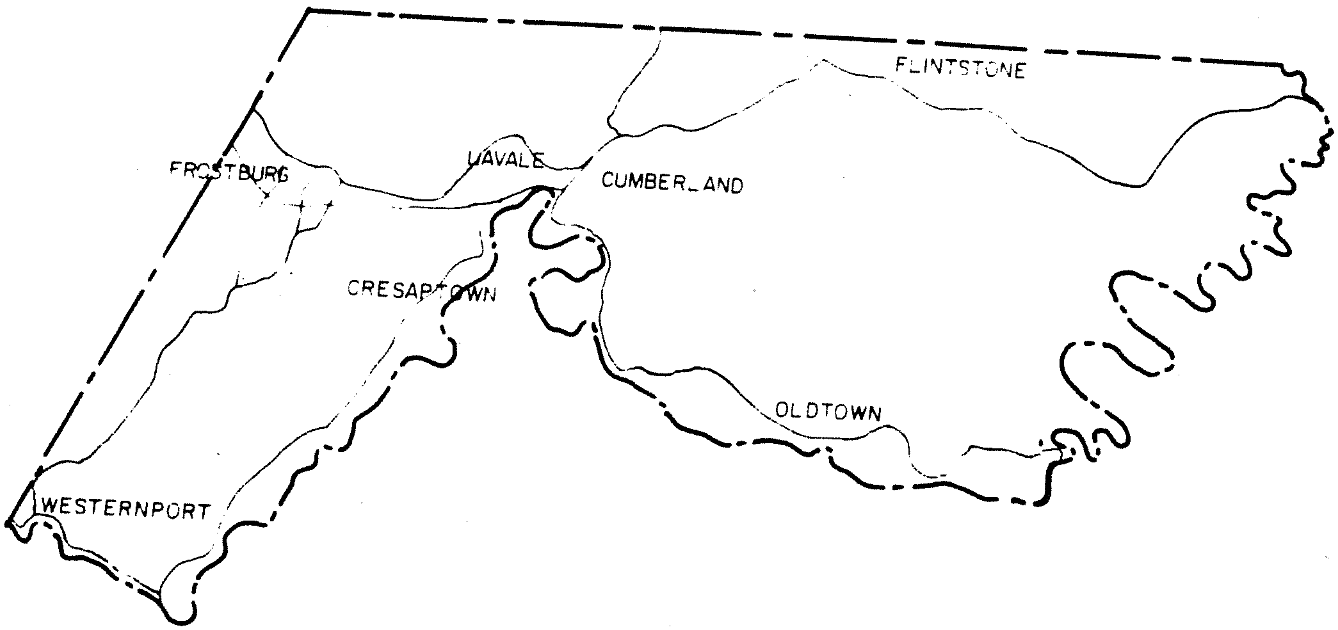
ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY
UPPER GEORGES CREEK



SEPTEMBER 1986

PREPARED FOR

WATER RESOURCES ADMIN.
MARYLAND DEPARTMENT
OF NATURAL RESOURCES

ALLEGANY COUNTY
COMMISSIONERS

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September 30, 1986

Mr. Arthur T. Bond, President
Allegany County Commissioners
County Office Building
3 Pershing Street
Cumberland, Maryland 21502

Subject: Allegany County Flood Management Study
Upper Georges Creek Watershed

Dear Mr. Bond:

We are pleased to submit herewith the final copies of the Upper Georges Creek Watershed Flood Management Study.

We accomplished the following:

(1) Developed a hydrologic (TR-20) model of the watershed for existing and planned development conditions.

(2) Developed hydraulic (HEC-2) models of the designated stream reaches.

(3) Delineated the 100-year flood hazard zone.

(4) Defined and evaluated the effectiveness of flood hazard mitigation alternatives.

(5) Prepared a report summarizing the above efforts.

Purdum and Jeschke is pleased to have had the opportunity to perform this interesting and challenging study and stands ready to assist you in the future.

Very truly yours,

PURDUM AND JESCHKE

Cay G. Weinel, Jr., P.E.
Partner

CGW/jm
Attachment

ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY

UPPER GEORGES CREEK

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ALLEGANY COUNTY

FLOOD MANAGEMENT STUDY

UPPER GEORGES CREEK

I. INTRODUCTION

The Allegany County Planning and Zoning Commission and the State of Maryland Water Resources Administration, Department of Natural Resources, have contracted Purdum and Jeschke to perform a study of the Upper Georges Creek watershed. The purpose of the study is to identify the existing flood hazard areas and evaluate measures to prevent or reduce future flood damages.

The following items have been submitted under separate cover:

1. 1" = 200' mylar subbasin overlay maps to the County topographic maps.

2. 1" = 200' mylar TR-20 schematic overlay maps to the County topographic maps.

3. 1" = 500' mylar TR-20 schematic overlay map and subbasin map.

4. Bound computational data book containing subbasin data. This includes geographic data base attribute files, HYDPAR generated Soil Conservation Service (SCS) runs, runoff curve numbers (RCN), and time of concentration (t_c) computations.

5. The hydrologic (TR-20) computer model for the watershed for existing and ultimate conditions.

6. Bound computational book for the hydraulic data. This includes survey notes, cross-section location map and plots.

7. The hydraulic (HEC-2) computer model for the watershed for existing and ultimate conditions.

8. 1" = 200' scale floodplain delineation maps.

9. Bound computations for flood dollar damage computations.

10. 1" = 600' scale floodplain delineation maps for overlay on the County Tax Maps.

CITIZENS' PARTICIPATION

Two public meetings were held to coordinate the study activities with local and state officials, the consultant, residents, and interested and/or affected organizations. On July 31, 1985, an organizational meeting was held to explain and to coordinate the study effort. At the July 16, 1986 public meeting the results of the floodplain modeling were presented, and a discussion of the possible flood hazard mitigation alternatives prior to their detailed evaluation was undertaken.

A third public meeting will be scheduled following the completion of the final report. At this meeting the detailed evaluation of the alternatives and final report will be presented.

Through the course of this study citizen participation and input has been greatly received. Information on historical flooding was obtained from flood damage survey questionnaires distributed to the residents. Valuable information was also obtained from interviews in the field and at the public meetings.

II. SCOPE OF STUDY

Purdum and Jeschke's agreement with Allegany County and the Water Resources Administration requires that the following tasks be undertaken in order to define the flood hazard areas and evaluate alternative measures.

1. Collect and review all available information, mapping, and reports pertinent to the study. Determine the acceptability and applicability of the data.

2. Field reconnaissance of the watershed and designated stream study reaches. This will include examination of existing conditions, visual inspection of channels and overbanks areas, and interviews with residents.

3. Develop a hydrologic computer model (TR-20) for the Upper Georges Creek watershed and develop peak stream flows for the 2, 10, 50, 100, and 500-year frequencies for both existing conditions and ultimate development conditions based on the current zoning maps.

4. Develop a hydraulic computer model (HEC-2) for the designated stream reaches. This will include the delineation of the 100-year floodplain.

5. Investigate flood hazard mitigation alternatives for the watershed and recommend action to alleviate flooding problems.

6. Prepare a report summarizing the computations, data, alternatives, and recommendations.

III. DESCRIPTION OF WATERSHED

A. NATURAL DRAINAGE BOUNDARIES

The Upper Georges Creek drainage area is approximately 937 acres in size and is shown in Figure 1, Vicinity Map, Appendix A. The southern boundary of the watershed touches U.S. Route 48. The new U.S. Route 36 approximates the eastern boundary of the watershed. U.S. Route 40 approximates the northern watershed boundary. Frostburg State Teachers College forms the western boundary limit of the Upper Georges Creek watershed.

B. SUBBASINS

The total drainage area of the Upper Georges Creek is divided into 12 subbasins ranging from 17 acres to 133 acres, with 78 acres the average size. Subbasins are delineated so that stream flow rates can be computed to design points in the main channel and tributary. These design points are defined at changes in channel characteristics, bridges and culverts, road crossings, and at branch tributaries.

C. SOILS

Soil Conservation Service (SCS) Hydrologic Soil Groups B, C, and D occur in the Upper Georges Creek drainage area. Ninety-five percent of the watershed contains Type C soil which has a low infiltration rate and a high runoff potential. Group B, which occurs in approximately four percent of the area, has a moderate infiltration rate and a correspondingly moderate storm water runoff rate. Soil Type D, covering only one percent of the watershed, has the lowest infiltration rate and highest runoff potential.

D. SLOPE

The watershed slopes vary considerably, ranging from two percent in low-lying areas near the main stream to ten percent in hilly areas in Frostburg, to as high as 20 percent on the edges of the watershed boundary.

E. LAND USE AND ZONING

The existing land use of the watershed was determined from field reconnaissance, aerial photographs, and existing topographic mapping. Residential and rural residential areas located in the central part of the watershed comprise 37 percent of the watershed. The southern part of the watershed consists of meadow and pastures, making up 34 percent of the land area. Wooded areas comprise 14 percent of the watershed in steeply sloped areas in the east. The remaining 16 percent of the watershed consists of colleges, schools, parks, commercial, or industrial areas.

The current zoning maps indicated that 70 percent of the watershed is zoned for residential or rural residential use. The remaining 30 percent is zoned for business and industrial use.

IV. FIELD INVESTIGATION

Field investigations were necessary to ensure proper modeling of the Upper Georges Creek watershed. The data gathered during field investigations are summarized as follows:

A. HYDRAULICS OF DESIGNATED STREAM REACHES

Field examinations were made of the designated stream reaches in the Upper Georges Creek watershed. Channel size and shape were noted in order to develop reach cross-section data for the TR-20 hydrologic modeling and for hydraulic analysis of the study reaches.

B. DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS

The main stream and Tributary No. 1, as shown on the Location Map, Figure 3, Appendix A, were examined to determine ground conditions of the channel and overbanks. Existing ground conditions were recorded on 1" = 200' scale Allegany County topographic maps. Photographs were taken at various points along the streams to document field conditions. This information was used to determine the Manning's roughness coefficients for the HEC-2 model flood depth calculations.

The procedure to estimate roughness coefficients is described in the Guide for Selecting Roughness Coefficient 'n' Values for Channels (SCS Manual TR-24). It involved selecting a base roughness coefficient and adding modifying values that reflect: (a) degrees of surface irregularity, (b) variation of shape and size of cross-section, (c) obstructions, (d) vegetation, and (e) meandering of channel within the floodplain. Photographs with assumed roughness coefficients were compared to similar photographs appearing in SCS Manual TR-24 and in Roughness Characteristics of Natural Channels (Geological Survey Water Supply Paper 1849).

C. EXAMINATION OF STRUCTURES

All structures along the main stream and tributary were examined for evidence which might aid in better computer modeling. High water marks identified by debris suspended from the underside of a structure or along the brush on the stream banks indicated frequent flooding and provided insights into the hydraulic performance of the structure. Identification of likely flow paths for overtopping floods helped to later define the weir cross-section as well as other hydraulic modeling data for bridges and culverts.

D. STUDY METHOD DETERMINATION

From field investigations of the stream reaches and with the aid of existing topographic mapping, a determination was made as to which study method should be used to analyze each particular stream reach. The stream reaches were studied by either a detailed HEC-2 computer model or by other computational methods.

The HEC-2 computer model was used on stream reaches where a gradually varied flow condition and relatively similar cross-section existed. For these reaches, the surveying services of SPECS, Inc. of Cumberland, Maryland were used to obtain surveyed stream cross-sections, bridge and culvert measurements, and house first floor elevations.

In the Upper Georges Creek watershed the main stream was studied using the HEC-2 computer program.

Computational methods such as Manning's equations, culvert headwater nomographs, and capacity charts were used for those stream reaches exhibiting any of the following characteristics:

1. The majority of the reach was a closed storm drain system.

2. The reach consisted of roadside ditches with culverts crossing under the streets.

3. The reach was a steep sloped swale which conveyed water only during flood events.

4. The reach was located in areas which were undeveloped and where flood damages were unlikely to occur.

In the Upper Georges Creek watershed, Tributary No. 1 met the above criteria.

E. DISTRIBUTION OF QUESTIONNAIRES

Questionnaires were distributed during the field reconnaissance to residents living adjacent to the stream reaches. The questionnaires were designed to obtain information on past flooding events. Questions asked included: the number of years in residence, type of home, dates of most severe flood events, depth of flooding in basement or first floor, and known high water marks inside or outside of the home.

A copy of the questionnaire is found in Appendix C of this report. There was a 31 percent response from the questionnaires distributed. No first floor flooding was reported by any of the responses but some basement flooding was reported. The backup of sewers and drains was frequently mentioned.

V. COMPUTER APPLICATIONS

The use of microcomputers for digital mapping, automated computation of hydrologic parameters, and hydrologic and hydraulic computations greatly reduced the volume of manual work normally associated with watershed studies of this size. All applications were performed on an IBM PC with peripheral equipment including hard disk storage, digitizer, and color monitor.

A. DIGITAL MAPPING - GEOGRAPHIC INFORMATION SYSTEM

The Aeronca Electronics Geographic Information System (AE-GIS) was used to store, display, and analyze map data which included watershed boundaries, subbasins, existing land use, zoning classifications, Soil Conservation Service (SCS) soil types, and stream reaches. The microcomputer based AE-GIS stores map data as well as any form of demographic data in grid cell form based on any cell size and reference data. For the Upper Georges Creek watershed, a cell size of 50 feet by 50 feet (0.06 ac.) was selected as an appropriate size for calculation of hydrologic parameters for subbasins as small as 17 acres. The reference datum selected was the Maryland State Plane Coordinate System.

B. IDENTIFICATION OF LAND COVER

Existing land cover identification was made from Allegany County 200-foot-scale topographic maps with updates from field observations and 1982 aerial photographs from the Soil Conservation Service. Ultimate land cover was determined from Frostburg zoning maps. Land cover was classified into one of the following eight land cover classes: Wooded, Parks/Schools, Rural Residential, Residential, Commercial, Industrial, Meadow/Pasture, Water.

C. AUTOMATED COMPUTATION OF HYDROLOGIC PARAMETERS

Hydrologic parameters were computed by using HYDPAR, a program module added to the AE-GIS software. Utilizing the grid cell data bases created for soil types, land use, zoning, and subbasins; the HYDPAR program computes the runoff curve numbers (RCN) and area for each of the nine subbasins. RCN values were computed for existing and ultimate conditions. The RCN value for each subbasin is shown in the Drainage Area Summary, Table 1 in Appendix B.

D. WATERSHED HYDROLOGIC MODELS USING SCS TR-20

1. Description of TR-20 Model

The U.S. Department of Agriculture SCS program, TR-20 (1983 version), was used to model hydrology in the Upper Georges Creek watershed. This program uses the SCS runoff and unit hydrograph procedure, stage-discharge reservoir routing, and modified attenuation-kinematic routing procedure to generate stream flow rates at all design points along the main stream and tributary.

2. Times of Concentration

Times of concentration were determined by charting flow paths on Allegany County topographic maps with divisions for overland flow (forest, open, urban, or combined), swale or ditch flow, and stream flow. Velocities were obtained from:

Figure 3-1, SCS, Urban Hydrology for Watersheds, TR-55.

Figure SHA-61.1-402.2, Maryland State Highway Administration, Highway Drainage Manual, December 1981.

3. Reach Cross-sections

In order to route the runoff hydrographs through stream reaches, discharge-end area tables were input into the TR-20 model. The discharge-end area tables were developed by running multiple flows through the reaches using the HEC-2 computer program. Channel cross-section shapes and roughness coefficients for HEC-2 input were determined during field investigations.

4. Rainfall

The standard SCS Type II 24-hour rainfall storm distribution with a rainfall increment of 0.25 hours and a main time increment of 0.10 hours was initially used in the TR-20 modeling. The results of the modeling showed that the reach routings were defaulting, and no attenuation of flow was occurring due to the main time increment size. A smaller main time increment could not be used with this rainfall table because of the limiting value in the TR-20 program of 300 points per output hydrograph. This was not sufficient to obtain the peak flows for some subbasins.

A portion of the standard SCS Type II 24-hour rainfall distribution from hour 7.5 to 13.5 with a rainfall increment of 0.10 hours was used in the final modeling. This rainfall table allowed the use of a main time increment of 0.02 hours. The output hydrographs began at 7.5 hours because there is no runoff from hour zero to 7.5 hours. The peak flows for all subbasins were obtained within the 300 point limit of the program. The reach routings now were attenuating all flows.

5. Flow Comparison

The estimated 100-year frequency storm discharges for gaged streams of similar size watersheds in Allegany and the three neighboring counties of Frederick, Carroll, and Washington was obtained from the U.S. Geological Survey. The discharge versus drainage area was plotted for the gaged streams and is presented as Figure 2 in Appendix A. An upper and lower limit line was drawn for the gage data for the four counties along with a separate upper limit line for Allegany and Washington Counties. The 100-year discharge for existing development from the TR-20 model of the Upper Georges Creek watershed is shown as Point Number 2 on this plot.

The TR-20 discharge is above the upper limit line for all four counties indicating that the TR-20 modeling is predicting higher 100-year flood discharges than would be expected based on stream gage data. Changing the TR-20 model watershed parameters within reasonable engineering limits could not produce discharges that were compatible with the regional gage information. This fact led to the examination of the standard Type II rainfall distribution. The Type II rainfall distribution contained rainfall intensities that were higher than what has been experience in the Allegany County area.[1] Input of the lower intensity rainfall into the TR-20 model produced 100-year frequency discharges which fall within the upper and lower limits of the regional gage data. The Type II rainfall distribution is required by the State regulations.

The discharges from the TR-20 model were also compared to the discharges from the Allegany County Flood Insurance Study prepared by the Federal Emergency Management Agency (FEMA). The discharges from the TR-20 model are higher than those generated in the FEMA study.

E. HYDRAULICS

1. Description and Input Data Requirements

The HEC-2 program is designed to model the stream hydraulics. The program will compute the water surface profile, flow velocities, energy gradient, and friction losses. Additionally, it will accommodate hydraulic structures such as bridges, culverts, weirs, and any combination of flow through or over these structures. Input information used in programming HEC-2 includes cross-section geometry, Manning's roughness coefficients,

[1] Maryland Department of Transportation, State Highway Administration, Highway Drainage Manual, Table S.H.A. - 61.1-403.1, December 1981.

stream flow rate, and minor losses due to expansion and contraction of the cross-sectional areas.

Peak discharges for the 2, 10, 50, 100, and 500-year frequency storms for both existing and ultimate land use, developed by the TR-20 models, were programmed into HEC-2. Water surface profiles were calculated for each frequency storm.

2. Accuracy of HEC-2

The accuracy of any computer model is, in part, dependent on the basic assumptions inherent in the modeling technique. The HEC-2 computer program is a one-dimensional model based on the assumption of steady, gradually varied flow. The accuracy of the model is partially dependent on how closely the prototype conforms to these basic assumptions. As a general rule, the steady gradually varied flow assumption yields good results for streams with gentle slopes (10 percent or less) and relatively constant cross-sections. The main stream of Upper Georges Creek meets both of these requirements.

The other factors affecting the accuracy of the HEC-2 model are as follows:

a. Stream flow rate and variation along length of reach.

b. Manning's roughness coefficient for determining resistances to flow from channel and overbank surfaces.

c. Stream geometry - such as cross-sectional form and channel slopes.

The flow rates at design points along the length of the stream are computed by using the Soil Conservation Service computerized hydrograph method for runoff determination (TR-20) as described previously.

The assignment of Manning's roughness coefficients were chosen by applying data from careful field observation to the techniques presented in SCS publication, TR-24. Several roughness coefficients were chosen for each cross-section in the study areas.

Stream geometry is defined by locating cross-sections along the stream. The impact each cross-section has on the model is dependent on the distance between cross-sections. Sections were chosen where it was necessary to describe changes in cross-section shape, channel or overbank roughness coefficients, channel slope, or in flow rate at a location of stepped increase. Cross-section information was obtained from field surveys performed by SPECS, Inc. of Cumberland, Maryland.

3. Development of HEC-2 Models

The HEC-2 models were developed in two steps. First, all bridges were analyzed individually to determine the best HEC-2 modeling application. Second, each reach between the structures was analyzed to determine general stage-discharge and flow regime characteristics which aided in development of the final stream model.

4. Structures

Each of the structures in the detailed study areas was analyzed separately to determine which of the following two techniques would provide the most accurate model for use in the final HEC-2 programs.

a. Calculating the energy loss using the HEC-2 normal bridge routine.

The normal bridge routine handles a bridge cross-section in the same manner as a natural river cross-section with the following exception. The area of the bridge structure that is below the water surface is subtracted from the total area, and the wetted perimeter is increased where the water is in contact with the bridge structure. This routine is most applicable when friction losses are the predominant consideration.

b. Calculating the energy loss using the HEC-2 special bridge routine.

The special bridge routine computes losses through the structure for either low flow (water surface below low chord of structure), pressure flow (water surface above low chord of structure), weir flow (flow around bridge and/or over bridge deck), or for a combination of these. The profile through the bridge is calculated by using hydraulic formulas to determine the change in energy and water surface elevation through the bridge. Although this technique is capable of solving a wide range of flow problems, it is most applicable for structures operating under pressure flow conditions with road embankments having well-defined weir surfaces.

c. In this study the Welsh Hill Road, the Trailer Park Road, Troutmans Lane, Powells Lane, and Glenn Street were modeled with the normal bridge routine. The abandoned railroad structure and the Grant Street culvert were studied by the special bridge routine.

VI. STREAM STUDY REACHES

A. DESCRIPTION OF STREAM STUDY REACHES

The stream reaches studied in this watershed are described below and are depicted on Figure 3, Location Map, in Appendix A.

1. Main Stem

The main stem of the Upper Georges Creek begins at the stormwater management pond at the Frostburg Shopping Center. The outfall from the pond empties into the closed storm drain system which flows in a westerly direction through the Beall High School ball field and track area. The system then turns south at the tennis courts and outfalls into an open channel section west of the school property. The stream continues in a westerly direction flowing in a culvert under Green Street and Route 936 (Grant Street). At this point the main stream confluences with Tributary No. 1. The main stream turns to flow in a southwesterly direction down to the confluence with Sand Spring Run. There are five road crossings and one abandoned railroad crossing in this stretch. The stream is 8,230 feet long with an average slope of one percent.

2. Tributary No. 1

Tributary No. 1 begins at the south entrance of the abandoned C & P railroad tunnel. The stream flows in a southerly direction through the Bowery Street old railroad bridge and enters a culvert which outfalls at the power station on Grant Street. An open channel then exists from here to the confluence with the main stream. This tributary is 2,200 feet long with an average stream slope of 1.7 percent.

B. MANNING'S ROUGHNESS COEFFICIENT

Manning's roughness coefficients average 0.06 for the channel section of the streams. A value of 0.06 for lawns, 0.07 for high grass and shrubs, and 0.10 for wooded areas was used in the overbank areas.

C. STRUCTURES

Ten culvert structures were identified within the stream study reaches and were examined in the field. The size of each was determined from either field surveys or from field reconnaissance as indicated on Table 2, Appendix B.

D. IDENTIFICATION OF FLOOD HAZARDS

The water surface elevations for the 2, 10, 50, and 100-year frequency storms were developed for both existing development conditions and ultimate development conditions, based on the current zoning maps. The elevations are presented in Table 3, Appendix B. The water surface elevations for ultimate conditions showed an average increase of less than 0.5 foot over existing conditions. Hence, the full development of the Upper Georges Creek watershed based on the current zoning maps will show little change from the existing flooding conditions. Existing flooding conditions can, therefore, be said to equal the ultimate flooding conditions.

The water surface profiles for the 2, 10, and 100-year frequency storms, existing conditions, are shown in Appendix D. The water surface profiles also depict the first floor and basement elevations of flooded structures in the floodplain. These have a letter and/or number code. The bridges and culverts within the study reaches are also shown on the profiles.

The delineation of the 100-year flood zone, ultimate conditions, is presented in Appendix E. A description of the flooding conditions on each study reach is given below.

1. Main Stream

The 100-year floodplain of Upper Georges Creek from the confluence of Sand Spring Run to Welsh Hill Road varies in width. The width is approximately 150 feet at Welsh Hill Road and expands to 700 feet at the confluence. Only one house (AF) is subject to flood damage in this reach of stream, and it will experience first floor flooding. The flooding in this reach is the natural floodplain of the stream; that is, not caused by any obstruction or restriction.

The floodplain from Welsh Hill Road to the trailer park road is approximately bounded by the railroad embankment on the north and Route 936 on the south. In this reach of stream the 11 trailers (typical trailers AG and AH) in the trailer park, seven homes (4, 5, 6, 13, 17, 18, and 19), and two concrete block garage structures (21, 23) will receive first floor flooding. Nine other homes (1, 2, 3, 7, 8, 14, 15, 20, and 22) will receive basement flooding and three (9, 10, and 16) will receive flooding around the foundation of the home. The flooding is caused by the backwater from Welsh Hill Road and the abandoned railroad. Both are overtopped by the 100-year storm.

The floodplain from the trailer park to Route 936 averages 300 feet in width. In this reach eight homes (AJ, AN, AN-1, AN-5, AN-8, AN-11, AQ and AP) will experience first floor flooding from the 100-year storm. There are 12 homes (AK, AL, AM, AN-2, AN-3, AN-4, AN-6, AN-9, AN-12, AO, AR, and AS) which will experience basement flooding and four homes (AI, AN-7, AN-10, and AT) which will experience foundation flooding. All three roads in this reach, Troutman's Lane, Powells Lane, and Glenn Street are overtopped by the 100-year storm. The floodplain occupies the low area adjacent to the stream. The three roads do not cause significant backwater to aggrevate the flooding conditions.

The remaining reach of the floodplain on the main stem goes from Route 936 to the Beall High School property and averages 200 feet in width. There will be no structural or contents damage to homes in this reach; however, there will be flooding to the properties in the trailer park (typical trailer AV) above Green Street. Green Street will be overtopped by the 100-year storm, but the backwater does not increase the flooding situation. This flooding in this reach is confined to the low areas adjacent to the stream.

A closed storm drainage system drains the runoff from the Beall High School property. The track and ball field area has experienced flooding in the past due to an undersized drainage system.

2. Tributary No. 1

The 100-year floodplain from the south entrance of the C & P Tunnel to Bowery Street averages 35 feet in width. The floodplain is confined to the old railroad right-of-way. No flood damage occurs in this reach of stream.

Below Bowery Street the flood waters enter a culvert which discharges at the power station. The culvert cannot convey all the flood waters, and the overflow will be directed to the rowhouses at the end of Hill Street. These homes may experience some foundation flooding due to this overflow.

The floodplain from the power station to the confluence with the main steam averages 50 feet in width. Two homes (AX and AY) in this reach will experience basement flooding due to the closeness of the homes to the stream.

E. FLOOD ZONE COMPARISON

The FEMA Flood Insurance Study presents a 100-year flood zone for Upper Georges Creek from the confluence with Sand Spring Run to the Frostburg city limits. The flood delineation of this study are similar to the FEMA study. The flood elevations are approximately 0.5 to 1.5 feet higher than the FEMA 100-year flood elevations.

VII. ESTIMATED FLOOD DAMAGE COSTS

The dollar damages that would be caused by a 2, 10, and 100-year storm were estimated. These damages consisted of public and private sector damages as well as abstract losses described below. The damages computed for these three storms were converted to an average annual flood damage cost. This is the amount of dollar damage that can be expected to occur on the average every year. The purpose of computing the average annual flood damage cost is to enable comparison with the annual cost of flood mitigation alternatives or projects. The average annual flood damage costs were converted to a single present value based on a nominal interest rate for a 30-year period. This present value represents the maximum expense that could be justifiably spent at today's dollars to alleviate all the flood damages. Spending this amount of money on improvements may not remove all flood damages.

A. PRIVATE SECTOR DAMAGE COSTS

Three types of flood damage costs are computed to determine the private sector losses. These costs consist of flood damages to the home and its contents, damage to exterior property, and damage to vehicles.

Flood damage losses for private homes are dependent on the depth of flood water within the home, the value of the home, and the value of its contents. The average value of each home and its contents are estimated based on the method found in the Corps of Engineers' Institute for Water Resources, Pamphlet No. 4 titled, "Cost Report on Non-Structural Flood Damage Reduction Measures For Residential Buildings Within the Baltimore District" (Reference 1).

The base structural value of a home is determined from the type of home, the structural composition, and type of foundation. Table III-2, shown in Appendix C, taken from Reference 1, gives a high and low base structural value of a home. This table reflects a seven percent annual inflation adjustment. Base value adjustment factors are used for location, quality of construction, condition of house, and size according to the age of the house. Table III-4, Appendix C, is used with the low base value of the home for structures over 25 years in age. Table III-5, Appendix C, is used with the high base value of the home for newer structures less than 25 years in age. The adjusted base values of the homes in the floodplain ranged from $39,000 to $68,000. The adjusted base value for trailers averaged $22,000.

The value of the contents of a home is based on the square footage of the first floor, shown in Table 2-5, Appendix C, taken from the Corps of Engineers "DAPROG2, Flood Damage Assembly Computer Program" (Reference 2). The values on this table also reflect a seven percent annual inflation adjustment. The average contents value of the homes and trailers within the study area ranged from $18,000 to $21,000.

The dollar damage to the home and its contents is based on the flood depth of the 2, 10, and 100-year frequency storms determined from the flood profiles and floodplain delineation. The computed flood depth is referenced to the first flood level (Stage Zero). Flood stage above the first floor is indicated by a positive value while flood stage below the first floor (basement flooding) is a negative value. The percent damage to the structure and its contents is based on this flood stage. The percent damage is determined from Table 5, Appendix C, taken from Reference 1. These percentages are multiplied by the house and contents values determined above to determine the dollar damages. Damages are calculated in this manner for the 2, 10, and 100-year frequency storms.

A clean-up cost for exterior flood damage is estimated for each property. This includes removal of debris left by the storm and repair of lawns and plantings. Also, an estimated cost to repair or replace damaged fences and sheds and their contents is included in the exterior property damages.

The final item considered under private sector losses is vehicular damages. One car per household is used for damage cost calculations.

The total private sector losses for the watershed are shown in Table 4, Appendix B, for existing conditions and Table 5, Appendix B, for ultimate conditions.

B. PUBLIC SECTOR DAMAGE COSTS

Public sector losses are computed for emergency police service to assist residents and divert traffic from flooded roadways, city clean-up services within the public rights-of-way, and private utility clean-up services.

The estimated cost of emergency police service includes one police car and two policemen for each flooded intersection. For the 2 and 10-year storms, one-half day of service is estimated. One day of service is estimated for the 100-year storm. The cost of a police car is based on a rental vehicle rate of $50 per day. The wages for a police officer is estimated to be $120 per day.

The clean-up costs of public road rights-of-way includes the labor and equipment costs for the community maintenance crews. It is estimated that a dump truck and a front-end loader would be the minimum equipment required to load and haul debris left by a storm. A rental rate of $44 and $54 per hour is used for the dump truck and front-end loader, respectively, which includes the cost of the equipment and driver. Laborers are also needed to pick up and clean up the debris prior to being handled by the equipment. It is estimated that two laborers would be required for one day to clean up the debris from a 2-year and 10-year storms. The 100-year storm would require four workers for two days of clean-up. The average wage cost is estimated at $10 per hour.

Estimated costs are also made for private utility clean-up and repairs. Lump sum estimates of $300 per day are used for telephone and electrical clean-up. This amount includes the cost of equipment and manpower. The 2-year and 10-year storms require one day of clean-up for each utility. The 100-year storm requires two days for telephone and gas and electric utilities.

The total public sector losses for the study area for existing and ultimate conditions are shown in Tables 4 and 5 of Appendix B.

C. ABSTRACT LOSSES

Flood damage costs are computed for a loss of income to homeowners who will take time off from work to clean their home and property after a storm.

The loss of income to homeowners is based on the days off from work and the average daily wage earned per household. The clean-up times estimated for the 2, 10, and 100-year storms are one, one, and two days, respectively. The number of flooded households is determined for each storm from the flood delineation maps. An average wage of $15 per hour ($120 per day) per household is multiplied by the days out of work and then by the number of households. The results are also shown in Tables 4 and 5 of Appendix B.

D. AVERAGE ANNUAL FLOOD DAMAGE COST

The total dollar damages for the private, public, and abstract losses are added together for the 2, 10, and 100-year storms. The computational method presented by the Corps of Engineers in "Computations of Expected Annual Damages" is used to convert the total dollar damages for the 2, 10, and 100-year storms to average annual damages (Reference 3). The average annual flood damages are costs that would occur every year on the average. The average annual damages for Upper Georges Creek for existing and ultimate conditions is $484,000 and $508,000, respectively.

E. PRESENT VALUE OF AVERAGE ANNUAL FLOOD DAMAGE COST

The amount of money you would need to have in the bank today at a nominal interest rate of 8 percent which would pay average annual flood damage costs every year for the next 30 years is called the present value of the average annual flood damages.

The present value of the flood damages can be estimated based on the calculated annual flood damages and a discount rate of eight percent. The present value is a lump sum equivalent to an unending annual series of payment or, in this case, losses. A discount rate of eight percent is customarily used for flood protection projects. It represents the relative value of money today compared to money in the future. The inflation rate can be ignored since it will not affect the calculations.

The present value of the average annual flood damages for Upper Georges Creek is $5,400,000 and $5,700,000 for existing and ultimate conditions, respectively.

These dollar values represent the maximum amount of money that could be spent on improvements. However, spending this amount of money may not eliminate all flood damages. There still may be residual damage costs.

VIII. FLOOD MANAGEMENT ALTERNATIVES

A. PRELIMINARY ALTERNATIVES SCREENING

The initial investigation of flood hazard mitigation alternatives involved a screening of possible alternatives to determine which measures may be applicable to the watershed. Both structural and non-structural measures were considered. Structural improvements involve construction in the floodplain to reduce damages, while non-structural considerations are plans and policies to control effects of flood damage without altering the floodplain itself. A combination of structural and non-structural measures are often utilized in flood mitigation projects. The following is a list of alternatives that were considered:

Structural Improvements:

(1) Bridge and culvert replacement
(2) Retention structure
(3) Detention structure
(4) Stream relocation
(5) Stream enclosure
(6) Levees
(7) Flood walls
(8) Channelization
(9) Foundation raising
(10) Floodproofing

Non-Structural Considerations:

(1) Acquisition
(2) Flood insurance
(3) Flood warning system
(4) Zoning and land use runoff characteristics and regulations
(5) Stormwater management regulations

Each of the above alternatives was evaluated for feasibility within the watershed, and a preliminary list of applicable alternatives was compiled. A meeting was held between the representatives of the Consultant, Allegany County, and the Water Resources Administration to review the preliminary list of alternatives, and a final list of improvement alternatives was developed for a more detail analysis.

B. COST BENEFIT COMPARISON

In order to assess the economic efficiency of each of the floodplain management mitigation alternatives, projects costs, and benefits were determined. Project costs as defined in this study are labor, equipment, materials and construction costs, operation and maintenance costs, and administration costs. Benefits are defined as reduction in areas of physical damage, emergency costs, and income losses. The project cost and benefits are compared on a present value basis. When project costs exceed benefits, it is an indication that the alternative is not economically justifiable.

C. PROPOSED FLOODPLAIN MITIGATION ALTERNATIVES

1. Welsh Hill Road and Abandoned Railroad

The abandoned railroad bed backs the flood waters up behind it beyond the trailer park. The tracks are no longer in use and have been removed. It is proposed that the railroad twin culverts be removed and the embankment be cut away as shown in Figure 4, Appendix A. In conjunction with this improvement, the Welsh Hill Road box culvert just downstream should be replaced by two 11' by 8' concrete box culverts. The sizes are based on a 10-year design storm. The reduction in the 10-year floodplain limits are shown in Figure 5, Appendix A. The limits of the 100-year floodplain existing and with the proposed improvements are shown in Figure 6, Appendix A. The total project costs for these improvements would be $87,000. The reduction in the present value flood damage costs would be approximately $2,800,000. The reduction is due to the lowering of the flood elevations to the 23 homes and trailer park in this reach.

2. Glenn Street

The Glenn Street culvert is overtopped by all storm flows. The 2-year design would require three 60-inch RCP culverts to prevent the water from overtopping the street. The 10-year design would require five 72-inch RCP culvert. Five culverts are not feasible to be placed under the road, so only the 2-year design was considered. The lengths of the culverts were extended downstream beyond House AO. The cost of this improvement would be approximately $52,000. The reduction in the present value flood damages cost would be $46,000. A bridge or box culvert would not be feasible in this area due to the closeness of the homes.

3. Stream Adjacent to Houses AX and AY

The residents at Houses AX and AY have complained about swift stream flows and the danger of children being carried away. An improvement to enclose the stream with two 48-inch RCP culverts for a 100-foot stream length between House AY and AX is proposed. The cost of this improvement would be approximately $30,000. The reduction in the present value flood damages cost would be approximately $20,000. Piping is the only feasible alternative.

4. Beall High School

To reduce the flooding in the Beall High School ball field and track area, an additional parallel storm drain system is proposed as shown in Figure 7, Appendix A. The system proposed is for a 10-year storm design and will consist of a 60-inch RCP approximately 1,000 feet in length. Two inlets will be located in the ball field and track area to catch the runoff and any overflow of the existing system. The system will discharge into the open channel west of the school property. The estimated construction cost for this system is $290,000.

No existing flood damage costs were computed at Beall High School, because no structures would be affected and only nuisance flooding would occur to the track and ballfield area. Therefore, no reduction in the flood damage costs would be experienced by this improvement.

5. Troutmans and Powells Lane

The replacement of the Troutsmans and Powells Lane culverts does not significantly reduce the flood levels to be economical. This entire vicinity is a low, flat area adjacent to the stream.

Six houses (AJ, AN, AN-1, AN-5, AN-8, AN-11) recieve first floor flooding. Four houses (AI, AL, AM, AN-10) will have more than one foot of depth around their foundation or basement. All ten structures are candidates for the purchase option. However, purchasing these ten homes will tend to break up the neighborhood environment. In lieu of purchase, the homeowners should purchase flood insurance and practice floodproofing methods to protect against flood losses. This will keep the neighborhood atmosphere intact.

6. Green Street

The overflow of the Green Street culverts is dependent on the downstream flood elevations. Replacement of the Green Street culverts to prevent overtopping of the road would not be possible without major channel improvements downstream to reduce the tailwater elevation on any new culverts. The flooding that exists now will vary from a few inches to as high as one foot. The only alternative in this area may be the placement of a flood warning sign along the road. One home (AU) is effected by flooding in this area, and it will experience shallow property flooding.

7. Tributary No. 1 Culvert

The runoff which cannot be conveyed by the 36-inch RCP culvert on Tributary No. 1 will flow toward the townhouses at the end of Hill Street. Although no damages other than foundation wetting may be experienced by the townhouses, future development should consider the safe conveyance of this water.

IX. RECOMMENDATIONS

Table 6 of Appendix B lists the proposed flood mitigation alternatives for the Upper Georges Creek watershed.

The replacement of the Welsh Hill Road culvert and the removal of the old railroad culverts and embankment are economically justified. It is recommended as the first priority for improvement alternatives.

Three homes in this area will still be susceptible to first floor flooding after the structural improvements are made. These three homes (AF, 17, 18) are recommended as purchase candidates. Two homes will have more than one foot of flooding around the structure. These two homes (4, 6) are also recommended for the purchase option due to the access problem during flood conditions. Eight structures (3, 5, 7, 13, 14, 19, 21, 23) in this area will still be required to obtain flood insurance and/or floodproof their homes to further mitigate their losses. Structures 21 and 23 are garage structures.

The trailer park will experience reduced flood depths; however, flood insurance will still be required to cover any flood damage.

There are ten structures in the vicinity of Troutmans and Powells Lane which are candidates for the purchase option. It is recommended that the homes in this area not be purchased so that the neighborhood atmosphere remain intact. All homeowners should purchase flood insurance and practice the floodproofing methods.

Two homes (AO, AP) on Glenn Street are recommended for purchase because of an access problem during flooding. Similarly, House AY is also recommended for purchase.

Some measures for floodproofing are the following: clearing basement of items subject to water damage, permanent blocking of basement openings, providing a sump pump, and waterproofing of exposed interior and exterior walls.

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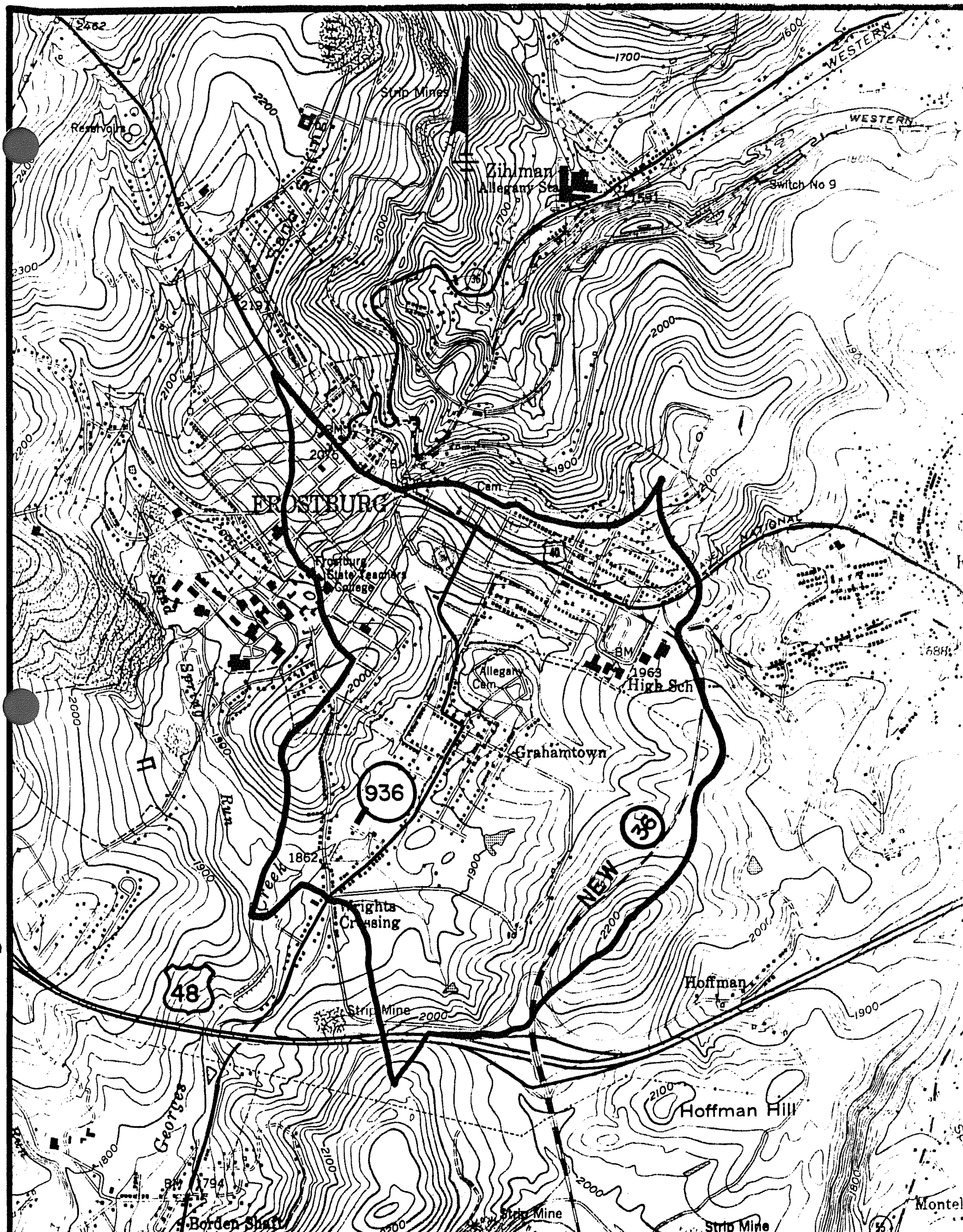
APPENDIX A - FIGURES



PURDUM & JESCHKE
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1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202

UPPER GEORGES CREEK WATERESHED

VICINITY MAP

2000 0 2000

SCALE: 1" = 2000'

FIGURE 1

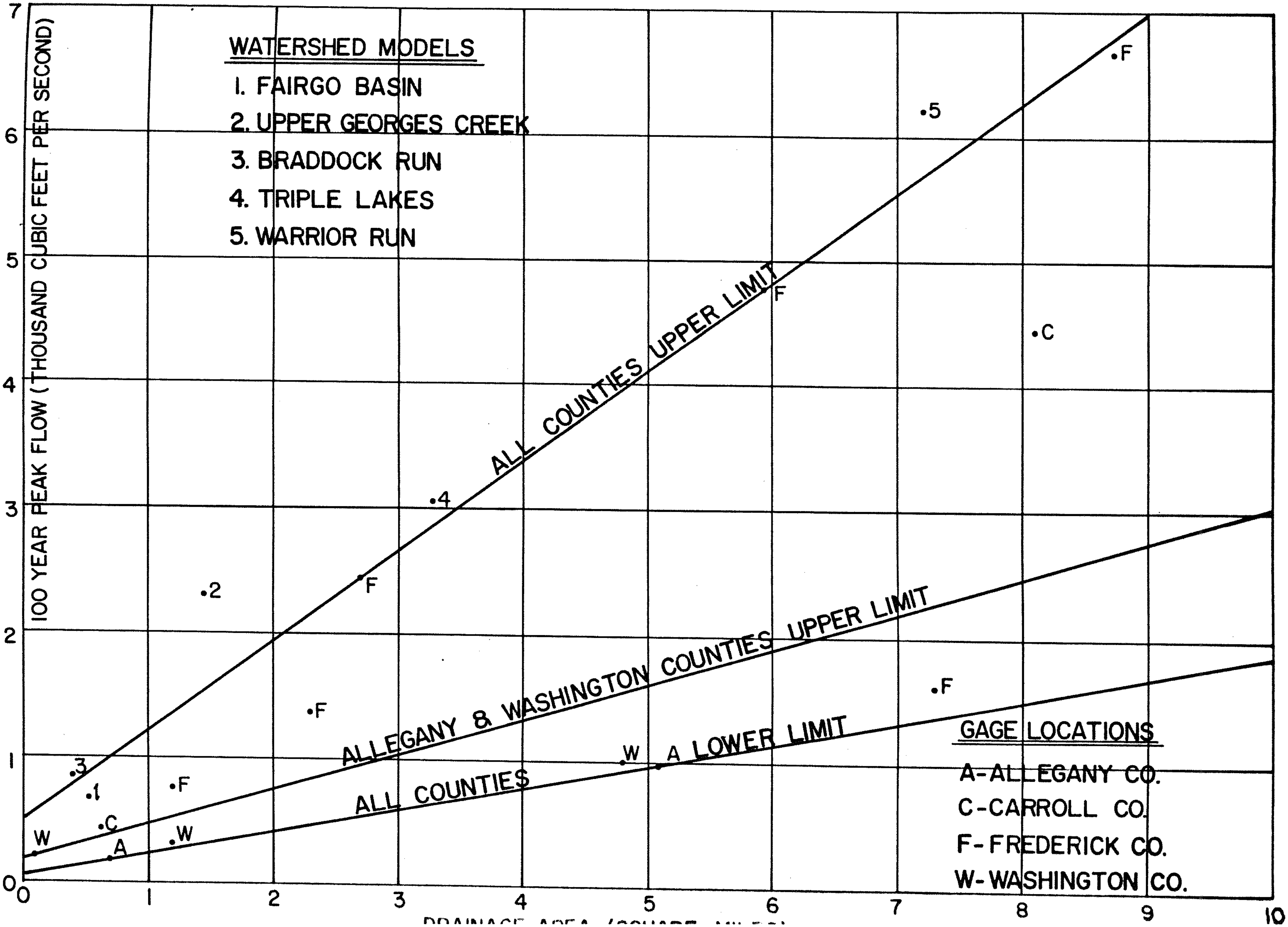

100 YEAR PEAK FLOW (THOUSAND CUBIC FEET PER SECOND)
WATERSHED MODELS
1. FAIRGO BASIN
2. UPPER GEORGES CREEK
3. BRADDOCK RUN
4. TRIPLE LAKES
5. WARRIOR RUN
ALL COUNTIES UPPER LIMIT
ALLEGANY & WASHINGTON COUNTIES UPPER LIMIT
ALL COUNTIES LOWER LIMIT
GAGE LOCATIONS
A-ALLEGANY CO.
C-CARROLL CO.
F-FREDERICK CO.
W-WASHINGTON CO.

FIGURE 2

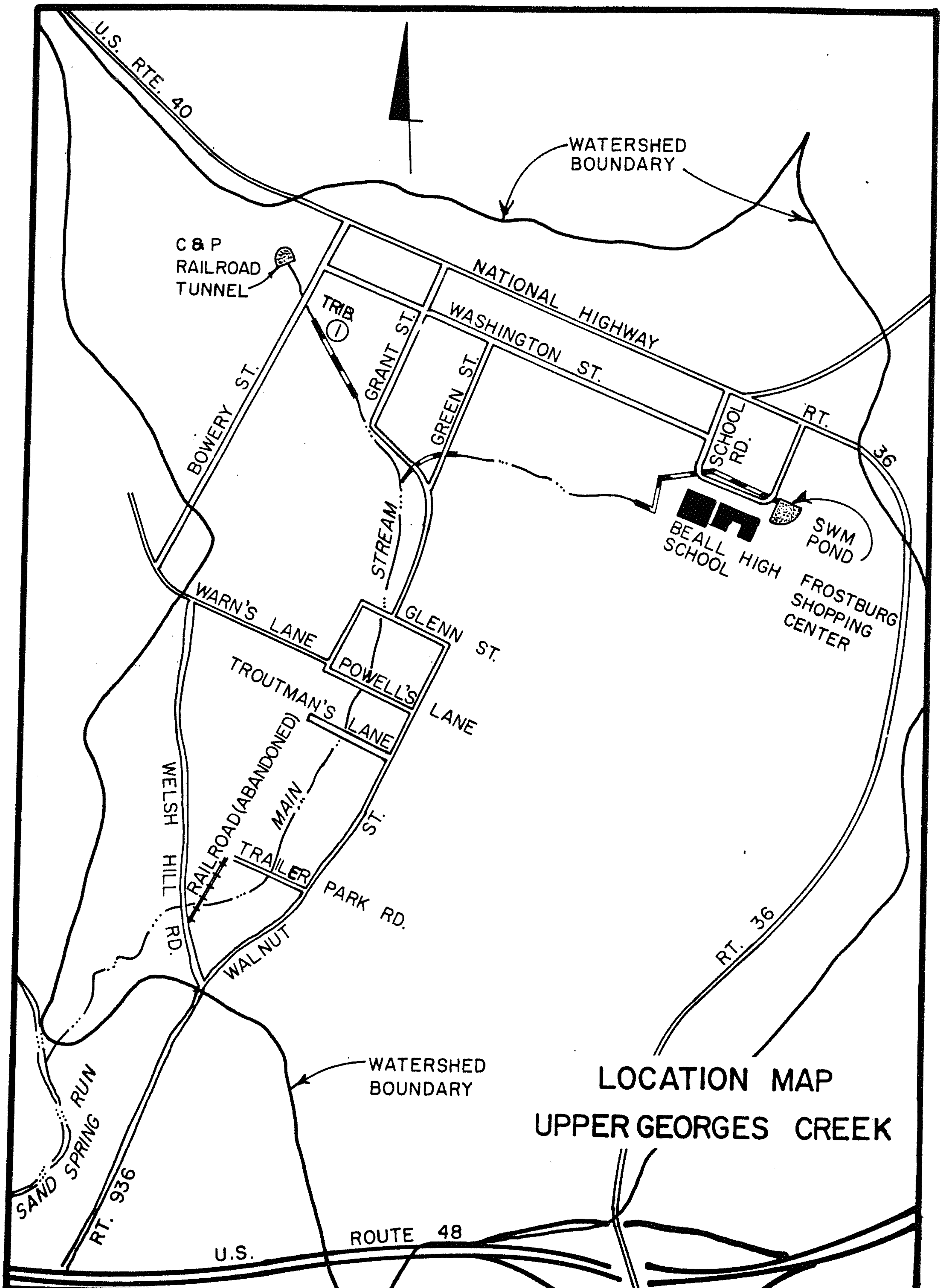
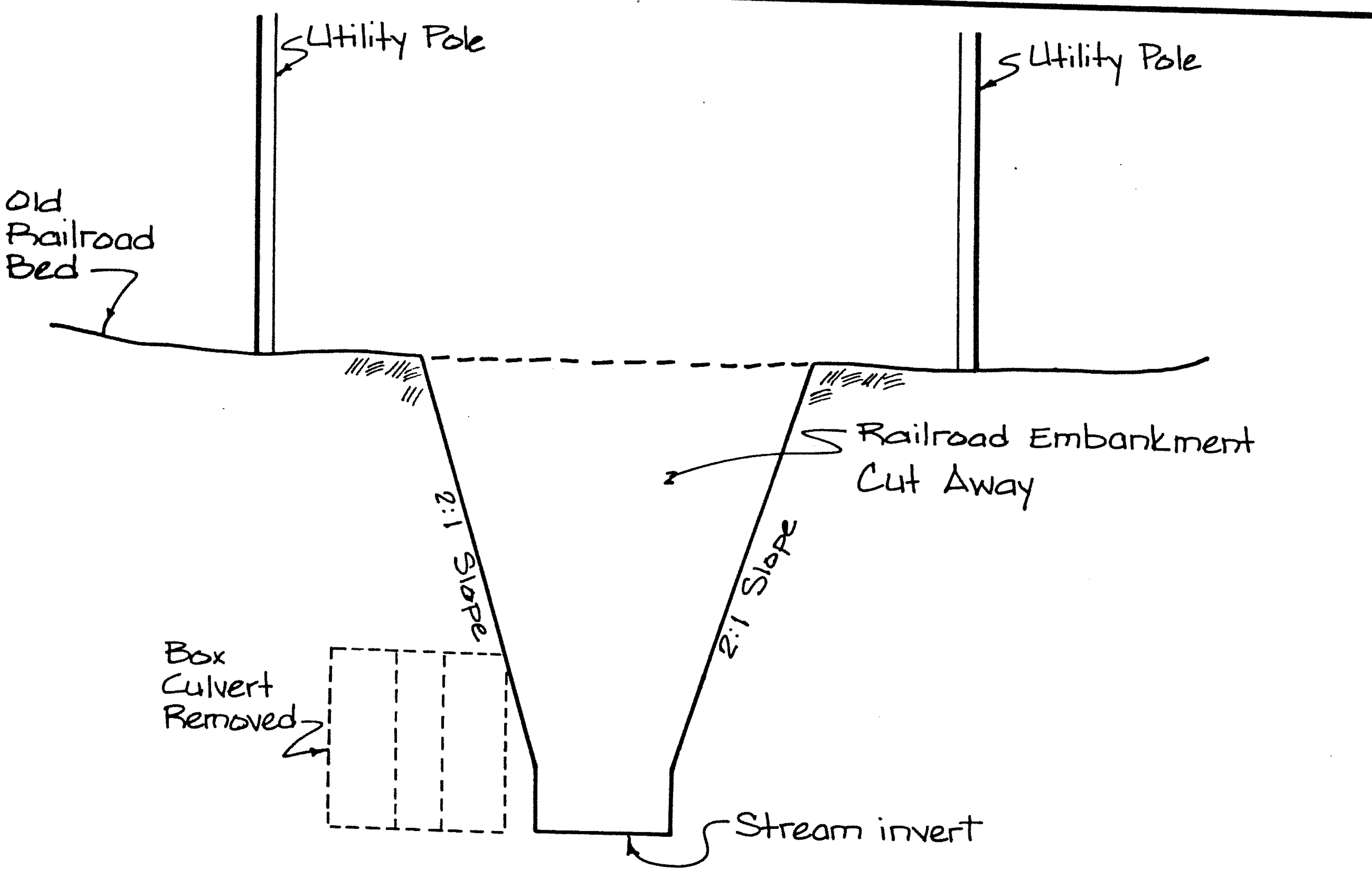

U.S. RTE. 40
WATERSHED BOUNDARY
C & P RAILROAD TUNNEL
NATIONAL HIGHWAY
TRIB 1
GRANT ST.
WASHINGTON ST.
GREEN ST.
BOWERY ST.
SCHOOL RD.
RT. 36
STREAM
BEALL HIGH SCHOOL
SWM POND
FROSTBURG SHOPPING CENTER
WARN'S LANE
GLENN ST.
POWELL'S LANE
TROUTMAN'S LANE
RAILROAD (ABANDONED)
MAIN ST.
WELSH HILL RD.
TRAILER PARK RD.
WALNUT
RT. 36
WATERSHED BOUNDARY
SAND SPRING RUN
RT. 936
U.S. ROUTE 48
LOCATION MAP
UPPER GEORGES CREEK

FIGURE 3



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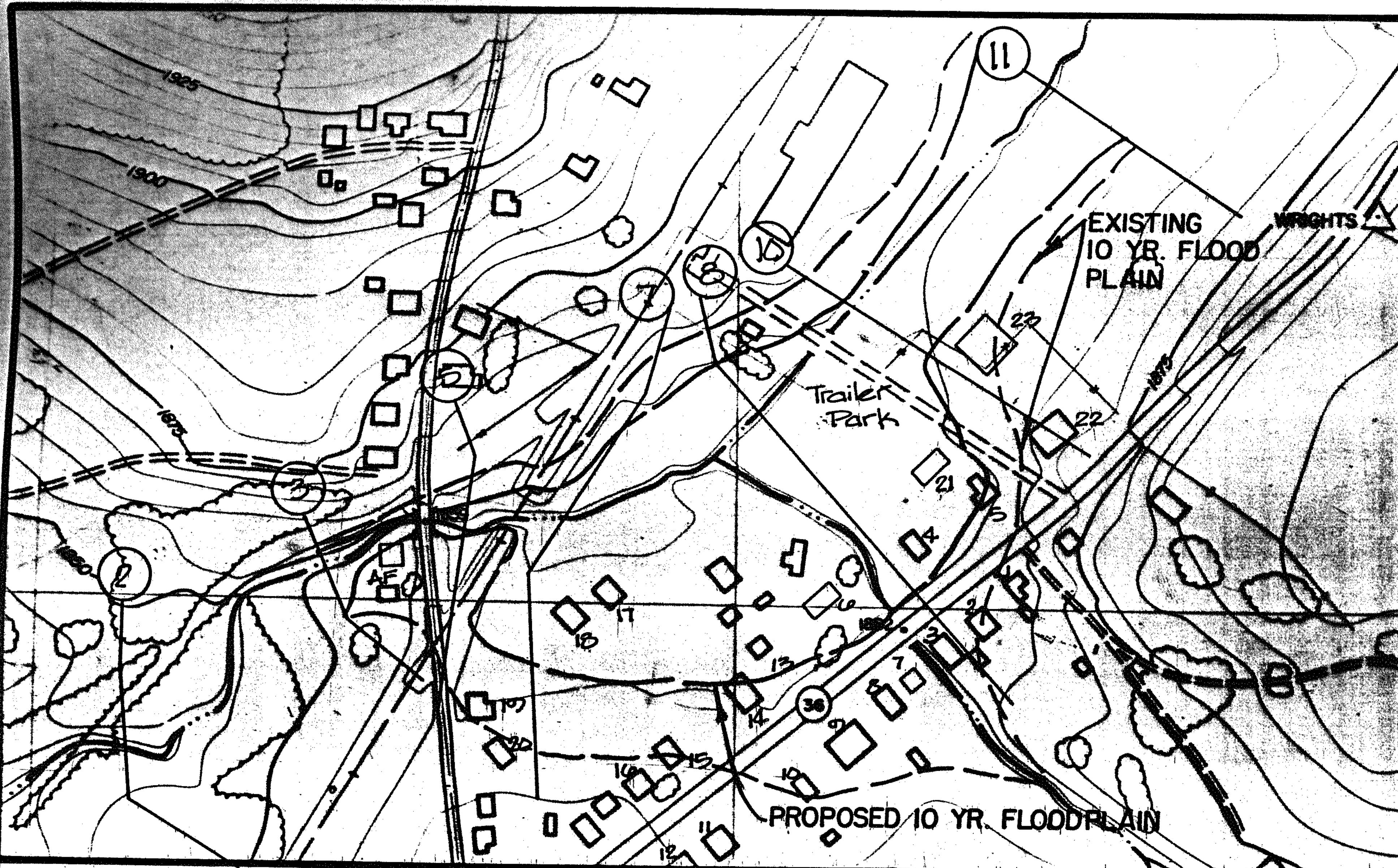
UPPER GEORGES CREEK
PROPOSED IMPROVEMENTS
REMOVAL OF RAILROAD CULVERTS & EMBANKMENT CUT AWAY



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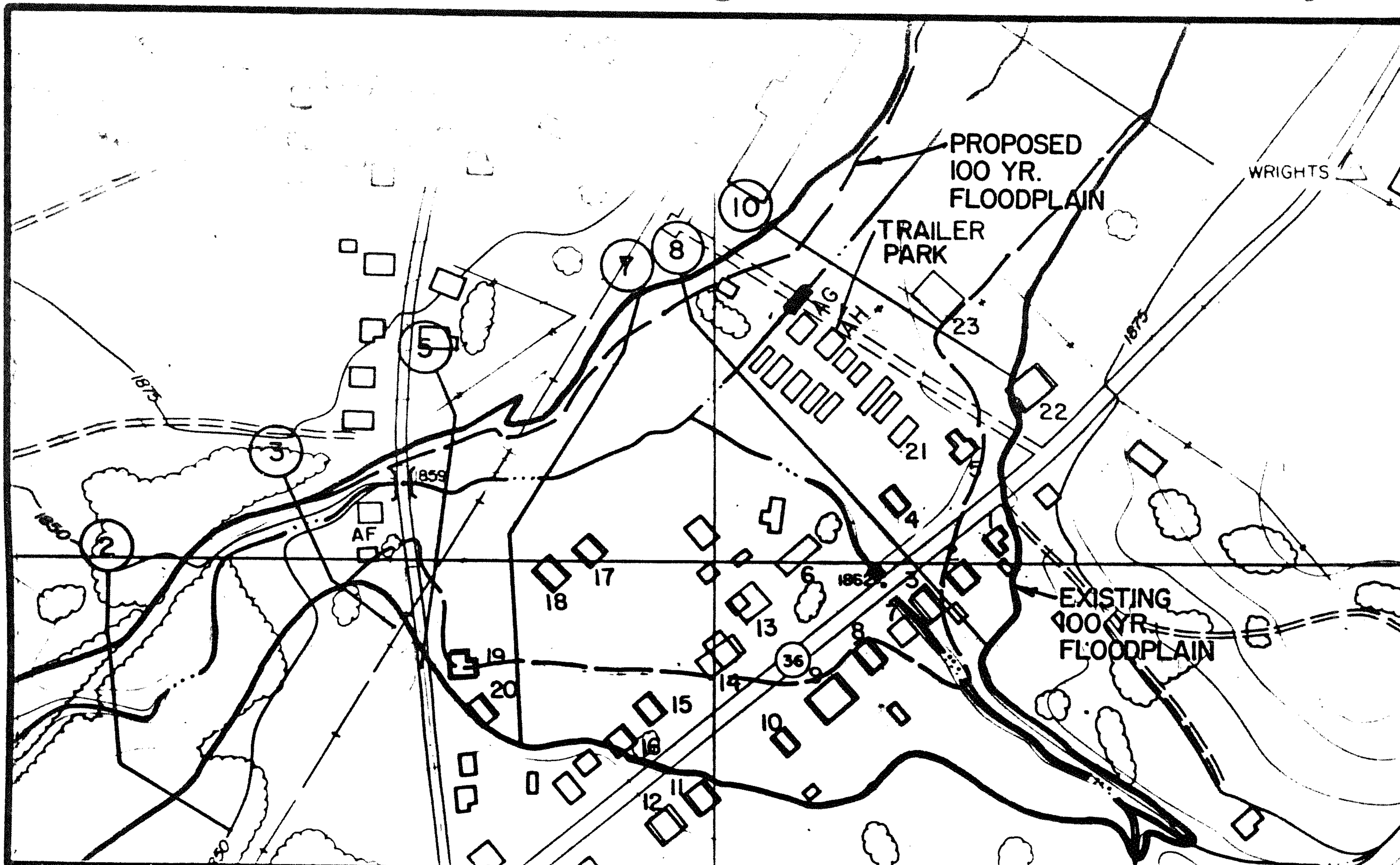
UPPER GEORGES CREEK
REDUCTION OF 10 YEAR FLOODPLAIN
WELSH HILL ROAD & R/R IMPROVEMENTS

FIGURE 5



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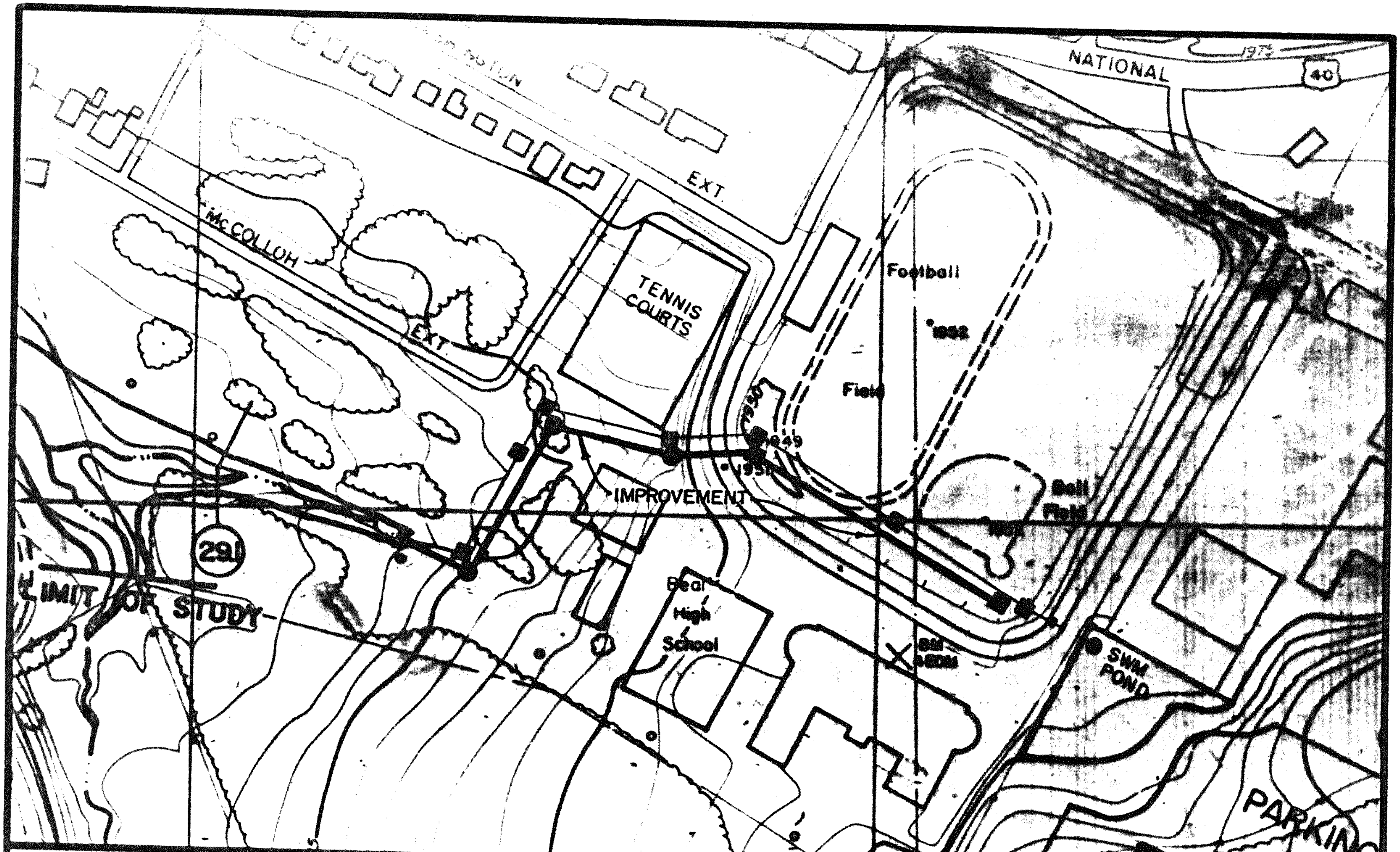
UPPER GEORGES CREEK

REDUCTION OF 100 YEAR FLOODPLAIN
WELSH HILL ROAD & R/R IMPROVEMENTS

FIGURE 6



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UPPER GEORGES CREEK
PROPOSED IMPROVEMENTS
PROPOSED PARALLEL 60" STORMDRAIN

FIGURE 7

APPENDIX B - TABLES

TABLE 1- DRAINAGE AREA SUMMARY

UPPER GEORGES CREEK WATERSHED

Area	Acreage	Existing CN	Ultimate CN	t_c (hrs.)
1.	78.03	84.4	86.0	.27
2.	63.78	85.1	85.1	.13
3.	103.74	80.9	86.6	.23
4.	78.49	73.1	86.0	.17
5.	47.37	71.2	74.4	.62
6.	74.61	83.4	83.4	.19
7.	99.29	81.0	81.0	.43
8.	86.75	79.1	85.8	.32
9.	131.96	74.5	80.9	.39
10.	113.54	74.0	81.7	.38
11.	17.04	77.4	79.1	.16
12.	36.25	76.5	87.8	.19
Total Acreage	937.27			
Weighted CN		78.4	83.1	

TABLE 2-UPPER GEORGES CREEK STRUCTURES

Structure No.	Location	Description	From Surveys	From Field Reconnaissai
	Main Stream			
1	Welsh Hill Road	8.8' x 7.2' Concrete Box	X	
2	Abandoned Railroad	6.5' x 5.8' Twin Cell Conc. Box	X	
3	Trailer Park Road	72" x 42" CMPA	X	
4	Troutmans Lane	48" RCP, 12" CIP, 18" Conc. Box in Concrete Headwall	X	
5	Powells Lane	10.8' x 3.2' Concrete Box	X	
6	Glenn Street	3.8' x 2.8' CMPA	X	
7	Grant Street to Green Street	Two 24" TC Pipes	X	
8	Station 82+30	Beginning of School Storm Drainage System		X
	Tributary No. 1			
9	Station 6+40	36" RCP		X
10	Bowery Street	30' x 35' Concrete Bridge		X

TABLE 3

UPPER GEORGES CREEK

Computed Water Surface
Elevations for Each Cross Section

Q in cfs; WSEL in feet

SECTION	EXISTING DEVELOPMENT CONDITIONS						ULTIMATE DEVELOPMENT CONDITIONS					
	Q2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$
						MAIN STREAM						
1.0	581	1835.6	1367	1836.2	2314	1836.8	749	1835.7	1638	1836.4	2607	1837.0
2.0		1843.4		1844.5		1845.3		1843.7		1844.7		1845.5
3.0	615	1852.3	1516	1853.7	2611	1854.5	801	1852.6	1813	1853.9	2958	1854.8
3.1		1855.8		1859.4		1859.4		1856.8		1859.6		1859.6
3.2		1857.2		1860.8		1861.5		1860.7		1861.0		1861.9
4.1		1857.2		1861.4		1862.4		1860.8		1861.7		1862.5
4.2		1857.5		1861.9		1862.9		1861.0		1862.2		1863.0
5.0		1859.7		1861.9		1862.9		1861.0		1862.2		1863.1
5.1		1859.7		1861.9		1862.9		1861.1		1862.2		1863.1
6.1		1861.3		1862.5		1862.0		1862.4		1862.7		1861.9
7.0		1861.7		1863.3		1864.3		1862.6		1863.6		1865.0
8.0	447	1861.7	1080	1863.3	1843	1864.3	553	1862.6	1242	1863.6	2029	1865.0
8.1		1861.7		1863.4		1864.4		1862.6		1863.6		1865.0
8.2		1861.7		1863.4		1864.4		1862.6		1863.6		1865.0

TABLE 3

UPPER GEORGES CREEK

Computed Water Surface
Elevations for Each Cross Section

Q in cfs; WSEL in feet

SECTION	EXISTING DEVELOPMENT CONDITIONS						ULTIMATE DEVELOPMENT CONDITIONS					
	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$
9.1	447	1861.7	1080	1863.4	1843	1864.4	553	1862.6	1242	1863.6	2029	1865.1
9.2		1861.8		1863.4		1864.4		1862.6		1863.6		1865.1
10.0		1861.7		1863.4		1864.4		1862.6		1863.6		1865.0
11.0		1862.3		1863.8		1864.8		1862.9		1864.0		1865.3
12.0	468	1865.9	1081	1866.3	1800	1866.7	573	1866.0	1227	1866.3	1965	1866.7
12.1		1868.7		1869.3		1869.8		1868.8		1869.5		1869.9
12.2		1869.3		1869.8		1870.0		1869.4		1869.8		1870.2
13.1		1869.7		1870.2		1870.6		1869.8		1870.3		1870.6
13.2		1869.8		1870.3		1870.7		1869.9		1870.4		1870.7
14.0		1869.8		1870.4		1870.8		1870.0		1870.5		1870.9
15.0		1870.3		1870.9		1871.4		1870.4		1871.0		1871.5
15.1		1871.0		1872.0		1872.6		1871.3		1872.1		1872.7
15.2		1871.4		1872.5		1873.0		1872.1		1872.6		1873.1

TABLE 3

UPPER GEORGES CREEK

Computed Water Surface
Elevations for Each Cross Section

Q in cfs; WSEL in feet

SECTION	EXISTING DEVELOPMENT CONDITIONS						ULTIMATE DEVELOPMENT CONDITIONS					
	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$
16.1	468	1873.6	1081	1873.0	1800	1873.5	573	1872.4	1227	1873.1	1965	1873.6
16.2		1873.6		1873.2		1873.8		1872.6		1873.4		1873.9
17.0		1873.6		1873.3		1873.9		1872.7		1873.5		1874.0
18.0		1873.7		1873.7		1874.3		1873.0		1873.8		1874.4
19.0	430	1874.6	974	1875.3	1608	1875.8	555	1874.8	1132	1875.4	1782	1876.0
19.1		1877.3		1877.3		1878.0		1877.4		1877.5		1878.2
19.2		1878.7		1879.3		1879.7		1878.9		1879.4		1879.8
20.1		1879.2		1879.9		1880.4		1879.4		1880.1		1880.6
20.2		1879.4		1880.0		1880.7		1879.5		1880.2		1880.8
21.0		1879.4		1880.2		1880.8		1879.6		1880.3		1880.9
22.0		1882.9		1884.7		1885.5		1883.3		1885.0		1885.7
23.0		1885.9		1887.2		1888.0		1886.3		1887.4		1888.2
23.1	242	1886.9	591	1887.3	1006	1888.2	359	1886.9	742	1887.6	1174	1888.4

TABLE 3

UPPER GEORGES CREEK

Computed Water Surface
Elevations for Each Cross Section

Q in cfs; WSEL in feet

SECTION	Existing Development Conditions						Ultimate Development Conditions					
	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$
27.1	242	1888.9	591	1889.2	1006	1889.3	359	1889.1	742	1889.3	1174	1889.3
28.0		1889.0		1889.5		1889.9		1889.2		1889.6		1890.1
29.0	196	1890.9	474	1891.3	807	1891.7	322	1891.1	637	1891.5	987	1891.9
29.1	149	1900.0	318	1901.0	510	1901.7	203	1900.3	384	1901.3	580	1901.8
23.0	430	1885.9	974	1887.2	1608	1888.0	555	1886.3	1132	1887.4	1782	1888.2
24.0	195	1888.8	400	1889.3	630	1889.6	202	1888.8	409	1889.3	641	1889.6
TRIBUTARY NO. 1												
24.1	128	1889.2	253	1890.0	390	1890.8	139	1889.2	266	1890.1	403	1890.8
24.2		1919.0		1919.0		1919.0		1919.0		1919.0		1919.0
24.3		1923.9		1924.8		1925.4		1924.2		1925.0		1925.5

UPPER GEORGE'S CREEK

TABLE 4 - FLOOD DAMAGE ESTIMATES EXISTING CONDITIONS

ITEMIZED LOSSES	2-YEAR STORM EXISTING CONDITIONS	10-YEAR STORM EXISTING CONDITIONS	100-YEAR STORM EXISTING CONDITIONS
PRIVATE LOSSES			
-STRUCTURES	$ 316,421	$ 409,073	$ 467,200
-CONTENTS	177,710	248,835	296,025
-EXTERIOR PROPERTIES	13,000	26,000	44,200
-VEHICLES	25,000	70,000	140,000
TOTAL PRIVATE LOSSES	$ 532,131	$ 753,908	$ 947,425
PUBLIC LOSSES			
-EMERGENCY POLICE SERVICES	$ 1,015	$ 1015	$ 2030
-CITY CLEAN-UP SERVICES	944	944	2208
-UTILITIES REPAIR SERVICES	600	600	1200
TOTAL PUBLIC LOSSES	$ 2,559	$ 2,559	$ 5,438
ABSTRACT LOSSES			
-LOST WAGES	$ 6,000	$ 7,800	$ 15,600
-EXTRA MILEAGE COST	0	0	0
TOTAL ABSTRACT LOSSES	$ 6,000	$ 7,800	$ 15,600
TOTAL OF ALL LOSSES	$ 540,690	$ 764,267	$ 968,463

AVERAGE ANNUAL DAMAGES = .45(2-YEAR TOTAL)+.245(10-YEAR TOTAL)+.055(100-YEAR TOTAL)= $ 483,821

PRESENT VALUE OF THE AVERAGE ANNUAL DAMAGES(TAKEN FOR 30 YEARS AT AN INTEREST RATE OF 8%)= $ 5,446,764

UPPER GEORGE'S CREEK
TABLE 5 -FLOOD DAMAGE ESTIMATES ULTIMATE CONDITIONS

ITEMIZED LOSSES	2-YEAR STORM ULTIMATE CONDITIONS	10-YEAR STORM ULTIMATE CONDITIONS	100-YEAR STORM ULTIMATE CONDITIONS
PRIVATE LOSSES			
-STRUCTURES	$ 333,660	$ 426,243	$ 487,922
-CONTENTS	195,150	259,275	311,635
-EXTERIOR PROPERTIES	13,000	26,000	44,200
-VEHICLES	25,000	70,000	140,000
TOTAL PRIVATE LOSSES	$ 566,810	$ 781,518	$ 983,757
PUBLIC LOSSES			
-EMERGENCY POLICE SERVICES	$ 1,015	$ 1015	$ 2030
-CITY CLEAN-UP SERVICES	944	944	2208
-UTILITIES REPAIR SERVICES	600	600	1200
TOTAL PUBLIC LOSSES	$ 2,559	$ 2,559	$ 5,438
ABSTRACT LOSSES			
-LOST WAGES	$ 6,000	$ 7,800	$ 15,600
-EXTRA MILEAGE COST	0	0	0
TOTAL ABSTRACT LOSSES	$ 6,000	$ 7,800	$ 15,600
TOTAL OF ALL LOSSES	$ 575,369	$ 791,877	$ 1,004,795

AVERAGE ANNUAL DAMAGES = .45(2-YEAR TOTAL)+.245(10-YEAR TOTAL)+.055(100-YEAR TOTAL)= $ 508,190

PRESENT VALUE OF THE AVERAGE ANNUAL DAMAGES(TAKEN FOR 30 YEARS AT AN INTEREST RATE OF 8%)= $ 5,721,097

Table 6. FLOOD MANAGEMENT ALTERNATIVES

UPPER GEORGES CREEK WATERSHED

House ID Code	Basement	100-Year Flood Elevation in Relationship to 1st Floor Elevation	100-Year Flood Depth Around Foundation or Basement Equal To or Greater Than One Foot	ALTERNATIVES				Comments
				Flood Proof	Flood Insur.	Purchase Candidate	Structural Improvements	
AF		2.0				X		
AG & AH		4.5			X			Includes 11 total trailers
1	X	-0.5					Replace Welsh Hill Road culvert with two 11' x 8' box culverts. Remove abandoned railroad culverts and embankment ($87,000)	
2	X	-1.5						
3	X	-2.0		X	X			
4	X	1.5	X			X		Access problem
5	X	1.5		X	X			
6		6.5	X			X		Access problem
7	X	-0.5		X	X			
8	X	-0.5						
9		-						Foundation flooding
10		-						Foundation flooding
11		-						Out of flood zone
12		-						Out of flood zone
13		0.5		X	X			
14	X	-1.5		X	X			
15	X	-3.5						
16		-						Foundation flooding
17		7.5				X		
18		7.5				X		
19	X	4.5		X	X	X		
20	X	-2.0						
21		3.5		X	X			Garage structure
22	X	-7.5						Edge of flood zone
23	X	4.5		X	X			Garage structure
Beall High School		Ballfield and track area flooding					Additional 60" RCP system ($290,000) not economically justified	
AI		-	X	X	X	X	None	Purchase not recommended
AJ	X	2.5		X	X	X		
AK	X	-5.0		X	X			
AL	X	-2.0	X	X	X	X		
AM	X	-2.5	X	X	X	X		
AN	X	0.5		X	X	X		
AN-1	X	0.5		X	X	X		
AN-2	X	-2.0		X	X			
AN-3	X	-2.0		X	X			
AN-4	X	-2.0		X	X			
AN-5	X	0.5		X	X	X		
AN-6	X	-4.0		X	X			
AN-7		-						
AN-8	X	1.5		X	X	X		
AN-9	X	-7.0		X	X	X		
AN-10		-	X	X	X	X		
AN-11	X	0.0		X	X	X		
AN-12	X	-3.0		X	X			
AO	X	-3.0	X			X	Replace Glenn St. culvert with three 60" RCP ($52,000). Not economically justified.	
AP	X	0.0	X			X		
AQ		-0.0		X	X			
AR	X	-1.5		X	X			
AS	X	-3.0		X	X			
AT		—						Commercial structure
AU		-					None	Flooding of property exists
AV		-						
AW	X	-						
AX	X	-1.5		X	X		Enclose stream with two 48" RCP (30,000). Not economically justified.	
AY	X	-3.5	X			X		Access problem

APPENDIX C

DAMAGE REFERENCE TABLES

NORTH BRANCH POTOMAC WATERSHED STUDY
FLOOD SURVEY

Name: ______________________ Date: ______________________

Address: ____

City: ______________________ State: __________ Zip Code: __________

Phone (Optional): Home: ______________ Work: ______________

Please accept our thanks in advance for taking your time to read and complete this questionnaire.

1. Number of years at present residence? _____ Years

2. What type of house do you live in?

   ___ 1-Story with no basement ___ 1-Story with basement

   ___ 2-Story with no basement ___ 2-Story with basement

   ___ Other - Describe: ______________________________

3. Where is your furnace or hot water heater located? ______________________________

4. What were the dates and depths of the most severe floods that affected your property?

Date		Depth of Water Outside of House	Depth of Water in Basement	Depth of Water Above First Floor
_____Month	_____Year	_________feet	_________feet	_________feet
_____Month	_____Year	_________feet	_________feet	_________feet
_____Month	_____Year	_________feet	_________feet	_________feet
_____Month	_____Year	_________feet	_________feet	_________feet

5. Where did the water enter your home? ______________________________

   ____

6. Are there visible watermarks from interior flooding? ___ Yes ___ No

   Indicate date. __________ Month _______ Year

   Describe location. ______________________________

   ____

7. Can you indicate a definite water level on the outside of your home or on another landmark? ___ Yes ___ No

   Indicate date. __________ Month _______ Year

   Describe location. ____

   ____

8. Do you have photographs which show the flooding on or around your property? ___ Yes ___ No

   If yes, would you loan these photographs to the Allegany County Commissioners in order that we may reproduce them. ___ Yes ___ No

9. Do you have any other comments or information you can present? ______________________________

   ____

   ____

   ____

   ____

Please return this questionnaire in the enclosed self-addressed, stamped envelope to our consultants:

Purdum and Jeschke
1029 North Calvert Street
Baltimore, Maryland 21202

(Attention: North Branch Potomac Watershed Study)

Table III-2 (Reference 1)
HOME PRICE RANGES

Type of Home	Structural Composition	Foundation Construction	Dwelling Only ($) Low - High
Split Level	Brick	Block	40,000 - 80,000
Split Level	Frame	Block	38,000 - 76,000
Slab on Grade	Brick	N/A	40,000 - 70,000
Slab on Grade	Frame	N/A	38,000 - 66,000
One or Two Story w/Basement	Brick	Block or Stone	32,000 - 80,000
One or Two Story w/Basement	Frame	Block or Stone	30,000 - 76,000
One Story w/o Basement	Brick	Block or Stone	36,000 - 74,000
One Story w/o Basement	Frame	Block or Stone	34,000 - 71,000

Table 2-5 (Reference 2)
RESIDENTIAL CONTENT VALUES

Total Square Footage	Furnishings Value	Content Value
$0 < x \leq 1000$	High	$33,000
	Average	18,100
	Low	10,200
$1000 < x \leq 1500$	High	$37,200
	Average	20,600
	Low	11,100
$1500 < x \leq 2000$	High	$46,400
	Average	25,700
	Low	14,000
$x > 2000$	High	$54,100
	Average	30,000
	Low	16,500

TABLE III-4 (Reference 1)
Numerical Rating Values
Houses Over 25 Years Old
Not Remodeled
Flood Plain Area

Adjustment Factors	Rating: Poor	Fair	Good	Excellent
Location	0.00	0.033	0.067	0.10
Quality of Construction	0.00	0.033	0.067	0.10
Condition of House	0.00	0.033	0.067	0.10
	Square Foot Area: Small 800 to 999	Sm/Med 1,000 to 1,199	Med/Lge 1,200 to 1,399	Large 1,400 to 1,600+
Size	0-0.06	0.06-0.12	0.12-0.18	0.18-0.24
	Years: 100+	75-100	50-75	25-50
Age	0.00	0.033	0.067	0.10

TABLE III-5 (Reference 1)
Numerical Rating Values
Houses Less Than 25 Years Old
Or Completely Remodeled Old House
Flood Plain Area

Adjustment Factors	Rating: Poor	Fair	Good	Excellent
Location	0.10	0.067	0.033	0.00
Quality of Construction	0.10	0.067	0.033	0.00
Condition of House	0.10	0.067	0.033	0.00
	Square Foot Area: Small 800 to 999	Sm/Med 1,000 to 1,199	Med/Lge 1,200 to 1,399	Large 1,400 to 1,600+
Size	0.24-0.18	0.18-0.12	0.12-0.06	0.06-0.00
	Years: 75-100+	50-75	25-50	New-25
Age	0.10	0.067	0.033	0.00

Table 5

FIA 1974 RESIDENTIAL DAMAGE CURVES
(VALUES IN PERCENT DAMAGE)

	1		2		3		4	
	1 STORY WITH BASEMENT		1 STORY W/O BASEMENT		1 1/2 & 2 STORY W/ BASEMENT		1 1/2 & 2 STORY W/O BASEMENT	
STAGE	STRUCTURE	CONTENT	STRUCTURE	CONTENT	STRUCTURE	CONTENT	STRUCTURE	CONTENT
-9	0.	0.	0.	0.	0.	0.	0.	0.
-8	0.	0.	0.	0.	0.	0.	0.	0.
-7	1.	1.	0.	0.	1.	1.	0.	0.
-6	3.	2.	0.	0.	2.	2.	0.	0.
-5	4.	3.	0.	0.	3.	3.	0.	0.
-4	5.	4.	0.	0.	3.	3.	0.	0.
-3	6.	5.	0.	0.	4.	4.	0.	0.
-2	7.	7.	0.	0.	5.	5.	0.	0.
-1	8.	8.	0.	0.	6.	6.	0.	0.
0	11.	15.	7.	10.	7.	9.	0.	0.
1	18.	20.	10.	17.	7.	11.	5.	7.
2	20.	22.	14.	23.	11.	17.	9.	9.
3	23.	28.	26.	29.	17.	22.	13.	17.
4	28.	33.	28.	35.	22.	28.	18.	22.
5	33.	39.	29.	40.	28.	33.	20.	28.
6	38.	44.	41.	45.	33.	39.	22.	33.
7	44.	50.	43.	50.	35.	44.	24.	39.
8	49.	55.	44.	55.	38.	49.	26.	44.
9	51.	60.	45.	60.	40.	55.	31.	50.
10	53.	60.	46.	60.	44.	61.	36.	55.
11	55.	60.	47.	60.	46.	64.	38.	58.
12	57.	60.	48.	60.	48.	71.	40.	65.
13	59.	60.	49.	60.	50.	76.	42.	72.
14	60.	60.	50.	60.	52.	78.	44.	78.
15	60.	60.	50.	60.	54.	79.	46.	79.
16	60.	60.	50.	60.	56.	80.	47.	80.
17	60.	60.	50.	60.	58.	81.	48.	81.
18	60.	60.	50.	60.	59.	81.	49.	81.
19	60.	60.	50.	60.	59.	81.	49.	81.
20	60.	60.	50.	60.	59.	81.	49.	81.
21	60.	60.	50.	60.	59.	81.	49.	81.
22	60.	60.	50.	60.	59.	81.	49.	81.
23	60.	60.	50.	60.	59.	81.	49.	81.
24	60.	60.	50.	60.	59.	81.	49.	81.
25	60.	60.	50.	60.	59.	81.	49.	81.
26	60.	60.	50.	60.	59.	81.	49.	81.
27	60.	60.	50.	60.	59.	81.	49.	81.
28	60.	60.	50.	60.	59.	81.	49.	81.
29	60.	60.	50.	60.	59.	81.	49.	81.
30	60.	60.	50.	60.	59.	81.	49.	81.

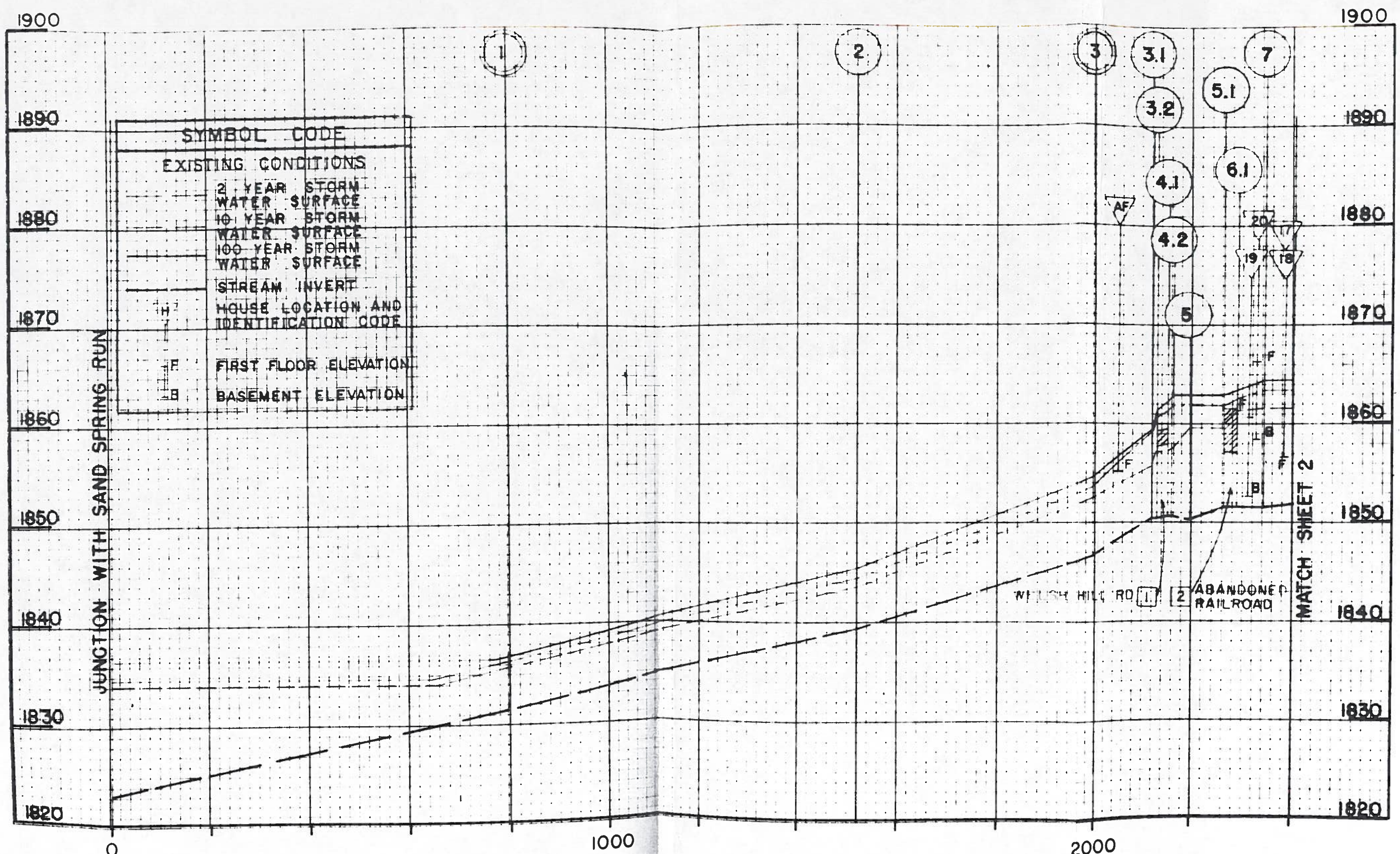
Table 5

FIA 1974 RESIDENTIAL DAMAGE CURVES
(VALUES IN PERCENT DAMAGE)

	5		6		7	
	SPLIT LEVEL W/ BASEMENT		SPLIT LEVEL W/O BASEMENT		TRAILERS	
STAGE	STRUCTURE	CONTENT	STRUCTURE	CONTENT	STRUCTURE	CONTENT
-9	0.	0.	0.	0.	0.	0.
-8	0.	0.	0.	0.	0.	0.
-7	1.	1.	0.	0.	0.	0.
-6	2.	2.	0.	0.	0.	0.
-5	2.	4.	0.	0.	0.	0.
-4	3.	6.	0.	0.	0.	0.
-3	3.	8.	0.	0.	0.	0.
-2	4.	10.	0.	0.	0.	0.
-1	5.	15.	0.	0.	0.	0.
0	6.	18.	3.	2.	8.	0.
1	16.	31.	9.	19.	45.	20.
2	19.	44.	13.	32.	64.	50.
3	22.	52.	25.	41.	74.	60.
4	27.	58.	27.	47.	79.	70.
5	32.	61.	29.	51.	80.	73.
6	35.	63.	33.	53.	81.	76.
7	36.	64.	34.	55.	82.	79.
8	44.	66.	41.	56.	82.	82.
9	49.	69.	43.	62.	82.	85.
10	50.	73.	45.	69.	82.	85.
11	52.	76.	46.	75.	82.	85.
12	54.	79.	47.	78.	82.	85.
13	56.	80.	48.	80.	82.	85.
14	58.	80.	49.	81.	82.	85.
15	59.	80.	50.	81.	82.	85.
16	60.	80.	50.	81.	82.	85.
17	60.	80.	50.	81.	82.	85.
18	60.	80.	50.	81.	82.	85.
19	60.	80.	50.	81.	82.	85.
20	60.	80.	50.	81.	82.	85.
21	60.	80.	50.	81.	82.	85.
22	60.	80.	50.	81.	82.	85.
23	60.	80.	50.	81.	82.	85.
24	60.	80.	50.	81.	82.	85.
25	60.	80.	50.	81.	82.	85.
26	60.	80.	50.	81.	82.	85.
27	60.	80.	50.	81.	82.	85.
28	60.	80.	50.	81.	82.	85.
29	60.	80.	50.	81.	82.	85.
30	60.	80.	50.	81.	82.	85.

APPENDIX D

WATER SURFACE PROFILES



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

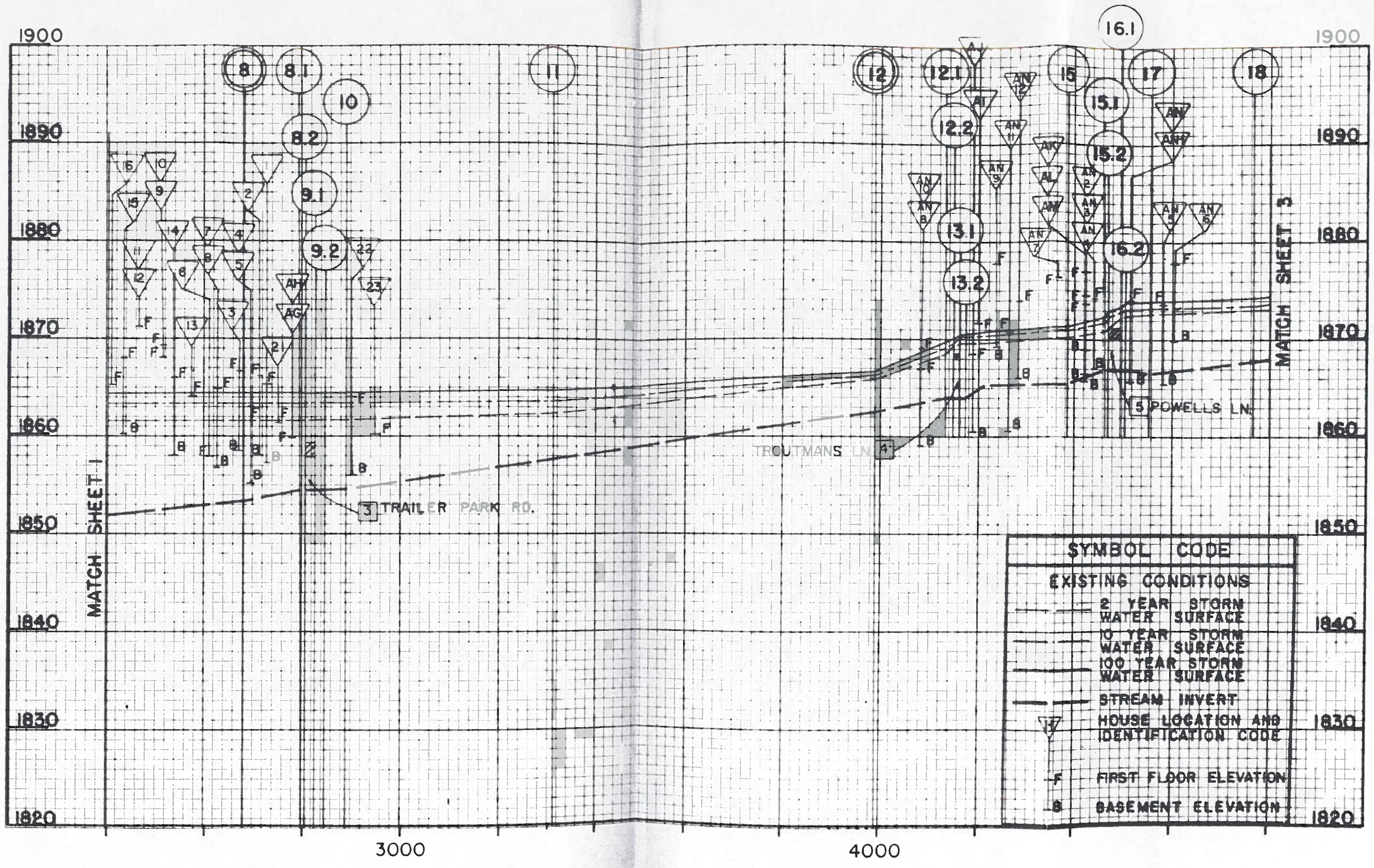
(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1" = 200'
VERTICAL : 1" = 10'

STREAM PROFILE

UPPER GEORGES CREEK MAIN STREAM

SHEET NO. 1 OF 4



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

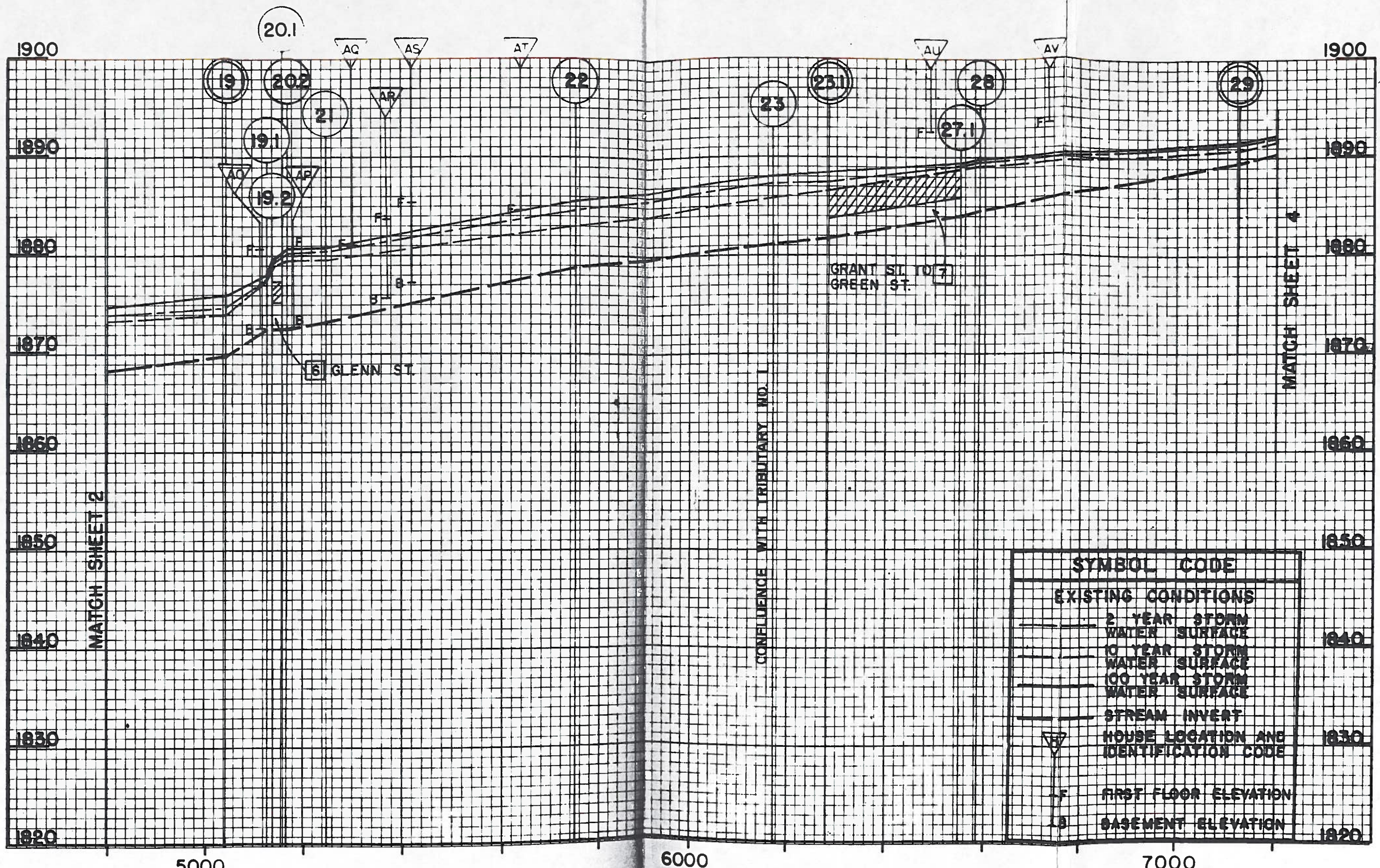
(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1" = 200'
VERTICAL : 1" = 10'

STREAM PROFILE

UPPER GEORGES CREEK MAIN STREAM

SHEET NO. 2 OF 4



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

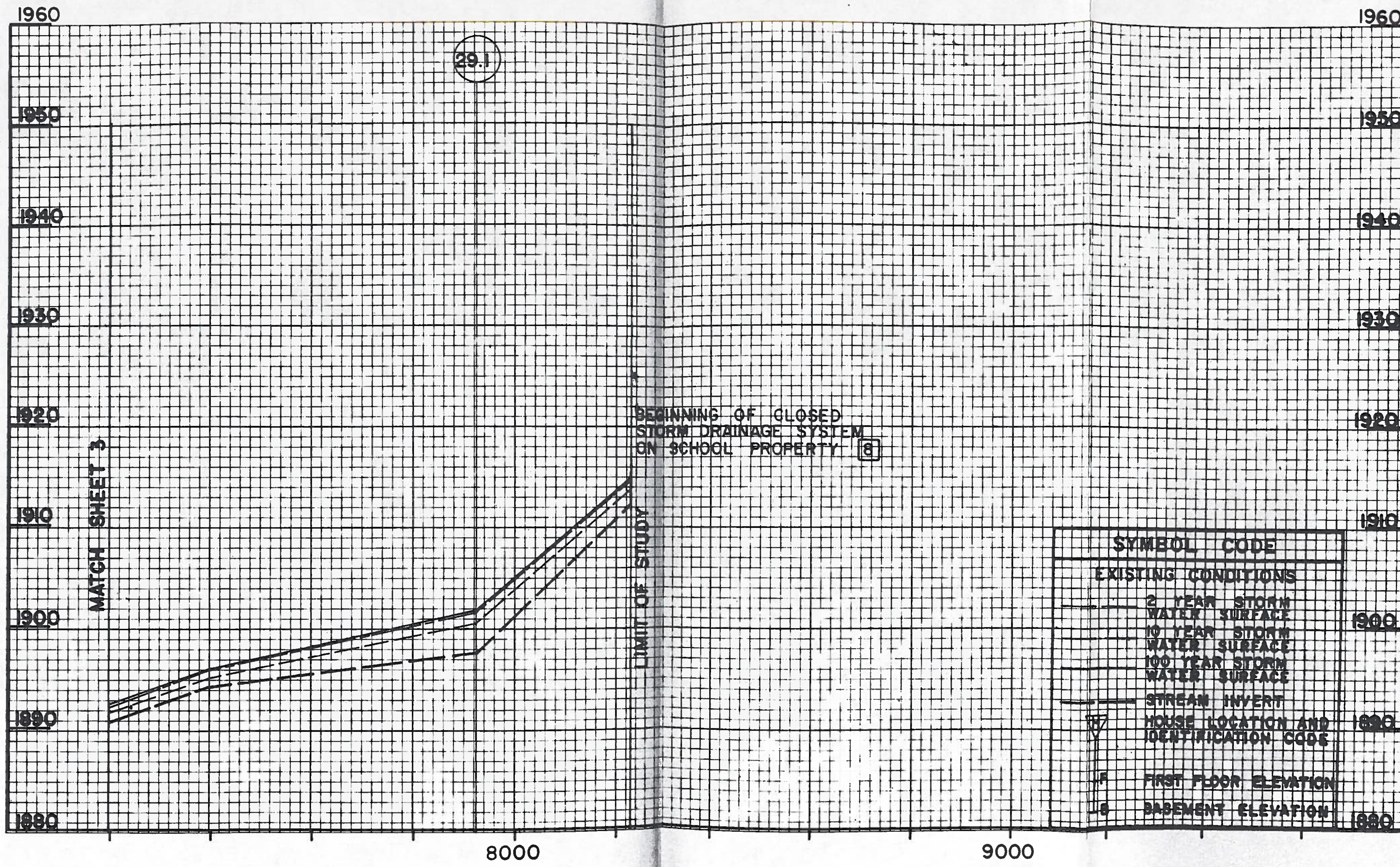
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1"=200'
VERTICAL : 1"=10'

STREAM PROFILE
UPPER GEORGES CREEK MAIN STREAM

SHEET NO. 3 OF 4



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

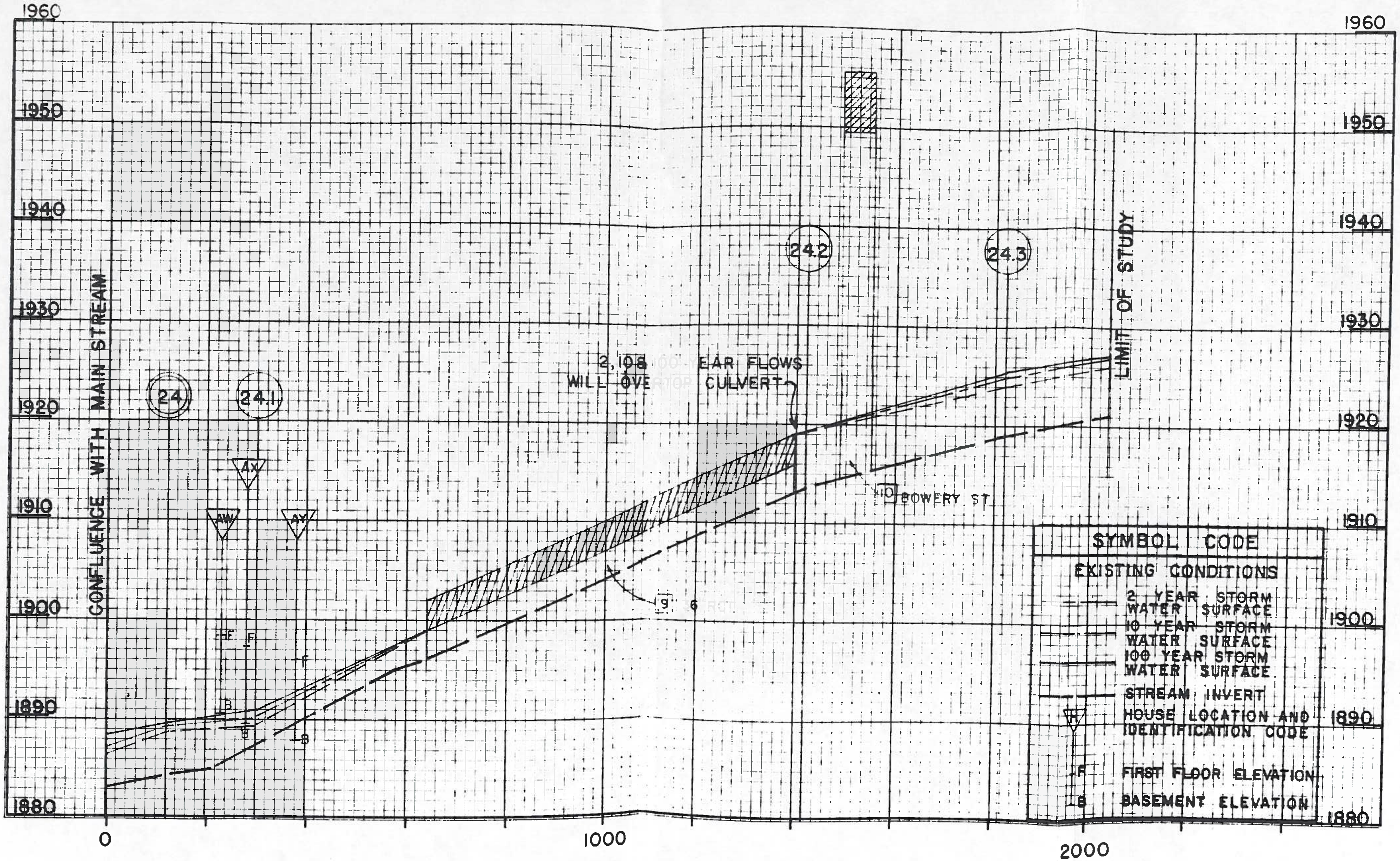
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1"=200'
VERTICAL : 1"=10'

STREAM PROFILE
UPPER GEORGES CREEK MAIN STREAM

SHEET NO. 4 OF 4



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LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1" = 200'
VERTICAL : 1" = 10'

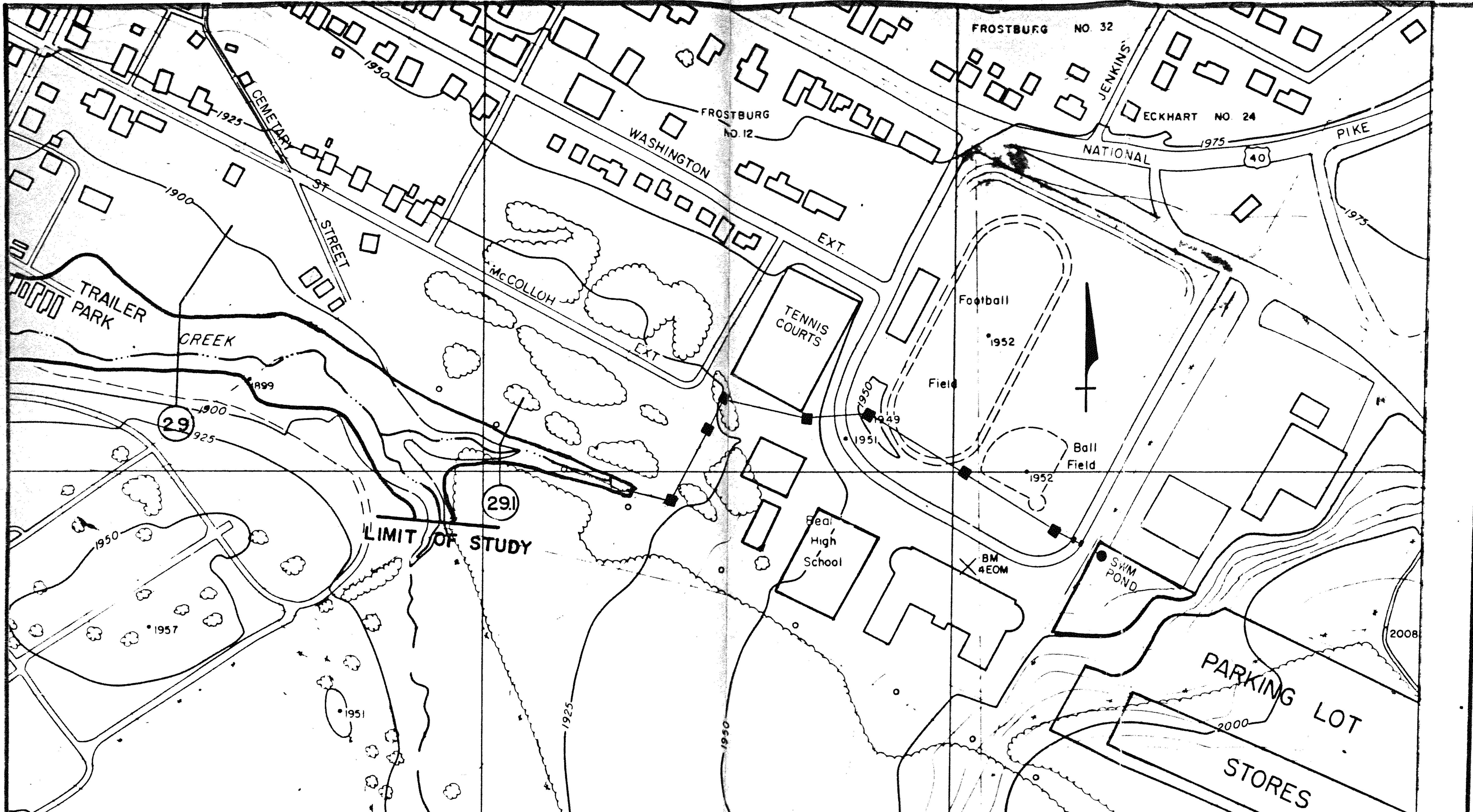
STREAM PROFILE

UPPER GEORGES CREEK TRIBUTARY NO. 1

SHEET NO. 1 OF 1

APPENDIX E

100-YEAR FLOOD DELINEATION



PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202

UPPER GEORGE'S CREEK

LIMITS OF 100 YEAR FLOOD

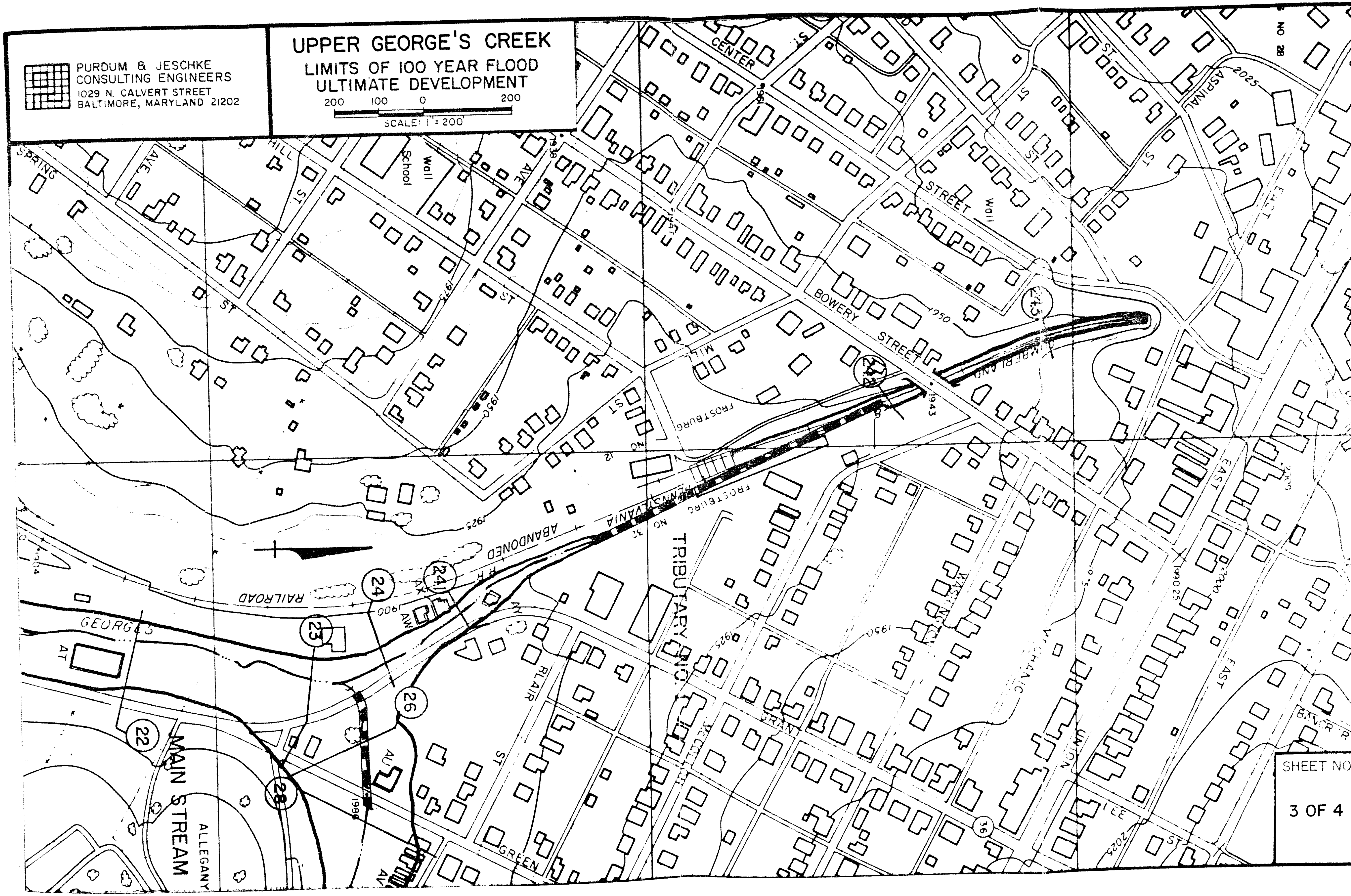
ULTIMATE DEVELOPMENT

200 100 0 200

SCALE: 1" = 200'

SHEET NO.

4 OF 4


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
UPPER GEORGE'S CREEK
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
SHEET NO.
3 OF 4
MAIN STREAM
ALLEGANY
GEORGE'S
RAILROAD
ABANDONED
R R
PENNSYLVANIA
NO 32
NO 12
FROSTBURG
TRIBUTARY NO. 1
BOWERY STREET
CUMBERLAND
MILL
BLAIR
ST
GREEN
WASHINGTON
MECHANIC
UNION
LEE
EAST
ASPINAL
CENTER
SPRING
AVE
HILL
School
Wall
STREET
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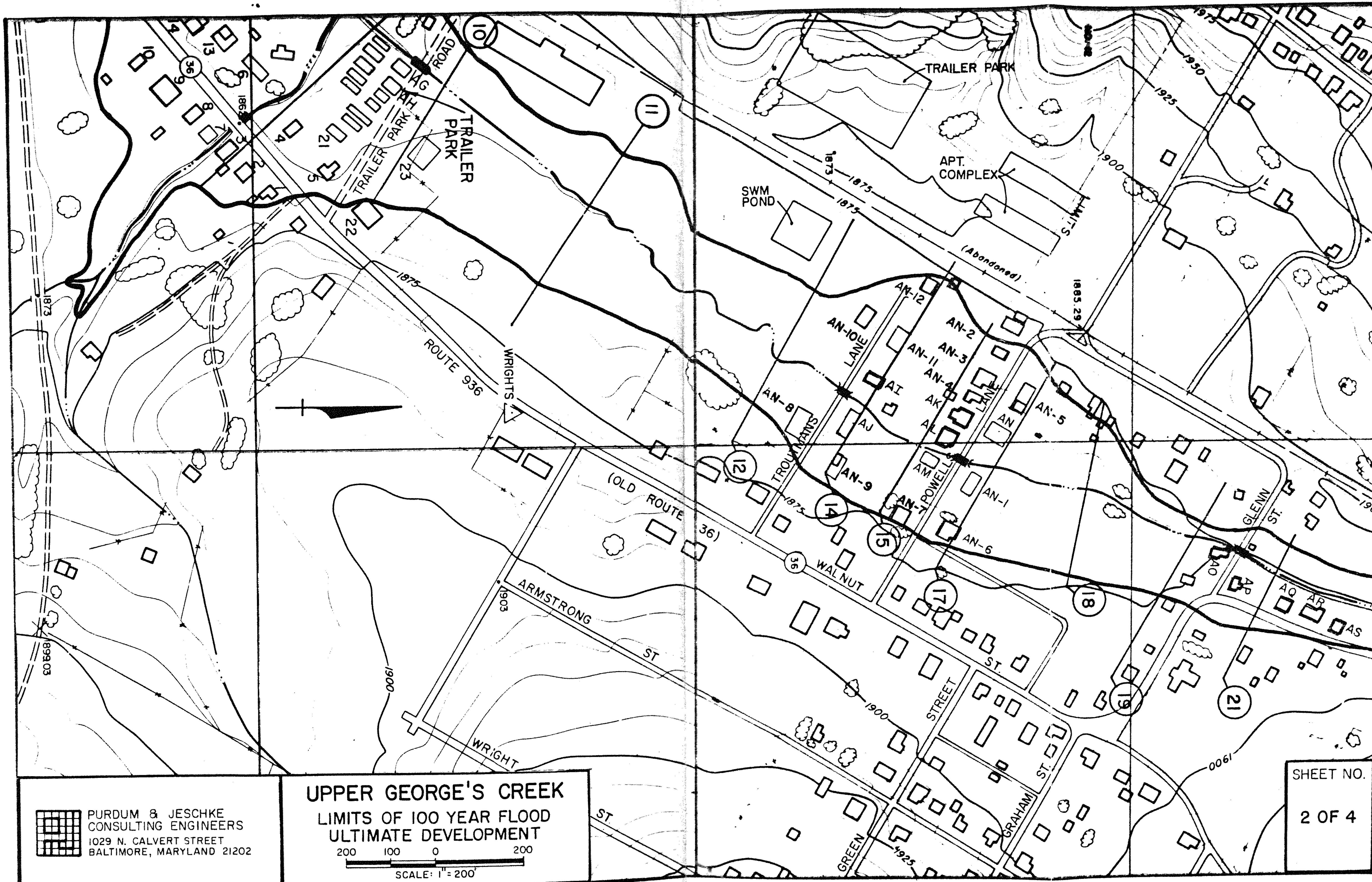
1975
1943
1986
2025
AT
AU
AW
AX



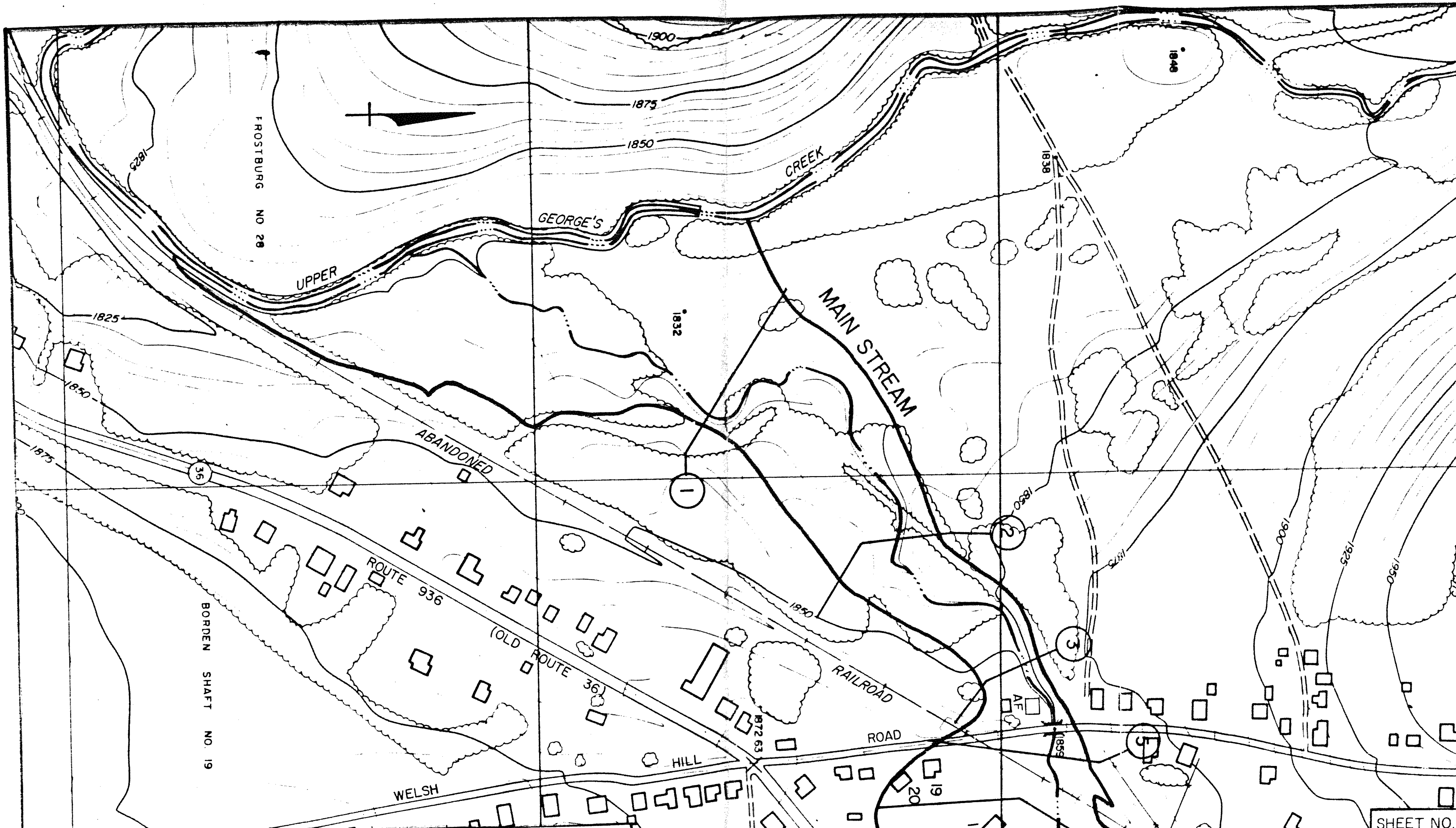
PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202

UPPER GEORGE'S CREEK

LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT

200 100 0 200
SCALE: 1" = 200'

SHEET NO.
2 OF 4

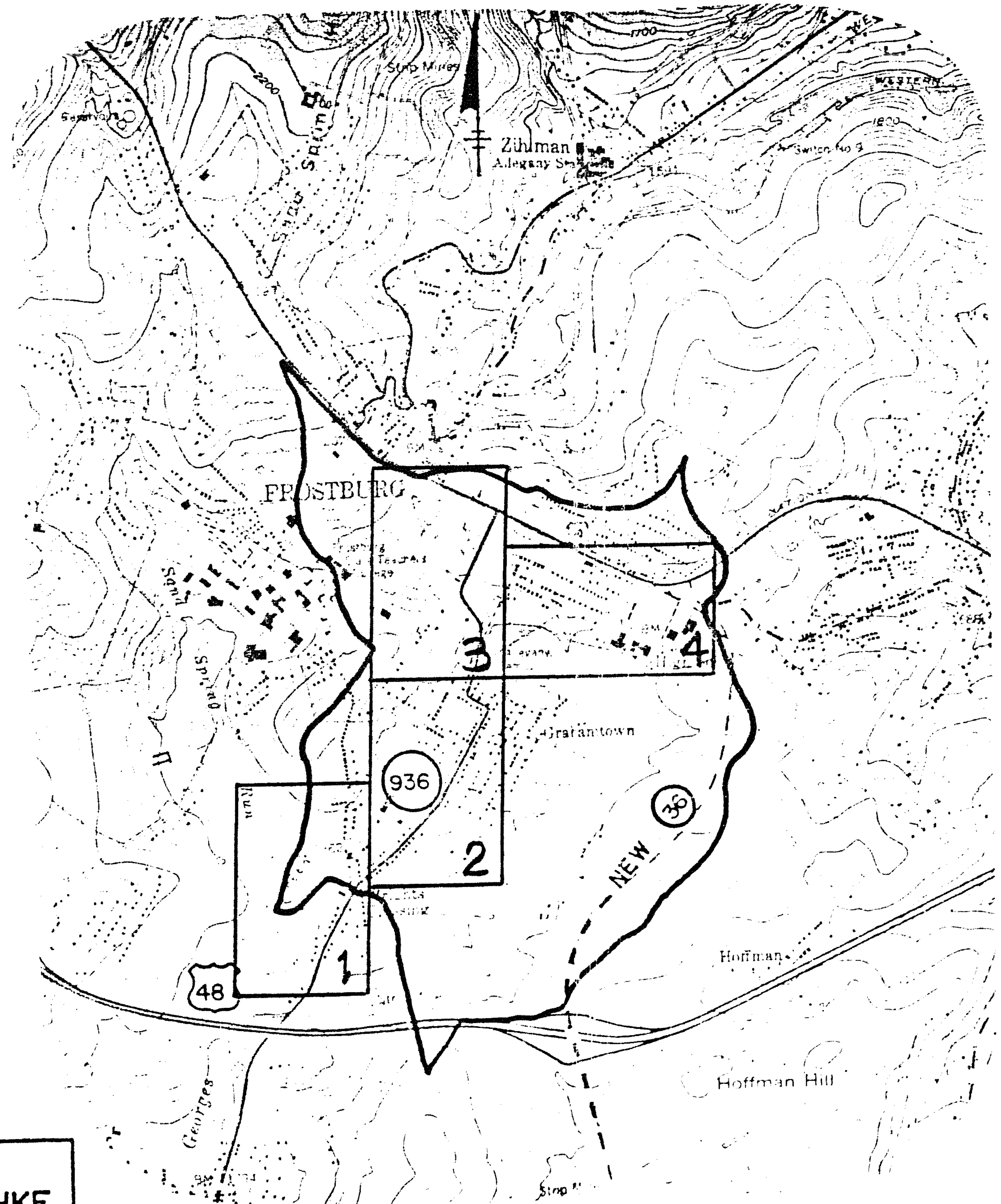


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202

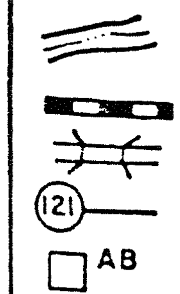
UPPER GEORGE'S CREEK
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT

200 100 0 200
SCALE: 1" = 200'

SHEET NO.
1 OF 4



LEGEND



STREAM AND 100-YEAR FLOOD LIMITS
CULVERT
BRIDGE
CROSS SECTION NUMBER AND LOCATION
AB HOUSE IDENTIFICATION CODE

PURDUM & JESCHKE
CONSULTING ENGINEERS
AND
LAND SURVEYORS

ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY
UPPER GEORGES CREEK

INDEX MAP

LIMITS OF 100-YEAR FLOOD
ULTIMATE DEVELOPMENT