

AN ORDINANCE AUTHORIZING THE MAYOR TO EXECUTE AN AGREEMENT WITH THE CITY OF CHAMPAIGN AND THE UNIVERSITY OF ILLINOIS RESPECTING FLOODPLAIN REMAPPING OF THE BONEYARD CREEK (AMENDMENT #1)

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF URBANA, ILLINOIS, as follows:

Section 1. That An Agreement Between The City of Champaign, The City of Urbana, and the University of Illinois Respecting Floodplain Remapping of the Boneyard Creek, in substantially the form of the copy of said Agreement attached hereto and hereby incorporated by reference, be and the same is hereby authorized and approved.

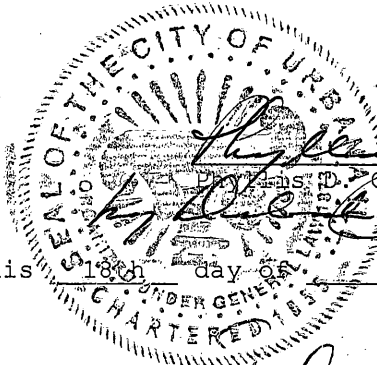
Section 2. That the Mayor of the City of Urbana, Illinois, be and the same is hereby authorized to execute and deliver and the City Clerk of the City of Urbana, Illinois, be and the same is authorized to attest to said execution of said Agreement as so authorized and approved for and on behalf of the City of Urbana, Illinois.

PASSED by the City Council this 7th day of March, 2005.

AYES: Alix, Chynoweth, Hayes, Patt, Roberts, Whelan, Wyman

NAYS:

ABSTAINS:



Thyler D. Clark
Thyler D. Clark, City Clerk

[Signature]
Deputy Clerk

APPROVED by the Mayor this 18th day of March, 2005.

Tod Satterthwaite
Tod Satterthwaite, Mayor

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Original - Clerk

cc: Bill G
Jack W
Gale J
Brad B
AGREEMENT FILE
LIBBY T

Facilities & Services

Physical Plant Service Building
1501 South Oak Street
Champaign, IL 61820



RECEIVED

APR 27, 2005
URBANA PUBLIC WORKS
URBANA, ILLINOIS

2005-02-026

April 25, 2005

Mr. William Gray, Director
Urbana Public Works
706 S. Glover Street
Urbana, Illinois 61801

Ms. Eleanor Blackmon, Assistant City Engineer
Champaign Public Works
702 Edgebrook Drive
Champaign, Illinois 61820

Dear Bill and Eleanor:

Enclosed please find an originally executed Amendment #1 to the Boneyard Agreement for each of your files. Please note that Clif Carey will replace me as representing the University. Eliana Brown will continue as our technical staff.

Thank you.

Sincerely,

April D. Getchius, AICP
Associate Director/Campus Planner

c: Clif Carey
Eliana Brown

**AMENDMENT #1
TO AN AGREEMENT BETWEEN
THE CITY OF CHAMPAIGN, THE CITY OF URBANA,
AND THE UNIVERSITY OF ILLINOIS
RESPECTING IMPROVEMENTS TO THE BONEYARD CREEK**

THIS Amendment No. 1, made as of the date below the signature of the last entity to sign it ("effective date"), clarifies and modifies the Intergovernmental Agreement entered into between the City of Champaign ("Champaign"), the City of Urbana ("Urbana") and the Board of Trustees of the University of Illinois ("University") effective February 19, 2001 and approved in CB 2000-024 by the City of Champaign and Ordinance 2000-08-100 by the City of Urbana.

WHEREAS, pursuant to the laws of the State of Illinois and the ordinances of the City of Champaign, the undersigned agree that this amendment is authorized by law and is in the best interest of the parties; and

WHEREAS, the parties desire to revise the existing 100 year flood hazard maps to accurately reflect post-improvement conditions of the Boneyard Creek; and

WHEREAS, the Cities and the University have an existing agreement between themselves and with the United States Geological Survey (USGS) to compare the hydrologic/hydraulic model used for the Phase I-A, I-B, and I-C improvements with post improvement Boneyard Creek flow which agreement is attached to the February 19, 2001 agreement; and

WHEREAS, the USGS has presented an agreement to each of the Cities and the University to document the 100 year flood conditions as the result of the improvements, and to apply for revised FEMA flood hazard maps to reflect current conditions, a copy of which is attached hereto as "Amendment Exhibit A".

NOW, THEREFORE, in consideration of the foregoing premises and the other undertakings contained in this Agreement, the Cities and the University agree as follows:

I. Amendments.

"Section 11. Notices" shall be amended as follows:

Notice hereunder shall be considered delivered when delivered personally or sent by certified mail, postage prepaid, to:

City of Champaign City Manager 102 North Neil Street Champaign, IL 61820	City of Urbana Mayor 400 South Vine Street Urbana, IL 61801
University of Illinois Executive Director, Facilities & Services 1501 S. Oak Street Champaign, IL 61820	

II. Additions.

The following provisions shall be added to the Agreement:

Section 14. USGS Remapping Services.

A. The Cities and the University acknowledge the importance of remapping the 100 year floodplain and floodway so as to more accurately reflect current flood conditions. Remapping is indicated primarily due to the Phase I construction improvements, but also due to improvements in modeling techniques.

(1) The Cities and the University agree that the USGS proposed agreement (Exhibit A) shall be used for the floodplain remapping services provided for herein.

(2) The Cities and the University agree that each entity will enter into a cooperative agreement with the USGS to perform the services as outlined in Exhibit A. The parties agree that the total cooperative share for Urbana, Champaign, and the University shall be a not to exceed amount of \$120,000 broken down as follows: Champaign shall contribute a not-to-exceed amount of \$56,400 (47%), Urbana shall contribute a not-to-exceed amount of \$42,000 (35%), and the University shall contribute a not-to-exceed amount of \$21,600 (18%).

Section 15. Contours.

Accurate contours are required for the FEMA floodplain map generation. Each entity shall be responsible for obtaining and paying for the contours within its jurisdiction. The parties

agree that the floodplain remapping contours shall ideally be procured as an additional service from the 2005 Aerial Photograph Services for Champaign County Illinois to be obtained by the Champaign County GIS Consortium. If contours are obtained through another source or means, the results of the same shall be delivered not later than September 30, 2005. Any contours shall be obtained on a two foot elevation interval.

III. Continuation of Other Conditions.

All other terms and conditions of the Intergovernmental Agreement shall remain in full force and effect.

IN WITNESS HEREOF, the authorized officers of the respective parties have hereunto set their hands.

<p>CITY OF CHAMPAIGN, ILLINOIS</p> <p>By: <u>Paul O. Berg</u> City Manager</p> <p>ATTEST: <u>Marilyn K. Durko</u> City Clerk</p> <p>Date: <u>3-15-2005</u></p> <p>APPROVED AS TO FORM FOR CITY: <u>[Signature]</u> Assistant City Attorney <u>CB 2005-59</u></p>	<p>BOARD OF TRUSTEES OF THE UNIVERSITY OF ILLINOIS</p> <p>By: <u>Stephen K. Russ</u> Its: <u>Comptroller</u></p> <p>ATTEST: <u>Nichelle M. Thompson</u> Its: <u>Secretary</u></p> <p>Date: <u>4/5/05</u></p> <p>APPROVED AS TO FORM: <u>Marcia B. Lotunda</u> Its: <u>Associate University Counsel</u></p>
<p>CITY OF URBANA, ILLINOIS</p> <p>By: <u>Paul A. Bittel</u> Mayor</p> <p>ATTEST: <u>Shirley J. Clark</u> City Clerk</p> <p>Date: <u>March 18, 2005</u></p> <p>APPROVED AS TO FORM FOR CITY: <u>[Signature]</u> City Attorney</p>	<p>REVIEWED BY: <u>John Garrett Dempsey</u> Executive Director, Facilities & Services</p>

FINAL

U.S. Geological Survey Cooperative Program Proposal

**INVESTIGATION OF ADVANCED HYDROLOGIC AND HYDRAULIC METHODS
FOR URBAN FLOOD HAZARD ANALYSIS**

Prepared for

City of Champaign, City of Urbana, and University of Illinois

by

U.S. Geological Survey
Illinois Water Science Center
Surface Water Modeling Team
1201 W. University Ave., Suite 100
Urbana, Illinois 61801
(217) 344-0037

December 6, 2004

Amendment Exhibit A

Title: Investigation of Advanced Hydrologic and Hydraulic Methods for Urban Flood Hazard Analysis

Introduction: Boneyard Creek (figure 1) drains a highly urbanized watershed of approximately 7.31 square miles to the confluence with the Saline Ditch, which is part of the Wabash River watershed. The Creek has experienced recurrent overbank and drainage system backwater flooding for decades. An extensive storm sewer system drains much of the Boneyard Creek watershed. In the late 1950's and early 1960's, the Boneyard Creek channel was lined with sheet piling walls and a concrete floor in Urbana from near Race Street to the upstream side of Lincoln Avenue. In addition, the Northwest Diversion Structure was completed in August 1960, resulting in the upper 0.88 square miles of watershed being diverted directly into the Saline Drainage Ditch. This diversion decreased the contributing watershed area at the mouth of the Boneyard to approximately 6.43 square miles.

The 1950/1960 era channel improvements in Urbana resulted in a discontinuity (drop) in the channel bottom of approximately 4 feet at Lincoln Avenue. This drop remained until the Phase 1 Boneyard Creek channel and basin improvements were substantially completed in 2003.

The Phase 1 improvements consisted of the enlargement and enclosure of 2,734 feet of the Boneyard Creek upstream of Wright Street in Champaign (Campustown) resulting in 20 acre-feet of flood volume storage, lowering (by as much as 4 feet) 2,600 feet of the Boneyard Creek channel between Wright Street and Lincoln Avenue; construction of the 118 acre-foot Healey Street detention basin adjacent to the Boneyard between the Illinois Central Railroad Tracks and First Street in Champaign, and selected storm-sewer renovations. A restrictor was constructed at Wright Street to offset the additional flow volume from the enlarged enclosed channel that was not compensated for by the construction of the upstream Healey Street detention basin. These improvements, along with construction of the Dorner Drive detention basin by the University of Illinois, have significantly altered the watershed hydrology and hydraulic characteristics of the Boneyard Creek in the past 10 years.

Before the construction of the Phase 1 improvements began, concerns were raised regarding the possibility of increased discharge downstream in the City of Urbana. As a result of these

concerns and subsequent negotiations between the governmental entities involved, the U.S. Geological Survey (USGS), in cooperation with the Cities of Urbana and Champaign and the University of Illinois, began conducting a study (which is currently in progress) to assess the post-Phase 1 improvements flood hydrology and hydraulics of the Boneyard Creek. As part of this study, USGS is collecting detailed rainfall and streamflow data and modeling selected storm events with the existing StormWater Management Model (SWMM) model of Boneyard Creek. The verification of the model with field data can be used as the basis for a recalibration (if needed) to the actual field performance of the as-built structures for the Campustown, University of Illinois, and Urbana reaches. However, because of the extensive changes in the channels and land use in the Boneyard Creek watershed over time, it is not possible to determine meaningfully accurate flood-peak frequency relations at the Boneyard Creek gaging station for identifying the recurrence intervals of these selected events, despite the long record. Knowledge of accurate flood-peak frequency relations (the flood-frequency curve) is important in determining the floodplain, floodway, and for many other design and regulatory purposes.

Because SWMM can be run as a continuous-simulation model, it is possible to generate a synthetic streamflow record for the period of record of precipitation and other climatic data in the vicinity. For the Boneyard Creek basin, nearby hourly precipitation record extends back to approximately 1948, enabling the generation of 56 years of synthetic streamflow record using present land-use and hydraulic conditions, which can be used as the basis for determining flood frequency curves at various locations in the watershed. This methodology has several advantages over the traditional design-storm approach. The uncertain probabilities of various antecedent soil moisture and detention basin volume conditions are automatically included in the analysis, and the peaks are generated for the entire period of record, giving a measure of flooding that could have occurred. More confidence can be given to flood-frequency curves developed using the synthetically simulated floods. Furthermore, in the continuous-simulation approach, flood-frequency curves can be generated at any location along the Boneyard Creek without precipitation depth-area adjustments required in the design-storm approach. Finally, a well-calibrated continuous-simulation model can reproduce low flows as well as high flows, enabling future consideration of water-quality concerns. If this methodology is selected, the climatologic database for the period of record must be compiled, which will provide an additional valuable resource for future analyses.

Problem: The current Flood Insurance Rate Maps (FIRM), which contain floodplain and floodway identification, were based on hydrologic and hydraulic analysis completed in 1977, before the Phase 1 improvements and other stormwater management practices were placed in service. It is believed that the Phase 1 improvement and other stormwater management practices have had a noticeable impact on the hydrology and hydraulics of Boneyard Creek. Additionally, many more years of rainfall data have been collected and analyzed since the previously utilized ISWS Technical Letter 13 (1970), which has resulted in updated rainfall depths for given frequencies (Huff and Angel, 1989). Finally, hydraulic structural and topographic changes have undoubtedly been made throughout the floodplain. The 1986 Boneyard Creek Strategic Plan Study made use of hydraulic structure data obtained by the Illinois Department of Transportation (IDOT) in 1980. The University of Illinois to Urbana reaches were further field verified or resurveyed in 1997 and 1998, and the Logan Avenue storm sewer and the SW Branch double box culvert were field-checked in about 1998. The hydraulic structure geometry in the model for the Boneyard Creek in the City of Champaign is apparently still based on the 1980 IDOT surveys with the exception of the more recently surveyed reaches and structures. Changes to the hydraulic control structures and channel hydraulic properties result in different flood elevations and profiles in the reaches upstream from the Campustown/University reaches, and should be remapped after model updating, recalibration, and verification is completed. Therefore, updated floodplain and floodway mapping are needed to update the FIRM for Boneyard Creek from the Saline Ditch to the Northwest Diversion Structure at Neil Street.

Objectives and Scope: The objectives of this project are to update the hydrology and hydraulics of the Boneyard Creek watershed models and produce new digital floodplain and floodway maps for approximately 5 miles of the Boneyard Creek. The reaches to be mapped include the following (see figure 2):

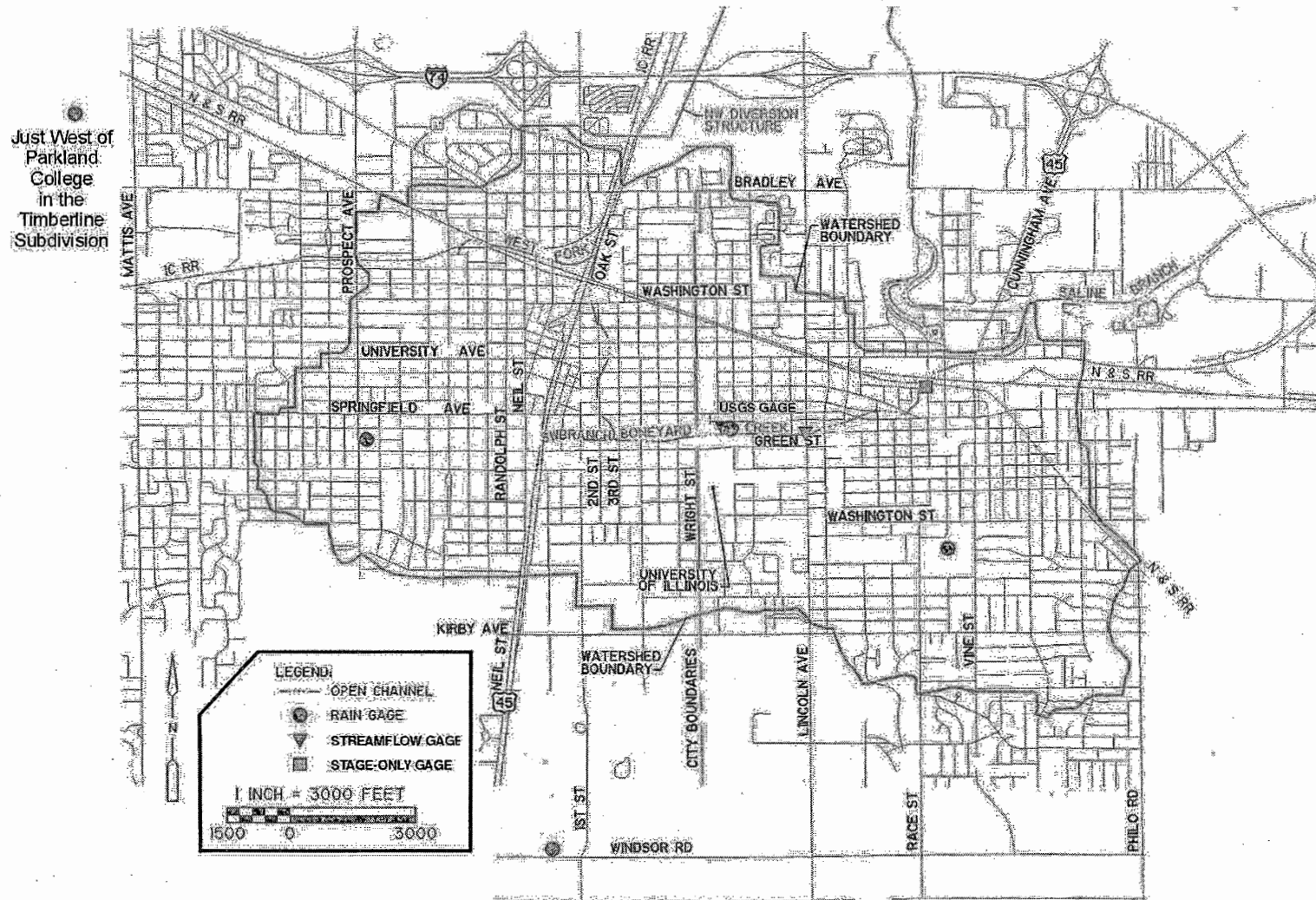
- North Reach (from Northwest Diversion Structure to Oak-Ash Detention Basin) 3,830 feet, including 10 bridges or culverts (one double opening);
- West Fork Reach (from Prairie Street to Oak-Ash Detention Basin) 3,725 feet, including 7 bridges or culverts;
- Second Street Reach (from Oak-Ash Detention Basin to confluence with SW Branch near Scott Park) 5,320 feet, including 22 bridges or culverts (some double openings);
- SW Branch Reach (from First Street to Third Street) 744 feet, including the enclosed channel;

- Campustown Reach (from Third Street to Wright Street) 1,990 feet, including 8 bridges or enclosed channel reaches;
- University Reach (from Wright Street to Lincoln Avenue) 2,600 feet, including 9 bridges;
- Urbana Reach (from Lincoln Avenue to Boneyard Mouth at the Saline Drainage Ditch) 7,105 feet, including 14 bridges (some double openings).

The following components will be completed as part of the project:

- 1) Obtain existing surveys of the channel cross section for the above mentioned reaches of the Boneyard Creek (figure 2). Conduct surveys for needed additional channel cross- sections that are not available through other sources. Obtain updated hydraulic geometry data from the City of Champaign, or field verify the 1980 IDOT survey data for Champaign bridges and culverts. Reviews the as-built geometry for the Campustown/University of Illinois reaches.
- 2) Utilize existing color digital orthophoto quadrangle (DOQ) and Digital Elevation Models (DEM) currently or soon becoming available for the Boneyard Creek watershed as base maps and for the extension of previously surveyed cross sections to the 500-year floodplain.
- 3) Conduct hydrologic and hydraulic analysis for floodplain/floodway determination. The hydraulic model geometry will be converted to HEC-RAS for floodway analysis using the method of equal reduction in conveyance. The climatic database for continuous simulation modeling will be compiled, checked, filled, and the hydrologic calibration verified (or modified if needed). The SWMM model will be run in the continuous simulation mode for the period of precipitation record (since approximately 1948).
- 4) Conduct frequency analysis for the continuously simulated period of record to obtain peak flood discharges and elevations at locations in the watershed. The frequency curves resulting from the simulated record will give a realistic assessment of the flood-peak probabilities for the post-project waterway.

- 5) Model the design storm hydrographs for 10-, 25-, 50-, 100-, and 500-year recurrence intervals. These will provide a basis for comparison with the results of the continuous-simulation approach and for extrapolating those results to the 100- and 500-year events.
- 6) Produce FEMA-approved flood-peak discharges and elevations for 10-, 50-, 100-, and 500-year recurrence intervals, floodplain and floodway maps for the base (100-year) flood, and floodplain map for the 500-year flood. These maps will be in digital format as inundation surfaces, which can be overlaid with a variety of geographic, hydraulic, and real-time data within the Internet Map Server developed for hydraulic/hydrologic data statewide.
- 7) Complete a report describing the hydrologic and hydraulic analysis and floodplain and floodway mapping of the Boneyard Creek. The results will be served on the USGS Internet Map Server website, as well as provided digitally for use on applicable state or national DFIRM viewers.



Just West of
Parkland
College
in the
Timberline
Subdivision

Figure 1. Boneyard Creek Watershed (figure adapted from Berns, Clancy, and Associates Construction Permit Application Report, April 30, 1998)

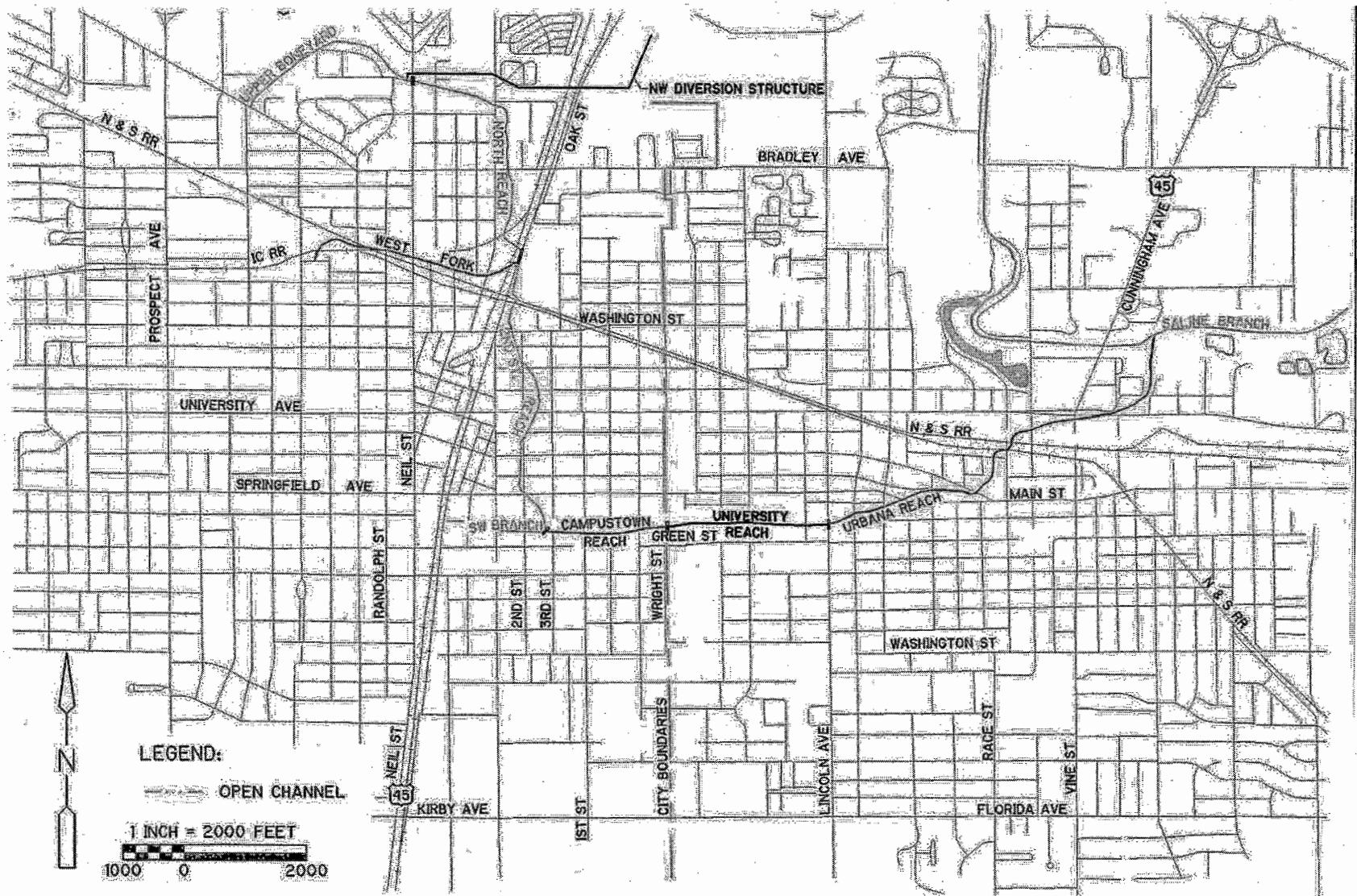


Figure 2. Boneyard Creek reaches (figure adapted from Berns, Clancy, and Associates Construction Permit Application Report, April 30, 1998)

Benefits: An important part of the USGS mission is to provide scientific information to minimize the loss of life and property from natural disasters. As a part of effectively accomplishing this mission, the USGS provides reliable, impartial, and timely information needed for understanding flood hazards to other Federal, State, and local agencies.

The Cities of Champaign and Urbana and the University of Illinois will utilize the analysis and information produced by this project to mitigate flooding in their jurisdictional areas of the Boneyard Creek. The Federal Emergency Management Agency (FEMA) will utilize the analysis and information produced by this project to administer its programs under the National Flood Insurance Program (NFIP) and in disaster mitigation. Floodplain maps prepared for the NFIP also are used by lending institutions, businesses and industry, and the public for making informed decisions about land use in areas potentially subject to flood hazards. The USGS works to improve field and analytical floodplain-mapping methodologies and uses the information generated by floodplain-mapping activities to advance the scientific understanding of hydrologic processes related to flood hazards. The information also is used for planning, for resolving potential conflicts, and for protecting life and property. The floodplain mapping done by the USGS in Illinois is an integral part of the nationwide floodplain-mapping network. Because of the USGS role in both the long-term and intensive hydrologic and hydraulic data collection for the Boneyard Creek and current hydrologic/hydraulic model verification study, it is uniquely qualified to both review and update the existing models and studies. The Boneyard Creek watershed is one of the few small, urban watersheds with a long-term record in the state of Illinois, and with properly developed and well-understood modeling and analytical tools, is expected to continue to yield scientific insights into the effects of hydrologic, hydraulic, and climatologic change. The generation of a long-term synthetic streamflow record is a technique that is particularly applicable in watersheds that have experienced significant change in both hydrologic and hydraulic relations.

Approach: The following primary components will be completed as part of this project.

- 1) An assessment will be made of all available cross-sectional and hydraulic geometry data. It is assumed that the Champaign portion of the Creek will require reconnaissance and critical channel sections, and hydraulic structures will be checked against existing data. If a substantial amount of resurveying is required, estimates will be provided for the additional work. Extensions to existing cross-sections to the

500-year floodplain will be made using the best available DEM. All data will be uploaded into the hydraulic model for the stream system.

- 2) A color Digital Orthophoto Quadrangle (DOQ) available for the region at <http://mapping.usgs.gov/> will be downloaded and used as a background for the floodplain and floodway map, and analyzed for flood-hazard areas. The 1999 DOQ is currently available; a new DOQ will be available in 2005. The DOQ's will be installed in the Internet Map Server, which will enable the inundation surface and other geographic and hydrologic data (for example, real-time gage data) to be overlaid and updated. Land-use data will be checked and updated if necessary.
- 3) The climatic database for the period of precipitation record will be compiled and checked for temporal homogeneity for use in continuous simulation of the rainfall-runoff process in the Boneyard basin.
- 4) Because of the extensive urban storm sewer network present in the Boneyard Creek watershed, a computer model with the capability to simulate the rainfall-runoff process in an urban hydrologic setting is needed. The StormWater Management Model (SWMM) EXTRAN computer module was specifically built for such hydrologic situations. As part of the design of the Phase 1 improvements, a SWMM model was built and calibrated in the late 1990's to USGS streamflow data at the Boneyard Creek streamflow gaging station downstream of Wright Street on the University of Illinois campus (figure 1). The USGS calibration data was for pre-Phase 1 Boneyard Creek hydrology and hydraulics. As part of this study, the hydrologic component of the SWMM model will be run in the continuous simulation mode, and the resulting flow volumes verified with the USGS discharge records for some period of record. If necessary, the existing SWMM model will be recalibrated, while ensuring that the calibration and verification events continue to simulate accurately. The recalibration of the SWMM model will be conducted using post-Phase 1 data collected at both the previously existing USGS streamflow gage downstream of Wright Street and the new streamflow gaging stations at Lincoln Avenue and Race Street, as well as the Illinois Department of Natural Resources Office of Water Resources crest stage gages. This will ensure greater confidence in the ability of the model to simulate the rainfall-runoff relations for the Boneyard basin. Once the hydrologic model is recalibrated, a simulated record of approximately 56 years can be generated and flood frequency relations determined at various points in the watershed.

- 5) The calibrated SWMM model will be used to generate the flood discharges and elevations at the specified recurrence intervals by a log-Pearson Type III frequency analysis of the simulated annual peak discharges (U.S. Interagency Advisory Committee on Water Data, 1982), accompanied by the use of SWMM-generated stage-discharge rating curves to obtain elevations. Where the stage-discharge relation is not a single-valued function due to dynamic effects, it may be necessary to determine a representative hydrograph for use in obtaining the peak elevation for a given recurrence interval. The resulting peak discharges and stages will be compared to the results obtained by the use of design storms (Huff and Angel, 1989); this comparison will form the basis for extrapolating the continuous modeling results to the 100- and 500-year events. Direct frequency analysis of the simulated annual peak elevations will also be performed. HEC-RAS will be used in conjunction with the SWMM model to determine the floodway according to the standard technique (FEMA, 2001). (The HEC-RAS model will also undergo calibration verification using flood profiles determined during post-Phase 1 flood events.) The floodplain and floodway analysis will utilize the best existing DEM of the Boneyard Creek. All study results, including the estimated flood-peak discharges, the inundation surfaces, and GIS data layers (as discussed in step 2) will be installed in the Internet Map Server for display and access. Digital versions of this information will be submitted to FEMA for review and approval.
- 6) A USGS report will be written and published, and include the floodplain and floodway discharges and maps. Digital versions of this information will be submitted to FEMA for review and approval.

Products: The following will be the products of this study:

- 1) An hourly climatic database for the Champaign-Urbana area extending from 1948 through 2003 applicable to this and any future continuous-time hydrologic modeling projects;
- 2) A verified and updated SWMM model of Boneyard Creek with a continuous-time run for 1948 through 2003, and design storm runs of 10-, 25-, 50-, 100-, and 500-year recurrence intervals;
- 3) Floodplain maps at the 1:12,000 scale showing the 100- and 500-year floodplains and the floodway, plotted on Digital Orthophoto Quadrangle maps. The maps will be available as

digital data integrated in a querying and display tool in Arc-IMS and submitted to FEMA (through IDNR) for approval;

- 4) A USGS report describing in detail the methods and results of the study;
- 5) FEMA approval of the floodplain / floodway mapping and report.

Personnel: The project chief will be a hydrologist with professional experience and training in the areas of hydrologic/hydraulic modeling and stochastic hydrology, and will be assisted by another hydrologist also with experience and training in hydrologic/hydraulic modeling. The project chief is completing a similar database development project, and will be assisted by other technical staff in this effort on this project. A GIS specialist with advanced training will complete the geospatial analysis and mapping. The Arc-IMS development will be led by a hydrologist with significant recent experience in this area. A graduate student in the Department of Civil and Environmental Engineering at the University of Illinois will also assist in the modeling and other activities. Surveying will be completed by professional and technical staff available in the Illinois Water Science Center, with assistance from the cooperators.

Budget: The following table shows the estimated project budget by category and federal fiscal year.

ITEM	FY2005	FY2006	FY2007	FY2008	TOTAL
Salary	\$92,090	\$101,950	\$34,960	\$3,080	\$232,080
Software/Travel/Training	\$4,780	0	0	0	\$4,780
Equipment	\$3,000	0	0	0	\$3,000
TOTAL	\$99,870	\$101,950	\$34,960	\$3,080	\$239,860
USGS Coop Share	\$49,935	\$50,975	\$17,480	\$1,540	\$119,930
Cooperator Share	\$49,935	\$50,975	\$17,480	\$1,540	\$119,930

References:

Federal Emergency Management Agency, 2001, Floodway Analysis for SWMM Models, http://www.fema.gov/fhm/dl_swmm.shtm, accessed December 3, 2004.

Huff, F.A. and Angel, J.R., 1989, Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois, Illinois State Water Survey Bulletin 70, 177 pages.

U.S. Interagency Advisory Committee on Water Data, 1982, Guidelines for Determining Flood Flow Frequency, Bulletin 17-B of the Hydrology Subcommittee, Reston, Virginia, U.S. Geological Survey, Office of Water Data Coordination, 183 pages.