A SUBSIDENCE ENGINEERING INVESTIGATION AT THE WILDLIFE PRAIRIE PARK[1]

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ABSTRACT. An investigation of the potential for subsidence and associated damage at the Wildlife Prairie State Park was undertaken. The park contains a variety of existing structures on about 2,000 acres of land. The investigation consisted of obtaining the best available information on the geologic and mining conditions across the site, in order to perform subsidence and damage assessment at the existing structure locations and to assess the more suitable building sites for future construction from a subsidence potential standpoint. This paper presents the results as well as the analysis conducted to achieve these objectives.

Additional Key Words: mine subsidence, mine stability, subsidence potential

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Introduction

The purpose of this study was to perform a subsidence engineering investigation of the Wildlife Prairie State Park (WPSP). The specific investigation objectives were to:

1. determine the subsidence conditions across the site;
2. assess the vulnerability of subsidence to existing structures and any possible mitigation measures which could be taken; and
3. evaluate future building sites for potential subsidence.

This investigation began with a site visit and the acquisition of all available geologic, mining and subsidence data in the area. The data was then reduced and summarized for subsidence potential across the site. Based on the available data concerning subsidence related site conditions, the subsidence potential was determined. After reviewing some basic information on the various structures at the park, the potential subsidence conditions and associated damage and hazards were generally evaluated for existing park structures. Possible damage mitigation measures for these existing structures were assessed as well as some suggestions on future construction at the park. This paper presents this analysis and the study's findings.

Site Description

The Wildlife Prairie State Park is located about 10 miles west of downtown Peoria (see Figure 1). This previously privately owned 2,000-acre zoological park is now owned by the Illinois Department of Natural Resources (IDNR). The park contains many attractions including walking trails, museums, wildlife observation areas, a touring train, historic buildings, eating areas and unique lodging accommodations.

As can be seen in Figure 2, the north area of the park is in the flood plain of the Kickapoo Creek at approximately 500 ft MSL. The park (proper) actually exists south of the flats and adjacent bluffs where the elevation dramatically increases to 550-600 ft MSL. In general the maximum elevations on the site are found in the south central area of the park reaching 650 ft MSL. Surface contours generally decrease from this high point in all directions across the site (i.e. east, north and west) and toward the total bluffs.

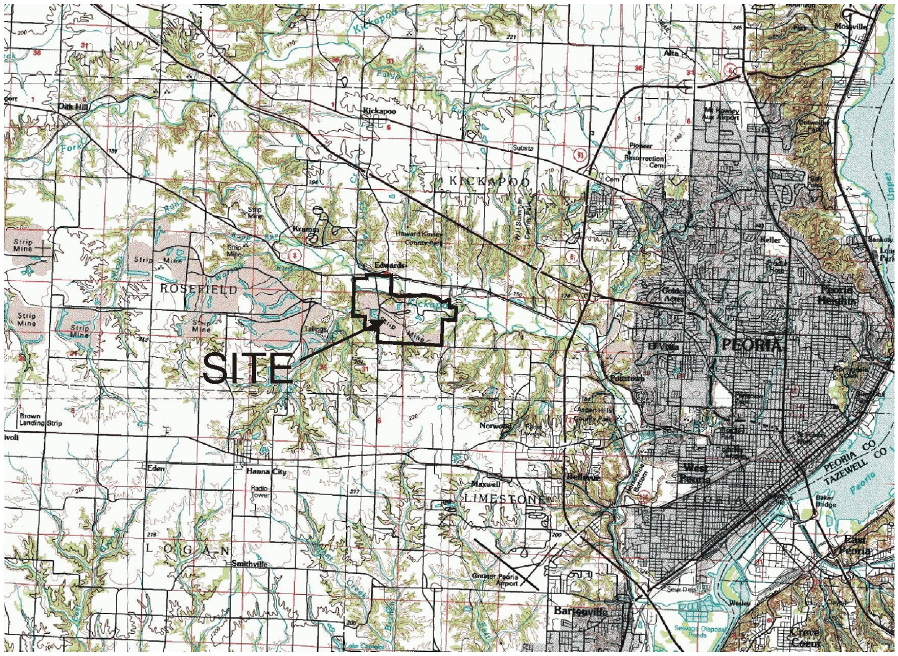

Figure 1. Location of Wildlife Prairie State Park, Peoria, IL.

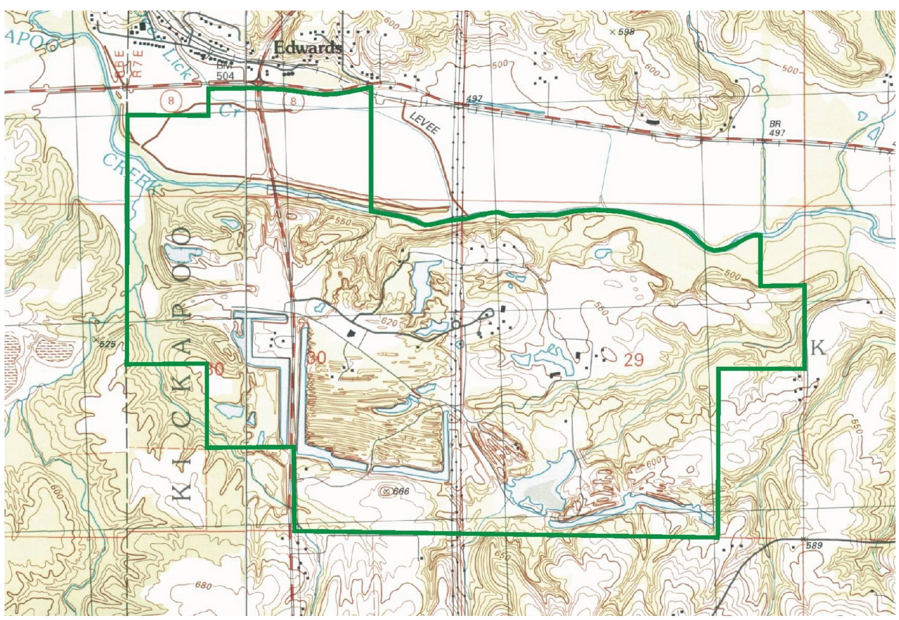

Figure 2. Quad map showing general topography across the site.

The topography across the park ranges from rugged (old unreclaimed strip-mined areas) to hilly to flat (which exists in general in the west central to middle central section of the park). Bisecting the hills are natural drainage ravines or draws which are typically 20-30 ft deep but can be up to 40-50 ft deep in places. Area drainage flows north to Kickapoo Creek. In the unreclaimed strip-mined areas the topography consists of a parallel to irregular pattern of ridges and valleys with typical variations in elevation of 10-20 ft which can be greater in places. Note that some of the strip-mined land has been reclaimed by either the mining company or later by the park.

There are a variety of structures at the site. Most of the park structures exist in the central to western part of the site and are over 90 in number. The park structures range from small, such as animal shelters, to large intricate buildings several stories high and about 100 x 140 ft arially. There are also 9 earthen impoundments which have been constructed on site. A site plan showing the location of each structure or feature by number is given in Figure 3. The various park structures have been grouped below into different categories.

1. GATES.
2. PLAYGROUND STRUCTURES (+MISC. SMALL STEEL STRUCTURES).
3. PORTABLE STRUCTURES.
4. RAILROAD TRACKS.
5. ANIMAL VESTIBULES/DENS/SHELTERS, SHEDS, BARNS.
6. ABOVE-GROUND TANKS.
7. SILOS/BINS.
8. ABOVE AND BELOW GROUND UTILITIES.
9. FOOT BRIDGES.
10. SHELTERS, VIEWING PLATFORMS.
11. ‘WAREHOUSE’/POLE-FRAMED BUILDINGS.

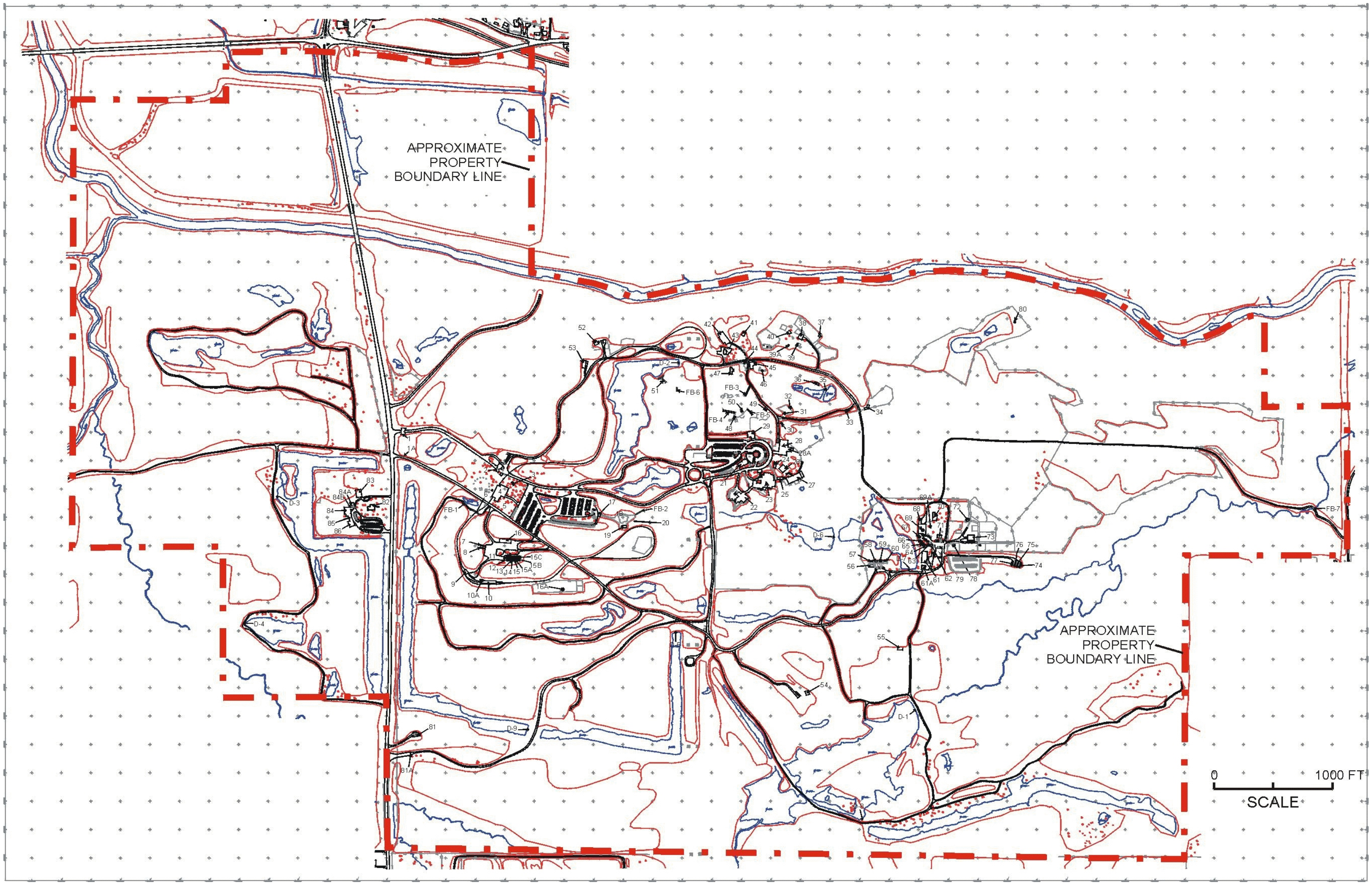

Figure 3. Site plan of Wildlife Prairie State Park.

12. WOOD-FRAMED BUILDINGS.

13. BLOCK BUILDINGS.

14. CRITICAL STRUCTURES. These buildings are individually described below.

A. Forest Hall/Reptile Hall (22) is a two-story wood-framed structure with about a 50 ft x 85 ft plan area. It includes lab space, large meeting rooms, offices, museum and other areas. Intricate multi-sided exterior (block, brick, wood and metal panel, and a lot of glass). Structure 22 is connected to Structure 23 by an enclosed wood-framed corridor, slightly elevated on pole supports (likened to a covered bridge structure).

B. Prairie Hall (23) is a two-story bi-level wood-framed structure which is about 110 ft by 190 ft in plan. The building has a complex layout, which includes dining, office and bar rooms as well as kitchen facilities. This building has a glass front with approximately 2 ft brick veneer or concrete bottom in most places. It is the largest park building and contains much glass. There is also a significant amount of brick veneer, wood paneling, concrete siding and block foundation exterior to one story heights in a detailed layout. Attached to the building there is an intricate exterior wood stairway structure and also a covered (pole-supported) walkway leading up to the building. Next to the building on one side there is an elevated platform formed by constructing a block retaining wall to the lower existing grade elevations.

C. Arboretum (27) is a two-to three-story (bi-level) wood-framed building about 50 ft x 85 ft in plan with much glass with brick veneer and wood paneling on all levels. Some of the brick veneer is two stories high. The building contains office, dining and banquet rooms, museums space, kitchen facilities and reception hall on the upper level. A wood-framed walkway bridge connects to the building.

D. Visitor Center (28) is a two-story (bi-level) building which appears to be wood-framed and is about 60 ft x 100 ft in plan. One two-story face of the building is all stone masonry. On the other sides, wood paneling and glass as well as block and glass are present. The building includes banquet, conference and mechanical rooms, a gift shop, an exhibit hall as well as reception area. There are covered walkways to the building.

E. Stone House (82) is a two-story old stone block house built by early settlers in the area. The structure has an old brick chimney attached to one side and is about 35 ft x 50 ft in plan. The house has a newer addition on the back third which is covered with aluminum siding and appears to be wood-framed.

F. Stone Barn (83) is a 2 ½ story converted old stone block masonry building. The barn, which is about 45 ft x 65 ft in plan (45 ft x 77 ft including three 12 ft long buttresses), has an archway entrance. On one side of the converted barn only one story is above ground while the lower half of the building is below. On the north side of the structure the exterior masonry is supported by three stone buttresses.

General Area Geology

Illinois subsidence is associated with mined-out coal belonging to the Illinois Basin. The Basin includes all of the central and southern parts of the state. Figure 4 shows a generalized geologic column. The coal measures have been deposited in cyclothems and consist of mostly clastic rocks. Therefore vertical lithologic changes are common. The coal measure rocks are primarily sandstone, siltstone, claystone and shale which make up 90 to 95 percent of the formation while less than 2 percent is comprised of coal, underclay and limestone. Outcrops of the Herrin and Springfield Coal can be found around the periphery of the Basin such as at Wildlife Prairie State Park. Both these seams have been mined at the project site.

The bedrock surface is covered by varying thickness of glacial deposits from the Quaternary period. Glaciation covers most of Illinois with deposits typically up to 50 ft thick and over 200 ft in thickness in buried bedrock valleys. Sediments of the Wisconsinian stage predominantly exist in northeast to east central Illinois. Illinoisian glacial deposits cover 90 percent of Illinois, and are extensive in the west and to the south of the limit to the Wisconsin movement. These Illinoisian and

Wisconsinian deposits are covered with widespread Wisconsin loess. Pre-Illinoisian deposits are irregularly distributed and of unknown extent in Illinois.

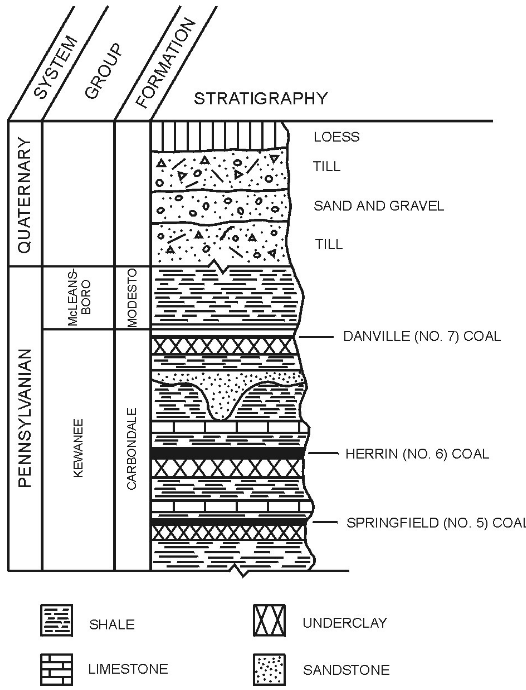

Figure 4. Generalized geologic column (DuMontelle, et al., 1981).

Site Geologic Conditions

The site geology given herein is primarily based on the available boring logs located within and adjacent to WPSP. A total of 165 drill core descriptions were evaluated from the ISGS historical records collected from a variety of sources. Many of the logs for these borings only show coal thickness and depths. Of the total 99 borings on site, 92 terminated immediately below the Herrin Coal with only 7 borings available which were drilled through the Springfield No. 5 Coal seam. It should also be noted that borings which only go to the No. 6 Coal exist at the west end and southern portion of the park while the No. 5 Coal core borings are all located in the southwest quadrant of WPSP.

The borehole data indicates an unconsolidated (soil cover) thickness across the park (proper) of about 15 to 35 ft outside strip-mined areas and 10 to 60 ft within strip-mined areas (mine spoil to the depth of the No. 6 seam). Because the historical drilling targeted coal geologic conditions, soil character descriptions were vague and general. The soil conditions should be in general agreement with the regional soil geology.

The geologic column characteristics given in Figure 4 are consistent with the rock geology found on the site. The Danville No. 7 Coal is actually only present along the southern boundary of the site. This coal member is altogether absent to the north where it has been eroded out or geologically removed. The available boring logs which described the overburden rock above the No. 6 Coal indicate the presence of the Anvil Sandstone and the Brereton Limestone. Neither of these units appear to be continuous. Where present, the Brereton Limestone was found up to 6.8 ft thick but typically ranged from 3 to 5 ft. The Herrin No. 6 Coal was present in the western half of the site from the southern boundary to just south of the Kickapoo Creek bluffs and in the southern region of the eastern half of the site. This coal member has been removed by erosion in the ravines and consequently outcrops in the sides of the naturally draining ravines which flow to Kickapoo Creek to the north. As noted above, this coal seam has been surface mined on the site and where it is still present is probably less then 50 ft deep except along the southern border where the depth may be up to about 70 ft. The No. 6 Coal ranges in thickness from about 2.5 to 4.8 ft.

Based on the available boring information, the bedrock interburden between the No. 6 Coal and No. 5 Coal seams is about 65-75 ft thick. The rock immediately above the Springfield Coal is a 'dark or black shale' with average thickness of about 2.5 to 4 ft. Above the roof shale rests about 0.6-0.8 ft of St. David Limestone (see Figure 4). Proceeding upward in the roof there is a 'dark gray shale' of about 10 to 20 ft in thickness that might be calcareous.

The Springfield Coal seam is about 3.7-3.9 ft thick and has also been extensively mined by underground methods. The seam generally dips to the southeast as shown on Figure 5. Figure 5 is a structural contour map of the Springfield seam that was developed from the available boring data in and around the site as well as approximate portal elevations where the coal outcrops along the bluff. As can be seen from this figure the seam dips from an elevation of about 510 ft MSL at the bluff to about 470 ft MSL in the southeast corner of the site, ranging from 85 to 140 ft deep (north to south). This coal is absent in the flood plain of Kickapoo Creek due to natural erosion.

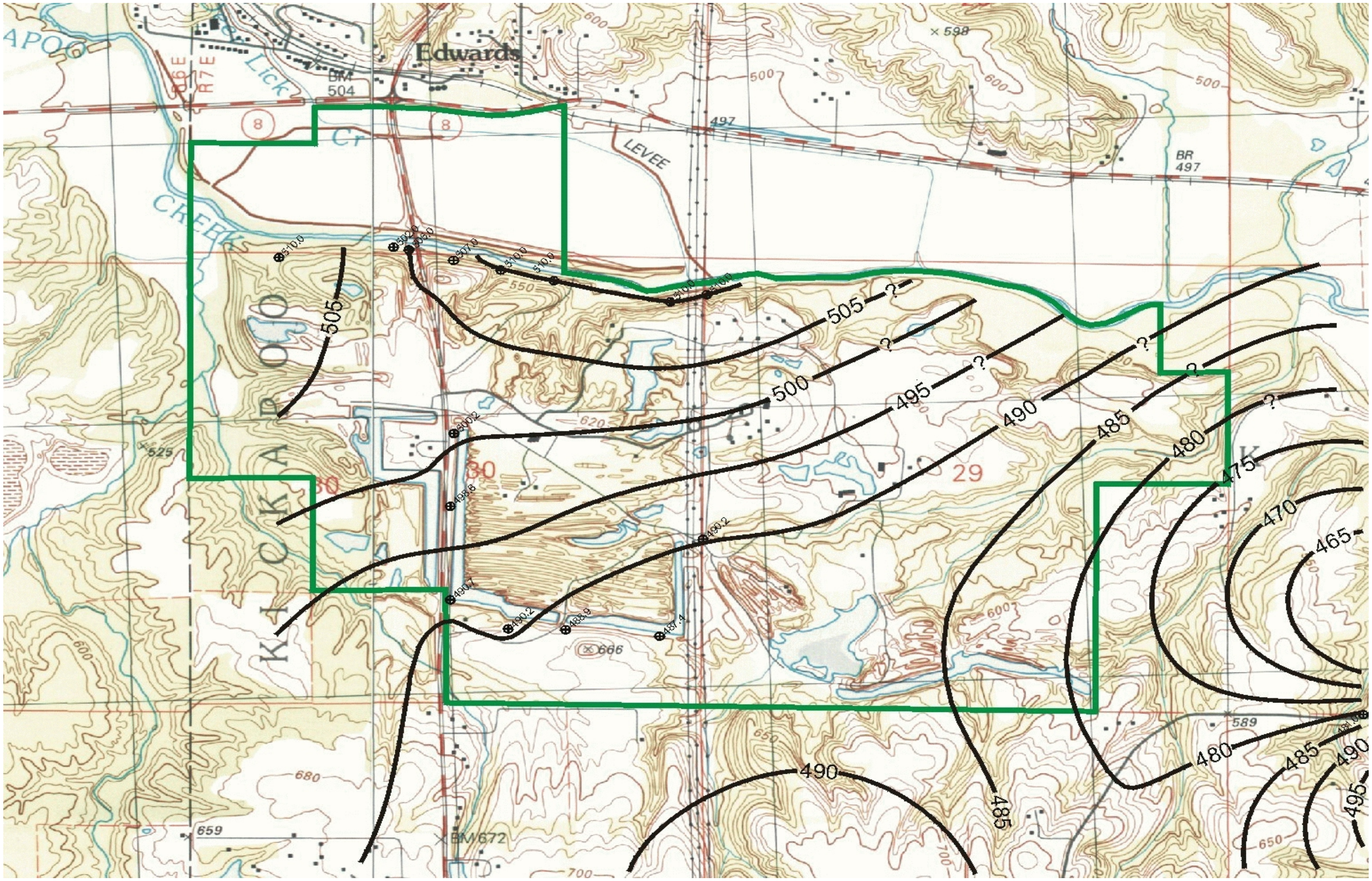

Figure 5. Structural contour map of the No. 5 Springfield coal.

The rock immediately below the Springfield seam is described as underclay with thicknesses of greater than 2.4 to 5.3 ft. It should be noted that all the No. 5 Coal borings terminated in this floor unit, thus subfloor information was not available. .

Site Mining Conditions

At the Wildlife Prairie State Park there has been both underground and strip mining of coal. Much of the upper coal seam (Herrin No. 6 Coal) was stripped (or removed by open excavation methods) and the lower Springfield No. 5 Coal was underground mined.

Illinois State Geological Survey (ISGS) records indicate there is one strip mine and seven underground mines at the Wildlife Prairie State Park. All underground mining occurred from 1919 to 1945 under various ownerships and prior to strip mining. Figure 6 shows all the available underground mine maps superimposed onto the WPSP site. Note there is no mine map for Mine No. 5882 which is only generally located.

There appear to be three (3) other portals noted in the Kickapoo Creek Bluff on various project mine maps without identification. It should be noted that based on the mine map information there are two possible locations of the Fairmount Mine (ISGS 3075), which is shown to be a drift mine entered at a bluff outcrop. The location assumed in this investigation was the northern location as this position is closest to the outcrop of the No. 5 Coal and the portal. The alternative southern location would be 2,625 ft south of the assumed northern location. The elevations of these north portal entrances appear to be about 502 to 510 ft MSL and adjacent to the flood plain.

As can be seen from Figure 6 most of the western half to two thirds of the Wildlife Prairie State Park appears undermined south of the Kickapoo Creek bluffs except for possibly some extreme southern areas. In other words, little mining of the No. 5 Coal is indicated to the east and south of this location although this should be considered highly suspect given the incompleteness of the mining information. The only known mining in the area to the east appears to have been a small slope mine operation called the Stear Mine which is outside the park boundaries. However, the mine drawing appears to be conspicuously limited in size and consequently the Stear Mine may extend west under the park property.

The strip mining, as mentioned above, occurred in the Herrin No. 6 Coal seam (a coal seam above the No. 5 Coal). This strip mine was called the Edwards Mine and operated on the project site from 1952 to 1975. An outline of the stripped mined areas is shown in Figure 7. As can be seen in Figure 7 the strip-mined land exists in the west central and south central parts of the site. Some of the park areas which were strip mined are quite evident by parallel "ridge and valley" topography (spoil ridges or windrows of overburden debris from excavating the coal from beneath). These windrow areas are fairly evident on the site topo and are found in the southern central area of the park. Most of the remaining strip mined areas appear to have been reclaimed to about the original ground contours.

Although most of the No. 6 Coal has been stripped, there are still some areas where it is still present, primarily along the western portion of the southern border and probably in the north central area south of the bluffs. There is a possibility that these No. 6 Coal areas could contain old underground works. Four (4) of the available borings located in the south central end of the park property indicated they intersected old room-and-pillar workings in the Herrin No. 6 Coal at a depth of only about 25 to 30 ft. It appears the coal was probably accessed, prior to stripping this particular location, from the northeasterly sloping ravine just north of the borings where the No. 6 Coal would have outcropped. Therefore, the strip mining may have removed the remnants of pillars. North of this northeast drainage feature the topography again rises and the No. 6 Coal should outcrop in the north slope from which the coal could have been accessed by drift entries and mined out. It is important to note that such old works could extend under park structures (eg. Structures 21 to 29, see Figure 3). It may be also possible that this coal was accessed from the south along the same ravine and developed underground to the west where the No. 6 Coal has not been stripped near the southwest border of the site (see Figure 6).

Overall the mine depth (or depth to the bottom of the No. 5 Coal) generally increases to the south and ranges from about 85-90 ft near the bluffs to 125-140 ft at the south end. The mine extraction height should have been fairly consistent with the coal seam thickness which is about 3.8 ft but can be higher in places since the seam thickness does not afford easy movement of mining operations (i.e. roof and/or floor rock may have been extracted for greater clearance, especially in the main entries).

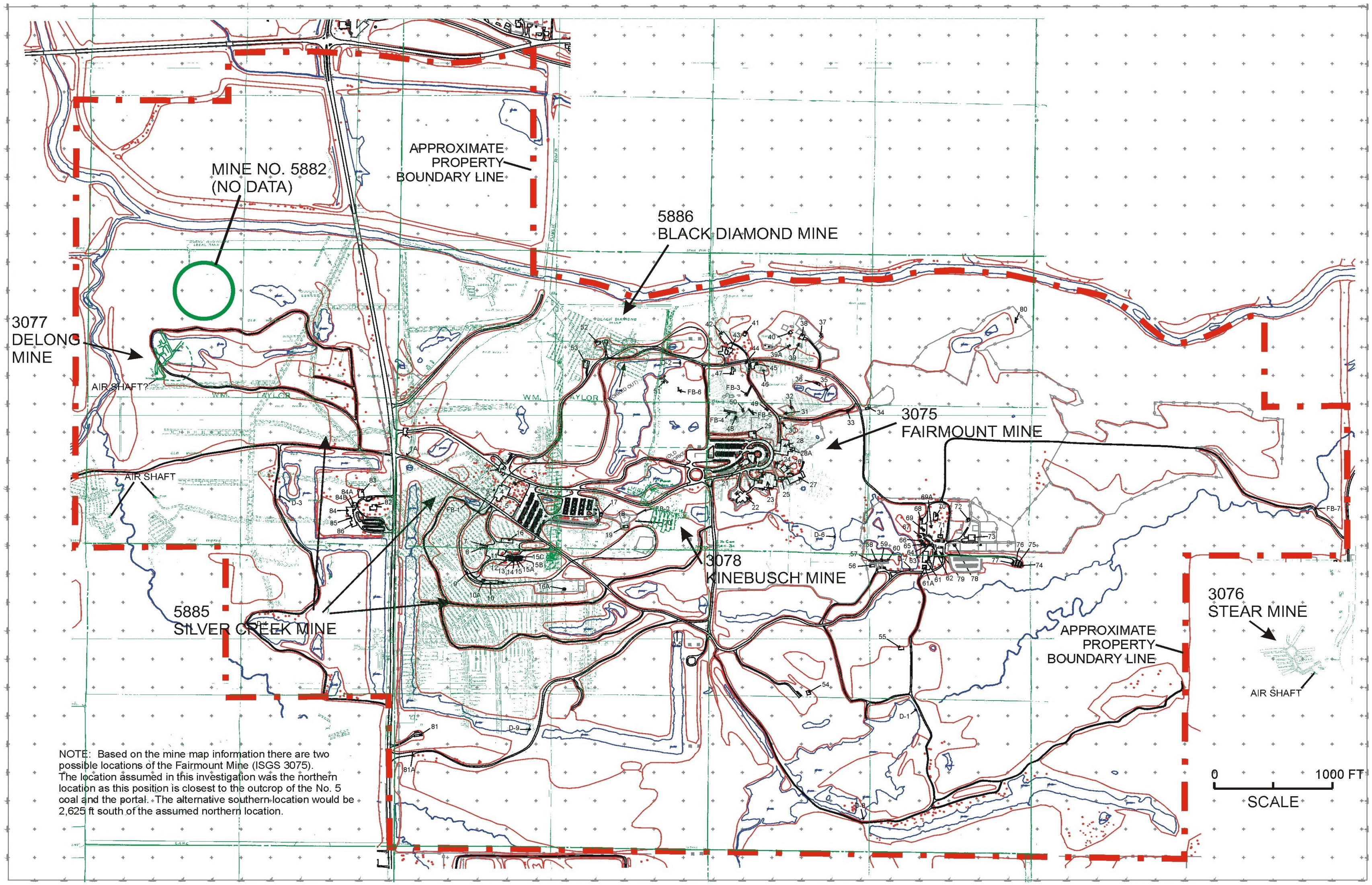

Figure 6. Underground mining beneath Wildlife Prairie State Park based on available records.

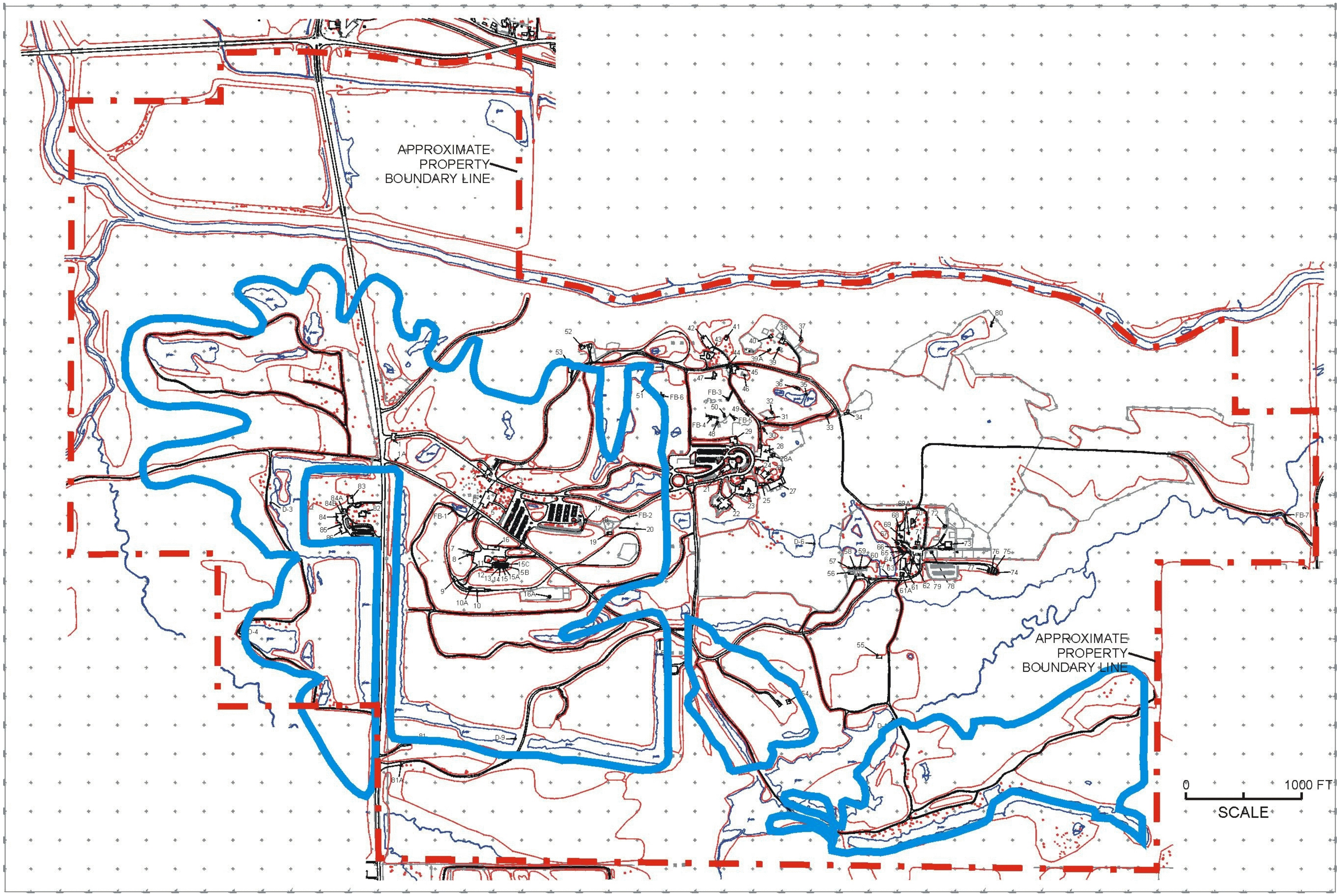

Figure 7. Strip-mined areas at Wildlife Prairie State Park based on Midland Coal Co. strip mine map.

The historical underground mine maps show that the production areas of the mines (i.e. the higher extraction areas) typically have narrow pillars from 5-10 ft wide and rooms 25-35 ft wide. All the mining records indicate fairly high extraction ratios ranging from 67 to 90% with most of the mined out areas at about the 85% range.

The two largest known mine complexes in the western and central parts of the site are the Silver Creek Mine and the Fairmount Mine, respectively. The mine development for these operations appears to have begun at the creek bluff and then worked south across the site. As these two drift mines were worked to the south they became deeper. The map for the Silver Creek Mine shows only the more recent mining pillar geometry to the south with "old works" noted to the north (no pillar detail). The available Silver Creek Mine and the Fairmount Mine drawings are progress maps and consequently the mining limits are likely to extend beyond those indicated particularly in the southern and western directions (see Figure 6). There are two or three smaller documented mines (the Kinebusch Mine and one called " Old Local Mines" and probably a third, the Black Diamond Mine, which does not have portals to the bluffs indicated on the mine map), which worked their way south from drift portals at the bluffs (see Figure 6). Other smaller mines known to exist are the Delong and the Stear Mines in the western and eastern ends of the site (see Figure 6).

Subsidence Potential

Subsidence Mechanics

Surface subsidence results from an underground mine failure. Mine stability depends upon the capacity of all the support elements to resist the applied overburden pressures. Ground surface subsidence results after instability has initiated at mine level and then propagates through the overburden to the surface. The sequence by which instability of the overburden and mine occurs is illustrated in Figure 8.

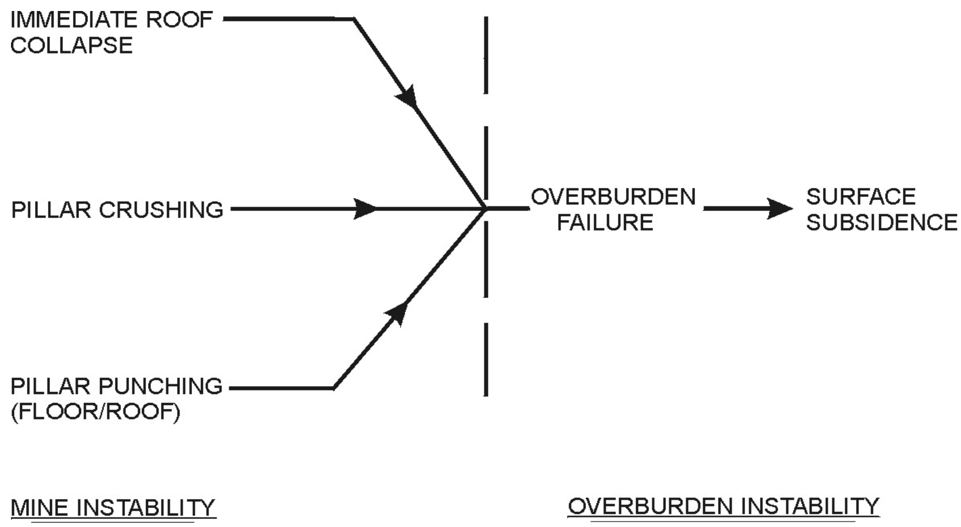

Figure 8. Mechanics of room-and-pillar workings and the overburden.

Modes of failure and the associated subsidence in abandoned room and pillar mines in Illinois have been previously discussed in detail (Hunt, 1980; Bauer and Hunt, 1981; Marino, 1985; Marino and Cording, 1985; Marino, 1986). There are three prominent modes of failure of the mine structure which result in surface subsidence: a vertical progressive roof collapse over a mine room, or a massive failure of a number of pillars from either pillar crushing or from a loss of floor bearing support. The room-roof failure can result in a pit or small sag subsidence with mine depths typically up to 165 ft, whereas a massive failure results exclusively in a sag.

The subsidence process can stabilize at a number of points after the initial instability at mine level and prevent ultimate failure of the ground surface. If in one area the short-term or long-term capacity of the mine support is exceeded by overburden pressures the overburden loads can redistribute in the roof and become stable. When the ultimate capacity of the roof is reached, adequate load redistribution cannot be achieved within the overburden and failure of the soils and subsidence of the ground surface results. Herein the roof is defined as those overburden materials which support themselves and possibly the rock and soils above. The actual mechanics by which a particular site will fail depend on the insitu stresses and the mining and ground conditions.

As subsidence movements propagate to the surface, the angle of draw induces movements beyond the failure area at mine level. Because the surface area impacted by subsidence is typically larger than the mine level failure, it is possible that separate but adjacent and somewhat overlapping subsidence events could result. Once a mine collapse occurs there is a significant disturbance which may result in failure of adjacent uncollapsed (possibly metastable) workings. Subsequent failures of these adjacent areas of the mine (likened to a "domino" effect) occur many times, thus causing adjacent surface subsidence events. These subsequent events have been noted to result days to a number of years after the initial subsidence event (Marino, 1990).

<u>Surface Subsidence History in Area</u>

Based on reports from the park staff there may have been pit or sag subsidence in the past on the site. Also, within 20 miles of the Wildlife Prairie Park nine structures were damaged by mine subsidence in five separate subsidence events in the last 10 years. One compounding problem contributing to major damage to structures in the Peoria area involves slope movement triggered by mine subsidence. In at least one area west of Peoria, mine subsidence triggered ground movement in a previously unstable slope on which structures were built at the crest of the hillside. The mine subsidence induced slope movement produced cracks and separations on the order of feet and ultimately the foundations were completely destroyed.

The nine structures were damaged by the pit and/or sag mine subsidence mentioned above, and were associated with shallow underground mining activity (less than 150 ft depth). In general, the subsided areas were relatively small and typically encompassed one to three adjacent structures and had maximum subsidence of 0.8 to 3 ft. Six of the nine subsidence-damaged buildings were on or adjacent to hill slopes and were the most heavily damaged structures because they were located at or near the crests of slopes which became unstable as a result of pit or sag subsidence movement.

<u>Site Specific Subsidence Conditions</u>

A pit develops when the entire thickness of rock above an individual mine room collapses causing the soil to fall in. Based on the site conditions and because this failure mechanism is possible a pit or sinkhole-type subsidence can unpredictably result at WPSP. Bauer and Hunt, 1981 reported pit development up to mine depths of 165 ft. Note the estimated depths of mining at the park are about 85-140 ft and may be as shallow as about 25 ft if old works exist in the No. 6 seam. A resistant rock bed (e.g. a limestone layer) in the roof overburden could, however, suppress upward caving.

Sag subsidence may also result unpredictably at the site. Based on the available information a massive collapse of the soil and rock overburden can occur from pillar failure as well as floor bearing failure of a mine area or from a progressive upward failure of the roof in a mine room(s). Also, based on the subsidence history in the vicinity of the park, pit or sag subsidence can trigger damaging slope movements. Obviously, if the mine workings had already collapsed beneath the site areas in question, additional subsidence potential would be significantly reduced. There is, however, no specific evidence that sag or pit subsidence has previously occurred on site.

Park Structures

Where mining is present on site, there is a significant risk of settlement from surface mining and pit subsidence and/or sag subsidence from underground mining. Subsidence from underground mining can be significant as discussed earlier in this report. Settlement from strip-mined debris (gob) which is composed of loose soil and blast rock may also present some foundation concerns. Consequently, known strip-mined areas were also considered in this analysis. Therefore, based on the available mining, geologic and site data an evaluation was performed to assess the potential for mining-related subsidence damage to existing park structures, and to define those areas which are less likely to sustain the effects of mining for future construction.

In order to assess the existing and future building sites a map was created which approximately outlines areas with various mining scenarios. The categories of potential impact areas are given below.

1. Known Strip and Underground Mining
2. No Known Strip Mining- Known Underground Mining
3. Known Strip Mining-No Known Underground Mining
4. No Known Strip or Underground Mining
5. No Mining (No coal present)

A map of the site showing the areas with these various mining scenarios given in Figure 9. It is important to note that the limits as shown in Figure 9 are very approximate. Although available strip-mine data appears to be fairly reliable, mining limits from the maps of the old underground workings are incomplete. Moreover, the possibility of other local mines with unknown location of workings exists.

Based on the limited available No. 5 Coal elevation data the coal depths were also determined where no known mines exist and can be seen in Figure 9. The coal depths were determined to supplement the suspect mine map information. The depth of the coal may have been a limiting factor for mining due to insufficient bedrock cover and possible groundwater inflow problems. Although old localized mines can exist at very shallow depths a possible limiting mineable depth of 50 ft may be assumed. These No Known Mining areas have been discerned and are shown in Figure 9.

Existing Structures

All the Critical Structures: Forest Hall/Reptile Hall (22), Prairie Hall (23), Arboretum (27) and Visitor's Center (28), Stone House (82) and Stone Barn (83) are indicated as undermined with the subjacent mine estimated at depths of 85 to110 ft and are consequently subjected to future pit or sag subsidence. Further, below Structures 22, 23, 27 and 28 the potential exists for the upper No. 6 Coal seam, which would be at a depth of about 60 ft, to contain old localized works. Therefore, based on the available information both pit and sag subsidence can result at critical structure locations.

Future Construction Areas

Based on Figure 9 the best building sites (with the least chance of the effects of mining) are the northeast areas south of the Kickapoo Creek Bluff and of course areas north of the bluffs where the mined-out coal seams are absent. These areas south of the bluffs have no known mining, probably no No. 6 Coal, and No. 5 Coal at depths on the order of 50 ft or less. Other unstripped areas where the coal seam(s) is at greater depths and not reported to be mined may also have not been worked.

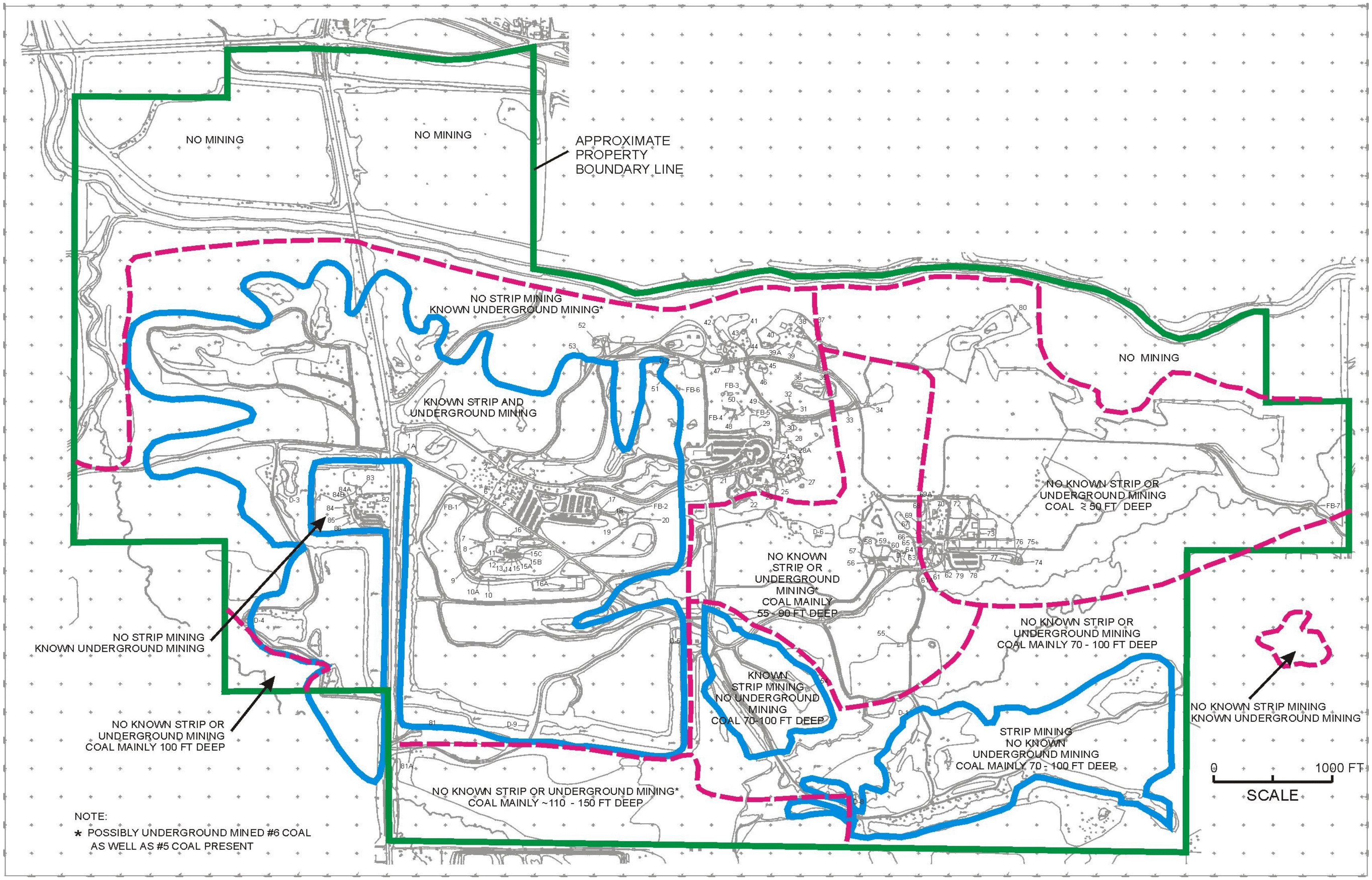

Figure 9. Map depicting approximate limits of various mining scenarios across the site.

Existing Park Structures

Obviously the rapid development of a pit is hazardous wherever the public and staff are present. The cost of repairs depends on pit size and the characteristics of the affected building or park structures. Because of the abrupt nature of pit subsidence movements, both flexible (e.g. wood) and rigid structures (e.g. concrete and masonry) are equally affected. The structures with the most serious damage potential in terms of repair costs are: Silos/Bins; Block Buildings; Wood-Framed Buildings (considering the larger residences and store or office-like structures); and Critical Structures (with historical buildings - Stone House (82) and Stone Barn (83) if repair is acceptable), followed by Forest Hall/Reptile Hall (22), Prairie Hall (23), Arboretum (27), and Visitor Center (28).

Sag subsidence occurs much more gradually than pit subsidence and encompasses a much broader area. Hazards can result from sag subsidence and should be dealt with in a similar manner as given above for pit subsidence. The most significant hazards are typically related to underground utility lines buried in the vicinity of the connection with a building; loosened, detached or damaged structural connections or supports, unstable tilted or rotated masonry walls, broken glass, and structures sensitive to small movements which are displaced and/or tilted.

Damage Potential Classification

1. No to minor damage would be expected from sag subsidence to: Gates; Playground Structures; Portable Structures; Above-Ground Tanks; Animal Vestibules/Dens/Shelters, Sheds, Barns; Railroad Tracks; and Above-and-Below-Ground Utilities.

2. Minor to moderate subsidence damage could be sustained by Silos/Bins (excluding the converted 4 story block Silo 85 which could result in major damage); Foot Bridges (Foot bridges FB2-5 can have greater damage if the slopes of 40-50 ft deep ravines which they cross become unstable from subsidence); Shelters, Viewing Platforms (significant enclosures in some shelters can result in greater damage); 'Warehouse'/Pole-Framed Buildings; and Wood-Framed Buildings (includes all the small structures to non-masonry 'homes').

3. Moderate to major damage from the full impact of sag subsidence can occur in the following park structures: Silos/Bins (only the converted 4 story block Silo 85); Foot Bridges (only

FB2-5); Shelters, View Platforms (only shelters with significant enclosures); and Wood-Framed Buildings (only masonry 'homes' and 'store' size structure), and Block Buildings.

4. Serious or major damage can occur in some structures if substantially impacted by sag subsidence and are considered herein to have the largest cost to repair, retrofit and/or replace portions if not all the structure. These buildings include the Critical Structures, in other words, Forest Hall/Reptile Hall (22), Prairie Hall (23), Arboretum (27), Visitor Center (28), Stone House (82) and Stone Barn (83).

Summary and Conclusions

A mine subsidence engineering investigation was performed for the Wildlife Prairie State Park (WPSP) just west of Peoria, Illinois. The park site contains extensive underground mining of the No. 5 Springfield coal seam and surface mining of the No. 6 Herrin coal seam.

Illinois State Geological Survey (ISGS) records indicate one strip mine and seven known underground mines at the Wildlife Prairie State Park. Available records show that all underground mining occurred from 1919 to 1945 and prior to strip mining of the No. 6 Coal. Most of the available underground mine maps are progress maps and do not show the complete final mine workings. At least one of the maps (the Fairmount Mine) placed the mine in a highly suspect location. Essentially all of the western half to two thirds of the Wildlife Prairie State Park appears undermined south of the Kickapoo Creek bluffs. In other words, little mining of the No. 5 Coal is indicated to the east of this area although this should be considered highly suspect given the incompleteness of the mining information. The strip mining occurred in the Herrin No. 6 Coal Seam from 1952 to 1975. The strip-mined land exists in about the western and southern central part of the site south of the bluffs. Although most of the No. 6 Coal has been stripped there are still some areas where it still is present. There is a possibility that these No. 6 Coal areas could contain old underground works.

There have been reports subsidence on site by park staff. Also, there are 6 known mine subsidence events which have occurred in the last 10 years in the vicinity of the park. Pit or sinkhole-type and sag subsidence can unpredictably result at WPSP. Based on the subsidence history in the vicinity of the park pit or sag subsidence can trigger damaging slope movements.

Furthermore, foundation settlement can result over strip-mined areas where gob is present.

All the Critical Structures: Forest Hall/Reptile Hall (22), Prairie Hall (23), Arboretum (27), Visitor Center (28), Stone House (82) and Stone Barn (83) are indicated as undermined with the subjacent mine estimated at depths ranging from about 85 ft to 110 ft and are consequently subjected to future pit or sag subsidence. Also the potential exists in the area of Structures 22, 23, 27 and 28 for the upper No. 6 Coal seam, which would be at a depth of about 60 ft, to contain old localized works. Mining of the No. 6 Coal is considered much less likely below Structures 82 and 83. Based on the available information both pit or sag subsidence can result at these critical structure locations if undermined.

Those park structures which can result in serious or major damage if substantially impacted by subsidence are considered herein to have the largest cost to repair, retrofit and/or replace portions if not all the structure. These buildings included all the Critical Structures.

In selecting future construction sites the subsidence potential based on existing mining effects across the park should be considered. All areas north of the bluffs in the Kickapoo Creek Flats are not undermined and the northeast quadrant of the park south of the Kickapoo Bluffs appears to have the least chance of mining effects. Also where subsidence potential exist a site becomes potentially more hazardous and risky if it exists within influence of significant ground slopes.

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