

***ENGINEERING AND ENVIRONMENTAL
GEOLOGY
of the
SPRINGFIELD URBAN AREA***



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CITY OF SPRINGFIELD

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PREFACE

This guidebook, describing a number of karst features in the Springfield urban area, is an outgrowth of preliminary preparations for a proposed (but aborted) field trip to be held in connection with the annual meeting of the North-Central Section, Geological Society of America, that was held in Columbia, Missouri, April 1973.

For the preliminary planning and writing we are indebted- and express our appreciation - to L. D. Fellows, J.H. Williams, W.C. Hayes, and J.D. Vineyard.

It is hoped that this guidebook may illustrate how natural geologic phenomena may pose potential hazards in man's continuous modification of our natural environment.

W.C. Hayes

K.C. Thomson

I INTRODUCTION - The City of Springfield

Springfield, the third largest city in Missouri and the only SMSA (standard metropolitan statistical area) in the southwest quadrant of the state, is situated near the eastern edge of the Springfield Plateau. Physiographically it has greater similarity to the western plains than to the more rugged topography of the typical Ozarks to the east and south.

A major east-west interfluvial divide transects the northern part of the city. Runoff north of the divide follows the Sac and Osage basins to the Missouri, whereas runoff south of the divide is carried by James River to the White River system that empties into the Mississippi. The low relief of the prairie upland is moderately dissected by tributary headwaters; many of which, even in their youthful and early mature stages, exhibit multiple erosion cycles. Climate is moderately temperate with the annual average temperature of 56.5°, although temperatures higher than 100° and lower than zero are common every year. Precipitation averages about 41 inches a year, only about one inch less than the annual evaporation rate.

Native Delaware and Kickapoo Indians inhabited the area and local hunting parties of the Osage occasionally roamed the Western Ozarks. Schoolcraft (1819) camped near the mouth of Pearson Creek, a tributary to the James, and reported lead mines worked by the Indians. The mines were later worked by whites, and Shephard (1898) reported the occurrence of lead and zinc in fault zones and crevices. John Campbell and A.J. Burnett were the early settlers in 1829, establishing their land holdings a few blocks northeast of Park Central Square. William Fulbright cleared a rather extensive land area to the south and later established a mill north of town near Fulbright Spring - which is even today a part of Springfield's water supply system.

Greene County, with Springfield as its county seat, was established in 1833. Springfield was incorporated in 1839 and received its charter from the State Legislature in 1855. The important Civil War battle of Wilson's Creek took place in August of 1861; the 11,600 Confederate soldiers outnumbering the Union troops some 2 to 1. The chief engagement was some 10 miles southwest of Springfield, and has been established as the Wilson's Creek Battlefield National Park. The arrival (1870) of the "Frisco" railroad provided an important link with St. Louis and the establishment of "North Springfield" adjacent to the tracks. Seven years later the two towns were consolidated.

Springfield has long been a trade center for southwest Missouri and parts of three adjoining states. It is an agri-business, financial, dairy, railroad, and educational center with adequate light industry. Its growth since World War II has been exceptional; from 1950 to 1960 the population increased 43 percent to 95,865, and the 1970 population is 120,096.

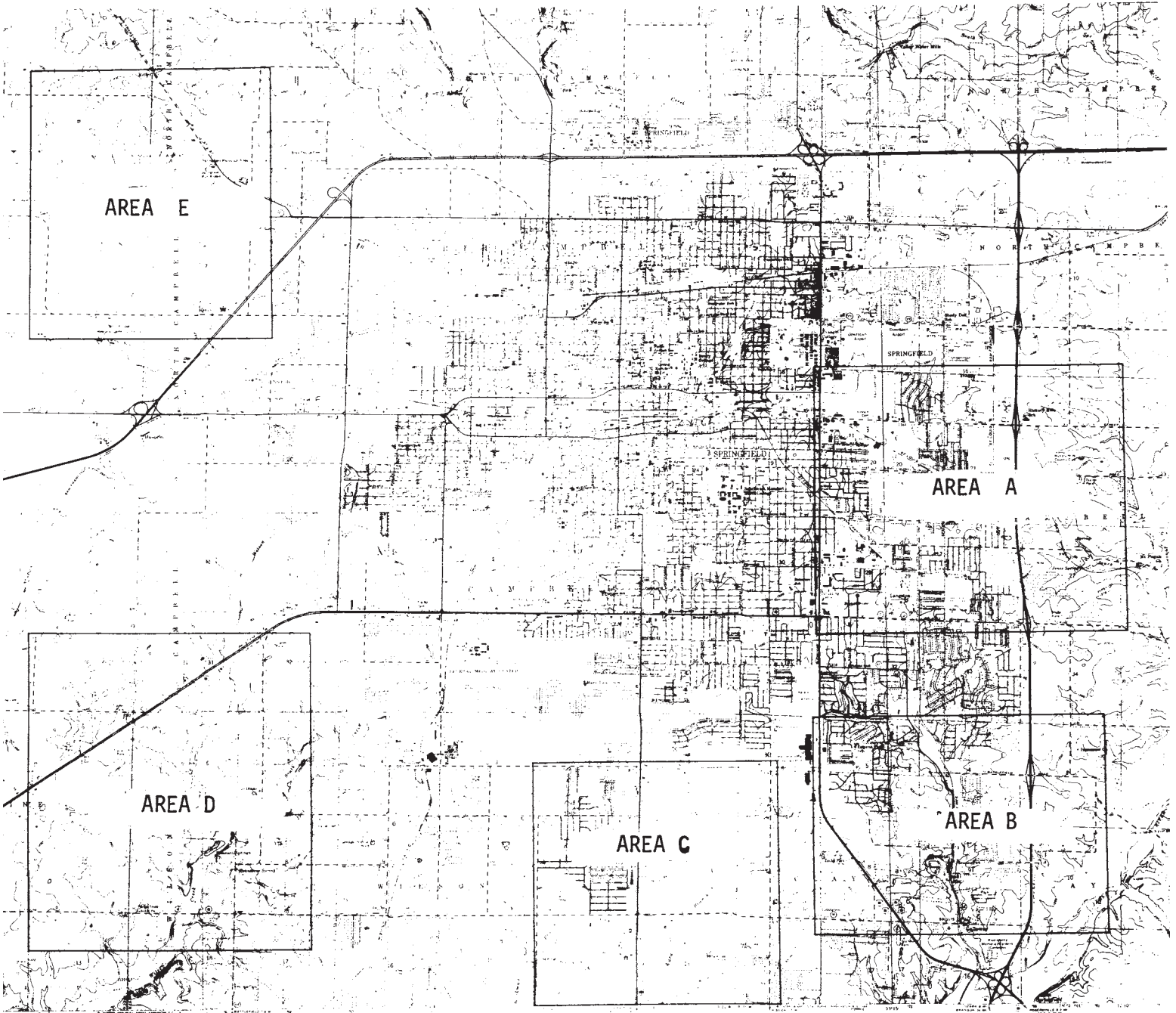


Figure 1. Index and location map of the field trip area.

II GEOLOGIC SETTING

The Springfield area is on the southwestern flank of the Ozark uplift. Rock layers dip gently (20 - 80 feet per mile) toward the west with only minor folding and faulting. Most of the faults have less than 50 feet of displacement. These predominantly limestone strata have been extensively weathered resulting in the formation of numerous karst features: caves, springs, sinks, losing streams, cherty clay residuum, etc. In many areas stream erosion has removed the residuum and rock is at or very close to the surface, whereas in other areas as much as 40 feet of residuum remains.

The Burlington-Keokuk limestone (Mississippian age), present throughout most of the Springfield area, is composed almost entirely of fragments of crinoids. It is nearly pure calcium carbonate CaCO_3 , although there are some discontinuous bands of chert nodules parallel with bedding planes. The formation thickness is variable because of erosion, but where present in its entirety it is almost 200 feet thick. Joints in the limestone have had a pronounced influence on the surface drainage pattern and probably also on the drainage of water into the subsurface. The contact between the bedrock and residual soil is highly uneven due to etching by water that was moved laterally through the residual soil. Bedrock "pinnacles" commonly have 10-15 feet of relief.



Plate 1. Cutters and pinnacles shown in railroad cut near Frisco Building on east Trafficway. Photo by R. L. Taylor.

III KARST FEATURES

Springfield occupies high ground separating the Sac and Pomme de Terre basins on the north from the valley of the James on the south. The topography is limestone karst, modified by Wilson Creek and its headwater tributaries, Jordan, Fassnight and South Creek, and more recently by urbanization. In the early days the region was literally "a field of springs". The industrial and commercial heart of the city developed along Jordan Creek, where numerous springs are said to have provided pure water for the first Springfieldians (Rafferty, 1971). Today many stretches of Jordan Creek are hard to find. In the city center area it is confined to a concrete-lined trench and tunnel system beneath asphalt-and-concrete. The present water table is from 75 to 100 feet below the surface, thus the springs have long since disappeared.

Only vestiges of the "original" karst landscape are identifiable in the urbanized areas today, but in the suburban areas residents must grapple with the peculiarities of karst on a personal basis. The practice of filling sinks to provide more space for development is perhaps at its peak in suburban areas today. Because of the short-term convenience of using karst drainage systems for storm-water removal and waste disposal, the city has never had an adequate storm sewer system. A dozen especially active and strategically located sinkholes are carefully maintained by the city so that they can continue to carry off floodwaters, and so that the connected springs on the urban fringes can continue to maintain their flow- if not their water quality (Hayes, 1972).

The natural system has many limitations, especially when unplanned development results in indiscriminant filling of many sinks and clogging of others by siltation. Wet basements, cracked foundations, flooded streets, and collapses are common problems in a plateau setting that would be well drained if it were not for the activities of man.

Numerous caves undoubtedly have been lost during urbanization, yet many remain. Some, such as By-Pass 65 Cave (sometimes called "Cherry St. Cave" and "Steury Cave"), have had their entrances filled but in such a way that underground drainage relationships are undisturbed (Vineyard, 1968).

Others, such as the one persistently rumored to lie beneath Park Central Square and connects with Doling Park Cave (1) have been lost, their entrances long covered by streets and buildings.

Karst was an asset to early settlers because the springs provided good water. Where there were no springs, wells could sometimes be developed by digging in sinks to reach the ground water in cave systems below. Some of these sinkhole wells still remain, but the multiple-use concept that was applied to sinkholes--using some for waste disposal and others for water supply--soon ruined the water supply. Shepard (1898) reported a sink at the southwest corner of Dollison and Cherry that was being used as a dump and to convey the sewage of the neighborhood. He also reported that some springs were unfit for public use, though even today some farmers still prefer their "pure" spring water to chlorinated city water.

Development of the Springfield karst has resulted in a thick residuum that masks the bedrock surface, which throughout much of the area has been pinnacled. Construction can be very expensive when the pinnacles have to be removed. The residuum must first be cleaned out, then the pinnacles broken by drilling and blasting, then hauled away. In road cuts, the Missouri State Highway Department often leaves exposed pinnacles in the back slope for a decorative touch.

On the fringes of the urban area, springs still flow cool, clear water, at least most of the time. In some springs, water quality is still good and cave-adapted organisms such as blind fish and crayfish may still be found. But other springs are high in nitrate and coliform bacteria and give off disagreeable odors.

An interesting aspect of karst in suburban Springfield is its contemporary development in stream valleys of the present erosion cycle. In the valleys of Wilson Creek and Pearson Creek south of the city, and in the Little Sac drainage north of Springfield, solution channels lie at shallow depths beneath floodplains. In dry weather the channels may be dry or nearly so, the water levels sometimes falling below permanent flow levels in nearby streams. In rainy weather, the solution channels fill rapidly and completely, causing flow reversals in some low-level sinkholes (called estavellas). Losing reaches of streams may become gaining reaches when the solution channels are functioning at capacity.

Limestone karst was a major environmental factor in early Springfield, and its effects remain profound today. Karst features have largely been obliterated in the more heavily urbanized areas of the city, but on the suburban fringes the peculiarities of karst greatly influence urban expansion.

IV ENGINEERING GEOLOGY

The critical location of a growing urban area in a fragile karst environment imposes potential problems that appear obscure to the uninitiated. Intensive residential developments completed in the county - adjacent or near to the city limits - have been annexed and the city has inherited problems of poorly planned and inadequately constructed septic tank drain fields, sewage lagoons, drainage structures, street systems and water supply systems. The uniqueness of a large metropolitan complex situated on a karst plateau dramatizes the more formidable aspects of construction and waste disposal in carbonate terrain.

The soil residual on the limestone is striking in its physical characteristics. For example, this soil although classified CH in Unified Soil Classification System and having a fraction of more than 80% smaller than 2 microns in size, still exhibits high permeability. It has many of the features of a silt, thus making water impoundment structures frequently ineffectively in this region (Graham, 1969). Other physical characteristics that are unique to this residual clay soil include low maximum density (75 - 85 pcf) and a high optimum water content. The liquid limit is typically 75 to 85, although it may exceed 100. This type soil, halloysitic in structure, has low base exchange capacities thus hindering its uptake of nutrients such as may be discharged in waste treatment effluent. In general the engineering properties of the residual red clay are like that of halloysitic clays (Graham, 1969).

Although the red clay soil is by far the most predominate soil type in the Springfield region, local upland prairies, capped by a modified loess, have a plastic clay-rich subsoil and fragipan. Engineering characteristics of this soil are markedly different from the red clay. For example, maximum densities are decidedly higher: from 110 - 115 pcf. This soil is relatively impermeable and thus provides excellent sites for lagoons. Unfortunately, this upland prairie soil is limited in areal extent and thus affords little respite from the ardors of the more widespread cherty red clay.

Problems related to solid waste are essentially concerned with sanitary landfill site locations that are geologically unacceptable. The thin, permeable, cherty red clay soils are generally not acceptable. Alluvial soils and some silty clay soils in the uplands have proven to be the best host for sanitary landfills in the past. Even with proper construction and operational methods, leachates from sanitary landfills may prove elusive by movement through alluvial material to reappear in the stream channel, as finding their way into bedrock through cracks and crevices and becoming a potential pollutant to groundwater resources (Howe, 1972).

Sanitary sewage systems including both the collection systems and treatment facilities, must receive special attention regarding the rock, soil, hydrology, and karst characteristics.

Design and construction of sewer trunk lines are plagued with the pinnacle problem. The engineering section of the Department of Public Works, designs new and additional trunk lines and must meet grade requirements. Bid proposals for sewer construction do not contain a rock clause because of the difficulty of estimating rock quantities. Thus the contractor must make a judgement decision on his bid price -- and is usually somewhat high to cover costs of possible rock excavation.

Infiltration into existing sewer lines has been a continual problem in the area. In addition to a nominal 4 or 5 percent "normal" that might be expected, there are many basement and yard drains in the older part of the city that are connected with the sanitary sewer system. The normal average daily quantity processed at the southwest sewage treatment plant is 17 mgd with a maximum 36-hour period of an estimated 136 mgd inflow.

Surface runoff in the interfluvial area is characteristically minimal, but intense precipitation in the downtown urban area poses the problem of rapid and intense flood crests. Much of the runoff is usurped through some sinkholes and losing streams to reappear as springs lower in the drainage system. Design of storm water drainage structures is complicated in many areas where there is inadequate data relative to the capacity of the sinks to either pond runoff or to transfer it to the subsurface.

The many losing streams present a serious potential pollution threat to ground water. Receiving streams of sewage plant effluent must be scrupulously inspected before it is planned to discharge effluent to the stream. In fact, several areas within the Ozarks have been designated by the Missouri Clean Water Commission as "no discharge areas". Unfortunately, alternative methods of sewage collection and disposal are not easily or readily available in areas lacking sanitary sewer facilities. Consequently, the methods of waste disposal acceptable by the Clean Water Commission and suitable from a geologic aspect range from irrigation to no-discharge lagoons. Either choice is an expensive alternative. There are additional problems of irrigation existing since the low base exchange soils have limited uptake capacity, especially from industrial discharges (Howe, Fuller, and Williams, 1972). In many areas no-discharge lagoons should be treated with a sealant utilizing a sodium-rich compound (such as soda-ash) to deflocculate the clays. Sites for sewage lagoons require careful investigation and supervision during construction. Failures of lagoons have been caused by dikes washing out; underflow in the dikes; collapse of sinks; and inadequate design factors.

Concentrations of septic tank drain fields in subdivision developments are sources of pollution for ground and surface water. The thin soil cover in many areas should preclude the use of septic tanks, and the relative high permeability of the soil should dictate the separation of drain fields to the extent that only on multiple-acre dwelling plots should septic tanks be permitted (Clark and Lutzen, 1971).

The attempts by residential developers to utilize septic tanks for dense urban-suburban settings is as harmful to groundwater and spring flow quality as the discharge of industrial effluent. Thus, an area that is intensely karst must be considered from the aspect of groundwater quality as a region unsuitable for dense residential development unless centralized waste treatment systems are available and the waste can be treated sufficiently for discharge in a receiving watershed outside the area which is not subject to significant surface water loss into the groundwater supplies.

Foundation exploration can also be a perplexing and frustrating task. The extremely pinnacled bedrock surface having relief that may be as much as 30 feet is difficult to explore for cut and fill estimates or for building foundations. Typically the limestone pinnacles project vertically upward from narrow bedrock lows or cutters between the pinnacles. Locally, a mass of limestone may be "floating" with clay completely surrounding the large limestone block.

A somewhat dramatic karst phenomena is that of catastrophic surface collapse. Several collapses have been examined in the Springfield area. Most of these have been small, with diameters of only 5 to 10 feet and depths of 10 to 15 feet. More dramatic collapses have occurred several miles distance where large voids have resulted from roof failures over caves (Aley, Williams, and Massello, 1972). Typically the cave is developed at the bedrock-soil contact with the cave roof supported by the overlying residual soil. Changes in soil moisture or a continuous vibratory load are capable of causing a disastrous collapse.

V SITE DESCRIPTIONS

Area A. East Cherry Street. Location: Section 20 and 21, T. 29 N., R. 21 W., Galloway Quadrangle (7 1/2 series).

This area, located between Glenstone Avenue and U.S. Highway 65, is bounded on the north by Mill Street and on the south by Catalpa Street. Refer to the location map(Figure 1).

Limestone pinnacles and the overlying red residual "soil" are well exposed in cuts along the St. Louis and San Francisco Railroad west of the Frisco Building (Figure 2, site A-1). This exposure is typical of the bedrock-soil contact throughout the entire area. Although the pinnacle nature of the limestone bedrock is not usually observed in natural exposures, it is well recognized in almost every excavation. Closely spaced borings also indicate the uneven bedrock surface. The depth to bedrock commonly varies by as much as 10 feet or more in borings just a few feet apart.

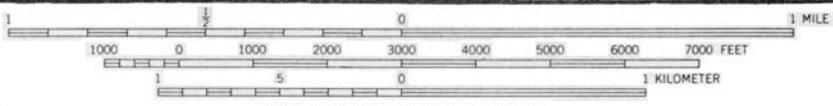
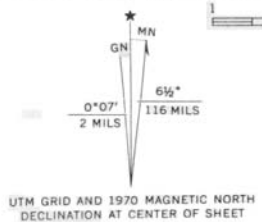
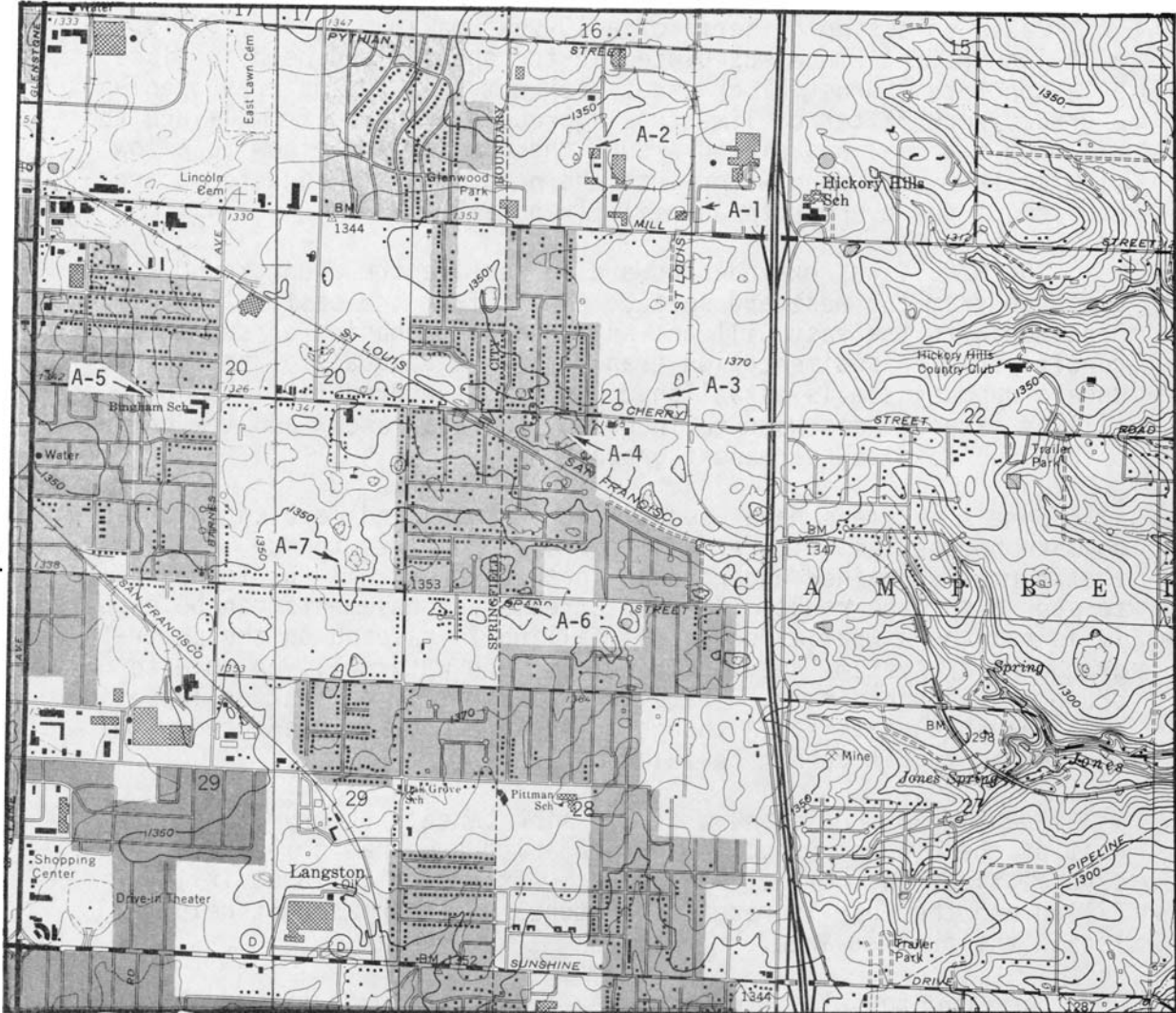
The East Cherry Street area has more than 100 sinks, but most of them are too small to be shown on the topographic map. The RDI sink (Figure 2, site A-2) actively captures runoff from as distant as the Highway 65 and Division Street interchange -- a mile to the northeast. Dye injected in the sink was recovered in the Jones spring complex 2 miles to the southeast. Apparently in line with the direction of underground movement is the Highway 65 ByPass sink near Cherry Street and Highway 65 previously described.

Two sinks are present within the Cherry Street Industrial Park on the north side of the 3000-block of Cherry Street (Figure 2, site A-3). The largest sink near the southeast corner of the property receives additional runoff from property to the east through a drainage structure under a railroad along the east side of the property. Filling of the sinks to provide adequate surface drainage was not considered practical because flow would be reversed to the east and a slope to the south would dictate revisions of west-flowing drains along the north side of Cherry Street to a sink farther west (and on the south side of Cherry Street) that receives some drainage from the extreme western edge of the industrial park property.

The developers and their engineers developed a plan in conformance with recommendations of the city's environmental geologist to fill the shallow sink near the southwest corner, and to collect runoff in curb drop-inlets that will flow in an underground storm drainage system to the large sink. Although the large sink had no visible "eye" or swallow hole, the rate at which water drained indicated the existence of a natural underground drainage system that should be adequate to accomodate the runoff.

R.21 W.

T.29 N.



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

Figure 2. Area A: East Cherry Street.

Excavation of overburden (not without some difficulty!) finally exposed a vertical opening below a weathered crevice approximately 3½ feet wide and 4 feet high that lead westwardly through a tunnel-like cavern some 15 feet before entering a room with height and width of approximately 10 feet.

Based on design criteria of a 10-year maximum flow of 93cfs, a 36-inch R.C.P. elbow was placed in the opening and held in place by a concrete "thrust block" that does not seal the natural opening. A graded rock filter of limestone aggregate ranging from 4-inch to 3/4-inch material was placed around the opening and elbow to allow slow seepage of ground water into the natural system and to retard erosion of the overburden and fill (Figure 3).

The R.C.P. was extended upward to receive the underground storm drainage from the west and surface runoff from the east. A catchment basin to the east will act as a detention basin for storm runoff and as a sedimentation trap until the adequacy of the natural underground system is established. If it is proved feasible, pipe will be extended eastward to intercept surface runoff and the basin backfilled to final permanent grade.

Some sink areas have been filled (by man) and leveled in order to make home sites (Figure 2, site A-4). Needless to say, rainwater that normally drained underground in these areas will be forced to seek a surface route. Flooded streets and basements can be expected. It is not known what effects this filling is having on the underground water system. Obviously not as much water will be able to drain to the subsurface. There is a possibility of sink collapse in any area such as this. Although collapse cannot be predicted with any certainty, it cannot be ruled out!

Speaking of collapse, a filled-sink beneath Cherry Street just west of the Bingham School (Figure 2, site A-5) has collapsed several times in the last ten years. After each collapse it is filled and the road is rebuilt. Patches of fresh asphalt help locate the problem area.

Building too close to sinks may result in foundation problems as may be observed at the southwest corner of the East Grand Avenue Church of the Nazarene (Figure 2, site A-6). Problems such as these can be avoided by proper engineering and construction procedures but are difficult to remedy once they have occurred.

CROSS SECTION OF SINK MODIFICATION

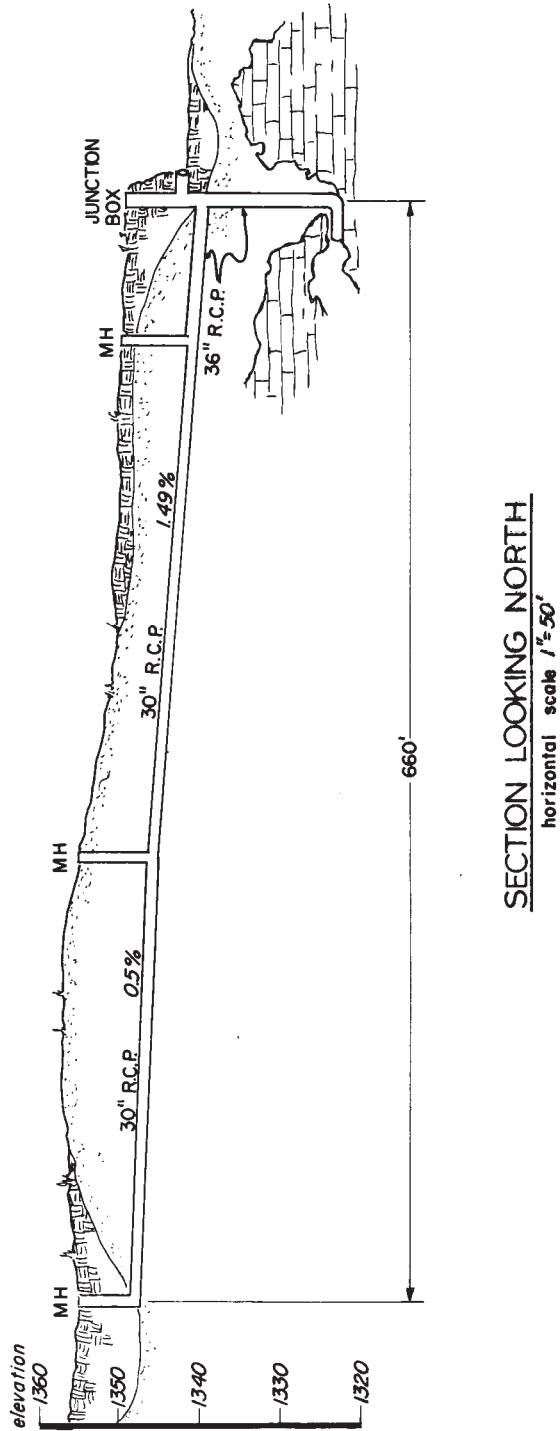


Figure 3. Cherry Street Industrial Park Sinks, Cross Section.

Springfield recently acquired a tract of land in the 2400 block of East Grand Street (containing four sinks) with plans to preserve the relatively "wild" environment as a park area (Figure 2, site A-7). Acquisition was assisted by a Bureau of Outdoor Recreation grant.

A 3-acre tract -- some 1600 feet south of the park -- adjacent to the Catalpa and Lone Pine intersection contains a broad shallow sink. It is owned by the county, but ownership is anticipated to be transferred to the City. The shallow sink receives direct runoff from about 44 acres and drainage of the impounded water is slow, which creates an unsightly environment. The ponded water has been high enough to flood Catalpa Street; and saturation of the road base has allowed subsidence of the north half of the pavement producing a longitudinal crack in the pavement.

The low points of the sinks are being connected by a 15-inch underground relief drain from the county sink. It is computed that the county sink will hold approximately 150,000 cf; thus the relief drain was designed to provide a flow of 3.2 cfs in order to drain the county sink in about 11 hours. The proposal has received approval by the Bureau of Outdoor Recreation and construction is underway (Figure 4).

The orifice in the park sink will be partly concealed by hand-placed natural rock, and a small sedimentation basin will be constructed at the intake in the county sink.

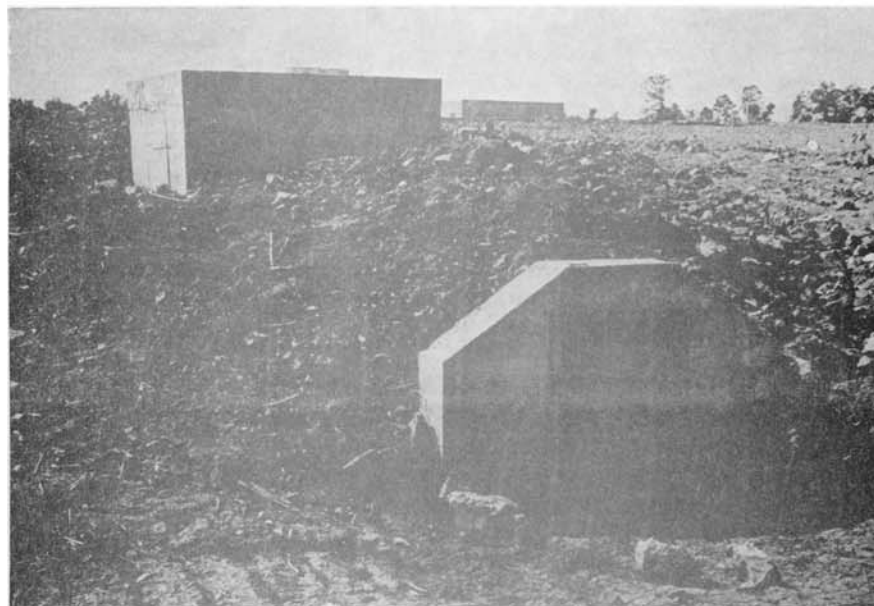
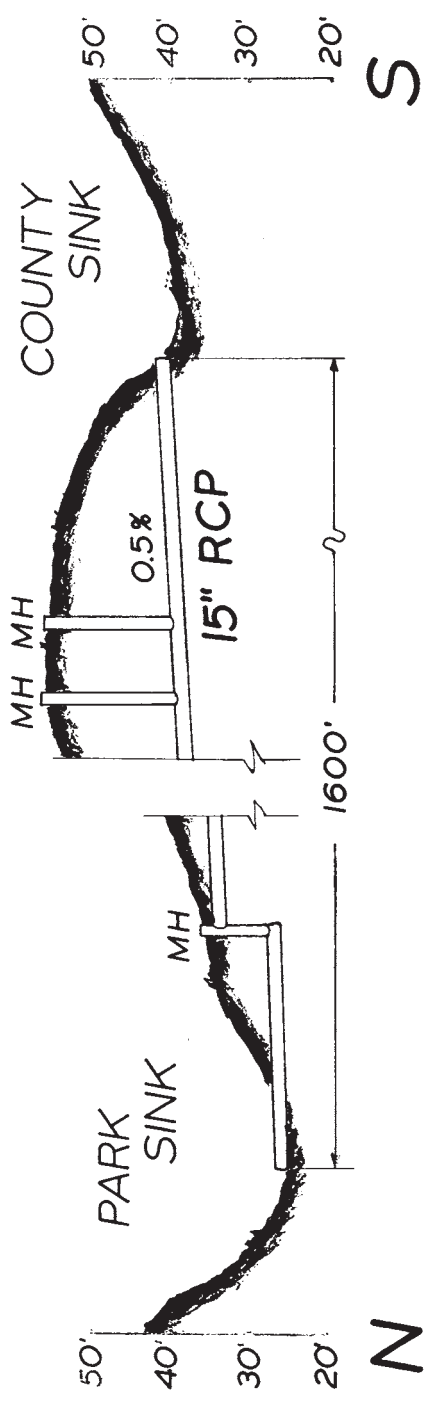


Plate 2. Concrete intake for sinkhole drainage in Cherry Street Industrial Park area. Photo by R. L. Taylor.

CROSS SECTION OF PROPOSED 15-INCH STORM SEWER



VERT. EX. x 10

Figure 4. Oak Grove - County Sink, Cross Section.

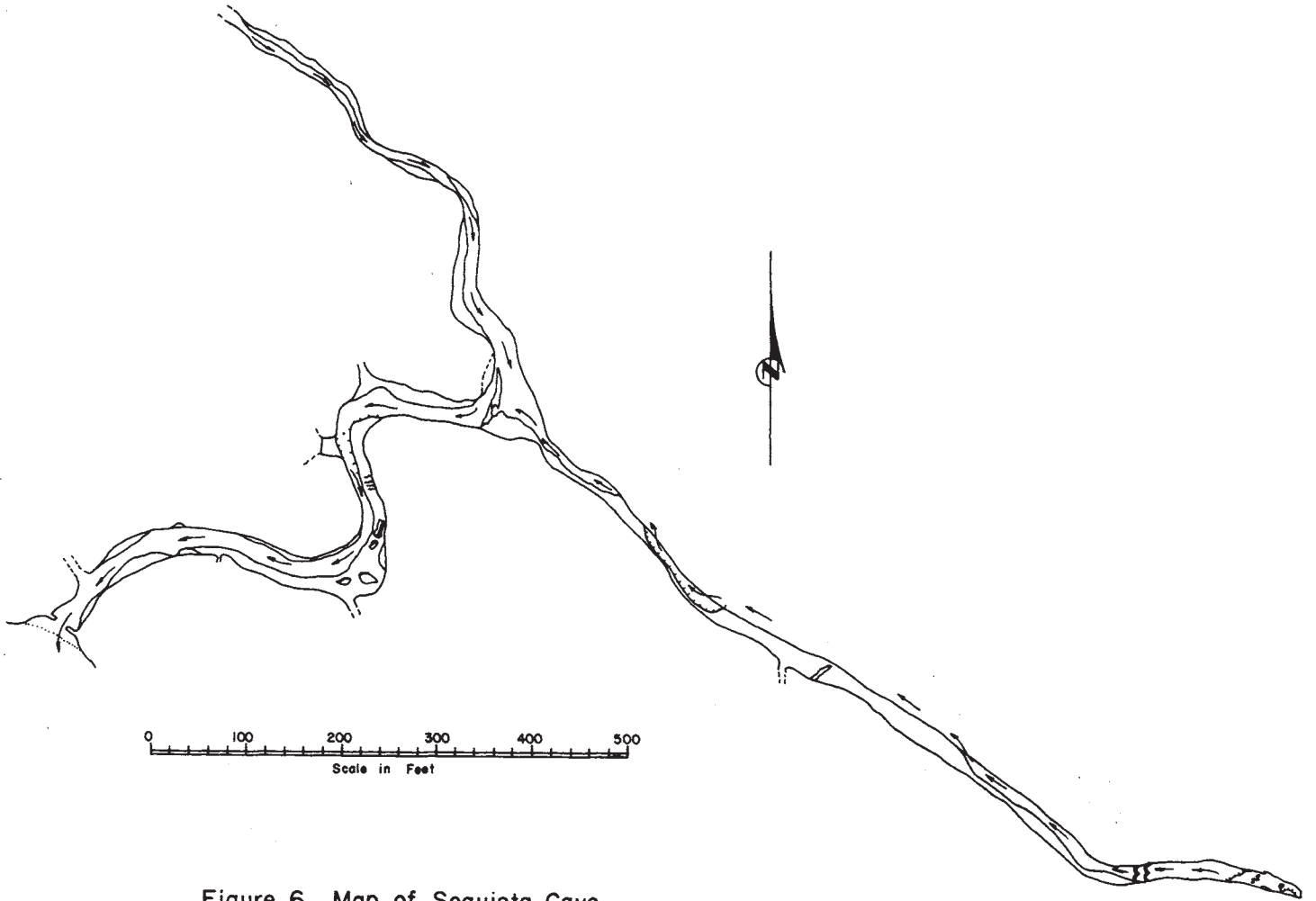


Figure 6. Map of Sequiota Cave.

Area B. Sequiota Area. Location: Section 4,5,8, and 9 of T.28 N., R.21 W., Galloway and Springfield Quadrangles (7 1/2" series).

The area is located between Glenstone Avenue (U.S. Business 65) and U.S. 65. The northern limit of the area is 1/2 mile north of Battlefield Road and the southern limit is Highway M (Figure 5).

In the Sequiota area much the same conditions exist as in the East Cherry Street area. ~~Cutters and pinnacles that are~~ characteristic can be observed in the roadcut at Battlefield Road and highway 65, and in the quarry of Ash Grove Cement Company. These features underly most of the area making excavation potentially costly. Sinkholes do not appear to be as abundant here as in the Cherry Street area, but there are many which are not shown on the topographic maps. Some of the sinkholes have been filled in to provide more "suitable" building sites. The urban development of the area has progressed extremely rapidly with most of the growth taking place within the past 10 years. Paving and buildings have resulted in an increase in rainwater runoff. Sinkholes fill with water rapidly during storms and with the new construction have filled with silt and clay which either partially or completely blocked them as normal drainage areas. One sinkhole on the corner of Valleyview and Shady Glen, drains extremely slowly. During a 5-inch rainfall in November of 1971 the water level in the sink was raised about 8 feet and flooded streets and homes. At various times the city has pumped excess water to active sinks; one some 100 yards northeast, the other some 500 yards to the southeast.

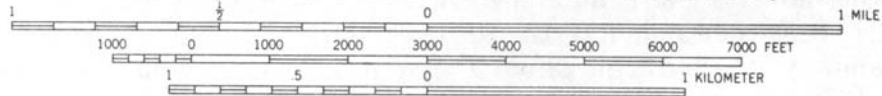
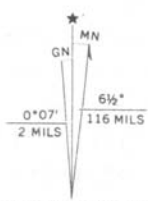
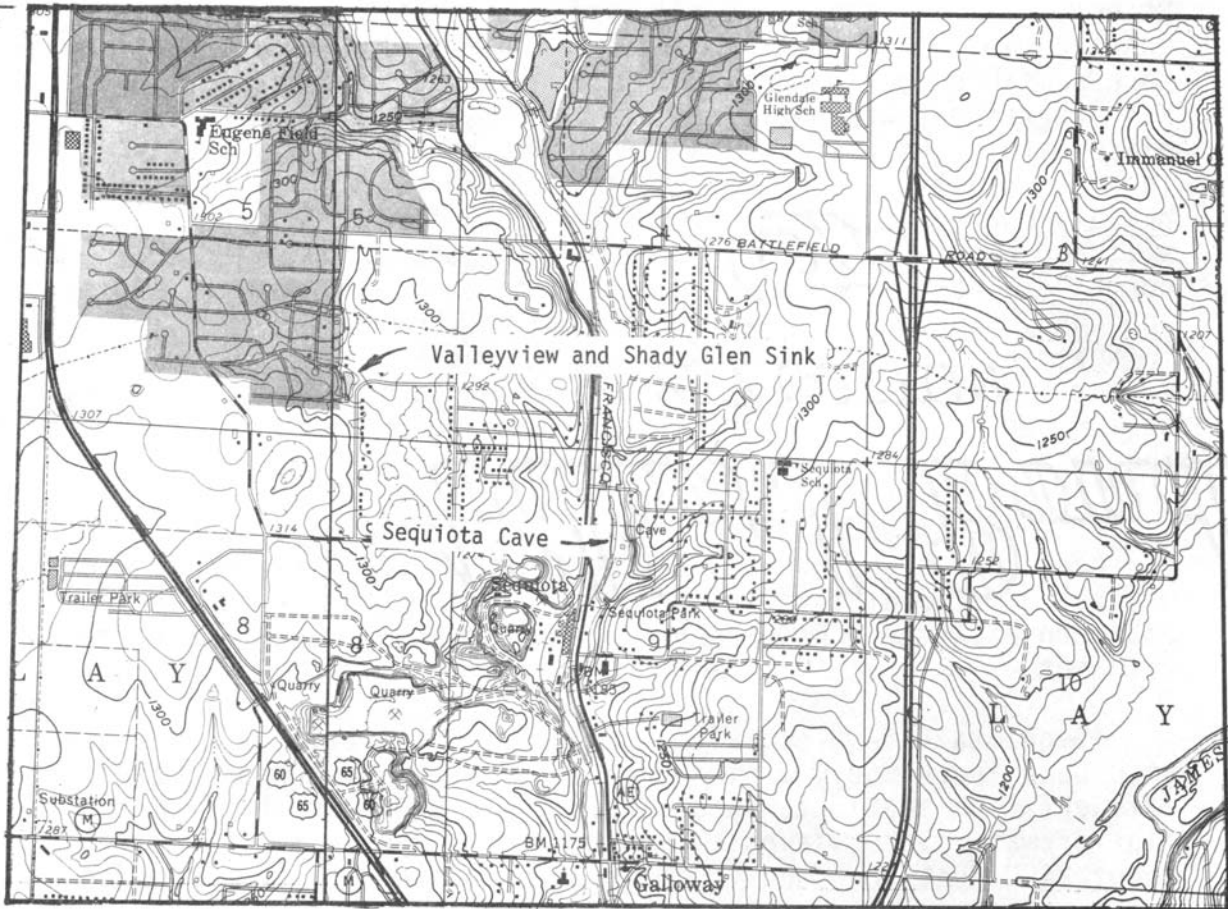
The use of septic tanks and lack of a sewer system in the area for many years has resulted in the movement of this contaminated water and material into the shallow ground water. Lakes in the Southern Hills area have been contaminated to some extent by this effluent.

Sequoiata Cave (formerly a semi-commercial cave) and its associated pond (~~perviously a fish hatchery~~) have been contaminated by effluent from septic tanks on the hill to the east and from the influx of water into sinkholes in the valley upstream. The cave is about 2400 feet long and is "Y" shaped in plan with one passage extending to the east and the other to the northwest (Figure 6). A pit 21 feet deep and 8 to 10 feet wide opened up above Sequiota cave in January 1973 after several rain storms. Another eastward extending cave (a half mile northwest) is the extension of the sink that received pumped water from the Valleyview and Shady Glen sink. Two other small caves have been observed in the valley to the north of Sequiota Cave, but these are of little significance compared to Sequiota.

Examination of valleys in the area reveals that many of them have disappearing and reappearing streams during wet seasons.

T.29 N.
T.28 N.

R.21 W.



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1970 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Figure 5. Area B: Sequiota Area.

Area C. Parkcrest Village. Location: S 1/2 of sections 11 and 12 and all of sections 13 and 14, T. 28 N., R. 22 W., Springfield Quadrangle (7 1/2' series).

This area includes the intersection of Highway M and Campbell Street (U.S. 160 at Parkcrest Village. Refer to the location map, Figure 1.

Losing streams are common in the Springfield area and throughout the Ozarks. The stream valley just east of Campbell Street across from Parkcrest Village has been modified by subsurface stream capture through two sinks (Figure 7, sites C-1 and C-2). The southern sink (C-2) has been partially filled by man. The valley downstream from these sinks (C-3) was then abandoned as is indicated by the grassed valley floor and no stream channel.

Dye introduced into the northern sink (C-1) emerged at Ward Spring (C-4). It is probably safe to assume any water flowing into the subsurface in this area, whether it's rainwater or liquid waste from a septic tank or sewage lagoon, will emerge at Ward Spring.



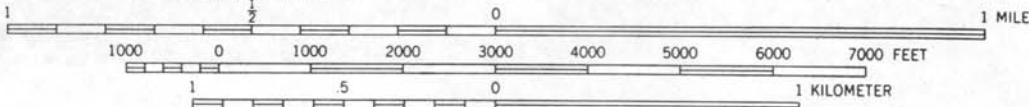
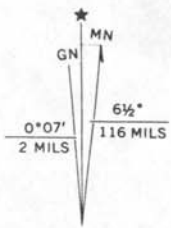
Plate 3. View of the entrance to Sequiota Cave. Photo by R.L.Taylor.

R.22 W.

T.28 N.



(NIXA) 473 NIXA 6.1 MI. BRANSON 42 MI. 474 17'30" R. 22 W. R. 21 W.



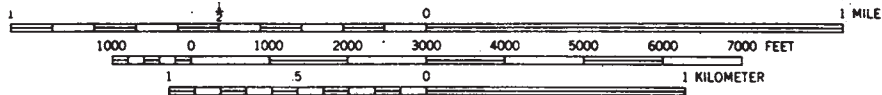
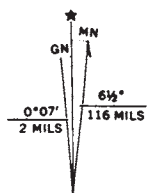
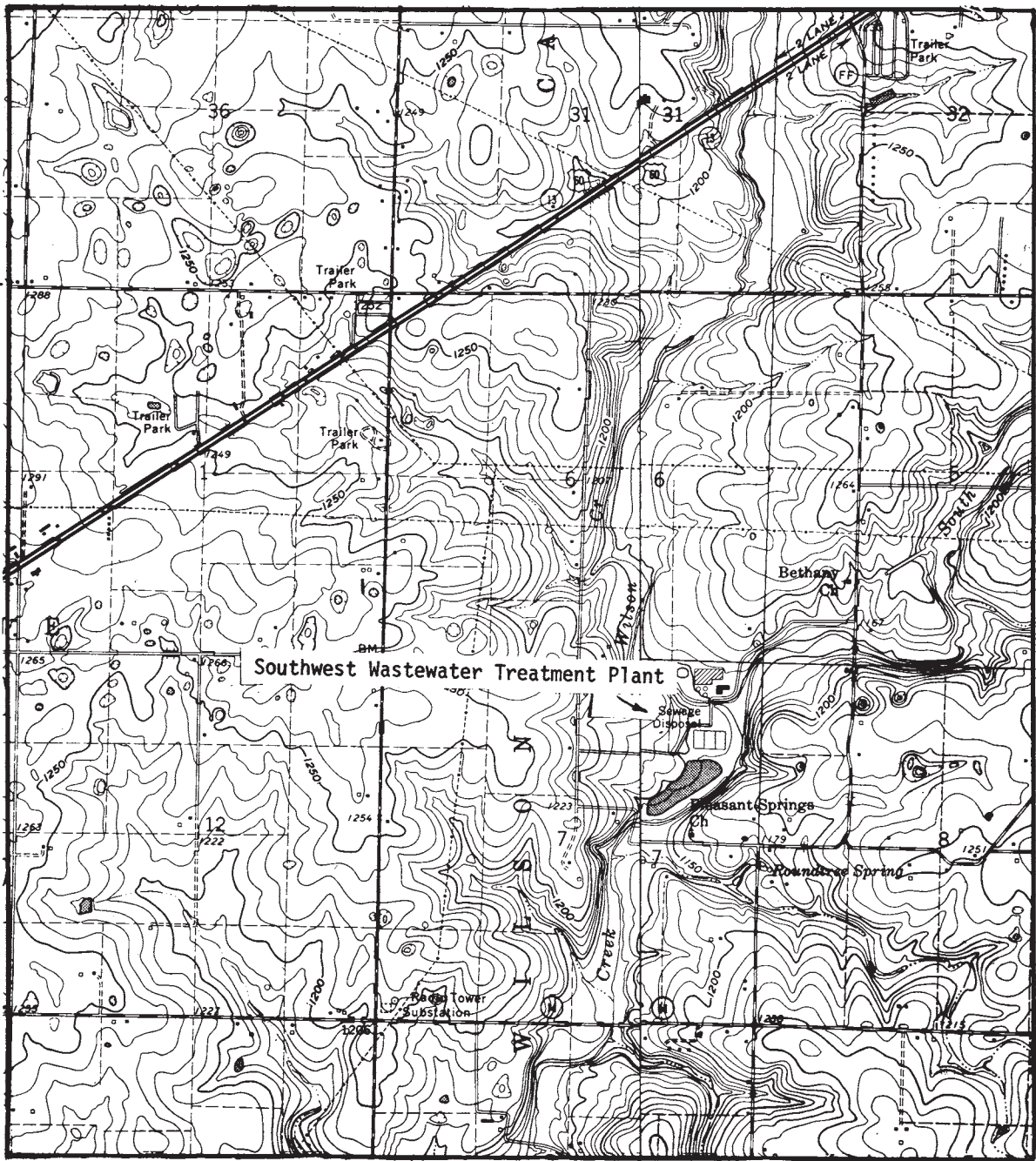
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

Figure 7. Area C: Parkcrest Village.

UTM GRID AND 1970 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

R. 22 W.

T. 29 N.
T. 28 N.



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

Figure 8. Area D: Southwest Wastewater Treatment Plant.

UTM GRID AND 1970 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Area D. Southwest Wastewater Treatment Plant. Location:
Sections 6 and 7, T.28 N., R.22 W., Springfield Quadrangle (7 1/2' series).

The Southwest Wastewater Treatment Plant began secondary treatment of sewage from approximately 85 percent of the sewered population of Springfield in December 1959. The remaining sewered population is served by the northwest plant. The plant is situated on the right (west) floodplain of Wilson Creek, a tributary to James River (Figure 8). Wilson Creek receives the greater part of urban runoff from all the area south of Commercial Street via the Jordan, Fassnight, South Creek, and South Branch.

The plant was designed for an average flow of 12 mgd, but modifications installed in 1964 and 1968, and the construction of a 10-acre tertiary lagoon in 1970, have increased the average daily capacity to about 18 mgd.

A number of fish kills in the lower Wilson Creek and in the James below the mouth of Wilson have occurred when the flow of James River was less than 25 cfs. Urban runoff resulting from summer thunderstorms over the city has dominated the flow of Wilson Creek over that of the James by as great as 40 to 1.

A typical hydrograph (Figure 9) of July 30, 1968 indicates the flow of Wilson Creek as 35 cfs before the leading edge of a flood arrived. The leading edge shows a sharp drop in DO, a strong increase in conductivity, and noticeable increases in pH and temperature. The flood crested at 1065 cfs 2 hours after arrival of the leading edge.

Results of a 2-year study by the FWPCA (EPA, 1969) recommended that the City determine a method of reducing peak storm flows of Wilson and that the City proceed with construction of the 10-acre tertiary lagoon.

The proposed lagoon area was immediately downstream of the plant facilities, but considerable concern existed regarding the geologic feasibility of the area. Upstream and downstream from the plant, and in the tributary South Creek, there are numerous losing stretches and open sinks.

Tube Cave and an open sink are immediately south of the sludge drying beds in the floodplain. The proposed area was thoroughly explored by test pits and the Missouri Geological Survey conducted a seismic exploration for covered sinks and caverns. Present drainage from the slope on the west flows east to Wilson Creek between the sludge beds and the lagoon, where most runoff is usurped by Tube Cave. The 10-acre lagoon has a water depth of about 8 feet providing approximately 32 mg storage, or equivalent to a 48-hour retention under "normal" operating conditions.

WILSON CREEK HYDROGRAPH

STATION 27 JULY 30, 1968
(EPA)

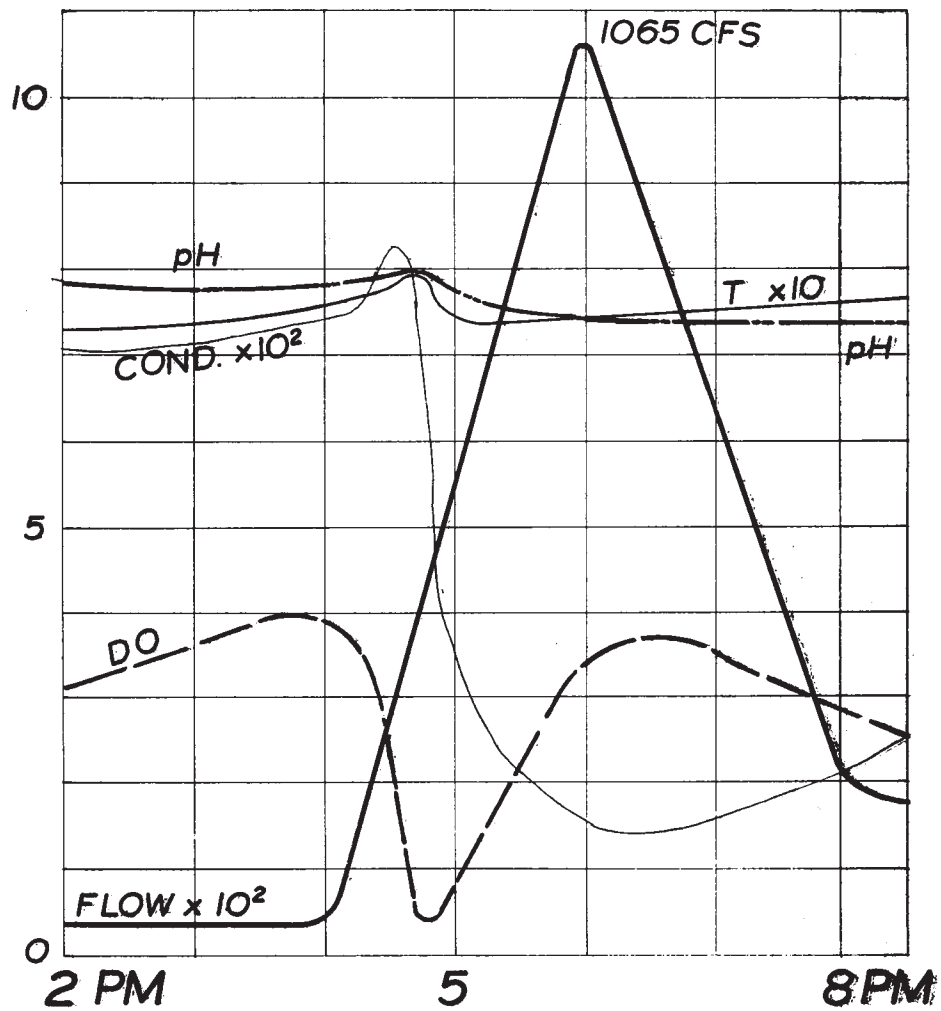


Figure 9. Wilson Creek Hydrograph.

Two possible locations along Wilson Creek were considered for investigation of a detention reservoir site; one is 3 miles southwest of the plant, the other immediately upstream of the plant. The upstream site appeared to be the most economical site, provided that was geologically acceptable.

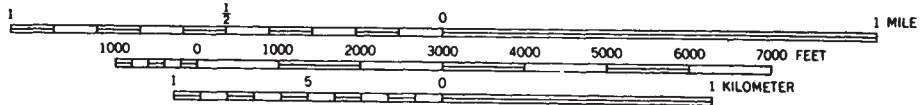
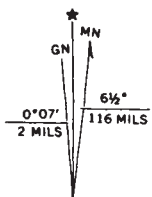
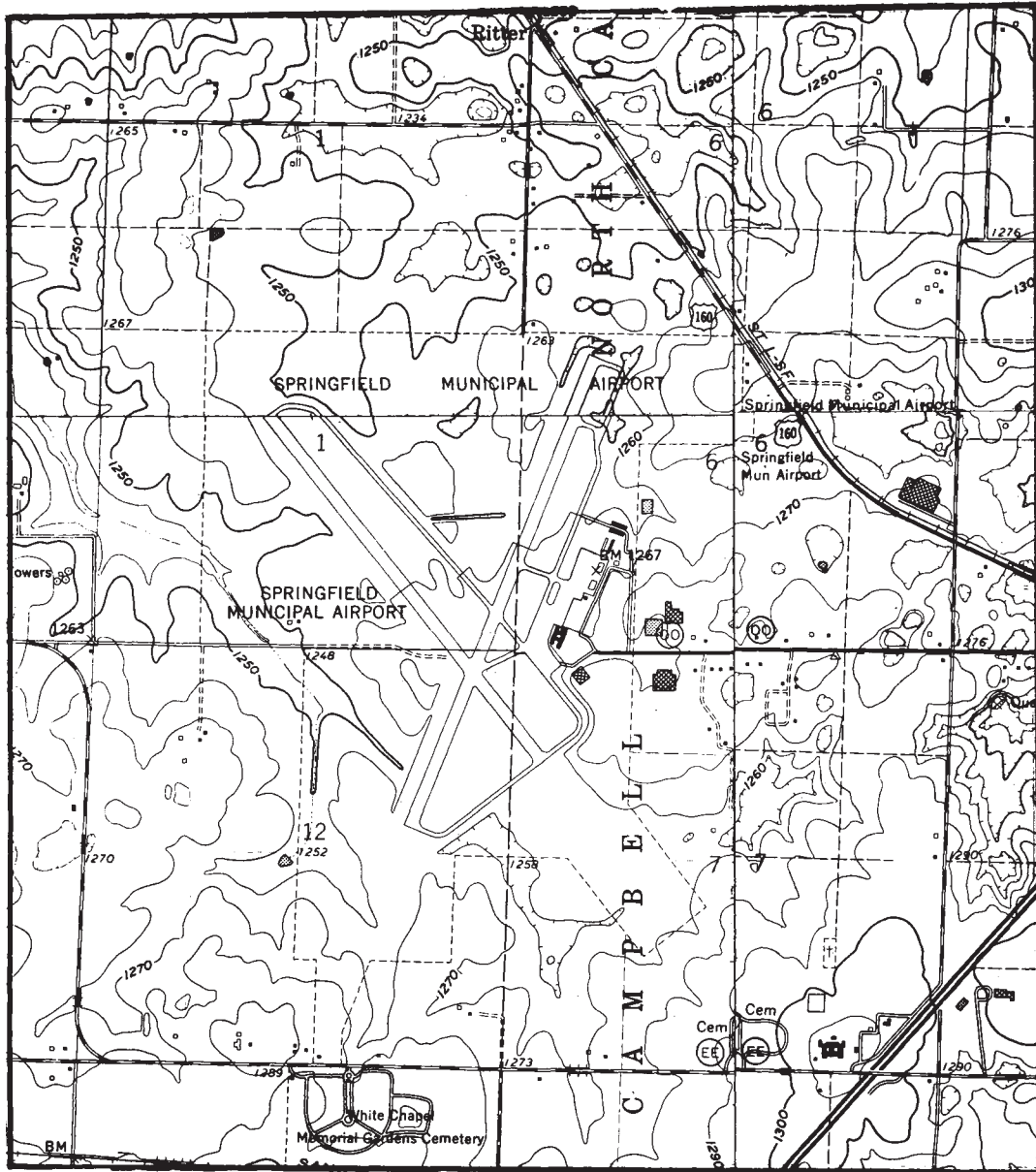
In December 1971, the City began investigation of the upstream site by accumulation of data from topographic, geologic, and soil maps; a radiometer field survey; study of aerial stereopairs, thermal imagery, color photos, and infra red aerial photos provided by the Water Resources Division of the USGS and the Missouri Geology Survey. Detailed geologic field investigation preceded exploration by means of 14 test holes averaging 8 - 10 feet in depth in the flood plain area and along the lower part of the east valley slopes. The site appears favorable and has been acquired by the City.

Preliminary plans include construction of a 20-acre, 8- to 9-foot deep reservoir some 150 feet wide and 3,500 feet long on the left (east) side of the existing channel. This will provide a detention capacity of approximately 55mg. It is anticipated that the diversion and detention of this quantity of water will adequately trap the major part of the poor quality water in the leading edge of storm runoff.

Automatic water quality sensors and controls (as well as manual controls) are planned to operate the diversion gate. The collected water in the detention reservoir will be treated at the plant when inflow is not surcharged.

R.22 W.

T.29 N.



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

Figure 10. Area E: Springfield Municipal Airport Vicinity.

UTM GRID AND 1970 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Area E. Springfield Municipal Airport Vicinity. Location:
Section 1 and 12, T. 29. N., R. 23 W. and section 6 and 7, T. 29
N.m R. 22 W. Brookline Quadrangle (7 1/2 ' series).

The broad upland karst plain that lies west and northwest of Springfield has been intensely effected by solutioning and weathering of the underlying carbonate bedrock. Solution collapse features (sinkholes), interior drainage into groundwater supplies, springs, and permeable soil cover are widespread. The airport is within an area of 5.5 square miles where surface runoff must flow into, or overflow, a sink before reaching a "normal surface drainage pattern". In spite of these features, the airport, many commercial, industrial, and residential sites, and Interstate 44 utilizes many square miles of this active, karstic, upland plain in the northwest corner of Springfield (Figure 10).

Experience has shown that a karst setting such as this in the Springfield region may be an excellent area to select for some developments, such as the airport, where waste disposal for example, is not a serious problem. However, the attempts to locate industries or suburban communities on this karst plain has been almost disastrous at times with serious pollution problems and poor foundation sites.

The soil cover varies from 10 to locally as much as 50 feet in thickness. It is typically a stoney red clay, moderately to highly permeable, and is difficult to compact properly because of the low natural density.

Specific problems of waste disposal are those of effluent loss by rapid movement through permeable clay subsoils and sinkholes. Effluent resurgence in springs, particularly on the Sac River watershed to the north, and in shallow cased wells, is commonplace. This is a particularly serious problem with effluent discharged by industrial concerns.

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Association of Missouri Geologists
20th Annual Meeting and Field Trip
22 September 1973

Branson to Springfield

Trip Leaders: Tom Thompson, Helmer Turner, Larry Fellows

This trip will be run from Branson to Springfield, just the reverse from the way it is run in the yellow guidebook (RI 37). In addition, there will be only three stops, two of which are also stops in RI 37.

<u>Guidebook Mileage</u>	<u>Odometer Reading</u>	<u>Miles to Next stop</u>	<u>Comments</u>
37.8	0.0	13.3	Stop at Branson Inn. Turn north on Highway 65. Between here and Stop 1 (Stop 3, p. 16, in guidebook) roadcuts are all in Cotter Dolomite (Early Ordovician-age). Strata were shallow water lime muds that have been dolomitized.
24.5	13.3	3.9	<u>Stop 1</u> (Stop 3, p. 16, in guidebook) This section was described in detail in MGS RI 45 as Section M, the Chestnut Ridge section. It was included as one of 42 outcrop sections in the southwestern Missouri area described and sampled for conodonts for this comprehensive Lower Mississippian stratigraphic and biostratigraphic report.
20.6	17.2	9.3	<u>Stop 2</u> (Stop 2, p. 11, in guidebook) This stop was discussed in MGS RI 45 because of the presence of Chattanooga Shale and Sylamore Sandstone beneath the Bachelor Formation.
11.8	26.0		Turn right (East) on Highway 14. Turn around at Ozark High School, back track to the first rock cut, and park along north side of road.
	26.5		<u>Stop 3</u> (Not included in the guidebook.) The stratigraphic section here is the same as that discussed at Stop 1 (p. 8) in the guidebook and the description of that stop is applicable here as well.

Return to Highway 65 and turn right (North). Road log in guidebook at mileage 5.1 (p. 7) is at the bridge over Lake Springfield.

Take Highway 65 Bypass to the Battlefield Road Exit. Turn left (West) on Battlefield and in less than 1/4 mile turn right (North) and watch for Glendale High School. Park cars and board buses in parking lot on South side of school.