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NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR. --ETC(U)
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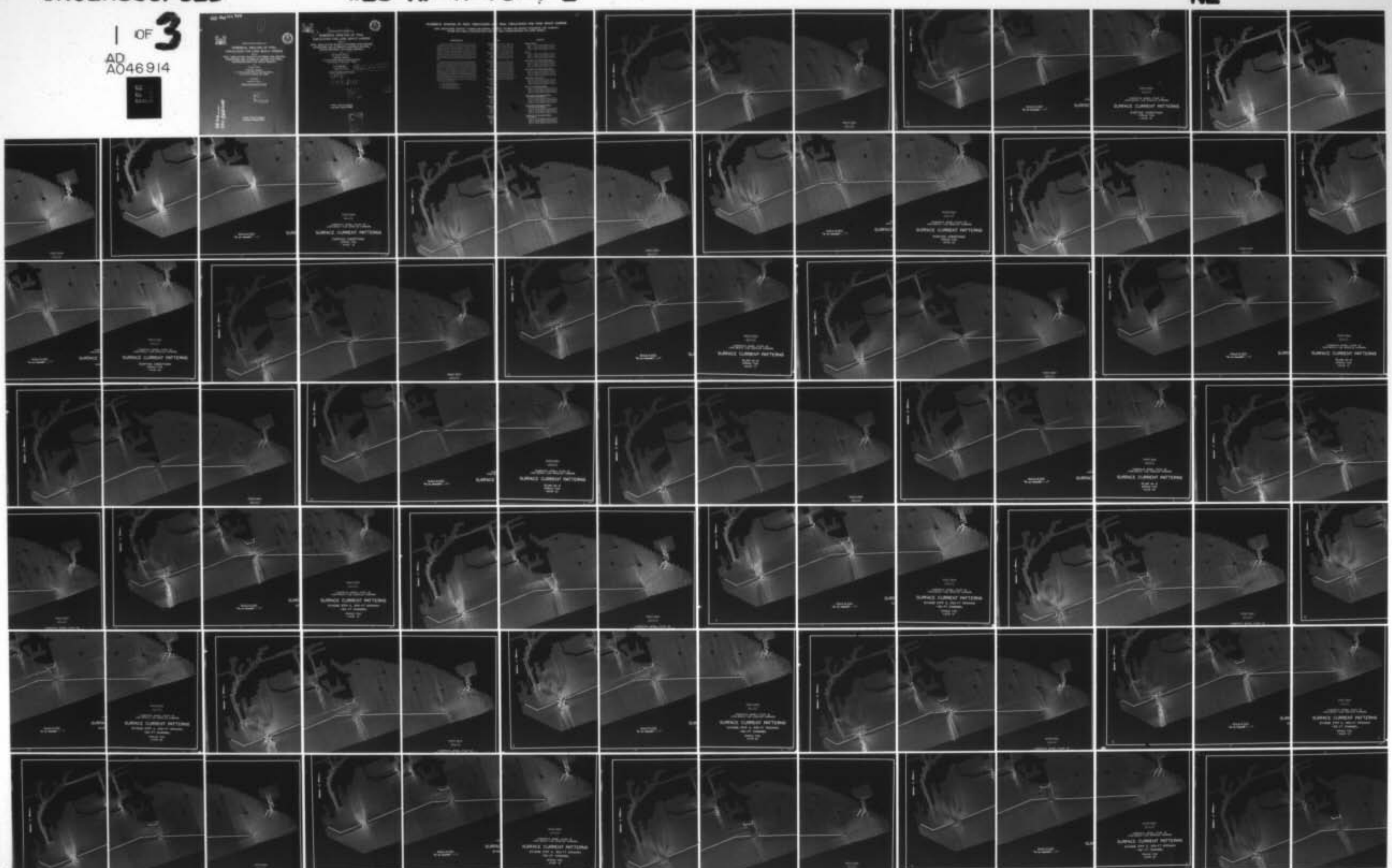

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MISCELLANEOUS PAPER H-76-4

NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR

Report 2

TIDAL CIRCULATION VELOCITY PATTERNS FOR EXISTING CONDITIONS AND ALTERNATE MASTER PLAN PIER-J CONFIGURATIONS FOR SOHIO PROJECT

by

Donald C. Raney

Hydraulics Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

March 1976

Report 2 of a Series

Prepared for Port of Long Beach
Long Beach, California 90801

1

9 MISCELLANEOUS PAPER H-76-4

6

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NUMERICAL ANALYSIS OF TIDAL CIRCULATION F

TIDAL CIRCULATION VELOCITY PATTERNS FOR EXISTING C
MASTER PLAN PIER-J CONFIGURATIONS FOR S

INTRODUCTION

A study was conducted for Long Beach Harbor to numerically investigate tidal circulation in existing basins and to define and evaluate the impact of possible modification of Pier-J for SOHIO (Standard Oil, Ohio) on existing harbor circulation. A two-dimensional depth-averaged formulation of the hydrodynamic equations was used in the model and an implicit-explicit finite difference scheme was used to numerically solve the equations. The numerical model was verified using prototype tide and velocity data and tide and velocity data from physical model tests conducted at WES.

Details of the numerical investigation are presented in Report 1 of this series. This report presents vector plots of the tidal circulation patterns at four times during the tidal cycle for existing conditions and for four modifications to Pier-J. In addition, tidal circulation patterns for each modification are compared with circulation patterns for existing conditions. Vector plots are presented indicating the extent and magnitude of velocity changes produced by each modification. In both sets of vector plots the direction of the vector indicates the direction of current flow and the length indicates the magnitude of the current velocity. The four vector plots of tidal circulation pattern for each Pier-J configuration correspond to flow conditions:

a. Near slack water (hour 15).
b. Near maximum flood (hour 19).
c. Near slack water (hour 22).
d. Near maximum ebb (hour 24).

2

F TIDAL CIRCULATION FOR LONG BEACH HARBOR

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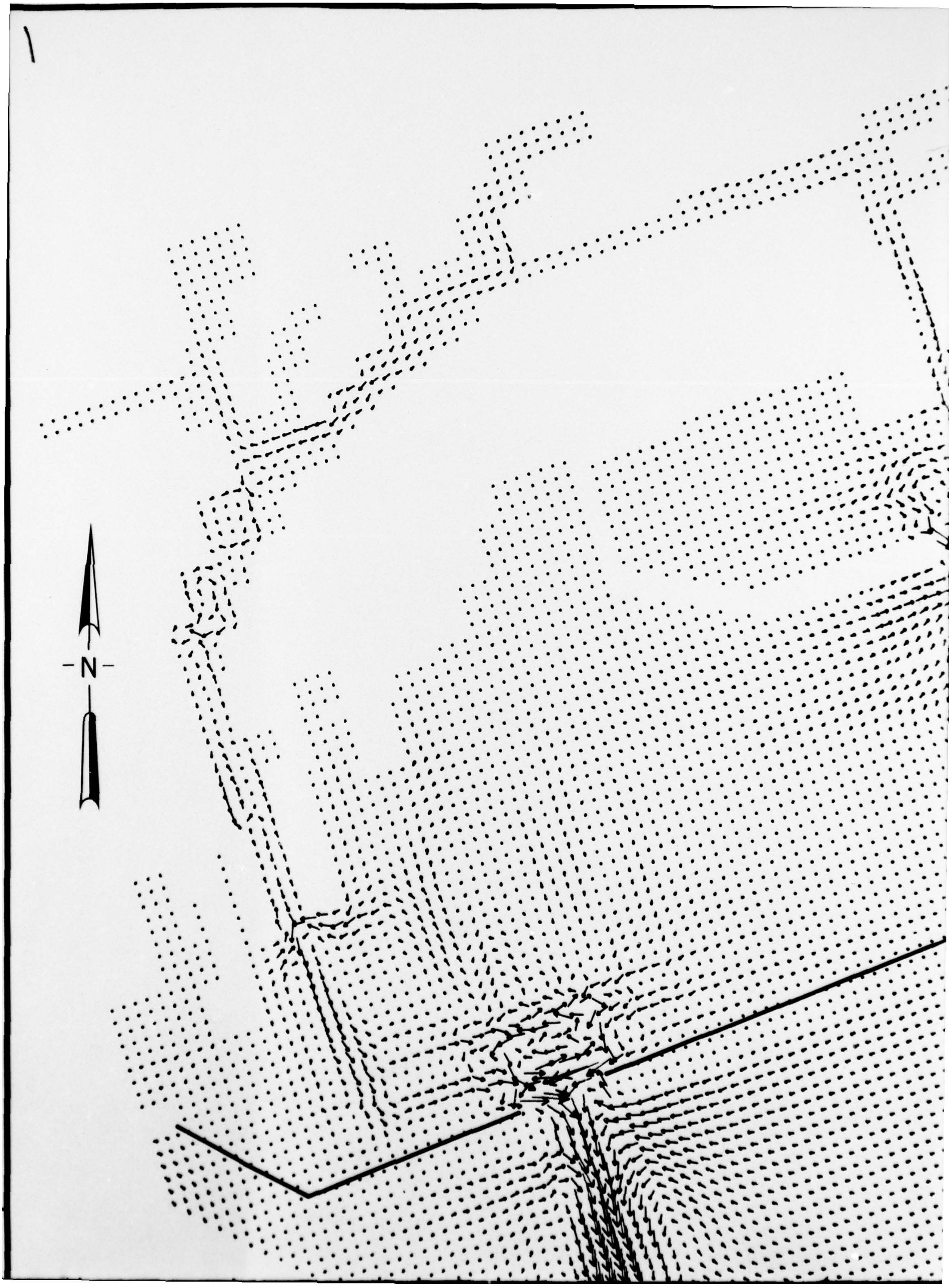
CONTENTS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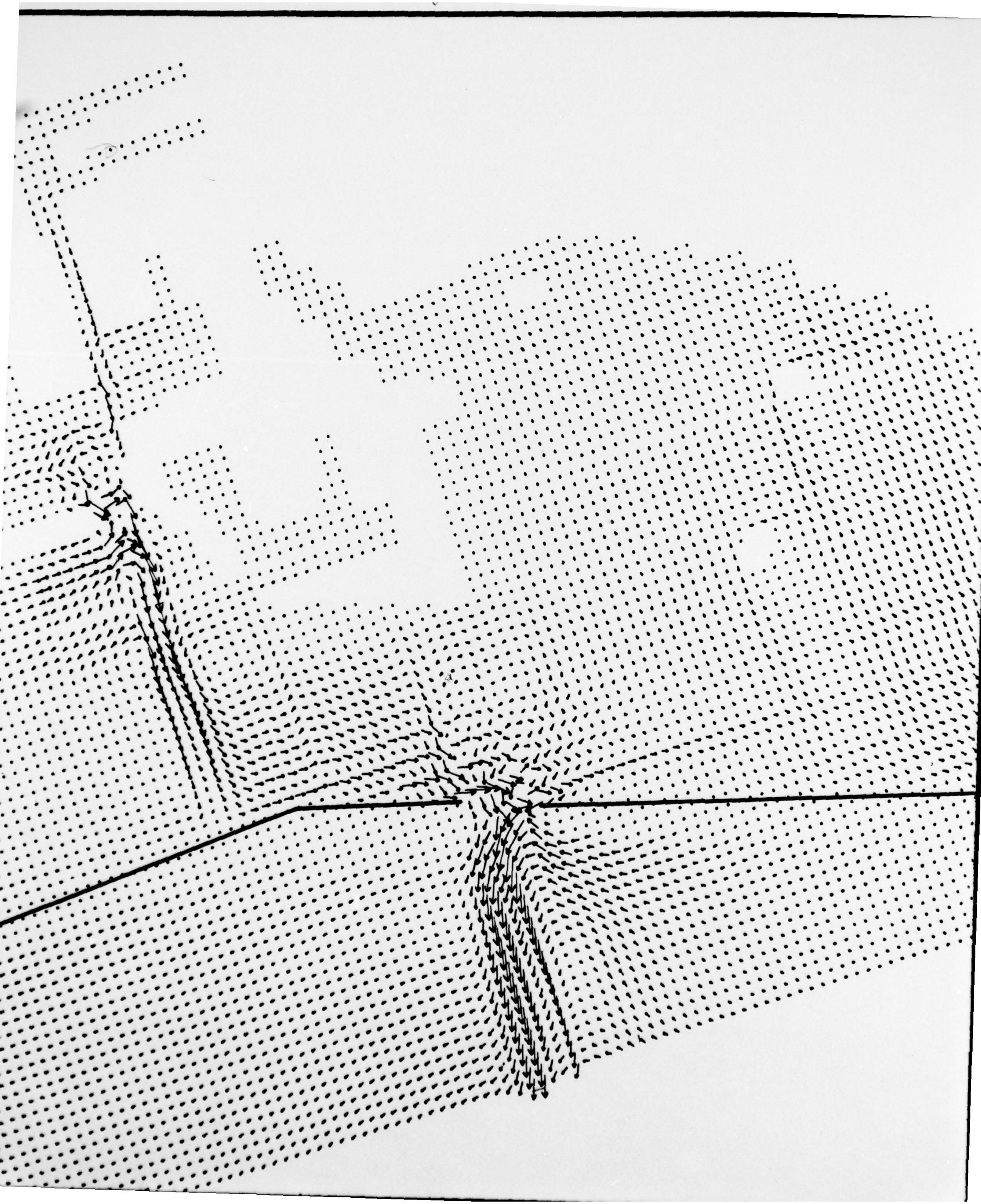

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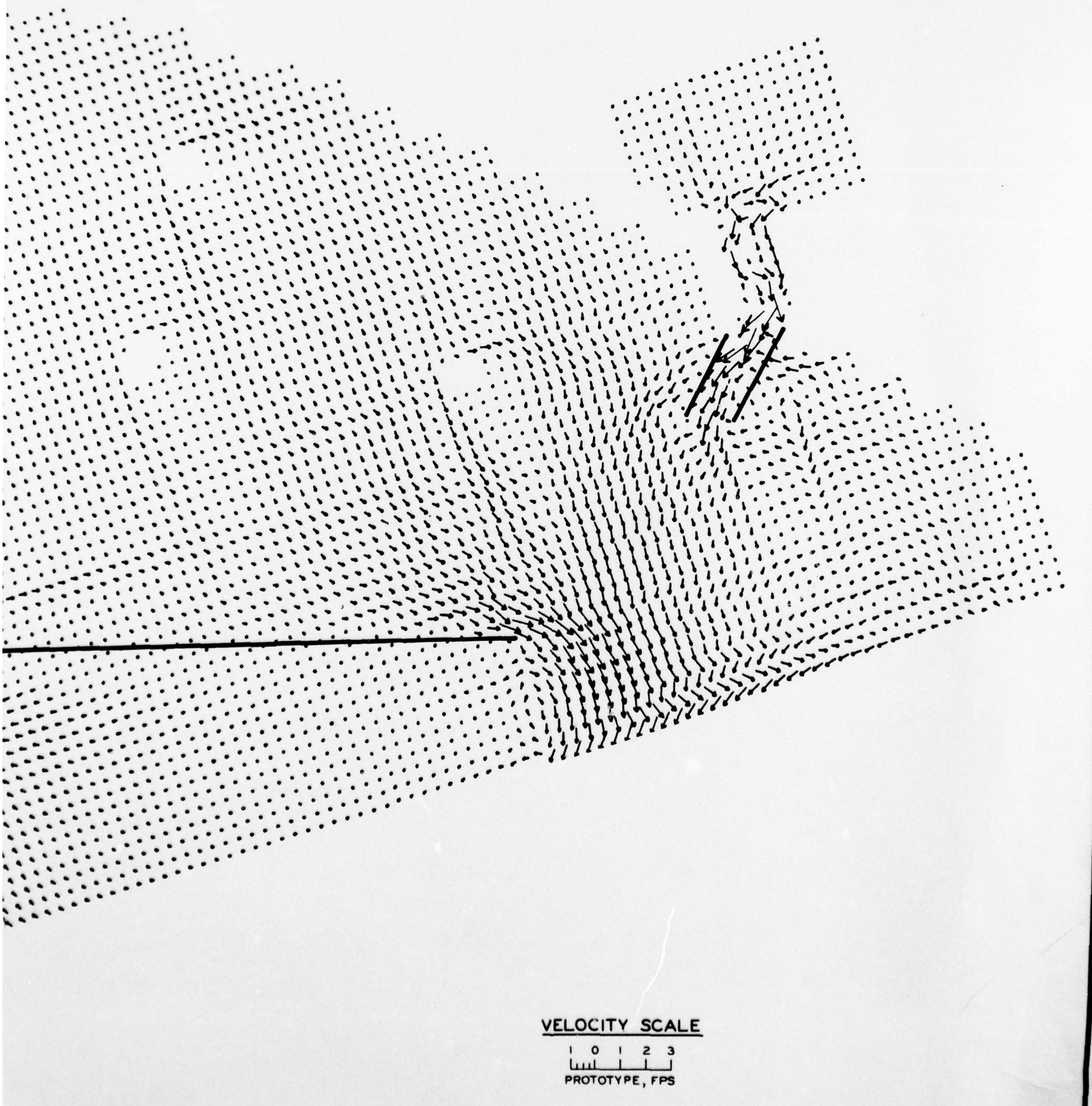

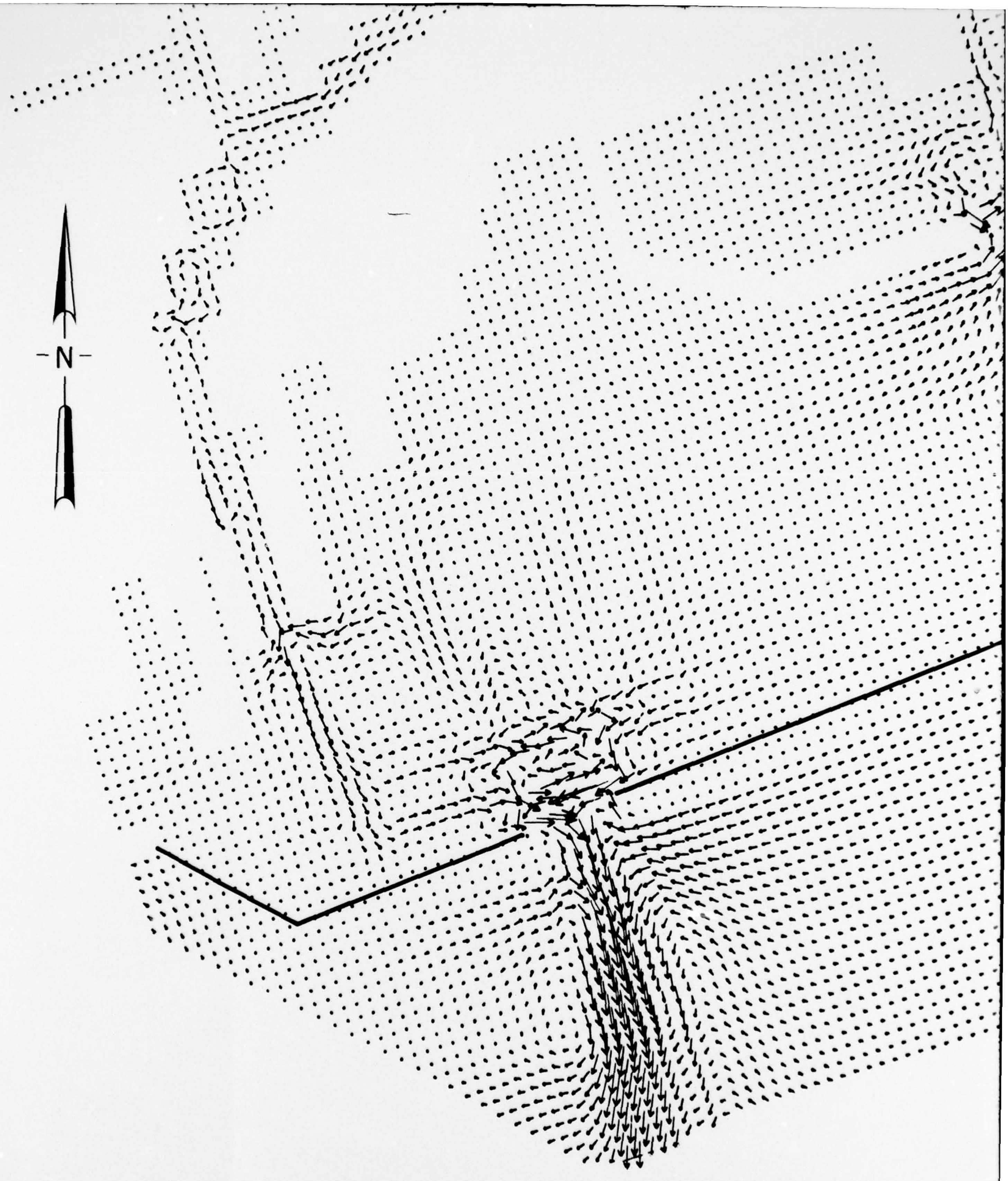

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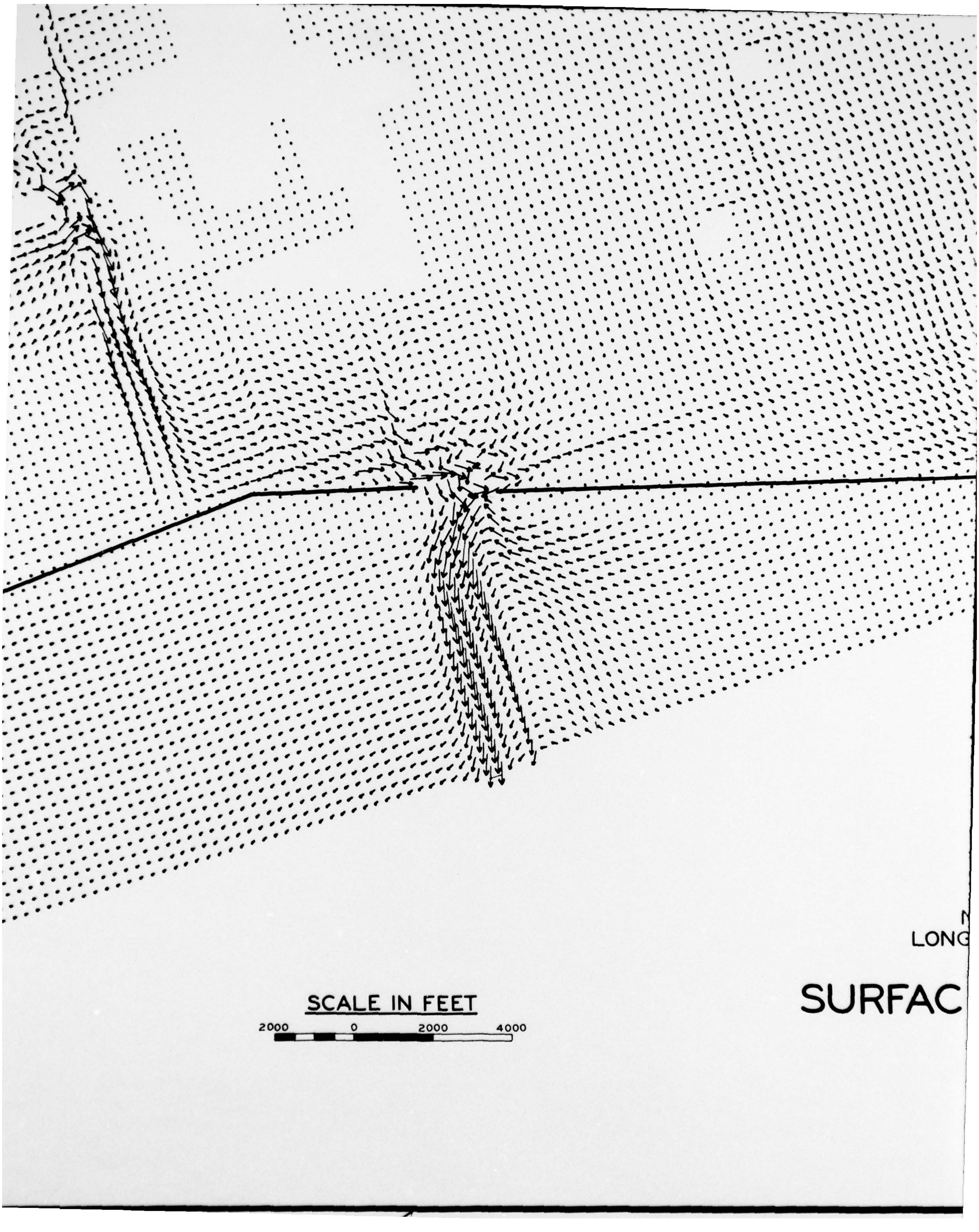
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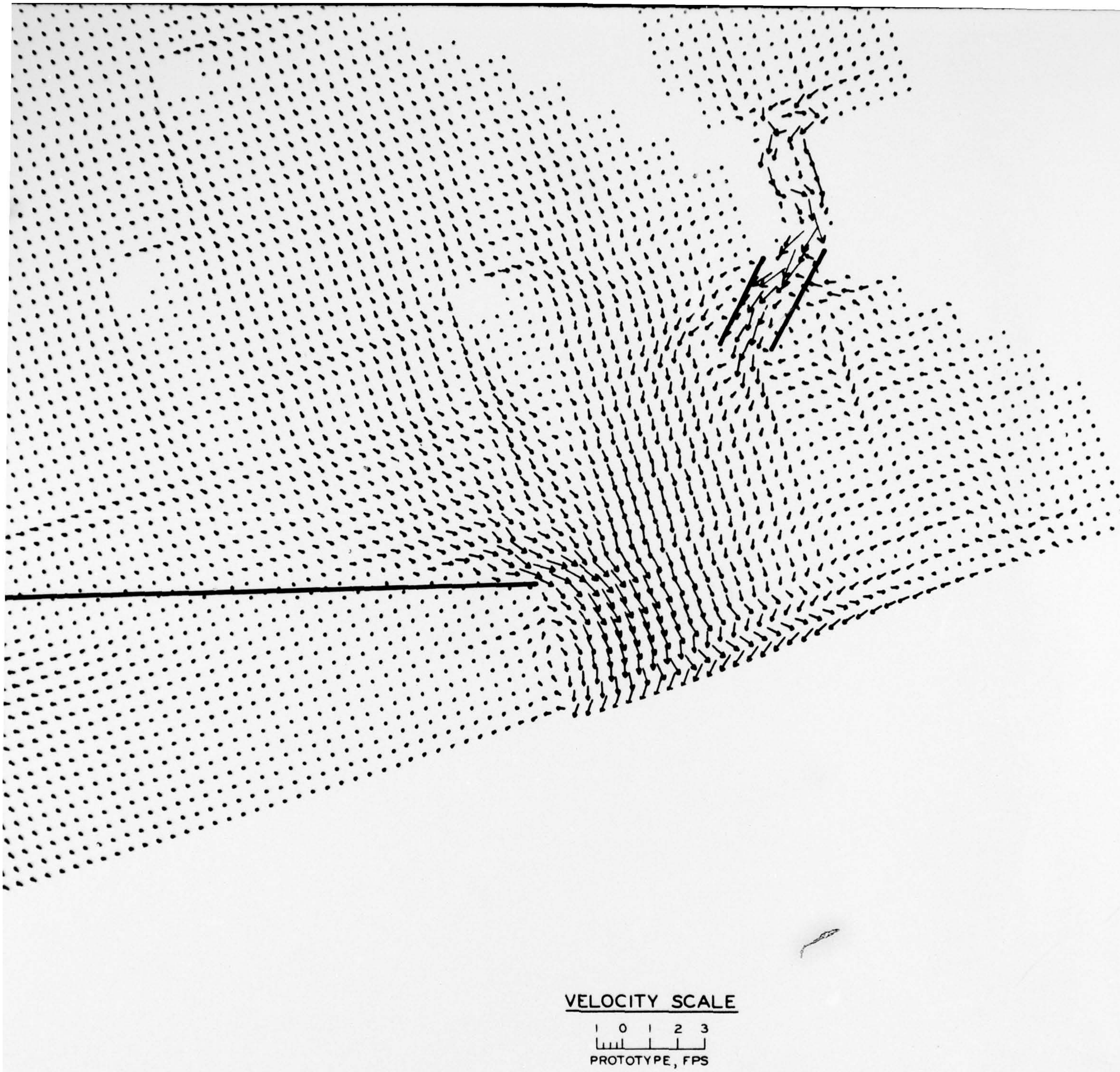
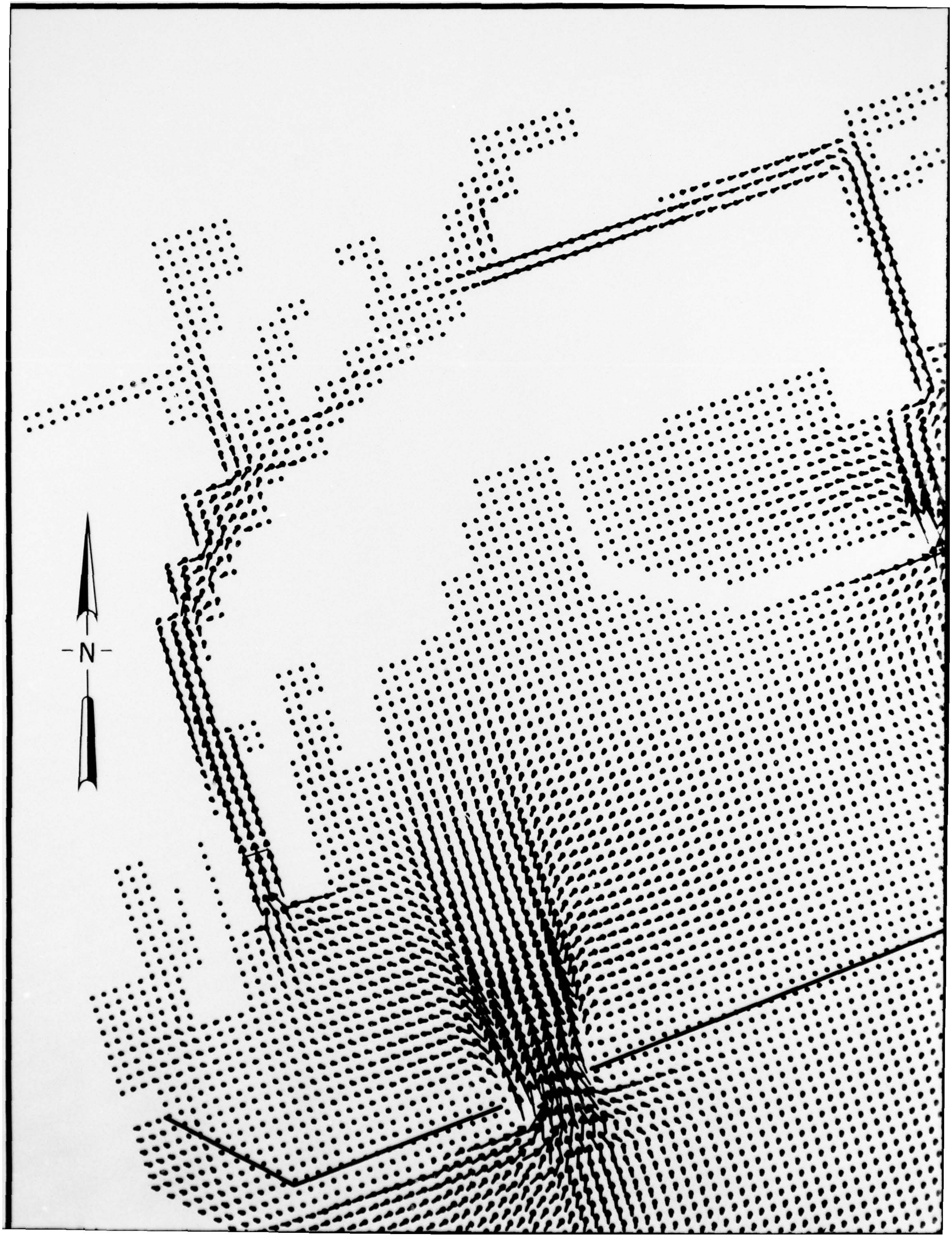


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 15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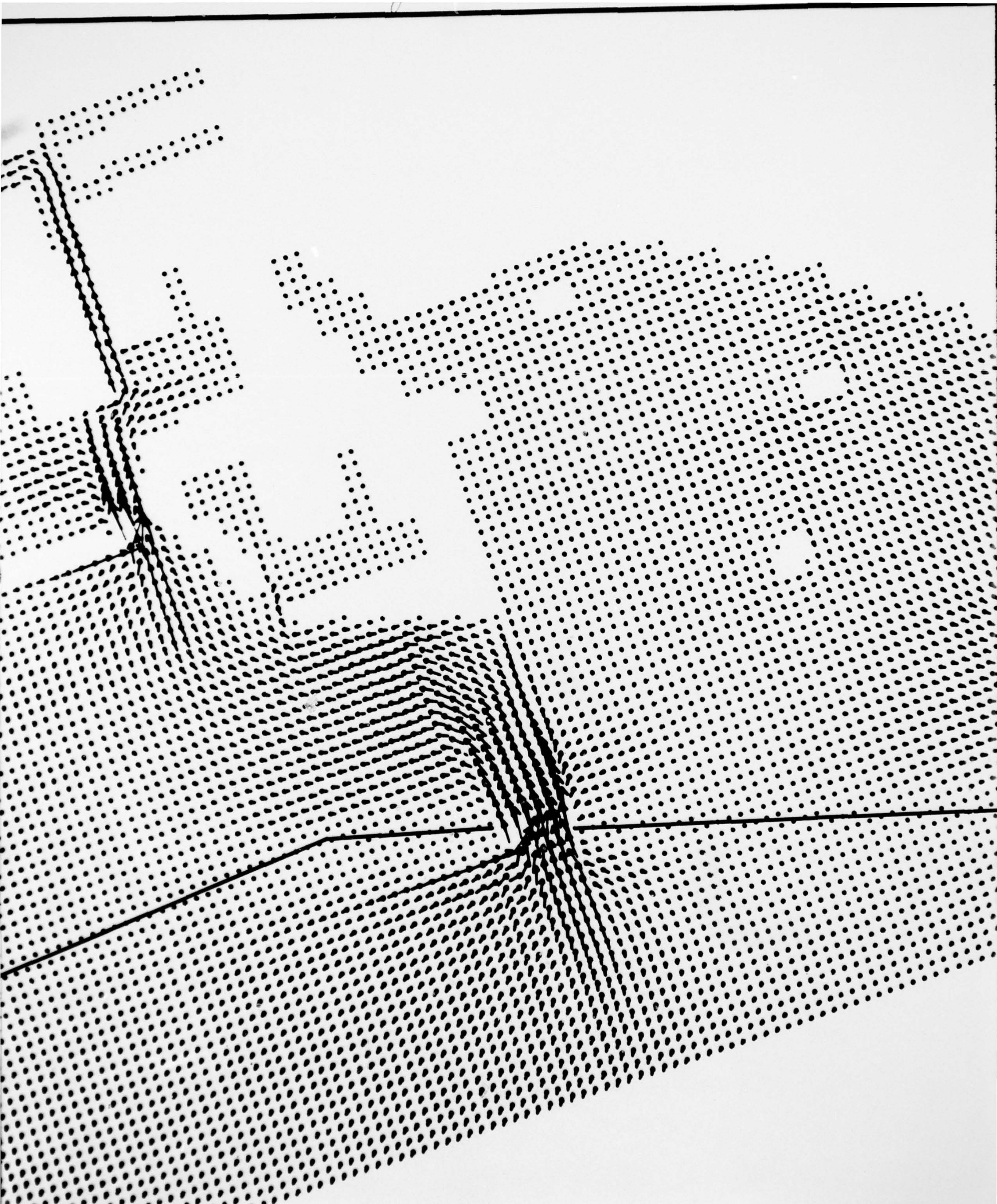

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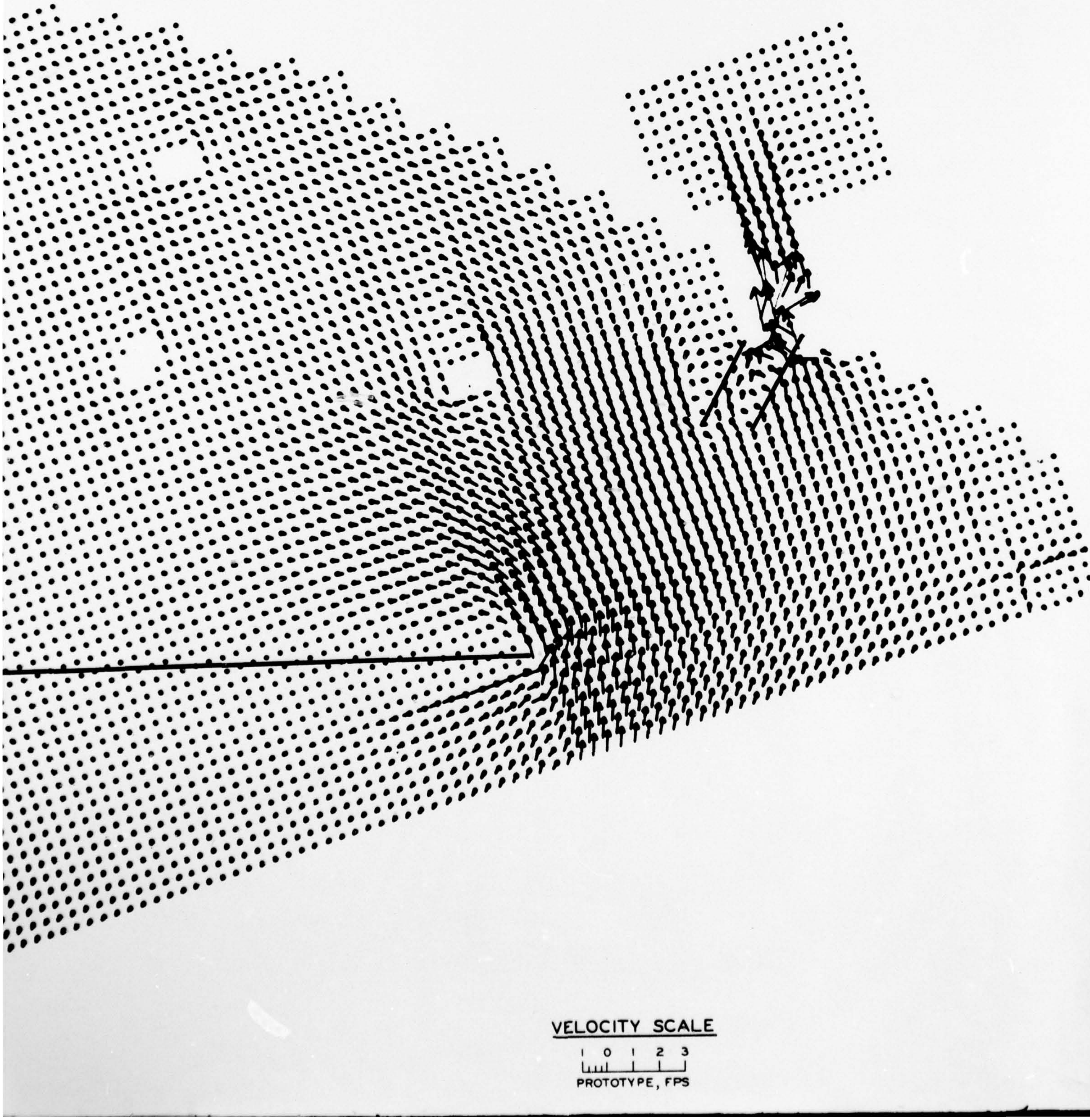

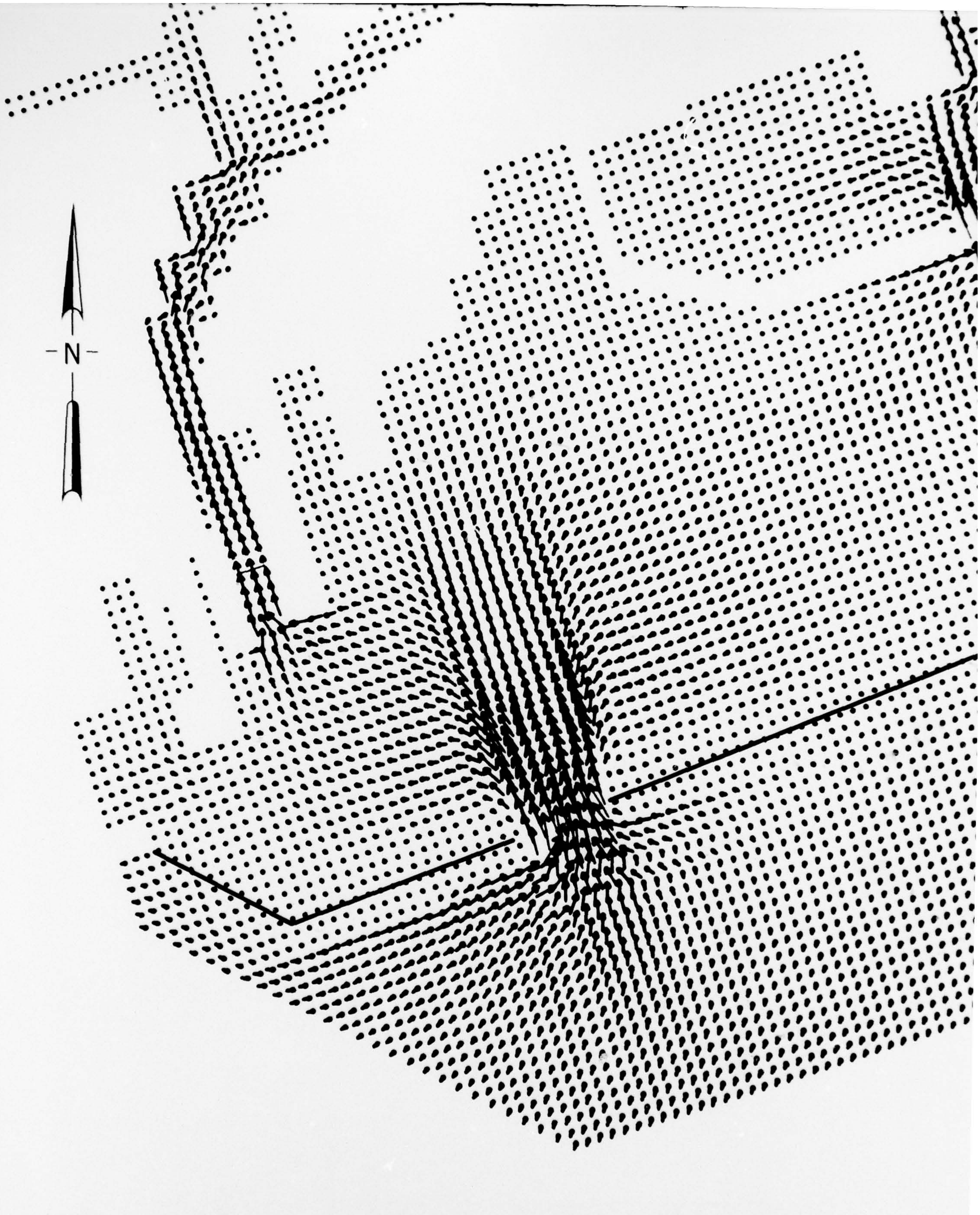

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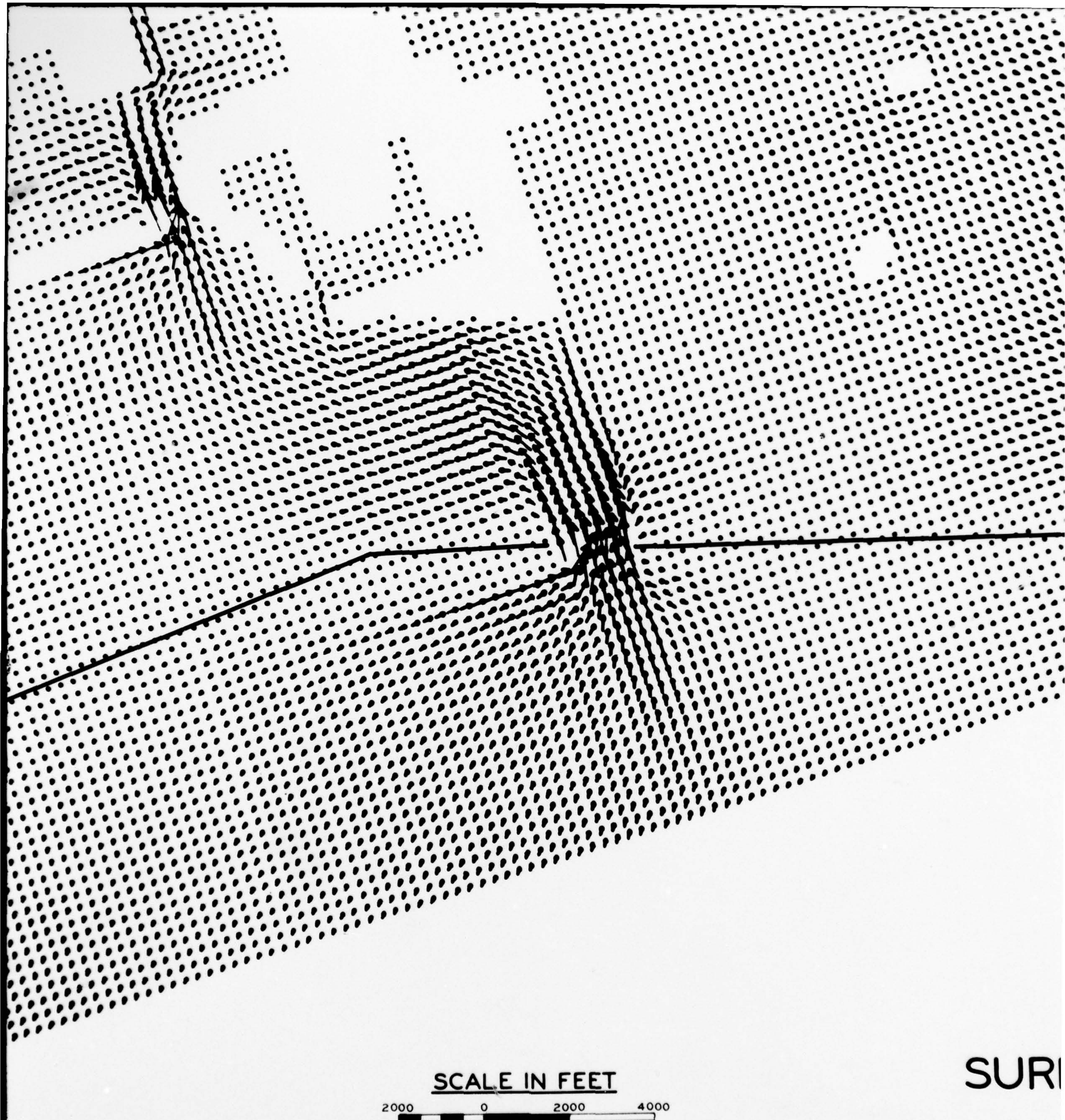

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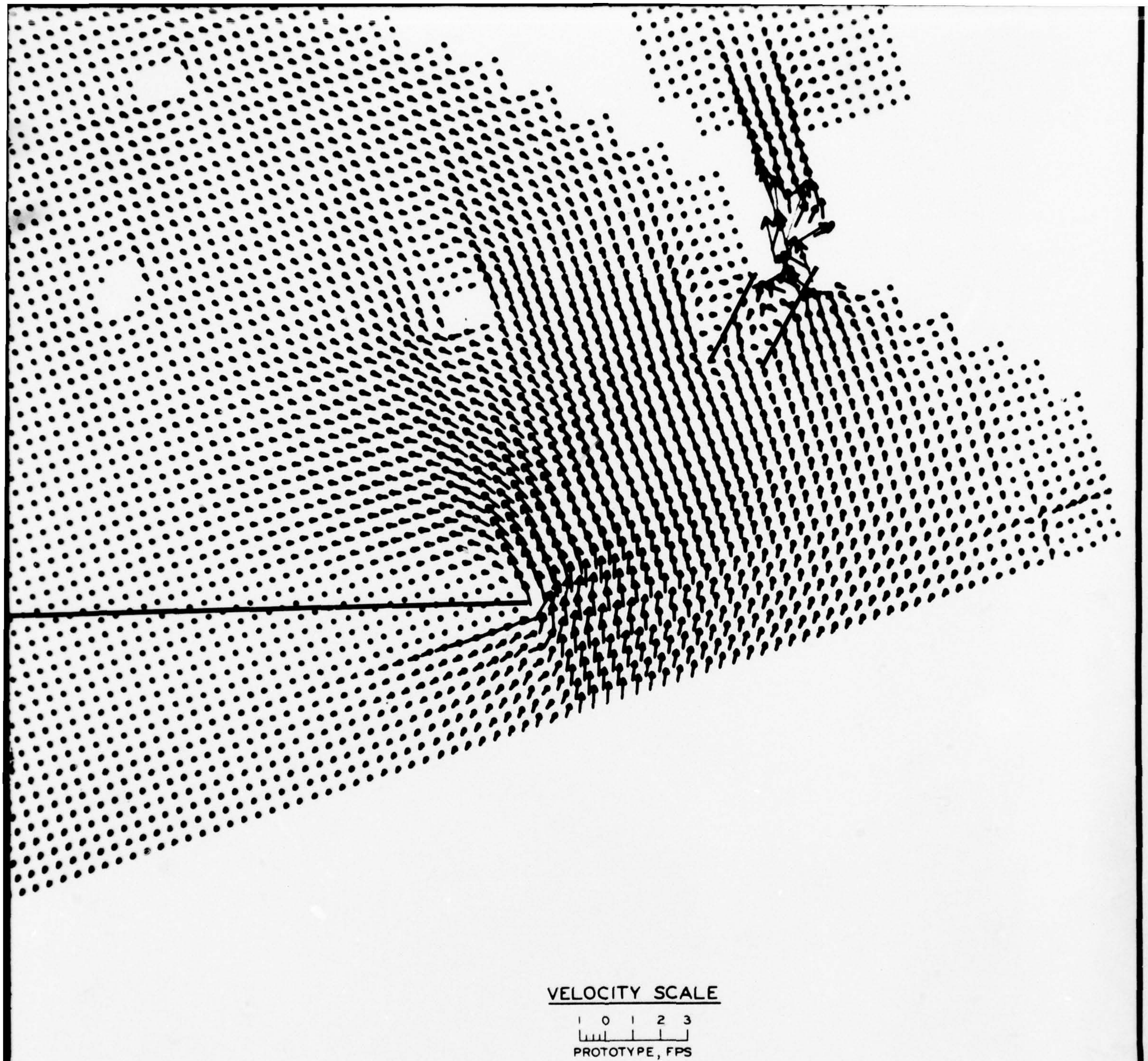
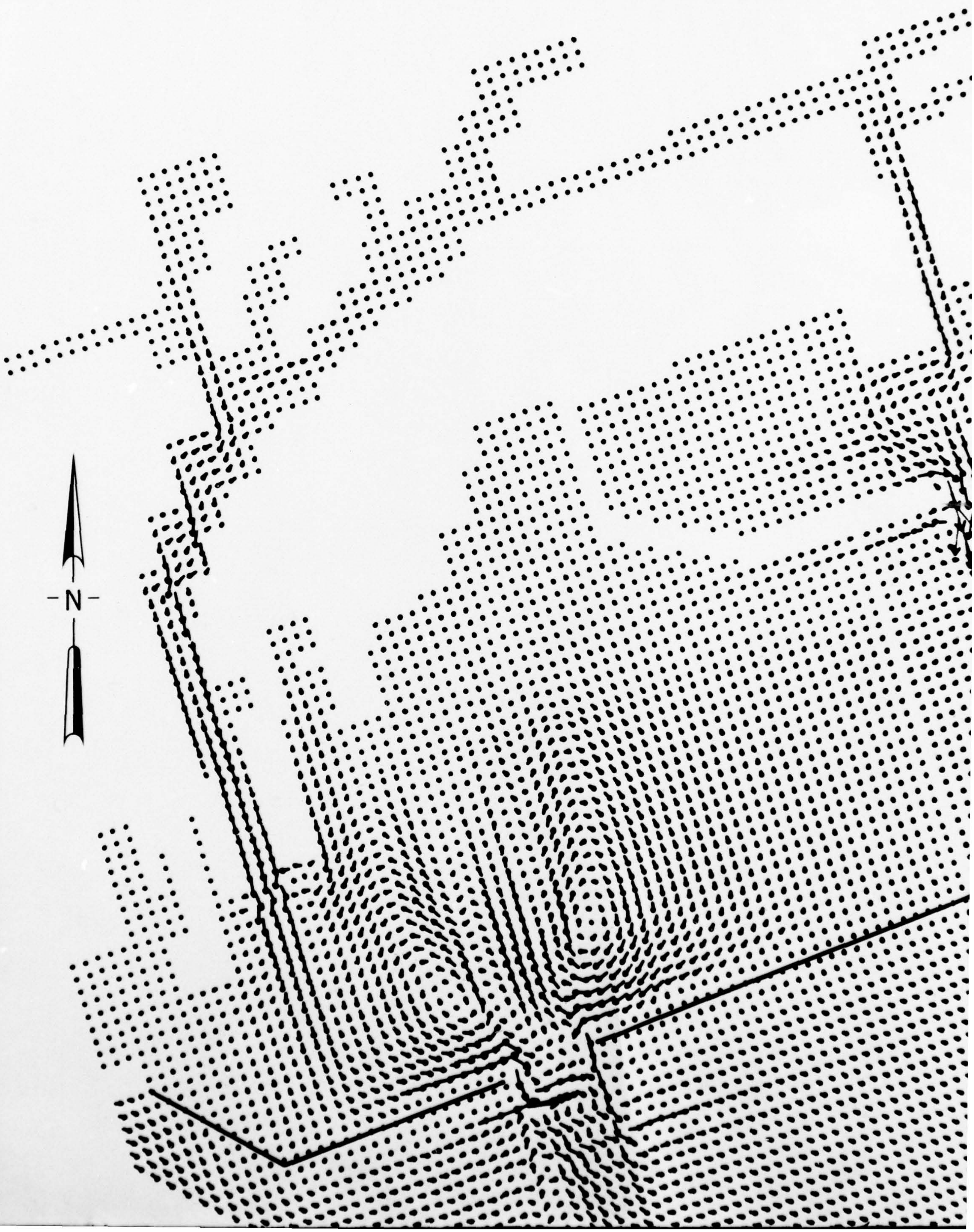


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 19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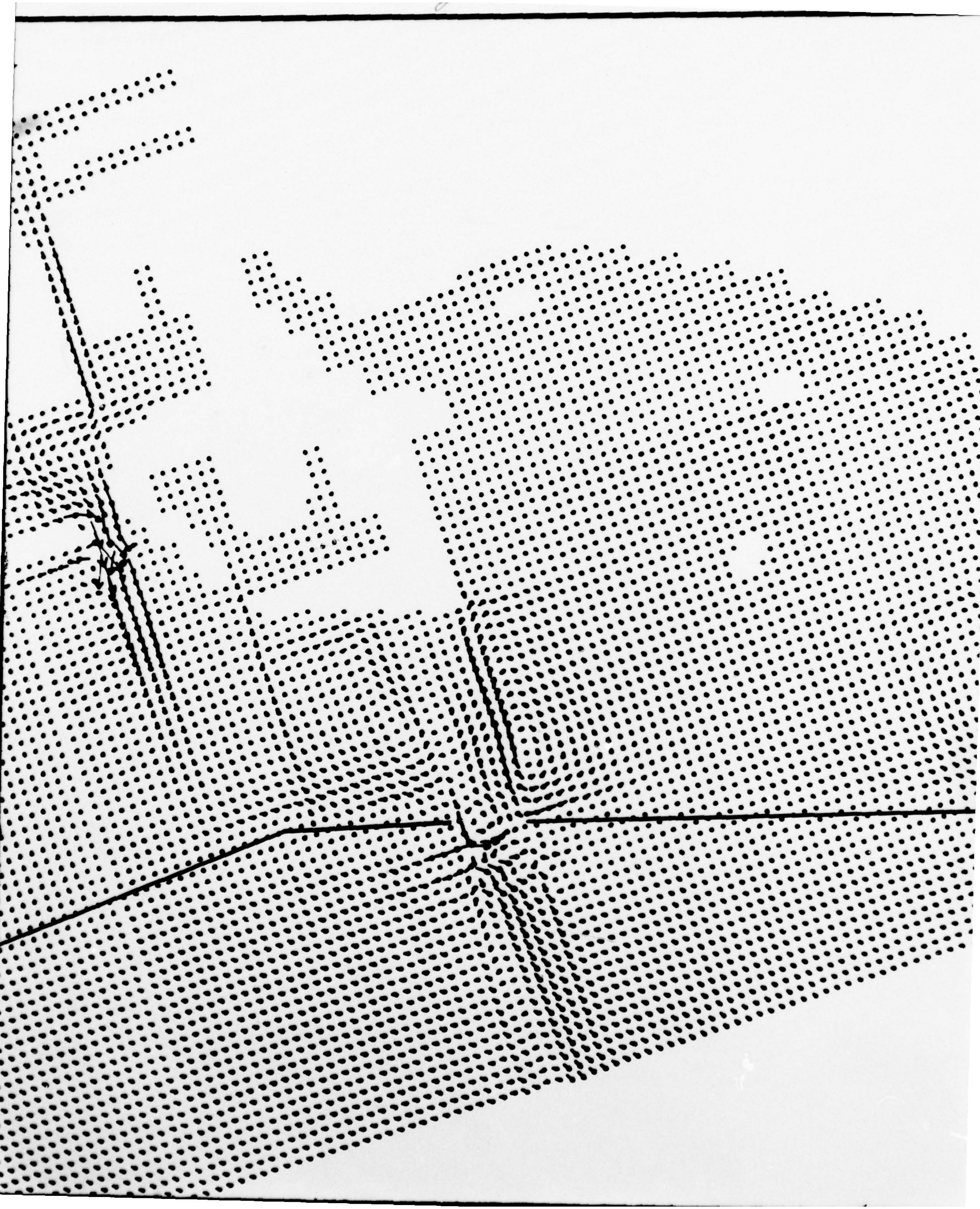

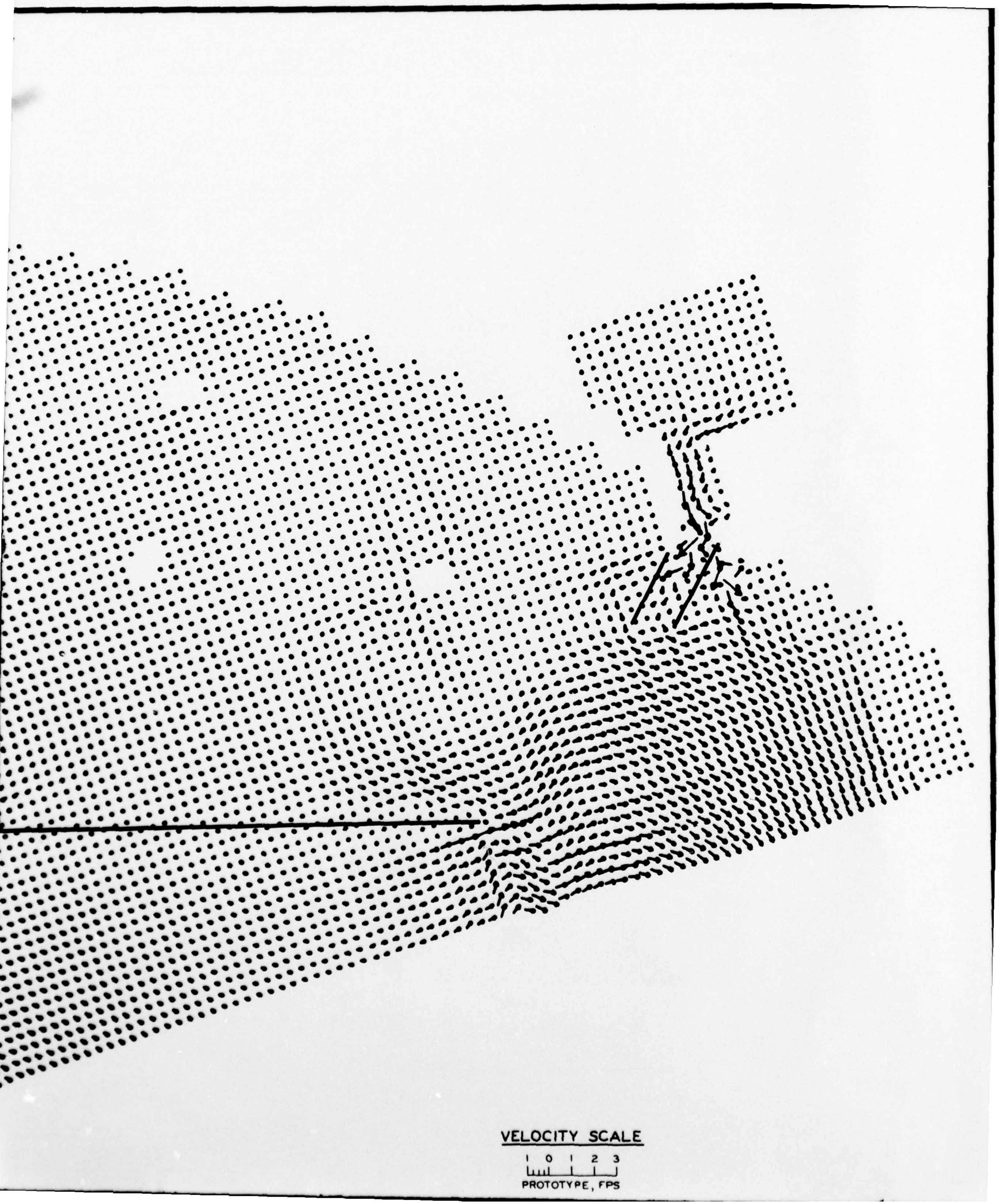
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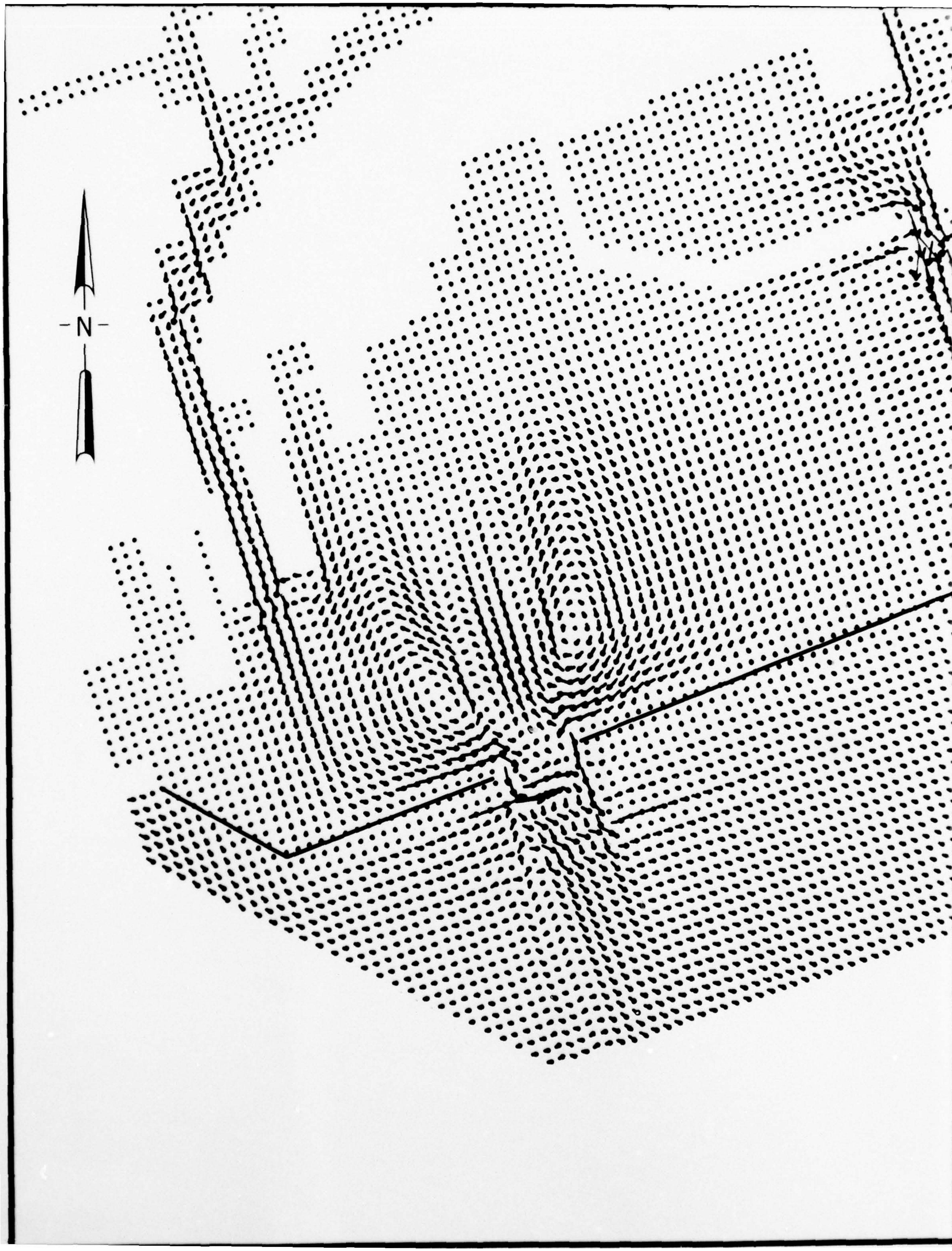
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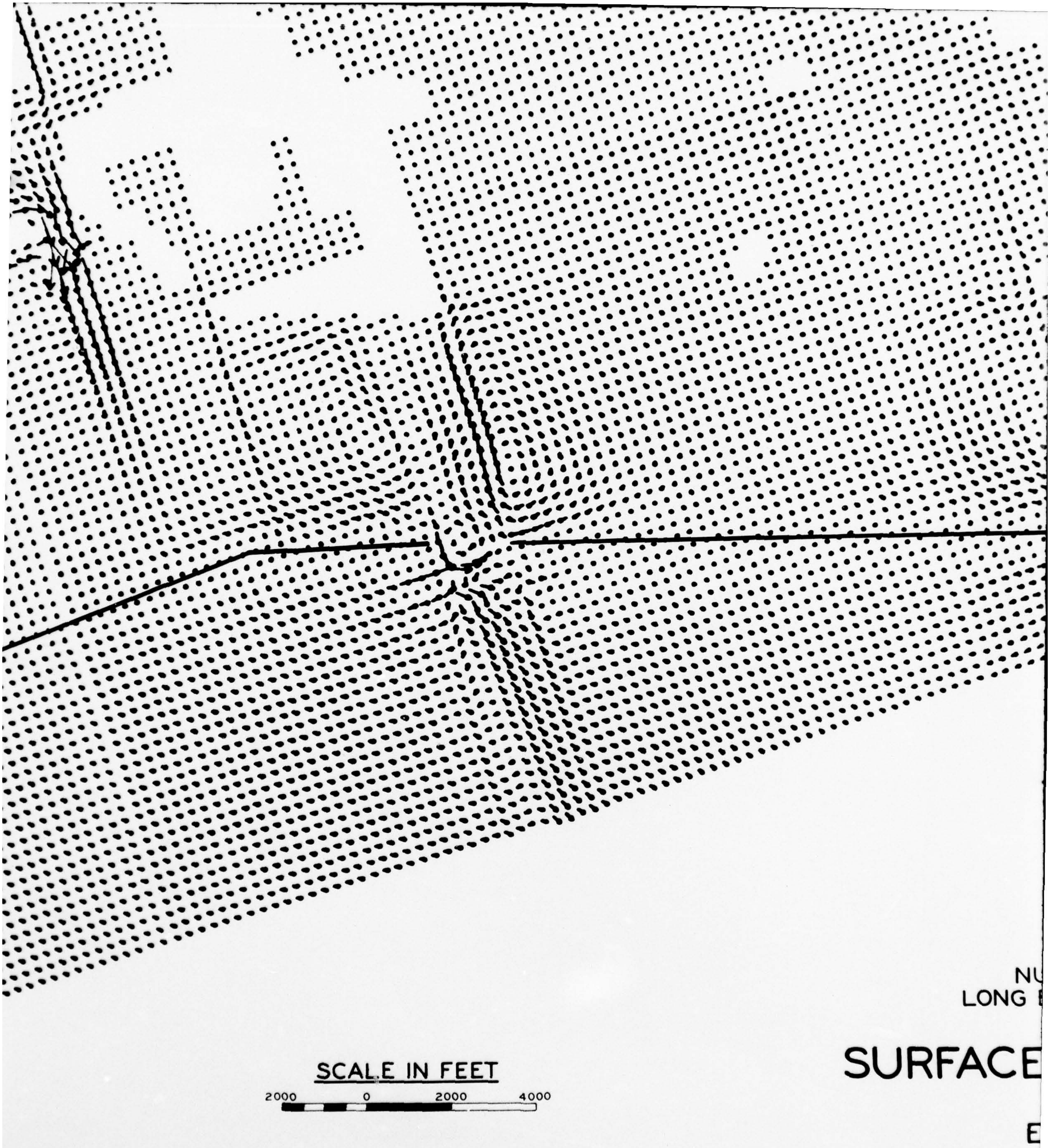

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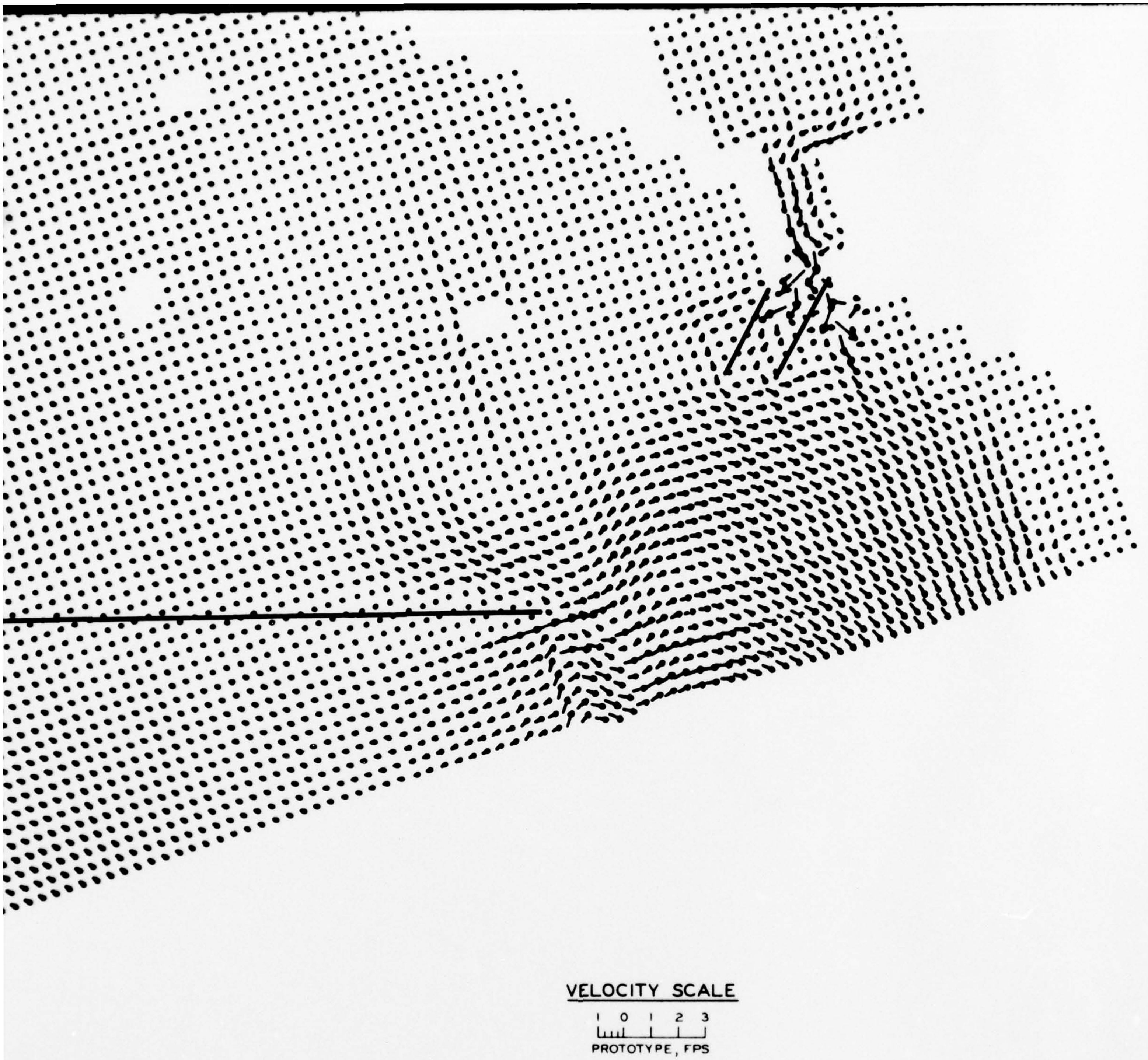
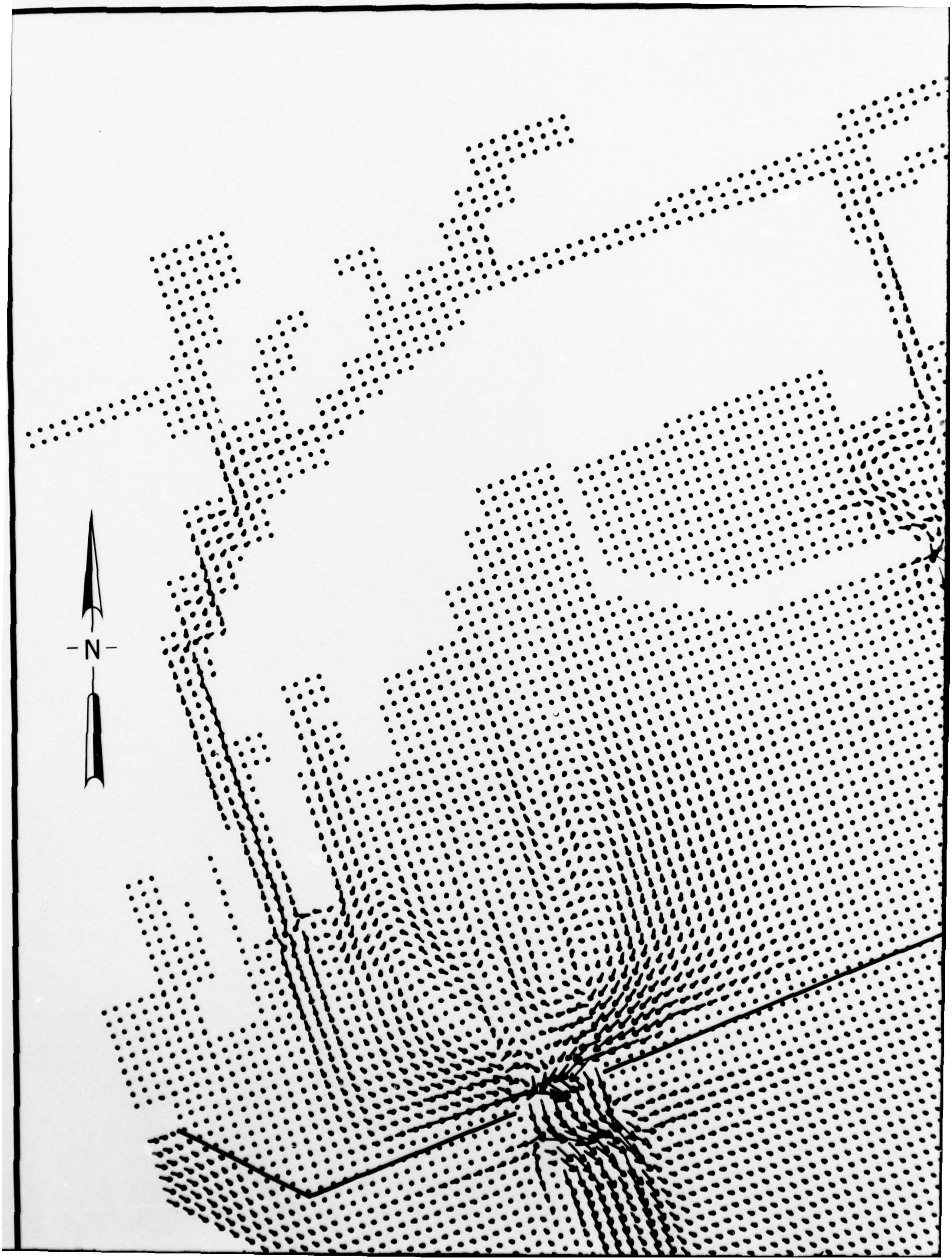


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 22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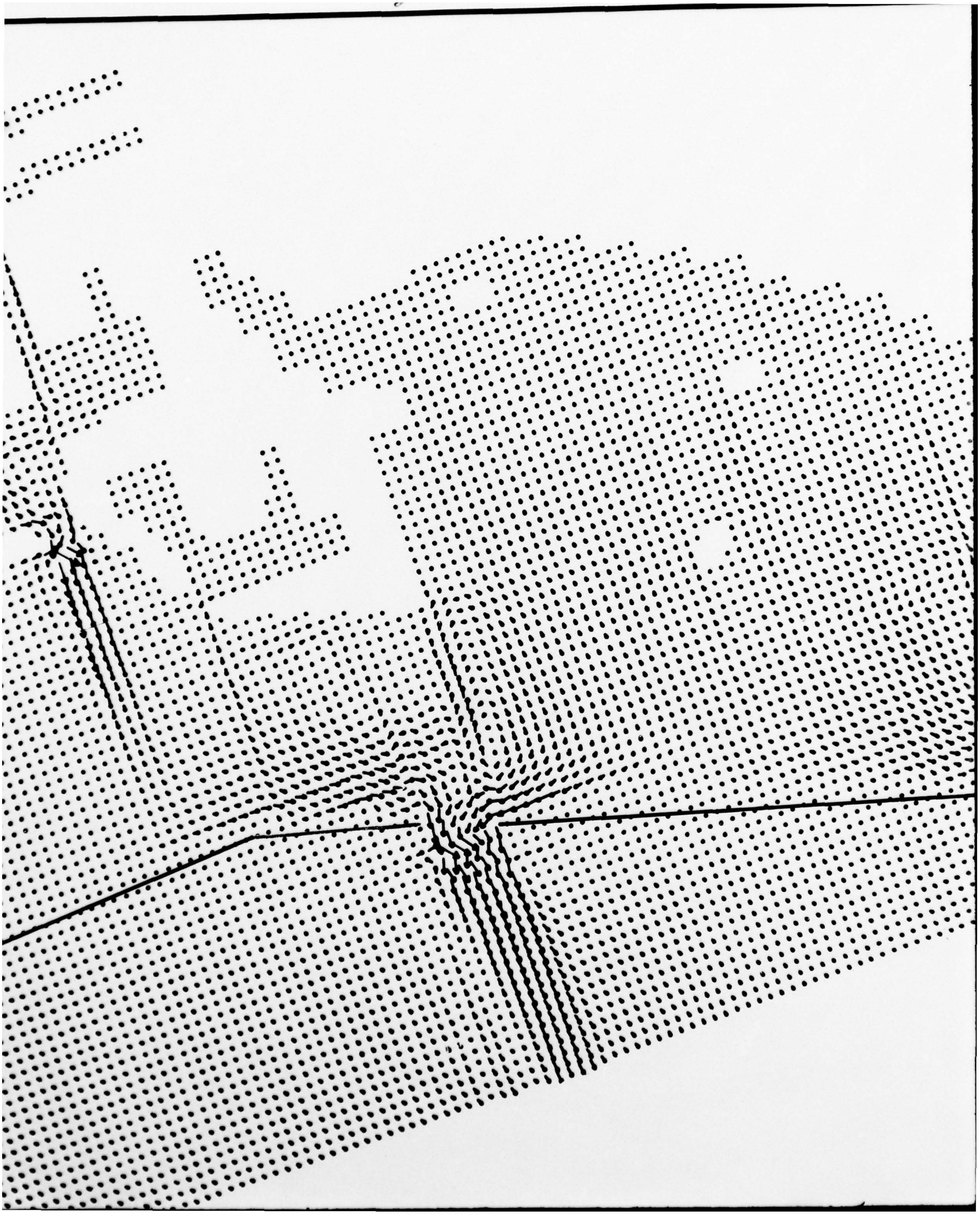

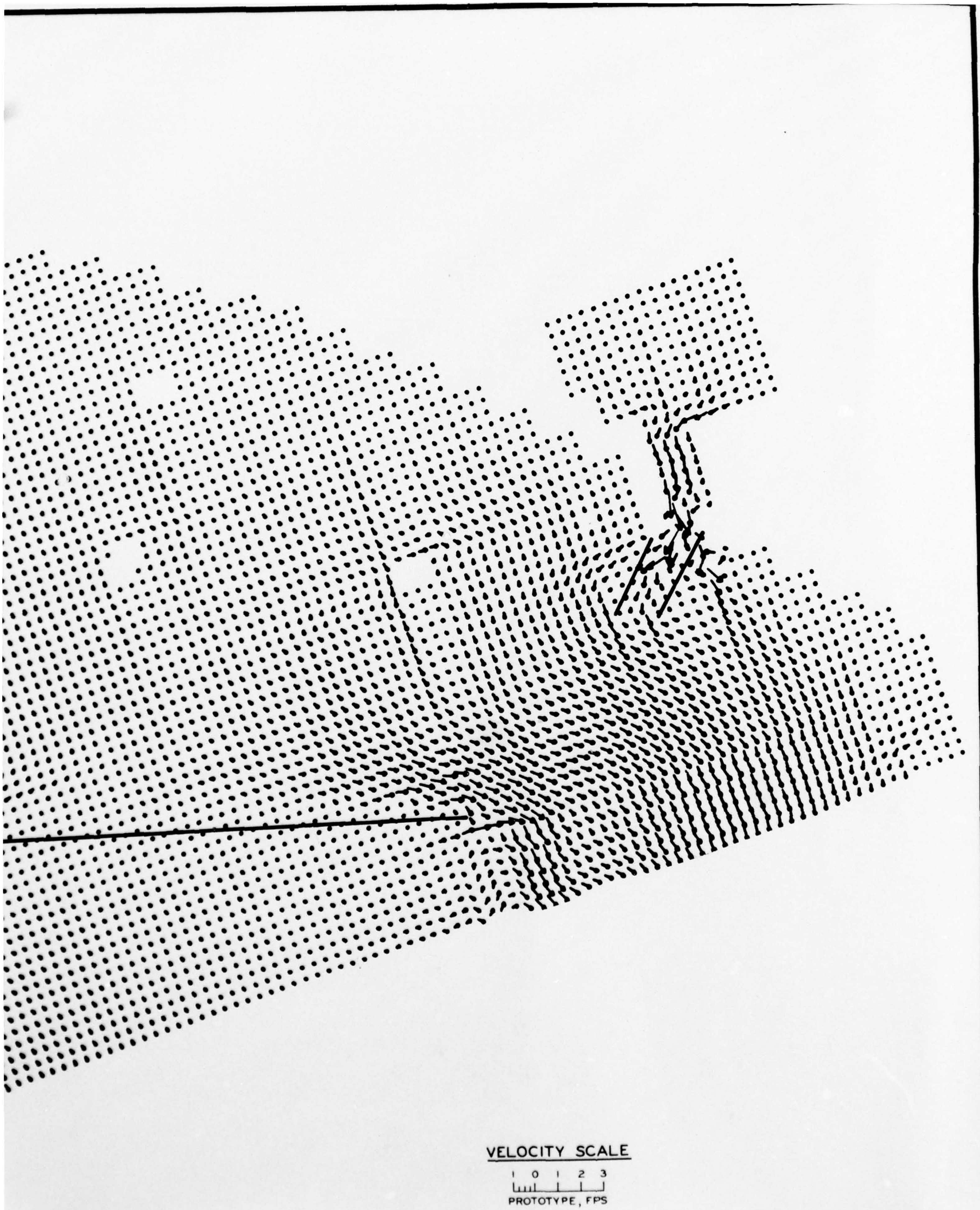
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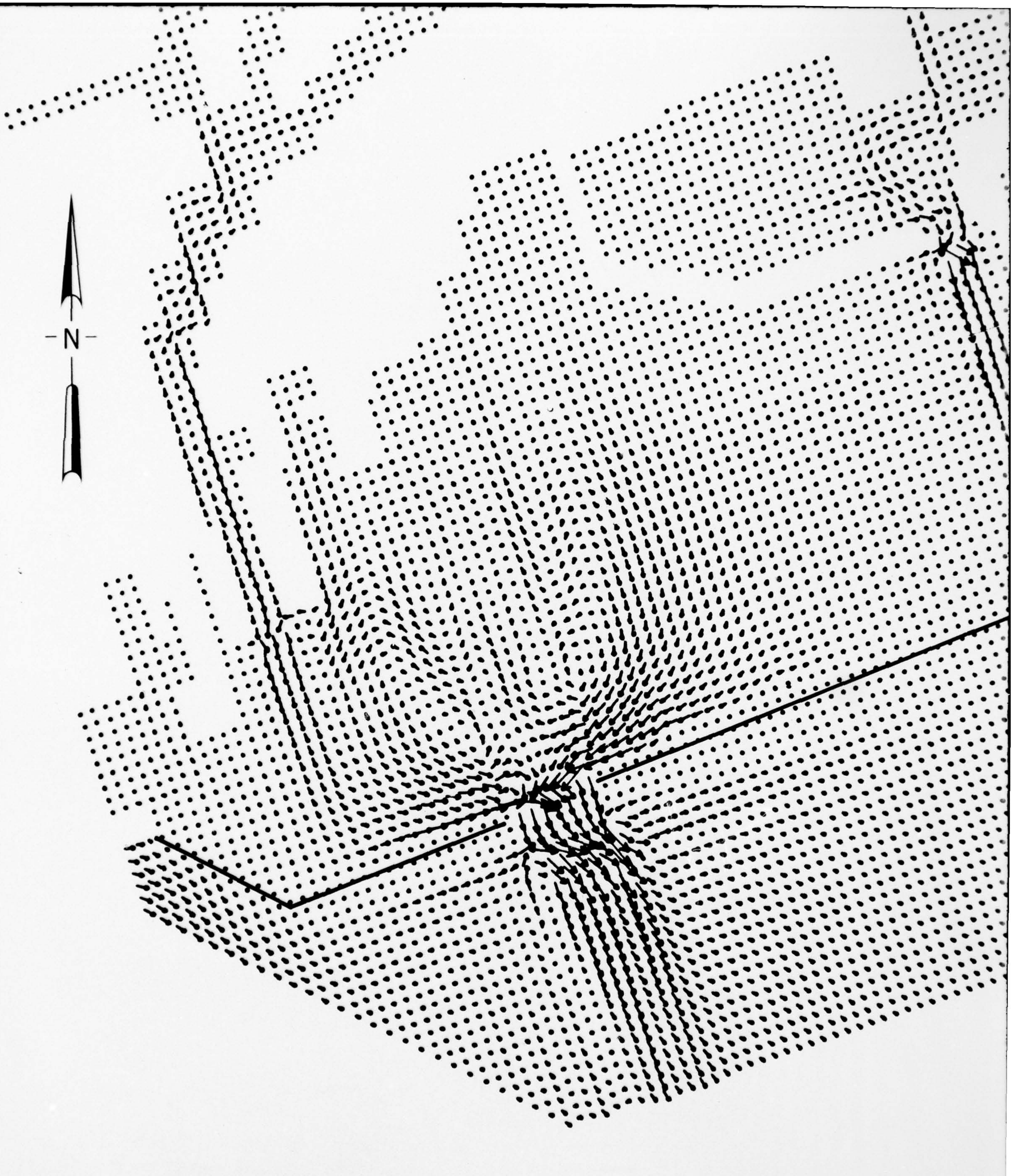

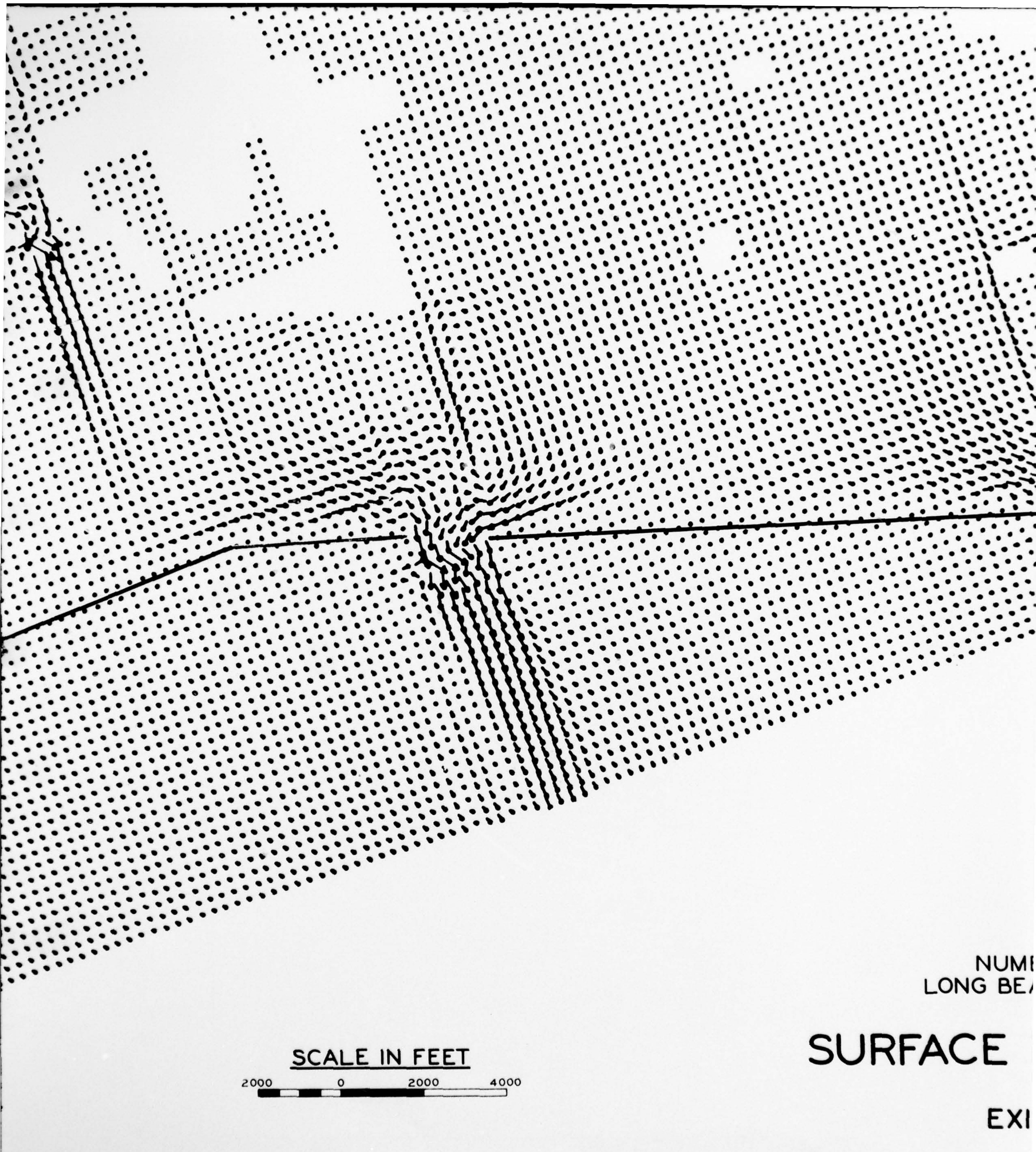

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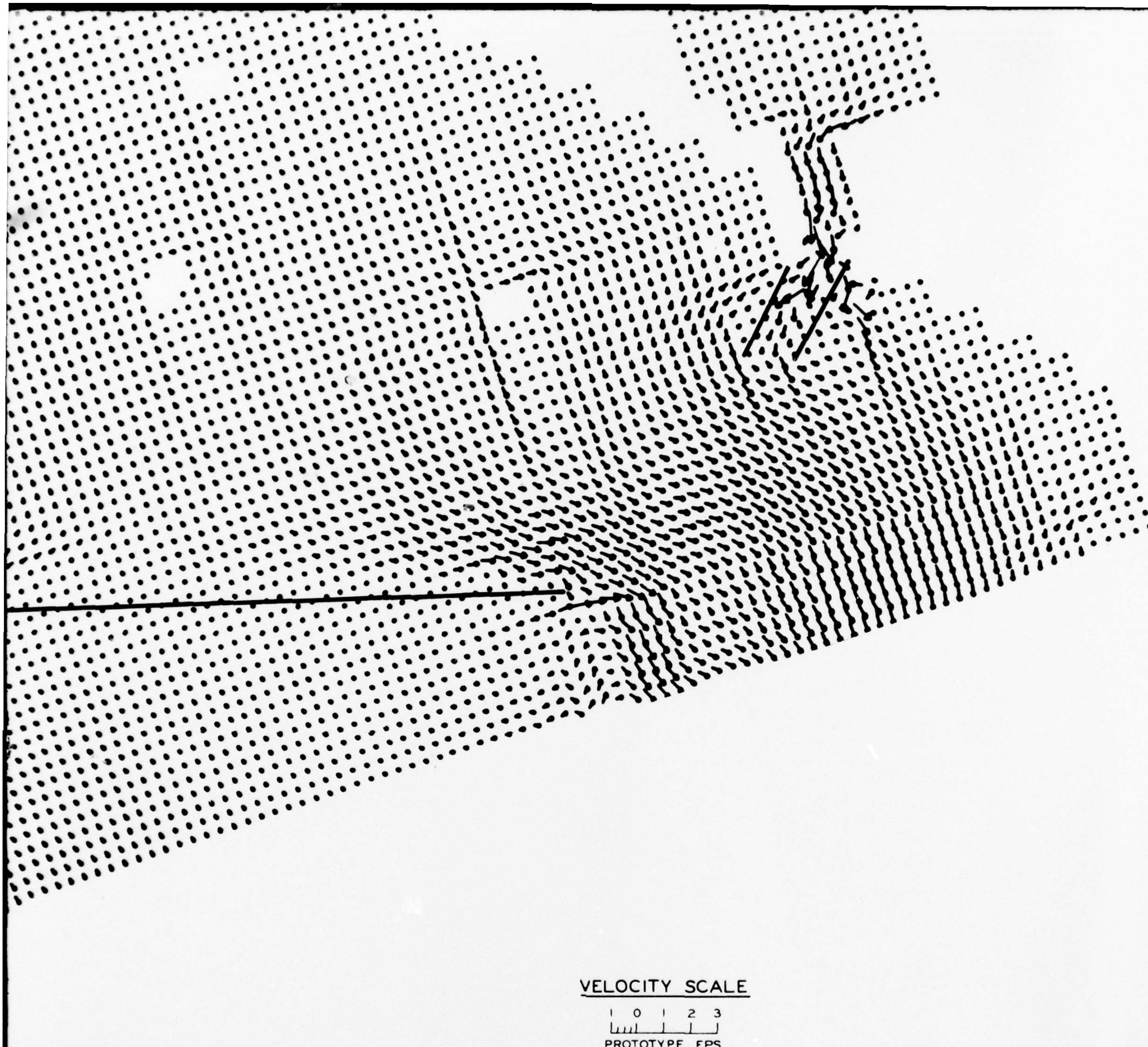
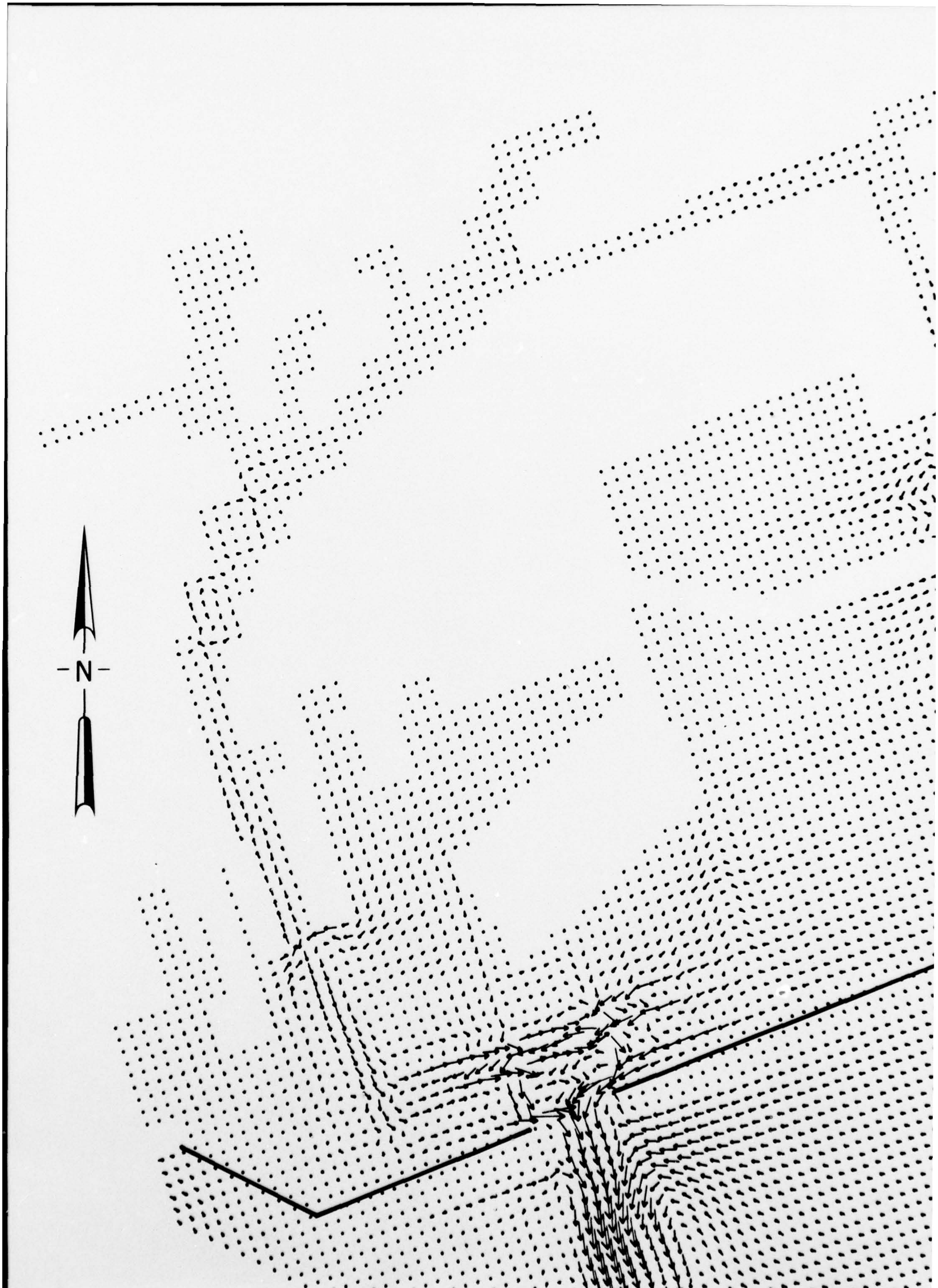


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 24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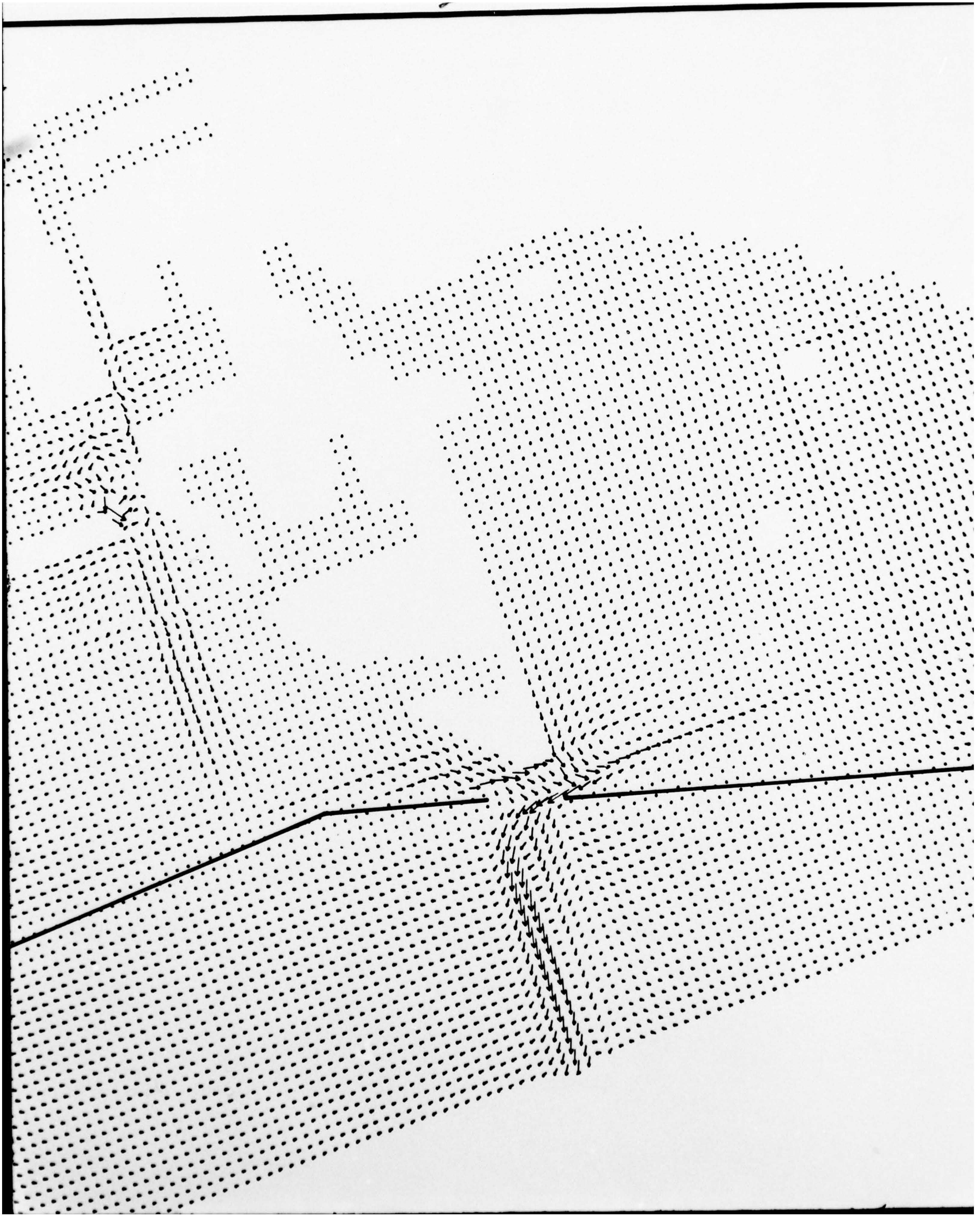

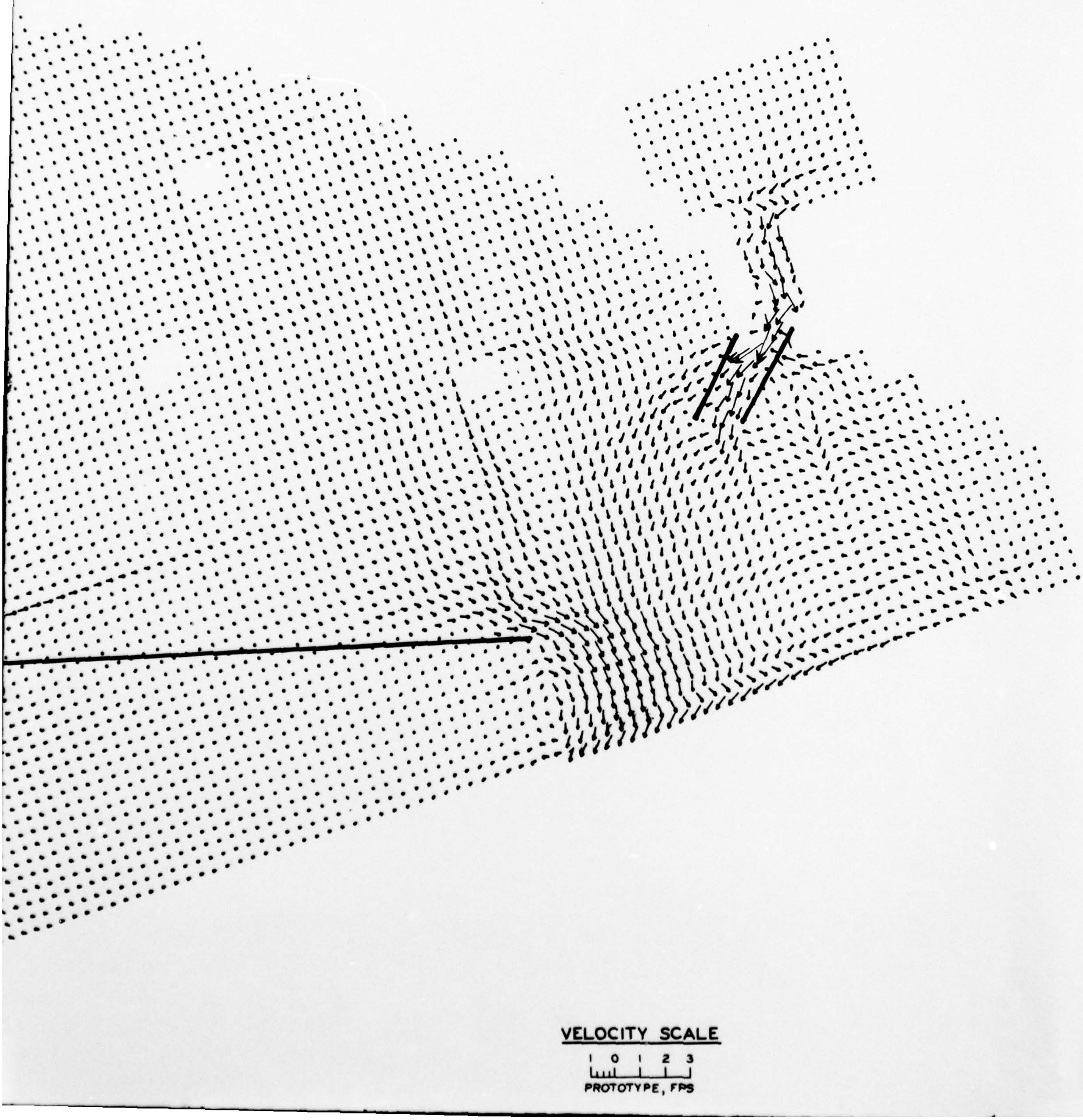
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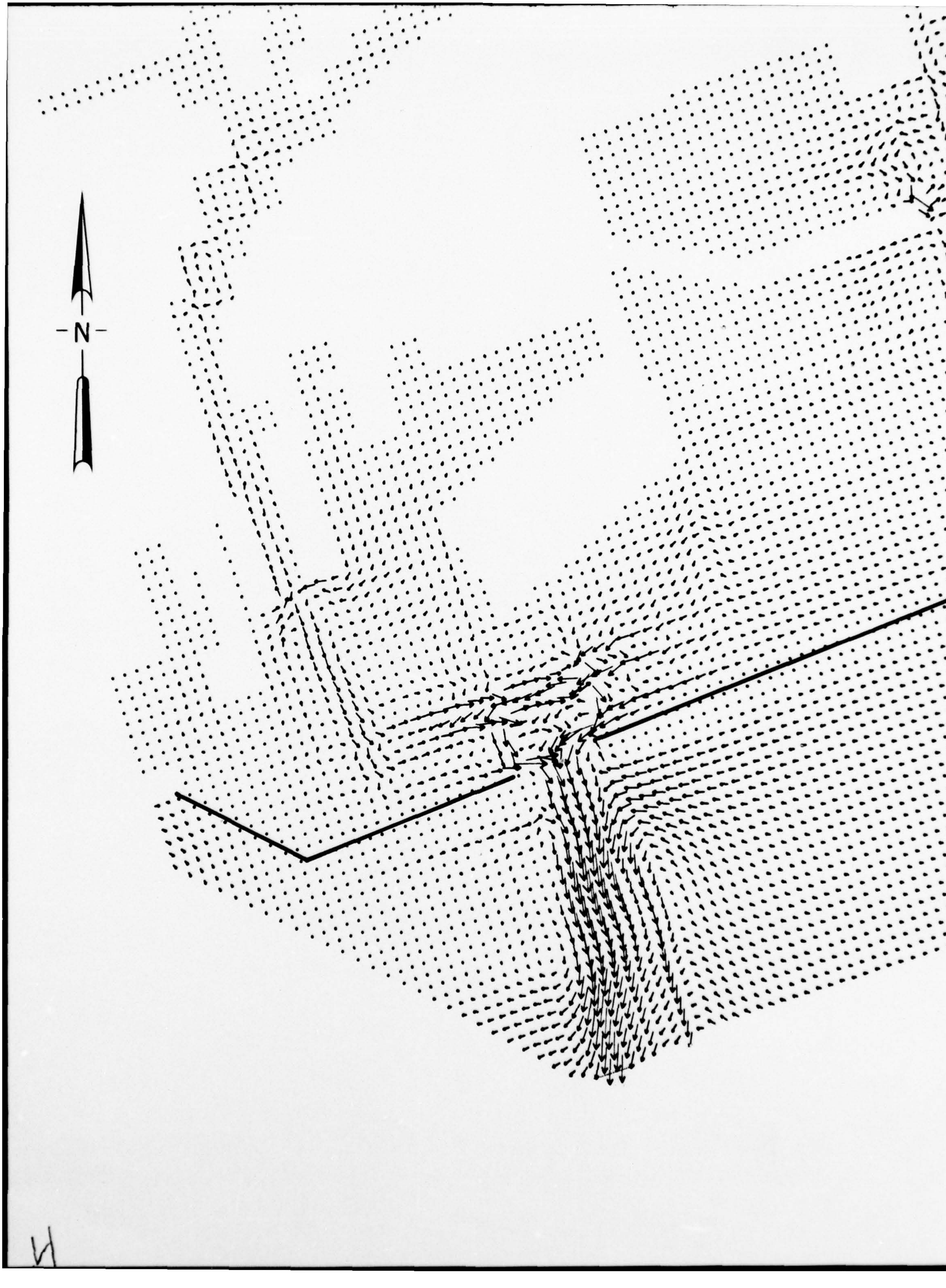
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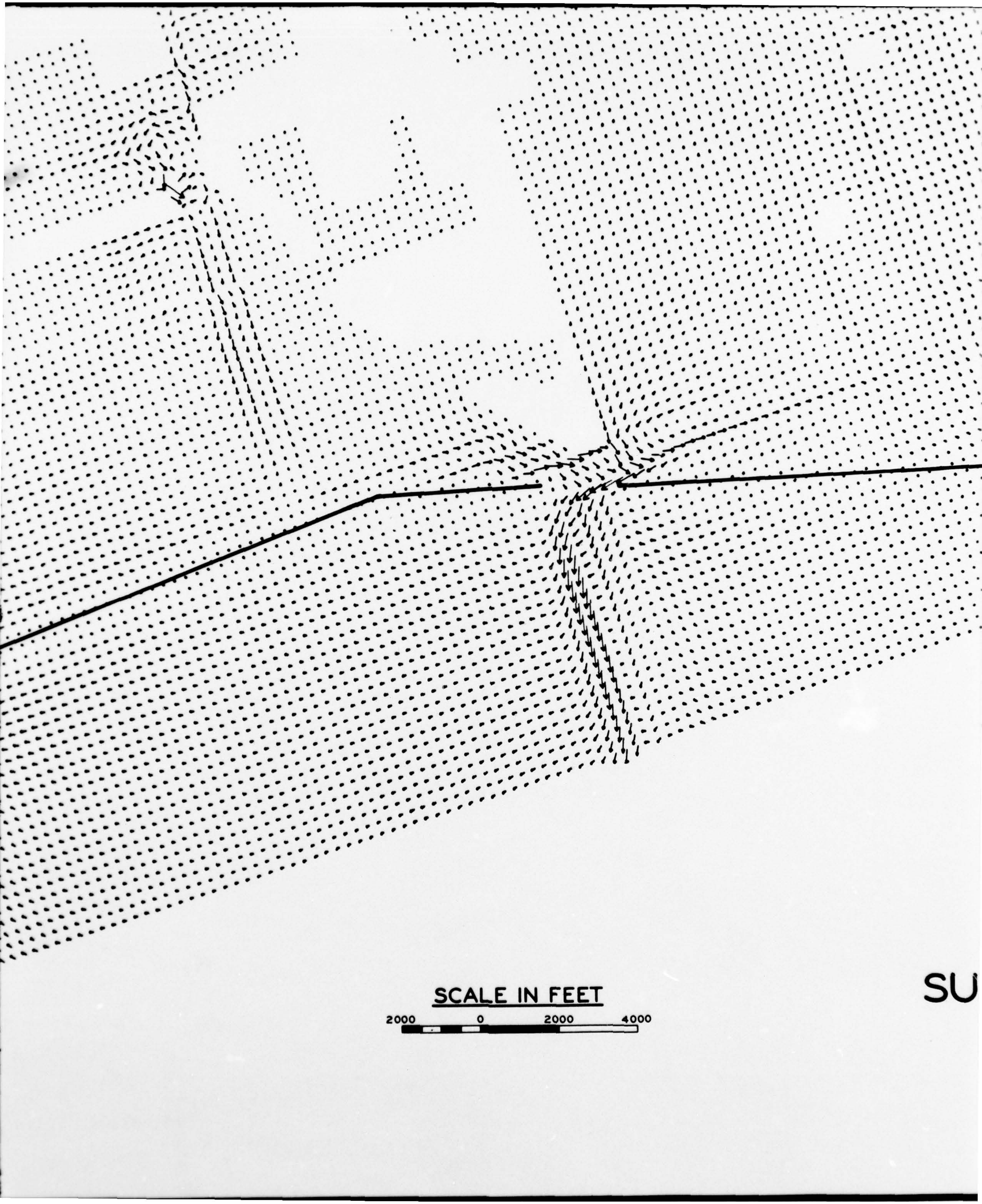
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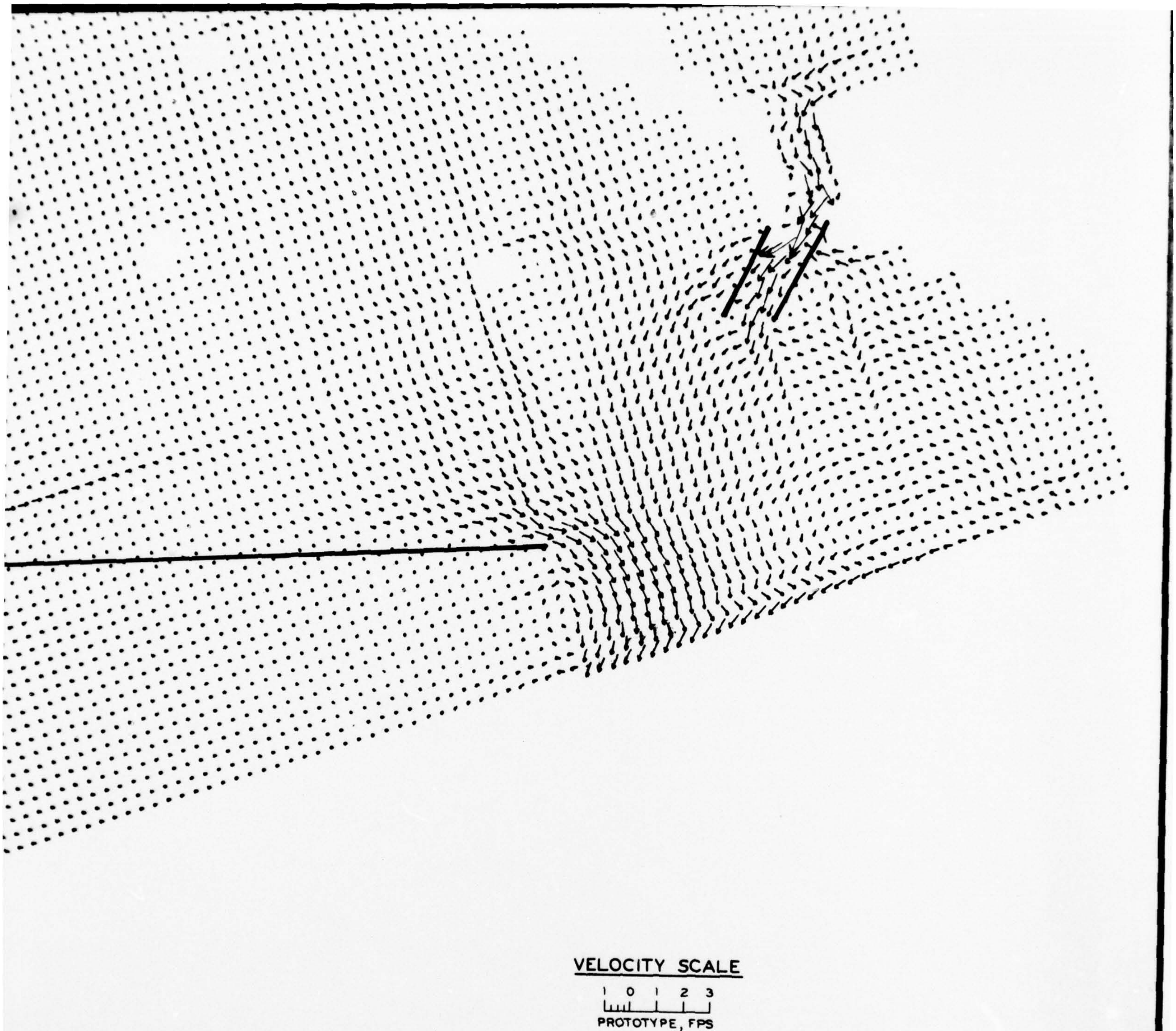

NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

PLAN 1A-2
SPRING TIDE
HOUR 15

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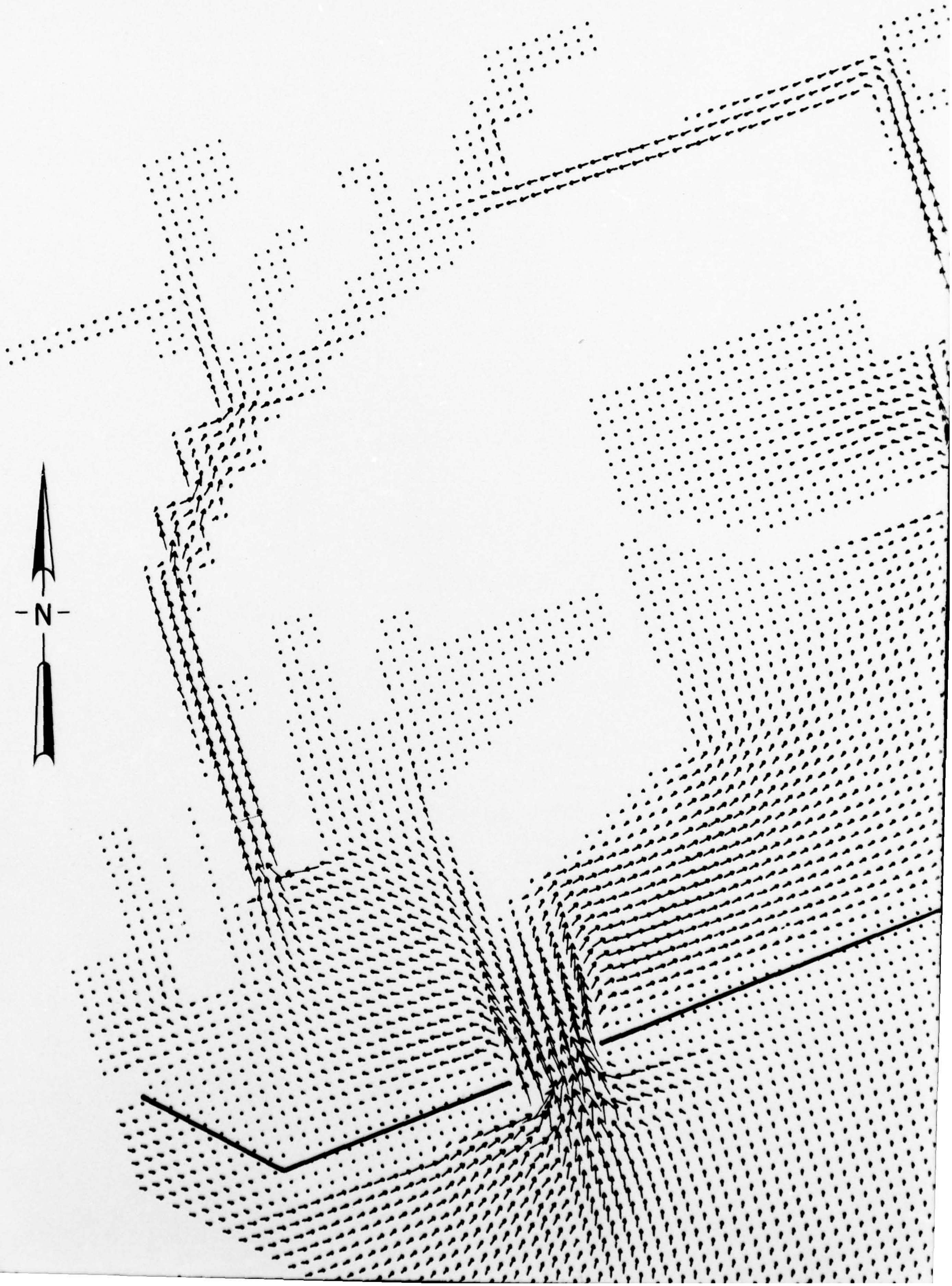
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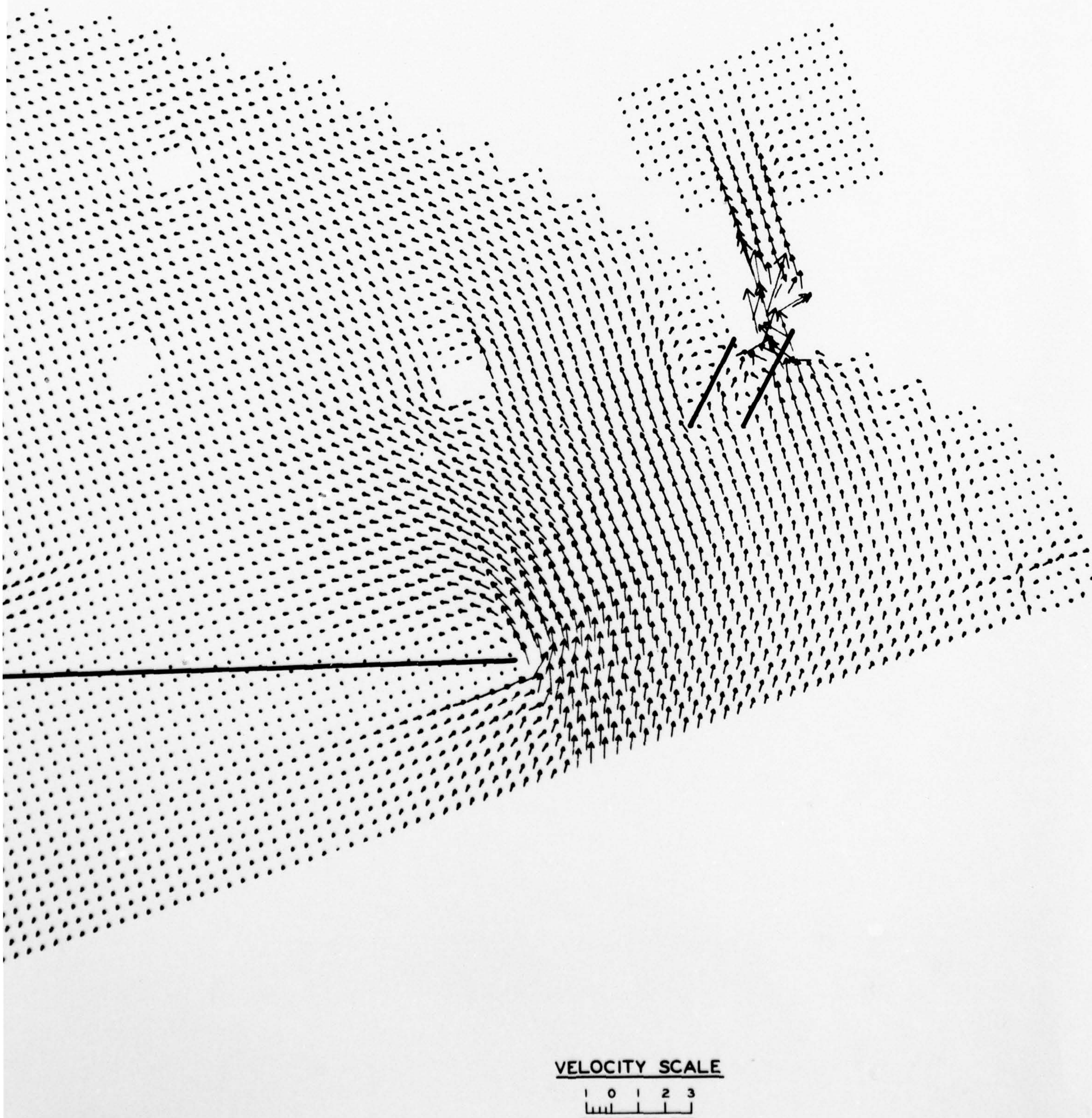
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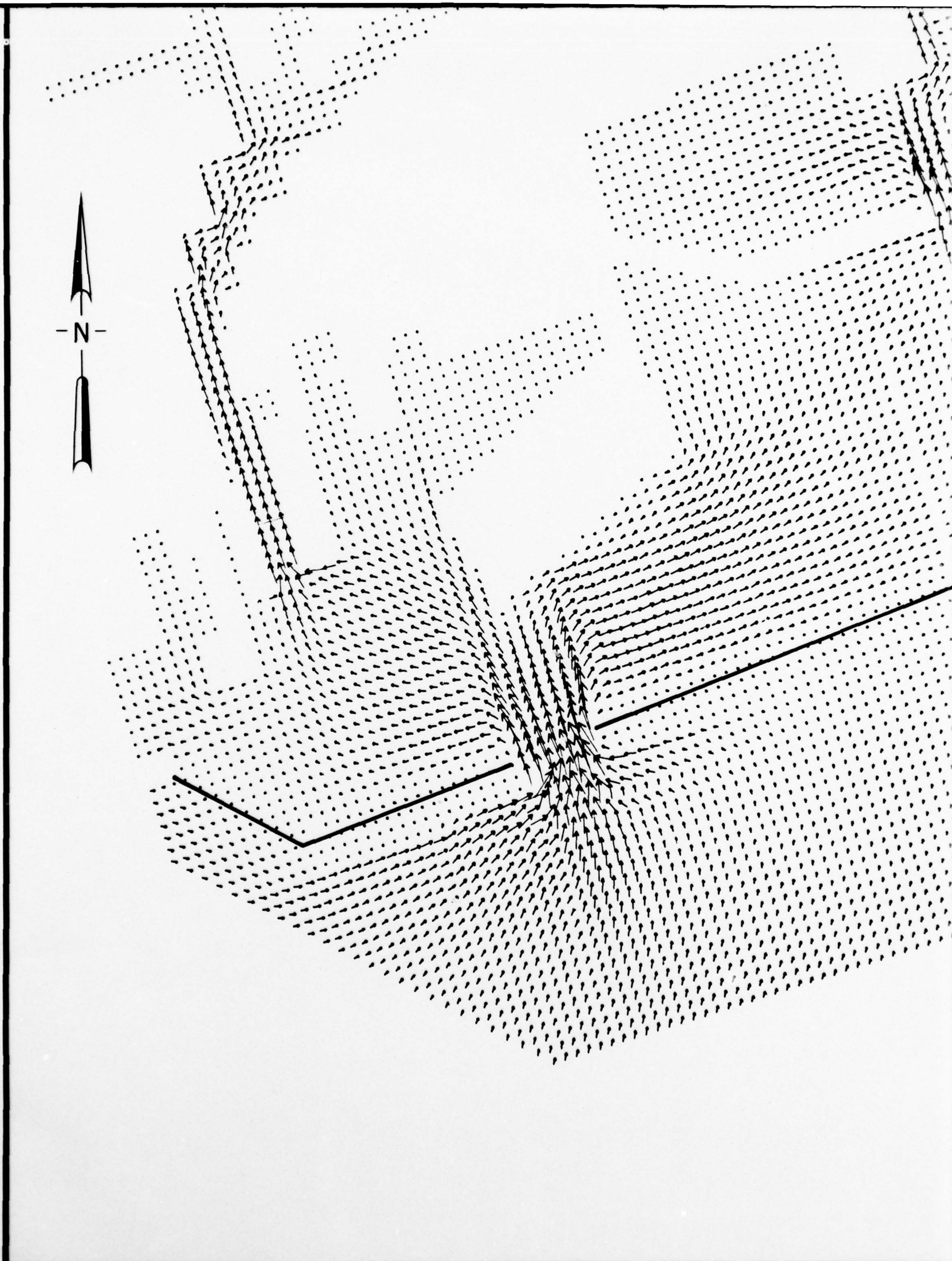

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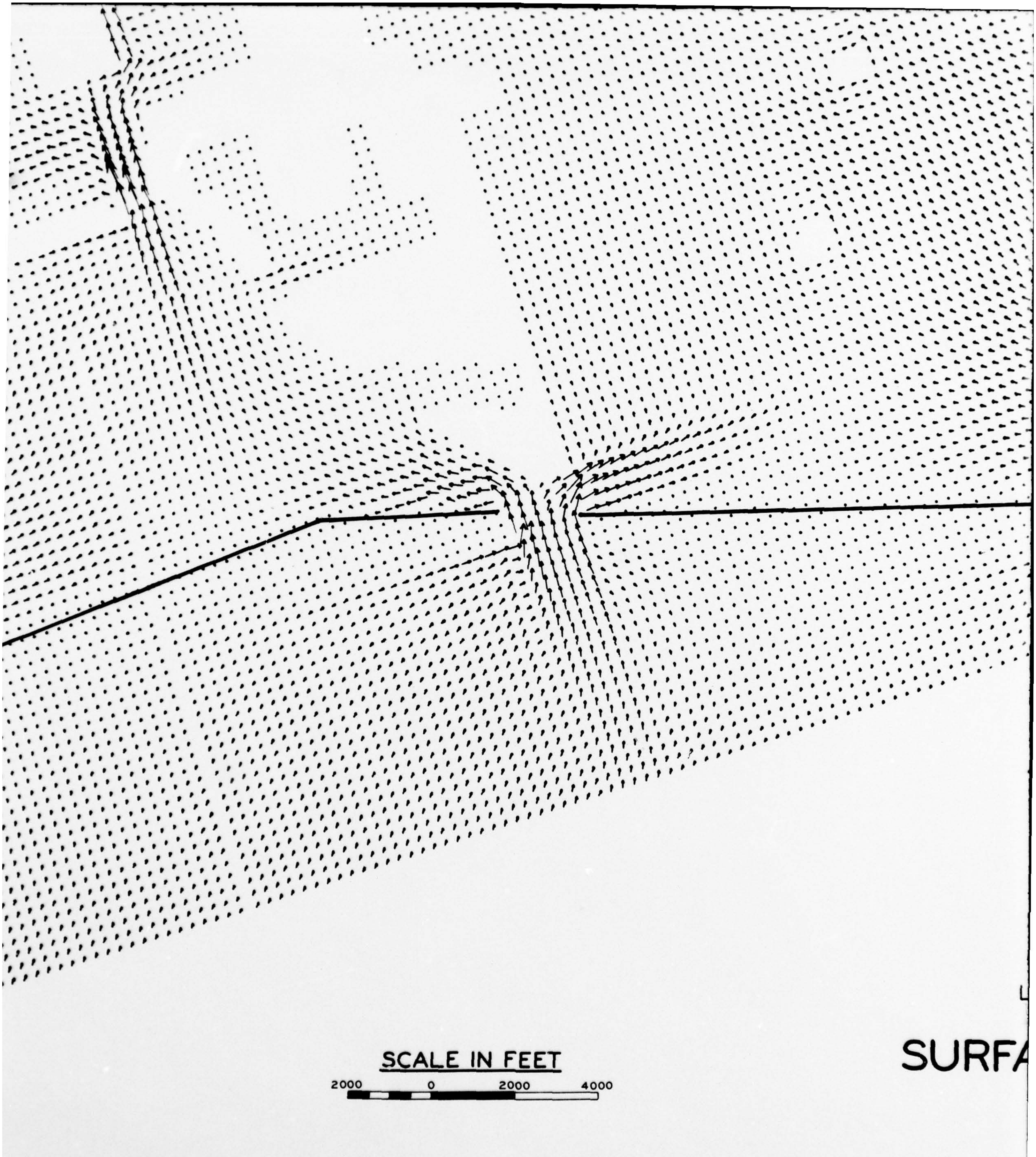

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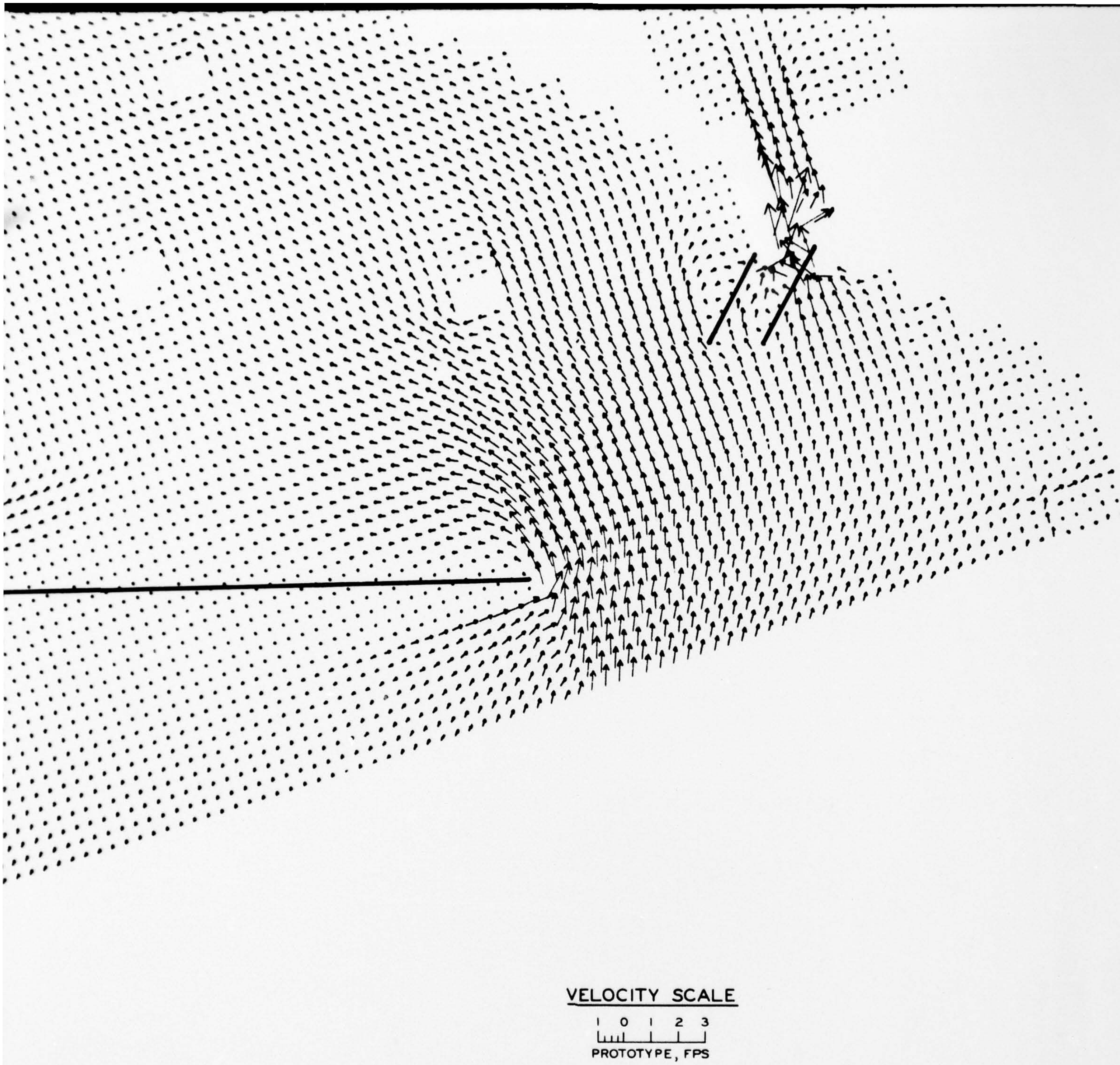
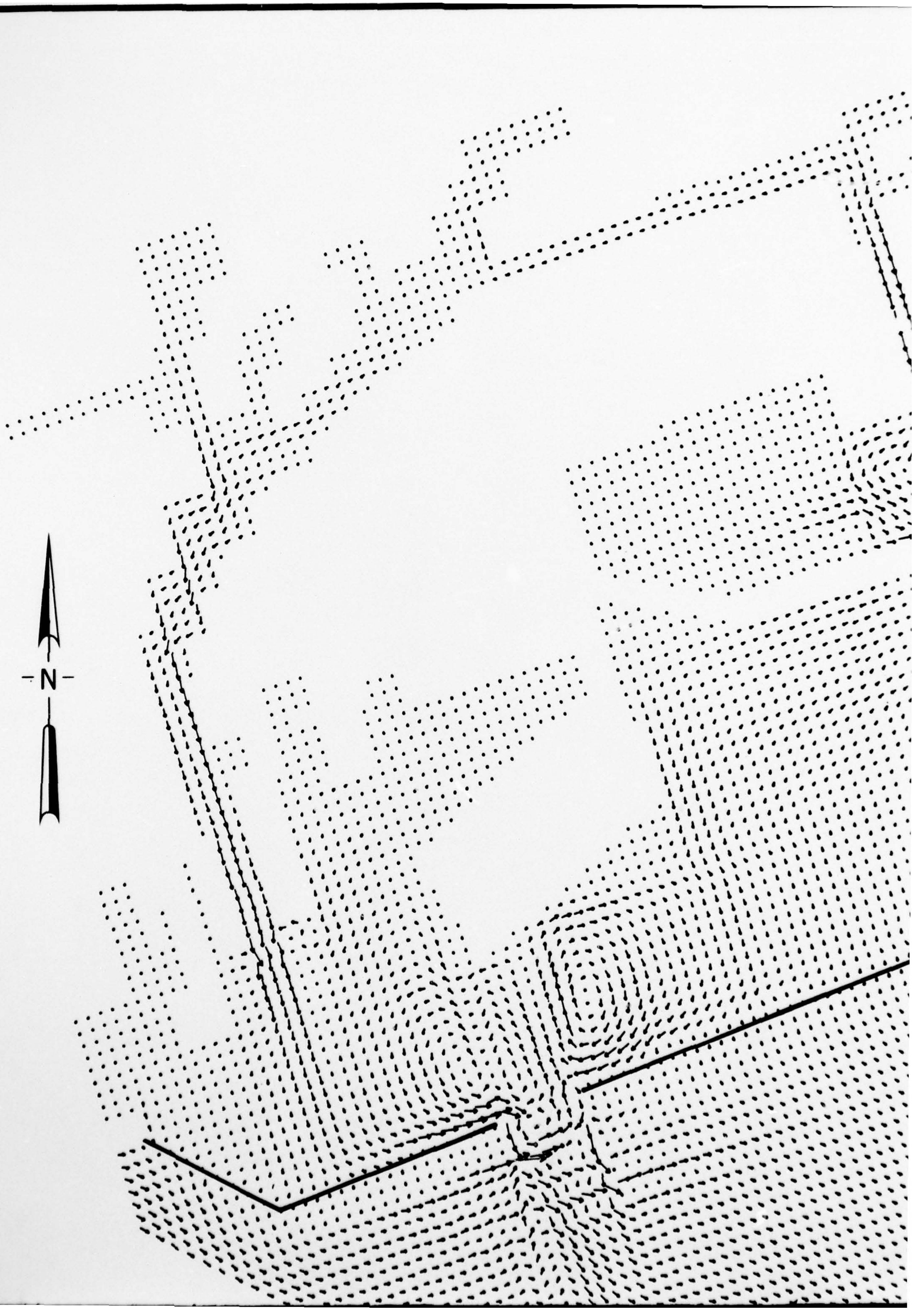


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

PLAN 1A-2
SPRING TIDE
HOUR 19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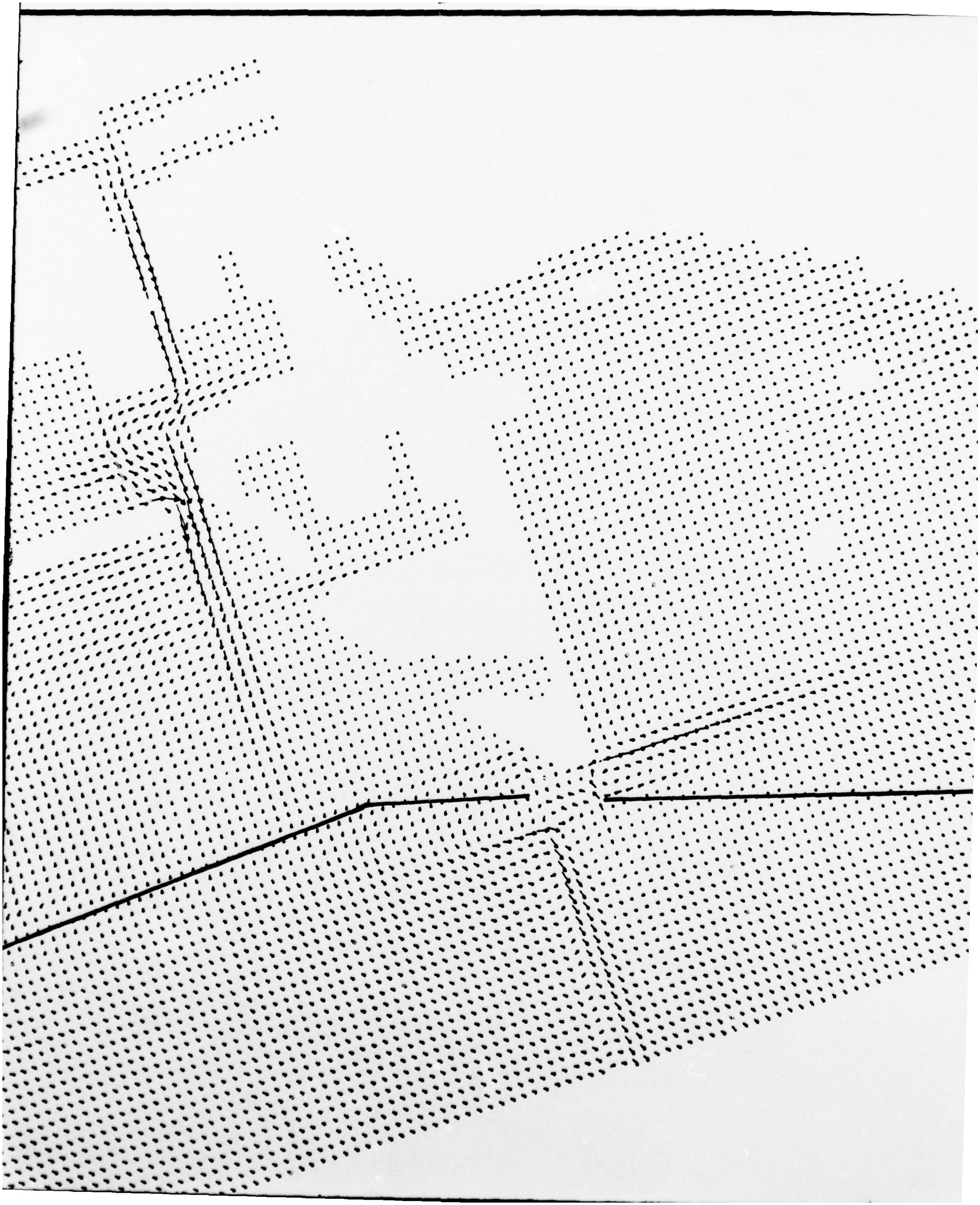

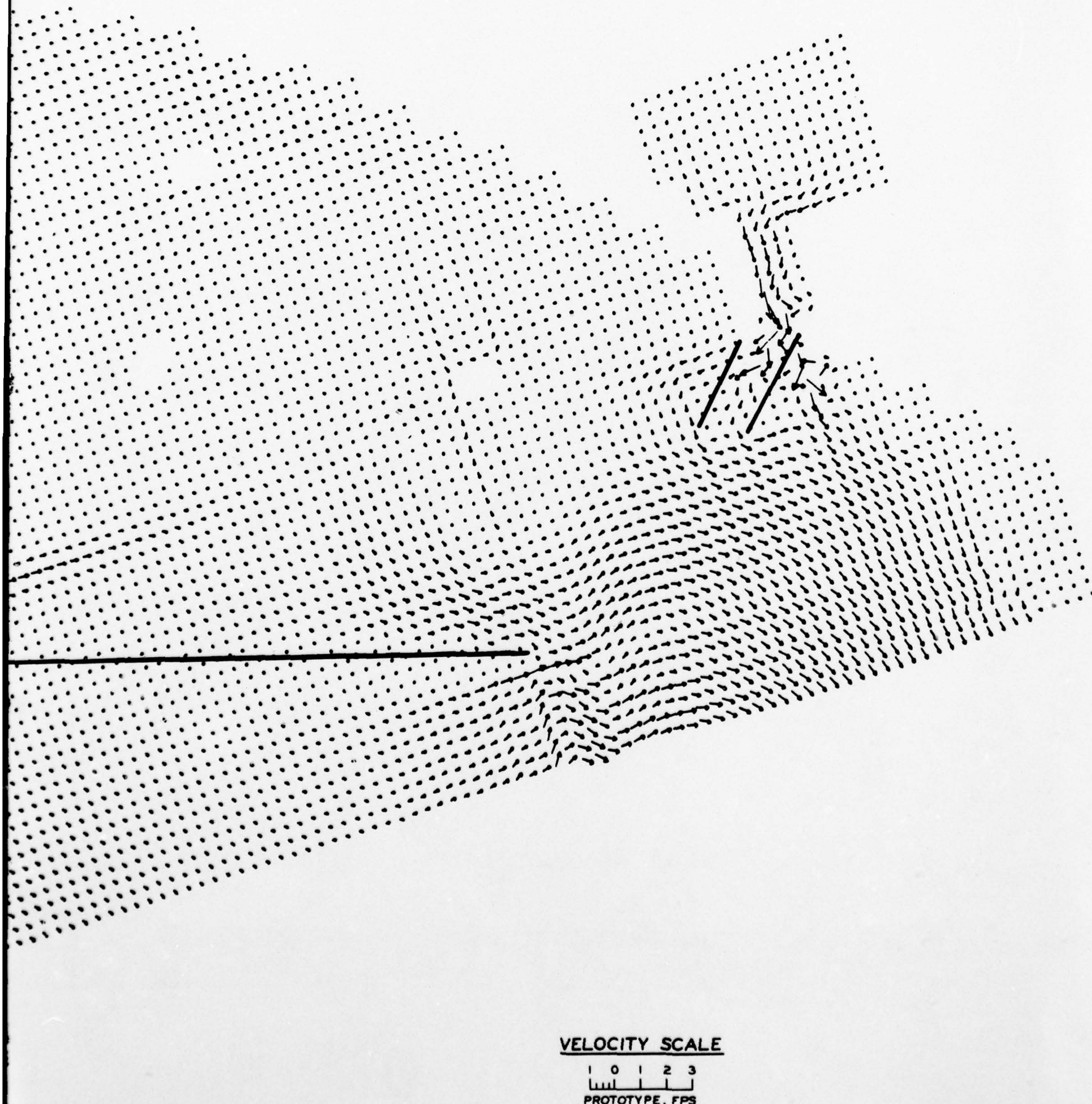
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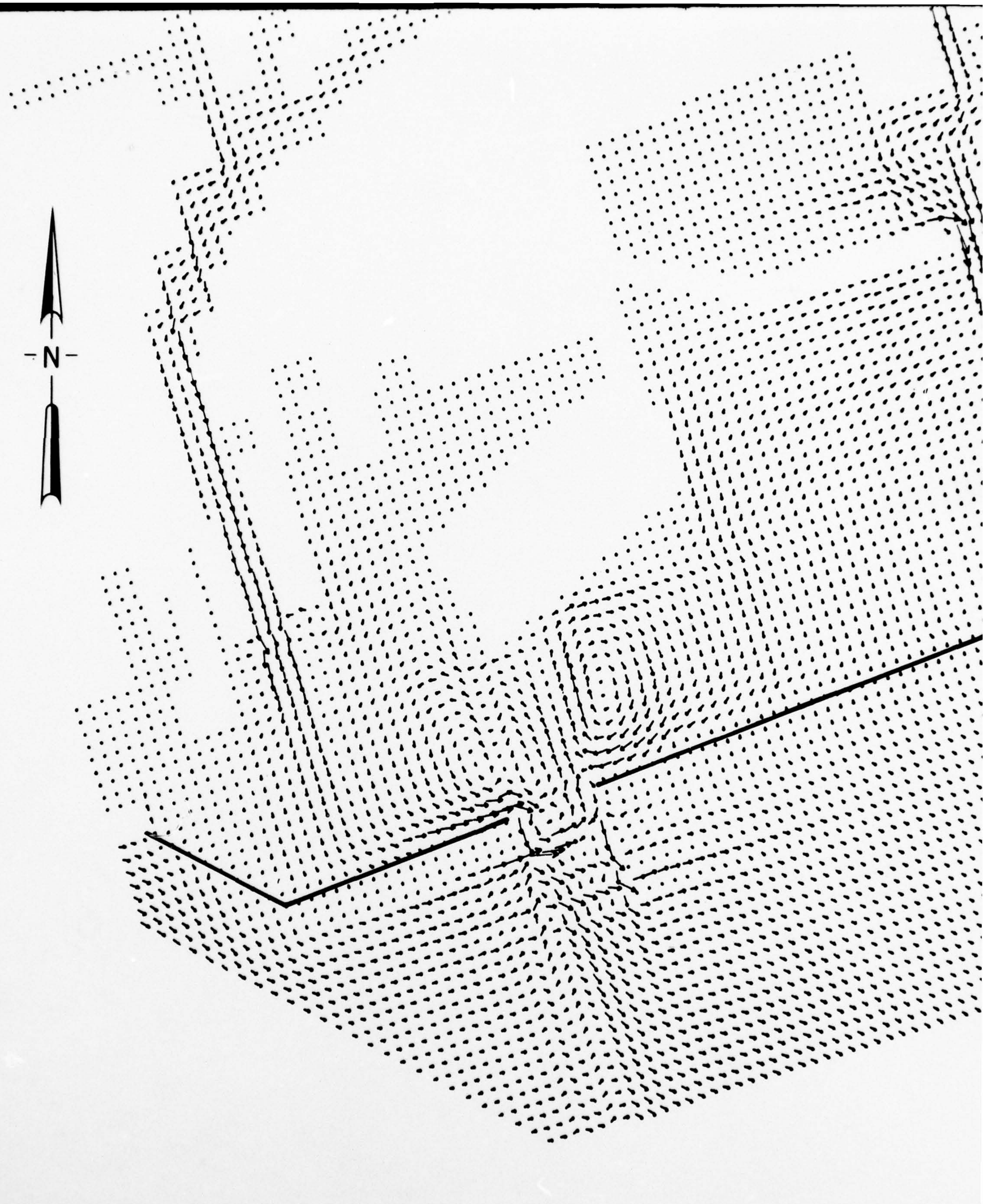

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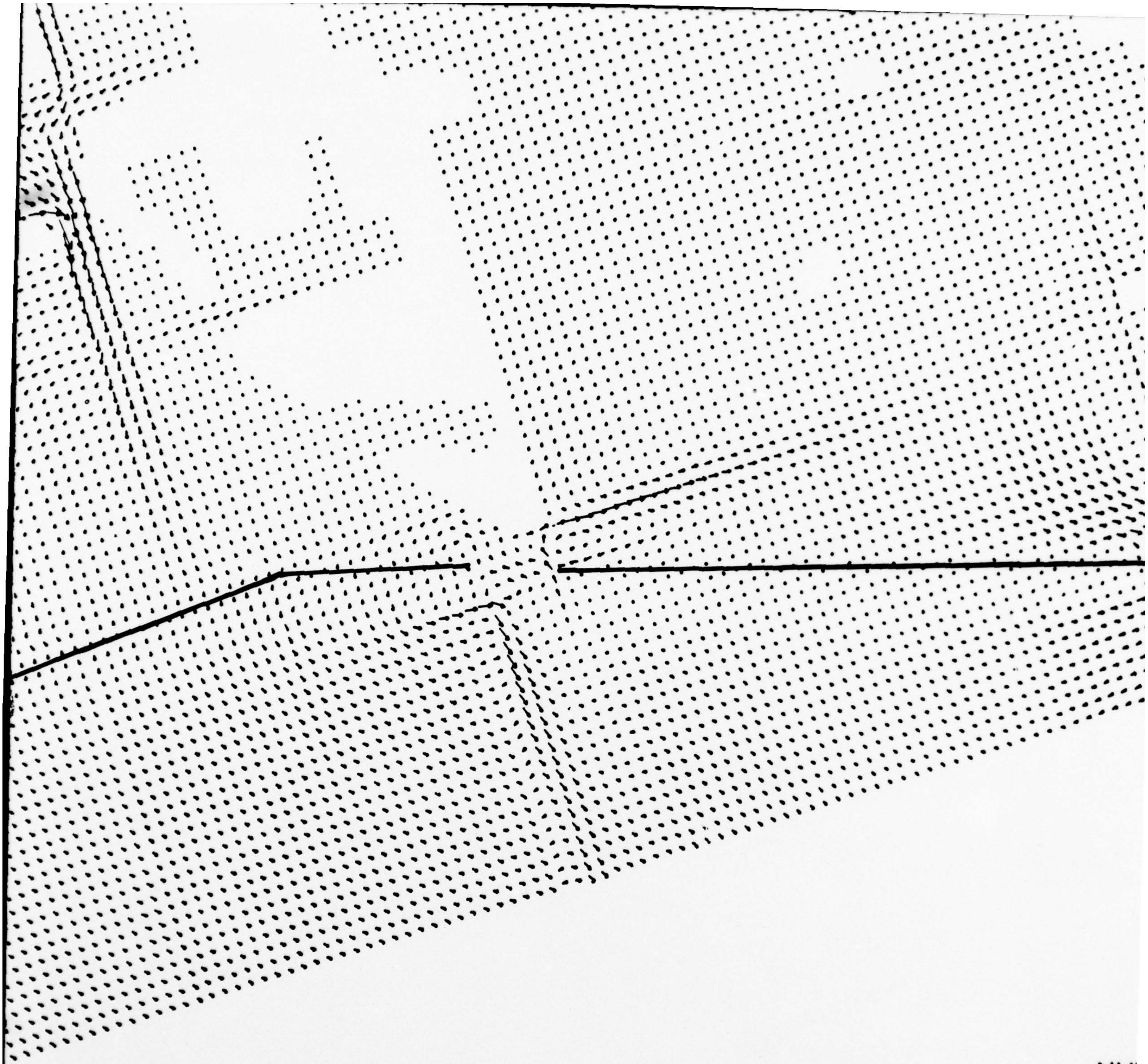

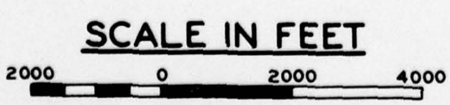

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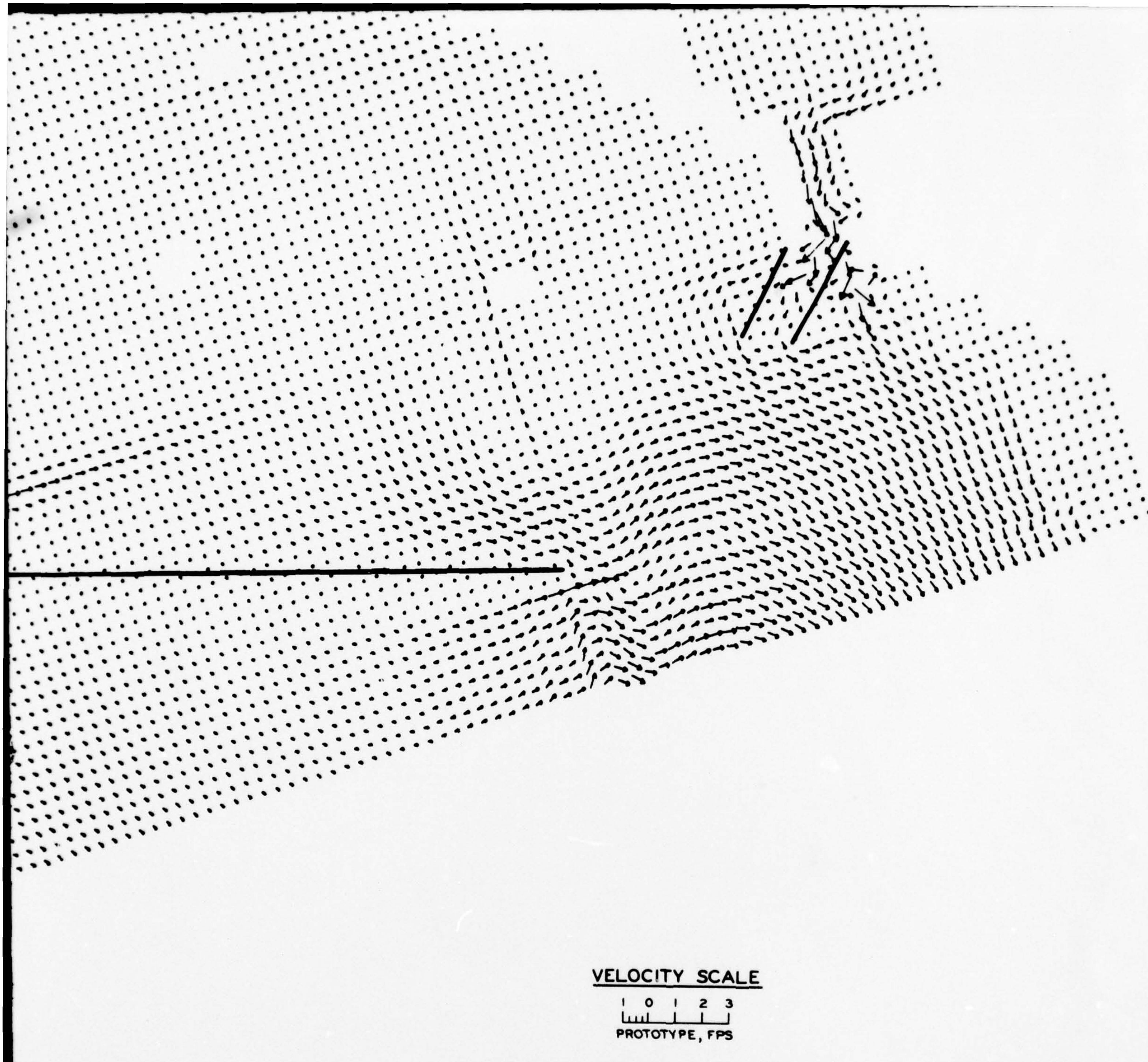
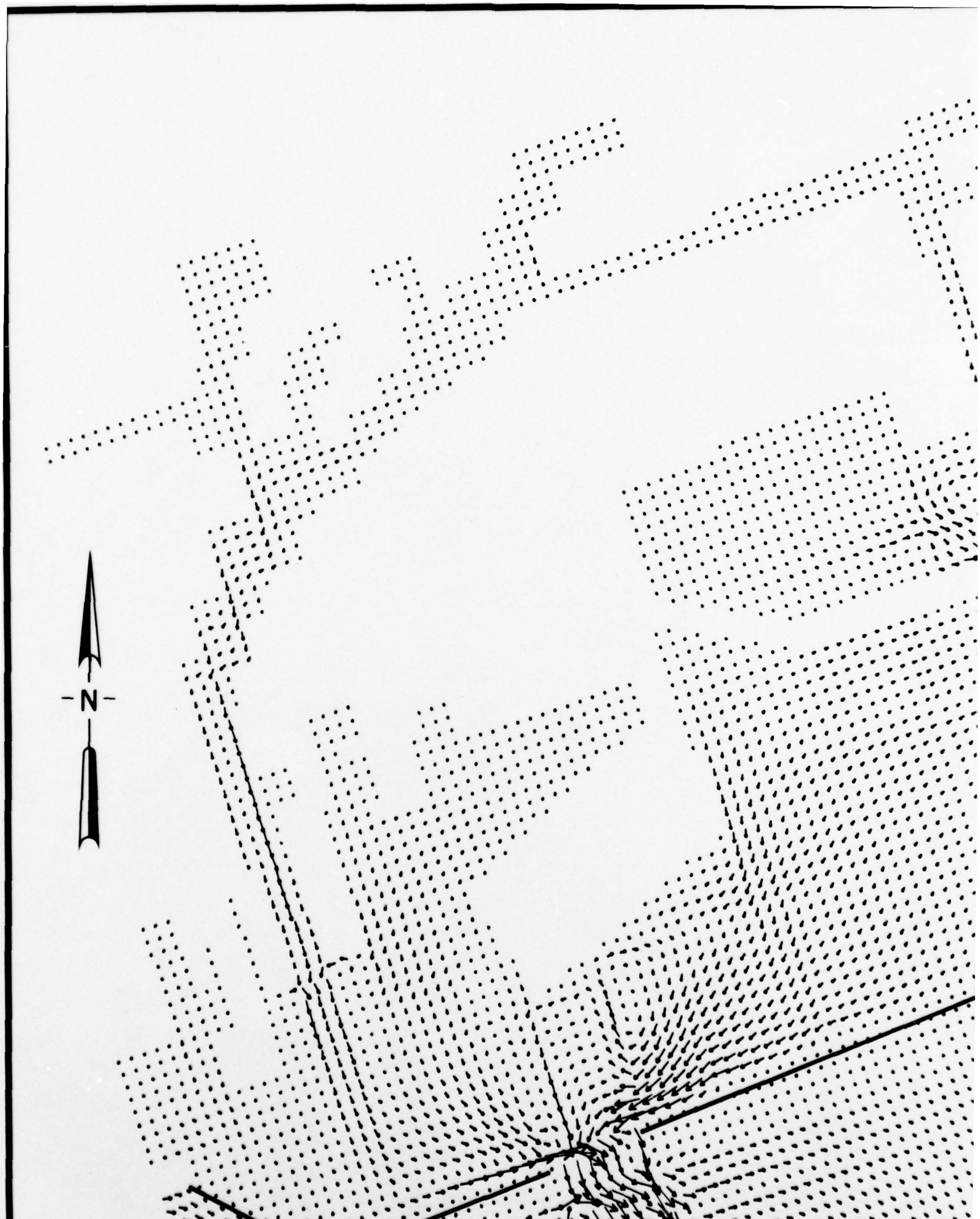


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

PLAN 1A-2
SPRING TIDE
HOUR 22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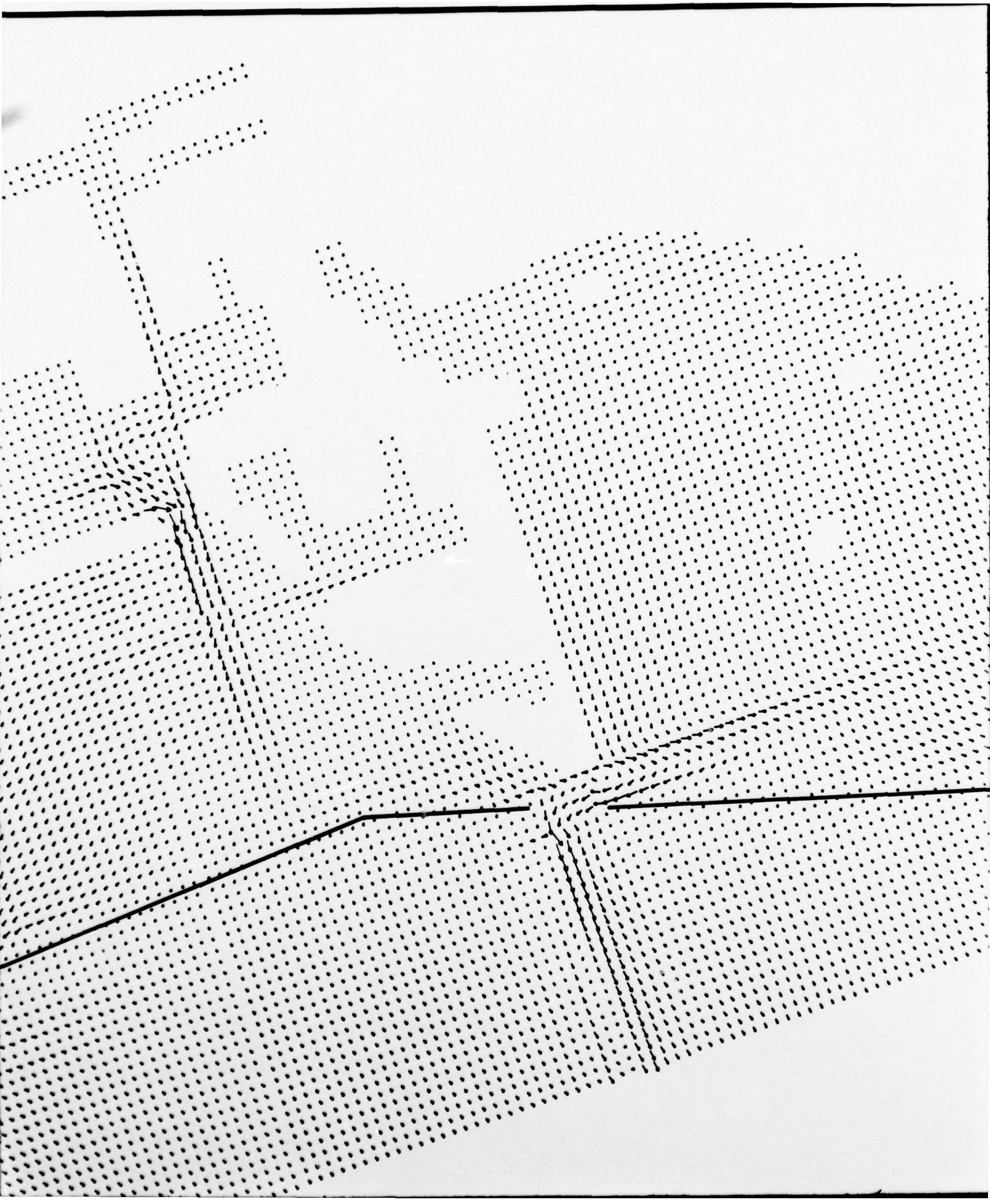

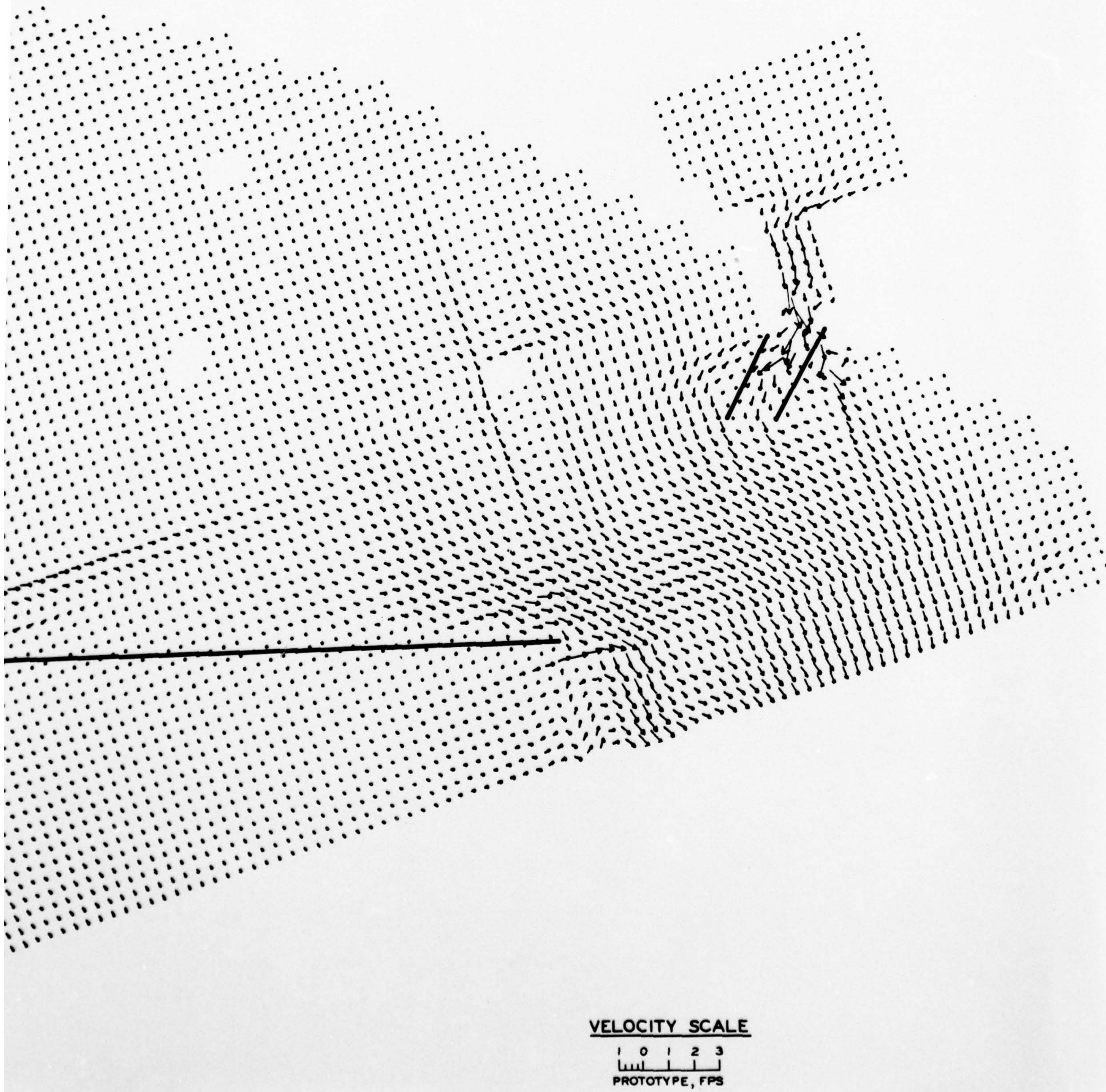
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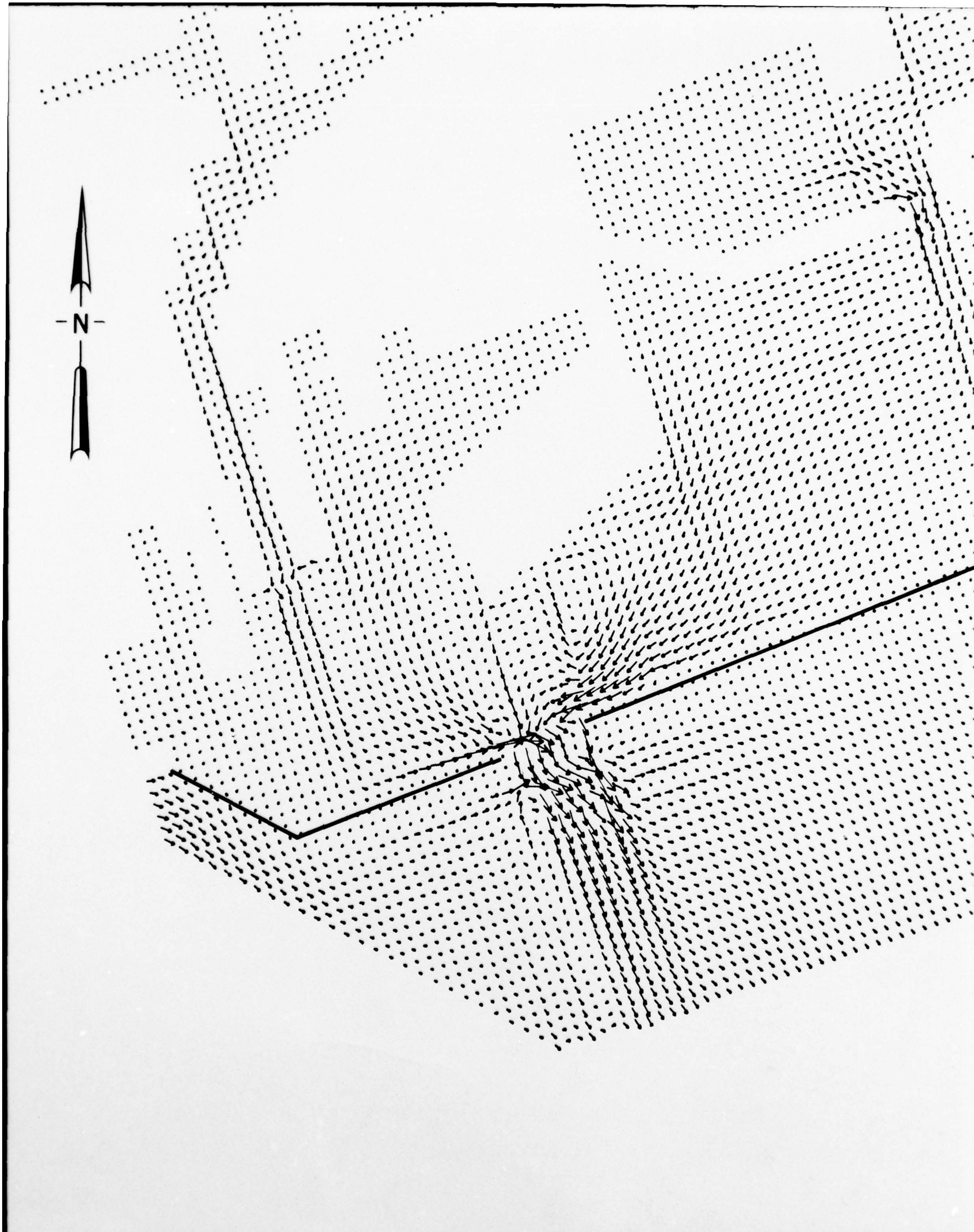
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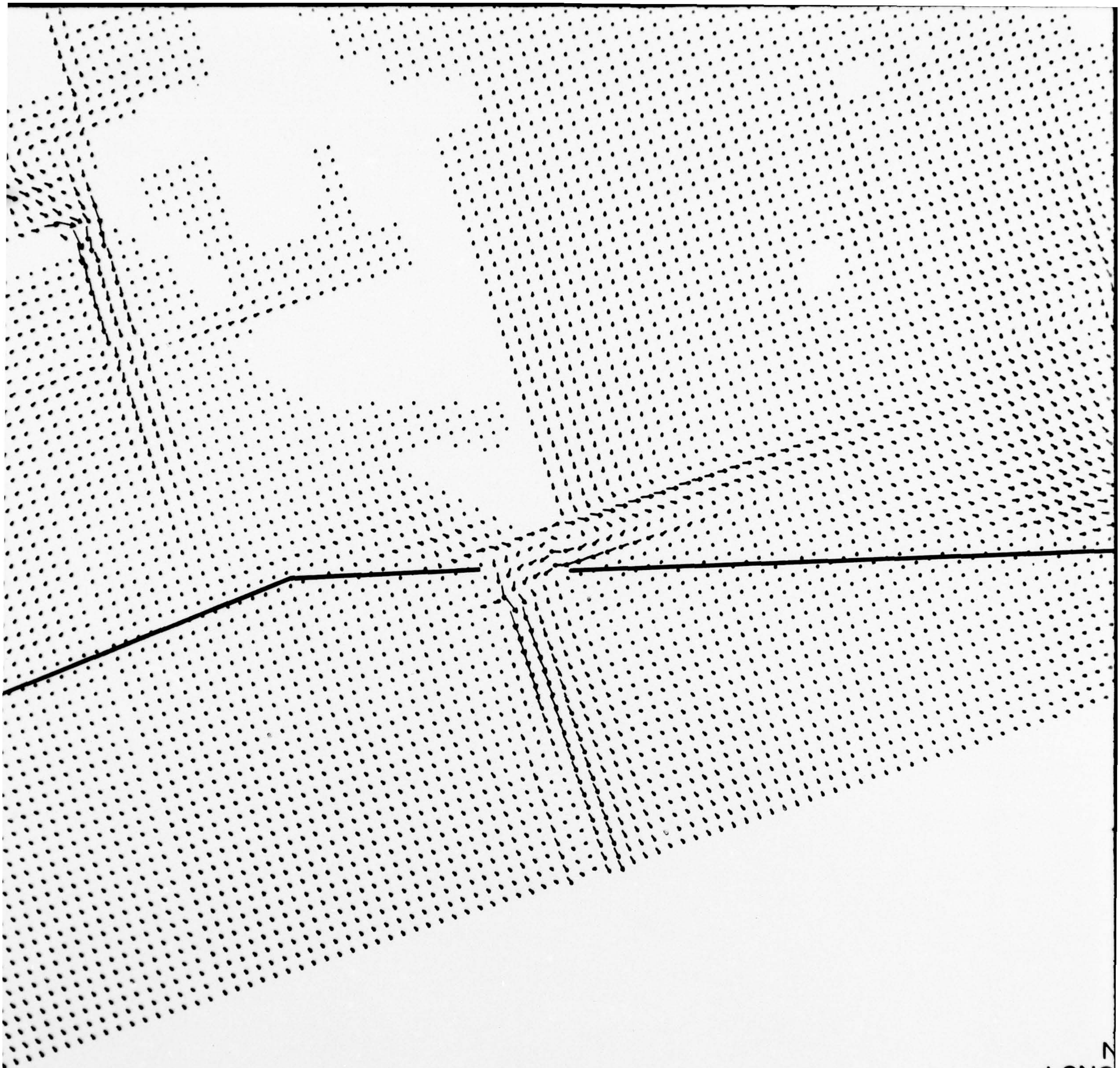

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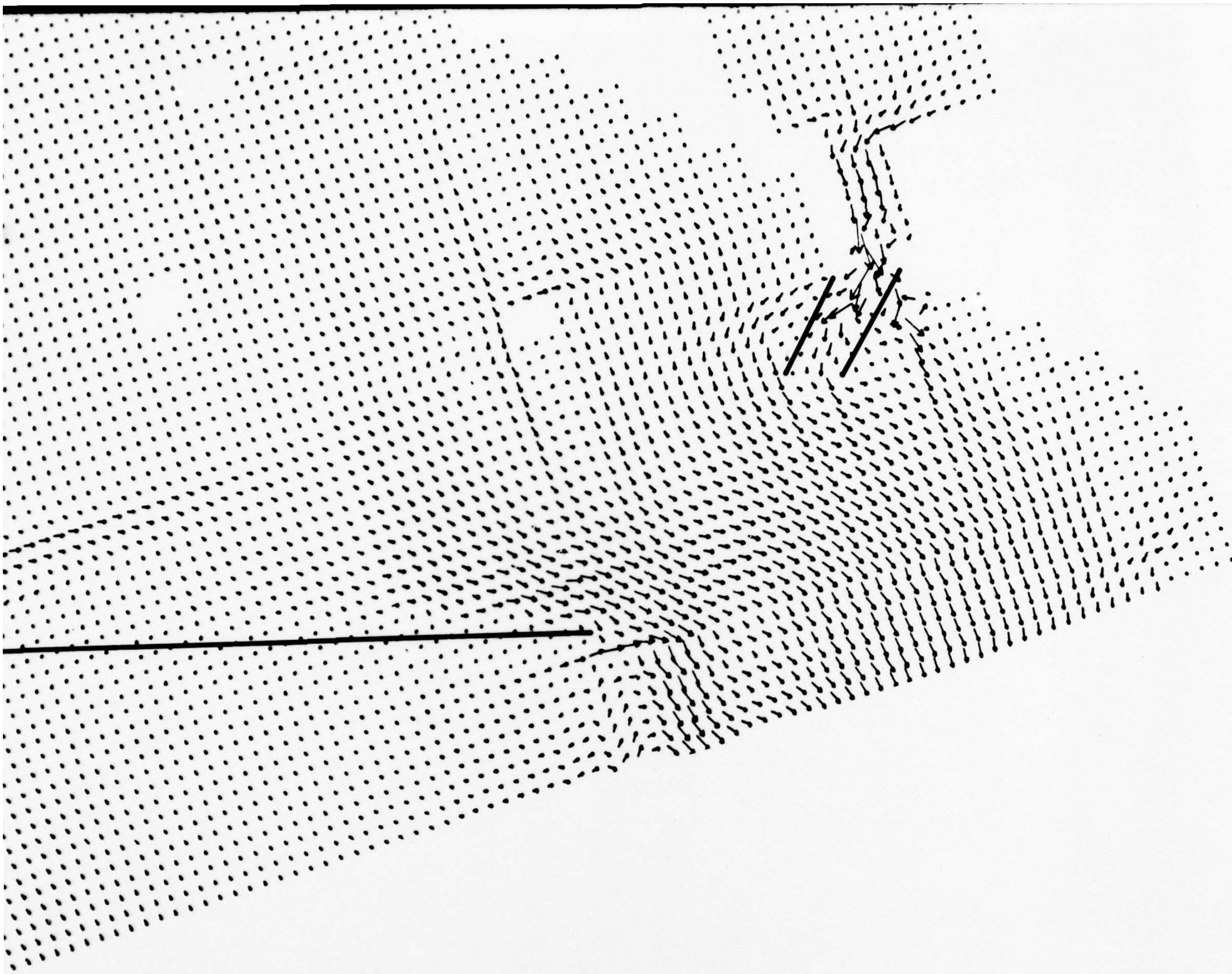

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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

PLAN 1A-2
SPRING TIDE
HOUR 24

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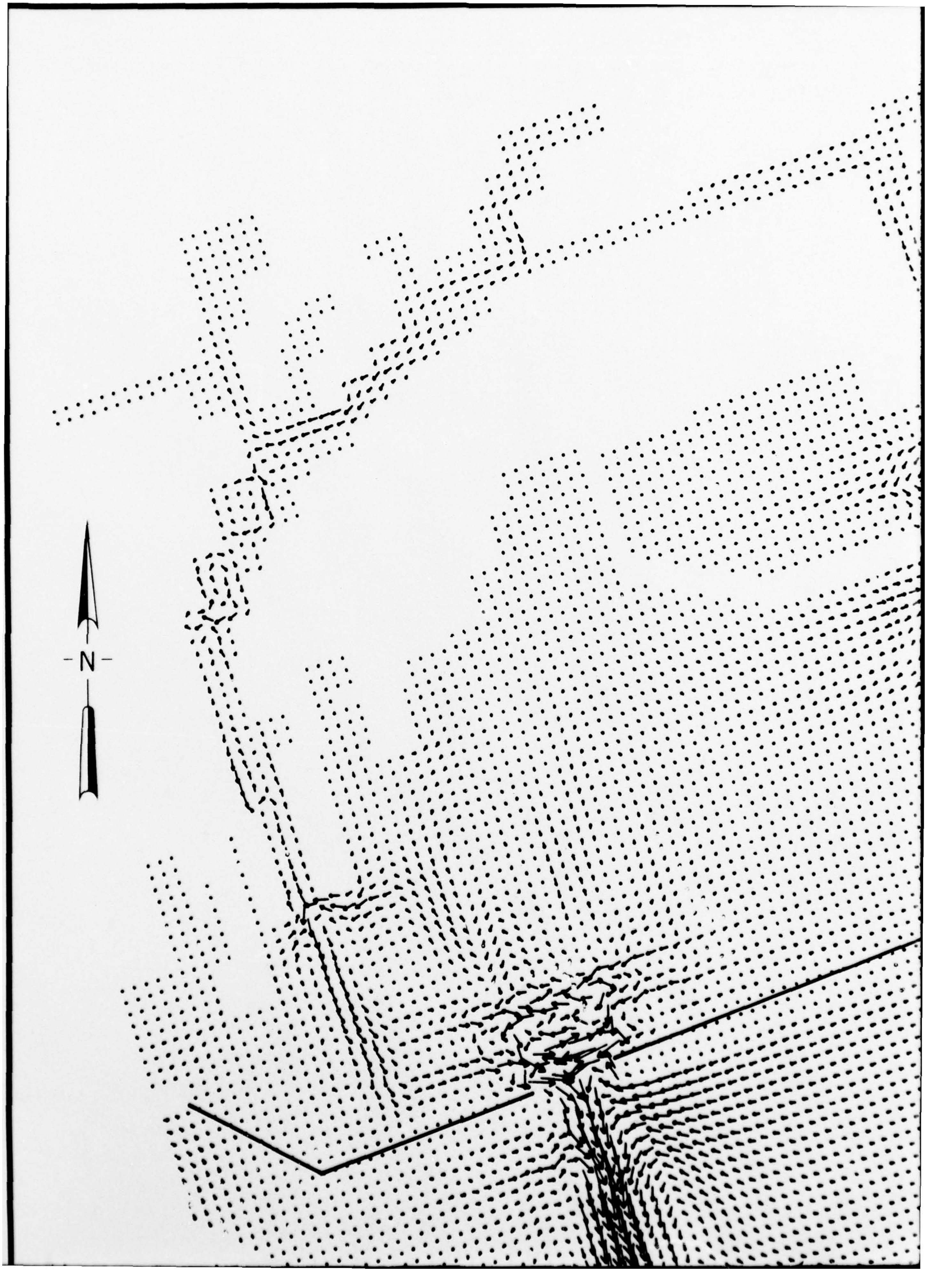
FIGURE 8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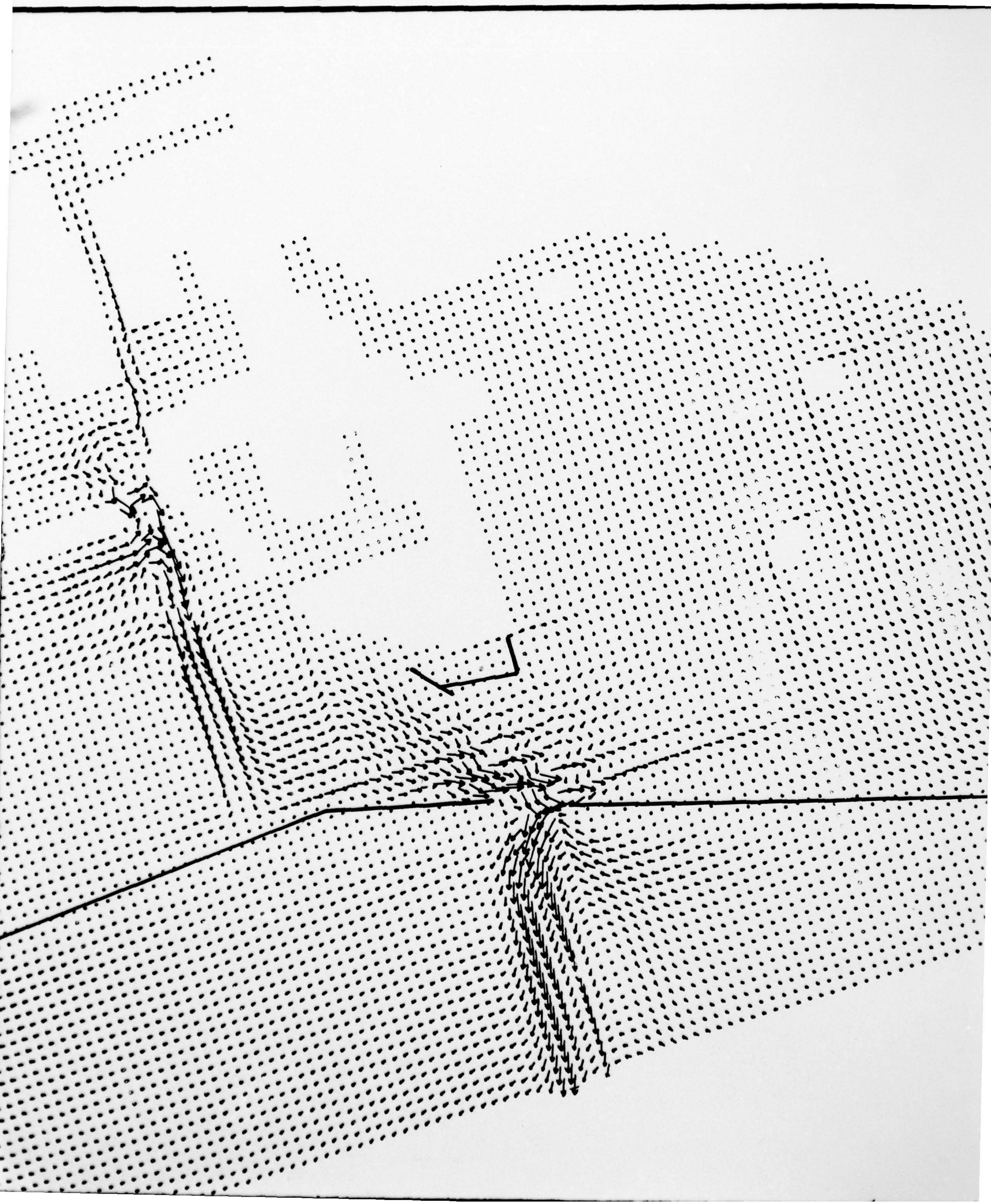

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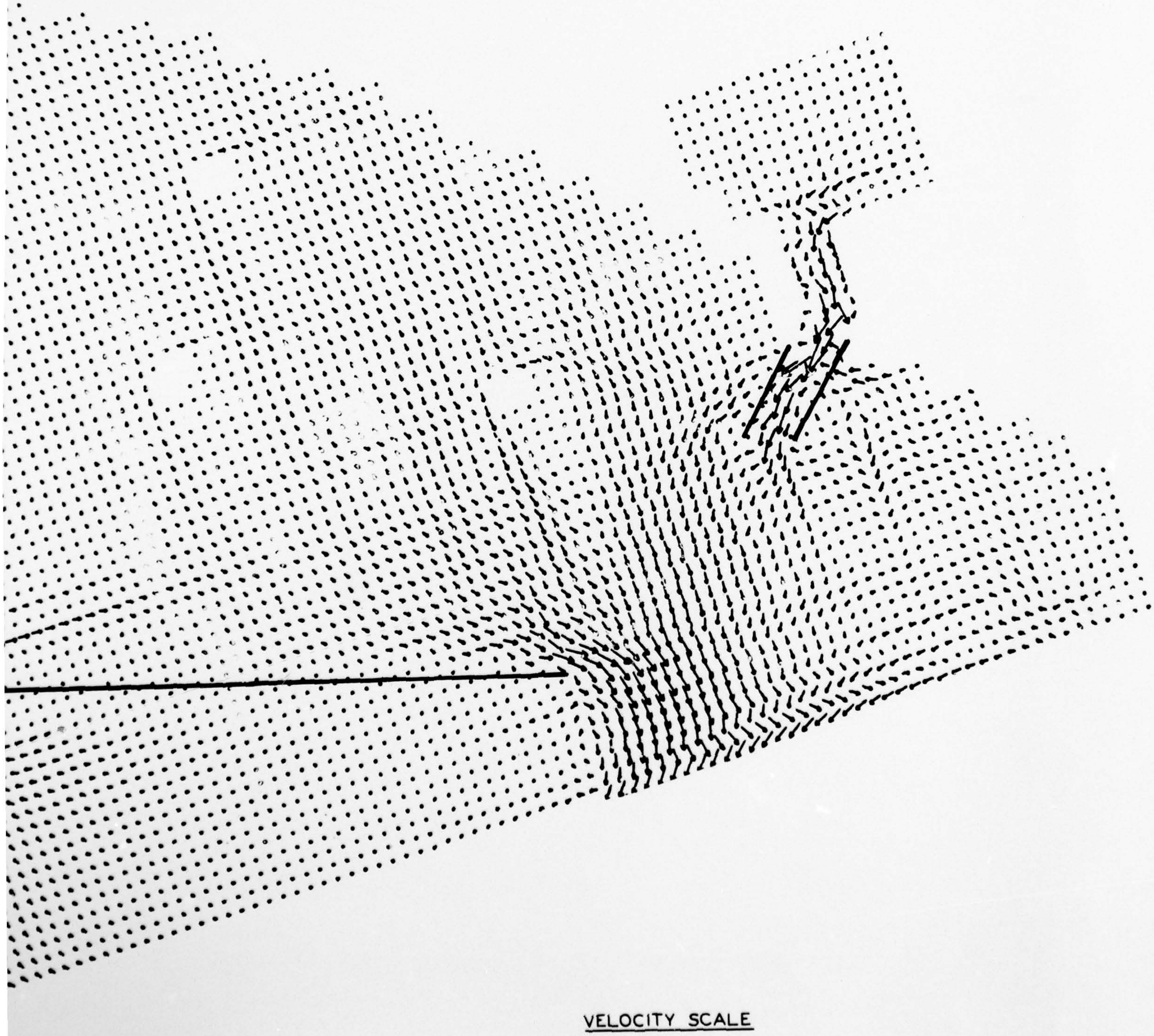

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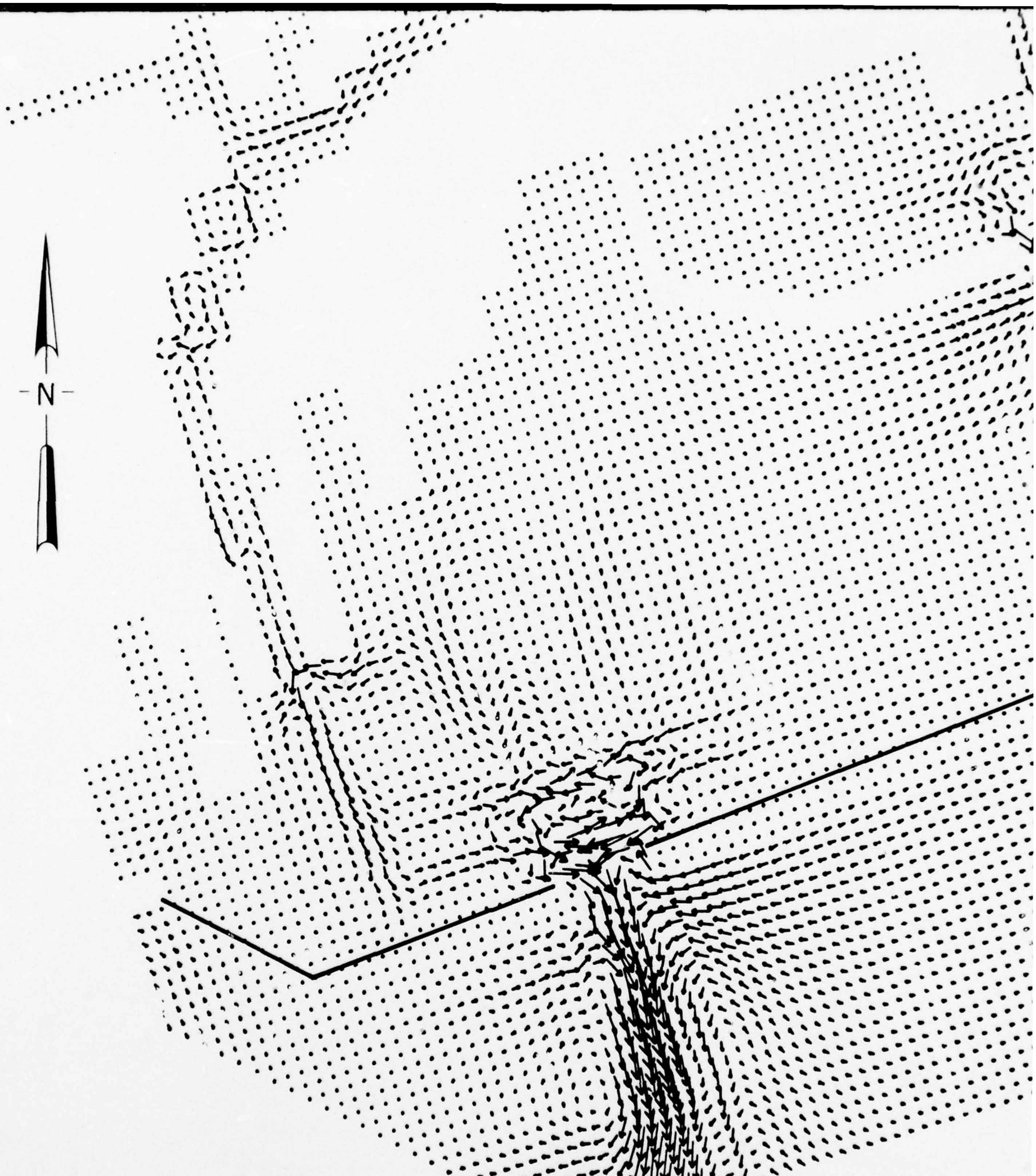
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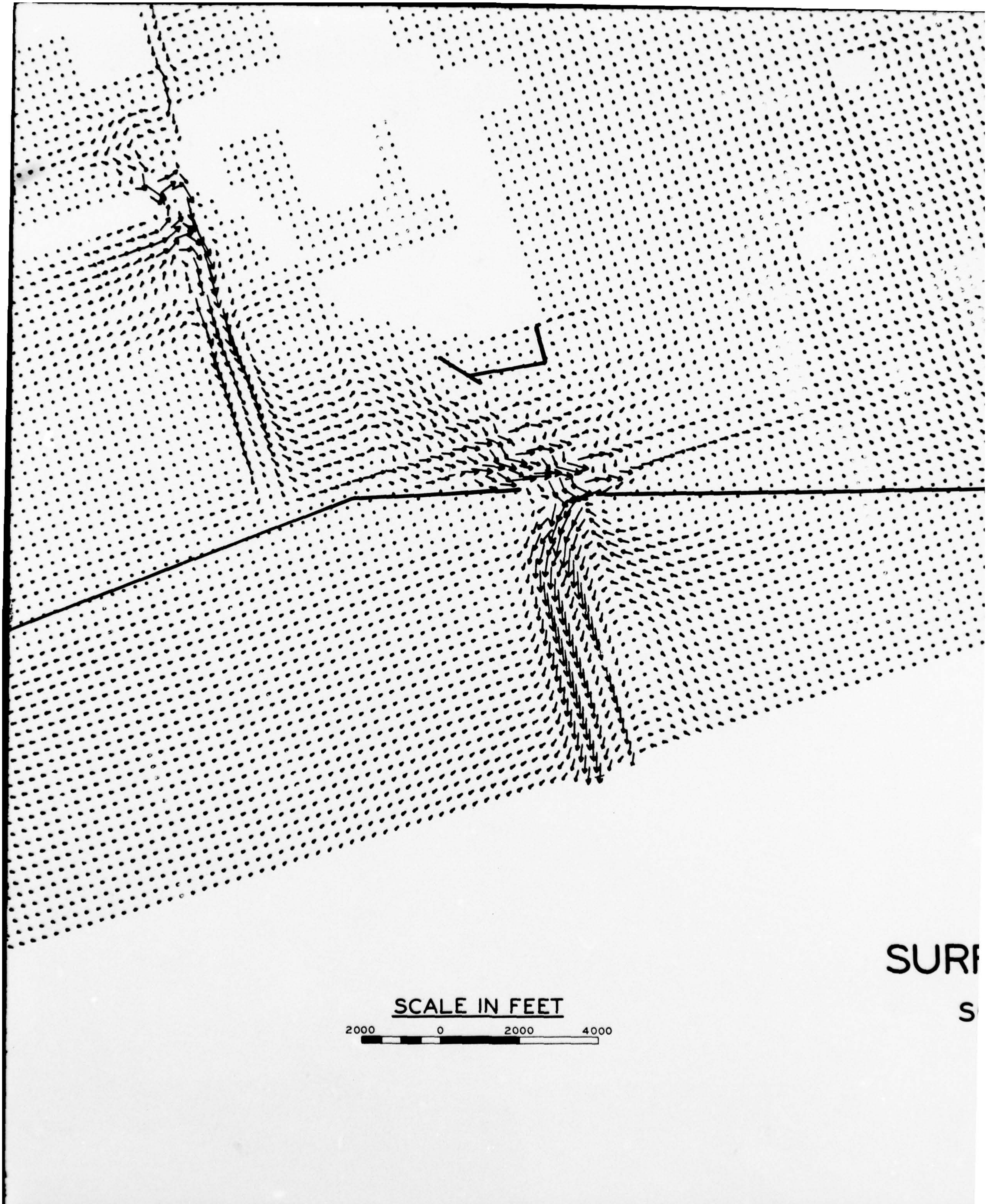
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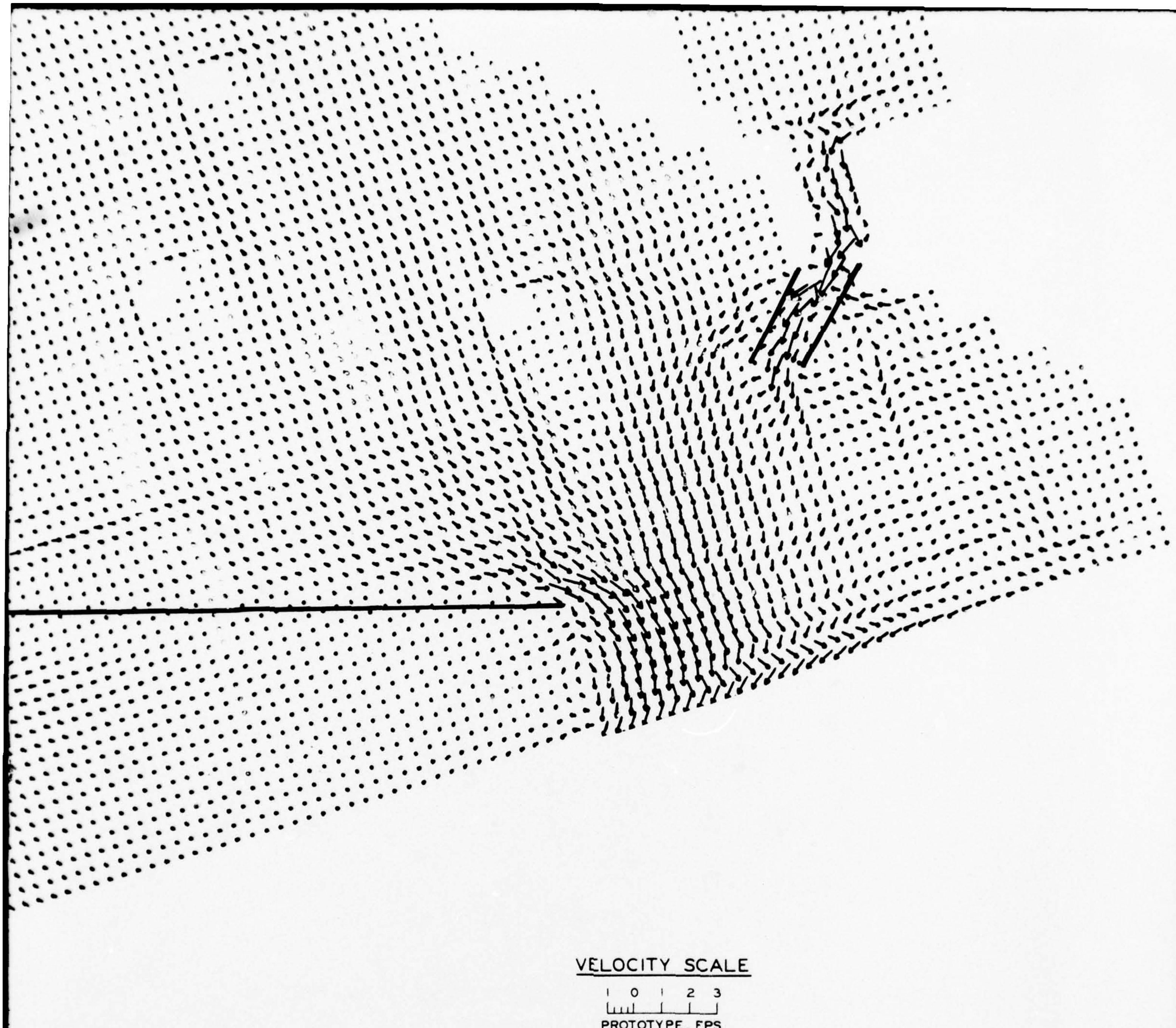
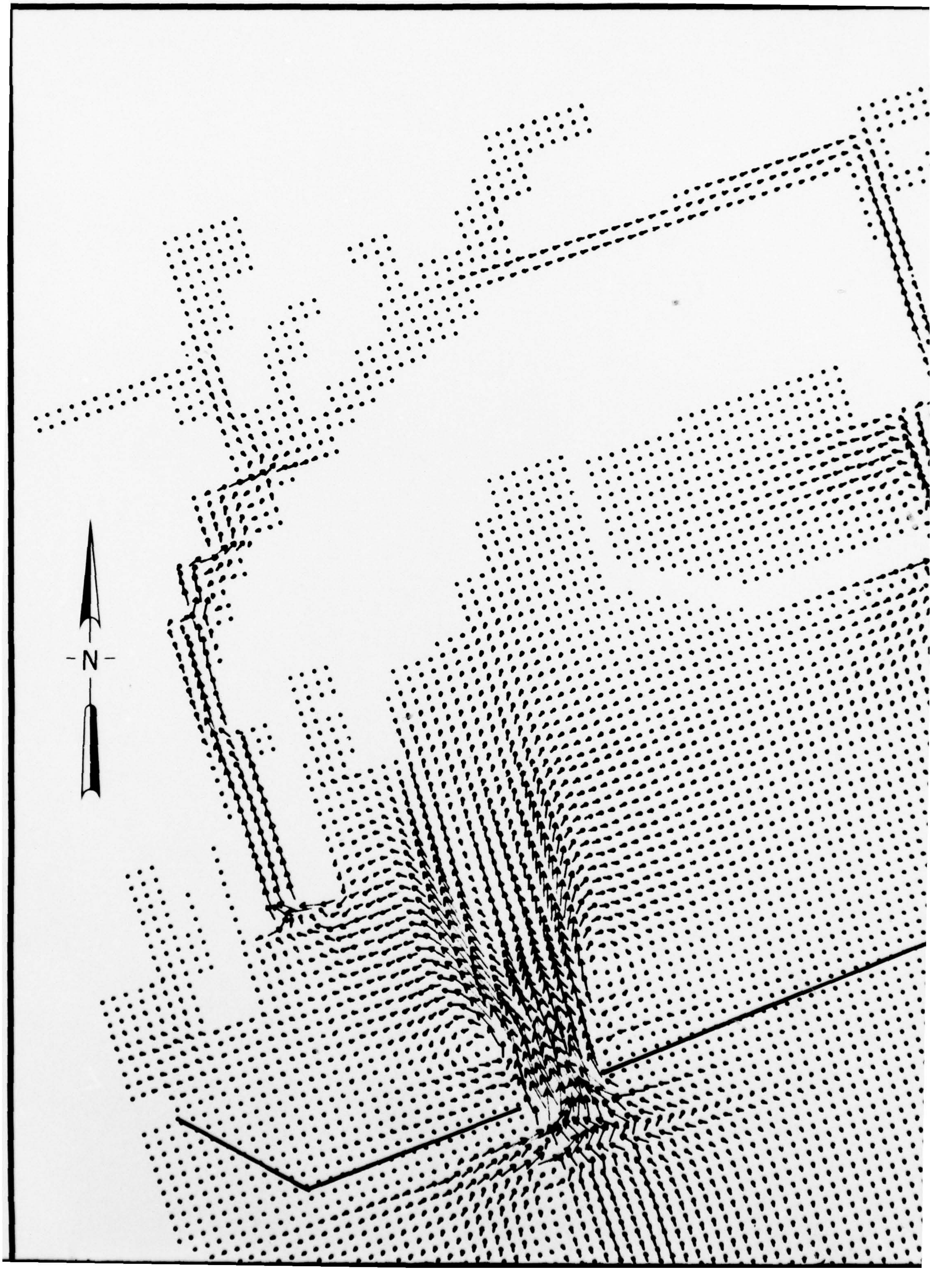


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 300-FT OPENING
–62-FT CHANNEL

SPRING TIDE
HOUR 15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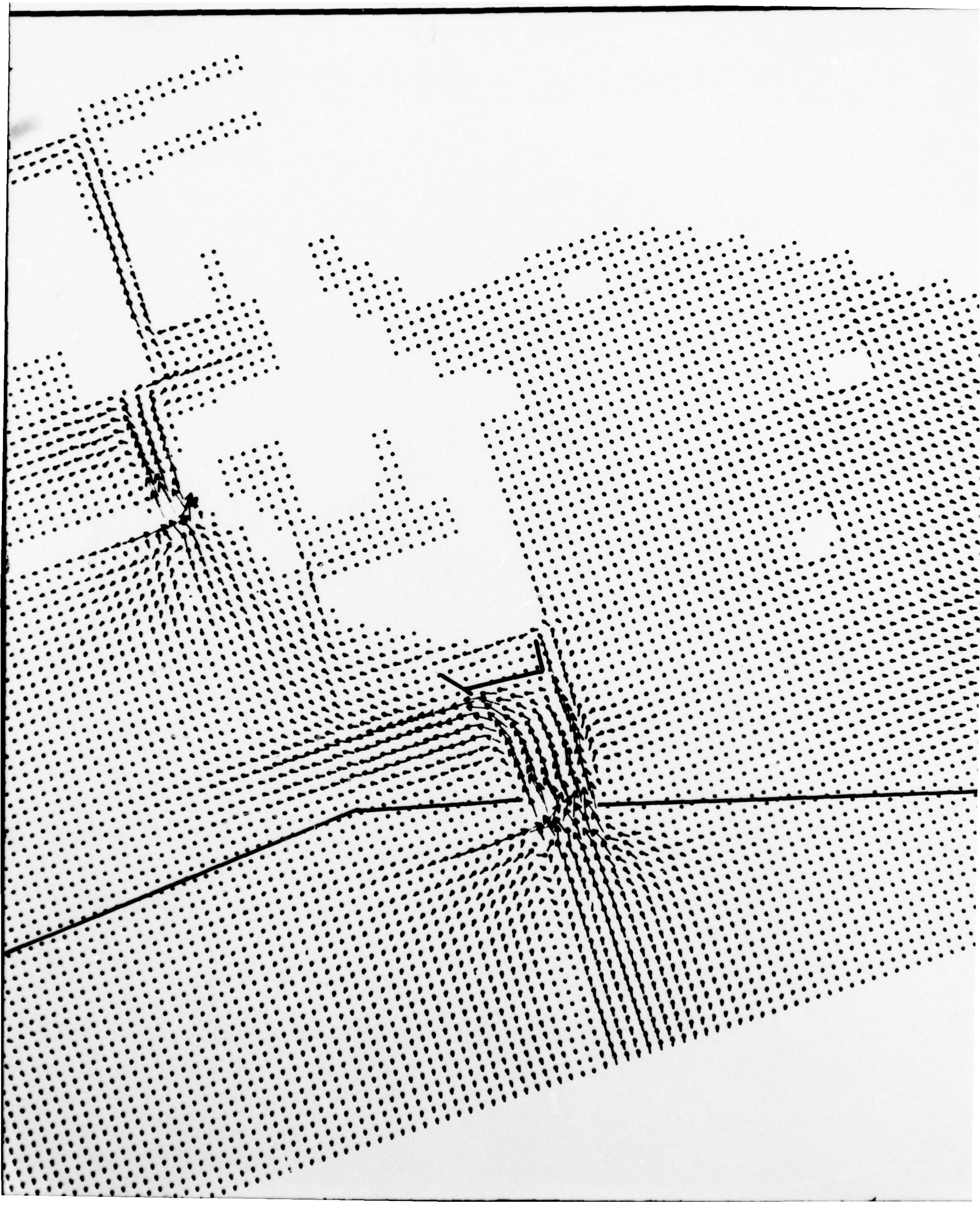
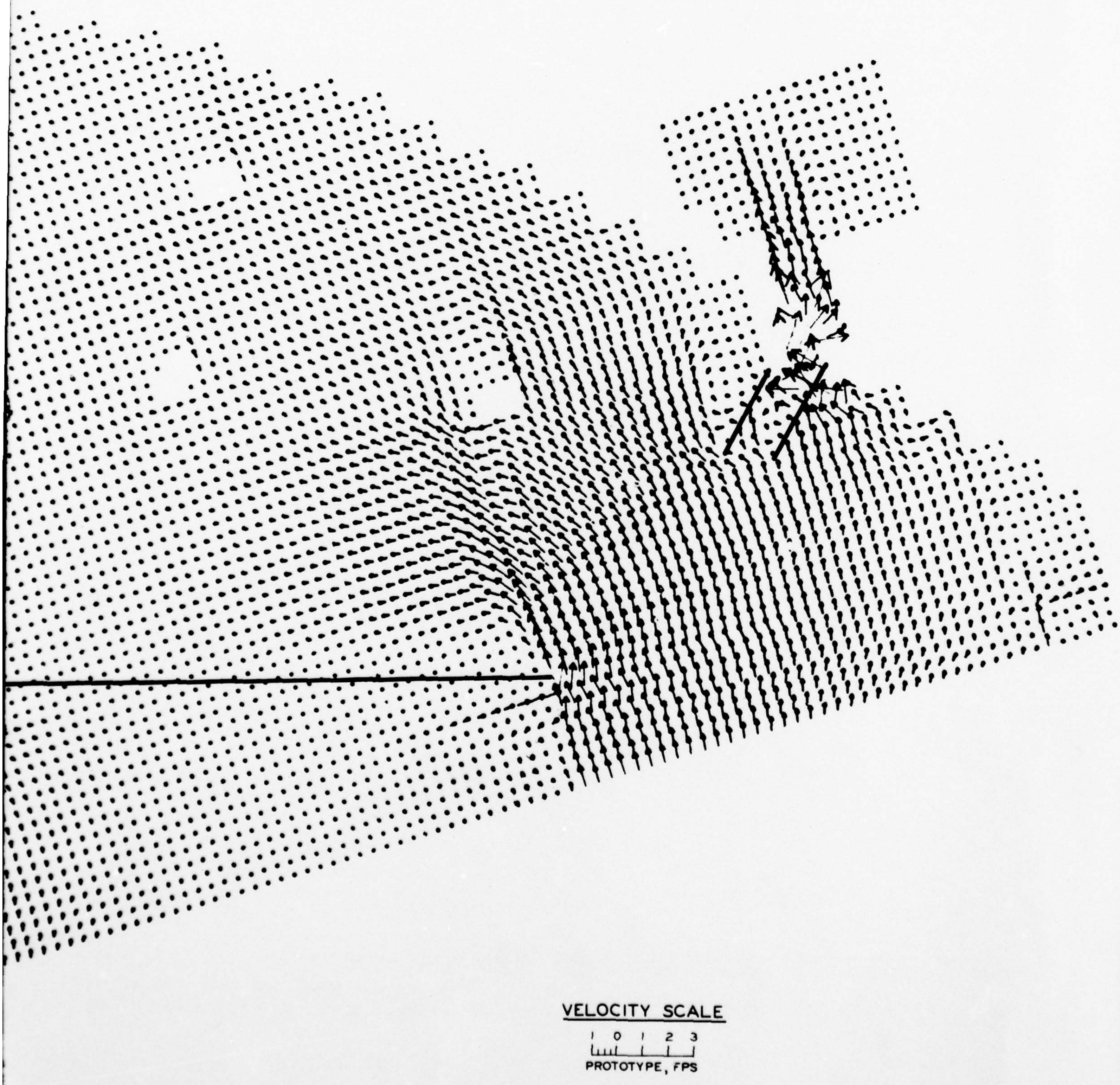
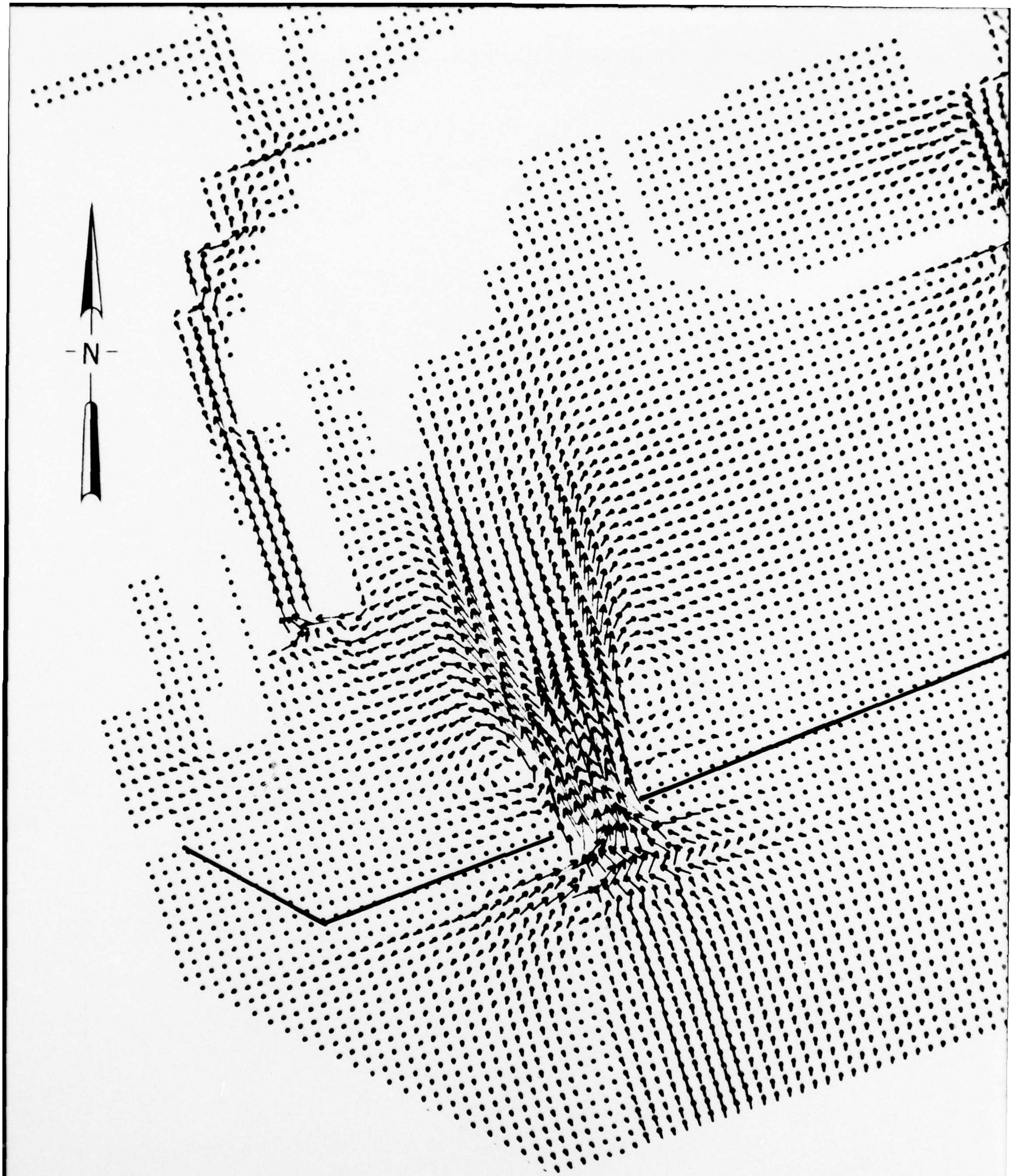




NUMERICAL MODEL STUDY OF
LONG BEACH–LOS ANGELES HARBORS



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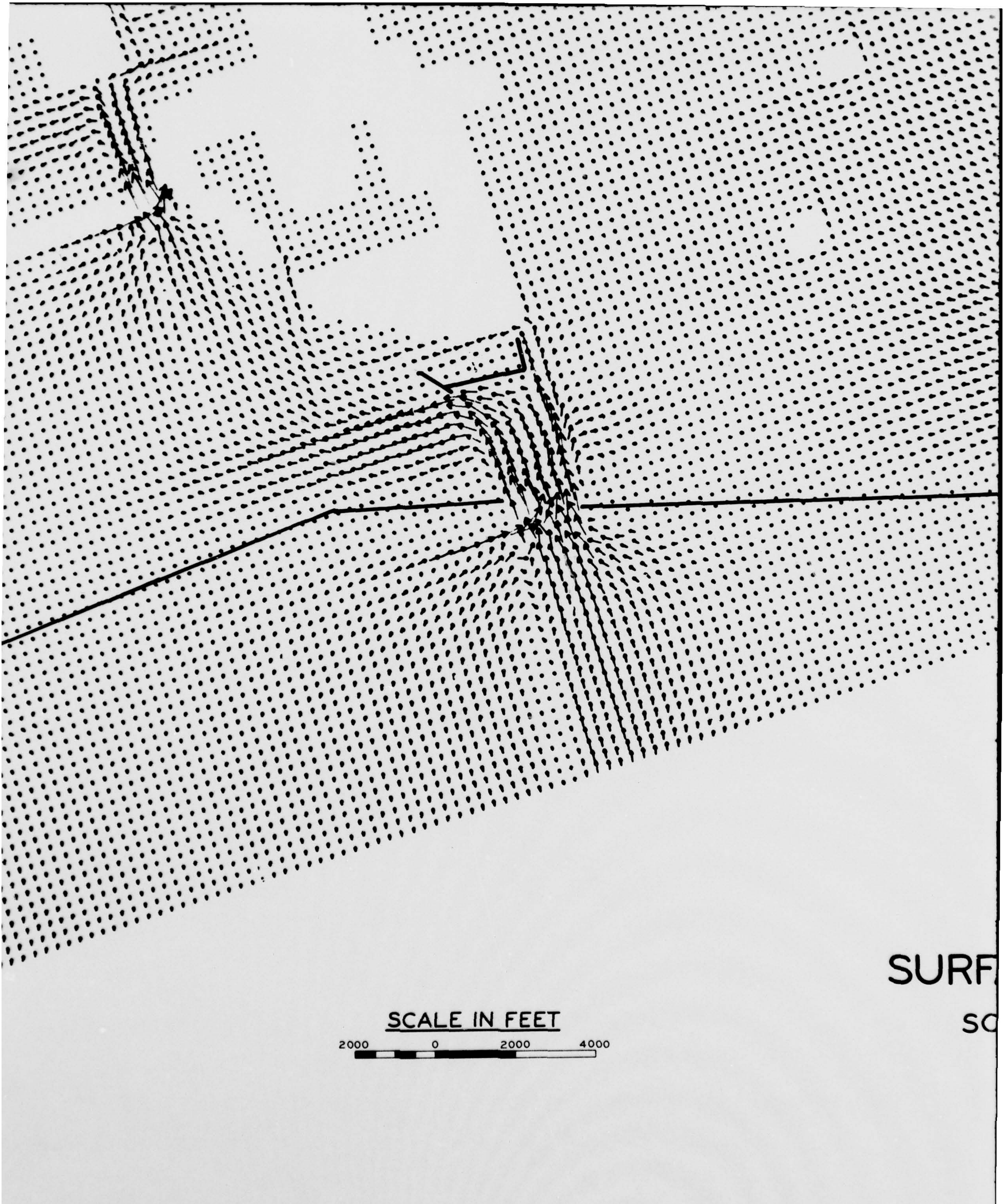
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2000
0
2000
4000
SURF
SC

VELOCITY SCALE

1 0 1 2 3

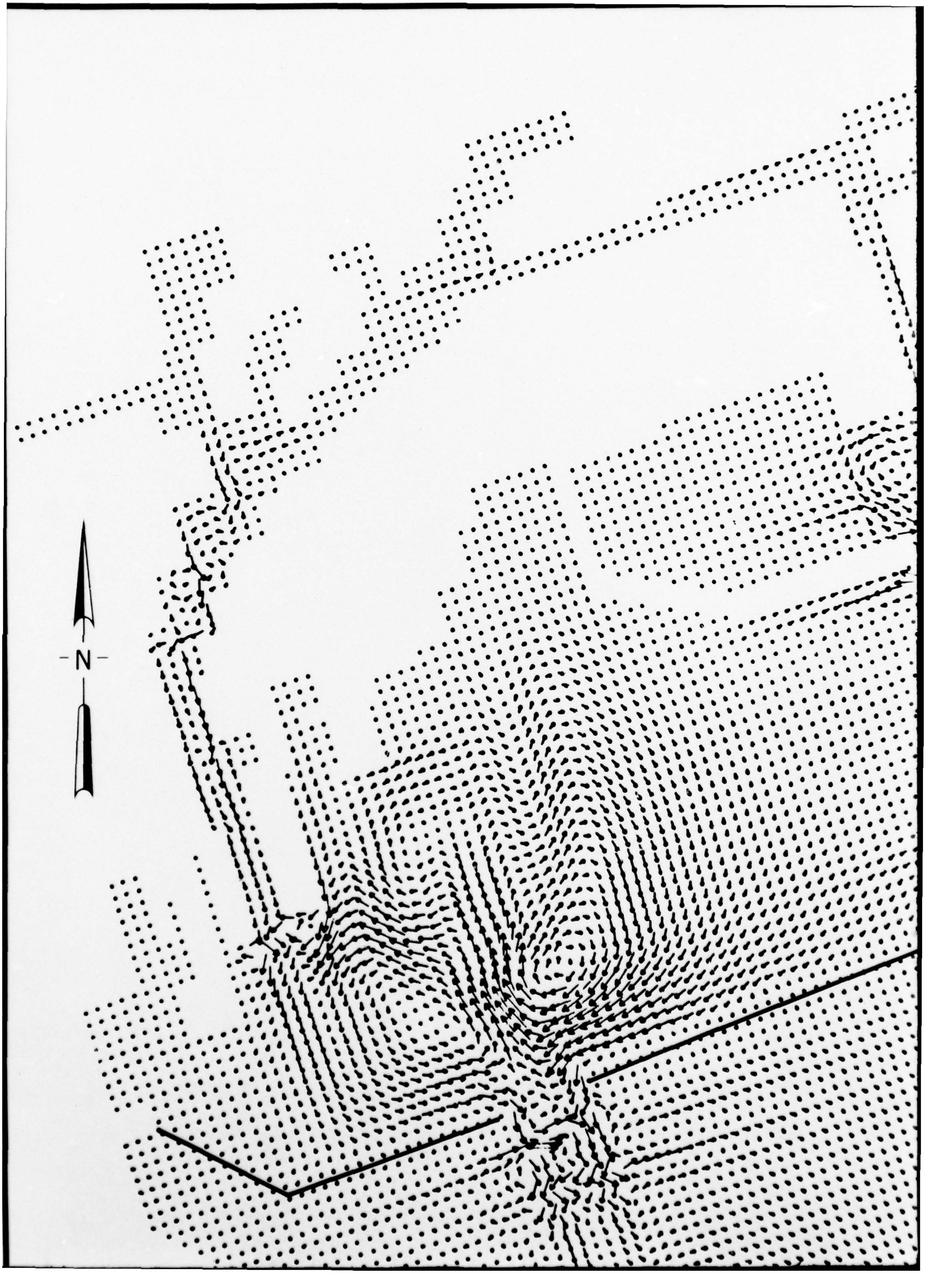
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 300-FT OPENING
–62-FT CHANNEL

SPRING TIDE
HOUR 19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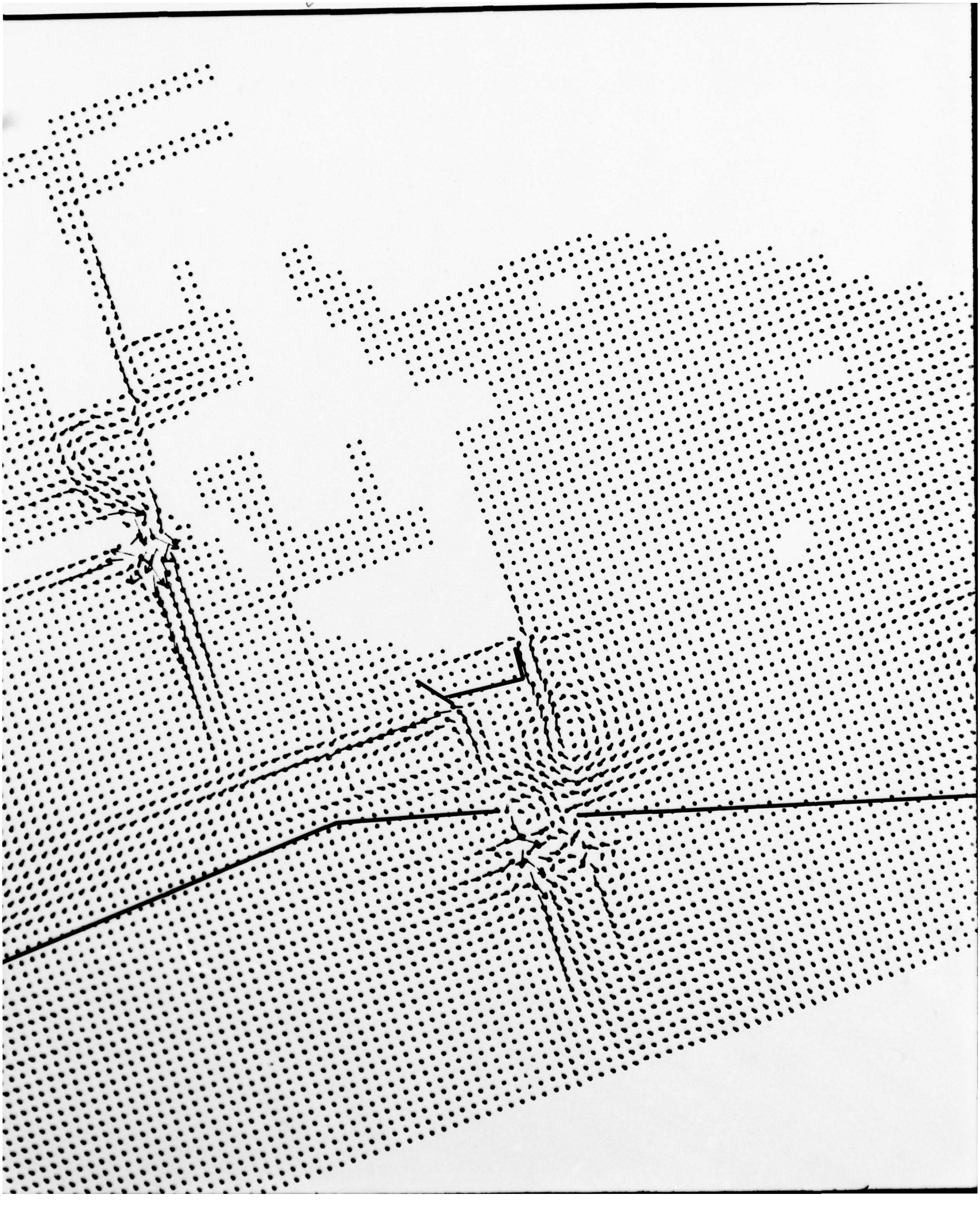

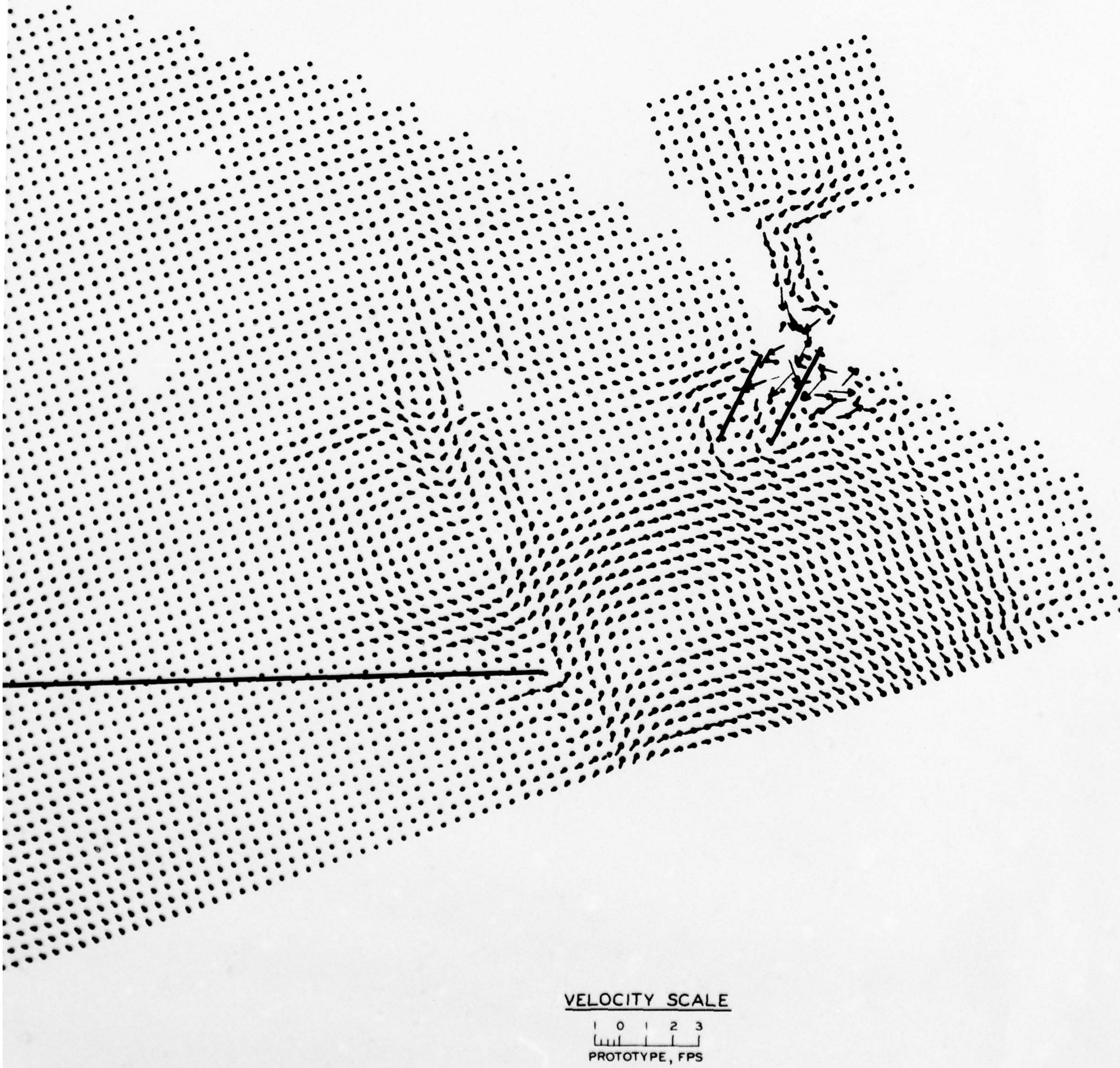

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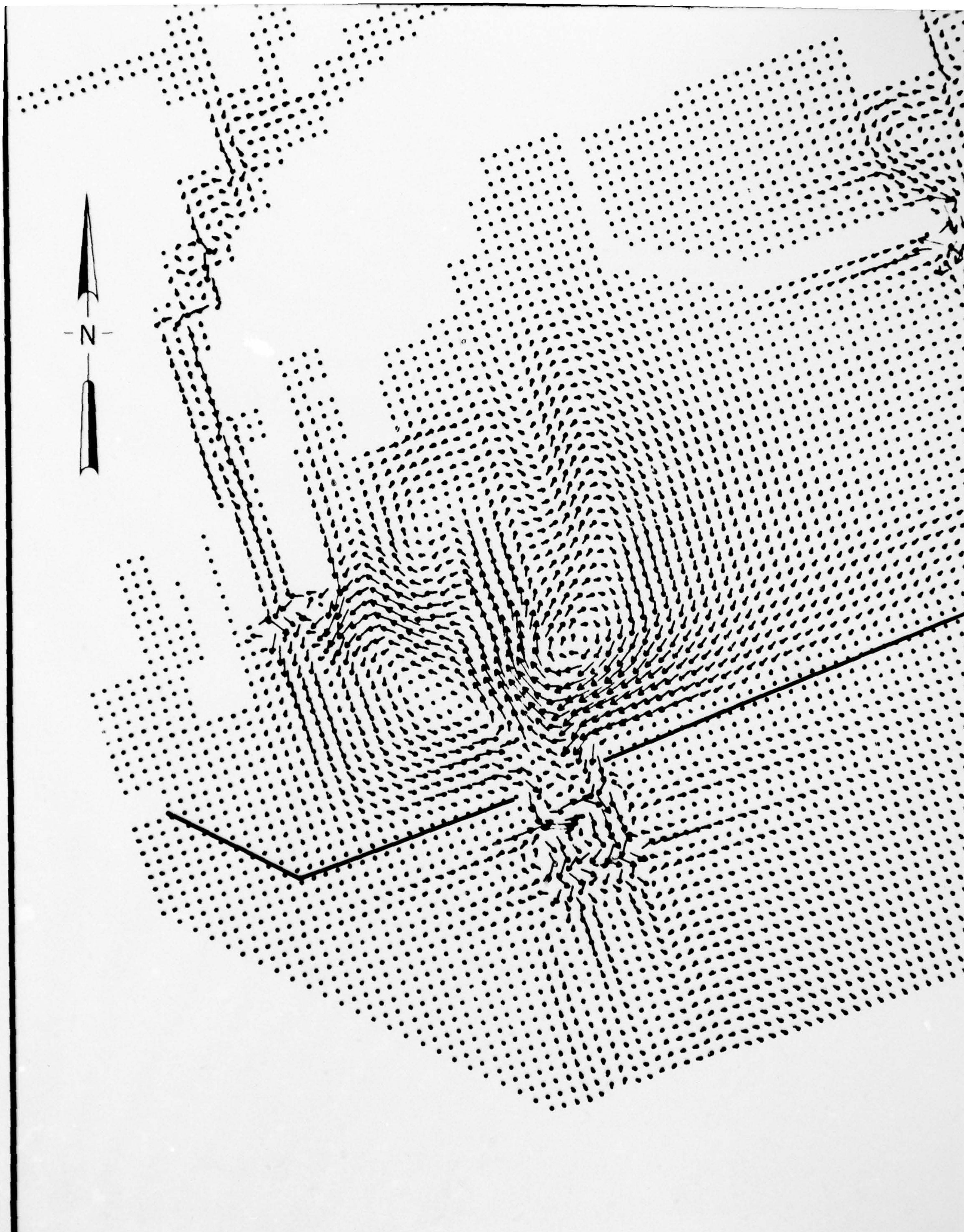

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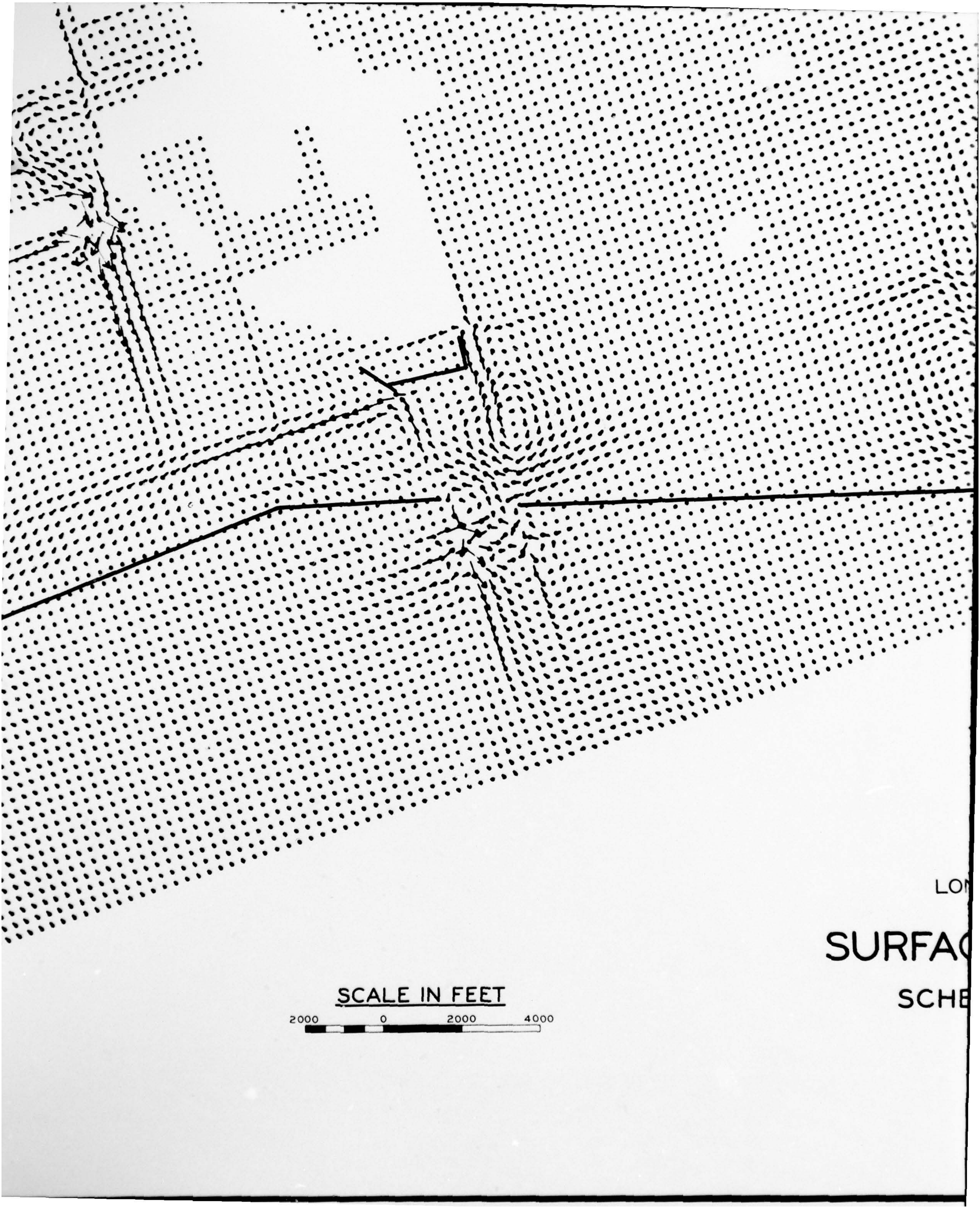
SCALE IN FEET
2000 0 2000 4000
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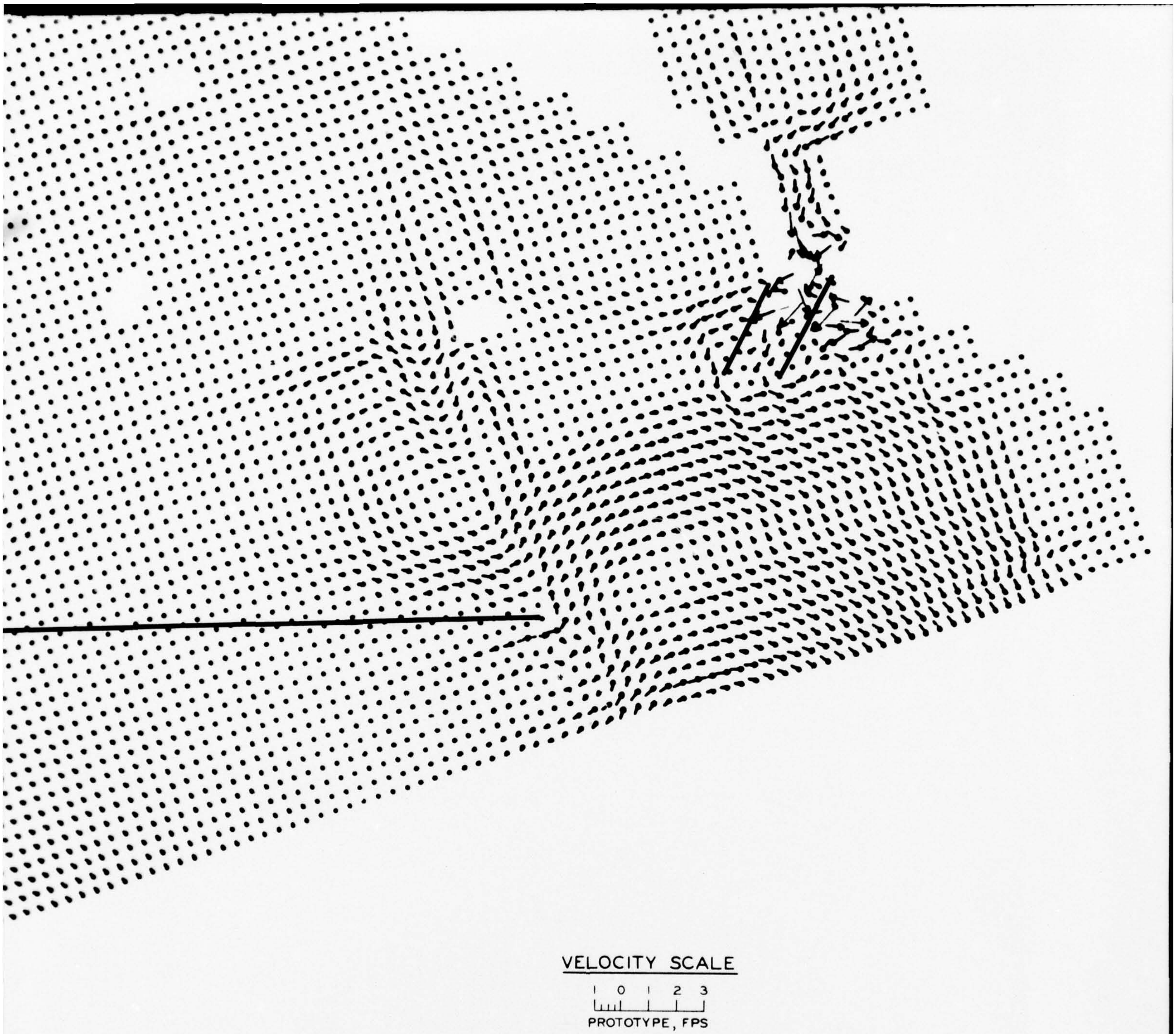
SURFAC
SCHE

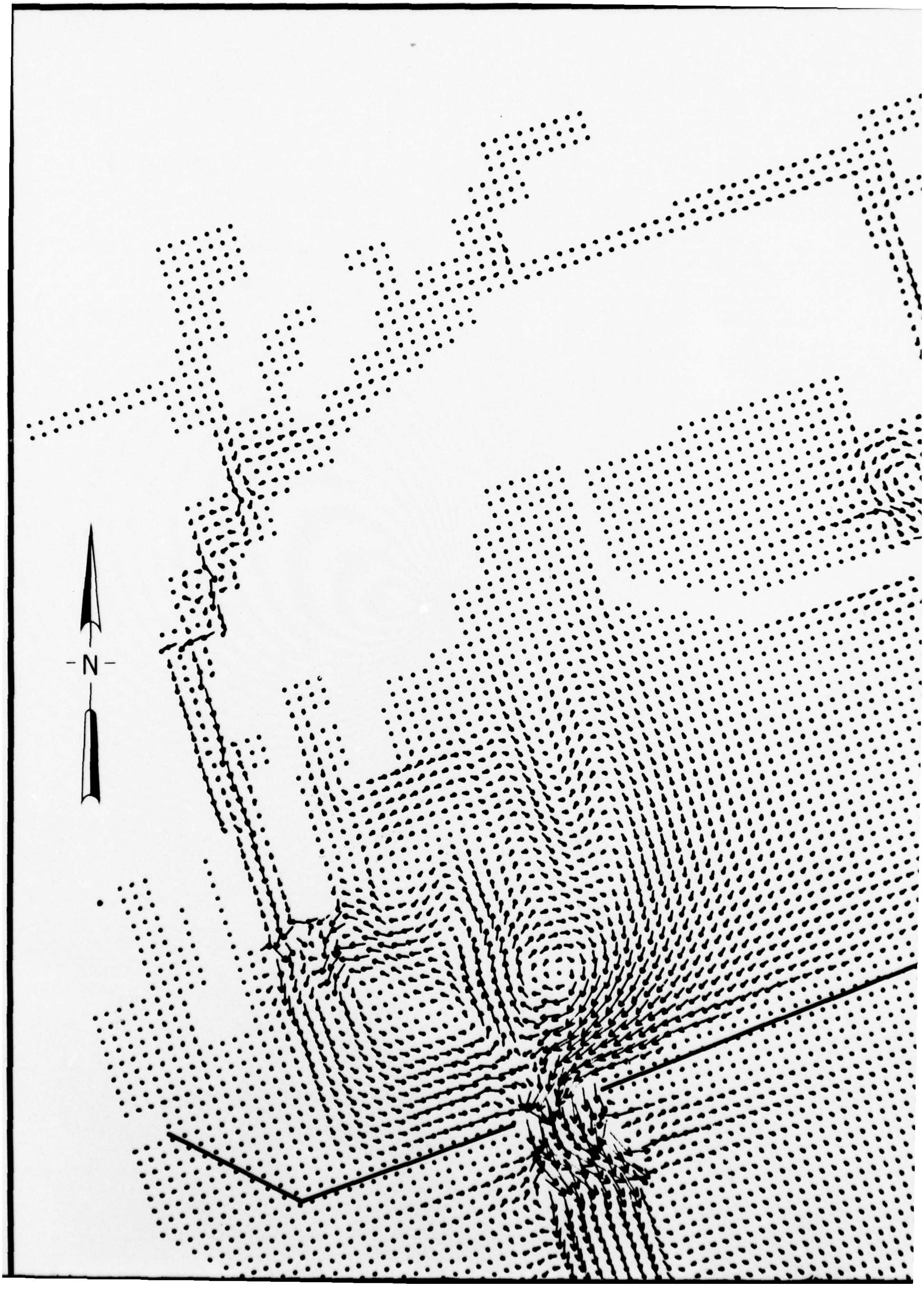


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 300-FT OPENING
-62-FT CHANNEL

SPRING TIDE
HOUR 22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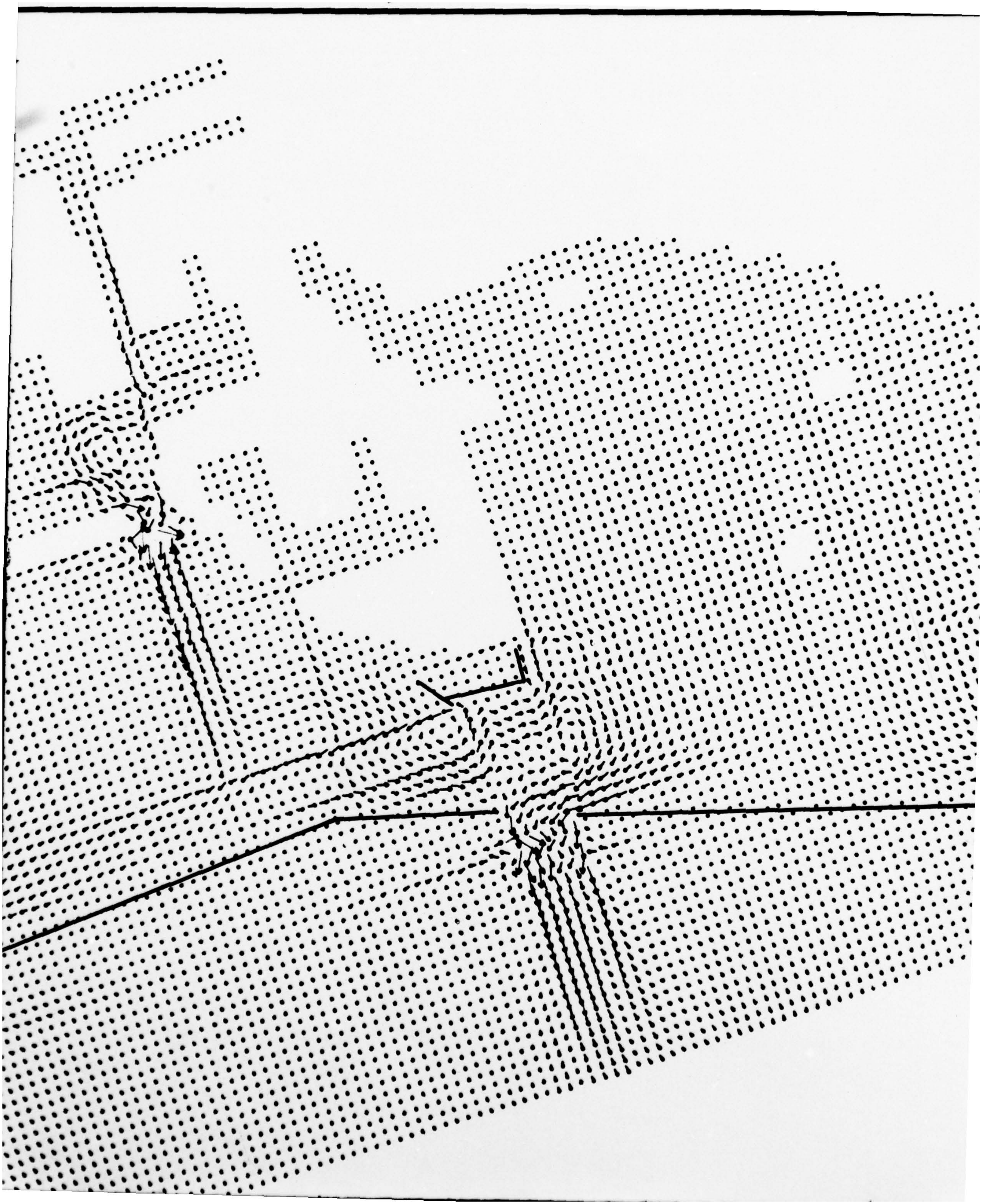

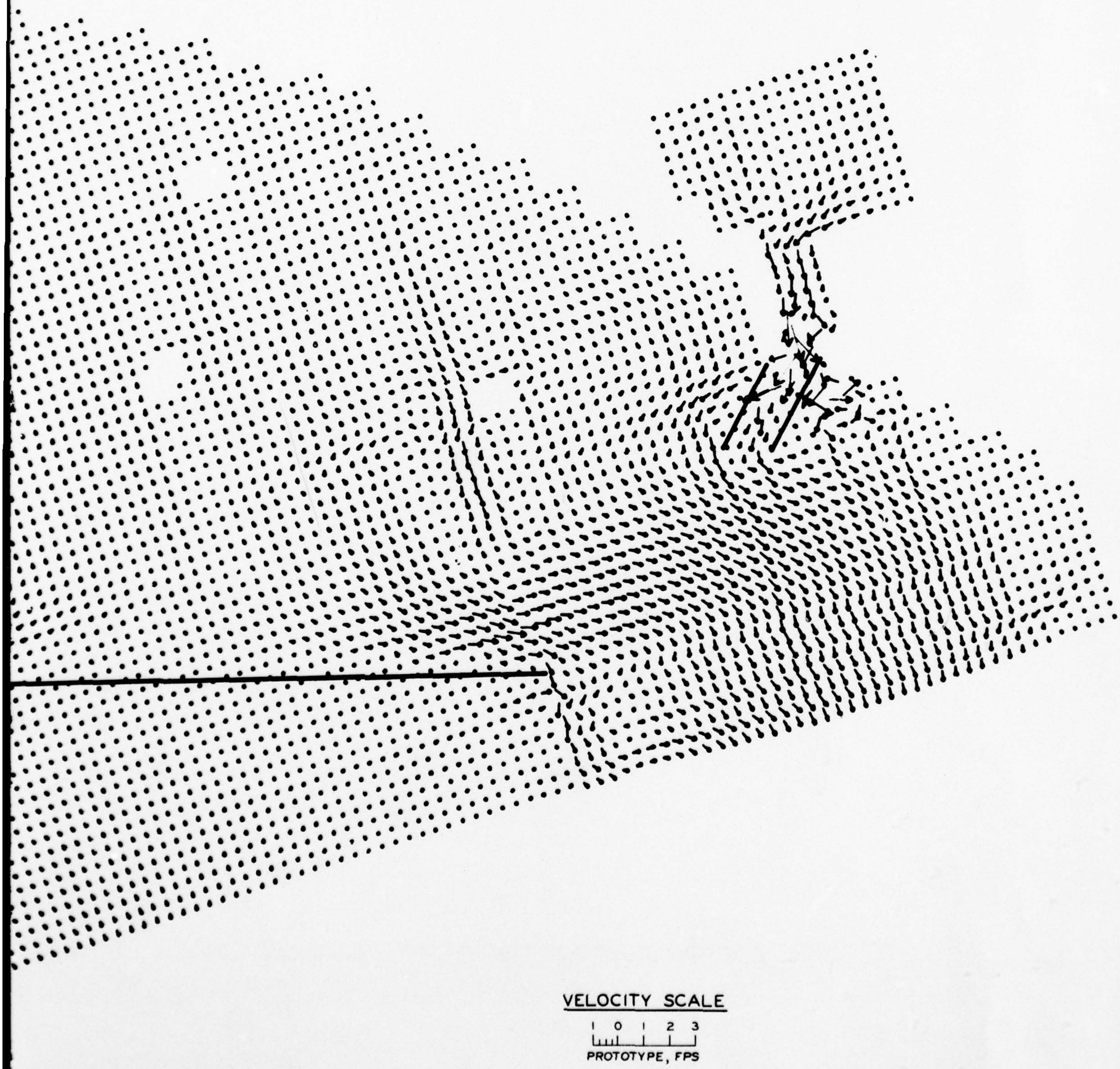

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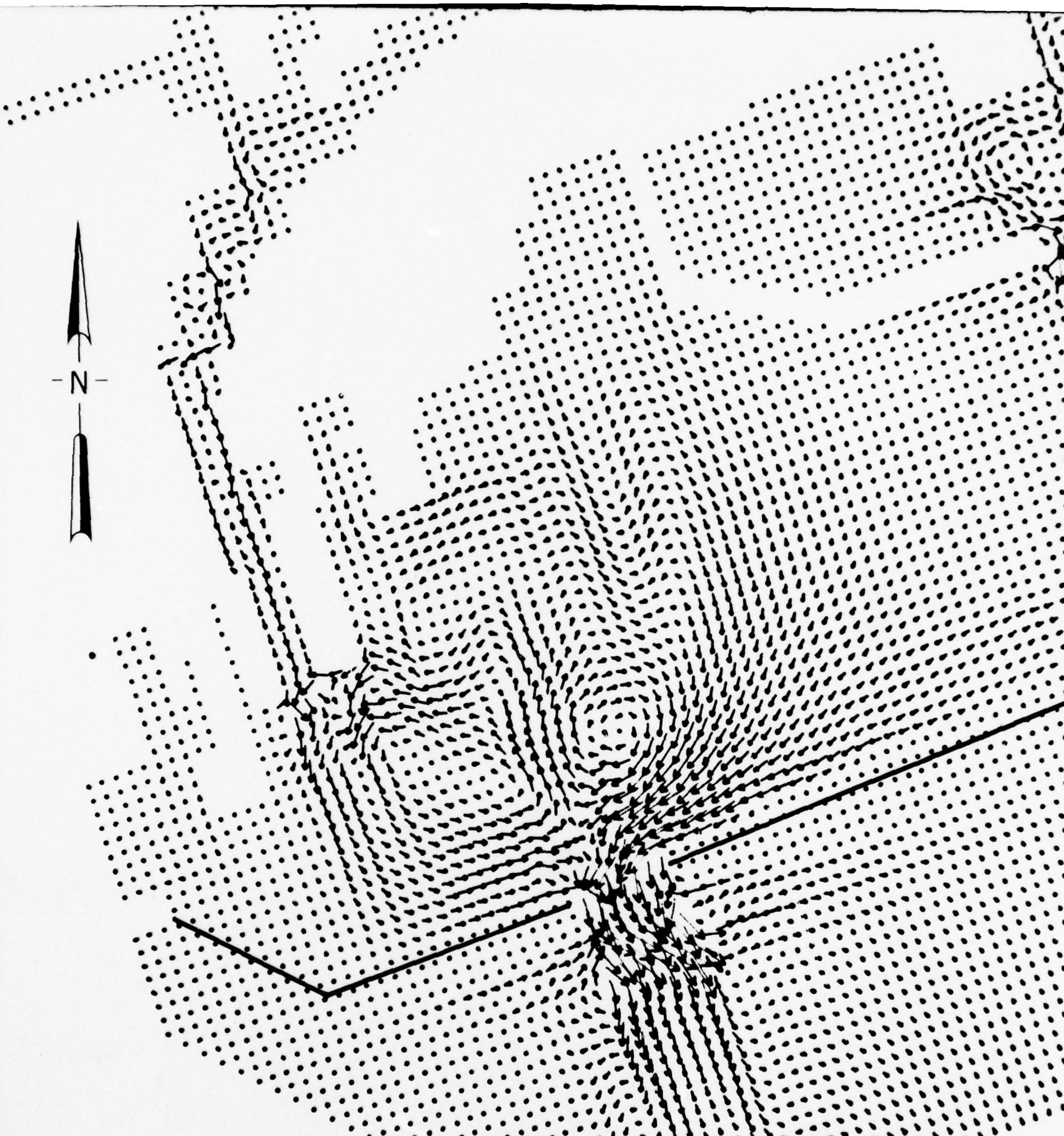

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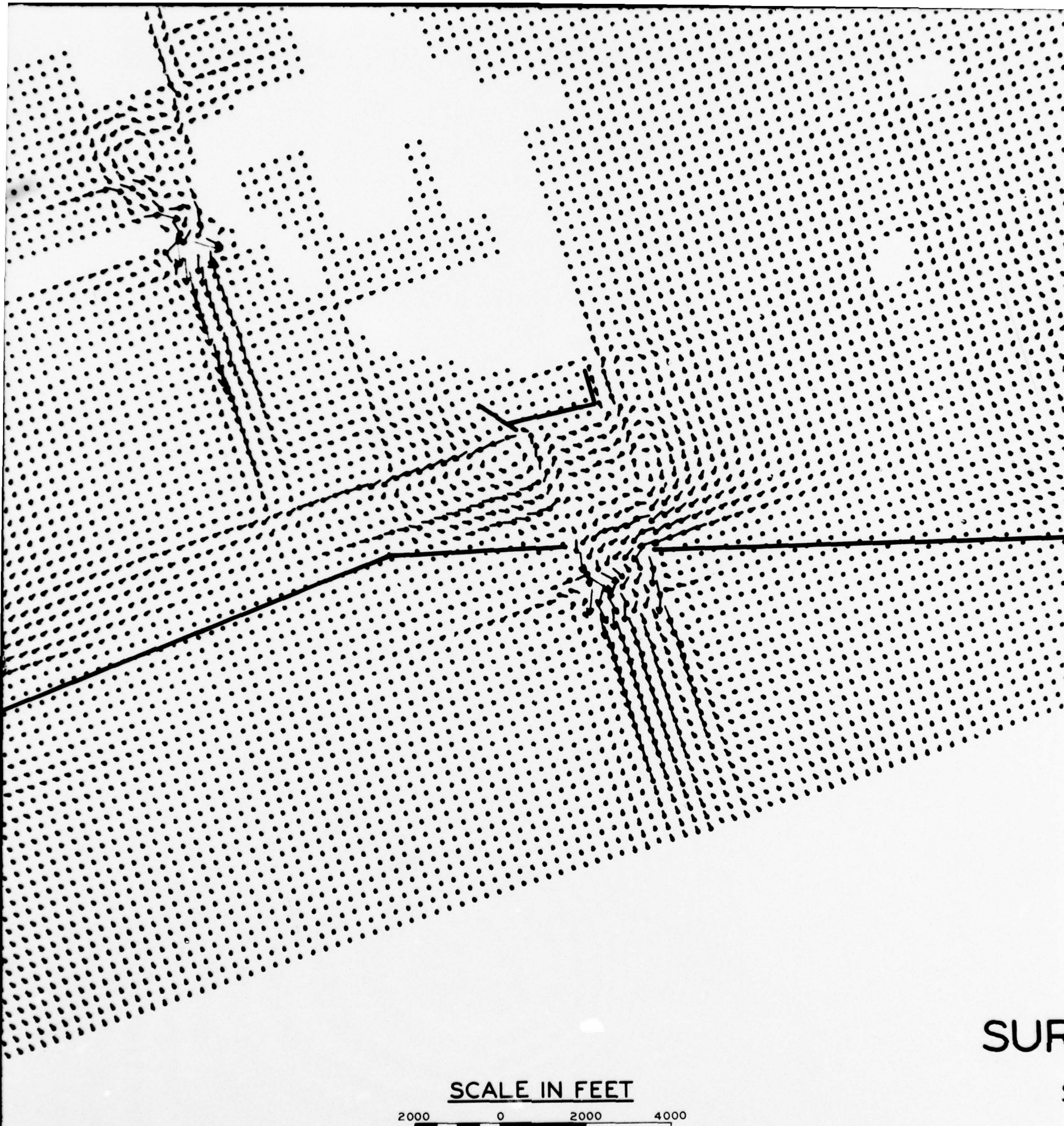

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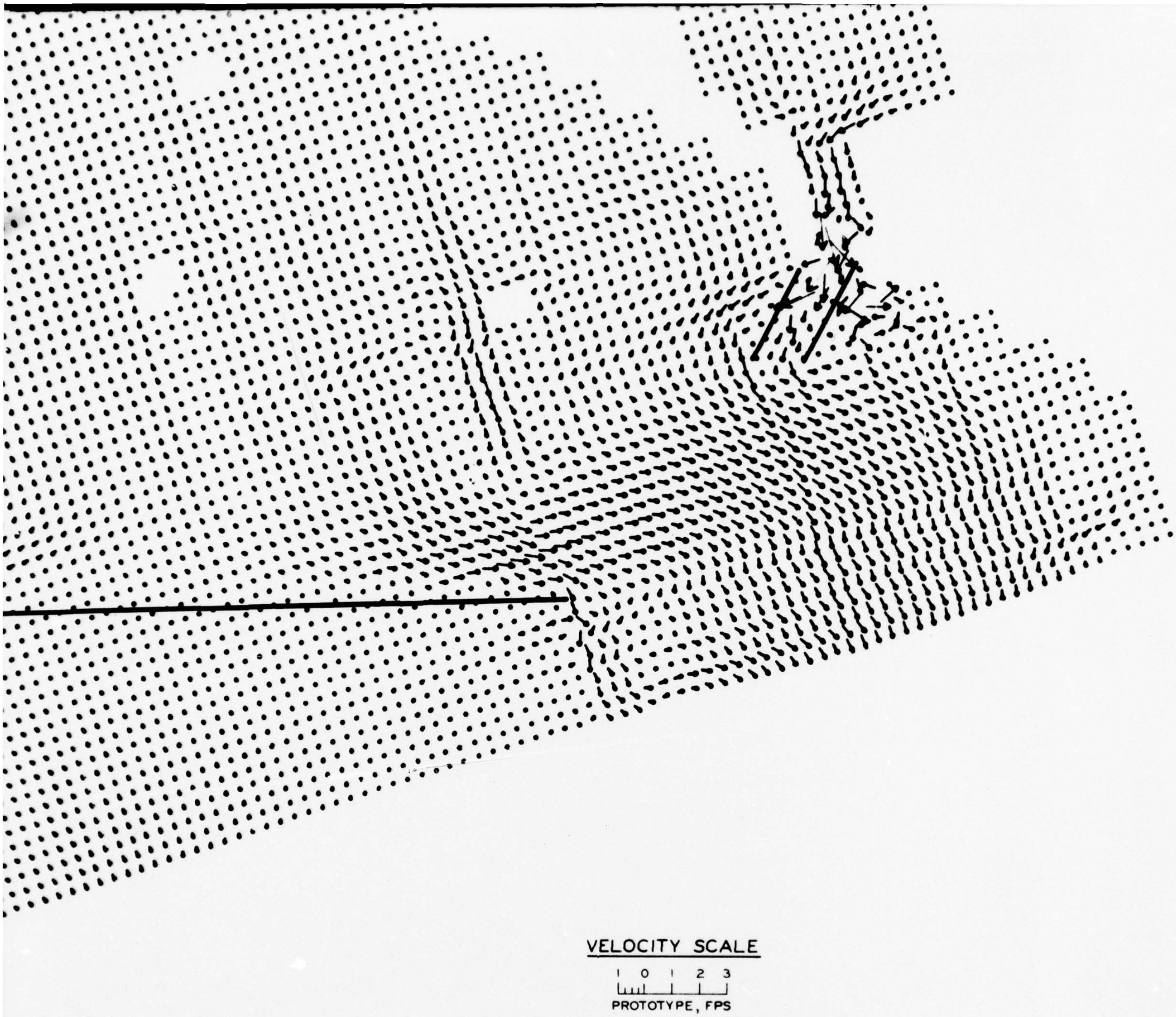
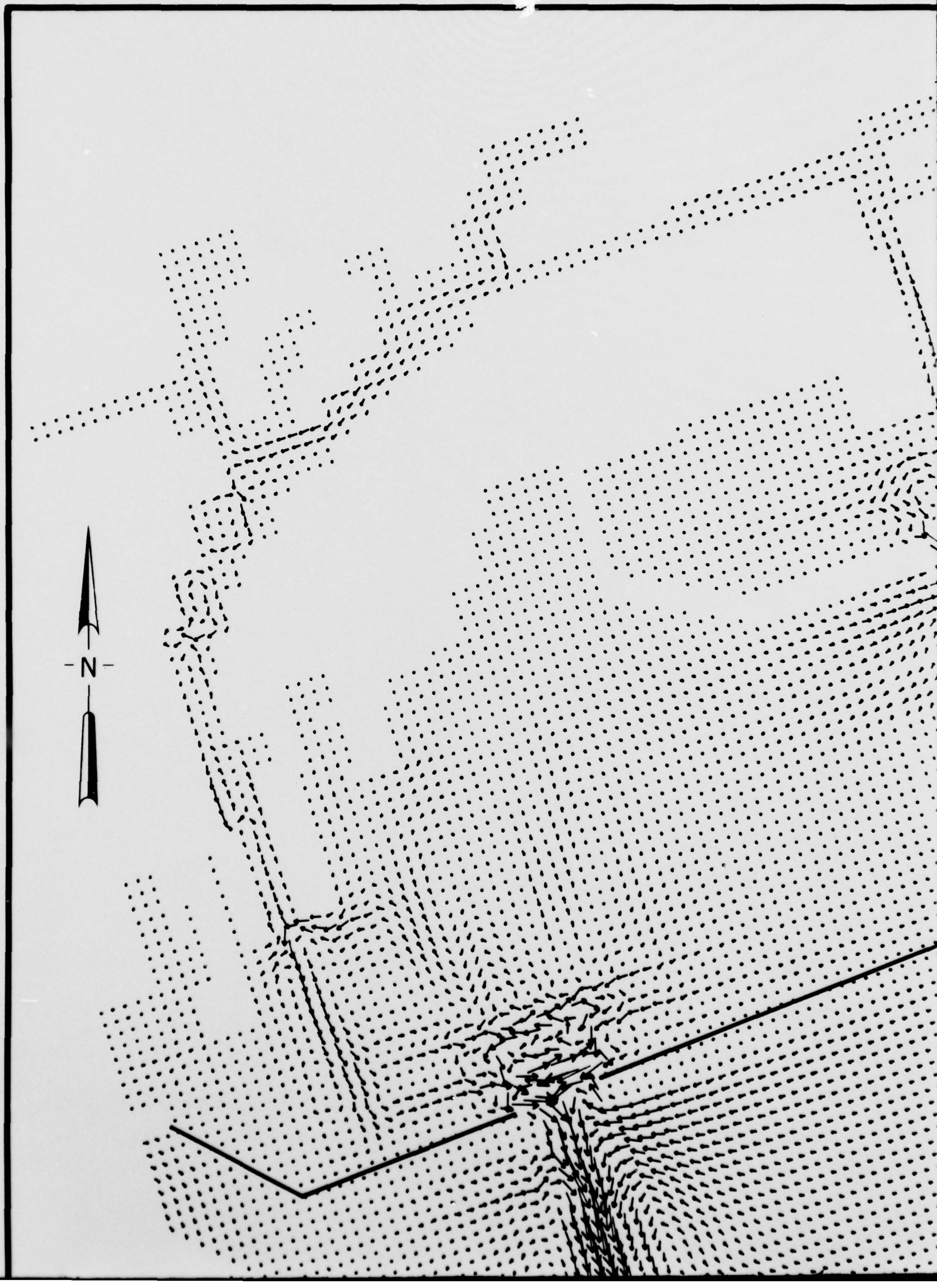


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 300-FT OPENING
–62-FT CHANNEL

SPRING TIDE
HOUR 24



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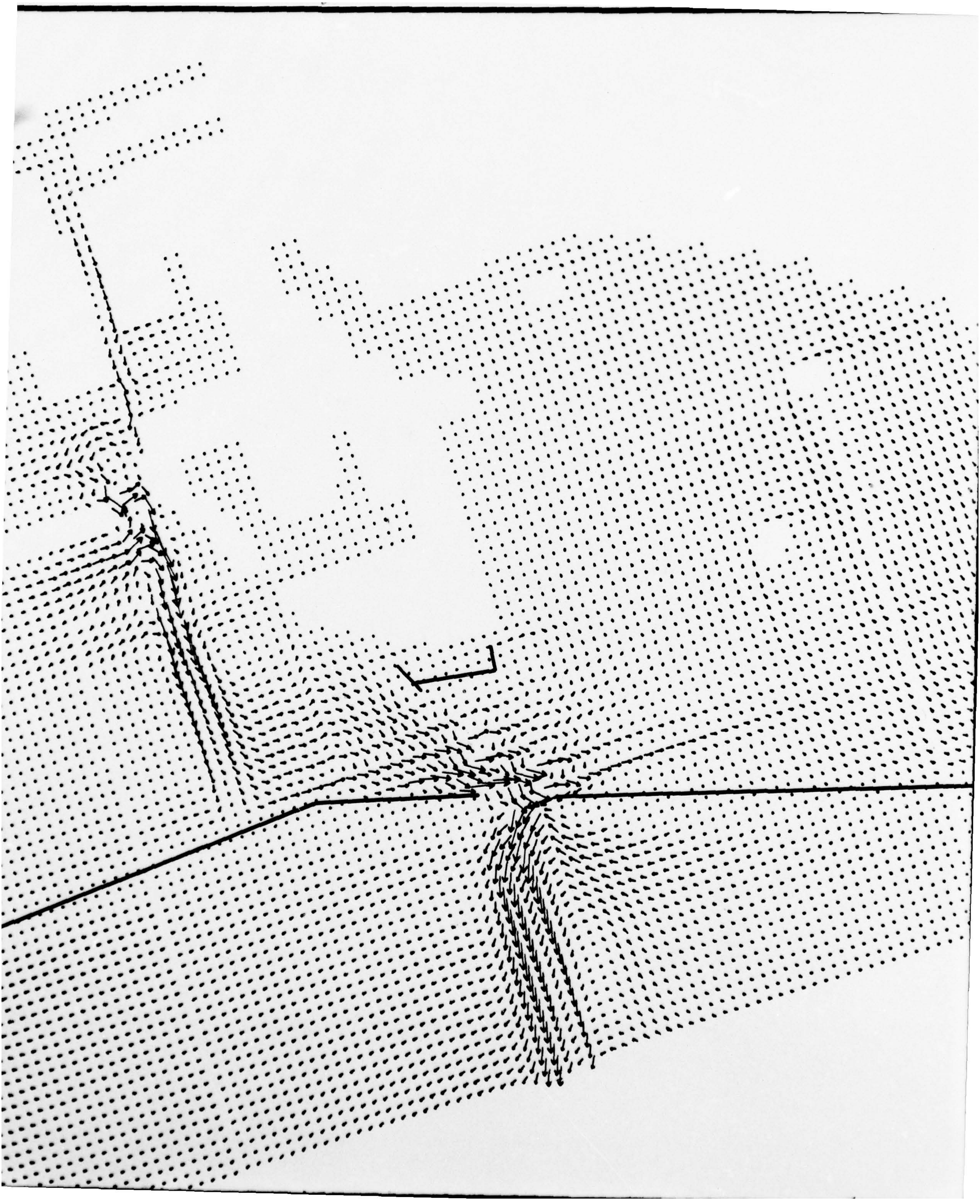

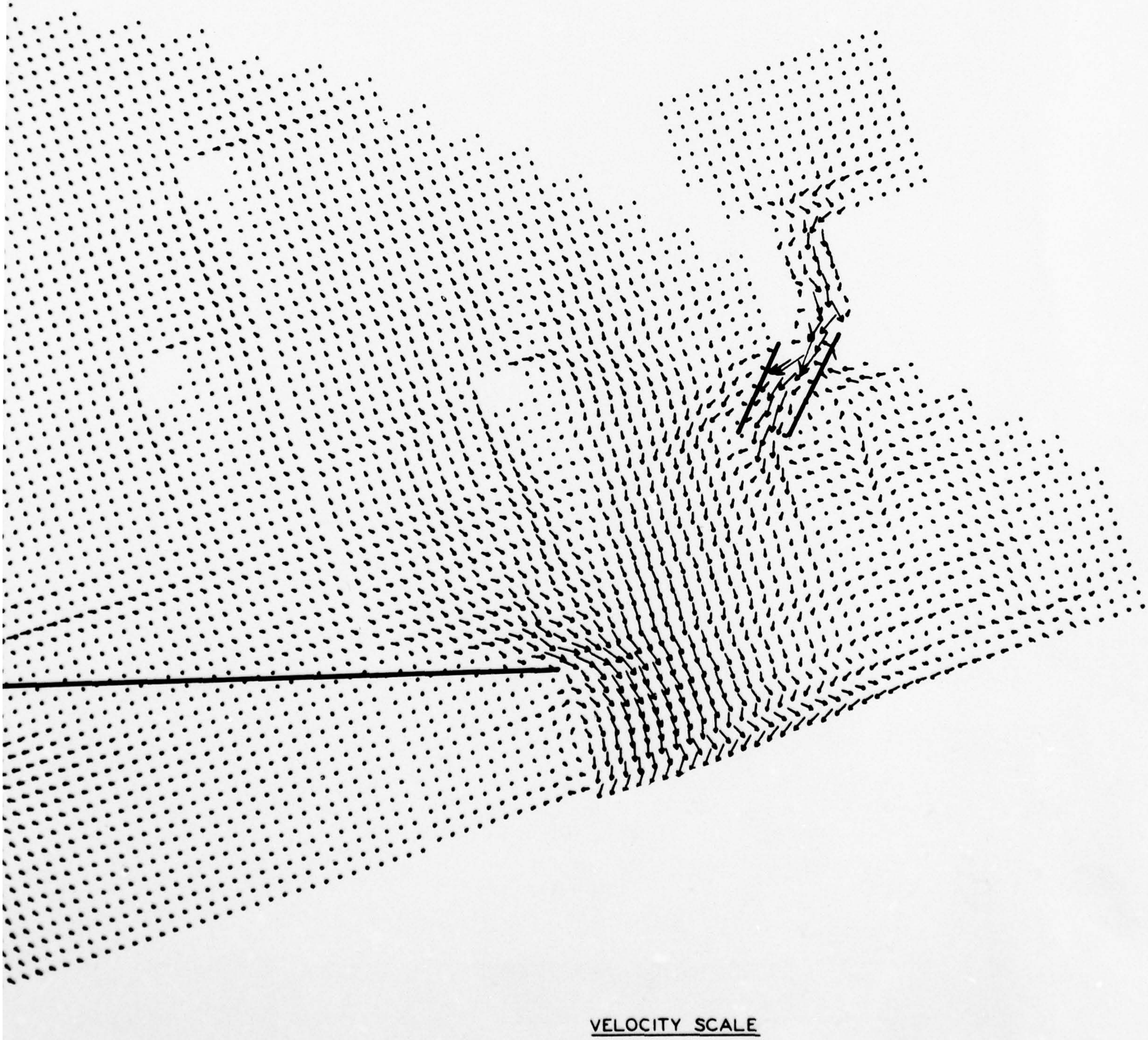

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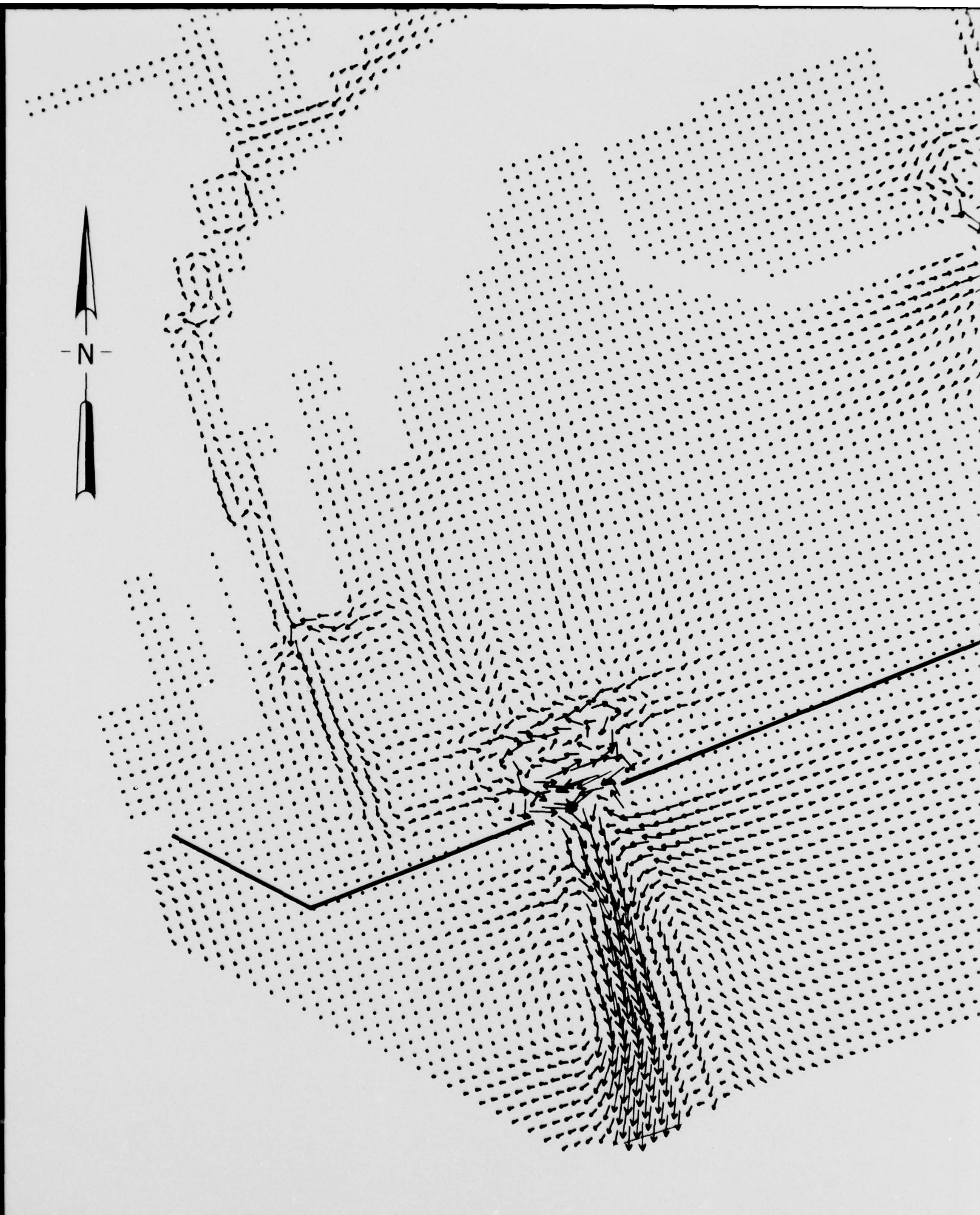

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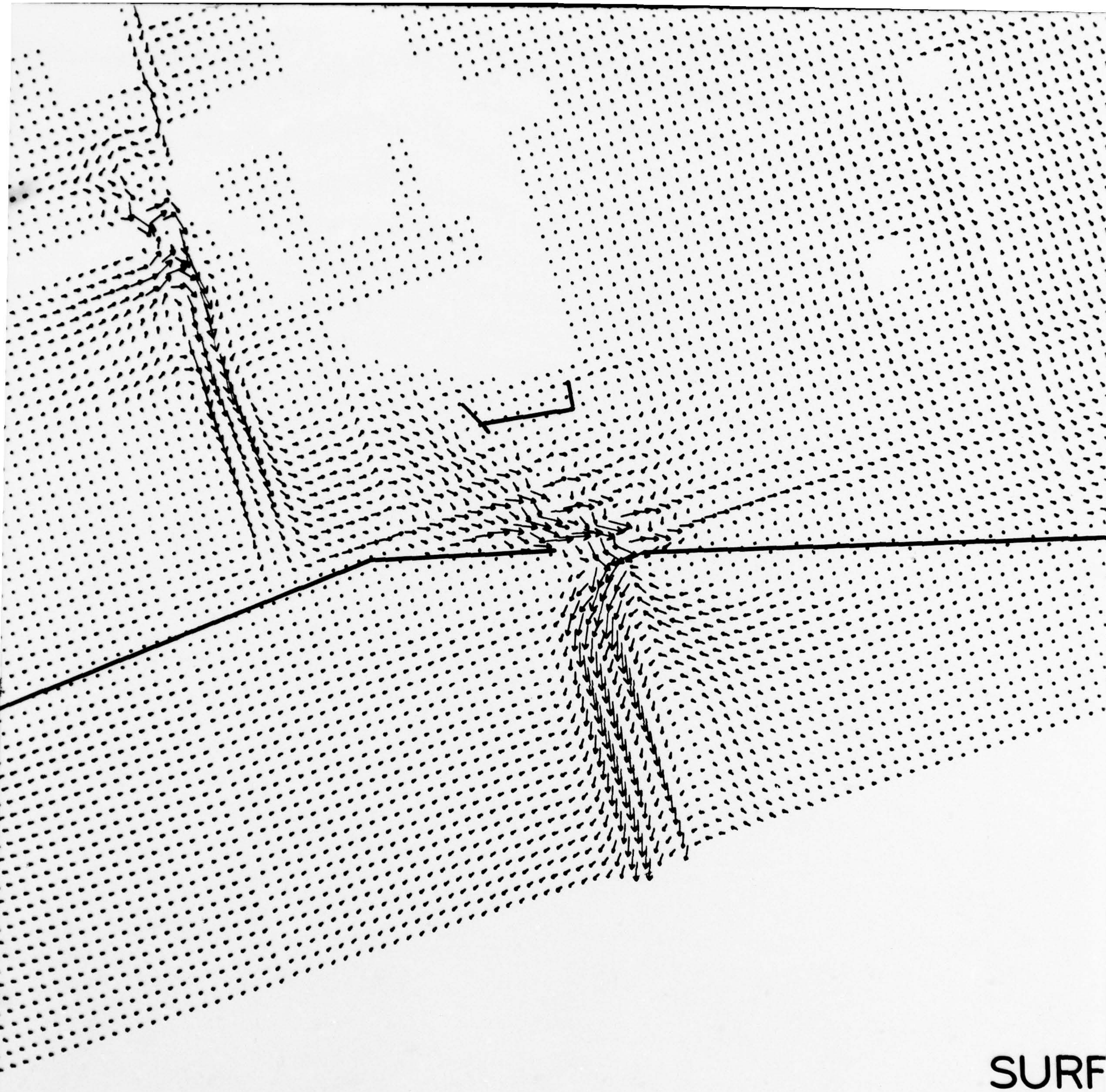

SURF

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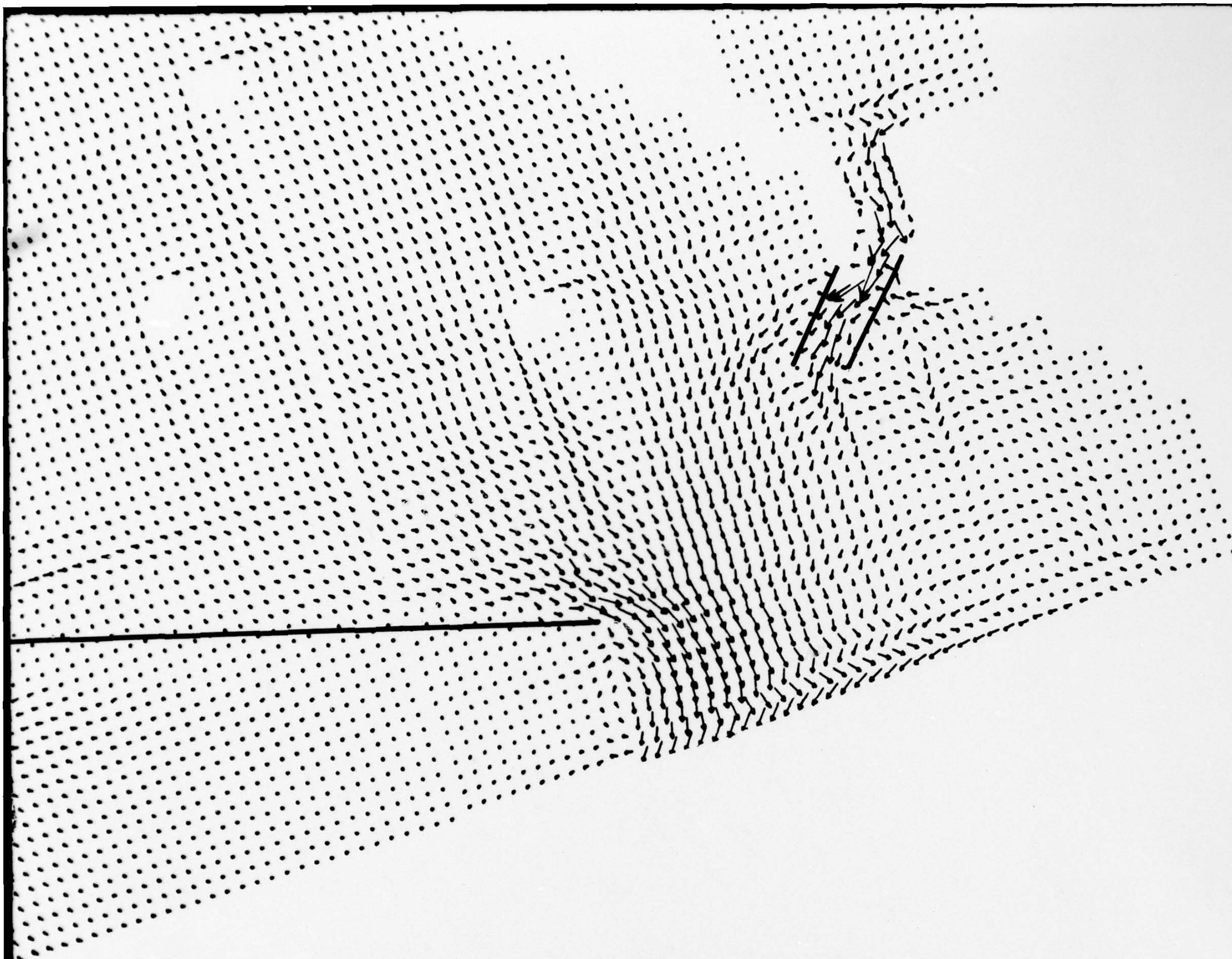
SCALE IN FEET

2000 0 2000 4000



VELOCITY SCALE

1 0 1 2 3

PROTOTYPE, FPS

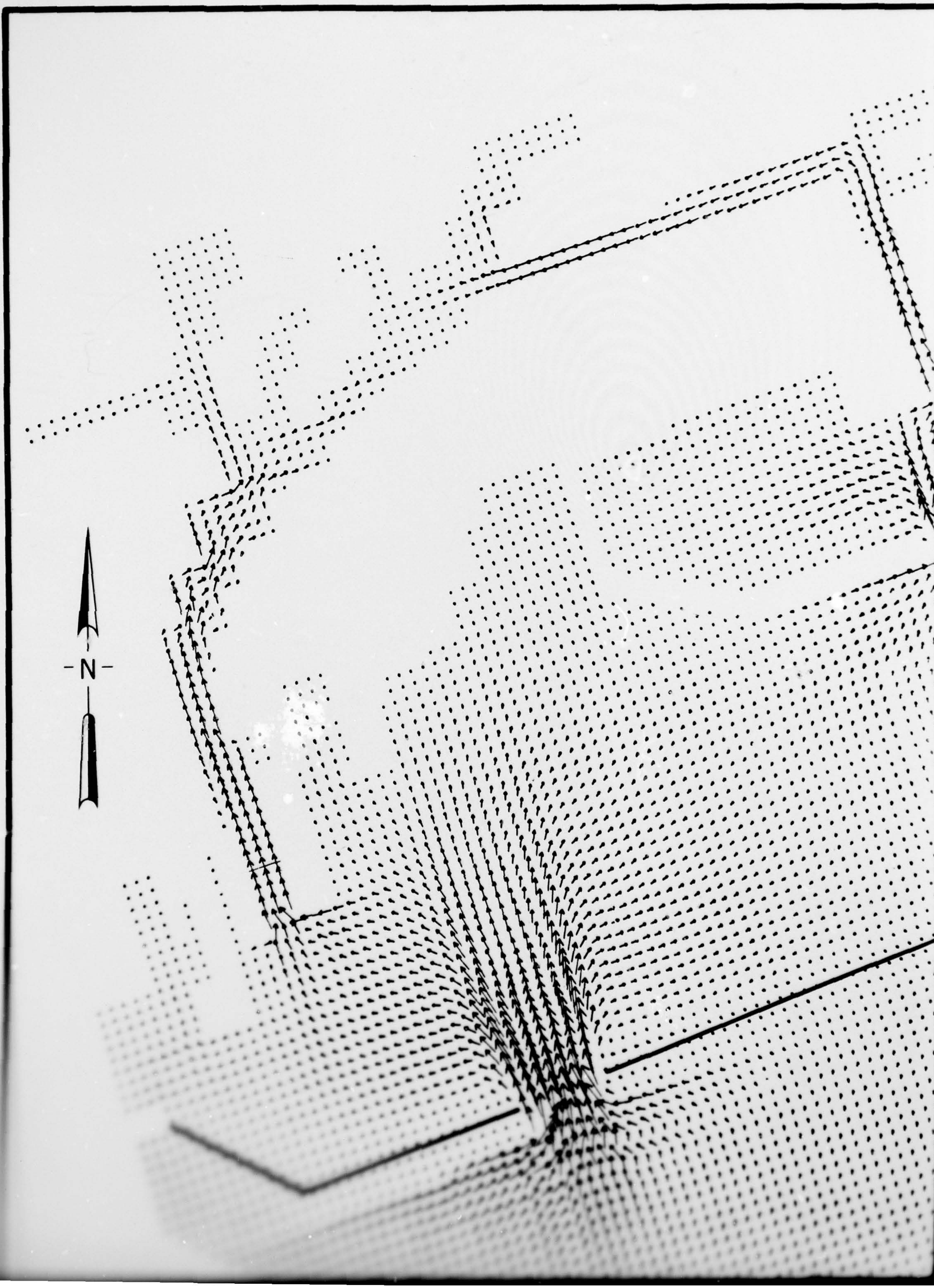
NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 600-FT OPENING
–62-FT CHANNEL

SPRING TIDE
HOUR 15

6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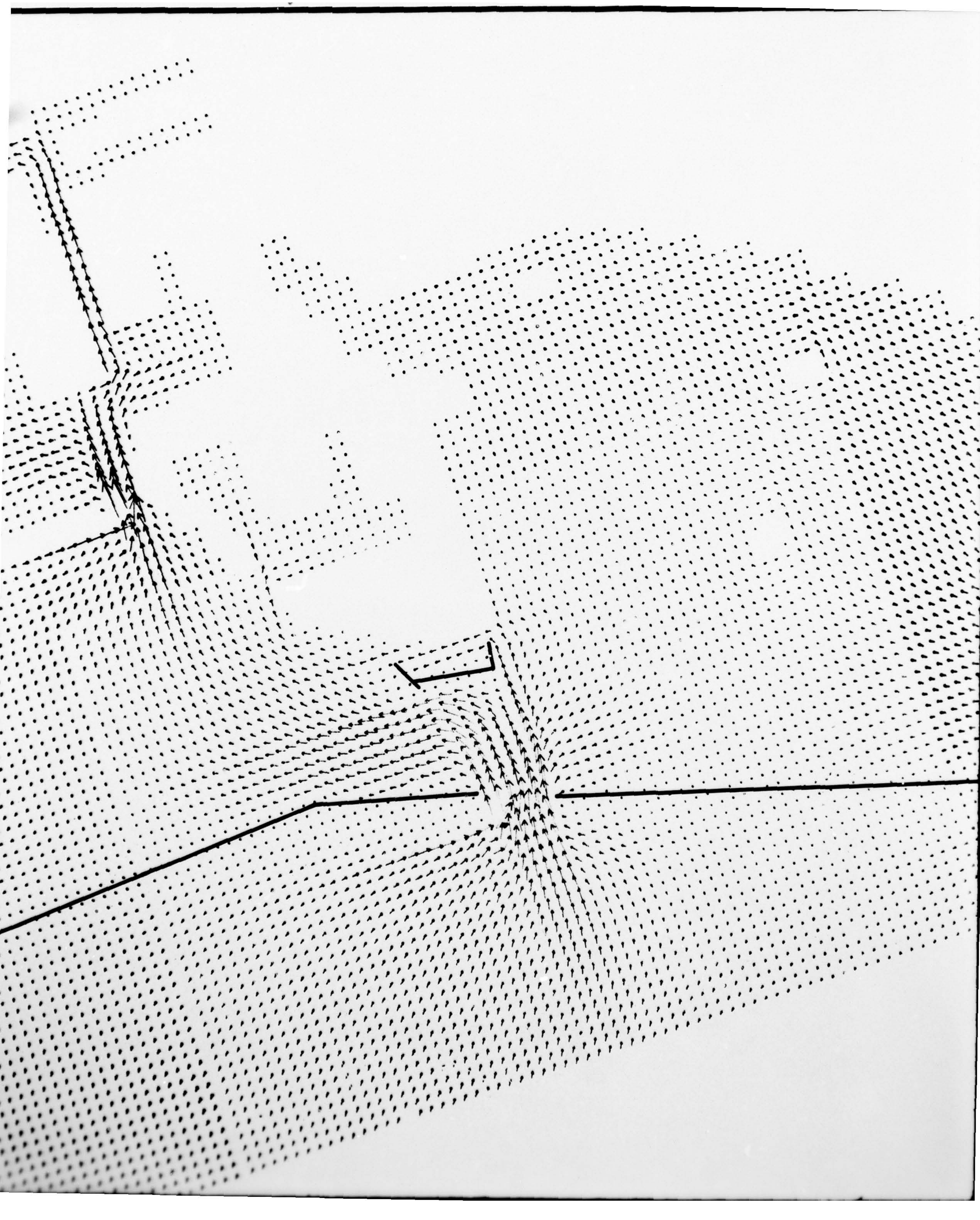

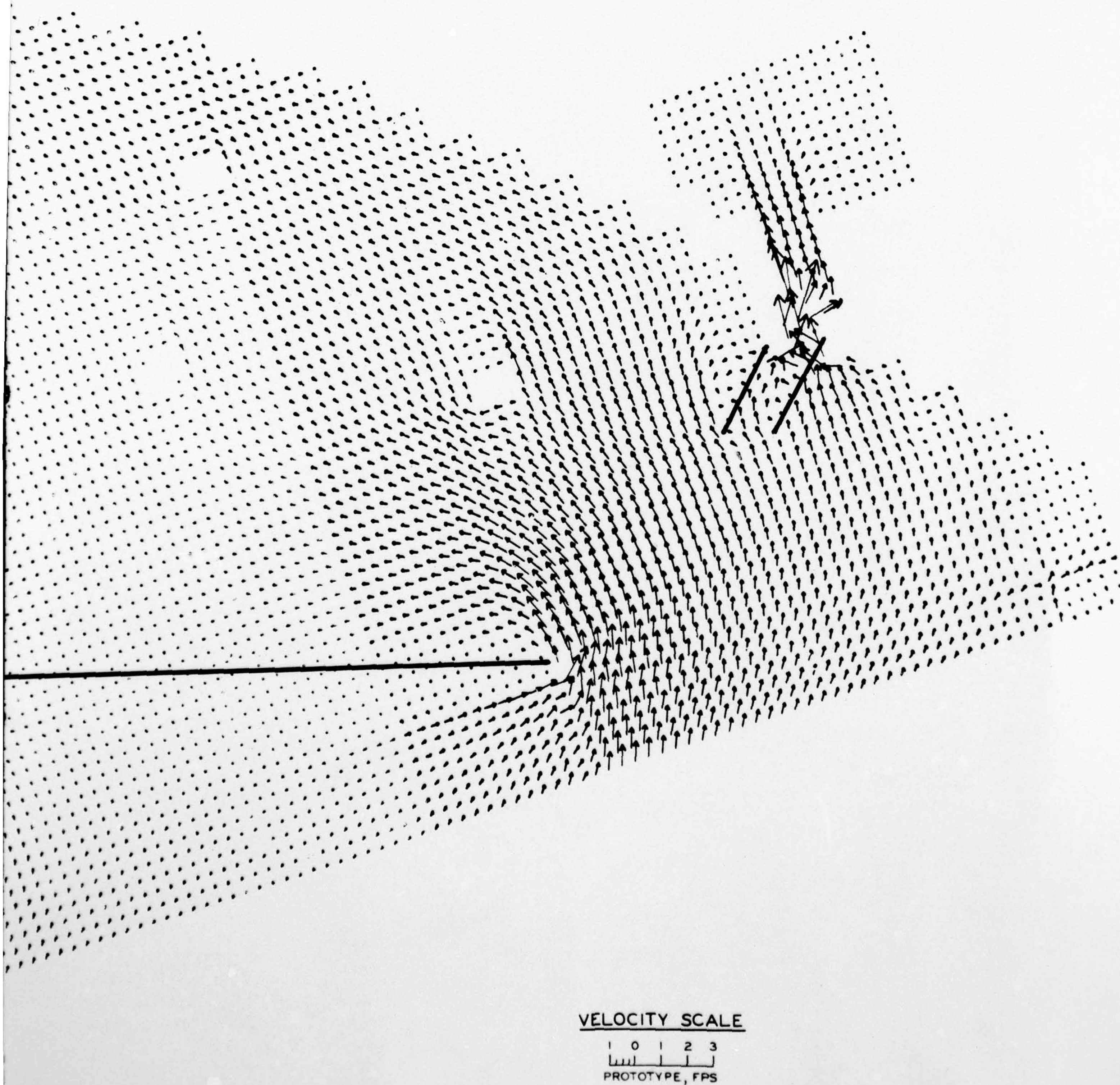

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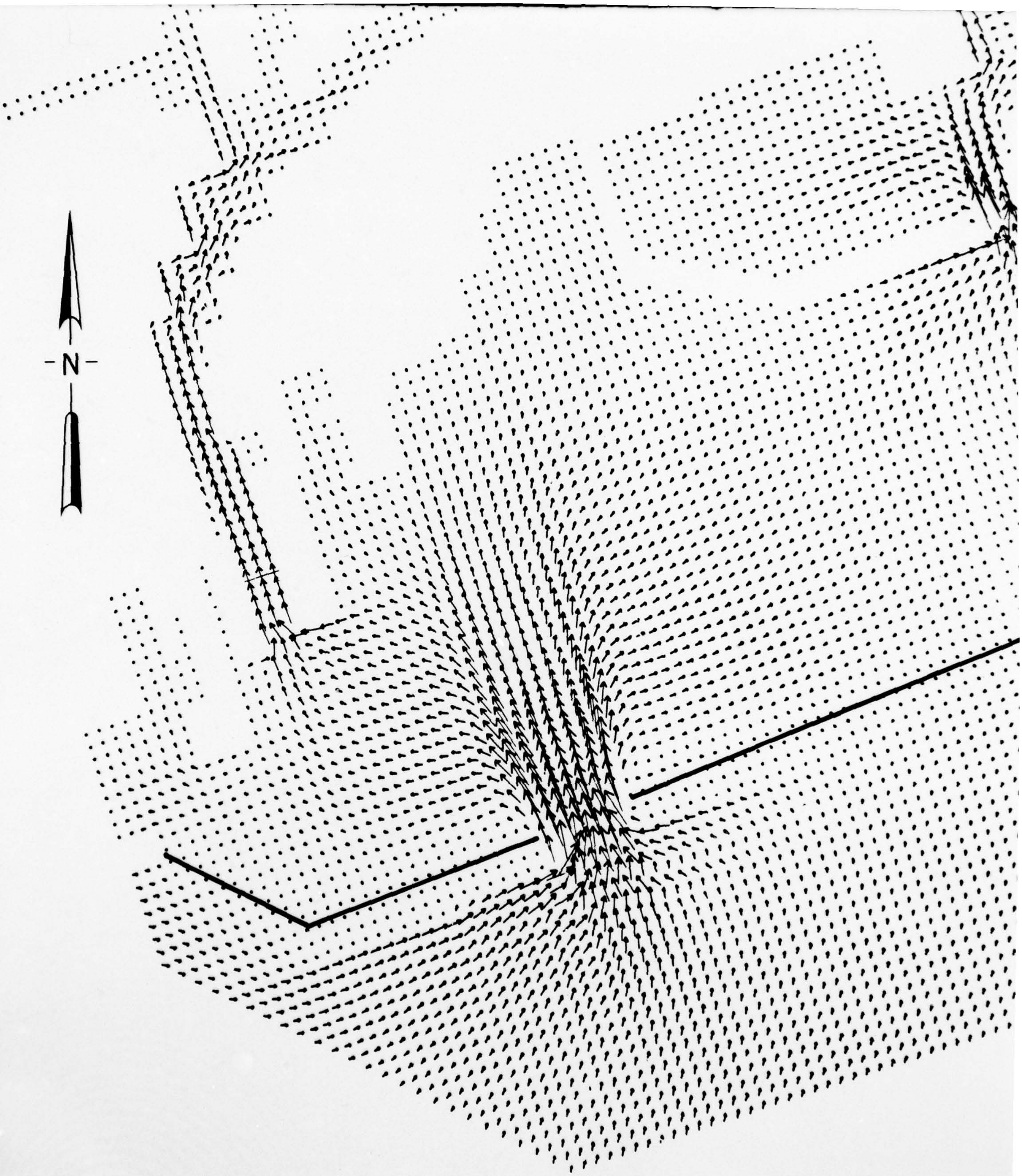
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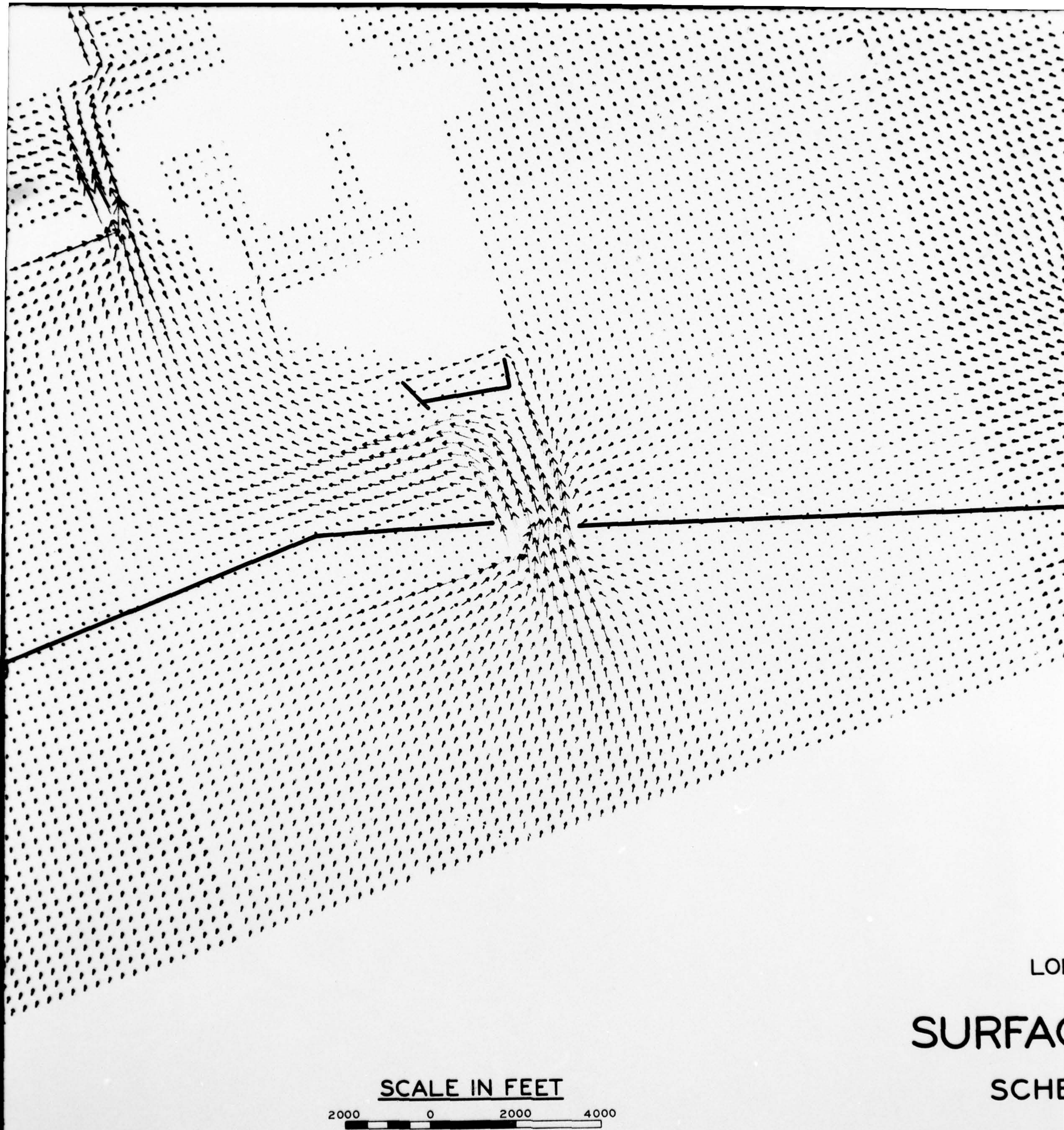
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SCALE IN FEET
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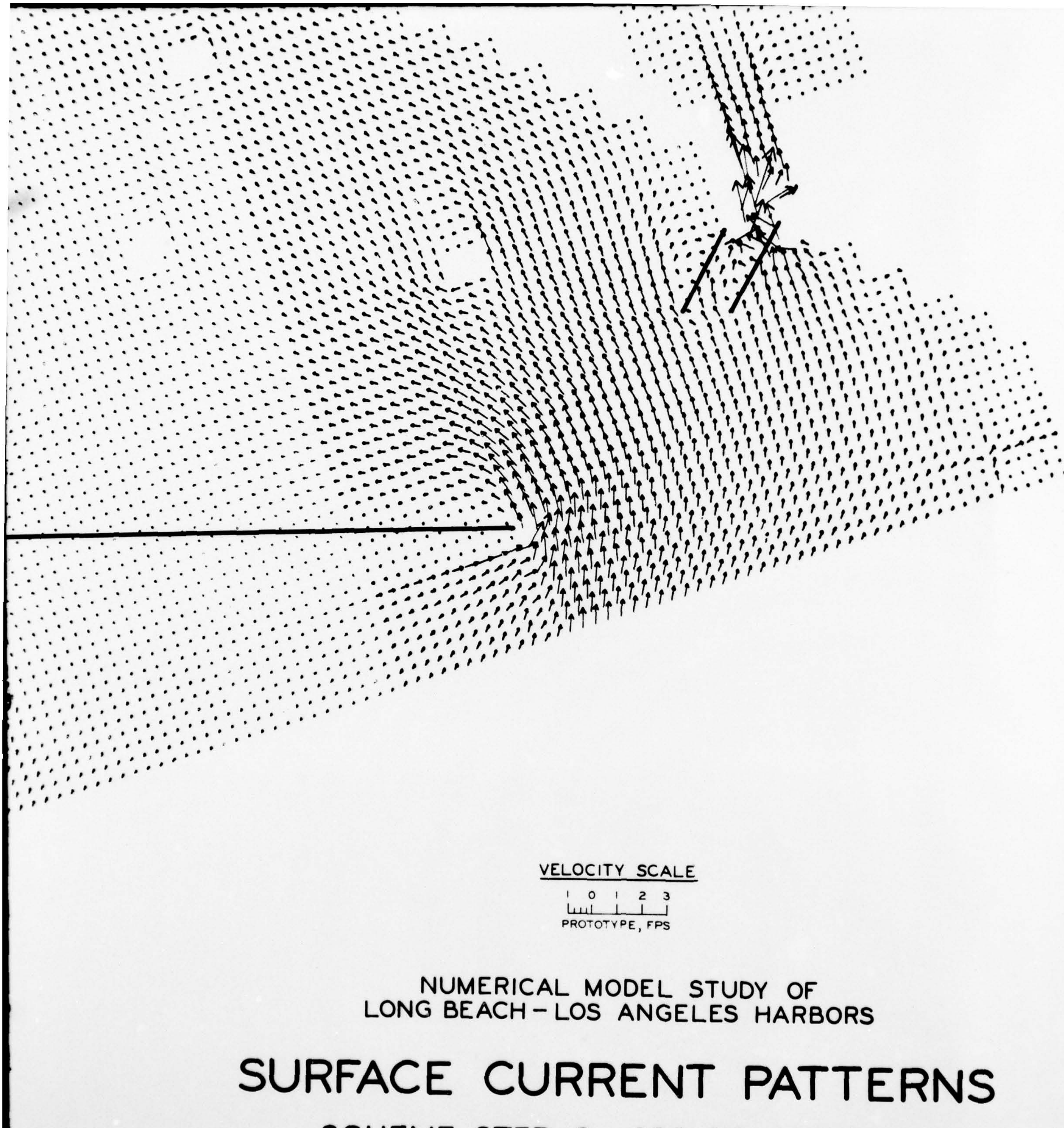
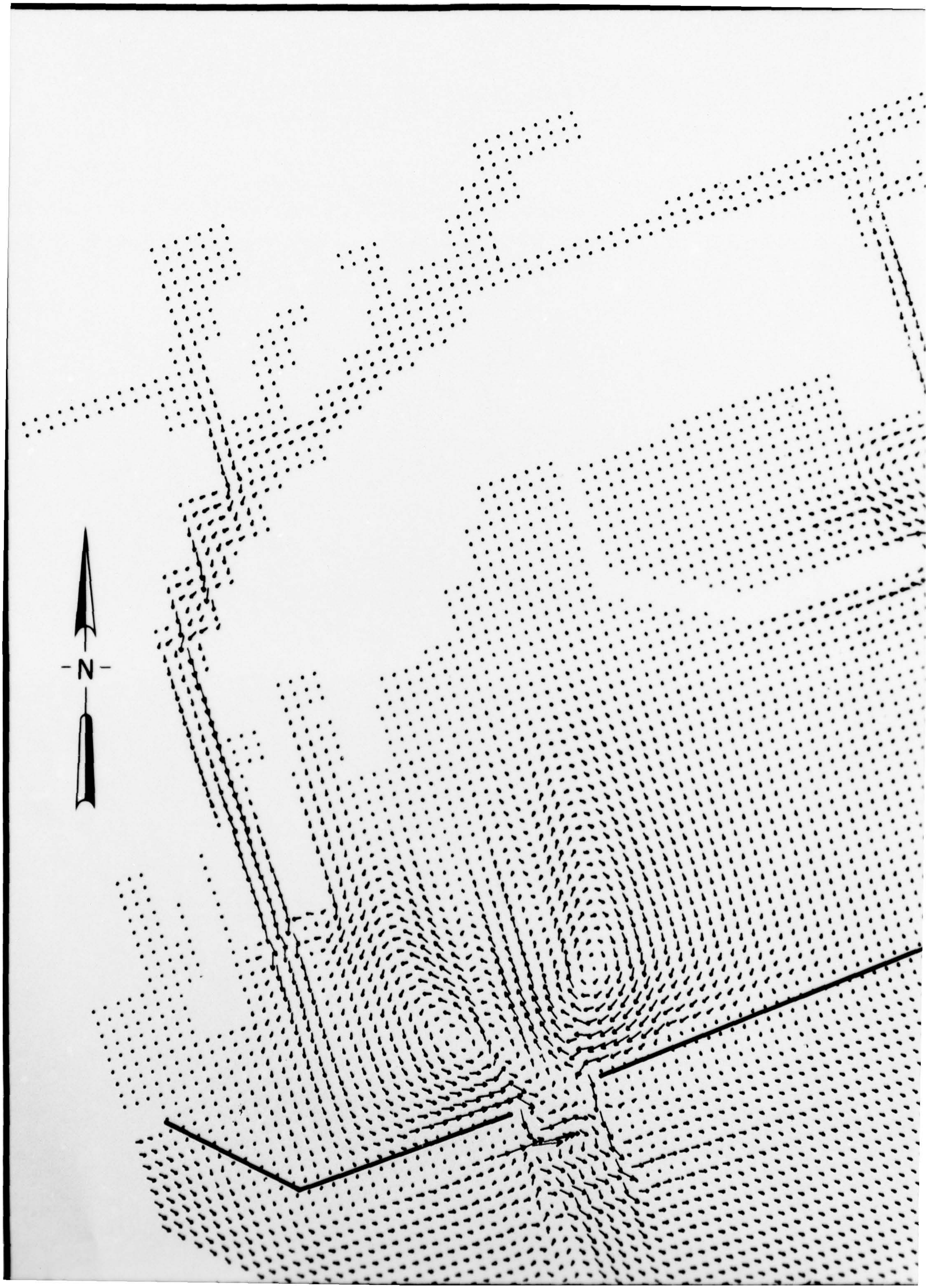


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 600-FT OPENING
-62-FT CHANNEL

SPRING TIDE
HOUR 19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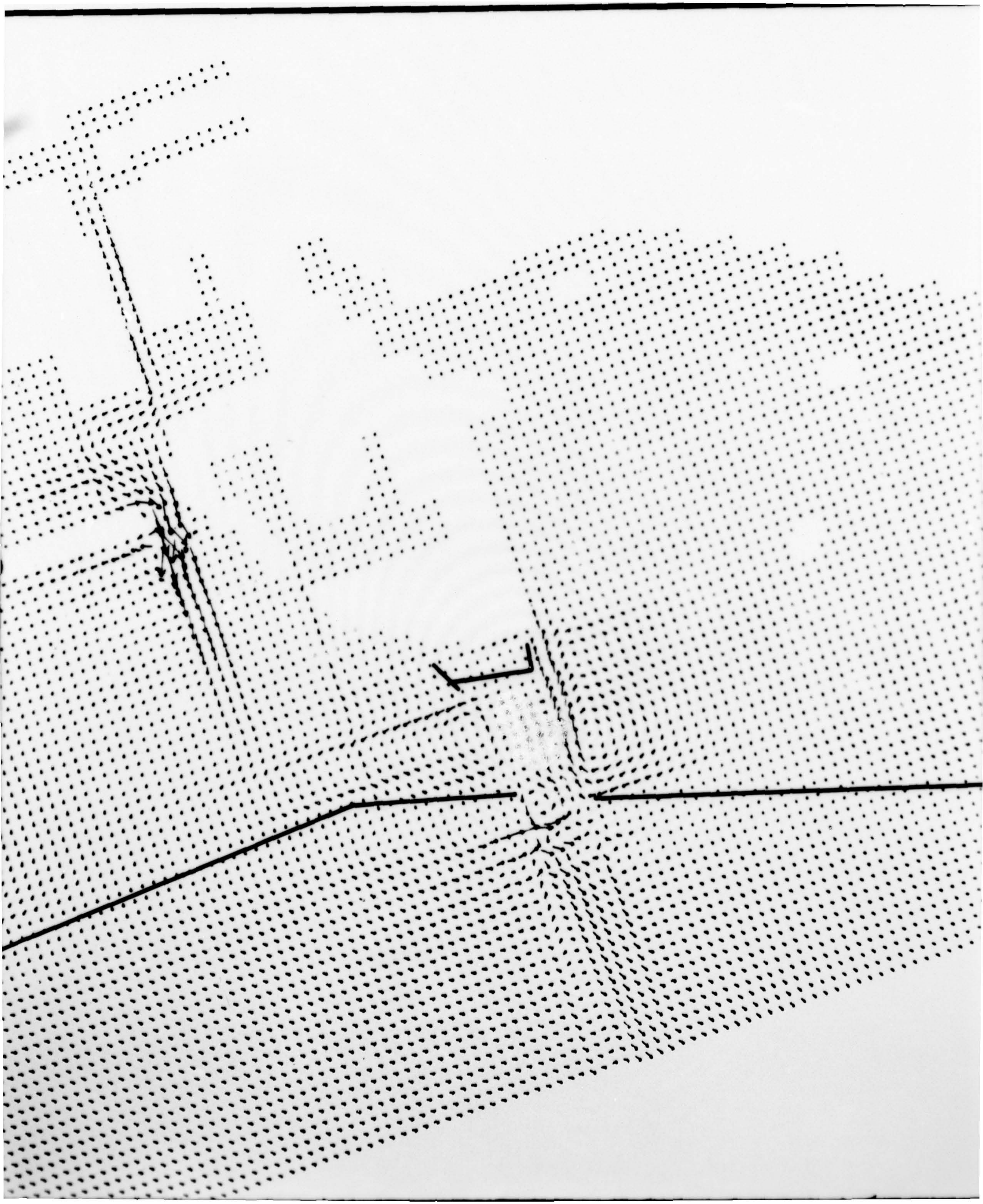

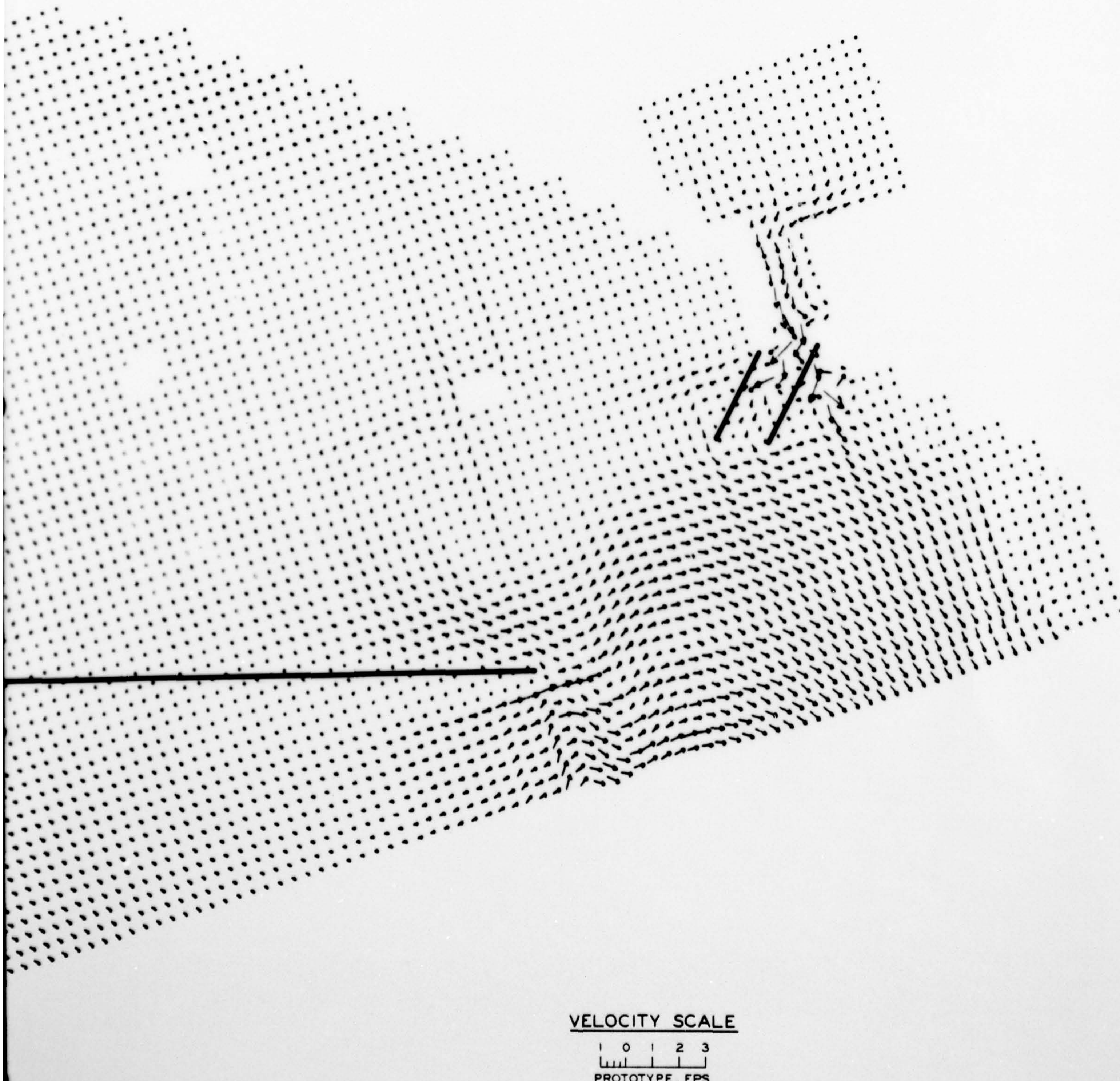

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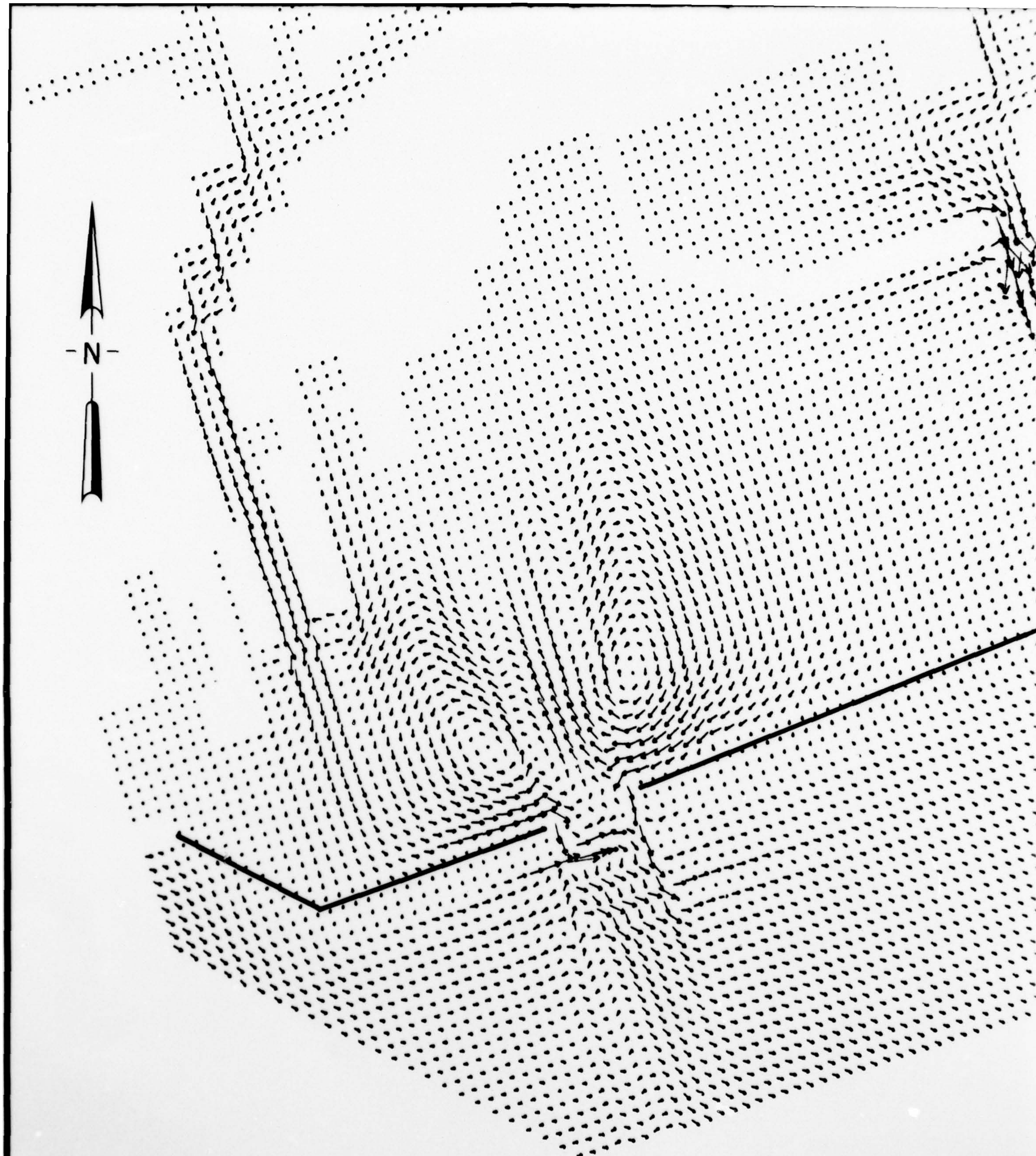

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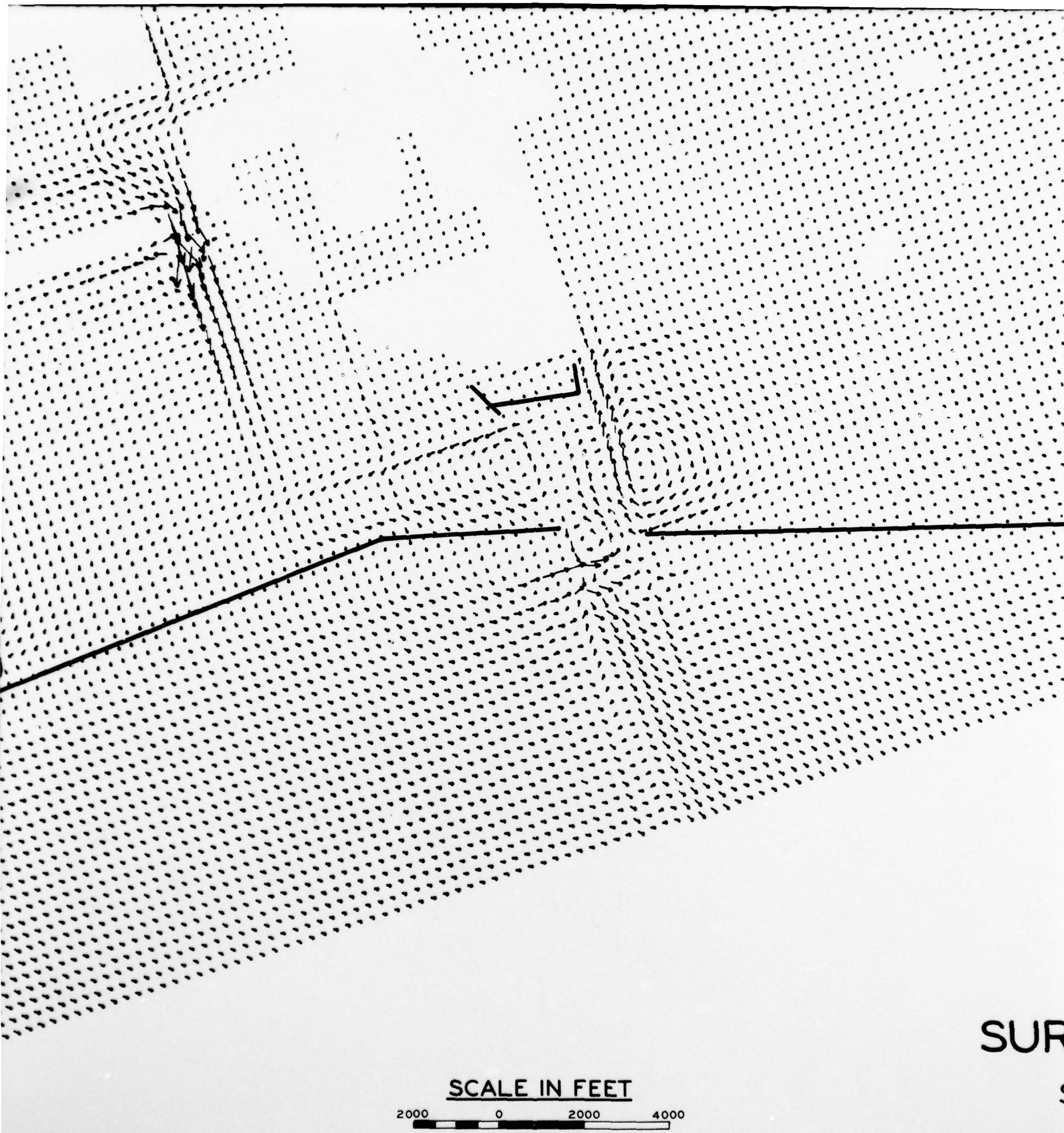

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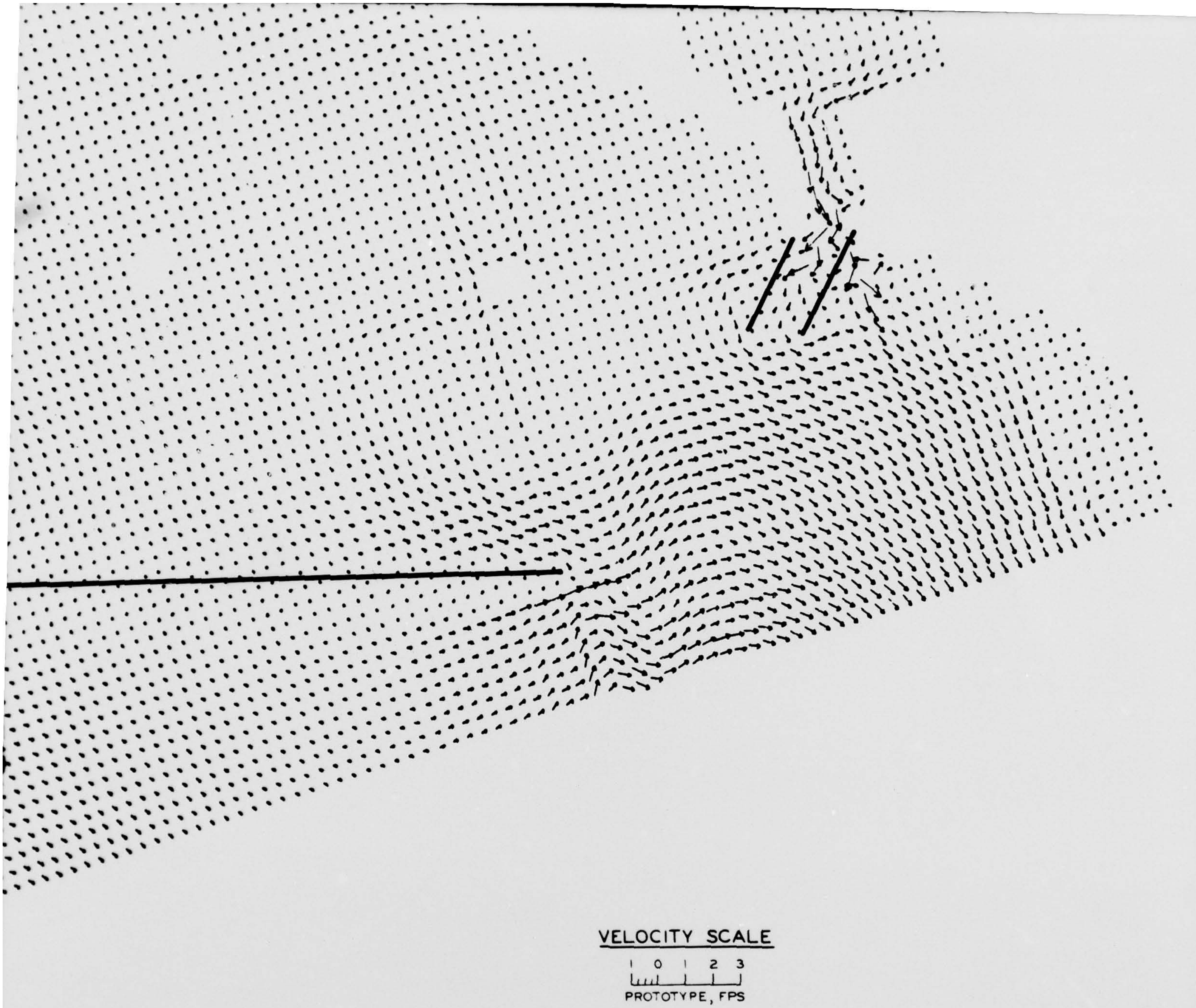
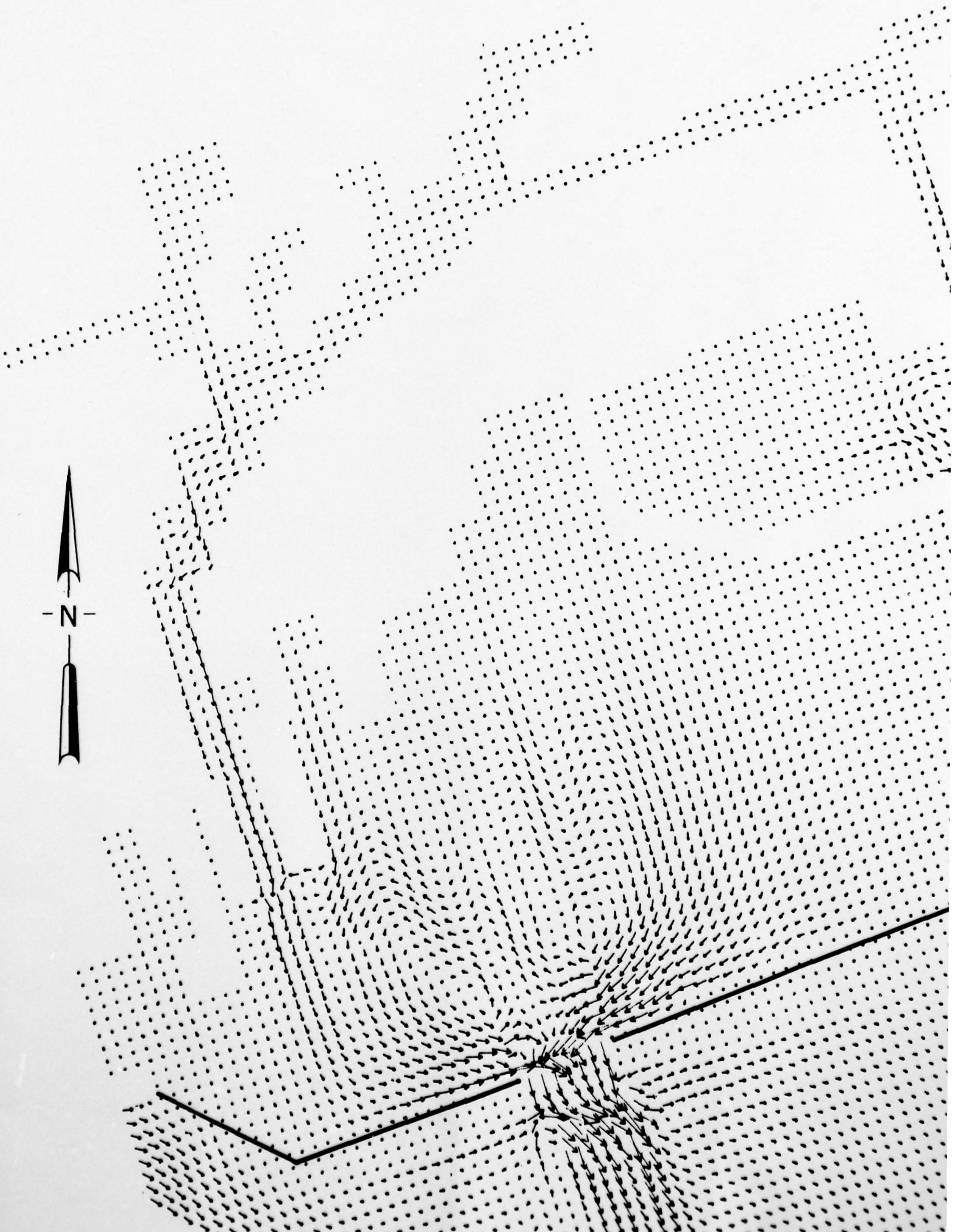


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 600-FT OPENING
-62-FT CHANNEL

SPRING TIDE
HOUR 22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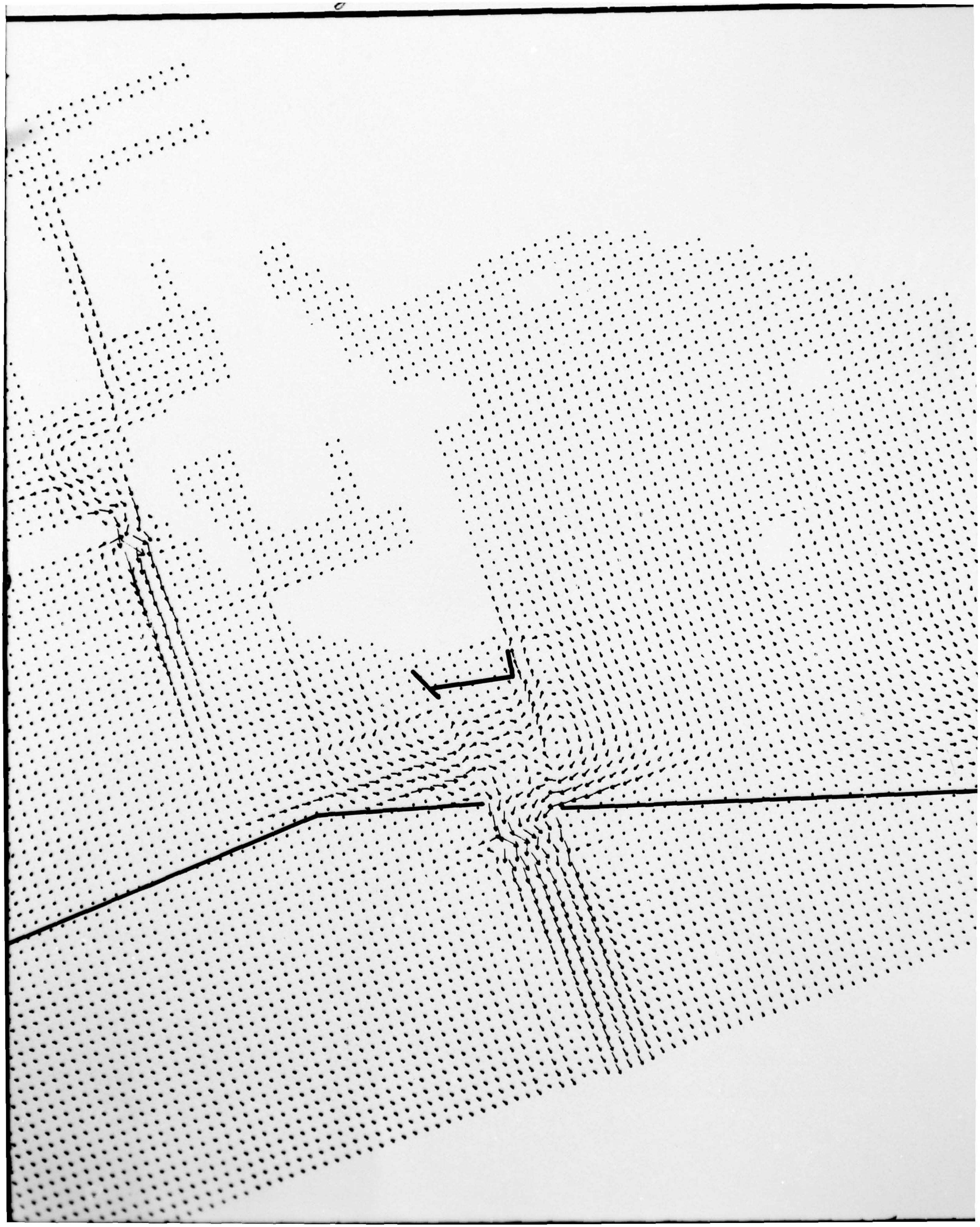

AD-A046 914 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 8/3
NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR. --ETC(U)
MAR 76 D C RANEY

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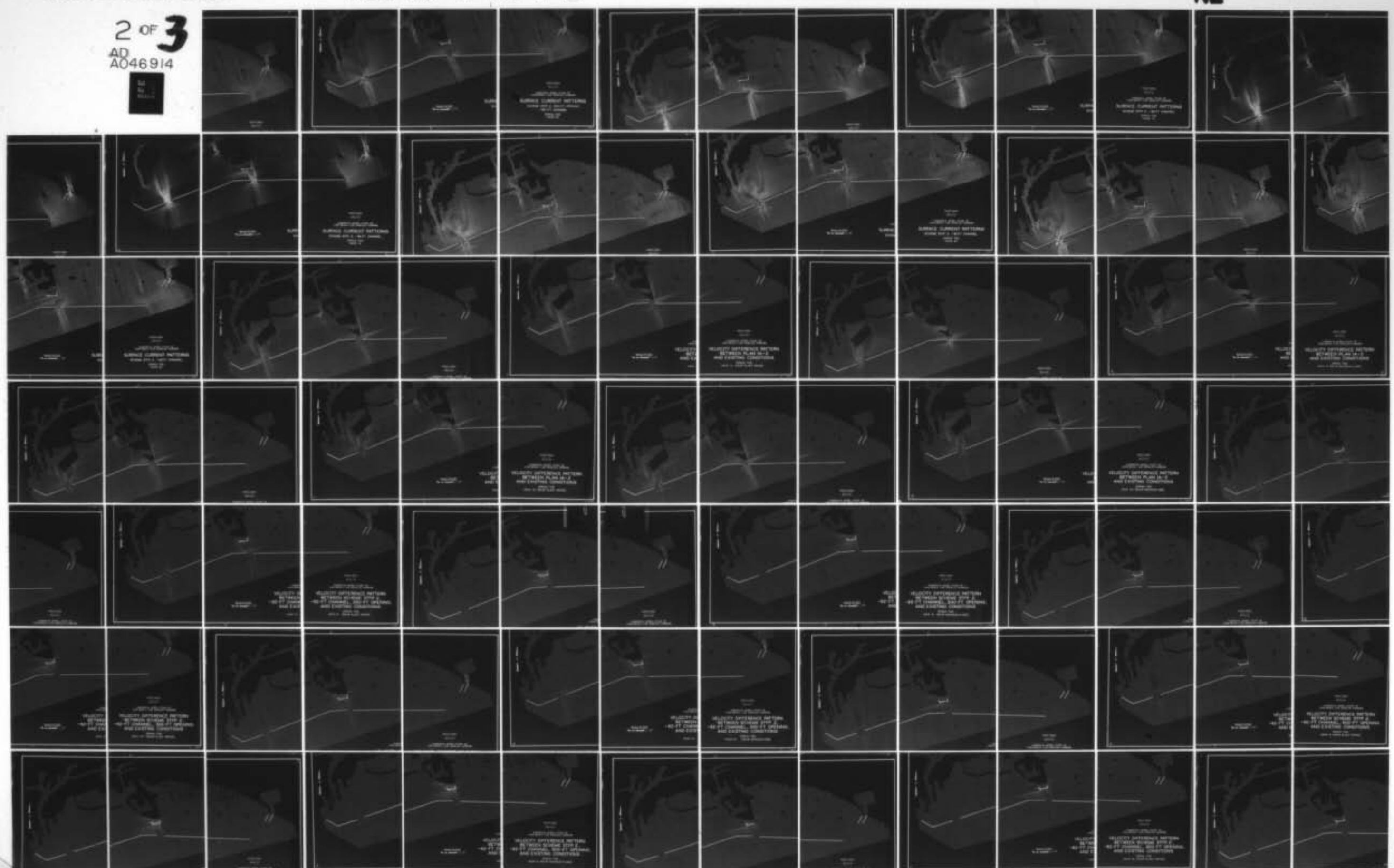
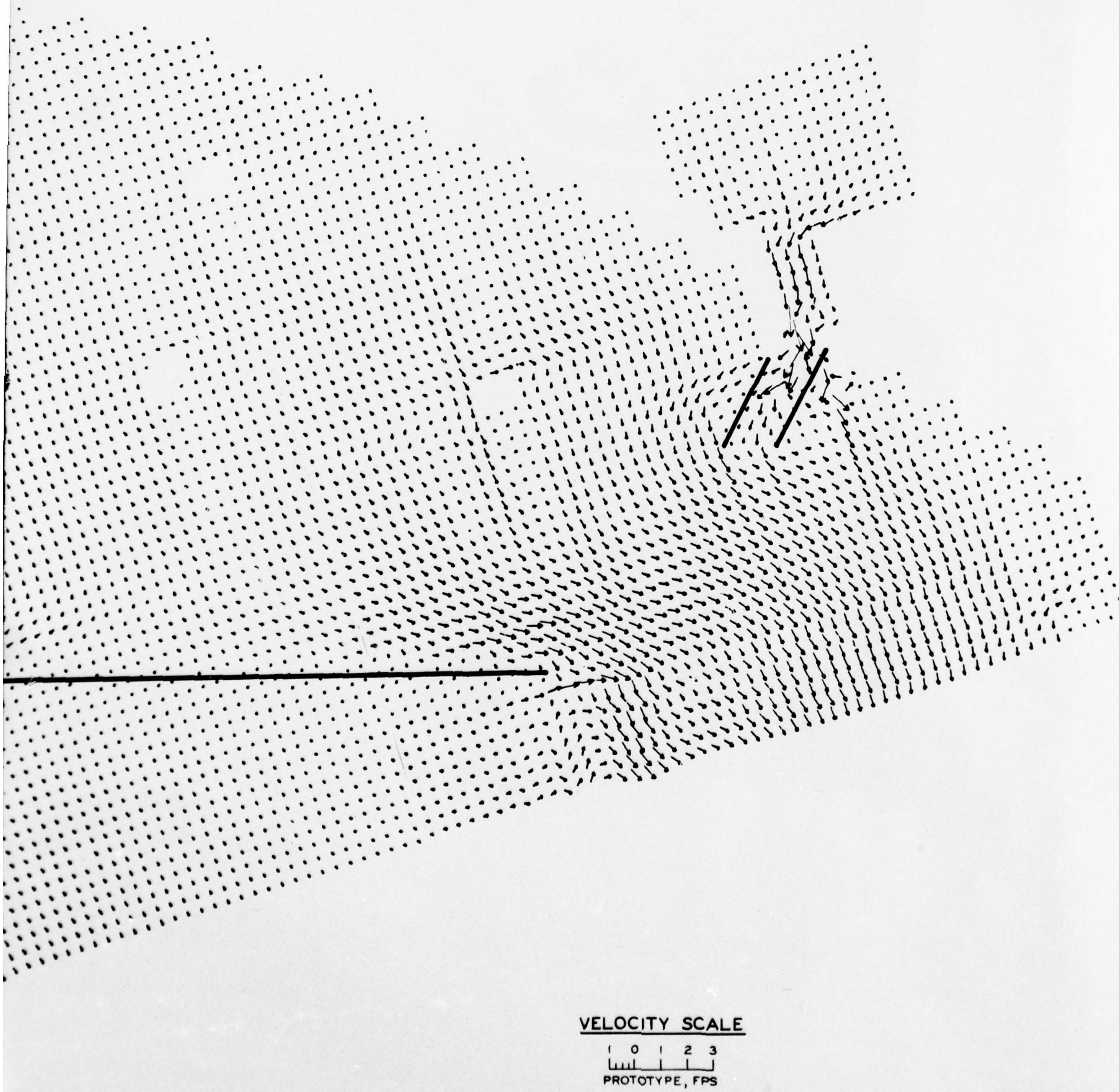
2 OF 3
AD A046914

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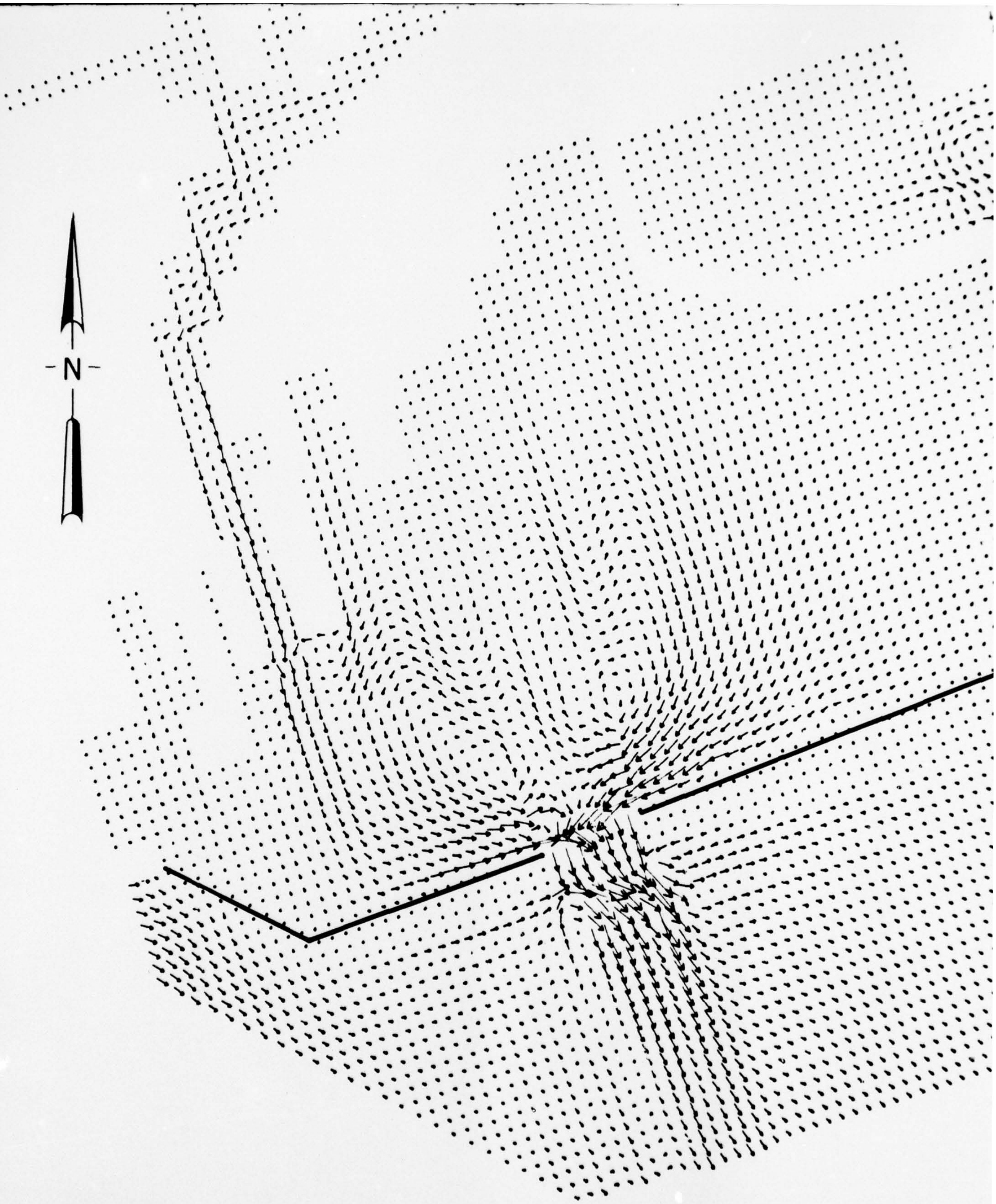
PROTOTYPE, FPS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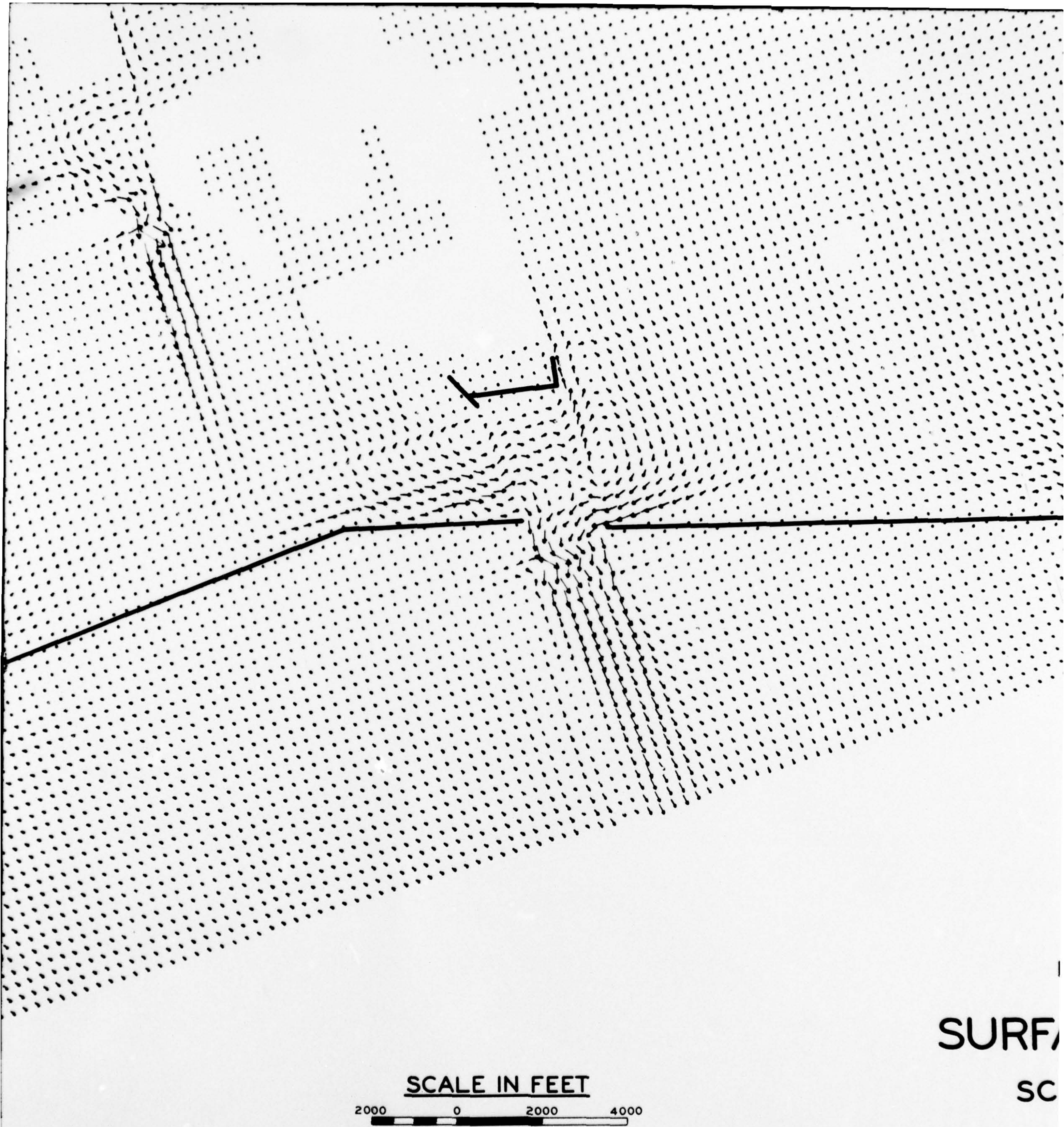
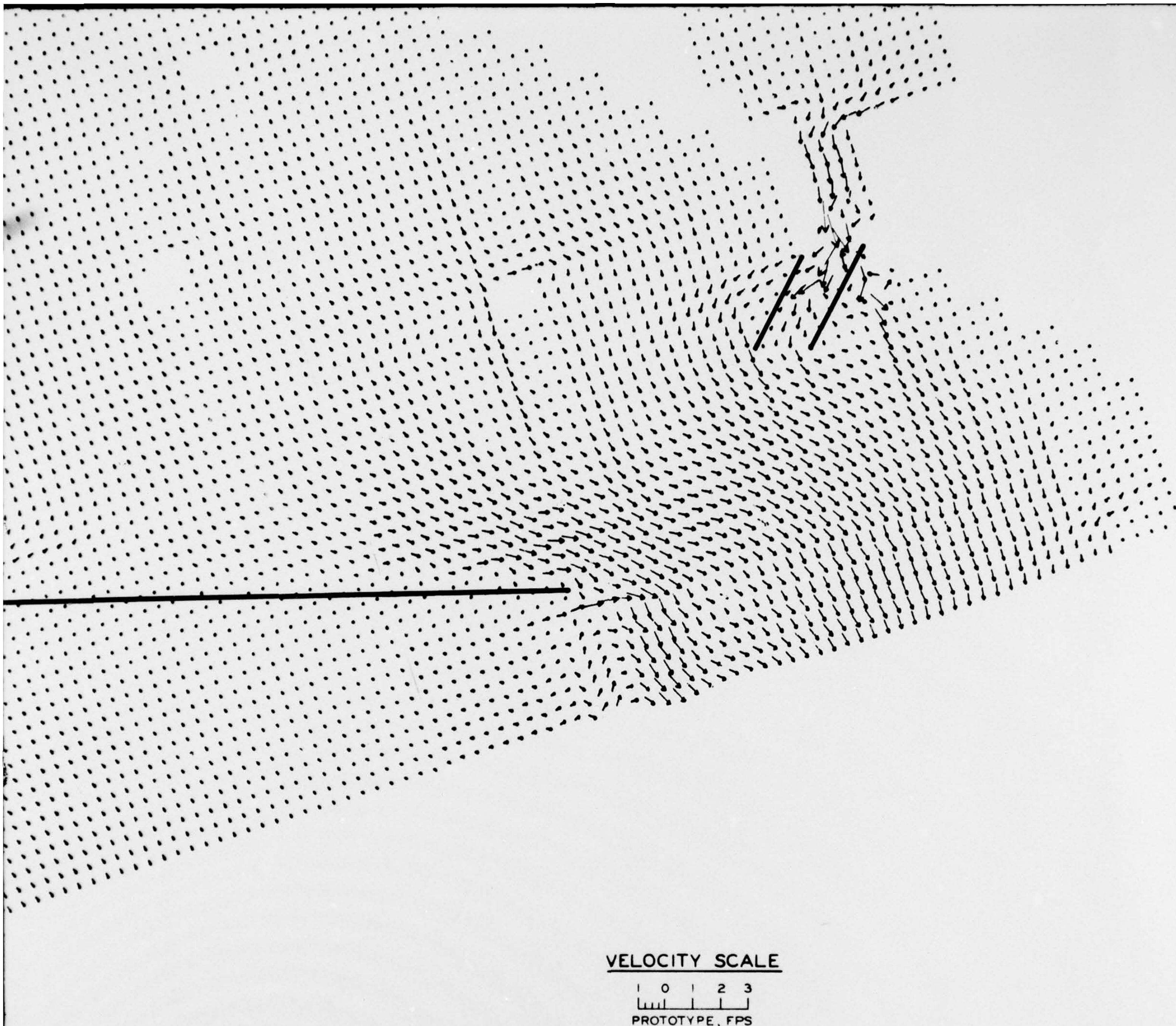


SURF

SC

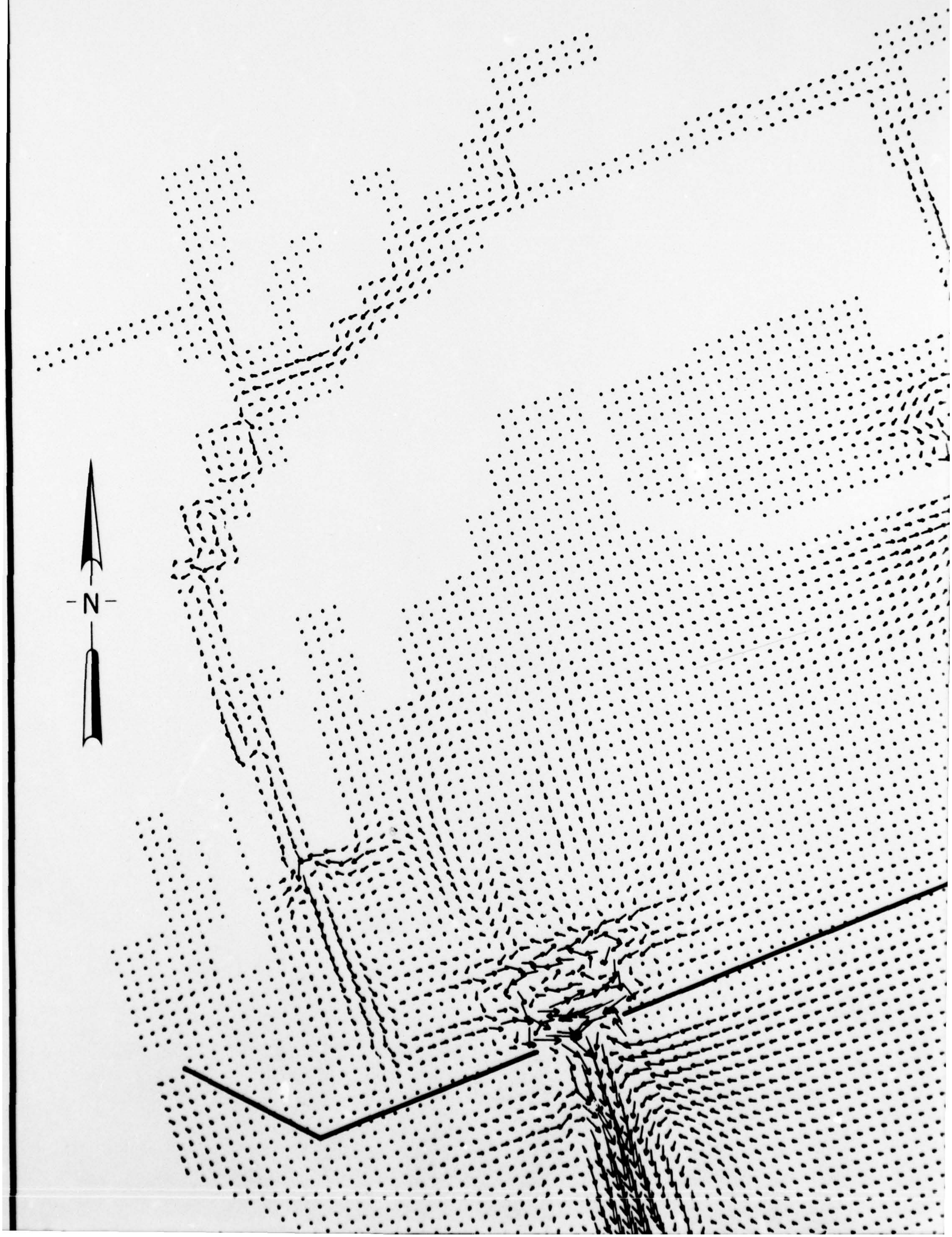


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 600-FT OPENING
-62-FT CHANNEL

SPRING TIDE
HOUR 24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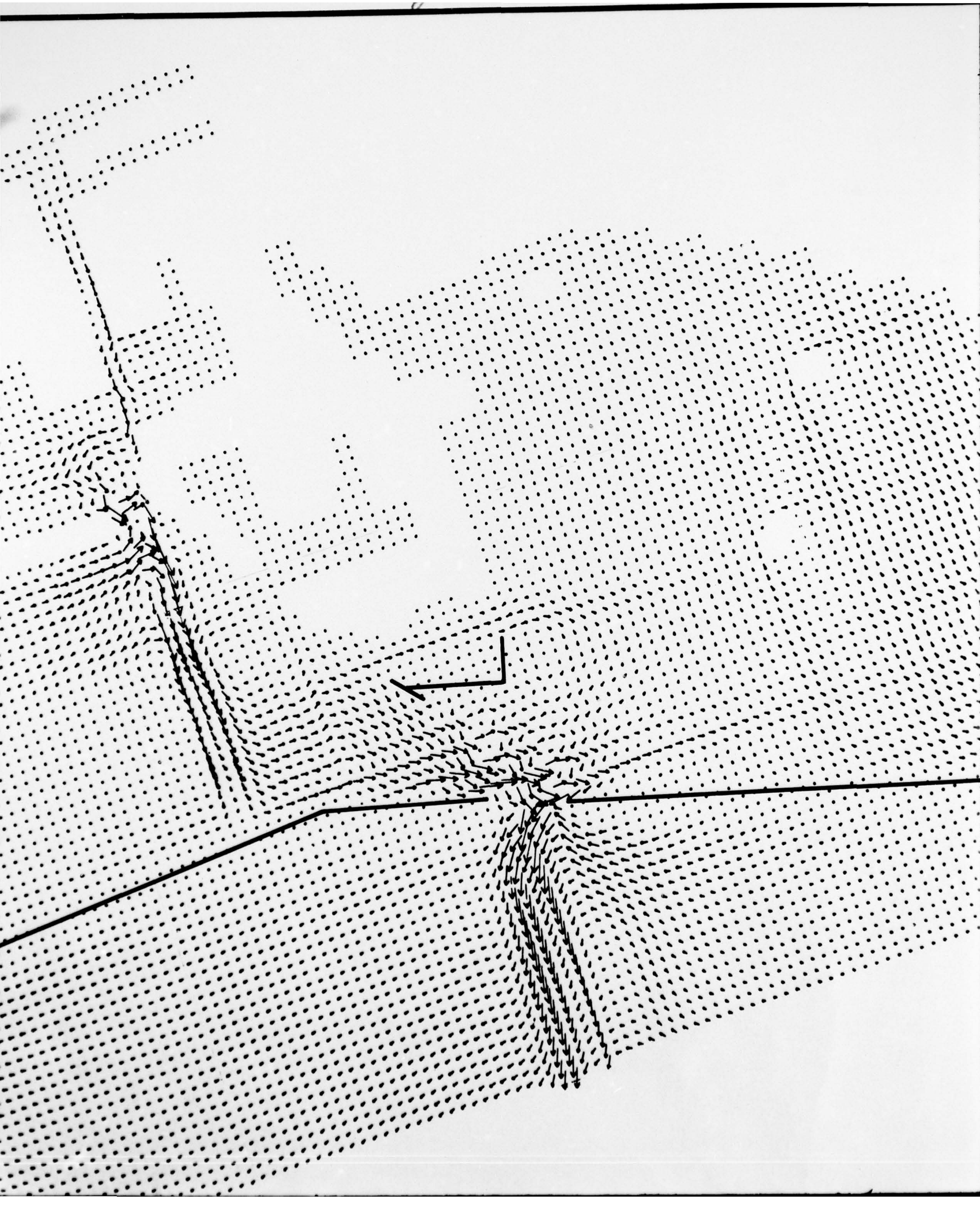

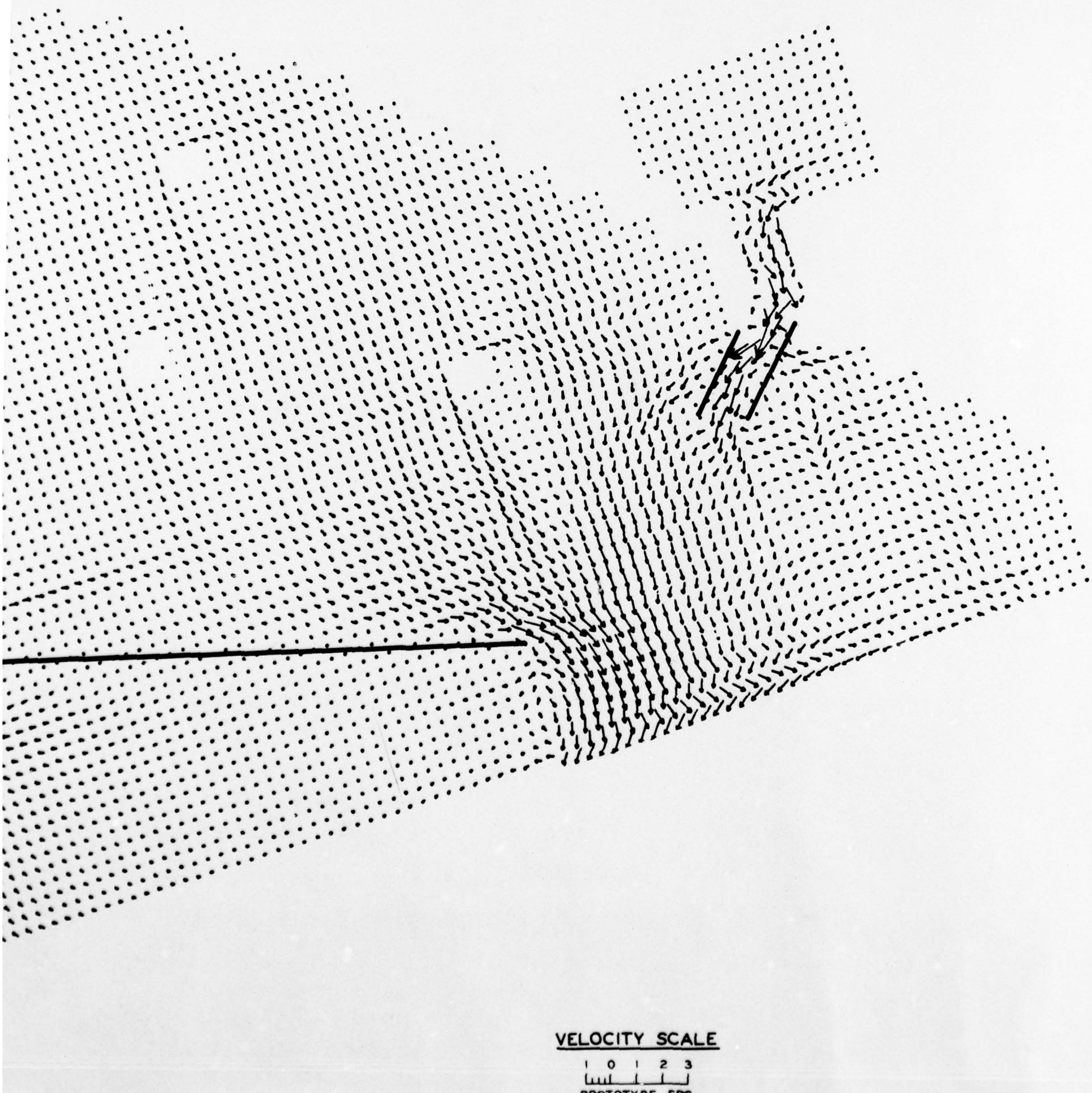
VELOCITY SCALE
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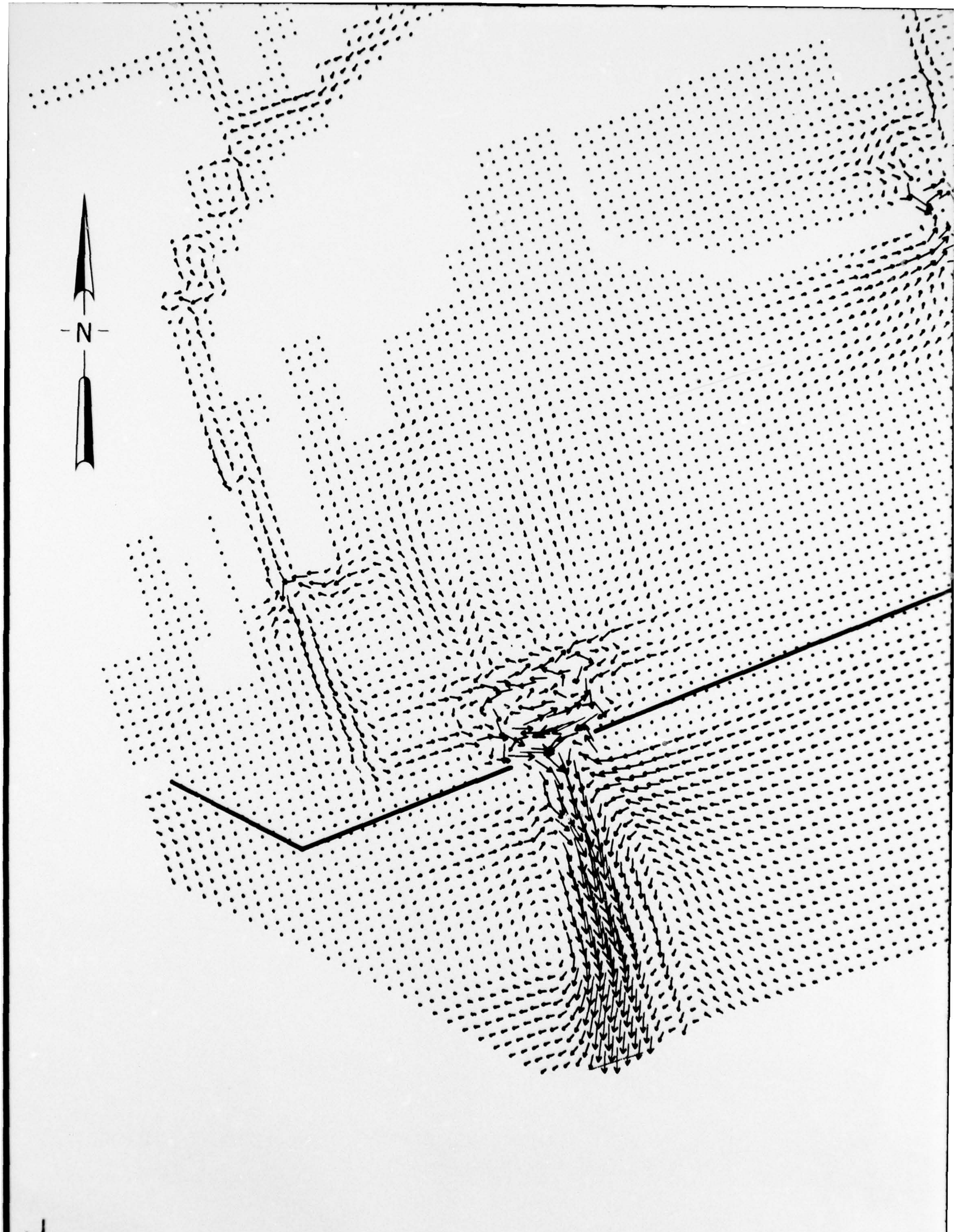
PROTOTYPE, FPS



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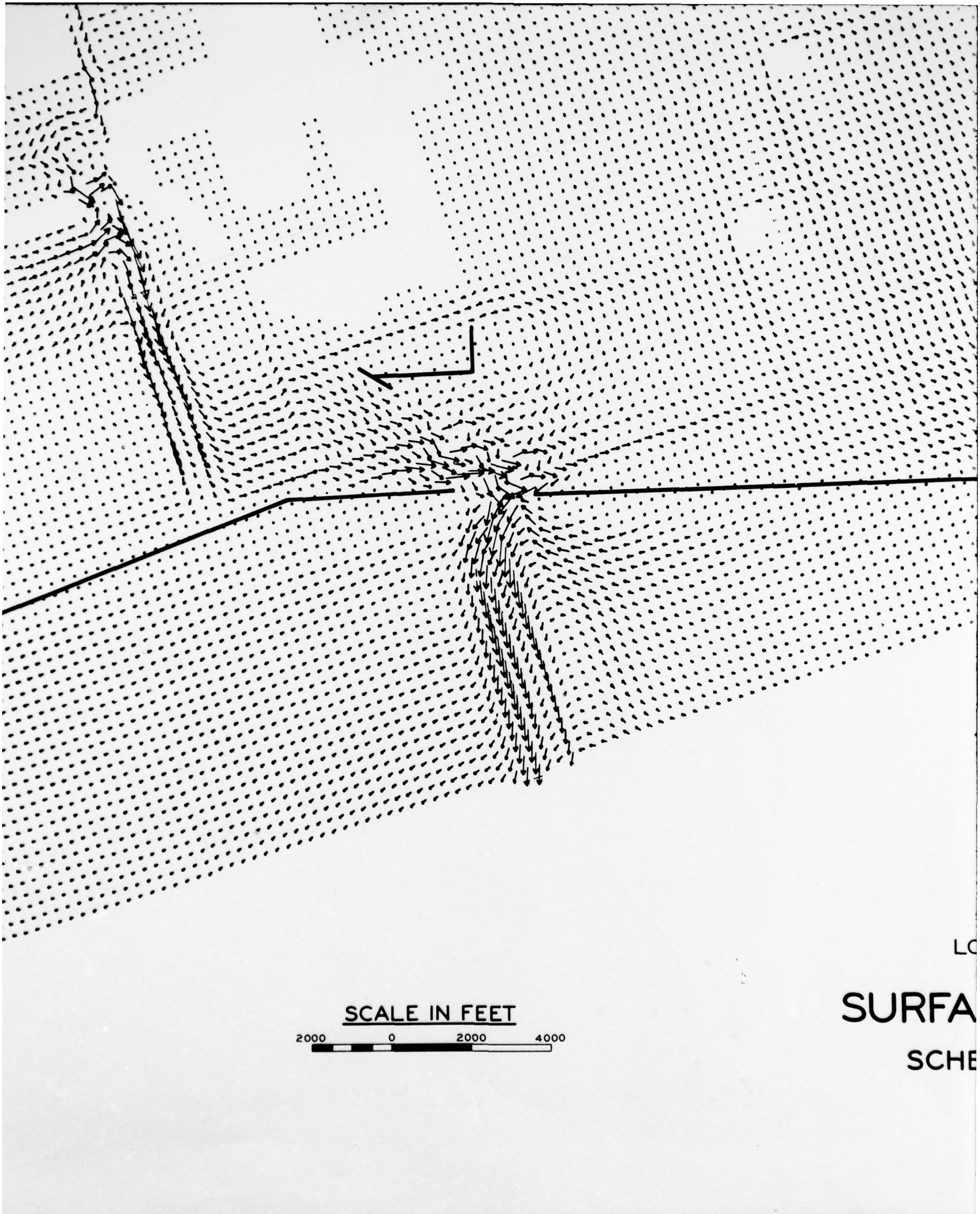
SCALE IN FEET
2000 0 2000 4000
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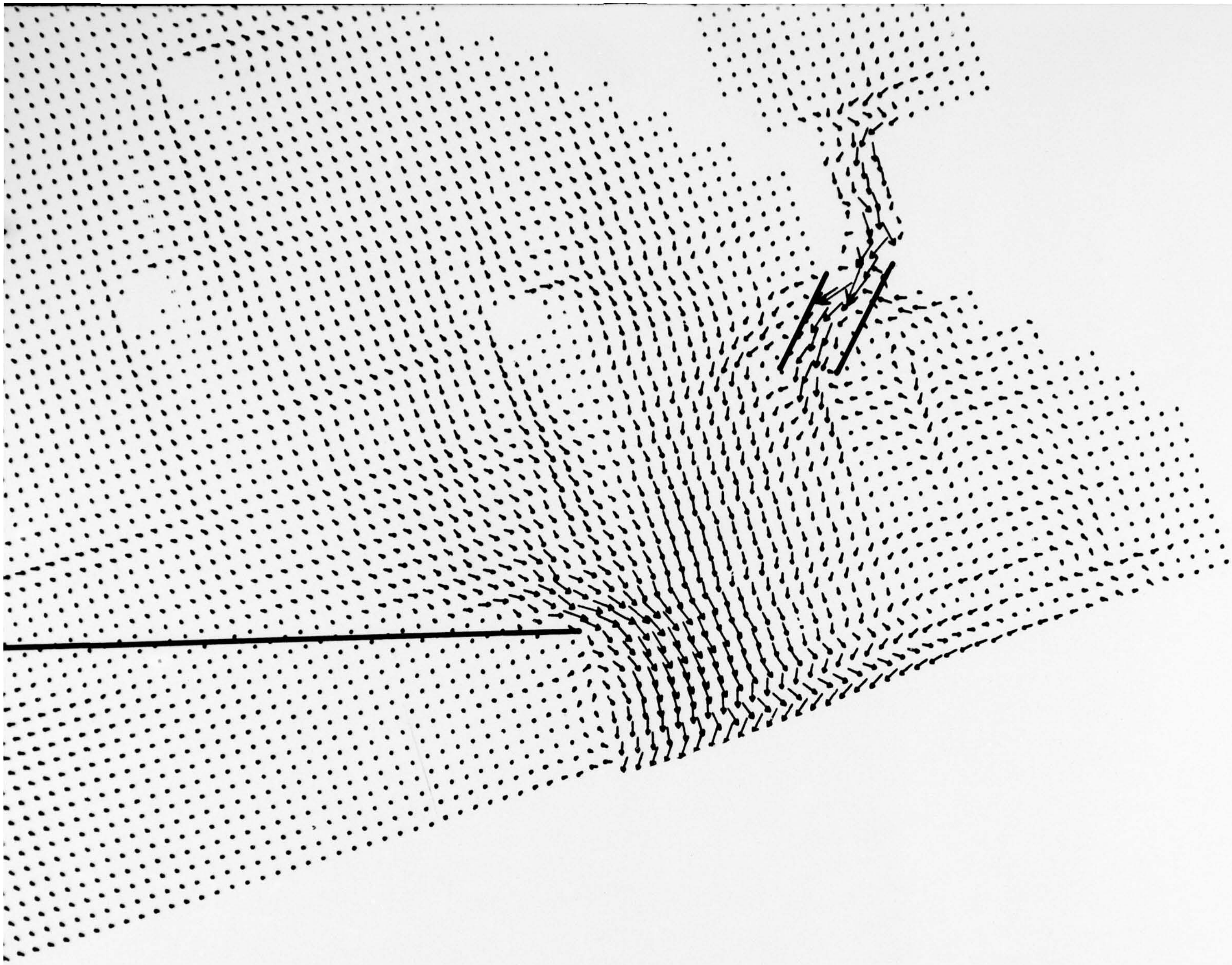


VELOCITY SCALE

1 0 1 2 3

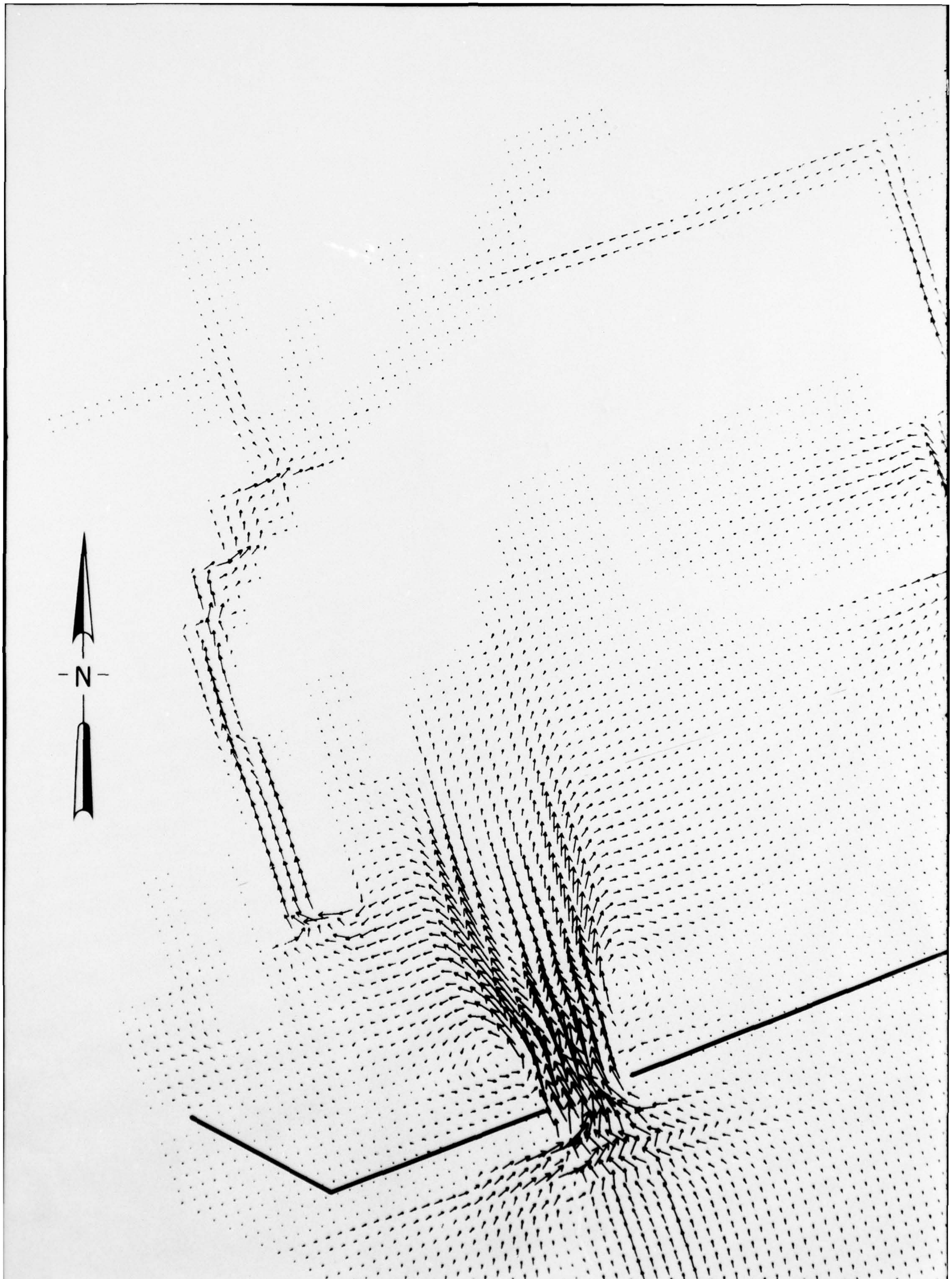
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 3, -62-FT CHANNEL

SPRING TIDE
HOUR 15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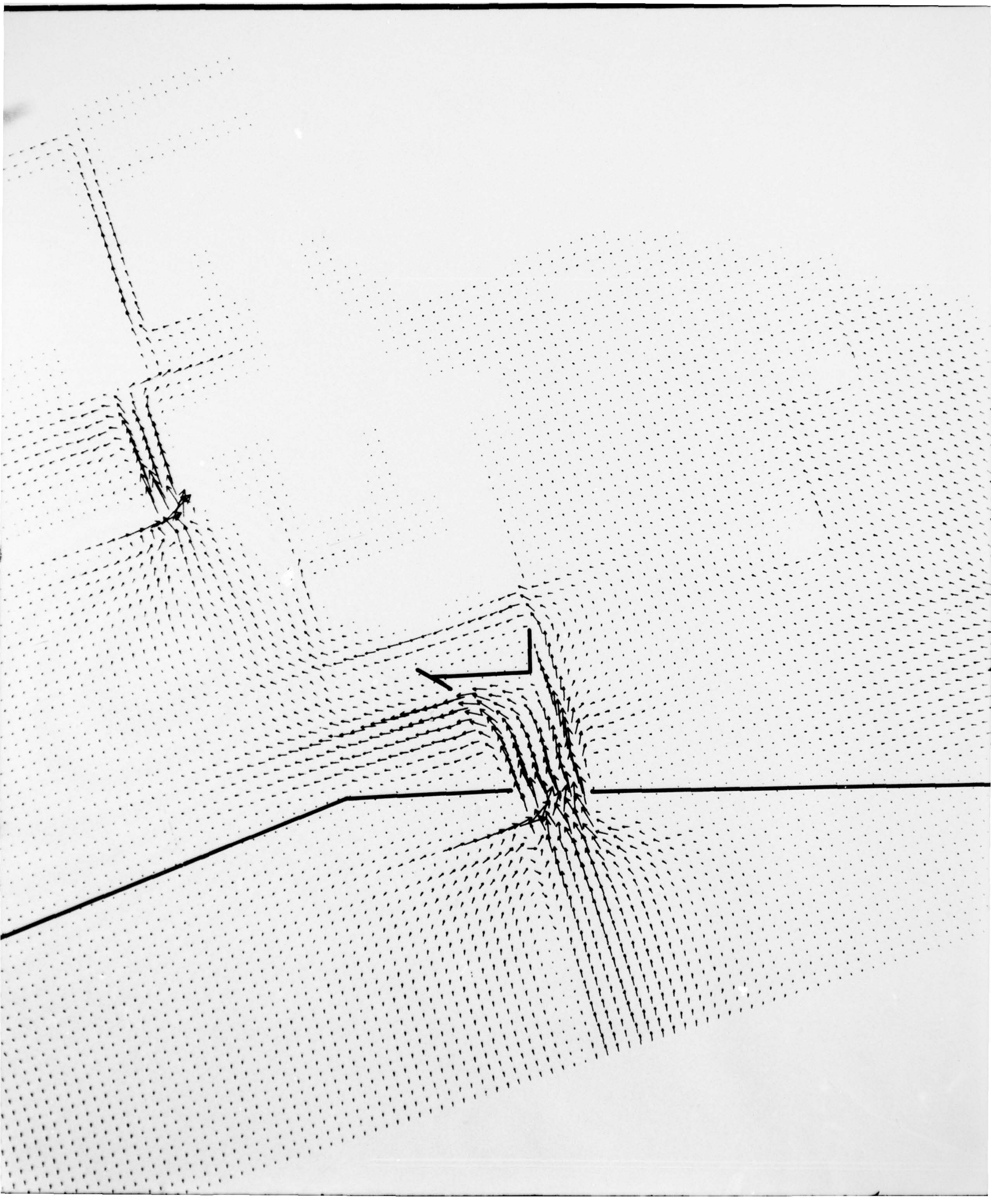

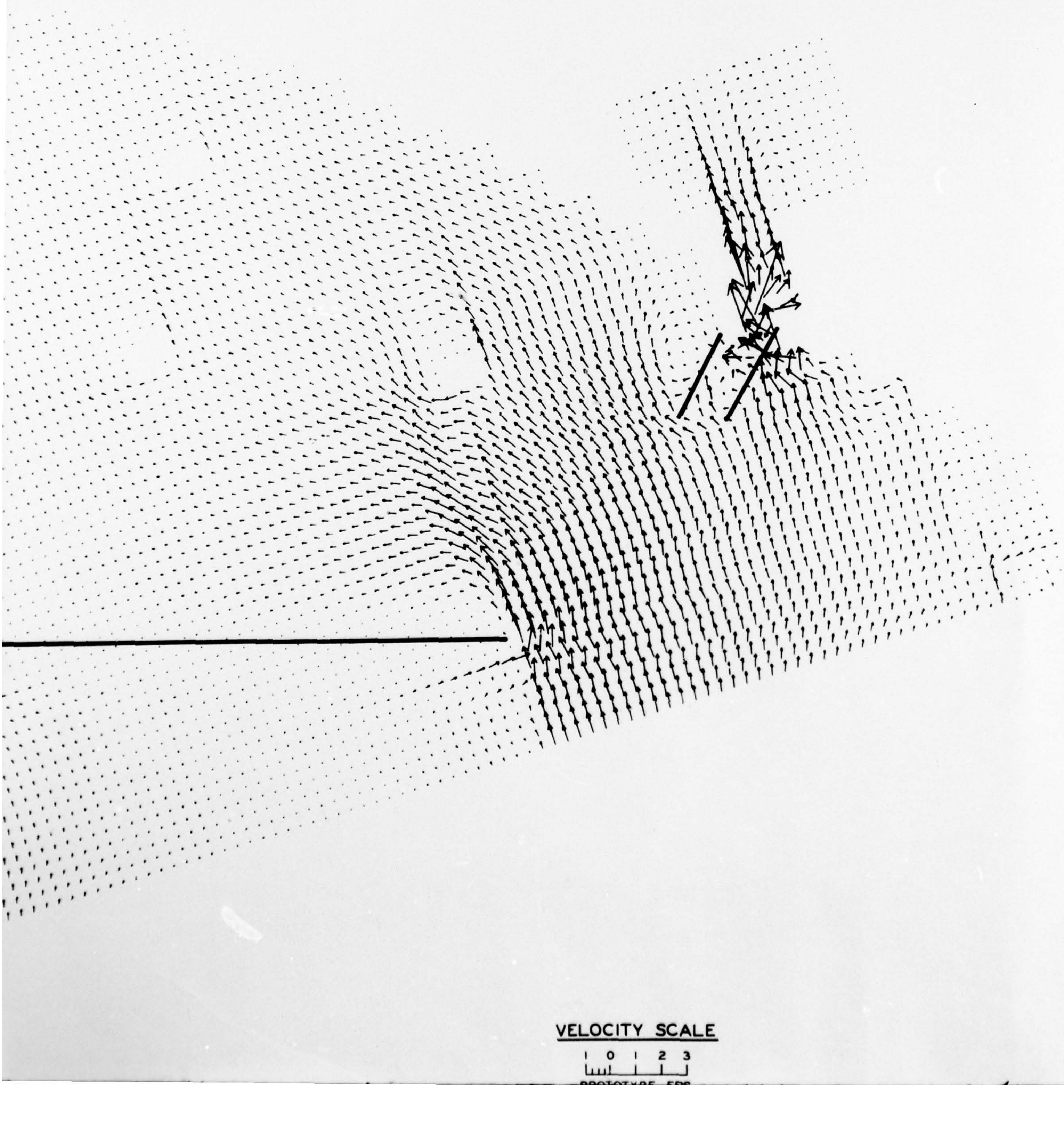

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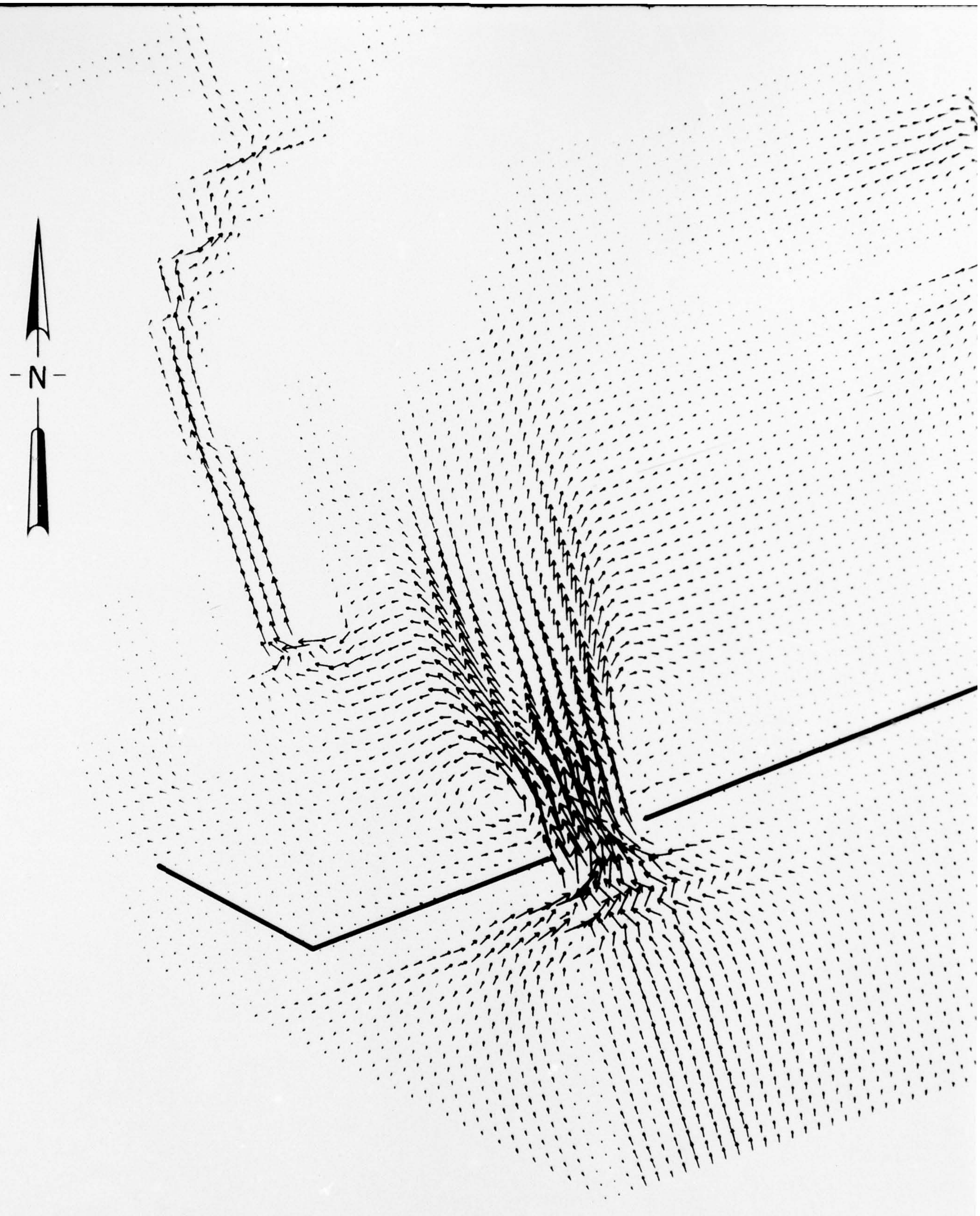
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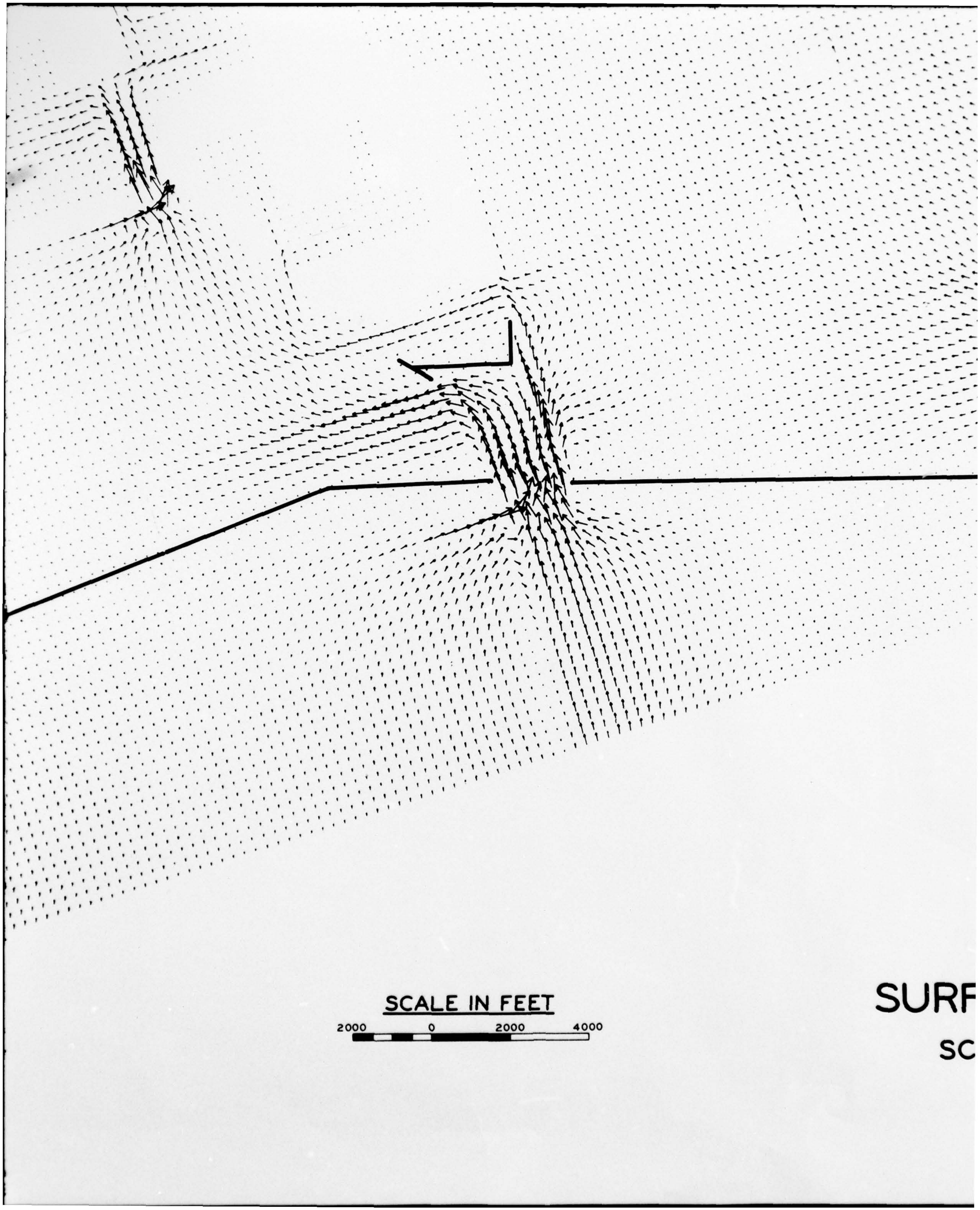
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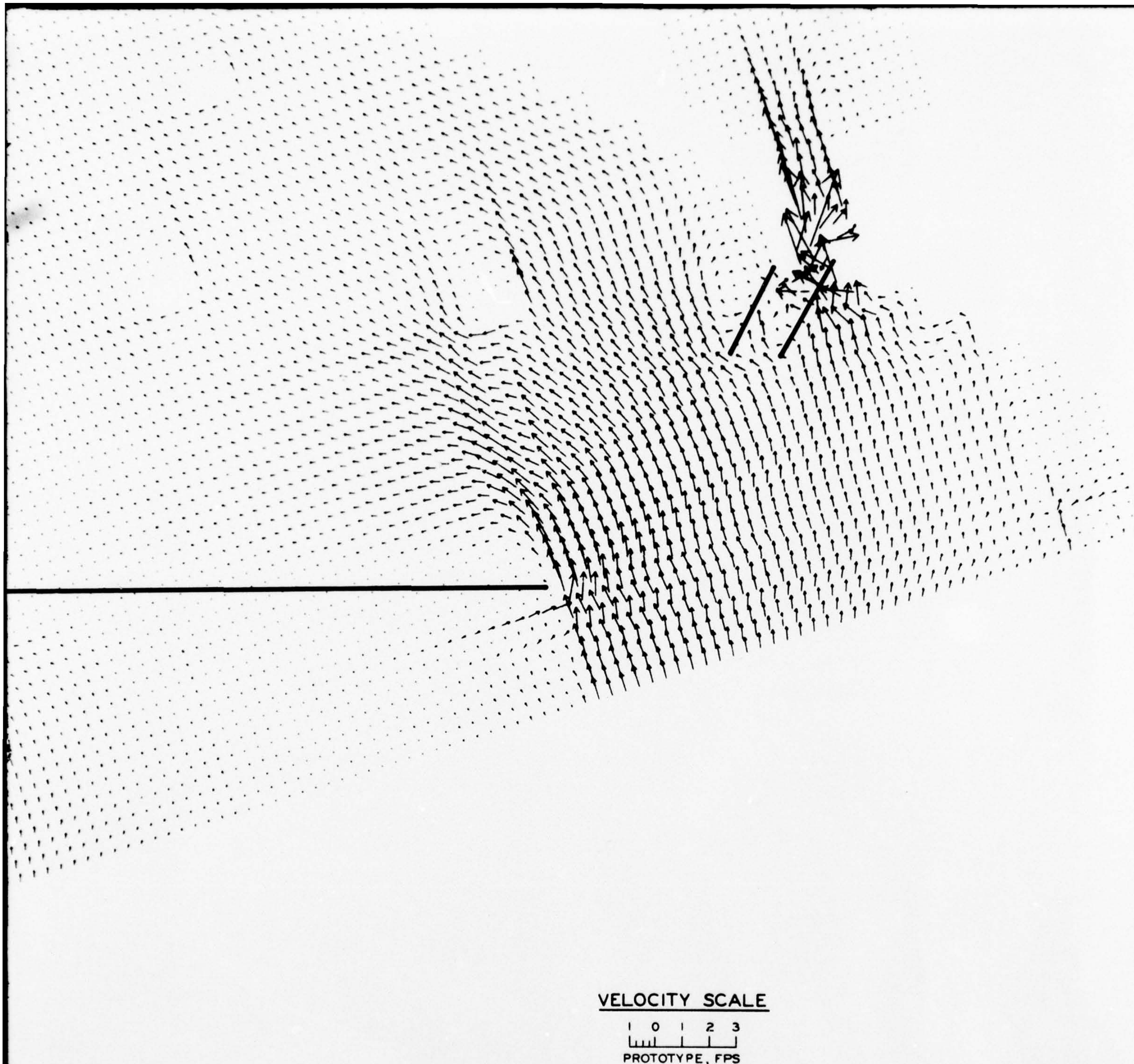
SURF
SC

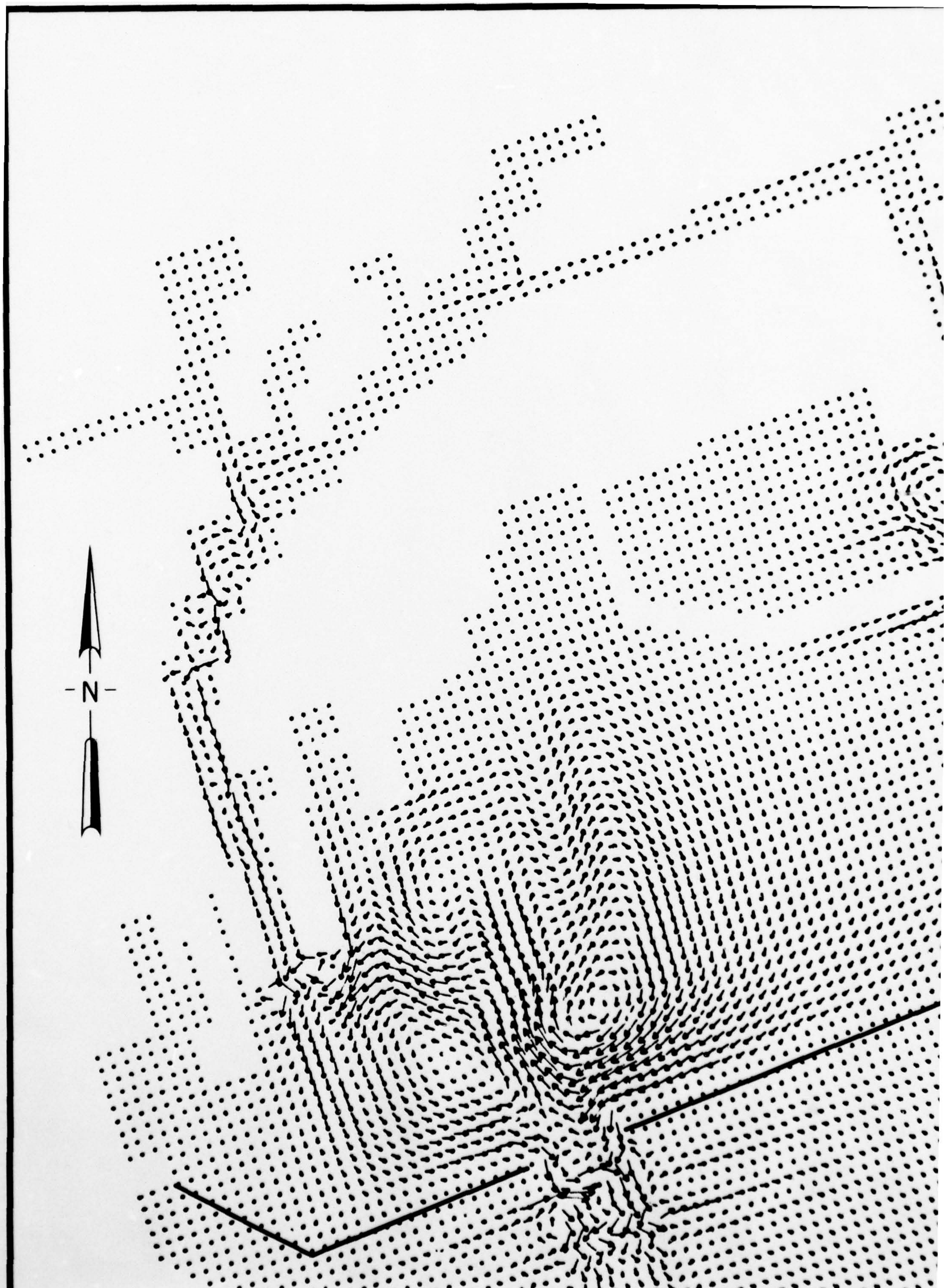


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 3, –62-FT CHANNEL

SPRING TIDE
HOUR 19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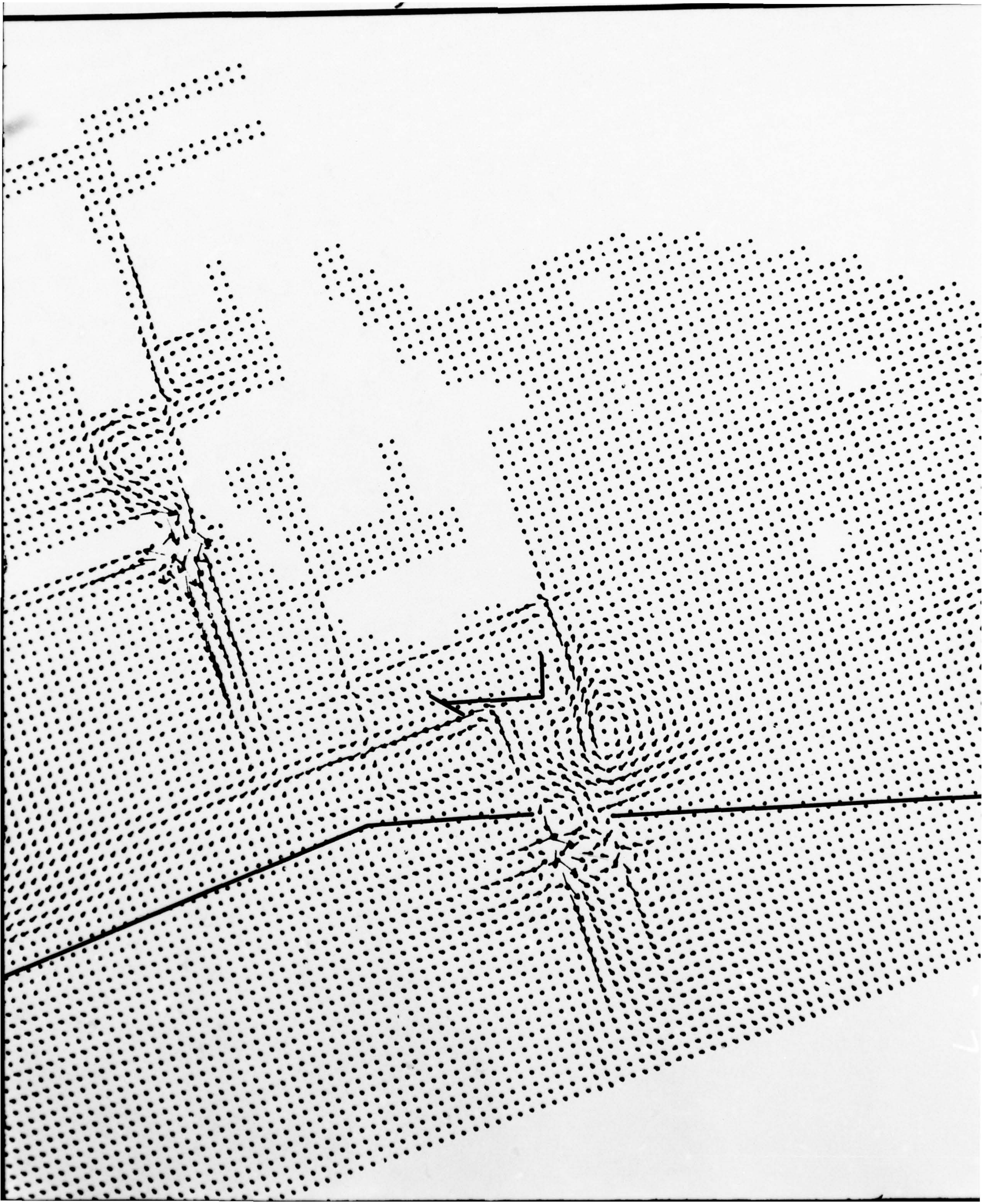

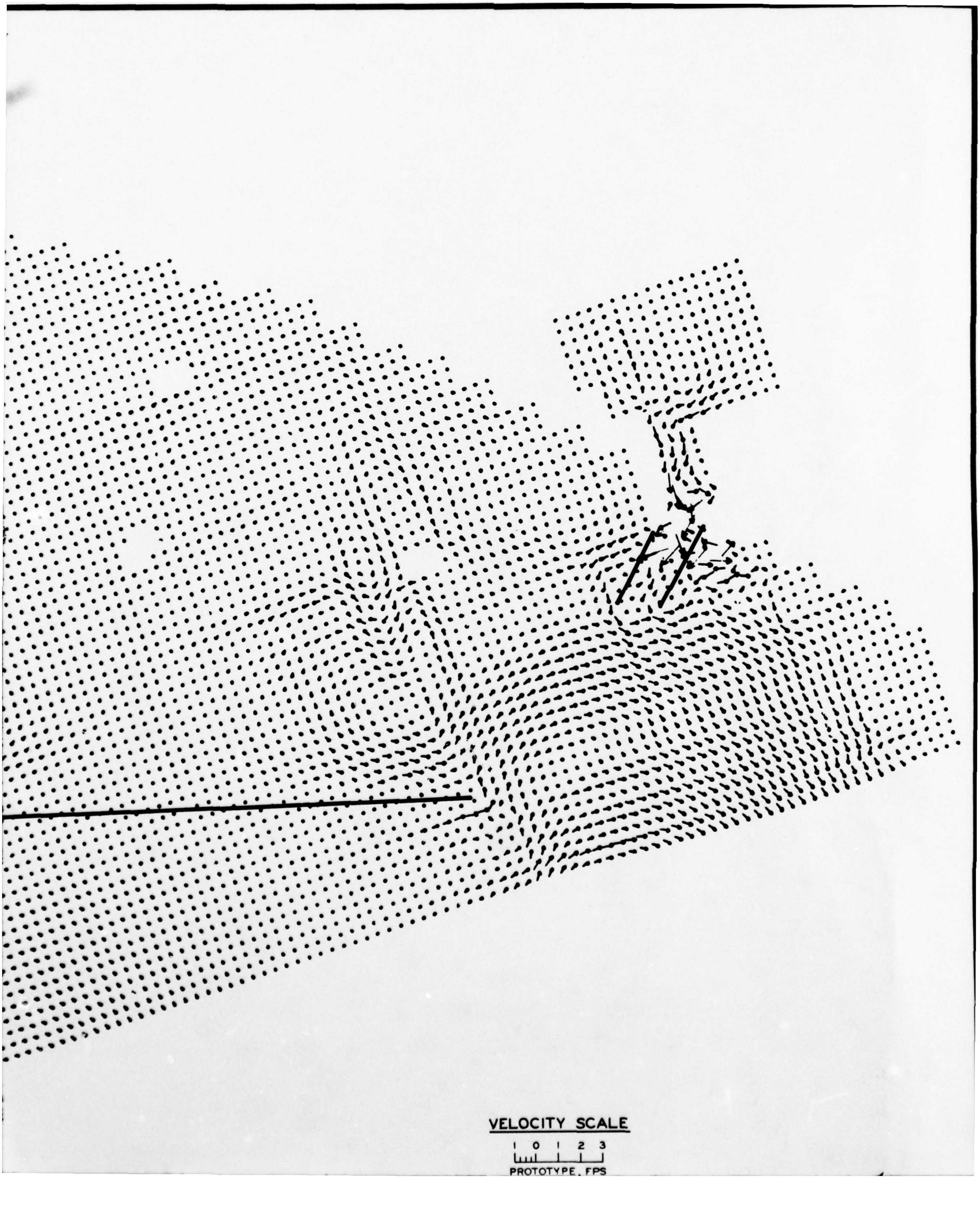
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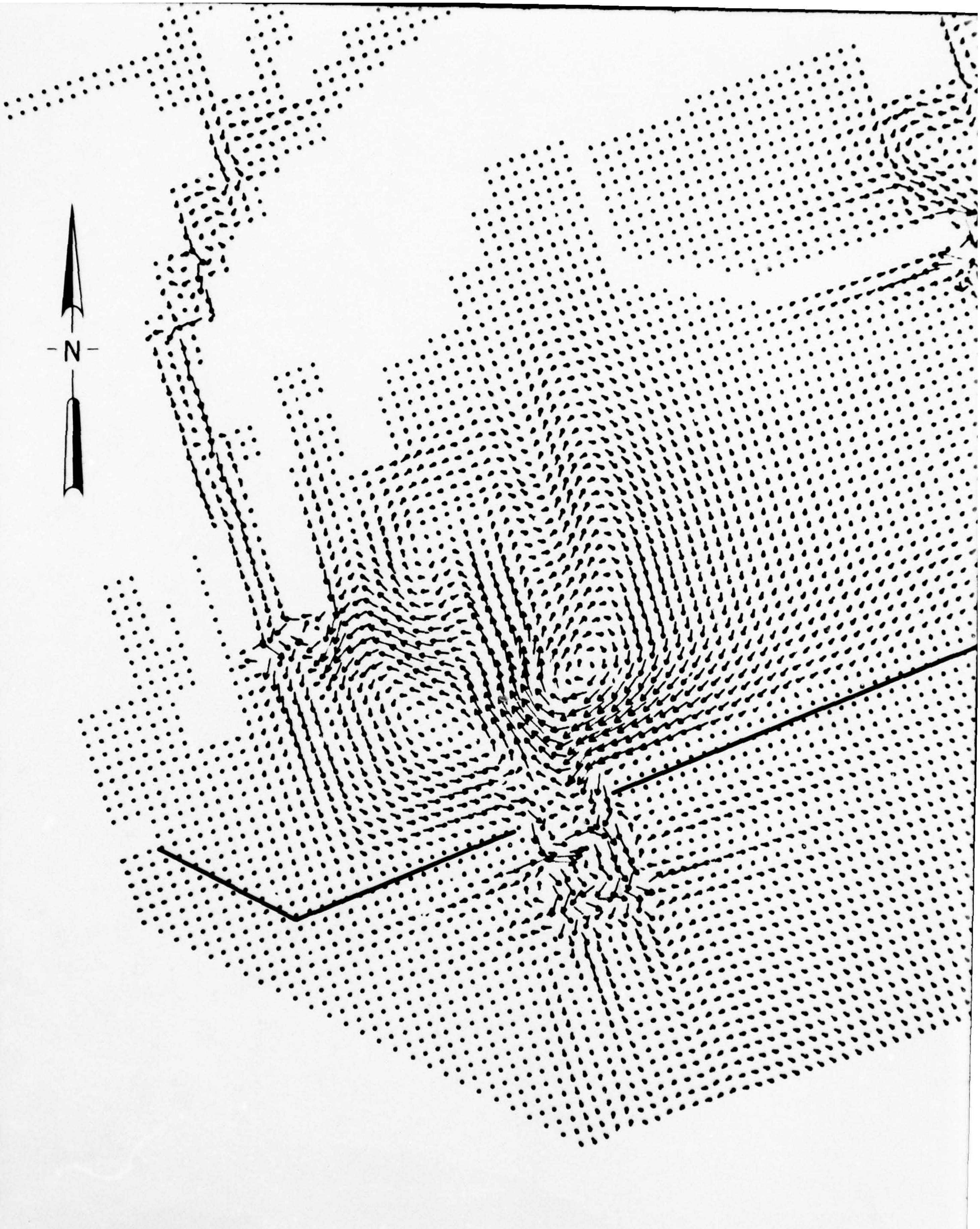
PROTOTYPE, FPS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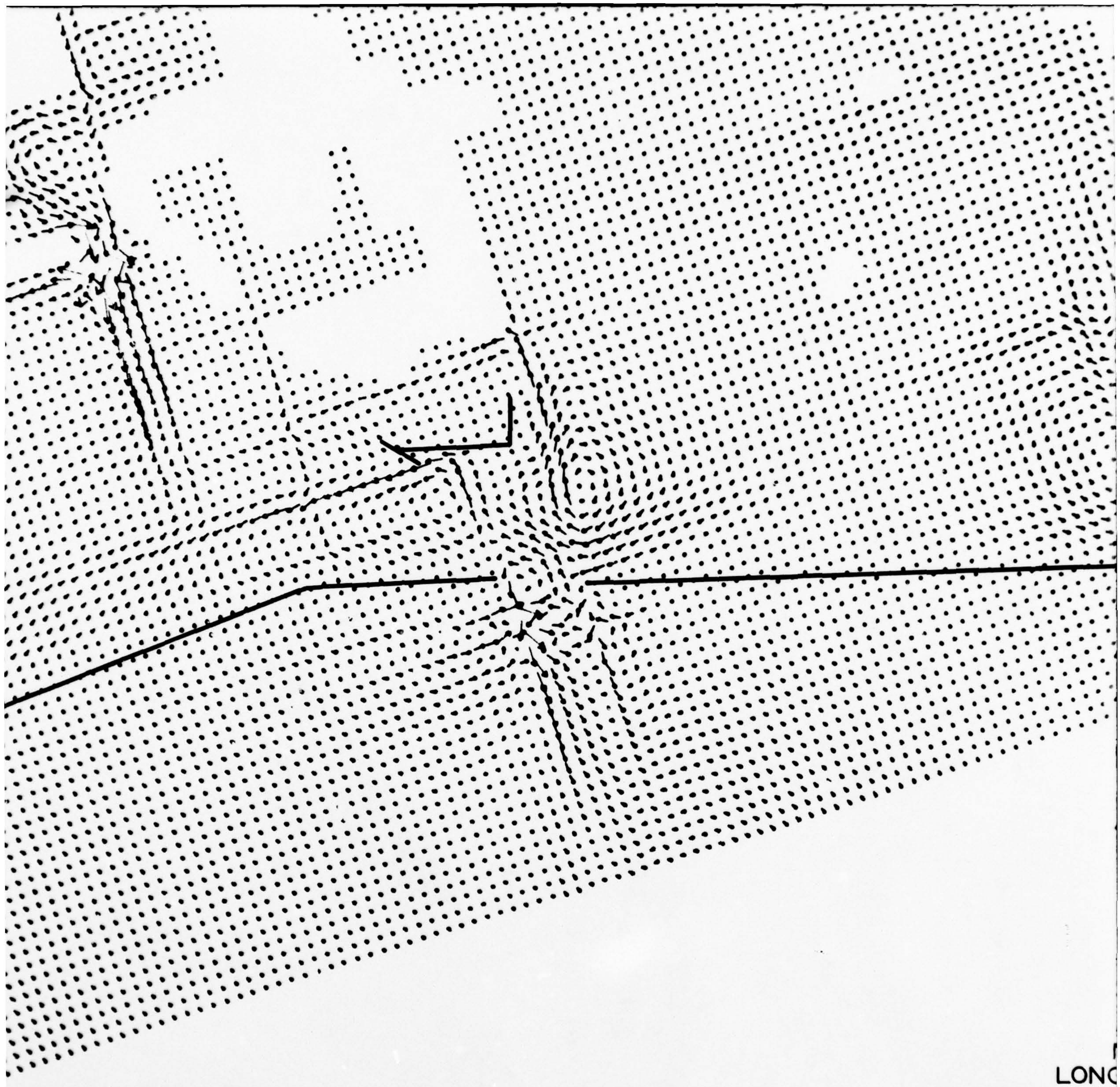

SCALE IN FEET

2000 0 2000 4000

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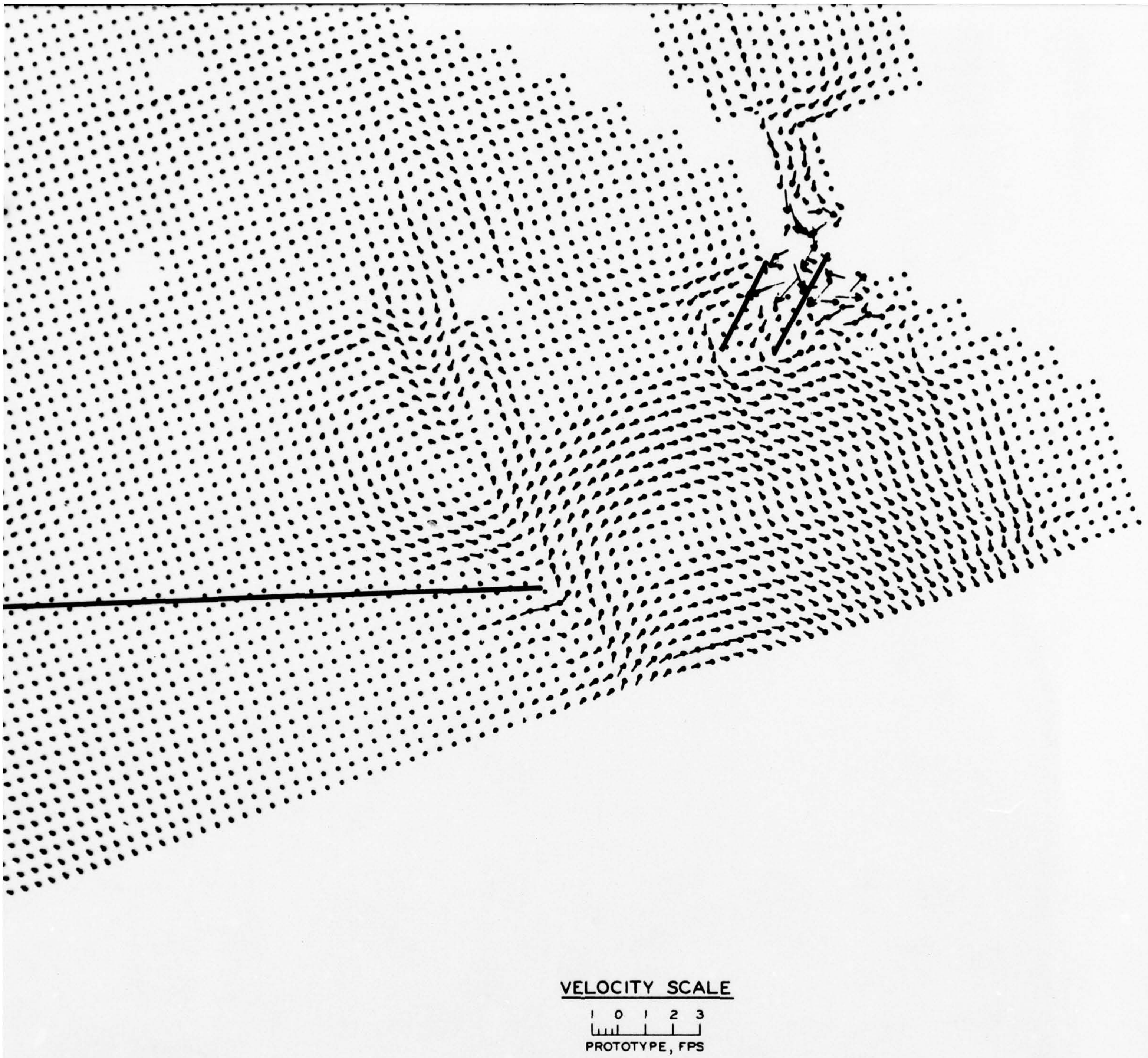
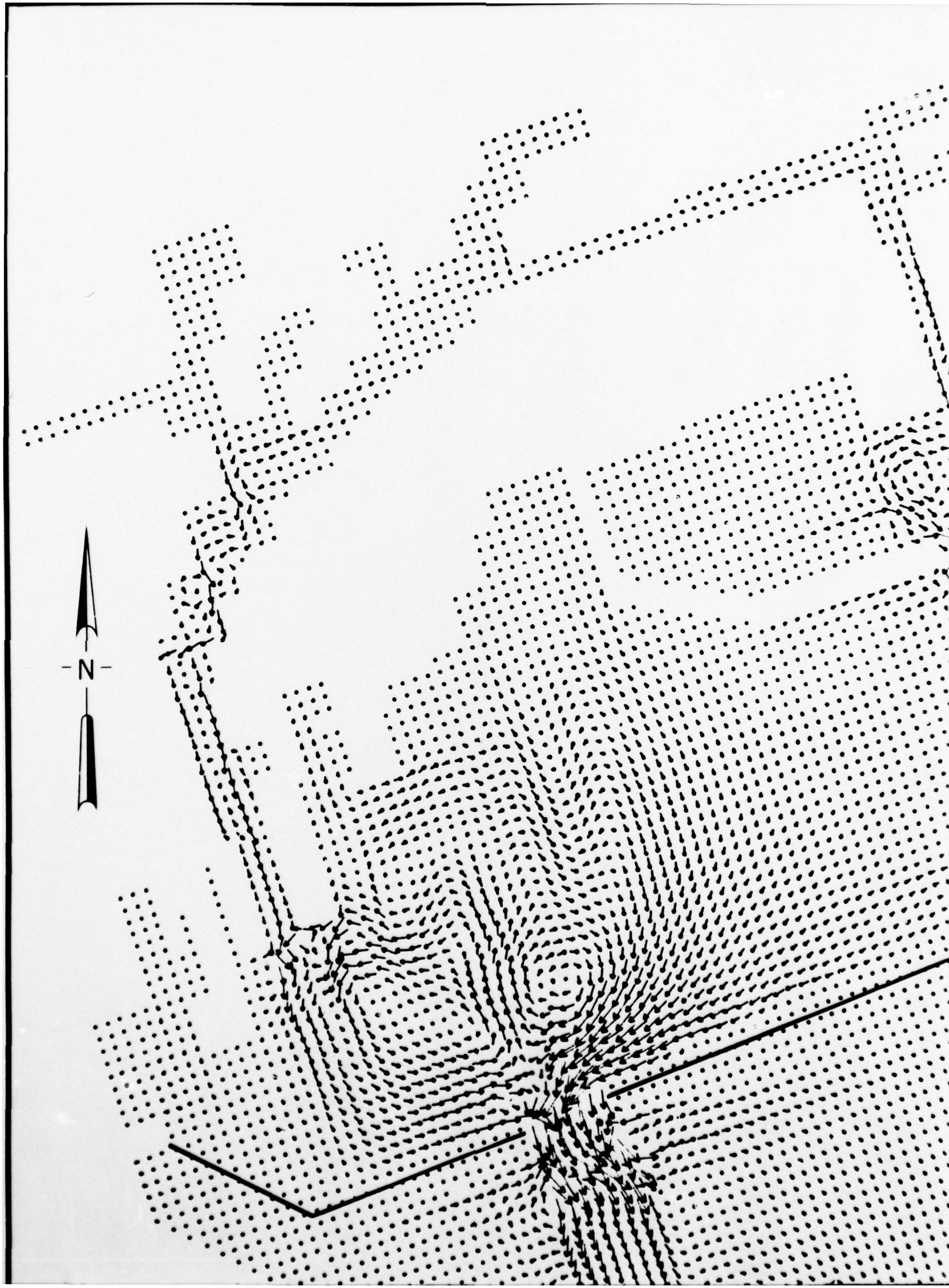


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 3, -62-FT CHANNEL

SPRING TIDE
HOUR 22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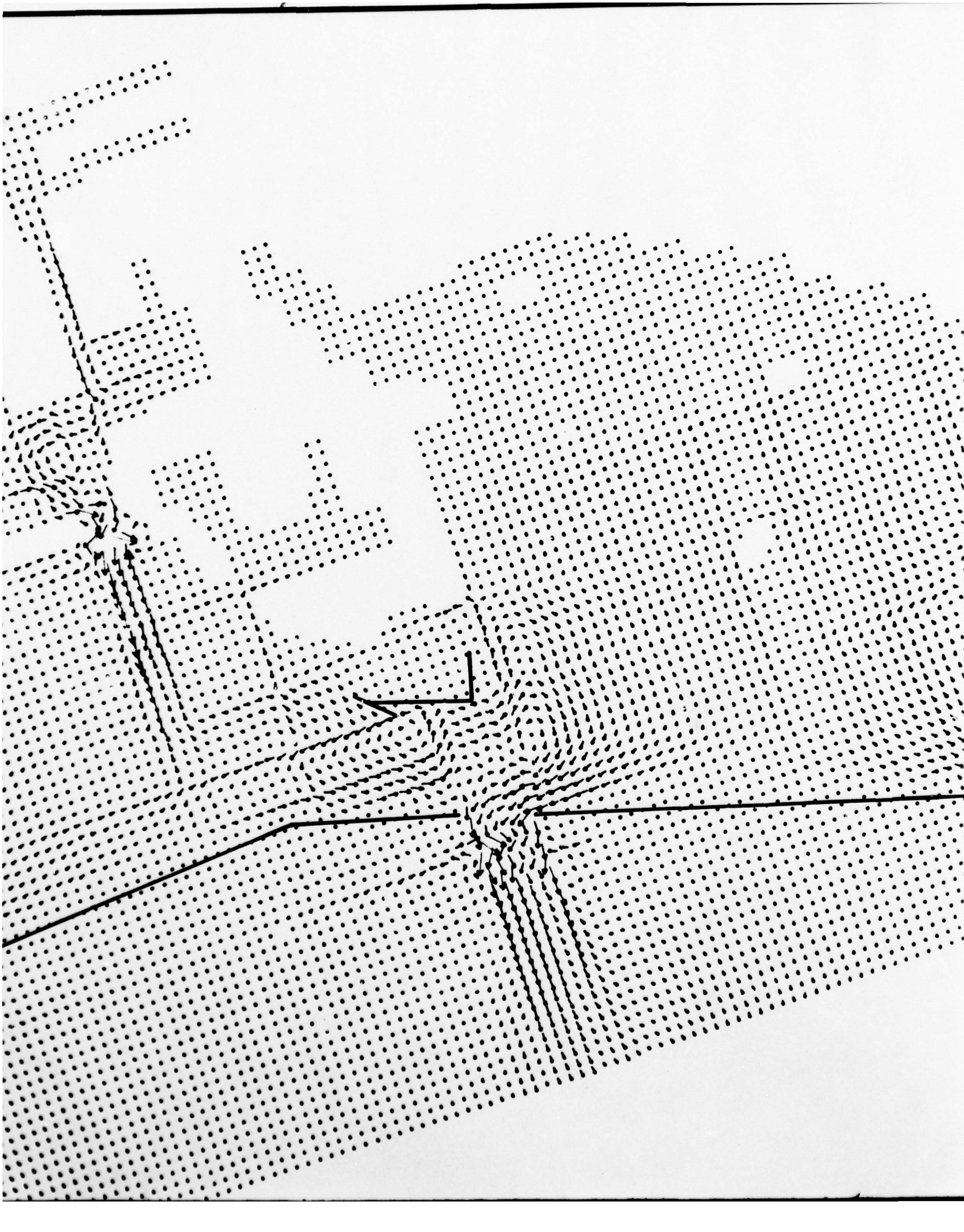

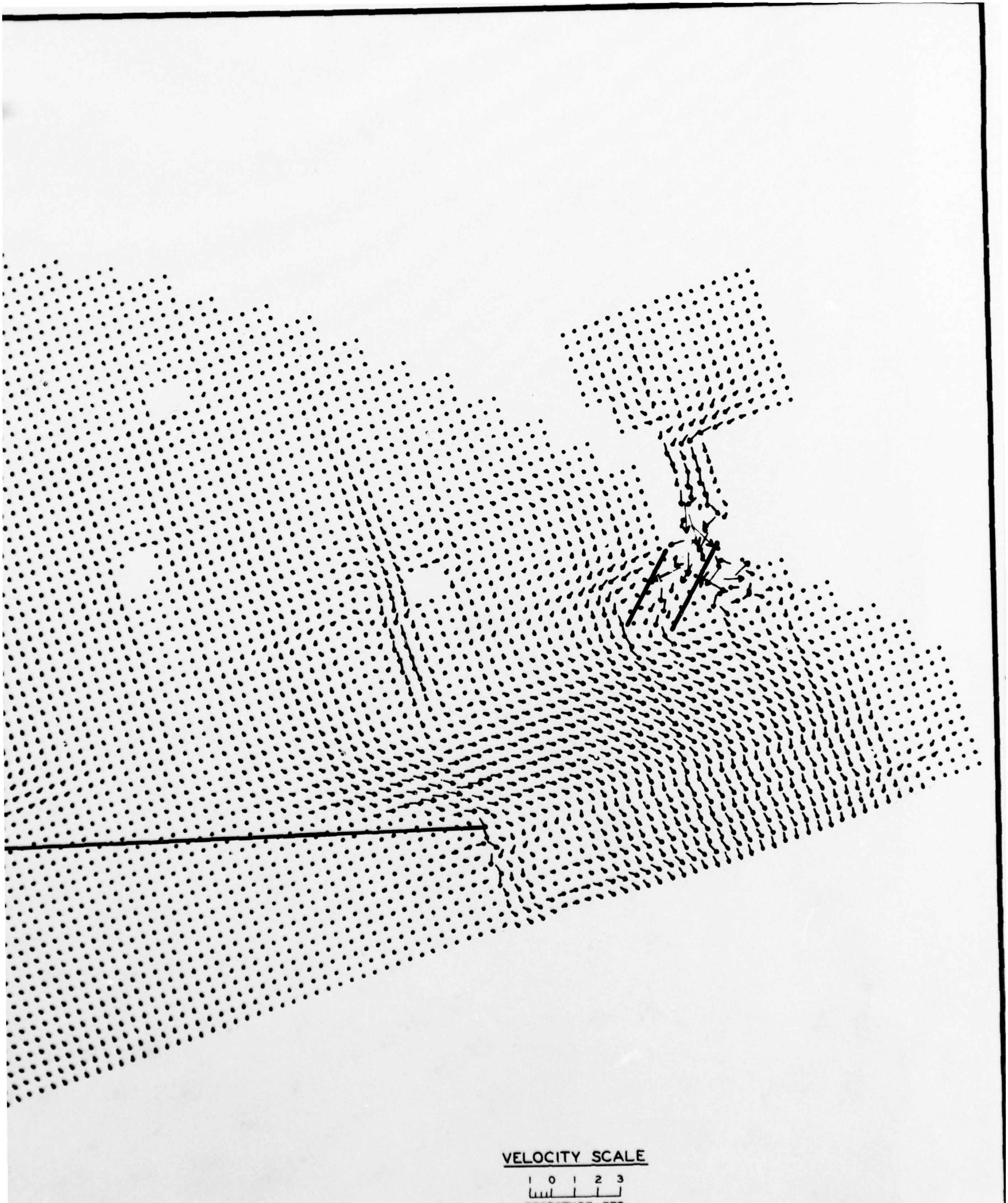
VELOCITY SCALE
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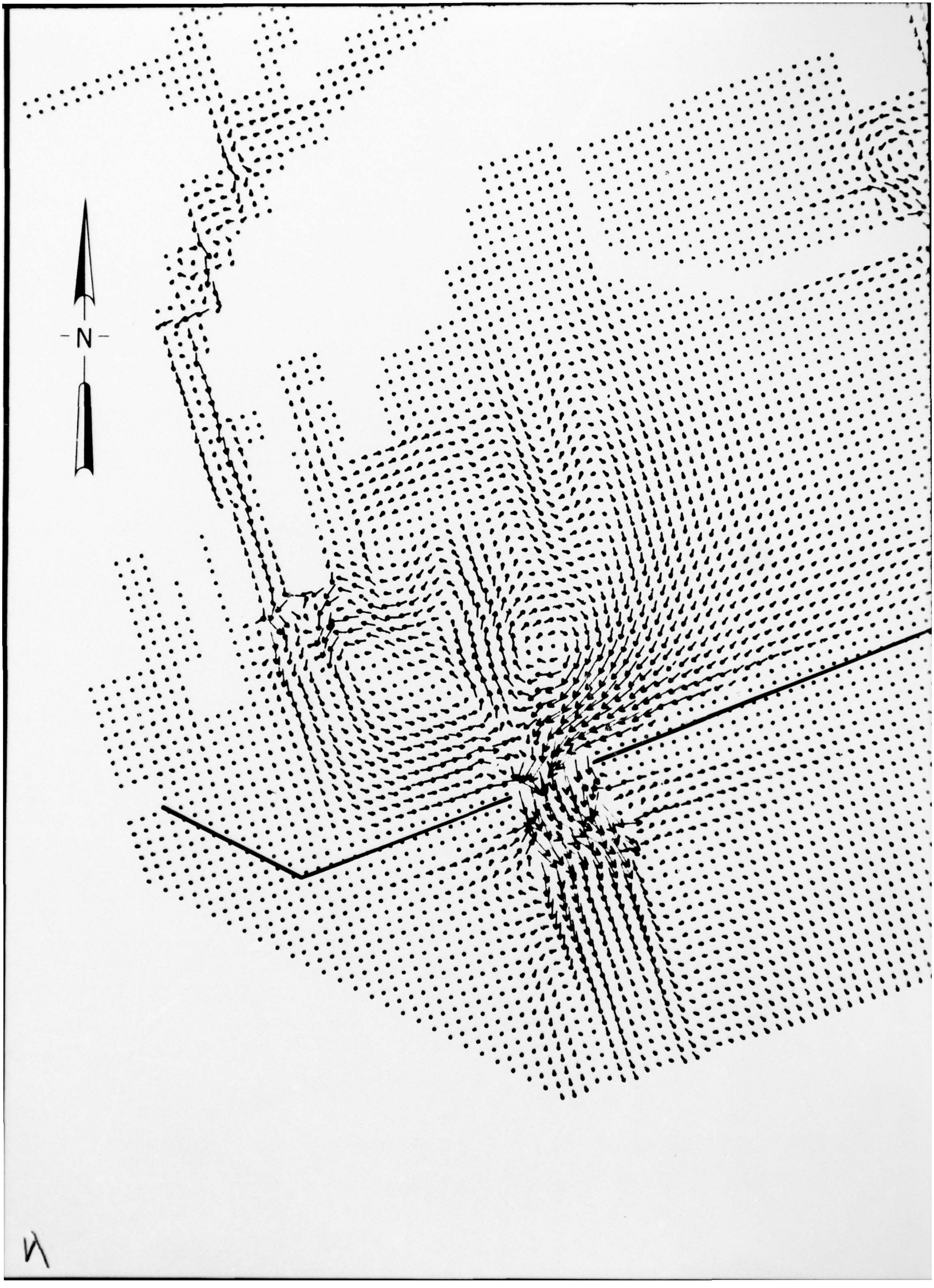
PROTOTYPE, FPS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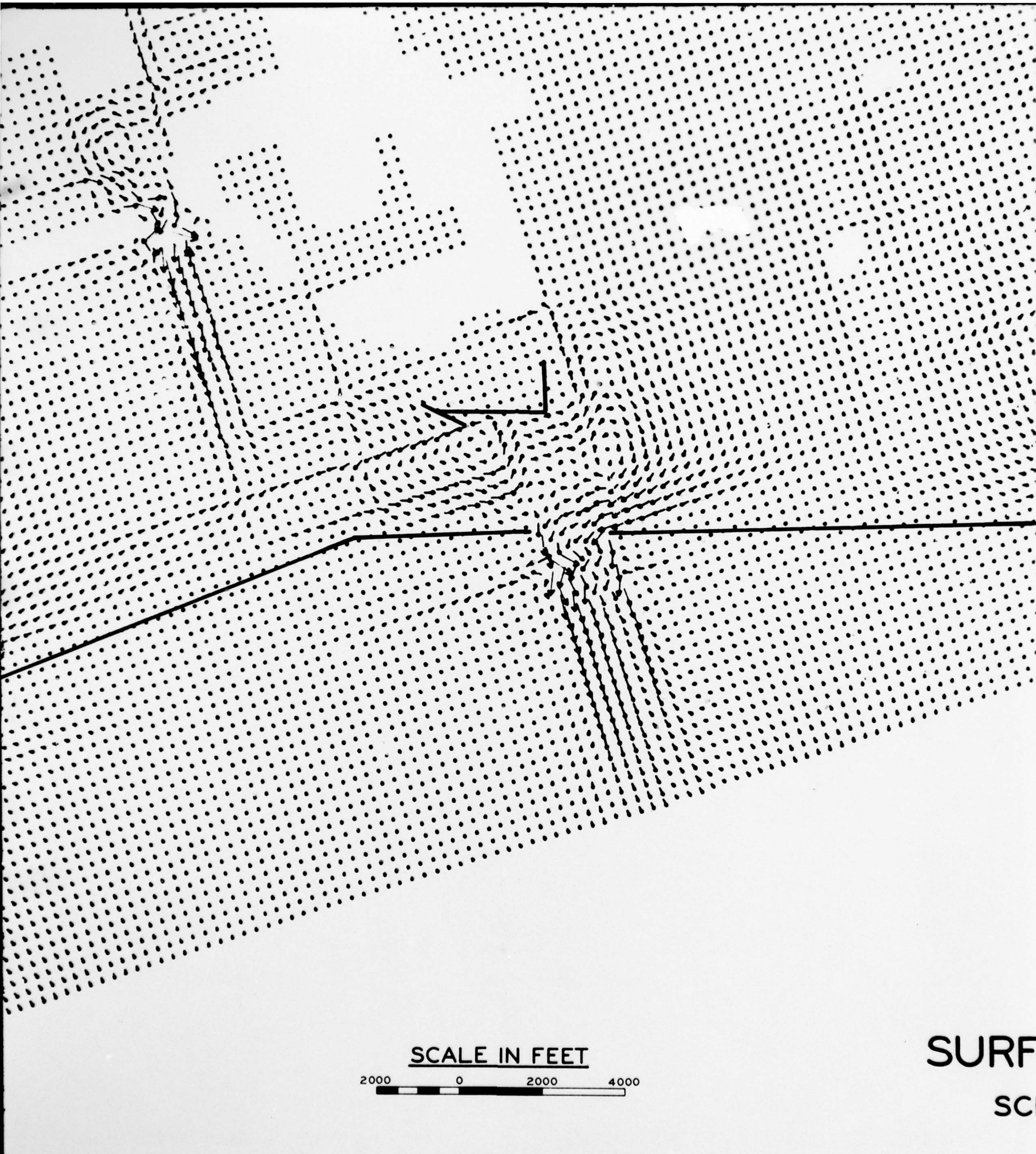

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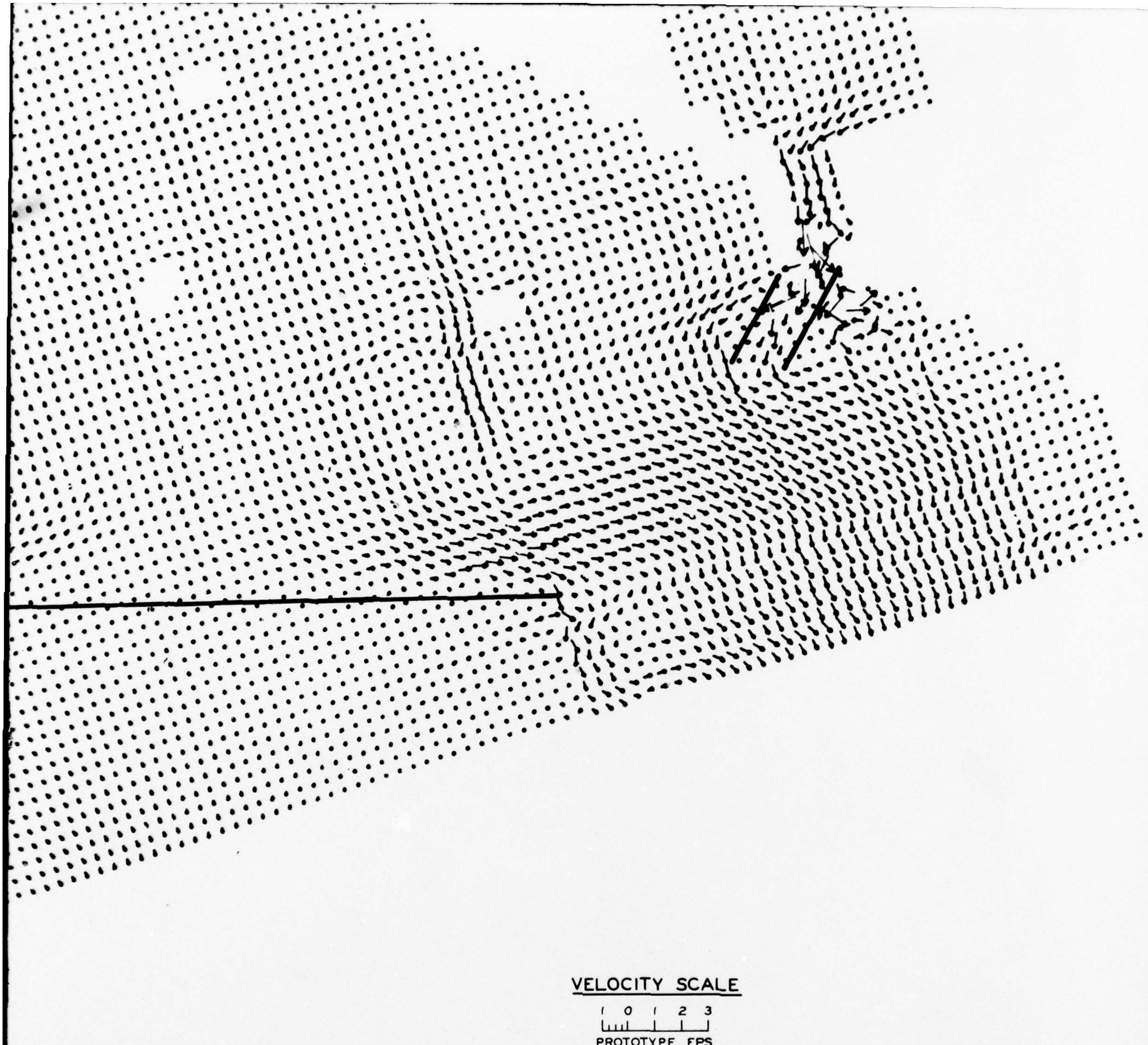
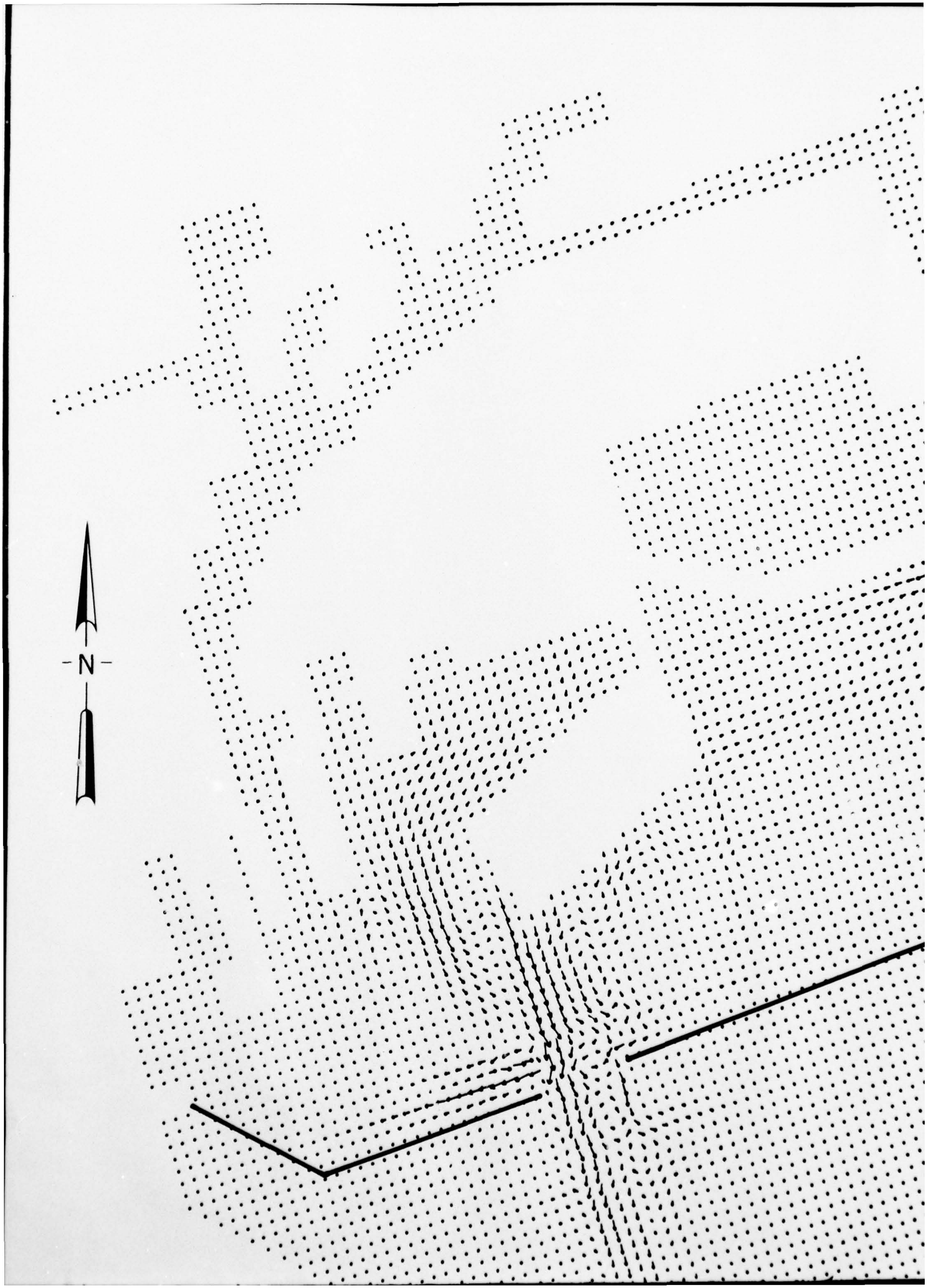


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 3, –62-FT CHANNEL

SPRING TIDE
HOUR 24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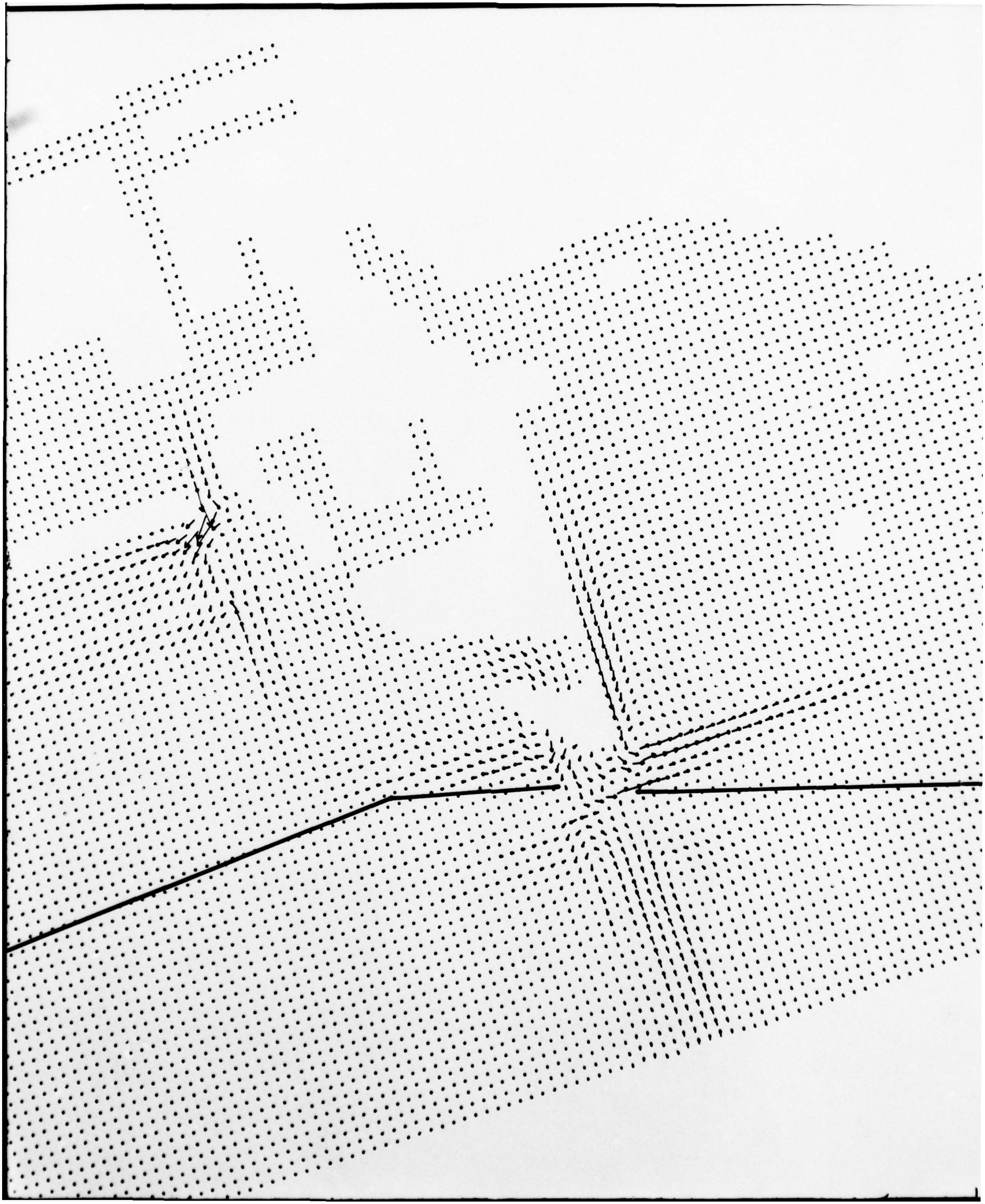
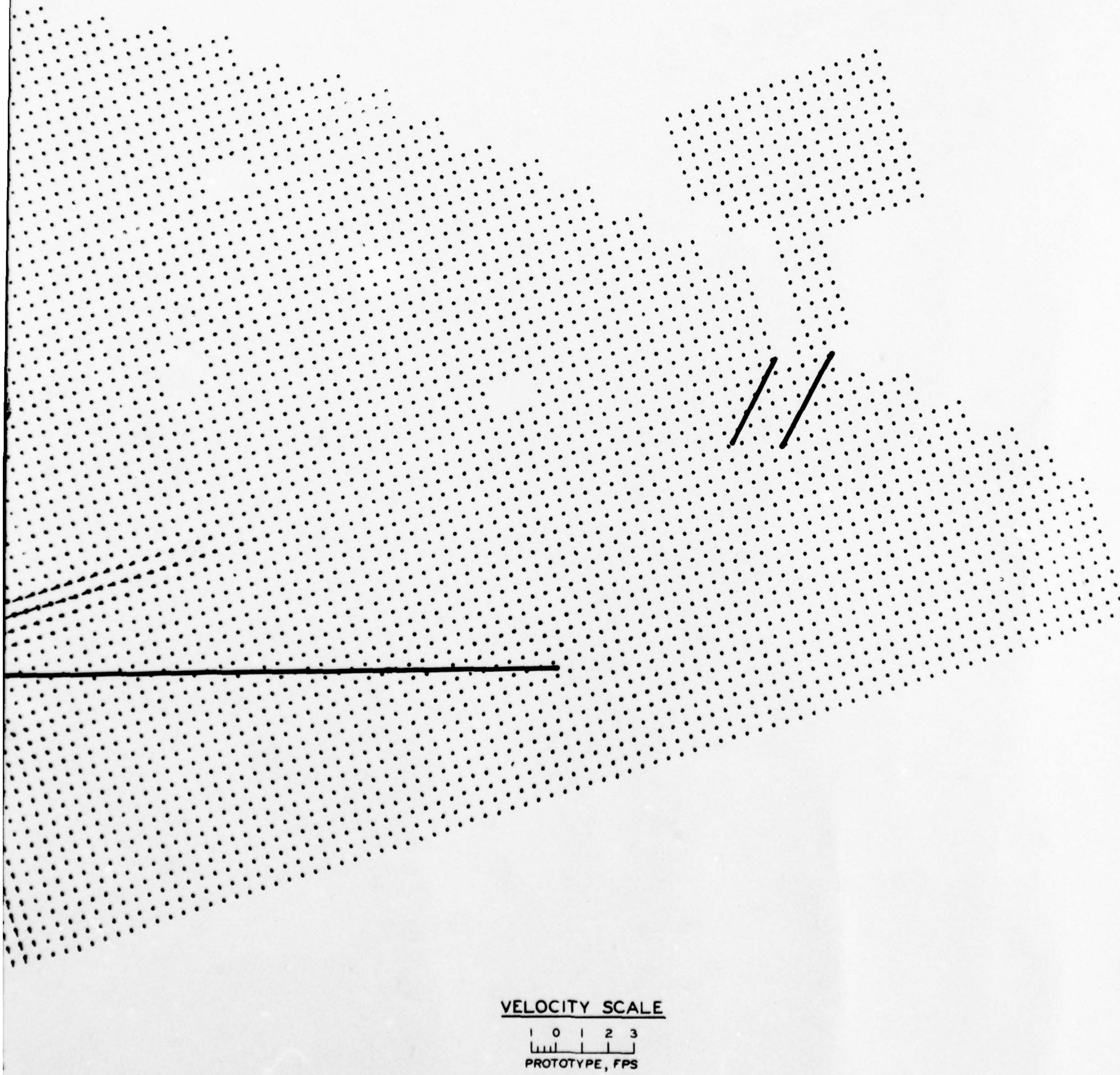
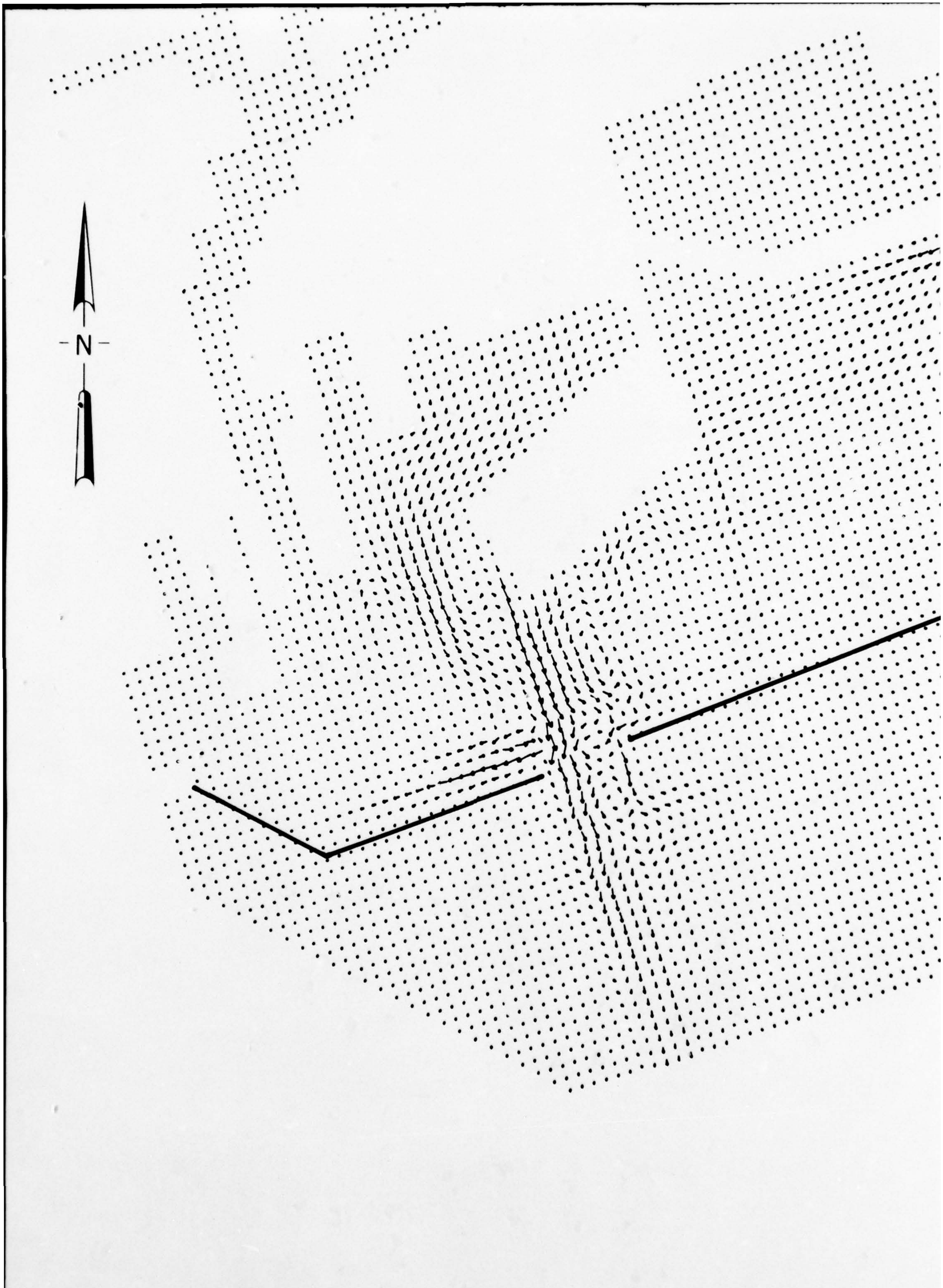




NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS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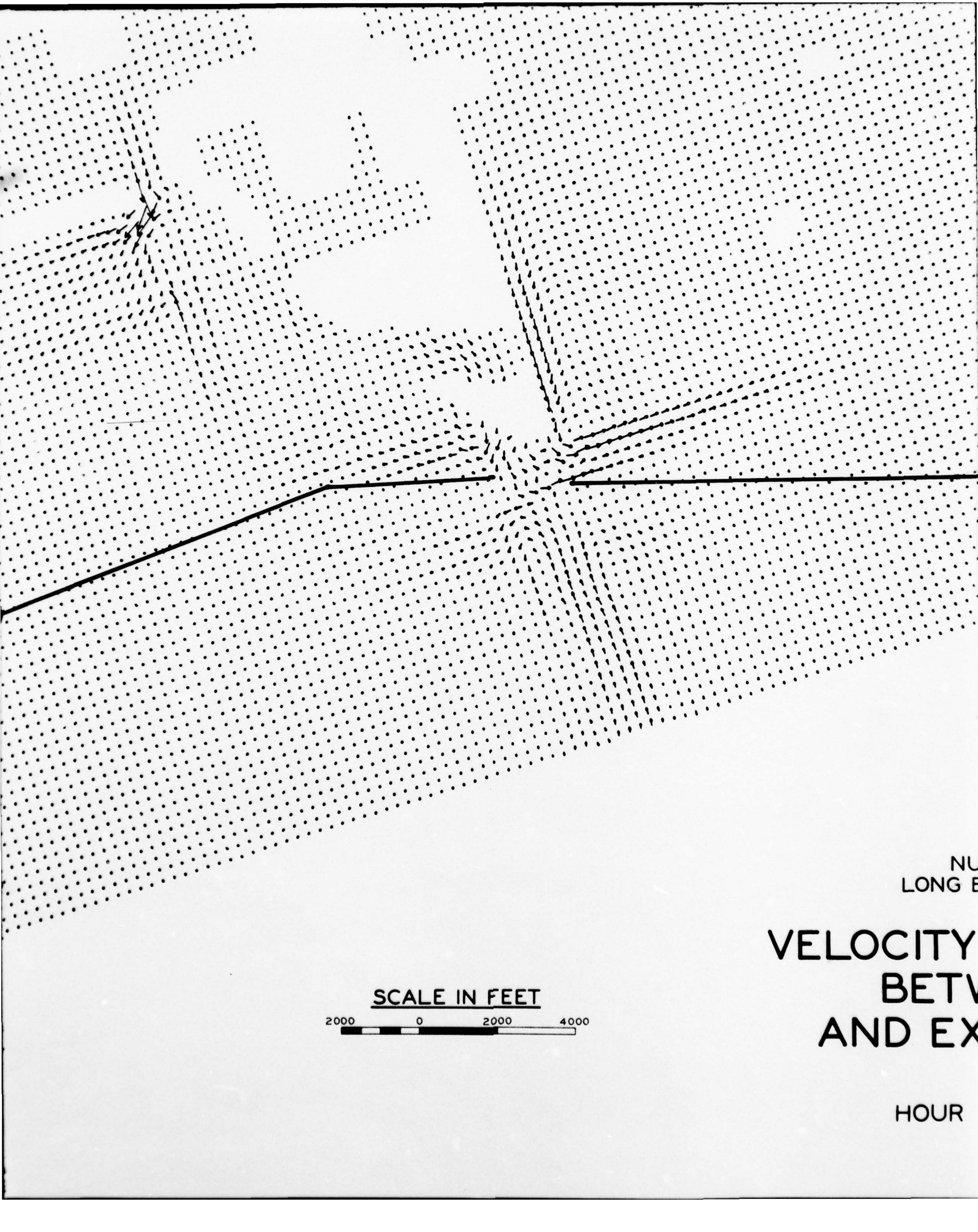

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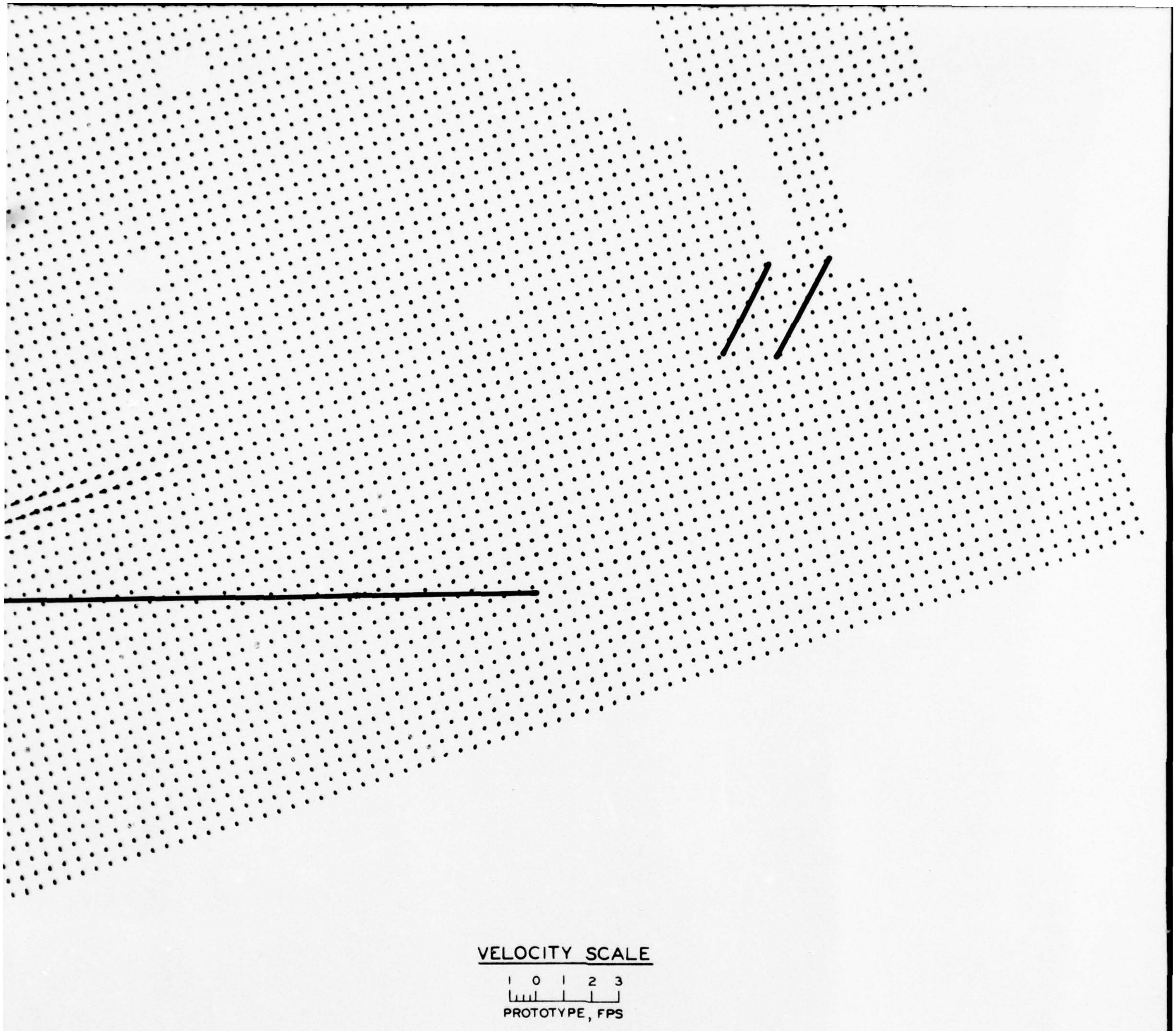
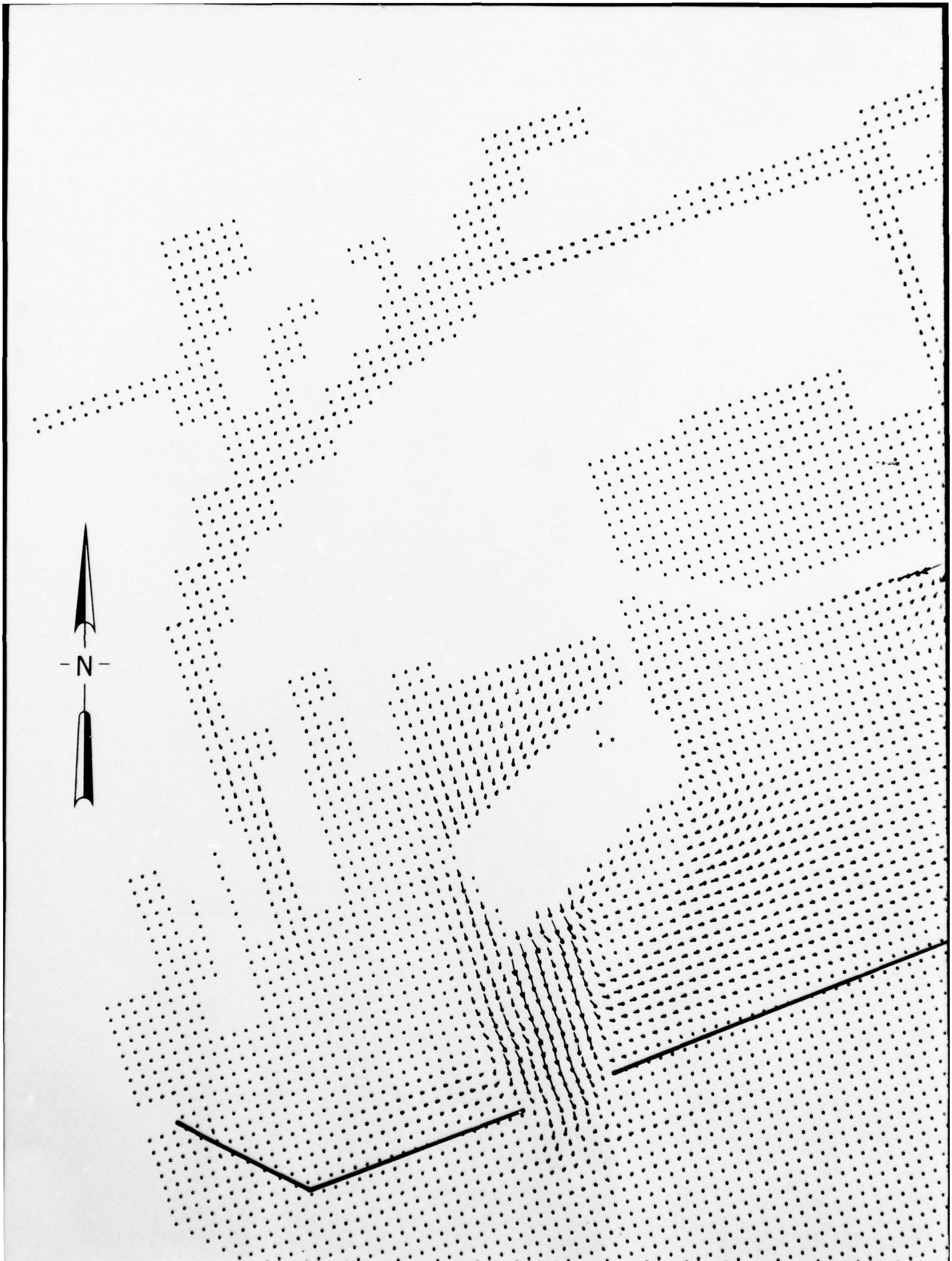


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)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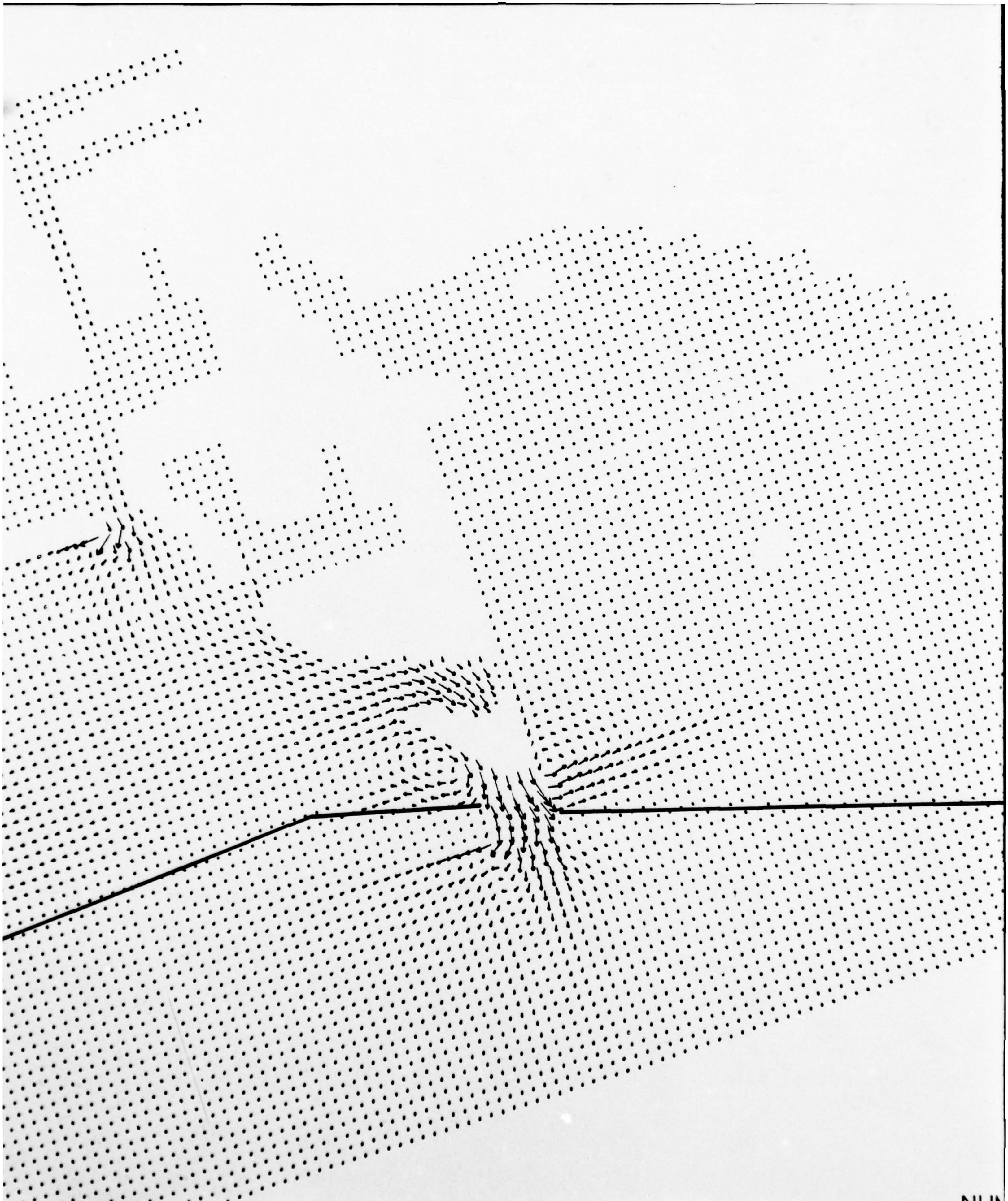
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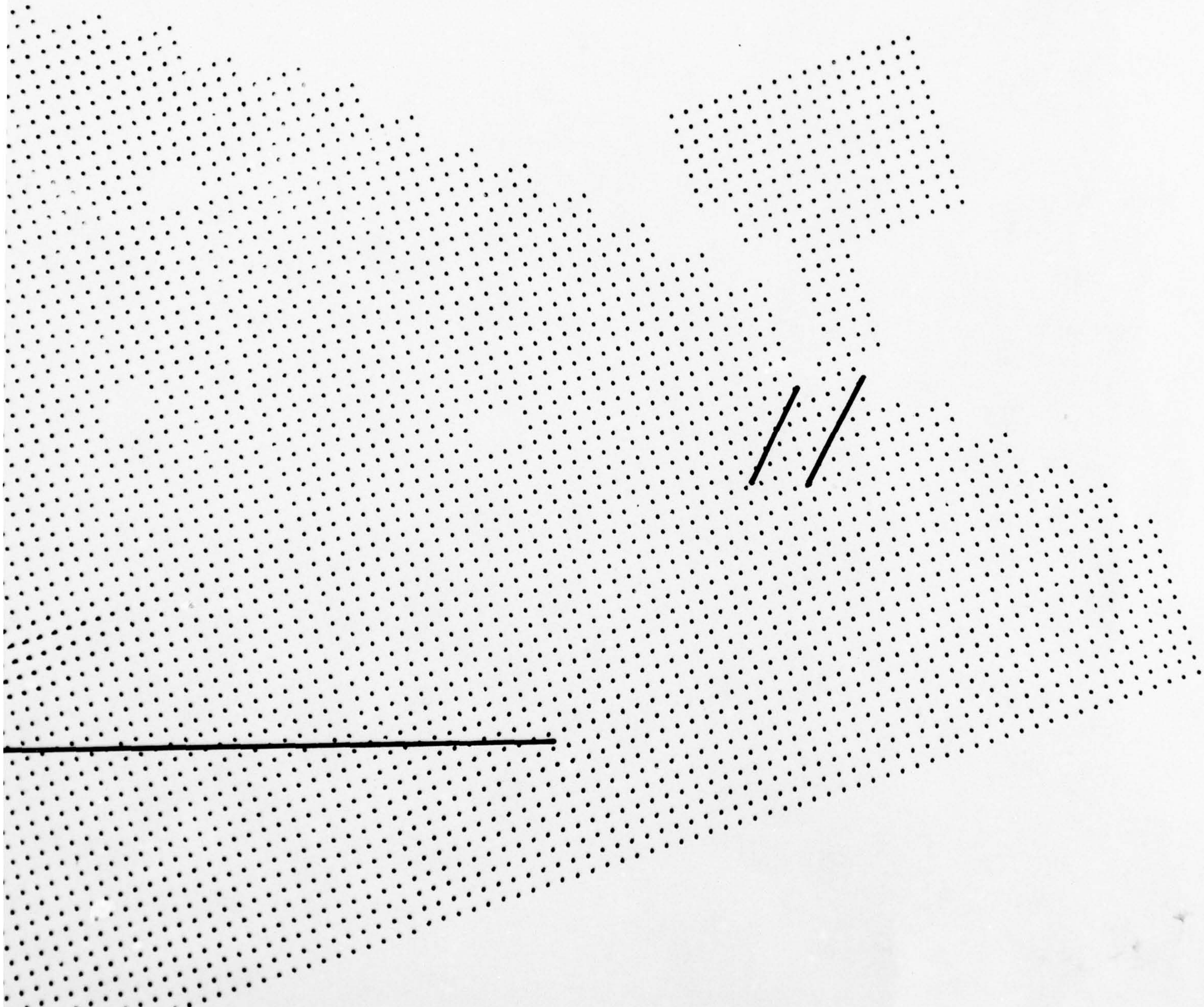

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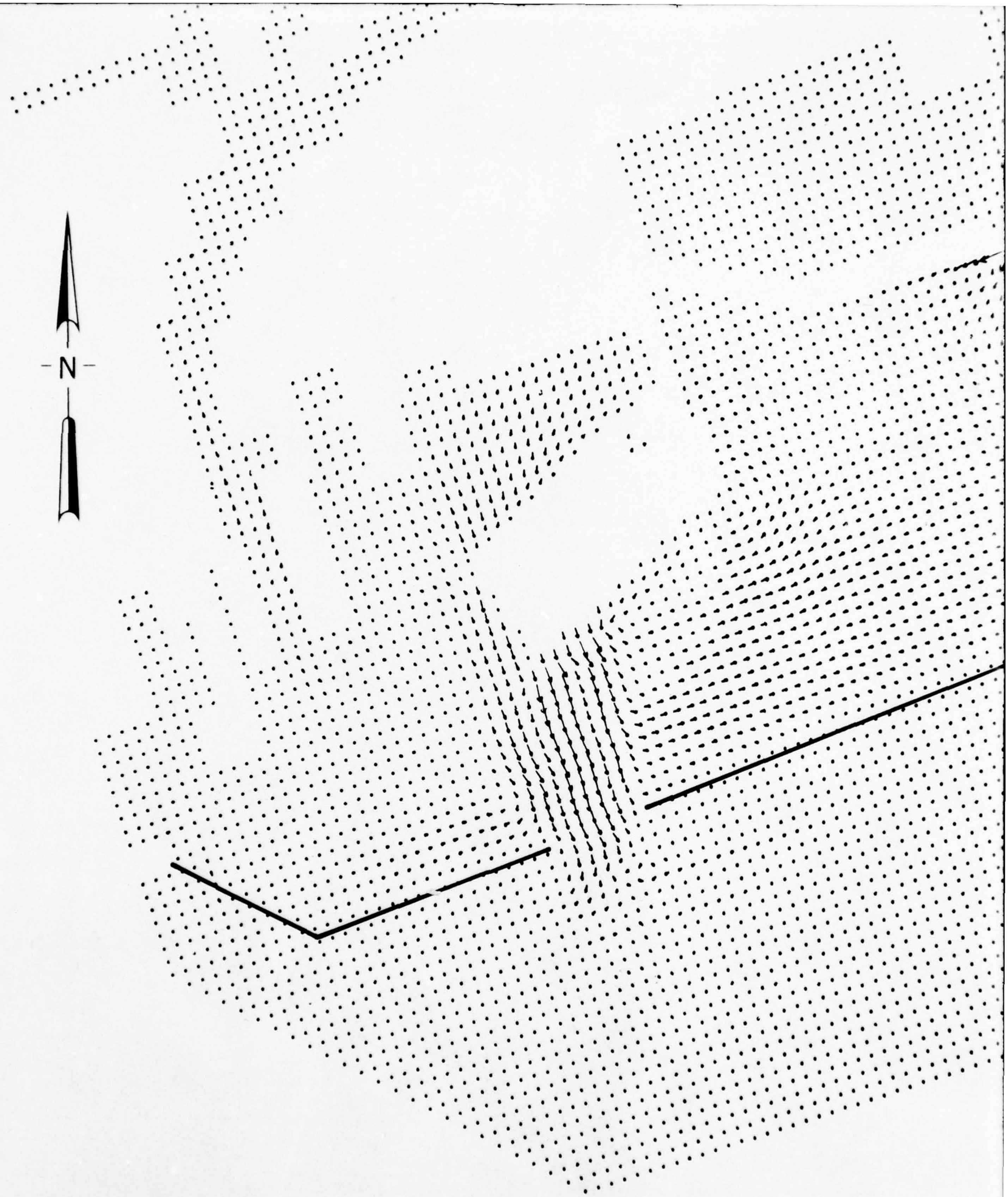

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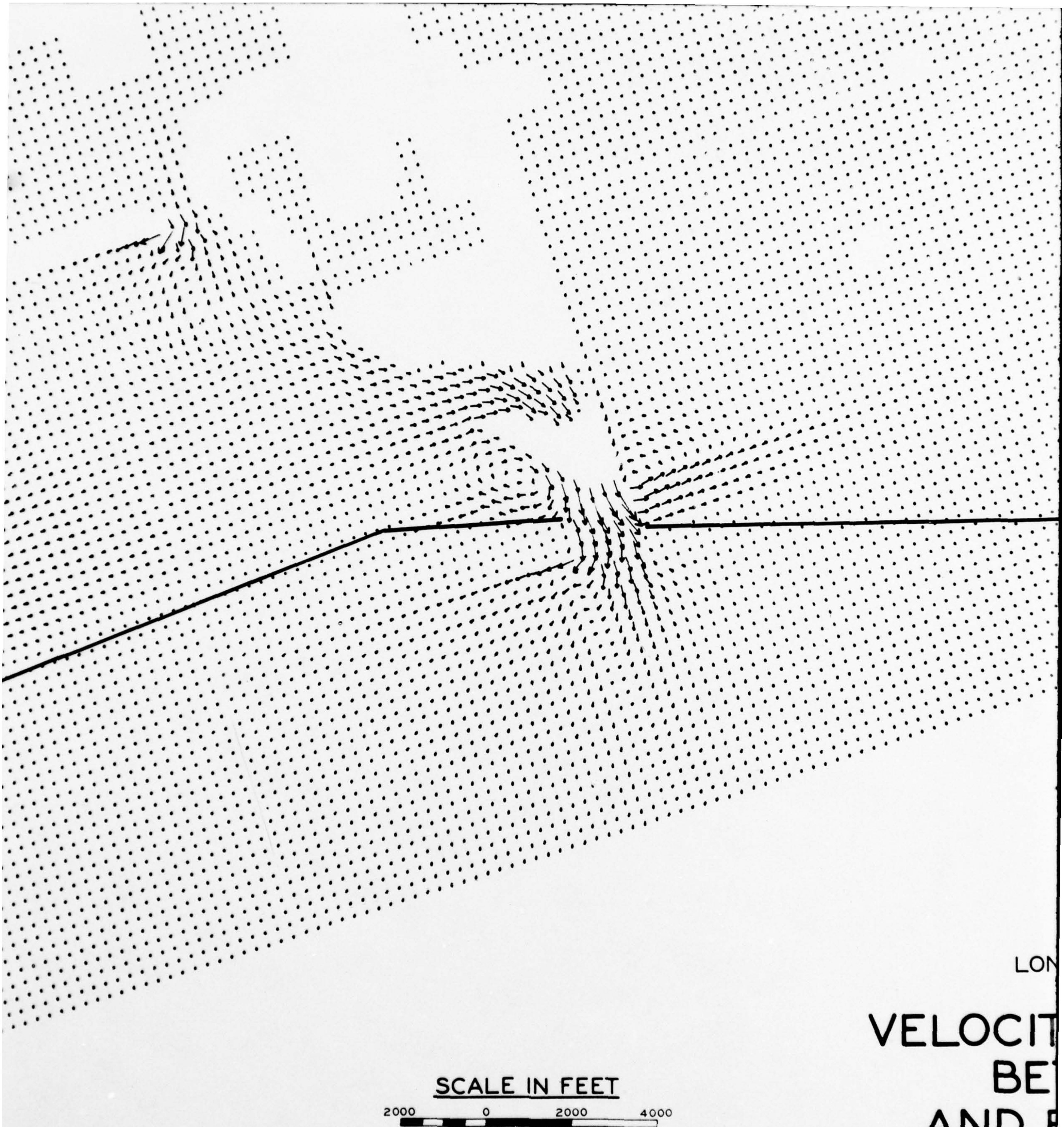

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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)

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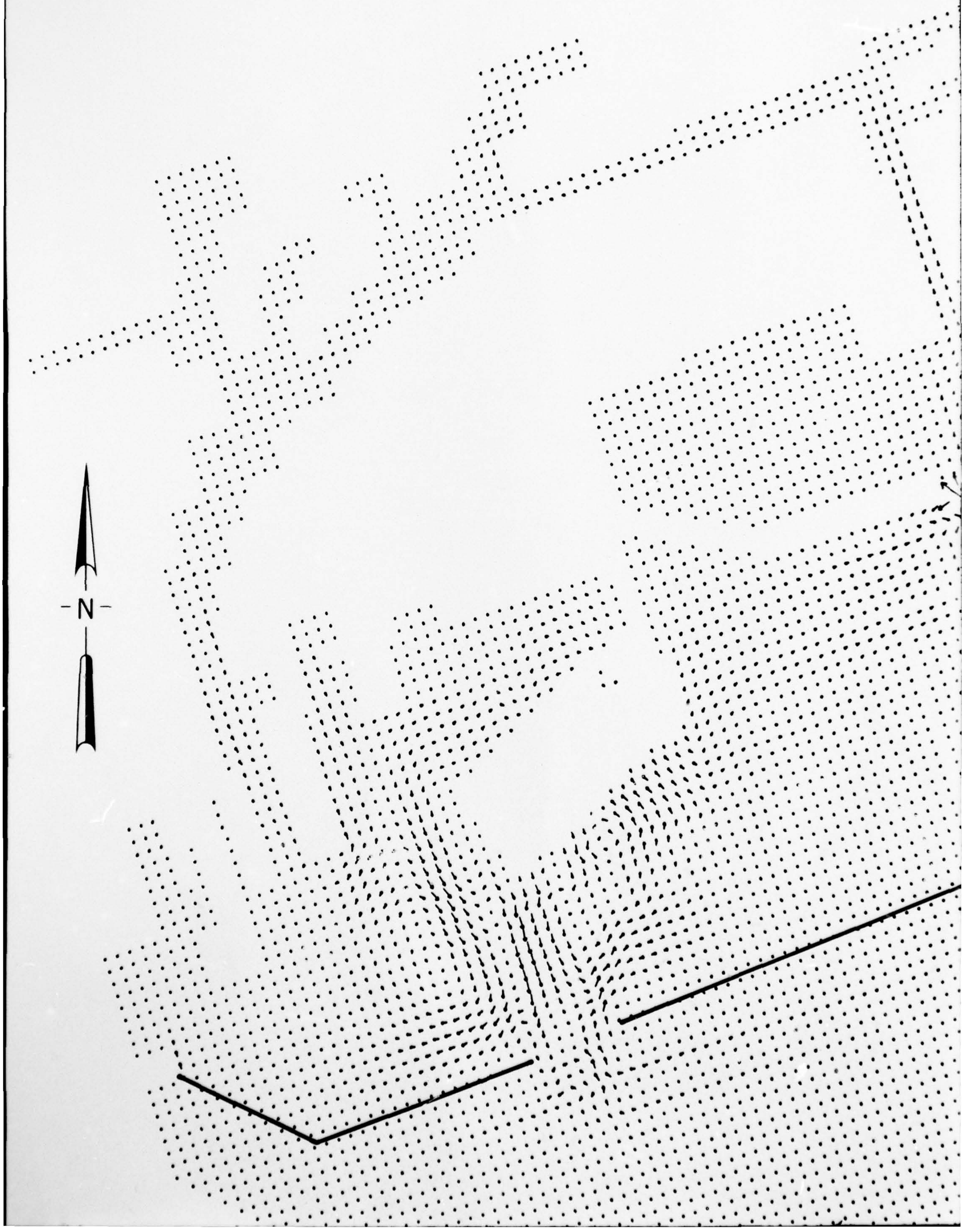
FIGURE 22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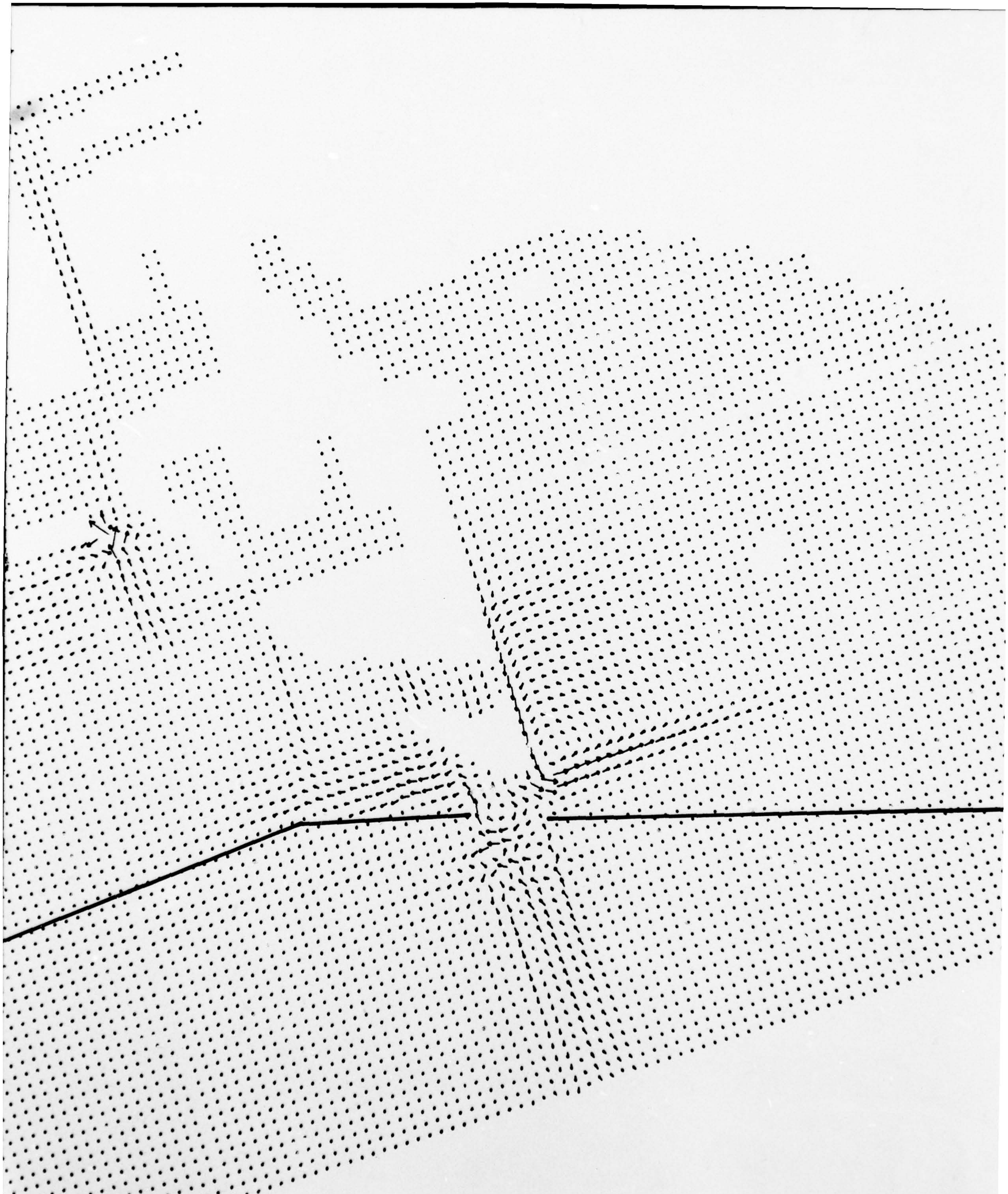

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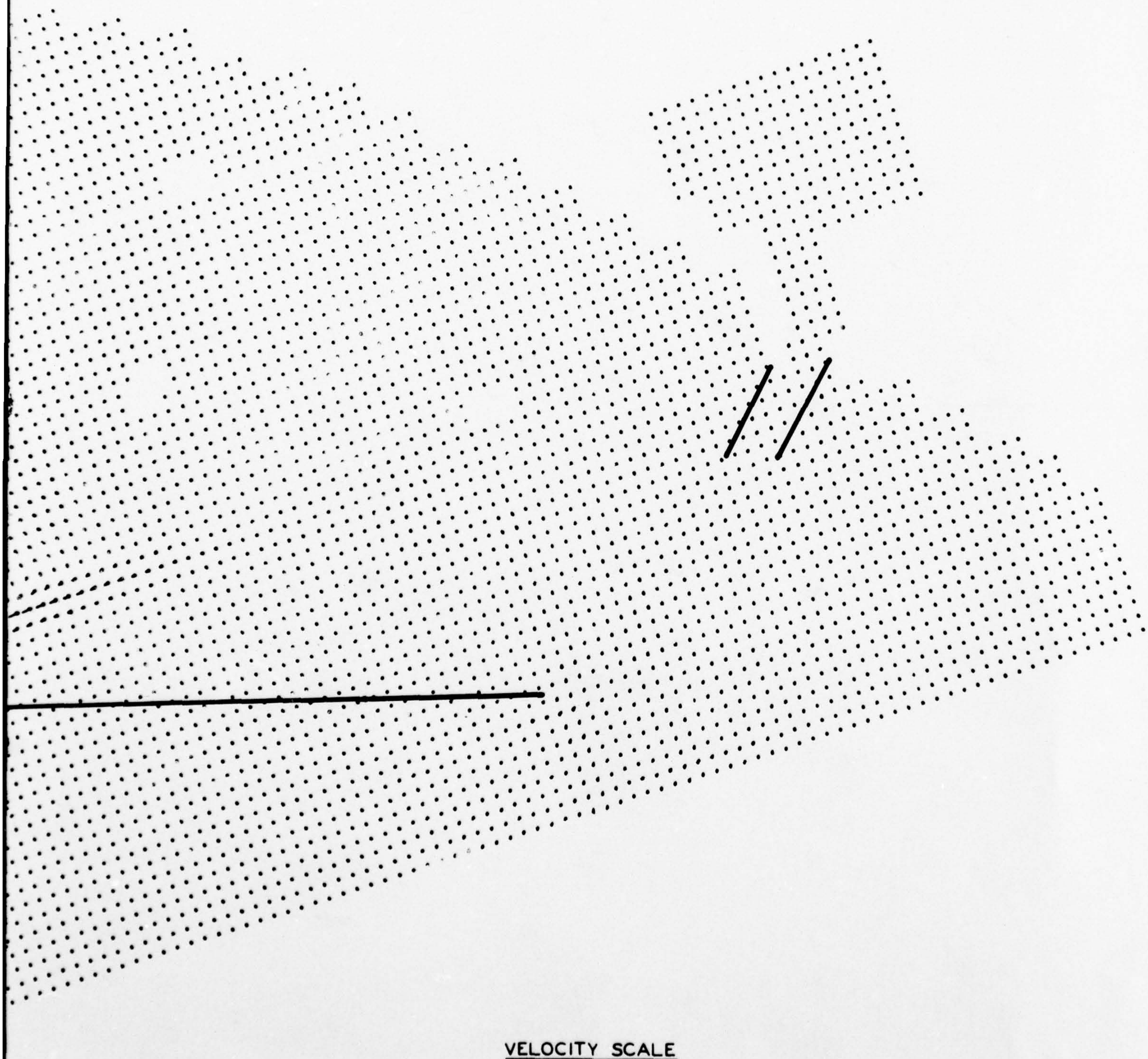

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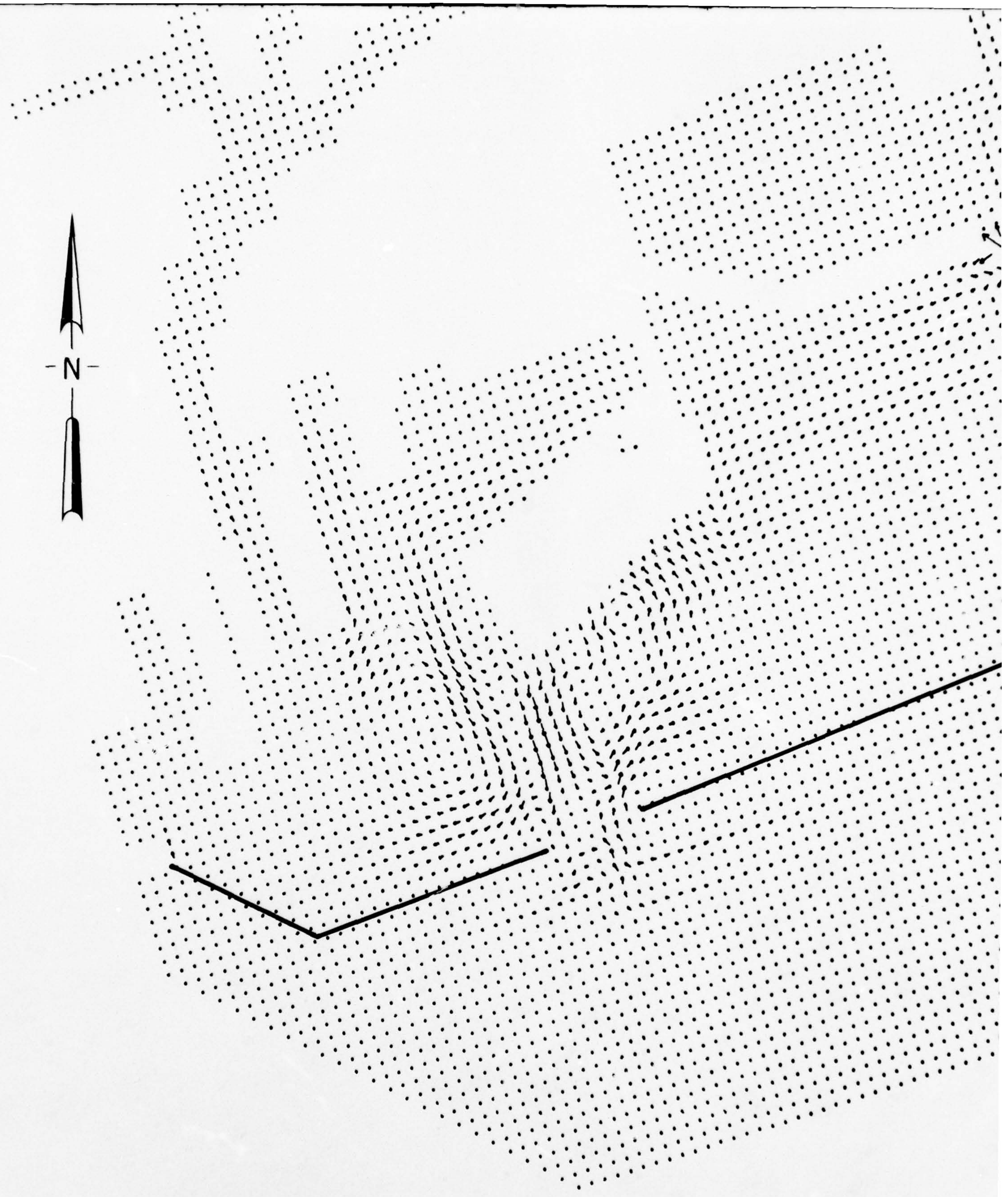

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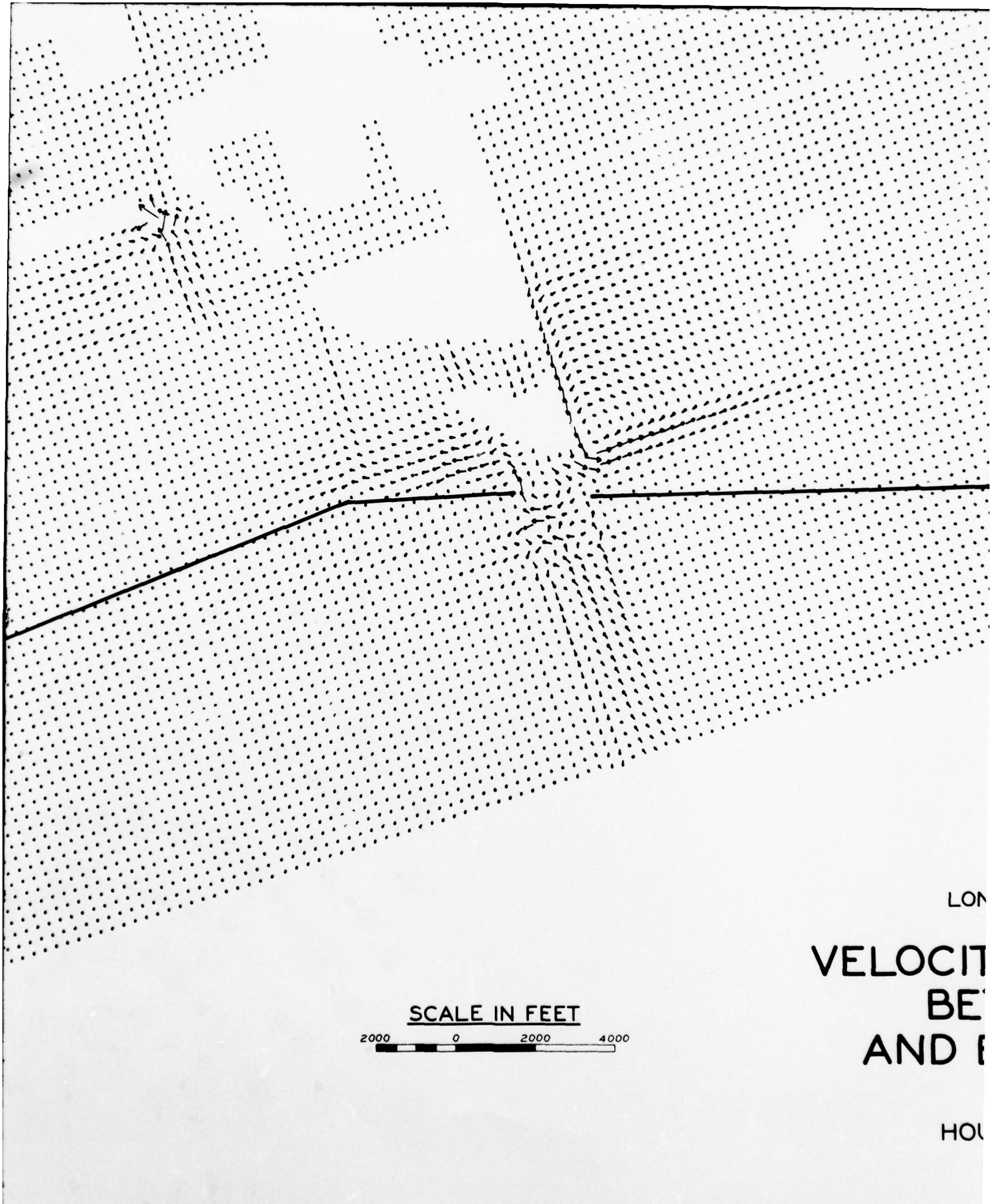

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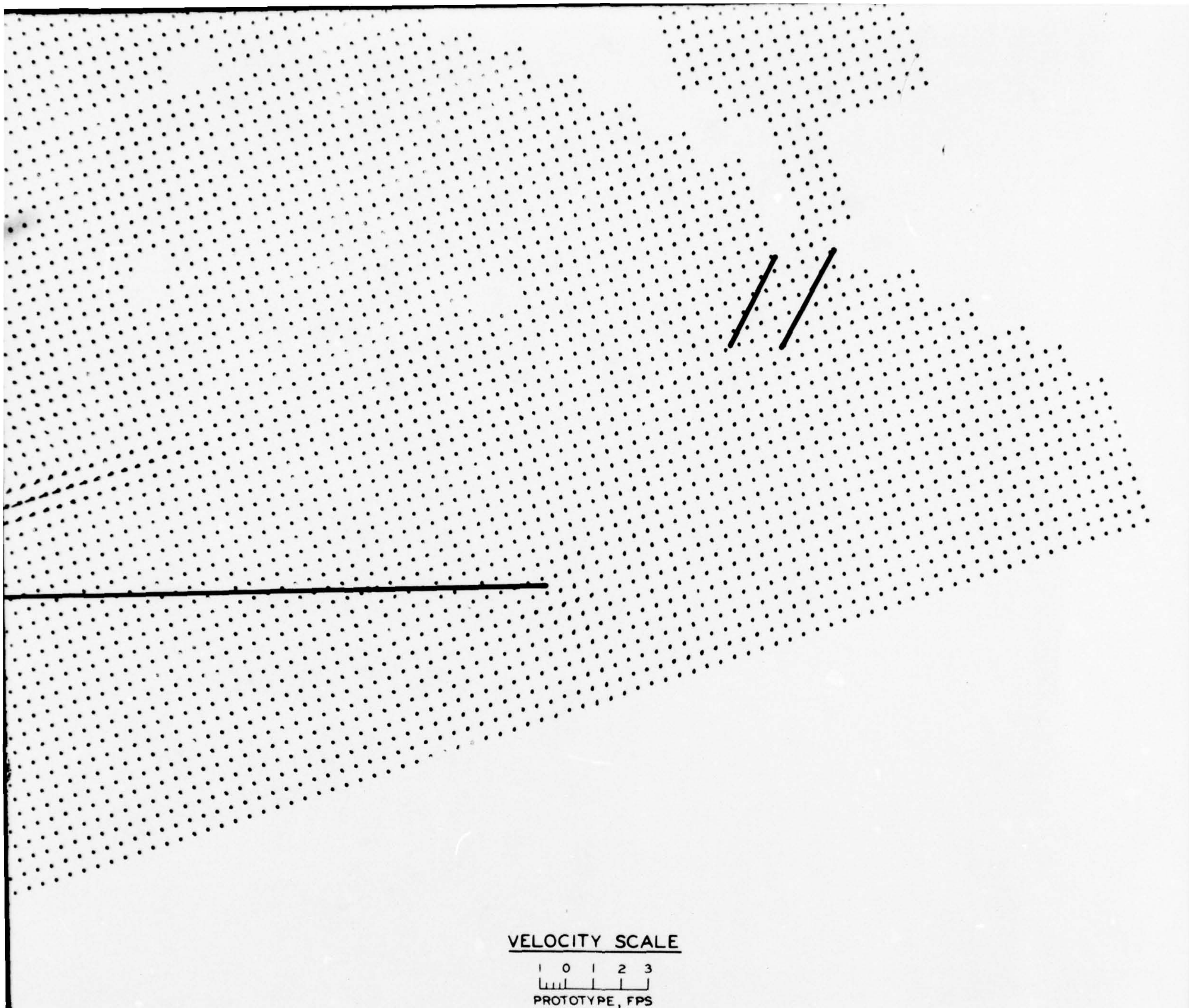
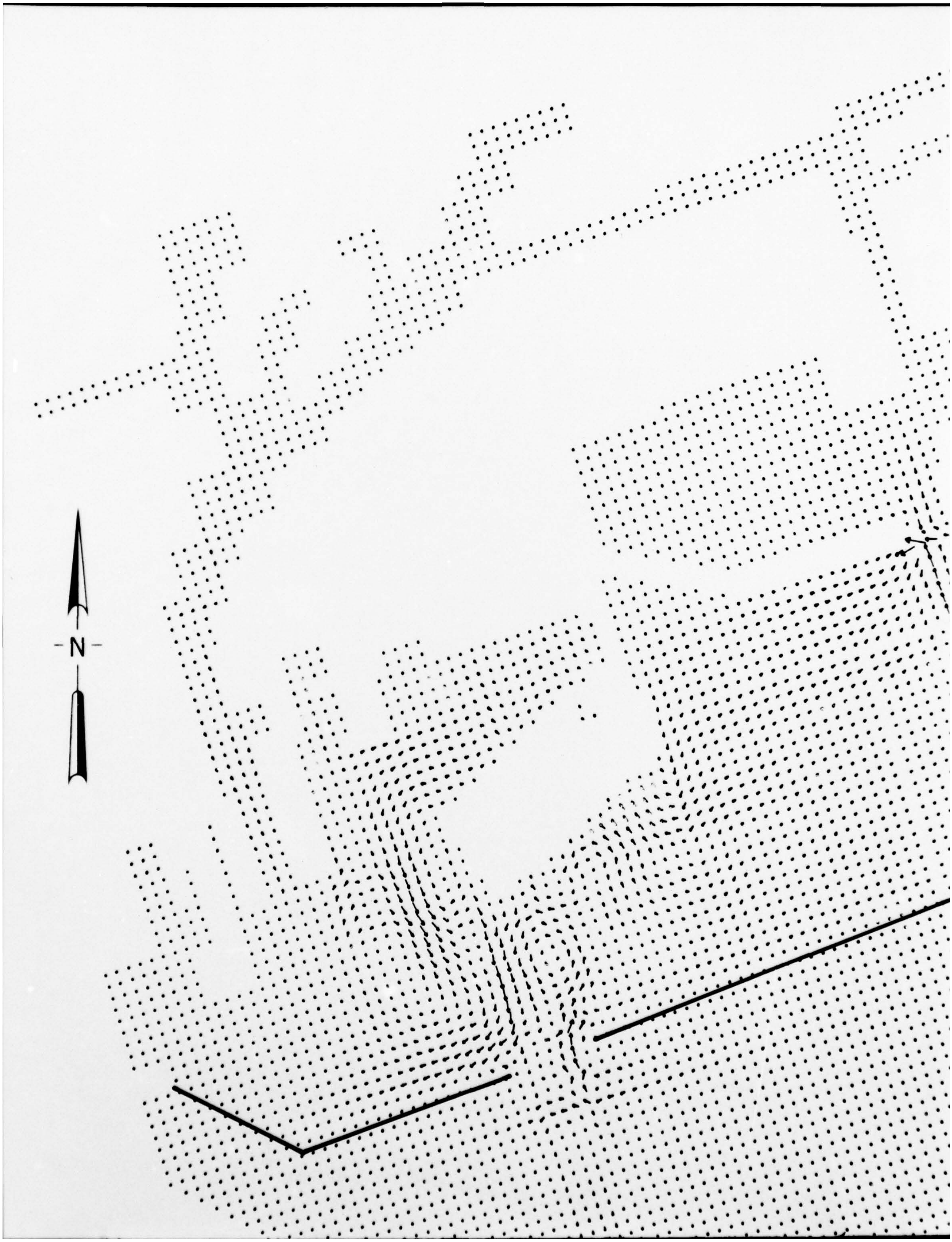


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A–2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)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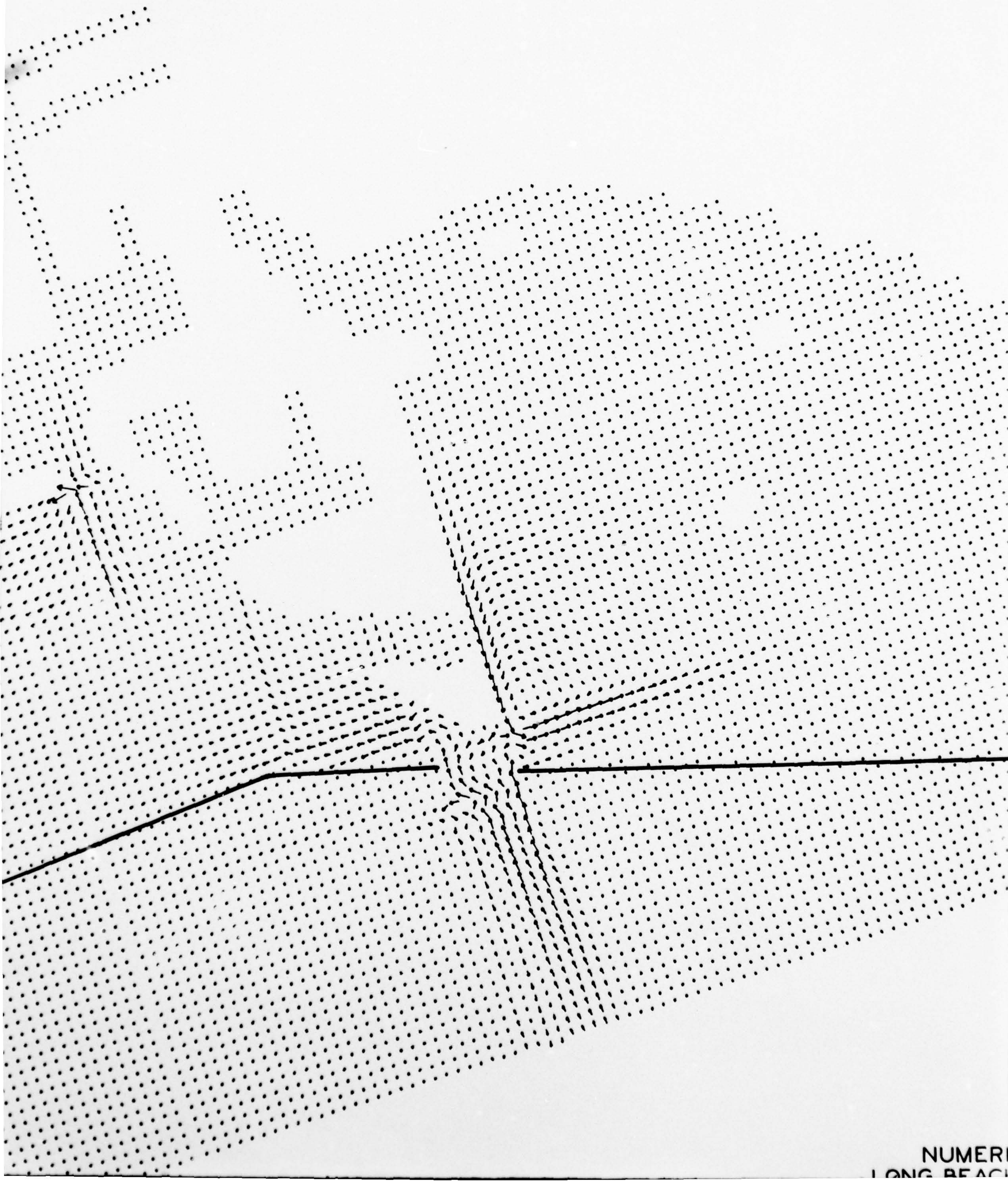

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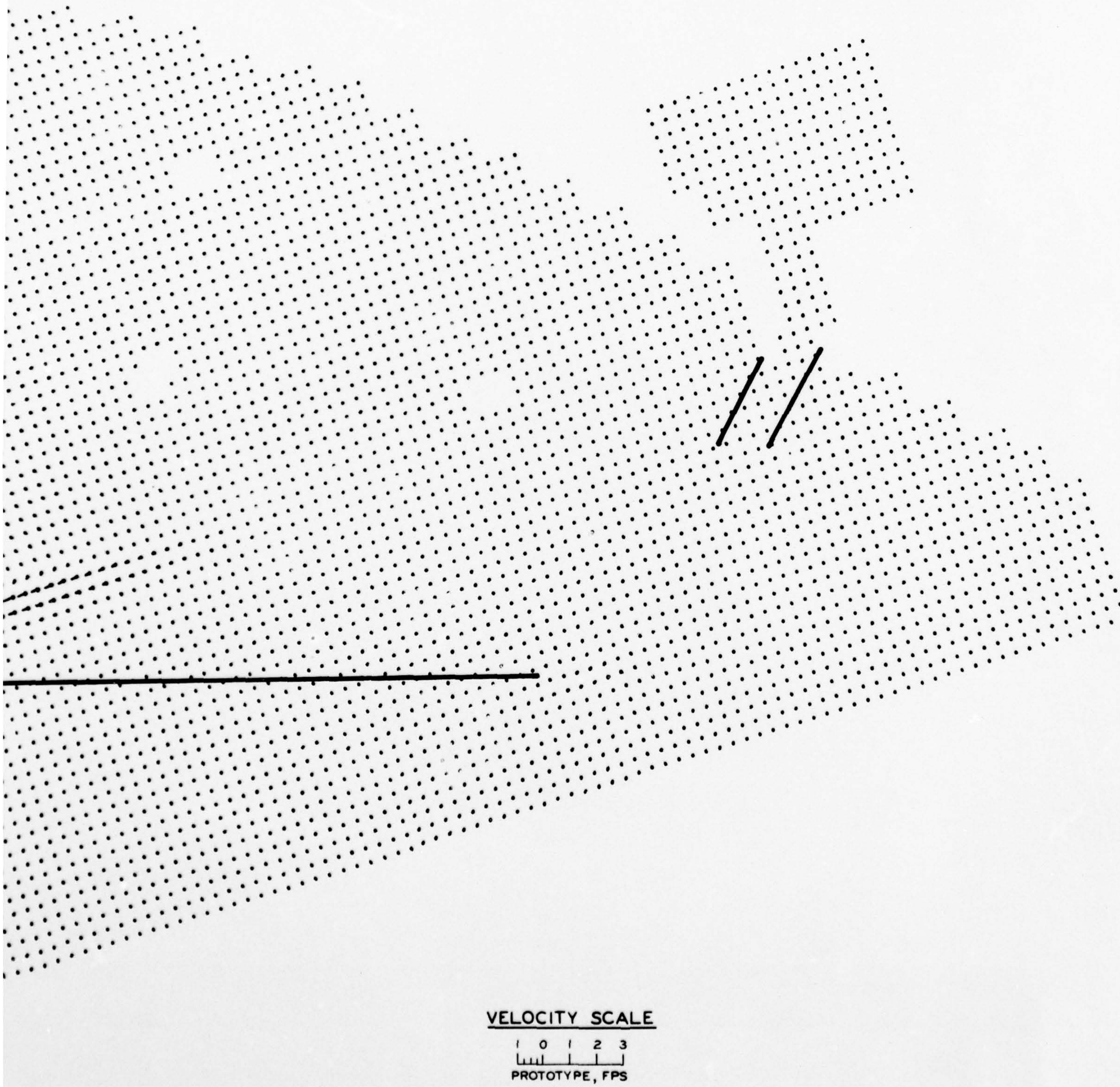
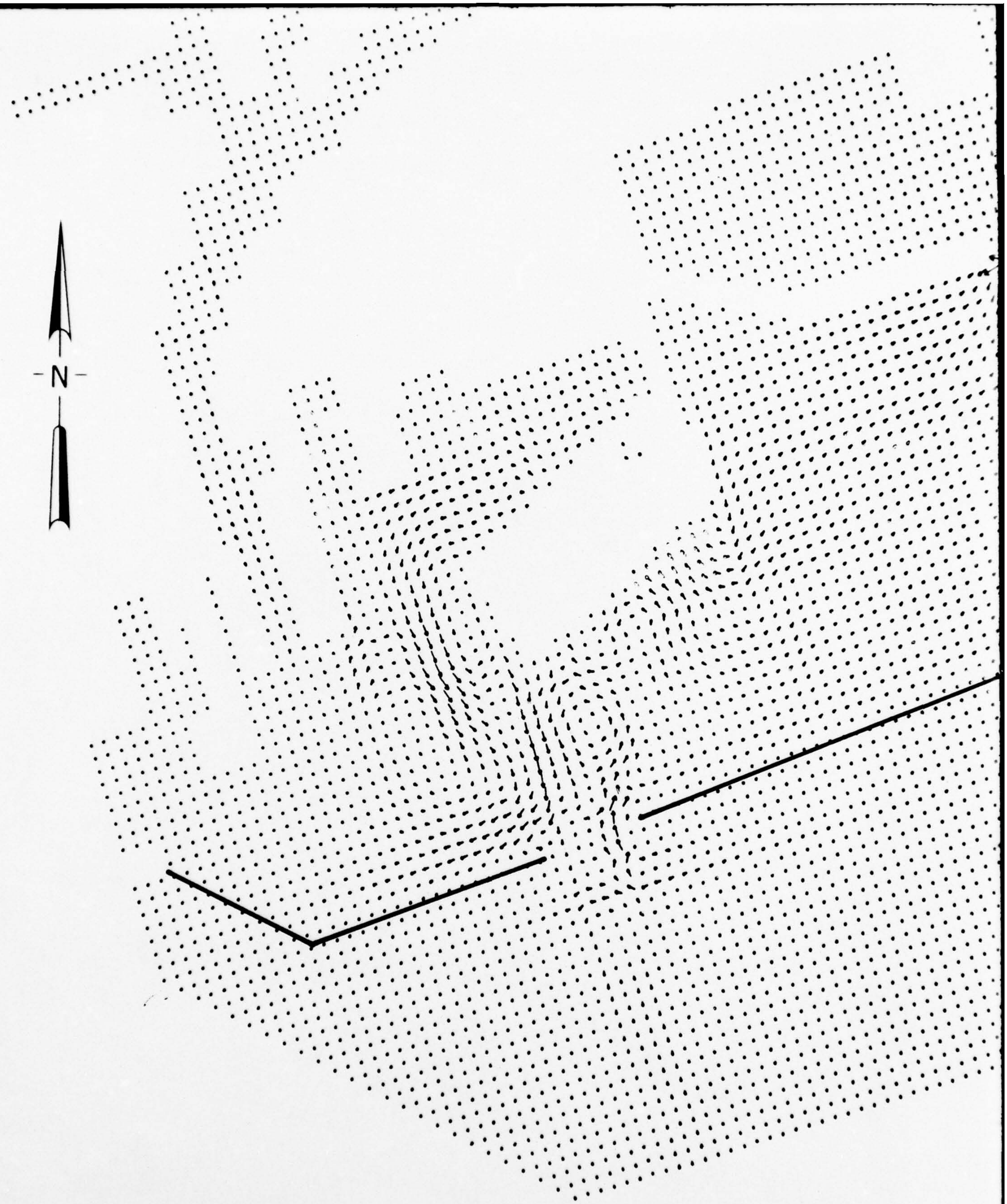


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS



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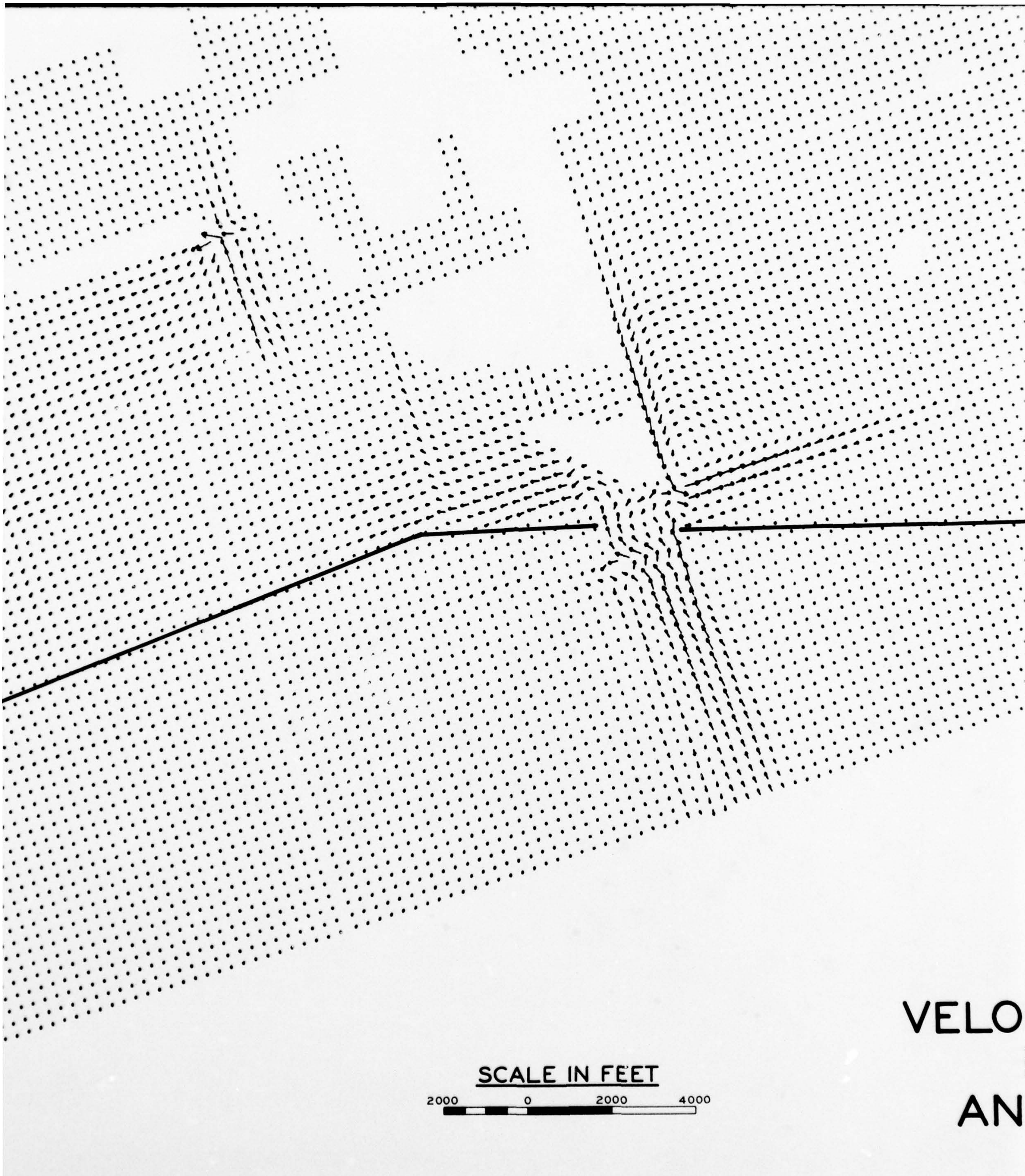

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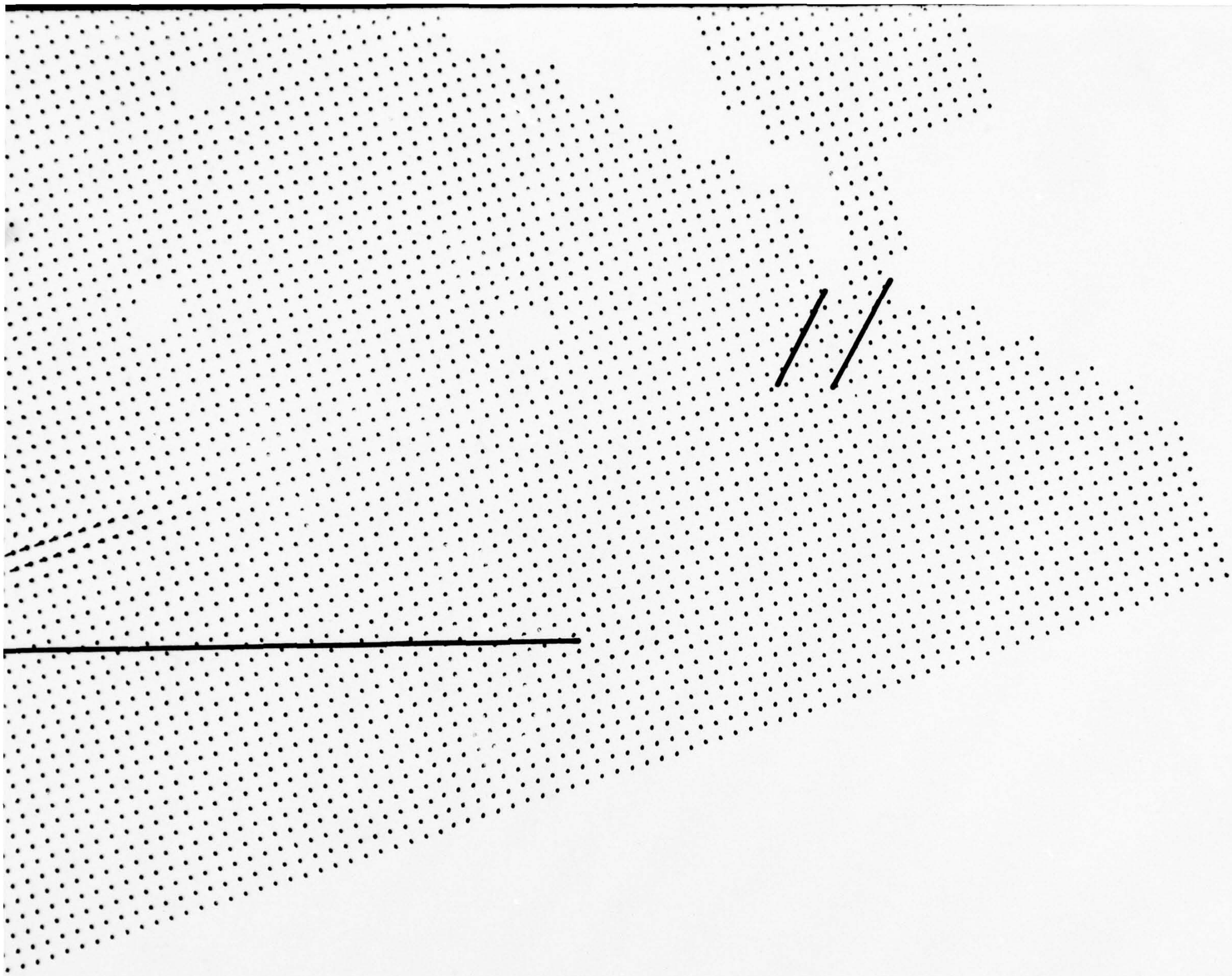

VELOCITY SCALE

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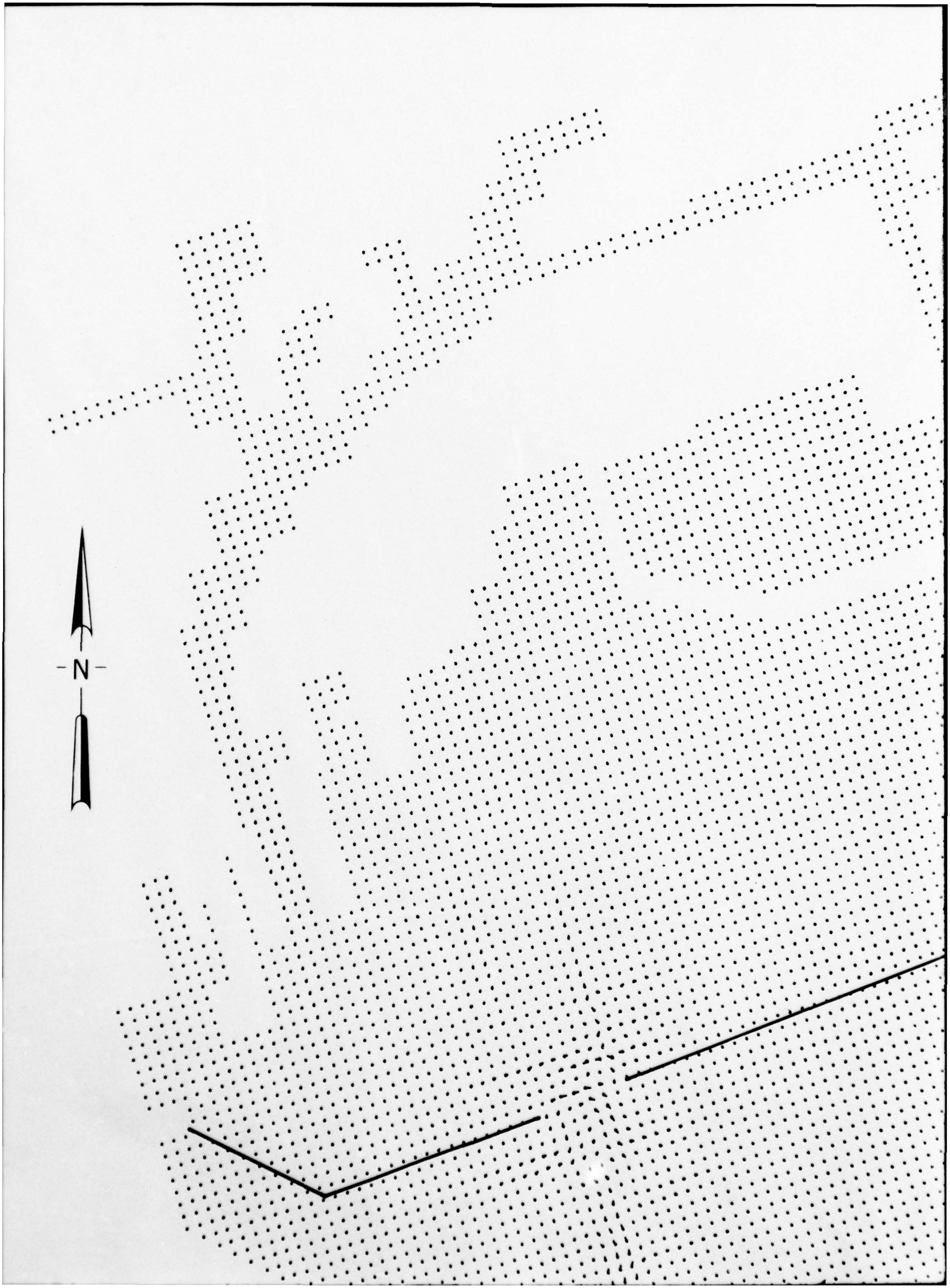
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)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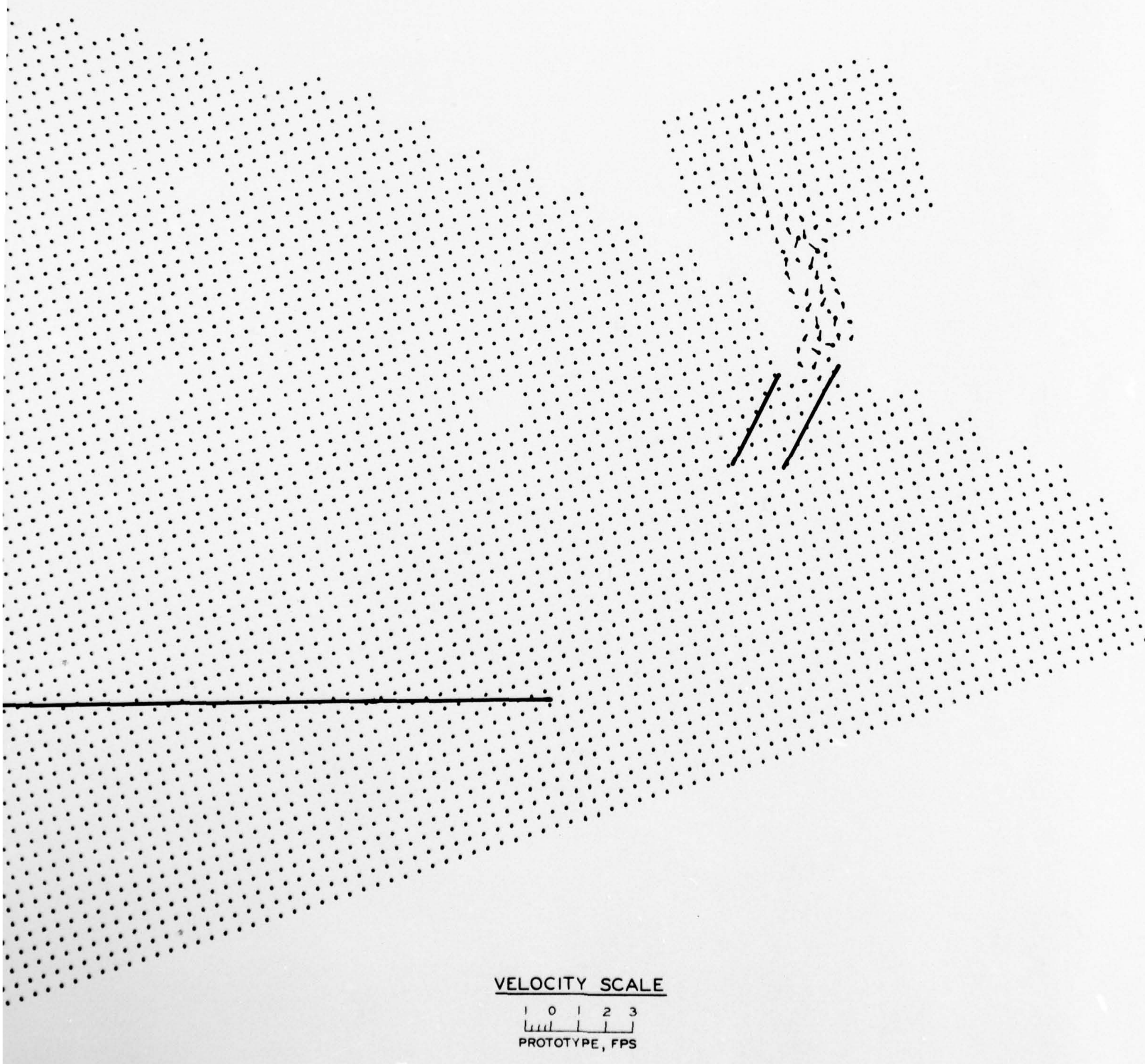
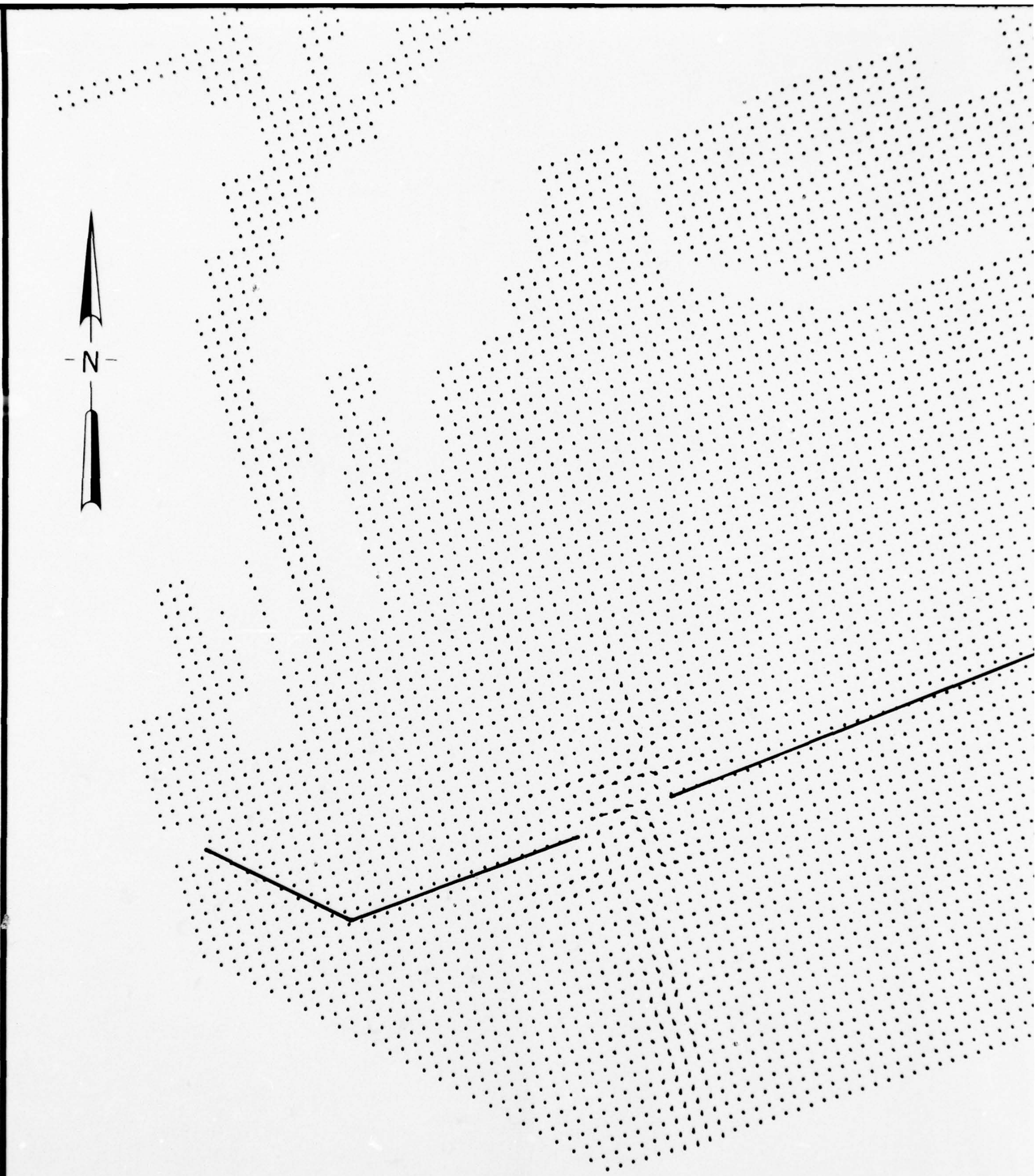


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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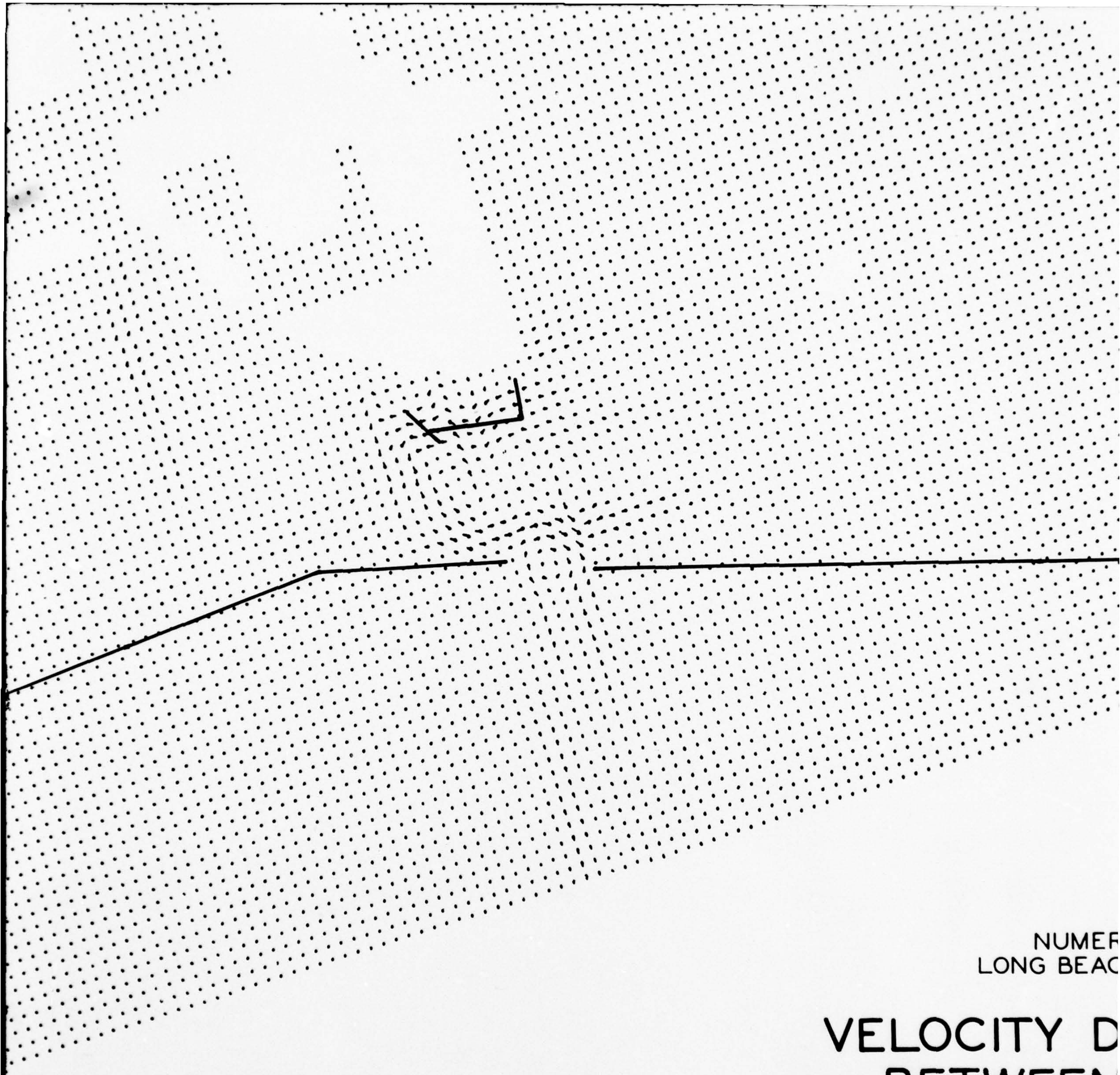

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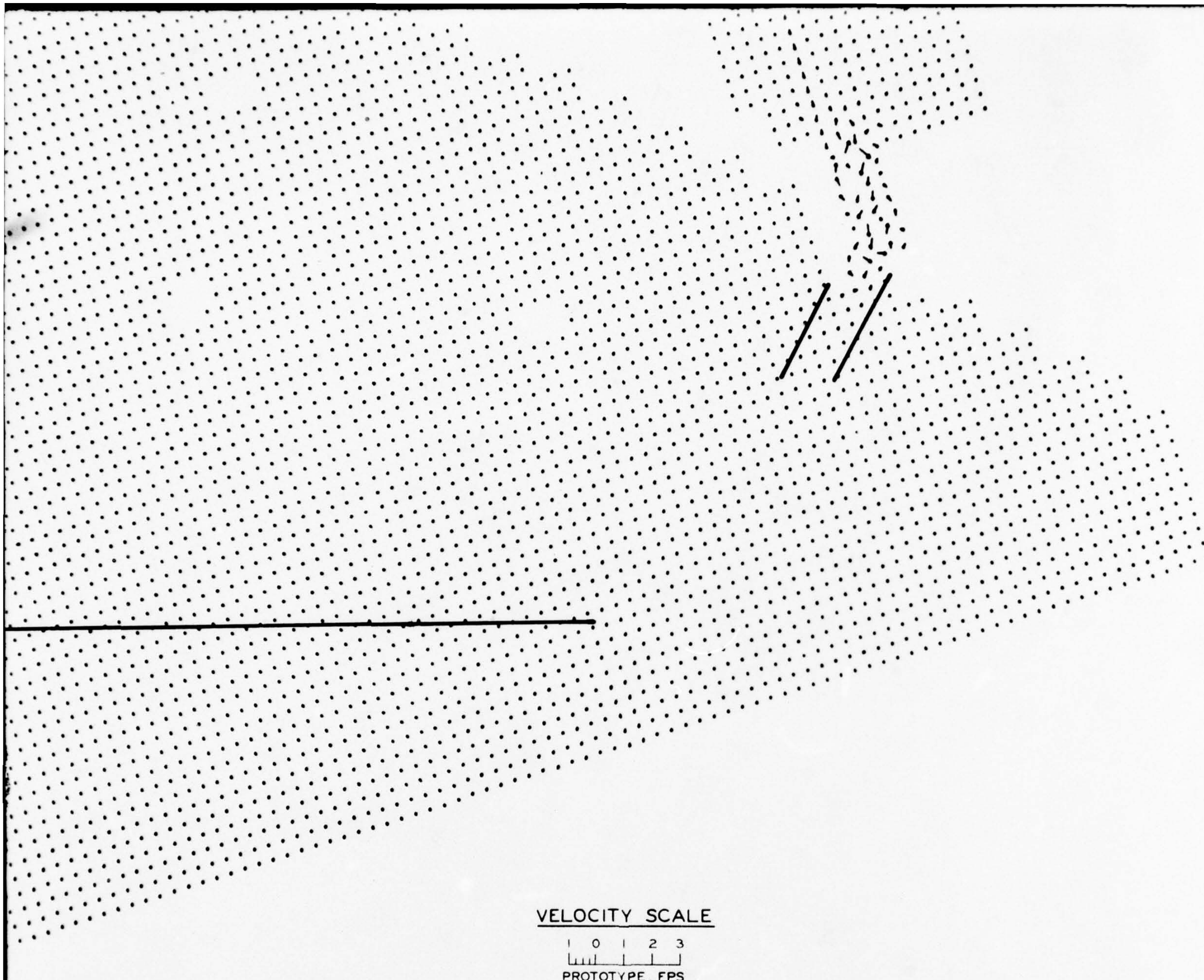
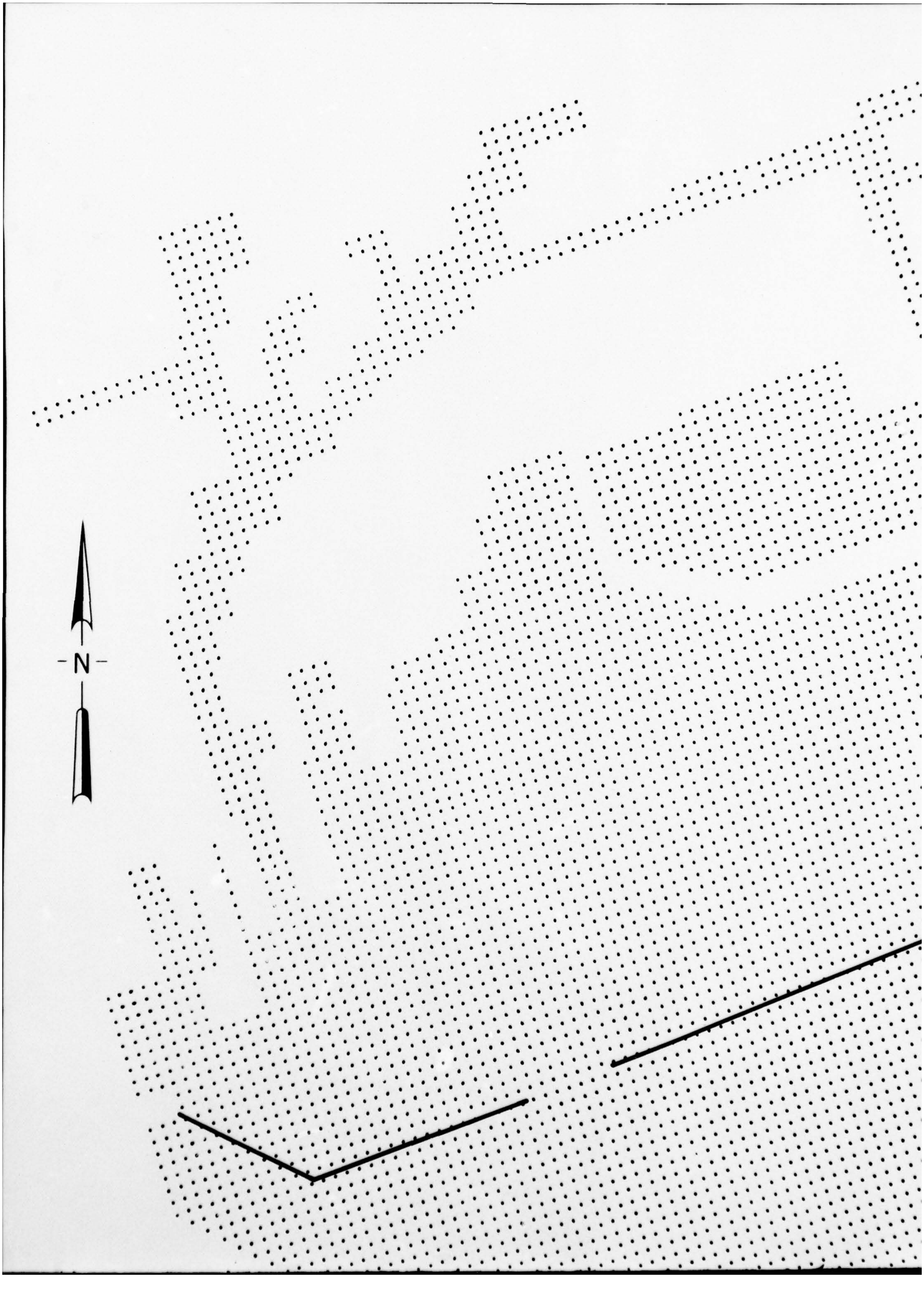


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -62-FT CHANNEL, 300-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)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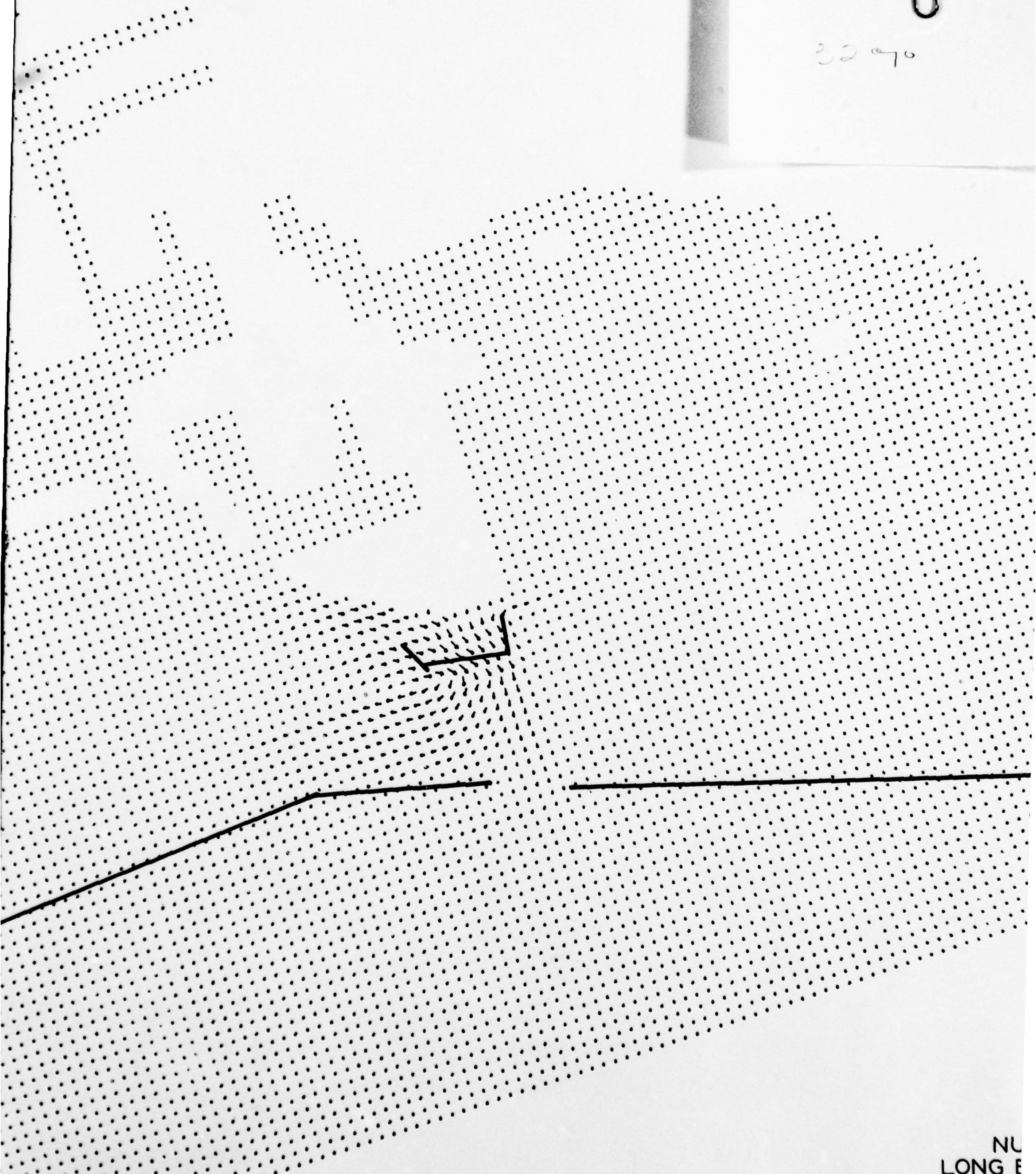

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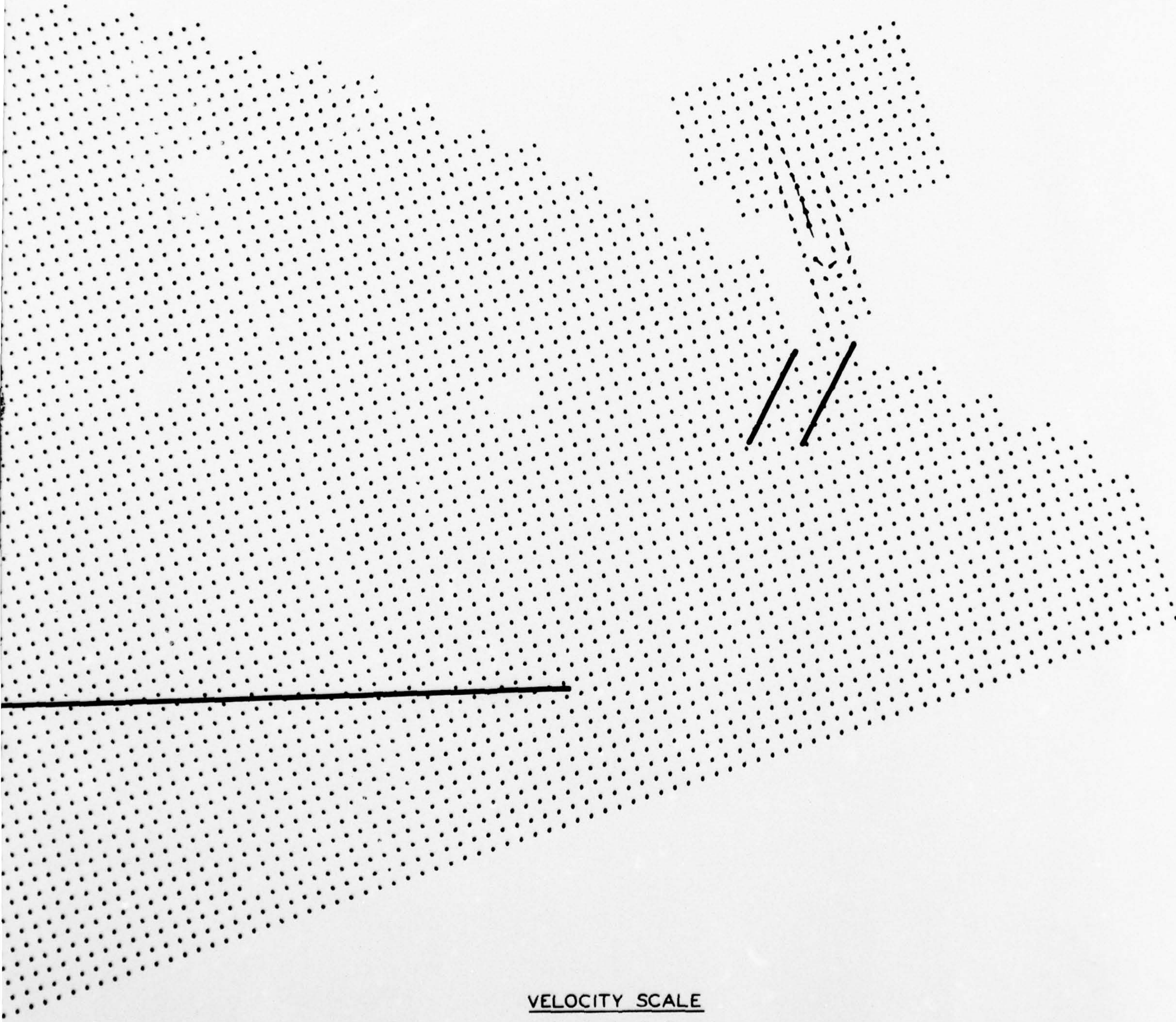

VELOCITY SCALE

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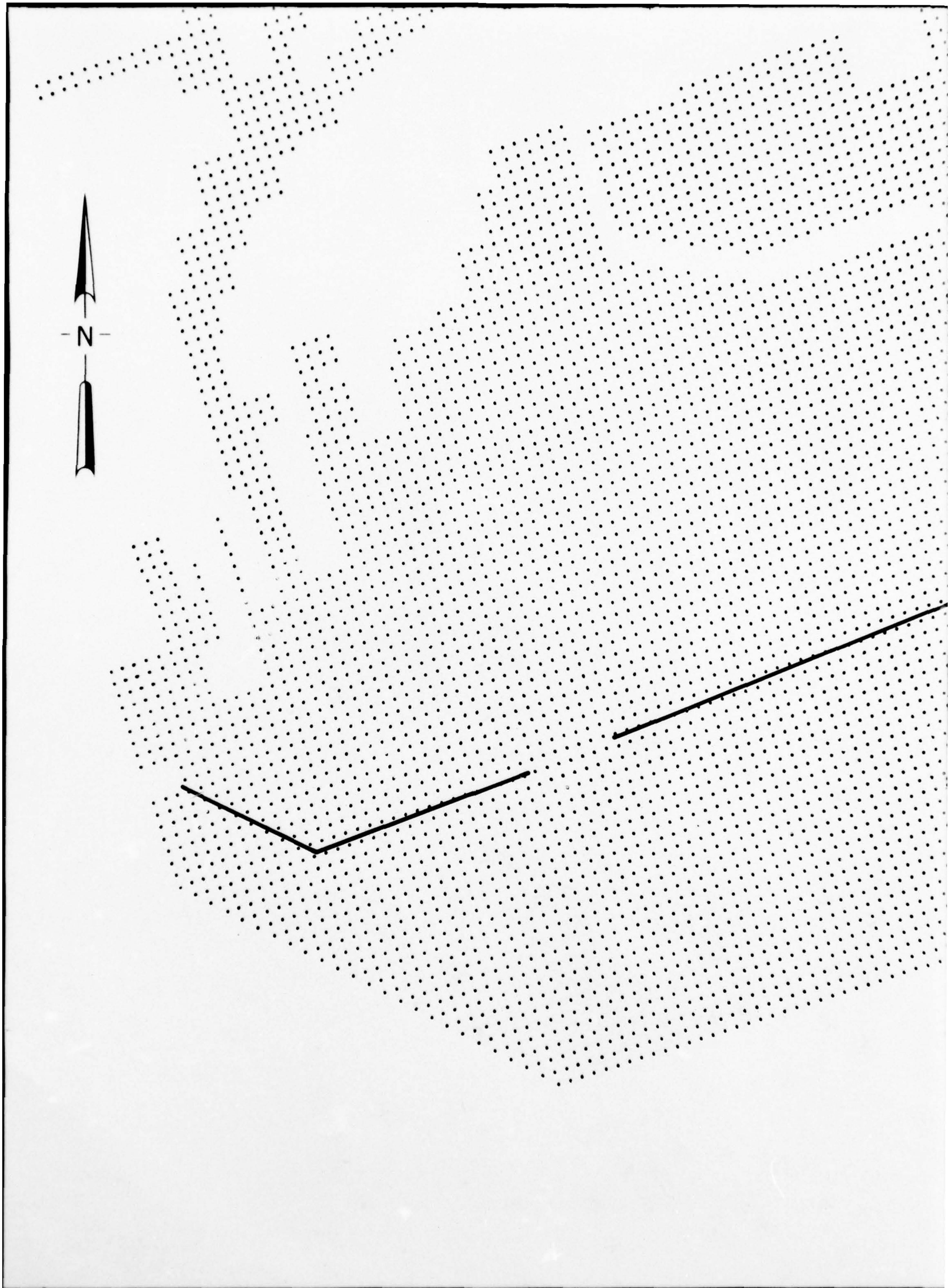
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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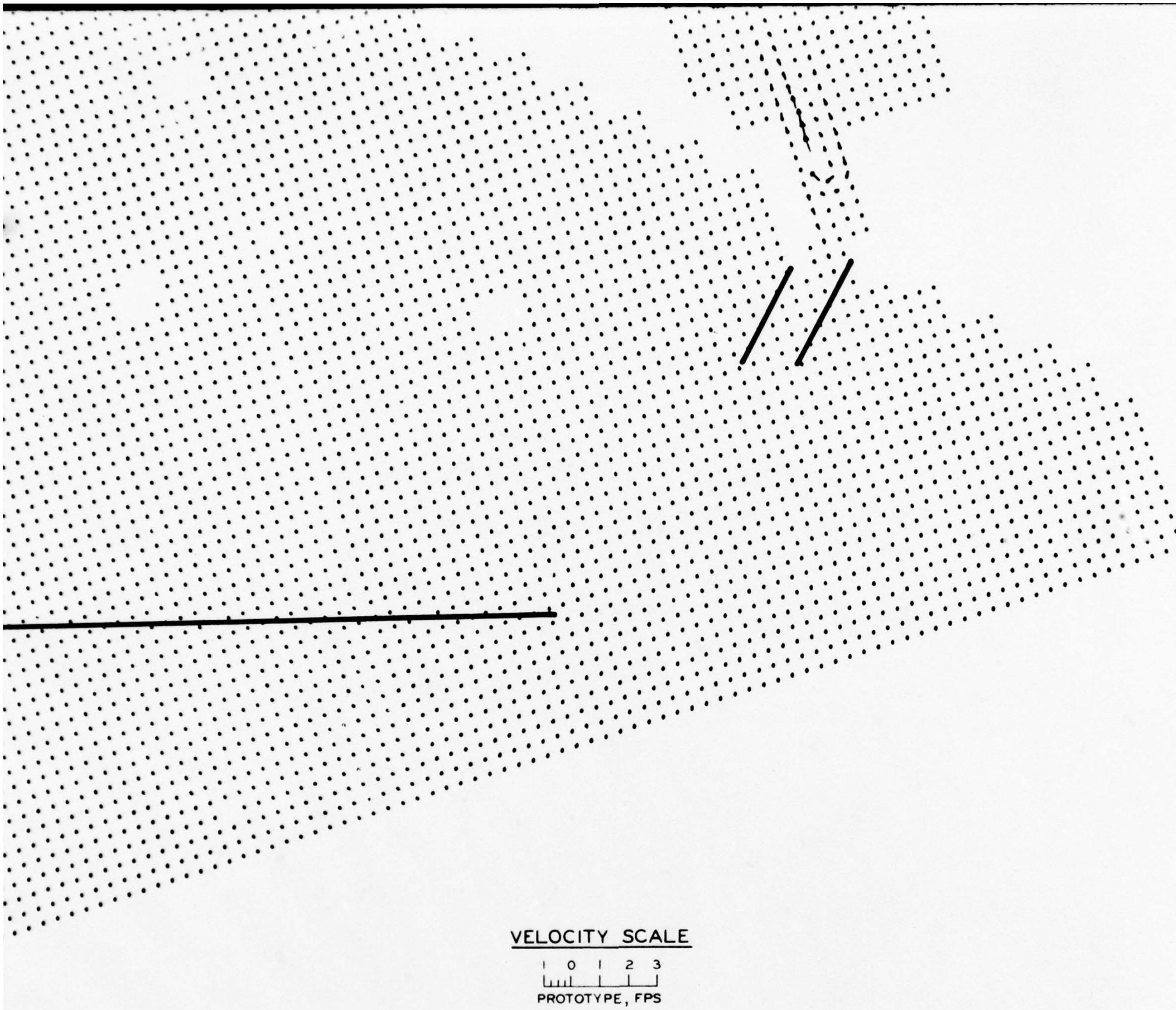
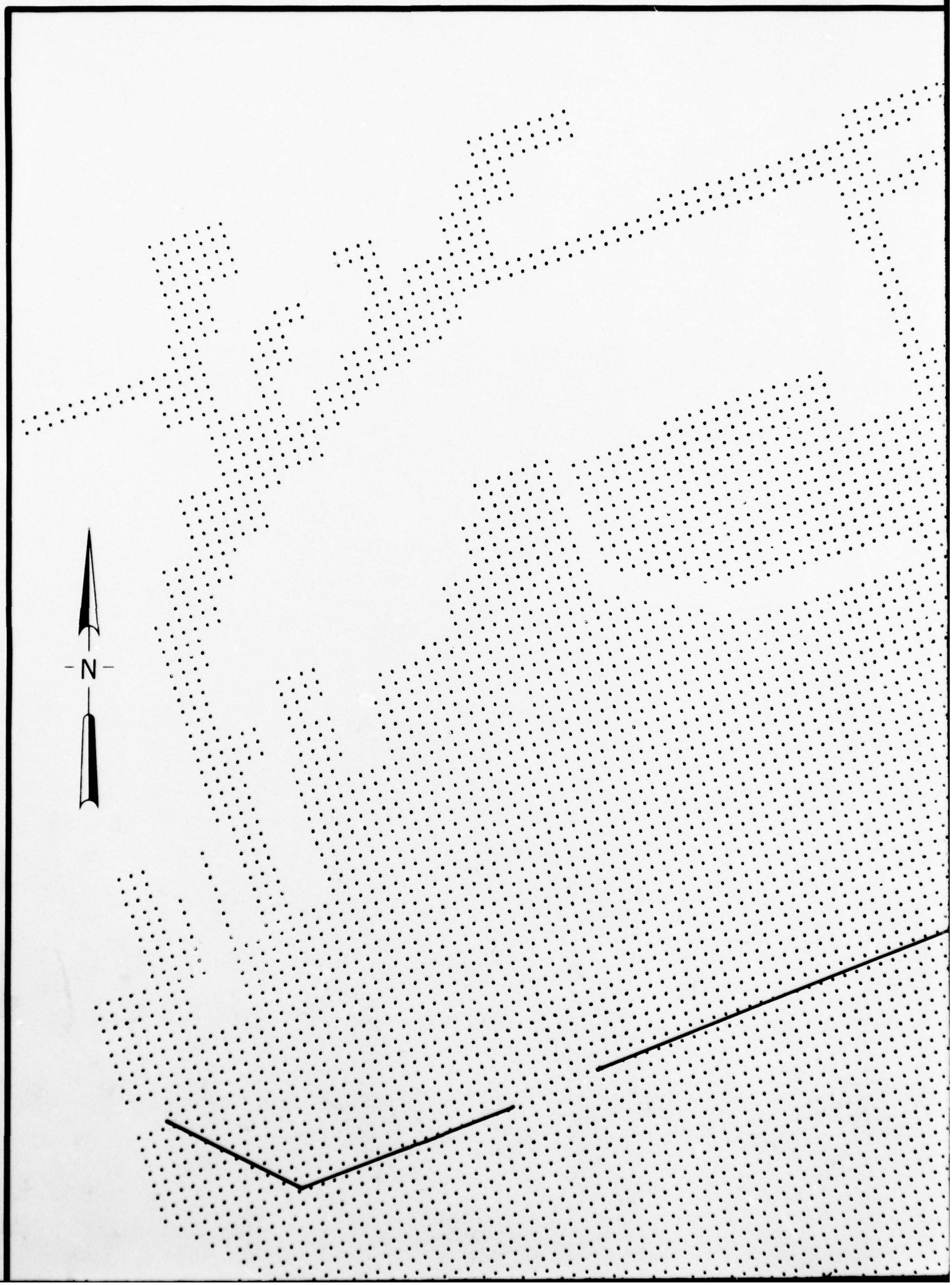


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -62-FT CHANNEL, 300-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)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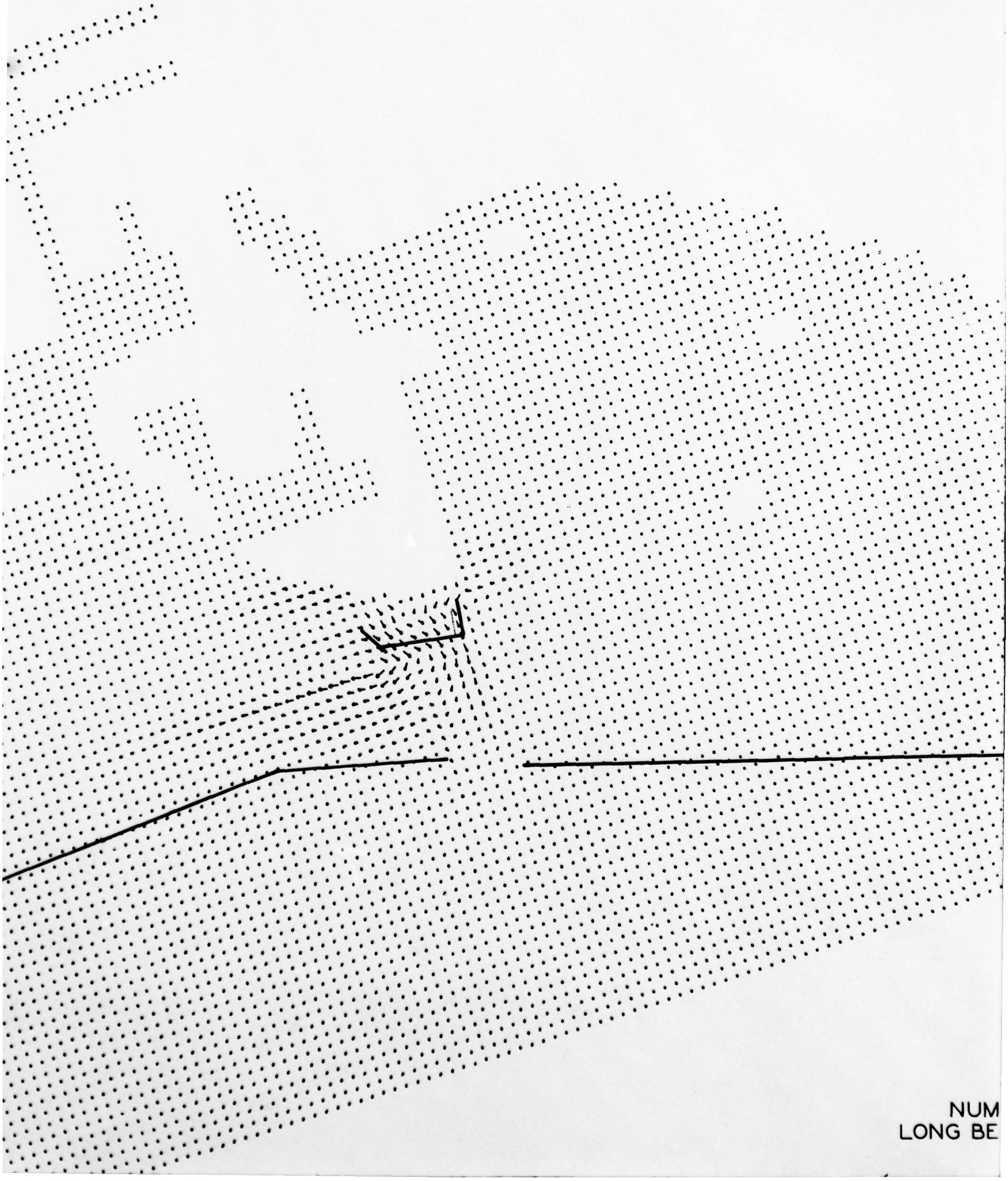

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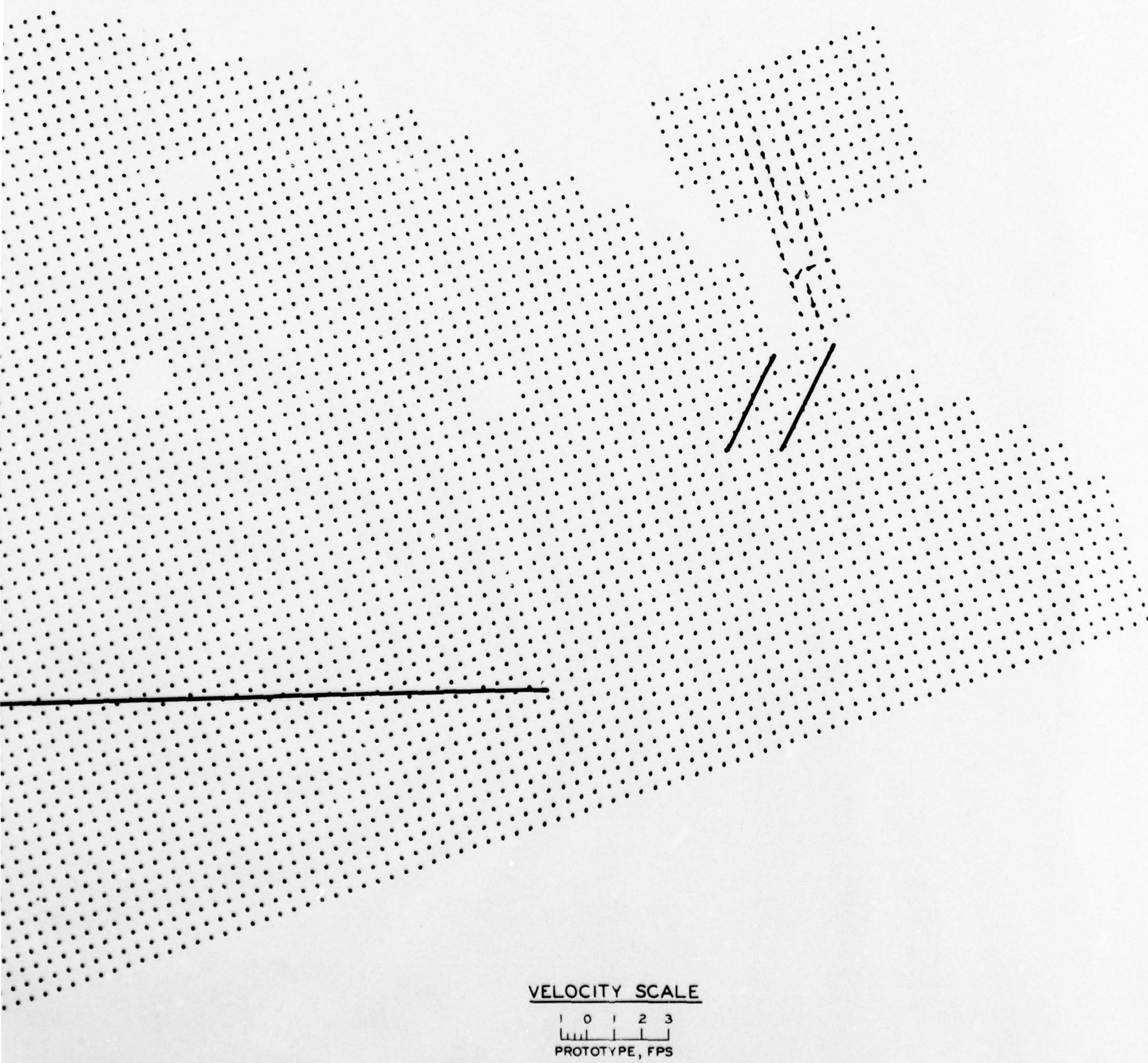
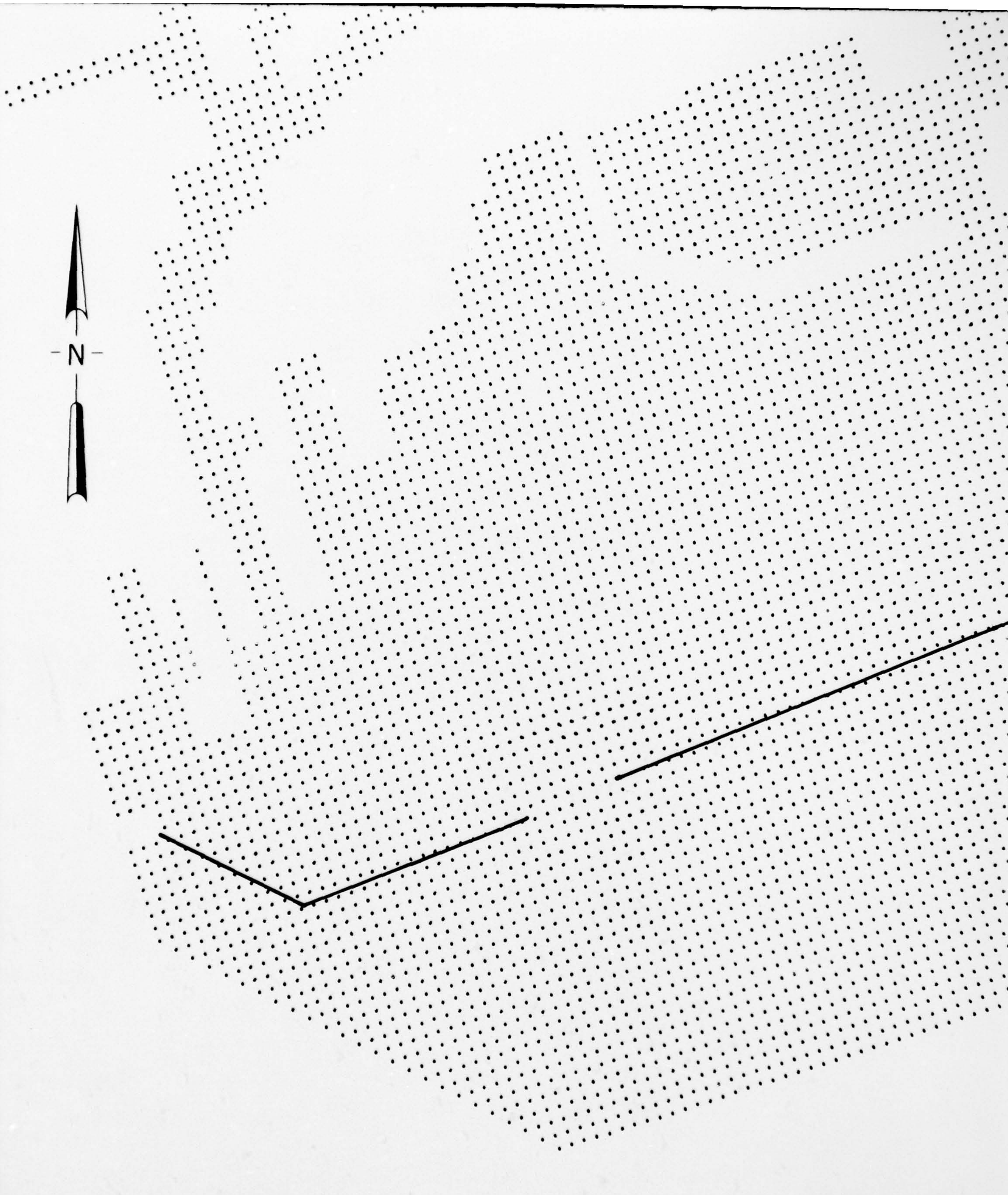


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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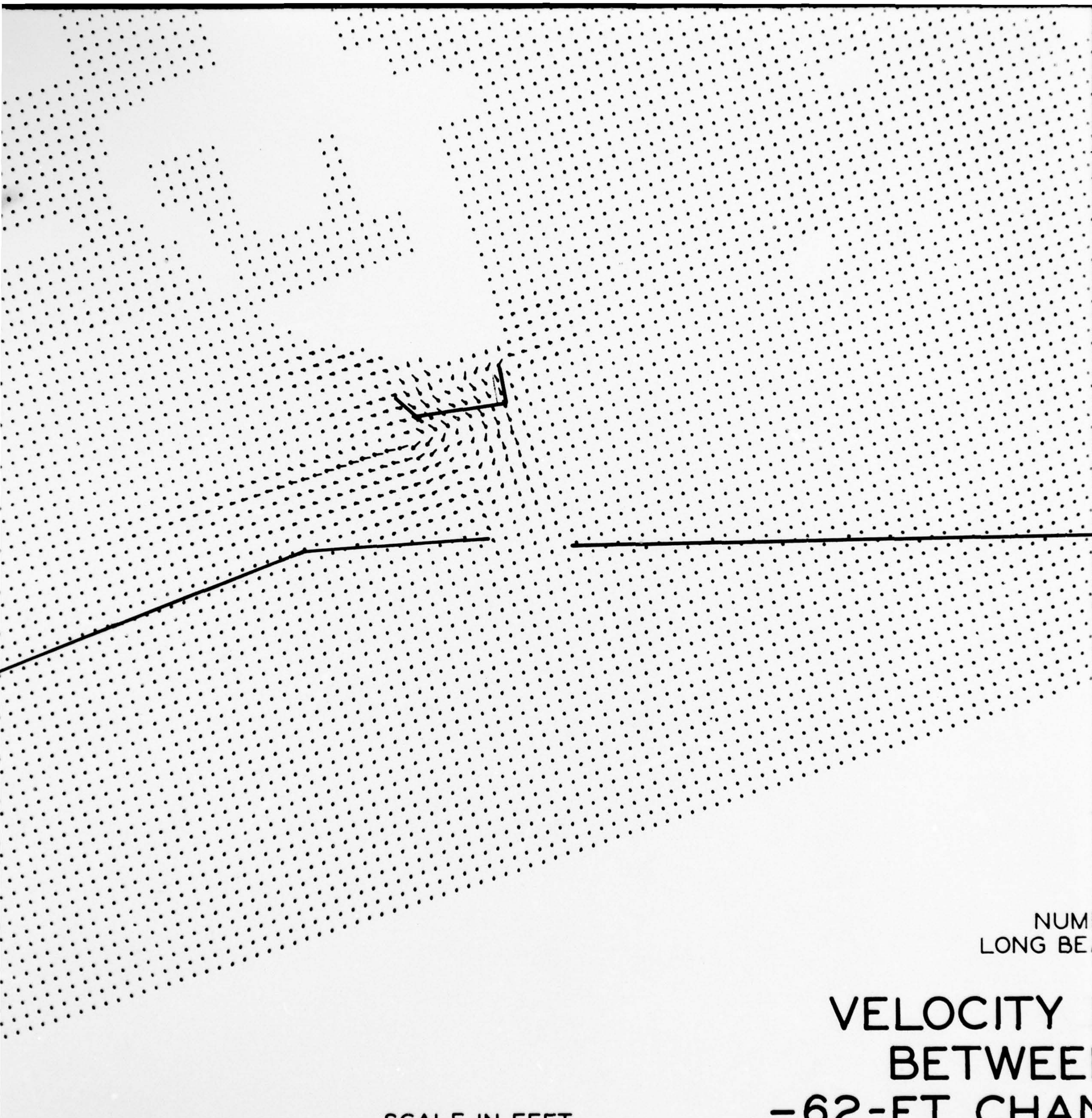

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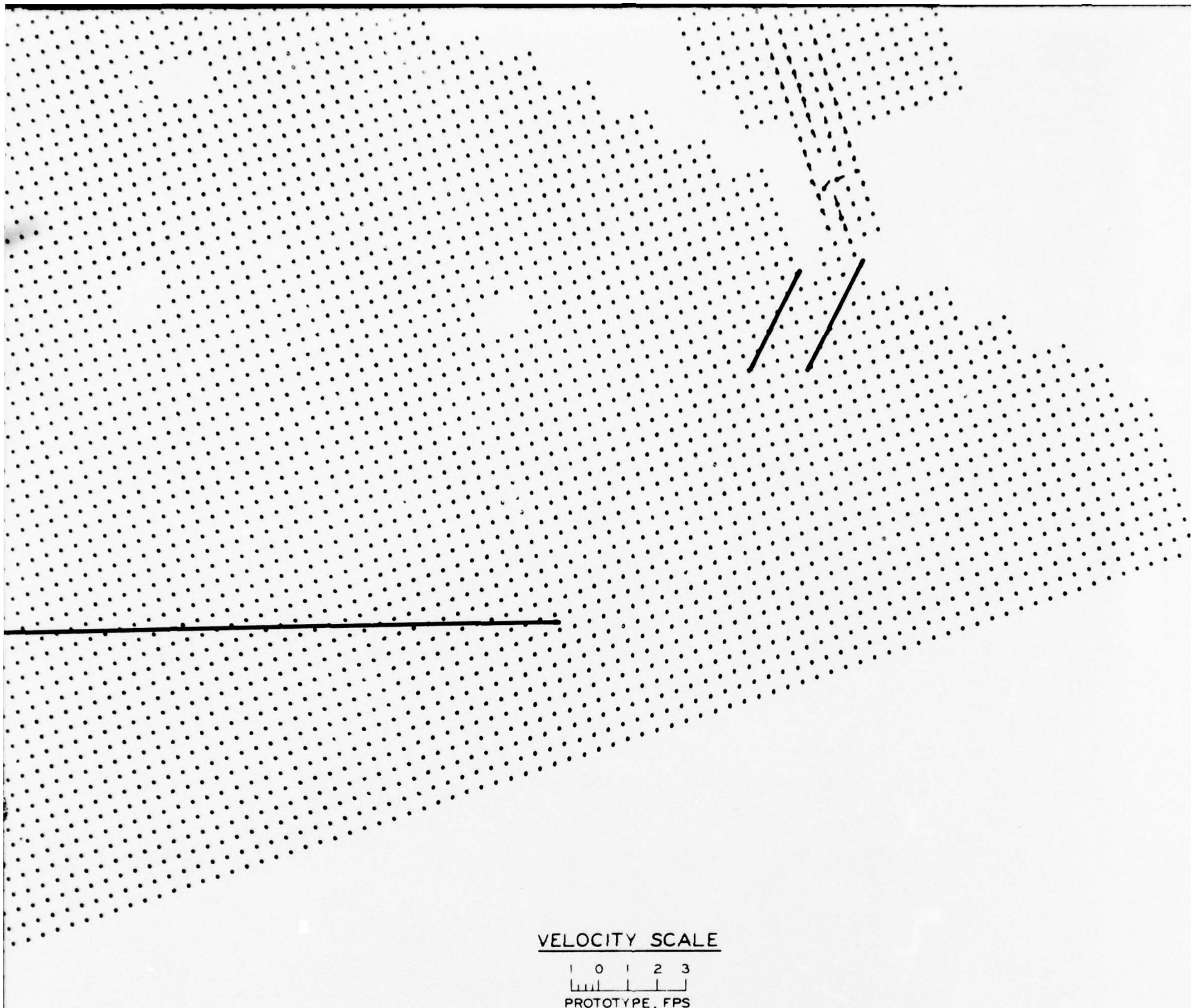
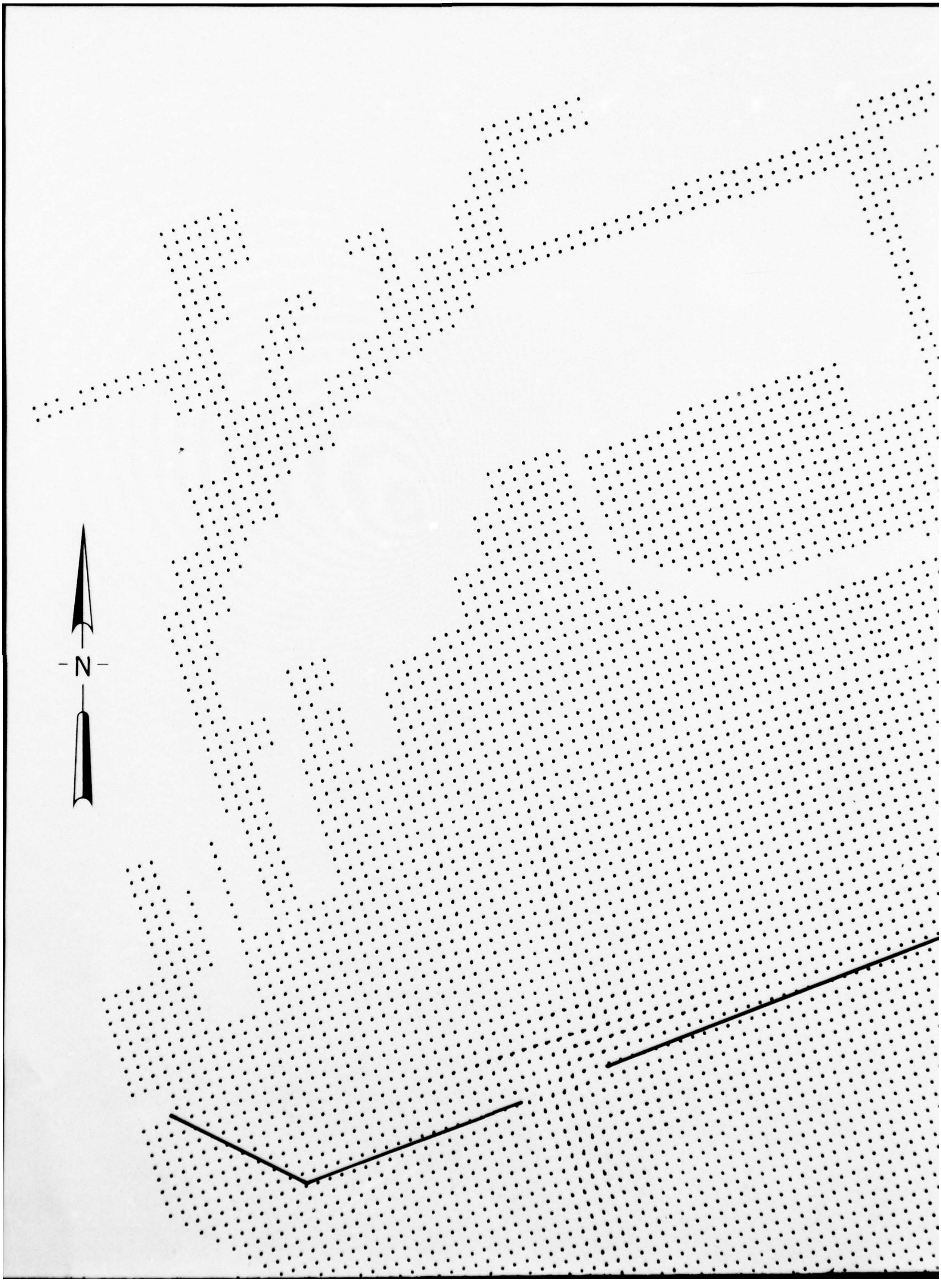


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -62-FT CHANNEL, 300-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)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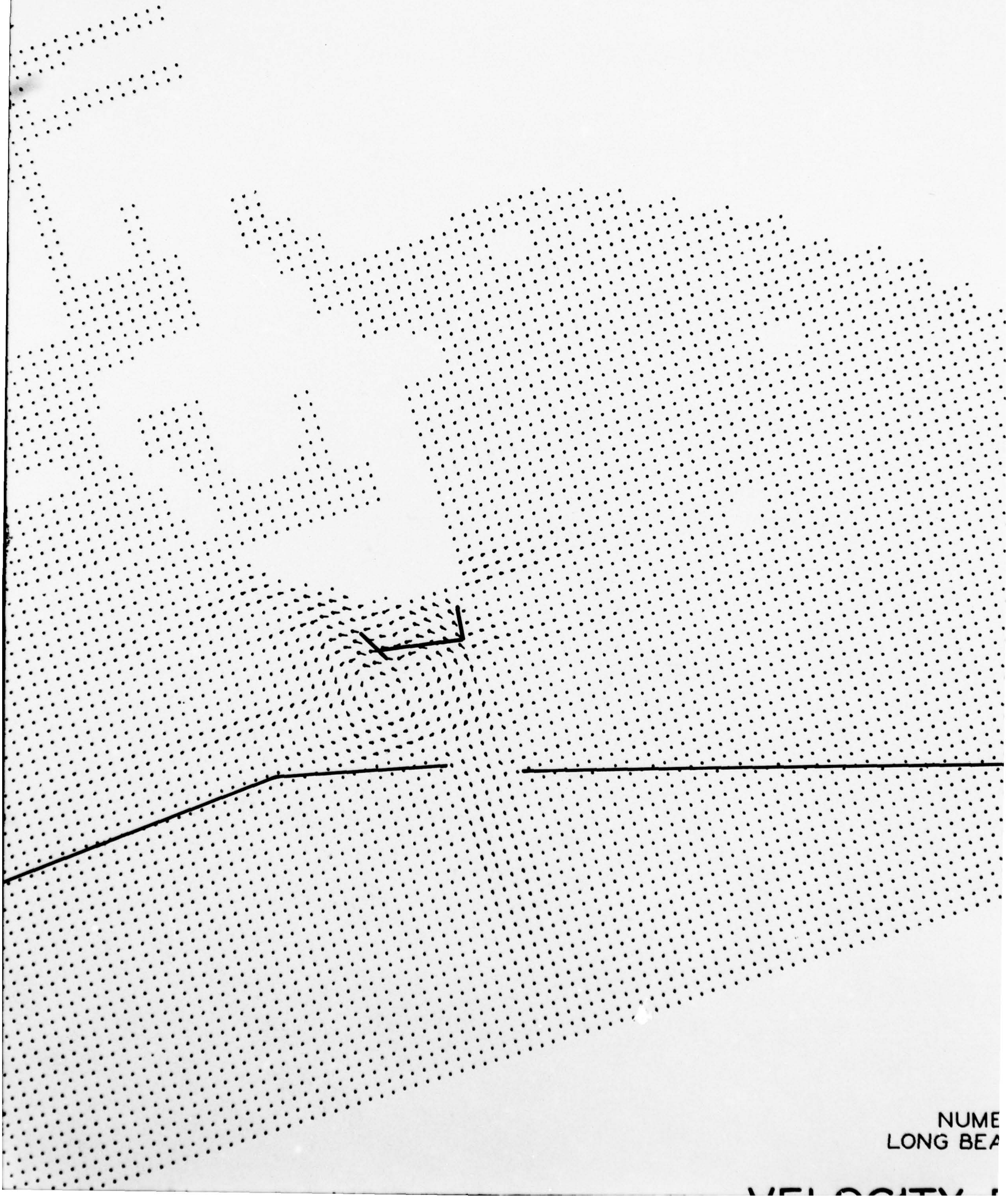

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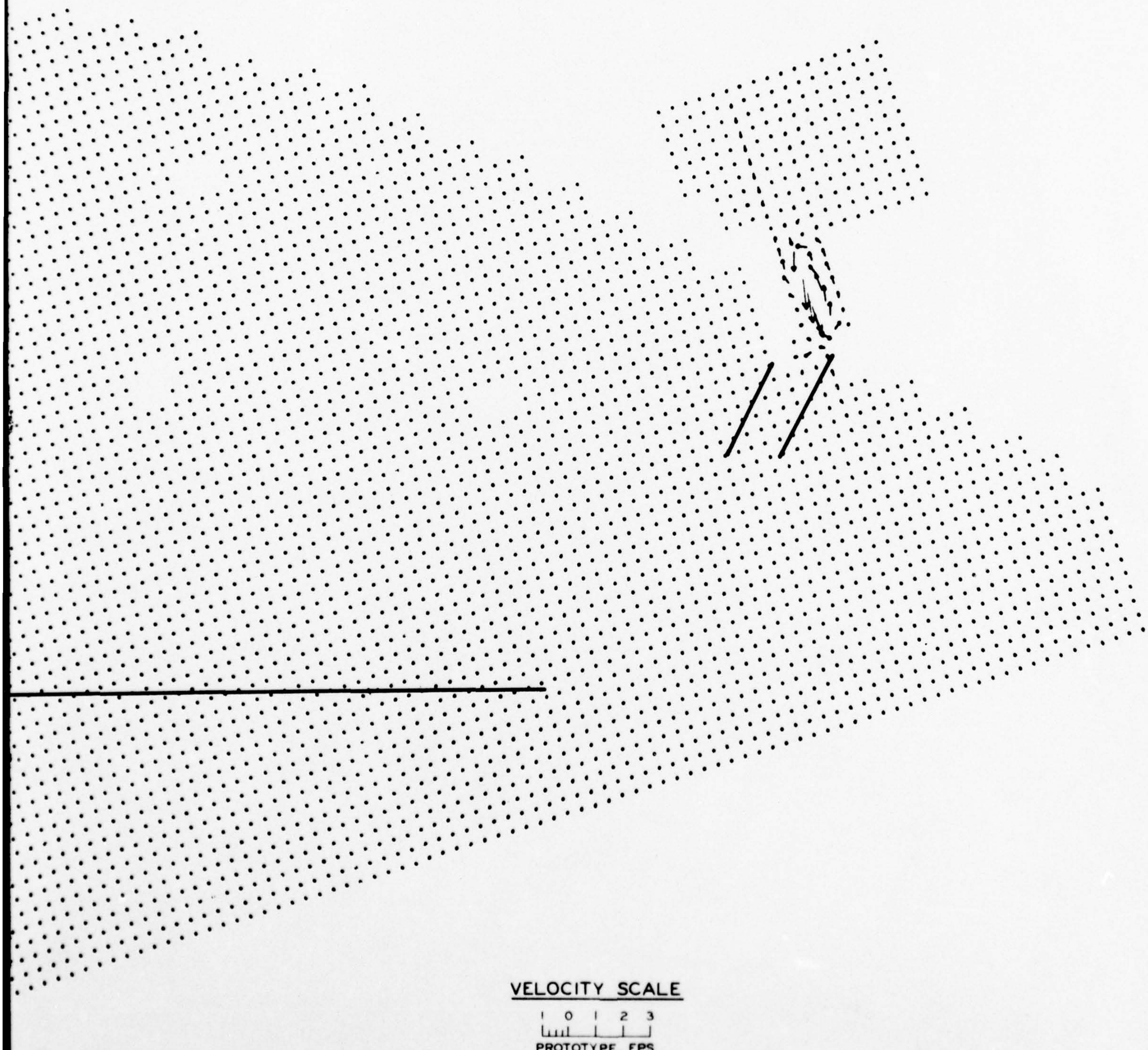
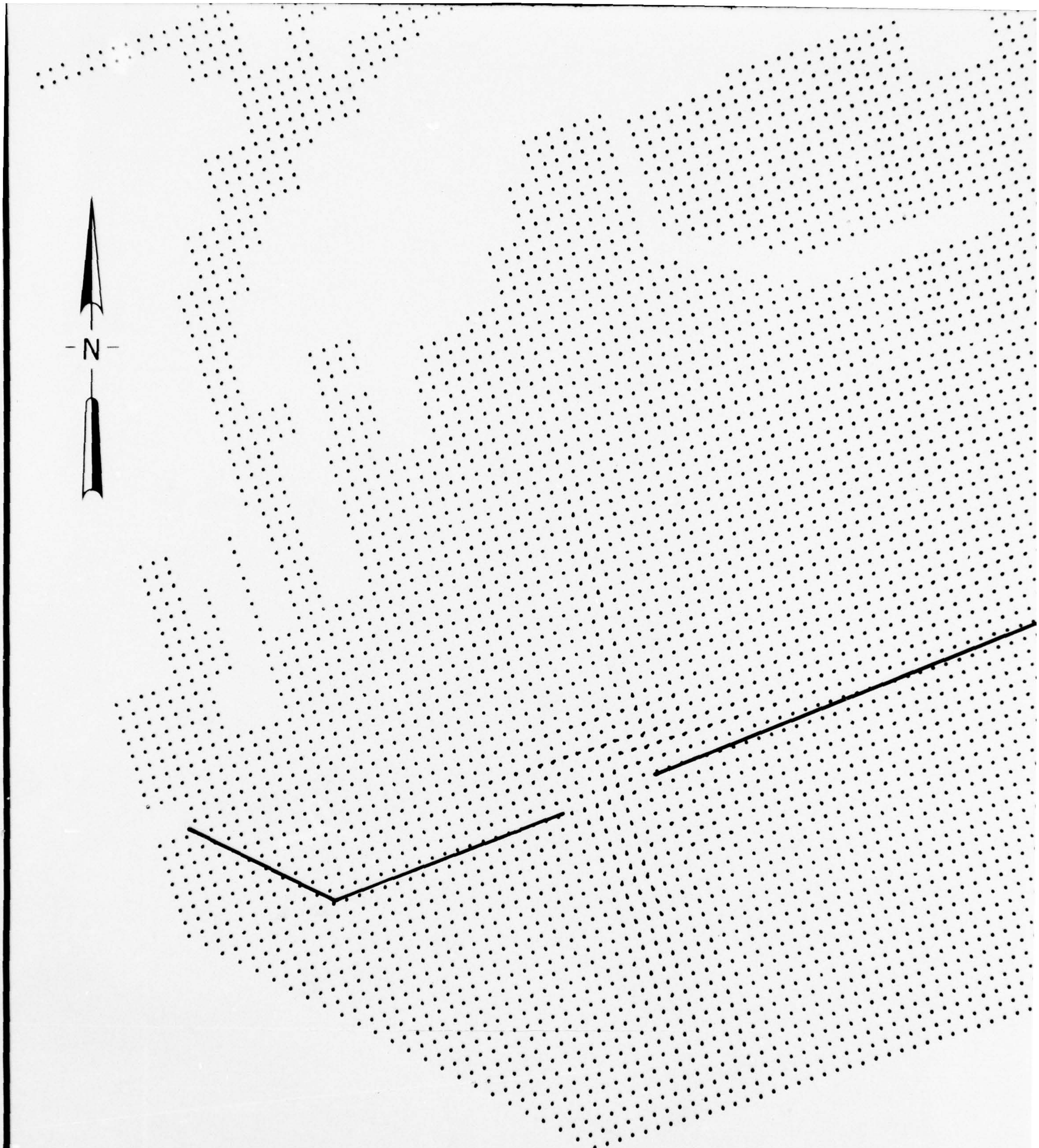


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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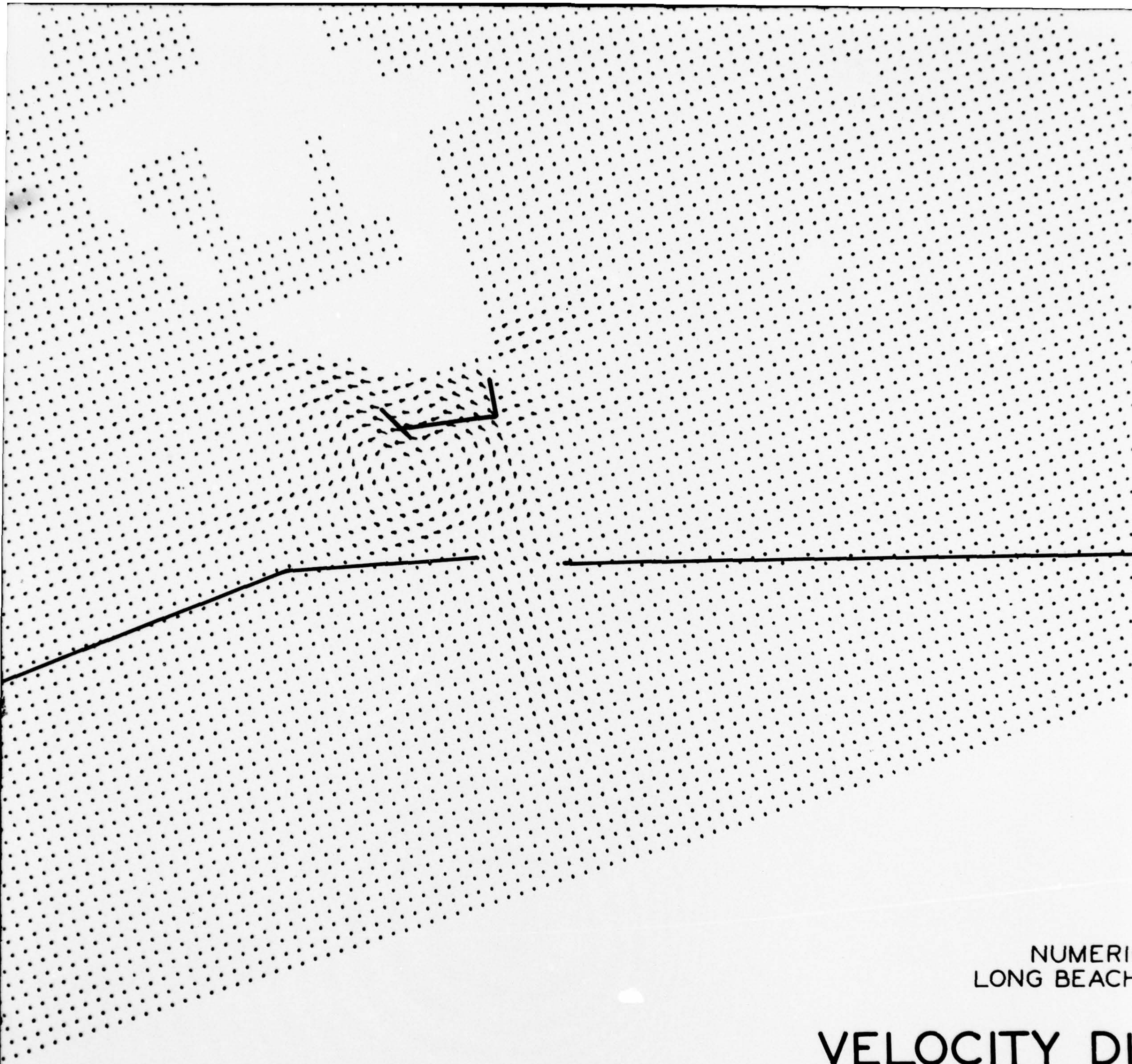

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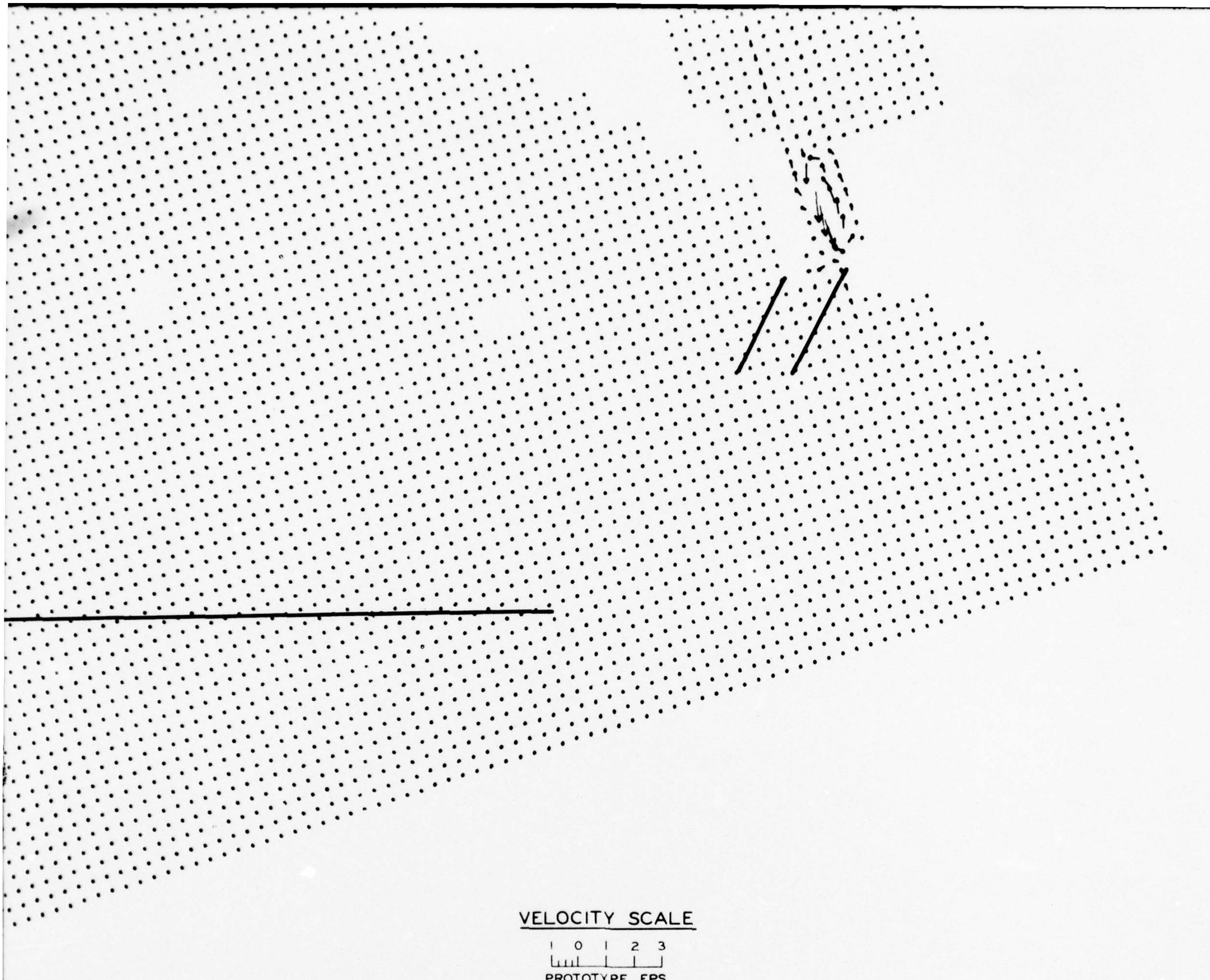
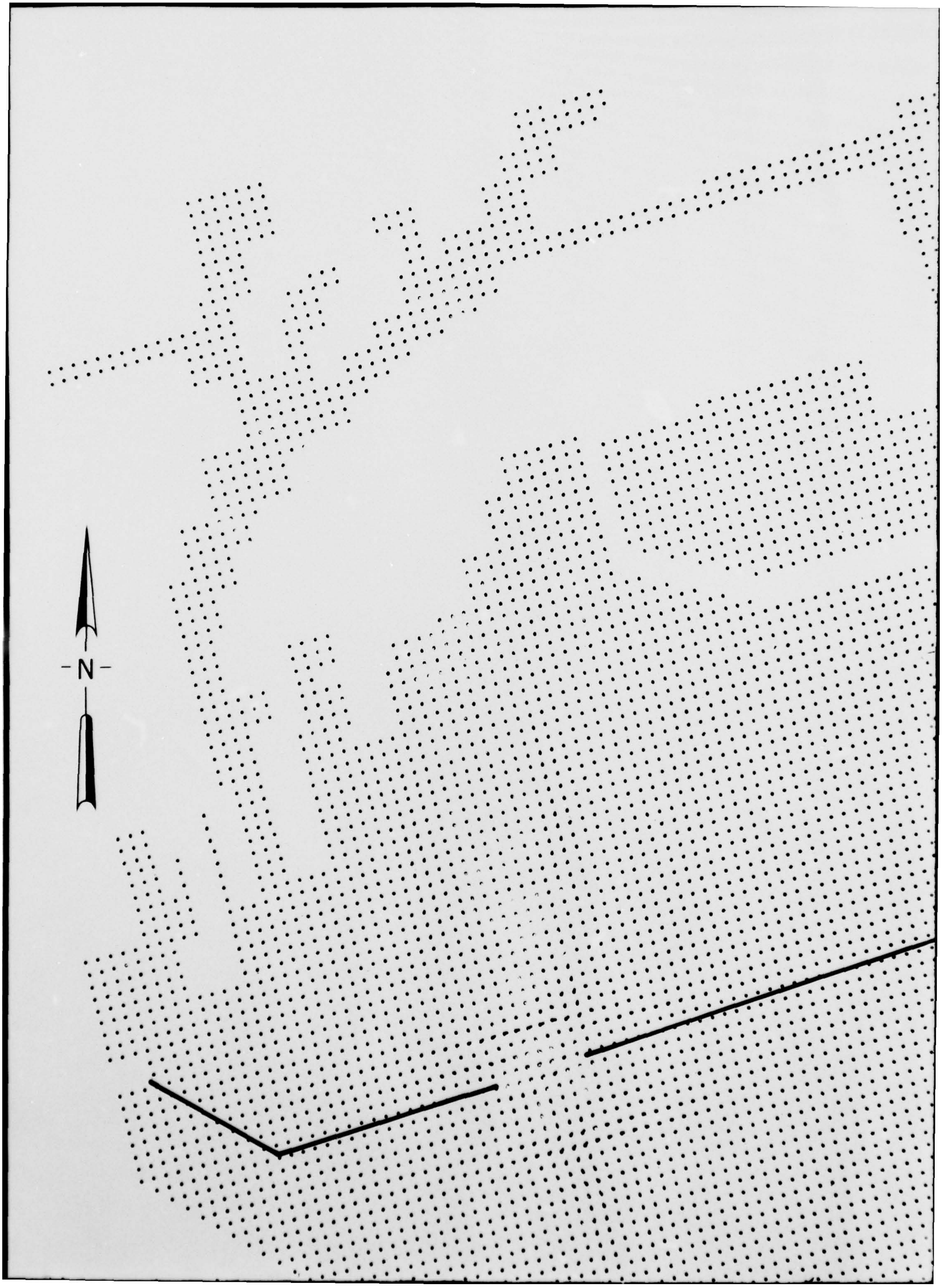


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -62-FT CHANNEL, 300-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)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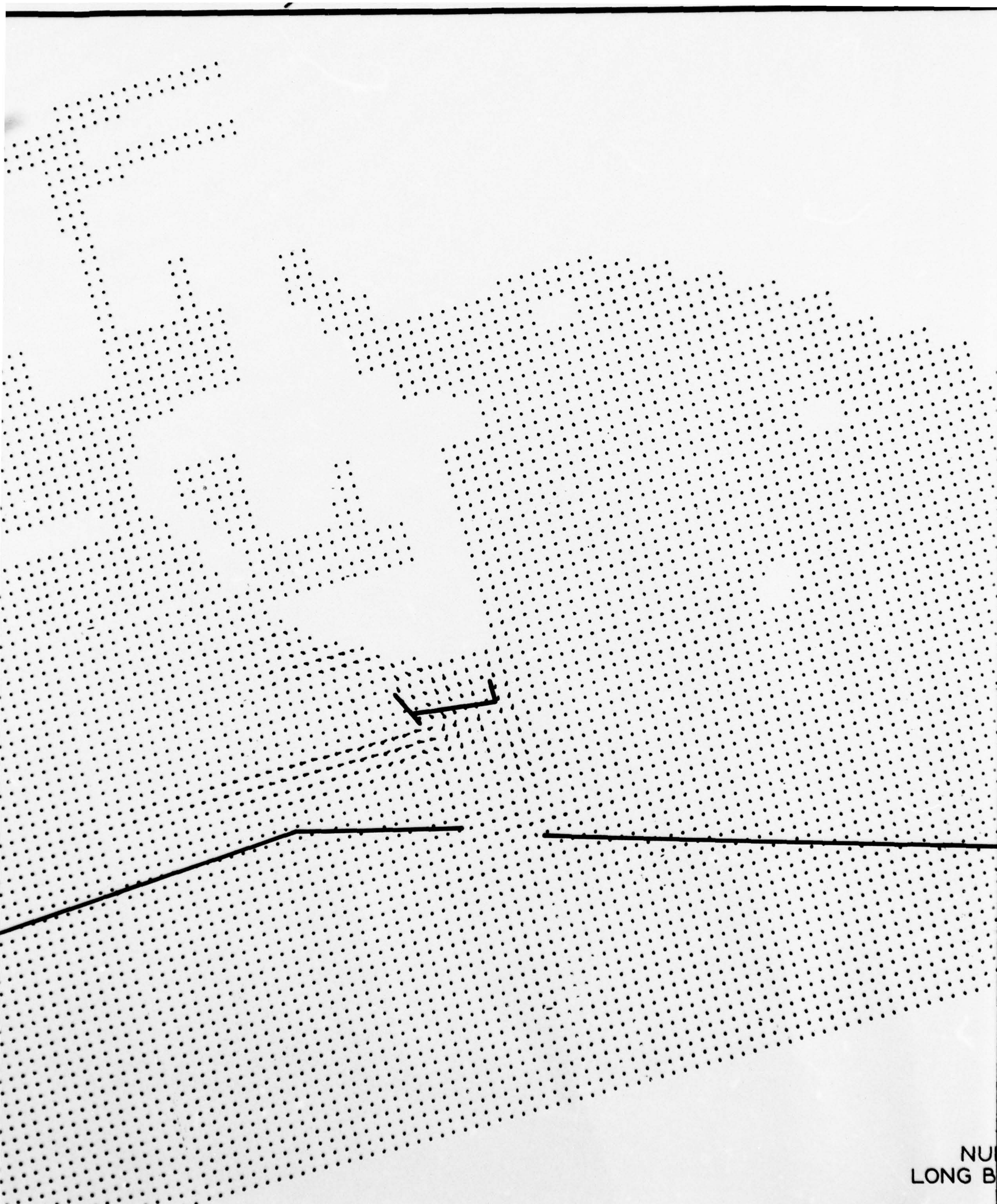
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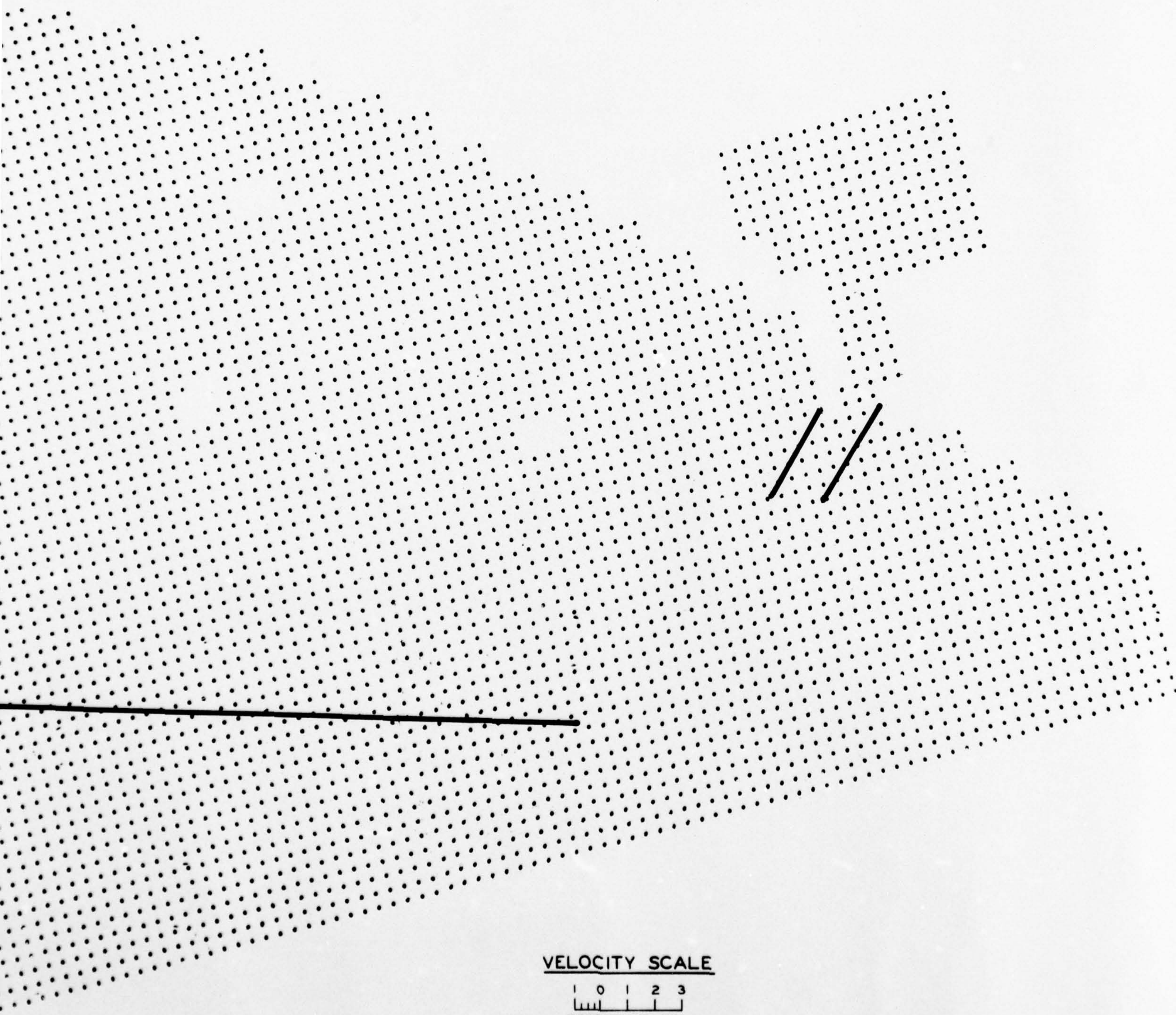
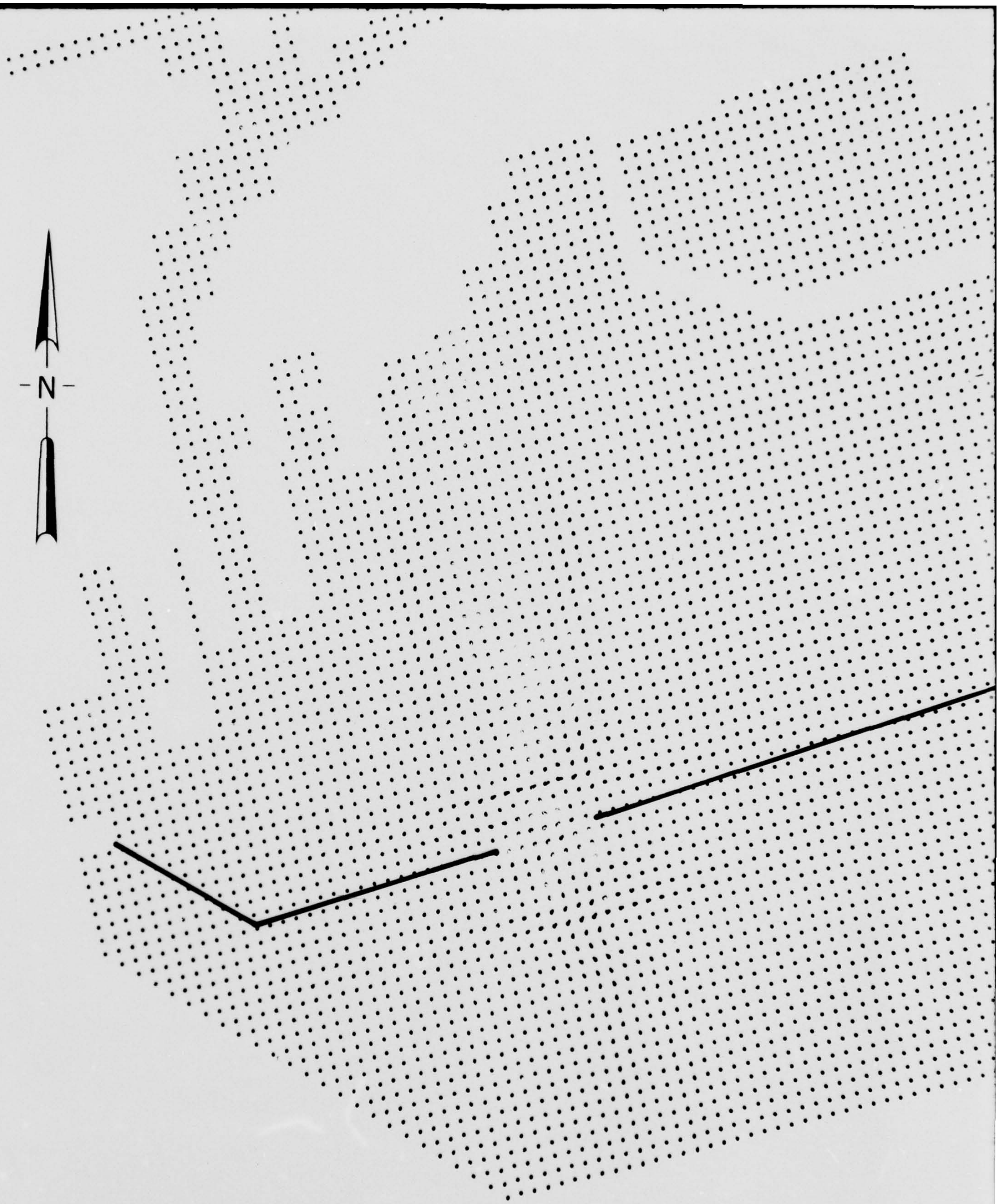


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS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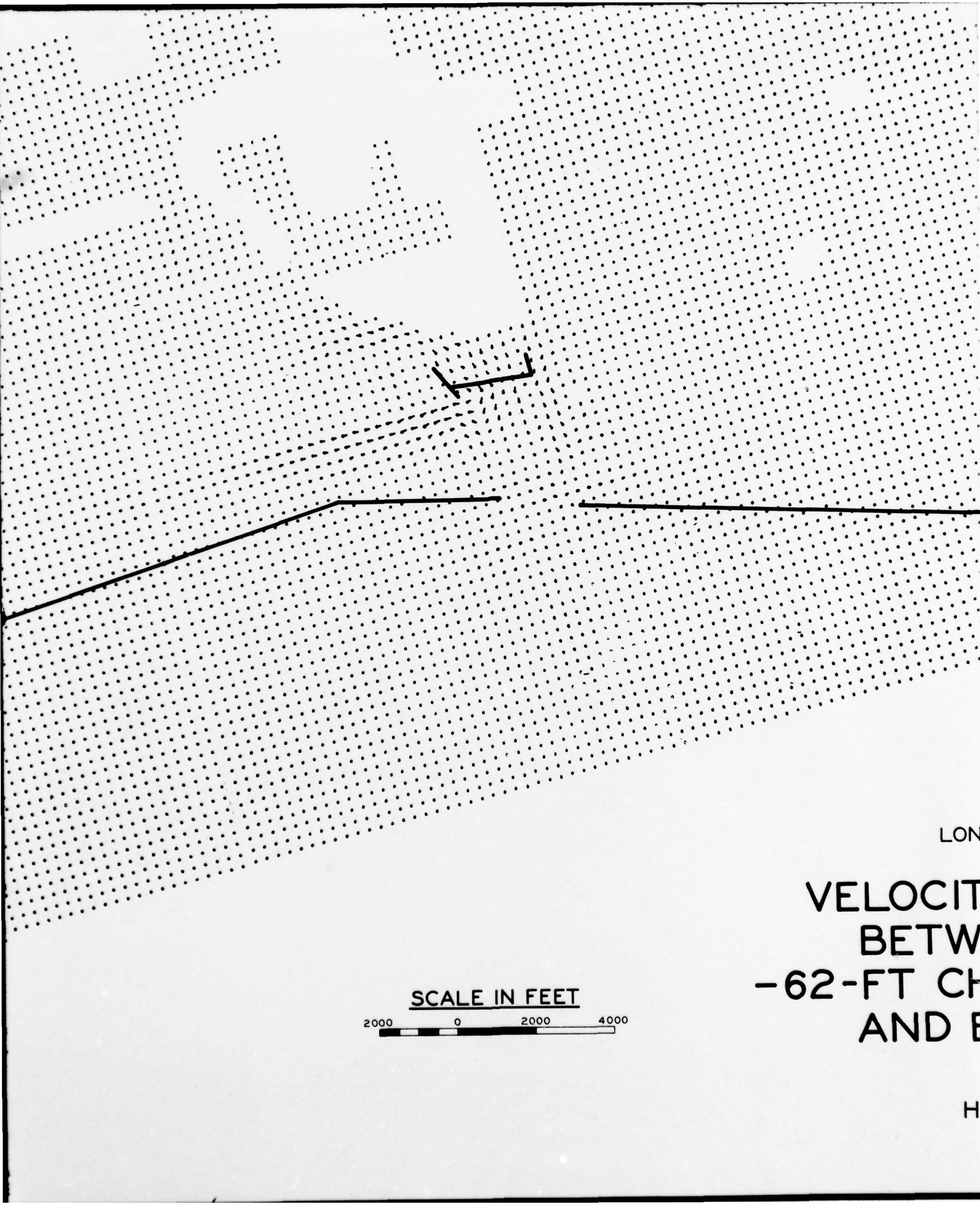

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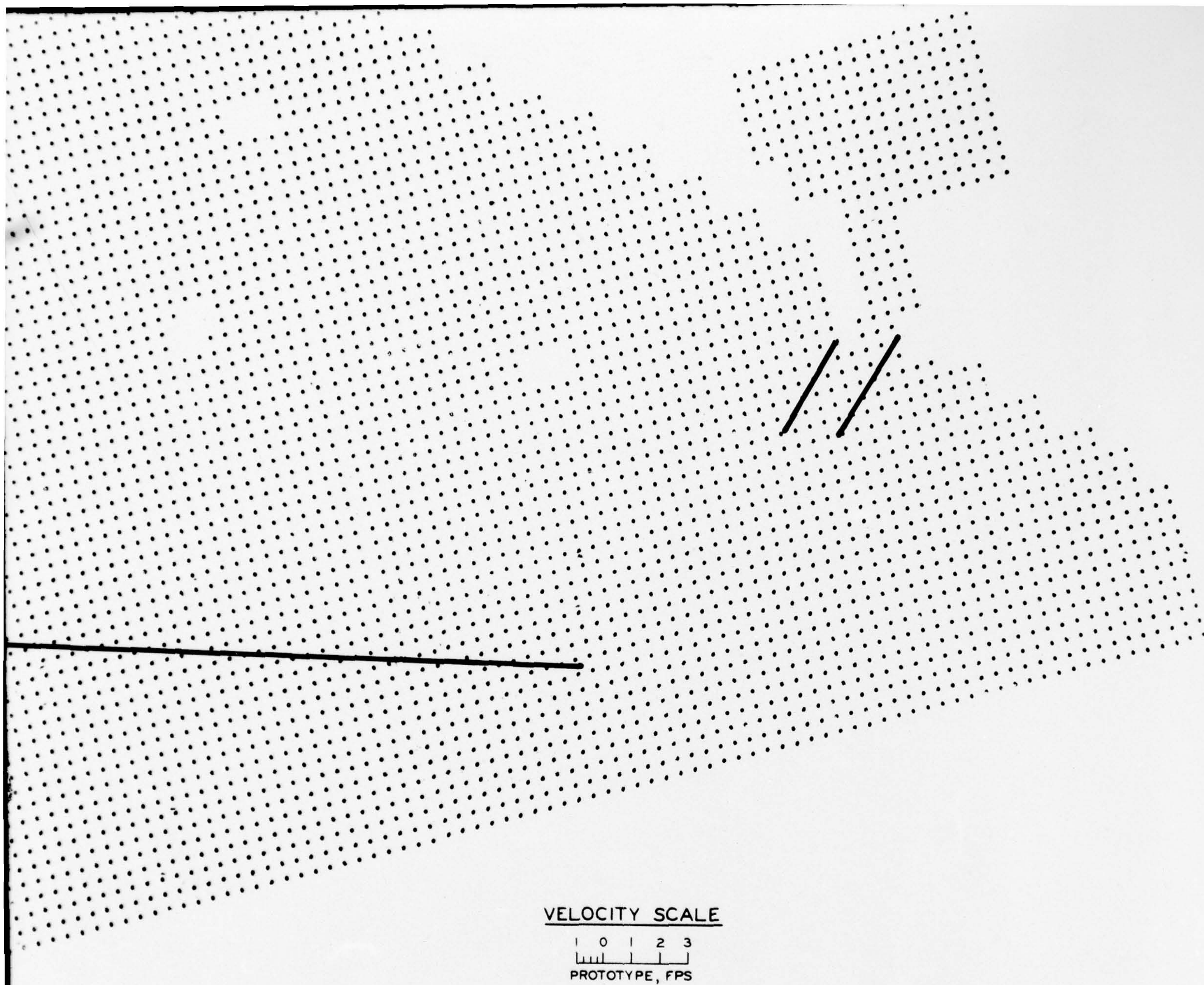
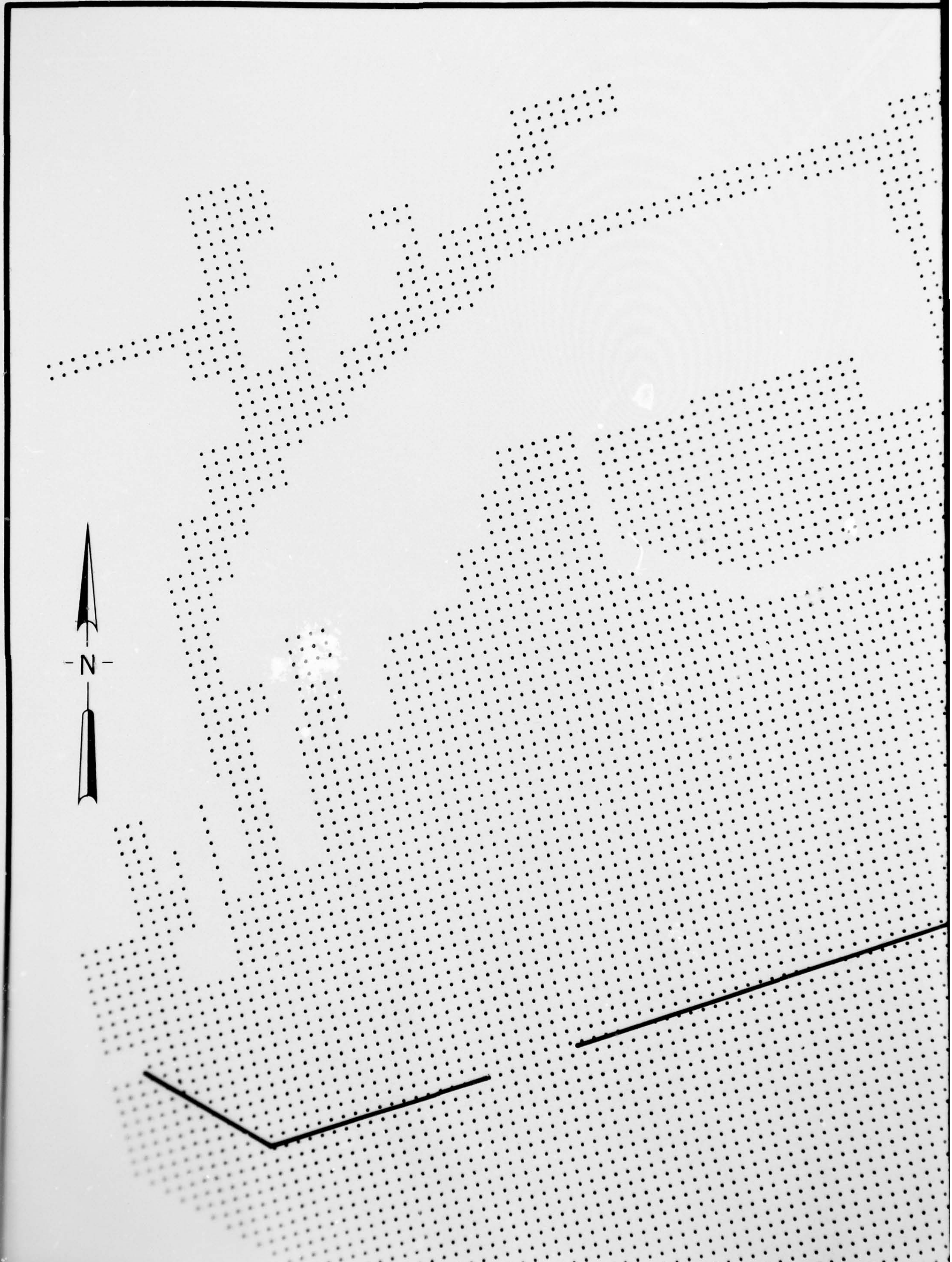


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, –62-FT CHANNEL, 600-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)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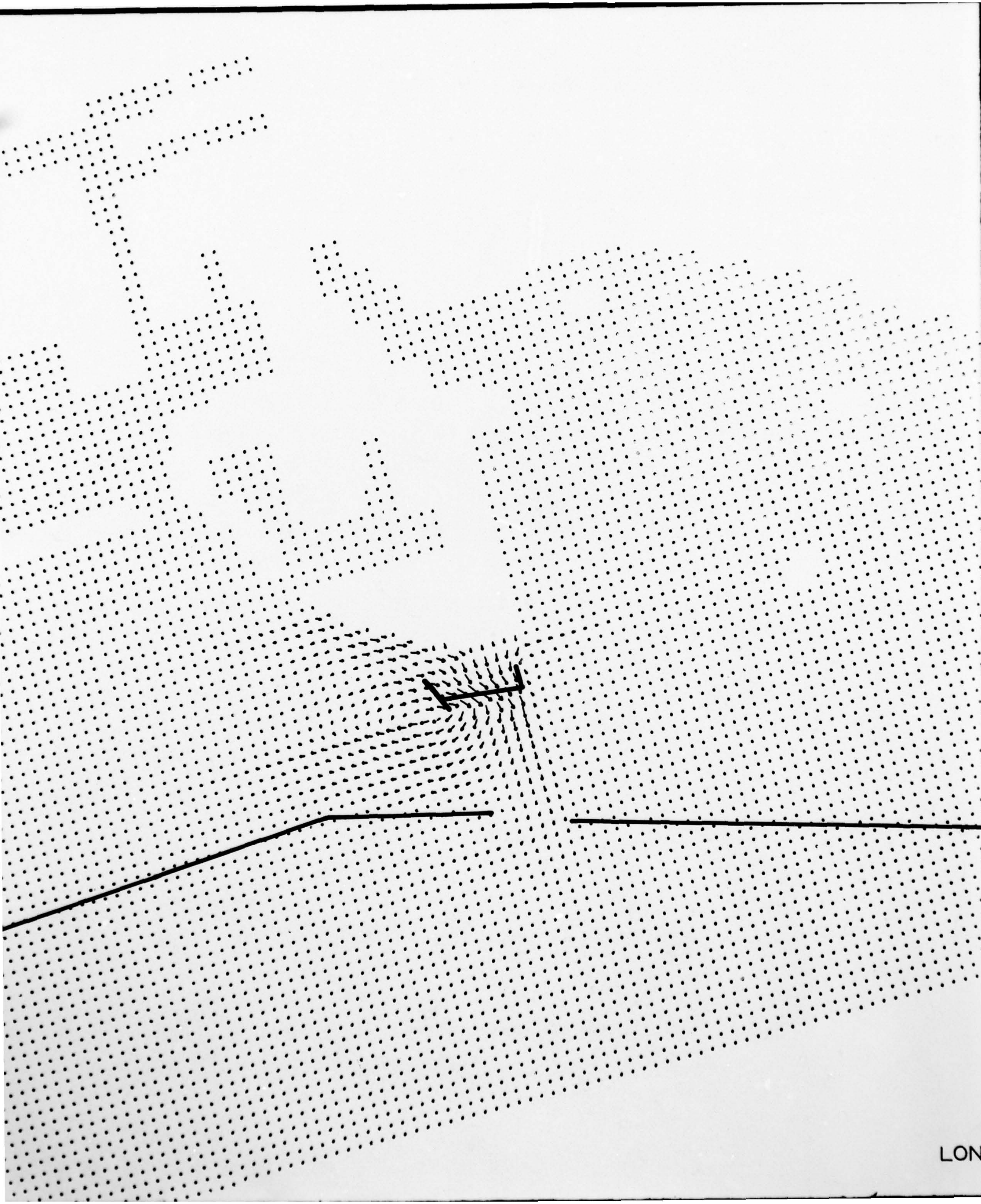
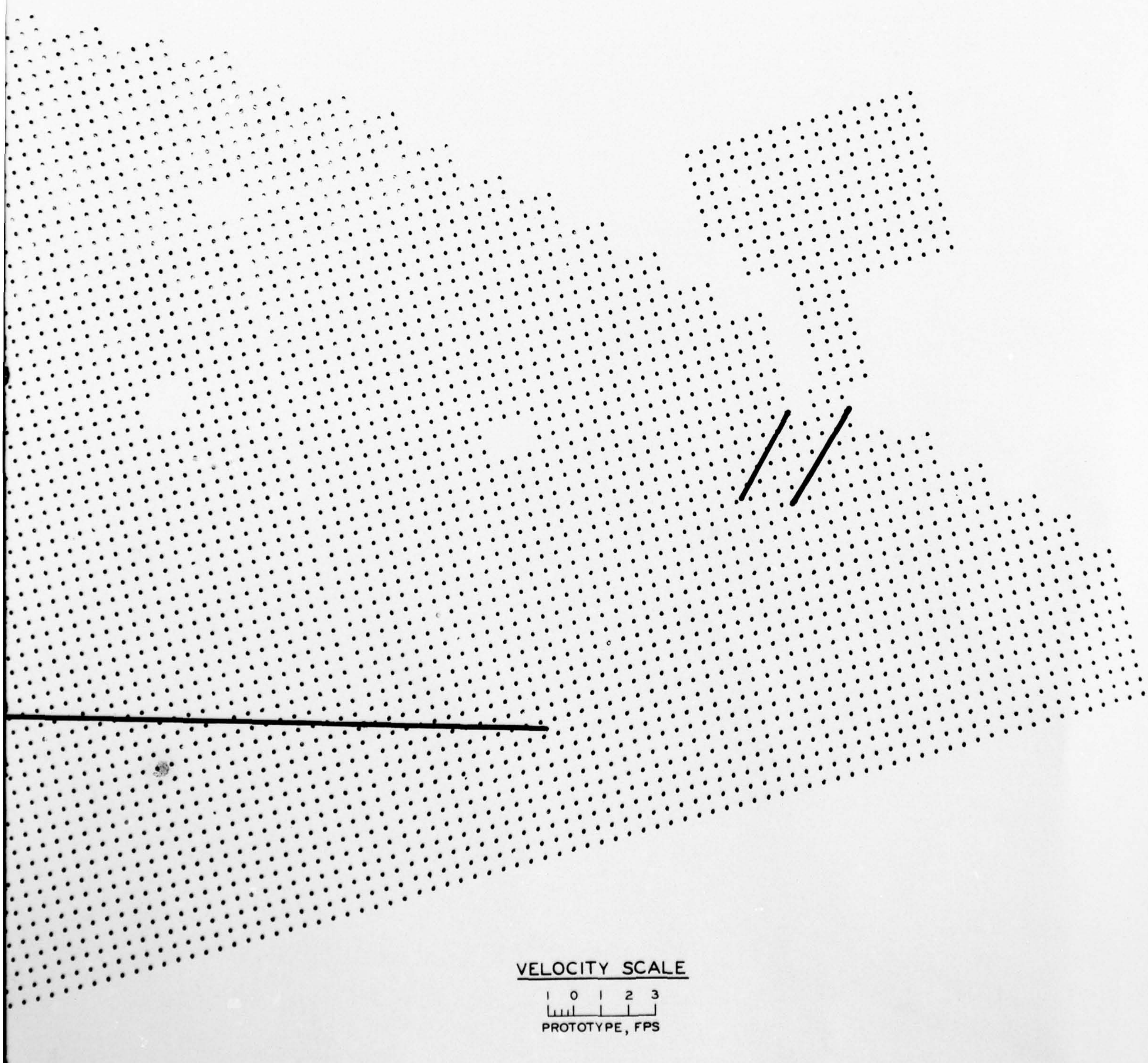
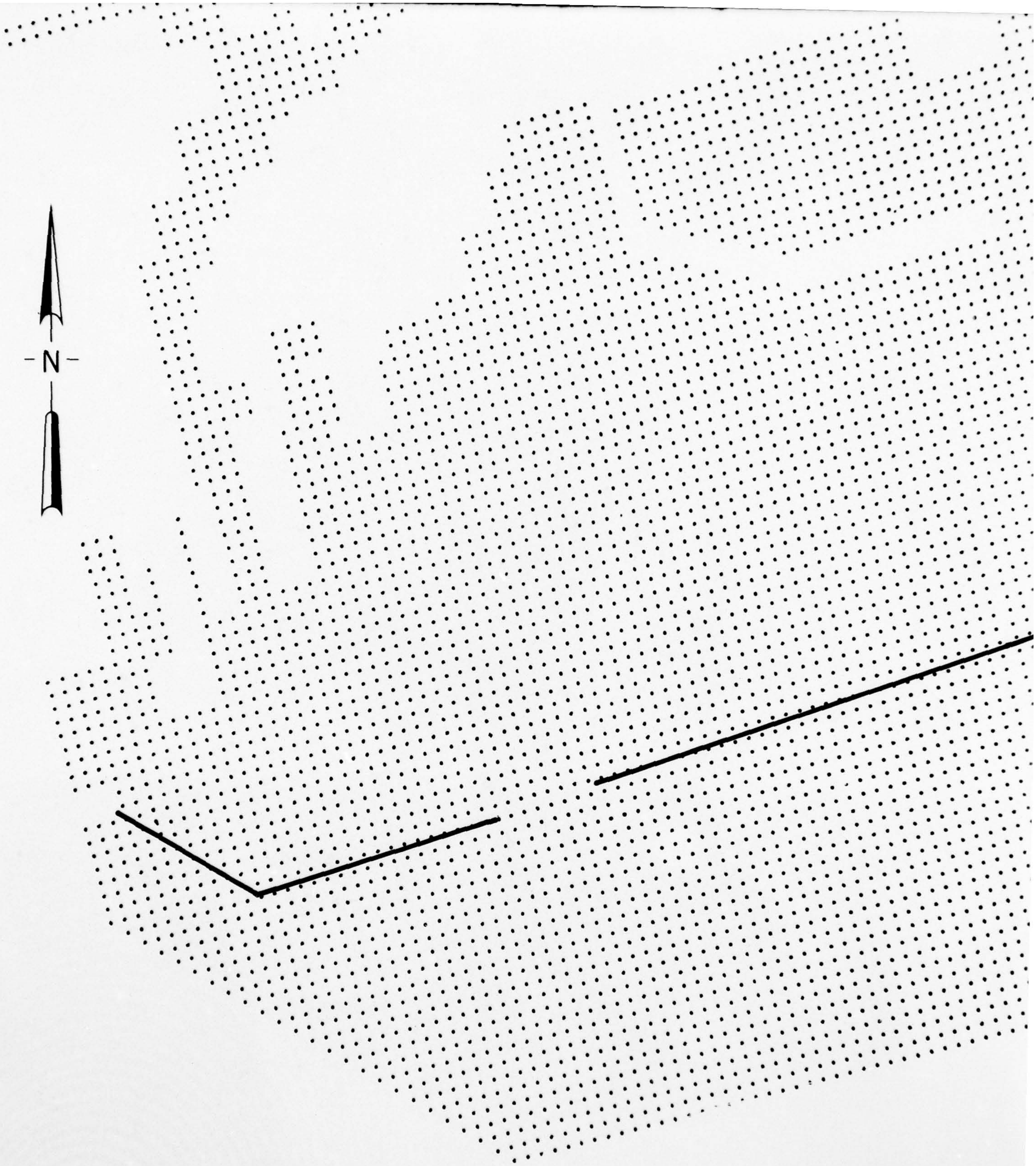




NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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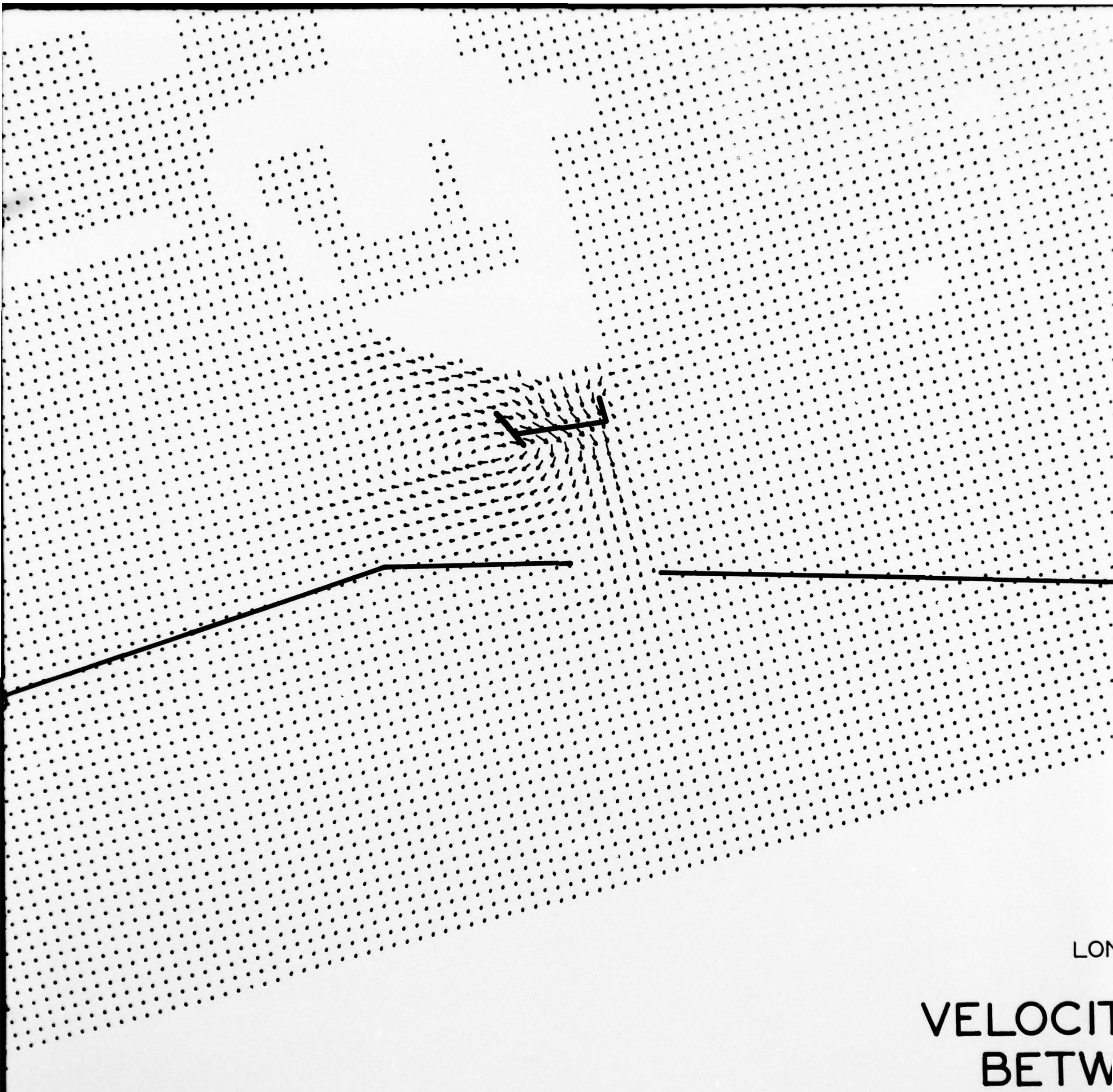

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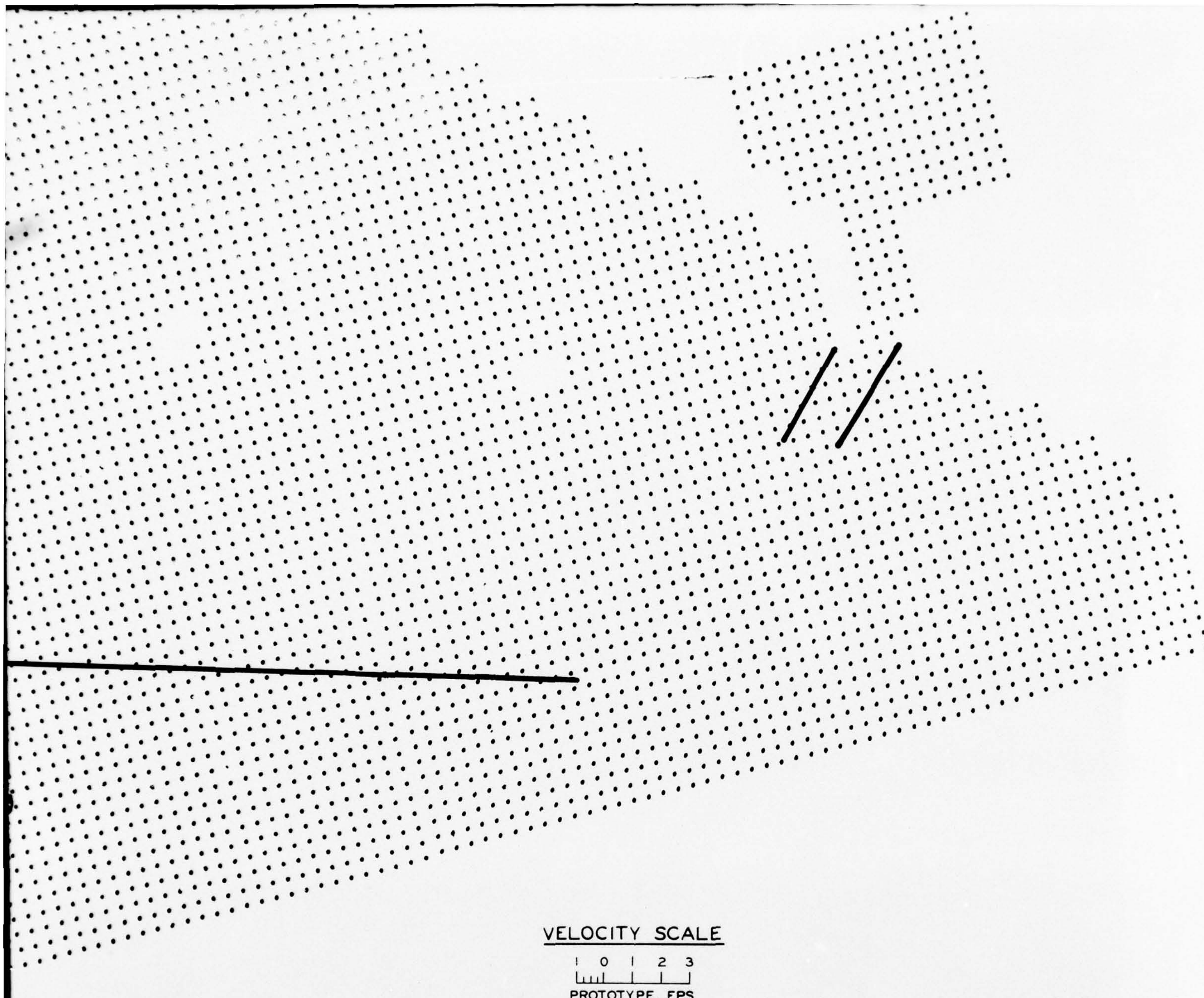
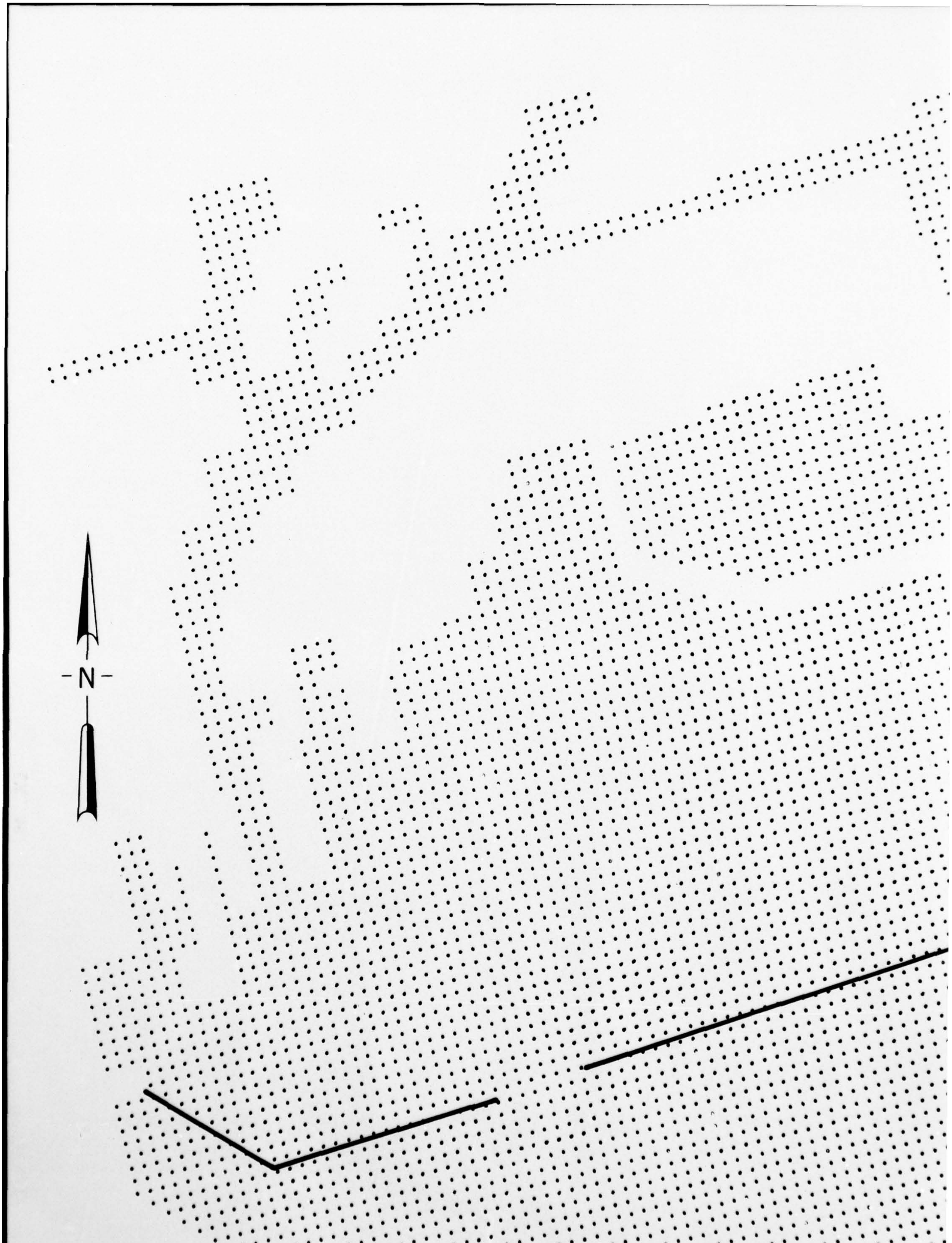


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, −62-FT CHANNEL, 600-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)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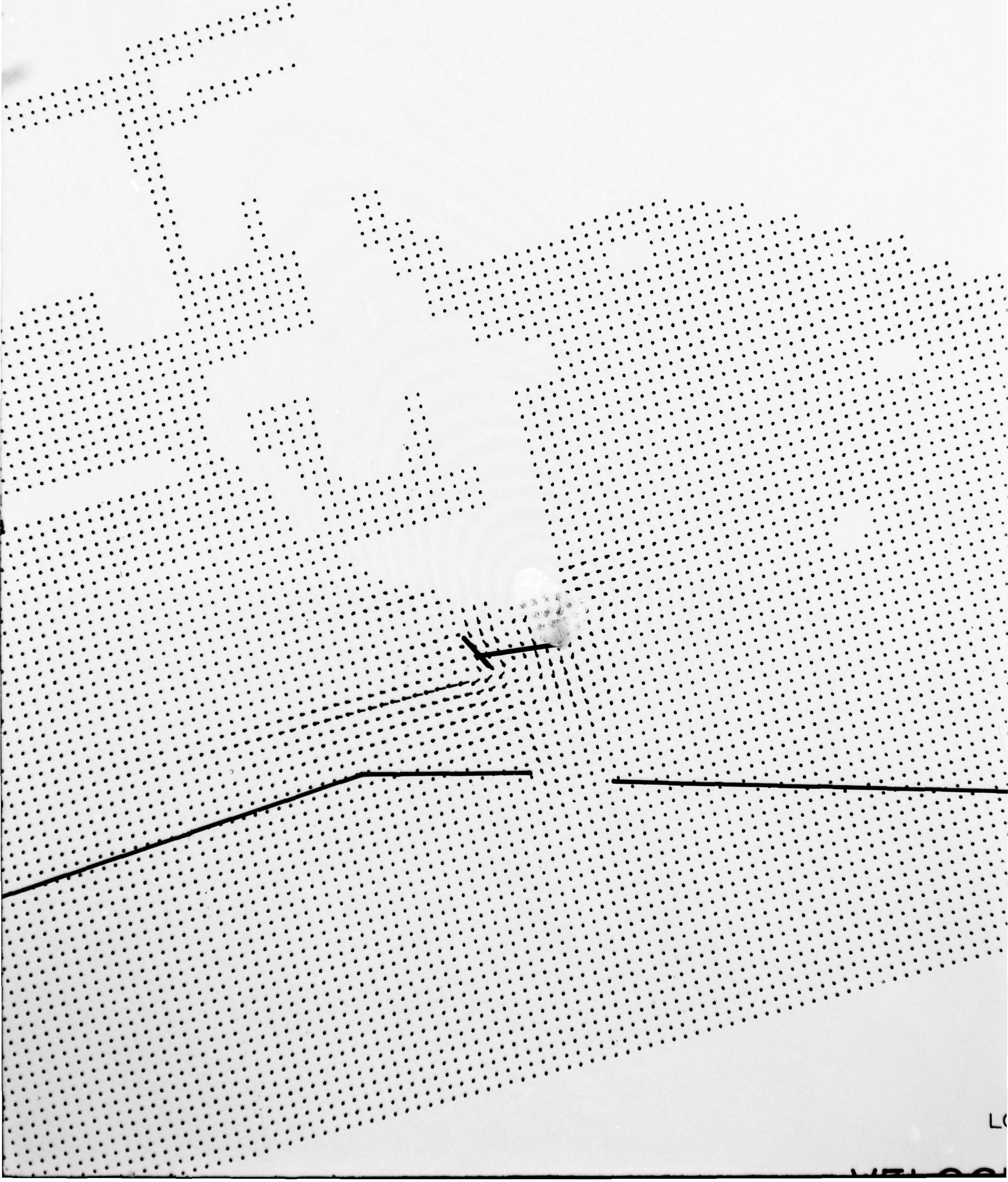
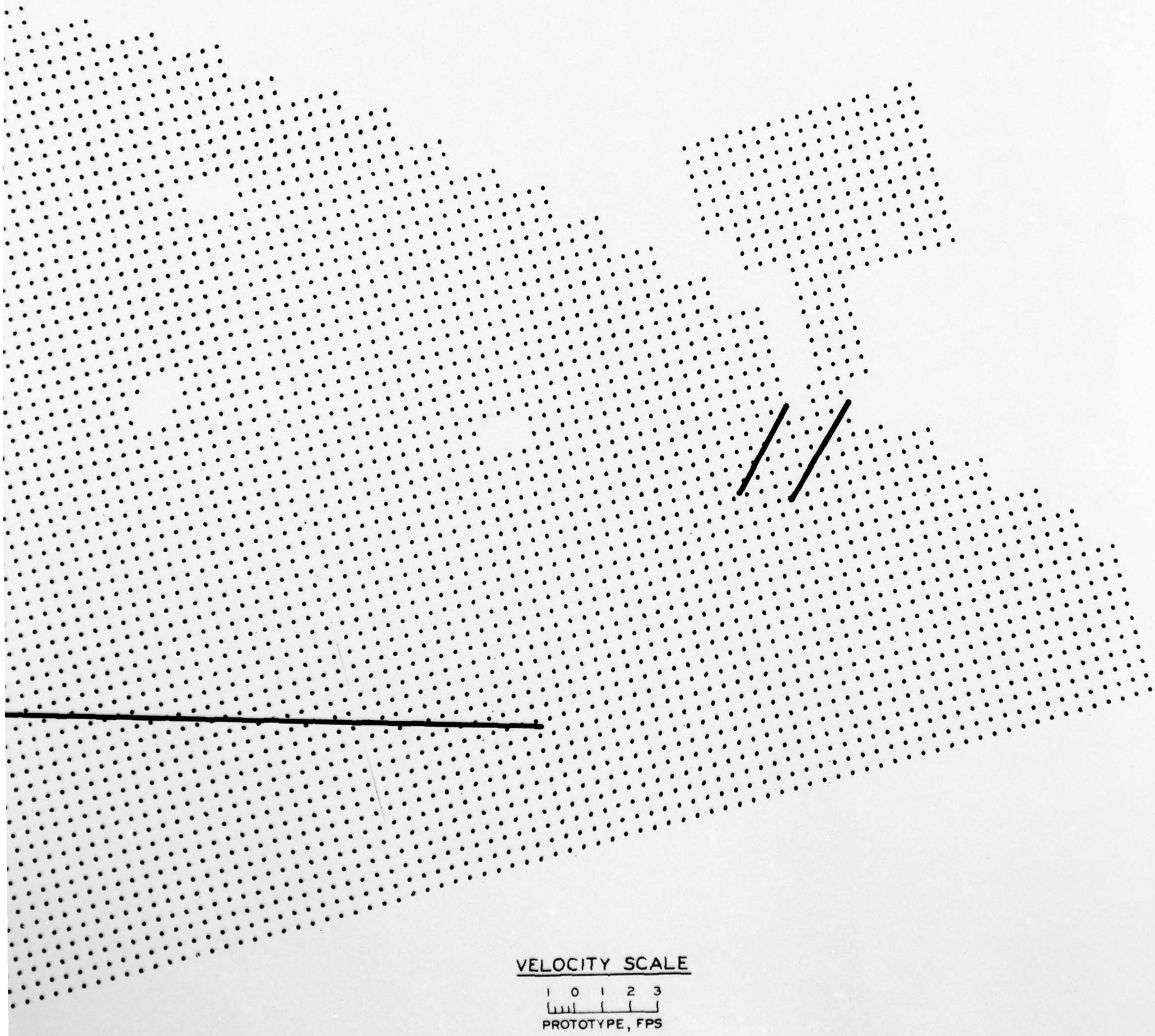
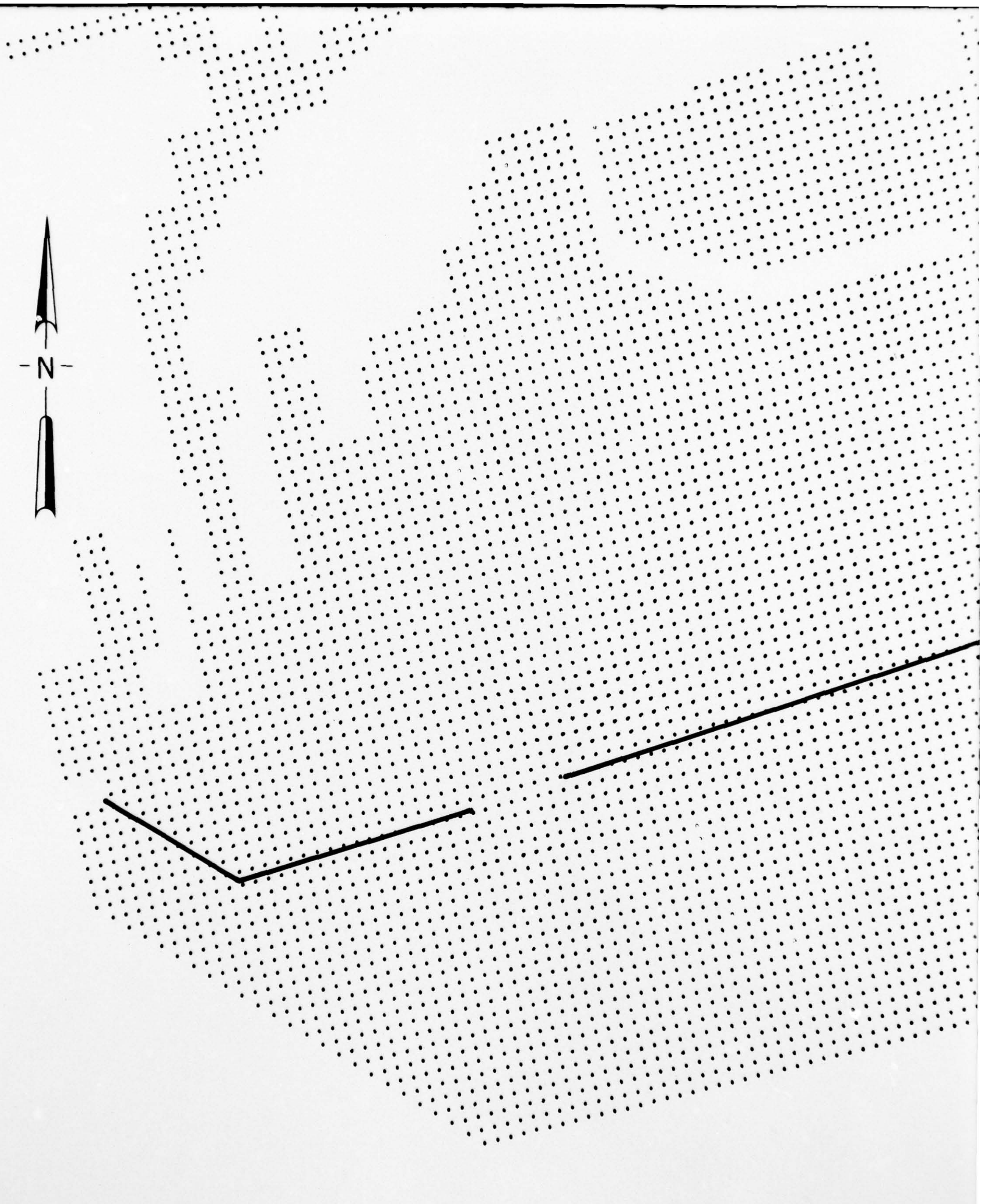




NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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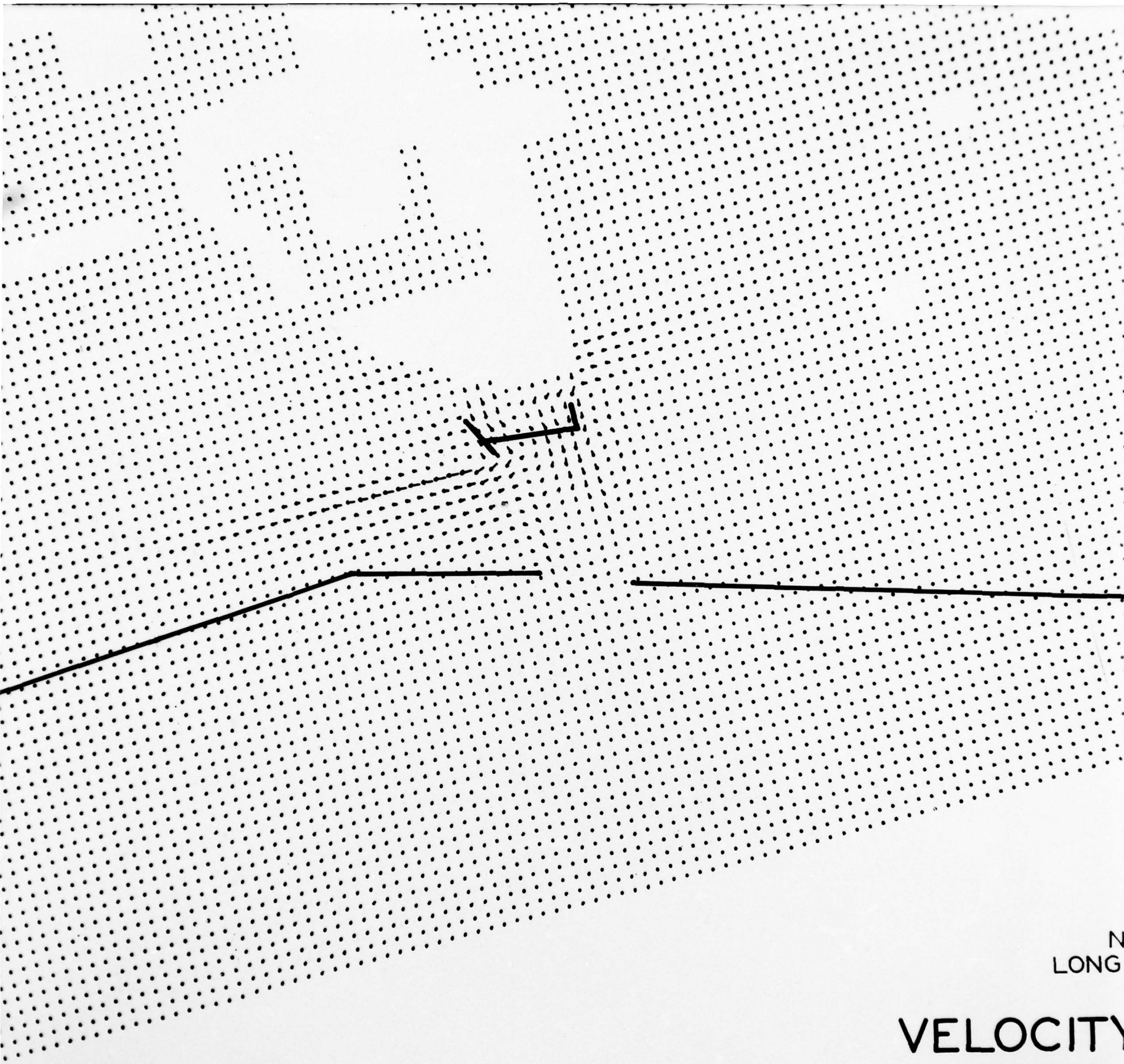

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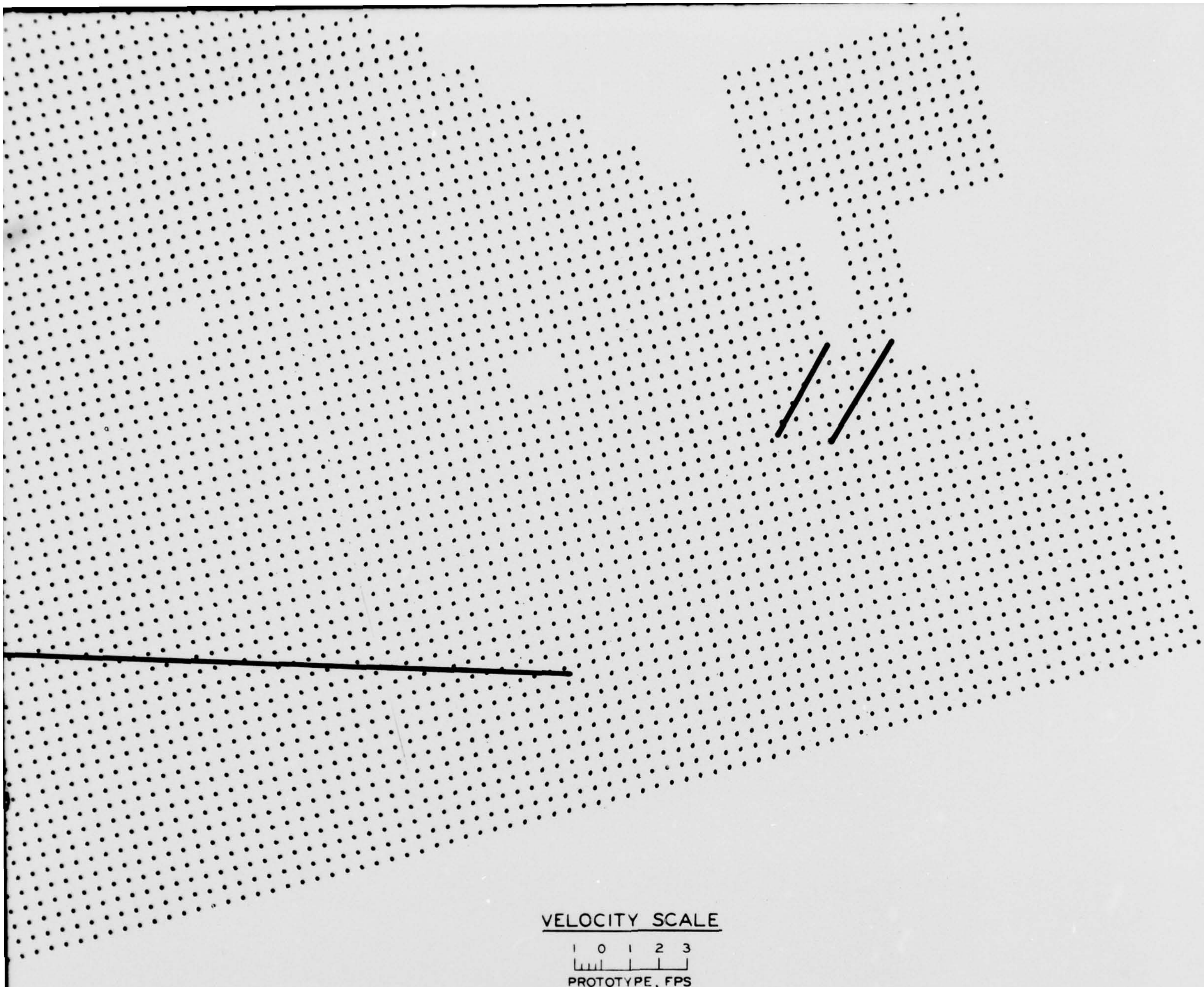
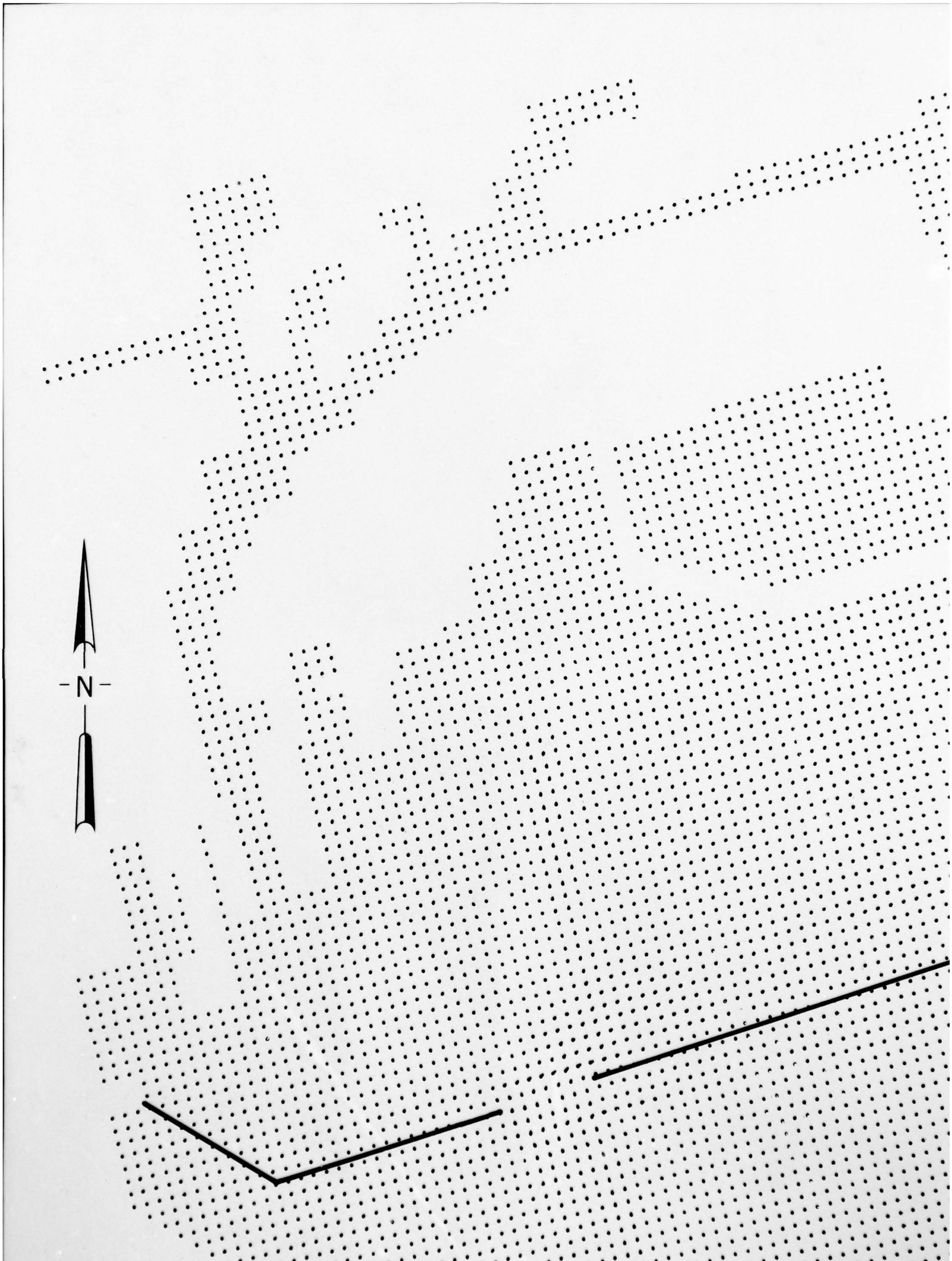


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -62-FT CHANNEL, 600-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)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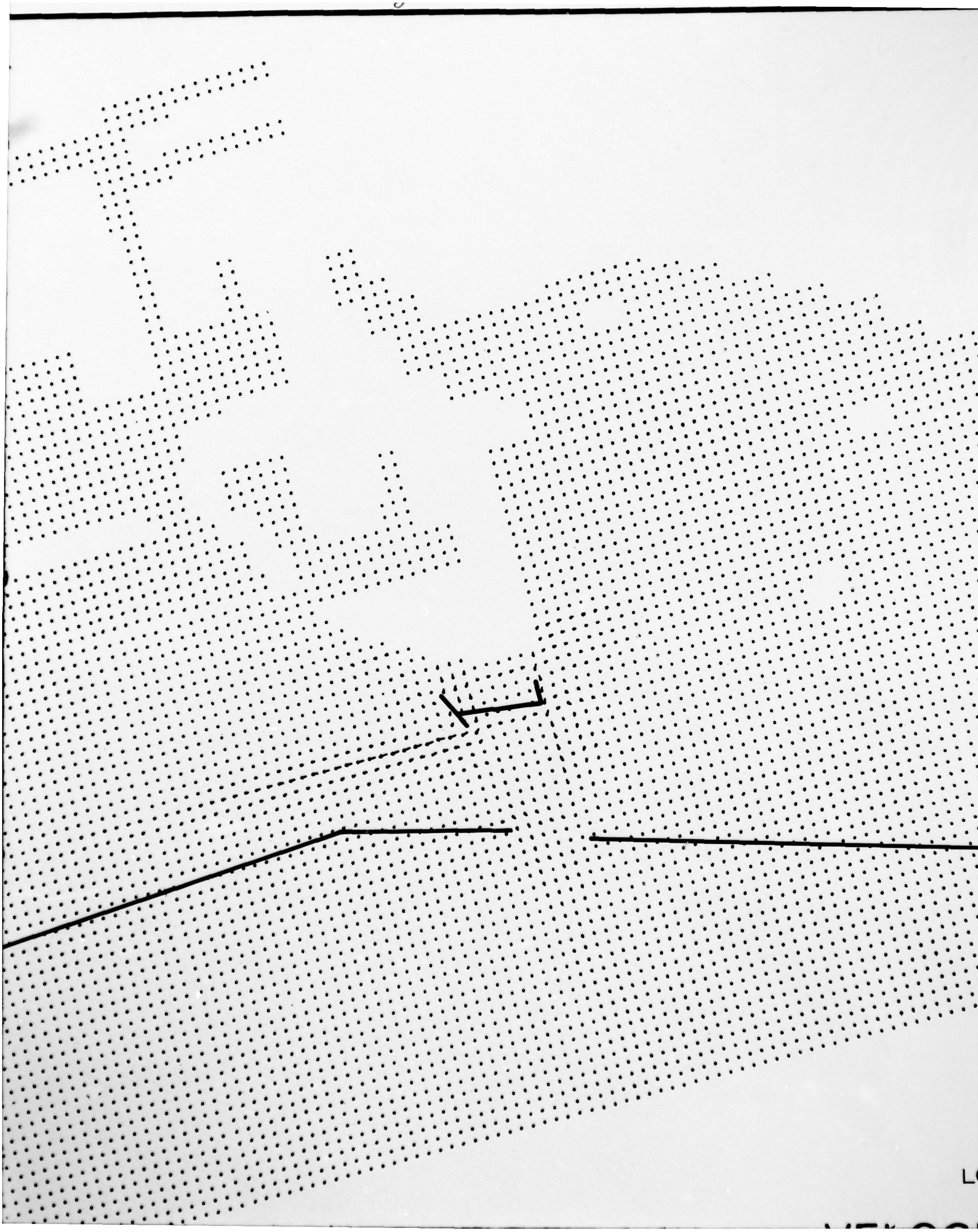

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NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR. --ETC(U)
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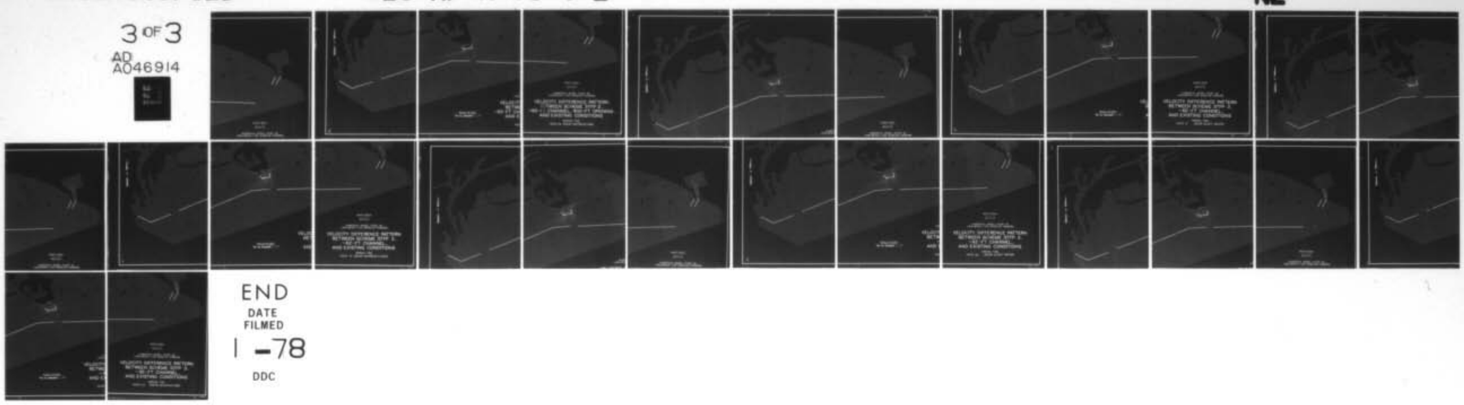

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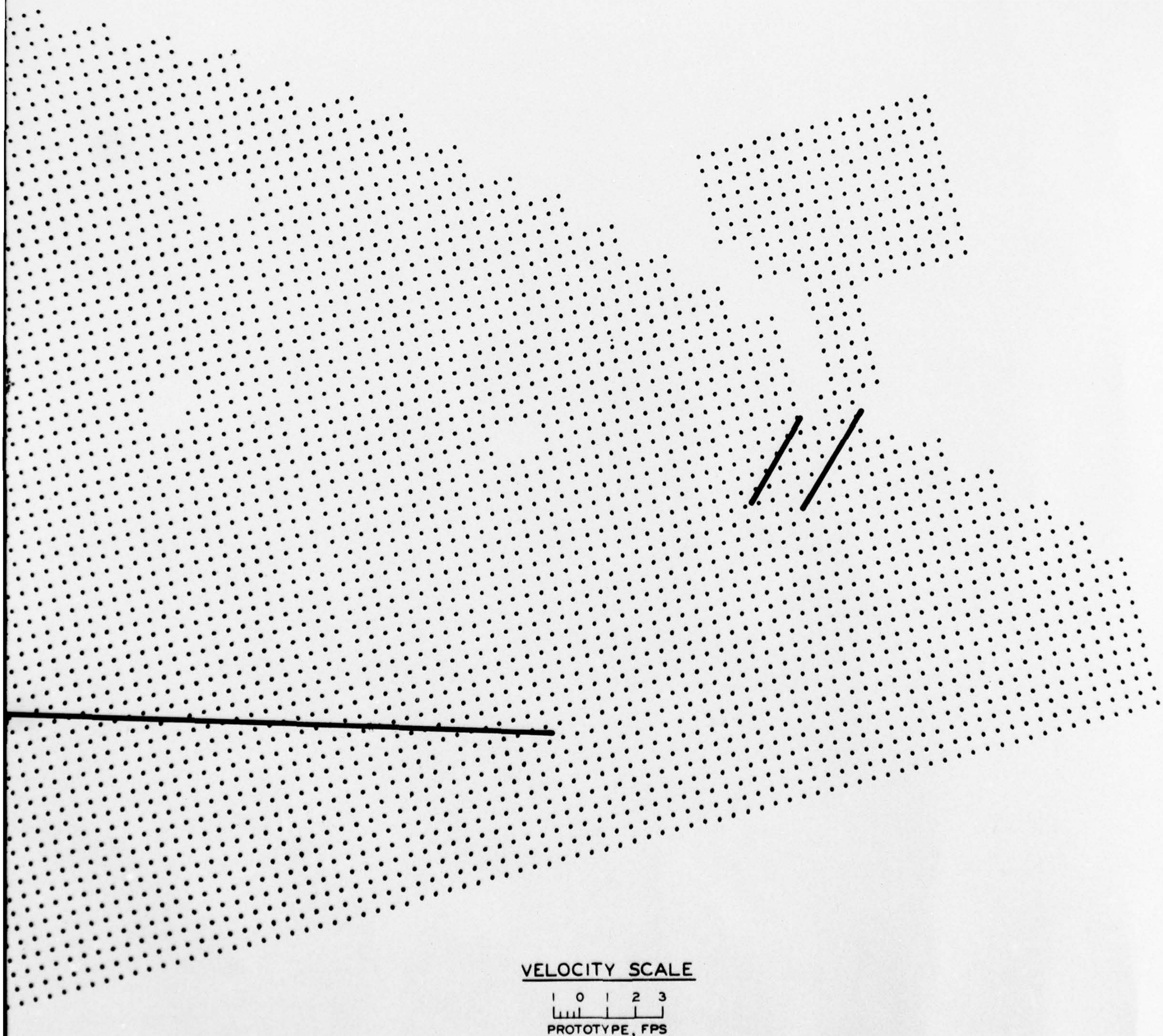
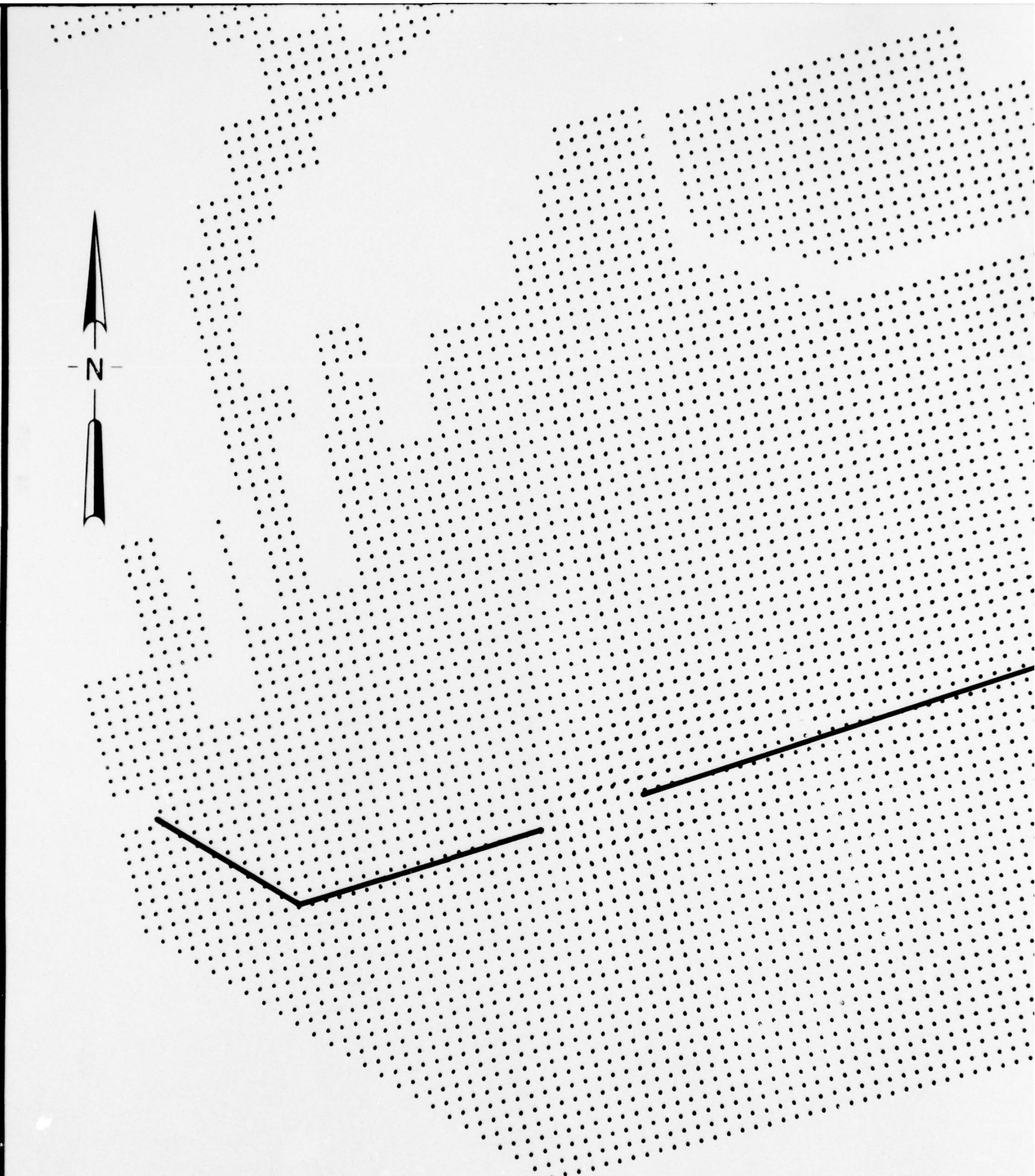


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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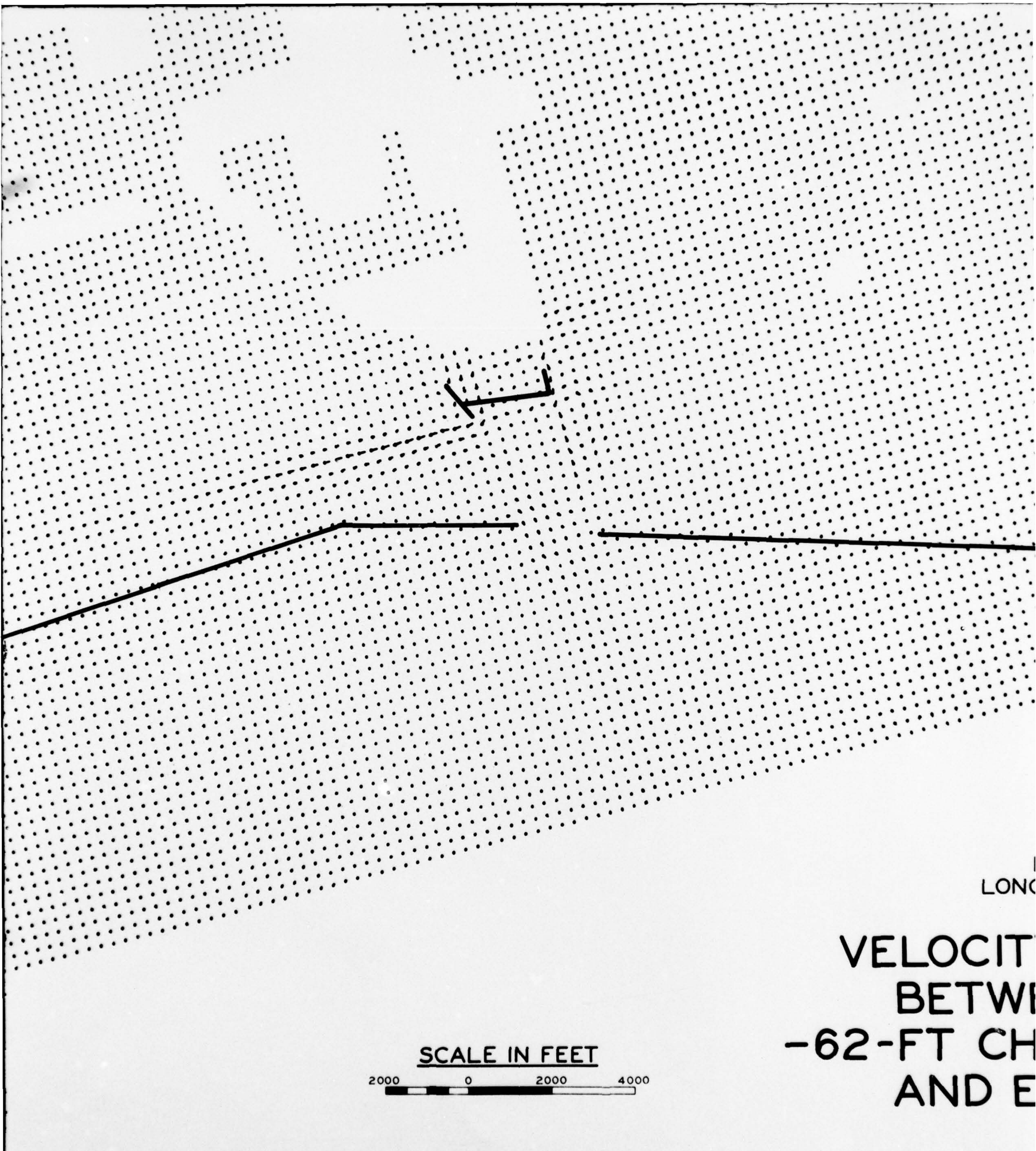

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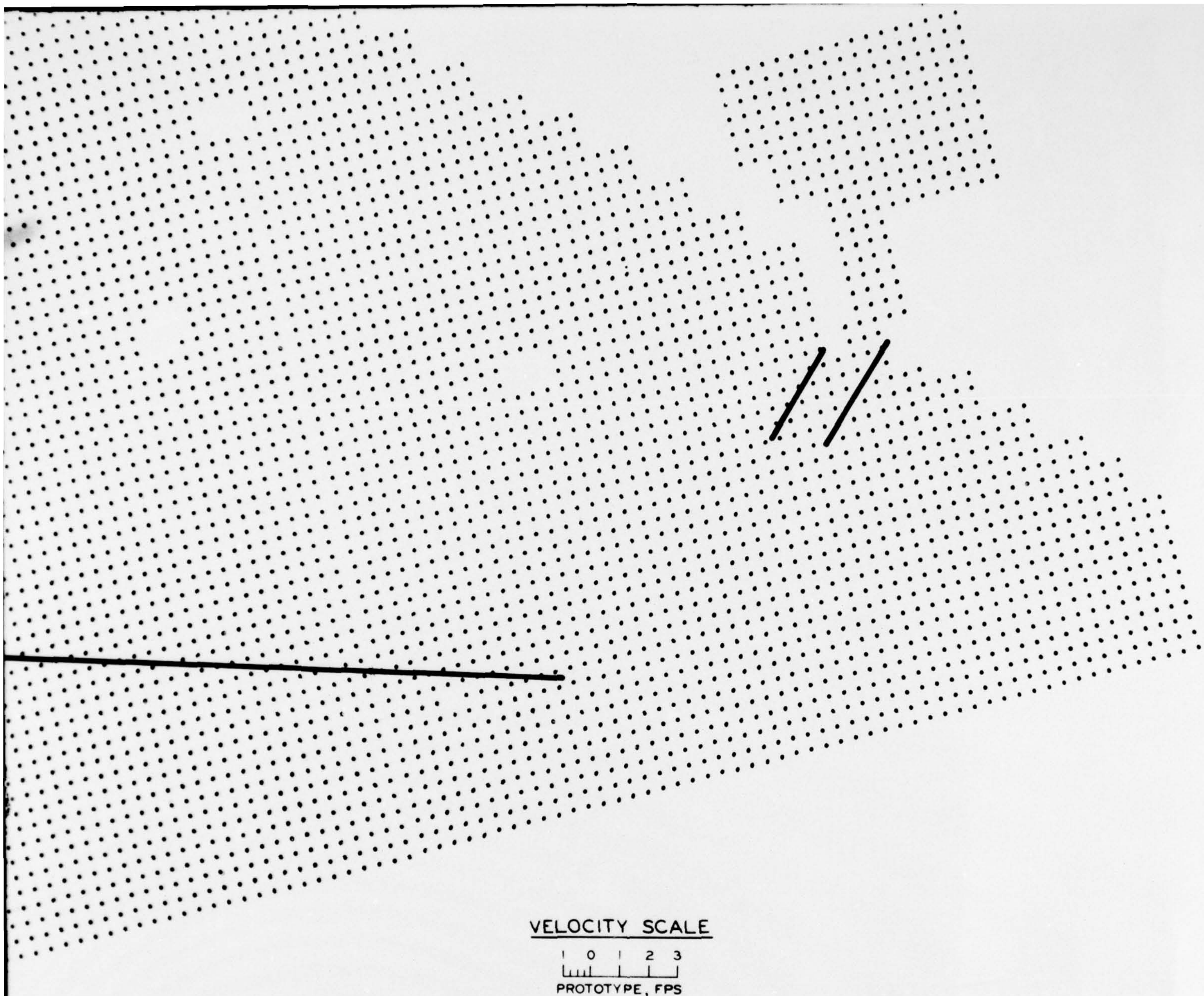

NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -62-FT CHANNEL, 600-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)


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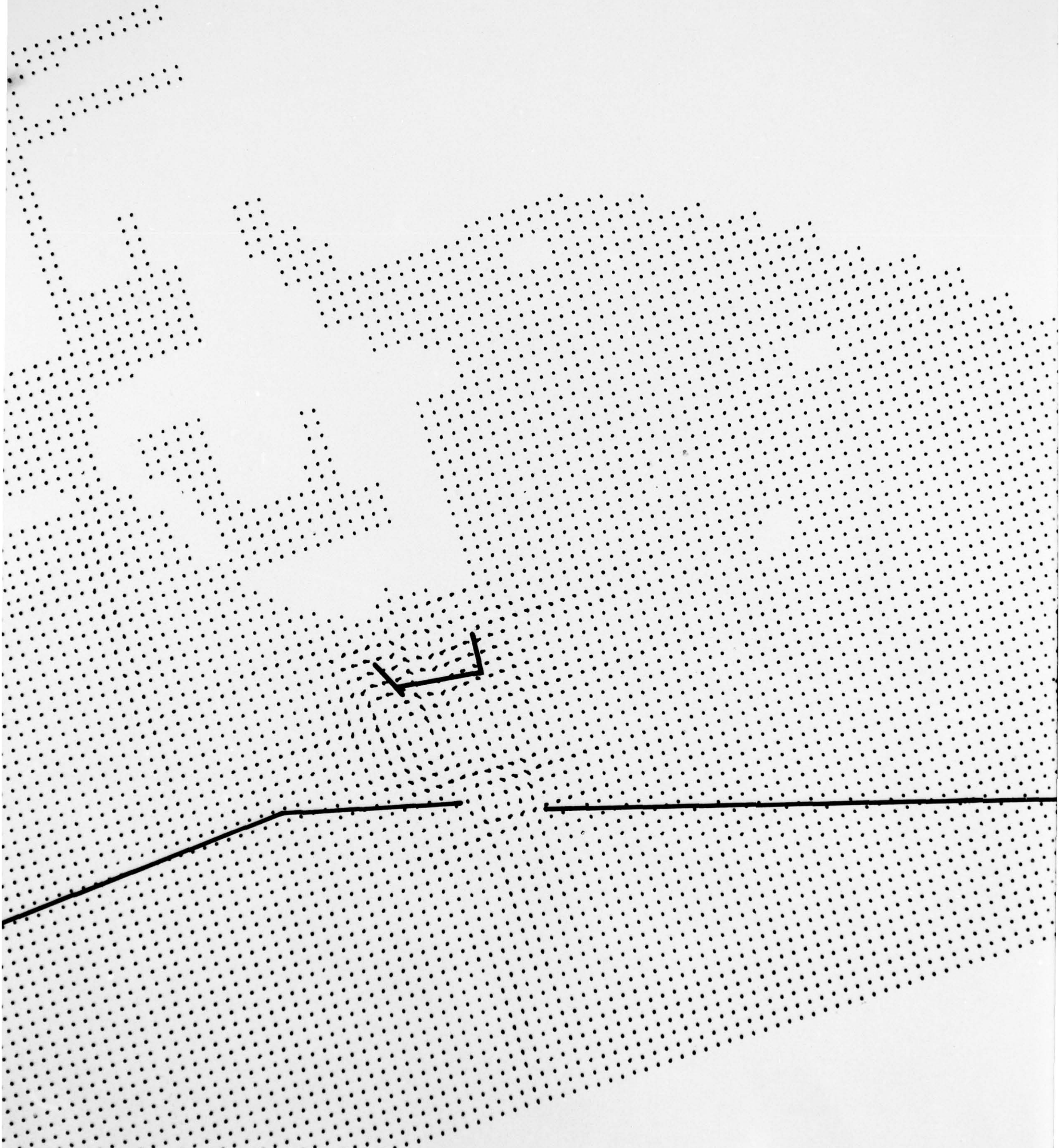

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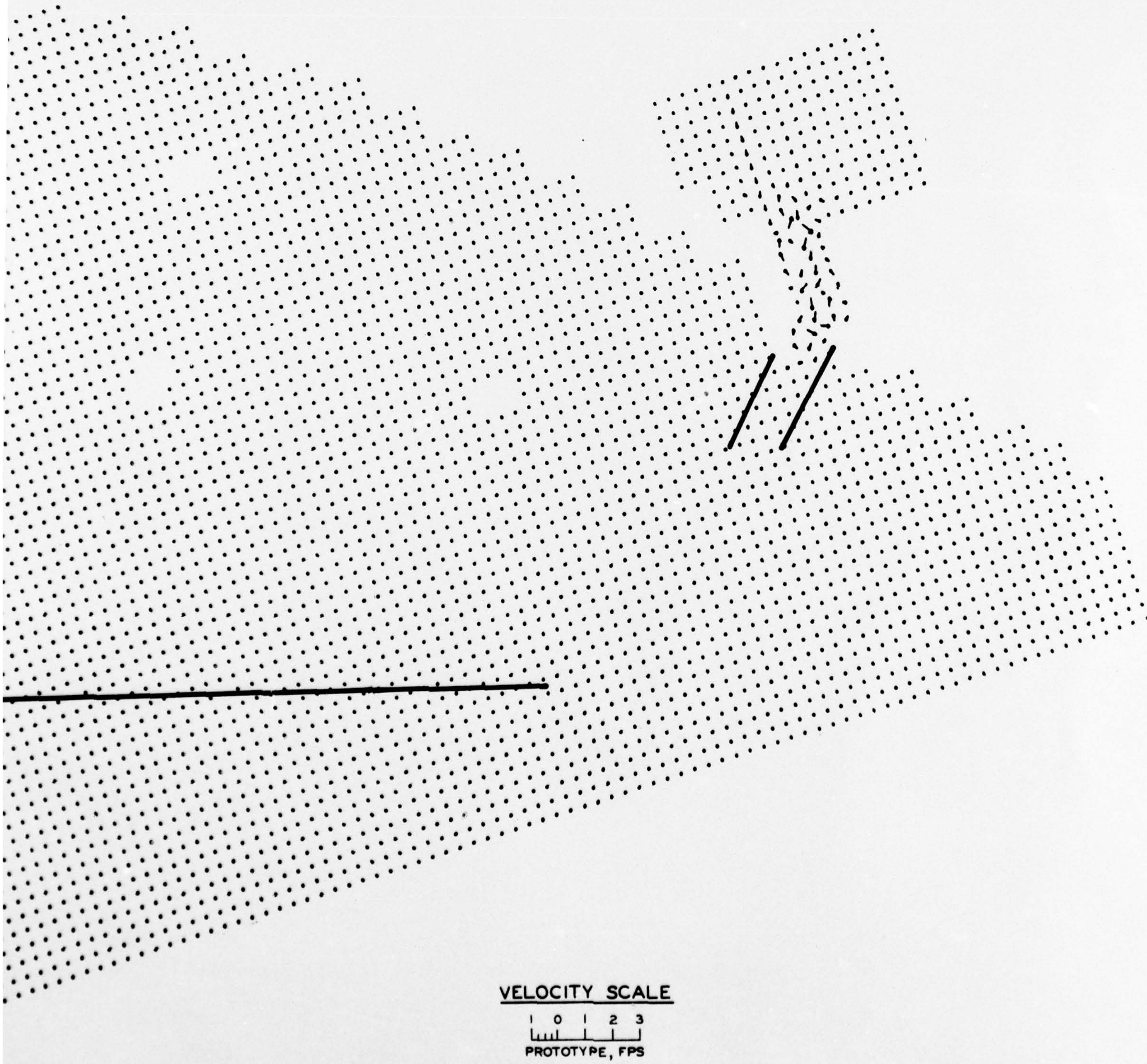
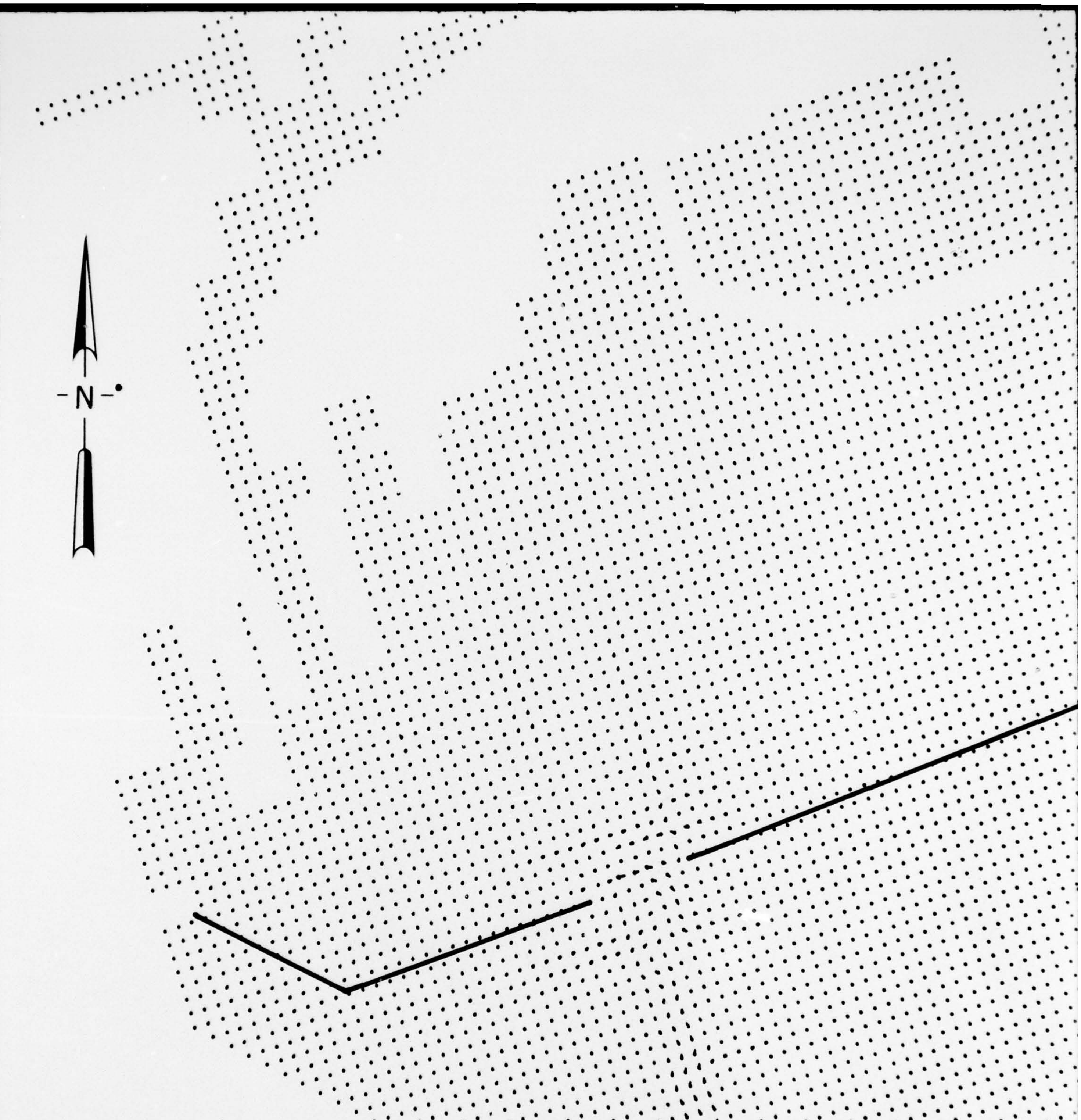


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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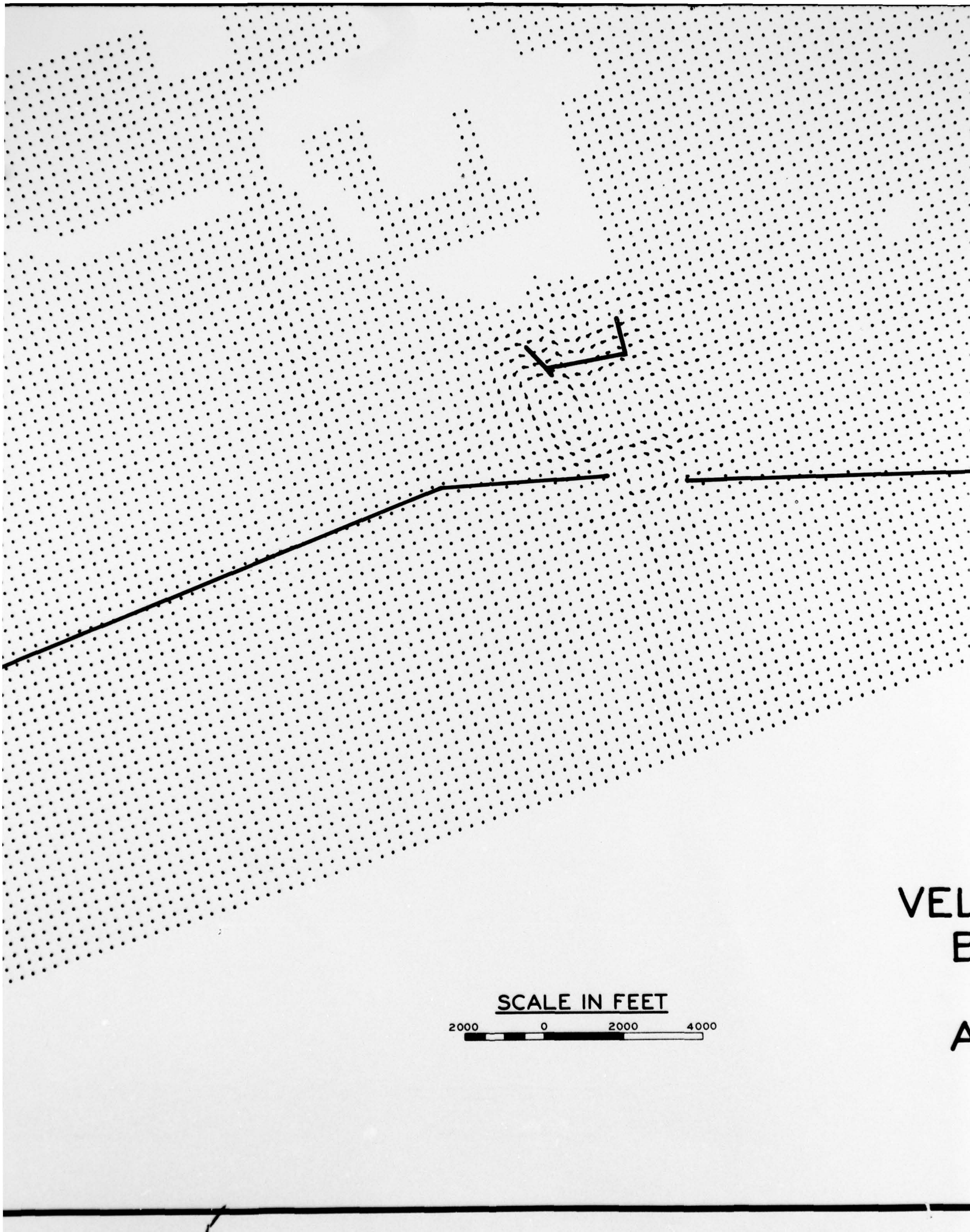

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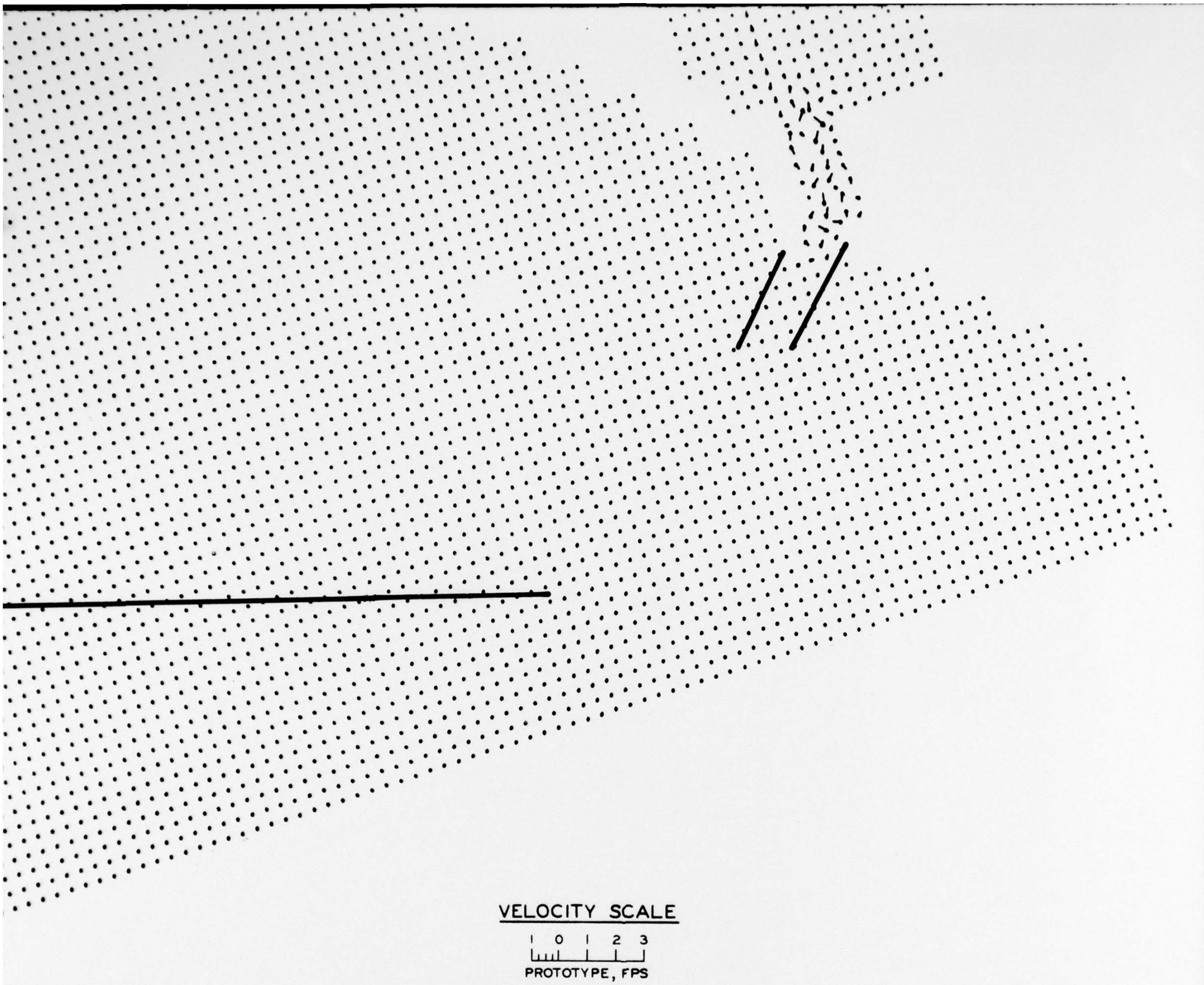
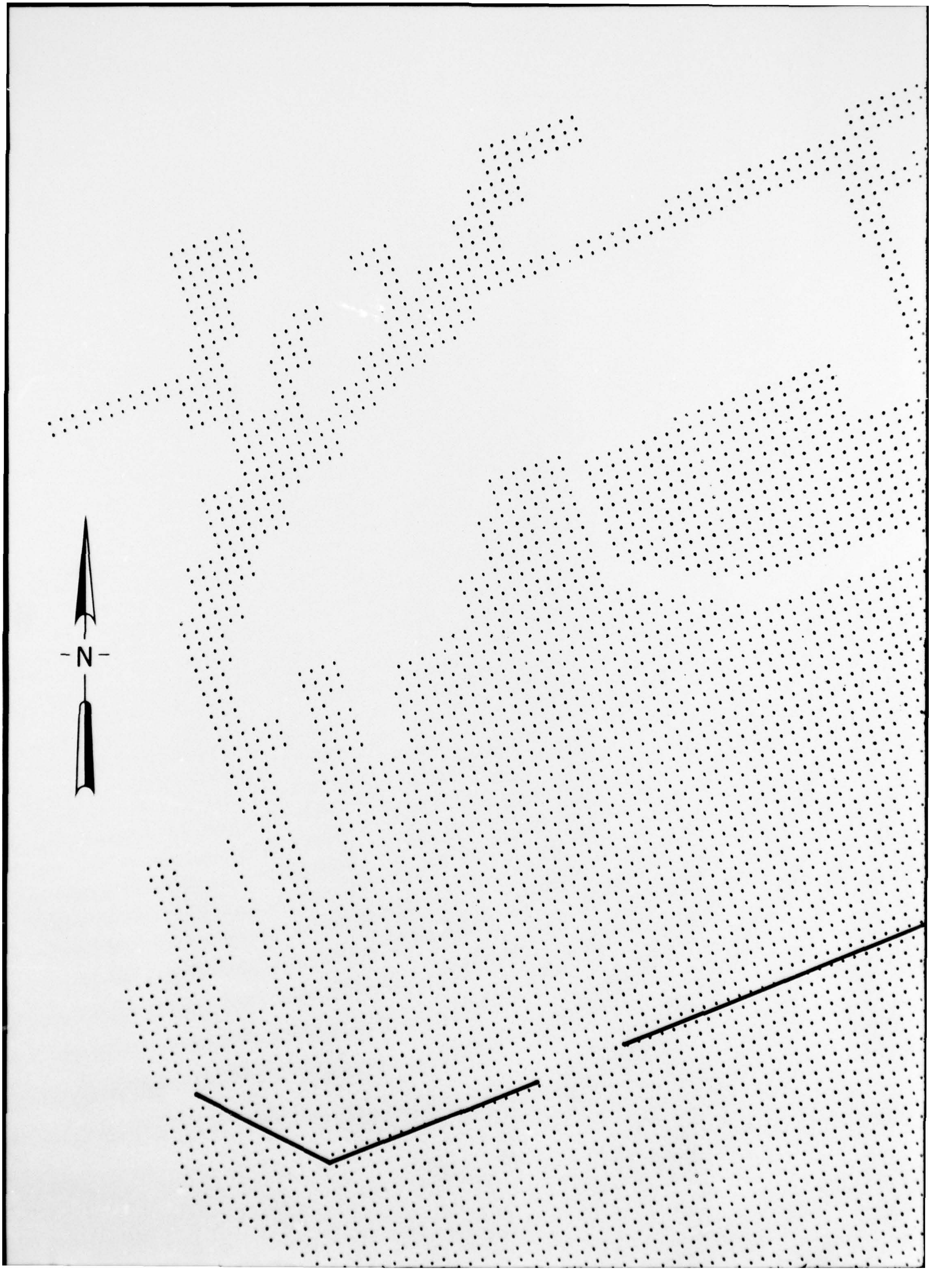


NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 3, –62-FT CHANNEL, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)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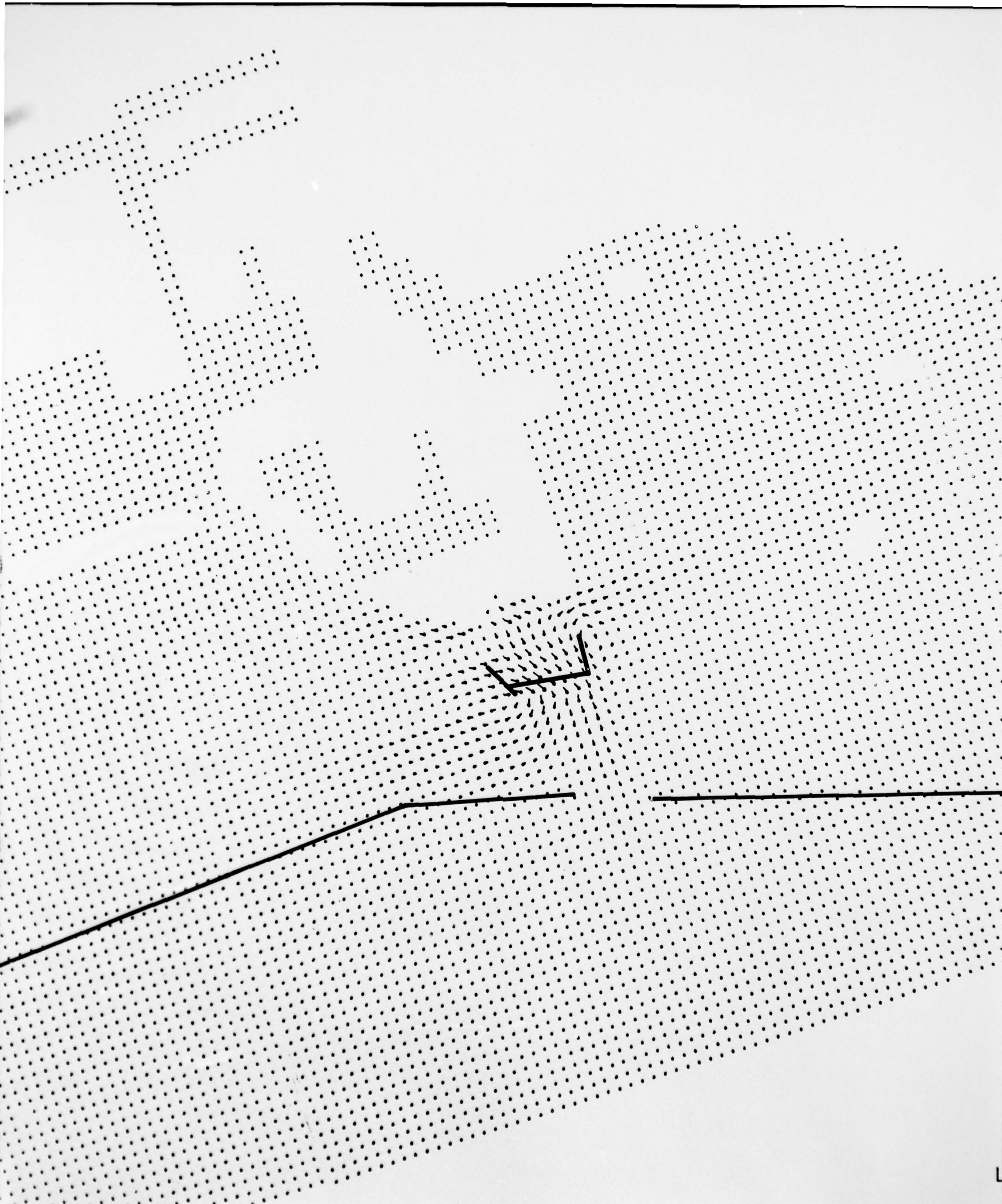
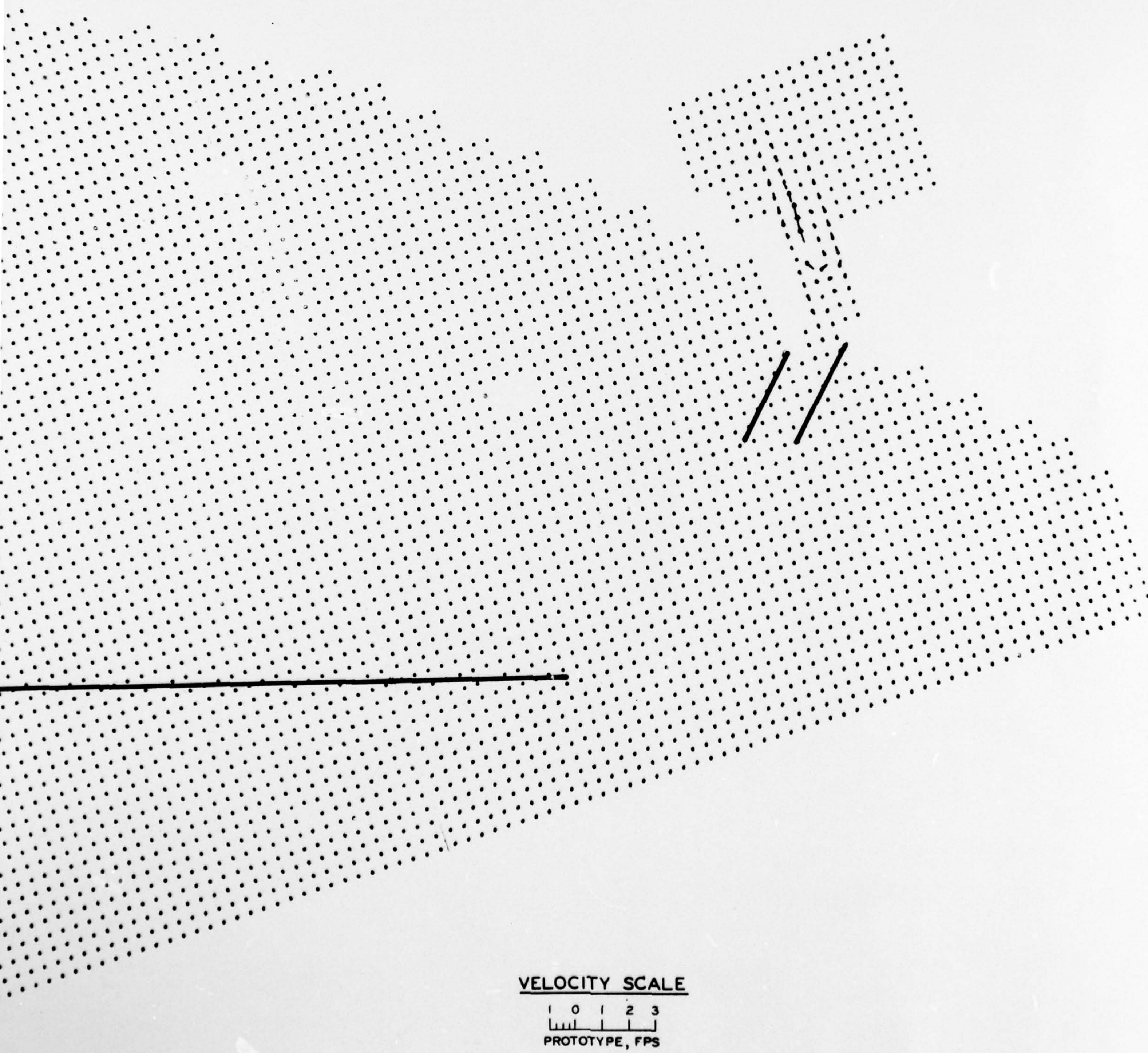
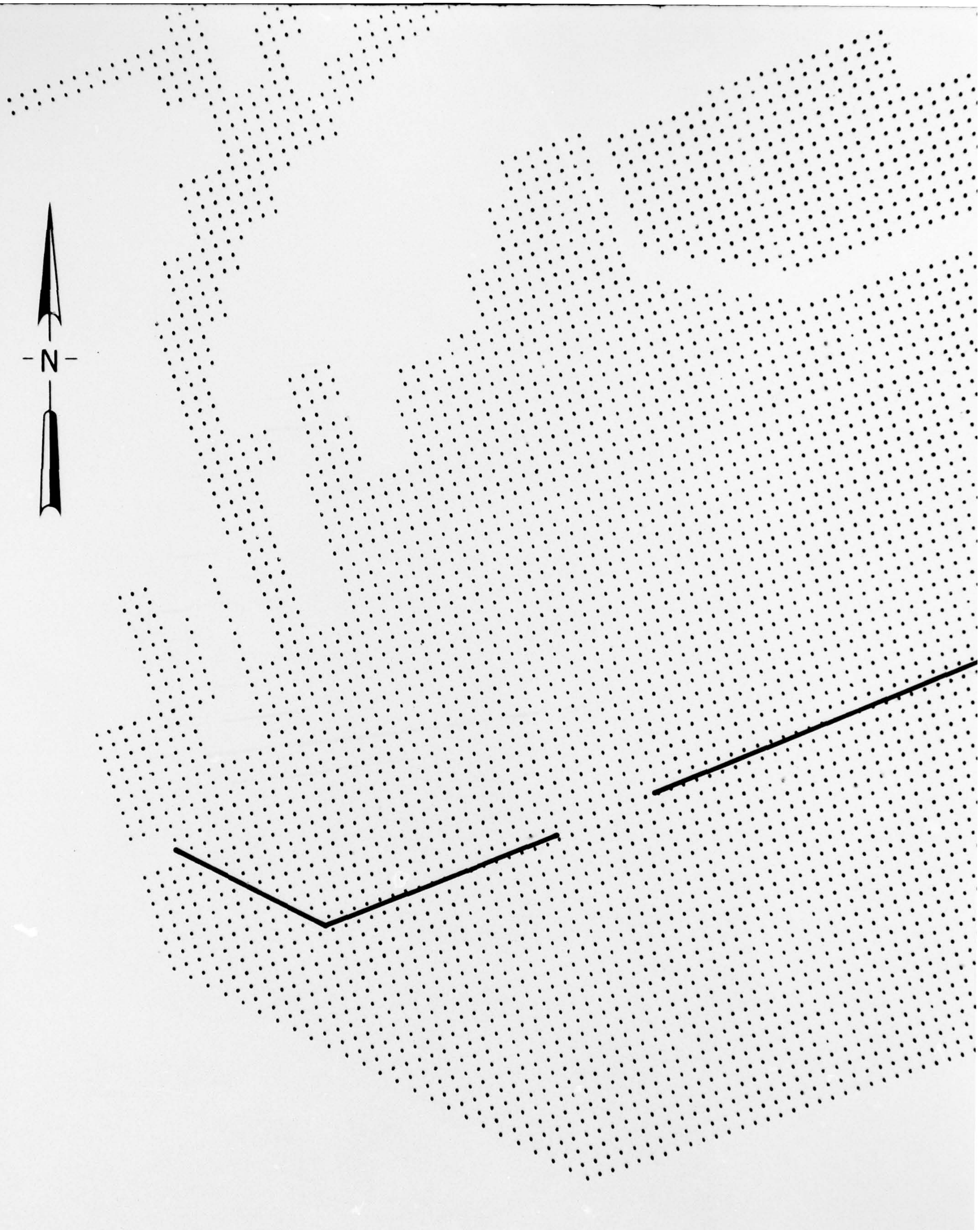




NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS



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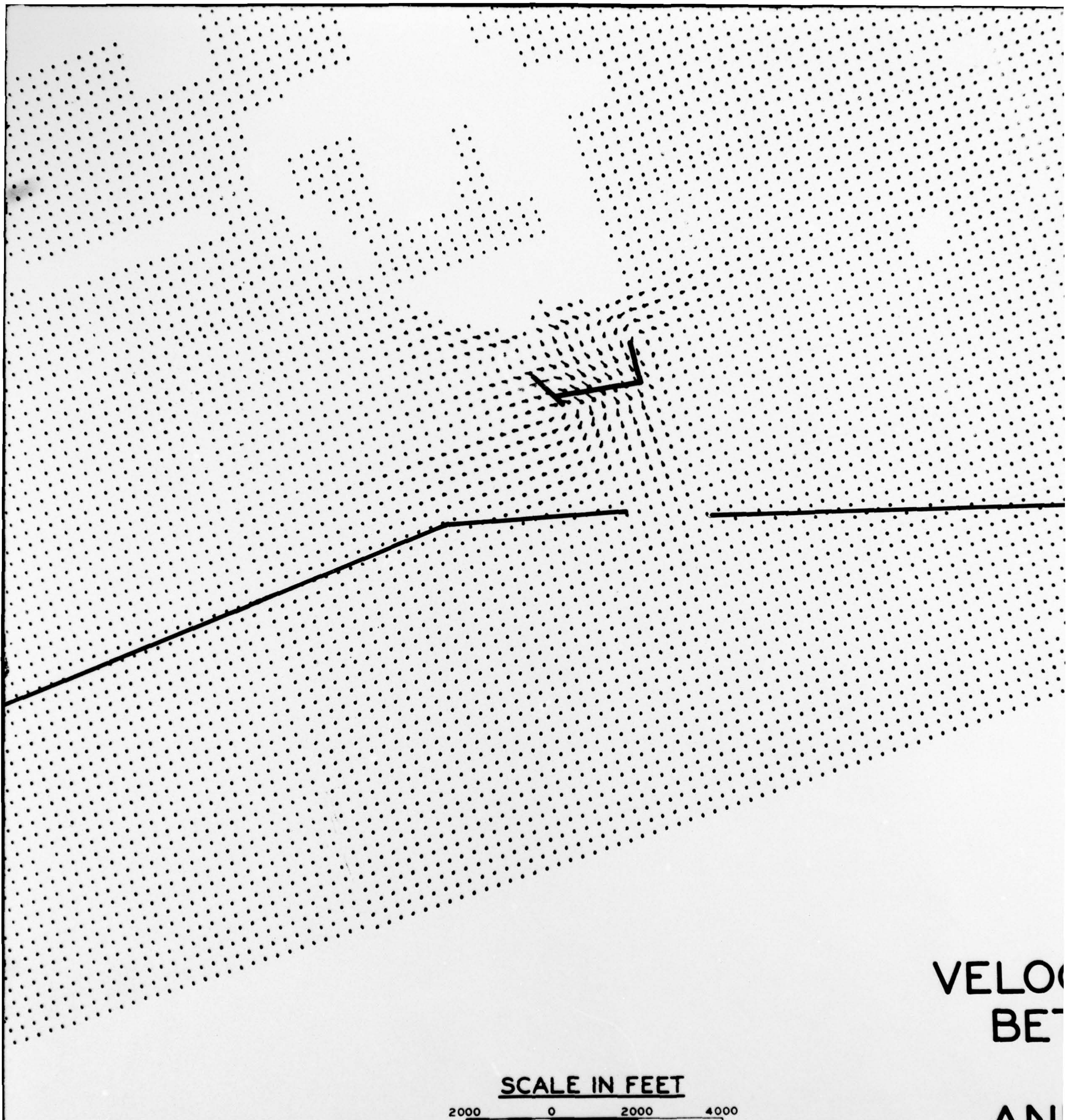

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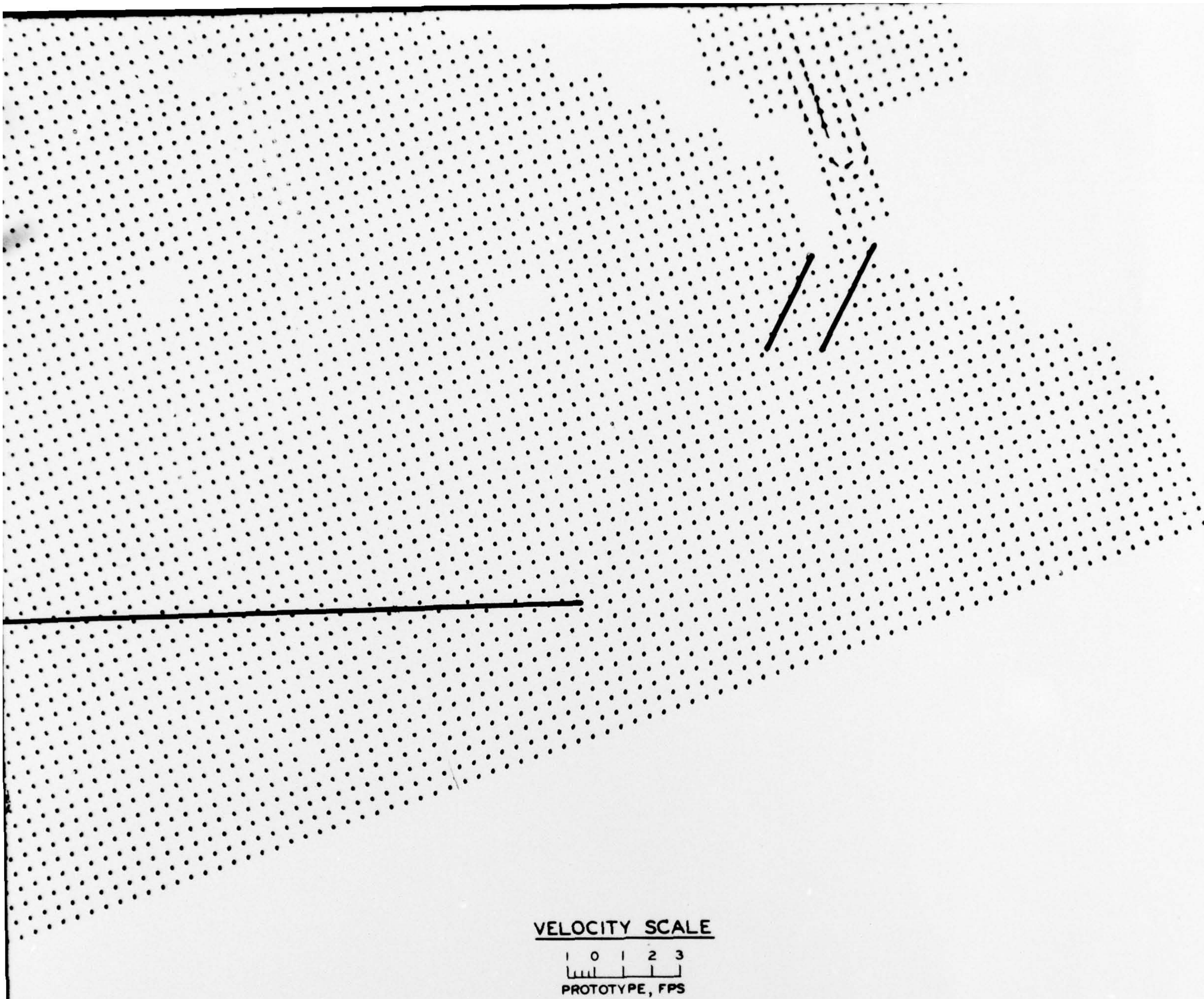
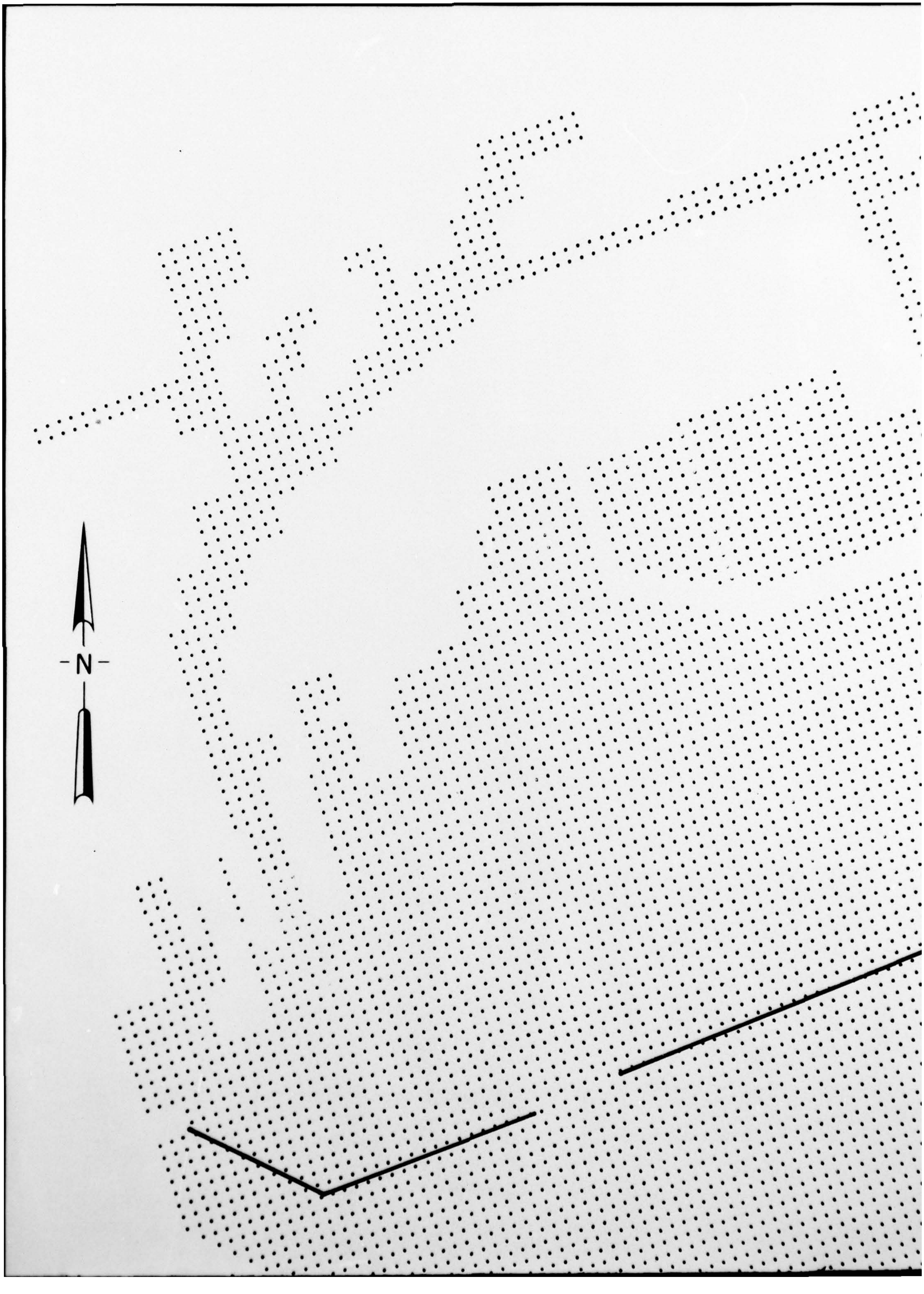


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 3, -62-FT CHANNEL, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)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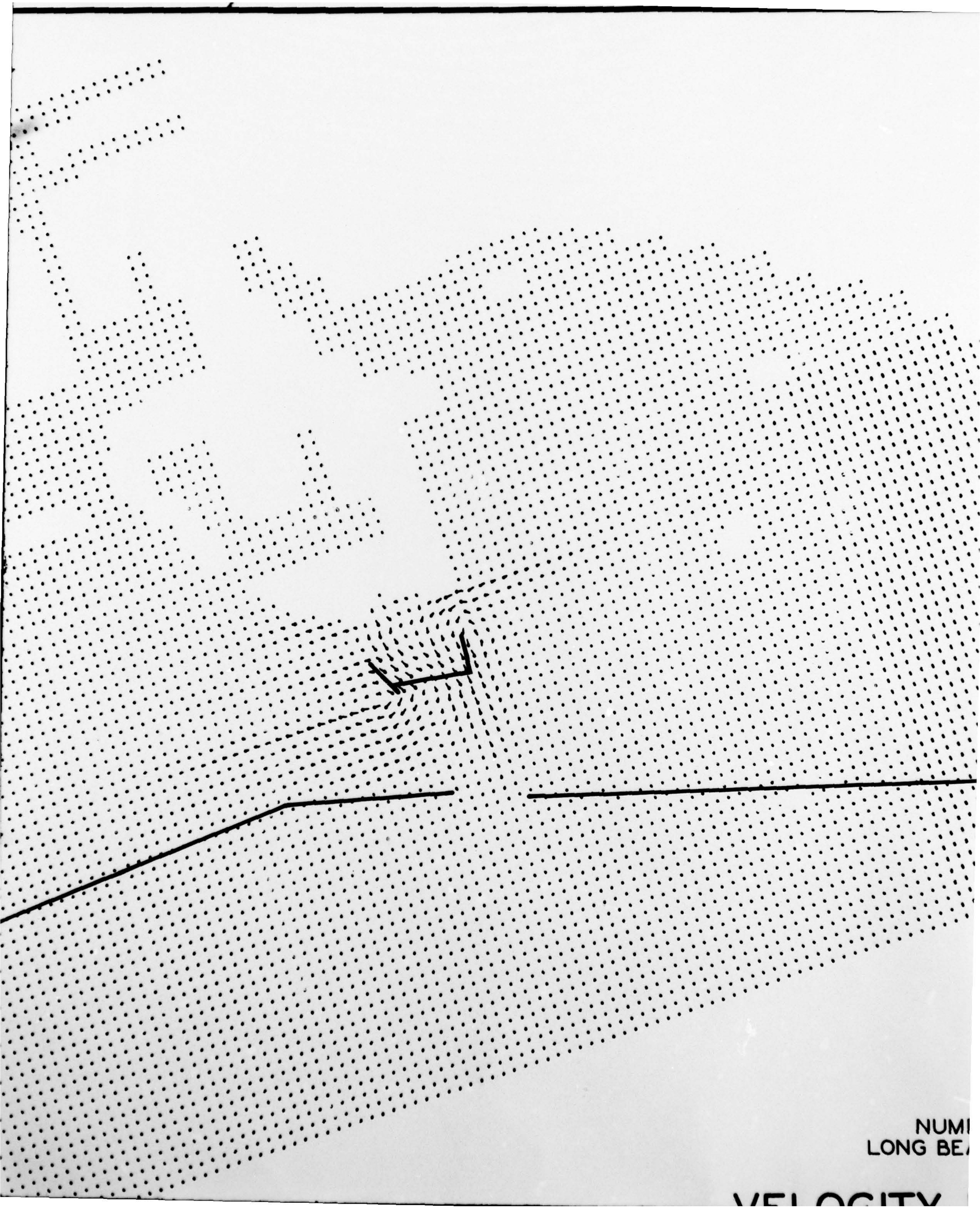

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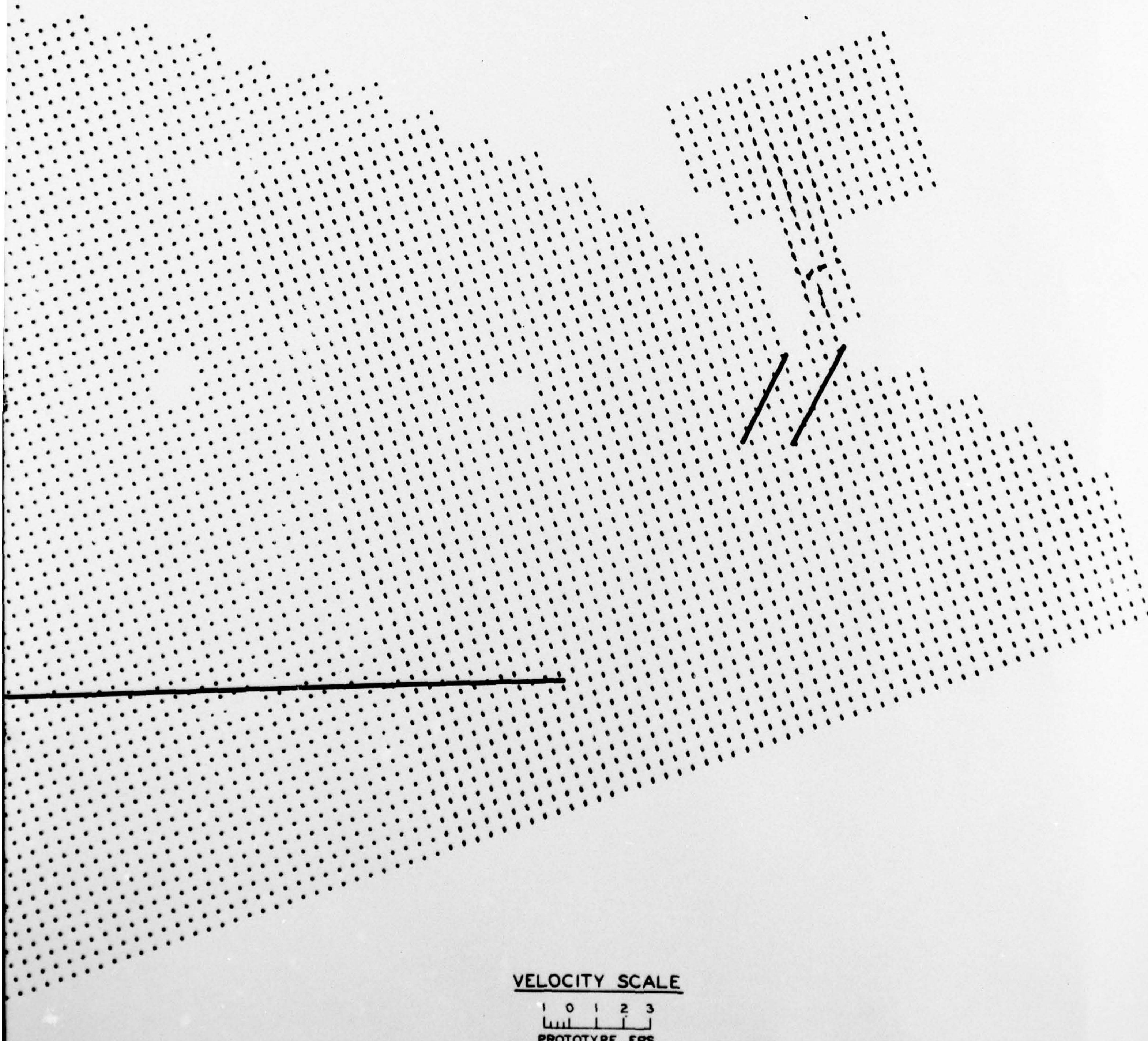
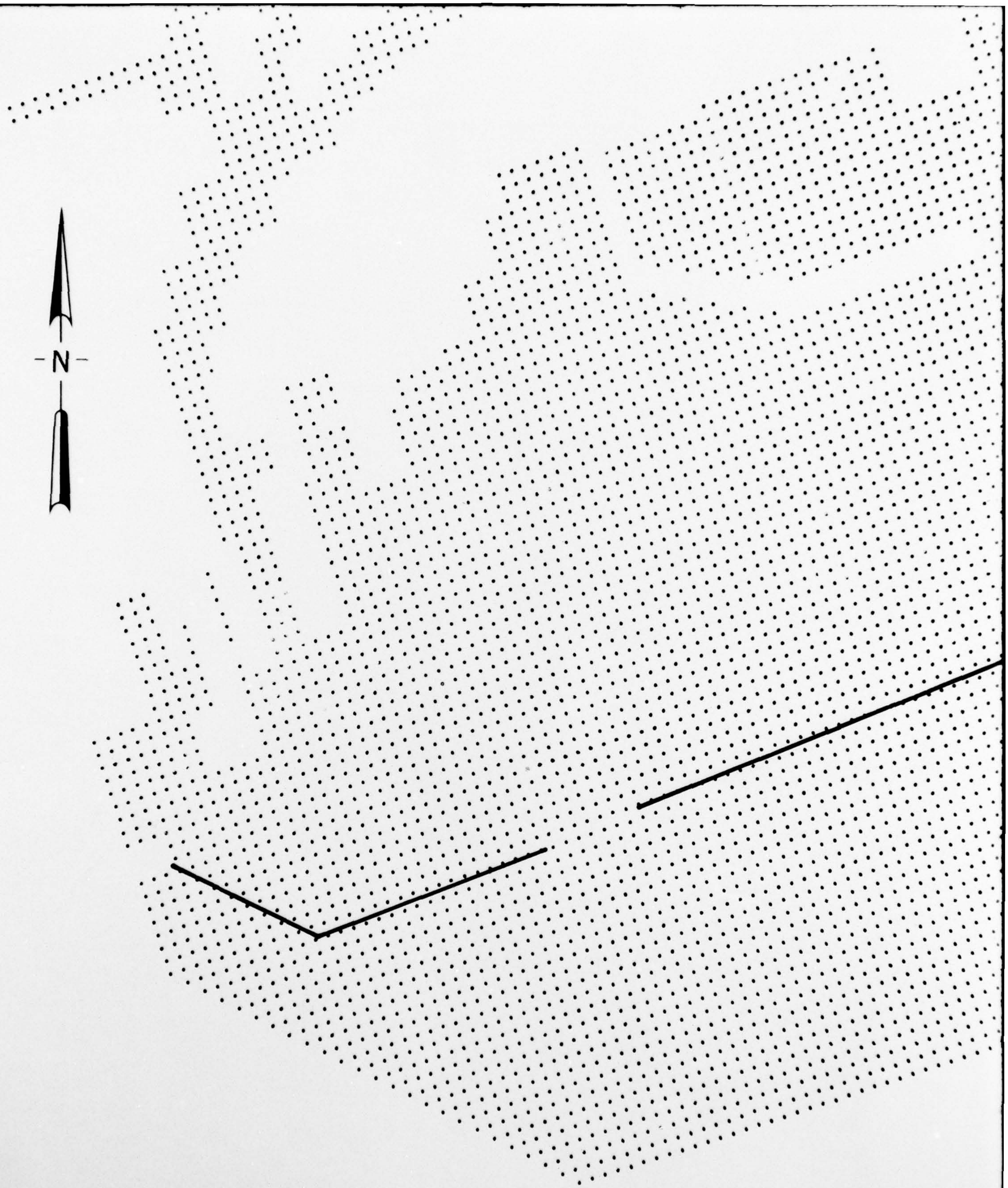


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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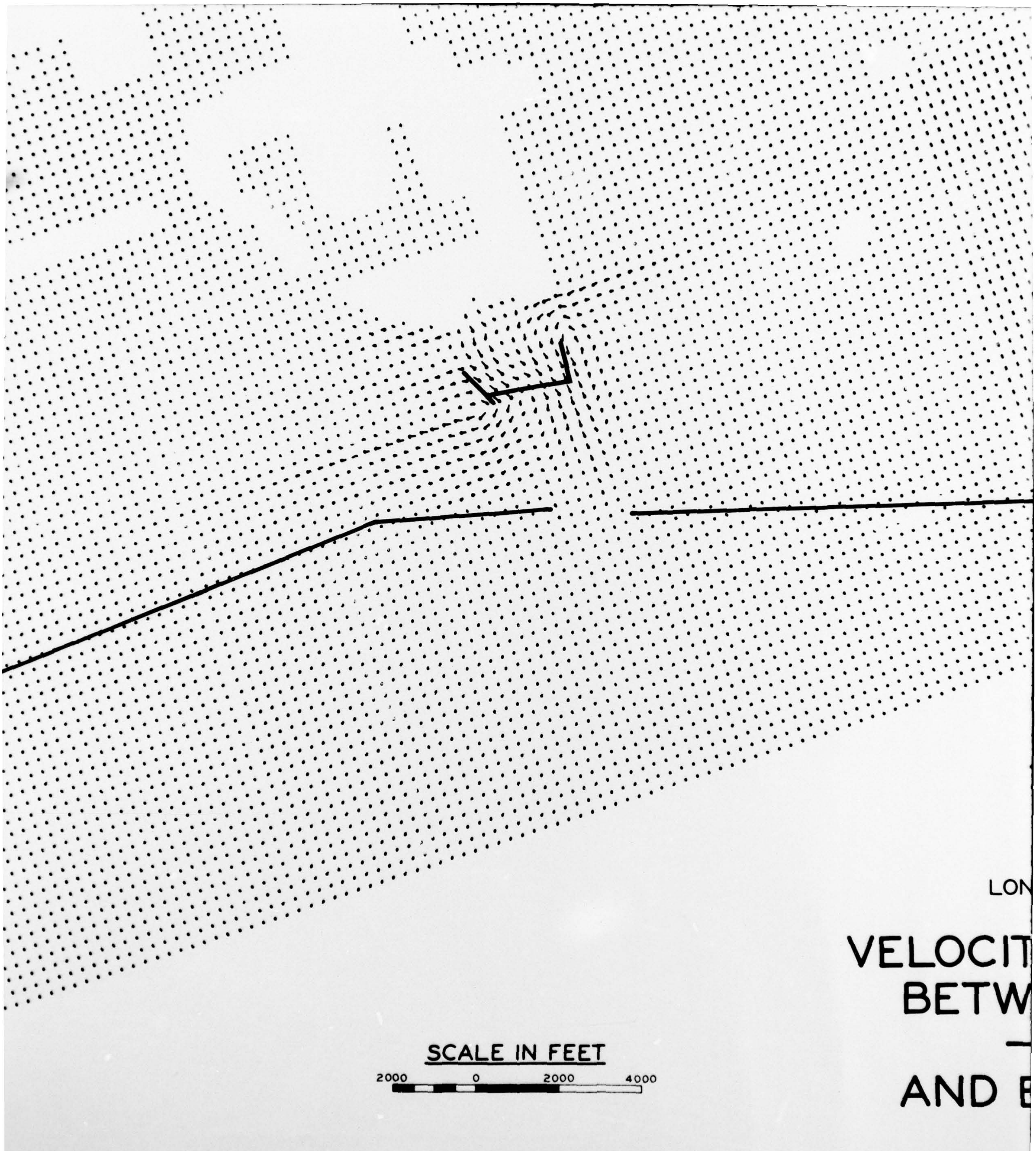

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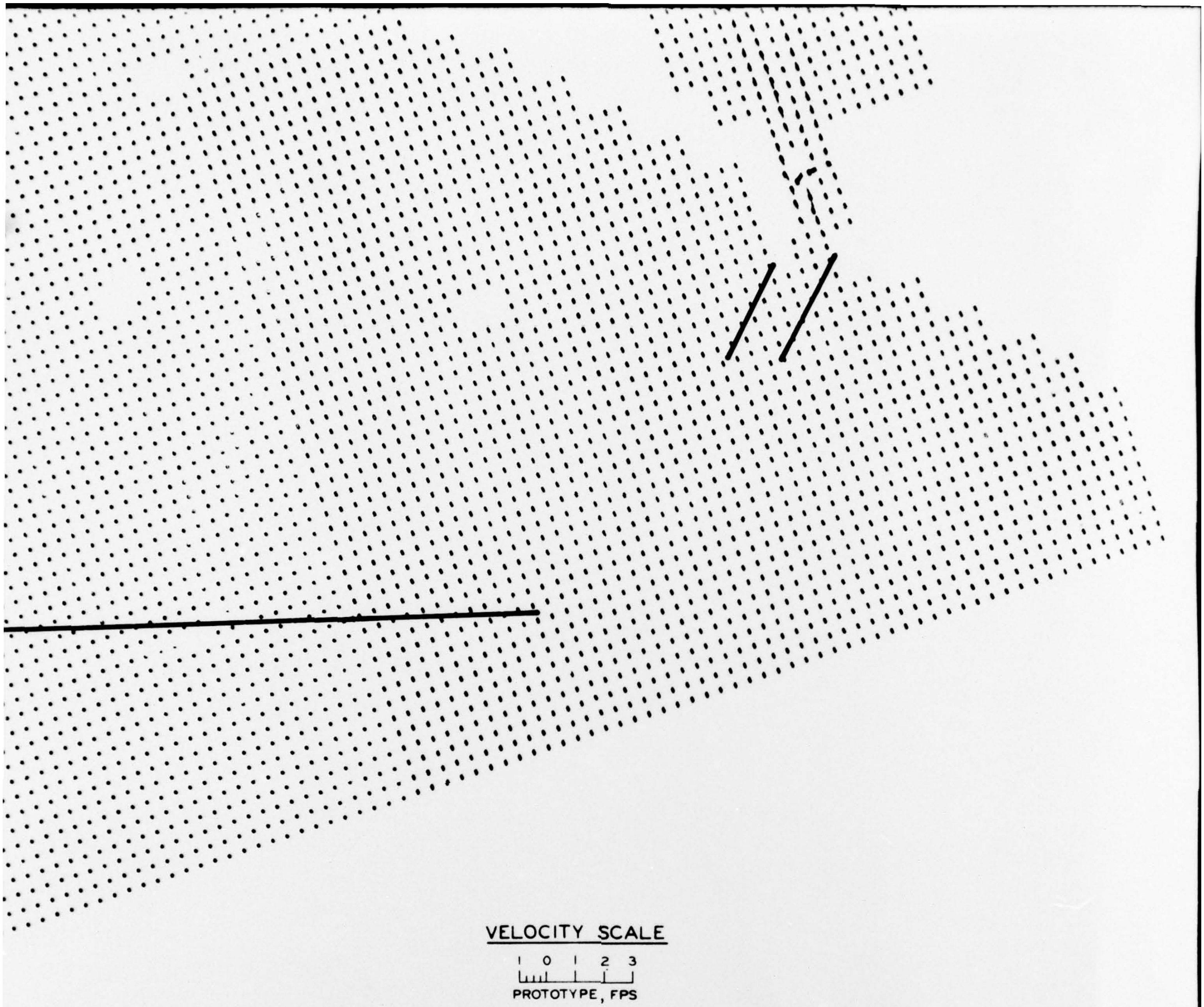

NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 3, –62-FT CHANNEL, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)


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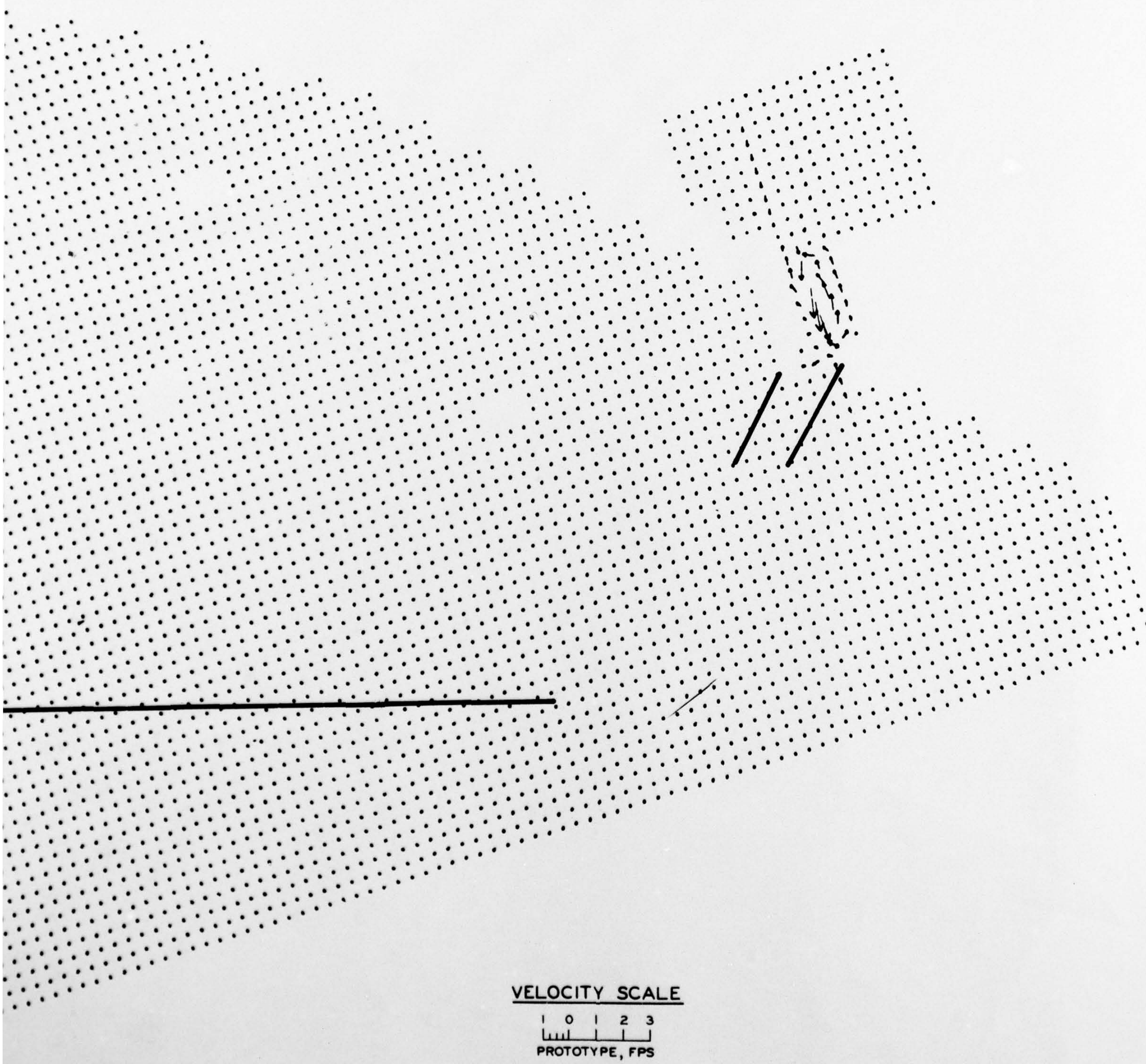
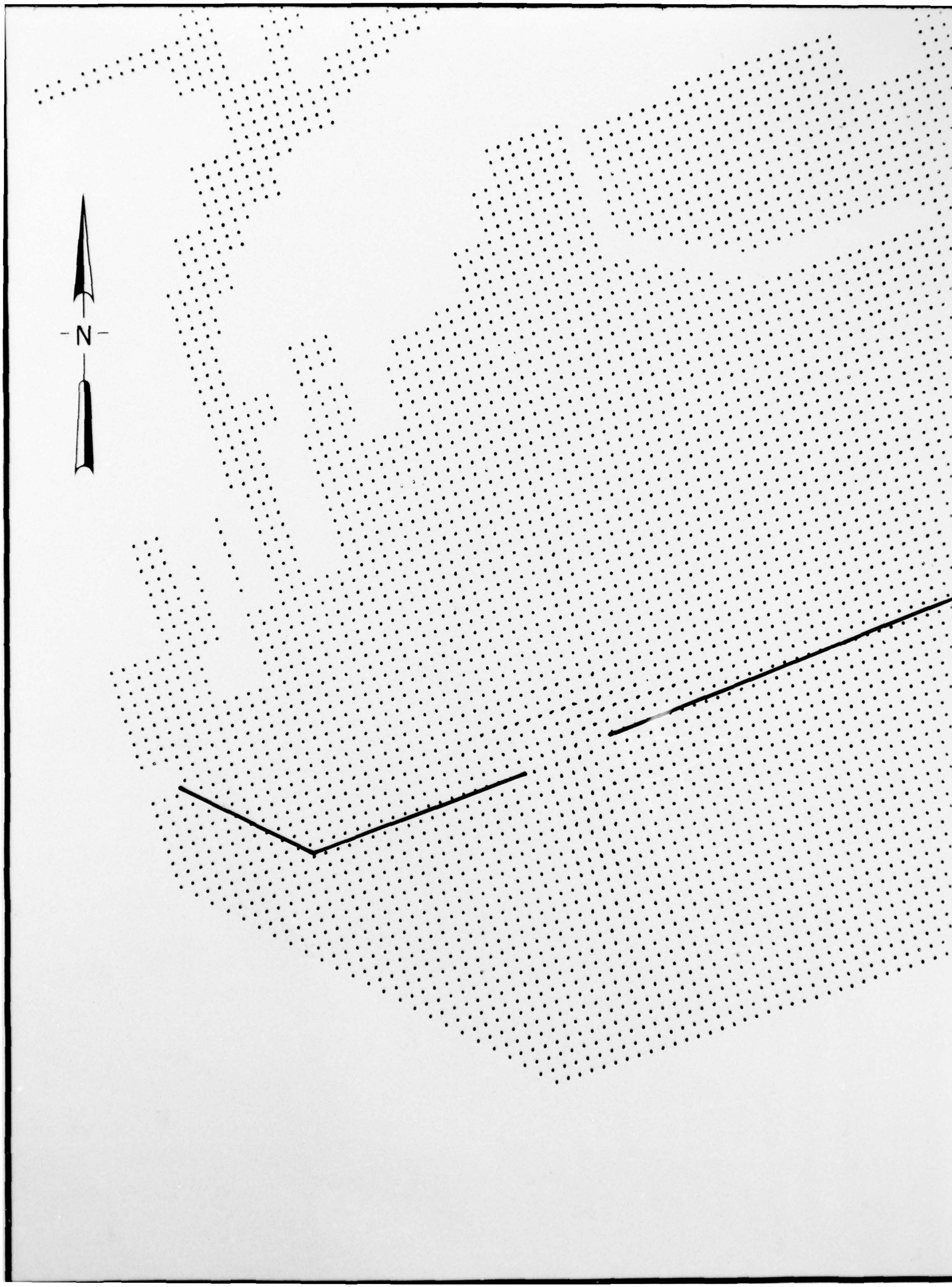


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS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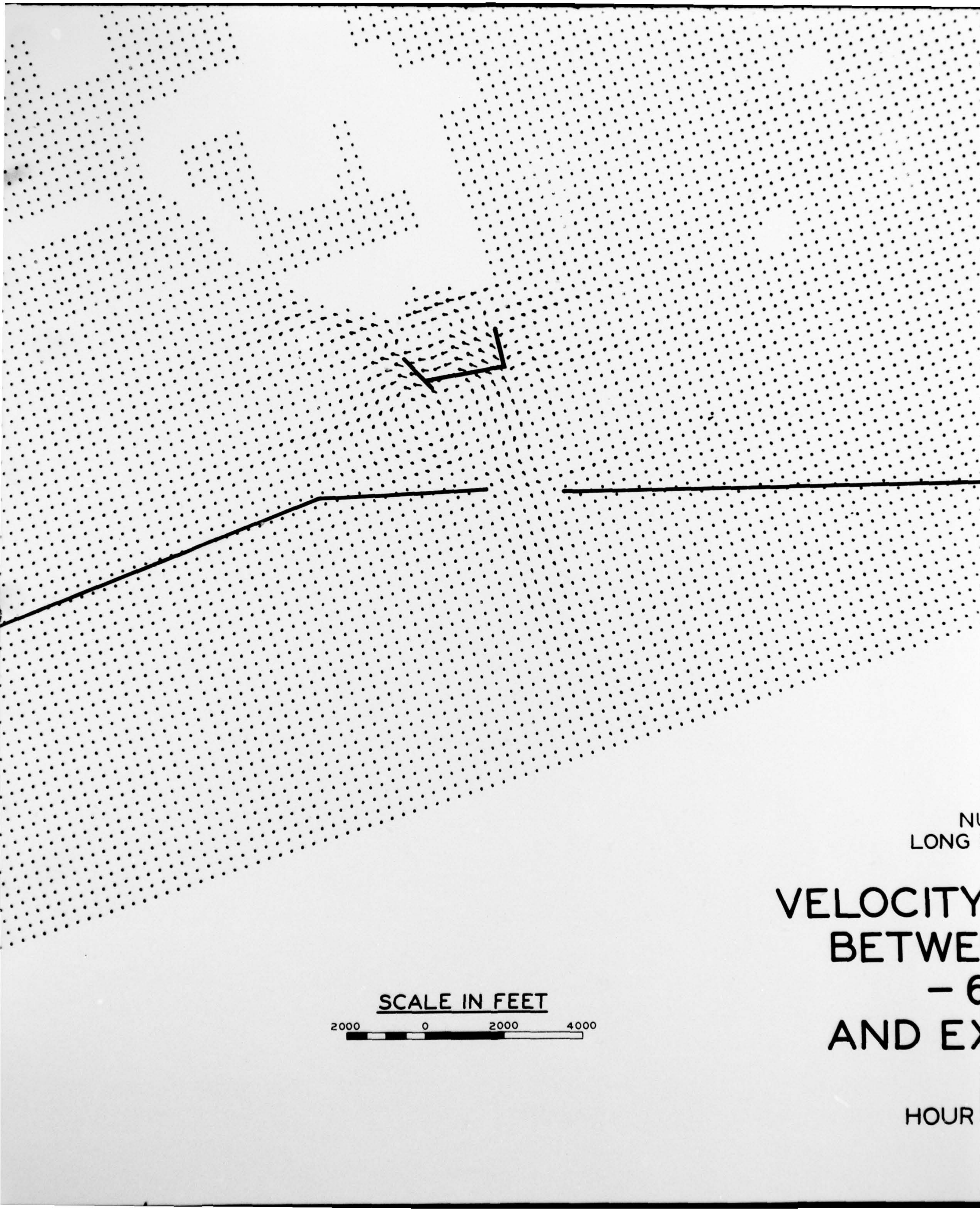
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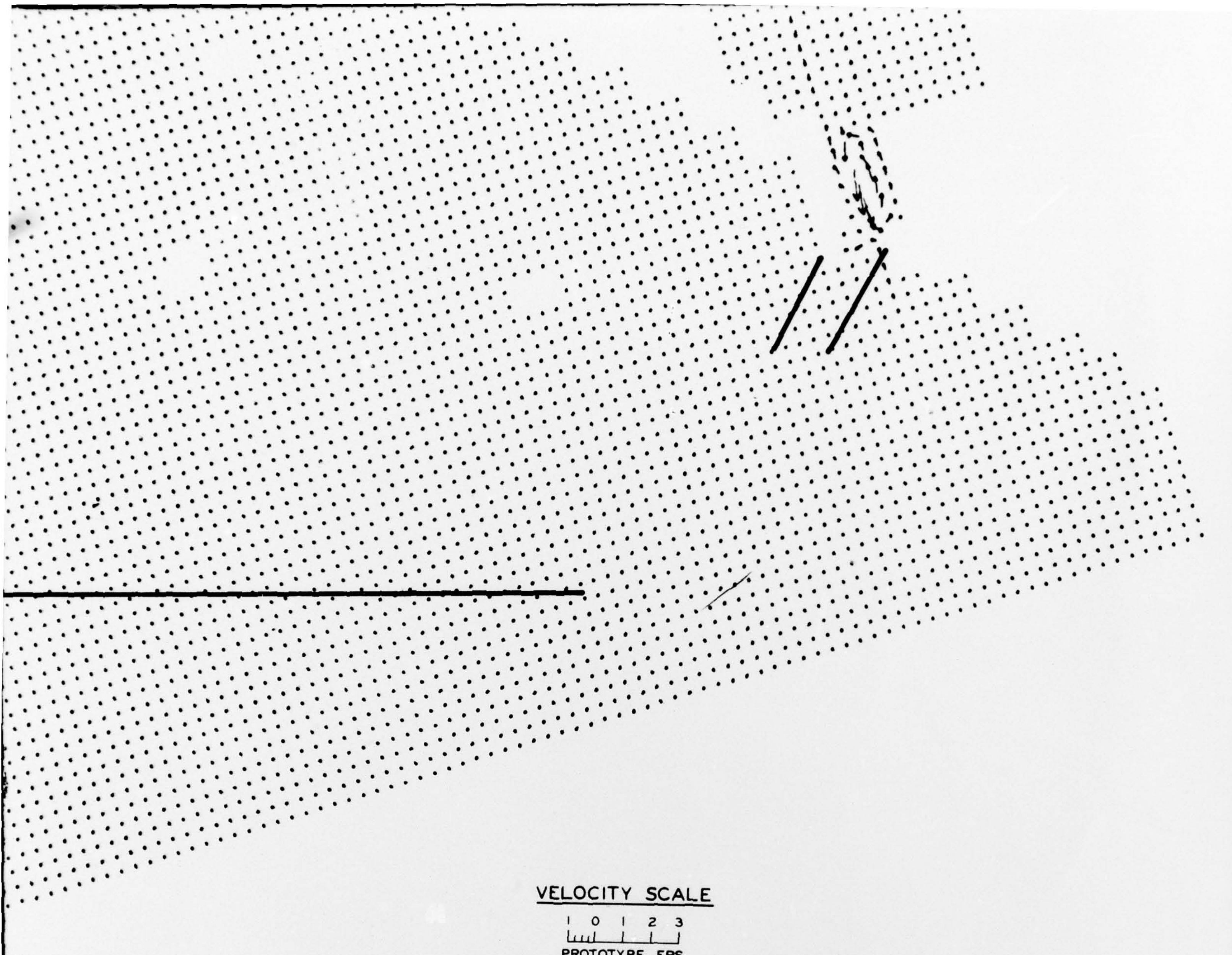

NUMERICAL MODEL STUDY OF
LONG BEACH – LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 3, – 62 -FT CHANNEL, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)