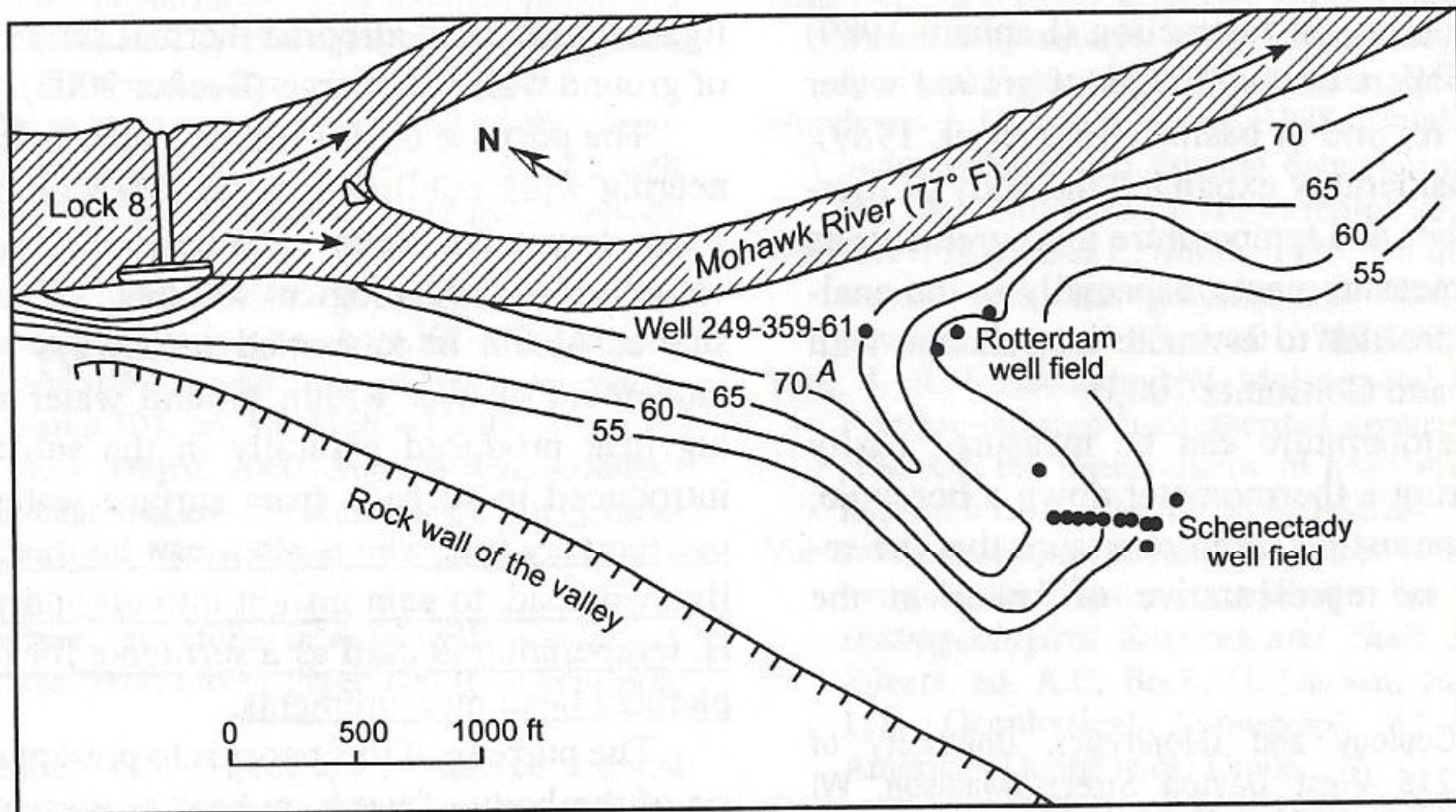


A dark, atmospheric photograph of a tunnel. The tunnel is mostly black, with a bright light source at the far end, creating a strong lens flare and illuminating the water surface at the bottom of the tunnel. The water shows ripples and reflects the light from the opening. The tunnel walls are visible as dark, textured surfaces.

Thermal Pollution Of Groundwater Under Minneapolis

Greg Brick PhD

MGWA Spring Conference 2014

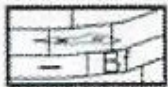


Winslow (1962)

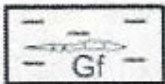
LEGEND



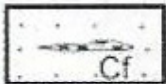
Water well and groundwater level



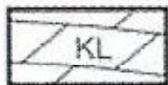
Bakirkoy formation
(Karstic limestone with marl and clay lenses-Miocene)



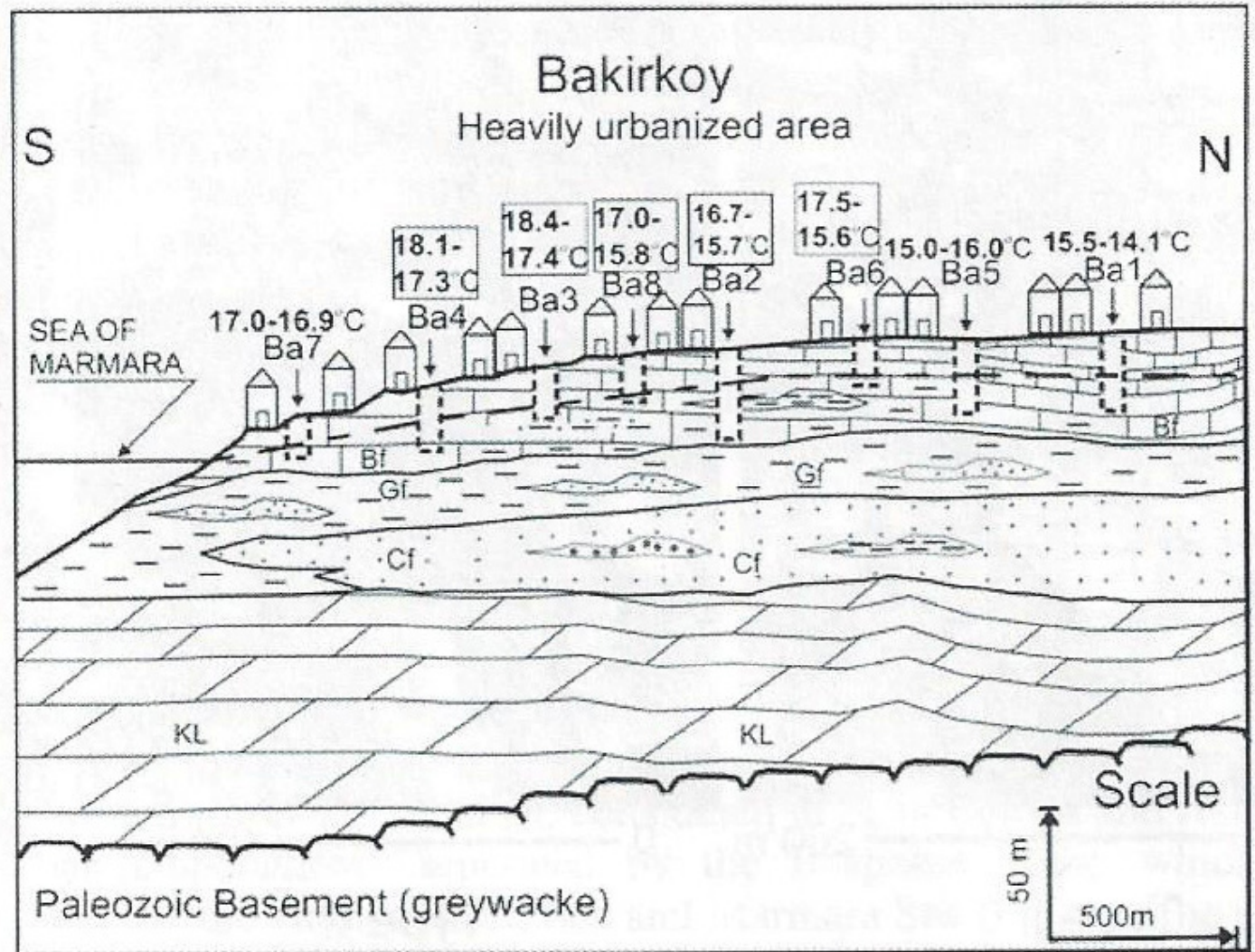
Gungoren formation
(Clay with sand lenses-Miocene)



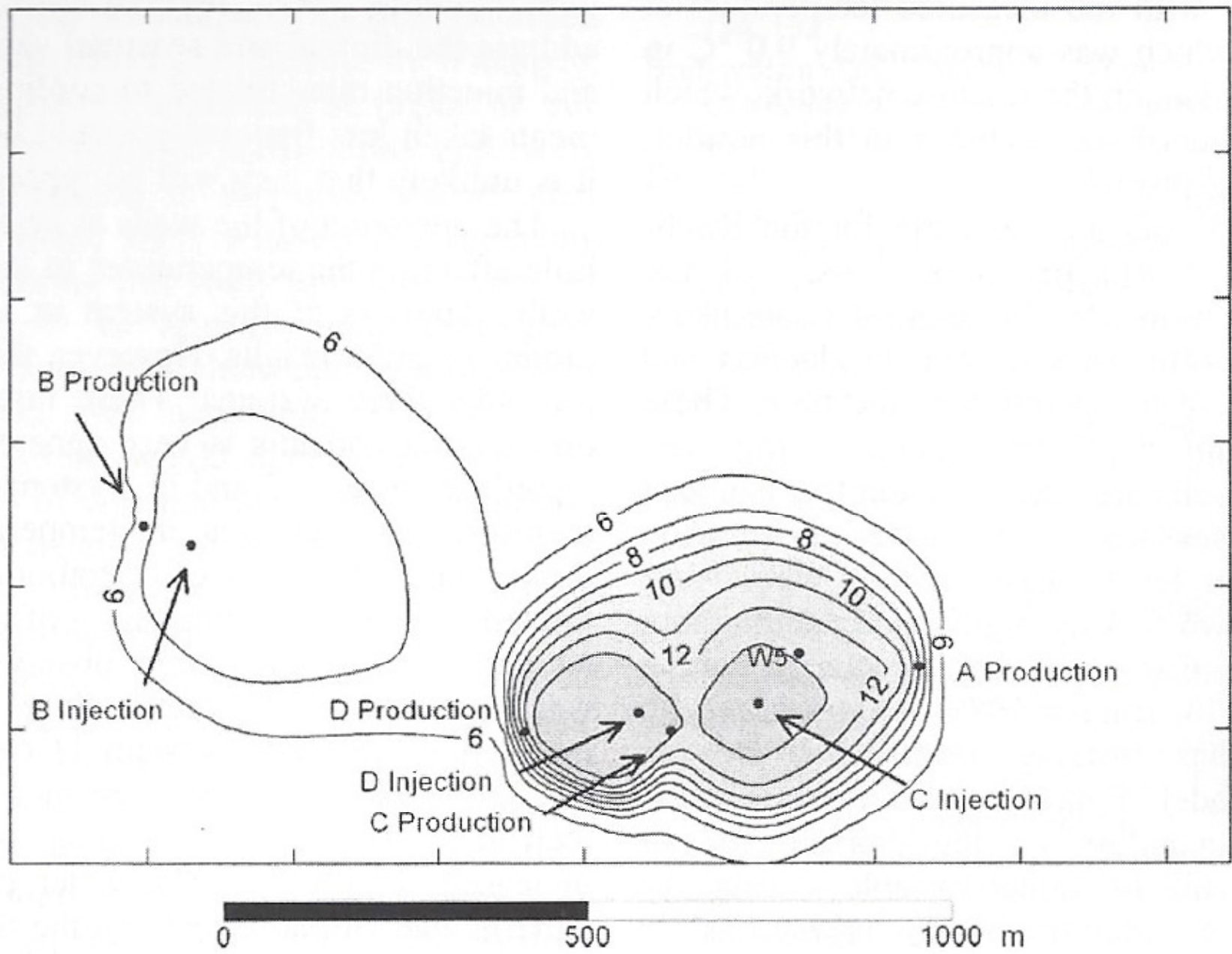
Cukurcesme formation
(Sand with clay and gravel lenses-Miocene)



Kirklareli limestone
(Karstic reefal limestone - Eocene)



Yalcin & Yetemen (2009)



Ferguson & Woodbury (2006)

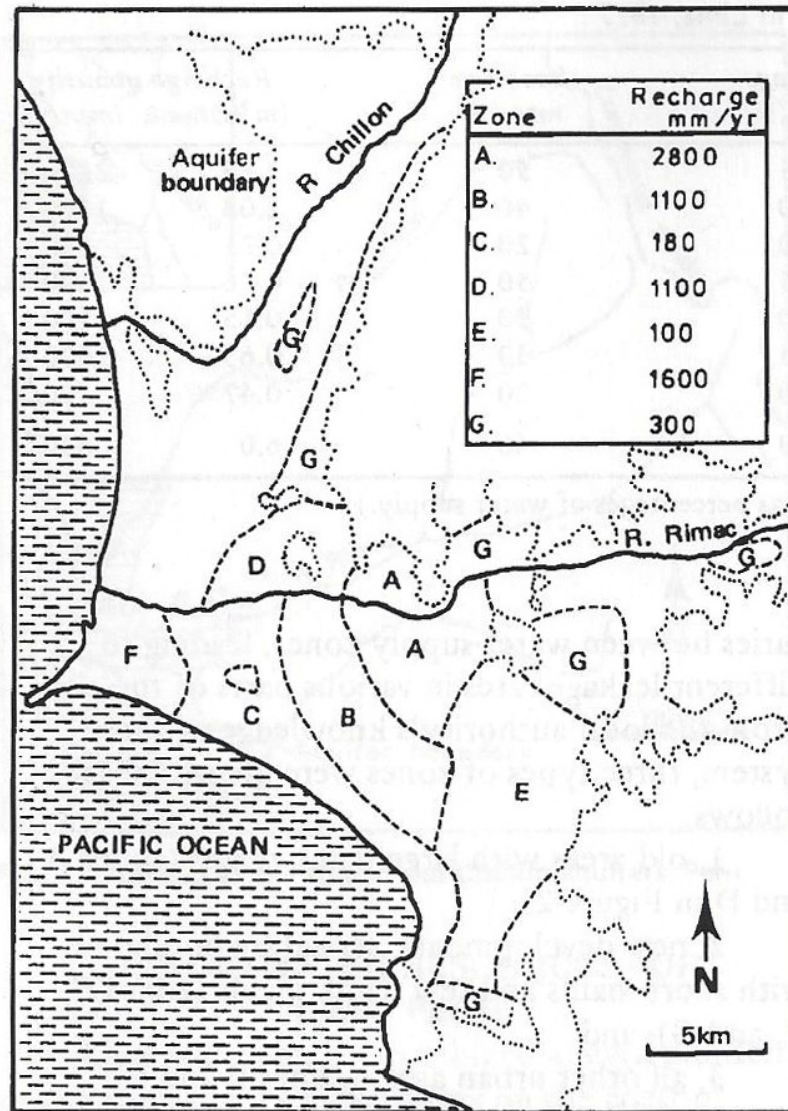
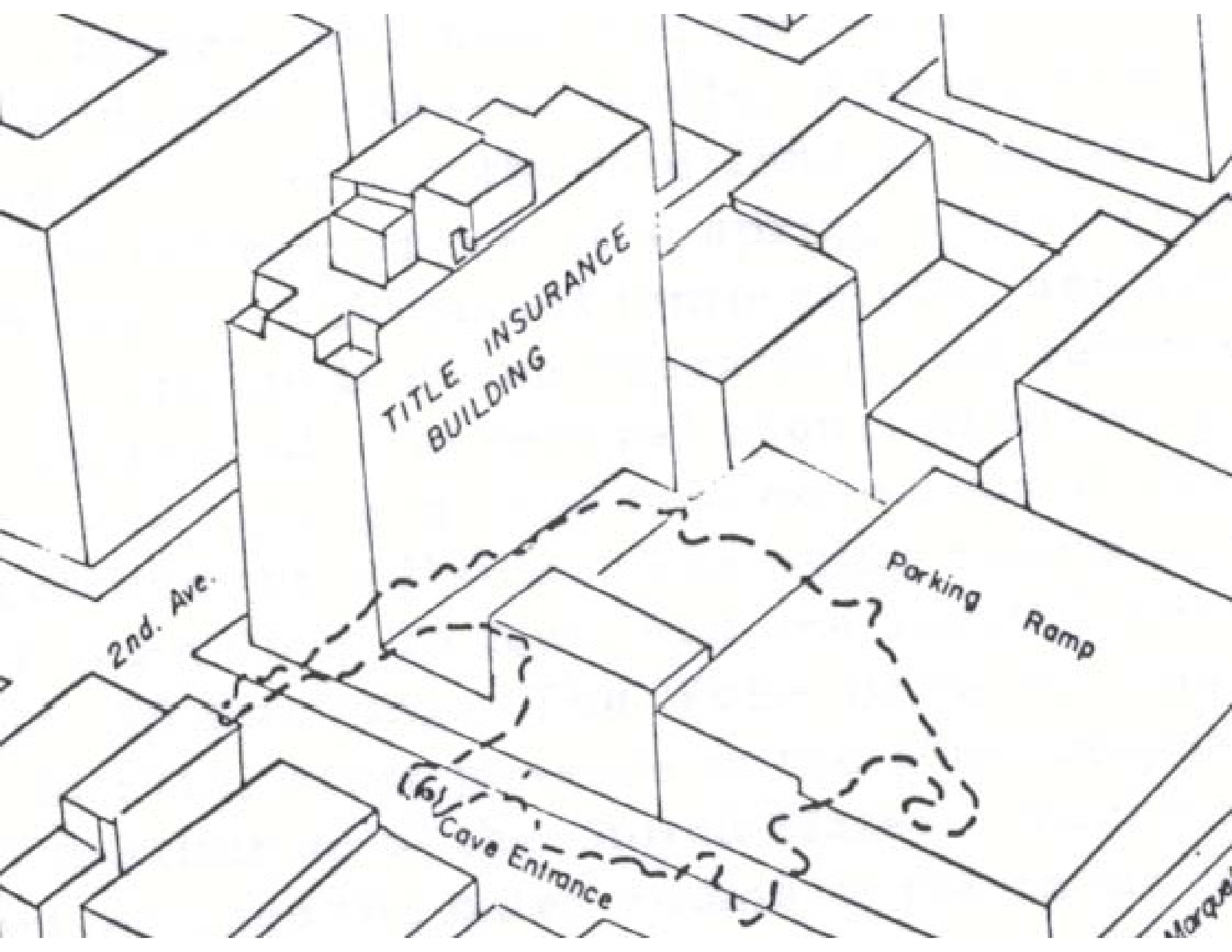


Fig. 2. Water-supply zones for Lima, showing estimated recharge from leakage.

Lerner (1986)



TITLE INSURANCE
BUILDING

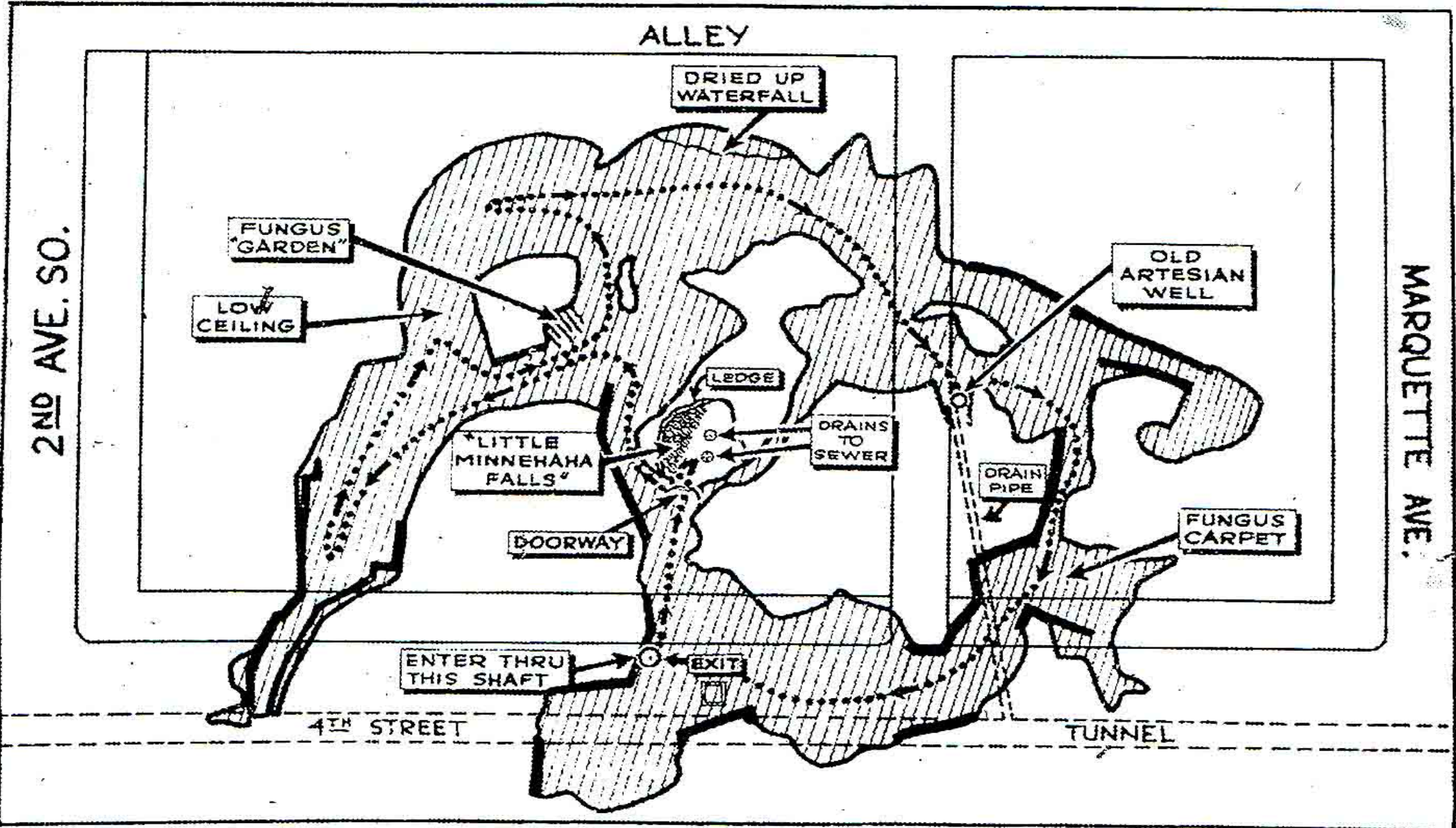
2nd. Ave.

Parking
Ramp

(6) Cave Entrance

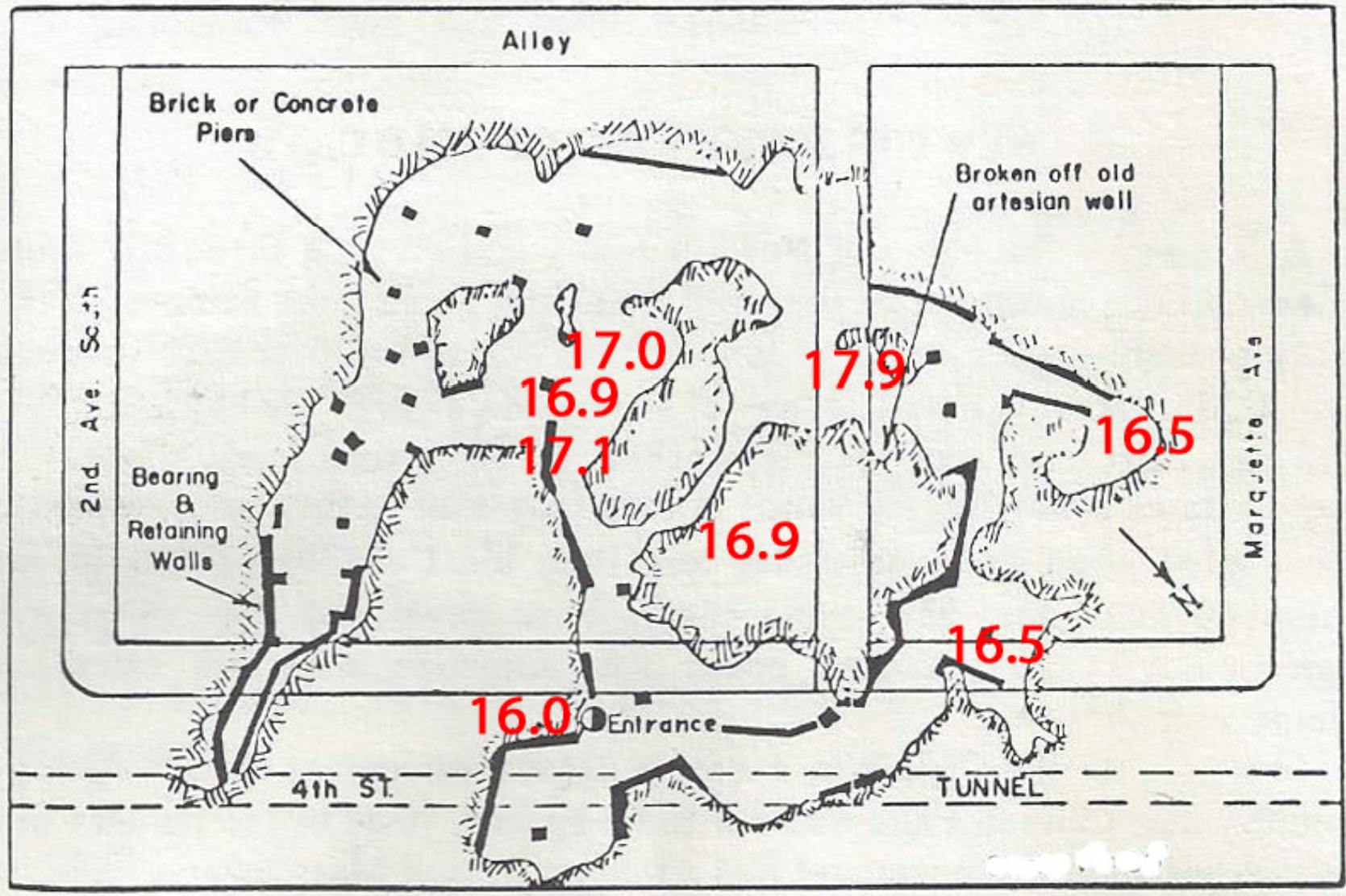
Marque

Camera Safari Explores 'Lost World' Under Loop



ROUTE OF CAMERA EXPLORATION UNDER MINNEAPOLIS LOOP





Temperatures (Celsius), April 15, 2007.

IN CAVERNS of ETERNAL NIGHT

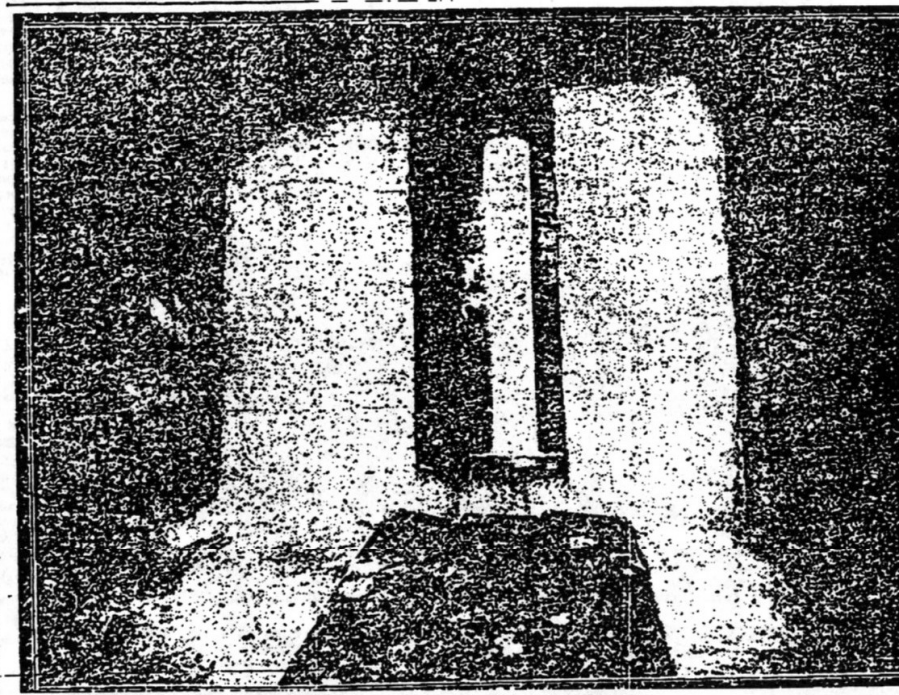


city and its din. There would be no morning, no noon, only the long, endless night and stillness, broken only by the water fall and the rushing torrent by which you enter this hidden Eden.

How Caves Were Found.
Five or six years ago a branch tunnel was dug to connect with a new skyscraper. One of the workmen, digging in the soft sandstone, struck the wall of his shaft with his pick and it sounded hollow—curious. How and the pick flew from his hands. The lights on the men's caps flickered and went out, foretelling

it were others and from them still more. Often the men could only reach an inch through between the rocks, and when a hole was dug it was found to lead to a large cave, and in this way the hidden caverns were found.

What Made the Caves.
These caves have been made by action of the water, but now that have been discovered, there will be more formed in the same part of Minneapolis. Neither can those now known become larger. Under the city of Minneapolis, 20 or 30 feet deep, is a strata of water-bearing limestone, 20 or 30 feet thick.



NATURE BOWS TO SCIENCE.

When the big cavern was discovered several years ago, there was a beautiful lake, ten feet deep, over 100 feet long, and 100 feet wide. This lake has been drained and the springs which fed it have been "harnessed." There is now a constant flow of pure water, which drops to the concrete basin in a twelve-inch stream at the rate of fifteen feet per second. There is no water here to supply the city with pure drinking water.

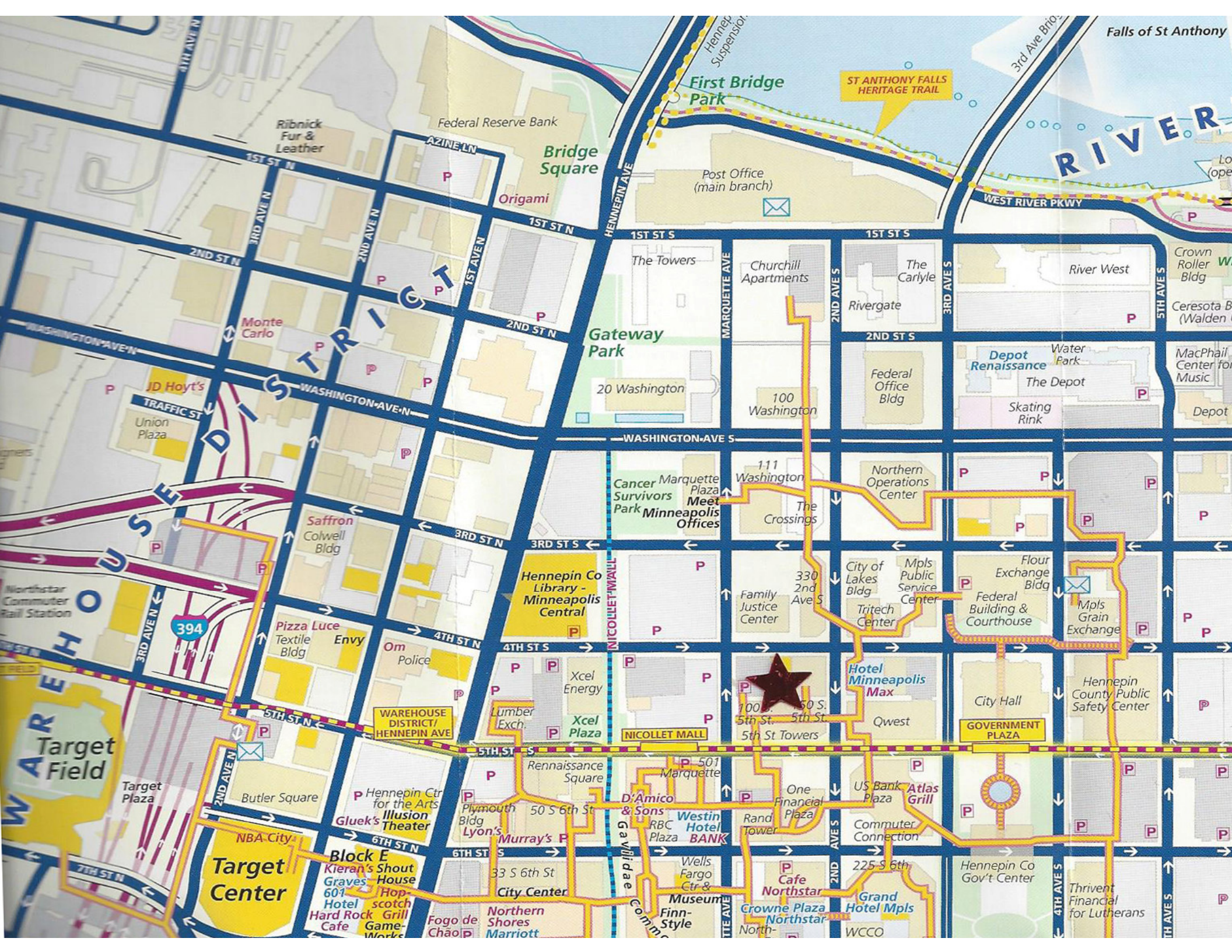
would come from the streets and conspicuous by their absence would be the clang of the street car bell and the honk of automobile horns.

the current of dead air from the cavern where it had been imprisoned for the Creator only knows how long. The men escaped, and after waiting for

Under this is a strata of soft water-bearing limestone, 20 or 30 feet thick. The cracks and crevices in the limestone are perpendicular as well as



A perfect grade from start to finish.



ST ANTHONY FALLS HERITAGE TRAIL

First Bridge Park

Bridge Square

Gateway Park

Target Center

Target Field

Falls of St Anthony

RIVER

Post Office (main branch)

River West

20 Washington

100 Washington

Hennepin Co Library - Minneapolis Central

Xcel Energy

Hotel Minneapolis Max

Renaissance Square

City Center

Westin Hotel

Cafe Northstar

Hennepin Co Gov't Center

Thrivent Financial for Lutherans

Ribnick Fur & Leather

Federal Reserve Bank

Origami

The Towers

Churchill Apartments

The Carlyle

Depot Renaissance

The Depot

Cancer Survivors Meet Minneapolis Offices

111 Washington

Northern Operations Center

Saffron Colwell Bldg

Pizza Luce Textile Bldg

Envy

Om Police

Xcel Plaza

NICOLLET MALL

D'Amico & Sons

RBC Plaza

Museum

One Financial Plaza

Rand Tower

Wells Fargo Ctr & Museum

Crowne Plaza Northstar

US Bank Plaza

Commuter Connection

Grand Hotel Mpls

WCCO

394

NBA CityCenter

Hennepin Ctr for the Arts

Gluek's Illusion Theater

Kieran's Shout House

Hard Rock Cafe

Fogo de Chão

Northern Shores Marriott

Museum

Westin Hotel

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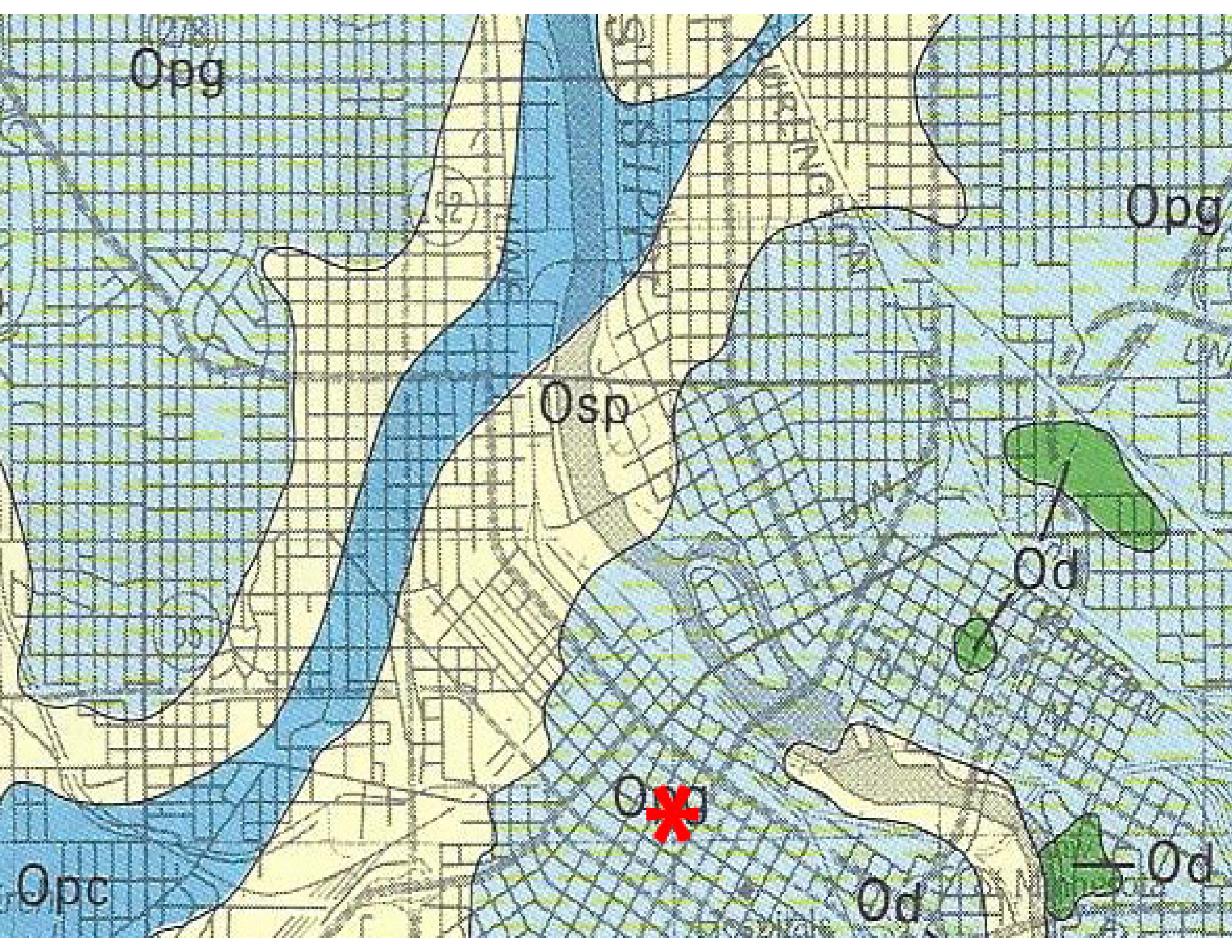
Museum

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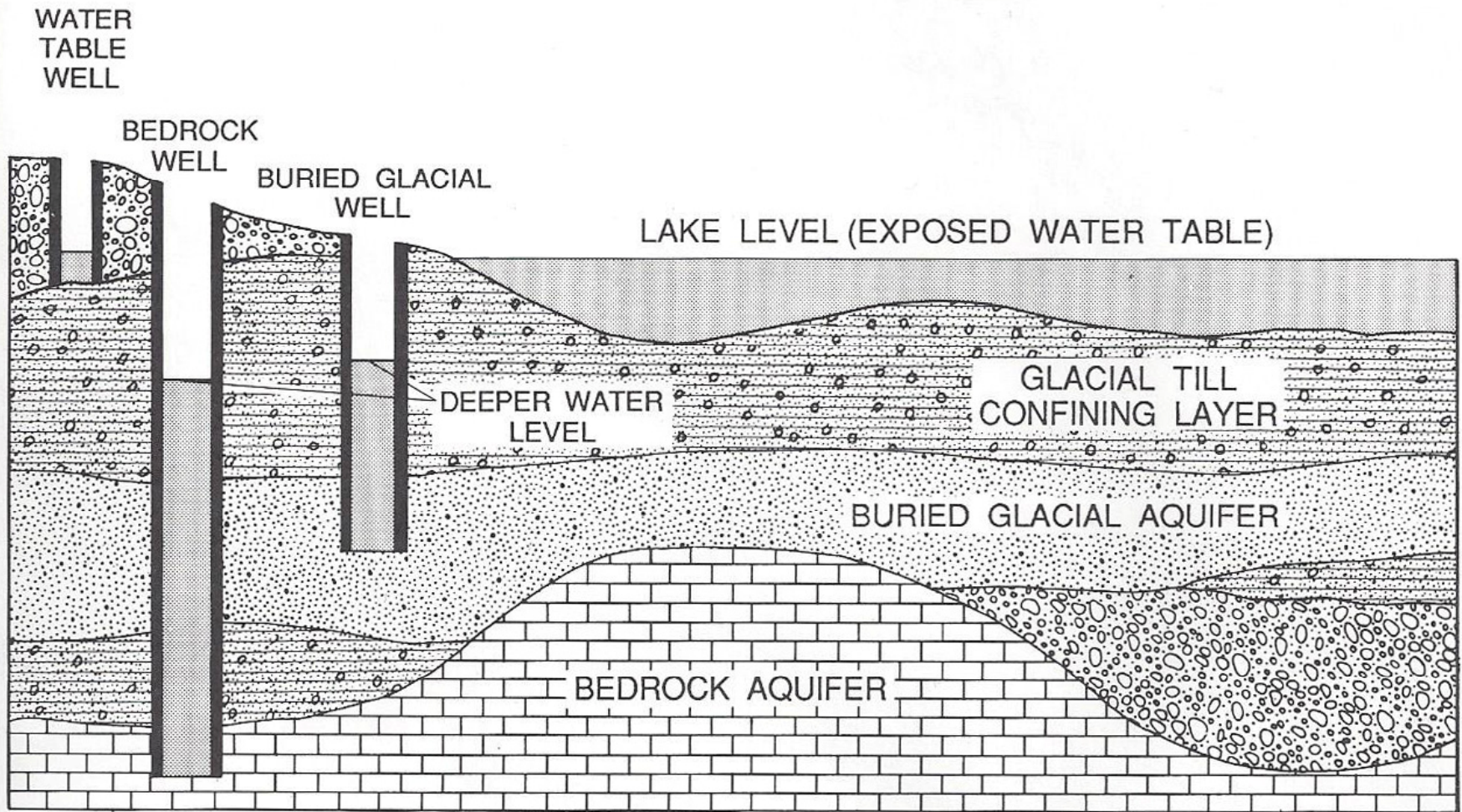


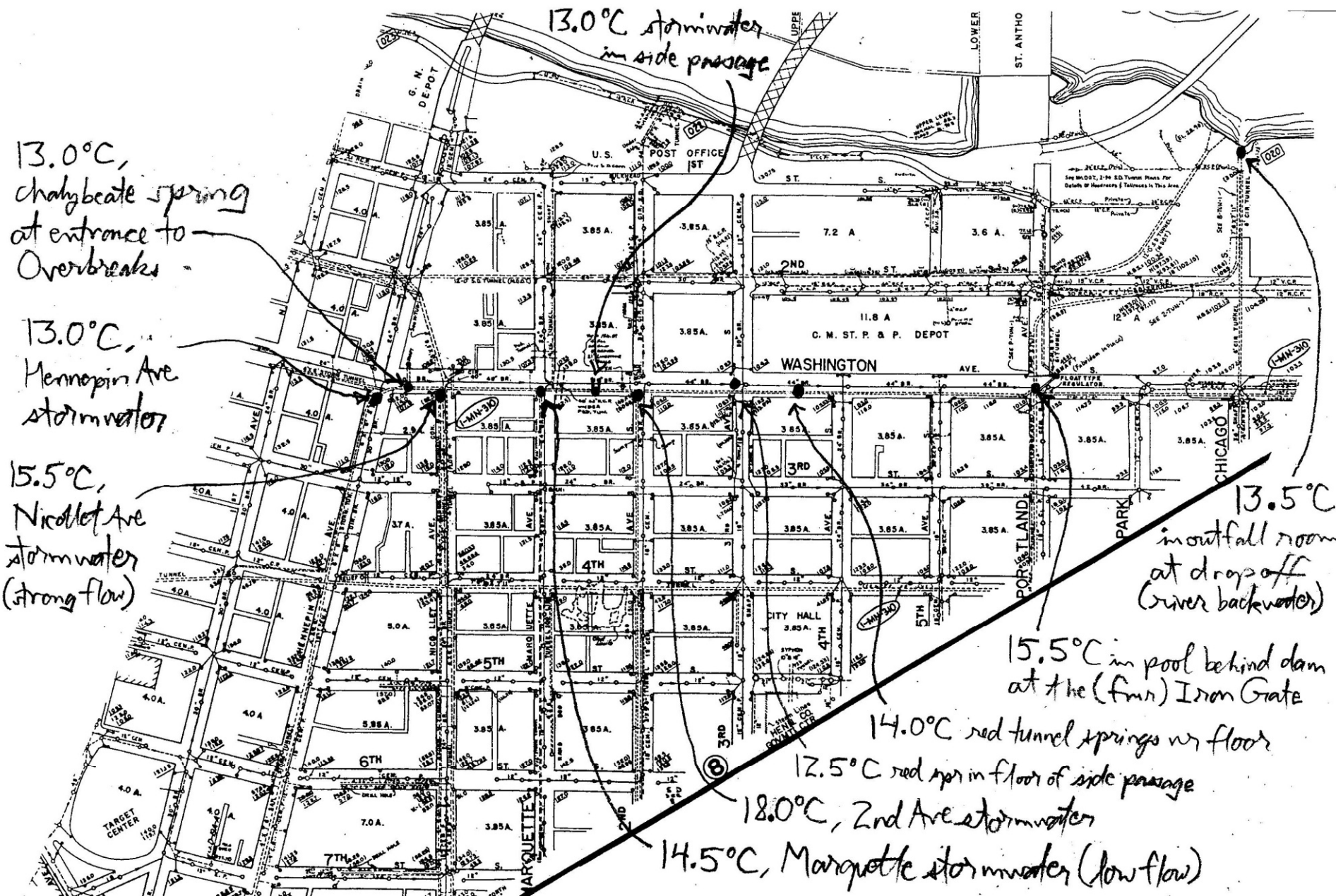
Figure 1. Water-level relationships between the water-table, buried glacial, and uppermost bedrock aquifer systems.

Kanivetsky (1989)









13.0°C,
chalybeate spring
at entrance to
Overbreaks

13.0°C,
Hennepin Ave
stormwater

15.5°C,
Nicollet Ave
stormwater
(strong flow)

13.0°C stormwater
in side passage

13.5°C
in outfall room
at drop off
(river backwater)

15.5°C in pool behind dam
at the (fmr) Iron Gate

14.0°C red tunnel springs w/ floor

12.5°C red spr in floor of side passage

18.0°C, 2nd Ave stormwater

14.5°C, Marquette stormwater (low flow)

Temperatures (Celsius), April 15, 2007.

2 distinct sets of temperatures:

Platteville LS (cave): 16-19 °C

St. Peter SS (tunnels): 12-14 °C



Summary

- Explanations for elevated temperature, and for LMF itself.
- Sampling points
- Much more data needed!
- Access, need dataloggers

Questions