



AN ANALYSIS OF NATURALLY-INDUCED

WATER MOTION WITHIN BOTH OPEN

AND CLOSED BASINS

by

Brenton Webber

B.Sc. (Hons.), Dip. Ed., University of Adelaide

Thesis submitted for the degree of

Doctor of Philosophy
(Degree awarded, A. Sc.)
in the

University of Adelaide

Department of Applied Mathematics.

March 1980

TABLE OF CONTENTS

	Page
SUMMARY	(i)
SIGNED STATEMENT	(ii)
ACKNOWLEDGEMENTS	(iii)
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: DEVELOPMENT OF THE DEPTH-INTEGRATED AND DEPTH-CONTOURED EQUATIONS	
2.1 Introduction	4
2.2 Vertically Integrated Equations	6
2.3 Depth-Contour Equations	10
2.4 Boundary Conditions	21
CHAPTER 3: NUMERICAL ANALOGUES OF THE SYSTEM OF DIFFERENTIAL EQUATIONS	
3.1 Introduction	24
3.2 Depth-Integrated Model	26
3.3 Numerical Formulation for Depth-Contour Model	41
CHAPTER 4: VERIFICATION AND INVESTIGATION OF THE NUMERICAL SCHEMES	
4.1 Introduction	57
4.2 Analytic Solutions	58
4.3 Comparison Between Analytical and Numerical Models	74
4.4 Numerical Testing of the Models	96
4.5 Analysis of Possible Functional Forms for the Vertical Eddy Viscosity	103

CHAPTER 5: APPLICATION OF THE NUMERICAL MODELS TO THE SOUTH AUSTRALIAN GULF SYSTEM	
5.1 Introduction	129
5.2 Selection of Physical Data	129
5.3 Effect of Dominant Tidal Components	131
5.4 Analysis of Spencer Gulf Tidal Motion	142
CHAPTER 6: CONCLUSION	156
REFERENCES	159
APPENDIX A: Finite Difference Equations for Depth- Integrated Model	167
APPENDIX B: Finite Difference Equations for Depth- Contour Model	174
APPENDIX C: Explanation of Grid Labelling Scheme	185
APPENDIX D: Notation	188

SUMMARY

This thesis describes two numerical models for the analysis of naturally induced water motion with emphasis on tidal flow. The first of these models is based upon a two-dimensional system of depth-integrated equations. The result of the depth integration is a system of differential equations in which the unknowns are two flow variables and the displacement. The second model is a three-dimensional depth-contour model which is based upon a system of equations which has been non-dimensionalized over depth. This non-dimensionalization allows a more detailed analysis to be made in areas of shallow water.

The two models are verified by first comparing results obtained from the models with analytic solutions for similar situations. Secondly, the results of the two models are compared. A series of numerical tests are then performed to see the effect of varying certain parameters, in particular the vertical eddy viscosity, on the model predictions. Finally, comparisons are made with results obtained from data measurements taken in the South Australian Gulf system. A brief analysis is then made of tidal velocities in this particular situation.

The results obtained from both the analytic and real comparisons indicate that models are likely to be suitable for predictive purposes.

SIGNED STATEMENT

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma in any University and, to the best of my knowledge, it contains no material previously published by any other person, except where due reference is made in the text of the thesis.

B. Webber.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. B. J. Noye, for his guidance and advice during the research for, and the preparation of, this thesis.

Thanks are also due to Mrs. W. Major for her excellent typing, Miss Liz Henderson and Mrs. Angela McKay for their assistance with typing corrections and Mrs. Judy Laing for the preparation of the diagrams.

The work associated with this thesis was carried out from January 1974 to March 1980. During most of this time I was a tutor in the Department of Applied Mathematics, University of Adelaide.

B. Webber.