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.
- <u>Settling Velocity</u> 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:

$$R = 1 - \left[1 + \frac{1}{n} * \frac{V_S}{Q/A}\right]^{-n} \tag{4.1}$$

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.

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

$$R = 1 - \exp[-k * t] \tag{4.3}$$

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

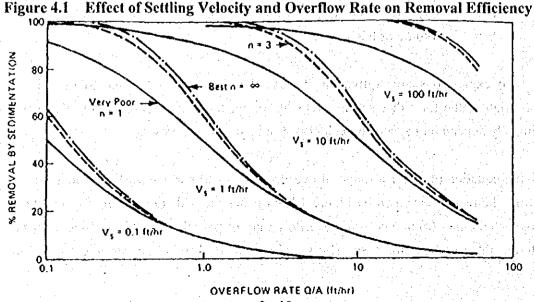
present in urban runoff applications. The effect of a range of particle settling velocities is addressed by performing separate computations for a number of settling velocities and then using weighted mass fraction to compute net removal.

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: A beginning to the control of the control

- 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

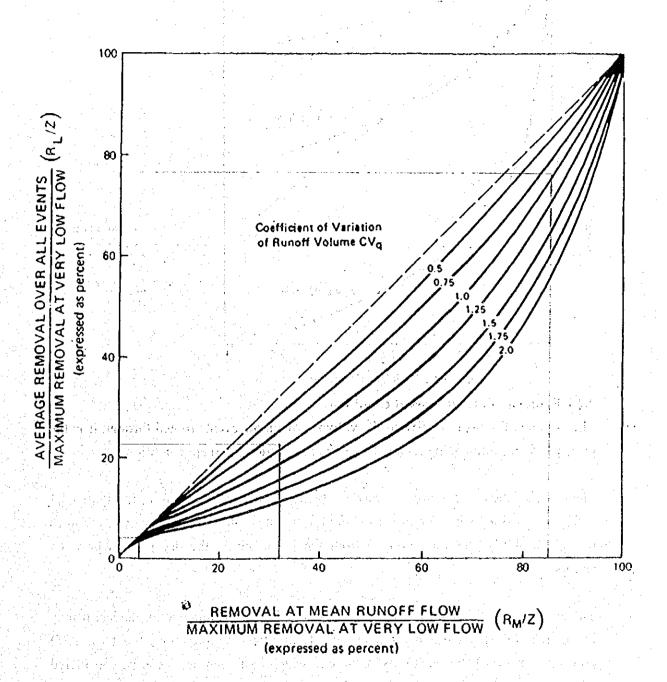
Removal fractions for a range of settling velocities representative of urban runoff, as computed by equation (4.1), are presented in Figure 4.3 as a semi-log plot on which the exponential approximation, equation (4.2), would plot as a straight line.

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.



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



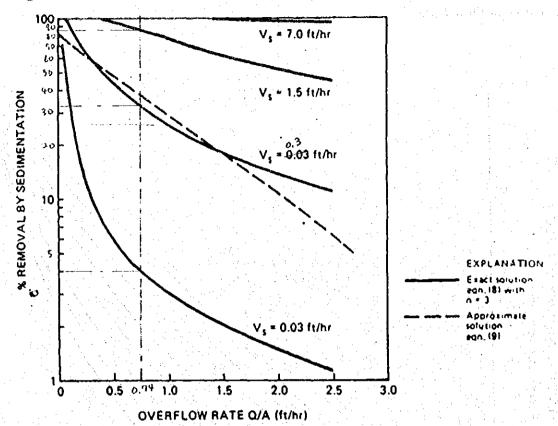


Figure 4.3 Flow-Removal Relationship for Exponential Approximation

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

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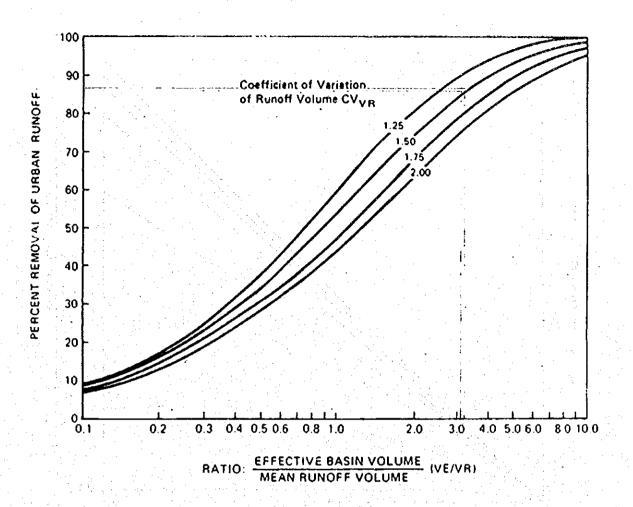
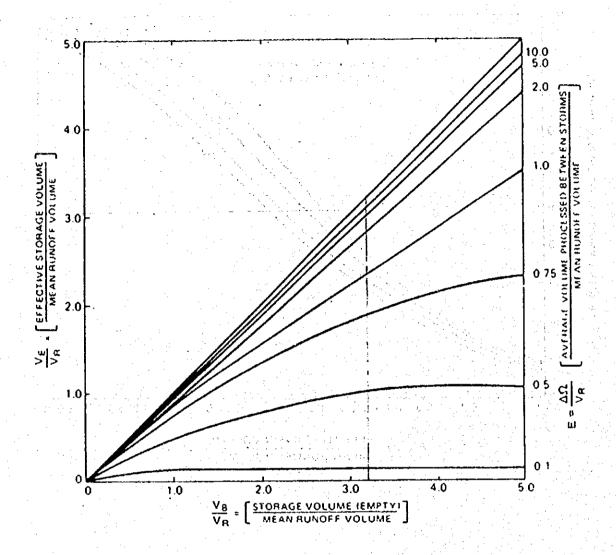


Figure 4.5 Effect of Previous Storms on Long-Term Effective Storage Capacity



$$\Omega = v_s * A \qquad (4.4)$$

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:

Fraction of residence time under dynamic conditions =
$$D/\Delta$$
 (4.5a)

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

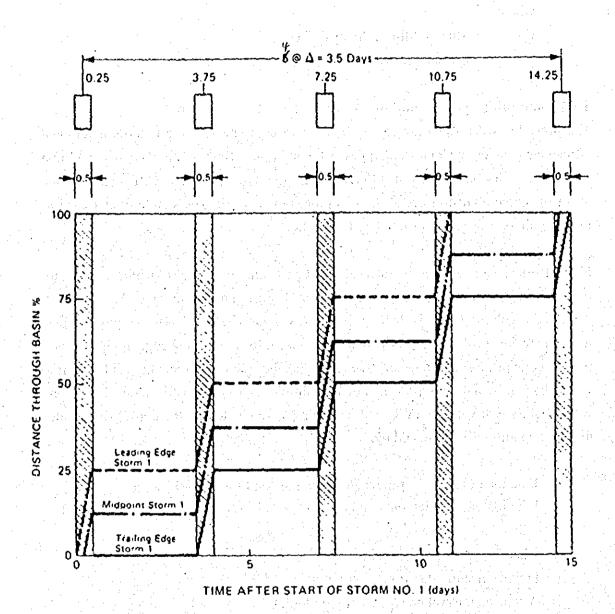
where:

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

Oynamic Time: (0.25) + (3 x 0.5) + 0.25 = 2.0 Days

2/14 # U.14

Quiescent Time: 14.0-2.0 = 12 Days

12/14 = 0.86

 $D/\Delta = 0.5/3.5 = 0.14$ (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.

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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:

COMBINED % REMOVAL =
$$100 [1 - (f_D^* f_O)]$$
 (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	Average Settling
	Urban Runoff	Velocity (ft/hr)
erica e la Maria	0-20%	0.03
2 2 2 2	20-40%	Ji karatan 0.3 Jahar da
3	40-60%	1.5 mg 1.5 mg (1.5 mg)
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 fl/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)

			0e	tention Bas	sin Size
Code No.	Project and Site	Approx. Average Average Basin Depth (Ft)	Relative Monitore Overflow Rate QR/A (ft/hr)		Relative to Size of Urban Catchment (Surf Area/Drain Area X 100%)
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	Project	No.	Size	Ratios	Ave	Average M	Mass Re	Removals	- A11	Monitored		Storms (Percent)	Percen	£
No.	and Site	of Storms	QR/A	VB/VR	TSS	GOS	goo	TP	Sol.P	TION	NO2+3	T.Cu	T.Pb	T.Zn
٦	Lansing Grace St. N.	18	8.75	0.05	(-)	14	(-)	ũ	1	:	(-)	3	6	Ĵ
٥	Lauding Grace St. S.		2.37	0.17	32	m	ı	12	23			ĵ	56	ĵ.
m	Ann Arbor Pitt-AA	9	1.86	0.52	32	21	23	80 17	ĵ	7			62	<u> </u>
.	Ann Arbor Traver	6	0.30	1.16	\$	ĵ	15	34	26	20	27	•	•	v
^	Ann Arbor Swift Run	•	0.20	1.02	85	•	2	М	53	19	8	•	82	<u> </u>
9	Long Island Unqua	&	0.08	3.07	9	٤	(roc=7)	45		Ξ	:	•	8	
-	Washington, D.C. Westleigh	32	0.05	5.31	81		35	54	7.1	27	•	đ	•	56
₩.	Lansing Waverly Hills	73	0.04	7.57	91	69	69	79	70	09	99	57	95	2
δ	NIPC Lake Ellyn	23	0.10	10.70	84		•	34			•	2	78	

Motes: (-) 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.

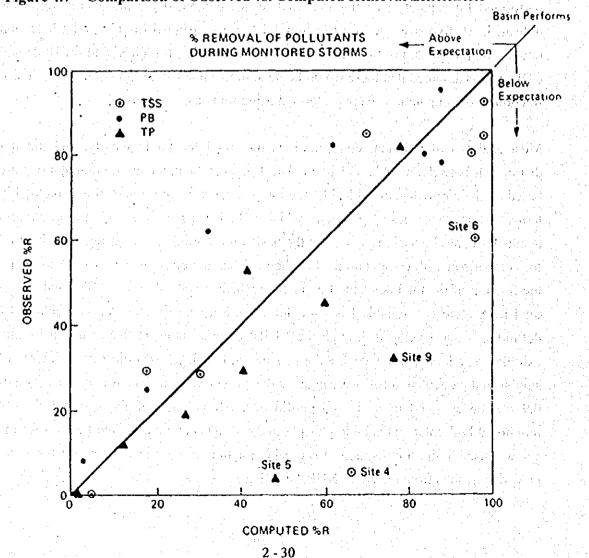
Because of the wide variability in particle settling velocities, and their important effect on removal by sedimentation, independent removal efficiency computations were performed for separate size fractions and results combined for the overall removals indicated. All five size fractions (Section 4.3.1) 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 of the state of the second of

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"Floral" drainage area, total area of 2.058 km², 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 m * 0.74 * 2.058 * 10⁶ m²
= 38,700 m³
Therefore V_{total} = 40,000 m³

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

$$V_L = [(Rm)(Rv)/12](A)$$
= [(0.45 inches*25.4/1000 m/inch)(074)](2.058 * 10⁶ m²)
= 17,400 m³

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

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$$A_L = 17,400 \text{ m}^3 / (12 \text{ inches * } 25.4 / 1000 \text{ m/inch})$$

= 57,100 m² $\approx 60,000 \text{ m}^2$

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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).

$$OR = (I) (Rv) * (Area)$$

=
$$0.031$$
 inches/hr * 25.4/1000 m/inches * 0.74 * 2.058 * 10^6 m²

 $= 1,200 \text{ m}^3/\text{hr}$

$$VR = (V) * (Rv) * (Area)$$

=
$$0.14$$
 inches * $25.4/1000$ m/inch* 0.74 * 2.058 * 10^6 m²

$$= 5,400 \,\mathrm{m}^3$$

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)
l	1	0.03	4	
1	2	0.3	32	23
	3	- 115 1.5 (1.5 takes)	85	77
	4	7.	100	100
	5	65.	100	100

$$= 61$$

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$$= (100-61)/100 = 0.39$$

<u>Step 3</u> - 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 m³

 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	FRACTION Vs,	Ω (= Vs A),	E (=ΔΩ/VR)	VE/VR	% REM
NO.	ft/hr(m/hr)	m/hr		(Fig. 4.5)	(Fig. 4.4)
1 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

0.13

OVERALL AVERAGE REMOVAL = 87 fraction NOT removed f_0 = (100-87)/100 = 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 \approx 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.

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

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SIZE	FRACTION Vs,	% REMOVAL	% REMOVAL	% REMOVAL
NO.	ft/hr(m/hr)	DYNAMIC	QUIESCENT	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

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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:

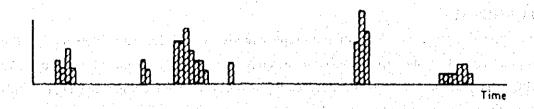
The average number of storms during any period of time is defined by the ratio between the total number of hours in the selected period and the average interval between storms (Δ) . For example, on an annual basis:

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

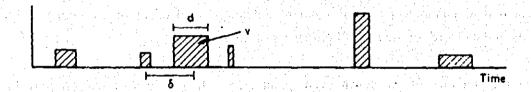
The storm event parameters of interest have been shown to be well represented by a gamma distribution. The results indicate that the coefficient of variation of the event parameters generally falls between 1.0 and 1.5. Figure A-2 plots the probability distribution of gamma distributed variables with 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

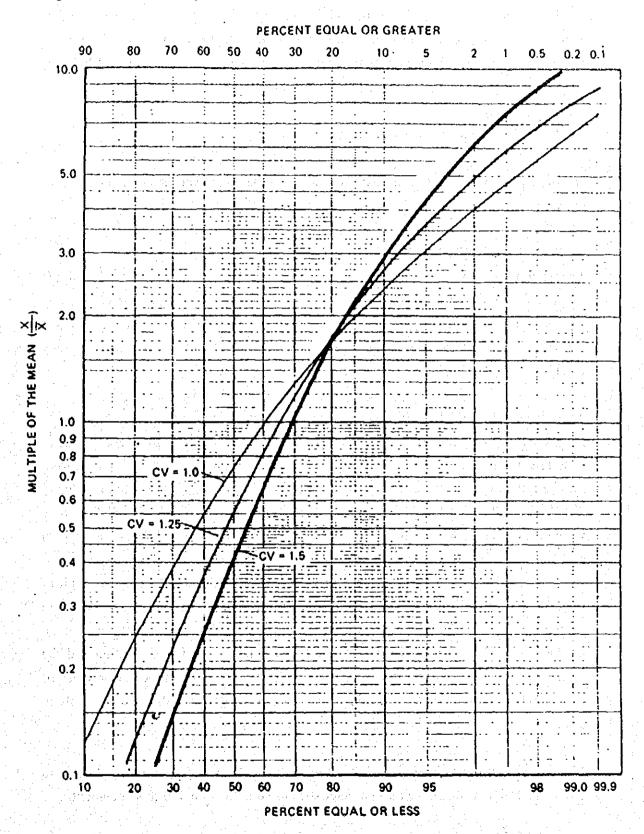


(b) STORM EVENT VARIATION



	PARA	METER
	For each storm event	For all storm events
Volume	v (inches)	Mean Coef Var
Duration	d (hours)	D v _d
Average intensity Interval between event midpoints	i (inch/hour) δ (hours)	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.

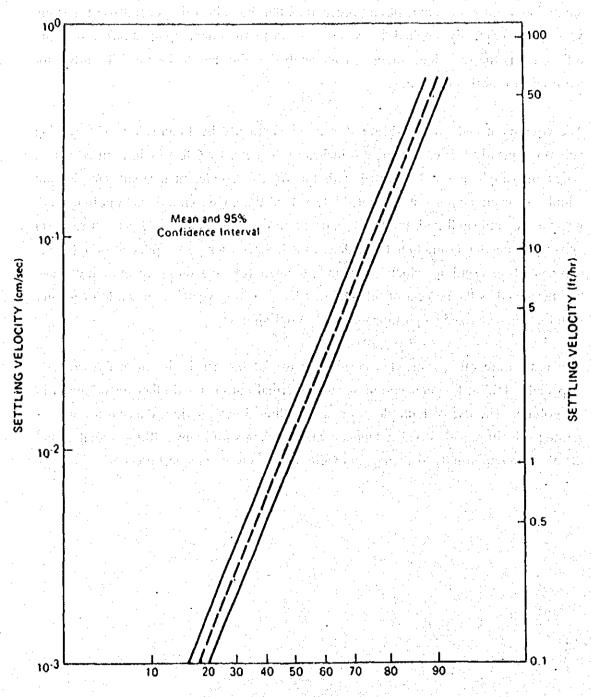
For analysis purposes, the indicated range of settling velocities can be broken down into five equal fractions that have the characteristics listed in Section 4 of this document.

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.

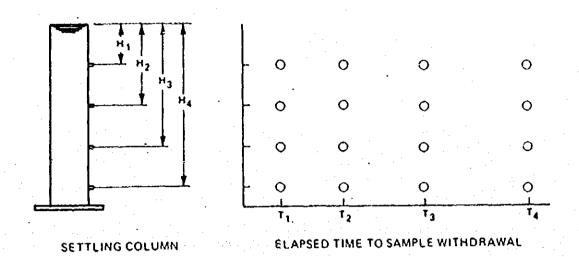
Test results are often somewhat erratic because of the sensitivity of analytical tests (especially TSS at low concentrations) and thermal currents and other disturbances in the column. The use of multiple ports and settling times provides data on a range of settling velocities, and provides duplicate 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



PERCENT WITH SETTLING VELOCITIES EQUAL TO OR LESS THAN INDICATED VALUE

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

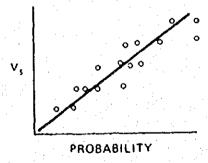


O = Data Point - Record % removed based on observed vs. initial concentration

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 $\boldsymbol{V_{5}}$

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



그 그는 사람들이 되었다. 그 그 사람들이 가장 그리고 하는 사람들이 가장 하는 것이 되었다. 그는 사람들이 가장 하는 것이다.	
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그리고 하면 있다. 그는 소설 전 맛이라면 하고 하는데 하는 것이다고 하는데 한 점점하는 것이다. 그는 다 무슨 하는데 없다.	
그 보면 진행되는 생물을 다른 어머니는 열심을 받을 때 그리는 다른 사람들이 본 이 문에 본 하는 것이 없다.	
그 하늘 말했다면요. 그들을 수 나라는 하는 전쟁을 하는 그 보는 것 같아 그 하는 말이 되는 것이 되는 것이다. 그런 그 전쟁이다	
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그 시작 하는 회장 원인 대통 교회의 작업 기업 등장 대통원 경기에 가장 기업 경우를 가장 하는 것이 되었다. 그는 다른 기업	
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A ACDICULTUDAL MONDOINT DOLLUTION COUDOR OUDA	
3. AGRICULTURAL NONPOINT POLLUTION SOURCE SURV	EY
그는 그는 이번 가게 되는 것 같아. 작가는 사람들이 가게 되었다면 하는 것 같아. 그는 그를 다 하는 것 같아. 그는 것 같아. 그는 그를 다 하는 것 같아.	
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그 항의 물건 하는 경기 그리고 있는 것만 말하다 한 회원에 가는 한다. 맛이는 중에서 나타가게 하게 되었다고 하고 있다. 중에 말했다	
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그는 아일하다 된 본 살에 마음이 있다면 하는 물론 방에 그리는 사람들이라 속되는 이렇는 이번 그는 바다 하면 하면 된 본 사람들이 되었다.	
그는 이 집에 가는 항상한 집에 물이를 보고 있다. 소리에 와 사진 이 병에 다양하는데 어떤 사람들이 원래된 내고 그를 모르는 것이 살아왔다. 그리는 학생들은 다양하는 것이다.	
그 내가 나타들로 하자 마음 동안 물을 하는 사람이라다고 마음 학자는 생물들을 만들어야 하는데 나는 것을 내가 나가요?	
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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
- ① Orkopata
- ⑤ Pucamayo
- 6 Chacarilla
- (7) Santa Rosa
- (8) San Martin
- Alto manto
- (10) Huayna Pucara
- (II) Capullani
- 1 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 Com
- ® Onion
- 10 Flores
- (I) 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.

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

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

Ž	Dote	Location					direct	a de Cultura	Nombor de Cultura Producence y Eroca de sumbra	Nomber de Culture Production v Eroch de sumbre					Total	MAN MANAGEMENT	1	(Next, Assessed)	(Nurt, Americant)
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C-AM-0	17-Fub-94	C-AM-01 17-Fub-00 Alto Manto	3 Sac	P 01	9	1.00 mg/s	4	Sac	7 11	9			X X		\$2 \$2 \$6	40,000	3,000,3	00%	
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C-AM-03	3 17-Feb-04	C-AM-03 17-Feb-wo Alto Manto	3 Sac	10	9 , 3					See	\$3000 1000 1000 1000 1000 1000 1000 1000	N. Oct.	**			5,000	2,000 30	300	그 선생은 사용을 하
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C-AM-C	4 17.Fub.W	C-AM-UN 17-Fob-99 Alto Manto(Suctor Canchurani)	3 Sac	10 4	9			2 Art	77	\$						2,000	3.500	90%	
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C-AM-0x	9 17-Pub-94	C-AM-100 17-Fub-30 Alto Manto (Suctor Canchanni)	1 Sac	101	2.0			1.000 Kg	11 4	o S I Sac	4	, Ar	4		San C	5,000	5,000 1,300	% %	
C-AM-II	9 17-Fcb-94	C-AM-19 17-Peb-99 Alto Manto (Sector Cancharani)	3 Sac	01	2 × 4		_	2 Arr	7	**		2 Arr	\frac{1}{2}		8	00001	4,000	894	
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Summary of agricultual survey in the microcuencas Estudio sobre el pastoreo en las microcuencas

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C-CA-12 1X-Pub-144 Capullani	oc. 4	10 4 6	÷	100			2 Sac	11 4	. 5 2 Sac	×	4 % %	2 Arr 0	4 7 2 AH	λ ×	* 7	5,000	4,000 2,4	2,400	
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C-CA-U4 1%-Feb-uv Capultani	4 Sac	9 2 7 01	6 0.5 Amor	(3000)			- V	4/2	2 Sac	8	\$ *		V 1	Arr ×	£	\$,000	2,000	×40	
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C-CA-DV 18-Pob-VV Capullan	18,000 Kg	10 4.5		10,000 Kg/MV	20 Kg/MV	11	7,000 Kg/MN	11	- Sec.		02,00	2,000 Kg 9	4			500,000 50	500,000 70,000	600	
C-CA-113 1X-Feb-vv Cagullani	2 Sac	10 4		all property.	·		Sac	11 4	Sac	*		1 Sac 9	3.38 5		700 mg/s 200 mg/s 200 mg/s	000'\$	3,500	1,500	
C-CA-11 1X-Feb-09 Capullan	A Nac	7 T	500	0 7	400 Kg/Fo	<u>्</u> र	S. I. Sad	11			286		(See See		\$ 1.50 pt	10,000	5,000	1,800	
C-CA-12 IN-Fub-W Capullam	2 Sac	7 OI		80'1 Jane 1	LOND Ka/ROMA	्र ^क ।।	S Sac	P 11	S Spe	×	\$ \$ \$ \$ \$		180	-	572 1	10,000	5,000 2,4	2,409	
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Jayllihuaya Summary of agricultual survey in the microcuencas Estudio sobre el pastoreo en las microcuencas

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No. Forth	- Industrial a		Paper		21	Usruad Nean Flahss		Out		Elan. Coh.	Barley Cehada		90		Ceballa			Ownrea		Force	ş	Ante aptu- una Tual pepa cultivo	upte Area	Abran Apran	, and	Ancoda Ancoda
		Producti	Production Ameng Harves		Production Same Comme	Tarrente l'Intre	Ħ	Principal statement of the statement of	Productions Productions	(BOSHUS Sames		Pedaxxam	January States	Production	Buseson;	larve terminal	Production	A. January	Production	panel Between	Ţ		(m2) (m2)]
JAY411 22-Fub	JAVA1 22-Feb-39 Javildranse (Sector Alta Javildranea)	I	8	3°	1 Arr	-		-	i e	ļ) Sange	7 T	2	7 000 Kg	01	* · ·	4 Art	7	L 0.00		oź "	20,000 10,	91 000'01	1 Glax		
JAYOR 22-Feb.	JAYAR 22-Februar Inglibrarya (Nester Alts Inglibrarya)	l⊟	£ : 10	4			-	_	-	1			4	(12) W	Arr ×	2 6					ol S	0,000	5,000	3,000,5		
JAY-01 22-Peh-	22-Per-99 Jaylibanes (Alto Jaylihanes)	30 Suc	G	Ą	j	-		_	64 (5)	3 Sec. 11	4	3. v	0	7 250 Kg	7	H 01			25.5		9	6,000	5,000	1,450	**************************************	G = 5
JAY-04 22-16th	JAY-04 22-Feb-29 Juelihages (Alic Jaylihanya)	3 Sug	101	9 7	2 Arr	** *	3.5		1	Nec.) •	3/3		100 Kg	¥ 2	1.2 5.5		2/3				5,000	0.000,1	050		
JAY-05 22-15-b	JAY-05 22-Feb-09 Jaylibuays (Alto Jaylibuays)	15 Suc	=	Ŷ	N _{DC}	-	-			3	ļ	S Nec		400 Ky	*	2-1 6.5) 	01 000'01	000'01	5 (100)		10 mg/s
JAY-06 22-Fob-	JAY-00 22-Foh-00 Jughtman (Sector Alto Juylihmon)	H	2	7		_		_		L	Ď	L.,		AHD Kg	9	7						S, CORD	\$,000	005		
-JAY-01 22-Fch	JAY-07 22-Feb-09 Juvilinawa (Sector Alto Juvilinawa)	15 Sau	3	7	3	- 5	\$ ~		-	- Sec	7	- S		1500 Kg	ž	9 S C		8	4X 001	\$ 21	\$ 8	S, CKK)	5,000) (XIO) ×	W100 S	State of the
JAY-ON 12-Pub.	JAY-ON 22-Poh-90 Juvilihanes (Section Alto Juvilihanea)	3 Nate	OI.	4 .	7,	\$	٠ ا			ļ	100 m	3.5		S 25KD Kg	C.	5'9 7'			150 Kg	12 5	, ,	5 0000	5,000 3.2	3,200 SC 360.0		
HON-22 KMAYI"	22-Pote-09 Joylahinen (Society Alie Javilshnaya)	25 Sac		7. A	- Xec	2	4 000		1 Samuel	1 Nec 1	Ľ	3.24		700 Ky	111	S 3.		38	W.759		¥	\$ (000)\$1	01 000'5	1 OOO 1		
-3AV-10 22-FUB	22-Pob-99 Juylilmaya (Sector Puntou)	-	0.	9 7	- Sie	5	2.1 6.8.5	-	Section 1 No.	Sec	1.00 P	.50	- 6	% 1200 Kg	01 (6)	Y 100		*	\$100 kg		> 200	S,OKIO S,		2.500		6-20C
JAY-11 22-Fub	JAY-11 22-Fuh.99 Juvilahusya (Sautes Prestrue)	268. P.1	0	9		6	ASS P	_	- C. W.	- Sec	598 T	چ	270	200 Kg	111	9 000 5		±35.	of the control	_	े	SOOK	5,000 2,2	2 200 500 500	Section Section	William Section
JAY-14 23-FUL	JAY-13 23-Pob-99 Juvilihunsa (Sector Yensmire)	750 Kg	01	€ ∴4*		-	(S)		350		91			TYON K	11	2005			\$ 1000	\$ 21	>	So, OND 40	40,000 20,000	, 000		
JAY-13 23-Feb.	JAP-13 23-februs Judithanes (Sector Personiere)	X Sec	01	9:30	1 Suc	0	3 × 4		inga s	Sec.	\$≤ * [†]		- eg	1200 Kg	01	9 *		100	2.33	-	3	5,000	3,000 2,0	2,000		N. West Co.
JAY-14 23-FOR-	23-Februa Javilihuwa (Sector Paramero)	1 Sac	11	9 5	Swe	10	\$ 5.7		G.:		1 कि	OWN -	-	1200 Ky	01 .63	4 5		(ξ ²)			S 1	15,000	4,000 0,000,000			
JAYALS 23-Pullanous	Developmen (Sector Parameter)	SO Sag	101	9: •	5 Suc	10)	2-0-5		20 Nag	New 11	4	\$	YY.	Section Kg	(a. 10)	9 8 7					্	0X 0000+	30,000 22,000	00		
JAY-16 23-Fob	JAY-16 23-Fob-19 Jaylihusya (Sector Vinsenery)	10 Sac	01 0	4			888		2,	2 Suc 11	\$ 7			Carlo Kp	×	2 6					\$4 (* 4.5)	15,000 5,	5,000 2,1	2,40k)		
JAY-17 23-Pub	JAY-17 23-Pob-Ds Jaylishugu (Sector Yunanuro)	70 Sac	01 3	4 4			(A)				1000	- F		ZOKKI K	,	% ४			30	\$ 21	S V	KO,000 15	15,000	XIO .		100
- ANY-18 27-WAL	JAY-18, 23-School Juglishings (Sector Yunimers)	X Sau	112	3 ∾ 6			200		3515		38.8		-	200		hoja			1000	:	\$ 18 S	s coos	1,000	(A)	43 S	100
	JAY-19 27-25-000 Jaylidmove (Sector Yumanums)	20 New		36	Sac		100		35.20	_	(See)	353	-22	ें 2500 Kg] [-)X296	_	×:< 20	20,000	5 DXN 2.5	2,500		
AAY-20 23-9-ch-m Javilihums	Paylishages	10 New	101	4			(2×2)		Sec. 1	Nage 1	4 1.00 S	Š	9.3	ुं [©] ं 1200 Kµ	101	9 4		3	200		3	5,000	4,0XX1 1,14) 3 () () () () ()	19 19 19 19 19 19 19 19 19 19 19 19 19 1	
JAY-2 21-Fob-	JAY-2 21-Fob-19 Jaylihuwa (South Yuanwa)	X Sinc	101	**************************************			W 300 K		- 888	7	80° 18		.a.	See soo Ke	0 %	3,000	-	300	350		* E-3	r (XXI) 3	7 000 L	S S 007	The second size	
JAY-22 23-Poh-	JAY-22 23-Fox-99 Javililinava (Nodew Yourney)	SO Ninc	2	Y 7			1		S.S. 2 No.	=		ా	46	3500 Kg	CI S	Y 7		*) 	S	5 31	20,	20,000	000'01 000'51	္သ	September 1	
-JAY-21 23-Fide-	JAY-21 23-For-38 Jaylihuaya (Nouve Incapuse)	X Sac	c 10	٠ ۲	3	6	يا څار		2 Sec.	Sac 11	\$ 200°		21.6	2500 Kg	0	\$ 100 mg		্যু	1	_	*	5,000	0't 000'7	1,000		18.5 S. S.
-JAY-24 27-Poh-	-JAW-24 27-Pob-592 Jaylihuaya (Nester Incapujes)	6 Suc	01 0	4	2 Am	9	4 8 m		1 See	Sec.	\$30 P			1000 Kg	63	\$ See 1						4,000	3,000	008		
JAY.23 27-16-	23-Pobles Javilshneye (Septor Incaptors)	X N. N.	01	9 4	2 Arr	9	- A		No. 2 Nat	ll mi	188		*:	1500 Kg	11	5 6				_	30	20,000	5,000 2,04	2,600		
JAY-26 27-Ker-	JAY-20 27-Rep-00 Jaylahunya (Nector Incapoja)	20 Nuc	01	2			<u> </u>		2.5	3,6		9.	- 4,78	1200 Ku	C E	٠.					. 5,	5,000	4,000	3,200		
-JAY-2 27-Fub	JAY-27 27-Pet-00 Jaylishings (Nation Pluchin)	000 Kg.	£	y 					14.00			, <u>X</u> §	1795	SOXO KE	×	2 5			3.00A	_	(S)	01 000'01	2,000,01	7,500	(S) (S)	
JAY-28 23-Pah-	-JAY-22 27-Pab-99 Jaylihuaya (Notine Pushin)	O N.60	CI O	4			10.142% 10.142%	-	2 Name	5	4 45%		45	ેં ICXO Kµ	0	10006		19	86/38		100 S	5,000	5,000 2,00	2,000		**************************************
-JAY-27 23-Fub-	-JAY-24 27-Fob-99 Javilihuava (SactorAziman III)	10 Sac	101	9,5		_	100	_	2000		Sept. 1	18	1	SXX Kp	×	2 ∵ે 6		×.	9000	L	'S	5,000	4,000) 2,54	2,500		
Total			_	1000			Section of the sectio		Section Co.		200	14		33993		PARK.		(E)	College Sec		390,000		225,000 0,126,368	ં. ઃ ઋ		S. C. C.

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Dutte	i estaturi.								_	Namber de	Number of querywhers, Tendination and weveriff time. Neother do Celliste, Predicación y Francia do suceries	TOURNALON AND THE TANK	antering lines on the accompan	_			:					Textal	_	J	(Inc. Assess)	(her, Assess)	ĵ
No. Youhu	Localida		Potenti		\$1	Monthly Down	_	Cont		Harlov C. charle			å	-	Cuema	3		Š.			(m.co) Ceballa	Age Ton	Ante apte	Anse apris Arus paps cultivo cultivada		1	
		Productors	PERMINATURE Survey of Lawrent		Production S.		Tendent Tendentian Joseph December Tendentian T		"Inductive	Marine Section Section		Presiment	ļ į	matachar!	CIKHI America	Anna lawa lawa	Preduction	12.2	1	Princetium No.	1	<u> </u>	(a)	- F			Î
C-CIB-DI 24-Koh-9	C-C(Ba) 24-(kha) (Turni (Villa San Jose)	2 Nat	Į.		3	0	5 × 5		-	=				±V 1	r L	4 5		-	*6 2.2		1	9.	_	ءَ	\$ 1.50		<u>(</u>
C-CIRAR DARWE	Coci Rath 2 24-84b-09 Chimii (Villa Sun Jame)	1 Nac	<u>c</u>							Ξ	7	- Nac	3	-	3	7	1 100	-01	÷			0.	1,000	3,000 2,900			100
CATHAMIZABORA	C. et Hart (24-February Chumu (Villa Sun Jose)	J. San	10	ું			4.00	15%		Ξ	\$. \$2.	E		- Sec.	3				ξ ₁			1.0	2,5	2,500 1,000			
C-CITIAN 24-FOR-SP	C-CI field 24-Fub-vol Chami (Vella Siet Jose)	2 Smc	S	4				*	٢٠	<u>ō</u>	<u>.</u>			-	Sinc				- 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10	<u> </u>		2.0	2,000 2,00	2,000 1,900			ं
C-C! R-OS 24-Fob-o	C-Clitical 24-Fabron Chima (Valla San Jose)	2 Sim	lot	4 6 6	1 /4	1 0	3 %			Ξ	4			200	_		- 41	<u>c</u>	. v	3. €.	٠ 2	L.	2,010 2,00	2,000 1,500	W. S. S. S.		J. C. C. C.
C-CFR-06 24-Ryh-9	C-CHRISK 24-Pehrost Chrimi (Valia San Jewa)	5 Sinc	ol	٠, ٠	iski i	0 4 25	*	Ŕ.	- Nec	=	4			100	_	X.	3,	3	×		23.	0.	3,000 2,500	00% 1 000		27.23/21/2	
CHURDA 24-KAND	C-CITI-DZ 24-Foh-DS/Chims (Valla San Jose)	h Ninc	(CI	ું		.58	#700	S.	3 2 公公	-	\$4000 1			SASSE 1 Sec.	(1	9:::I	75. 2		(5) (2)			57	2,500 2,00	2,000 900	961 O 13		
C-C111-08 24-F0b-9	C-CITE-DK 24-Fob-99 Chims (Valu San Jews)	S. N.R.	(OI		30,1	10 4 25		-3.	30% I Suc	=======================================	S			- News	6 20	4867	- Xac	u	\$ 6 5 4	-	_	0.4	4,000	4,000 2,500			
C-CHIANO 24-Nob-O	C-CHIGO 24-Pet-30 Chima (Valla Sun Jose)	1 Nec	ļoj	ं १		.5%		38	3 Nec	=	. v			-	2	5	L_	L				4.0	4,000 1,0X	3,000 2,600			
C-C II-10 24-Pch-09 Chimu	УСъим	L Sec					8	127	- See						-			-	Ý.			o.c	L	000 000			
C4C111-11 24-168-09	CACHIELL (24-Peb-09 Chama (Barres Cantral)	S Sing	(1)	٥		58		Ų.	- New	=	<u></u>		ľ.	- Ne	2	1	Ļ	-		-	Ĺ	9	L	_			
C.C.H. 12 24-Puberty Chimi (Vullectur)	Chuma (Vullectus)	4 Nac	10	4 6	-	4.02	200	Y.	* * * * * * * * * * * * * * * * * * *	=	3		Ē	2 Nuc	3	*	7	Ξ	9	-		0.8	5,000,4	00,1			
CAMBELL CAMBERTON COMMISSION	ACTIONIA (Vallegator)	2 Nac	υ.	4		100			- Nec	=	\$	N. Nac	2	7	3					 -		01	1,000 2,000	1.500			
_				22. 22				.9(:)	10.00						_		L,		3	 -		(1) (2)			15		
				*		200	25.2	7.8	200		78 18			A A	-	9000			152 157	-							
				360 mg		-82	1,600	88	200		\$			\$00 B	_			L	2500 P.		<u> </u>			_			
				800		***	110.00	o'	***		10000			*00000		**************************************		_	(%) (A)	-	ia y	7 6 8 8 70	_		CE 54.83)		
				100			1,8%		1000		100 M				H	\$1 \$1	9.7		13 cg		10.5	200			medical company		Salating (S
				5.18		3.5		.# 			45. 24.				L				70 20 20	-	36 ¹ .1	7.7 6.			4.4		A
				1 (1) 1 (1) 1 (1) 1 (1)				Ş.	5 22		Appendic			200 200 200 200 200 200 200 200 200 200	H	8508			100 A 100		<u>. 34</u>	100	_		S 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1		
				507 201										1						-	انقا	in the second		_			
				3			200				**************************************			74 S			य स									14 (ph d %	
Total							\$ 1.00 m				2500 E		_	1				-	8			39,500	L	12,500 24,700			

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Summary table of applied fertilizer on farms

Fordes Area	ı	2	3	4	\$	6	7	8	9	10	11	12	13
78.300	Heaje	Dur de Mejo	Ventilla	Orkopata	Pocamaya	Chacarilla	Santarosa	Sas Martin	Alto Manto	Hoayna	Capullani	Jaylikanya	Chimu
Gueno de ovino	2,310	450	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 Ista	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	9	1	0	0	. 0	0	0	0	0	0	100	0
Potacio	0	0	0	Q	0	0	. 0	0	0	0	0	22	0
Nitroforka	0	0	0	0	0	; O	- 1	. 0	. 0	0	0	• 4	0
Fosfato	- 1	0	0	0	٥	; 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 Ilama	. 0	0	60	0	0	0	0	0	0	0	0	. 0	0
Bayfelam	0	0	2	0	0	: 0	0	. 0	0	Ó	. 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

01111110	au
<u>uni</u>	L % (w/a)
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
111	8
. 0	0
0	0

	ı	2	3	4	5	6	. 7	8	9	10	11	12	13	I-N(kg)
Forulard Area	Haaje	Det de Mero	Ventilla	Orkopata	Pucamay a	Chacanila	Santarosa	San Martim	Aho Mario	Heayna	Capullani	Jaylikuaya	Chimu	Total
Guano de ovino	184.5	38.4	761.6	9.6	345.6	: 48	180.8	70.4	54.4	30.4	13520	2665.6	576.0	6274.4
Fosfato Diamonico	00	00	5.4	0.0	0.0	0.0	-18	0.0	0.0	0.0	0.4	8.8	4.5	20.9
Urea	117.8	92	56.6	0.0	7.8	0.0	4.6	4.6	23	12.0	29.4	334.9	32.2	611.3
Nutrifo@aje	01	02	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.2	0.5	20
Guano de Ista	0.0	80	1.0	0.0	0.0	0.0	0.0	0.0	-00	0.0	20	26.0	20	39.0
Nitrato de Amonio	0.7	0.0	0.0	0.0	0.0	1 0.0	0.0	1.3	0.0	7.4	0,0	6.7	0.0	16.1
Superfestato triple	0.0	0.0	0.0	0.0	00	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fotocio	00	0.0	0.0	0,0	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitreforka	00	0.0	0.0	0.0	00	0.0	02	0.0	00	0.0	0.0	0.8	00	10
Fosfato	00	0.0	0.0	90	00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cloruro de potacio	00	0.0	0.0	00	0.0	0.0	00	0.0	0.0	0.0	. 0.0	0.0	0.0	0.0
Guaso Ifama	0.0	0.0	48	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	02	0.0	- 0.0	0,0	0.0	0.0	0.0	0.0	0.0	. 0.0	0.0	02
Kurov anuchi	00	0.0	0.0	0.0	0.0	00	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	00	0.0	0.0	0.0	. 00	0.0	0,0	0,0	0.0
													Tota!	6,969.7
														19.1
Phosphorus	(T-P)							[1.7]						
	1		T 7		1 .	T .	F 7		۱ ۵	10	11	12	3.3	T.P/tal

Phosphorus (T-P)

Fordizo Area	ı	2	3	4	5	6	7	8	. 5	10	11	12	13	T-P(kg)
rassza Ala	Huaje	Dos de Mario	Ventilla	Orkopata	Pucamaya	Chacacilla	Santarosa	San Martin	Alto Manto	Huayna	Capullani	Indikuna	Chimo	Total
Guano de ovino	1386	28 8	571 2	72	259 2	3.6	135.6	52.8	40.8	22.8	1,014.0	1,599.2	432.0	4705.8
Fosfato Diamonico	. 00	00	13.8	0.0	. 00	00	4.6	0.0	0.0	· 0.0	0.9	22 5	11.5	.: §3.4
Urca	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
Nutrafolisje	01	02	00	00	0.0	0.0	.0.0	0.0	. 00	0.0	0.9	0.2	0.5	20
Guano de Isla	0.0	80	1.0	00	0,0	0.0	0.0	0.0	0.0	0.0	20	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
Superfestato triple	00	0.0	02	0.0	0.0	00	0.0	0.0	0.0	0.0	00	18,0	0.0	18 2
Potacio	00	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	, 0.0	: 0.0
Nitroforka	00	0.0	0.0	0.0	. 0.0	00	02	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	Ó,0	0.0	9.2	0.0	9.7
Cloruro de potacio	0.0	0.0	00	0.0	0.0	00	0.0	0.0	00	: 60	0.0	0.0	0.0	0.0
Guana Ilama	0.0	0.0	36	00	0.0	0.0	0.0	0,0	0.0	0,0	0.0	0.0	0.0	3.6
8 systolans	0.0	0.0	02	0.0	- 0.0	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Kurowanuchi	00	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceniza	00	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
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