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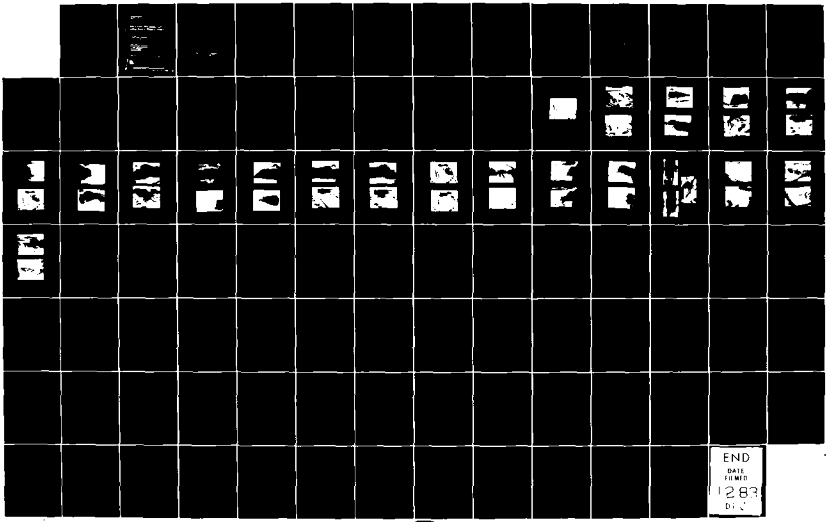

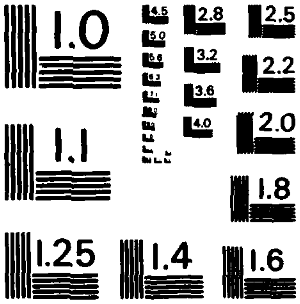

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Willow Creek Dam Spillway and Stilling Basin at Heppner, Oregon

Sponsored by
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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A 1:36-scale model study was used to verify design of the Willow Creek Dam spillway and stilling basin and to evaluate downstream flooding conditions both with and without the project.

Three alternative stilling basin geometries having design discharges of 11,700, 18,000, and 91,700 cfs were evaluated. For each design, discharge
(continued)

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conditions were identified at which basin sweepout began and when basin sweepout was complete. Downstream flow conditions were evaluated during each condition. The prototype design was based on the 18,000-cfs discharge (regulated winterflood probable maximum flood).

Willow Creek Dam is a roller-compacted concrete (RCC) structure. Since the spillway face is the outer edge of the RCC, the model was used to evaluate the effect of potential spillway spalling on flow conditions in and downstream from the stilling basin.

PREFACE

Hydraulic model studies of the spillway and stilling basin for Willow Creek Dam were requested by the District Engineer, U.S. Army Engineer District, Walla Walla, on 27 August 1979 and approved by the Division Engineer, North Pacific Division, on 10 September 1979. The studies were accomplished at the Division Hydraulic Laboratory, North Pacific, during the period January to November 1981.

During the studies personnel from the Office of Chief of Engineers, North Pacific Division, and Walla Walla District visited the laboratory to discuss test results and correlate them with design work in progress. The studies were conducted by Mr. R. L. Johnson with the assistance of Mr. F. S. Bahler under the supervision of Mr. P. M. Smith, Director of the Laboratory. This report was prepared by Mr. J. L. Lencioni of Seattle District.

A-1

TABLE OF CONTENTS

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
miles (U.S. statue)	1.609344	kilometers
square feet	0.092903	square meters
feet per second	0.3048	meters per second
cubic feet per second	0.0283168	cubic meters per second
pounds	0.4535924	kilograms

WILLOW CREEK DAM
SPILLWAY AND STILLING BASIN
AT
HEPPNER, OREGON

Hydraulic Model Investigations

PART I: INTRODUCTION

The Project

1. Willow Creek project is located on Willow Creek about 47.5 miles upstream from its confluence with the Columbia River and immediately upstream of Heppner, Oregon (figure 1).* The project is a roller compacted concrete (RCC) dam with a spillway and outlet works (plate 1). The dam will create a reservoir with 11,250 acre-feet of exclusive flood control storage and 2,000 acre-feet of storage for other purposes at pool elevation 2113.5 feet.** The project will be operated for flood control, fish, wildlife, recreation, and future irrigation.

2. The dam is 154 feet high and 1,780 feet long at top elevation 2130. The 380-foot wide uncontrolled overflow spillway located in the center of the dam has a crest elevation of 2113.5 feet and empties into a conventional hydraulic jump stilling basin. The spillway crest conforms to the standard ogee shape with a design head of 15.35 feet. The spillway design discharge is 91,700 cubic feet per second (cfs). Normal releases will be through a freestanding, uncontrolled intake tower and cut and cover conduit located near the left abutment. The design discharge of the outlet is 500 cfs at minimum pool elevation 2047.0 feet.

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*A table for converting U.S. customary units of measurement to metric (SI) units is presented on page iii.

**All elevations are in feet National Geodetic Vertical Datum.

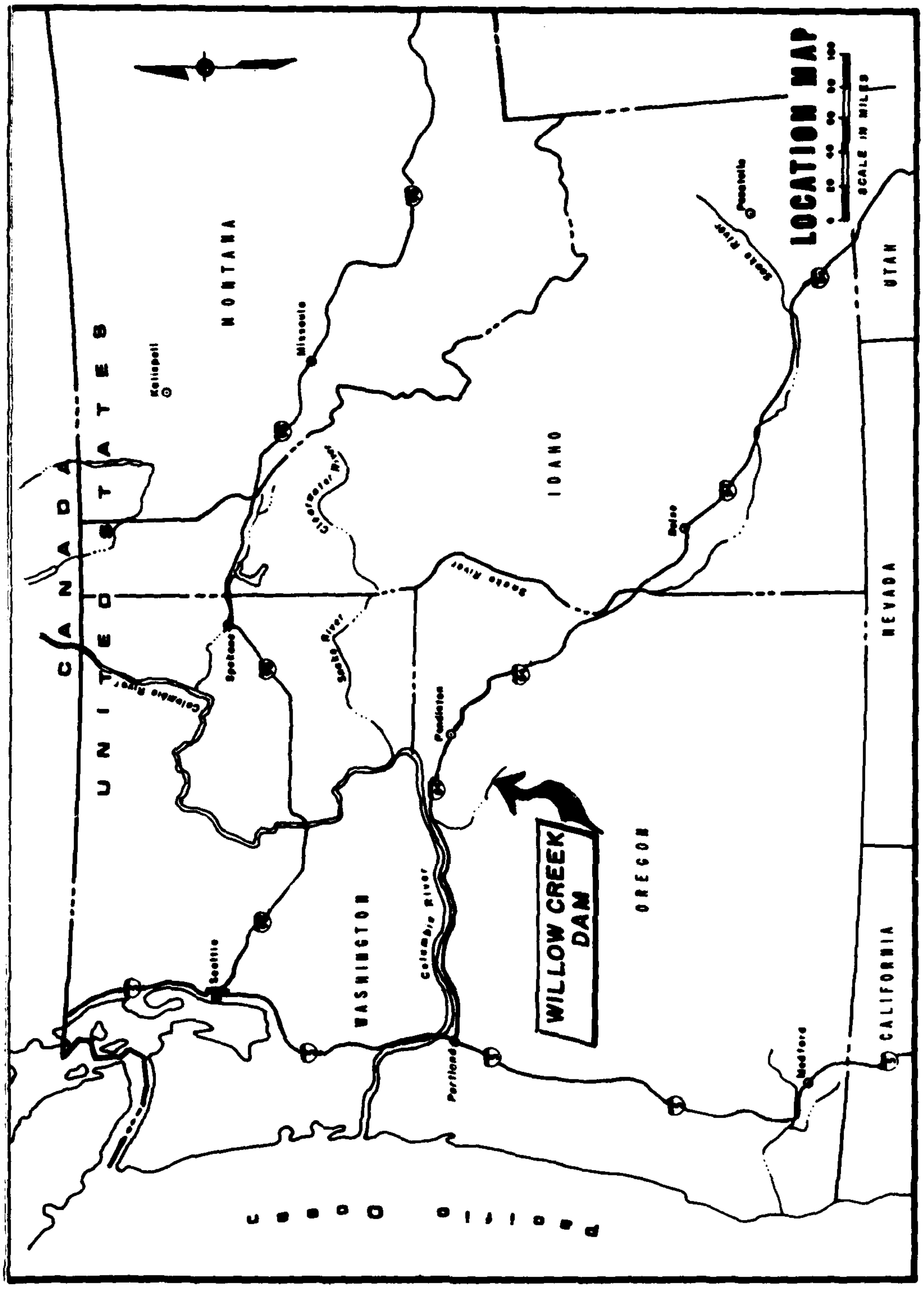

LOCATION MAP
SCALE IN MILES
0 20 40 60 80 100
CANADA
UNITED STATES
MONTANA
IDAHO
WASHINGTON
OREGON
NEVADA
UTAH
CALIFORNIA
Pacific Ocean
WILLOW CREEK DAM
Kalispell
Missoula
Spokane
Seattle
Portland
Pendleton
Boise
Pocatello
Medford
Columbia River
Snake River
Clearwater River

Figure 1

Need for Model Study

3. A model study was considered necessary to verify design of the spillway and stilling basin and, due to the project's close proximity to the town of Heppner, to evaluate flooding conditions in the town for various flows both with and without the project. Late in the design, the decision was made to construct the project, including the spillway, by RCC methods. The model was used to evaluate the effects of concrete spalling in the stilling basin and downstream.

PART II: THE MODEL

Description

4. The studies were accomplished in a 1:36 scale model. The model simulated the spillway, nonoverflow section and stilling basin of the dam, and the natural topography extending 350 feet upstream and 1,850 feet downstream from the dam axis.

5. The spillway chute, nonoverflow section, and stilling basin were constructed of waterproofed wood. The spillway crest was of plastic.

6. The natural topography up and downstream from the axis was molded in concrete using sheet metal templates cut to conform to field survey data. Buildings were shaped from styrofoam and located to match local residences in the flood plain downstream from the dam. Hydraulic roughness downstream was simulated by shrubs, trees, and packing material.

Facilities

7. Water for the model was pumped from storage tanks through a recirculating system and was measured using calibrated orifices in the supply line. Tailwater was controlled by an overflow tailgate. Water surface elevations were determined at four locations (gages 1-4 shown on plate 2) using piezometers which were piped to a central gage pit and connected to stilling buckets. Standard laboratory procedures were used to measure water surface elevations, discharges, and velocities.

Scale Relationships

8. Model measurements were converted to prototype values using equations of similitude based on the Froude model law as follows:

Dimension	Ratio	Scale Relation
Length	L_r	1:36
Discharge	$Q_r = L_r^{5/2}$	1:7776
Pressure	$P_r = L_r$	1:36
Velocity	$V_r = L_r^{1/2}$	1:6

PART III: EXISTING CONDITION STUDIES

9. Initial studies were conducted to evaluate preproject flooding conditions through Heppner. Estimated water surface elevations for discharges between 500 cfs (approximate bank-full condition) and 114,000 cfs were used for model verification. Photograph 1 shows an overall view of the model (without dam) following verification.

Flow conditions with a discharge of 45,000 cfs, the unregulated summer thunderstorm standard project flood (SPF), are shown in photograph 2 and on plate 2. Velocities over the existing topography were 15 feet per second (fps) just downstream from the dam site, 14 fps at Alfalfa Street bridge, and 19 and 20 fps along Hager Street below Alfalfa Street. Flow conditions with a discharge of 107,000 cfs, the unregulated spillway design flood (SDF), are shown in photograph 3 and on plate 3. Velocities were 18 fps near the damsite and at Alfalfa Street. The water was 30 feet deep in Willow Creek at the downstream end of the test area.

PART IV: STILLING BASIN STUDIES

Plan A, Design Discharge 91,700 cfs

10. The Plan A basin (plate 4), designed for the spillway design flood of 91,700 cfs, was a 66-foot-long concrete apron at elevation 1962.0 feet which continued as a 66-foot-long rock apron at the same elevation. Downstream from the basin apron an excavated runout on a 1 vertical (V) to 10 horizontal (H) slope daylighted at top of rock elevation 1975. Due to the high-velocity flow existing downstream from the project, significant scour may occur during passage of high discharges. In order to evaluate basin performance with a scoured condition, the model was constructed to simulate scour to top of rock elevation 1975 between Willow Creek Road on the right bank and the oulet channel on the left bank from the end of the basin downstream to Alfalfa Street and to remove the Alfalfa Street bridge. Tests were accomplished with discharges of 11,700, 45,000, 85,000, and 91,700 cfs. At 45,000 cfs, a severe eddy formed near the right training wall (photograph 4). The maximum capacity of the basin was 85,000 cfs (photograph 5). At the design discharge of 91,700 cfs the jump was swept out of the basin, and a jump was created by the fill of Alfalfa Street (photographs 6 and 7).

11. The addition of a 4-foot-high sloping end sill at the downstream end of the concrete apron was sufficient to contain the hydraulic jump within the basin apron and runout slope for all discharges up to 91,700 cfs (photographs 8 and 9). At the design discharge and with the end sill added, velocities on the excavated runout slope were 15 fps and velocities over the simulated scoured area downstream from the runout and near Alfalfa Street were 12-13 fps (plate 5).

Plan B, Design Discharge 11,700 cfs

12. The Plan B basin (plate 4), designed for the regulated thunderstorm SPF 11,700 cfs, was 46 feet long with a floor elevation of 1973.0 feet and a 3-foot-high sloping end sill. Tests were made for discharges of 11,700, 15,000, 45,000, and 91,700 cfs.

13. With the basin design discharge of 11,700 cfs, a good hydraulic jump formed totally within the basin (photograph 10). Velocities were 10 fps just downstream from the end sill, 6 fps at the washed out Alfalfa Street bridge, and 12 fps in the creek approximately 100 feet farther downstream (photograph 11 and plate 6). With 15,000 cfs the jump began to sweep out of the basin (photograph 12), and velocities were 11 fps downstream from the sweepout, 6 fps at the bridge, and 14 fps 100 feet beyond the bridge. A flow of 45,000 cfs caused a complete sweepout of the basin (photograph 13) and velocities of 19, 14, and 21 fps at the locations previously noted. The regulated spillway design flood of 91,700 cfs was flipped from the basin for about 200 feet downstream and created velocities of 49 fps upstream from Alfalfa Street, 28 fps at the bridge, and 37 fps 100 feet farther downstream (photographs 14 and plate 7). Depth in the creek near the downstream end of the test area (gage 4) was 2.3 feet lower than with the same unregulated flood. Flooding downstream from Alfalfa Street with the spillway design flood is shown in photograph 15.

Plan C, Recommended Plan, Design Discharge 18,000 cfs

14. The basin recommended for final design was sized for the regulated winter PMF of 18,000 cfs. The length of the basin was 66 feet and the floor was at elevation 1970.75 with a 4.25-foot-high sloping end sill to elevation 1975, the approximate top of rock (photograph 16 and plate 4). A good hydraulic jump occurred in the basin with discharge of 11,700 cfs (regulated summer thunderstorm SPF) and 18,000 cfs (photographs 17 and 18). Velocities were 6 to 8 fps in the simulated scoured

area just downstream from the basin, 6 fps at Alfalfa Street bridge, and 12 and 14 fps 100 feet farther downstream (plates 8 and 9). With a discharge of 24,000 cfs, the jump began to sweep from the basin (photograph 19). Velocities in the simulated scoured area were as high as 17 fps. Velocities were 6 fps at the bridge and 14 fps 100 feet downstream (plate 10). With 45,000 cfs, velocities were 37 fps downstream from the sweepout, 12 fps at the bridge, and 18 fps 100 feet downstream (photographs 20 and 21 and plate 11). With the spillway design flood of 91,700 cfs, velocities were 48 fps downstream from the sweepout, 26 fps at the bridge, and 36 fps about 100 feet downstream (photographs 22 and 23 and plate 12). Flooding conditions with the regulated thunderstorm SPF and the SDF are shown in photographs 24 and 25.

15. Performance of the Plan C basin was also evaluated assuming no scouring would occur downstream from the basin (photographs 26 and 27). Flow conditions assuming no scour of the overburden downstream with discharges of 11,700 and 18,000 cfs are shown on plates 13 and 14. Velocities across the overburden were 11 and 12 fps. Velocities were 12 and 13 fps under the Alfalfa Street bridge and 12 and 14 fps just downstream from the bridge. The velocities in the area upstream of the bridge were approximately double those occurring with the area assumed to be scoured to rock. A good hydraulic jump formed in the basin with both flood discharges (photographs 28 and 29). Maximum water surface behind the basin walls was at elevation 1989.0, 1 foot below the walls (plate 14). The jump began to sweep out of the basin with a discharge of 38,800 cfs (photograph 30 and plate 15).

16. The Plan C stilling basin without a curved bucket (plate 16) also performed well and was selected as the final design. A good hydraulic jump formed in the basin with the design discharge of 18,000 cfs (photograph 31). Impact pressures on the basin floor 26 inches from the intersection with the spillway chute were 77 feet of water with a discharge of 91,700 cfs, 59 feet with 65,000 cfs, and 43 feet with 45,000 cfs.

17. Flow conditions assuming the end sill washed out and the area immediately downstream scoured to rock are shown on plates 17 through 19 for the greater-than-design-discharges of 24,000, 45,000, and 91,700 cfs. Flow swept out of the basin and a hydraulic jump formed in the scoured area downstream (photographs 32 and 33). With 91,700 cfs, the jump was at Alfalfa Street (photograph 34). Velocities at the jump were as high as 46 fps.

PART V: SPILLWAY STUDIES

Roller-Compacted Concrete Spalling

18. The spillway was modeled with a smooth surface to create maximum energy at the stilling basin for testing of the basin. During the studies the decision was made that the face of the spillway chute would be the outer edge of the compacted concrete of the dam which would be subject to some spalling during spill. The effect of spalling on flow conditions in the basin and downstream was studied with the Plan C basin and unscoured overburden downstream by slowly adding 1,700 cubic yards of spall material to the chute as spill increased from no spill to 18,000 cfs, and then flow was slowly decreased to no spill again. Approximately 50 percent of the material was deposited on the right bank of the outlet channel (photographs 35, 36, and 37). A log of observations during the test is listed in table 1.

Discharge Rating

19. The discharge rating of the 380-foot-long ungated spillway is shown on plate 20. The maximum pool with the regulated SDF of 91,700 cfs is elevation 2129.25.

PART VI: SUMMARY

20. Studies were accomplished for stilling basins designed for three different discharges--11,700 cfs (regulated thunderstorm SPF), 18,000 cfs (winter flood PMF), and 91,700 cfs (SDF). The studies evaluated basin performance and downstream flooding conditions both with design discharges and discharge in excess of the basin design capacity. The basin recommended for final design was sized for the 18,000 cfs discharge.

21. The project, including the outer surface of the spillway, will be constructed by roller-compacted concrete methods. The model spillway, however, simulated a smooth concrete face to maximize energy entering the stilling basin. Due to potential for scour downstream of the basin, the studies assumed that overburden downstream would be scoured to bedrock, thereby reducing tailwater. With basin design discharge, the assumed scour reduced downstream velocities by about 50 percent from those occurring with no scour. With scour, however, basin sweepout bagan at a discharge of 24,000 cfs as compared to 38,800 cfs without the estimated scour.

22. The study showed that deposition of spalled material from the roller-compacted concrete spillway face would not cause adverse hydraulic conditions in or downstream from the basin. Studies also showed that acceptable hydraulic conditions would occur without a radius between the spillway face and basin floor. The requirement for a firmly anchored and constructed end sill was illustrated by studies of conditions which would exist downstream from the basin if the end sill were washed out.

TABLE 1

LOG OF TEST OF EROSION OF SPILLWAY FACE DURING FLOOD

0 - 4,000 cfs: Slow addition of 1,700 cu yds of spall material to spillway chute began as crest overtopped. Material collected in basin.

4,000 - 5,000 cfs: Material collected in downstream end of basin and moved up onto runout slope.

5,000 - 8,000 cfs: Material collected on runout slope and feathered out in streamers on unscoured overburden downstream. On left side of runout slope, material washed over top of outlet channel bank and collected on bank slope. Small amount of material swept into creek. In the middle of runout slope, material washed downstream about 200 ft and stopped in a secondary jump. On right side of runout slope a strong eddy kept material in the basin and on the runout slope.

8,000 - 10,000 cfs: Material continued to collect in all areas noted above.

10,000 - 14,000 cfs: All material swept from basin except in eddy on right side. Material continued to build up in all other areas except left side of runout slope where material was swept clean but collected on bank of outlet channel.

14,000 - 16,000 cfs: Remainder of 1,700 cu yds of spall material added to model. Clean sweep of left side of runout slope continued. Material continued to collect on outlet channel bank. Material in secondary jump slowly swept to the right and left into outlet channel. Small amount of material remained on creek bottom upstream from Alfalfa Street; none observed downstream from bridge. All material swept through bridge moved on downstream.

TABLE 1 (CONTINUED)

16,000 - 18,000 cfs: Runout slope swept clean of material except at eddy on right side. Material on left side of runout slope swept onto outlet channel bank. Material on right side strung out but remained stationary. Strong eddy in right side of basin kept material moving continuously.

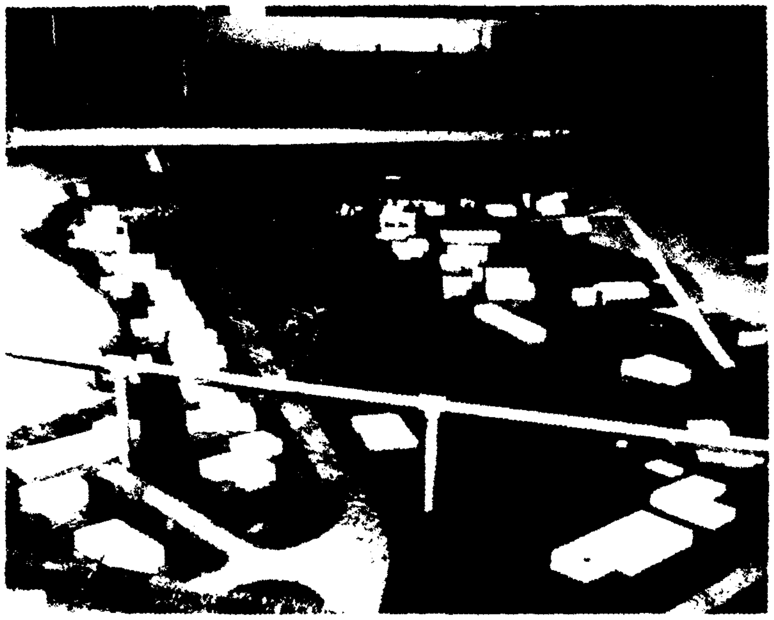
18,000 - 14,000 cfs: Flow recession began. Material in left side of secondary jump continued to move onto outlet channel bank. More and more material on channel bank swept into creek.

14,000 - 10,000 cfs: Material in left side of secondary jump continued to move onto outlet channel bank. Shallow flow over top of channel bank swept material lower on bank and onto channel bottom. Slight buildup on channel bottom just upstream from Alfalfa Street bridge. All material passing under bridge swept on downstream.

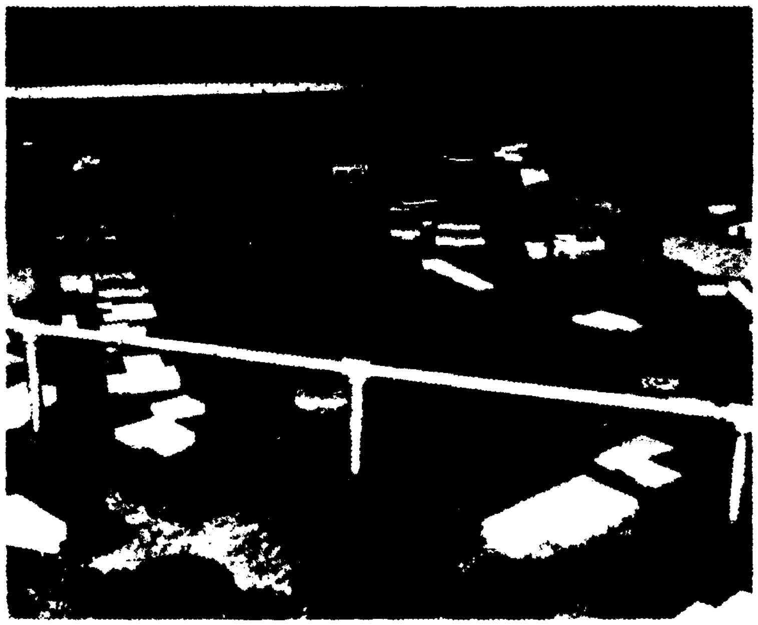
10,000 - 5,000 cfs: Shallow flow on left side swept material down outlet channel bank into channel. Eddy in right side of basin kept material moving in basin.

5,000 - 0 cfs: Eddy on right side left small amount of material in basin and on runout slope. Most material on left side in outlet channel. Material on right side remained in place. Approximately 90 percent of material remained upstream of Alfalfa Street; remaining 10 percent swept beyond test area.

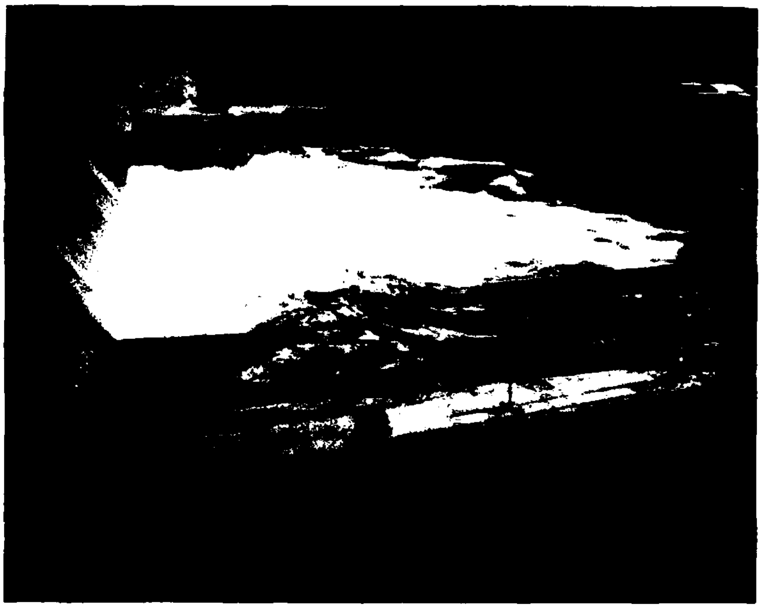
Photograph 1. Overall view of model



Photograph 2. Existing condition looking upstream at residential area. Unregulated standard project flood; discharge 45,000 cfs



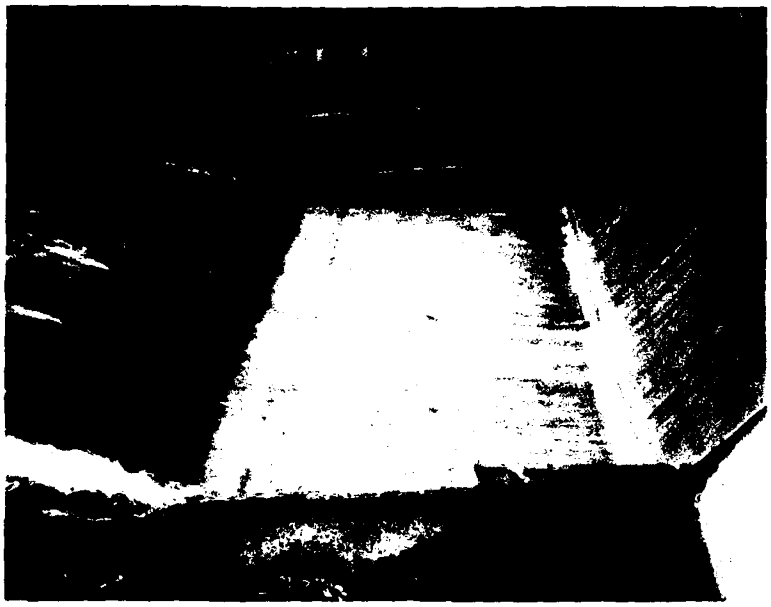
Photograph 3. Existing condition looking upstream at residential area. Unregulated spillway design flood; discharge 107,000 cfs



Photograph 4. From right bank. Note severe eddy in stilling basin; discharge 45,000 cfs

Photograph 5. From left bank; discharge 85,000 cfs

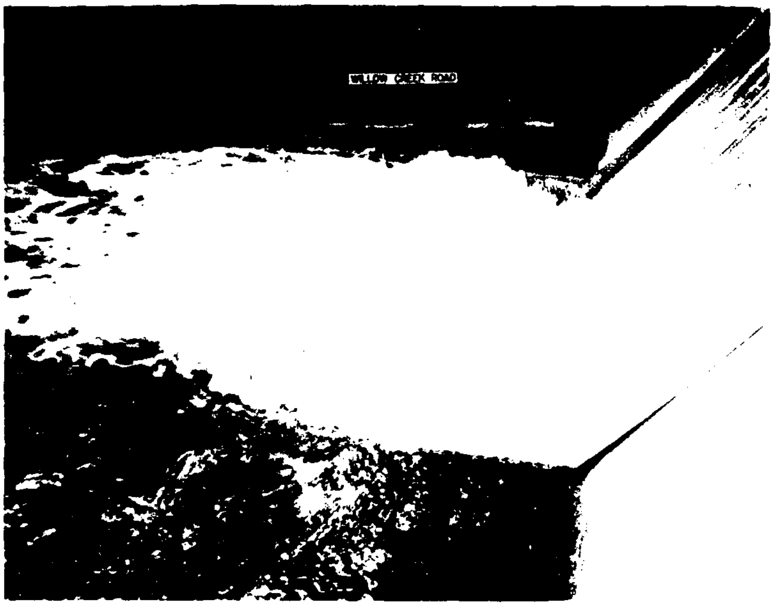
Plan A Stilling Basin



Photograph 6. From left bank

Photograph 7. Looking upstream

Plan A Stilling Basin
Discharge 91,700 cfs

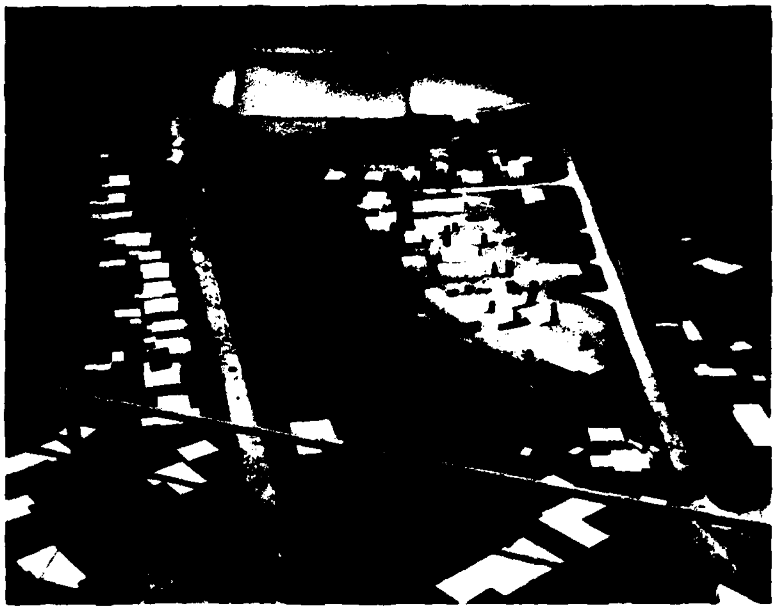


Photograph 8. From left bank; discharge 91,700 cfs

Photograph 9. Looking upstream; discharge 91,700 cfs

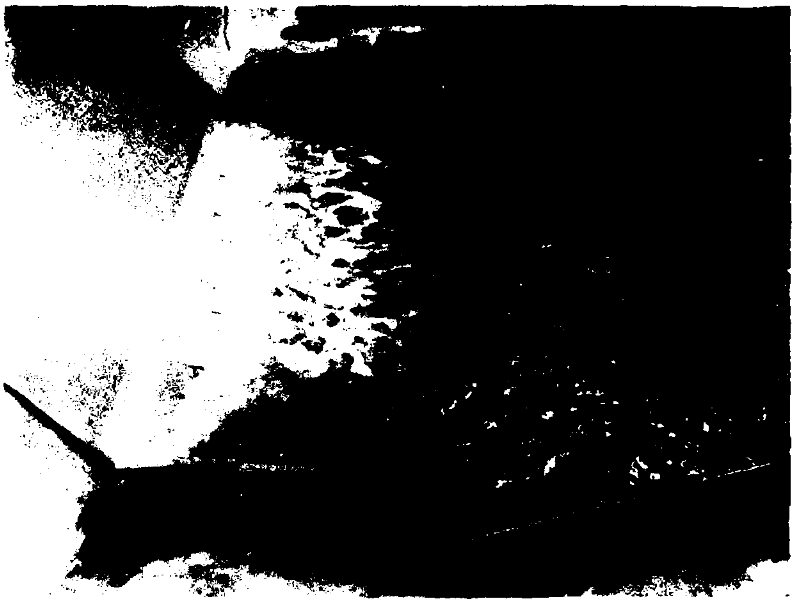
Plan A Stilling Basin With 4-Foot-High End Sill

Photograph 10. From right bank; discharge 11,700 cfs



Photograph 11. Looking upstream; discharge 11,700 cfs

Plan B Stilling Basin



Photograph 12. From right bank; discharge 15,000 cfs

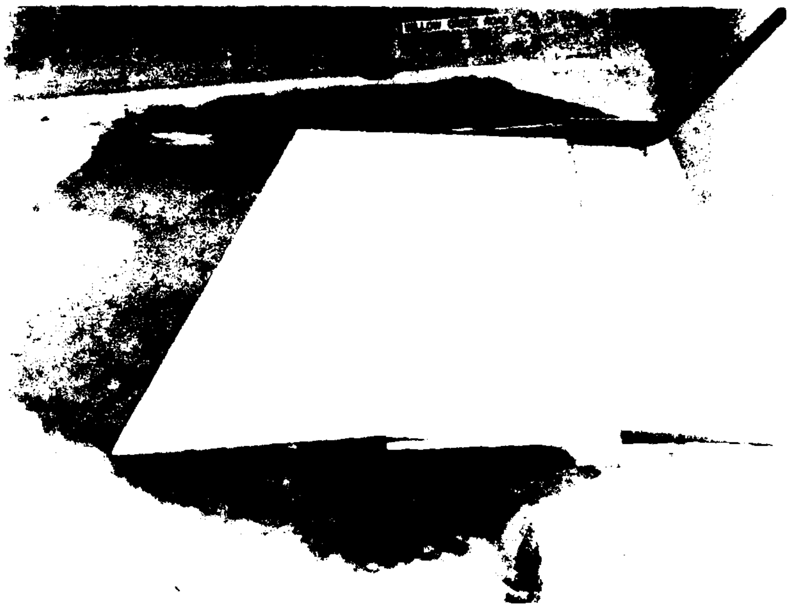
Photograph 13. From right bank; discharge 45,000 cfs

Plan B Stilling Basin

Photograph 14. From right bank

Photograph 15. Looking upstream through residential area

Plan B Stilling Basin
Regulated Spillway Design Flood; Discharge 91,700 cfs



Photograph 16. Dry bed

Photograph 17. Discharge 11,700 cfs

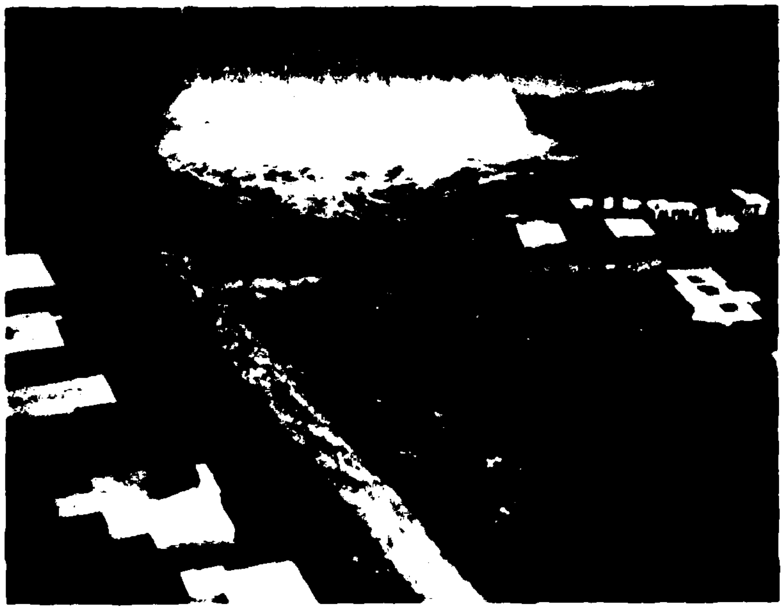
Plan C Stilling Basin (Recommended Plan)

Photograph 18. Discharge 18,000 cfs

Photograph 19. Discharge 24,000 cfs

Plan C Stilling Basin (Recommended Plan)

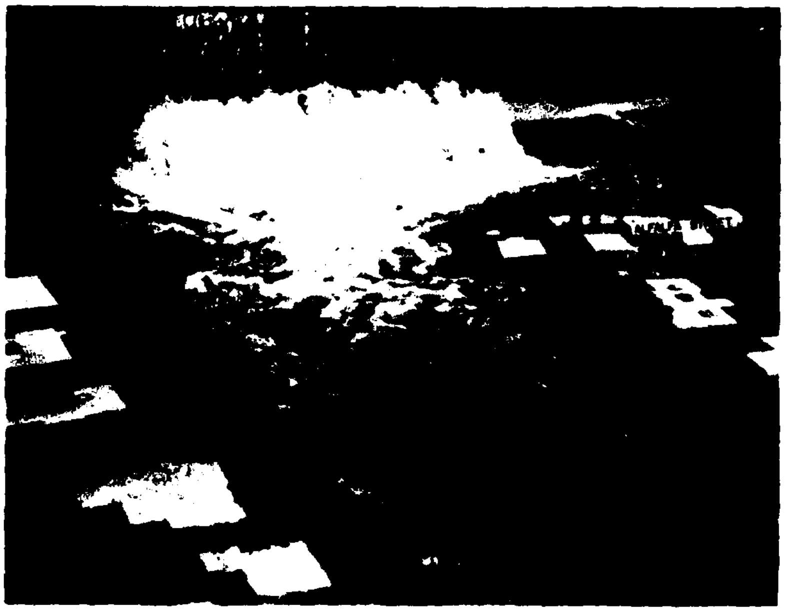
Photograph 20. Discharge 45,000 cfs



Photograph 21. Looking upstream through residential area; discharge 45,000 cfs

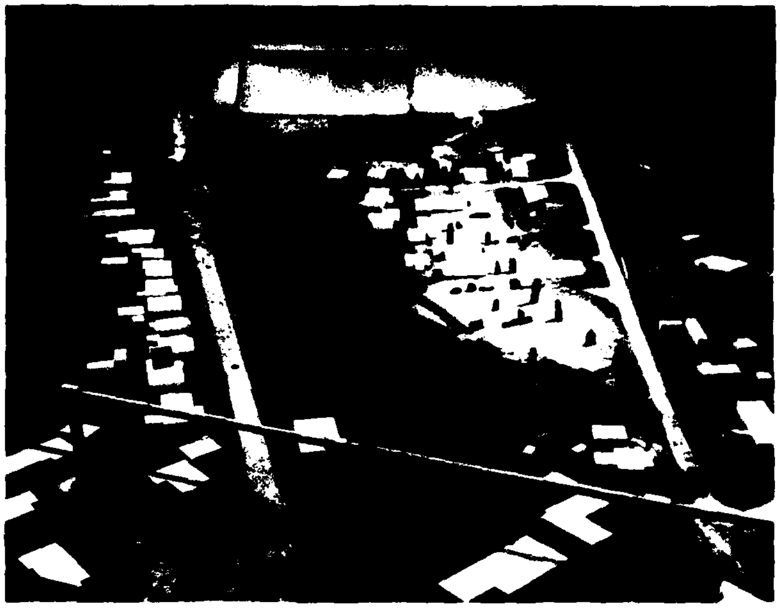
Plan C Stilling Basin (Recommended Plan)
With Alfalfa Street Bridge Washed Out

Photograph 22. From left bank

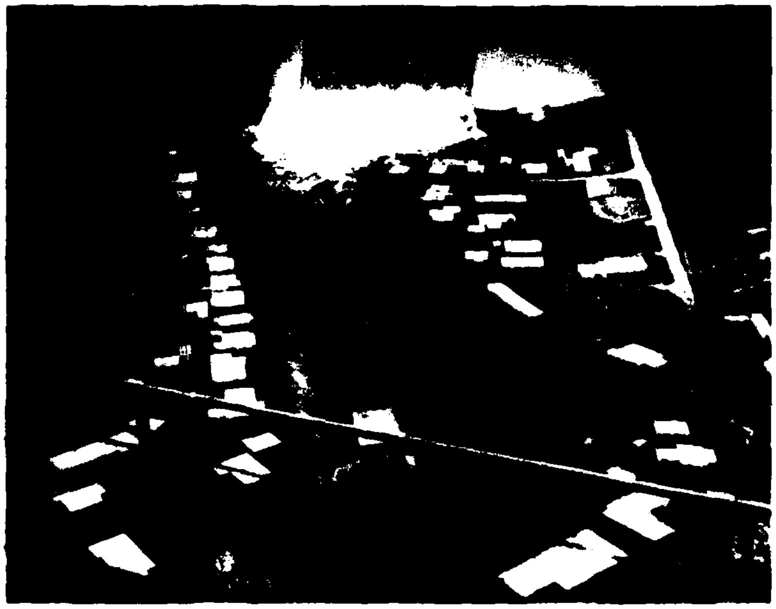


Photograph 23. Looking upstream through residential area

Plan C Stilling Basin (Recommended Plan)
With Alfalfa Street Bridge Washed Out
Regulated Spillway Design Flood; Discharge 91,700 cfs



Photograph 24. Looking upstream through residential area. Regulated standard project flood; discharge 11,700 cfs



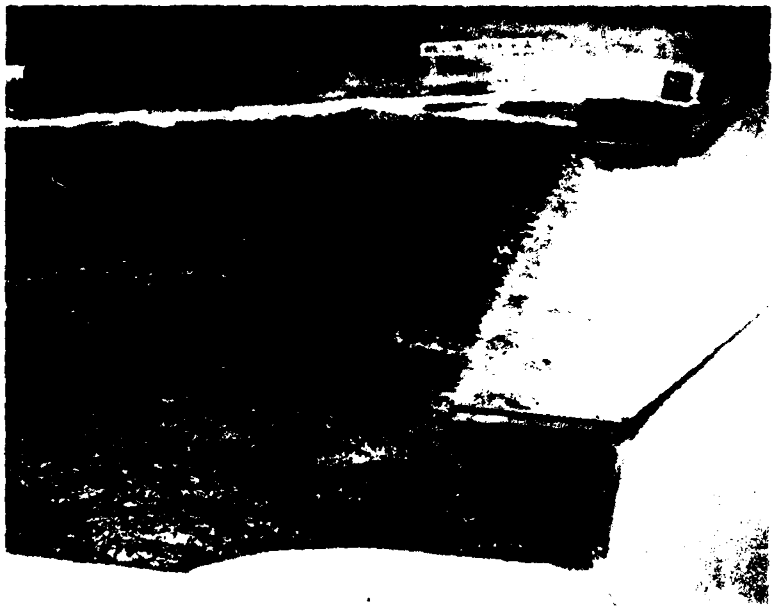
Photograph 25. Looking upstream through residential area. Regulated spillway design flood; discharge 91,700 cfs

Plan C Stilling Basin (Recommended Plan)

Photograph 26. Dry bed from left bank

Photograph 27. Dry bed looking upstream

Plan C Stilling Basin With Unscoured Overburden Downstream

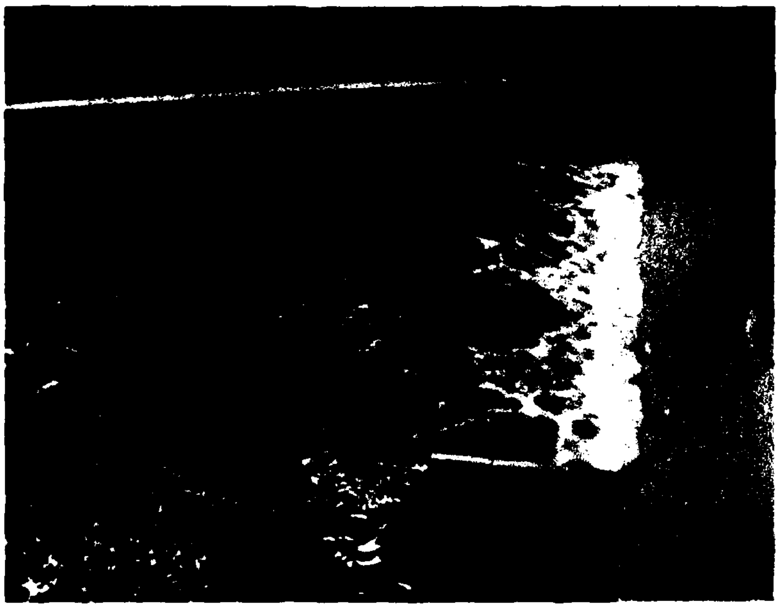


Photograph 28. Discharge 11,700 cfs

Photograph 29. Discharge 18,000 cfs

Plan C Stilling Basin With Unscoured Overburden Downstream

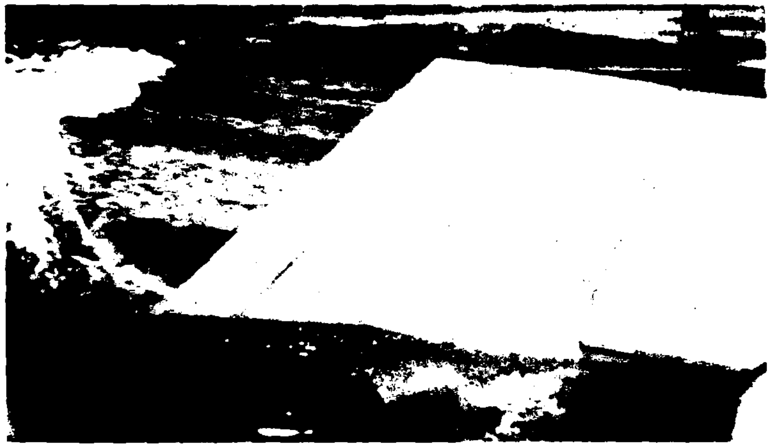
Photograph 30. Basin sweepout; discharge 38,80C cfs



Photograph 31. Without bucket radius (final design); discharge 18,000 cfs

Plan C Stilling Basin With Underscoured Overburden Downstream

Photograph 32. Discharge 24,000 cfs



Photograph 33. Discharge 45,000 cfs

Photograph 34. Discharge 91,700 cfs

Plan C Stilling Basin Without End Sill

Looking downstream from left bank

Looking upstream from left bank

Photograph 35.

Deposited Spall From Spillway Chute

Looking downstream from right bank

Looking upstream from right bank

Photograph 36.

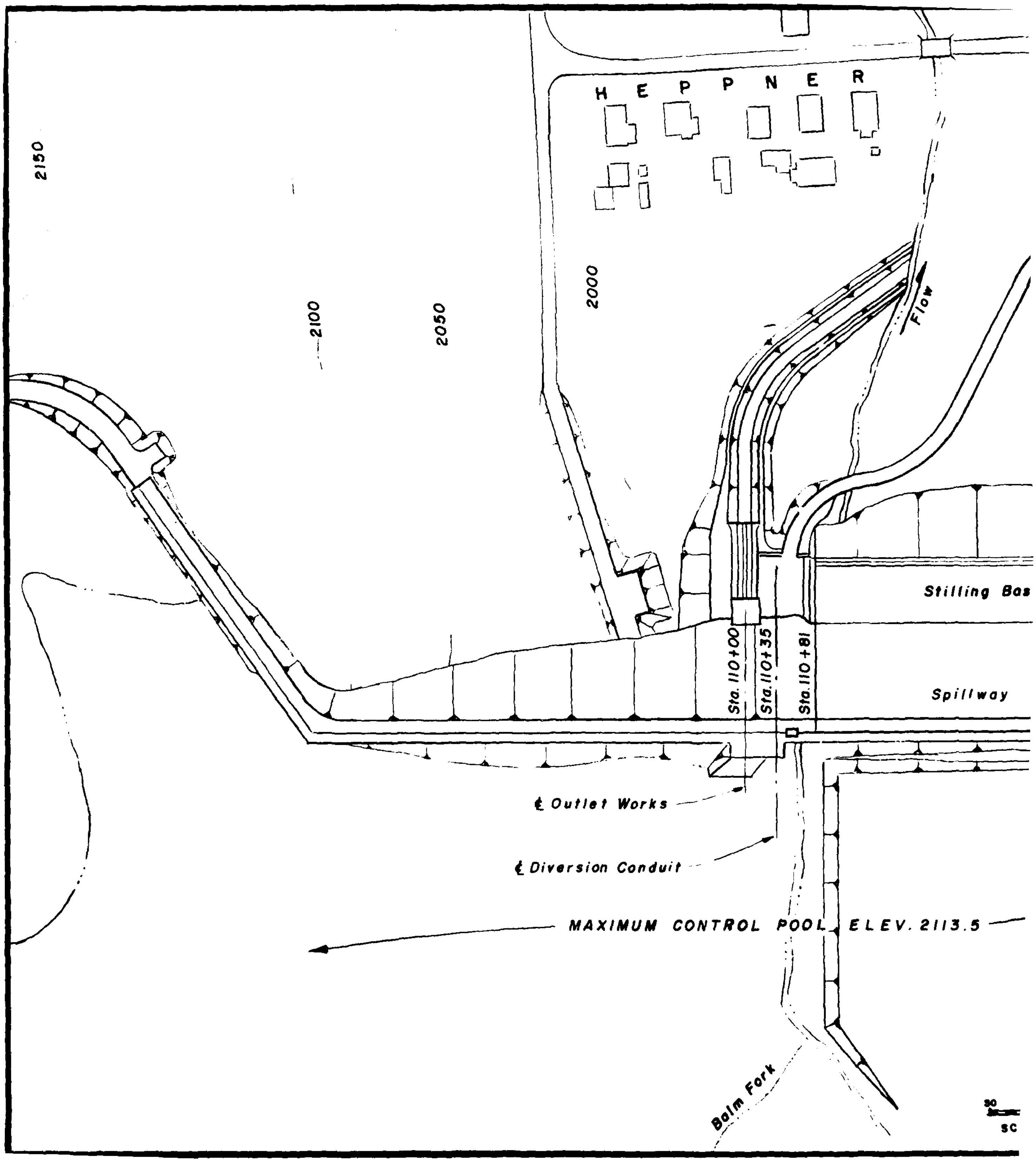
Deposited Spall From Spillway Chute

View from left bank

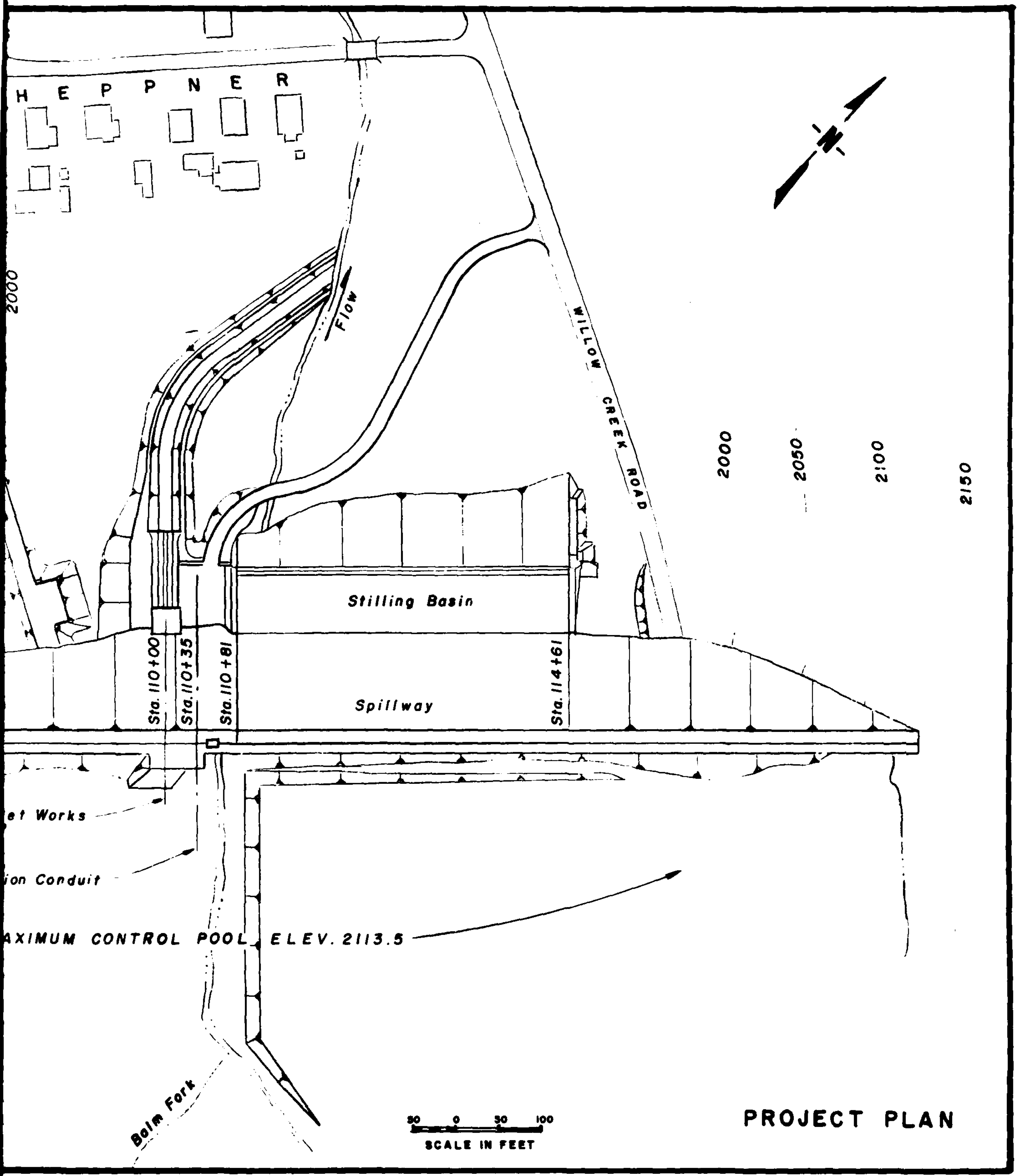
View from right bank

Photograph 37.

Deposited Spall From Spillway Chute

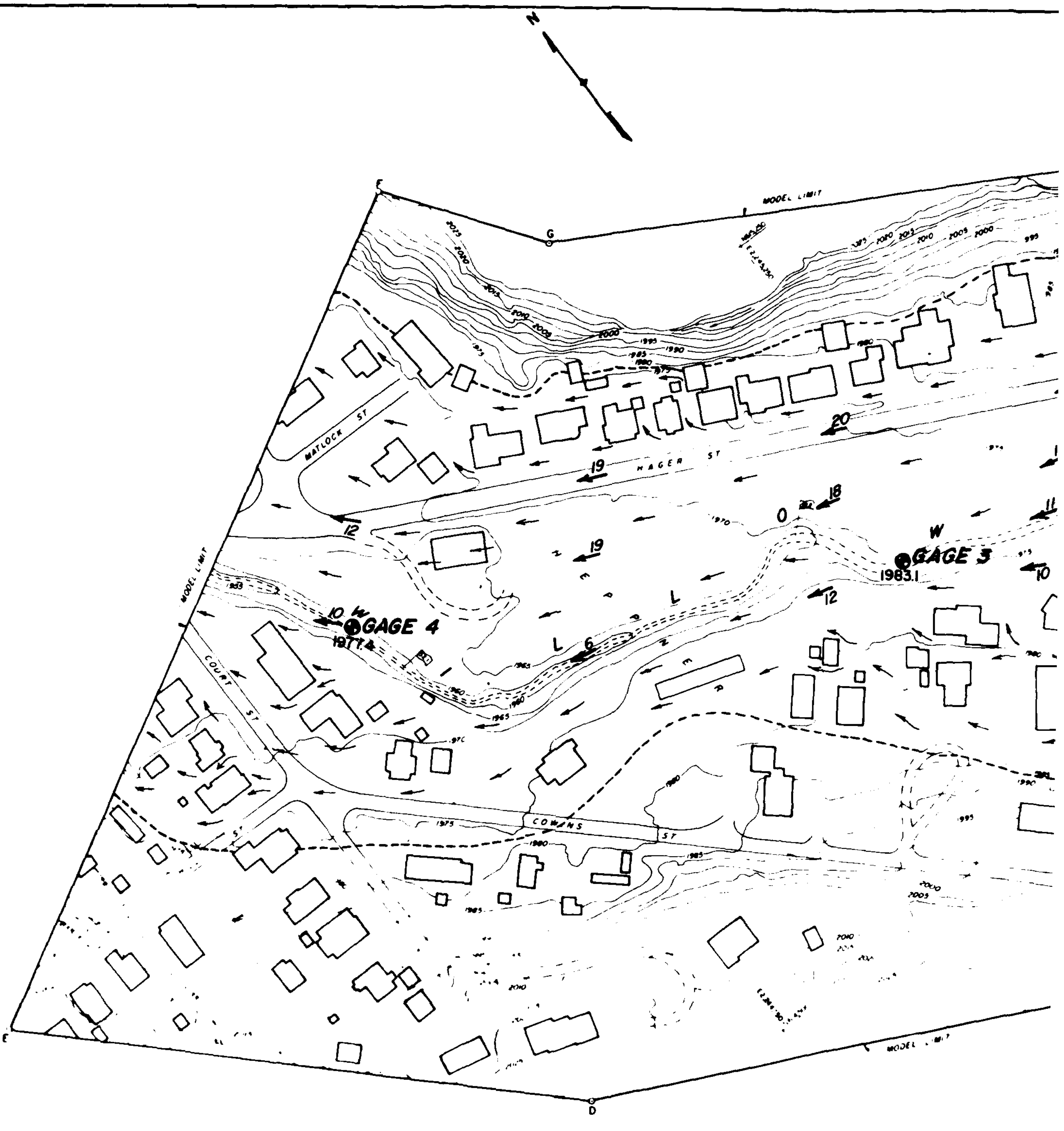


H E P P N E R
2150
2100
2050
2000
Flow
Stilling Bas
Spillway
Sta. 110+00
Sta. 110+35
Sta. 110+81
℄ Outlet Works
℄ Diversion Conduit
MAXIMUM CONTROL POOL ELEV. 2113.5
Balm Fork
30
SC

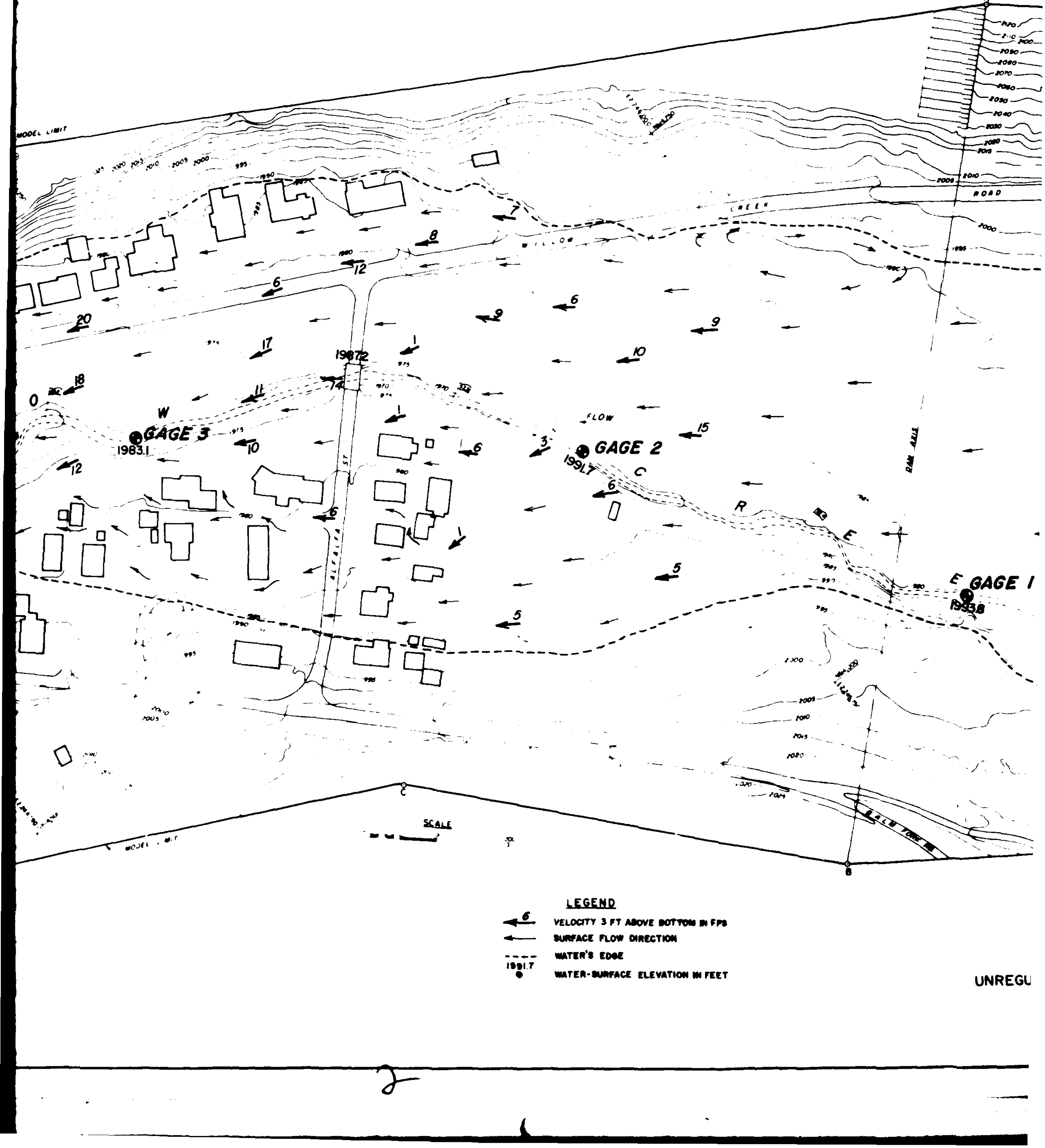


PROJECT PLAN

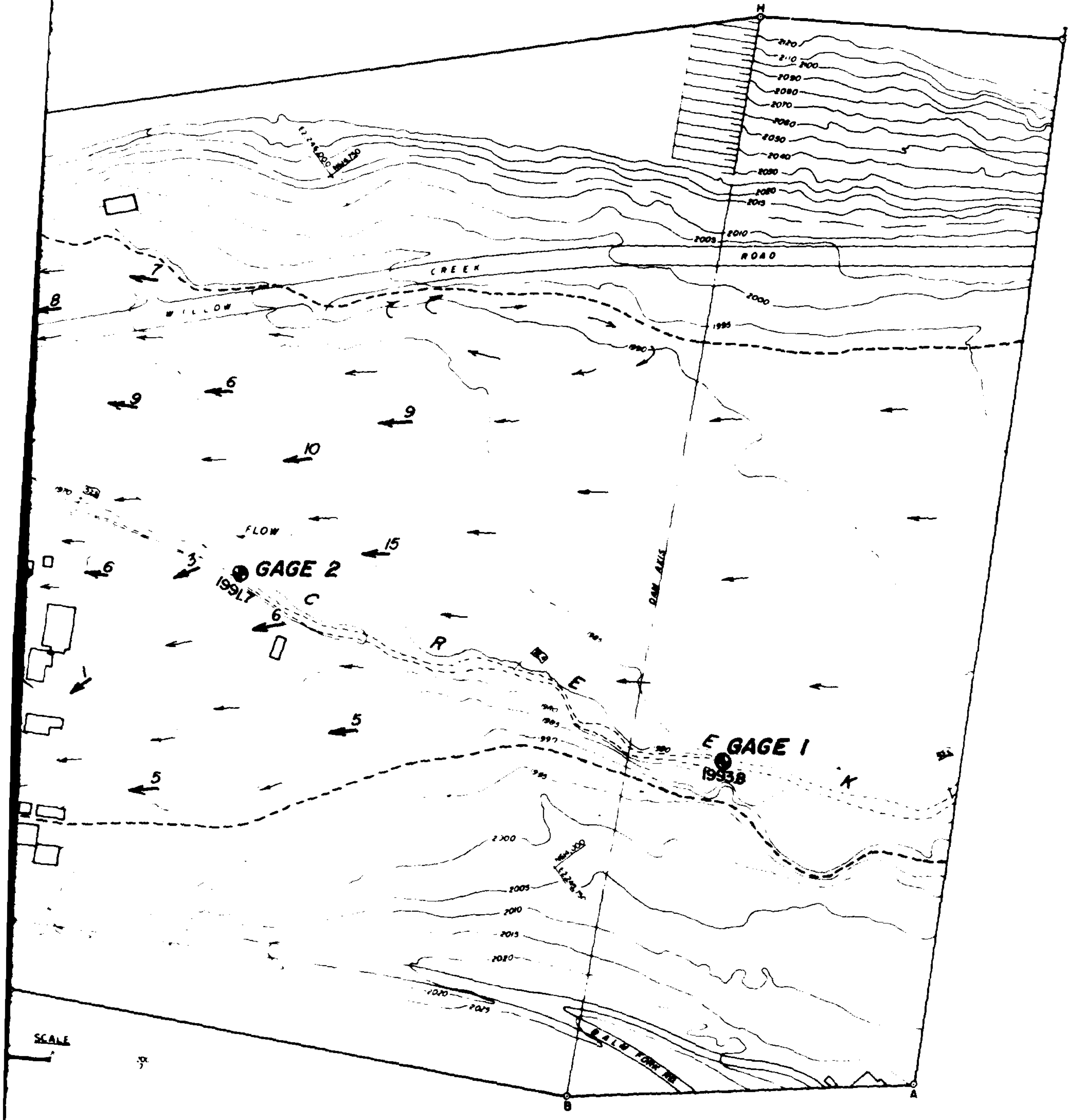
PLATE 1



N
MODEL LIMIT
MODEL LIMIT
MODEL LIMIT
F
G
E
D
MATLOCK ST
HAGER ST
COURT ST
COWINS ST
GAGE 4
1977.4
10 W
GAGE 3
1983.1
W
O
L
L
N
E
P
R
19
20
12
19
18
11
10
12
6
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
1965
1960


MODEL LIMIT
WILLOW CREEK
ROAD
ALFALFA ST
DAM AXIS
FLOW
GAGE 3
1983.1
GAGE 2
1991.7
GAGE 1
1993.8
1987.2
O W C R E E
SCALE
MODEL LIMIT
H
C
B
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1991.7 WATER-SURFACE ELEVATION IN FEET

UNREGU



LEGEND

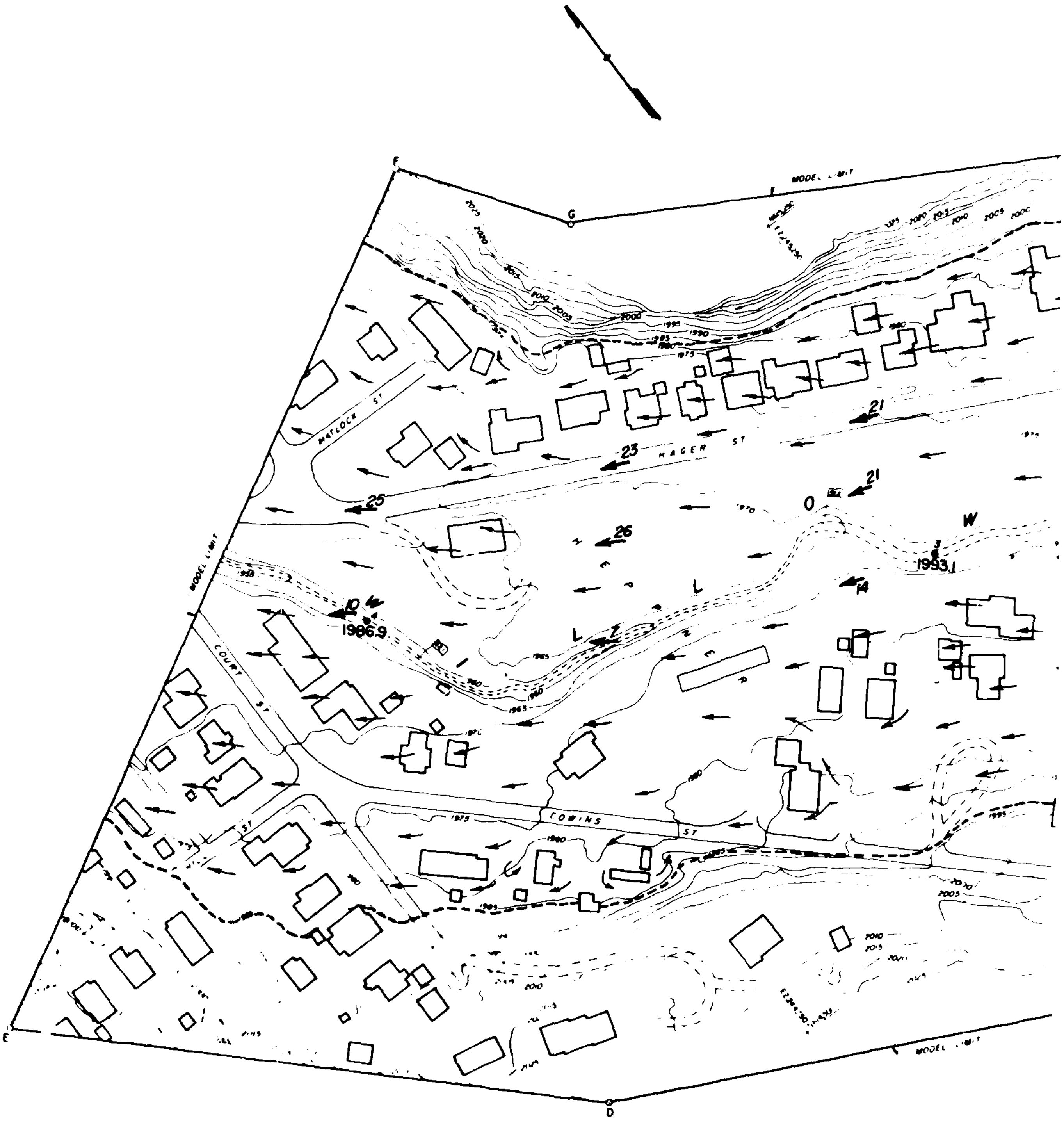
6 (heavy arrow)	VELOCITY 3 FT ABOVE BOTTOM IN FPS
←	SURFACE FLOW DIRECTION
----	WATER'S EDGE
1991.7 ●	WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS

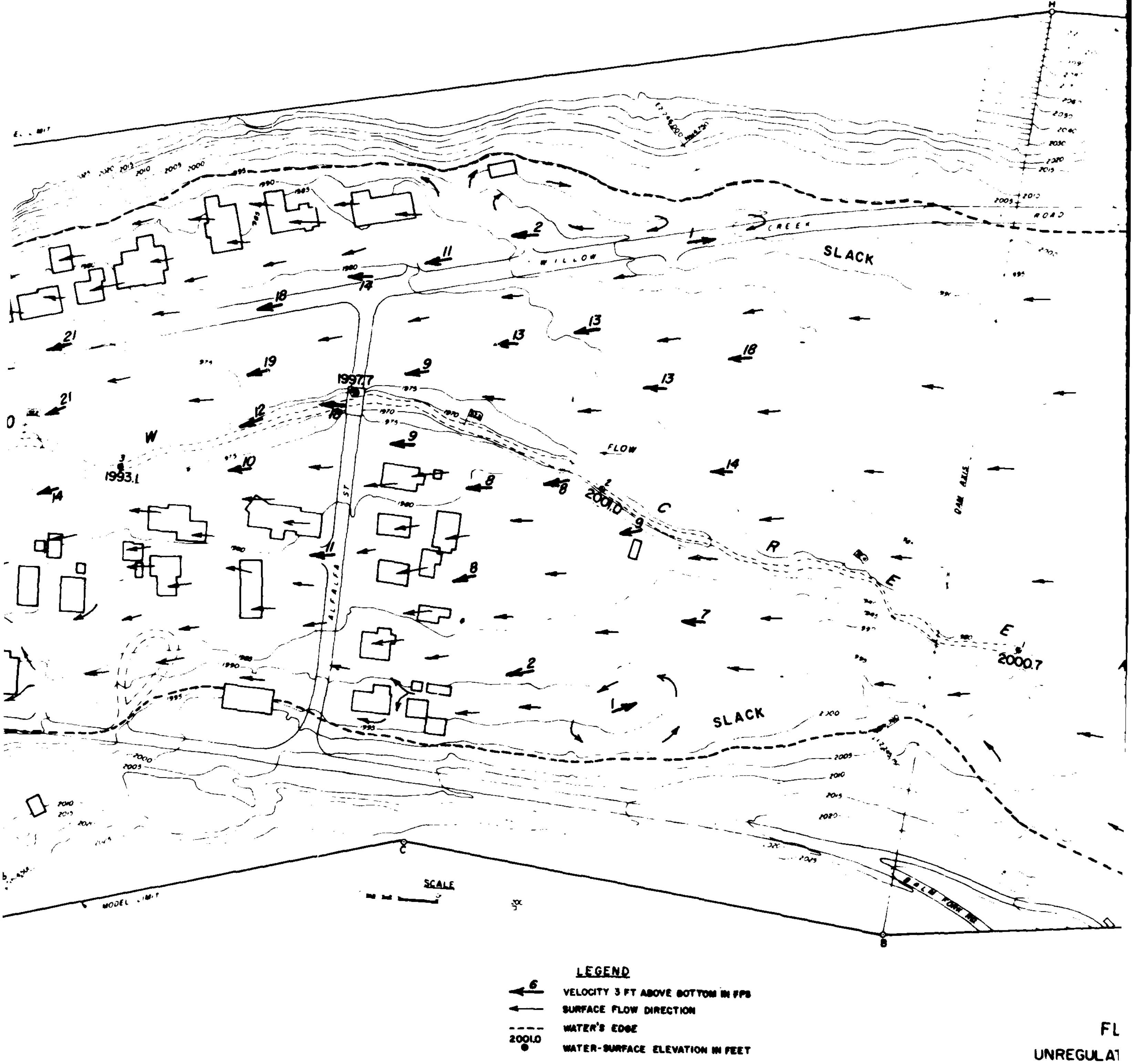
UNREGULATED STANDARD PROJECT FLOOD
DISCHARGE 45 000 CFS

3

PLATE 2



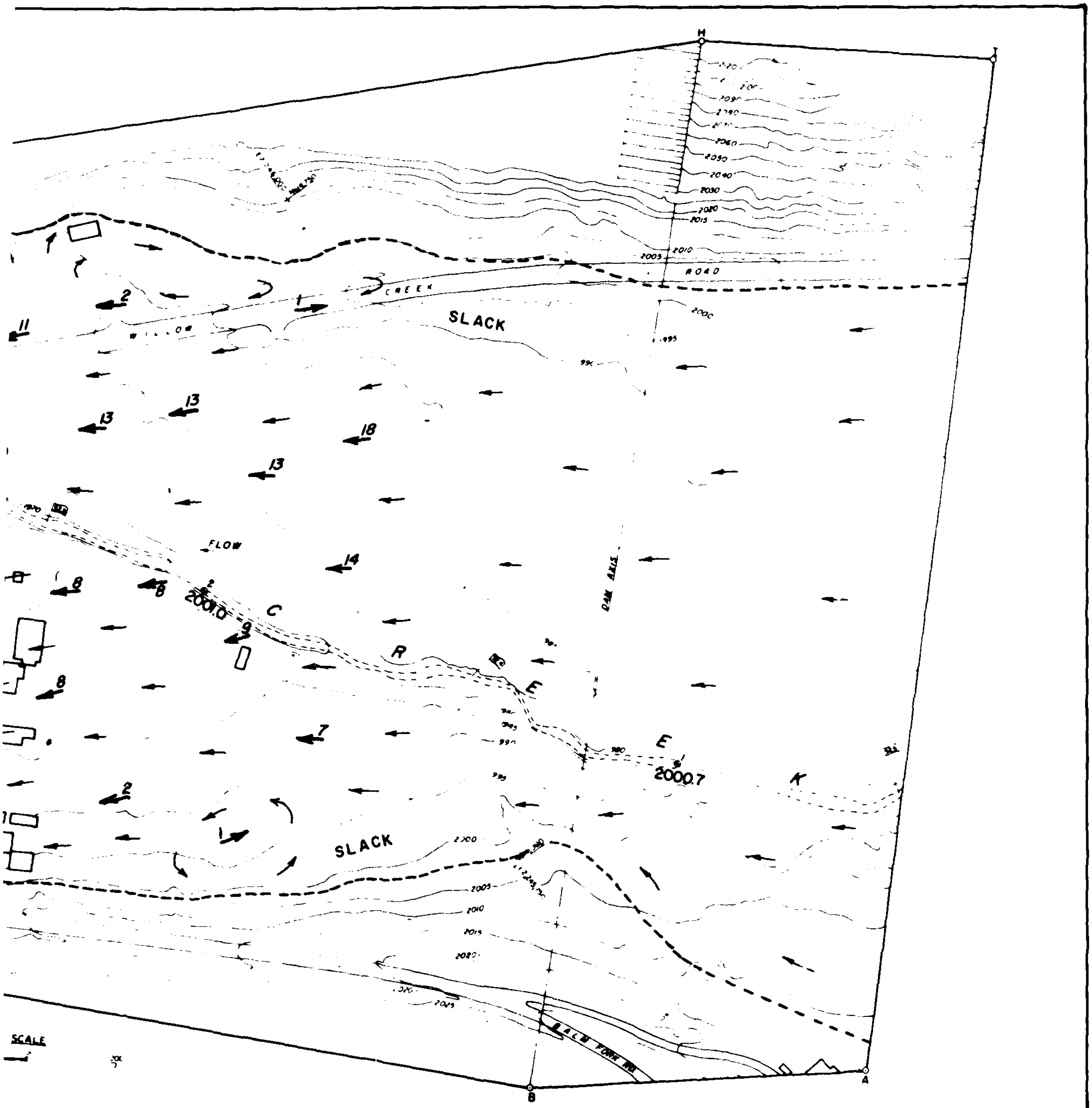
N
F
G
D
E
MODEL LIMIT
MODEL LIMIT
MODEL LIMIT
MATLOCK ST
HAGER ST
COURT ST
CORWINS ST
25
23
21
21
26
14
10
W
1986.9
W
1993.1
O
L
L
2000
1995
1990
1985
1980
1975
1970
1965
2005
2010
2015
2020



FL

UNREGULAT

DI



LEGEND

← 6 VELOCITY 3 FT ABOVE BOTTOM IN FPS

← SURFACE FLOW DIRECTION

- - - - WATER'S EDGE

2001.0 ● WATER-SURFACE ELEVATION IN FEET

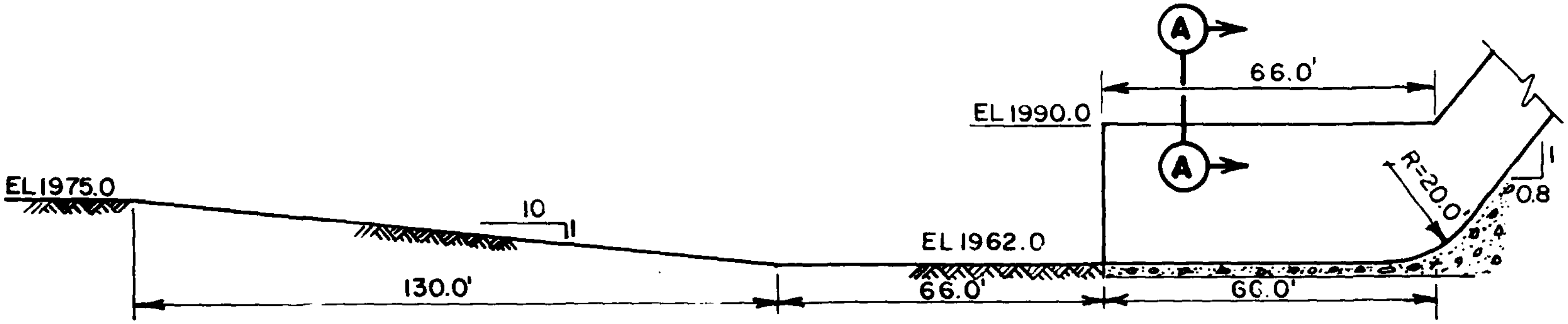
FLOW CONDITIONS

UNREGULATED SPILLWAY DESIGN FLOOD

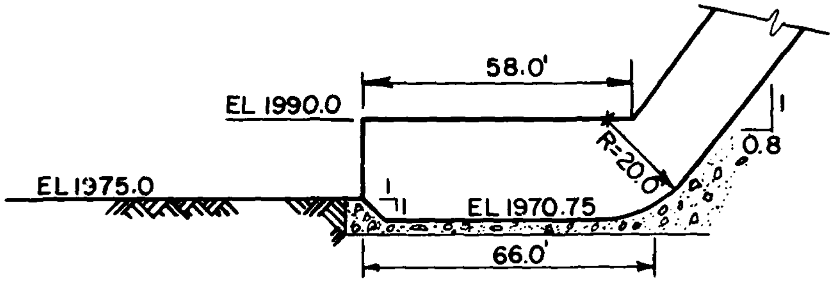
DISCHARGE 107 000 CFS

3

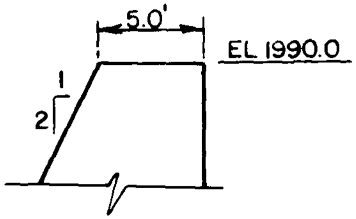
2



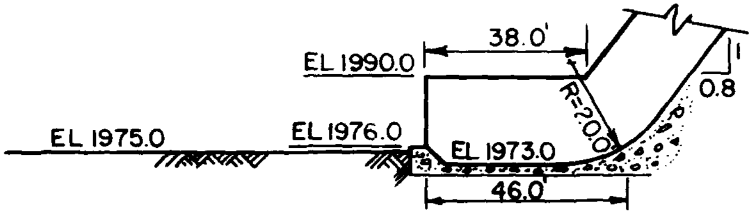
PLAN A STILLING BASIN (91 700 CFS)



PLAN C STILLING BASIN (18000 CFS)

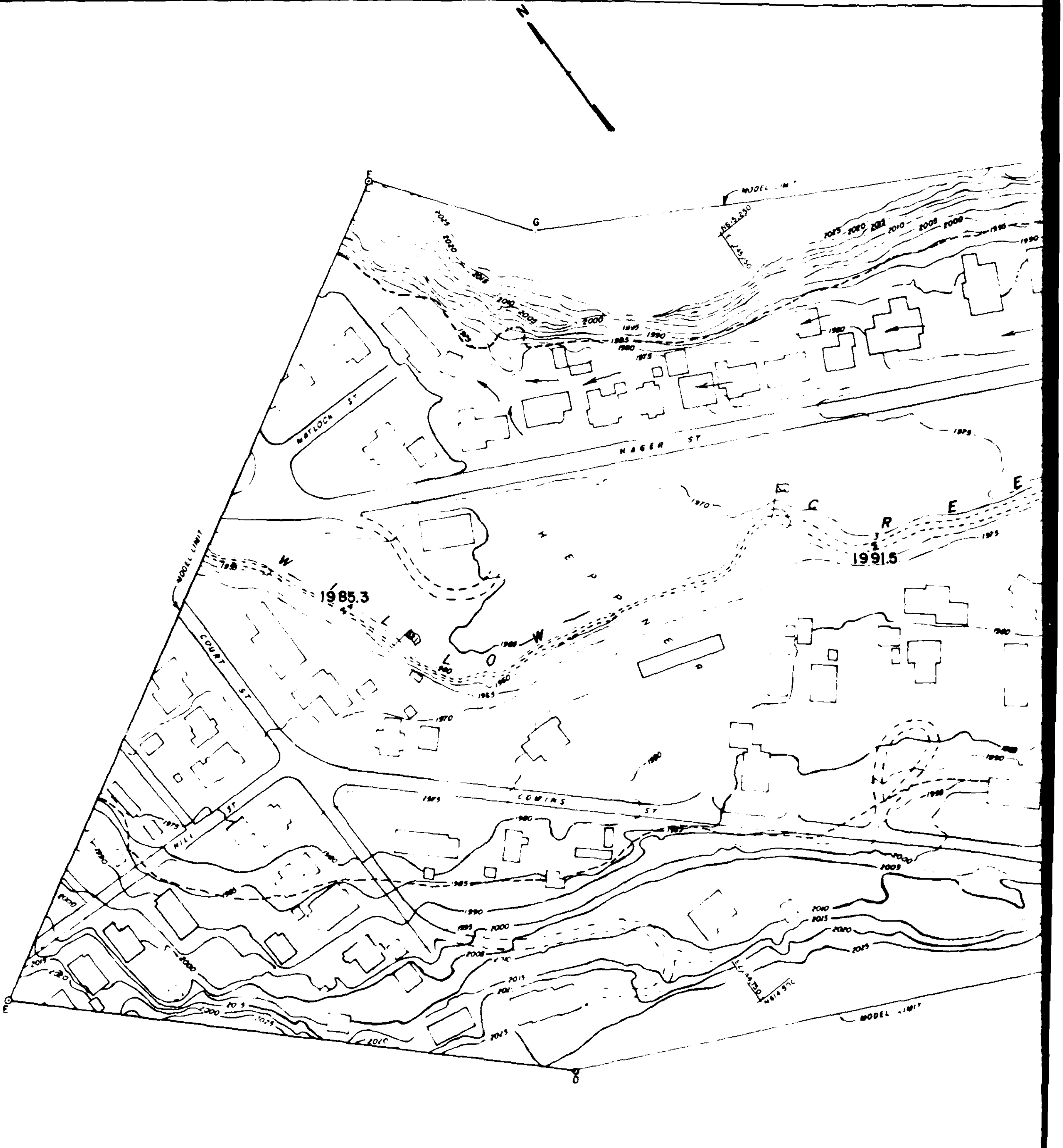


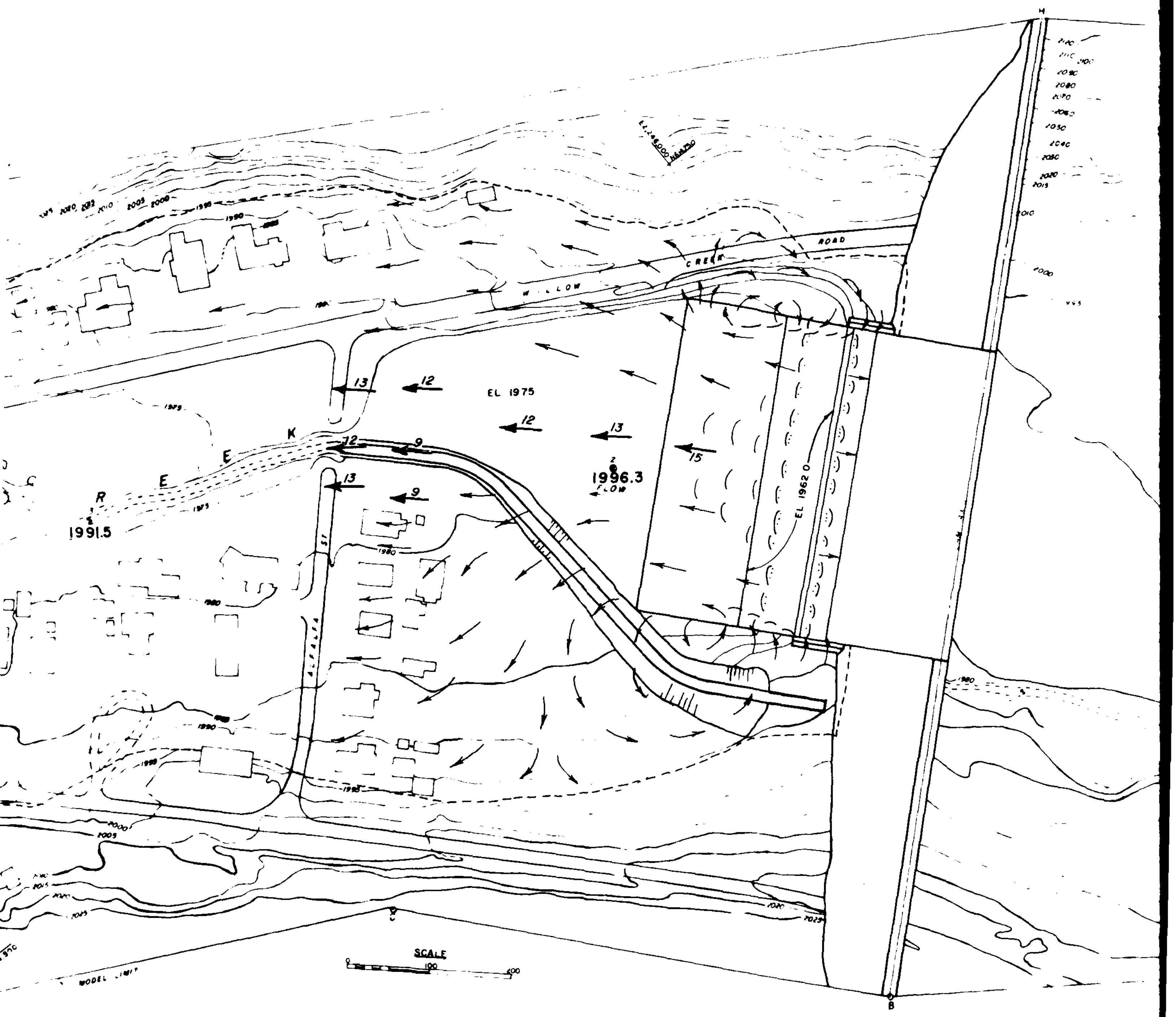
WALL SECTION A-A



PLAN B STILLING BASIN (11 700 CFS)

PLAN DESIGNATION
STILLING BASIN PLAN A TO C


N
F
G
MODEL LIMIT
MATLOCK ST
HAGER ST
WILLOW
CREEK
HEPPNER
1985.3
1991.5
COURT ST
HILL ST
COWINS ST
MODEL LIMIT
MODEL LIMIT
E
D
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025



LEGEND

- ← 6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
- ← SURFACE FLOW DIRECTION
- ---- WATER'S EDGE
- ⊙ 1996.3 WATER-SURFACE ELEVATION IN FEET

FLO

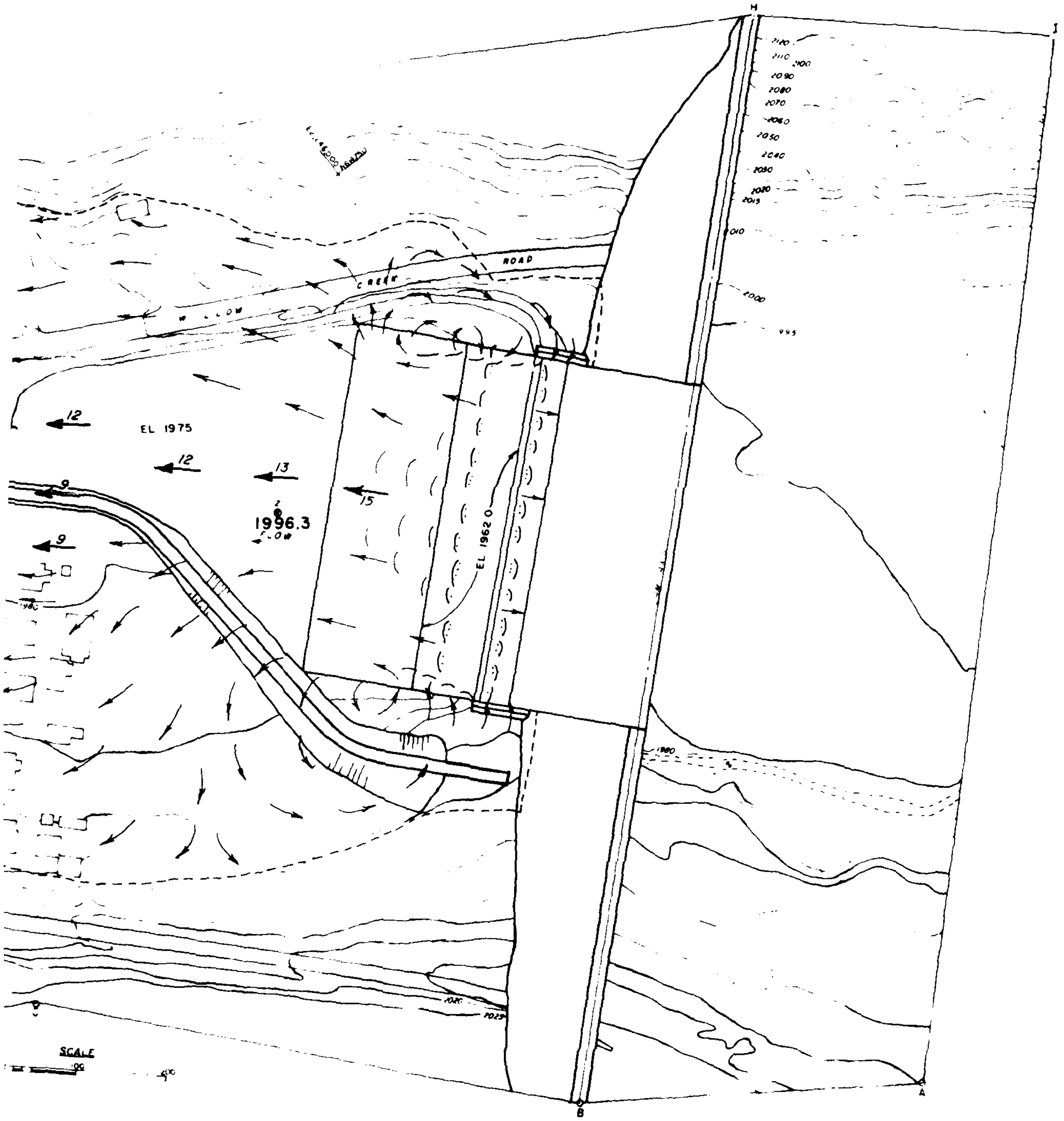
REGULATED

DISCHA

STILLING BASI

AND 4-FT-HI

2



LEGEND

6 VELOCITY 3 FT ABOVE BOTTOM IN FPS

SURFACE FLOW DIRECTION

WATER'S EDGE

1996.3 WATER-SURFACE ELEVATION IN FEET

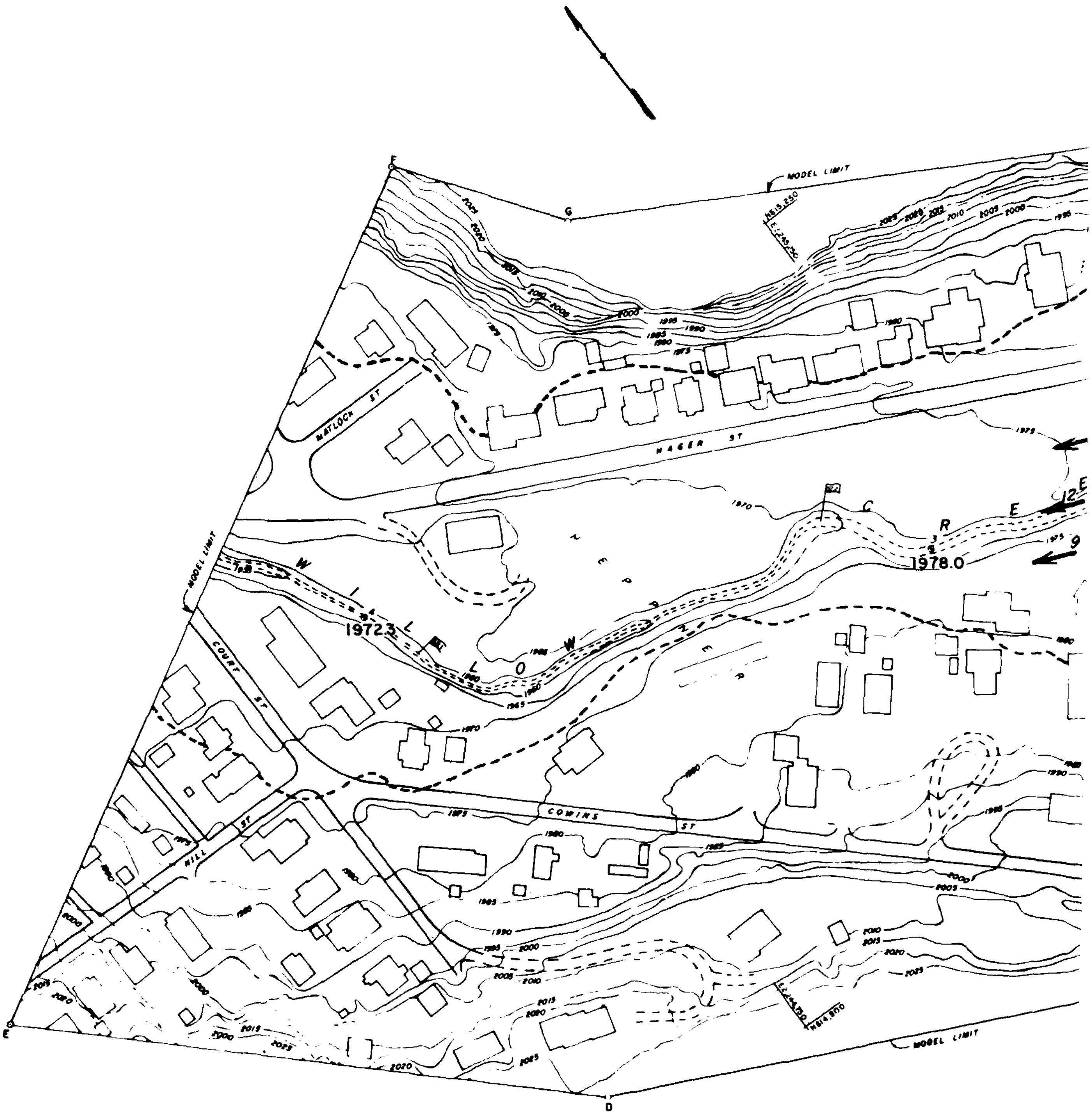
FLOW CONDITIONS

REGULATED SPILLWAY DESIGN FLOOD
DISCHARGE 91 700 CFS

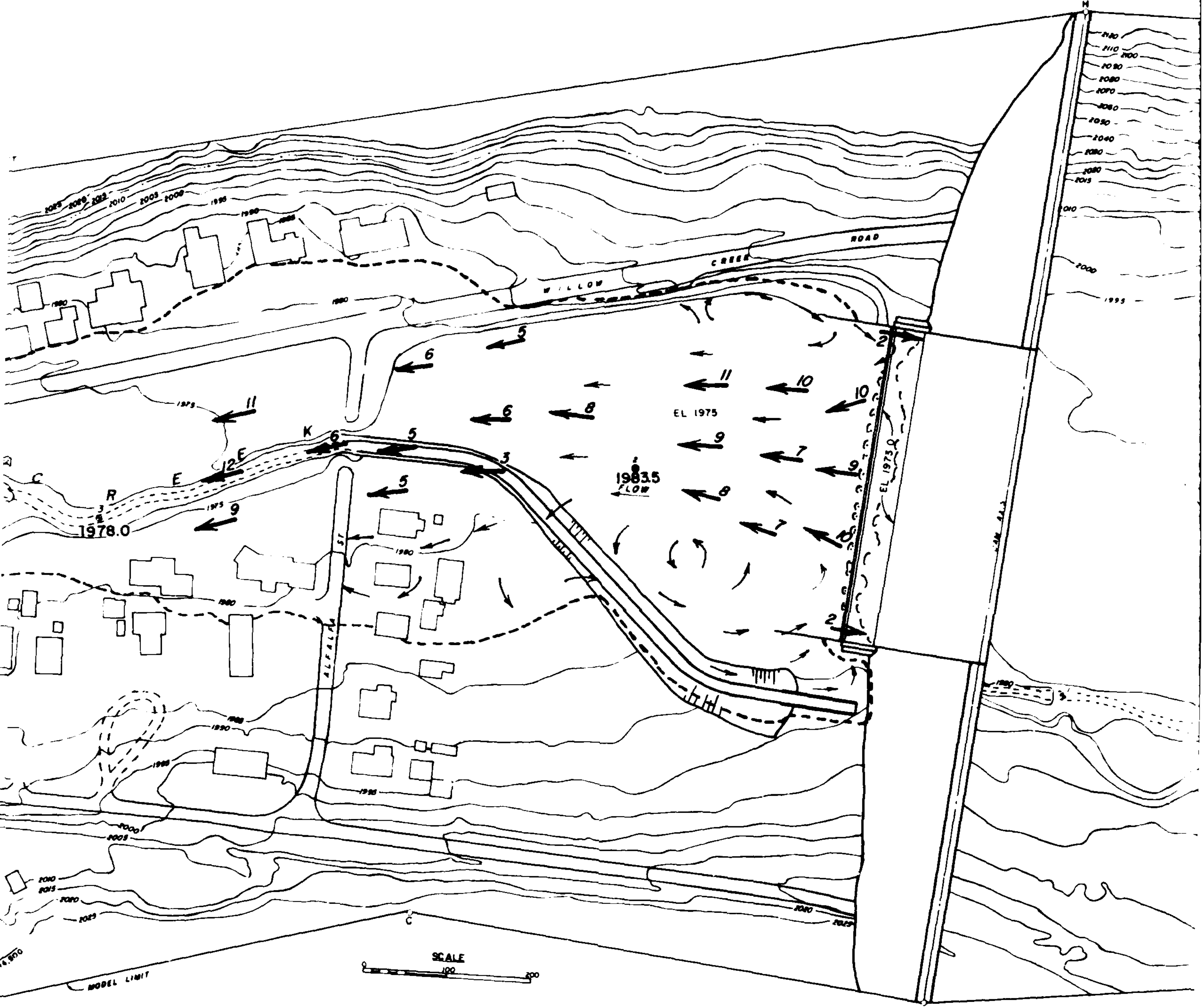
STILLING BASIN FOR 91 700 CFS WITH SCOUR
AND 4-FT-HIGH END SILL INSTALLED

3

2



N
F
G
MODEL LIMIT
N515,250
E 2,245,250
HAGER ST
MATLOCK ST
W I L L O W
C R E E K
1972.3
1978.0
12
9
COURT ST
HILL ST
COWINS ST
E 2,244,750
N514,800
MODEL LIMIT
MODEL LIMIT
E
D
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025



LEGEND

← 6 VELOCITY 3 FT ABOVE BOTTOM IN FPS

← SURFACE FLOW DIRECTION

- - - WATER'S EDGE

1983.5 ● WATER-SURFACE ELEVATION IN FEET

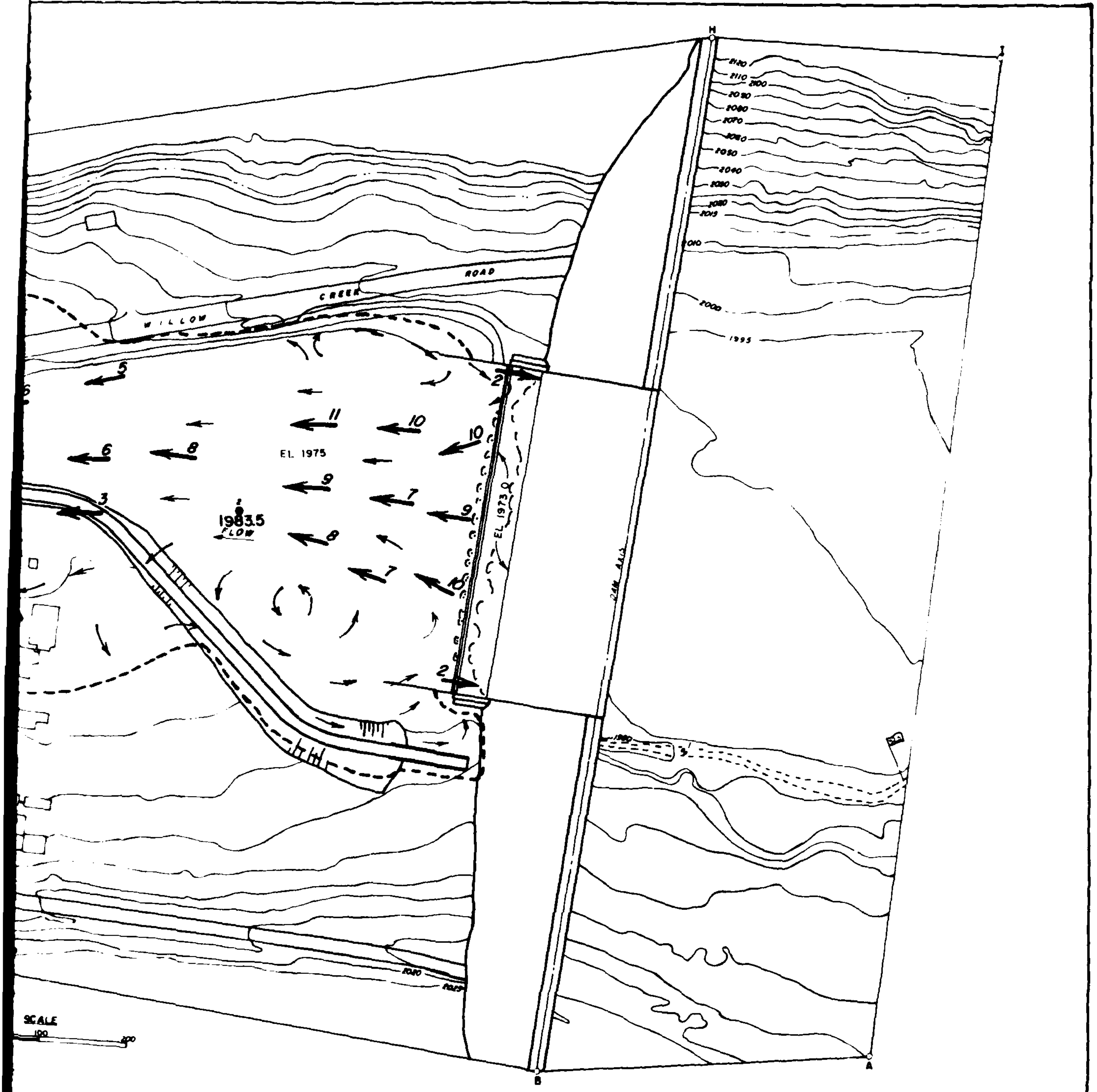
FLC

REGULATED

DIS

STILLING BAS

2



LEGEND

- 6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
- SURFACE FLOW DIRECTION
- WATER'S EDGE
- 1983.5 ⊕ WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS
REGULATED STANDARD PROJECT FLOOD

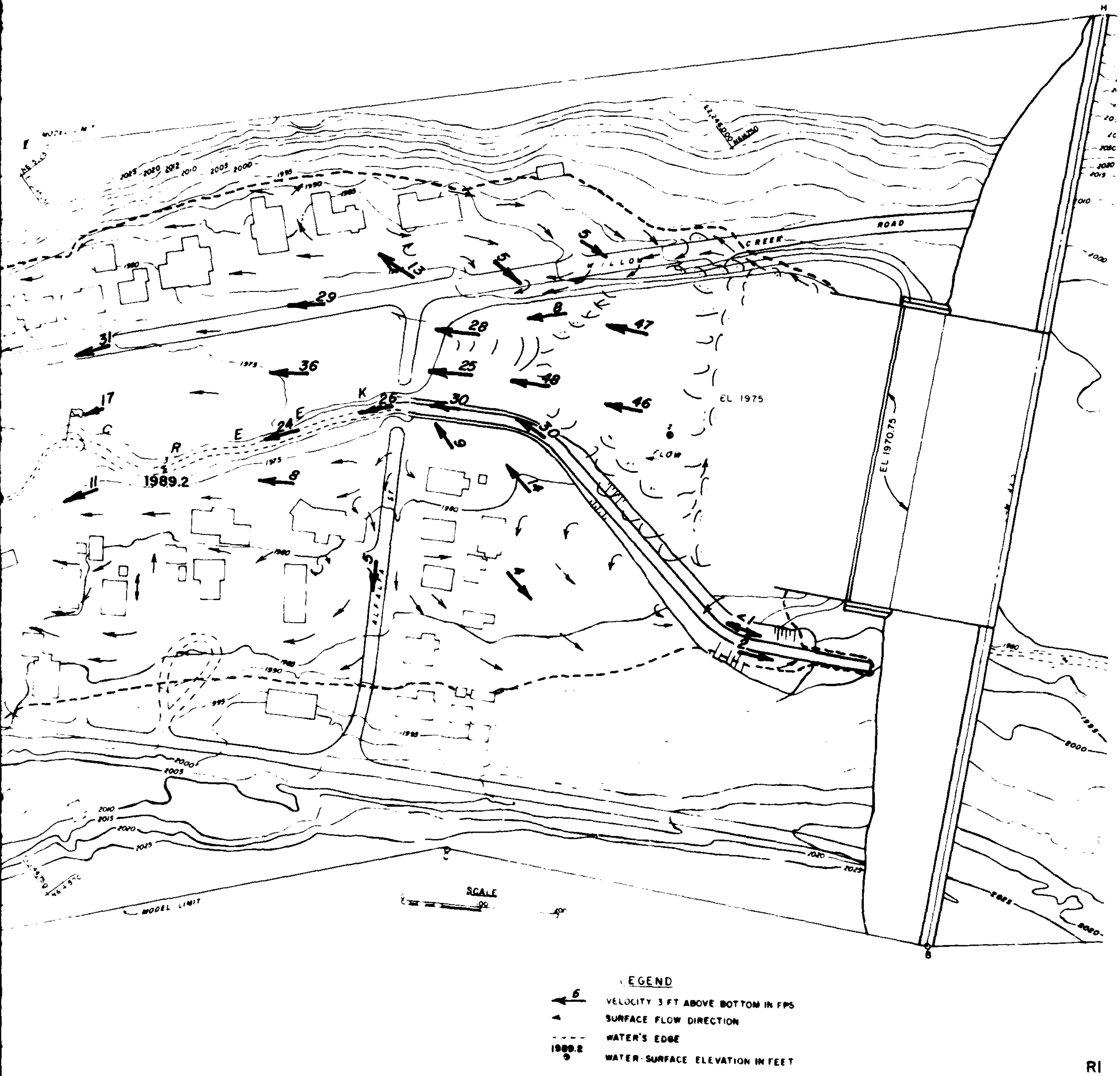
DISCHARGE 11 700 CFS

STILLING BASIN FOR 11 700 CFS WITH SCOUR

2

3

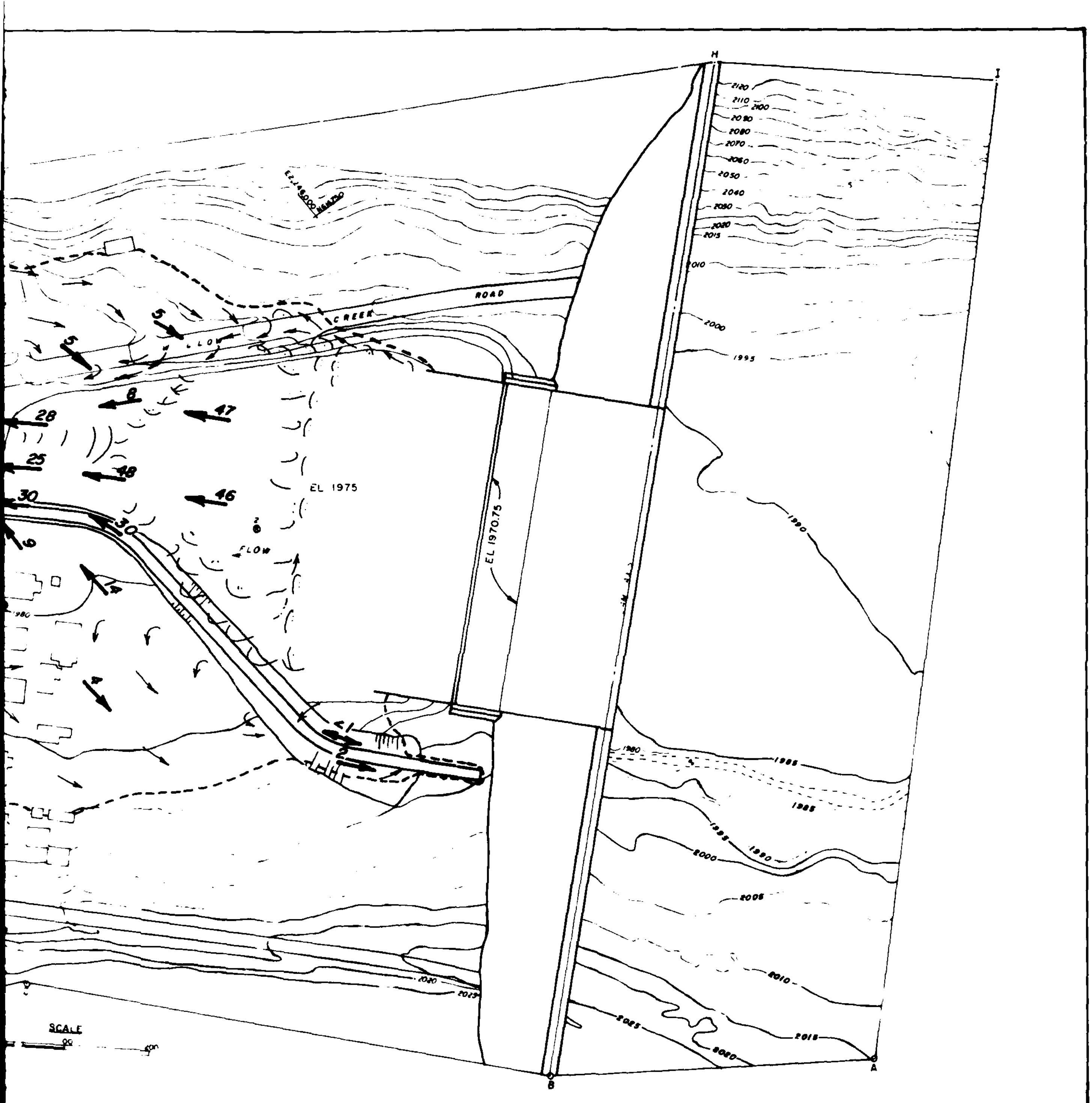

N
F
G
E
D
MODEL LIMIT
MATLOCK ST
HAGER ST
COURT ST
HILL ST
COWINS ST
W I L L O W
C R E E K
H E P P N E R
1984.9
1989.2
26
28
31
17
29
10
11
8
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
1965
1960


H
WILLOW CREEK ROAD
CREEK
ALFALFA ST
EL 1975
EL 1970.75
FLOW
1989.2
K
MODEL LIMIT
SCALE
E 2,246,000
N 68750
5
5
13
29
31
8
28
47
36
25
48
17
26
30
46
24
30
9
11
8
14
5
4
21
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
B
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1989.2 WATER-SURFACE ELEVATION IN FEET

RI

ST

2



LEGEND

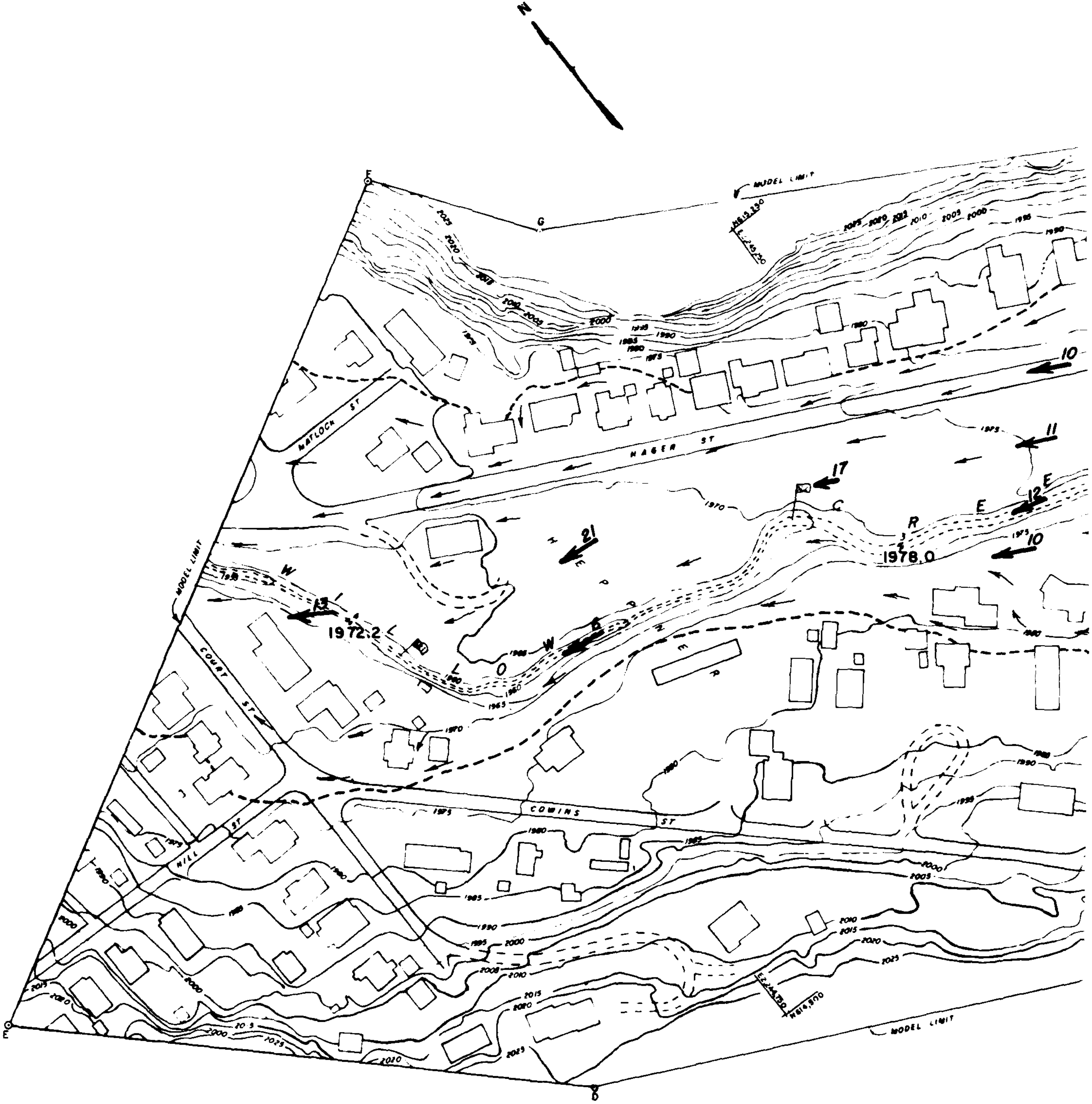
6 ←	VELOCITY 3 FT ABOVE BOTTOM IN FPS
←	SURFACE FLOW DIRECTION
- - - -	WATER'S EDGE
1989.2	WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS

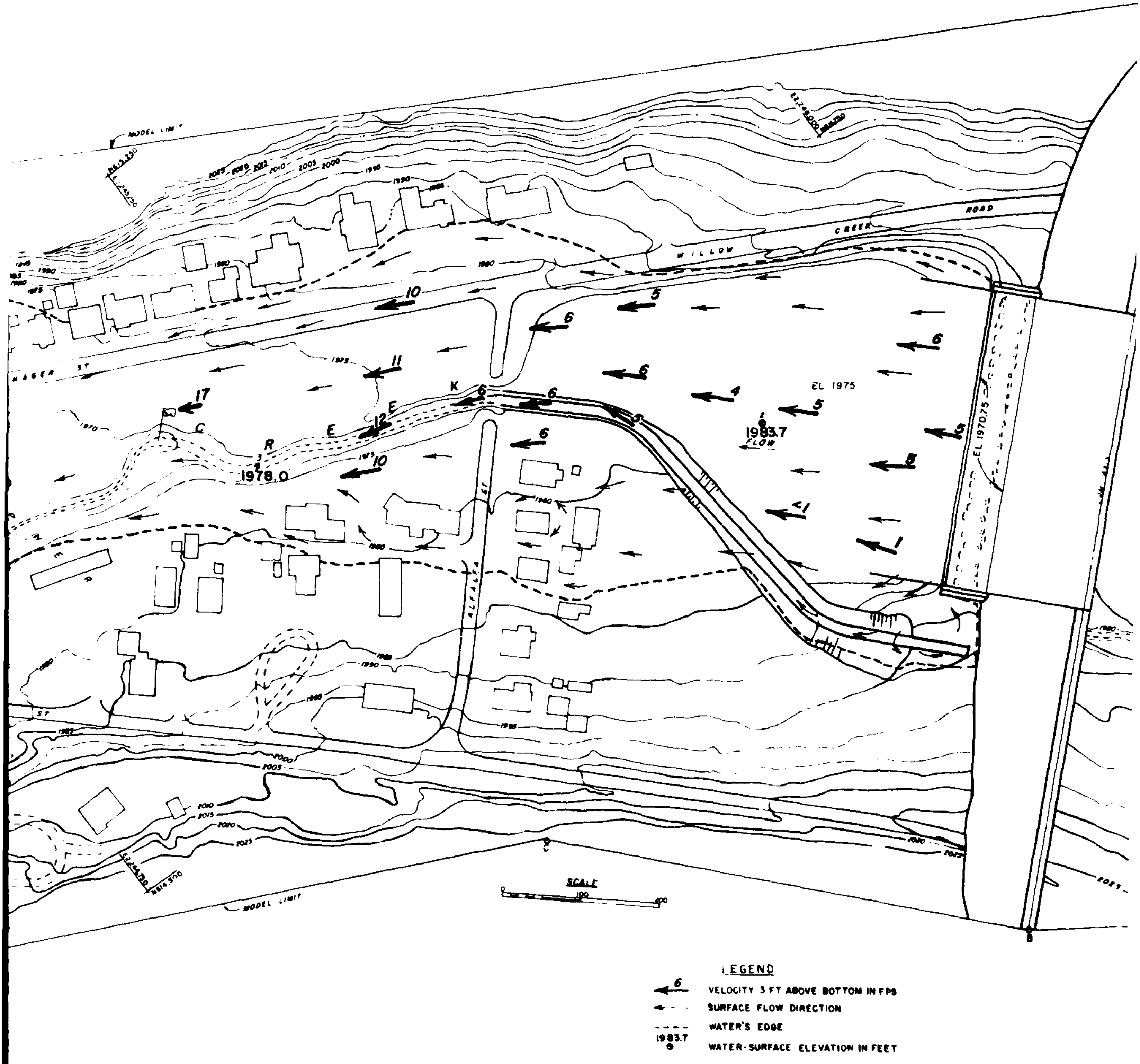
REGULATED SPILLWAY DESIGN FLOOD

DISCHARGE 91 700 CFS

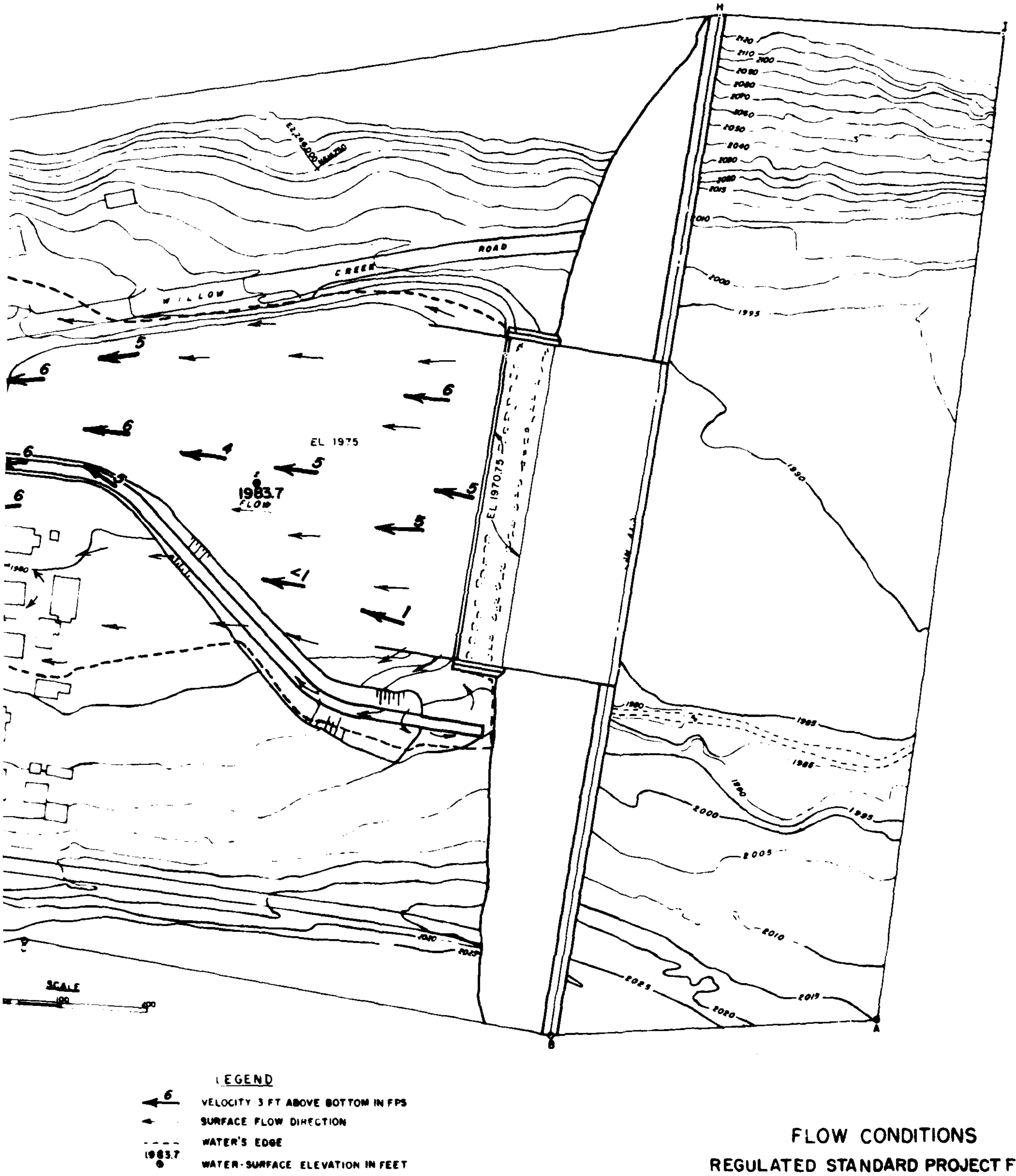
STILLING BASIN FOR 18000 CFS WITH SCOUR 3



N
MODEL LIMIT
F
G
E
D
N 815,230
E 2,245,730
E 2,244,730
N 816,300
MATLOCK ST
HAGER ST
COURT ST
COWINS ST
HILL ST
W I L L O W
C R E E K
H E P P N E R
1972.2
1978.0
10
11
12
17
21
13
6
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
1965


MODEL LIMIT
N813,250
E2,245,250
E2,248,000
N814,750
WILLOW
CREEK
ROAD
HAGER ST
ALFALFA ST
ST
CREEK
EL 1975
EL 1970.75
1983.7
FLOW
1978.0
17
12
11
10
10
6
6
6
6
6
6
5
5
5
5
4
<1
1
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
E2,244,750
N814,250
SCALE
0
100
200
LEGEND
6
VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1983.7
WATER-SURFACE ELEVATION IN FEET

2



FLOW CONDITIONS

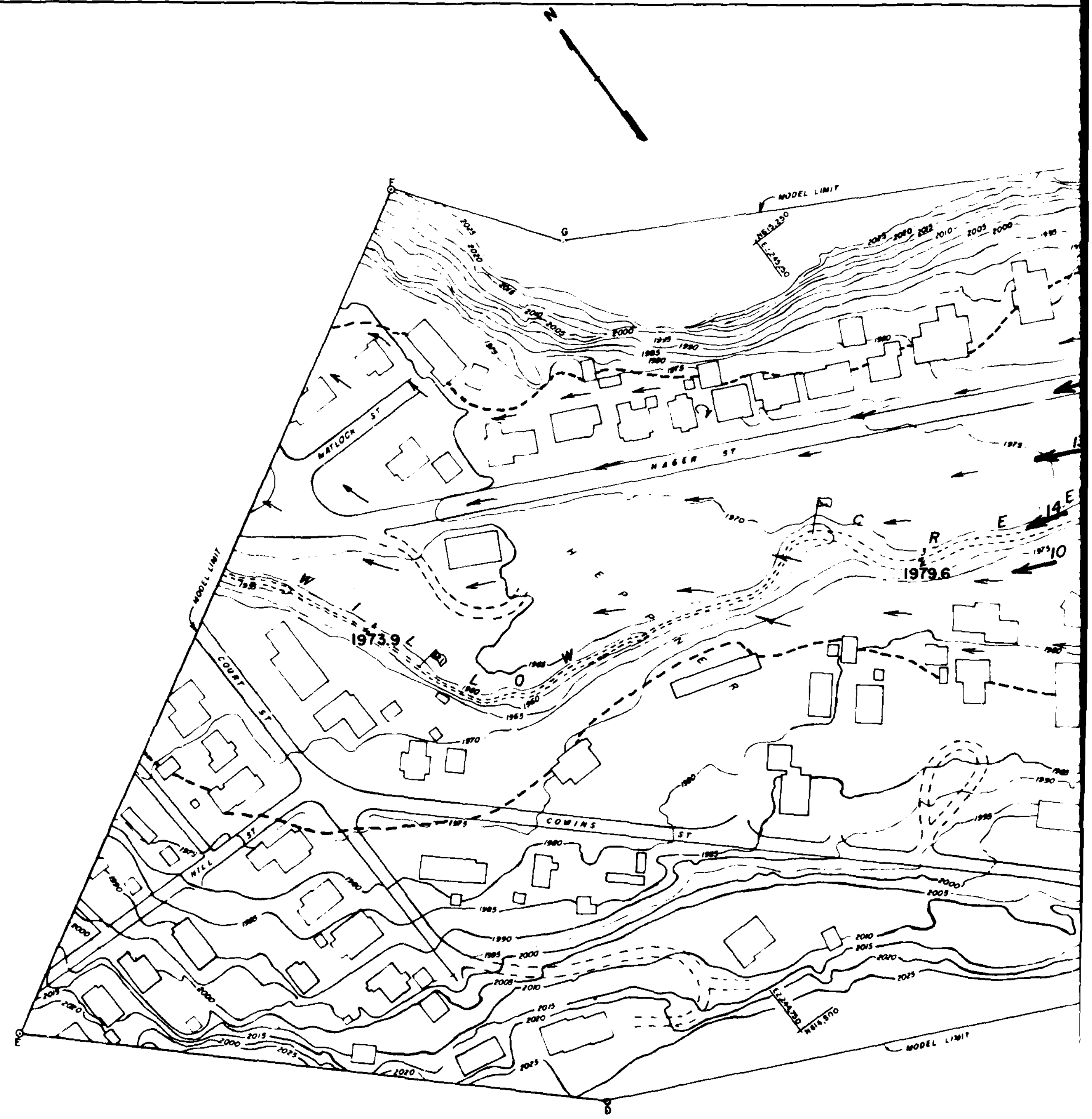
REGULATED STANDARD PROJECT FLOOD

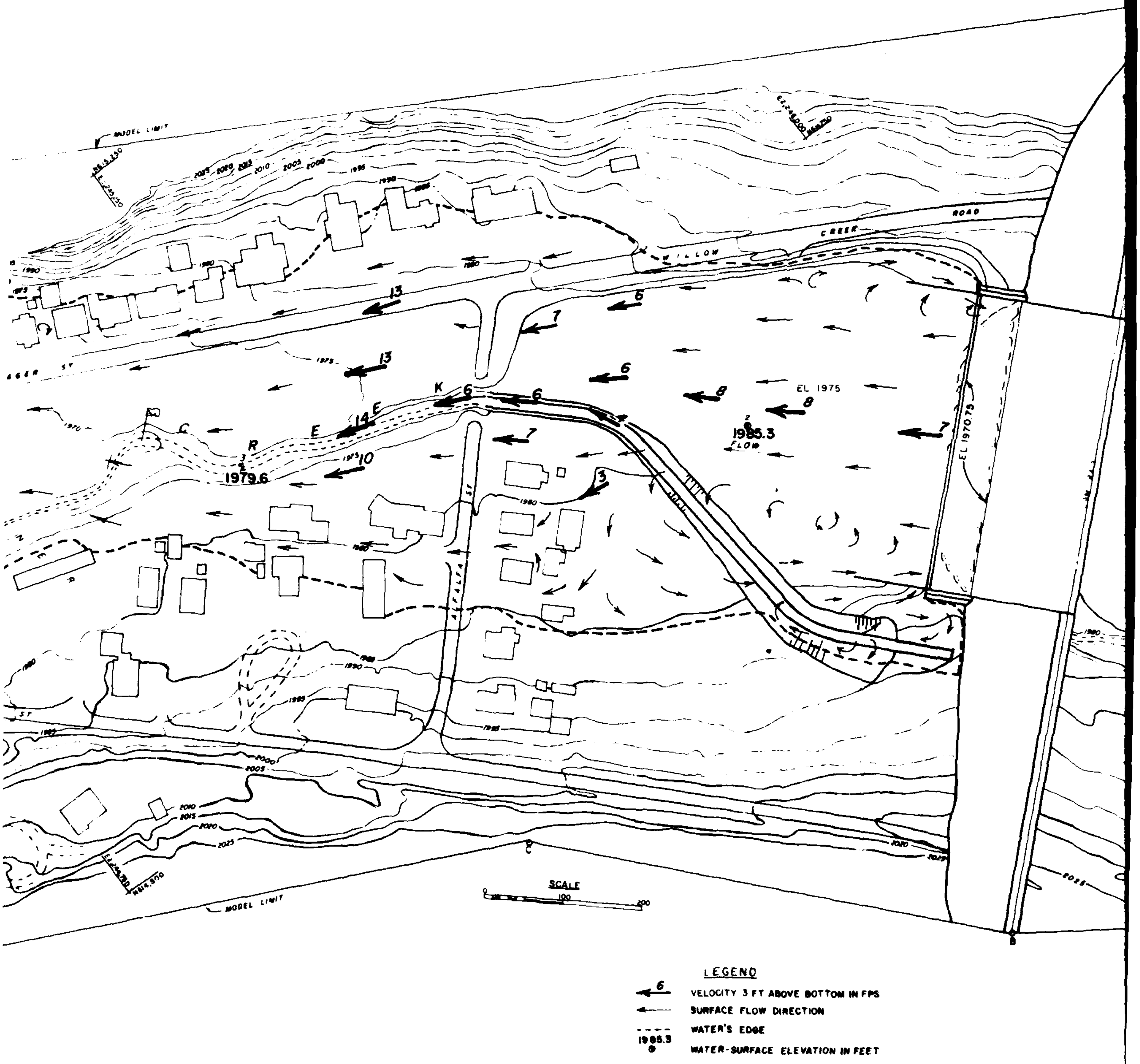
DISCHARGE 11 700 CFS

STILLING BASIN FOR 18000 CFS WITH SCOUR

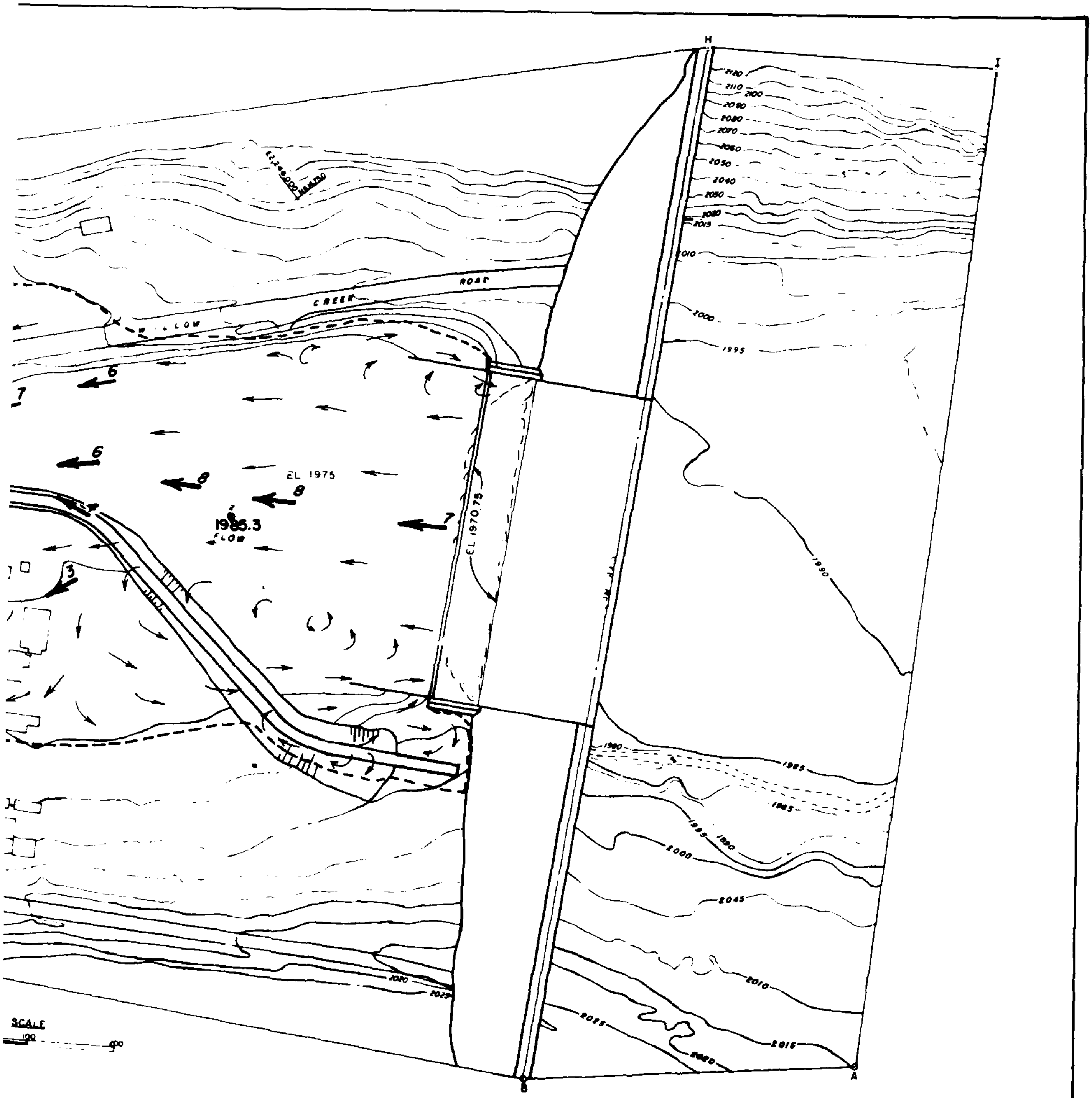
3

PLATE 8


N
MODEL LIMIT
F
G
N615,250
E 245,250
MATLOCK ST
HAGER ST
COURT ST
HILL ST
COWINS ST
W I L L O W
C R E E K
H E P P N E R
1973.9
1979.6
13
14
10
MODEL LIMIT
E 244,750
N614,500
MODEL LIMIT
E
D
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


MODEL LIMIT
N615,250
E 2,35,250
2015
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
WILLOW CREEK ROAD
ST
CREEK
13
6
7
13
6
K
6
6
8
8
EL 1975
1985.3
FLOW
7
14
10
7
3
1979.6
EL 1970.75
ALFALFA ST
ST
2025
E 2,48,000
N 614,750
E 2,35,250
N 614,900
SCALE
100
200
LEGEND
6
VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1985.3
WATER-SURFACE ELEVATION IN FEET

2



LEGEND

6 VELOCITY 3 FT ABOVE BOTTOM IN FPS

SURFACE FLOW DIRECTION

WATER'S EDGE

1985.3 WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS

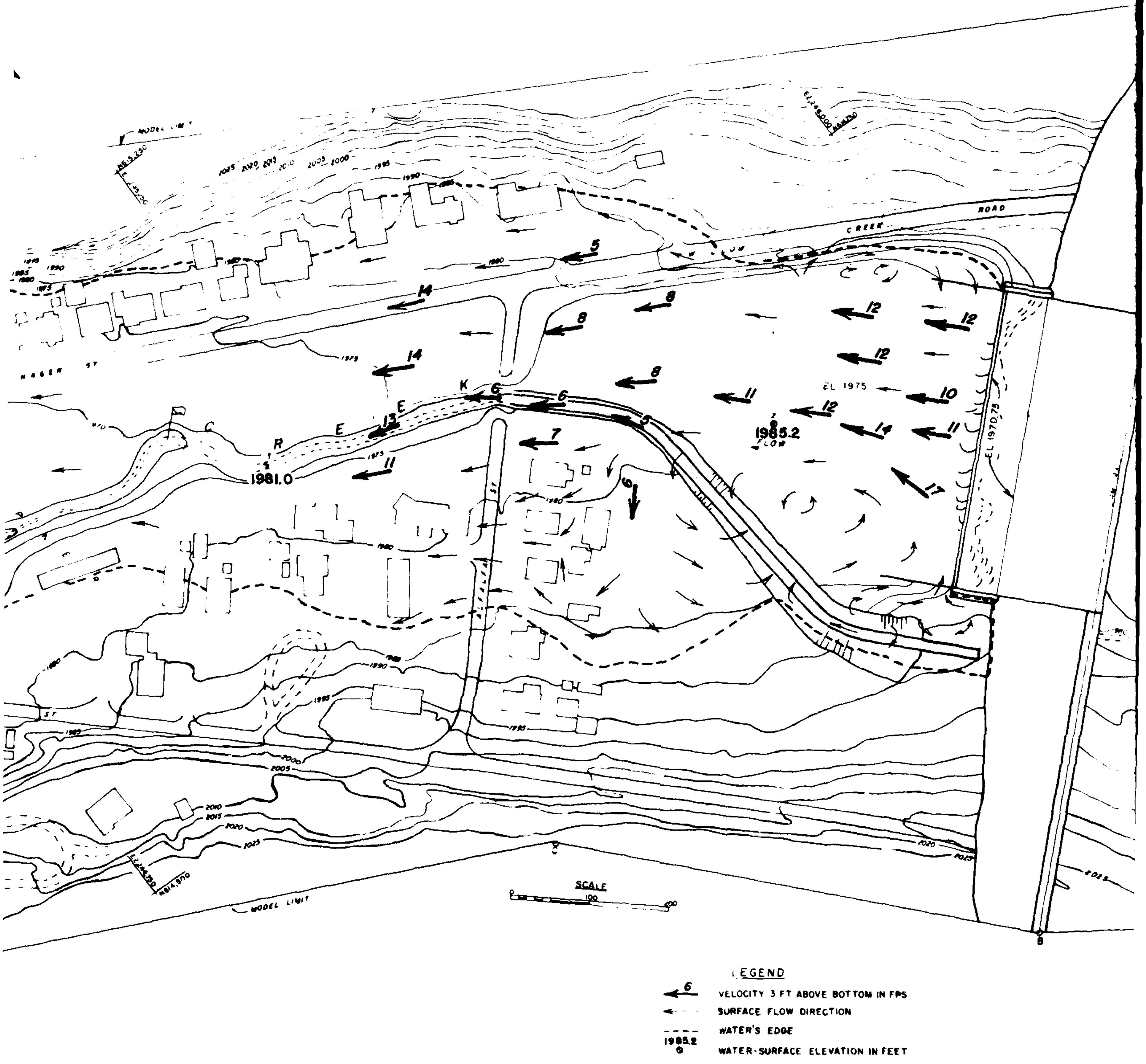
DISCHARGE 18 000 CFS

STILLING BASIN FOR 18000 CFS WITH SCOUR

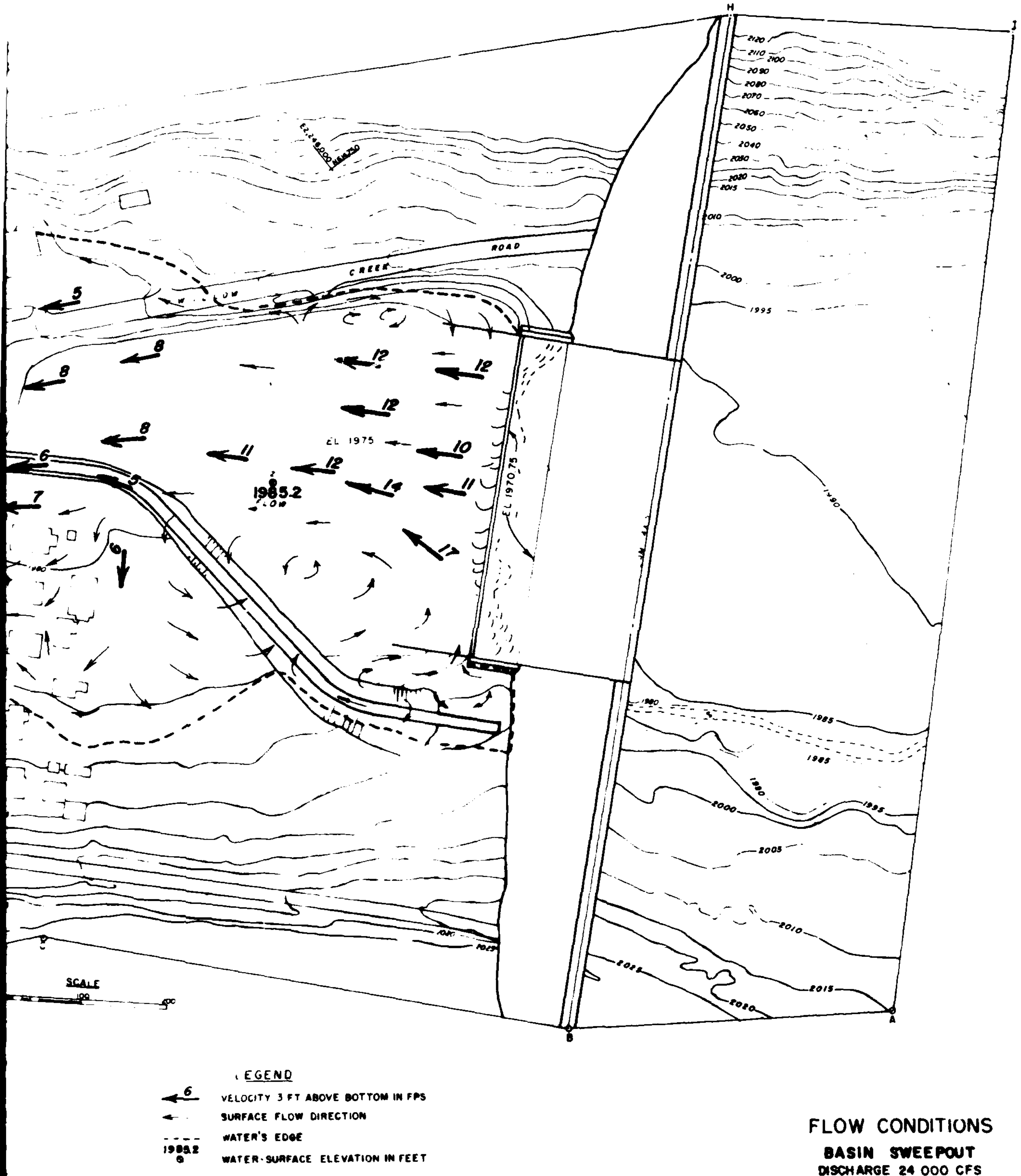
3

PLATE 9


N
F
G
D
E
MODEL LIMIT
MODEL LIMIT
MODEL LIMIT
MATLOCK ST
HAGER ST
WILLOW
CREEK
1975.2
1981.0
COURT ST
COWINS ST
HILL ST
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


MODEL LIMIT
HAGER ST
CREEK ROAD
C R E E K
EL 1975
1985.2
FLOW
1981.0
EL 1970.75
5
14
8
8
12
12
12
14
8
11
12
10
13
6
6
5
7
11
14
11
17
6
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
SCALE
0
100
200
B
LEGEND
6
VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1985.2
WATER-SURFACE ELEVATION IN FEET

2



FLOW CONDITIONS

BASIN SWEEPOUT

DISCHARGE 24 000 CFS

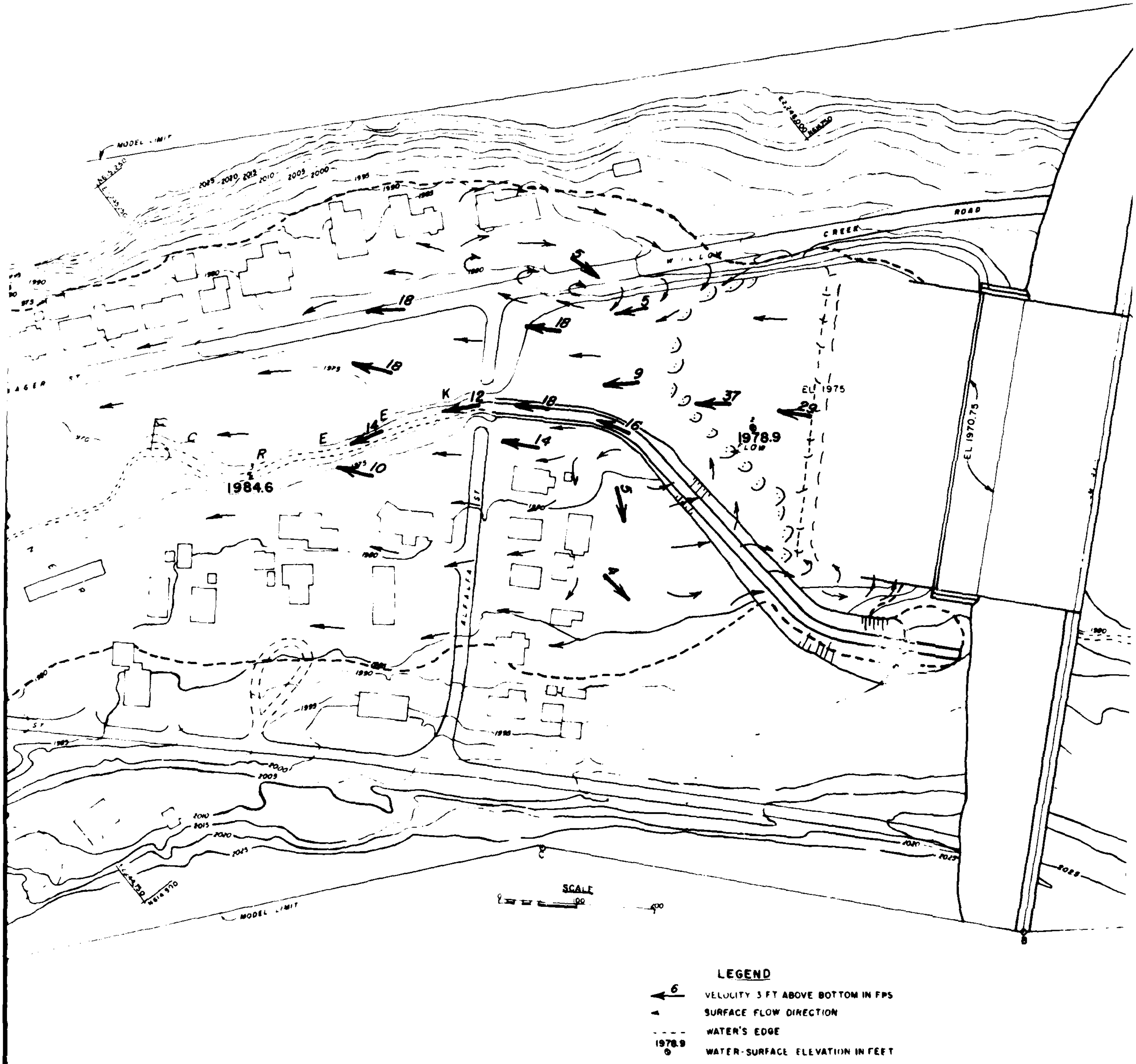
STILLING BASIN FOR 18000 CFS WITH SCOUR

2

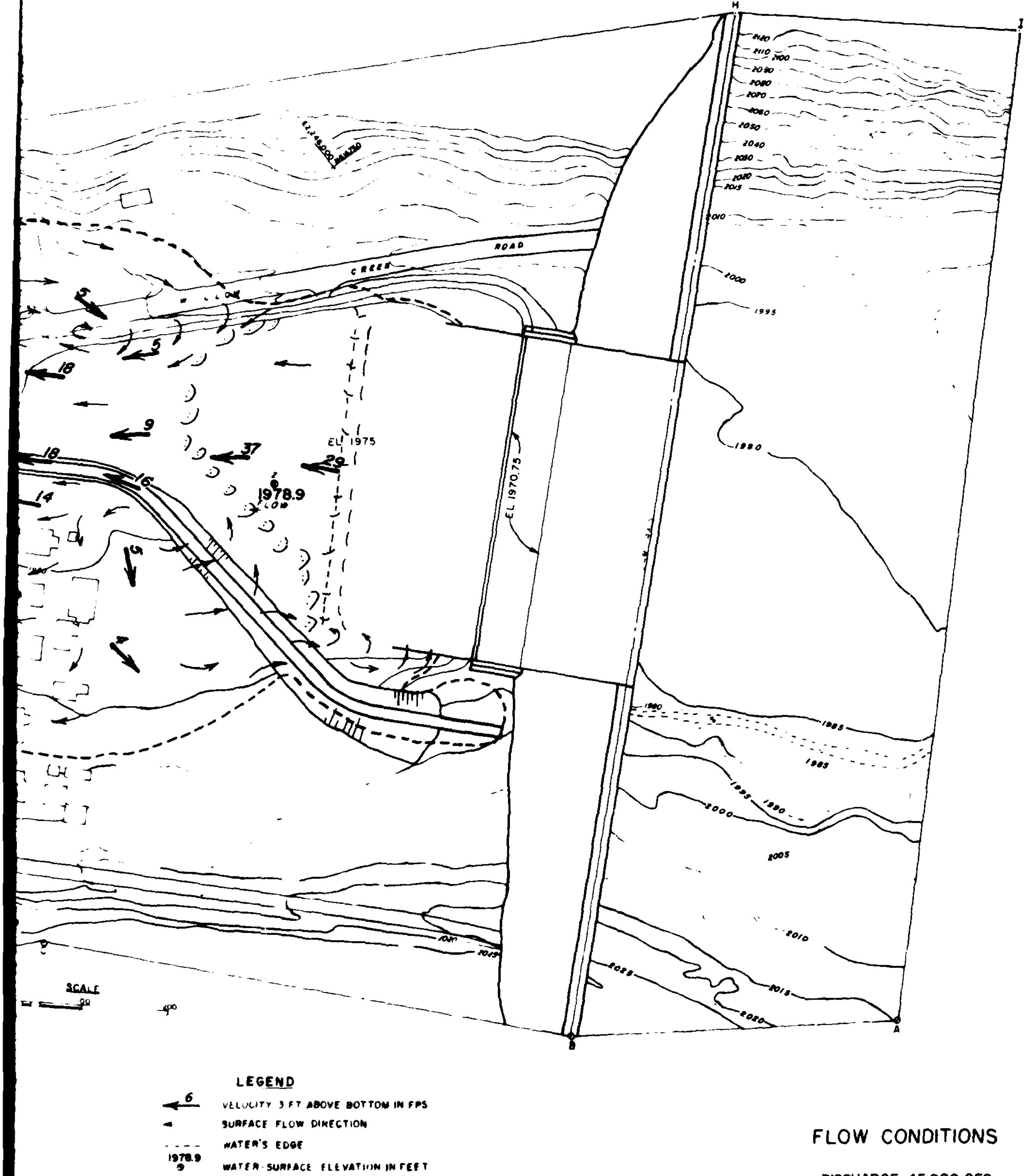
3

PLATE 10

N
F
G
E
D
MODEL LIMIT
MODEL LIMIT
MODEL LIMIT
MATLOCK ST
HAGER ST
COURT ST
COWINS ST
HILL ST
W I L L O W
C R E E K
H E P P N E R
1979.1
1984.6
18
18
14
10
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
1965
1960


MODEL LIMIT
WILLOW CREEK ROAD
CREEK
ALFALFA ST
EL 1975
EL 1970.75
1978.9
1984.6
FLOW
5
5
18
18
18
9
37
29
12
18
16
14
14
10
5
4
2025 2020 2015 2010 2005 2000
1995
1990
1985
1980
1975
2030
SCALE
0 100 400
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1978.9 WATER-SURFACE ELEVATION IN FEET

2



FLOW CONDITIONS

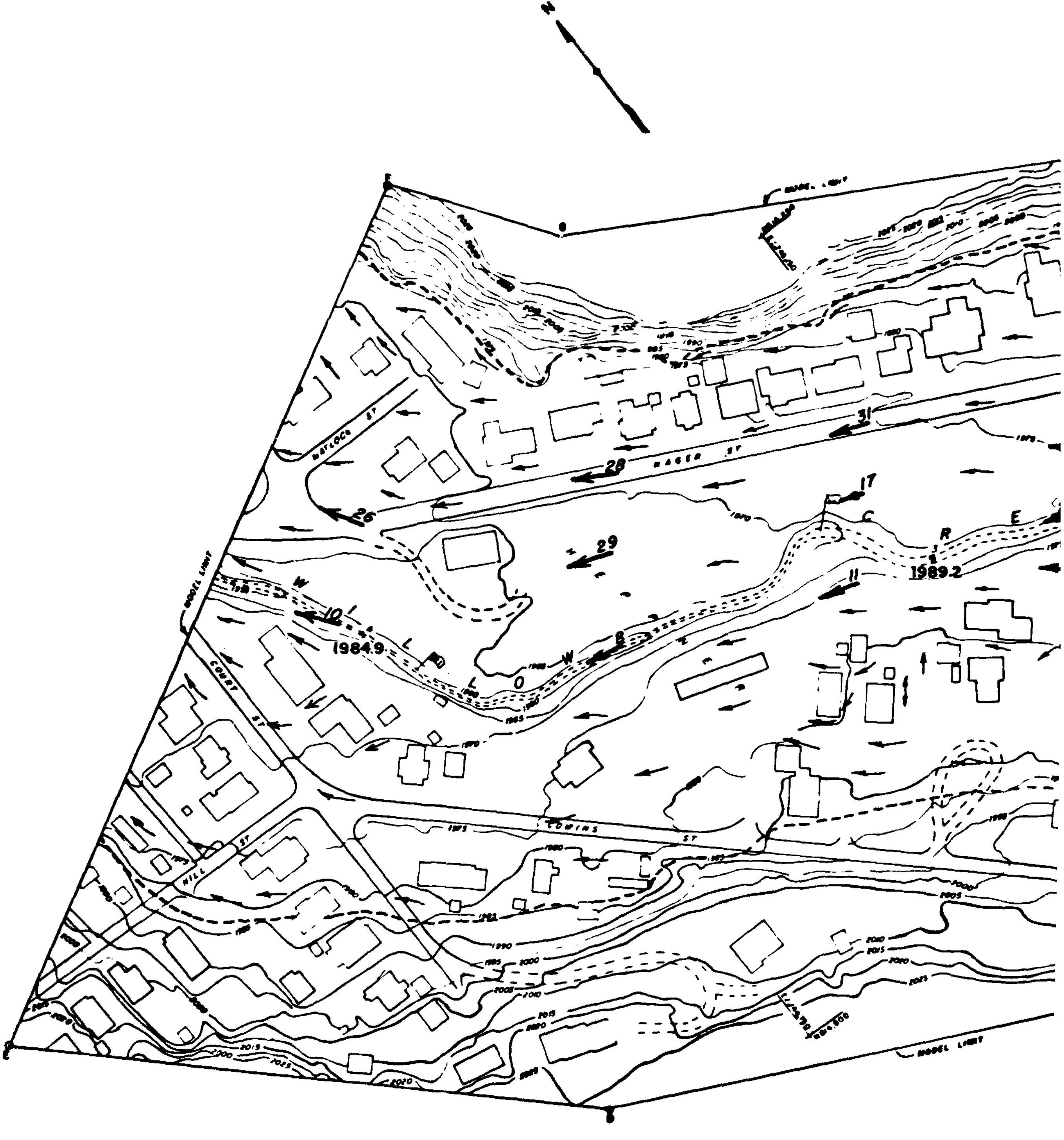
DISCHARGE 45 000 CFS

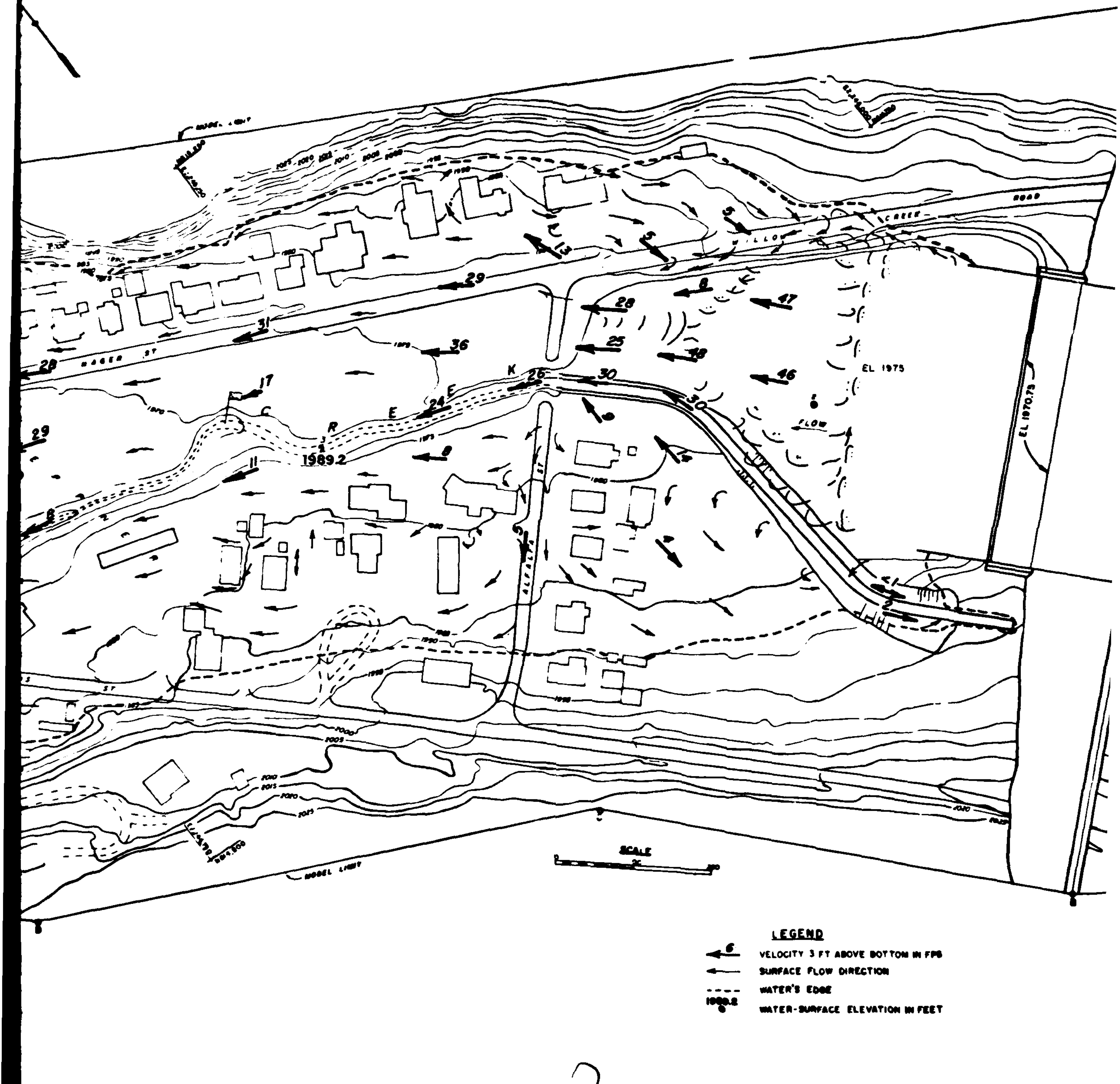
STILLING BASIN FOR 18000 CFS WITH SCOUR

2

3

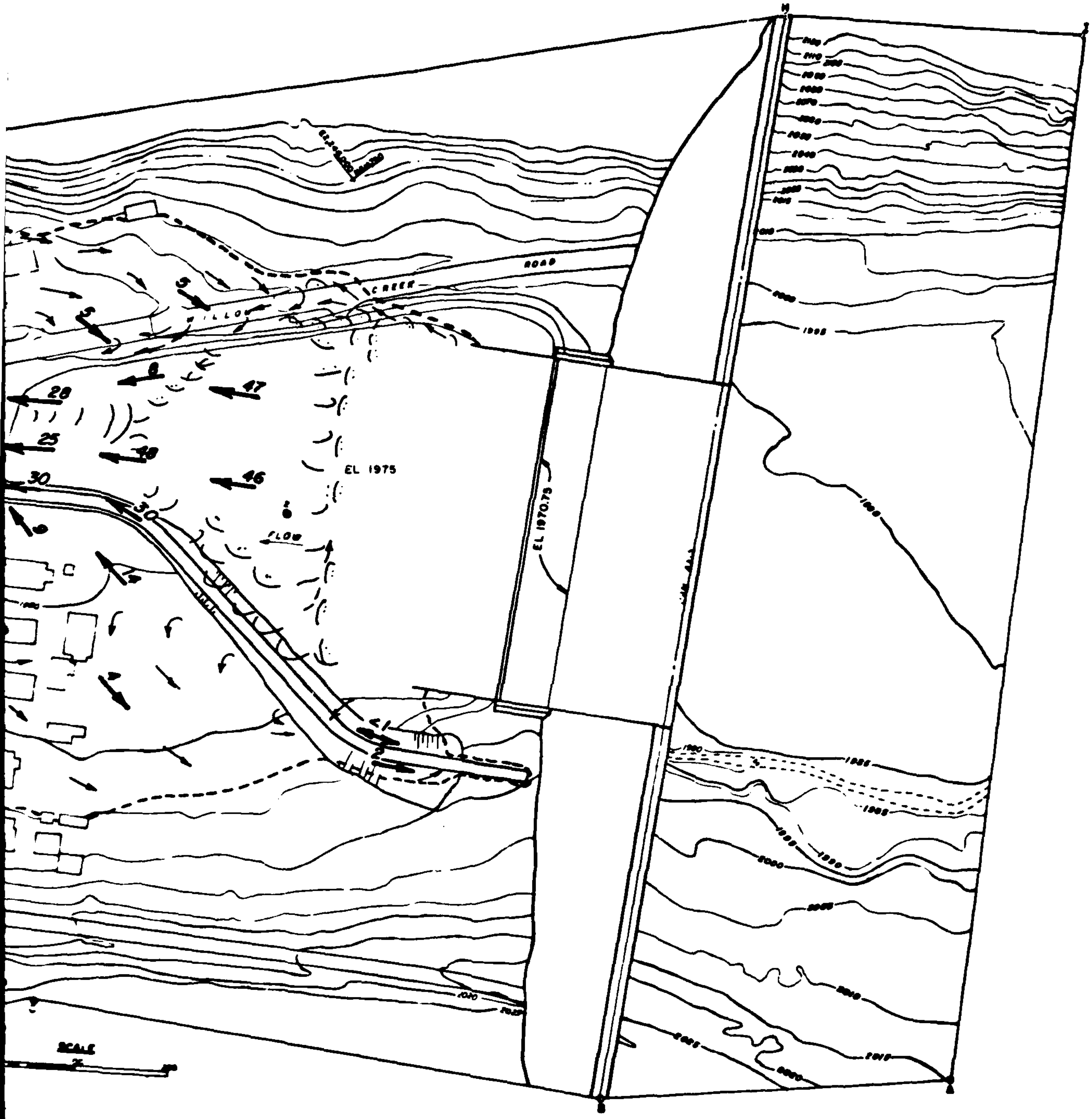
PLATE 11


N
MODEL LIMIT
MATLOCK ST
HAGER ST
COURT ST
COWINS ST
HILL ST
W I L L O W
C R E E K
26
28
29
31
17
10
11
8
1984.9
1989.2
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
MODEL LIMIT
MODEL LIMIT

WILLOW CREEK ROAD
HAGER ST
CREEK
ALFALFA ST
1989.2
EL 1975
EL 1970.75
FLOW
MODEL LIMIT
SCALE
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1989.2 WATER-SURFACE ELEVATION IN FEET

2

2



LEGEND

6 VELOCITY 3 FT ABOVE BOTTOM IN FPS

SURFACE FLOW DIRECTION

---- WATER'S EDGE

1969.2 ● WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS

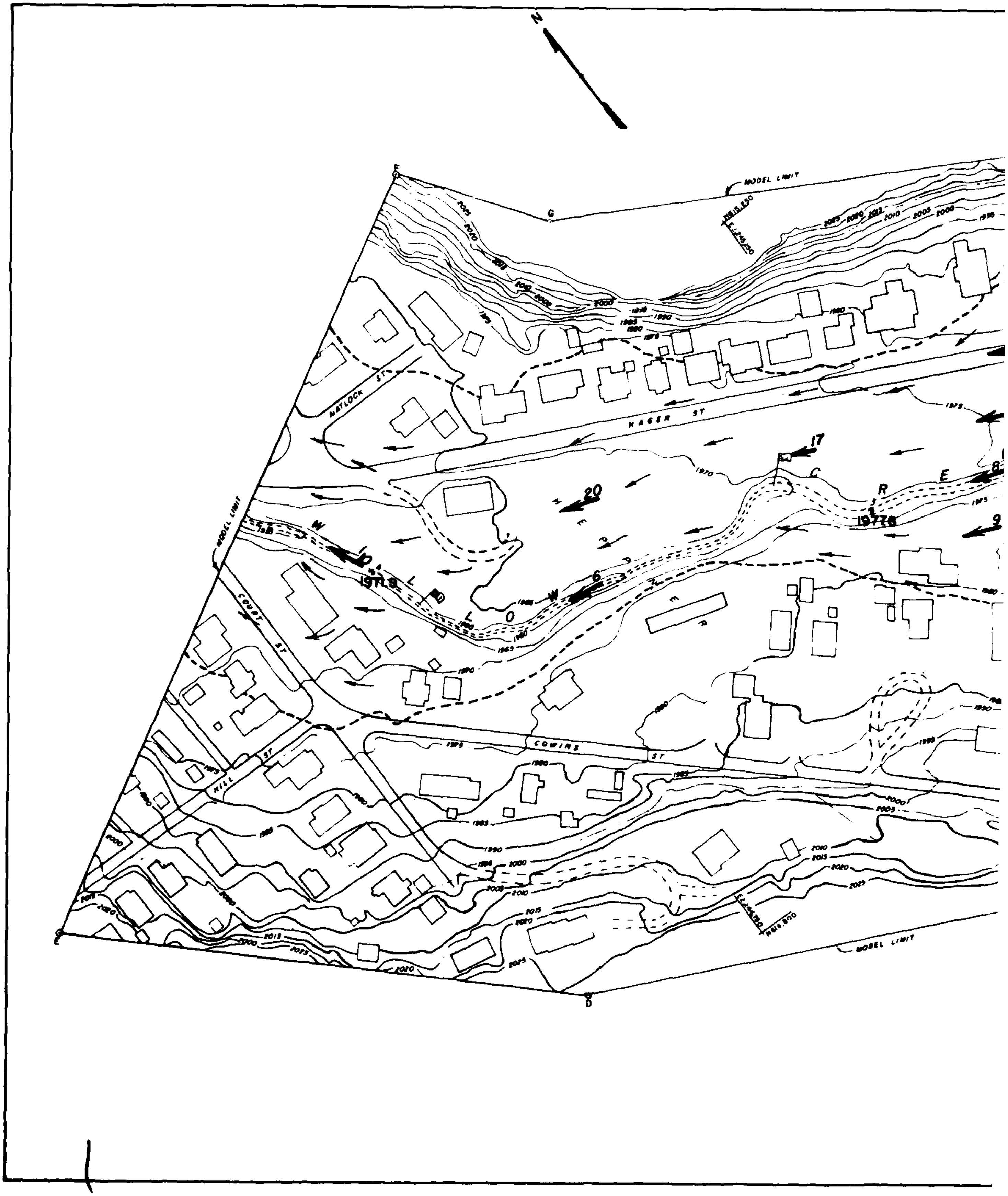
REGULATED SPILLWAY DESIGN FLOOD

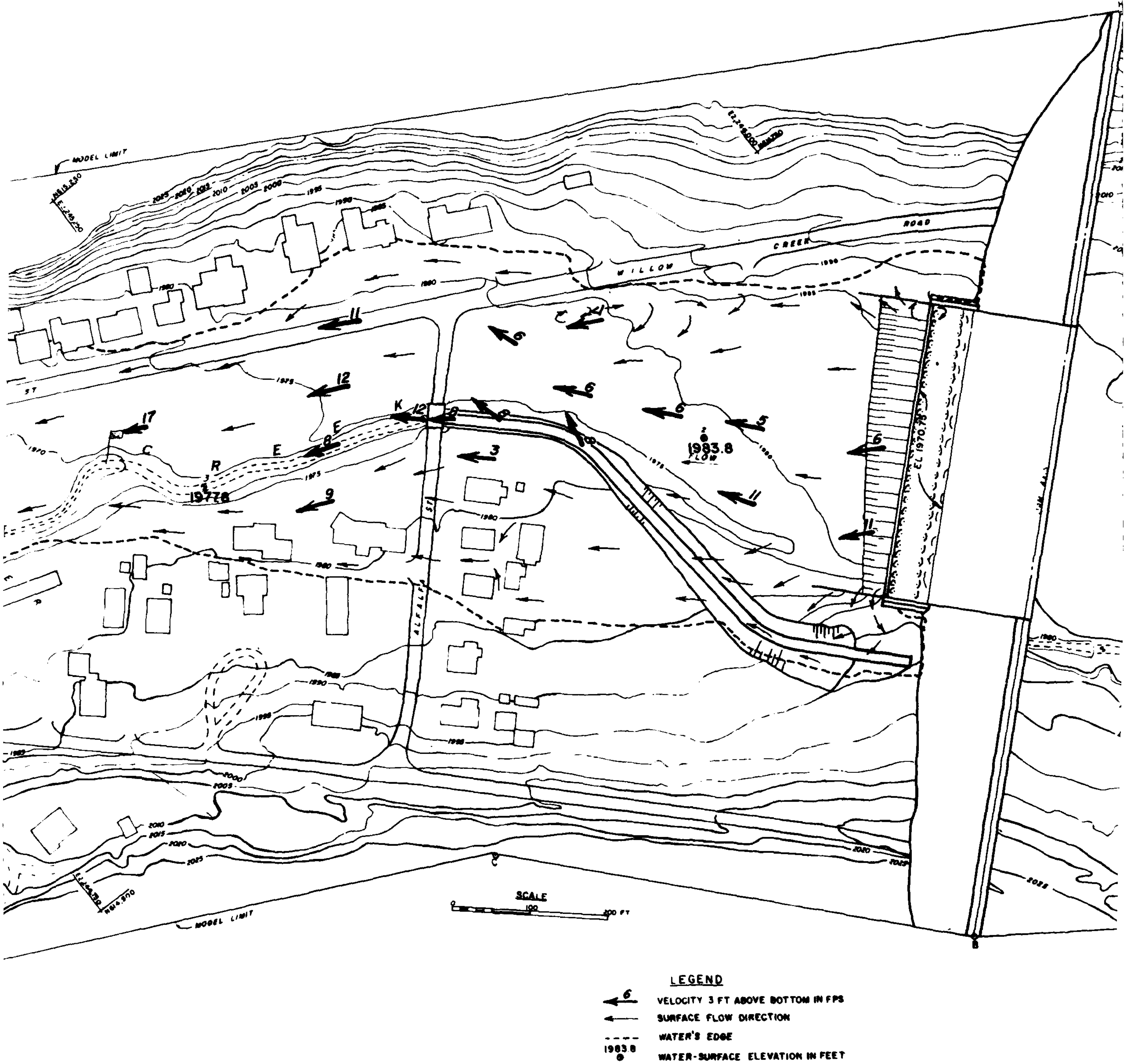
DISCHARGE 91 700 CFS

STILLING BASIN FOR 18000 CFS WITH SCOUR

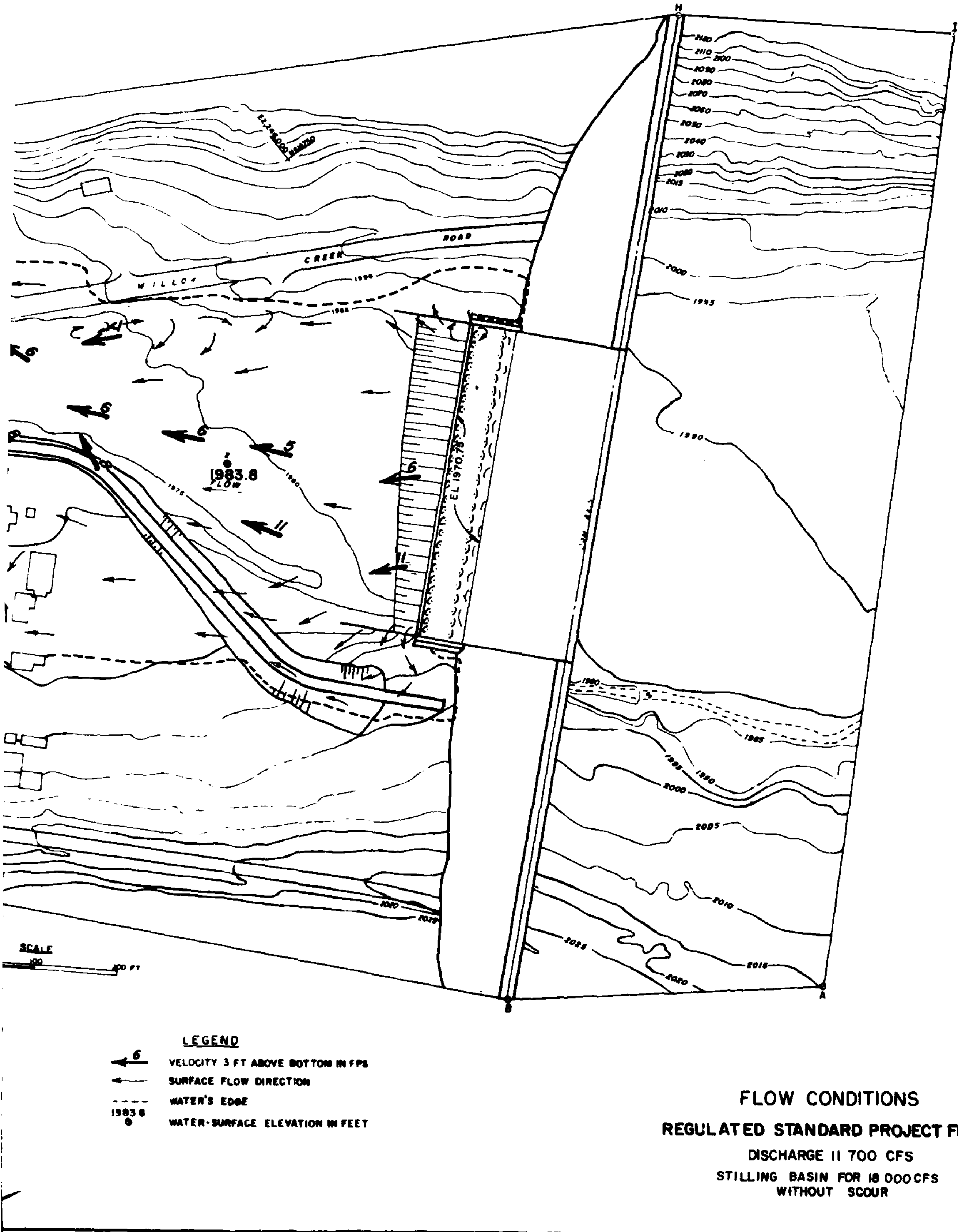
3

PLATE 12


N
MODEL LIMIT
E
G
D
N613,250
E2,245,250
E2,244,750
N614,870
MATLOCK ST
HAGER ST
COURT ST
HILL ST
COWINS ST
WILLOW CREEK
HEPPNER
17
20
8
9
10
6
1971.9
1977.6
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

MODEL LIMIT
N 815,250
E 2,445,250
E 2,448,000
N 814,750
WILLOW CREEK ROAD
ST
C R E E K
ALFALFA ST
1983.8
FLOW
1977.8
EL 1970.75
11
12
17
8
9
3
6
5
6
11
11
6
12
8
2025
2020
2015
2010
2005
2000
1995
1990
1985
1980
1975
1970
SCALE
0
100
200 FT
C
B
LEGEND
6
VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1983.8
WATER-SURFACE ELEVATION IN FEET

2



LEGEND

← 6	VELOCITY 3 FT ABOVE BOTTOM IN FPS
←	SURFACE FLOW DIRECTION
- - - -	WATER'S EDGE
1983.8 ●	WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS

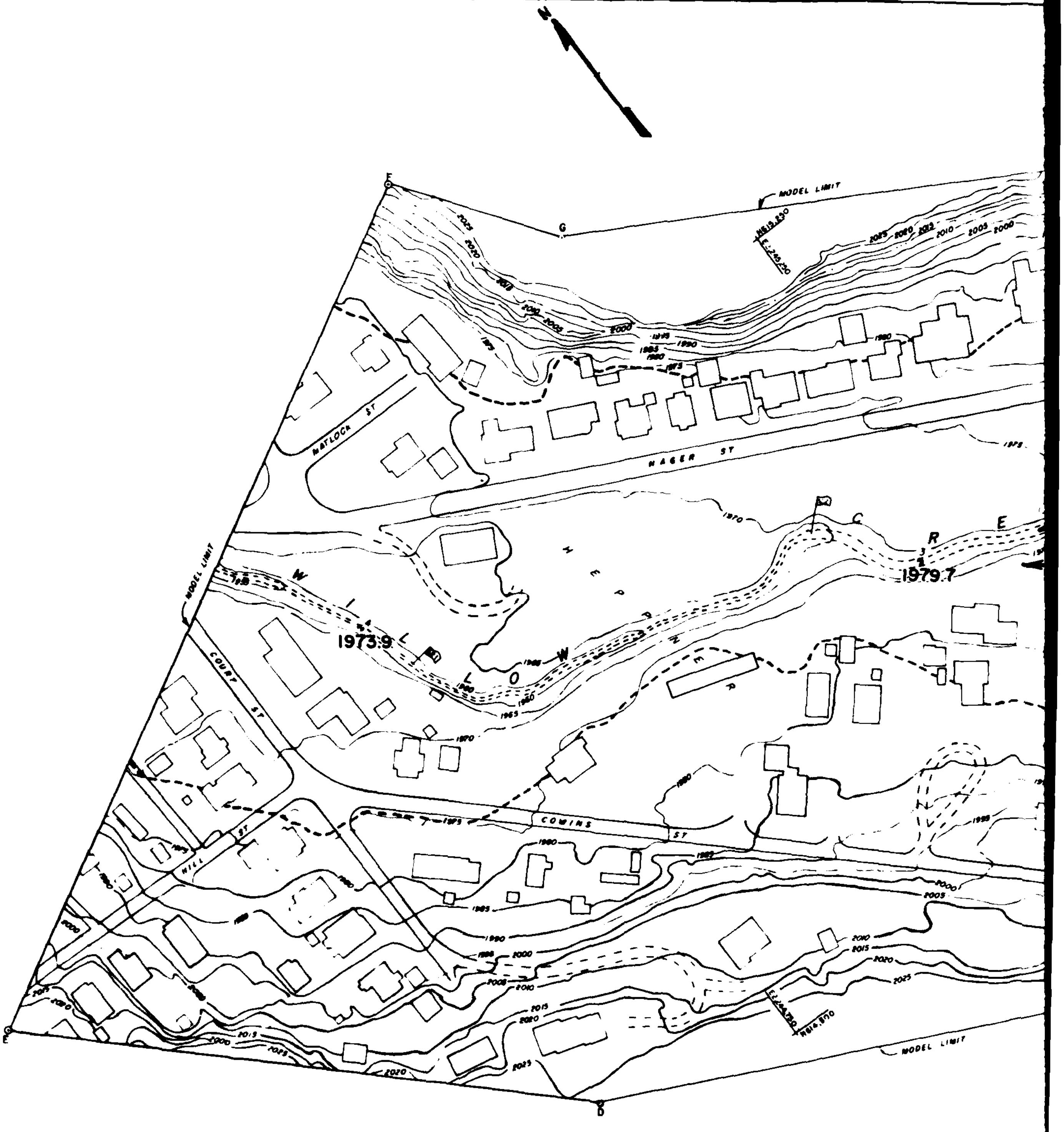
REGULATED STANDARD PROJECT FLOOD

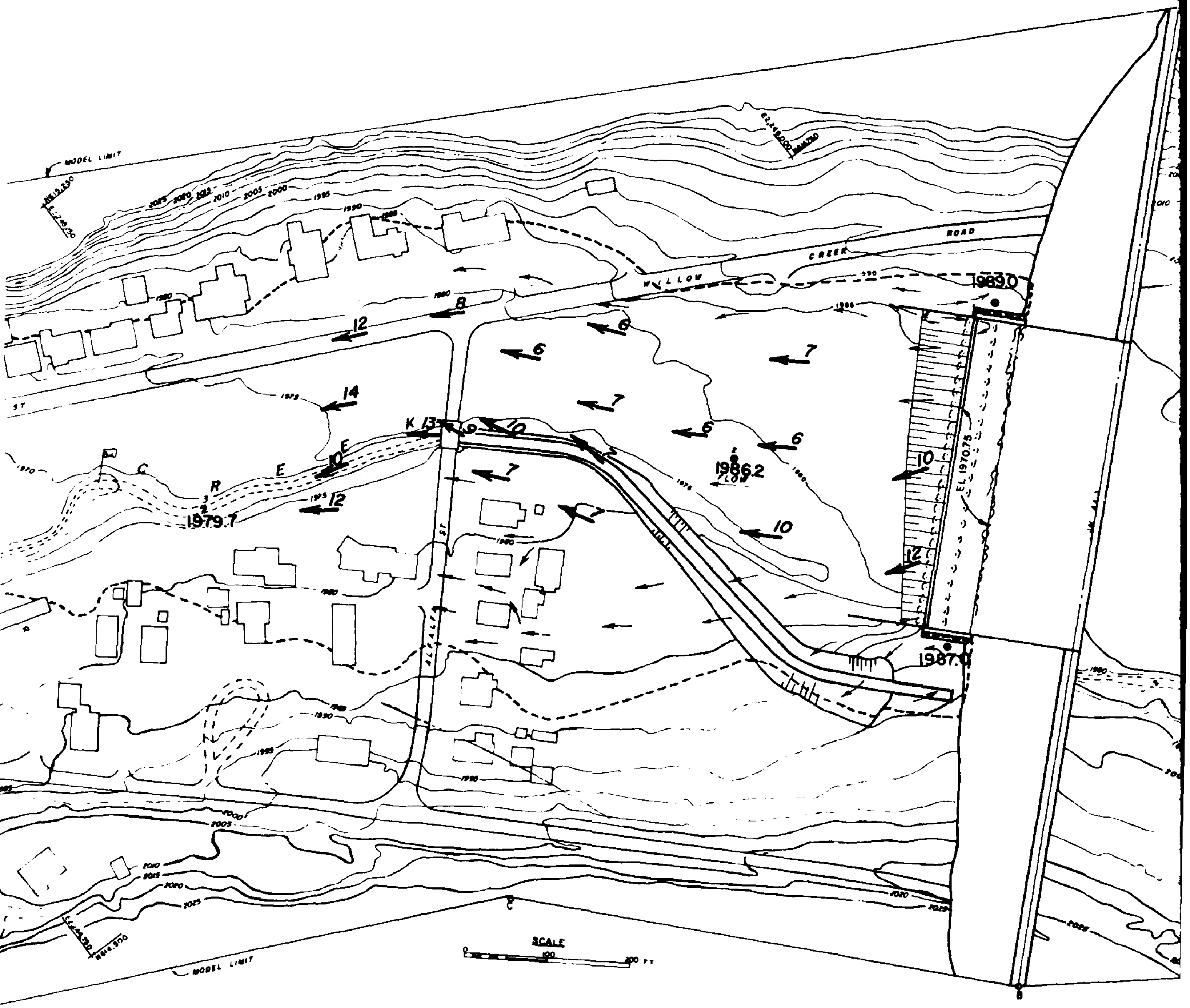
DISCHARGE 11 700 CFS

STILLING BASIN FOR 18 000 CFS
WITHOUT SCOUR

3

PLATE 13

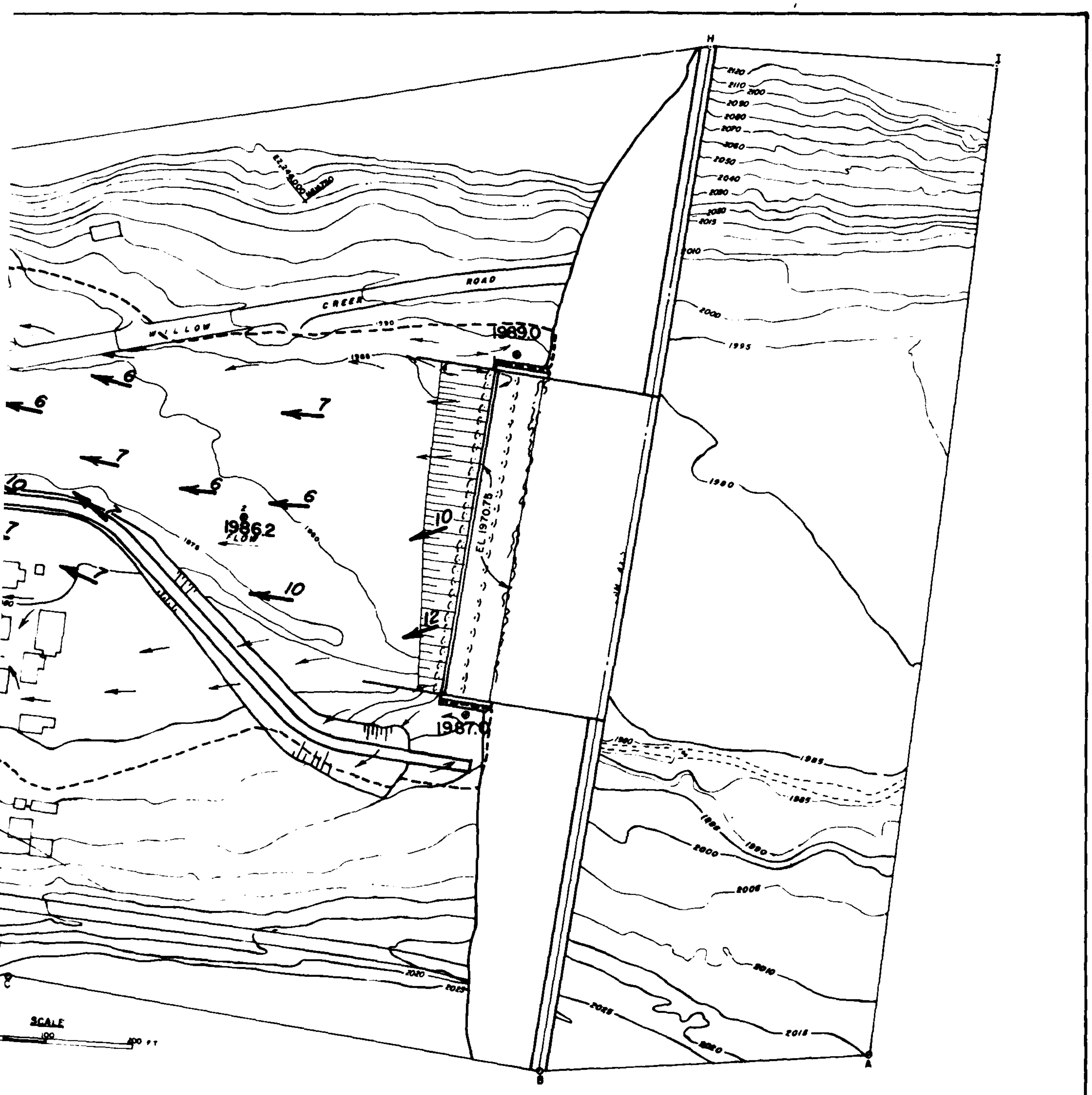

N
MODEL LIMIT
F
G
N:619,250
E:245,250
MATLOCK ST
HAGER ST
W I L L O W
C R E E K
1973.9
1979.7
COURT ST
COWINS ST
HILL ST
MODEL LIMIT
E
D
E:244,750
N:616,870
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025



LEGEND

← 6	VELOCITY 3 FT ABOVE BOTTOM IN FPS
←	SURFACE FLOW DIRECTION
- - - -	WATER'S EDGE
1986.2 ●	WATER-SURFACE ELEVATION IN FEET

2



LEGEND

6	VELOCITY 3 FT ABOVE BOTTOM IN FPS
←	SURFACE FLOW DIRECTION
----	WATER'S EDGE
1986.2 ⊕	WATER-SURFACE ELEVATION IN FEET

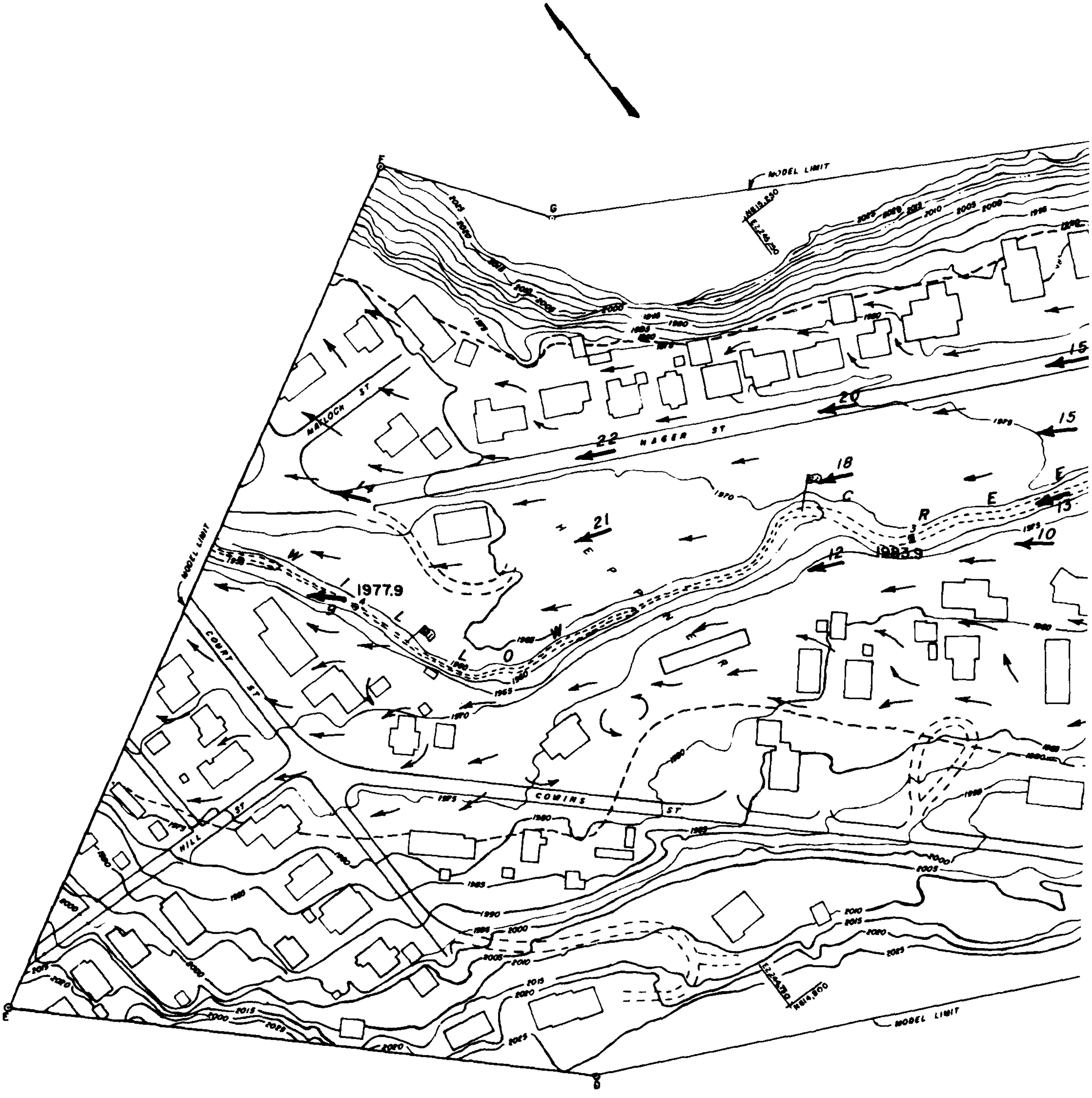
FLOW CONDITIONS

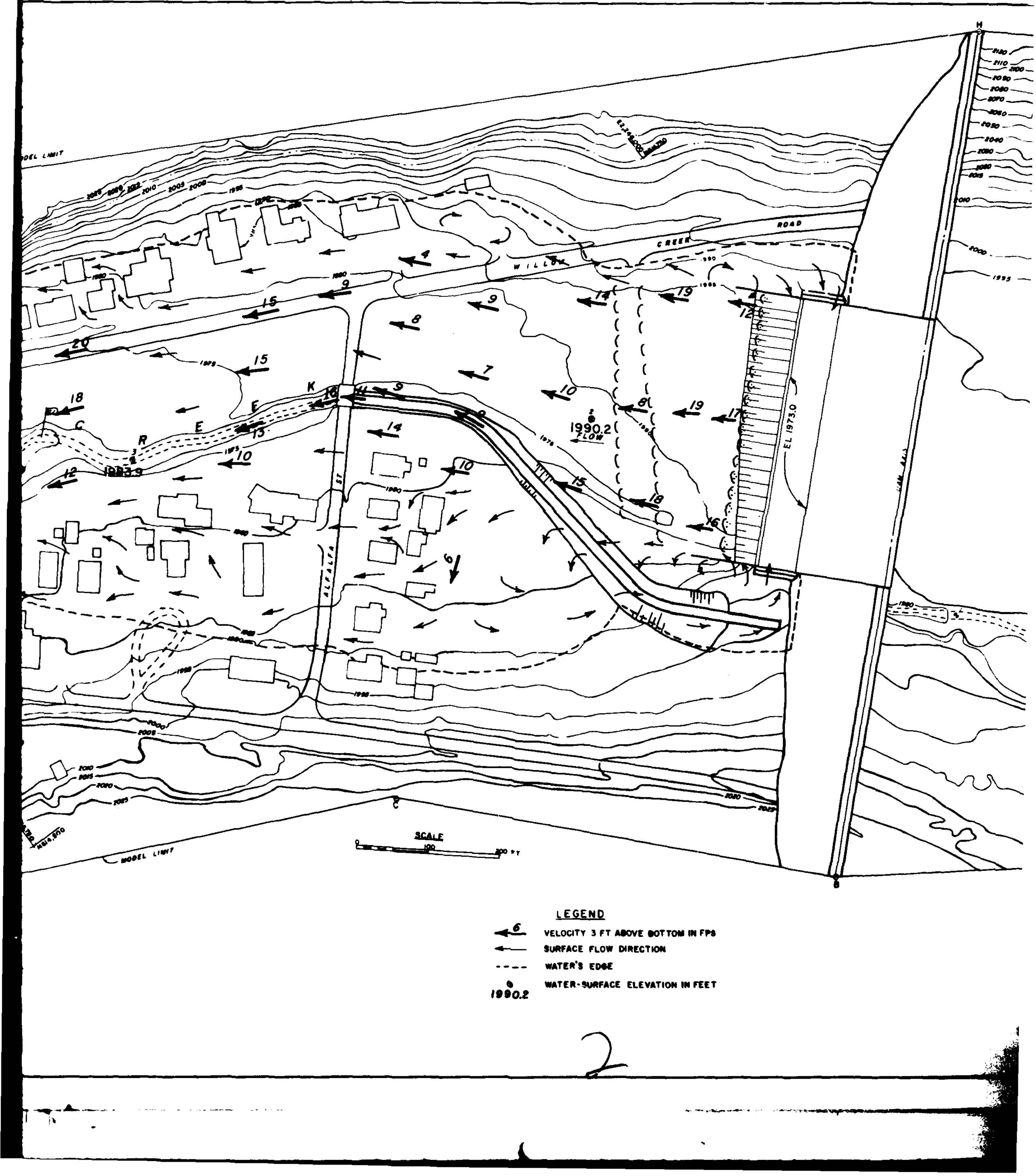
DISCHARGE 18 000 CFS

STILLING BASIN FOR 18 000 CFS
WITHOUT SCOUR

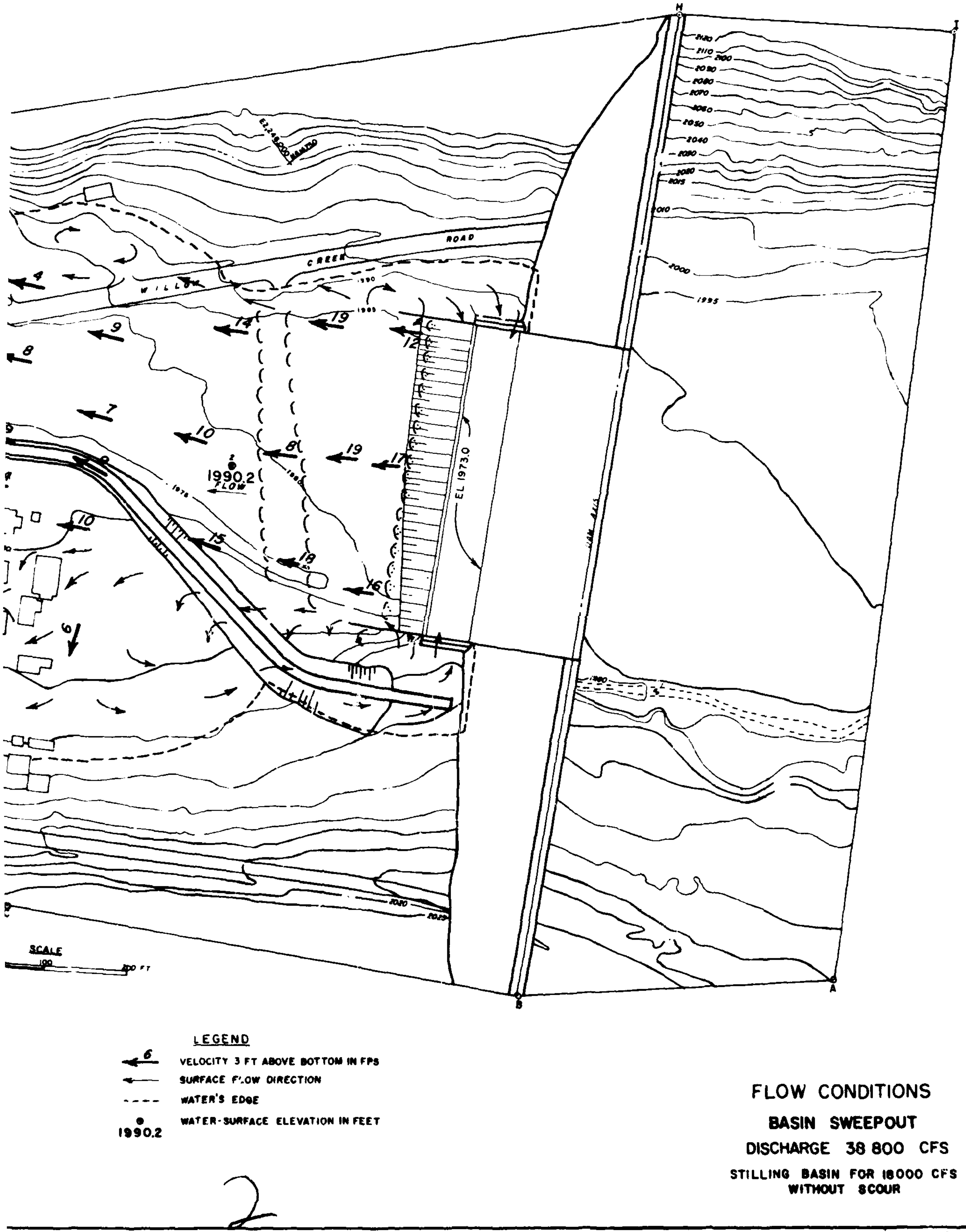
3

PLATE 14


N
F
G
E
D
MODEL LIMIT
MODEL LIMIT
MODEL LIMIT
N815,250
E2,246,250
E2,244,750
N814,800
MATLOCK ST
HAGER ST
COURT ST
HILL ST
COWINS ST
W I L L O W
C R E E K
1977.9
1983.9
22
20
21
18
15
15
14
13
12
10
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


MODEL LIMIT
WILLOW CREEK ROAD
ALFALFA ST
C R E E K
K
1990.2
FLOW
1983.9
EL 1973.0
H
B
C
SCALE
100
200 FT
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1990.2 WATER-SURFACE ELEVATION IN FEET

2



LEGEND

6 — VELOCITY 3 FT ABOVE BOTTOM IN FPS

SURFACE FLOW DIRECTION

- - - - WATER'S EDGE

● 1990.2 — WATER-SURFACE ELEVATION IN FEET

2

FLOW CONDITIONS

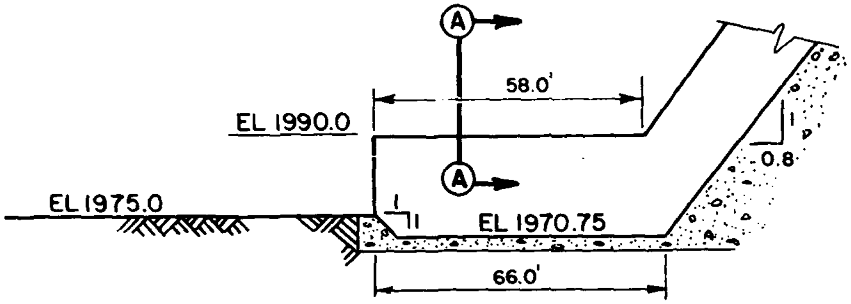
BASIN SWEEPOUT

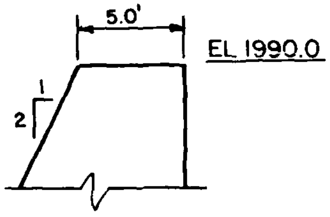
DISCHARGE 38 800 CFS

STILLING BASIN FOR 18000 CFS
WITHOUT SCOUR

3

PLATE 15

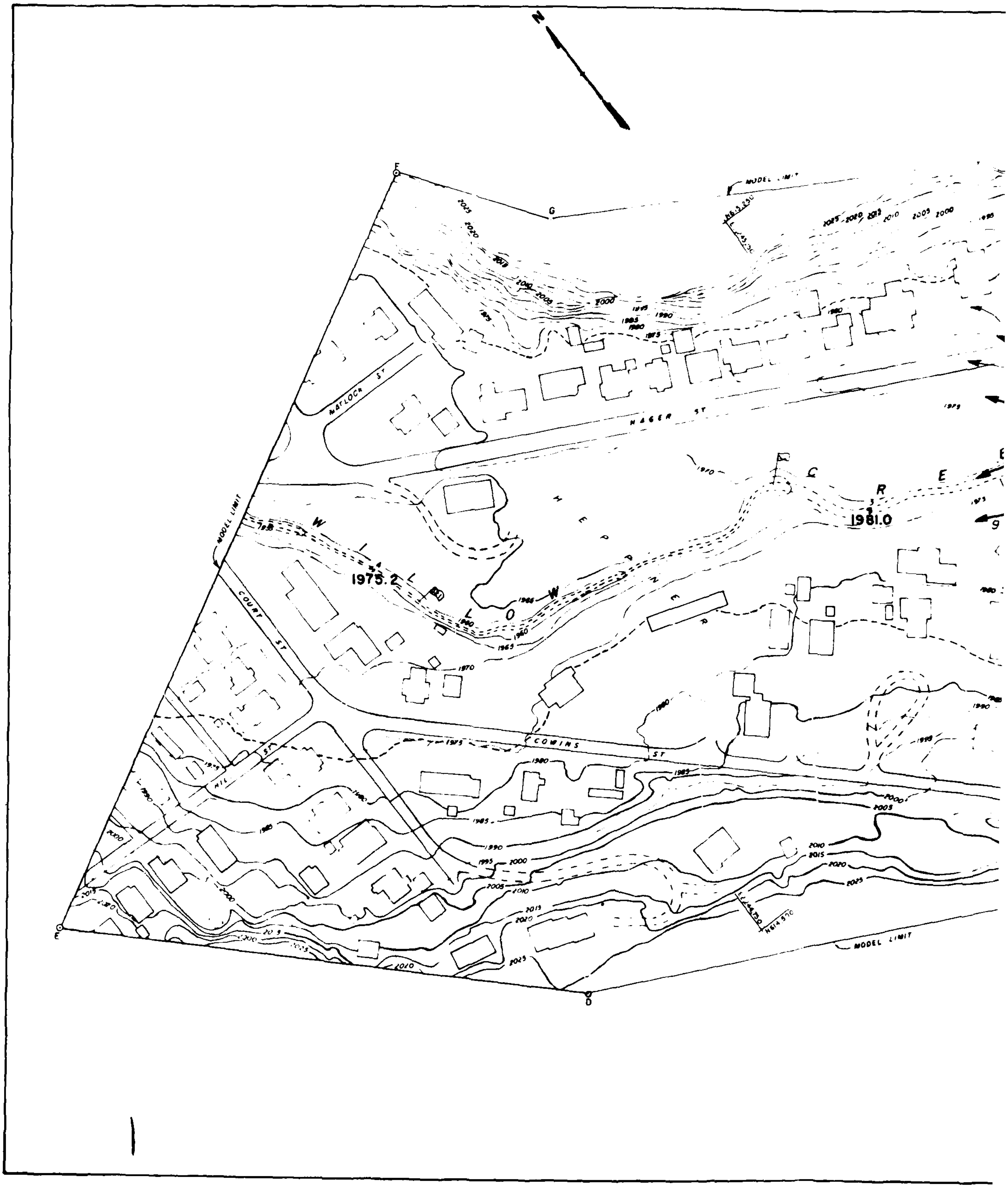


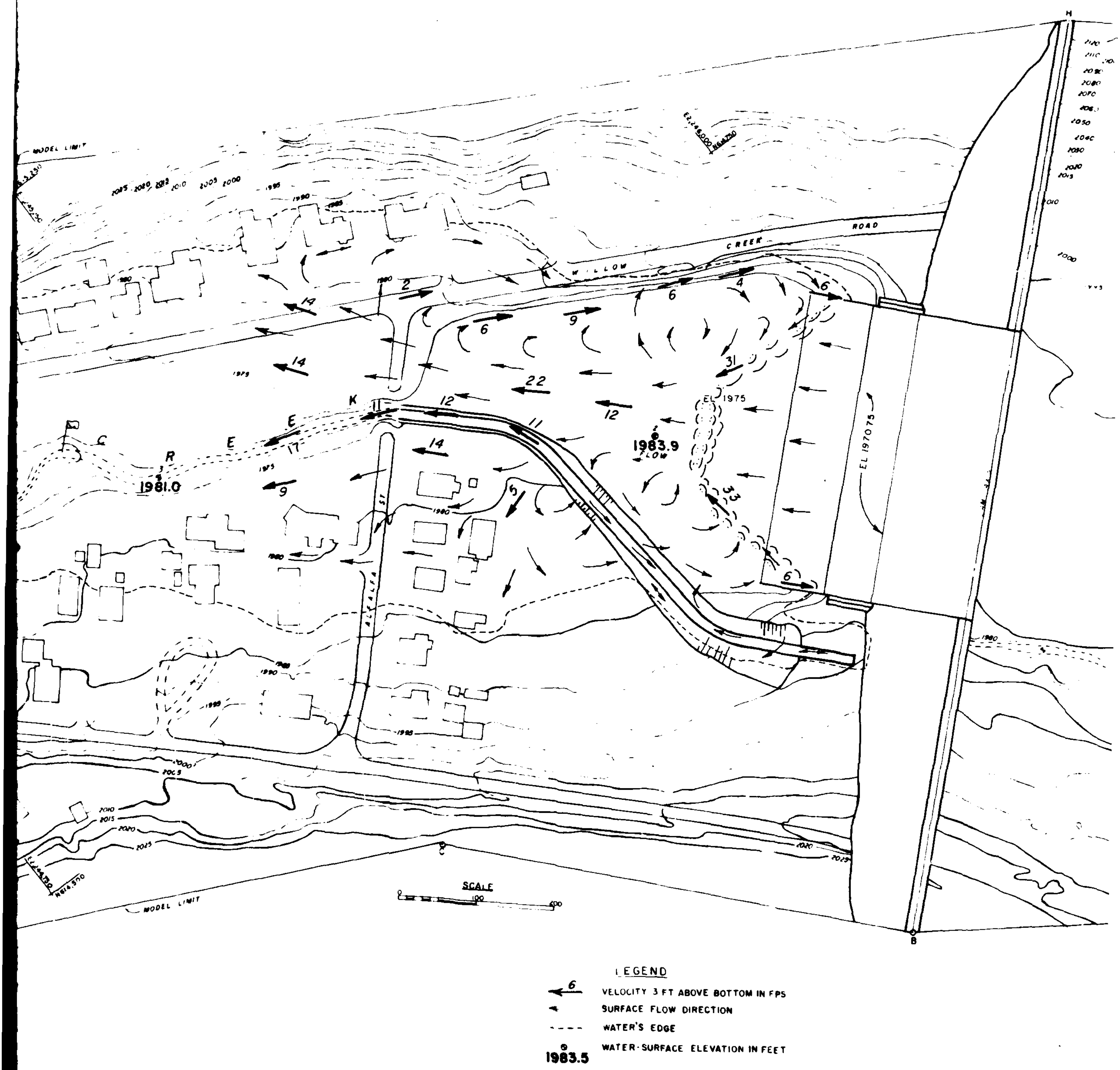


WALL SECTION A-A

STILLING BASIN PLAN C
WITHOUT CURVED BUCKET

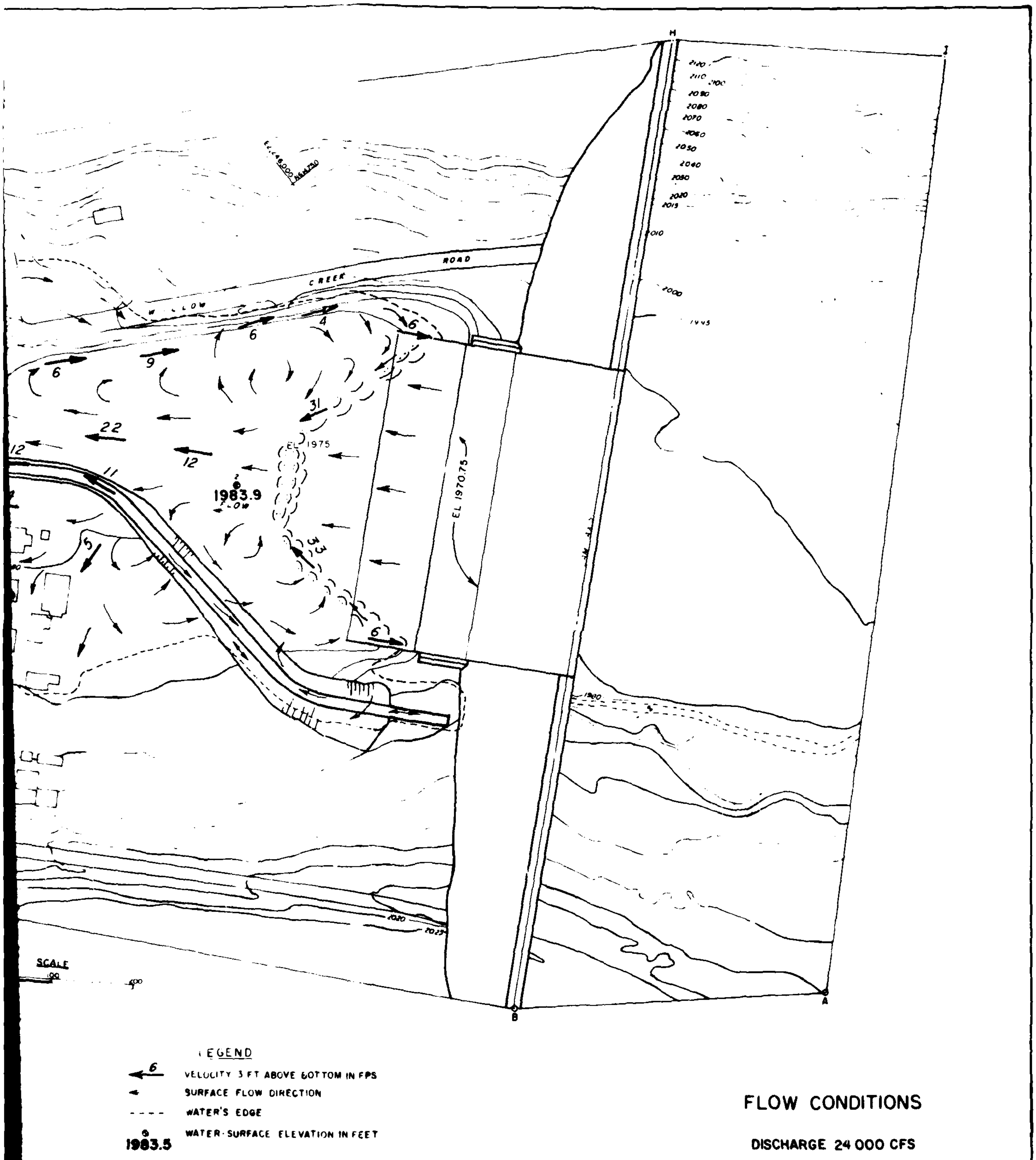
FINAL DESIGN


N
F
G
E
D
MODEL LIMIT
MATLOCK ST
HAGER ST
WILLOW
CREEK
HEPPNER
1975.2
1981.0
COURT ST
COWINS ST
HILL ST
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


MODEL LIMIT
WILLOW CREEK ROAD
C R E E K
1981.0
1983.9
FLOW
EL 1975
EL 1970.75
ALFALFA ST
K
H
B
C
14
14
2
6
9
22
12
12
11
14
17
9
6
4
6
31
33
6
5
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
SCALE
0
100
400
LEGEND
6
VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1983.5
WATER-SURFACE ELEVATION IN FEET

STILL

2



FLOW CONDITIONS

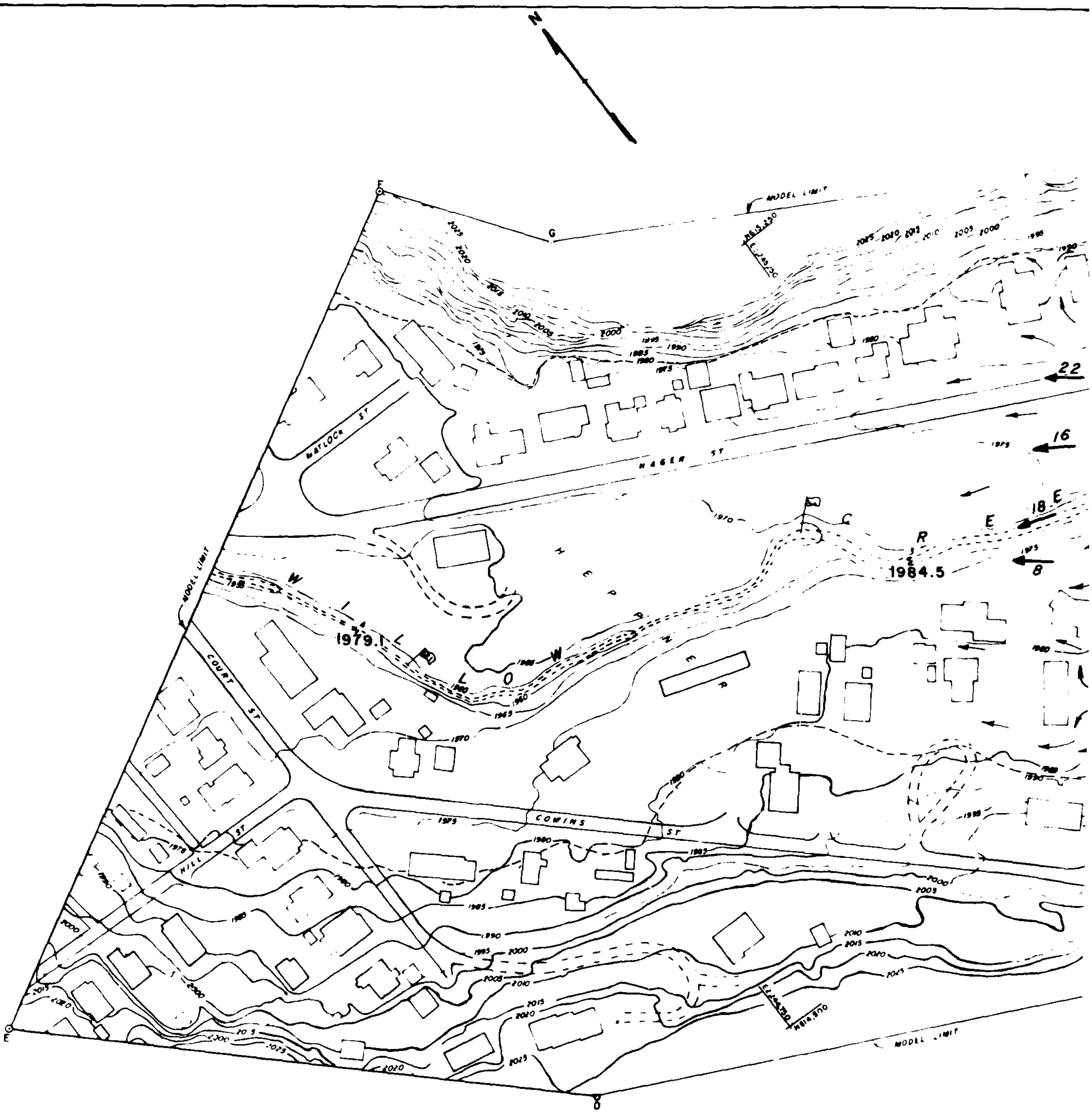
DISCHARGE 24 000 CFS

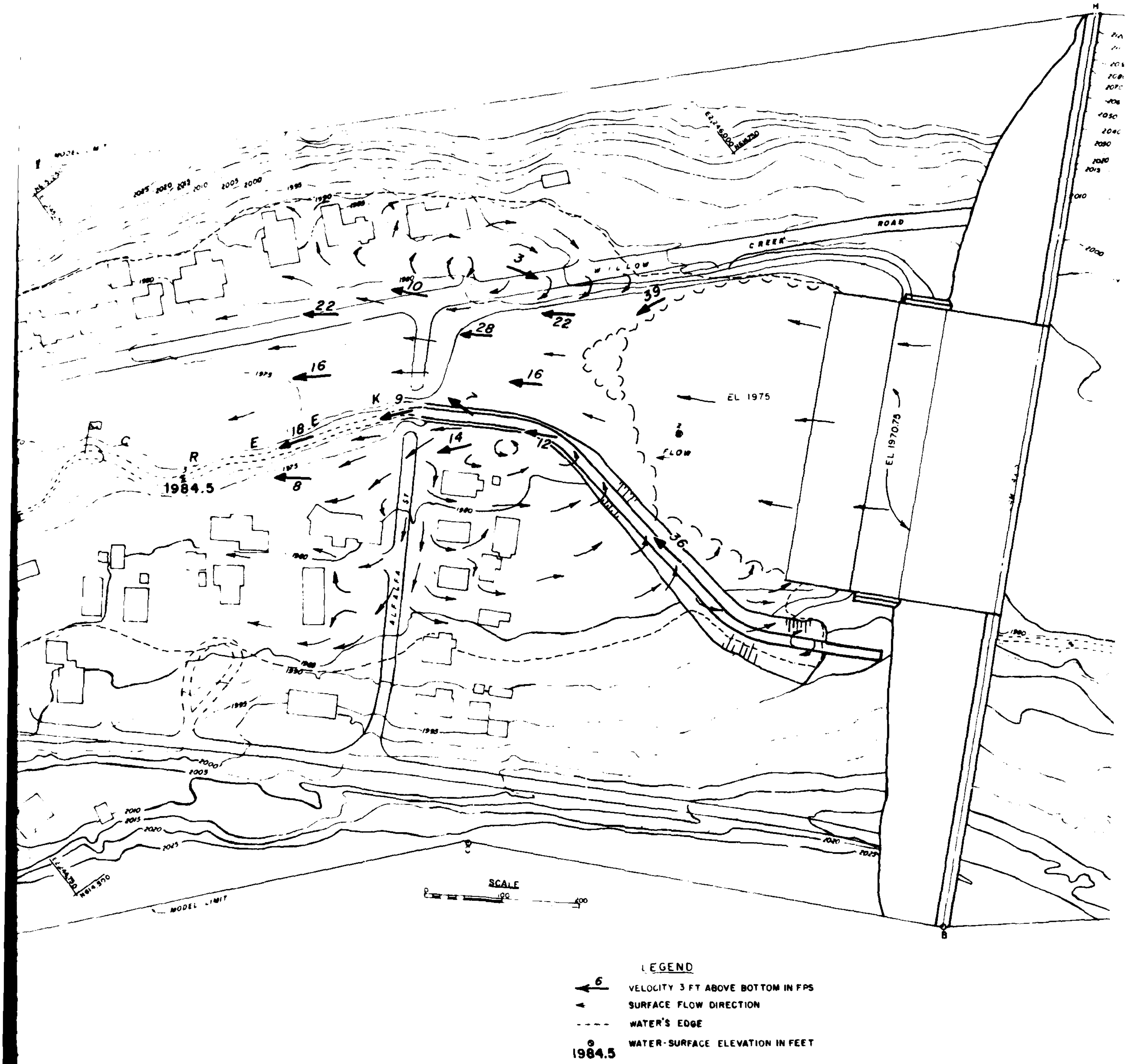
STILLING BASIN FOR 18000 CFS WITH SCOUR
AND NO END SILL

2

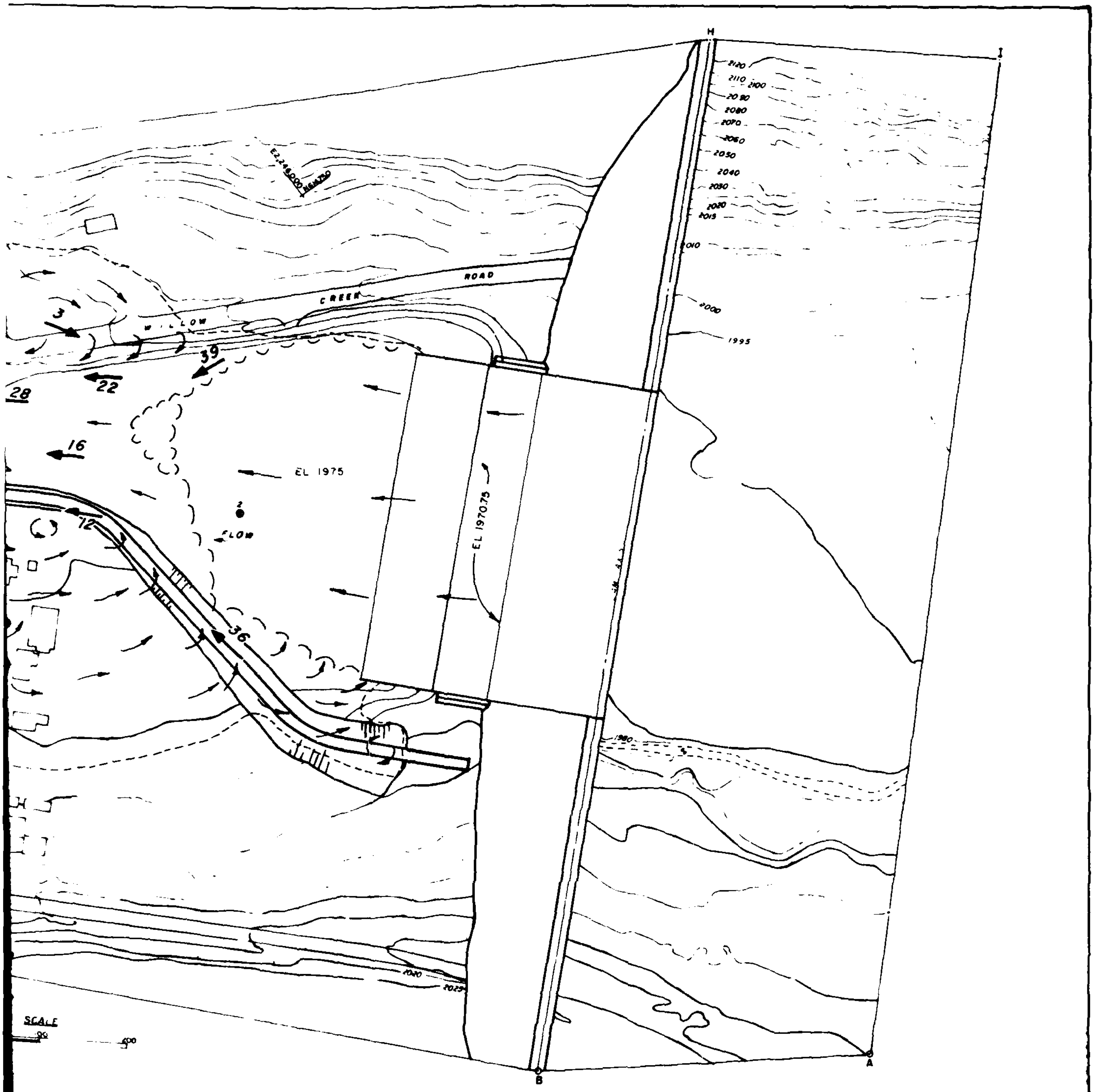
3

PLATE 17


N
F
G
MODEL LIMIT
N615,250
E 243,750
MATLOCK ST
HAGER ST
22
16
18
8
1975
C R E E K
1984.5
H E P P N E R
W I L L O W
1979.1
MODEL LIMIT
COURT ST
COWINS ST
HILL ST
1970
1965
1960
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
E 244,750
N614,500
MODEL LIMIT
E
D


WILLOW CREEK ROAD
CREEK
ALFALFA ST
EL 1975
EL 1970.75
FLOW
1984.5
MODEL LIMIT
SCALE
0
100
200
3
10
22
28
22
39
16
16
9
18
14
12
8
36
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1984.5 WATER-SURFACE ELEVATION IN FEET

2



LEGEND

6	VELOCITY 3 FT ABOVE BOTTOM IN FPS
◄	SURFACE FLOW DIRECTION
- - - -	WATER'S EDGE
⊙ 1984.5	WATER-SURFACE ELEVATION IN FEET

FLOW CONDITIONS

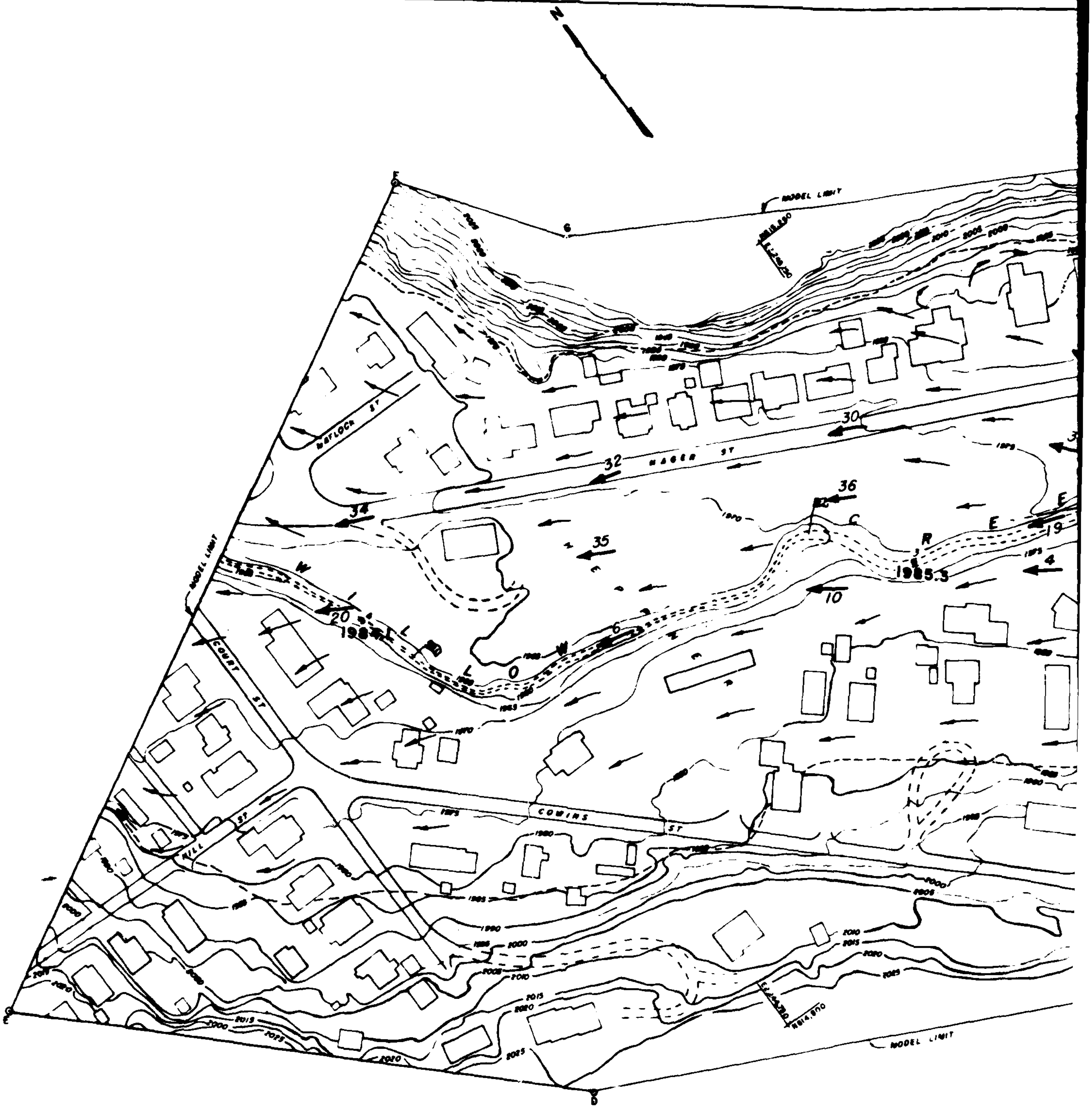
DISCHARGE 45 000 CFS

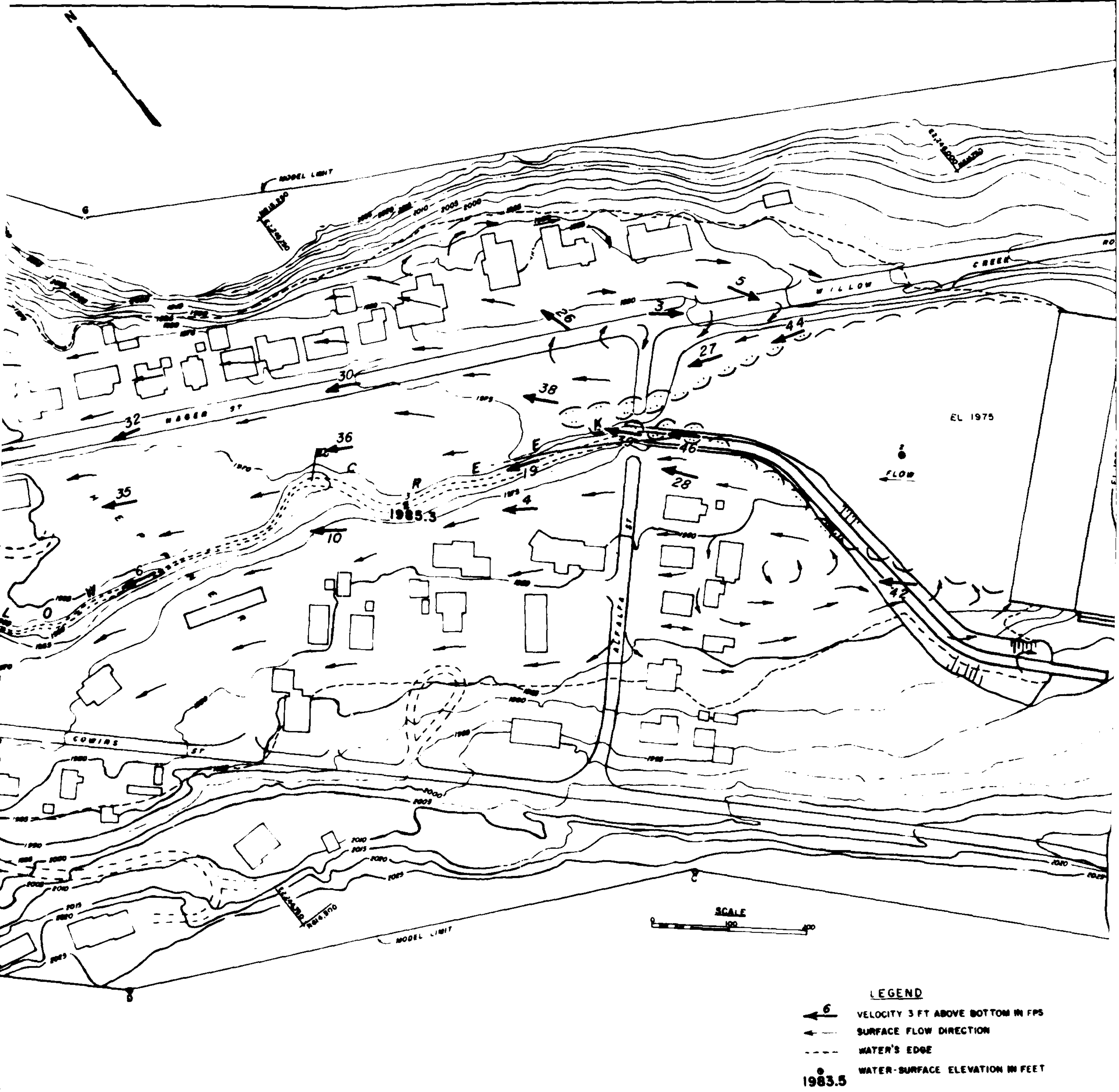
3

STILLING BASIN FOR 18000 CFS WITH SCOUR
AND NO END SILL

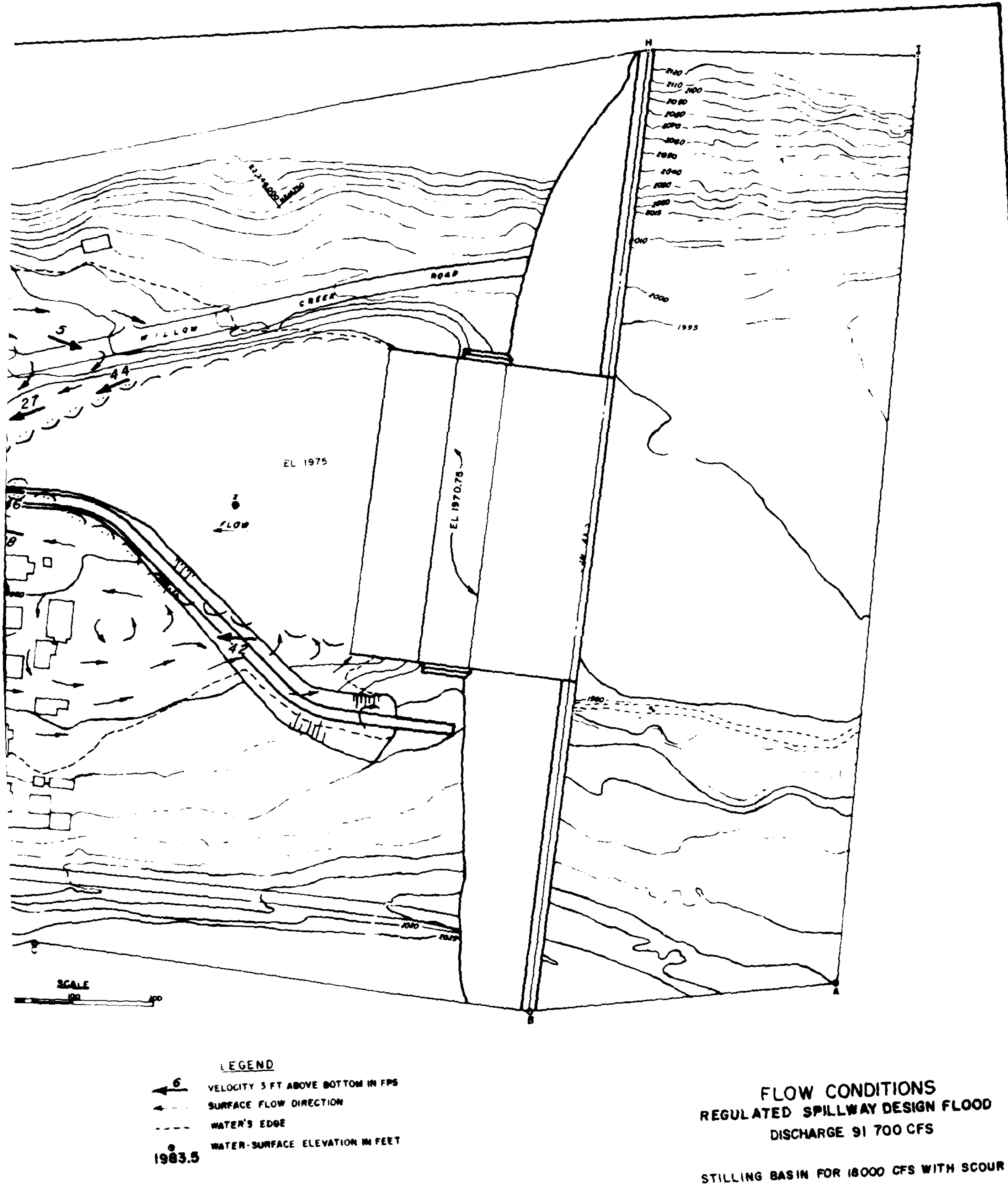
2

PLATE 18


N
E
G
C
D
MODEL LIMIT
MODEL LIMIT
MODEL LIMIT
MATLOCK ST
HAGER ST
COURT ST
COWINS ST
HILL ST
W I L L O W
C R E E K
30
32
34
35
36
20
19
4
10
6
1985.3
1970
1975
1980
1985
1990
2000
2005
2010
2015
2020
2025


N
MODEL LIMIT
WILLOW CREEK
HAGER ST
COWINS ST
ALFALFA ST
EL 1975
FLOW
1985.3
5
3
26
44
27
30
38
32
36
35
39
46
19
4
28
10
6
42
SCALE
0
100
200
LEGEND
6 VELOCITY 3 FT ABOVE BOTTOM IN FPS
SURFACE FLOW DIRECTION
WATER'S EDGE
1983.5 WATER-SURFACE ELEVATION IN FEET

2

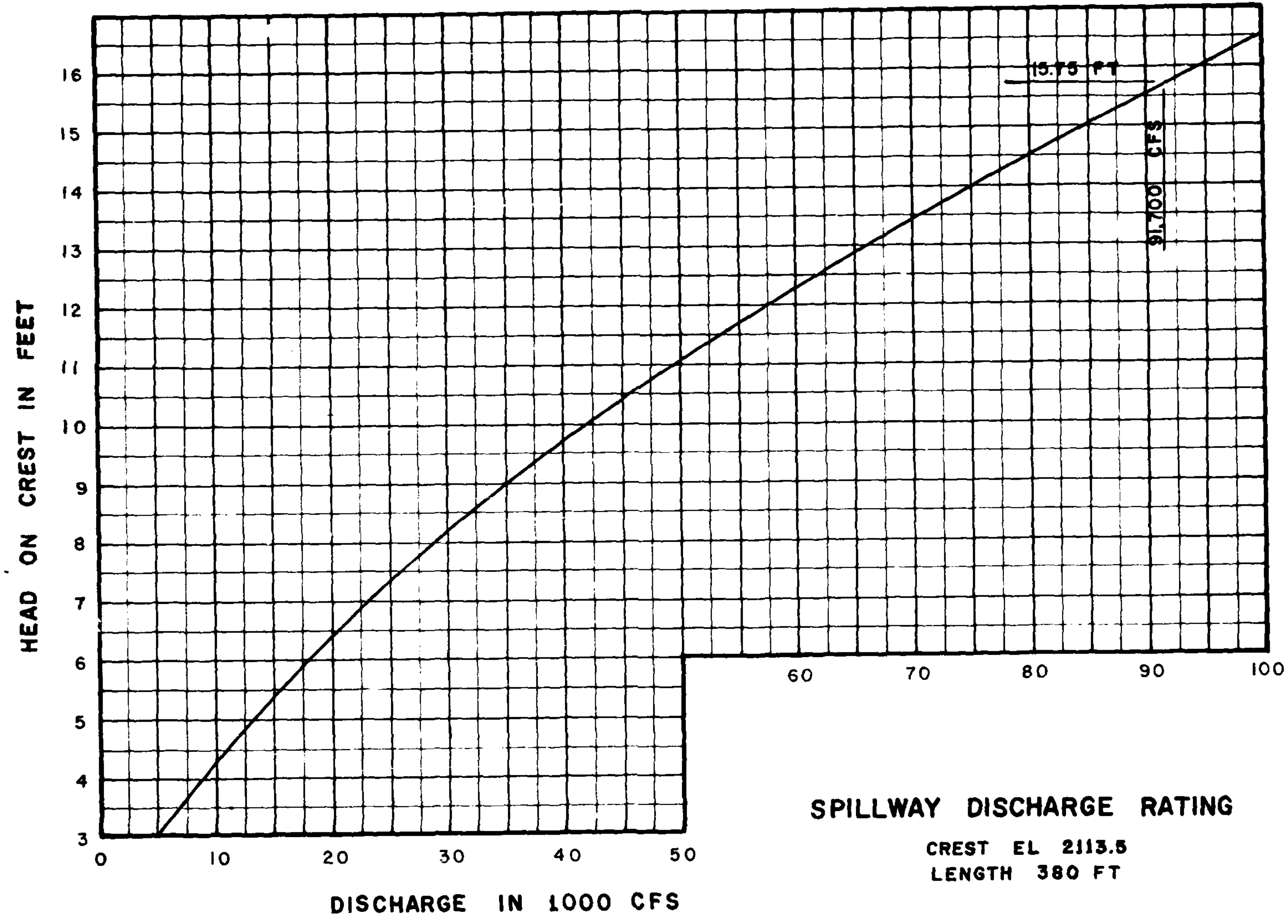


FLOW CONDITIONS
REGULATED SPILLWAY DESIGN FLOOD
DISCHARGE 91 700 CFS

STILLING BASIN FOR 18000 CFS WITH SCOUR
AND NO END SILL

3

PLATE 19



SPILLWAY DISCHARGE RATING

CREST EL 2113.5
LENGTH 380 FT

PLATE 20

DATE
FILMED

2 8