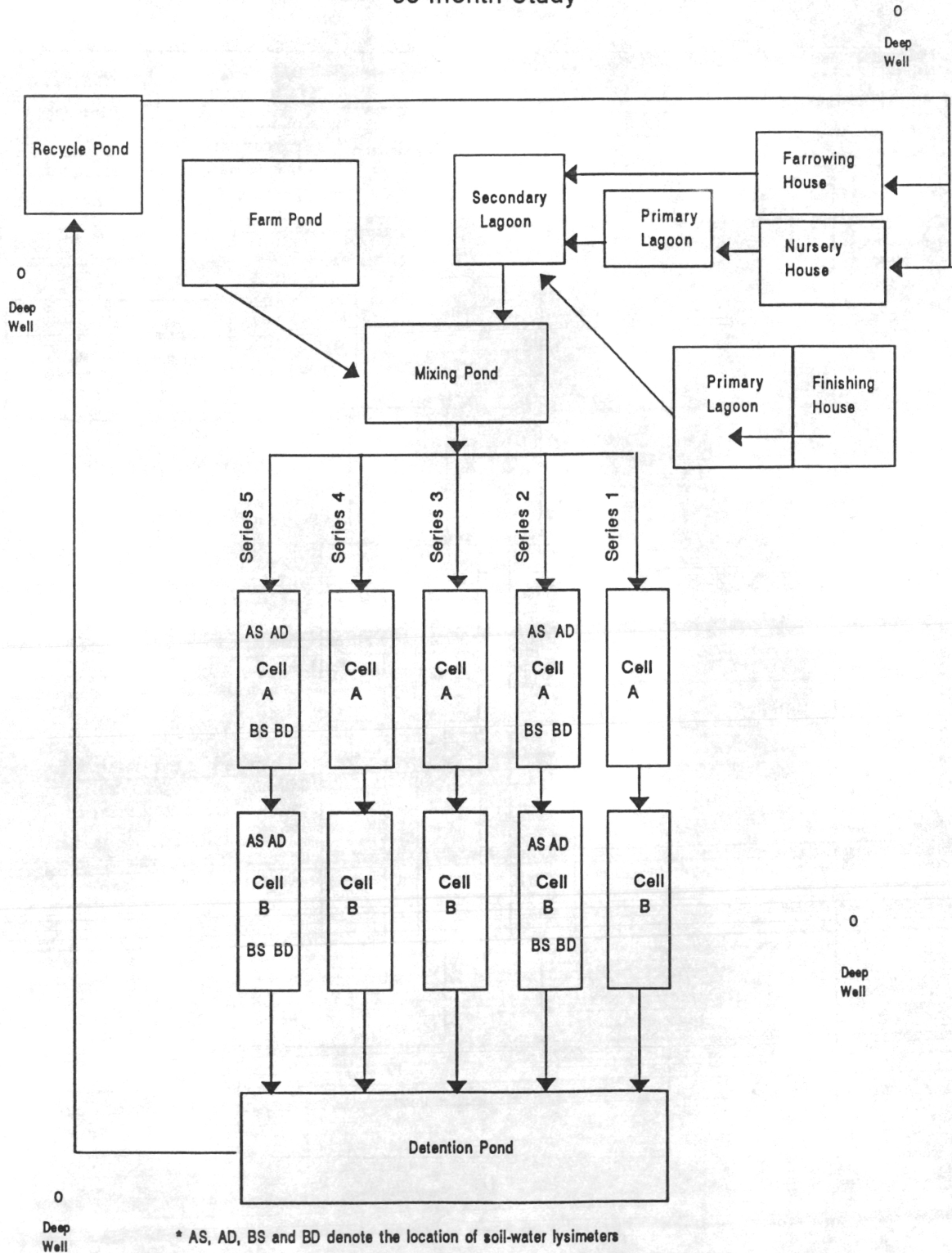


Figure 1. Flow Path of Swine Lagoon Effluent Through the Constructed Wetland System at SMSS 55-month Study



* AS, AD, BS and BD denote the location of soil-water lysimeters

Figure 2. Plan View for Evaluating BOD₅ Loading on Wetland Treatment of Swine Lagoon Effluent

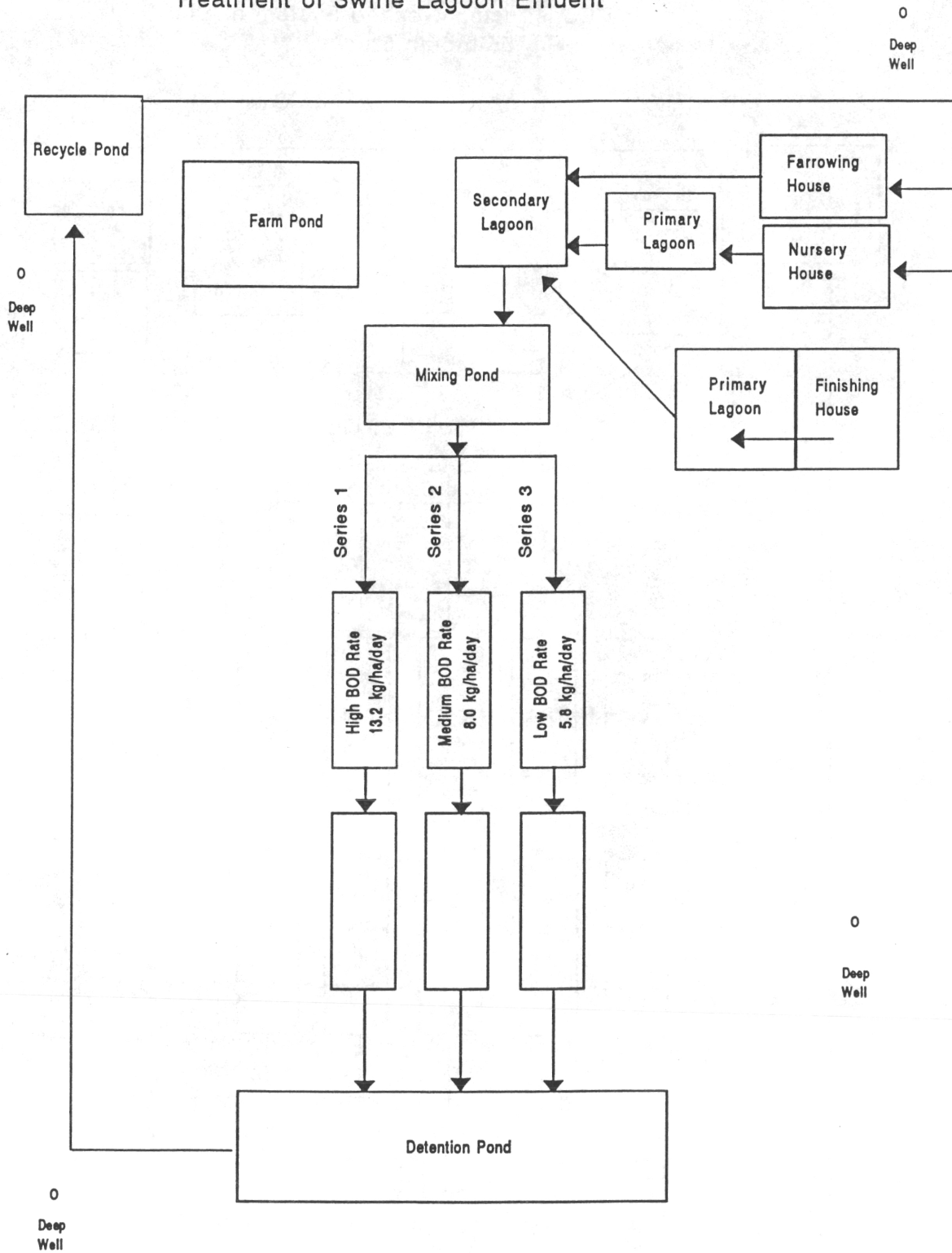


Table 1. Average Wetland Influent Hydraulic and BOD₅ Loading Rate Parameters

Influent Loading Rate	Hydraulic Loading Rate	Hydraulic ^a Retention Time	BOD ^b Loading Rate		TKN ^d Loading Rate	
	L/day	days	mg/L	kg/ha/day ^c	mg/L	kg/ha/day ^c
High	13,234	5.7	80.6	13.18	89.3	14.60
Medium	8,043	8.7	80.6	8.01	89.3	8.87
Low	5,821	11.4	80.6	5.80	89.3	6.42

^aHydraulic Retention Time (HRT) = $\frac{(L)(W)(y)(n)}{Q}$

Where: L=Length of wetland (m)
W=Width of wetland (m)
y=operating water depth, 0.1524 m
n=porosity of litter/stalks, 0.65 for mature wetland
 $Q = \frac{\text{Flow in (m}^3/\text{d)} + \text{Flow out (m}^3/\text{d)}}{2}$

HRT over both tiers, $Q = \frac{\text{Flow into upper tier (m}^3/\text{day)} + \text{Flow out of lower tier (m}^3/\text{day)}}{2}$

2

^bBiological/biochemical oxygen demand.

^cBOD loading rate based on two-tiered system.

^dTotal kjeldahl nitrogen.

^eTKN loading rate based on two-tiered system.

Table 2 Wastewater Treatment Efficiencies for Constructed Wetland Cells Loaded at Three BOD Loading Rates^a Over 23 Months

Wetland Loading	Upper Tier			Lower Tier		Total Reduction %
	Inflow mg/L	Outflow mg/L	Reduction %	Outflow mg/L	Reduction %	
High						
TKN	89.3	56.2	37.1	36.0	35.9	59.7
NH ₃ -N	63.6	44.3	30.3	28.7	35.2	54.9
BOD ₅	80.6	37.8	53.1	24.3	35.7	69.9
TP	31.6	26.9	13.2	18.0	33.1	41.9
TSS	161.6	39.6	75.5	33.6	15.2	79.2
Medium						
TKN	89.3	45.3	49.6	27.1	40.2	69.7
NH ₃ -N	63.6	36.2	43.1	21.0	42.0	67.0
BOD ₅	80.6	28.6	64.5	15.0	47.6	81.4
TP	31.0	22.4	27.7	15.5	30.8	50.0
TSS	161.6	34.6	78.6	25.5	26.3	84.2
Low						
TKN	89.3	33.8	62.2	20.2	40.2	77.4
NH ₃ -N	63.6	27.2	57.2	14.7	46.0	76.9
BOD ₅	80.6	20.5	74.6	9.5	53.7	88.2
TP	31.0	16.1	48.1	10.8	32.9	65.2
TSS	161.6	28.2	82.6	25.1	11.0	84.5

^aLoading rates (kg BOD/ha/d): high=13.18; medium=8.01; and low=5.80.

TKN Loading Rates (kg TKN/ha/d): high=14.60; medium=8.87; and low=6.42.

Table 3 Wastewater Treatment Based on Three Loading Rates of TKN^a and BOD₅ Entering and Exiting a Two-Tiered Wetland System Over 23 Months

Wetland Loading	Upper Tier			Lower Tier		Total Reduction %
	Inflow kg/ha/day	Outflow kg/ha/day	Reduction %	Outflow kg/ha/day	Reduction %	
High						
TKN	14.60	9.44	35.3	6.74	28.6	53.8
BOD ₅	13.18	6.35	51.8	4.55	28.3	65.5
Medium						
TKN	8.87	4.99	43.7	3.48	30.3	60.8
BOD ₅	8.01	3.15	60.7	1.92	39.0	76.0
Low						
TKN	6.42	3.05	52.5	2.07	32.1	67.8
BOD ₅	5.80	1.85	68.1	0.97	47.6	83.3

^a BOD₅ Loading Rates (kg/ha/day): high=13.18; medium=8.01; and low=5.80.

^b TKN Loading Rates (kg/ha/day): high=14.60; medium=8.87, and low=6.42.

Note: See Table 1 for loading rate calculations.

Table 4 Overall Treatment Efficiency of Constructed Wetlands Treating Swine Lagoon Effluent

Analytes	Lagoon Effluent ^a mg/L	Recycle Water ^b after Wetland Treatment mg/L	Reduction %	Farm Pond ^c mg/L
TKN	148.5	7.7	94.8	2.1
NH ₃ -N	117.2	2.2	98.1	0.5
NO ₃ -N	1.1	3.7	+236.4	1.2
COD	492.9	103.2	79.1	40.0
BOD	125.6	13.8	89.0	3.4
TP	56.0	6.8	87.9	1.4
TSS	210.4	34.7	83.5	20.2
FCG ^d	590000	374	99.9	62

^aRaw wastewater prior to treatment

^bFinal treated wastewater recycled for cleaning swine facilities

^cNatural overland flow from grasslands due to rainfall events

^dFecal coliform bacteria, #/100 mL