1981 SUISUN MARSH VEGETATION SURVEY

Prepared by

Frank G. Wernette
California Department of Fish and Game

Interagency Ecological Study Program
for the Sacramento-San Joaquin Estuary
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Chapter 1. INTRODUCTION

This report presents a summary of the results of the 1981 aerial survey of the vegetation of Suisun Marsh. This aerial survey is one feature of the monitoring plan outlined in the Plan of Protection for the Suisun Marsh (California Department of Water Resources 1984). It was designed to assist in assessing the effectiveness of the Plan of Protection in meeting its objectives to restore and maintain the marsh primarily as a brackish water marsh capable of producing high quality feed and habitat for waterfowl and other marsh-related wildlife. It was also intended to monitor impacts on preferred habitat of the salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*).

The 1981 survey was conducted to serve two additional purposes: (1) to provide a baseline year with which future surveys, completed every three years, would be compared; and (2) to assess vegetative composition changes in the marsh since aerial surveys in 1973 and 1978.

Because of delays in completing facilities described in the Plan of Protection and the desirability of having a baseline year as close as possible to start of operation of these facilities, the 1981 survey will not serve as the base line. The 1985 survey will now serve this purpose.

The vegetative data gathered in 1985 and in each subsequent survey will help the Department of Water Resources meet San Francisco Bay Conservation and Development Commission permit requirements that call for assessments of significant changes to plant composition, diversity, and density.

Chapter 2. METHODS

Aerial photographs were taken of Suisun Marsh on June 18, 1981. True color Kodak MS 2448 film was used, providing a continuous roll of 128 9-inch by 9-inch color transparencies. The photograph scale was (1 inch to 800 feet). Each photograph was cut from the roll and inserted into a clear plastic envelope to protect it during handling and allow recording vegetative types and boundaries without damaging the photograph.

A photograph index was prepared using (1-inch to 4,000-foot) scale Suisun Resource Conservation District ownership map. This index was critical during the survey, particularly during field verification. Colored pencils were used to record data on evelopes.

Habitat types were classified according to dominant species. Classifications of open water, miscellaneous, and bare ground were exceptions. The marsh was classified into 13 habitat categories (Table 1), which differed in some respects from the 14 used in 1973 and 1978 (Table 2). Differences are:

- Because the crops category used in 1973 and 1978 was eliminated, crops were assigned to the annual category for grains and to miscellaneous for orchards and the turf nursery near the Fairfield sewer treatment plant.
- The categories for cattails (*Typha* sp.) and tules (*Scirpus* sp.) were combined for the 1981 survey.
- The open water category was used in 1981 instead of ponds to avoid confusion between water in channels or sloughs and temporary or permanent water in club ponds.
- The miscellaneous category covered areas with blue gum (*Eucalyptus* sp.), willows (*Salix* sp.) and other trees, common reed (*Phragmites communis*), buildings, corrals, roads, gas pump pads, quarries, land fill dumps, and similar areas.

Table 1
HABITAT CLASSIFICATION CATEGORIES USED IN THE 1981 SURVEY

Habitat Type	Map Symbol
Pickleweed	PW
Alkali bulrush	AB
Olney bulrush	OB
Cattails and tules*	C&T
Brass buttons	BB
Fat hen	FH
Saltgrass	SG
Baltic rush	J
Lowland purslane	LLP
Annuals	A
Bare ground	BG
Open water	W
Miscellaneous	M

*"Tules" included all species of the genus *Scirpus* other than alkali bulrush and olney bulrush.

Table 2
HABITAT CLASSIFICATION CATEGORIES USED IN 1973 and 1978

Habitat Type	Map Symbol
Miscellaneous	M
Pickleweed	PW
Saltgrass	SG
Alkali bulrush	AB
Annuals	A
Tules*	T
Brass buttons	BB
Crops	C
Olney bulrush	OB
Cattail	C
Baltic rush	J
Bare ground	BG
Ponds	P
Fat hen	FH

*"Tules" include all species of the genus *Scirpus* other than alkali bulrush and olney bulrush.

- The bare ground category included bare areas with high soil salinities incapable of supporting vegetation, disked areas, spoil areas, and areas drained just before the aerial photos were taken and, therefore, temporarily bare. Some of these recently drained areas were found to be supporting brass buttons when field verification took place. Regardless, they were classified based on conditions when the photograph was taken.

The remaining categories were comparable among the three surveys.

Parcels as small as one-half acre were recorded. Field verification to delineate habitat types was during summer and fall 1981. About 5 days were spent in the field to help correlate aerial photo color and texture with actual habitat type.

The marsh was divided into five zones for vegetative monitoring (Figure 1). This division was in response to a concern of the Endangered Species office of the U. S. Fish and Wildlife Service expressed during preparation of Biological Assessment of the Impacts of the Suisun Marsh Management Plan on the Salt Marsh Harvest Mouse and California Clapper Rail (United States Bureau of Reclamation 1981). Since monitoring preferred mouse habitat was a key component of the assessment and subsequent biological opinion, the Fish and Wildlife Service believed zoning the marsh would decrease the potential for significant local changes being masked by changes in a different area of the marsh. (For example, preferred mouse habitat in the eastern marsh should not be sacrificed even if it had increased a similar amount in the western marsh.)

In delineating the five zones, no attempt was made to divide the marsh into zones of equal area. Instead, factors such as expected water quality, potential for creating new wetlands, and ease with which zone boundaries could be identified were considered. Boundary descriptions for the five zones are included in Appendix A.

After the habitat types were recorded on each photo's envelope, the photos were removed and a zoom transfer scope was used to reduce each photo's data and transfer it onto the six 7.5-minute quads covering the marsh. Map scales were reduced from 1 inch = 800 feet to 1 inch = 2,000 feet. Quads used were fadeout blue mylars provided by the Department of Water Resources. Reduced copies of these quads are included in Appendix B.

Sepias made of the quads were cut and separated into appropriate habitat types and zones. A Mettler balance was used to weigh each category to the nearest 1.0×10^{-5} gram. Weights for each category were then converted to area using a ratio of the weight of each whole quad and its known area.

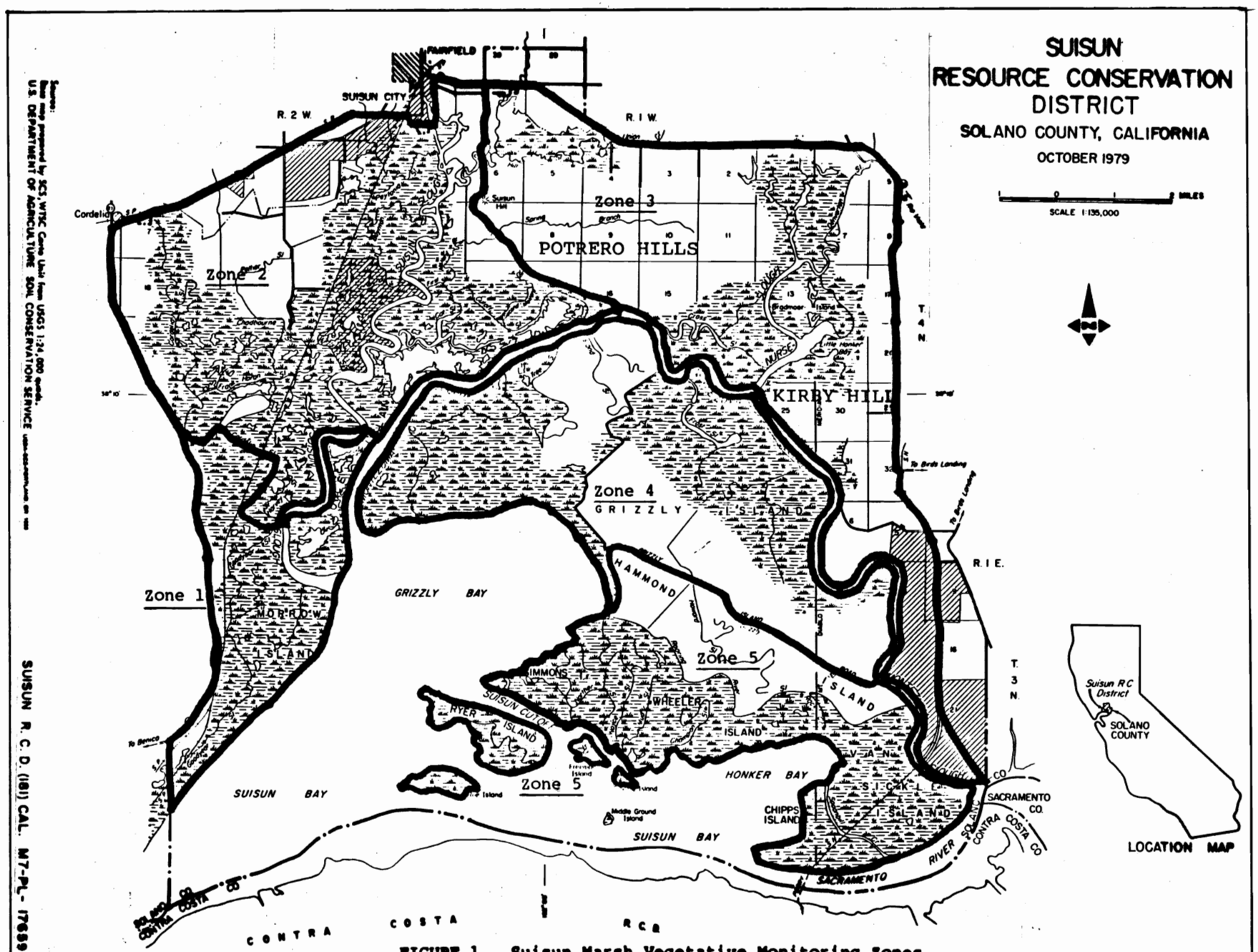

FIGURE 1. Suisun Marsh Vegetative Monitoring Zones

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:24,000 quads.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

SUISUN R. C. D. (181) CAL. M7-PL- 17689

Chapter 3. RESULTS AND DISCUSSION

Table 3 summarizes the habitat data recorded for Suisun Marsh using the 1981 aerial photos. A total of 78,435.3 acres was classified into the 13 habitat categories. This total represented nearly a 50 percent increase over the 52,571 acres surveyed in 1973 and 53,395 acres surveyed in 1978. The large increase resulted from an effort to standardize the survey boundaries with readily identifiable boundaries for future surveys, while also including potential new wetland areas.

The percent of each habitat classification varied considerably by zone (Table 4). Except for annual habitat in Zone 3, no habitat type had a significantly higher representation than would otherwise be expected due solely to the size of the zone. Zone 3 contained a large percentage of the annual habitat in the marsh, primarily because Potrero Hills, Kirby Hill, and the eastern side of the marsh were principally annual grasses. Zone 3 had nearly 53 percent of all the annual habitat surveyed, yet the zone represented only 27.3 percent of the total surveyed acreage.

The percent of each habitat classification within each zone was also compared (Table 5). Before the survey, the percentage of pickleweed was expected to be significantly higher and alkali bulrush significantly lower in Zone 1 than in the other zones because applied water salinities were generally higher in Zone 1. This was not the case. The percentage of pickleweed in Zone 1 was not appreciably higher than in Zone 4 (22.1 percent vs. 21.9 percent). Zones 2 and 5 also had relatively high percentages (both 17.9 percent). Alkali bulrush made up over 30 percent of the Zone 1 habitat, and only Zone 5 had a higher percentage of alkali bulrush (32.4 percent).

Table 3
SUMMARY OF 1981 SURVEY HABITAT ACREAGE BY ZONE

Habitat Classification	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
Pickleweed	1,435	3,695	1,585	3,713	2,317	12,745
Alkali bulrush	1,951	3,303	1,050	3,576	4,208	14,088
Olney bulrush		48				48
Cattails and tules	758	1,240	1,462	1,305	2,189	6,954
Brass buttons	585	1,093	61	1,439	631	3,809
Fat hen	47	242	77	62	16	444
Saltgrass	53	1,517	1,934	464	479	4,447
Baltic rush	4	16	16	59	45	140
Lowland purslane			22			22
Annuals	636	6,003	13,863	4,495	1,404	26,401
Bare ground	300	1,114	451	1,237	811	3,913
Open water	593	1,411	673	418	813	3,908
Miscellaneous	126	934	189	214	57	1,520
Total	6,488	20,616	21,383	16,982	12,970	78,439

Table 4
PERCENT OF TOTAL SURVEYED AREA REPRESENTED BY EACH HABITAT CLASSIFICATION
1981 SURVEY

Habitat Classification	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
Pickleweed	1.8	4.7	2.0	4.7	3.0	16.2
Alkali bulrush	2.5	4.2	1.3	4.6	5.4	18.0
Olney bulrush	-	<0.1	-	-	-	<0.1
Cattails and tules	1.0	1.6	1.9	1.6	2.8	8.9
Brass buttons	0.7	1.4	0.1	1.8	0.8	4.8
Fat hen	0.1	0.3	0.1	0.1	<0.1	0.6
Saltgrass	0.1	1.9	2.5	0.6	0.6	5.7
Baltic rush	<0.1	<0.1	<0.1	0.1	<0.1	0.2
Lowland purslane	-	-	<0.1	-	-	<0.1
Annuals	0.8	7.7	17.7	5.7	1.8	33.7
Bare ground	0.4	1.4	0.6	1.6	1.0	5.0
Open water	0.8	1.8	0.9	0.5	1.0	5.0
Miscellaneous	0.1	1.2	0.2	0.3	0.1	1.9
Total	8.3	26.3	27.3	21.6	16.5	100

Table 5
PERCENT OF EACH ZONE REPRESENTED BY EACH HABITAT CLASSIFICATION
1981 SURVEY

Habitat Classification	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Pickleweed	22.1	17.9	7.4	21.9	17.9
Alkali bulrush	30.1	16.0	4.9	21.0	32.4
Olney bulrush	-	0.2	-	-	-
Cattails and tules	11.7	6.0	6.8	7.7	16.9
Brass buttons	9.0	5.3	0.3	8.5	4.9
Fat hen	0.7	1.2	0.4	0.4	0.1
Saltgrass	0.8	7.4	9.0	2.7	3.7
Baltic rush	0.1	0.1	0.1	0.3	0.4
Lowland purslane	-	-	0.1	-	-
Annuals	9.8	29.1	64.8	26.5	10.8
Bare ground	4.6	5.4	2.1	7.3	6.2
Open water	9.1	6.9	3.2	2.4	6.3
Miscellaneous	2.0	4.5	0.9	1.3	0.4
Total	100	100	100	100	100

In Zones 2, 3, and 4 the annual category was dominant, and in Zones 1 and 5 alkali bulrush was dominant. Pickleweed was the second most dominant type in four zones; in Zone 3 saltgrass (Distichlis spicata) was the second most dominant type. Table 6 shows the habitat classifications with the two highest percentages in each zone.

Table 6
DOMINANT HABITAT CLASSIFICATION, BY ZONE

Zone	Most Dominant	Second Most Dominant
1	Alkali bulrush	Pickleweed
2	Annuals	Pickleweed
3	Annuals	Saltgrass
4	Annuals	Pickleweed
5	Alkali bulrush	Pickleweed

One goal of the 1981 survey was to compare vegetative composition changes since aerial surveys in 1973 and 1978 (Table 7). However, several significant differences in techniques made comparisons difficult. Different classification categories, a large increase in total area surveyed in 1981, and different zone designations make a complete comparison impossible. Because of these differences the reader should be cautioned about making invalid comparisons of habitat class percentages between years. Several observations can be made, since more than 95 percent of the difference in total area sampled was in the annual, bare ground, water, and miscellaneous categories (Table 8).

Table 7
COMPARISON OF 1981 AERIAL SURVEY WITH TWO PRIOR SURVEYS
(In Acres)

Habitat Classification	1973	1978	1981
Pickleweed	12,990	17,993	12,745
Alkali bulrush	6,835	7,021	14,088
Olney bulrush	238	71	48
Cattails and tules	9,239	6,398	6,954
Brass buttons	1,912	1,943	3,808
Fat hen	3,956	1,963	444
Saltgrass	5,596	5,671	4,446
Baltic rush	569	707	140
Lowland purslane	1/	1/	22
Annuals	3,965	6,094	26,401
Bare ground	586	665	3,913
Open water 2/	2,285	1,043	3,908
Miscellaneous	258	558	1,520
Crops	4,143	3,269	3/
Total	52,572	53,396	78,434

1/ Not measured.
2/ Classified as Ponds in 1973 and 1978 surveys.
3/ Included in Annuals and Miscellaneous.

Table 8
PERCENT HABITAT CHANGE

Habitat Classification	1973 to 1981 % Increase	1973 to 1981 % Decrease	1978 to 1981 % Increase	1978 to 1981 % Decrease
Pickleweed		3		29
Alkali bulrush	107		101	
Olney bulrush		79		33
Cattails and tules		25	9	
Brass buttons	99		96	
Fat hen		89		77
Saltgrass		20		22
Baltic rush		75		80
Lowland purslane		Not Comparable		
Annuals		Not Comparable		
Bare ground		Not Comparable		
Open water		Not Comparable		
Miscellaneous		Not Comparable		

The area of pickleweed is significantly less in 1981 than in 1978 (29 percent decrease) and is similar to that surveyed in 1973. This indicated that the increase in pickleweed attributed to the drought in 1976 and 1977 had been reversed.

Brass buttons showed an increase of 99 percent over 1973 levels and 96 percent over 1978 levels. The reason for this increase is now known. Fat hen showed a decrease of 89 percent since 1973 and 77 percent since 1978. A strong emphasis through this period to manage exclusively for alkali bulrush may have been the largest factor contributing to this change. Reasons for this emphasis and the vegetative changes expected with alkali bulrush management are described in A Guide to Waterfowl Habitat Management in Suisun Marsh (Rollins 1981).

Cattails and tules had increased 9 percent since 1978; this was still a reduction of 25 percent since 1973. Whether this reduction represents the continued effects of the 1976-1977 drought or the effects of club management activities since the 1973 survey is now known. Saltgrass showed a decrease of 20 percent from the 1973 survey and 22 percent from the 1978 survey. Club management appears to have been responsible.

Alkali bulrush increased 107 percent from the 1973 survey and 101 percent from the 1978 survey. This increase is attributed to the continued emphasis on alkali bulrush production in combination with the availability of relatively low salinity water.

Two other habitat categories, olney bulrush (*Scirpus olneyi*) and baltic rush (*Juncus balticus*), showed reductions from earlier surveys. Olney bulrush decreased 80 percent since 1973 and 33 percent since 1978, and baltic rush decreased 75 percent since 1973 and 80 percent since 1978. These apparent changes may be related to sampling methodology rather than any real change in habitat composition. Since the smallest unit measured was about 0.5 acre, and since these species are often found in units smaller than this, the apparent reductions may be reflecting a failure to survey these areas.

Lowland purslane (*Sesuvium sessile*) was not sampled in previous years but appeared common enough in some areas in 1981 to warrant its measurement in future surveys.

The increases in alkali bulrush and brass buttons undoubtedly improved habitat for wintering waterfowl. The decrease in fat hen, however, represented a less favorable trend toward a marsh with lower diversity. The 1985 survey will allow the Department of Fish and Game to determine if this trend is continuing or if it represents a slow recovery from the 1976-1977 drought.

During the 1981 vegetation survey, it became apparent that for a marshwide survey to be useful, several modifications should be considered. Study personnel found it difficult to assign a habitat classification to areas with extremely diverse species composition. Some parcels had no obvious dominant species but, instead, appeared to be fairly equally composed of as many as three species. In these cases, the parcel was randomly assigned to the classification of one of the dominant species. This technique did not provide the level of precision needed to adequately monitor what may be relatively subtle changes in plant species composition in the marsh. In addition, areas dominated by species such as olney bulrush or baltic rush but totaling less than 0.5 acre were often not inventoried.

As a result of these shortcomings, a modified classification technique is proposed for the 1985 aerial survey. Survey techniques would follow those described by Stone et al. (1984). With these techniques, areas with the same visual qualities would be delineated on

aerial photos in the laboratory. Field vegetative sampling would be used to determine the actual species composition of these areas. A method that would accurately sample these pre-delineated areas (line intercept or toe-point techiuque) would be used. The result would more accurately represent the vegetative composition of the marsh and bypass the need for subjective judgments as to dominant species of a parcel.

This technique would also serve to sample and monitor the extent of preferred mouse habitat. No separate survey would be needed. Because of the duplication of effort needed with the current procedure, there was not enough time to survey for preferred mouse habitat in 1981. Therefore, no 1981 mouse habitat data are available to serve as a base line for comparisons. The original intent of using the 1981 survey was to obtain baseline preferred mouse habitat data shortly before start of facility construction. Since construction was delayed, the 1985 survey will provide the baseline. No increase in survey costs is expected with this revised survey methodology.

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U. S. Bureau of Reclamation. 1981. Biological Assessment of the Impacts of the Suisun Marsh Management Plan on the Salt Marsh Harvest Mouse (*Reithrodontomys raviventris halicoetes*) and California Clapper Rail (*Rallus longirostris obsoletus*), 52 p.

Appendix A

BOUNDARY DESCRIPTIONS FOR VEGETATIVE MONITORING ZONES

Appendix A

BOUNDARY DESCRIPTIONS FOR VEGETATIVE MONITORING ZONES

Zone 1

The area in Suisun Marsh within a line beginning at the junction of Hunter Cut and Montezuma Slough south along Joice Island to its southern end; across Suisun Slough to the eastern shore of Morrow Island; south on Morrow Island's eastern edge to its junction with the Suisun Marsh boundary as described in Section 29101 of the Public Resources Code; north along this boundary to its junction with Highway 680; north on Highway 680 to a point closest to Cordelia Slough just north of the Marshview Road offramp; east along the east shore of Cordelia Slough to its junction with Suisun Slough; east across Suisun Slough to the western shore of Joice Island; north to Hunter Cut; east to the point of beginning.

Zone 2

The area in Suisun Marsh within a line beginning at the junction of Montezuma Slough and Grizzly Island Road at Beldon's Landing; west along the south shore of Joice Island to Hunter Cut; west along Hunter Cut to its junction with Suisun Slough; west across Suisun Slough to the opposite shore; south to the junction of Suisun Slough and Cordelia Slough; north and west along the northern and eastern shore of Cordelia Slough to a point nearest Highway 680; north on Highway 680 to its junction with the Southern Pacific Railroad tracks; east along the Southern Pacific tracks to their junction with Suisun City city limits; east and north along the city limits to the junction of Highway 12; east on Highway 12 to the junction of Grizzly Island Road; south on Grizzly Island Road to the point of beginning.

Zone 3

The area of Suisun Marsh within a line beginning at the junction of Highway 12 and Grizzly Island Road; east on Highway 12 to its junction with Shiloh Road; south to the junction of Shiloh Road and the old Sacramento-Northern Railroad; south to the junction of the Sacramento-Northern Railroad and the boundary of the Suisun Marsh primary management area as described in Section 29101 of the Public Resources Code; south and east along this boundary to its junction with the Sacramento River west of Collinsville; north and west along the east shore of Montezuma Slough to its junction with Grizzly Island Road at Beldon's Landing; north on Grizzly Island Road to the point of beginning.

Zone 4

The area in Suisun Marsh within a line beginning at the junction of Grizzly Island Road and Montezuma Slough at Beldon's Landing; east on the north shore of Grizzly Island to its junction with Grizzly Island Road near the Roaring River intake; west on Grizzly Island Road to its junction with the levee on the east side of

Individual Ownership 513; south on this levee to its junction with the south boundary of Individual Ownership 513; west along this boundary to its junction with Grizzly Bay; north and west along the shore of Grizzly Bay to the mouth of Montezuma Slough; north and east along the north shore of Grizzly Island to the point of beginning.

Zone 5

The area in Suisun Marsh within a line beginning at the junction of Grizzly Island Road and Montezuma Slough near the Roaring River intake; south and east along Montezuma Slough to its junction with the Sacramento River; west along the south shore of VanSickle and Chipps islands; north and west along the shore of Honker Bay and Suisun Cutoff to Point Buckler; north and east along the north shore of Simmons Island to its junction with the property line of Individual Ownership 513; east along this property line to its junction with the levee road at the southeast corner of Individual Ownership 513; north along this road to its junction with Grizzly Island Road; south and east along this road to the point of beginning. Zone 5 also consists of the Channel Islands (Roe, Ryer, Freeman, and Snag).

Appendix B

QUADS OF HABITAT ZONES

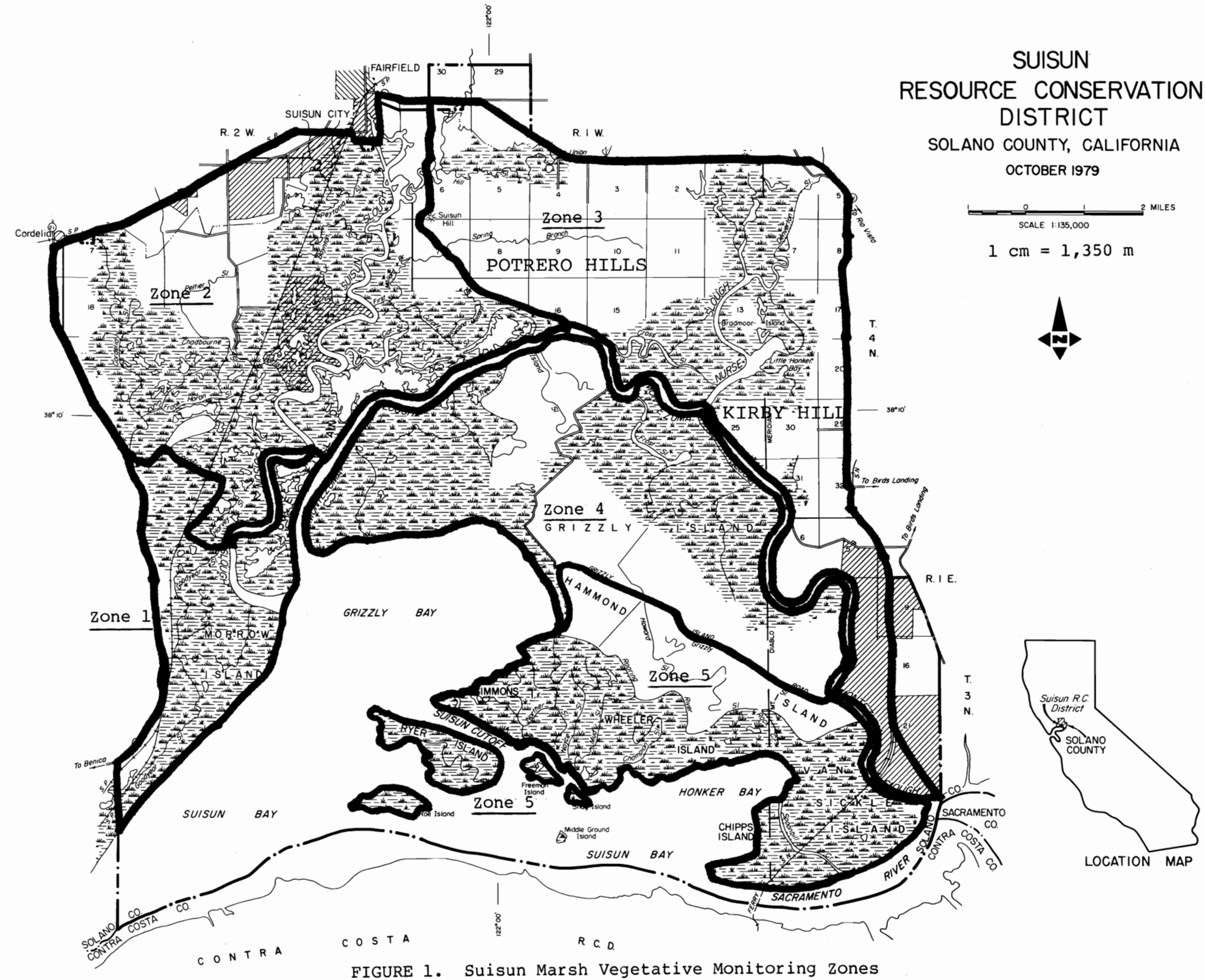


FIGURE 1. Suisun Marsh Vegetative Monitoring Zones

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:24,000 quads.
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR. 1980

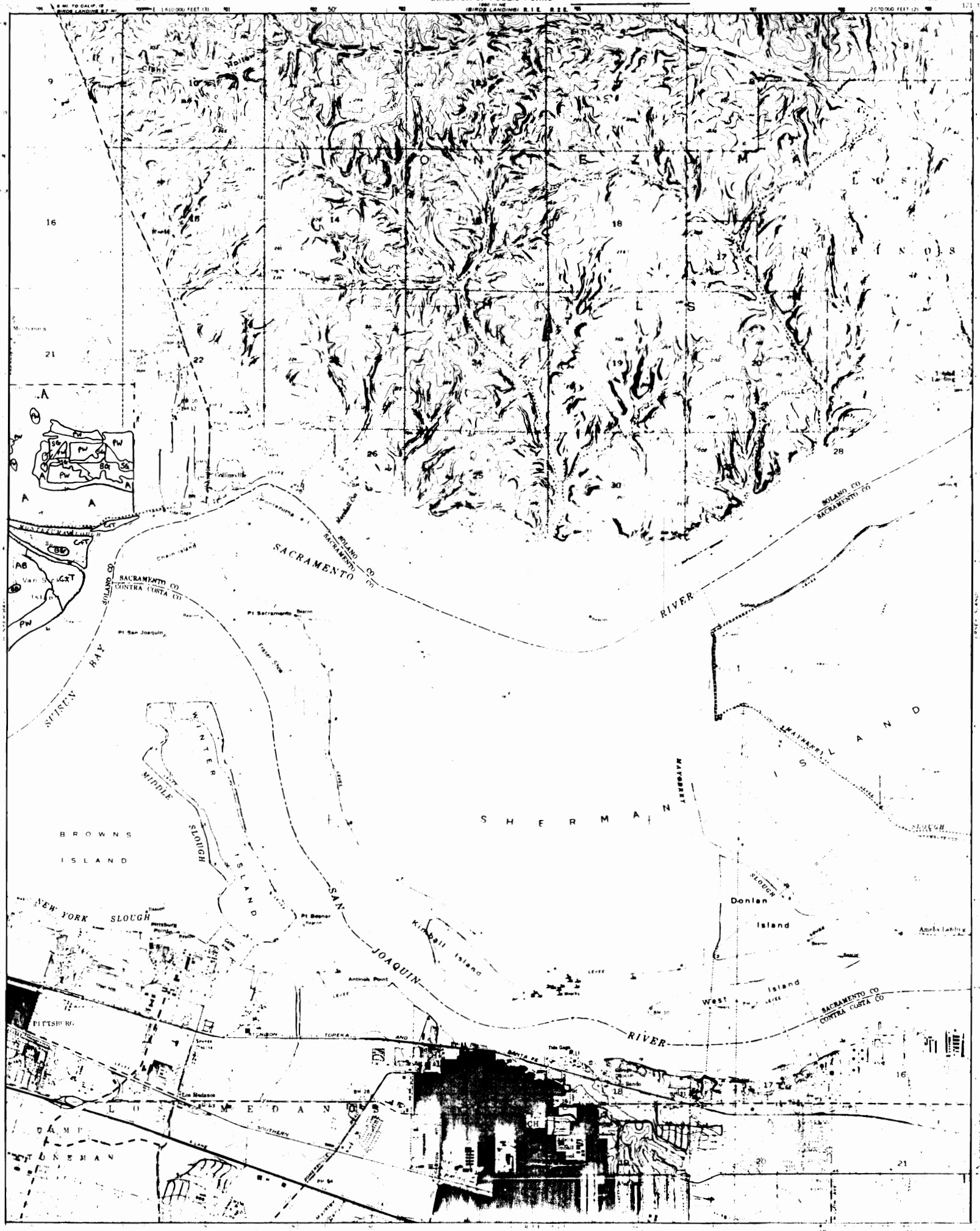
SUISUN R. C. D. (181) CAL. M7-PL- 17659

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

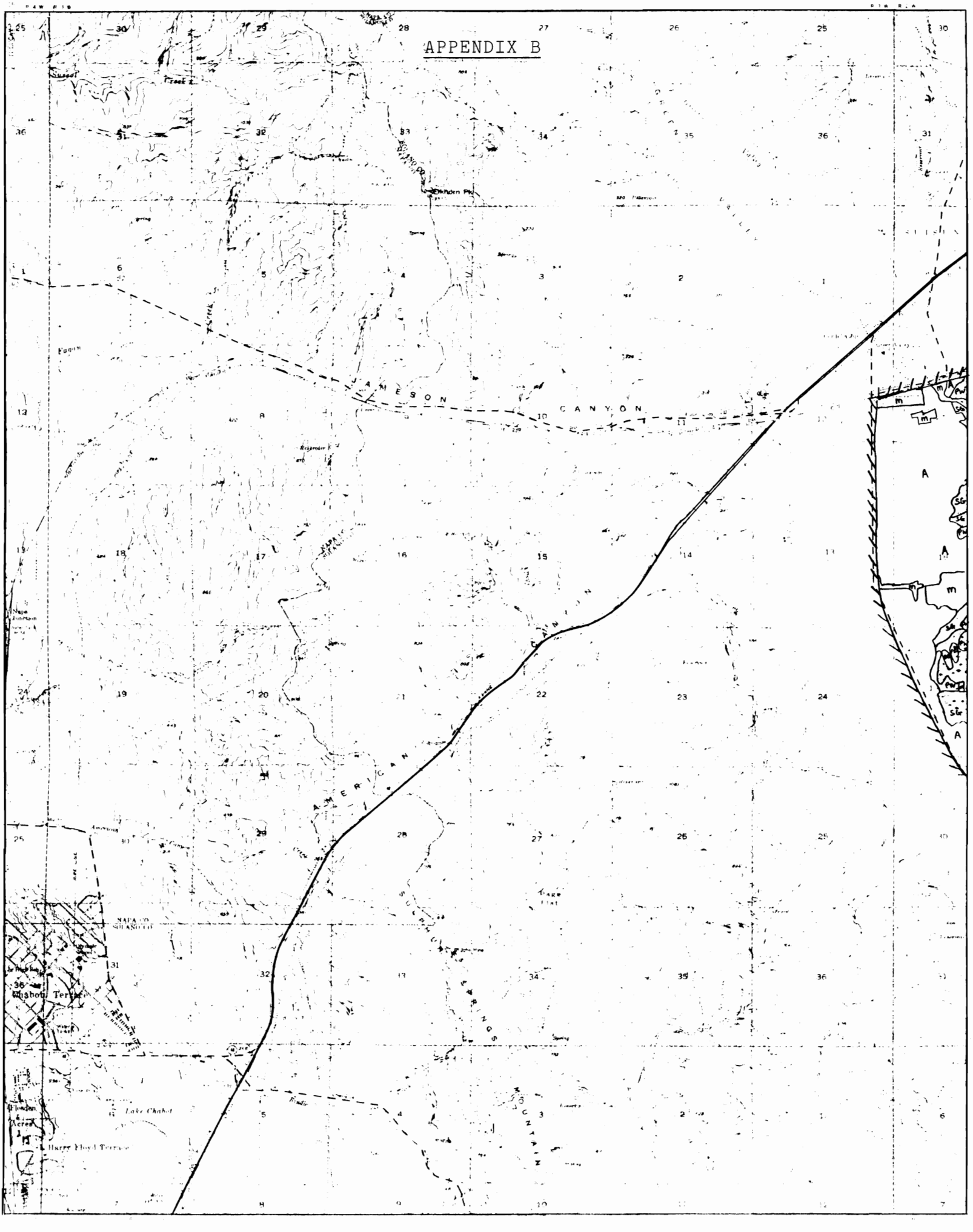
STATE OF CALIFORNIA
REPRESENTED BY THE
DIRECTOR OF PUBLIC WORKS

APPENDIX B

CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



APPENDIX B

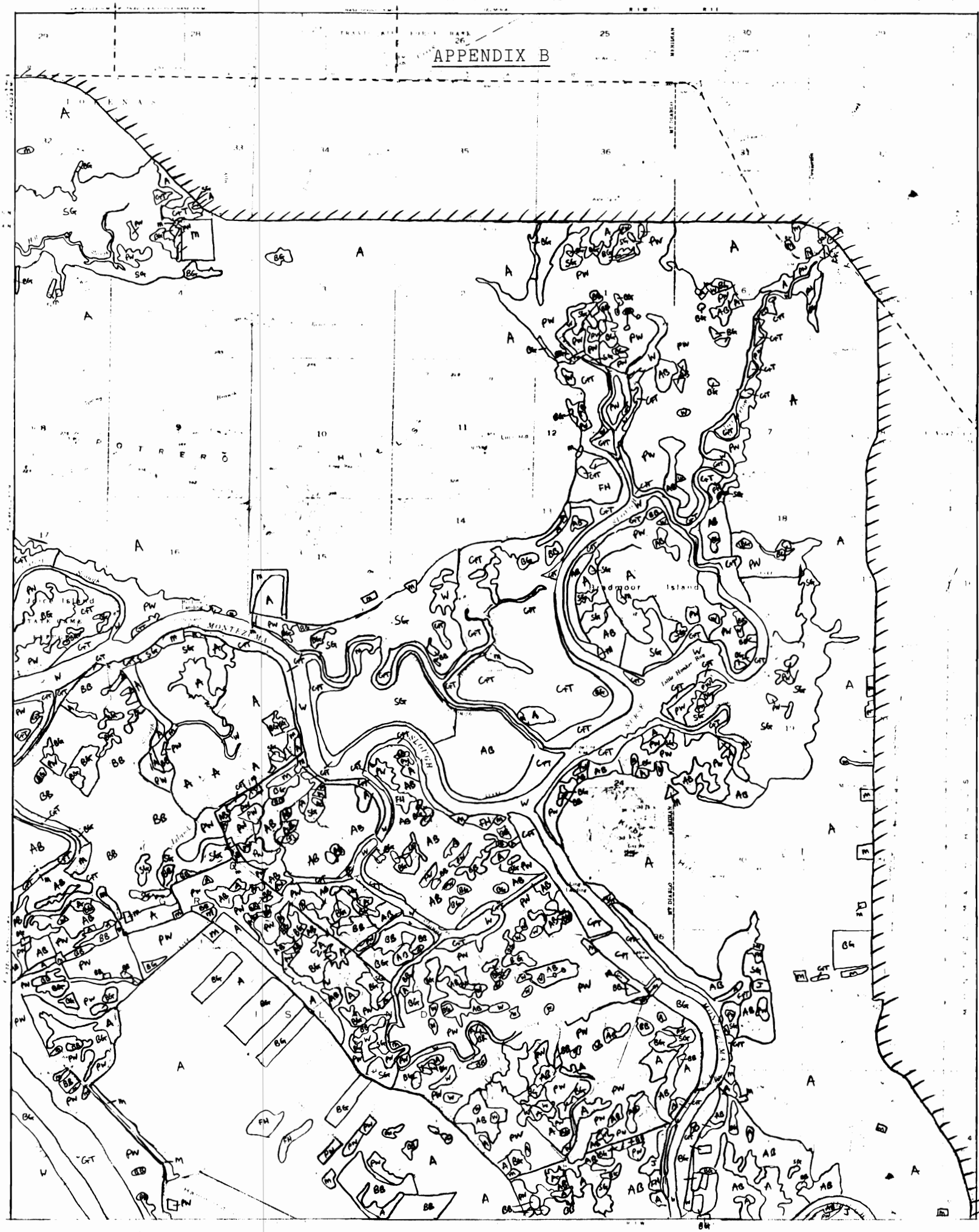


JAMESON CANYON
AMERICAN CANYON
Elkhorn Pk
Fagan
Napa Junction
Chabot Terrace
Lake Chabot
Harry Floyd Terrace
NAPA CO
SOLANO CO
Page Flat

APPENDIX B

Suisun City
SUISUN
TOLENAS
POTRERO
HILLS
Suisun Hill
W SUISUN
SLOUGH
MONTEZUMA
W SLOUGH
MUD
Morrow Island

APPENDIX B



POTRERO
HILLS
Joice Island
Bradmoor Island
MONTEZUMA
SLOUGH

UNITED STATES
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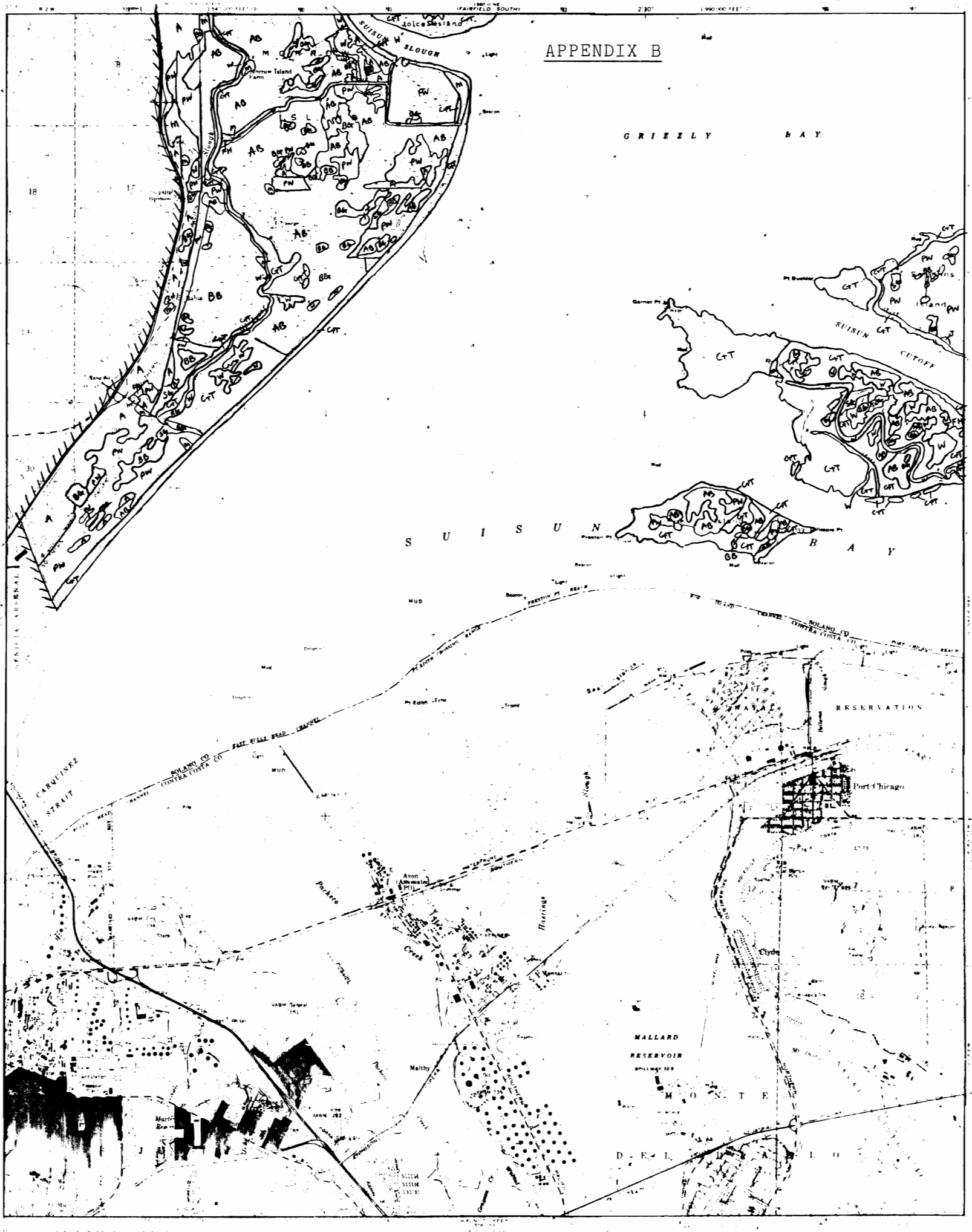
HARVEY O. BANKS, DIRECTOR OF WATER RESOURCES

CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)

APPENDIX B



APPENDIX B

GRIZZLY BAY
HONKER BAY
SUISUN BAY
Point Pinole
Point Pulgas
Point Pinole
Point Pulgas
Point Pinole
Point Pulgas