

## The 1977 and 1998 Brush Creek Flash Floods, Kansas City

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### Introduction

On September 12, 1977, up to 40 cm of rain fell on the drainage basin of Brush Creek, an urbanized tributary of the Blue River, causing a peak discharge of 18,000 cubic feet per second (525 cubic meters per second, cms) (Fig. 1). The resultant flood led to the deaths of 25 individuals

and an estimated \$100 million in property damage in Brush Creek and other drainage basins in Kansas and in Missouri (U.S. Army Corps of Engineers, 1981; Burnes, 2002). This flood is referred to as the Plaza Flood because much of the damage occurred on the Country

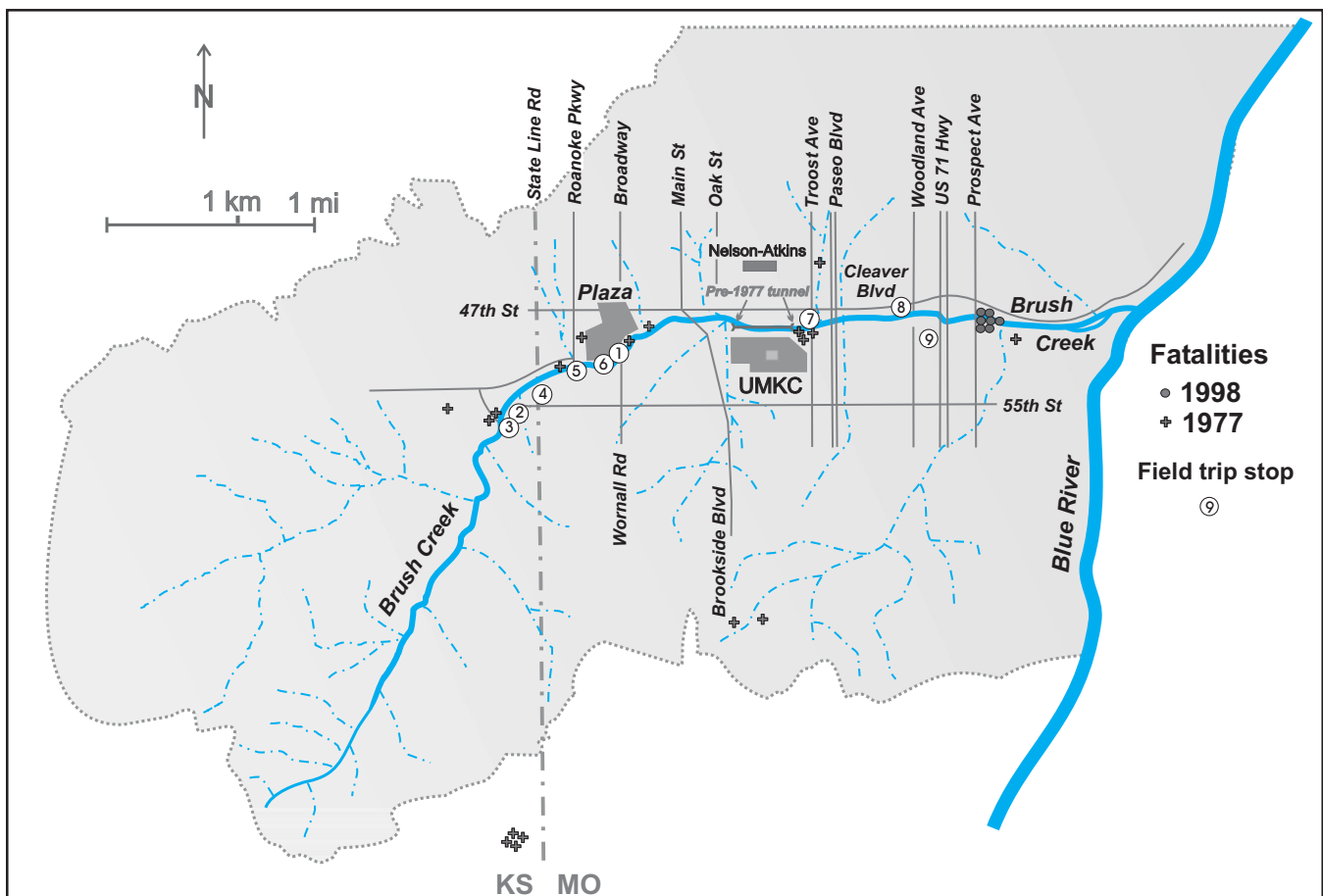


Figure 1. Brush Creek Drainage basin, Missouri and Kansas. Encircled numbers indicate locations of field stops. The area of the Brush Creek drainage approximates 76 sq km (29.4 sq mi). Brush Creek flows from its headwaters in Overland Park and Shawnee Mission, Kansas, eastward through Kansas City, Missouri, to join the Blue River, a tributary to the Missouri. The locations of fatalities are approximate.



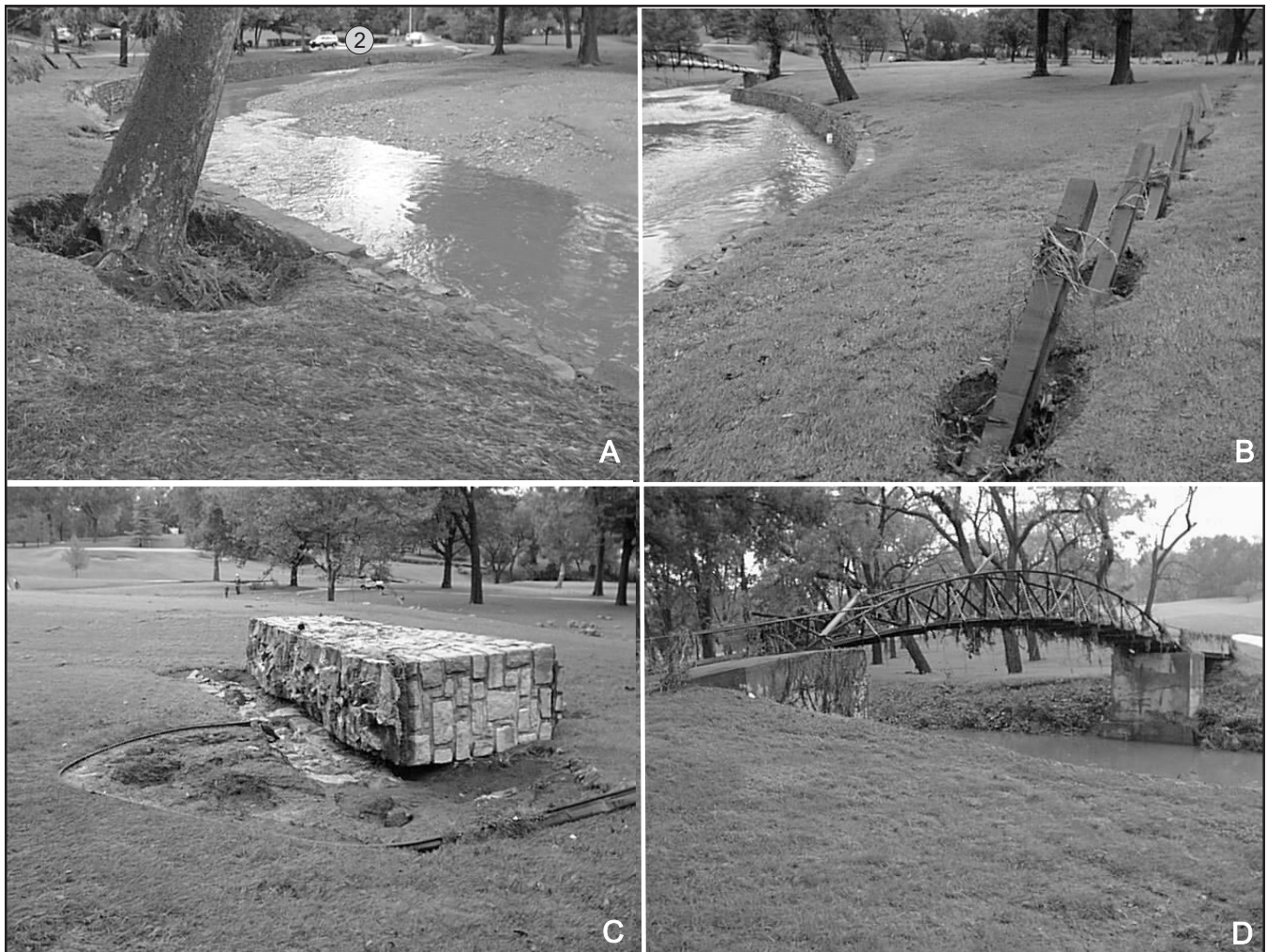
Figure 2. The Country Club Plaza, developed by the J.C. Nichols Company in the 1920s, and modeled after the architecture of Seville, Spain. A. Statue of Pomona with starting point, intersection of Broadway and Ward Parkway in background. B. Wornall-Broadway Bridge over Brush Creek, view toward southwest and Fairmont Hotel. C. Plaza III steakhouse, original west end of the Country Club Plaza District. D. Former headquarters of the J.C. Nichols Company with elaborate stone and tile work typical of the Plaza. E. Tivol Jewelry, Nichols Road on the Plaza, where employees used gold pans to recover jewelry from flood muck in 1977. F. Intersection of Emanuel Cleaver II Boulevard and J.C. Nichols Parkway with structure modeled after the Giralda Tower of Seville visible to the right. The high-water mark for 1977 flood was located near the point from which the picture was taken.



Club Plaza (Fig. 2). On October 4, 1998, a second deadly flash flood occurred in Kansas City as a result of up to 17 cm of rain – much of which fell within a single hour! The 1998 flood caused considerable damage (Fig. 3) and eleven deaths.

To date \$86 million dollars have been spent to lessen the impact of heavy rains on the Brush

Creek drainage (Burnes, 2002). This article covers some of the highlights of the damage from the two flood events (Figs. 4 and 5). A web site devoted to the Brush Creek floods was developed for instructional purposes for the Department of Geosciences at the University of Missouri-Kansas City by Tabor (1996).



*Figure 3. Flood damage in Mission Hills, Kansas. A. View toward stop 2, stream channel and active gravel bar. Note scouring at base of sycamore, 2 m above normal stream level. Note fence posts located 3 m above normal stream a level and visible in upper left hand corner of photograph. B, C. Fence posts and toppled stonewall just downstream from stop 2. D. Pedestrian bridge on Mission Hills golf course with flood debris sitting six meters above the normal level of Brush Creek, near stop 4 on State Line Road.*

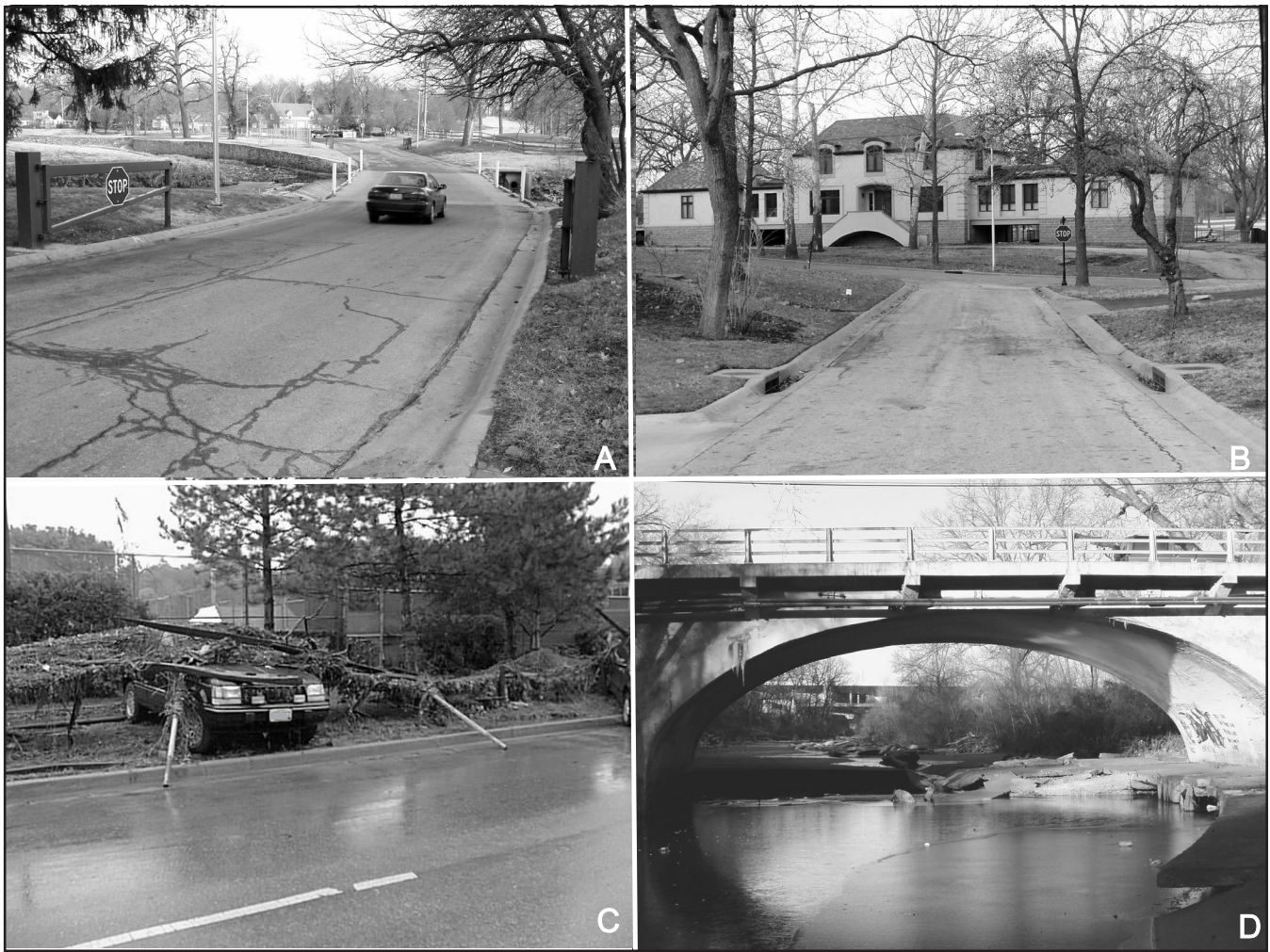


Figure 4. Hazardous sites along Brush Creek. A. Belinder road crossing at the border between Mission Hills and Fairway Kansas, where two individuals died in their car when they attempted to cross Brush Creek during the 1977 flood. Note wooden gate that is closed during major rainfalls in an effort to prevent the occurrence of such tragic events in the future. B. Home just west of Stop 2 on Mission Parkway replacing house that was flooded in 1977 and 1998. The new house was built after the 1998 flood and is elevated to permit the flow of storm water. Two residents were trapped in the attic of the original house in 1998, and had to be rescued by firefighters who came through the roof with axes. C. SRV whose driver perished on State Line Road during the 1998 flood. D. Prospect Avenue Bridge, 2003, from which seven individuals were swept away during the 1998 flood. An inexpensive solution, such as the wooden gate depicted in Fig. 5A, may have prevented such a tragedy. The bridge is slated for demolition in 2003. Note disrupted and undermined Pendergast-era concrete to lower right and also beneath the bridge.



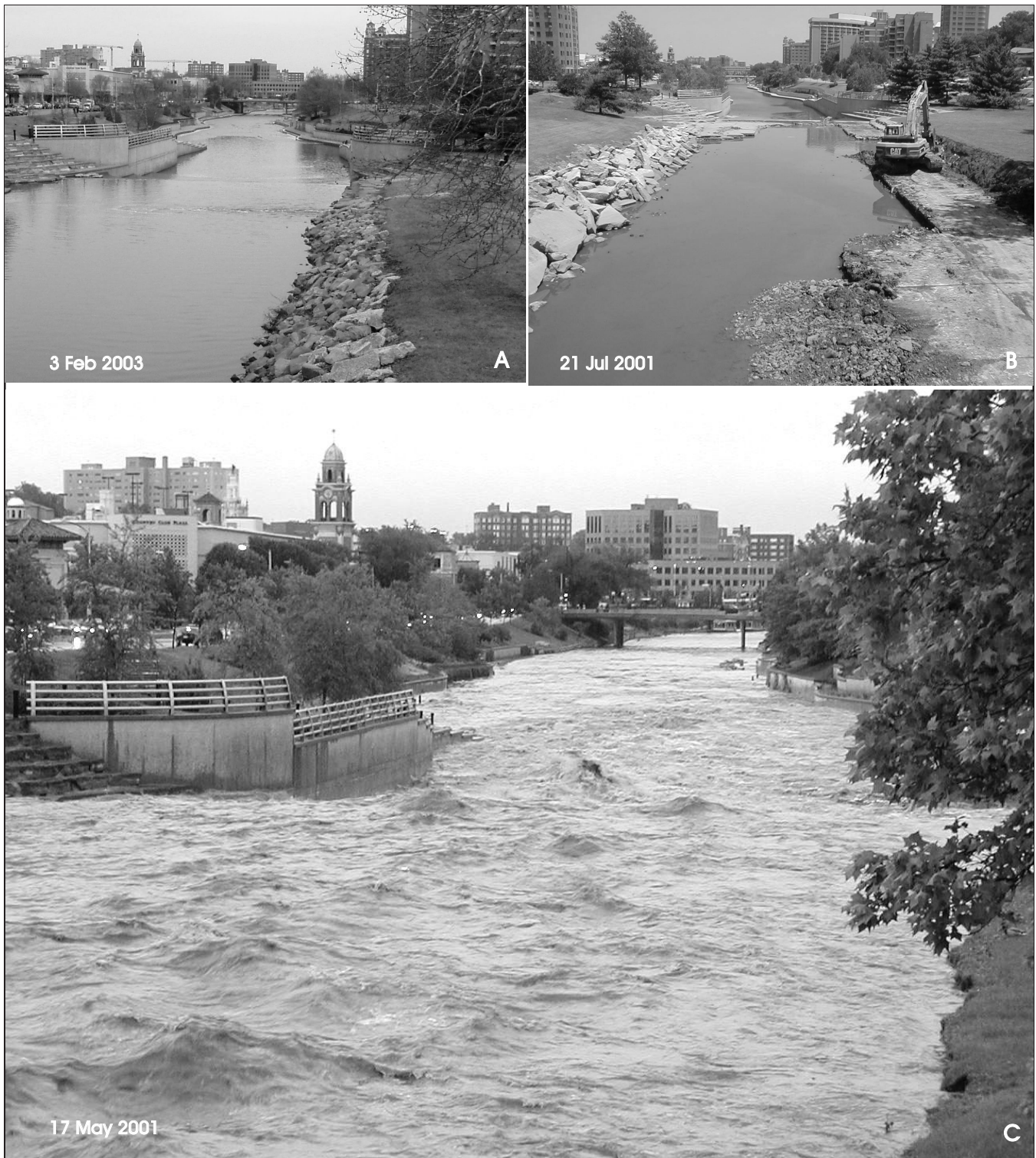


Figure 5. Brush Creek and Country Club Plaza, viewed toward the east from Roanoke Parkway Bridge. A. on a dry day after a prolonged drought in February 2003. B. During July 2001 when the channel was stripped of a concrete liner and deepened by about 2 m to facilitate flow and lessen the impact of rain events and flooding. C. After rainfall of several inches on 17 May 2001. The tower visible in the distance in all three photographs is located at the starting point of the trip.

## The 1977 Plaza Flood

The Country Club Plaza Shopping District is located on the northeast corner of a 25 square kilometer residential development area constructed by the J.C. Nichols Company in the 1920s (Worley, 1996; Faulkner, 1996). The Plaza, as it is known informally, lies midway in the drainage of Brush Creek, which drains 76 sq km, about half of which is in Johnson County, Kansas, and half in Jackson County, Missouri. On September 12, 1977, a total of 40 cm of rain fell within the drainage basin of Brush Creek. Isoleths of the rainfall were first reported in the *Kansas City Times* (KCT, 1977a) which indicated an unfortunate coincidental alignment of the maximum rainfall amounts with the Brush Creek drainage basin. The largest rainfall rates were centered on the Country Club Plaza. Each of the two September 12 rain periods was, in itself, a 100-year event (Clark, 1982). The first rain resulted in a flow rate of 175 cms (U.S. National Weather Service, 1978). The second rainfall that occurred less than 12 hours later resulted in a maximum flow rate of 525 cms (U.S. National Weather Service, 1978).

The peak flow rate in Brush Creek on September 12, 1977, was approximately as large as the normal flow rate of the Missouri River. This extraordinary discharge can be attributed to the urbanization of the watershed area and to saturation of the ground in the drainage basin of Brush Creek during the earlier rainfall. The U.S. Army Corps of Engineers (1981) estimated the recurrence rate for a flow rate of 175 cms at 200-500 years. During the peak of the flood, water flowed above each of the existing bridge overpasses that cross Brush Creek between State Line Road and the confluence with the Blue River. Eyewitnesses described a 6-m-high wave of water that rushed down Brush Creek and overtopped the Broadway-Wornall Bridge located near Stop 1 (Fig. 2A). During the Plaza Flood, a total of 25 people were killed by the unexpected nature of the “flash flooding” in the Greater Kansas City area. Seventeen were trapped in automobiles while crossing submerged bridges and roadways. Twelve of the deaths occurred in the Brush Creek basin (see Fig. 1; KCT, 1977b; U.S. Army Corps of Engineers, 1981) near the locations shown in Fig. 1. Several hundred automobiles were carried away by the floodwaters and a reported \$66 million dollars in property damage resulted. In the Country Club Plaza alone, 77 of 155 businesses were inundated by floodwaters (Burnes, 2002).

Descriptions of the flood and its aftermath have been recounted by a series of articles in the *Kansas City Times* and the *Kansas City Star* daily newspapers (KCT, 1977a-c; KCS, 1977d-f), by the U.S. Army Corps of Engineers (1981; 1999), and by the U.S. National Weather Service (1978). Summaries of the flood have also been provided by Faulkner (1996), Nelson (1999), and Burnes (2002). A report by Driever and Vaughn (1988) focused on the severe flooding that occurred in the Blue River basin both downstream and upstream of the confluence of Brush Creek and the Blue River in 1977 and in previous years.

## Responses to the 1977 Plaza Flood

The reaction to the 1977 flood disaster was immediate (KCT and KCS, 1977 a-f). A state of emergency was declared by city, state, and federal authorities. Educational and commercial operations in Kansas City were suspended for the day after the flooding on September 13, 1977.

In the years following the 1977 flood, plans to deepen and widen the creek were devised. The plans included the removal of obstacles such as the tunnel that once carried the water of Brush Creek between Oak and Rockhill Road. Serious reconstruction began in 1991 and to date more than \$86 million have been spent to widen, deepen, and beautify the 2.5 km reach of Brush Creek between Roanoke Parkway and Troost Avenue. The 15 to 20-cm-thick concrete channel liner that was emplaced during the Pendergast political era in the 1930s (Fig. 6) has largely been removed from this reach of the channel in order to widen the channel to a width of 3-6 m, and to deepen the channel to an average depth of 2.5 m. The result of this reconstruction are seen in the flow rates presented in Figs. 5 and 6. Efforts to engineer the channel and control the flow of the remainder of the Brush Creek drainage in Missouri are still underway more than twenty-five years after the Plaza Flood.

## The 1998 Brush Creek Flash Flood

Late on Sunday, October 4, 1998, 18 cm of rain fell on the Brush Creek watershed and resulted in a major flash flood in which eleven individuals perished. Although the total amount of rainfall that caused the 1998 flood was much less than in 1977, the duration of the storm was much shorter. In a single 75-minute period, a total of 11.5 cm of rain fell on the community of



Fairway, Kansas (Stop 2). The Kansas City Chiefs NFL football game had to be suspended during the storm. People were evacuated from the exposed portions of Arrowhead Stadium (east of Fig. 1) because of concerns over lightning and the danger of structural damage to the stadium because of the enormous weight of the water. After the 1998 flood, the Woodland Avenue Bridge, that severely restricted the flow of the Brush Creek was demolished and not replaced. At the time of this writing (2003), the Prospect Avenue Bridge (Fig. 4D), from which six or seven individuals (the number varies in different accounts) were swept to their deaths in 1998, is slated for demolition.

### Overview of Field Excursion

This self-guided field trip to the Brush Creek flood area was prepared for distribution at the 37<sup>th</sup> annual meeting of the North-Central Section of the Geological Society of America. The trip features nine stops within the Brush Creek drainage basin in Kansas and Missouri. The stops focus on locations where people have lost their life and where design modifications have been made to the creek channel since the 1977 flood. The trip begins and ends in the Country Club Plaza, that was developed as the county's first suburban shopping mall in the 1920's by the J.C. Nichols Company. The road log for the trip follows below.



Figure 6. Pre-1977 and 2001 Views of Brush Creek flow rates.

A. Brush Creek after 9 cm rainfall ca. 1974. B. Same scene as 6A on normal day ca. 1974. Note Pendergast-era concrete pavement. C. July 2001 view of stepped waterfall built when the Brush Creek channel was modified after the 1977 flood. The water flow results from recirculation of water by pumping from the east end of the Country Club Plaza to the south bank near Roanoke Parkway (Stop 5). D. Flowage of Brush Creek and standing wave at Stop 5 resulting after 10-15 cm of rain on 17 May 2001.

## **Road Log**

### **for the SELF-GUIDED tour of the Brush Creek flash floods of 1977 and 1998.**

- 0.0 mi STOP 1.** Begin the trip in the County Club Plaza from the intersection of Broadway Avenue and Ward Parkway (Fig. 2A). Cross the Broadway Avenue Bridge over Brush Creek and continue south on Broadway Avenue until it becomes Wornall Road. The present bridge was built in 1980 to replace an earlier structure, which created a dam and restricted considerable downstream flow of water during the 1977 Plaza Flood (Faulkner, 1996). The high water mark at the Broadway Avenue Bridge was about 1.5 m above the level of Ward Parkway pavement at the peak of the 1977 Plaza flood. However, a previous publication issued by the Kansas City municipal government, predicted a standard, projected flood height of ca. 2.5 m (anonymous, 1970).
- 0.1 mi At the intersection of Wornall Road and Ward Parkway, pass a large hotel, presently a Fairmont Hotel franchise, from which eyewitnesses viewed a 6-m-high wave of water that rushed eastward down Brush Creek and overtopped the original bridge that stood on this site on the evening of September 12, 1977.
- 0.4 mi View Loose Park, site of the original Kansas City Country Club, for which the Country Club Plaza is named.
- 0.9 mi Reach 55<sup>th</sup> Street, turn right to the west towards Kansas.
- 1.3 mi Pass the Bent and Ward houses. William Bent was a well-known fur trader active throughout Colorado, Kansas, and Missouri, who was depicted in the film *Little Big Man*, with actor Dustin Hoffman playing the lead role.
- 1.7 mi Enter Kansas and continue across State Line Road into Mission Hills known for its luxurious estates. Turn left (west), and follow Mission Drive along the course of Brush Creek.
- 1.9 mi STOP 2.** On the right view house that was reconstructed after the 1998 flood. The earlier 1½ story house that was located on this property was flooded in 1998. The homeowners were rescued from the attic by firefighters who came through the roof with axes. The present house is elevated to allow water to pass readily underneath during major rain events. Fence posts, a pedestrian bridge, and a large mortared stonewall at the entrance to the Mission Hills Country Club were all flattened by the 1998 flood (Fig. 3).
- 2.3 mi Turn right on Belinder Avenue and keep to the left and park on Brookbank Lane.
- 2.35 mi STOP 3.** Belinder Avenue crosses Brush Creek through a gate that can be closed during major rainfalls to prevent people from attempting to pass over Brush Creek. Two individuals were killed in 1977 as they attempted to cross the creek in their car. Continue north on Belinder Avenue past the Mission Hills Country Club. After crossing Brush Creek, the route leads into Fairway, Kansas.
- 2.4 mi Continue north on Belinder Avenue.
- 3.0 mi Turn right towards the east on Shawnee Mission Parkway.
- 3.4 mi Enter parking lot of Country Club Bank.
- 3.5 mi STOP 4.** The State Line Bridge and the Ward Parkway Bridge visible about 50 m downstream were both overtopped by the 1977 and the 1998 floods. Across Brush Creek on the east side of State Line Road is a low spot where the driver of a sports utility vehicle (depicted in Fig. 4C) was killed during the 1998 flood.
- 3.5 mi Turn right to the south on State Line Road. Immediately cross a bridge over Brush Creek.
- 3.9 mi Reach 55<sup>th</sup> Street (the intersection previously crossed) and double back towards the east by taking a left turn on 55<sup>th</sup> Street.
- 4.15 mi Turn north on Ward Parkway enter the valley of Brush Creek. A 40 ft (12 m) decline leads to the base of the hill and the floodplain of Brush Creek. Follow Ward Parkway eastward past elegant homes, some of which are protected from flooding by berms.



- 4.9 mi Pass low-lying homes that were inundated by the 1977 and the 1998 floods.
- 5.1 mi Turn left on Roanoke Parkway cross a bridge.
- 5.2 mi Turn right on Ward Parkway.

**5.25 mi STOP 5** Park on the right hand side and view the bridge and the channels shown on Figure 2. Continue east on Ward Parkway.

**5.4 mi STOP 6** Sign on left indicates the original west end of the Country Club Plaza, developed by the J.C. Nichols Company in the 1920s (Worley, 1990). Beneath the sign is the Plaza III Steakhouse, which has been in business at this location for more than 50 years. The crest of the 1977 Plaza Flood is marked at eye level in the restaurant's bar where, for a price, you may partake of your favorite beverage.

5.5 mi Pass Stop 1, the starting point, at the intersection of Ward Parkway and Broadway turn north

5.55 mi Turn right to the east on Nichols Road.

5.6 mi Pass Tivol Jewelry, one of 77 Country Club Plaza businesses that was flooded in 1977. Tivol employees used gold pans to recover the jewelry from the mud and silt that filled the store after the flood waters receded. Turn left (north) on Wyandotte Street.

5.65 Turn right on 47<sup>th</sup> Street.

5.75 At the intersection of 47<sup>th</sup> Street and J.C. Nichols Parkway, you are located at the approximate flood crest of 1977. The tennis court to the right was completely flooded by the 1977 flood. The south end of the court was covered by automobiles stacked on top of each other in a manner reminiscent of imbricated stream cobbles. Here, 47<sup>th</sup> Street becomes Cleaver Boulevard named for Emanuel Cleaver II, who was mayor at the time of the 1998 flood.

5.9 mi Pass Winstead's Drive-in whose hamburgers were brought to national attention by Kansas City native, Calvin Trillin, in the *New Yorker*.

6.1 mi Cross Oak Street. To the left are the grounds of the Nelson-Atkins Museum and to the right in the distance you can see the Midwest Research Institute and the campus of the University of Missouri-Kansas City. Prior to the 1977 Plaza Flood, this section of Brush Creek between Oak and Locust streets passed through an underground tunnel. The tunnel created a flow restriction that caused flooding upstream. The tunnel has now been removed and replaced with a wider and deeper open channel. This reach of Brush Creek now includes a broad, shallow holding pond that is sufficient to lessen the effects of minor floods.

6.6 mi Turn right to the south on Troost Avenue. Visible in the distance to the south is the Stowers Institute for Medical Research.

**6.7 mi STOP 7.** Kansas City Urban Conservation Discovery Center was constructed in 2001 and is administered by the State of Missouri Conservation Department and the Department of Natural Resources. The headquarters for the Kauffman Foundation is located to the southwest of this building. The Discovery Center and the Kauffman Foundation Headquarters are located on what was a residential neighborhood during the 1977 flood. Residents fled their homes, some with nothing but the clothes on their backs, and some of the homes were destroyed by the flooding. One roof top was carried downstream to Paseo Boulevard, near Stop 8 (U.S. National Weather Service, 1978). Shortly after the 1977 flood, the University of Missouri-Kansas City gained ownership of the land and cleared it for non-residential development. A working model of the Brush Creek drainage is one of the exhibits in the Discovery Center.

To the south of the Discovery Center parking lot, you can see the Troost Avenue Bridge. This bridge is one of the few bridges that remain from the era predating the 1977 flood. From this point upstream to the headwaters of Brush Creek in Johnson County, only two bridges from 1977 remain. All other bridges have been demolished and replaced with structures that have higher and longer spans. The new bridges allow a higher volume of water to pass underneath them and thus reduce the impact of flooding. For the reach on Brush Creek between the west end of the Country Club Plaza (Stop 5) and this point, the channel was also deepened.

6.8 mi Leave the Discovery Center parking lot. Turn left to the north on Troost Avenue.

7.0 mi Turn right to the east on Cleaver II Boulevard.

7.2 mi Pass a Kansas City institution, Gates Barbeque, which was located on the south side of Brush Creek prior to the Plaza flood.

7.3 mi Cross Paseo Boulevard, which crosses Brush Creek over a wide bridge, completed in 2000.

- 7.4 mi STOP 8.** Pull over on the right side of Emanuel Cleaver II Boulevard to examine the Village Green Apartments, located on the north side of the road. These apartments received an estimated \$4 million in damage during the 1977 flood (U.S. Army Corps of Engineers, 2000) and were flooded again in 1998. On the south side of 47<sup>th</sup> Street, stop to view the creek bed. Here are the remnants of a 15 to 20-cm-thick concrete pavement that was laid down during the Depression and the Tom Pendergast political machine era. Most of the drainage of Brush Creek in Kansas City, Missouri, was formerly lined by this concrete pavement. Similar pavement remains in much of the Brush Creek drainage in Johnson County, Kansas, to the present day. During the flooding of 1977 and 1998 floods, the concrete pavement was disrupted at numerous locations. In some cases slabs of concrete measuring 4 m by 4 m were dislodged and completely flipped over as a result of the force of the flood. View outcrop of Bethany Falls Limestone that forms a natural surface within the Brush Creek channel.
- 7.5 mi Cross Woodland Avenue.
- 7.7-7.9 mi Pass beneath the elevated Highway 71 Bridge completed in 2001. Note the broad, high expanse capable of handling any conceivable future flood.
- 8.0 mi Turn right to the south at Prospect Avenue and cross bridge. Six or seven individuals were swept to their deaths by floodwaters in 1998 from the Prospect Avenue bridge. The bridge is slated for demolition in 2003 (Horsely, 2002). In early 2003, dislodged and overturned sections of Pendergast-era concrete could be viewed in the channel.
- 8.3 mi Turn right (west) and follow Swope Parkway and Highway 56.
- 8.4 mi Cross beneath the Highway 71 Bridge.
- 8.7 mi Turn right to the north on Woodland Avenue.
- 8.8 mi STOP 9** Martin Luther King Park. View footings of the former Woodland Avenue Bridge and the broadened flood channel for a reach of about a 0.5 mile in each direction. The Paseo Bridge is visible to the west and Highway 71 Bridge to the east.
- 8.9 mi Exit the parking lot. Turn south on Woodland Avenue.
- 8.95 mi Turn right to the west on Swope Parkway (Highway 56), which eventually becomes Volker Boulevard. The field trip route follows the channel of Brush Creek that is visible on the right hand side.
- 9.1 mi Pass the Paseo Bridge visible to the right at 9.0 mi. Cross Paseo Boulevard and continue to follow the south bank of Brush Creek.
- 9.2 mi Excellent view of the improvements that have been made in the channel of Brush Creek.
- 9.5 mi Just east of Troost Avenue one can see the pre-1977 condition of the creek. At the time of this writing (2003), the Troost Avenue bridge remains one of the few bridges over Brush Creek that predate the 1977 and 1998 floods. View to the Kansas City Discovery Center and the Kauffman Foundation across Brush Creek. On the left side of the road to the south are the Stowers Institute of Medical Research and the campus of the University of Missouri-Kansas City. Continue along Swope Parkway passing the Midwest Research Institute.
- 10.0 mi Cross Oak Street and then Brookside Boulevard. The two roads were inundated with water from the floods. They combined to form a major flood channel that was impassable during both the 1977 and the 1998 floods. In 1977, more than a hundred automobiles were flooded in the underground parking of what is now the Town Oaks dormitory of the University of Missouri-Kansas City located 100 m south of this intersection.
- 10.2 mi Turn right to the north on Main Street. Get in the left hand lane to reach Ward Parkway.
- 10.3 mi Turn left towards the west on Ward Parkway.
- 10.4 Halls Department Store to the right was flooded to nearly 2 m above floor level and about 8 m above the normal level of the creek in 1977. The fountains to the left aerate the water and are essential for maintaining good water quality in Brush Creek. One flood victim was found at 315 Nichols Road not far from 301 Ward Parkway, the former headquarters of the J.C. Nichols Company.
- 10.5 mi End of trip** at intersection of Broadway and Ward Parkway, which was the starting point for the field trip.
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