479	1.335	0.856	0.27
JWM10C96.31R	0.27	0.275	1.191	0.916	0.27
JWM10C96.34R	0.16	0.161	0.645	0.484	0.16
JWM10C96.35R	0.16	-0.215	0.271	0.486	0.16
JWM10C96.36R	0.074	0.536	0.890	0.354	0.074
JWM10C96.37R	0.074	0.447	0.684	0.237	0.074
JWM10C96.38R	0.074	0.768	0.986	0.218	0.074
JWM10C96.39R	0.074	0.445	0.674	0.229	0.074
JWM10C96.40R	0.04	0.291	0.406	0.115	0.04
JWM10C96.41R	0.04	0.433	0.546	0.113	0.04
JWM10C96.42R	0.04	0.588	0.678	0.090	0.04
JWM10C96.43R	0.04	0.580	0.700	0.120	0.04
JWM10C96.44R	0.04	0.477	0.613	0.136	0.04
JWM10C96.45R	0.02	0.000	0.000	0.000	0.02
JWM10C96.46R	0.02	0.000	0.000	0.000	0.02
JWM10C96.08R	0	0.050	0.174	0.124	0
JWM10C96.09R	0	0.000	0.000	0.000	0


All Cl standards and regression line
mg / L
6
5
4
3
2
1
0
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
peak height (mV)
y = 0.3284x
R² = 0.9993

AP F.6.1 HPLC results for Cl standards and samples of drum leachates

Peak heights were determined using Chromperfect.

Cl standard results	retention time = 3.55 minutes	
FILENAME	chloride concentration (mg/L)	peak height
JWM10B96.02R	2.0	6054

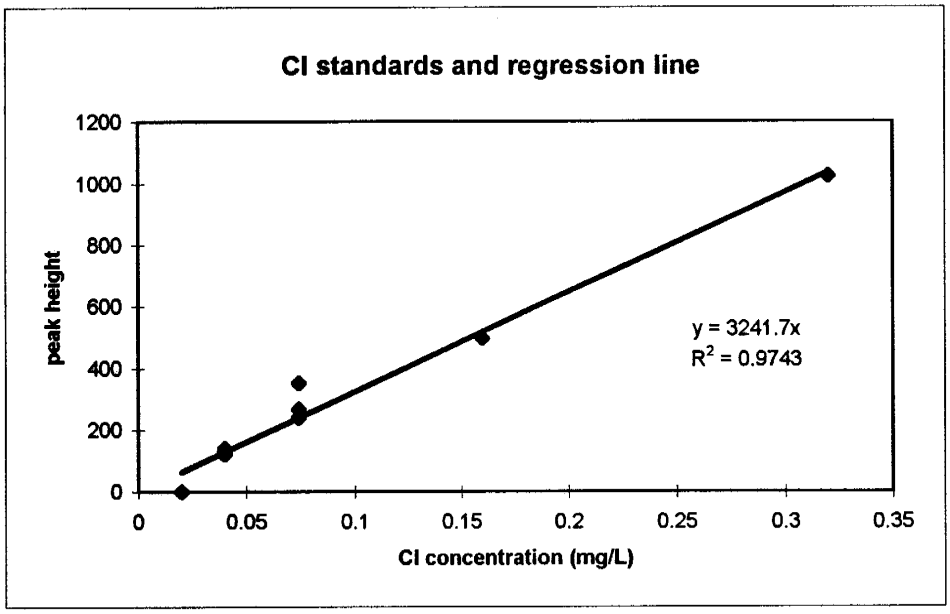
slope for single-point calibration :	2 / 6054 =	0.0003304

sample results			
FILENAME	SAMPLE	peak height	chloride concentration (mg/L)
JWM10B96.06R	WATER18	379.35	0.125
JWM10B96.08R	WATER18	442.31	0.146
JWM10B96.09R	WATER18	410.66	0.136
JWM10B96.12R	WATER25	683.17	0.226
JWM10B96.13R	WATER25	712.53	0.235
JWM10B96.14R	WATER38	697.64	0.230
JWM10B96.15R	WATER38	404.10	0.133
JWM10B96.16R	WATER38	343.99	0.114
JWM10B96.18R	WATER32	574.04	0.190
JWM10B96.01R	WATER6	100.07	0.033
JWM10B96.02R	WATER9	57.00	0.019
JWM10B96.25R	WATER9	0.00	0.000
JWM10B96.03R	WATER12	36.71	0.012
JWM10B96.24R	WATER12	0.00	0.000
JWM10B96.27R	WATER15	0.00	0.000
JWM10B96.28R	WATER17	40.00	0.013

AP F.6.2 HPLC results for Cl standards and samples of drum leachates

Peak heights were determined using Chromperfect.

Cl standard results	retention time = 3.4 minutes	
FILENAME	chloride concentration (mg/L)	peak height
JWM10C96.32R	0.32	1023.8
JWM10C96.33R	0.16	496.3
JWM10C96.36R	0.074	350.7
JWM10C96.37R	0.074	266.8
JWM10C96.38R	0.074	240.6
JWM10C96.39R	0.074	241.5
JWM10C96.40R	0.04	134.8
JWM10C96.41R	0.04	129.7
JWM10C96.42R	0.04	121.5
JWM10C96.43R	0.04	126.2
JWM10C96.44R	0.04	139.8
JWM10C96.45R	0.02	0.0
JWM10C96.46R	0.02	0.0



sample results			
FILENAME	SAMPLE	peak height	chloride concentration (mg/L)
JWM10C96.49R	WATER 24 (leach 6)	0.0	0.0
JWM10C96.50R	WATER 24 (leach 6)	0.0	0.0
JWM10C96.51R	WATER 31 (leach 6)	0.0	0.0
JWM10C96.52R	WATER 31 (leach 6)	0.0	0.0

AP F.6.3 HPLC results for Cl standards and samples of leachates of washed and dried sand

Peak heights were determined using Chromperfect.

Cl standard results	retention time = 3.4 minutes	
FILENAME	chloride concentration (mg/L)	peak height
JWM10F96.03R	2.6	8350.82

slope for single-point calibration :	2.6 / 8350.82	=	0.00031

sample results			
FILENAME	SAMPLE	peak height	chloride concentration (mg/L)
JWM10F96.01R	leachate of dried sand	0.0	0.0
JWM10F96.02R	leachate of dried sand	0.0	0.0
JWM10F96.05R	leachate of dried sand	75.45	0.023
JWM10F96.06R	leachate of dried sand	46.12	0.014
JWM10F96.09R	leachate of dried sand	0.0	0.0
JWM10F96.10R	leachate of dried sand	0.0	0.0

AP F.6.4 HPLC results for Cl standards and samples of leachates of washed and dried sand

Peak heights were determined with the HPLC method in Appendix A.

Cl standard results	retention time = 3.4 minutes			
FILENAME	chloride concentration (mg/L)	mV value at base of peak	mV value at top of peak	peak height (mV)
JWM10F96.03R	2.6	0.350	8.700	8.350

slope for single-point calibration :	2.6 / 8.35	0.31

sample results					
FILENAME	SAMPLE	mV value at base of peak	mV value at top of peak	peak height (mV)	chloride concentration =ht x 0.31
JWM10F96.01R	leachate of dried sand	0.050	0.075	0.025	0.008
JWM10F96.02R	leachate of dried sand	0.398	0.452	0.054	0.017
JWM10F96.05R	leachate of dried sand	0.101	0.150	0.049	0.015
JWM10F96.06R	leachate of dried sand	0.158	0.180	0.022	0.007
JWM10F96.09R	leachate of dried sand	-7.800	-7.670	0.130	0.040
JWM10F96.10R	leachate of dried sand	0.267	0.330	0.063	0.020