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Atkinson Island BUG Marsh Demonstration Planting

Project Report

by

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USDA/Natural Resources Conservation Service

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Background

Coastal wetlands play an important role in the productivity of Galveston Bay. Ecosystems and the economics of the bay area depend on these "estuarine emergent wetlands" and their stands of smooth cordgrass (*Spartina alterniflora*) for bird and fisheries habitat, water quality, and erosion and storm protection. The Galveston Bay National Estuary Program (GBNEP) has documented the loss of more than 30,000 acres of coastal wetlands in the Galveston Bay system since the 1950's (GBNEP, 1994) and the Galveston Bay Program has identified the creation and restoration of this habitat as a priority (White, et al. 1993). The Natural Resources Conservation Service (NRCS) is committed to conserving the resources that wetlands provide, and has successfully demonstrated the restoration of coastal wetlands.

An Interagency Coordination Team (ICT) was established by the U. S. Army Corps of Engineers (Corps) and was charged with the oversight of a range of environmental issues attendant upon the proposed Houston-Galveston Navigation Channels (HGNC), Texas Project. The Beneficial Uses Group (BUG) was created in early 1990 as a subcommittee of the ICT with the assigned task of evaluating possible beneficial uses of dredged material and incorporating them into a dredged material placement plan for the HGNC, Texas Project. The BUG's membership includes 5 federal agencies: USF&W, U. S. Environmental Protection Agency (EPA), Corps, NRCS and National Marine Fisheries Service (NMFS); 2 state agencies: Texas Parks and Wildlife Department (TPWD), and Texas General Land Office (TGLO); and the Port of Houston Authority (PHA).

The BUG developed a demonstration project at Atkinson Island that would create a marsh using large scale cutter head dredging equipment similar to the equipment likely to be utilized for the HGNC, Texas Project. In the past, dredged material was disposed of at upland sites or by an open-bay disposal method. Therefore, utilizing dredged material to create, restore or renourish valuable coastal wetlands may revolutionize dredging in the Galveston Bay system.

Objectives

In September 1994, the Port of Houston Authority and the Natural Resources Conservation Service entered into a Cooperative Agreement to accomplish the following objectives on the demonstration marsh at Atkinson Island.

1. To assess the effectiveness of different nursery techniques in producing marsh plants.

2. To assess the relative effectiveness of marsh planting by varying plant densities (i. e., survival rates and rates of plant colonization over specified time periods.)

3. Compare the success of the demonstration marsh planting

plan in relation to the parameters derived by NMFS from the reference marshes for plant coverage and density.

4. To develop base line data on the major cost elements of marsh planting that provides a closer identification of actual costs for evaluation of completing proposals for future marsh construction associated with the Beneficial Uses Plan.

The planting was completed by twenty AmeriCorps Members under the direct supervision of NRCS employees. AmeriCorps is a government-wide program, authorized by the National and Community Trust Act of 1993 (Pub. L. No. 13-82), and administered by the Corporation for National Community Service. The purpose of the AmeriCorps Program is to provide opportunities that engage Americans in meeting critical needs through direct community-based service across the United States.

Laboratory Site

The project was housed at the Cedar Bayou Marine Laboratory at Houston Lighting and Power Company (HL&P), Cedar Bayou Electricity Generating Plant in Baytown, Texas. Mr. Bill Baker, Staff Environmental Specialist of HL&P was designated as technical representative. HL&P provided laboratory and greenhouse space and cultivation ponds as well as all utilities necessary to meet the Purposes and Objectives stated above. The dollar value for the physical facilities is included in this report under the item "capital improvements." Capital improvements include the following: laboratory space; office space; storage building for supplies, equipment, and boats; greenhouse; two 1/2 acre ponds; two 1/4 acre ponds; irrigation system and water; one 1/4 acre pond of mature *S. alterniflora* for seed stock; and the utilities and maintenance of these facilities.

Transportation

A variety of methods of transportation were utilized to complete this project. The dollar value for transportation is included in this report under the item "transportation." Transportation costs includes the use of the following vehicles as well as maintenance and fuel: two trucks for transporting boats and plants; one eighteen passenger van for transporting personel; two boats for tranporting plants and personel to Demonstration site; one canoe; and one four wheeler.

Plant Material Preparation

Introduction

Smooth cordgrass, (*Spartina alterniflora*), which tolerates a wide range of salinities, soil types and water levels, has been selected as the plant species best suited for creating or restoring coastal wetlands in the Galveston Bay system. In the past, the majority of marsh creation projects relied on harvesting smooth cordgrass from native stands. However, this process limits created marshes to areas with convenient access to native stands of the plant and restricts the size of created marshes. It may also risk the health and viability of the native stands being harvested. NRCS adapted previously developed techniques, particularly those of Dr. Stephen W. Broome, Department of Soil Science, North Carolina State University (Broome 1993), and Mike Materne, Plant Material Specialist with NRCS in Baton Rouge, Louisiana (Materne 1993) to conditions found in the Galveston Bay system.

Seed Harvesting

The seed source for this project was a variety of *S. alterniflora* that originated in Vermillion Bay, Louisiana. This variety was determined by a NRCS's Plant Material

Center study to be a hardier and more vigorous strain than that found in the Galveston Bay system. The Vermillion variety also exhibits signs of being resistant to the *Rhizoctonia* fungus that has damaged smooth cordgrass in the Galveston Bay system.

Prior to this project, sprigs from the Vermillion variety obtained from the NRCS Plant Materials Center in Golden Meadows, Louisiana were planted in Pond #24 at the Cedar Bayou Marine Laboratory in the summer of 1993. By the fall of 1994, the original 125 sprigs had fully covered the quarter-acre pond and produced a healthy crop of seed culms. For the past twenty years, Pond #24 was used primarily for fish aquaculture. An accumulation of nutrients from the aquaculture is suspected to have contributed to healthy seed productivity of these plants.

The seeds from this stand of a variety of *S. alterniflora* was harvested as near to maturity as possible. After the appearance of the inflorescence in late summer, the seeds were inspected weekly for signs of maturity. Seed was also harvested from cultivated stock from a 1993-1994 NRCS cultivation project and from a stand of the Vermillion variety at the commercial nursery Black Lake Nursery, Inc in Lake Charles, Louisiana. Seeds were considered mature and ready for harvest when the caryopses, or fruits, are no longer doughy, but firm, usually in late November or early December. Seeds must be harvested shortly after maturity, before they shatter or spread with the assistance of weather events such as cold fronts.

The seeds were manually harvested by cutting the seed heads off the culms with scissors during the last week of November and the first week of December 1994. After harvesting, the seed heads were stored in brown paper bags for two to three weeks in a room-temperature and ambient-humidity environment. This stage allowed the seed to continue to mature which made threshing easier. Threshing was performed by hand by stripping each seed head of its individual seeds.

Seed Treatment

Freshly threshed seeds were immersed in artificial seawater at 22 parts per thousand, placed in sealed plastic containers, and stored in a non-frost-free refrigerator at the HL&P Cedar Bayou Laboratory at 2-3 degrees Celsius for a minimum of six-weeks for germination. The artificial seawater solution was changed weekly to prevent unwanted fungal growth. The storage time ensured the germination process by preventing desiccation while allowing for continued maturation. The minimum storage time is six weeks, and the maximum time we stored seed with successful germination was sixteen weeks.

Approximately 50 pounds of seed were threshed. The laboratory refrigerators held only thirty pounds of the treated threshed seed. The remaining untreated seed was hand broadcast on the treatment area originally intended for *Spartina spartine*. This area was lower in elevation than originally predicted and therefore suitable for *S. alterniflora*. Twenty-pounds of seed were hand sown on this area, with an estimated germination rate of less than 5%.

Cost Estimates for Treated Seed and Untreated Seed

The following table compares the costs of treated seed versus untreated seed. Based on informal greenhouse estimates, the untreated seed had a germination rate of 5%, and the treated seed had a germination rate of 75%.

Table 1. Actual costs for seed production.

50 Pounds of Seed	Untreated	Labor	Treated	Labor
Labor Gathering Seed	$306	72 hours	$306	72 hours
Labor Threshing Seed	3,060	720 hours	3,060	720 hours
Capital Improvements	10,000		10,000	
Transportation	800		800	
Refrigerator			400	
Storage Supplies			150	
Technical Supervision	8,000	320 hours	10,000	400 hours
Total	$22,166		$24,716	

Germination Procedure

The treated seeds were removed from the storage solution and spread on flats of premixed potting soil at the HL&P Cedar Bayou Marine Laboratory greenhouse after a minimum of six weeks in cold storage. Beginning in early February, the seed preparation was staggered weekly to ensure a ready supply of transplants. The seedlings were considered ready for transplanting when they reached the two-leaf stage with a height of 3 or more inches. Germination time ranged from ten to twenty days. The flats were placed in plastic-lined wooden boxes filled with fresh water to increase the humidity inside the greenhouse. The seedlings were also kept moist by misting daily with water. The first signs of germination were observed in mid-February and continued through the last week of April.

Transplanting Seedlings to Peat Pots/Gallon Pots

After reaching the two leaf stage the seedlings were transplanted to peat pots and one-gallon plastic containers. Two 1/2 acre ponds at the HL&P facility were used for cultivation. The soil mixture used in peat pots and one-gallon plastic containers was one-third sharp sand, one-third screened compost, and one-third top-soil. Micromix (TM) was also added, which contains essential elements such as iron, boron, magnesium and copper.

Ten-thousand plastic gallon pots were filled with the soil mixture and two or three seedlings were placed into the pots by hand as the seedlings reached the two-leaf stage. An Agriform (TM) fertilizer tablet was added to each pot. The pots were then placed in Ponds #26 and #27, and the water flow adjusted to maintain a depth of 10cm.

Ten-thousand 4" peat pots were filled with the soil mixture and fertilized with a solution of Miracle-Gro (TM). Two or three seedlings were placed in each pot, placed in flats containing sixteen pots each, and then placed in Ponds #26 and #27. The water flow was adjusted to maintain a depth of 10cm.

As of June 15, 1995 an average of 15 stems were in each gallon plastic pot reaching a maximum height of four feet. Peat pots contained an average of 6 stems per pot with a maximum height of one foot in the same time period.

Single sprigs were obtained from one of two sources; Pond #24, and from the head-start portion of the Demonstration Marsh. The sprigs are dug with a sharp-shooter shovel and divided into single sprigs. To decrease the weight of the sprigs for easier transportation, the soil was washed from the roots with water. It was also very important at this stage not to bend the stems, as this will limit the survivability of the sprigs, due to oxygen being cut off from the roots.

Table 2. Cultivation Costs for Plant Materials.

	Gallon Pots	Labor	Peat Pots	Labor	Sprigs	Labor
Soil	$520		$520		$0	
10,000 Pots	100		631		0	
6 Shovels	72		72		72	
Fertilizer	450		48		40	
Flats			500			
Gathering Seed	306	72 hours	306	72 hours		
Threshing Seed	3,060	720 hours	3,060	720 hours		
Refrigerator	500		500			
Containers	100		100			
Instant Ocean	50		50			
Storage Maint.	272	64 hours	272	64 hours		
Germ. Trays	120		120			
Potting Soil	28		28			
Greenhouse	1,088	256 hours	1,088	256 hours		
Transplanting	4,080	960 hours	2,040	480 hours		
Plant Maint.	816	192 hours	1,632	384 hours	250	59 hours
Digging Sprigs	0		0		640	150 hours
Cap. Improve.	10,000		10,000		10,000	
Transportation	800		800		800	
Total	22,362		21,767		11,802	
Number of Units	10,000		10,000		10,000	
Plants Per Unit	15		6		1	

The cost and time involved in the delivery of sprigs, peat pots and gallon pots to the planting site is the same and is included in Table 4.

Transporting Plants to Planting Site

The peat pots, the plastic pots, and the sprigs were placed in plastic bushel buckets with enough water to cover the roots, preventing root dessication and transplant stress. The buckets were then transported to the island by boat. Conditions on the island varied according to the tide. When the tide was low, the buckets were hand carried to the designated planting plot. When the tide was high, more inventive measures were used. A sled was constructed with handles that the buckets were hung on. The sled was then pushed by one person to the specified site. A canoe was also used with the buckets placed directly into the canoe and floated to the specified planting site.

Transplanting Plant Materials

The substrate was so pliable, that the plant material was placed directly in the substrate without the use of a shovel or planting-bar. The one-gallon plastic containers were removed before being transported to the Demonstration Site, while the peat-pots were not removed, but planted directly into the substrate. In order to reduce plant stress, the root portion of all three of the plant materials were always be kept covered with water until transplanting.

Demonstration Marsh Planting Plan

The Demonstration Marsh was divided into one-acre plots for comparison of various planting methods. The plots varied from a plant-spacing of 3-foot to 48-foot centers, including plots without planting for measurement of natural colonization and establishment. One-gallon pots, four-inch peat-pots and single-sprigs were transplanted on three randomly selected plots each in order to evaluate the three different plant materials (Figure 1).

Plant Spacing Determination

To measure the plant-spacing while transplanting, a 210-foot rope with the three-foot increments marked was used. Each different plant-spacing center was marked with a piece of colored tape. For example, every 3-feet was marked with pink tape, 6-feet with blue, 12-feet with green, etc. Using the marked rope, two opposite end rows of the specified plant-spacings were marked with wire flagged stakes. The rope was then streched between the two stakes, one person holding the rope taunt at each stake, and the plants then planted at the specified increments. When that line was finished, the two "rope holders" then held the rope between the next corresponding stakes, and the transplanters moved along with the rope. A non-toxic spray paint was also used to mark the plant-spacings directly on the surface of the dredged material. It could only used during periods of low tides because at medium-to-high tides the surface was under water. Therefore, the majority of the time, the marked rope was used, because most of the transplanting occurred during medium-to-high tides.

The following table illustrates the labor hours required for planting.

Table 3. Labor for plant material installation per acre.

Spacing	Labor Hours	# of Plant Units
3 foot centers	640 hours	4500 units
6 foot centers	160 hours	1156 units
12 foot centers	40 hours	306 units
24 foot centers	20 hours	76 units
36 foot centers	20 hours	34 units
48 foot centers	20 hours	18 units

The 24, 36 and 48 foot centers utilized the same number of man hours because the set time required for staking out the square and the mobilization of material, personnel and equipment is the same. A Demonstration Marsh Planting Plan Summary can be found in Appendix B.

Conclusions and Recommendations

After assessing different cultivation methods and transplanting techniques, our initial evaluation is in favor of a combination of broadcasting treated seed and planting one-gallon container grown *S. alterniflora*. The perimeter of the planting cells should be planted with one-gallon containers of plants on 24-foot centers. The perimeters of the planting cells will require the least amount of mobilization and therefore, are the easiest to plant. The one-gallon container plants demonstrated the highest quality of growth and suffered the least amount of transplant shock.

If planting is planned for early spring, single sprigs could be planted in one gallon containers in November or December of the previous year. This would ensure a ready supply of one-gallon plants for planting in early spring. The one-gallon containers cultivated from seed are not ready to transplant to a site until late spring. But, based on our experiences, Texas weather in the early spring is too unpredictable. May, June and July are the optimum planting months, both for the plants and for the mobilization of equipment and personnel.

The interior of the planting cells should then be sown with treated seed no earlier than March and no later than May. The treatment areas that were seeded demonstrated healthy plants growth in spite of predation of the seeds by birds and the drying out and cracking of the substrate. The treated seed has a much higher germination rate, but in case of natural catastrophes such as flooding or drought, the container grown plants will ensure a seed source and a head start area which will reproduce asexually. The following table summarizes the cost/unit and spacing comparison.

Table 4. Unit costs of installed plant materials.

Plant Material	Treatment Spacing	# of Plants Per Treatment	$ Plant Cost	Installation Cost @ $ 7 p/h	Plant & Inst. Cost	Unit Plant & Inst. Cost
Gallon Pots	12	306	$459	40 hours $280	$739	$2.42
10 Stems	24	76	114	20 hours $140	254	3.34
$1.50 each	36	34	51	20 hours $140	191	5.62
	48	18	27	20 hours $140	167	9.28
Peat Pots	12	306	661	40 hours $280	941	3.08
6 Stems	24	76	164	20 hours $140	304	4.01
$2.16 each	36	34	73	20 hours $140	213	6.26
	48	18	39	20 hours $140	179	9.94
Sprigs	3	4500	5310	640 hours $4480	9790	2.18
1 stem	6	1156	1364	160 hours $1120	2484	2.15
$ 1.18 each	12	306	361	40 hours $280	641	2.09
	24	76	90	20 hours $140	230	3.03
	36	34	40	20 hours $140	180	5.31

The effectiveness of marsh planting by varying the plant densities has yet to be evaluated. Our initial observation is the 3-foot centers made a solid stand after 60 days. The 6 and 12-foot centers are approaching a solid stand after 90 days.

References

Broome, Steven., 1993. Telephone conversation concerning *Spartina alterniflora* cultivation. Associate Professor, Department of Soil Science, North Carolina State University, Raleigh, NC.

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Materne, Mike., 1993. Personal interview concerning *Spartina alterniflora* cultivation. Plant Material Specialist, USDA Natural Resources Conservation Service, Baton Rouge, LA.

White, W. A., T. A. Tremblay, E. G. Wermund, Jr. and L. R. Handley. 1993. Trends and Status of Wetand and Aquatic Habitats in the Galveston Bay System, Texas. Galveston Bay National Estuary Program Publication GBNEP-31. Webster, TX. 225 pp.

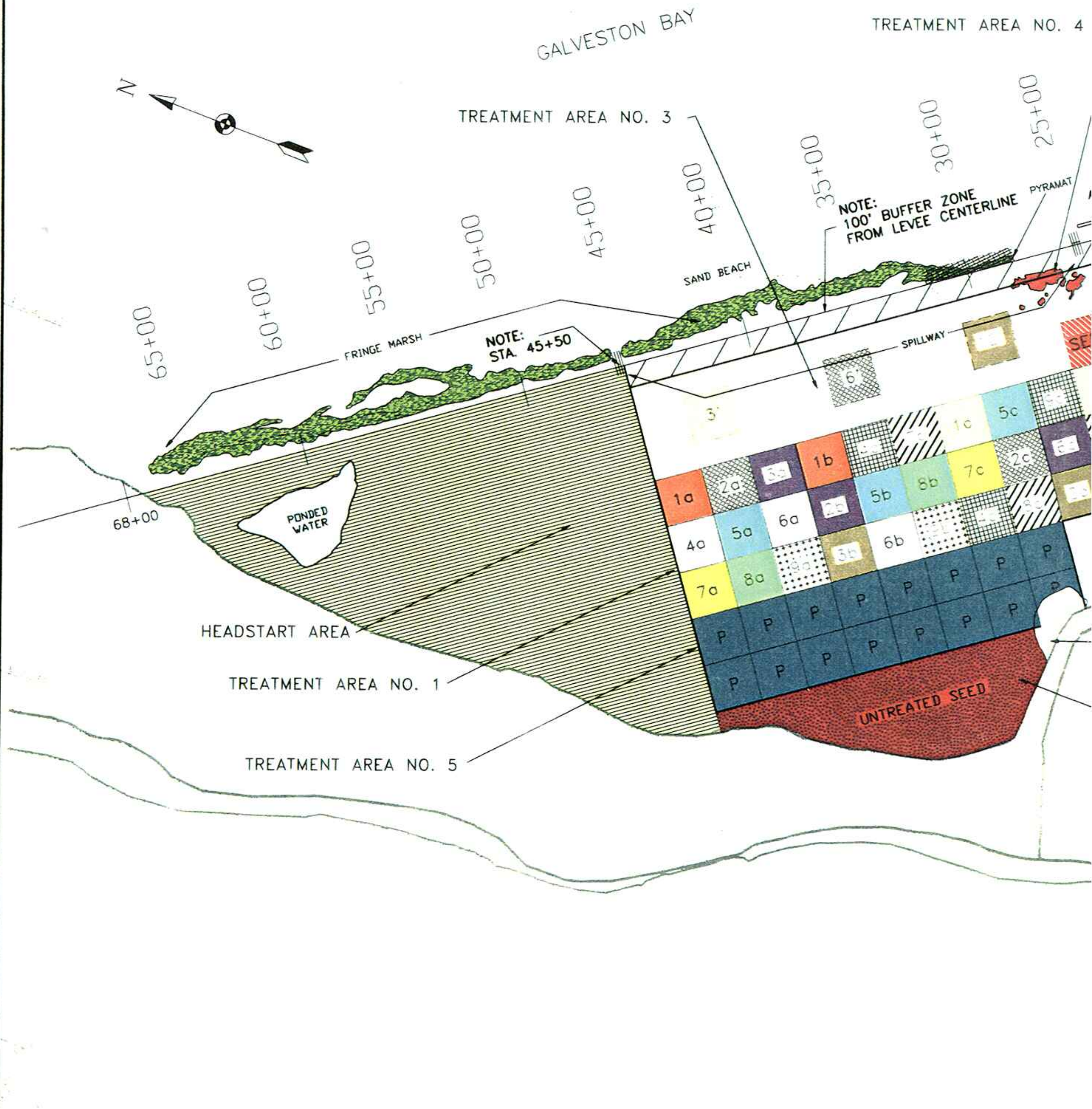
Appendix A

Spartina alterniflora seed treatment, cultivation and transplanting time line.

Month(s)	Task
October	Locate healthy donor stock.
November--December	Inspect weekly for signs of seed maturation.
	The third and fourth week of November and the first week of December are optimum times for maturity. Each stand may mature at different times.
December	Two-week ambient storate prior to threshing.
	Hand thresh seed.
January	Cold storage in Instant Ocean (TM) at 22 ppt. for a minimum of six weeks.
March	Treated seed placed in greenhouse for germination for cultivation
	Treated seed broadcast on planting sites.
May--July	Cultivated plants are ready for transplanting.

Appendix B

Demonstration Marsh Planting Plan Summary



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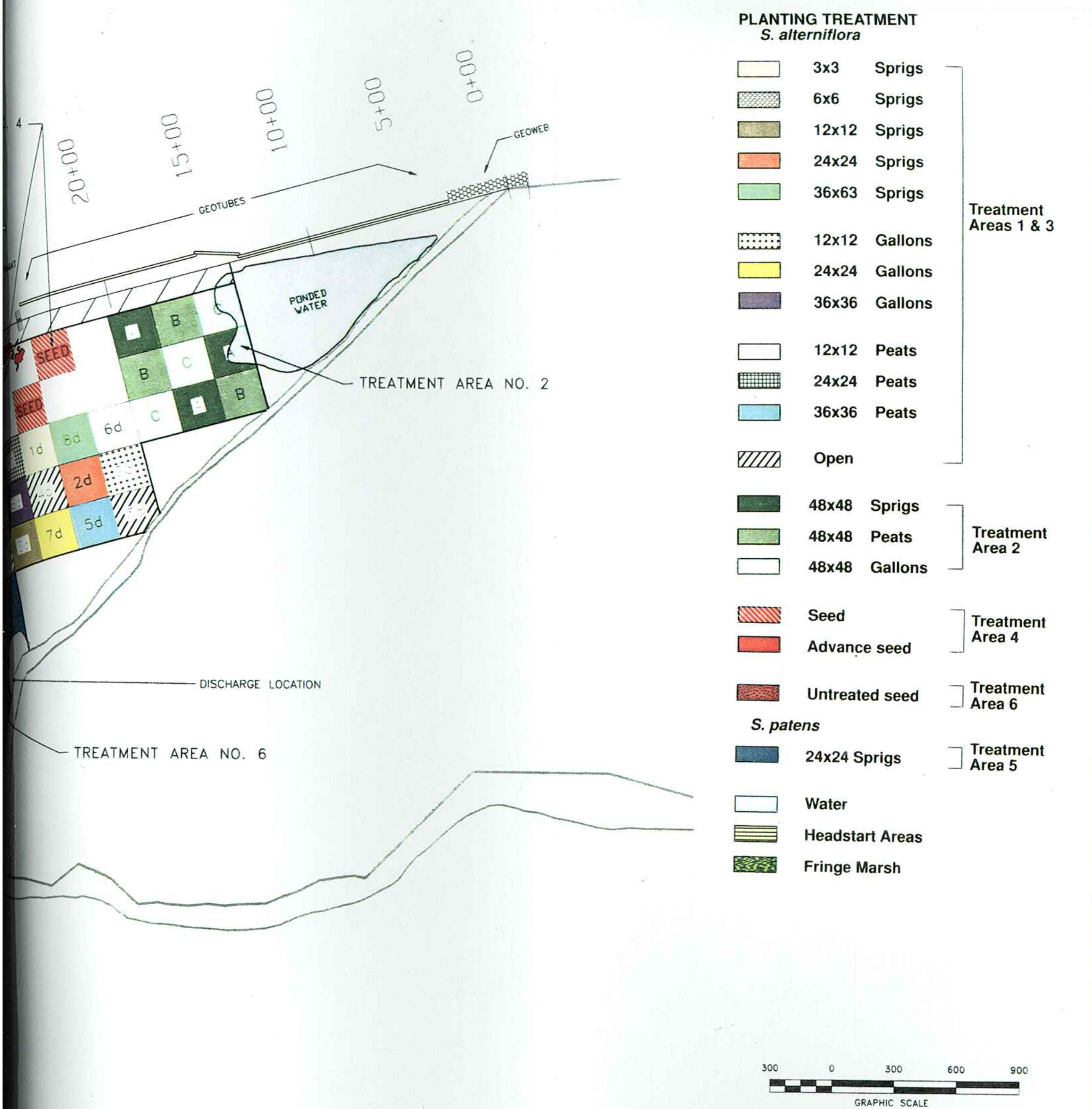


PORT OF HOUSTON AUTHORITY

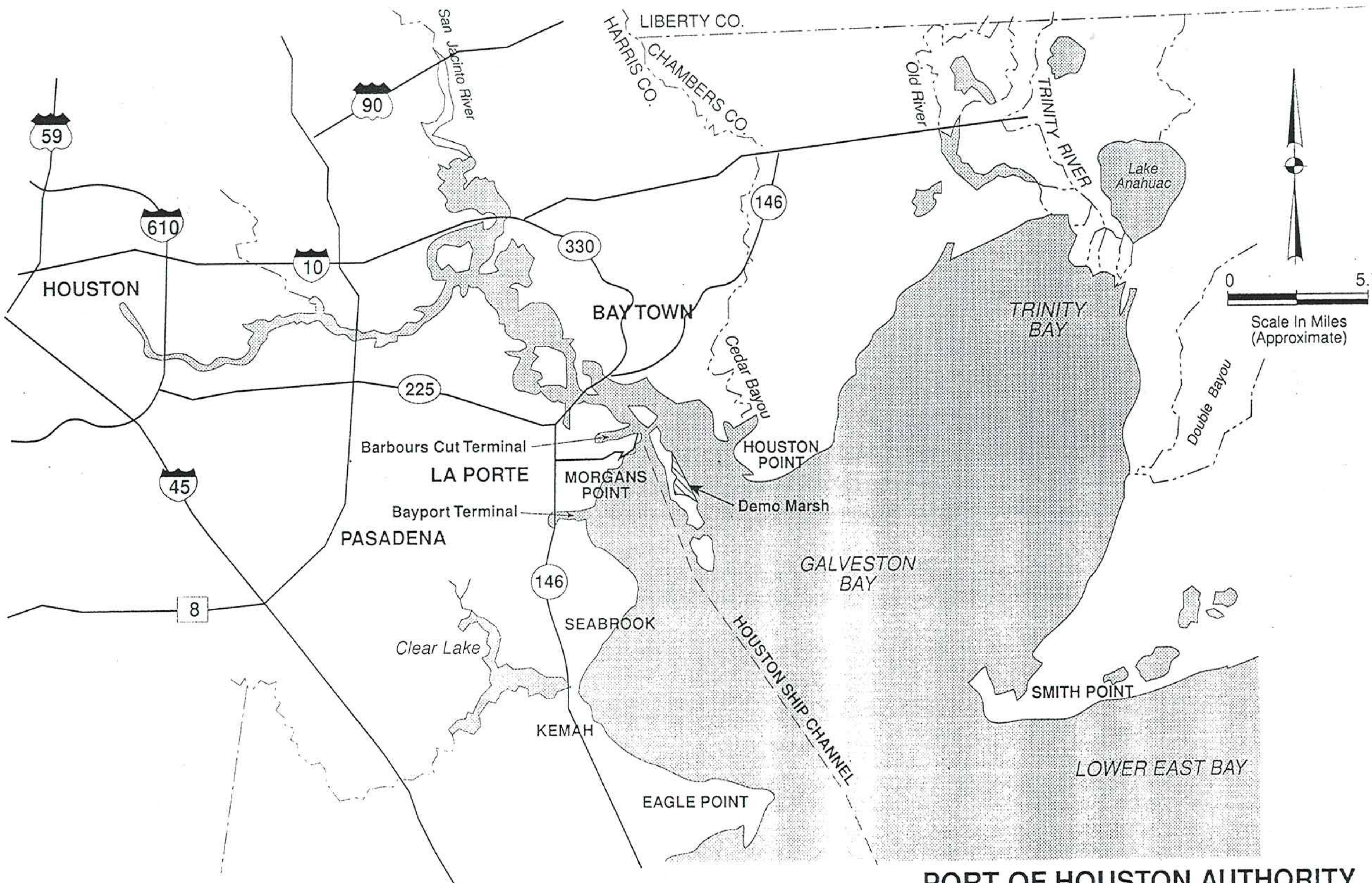
DEMONSTRATION MARSH PLANTING PLAN

	BY	DATE	DRAWING NAME
PLOTTED BY	J.W.D.	8-21-95	044DMLP.DWG
CHECKED BY			SHEET NO.
SCALE: AS NOTED			1 OF 1

NO.	REVISIONS	DATE

Appendix C

Project Site Map



PORT OF HOUSTON AUTHORITY DEMONSTRATION MARSH LOCATION MAP

Appendix D

Project Photographs

AmeriCorps Members.
Members received experience in wetland restoration in the Galveston Bay System.

Laboratory facilities at HL&P.
Water is manipulated by a gravity flow system from HL&P's Cedar Bayou Plant.

Harvesting Seed.
After maturing in late fall, *Spartina alterniflora* is harvested.
Seed heads are cut off with ordinary scissors.

Seed in cold storage.
The seed was stored at 2-3 degrees centigrade in a solution of 22 ppt. of Instant Ocean (TM) for a minimum of six weeks.

Seedlings at two-leaf stage in greenhouse.
The seed is placed in the greenhouse for germination in early March.
Four weeks later they are ready for transplanting into containers.

Fertilizing the one-gallon pots.
Agriform (TM) tablets, used to fertilize the one-gallon pots,
are high in nitrogen, and the tablet form makes application fool-proof.

Placing one-gallon pots in pond.
The gravity flow ponds allowed manipulation of water levels.
The ultimate source of water from Cedar Bayou is Tabbs Bay.

Transporting plants to planting site.
Plants were transported in bushel buckets.
Root mass must be covered with water to prevent damage to root system.

Inventive measures for transporting plants.
Mary Landon, of the USACE's Waterways Experiment Station, suggested a canoe for transporting plants during high tides.

Transporting at high-tide.
During high-tides, transplanters often sank up their knees in the substrate.

Aerial view of completed planting.
From a helicopter the one-acre plots are visible.