OOD PLAIN MANAGEMENT STUDY

COLDWATER RIVER
BRANCH COUNTY, MICHIGAN

MAY 1988

prepared by:

U.S. Department of Agriculture
Soil Conservation Service
East Lansing, Michigan

in cooperation with:

Michigan Department of Natural Resources
Coldwater Township, City of Coldwater
Branch County Soil Conservation District

FOREWORD

This report defines the flood characteristics of Coldwater River, Sauk River, South Lake Drain, County Drain No. 40, South Lake, Randall Lake and the southern part of Morrison Lake located in Coldwater Township, Branch County, Michigan. Development exists within the flood plain and can be expected to increase in the future.

This cooperative report was prepared for the guidance of local officials in planning the use and regulation of the flood plain. Four potential floods are used to represent the degrees of major flooding that may occur in the future. These floods, the 10-year, 50-year, 100-year and 500-year, are defined in the report and should be given appropriate consideration in future planning for safety of development in the flood plain. Over 16 miles of high water profiles along the Coldwater River Chain show the expected flood elevations and water depths relative to the stream bed and flood plain. The 100-year and 500-year potential floods around the Lower Lake Chain are further defined by flood hazard area photomaps that show the approximate areas that would be flooded.

Flood hazard area photomaps and high water profiles are based on existing conditions of the basin, stream and valley when the report was prepared.

Information in this report does not imply any federal authority to zone or regulate the use of flood plains; this is a state and local responsibility. This report provides a suitable basis for adoption of land use controls to guide flood plain development, thereby preventing intensification of flood losses.

Technical documentation for this study is on file with the Soil Conservation Service-USDA, 1405 South Harrison Road, East Lansing, Michigan 48823 (telephone (517) 337-6612) and the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909.

Assistance and cooperation of the U.S. Geological Survey, Branch County Soil Conservation District, city of Coldwater, Coldwater Township and Michigan Department of Natural Resources in the preparation of this report is greatly appreciated.

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COLDWATER RIVER

BRANCH COUNTY, MICHIGAN

INTRODUCTION

The flood plains of rivers, lakes and streams have been formed by nature to provide for the conveyance of flood flows resulting from large amounts of snowmelt and rainfall. Floods are acts of nature which cannot be wholly prevented by man. Therefore, the long-term solution to reducing flood damage and loss of life is to keep the flood plain void of development which could be damaged or which could obstruct the conveyance of flood waters. There are three basic actions which can be used to assure that flood plain areas are kept open:

1. Provide information to make lending institutions and prospective property buyers aware of the flood hazards.

2. Initiate flood plain regulations to prevent the development of the flood plain in a manner which would be hazardous during floods.

3. Acquisition of flood prone areas for use as parks, open space, wildlife habitat and other public uses.

Potential users of the flood plain should base their decisions upon the advantages and disadvantages of such a location. Knowledge of flood hazards is not widespread and, consequently, the managers, potential users and occupants cannot always accurately assess the risks. In order for flood plain management to be effective in the planning, development and use of flood plains, it is necessary to:

1. Develop appropriate technical information and interpretations for use in flood plain management.

2. Provide technical services to managers of flood plain property for community, recreational, industrial and agricultural uses.

3. Improve basic technical knowledge about flood hazards.

Two Michigan state laws provide the Michigan Department of Natural Resources the responsibility and the authority to regulate all development in the flood plain areas.

> Act 288, Public Acts of 1967, establishes minimum standards for subdividing land and for new development for residential purposes within flood plain areas. This act requires that preliminary plats be submitted to the Land and Water Management Division, Michigan Department of Natural Resources for review and determination of flood plain limits. Upon completion of review and establishment of the 100-year frequency flood plain limits, the preliminary plat may be approved and minimum building requirements specified.

> Act 245, Public Acts of 1929 as amended by Act 167, Public Acts of 1968, requires that a permit be obtained from the Land and Water Management Division, Michigan Department of Natural Resources before filling or otherwise occupying the flood plain or altering any channel or watercourse in the state. The purpose of this control is to assure that the channels and the portion of the flood plain that are the floodways are not inhabited and are kept free and clear of interference or obstruction which will cause undue restriction of flood carrying capacities.

Requirements established by the Michigan Department of Natural Resources for occupation and development of flood plain areas under Acts 288 and 245 are intended to be minimum requirements only. The Michigan Department of Natural Resources urges local units of government to adopt reasonable regulations which can be used to guide and control land use and development in flood hazard areas.

The Soil Conservation Service, United States Department of Agriculture carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulations of Land Use", of House Document No. 465, 89th Congress, 2nd Session and in compliance with Executive Order 11988, dated May 24, 1977. Flood plain management studies are carried out in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management". The Soil Conservation Service and the Michigan Department of Natural Resources have agreed to carry out flood plain management studies in Michigan under provisions of the Joint Coordination Agreement. Priorities regarding location and extent of such studies in Michigan have been set in cooperation with the Michigan Department of Natural Resources.

The Branch County Soil Conservation District, city of Coldwater, Coldwater Township and Michigan Department of Natural Resources (Sponsors) believed that a flood plain management study was needed for the Coldwater River, Sauk River, South Lake Drain, County Drain No. 40 and the Lower Lake Chain, which includes South Lake, Randall Lake and the southern part of Morrison Lake due to urbanization and the flooding problems that have already occurred. The Sponsors have determined that there is an increasing need to properly plan for the preservation and use of the flood plain in their urban and rural areas. They have indicated a need to develop technical information along the Coldwater River Chain to develop effective management programs.

The Sponsors have adopted resolutions indicating they intend to use the technical information from the flood plain management study as a basis for adopting zoning regulations, health and building codes, subdivision control regulations and such other regulations that may be needed to preserve the environmental quality of their natural resources, and to protect the health, safety, welfare and well-being of the citizens of their communities.

A request for a flood plain management study was made by the Sponsors and a plan of work, dated August 1985, was agreed to by the Sponsors, along with the Soil Conservation Service. Financial contributions for this study were made by the Sponsors and the Soil Conservation Service. The Branch County Soil Conservation District will assist the other Sponsors with public information dissemination.

The Sponsors provided money for aerial photography and topographic mapping for flood plain delineation uses and for watershed modeling purposes. They also furnished assistance to the Soil Conservation Service in gathering basic data. In addition, they also provided input to identify and select appropriate flood plain management alternatives.

The Land and Water Management Division, Michigan Department of Natural Resources provided coordination services with respect to study area discharges and hydraulics. They reviewed the technical aspects of the study and concurred with study results, as applicable, to implement various state statutes and provisions of the Federal Flood Insurance Program.

Natural flood plain values were obtained by Soil Conservation Service field people. Aerial photographs and field checks were used to identify and delineate wetland areas. Topographic maps, planning commission data and communications with government officials were used to determine land use and development trends. Soils information was obtained from the published soil survey report for Branch County.

Historic and archaeological data were obtained from township and county historians. Fishery management information was obtained from Michigan Department of Natural Resources field people.

In addition to flood prone areas, two floods are delineated, the 100-year and the 500-year frequency events. These floods have an average occurrence of once in the number of years as indicated; e.g. the 100-year flood occurs once in 100 years on the average. The 100-year flood has a one percent chance of being equaled or exceeded in any given year. In addition to flood prone areas and the two floods delineated on the aerial photomaps, the 10-year and 50-year floods are also shown on the high water profiles. The flood plain management program enacted by local action is to be based on the technical results and recommendations of this report.

The Land and Water Management Division, Michigan Department of Natural Resources and the Soil Conservation Service-USDA will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study. For assistance contact:

Branch County Soil Conservation District
1110 West Chicago Road
Coldwater, Michigan 49036-7307
Telephone: (517) 278-8008

DESCRIPTION OF STUDY AREA

Watershed Area

The Coldwater River is located in the south-central part of lower Michigan in the eastern half of Branch County. It is located in the U.S. Geological Survey's State Hydrologic Unit 04050001. Its headwaters are located in the southeastern corner of Branch County. From there, the Coldwater River flows in a northerly direction into the Upper Lake Chain which includes, from south to north, Coldwater, East, Long, Wright, Bartholomew, Archer, Middle, Marble and First Lakes. The level of the Upper Lake Chain has a common level and is controlled by dams on Sauk River (outlet of Marble Lake) and Coldwater River (outlet of Coldwater Lake). The Sauk and Coldwater Rivers flow in a northerly direction and outlet into the Lower Lake Chain which includes, from south to north, South, Randall, Morrison and Craig Lakes and Hodunk Pond. From there, the Coldwater River flows north into the St. Joseph River.

The drainage area to Hodunk Pond is approximately 173 square miles with land uses of commercial, residential, recreation, agriculture, forest and open space. About 19 percent of the area is in woodland and about 67 percent is in cultivated crops. The remaining 14 percent is roads, urban and small water areas. There are numerous culverts and crossings along the river system. Some of these are restrictive and cause the flooding of buildings and roads. Any replacement of crossings should be evaluated to see what the effect would be on downstream flooding.

There are six soil associations in the drainage area. Twenty percent of the area consists of the Fox-Oshtemo-Ormas association, which has nearly level to moderately steep, well drained loamy and sandy soils on outwash plains and moraines. Six percent is the Hatmaker-Locke-Barry association, which is level to undulating, somewhat poorly drained loamy soils on till plains and moraines. Twelve percent of the area is the Fox-Houghton-Edwards association, which has nearly level to moderately sloping, well drained loamy soils on outwash plains and moraines and level, very poorly drained mucky soils in swamps, depressions and drainageways. Fifteen percent is the Matherton-Sebewa-Branch association, which has level to gently sloping, moderately well drained to poorly drained and sandy soils on outwash plains and moraines. About forty-five percent of the area is the Locke-Barry-Hillsdale association, which has level to moderately sloping, somewhat poorly drained, poorly drained and well drained loamy soils on till plains and moraines. Two percent of the area is the Morley-Locke-Houghton association, which has nearly level to gently rolling, well drained and somewhat poorly drained, silty and loamy soils on till plains and moraines and level, very poorly drained mucky soils in swamps and depressions.

In winter, the average temperature is 25°F., and the average daily minimum temperature is 17°F. In summer, the average temperature is 69.1°F., and the average daily maximum temperature is 80.7°F.

The average annual temperature is 47.8°F. The average annual precipitation is 33.49 inches. Of this, 20.68 inches, or 62 percent, usually falls in April through September, which includes the growing season for most crops. The average annual snowfall is 47.8 inches.

United States
Department of
Agriculture

Soil
Conservation
Service

1405 South Harrison Road, Room 101
East Lansing, Michigan
48823

October 5, 1988

United States Department of Agriculture
National Agricultural Library
Beltsville, Maryland 20705

Dear Sir:

Enclosed for your information and use is a copy of the recently completed Flood Plain Management Study Report for Coldwater River, Branch County, Michigan. This study was made in cooperation with the city of Coldwater, Branch County Soil Conservation District, Coldwater Township and the Michigan Department of Natural Resources at the request of the local governmental units.

The study was carried out under the authority of Section VI of Public Law 83-566, in accordance with Executive Order 11988, and House Document No. 465, 89th Congress, Second Session, Recommendation 9(c), "Regulation of Land Use". The purpose of this study is to make flood plain management and land use information available to the local governments and citizens to encourage land use appropriate to the degree of the hazard involved.

The Soil Conservation Service's objective in developing this technical data is to help reduce present and potential flood damages through wise use of flood plain lands, thereby improving the health, safety, economy and environmental conditions of the community.

Sincerely,

Homer R Hilner

Homer R. Hilner
State Conservationist

Enclosure

HRH:tdb:glo 1840D

The Soil Conservation Service
is an agency of the
Department of Agriculture

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

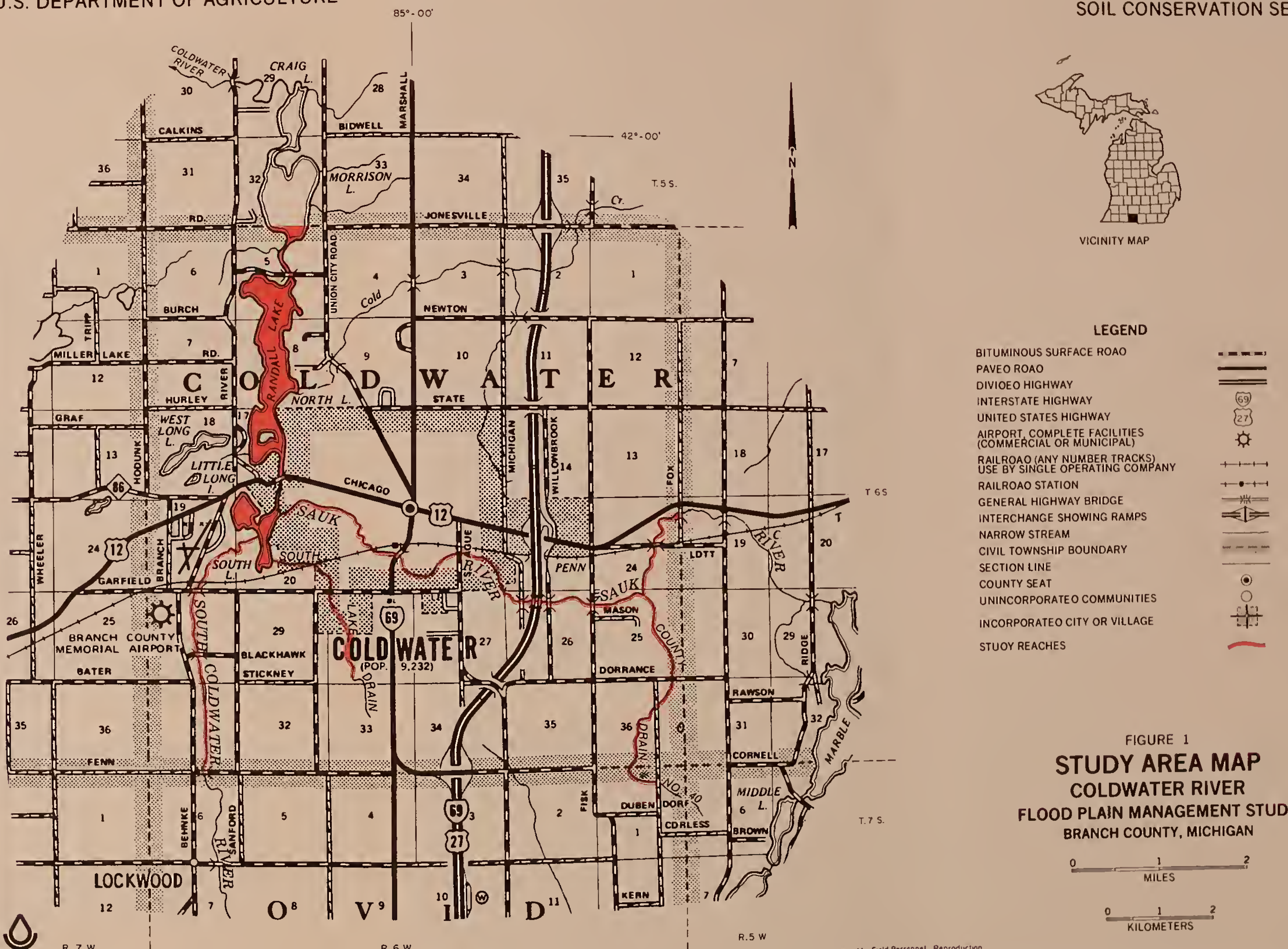

FIGURE 1

STUDY AREA MAP
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

SOURCE:
MICHIGAN COUNTY HIGHWAY MAP
POLYCONIC PROJECTION

Material prepared by Field Personnel. Reproduction only by SCS Cartographic Staff, Fort Worth, Texas

MAY 1988 1003393

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NATURAL VALUES

The study area flood plain has a number of natural and beneficial values. It serves as a storage area for spring rains and snow melts. It acts as a filter for minimizing the amount of pollutants reaching the lakes, creeks and open drains, thereby maintaining water quality. It supports a wide variety of plant, animal and tree species.

"These species are found in suitable habitat in the river flood plain itself or in the environments adjacent to the actual flood plain. Some of these species are abundant, some common and some are little known by human inhabitants living in this drainage system." [1]

Representative mammals found in the flood plain area are the white-tailed deer, striped skunk, mink, least weasel, long-tailed weasel, raccoon, gray and red fox, coyote (population low), meadow jumping mouse, house mouse, Norway rat, southern bog lemming, muskrat, woodland vole, white-footed mouse, beaver, southern flying squirrel, red squirrel, fox squirrel, limited number of gray squirrels (mostly black phase), thirteen-lined ground squirrel, woodchuck, eastern chipmunk, eastern cottontail rabbit, red bat, big brown bat, silver-haired bat, Indiana bat (status not known in Branch County), little brown bat, Keen's bat, star-nosed mole, eastern mole, least shrew, short-tailed shrew and masked shrew. Virginia oppossum and badgers are sometimes observed in the upland sites.

Various species of upland game birds, non-game birds and raptors are found in the flood plain. These include screech owl, horned owl, night hawk, red tailed hawk, sharp-shinned hawk, coopers hawk, bob white, quail, ring-necked pheasant, sora rail, killdeer, woodcock, mourning dove, chimney swift, ruby throated hummingbird, flicker, belted kingfisher, redheaded woodpecker, hairy and downy woodpeckers, eastern kingbird, horned lark, tree swallow, barn swallow, purple martin, blue jay, robin, crow, black capped chicadee, tufted titmouse, white breasted nuthatch, brown creeper, house wren, catbird, brown thrasher, bluebird, cedar waxwing, starling and English sparrow. Several species of warblers migrate through the area and the yellow-throated warbler nests there.

Common waterfowl that may be found during migration are the mute swan, Canada goose, mallard duck, black duck, baldpate, pintail, green-winged teal, shoveller, wood duck, redhead duck, ring-neck duck, canvas-back duck, lesser scaup, American golden eye, bufflehead, hooded merganser and red-breasted merganser. Great blue herons, little blue herons, green herons and American bitterns can also be found.

"There are no known endangered or threatened species in the area. However, there are historical records of two fish species that are listed as special concern species. They are the spotted gar (Lepisosteus oculatus) and the starhead topminnow (Fudulaus notti)." [2]

1/ Ralph Anderson, Wildlife Habitat Biologist, Michigan Department of Natural Resources.

2/ Thomas Weise, Endangered Species Coordinator, Michigan Department of Natural Resources.

The tree species in the river bottoms are primarily hardwoods.

"Southern Michigan is where northern species and southern species come together so there is a great variety of species present." [1]

The genus with the most representatives is the white oak group, consisting of White Oak, Burr Oak, Swamp White Oak and Chinkapin Oak. In the red oak group are the Northern Red Oak, Black Oak, Pin Oak and Shingle Oak.

There are several willow species: Cottonwood, Quaking Aspen, Bigtooth Aspen, Black Walnut and Butternut. There are four different hickories: shagbark, pignut, bitternut and shellbark. There are hophornbeam, hornbeam and American beech.

The native elm trees have been severely impacted by Dutch Elm Disease. Hackberry and Mulberries are found, as are Yellow Poplar, Whitewood and Sassafras. Sycamore, Black Cherry, Pin Cherry and Chokecherry are also found. Sugar Maple, Black Maple, Red Maple, Silver Maple and Box Elder represent the maple family. Also found within the flood plain are Basswood, Dogwood, White Ash, Black Ash, Green Ash, Tamarack and Red Cedar.

Water Quality

"The lake chains provide a haven for swimming, boating, fishing, skiing and other recreational opportunities for both property owners and the general public. Historical and recent baseline limnological surveys for the eastern chain of lakes of the flood plain area indicate the lakes in the chain, with the exception of Coldwater Lake, to be eutrophic. Coldwater Lake, the deepest and largest lake in the chain, is mesotrophic." [2]

Sediment loading to the waters in the lake chain has significantly impaired fishery habitat and recreational utilization of the lakes. It is thought that fish populations have been severely impacted by sediment settling in spawning strata. Also, excessive algae growth in all the lakes in the flood plain study area has impaired recreational usage.

High water levels in the spring and the water quality concern prompted the establishment in 1986 of the Marble-Coldwater Lake Board. Pursuant to this board's request, an engineering study was completed in November 1986 which outlined remedial actions to stabilize lake levels and improve the water quality in the Marble-Coldwater Lake Chain.

In October 1987, the Messenger-Hodunk Lake Association entered into an agreement with the Branch County Soil Conservation District to evaluate non-point source pollution entering the chain of lakes.

1/ William Hoppe, Area Forester, Michigan Department of Natural Resources.

2/ Marble-Coldwater Lake Chain Feasibility Study - Progressive Architects/Engineers/Planners, Inc., Published November 1986.

FLOOD PROBLEMS

Annual flooding occurs in the early spring due to a combination of snowmelt and rainfall, and occasionally in the fall due to heavy rains.

Coldwater River:

Flood damages along Coldwater River in Coldwater Township are primarily limited to Fenn and Blackhawk Roads. The 100-year water surface elevation is approximately 0.5 ft. higher than the low in the road at Fenn Road Crossing. Assuming the road is structurally adequate, it is conceivable the road could still be used by emergency vehicles. The 100-year flood tops the new Blackhawk Mill Pond Dam. The 100-year flood inundates approximately 150 acres. A few residents would experience basement flooding during a 100-year flood.

Sauk River:

Frequent flooding occurs along Sauk River. The 100-year flood tops several road crossing and inundates residential areas east of I-69. Race and Jefferson Streets, in addition to Michigan Avenue and Willowbrook Road, would be impassable in the event of a 100-year flood. The 100-year flood inundates approximately 695 acres. Approximately 40 residents and a few businesses would experience flooding during a 100-year flood.

South Lake Drain:

The 100-year flood will inundate most of the road crossings on South Lake Drain. Emergency use of these existing road crossings is questionable. Approximately 80 acres would be inundated by the 100-year flood. A few businesses would experience flooding during a 100-year flood. Also, settling basins upstream of the Penn Central Railroad would be threatened.

County Drain No. 40:

The 100-year flood would inundate approximately 445 acres of land on County Drain No. 40. Dorrance Road could probably be used in an emergency; however, Wood Road would be impassable. Most of the flooded areas along County Drain No. 40 are either woods or idle land. No residents or businesses are threatened by the 100-year flood.

Lower Lake Chain (South, Randall and Morrison Lakes):

A considerable amount of flooding occurs in areas around the Lower Lake Chain in Coldwater Township. The 100-year flood inundates approximately 610 acres. About 50 residents would experience first floor flooding. Most of the major roads would be passable during an emergency.

This study provides high water profiles and areas subject to flooding based on analyses of existing stream hydraulics and current watershed and flood plain conditions. Water surface profiles along the study reaches are shown for the 10-year, 50-year, 100-year and 500-year flood events. The approximate areas of inundation for two floods, the 100-year and 500-year, are shown on the aerial photomaps.

There are areas in Coldwater Township that are flood prone and are not shown in this report. These flood prone areas are a result of soil and high water table conditions. The Soil Survey of Branch County, issued in September 1986, describes and delineates these areas.

Typical valley sections shown in Appendix B indicate the effects of the four floods. Flood discharges used for computing high water profiles in the study area are shown in Table 1 in Appendix C. Table 2 in Appendix C shows flood elevations at each of the surveyed valley sections for present conditions.

Floodways have been delineated for the Coldwater River Chain and have been provided to the Sponsors in a separate report.

While no computations were made to reflect the problems of ice and debris blockage at bridges, because of the wide possible variations in conditions, a few generalized comments can be made. Ice and debris can often totally block an opening. To determine possible effects, look at the high water profile sheets. At each bridge or culvert, a "low point or road overflow" symbol is shown. Based on field surveys, this is the elevation at which the road would flood. If there is no culvert capacity available, all flows would need to go over the road through this low section. The depth of flow and flooding would depend on the quantity of flow, as well as cross-sectional area available for flow.

DETERMINATION OF FLOOD HAZARD FOR SPECIFIC LOCATION

To determine flood levels for a specific location, locate the area on the sheet index, Figure 2 (Appendix A), identifying the appropriate flood hazard photomap. Using this photomap, locate the specific location on the map and its relationship to the nearest identification point (cross-section, road).

If the specific location is outside the flood hazard boundaries, there is no apparent flood hazard, unless the area is subject to high water table conditions (see soil survey report).

For those areas within the flood hazard boundaries, refer to the adjacent high water profile, locating the area on the profile. The mean sea level flood elevation can then be determined for the appropriate flood event. Table 2 (Appendix C) shows flood elevations at each cross-section.

EXISTING FLOOD PLAIN MANAGEMENT

Currently, Coldwater Township and the city of Coldwater have no existing flood plain ordinances or flood insurance. Even though a flood plain ordinance is not in effect in either the city of Coldwater or Coldwater Township, the Basic Building Code (BOCA) enforced in each community requires that the lowest horizontal structural member be at or above the 100-year flood plain elevation. The flood plain management study will provide the information needed to enforce the existing building code.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

The objectives of flood plain management are to reduce the damaging effects of floods, preserve and enhance natural values and provide for optimal use of land and water resources within the flood plain. Flood plain management can minimize potential flood damages by:

1. Prohibiting uses which are dangerous to public health or safety in times of flood.

2. Restricting building or other development which may cause increased flood heights or velocities.

3. Requiring that public or private facilities that are vulnerable to floods be protected against flood damage at the time of construction.

4. Protecting individuals from investments in flood hazard areas which are unsuited for their intended purposes.

5. Providing information on flood proofing techniques for existing structures in the flood plain.

There are numerous flood plain management alternative categories and tools that can be employed to accomplish the above objectives and goals. The ones that apply to this area are suggested below. Other flood plain management techniques should be considered and may well prove to be effective in reducing or preventing flood damages. Many of the road crossings should be resized when replacement is necessary.

Present Condition

This is the "no change" alternative, which reflects ongoing flood plain development pressures and management trends. Local governmental units can continue to plan, zone and accept or reject requests for alternative flood plain and adjacent land uses. Flood problems may continue to increase if development continues.

Land Treatment

This alternative discusses opportunities to minimize or decrease changes in upland runoff and erosion because of land use changes. The traditional approach of accelerating conservation land treatment, by working with landowners to install conservation practices, will minimize soil erosion and reduce runoff. Installation of such measures as tree planting, windbreaks, forest management, permanent vegetative cover and on-site water storage will all reduce runoff, erosion and sedimentation.

As rural areas urbanize, the increase in peak discharges due to more efficient conveyance paths and increased impervious areas can have a significant adverse impact on downstream areas. There is a growing interest on the part of planners, developers and the public in protecting downstream areas from induced flood damages that may accompany increased peaks and stages. Planning authorities are proposing local ordinances that restrict the type of development permitted and the impact development can have on the watershed. One of the primary controls that could be imposed is that future-condition discharges cannot exceed present-condition discharges at some predetermined frequency of occurrence at specified points on the channel.

Methods to control runoff in urbanizing areas reduce either the volume or the rate of runoff. The effectiveness of any control method depends on the available storage, the outflow rate and the inflow rate. Because a great variety of methods can be used to control peak flows, each method proposed should be evaluated for its effectiveness in the given area.

MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF

Area	Reducing Runoff	Delaying Runoff
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measure for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Groundwater recharge a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir or detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters or diversions

Preservation and Restoration of Natural Values

Flood plains, in their natural or relatively undisturbed state, provide three broad sets of natural and beneficial resources and resource values.

Water resource values include natural moderation of floods, water quality maintenance and groundwater recharge. The physical characteristics of the flood plain shape flood flows. Flood plains generally provide a broad area to spread out and temporarily store flood waters. This reduces flood peaks and velocities and the potential for erosion.

Flood plains serve important functions in protecting the physical, biological and chemical integrity of water. A vegetated flood plain slows the surface runoff, causing it to drop most of its sediment load on the flood plain. Pathogens and toxic substances entering the main water body through surface runoff and accompanying sediments are decreased.

The natural flood plain has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. The slowing of runoff provides additional time for it to infiltrate and recharge available ground water aquifiers, and also provides for natural purification of the waters.

Flood plains support large and diverse populations of plants and animals. In addition, they provide habitat and critical sources of energy and nutrients for organisms in adjacent and downstream terrestrial and aquatic ecosystems. The wide variety of plants and animals supported directly and indirectly by flood plains constitutes an extremely valuable, renewable resource important to economic welfare, enjoyment and physical well-being.

The flood plain is biologically important because it is the place where land and water meet and the elements of both terrestrial and aquatic ecosystems mix. Shading of the stream by flood plain vegetation moderates water temperatures; roots and fallen trees provide instream habitat; and near stream vegetation filters runoff, removing harmful sediments and buffering pollutants, to further enhance instream environments.

Flood plains contain cultural resources important to the nation and to individual localities. Native American settlements and early cities were located along the coasts and rivers in order to have access to water supply, waste disposal and water transportation. Consequently, flood plains include most of the nation's earliest archeological and historical sites. In addition to their historical richness, flood plains may contain invaluable resources for scientific research. For example, where flood plains contain unique ecological habitats, they make excellent areas for scientific study. Flood plains may provide open space community resources. In urban communities, they may provide green belt areas to break urban development monotony, absorb noise, clean the air and lower temperatures. Flood plain parks can also serve as nature study centers and laboratories for outdoor learning experiences.

It is recommended that several selected open space areas be preserved, especially in the undeveloped areas. Their preservation, in accordance with soil limitations and good land use management, will reduce development hazards, prevent additional future flood damages and enhance the urban environment.

1. Soils with high water tables should be retained in natural vegetation. No commercial or residential construction should take place on these soils since the limitations are very severe. The Soil Conservation Service has completed a detailed soil survey of Branch County. Copies of the material, including maps and interpretations, are available for reference in the Branch County Soil Conservation District Office located at 1110 West Chicago Road, Coldwater, Michigan 49036-9307. This information can be used to determine the kinds of soils in a given area and their limitations for various uses.

2. Upland open space should be retained in the natural state as much as possible.

3. Private wooded areas on steep slopes should be preserved from all development. Destruction of natural cover on these steep slopes usually causes excessive erosion during construction. Preservation of these wooded sites would also enhance housing developments in the area.

4. Developing areas should provide on-site flood water storage to temporarily store additional runoff volumes and peaks created by their urbanization.

5. Undeveloped flood plain areas should be managed for wildlife and recreation. These areas have potential for an excellent outdoor classroom. The Coldwater River system is easily accessible to many school and college students.

Non-Structural Measures

1. Develop and implement, or update, a flood plain protection and zoning ordinance based on the 100-year frequency high water profile and the flood plain delineations (Appendix A). Retaining the storage in the existing flood plain area will be necessary if this flood profile is to remain valid. Reducing the storage capacity in the system will tend to increase elevations and discharges above that indicated in this report.

2. Flood proof buildings and residences already in the flood plain to reduce flood damages. Some basement windows and doors, floor drains and foundations can be modified to reduce effects of flood waters. Materials and supplies stored in vulnerable positions can be relocated and protected. These modifications can be planned and installed where it is desirable and/or feasible to continue using facilities currently in the flood plain.

3. Plans should be developed for alternate routes for automobile, truck and emergency vehicle traffic around those roads that will be inundated during the flood. This will require cooperation between city, township, county and state officials.

4. Maintenance of the Sauk River from the outlet at South Lake through the city of Coldwater appears to be good. Debris, fallen trees and brush should be removed at least yearly. Snow and ice from road clearing operations should not be piled in the flood plain. The dam should be opened as early in the fall as possible to provide storage for spring runoff.

5. Owners and occupants of all types of buildings and mobile homes should obtain flood insurance coverage for the structure and contents, especially if located within or adjacent to the delineated flood hazard areas. The Sponsors should make necessary applications and pass needed resolutions and zoning ordinances to qualify for subsidized federal flood insurance. Contact the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909 for additional information.

Structural Measures

Flood stages can be reduced by improving flow conditions within the channel by increasing the stream's carrying capacitiy. Methods recommended are improved bridge openings with reduced channel obstructions.

The following structural measures were considered as requested by the Sponsors:

Coldwater River:

1. Replace existing bridge deck at Blackhawk Road and excavating the bottom to elevation 940.2 ft. Abutments would need to be analyzed for structural adequacy. In addition, channel construction would be required from Station 97+00 to Station 114+00. The installation of these structural measures would allow safe passage of a 100-year flood.

Sauk River:

1. Currently, the city owns much of the land between Jay Street and the South Lake Outlet and plans on developing a natural hiking and biking trail along the Sauk River. This is an excellent use of the flood plain. Filling should be held to a minimum.

2. Construction of a 1.44 foot high dike to elevation 962 ft. along the east side of South Business 69, approximately 1/4 mile north of Garfield Street, would force water back into the channel and reduce flooding on the west side of Old 27. The tailwater above South Business 69 would increase by approximately 0.4 feet for the 100-year flood. Flood easements would need to be obtained.

3. Channel construction for a distance of about 2.7 miles from Sprague Street to the foot bridge at Station 277+98 on the Sauk River would provide capacity for a 100-year flood in the residential areas east of I-69. Michigan Avenue, Willowbrook Road and Fiske Road bridges would need to be replaced.

South Lake Drain:

1. The following road crossings are undersized for a 100-year flood and should be replaced as follows:

Crossing	Existing	Improved
Race Street, C.S.20.0	4.5 ft. CMP *	7.25 ft. X 11.42 CSP Arch **
Butters Ave, C.S.20.0	5 ft. CMP	2-5.4 ft. X 7.67 ft. CSP Arch
Penn Central R.R., C.S.21.0	Bridge	Replacement not needed
Garfield Road, C.S.22.0	3.5 ft. CMP	2-5.08 ft. X 7 ft. CSP Arch
Farm Lane, C.S.22.5	2-2.5 ft. CMP	2-5.75 ft. X 8.17 ft. CSP Arch
Farm Lane, C.S.23.0	3.5 ft. CMP	2-5.75 ft. X 8.17 ft. CSP Arch

* Corrugated metal pipe.
** Corrugated steel pipe arch.

2. In addition to replacing the crossings, some channel construction will be required near the farm crossings at C.S.22.5 and C.S.23.0.

3. The South Lake drainage area is becoming increasingly industrialized. Further development will increase storm runoff and the use of retention ponds is recommended.

County Drain No. 40:

1. Channel construction is needed for a distance of about 1.8 miles from about 600 ft. below Dorrance Road to Wood Road at Station 158+00. Both Wood Road crossing and Dorrance Road crossing would need to be replaced. The work will provide protection from a 100-year flood.

APPENDIX A

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

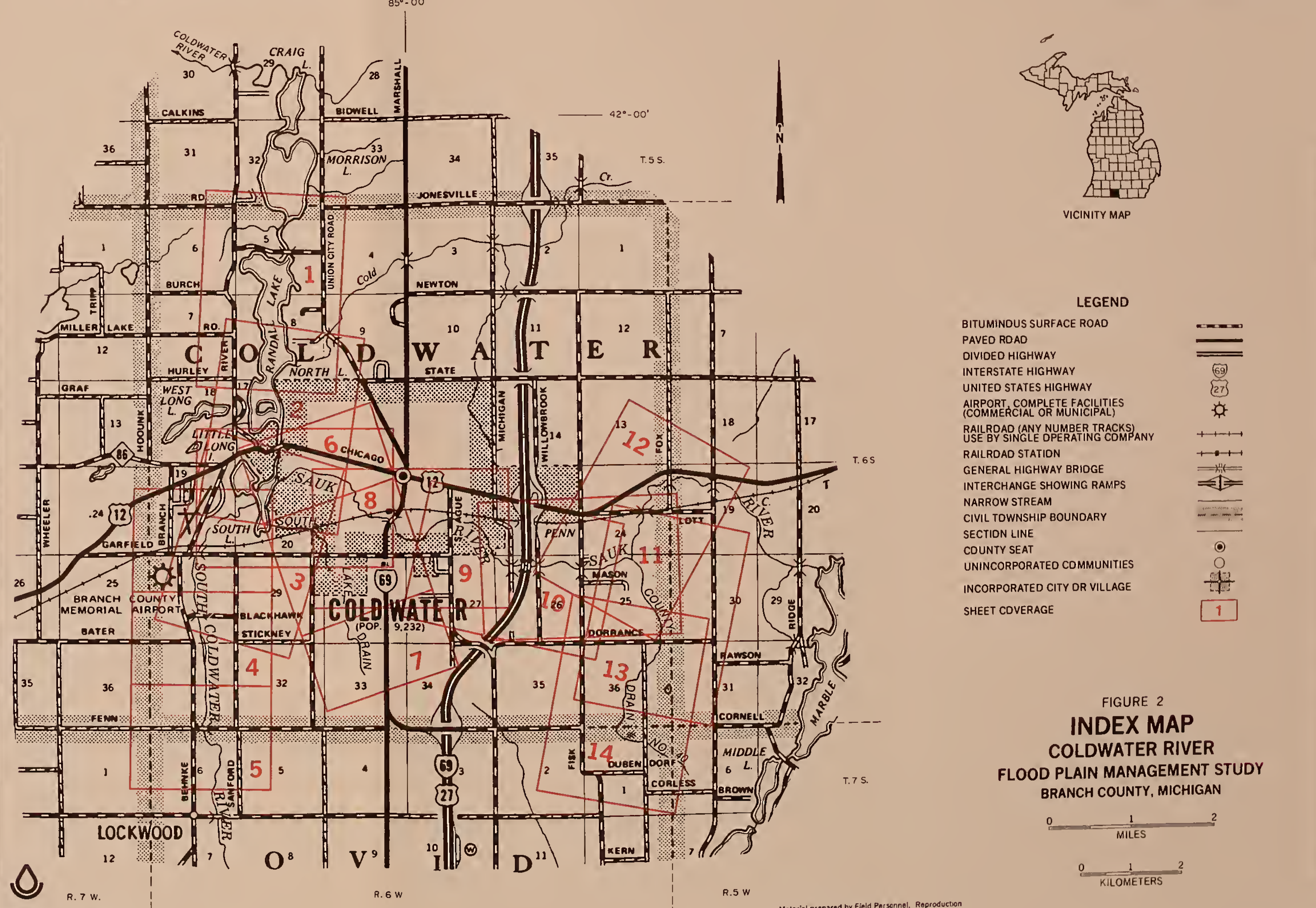

FIGURE 2

INDEX MAP

COLDWATER RIVER

FLOOD PLAIN MANAGEMENT STUDY

BRANCH COUNTY, MICHIGAN

SOURCE:
MICHIGAN COUNTY HIGHWAY MAP.
POLYCONIC PROJECTION.

Material prepared by Field Personnel. Reproduction only by SCS Cartographic Staff, Fort Worth, Texas.

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LEGEND

▨ 100 Year Flood Hazard Area

▨ 500 Year Flood Hazard Area

63.0 Valley Section Location

→ Stream Channel

0+00 Channel Station

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

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FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

LOWER LAKE CHAIN

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LEGEND

▨	100 Year Flood Hazard Area	⟶	Stream Channel
▨	500 Year Flood Hazard Area	0+00	Channel Station
63.0	Valley Section Location		

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BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

LOWER LAKE CHAIN

NOTE:
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BRIDGE DECK ┬
ROAD OVERFLOW ●
BRIDGE LOW CHORD ┴

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HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
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		Date
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Traced		
Checked	R.H. BAUERLE	11-87

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Title
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LEGEND

🟦	100 Year Flood Hazard Area
🟦	500 Year Flood Hazard Area
63.0	Valley Section Location
→	Stream Channel
0+00	Channel Station

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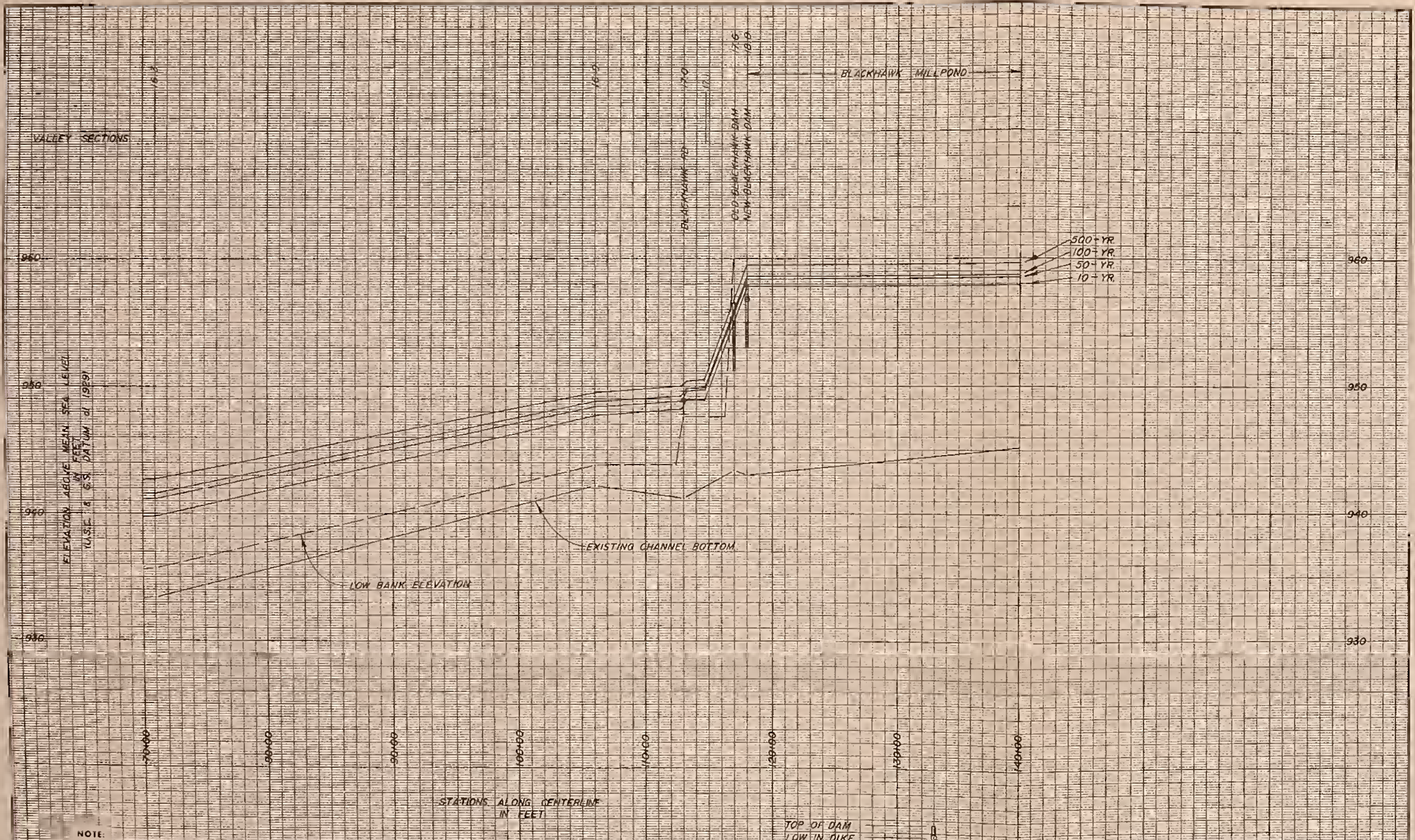
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLDWATER RIVER



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HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
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LEGEND

▨ 100 Year Flood Hazard Area

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63.0 Valley Section Location

→ Stream Channel

0+00 Channel Station

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FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLDWATER RIVER

SHEET 4 OF 14

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ROAD OVERFLOW
BRIDGE LOW CHORD

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HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

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LEGEND

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- ▨ 500 Year Flood Hazard Area
- 63.0 Valley Section Location
- → Stream Channel
- 0+00 Channel Station

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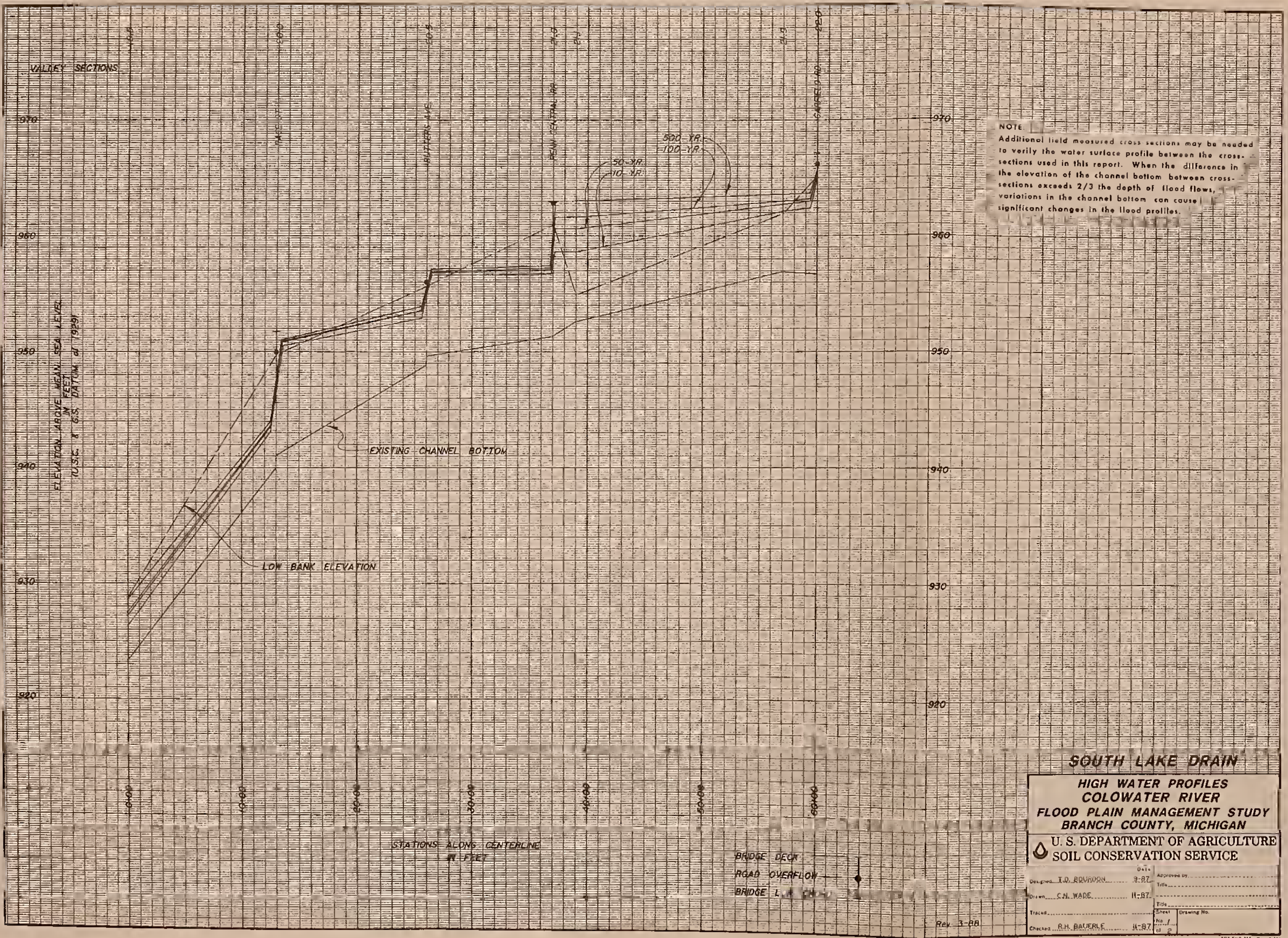
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COLDWATER RIVER

MAY 1988 1003392



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SOUTH LAKE DRAIN

HIGH WATER PROFILES
COLOWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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LEGEND

▭	100 Year Flood Hazard Area
▬	500 Year Flood Hazard Area
63.0	Valley Section Location
→	Stream Channel
0+00	Channel Station

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FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

SOUTH LAKE DRAIN

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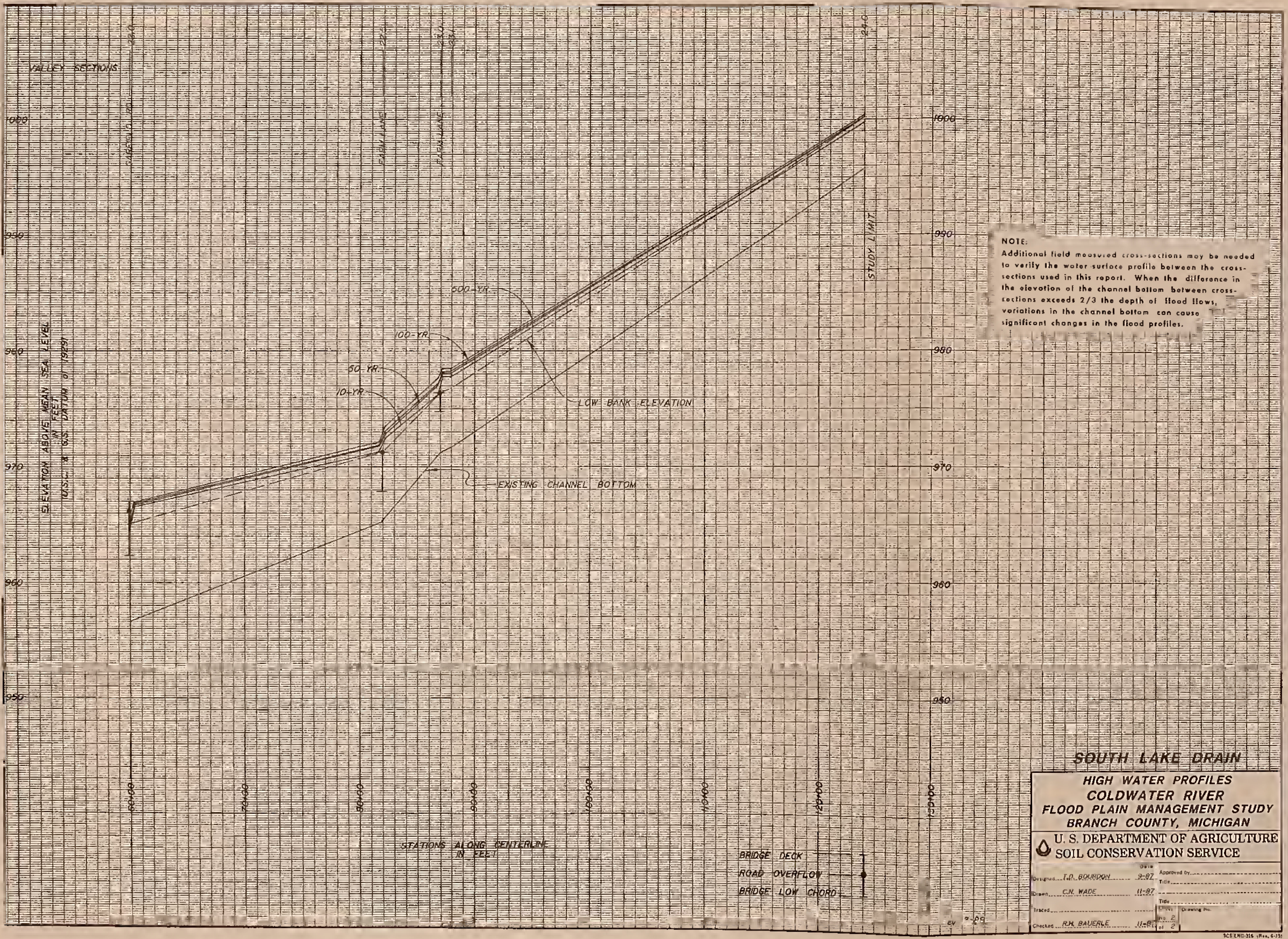

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SOUTH LAKE DRAIN

HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

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LEGEND

▨ 100 Year Flood Hazard Area

▨ 500 Year Flood Hazard Area

63.0 Valley Section Location

→ Stream Channel

0+00 Channel Station

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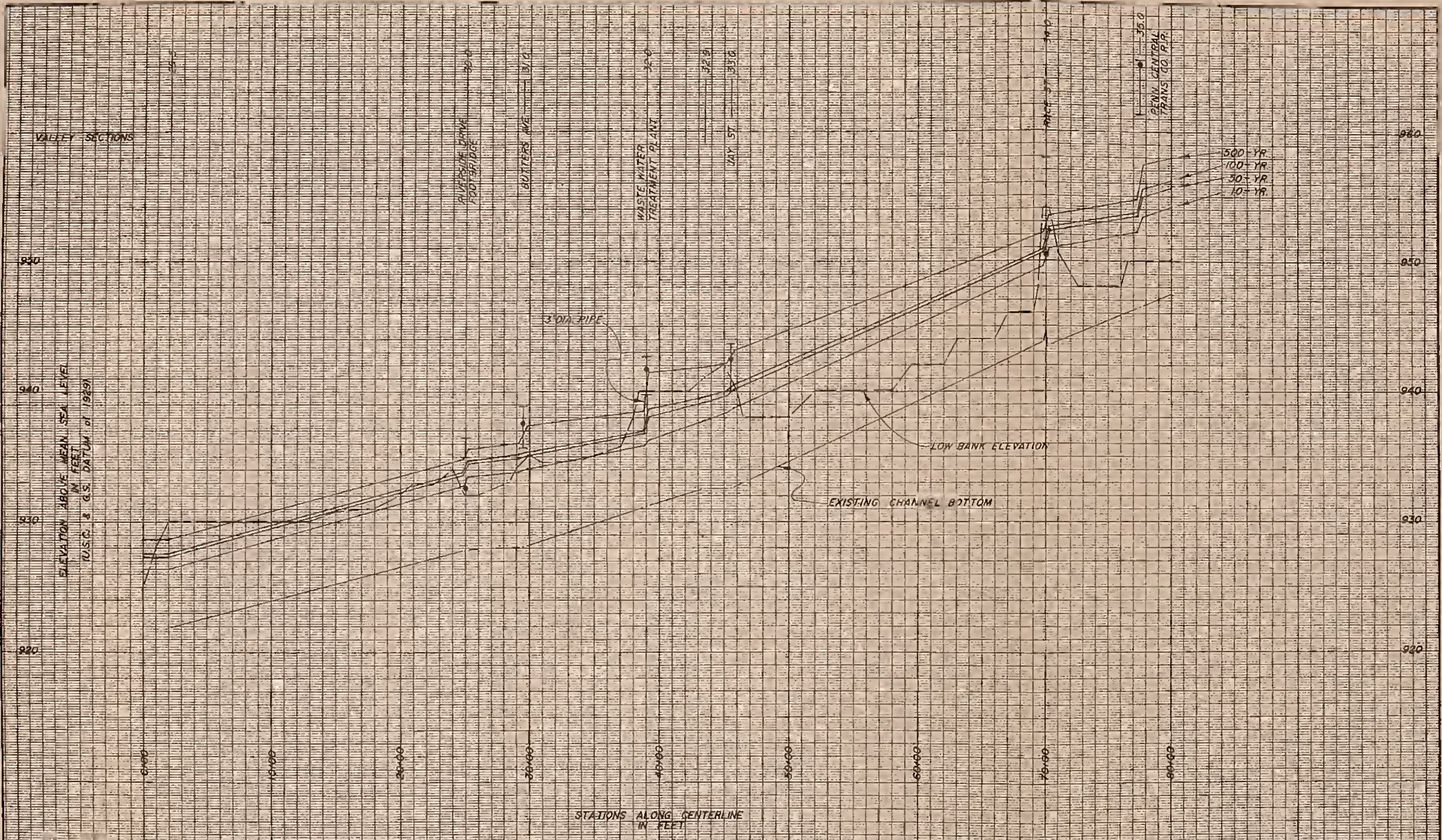
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

SOUTH LAKE DRAIN



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SAUK RIVER

HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

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LEGEND

▨ 100 Year Flood Hazard Area

▨ 500 Year Flood Hazard Area

63.0 Valley Section Location

Stream Channel

0+00 Channel Station

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COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

SAUK RIVER

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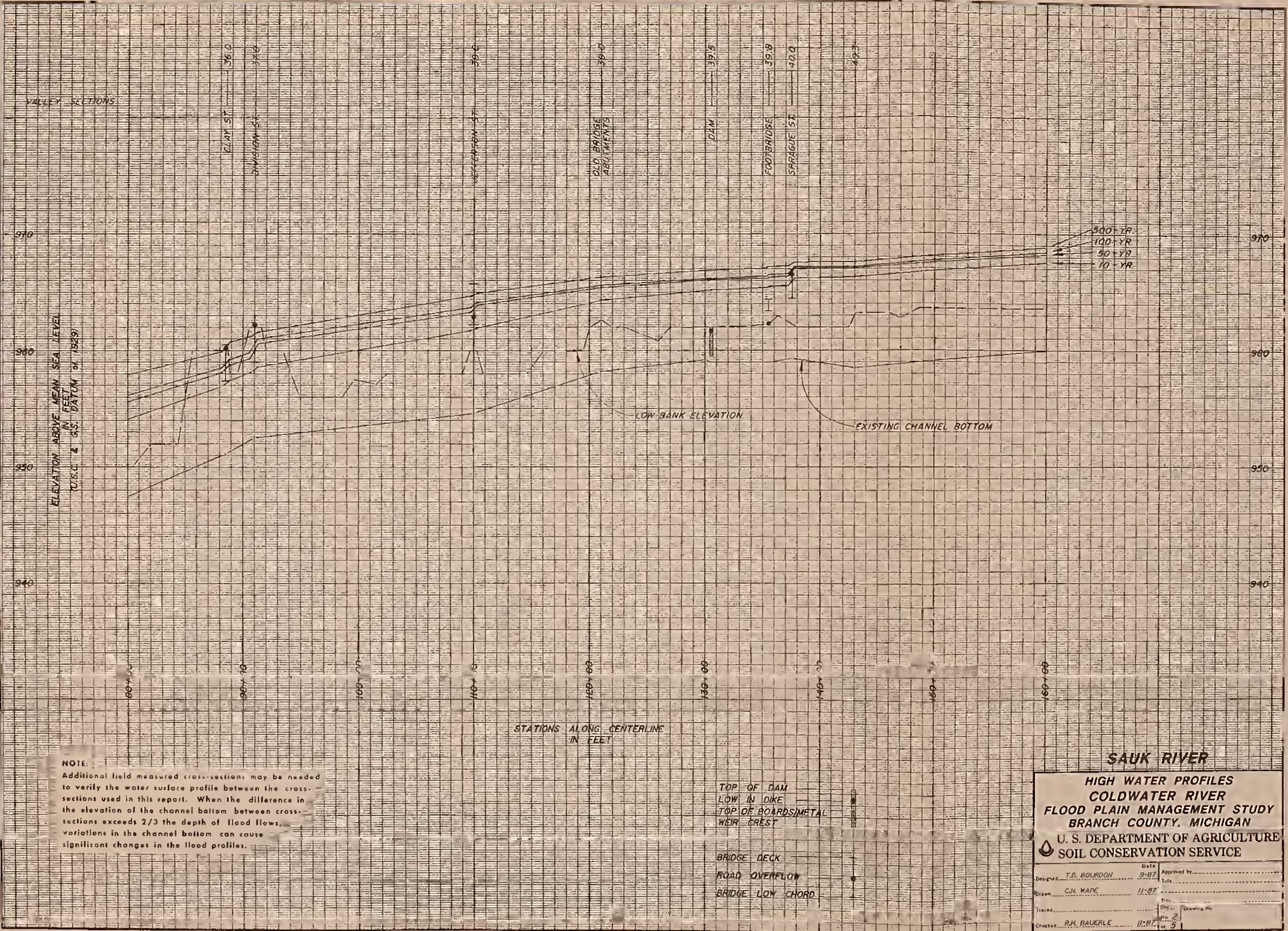

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SAUK RIVER

HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

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LEGEND

▨	100 Year Flood Hazard Area
▨	500 Year Flood Hazard Area
53.0	Valley Section Location
→	Stream Channel
0+00	Channel Station

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BRANCH COUNTY, MICHIGAN

SHEET 9 OF 14

FLOOD HAZARD AREA

SAUK RIVER

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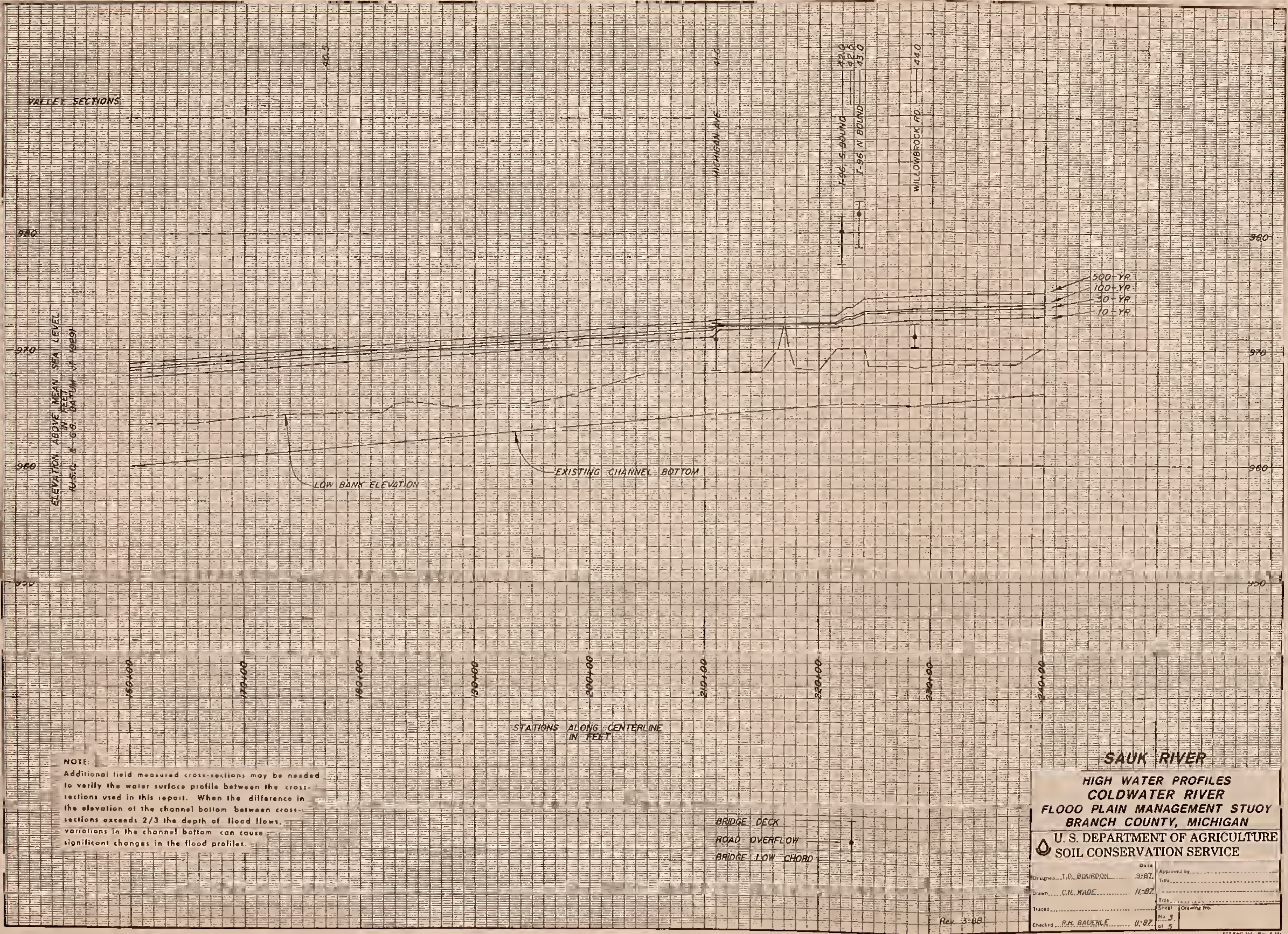

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SAUK RIVER

HIGH WATER PROFILES
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FLOOO PLAIN MANAGEMENT STUOY
BRANCH COUNTY, MICHIGAN

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LEGEND

🟦 100 Year Flood Hazard Area

🟦 500 Year Flood Hazard Area

63.0 Valley Section Location

Stream Channel

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BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

SAUK RIVER

SHEET 10 OF 14

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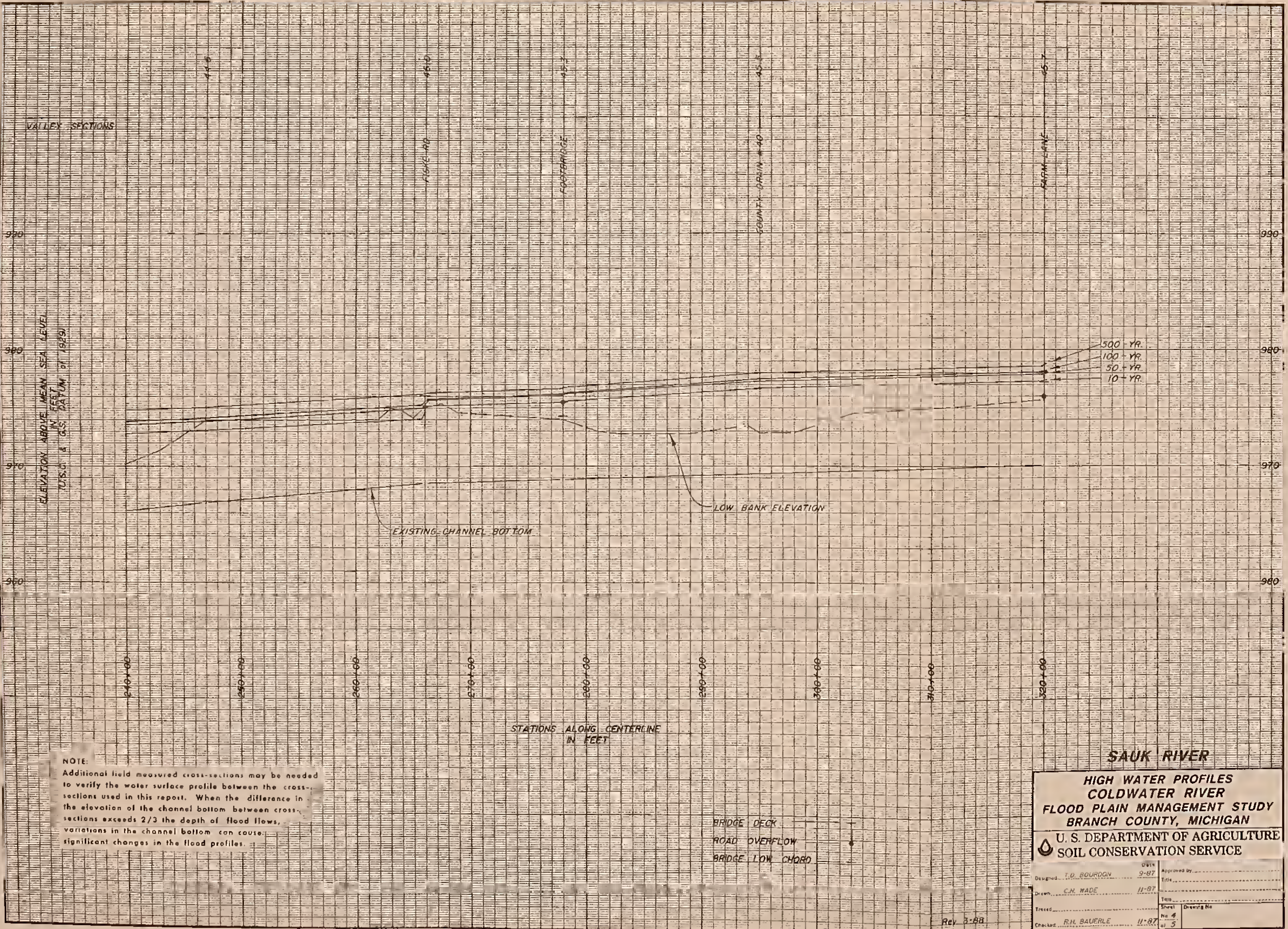

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SAUK RIVER

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BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
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Title
Title

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LEGEND

▨	100 Year Flood Hazard Area
🟦	500 Year Flood Hazard Area
63.0	Valley Section Location
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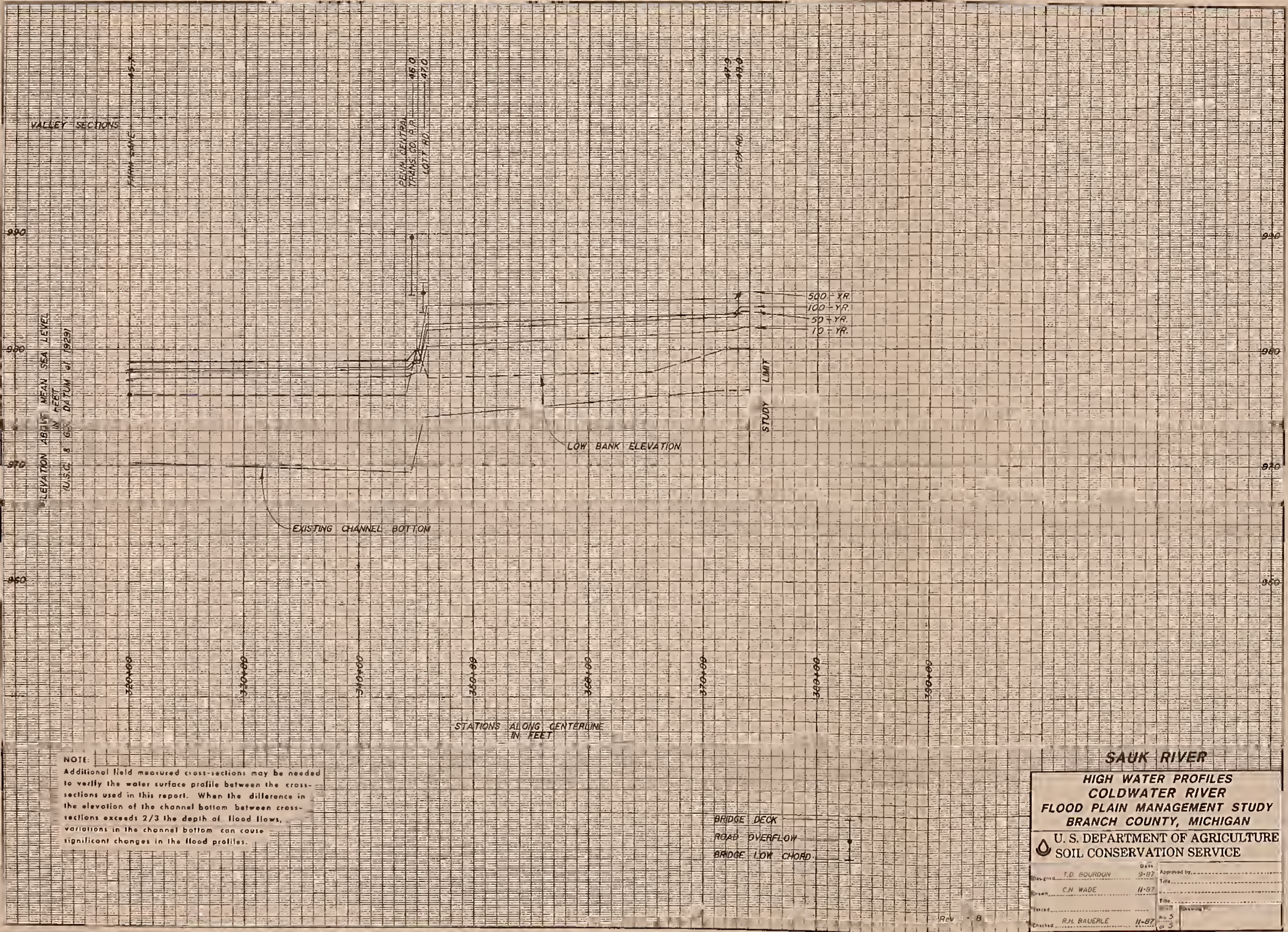
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

SAUK RIVER

MAY 1988 1003392



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SAUK RIVER

HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. BOURDON Date 9-87
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LEGEND

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BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

SAUK RIVER

SHEET 12 OF 14

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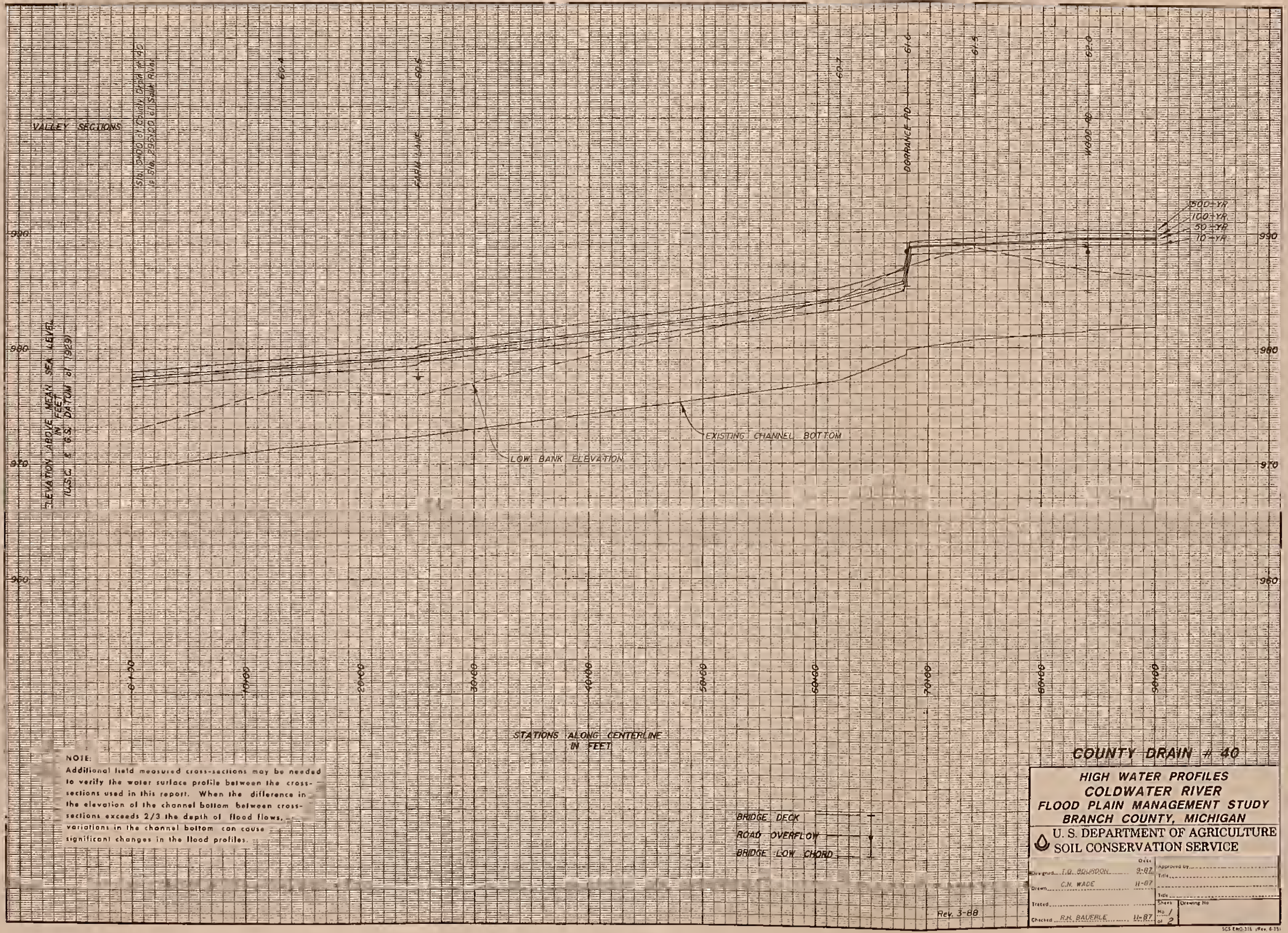

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COUNTY DRAIN # 40

HIGH WATER PROFILES
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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LEGEND

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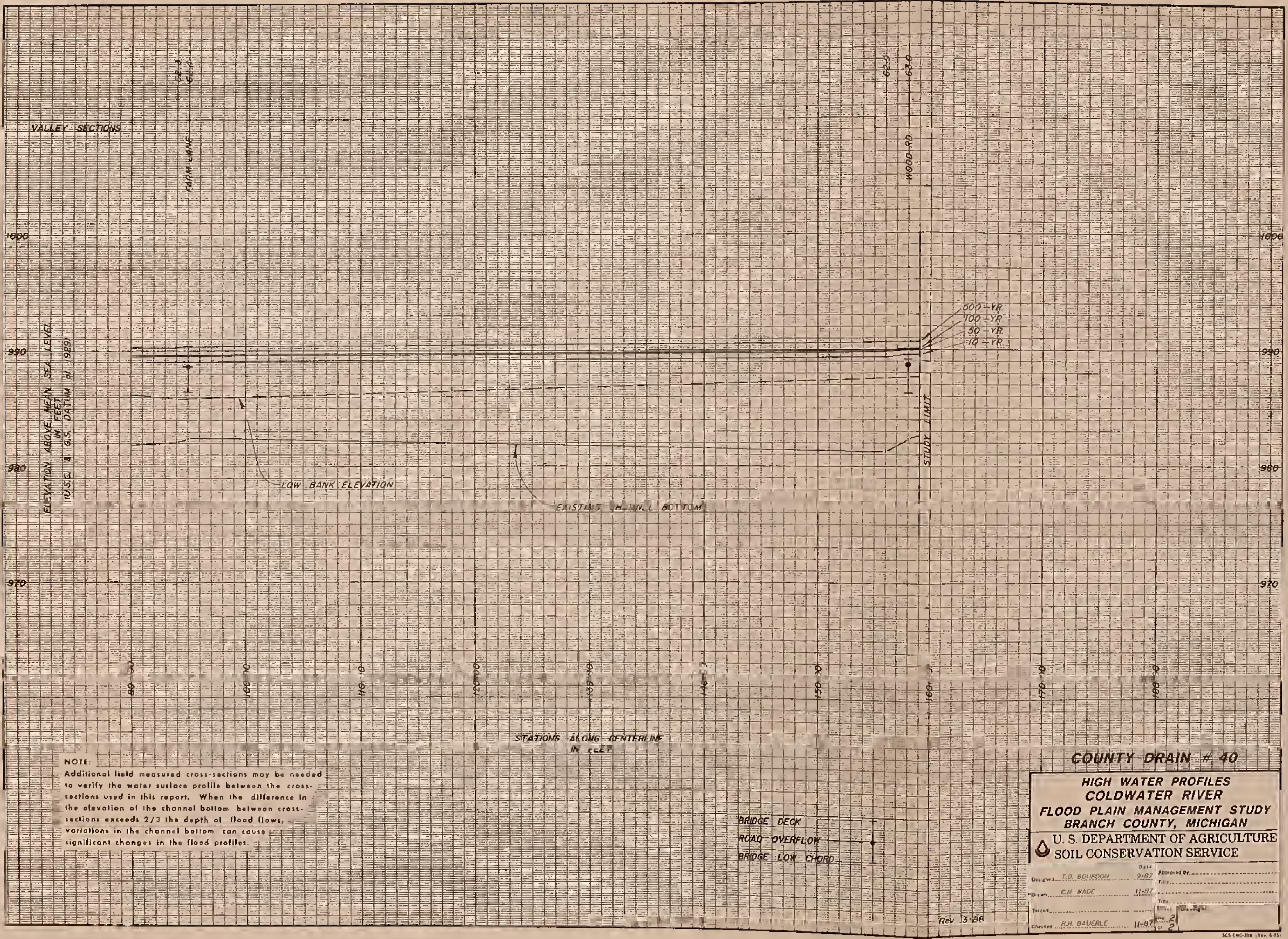
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

FLOOD HAZARD AREA

COUNTY DRAIN 40

MAY 1988 1003392



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FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	T.D. BOURDON	9-87	Approved by
Drawn	C.N. WADE	11-87	Title
Traced			Title
Checked	R.H. BAUERLE	11-87	Sheet No. 2 of 2 Drawing No.

SCS-ENG-318 (Rev. 8-75)

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT WORTH, TX 1988

LEGEND

🟦 100 Year Flood Hazard Area

🟦 500 Year Flood Hazard Area

63.0 Valley Section Location

→ Stream Channel

0+00 Channel Station

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.

SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

1985 Photography From
Abrams Aerial Survey Corp.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

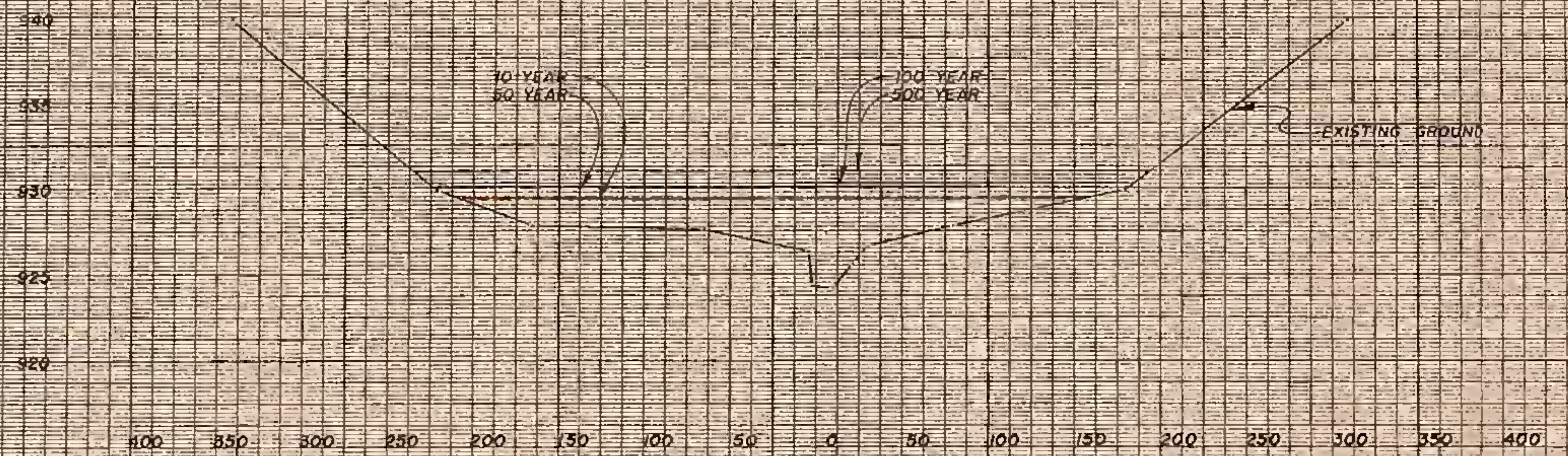
SHEET 14 OF 14

FLOOD HAZARD AREA

COUNTY DRAIN 40

MAY 1988 1003392

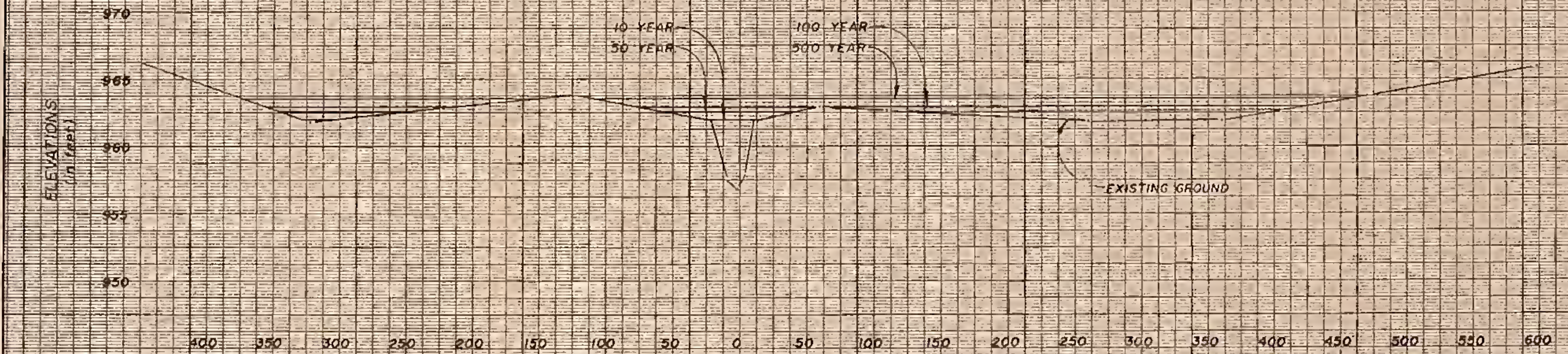
APPENDIX B



SECTION 14.8 — STATION 26+00

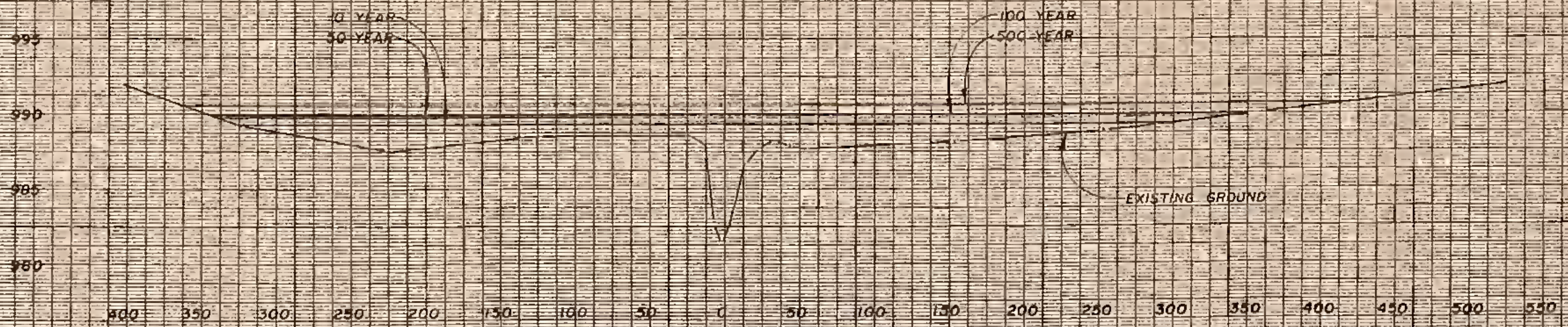
COLDWATER RIVER

(DISTANCE (in feet))



SECTION 21.9 — STATION 57+00

SOUTH LAKE DRAIN



SECTION 62.5 — STATION 156+00

COUNTY DRAIN #40

Rev. 3-88

TYPICAL VALLEY SECTIONS

COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

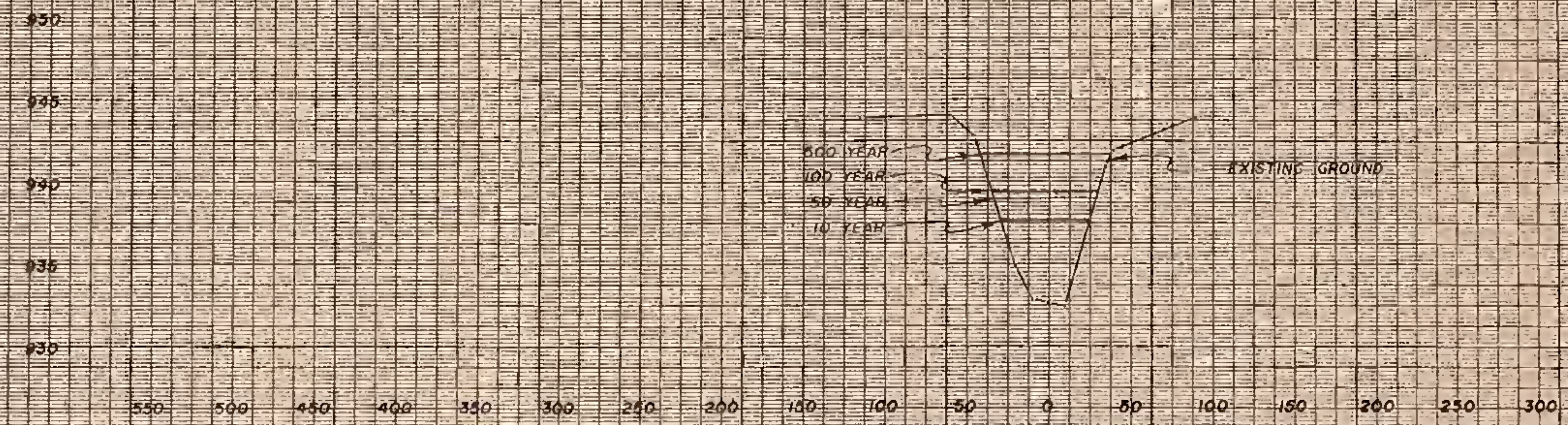
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	T.D. Bourdon	12-8
Drawn	C.N. Wade	12-8
Traced		
Checked	R.H. Bauerle	12-8

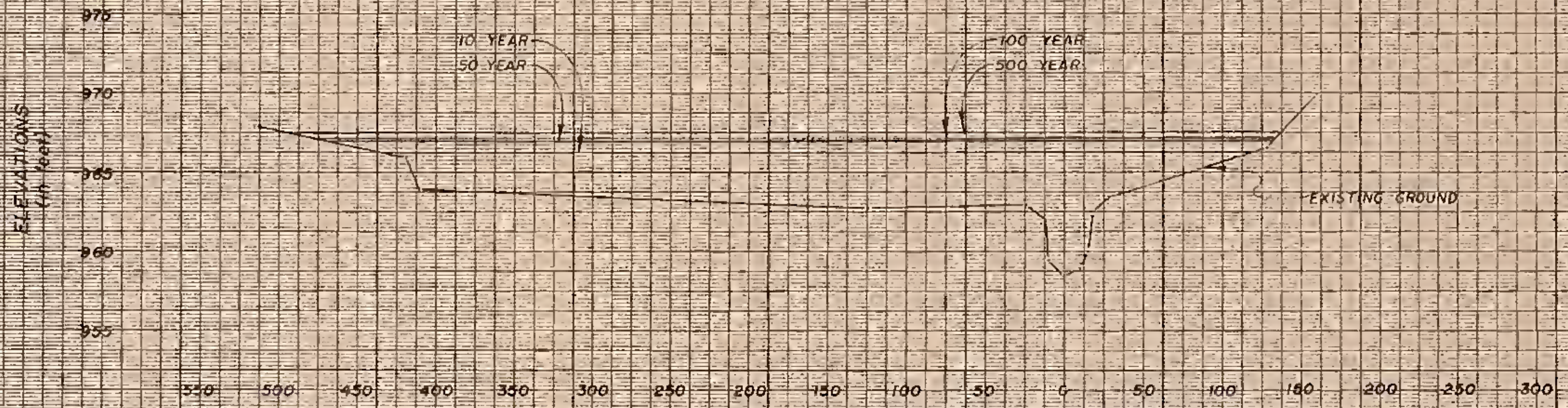
Approved by
Title
Title

Sheet No. 1 of 2
Drawing No.

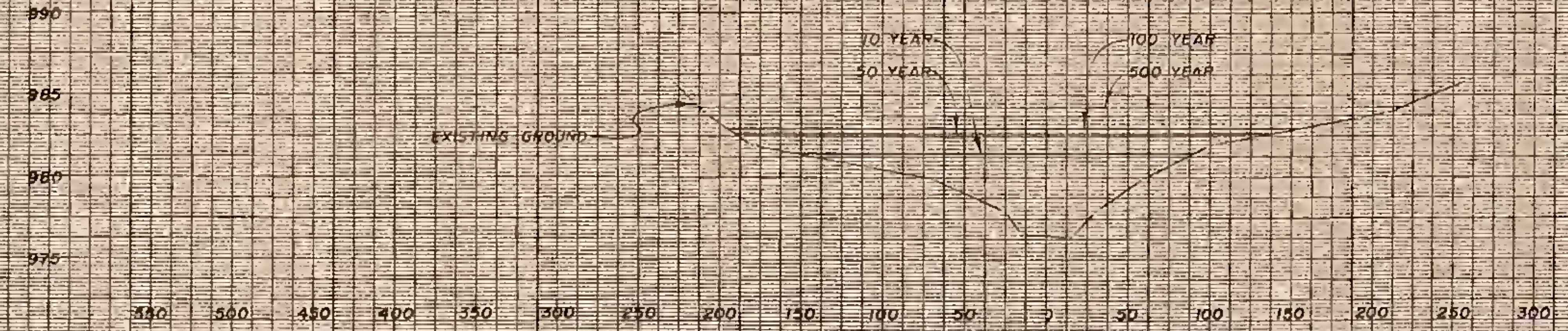
SCS-ENG-316 (Rev. 5-75)



SECTION 32.9 -- STATION 48+50
SAUK RIVER
DISTANCE (in feet)



SECTION 40.3 -- STATION 143+00
SAUK RIVER



SECTION 47.9 -- STATION 372+00
SAUK RIVER

Rev. 3-88

TYPICAL VALLEY SECTIONS

COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	T.D. Bourdon	12-8
Drawn	C.N. Wade	12-8
Traced		
Checked	R.H. Bauerle	12-8

Approved by
Title
Title
Sheet No. 2 of 2
Drawing No.

APPENDIX C

TABLE 1 - FLOOD DISCHARGES - REV. 3/88

LOCATION	TR-20 SEC.	FROM WSP-2 SEC.	TO WSP-2 SEC.	DRAINAGE AREA SQ MILES	ESTIMATED PEAK DISCHARGES (CUBIC FEET PER SECOND)			
					10-YR	50-YR	100-YR	500-YR
COLDWATER RIVER								
* From Coldwater Lake to Station 484+00	001	19.8	19.5	42.10	145	175	185	210
To Station 335+00	009	19.4	19.3	49.58	555	785	855	1195
To Fenn Road	016	19.2	18.9	69.56	980	1430	1600	2290
To Blackhawk Millpond Inflow	018	-	-	71.4	1235	1800	2015	2870
From Blackhawk Millpond Outflow	03	-	-	71.4	1060	1530	1685	2320
To Garfield Road	019	17.1	15.9	71.4	1060	1530	1685	2320
To South Lake	024	15.5	14.7	72.23	1060	1530	1685	2330
SAUK RIVER								
* From Marble Lake to upstream Freemont Road	025	52.1	49.9	42.10	160	210	230	275
To downstream of Fox Road	028	49.1	47.95	44.47	260	350	385	525
To upstream of the Junction of Co. Drain #40	033	47.9	45.6	47.02	425	595	660	850
To downstream of I-69	045	45.5	41.9	53.32	735	1030	1140	1545
To downstream of Sprague Street	047	41.1	39.95	54.52	795	1125	1245	1695
To South Lake	060	39.9	29.5	56.22	855	1220	1345	1820
SOUTH LAKE DRAIN								
To Garfield Road	064	24.0	21.95	1.59	225	355	405	600
To South Lake	067	21.9	19.5	2.28	285	410	455	605
COUNTY DRAIN NO. 40								
To Wood Road	034	63.1	62.95	1.38	130	200	230	335
To Dorrance Road	037	62.9	60.9	2.90	215	260	275	390
To Outlet	040	60.7	60.3	4.66	310	400	440	650
OUTLET OF LOWER LAKE CHAIN	04	-	-	173.3	1395	1910	2115	2900

* Flood discharges from (WRSCOLDW/TR20)

TABLE 2 - FLOOD ELEVATIONS AT SECTIONS - REV. 3/88

LOCATION	SECTION	STATION	10-YEAR	50-YEAR	100-YEAR	500-YEAR
COLDWATER RIVER						
Confluence at South Lake	-	0+00	926.3	927.2	927.5	928.6
	14.7	5+00	926.3	927.2	927.5	928.6
	14.8	26+00	929.5	930.2	930.4	931.1
Penn. Central Railroad	15.0 D	52+78	937.2	937.7	937.9	938.4
	15.0 U	53+22	937.7	938.9	939.3	940.9
	15.5	56+00	938.1	939.1	939.5	941.0
Garfield Road	16.0 D	60+74	938.7	939.6	940.0	941.3
	16.0 U	61+27	939.3	940.8	941.3	942.4
	16.3	71+00	939.8	941.2	941.6	942.7
	16.9	106+00	947.7	948.4	948.8	949.5
Blackhawk Road	17.0 D	112+83	948.2	948.8	949.2	950.0
	17.0 U	113+17	948.9	949.6	949.8	950.4
	17.1	114+70	948.9	949.7	949.9	950.5
* New Blackhawk Dam	18.0	118+00	957.8	958.4	958.6	959.5
Fenn Road	19.0 D	192+69	958.1	958.7	958.9	959.8
	19.0 U	193+31	959.4	959.8	959.9	960.4
	19.1	196+00	959.7	960.2	960.4	961.1
SAUK RIVER						
Confluence at South Lake	-	0+00	926.3	927.2	927.5	928.6
	29.5	2+00	926.3	927.2	927.5	928.6
Riverside Drive Footbridge	30.0 D	24+92	932.7	933.5	933.7	934.7
	30.0 U	25+09	933.4	934.4	934.6	935.5
Butters Avenue	31.0 D	29+10	933.8	934.8	935.1	936.0
	31.0 U	29+91	934.0	935.0	935.3	937.3
Waste Water Treatment Plant	32.0 D	38+76	935.8	936.7	936.9	938.4
	32.0 U	39+24	936.2	938.0	938.6	941.4
	32.9	43+50	937.7	939.1	939.5	941.8
Jay Street	33.0 D	45+19	938.3	939.6	940.0	942.1
	33.0 U	45+81	938.7	940.1	940.5	943.1

* From (WRSCOLDS/TR20), Rev. 3/88, Structure 03

LOCATION	SECTION	STATION	10-YEAR	50-YEAR	100-YEAR	500-YEAR
SAUK RIVER - Continued						
Race Street	34.0 D	69+76	949.5	950.6	950.8	952.1
	34.0 U	70+24	950.9	952.2	952.5	953.4
Penn. Central Trans. Co. Railroad	35.0 D	77+28	952.2	953.4	953.7	954.7
	35.0 U	77+73	953.3	954.9	955.5	957.4
Clay Street	36.0 D	88+15	956.9	958.1	958.5	959.9
	36.0 U	88+85	957.4	958.7	959.2	960.7
Division Street	37.0 D	90+65	958.1	959.3	959.8	961.2
	37.0 U	91+35	958.6	960.6	961.0	961.6
Jefferson Street	38.0 D	109+74	961.7	963.3	963.7	964.7
	38.0 U	110+26	961.9	963.9	964.1	964.9
Old Bridge Abutment Dam	39.0	121+00	964.3	965.4	965.6	966.3
	39.5	130+50	965.2	966.1	966.2	966.9
Footbridge	39.8 D	135+48	965.4	966.2	966.4	967.1
	39.8 U	135+52	965.5	966.3	966.5	967.2
Spraque Street	40.0 D	137+23	965.6	966.4	966.6	967.3
	40.0 U	137+77	966.2	967.1	967.2	967.6
	40.3	143+00	966.3	967.1	967.2	967.6
	40.5	177+00	968.8	969.4	969.7	970.1
Michigan Avenue	41.0 D	210+70	971.1	971.7	971.9	972.5
	41.0 U	211+30	971.7	972.1	972.2	972.6
I-69, S. Bound	42.0 D	221+50	971.9	972.2	972.3	972.9
	42.0 U	222+50	972.0	972.6	972.8	973.6
	42.5	222+75	972.0	972.6	972.8	973.6
I-69, N. Bound	43.0 D	223+00	972.0	972.6	972.8	973.6
	43.0 U	224+00	972.2	973.0	973.2	974.3
Willowbrook Road	44.0 D	228+28	972.4	973.2	973.4	974.5
	44.0 U	228+72	972.4	973.2	973.4	974.5
	44.5	247+00	973.1	973.9	974.2	975.1
Fiske Road	45.0 D	265+77	974.1	975.0	975.3	976.2
	45.0 U	266+23	975.2	975.7	975.8	976.3
Footbridge	45.3 D	277+98	975.5	976.1	976.2	976.7
	45.3 U	278+02	975.6	976.2	976.3	976.8
Confluence at Co. Drain #40	45.5	295+00	976.7	977.3	977.5	978.0
Farm Lane	45.7 D	319+87	977.3	977.9	978.1	978.6
	45.7 U	320+13	977.4	978.0	978.2	978.8

LOCATION	SECTION	STATION	10-YEAR	50-YEAR	100-YEAR	500-YEAR
<u>SAUK RIVER - Continued</u>						
Penn. Central Trans. Co.	46.0 D	344+18	977.6	978.2	978.4	979.0
Railroad	46.0 U	344+82	977.9	978.7	979.0	979.8
Lott Road	47.0 D	345+22	977.9	978.8	979.0	979.8
	47.0 U	345+78	980.2	981.6	982.1	983.7
	47.9	372+00	981.5	982.7	983.0	984.3
Fox Road	48.0 D	372+75	981.6	982.7	983.1	984.3
	48.0 U	373+25	981.8	983.2	983.6	984.9
<u>SOUTH LAKE DRAIN</u>						
Confluence at South Lake	19.5	0+00	926.3	927.2	927.5	928.6
Race Street	20.0 D	12+51	943.1	943.5	943.6	944.0
	20.0 U	13+49	950.5	950.8	950.9	951.0
Butters Avenue	20.5 D	25+60	952.9	953.5	953.6	953.9
	20.5 U	26+41	956.6	956.8	956.9	957.1
Penn. Central Railroad	21.0 D	36+87	956.7	957.1	957.2	957.4
	21.0 U	37+13	958.6	960.6	961.6	963.0
	21.1	39+00	958.6	960.6	961.6	963.0
	21.9	57+00	962.1	962.7	963.0	963.6
Garfield Road	22.0 D	59+58	962.4	963.0	963.2	963.7
	22.0 U	60+42	966.6	966.8	966.9	967.0
Farm Lane	22.5 D	81+81	971.3	971.8	971.9	972.2
	22.5 U	82+19	972.5	972.9	973.1	973.5
Farm Lane	23.0 D	86+79	976.2	977.0	977.2	977.7
	23.0 U	87+21	977.8	978.1	978.2	978.5
	23.1	88+00	977.8	978.1	978.3	978.5
	24.0	124+00	999.7	1000.1	1000.2	1000.3
<u>COUNTY DRAIN #40</u>						
Confluence at Sauk River	-	0+00	976.7	977.3	977.5	978.0
	60.4	13+00	977.7	978.3	978.5	979.1
Farm Lane	60.6 D	24+86	978.6	979.2	979.4	980.1
	60.6 U	25+14	978.9	879.3	979.5	980.3
	60.7	62+00	983.3	984.1	984.3	985.2
Dorrance Road	61.0 D	67+74	984.9	985.5	985.7	986.7
	61.0 U	68+26	988.0	988.6	988.7	989.1
	61.5	74+00	988.3	988.9	989.0	989.5

LOCATION	SECTION	STATION	10-YEAR	50-YEAR	100-YEAR	500-YEAR
<u>COUNTY DRAIN #40 - Continued</u>						
Wood Road	62.0 D	83+77	988.9	989.5	989.6	990.3
	62.0 U	84+23	989.0	989.5	989.6	990.3
	62.3	94+00	989.1	989.6	989.7	990.3
Farm Lane	62.4 D	94+86	989.1	989.6	989.7	990.4
	62.4 U	95+14	989.1	989.6	989.7	990.4
	62.9	156+00	989.4	989.9	990.0	990.7
Wood Road	63.0 D	157+68	989.6	990.0	990.1	990.7
	63.0 U	158+32	989.6	990.0	990.1	990.7
<u>LOWER LAKE CHAIN</u>						
	04	-	926.3	927.2	927.5	928.6

APPENDIX D

INVESTIGATIONS AND ANALYSES

Survey Procedures

Field surveys were made of bridges, roads, structures, channels and flood plains of the Coldwater River and its tributaries by the Soil Conservation Service and Coldwater Township employees in 1986. Temporary bench marks based on USC&GS mean sea level elevations datum of 1929 were also set at this time and used for this study. In addition, several temporary bench marks set by the city of Coldwater were used. Surveys were made using second order accuracy. Temporary bench marks are described in Appendix E of this report.

For the Coldwater River and its tributaries, 22 valley and channel cross-sections plus 47 roads, bridges and structures were surveyed. Aerial photography flown on March 27, 1985 was used as a base for the photo mosaic sheets used to delineate the flood plains. U.S. Geologic Survey topographic maps and two-foot contour maps prepared by Abrams Aerial Survey were used to extend valley cross-sections.

Hydrology and Hydraulics

Physical data were obtained from U.S.G.S. topographic maps, soil survey maps, local topographic maps and aerial photographs, as well as on-site field inspections. The watershed boundary was determined from map studies and field checks. The watershed was divided into 29 sub-watershed areas for use in evaluating the runoff volumes. Drainage areas for the sub-watersheds were measured from U.S.G.S. topographic maps. Times of concentration were calculated for the sub-watersheds using the upland flow method. With the exception of sub-watershed 1A, each sub-watershed was evaluated for land use, cover and soils. Runoff curve numbers were calculated.

The analysis basically consists of three parts, which includes the Upper Lake Chain, the Coldwater River and its tributaries and the Lower Lake Chain. Breach routings were not considered in this study.

Upper Lake Chain:

> The lakes were treated as one body of water. The drainage area above the lakes is approximately 84 square miles. Some of the soils are very sandy and pervious with considerable vegetative cover. Also, some of the roads prevent surface runoff from directly entering the lakes. In addition, some of the smaller lakes and swamps above the Upper Lake Chain are landlocked. Therefore, a surface water analysis alone would not be adequate. Snowmelt and groundwater needed to be included.

Information from U.S.G.S. stream gage No. 04096600, located near Hodunk, was utilized to develop information for the TR-20 flood routing program and used to determine elevations and peak discharges out of the lakes. Inflow hydrographs into the lakes were developed based on a volume-duration-probability analysis of the gage and the area above the lakes. Outflow hydrographs were based on elevation-discharge relationships developed by the WSP-2 water surface profile program and storage calculations. A starting lake elevation of 984.5 feet was used to model existing conditions. The TR-20 computer program used the Storage Indication method of evaluating the effect of the lakes in reducing peak flood discharges into the Sauk River and South Coldwater River. Discharges obtained from the flood routings and lake elevations are shown in the report.

Information from the U.S.G.S. staff gage, located at Coldwater Lake, was used to verify the peak lake elevations. A frequency analysis, using a Wiebull plot, very closely approximates peak elevations as determined by the TR-20 model.

Coldwater River and Tributaries:

Channel flood routings to establish peak discharge-frequency relationships were made using the SCS TR-20 Hydrology Computer Program and U.S. Department of Agriculture computer facilities. The Modified Attenuation-Kinematic (Att-Kin) method of routing through stream channels is used by this program. This method is derived from inflow-outflow hydrograph relationships.

Flood flows from the Upper Lake Chain, local runoff and valley sections were used to flood route and model study area conditions. Table 1 lists discharges obtained from the flood routings and Table 2 lists flood elevations at sections located in the study area.

Information from the U.S.G.S. stream gage at Hodunk and U.S.G.S. Water Supply Paper 1677 were used to verify peak discharges below the Lower Lake Chain as determined by the TR-20 model. Peak discharges for the 100-year, 50-year and 10-year storms compared within 5 percent.

Lower Lake Chain:

The Lower Lake Chain drainage area is approximately 174 square miles.

The TR-20 flood routing program was used to determine inflow hydrographs. Outflow hydrographs for discharge out of the lakes were based on elevation-discharge relationships developed by the WSP-2 water surface profile program and TR-20 flood routing program. A starting lake elevation of 924 feet was used to model existing conditions. Table 1 lists discharges obtained from the flood routings and Table 2 lists lake elevations.

Water surface profiles for the Sauk River, County Drain #40, South Coldwater River and South Lake Drain were developed using the Soil Conservation Service WSP-2 computer program. This program uses the step method of computation to solve the Bernoulli equation and the Bureau of Public Roads' bridge loss analysis. Flood discharges determined from flood routings were used in the water surface profile program to develop high water profiles along the channels. Mannings "n" values were determined from field investigations of the channels and flood plains.

Normal bridge and channel flow conditions were assumed in the hydraulic computations. No consideration was made for openings blocked by ice or other debris. Channel and flood plain flow characteristics may change due to vegetative growth, sedimentation, scour, debris accumulation, filling and encroachment. Computations for this study considered only those features in the flood plain at the time of field surveys. Future flood plain developments and modifications, as well as changes in the upstream drainage area and land use and cover, will require recomputation of water surface profiles.

Flood plain delineations were made on the contour maps and photomap sheets. Computed water surface elevations at surveyed sections and bridges were used to identify flood plain limits. Between sections, topographic map interpretations and field inspections were used to delineate the flood boundary lines. Limits of flooding shown on the photomaps may vary from actual location on the ground, and the photographic image may vary from true ground location due to inherent aerial photograph displacement. Flood plain delineations around the Lower Lake Chain were based on the computed lake level only. Wave action may cause flooding of additional areas. In addition, road fills with inadequate or no crossings may be causing some flooding above the roads. These areas were not delineated in this study. High water profile elevations and detailed field surveys should be used to determine the extent or depth of flooding at any specific site.

Where the limits of the 500-year and 100-year floods were too close to delineate, the limits of the two flood plains are shown as the same line on the photomap sheets.

APPENDIX E

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

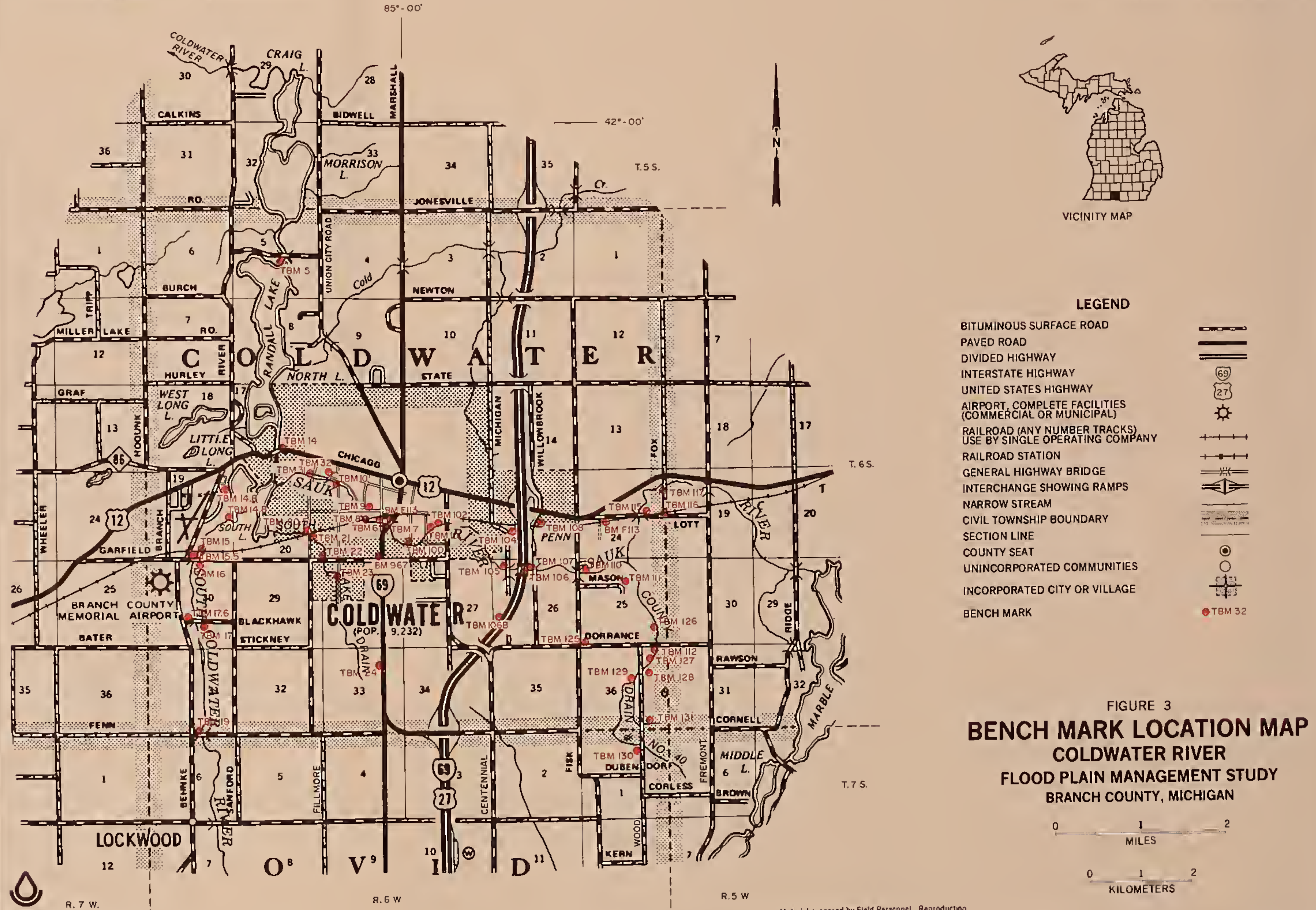


FIGURE 3

BENCH MARK LOCATION MAP
COLDWATER RIVER
FLOOD PLAIN MANAGEMENT STUDY
BRANCH COUNTY, MICHIGAN

SOURCE:
MICHIGAN COUNTY HIGHWAY MAP.
POLYCONIC PROJECTION.

Material prepared by Field Personnel. Reproduction only by SCS Cartographic Staff, Fort Worth, Texas.

USDA SCS NATIONAL CARTOGRAPHIC CENTER FT WORTH TX 1988

MAY 1988 1003393-02

BENCH MARK DESCRIPTIONS *

COLDWATER RIVER

BRANCH COUNTY, MICHIGAN

BM USGS E 113 1934

Section 21, T6S, R6W - Coldwater, about 57 yards east of the southeast corner of the New York Central Railroad Station, at the crossing of U.S. Highway 27, about 76 yards west of the centerline of the highway, 27.8 feet north of a water tower and about 2 yards west of a pole.

A standard disk (USC&GS) stamped "E 113 1934" and set in the top of a concrete post.

Elev. 968.869

BM USC&GEO F 113 1934

Section 24, T6S, R6W - 2.4 miles east along the New York Central Railroad from the station at Coldwater, about 235 yards west of milepost C 158, at a private road crossing, 17 yards northeast of the crossing of the centerline of the private road and the north rail, 13 yards north of the north rail and about 1 foot lower than the top of the rail.

A standard disk stamped "F 113 1934" and set in the top of a concrete post.

Elev. 988.443

BM USGS 967

Section 21, T6S, R6W - UE E 113 A; 0.6 mile south of disk, at south city limits of Coldwater; 100 feet north, 137 feet west and same elevation as U.S. Highway 27 at an east-west road crossing; near northwest corner of Grange Hall.

On chiseled square on northwest corner of concrete entrance.

Elev. 966.90

TBM #5

Section 5, T6S, R6W - Off southwest corner of Narrows Street Bridge.

SCS spike and disk in power pole #MO-75j SPG 5-30.

Elev. 937.78

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* Elevations based on USC&GS mean sea level datum of 1929.

TBM #6

Section 21, T6S, R6W - West side of Clay Street, first pole north of bridge over Sauk River.

SCS spike and disk in pole.

Elev. 960.52

TBM #7

Section 21, T6S, R6W - Off southwest corner of Division Street Bridge over Sauk River.

SCS spike and disk in pole.

Elev. 963.88

TBM #8

Section 21, T6S, R6W - At centerline of railroad bridge over Sauk River.

SCS spike and disk in center of railroad tie.

Elev. 965.08

TBM #9

Section 21, T6S, R6W - At northeast corner of Race and Walnut Streets.

SCS spike and disk in old power pole #197-B.

Elev. 961.38

TBM #10

Section 21, T6S, R6W - Off southwest corner of Jay Street Bridge over Sauk River.

SCS spike and disk in power pole.

Elev. 944.43

TBM #14

Section 17, T6S, R6W - 50 feet east of the southeast corner of "Old US-12" steel bridge over Coldwater River.

SCS spike and disk in power pole.

Elev. 940.93

TBM #14.6

Section 19, T6S, R6W - 60 feet south of South Park Drive, 500 feet east of Behnke Road and approximately 500 feet north of Coldwater River.

SCS spike and disk in power pole.

Elev. 939.78

TBM #14.8

Section 19, T6S, R6W - 900 feet south of TBM #14.6 and 25 feet north of north bank of South Coldwater River.

SCS spike and disk in fence corner.

Elev. 928.54

TBM #15

Section 19, T6S, R6W - 400 feet east of Behnke Road.

SCS spike and disk in top of northwest corner of railroad bridge.

Elev. 951.41

TBM #15.5

Section 19, T6S, R6W - At northeast corner of Garfield Avenue and Behnke Road.

SCS spike and disk in power pole.

Elev. 953.26

TBM #16

Section 30, T6S, R6W - 2 feet east of the southeast corner of Garfield Avenue bridge over South Coldwater River, approximately 200 feet east of Behnke Road.

SCS spike and disk in 8 inch by 8 inch guardrail post.

Elev. 946.53

TBM #17

Section 30, T6S, R6W - At southeast corner of Blackhawk Road Bridge.

SCS spike and disk in telephone pole.

Elev. 949.59

TBM #17.6

Section 30, T6S, R6W - At northeast corner of Blackhawk and Behnke Roads.

SCS spike and disk in power pole.

Elev. 964.31

TBM #19

Section 31, T6S, R6W - Approximately 75 feet west of culverts on Fenn Road over South Coldwater River and approximately 200 feet east of Behnke Road.

SCS spike and disk in telephone pole.

Elev. 961.20

TBM #20.5

Section 20, T6S, R6W - At Butters Avenue and tributary culvert.

SCS spike and disk in power pole.

Elev. 959.47

TBM #21

Section 20, T6S, R6W - At centerline of tracks and centerline of culvert over tributary, approximately 300 feet east of Butters Avenue.

SCS spike and disk in railroad tie. Disk in large yellow paint spot.

Elev. 962.31

TBM #22

Section 21, T6S, R6W - 15 feet west of ditchbank on north side of Garfield Avenue and culvert.

SCS spike and disk in power pole.

Elev. 967.76

TBM #23

Section 28, T6S, R6W - West side of Jay Street, 25 feet south of culvert on tributary and approximately 700 feet south of Garfield Avenue.

SCS spike and disk in power pole.

Elev. 976.16

TBM #24

Section 33, T6S, R6W - West side of "Old US-27" in lawn area of radio station WTVB-WANG.

SCS spike and disk in telephone pole.

Elev. 1008.33

TBM #31

Section 20, T6S, R6W - 100 feet north of Butters Avenue bridge at Riverside Drive over Sauk River.

SCS spike and disk in power pole.

Elev. 938.23

TBM #32

Section 21, T6S, R6W - 150 feet north of wastewater treatment plant bridge over Sauk River.

SCS spike and disk in power pole.

Elev. 943.12

TBM #100

Section 22, T6S, R6W - Off northwest corner of Jefferson Street Bridge over Sauk River.

SCS spike and disk in pole.

Elev. 965.92

TBM #101

Section 22, T6S, R6W - 100 feet north of old road crossing behind Lincoln Elementary School.

SCS spike and disk in pole.

Elev. 965.03

TBM #102

Section 22, T6S, R6W - In northeast corner of concrete box north of Waterworks Park Dam.

Top of rusty bolt.

Elev. 963.26

TBM #104

Section 23, T6S, R6W - At northeast corner of Michigan Avenue at 90° turn to south.

SCS spike and disk in power pole.

Elev. 980.07

TBM #105

Section 26, T6S, R6W - 100 feet north of culverts on Sauk River, west side of Michigan Avenue.

SCS spike and disk in power pole.

Elev. 970.84

TBM #106

Section 26, T6S, R6W - 100 feet south of Sauk River on west side of north-bound lane of I-69.

SCS spike and disk on south side of wood guardrail post.

Elev. 982.23

TBM #106B

Section 26, T6S, R6W - At road culvert on west side of south-bound lane of M-69 near a McDonald's sign.

Top of white drain post, chiseled line in center.

Elev. 980.64

TBM #107

Section 26, T6S, R6W - Approximately 30 feet north of Sauk River on west side of Steffey Road.

SCS spike and disk in 8 inch diameter maple tree.

Elev. 971.73

TBM #108

Section 23, T6S, R6W - At northeast corner of intersection of Penn. Central T.C. Railroad and Steffey Road, approximately 20 feet north of railroad tracks.

SCS spike and disk in power pole.

Elev. 984.07

TBM #110

Section 25, T6S, R6W - 15 feet east of Fiske Road and 45 feet north of Sauk River.

SCS spike and disk in power pole.

Elev. 976.51

TBM #111

Section 25, T6S, R6W - North of 90° south turn of Mason Road.

SCS spike and disk in west side of 10 inch diameter shagbark hickory.

Elev. 985.75

TBM #112

Section 36, T6S, R6W - South of Dorrance Road, west of County Drain 40.

SCS spike and disk in north side of 18 inch diameter walnut tree, 2 feet above ground.

Elev. 988.09

TBM #115

Section 24, T6S, R6W - 15 feet north of Lott Road and 50 feet east of Sauk River.

SCS spike and disk in power pole.

Elev. 983.91

TBM #116

Section 24, T6S, R6W - 30 feet south of railroad tracks, 30 feet north of Lott Road and 10 feet west of Fox Road.

SCS spike and disk in power pole.

Elev. 990.67

TBM #117

Section 24, T6S, R6W - 10 feet west of Fox Road and 67 feet south of Sauk River.

SCS spike and disk in 24 inch diameter maple tree.

Elev. 986.61

TBM #125

Section 25, T6S, R6W - At northeast corner of Fiske and Dorrance Roads.

SCS spike and disk in corner post with band near top.

Elev. 1017.57

TBM #126

Section 25, T6S, R6W - On west side of County Drain 40, 1,000 feet north of Dorrance Road Bridge.

SCS spike and disk in 4.5 foot tall stump.

Elev. 986.29

TBM #127

Section 36, T6S, R6W - 20 feet west of County Drain 40 and 600 feet south of Dorrance Road Bridge.

SCS spike and disk in 3 inch diameter sapling.

Elev. 987.25

TBM #128

Section 36, T6S, R6W - 100 feet east of Wood Road, south of County Drain 40.

SCS spike and disk in north side of power pole, 1.5 feet above ground.

Elev. 990.90

TBM #129

Section 36, T6S, R6W - West of Wood Road, northwest of County Drain 40.

SCS spike and disk in 3 inch diameter, 10 foot tall dead sapling.

Elev. 989.72

TBM #130

Section 1, T7S, R6W - West of Wood Road and approximately 25 feet south of County Drain 40.

SCS spike and disk in corner fence post.

Elev. 988.67

TBM #131

Section 36, T6S, R6W - Approximately 15 feet east of Wood Road and 30 feet north of County Drain 40.

SCS spike and disk in small aspen sapling.

Elev. 990.82

APPENDIX F

GLOSSARY

BACKWATER--The resulting highwater surface upstream from a dam, bridge or other obstruction in a river channel or high stages in a receiving stream.

BRIDGE DECK--Elevation of road surface at the bridge.

BRIDGE LOW CLEARANCE--The lowest point of a bridge or other structure over or across a river, stream or water course that limits the opening through which water flows. This is referred to as "low steel" or "low chord". It often is higher than the low point of the roadway.

CHANNEL or WATER COURSE--An elongated depression either natural or man-made having a bed and well-defined banks varying in depth, width and length which gives direction to a current of water and is normally described as a creek, stream or riverbed.

CHANNEL BOTTOM--The lowest part of the stream channel (either in a constructed cross-section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

CONFLUENCE--A flowing together or place of junction of two or more streams.

CROSS-SECTION or VALLEY SECTION--A graph showing the shape of the stream bed, banks and adjacent land on either side made by plotting elevations at measured distances along a line perpendicular to the flow of the stream.

DATUM--An assumed reference plane from which elevations and depths are measured such as from sea level.

ELEVATION-DISCHARGE RELATIONSHIP--The relationship between water surface elevation and rate of flow at a specified location for a range of flow rates.

FLOOD--A temporary overflow by a river, stream, ocean, lake or other body of land not normally covered by water. It does not include the ponding of surface water due to inadequate drainage such as within a development. It is characterized by damaging inundation, backwater effects of surcharging sewers and local drainage channels, and by unsanitary conditions within adjoining flooded habitated areas attributable to pollutants, debris and water table.

FLOOD CREST--The maximum stage or elevation reached by flood waters at a given location.

FLOOD FREQUENCY--A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equaled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequence", but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years.

10-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 10 years. It has a ten percent chance of being equaled or exceeded in any given year.

100-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 100 years. It has a one percent chance of being equaled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers.

FLOOD PEAK--The maximum instantaneous discharge or volume of flow in cubic feet per second passing a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN--The relatively flat area or low lands covered by flood waters originating with either the adjoining channel of a water course such as a river or stream, or a body of standing water such as an ocean or lake.

FLOOD PRONE AREA--Areas that experience ponding due to high water table soils and/or inadequate outlets.

FLOOD ROUTING--The process of determining progressively the timing and shape of a flood wave at successive points along a stream. This procedure is used to derive a downstream hydrograph from an upstream hydrograph. Local inflow and tributary hydrographs are considered.

FLOOD STAGE--The elevation at which overflow of the natural stream banks or body of water occurs.

FLOODWAY--The portion of the flood plain including the channel of the stream that is required for the conveyance of flood flow.

FLOODWAY FRINGE--The area of the flood plain lying outside the floodway which may be covered by flood waters originating from an adjoining river or stream.

HEAD LOSS--The effect of obstructions, such as narrow bridge openings, dams or buildings, that limit the area through which water must flow, raising the surface water upstream from the obstruction.

HEADWATER--The tributaries and upper reaches which are the sources of the stream.

HIGH WATER or FLOOD PROFILE--A graph showing the relationship of water surface elevation location along the stream. While it is drawn to show surface elevations for the crest of a specific flood, it may be prepared for conditions at any other given time or stage.

HYDRAULICS--The science of the laws governing the motion of water and their practical applications.

HYDROGRAPH--A graph denoting the discharge or stage of flow over a period of time.

HYDROLOGY--The science dealing with the occurrence and movement of water upon and beneath the land areas of the earth.

INUNDATION--The flooding or overflow of an area with water.

LEFT BANK--The bank of the left side of a river, stream or water course, looking downstream.

LOW GROUND--The highest elevation at a specific stream channel cross-section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

MANNING'S "n"--A coefficient of channel and overbank roughness used in Manning's open channel flow formula, commonly called a retardance factor.

REACH LENGTH--A longitudinal length of stream channel selected for use in hydraulic or other computations.

RIGHT BANK--The bank on the right side of the river, stream or water course, looking downstream.

ROAD OVERFLOW--The lowest elevation on a road profile in the vicinity of where the road and stream cross. It is the first point on the roadway inundated if overtopping of the road occurs during a storm.

RUNOFF--That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

TIME OF CONCENTRATION--Time required for water to flow from the most remote point of a watershed to the outlet or other point of reference.

WATERSHED--A drainage basin or area which collects runoff and transmits it, usually by means of streams and tributaries, to the outlet of the basin.

WATERSHED BOUNDARY--The divide separating one drainage basin from another.

APPENDIX G

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