

Three Problem Areas For Future Highway Construction in Eastern Kansas

By Richard Ryan, PG,
Kansas Department of Transportation



- Johnson County – Gateway Project,
 - Kansas City
- New Pittsburg Bypass, Pittsburg, Kansas
 - K -7 Widening – Cherokee County,
 - Columbus to Cherokee

The Kansas Department of Transportation has a \$600 million Dollar Johnson County Gateway Project Interchange Improvement Project at the intersection of I-35, I-435 and Kansas Highway K-10 in Lenexa

The Project is to be Let in the Fall of 2013.

This is a “Design-Build” Highway Project. In other words the Contractor will design the roadway and do the construction.

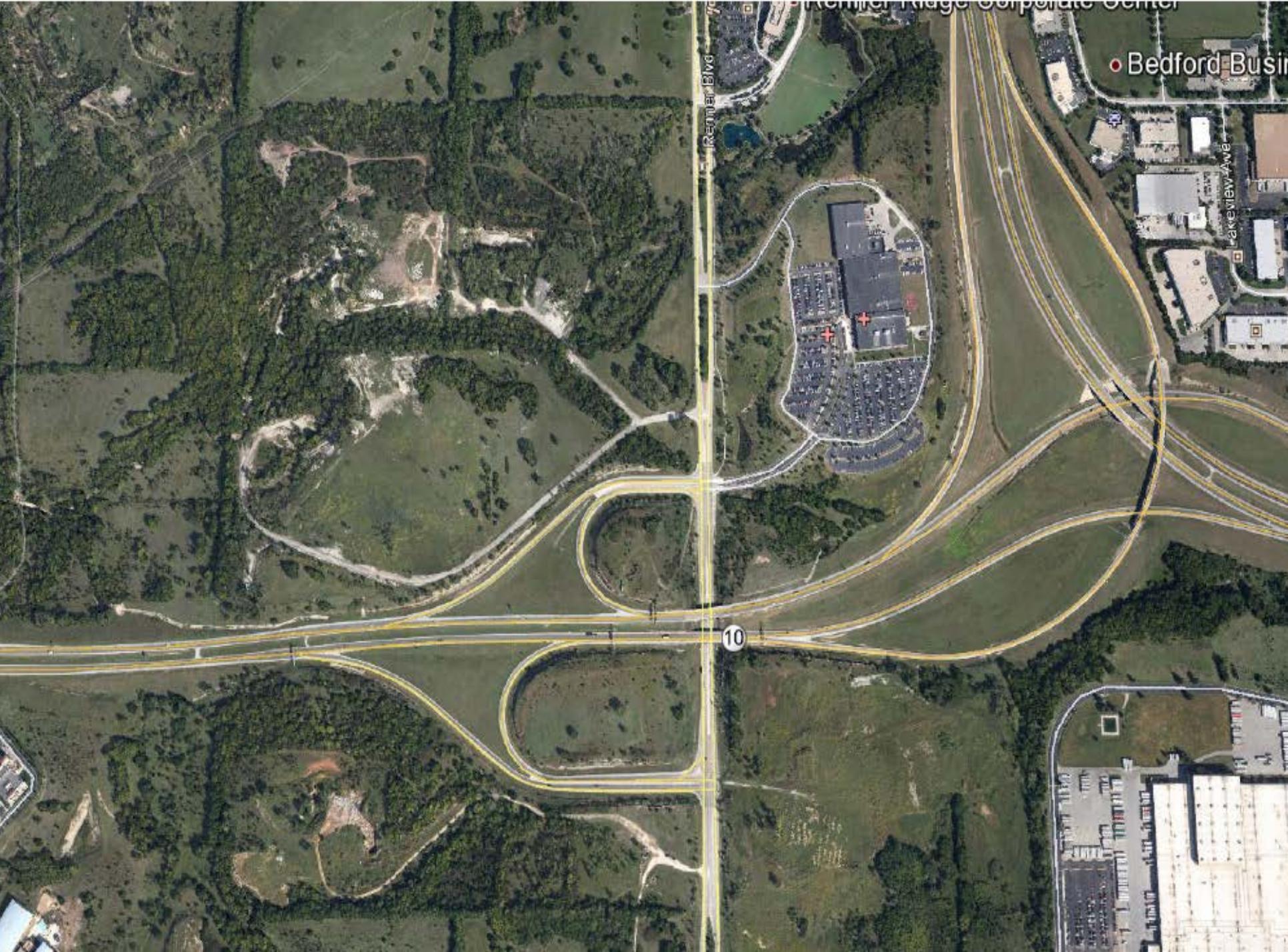
Kansas City is well known for its re-use of mined out caverns . There are over a dozen underground business complexes or industrial parks in the area with over 20 million square feet of space . The Meritex underground in Johnson County has over 2.2 million square feet of space and 35 tenants which include the National Archives, Bureau of Indian Affairs and Cavern Technologies, Blue Cross and Blue Shield.

The limestone formations that are mined and later used for Storage are the Argentine Limestone Member of the Wyandotte Formation and the Bethany Falls Limestone Member of the Swope Formation both of the Kansas City Group which is Upper Pennsylvanian.

The mines are dry with low humidity and the temperatures hover about 68 degrees all year round which make the mines ideal storage areas for documents, food, furniture





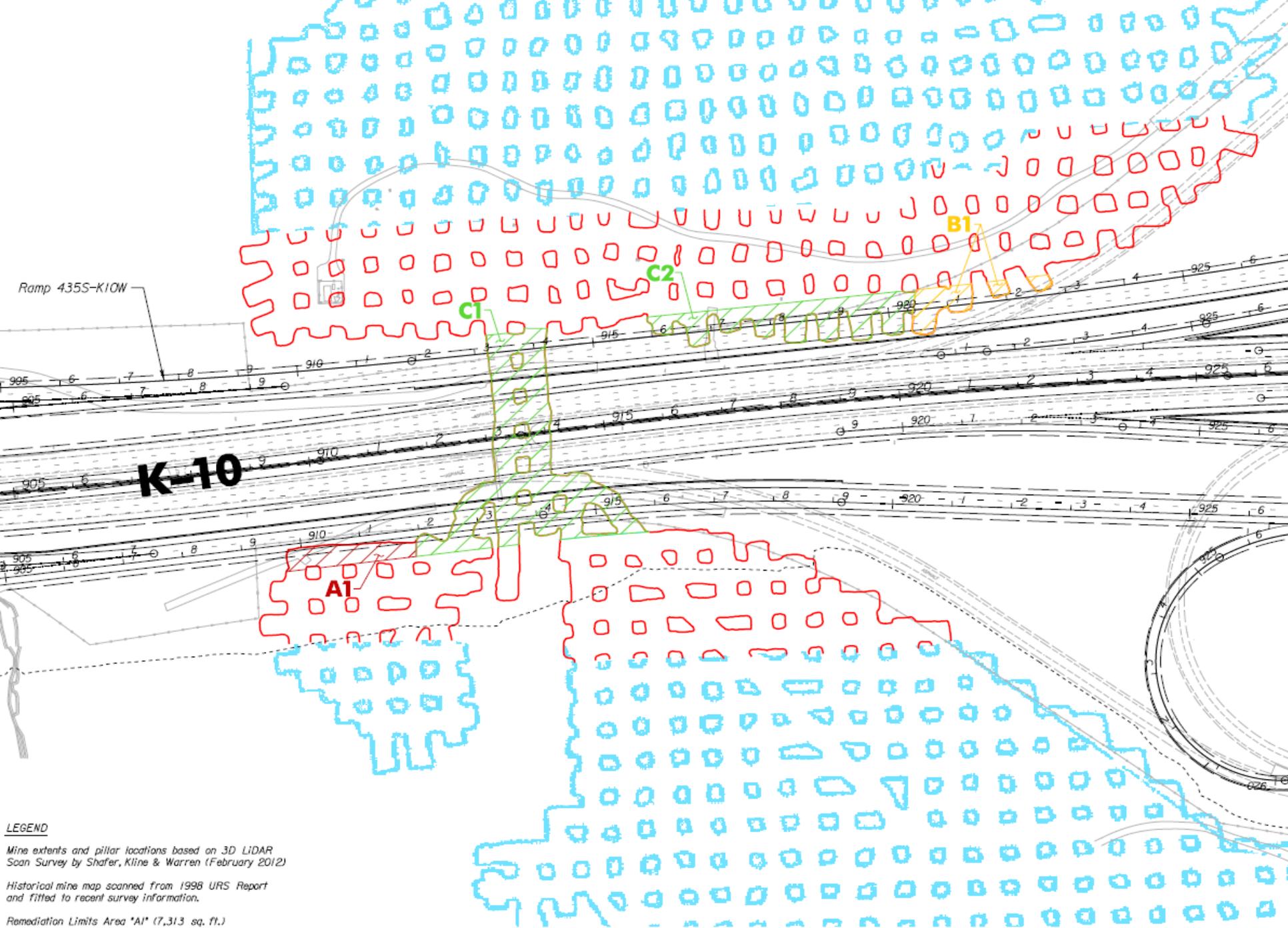


Remmer Blvd

Bedford Business Center

Lakeview Ave

10



Ramp 435S-K10W

K-10

AI

C1

C2

B1

LEGEND

Mine extents and pillar locations based on 3D LIDAR Scan Survey by Shafer, Kline & Warren (February 2012)

Historical mine map scanned from 1998 URS Report and fitted to recent survey information.

Remediation Limits Area "AI" (7,313 sq. ft.)

Mining ended in 1988 and currently a portion of the mine is being used for storage. Remediation involves back filling with grout from the surface or reinforcing the mine roof or back with rock bolts and shotcrete which will be done at the mine level.

There are some Unique Challenges for Geotechnical specialists. A portion of the project is over limestone mines that are 80-85 feet deep with drifts that are 16 feet high and 35 feet wide. The pillars are 25 feet wide.

HNTB has done a considerable amount of work on investigating this Mined area and developing a Mine Remediation Plan.

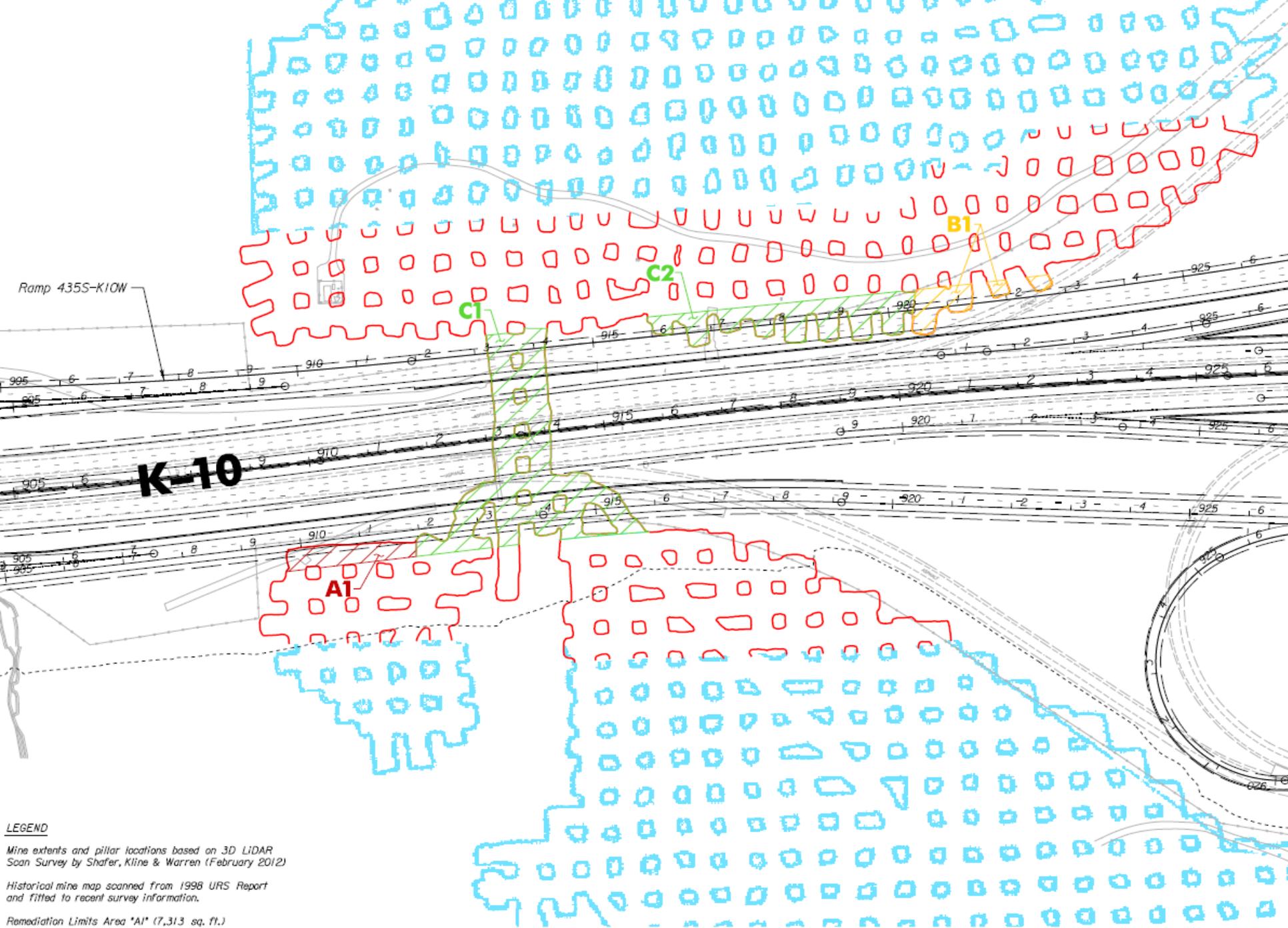
The Mine remediation will include any undermined space directly beneath proposed roadways and a 25-foot wide buffer zone measured from the proposed shoulder.

One area will be Reinforced with rock bolts and shotcrete to maintain access through the existing tunnel beneath K-10.

Certain areas will accessed from the mine level for remediation. Other Areas will be filled from the surface.

The estimated cost of Remediation is roughly \$4 million. The costs include grout, grout placement, and monitoring of the grouting operation.

In one area, rock bolts will be placed through the upper 6 feet of limestone in the mine roof through the shale and 4 feet into the Lower Farley Limestone Member with a 100 percent bond length. The bolts will be over 15 feet long. These bolts are modeled after the ones used in the Meritex underground storage facility just to the north of this area.



Ramp 435S-K10W

K-10

AI

C1

C2

B1

LEGEND

Mine extents and pillar locations based on 3D LIDAR Scan Survey by Shafer, Kline & Warren (February 2012)

Historical mine map scanned from 1998 URS Report and fitted to recent survey information.

Remediation Limits Area "AI" (7,313 sq. ft.)

K-10

A2
A3

Ramp K10E-35N

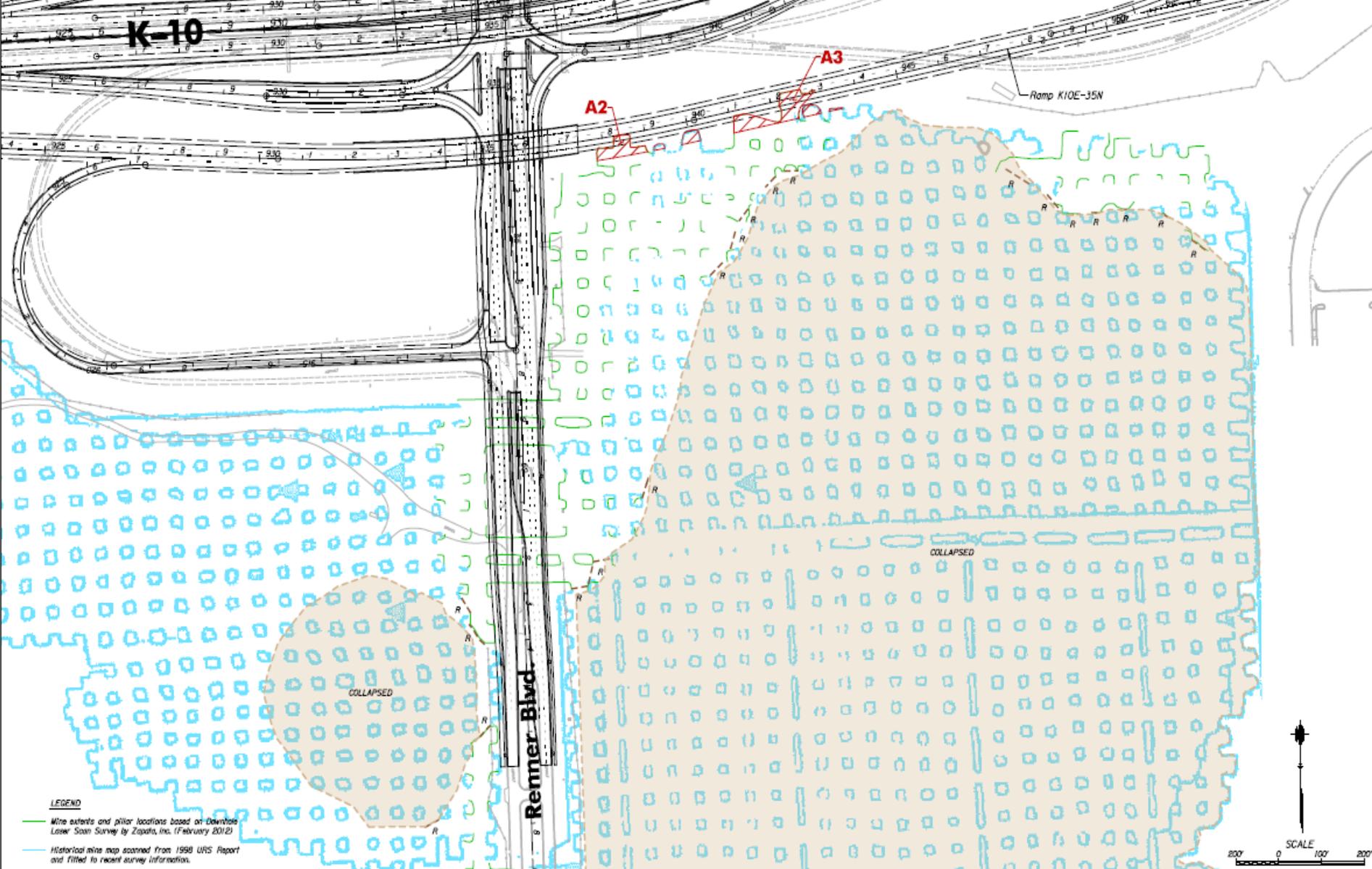
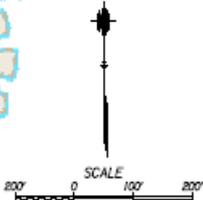
Renner Blvd

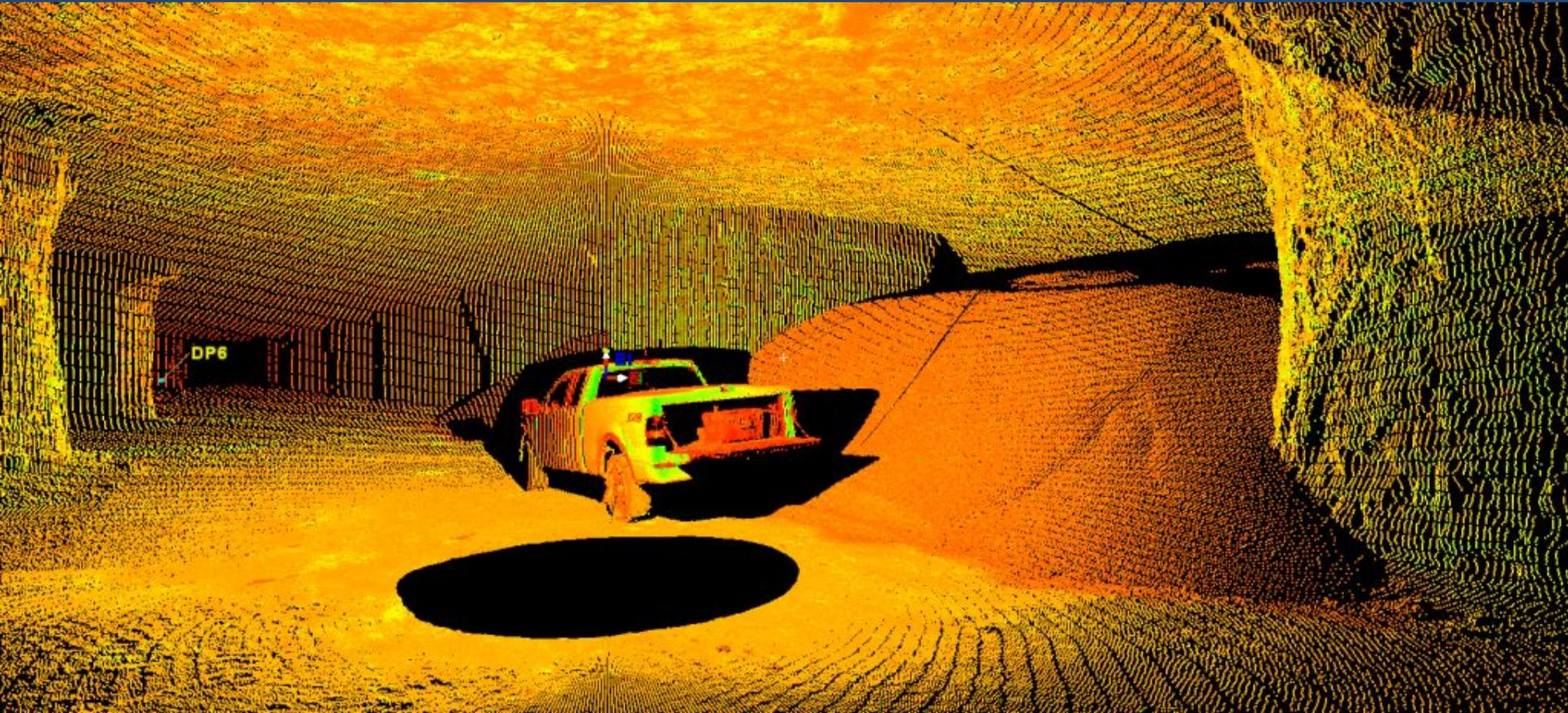
COLLAPSED

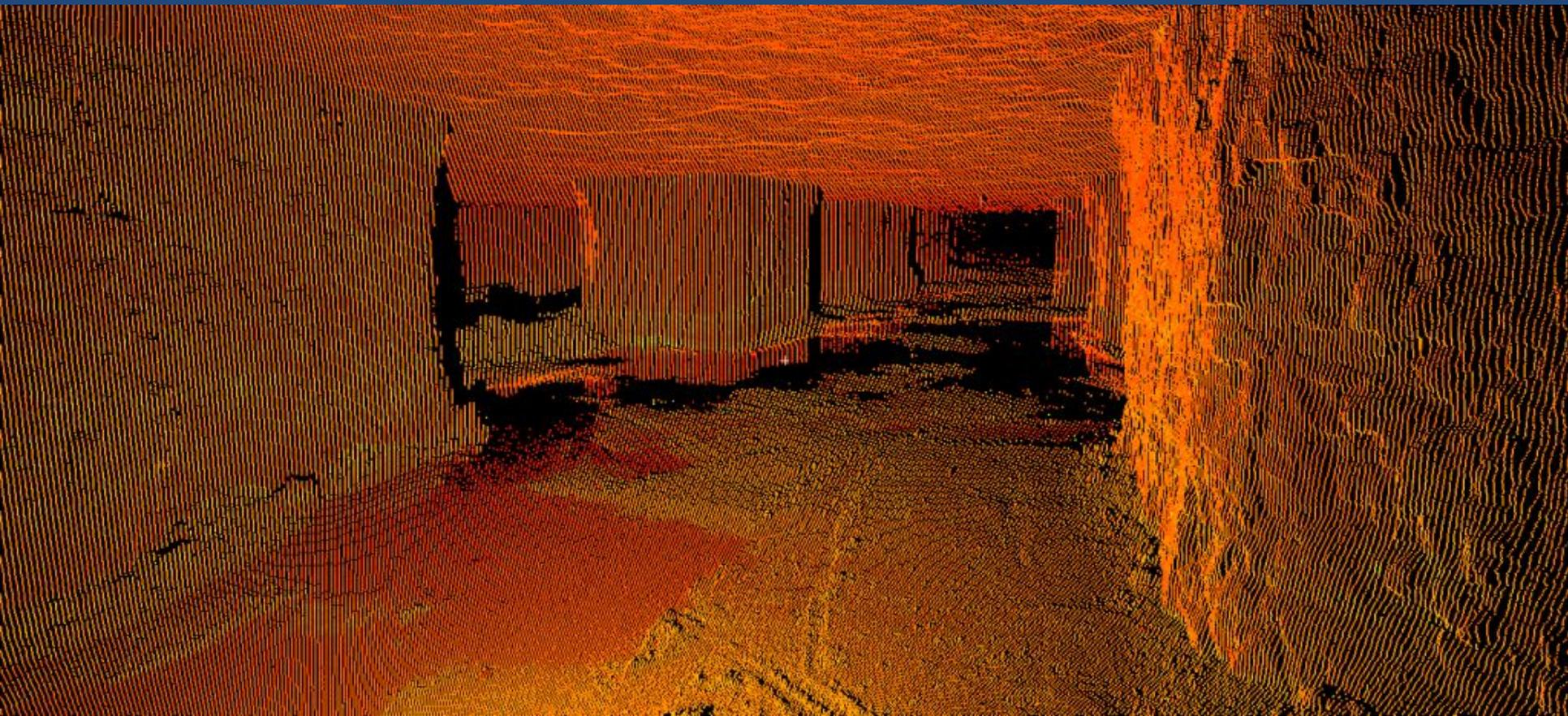
COLLAPSED

LEGEND

- Mine extents and pillar locations based on Downhole Laser Scan Survey by Zapata, Inc. (February 2012)
- Historical mine map scanned from 1998 URS Report and filled to recent survey information.

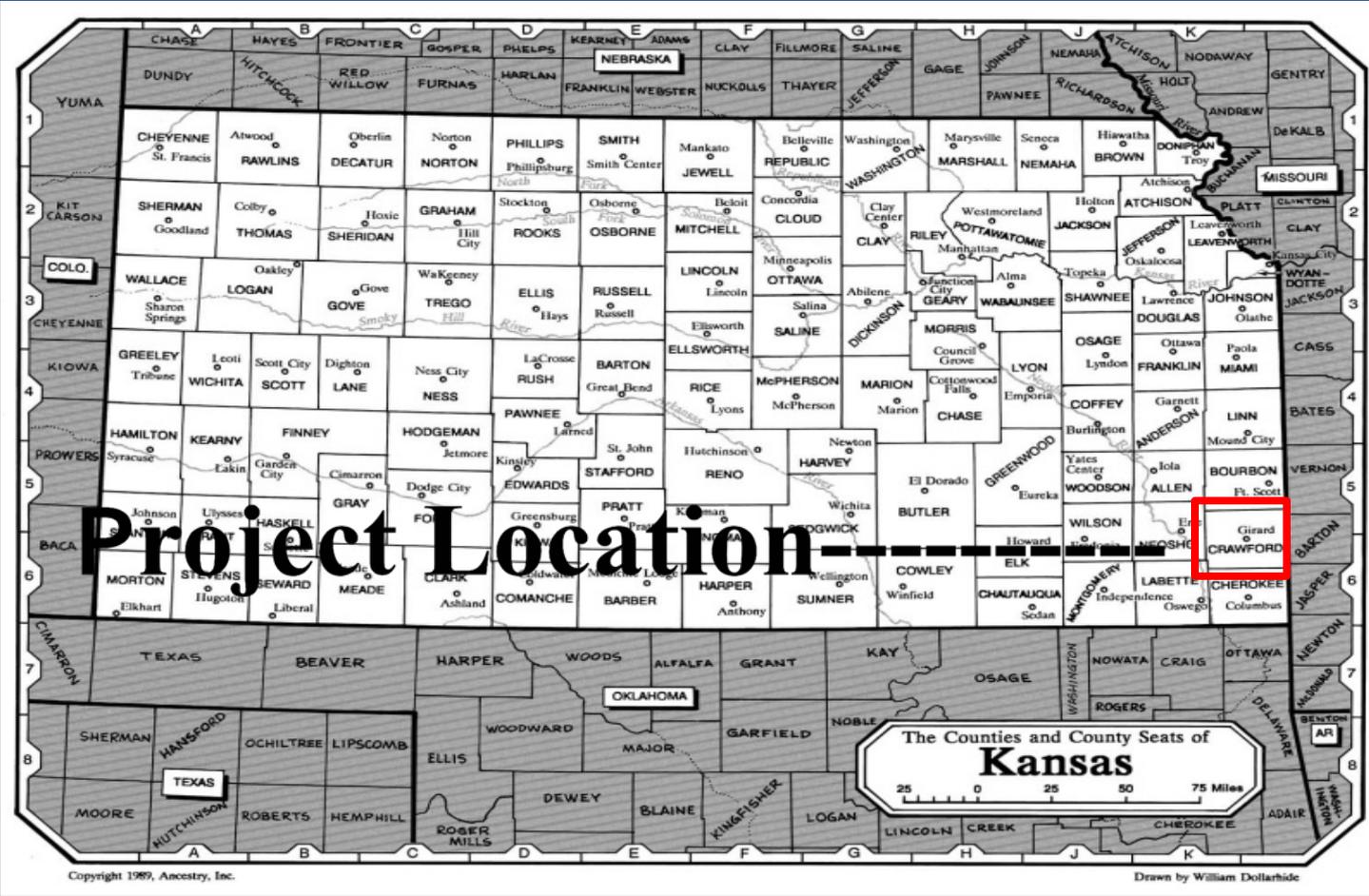








New Pittsburg Bypass, Pittsburg, Kansas

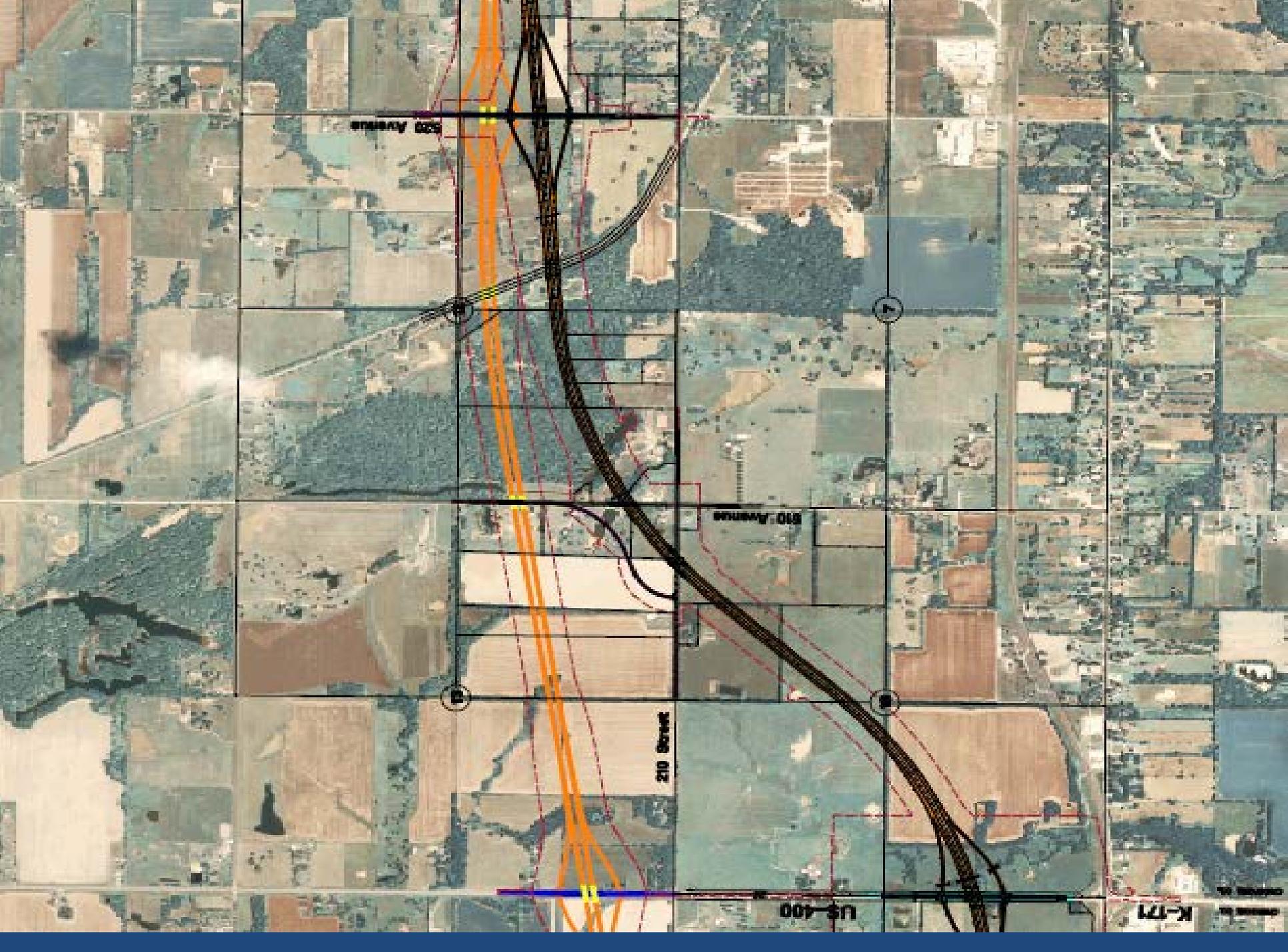


Much of the underground mining supplied coal for the railroads and for a zinc smelter located in Pittsburg.

Pittsburg had a ready supply of coal 20 to 100 feet below the surface. Extraction of the coal was done by using the room and pillar mining method and it seems that roughly 80% of the City of Pittsburg and the proposed Pittsburg Bypass are undermined.

What mine maps we have are vague, incomplete and difficult to pinpoint as far as exact locations of the voids. The Surface Mining Unit in Pittsburg has done an excellent job in lining up what old maps we do have with the surface maps at a very close fit to the correct map scale.

The New Hwy 69 Crawford County Corridor is a proposed 19.5 mile bypass of Pittsburg through the county from the Cherokee-Crawford County Line (Hwy US-400) north to a location north of the town of Arma. At that point the proposed 4-lane roadway ties back into Existing US-69. The average daily traffic is 11,300 VPD on the current Bypass and passing demand is high with an accident rate higher than average for roads in the state.



500 Avenue

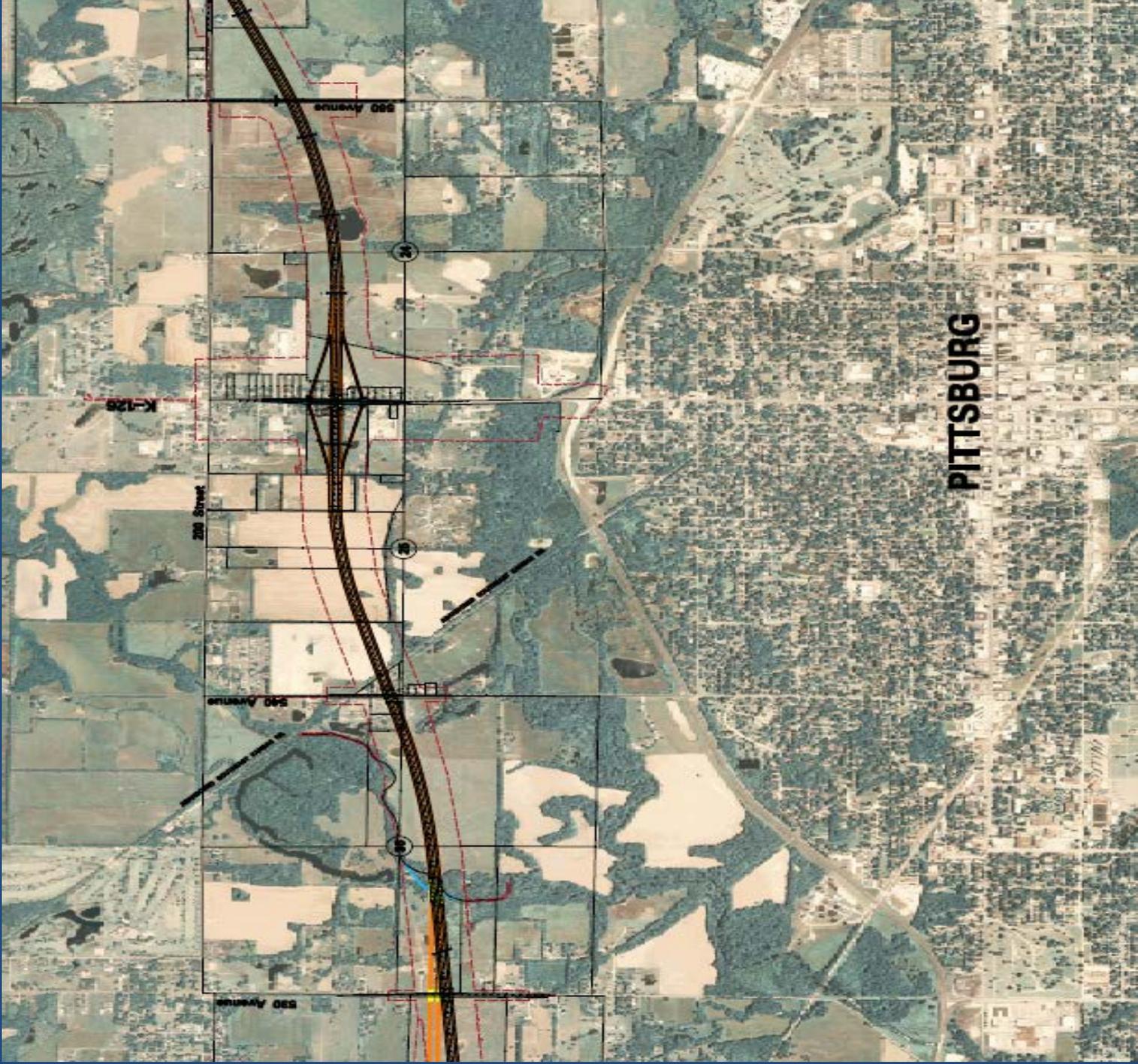
600 Avenue

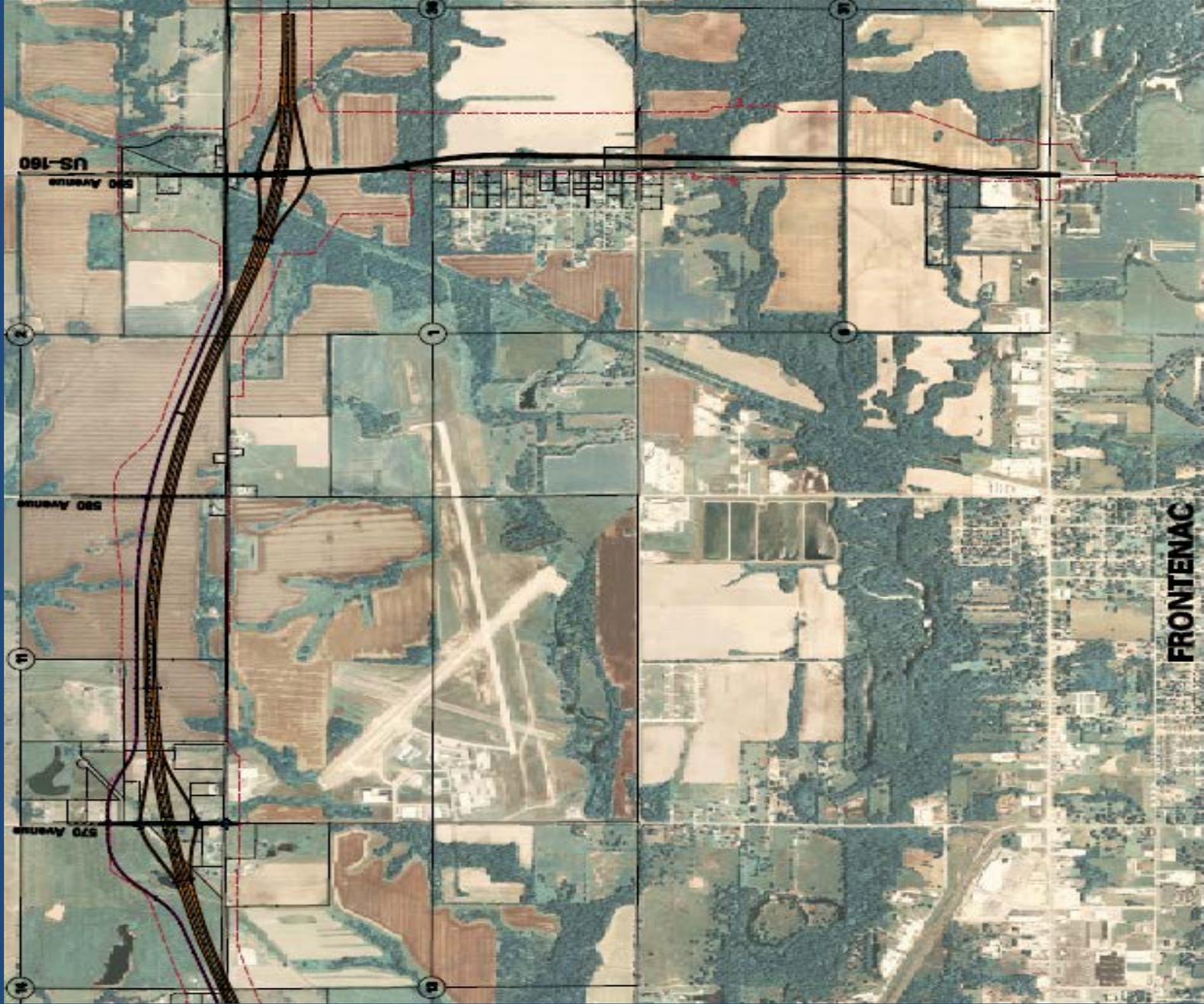
210 Street

US 400

K-171

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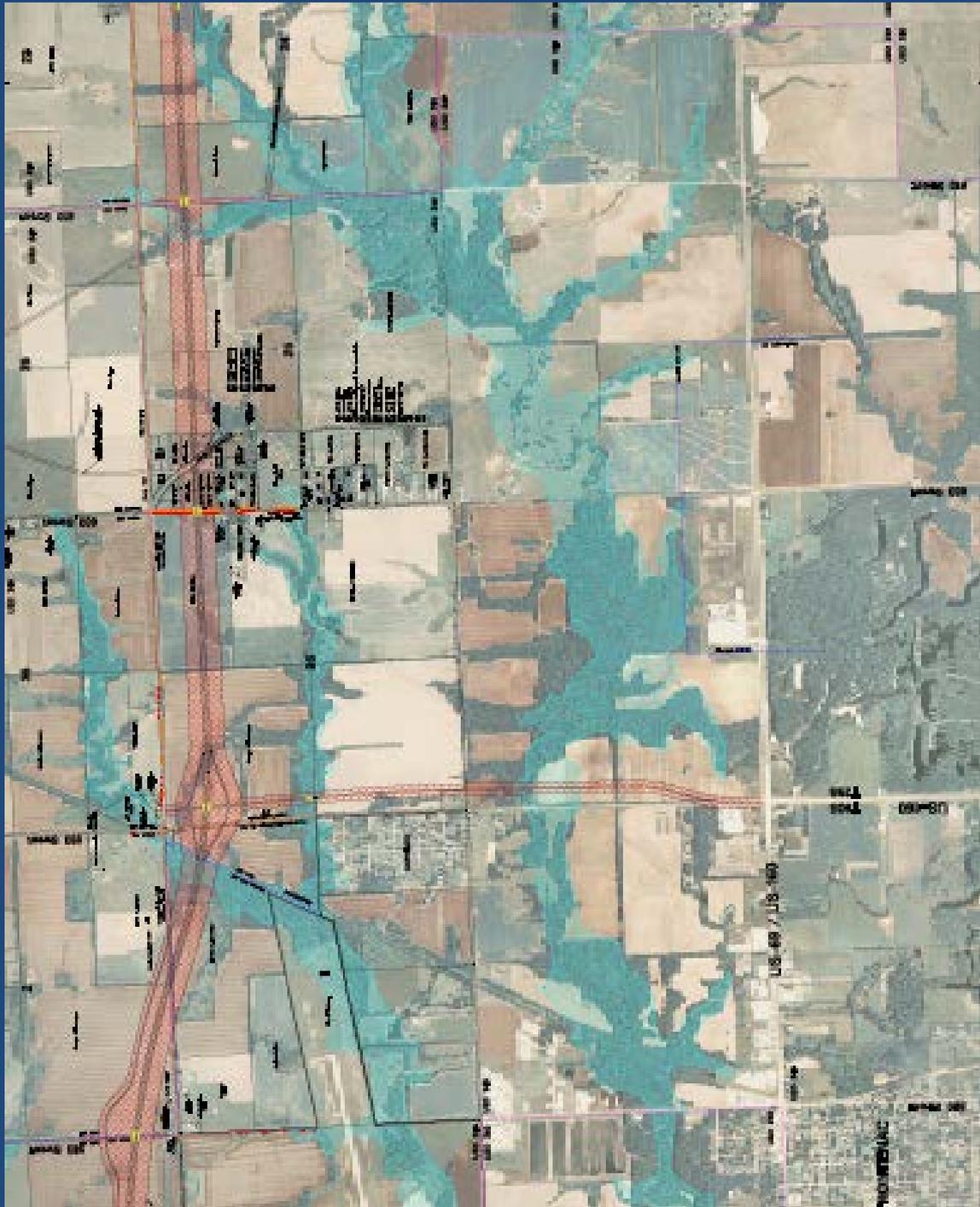


FRONTENAC

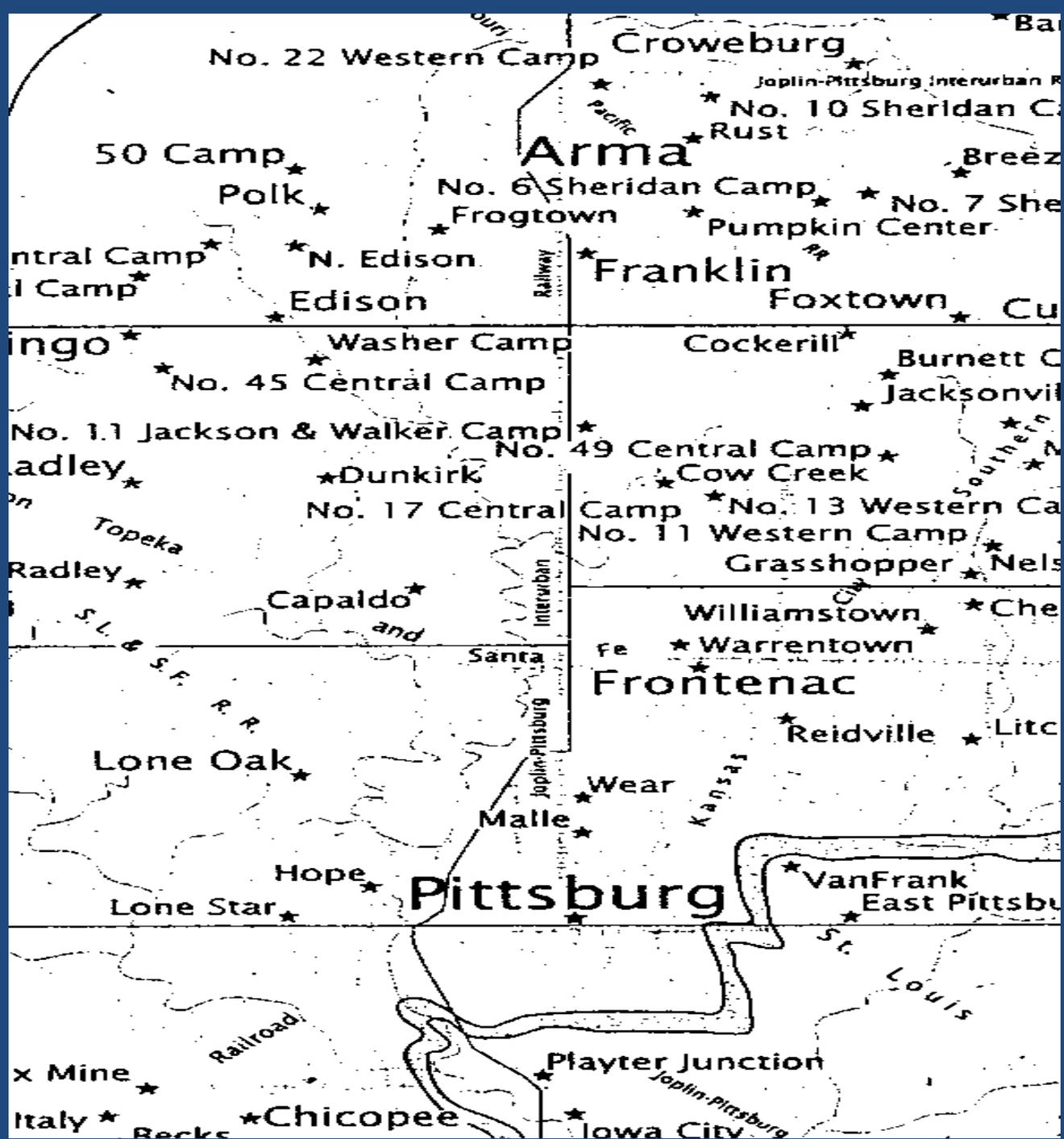
US-160
530 Avenue

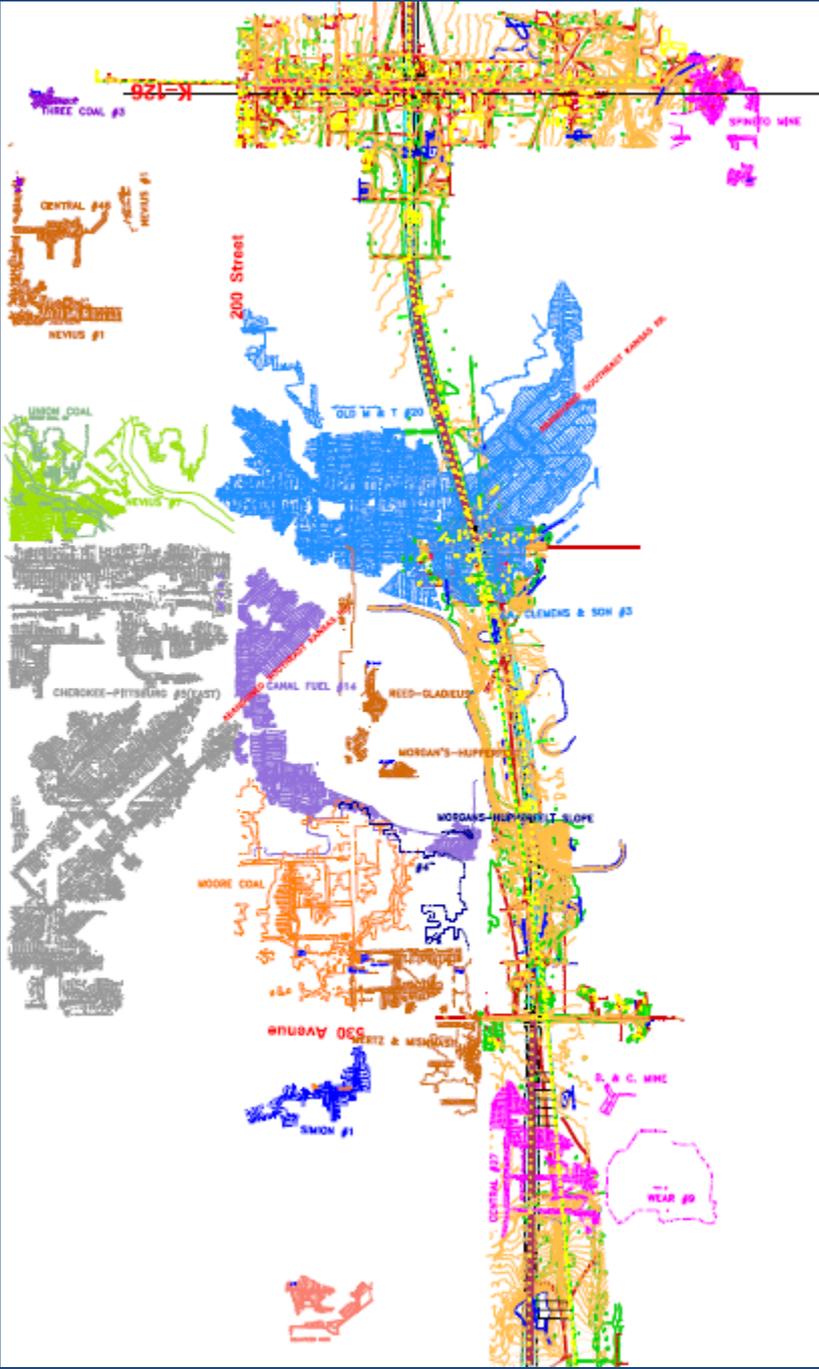
530 Avenue

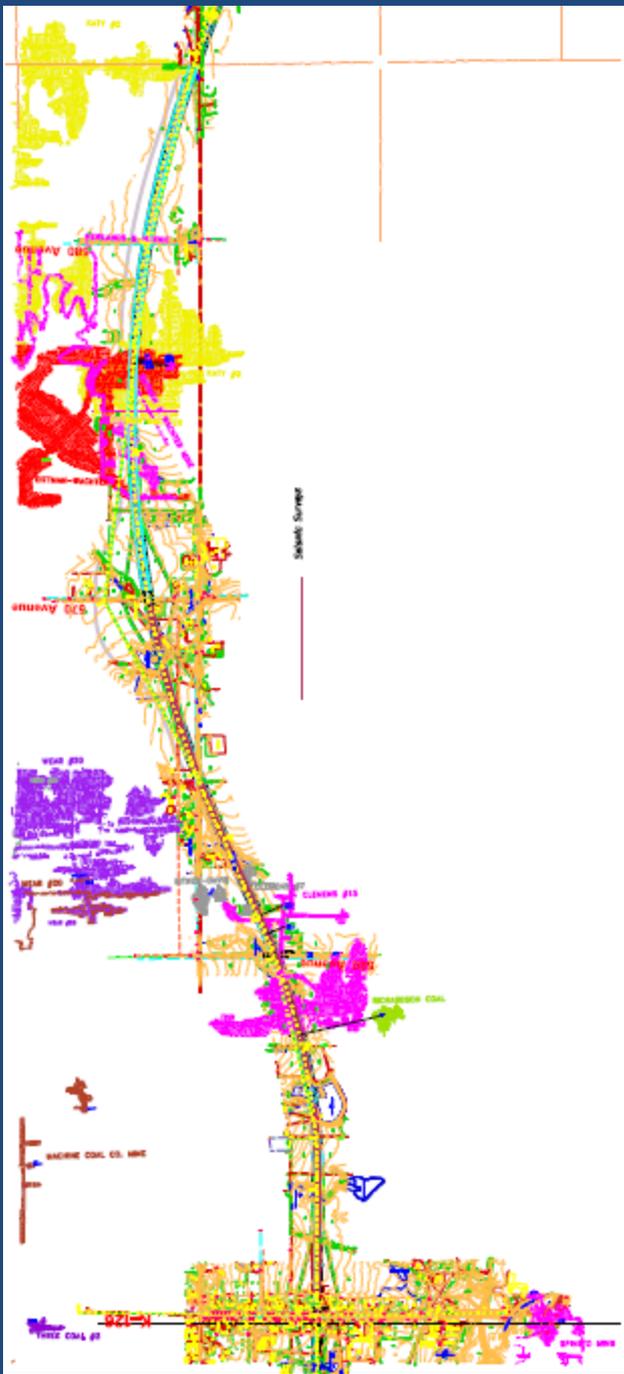
570 Avenue











KDOT Geology started their Investigation in 2009 while Surveyors were still surveying the alignment. The alignment and interchanges were moved several times partly to accommodate businesses, city officials, land owners, cultural features such as the 4-yr college - Pitt State, airport , drainage, avoiding an old city waste dump and attempts to find the best path around homes and over strip mined and undermined areas.

In the Summer of 2009 Kdot contracted with Zapata Incorporated, Blackhawk Division, to do a Geophysical Investigation in Key areas to image coal mine voids within 60 feet & help KDOT determine tops of these voids. The main focus was over a distance of 5.8 miles.

Zapata used Multichannel Analysis of surface waves (MASW, Direct current Resistivity (DC RES) and down hole sonar imaging techniques.

Over 32 borings were drilled by KDOT Personnel along select portions of the corridor in depths ranging from 21 feet to 102 feet.







Core Drillers

Burns

487-0021

GVW



1000 201-101
5/16 2.82 100
30 100 100

KDS



VOID 27¹/₂ - 29⁰ -

STA 282+00

30' LONG PIPE









Z ZAPATA ENGINEERING
TRUST • INTEGRITY • QUALITY

200

WARNING
FIRE HAZARD
DO NOT TOUCH
HOT SURFACES



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The New Pittsburgh Bypass is now scheduled to be Let in 2021.

My estimate for the cost of mine remediation over 5.8 miles of alignment including 6 deep bridge structures is over \$23 million dollars or approximately 3.9 million per mile of 4-Lane.







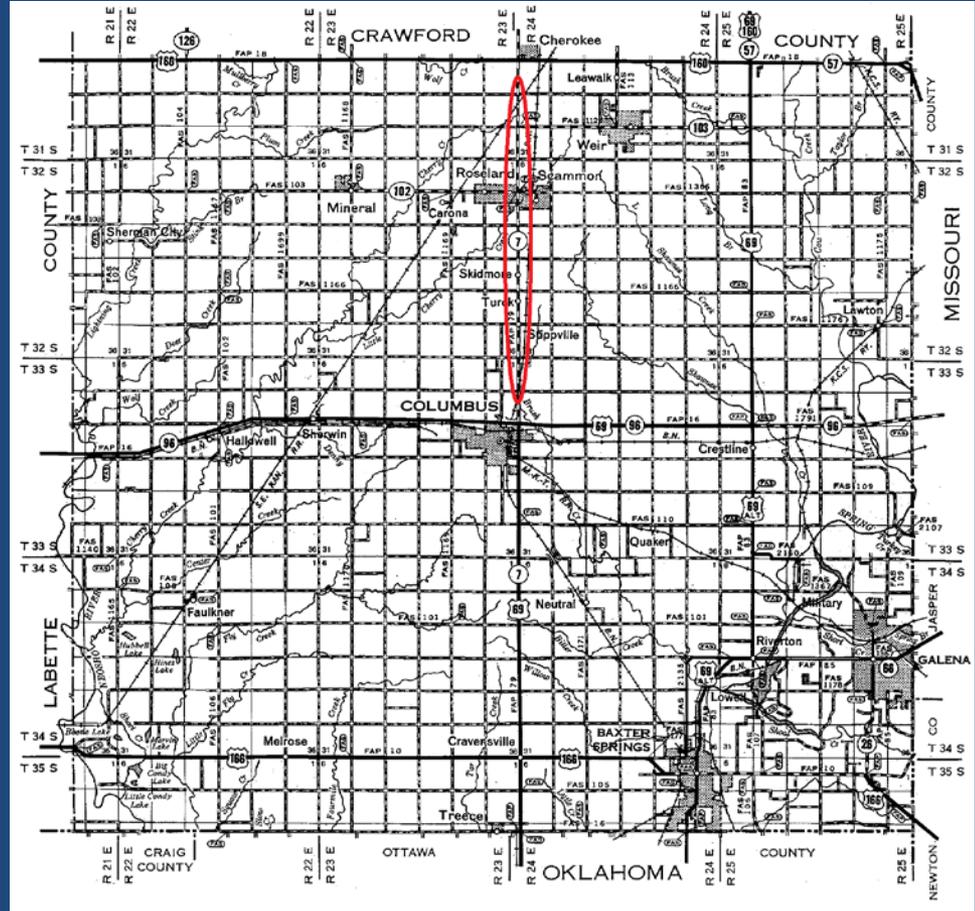




In this area, south of 530 Road, the 2-4 foot thick Weir-Pittsburg Coal bed is only 10 to 25 feet below the surface. Here we will most likely dig down through the soil and clean shale layers stockpiling this material. Then excavate to the bottom of the soft incompetent oxidized coal that is left from underground mining and expose the shafts and remove the remaining coal wasting the material off site. Then reconstruct the roadway re-compacting the saved excavated material in lifts to build up the roadway embankment. The Project north of 530 road where the coal is 30 or more feet deep will most likely be grouted as you will see we have done on K-7 Highway in the past.

The Let date at this time is projected to be year 2021. The Field work for Geology has been completed and over half of the 32 Foundation Geology Bridge Reports are complete. Finding the time to write the Reports has been a problem since Geology has worked on several other projects where deadlines were more pressing. A "Final Report" for the Surface Geology Investigation will address the remediation of the underground and strip mined areas in further detail. Suggestions for Grouting voids or excavating down to 30 feet in depth along with excavating and re-compaction of strip pits and mine dumps up to 50 feet deep along with mine water drainage will be addressed at that time.

- ❖ The proposed realignment extends north of the City of Columbus for approximately 10 miles to the Town of Cherokee at the Crawford county line.

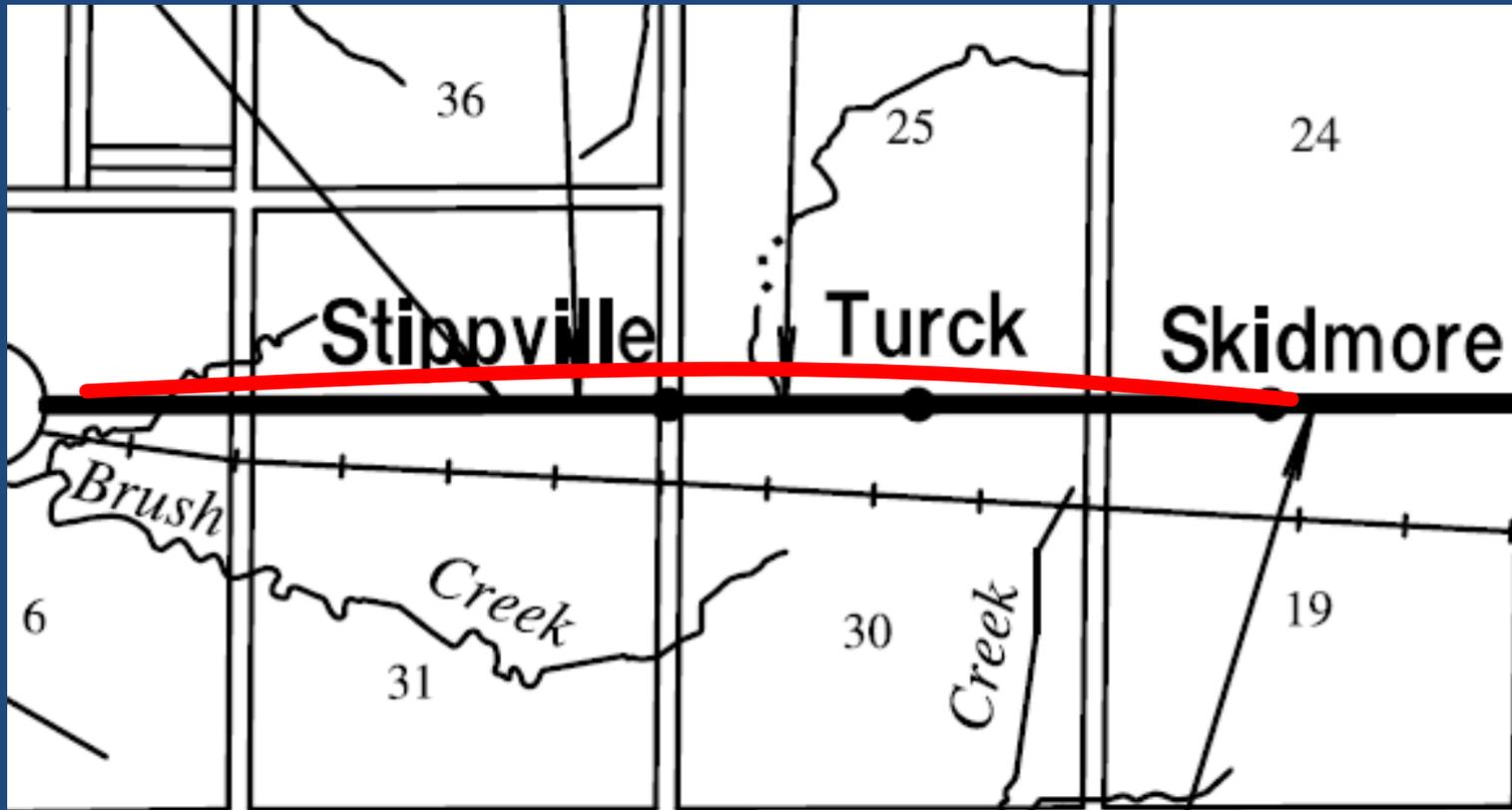


To meet increases in traffic and to improve the safety of the roadway and service to the town of Columbus, KDOT wanted to widen the road on both sides of the Highway.

However, since the highway had 4 miles that was undermined on both sides of the highway, Geology suggested widening the roadway only on one side to reduce cost of filling the voids to half as much.

This section the proposed alignment of K-7 shifts slightly to the west of the existing alignment

The realignment is from Station 195+00 to 351+00





STAR VALLEY RD











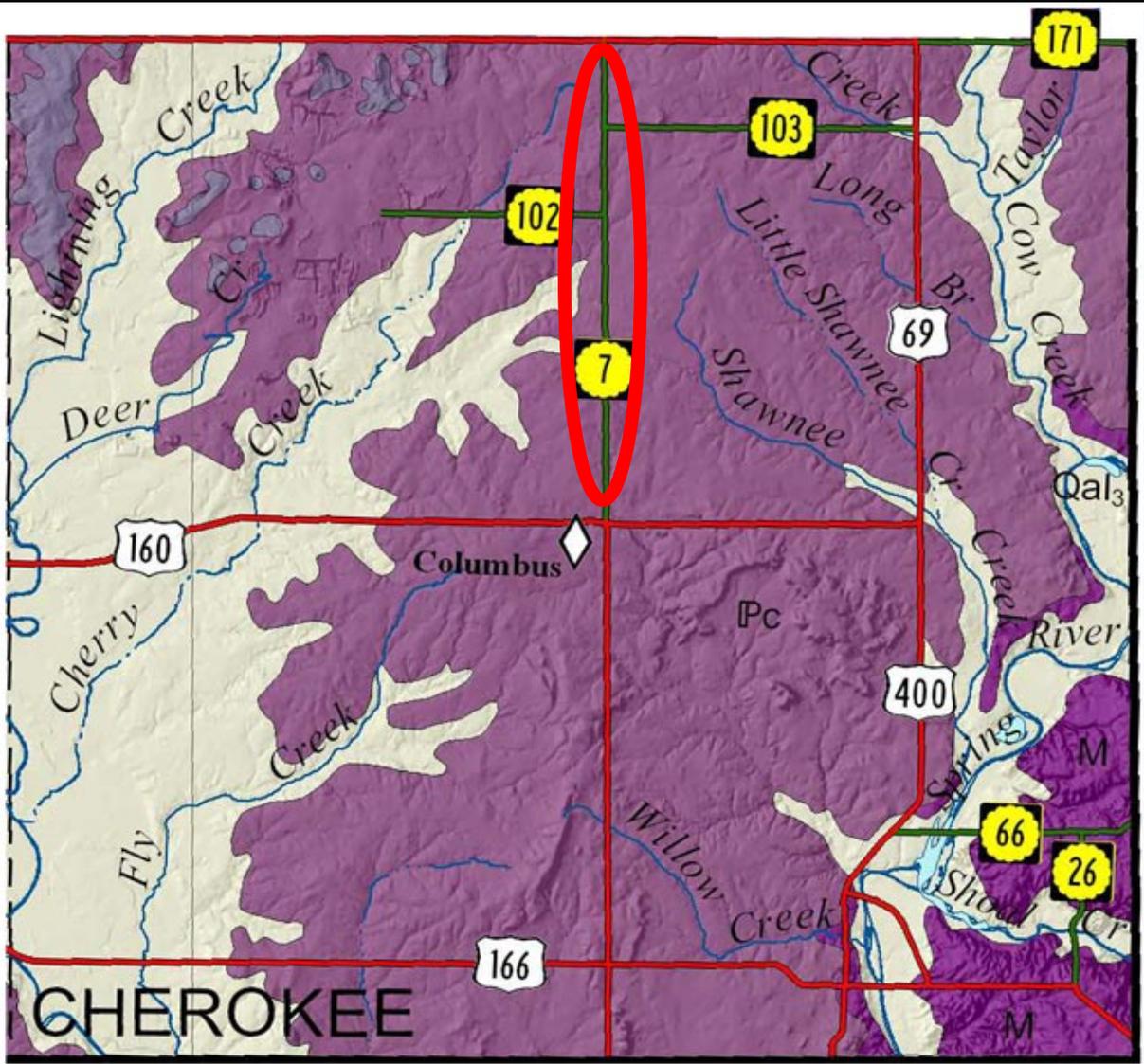








**WHEATLAND
LANDFILL**

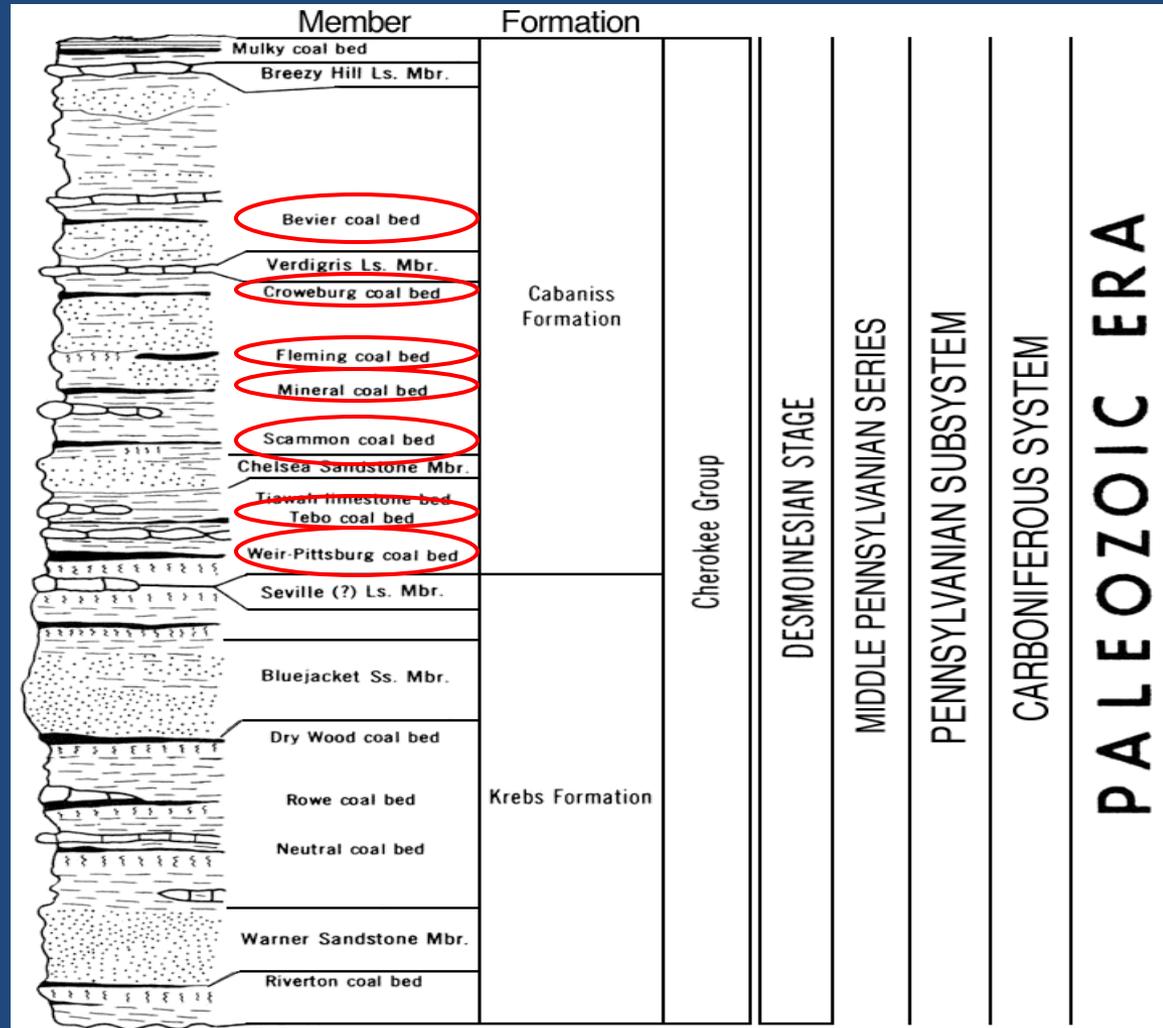


Cenozoic Era		Paleozoic Era	
Quaternary System		Permian System	
Qal3	Alluvium (late Pleist. and Holocene)	Pbd	Big Basin Fm Day Creek Dol
Qds	Dune sand	Pwn	Whitehorse Fm Nippewalla Gp
Ql	Loess	Ps	Sumner Gp
Qal2	Alluvium (early Pleistocene)	Pc	Chase Gp
Qgd	Glacial drift	Pcg	Council Grove Gp
Neogene System		Carboniferous System	
Ntd	Terrace deposits	Pennsylvanian Subsystem	
No	Ogallala Fm	IPcg	Council Grove Gp
Mesozoic Era		IPa	Admire Gp
Cretaceous System		IPw	Wabaunsee Gp
Kp	Pierre Sh	IPs	Shawnee Gp
Kn	Niobrara Clk	IPd	Douglas Gp
Kc	Carlile Sh	IPi	Lansing Gp
Kgg	Greenhorn Ls Graneros Sh	IPkc	Kansas City Gp
Kd	Dakota Fm	IPn	Placanton Gp
Kkc	Kiowa Fm Cheyenne SS	IPm	Marmaton Gp
Igneous rocks emplaced during Cretaceous		PC	Cherokee Gp
K	Kimberlite	Mississippian Subsystem	
L	Lamproite	M	Warsaw Ls Burlington Keokuk Ls
Jurassic System		JR	

❖ The Cabaniss Formation was identified across the majority of the project. This formation is predominately shale and sandstone with very little limestone.

❖ The most significant units within the “Cabaniss” are the coal beds.

❖ The Wier-Pittsburg coal bed within the Cabaniss Formation was the main coal bed being mined commercially in the area.



From the late 1890's to the 1940's Coal was extensively mined from the Wier-Pittsburg Coal Bed for the lead-zinc smelters and mainly to supply railroads . The method of mining was "room and pillar" mining. By the early 1930's most of the mining practices in the area went from underground to surface, however some underground mining continued.

Consequently after the major mining companies left, locals and small mining outfits came in and continued to mine the coal with no regulation or oversight.

The undermining of K-7 Highway was known but did not seem to be a problem until surface damage started being observed in the mid 1980's.

In 1986 K-7 began to show significant stress due to an increase in traffic and a weight restriction of 24 tons was implemented.

At this point KDOT Geology began a mine investigation to determine the condition and extent of the subsurface mines.

The complete investigation took 3.5 years to finish.

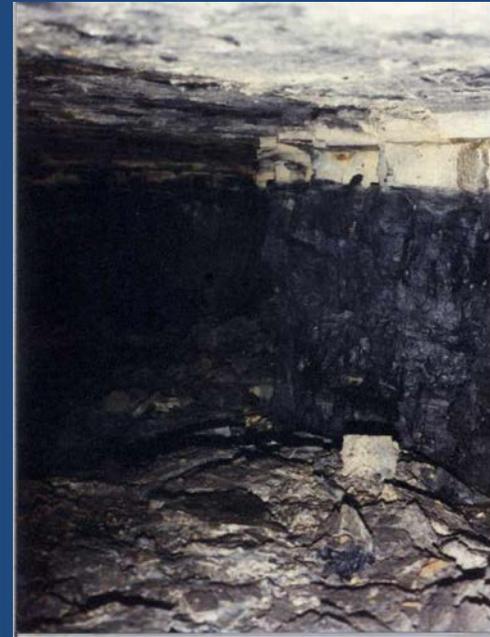
Borings along K-7 Highway were performed every 25 ft and alternated from the edge of pavement to a few feet either side of centerline.

After the initial borings were completed and the mine extent was determined larger 8" borings were done to obtain subsurface photos.

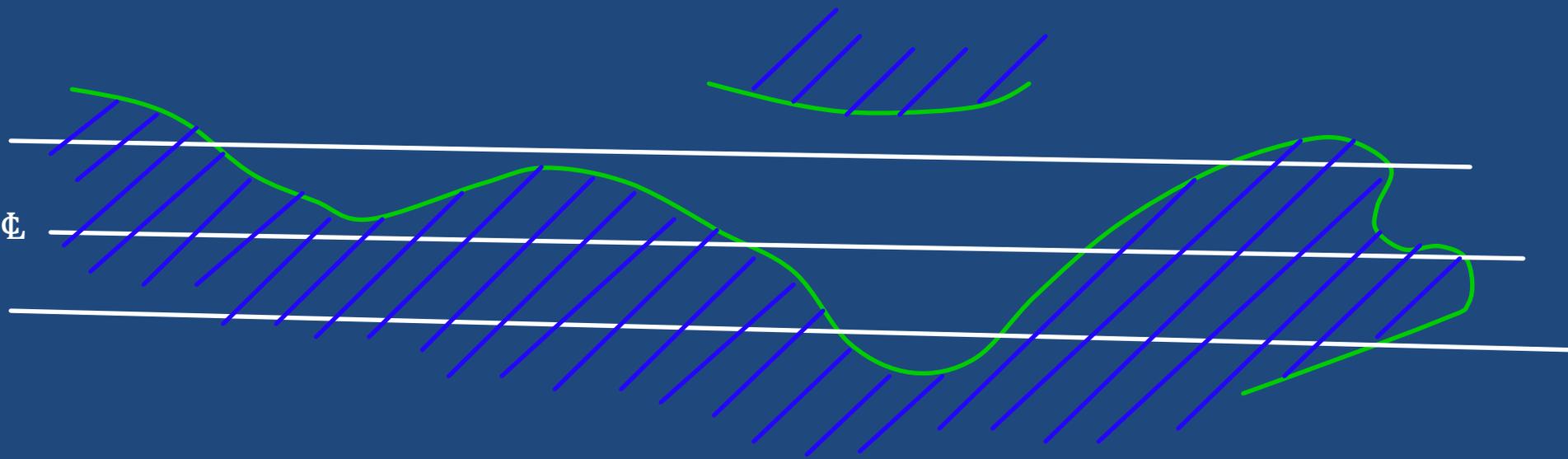




Photographs of mines under K-7 Highway



Pictures taken with a Nikon 2002
35mm camera



☺

10'

The remediation began in May 1991.

The methods that were determined to be the best overall fix were:

- Building grout columns using low-slump concrete
- Construct barrier walls and fill interior void with high-slump flowable grout

980

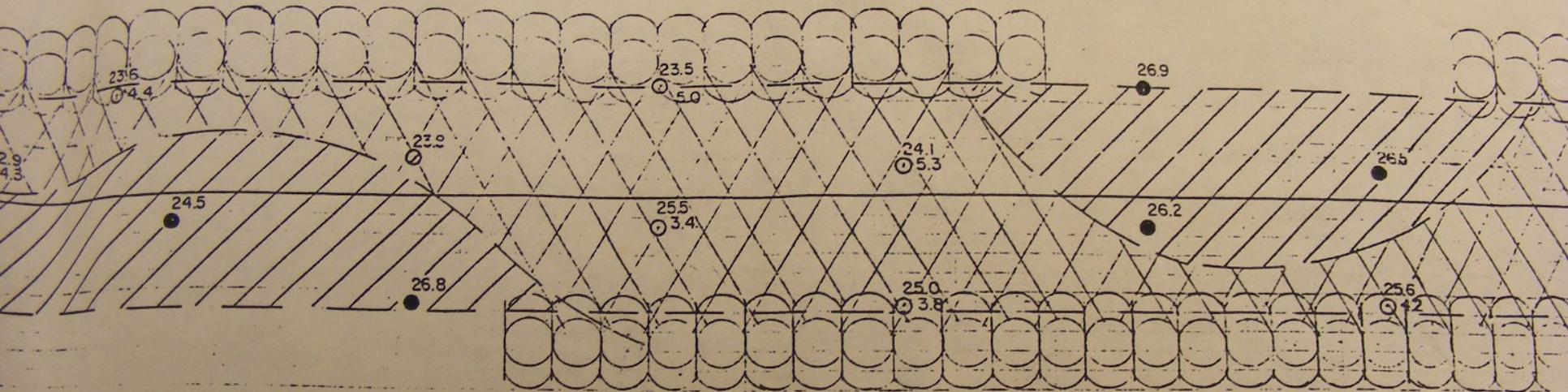
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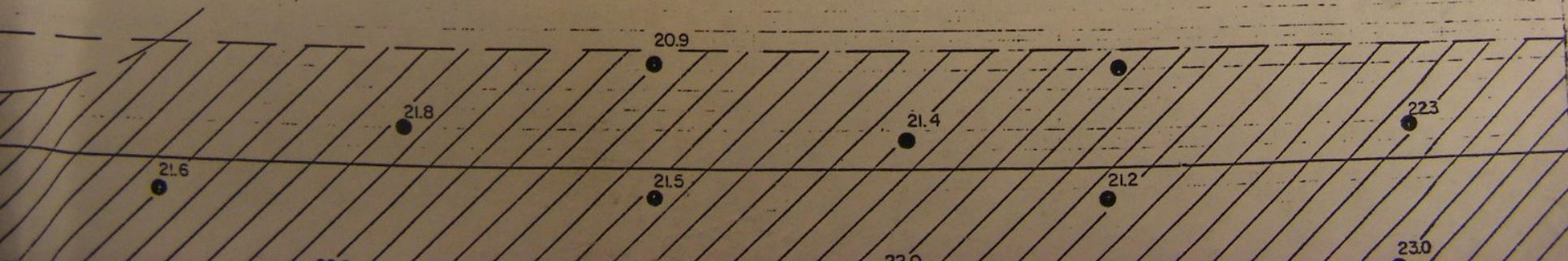
FL 11

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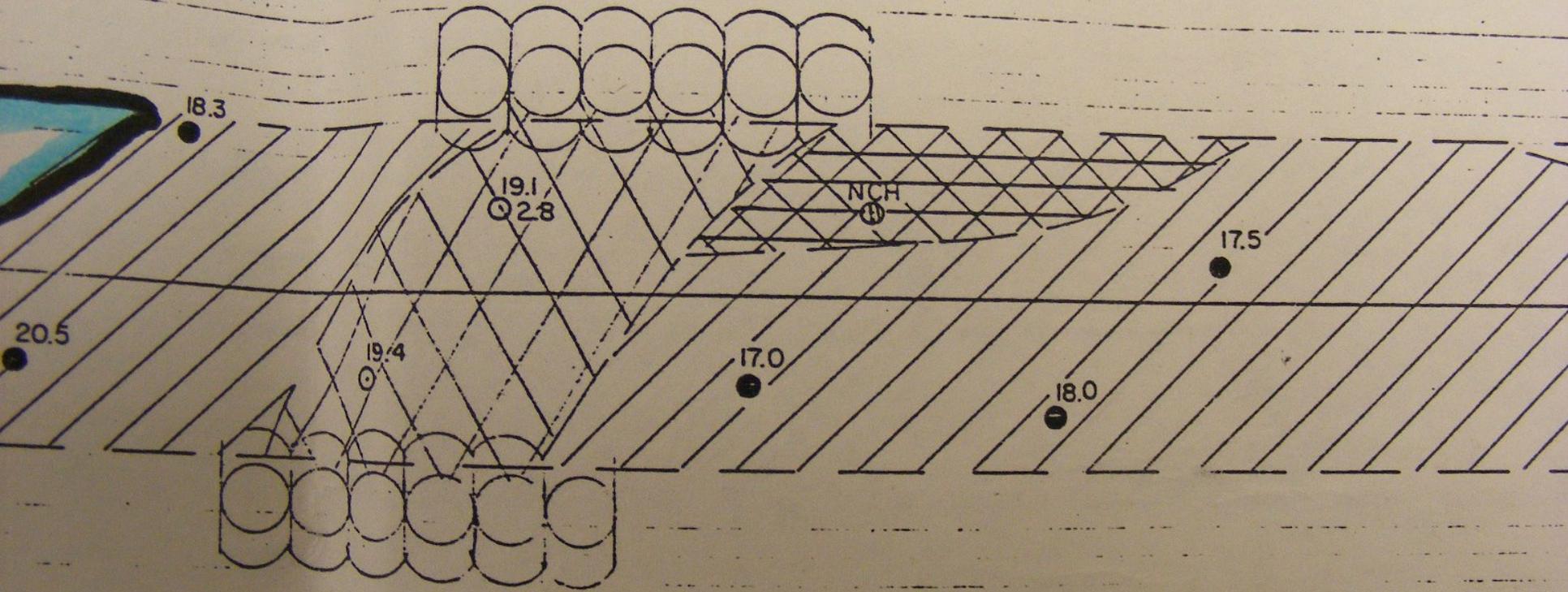
STA. 220+00 --- STA. 223+00

0 40 221+50 60 70 80 90 222+00 10 20 30 40 222+50 60 70 80 90



STA. 198+00 --- STA. 201+00

20 30 40 199+50 60 70 80 90 200+00 10 20



STA. 195+00 --- STA. 198+00

20 30 40 196+50 60 70 80 90 197+00 10 20

Low strength Grout design:

7 Sacks of sand

2 Sacks fly ash

1 Sack of cement

Compressive strengths for the Barrier Wall Mix.

7 Day - 1,490 psi

14 Day - 2,019 psi

The construction of the barrier walls and interior void fill with high-slump flowable grout was done in areas where there was extensive mine deterioration, and where water was observed in the mine.

The water observed in these locations was anywhere from a few inches deep to completely filling the mine.

The barrier walls were poured on 5 ft center using the same method as the grout columns.

The barriers were poured along the outside edge of both lanes of K-7

The high-slump flowable grout was placed under the pavement between the barrier walls and spaced every 10'

The grout holes alternated between both lanes of K-7 Highway

The grout had a slump of 8"-10"

Grout was pumped until pressure reached a predetermined pressure or until grout came up adjoining injection hole

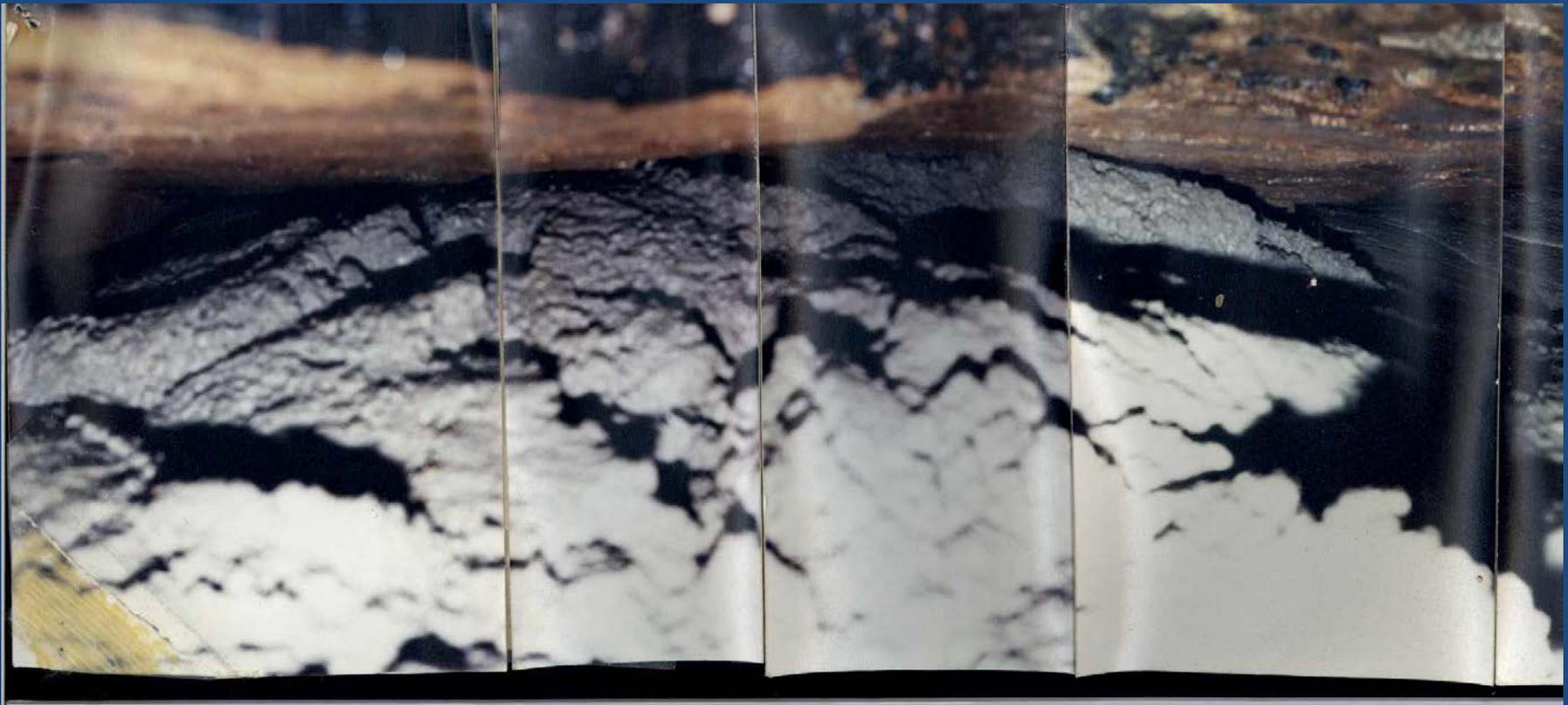




DEC 3 2004



- Past remediation's; successes and failures
 - The remediation's that KDOT implemented in the 1990's has proven affective for the short and long term.



The cost of the remediation that took place in 1991 alone is estimated to be over \$3 million.

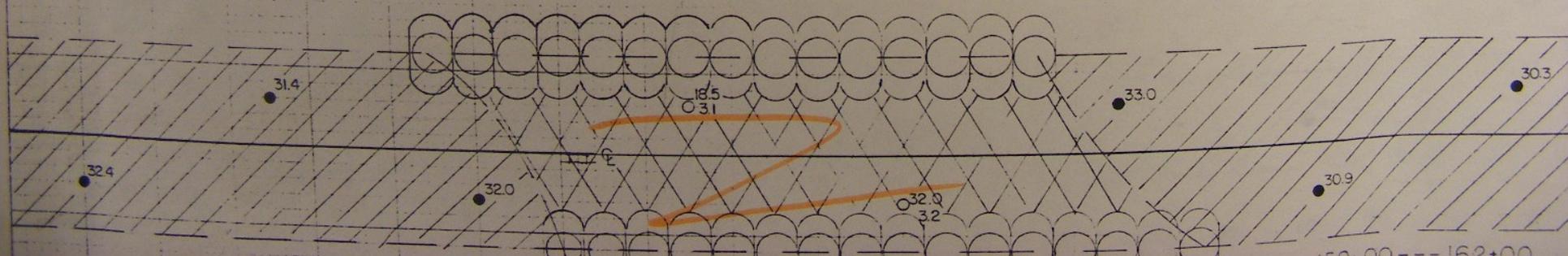
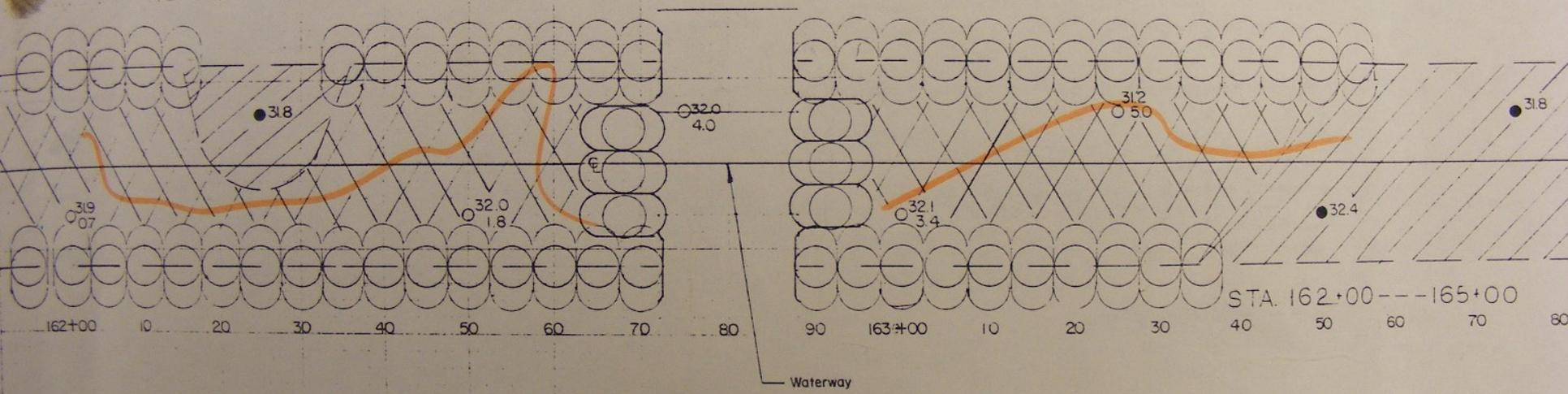
The bulk of the cost was from the drilling and grouting.

The cost of the remediation average \$12.50 per square foot of roadway



Chord

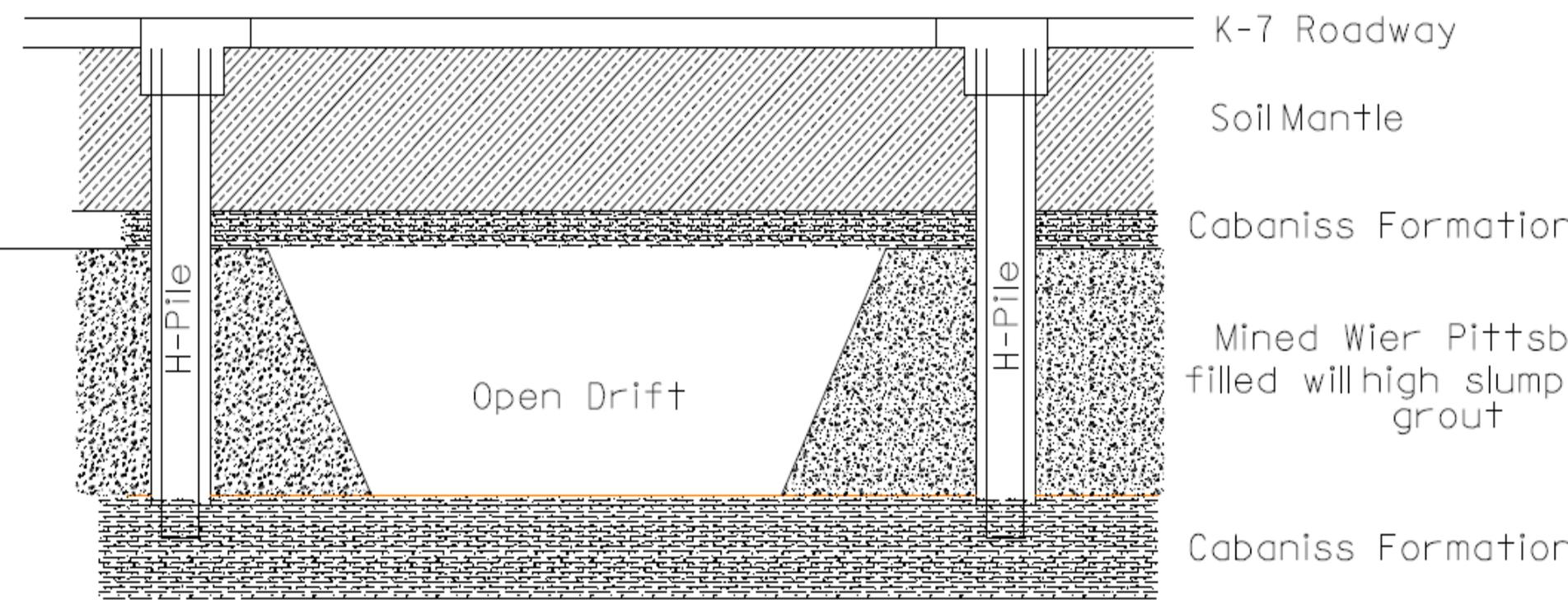
PLAN VIEW











K-7 Roadway

Soil Mantle

Cabaniss Formation

Mined Wier Pittsbu
filled with high slump
grout

Cabaniss Formation

H-Pile

H-Pile

Open Drift

Waterways were required by Kansas Surface Mining Section to allow underground streams that would potentially flood some fields upstream if the streams were blocked.

The “Slab” Bridges will be widened roughly 22 feet to one side of the existing Slab Bridges

The estimated cost for the remediation of the subsurface mines for the widening alone will be approximately \$1.7 million per mile.

There is approximately 4 miles of the K-7 realignment that is possibly undermined



↑ COL
← SC
WEST MINER

7

↑

102

→

COLUMBUS 7

Black and yellow chevron sign

Black and yellow chevron sign







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MUSEUM
AND
VISITOR CENTER







P&M

BRUTUS

MINE 12

