United States Department of Agriculture

Soil Conservation Service

Americus Plant Materials Center

Americus, Georgia

Release of

'WETLANDER' Giant Cutgrass

Zizaniopsis miliacea

A plant for use in constructed wetlands to treat agricultural non-point source pollution, and for the creation and restoration of wetlands.

A release of the U.S. Department of Agriculture, Soil Conservation Service.

June 1993

'WETLANDER' GIANT CUTGRASS

PUBLIC RELEASE DOCUMENTATION

Zizaniopsis miliacea (Michx.) Doell & Asch.

A PLANT FOR USE IN CONSTRUCTED WETLANDS TO TREAT AGRICULTURAL NON-POINT SOURCE POLLUTION, AND FOR THE CREATION AND RESTORATION OF WETIANDS.

'WETLANDER' GIANT CUTGRASS

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NOTICE OF RELEASE OF 'WETLANDER' GIANT CUTGRASS

The United States Department of Agriculture, Soil Conservation Service, announces the release of 'WETLANDER' Giant Cutgrass, Zizaniopsis miliacea , (Michx.) Doell & Asch., as a selected ecotype. This plant is for use in constructed wetlands to treat agricultural non-point source pollution, and for the creation and restoration of wetlands.

WETLANDER Giant Cutgrass was evaluated and selected for constructed wetlands at the Americus Plant Materials Center.

Over the last 2 years, constructed wetlands recently received increasing interest in the southeast particularly concerning their potential for treating animal wastes. Research has demonstrated that wetland ecosystems have a natural capacity to assimilate or remove organic pollutants. Recent evaluations reflect a growing concern over non-point source (NPS) pollution, especially agricultural wastewater, agricultural cropland runoff, and urban stormwater runoff. These principal contributors to NPS pollution problems have been difficult to remedy with conventional wastewater treatment and soil/water conservation methods.

NPS pollution from agricultural, urban areas, failed home septic tank drain fields, mining, and other land disturbing activities continue a detrimental impact 30-50% of our nations' waterways. Constructed wetlands have recently received considerable attention as low-cost, efficient means to clean up many types of wastewater.

Contaminated waters flowing through constructed wetlands are cleansed by a combination of physical, chemical, and biological activities and emerge as clean water (Hammer, 1990).

The vegetative components is a major factor in the treatment processes that occur in constructed wetlands. There is a complex symbiotic relationship between the plants (root system), microorganisms, substrata, soil and the nutrients in wastewater.

In 1989 the Soil Conservation Service, Americus Georgia Plant Materials Center evaluated a large assembly of aquatic plant species for potential use in constructed wetlands in Alabama and Georgia. Plants were assembled and evaluated in constructed wetland projects treating wastewater from a hog operation, dairy, catfish and a small municipality. The projects focused on obtaining more information on plants that will grow under different hydrological and substrate conditions. In addition, the projects were designed to determine which plants that provided the appropriate attributes for wastewater treatment. Also, planting methods, depth, spacing by species, tolerance to ammonia, and operation and maintenance requirements of aquatic species were tested.

Wetlander Giant Cutgrass and giant bulrush were the best wetland plants for constructed wetlands based on data obtained from our years of field testing. They are more adapted to the higher nutrient concentrations that occur in the first cell of a constructed wetland system, than other tested entries.

WETLANDER can be transplanted easily with a hand tree dibble or a tractor drawn tree planter for planting larger constructed wetland sites. Bare root and container grown material can be used for transplanting. WETLANDER will be commercially available in 1994.

Stem counts at two sample locations, Eatonton, Georgia and Sand Mountain, Alabama revealed significant increases. Site **1** (Eatonton) was transplanted with two stem plants in June, 1991, in a constructed wetland cell at eight feet centers and the stems steadily increased to 15 stems in six weeks. Surface coverage at site 1 was significant and filled in all open spaces in the first growing season. Site 2 (Sand Mountain) was transplanted with two stem plants in May, 1989, and they increased significantly in six weeks. **The** vigorous rhizome spread and tillering indicates that **WETLANDER** can be planted on eight feet centers and provide good surface coverage the first growing season. Therefore, from an economic point of view, it costs the farmer, or other user about ***50%*** less to plant WETLANDER than plants such as cattail that will require a spacing of three ft. centers.

The Sand Mountain wetlands have been efficient in the reduction of nutrients in swine lagoon effluent. Ammonia and nitrogen reduction was more than 95%. BOD_5, total phosphorus and total suspended solids were reduced 91%, 78%, and 92% respectively.

Director, Ecological Science Division
United States Department of Agriculture
Soil Conservation Service
Washington, D.C.

11-25-93
Date

State Conservationist
United States Department of Agriculture
Soil Conservation Service
Auburn, Alabama

4-1-93
Date

State Conservationist
United States Department of Agriculture
Soil Conservation Service
Athens, Georgia

4/1/93
Date

State Conservationist
United States Department of Agriculture
Soil Conservation Service
Columbia, South Carolina

4/1/93
Date

RELEASE OF 'WETLANDER' GIANT CUTGRASS

Introduction:

Scientific Name:	Zizaniopsis miliacea (Michx.) Doell & Aschers
Common Name:	Giant Cutgrass, Marshmillet, Southern Wildrice
Plant Type:	Native perennial emergent grass
Wetlands Indicator Status:	Obligate
Varietal Name:	Wetlander
	PI-565302
Origin/Source:	Wetlander originated from vegetative plant material collected at the Golden Meadow Louisiana Plant Materials Center.
Locale:	**Golden** Meadow Louisiana **PMC**
County:	Lafourche Parrish Louisiana
State:	Louisiana
Elevation:	less than .5%
Mean Annual Precipitation:	**68** inches

DESCRIPTION: Wetlander giant cutgrass is a coarse perennial grass with extensive creeping rhizomes. Stems are elongated and mostly flat; up to **3** feet long and to 2 inches wide. The leaves may **be** smooth in the center but otherwise are rough, especially on the margins.

The male spikelets are separate from the female spikelets, but occur on the same panicle branches. The female spikelets are at the tips of the panicle branches with male spikelets lower on the panicle branch. The seeds fall from the panicle as they begin to ripen, making seed harvest difficult.

The seed head culms bend over to touch the water about the time of seed ripening. These culms will root at each node to produce new plants vegetatively.

SELECTION STATEMENT:

There is no cultivar of giant cutgrass is common use in the Southern U.S. Commercial sources of giant cutgrass plants are variable in origin, quality and adaptation.

In 1989 the Americus PMC evaluated a large assembly of aquatic plant species for potential use in Alabama and Georgia. Plants were assembled and evaluated in constructed wetland systems that were designed to treat wastewater from swine, dairy and catfish operations and a small municipality is south Georgia. The projects focused on obtaining more information on plants that were adapted to different hydrological and substrate conditions. In addition, the projects were designed to determine the plants that provided the appropriate attributes for wastewater treatment. Also, planting methods, depth, spacing, nutrient tolerance (ammonia) post planting water regime requirement were evaluated and operation and maintenance requirement of aquatic plants were tested.

WETLANDER Giant Cutgrass stands were excellent at constructed wetland sites in Alabama and Georgia. It is very aggressive in all cells and usually crowds out other species with its' profilic growth, spread and vigorous rhizomatous root system. Water level adjustments up to twelve (12) inches did not affect its vigor, growth or survival. Based on the spread by rhizomes the first year, this plant can be planted on six (6) or eight ***(8)*** feet centers and established quickly. It also roots when in contact with water and the substrate. Wetlander can tolerate animal wastes. It also survived winter temperatures to -2 **F.** recorded at the Sand Mountain Alabama Experiment Station.

In constructed wetland field planting studies at Sand Mountain, Alabama and Eatonton, Georgia. WETLANDER Giant Cutgrass survived ammonia concentrations greater than 100 mg/l for extended periods. (EPA Data) WETLANDER's tolerance to ammonia, which is a serious problem in treating effluent makes it a superior plant to use in the first cell or second of the constructed wetland systems,. At the Eatonton, Georgia study site, cattails were killed in the first cell as a result of the high ammonia concentration.

WETLANDER Giant Cutgrass (Zizaniopsis milliacea) an excellent aquatic plant for transplanting into constructed wetlands. Consistent survival and rapid growth response after transplanting was documented at all field planting study sites. Growth densities allow for good coverage in substrates usually found in most of the MLRA's in Alabama and Georgia, including the Blackland Prairie. WETLANDER has desirable growth pattern for constructed wetland. It is a vigorous rhizome producer and has growth into the winter months when many of the warm season wetland plants have become dormant.

Site Description:

Soil series:	Rita muck
MLRA:	152A.
pH:	6.6 - 8.4
Slope:	less than .5%
Texture:	muck (high shrink swell)
Hydrology:	wet, wetland; hydric soils, hydrophytic vegetation, water depth **1-2** feet.

Climate:

Mean temperature:	68°F
Low:	44°F
High:	**90°F**
Averages:	77.4 High 58 Low
Extremes:	98°F
Associated Plants:	

- cattails
- soft stem bulrush
- woolgrass

ENVIRONMENTAL **IO**

Giant cutgrass is **a** warm season grass that occurs natively in wetland sites along the Gulf Coast and Atlantic Coast from Houston, Texas, to about Washington D.C. It grows inland up to the Mississippi River Delta area to Kentucky. **It** also grow inland on fresh water sites to Little Rock, Texarkana, Abilene, San Angelo and San Antonio.

From an environmental standpoint, Wetlander will not result in vegative impacts when used in constructed wetlands. Wetlander is one of the best plants to use in cell 1 and 2 of a constructed wetland that is associated with animal waste.

Wetlander will be used for the creation and restoration of wetlands where giant cutgrass occurred naturally.

METHOD OF [illegible]OPMENT:

Selection and direct increase of plant ecotype. (PI-565302)

SUPERIOR CHARACTERISTIC:

WETLANDER can tolerate high ammonia level that are associated with animal wastes. It also survived winter temperatures to -2 F recorded at the Sand Mountain Alabama Experiment Station. It can be planted on 6 to 8 feet centers and provide good cover in constructed wetlands the first growing season.

CONSERVATION USES:

WETLANDER giant cutgrass can be used in constructed wetlands to treat agricultural non-point source pollution, municipal wastewater treatment systems, and for the creation and restoration of wetlands.

AREA OF ADAPTATION:

Giant cutgrass is a warm season grass that occurs in wetland sites along the Gulf Coast and Atlantic Coast from Houston, Texas, to about Washington D.C. It grows inland up the Mississippi River Delta area to Kentucky. It also grows inland on fresh water sites to Little Rock, Texarkana, Abilene, San Angelo and San Antonio.

Field plantings in constructed wetlands have been made in Alabama and Georgia. IT survived winter low temperatures of -2° F recorded at the Sand Mountain Experiment Station. Plantings have been made in Louisiana on marsh sites and in North Carolina on bay shoreline sites for stabilization purposes.

DISEASE AND INSECT PROBLEMS:

Initial and advanced evaluation test have indicated no major disease or insect problem. In 1991 Army worms defoliated the cattail plantings at three locations but did not attack the Cutgrass plantings.

PRODUCTION AND DISTRIBUTION:

WETLANDER will be propagated vegetatively at the Americus Plant Materials Center. Generation 1 plants will be provided to commercial nurseries for increase and commercial distribution.

Generation 1 plants will be maintained by the Soil Conservation Service Plant Materials Centers, in Americus, Georgia. Generation 2 plants will be provided to commercial nurseries from which plants may be produced vegetatively. Generation 1 plants will be available in the Summer of **1994.**

PUBLICITY AND TECHNOLOGY TRANSFER ACTION PLAN:

Objective: To increase the use of WETLANDER Giant Cutgrass for water quality improvement, including wetland creation and restoration, and constructed wetlands.

Target Audiences: Commercial Nurseries, University an College Professionals, Agency and Resource Specialists, SCS Specialists, and Planning Consultants. Region includes GA, AL, **FL,** NC, SC, and TN.

Message: WETLANDER Giant Cutgrass can be used in constructed wetlands to treat agricultural non-point source pollution, and for the creation and restoration of wetlands.

Channels:

1. Descriptive brochure of characteristics of new plant release, including area of adaptability, production techniques, and availability of vegetative materials. Distribution will be to all identified audiences.

2. News release sent to all regional daily and weekly newspapers, radio stations, Extension editors and other media specialists, and university and agency newsletter editors.

3. Notification of plant release to State FAC.

4. Contact agricultural television programs such as Georgia Farm Bureau's *Farm Monitor* television program (Steve Malone) to do a story on the new plant release and its use in constructed wetland systems. Emphasize use its use in meeting requirements of conservation and FSA plans.

5. Feature article and/or abstract on new plant release to submit to selected publications, including Southeast Farm Press, Progressive Farmer, etc.

6. Prepare and submit registration article for Crop Science Society of America.

7. Prepare and submit article for scientific journal with assistance from University scientists.

8. Prepare Technical Note for inclusion in the SCS FOTG.

9. Send copy of release document to NHQ, NTCs, 50 State Conservationists, PMCs, Plant Materials Specialists, Agronomists and Biologists.

10. Plant Materials Specialist will present programs at Natural Resources and agricultural related conferences, such as SWCS, National Agronomy Conference, National PM Conference, and Water Quality Conferences.

Prepared by Diane Holcomb, Public Affairs Specialist,
Athens, GA

TECHNICAL REVIEW

1. Earl Norton, SRC, Auburn, AL
2. Ron Barton, SRC, Athens, GA
3. Ronnie Feaster, SRC, Columbia, SC
4. Dana York, SRC, Nashville, TN
5. H. Wayne Everett, PMS, Ft. Worth, TX
6. Dave Kelly, Biologist, Auburn, AL
7. Lawrence Robinson, Biologist, Columbia, SC
8. Louis Justice, Biologist, Athens, GA
9. John Kazda, Agronomist, Nashville, TN
10. Mike Materne, **PMS,** Baton Rouge, LA
11. Richard Simmering, Biologist, Alexanderia, LA
12. Sam Sanders, PMS, Gainesville, GL
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16. Malcome Kirkland, Asst., Mgr., Americus PMC, Americus, GA
17. Billy Craft, SRC, Alexandria, LA
18. Tommy Counts, Biologist, Auburn, AL
19. Michael E. Zeman, Biologist, Tennessee

PLANTING GUIDE

'WETLANDER' GIANT CUTGRASS

Zizaniopsis miliacea

Description: Wetlander giant cutgrass is a coarse perennial grass with extensive creeping rhizomes. Stems are elongated and mostly flat; up to 3 feet long and to 2 inches wide. The leaves may be smooth in the center but otherwise are rough, especially on the margins. The male spikelets are separate from the female spikelets, but occur on the same panicle branches. The female spikelets are at the tips of the panicle branches with male spikelets lower on the panicle branch. The seeds fall from the panicle as they begin to ripen, making seed harvest difficult.

The seedhead culms bend over to touch the water about the time of seed ripening. These culms will root at each node to produce new plants vegetatively.

Conservation Use: Wetlander Giant Cutgrass can be can be used in constructed welands to treat agricultural non-point source pollution, to treat the effluent from small towns, communities and for residences where septic tank systems have failed, and for the creation and restoration of wetlands.

Habitat: It occurs as an emergent in marshes, in swamps, and on shorelines, usually in shallow water. Adapted to freshwater sites but will tolerate water salinity of up to 1 percent.

Distribution: Giant Cutgrass is a warm season grass that occurs in wetland sites along the Gulf Coast and Atlantic Coast from Houston, Texas to about Washington, D.C. It grows inland along the Atlantic and Gulf coasts and up the Mississippi River delta area to Kentucky. It also grows inland on fresh water sites to Little Rock, Texarkana, Abiliene, San Angelo and San Antonio. Plant growth regions 1, 2, 3, 6.

WETLANDER is a selection made from a collection made along the South Atlantic and Gulf coastal areas.

Field planting trials have been made in constructed wetlands in Alabama and Georgia.

Plant Spacing: The desirable spacing for constructed wetlands is on 6 to 8 feet centers. Planting distance can be as much as 6 to 8 feet apart in the row with rows 6 feet apart.

Plantina Methods: WETLANDER can be planted vegetatively by hand with a tree dibble, or mechanically with a tractor drawn tree planter, or a ditch witch, on good sites that are accessible with mechanical equipment.

Plantina Time: WETLANDER should be planted vegetatively with nursery grown plants from March 1 to June 30 in the southeast. Be sure to keep the substrate moist for about six weeks with good quality water, well or lake sources, and not the lagoon wastewater.

Fertilization: None required for constructed wetlands.

Site Preparation: The bottom of constructed wetlands that have a heavy clay substrates should be backfilled with about six inches of good soil that will provide a good planting medium to support root growth and development. During construction the bottom must be level to allow a uniform water depth.

Water Level Manaaement: Keep the site moist after planting with good quality water from a well on lake. Do not use the lagoon wastewater as a source of water for the transplated materials because of the high nutrient concentration. Do not allow the water to flood the new plants within the first six weeks. During the seventh week, begin to gradually, very slowly acclimate the plant material to increased depth by applying about one inch per week for six weeks. At the end of the twelth week, the desired water level of six to seven inches can be obtained without causing any damage to the plants.

Wastewater from the animal waste lagoon can be loaded or distributed continuously to the wetlands at a rate of ***8,600*** gal per day per acre.

At no time should water levels overtop the plants. In contrast, water levels for emergent plants should never be lowered to the extent that the plant roots become exposed. Dry substrate conditions in the constructed wetland (substate) will result in poor plant survival, growth and development.

Plant Sources: WETLANDER will be available from most commercial nurseries in the southeast that handle wetland plants in **1994.** For a quick reference check the wetland plant source database.

WETLANDER will be maintained by the Americus, Georgia Plant Materials Center. Generation **1** plants will be provided to commercial nurseries form which plants may be produced vegetatively for increase and commercial distribution.

REFERENCES

1. Hammer, Donald A. 1989. Constructed Wetlands for treatment of agricultural waste and urban stormwater. Wetland Ecology and Conservation: Emphasis in Pennsylvania. The Pennsylvania Academy of Science.

2. Hammer, Donald A., 1992. Creating Freshwater Wetlands. Ann Arbor: Lewis Pulishers.

3. Harley, Dwight, 1991. Wildlife Usage of Constructed Wetlands. Evaluations: Georgia Department of Natural Resources, Forsyth, Georgia.

4. Howard, Hoke S., 1991. Constructed Wetlands For Assimilation of Dairy Effluents: Monitoring Studies. Proceedings of the 1991 Georgia Water Resources Conference. The University of Georgia, Athens, Georgia.

5. Surrency, Donald, 1993. Selection and Evaluation of Plant Materials for Constructed Wetlands. Proceedings: Society of Wetland Scientists, 14th Annual Meeting, University of Edmonton, Alberta, Canada.

6. Wegrzek, Robert J., and Terrell, Charles R., 1990. Using Constructed Wetlands to Control Agricultural Nonpoint Source Pollution. Proceedings: The international Conference on The Use of Constructed Wetlands in Water Pollution Control, Churchill College, Cambridge, United Kingdom.

7. Wolverton, B.C., 1987. Aquatic plants for wastewater treatment: an overview. In: Reddy, K.R. and Smith, W.H., (Eds.), Aquatice plants for wastewater treatment and resource recovery. Magnolia Publishing Inc., Orlando, Florida.

8. Wolverton, B.C., and McDonald, R.C., 1980. Vascular plants for water pollution control and renewable sources of energy. Proceeding Bio-Energy '80, Atlanta, Georgia.

9. Wolverton, B.C., and Wolverton, John D., 1992. Microecology: Environmental Pollution Control Technology For the 21st Century. Proceedings: EcoWorld '92 Conference and Exhibit, Washington, D.C.

PLANTS EVALUATED
1989-1992

1. Maidencane ('Halifax')
2. Giant cutgrass
3. Prairie cordgrass
4. Common reed
5. Water chestnut
6. California bulrush
7. Bulrush
8. Arrowhead
9. Elephant ear
10. Pickerelweed
11. Blueflag iris
12. Cattail
13. Giant reed
14. Canna lily
15. Smooth cordgrass

Constructed Wetlands in Alabama and Georgia

Type	Location	Year
Swine	Sand Mountain, AL	1989
Dairy (2)	Eatonton, GA	1990
Municipal	Ochlocknee, GA	1990
Dairy	LaGrange, GA	1991
Dairy	Jasper, GA	1991
Swine	Huntsville, AL	1992
Catfish	Greensboro, AL.	1992
Residences (12)	Gunterville, AL	1992
Swine	Watkinsville, GA	1992
Dairy	Greensboro, AL	1992
Dairy	Lajas, PR	Planned 1993
Dairy	St. Croix, USVI	Planned 1993
Dairy	Bay Minette, AL	Planned 1993
Poultry	Auburn University	Planned 1993
Swine	Vienna, GA	Planned 1992
Poultry	Gainesville, GA	Planned 1993
Catfish	Greensboro, AL	Planned 1993

Table I

Percent Stand in CWS

Sand Mountain, Alabama, 1989-92

Suecies	1989	1990	1991	1992
Halifax maidencane	70	80	100	100
giant cutgrass	100	100	100	100
giant reed	50	0	0	0
prairie cordgrass	80	70	65	65
common reed	90	80	80	75
water chestnut	90	70	50	30
giant bulrush	95	100	100	100
canna lily	90	80	70	70
pickerelweed	95	100	100	100
arrowhead	90	85	85	85
cattail	95	100	95	70
elephant ear	90	60	20	10
blueflag iris	90	70	70	70

TABLE 2

Plant Materials	October			November			December			January			February		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
cattail	1	1	1	2	2	1	3	3	2	4	4	4	4	4	4
canna lily	2	3	1	4	4	3	4	4	4	4	4	4	4	4	4
prairie cordgrass	2	2	2	3	3	3	4	4	4						
common reed	2	2	2	3	3	3	4	4	4						
water chestnut	3	2	1	4	4	4									
giant bulrush (S. validus)	1	1	1	1	1	1	2	1	1	3	2	1	4	2	1
giant bulrush (S. californicus)	1	1	1	1	1	1	2	1	1	3	2	1	4	2	1
common bulrush	2	1	1	2	2	2	4	3	3	4	4	4			
elephant ear	3	3	2	4	4	3	4	4	4	4	4	4	5	5	4
blue flag iris	3	3	2	4	4	3	4	4	4	4	4	4			
giant cutgrass	3	2	1	3	3	2	4	3	2	4	4	4			
arrowhead	4	3		4	4										
Halifax maidencane	2	2	1	3	3	1	4	4	2	4	4	4			
pickerelweed	4	3		4	4										
giant reed	3			4											

A. Sand Mountain Alabama (-2° F)
B. Eatonton. Georgia
C. Ochlocknee

1. Slight
2. Moderate
3. Frost damage (severe)
4. Dormant
5. Winter kill

TABLE 3

RECOMMENDED SPACING FOR CWS

PLANT MATERIALS	SPACING
maidencane	3' x 3'
giant cutgrass	6' x 6' OR 6'X 8'
prairie cordgrass	3' x 3'
common reed	3' x 3'
water chestnut	3' x 3'
giant bulrush	4' x 4'
cattail	3' x 3'
elephant ear	3' x 3'
blueflag iris	3' x 3'
canna lily	3' x 3'
arrowhead	3' x 3'
smooth cordgrass	3' x 3'

TABLE 4

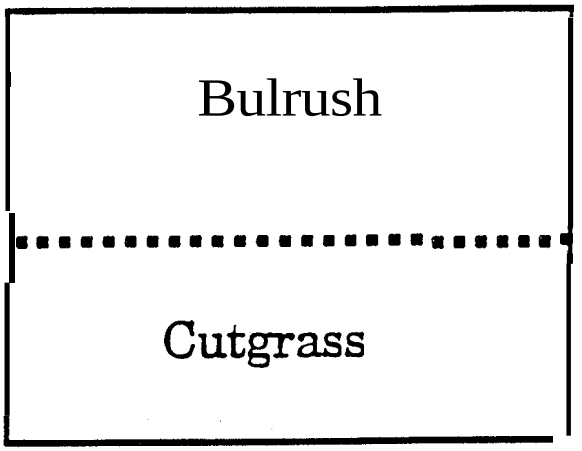
PLANT MATERIALS EVALUATIONS, 1990-91
SAND MOUNTAIN, ALABAMA

PLANT MATERIAL	VIGOR	TILLERS	SPREAD	HEIGHT	DISEASE RESIST.	INSECT/RESIST.	BASA
giant cutgrass	1	60	1	9'	1	1	
Halifax maidencane	1	50	1	22"	1	1	
prairie cordgrass	3	10	3	50"	3	3	
common reed	3	10	5	80"	3	3	
water chestnut	3	20	3	12"	3	7	
joint bulrush (Scirpus californicus)	1	80	1	8'	1	1	
giant bulrush (Scirpus validus)	1	40	1	5'	1	1	4
cattail Typha latifolia	3/5	30	3	45"	5	7	4
elephant ear	1	5	5	5'	3	3	11
blueflag iris	1	3	5	26"	3	3	12
canna lily	1	10	3	38"	3	3	10
arrowhead	1	25	1	72"	1	1	U
smooth cordgrass	1	10	5	25"	3	3	12

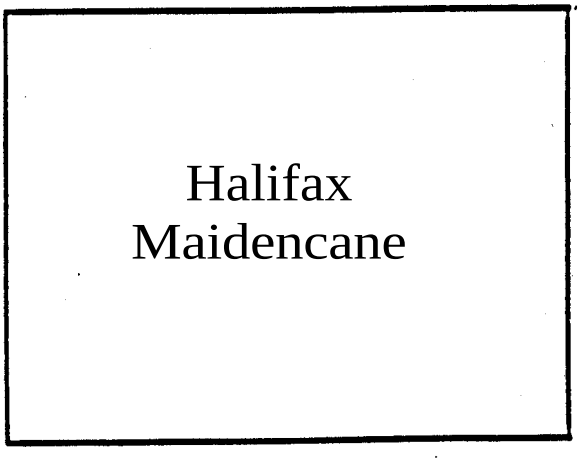
Evaluation Scale for vigor, spread, Disease and insects
1= Excellent; 3= Good; 5= Average; 7= Poor

Constructed Wetland for Catfish Production Pond

Bill Kyser
Hale County, Alabama



Cell 1



Cell 2

Swine Operation

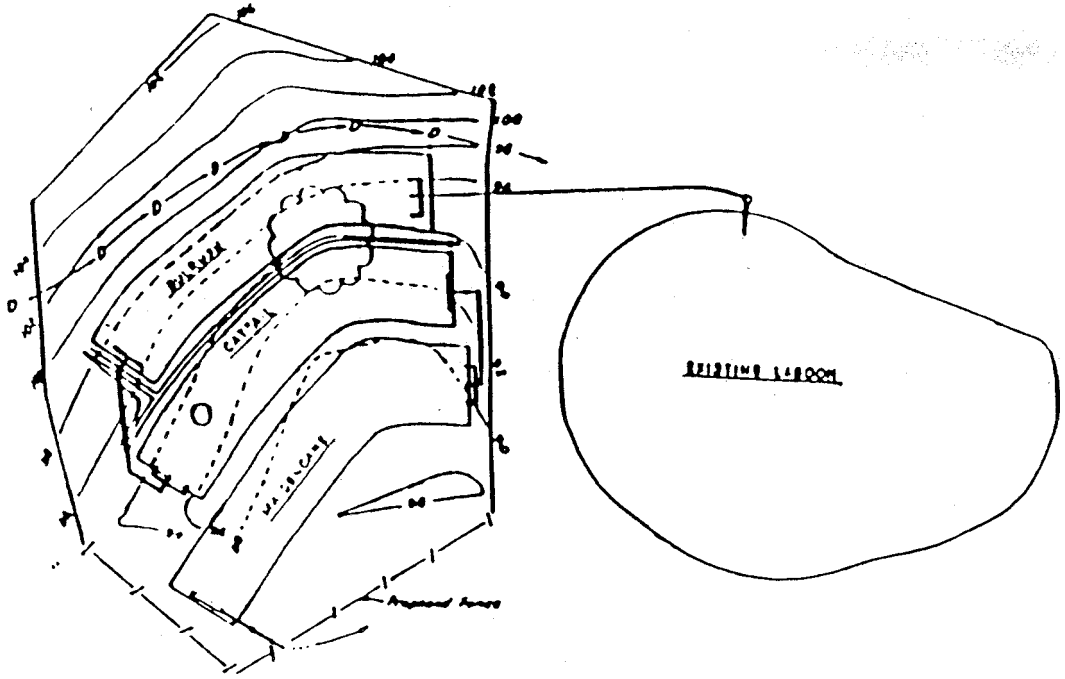
CONSTRUCTED WETLAND
(5-two cell systems)

Cattail	PM Evaluations	Control	Bulrush	Cattail

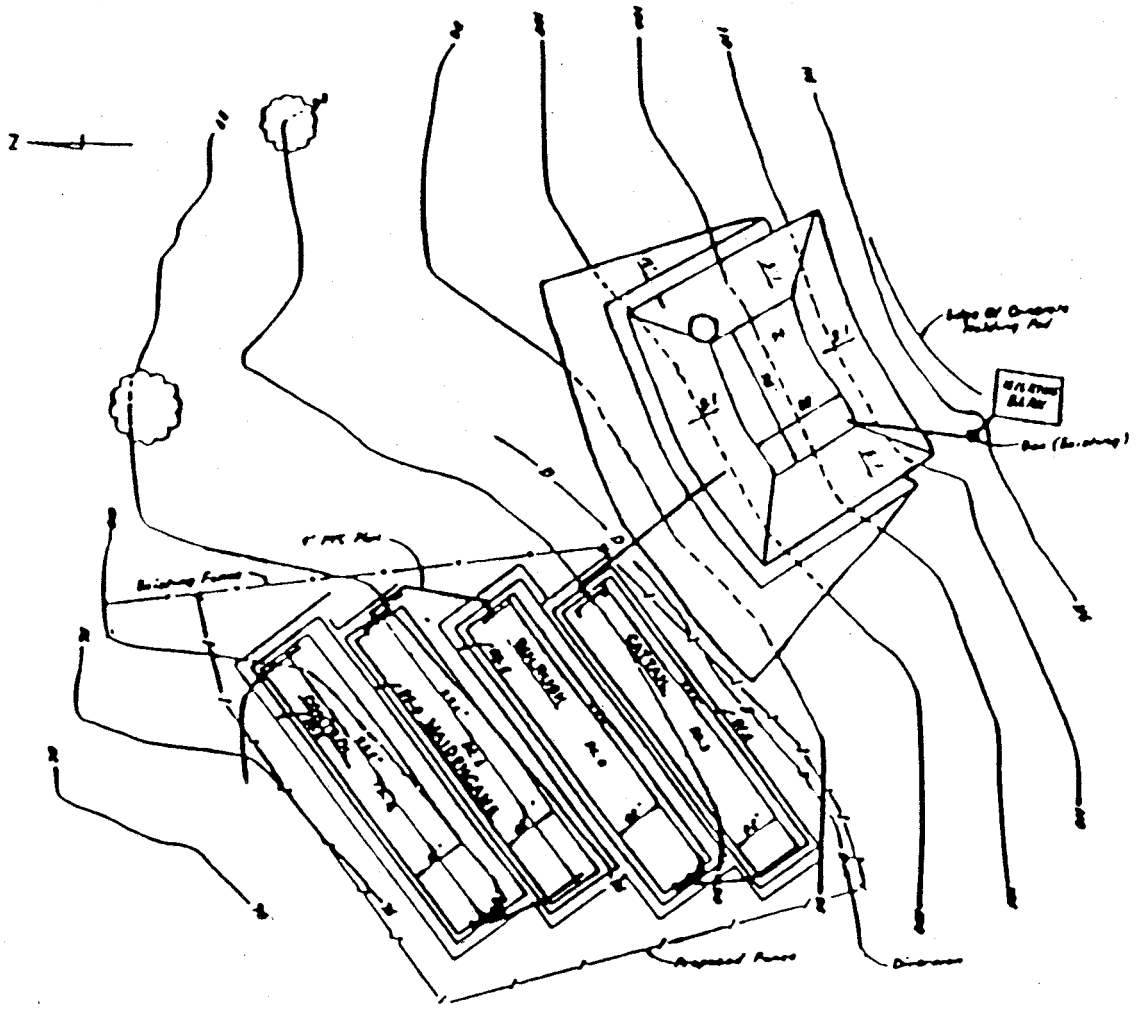
BERM

Cattail	PM Evaluations	Cattail	Bulrush	Cattail

Richard Key Dairy

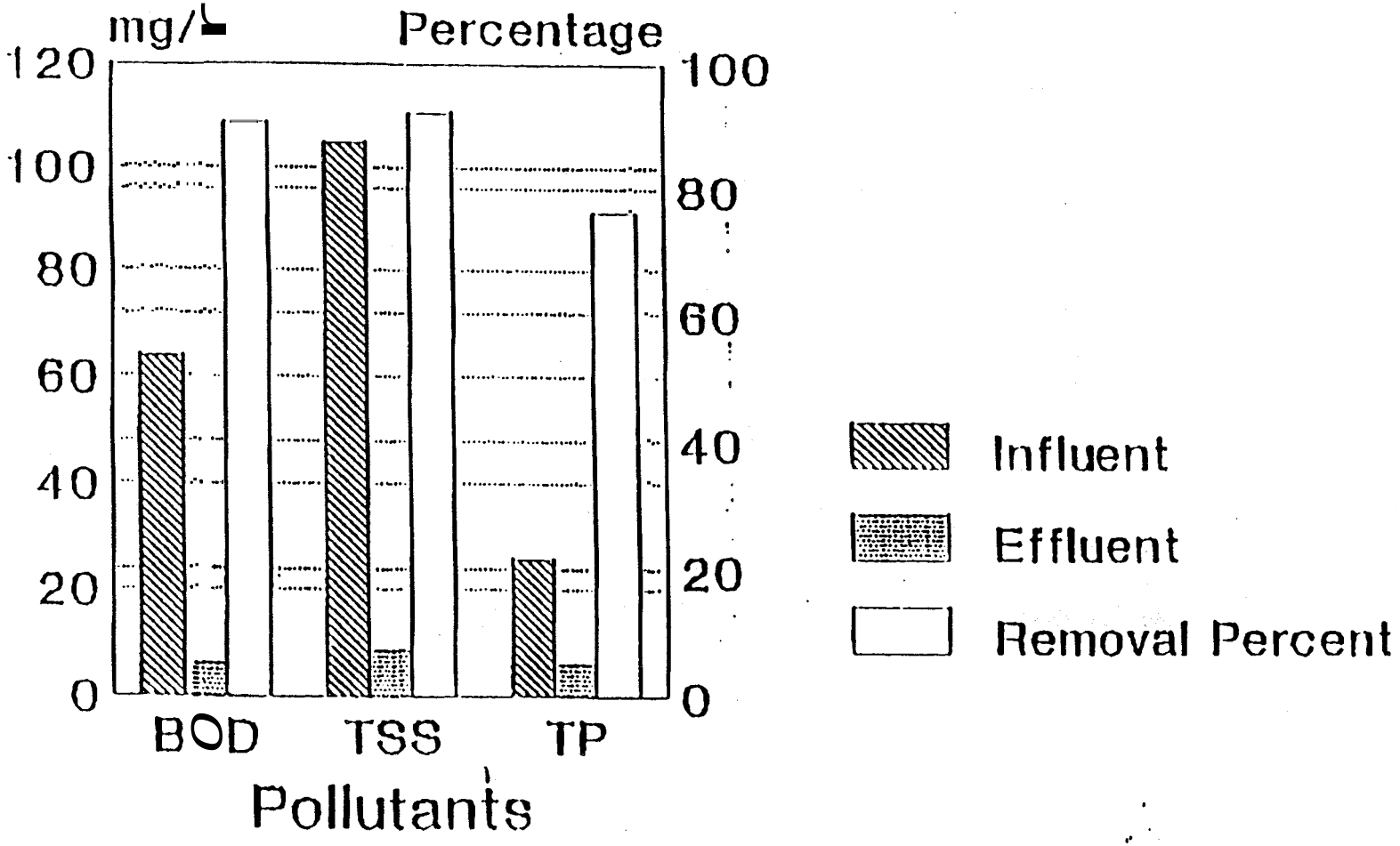


Howard McMichael Dairy



Removal Performance

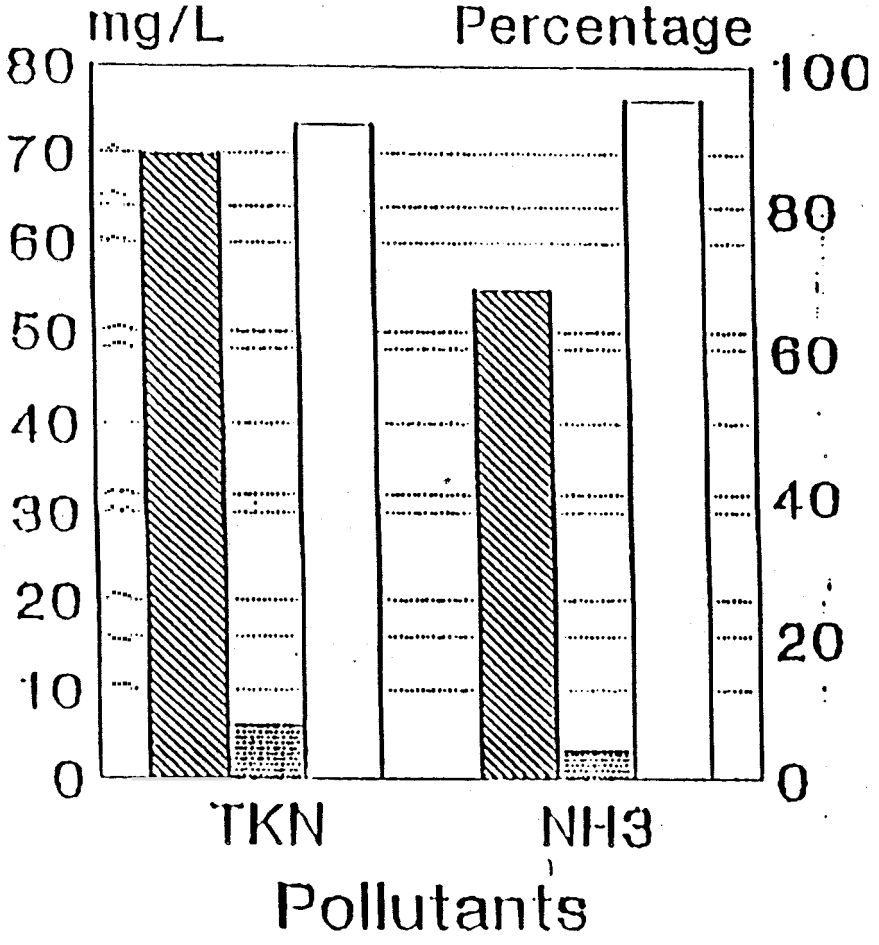
Swine Waste Treatment Wetlands

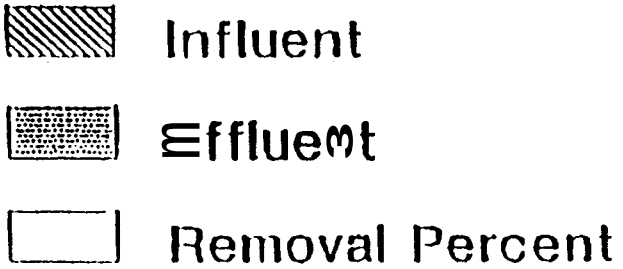


Auburn/Sand Mtn Experiment Station

Removal Performance

Swine Waste Treatment Wetlands





Auburn/Sand Mtn Experiment Station

Monitoring Results

Sand Mountain, Alabama

Parameter	Lagoon (mg/L)	Cell 1	Cell 2
TSS	430	24	
Ammonia	54	21	3.4
Nitrate-Nitrite N	0.29	0.05	0.050
TKN	140	30	21
TP	35	7.2	5.2
Total Organic Carbon	130	67	

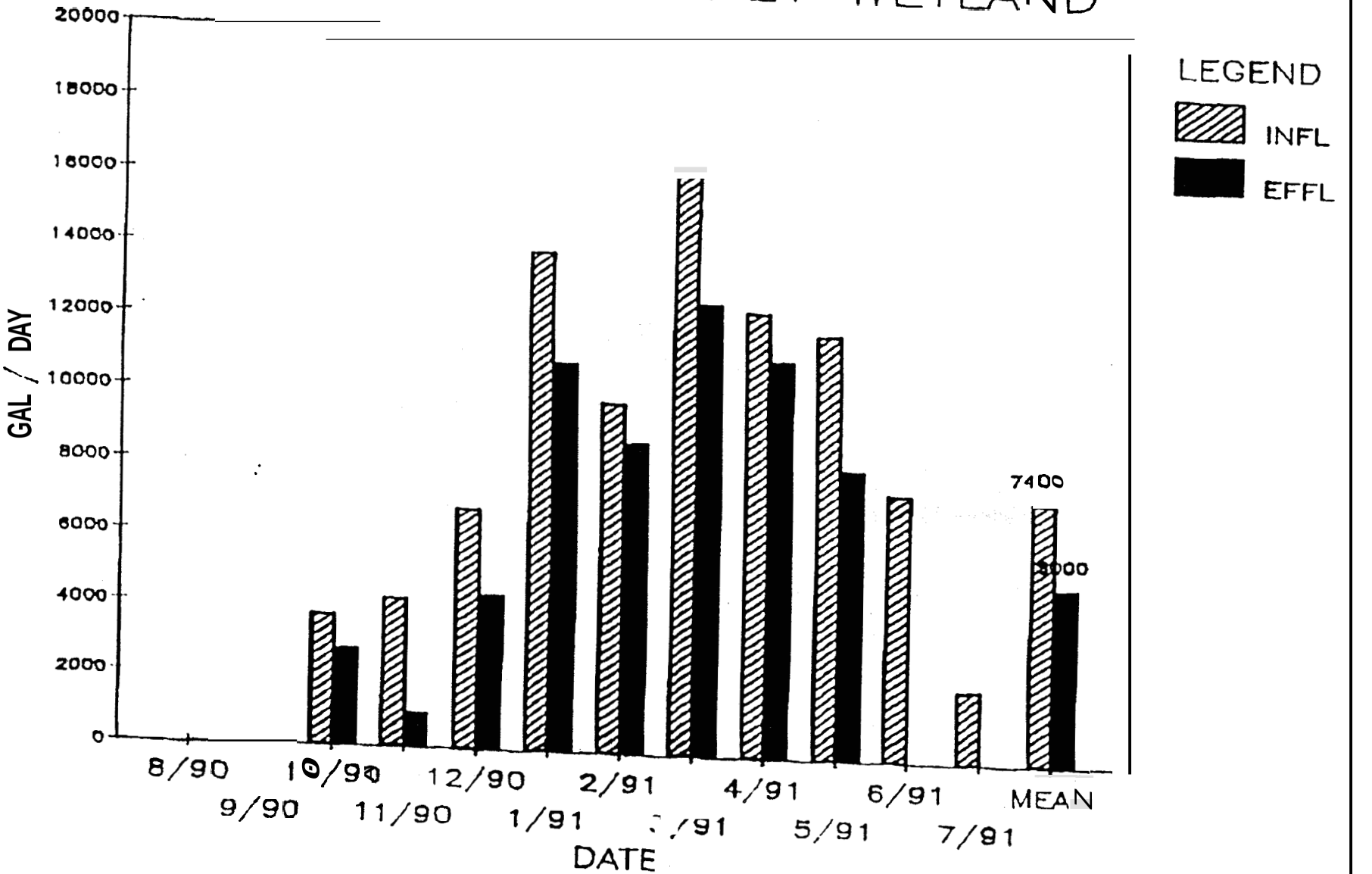
Ochlocknee, Georgia

Parameter	Lagoon	MB	Stream
Ammonia	48	0.05	0.06
Nitrate-Nitrite N	0.050	0.05	0.32
TKN	8.4	1.1	0.57
TP	1.1	0.14	0.12
Total Organic Carbon	24	14	9.6
TSS	56	2.0	4.0
DO	1.37	5.94	5.45
pH	9.13	6.94	7.17
Conductivity	357	374	168

Putnam County, Georgia

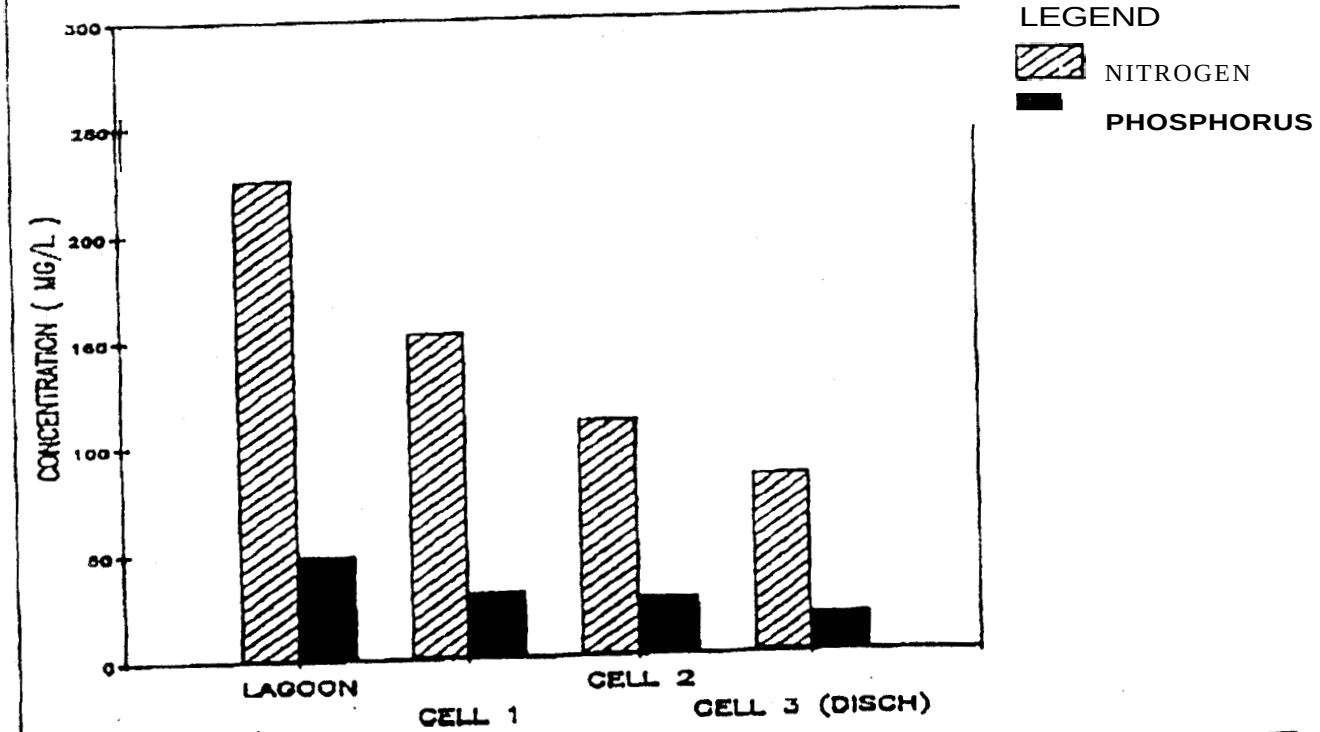
Parameter	Lagoon	Cell 1	Cell 2	Cell 3
DO	2	16	8	8
Ammonia	80	6.9	0.34	
Ammonia	100-15 long	15	10	
pH				7.6
Nitrate-Nitrite	0.52		0.52	0.05
TP	35	17	7.6	

FLOW RATES - KEY WETLAND

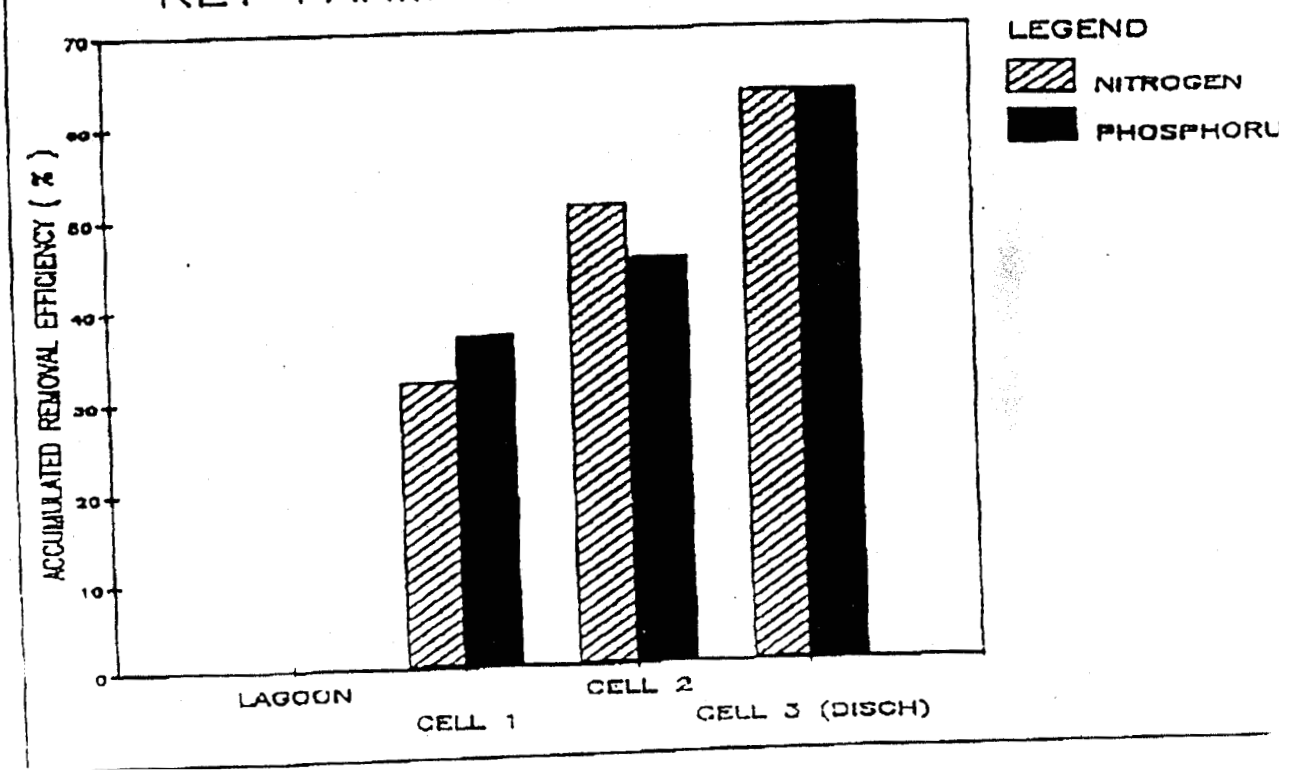


FYI 8/92 file

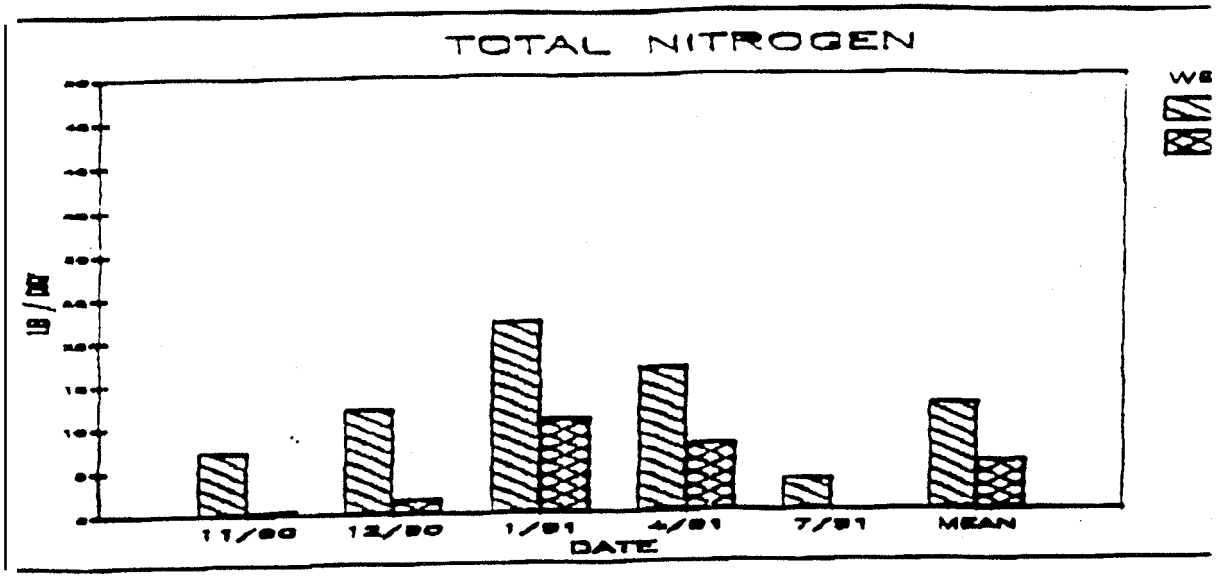
NUTRIENT KEMOVAL
KEY FARM WETLANDS 7/90 - 7/92

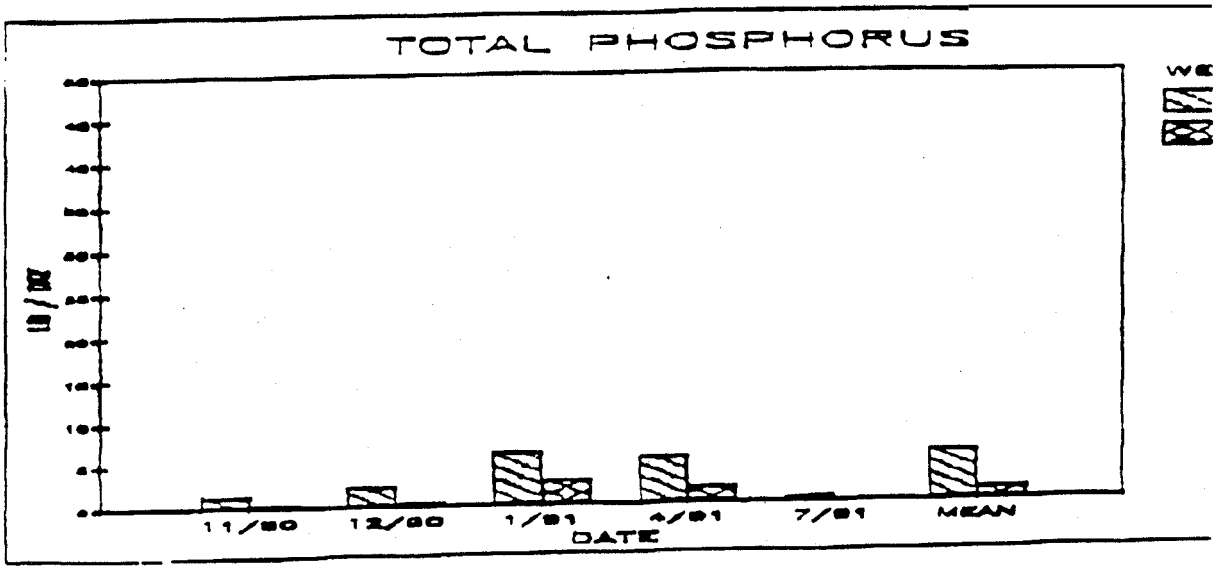


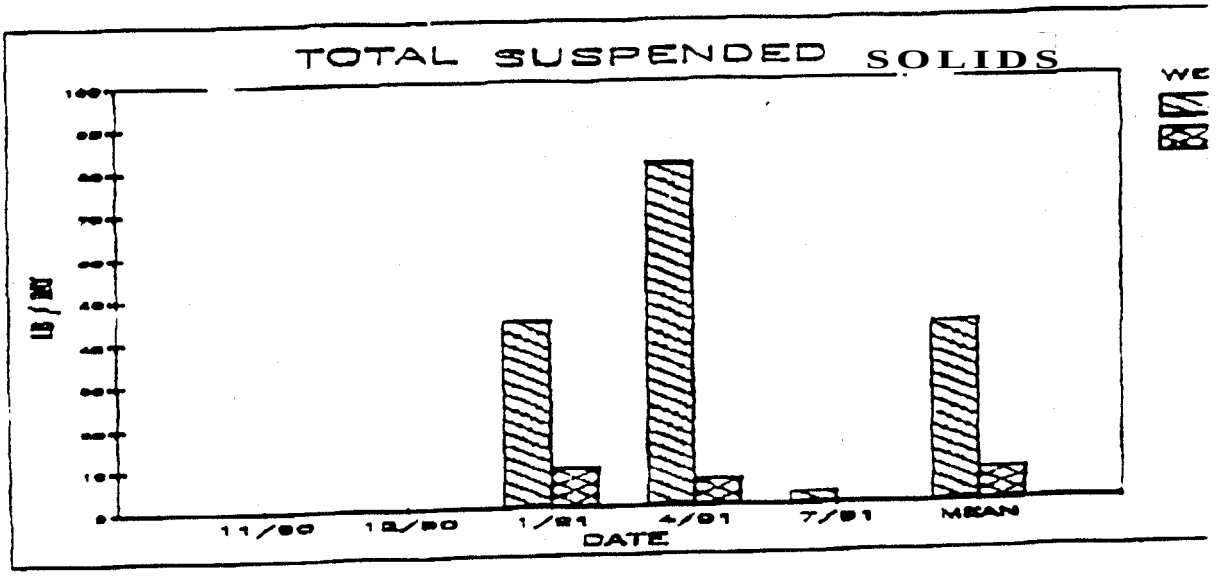
NUTRIENT REMOVAL
KEY FARM WETLANDS 7/90 - 7/92

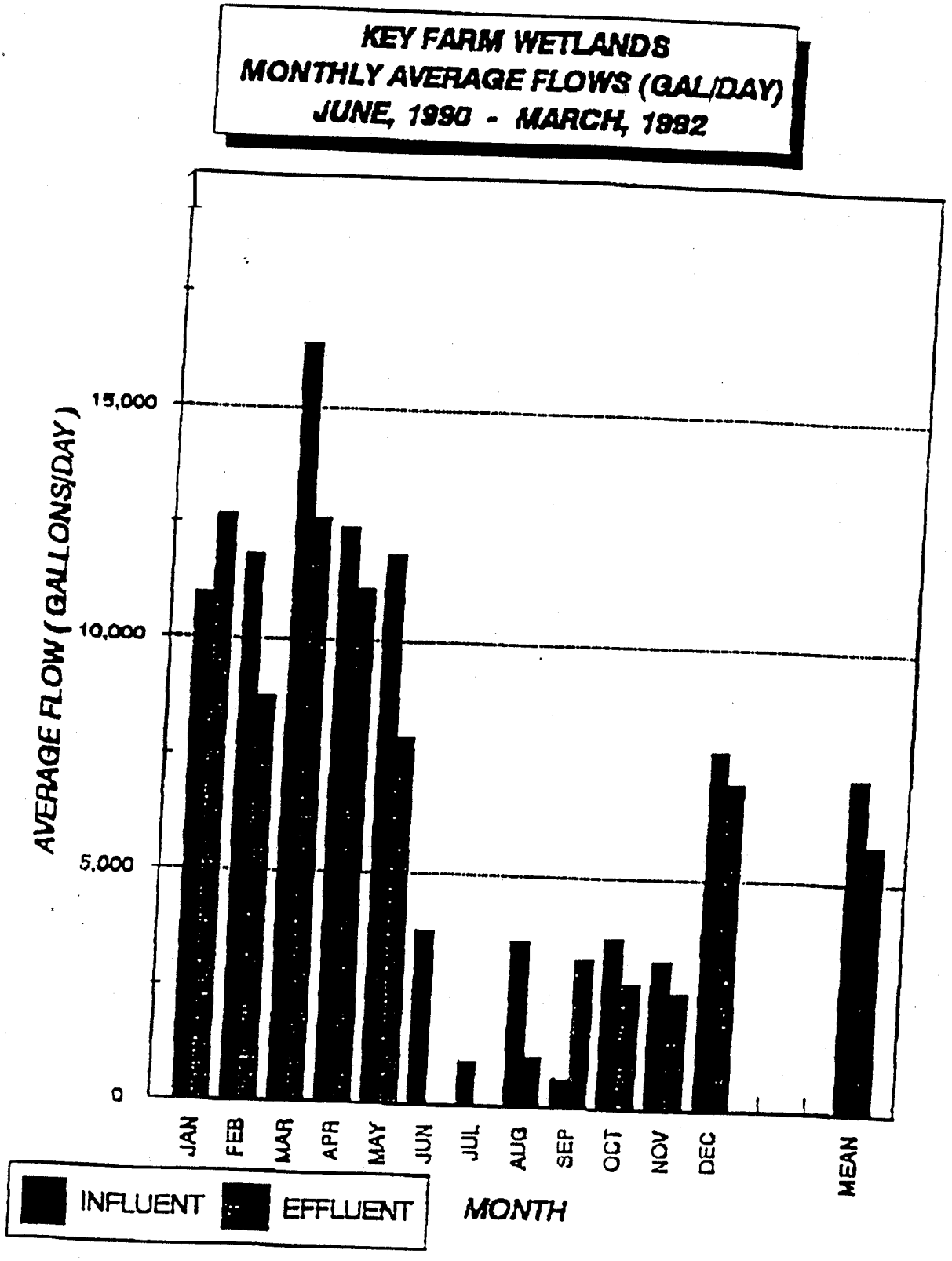


NUTRIENT LOADINGS - KEY WETLAND








KEY FARM WETLANDS
MONTHLY AVERAGE FLOWS (GAL/DAY)
JUNE, 1990 - MARCH, 1992
AVERAGE FLOW (GALLONS/DAY)
15,000
10,000
5,000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MEAN
MONTH
INFLUENT
EFFLUENT