4. PERFORMANCE ANALYSIS OF EXTENDED DETENTION BASIN

(Based on "Methodology for analysis of detention basins for control of urban runoff quality" by USEPA, September 1986)

4.1 General

Detention basins that receive storm runoff, but that have negligible losses through infiltration, must rely principally on sedimentation processes for pollutant removal.

Of the variety of configurations and operational modes that have been used, stormwater detention basins that maintain a permanent pool of water, often referred to as "wet ponds," are generally considered to be the most effective for pollutant reduction.

This section presents a procedure for projecting performance of such devices, and a comparison of results with observed performance of the operating detention basins.

The input data requirements for use of the analysis procedure consist of the following:

- Rainfall - mean and coefficient of variation of rainfall intensity.
- Urban Catchment - area and runoff coefficient (ratio of runoff to rainfall).
- Device Size - surface area provided for percolation, and storage volume.
- Settling Velocity - settling velocity of the particulate present in the urban runoff. The settling velocity defines a "Treatment Rate". Representative values for settling velocity can be assigned to urban runoff on the basis of a significant number of settling column tests.

The data used in the following sections are mainly based on the actual performance data developed by the USEPA Nationwide Urban Runoff Program (NURP) in 1980's.

4.2 Analytical Method

A basic aspect of detention basin is that part of the time (while runoff inflows occur), stormwater is moving through the basin, and sedimentation takes place under dynamic conditions. During the considerably longer dry periods between storm events, sedimentation takes place under quiescent conditions.

4.2.1 Removal under dynamic conditions

Removal due to sedimentation in a dynamic (flow through) system is expressed by the following equation:

$$R = 1 - [1 + \frac{1}{n} * \frac{Vs}{Q/A}]^{-n} \qquad (4.1)$$

where:

R = fraction of initial solids removed (R 100 % Removal)

Vs = settling velocity of particles

Q/A = rare of applied flow divided by surface area of basin (an "overflow velocity," often designated the overflow rate)

n = a parameter which provides a measure of the degree of turbulence or short-circuiting, which tends to reduce removal efficiency

Empirical relationship between performance and the value "n"

Performance	"n" value
Very poor	1
Good	3
Very good	> 5

Source: Fair and Geyer (1954)

In addition, when a value of n = is assigned (ideal performance), the equation reduces to the familiar form wherein removal efficiency is keyed to detention time.

$$R = 1 - \exp[-\frac{Vs}{Q/A}] \qquad \text{or} \qquad (4.2)$$

$$R = 1 - \exp[-k * t] \qquad (4.3)$$

where:

k = Vs / h (sedimentation rate coefficient)

h = average depth of basin

t = V/Q residence time

V = volume of basin

The two expressions are equivalent. To use them, one must be able to identify an appropriate value for either settling velocity, or for the rate coefficient (k), which will ultimately depend on the settling velocity of the particulates present.

Solving equation (4.1) for a range of overflow rates and particle settling velocities and plotting the results as shown by Figure 4.1, indicates the wide range in removal that can be expected either (a) at a constant overflow rate for particles of different size, or (b) at different rates of flow for a specific size fraction. Both of these variable factors are present in urban runoff applications. The effect of a range of particle settling velocities is addressed by performing separate computations for a number of settling velocities and then using weighted mass fraction to compute net removal.

Storm sequences result in variable overflow rates, each event producing a different average rate, and hence, removal efficiency. The probabilistic analysis procedure summarized by the design performance curves in Figure 4.2, is the relevant analysis to apply. This analysis makes the following assumptions:

- The short-term variability of flows (within storm events) is small compared with the variability of average flows between storms. To the extent that this is not the case, Figure 4.2 will overestimate long-term performance.
- Storm flows and pollutant concentrations are independent. If flow rate and concentration are negatively correlated (high flows produce lower concentrations), performance will be better than indicated. For positive correlations, performance will be poorer than indicated.
- Removal efficiency is an exponential function of flow

Removal fractions for a range of settling velocities representative of urban runoff, as computed by equation (4.1), are presented in Figure 4.3 as a semi-log plot on which the exponential approximation, equation (4.2), would plot as a straight line.

Long-term average removal of a pollutant under dynamic conditions can, therefore, be estimated from the statistics (mean and coefficient of variation) of runoff flows, basin surface area, and representative particle settling velocities for urban runoff.

Figure 4.1 Effect of Settling Velocity and Overflow Rate on Removal Efficiency

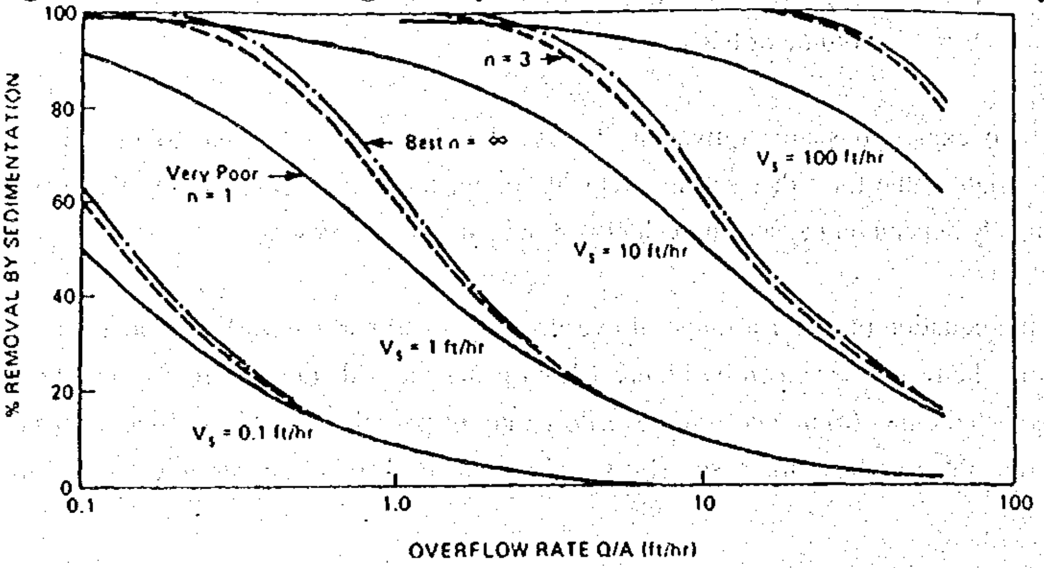


Figure 4.2 LongTerm Performance of a Device Where Removal Mechanism is Sensitive to Flow Rate

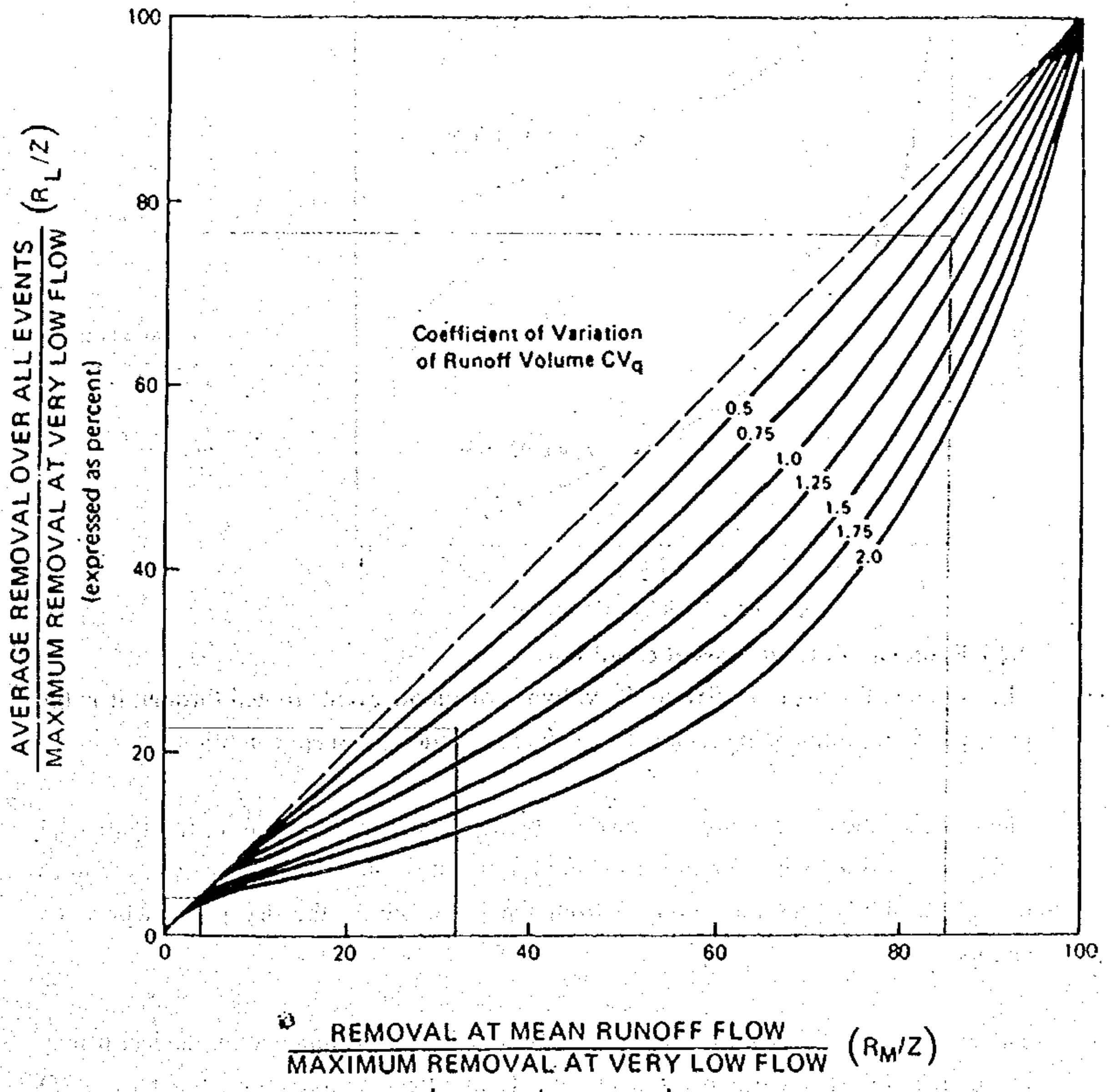
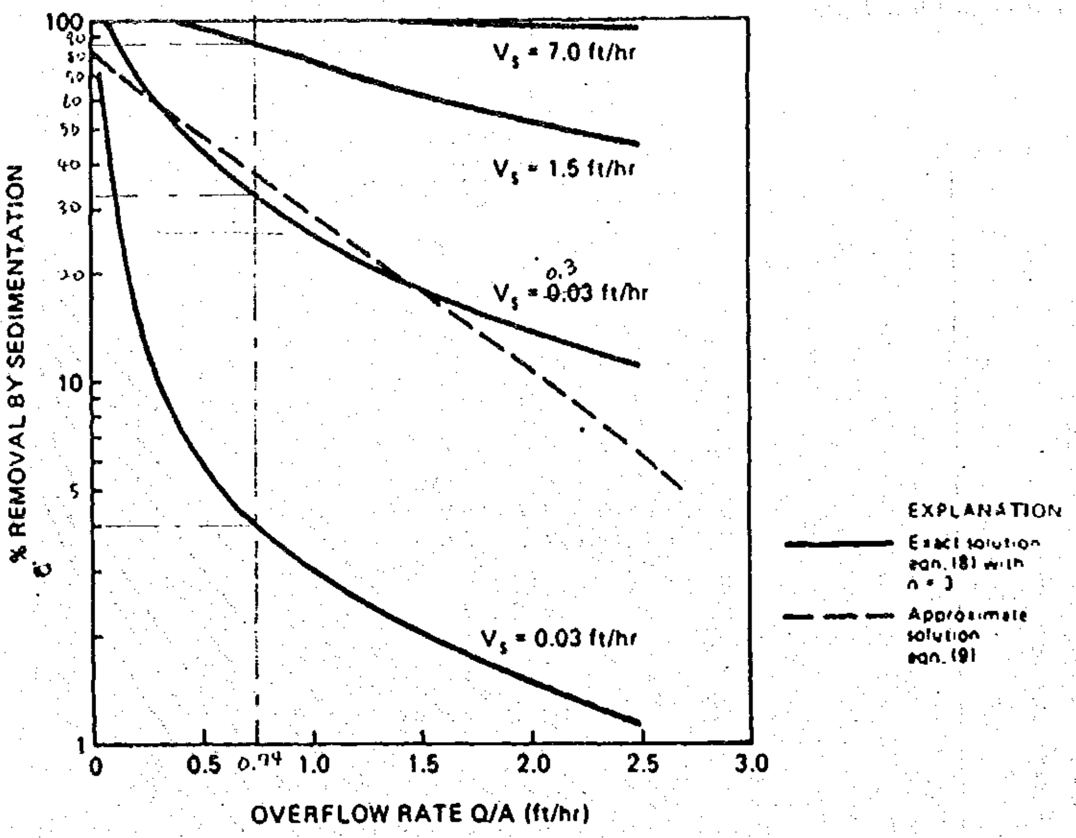


Figure 4.3 Flow-Removal Relationship for Exponential Approximation



4.2.2 Removal under quiescent conditions

The volume of a basin relative to the volumes of runoff events routed through it is the principal factor influencing removal effectiveness under quiescent conditions.

The probabilistic computation summarized by design performance curves in Figures 4.4 and 4.5 is used to estimate removals under quiescent conditions. This analysis assumes that physical volumes are removed from the basin during the dry periods between storms.

The term may be thought of as a "processing rate." For a sedimentation device, it may be thought of as a particle removal rate. Using this interpretation, the term $\Delta^*\Omega$ ("average interval between storms" x "rate at which basin empties") can be considered to represent that portion of the basin volume from which solids with a selected settling velocity have been completely removed. Instead of the TSS concentration of the entire volume diminishing with time under quiescent settling, the concentration is assumed to remain constant, while the remaining volume with which this concentration is associated diminishes with time. The solids removal rate is then:

Figure 4.4 Average Long-Term Performance: Volume Device

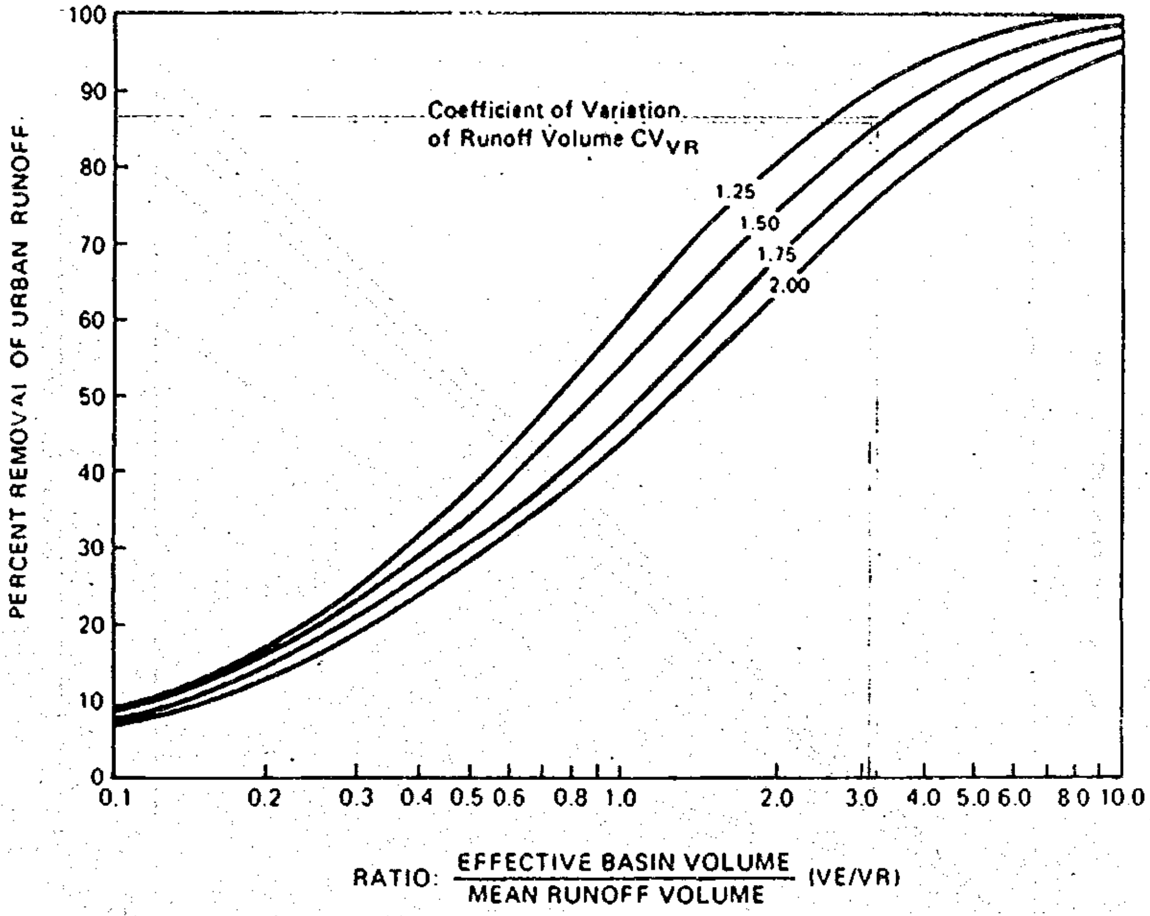
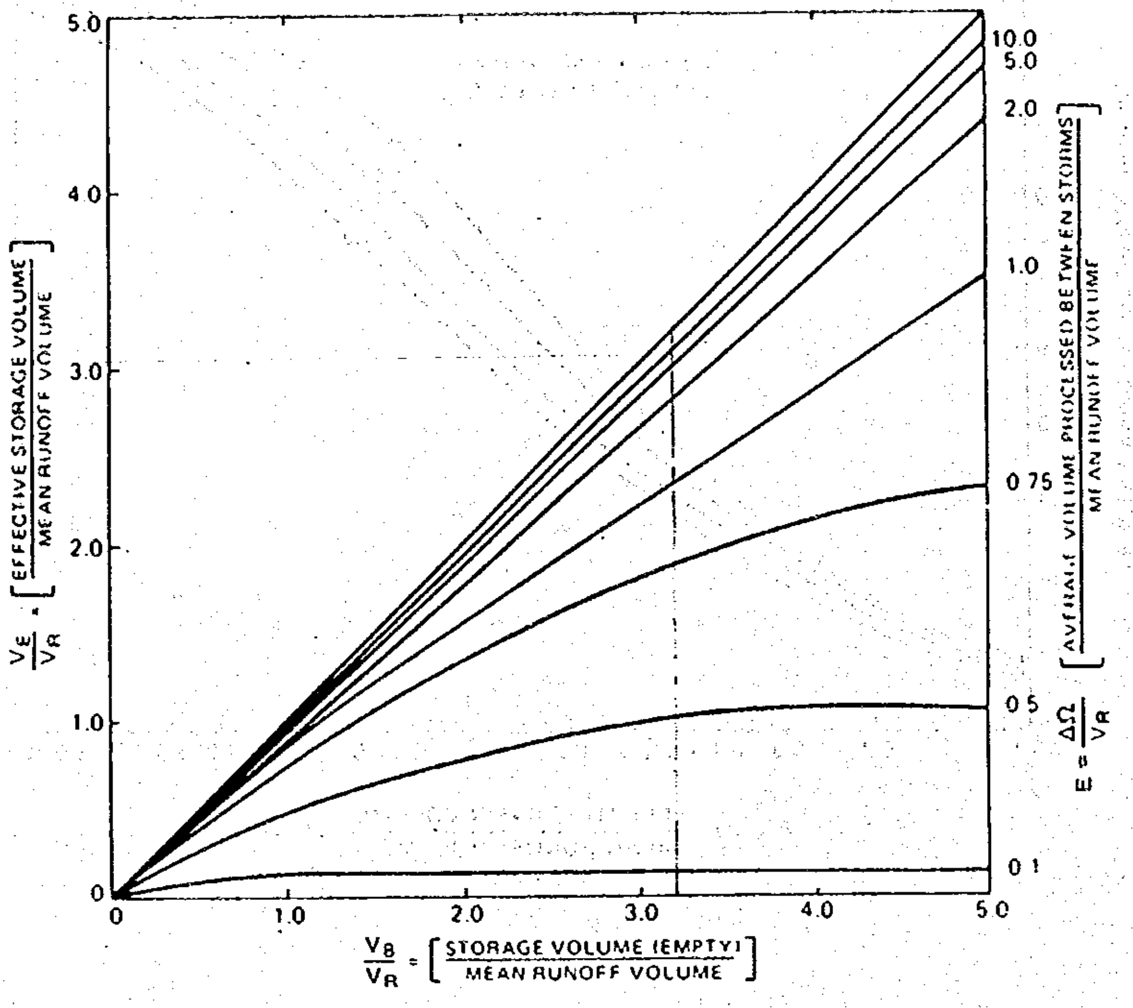


Figure 4.5 Effect of Previous Storms on Long-Term Effective Storage Capacity



$$\Omega = v_s * A \tag{4.4}$$

where:

v_s = particle settling velocity (ft/hr)

A = basin surface area (square feet)

4.2.3 Combining dynamic and quiescent effects

The procedures described above can be used to compute separate long-term removal efficiencies under dynamic and quiescent conditions. Since each type of condition prevails in a detention basin at different times, the overall efficiency of a basin is the result of the combined effect of the two processes at work. The simple model used to integrate these effects is illustrated by Figure 4.6.

Five identical storms with an interval between event midpoints (Δ) of 3.5 days are routed through a basin, assuming plug flow. Each storm has a duration of 12 hours (0.5 day), and a volume which is 25% of the basin volume (VB/VR = 4). The plotted lines track the residence/displacement pattern in the basin for the leading edge, midpoint, and trailing edge of Storm #1. The shading highlights the fraction of the total residence time when dynamic conditions prevail. For this simplified case, and for actual conditions where both storm volumes (VR) and intervals (Δ) fluctuate, the fraction of time under dynamic conditions is estimated by:

$$\text{Fraction of residence time under dynamic conditions} = D/\Delta \tag{4.5a}$$

$$\text{Fraction under quiescent conditions} = 1-(D/\Delta) \tag{4.5b}$$

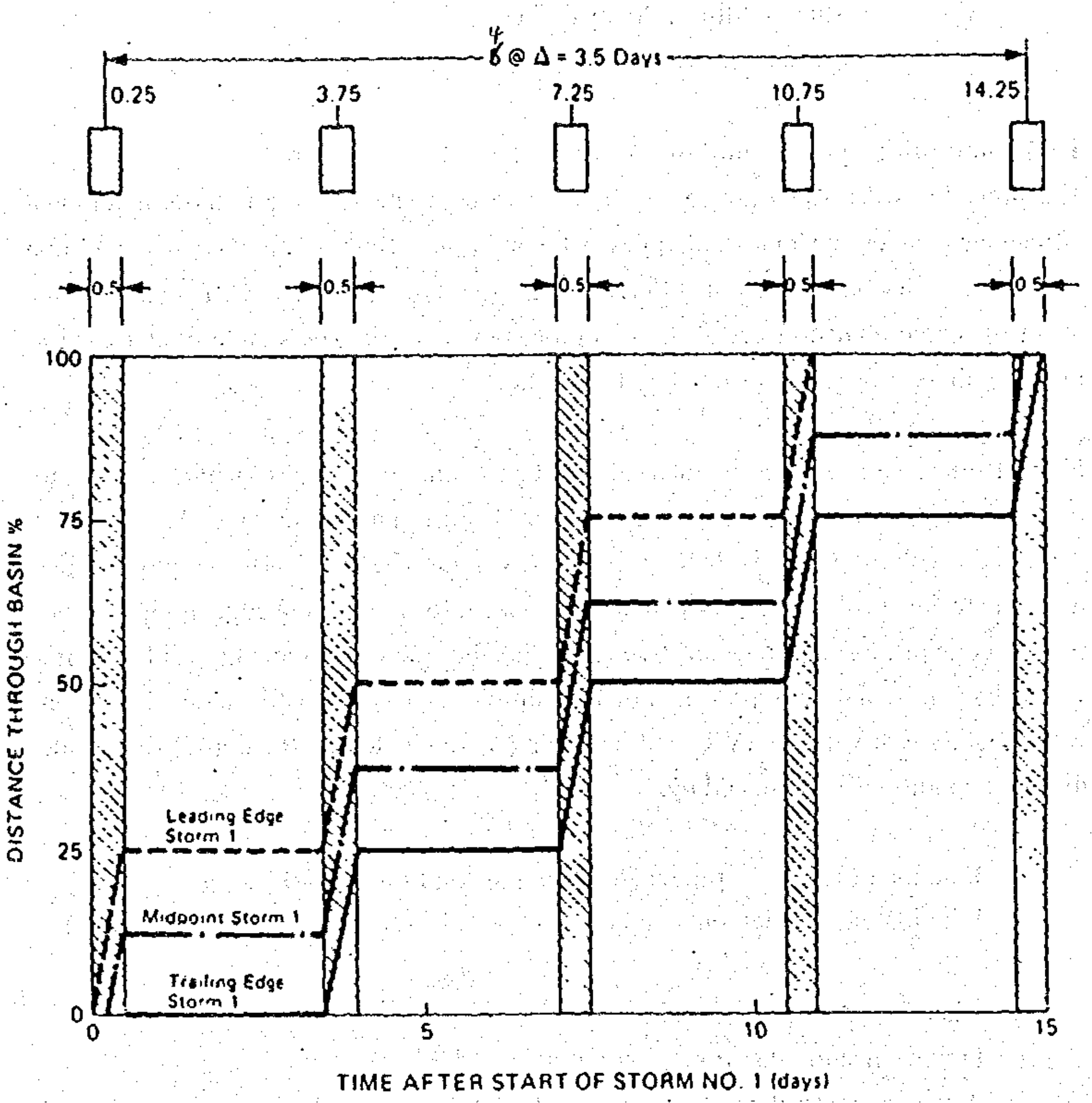
where:

D = mean storm duration

A = mean interval between storm midpoints

This simple schematic illustrates several relevant features of the operation of this type of device. When the basin is as large as that indicated (which is not uncommon for current practice), the outflow volume during an event represents a different parcel of water than that for the storm that causes it to be displaced. Assessing performance by comparing paired influent and effluent loads for individual storms is less appropriate than the comparison of overall influent and effluent loads for a long-term sequence of storm events.

Figure 4.6 Illustration of Quiescent vs. Dynamic Residence Time in a Storm Detention Basin



For Storm Midpoint Volume

Total Residence Time = 14.0 Days

Dynamic Time: (0.25) + (3 x 0.5) + 0.25 = 2.0 Days 2/14 = 0.14

Quiescent Time: 14.0-2.0 = 12 Days 12/14 = 0.86

D/Δ = 0.5/3.5 = 0.14
(1-D/Δ) = 0.86

All runoff volumes which enter the basin undergo the dynamic removal process one or more times before discharge. For the large basin illustrated, this is broken up into four different periods of displacement. For a basin with a volume small enough that the runoff passes all the way through, there would be only one such period of dynamic removal. Performance efficiency is affected simply on the basis of the "overflow rate" that the basin size provides.

The quiescent removal process then operates on (a) those portions of the total runoff volume that remain in the basin during the dry interval that follows an event, and (b) on that fraction of the influent pollutants that remain in the water column after operation of the dynamic process. In the situation illustrated, the average runoff volume is exposed to four different periods of quiescent settling, amounting to an extended period under this condition. In a very small basin, the relative effect of the quiescent removal process may be insignificant, simply because such a small fraction of the total runoff remains in the basin at the end of each storm.

The removal efficiency for the basin under the combined effect of both dynamic and quiescent processes can be computed by applying the removal efficiency of either the dynamic or quiescent process to the pollutant fraction remaining after the operation of the other. If the fractions not removed by the dynamic and quiescent processes operating independently are f_D and f_Q, respectively:

$$\text{COMBINED \% REMOVAL} = \quad 100\,[1 - (f_D * f_Q)] \qquad (4.6)$$

It should be noted that in the larger basins, either process operating alone will be capable of high degrees of removal. One might consider the quiescent process to be the dominant one in large basins, because high particulate reductions can be produced even if there were no removal during dynamic periods, and because the quiescent periods provide the conditions in which the removal processes other than sedimentation can come into play. In small basins, the dynamic process will be the dominant one because only small fractions of the runoff will remain in the basin subject to the quiescent process.

4.3 VALIDATION

4.3.1 Settling Velocity of Particles in Urban Runoff

Figure A-5 in Appendix illustrates best estimates (at present) for the distribution of particle settling velocities in urban runoff from any site. For the calibration tests and subsequent projections, computations are performed for five size fractions having the following average settling velocities (based on the distribution shown by Figure A-5):

Size Fraction	% of Particle Mass in Urban Runoff	Average Settling Velocity (ft/hr)
1	0-20%	0.03
2	20-40%	0.3
3	40-60%	1.5
4	60-80%	7.
5	80-100%	65.

4.3.2 Actual Performance Results

Performance characteristics of actual basins have been analyzed and used to compare observed removals to those predicted using the methodology described earlier.

Table 4.1 summarizes such size relationships for the wet basins, which are arranged in order of increasing performance expectations. Based on the analysis presented in the previous section, one should expect that lower overflow rates (QR/A) and higher volume ratios (VB/VR) would tend to produce better removal efficiencies by sedimentation. Therefore, these ratios are used in Table 4.1 as qualitative indicators of performance. The wide range provided by the data set is apparent. Basin #1 has an average overflow rate during the mean storm of about six times the median settling velocity (1.5 ft/hr) of particles in urban runoff. Further, less than 5% of the mean storm volume remains in the basin after the event, to be susceptible to additional removal by quiescent settling. At the other end of the scale, the mean storm displaces only about 10% of the volume of Basin #9, and the average overflow rate is a small fraction of the median particle settling velocity.

Table 4.2 summarizes the observed overall average performance of the NURP detention basins over all monitored storms. Removal efficiency is determined from the sum of pollutant masses entering and leaving the device for all storms. At some sites, there were an appreciable number of events for which monitoring data were only available for either inflows or outflows. In such cases, a reduced data set (consisting of only those events for which both inlet and outlet data were available) was used in the computation.

Table 4.1 Size Relationships for NURP Detention Basins (Based on Monitored Storms)

			Detention Basin Size		
			Relative to Mean Monitored Storm		Relative to Size of Urban Catchment (Surf Area/Drain Area X 100%)
Code No.	Project and Site	Approx. Average Average Basin Depth (Ft)	Overflow Rate QR/A (ft/hr)	Volume Ratio VB/VR	
1	Lansing Grace Street N.	2.6	8.75	0.045	0.0095%
2	Lansing Grace Street S.	2.6	2.37	0.17	0.035%
3	Ann Arbor Pitt-AA	5.0	1.86	0.52	0.09%
4	Ann Arbor Traver	4.1	0.30	1.16	0.31%
5	Ann Arbor Swift Run	1.5	0.20	1.02	1.15%
6	Long Island Unqua	3.3	0.08	3.07	1.84%
7	Washington, D.C. Westleigh	2.0	0.05	5.31	2.85%
8	Lansing Waverly Hills	4.6	0.09	7.57	1.71%
9	Northern Illinois Lake Ellyn	5.2	0.10	10.70	1.76%

Table 4.2 Observed Performance of Wet Detention Basins
Reduction in Percent Overall Mass Load

Site No.	Project and Site	No. of Storms	Size Ratios		Average Mass Removals - All Monitored Storms (Percent)									
			QR/A	VB/VR	TSS	BOD	COD	TP	Sol.P	TKN	NO_{2+3}	T.Cu	T.Pb	T.Zn
1	Lansing Grace St. N.	18	8.75	0.05	(-)	14	(-)	(-)	(-)	(-)	(-)	(-)	9	(-)
2	Lansing Grace St. S.	18	2.37	0.17	32	3	(-)	12	23	7	1	(-)	26	(-)
3	Ann Arbor Pitt-AA	6	1.86	0.52	32	21	23	18	(-)	14	7	•	62	13
4	Ann Arbor Traver	5	0.30	1.16	5	(-)	15	34	56	20	27	•	•	5
5	Ann Arbor Swift Run	5	0.20	1.02	85	4	2	3	29	19	80	•	82	(-)
6	Long Island Unqua	8	0.08	3.07	60	(TOC=7)		45	•	(-)	(-)	•	80	•
7	Washington, D.C. Westleigh	32	0.05	5.31	81	•	35	54	71	27	•	•	•	26
8	Lansing Waverly Hills	29	0.04	7.57	91	69	69	79	70	60	66	57	95	71
9	NIPC Lake Ellyn	23	0.10	10.70	84	•	•	34	•	•	•	71	78	71

Notes: (-) Indicates apparent negative removals.

• Indicates pollutant was not monitored.

The qualitative indications of relative performance suggested by the ranking (based on size) are supported by the tabulated results. However, the variability in actual performance results tends to confuse the picture somewhat, such that the performance relationships may be better seen in the illustrations presented in the following section.

4.3.3 Calibration Results

The probabilistic methodology was used to compute the expected removal by sedimentation of a number of pollutants. The surface area and volume of each of the nine detention devices was determined from the project reports. The statistics (mean and coefficient of variation) of runoff flow rate and volume were computed from monitoring data for storms entering the basin. A value of n = 3 was arbitrarily assigned for the short-circuiting factor for all of the analyses which follow.

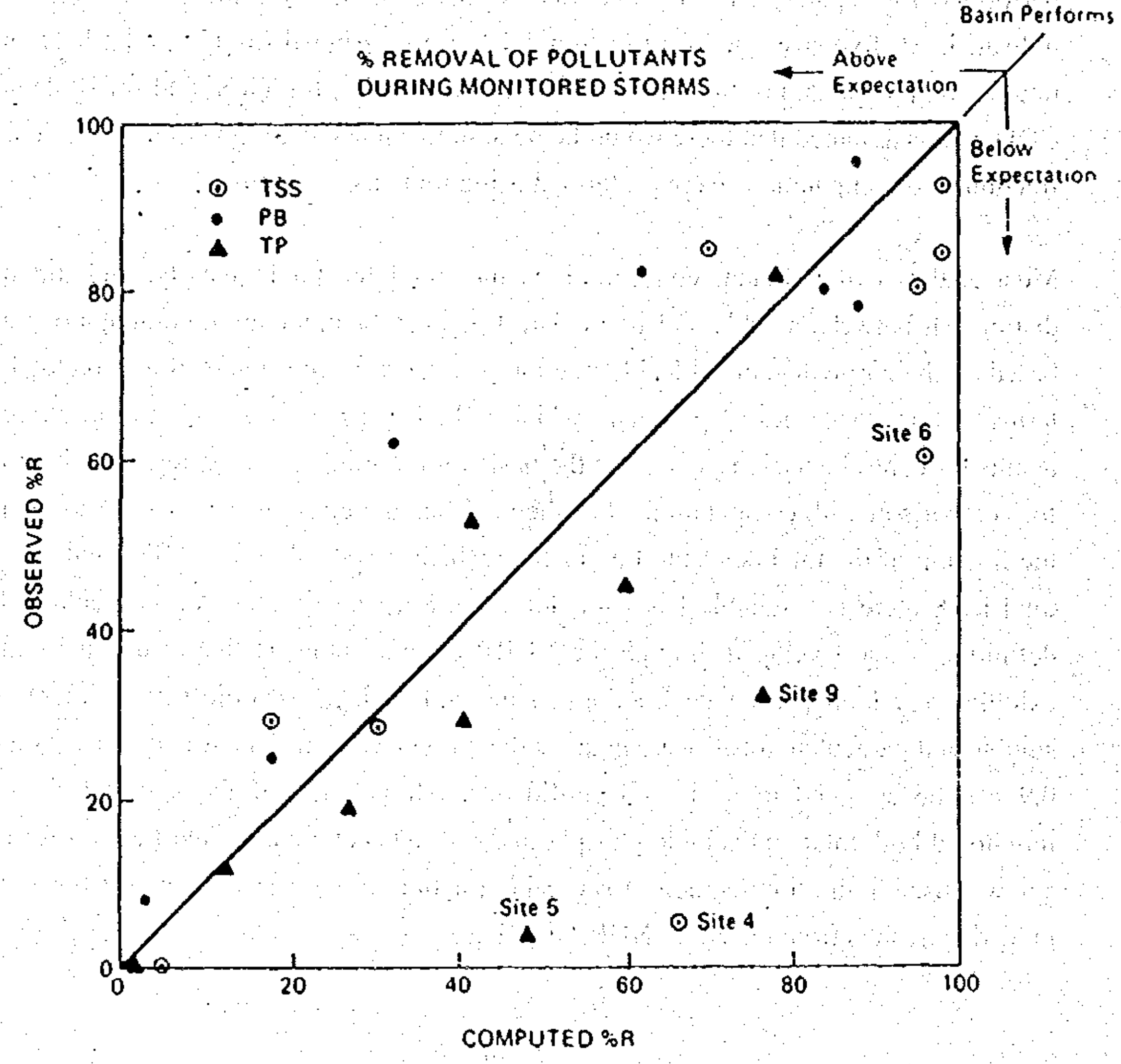
Because of the wide variability in particle settling velocities, and their important effect on removal by sedimentation, independent removal efficiency computations were performed for separate size fractions and results combined for the overall removals indicated. All five size fractions (Section 4.3.1) were assigned for TSS, total lead, and total P computations. For the other heavy metals (Cu, Zn), for TKN, and for BOD and COD, it was assumed that there would be no significant association with the largest size fraction, and computations were performed using four size fractions.

Most analyses of pollutant concentrations measured the total quantity, and did not distinguish between soluble and particulate fractions. Sedimentation computations are based on the particulate or settleable fraction. However, overall removal is expressed in terms of total quantities of pollutant, which is both the most relevant way to express results for control decisions as well as the basis for reporting observed results to be used for comparison with computations. For the analysis, therefore, it is necessary to assign the fraction of the total concentration or load which is settleable. For TSS, total P. and total lead, there is a reliable basis for doing so. Suspended solids are particulates by definition. Data developed through the NURP program indicate that lead consistently exhibits very high particulate fractions. Thus, although no specific measurements of soluble and paruculate forms were made at detention basin sites, a particulate fraction of 0.9 can be assigned to lead with confidence. All but one of the sites (Basin #6) monitored both total and soluble phosphorus, and the actual particulate fraction for the site was used in the computation. A settleable fraction of 0.6 was assigned for Basin #6, guided by results from the entire NURP data base.

For these three pollutants, for which reliable estimates of particulate fractions are available and for which a significant fraction of the total is settleable, the comparison between observed removal efficiency and removals computed by the methodology described earlier is presented in Figure 4.7. There are a few obvious outliers; however, in general, predictions are within 10% to 15% of observed performance results. Additional confidence is derived from the fact that both observed and computed results span the entire range of performance possibilities, from less than 5% to 10%, to 90% or better.

In the absence of appropriate local data, the particle fraction for lead (0.9) and total P (0.67) are typical values for urban area. For TKN, Cu, Zn, BOD and COD, the estimates of particle fraction (0.5) are based on more limited data are less certain.

Figure 4.7 Comparison of Observed vs. Computed Removal Efficiencies



5. EXAMPLE DESIGN CALCULATION

5.1 Conditions

"Floral" drainage area, total area of 2.058 km^2, has a average runoff coefficient (Rv) estimated at 0.74. (Table VII.2.6 "Supporting Report") All stormwater runoff from the area is to be routed to a extended (wet pond) detention basin.

The volume of runoff detained is set as equivalent to the runoff volume produced by a one-inch (25.4 mm) storm. The total detention volume is:

$$V_{total} = 25.4/1000 \text{ m} * 0.74 * 2.058 * 10^6 \text{ m}^2$$
$$= 38{,}700 \text{ m}^3$$

Therefore $V_{total} = 40{,}000 \text{ m}^3$

The volume of the lower stage (V_L) is equal to:

$$V_L = [(Rm)(Rv)/12](A)$$
$$= [(0.45 \text{ inches}*25.4/1000 \text{ m/inch})(074)](2.058 * 10^6 \text{ m}^2)$$
$$= 17{,}400 \text{ m}^3$$

The depth is set as 12 inches (6 – 12 inches for optimal wetland growth). The surface area is calculated as:

$$A_L = 17{,}400 \text{ m}^3 / (12 \text{ inches} * 25.4/1000 \text{ m/inch})$$
$$= 57{,}100 \text{ m}^2 \approx 60{,}000 \text{ m}^2$$

The surface area of the pond is 60,000 square meters with the basin dimensions of 200 by 300 meters. The basin will have an average depth of 0.67 m. Physical storage volume of the lower stage (the permanent pond) is 17,400 cubic meters (VB).

Rainfall statistics for the Puno area are presently not available. The statistics of Northeastern region of the United States are used instead for this example:

	unit	mean	coef. of variation
Volume (V)	inch	0.14	1.42
Intensity (I)	in./hr	0.031	0.91
Duration (D)	hr	4.5	0.92
Interval (A)	hr	94	1.39

Particle settling velocities as tabulated in Section 4.3.1 are assumed to apply for this site.

5.2 Required

Estimate the long-term average reduction in total suspended solids (TSS) in storm runoff that can be obtained from the specified basin size.

5.3 Procedure

Step 1 - Compute runoff parameters for mean storm - flow rate (QR) and volume (VR).

$$
\begin{aligned}
QR &= (I)(Rv) * (Area) \\
&= 0.031 \text{ inches/hr} * 25.4/1000 \text{ m/inches} * 0.74 * 2.058 * 10^6 \text{ m}^2 \\
&= 1{,}200 \text{ m}^3\text{/hr} \\
VR &= (V) * (Rv) * (Area) \\
&= 0.14 \text{ inches} * 25.4/1000 \text{ m/inch} * 0.74 * 2.058 * 10^6 \text{ m}^2 \\
&= 5{,}400 \text{ m}^3
\end{aligned}
$$

Assume that the variability of runoff parameters is the same as for the corresponding rainfall parameters.

$CVq = 0.91$ and $CVv = 1.42$

Step 2 - Compute the removal under DYNAMIC conditions.

The overflow rate during the mean storm (QR / A) is

$QR/A = 1{,}200 \text{ m}^3\text{/hr} / 5{,}400 \text{ m}^3 = 0.22 \text{ m/hr} = 0.74 \text{ ft/hr}$

If estimates of "Z" are 100% for all size fractions (a reasonable estimate in this case), the long-term average removals (RL) can be scaled directly from Figure 4.2. Since the size fractions are mass weighted, the overall TSS removal will be the average of the five size fractions.

Results using the graphic approach are as follows:

Size Fraction	Average Settling Velocity (ft/hr)	RM(%) (Fig. 4.3)	RL(%) (Fig. 4.2)
1	0.03	4	4
2	0.3	32	23
3	1.5	85	77
4	7.	100	100
5	65.	100	100

OVERALL AVERAGE REMOVAL = 61

fraction NOT removed f_D = (100-61)/100 = 0.39

Step 3 - Compute the removal under QUIESCENT conditions.

Basin Volume ratio (VB/VR)

(VB/VR) = 17,400/5,400 = 3.2

The long-term average removal efficiency is defined by Figure 4.4. This is based on the coefficient of variation of runoff volumes (estimated at 1.42 in Step 1) and the "Effective" Volume ratio (VE/VR), rather than the volume ratio computed immediately above, which is based on physical size of the basin.

The desired ratio (VE/VR) is scaled from Figure 4.5 using the ratio VB/VR = 3.2 computed above, and the Emptying Rate ratio (E).

$$E = \Delta * \Omega / VR$$

Δ is the average interval between storms = 94 hr

VR is the mean storm runoff volume = 5,400 m^3

Ω is the solids removal rate as defined by equation (4.4) in Section 4.2.2, and is the product of basin surface area (60,000 sq meters) and the settling velocity (v_s).

$$\Omega = v_s * A$$

Each of the five size fractions has a different settling velocity, and therefore different values for Ω, E, the effective volume ratio VE/VR, and finally the quiescent removal efficiency. The table below lists the results of the foregoing procedure for estimating removals under quiescent settling.

SIZE NO.	FRACTION Vs, ft/hr(m/hr)	Ω (= Vs A), m/hr	E (=ΔΩ/VR)	VE/VR (Fig. 4.5)	% REM (Fig. 4.4)
1	0.03 (0.0091)	5.5	9.6	3.1	86
2	0.3 (0.091)	55	96	3.2	87
3	1.5 (0.46)	276	480	3.2	87
4	7 (2.1)	1,260	2,190	3.2	87
5	65 (20)	12,000	20,900	3.2	87

OVERALL AVERAGE REMOVAL = 87

fraction NOT removed f_Q = (100-87)/100 = 0.13

Step 4 - Compute the COMBINED removal under both dynamic and quiescent conditions.

Overall removal accomplished by the combination of dynamic and quiescent computed directly from the fractions NOT removed by each process.

Fraction NOT removed by quiescent settling $f_Q = 0.13$

Fraction NOT removed by dynamic settling $f_D = 0.39$

% Removed (overall) = $[1 - (f_Q * f_D)] * 100\,\%$

= $[1 - (0.13*0.39)] * 100\,\%$

= 95 %

A careful examination of the results is instructive. When a basin volume is about equal to the mean storm runoff volume (VB/VR ≈ 1.0), a significant percentage of storm event runoff volumes are greater than the basin capacity. Then, the quiescent process has a lesser effectiveness for the removal of particles with the higher settling velocities, compared with dynamic removals. This is not because the process provides less efficient sedimentation. The indicated quiescent removals reflect the fact that some fraction of the total runoff does not remain in the basin to undergo quiescent settling.

The efficiency and importance of the quiescent process is reflected by its significantly higher effectiveness in removing the slower settling fractions.

SIZE NO.	FRACTION Vs, ft/hr(m/hr)	% REMOVAL DYNAMIC	% REMOVAL QUIESCENT	% REMOVAL COMBINED
1	0.03 (0.0091)	4	86	87
2	0.3 (0.091)	23	87	90
3	1.5 (0.46)	77	87	97
4	7 (2.1)	100	87	100
5	65 (20)	100	87	100
	All	61	87	95

Trial and error is required to find optimal pond size and pollutants' removal.

APPENDIX

DATA ON INPUT PARAMETERS

1.0 GENERAL

This Appendix presents information on representative values for parameters used in the computations. It is intended to serve as a reference that will permit the user to make preliminary estimates for use in a screening analysis, and for comparing local values against those developed from a broader database.

2.0 RAINFALL STATISTICS

The analysis procedures used in this manual are based on the statistical characteristics of storm "events." As illustrated by Figure A-1, the hourly record may be converted to an "event" record by the specification of a minimum number of dry hours that defines the separation of storm events. Routine statistical procedures are then used to compute the statistical parameters (mean, standard deviation, coefficient of variation) of all events in the record for the rainfall properties of interest.

From the statistics of the storm event parameters, other values of interest may be determined. The ratio of mean storm duration (D), to the mean interval between storms (Δ), reflects the percent of the time that storm events are in progress:

$$\%\ \text{time that it is raining} = D/\Delta$$

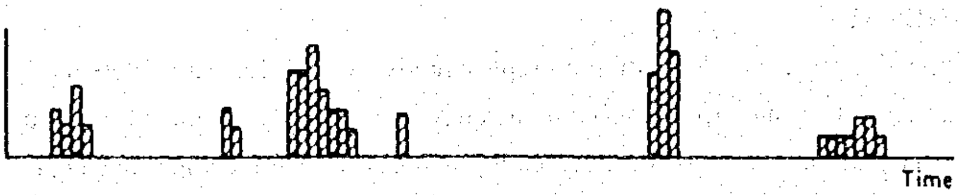
The average number of storms during any period of time is defined by the ratio between the total number of hours in the selected period and the average interval between storms (Δ). For example, on an annual basis:

$$\text{Avg. number of storms per year} = \frac{365 * 24}{\Delta}$$

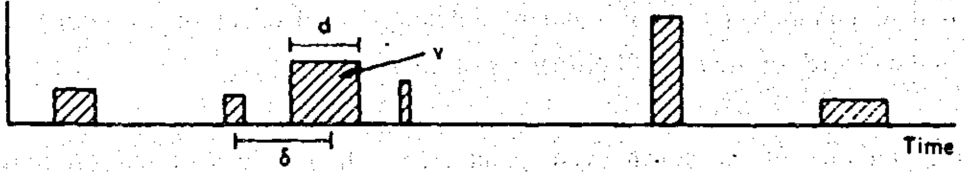
The storm event parameters of interest have been shown to be well represented by a gamma distribution. The results indicate that the coefficient of variation of the event parameters generally falls between 1.0 and 1.5. Figure A-2 plots the probability distribution of gamma distributed variables with coefficients of variation of 1.0, 1.25, and 1.5, in terms of probability of occurrence as a function of the magnitude, expressed as a multiple of the mean. This plot can be used to approximate the magnitude of an event with a specified frequency of occurrence.

Figure A-1 Characterization of a Rainfall Record

(a) HOURLY RAINFALL VARIATION

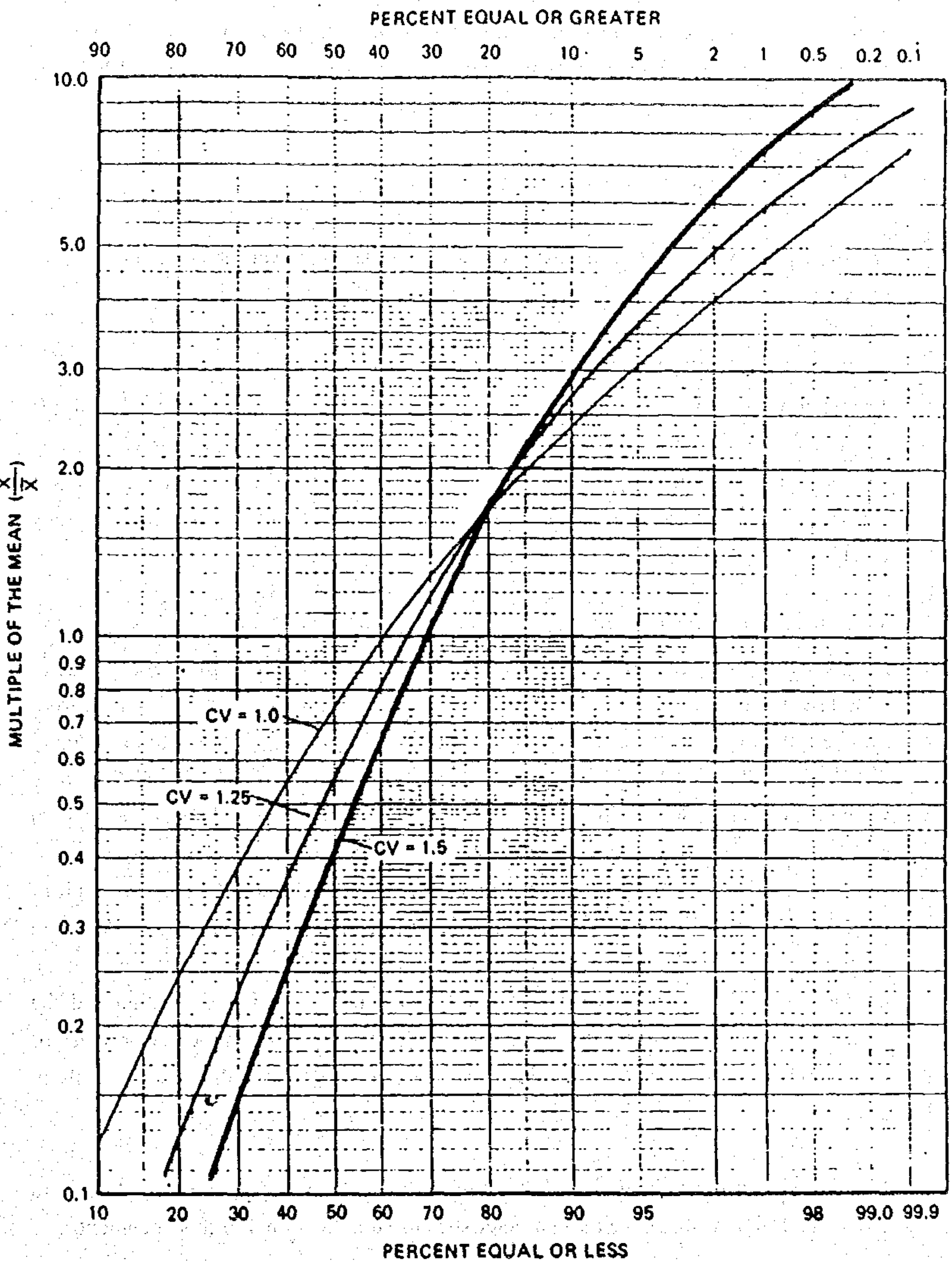


(b) STORM EVENT VARIATION



	PARAMETER			
	For each storm event		For all storm events	
			Mean	Coef Var
Volume	v	(inches)	V	ν_v
Duration	d	(hours)	D	ν_d
Average intensity	i	(inch/hour)	I	ν_i
Interval between event midpoints	δ	(hours)	Δ	ν_δ

Figure A-2 Probability Distribution for a Variable with a Gamma Distribution



For example, consider a site where storm events have volume statistics for mean and coefficient of variation of 0.4 inch, and 1.5 respectively. Figure A-2 can be used to estimate that 1 percent of all storm events have volumes that exceed about 7.5 times the mean (or 7.5 * 0.4 = 3 inches). If the same location has an average interval between storms (Δ) of 87.5 hours, there will be an average of:

(365 *24)/87.5 = 100 events/year

and the 1 percentile event (3 inches) reflects a storm volume exceeded on average, once per year.

3.0 SETTLING VELOCITIES

The settling velocity of particulates in urban runoff is a key determinant of the efficiency of pollutant removals by sedimentation. Settling velocity measurements were conducted on approximately 50 different runoff samples from seven urban sites in USA. These data may be used to guide estimates in the absence of local settling column study results.

There is a wide range of particle sizes, and hence settling velocities, in any sample of stormwater runoff. This range can be described by a probability distribution of pollutant settling velocities and determined by an appropriate analysis of the data obtained from standard settling column tests, as described farther below. When the settling velocity distributions obtained from the NURP studies were analyzed, it was found that there were differences between separate storms at a site, and differences between individual storms at different sites. Site-to-site differences were of the same order as storm-to-storm variations at a particular site, justifying the combination of all data. The result of such an analysis, illustrated by Figure A-3, indicated that it is reasonable to make estimates of "typical" urban runoff settling characteristics and expect that, in an appropriate analysis, short-term variations will average out. This assumption and the relationship shown, proved to work out quite well in the analysis of the performance of nine different detention basins in different parts of the country and differing radically in size.

For analysis purposes, the indicated range of settling velocities can be broken down into five equal fractions that have the characteristics listed in Section 4 of this document.

While the "typical" values provided here are considered to be satisfactory for initial estimates, and for screening analyses, additional settling column studies are encouraged to expand the database and improve site-specific estimates. The test procedure is quite simple, and utilizes equipment and procedures that have been in general use for many years and frequently applied in water and waste treatment applications. The only difference is the technique suggested for analyzing the data to increase its utility for stormwater runoff applications.

The equipment and procedure are shown schematically by Figure A-4. The settling column, typically Lucite and about 6 inches in diameter by 6 feet high, is fitted with a series of sample ports It is filled with the runoff sample, then small samples are withdrawn from the ports at scheduled intervals of time. Concentrations of pollutants of interest are compared with the initial concentration and the pattern of percent removal versus port depth (H) and time (T) is determined. Since each port depth and sample time corresponds to a settling velocity, each measurement (expressed as percent removal) can be interpreted as the percent of the total that have settling velocities equal to or greater than that characterized by port location and sampling time.

Test results are often somewhat erratic because of the sensitivity of analytical tests (especially TSS at low concentrations) and thermal currents and other disturbances in the column. The use of multiple ports and settling times provides data on a range of settling velocities, and provides duplicate measurements for many settling velocities and therefore an opportunity to average out variations inherent in the test procedure.

Figure A-3 Probability Distribution of Settling Velocities in Urban Runoff – Typical Based on Pooled Data

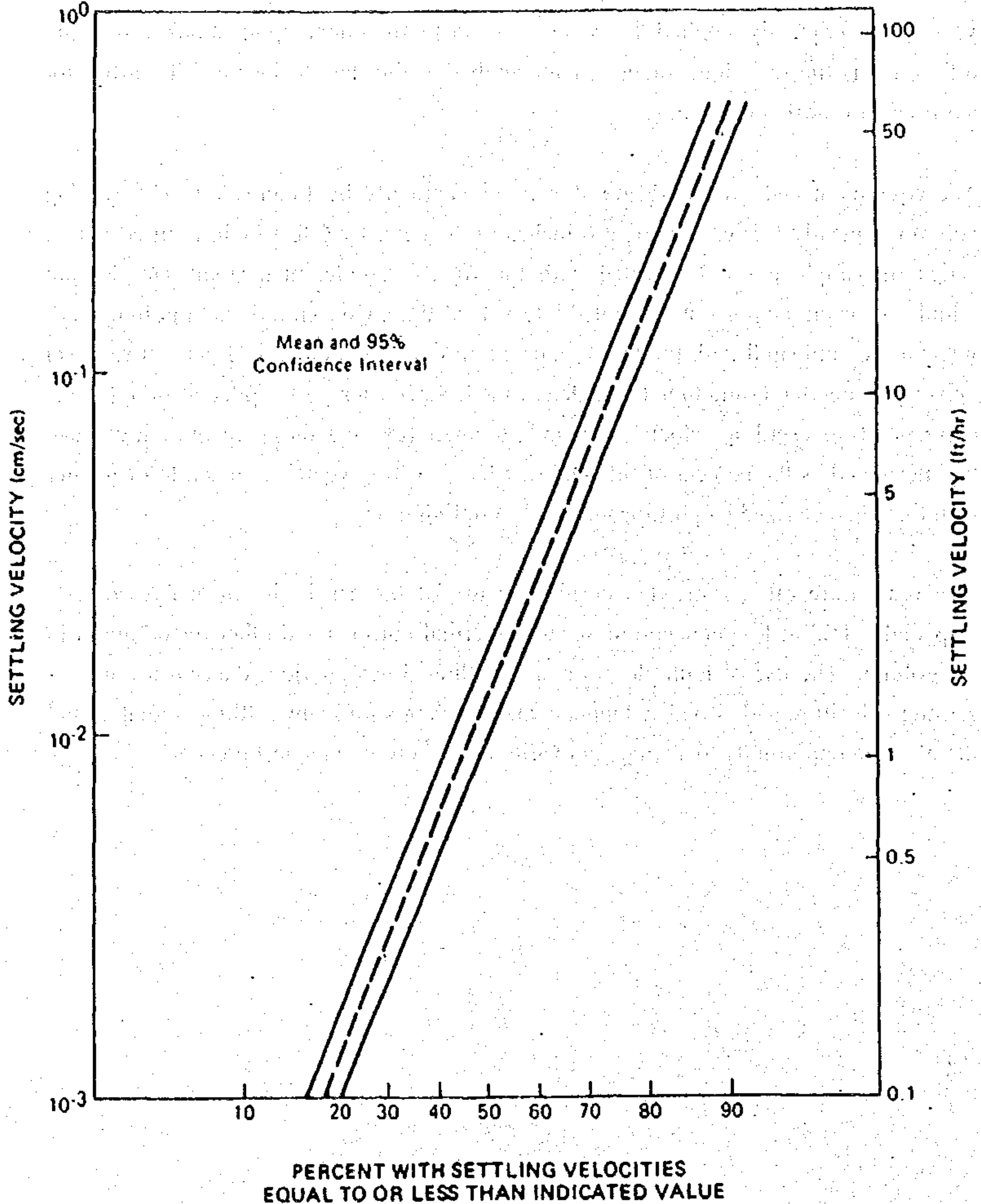
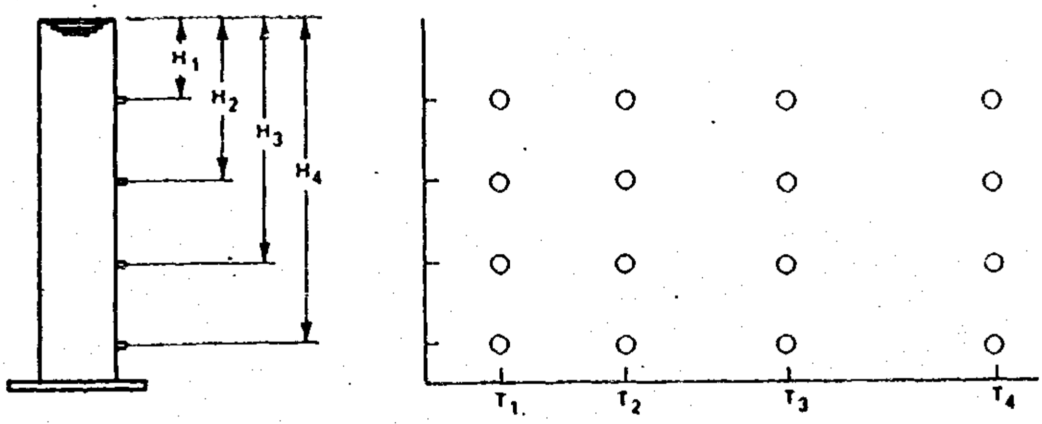


Figure A-4 Estimating Settling Velocity Distributions from Settling Column Tests



SETTLING COLUMN

ELAPSED TIME TO SAMPLE WITHDRAWAL

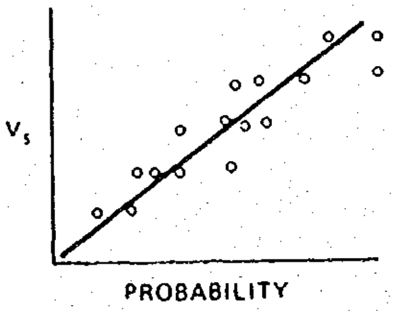
O = Data Point - Record % removed based on observed vs. initial concentration

Settling velocity (V_s) for that removal fraction is determined from the corresponding sample depth (h) and time (t)

$$V_s = H/T$$

Observed % removed reflects the fraction with velocities equal or greater than computed V_s

A probability plot of results from all samples describes the distribution of particle settling velocity in the sample



3. AGRICULTURAL NONPOINT POLLUTION SOURCE SURVEY

3. Agricultural Nonpoint Pollution Source Survey

I. GENERAL

In order to estimate pollution load of agricultural nonpoint source to the Puno Interior Bay, questionnaire survey in the study area was conducted to obtain statistics information on crop and livestock farming.

1. Survey Duration

February 13-25, 1999

2. Survey Area

Survey area is composed of the following sub-areas in the catchment area of the Puno Interior Bay.

① Huaje
② Dos de Mayo
③ Ventilla
④ Orkopata
⑤ Pucamayo
⑥ Chacarilla
⑦ Santa Rosa
⑧ San Martin
⑨ Alto manto
⑩ Huayna Pucara
⑪ Capullani
⑫ Jayllihuaya
⑬ Chimu

3. Survey Method

In the above survey area, interview survey was conducted using attached questionnaire. In some sub-areas where the interviewers did not cover all the farms in the sub-area, total figures are estimated from the collected samples.

I. CROP FARMING SURVEY

1. Surveyed variables

(1) Type and number of crops

The following types of crops grown on farms in the study area.

① Potato
② Broad bean
③ Oat
④ Barley
⑤ Oca
⑥ Quinua
⑦ Corn
⑧ Onion
⑨ Cebolla
⑩ Flores
⑪ Olluco

(2) Total area of farm

(3) Suitable area for cultivation on farm

(4) Cultivated area

(5) Type and amount of fertilizer applied

(6) Type and amount of pesticide used

2. Results

The results of the survey ware summarized in the following tables.

Summary of agricultual survey in the microcuencas Huaje
Estudio sobre el pastoreo en las microcuencas

▨: Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Quinua				Onion Cebolla								
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-HU-01	13-Feb-99	Huaje	1 Sac	11	4	5	1 Arr	9	3	6									1 Arr	10	4	6									180	100	100		
C-HU-02	13-Feb-99	Huaje	7 Sac	10	4	6	2 Arr	9	3	6					2 Sac	11	4	5					2 Arr	9	4	7					5,000	3,000	2,250		
C-HU-03	13-Feb-99	Huaje	30 Kg	11	4	5													2 Arr	10	4	6									300	200	150		
C-HU-04	13-Feb-99	Huaje	2 Sac	11	4	5	1 Arr	9	2	5									3 Arr	10	4	6									1,500	1,000	700		
C-HU-05	13-Feb-99	Huaje	70 Kg	11	4	5													30 Kg	10	4	6									1,500	1,000	300		
C-HU-06	13-Feb-99	Huaje	4 Sac	11	4	5	1 Arr	9	4	7					1 Sac	11	4	5	1 Sac	9	4	7					15 Kg	11	3	4	100,000	20,000	1,800		
C-HU-07	13-Feb-99	Huaje	7 Sac	10	5	7	2 Arr	9	4	7	600 Kg/Fo/MV	11	5	6	1 Arr	11	4	5													5,000	2,000	1,500		
C-HU-08	13-Feb-99	Huaje	3 Sac	11	5	6	1 Sac	9	4	7																					800	600	500		
C-HU-09	13-Feb-99	Huaje	3 Sac	11	5	6	2 Arr	9	4	7	500 Kg/Fo	11	4	5	1 Sac	11	4	5													5,000	1,500	1,200		
C-HU-10	13-Feb-99	Huaje	20 Sac	11	5	6	2 Sac	9	4	7	5,000 Fo/MV	11	5	6					10 Sac	9	4	7									80,000	10,000	5,000		
C-HU-11	13-Feb-99	Huaje	2 Sac	10	4	6				12					1 Sac	11	4	5													10,000	5,000	700		
C-HU-12	13-Feb-99	Huaje	3 Sac	10	4	6	2 Arr	9	4	7									1 Sac	9	4	7									10,000	1,500	1,000		
C-HU-13	13-Feb-99	Huaje	2 Sac	10	3	5									1 Sac	11	3	4					2 Arr	9	3	6					2,000	1,500	1,200		
C-HU-14	13-Feb-99	Huaje	1 Sac	11	5	6									2 Arr	11	4	5													250	150	150		
C-HU-15	13-Feb-99	Huaje	2 Sac	11	4	5	80 Kg	9	3	6					1,5 Sac	11	4	5	1 Sac	10	4	6									10,000	2,000	1,500		
C-HU-16	13-Feb-99	Huaje	2 Arr	10	4	6	1 Arr	10	4	6													1 Arr	9	4	7					300	200	200		
C-HU-17	14-Feb-99	Huaje(Sector San Jose)	3 Sac	11	4	5	30 Kg	10	4	6					1 Sac	11	4	5	1 Sac	10	4	6									20,000	2,500	2,000		
C-HU-18	14-Feb-99	Huaje(Sector San Jose)	3 Sac	11	4	5	120 Kg	10	3	5					1 Sac	11	4	5	1 Sac	10	4	6	2 Arr	10	4	6					10,000	4,000	3,000		
C-HU-19	14-Feb-99	Huaje(Sector San Jose)	200 Kg	11	4	5	100 Kg	10	4	6																					10,000	5,000	1,000		
C-HU-20	14-Feb-99	Huaje(Sector San Jose)	200 Kg	11	4	5	70 Kg	10	4	6					120 Kg	11	4	5													25,000	10,000	3,000		
C-HU-21	14-Feb-99	Huaje(Sector San Jose)	70 Kg	11	4	5	25 Kg	10	4	6					50 Kg	11	4	5													1,200	1,000	800		
C-HU-22	14-Feb-99	Huaje(Sector San Jose)	1 Sac	11	4	5	1 Arr	10	4	6					2 Arr	11	4	5													1,000	500	350		
C-HU-23	14-Feb-99	Huaje(Sector San Jose)	100 Kg	10	4	6	50 Kg	10	5	7					70 Kg	11	4	5	50	10	4	6									3,000	2,000	1,800		
C-HU-24	14-Feb-99	Huaje(Sector San Jose)	1 Sac	11	4	5	25 Kg/MS	10	4	6					2 Arr	11	4	5	1 Sac	10	4	6									5,000	2,000	1,500		
C-HU-24							12 Kg/Ver																												
C-HU-25	14-Feb-99	Huaje(Sector San Jose)	3 Sac	11	4	5	1 Sac	10	4	6	1,500 Kg/For				1 Sac	11	4	5	1.5 Sac	10	4	6									10,000	5,000	2,500		
C-HU-26	14-Feb-99	Huaje(Sector San Jose)	12 Sac	11	4	5	80 Kg	10	4	6	500 Kg/For/MS				2 Sac	11	5	6	2 Sac	10	4	6									10,000	5,000	3,500		
C-HU-27	14-Feb-99	Huaje(Sector San Jose)	150 Kg	10	3	5	70 Kg	9	3	6					60 Kg	11	4	5													3,000	2,000	1,350		
C-HU-28	14-Feb-99	Huaje(Sector San Jose)	150 Sac	10	4	6	100 Kg	10	4	6					50 Kg	11	4	5													3,000	2,000	1,850		
Total																															301,850	74,650	30,100		

Summary of agricultual survey in the microcuencas Huaje
Estudio sobre el pastoreo en las microcuencas

Not necessary to entry

No	Date Fecha	Location Localidad	Name of cultivation Production and sowing time / Nombre de Cultivo Produccion y Epoca de siembra: Potato / Papa: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Broad bean / Haba: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Oat / Avena: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Barley / Cebada: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Oca: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Quinua: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Onion / Cebolla: Production / Produccion	Sowing / Siembra	Harvest / Cosecha	[illegible]	Total Area / Area Total (m2)	Cultivation possible area / Area apta para cultivos (m2)	Cultivated area / Area cultivada (m2)	Fertilizer / Abono	Agricultural chemicals / Insecticida
C-HU-01	13-Feb-99	Huaje	1 Sac	11	4	5	1 Arr	9	3	6									1 Arr	10	4	6									180	300	100		
C-HU-02	13-Feb-99	Huaje	7 Sac	10	4	6	2 Arr	9	3	6					2 Sac	11	4	5					2 Arr	9	4	7					8,000	3,000	2,250		
C-HU-03	13-Feb-99	Huaje	30 Kg	11	4	5													2 Arr	10	4	6									300	200	150		
C-HU-04	13-Feb-99	Huaje	2 Sac	11	4	5	1 Arr	9	2	5									3 Arr	10	4	6									500	1,000	200		
C-HU-05	13-Feb-99	Huaje	20 Kg	1	4	5													30 Kg	10	4	6									1,500	1,000	500		
C-HU-06	13-Feb-99	Huaje	4 Sac	1	4	5	1 Arr	9	4	7					1 Sac	11	4	5	1 Sac	9	4	7					15 Kg	12	6	4	100,000	20,000	1,500		
C-HU-07	13-Feb-99	Huaje	7 Sac	10	5	7	2 Arr	9	4	7	600 Kg Fo MV	11	5	6	1 Arr	11	4	5													5,000	2,000	1,500		
C-HU-08	13-Feb-99	Huaje	3 Sac	1	5	6	1 Sac	9	4	7																					800	600	500		
C-HU-09	13-Feb-99	Huaje	3 Sac	1	5	6	2 Arr	9	4	7	500 Kg Fo	1	4	5	1 Sac	11	4	5													8,000	2,500	1,200		
C-HU-10	13-Feb-99	Huaje	20 Sac	1	5	6	2 Sac	9	4	7	5,000 Fo MV	11	5	6					10 Sac	9	4	7									80,000	10,000	5,000		
C-HU-11	13-Feb-99	Huaje	2 Sac	10	4	6				12					1 Sac	11	4	5													10,000	5,000	700		
C-HU-12	13-Feb-99	Huaje	5 Sac	10	4	6	2 Arr	9	4	7									1 Sac	9	4	7									10,000	2,500	1,000		
C-HU-13	13-Feb-99	Huaje	2 Sac	10	3	5									1 Sac	11	3	4					2 Arr	9	3	6					2,000	1,500	1,200		
C-HU-14	13-Feb-99	Huaje	1 Sac	11	5	6									2 Arr	11	4	5													150	150	150		
C-HU-15	13-Feb-99	Huaje	2 Sac	11	4	5	80 Kg	9	3	6					1.5 Sac	11	4	5	1 Sac	10	4	6									10,000	1,000	1,500		
C-HU-16	13-Feb-99	Huaje	2 Arr	10	4	6	1 Arr	10	4	6													1 Arr	9	4	7					500	200	200		
C-HU-17	14-Feb-99	Huaje Sector San Jose	3 Sac	11	4	5	50 Kg	10	4	6					1 Sac	11	4	5	1 Sac	10	4	6									20,000	2,500	2,000		
C-HU-18	14-Feb-99	Huaje Sector San Jose	3 Sac	1	4	5	120 Kg	9	5	5					1 Sac	11	4	5	1 Sac	10	4	6	2 Arr	10	4	6					[illegible]	4,000	[illegible]		
C-HU-19	14-Feb-99	Huaje Sector San Jose	250 Kg	11	4	5	100 Kg	10	4	6																					[illegible]	8,000	[illegible]		
C-HU-20	14-Feb-99	Huaje Sector San Jose	200 Kg	11	4	5	20 Kg	10	4	6					120 Kg	11	4	5													25,000	20,000	[illegible]		
C-HU-21	14-Feb-99	Huaje Sector San Jose	30 Kg	1	4	5	25 Kg	10	4	6					50 Kg	11	4	5													1,250	1,000	500		
C-HU-22	14-Feb-99	Huaje Sector San Jose	1 Sac	1	4	5	1 Arr	10	4	6					2 Arr	1	4	5													1,000	500	250		
C-HU-23	14-Feb-99	Huaje Sector San Jose	100 Kg	20	4	6	50 Kg	10	5	7					70 Kg	11	4	5	50	10	4	6									5,000	2,000	1,500		
C-HU-24	14-Feb-99	Huaje Sector San Jose	1 Sac	1	4	5	25 Kg MS	10	4	6					2 Arr	11	4	5	Sac	10	4	6									5,500	2,000	1,500		
C-HU-24							25 Kg Ver																												
C-HU-25	14-Feb-99	Huaje Sector San Jose	1 Sac	1	4	5	1 Sac	11	4	6	1,500 Kg For				1 Sac	11	4	5	1.5 Sac	10	4	6									10,000	5,000	2,500		
C-HU-26	14-Feb-99	Huaje Sector San Jose	12 Sac	1	4	5	80 Kg	11	4	6	500 Kg For MS				2 Sac	11	5	6	2 Sac	10	4	6									10,000	5,000	[illegible]		
C-HU-27	14-Feb-99	Huaje Sector San Jose	150 Kg	1	4	5	3 Kg	9	3	6					60 Kg	11	4	5													1,000	2,000	1,250		
C-HU-28	14-Feb-99	Huaje Sector San Jos	50 Sac	1	4	6	100 Kg	[illegible]	4	6					50 Kg	11	4	5													1,000	2,000	[illegible]		
	Total																														[illegible]	84,650	[illegible]		

Summary of agricultual survey in the microcuencas   Dos de Mayo
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Onion Cebolla				Olluco								
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-2M-01	15-Feb-99	2 de Mayo	6 Arr	12	5	5									6 Arr	12	5	5					30 Kg	11	4	5					5,000	4,000	1,000		
C-2M-02	15-Feb-99	2 de Mayo	8 Sac	11	4	5									2 Sac	11	4	5	3 Arr	10	4	6					3 Arr	10	4	6	20,000	5,000	2,300		
C-2M-03	15-Feb-99	2 de Mayo	3 Sac	11	4	5																									1,500	1,000	350		
C-2M-04	15-Feb-99	2 de Mayo	17 Sac				20 Kg								1 Sac				4 Arr												100,000	20,000	2,500		
C-2M-04							1 [illegible]																												
Total																															126,500	30,000	6,150		

Summary of agricultual survey in the microcuencas Ventilla
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Olluco				Quinua								
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-VEN-01	15-Feb-99	Ventilla (Barrio Cuesta Blanca)	8 Sac	11	4	5					7000 Kg/Ha	11	4	5	3 Sac	11	4	5													50,000	15,000	10,000		
C-VEN-02	15-Feb-99	Ventilla (Barrio Cuesta Blanca)	3 Sac	11	4	5					4000 Kg/Ha	12	4	4	1 Sac	12	5	5	3 Arr	10	4	6	2 Arr	10	4	6					150,000	20,000	5,000		
C-VEN-03	15-Feb-99	Ventilla (Barrio Cuesta Blanca)	90 Sac	10	4	6	2 Sac	9	4	7	15000 Kg/Ha	11	4	5	2000 Kg/Ha	11	4	5									5 Sac	10	4	6	600,000	80,000	50,000		
C-VEN-03															8 Sac																				
C-VEN-04	15-Feb-99	Ventilla (Barrio Cuesta Blanca)	4 Sac	10	4	6									2000 Kg/Ha	11	4	5													110,000	10,000	2,400		
C-VEN-04															1 Sac																				
C-VEN-05	16-Feb-99	Ventilla Barrio Pirhuapihuani	2 Sac	11	4	5	1 Arr/Se	8	3	7																					5,000	2,000	350		
C-VEN-05							1 Arr/Ve																												
C-VEN-06	16-Feb-99	Ventilla Barrio Pirhuapihuani	2 Sac	11	4	5	2 Arr	9	4	7																					5,000	1,000	350		
C-VEN-07	16-Feb-99	Ventilla Barrio Pirhuapihuani													1500 Kg/Ha	11	4	5													5,000	2,000	1,500		
C-VEN-08	16-Feb-99	Ventilla Barrio Pirhuapihuani	30 Sac	10	4	6	1 Sac	9	4	7	10000 Kg/Ha	11	4	5					5 Sac	10	4	6									220,000	30,000	22,000		
C-VEN-09	16-Feb-99	Ventilla Sector Pirhuapihuani	2 Sac	11	5	6																									1,000	500	180		
C-VEN-10	16-Feb-99	Ventilla Barrio Pirhuapihuani	2 Sac	11	5	6									3 Arr	11	4	5													1,500	1,000	500		
C-VEN-11	16-Feb-99	Ventilla Sector Pilcopata	1 Sac	10	4	6									1 Sac	11	4	5													80,000	15,000	5,100		
C-VEN-12	16-Feb-99	Ventilla Sector Pilcopata	4 Sac	11	5	6									1 Sac	11	5	6									3 Arr	10	5	7	30,000	5,000	1,900		
	Total																														,257,500	181,500	99,280		

Summary of agricultual survey in the microcuencas Orkopata
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca																
			Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months	Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months	Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months	Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months	Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months	Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months	Production Produccion	Sowing Siembra	Harvest Cosecha	Cultivation months					
C-ORK-01	16-Feb-99	Orkopata (Barrio 8 de Octubre)	3 Sac	10	4	6									1 Sac	11	4	5													10,000	5,000	800		
C-ORK-02	17-Feb-99	Orkopata (Barrio 8 de October)	15 Sac	11	4	5																									10,000	5,000	1,000		
C-ORK-03	17-Feb-99	Orkopata (Barrio 8 de Octubre)	10 Sac	11	4	5																									10,000	5,000	900		
Total																															30,000	15,000	2,700		

Summary of agricultual survey in the microcuencas Pucamayo
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																								Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca															
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-PUC-01	16-Feb-99	Pucamayo	6 Sac	12	4	5					1000 Kg.Fc	12	5	5	1 Sac	11	4	5													5,000	3,000	2,100		
C-PUC-02	17-Feb-99	Pucamayo (Sector Quinsa Cruz)	5 Sac	11	5	6									2 Sac	11	5		5 Sac	10	5	7	2 Arr	10	5	7					30,000	10,000	1,400		
C-PUC-03	17-Feb-99	Pucamayo (Sector Quinsa Cruz)	2 Sac	11	5	6													1 Sac	10	5	7	1 Arr	10	5	7					10,000	3,000	400		
Total																												45,000	16,000	3,900		

Summary of agricultual survey in the microcuencas
Estudio sobre el pastoreo en las microcuencas

Chacarilla

▨ ; Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca																
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-CHA-01	16-Feb-99	Chacarilla Alta (Barrio Ricardo Palma)	1 Sac	10	4	6																									50,000	5,000	100		
C-CHA-02	16-Feb-99	Chacarilla Alta (Barrio Ricardo Palma)	1 Sac	10	4	6																									20,000	500	100		
	Total																														70,000	5,500	200		

Summary of agricultual survey in the microcuencas Santa Rosa
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																													Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Quinua													
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-SR-01	17-Feb-99	Santa Rosa(Barrio Villa Hermosa)	5 Sac	10	4	6									1 Sac	11	4	5													2,500	1,500	1,000		
C-SR-02	17-Feb-99	Santa Rosa (Barrio Jose Carlos Mariategui)	2 Sac	10	4	6									2 Arr	10	4	6													10,000	5,000	400		
C-SR-03	17-Feb-99	Santa Rosa(Barrio Manto Central)	2 Sac	10	4	6									1 Sac	11	4	5													5,000	2,000	800		
C-SR-04	17-Feb-99	Santa Rosa	50 Sac	10	4	6									1 Sac	11	4	5	3 Sac	9	4	7	1 Sac	9	5	8					30,000	10,000	6,900		
C-SR-05	21-Feb-99	Santa Rosa	4 Sac	10	4	6													1 Sac	9	4	7									10,000	5,000	500		
	Total																														57,500	23,500	9,600		

Summary of agricultual survey in the microcuencas San Martin
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Quinua												
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-SM-01	21-Feb-99	San Martin	2 Sac	11	5	6									0.5 Sac	11	5	6													2,000	1,500	500		
C-SM-02	21-Feb-99	Alto San Martin	8 Sac	11	5	6									1 Sac	11	4	5	1 Sac	10	4	6									5,000	5,000	2,000		
C-SM-03	21-Feb-99	San Martin	2 Sac	11	4-5	5.5									1 Sac	11	4-5	5.5													500	500	500		
C-SM-04	21-Feb-99	Alto San Martin	2 Sac	10	4	6	0.5 Sac	10	5	7					1 Sac	11	4	5	1 Sac	9	4	7									10,000	2,500	1,800		
C-SM-05	25-Feb-99	San Martin	6 Sac	11	5	6									1 Sac	12	5	5													2,000	1,500	1,000		
C-SM-06	25-Feb-99	San Martin	6 Sac	10	4	6	1 Sac	10	4	6																					5,000	5,000	1,600		
C-SM-07	25-Feb-99	San Martin	10 Sac	10	4	6	1 Sac	10	4	6																					5,000	5,000	2,000		
C-SM-08	25-Feb-99	San Martin	2 Sac	11	5	6									1 Sac	11	5	6													1,000	1,000	700		
C-SM-09	25-Feb-99	San Martin	2 Sac				1 Arr																								1,000	800	500		
C-SM-10	25-Feb-99	San Martin	20 Sac	10	4	6	1 Sac	10	4	6																					10,000	8,000	2,500		
C-SM-11	25-Feb-99	San Martin	2 Sac	11	5	6									2 Sac	11	5	6	2 Sac	10	5	7	1 Sac	9	5	x					5,000	3,000	2,000		
Total																															46,500	33,800	15,100		

Summary of agricultual survey in the microcuencas Alto Manto
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																								Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca																
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-AM-01	17-Feb-99	Alto Manto	3 Sac	10	4	6									1 Sac	11	4	5													40,000	5,000	900		
C-AM-02	17-Feb-99	Alto Manto	4 Sac	10	4	6									1 Arr	11	4	5					1 Arr	9	4	7					40,000	5,000	600		
C-AM-03	17-Feb-99	Alto Manto	3 Sac	10	4	6																									5,000	2,000	300		
C-AM-04	17-Feb-99	Alto Manto	4 Sac	10	4	6									3 Arr	11	4	5					3 Arr	9	4	7					25,000	5,000	1,200		
C-AM-05	17-Feb-99	Alto Manto(Sector Cancharani)	3 Sac	10	4	6																									10,000	2,000	300		
C-AM-06	17-Feb-99	Alto Manto(Sector Cancharani)	3 Sac	10	4	6									2 Arr	11	4	5													2,000	1,500	500		
C-AM-07	17-Feb-99	Alto Manto(Sector Cancharani)	2 Sac	10	4	6									1 Arr	11	4	5					1 Arr	10	4-5	6.5					50,000	1,500	400		
C-AM-08	17-Feb-99	Alto Manto(Sector Cancharani)	2 Sac	10	4	6	0.5 Arr	9	4	7					1 Arr	11	4	5					0.5 Arr	9	5	8					5,000	3,000	500		
C-AM-09	17-Feb-99	Alto Manto(Sector Cancharani)	1 Sac	10	4	6									1,000 Kg	11	4	5	1 Sac	9	4	7	1 Arr	9	4	7					5,000	5,000	1,300		
C-AM-10	17-Feb-99	Alto Manto(Sector Cancharani)	3 Sac	10	4	6									2 Arr	11	4	5					2 Arr	10	5	7					10,000	4,000	600		
	Total																												192,000	34,000	6,600		

Summary of agricultual survey in the microcuencas
Estudio sobre el pastoreo en las microcuencas

Huayna Pucara

Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																												Total Area Total (m2)	Cultivation possible area Area apta papa cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca																
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-HP-01	20-Feb-99	Huayna Pucara Sector Punanagui	5 Sac	11	4	5	1 Arr	10	4	7					2 Arr	11	4	5													15,000	3,000	900		
C-HP-02	20-Feb-99	Huayna Pucara Sector Punanagui	4 Sac	11	5	6	2 Arr	10	4	6	500 Kg/MV	12	5	5	2 Sac	12	5	5													15,000	5,000	2,100		
C-HP-03	20-Feb-99	Huayna Pucara Sector Punanagui	3 Sac	11	5	6	2 Arr	10	4-5	5.5					1 Sac	11	5	6													5,000	2,000	1,000		
C-HP-04	20-Feb-99	Huayna Pucara Sector Punanagui	2 Sac	11	5	6	1 Arr	10	5	7					3 Arr	11	5	6													5,000	1,000	650		
C-HP-05	20-Feb-99	Huayna Pucara	5 Sac	11	5	6	2 Arr	10	5	7					1 Sac	11	5	6	1 Sac	10	5	7									30,000	10,000	1,400		
	Total																														70,000	21,000	6,050		

Summary of agricultual survey in the microcuencas Capullani
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																														Total Area Area Total	Cultivation possible area Area apta papa cultivo	Cultivation area Area cultivada	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Quinua				Olluco								
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	(m2)	(m2)	(m2)		
C-CA-01	18-Feb-99	Capullani	6 Sac	10	4	6									2.5 Sac	11	4	5	1 Sac	8	4	8	1 Sac	9	4	7					5,000	2,500	2,300		
C-CA-02	18-Feb-99	Capullani	6 Sac	10	4	6									2 Sac	11	4	5	2 Sac	8	4	8	2 Arr	9	4	7	2 Arr	8	4	8	5,000	4,000	2,400		
C-CA-03	18-Feb-99	Capullani	1 Sac	10	4	6									1.5 Sac	11	4	5					1 Arr	9	4	7					10,000	5,000	1,000		
C-CA-04	18-Feb-99	Capullani	4 Sac	10	4	6	0.5 Arr/Sec												2 Sac	8	4	8					1 Arr	8	3	7	5,000	2,000	850		
C-CA-04							1 Arr/Var																												
C-CA-05	18-Feb-99	Capullani	5 Sac	10	4	6					1,000 Kg/MV	11	4	5	2 Sac	11	4	5													5,000	3,500	2,200		
C-CA-06	18-Feb-99	Capullani	5 Sac	10	4	6									4 Sac	11	4	5					2 Arr	9	5	8					10,000	5,000	2,800		
C-CA-07	18-Feb-99	Capullani	5 Sac	10	4	6	1 Sac/Var	8	2-4	7	1,000 Kg/MV	11	4	5	1 Sac	11	4	5					1 Arr	9	4	7					5,000	4,000	2,600		
C-CA-07							1 Arr/Sec																												
C-CA-08	18-Feb-99	Capullani	1 Sac	10	4																										200	200	70		
C-CA-09	18-Feb-99	Capullani	18,000 Kg	10	4-5						10,000 Kg/MV	11	4		7,000 Kg/MV	11	4						2,000 Kg	9	4						500,000	500,000	70,000		
C-CA-10	18-Feb-99	Capullani	2 Sac	10	4										1 Sac	11	4		1 Sac	8	4		1 Sac	9	5						5,000	3,500	1,500		
C-CA-11	18-Feb-99	Capullani	6 Sac	10	4						400 Kg/Fo	11	4-5		1 Sac	11	4														10,000	5,000	1,800		
C-CA-12	18-Feb-99	Capullani	2 Sac	10	4						1,000 Kg/Fo/MV	11	4		2 Sac	11	4		2 Sac	8	4										10,000	5,000	2,400		
C-CA-13	18-Feb-99	Capullani	2 Sac	10	4										1 Sac	11	4						1 Arr	9	4						10,000	2,000	1,000		
Total																															580,200	541,700	90,920		

Summary of agricultual survey in the microcuencas　　Jayllihuaya
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																																Total Area Total (m2)	Cultivation possible area Area apta para cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Cebolla				Quinua				Flores								
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
JAY-01	22-Feb-99	Jayllihuaya (Sector Alto Jayllihuaya)	20 Sac	10	4	6	1 Arr	9	4	7									4 Sac	9	4	7	600 Kg	10	4	6	4 Arr	9	4	7					20,000	10,000	1,666		
JAY-02	22-Feb-99	Jayllihuaya (Sector Alto Jayllihuaya)	14 Sac	10	4	6	1 Sac	9	4	7					1 Sac	11	4	5	1 Sac	9	4	7	30 Arr	8	2	6									10,000	5,000	2,000		
JAY-03	22-Feb-99	Jayllihuaya (Alto Jayllihuaya)	30 Sac	10	4	6									2 Sac	11	4	5	6 Sac	9	4	7	250 Kg	4	10	18									6,000	5,000	3,450		
JAY-04	22-Feb-99	Jayllihuaya (Alto Jayllihuaya)	3 Sac	10	4	6	2 Arr	8	1-2	5.5					1 Sac	11	4	5					100 Kg	8	1-2	5.5									5,000	3,000	1,050		
JAY-05	22-Feb-99	Jayllihuaya (Alto Jayllihuaya)	35 Sac	10	4	6	1 Sac	9	4	7					1 Sac	11	4	5	5 Sac				400 Kg	8	2-3	6.5									10,000	10,000	5,000		
JAY-06	22-Feb-99	Jayllihuaya (Sector Alto Jayllihuaya)	20 Sac	10	4	6																	600 Kg	10	4	6									5,000	5,000	1,500		
JAY-07	22-Feb-99	Jayllihuaya (Sector Alto Jayllihuaya)	15 Sac	10	4	6	1 Sac	9	3	6					1 Sac	11	4	5					1500 Kg	8	2	6					100 Kg	12	5	5	5,000	5,000	3,000		
JAY-08	22-Feb-99	Jayllihuaya (Sector Alto Jayllihuaya)	12 Sac	10	4	6	1 Sac	9	4	7													2500 Kg	9	3-4	6.5					150 Kg	12	5	5	10,000	5,000	3,200		
JAY-09	22-Feb-99	Jayllihuaya (Sector Alto Jayllihuaya)	25 Sac	10	4	6	1 Sac	9	4	7					1 Sac	11	4	5					700 Kg	11	5	6									15,000	5,000	3,000		
JAY-10	22-Feb-99	Jayllihuaya (Sector Puntine)	10 Sac	10	4	6	1 Sac	9	2-3	5.5					1 Sac	11	4	5					1200 Kg	10	4	6									5,000	5,000	2,500		
JAY-11	22-Feb-99	Jayllihuaya (Sector Puntine)	15 Sac	10	4	6	1 Sac	9	4	7					1 Sac	11	4	5					1200 Kg	11	5	6									5,000	5,000	2,200		
JAY-12	23-Feb-99	Jayllihuaya (Sector Yanamirre)	750 Kg	10	5	7											4	16					7500 Kg	11	5	6						12	5	5	50,000	40,000	20,000		
JAY-13	23-Feb-99	Jayllihuaya (Sector Yanamirre)	8 Sac	10	4	6	1 Sac	9	3	6					1 Sac	11	4	5					1200 Kg	10	4	6									5,000	3,000	2,000		
JAY-14	23-Feb-99	Jayllihuaya (Sector Yanamirre)	3 Sac	11	5	6	1 Sac	10	5	7						11	4	5	1 Sac				1200 Kg	10	5	7									15,000	4,000	0,000,000		
JAY-15	23-Feb-99	Jayllihuaya (Sector Yanamirre)	50 Sac	10	4	6	5 Sac	10	5	7					20 Sac	11	4	5					5000 Kg	10	4	6									40,000	30,000	22,000		
JAY-16	23-Feb-99	Jayllihuaya (Sector Yanamirre)	10 Sac	10	4	6									2 Sac	11	4	5					600 Kg	8	2	6									15,000	5,000	2,300		
JAY-17	23-Feb-99	Jayllihuaya (Sector Yanamirre)	70 Sac	10	4	6																	2000 Kg	11	5	6						12	5	5	60,000	15,000	12,000		
JAY-18	23-Feb-99	Jayllihuaya (Sector Yanamirre)	8 Sac	11	5	6																													5,000	3,000	600		
JAY-19	23-Feb-99	Jayllihuaya (Sector Yanamirre)	20 Sac				1 Sac																2500 Kg												20,000	5,000	2,500		
JAY-20	23-Feb-99	Jayllihuaya	10 Sac	10	4	6									1 Sac	11	4	5					1200 Kg	10	4	6									5,000	4,000	1,800		
JAY-21	23-Feb-99	Jayllihuaya (Sector Yauruyo)	8 Sac	10	4	6									1 Sac	11	4	5					600 Kg	9	3	6									5,000	3,000	1,400		
JAY-22	23-Feb-99	Jayllihuaya (Sector Yauruyo)	50 Sac	10	4	6									2 Sac	11	4	5					2500 Kg	10	4	6						12	5	5	20,000	15,000	10,000		
JAY-23	23-Feb-99	Jayllihuaya (Sector Incapujo)	8 Sac	10	4	6	1 Sac	9	3	6					2 Sac	11	4	5					2500 Kg	10	4	6									5,000	4,000	3,000		
JAY-24	23-Feb-99	Jayllihuaya (Sector Incapujo)	6 Sac	10	4	6	2 Arr	9	4	7					1 Sac	11	4	5					1000 Kg	10	3-4	5.5									4,000	3,000	1,800		
JAY-25	23-Feb-99	Jayllihuaya (Sector Incapujo)	8 Sac	10	4	6	2 Arr	9	4	7					2 Sac	11	4	5					1500 Kg	11	5	6									20,000	5,000	2,600		
JAY-26	23-Feb-99	Jayllihuaya (Sector Incapujo)	20 Sac	10	4	6									2 Sac	11	4	5					1200 Kg	9	3	6									5,000	4,000	3,200		
JAY-27	23-Feb-99	Jayllihuaya (Sector Pueblo)	000 Kg	10	4	6																	5000 Kg	8	2	6									10,000	10,000	7,500		
JAY-28	23-Feb-99	Jayllihuaya (Sector Pueblo)	9 Sac	10	4	6									2 Sac	11	4	5					1000 Kg	9	3	6									5,000	5,000	2,600		
JAY-29	23-Feb-99	Jayllihuaya (SectorAziruni III)	10 Sac	10	4	6																	2500 Kg	8	2	6									5,000	4,000	2,500		
Total																																			390,000	225,000	0,126,368		

Summary of agricultual survey in the microcuencas Chimu
Estudio sobre el pastoreo en las microcuencas

▨ : Not necessary to entry

No.	Date Fecha	Location Localidad	Name of cultivation, Production and sowing time Nombre de Cultivo, Produccion y Epoca de siembra																																Total Area Total (m2)	Cultivation possible area Area apta para cultivo (m2)	Cultivation area Area cultivada (m2)	Fertilizer (Sort, Amount) Abono (Tipo y cantidad)	Agricultural chemicals (Sort, Amount) Insecticida (Tipo y cantidad)
			Potato Papa				Broad bean Haba				Oat Avena				Barley Cebada				Oca				Quinua				Corn Maiz				Onion Cebolla								
			Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]	Production Produccion	Sowing Siembra	Harvest Cosecha	[illegible]					
C-CH-01	24-Feb-99	Chimu (Villa San Jose)	2 Sac	10	3	5	1 Sac	9	4	7					1 Sac	11	4	5					1 Arr	9	4	7									3,000	2,000	1,000		
C-CH-02	24-Feb-99	Chimu (Villa San Jose)	3 Sac	10	3	5									2 Sac	11	4	5	1 Sac	9	4	7	1 Sac	9	4	7	1 Sac	10	4	6					3,000	3,000	2,900		
C-CH-03	24-Feb-99	Chimu (Villa San Jose)	3 Sac	10	3	5									1 Sac	11	4	5					1 Sac	9	4	7									3,000	2,500	1,000		
C-CH-04	24-Feb-99	Chimu (Villa San Jose)	2 Sac	10	4	6									2 Sac	10	3	5					1 Sac	9	4	7									2,000	2,000	1,800		
C-CH-05	24-Feb-99	Chimu (Villa San Jose)	2 Sac	10	4	6	1 Arr	9	3	6					2 Sac	11	4	5									1 Arr	10	4	6	50 Kg	9	2	5	2,000	2,000	1,500		
C-CH-06	24-Feb-99	Chimu (Villa San Jose)	5 Sac	10	4	6	1 Sac	9	4	7					1 Sac	11	4	5									1 Sac	9	5	8					3,000	2,500	1,800		
C-CH-07	24-Feb-99	Chimu (Villa San Jose)	6 Sac	10	4	6									2 Sac	11	4	5					1 Sac	9	3	6									2,500	2,000	1,900		
C-CH-08	24-Feb-99	Chimu (Villa San Jose)	5 Sac	10	4	6	1 Sac	10	4	6					1 Sac	11	4	5					1 Sac	9	4	7	1 Sac	10	4	6					4,000	4,000	2,500		
C-CH-09	24-Feb-99	Chimu (Villa San Jose)	3 Sac	10	4	6									3 Sac	11	4	5					1 Sac	9	4	7									4,000	3,000	2,800		
C-CH-10	24-Feb-99	Chimu	3 Sac												1 Sac																				2,000	1,500	900		
C-CH-11	24-Feb-99	Chimu (Barrio Central)	5 Sac	10	4	6									1 Sac	11	4	5					1 Sac	9	4	7									3,000	2,000	1,200		
C-CH-12	24-Feb-99	Chimu (Vallecito)	4 Sac	10	4	6									3 Sac	11	5	6					2 Sac	9	5	8	1 Sac	11	5	6					5,000	4,000	3,900		
C-CH-13	24-Feb-99	Chimu (Vallecito)	2 Sac	10	4	6									1 Sac	11	4	5	2 Sac	9	4	7	1 Sac	9	4	7									3,000	2,000	1,500		
Total																																			39,500	32,500	24,700		

Summary table of applied fertilizer on farms

Fertilizer \ Area	1	2	3	4	5	6	7	8	9	10	11	12	13
	Huaje	Dos de Mayo	Ventilla	Orkopata	Pucamaya	Chacarilla	Santarosa	San Martin	Alto Manto	Huayna	Capullani	Jayllihuaya	Chimu
Guano de ovino	2,310	480	9,520	120	4,320	60	2,260	880	680	380	16,900	33,320	7,200
Fosfato Diamonico	0	0	30	0	0	0	10	0	0	0	2	49	25
Urea	256	20	123	0	17	0	10	10	5	26	64	728	70
Nutrifollaje	1	1	0	0	0	0	0	0	0	0	5	1	2
Guano de Isla	0	80	10	0	0	0	0	0	0	0	20	260	20
Nitrato de Amonio	2	0	0	0	0	0	0	4	0	22	0	20	0
Superfosfato triple	0	0	1	0	0	0	0	0	0	0	0	100	0
Potacio	0	0	0	0	0	0	0	0	0	0	0	22	0
Nitroforka	0	0	0	0	0	0	1	0	0	0	0	4	0
Fosfato	1	0	0	0	0	0	0	0	0	0	0	20	0
Cloruro de potacio	0	0	0	0	0	0	0	0	0	0	0	40	20
Guano llama	0	0	60	0	0	0	0	0	0	0	0	0	0
Bayfolam	0	0	2	0	0	0	0	0	0	0	0	0	0
Kurowanuchi	0	2	0	0	0	0	0	0	0	0	0	0	0
Ceniza	0	0	0	0	0	0	0	0	0	0	0	0	40

Unit load

unit % (w/w)

N	P
8	6
18	46
45	0
20	20
10	10
34	0
0	18
0	0
20	19
0	46
0	0
8	6
11	8
0	0
0	0

Nitrogen (T-N)

Fertilizer \ Area	1	2	3	4	5	6	7	8	9	10	11	12	13	T-N (kg)
	Huaje	Dos de Mayo	Ventilla	Orkopata	Pucamaya	Chacarilla	Santarosa	San Martin	Alto Manto	Huayna	Capullani	Jayllihuaya	Chimu	Total
Guano de ovino	184.8	38.4	761.6	9.6	345.6	4.8	180.8	70.4	54.4	30.4	1352.0	2665.6	576.0	6274.4
Fosfato Diamonico	0.0	0.0	5.4	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.4	8.8	4.5	20.9
Urea	117.8	9.2	56.6	0.0	7.8	0.0	4.6	4.6	2.3	12.0	29.4	334.9	32.2	611.3
Nutrifollaje	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.2	0.5	2.0
Guano de Isla	0.0	8.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	26.0	2.0	39.0
Nitrato de Amonio	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	7.4	0.0	6.7	0.0	16.1
Superfosfato triple	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potacio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitroforka	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.8	0.0	1.0
Fosfato	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cloruro de potacio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guano llama	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8
Bayfolam	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Kurowanuchi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceniza	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
													Total	6,969.7 kg/year
														19.1 kg/day

Phosphorus (T-P)

Fertilizer \ Area	1	2	3	4	5	6	7	8	9	10	11	12	13	T-P (kg)
	Huaje	Dos de Mayo	Ventilla	Orkopata	Pucamaya	Chacarilla	Santarosa	San Martin	Alto Manto	Huayna	Capullani	Jayllihuaya	Chimu	Total
Guano de ovino	138.6	28.8	571.2	7.2	259.2	3.6	135.6	52.8	40.8	22.8	1,014.0	1,999.2	432.0	4705.8
Fosfato Diamonico	0.0	0.0	13.8	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.9	22.5	11.5	53.4
Urea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nutrifollaje	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.2	0.5	2.0
Guano de Isla	0.0	8.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	26.0	2.0	39.0
Nitrato de Amonio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Superfosfato triple	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	0.0	18.2
Potacio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitroforka	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.8	0.0	1.0
Fosfato	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.0	9.7
Cloruro de potacio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guano llama	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6
Bayfolam	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Kurowanuchi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceniza	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
													Total	4,832.7 kg/year
														13.2 kg/day