ANALYSIS OF FLOODING
FLAT RUN

EMMITSBURG
FREDERICK COUNTY
MARYLAND

December 18, 1990
Final Report

Water Resources Administration
Watershed Management Division

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES

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FLAT RUN - REPORT

ACKNOWLEDGEMENTS

As in any project of this magnitude, the efforts of many people were essential to the successful completion of this study. These people include David Vodak, K. Darwin Feheley, and David Montgomery, of the Water Resources Administration (WRA) Technical Services Division, who preformed the surveying of cross-sections and house elevations; Harvey Bryant, formerly of WRA, who was the original project manager; John H. Smith, of the WRA Watershed Management Division, who preformed the Engineering Analysis that is the basis of this study; John I. Callenbach, of the Adams County Office of Planning and Development, who provided zoning and planning information for Carroll Valley Borough, Liberty Township and Freedom Township in the Commonwealth of Pennsylvania; Mike Duigon, of the Maryland Geologic Survey, who provided geological information for Maryland and Pennsylvania; Allen Stahl, of the Soil Conservation Service, who analyzed cost data for flood control dams; and Carroll "Duke" Martin, who represented the Town of Emmitsburg.

INTRODUCTION

This study was performed by the Water Resources Administration's Watershed Management Division at the request of the Town of Emmitsburg. The Town has asked that a technical watershed study be performed for Flat Run. The study is intended to identify any existing flooding problems and to provide information needed to guide new construction in or near the floodplain.

DESCRIPTION

Flat Run drains a 12 square mile area in Frederick County, Maryland and Adams County, Pennsylvania. Land is used predominantly for grazing, growing crops for feed, and forest and open space.

Slopes are moderate in the southern and eastern portions of the watershed, and are flat, rising to steep at the edge of the drainage area in the northwest portion. The Town of Emmitsburg is the only significant development at present. Future conditions are expected to resemble current conditions in the near term.

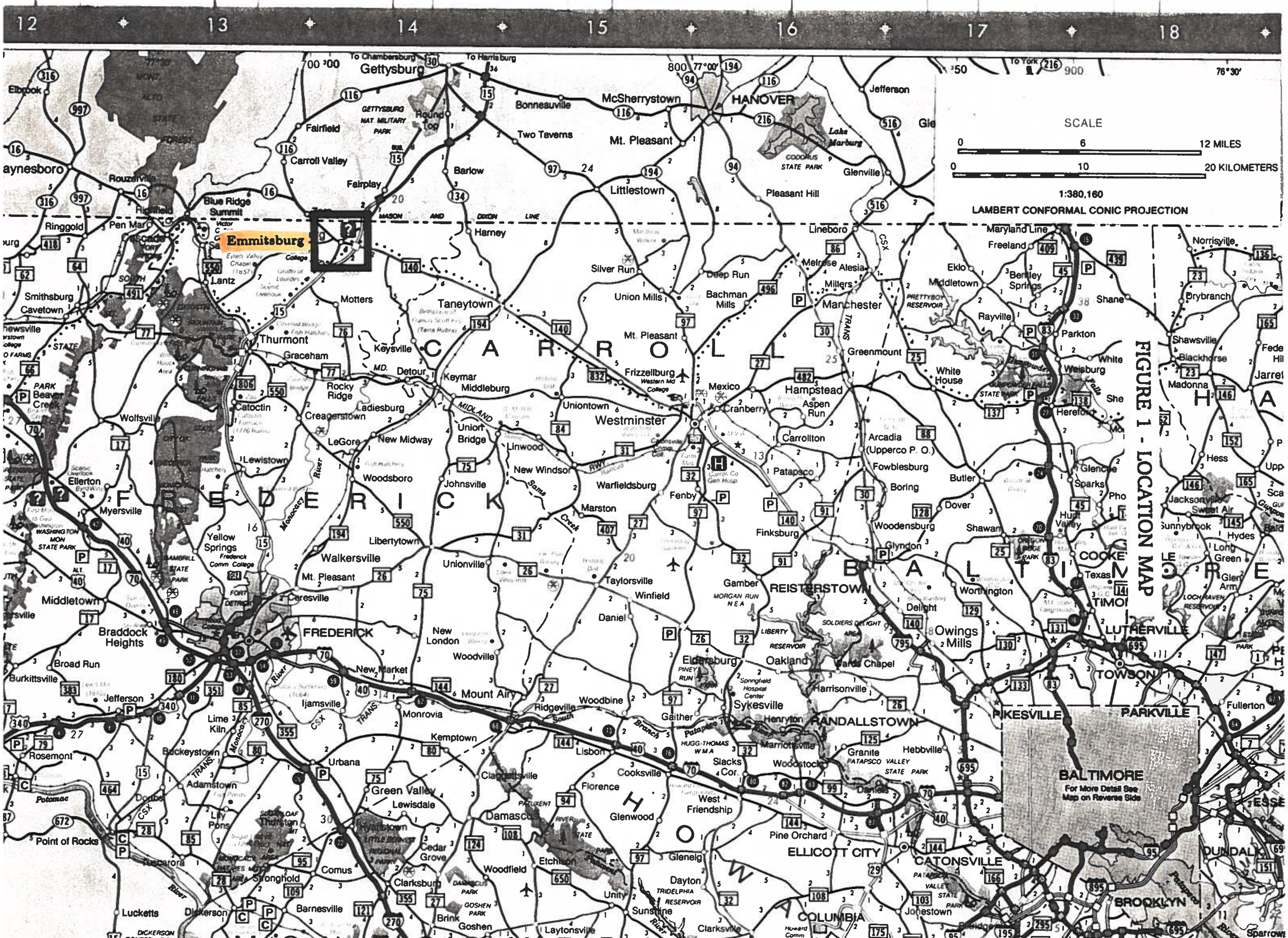

FIGURE 1 - LOCATION MAP

SCOPE OF STUDY

The scope of study includes development of discharges for the 2, 10 and 100-year frequency flood events and computation of corresponding water surface elevations through the defined study reaches. The 100-year floodplain is delineated on 1" = 100' topographic maps paid for by the Maryland Department of Natural Resources. Identification of flood-prone areas and preliminary assessments of alternatives to mitigate future flood damage are included.

HYDROLOGY

Peak discharges were computed for existing conditions using the U. S. Department of Agriculture, Soil Conservation Service (SCS) model. TR-20 (Computer Program for Project Formulation Hydrology) is a deterministic, single event model which computes direct runoff resulting from any natural or synthetic storm. It develops hydrographs from the computed runoff and routes them through stream channels and reservoirs. Hydrographs are combined at appropriate points; peak discharges are computed at points of interest.

Input to the TR-20 model consists of runoff curve numbers, watershed areas, times of concentration and rainfall amounts. The runoff curve number is a measure of the potential runoff of a particular area and depends on soil type and land use. Soil type is determined using soils maps prepared by SCS, tables provided in the Maryland Supplement to the SCS Engineering Field Manual, the Pennsylvania Supplement to the Engineer Field Manual, and in TR-55. Time of concentration is defined as the time it takes water to travel from the hydrologically most distant point in the watershed to the study area. This time is computed using a combination of overland, swale, and channel flow as described in the June 1986, TR-55 manual.

After delineating and subdividing the Flat Run watershed on two USGS Topographic Quadrangle sheets, field inspections were made to verify certain drainage features and to examine land use in the watershed. After adjusting the drainage delineation to reflect field data, SCS soil maps were used to develop curve numbers for the watershed. Times of concentration were developed using the method described in the 1986 edition of TR-55. Data for reach routings were taken from the HEC-2 computer model developed concurrently with these hydrologic calculations. The drainage area delineation used for this project is shown in Figure 2.

FIGURE 2 - DRAINAGE AREA

The results of this portion of the study are as follows:

TABLE 1. - Computed Flows at Selected Locations

	U.S. 15	Seton Ave.	Irishtown Road
2 - year discharge (cfs)	1500	1560	1500
10 - year discharge (cfs)	4110	4260	4110
100 - year discharge (cfs)	8040	8230	7670

OTHER WATERSHED STUDIES

In 1977, Flat Run was studied in detail the by Federal Emergency Management Agency (FEMA)[1]. This study used USGS regression equations and regional analysis. The discharges computed by FEMA were considerably less than those computed in this study. In particular:

TABLE 2. - A Comparison of Discharges at U.S. 15

	WRA	FEMA	% increase
10 - year discharge (cfs)	4110	1195	243%
100 - year discharge (cfs)	8040	2800	187%

[1] Frederick County, Unincorporated Areas. Discharges from this study were used in the 1980 FEMA study of Emmitsburg.

In 1984, the Beavin Company conducted a study of Tom's Creek and Flat Run as part of a permit application for the construction of a sewage treatment plant[2]. Flows were calculated using multiple regression analysis of gaged streams published by the Maryland Geologic Survey as RI 16 "Flow Characteristics of Maryland Stream", 1971, and RI 35 "Characteristics of Streamflow in Maryland", 1983. Due to the extremely mild slopes in the watershed, the regression formulas for the southern region of the State rather than the northern region were used. A 100-year discharge of 5527 cfs was computed at the treatment plant location. This discharge is 97% more than the FEMA discharge for the same location, but only 69% of the discharge computed in this current study. The discharge computed by TR-20 in the current study is well within the margin of error of Beavin's study.

HYDRAULICS

Floodplain elevations were developed for the 2, 10, and 100-year frequency events using the U.S. Army Corps of Engineers' HEC-2, Water Surface Profile Computer Program. The computational procedure used by the program is referred to as the Standard Step Method. With this method, a starting water surface elevation is assumed at one end of the study reach. The program then calculates the energy at the current cross-section. If flow is assumed (by the engineer) to be subcritical, the

[2] Beavin Company, Engineers - Surveyors, Baltimore, MD - contract #844323

program makes an estimate of the water surface elevation at the next upstream cross-section. An energy elevation and average energy slope is then calculated on the basis of this estimated water surface. The program uses Bernoulli's equation, the Manning equation, and an equation governing minor head losses to determine the error in the initial assumption of water surface. This calculated error is used to make an improved estimate of the water surface at the upstream cross-section. This procedure is repeated several times until the error in the estimated water surface is not significant. The program then moves to the next upstream cross-section and repeats the procedure.

Input required for the HEC-2 consists mainly of the surveyed cross-section information which describes the channel and overbank geometry. The Technical Services Division of the Water Resources Administration performed the field surveys which are referenced to the National Geodetic Vertical Datum of 1929. Bench marks were taken from the 1980 FEMA study of Emmitsburg. Cross-sections were located upstream and downstream of each bridge and at major changes in topography. Additional cross-sections downstream of the study area proper were taken from Beavin's previous study in order to improve the estimate of starting water surface elevation. Manning's "n" values, which are a measure of channel and overbank roughness and are used to estimate frictional losses, were estimated in the field. The channel areas were assigned "n" values of 0.045 to 0.067; the overbanks ranged from

0.015 to 0.150. Areas of ineffective flow were blocked with X3 cards, "n" values of 999, or direct modifications of cross-section geometry. All bridge openings were considered to be fully effective, i.e., blockage by debris was not considered in the model.

Based on the slope of the Flat Run channel, it was determined that subcritical flow would occur throughout the study reach, except possibly at and immediately downstream of bridges. Because cross-sections were available extending some 3,800 feet downstream of the original study area, it was determined that any reasonable error in the estimate of the starting water surface elevation would dissipate downstream of the study reach. Critical depth was used as a starting condition for backwater computations for the 2 and the 10-year profiles; starting water surface for the 100 year-profile was taken from Beavin's study of Tom's Creek as this represented the best available information. The elevations computed in this study are greater than those computed in previous studies of Flat Run because the flows were larger. Predicted water surface elevations for the study reach proper are shown in Table 3. Water depths over bridges in the study area are shown in Table 4.

TABLE 3
PREDICTED WATER SURFACE ELEVATION[3]

SECTION NUMBER	DISTANCE upstream of US 15	100 year flood	10 year flood	2 year flood	Location
8	-1668	382.0			
9	-949	384.0			
51	-354	385.2			
52.1	-154	385.6			US 15 (downstream)
52.4	0	386.5	384.1	381.8	US 15 (upstream face)
54	250	387.7	384.6	382.0	
54.5	580	387.9	385.0	382.5	
55	1090	388.4	385.6	383.3	
55.5	1370	388.5	385.8	383.7	
56	1780	389.0	386.7	384.7	
57	2140	389.7	388.0	385.8	
58.1	2300	390.3	388.6	386.4	Main Street (DS)
58.3	2345	393.8*	391.3*	386.4	Main Street (US)
60	2835	394.2	391.6	387.5	
61	3295	395.1	392.4	389.1	
61.5	3825	395.9	393.3	390.8	
62	4285	396.5	394.0	391.8	
63.1	4485	396.7	394.3	392.4	Seton Avenue (DS)
63.3	4511	396.8	395.5	392.5	Seton Avenue (US)
64	4722	398.1	396.1	393.3	
65	5192	399.9	397.6	394.7	
67	5732	402.6	400.3	397.5	
68	6532	406.2	403.7	400.9	
69	7062	408.0	405.5	402.8	
70	7432	410.0	407.6	405.3	
71.5	7692	412.7	410.4	407.8	
72.4	8172	414.9	412.5	409.8	
73	8612	417.0	414.3	411.3	
74.2	8982	420.6	417.1	414.1	
136	9332	421.4	418.8	416.3	
137	9762	422.6	420.1	417.4	
138	10092	423.8	421.3	418.5	
139.1	10422	426.2	423.5	420.7	Irishtown Rd. (DS)
139.3	10453	426.8	424.2	421.5	Irishtown Rd. (US)
140	10634	427.1	424.6	422.1	

* The computed energy elevation was determined to be a better representation of the actual water surface than the computed water surface elevation at this section.

[3] Sections 8 thru 52.1 were not part of the original study area. Only the 100 year elevations are provide for this reach. Negative distances indicate that the section is downstream of U.S. 15.

TABLE 4
DEPTH OF FLOW OVER BRIDGES

Bridge	Recurrence Interval	Estimated Water Elevation	Lowest Top of Road	Depth of Flow
U.S. Rt. 15	100	386.5	389.7	Not flooded
	10	384.1	389.7	Not flooded
	2	387.8	389.7	Not flooded
Main Street	100	393.8 *	390.0	3.8
	10	391.3 *	390.0	1.3
	2	386.4	390.0	Not flooded
Seton Road	100	396.8	394.5	2.3
	10	395.5	394.5	1.0
	2	392.5	394.5	Not flooded
Irishtown Road	100	426.8	419.0	7.8
	10	424.2	419.0	5.2
	2	421.5	419.0	2.5

* Denotes energy elevation

RESULTS

As shown in Table 5, several buildings in the Flat Run study area are near or within the newly delineated 100-year floodplain. The table provides first floor elevations and estimated depths of flooding above the first floor. The 100-year floodplain has been delineated on the topography provided. Flood profiles are provided as an appendix to this report.

A major flood occurred in Emmitsburg in 1973. Elevations in the 1st Street/2nd Avenue/Park Drive area (downstream of Main Street and upstream of U.S.

15) were several feet higher than the currently predicted 100-year flood in that area. These higher elevations were due to the original, hydraulically inadequate triple cell box culvert under U.S. 15. Subsequent to this flood, the original set of culverts was supplemented with a clear span bridge. Elevations similar to the 1973 flood were obtained with 100-years flows when this reach was modeled with the new bridge span blocked, thus providing a reasonable calibration check.

Silt and debris buildup continue to be a problem at the U.S. 15 bridge, requiring continual maintenance to assure adequate conveyance. The Main Street bridge also catches debris which aggravates the existing conveyance problems at the bridge.

A number of buildings in Emmitsburg are known to receive serious basement flooding. In the 1st Street/2nd Avenue/Park Drive area, this flooding occurs several times a year. The majority of the problem is caused by sewer backup, which is said to almost immediately follow out-of-bank stream flows. Considerable pressure is said to be associated with this sewer back-flow, which could indicate that it is a result of infiltration and inflow upstream of the 1st Street area.

Two homeowners in this area report that a high volume of apparently clear water pours into their basement through joints in the walls and floor almost immediately after Flat Run gets out of bank. The flow in one residence was reported to require three sump pumps. This would correspond to a flow of about three cubic feet per second. The cause of this high flow is unknown, but might be related to a gravel lens or a remanent stream bed, left from a time in the geological past when the stream flowed in the area where the houses are now located.

TABLE 5
ELEVATIONS AND FLOOD DEPTHS OF STRUCTURES

Address	First Floor Elevation (feet, NGVD)	Estimated 100 year Flood Elev. (feet, NGVD)	Depth of Flooding (feet)	Comments
41 Park Drive	386.34	387.9 (energy)[4]	1.6	Split foyer with walk out "basement" considered the first floor. Elevation is at rear door. Floodproofing may be feasible.
39 Park Drive	386.15	387.9 (energy)	1.7	Same as above.
19 First Ave.	386.85	389.2	2.4	Split foyer, lower floor. Also flooded by 10 year.
13 First Ave.	388.40	389.6	1.2	Split foyer, lower floor.
461 Main St.	392.34	394.0 (energy)	1.6	
505 Main St.	393.84	394.0 (energy)	.1	
Quality Tire (Main St.)	391.94	394.0 (energy)	2.1	Also flooded by 10 year.
Mobile Homes North of Depaul St.				
Mobile Home furthest North	394.1	395.1	1.0	
Mobile Home just south of above	394.3	395.0	.7	
Mobile Home just south of above	394.8	394.9	.1	
236 Depaul St.	392.7	394.2	1.5	Mobile Home
238 Depaul St.	393.5	394.2	.7	Mobile Home
Seton Ave. Shed East of Bridge	392.0	397.5	5.5	Also flooded by 2 year
Seton Ave. Tavern	391.2	397.5	6.8	Also flooded by 2 year
Seton Ave. AP auto parts	393.6	396.7	3.1	Also flooded by 10 year
Seton Ave. B.P. gas	389.2	396.7	7.1	Also flooded by 2 year
336 Seton Ave.	395.9	396.7	.8	

Some additional buildings in or near the 100 year floodplain but with first floor elevations above flood level are:

43 Park Drive	394.36	387.9 (energy)	Not Flooded (NF)
27 Park Drive	393.04	388.2	NF - House was built prior to U.S. 15 bypass of Emmitsburg and flooded only twice. Once by old (pre dualization) U.S. 15 bridge, once by sewer backup.
25 Park Drive	391.29	388.2	NF - Finished and enclosed carport is lowest floor.
23 Park Drive	390.28	388.3	NF
17 First Ave.	392.28	389.4	NF
15 First Ave.	393.28	389.4	NF Severe basement flooding occurs almost immediately when stream gets out of bank. Flow rate estimated to be almost 3 cfs
Reynold Supply (main building only)	393.20	390.8	NF - outbuildings may be below flood level
East End Garage	395.06	394.0 (energy)	NF
303 Depaul	394.7	394.2	NF
The Cools (Depaul)	395.3	394.2	NF
232 Depaul	398.1	394.2	NF
234 Depaul	396.0	394.2	NF
Seton Ave. Mobile Home E of bldg.	398.3	397.5	NF - no access during flooding.

[4] (energy) - The computed energy was determined to be a better representation of actual water surface than the computed water surface at this point.

ALTERNATIVES TO REDUCE FLOOD DAMAGE

Several alternatives were considered, including structural solutions to reduce flood levels, such as Dams and Channelization, and so-called non-structural measures, such as floodproofing, flood insurance, and acquisition.

Dam:

In the past, people have suggested building a dam on Flat Run for recreation or for water supply. Topographically, an excellent site exists just north of the Pennsylvania border. At this site appreciable storage could be achieved with a comparatively small dam, more than enough for a multi-purpose structure that would include flood control. Appreciable reductions in flood peaks would result from the adoption of this alternative.

The site is located in Pennsylvania approximately 500 feet upstream (north) of the Mason - Dixon line, near Maryland State Coordinates N688, E0707. It is on a diabase ring dike; the basin as a whole is in the Gettysburg formation[5]. The formation is primarily shale and, although it is known to contain thin beds of impure limestone, is unlikely to have a problem with cavernous limestone. Thus, geologically the site appears reasonable to consider for construction of an impoundment.

[5]Phone conversation with Mike Duigan of the Maryland Geologic Survey, 9/22/89

Based on the USGS topographic quadrangles for Emmitsburg MD-PA and Fairfield PA, the following table was generated for the site described above:

Table 6. - Available Storage and Inundated Area as a Function of Pool Elevation

Pool elev. (feet)	Surface area (acres)	Total Storage (acre-feet)	Crest length (feet)
436	0	0	0
440	1	2	150
460	40	331	250
480	310	3408	400
500	1154	17152	1000

An examination of the TR-20 hydrology model for Flat Run indicates that, for existing conditions, approximately 4.01 inches of runoff (1619 acre-feet) can be expected from the 100-year storm. Based on this storage, the following dam design (single purpose, for flood control only) was examined:

Type: Earth with 5:1 sideslopes Height: 47 feet Crest width: 10 feet

Crest length: 580 feet Volume of earth: 87,500 cubic yards

Freeboard: 10 feet Storage at design pool: 1690 acre-feet

Inundated area at design pool: 187 acres

Based on past experience, SCS estimates that high hazard earthen flood control dams in this size range have construction costs between five and six dollars per cubic yard[6]. This would indicate construction costs between $440,000 and $525,000. Due to the geology of the area however, on site materials (montmorillonite clay from weathered diabase) would be undesirable for use in the dam. This would increase construction costs and might make a concrete dam a better alternative. Land acquisition costs are not included in the above estimate. Clearly, consideration of interstate coordination would be critical in the very early stages of an effort of this nature.

The largest feasible dam at the proposed site was also examined, and determined to have the following characteristics:

Type: Earth with 5:1 sideslopes   Height: 64 feet   Crest width: 10 feet

Crest length: 1000 feet   Volume of earth: 190,000 cubic yards

Freeboard: 10 feet   Storage at design pool: 8170 acre-feet

Inundated area at design pool: 664 acres

Maximum storage: 17,200 acre-feet (at top of dam)

Effect of Dam: Either of the proposed dams would lower the predicted flood discharges and elevations throughout the study reach, as shown in Tables 7 and 8.

[6] Phone calls with Allen Stahl of the Soil Conservation Service, 9/6/89. Based on engineers final estimate. Based on original size estimate of 75000 cubic yards.

Either dam would remove a total of 11 structures (some of which are mobile homes) from the 100-year floodplain.

Table 7
Discharge in cubic feet per second at selected locations with and without dam

Location		100 year	10 year	2 year
Just upstream of	w/o dam	8232	4263	1560
Seton Ave	w/ dam	3703	2112	791
Percent of existing flow		45%	50%	51%
Downstream of	w/o dam	8139	4187	1532
Main Street	w/ dam	4160	2362	894
Percent of existing flow		51%	56%	58%
At U.S. 15	w/o dam	8039	4107	1504
	w/ dam	4647	2627	1004
Percent of existing flow		58%	64%	67%

Table 8
Flood elevations at selected sections between U.S. 15 and Seton Avenue with and without dam

Section number	100-year			10-year			2-year		
	w/o dam	with dam	diff	w/o dam	with dam	diff	w/o dam	with dam	diff
51	385.2	383.8	1.4	383.5	382.5	1.0	381.5	380.8	0.7
54	387.7	385.0	2.7	384.5	383.2	1.3	382.0	381.1	0.9
54.5	387.9	385.4	2.5	385.0	383.7	1.3	382.5	381.5	1.0
55	388.4	386.0	2.4	385.6	384.4	1.2	383.3	382.5	0.8
55.5	388.5	386.2	2.3	385.8	384.7	1.1	383.7	383.1	0.6
56	389.0	386.9	2.1	386.7	385.7	1.0	384.7	383.7	1.0
57	389.7	388.0	1.8	388.0	386.8	1.2	385.9	384.6	1.3
58.1	390.3	388.6	1.7	388.6	387.4	1.2	386.4	384.9	1.5
58.3	393.7	391.2	2.5	391.2	387.4	3.8	386.4	385.0	1.4
60	394.2	391.6	2.6	391.6	388.8	2.8	387.5	386.0	1.5
61	395.1	392.4	2.7	392.4	390.1	2.3	389.1	387.9	1.2
61.5	395.9	393.3	2.6	393.3	391.6	1.7	390.8	389.6	1.2
62	396.5	394.0	2.5	394.0	392.5	1.5	391.8	391.0	0.8
63.1	396.7	394.2	2.5	394.3	393.0	1.3	392.4	391.5	0.9
63.4	396.5	395.4	1.1	395.5	394.2	1.3	392.9	391.7	1.2
64	398.1	396.1	2.0	396.1	394.5	1.6	393.3	391.9	1.4

Channel Relocation and Conveyance Improvements:

A modest channel improvement with a significant decrease in channel roughness was modeled between U.S. 15 and a point 950 feet upstream of Main Street. This 3000 foot long conveyance improvement did not appreciably lower the 100-year water surface elevation.

Subsequently, based on comments provided by the Town, two additional channel improvements were evaluated:

1. A major channel relocation, straightening and conveyance improvement from U.S. 15 to 200 feet downstream of Main street.
2. A more limited channel improvement straightening, from U.S. 15 to 850 feet upstream.

Option One involved the net removal of approximately 24,000 cubic yards of earth. The proposed channel was realigned to follow a smooth curve from Main Street to U.S. 15. Roughness in the channel and overbank areas were reduced to represent the smoother, artificial condition. Bridge losses were reduced to reflect the new alignment. The overbanks were cut and flattened, the new channel was reshaped in an attempt to reduce maintenance.

Option Two was proposed mainly to improve bridge hydraulics. The channel and overbank improvements were similar to Option One, but assumed to be carried out over a more limited length of channel.

Table 9 compares the results of Option One with existing conditions. Option two caused little decrease in flood elevation and the results are not tabulated.

TABLE 9
A Comparison of Water Surface Elevations for Existing Conditions and Channel Relocation, Option One

Section Number	Existing Conditions 2 year	10 year	100 year	Option One 2 year	10 year	100 year	Change in 100 year
54	382.0	384.5	387.7	382.0	384.6	387.5	-.2
54.5	382.5	385.0	387.9	382.1	384.8	387.6	-.3
55	383.3	385.6	388.4	382.5	385.1	388.0	-.4
55.5	383.7	385.8	388.5	383.1	385.3	388.1	-.4
56	384.7	386.7	389.0	384.2	385.9	388.4	-.6
57	385.9	388.0	389.7	385.1	386.8	388.9	-.8

The net effect of this channel improvement is to reduce flood levels on structures during the 100-year event. Water surface elevations are not sufficiently lowered to prevent flooding of any buildings in the 1st Avenue/Park Drive area but did lower flood waters on the building at 505 Main Street below the first floor elevation. One mobile home further upstream also had it's first floor protected by the proposed improvement.

Based on further comments from the Town, an additional channel improvement was considered. This improvement was the same as Option One upstream of U.S. 15 but with overbank improvements extended 2000 feet downstream of U.S. 15. This improvement did lower flood levels further, but not enough to place the first floor of any additional structures above flood level.

Conveyance Improvements at the U.S. 15 Bridge

The original U.S. 15 bridge had significant conveyance problems. As stated in the results section, it was partly responsible for the severity of the 1973 flood. The question becomes, could further bridge improvements significantly reduce flood levels? Because it was fairly easy to examine the resulting flood levels if the bridge were removed entirely, it was decided to model removal of the bridge as a limiting case, demonstrating the best that could be achieved by conveyance improvements. This situation was also examined when combined with channel improvement option one. Only when bridge removal was combined with channel improvement was flooding of one house in the 1st Avenue/Park Drive area eliminated.

It is apparent that as long as the bridge is kept free of debris, it doesn't have an enormous impact on flooding. Structural conveyance improvements at the bridge will not achieve a desirable level of flood reduction.

Channel Maintenance

Several citizens have suggested that dredging or mowing vegetation in the channel of Flat Run would reduce flood levels. Hydraulic analyses indicate that this is generally untrue because:

1. The model has demonstrated a relative insensitivity to changes in channel roughness, and the channel vegetation (grass) has a relatively small effect on channel roughness.
2. The study of channel improvement and realignment options indicates that even significant structural conveyance improvements produce marginal reductions in flood levels.

A general dredging and lowering of the channel would also be problematic due to the fact that a sewer line has already been exposed by the natural processes of erosion. This is not to imply that channel maintenance is to be avoided. Ordinary debris removal throughout the channel plays an important part in keeping the U.S. 15 bridge clear. Preventing the growth of trees or thick brush that could anchor sediment deposition in front of the bridge is also important so that sediment is free to wash away during high flows. In fact, sediment buildup in front of the southern spans has reached a point where some localized dredging might be advisable. It must be understood, however, that sediment buildup is a normal feature where the stream channel has been unnaturally widen and is aggravated, in this case, by curvature of the channel in the vicinity of the bridge. Without question, buildup will reoccur if it is removed.

Bridge Removal:

A brief examination was made of the possibility of removing the Main Street bridge. This would reduce flooding of several buildings right on Main Street, but the effects dissipate rather rapidly. Qualitatively, it appears to be an expensive and highly disruptive option compared with the reduction of flooding that would be achieved.

Elevation and Floodproofing:

The concept behind floodproofing is to minimize flood damage either by keeping flood waters away from damageable property or by making the property less susceptible to damage when flood waters get to it.[7] Elevation in place and structural dry floodproofing are methods of reducing damage to structures. They are not intended to make a structure safe to inhabit during a flood. Some types of floodproofing can fail suddenly when flood waters reach heights above design levels. Even if there is some warning of impending failure, surrounding flood waters could prevent access or egress from the structures. Moreover, "there is nothing magical about the 100-year event; floods larger than this can and do occur."[8]

Several of the flood-prone structures within the Town of Emmitsburg are mobile homes. These could, presumably, be relocated out of the floodplain, or

[7] Flood Proofing Systems & Techniques, US Army Corps of Engineers, December, 1984, page 4

[8] Ibid., page 5

elevated on site so that the first floors are above the predicted flood level. As indicated in Table 5, other structures appear to be suitable for structural dry floodproofing. The two structures that are listed as possibly suitable are split foyer homes with shallow depths of flooding which could be floodproofed with comparatively short lengths of floodwalls. Detailed investigation should be made prior to any attempt to floodproof structures, however, as inappropriately designed floodproofing can cause far greater damage than a flood. In particular, buildup of hydrostatic pressure on the walls and floor of a floodproofed structure can cause sudden collapse.

Sewer Improvements:

Improvements to reduce or eliminate infiltration and inflow during the more frequent storm events would certainly be appreciated by residents in the 1st Street/2nd Avenue/Park Drive area. Residents interviewed in this area stated that they had already installed anti-backflow valves in the sewer lines, but indicated that the valves were not entirely effective, i.e. that significant leakage occurred. The Town is already pursuing this alternative to some extent. However, more extensive sewer improvements, possibly including a separate sewer line bypassing the upstream sewer flow around the 1st Street area might be necessary to solve the problem. Given the magnitude of the reported problem and the uncertainty about it's exact cause, even this approach might not be effective.

Do Nothing:

The "do nothing" alternative entails continuing current policies without change. Costs associated with this alternative are the continuing cost of recurring flood damage.

CONCLUSIONS

Although a number of homes experience regular basement flooding severe enough to restrict or prevent use of those areas, on the whole the Town of Emmitsburg does not currently appear to have a great problem with flooding.

RECOMMENDATIONS:

- Efforts should be made to keep bridges free of debris and growth of trees within the channel. Inspection by Town staff should be conducted periodically, and after every rain which causes bankfull flow conditions.
- Investigate sanitary sewer improvements to prevent surcharging of the collection line and backflow into the houses in the 1st Street/2nd Avenue/Park Drive area.
- Purchase of Flood Insurance by homeowners should be encouraged.
- Relocate mobile homes. Assure proper elevation and tie-downs if mobile homes are replaced.
- Contact owners of two homes that appear to be reasonably easy to floodproof and provide additional technical information regarding construction of floodwalls.

Appendices

Appendix One

Ultimate Development

ULTIMATE DEVELOPMENT

As a watershed develops, the peak discharge of its streams generally increases. This is because a greater proportion of the watershed is covered with imperious surfaces (roads, rooftops, etc.) which increases the total runoff volume. Storm drains and paved surfaces also generally increase the rate at which stormwater runs off to speed its collection in the drainage system. Thus, the 100-year flood experienced after the upland development occurs will be larger than if the 100-year flood occurred today. The question naturally arises: What will the 100-year flood be after all foreseeable development takes place? Such a flood may reasonably be predicted based on the zoning maps currently in effect. The Waterway Permits Division of the Water Resources Administration regulates the 100-year floodplain based on the ultimate development of the watershed given existing zoning.

In 1989 Fox Engineering[9], analyzed a proposed modification to Creamery Road.[10] Runoff curve numbers reflecting ultimate development of the Flat Run watershed were developed. Because parts of Pennsylvania are unzoned, the entire watershed was built out to the average Maryland land uses and densities. Flows based on the these runoff curve numbers were calculated and are compared to

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[9] Fox and Associates, 82 Worman's Mill Court, Suite G, Frederick Maryland 21701, (301) 695-0880

[10] Waterway Permit application number 90-WC-0052

discharges computed for existing conditions in this study in Table 10.

Table 10. - A comparison of flows for existing and ultimate development (cfs)

	2 Year	10 Year	100 Year	Location
Existing	1500	4110	8040	At U.S. 15
Ultimate	2140	5270	9050	
Existing	1560	4260	8230	At Seton Ave.
Ultimate	2230	5480	9290	
Existing	1500	4110	7670	At Irishtown Rd.
Ultimate	2140	5200	8720	
Average	670	1200	1060	Over six locations
Increase	43%	28%	13%	

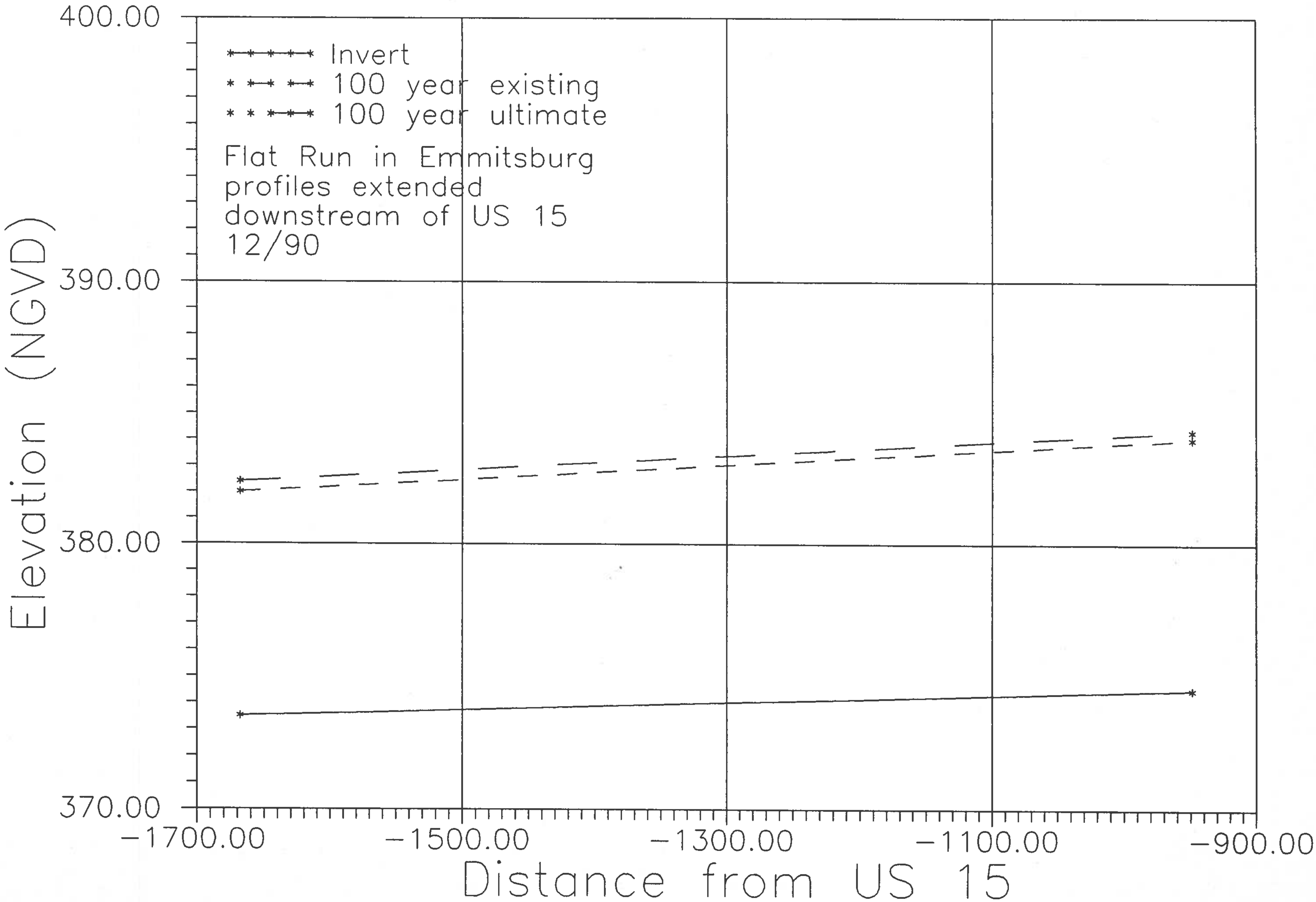
Water surface elevations were then computed using the ultimate development discharges. Table 11 provides a section by section comparison of the 100-year existing flood elevations with the 100-year ultimate flood elevations. The maximum increase is .8 feet.

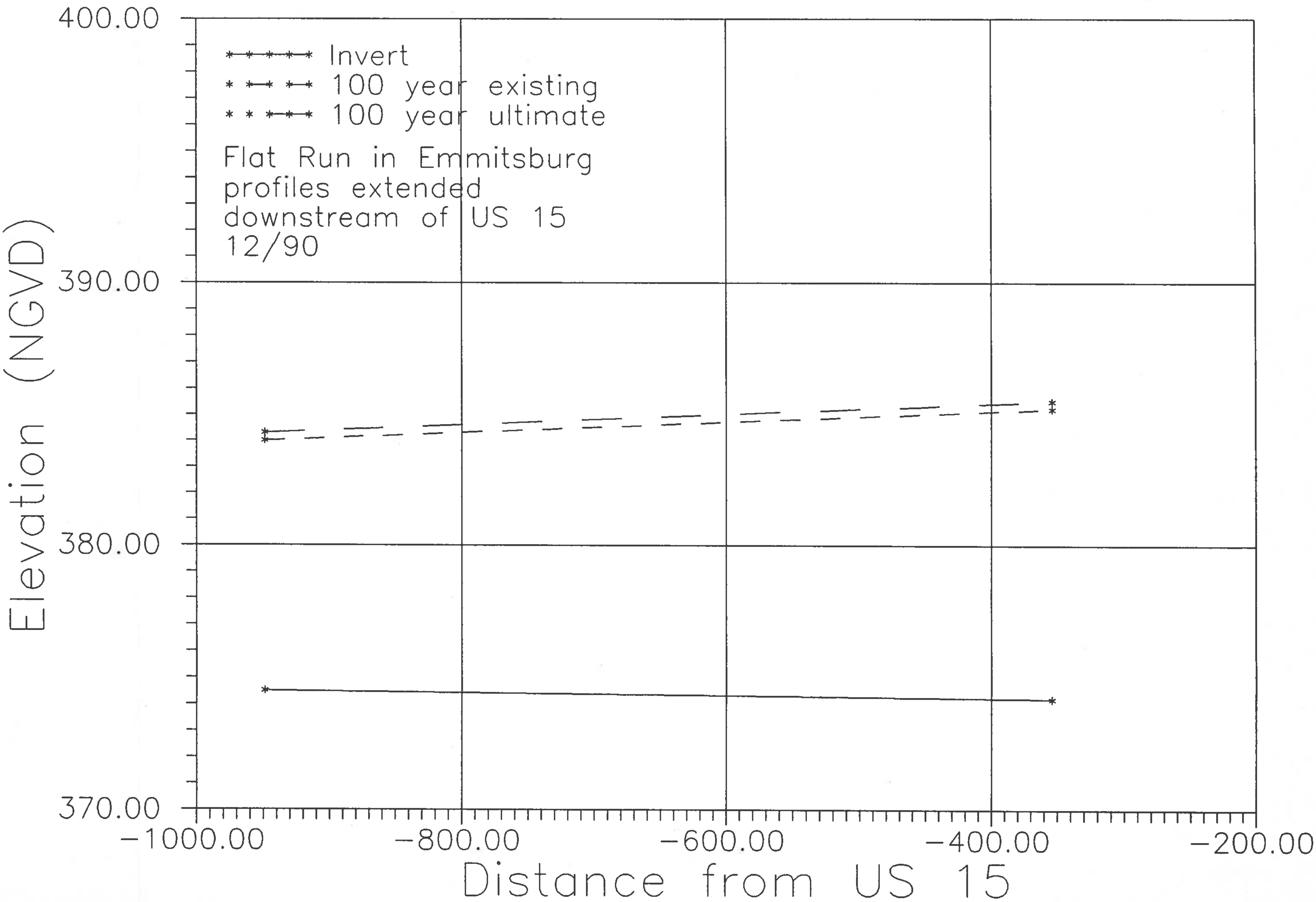
Table 11. - A Comparison of Water Surface Elevations for Existing and Ultimate Conditions for the 100-year Flood (feet NGVD)							
Section Number	Existing	Ultimate	Diff.	Section Number	Existing	Ultimate	Diff.
8.	382.0	382.4	.39	63.4	396.5	396.8	.35
9.	384.0	384.3	.27	64.	398.1	398.5	.43
51.	385.2	385.5	.34	65.	399.9	400.4	.47
52.1	385.6	385.9	.34	67.	402.6	403.0	.47
52.4	386.5	387.1	.63	68.	406.2	406.7	.50
54.	387.7	388.5	.79	69.	408.0	408.6	.53
54.5	387.9	388.7	.75	70.	410.0	410.4	.48
55.	388.4	389.2	.71	71.5	412.7	413.2	.45
55.5	388.5	389.2	.69	72.4	414.9	415.4	.47
56.	389.0	389.6	.61	73.	417.0	417.6	.52
57.	389.7	390.2	.48	74.2	420.6	421.3	.73
58.1	390.3	390.7	.42	136.	421.4	422.0	.63
58.3	393.7	394.1	.46	137.	422.6	423.2	.61
60.	394.2	394.7	.49	138.	423.8	424.4	.61
61.	395.1	395.6	.53	139.1	426.2	426.8	.66
61.5	395.9	396.4	.53	139.2	426.8	427.4	.64
62.	396.5	397.0	.52	139.3	426.8	427.4	.63
63.1	396.7	397.2	.52	139.4	426.6	427.3	.64
63.2	396.5	397.1	.53	140.	427.1	427.7	.61
63.3	396.8	397.2	.40				

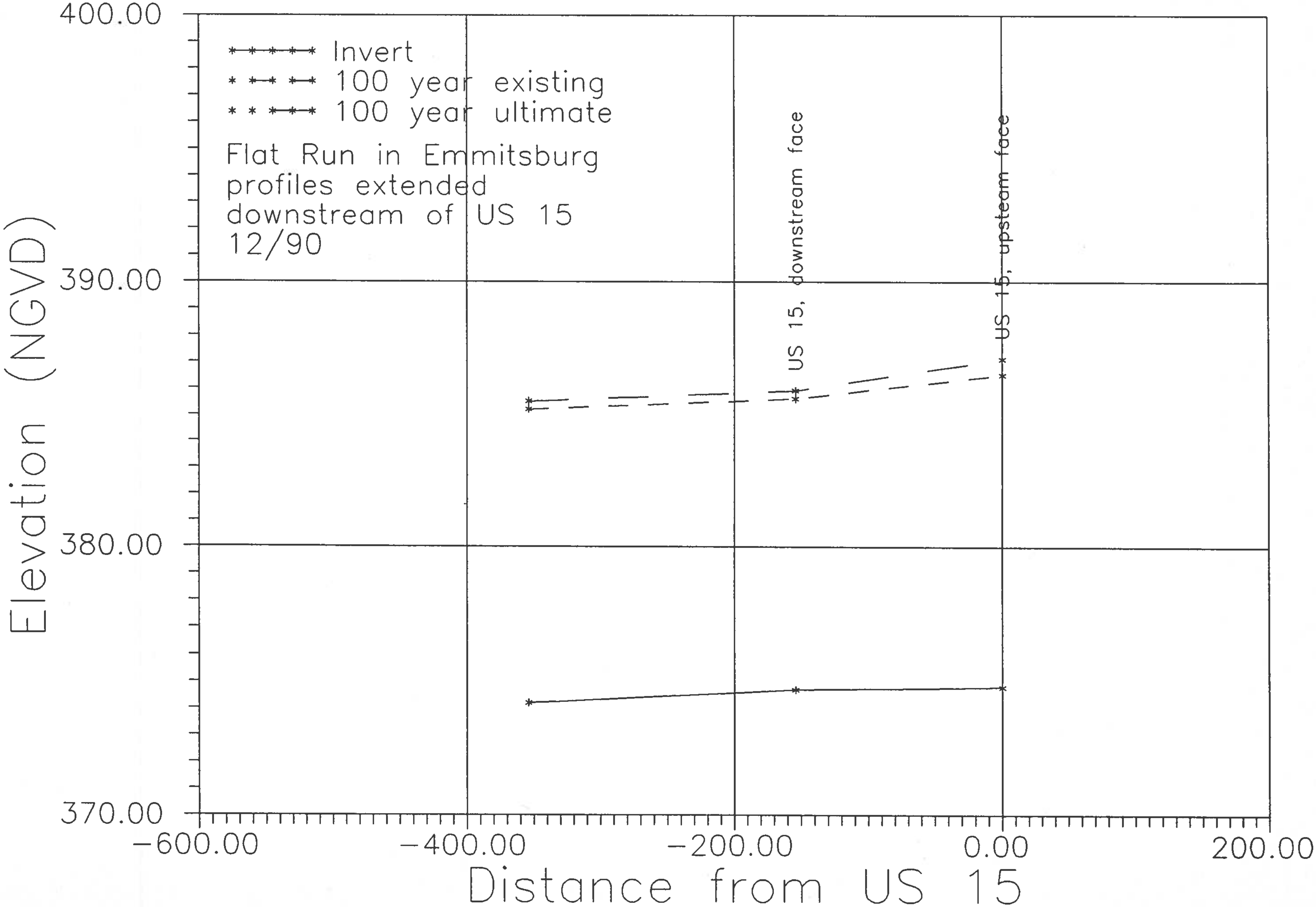
The practical effect of ultimate development would be to increase water levels on structures already flooded and to marginally flood one additional house (303 Depaul will have a first floor elevation equal to the 100 year ultimate development flood elevation). Nothing resembling ultimate development is expected in the near term. Therefore, **this report is mainly concerned with existing conditions.**

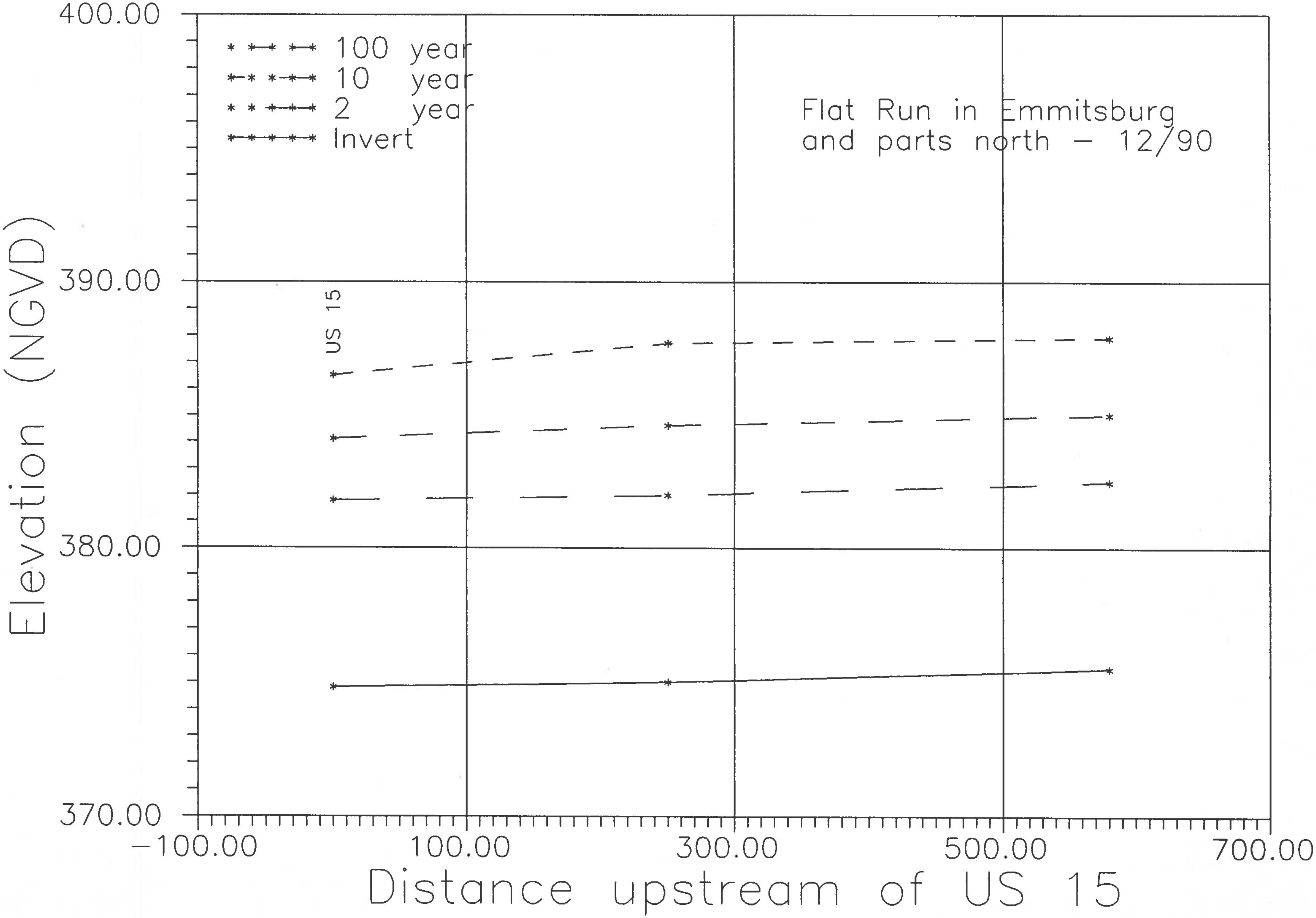
Appendix Two

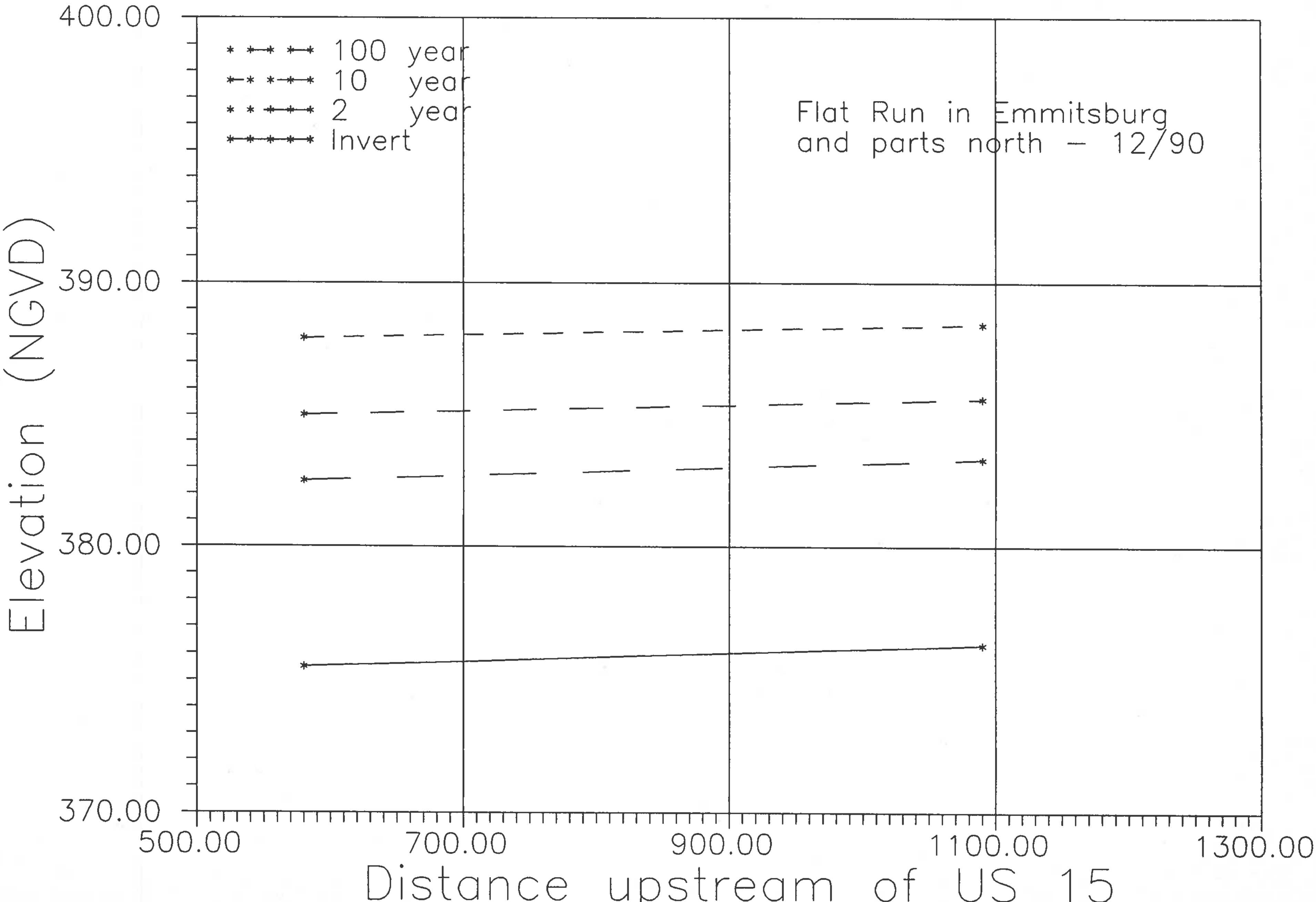
Flood Profiles for Existing Conditions


Invert
100 year existing
100 year ultimate
Flat Run in Emmitsburg
profiles extended
downstream of US 15
12/90
Elevation (NGVD)
400.00
390.00
380.00
370.00
-1700.00
-1500.00
-1300.00
-1100.00
-900.00
Distance from US 15

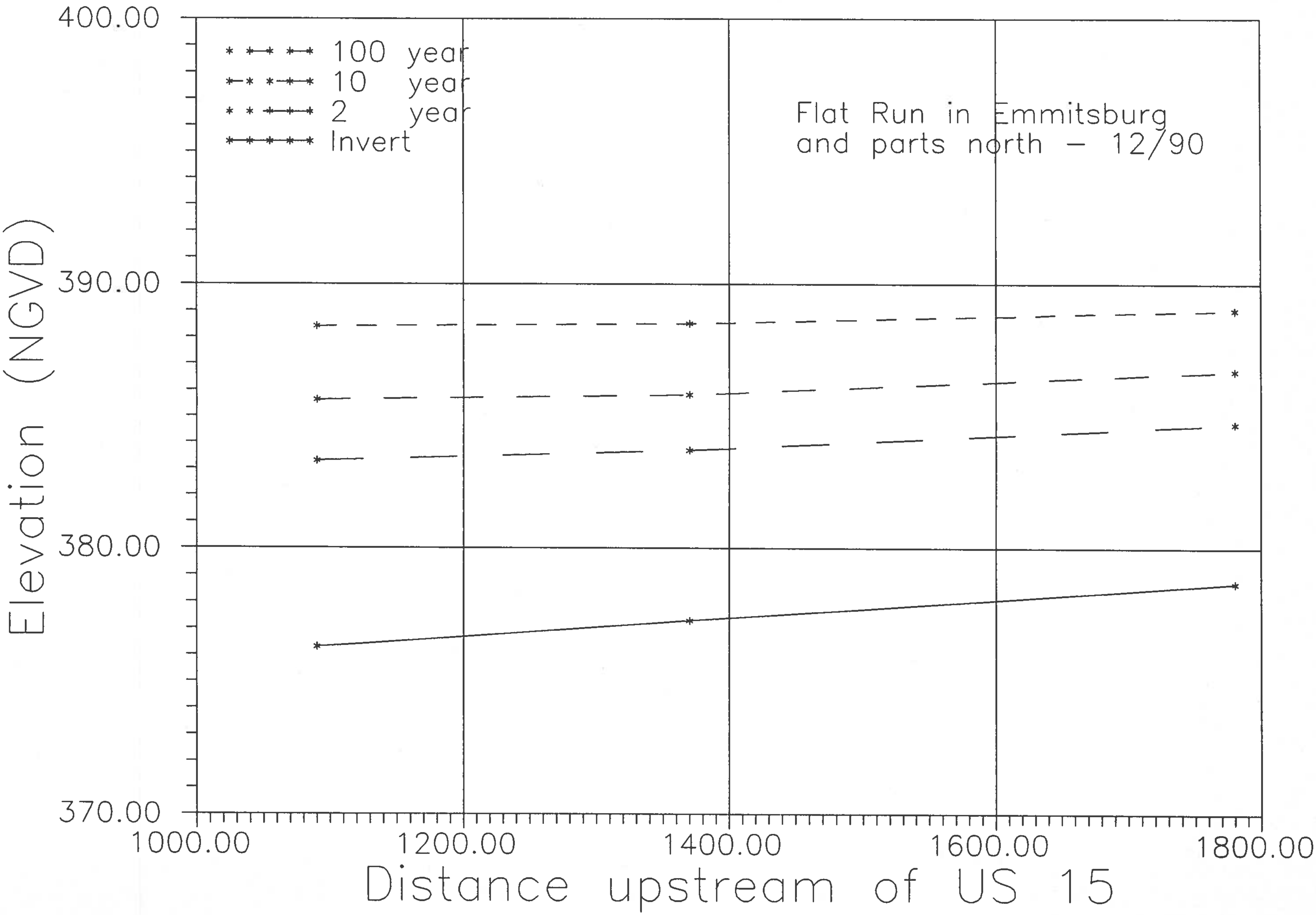

Invert
100 year existing
100 year ultimate
Flat Run in Emmitsburg
profiles extended
downstream of US 15
12/90
Elevation (NGVD)
400.00
390.00
380.00
370.00
-1000.00
-800.00
-600.00
-400.00
-200.00
Distance from US 15

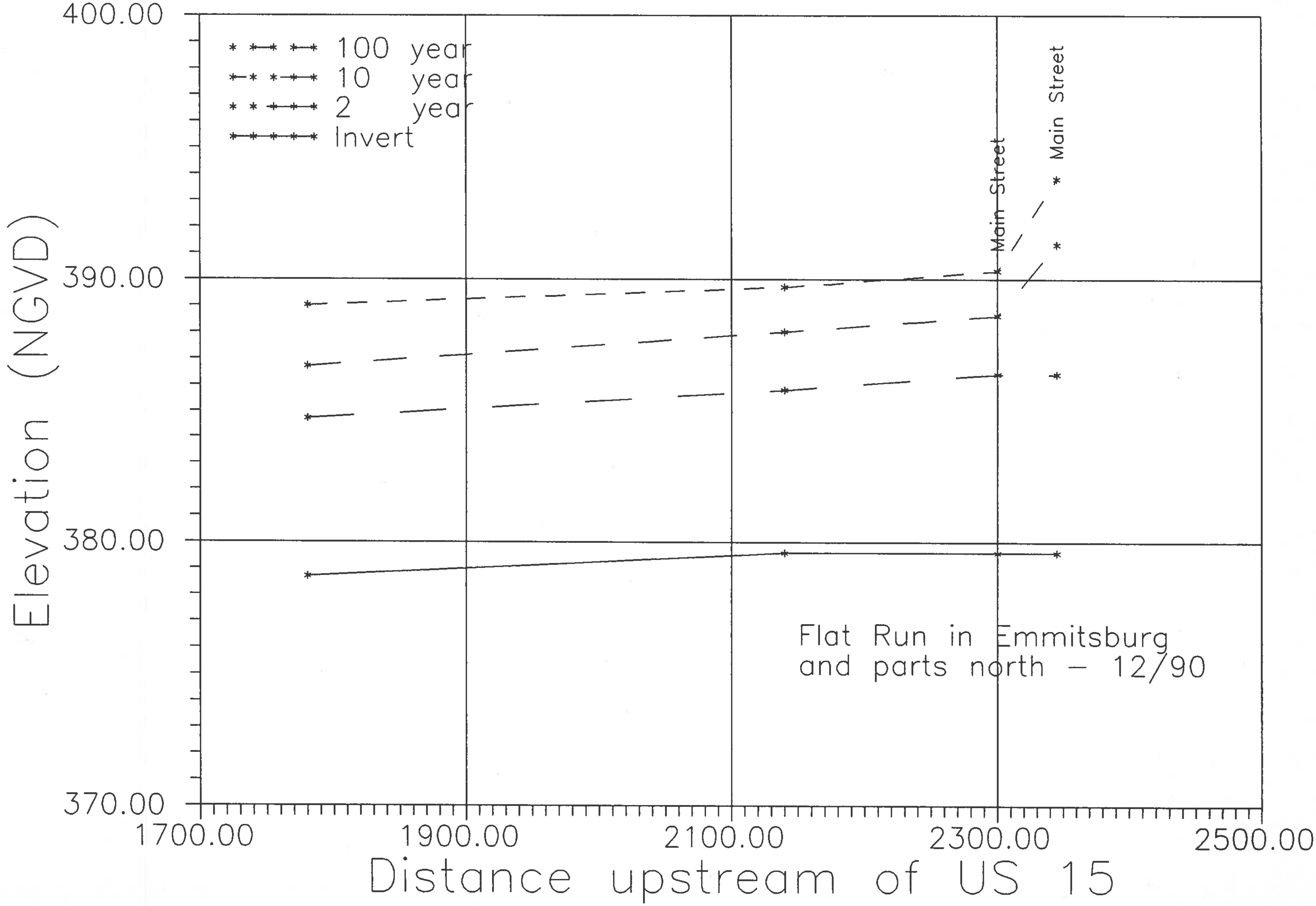

Invert
100 year existing
100 year ultimate
Flat Run in Emmitsburg
profiles extended
downstream of US 15
12/90
US 15, downstream face
US 15, upsteam face
400.00
390.00
380.00
370.00
Elevation (NGVD)
-600.00
-400.00
-200.00
0.00
200.00
Distance from US 15


100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/90
US 15
400.00
390.00
380.00
370.00
Elevation (NGVD)
-100.00
100.00
300.00
500.00
700.00
Distance upstream of US 15

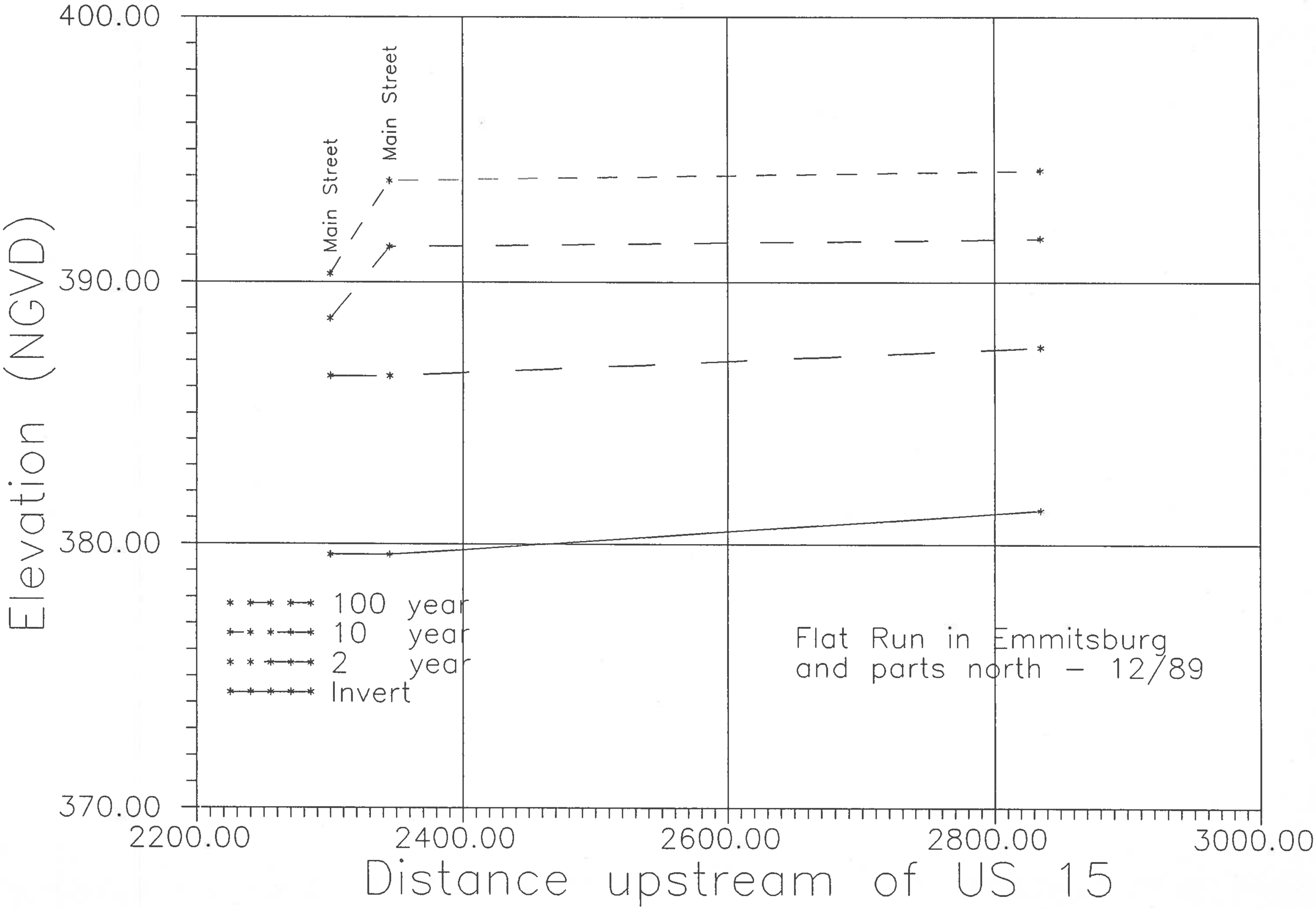


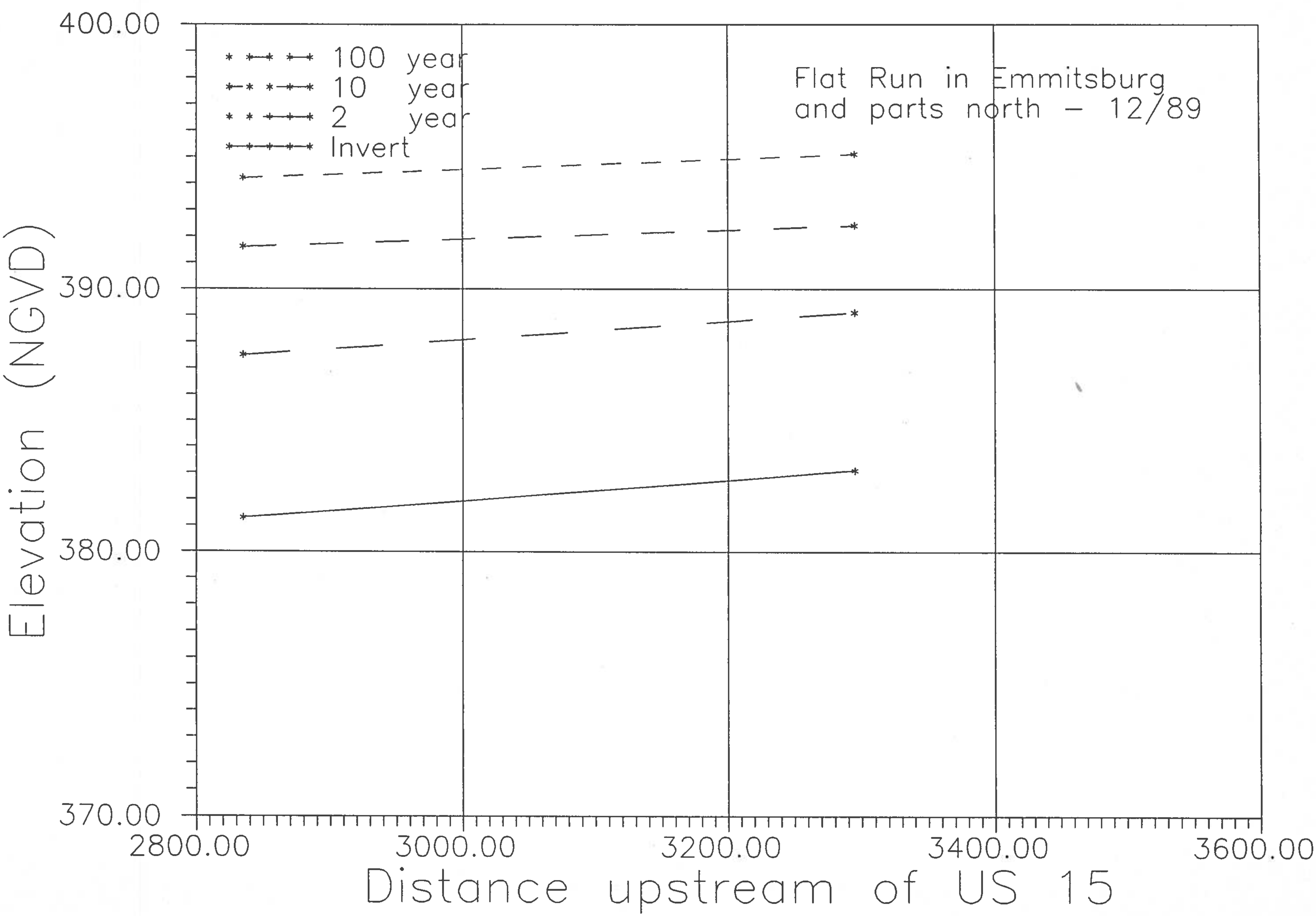
400.00
390.00
380.00
370.00
Elevation (NGVD)
500.00
700.00
900.00
1100.00
1300.00
Distance upstream of US 15
100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/90


100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/90
Elevation (NGVD)
400.00
390.00
380.00
370.00
1000.00
1200.00
1400.00
1600.00
1800.00
Distance upstream of US 15

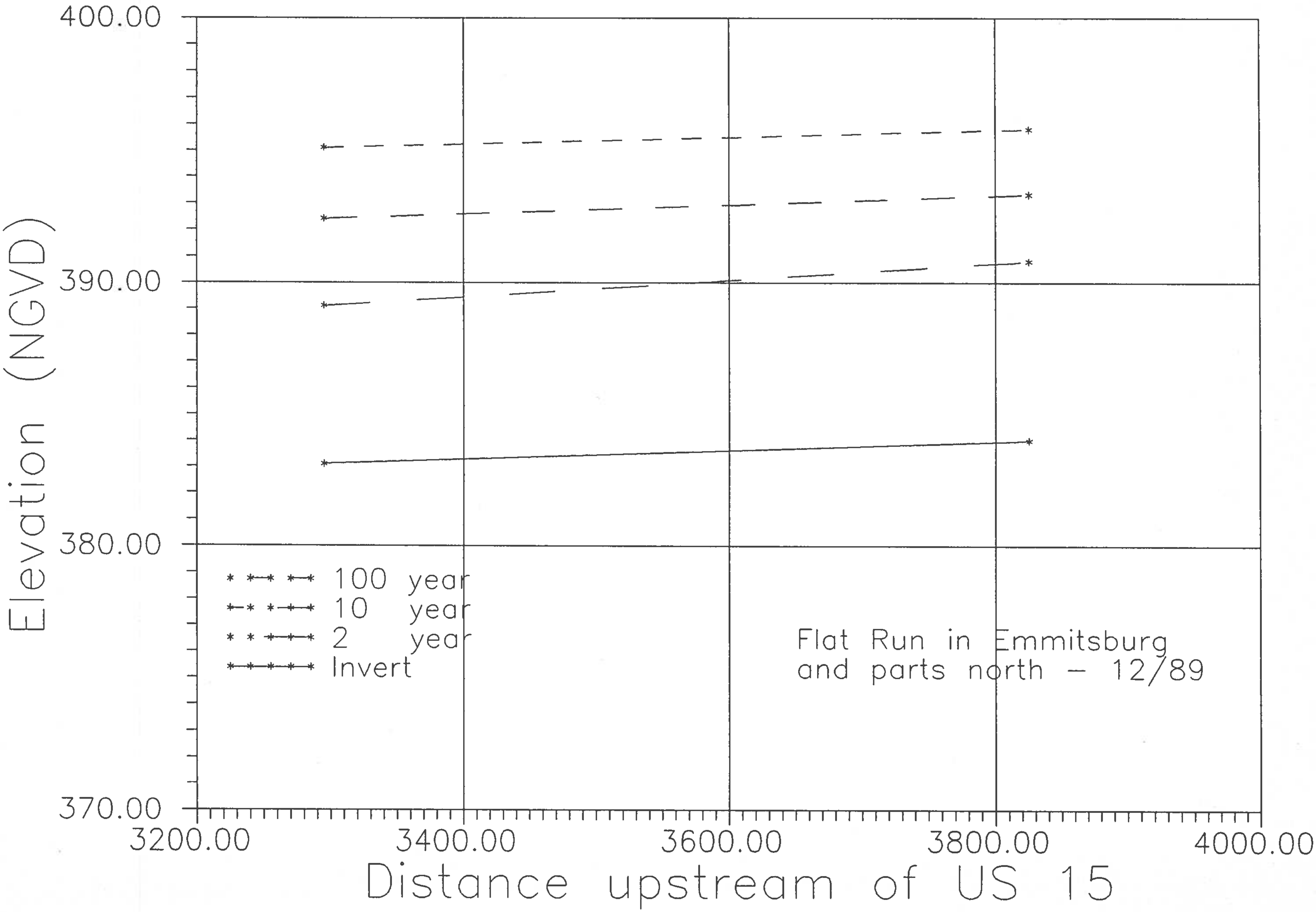


400.00
390.00
380.00
370.00
Elevation (NGVD)
1700.00
1900.00
2100.00
2300.00
2500.00
Distance upstream of US 15
100 year
10 year
2 year
Invert
Main Street
Main Street
Flat Run in Emmitsburg
and parts north – 12/90

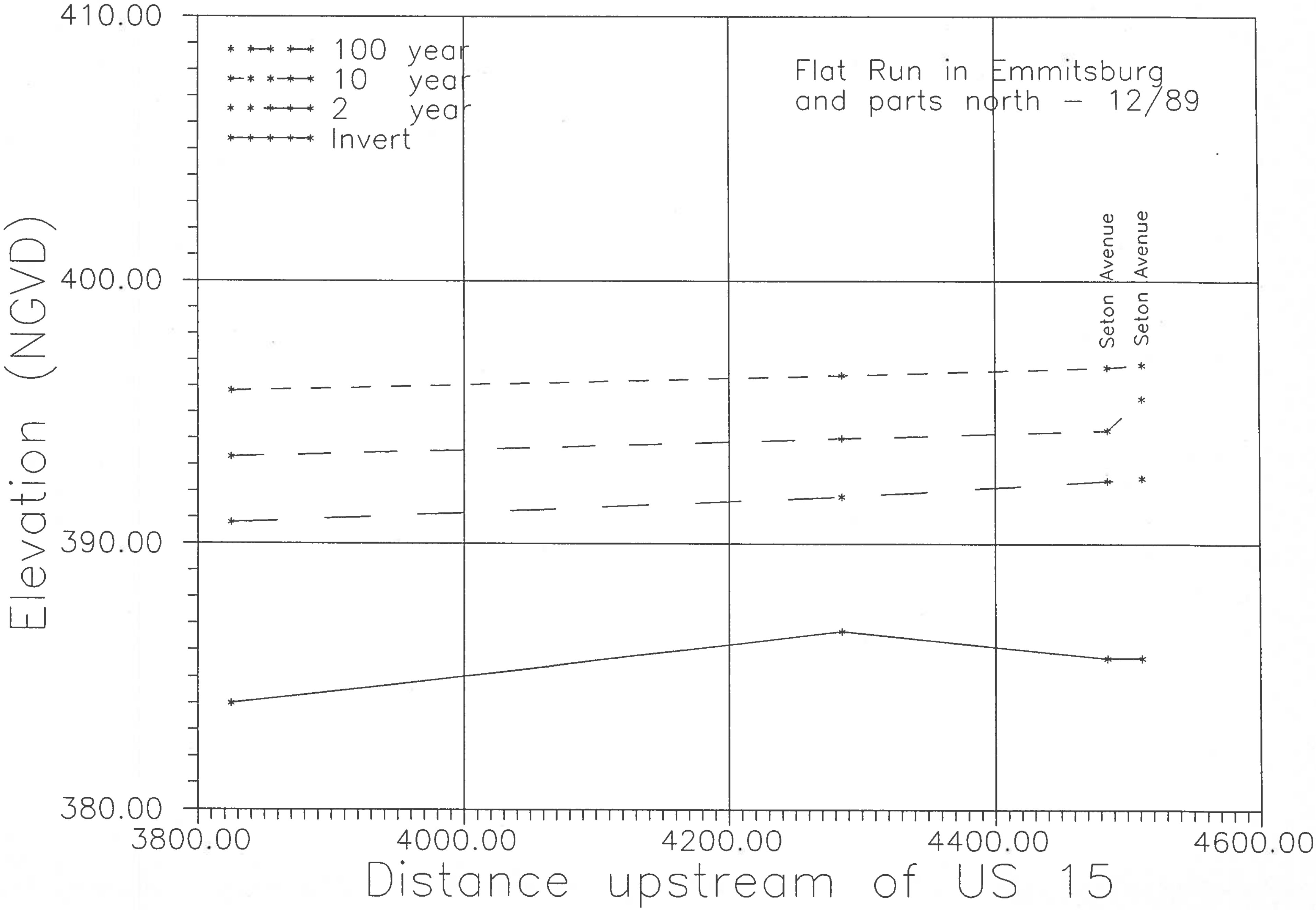

400.00
390.00
380.00
370.00
Elevation (NGVD)
2200.00
2400.00
2600.00
2800.00
3000.00
Distance upstream of US 15
Main Street
Main Street
100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89



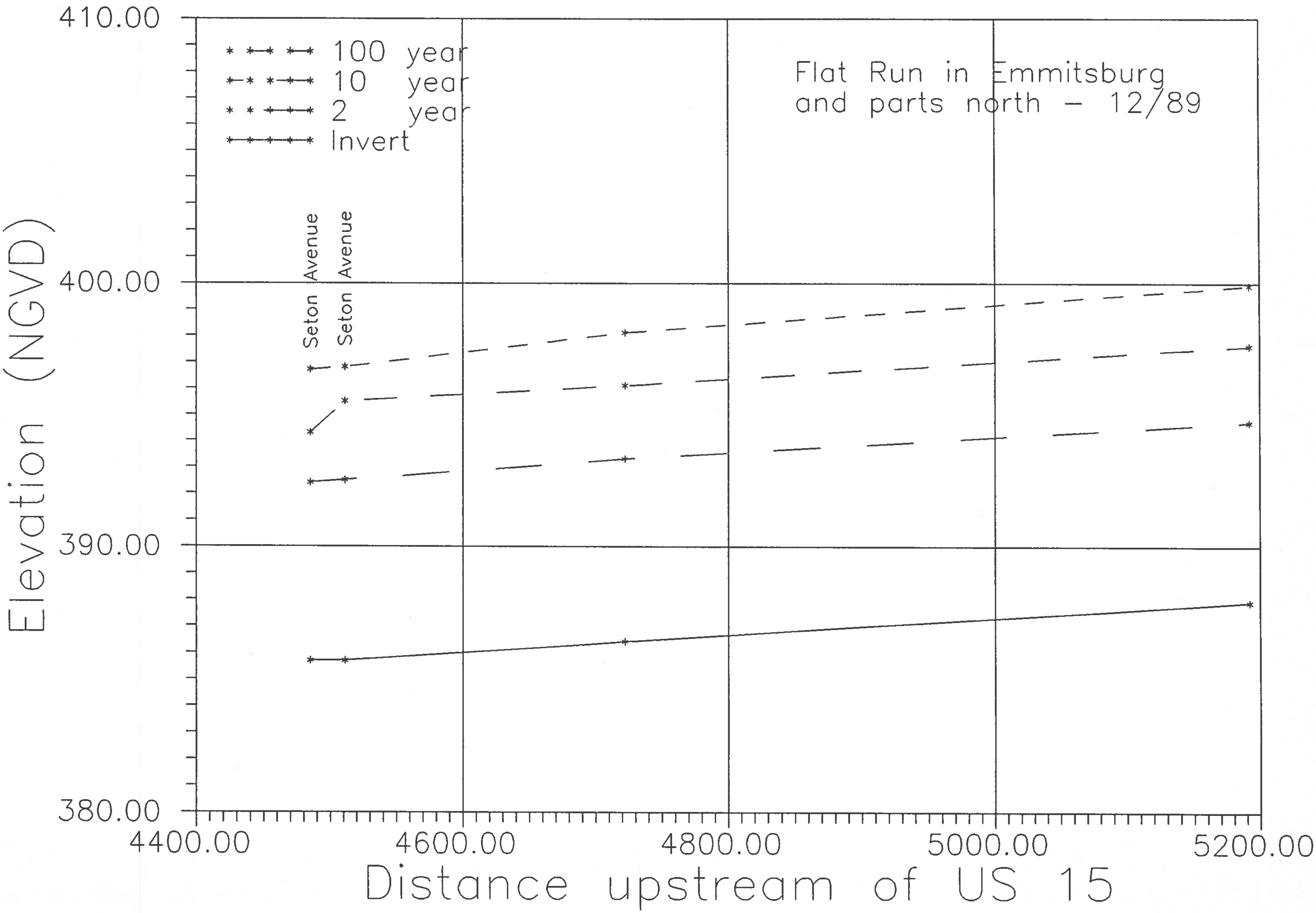
Flat Run in Emmitsburg
and parts north - 12/89
100 year
10 year
2 year
Invert
Elevation (NGVD)
400.00
390.00
380.00
370.00
2800.00
3000.00
3200.00
3400.00
3600.00
Distance upstream of US 15



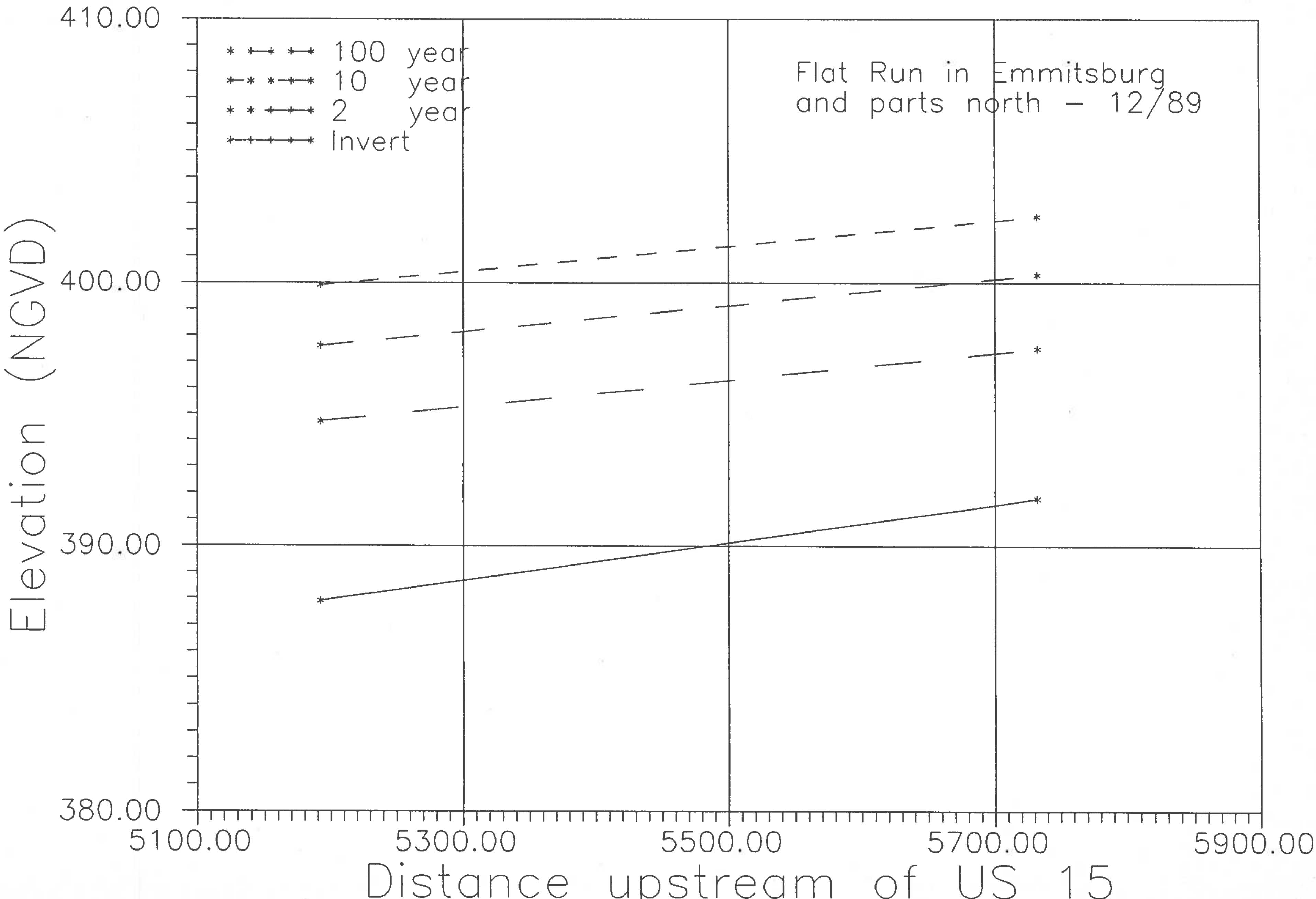
400.00
390.00
380.00
370.00
Elevation (NGVD)
3200.00
3400.00
3600.00
3800.00
4000.00
Distance upstream of US 15
100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89



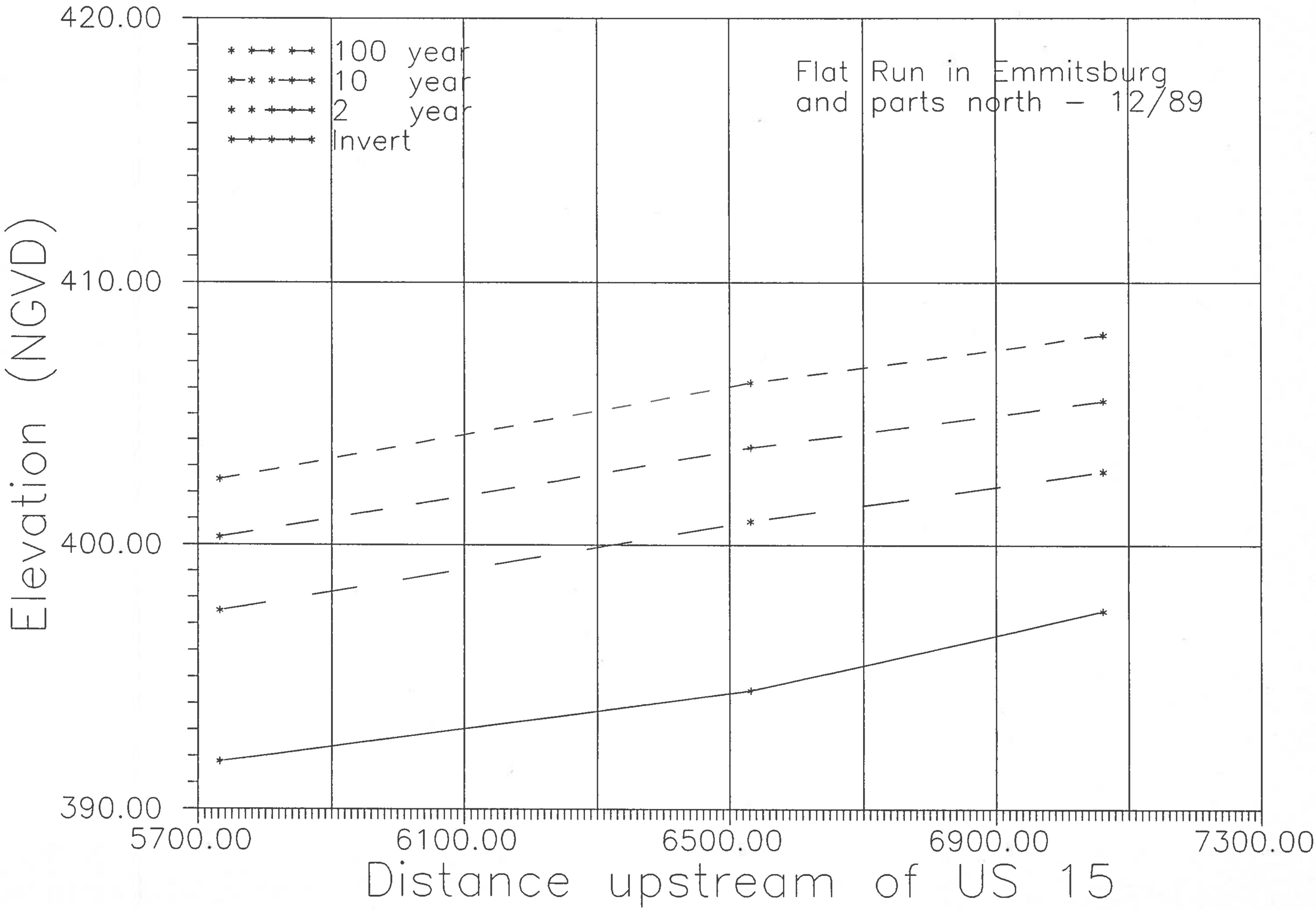
100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
Seton Avenue
Seton Avenue
410.00
400.00
390.00
380.00
Elevation (NGVD)
3800.00
4000.00
4200.00
4400.00
4600.00
Distance upstream of US 15

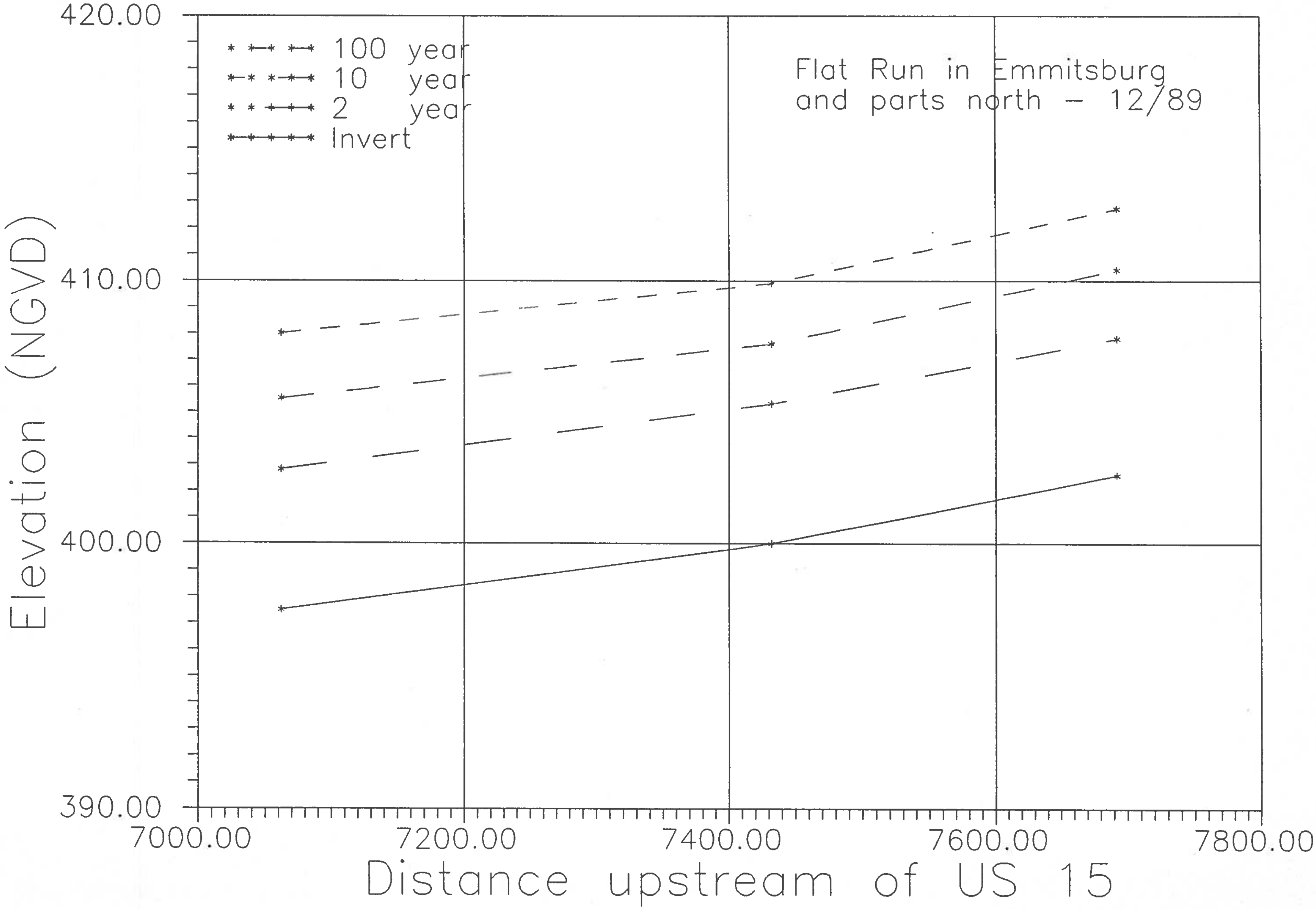


100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
Seton Avenue
Seton Avenue
410.00
400.00
390.00
380.00
4400.00
4600.00
4800.00
5000.00
5200.00
Elevation (NGVD)
Distance upstream of US 15

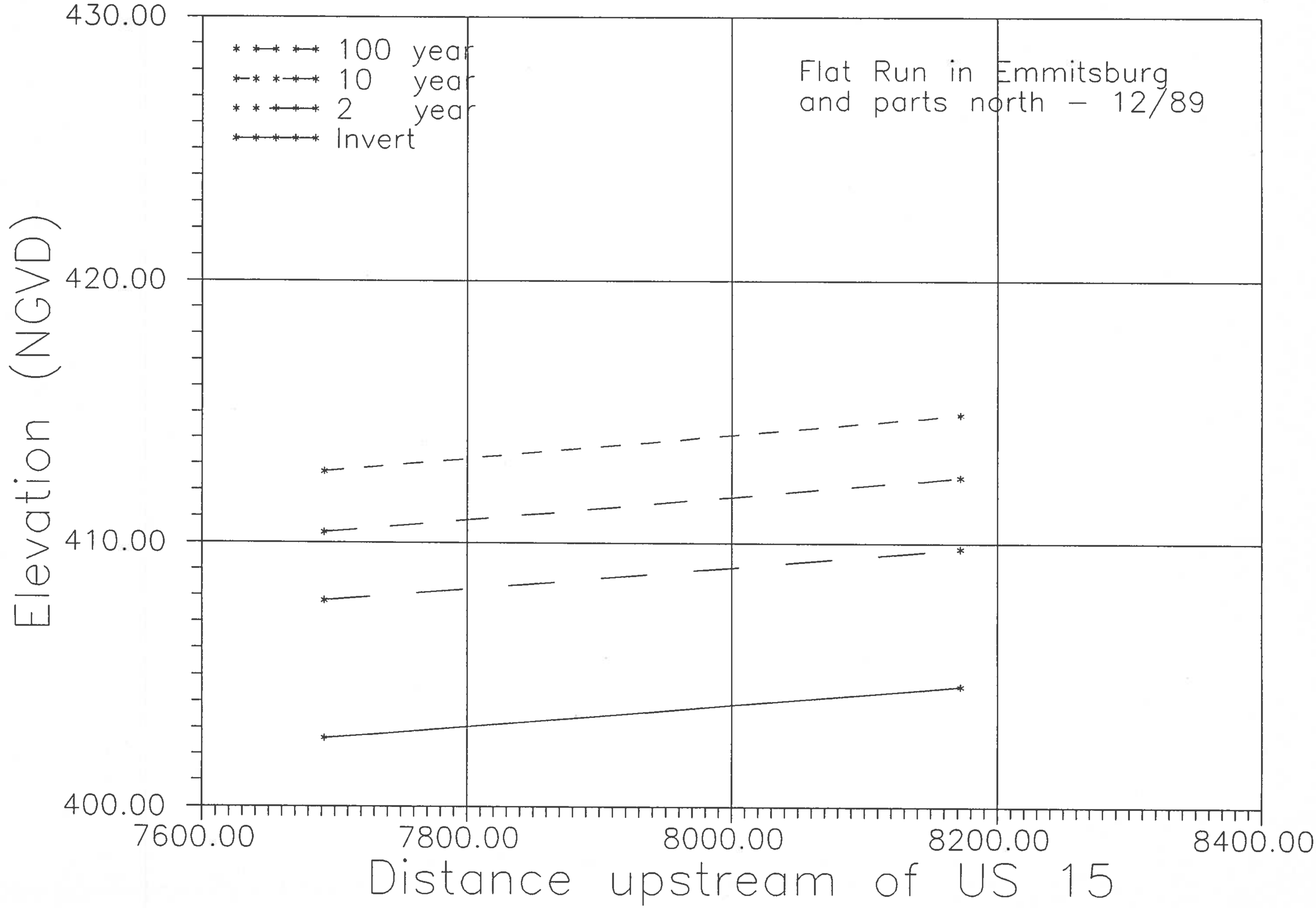


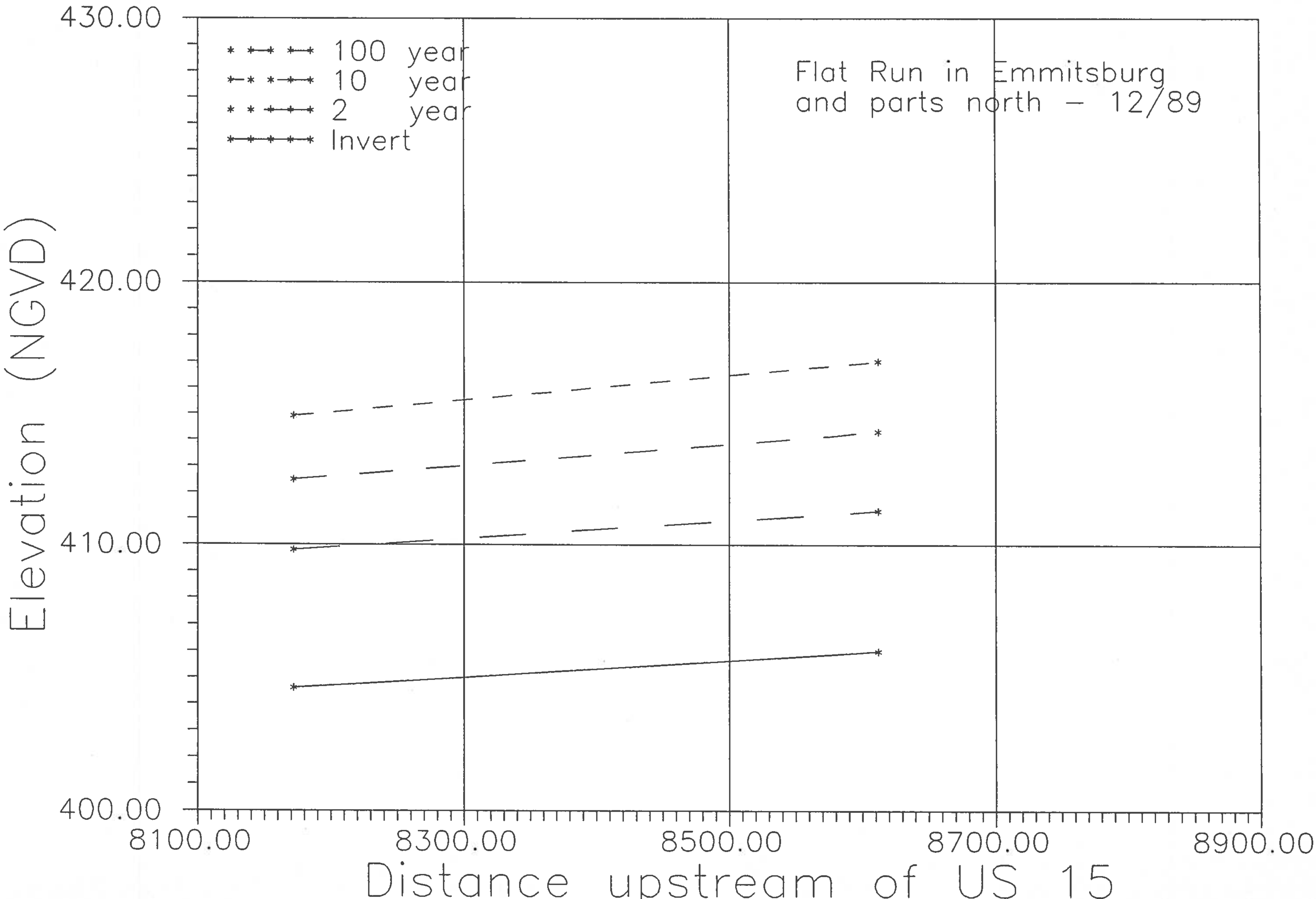
410.00
400.00
390.00
380.00
5100.00
5300.00
5500.00
5700.00
5900.00
Elevation (NGVD)
Distance upstream of US 15
100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89

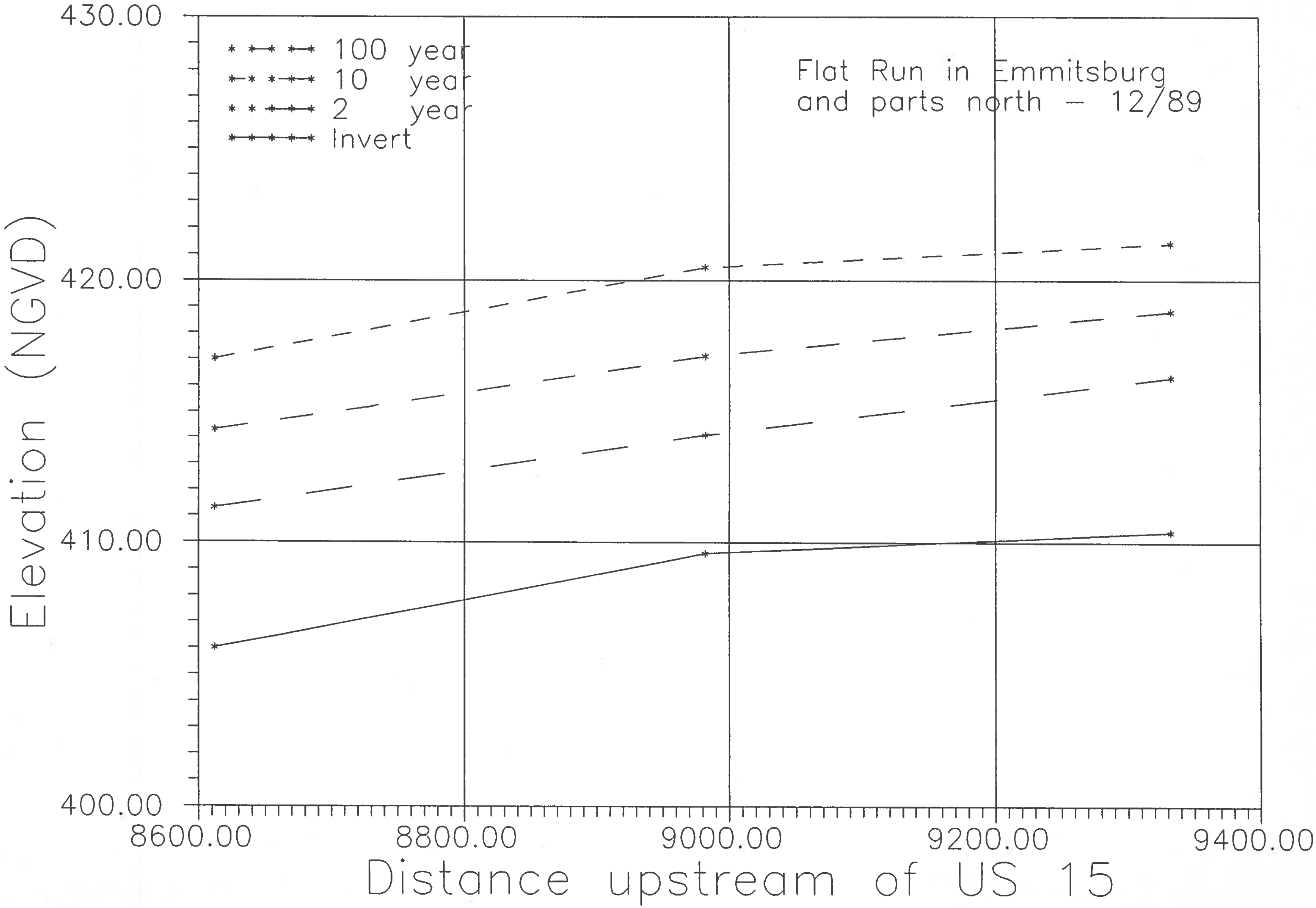

100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
Elevation (NGVD)
420.00
410.00
400.00
390.00
5700.00
6100.00
6500.00
6900.00
7300.00
Distance upstream of US 15



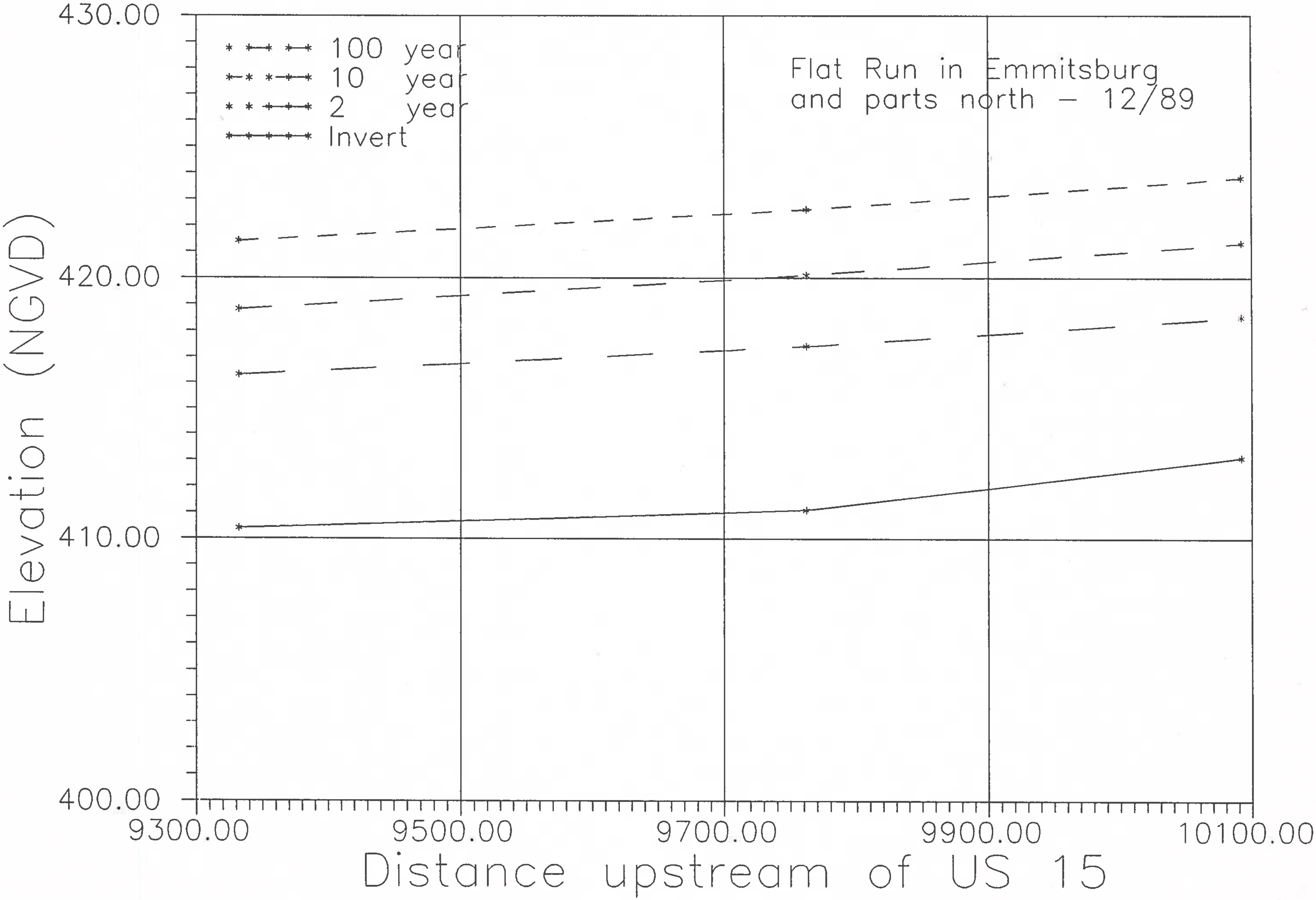
100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
420.00
410.00
400.00
390.00
Elevation (NGVD)
7000.00
7200.00
7400.00
7600.00
7800.00
Distance upstream of US 15


100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
430.00
420.00
410.00
400.00
Elevation (NGVD)
7600.00
7800.00
8000.00
8200.00
8400.00
Distance upstream of US 15

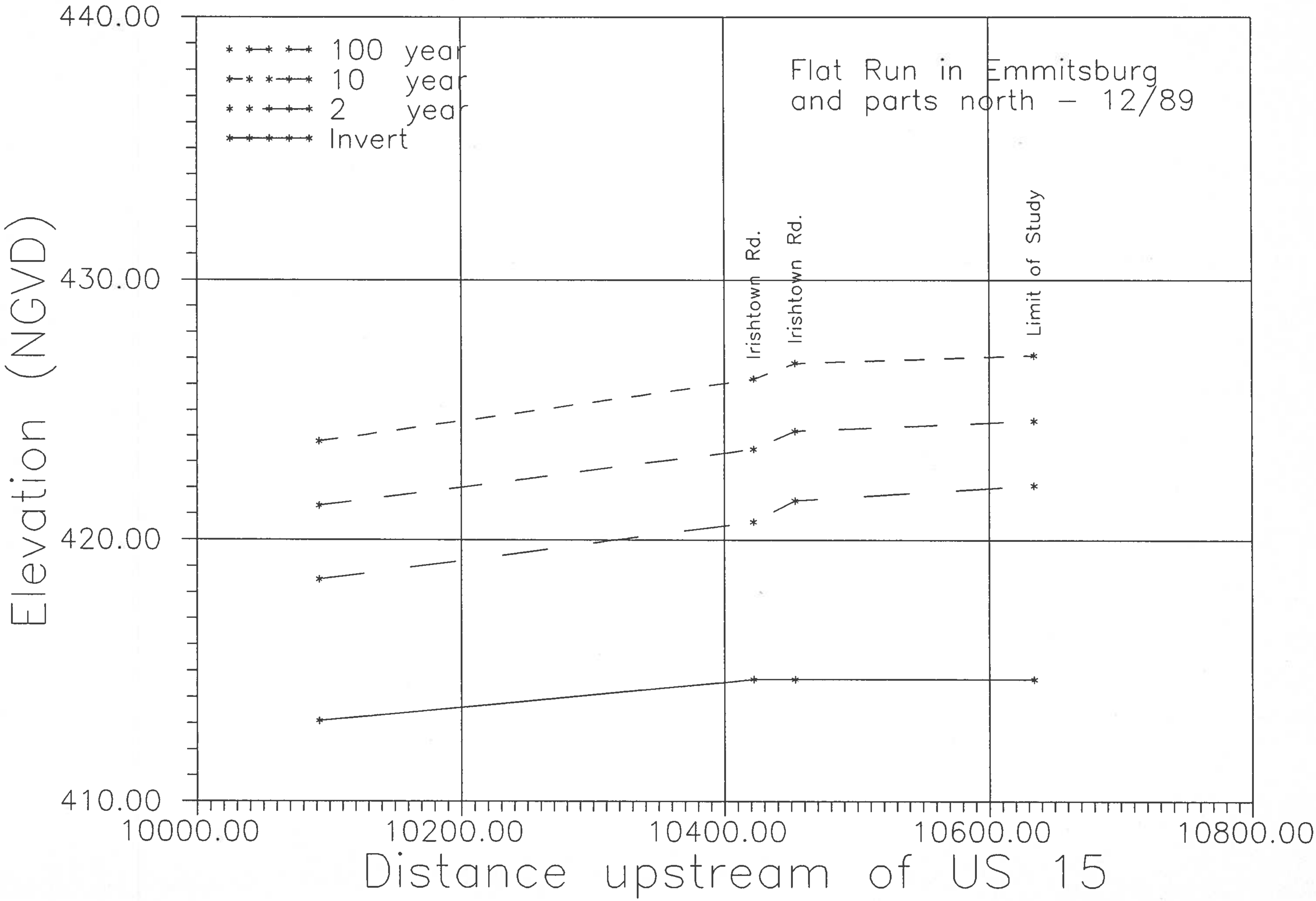

100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
430.00
420.00
410.00
400.00
Elevation (NGVD)
8100.00
8300.00
8500.00
8700.00
8900.00
Distance upstream of US 15



Flat Run in Emmitsburg
and parts north - 12/89
100 year
10 year
2 year
Invert
Elevation (NGVD)
430.00
420.00
410.00
400.00
8600.00
8800.00
9000.00
9200.00
9400.00
Distance upstream of US 15



100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
430.00
420.00
410.00
400.00
Elevation (NGVD)
9300.00
9500.00
9700.00
9900.00
10100.00
Distance upstream of US 15



100 year
10 year
2 year
Invert
Flat Run in Emmitsburg
and parts north - 12/89
Irishtown Rd.
Irishtown Rd.
Limit of Study
440.00
430.00
420.00
410.00
Elevation (NGVD)
10000.00
10200.00
10400.00
10600.00
10800.00
Distance upstream of US 15