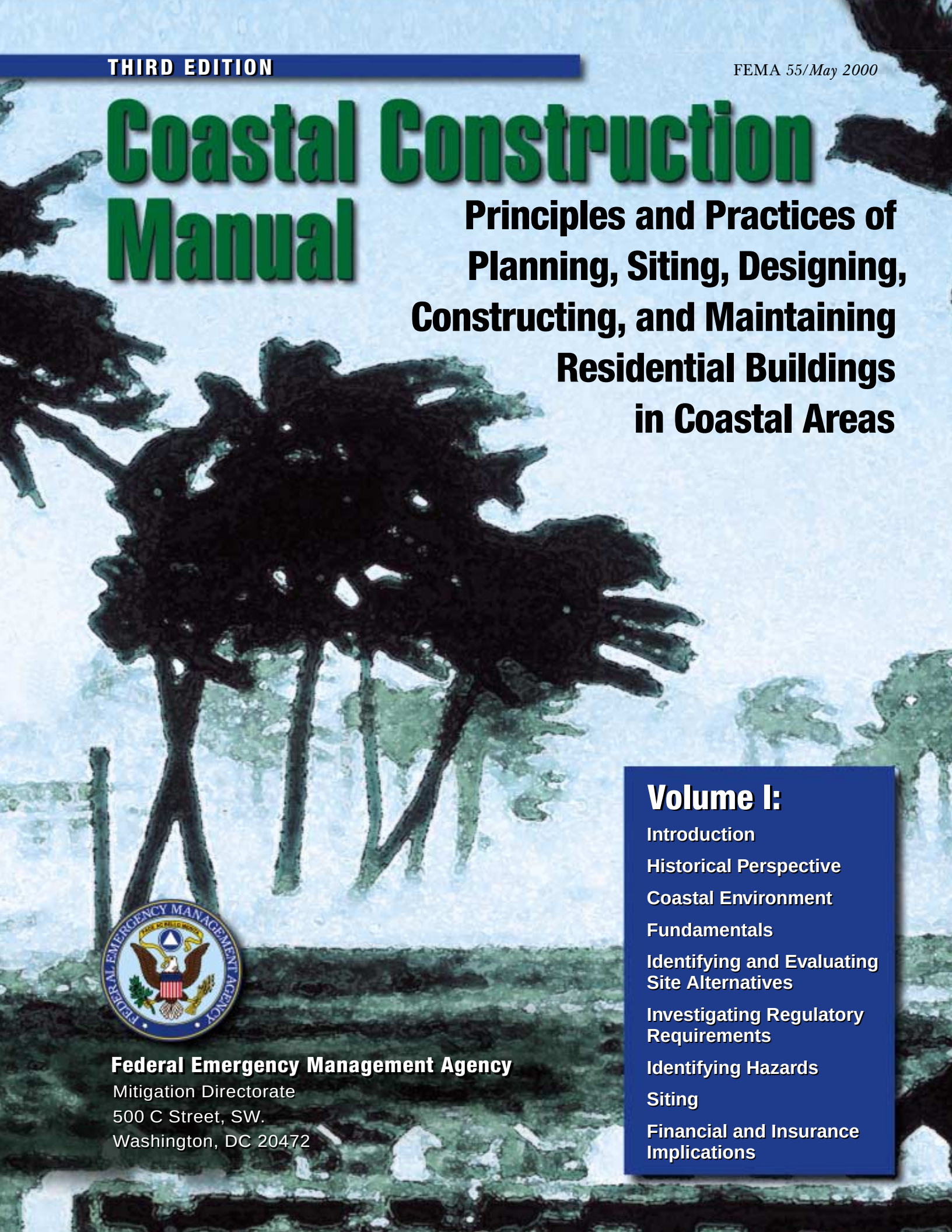
THIRD EDITION

FEMA 55/*May 2000*

Coastal Construction Manual

Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas



Volume I:

- Introduction
- Historical Perspective
- Coastal Environment
- Fundamentals
- Identifying and Evaluating Site Alternatives
- Investigating Regulatory Requirements
- Identifying Hazards
- Siting
- Financial and Insurance Implications

Federal Emergency Management Agency
Mitigation Directorate
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Dedication

Ray Fox (1923-1997)

FEMA is honored to dedicate this edition of the *Coastal Construction Manual* to the memory of Ray Fox.

Ray Fox, Chairman of the Civil Engineering Department at George Washington University in Washington, DC, was a national expert on coastal construction. A consultant to FEMA on many projects, Ray was the principal writer of the first two editions of the *Coastal Construction Manual*. Ray was dedicated to improving the quality of buildings constructed in coastal areas. He emphasized that a building was only as strong as its weakest link. “Connections, connections, connections!” was the phrase he often used to stress the importance of adequately connecting all components of a well-designed building. There was no compromise by Ray when it came to building design. He would often say “ If you can’t build it right then don’t build it.”

Foreword

This is the third edition of the Federal Emergency Management Agency's ***Coastal Construction Manual.*** The manual provides technical guidance for evaluating natural hazards in coastal areas and mitigating those hazards through sound siting, design, construction, and maintenance practices. It is not the intent of this manual to encourage the construction of buildings in hazardous coastal areas. Rather, when such construction does occur, following the recommendations in this manual will help ensure that the buildings are sited, designed, constructed, and maintained in a manner that reduces their vulnerability to natural hazards and therefore reduces the potential for damage.

This manual is not a design document. It does, however, provide detailed guidance and a "best practices" approach to the construction of coastal residential buildings. The user must assume responsibility for adapting and/or supplementing the information contained herein to meet the particular requirements of a project. This manual is intended to complement and supplement the **National Flood Insurance Program** regulations and the codes, ordinances, laws, and regulations of state and local governments.

As a guidance document tailored to the needs of both public and private sector users—including design professionals, contractors, and community building officials—this manual contributes to the goal of reducing the loss of life, damage, and costs that result from natural disasters. An important part of FEMA's mission is helping communities take action to protect themselves from the devastating effects of natural disasters. FEMA has used a variety of mechanisms to transfer information to communities and individuals about the latest hazard mitigation practices. This manual adds to that effort by providing technical information on the best practices for reducing damage in coastal areas. Historically, the most successful application of hazard mitigation practices has rested on cooperation between the private sector and local government. The information in this manual will facilitate the cooperation that is so vital in meeting hazard mitigation goals.

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Greenhorne & O'Mara, Inc.

American Institute of Architects

American Society of Civil Engineers

American Wood Council

Association of State Floodplain Managers

Florida Department of Environmental Protection

Institute for Business & Home Safety

National Association of Home Builders

National Concrete Masonry Association

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Acronyms and Abbreviations

The following are lists of acronyms and abbreviations used in this manual and the terms they represent.

Acronyms

AEC	Area of Environmental Concern
AFPA	American Forest and Paper Association
AIA	American Institute of Architects
AIRAC	All-Industry Research Advisory Council
APA	American Planning Association
ASCE	American Society of Civil Engineers
ASD	allowable stress design
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
BCEGS	Building Code Effectiveness Grading Schedule
BFE	Base Flood Elevation
BOCA	Building Officials and Code Administrators International, Inc.
BPAT	Building Performance Assessment Team
BUR	built-up roof
CABO	Council of American Building Officials
CAFRA	Coastal Area Facility Review Act
CAMA	Coastal Area Management Act
CBIA	Coastal Barrier Improvement Act
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CCCL	Coastal Construction Control Line (Florida)
CEA	California Earthquake Authority
CFR	Code of Federal Regulations
CMU	concrete masonry unit
CRS	Community Rating System
CZM	coastal zone management
DFE	design flood elevation

EIFS	exterior insulating finishing system
FBBCS	Florida Bureau of Beaches and Coastal Systems
FEMA	Federal Emergency Management Agency
FIA	Federal Insurance Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FS	factor of safety
GLSDRS	Great Lakes Storm Damage Reporting System (USACE)
HO	homeowner
HVAC	heating, ventilating, and cooling
IBC	International Building Code
IBHS	Institute for Business & Home Safety
ICBO	International Conference of Building Officials
ICC	International Code Council
IRC	International Residential Code
ISO	Insurance Services Office
LRFD	load resistance factor design
LVL	Laminated-Veneer Lumber
MHW	mean high water
MHHW	mean higher high water
MLW	mean low water
MLLW	mean lower low water
MSL	mean sea level
MWFRS	main wind force resisting system
NAHB	National Association of Home Builders
NAS	National Academy of Sciences
NAVD	North American Vertical Datum
NCRS	Natural Resources Conservation Service (formerly Soil Conservation Service)
NEHRP	National Earthquake Hazards Reduction Program
NFIP	National Flood Insurance Program
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NRCA	National Roofing Contractors Association

NRCS	Natural Resources Conservation Service
NSPE	National Society of Professional Engineers
NWS	National Weather Service
OCRM	Office of Ocean and Coastal Resource Management (National Ocean Service)
OPA	Otherwise Protected Area
OSB	oriented strand board
PSL	parallel-strand lumber
SBC	Standard Building Code
SEAOC	Structural Engineers Association of California
SFHA	Special Flood Hazard Area
SFIP	Standard Flood Insurance Policy
SBCCI	Southern Building Code Congress International
SPF	sprayed polyurethane foam
SWL	stillwater level
UBC	Uniform Building Code
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
Wind-MAP	Windstorm Market Assistance Program (New Jersey)

Abbreviations for Units of Measure and Technical Terms

C_d	drag coefficient
C_p	dynamic pressure coefficient
C_p	external wind pressure coefficient
cos	cosine
D	dead load
d_s	design stillwater flood depth
dia	diameter
E	earthquake load
E_{sw}	design stillwater elevation
F	load due to fluids with well-defined pressures and maximum heights
F_a	flood load
F_{brkp}	breaking wave load on pile
F_{brkw}	breaking wave load on wall
F_{dyn}	hydrodynamic load

F_i	debris impact load
F_{sta}	hydrostatic load
ft	foot, feet
ft^2	square foot, square feet
ft/sec	feet per second
g	gravitational constant
G	wind gust effect factor
H	loads due to weight and lateral pressures or soil and water in soil
H_b	breaking wave height
in	inch, inches
lb	pound, pounds
lb/ft^3	pounds per cubic foot
L	live load
L_r	roof live load
m	meter, meters
mph	miles per hour
o.c.	on center
p	design wind pressure
psf	pounds per square foot
psi	pounds per square inch
R	response modification coefficient (of a structural system)
R	rain load
S	snow load
sec	second
S_{max}	maximum depth of scour
t	time
t	duration of impact
T	self-straining load
V	velocity
Vol	volume of water displaced by a submerged object
w	weight (of an object)
W	effective seismic weight (of a building)
W	wind load
ρ	mass density of fluid
γ	specific weight of water

Metrification

FEMA is committed to the Federal Government's transition to the metric system; however, English units remain the standard of practice for residential construction. Therefore, all measurements in this manual are presented in English units. Because the metric system may eventually become the standard of measurement in the United States, approximate metric conversions are presented below to promote familiarity with that system.

A critical component of unit conversion is rounding. Designers should check to ensure that rounding does not exceed allowable tolerances for design or fabrication.

Metric Conversion Factors

Quantity	To Change English Units	To Metric Units	Multiply English Units By:
Length	inch (in) foot (ft) mile (mi)	millimeter (mm) meter (m) kilometer (km)	25.4000 0.3048 1.6093
Area	square foot (ft^2) acre (a)	square meter (m^2) square meter (m^2)	0.0929 4,046.8564
Volume	gallon (gal) cubic foot (ft^3)	liter (L) cubic meters (m^3)	3.7854 0.0283
Pressure	psf (lb/ft^2) psi (lb/in^2)	Pa kPa	47.8803 6.8947
Weight	pound (lb)	kilogram (kg)	0.4536
Flow	cfs (ft^3/sec)	lps	28.3168
Velocity	fps (ft/sec) mph	mps kph	0.3048 1.6093