

**1999 Archeological Geophysical Survey Tests  
at Monroe School  
Brown v. Board of Education National Historic Site,  
Topeka, Kansas**



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By  
Robert K. Nickel  
and  
William J. Hunt, Jr.

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This report has been reviewed against the criteria contained in 43CFR Part 7, Subpart A, Section 7.18 (a) (1) and, upon recommendation of the Midwest Regional Office and the Midwest Archeological Center, has been classified as

*Available*

Making the report available meets the criteria of 43CFR Part 7, Subpart A, Section 7.18 (a) (1).



## **Abstract**

In 1999, the Midwest Archeological Center undertook historical research and geophysical survey at Monroe School, Brown v. Board of Education National Historic Site, Topeka, Kansas. Monroe was a segregated school within a historic African American community. It was the focus of a 1951 lawsuit against the Topeka Board of Education to end public school segregation. The suit played an important role in the Supreme Court's 1954 ruling that separate educational facilities are inherently unequal and violate the 14th Amendment to the United States Constitution, which guarantees all citizens equal protection of the laws.

The school and grounds will see major renovation to become an interpretive and resource center and to create office space for National Park Service administrators. Historic research identified at least 18 buildings that stood on the current school grounds between 1889 and 1926. There is no surface evidence for these structures today. Geophysical survey used a fluxgate magnetometer, a resistivity meter, and ground-penetrating radar to determine whether structural remnants are likely to exist, where they occur, and (in some cases) make tentative identifications of the resource.

The survey confirmed the presence of many buried cultural features around Monroe School. Some features correlate with remnants of historic structures, although most appear to represent smaller undocumented cultural features. Anomaly concentrations and patterns conform with known property boundaries and probably reflect variations in owners' use activities. The survey information can help guide development planning and archeological investigations during renovation.

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## Introduction

During the week of June 28 through July 2, 1999, a team of archeologists from the Midwest Archeological Center (MWAC), with the assistance of members of the park staff, conducted exploratory geophysical mapping around the Monroe School at Brown v. Board of Education National Historic Site (BRVB), Topeka, Kansas (Figure 1). The purpose of the work was to assess the suitability of geophysical instruments for detecting the physical remains of structures that were previously located in the area of the present Monroe School building. The photographs, field records, and magnetic media resulting from this project are curated at the Midwest Archeological Center as Accession MWAC-853/BRVB-2. In 2000, several of the anomalies identified during this geophysical survey work were investigated through test excavations and are separately reported (Stadler 2002).

Monroe was a segregated school attended by the daughter of Oliver Brown, the lead plaintiff in a lawsuit aimed at ending segregation in public schools filed in 1951 against the Topeka Board of Education. This case was eventually taken to the United States Supreme Court, which unanimously declared on May 17, 1954, that “separate educational facilities are inherently unequal” and, as such, violate the 14th Amendment to the United States Constitution, which guarantees all citizens “equal protection of the laws.” Upon completion of a major renovation effort, Monroe School will be open to the public as an interpretive and resource center for information about *Brown v. Board of Education of Topeka* and its role in the civil rights movement. Renovation will also create office space for park administrators, allowing them to move from a remote site at the U.S. Federal Post Office Building in downtown Topeka. The school was designated a national historic landmark in 1987.

A brief history of the Monroe School block is presented in the Cultural Landscape Inventory for the park (National Park Service 1995:7–8). The property was originally part of a 160-acre homestead purchased in 1856 by John Ritchie from one of Topeka’s founders. Ritchie farmed part of this ground, but by the mid-1860s he had become an active land speculator subdividing what became known as the “Ritchie Tract” or “Ritchie Addition” into 75- and 150-ft-wide lots. A staunch abolitionist, Ritchie favored sale to African Americans and, by the mid-1880s, the tract was largely occupied by that ethnic group. In 1888, a year after his death, Ritchie’s land was incorporated into Topeka. Streets were laid out at this time, with blocks split by 20-ft-wide alleys running north-south. Ritchie’s 75-ft-wide lots were subdivided again, this time into lots 25 ft wide and 150 ft deep.

The arrangement of the structures occupying the Monroe School lot through time is important for a tentative interpretation of anomalies identified during the geophysical survey. Unfortunately, the history of Monroe School prior to the construction of the present school building is poorly understood at present. Apparently, Lots 50, 52, and 54 on Monroe Street were purchased in 1868 for a school building, but nothing was constructed immediately. In the meantime, a building on Lot 51 was rented and used as an elementary school (National Park Service 1995:8). A new school may have been constructed in 1874 at the intersection of 15th and Monroe Streets. In any event, by 1889 the school that immediately preceded the present Monroe School had been constructed on lots that were then identified as 505, 507, 509.

A visit to the Kansas State Historical Society provided little additional information about the school and its physical surroundings. A search of the card catalogs for the library, manuscripts, and photographs provided no information for Monroe School and its surrounding community. Although all 19th-century and early-20th-century maps of Topeka were examined, the only detailed information on the school block was found among the Sanborn insurance maps on microfilm. The earliest available Sanborn maps for Topeka did not include the Monroe School block prior to 1889. The 1883 map book shows the Monroe School area as platted but provides no structural information (Sanborn Map and Publishing Co. 1883:Sheet 13). The 1885 publication does not provide any information for the Monroe School area (Sanborn Map and Publishing Co. 1885).

Later Sanborn maps, however, do provide information about the school and the immediately surrounding community at four times—1889 (Sanborn Perris Map Co. Ltd. 1889:Sheet 14), 1896 (Sanborn

Perris Map Co. Ltd. 1896:Sheet 34), 1913 (Sanborn Perris Map Co. 1913:Sheet 82), and 1945 (Sanborn Perris Map Co. 1945:Sheet 82). A Sanborn map earlier than the 1945 map and postdating the 1913 map is referenced on the 1945 document but is not available at the Kansas State Historical Society. These documents essentially serve as “temporal snapshots” of the Monroe School block and portions of that block prior to the construction of the present Monroe School building in 1926. The lots illustrated on the Sanborn maps reflect the subdivision of the original Ritchie Tract into six smaller lots 25 ft wide and 150 ft deep divided by a north-south alley. The Sanborn map for 1945 shows the current Monroe School and surrounding playground occupying the greater portion of the block east of the alley from Lot 505 through Lot 529. It is the development of these lots and their cultural features that we are concerned with when interpreting the geophysical survey data.

Together, the Sanborn maps indicate that a total of 18 buildings existed on the immediate school property west of Monroe Street between 1889 and 1913 (Table 1). These should be considered a minimum number of structures because the maps for 1889 and 1896 do not show areas south of Lots 515 where additional structures may have once stood. In 1889, the area now encompassing the 1926 Monroe School and grounds included at least eight structures (Figure 2): Monroe School (Structure 1), three school outbuildings (Structures 2–4), a frame dwelling (Structure 5), an associated structure that may have been a horse barn (Structure 6), a brick dwelling (Structure 7), and its outbuilding (Structure 8). Lot 515 appears on the 1889 Sanborn map but has nothing built on it.

By 1896, there were nine structures on the same lots (Figure 3). These include the school (Structure 1) and two of the dwellings (Structures 5 and 7) shown on the 1889 map. The outbuildings for these structures appear to have been replaced, as suggested by changes in dimension. Structures 9–11 are larger outbuildings for the school. The “barn” of 1889 in Lot 511 had been replaced with a smaller outbuilding (Structure 12). The single small outbuilding at the rear of Lot 513 in 1889 had been replaced by a larger outbuilding (Structure 13) and another (Structure 14) that abuts the latter’s south wall. Lot 515 appears to remain empty.

The 1913 Sanborn map provides considerably more information about the early Monroe School and its immediate environs (Figure 4). All lots occupied by the current Monroe School and its playgrounds are illustrated. The school itself had been enlarged considerably with an approximately 30-ft (east-west) by 54-ft addition attached to the older building at its southeast corner. The map suggests that all of the school’s outbuildings had been removed by this time. The frame dwelling (Structure 5) in the lot immediately south of the school was still in place, as was its outbuilding (Structure 12). The small brick house (Structure 7) and its outbuildings (Structures 13 and 14) had apparently been razed. The 1913 map provides the first information for Lots 517 through 529. Lots 515, 517, 519 and 527 remain empty, but a frame dwelling (Structure 15) and its outbuilding (Structure 16) occupy Lots 521 and 523. An L-shaped brick dwelling (Structure 17) occupies Lot 525, while a small frame dwelling (Structure 18) occupies Lot 529.

The modern school’s position on the same lots is shown in Figure 5. Curiously, at the Kansas State Historical Society and at BRVB headquarters there are no photographs of Monroe School prior to the present building’s construction in 1926. There are two photographs in the collections at BRVB, class pictures taken in front of the Monroe School, that provide some small amount of information about the structure. Although only a small portion of the building is shown, it is enough to demonstrate that it was founded on stone and had a brick superstructure that began about six feet above the ground surface. Two large windows at ground level behind the children and their teachers indicate a probable basement.

The Sanborn maps, in short, indicate that 18 structures once existed on the property occupied by the current school building. There remains no surface evidence for any of these structures today. Therefore, non-destructive geophysical survey methods were used to assess Monroe School’s buried cultural resources with the goal of identifying these and other cultural remnants of the former Monroe School community. In other words, the survey was directed toward determining whether such resources are likely to exist, where they occur, and (in some cases) making tentative identifications of the resource.

Table 1. Former historic structures and their locations as determined from 1889, 1896, 1913 Sanborn maps.

Structure Number	Structure Name	Function	Year(s)	Lot(s)	Feet E-W	Feet N-S	Distance to 15th St. (ft)	Distance to Monroe St. (ft)
1	Monroe School <sup>1</sup>	school	1889, 1896	505, 507, 509	40	68	3	38
1	Monroe School	school	1913	505, 507, 509	70	68	3	38
2	Outbuilding A	school storage shed or privy	1889	505	6	16	5	144
3	Outbuilding B	school storage shed or privy	1889	505, 507	6	12	21	144
4	Outbuilding C	school storage shed or privy	1889	507	6	12	33	144
5	Frame Building A	dwelling	1889, 1896, 1913	511	46	15	82	16
6	Outbuilding D	barn (?)	1889	511	12	24	75	138
7	Brick Building A <sup>2</sup>	dwelling	1889, 1896	513	15	15	110	16
8	Outbuilding E	storage shed or privy	1889	513	10	8	302	140
9	Outbuilding F	school storage shed or privy	1896	505	10	15	5	135
10	Outbuilding G	school storage shed or privy	1896	505, 507	8	14	20	142
11	Outbuilding H	school storage shed or privy	1896	507	8	14	38	142
12	Outbuilding I	storage shed	1896, 1913	511	12	18	75	138
13	Outbuilding J	storage shed	1896	513	14	14	103	136
14	Outbuilding K <sup>3</sup>	storage shed or privy	1896	513	8	6	117	142
15	Frame Building B <sup>4</sup>	dwelling	1913	521, 523	34	28	222	16
16	Outbuilding L	storage shed or privy	1913	523	8	16	205	142
17	Brick Building B <sup>5</sup>	dwelling	1913	525, 527	30	22	253	16
18	Frame Building C	dwelling	1913	529	24	14	303	30

<sup>1</sup> According to the 1896 Sanborn map, the school's southern wall was about 12 ft from the north wall of Structure 5. An addition to the west (rear) side of the school after 1896 but before 1913 expanded the school's size considerably. Two sets of fire escape stairs were also added to the south side of the structure.

<sup>2</sup> According to the 1896 Sanborn map, Structure 7's north wall was about 13 ft from the south wall of Structure 5. Although this building originally had no porch, a 5-ft-wide porch had been added to the front of this building by 1896.

<sup>3</sup> Structure 14 abutted the south wall of Structure 13.

<sup>4</sup> Structure 15 was Z-shaped in plan view and had a full-width, 5-ft-deep porch on the front.

<sup>5</sup> Structure 17 was an L-shaped building with a 12-ft-long by 5-ft-deep porch centered on its front.

Table 2. Organization of data files from the 1999 geophysical survey at Brown v. Board of Education NHS.

Survey Area	Traverse Direction / Direction of Next Traverse	Instrument	Date	File ID	Format
A	West-East / North	Noggin 500	6/30	Buffers 1–17	Spiview
A	West-East / East	RM 15	6/30	Mon2X6	Geoplot
B	West-East / North	Noggin 500	6/30	Buffers 17–22	Spiview
B	West-East / East	RM 15	6/30	Mon2X7	Geoplot
C	West-East / North	Noggin 500	7/01	Buffers 1–20	Spiview
C	South-North / East	FM 36	7/01	BLK3	Geoplot
C	South-North / West	Noggin	7/01	Buffers 53–69	Spiview
D	North-South / West	Noggin 500	7/01	Buffers 21–27	Spiview
E	North-South / West	Noggin 500	7/01	Buffers 27–33	Spiview
F	North-South / West	Noggin 500	7/01	Buffers 33–39	Spiview
G	East-West / South	Noggin 500	7/01	Buffers 40–49	Spiview
G	Speed Test E-W	Noggin 500	7/01	Buffers 50–52	Spiview
G	Lift Test, Stationary	Noggin 500	7/01	Buffers 52–53	Spiview
H	South-North / East	RM 15	6/30	Mon2X1	Geoplot
H	South-North / East	FM 36	6/30	BLK1	Geoplot
I	South-North / East	RM 15	6/30	Mon2X2	Geoplot
I	South-North / East	FM 36	6/30	BLK2	Geoplot
J	South-North / East	RM 15	6/30	Mon2X3	Geoplot
K	South-North / East	RM 15	6/30	Mon2X4	Geoplot
L	South-North / East	RM 15	6/30	Mon2X5	Geoplot

*Notes:*

Geoplot files of raw field data for a single survey grid consist of three files with a user-assigned file name and extensions of dat, grd, and grs. These files can be read by Geoplot and merged and manipulated in various forms as grids and composites. The latter may be exported as X, Y, Z files suitable for manipulation by other programs such as Surfer.

Spiview files of raw field data are stored in a sequence of files with the name spiN.pcx, where N is a continuous sequence of numbers from 1 to N. Each pcx file holds one screen of radar data. These files can be viewed and printed by many “office automation” packages.

## Tools and Methods

### *Instrument Properties and Survey Plan*

The choice of which instrument to use in which area was based on a series of assumptions, some of which proved to be valid and some of which did not. The soil resistance meter, a Geoscan RM 15, was selected because it is not much affected by proximity to buildings and utilities and because it can often detect brick and stone footings buried in soil. Based on earlier work by Hunt, the remnants of earlier buildings were expected to be relatively shallow, and the stratigraphic column was expected to include soils with significant clay content. This circumstance should result in masonry footings (high resistance) being easy to detect in soils with expected low resistance.

The ground-penetrating radar (GPR) unit was a Noggin 500 that operates with a center frequency of 500 MHz and is controlled by a laptop computer. The choice of frequency in GPR studies always involves a trade-off between depth of penetration and resolution. Higher-frequency units resolve smaller targets but penetrate soils only to a relatively shallow depth. By selecting a lower-frequency system, one can obtain useful reflections from a greater depth, but the units will not necessarily resolve smaller objects or soil discontinuities. The 500-MHz unit that Nickel selected was expected to provide good resolution and depth penetration of a meter or more. High clay content soils and heavy precipitation just before the survey limited the effective depth to about 50 cm in many areas, although we realized better performance in some areas covered by pavement and in areas with apparent fill of a less clayey nature.

The magnetometer used at Monroe School was a Geoscan FM36 Fluxgate Gradiometer. Magnetometers are typically affected greatly by large amounts of iron and also by the fluctuating magnetic fields that surround AC electrical lines. It was expected that the iron and electrical lines in the school building, as well as in steel fencing, motor vehicles, and other magnetic noise, would greatly limit the utility of the magnetometer. While it is possible to use models to predict the effects of relatively simple sources of magnetic interference, the complex geometry and potential time-transient nature of some sources of noise around the Monroe School made it impractical to predict the level of success. As it developed, the magnetic survey south of the school produced interesting data with apparent archeological patterns, while the area located grid north of the school was dominated by a very strong gradient and does not seem to contain archeologically useful information.

The type of soil resistance meter used at BRVB depends upon making good electrical contact between metal probes and the earth. At Monroe School, the Geoscan RM 15 was used in the “twin array” mode in which only two of the four probes need to be moved about over the survey area. In the twin configuration, the second pair of probes is placed some distance outside the actual survey area and they remain fixed during data collection. It is possible to operate the Geoscan RM 15 over pavement by using small wicks moistened with a salt solution in order to make the necessary electrical contact with pavement. We were prepared to attempt this if the radar proved unsuccessful at penetrating the hard-surfaced areas around the school. As it turned out, the best radar data were from the concrete and asphalt zones, so we restricted our use of the soil resistance meter to the grassy areas where it could be operated normally. Heavy rain (3–4 inches, 7–10 cm) at the start of the survey probably reduced the electrical resistance contrast of some archeological features. The resulting geophysical data files and their organization are described in Table 2.

### *Survey Areas and Sequence of Instrument Use*

A series of geophysical survey units were established on the basis of modern developed features, i.e., the school, sidewalks, fences, and the alley. Field notes by Hunt (1999) document the relationships and dimensions of the initial survey units, A through G. Figure 6 illustrates the relationship of these first seven survey units and also the placement of the last survey units, H through L. The 1999 geophysical survey strategy was to explore the area north of the school as portions of two 20-meter-square grids consisting of the survey areas designated A, B, and C. Ground-penetrating radar was the first instrument em-

ployed in this area by Hunt, while Nickel subsequently surveyed the eastern grassy area (Grid A) with a soil resistance meter as Hunt moved the GPR survey to Grids B and C.

Except for an elevated, 2-meter-wide grass/shrub border, the area east of the school consisted of concrete from the public sidewalk west to the front of Monroe School. Only GPR was used in the area east of the school (D, E, and F), and it was confined to the level concrete area from the east edge of the public sidewalk west to the elevated planting area. There were a few surface features in the paved area. Near the south end of Grid D was a section of pavement that had subsided. Remnants of what appeared to have been a line of posts for a chain-link fence were visible, and in Grid F two large circular holes in the concrete remained from where trees had been planted at some time in the history of the school.

South of the school, only the area of the paved sidewalk that ran parallel to the south end of the school was explored with the GPR unit (Grid G). The larger southern grassy area consisted of two 20-meter-square grids, designated H and I, which were mapped with both the soil resistance meter and the magnetometer. The soil resistance survey was continued in a series of partial grids behind the school (J, K, and L). Since some of the school grounds adjacent to the alley were hard surfaced, work behind the school was limited to areas where the resistance meter could make adequate contact with the soil.

## The Geophysical Data

### *Grids A, B, and C*

It is most useful to examine the data based on the platted building lots and the structures shown on the Sanborn maps. Our first three geophysical grids — Grids A, B, and C — covered the area north of Monroe School. Grids A and B were in grass at the time of the survey, and Grid C was covered with asphalt. It was expected that the early school (Figure 2) and its additions (Figure 4) extended into all three of the geophysical grids in this area. The soil resistance meter was used to examine Grids A and B.

Figure 7 illustrates three versions of the soil resistance data. Monroe School is just south of the area mapped in Figure 7, and the rectangular blank region is the asphalt parking surface. Figure 7a shows the raw resistance data after simple interpolation to calculate intermediate values and smooth the appearance. This presentation is dominated by numerous, spatially restricted high-resistance values indicated by darker shades on the map. Figure 7b presents the data after a low-pass filter, which de-emphasizes local variation in favor of broad regional trends. It shows a large region of high resistance centered at 2.5 meters north and 12.5 meters west. Also present is a broad zone of high-resistance values that extends from south to north across most of the east end of the survey area. Two areas of moderately high values are located at about 12.5 meters west and 19 meters west along the very northern limits of the survey area. Figure 7c illustrates the results of a band-pass filter (Scollar 1969:79), in which a low-pass filter is followed by the application of a high-pass filter.

The two high-resistance anomalies (the dark regions) located at 12.5 meters west correspond to the approximate location of the southeast and northeast corners of the late-1800s school. Based on the probe separation used for this survey, we surmise that most of the source for this variation lies in the top meter of the soil. Stone, concrete, and brickwork could produce the high-resistance values shown in Figure 7. The relatively clayey soil around Monroe School should otherwise be rather low in soil resistance, especially after the heavy rain a couple of days before the survey. The broad curved band of high-resistance values along the east end of the survey is so strong and extensive that it suggests the remains of a concrete or masonry surface in front of the early school.

The fluxgate gradiometer was used to examine the area covered by asphalt, Grid C. Magnetometers of all types are poorly suited to work in cities with the numerous electrical lines and many objects that contain substantial amounts of iron. Nonetheless, the gradiometer had been relatively successful in mapping features in the south yard of Monroe School and it required less than an hour to record data from Grid C. The hope was that the area beneath the old elementary school would be distinct from that which surrounded it and thus could be detected by the gradiometer.

The data from the magnetic survey are presented in Figure 8. Figure 8a presents the data after simple interpolation has been performed. Figure 8b shows the results of despiking and of further processing with a band-pass filter. The despiking process is intended to lessen the impact of localized extreme magnetic values on subsequent processing. The extant school produced a border of very high magnetic values along the southern edge of the grid, and the chain-link fence produced an intermittent line of high values along the northern limit. These high values are modified by the processing but not eliminated.

Two points, one at 3 north / 33 west and one at 10 north / 33 west have extremely high and low magnetic values close together. These are the result of segments of pipe or tubular fence posts that were cut off even with the asphalt surface. These anomalies are reduced after the despiking processing. Two north-south lines of magnetic high points at 37 west and 32 west may be the products of utility lines running from Monroe School to 15th Street. The area of the early elementary school lies in the lower third of both representations in Figure 8. No magnetic anomalies that can be associated with architectural features are discernable. However, the relatively uniform magnetic values suggest either that no basement was excavated under this portion of the early school or that it was filled with uniform soil of low magnetic susceptibility. This latter hypothesis is supported by the east-west GPR data from Grid C.

The radar profile of the line 6 meters north into Grid C is shown in Figure 9. It was recorded from the west to the east along a 20-meter traverse. The start of recording at the zero-meter mark is indicated by the triple dashed line at the left of the profile and the 20-meter mark is the right limit of the chart. The other dashed lines indicate the 5-, 10-, and 15-meter marks. The double-dashed line at 5 meters was used to mark a slightly sunken area in the asphalt surface, probably resulting from subsidence of soil in a utility trench.

A distinct point-source anomaly exists just before the 10-meter mark, perhaps indicating a footing or architectural element related to the rear wall of the original structure from the 1800s elementary school (compare Figure 2). The distinct anomalies seen around the 2.5- and 5-meter points are most likely associated with the strong magnetic anomalies and are plausibly explained by modern utilities. Much of the region between 10 and 20 meters east seems to illustrate a potential “velocity pull down” that Conyers and Goodman (1997:93) describe when the upper soil strata consist of low-velocity material. If the area under the old school contained a thicker deposit of high clay content soil, then one could expect radar reflections to include longer two-way travel time (because of the lower velocity of the radar wave) and thus be mapped as apparently lower.

Two other radar profiles are presented in Figure 10. These illustrate two lines from Grid A and were also recorded from west to east. The length of these traverses was 14 meters. The upper profile illustrates the radar line at 3 meters north into Grid A, and the lower profile shows the data from the line at 9 meters north. Both show a distinct anomaly at a point 5 meters into the traverse that corresponds with the eastern edge of the high-resistance anomalies and the approximate location of the front of the early elementary school.

### ***Grids D, E, F, and G***

The three grids in front of Monroe School were surveyed with the GPR unit. The concrete that covers almost the entire area made resistance survey impractical and the combination of the school building, remnants of steel fence posts, and moving vehicles on Monroe Street made magnetic surveying equally impractical. Three historic structures (Structures 5 and 7 on Figure 2 and Structure 15 on Figure 4) were located in this area prior to the construction the present Monroe School building. The location of Monroe School is such that remains of portions of the two historic structures might exist under the concrete walk in front of the school. Any surviving remains of Structure 17 (Figure 4) may be partially under the south-east corner of Monroe School. The evidence for this last structure is best demonstrated with data from our speed tests in Grid G. Figures 11, 12, and 13 each present three north-south radar profiles from Grids D, E, and F respectively. In each figure the top profile was recorded immediately adjacent to the planter in front of Monroe School and the next profiles were each recorded one meter to the east.

The Sanborn maps indicate that Structures 5 and 7 should be in Grid D. The front-center portion of Structure 5 and the center-rear portion of Structure 7 should have been crossed by the sequence of radar profiles presented in Figure 11. The location of Structure 5 should be indicated in the portion of the radar profiles from 1 to 5 meters south, and the location of Structure 7 should be represented by data from 9 to 14 meters south along the profiles. These regions are, with the exception of two features, quite uniform in their radar responses. Such uniformity might be expected if the structures did not have basements under the portion of the homes represented on the radar profiles. Although less likely, such a response could also result from highly uniform fill if the homes had basements that were filled after the structures were razed. The two features are most visible on the bottom profile. The moderately narrow reflection at the 1 meter mark could result from the remnant of a footing or foundation segment of brick or stone. Just beyond the 10-meter mark is a distinct point-source anomaly that one would expect from a pipe or wire.

Figure 12 presents one major anomaly. The middle of each radar profile is centered on the main entrance to the present school building. The upper profile actually crossed the upper step, and the effects of tipping the antenna can be seen at the edges of the reflection anomaly. The persistence of the anomaly pattern from 1 to 2 meters in front of the steps suggests that the soil beneath the front approach to the school has been disturbed less than the adjacent areas, both before and since the present school was constructed.

Figure 13 presents the radar profiles from Grid F. The Sanborn maps indicate that Structure 15 existed in the north half of this grid and that a portion of Structure 17 might have been included in the very southern area of Grid F. Structure 15 is unusual in that it is the only one indicated to have occupied two of the present 25 ft-wide building lots. As with the building locations in Grid D, the portion of the profiles from 3 to 8 meters south is relatively uniform and is bounded by reflections indicating moderate soil contrasts or discontinuities which may associate with Structure 15. It is not possible to recognize even a weak expression of Structure 17 on the profiles presented.

Grid G included three east-to-west radar traverses on the sidewalk south of Monroe School and one on the adjacent grass lawn. The unit abutted Grid F on the east end and extended 24 meters west to the western limit of the pavement. The northern transect, closest to the school, was recorded first with the next three each one meter to the south. The three traverses on the concrete are all quite noisy with numerous reflections evident along each traverse. It is not possible to tell if features associated with the present school or ones that preceded it produced the numerous reflections.

However, the transect recorded in the grass adjacent to the walk suggests that features associated with Structure 17 may be present. The line in the grass was actually recorded three times. It was recorded at our normal walking speed and also much faster and much slower. The objective was to evaluate the impact of the antenna towing speed on the interpretability of the resultant profiles. The first 10 meters of the three profiles from this line are presented in Figure 14. The upper radar profile shows the result of towing the radar antenna at about half our normal walking speed. The radar profile in the lower left shows the same region recorded when the speed was double our normal walking speed. The chart in the lower right was produced at our typical rate of towing.

It became clear that a slower tow rate made the profiles easier to interpret. The upper chart shows a distinct reflection anomaly that extends from 0.5 to 3 meters into the traverse and also a well-defined localized reflection just beyond the 5-meter mark. These may indicate a cellar excavation and footing associated with Structure 17 since the radar reflections correspond well with the previous location of Structure 17. These radar features were distinguishable at all three speeds, but they are progressively more difficult to interpret with increasing speed because the individual reflections are greatly compressed from side to side as the radar unit is moved more quickly over a feature. In fact, at the highest speed it is not clear from the profile that the two major features are not part of a single anomaly. At our normal tow rate, the separation between the two features in the profile is clear but there is a loss of detail in the reflection complex where the front of Structure 17 had been located if it is compared to the profile produced at the slow tow speed.

### ***Grids H and I***

These two grids are in the yard south of Monroe School, each 20 meters square and forming a block measuring 20 meters north-south by 40 meters east-west. The northern limit of the grids was adjacent to and parallel to the south wall of the school. These two grids were surveyed first with the soil resistance meter and then with the fluxgate gradiometer. The former location of Structure 17 should be in the north-east quadrant of Grid I and the location of Structure 18 should be in the southeast quadrant of Grid I. Outbuildings belonging to these two residences may have been included in the extreme western portion of Grid H, adjacent to the alley. The data from Grid H are shown in the upper halves of Figures 15 and 16, while the data from Grid I are shown in the lower halves of Figures 15 and 16.

Two versions of the resistivity data are presented in Figure 15. The left image shows the field data after simple interpolation to smooth the levels. The image on the right shows the results of a low-pass filter with a broad radius (10 readings). It is noteworthy that the pattern does not change markedly. It was hoped that the resistance data would shed light on the former locations of Structures 17 and 18. The very dark pattern across the top of each image probably is the result of gravel and asphalt added to the area along the alley in recent years and does not reflect historic use of the properties, i.e., late 1800s to early 1900s. The broad regions of low resistance (light values) that cross the images from side to side could result from the distribution of clay subsoil removed from the basement excavation of the modern Monroe School. The

excavation of small utility cellars or basements in structures the size of the homes that had been built here prior to the construction of the school would probably not produce enough subsoil to account for these extensive low-resistance anomalies. The resistance data were recorded on a half-meter by half-meter grid and should be fine-grained enough to reveal basements or footings if the fill or construction fabric contrasted with the soil matrix. One would expect foundation elements and basements to produce sharply linear and rectangular anomalies, although these could be altered during demolition. A few of the areas of localized resistance change in these grids correspond with similarly localized magnetic anomalies.

The magnetic data from Grids H and I are presented in Figure 16. As in Figure 15, the alley is at the top of the images, Monroe School is to the right and the Monroe Street public walk is at the bottom of the images. The corners of the magnetic and soil resistance surveys were identical. Although Monroe School is only a small distance to the north of the grid, the vertical gradiometer's design helped minimize bias in the data from the portions of the grids closest to the school building.

The image on the left in Figure 16 shows the magnetic field data with only simple interpolation. The image on the right presents the same data after despiking. One feature of both images is a line of moderate magnetic contrast that extends from bottom to top at about 8 meters east. This corresponds closely to the boundary between Lots 527 and 529 (Figure 4) and suggests a difference in the pattern of use of the properties associated with Structures 17 and 18. Since a great many anomalies occur on these lots it becomes difficult to sort out all of the individual features. Although magnetic anomalies can be produced by burned earth, ash, and even soil or rock with differing magnetic susceptibility, most of the magnetic anomalies from around homes and industrial sites are likely to be caused by iron. Such was the case for the strong magnetic anomaly at 7–8 meters east and 4 meters north. Subsequent testing revealed a segment of construction re-bar at this location. It was hoped that the occurrence of a moderate-amplitude resistance anomaly at the same location might indicate a historic feature such as a well. Although the excavation was not extensive enough to rule out a feature associated with a historic structure, the magnetic anomaly could be accounted for entirely by the iron re-bar. The complex of very high and very low magnetic values seen at 20 meters east and 0–2 meters north is certainly the result of a steel fence post in the fence between the school property and the private residence to the south.

The broad magnetic anomaly at 24–29 meters east and 4–7 meters north contrasts with the one noted above that was caused by the metal re-bar. The magnetic anomalies due to the re-bar varied from about +180 nT (nanotesla) to -130 nT within half a meter. The broader anomaly has less extreme values (both high and low), and the maximum and minimum values are farther apart. Although iron is a likely contributor to this broad anomaly, it is also likely that the magnetic values are due to multiple objects more deeply buried than the re-bar. The complex of predominantly positive anomalies from the vicinity of Structure 17 (15–20 meters north and 27–37 meters east) contains the signatures of two sizable and shallow iron objects combined with three clusters of deeper material. Retrieval of some of the artifacts that associate with the numerous positive magnetic anomalies from the center and rear of the lots might reveal whether the difference is due to length of occupation or due to the habits or profession of the occupants.

### *Grids J, K, and L*

The three partial geophysical grids behind Monroe School were surveyed with the soil resistance meter. A number of small outbuildings had been recorded on the Sanborn maps in the area along the alley and near the north end of the extant school. It is unlikely that these small buildings had cellars or substantial footings, although some may have been outhouses that covered privy pits. The raw data from these grids contained some seemingly random variation that probably resulted when the meter's probes hit a bit of asphalt or gravel. Figure 17 presents the data from this area. The present school lies in the blank region (bottom) of the maps. The top image shows the raw data after despiking and interpolation processing. The bottom image shows the effects of subsequent low-pass filtering. The filtered data are better in only one obvious area. A utility trench was recently excavated from the alley to the rear of the school building, and the trench can be seen as a low-resistance (light) streak that extends from the school (at 47 north and 8 east) northwest to the alley (at 51 north and 0 east). A prominent high-resistance anomaly exists along

the alley at 56–58 north and 0–4 east. This coincides reasonably with the former location of Structures 6 (Figure 2) and 12 (Figure 3).

South of this anomaly is another one that might correspond to Structures 13 and 14 (Figure 3). It is both smaller and weaker than the one adjacent to it. The cluster of high-resistance anomalies that extend between the alley and the school at about 45 meters north are likely to be the product of recent efforts to produce a durable surface for parking behind the school. The high-resistance anomaly adjacent to the school at 51–55 meters north may associate with the “coal pit of fireproof construction” shown on Figure 4, although the location seems a bit too far north when compared with the Sanborn rendering. Some of the minor architectural details of the school caused the grid to end a meter or so farther west in the area of the “coal pit” and only the westernmost portion of this feature might have been included in the grid.



## Conclusions

Overall, the geophysical instruments provided useful information on the existence and nature of many of the historic structures that preceded the present Monroe School. No single instrument was best or universally applicable. Electrical resistance was limited by two factors. The heavy rain at the beginning of the week probably reduced the contrast between some targets and their soil matrix. The presence of concrete or asphalt surface over many targets makes resistance mapping either difficult or impractical. Electrical resistance mapping tends to be most effective when the targets are stone or masonry footings, walls, or walks buried in soil. If these targets are buried in a matrix of building rubble (composed of similar fabric) then resistance mapping is less likely to be successful. Resistance mapping appears to have recorded high-resistance anomalies associated with the pre-1900 elementary school and some of the minor buildings associated with residences that occupied lots under the north portion of Monroe School. It was ineffective in detailing buildings and activity areas in the south yard of Monroe School. It is possible that some of these areas would yield more useful resistance data if mapped during a somewhat dryer period.

The magnetometer survey was surprisingly effective in the south yard area. Magnetometers are, by design, very sensitive to minor changes in magnetic fields and urban environments have abundant magnetic “noise.” However, the fluxgate gradiometer used at BRVB uses two sensors arranged in a manner that emphasizes change in the vertical component of the magnetic field and hence is most sensitive to changes caused by objects (or soil features) beneath the instrument. This design, which has limits for some applications, is particularly well suited to minimizing the effects of unwanted variation in the magnetic field in areas like that around Monroe School. The magnetometer also responds to individual iron objects. In some applications this is detrimental. However, it no doubt contributed to our ability to see differences in the lots associated with Structures 17 and 18. The different magnetic appearance of these two residential units is no doubt the result of different use-histories. Modest excavations coupled with additional historic research should allow the nature of the difference to be documented.

The results of the magnetic survey in the parking lot north of Monroe School were less useful. Utilities associated with the modern school were recorded and some indication of the nature of the soil under the rear portion of the pre-1900 school was gleaned from the data. It is unlikely that additional magnetic surveying would be productive unless much more of the post-1900 iron could be removed from the area of the north parking lot, the front walks and along the alley.

Ground-penetrating radar was also fairly successful in selected areas. The BRVB study was the first time the authors had operated this instrument and analyzed the data. GPR is affected by moisture somewhat like soil resistance measurements. Both moisture and the nature of the soil particles contribute to the amount of depth penetration that any given antenna will produce. We opted for a 500-MHz antenna with the goal of getting better resolution of smaller objects and soil discontinuities. The soils around Monroe School have enough clay content to make radio wave penetration minimal. The heavy rain at the beginning of the study made the soil conditions even less favorable. Nonetheless, the Noggin unit that we were using gave us useful data in several target areas.

The GPR unit is little affected by concrete or asphalt paving, so we were able to work across areas for which the resistance meter was not well suited. Our lower limits of detection were about 60 to 70 cm. This was shallower than we had hoped for but adequate to reach the upper portions of some buried features. The circumstance was actually better in areas with pavement. This may be due both to the greater facility at coupling the radio energy with the pavement and also the fact that the soil beneath the pavement had not been recently saturated by rain. The GPR unit seemed to record some architectural features associated with the pre-1900 elementary school and with some of the residential buildings that are now under the front sidewalk and north edge of the south yard.

We used a feature of the GPR controlling software to put vertical dashed lines on the profiles. By using different numbers of these markers we were able to flag regular 5-meter intervals and occasionally surface features. The markers for the 5-meter marks are important since the radar streams data at a con-

stant rate and there is bound to be some variation in the speed at which the antenna is pulled. Hence, a centimeter of profile does not always equate with a meter of ground covered. Bevan (1998:49) recommends the use of a small electronic timer to help regulate the pace at which the antenna is towed. It is apparent from our speed trials, discussed above, that the ease of interpreting the data is affected by the speed at which the antenna is towed. In general, our tow rate was adequate but a slower speed would have made interpretation easier. Furthermore, the use of an audible-tone timer would have resulted in a more consistent towing speed, thus facilitating comparison of adjacent radar profiles. We selected a hand-towed unit controlled by a laptop computer as a means to keep the cost of the GPR trials low. The results of these trials are positive enough to recommend that additional GPR would be useful. A lower-frequency antenna (ca. 200–300 MHz) and the use of a cart-based system to make the rate of ground coverage more consistent would both be of substantial benefit. The use of a system that allows plan-view mapping of the radar reflections would also enhance the value of the radar data.

On balance, the suite of geophysical studies help to understand the complex history of construction and demolition on this rather small parcel of land. The data can at a minimum provide an indication of areas that are most likely to contain intact historic remains. In addition, they can provide a basis for predicting the complexity of the archeological deposits that will be encountered in future archeological testing. The assessment of complexity is useful in selecting staff and allocating supervisory time on any excavation project (Hunt and Peterson 1988:116–117).

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Figure 1. Qefiri Colbert (right) and Robert Nickel (left) recording radar data east of Monroe School.

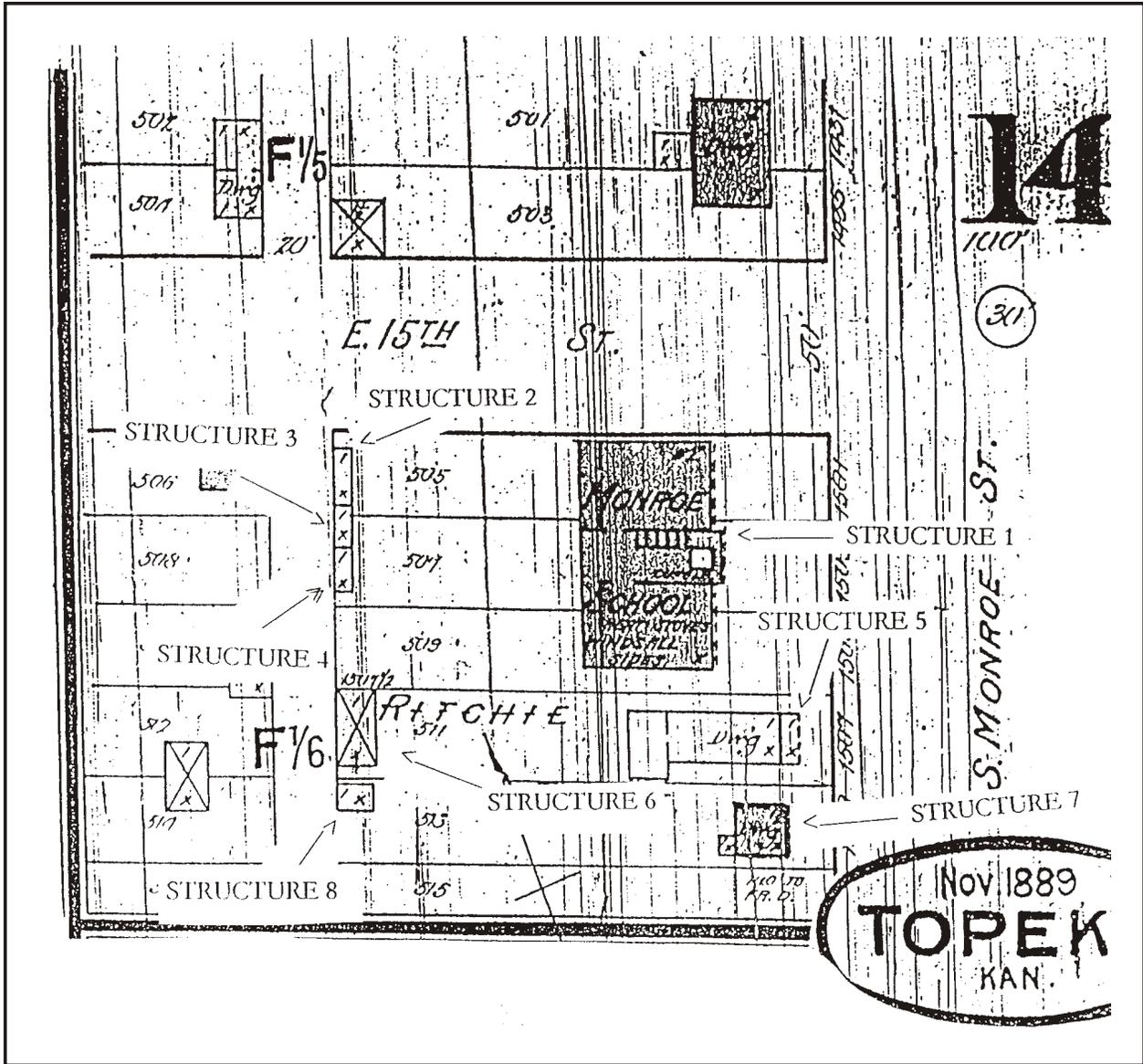


Figure 2. Detail from a 1889 Sanborn map showing the location of Monroe School and seven other structures; compare with Figure 5 to see the spatial relationships of these structures to the current Monroe School building.

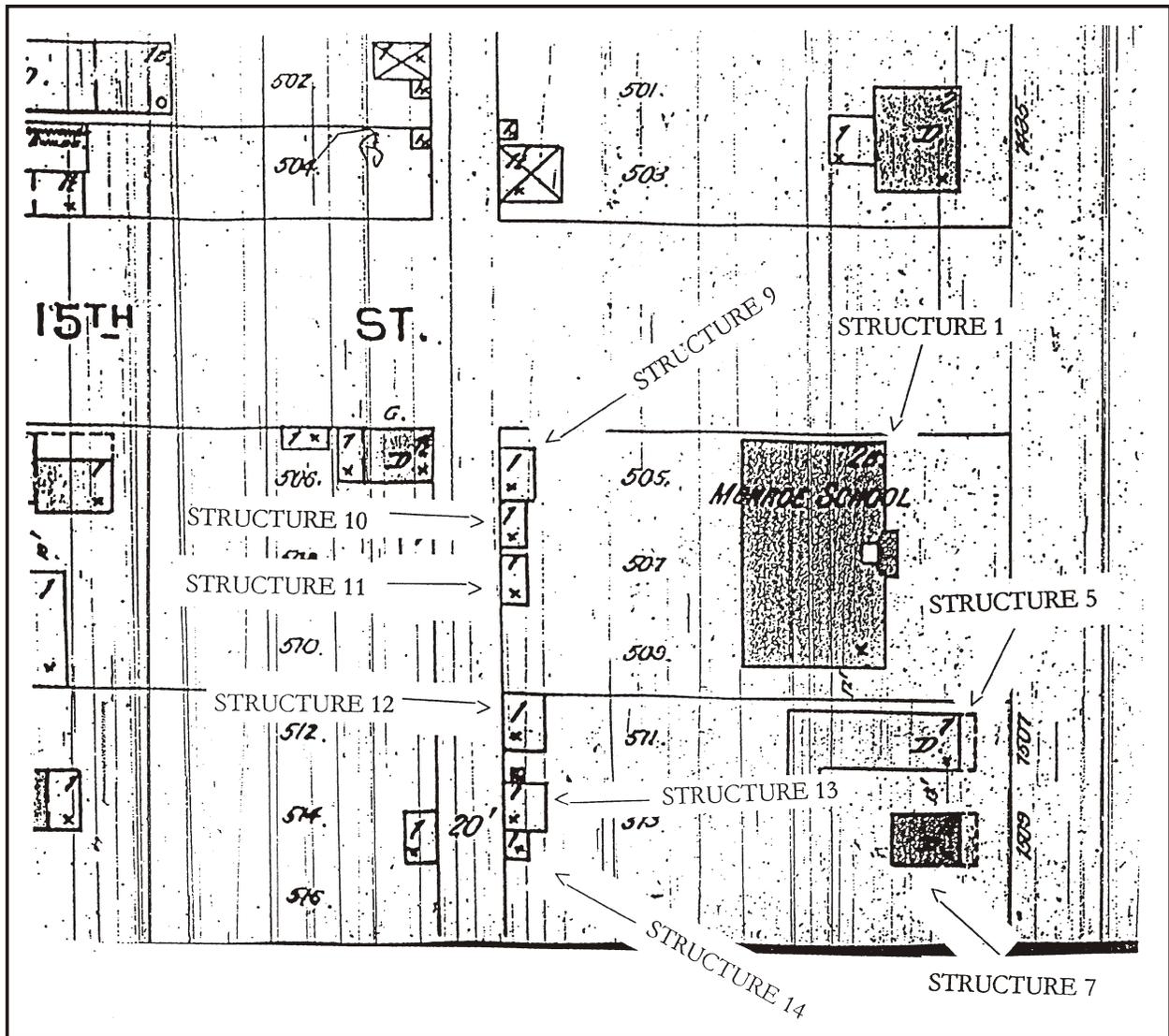


Figure 3. Detail from a 1896 Sanborn map showing the location of Monroe School and eight other structures; compare with Figure 5 to see the spatial relationships of these structures to the current Monroe School building.



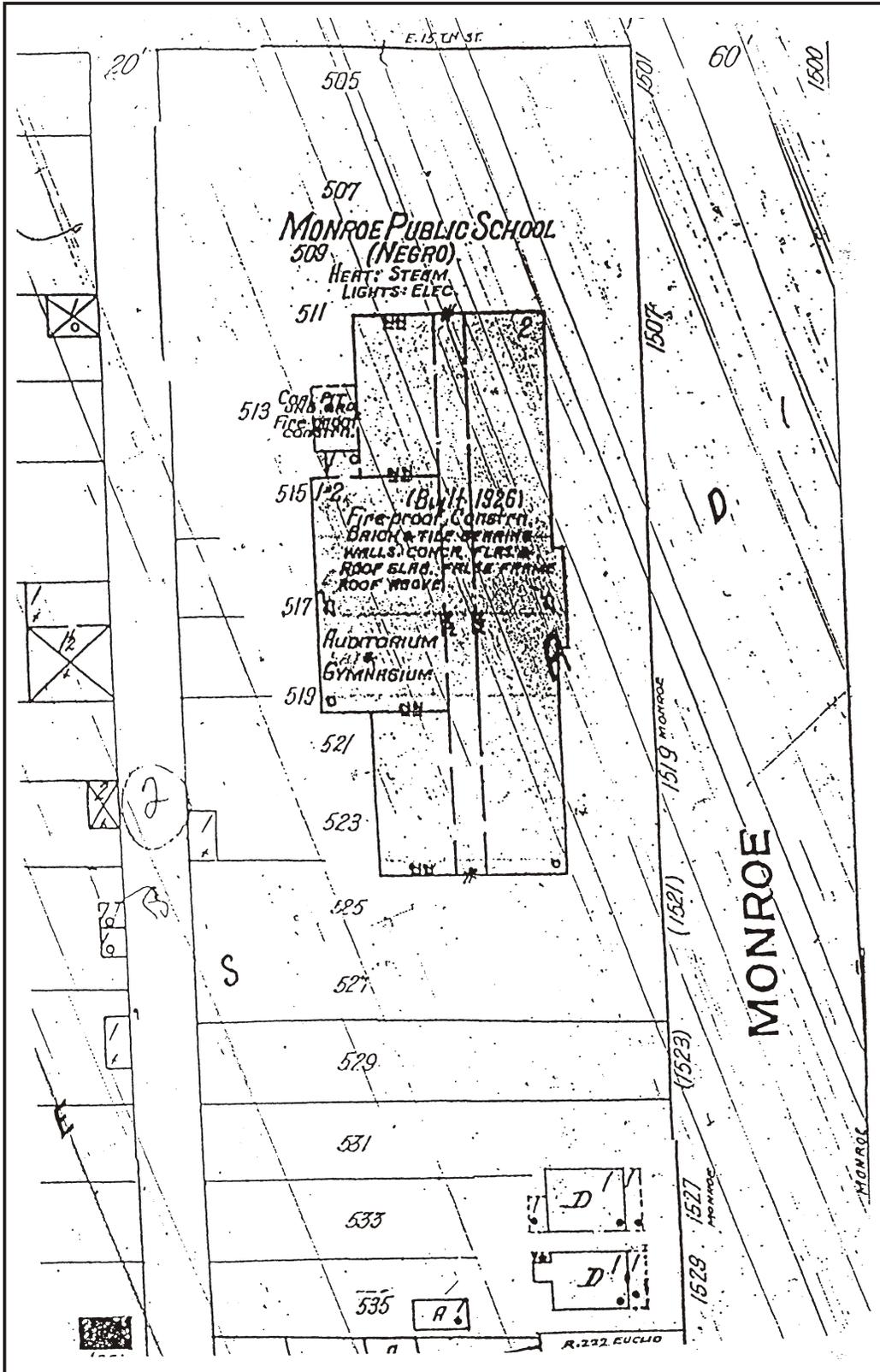


Figure 5. Detail from a 1945 Sanborn map showing the location of the current Monroe School building.

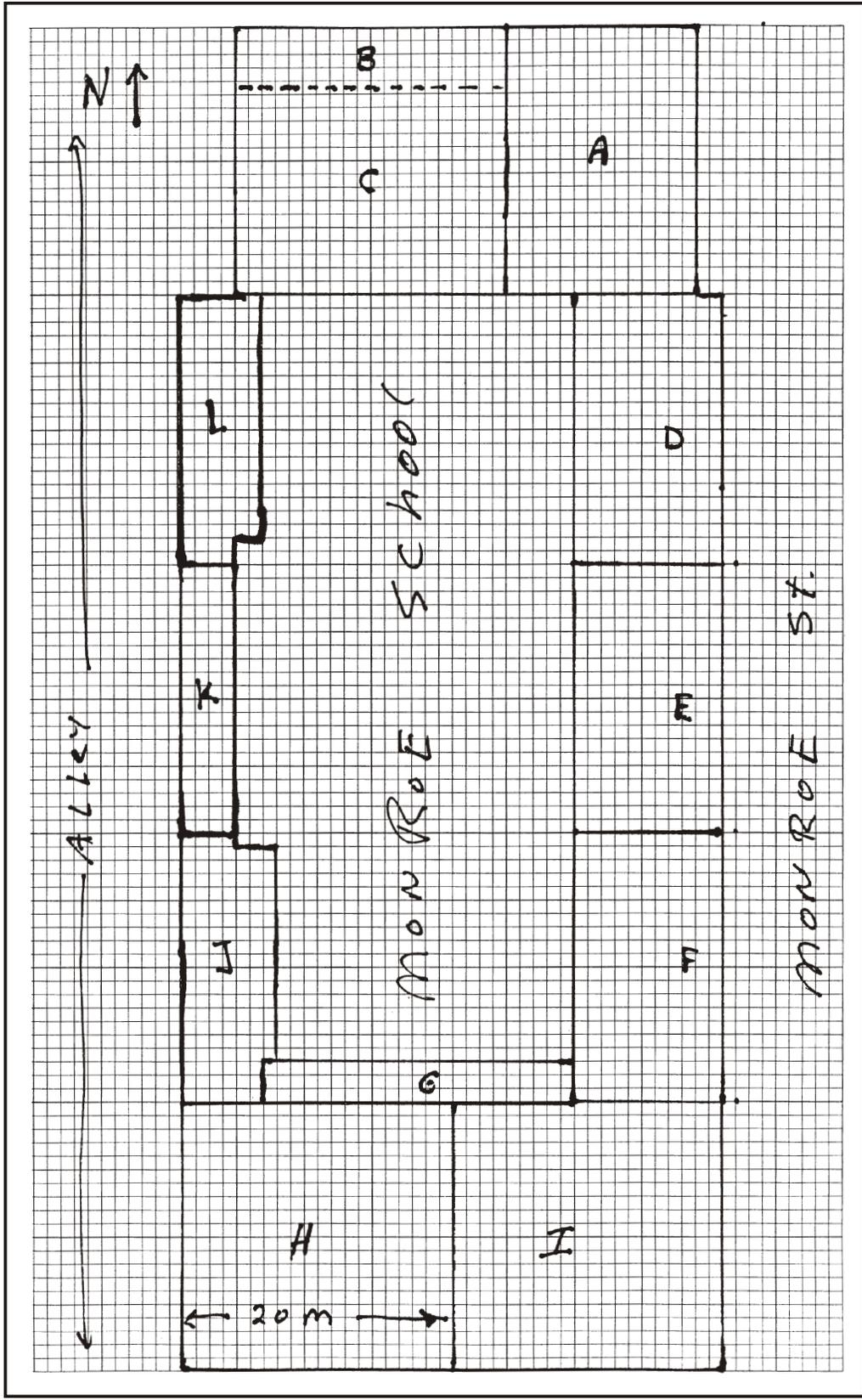


Figure 6. Plan view map of the 1999 geophysical survey grids surrounding Monroe School.

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Comp. : res67\					
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Maximum	1	Palette	Positive		
Contrast	2			Black	High
Units	Std.Dev.			White	Low

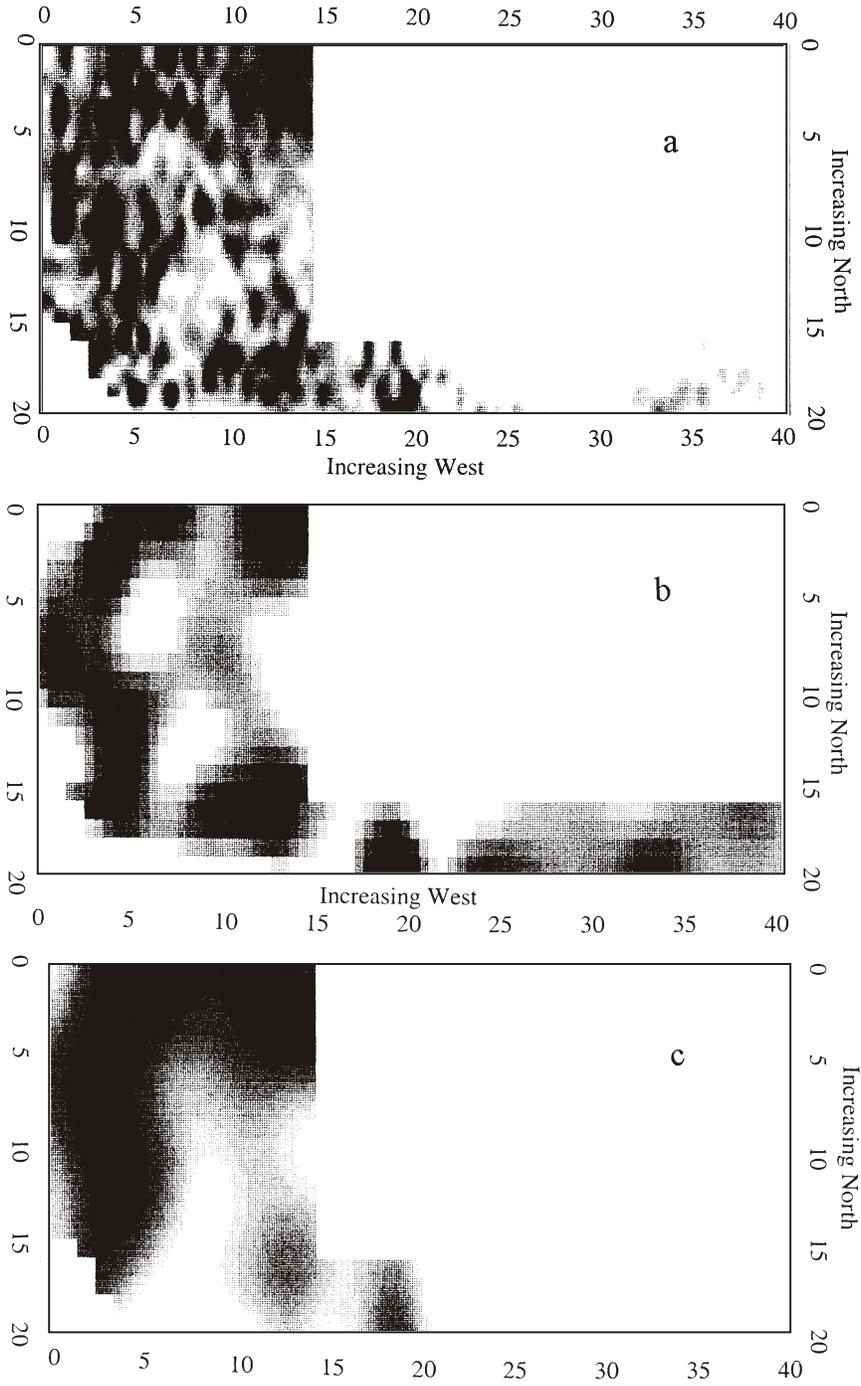
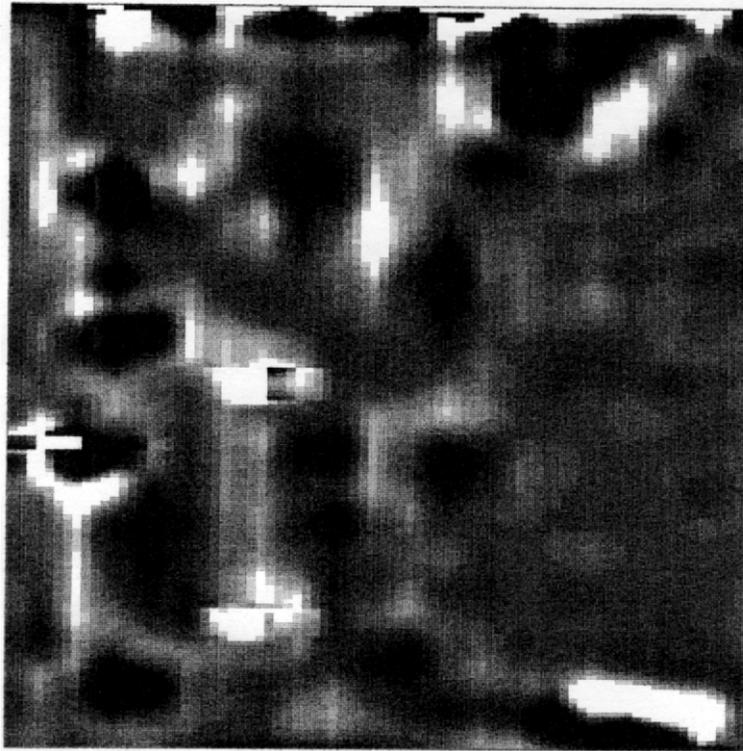


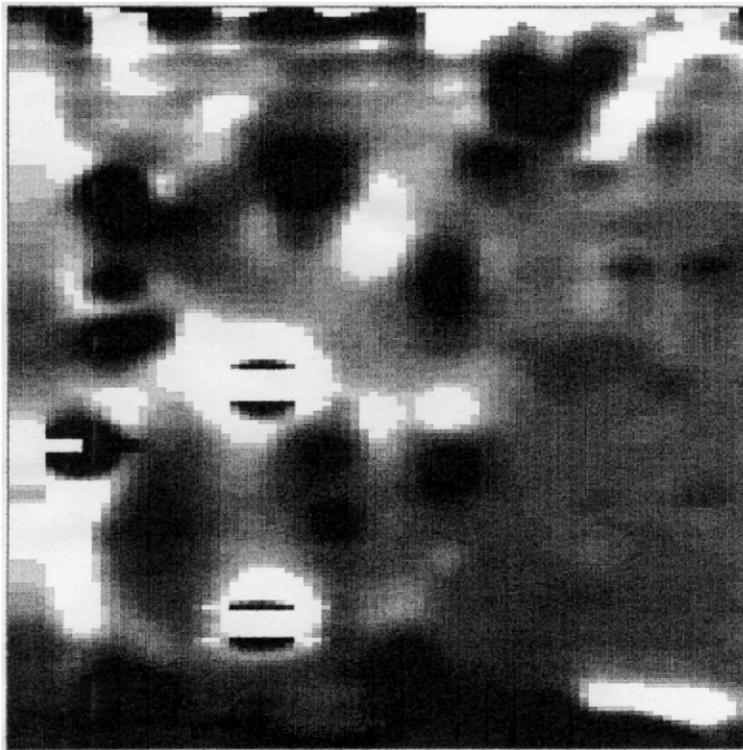
Figure 7. Soil resistance maps of Grids A and B, north of Monroe School.

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Comp. : mag3ax			
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Maximum	1	Palette	Positive
Contrast	1		
Units	Std.Dev.		
		Black	Positive
		White	Negative



B

Site : brvb	Gradiometer Survey	Scale	1:185
Comp. : mag3			
Shade Plot (Clip)		Size x 4	Block
Minimum	-1	Grey Levels	17
Maximum	1	Palette	Positive
Contrast	1		
Units	Std.Dev.		
		Black	Positive
		White	Negative



A

Figure 8. Magnetometer data from Grid C, north of Monroe School; raw data on the left and processed magnetic data on the right.

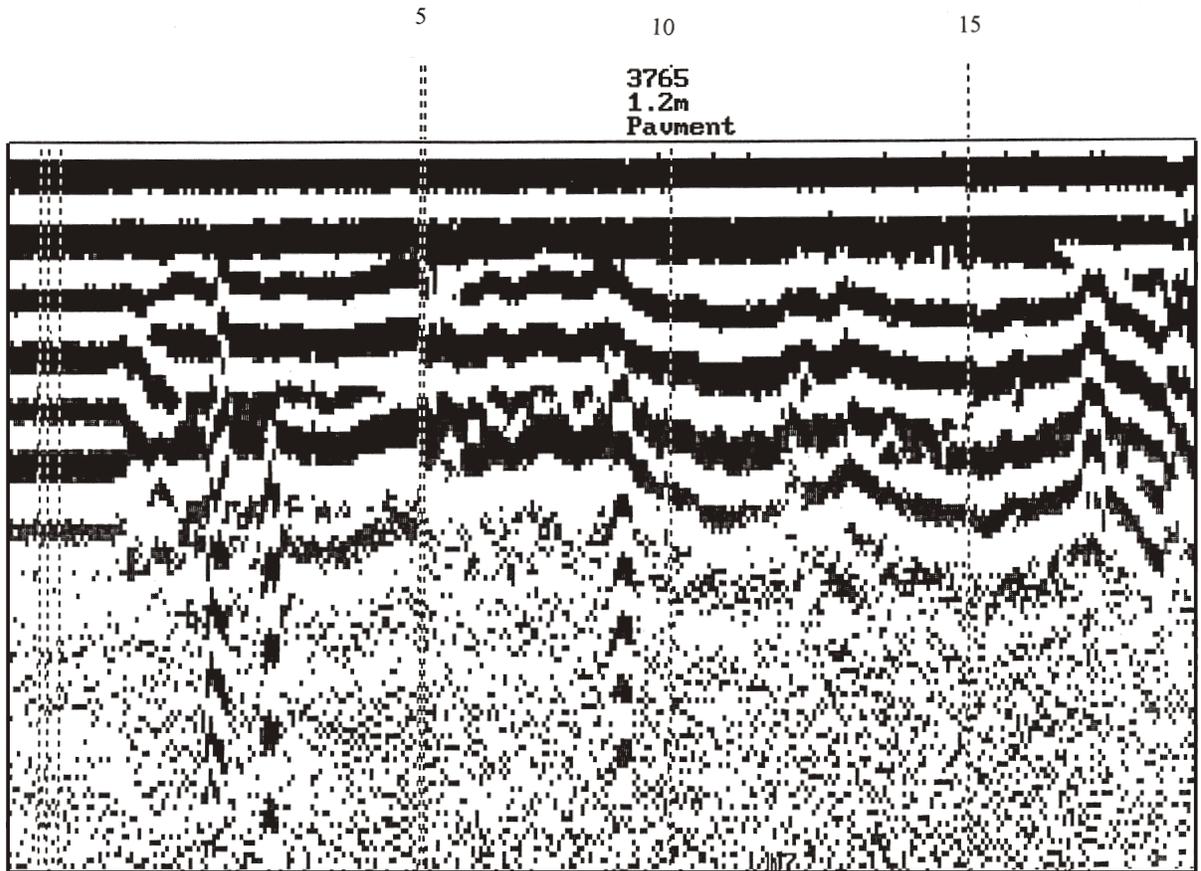
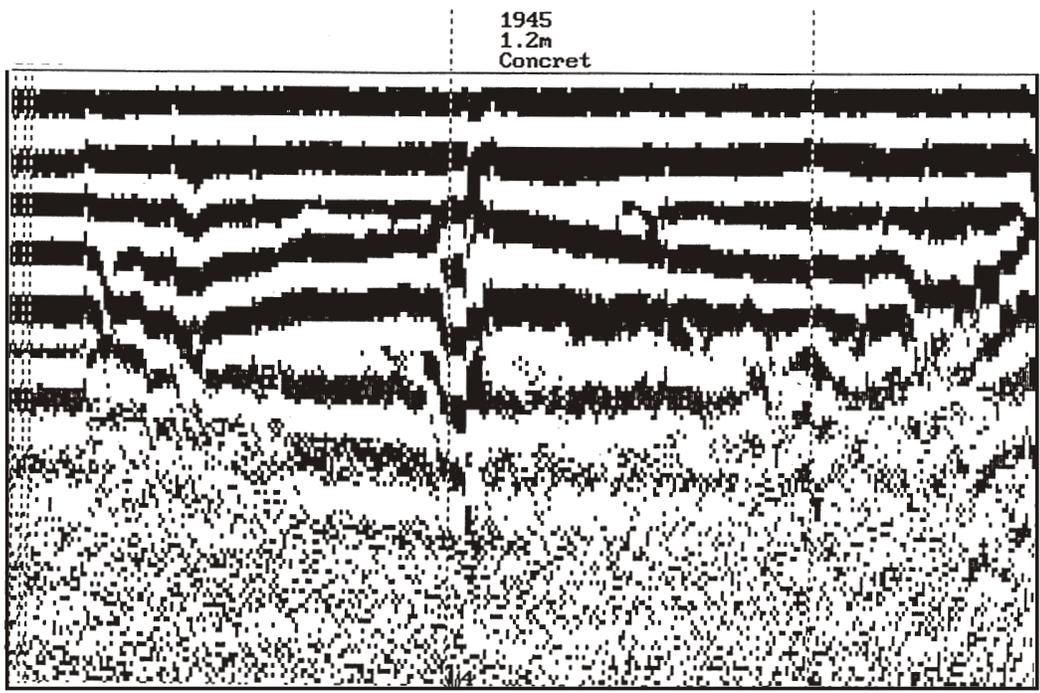


Figure 9. Radar profile of the line at 6 north in Grid C, north of Monroe School; short-dashed lines occur at the 5-, 10-, and 15-meter marks.

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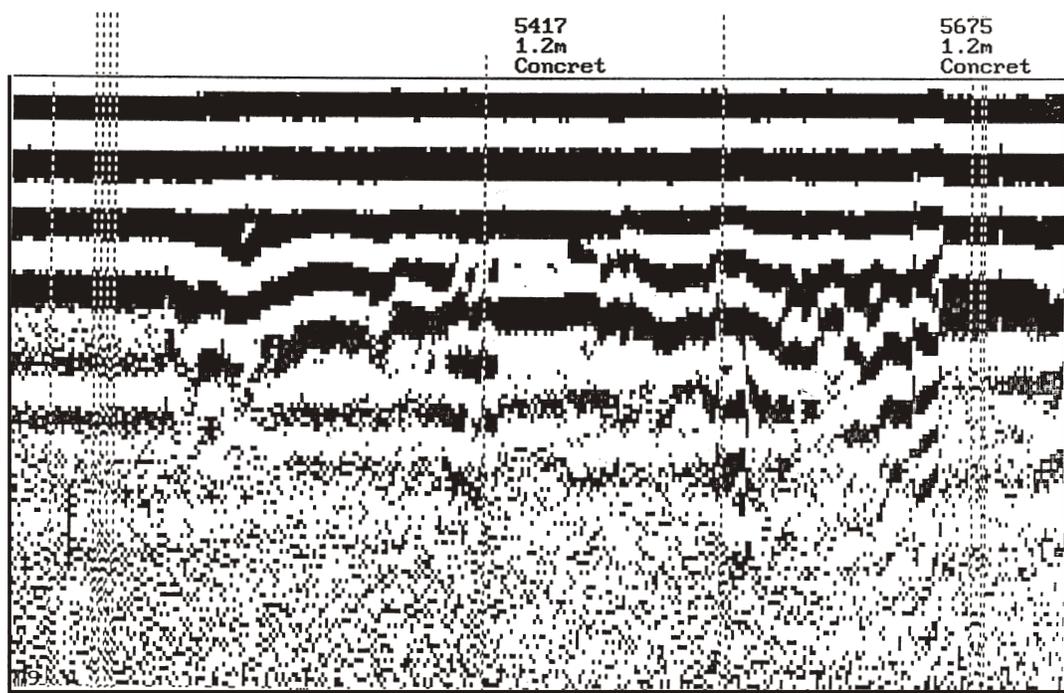
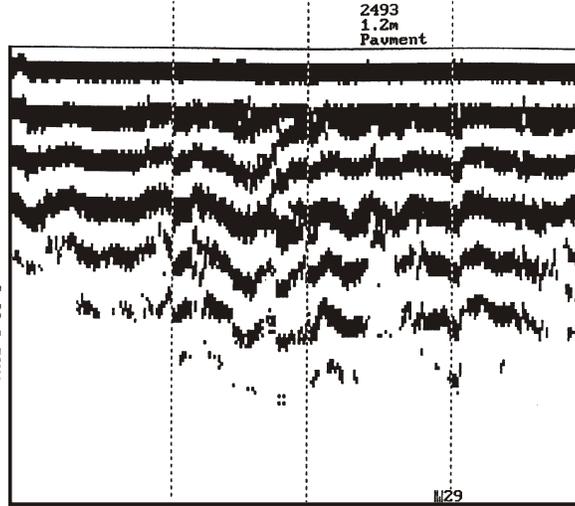
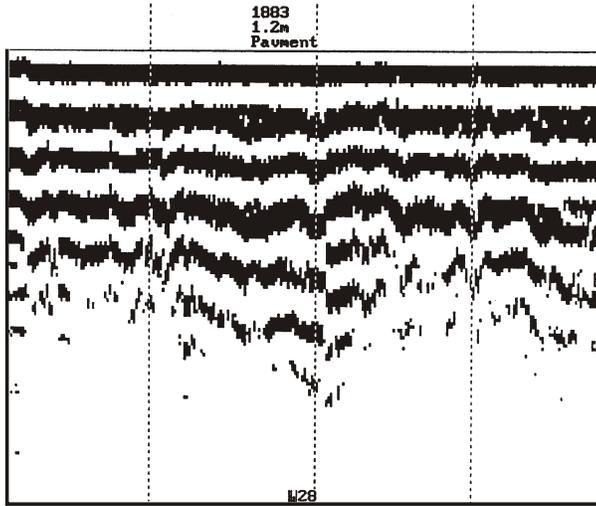


Figure 10. Radar profiles of the lines at 3 north (top) and 9 north (bottom) in Grid A.

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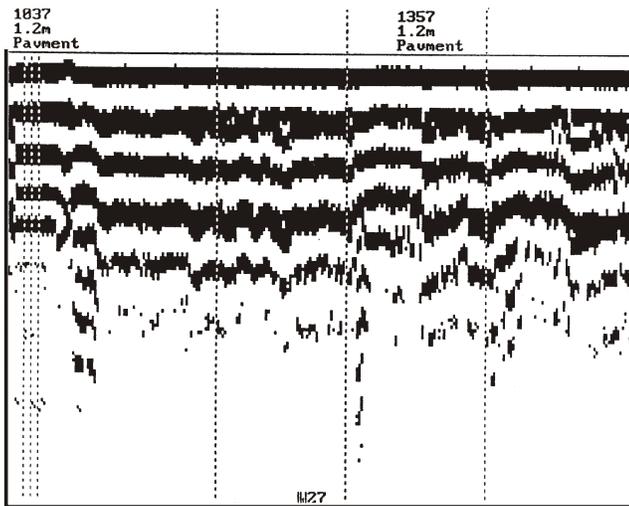
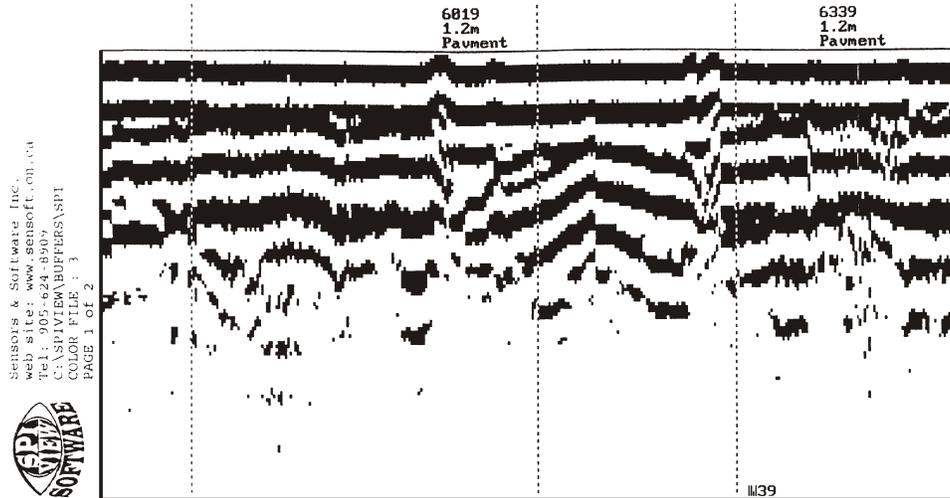
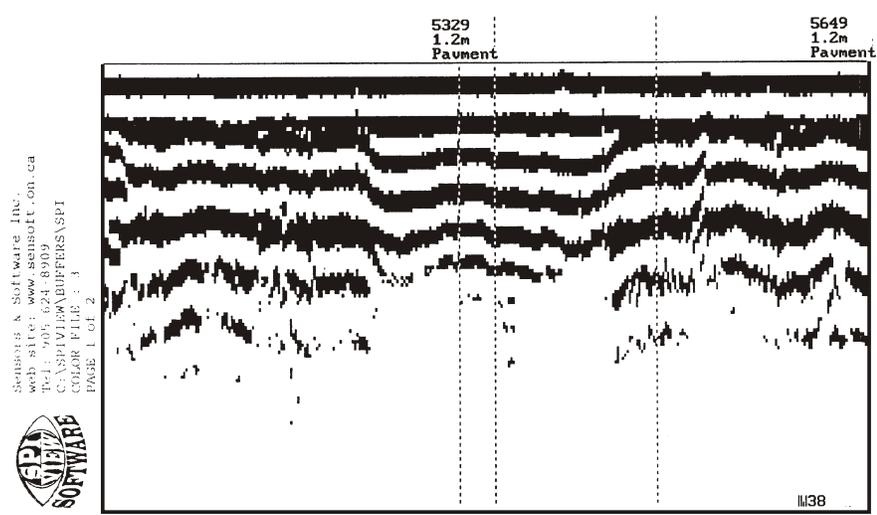


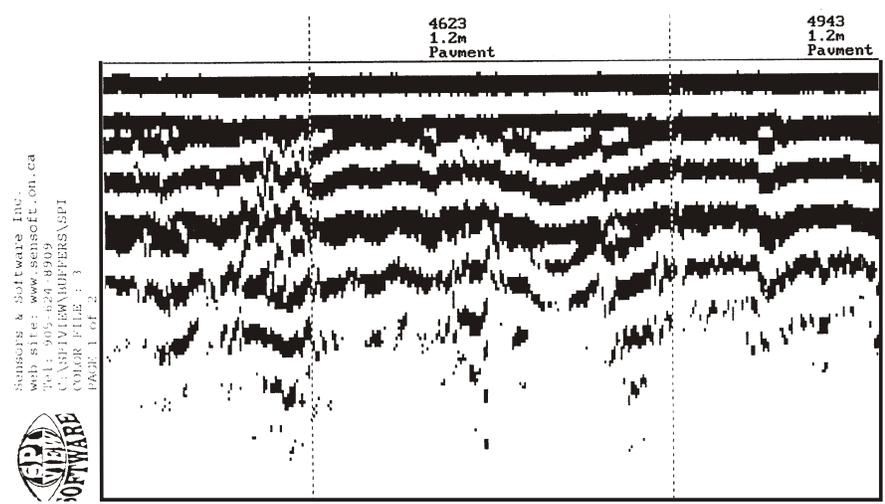
Figure 11. Three radar profiles from the west edge of Grid D, east of Monroe School.



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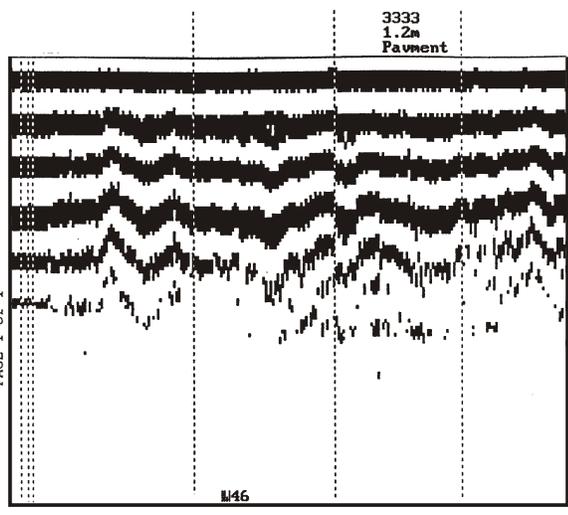


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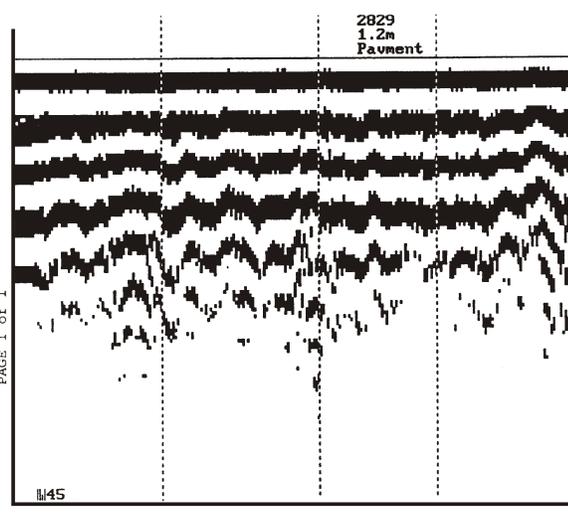


Figure 12. Three radar profiles from the west edge of Grid E, east of Monroe School.

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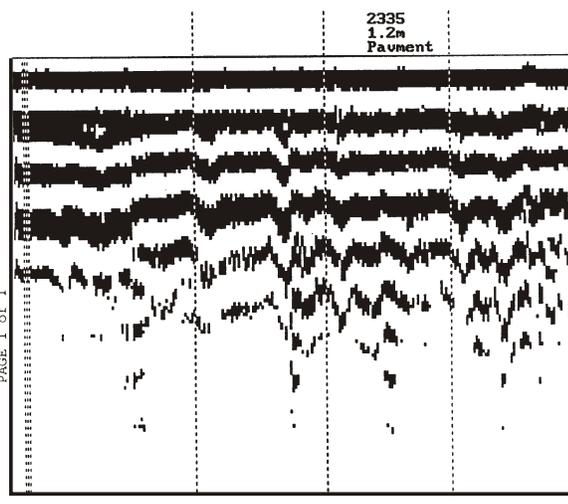


Figure 13. Three radar profiles from the west edge of Grid F, east of Monroe School.

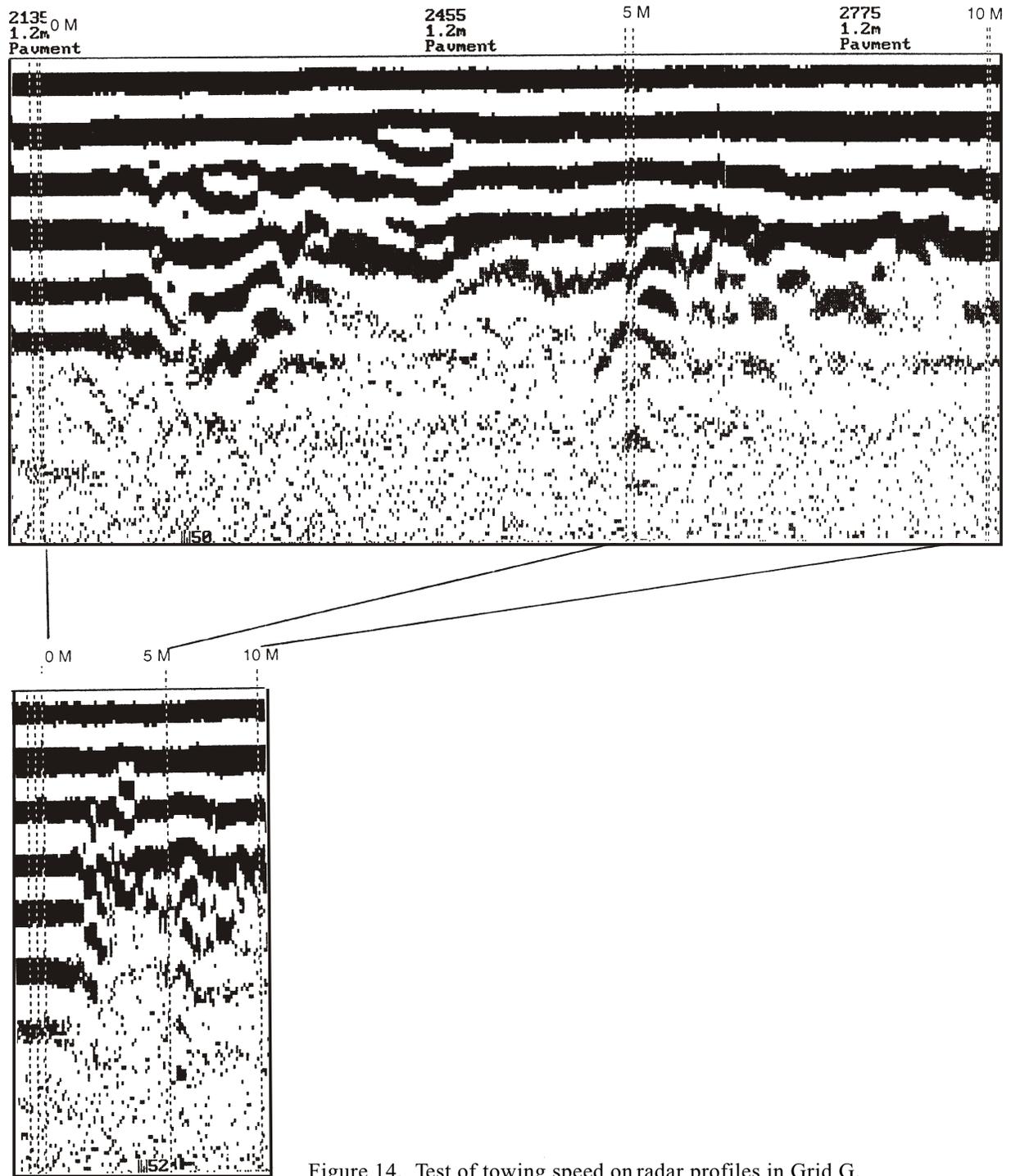


Figure 14. Test of towing speed on radar profiles in Grid G.

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Units	Std.Dev.			White	Low

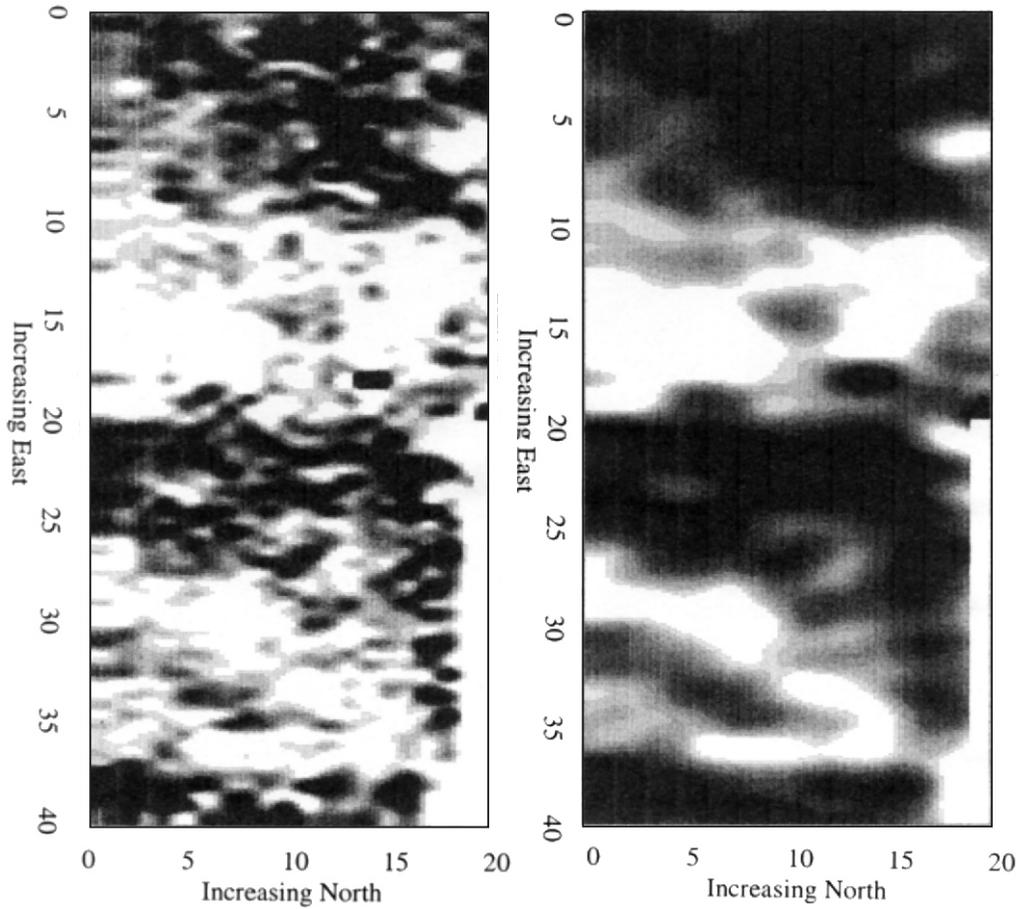


Figure 15. Soil resistance data from Grids H and I, south of Monroe School; low-pass filtered data on right.

Site : brvb		Gradiometer Survey		Scale	1:369
Comp. : mag12ii					
Shade Plot (Clip)			Size x 2	Block	Off
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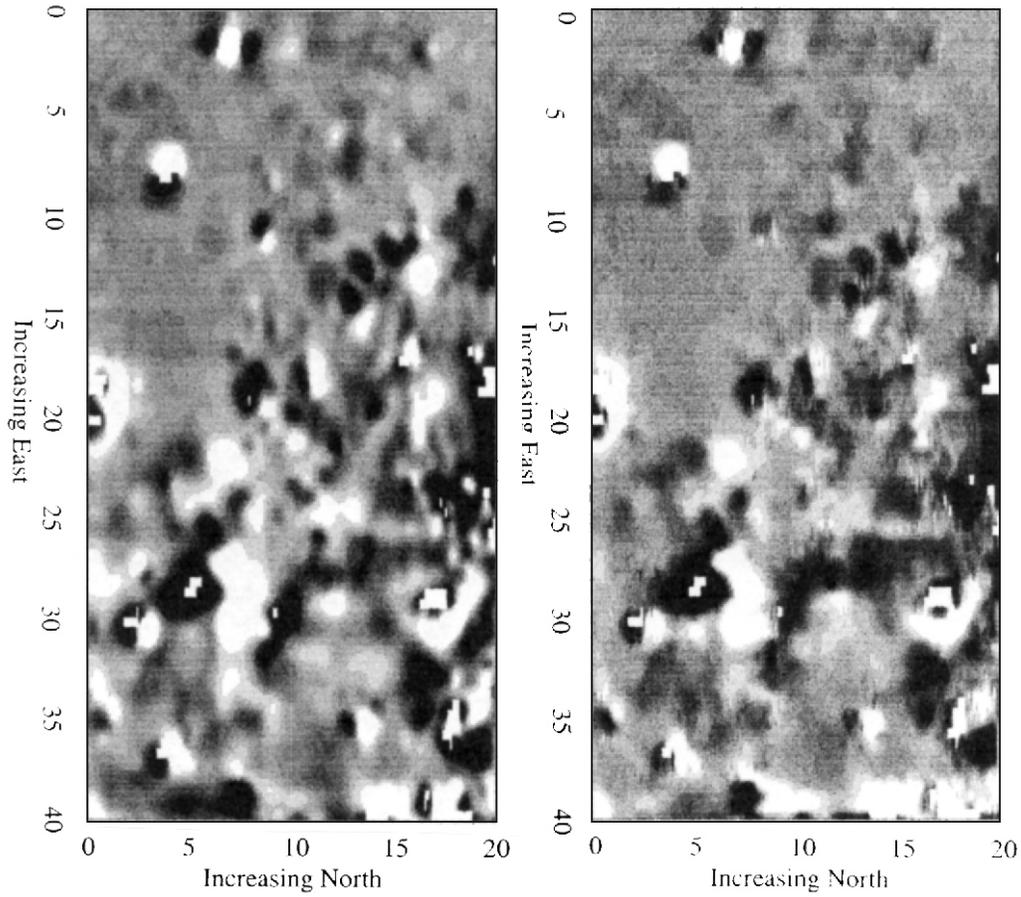
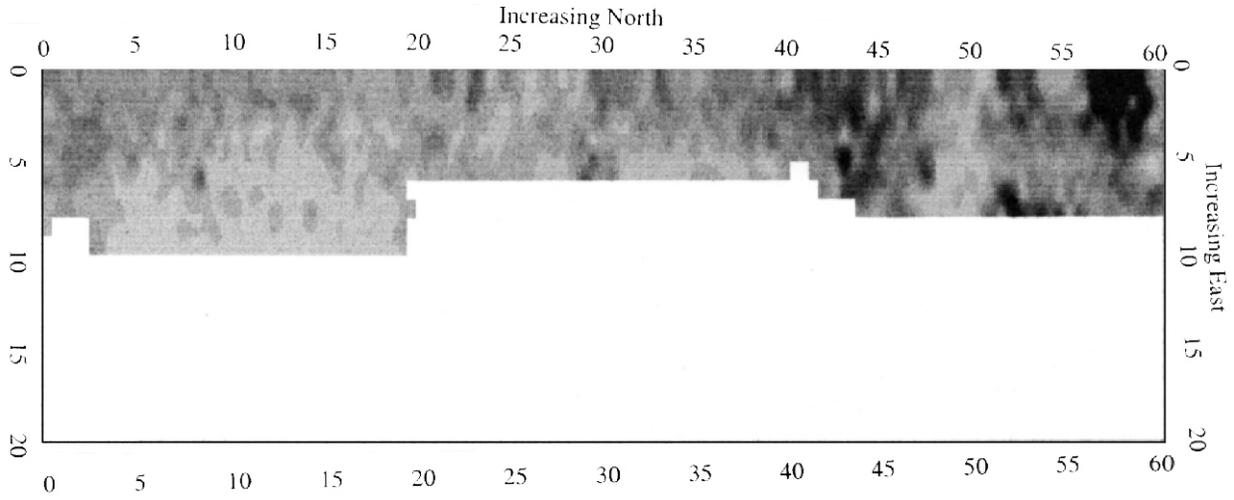


Figure 16. Magnetometer data from Grids H and I, south of Monroe School; raw data on the left and processed magnetic data on the right.



Site : monres2		Resistivity Survey		Scale	1:369
Comp. : res35i					
Shade Plot (Clip)		Size x 2		Block	Off
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Units	Std.Dev.			White	Low

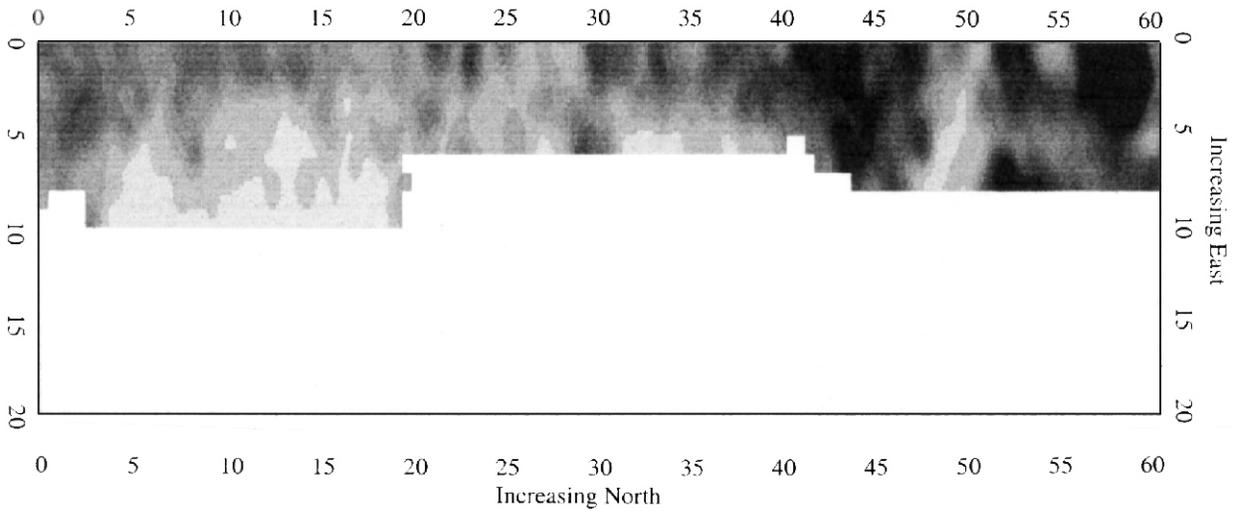


Figure 17. Soil resistance data from Grids H and I, south of Monroe School; low-pass filtered data on bottom.

