

PROGRESS REPORT OF COMMITTEE ON CONTROL FOR PHOTO-MAPPING

BELTSVILLE, MARYLAND TEST PROJECT FOR HORIZONTAL CONTROL OF PHOTOGRAPHIC MAPPING BY DIFFERENT METHODS IN GENTLY ROLLING TERRAIN

FOR A LONG TIME, MANY ORGANIZATIONS THAT USE AERIAL PHOTOGRAPHS - AND THESE INCLUDE BOTH GOVERNMENT AND PRIVATE AGENCIES - HAVE FELT THE NEED OF TESTING THE DIFFERENT KINDS OF PHOTOGRAPHS AT THEIR COMMAND AND THE SEVERAL METHODS USED IN COMPILING MAPS FROM THEM, IN ORDER TO DECIDE WHICH METHOD WILL BEST FIT THEIR REQUIREMENTS IN MAPPING DIFFERENT TYPES OF TERRAIN. SUCH TESTS, TO BE ADEQUATE, MUST BE MADE IN AREAS IN WHICH A LARGE AMOUNT OF CONTROL EXISTS, IN ORDER TO DETERMINE THE MINIMUM AMOUNT NEEDED FOR ADEQUATE COMPILATION BY EACH OF THE SEVERAL METHODS NOW IN USE. EARLY IN 1937, THE AMERICAN SOCIETY OF PHOTOGRAMMETRY, AT THE SOLICITATION OF MANY OF ITS MEMBERS, UNDERTOOK THE SELECTION OF FOUR AREAS SUITABLE FOR SUCH TESTS, AS FOLLOWS:

1. FLAT AREA IN SECTIONIZED COUNTRY.
2. GENTLY ROLLING AREA WITH CONSIDERABLE CULTURE AND DRAINAGE AND A REASONABLE AMOUNT OF TIMBER COVER.
3. MOUNTAINOUS AREA WITH HIGH PEAKS AND DEEP GORGES, AND A REASONABLE AMOUNT OF TIMBER COVER.
4. MESA AREAS WITH CONSIDERABLE DIFFERENCE OF ELEVATION BETWEEN HIGH FLAT MESAS AND LOWER ERODED TERRAIN WITH A MINIMUM AMOUNT OF TIMBER COVER.

SELECTION OF AREAS: THE COMMITTEE ON CONTROL FOR PHOTO-MAPPING SELECTED THE ARMY AIR CORPS "PHOTOGRAPHIC PROVING GROUND" NORTHWEST OF DAYTON, OHIO AS THE FLAT AREA IN SECTIONIZED COUNTRY TO BE USED IN THE TESTS FOR ITEM 1. ADEQUATE HORIZONTAL AND VERTICAL CONTROL IS AVAILABLE FOR THIS AREA AND THE CORPS OF ENGINEERS HAS MADE SEVERAL TESTS OF AERIAL PHOTOGRAPHY BY MULTIPLE-LENS AND SINGLE-LENS CAMERAS. HOWEVER, THE OTHER FEDERAL MAPPING AGENCIES HAVE NOT YET ATTEMPTED TO COMPILE PLANIMETRIC MAPS OF THIS AREA.

THE COMMITTEE HAS MADE TENTATIVE SELECTIONS OF A MOUNTAINOUS AREA IN UTAH AND A MESA AREA IN ARIZONA FOR ITEMS 3 AND 4, ON WHICH THE COAST AND GEODETIC SURVEY HAS EXECUTED TRIANGULATION FOR THE SOIL CONSERVATION SERVICE, AND IT IS EXPECTED THAT THE SOIL CONSERVATION SERVICE WILL CONDUCT TESTS ON THESE AREAS.

THE COMMITTEE SELECTED THE BELTSVILLE, MARYLAND AREA FOR ITEM 2 - A GENTLY ROLLING AREA WITH CONSIDERABLE CULTURE AND DRAINAGE AND A REASONABLE AMOUNT OF TIMBER COVER. THIS AREA EMBRACES A REGULAR FIELD PROJECT OF THE SOIL CONSERVATION SERVICE, WHICH HAD CONTRACTED FOR SINGLE-LENS 9 X 9 INCH AERIAL PHOTOGRAPHS ON THE SCALE OF 1:12,000. BY ESTABLISHING IN THIS AREA A SUPERFLUITY OF HORIZONTAL CONTROL SO THAT ONLY A PORTION OF THE CONTROL WOULD BE REQUIRED FOR COMPILATION OF PLANIMETRIC MAPS BY ANY ONE OF THE SEVERAL METHODS NOW IN USE, THE SURPLUS CONTROL DATA CAN BE USED IN TESTING THE VARIOUS PHOTO-MAPPING COMPILATIONS, AND THE CONTROL DATA WOULD BE AVAILABLE FOR AN APPROVED FEDERAL PROJECT, THUS AVOIDING THE CHARGE OF THE COST OF A LARGE PART OF THE CONTROL SURVEYS TO EXPERIMENTATION.

THE BELTSVILLE AREA LIES JUST NORTHEAST OF WASHINGTON, D. C. IT IS RECTANGULAR IN SHAPE AND COVERS APPROXIMATELY 155 SQUARE MILES. HYATTSVILLE, MARYLAND, IS NEAR ITS SOUTHWEST CORNER, LAUREL, MARYLAND, IS NEAR ITS NORTHCENTER, AND FORT GEORGE G. MEADE IS NEAR ITS NORTHEAST CORNER. THE MAIN HIGHWAY FROM WASHINGTON TO BALTIMORE PASSES THROUGH THE AREA AND THE RESETTLEMENT ADMINISTRATION'S PROJECT OF GREENBELT OCCUPIES THE CENTRAL PART OF THE AREA.

THE COMMITTEE HAS REQUESTED THE SOIL CONSERVATION SERVICE TO PLOT PLANIMETRIC MAPS BY THE SLOTTED TEMPLATE METHOD, THE COAST AND GEODETIC SURVEY BY THE GRAPHIC TEMPLATE METHOD AND THE GEOLOGICAL SURVEY BY THE GRAPHIC RADIAL LINE METHOD WITHOUT TEMPLATES. EACH OF THESE AGENCIES HAS BEEN REQUESTED TO SUBMIT REPORTS WITH ACCURATE COST AND TIME RECORDS AND ACCURACY RESULTS OF THEIR OPERATIONS.

COPIES OF THE GEOGRAPHIC POSITIONS OF THE PICTURE POINTS, TOGETHER WITH SKETCHES OF EACH PICTURE POINT, CAN BE FURNISHED BY THE COMMITTEE TO ANY

OTHER AGENCY WHICH DESIRES TO MAKE A TEST PLOT AND IS WILLING TO PURCHASE FROM THE GOVERNMENT A SET OF AERIAL PHOTOGRAPHS.

DESCRIPTION OF CONTROL SURVEYS: A BRIEF DESCRIPTION OF THESE CONTROL SURVEYS IS CONTAINED IN THIS PROGRESS REPORT. A FINAL REPORT WILL BE PREPARED FOR PUBLICATION IN PHOTOGRAMMETRIC ENGINEERING AS SOON AS THE SEVERAL FEDERAL AGENCIES HAVE TESTED THE COMPILATION OF PLANIMETRIC MAPS BY THE SEVERAL METHODS NOW IN USE. LATER, THE COMMITTEE PROPOSES TO RECOMMEND THE ESTABLISHMENT OF AN ADEQUATE AMOUNT OF VERTICAL CONTROL, SO THAT CONTOUR MAPS CAN BE PLOTTED BY STEREO-PHOTO-TOPOGRAPHIC METHODS AND TESTED BY PROFILES OR SUPPLEMENTAL GROUND SURVEYS.

ORGANIZATION OF FIELD PARTY: IT WAS INTENDED ORIGINALLY THAT THE WORK SHOULD BE DONE BY A REGULAR FIELD PARTY OF THE GEOLOGICAL SURVEY, AND THAT THE SOIL CONSERVATION SERVICE SHOULD COOPERATE BY SHARING THE EXPENSE. BY THE TIME THE WORK WAS UNDERTAKEN, HOWEVER, THE STATUS OF ITS APPROPRIATIONS MADE IT IMPRACTICABLE FOR THE SOIL CONSERVATION SERVICE TO TRANSFER ANY OF ITS FUNDS, SO THAT AGENCY ARRANGED, INSTEAD, TO SUPPLY PART OF THE PERSONNEL FOR THE FIELD PARTY, CHOOSING THE MEN FROM ITS REGULAR EMPLOYEES. THE CHIEF OF PARTY, THE RECORDER AND TWO TAPE-MEN WERE GEOLOGICAL SURVEY EMPLOYEES AND SEVEN ASSISTANTS WERE ASSIGNED BY THE SOIL CONSERVATION SERVICE, ROTATED SO THAT FIVE MEN WERE ON DUTY DURING THE PROGRESS OF FIELD WORK.

WORK ON THE BELTSVILLE PROJECT WAS BEGUN ON MARCH 15, 1937, BY THE SENDING OF TWO EMPLOYEES OF THE GEOLOGICAL SURVEY TO THE OFFICES OF THE CHIEF ENGINEER, WASHINGTON SUBURBAN SANITARY DISTRICT, AT HYATTSVILLE, MD., TO COPY FIELD NOTES OF TRANSIT TRAVERSE ALREADY DONE BY THE SANITARY DISTRICT IN THE AREA COVERED BY THE PROJECT. THE RESULTS OF THIS TRAVERSE WERE USED TO SUPPLEMENT THE NEW LINES OF TRAVERSE. THIS ADDITIONAL CONTROL WAS MADE AVAILABLE THROUGH THE COURTESY OF MR. VERNON D. GEORGE, DIVISION ENGINEER, SURVEYS DIVISION OF THE WASHINGTON SUBURBAN SANITARY DISTRICT. AT THE SAME TIME PICTURE POINTS WERE SELECTED ALONG THE LINES OF THIS TRAVERSE AND TIED IN TO THE MOST CONVENIENT ESTABLISHED STATIONS.

ACTUAL RUNNING OF NEW TRANSIT TRAVERSE BEGAN ON APRIL 12, 1937, WITH A FIELD PARTY OF ONLY SIX OR SEVEN MEN, WHICH NUMBER WAS GRADUALLY INCREASED UNTIL ON MAY 1, THE FULL PARTY OF NINE MEN WAS ASSEMBLED. THE FIELD WORK WAS COMPLETED ON JUNE 14, 1937. THE FULL PARTY CONSISTED OF AN INSTRUMENT-MAN, A RECORDER, FOUR TAPEMEN, TWO RODMEN, AND ONE MAN TO MAKE PICTURE-POINT IDENTIFICATIONS.

EQUIPMENT: THE WORK WAS DONE WITH A 30-SECOND TRANSIT AND 300-FOOT STEEL TAPES, ONE OF WHICH WAS STANDARDIZED AND USED ONLY TO TEST THE OTHERS. THE SOIL CONSERVATION SERVICE FURNISHED A SET OF SINGLE-LENS PHOTOGRAPHS TO BE USED IN IDENTIFYING THE PICTURE POINTS LOCATED BY THE TRAVERSE LINES. THE GEOLOGICAL SURVEY FURNISHED THREE LIGHT TRUCKS FOR TRANSPORTATION.

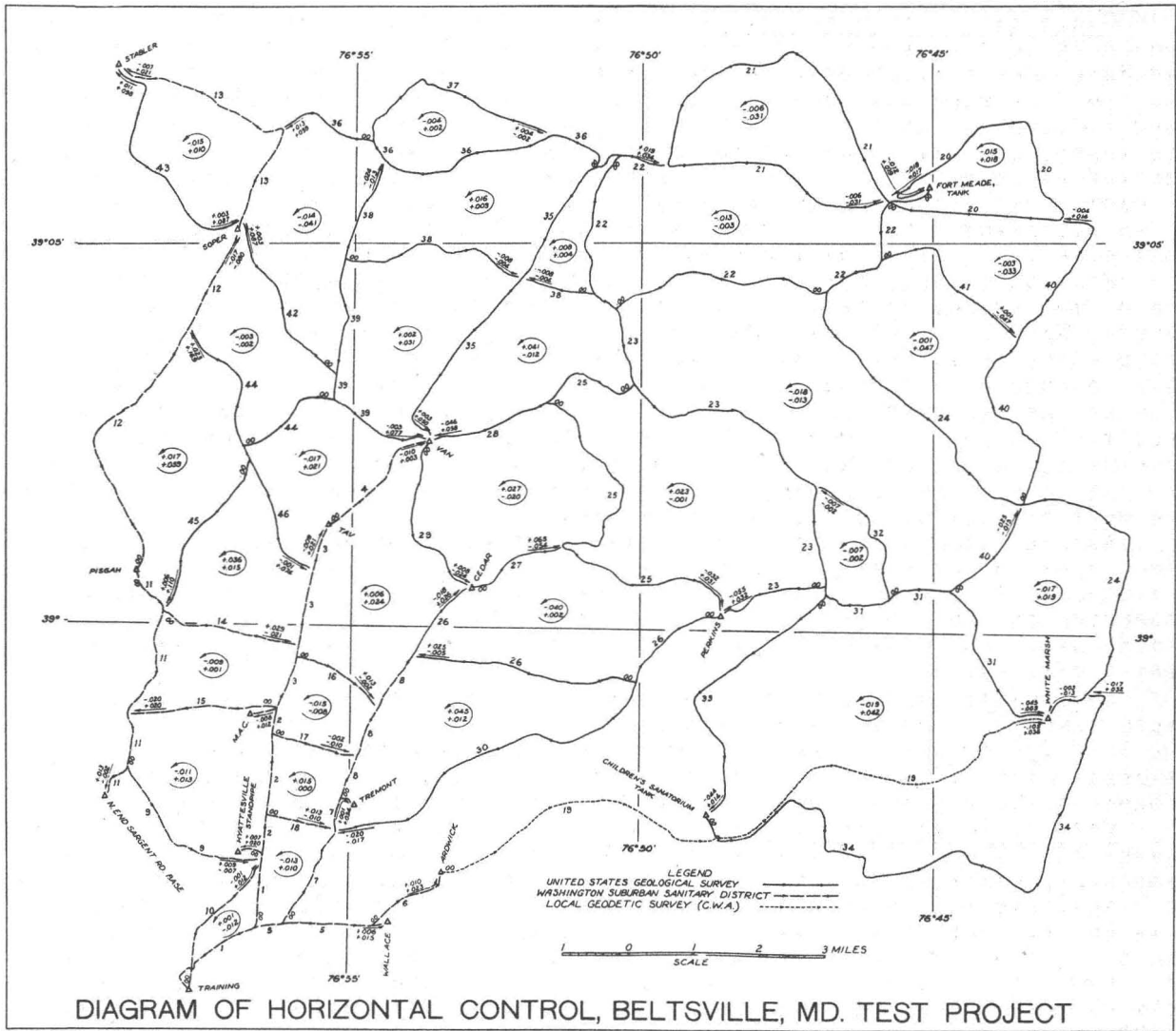
METHODS OF TRAVERSE USED: THE USUAL METHODS ADOPTED BY THE GEOLOGICAL SURVEY FOR THIRD-ORDER TRAVERSE WERE EMPLOYED ON THIS PROJECT, REFINED SUFFICIENTLY, HOWEVER, TO ATTAIN SECOND-ORDER PRECISION. ALL COURSES WERE DOUBLE TAPED, AND THE INDEPENDENT RESULTS OF THE TWO MEASUREMENTS WERE COMPARED; A THIRD MEASUREMENT WAS MADE OF ANY COURSE FOR WHICH THE RESULTS OF THE FIRST TWO DID NOT AGREE WITHIN 1 PART IN 10,000. THE FULL LENGTHS OF THE TAPES WERE USED ONLY ALONG LEVEL GROUND. ON ANY APPRECIABLE GRADE BROKEN TAPE LENGTHS WERE USED, THE TAPEMEN HOLDING THE TAPE HORIZONTAL UNDER A TENSION OF 20 POUNDS. PLUMB BOBS WERE USED AT THE HIGH ENDS OF THE TAPES TO TRANSFER THE HORIZONTAL MEASUREMENTS TO THE GROUND, AND NOT MORE THAN 120 FEET OF TAPE WAS USED UNSUPPORTED. TEMPERATURE WAS RECORDED IN ORDER THAT PROPER CORRECTIONS FOR IT MIGHT BE APPLIED.

ANGLES WERE MEASURED AS DEFLECTIONS - THREE DIRECT AND THREE REVERSED AT EACH STATION. THE MEAN DEFLECTION ANGLES WERE THEN USED TO FORWARD THE AZIMUTH THROUGH THE LINE. THE CONTROL FOR AZIMUTH WAS TAKEN FROM TRIANGULATION IF POSSIBLE, AND ALSO BY MAKING FREQUENT AZIMUTH OBSERVATIONS ON POLARIS. POLARIS OBSERVATIONS WERE MADE AT POINTS AT ABOUT THE DISTANCE OF 20 STATIONS APART, EXCEPT THAT THREE MILES WAS THE GREATEST DISTANCE ALLOWED BETWEEN ANY TWO CONSECUTIVE OBSERVATIONS.

RESULTS: ABOUT 25 PERMANENT MARKS WERE ESTABLISHED ON THE NEW LINES OF TRANSIT TRAVERSE, AND 192 PICTURE POINTS, WHICH WERE IDENTIFIED ON THE PHOTO

GRAPHS USED IN THE FIELD AND FOR WHICH COORDINATES WERE COMPUTED, WERE LOCATED. IN ORDER TO FURTHER MAKE PERMANENT THE RECORD OF THE PICTURE POINTS, A SMALL SKETCH SHOWING ITS RELATION TO LOCAL FEATURES WAS MADE FOR EACH PRINT.

IN ALL, 146 LINEAR MILES OF NEW TRAVERSE WAS RUN, AND TO SUPPLEMENT THIS, 49 MILES RUN BY THE WASHINGTON SUBURBAN SANITARY DISTRICT WAS ALSO USED. THE TRAVERSE OF THE SANITARY DISTRICT HAD BEEN COMPUTED IN TERMS OF RECTANGULAR COORDINATES BASED UPON A LOCAL ORIGIN AND CENTRAL MERIDIAN, AND IN ORDER THAT THE FORM OF ITS RESULTS MIGHT BE CONSISTENT WITH THOSE OF THE NEW TRAVERSE, FREQUENT AZIMUTH OBSERVATIONS ON POLARIS WERE MADE ALONG ITS



Lines and the true azimuths of all courses were obtained. The results were then recomputed to express determined positions in terms of geographic coordinates. No new permanent marks were established along these lines, as the Washington Suburban Sanitary District had already indicated every angle point by a bronze plug in the pavement or by some other mark of a reasonably permanent kind. The results of a traverse line run in the area by the Civil Works Administration were also available and were utilized by the Beltsville project. This line runs along the Defense Highway from a point near Hyattsville to the southeast corner of the project - a distance of 11 miles. It

WAS RUN UNDER THE IMMEDIATE DIRECTION OF PROF. S. S. STEINBERG, OF THE UNIVERSITY OF MARYLAND, AND WAS SPONSORED BY THE UNITED STATES COAST AND GEODETIC SURVEY. THE RESULTS OF THIS TRAVERSE, LIKE THOSE OF THE TRAVERSE OF THE WASHINGTON SUBURBAN SANITARY DISTRICT, WERE RECOMPUTED WITH TRUE AZIMUTHS TO OBTAIN GEOGRAPHIC COORDINATES. ALONG THE LINES RUN BY THE TWO ORGANIZATIONS JUST MENTIONED 81 PICTURE POINTS WERE ESTABLISHED.

AN EFFORT WAS MADE TO SELECT PICTURE POINTS WHICH WOULD ENDURE; THAT IS, WHICH WOULD NOT BE CHANGED OR EFFACED BY CHANGES IN ROADS OR OTHER CULTURAL IMPROVEMENTS IN THEIR VICINITY. THEY WERE ESTABLISHED ABOUT 2,500 FEET APART ON THE AVERAGE, ALTHOUGH THIS DISTRIBUTION COULD NOT BE MAINTAINED AT ALL TIMES. POINTS OF MANY DIFFERENT KINDS WERE CHOSEN, SO THAT THE TEST TO BE MADE MIGHT INDICATE THE KIND MOST LIKELY TO PROVE SATISFACTORY FOR THE CONTROL OF PHOTOGRAPHS.

COMPUTATION: THE TRAVERSE LINES WITHIN THE PROJECT HAVE BEEN TIED TO 16 TRIANGULATION STATIONS, THE ADJUSTED POSITIONS FOR SOME OF WHICH HAD ALREADY BEEN REFERRED TO THE NORTH AMERICAN DATUM OF 1927 AND WERE THEREFORE IMMEDIATELY AVAILABLE. FOR OTHER STATIONS, HOWEVER, THE POSITIONS WERE NOT AVAILABLE, BECAUSE THEY HAD BEEN ESTABLISHED ONLY A SHORT TIME BEFORE BY THE WASHINGTON SUBURBAN SANITARY DISTRICT. THE NOTES ON THESE STATIONS WERE TRANSMITTED TO THE UNITED STATES COAST AND GEODETIC SURVEY FOR COMPUTATION AND ADJUSTMENT, AND SINCE TRAVERSE LINES COULD NOT BE BASED UPON THESE STATIONS UNTIL THE WORK OF COMPUTATION AND ADJUSTMENT HAD CORRECTLY ESTABLISHED THEIR POSITIONS, IT WAS NECESSARY TO EXPEDITE THAT WORK. COMPUTERS FROM THE GEOLOGICAL SURVEY WERE ACCORDINGLY ASSIGNED TO THE TASK, WHICH THEY COMPLETED UNDER THE DIRECTION OF THE COAST AND GEODETIC SURVEY.

THE ATTACHED DIAGRAM SHOWS THE TRAVERSE NET AND THE TRIANGULATION STATIONS UPON WHICH THE LINES DEPEND. CLOSURES HAVE BEEN INDICATED IN TERMS OF SECONDS OF LATITUDE AND LONGITUDE. IF THEY ARE SHOWN AT JUNCTION POINTS THEY ARE THE CLOSURES OF THE UNADJUSTED LINES UPON ONE ANOTHER, AND THE QUANTITIES SHOWN IN THE CENTER OF EACH CIRCUIT INDICATE THE DEDUCED CIRCUIT CLOSURES.

THE FIRST STEP IN CONDUCTING THE COMPUTATIONS WAS TO CORRECT ALL AZIMUTHS FOR THE CONVERGENCE OF MERIDIANS. THE REMAINING ERRORS EXISTING BETWEEN AZIMUTH-CONTROLLED STATIONS WERE TAKEN CARE OF THEN BY PRORATED CORRECTIONS. DISTANCES WERE TAKEN AS THE MEAN OF THE TWO INDEPENDENT MEASUREMENTS CORRECTED FOR TEMPERATURE AND TENSION. LATITUDES AND DEPARTURES WERE COMPUTED ON CALCULATING MACHINES, WITH WHICH NATURAL TRIGONOMETRIC FUNCTIONS WERE USED. COMPUTATIONS WERE CONDUCTED IN DUPLICATE BY DIFFERENT COMPUTERS IN ORDER TO GUARD AGAINST ERRORS.

THE ADJUSTMENT OF CLOSURES WAS ACCOMPLISHED BY THE METHOD OF LEAST SQUARES. THE CIRCUITS CONSISTING MOSTLY OF LINES RUN BY THE WASHINGTON SUBURBAN SANITARY DISTRICT WERE INCLUDED IN ONE SOLUTION, WHICH CONTAINED 13 CONDITION EQUATIONS. ANOTHER SOLUTION OF 26 EQUATIONS WAS MADE FOR THE GROUP OF CIRCUITS MADE UP MOSTLY OF THE NEW LINES OF TRAVERSE. THE RESIDUALS IN BOTH SOLUTIONS INDICATE A PRECISION OF APPROXIMATELY 1 PART IN 12,500. ALL OF THESE COMPUTATIONS AND ADJUSTMENTS WERE MADE BY COMPUTERS OF THE GEOLOGICAL SURVEY.

THE TOTAL AMOUNT OF TRANSIT TRAVERSE MADE AVAILABLE FOR THIS PROJECT, WITH RESULTS IN THE FORM OF GEOGRAPHIC COORDINATES, IS 206 LINEAR MILES. IN ALL, 273 PICTURE POINTS WERE LOCATED, AND 25 NEW PERMANENT MARKS WERE ESTABLISHED. THE WORK IS WELL WITHIN THE LIMITS OF SECOND-ORDER ACCURACY. COORDINATES ARE REFERRED TO THE NORTH AMERICAN DATUM OF 1927. THE WORK WAS CONDUCTED IN A MANNER CONFORMING AS NEARLY AS POSSIBLE TO THE RECOMMENDATIONS OF THE SEVERAL MEMBERS OF THE COMMITTEE.

COMMITTEE ON CONTROL FOR PHOTO-MAPPING:

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