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TECHNICAL REPORT CERC-91-8



US Army Corps of Engineers

# FIELD WAVE GAGING: FIVE-YEAR DEPLOYMENT PLAN, FY90-94

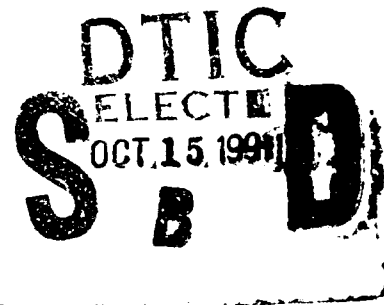
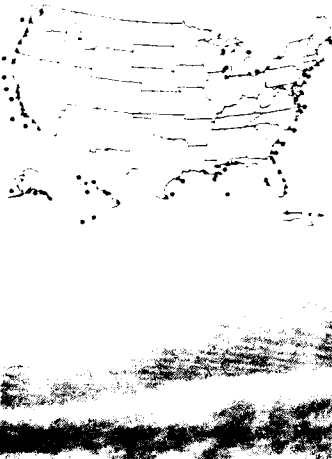
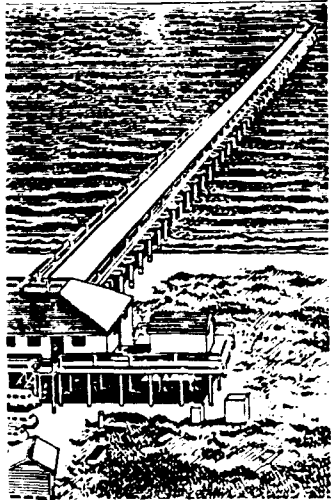
by

David D. McGehee

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY

Waterways Experiment Station, Corps of Engineers  
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199



September 1991

Final Report

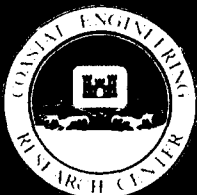
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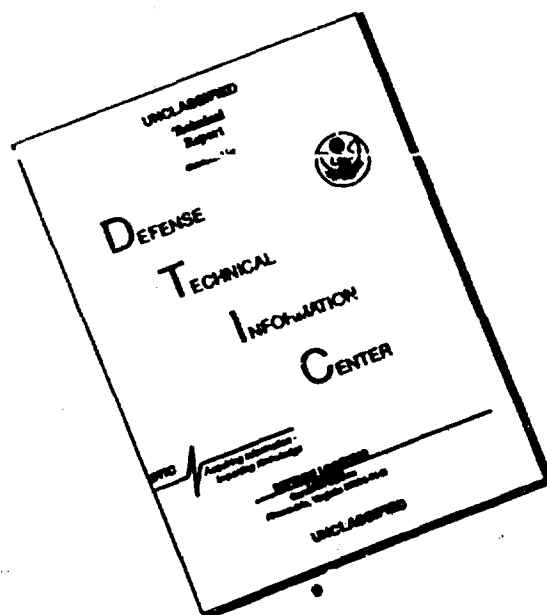


Prepared for DEPARTMENT OF THE ARMY  
US Army Corps of Engineers  
Washington, DC 20314-1000

Under Work Unit 12115



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# Preface

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This is the first Five-Year Deployment Plan of the Field Wave Gaging Program (FWGP), sponsored by Headquarters, US Army Corps of Engineers (HQUSACE). Subsequent plans will be published annually. This report is a product of the Coastal Field Data Collection Program (CFDCP), Coastal Engineering Research Center (CERC), US Army Engineer Waterways Experiment Station (WES), under Work Unit 12115. Mr. J. Michael Hemsley was the former CFDCP Program Manager, and Ms. Carolyn M. Holmes is the present CFDCP Program Manager. The HQUSACE Technical Monitors are Messrs. John H. Lockhart, Jr.; John G. Housley; James E. Crews; and Robert H. Campbell.

This report was prepared by Mr. David D. McGehee of the Prototype Measurement and Analysis Branch (PMAB), Engineering Development Division (EDD), CERC. The FWGP is administered at CERC under the supervision of Mr. William L. Preslar, Chief, PMAB, and Mr. Thomas W. Richardson, Chief, EDD. Mr. Charles C. Calhoun, Jr., and Dr. James R. Houston are Assistant Chief and Chief, CERC, respectively.

Commander and Director of WES is COL Larry B. Fulton, EN. Dr. Robert W. Whalin is Technical Director.

# Introduction

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The Field Wave Gaging Program (FWGP) is provided by Work Unit 12115 of the Coastal Field Data Collection Program, US Army Corps of Engineers. It is managed by the US Army Engineer Waterways Experiment Station (WES), Coastal Engineering Research Center (CERC). The purpose of the FWGP is to collect coastal wave climatology data sets for use in the planning, design, and operation of coastal projects and for coastal research for all sections of the United States coastline (Figure 1). This goal will be accomplished through a combination of long-term measurements to directly establish wave statistics and short-term measurements to calibrate and verify numerical transformation models and hindcasts. This plan is a schedule of the number, location, and type of wave gages deployed in the current fiscal year (FY90) and to be deployed in the next 4 fiscal years (FY91-FY94).

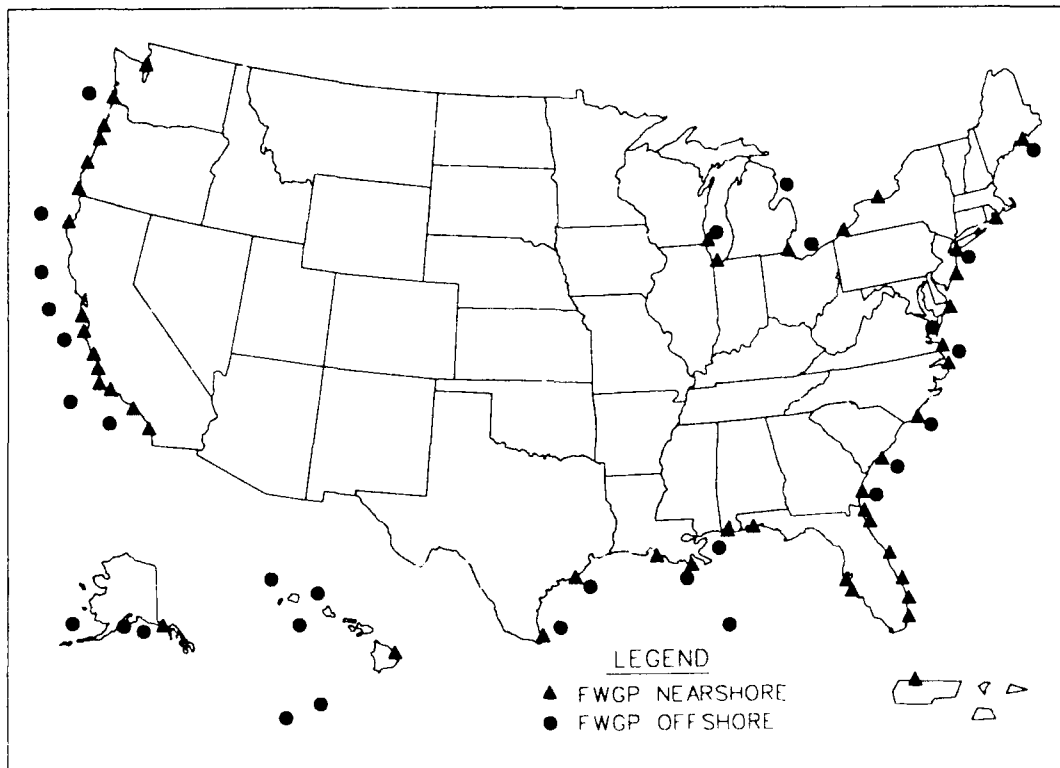


Figure 1. Field Wave Gaging Program Projected Deployments through FY 94

The plan is presented as a series of tables and accompanying charts. The first section consists of the data needs identified by the major subordinate commands (MSC) in a series of meetings held at each Division Headquarters and by CERC researchers for use in model validation. Data requested for improvement of design, operation, or maintenance of existing or future coastal projects, and for calibration and verification of wave propagation/transformation models, included wind and current in addition to directional and non-directional waves. A total of 241 areas were selected, with 176 rated as high priority by the MSC. A table and a chart are presented for each coastal Corps Division with corresponding map index numbers for each area.

These locations represent areas with specific data requirements, and not actual instrument sites. Some areas may require multiple gages, while others may not be suitable for gage deployment. Many have immediate and unique utility for model calibration; others may be redundant for that purpose. Technical, logistic, and economic constraints can vary widely, sometimes for adjacent areas. The interaction of these factors with the MSC needs resulted in the prioritization of the areas in the schedule.

Section II contains the 5-year deployment schedule for each Division that most economically contributes to the needs of the MSC and the goal of the FWGP. The type of gage and deployment date, by quarter, are listed in a table and shown on a Divisional chart. Numerical models that would use an area's data for input or verification are listed. The existing data-base, in gage years, from historical measurements in an area is also included.

The Division deployment maps indicate by symbols existing and scheduled gage locations, as well as discontinued gage sites where sufficient data have been collected to make reliable projections. Other agencies and programs have deployed gages, but only data sets several years in length will be included in the FWGP database. This includes the National Data Buoy Center (NDBC) network of deep ocean, nondirectional gages. These are indicated on the maps with a separate symbol when not supported by FWGP funds. However, the FWGP has funded the installation or the conversion to directional gages by the NDBC. These are included in the table with appropriate comments.

This plan is based on projected funding levels of the FWGP, presented below, according to the FY90 Work Unit 12115 Implementation Plan. It is also based on scheduled developments in gage technology and anticipated gage mortality based on past experience. Cooperative efforts and cost sharing with other Corps and non-Corps elements could enhance the number and schedule of gages in a Division.

FWGP Projected Funding					
Fiscal Year	90	91	92	93	94
Budget - M\$	1.1	1.6	2.1	2.5	2.5

# List of Symbols

---

## Data Needs

- $\alpha$  Directional wave spectra
- $\odot$  Nondirectional wave spectra
- $\nabla$  Low-frequency wave, tides, and average water levels
- $\rightsquigarrow$  Winds
- $\rightarrow$  Currents

## Gage Types

- @ DWG-CM (directional + currents)
- # Puv gage (directional + currents)
- % Anemometer
- \* Single pressure gage (nondirectional)
- = Linear array (directional)
- X Sxy or DWG-1 (directional)
- 0 Nondirectional buoy wave gage
- / Directional buoy wave gage

# List of Abbreviations

---

BFY	Budget fiscal year, FY91
CFY	Current fiscal year, FY90
COE	Corps of Engineers
CM	Current meter
C-MAN	Coastal Marine Automated Network (by NDBC)
Dir.	Directional wave gage or measurement
Div.	Division
DWG-1	Directional Wave Gage, version 1 (by COE)
DWG-CM	Directional Wave Gage, with current meter option (by COE)
FY	Fiscal year
HRB	Harbor Oscillation model
IE	Inlets and Entrances Wave/Current Interaction Model
L	Long duration gage (30 to 50 years)
MCCP	Monitoring Completed Coastal Projects Program (by COE)
MMS	Minerals Management Service
NDBC	National Data Buoy Center, National Oceanic and Atmospheric Administration
NOAA	National Oceanic and Atmospheric Administration
Non-dir.	Nondirectional wave gage or measurement
(P)	Partial support

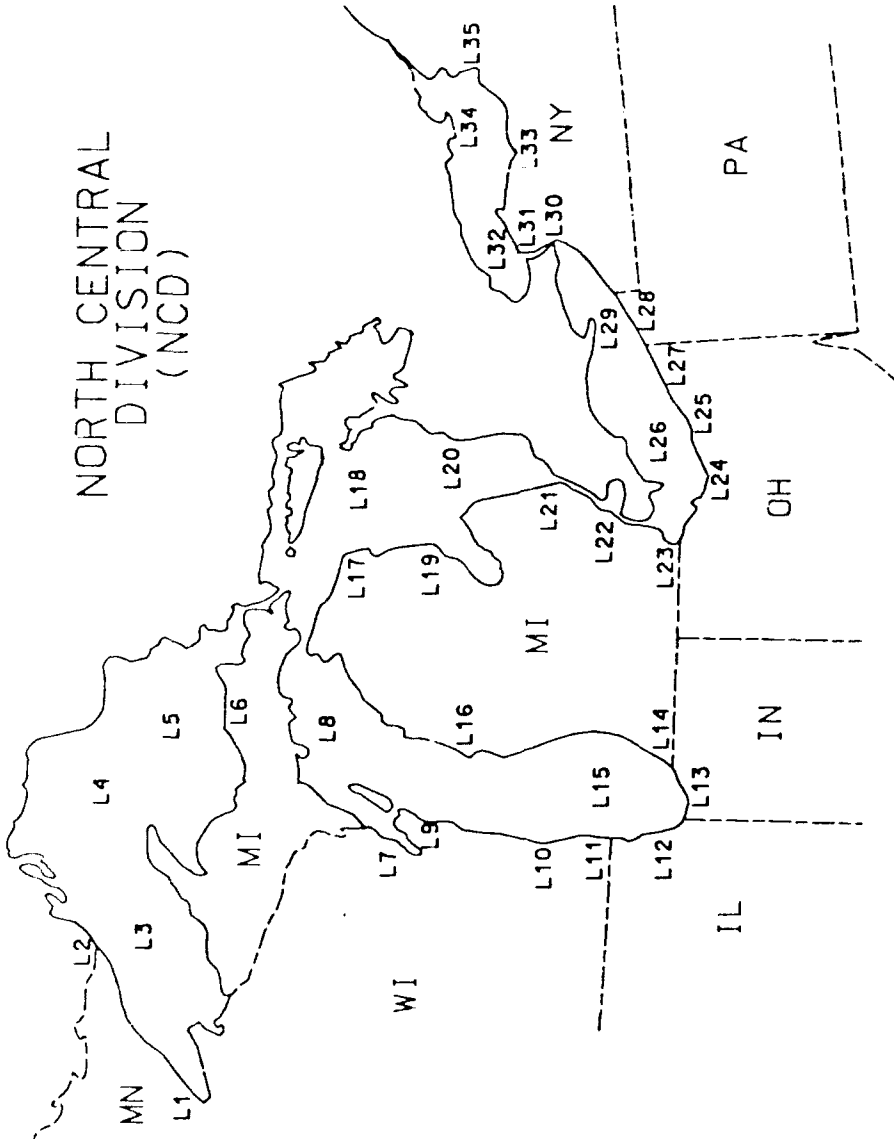
Puv	Combination pressure and current meter wave gage (directional)
RCP	Regional Coastal Processes Wave Transformation Model
S	Short duration gage (3 to 5 years)
SED	Sediment Transport Model
SIO	Scripps Institution of Oceanography
Sxy	Radiation Stress, as measured by large slope array wave gage
USN	US Navy
WIS	Wave Information Study (hindcast)

# **Section I**

## **Data Needs**

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NORTH CENTRAL  
DIVISION  
(NCD)



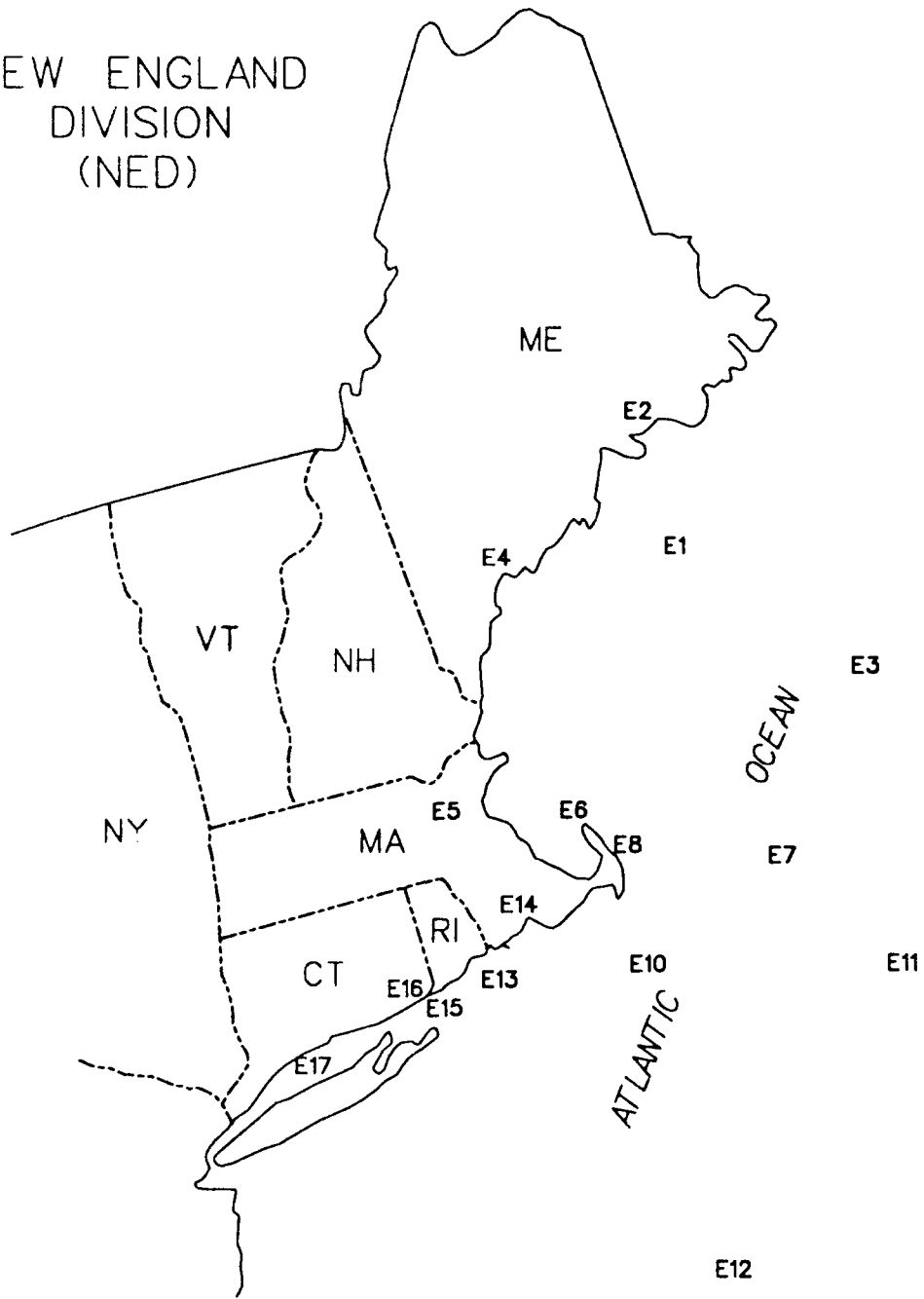
FIELD WAVE GAGING - DATA NEEDS

DIVISION NCD

MAP INDEX NO.	AREA NAME	HIGH PRIORITY	MED. PRIORITY	DURATION	DIR. WAVES	NONDIR. WAVES	TIDES/WL	WINDS	CURRENTS	OTHER	EXISTING GAGES		
											COE	OTHER	
L1	Duith			S									
L2	Grand Marais			S									
L3	West Lake Superior			L								1	
L4	Mid Lake Superior			L								1	
L5	East Lake Superior			L								1	
L6	Grand Marais, MI			S									
L7	Green Bay			S									
L8	North Lake Michigan			L								1	
L9	Kewaunee			S									
L10	Sheboygan			L									
L11	Milwaukee			S									
L12	Chicago			L									
L13	Indiana Shores			S									
L14	Benton Harbor			S									
L15	South Lake Michigan			L								1	
L16	Big Saible Point			S								1	
L17	Hammond Bay			S									
L18	North Lake Huron			L								1	
L19	Harrisville			S									
L20	South Lake Huron			L								1	
L21	Harbor Beach			S									
L22	Detroit			S									
TOTALS													

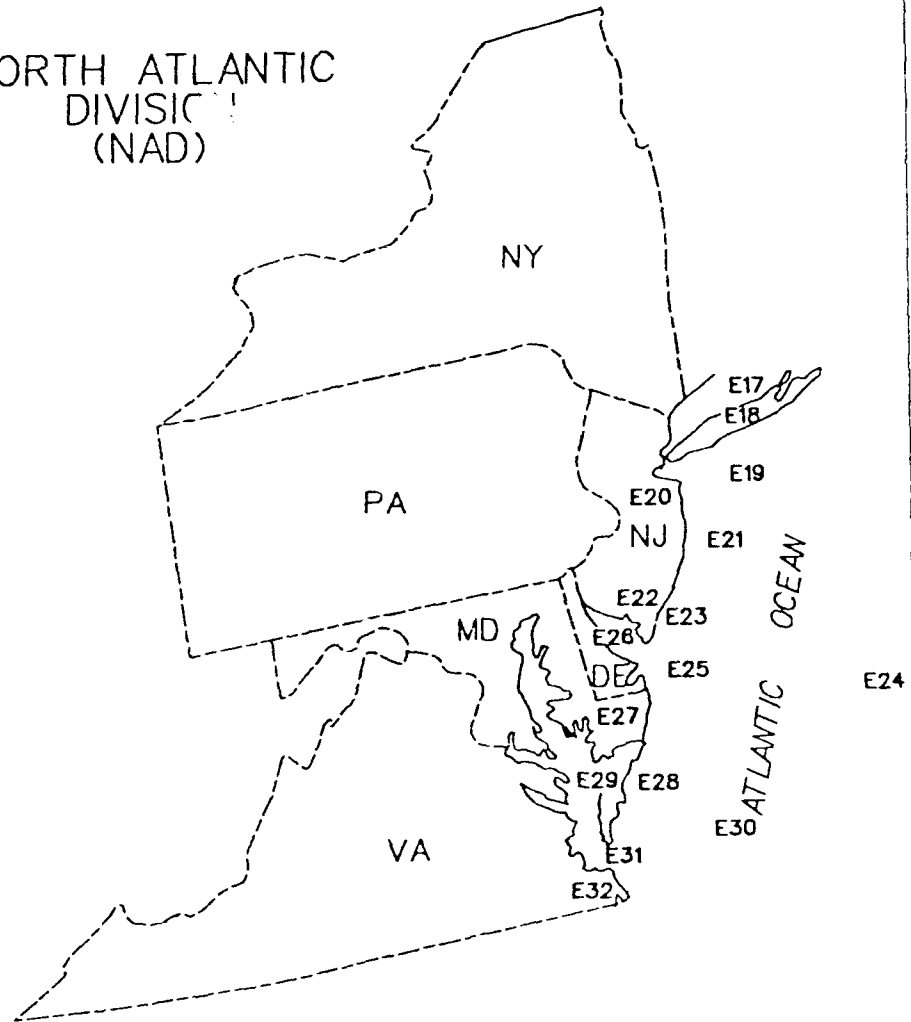


NEW ENGLAND  
DIVISION  
(NED)





NORTH ATLANTIC  
DIVISION  
(NAD)



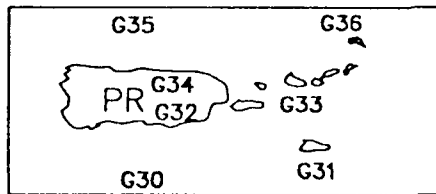
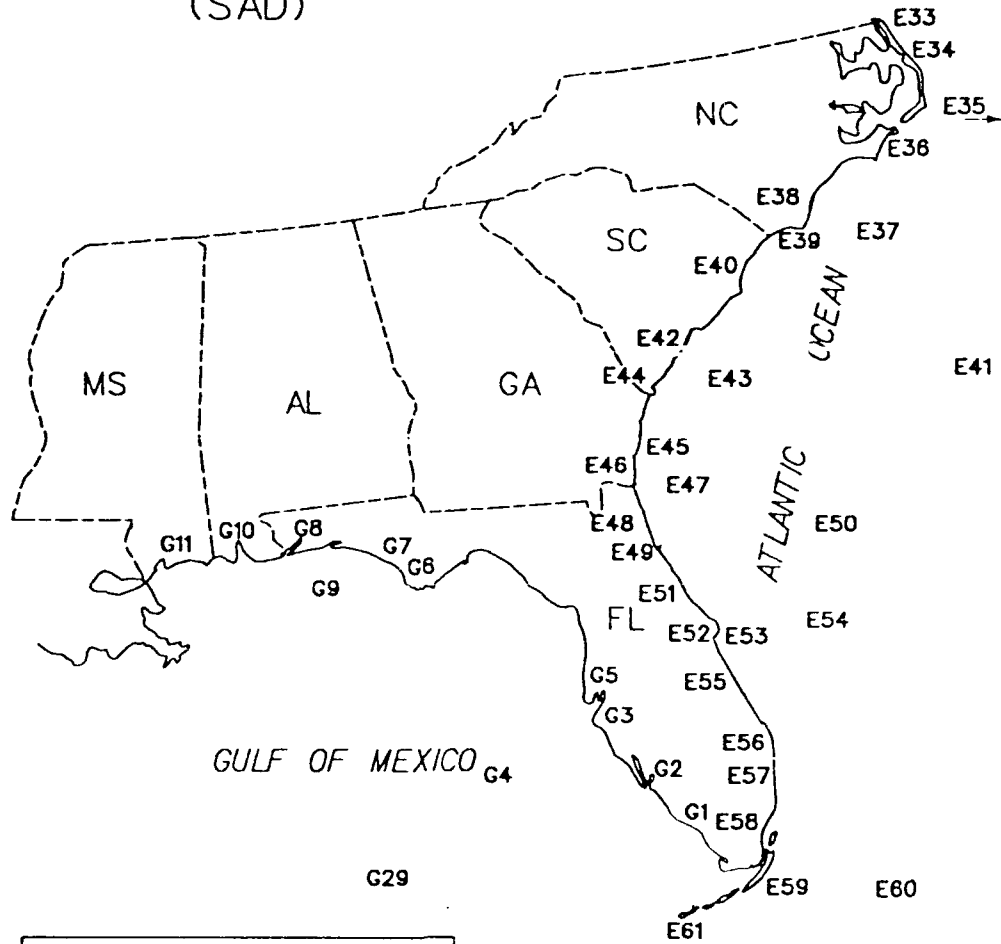
# FIELD WAVE GAGING - DATA NEEDS

DIVISION NAD

MAP INDEX NO.	AREA NAME	HIGH PRIORITY	MED. PRIORITY	DURATION	DIR. WAVES	NONDIR. WAVES	TIDES/WL	WINDS	CURRENTS	OTHER	COMMENTS	EXISTING GAGES	
												COE	OTHER
E17	Long Island Sound	●		S	●			●	●		2 locations for a dir. buoy		
E18	Long Island Shoreline	●		S	●		●	●	●		5 sites identified		
E19	Ambrose	●		L	●		●						
E20	N. Jersey Shore	●		S	●		●						
E21	Barnegat Inlet		●	S	●		●		●				
E22	Atlantic City	●		L	●		●		●				
E23	Cape May	●	●	S	●		●		●				
E24	Hotel	●		L	●		●				NNBC buoy #44004-6N; non-directional		I
E25	Delaware Bay Entrance	●		L	●		●				NDBC buoy #44009-LNB; non-directional		I
E26	Delaware Shore	●		S	●		●		●		Gage mount & cable in place		
E27	Ocean City	●		S	●		●				Co-operation w/Episodic Events		2
E28	Chincoteague Inlet	●		S	●		●						
E29	Chesapeake Bay (A-K below)												
E29-A	Baltimore		●	S	●		●		●				
E29-B	Chester River	●		S	●								
E29-C	Kent Island		●	S	●		●						
E29-D	Tilghman Island	●		S	●		●						
E29-E	Choptank River	●		S	●								
E29-F	Cambridge & VIC		●	S	●		●				Multiple sites		
E29-G	Calvert Cliffs	●		S	●		●						
E-29-H	Potomac River	●		S	●								
E29-I	S. Potomac Shores		●	S	●		●				Multiple sites		
TOTALS													



SOUTH ATLANTIC  
DIVISION  
(SAD)



# FIELD WAVE GAGING - DATA NEEDS

DIVISION SAO

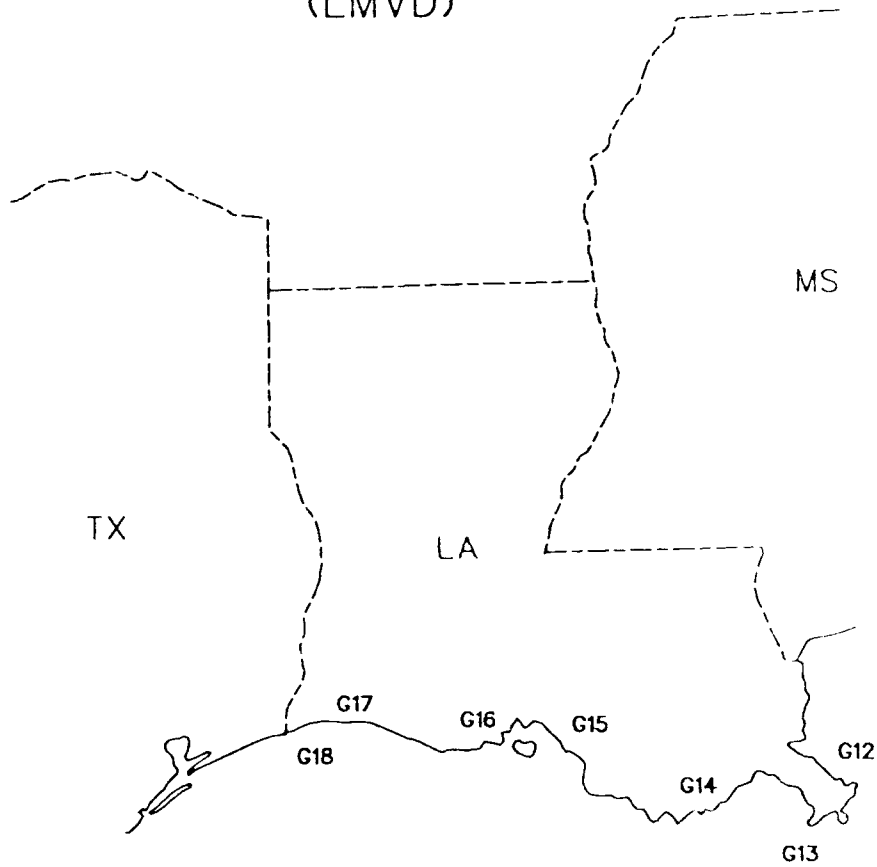
MAP INDEX NO.	AREA NAME	HIGH PRIORITY	MED. PRIORITY	DURATION	DIR. WAVES	NONDIR. WAVES	TIDES/WL	WINDS	CURRENTS	OTHER	EXISTING GAGES	
											COE	OTHER
E30	Duck	•		L	•	•	•	•	•	•		3
E31	Bayou Inlet		•	S	•							
E35	East Hatteras	•		L	•							
E39	Beaufort	•		S	•							
E37	North Core's Light	•		L	•							
E38	Wilmington	•		S	•							
E39	Little River Inlet	•		S	•							
E40	Ward's Inlet	•		S	•							
E41	South Hatteras		•	L	•							
E47	Ferry Island	•		S	•							
E4	South Core's Light	•		L	•							
E44	Wright Island	•		S	•							
E45	St. Marks Island	•		S	•							
E46	Cambermont (near) Island	•		S	•							
E47	St. Marks Entrance	•		S	•							
E48	Rocky Point	•		L	•							
E49	Flayer		•	S	•							
E50	East Daytona		•	L	•							
E51	Ponce de Leon Inlet	•		S	•							
E52	Port Canaveral		•	S	•							
E53	Cape Canaveral	•		L	•							
upgrade to Invest. Gulf Stream effects												
TOTALS												

TOTALS





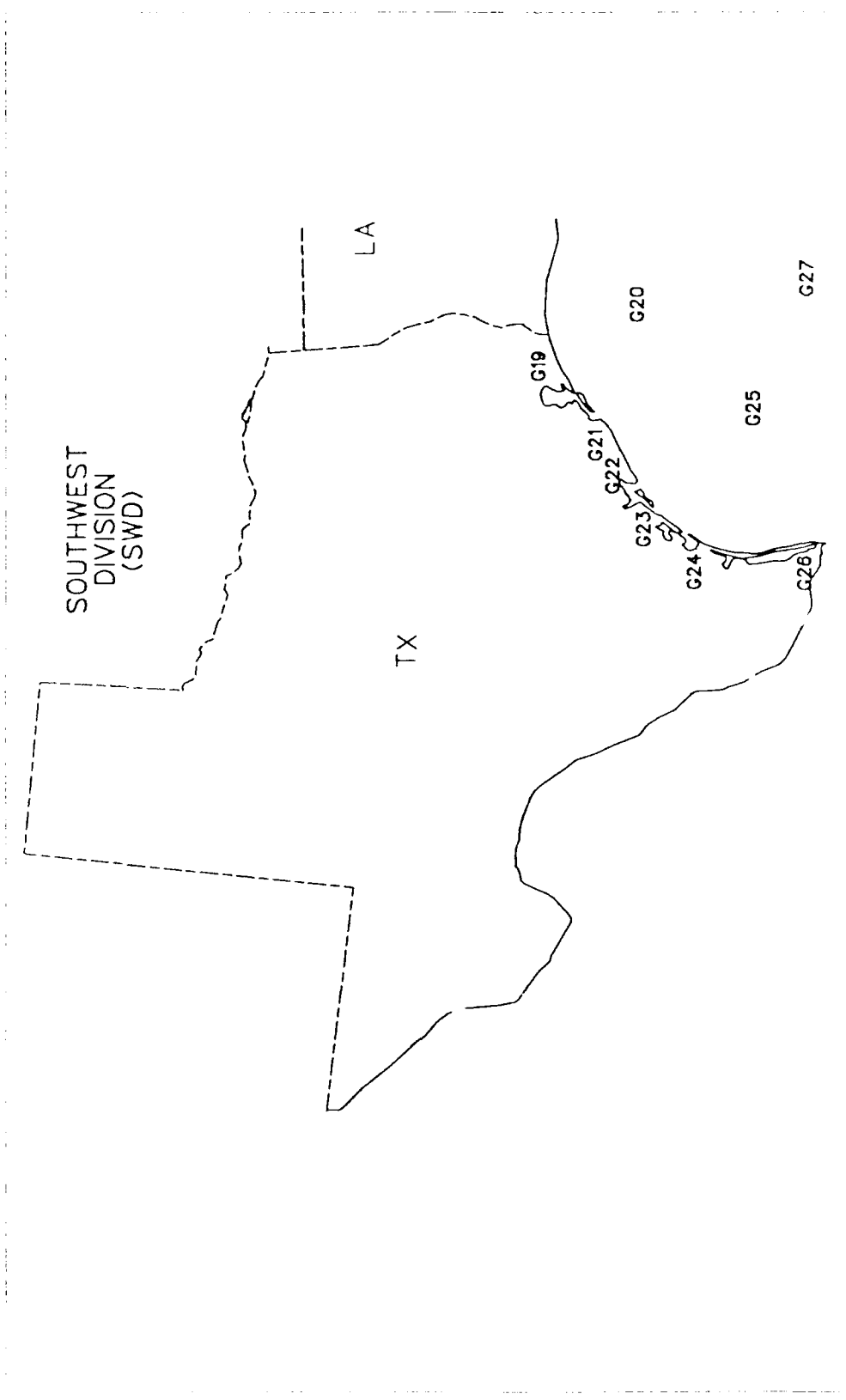
LOWER MISSISSIPPI  
VALLEY DIVISION  
(LMVD)



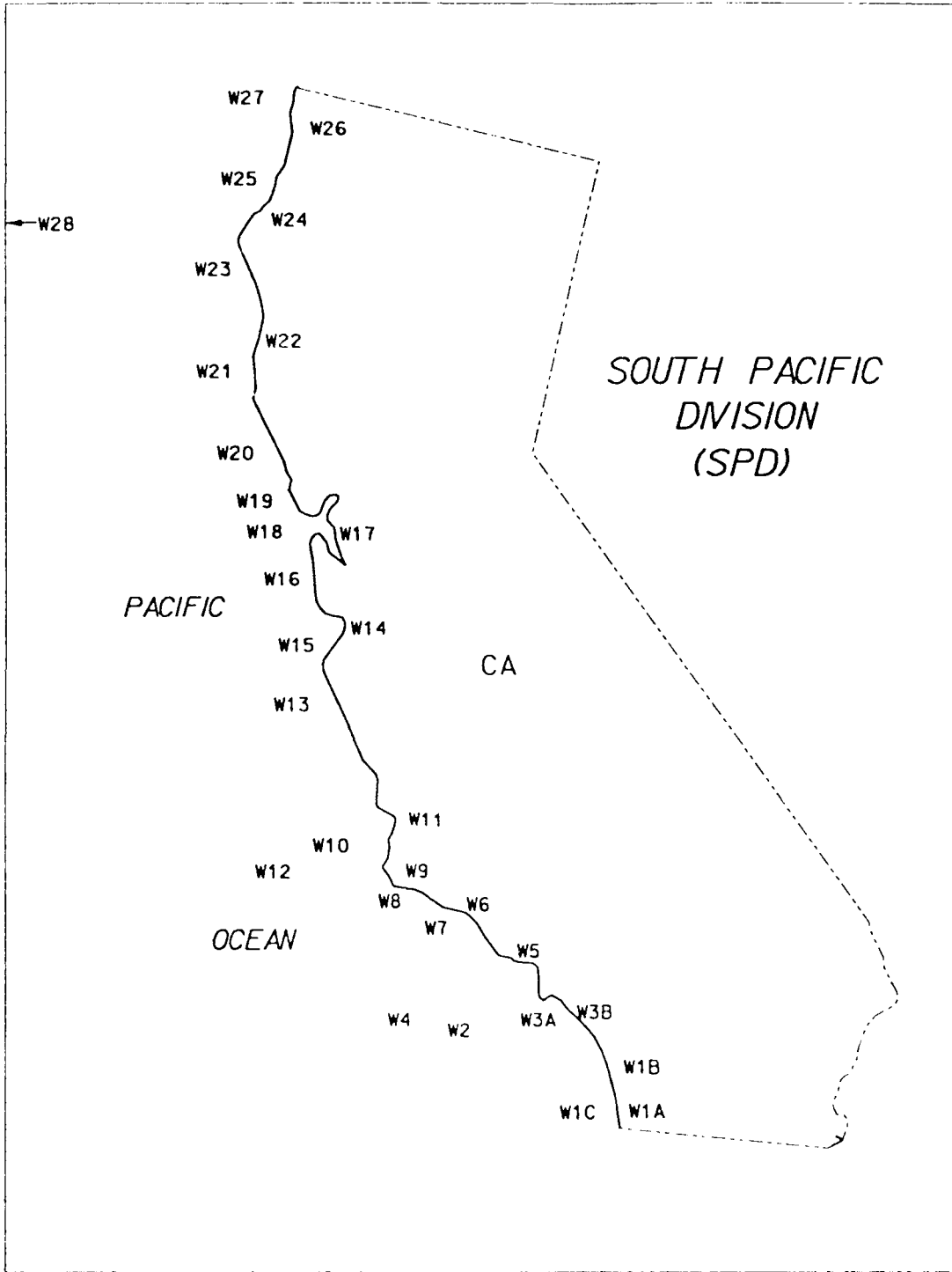
GULF OF MEXICO

G28







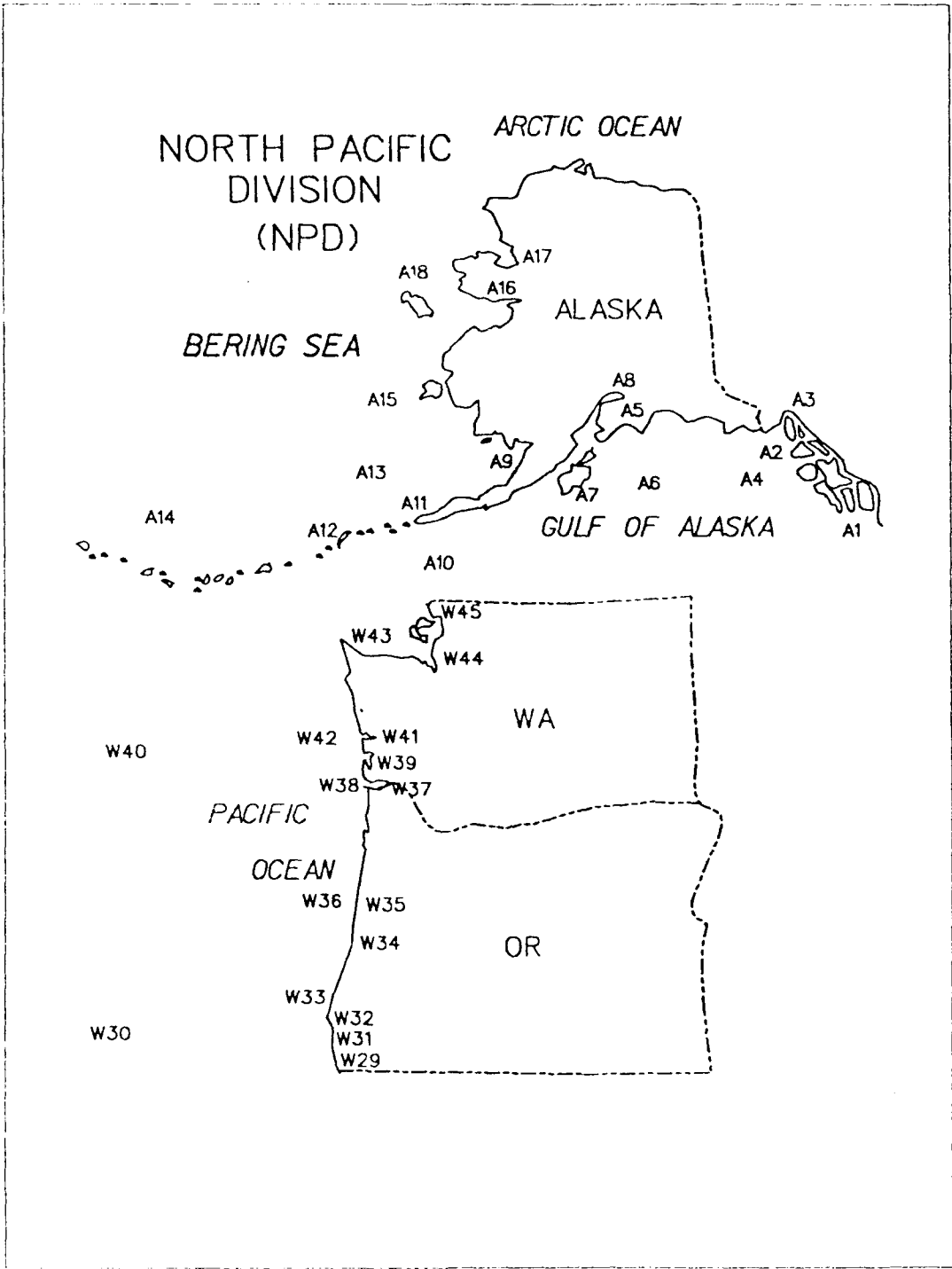


# FIELD WAVE GAGING - DATA NEEDS

DIVISION SPD

MAP INDEX NO.	AREA NAME	HIGH PRIORITY	MED. PRIORITY	DURATION	DIR. WAVES	NONDIR. WAVES	TIDES/WL	WINDS	CURRENTS	OTHER	COMMENTS	EXISTING GAGES	
												COE	OTHER
W1-A	San Diego	•		S	•	•	•	•	•		Potential co-op w/o O&M, SPD: Significant data base exists from 3 sites	2	
W1-B	Oceanside	•		S							Significant database exists from 3 sites	2	
W1-C	San Pedro Channel	•		L	•		•				Provide Southern Swell effect on South. California		
W2	Catalina Ridge	•		L	•		•				NDBC buoy •46025-3D: directional	(P)	1
W3-A	San Pedro Bay	•		S	•	•	•	•			Co-op w/MCCP Redondo Beach work unit		
W3-B	Redondo Beach	•		S	•	•	•	•			Potential co-op w/SPD and Ports of LA/LB	1	
W4	South. California Bight	•		L	•		•				Co-op w/MCCP Redondo Beach work unit	(P)	1
W5	Santa Monica	•		S	•		•				Co-op w/USN		
W6	Santa Barbara	•		S	•		•				Navy owned, COE operated		1
W7	Santa Cruz Canyon	•		S	•								
W8	Point Conception	•		L	•		•				NDBC buoy •46023-10D: non-directional		1
W9	Point Arguello	•		S	•		•				Non-directional gage on Harvest Platform	1	
W10	Santa Maria	•		S	•		•				NDBC buoy •46011-6N non-directional		
W11	Marro Bay	•		S	•		•				S10 buoy at Diablo Canyon: non-directional	1	
											2 g-ges required		
W12	Pt. Buchon	•		S	•			•					
W13	Cape San Martin	•		S	•		•				NDBC buoy •46028-6N: non-directional		1
W14	Monterey Bay	•		S	•		•						2
W15	Monterey Offshore	•		L	•		•				NDBC buoy •46042-3D: directional		1
TOTALS													



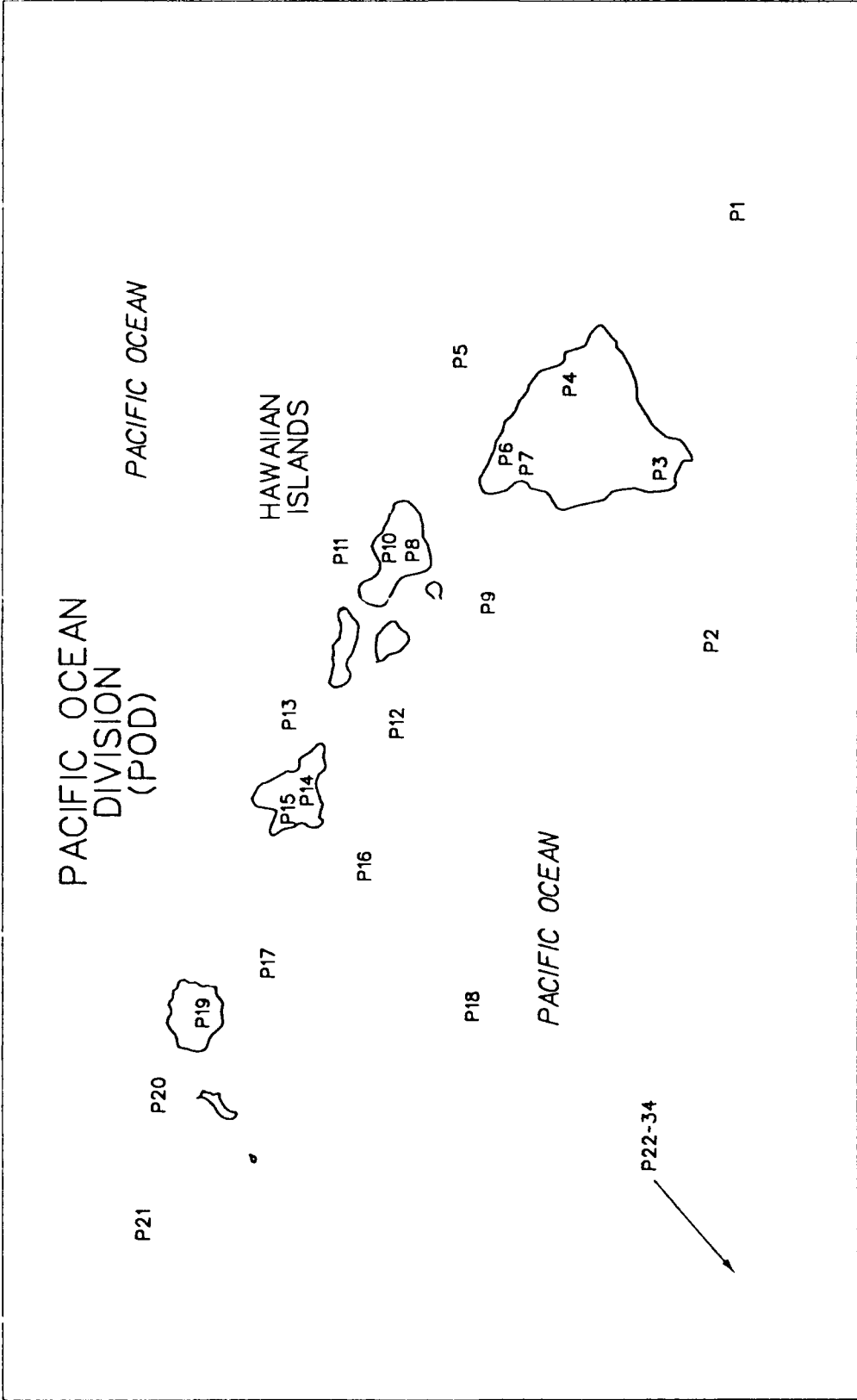


# FIELD WAVE GAGING - DATA NEEDS

DIVISION NPD

MAP INDEX NO.	AREA NAME	HIGH PRIORITY	MED. PRIORITY	DURATION	DIR. WAVES	NONDIR. WAVES	TIDES/WL	WINDS	CURRENTS	OTHER	EXISTING GAGES		
											COE	OTHER	
W29	Cape Sebastian			S	•		•						
W30	Oregon			L	•		•			NDBC buoy •46002-6N: non-directional		1	
W31	Coquille	•		S	•		•				2		
W32	Coos Bay	•		S	•		•						
W33	Cape Arago	•		L	•		•			S10 buoy at Coquille: non-directional	1		
W34	Siuslaw	•		S	•	•	•			Coop w/MCCP Program planned	1		
W35	Yaquina	•		S	•	•	•			Coop w/MCCP Program planned; multiple gages			
W36	Cape Foulweather			L	•		•			NDBC buoy •46040-3D; non-directional		1	
W37	Columbia River entrance	•		L	•		•			Need gages on both sides of entrance	1		
W38	Columbia River Offshore	•		L	•		•			NDBC buoy •46010-LNB: non-directional		1	
W39	Willapa Bay			S	•		•						
W40	Washington	•		L	•		•			NDBC buoy •46005-6N: non-directional		1	
W41	Grays Harbor	•		S	•		•						
W42	Grays Harbor Offshore	•		L	•		•			Replace waverider w/upgraded NDBC	1	1	
W43	Strait of Juan de Fuca			L	•	•	•					1	
W44	Seattle	•		S	•		•						
W45	San Juan Islands	•		S	•		•						
A1	Ketchikan	•		S	•		•						
A2	Sitka	•		S	•		•			Multiple gages required			
A3	Youn Canal			S	•		•						
A4	Southeast Alaska	•		L	•		•						
TOTALS													



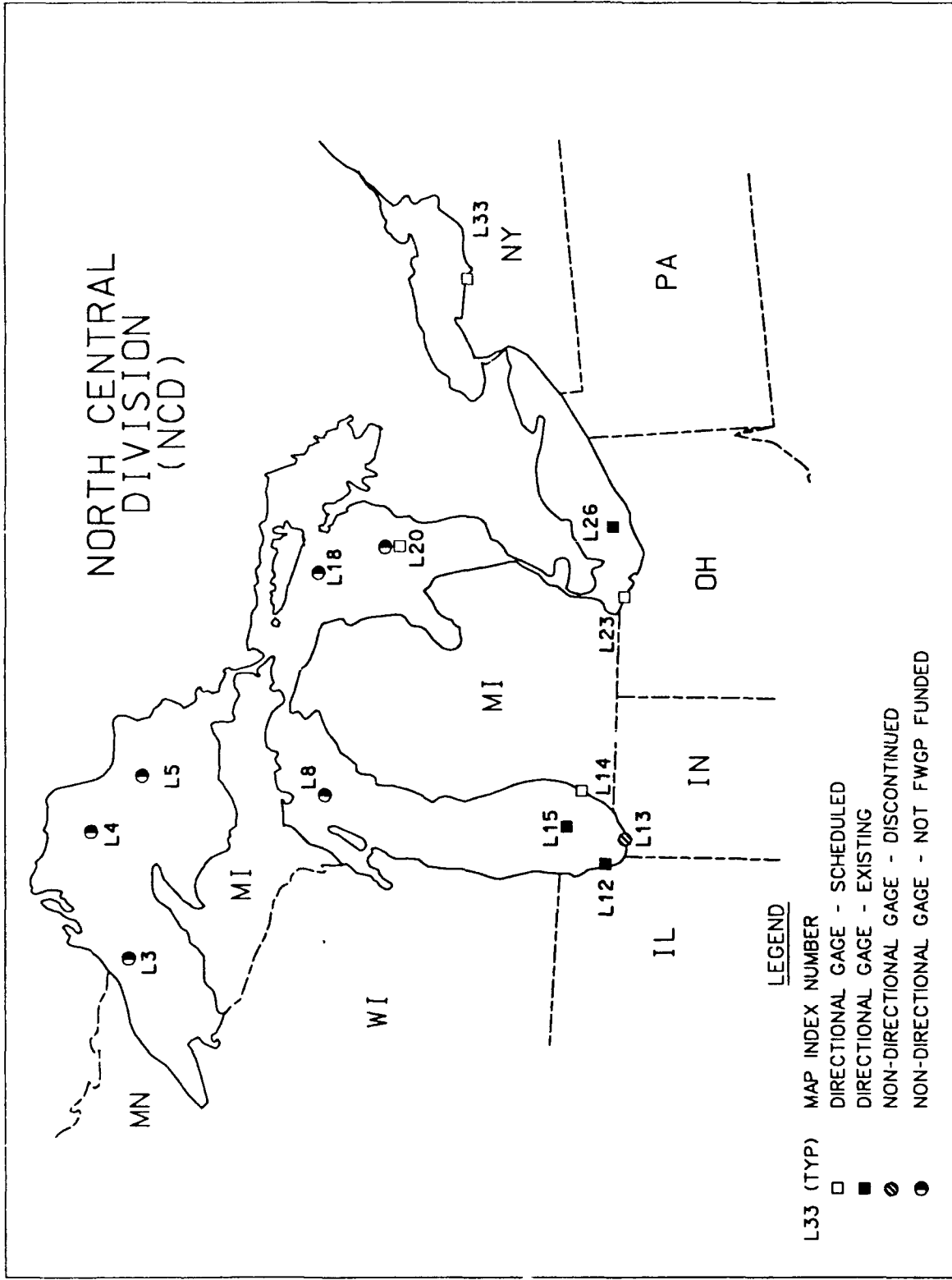






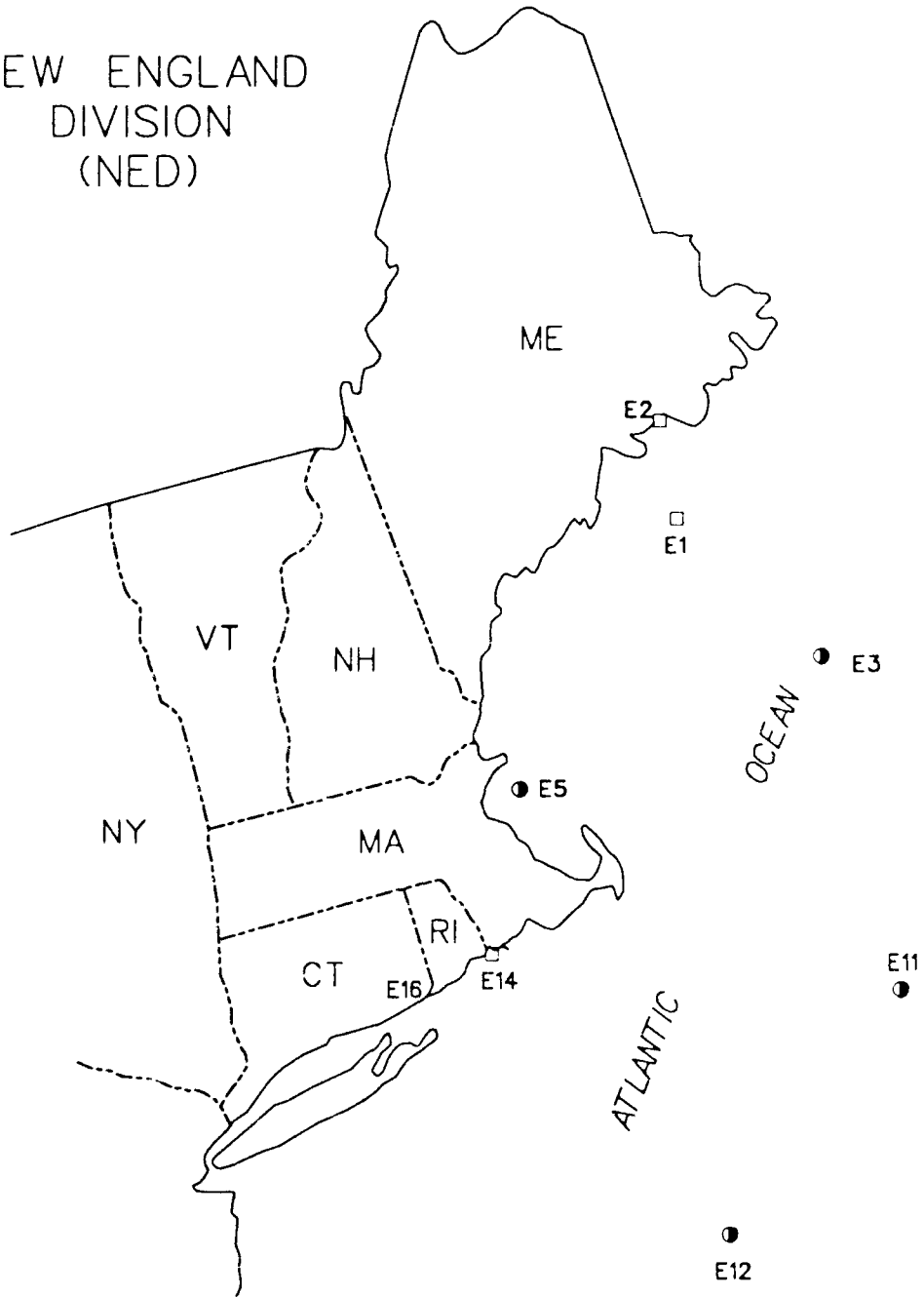
# **Section II Deployment Plan**

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NEW ENGLAND  
DIVISION  
(NED)

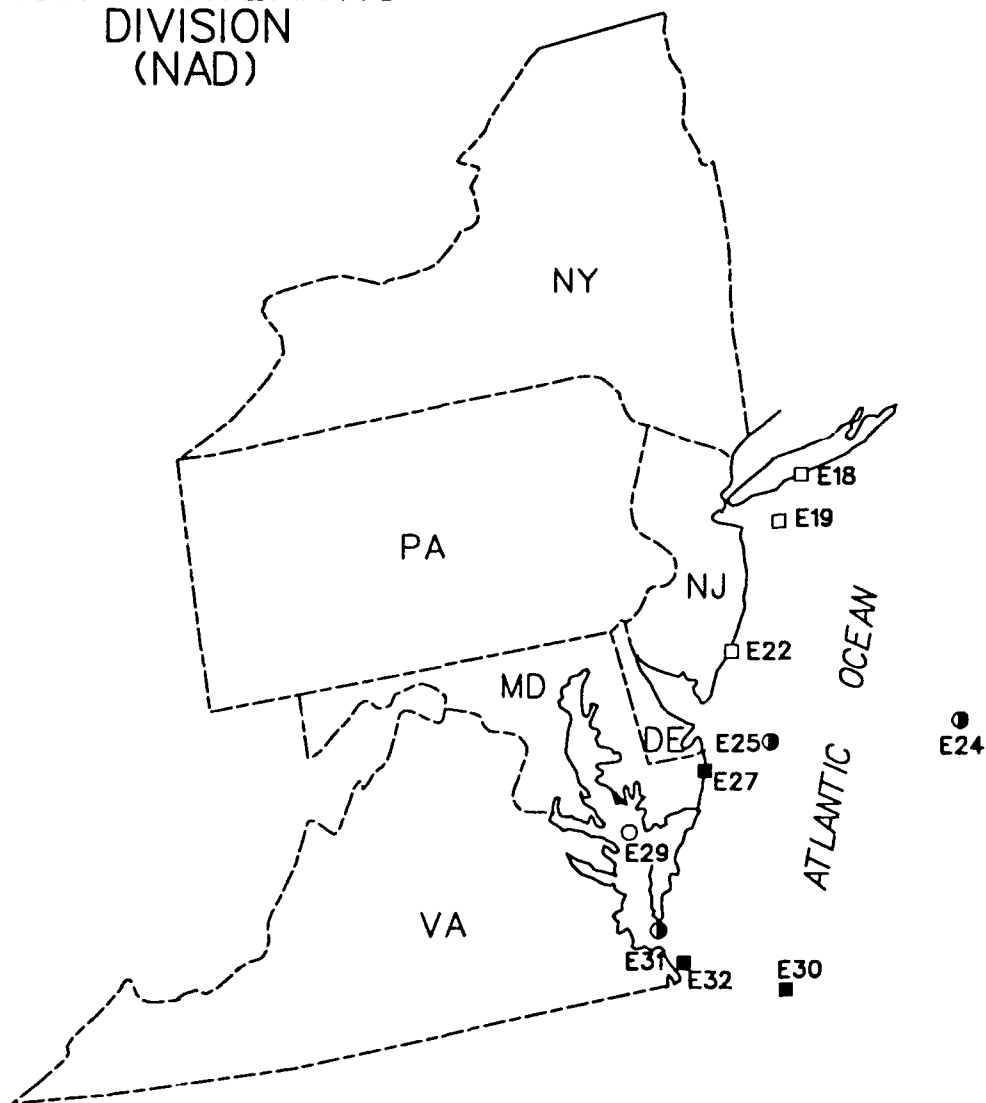


LEGEND

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- NON-DIRECTIONAL GAGE - NOT FWGP FUNDED



NORTH ATLANTIC  
DIVISION  
(NAD)

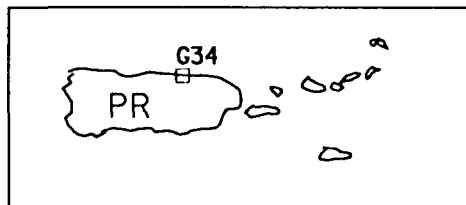
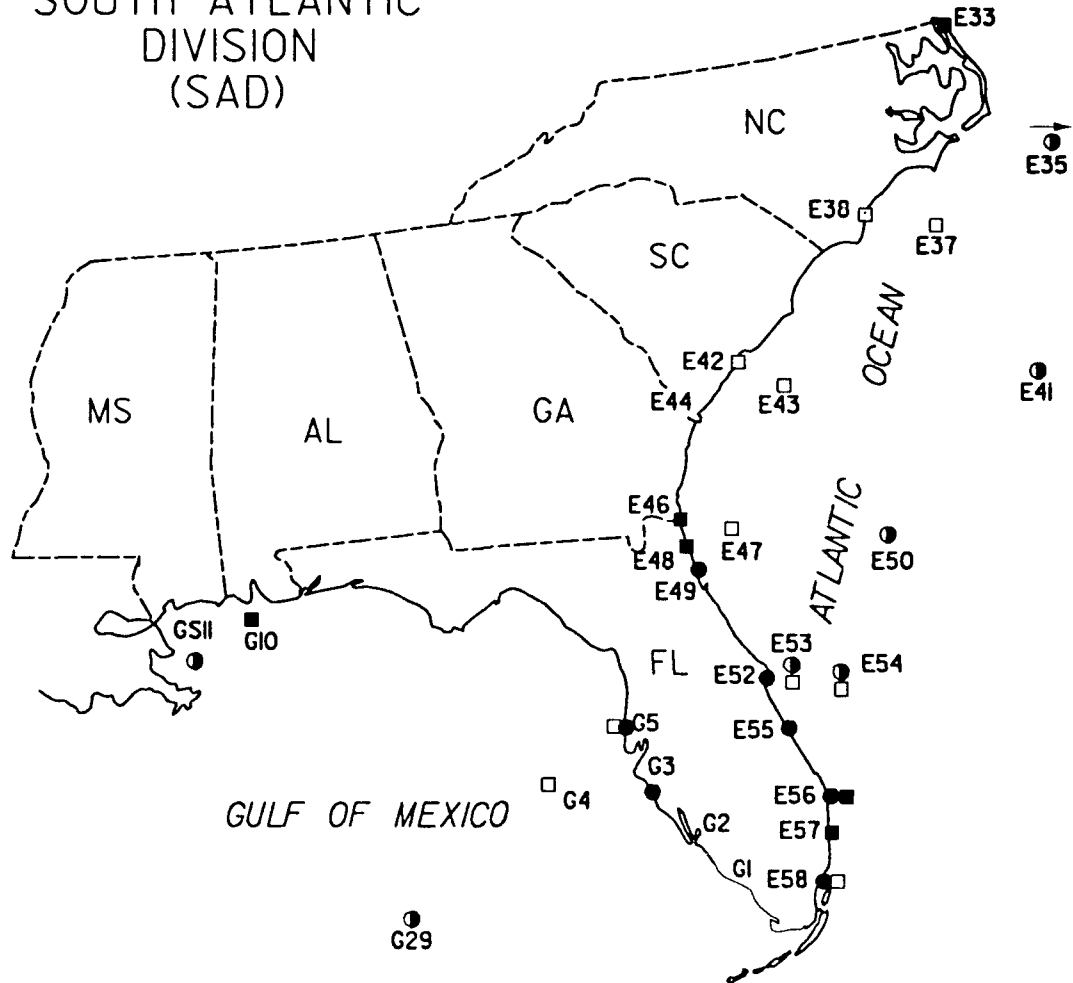


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  - NON-DIRECTIONAL GAGE - SCHEDULED
  - NON-DIRECTIONAL GAGE - NOT FWGP FUNDED



SOUTH ATLANTIC  
DIVISION  
(SAD)



LEGEND

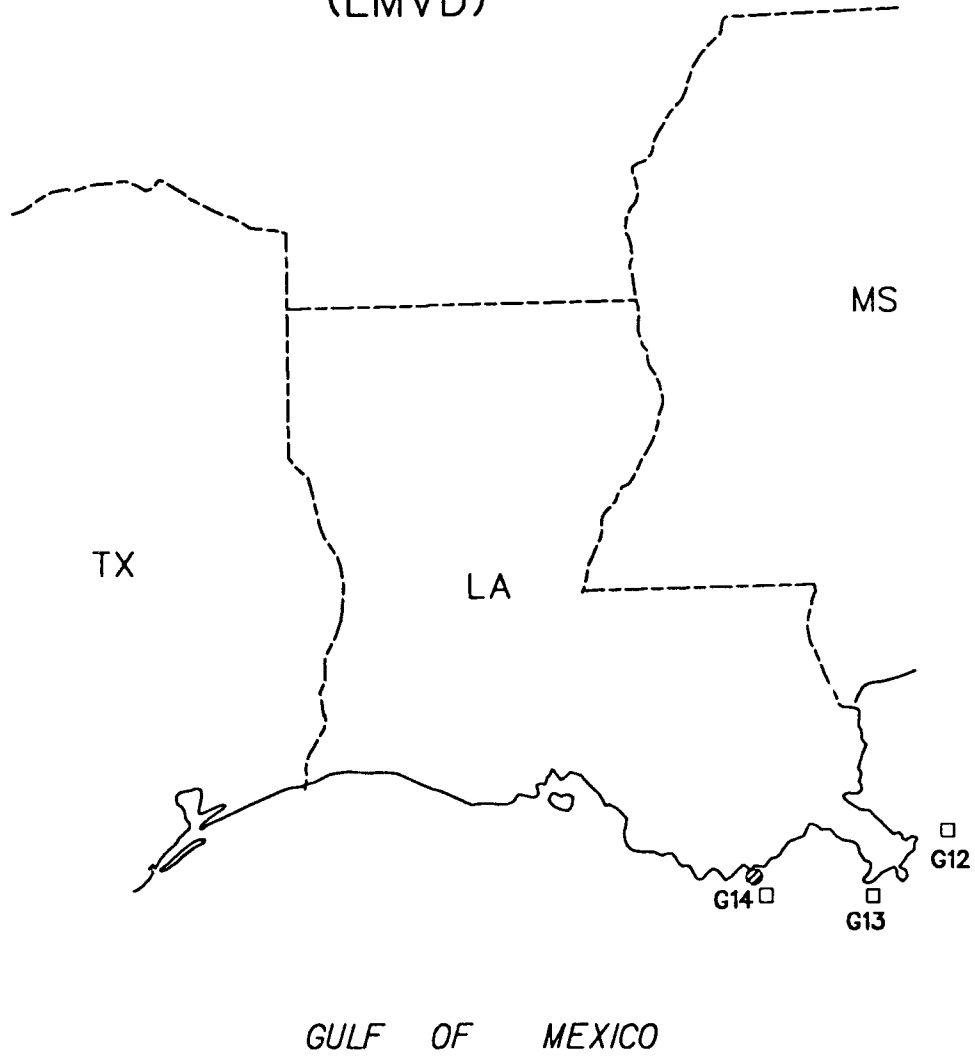
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| E58 (TYP) | MAP INDEX NUMBER                       |
| □         | DIRECTIONAL GAGE - SCHEDULED           |
| ■         | DIRECTIONAL GAGE - EXISTING            |
| ●         | NON-DIRECTIONAL GAGE - EXISTING        |
| ○         | NON-DIRECTIONAL GAGE - NOT FWGP FUNDED |







LOWER MISSISSIPPI  
VALLEY DIVISION  
(LMVD)



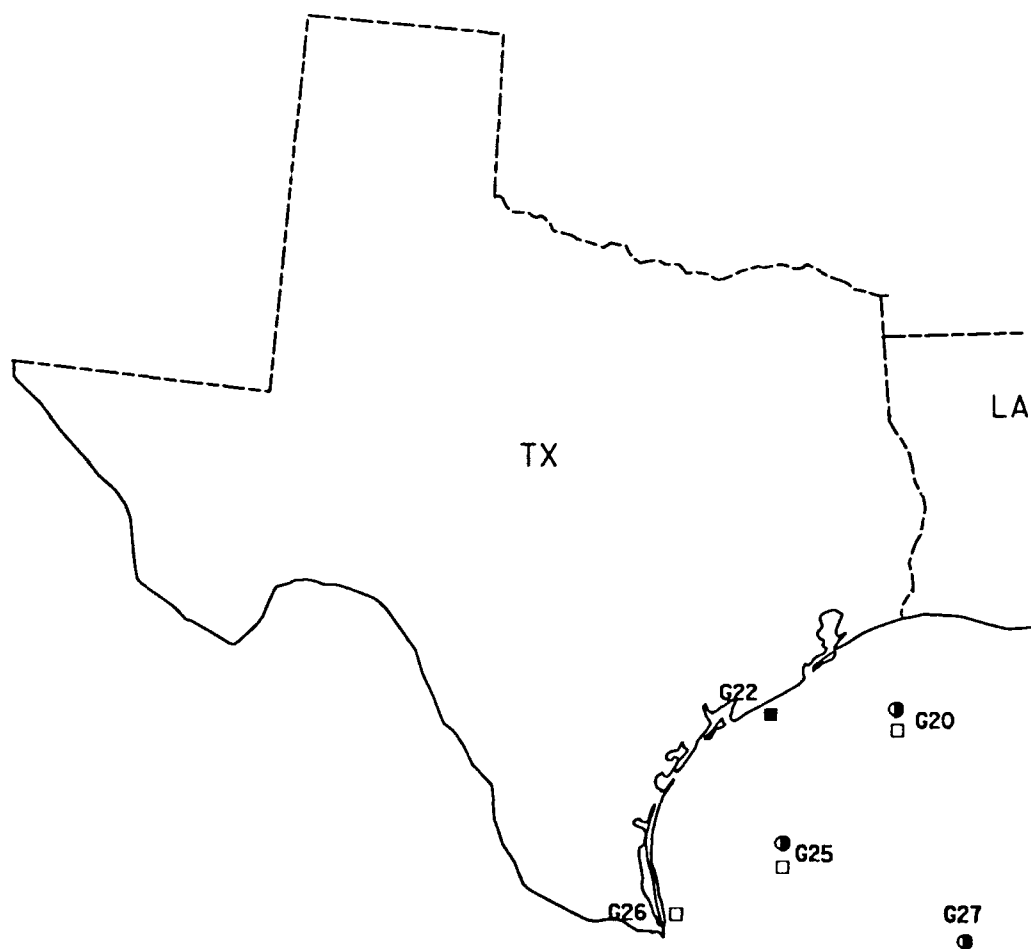
LEGEND

- |           |  |
|-----------|--|
| G28 (TYP) | MAP INDEX NUMBER                       |
| □         | DIRECTIONAL GAGE - SCHEDULED           |
| ⊘         | NON-DIRECTIONAL GAGE - DISCONTINUED    |
| ●         | NON-DIRECTIONAL GAGE - NOT FWGP FUNDED |

□●  
G28



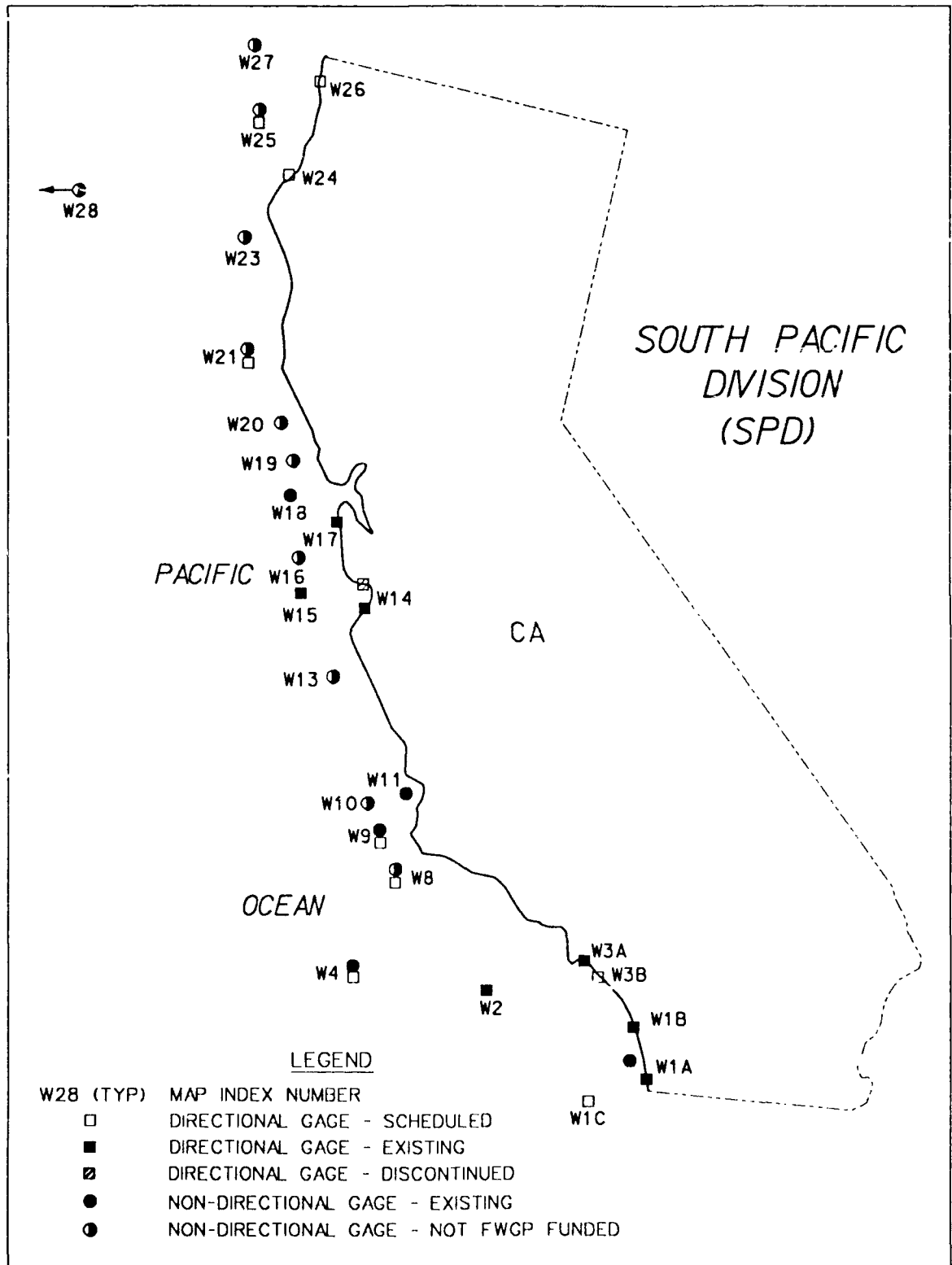
SOUTHWEST  
DIVISION  
(SWD)



LEGEND

- | G27 (TYP) | MAP INDEX NUMBER                       |
|-----------|--|
| □         | DIRECTIONAL GAGE - SCHEDULED           |
| ■         | DIRECTIONAL GAGE - EXISTING            |
| ●         | NON-DIRECTIONAL GAGE - NOT FWGP FUNDED |







# FIELD WAVE GAGING PROGRAM - GAGE DEPLOYMENT PLAN

DIVISION SPD

MAP INDEX NO.	AREA NAME	DATA NEEDS						GAGE STATUS						GAGE DEPLOYMENT				COMMENTS
		DIR. WAVES	NONDIR. WAVES	TIDES/WL	WINDS	CURRENTS	OTHER	MODEL VERIFICATION	GAGE YEARS	GAGE YEARS	CFY	BFY	FY	FY	FY	FY		
W17	San Francisco	•	•	•	•	•	•	WIS	8	3	XXXX	XXXX					Transmission Scope array at Pt. Montez	
W18	Farallon Islands	•						WIS	7	0	0000	0000	0000	0000	0000		Waverider supported by City of San Francisco	
W21	Point Arena	•			•			W-S	9	0	0000	0000	0000	0000	0000		Upgrade NDBC 10M buoy #46014	
W38	Redondo Beach	•	•	•				WIS RCP	0	0	0000	0000	0000	0000	0000		Four DWGs and one NDBC 3M directional buoy instaled by MSCP	
W24	Humboldt	•						WIS	0	0		XX	XXXX	XXXX	XXXX			
W25	Eel River	•			•			WIS	8	0	0000	000	X	XXXX	XXXX		Replace NDBC Nomad buoy w/3M directional buoy at #46022	
W26	Crescent City	•						WIS	2					X	XXXX			
W1-C	San Pedro Channel	•			•			WIS	0	0					XX		Index gage for Southern California	
TOTALS									75	29	'5	'6	'6	'6	'6			

