A GEOLOGIC WALKING TOUR

Stone Landmarks

Flagstaff's Geology and Historic Building Stones

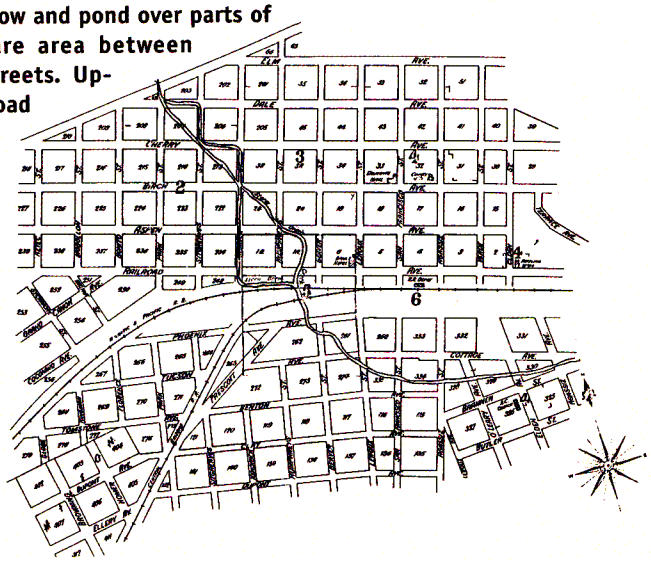
BY MARIE D. JACKSON

DEVIATION OF THE RIO DE FLAG DOWNTOWN

Most of the present course of the Rio de Flag downtown follows a series of trenches excavated between 1892 and 1901. These were meant to shift the stream channel with its propensity for damaging floods away from the center of commercial downtown. Before 1890, the Rio ran southeastward from what is now Frances Short Pond, just west of Flagstaff Middle School, to Aspen Avenue between Humphreys and Beaver Streets. There, the channel turned south. The Atlantic and Pacific Railroad built a trestle, which is still standing, over this section of the channel in 1882. South of Phoenix Avenue, the channel curved, running east-southeast for three quarters of a mile close to the south side of the railroad tracks until it plunged into a deep, fault-bounded canyon that joined Sinclair Wash near the high spans of Interstate 40. That deep canyon is exposed on either side of Butler Avenue about one-half mile east of its intersection with Enterprise Road.

Successive modifications to the channel of the Rio de Flag are recorded by the Sanborn Fire Insurance Maps compiled between 1890 and 1916. Incorporation of Flagstaff in 1894 brought new impetus for the completion of public works, and on February 28, 1895, the *Coconino Sun* reported "the reverberations that echo down by the River de Flag are caused by dynamite operations inaugurated for the purpose of widening and deepening the majestic stream." Instead of allowing the original channel to traverse P. J. Brannen's southside subdivision of upper-middle-class home sites (called the Brannen Addition) approved in April 1894, the Rio was redirected to a shallow and narrow 2,800-foot-long trench that ran southeast from Cottage Avenue to the head of a small unnamed tributary near O'Leary and Ashurst Streets, that drained into Sinclair Wash. This is the present channel of the Rio de Flag on the southside (see page 92).

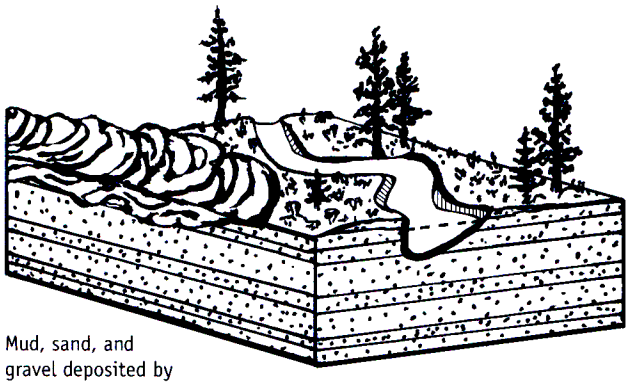
Alteration of the course of the Rio intensified floods in July 1896, April 1903, January 1916, February 1920, September 1923, and March 1938. Because the artificial channel could hold only a small volume of water, floodwaters would flow and pond over parts of a roughly six-block-square area between Agassiz and Sitgreaves Streets. Upstream, north of the railroad tracks, floodwaters would back up behind blocked street crossings and culverts, spreading over much of the area included in the hundred-year floodplain shown on the walking tour map. Streets became gullies, wooden sidewalks floated over submerged streets, and floodwaters destroyed bridges and filled the homes of many residents.



The Rio de Flag

The highly permeable cindery soils and fractured volcanic and sedimentary rocks of Flagstaff's landscape encourage much water to infiltrate the ground. After periods of especially abundant rain or snowfall, even these soils become saturated with moisture. Water then begins to run downslope and collect in tiny rivulets, which merge to form a network of watercourses that quickly conduct runoff to the steep, rocky canyons eroded from Flagstaff's volcanic landscape. These canyons remain dry through most of the year and it is only after heavy rain or rapid snowmelt that they transport runoff for a few hours or days into Flagstaff's main stream drainage, the Rio de Flag. The Rio de Flag runs intermittently, transporting only 0.1 percent of the annual precipitation that falls on its watershed! Flagstaff's absorbent rocks and its dry air, which promotes processes of evaporation and sublimation, absorb the remaining 99.9 percent.

WIDER EXPLORATIONS
To explore the Rio de Flag along the Museum of Northern Arizona Nature Trail, see page 97.



Mud, sand, and gravel deposited by repeated floods of sediment-laden waters from the Rio de Flag have constructed a flat strip of land, called a flood plain, along the stream. Much of downtown Flagstaff rests on unconsolidated sediments of the Rio de Flag's active floodplain.

The stream channel of the Rio de Flag originates within porous volcanic rocks near Fort Valley at about 7,300 feet elevation at Leroux Spring. The channel continues in a southeasterly direction until it abruptly narrows near the Museum of Northern Arizona. There, you can explore a canyon eroded by the Rio de Flag into the fractured 6-million-year old basalt lava flow. The channel then turns sharply to the south and makes its way to downtown Flagstaff, which occupies part of the active floodplain of the Rio de Flag, one of the widest expanses of flat land in the area.

When a river overflows its banks during floods, it covers the floodplain with water and sediment, or alluvium, that was eroded and carried from upstream. Away from the swiftly moving current of the stream, the sediment settles out of slow-moving or stagnant

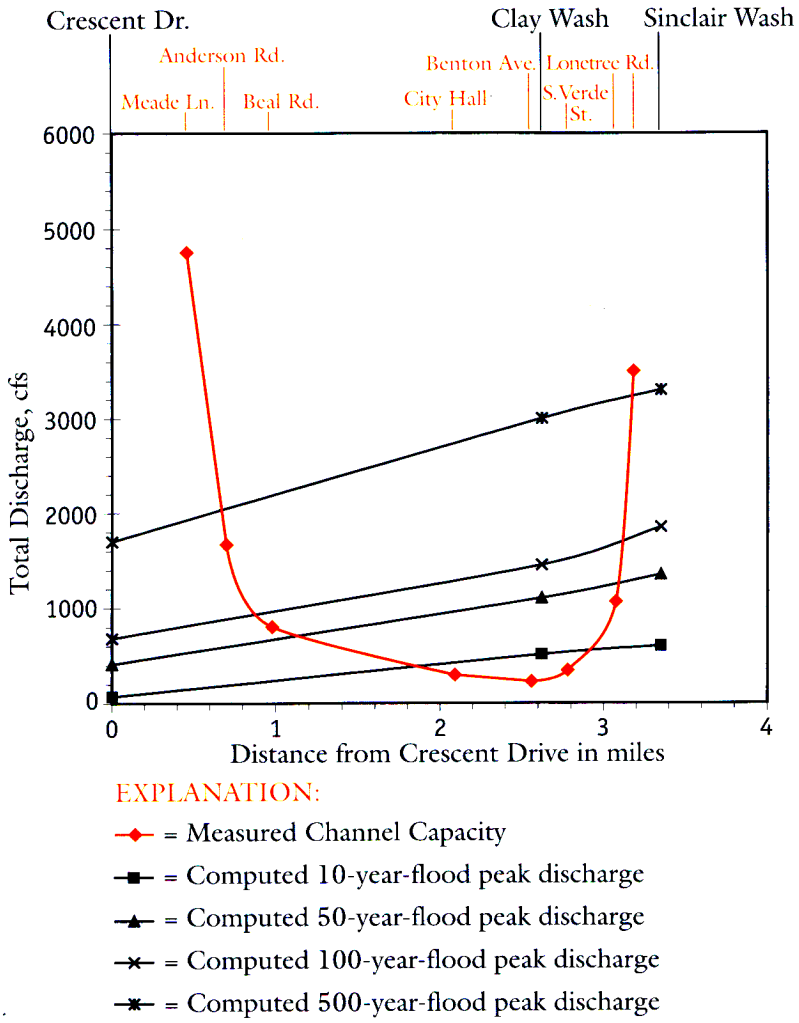
water and is deposited in a thin layer over the ground surface. The next time you wash dishes in a sink full of soapy water, scrub the last dirty dish, pull out the plug, and let the water run out. A layer of debris, made of coarse- to fine-grained food particles will have settled to the bottom of the sink. That layer of debris is analogous to the layer of geologic debris—mud, sand, and gravel—that is carried downstream by swiftly moving floodwaters and settles from standing, sediment-rich water.

Assessment of Flood Hazards

In recent history, the Rio de Flag has overtopped its mostly artificial banks and inundated downtown Flagstaff with sediment-rich floodwaters numerous times. The stream could still cause severe destruction on its downtown floodplain. In 1981, the Federal Emergency Management Agency (FEMA) computed long-term-average periods during which floods of a certain volume should occur in the Flagstaff area. The areas of downtown that are predicted to be covered by large floods occurring on average once during a 100-year and a 500-year period are shown on the walking tour map. These flood volumes, commonly called the 100-year and 500-year floods, have a 1 percent and 0.2 percent chance, respectively, of being equalled or exceeded during any year.

Flood waters rush along the Rio de Flag southside on a stormy day about 1900.

FEMA has also computed the peak volumetric discharge of floodwaters, in cubic feet per second (cfs), that could result in flooding at different locations along the Rio de Flag channel, predicted once over ten-year, fifty-year, one-hundred-year, and five-hundred-year intervals. The series of dashed curves on the graph (following page) shows those

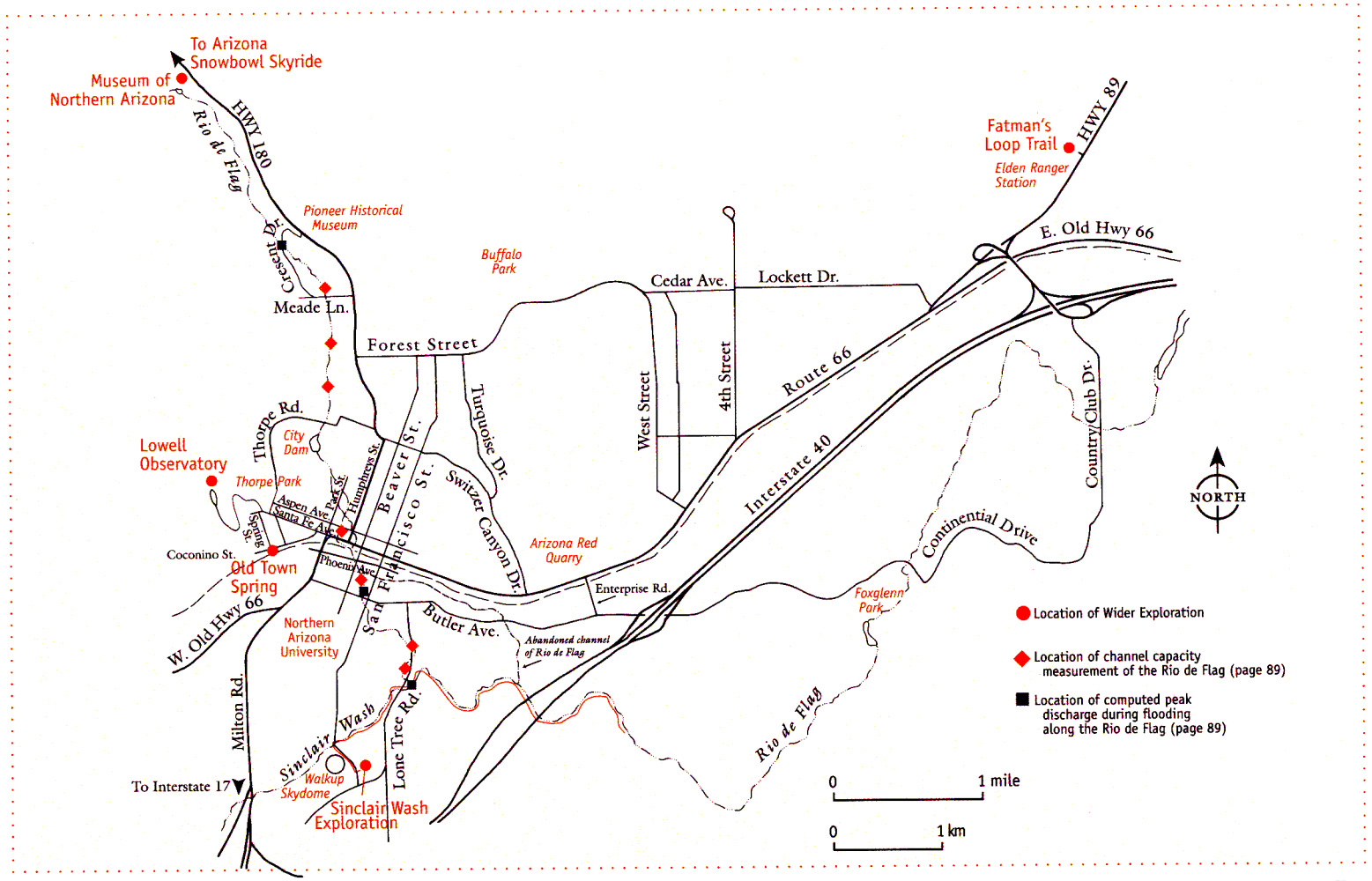


This graph, which plots the measured channel capacity of the Rio de Flag (the orange curve) and predicted peak discharges of variably sized floods (the black lines) through Flagstaff, illustrates the potential for damaging floods downtown. Between City Hall and South Verde Street, where the Rio follows a narrow, man-made ditch (see page 55), the peak discharge of a ten-year-flood can overtop the channel and cause flooding. To find the locations of the measurements and computations turn to the map of Flagstaff on page 92.

predicted discharges, going downstream along the Rio de Flag. These locations include Crescent Drive (across Highway 180 from the Pioneer Historic Museum), the confluence of Clay Wash with the Rio near Butler Avenue on the south side, and a point just above the confluence of the Rio with Sinclair Wash. (These points are shown on the street map of Flagstaff on page 92.) The predicted discharges increase going downstream, as the Rio receives increasing amounts of water from its watershed.

To gain an appreciation for the volumetric discharges that will overtop the banks of the Rio and cause flooding, you can compare FEMA's predictions of peak discharges (the black dashed lines on the graph) with the channel capacity (the orange curve on the graph) measured by the Army Corps of Engineers at eight locations along the downtown course of the Rio. These channel capacities, measured along the Rio at Meade Lane, Anderson Road, Beal Road, City Hall at Aspen Avenue, Benton Avenue, Verde Street, and at two spots along Lone Tree Road, decrease sharply at the initiation of the Rio's artificial channel downtown north of City Hall. The reduced channel capacities continue through the southside, as the Rio follows its turn-of-the-century ditch to the small natural tributary at Lone Tree Road that joins Sinclair Wash. On the graph, wherever the peak flood discharge curve exceeds the channel capacity curve, floodwaters will overtop the Rio's banks and flooding will occur. Thus, the predicted ten-year flood could cause flooding between City Hall and Verde Street, south of the railroad tracks.

Since 1979, when FEMA conducted its study of floods, impervious surfaces—roadways, parking lots, and buildings—have doubled within the Rio de Flag watershed, meaning that much less water soaks into the ground. The resulting increased discharges may cause even more blocking of culverts and roadway crossings along the Rio both north and south of the railroad tracks. As a result the risk of serious flooding continues to grow in downtown Flagstaff. The city has recently submitted a proposal to the Army Corps of Engineers to reroute the southside course of the Rio de Flag so that it could rejoin its abandoned channel. This, and enlargement of the artificial channel would greatly reduce future flood damages.


To Arizona Snowbowl Skyride
Museum of Northern Arizona
HWY 180
Rio de Flag
Crescent Dr.
Pioneer Historical Museum
Meade Ln.
Forest Street
Buffalo Park
Cedar Ave.
Lockett Dr.
Fatman's Loop Trail
Elden Ranger Station
HWY 89
E. Old Hwy 66
Route 66
Interstate 40
West Street
4th Street
Country Club Dr.
Thorpe Rd.
City Dam
Thorpe Park
Lowell Observatory
Humphreys St.
Park St.
Aspen Ave.
Santa Fe Ave.
Spring St.
Coconino St.
Old Town Spring
Beaver St.
San Francisco St.
Switzer Canyon Dr.
Turquoise Dr.
Arizona Red Quarry
Phoenix Ave.
Enterprise Rd.
Continential Drive
Foxglenn Park
W. Old Hwy 66
Northern Arizona University
Butler Ave.
Abandoned channel of Rio de Flag
Milton Rd.
Sinclair Wash
Lone Tree Rd.
Rio de Flag
To Interstate 17
Walkup Skydome
Sinclair Wash Exploration
NORTH
Location of Wider Exploration
Location of channel capacity measurement of the Rio de Flag (page 89)
Location of computed peak discharge during flooding along the Rio de Flag (page 89)
0 1 mile
0 1 km