

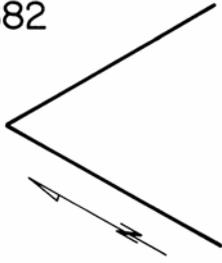
## **Chapter A**

### **Wyoming Resurvey Using Photogrammetry**

**A16**

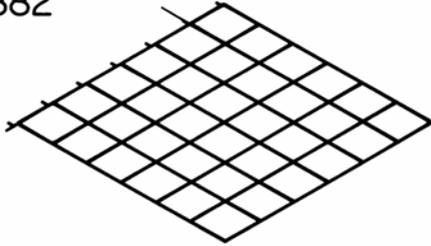
History of Surveys

1882



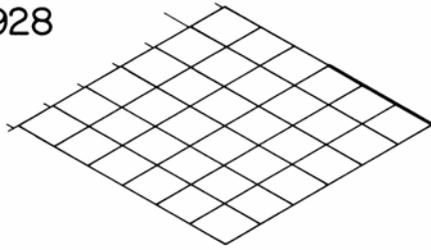
1882 Charles W. Brown surveyed the north boundary, a portion of the Seventh Standard Parallel North, and the west boundary, and a portion of the Eleventh Auxiliary Guide Meridian West.

1882



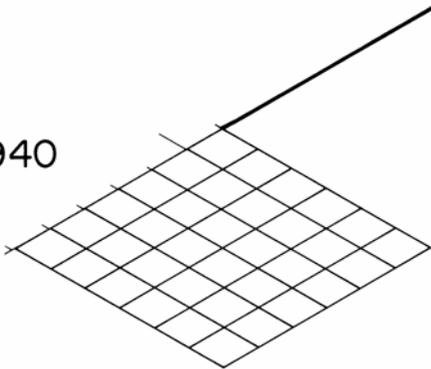
1882 Robert W. Black surveyed the south boundary the east boundary. retracements of the north and west boundaries, and the subdivisinal lines of the township as shown on the plat approved May 5, 1883, figure 1.

1928



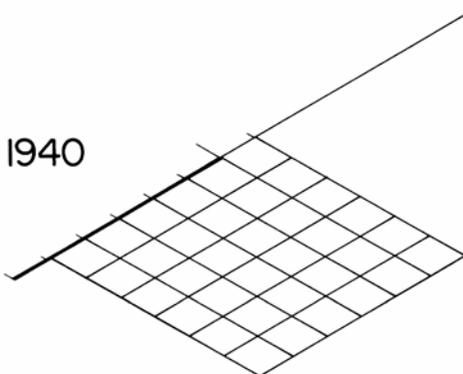
1928 Clyde W. Atherly resurveyed the south 3 miles of the east boundary.

1940



1940 Leo M. Peterson resurveyed the Seventh Standard Parallel North through Range 91 West.

1940



1940 Mark D. King resurveyed the Seventh Standard Parallel North, through Range 92 West.

## **Reasons for Request of this Survey**

By memorandum dated February 17, 1965, the Washington Office requested Wyoming to suggest a possible area of 15 to 20 contiguous townships containing mostly public lands that needed resurveying and which might lend itself to application of photogrammetric survey. The Wyoming Office responded with a block of 17 townships located in the Rawlins and Lander Districts. These districts had repeatedly requested resurveys in the area in previous years. T. 27 N., R. 90 W., was already programmed for resurvey by conventional methods under Group 282, Wyoming. The remainder of the 17 townships were mostly public land, were relatively open desert type lands, were being extensively leased for oil and gas exploration and were mostly old surveys with stone monuments difficult to identify. It was felt that this kind of situation lent itself to application of photogrammetric resurvey methods.

## **Special Instructions**

On July 1, 1965, Supplemental Special Instructions for Group 282, Wyoming, were prepared, adding the dependent resurvey of Tps. 25 N., Rs. 90 through 94 W.; Tps. 26 N., Rs. 92 and 93 W.; Tps. 27 N., Rs. 91 through 94 W., and Tps. 28 N., Rs. 90 through 94 W., to the original Group 282. T. 25 N., R. 94 W., was to be resurveyed by using electronic distance measuring equipment and personnel from the Alaska State Office. The remaining 16 townships were to be resurveyed by photogrammetric methods. Horizontal and vertical control would be derived from the existing triangulation net, with any necessary additional control points to be established by the Alaskan personnel. The aerial photography and analytical bridging, etc., would be contracted for by the Washington Office. On the ground paneling and corner monumentation would be executed by the Wyoming cadastral survey personnel. The topographic overlay for the plats was to be furnished by contract with the U.S. Geological Survey.

The initial corner search, monumentation and paneling commenced on July 1, 1965. This discussion is limited to T. 28 N., R. 92 W., as representative of the project as a whole.

## **Conditions Found on the Ground**

Using existing photography, the field notes and the plat, search was made for each corner of the original survey(s). If a corner was found it was monumented with a brass capped iron post (unless already so monumented) and paneled. The panels on this project consisted of a 4x4 foot piece of plywood, painted international orange centered over the corner, and two rays of "butcher" paper, 1 ½ feet wide and 20 feet long, placed in line on each side of the corner. The paper "rays" were fastened down with earth and stones.

If the original corner could not be found, a temporary point consisting of a 2x3 inch hub was set in the vicinity of the corner and paneled. The search areas were first identified on the photography using scaled distances, topography, fence lines, etc. to determine the locus of corners. The temporary points were located within the search area. If a found corner happened to be obscured from clear overhead view, an "offset" point tied by bearing and distance to the true corner, was paneled in a nearby but suitable location. Bearings were determined using the solar transit.

Carefully indexed and complete field notes were kept of each corner recovered, with details as to location, type of slope, fence lines, and nearby topography entered.

The triangulation network control stations and supplementary control stations were all paneled with the 4x4 foot piece of plywood and three 20 foot long rays of butcher paper.

After the initial search and all paneling were completed, the aerial photography was flown by a contractor. Two sets of photography were taken. The first flight was made using aerial color film, flown at 28,000 feet above mean sea level, or approximately 20,000 feet above average ground level. The resulting photography was at a scale of about 1:40,000. This color photography was made in late October, 1965.

The second set of photography was made on black and white film in the spring and summer of 1966. This resource photography was flown at 17,800 feet above mean sea level, using equipment that resulted in black and white photos at a scale of about 1:15,840.

The analytical work was performed by a contractor in Los Angeles, California. Using the glass diapositives of the color photography and a Wild PUG 2 point transfer device, the pass points and paneled points were drilled. The analytical bridging was done with a Mann 4220 screw comparator. The x, y and z coordinates of all points were based on the Wyoming State Plane Coordinate System, West Central Zone, in the foot unit. Each corner or paneled point was assigned a number. The computer printed out the x, y, and z coordinate of each point by number. The specifications called for the accuracy to be 1: 8000 of the flight height of the camera. This should result in a coordinate value within 2 ½ feet of the absolute true position of the point.

### **Preliminary Statement of the Problem**

Using the x, y and z coordinates of the paneled points, the surveyor must compute the moves from the temporary points to true corner points, convert the grid bearings to true astronomical bearings and the distances from sea level to the ground surface. He must make the computed moves and remonument the missing corners in their proper proportionate positions. The true bearings and distances between all corners must be computed.

### **Regulations**

This survey illustrates the application of the following sections of the Manual of Surveying Instructions, 1973.

2-8 to 2-16	Photogrammetry
3-87	Establishing quarter-section corners between closing corners
5-20 to 5-35	Restoration of lost corners, single and double proportion
5-41	Closing corners

### **Auxiliary Topic**

This photogrammetric resurvey was executed in 1965-68. It was found that 16 townships was too large an area, the color photography was not adequate and that the panels were too small for the scale of the photography. Recourse had to be made to the black and white resource photography to complete the panel identification and analytical bridging. Where panels could not be identified, three natural terrain features (tree, fence corner, road intersection, etc.) were identified and their positions computed from which the "corner moves" were made.

The technology of analytical aerotriangulation is an evolutionary stage. The "photo project" is a team effort and requires careful planning of the panel design and size, type of film, photo scale, project selection and size. At the present time (1974), it is felt that the given project should be more limited in area. On the latest photogrammetric resurveys it has been held to one township in area, black and white film was used, and the computer print-out returned the values of the panel points as geographic positions.

This photogrammetric resurvey illustrates the general methods used and should not be considered as an example of how a similar project would be executed now or in the future.

### **Solution**

Using the coordinates of all the original corners recovered in the initial search and paneling, the moves from the temporary point to a calculated proportionate point for a corner were computed. The "theta" angle and correction to ground surface was applied, with the final "move" referenced to true north.

Using a solar transit and steel tape, the calculated move was made. Further search for the original corner was then undertaken. All missing section corners were searched for first. If the original corner was found, it was remonumented and the true point tied to the temporary point. In T. 28 N., R. 92 W., only one section corner was never recovered and had to be proportioned, see figure 2. If a section corner was not found, the moves and section search was made for the missing corners in the four directions from it. When all controlling corners had been searched for the second time, the final move could be computed for a corner, the move made, and the proportioned position

monumented. All proportioning was done in the same manner as it would have been had the distances and bearings been determined by conventional methods of resurvey. Of 141 original corners involved in this township, only 20 had to be restored by proportionment.

The three "off-line" closing corners on the north boundary were amended by marking the original stone AM and burying it in place. The true point for the closing corner on the standard parallel was monumented. The  $\frac{1}{4}$  section corners for sections 1 thru 6 were established and monumented. The two locally established corners were verified by their relationship to original corners and were accepted, and functioned as the same as original corners.

The field notes were written in normal order as though the lines had been run on the ground, but with only the corner description, accessories, site location and nearby topography given. Direct ties from the closing corners and  $\frac{1}{4}$  section corners on the north boundary were made to the nearest standard corner. The tie was given in the field notes.

The bearings and distances between corners are shown only on the resurvey plat. The Geological Survey made two overlays of the topography at the scale of 1 inch equals 40 chains. The brown ink overlay shows all contour lines; the black ink overlay shows all water courses, roads, etc. The topography is shown only on the plat accepted November 3, 1969, shown in figure 3.



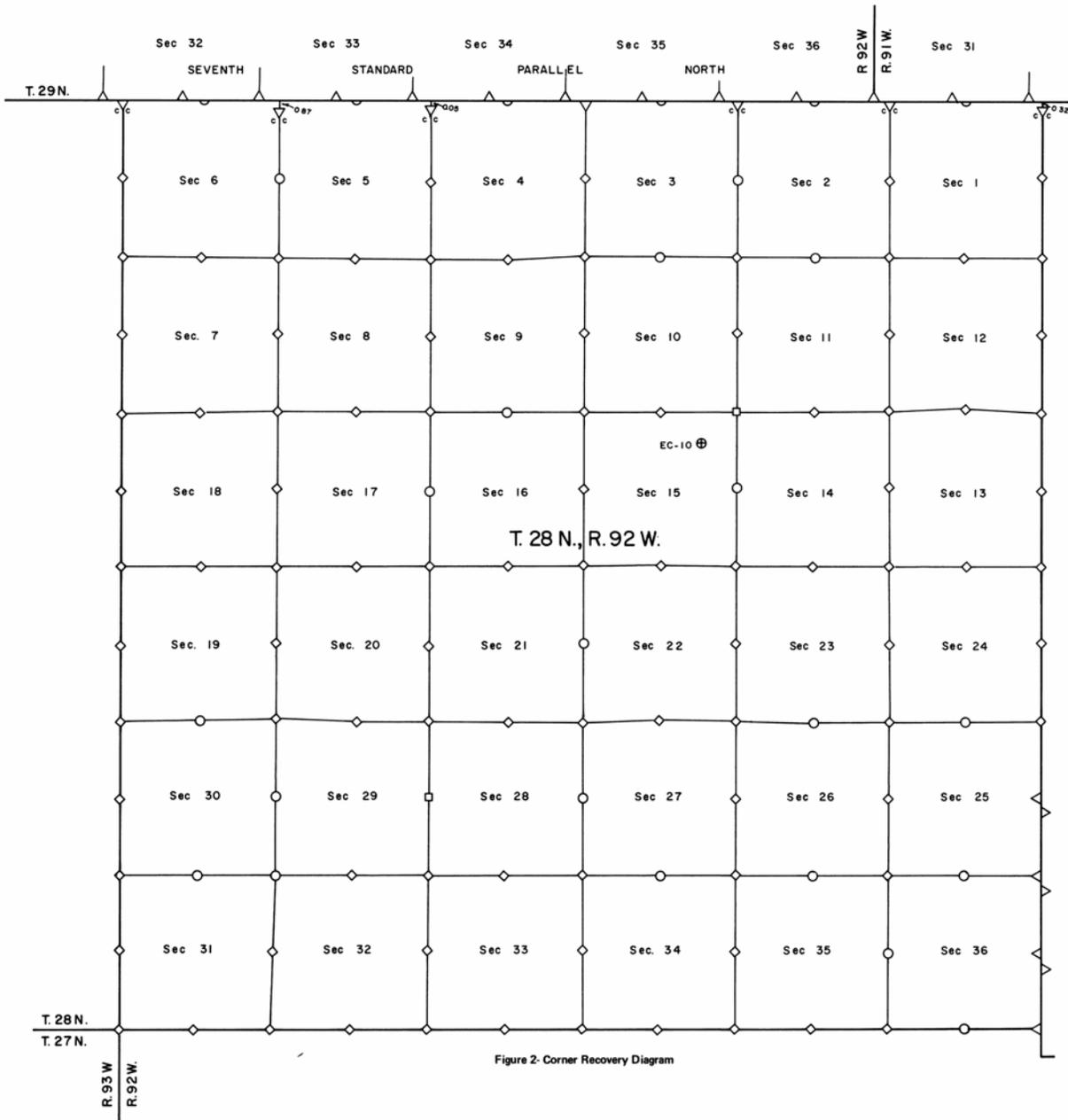


Figure 2- Corner Recovery Diagram

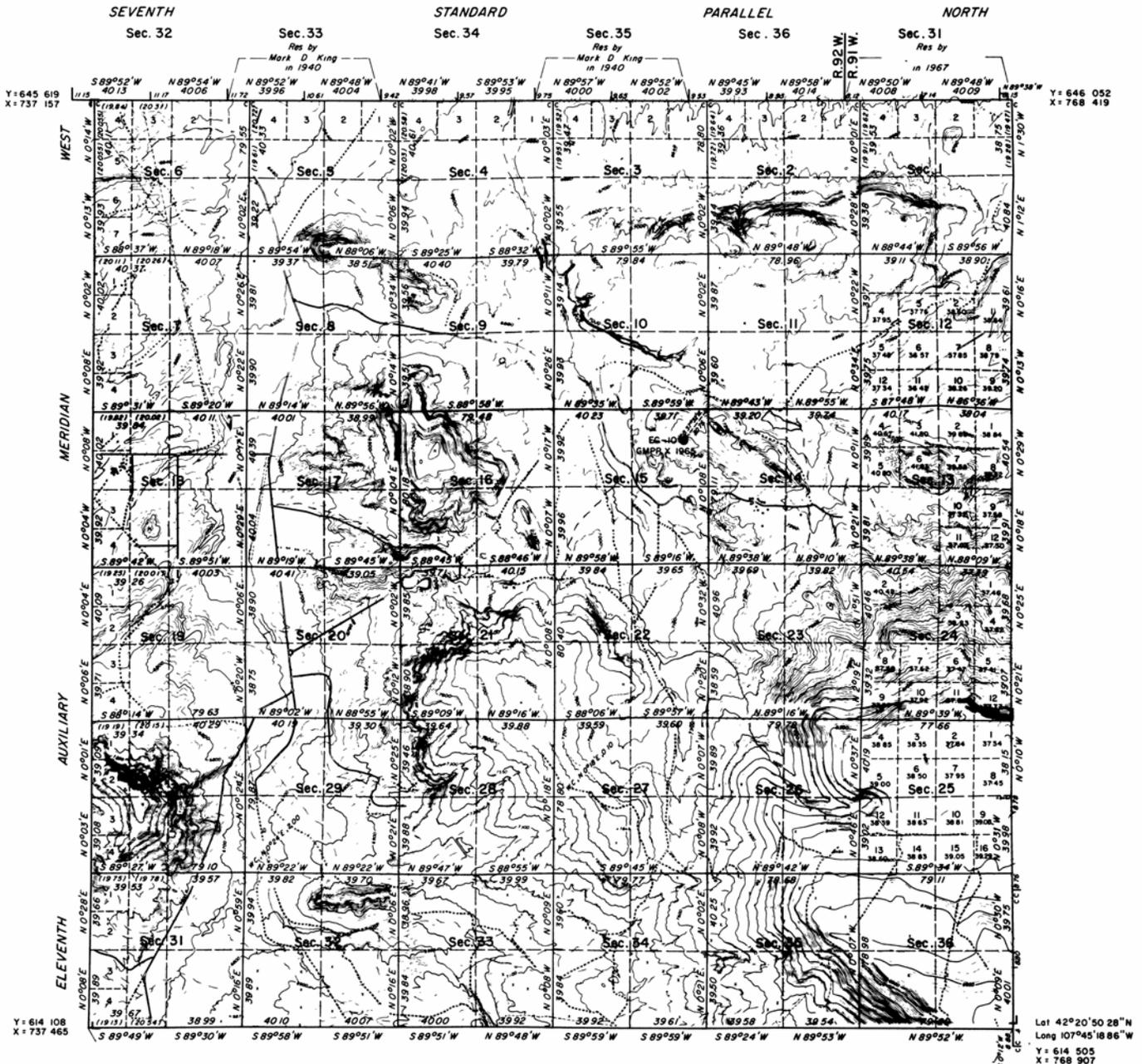


Figure 3 - Portion of Dependent Resurvey Plat, T. 28 N., R. 92 W., Sixth P.M., Wyoming