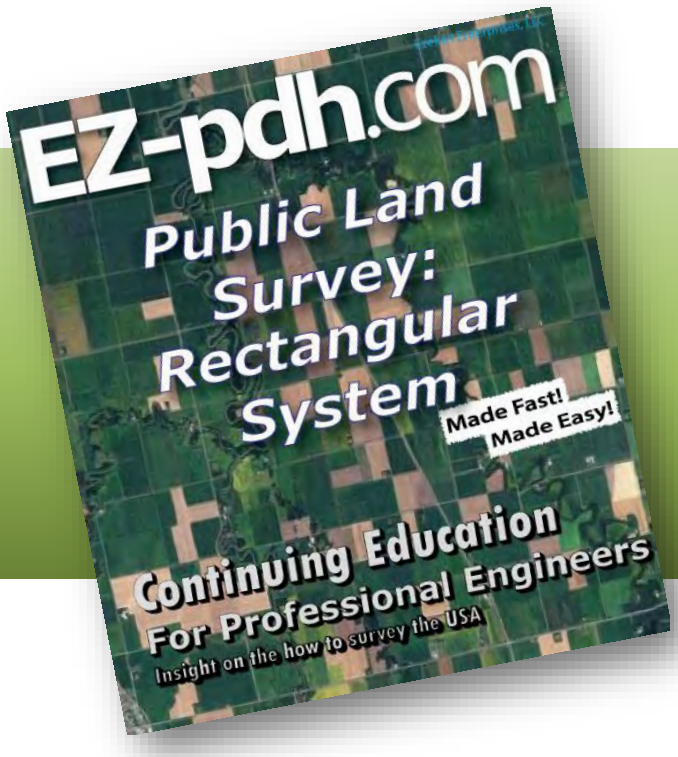

Public Land Survey: Rectangular System

Eight (8) Continuing Education Hours
Course #LS1008

Approved Continuing Education for Licensed Professional Engineers & Land Surveyors

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Course Description:

The Public Land Survey: Rectangular System course satisfies eight (8) hours of professional development.

The course is designed as a distance learning course that presents an overview of the rectangular system utilized for public survey for licensed land surveyors and professional engineers.

Objectives:

The primary objective of this course is to enable the student to understand and apply rectangular surveying methods which have been used continuously in the United States since 1785.

Grading:

Students must achieve a minimum score of 70% on the online quiz to pass this course. The quiz may be taken as many times as necessary to successful pass and complete the course.

A copy of the quiz questions are attached to last pages of this document.

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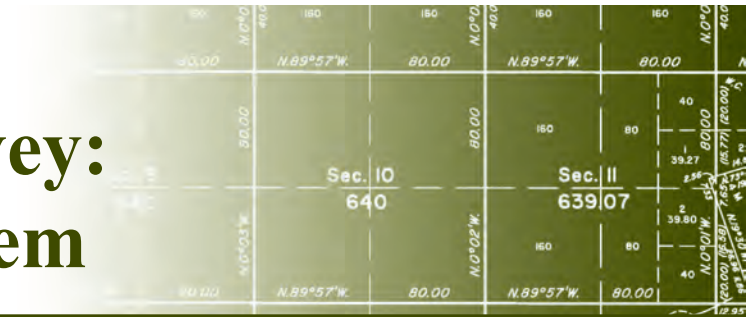


Introduction

1-1. The rectangular system of public land surveys over the public domain provides a simple and certain form of land identification and legal description. It has been used continuously since 1785. Although few of the original surveys now being made cover extensive areas, except in the State of Alaska, all facets of the rectangu-lar system occasionally come into use. For this reason, and to make clear the procedures that have been fol-lowed in surveying public lands, a complete discussion of the system is included in this Manual.

The field procedures outlined in this course include procedures used historically as well as current methods for conducting an original survey. Historically, original surveys were made to create surveys of new areas by extending existing rectangular surveys into unsurveyed lands. This approach differs from the modern practice of using a protraction diagram or predetermined plan of survey so new surveys can be made in areas where they do not necessarily adjoin existing rectangular surveys.

Other procedures discussed in this course include creat-ing protraction diagrams, special instructions diagrams where no protraction exists, and modifying approved protraction diagrams. Knowledge of the original field survey procedures used is important when resurvey-ing or retracing an original survey. Many different pro-cedures have evolved and the surveyor will reference the Manual in effect for the time of the survey being retraced.

General Scheme

1-2. Under the rectangular system, the unit of survey is the township of 36 sections. The unit of subdivision is the section of 640 acres. Under the general land laws, the unit of administration is the quarter-quarter section of 40 acres or the lot, either of which is often referred to as the smallest legal subdivision. Under mining and reclamation laws, the smallest legal subdivision is the quarter-quarter-quarter section of 10 acres. Some special statutes specified even smaller legal subdivisions, e.g., homestead entry surveys within National Forests and mining claim mill sites.

The law provides that (1) the public lands of the United States shall be divided by lines intersecting true north and south lines at right angles so as to form townships 6 miles square; (2) the townships shall be marked with progressive numbers from the beginning; (3) the townships shall be subdivided into 36 sections, each 1 mile square and containing 640 acres as nearly as may be; (4) the sections shall be numbered, respectively, beginning with the number 1 in the northeast section, and proceeding west and east alternately through the township with progressive numbers to and including 36; and (5) a fair plat describing the subdivisions and marks shall be made and recorded at a designated office (Rev. Stat. 2395; 43 U.S.C. 751).

3- In accordance with the foregoing legal requirements, the public lands are surveyed under the method called the system of rectangular surveys and uses the following procedure:

(1) The establishment of independent initial points, each to serve as an origin for surveys to be extended in separated localities.

(2) The survey of principal meridians and base lines, originating at the initial points.

(3) The establishment of guide meridians initiated at base lines, and of standard parallels initiated at principal meridians, at intervals short enough to maintain a workable adherence to the legal definition of the primary unit, the township 6 miles square.

(4) The survey of township exteriors within the established framework Townships are numbered

to the north or south commencing with number 1 at the base line, and with range numbers to the east or west beginning with number 1 at the principal meridian.

(5) The subdivision of the townships into 36 sections by running parallel lines through the township from south to north and from east to west at distances of 1 mile. The sections are numbered commencing with number 1 in the northeast section of the township, proceeding thence west to section 6, thence south to section 7, thence east to section 12, and so on, alternately, to number 36 in the southeast section.

1-4. By law, (1) the corners marked in public land surveys shall be established as the proper corners of sections, or of the subdivisions of the sections, which they were intended to designate; (2) the boundary lines actually run and marked shall be and remain the proper boundary lines of the sections or subdivisions for which they were intended, and the lengths of these lines as returned shall be held as the true length thereof; and (3) the contents of each section or subdivision of section returned shall be held and considered as containing the exact quantity expressed (Rev. Stat. 2396; 43 U.S.C. 752).

The original corners shall stand as the true corners they were intended to represent, even though not exactly where professional care might have placed them in the first instance. Lost corners must be reestablished in the identical positions they originally occupied. When the positions cannot be determined by existing monuments or other verifying evidence, resort shall be had to the official record (field notes and plat, or field notes on the plat) of the original survey. The law provides that the lengths of the lines, as returned in the official record, shall be held as the true lengths, and the distances between identified corner positions given in the official record constitute proper data from which to determine the position of a lost corner; hence, the rule that lost corners are restored at distances proportionate to the original measurements between identified positions.

Corners established but not marked on the original surveys (sixteenth-section corners, subdivision-of-section corners) will forever remain fixed in position when marked (1) using proper survey procedures, (2) without gross error in measurement, and (3) in accordance with substantial evidence of the position of the controlling corners.

1-5. In the sections that follow, the first explanations are with respect to ideal procedure in the rectangular plan. The plan must be modified in various ways in order to begin new work where the initial and closing lines already established by prior survey do not qualify under the current specifications for rectangularity and closure but cannot be changed now because of the passing of titles based on them. New survey work will avoid the incorporation of the discrepancies of the older lines in the running of new original surveys.

Initial Points

1-6. Since the organization of the system of rectangular surveys, numbered and locally named principal meridians and base lines have been established as listed in table 1-1. These bases and meridians are shown on a special map entitled "Principal Meridians and Base Lines Governing the United States Public Land Surveys" published by the BLM (figure 1-1).

The latitude and longitude coordinates given in table 1-1 are based upon the Greenwich Meridian and the best available information. The horizontal datum used is the North American Datum of 1983 (NAD 83). In some cases the coordinates shown are only an approximate value since many of the initial points were fixed in position by surveys that were largely completed before importance was attached to the matter of accurate coordinates. The geographic coordinates in table 1-1 should not be used in lieu of a field determination, except when an approximate value will satisfy all requirements.

1-7. The rectangular system was initiated in the State of Ohio in 1785 from a point on the west boundary of Pennsylvania, on the north bank of the Ohio River, in approximate latitude 40°38'22.051" N. and longitude 80°31'08.500" W. NAD 83. The State boundary served as the first reference meridian. A number of other reference meridians and bases were employed in Ohio to govern particular areas for purposes of disposal. In its early stages the system was somewhat experimental, and Ohio may well be referred to as the proving ground for the present rectangular system of surveys. The rectangular surveys that have no initial point as an origin of township identification are listed in table 1-2.

Principal Meridian

1-8. A principal meridian is intended to conform to the true meridian, extending north or south, or in both directions, from the initial point as conditions require. Regular quarter-section and section corners

Table 1-1. Meridians and Base Lines of the United States Rectangular Surveys

Meridian	Adopted	Governing surveys (wholly or in part) in States of	Initial Points (NAD 83)					
			Latitude N.			Longitude W.		
			°	'	"	°	'	"
Black Hills	1878	South Dakota	43	59	43.760	104	03	18.350
Boise	1867	Idaho	43	22	19.242	116	23	38.708
Chickasaw	1833	Mississippi and Tennessee	35	02	02.000	89	14	49.950
Choctaw	1821	Mississippi	31	52	28.932	90	14	42.408
Cimarron	1881	Oklahoma	36	30	05.266	103	00	08.589
Copper River	1905	Alaska	61	49	02.223	145	18	43.285
Fairbanks	1910	Alaska	64	51	48.503	147	38	34.683
Fifth Principal	1815	Arkansas, Iowa, Minnesota, Missouri, North Dakota, and South Dakota	34	38	44.455	91	03	07.337
First Principal	1819	Ohio and Indiana	40	59	21.760	84	48	11.650
Fourth Principal	1815	Illinois	40	00	51.254	90	27	13.290
Fourth Principal Wisconsin	1831	Minnesota and Wisconsin	42	30	25.900	90	25	36.210
Gila and Salt River	1865	Arizona	33	22	37.827	112	18	21.999
Humboldt	1853	California	40	25	01.985	124	07	13.942
Huntsville	1807	Alabama and Mississippi	34	59	27.050	86	34	16.480
Indian	1870	Oklahoma	34	30	24.496	97	14	50.191
Kateel River Principal	1956	Alaska	65	26	14.088	158	45	40.380
Louisiana	1807	Louisiana and Texas	31	00	31.928	92	24	55.880
Michigan	1815	Michigan and Ohio	42	25	28.751	84	21	52.884
Mount Diablo	1851	California and Nevada	37	52	54.112	121	54	50.958
Navajo	1869	Arizona and New Mexico	35	45	06.775	108	32	14.431
New Mexico Principal	1855	Colorado and New Mexico	34	15	35.946	106	53	14.962
Principal	1867	Montana	45	47	12.824	111	39	35.576
Salt Lake	1855	Utah	40	46	10.269	111	53	28.776
San Bernardino	1852	California and Nevada	34	07	12.997	116	55	51.511
Second Principal	1805	Illinois and Indiana	38	28	09.900	86	27	20.400
Seward Principal	1911	Alaska	60	07	34.933	149	21	33.551
Sixth Principal	1856	Colorado, Kansas, Nebraska, South Dakota, and Wyoming	40	00	07.100	97	22	09.124
St. Helena	1819	Louisiana	30	59	57.000	91	09	36.800
St. Stephens	1805	Alabama and Mississippi	30	59	52.094	88	01	21.067
Tallahassee	1824	Florida	30	26	04.148	84	16	37.559
Third Principal	1805	Illinois	38	28	25.968	89	08	40.269
Uintah Special	1875	Utah	40	25	58.379	109	56	07.418
Umiat Principal	1956	Alaska	69	23	28.279	152	00	15.186
Ute Principal	1880	Colorado	39	06	22.727	108	32	01.436
Washington	1803	Mississippi	30	59	57.000	91	09	36.800
Willamette	1851	Oregon and Washington	45	31	10.233	122	44	37.897
Wind River	1875	Wyoming	43	00	40.948	108	48	51.786

Table 1-2. Public Land Surveys Having No Initial Point as an Origin for Both Township and Range Numbers

Survey (and year commenced)		Townships numbered	Ranges numbered
Ohio River Survey (Ohio)	1785	North from Ohio River	West from west boundary of Pennsylvania
U.S. Military Survey (Ohio)	1797	North from south boundary of military grant.	West from west boundary of the Seven Ranges
West of the Great Miami (Ohio)	1798	North from Great Miami River	East from Ohio-Indiana boundary
Ohio River Base (Indiana)	1799	North from Ohio River	From Ohio-Indiana boundary and its projection south
Scioto River Base (Ohio)	1799	North from Scioto River	West from west boundary of Pennsylvania
Muskingum River Survey (Ohio)	1800	1 and 2	10
Between the Miamis, north of Symmes Purchase (Ohio)	1802	*East* from Great Miami River	*North* from Ohio River (continuing numbers from Symmes Purchases)
Twelve-Mile-Square Reserve (Ohio)	1805	1, 2, 3, and 4	None

are established alternately at intervals of 40 chains, and regular township corners at intervals of 480 chains. Corners designated as meander corners are established at the intersection of the line with meanderable bodies of water.

1-9. The survey of the principal meridian and other standard lines (base lines, standard parallels, and guide meridians), require independent verification of the accuracy of measurements made. Typically, verification of measurements will be done: (1) when subdivisional closings are provided in the same assignment with the establishment of the standard line, in which case the closings furnish a verification of the length; or (2) when the measurements are verified through other independent means such as the statistical analysis of measured data.

If the measurement error of a standard line exceeds 2 links per 80 chains, new measurements are made to reduce the measurement error. If independent tests of the alinement of a standard line indicate that the line has deflected more than 0'50" from the true cardinal course, the source of error will be identified and corrected. These are the maximum discrepancies allowable in new surveys.

Base Line

1-10. The base line is extended east and west from the initial point on a true parallel of latitude. Standard quarter-section and section corners are established alternately at intervals of 40 chains and standard township corners at intervals of 480 chains. Meander corners are established where the line intersects meanderable bodies of water.

1-11. The manner of making the measurement of the base line and the accuracy of alinement and measurement are the same as required in the survey of the principal meridian. The determination of the alinement of the true latitudinal curve process is described in the record.

Protraction Diagrams Plan of Survey

1-12. Protraction diagrams have been prepared for substantially all unsurveyed areas in the public domain. Such diagrams are prepared to describe unsurveyed land areas. A protraction diagram is not, and is not intended to be, a substitute for an official survey. Protraction diagrams consist of drawn lines that follow the public land survey system but are not an actual survey. They do not involve a field survey with monumentation and hence no monuments on the ground. They represent the plan for the extension of the rectangular system over unsurveyed lands, following the general scheme as outlined earlier. They are constructed based upon the following rules as far as practicable. For discussion on preparation of pro-traction diagrams see sections 1-138 through 1-157.

Standard Parallels

1-13. Standard parallels, which have also been called correction lines, are extended east and west from the

principal meridian, at intervals of 24 miles north and south of the base line, in the manner prescribed for the survey of the base line.

Where standard parallels previously have been placed at intervals of 30 or 36 miles, and present conditions require additional standard lines, an intermediate standard parallel line is established to which a local name may be given, such as "Fifth Auxiliary Standard Parallel North" and run like a regular standard parallel.

Guide Meridians

1-14. Guide meridians are extended north from the base line, or standard parallels, at intervals of 24 miles east and west from the principal meridian, in the manner prescribed for running the principal meridian. The guide meridians terminate at the points of their intersections with the standard parallels. The guide meridian is projected on the true meridian, and the excess or deficiency in measurement is incorporated in the last half mile. At the point of intersection of the guide meridian with the standard parallel, a township corner is established. The corner typically controls one side of a line only, a corner of minimum control. The parallel is retraced between the nearest corners on the standard parallel east and west to determine the alinement, and the distance is measured and recorded to each of the corners (figure 1-1).

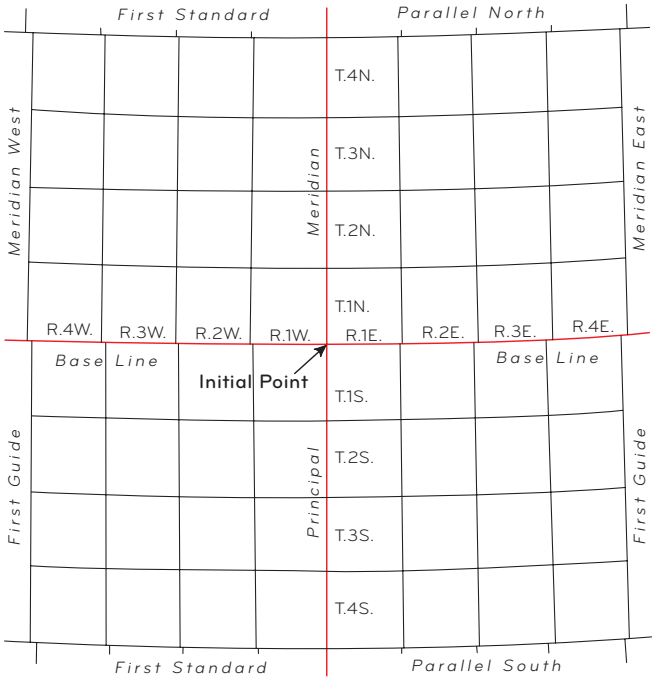


Figure 1-1. Survey of quadrangles, each embracing 16 townships bounded by standard lines, showing the coordinate system of numbering townships.

1-15. When existing conditions require that guide meridians be run south from the base or standard parallel lines, they are initiated at the theoretical point for the intersection of the guide meridian, calculated on the basis of the survey of the line from south to north initiated at the proper standard township corner. At the theoretical point of intersection a township corner is established.

1-16. Where guide meridians have been placed at intervals exceeding the distance of 24 miles, and new governing lines are required, a new guide meridian is established, and a local name is assigned, such as "Twelfth Auxiliary Guide Meridian West" or "Grass Valley Guide Meridian." Auxiliary guide meridians are surveyed in all respects like regular guide meridians.

Township Exteriors

Regular Order

1-17. The south and east boundaries of a township are normally the governing lines of the subdivisional surveys. Defective conditions in previously established exteriors cannot be eliminated where subdivisional lines have been initiated from or closed upon an old boundary, but the errors of former surveys are not incorporated into the new. Where the previously established south and east boundaries cannot on that account be used to govern the subdivision of the adjoining township, other controlling lines known as the sectional correction line and the sectional guide meridian, or the governing section line are employed (figures 1-2 through 1-7).

Meridional Boundaries

1-18. Whenever practicable, the township exteriors are surveyed successively through a quadrangle in ranges of townships, beginning with the townships on the south. The meridional township boundaries have precedence in the order of survey and are run from south to north on true meridians. Quarter-section and section corners are established alternately at intervals of 40 chains, and meander corners are established at intersections of the line with meanderable bodies of water. A temporary township corner is set at a distance of 480 chains, pend-ing determination of its final position. The temporary point is then replaced by a permanent corner in proper latitudinal position.

1-19. A meridional exterior is terminated at the point of intersection with a standard parallel. The excess or

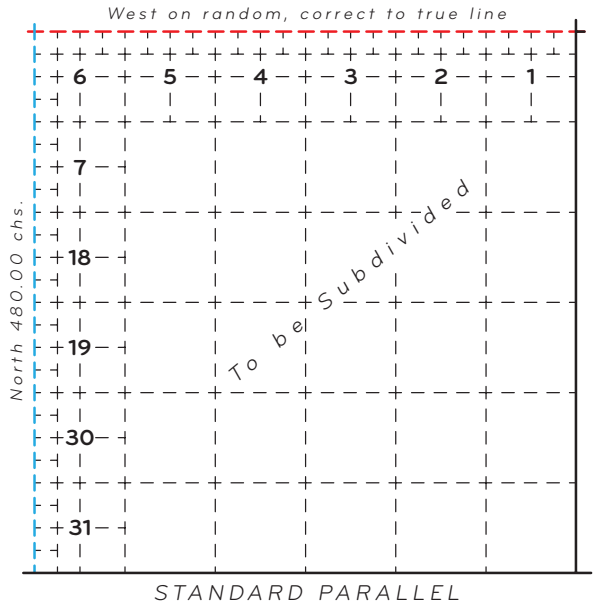


Figure 1-2. Regular order of completing exteriors where the south bound-ary (standard parallel) and east boundary were previously surveyed.

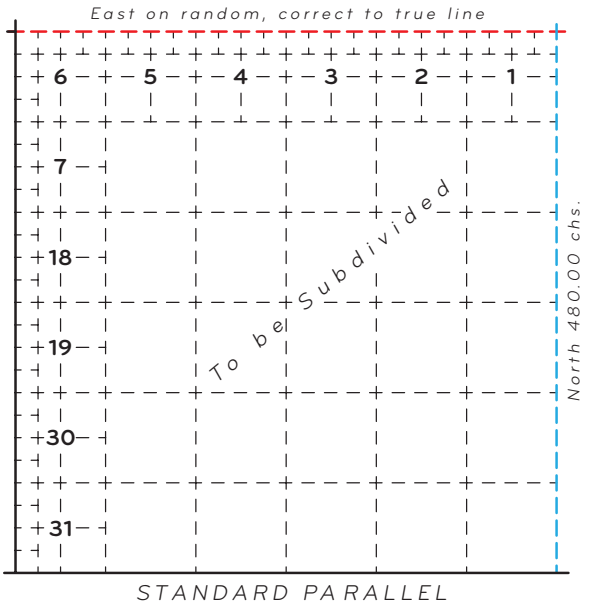


Figure 1-4. Regular order of completing exteriors where the south bound-ary (standard parallel) and west boundary were previously surveyed.

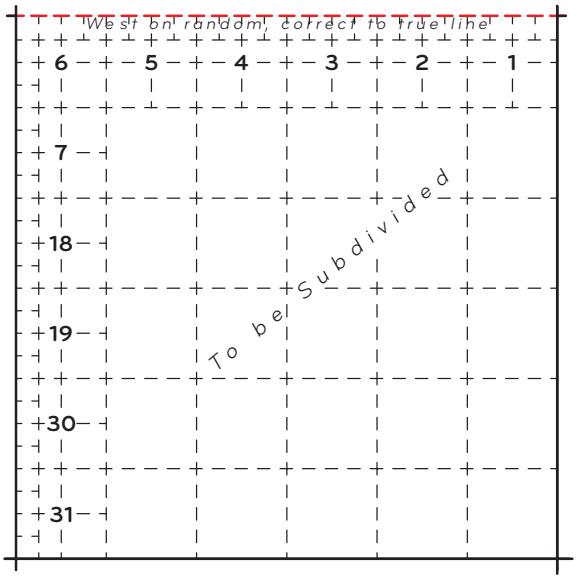


Figure 1-3. Regular order of completing exteriors where the south, east, and west boundaries were previously surveyed.

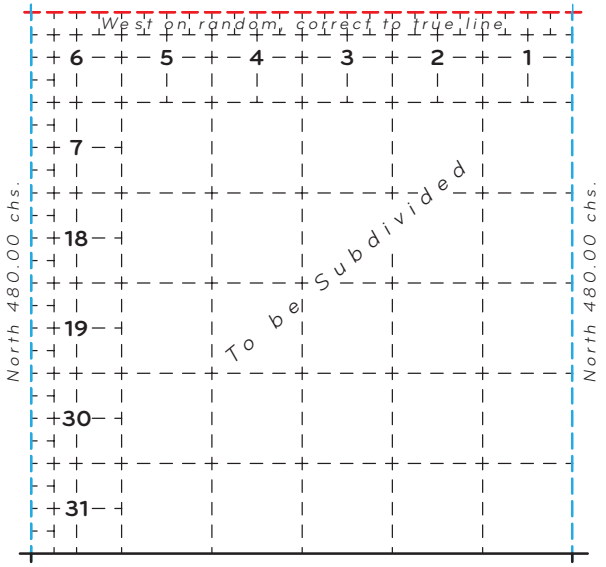


Figure 1-5. Regular order of completing exteriors where the south bound-ary was previously surveyed.

deficiency in measurement is incorporated in the north half mile. A corner is established at the point of intersection. The parallel is retraced between the nearest corners on the standard parallel east and west to determine the alinement, and the distance is measured and recorded to each of the corners.

1-20. In order to complete the exteriors of a township it often remains to establish a meridional boundary between previously established township corners. The meridional township boundary is run and, if defective conditions are not encountered, the corners are established from south to north on the line connecting the previously established township corners, at intervals of 40 chains and at intersections with meanderable bodies of water, marking the true line. By this procedure, the excess or deficiency in measurement is incorporated in the north half mile, and double sets of corners are avoided.

Latitudinal Boundaries

1-21. In order to complete the exteriors of a town-ship, and if defective conditions are not encountered, the latitudinal boundary is run connecting the objective

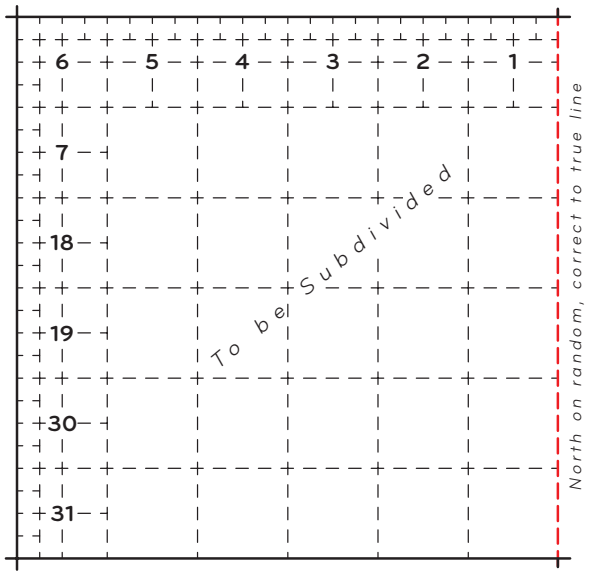


Figure 1-6. Regular order of completing exteriors where the north, south, and west boundaries were previously surveyed.

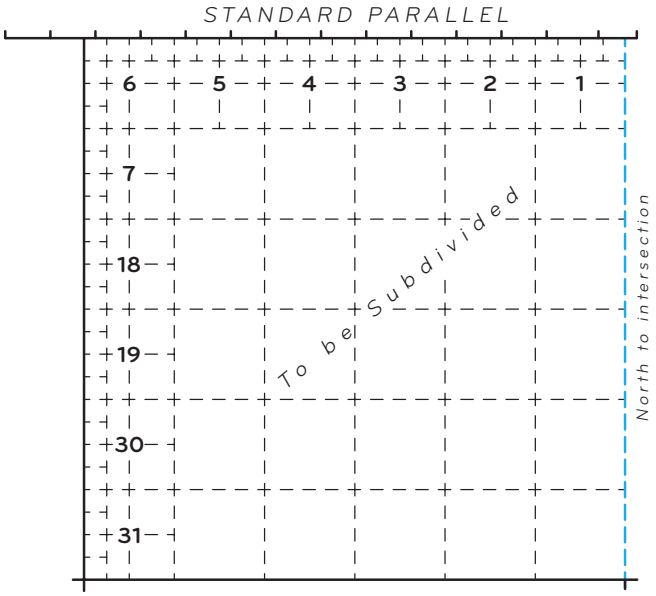


Figure 1-7. Regular order of completing exteriors where the north boundary (standard parallel), south boundary, and west boundary were previously surveyed.

township corners. Corners are established from east to west along the latitudinal curve connecting the township corners, at intervals of 40 chains and at intersections with meanderable bodies of water, marking the true line. By this procedure, the excess or deficiency in measurement is incorporated in the west half mile, and double sets of corners are avoided where unnecessary.

1-22. When lines are run by the random and true method, the bearing of the true line is calculated from the falling of the random line. The falling is the distance, on the normal, by which a line falls to the right or left of an objective corner. The temporary points on any random line are replaced by permanent corners on the true line, along the latitudinal curve. The true line is marked, and distances to important items of topography are adjusted to correct the true line measurement.

Official Record of Township Exteriors

1-23. The official record contains a complete record of the manner in which township exteriors have been run and established. The details of the measurement processes may be shown where a special purpose is served.

Irregular Order and Partial Surveys

1-24. Sometimes procedures will be modified and departure made from the ideal when creating protraction diagrams. The departure from the ideal order is specifically outlined by a new protraction diagram or by supplemental special instructions and diagram. Any such departure is always based on the principle of accomplishing the same relation of one township boundary to another as would result from regular establishment under ideal conditions. Some examples are illustrated in figures 1-8 through 1-13.

1-25. Where it is impracticable to establish the boundaries in full, it may be necessary to run section lines as offsets to township exteriors. Such lines are run either on cardinal courses or parallel to the governing township

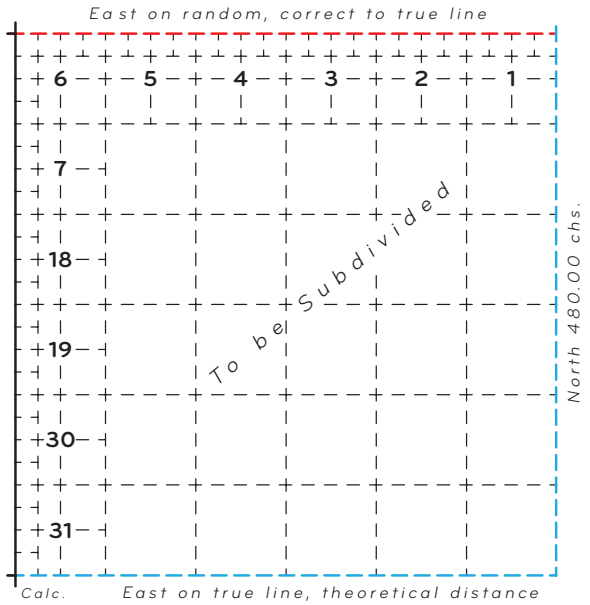


Figure 1-8. Exception to the regular order of completing exteriors; only the west boundary was previously surveyed.

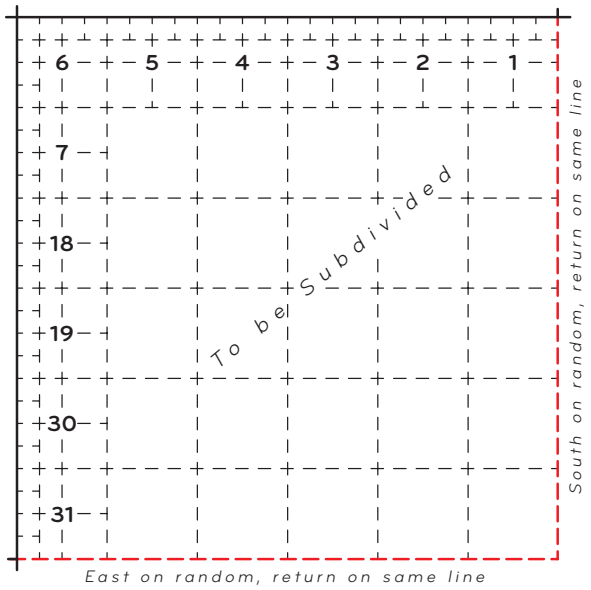


Figure 1-9. Exception to the regular order of completing exteriors; only the north and west boundaries were previously surveyed.

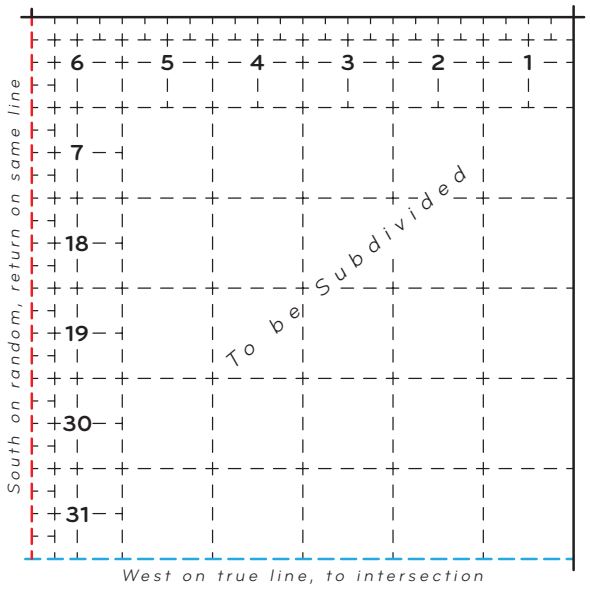


Figure 3-11. Exception to the regular order of completing exteriors; only the north and east boundaries were previously surveyed.

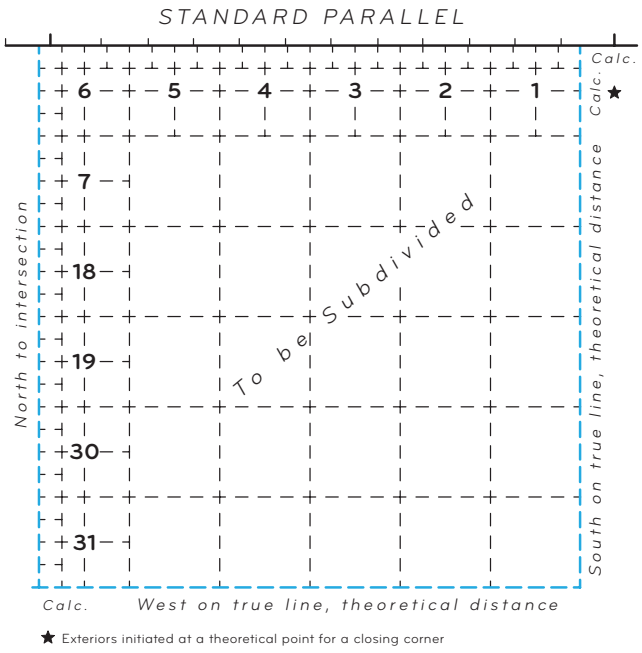


Figure 1-10. Exception to the regular order of completing exteriors; the only north boundary (standard parallel) was previously surveyed.

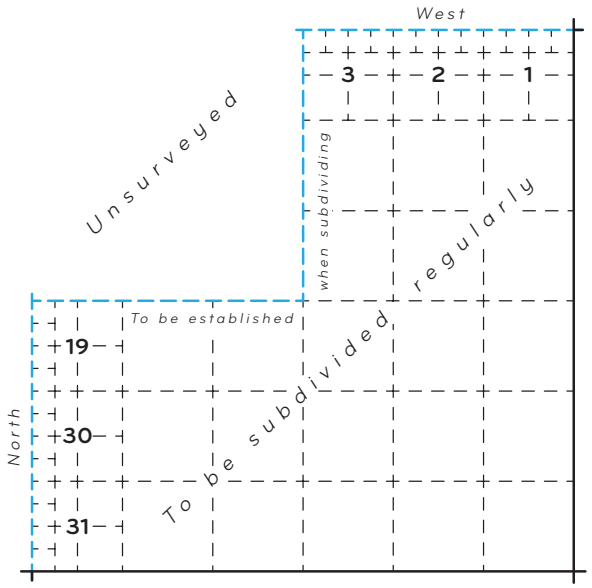


Figure 1-12. Exception to the regular order of completing exteriors; the south and east boundaries were previously surveyed, but part of the township is unsurveyed.

boundaries, and may be established when subdividing, as required.

1-26. For townships not monumented in full in the original survey, the spacing of the monumentation does not change the need for meeting all other requirements. The positions of corners are controlled by the monumented corners and the measurements and references provided in the official record. Thus, what is produced in the field will be in true proportion to the figure represented upon the plat.

Allowable Deviation in Bearing

1-27. It is desirable that the alinement of a new latitudinal boundary (which becomes the governing south boundary of the township to the north) will not depart more than 14' from the true cardinal course. Therefore, the true cardinal course is made the boundary where the alinement would otherwise require a correction exceeding 14' of arc. Where the latitudinal boundary terminates on a new meridional exterior, the temporary township corner is adjusted to the latitude of the

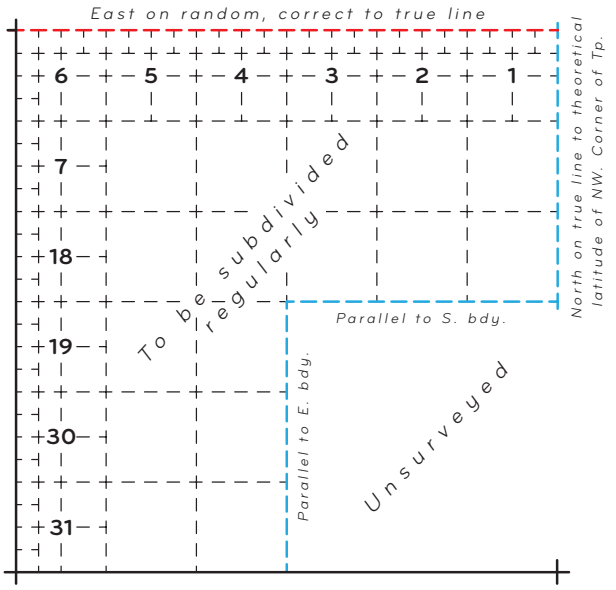


Figure 1-13. Exception to regular order of completing exteriors; the south and west boundaries were previously established, but part of the township is unsurveyed.

opposite township corner. But, where both meridional boundaries have been previously surveyed, a township corner is established at the point of intersection of the true cardinal course latitudinal line with the meridional boundary, or its projection to the north or south.

1-28. A true cardinal course meridional boundary becomes the true line if the falling plus the correction for parallelism of the meridional subdivisional lines results in calculated bearing (in the northernmost miles of the latter lines) in excess of 14' from cardinal (table 1-3). The bearing of a governing east boundary must, therefore, fall within certain extremes suited to the latitude of the township.

1-29. The 14' limit for exteriors applies only to the establishment of new boundaries. A previously established boundary, every part of which is within 21' of cardinal, is not considered defective in alinement. Even in the case of new exteriors, where the surveyor who establishes the line also subdivides the township of which it is the governing boundary, the margin of 14' may be exceeded to a limited extent if the existing conditions favor keeping within the 21' limit in the subdivisional survey. Therefore, the 14' limit facilitates the establishment of all subdivisional lines within the prescribed definite limit of 21' from cardinal (figure 1-14).

Completion of Partially Surveyed Exteriors

1-30. Where the end portions of a township exterior have been previously surveyed and fixed in position by use, the fractional unsurveyed middle part is completed by establishing a connecting line between the existing corners, regardless of the deviation from cardinal direction. The excess or deficiency in measurement is incorporated as a general rule in the north or west half miles, as the case may be, thereby permitting the subdivisional lines to be extended as usual from south to north or from east to west (figure 1-15).

1-31. Where a fractional part of an exterior remains unsurveyed at either end of the line, a connecting line from the previously established terminal corner toward the objective township corner becomes a true line where the calculated bearing of any subdivisional line governed by the exterior comes within 14' from cardinal direction. If this condition cannot be met, or if no objective township corner has been previously established, the partially surveyed exterior is completed on a true cardinal course. In either case, the excess or deficiency in measurement is generally incorporated in the north or west half mile.

Aliquot Parts in the Rectangular System

1-32. Relative to rectangular surveys the square mile, or section, is the unit of subdivision. The regular township includes 36 sections in all, 25 of which are regular sections returned as containing 640 acres each, subdivided into regular "aliquot parts," based on midpoint protraction and intersections. Irregular sections against the north and west boundaries, except section 6, contain regular aliquot parts returned as totaling 480 acres with four additional regular lots returned as containing 40 acres plus or minus the excess or deficiency in measurement in each section. Section 6 contains regular aliquot parts returned as totaling 360 acres with seven additional regular lots, each returned as containing 40 acres plus or minus the excess or deficiency in measurement.

The aforementioned section returned as containing 640 acres is termed "regular" with aliquot part legal subdivisions, such as a half-section, a quarter-section, a half-quarter section, or a quarter-quarter section. The smallest legal subdivision for purposes of disposal under the general land laws is 40 acres unless otherwise specified in a given law. The lots of sections, for purposes of disposal under the public land laws, are termed "legal subdivisions" and are the smallest legal subdivision unit where applicable.

1-33. In theory, aliquot parts can be divided ad infinitum. The common practice is to subdivide to a four

Table 3-3. Applying corrections for convergency within a township

Latitude 25° N.	
1st Mi. Mer. Subdv.	N. 0° 14' E.
Corr. for Conv.	+ 00
E. bdy. may be	N. 0° 14' E.
5th Mi. Mer. Subdv.	N. 0° 14' W.
Corr. for Conv.	– 02
E. bdy. may be	N. 0° 12' W.
Latitude 70° N.	
1st Mi. Mer. Subdv.	N. 0° 14' E.
Corr. for Conv.	+ 02
E. bdy. may be	N. 0° 16' E.
5th Mi. Mer. Subdv.	N. 0° 14' W.
Corr. for Conv.	– 10
E. bdy. may be	N. 0° 04' W.

component description. Aliquot parts with five components or more may be platted as lots to avoid complex descriptions subject to error (section 9-90).

Rectangular Limits

3-34. It is essential to understand the definite relationship between rectangularity as contemplated by law and the unit of subdivision resulting from a survey on the earth's curved surface. The ideal section is allowed to give way to one that is termed "regular" (see section 2-21 for apparent misclosure). The amounts by which a section, or its aliquot parts, may vary from the ideal section and still be considered regular are referred to as the *rectangular limits*:

(1) For *alinement*, the section's boundaries will not exceed 21' from cardinal in any part, nor will

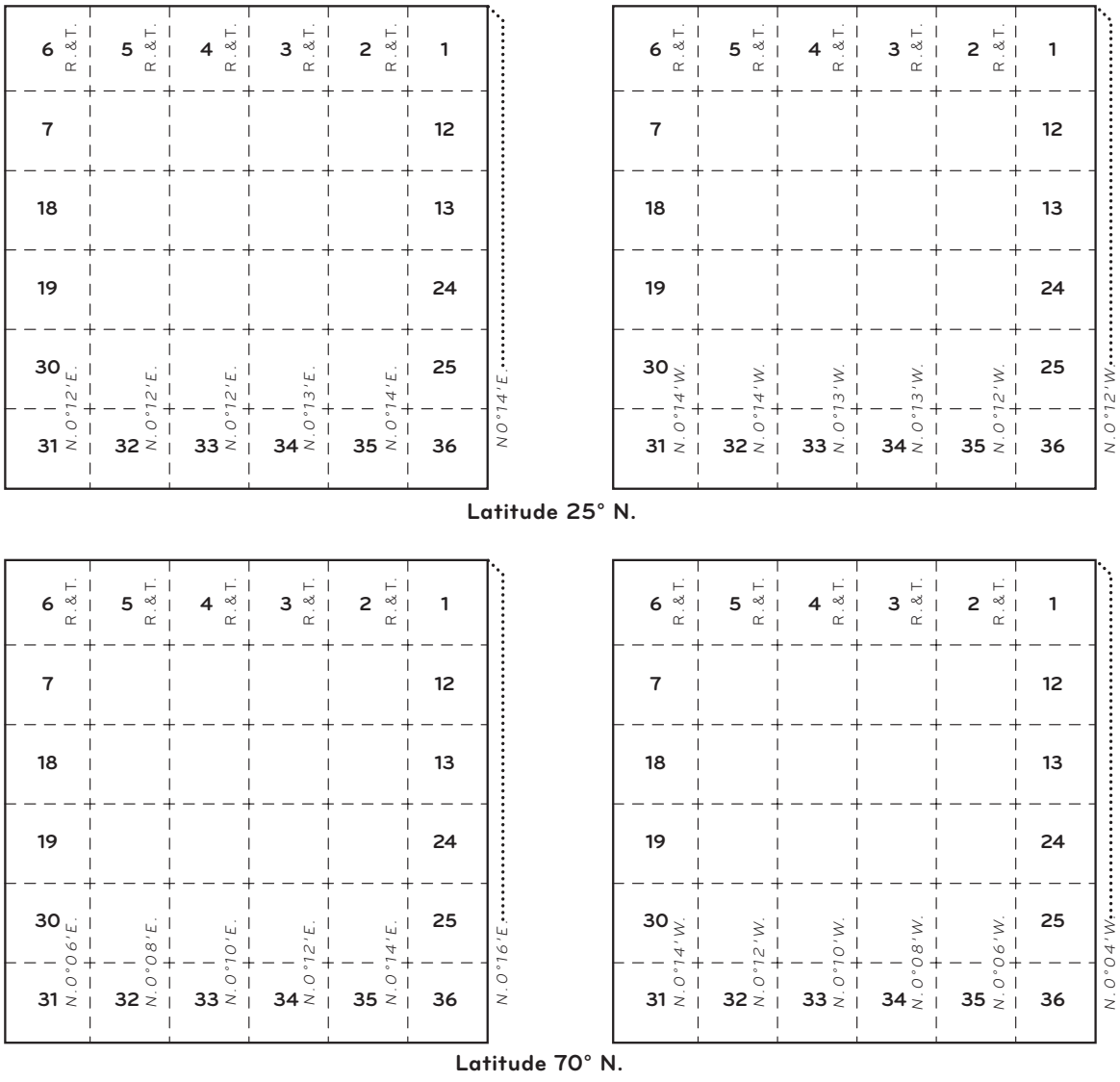


Figure 1-14. The adjustment in the direction of the meridional lines of a subdivisional survey on account of convergency of meridians and also the 14' limit of the rectangular "safety zone."

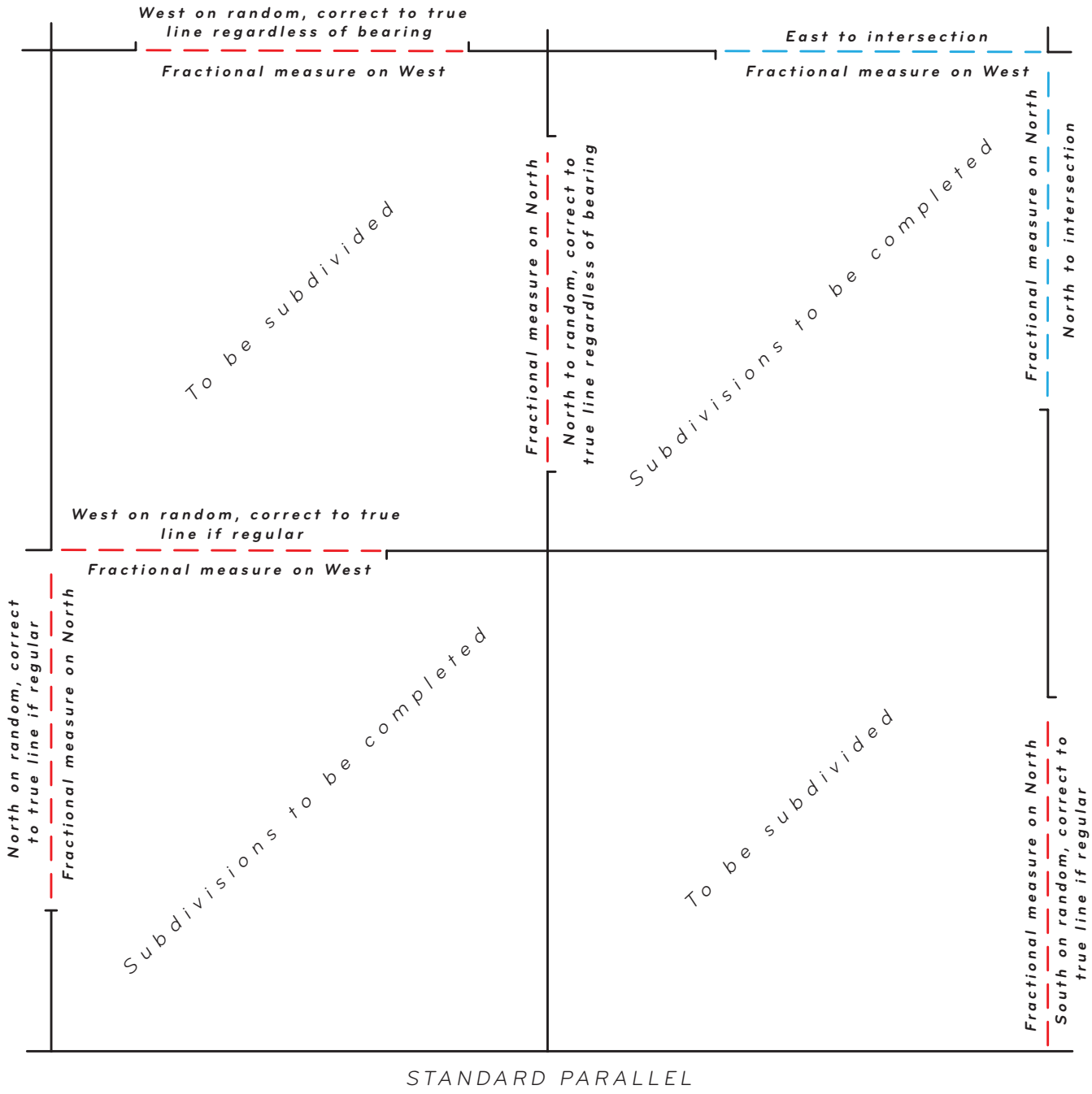


Figure 1-15. Representative cases of incomplete township exteriors showing methods for completion.

the opposite (regular) boundaries of a section vary more than 10'30".

(2) For *measurement*, the distance between regular corners is to be normal according to the plan of survey, with certain allowable adjustments not to exceed 25 links in 40 chains.

Township exteriors, or portions of exteriors, are considered defective when they do not qualify within the above limits. It is also necessary, in order to subdivide a township regularly, to set a third limit, as follows:

(3) For *position*, the corresponding section corners upon the opposite boundaries of the township are to be so located that they may be connected by true lines that will not deviate more than 21' from cardinal.

1-35. A previously established exterior is not defec-tive if the above limits are satisfied. If the rectangular

limits have already been exceeded, or the danger zone is likely to be reached at an early stage in the subdivisional survey, the necessary corrective steps are taken before subdividing.

1-36. The rectangular limits should not be confused with the allowable error of closure discussed under sections 1-50 and 1-215. When the allowable error of closure is exceeded, in the township exteriors, gener-ally the rectangular limits cannot be met in the subse-quent township subdivision. Typically corrective steps are required wherever the maximum allowable error of closure is exceeded.

The rectangular limits and limits of closure discussed in this course pertain to original surveys. They reflect the minimum requirements for original surveys and ensure that rectangularity is maintained and that surveyed lines can be safely incorporated into later new surveys. The desired result is to return a maximum number of regular sections within the township.

Retracements and Resurveys Before Subdividing

1-37. If there is reason to question the accuracy of previously surveyed township exteriors or the condition of the corner monuments, the special instructions should call for the surveyor to reestablish lost corners, remonument dilapidated corner monuments, determine the direction and length of all lines, furnish data needed for the computation of areas of irregular parts, and recommend any improvements indicated for the plan of subdivision.

1-38. For townships with protraction diagrams, where rectangular limit requirements can be met, original surveys should follow the plan outlined by the protraction diagram. Where field conditions reveal that the rectangular limit requirements cannot be maintained, and the corners are not fixed in position by use, the protraction diagram should be abandoned and a new plan for survey provided by a new protraction diagram or by supplemental special instructions and diagram.

1-39. All resurvey data are embodied in the official record, field notes and plat, or shown upon the plat only of the survey unless the retracement results are in substantial agreement with the record of the original surveys. In the latter case, a statement to the effect is made in the field notes or on the plat, and the original record governs the data placed on the plat.

Defective Exteriors

1-40. Township boundaries already established may be defective in alinement, measurement, or position. A defective boundary not previously closed upon and from which subdivisional lines have not been initiated is obliterated after being superseded by survey of a new boundary and connection of the old with the new monuments. If it is known that a mineral survey, homestead entry survey, small holding claim, right-of-way, reservoir, or other survey has been connected with a corner of an exterior subject to rectification, the fact is stated in the special instruction. In such a case the marks “AM” (signifying “amended monument”) are added to the original corner monument, the monument is buried in place, if practicable, and the old corner is connected by course and distance to the new. A record of the connection is placed in the official record together with a full description of the monument and its accessories. Where a special purpose is served, the position of the old monument is shown on the plat of the survey.

1-41. If a boundary is defective in measurement or position and is not subject to rectification, the location of the original corners cannot be changed, but the marks on the monuments and the marks upon (or position of) the accessories are appropriately altered to stand only for the sections of the previously established surveys. New corners to control the surveys of the adjoining township are established on the old line at regular distances of 40 and 80 chains. Where new corners are placed on an oblique exterior, whose bearing departs more than 30' from cardinal, they are so located for measurement that the *cardinal* equivalents are 40 and 80 chains.

1-42. Where subdivisional lines have been initiated from or closed upon one side of only a portion of a township boundary, the remaining portion may be superseded if it is found to be defective.

1-43. The position of the new exteriors, or of corners set on defective township boundaries in the new survey, will be established by an actual rerunning of the lines. Data acquired in surveying subdivisional lines intersecting a defective exterior is not acceptable in lieu of retracement or dependent resurvey.

1-44. The south boundary of a township is regularly the governing latitudinal boundary unless defective in alinement. If the boundary is defective in measurement

and not subject to rectification, the original corners are changed to refer only to the sections of the township to the south. New corners of two sections and quarter-section corners of sections of the township to the north are established at regular intervals of 40 chains, counting from the east, and the excess or deficiency in measurement is incorporated in the west half mile. If the south boundary is defective in alinement, a sectional correction line or a governing section line is required. Subdivision of the sections between the defective boundary and the sectional correction line is covered in section 1-112.

1-45. The east boundary of a township is regularly the governing meridional boundary unless defective in alinement. If the boundary is defective in measurement and not subject to rectification, the original corners are changed to refer only to the sections of the township to the east. New corners of two sections and quarter-section corners of the sections of the township to the west are established at regular intervals of 40 chains, counting from the south, and the excess or deficiency in measurement is incorporated in the north half mile. If the east boundary is defective in alinement, a sectional guide meridian or a governing section line is required. Subdivision of the sections between the defective boundary and the sectional guide meridian is covered in section 1-112.

1-46. New east and south boundaries of a township become the meridional and latitudinal boundaries of the townships to the east and south respectively. Where doubt exists as to how unsurveyed lines may relate to new lines, the corners are established only for the sections of the townships of which the new lines are the governing boundaries. The corners of the sections upon the opposite side are established at the time of subdivision of the adjoining townships if the original corners are found to be defective in position. If regular connections can be made at that time, the marks on the original monuments are altered to signify corners of maximum control.

1-47. Where the previously established north or west boundaries are defective in measurement or position and subdivisional surveys have been initiated from them, the original corners are changed to refer only to sections to the north or west, respectively. Section corners are established when subdividing. New quarter-section corners are placed on the old line at the mean distances between the new section corners, or at 40 chains from one direction, depending upon the plan of subdivision of the section. Where the previously established north or west boundaries are defective in alinement but not in measurement or position, no changes are required. The section lines of the township that is being subdivided are connected regularly to the original corners. Excess or deficiency in measurement is incorporated in the north and west half miles.

1-48. Figures 1-16 through 1-23 illustrate the guiding principles involved in establishing new governing boundaries where the previously surveyed exteriors

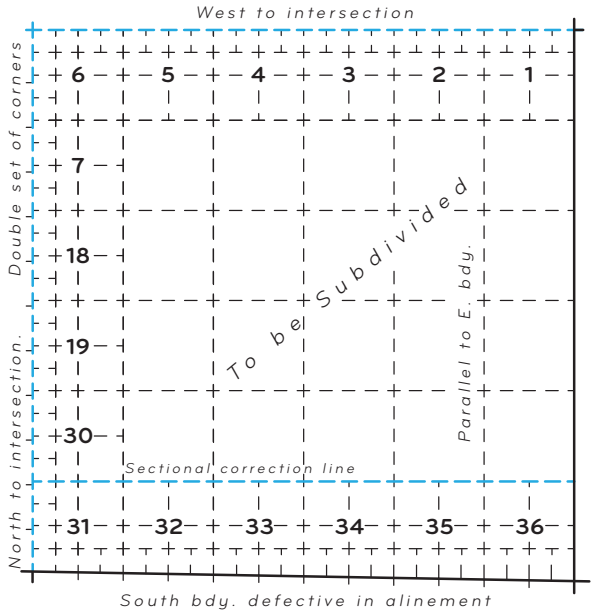


Figure 1-16. Rectification of a fixed south boundary defective in alinement.

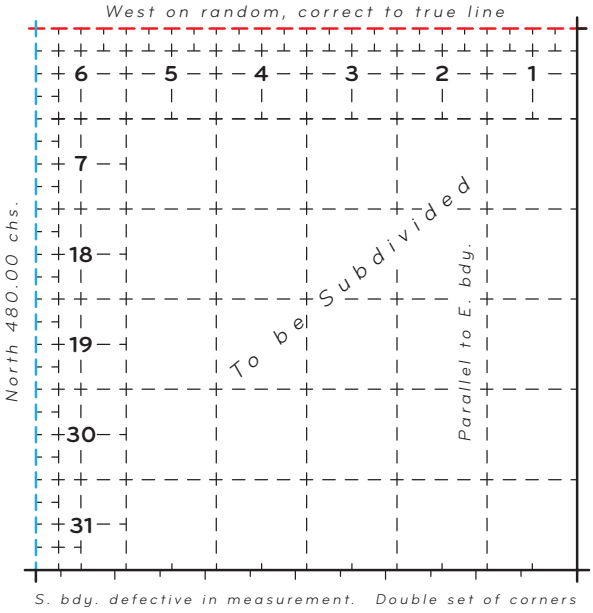


Figure 1-17. Rectification of a fixed south boundary defective in measurement.

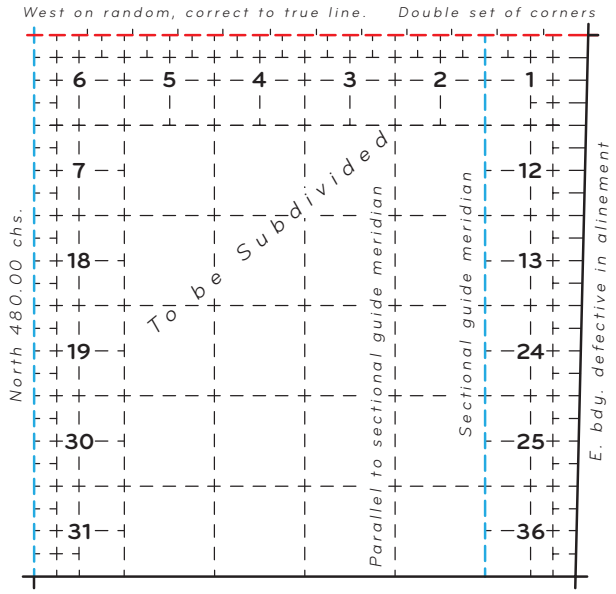


Figure 1-18. Rectification of a fixed east boundary defective in alinement.

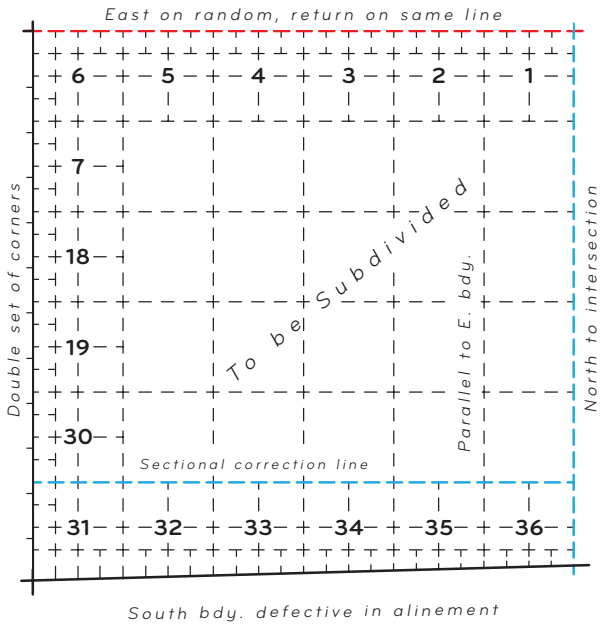


Figure 3-20.

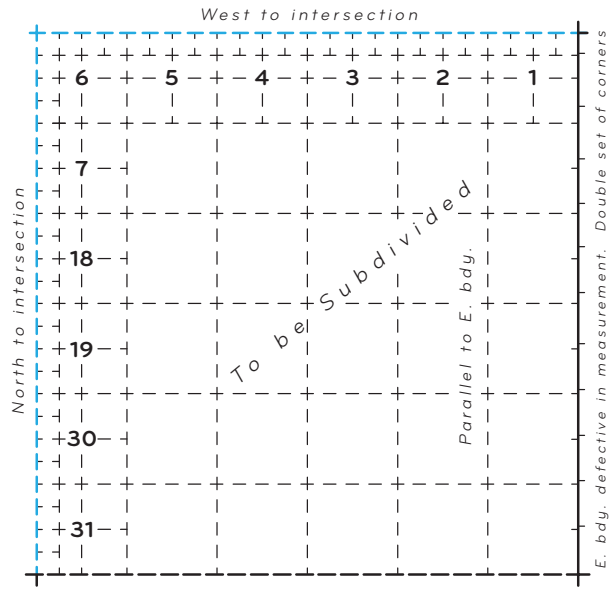


Figure 1-19. Rectification of a fixed east boundary defective in measurement.

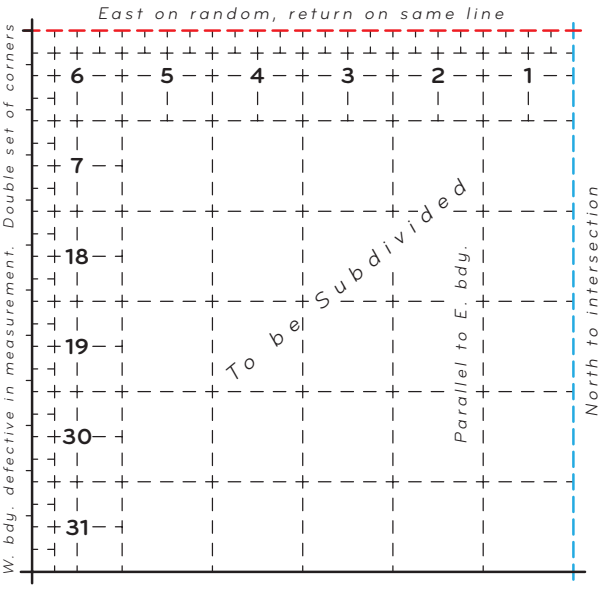


Figure 1-21. Rectification of a west boundary defective in measurement where both the south and west boundaries are

are defective. Each figure illustrates a simple condition affecting one boundary only, and the examples are taken only from the regular order of procedure. Figure 1-24 shows a series of conditions that might occur in the field. Combinations of defective conditions are best analyzed by breaking them down into the several simple defective conditions. The same holds true in the establishment of township exteriors under an irregular order of procedure. Where extraordinary conditions are encountered that cannot be solved in this manner, the surveyor will report the facts to the proper administrative office, which will issue appropriate instructions.

1-49. The rules for completion and rectification of township exteriors are intended to secure the most direct return to normal procedure. The preliminary retracements and resurveys may show that some modification will obtain better results. Approval of the modified plan will be obtained from the proper administrative office. Each case should be treated on its own merits.

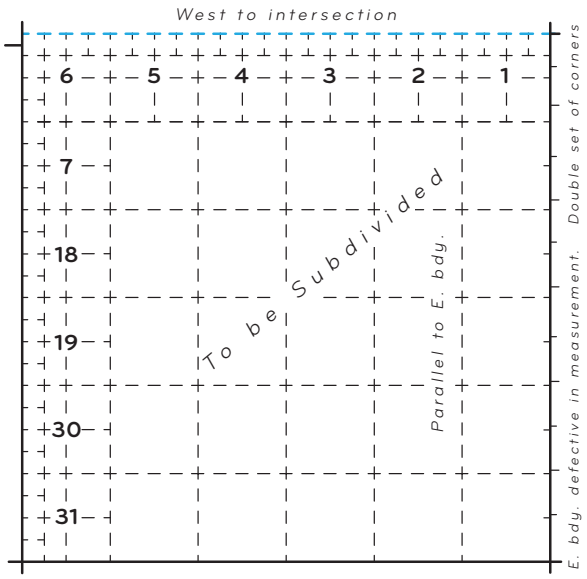


Figure 1-22. Rectification of an east boundary defective in measurement where the east and south boundaries are fixed in position.

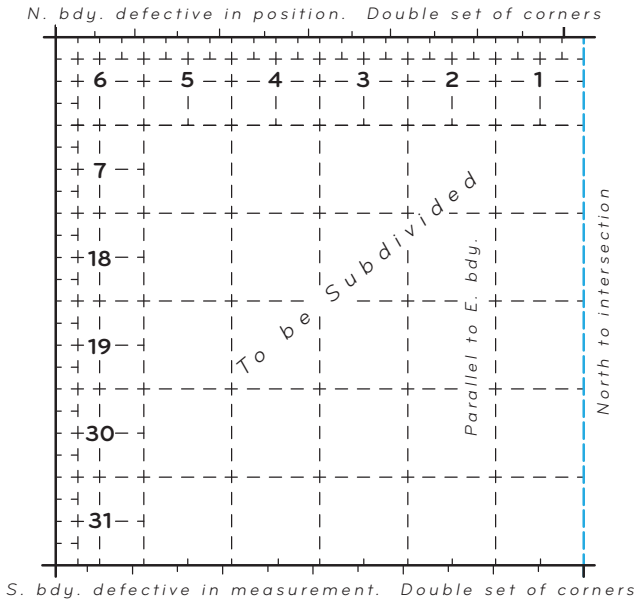


Figure 1-23. Rectification of a south boundary defective in measurement where the south, north, and west boundaries are fixed in position.

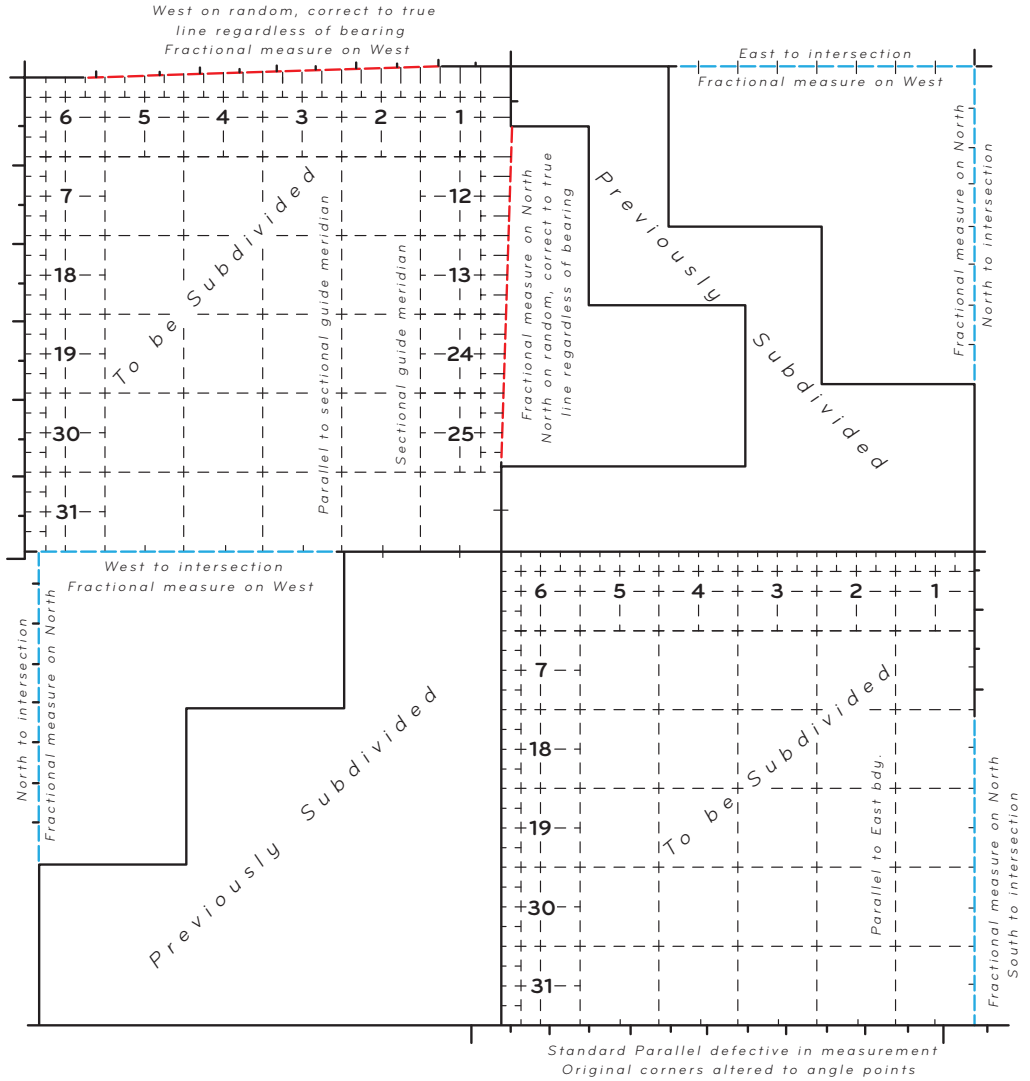


Figure 1-24. Various defective boundaries, showing methods for completing exteriors.

Tables of Latitude and Departure and Error of Closure

1-50. Upon the completion of the survey of one or more township exteriors closing the figure of either a regular or irregular township, a table of latitudes and departures will be prepared with allowance for convergency of meridians. The maximum allowable error of closure is 1/4000 of the perimeter in either latitude or departure. If the limit is exceeded, additional retracements or other corrective steps may be necessary to perfect the survey. A demonstration of the closing errors, including every part of any closed figure embracing township exteriors, will be returned with the field tablets, computation sheets, and survey data files. Together with proper field procedures the error of closure can be a test of the accuracy of the alinement and measurement of the township exteriors (section 1-215). For allowable error of closure of a new survey against an official survey record see section 1-217.

Subdivision of Townships

Regular Boundaries

1-51. The boundaries of a township are within satisfactory governing limits for control of the subdivisional survey when the lines may be theoretically projected from the boundaries without closely approaching the rectangular limits. The danger zone has been placed at theoretical bearings exceeding 14' from cardinal, and the corresponding danger zone in respect to lengths of lines placed at theoretical adjustments exceeding 33 links per mile.

Meridional Section Lines

1-52. Meridional section lines have precedence in the order of survey. They are initiated at the section corners on the south boundary of the township and are run north parallel to the governing east boundary. Meridional section lines are numbered counting from the east and surveyed successively in the same order. If the east boundary is within limits, but has been found by retracement to be imperfect in alinement, the meridional section lines are run parallel to the mean course ascertained by inverse from the most southerly to the most northerly corners as recovered and/or reestablished on the governing boundary. Regular quarter-section and section corners are established alternately at intervals of 40 chains as far as the northern-most interior section corner.

1-53. A meridional section line is not continued north beyond a section corner until after the latitudinal sectional line connecting east has been surveyed. In the case of the fifth meridional section line, both latitudinal section lines connecting east and west are surveyed before continuing with the meridional line beyond a section corner. The successive portions of the meridional lines are surveyed as convenient, but none should be carried beyond uncompleted sections to the east.

1-54. In the north tier of sections, the meridional section lines are connected to the objective section corner on the north boundary of the township. The quarter-section corners are established at a distance of 40 chains from the south, on the true line connecting the interior section corner and the objective section corner on the north boundary of the township. By this procedure, the excess or deficiency in measurement is incorporated in the north half mile, and double sets of corners are avoided where unnecessary. See section 1-104 for incorporation of the excess or defi-ciency when smaller subdivisions are to be protracted against the north boundary of the township.

1-55. Where the north boundary of the township is a base line or standard parallel, the last miles of the meridional section lines are continued as true lines parallel to the east boundary of the township. Permanent quarter-section corners are established at 40 chains from the south, and section corners are established at the points of intersection with the north boundary. The distances are measured and recorded to the nearest corners on the base line or standard parallel east and west in each case. New quarter-section corners for the sections of the township being subdivided are established on the line intersected and at mean distances, longitudinally, between the section corners, or at 40 chains from one direction, depending on the plan of the subdivision of the section.

Latitudinal Section Lines

1-56. The latitudinal section lines, except in the west range of sections, are run between the objective section corners. The quarter-section corners are established on the true latitudinal curve connecting the objective section corners, at the midpoints, and the true lines are marked.

1-57. In the west range of sections the latitudinal section lines are connected to the objective section corners on the west boundary of the township. The quarter-section corners are established at a distance of

40 chains from the east, on the true latitudinal curve connecting the interior section corner and the objective section corner on the west boundary of the township. By this procedure, the excess or deficiency in measurement is incorporated in the west half mile, and double sets of corners are avoided where unnecessary. See sec-tion 1-104 for incorporation of the excess or deficiency when smaller subdivisions are to be protracted against the west boundary of the township.

Survey Record

1-58. The field notes describing the survey of subdivisional lines are compiled in ranges of sections beginning with the easternmost, and the west two ranges are compiled by alternating with the adjoining east and west sections (figure 1-25). The official record contains a complete record of the manner in which the subdivi-sional lines are run and established. The details of the measurement processes may be shown where a special purpose is served.

Accumulated Error

1-59. Error in the alinement of the meridional section lines is partially incorporated into the measurement of the latitudinal lines, which will be within the rectangular limits for measurement (section 1-34), except in the west range of sections where the convergency of the meridional lines is provided for. The accumulated error in alinement for the 5 miles of true meridional line is incorporated in the sixth mile, connecting the northernmost interior section corner with the objective section corner on the north boundary of the township. Here the true line will be within the prescribed rectangular limits for alinement (section 1-34).

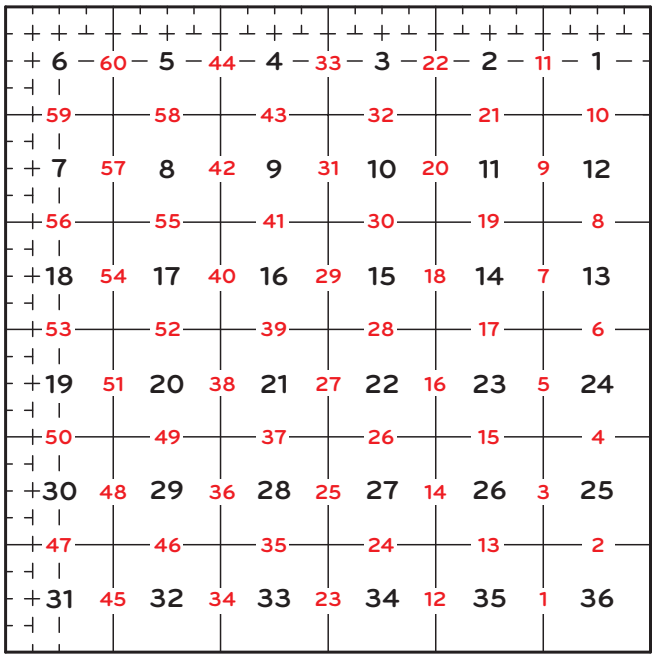


Figure 1-25. Sequence of numbers on section lines showing normal order of subdivision.

The slight, ordinary errors in the measurement of the meridional lines are incorporated into the adjustment of the bearings of the latitudinal section lines. The accumulated error in measurement in running north is incorporated in the last half mile. Here the meridional distance is checked by a calculated closing around the last section, and the latitudinal error will not exceed a value greater than what is allowed to attain the prescribed limits of closure (sections 1-50 and 1-215).

1-60. The surveyor should discriminate carefully between the rectangular limits for subdivision and the limits of closure. One or both of these requirements will be exceeded if the accumulated error is excessive in either alinement or measurement. Cumulative error must be guarded against and avoided, and the prescribed order of survey furnishes continuous checks upon the accuracy of all lines. Testing for each of these requirements within every new section provides a continuous check upon the accuracy of all lines so that cumulative error can be identified and avoided before the allowable limits within a subdivision are exceeded.

Irregular Boundaries

1-61. Where either of the governing boundaries of a township is disqualified as a controlling line upon which to initiate a subdivisional survey, the necessary retracements and resurveys or alterations are made before subdividing (section 1-37).

1-62. The specific plan described below may be modified where conditions justify a change. The basic requirements are (1) adherence to the normal rectangular plan where practicable; (2) a normal location and an area of 640 acres each for granted lands that are identified by the survey (the school sections, Alaska native corporation conveyances, etc.); (3) the maximum number of regular sections of 640 acres each, or aliquot parts of sections; (4) avoidance of two sets of corners when one set is ample for subdivisional requirements; and (5) simplicity of survey, most readily understood by the public.

Sectional Guide Meridian

1-63. If the east boundary of the township is defective in alinement, and cannot be rectified, the corners

on the north boundary will not be properly related to those on the south boundary, even though the measurement of the north boundary is not defective. The north boundary is then said to be defective in position (figure 1-26). The first meridional line is projected as a sectional guide meridian due north to an intersec-tion with the north boundary, where a section corner is established and the distances are measured and recorded to the nearest corners on the township line east and west. The intermediate quarter-section and section corners are established alternately at regular intervals of 40 chains, counting from the south unless the south boundary of the township is itself defective in alinement. The remaining meridi-onal lines are established parallel to the sectional guide meridian.

1-64. Where, as shown in figure 1-27, the north bound-ary is not defective in position (nor within the danger zone) with reference to the corners on the south bound-ary (errors in alinement of the east boundary being compensable), the first meridional section line is estab-lished to intersect the objective section corner on the north boundary. The remaining meridional section lines are run parallel to the one first established, in the usual manner, to section corners established at the point of intersection or the objective section corners on the north boundary of the township as the case may be.

1-65. The excess or deficiency in measurements of the latitudinal section lines in the first range of sections is incorporated in the east half mile. Elsewhere, unless the south boundary is defective in alinement, the latitudinal section lines are run in the usual manner.

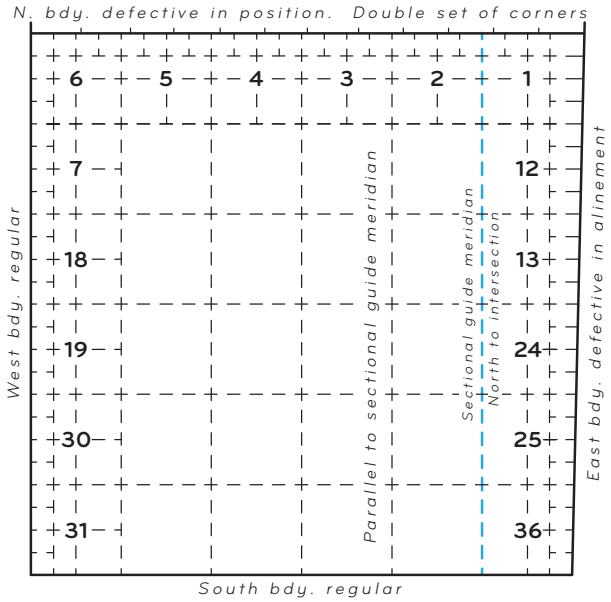


Figure 3-26.
meridian where defective alinement of the east boundary leaves the north boundary defective in position.

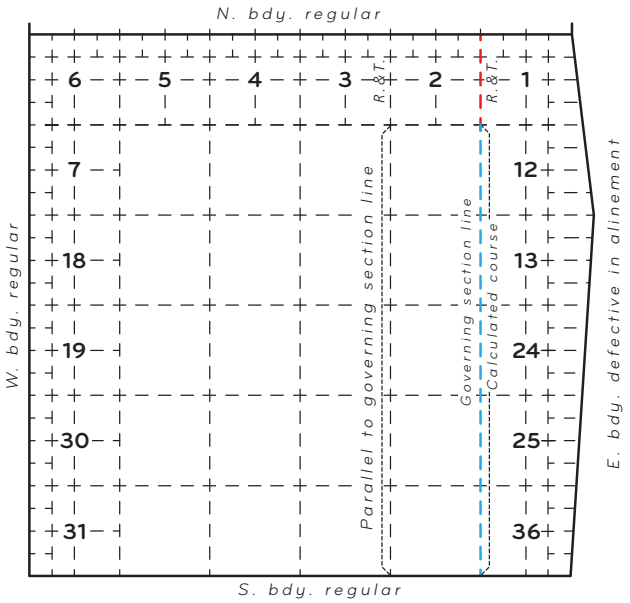


Figure 1-27. Projection of the first meridional section line as governing section line where the defective east boundary does not leave the north boundary defective in position.

Sectional Correction Line

1-66. If the south boundary of the township is defective in alinement and cannot be rectified so that the west boundary is defective in position, a sectional correction line is established (figure 1-28). This line is surveyed

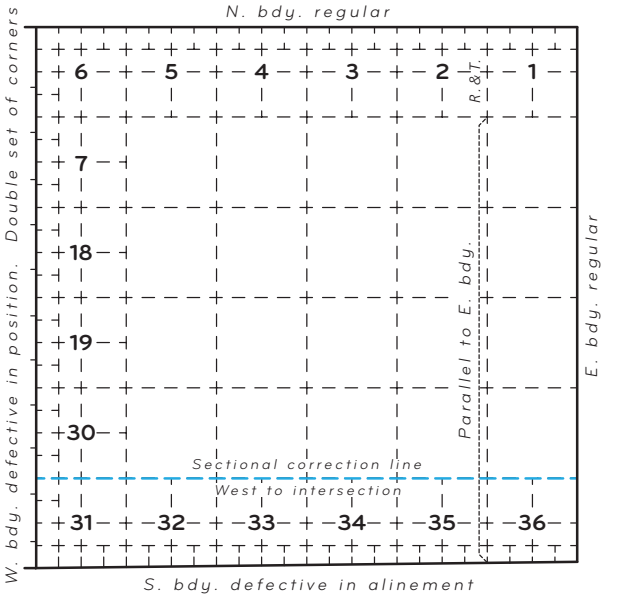


Figure 1-28. Projection of the first latitudinal section line as sectional correction line where defective alinement of the south boundary leaves the west boundary defective in position.

on a true latitudinal curve initiated at the first regular section corner on the east boundary and projected to an intersection with the west boundary of the township, where a section corner is established and the distances are measured and recorded to the nearest corners on the range line north and south. The intermediate quarter-section and section corners are established at regular intervals of 40 chains, alternately, counting from the east.

1-67. Where, as shown in figure 1-29, the west boundary is not defective in position (nor within the danger zone) with reference to the corners on the east boundary (errors in alinement of the south boundary being compensable), the first latitudinal section line is established to intersect the objective section corner on the west boundary.

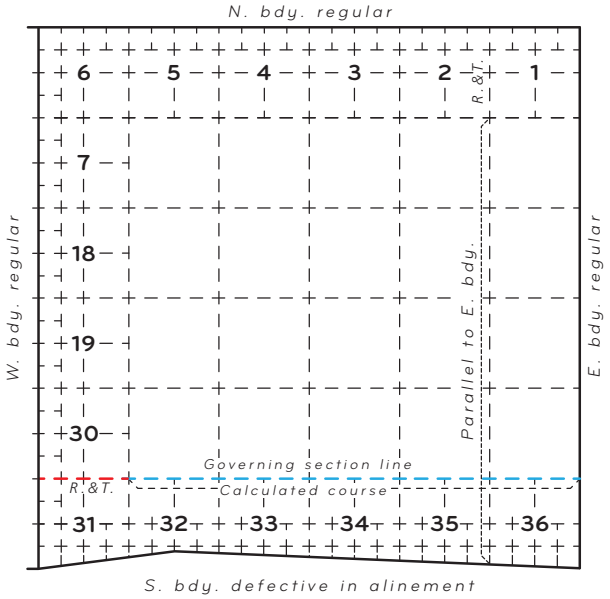


Figure 1-29. Projection of the first latitudinal section line as governing section line where the defective south boundary does not leave the west boundary defective in position.

1-68. The section corners on the sectional correction line are established at the points of intersection of the meridional section lines alined in the normal manner. Thereafter, the quarter-section corners on the sectional correction lines are established at the usual midpoints except in the east and west ranges of sections.

Referring to figure 1-30, the quarter-section corner between sections 25 and 36 is established at 40 chains from the west if the east boundary is defective in alinement. Otherwise it is fixed at the usual midpoint position. The quarter-section corner between sections 30 and 31 is placed at 40 chains from the east. The quarter-section corners on the meridional section lines in the south tier of sections are established at 40 chains south from the corners on the sectional correction line. The remaining subdivisional lines are continued from the sectional correction line in the usual manner.

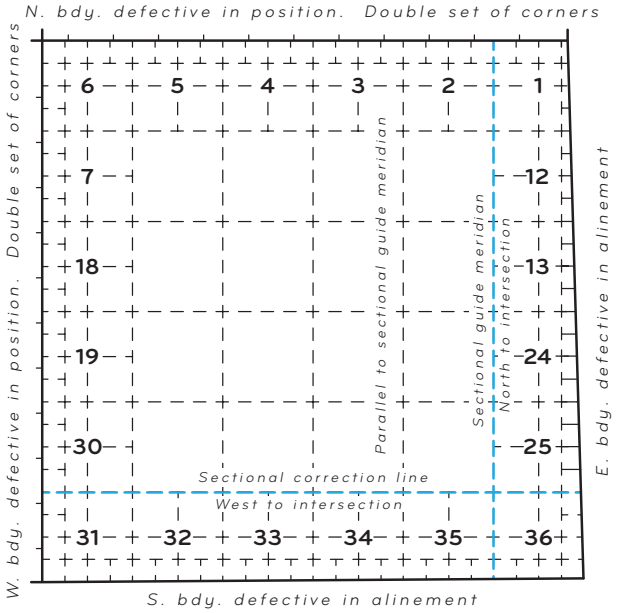


Figure 1-30. Projection of both the sectional guide meridian and sectional correction line where combination of defective conditions exists.

Partial Irregularity

1-69. Where the south part of the east boundary, or the east part of the south boundary, is regular, and the balance is defective in alinement and not subject to rectification, the subdivisional survey is made regular as far as possible. The initial point for the sectional guide meridian, or for the sectional correction line, is determined by existing conditions. The first meridional section line is continued as a sectional guide meridian if the north part of the east boundary is defective in alinement and the north boundary is therefore defective in position (figure 1-31).

1-70. If the north boundary is not defective in position (nor within the danger zone), the first meridional section line is established to intersect the objective section corner on the north boundary of the township. The same principle is observed if the west part of the south boundary is defective in alinement, and the west boundary is not defective in position (nor within the danger zone). If the west boundary is defective in position, the sectional correction line is established on the true latitudinal curve (figure 1-31).

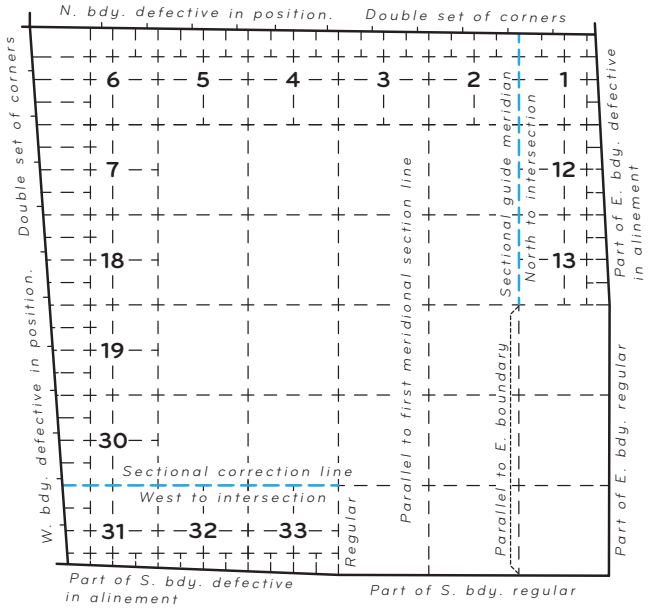


Figure 3-31. Projection of both the sectional guide meridian and sectional correction line in case of partial irregularity.

Survey Record

1-71. The official record of subdivisional surveys including a sectional guide meridian, a sectional cor-rection line, or other governing section line, is com-piled in the usual order and appropriate explanatory remarks added to show the method and order of proce-dure used to establish the lines.

Summary

1-72. A sectional guide meridian is created when the east boundary is defective to the point where the north boundary of the township is defective in position and double sets of corners are required on the north bound-ary (cannot be rectified with township to the north) (figures 1-26, 1-30, and 1-31). A sectional correction line is created when the south boundary is defective to the point where the west boundary of the township is defec-tive in position and double sets of corners are required on the west boundary (cannot be rectified with township to the west) (figures 1-28, 1-30, and 1-31). "Governing section lines" are created when the defective condi-tions of the governing boundaries (east and/or south) do not create defective conditions along the north and/or west boundaries that would require double corners (figures 1-27 and 1-29).

1-73. The object of the plan is to secure the maximum number of regular sections. The sections adjoining the east boundary are regular if they conform to the usual rectangular limits. Where that is the case, the quarter-section corners on the latitudinal section lines are placed at the normal midpoint position. The sections adjoining the south boundary of the township are not regular unless the meridional lines are established at 80 chains in length, and the sections are otherwise in conformity with the usual rectangular limits. Exceptions are noted in sections 1-80 and 3-83.

Intersecting and Terminating Section Lines

3-74. A different type of intersection occurs where the lines of the rectangular system intersect or terminate on the boundaries of special surveys, including reservations or grants, State boundaries, U.S. Surveys, or the lines of various kinds of claims.

A corner of minimum control is normally established and monumented where a section line terminates at the intersection with a special survey. It is necessary to retrace the intersected boundary to the nearest corner in each direction to find and record the alinement, distances, and assure placement of the monument at the intersection.

1-75. Quarter-section corners are established between section corners for sections terminating on a reservation or grant boundary when needed to provide control for the survey of the adjacent public land survey system or for the identification of Federal interest lands.

1-76. The Bureau of Land Management has no general authority to survey or resurvey State boundaries. However, quarter-section corners should be established and monumented between section corners for sections terminating on State boundaries when needed to provide control for the survey of the adjacent public land survey system or for the identification of Federal interest lands. Although the corners themselves are monumented, State names will not be marked on the monuments unless specifically sanctioned by appropriate authority (sections 4-27 and 6-31).

1-77. A corner of minimum control monument may also be set when a nonterminal section line intersects the line of a surveyed mineral claim, forest homestead claim, small holding claim, U.S. Survey, or the like. In some instances, monumented corners may be needed for administrative, operational, litigation purposes, or to provide an interval of monumentation of 45 chains or less (section 10-36), in which event they should be provided for in the special instructions.

Where a line of the rectangular survey crosses a surveyed claim, the bearing of the intersected claim line

and the distance to the nearest corners are determined and described. In the case of a claim or conveyance located entirely within a section, a connection is made from a regular corner of the section to a corner of the claim or conveyance for inclusion in the official record.

Since the accuracy of lotting in the section and management of the remaining Federal interest lands depend on a correct location of the claim or conveyance, it may be desirable to retrace one or all of the claim or conveyance lines. If a multiplicity of claims or conveyances exists, their treatment will be covered in the special instructions.

1-78. If a survey is concluded upon an irregular boundary at variance with the lines of legal subdivision, or if the survey is continued on a blank line to acquire a definite location upon the opposite irregular boundary, but without monumenting the rectangular survey between the irregular boundaries, a monument is required at the point of intersection of the regular with the irregular line. However, if the survey is continued across the reservation or grant for the purpose of establishing and monumenting a full complement of corners for the control of the subdivision of a section so invaded, the point of intersection is determined but a monument may not be required.

1-79. Monuments established where a line intersects a boundary already fixed in position will thereafter control the direction of and the proportioning along the intersecting line. A failure to place the monument at the point of intersection does not alter the position of the line intersected but may cause interested parties to rely on the faulty position and engender confusion. Care should be taken to avoid this result. The line intersected will be retraced between the first corners to the right and left. Determination of the point of intersection by calculation alone is not permissible. Once a corner is monumented at the point of intersection, without gross error, it will ordinarily be accepted as control for both lines. Subsequent technical repositioning of the line closed upon will be avoided.

Irregular Townships

1-80. The regular procedures described for subdividing regular townships cannot always be adopted. A township invaded by a large meanderable body of water, impassable objects, or a State, reservation, or grant boundary may lack a full linear south or east boundary. This may require controlling section lines to be established as offsets from the township exteriors, with the section lines south and east of these controlling lines being projected to the south and east. The excess or deficiency in measurement and the resulting lots are placed against the irregular boundary. If only the north or west part of a township is involved, no departure from the regular order of subdivision is necessary since the excess or deficiency in measurement, and the resulting lots, will be placed to the north and west against the irregular boundary.

1-81. Where no part of the south boundary of a township can be regularly established, the subdivision may proceed from north to south and from east to west, incorporating the excess or deficiency in measurement and areas against the west boundary and the meanderable stream or other boundary limiting the township on the south. If the east boundary is without regular section corners and the north boundary has been run eastwardly as a true line, with section corners at regular intervals of 80 chains, the subdivision of the township may be made from west to east. In that case the excess or deficiency in measurement and areas are incorporated in the irregular east boundary. However, if the north boundary of section 6 is irregular, a sectional guide meridian, initiated at the easternmost regular section corner on the north boundary, is projected to the south to take the place of a governing east boundary. The subdivisional survey is then projected from north to south and from east to west, with the excess or deficiency in measurement and resulting lots on the east, south and west boundaries of the township. Figures 1-32 through 1-37 illustrate the principles that control the subdivision of irregular townships.

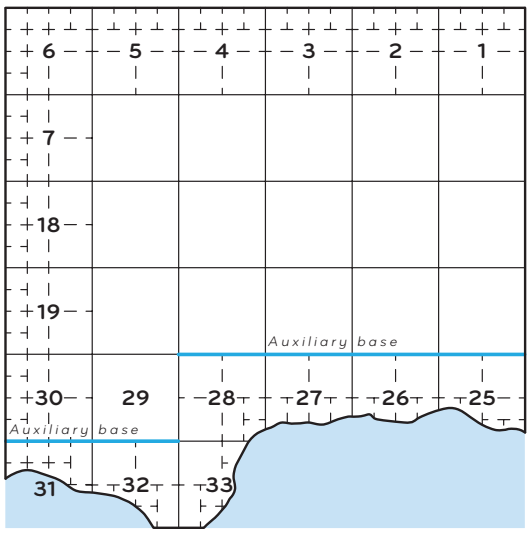


Figure 1-32. Use of auxiliary base.

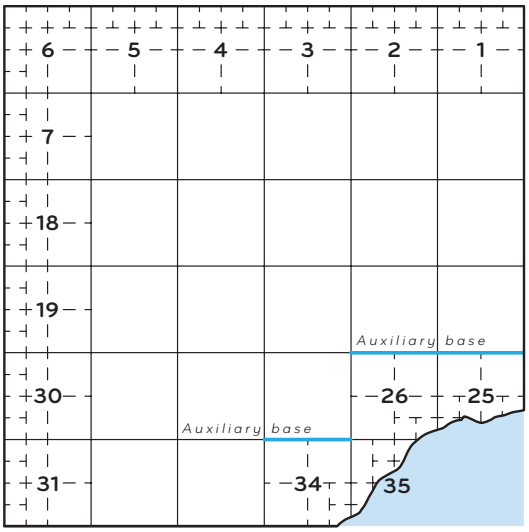


Figure 1-33. Use of auxiliary base.

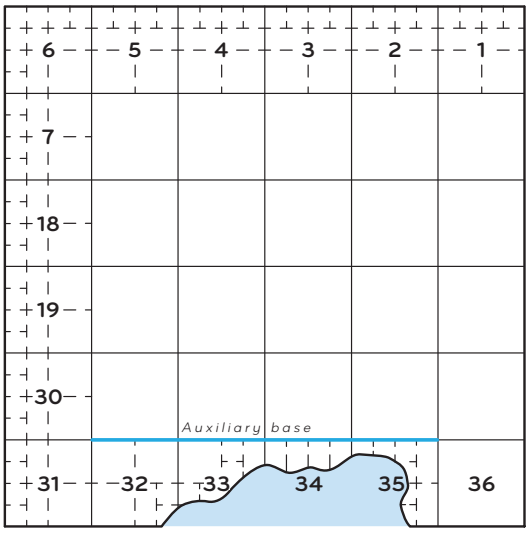


Figure 1-34. Use of auxiliary base.

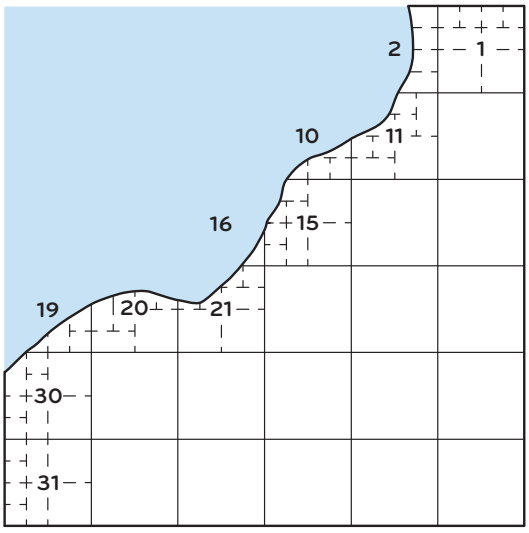


Figure 1-35. Regular subdivision of an irregular township.

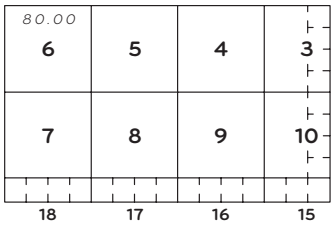


Figure 1-36. Subdivision from north to south and from west to east.

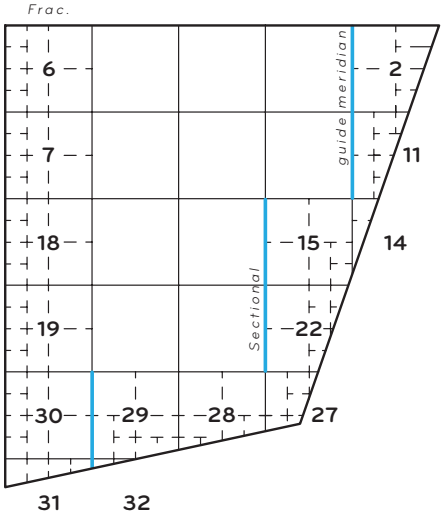


Figure 1-37. Subdivision from north to south and from east to west.

1-82. In the case of irregular townships the sections bear the same numbers they would have had if the townships were regular. That is, the section numbers are those relating to the governing boundaries.

Extension and Completion Surveys

1-83. Original surveys sometimes involve the continuation of the subdivisional survey of townships previously subdivided in part only. These surveys include the completion of partially surveyed sections (section 1-125), of sections containing outlying areas protracted as surveyed, or of protracted section lines. If defective conditions are encountered in the previously established surveys, the problems concerning the procedure to be adopted multiply rapidly and require the greatest skill on the part of the surveyor. In the construction of new township plats the former practice of platting sections containing outlying areas protracted as surveyed has been abandoned as unsatisfactory and inconsistent with the surveying laws.

1-84. In Alaska, platting sections protracted as surveyed is done to accommodate the Alaska Native Claims Settlement Act (ANCSA) selections. Dashed lines represent the section lines and indicate which lines were not run and marked, and the distances given are parenthetical distances.

Akin to extension and completion surveys are townships in Alaska, often called "Tract A" townships, surveyed to accommodate State of Alaska land selections. The township exteriors are run and marked with a minimum of 2-mile monumentation. No interior section lines are run and marked, or protracted. Sections do not exist within these types of townships.

1-85. It is often necessary to depart from the general scheme. The possible combinations are too numerous to describe in detail. The complexities multiply with various combinations of valid existing rights, questions of accuracy of previously surveyed lines, and the condition of the corner monuments. The surveyor is reminded that the principles outlined in this course are in conformance with due process of law and bona fide rights as to location standards. See sections 1-24 through 1-26 for original survey situations and chapters V, VI, and VII for resurvey situations. When application of the general rules do not meet the due process of law and bona fide rights as to location standards, then exceptions to the general rules must be applied. Such exceptions to the general rules may be applicable in (1) townships with improvements, use or occupancy; (2) townships with significant riparian rights; or (3) townships without improvement, use or occupancy but with uneven distribution of valuable natural resources.

1-86. Most original surveys that are now to be extended or completed were executed many years ago when the remaining areas were considered wastelands. Due to the ravages of time and the inferior monumentation of many early surveys, obliteration may be so far advanced that dependent resurveys are needed to identify and remonument the limiting boundaries of the area to be surveyed. The surveyor often must retrace additional lines that are not the boundaries of sections containing the new areas to be surveyed. In such cases, only the positions of corners that control the location of Federal interest land should be monumented. Identified original corners adopted as control in reestablishing corners of the Federal interest land are to be rehabilitated or remonumented, as necessary.

1-87. The official record of necessary resurveys shall include an explanation of their purpose and extent, including all needed historical references to the related prior surveys. The detail is written in the usual field note record form, following the introductory statement.

The plat, in addition to the usual data, may carry a marginal memorandum or diagram that clearly defines what lines of the prior survey have been retraced as a basis for extending the new lines. If no changes are made in the former lottings and areas in the dependently resurveyed portions, state that the lottings and area remain as shown on the plat or plats approved _____ (date or dates).

Extension or Completion of Partially Surveyed Sections or Sections Containing Outlying Areas Protracted as Surveyed

1-88. In extending or completing fragmentary surveys, consideration is given to the completion of (1) partially surveyed sections, and (2) sections containing outlying areas protracted as surveyed, returned on the previous plat. In such cases, it is usually necessary to complete the survey of each section in such a way as to protect acquired rights. The procedure adopted shall fix and mark the remaining quarter-section corners and the controlling corners not marked in the previous survey in a position that will control the center and other controlling lines as necessary to retain the form of the original areas within reasonable limits. If there are no valid existing rights or other interests to be protected as to location, it is not necessary to complete the survey of the section in a manner consistent with the previous plat.

1-89. The new quarter-section and controlling corners are regarded as reasonably fixed when (1) the new measurements produce subdivisions that meet or exceed the prescribed limits of closure, (2) the alinement does not exceed the rectangular limit of 21' from a cardinal course, and (3) the measurement does not exceed the rectangular limit of 25 links from 40 chains, or in proportion when the opposite portion of the section boundary was returned as more or less than 40 chains. This concession as to limits is made in the interests of simplicity where the rectangularity of both old and new surveys can thus be maintained.

1-90. The position of the corresponding corner on a new opposite boundary is controlled from only one direction if the old opposite distance was made to count from one direction only. If the old opposite distance

was made to count from two directions, the position of the new opposite corresponding corner is controlled from the two directions. The lengths of the two portions of the new line are made proportional to the two parts of the old opposite boundary.

1-91. If an original survey is within rectangular limits and valid existing rights or other interests is to be protected as to location, then the survey of a partially surveyed section, or a section containing outlying areas protracted as surveyed, is completed on the same plan begun in the original survey. When irregularity develops, the simplest method of survey that will correct any irregularities and provide an early resumption of regularity in the new subdivisional lines is adopted. The general rule is that each completed section will have four regular boundaries without offsets, with four governing section corners and four controlling quarter-section corners in such position as to maintain the integrity of the areas shown upon the original plat.

1-92. Modification of the general rule is necessary where extending or completing each of two sections in the above manner would cause an overlap or hiatus. In such a case each section is completed theoretically without regard to the other, and the position of each center line and other controlling lines is fixed. The most reasonable position for a common boundary between the two sections is then determined, and the new quarter-section corners are fixed at points that maintain the center lines in their positions. If the theoretical position for each quarter-section corner falls within 25 links of a common point, with allowance for variance in length of the center line, one corner may be fixed, which will secure maximum regularity in both sections.

1-93. The possible combinations of uncompleted sections are too numerous to discuss fully here. Directions must be given in the special instructions for the cases involved in an assignment, and surveyors will seek advice from the proper administrative office when irregularities develop. A diagram showing the exact field conditions should always accompany their reports.

1-94. Modification of the general rule for extending or completing sections is necessary, by Department decision, when a good faith location by local survey is followed by good faith use and occupancy; *Algoma Lumber Co. v. Kruger*, 50 Pub. Lands Dec. 402 (1923). A local survey made for the purpose of marking on the ground a protracted line, platted but not run by the Government, where executed within the allowable limit of error for an original survey of that date, and relied upon by an owner under title passed by the United States in the placing of improvements upon the patented land, will not be disturbed, but it will be adopted by the Government as a boundary for closure of the survey of the adjoining public land.

1-95. The best test of the fitness of a proposed method for the completion of partially surveyed sections, or sections containing outlying areas returned as sur-veyed is to plat the subdivisional lines by protraction, therefore, the regular rules for subdivision of sections are applicable. The position of the new quarter-section corners, established to control the subdivision of the section in question, shall permit the center lines to the opposite corresponding original quarter-section corners to be connected in harmony with conditions shown on the original plat, disregarding the effect upon the subdivision of the newly surveyed land. Likewise, the lines connecting the sixteenth-section corners on the opposite corresponding boundaries of a quarter-section shall conform to the conditions represented on the original plat. When the subdivision-of-section lines are platted, the section is satisfactory if the integrity of the original areas is in no way violated.

3-96. The following guidelines should be followed in platting:

(1) The new areas should be complementary to the original areas by extending the subdivision-of-section lines as already protracted upon the original plat. If poorly shaped lots or lots of too great or too little area result, then departure is indicated.

(2) In the interest of regularity and simplicity of platting, the same meridional limit may be permitted as is ordinarily allowed in latitudinal section lines. A section may be considered regular if its boundaries do not depart more than is allowed to achieve rectangular limits for both alinement and measurement between the section and quarter-section corners (section 1-34). Such regular sections may be subdivided into quarter-sections and quarter-quarter sections as far as possible. An irregular section having three regular boundary lines may be subdivided in accordance with the usual rules for subdividing sections along the north and west boundaries of a regular township. An irregular section having two adjacent regular boundary lines may be subdivided by the same manner in which section 6 of a regular township is treated (e.g. sections 1-32, 1-54, and 1-57). All other sections should be treated as irregular,

with subdivision-of-section lines protracted to midpoints on the boundaries of the quarter-sections, except as a calculated proportional position for a sixteenth-section corner is made necessary by the showing of the original plat.

(3) All new lots are numbered beginning with the next higher number in the series shown on the previously approved plat, and proceeding in the usual order. The new series may begin with No. 1 if the irregular parts of the original area are not designated by lot number.

Completion of Township Subdivision

1-97. If no irregularities are found in the previously established lines the new survey may proceed normally. If defective conditions are encountered, the irregularities are not extended into unsurveyed sections any farther than necessary to incorporate the resulting excess or deficiency in measurement into suitable lots adjoining the former surveys. Preference should be given to extending all surveys from south to north and from east to west. If a better control is available by reversing the procedure in one or both directions, resulting in a simpler survey by minimizing the number of extra corners as well as lots, reversal of the procedure is warranted. In the event that the previously surveyed subdivision lines are defective, the new section lines may serve the func-tion of a sectional guide meridian or a sectional correc-tion line as required. The corners, from which the new surveys are initiated, are established as corners of four sections, or of two sections as appropriate. Where new section lines cannot be connected regularly with the previously established section corners without exceed-ing the rectangular limits in alinement (section 1-34), a section corner is established at intersection with the line of the old survey. The excess or deficiency in measure-ment of the intersecting section lines is incorporated adjacent to the old surveys. The original lines forming the boundary of the lands to be surveyed are retraced as already provided and the marks upon the original corners are appropriately modified as necessary. New quarter-section corners marked to control the subdivi-sion of the new sections are established on the original lines at midpoints between the section corners, or at 40 chains from one direction, according to the manner in which a new section is subdivided.

1-98. There are often two or more ways in which a subdivision may be completed, but careful study of a sketch plat representing existing conditions will generally reveal the superiority of one method over another (figures 1-38 and 1-39).

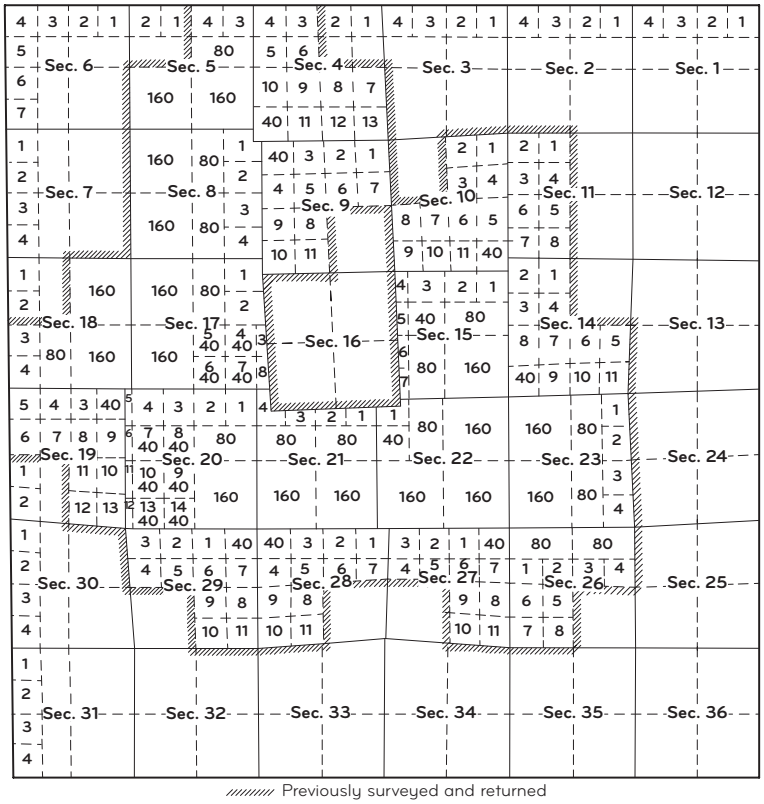


Figure 1-38. Example showing completion of sections containing outlying areas protracted as surveyed and completion of subdivisional lines of a town-ship with necessary lottings. On an actual plat, an area will be returned for each lot and each section.

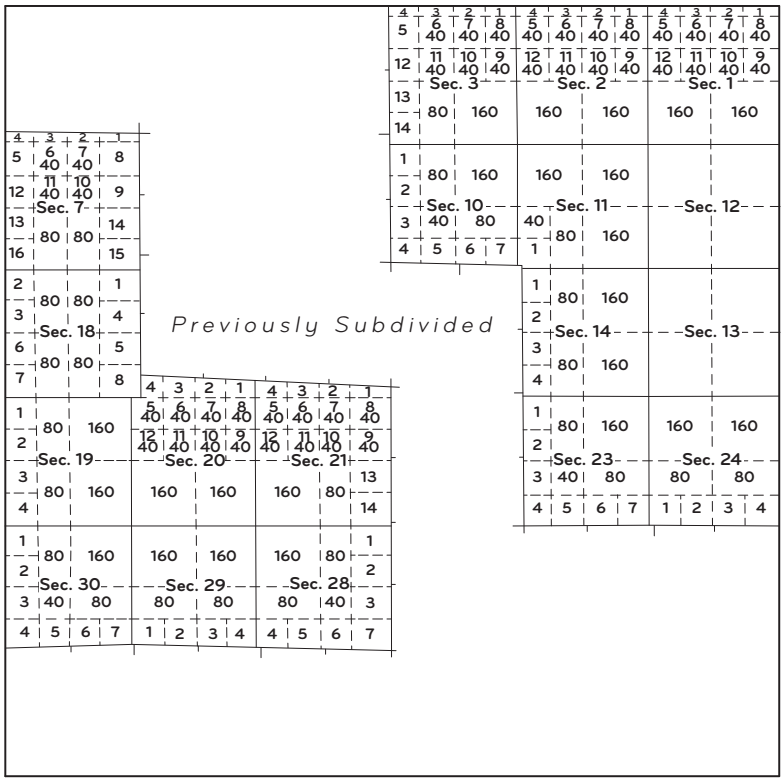


Figure 1-39. Example showing completion of subdivisional lines of a township where sections containing outlying areas protracted as surveyed returned earlier have been cancelled. On an actual plat, an area will be returned for each lot and each section.

Subdivision of Sections

3-99. Title 43 U.S.C. 752 and 753 (Rev. Stat. 2396 and 2397) contain the fundamental provisions for the subdivision of sections into quarter-sections and quarter-quarter sections. Sections are not subdivided in the field by Bureau of Land Management cadastral surveyors unless provision is made in the special instructions, but certain subdivision-of-section lines are protracted upon the official plat.

In the public land survey system a corner is fixed in position by operation of law. Corners marked in official surveys followed by use are fixed in position by monuments. Only a small portion of corners are marked on the ground in original surveys. Subdivision-of-section corners are generally not marked. Their positions are fixed on the plat by protraction. Their positions are fixed on the ground by the survey process of running (and marking) line between marked corners, and setting monuments.

1-100. The lands included in an entry or selection are identified on the ground by marked and fixed monuments, or by corner positions fixed by measurement and reference established in the survey. A United States patent grants to the entryman title of ownership to an area defined on the ground by those fixed monuments and related by description and outline to the protractions on the official plat. The land included in an interim conveyance, lease, order, proclamation, reservation, selection, tentative approval, or withdrawal, and related by description and outline to the official plat, is also identified on the ground in the same manner.

Subdivision of Sections by Protraction

1-101. The following sections address the procedures to be followed by the draftsperson after receiving the field returns from the field surveyor. The subdivision of sections into aliquot parts, lots, parcels, and other parts is performed in the appropriate office section of the respective cadastral survey offices.

1-102. The draftsperson is **first**, to plat each section in accordance with the field notes, and **second**, to subdivide each section as nearly as possible in conformity with the uniform plan, including connecting by straight lines opposite corresponding corners, incorporating excess or deficiency against the township boundary, creating as many aliquot part legal subdivisions as possible and following other lotting principles as stated in

the Manual and outlined in 43 U.S.C. 752(2)(cl. 2) and 753(cls. 1 and 3).

1-103. Upon the plat of all regular sections, the boundaries of the protracted quarter-sections are shown by dashed straight lines connecting the opposite corresponding quarter-section corners. Referring to figure 1-40 the sections bordering the north or west boundary of a regular township, excepting section 6, are further subdivided by protraction into parts containing two half-quarter sections and four regular lots. Section 6 has regular lots protracted against both the north and west boundaries, and so contains two half-quarter sections, one quarter-quarter section, and seven regular lots. The position of the protracted lines and the order of lot numbering are shown in figure 1-40. The lots are numbered in a series progressively from east to west or from north to south in each section. The lots in section 6

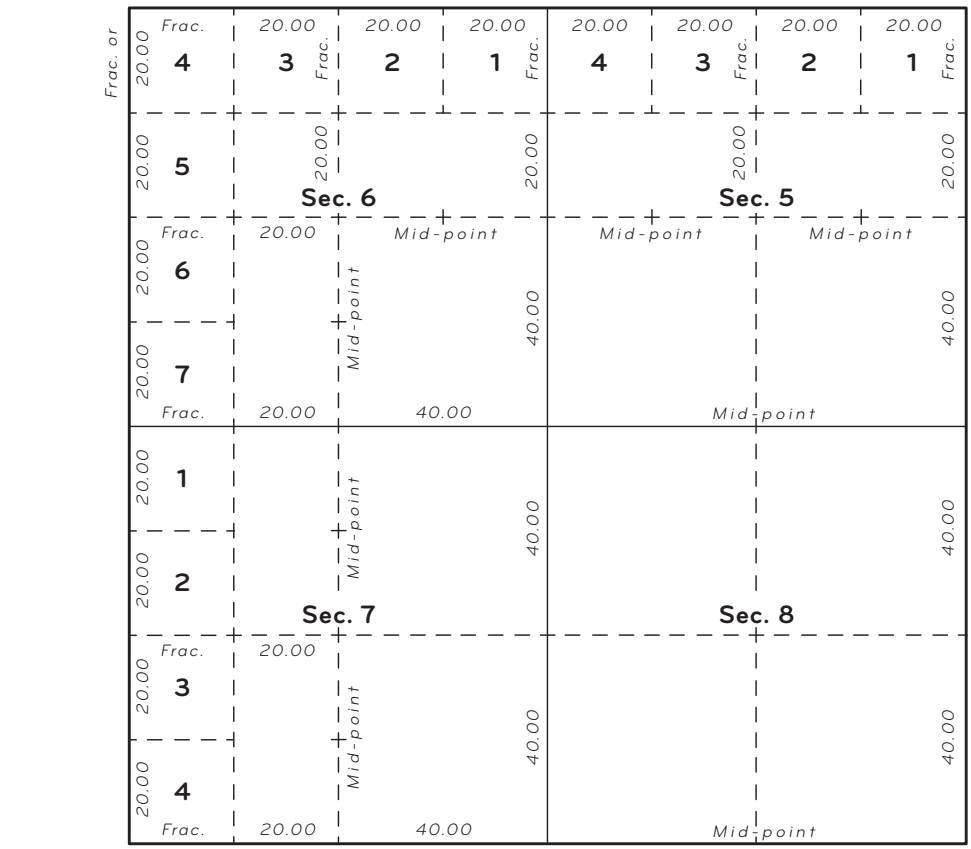


Figure 1-40. Examples of subdivision by protraction.

are numbered commencing with No. 1 in the northeast, thence progressively west to No. 4 in the northwest, and south to No. 7 in the southwest.

1-104. Subsequent to the filing of the official plat, further subdivision of lots can only be accomplished by survey or supplemental plat. However, when it is administratively advantageous and prior to the offi-cial filing, the legal subdivisions adjoining the town-ship exterior can be protracted into smaller than the customary lots. For example and again referring to figure 1-40, the sections bordering the north or west boundary of a regular township, excepting section 6, can be further subdivided by protraction into parts containing two half-quarter sections, four half-quarter-quarter sections, and four regular lots. In this exam-ple the north-north or west-west sixty-fourth section corners are established at 10 chains distant from the interior sixteenth-section corners, and the excess or deficiency in measurement is incorporated in the last distance to the township exterior. The same pattern is applied to section 6 on both its north and west boundaries.

1-105. The quarter-quarter sections are aliquot parts of quarter-sections based upon midpoint protraction. These lines are not indicated upon the official plat.

Sections are subdivided to contain as many aliquot parts as possible, but a departure from this practice is made where it would result in poorly shaped lots. In the case of the regular lots along the north and west boundaries of a township, and in other cases where a lot has a full normal width of 20 chains in one direction, it is gen-erally advisable to avoid areas of less than 10 or more than 50 acres. In the instance of irregular lots along a meander line or other irregular broken boundary, where the width of the lot in both directions may be consider-ably less than 20 chains, resulting in lots of more com-pact form, it is generally better to avoid an area of less than 5 or more than 45 acres. Extreme lengths or narrow widths should be avoided. The longer direction should extend back from a meander line or claim boundary rather than along it. It is inconsistent that a lot lay partly in two sections, and it is generally better, when consis-tent with other rules, to avoid lots extending from one quarter-section into another quarter-section.

3-106. Sections that are invaded by meanderable bod-ies of water or by approved claims at variance with the regular legal subdivisions are subdivided by protrac-tion into as many aliquot parts as possible and then lots, as may be necessary to form a suitable basis for the administration of the Federal interest lands and to describe the latter separately from the segregated areas.

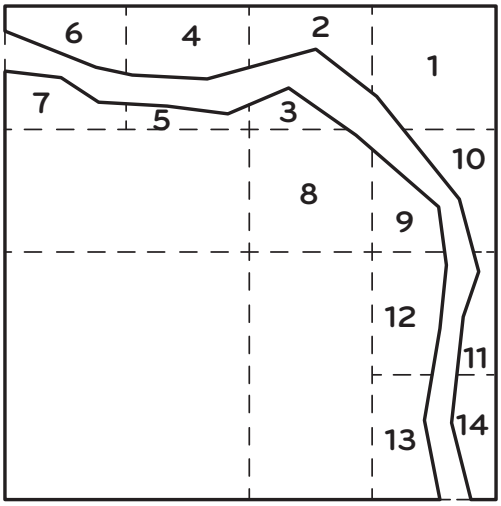
1-107. The meander line of a body of water and the boundary lines of private claims are platted in accordance with the lines run or connections made in the field. The sections invaded are subdivided by protraction as nearly as possible in conformity with the uniform plan. The subdivision-of-section lines are terminated at the meander line or claim boundary, but for platting purposes, the position of the subdivision-of-section lines is controlled as though the section had been completed regularly. In the case of a section whose boundary lines are in part within the limits of a meanderable body of water or within the boundaries of a private claim, the section lines are, for the purpose of uniformity, completed in theory and the protracted position of the subdivision-of-section lines is controlled by the theoretical points so determined.

1-108. The method of *subdivision by protraction* of fractional sections into lots is **first**, in accordance with the field notes, and **second**, as nearly as possible in conformity with the uniform plan for fractional sections. Protraction of subdivision-of-section lines will be made, as nearly as possible, in conformity with the procedures outlined for fractional sections in 43 U.S.C. 752(2)(cl. 3) and 753(cls. 2 and 4). Only in limited cases is there a significant difference between the two methods. See section 1-118 for *subdivision of fractional sections by survey*.

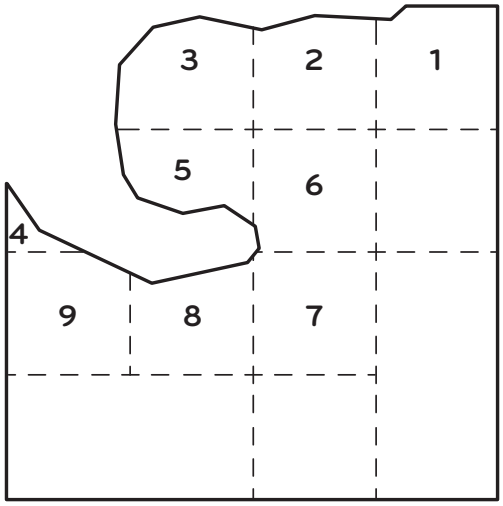
1-109. To visualize a uniform system for numbering lots of invaded sections and fractional sections, imagine the section divided by parallel latitudinal lines into four tiers, numbered from north to south. Then, beginning with the eastern lot of the north tier, call it No. 1, and continue the numbering west through the tier, then east in the second, west in the third, east in the fourth tier, until all lots have been numbered. These directions are maintained even though some of the tiers contain no lots. A lot extending north and south through two or part of two tiers is numbered in the tier containing its greater area. This method of numbering applies to any part of a section. A section that has been partly surveyed at different times will have no duplication of lot numbers (figure 1-41).

Elongated Sections

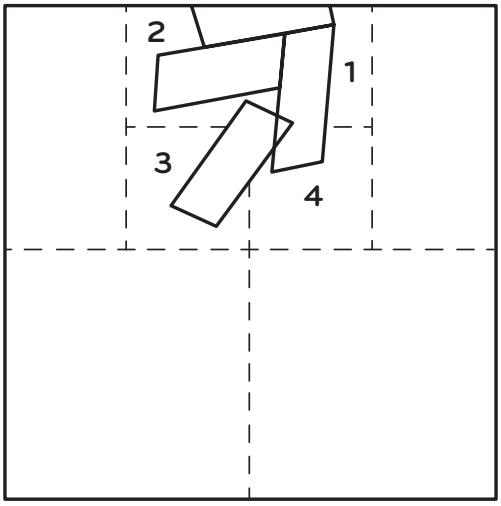
1-110. Prior to the 1973 Manual, when the length or width of a township exceeded 480 chains to such an



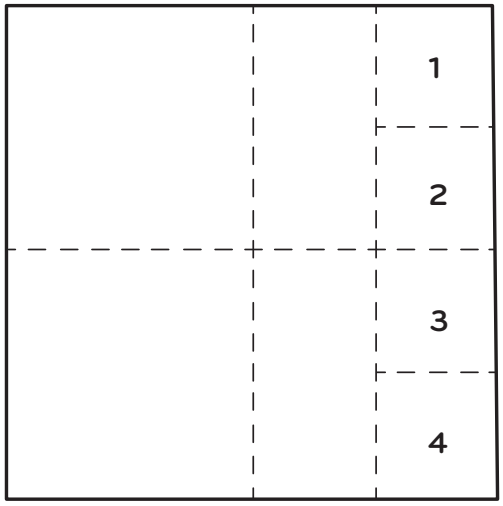
Meanderable River.



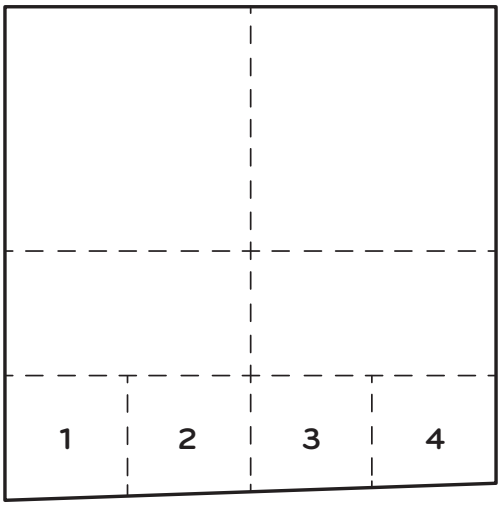
Meanderable Lake.



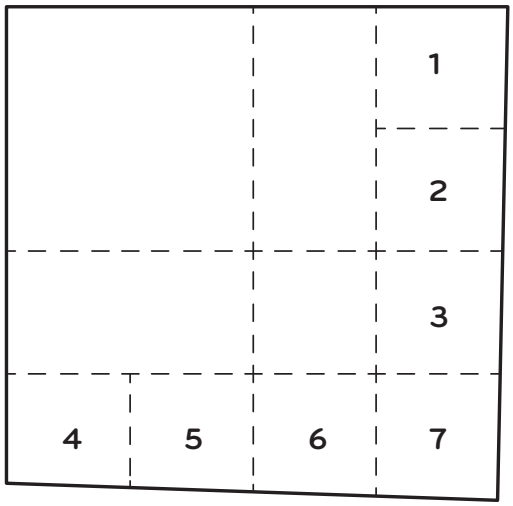
Mineral Claims.



E. bdy. defective in alinement.



S. bdy. defective in alinement.



E. & S. bdrs. defective in alinement.

Figure 1-41. Examples of subdivision by protraction.

extent as to require two or more tiers or ranges of lots adjoining the north or west boundary, the usual past practice was to lot all of the area beyond the regular legal subdivisions. Beginning with the 1973 Manual and in order to avoid possible confusion of descriptions, the lotting should be extended throughout the elongated half of the section as shown in figures 1-42 and 1-43. This will also apply to the platting of resurveyed sections insofar as Federal interest land is involved. Sections in excess of 120 chains are avoided by the creation of half-township or half-range numbers. This cannot be done where the elongated sections are situated in the interior of a township as the result of partially completed but grossly irregular former subdivisions. Lotting will then be extended as necessary.

3-111. If it has been necessary to establish a sectional guide meridian or a sectional correction line, lots may result along the east or south boundary of the township. The sections bordering the defective boundaries are subdivided on the same plan as sections bordering the north and west boundaries of a normal township.

Order of Procedure in Subdivision of Sections by Survey

1-112. The method of subdivision of section by survey is established during the survey of the section exte-rior and a subdivision of section by protraction, when applicable.

The subdivision of section by survey is performed dur-ing the field work by the field surveyor. The surveyor is guided by special instructions, the official plat(s), and the general plan of the rectangular survey system. When there is evidence of a prior survey or diagram, or use or occupancy within a section, the instructions outlined in chapters V and VI will be applicable and a corresponding plan of subdivision is proper.

1-113. Since the corners marked and fixed, or fixed by measurement and reference, in the original survey are controlling, it is essential that these corners be found, located, or properly restored, before the actual field work involving the subdivision of section is undertaken. The section boundaries should be retraced to develop the actual bearings and lengths of the lines between the marked corners.

The order of procedure is: First, identify or reestablish the marked corners on the section boundaries, including determination of the points for the necessary sixteenth-section corners. Next, fix the boundaries of

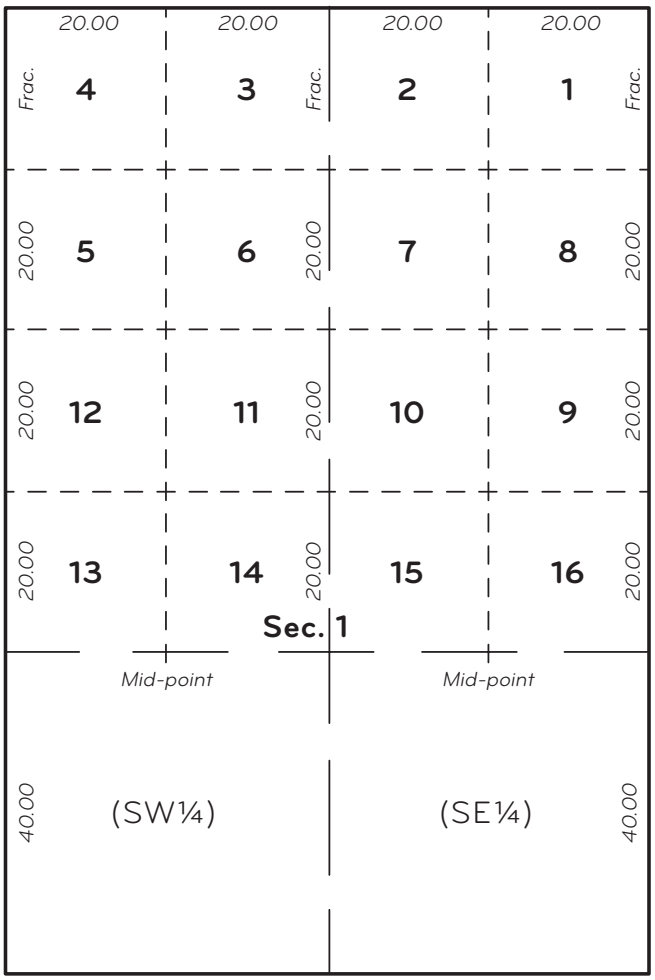


Figure 1-42. Extension of lotting in an elongated section. On an actual plat an area will be returned for each lot and the section.

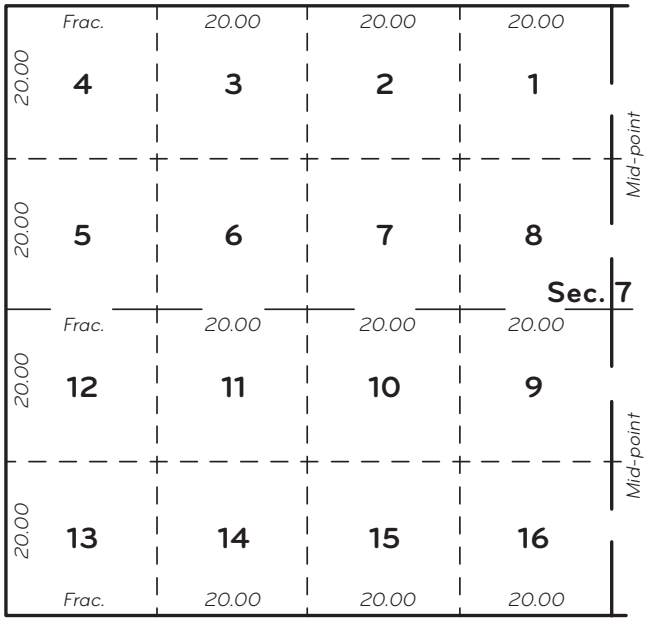


Figure 1-43. Extension of lotting in an elongated section. On an actual plat an area will be returned for each lot.

the quarter-sections and then form the quarter-quarter sections or lots by equitable and proportionate division (see section 10-5).

Subdivision of Sections into Quarter-Sections by Survey

3-114. To subdivide a regular section into quarter-sections, run straight lines from the fixed quarter-section corners to the opposite corresponding quarter-section corners. The point of intersection of the lines thus run and fixed will be the corner common to the several quarter-sections, or in other words, the legal center of the section. This method of subdivision is outlined in 43 U.S.C. 752(2)(cl. 2) and 753(cls. 1 and 3). In this application, "straight lines" implied "lines of constant bearing" (43 U.S.C. 752(2)).

1-115. The quarter-section corners upon the lines terminating on the north and west boundaries of a regular township were established originally at 40 chains to the north or west of the last interior section corners. The excess or deficiency in measurement was incorporated into the legal subdivision next to the township or range line, as the case may be. If such legal subdivision corners, usually quarter-section corners, are lost they shall be reestablished by proportionate measurement based upon the official record.

1-116. Where there are double sets of section corners on township and range lines, the quarter-section corners on the township line for the sections south of the township line and on the range line for the sections east of the range line historically were not marked in the original surveys. In subdividing such sections new quarter-section corners are required. The new corners shall be placed as to suit the calculations of the areas that adjoin the township boundary, as indicated upon the official plat, adopting proportional measurements where the new measurements of the north or west boundaries of the section differ from the record distances.

Subdivision of Quarter-Sections by Survey

1-117. Preliminary to the subdivision of quarter-sections, the quarter-quarter or sixteenth-section corners shall be fixed as nearly as possible equidistant or proportionate measurement from two corners which stand on the same line, and between the quarter-section corners and the center of the section. On the last half mile of the lines terminating on township boundaries, they should be placed at 20 chains, proportionate measurement, counting from the regular quarter-section corner.

Subsequent to the establishment of quarter-quarter or sixteenth-section corners, the center lines of the quarter-section shall be run as straight lines between opposite corresponding quarter-quarter or sixteenth-section corners on the quarter-section boundaries. The point of intersection of the lines thus run and fixed will be the legal center of a quarter-section.

Subdivision of Fractional Sections by Survey

1-118. By law a fractional section is (1) a section containing outlying areas protracted as surveyed, or (2) an invaded section in which at least one quarter-section corner has not been or cannot be fixed. The method of subdivision by survey is outlined in 43 U.S.C. 752(2)(cl. 3) and 753(cls. 2 and 4). By rule the procedure for subdivision of the fractional section is to be as nearly as possible in conformity with the official survey.

1-119. The law presumes that a corner has not been fixed when: (1) the section line on each side of the corner position has not been actually run (figure 1-44) or, (2) the section line has been actually run but at least one corner on either side, on the section line at issue, has not been monumented (figure 1-45). The rule presumes that a section line has been actually run when a bearing and distance of the line is returned in the official survey record.

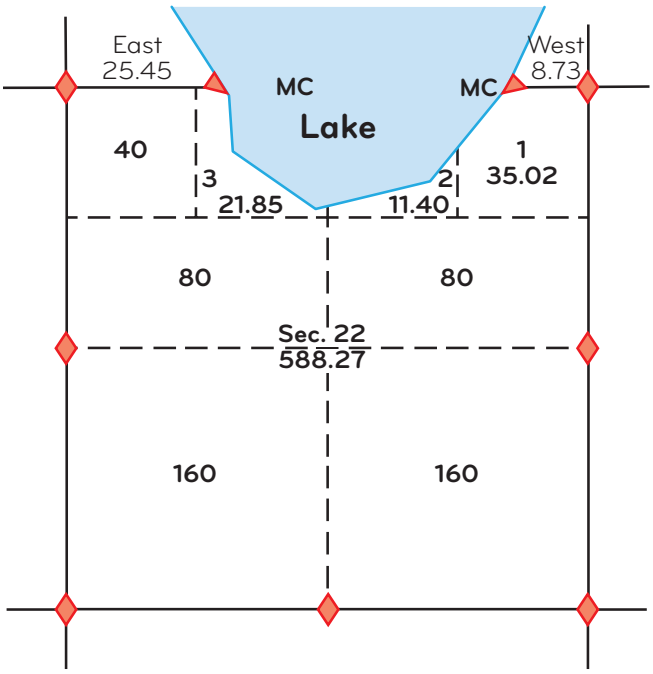


Figure 1-44. Fractional section. No bearing and distance returned between the meander corners.

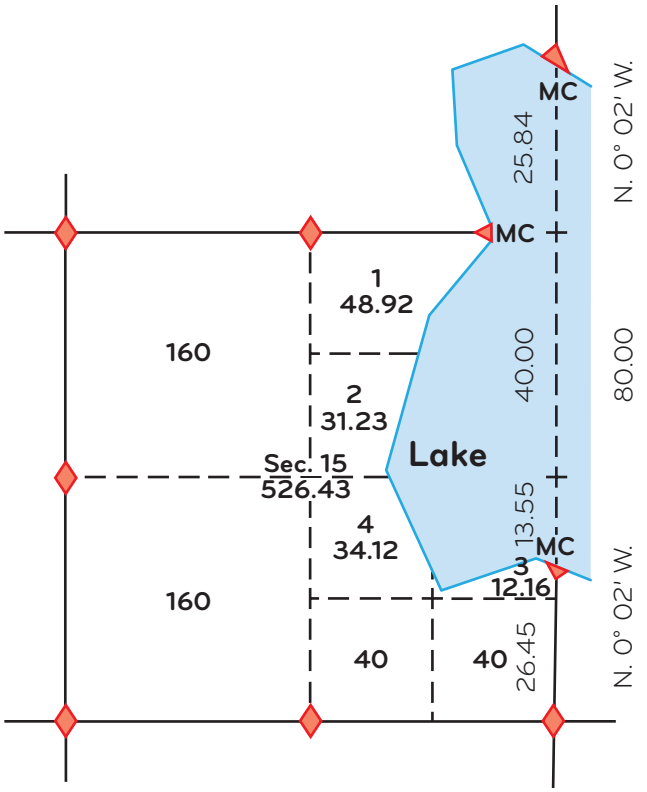


Figure 1-45. Fractional section. The section corner was not monumented.

1-120. The law provides that where no opposite corresponding quarter-section corners have been or can be fixed, the subdivision-of-section lines shall be ascertained, by running a line from the monumented corners due north and south, or east and west, as the case may be, to the water-course, reservation line, or other external boundary of such fractional section, as represented upon the official plat.

Under this subdivision-of-section method, the law presumes the section lines actually run and marked in the survey are due north and south, or due east and west lines, but usually this is not the case. Hence, in order to carry out the spirit of the law, it will be necessary in running the center lines through fractional sections to adopt mean courses, as ascertained from opposite corresponding section lines. Where an opposite corresponding section line does not exist, or the center line is platted parallel to one section boundary, run the center line parallel to the corresponding east, south, west, or north boundary of the section, as conditions may require.

1-121. The mean and parallel courses are based upon the weighted mean bearing of the controlling section line(s), equal to the bearing of the accumulated latitudes and departures of the controlling line(s) (figure 1-46).

This subdivision-of-section method is also used when the evidence conclusively shows that the meander corner, as well as closing or equivalent corners, was actually established as a terminal corner.

1-122. The basic principles outlined generally give satisfactory results except in special cases. The rules cannot be elaborated to rectify conditions that are at gross variance with the representations of the official survey record.

Examples of special cases that may warrant modification of the basic subdivision-of-section methods are situations where (1) the prescribed method does not result in lines and corners that represent the conditions on the official plat; or (2) a good faith rule occupation (section 6-35) has been established in reliance on a subdivision-of-section method reasonably consistent with the controlling survey plat(s). In such cases a corresponding modified plan of subdivision of section is proper.

Subdivision of Fractional Quarter-Sections by Survey

1-123. By law, for subdivision purposes, a fractional quarter-section is within (1) a section containing outlying areas protracted as surveyed, or (2) an invaded section in which at least one quarter-quarter-section corner of the quarter-section has not been or cannot be fixed.

3-124. The subdivision-of-section lines of fractional quarter-sections shall be ascertained by running from properly established quarter-quarter or sixteenth-section corners with courses governed by the conditions represented upon the official plat. This can generally be accomplished by running due north and south, or east and west lines, as the case may be, to the water-course, reservation line, or other external boundary of such fractional quarter-section.

In running the center lines through fractional quarter-sections it is necessary to adopt mean courses, as ascertained from opposite corresponding section and subdivision-of-section lines, or run parallel to a boundary of the section or quarter-section, as conditions require (figure 1-46).

Survey of Partially Surveyed Sections

1-125. In rare cases portions of the section boundaries are impassable or so insecure that acceptable monumentation is impracticable, or there is an administrative

Problem: Compute the weighted mean bearing of the N-S center line of fractional section 20.

The data shown in diagram 1 is measured data.

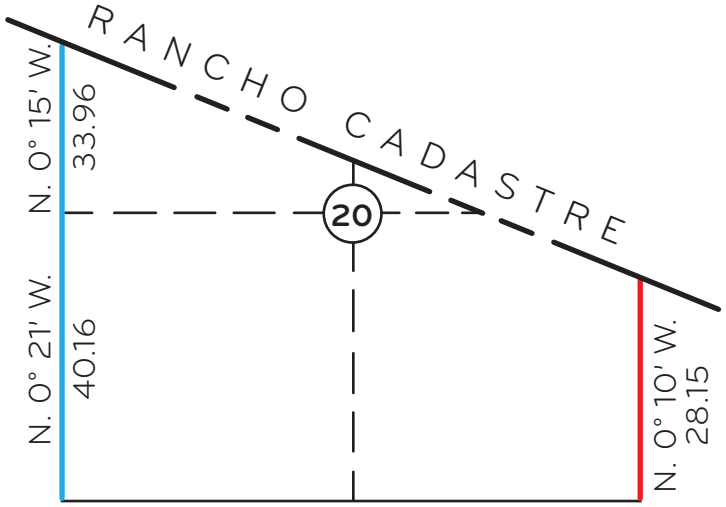


Diagram 1
(Measured)
(not to scale)

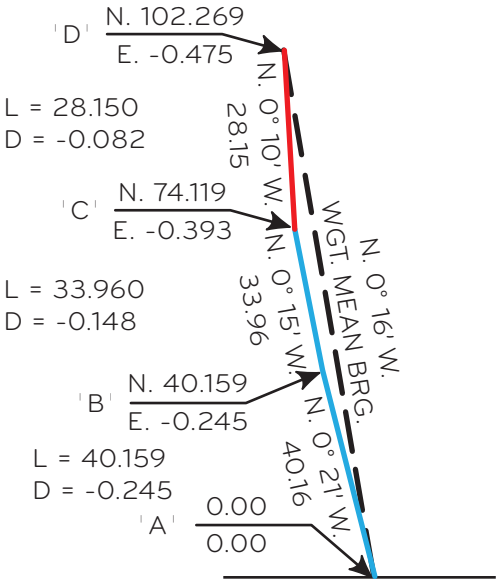


Diagram 2
(Measured)
(not to scale)

Traverse Method:

1) Traverse from 'A' to 'B' to 'C' to 'D'. See diagram 2.
2) Inverse from 'A' to 'D'.
3) The bearing 'A' – 'D' is N. 0° 16' W. = the weighted mean bearing.

Proportion Method:

1) The ¼ sec. cor. of secs. 19 and 20 was recovered. First compute the inverse for the sec. line:
   N. 0°18' 12" W. 74.12
2) Compute the difference in bearings between the east and the west section lines:
   N. 0° 18' 12" W. – N. 0° 10' W. = 8' 12" = 492"
3) Compute the sum of the lengths of the east and the west section lines:
   28.15 + 74.12 = 102.27
4) Compute the correction factor 'K'. Use the shorter (east) line:
   28.15 / 102.27 = 0.2753 = K
5) Compute the correction to the bearing of the west line:
   492" X 0.2753 = 135.45" = 2' 15"

Mathematically, the weighted mean bearing will be closer to the bearing of the longer line than of the shorter line, therefore, the computed correction using the shorter line is applied to the bearing of the longer line.

6) Compute the weighted mean bearing by, in this case, subtracting the correction from the bearing of the longer line:
   N. 0° 18' 12" W. - 0° 02' 15" = N. 0° 16' W. = the weighted mean bearing.

Figure 1-46. Weighted mean bearing example.

reason not to survey portions of the boundaries and yet a need exists for survey of the accessible area. These unsurveyed areas may be within sections on a protraction diagram, within sections or protracted blocks on an amended protraction diagram, or within an area where no protraction diagram exists. Since rules covering every set of conditions cannot be given, the methods to be used are set forth in the special instructions.

Although the running of traverse lines on the margin of impassable areas has been largely discontinued, such a survey is sometimes called for where rectangular boundaries cannot otherwise be completed within the section. The method must be authorized in the special instructions and supported by ample justification. In such surveys the angle points of the traverse line are given serial numbers in each fractional section, and the points are monumented. The subdivision-of-section lines are protracted only, unless a definition upon the ground is justified.

3-126. For sections within protraction diagrams, where rectangular limit requirements can be met, original surveys of the subdivision-of-section lines should follow the plan outlined by the protraction diagram. Where field conditions reveal that the rectangular limit requirements cannot be maintained, and the corners are not fixed in position by use, the protraction diagram will be abandoned and a new plan for survey provided by a new protraction diagram or by supplemental special instructions and diagram.

For sections within amended protraction diagrams the aliquot part corners are monumented at the latitude and longitude shown on or computed from the protraction diagram.

For areas within a protracted block the special instructions will set forth the plan for surveying the required areas, and the amended protraction diagram will be modified to reflect the new survey. When surveyed a protracted block will normally become a section containing the normal aliquot parts with the excess or deficiency against the previously surveyed boundary.

1-127. Figures 1-47 and 1-48 show rectangular boundaries of partially surveyed regular sections.

1-128. Figures 1-49 and 1-50 show rectangular bound-aries of partially surveyed irregular sections where lot-tings are indicated. In figure 1-49 the whole closing error in latitude is incorporated as normally in the north tier of lots. In figure 1-50 the whole closing error in departure is incorporated as normally in the west range of lots.

1-129. The field notes show only the true line courses and distances, the usual topography, the description of monuments, and a description of the difficulties or administrative need that warranted an elimination of parts of the section or sections.

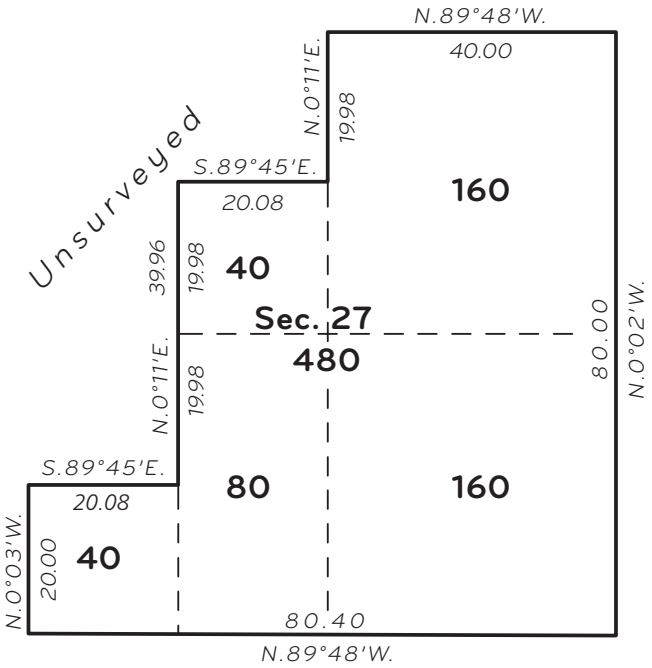


Figure 1-47. Rectangular boundaries of a partially surveyed regular section.

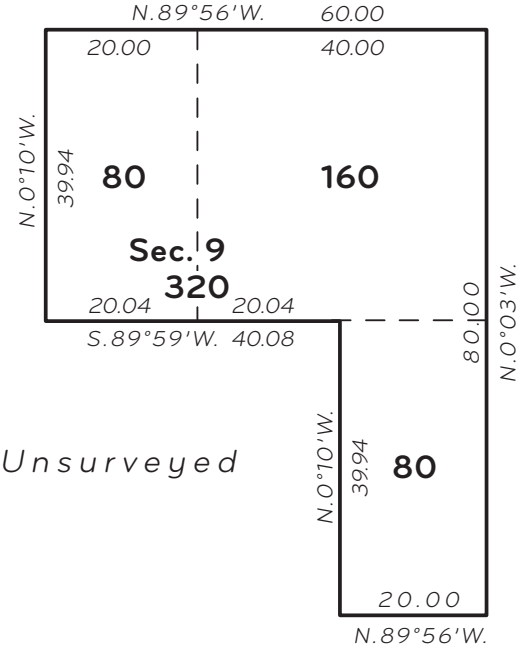


Figure 1-48. Rectangular boundaries of a partially surveyed regular section.

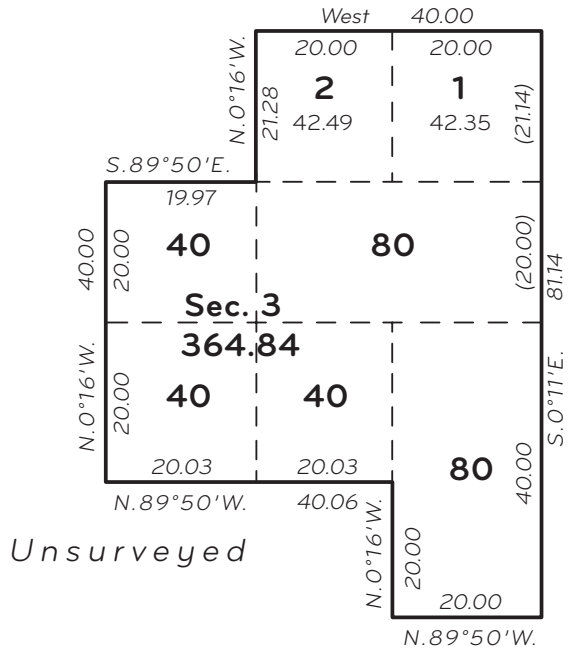


Figure 3-49. Rectangular boundaries of a partially surveyed irregular section adjoining the north boundary. Formerly protracted block 39 per the protraction diagram.

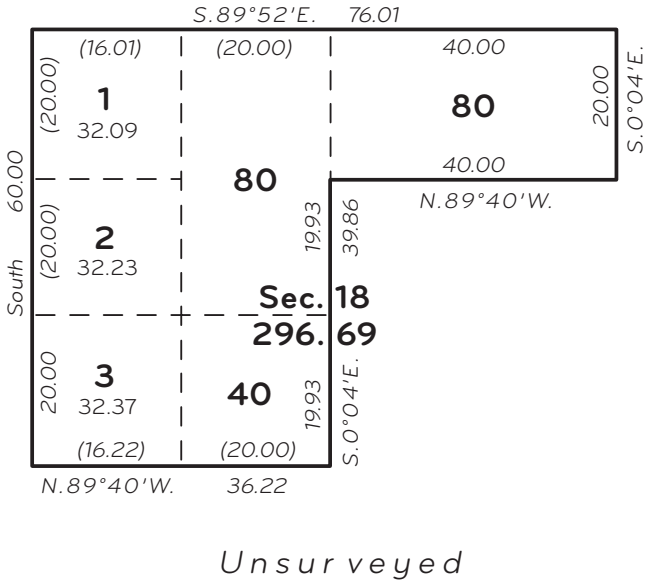


Figure 1-50. Rectangular boundaries of a partially surveyed irregular section adjoining the west boundary. Formerly protracted block 44 per the protraction diagram.

1-130. To subdivide a partially surveyed section, the remaining subdivision-of-section lines within the surveyed area are determined by running straight lines between the nearest fixed corners for the sectional center lines.

The remaining interior sixteenth-section corners on the sectional center lines are at midpoints between the exterior quarter-section corners and the center quarter-section corner, except within the sections normally fractional. The center lines of the quarter-sections are completed on a similar plan. In all sections normally irregular, the excess or deficiency in measurement is incorporated in its normal position as shown on the protraction diagram.

Subdivision of Sections by Local Surveyors

1-131. The function of the local surveyor begins when employed as an expert to identify lands that have passed into private ownership. This may be a simple or a most complex problem, depending largely upon (1) the condition of the original monuments as affected principally by the lapse of time since the execution of the original survey, the inferior monumentation of many early surveys, or the workmanship of the original surveyor; (2) the degree of irrelation between original corners; (3) the use and occupancy of the land; (4) the degree to which local surveys conform with the law, methods, and the exercise of ordinary intelligence under existing conditions; and (5) the presence of nonofficial surveys administered by Federal agencies, their employees, or agents.

1-132. The work of the local surveyor usually includes the subdivision of the section into the legal subdivisions shown upon the approved plat. In this capacity, the local surveyor is performing a function contemplated by law. He or she cannot properly serve the client or the public unless familiar with the legal requirements concerning the subdivision of sections.

1-133. In the event that the original monuments have become obliterated or lost, the local surveyor cannot hope to effectively recover the corner positions without a full understanding of the record concerning their original establishment and other evidence of establishment, subsequent recovery, or reestablishment. Nor can the local surveyor hope to legally restore or weigh evidence of subsequent corner location, use, or occupancy, until he or she has mastered not only the principles observed in the execution of the original survey, and later local practices, but also the principles upon which the courts and authorized administrative officials having jurisdiction over such matters have based their rulings.

1-134. The cadastral surveyor is required to establish the official monuments so that a proper foundation is laid for the subdivision of the section, whereby the officially surveyed lines can be identified and the subdivision of the section controlled as contemplated by law.

The local surveyor, who may be employed by a claimant, entryman, or owner to run subdivision-of-section lines and mark said corners, shall correlate the conditions as found upon the ground with those shown upon the official plat.

1-135. The Bureau of Land Management assumes no control or direction over the acts of local and county surveyors in the matters of subdivision of sections, evaluation of evidence of corner locations, and reestablishment of lost corners of original surveys where the lands have passed into private ownership, nor will the Bureau of Land Management issue instructions in such cases. It follows the general rule that disputes arising from uncertain or erroneous location of marked or unmarked protracted corners originally fixed by the United States are to be settled by the proper local authorities or by amicable adjustment. The Bureau of Land Management desires that the rules controlling the acts of its own cadastral surveying service, and other surveyors under its direction and control, be considered by all other surveyors as merely advisory and explanatory of the principles that should prevail in performing such duties. The Bureau of Land Management does not assume control, direction over, or responsibility for the acts of Federal employees performing or administrating surveys not authorized by the appropriate Chief Cadastral Surveyor.

1-136. The rules for subdivision of sections by survey are based on the laws governing the survey of the public lands. Some cases are not covered by these rules, and when inquiry is made, the Bureau of Land Management will offer advice. The letter of inquiry should contain a description of the particular tract or corner, with reference to principal meridian, township, range, and section of the public surveys, together with a diagram showing conditions found.

Summary

3-137. When any claimant, entryman, or owner has acquired bona fide rights as to location per 43 U.S.C. 772 to certain legal subdivisions, that claimant, entryman, or owner has rights as to the location of the identical ground location as represented by the same subdivisions upon the official plat, controlled by monuments on the ground. It is a matter of expert or technical procedure to mark out the legal subdivisions called for in an entry, claim, patent, selection, or order, and entrymen are advised that a competent surveyor should be employed.

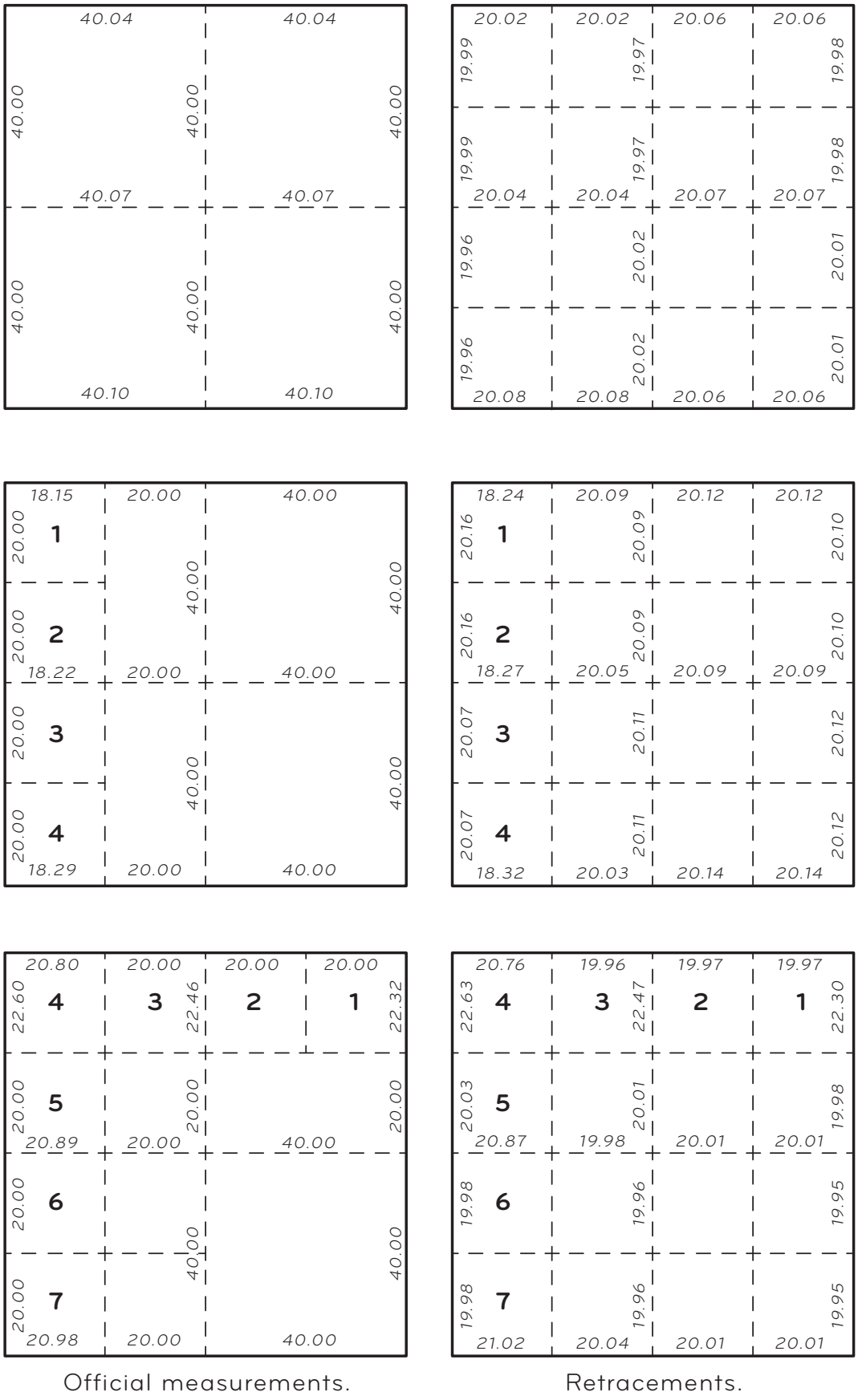
In marking the corners of subdivisions-of-section, the surveyor shall identify the section boundaries, run and mark the section center lines, and fix the legal center of the section in common, in order to determine the boundaries of the affected quarter-sections. Then, if the boundaries of quarter-quarter sections, or lots, are to be run and marked, the boundaries of the quarter-section shall be measured, and the sixteenth-section corners fixed and marked in accordance with the proportional distances represented upon the approved plat. Finally, the quarter-section center lines are run and marked and the legal center of the quarter-section duly fixed.

Thus will be produced in the field the figure represented upon the plat, as nearly as possible, every part of the former in true proportion to the latter, where the elements of absolute distance and area have given way to corresponding proportional units as defined by the running and marking of lines between fixed monuments established in the original or controlling survey. Examples are provided in figure 1-51.

The law presupposes the fact taught by experience that measurements of lands cannot be repeated with absolute precision and that the work of no two surveyors will exactly agree. The governing law, 43 U.S.C. 752(2), states that “boundary lines which have not been actually run and marked shall be ascertained, by running straight lines from the established corners to the opposite corresponding corners.” The protracted position of the legal subdivision corner on the survey plat is merely the first step in fixing the position of a corner. The corner position is fixed by the running and marking of the lines.

A decision to set aside previously fixed local survey legal subdivision corners must be supported by evidence that goes beyond mere demonstration of technical error, reasonable discrepancies between former and new measurement, and less than strict adherence to restoration and subdivision rules. Were the Federal Government obliged to open the question as to the location of a particular tract or tracts over technical differences or reasonable discrepancies, controversies would constantly arise, and resurveys and readjudication would be interminable. The law gives these activities repose.

It is unlawful for the surveyor to impair bona fide rights as to location. Proof of impairment of bona fide rights as to location per 43 U.S.C. 772, when lines have been run and marked and corners marked and fixed by local survey, must be positive evidence of an intentional departure from the legal principles governing recovery of original corner location, reestablishment and establishment of corner location, or subdivision of a section. Where the evidence of an extant subdivision-of-



Official measurements. Retracements.

Figure 1-51. Examples of subdivision by survey showing relation of official measurements and calculated distances to retracements and indicating proportional distribution of differences.

section survey indicates (1) a good faith attempt to relate it to the original controlling survey, (2) conformance as nearly as possible to legal subdivision principles, (3) reasonable accuracy standards for that time and place, (4) sufficiency for identification of the legal subdivisions, and (5) without fraud or gross error, the statutory intent of stability of boundaries and title to lands will have been met.

Cadastral surveyors conducting resurveys must recognize that they are responsible for locating the limits of Federal interest lands and protecting the interests of the United States and of the general public as well as protecting the bona fide rights of the private landowner. The surveyor must act in an impartial manner when evaluating the local survey evidence. A rule works in favor of and against all parties of interest equally. The final record should be transparent and complete.

Protraction Diagrams

Protraction Diagrams—Plan of Survey

1-138. Official protraction diagrams are intended to provide a basis for the administration and management of unsurveyed Federal lands for all purposes short of conveying title. Such protractions can become the basis of land location for leasing purposes and for various administrative boundaries, including wilderness, National Recreation Areas, special use areas, withdrawals, and selections. For further discussion on protraction diagrams and water boundaries see section 8-196. For further discussion on plats of protraction diagrams see section 9-114.

Protraction diagrams should not be treated as "protracted subdivision township surveys." The latter typically have run and marked exterior township lines and protracted section lines. The protracted section lines are represented as dashed lines indicating that they were not run and marked and the distances given are parenthetical distances.

1-139. The State of Alaska or an Alaska Native Corporation can elect to receive patent to certain lands in Alaska on the basis of protraction diagrams (43 U.S.C. 1635(c)(3) and 1637). In addition, protraction diagrams are used to describe certain lands selected by the State of Alaska. Upon tentative approval of such selection by the Secretary of the Interior, subject to valid existing rights, all right, title, and interest of the United States in and to such lands is deemed to have vested in the State as of the date of tentative approval (43 U.S.C. 1635(c)(1)).

Protraction diagrams are also used to describe certain lands to be conveyed to an Alaska Native, Native Corporation, or Native group. Subject to valid existing rights and such conditions and reservations authorized by law as are imposed, the force and effect of such an interim conveyance shall be to convey to and vest in the recipients exactly the same right, title, and interest in and to the lands as the recipients received had they been issued a patent by the United States (43 U.S.C. 1621(j)(1)). In other words, an interim conveyance vests the same rights, title, and interests as would have been received if issued a United States patent.

Upon survey of lands covered by an interim conveyance, a patent is issued to the recipient. The boundaries of the lands as defined and conveyed by the interim conveyance cannot be altered but may be redescribed, if need be, in reference to the plat of survey. The Secretary shall make appropriate adjustments to assure that recipients receive their full entitlement.

1-140. The locations depicted on the protraction diagrams are based on the best available evidence; however, the precise location for many claims and special surveys are uncertain. As a result, there are special survey parcels and leases described by legal subdivisions that are actually located miles from the location shown on the protraction diagram.

The process of surveying a protracted tract or legal subdivision while protecting its location based upon the protraction diagram can involve extensive work. First, all the corners on the exterior of the unsurveyed area controlling the corners to be established must be found or reestablished by dependent resurvey. Second, using the protraction diagram as the record, the protracted township corners must be located. Only then can the location and establishment of the needed township subdivision lines take place, followed by the needed monumentation.

Amended Protraction Diagrams

1-141. Protraction diagrams developed in two forms. Previous to 1993 corner positions were defined by bearing and distance with reference to the exterior boundary of the protraction. Subsequently, the process was amended and corner positions are now defined by geographic coordinates, defining all interior rectangular corners and corners necessary to protect prior existing rights and special areas. The revised procedure adds

more stability to land location and corner positions within protraction areas, allows a more economical corner position location procedure, and uses new developments in geographic position determinations. Any existing diagram revised or new diagram created by this procedure is referred to as an amended protraction diagram (see specimen plat, appendix V).

The surveyed exterior boundaries are as depicted on the latest official surveys. The interior portion of the diagram is constructed to produce the maximum number of regular sections following the general scheme, and an initial point for the interior subdivision is placed to accomplish this goal. Coordinate values, called the Plan Of Survey Coordinates (POSC), are published on the amended protraction diagram and determined for all interior section corners as well as corners of existing withdrawals and valid existing rights that fall in protracted blocks.

Protracted Blocks

3-142. Protracted block is a designation for an area of uncertain acreage that lies between the coordinate-based interior and an existing surveyed line that is a boundary of the protraction or the boundary of a special survey within the protractions. Protracted blocks provide a buffer between protracted section corners defined by the POSC and any existing survey lines. These blocks are configured and dimensioned the same way as a section that is adjacent to an existing surveyed boundary. A protracted block will not be described as less than a full block and will not be lotted or subdivided until surveyed. Protracted blocks will be large enough to ensure that protracted sections do not invade existing survey lines, including special surveys. In order to avoid confusion with section numbers, the protracted blocks are designated beginning with number 37 or the next number above the highest protracted number already used.

1-143. Since the actual position of the existing survey on the ground is uncertain; the area of the protracted block is also uncertain and is shown in parentheses on the plat. The boundaries of a protracted block are normally formed by (1) a protracted line between two POSC corners, (2) the existing surveyed line on the outboundary of the protraction, and (3) two protracted lines. The protracted lines are designated either as bearing, or as random and true, from the POSC corner points within the protraction to the existing protraction outboundary.

The protracted block may be bisected by a meanderable body of water or special survey, creating two or more separate parcels of land within the boundaries of the block. Normally these separate parcels will be combined to form a single protracted block. This single block is made up of every parcel within the block not included in the meanderable water body or special survey, even those too small to appear on the amended protraction diagram, such as islands, gaps between special surveys or within a group of mineral surveys. However, if the configuration of the parcels or the accuracy of the location of the existing special surveys or water body warrants, it is acceptable to create more than one protracted block.

1-144. When protracted lines close on an interior corner or a terminal line, it will be necessary to use a random and true line instead of a designated bearing line.

If a line is projected on a bearing from a POSC to an existing boundary corner, and a line is projected on a bearing from another POSC to the same existing boundary corner, they might meet before intersecting the existing corner. Therefore, one of the lines is run random and true to the existing corner. The random and true lines are labeled R/T on the plat.

Developing Amended Protraction Diagrams

Guidelines for Preparing Amended Protraction Diagrams

1-145. Amended protraction diagrams represent the plan for extending the rectangular survey system over unsurveyed Federal lands based upon assigned latitudes and longitudes for protracted corners, designated bearings for lines intersecting previously surveyed boundaries, and designated random and true lines connecting protracted corners with previously surveyed corners. The goal is to stabilize the interior of the protraction by assigning coordinates to section corner positions, called Plan of Survey Coordinates, and to create the maximum number of regular sections in the protracted area consistent with existing conditions. It is important to understand that these protraction diagrams do not absolutely fix corner positions, but are a plan of survey for defining corner positions more accurately than existing protraction diagrams whose accuracy and completeness vary considerably. The inherent imperfection of field survey procedures result in minor variations in positions when corners are established and monumented on the ground during the official survey.

Significant deviations between the amended protraction diagram and the field survey will be addressed in the special instructions at the time protraction areas are surveyed. Where possible, an amended protraction diagram should be consistent with the location of the original protraction diagram.

1-146. The amended protraction diagram standards have been designed to be extremely flexible. The amended diagram can be based on the existing diagram, on a selected point within the township usually near the southeast corner of the protraction, or on a combination of the two. By this process as many corners as possible within the protraction will have POSC latitude and longitude coordinates that will allow protraction-based descriptions to be located on the surface of the earth to a high degree of reliability. Unlike existing protraction diagrams in which corners could move every time a different bearing, distance, or position is found on the exterior protraction boundaries, amended protraction diagram protracted corner positions are not dependent on the position of an existing corner or surveyed line once its POSC have been determined. Protracted blocks, which are areas with uncertain acreage, will be used to form a buffer between the coordinate-based interior and the previously surveyed lines of the exterior perimeters. Therefore, even when the positions of the existing surveyed lines forming the protraction boundaries are uncertain, the plan of survey for the protracted area would not change, since POSC have been assigned to corners within the protraction.

1-147. Areas within an amended protraction diagram remain unsurveyed until such time as there is an approved official survey that returns the land as surveyed. The POSC represent the latitude and longitude at which the corners will be placed if a survey is done and are perfect positions on the surface of the earth. If there is a need to determine the position of a protracted corner for some administrative purpose, but not a need for an official survey, the position of the corner can be estimated accurately based on the control available at the time. But, it is only an estimate since the corner has still not been established and the land continues to be unsurveyed. At such time as an official survey is required, special instructions will be prepared specifying the control to be used, normally the nearest control and the latest adjustment.

1-148. As the coordinate values for the geographic position of the available control stations are refined, slight changes in the control coordinate values occur. The POSC do not change when the geographic position of the control changes slightly because the POSC are calculated based on the initial point of the protraction, not on the geographic position of existing control corners.

1-149. The first step in creating an amended protraction diagram is to determine the most reliable coordinates (latitude and longitude, State plane, etc.) for the surveyed boundaries of the protraction, any existing special surveys within the protraction, and the shoreline of meanderable waters within the protraction. The coordinates of the exterior boundaries may be generated by the Geographic Coordinate Data Base (GCDB) process, or any reliable source. As part of this process, it may become apparent that certain previously surveyed lines or whole townships should be evaluated for cancellation. Unpatented mineral surveys that are no longer valid should be canceled. If necessary, these surveys will be canceled at this time and the protraction diagram extended to include the canceled area. Since the protracted blocks are a buffer between the corners with POSC and the existing surveys, accurate coordinates for the monumented positions along the outboundaries are desirable but not essential. Protracted blocks are generally the same size as a section, but may be larger or smaller depending on the reliability of the existing surveys. Where existing surveys are known to be reliable, protracted blocks may be less than a section, but where the existing surveys are extremely unreliable and large discrepancies with the record are found, protracted blocks can be enlarged to ensure that protracted sections do not invade existing survey lines.

The next step is to decide on the procedure to be followed. There are two basic methods: (1) using the plan of survey of the existing protraction diagram, or (2) creating a new protraction from a selected initial point, usually near the southeast corner of the protraction.

Determining the Outboundaries of the Amended Protraction Diagram

1-150. The coordinates of the existing corners forming the outboundaries of the protraction may be determined by (1) GCDB coordinates, (2) mapping coordinates, or (3) a combination of GCDB and mapping coordinates. Interagency and intergovernmental cooperation, coordination, and consultation is critical for protraction diagram construction where the land status is mixed, Indian land is involved, water bodies are to be segregated, or the data will be integrated into mapping and geographic information systems. The identification of all existing leases, withdrawals, administrative boundaries, and

other interests with a fixed position that are to be protected will be done at this planning stage.

The existing surveys will be evaluated. Surveyed lines extending into or across the protraction will normally be canceled to allow for a greater number of POSC corner points. There may be some areas where whole townships will be canceled because of improperly executed, grossly erroneous, or fraudulent surveys.

The outboundaries of the protraction will follow the boundary of the land previously returned as surveyed but not canceled and may include subdivision-of-section lines on partially surveyed sections.

Coordinates of the corners along the outboundaries of the protraction will be calculated; however, those values should not be shown on the plat. The plat will show a heavy-weight line for previously surveyed lines, and no coordinates or tick marks will be shown for the existing corners on the plat(s).

Construction of the Amended Protraction Diagram

1-151. All POSC section corners within the protracted areas will be assigned geographic coordinates. These coordinates will be computed to establish intervals of 80-chain horizontal distances at ground or mean ground elevation on all township boundaries and subdivisional lines, except for lines intersecting previous surveys. See sections 9-114 through 9-118 for construction of plats of protraction diagrams.

Method 1 (Dependent)

1-152. The land status will be checked to determine if there is a need for the amended protraction diagram to protect the existing protraction either wholly or partially. Where withdrawals, administrative boundaries, or selections follow the protraction or where there is extensive leasing, it is desirable to follow the plan of survey established by the existing protraction diagram. The decision should be confirmed by the approving official prior to beginning construction of the diagram.

3-153. POSC corner positions within the protraction that are dependent on existing corners on the protraction outboundary are computed from the coordinate position of the existing corner and held fixed. The line from the POSC corner to an intersection with the existing boundary is shown with a designated bearing. Even though the POSC position is determined from the existing corner on the outboundary, the line shown on the final protraction diagram may not actually intersect the existing corner depending on the accuracy of the coordinates determined for that existing corner. The POSC are based on those previously determined coordinates, however, and they will be used in future surveys to determine the POSC corner position regardless of what occurs on the outboundary. Even if more accurate coordinates are determined later for the outboundary corner, the connecting line from the protracted section corner will still be surveyed to an intersection with the existing boundary. All POSC corner positions that are dependent upon existing corners should be computed first, followed by those independent of the existing boundaries and beyond the buffer or protracted blocks.

Method 2 (Independent)

1-154. When there is no need to follow the existing protraction diagram or when no protraction exists, an initial point will be selected, usually near the southeast corner of the amended protraction diagram, from which all other POSC within the protraction will be computed. In a regular township, the initial point would be the southeast corner of section 26 and would be positioned 1 mile from the east boundary and 1 mile from the south boundary. In this type of protraction there is no need for base lines, principal meridians, standard parallels, guide meridians, sectional correction lines, or sectional guide meridians because convergency is accounted for in each township and any error in the existing surveys is accounted for in the buffer created by the protracted blocks. Lines of designated bearing or random and true lines will be extended from the POSC corners within the protraction to the existing surveyed lines forming the protraction outboundary.

Method 3 (Combination)

1-155. In large protractions, a combination of methods 1 and 2 may be appropriate. If only a portion of the pro-tracted area has conditions that require conformity with the existing protraction diagram (method 1), the rest of the area could be protracted using method 2.

General Rules on Surveying Amended Protraction Diagrams

A Plan of Survey

1-156. To survey any portion of an unsurveyed area shown on an amended protraction diagram, follow the

method and order of procedure in the special instructions and the general rules set out herein to execute the survey. The special instructions will address the control to be used, latitude and longitude of control, general field methods, and special methods that may be required.

General Rules

1-157. The following general rules are intended as guidelines for the preparation of the special instructions and the execution of field surveys. Special procedures protecting valid existing rights and conforming to fixed corners while maintaining the intent of the protraction must be developed and set out in the special instructions. It may be necessary to modify portions of the protraction to resolve unforeseen conditions. The key point of the General Rules is that they are flexible and may be modified by the special instructions due to technological changes in survey methods, conditions on the ground, and the complexity of the protraction diagram:

(1) When section corners are to be monumented, based on an amended protraction diagram, the best available control stations should be selected and the latest adjustment or epoch of the North American Datum 1983 (NAD 83) coordinate values will be used to determine the position of the corner points.

(2) When a subsequent survey is to be done and a newer NAD 83 adjustment is available with differing control coordinate values for the same control stations, the latest NAD 83 coordinate values should be used to position the corner points. These latter positions could differ slightly from the corner positions monumented in an earlier survey. Once a corner point is monumented, approved, and filed in an official survey, it is fixed in position, similar to a corner monumented in an original survey under the public land survey system.

(3) When appropriate, the corner points are positioned using the current Federal standards and guidelines in place for geospatial positioning accuracy as it pertains to geodetic control networks referenced to the National Spatial Reference System or the equivalent, and any BLM supplemental accuracy standards and guidelines consistent with the Federal Geographic Data Committee Standards for geospatial data. The positioning of corners should meet the defined minimum accuracy standards and guidelines adopted by the BLM when establishing corners based on their protracted latitude and longitude, independent of other corners within the protraction.

When establishing several adjacent corners in a single survey with surveyed lines between corners, for reporting geographic data on the plat at least two monuments will be established that meet the accuracy classification level for Federal Geographic Data Committee Standards. This will provide relative control for the other corners. The survey standards and guidelines or survey measurement methods prescribed will be specified in the special instructions. Any standards and guidelines should be consistent with the accuracy specifications of the technology used and the most current specifications generally accepted by the professional survey community.

(4) Latitude and longitude are shown only for section corners on the amended protraction diagrams. The latitude and longitude for any aliquot part corner within the protraction computed from the section corner values, lottings, and areas may be shown on the diagram.

(5) Aliquot part corners down to 1/1024th section corners may be established at their protracted latitude and longitude coordinate without reference to other corners where no areas are to be returned, except under the conditions specified in General Rule (4) herein. Where areas will be returned within a section, all four section corners will be monumented. Where controlling corners have been established and are within limits for rectangularity, corners will be established at proportionate distance or intersection as appropriate, not at the protracted latitude and longitude.

(6) Bearing and distance ties to previously established corners of the same section within the protraction are desirable and are required where new aliquot part corners are established along the line surveyed. Ties between section corners are not normally necessary unless corners are required along the line, in which

case rectangularity will be ensured and corners placed appropriately.

(7) Intersecting lines and random and true lines normally form the boundaries of protracted blocks. Once the protracted corner is established by latitude and longitude from which the intersecting line is to be initiated, the line will be surveyed on the protracted bearing to an intersection with the existing surveyed line, random and true line, or water boundary. In a like manner, random and true lines will be surveyed from the established protracted corner to the existing corner designated on the amended protraction diagram. Where rectangular limits can be achieved in intersecting a corner on the boundary of the protraction block, the intersected corner will control the alinement of the intersecting line (section 1-34). Where there is a large misclosure in the exterior boundary of the protraction, it may be necessary to modify the plan of survey to avoid poorly shaped parcels.

(8) When surveyed, a protracted block will normally become a section containing the regular aliquot parts with the excess or deficiency against the previously surveyed boundary.

(9) When portions of the unsurveyed protracted areas are surveyed, it may not be necessary to create a new amended protraction diagram for the remaining unsurveyed areas. Since there will normally be no changes in the protracted latitude and longitude of other corners in the protraction, an appropriate notation to this effect on the amended protraction diagram is sufficient.

(10) In some cases, local or administrative surveys have been performed within the protracted area, prior to the official survey, to locate and mark lease boundaries, administrative boundaries, the extent of mineral interests, or to segregate meanderable water bodies for acreage chargeability. Positions established by these surveys have no official standing but, at the discretion of the appropriate BLM Chief Cadastral Surveyor, should be accepted as corner positions when they are in substantial conformity with the amended protraction diagram.

Meandering

1-158. This discussion on meandering pertains to original surveys and new meanders.

1-159. The traverse that approximates the margin of a permanent natural body of water, e.g., the bank of a stream, lake, or tidewater, is termed a meander line. Numerous decisions in the United States Supreme Court assert the principle that, in original surveys, meander lines are run, not as boundaries of the parcel, but (1) for the purposes of ascertaining the quantity of land remaining after segregation of the bed of the water body from the adjoining upland, (2) for defining the sinuosities of the water body for platting purposes, and (3) for closing the survey to allow for acreage calculations. The ordinary high water mark (OHWM), or line of mean high tide (line of MHT) of the stream, or other body of water, and not the meander line as actually run on the ground, is the actual boundary.

1-160. Properly executed meanders create certain riparian rights in the upland parcel. Chief among these rights is that ownership of the upland follows subsequent lateral change in location of the bed through slow and imperceptible processes, such as accretion, erosion, and reliction. When by action of water the bed of the body of water changes, the OHWM changes, and the ownership of adjoining land progresses with it (*Lane v. United States*, 274 F. 290 (5th Cir. 1921); *aff'd.* 260 U.S. 662 (1923)).

1-161. Meander lines will not be established at the segregation line between upland and swamp or overflowed land, but rather at the OHWM or line of MHT between the swamp or overflowed lands and the water body. Meanders between the swamp or overflowed lands and the upland are a common source of errors in older original surveys (section 1-211).

Ordinary High Water Mark and Line of Mean High Tide

1-162. All lands beneath navigable waters and other important rivers and lakes are to be segregated from the upland. Meanders are run along the OHWM for inland waters, and along the line of MHT for tidewater.

The general rule is that when the Federal Government conveys title to a lot fronting on a navigable body of

water, it conveys title to the water's edge, meaning the OHWM or line of MHT. Such riparian boundaries are ambulatory, not fixed in position. When an exception to the general rule is shown, the consequence is that the meander line becomes fixed and can become a fixed and limiting property boundary. Meander lines may be held fixed because of (1) an avulsive change, (2) gross error or fraud, (3) substantial accretion after survey but before entry, or (4) where the facts and circumstances disclose an intention to limit a grant or conveyance to the actual traverse lines. But the mere fact that an irregular or sinuous line must be run, as in the case of a reservation boundary, does not entitle it to be called a meander line except where it closely follows the bank of a stream, lake or tidewater.

1-163. Practically all inland bodies of water pass through an annual cycle of changes and multiyear cycles of drought and wet years. The OHWM is found between these extremes. In regions of broken topography, especially when bodies of water are bounded by sharply sloping lands, the horizontal distance between the margins of the various water elevations is comparatively slight, and the surveyor does not experience much difficulty in determining the horizontal position of the OHWM. However, where the meanderable bodies of water are bordered by relatively flat lands, the horizontal distance between the successive levels can be significant and the proper line difficult to measure.

1-164. For inland waters, the OHWM normally used is the line below which the water impresses on the soil by covering it for sufficient periods to deprive it of ter-restrial vegetation, and the soil loses it value for agri-culture, including grazing of livestock. Terrestrial veg-etation is to be distinguished from aquatic and wetland vegetation in that the same vegetation can be found at higher and drier sites. At this level a definite escarp-ment, and often a change in character in the soil, is gen-erally traceable, at the top of which is the true position for the meander line. A pronounced escarpment, the result of the action of storm and flood waters is often found above the principal water level and is separated from the OHWM by the storm or flood beach.

1-165. Some areas of riverbank or lakeshore lack veg-etation of any kind or escarpments that can be used to identify the OHWM for use in meandering. In those situations, an identifiable OHWM is identified between sites where vegetation capable of identification exists on either side of the barren area. Reliance on elevations to extend a continuous line projected on the bank that is parallel in height to the water surface of the river or lake is a common method.

1-166. The ordinary low-water mark is the point to which nontidal waters recede, under ordinary conditions, at their lowest stage. It is usually identified by a shelf in the bank. The shore is the space between the margin of the water at the ordinary low water mark and the OHWM (*Alabama v. Georgia*, 64 U.S. 505 (1859)).

The Vegetation Examination

1-167. The vegetation examination is conducted in the field to determine whether the grass, tree, shrub, or plant is aquatic or terrestrial vegetation.

Aquatic vegetation is any one of a variety of plants that must grow in water; they are obligated to grow with their roots in water. Many aquatic plants have hollow stems so as to stand upright in still water and others have floats in order to stay on the water surface. If a given plant is not found higher up on the bank, it is probably an aquatic species.

Transitional species, such as buttonwood, water oak, or cypress, are upland or terrestrial species that exist in very wet environments. There have been claims that cypress trees are aquatic plants. A number of court cases have used cypress as an upland indicator of the OHWM, however a mature cypress may no longer be a good indicator of OHWM.

Terrestrial vegetation is distinguished from aquatic vegetation by the location in which it grows. If vegetation type "A" is found along the water's edge—or even in the water—and type "A" is also found growing at sites situated more toward higher, drier ground (upland), then "A" is a terrestrial species. A good rule of thumb is to determine if the plant is part of a self-reproducing stand of woody vegetation and not a seasonal plant that can sprout and mature in the few months when the water is unseasonably low. Trees, shrubs, and other woody-stemmed plants are generally terrestrial.

A small pocket of an aquatic type plant growing in low places not in the riverbed is also not an indicator of the OHWM and does not indicate that the OHWM should be moved toward upland to include that pocket of aquatics. It is the most water-ward location of the terrestrial species that is determinative. A small pocket of terrestrial vegetation at a small area near the water's edge, for example, may be enough to identify that area as being a part of the upland.

Care must be taken with the evaluation of nonnative invasive species, because when introduced they can change or fix the previous natural indicators of the OHWM.

The Soils Examination

1-168. The soils examination is the next complementary examination. The leading court opinions regarding OHWM with reference to soils did not rely on or intend the use of laboratory tests of soils for this purpose. Accordingly, when a court decision dated before the 1940s refers to the character of the soil, it usually refers to the presence and shape of banks on rivers, shelving along lake shores, presence of sandbars and gravel bars, and other physical forms or manifestations of soil.

Extended inspection along a river boundary will usually result in some sort of correlation between the types of vegetation and the presence of banks or natural levees. The tests for vegetation and the test for soils can thus become complementary.

It is sometimes difficult to find a defensible OHWM because of conflicting evidence. When that occurs it is necessary to go upstream or downstream to locate another bank or banks where the OHWM is clear and convincing using vegetation and soils and then correlate that height of the OHWM above the surface of the flowing water in the difficult location.

Also a chemical soil test could be used provided that it is definitive. Soils that have been submerged for a long period of time are chemically different from upland soils, so it is important to establish the time period when that soil's particular chemical properties developed. Flooding that created a particular soil formation centuries before the original survey and grant should have no bearing on a present-day OHWM determination.

The Litter Examination

1-169. Litter is the rubbish, twigs, and other floatable material found in a rough alinement at the reach of the highest waves that wash up on the shore. Logs and stumps generally do not wash up along the litter line. They are usually stranded below and toward the water from the litter line.

The litter line along a river boundary is mostly parallel and higher in elevation than the OHWM determined by the vegetation and soils test. On a lake shore, particularly, the presence of litter may correlate with the other tests and be useful for OHWM determination. The presence of litter does not indicate the OHWM directly. Instead, the height of the litter above the water surface may be useful in correlating the OHWMs along the bank or shoreline.

The Agricultural Test

1-170. The agricultural test is another complementary test. The items to consider include cattle or sheep raising, mowing of wild hay or collection of wild rice, and the raising of typical crops of the region, including grains or tubers. In essence, the agriculture test is simply a vegetation test that is restricted to valuable crops.

1-171. For tidal waters, the shore, also called the tideland, is the space between the line of mean lower low tide and the line of MHT (section 1-204). For tidal water, in the interest of certainty, the line of MHT is the average elevation of all the high tides occurring over a period of 18.6 years. Because it is based on elevations, meanders along the tidelands are run either by refer-ence to tide gages and their reported elevations or by observation of physical conditions abutting the shore. Special instructions will provide guidance in selecting the method to be used.

1-172. Individual States may develop their own rules for determination of their own boundaries as against private owners but such State laws cannot generally act to reduce Federally owned areas or otherwise alter the boundaries of Federal land.

Meanders

1-173. A meander corner is established at every point where a standard, township, or section line or special survey boundary intersects the OHWM of a navigable stream or other meanderable body of water. For tidal waters, the meander corner is established at the inter-section of the surveyed line with the line of MHT. Meander corners are a controlling monument on the surveyed line and shall be treated similarly to other regularly established monuments such as section or quarter-section corners and tract corners for dependent resurvey purposes.

1-174. A "special meander corner" (SMC) is established at the intersection of the OHWM or line of MHT with a run and marked subdivision-of-section line. "Auxiliary meander corners" (AMC) are used

where there is no intersection of a surveyed line with the OHWM or line of MHT, as in the case of a meanderable lake found completely within a section not requiring subdivision. Auxiliary meander corners are also established at the intersection of avulsed lands with riparian lands, at the intersection of omitted land parcels with riparian lands, at the intersection between fixed and limiting original meanders and the current meanders, on the meander line of a previously unsurveyed island not intersected by a surveyed line, and at other intersections of riparian boundaries where use of a special meander corner is not appropriate.

1-175. No monument should be placed in a position exposed to the beating of waves and the action of ice in severe weather. In such cases a witness corner should be established at a secure point near the true point for the meander corner. The distance across the body of water, from the true point, is ascertained and reported in the survey record.

1-176. It is not practicable in public land surveys to meander in such a way as to follow and reproduce all the minute windings of the ordinary high-water mark, even though technology allows for a much more precise location at the time of the survey. The United States Supreme Court has given the principles governing the use and purpose of meandering shores in its decision in a noted case as follows:

> Meander lines are run in surveying fractional portions of the public lands bordering upon navigable rivers, not as boundaries of the tract, but for the purpose of defining the sinuosities of the banks of the stream, and as the means of ascertaining the quantity of land in the fraction subject to sale, and which is to be paid for by the purchaser.
>
> In preparing the official plat from the field notes, the meander line is represented as the border line of the stream, and shows, to a demonstration, that the watercourse, and not the meander line, as actually run on the land, is the boundary (*Railroad Co. v. Schurmeier*, 74 U.S. 272 (1868)).

There is no requirement that the meander line very closely approximate the OHWM such that every small indentation and projection is depicted by angle (often called meander) points on the traverse. An excessive number of angle points are not necessary as the true riparian boundary constantly changes through the processes of accretion and erosion. The intent is to show the general configuration of the water line. As a result, it is expected that when choosing the angle points, the meander courses may cross either water or land during the process to minimize the number of angle points. Effort should be made to balance the amount of water and land crossed to return accurate acreage.

Depending upon the terrain, meander courses may be as short as a chain or as long as twenty chains or longer. Meander lines may be surveyed by any reliable method of measurement that can determine bearing and distance or coordinates that may be mathematically converted to courses. The angle points along the traverse are not normally monumented.

1-177. Meanders are reported as a traverse from the beginning meander corner to the ending meander corner. The traverse is comprised of a series of meander courses running between angle points. These meander points are chosen at obvious breaks in the shoreline at the OHWM, line of MHT, or other required riparian line. Whether the angle points are measured by traditional traverse methods or by individual coordinate determination is immaterial.

The surveyor commences at one of the meander corners, follows the OHWM, and determines the length and true bearing of each course, from the beginning to the next meander corner. For tidal waters, the surveyor follows the line of MHT. All meander courses refer to the true meridian and are determined to the accuracy outlined in this Manual or, if more accuracy is necessary, as outlined in the special instructions.

1-178. The survey record of meanders shows the corner from which the meanders commenced, the true bearing and horizontal distance of each course, and the corner upon which the last course closed. The meanders may be reported in a separate section of the field notes segregated by section or tract. Meander line field notes may be placed on the plat.

1-179. The following items will be noted along the meander line in the field notes or on the plat: (1) all streams flowing into a river, lake, ocean, or meanderable bayou, with the width at their mouths and their course; (2) the position, size, and depth of springs, and whether the water is pure or mineral; (3) the heads and mouths of all bayous; (4) all islands, rapids, and bars, with intersections to the upper and lower ends; (5) the height of the banks of lakes, streams, and tidelands, the

height of falls and cascades, and the length and fall of rapids; and (6) artificial structures and other notables such as improvements in both land and water areas. Except for original survey meander lines, the above items may be noted when administratively necessary.

1-180. Where it is impossible or impracticable to mea-sure the meander line along the required riparian line due to physical impossibility, safety or cost, the official survey record will state the true location, noting the offset from the line measured.

1-181. Whenever the Secretary surveys lands selected by an Alaska Native, an Alaska Native Corporation, or the State of Alaska pursuant to the ANCSA, the Alaska Statehood Act, or the Alaska National Interest Lands Conservation Act (ANILCA), lakes, rivers, and streams shall be meandered in accordance with the principles in the 1973 edition of the Manual (43 U.S.C. 1631(a)(1)). Navigability investigations in Alaska are described in section 8-56.

Rivers and Tidewater

1-182. Facing downstream, the bank on the left hand is termed the left bank and that on the right hand the right bank. These terms will be universally used to distinguish the two banks of a river or stream.

Navigable rivers and bayous are meandered on both banks, at the ordinary high-water mark, by taking the general courses and distances of their sinuosities for that portion that is navigable. For rivers classed as nonnavigable, when duly authorized, the bed acreage is segregated where the average right-angle width is 3 chains and upwards. This width is chosen as a practical guideline to balance the cost of meandering all rivers against the value of the excluded acreage.

1-183. In selected lands in Alaska, by law, all nonnavigable inland rivers where the average right-angle width is 3 chains and upwards are meandered on both banks, at the ordinary high-water mark (43 U.S.C. 1631).

1-184. Tidewater streams, inlets, and bayous are meandered at the line of MHT up to the point of tidal influence or where they still allow free travel by customary watercraft, whichever is farther downstream. Tidewater inlets and bayous are meandered, when duly authorized, where the average right-angle width is 3 chains and upwards, and they no longer allow free travel by customary watercraft. Oceans, gulfs, bays, bayous, straits, and other tidally influenced waters are meandered at the line of MHT.

Lakes

1-185. All navigable lakes are meandered. Nonnavigable lakes are not meandered except for lakes of the area of 50 acres and greater when duly authorized. However, in selected lands in Alaska, nonnavigable lakes of the area of 50 acres and greater are meandered, but the area of such nonnavigable lakes is nonchargeable area (43 U.S.C. 1631).

1-186. Exceptions to the general size rule are shallow or poorly defined "lakes" that are actually pools that collect because of permafrost and lack of drainage or are seasonal. These "lakes" will not be meandered even when larger than 50 acres.

1-187. In the case of meanderable lakes that are located entirely within the boundaries of a section, a quarter-section line, if one crosses the lake, is run from opposite quarter-section corners. At intersection with the OHWM, one or more special meander corners are established, and the course and distances recorded.

If a meanderable lake is located entirely within a quarter-section, and if, during the subdivision of the quarter-section, a quarter-quarter section line crosses the lake at intersection(s) of the line with the OHWM, a special meander corner or corners are established and the course and distances recorded.

1-188. If a meanderable lake is found to be located entirely within the boundaries of a section and it is impracticable to run a subdivision-of-section line across the lake, an "auxiliary meander corner" is established at some suitable point on the OHWM and a connecting line is run from the monument to a regular corner on the section boundary. The course and length of the direct connecting line are shown on the plat of the survey.

1-189. The meander line of a lake lying within a section is initiated at the established special or auxiliary meander corner, as the case may be, and continued around the margin of the lake at its OHWM, to a closing at the point of beginning. All proceedings are fully entered in the official record. When the section is not monumented, a connecting line is run from the auxiliary meander corner to a suitable monumented point within the township. If there are numerous lakes within the township, and showing the connecting lines

will clutter the plat, the lines need not be shown on the plat.

1-190. Artificial lakes and reservoirs are not segregated from the Federal interest lands, unless specifically provided for in the special instructions, but the true position and extent of such bodies of water are determined in the field and shown on the plat.

Islands and Sandbars

1-191. For official survey purposes, an island is defined as a body of upland that is completely surrounded by water when the water is at the OHWM for inland waters or at the line of MHT for tidal waters. In those States that recognize the low water mark as the boundary and where State law appropriately serves as the source of law for the question, the water at low water mark may be the height of water defining the body of upland.

1-192. A gravel bar or sandbar is a formation of soil on the bed of a lake or river that rise above the OHWM but consists of loose and unconsolidated material consid-ered liable to be washed away during subsequent high water seasons and, most important, is devoid of woody vegetation.

Islands form in rivers by several different processes as follows:

(1) By deposit of alluvial material onto the bed of the river during high flow events that consolidates and supports terrestrial vegetation;

(2) By the river cutting across a vegetated point bar;

(3) By an avulsive change where a new channel is washed out around an existing area of upland;

(4) By marked scour of the river bed around a submerged area; and/or

(5) By the result of human activity in the river.

1-193. Every island above the OHWM of any meanderable body of inland water or above the line of MHT of tidal water, except islands formed in navigable bodies of water after the date of the admission of a State into the Union, is locatable by survey and should be meandered and shown on the official plat.

1-194. All islands will be meandered if practicable. In passing islands not to be meandered, estimated ties to their upper and lower ends will be reported to establish their location. Such islands are to be exhibited on the plat as accurately as practicable.

1-195. Even though the United States has parted with its title to the adjoining mainland, an island in a meandered body of water, navigable or nonnavigable, in continuous existence since the date of admission of the State into the Union and omitted from the original survey, remains as unsurveyed public land of the United States. As such, the island is subject to survey. Such islands were not a part of the bed at the date of statehood, and therefore their title remained in the United States, subject to survey and disposal when identified. The right that attaches to the riparian parcels along the meander line of the mainland pertains only to the bed of the water body, to access to the water, and to such islands in nonnavigable water bodies formed within the bed subsequent to the disposal of the title (sections 8-158 through 8-165).

> If the patent conveyed these lands to the State we are not concerned with their subsequent disposal, for that is a question of local law. But did the patent include them? This, of course, is a Federal question. *Francis Levee District*, 232 U.S. 186, 196 (1914); *United States v. Oregon*, No. 13, original, 295 U.S. 1, 27 (1935).

Whether an island in a meandered nonnavigable water body is subject to survey after the United States has parted with its title to the adjoining mainland has been subject to inquiry. The U.S. Supreme Court rulings on the subject, however, have consistently held that Federal law governs the intent and whether lands were conveyed or remain Federal, subject to survey.[1]

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[1] The Supreme Court in *State of California, ex rel. State Lands Commission v. United States*, 457 U.S. 273 (1982), held that whenever the United States has a claim to unsurveyed lands then Federal law will apply. State law should only apply when the dispute is between private parties see *Oregon ex rel. State Land Board v. Corvallis Sand & Gravel Co.*, 429 U.S. 363 (1977). Without reference to the Supreme Court decision in *State of California, ex rel. State Lands Commission* supra, two circuit courts have reach two dif *Koch v. United States*, 47 F. 3d 1015 (10th Cir. 1995) the court held that unsurveyed islands in nonnavigable water passed to the littoral owner under State law as a portion of the bed of the nonnavigable water. In *Wolff v. United States*, 967 F. 2d 222 (6th Cir. 1992), the Court held that State law would determine what was intended to be conveyed by the Federal government and if the intent of the Federal grant is unclear then State law will control the title to unsurveyed islands regardless of the navigable character of the water. However, Article IV, Section III, Clause 2 of the United States Constitution provides that Congress will make the rules concerning disposition of Federal lands.

1-196. The proof of the time of formation of islands is often difficult. It is the practice to make a careful examination of the history of an island in relation to the question of its legal ownership. Proof of island formation prior to the date of statehood is most readily presented in the form of historical maps and tree corings taken from the island that are accompanied by a professional correlation of the tree ring counts to the age-dating of the trees presently growing on the island.

Other means of presenting evidence of the age of islands comes from:

(1) the presence of fire pits correlated with prehistoric Indian dwellings;

(2) measurement of certain species of lichen diameters found on the island and correlated to similar lichens on datable grave markers, bridges or other structures of known date of construction;

(3) lead cesium dating of mollusks;

(4) identification of spores and pollen from introduced species whose date of introduction can be determined; identification of carbon layers from recorded fires; and

(5) overlays from historic records capable of showing the rate of changes in island configuration.

1-197. Islands that have been given well-known proper names are so identified, both in the field notes and on the plat. Sometimes there are a number of islands in the same section without proper names. Their identification can be uncertain unless the following rule is applied:

Where there are several unnamed islands within the same section, these will be referred to in the official record (when surveyed) according to the lot number (Island designated as lot No. __) that is assigned on the plat, excepting that islands that are crossed by section line boundaries, or by a centerline of the section, are readily identified by location.

1-198. The usual township, section, quarter-section, and meander corners are established on an island. Any township boundary or section line intersecting the island is extended as nearly in accordance with the plan of regular surveys as conditions permit. If an island falls in two or more sections, the lines between the sections should be established in their proper theoretical positions based on suitable field methods.

If an island falls entirely in one section, and is large enough to be subdivided (over 50 acres in area), the subdivision is accomplished by the protraction of suitable subdivision-of-section lines in their correct theoretical position. A corner will be located at the intersection with the OHWM. At the point thus determined a "special meander corner" is established.

In the case of an island falling entirely in one section and too small to be subdivided, a suitable field determination is made to locate on the OHWM of the island an intersection with the theoretical position of any suitable subdivision-of-section line. At the point thus determined a "special meander corner" is established.

If an island falls entirely in one section and it is impracticable to locate an intersection with the OHWM with the theoretical position of any subdivision-of-section line, an "auxiliary meander corner" is established. The corner will be located at any suitable point on the island's OHWM, and a connecting line run from the monument to any regular corner. The direct course and length of the connecting line is given in the field notes and shown on the plat.

1-199. Under special circumstances where administration or disposal requires no subdivision, an island is given a tract number within a township. In such cases, the section lines need not be extended to the island.

1-200. Agricultural upland within the limits of swamp and overflowed lands should be so classified and shown on the plat accordingly, but such land is not meandered as an island (section 1-211).

1-201. An unsurveyed island that was formed prior to statehood and found to be Federal interest land may be conveyed to States or their political subdivisions according to section 211(a) of the Federal Land Policy and Management Act (43 U.S.C. 1721(a)). Surveys intended for such islands will be conducted as if the island were to be patented to an individual and not conveyed without an official survey.

Original Survey of Federal Lands along Tidelands

1-202. Tidelands are coastal areas situated above the line of mean lower low tide and below the line of MHT,

particularly as they are alternately uncovered and covered by the ebb and flow of the daily tides. As a part of the lands beneath navigable waters, such lands belong to the States by right of sovereignty (*Pollard's Lessee v. Hagan*, 44 U.S. 212 (1845)).

Tidelands are mentioned here to stress their distinction from swamp and overflowed lands. Coastal "salt marshes" that are covered by the daily tide are tidelands to be segregated and not subject to survey. On the other hand, coastal marshes that are not covered by the daily tide are swamp and overflowed lands within the meaning of the grants and are subject to survey.

1-203. Meander corners are established at the line of MHT along the margin of tidewaters. The sites selected for meander corners along the coastal margin are ideally at the point where the long continued presence and action of tide and surf has completely suppressed the growth of terrestrial vegetation through its effect on the plants and the soil, and in many locales, is identical with a point on the line of MHT.

For title purposes, along shorelines, the meander line is not a boundary; the actual boundary is the line of MHT, however for practical matters, the line of suppressed terrestrial vegetation suffices for acreage determinations of the upland (*Udall v. Oelschlaeger*, 389 F.2d 974 (D.C. Cir. 1968), *cert. denied*, 392 U.S. 909 (1968)).

Tidewaters are segregated from the upland by a meander line at the line of MHT. This meander line differs from the meander lines described for inland water bodies only in that it approximates the line of MHT rather than the OHWM of an inland river or lake.

Offshore Islands and Offshore Rocks

1-204. Offshore islands and offshore rocks are those land forms lying offshore above the line of MHT. They may be identified as protracted blocks in a protraction diagram. They are to be located by auxiliary meander corners, special meander corners, or meander corners established on the line of MHT. Except in those States that have conveyed lands below the line of MHT, low-tide elevations are not located. The monumentation, ties, meandering, subdivision, and platting are the same as described for islands, except as noted.

Any township boundary or section line that will intersect an offshore island or offshore rock is extended as nearly in accordance with the protraction diagram or plan of regular surveys as conditions permit, and the usual township, section, quarter-section, and meander corners are established. If one falls in two sections only, the line between the sections will be established in its proper theoretical position based on suitable field methods.

1-205. Auxiliary meander corners on offshore islands and rocks are to be connected to a regular public land survey system corner by a measured course and distance. Meanders are continued around the island or rock at the line of MHT or, in the case of an inaccessible rock, at an elevation equivalent to the line of MHT along the coast. Where numerous small isles, rocks, or pinnacles, essentially circular in configuration, need to be identified for purposes of extending jurisdiction, it is appropriate to establish an auxiliary or special meander corner at the center of mass and call for, as an example, a 15-foot diameter pinnacle, 30 feet high, without attempting to return meanders around the feature.

Congressional Legislation Specific to Cadastral Survey Procedures in Alaska

1-206. All surveys of Federal interest lands in Alaska are to be conducted in accordance with the requirements of this Manual, except for variations of the requirements created by the Alaska Statehood Act, the ANCSA, the ANILCA, and other Congressional Acts specific to Alaska only, or except for specific contractual obligations approved under the survey authority of the Secretary to address special conditions in Alaska. Such variations, however, will be described in the special instructions and complied with during execution of the work.

The 1953 Submerged Lands Act, 67 Stat. L. 29; 43 U.S.C. 1301 et seq., is applicable to Alaska, and the State of Alaska has the same rights as other States to submerged lands within its borders (see 43 U.S.C. 1631(d) and section 6(m) of the Alaska Statehood Act, 79 Stat. L. 339, 343).

Use of Remote Sensing Techniques

1-207. Where conditions are favorable, meander lines may be surveyed by the use of remote sensing techniques after the meander corners have been established in the regular manner. The official record will state what lines were so determined and all pertinent data regarding the technique.

Swamp and Overflowed Lands

1-208. The acts of Congress that granted to certain States the swamp and overflowed lands within their respective boundaries were listed in section 1-17. Swamp and overflowed lands are also discussed in sections 1-161, 1-200, and 1-202.

The grant of these lands is one *in praesenti* passing an inchoate title to the lands as of the date of the grant, but requiring identification of the lands by survey and selection or patent to render the legal title (*United States v. Byrne*, 291 F.3d 1056 (2002); *cert. denied, Aria v. United States*, 537 U.S. 1088 (2002)).

However, the rights of the State or grantees of the State are not defeated if the Government does not make the identification; the State or grantees of the State can identify the lands in any other appropriate mode (*Wright v. Roseberry*, 121 U.S. 488 (1887)). When perfect title is vested, it relates back to the date of the grant. The lands are surveyed as public lands and subject to classification at that time. The character of the land is as of the date of the grant, not the date of survey. The United States did not retain the mineral estate to these lands.

In *San Francisco Savings Union, et al. v. Irwin*, 28 F. 708 (C.C.D. Cal. 1886), *aff'd, Irwin v. San Francisco Savings Union, et al.*, 136 U.S. 578 (1890), the Court stated:

> The act of 1850 grants swamp *and* overflowed lands. Swamp lands, as distinguished from overflowed lands, may be considered such as require drainage to fit them for cultivation. Overflowed lands are those which are subject to such periodical or frequent overflows as to require levees or embankments to keep out the water, and render them suitable for cultivation.

1-209. Swamp lands include marshes and intermittent ponds that do not have effective natural drainage, such as to require drainage to fit them for cultivation, particularly where such conditions are long continued.

Overflowed lands are subject to such periodical or frequent overflows as to require levees or embankments to keep out the water and render them suitable for cultivation. Overflowed lands are different from "overflow lands." The latter has reference to a temporary condition which may or may not exist at any given time. The former is in reference to a permanent condition.

1-210. It has already been emphasized in section 1-161 that meander lines will not be established between the upland and the swamp and overflowed lands. Riparian rights, which are applicable within the beds of lakes, streams, and tidal waters, are not enforceable across swamp and overflowed lands owned by another. In other words, the boundary between the ocean, lake, or river bed and the upland lies between that bed and the swamp and overflowed lands, not between the swamp and overflowed lands and the higher land. The survey of meander lines at the margin of swamps in the past has been a significant cause of the erroneous omission of lands from survey. Prior to the swamp and overflowed lands grants, these lands were generally not considered desirable by settlers and were often segregated from the upland by survey and platting.

1-211. The following rules should be followed in mak-ing surveys or field examinations of swamp and over-flowed lands:

(1) According to 43 U.S.C. 984 (Rev. Stat. 2481), any legal subdivision, quarter-quarter section or comparable lot, shall be included in the category of swamp and overflowed lands if the greater part is "wet and unfit for cultivation."

(2) "Wet and unfit for cultivation" is interpreted to mean that the land must have been so swampy or subject to overflow during the planting, growing, or harvesting season, in the majority of years at or near the date of the grant, as to be unfit for cultivation in any staple crop of the region in which it is located without the use of some artificial means of reclamation such as levee protection or drainage ditches.

(3) A subdivision that becomes swampy or overflowed at a season of the year when this condition does not interfere with the planting, cultivating, or harvesting of a crop at the proper time and by the ordinary methods is not "made unfit for cultivation" and does not qualify under the swamp land grant.

(4) Tame grass or hay, when produced by the ordinary methods of preparing the ground, is considered a staple crop, as well as the cereals, cotton, or tobacco.

(5) In the administration of the swamp acts, the States have been allowed optional methods

of preparing the lists of subdivisions that are to be identified as swamp and overflowed within the meaning of the acts. The surveyor must determine the position and extent of the swamp and overflowed land within the area under survey regardless of the methods employed by the States in asserting claims.

(6) Alabama, Indiana, Louisiana, Michigan, Minnesota (excepting as to lands within the Indian reservations), Mississippi, Ohio, and Wisconsin have elected to base their swampland lists on the field note record. In these States it is imperative that the field notes include a specific list of the subdivisions each of which is more than 50 percent wet and unfit for cultivation, regarding such character as at the date of the passage of the granting act.

Arkansas, by the Act of April 29, 1898 (30 Stat. L. 367; 43 U.S.C. 991), relinquished all right, title, and interest to the remaining unappropriated swamp and overflowed lands within its boundaries.

(7) In California, under 43 U.S.C. 987 (Rev. Stat. 2488), the swampland lists are based upon the representations of the plat of survey, and in this State it is imperative that the plats correctly show the conditions in this respect. Many early swamp and overflowed segregation maps and surveys were conducted under State authority and examined by the United States Surveyor General. Where they were found to conform to the Manual and related survey rules, the Surveyor General constructed and approved township plats based upon these surveys. They were then forwarded to the Commissioner of the GLO for approval.

(8) The selection of swamp lands in Florida, Illinois, Iowa, Missouri, and Oregon, and in Indian reservations within Minnesota, is based upon investigations and reports by representatives of the State and of the BLM, but this does not set aside the Manual requirements for the usual complete showing of the character of the land.

1-212. It is always important to note any marked changes in the water level and drainage conditions of the region and to ascertain the situation as of the date of the granting act. It is desirable to secure the testimony of persons who have known the lands for long periods. The most convincing evidence of the land's character at the date of the granting act is the older native timber, as the varieties reflect their site conditions with great certainty.

This line of investigation requires an inquiry into the habitat of the forest species that are found, particularly as to whether the usual range of the tree is within low wet ground, as for example the cypress, tupelo, sweet gum, water ash, water locust, and red bay of the southern latitudes, and the tamarack, white cedar, black spruce, swamp spruce, and black ash of the northern latitudes of the United States. The presence of any of the species named indicates the possibility of swamp land, and while conclusive with some of them, others of the species named have a wider range and may be found associated with upland varieties. If upland varieties are present the plain inference will be that the site conditions are that of upland, even though a forest species may favor moist rich soil.

1-213. When conducting an original survey of public lands, the surveyor must notify appropriate BLM land status officials by memorandum with a tabulation of the subdivisions classified as swamp and overflowed lands. Any indications of swamp and overflowed lands referred to in the official record shall be called to the attention of the Land Office at the time when the plats are transmitted to be filed in order that the notice will contain a statement to that effect. The showing made by the official record as to the swamp and overflowed or not swamp and overflowed character of the land can be overcome by proof by the State or other applicants.

1-214. The silence of the official record respecting the character of the land will be treated presumptively as a statement that the land is dry or not swamp and overflowed. In the States having a swamp land grant swamp and overflowed lands are the exception and not the rule. It is the practice in public surveys to make special notation of the swamp and overflowed lands rather than of the dry or nonswampy lands.

Limits of Closure for Original Surveys

3-215. Under the general subjects of "township exte-riors" (section 1-17) and "subdivision of townships" (section 1-51), certain definite limits were prescribed beyond which previously established surveys are

classed as "defective," or where, in the case of new surveys, corrective steps are required. Such limits are referred to as the "rectangular limit." A more general requirement known as the "error of closure" together with proper field procedures can be applied as a test of the accuracy of the alinement and measurement of all classes of lines embraced in any closed figure incident to the Federal land surveys. Corrective steps are required wherever this test discloses an error beyond the allowable limit.

The "error of closure" of a survey is defined in general terms as the ratio of the length of the line representing the equivalent of the errors in latitude and departure to the length of the perimeter of the figure constituting the survey. However, with due regard for the controlling coordinate governing lines of a rectangular survey, accuracy in latitude is not permitted to offset gross error in departure, or vice versa. A double test is therefore applied to United States rectangular surveys in place of the one expressed in general terms.

The "limit of closure" set for the public land surveys may now be expressed by the fraction 1/2828, provided that the limit of closure in neither latitude nor departure exceeds 1/4000. Where a survey qualifies under the latter limit, the former is bound to be satisfied. An accumulative error of 2 links per mile of perimeter, in either latitude or departure, will not be exceeded in an acceptable survey.

The latitudes and departures of a regular section will each close within 8 links; of a regular range or tier of sections, within 28 links; and of a regular township, within 48 links. The boundaries of each fractional section including irregular claim lines or meanders, or the meanders of an island or lake in the interior of a section, should close within a limit to be determined by the fraction 1/4000 for latitude or departure considered separately. The same rule applies to all broken or irregular boundaries. All closings will be computed in the field.

Stricter limits of closure or rectangular limits will be specified in the special instructions for classes of surveys where higher accuracy is indicated by the values involved.

1-216. The issues of "rectangular limits," "limits of clo-sure," "accuracy standards," and "correct plat represen-tations," individually or collectively can bear upon the dependability of the record direction and length of lines of older approved surveys. The question arises as to what extent those values can be incorporated safely into new surveys. When terrain, land use, and other relevant factors are given due weight, good judgment determines the limits of tolerance for each given situation.

1-217. Instances occur where all original corners may be fully identified and in a good state of preservation, but the previously established lines present defective conditions that exceed current allowable limits. In such cases the retracements of the section boundaries necessary to determine the factors entering into the error of closure and to furnish suitable data for the calculation of the areas of the resulting units embraced in the survey will be reported to the designated official. If it is determined that additional retracements or dependent resurveys are necessary, these will be provided for by supplemental special instructions.

When a new survey does not close against the latest official record within the current limits of closure, either additional surveying of the record lines or another independent verification of the new measurement is necessary. Generally, new acreage will not be assigned to legal subdivisions that do not close within the current limits of closure.

Marking Lines Between Corners

1-218. The survey is marked upon the ground in the following ways:

(1) The regular corners of the Federal land surveys are marked by fixed official monuments.

(2) The relationship to natural topographic features is recorded in the official record.

(3) Where administratively required or requested, the locus of the lines can be marked upon forest trees by blazing and by hack marks (figures 3-52 and 1-53). In the case of resurveys in areas of mixed Federal and alienated lands, it may be necessary to restrict the blazing to trees on Federal land. The surveyor on the ground should apply good judgment in particular cases not covered by the special instructions. Where it has been determined that lines will be marked, the methods discussed here are intended to

Figure 1-52.

Figure 1-53. Hack marks on a line tree.

fix the locus of the lines permanently with the minimum environmental impact and maximum utility.

(4) Where administratively required or requested, whether forested or not, the lines are marked upon the ground by posts, posts with officially designated signs, tags, or other approved marking material.

1-219. A *blaze* is a smoothed surface cut upon a tree trunk at about breast height. The bark and a small amount of the live wood tissue are removed with an axe or other cutting tool, leaving a flat surface that forever brands the tree. The size of the blaze depends somewhat upon the size of the tree, but should not be made larger than the surface of the axe blade. A blaze 5 or 6 inches in height and from 2 to 4 inches in width is usually ample.

A *hack* is a horizontal notch cut well into the wood, also made at about breast height. Two hacks are cut to distinguish them from other, accidental marks. A vertical section of the finished hack marks resembles a double-V extending across a tree from 2 to 6 inches depending upon the diameter of the tree.

The blaze and hack mark are equally permanent, but so different in character that one mark should never be mistaken for the other. The difference becomes important when the line is retraced in later years.

Trees intersected by the line have two hacks or notches cut on each of the sides facing the line, without any other marks whatever. These are called line trees when the species, diameter and distance are reported in the survey record. By past practice some surveys called these sight trees or station trees. A sufficient number of other trees standing within 50 links of the line, on either side of it, are blazed on two sides quartering toward the line, in order to render the line conspicuous and readily traced in either direction. The blazes are made opposite each other coinciding in direction with the line where the trees stand very near line and approaching nearer each other toward the line the farther the line passes from the blazed trees (figure 1-54).

The lines should be so well marked as to be readily followed and the blazes plain enough to leave recognizable scars as long as the trees stand. This can be accomplished by blazing just through the bark into the live wood tissue. The blazes should be narrow so that they will heal before decay begins, and special care should be taken not to loosen the cambium layer around the blaze, since this will prevent overgrowth.

1-220. Lines marked with posts and other markers to render the line conspicuous should be readily traceable in either direction. These lines should be especially well marked near ridges, creeks, within distances of 5 chains of corner monuments and within 2 chains of arteries of travel.

Blazing and posting are marked only with reference to the established true line. Where lines are run by the "random and true" line method, the marking of line is accomplished by returning over the line after all corrections or adjustments to the final line are definitely known. True line intersections with line trees will be made with precision, and distances thereto accurately measured.

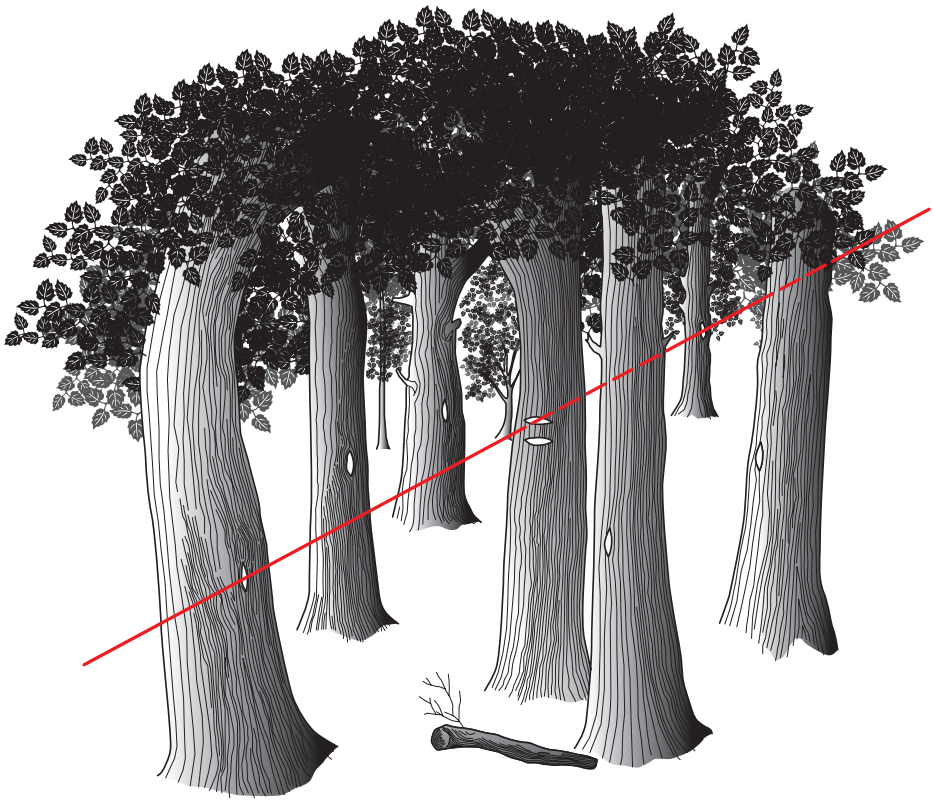

Figure 1-54. Marking a line through timber.

Summary of Objects to be Noted and Sketches

Official Record

1-221. The official record (field notes and plat) of a sur-vey furnishes a technical record of the procedures used. It also serves as a report on information about connec-tions showing the relation of the rectangular surveys to other surveys, to natural objects, and to improvements.

The connections can, through geodetic ties, provide the means of obtaining land information indirectly through the use of remote sensing, maps, or other sources. A triple purpose is thus served:

(1) The technical procedure is made a matter of official record.

(2) The purpose of the survey, along with general information relating to improvements, infrastructure, and land tenure, is incorporated with the survey results.

(3) The positional relationships between the corners, and features and objects recorded furnish important evidence by which the locus of the survey becomes practically unchangeable as contemplated by law.

1-222. The technical and topographical features that are to be carefully observed and recorded in the field during the progress of the Federal interest land survey are:

(1) The material of which corner monuments are constructed, their dimensions and markings, depth set in the ground, and their accessories.

(2) The nature and material of construction of corner monuments that are found; condition; dimensions and markings; height above the ground; accessories; and a statement with respect to the known record, but if there is no known record, a statement to that effect.

(3) The kind and diameter of bearing trees, the course and distance from their respective

corners, and the markings; all bearing objects and marks thereon, if any; and the position of witness corners relative to the true corners.

(4) The course and length of every line run, the method employed, and all necessary offsets therefrom.

(5) The form, location, and description of the evidence used and bearing upon items 1 thru 4.

(6) A complete description of ties to the National Spatial Reference System and related geodetic networks.

Additional Information

1-223. In addition, the following information is furnished to the extent that it is administratively required for the proper management of the lands to be surveyed:

(1) Line trees. The species, diameter, and distance on line to trees that line intersects and their markings.

(2) Intersections by line of land objects. The distance at which the line intersects the boundary lines of a reservation, townsite, special survey, or private claim, noting the exact bearing of such boundary lines, and the distance to the nearest boundary corners in both directions; the right-of-way and center lines of a railroad, canal, ditch, electric transmission line, or other right-of-way, noting the bearing of the center line and the width of the right-of-way on line, if only the center is noted; and the change from one character of land to another, with the approximate bearing of the demarcation, and the ascents and descents over the principal slopes traversed, with the slope direction; the distance to and the direction of the principal ridges, spurs, divides, rimrock, precipitous cliffs, etc.; the distance to where the line enters or leaves timber, with the approximate bearing of the margin, and the distance to where the line enters or leaves dense undergrowth. The amount of ascent or descent is only required where it will be of significant value to later surveyors. The slope on which a corner is situated should be shown.

(3) Intersections by line of water objects. Unmeandered rivers, creeks, and smaller watercourses that the line crosses; the distance measured on the true line to the center in the case of smaller streams and to both banks in the case of larger streams; the course downstream at points of intersection; and their widths on line, if only the center is noted. Intermittent watercourses, such as ravines, gulches, arroyos, draws, dry-drains, etc., with their downstream course.

(4) The land's surface; whether level, rolling, broken, hilly, or mountainous.

(5) The soil; whether rocky, stony, gravelly, sandy, loam, clay, etc.

(6) Timber and its density; the several kinds of timber and undergrowth, in the order in which they predominate.

(7) Bottom lands to be described as upland or swamp and overflowed, as contradistinguished under the law, noting the extent and approximate position of the latter and depth of overflow at seasonal periods. The segregation of bottom lands fit for cultivation without artificial drainage, from the swamp and overflowed lands, where the latter are subject to selection by the States, is always accomplished by legal subdivision. Each of the smallest legal subdivision is classified as all upland or all swamp and overflowed land accordingly as more than half of the same is of the character of the one or of the other class of lands.

(8) Springs of water, whether fresh, saline, or mineral, with the course of the stream flowing therefrom. The location of streams, springs, or water-holes, which because of their environment may be of value in connection with the utilization of public grazing lands, and which may be designated as public watering places, will be specially noted.

(9) Lakes and ponds, describing their banks, tributaries and outlet, and whether the water is pure or stagnant, deep or shallow.

(10) Improvements; towns and villages; post offices; occupancy; houses or cabins, fields, or other improvements; mineral claims; millsites. United States location monuments and all other official monuments not belonging to the system of rectangular surveys to be located by bearing

and distance or by intersecting bearings from given points.

(11) Coal banks or beds, ore bodies, with description as to quality and extent; mining surface improvements and underground workings; and salt licks. Reliable information that can be obtained respecting these objects, whether on the line or not, should appear in the general description.

(12) Roads and trails, with descriptions and their directions, whence and whither.

(13) Rapids, cataracts, cascades, or falls of water, in their approximate position and estimated height of fall in feet.

(14) Stone quarries and ledges of rocks, with the kind of stone they afford.

(15) The magnetic declination, including the observed local attraction within the area of the survey. The average value over the area surveyed will be shown on the plat.

(16) The above information is summarized by township in a general description that concludes the field notes of every survey. The general description embraces more comprehensive details of the characteristics of the region than is feasible to cover as an intimate part of the technical record of the survey, as follows:

(a) Land: A general outline of the drainage and topographical features of the township and approximate range of elevation above sea level.

(b) Soil: The prevailing and characteristic soil types. (See special reference to soil classification, section 1-227).

(c) Timber: The predominant forest species, age, size, condition, etc.

(d) Evidence of mineral: Known bodies of mineral, and lands of a formation that suggests mineral-bearing characteristics, especially with reference to lands of volcanic or igneous origin, are listed by appropriate legal subdivision, with brief description of the mineral indications. If there is no apparent indication of mineral deposits, a report to that effect is embodied in the general description.

(e) Watering places: The areas embracing all streams, springs, or water holes as may be of special value as public watering places, in connection with the utilization of public grazing lands, are listed by appropriate legal subdivision, with brief description of the nature of such water supply.

(f) Settlement: The extent of the settlement at the time of the survey.

(g) Industry: The industrial possibilities of the township, especially as to the adaptability of the region to agricultural pursuits, stock raising, lumbering, mining, recreation, or other profitable enterprise.

(h) Special: All exceptional steps in the technical process of the survey and other special matters not otherwise suitably recorded should be reported in the general description.

1-224. Natural curiosities, petrifactions, fossils, organic remains, etc.; also all archaeological remains, such as cliff dwellings, mounds, fortifications, or objects of like nature will not generally be reported in a public record. Disclosure in the survey record of information about the location of a historic resource shall be withheld when disclosure may cause a significant invasion of privacy, risk harm to the historic resource, or impede the use of a traditional religious site by practitioners (16 U.S.C. 470w-3). The approving officer should make note of these items and report them to the affected surface managing agency according to the applicable directives and special instructions.

Sketch Plat

1-225. In addition to the field notes the surveyor may be required to prepare an outline diagram showing the course and length of established lines with connections and a sketch embracing the features usually shown upon the official plat. If the area of the survey is covered by accurate maps or recent aerial photographs, topographic detail may be omitted from the sketch except in the immediate vicinity of the lines. The positions of the

details to be shown on the completed plat are located with an accuracy commensurate with their relative importance. The design of the specimen township plat should be followed closely in preparing the sketch plat. These sketches form the basis of the official plat, the ultimate purpose of which is a complete graphic representation of the public lands surveyed.

The subjects of the field sketches; accuracy of detail in special cases; use of aerial photographs; map features within the interior of sections; etc.

Soil Classification

3-226. Soil classification has been an invaluable aid in the development of the public domain, both to the prospective settler and in the administration of natural resources. Such information is now generally avail-able from other sources, and its provision by the offi-cial record is not as important as it once was. Yet, in the making of original surveys, it is necessary to tie the available information to specifically described lands. Further, the general law (Rev. Stat. 2395; 43 U.S.C. 751(7)) requires the surveyor to note and report upon the soil types. These requirements will hereafter be limited to lands being surveyed for the first time and need not be routinely applied to resurveys unless provided for by the special instructions.

The soil types, when considered in relation to precipitation and other climatic factors, the drainage, the adaptability of the terrain to irrigation, the elevation, and the latitude, will indicate whether the highest and best use of the land is for farming, grazing, forestry, or other purposes.

1-227. An outline of the matters to be considered in soil studies is presented below as a guide to the surveyor in making his or her report:

(1) Texture: Gravel, coarse and fine; sand, coarse and fine; sandy loam; silt loam; loam; clay, heavy and light; and muck.

(2) Structure: Single grained, pulverulent, and lumpy.

(3) Color: Surface soil and subsoil, both when dry and when wet.

(4) Chemical properties: Acidity, alkalinity, and humus content.

(5) Depth: Surface soil and subsoil.

(6) Location: River bottom or flood plain, bench, slope, plateau, prairie, and mountain.

(7) Topography: Level, rolling, broken, hilly, and mountainous, and elevation above sea level.

(8) Drainage: Direction, depth to water table, and quality as poor, good, or erosive.

(9) Mode of formation: Water laid, glacier laid, wind laid, and residual.

(10) Geological derivation:

(a) Sedimentary rocks: Formed of fragments of other rock transported from their sources and deposited as conglomerate, sandstone, and shale; or formed by simple precipitation from solution, as limestone, or of secretions of organisms, as some coastal rocks.

(b) Metamorphic rocks: Formed through change in constitution, especially those due to great pressure, heat, and water, and resulting in a more compact or more highly crystalline condition, including, for example, quartzite, marble, slate, and schist.

(c) Igneous rocks: Formed through the action of intense heat, including, for example (first, eruptive rocks) basalt, lava, and volcanic ash; (second, trap rock) felsite and quart-porphyry; and (third, granular rock) granite, diorite, and porphyry.

For additional information on important features of soils see *Soil Studies*, appendix VII, section 538, 1947 Manual.

Case Studies

The notes presented here are case studies that elaborate on or continue to discuss the topics presented . The case studies are used by permission from *River & Lake Boundaries* by James A. Simpson.

These case studies are provided as training tools, and must be viewed in their historical context. Please be aware that to the extent they refer to case law or legal analyses, such references have been provided in order to explain why certain surveys were conducted in the manner they were. Such case law may, however, have been subsequently superseded and/or may not be applicable outside the particular circumstances and timeframe of that case. Solicitor.

Ordinary High Water Mark (Case Studies)

1-162(n) through 1-172(n). The following case studies illustrate some of the various legal settings in which the OHWM is an issue. Surveyors need to be aware of these situations which may affect their resurvey work.

Howard v. Ingersoll, 54 U.S. 381 (1852)

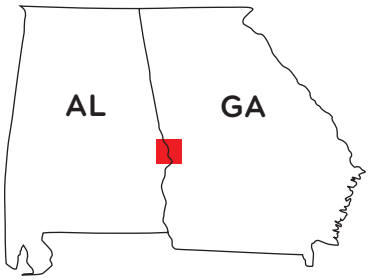

Figure 3-55. Vicinity map.

J. H. Howard of Columbus, Georgia, built a dam across the Chattahoochee River at a point above the head of usual navigation. The Chattahoochee River formed the boundary between Alabama and Georgia; the right/western (Alabama) bank or the river was defined as the State boundary (figure 1-56).

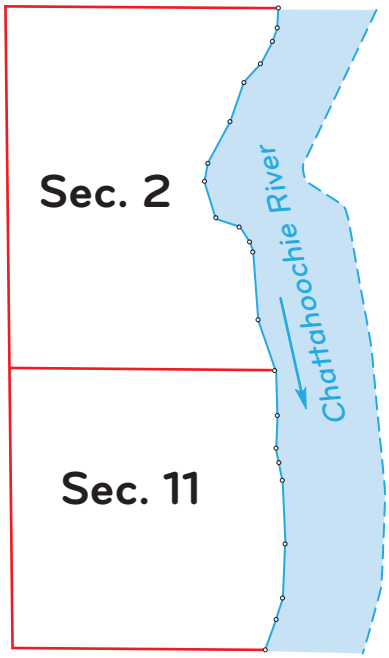

Figure 1-56. Portion of GLO plat of T. 17 N., R. 30 E., St. Stephens Meridian, Alabama, an 1833 survey by Josua Coffee.

As the water backed up it reached a grist mill owned by Stephen M. Ingersoll, a physician who owned land in Alabama down to the water's edge. Because the raised water level in the river caused Ingersoll's mill to cease functioning, Ingersoll sued in Alabama State Courts (figure 1-57).

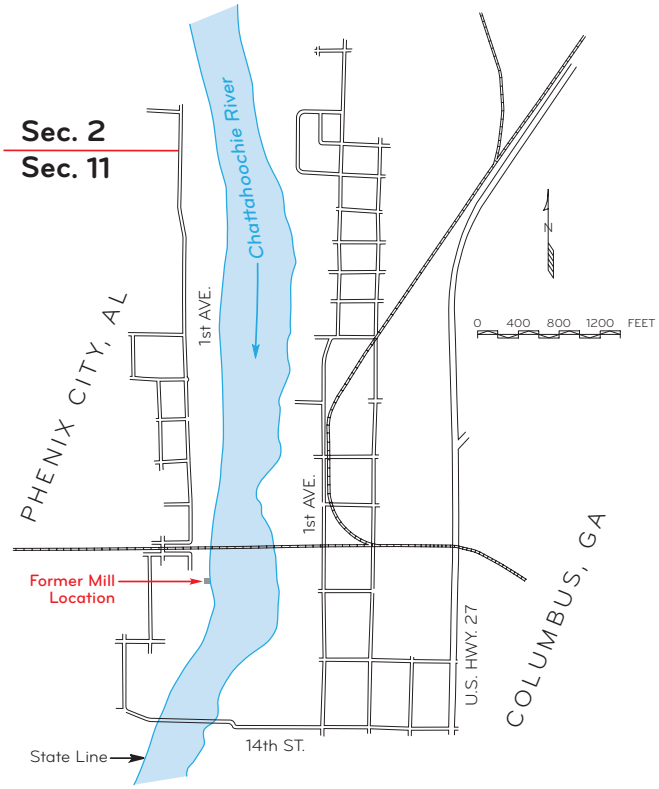

Figure 1-57. Sketch of Columbus and Phenix City showing the former grist mill location on the west bank of the Chattahoochee River.

The outcome of the case depended on the location of the boundary between Georgia and Alabama. The Alabama jury and Court found the State boundary to be at the ordinary low water mark of the left/east bank of the Chattahoochee and that Ingersoll had a right to operate his mill there. Verdict was given to Ingersoll.

Howard appealed and lost. Howard then brought another suit in the Circuit Court of the United States for the District of Georgia.

Eventually the case went to the Supreme Court of the United States. The Court's opinion provided the foundation of the OHWM concept.

When the State of Georgia ceded its lands west of the Chattahoochee to the United States, Georgia kept the ownership of the bed of the river. The boundary was described as, "a line beginning on the western bank of the Chattahoochee River, running thence up the said River Chattahoochee, and along the western bank thereof" (p. 420).

If the State boundary was at the low water mark, Ingersoll was legally damaged by the change in water level. On the other hand if the boundary was the top of flood stage (height) on the far bank, Ingersoll had no rights at all.

Ingersoll's mill was located on a small flat alongside the main river channel. At "ordinary high water" the flat where the mill was located was covered with water according to the evidence but at ordinary low water and extreme low water the mill was on dry ground. The dry situation lasted about one-third of the year. Evidence showed that the flat contained pine, oaks, gum and poplar trees. A small part of the flat had been cultivated and there was a cotton gin and a saw mill located there.

The bank at the mill itself was "never overflowed, even at the highest stages of the river, the water of which always remained several feet below it." The river valley is contained by bluffs, which vary from 15 to 150 feet in height, and the bank was 15 to 20 feet in height immediately at the mill.

In some very general language, the majority opinion of the High Court was that Georgia's jurisdiction extended to the "line which is washed by the water, wherever it covers the bed of the river within its banks. The permanent fast land bank is referred to as governing the line. From the lower edge of that bank, the bed of the river commences, and Georgia retained the bed of river from the lower edge of the bank on the west side. And where the bank is fairly marked by the water, that water level will show at all places where the line is." (p. 418.)

There were almost no usable words of direction to a surveyor in the majority opinion. Justice Nelson in a dissenting opinion came a little closer. He wrote that the line was marked by the permanent bed of the river from the flow of the water at its usual and accustomed stage and where the water will be found at all times of the season except when diminished by drought or swollen by freshets (floods).

The often quoted language from this leading case was written in a different dissenting opinion by Justice Curtis:

> That the banks of a river are those elevations of land which confine the waters when they rise out of the bed; and the bed is that soil so usually covered by water as to be distinguishable from the banks, by the character of the soil, or vegetation, or both, produced by the common presence and action of flowing water . . . . This line is to be found by examining the bed and banks, and ascertaining where the presence and action of water are so common and usual, and so long continued in all ordinary years, as to mark upon the soil of the bed a character distinct from that of the banks, in respect to vegetation, as well as in respect to the nature of the soil itself. (p. 427.)
>
> But in all cases the bed of a river is a natural object, and is to be sought for, not merely by the application of any abstract rules, but as other natural objects are sought for and found, by the distinctive appearances they present; the banks being fast land, on which vegetation, appropriate to such land in the particular locality, grows wherever the bank is not too steep to permit such growth, and the bed being soil of a different character and having no vegetation, or only such as exists when commonly submerged in water. (p. 428.)

Finally, this was something that could be used in the field: The boundary was where the bank was formed and the upland vegetation ceased to grow.

The case was sent back to the Alabama Supreme Court and the Federal Circuit Court for further hearings using the OHWM as the boundary between the two States.

Ingersoll accordingly lost his case.

Until this day the entire control of the water power from dams along the Chattahoochee is concentrated on the Georgia side of the river.

The Ingersoll case is of interest today. Ingersoll is classed as a leading case so it is important to know what kinds of vegetation grew on the banks of the Chattahoochee River. Where did it grow in relation to the top of the bank and what were the soil conditions along those banks.

Conditions along the river may not be exactly the same as they were more than 150 years ago. Accordingly, we have to rely on historical information and any photographs that survived from those times and then correlate that with what is on the ground today.

Examination of the sketches and photographs above shows that there were shrubs and trees on the banks of the Chattahoochee River in the 1840s through the 1880s and that similar vegetation is growing in similar situations there today. Photographs of steamboats loading cotton from the mills in Columbus incidentally show shrubs and trees growing along the banks, and the growth extends down to the water showing at the time of the photograph.

An illustrator's drawing of a man fishing on the Alabama bank of the Chattahoochee River that shows small but mature trees and shrubs growing on the bank where the fisherman sits with his back to the artist.

There is not enough detail in the sketches and the photography to identify what species of shrub or trees are growing there but that specificity is not necessary to illustrate the intent and meaning of the *Howard v. Ingersoll* decision.

In 1850, the intent of the Supreme Court was very probably that the boundary was to be at the bank where an angler would stand to fish. It would be at a place where the bushes had ceased to grow, where the soil was firm enough to stand—specifically a bank. The Court very probably did not intend that the boundary be located at a point separated from the flowing water by a forest or a thicket even though that thicket or forest is greatly affected by the presence of the water of the river. Nor was the intended boundary located at the top of the high bank, which, in the case of the Chattahoochee, would be from 15 to 20 feet in height immediately at the plaintiff's lands and lots.

Borough of Ford City v. United States, 345 F.2d 645 (3rd Cir. 1965), *cert. denied*, 382 U.S. 902 (1965)

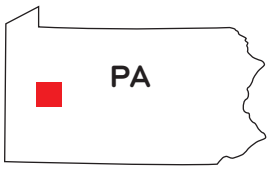

Figure 1-58. Vicinity map.

The sewage outlet for Ford City, Pennsylvania, was a pipeline emptying into the Allegheny River. When the Corps of Engineers built a lock and dam on the Allegheny downstream from Ford City, it raised the level of the river such that the City was required to pump the effluent instead using gravity flow. The City also claimed that the higher levels increased ground water leakage into their sewers (figure 1-59).

The Allegheny was agreed to be a navigable river. For so long as the Corps' dam did not raise the water level above the OHWM in normal flow times, the United States would not be liable. Property could be taken without compensation for navigational improvements but only below the OHWM.

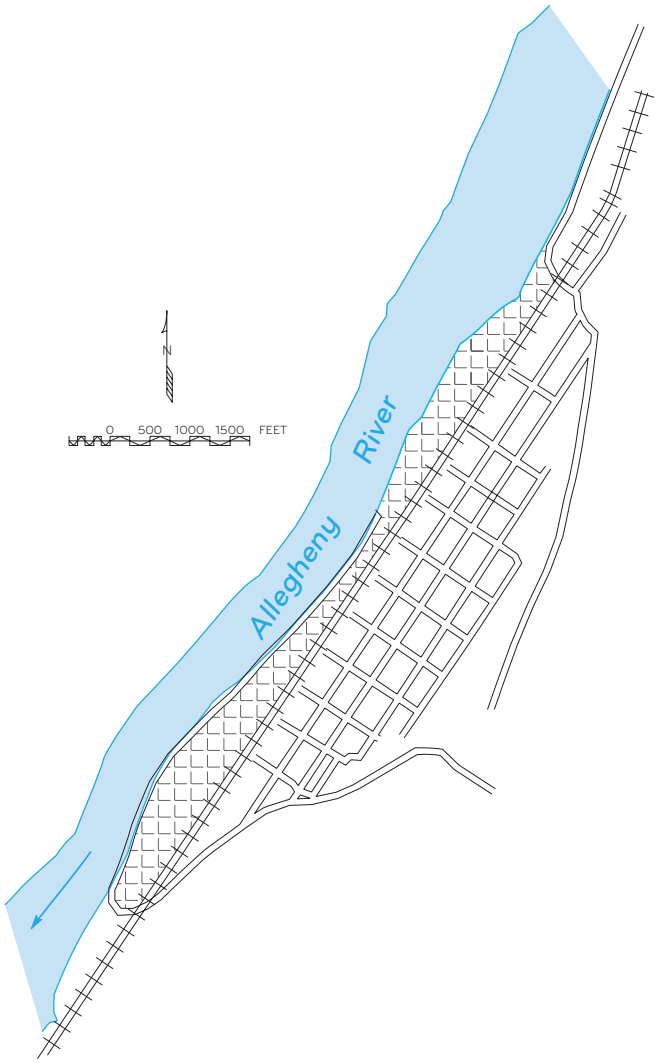

Figure 1-59. City of Ford City, Pennsylvania, from USGS maps.

The critical point of the trial became the elevation (or location) of the OHWM.

The District Court, 213 F.Supp. 248 (1963), held that the Government dam had raised the OHWM and the Government to be liable. That finding was based on a quotation from *U.S. v. Chicago B. & Q. R. Co.*, 90 F.2d 161 (1937), *cert. denied*, 302 U.S. 714 (1937), that: "The river bed is the land upon which the action of the water has been so constant as to destroy vegetation. It does not extend to nor include the soil upon which grasses, shrubs and trees grow." (p. 170, p. 251, and p. 647.)

The chief witness for the City of Ford City was a forester by training who admitted he had been engaged to make observations on the Allegheny River's bank vegetation.

He stated that his understanding of the law was that the vegetation was the controlling factor. The witness stated that he had found the line where the vegetation had ceased to grow to be at elevation 773.78 feet. His work was done after the dam was built and in operation.

From the District Court's findings of fact, it states the following:

> In order to fix the location of the pre-dam ordinary high-water mark, it was necessary to determine the elevation of the existing ordinary high-water mark and translate it into the location of the pre-dam ordinary high-water mark. This was done by utilizing the amount of flow of water necessary to reach the present ordinary high water mark and by determining where this same amount of flow of water would come on the banks of the stream in open river conditions. (*Borough of Ford City v. United States*, 213 F.Supp. 248, 254 (W.D. Penn. 1963).)

The pre-dam ordinary high-water mark was thus 766.8 feet, using hydraulic computational estimates, according to the Ford City's witness.

Among the Government's witnesses, a botanist gave his opinion that below elevation 776.4 (the First St. Outlet) terrestrial plants would not grow, and there would be no value to the land for agricultural use.

A hydraulic engineer for the Government testified that the impress of the line of ordinary high water was at 776.5 and that pre-dam ordinary high water was at 771.4. The Government witnesses all made use of shelving, erosion and litter in substantiation of their findings. They also covered the entire pool area not just the Ford City vicinity.

The Appeals Court held that the District Court's Judge erred in accepting Ford City's forester's testimony, which was based solely on the destruction of vegetation and using that testimony as the basis for his ruling.

In *Harrison v. Fite*, 148 F. 781 (8th Cir. 1906), the Appeals Court said, held that the "bed of a river . . . is that soil so usually covered by water that it is wrested from vegetation and its value for agricultural purposes is destroyed." (p. 783 and p. 648.) The Appeals Court also quoted *Howard v. Ingersoll*, above, as well.

They summed up the subject with:

> The value for agricultural purposes is destroyed where terrestrial plants not all plant life ceases to grow. Just as definitely the same law is that the bed of such stream . . . does not extend to or include that upon which grasses, shrubs and trees grow though covered by the great annual rises. (p. 648, again quoting *Harrison v. Fite*, p. 783.)

From the Appellate decision:

> The vegetation test is useful where there is no clear, natural line impressed on the bank. If there is a clear line, as shown by erosion, and other easily recognized characteristics such as shelving, change in the character of the soil, destruction of terrestrial vegetation, and litter, it determines the line of ordinary high-water (citations omitted). Also a test of the distinct line is the destruction of terrestrial vegetation so these are not really two separate tests but must, of necessity, complement each other. (p. 648.)

Another important Appellate conclusion: "If it is difficult to ascertain the line of ordinary high-water at this site, recourse may be had to other sites along the same stream to determine the line (citation omitted)." (p. 648.)

The Judgment against the Government was reversed.

United States v. Claridge, 279 F.Supp. 87 (D. Ariz. 1967), *aff'd*, 416 F.2d 933 (9th Cir. 1969), *cert. denied*, 397 U.S. 961 (1970)

Figure 1-60. Vicinity map.

The United States sued for quiet title in District Court on land in sections 22, 27 and 28, T. 3 N., R. 22 W., Gila and Salt River Meridian, (figure 1-1) to lands along the Colorado River running between Arizona and California, claiming the land had been withdrawn from entry for reclamation purposes since 1902. Claridge held a quit-claim deed only. He had also occupied the disputed land by virtue of a prior land use permit acquired from the United States Lower Colorado River Land Use Office. He had spent considerable money pre-paring the land for farming and was growing crops.

Claridge claimed that the disputed land was below the OHWMs of the river because the spring floods ordinar-ily covered the valley "from bluff to bluff." Claridge

also asserted that the closure of Boulder Dam (Hoover Dam) about 200 miles upstream had artificially changed the river banks to their present condition (figure 1-61).

Arizona became a State in 1912 and at that time the disputed lands were within the bed of the Colorado River according to Claridge. Under the Submerged Lands Act of 1953 title to lands below the OHWM were confirmed to the State of Arizona as of 1912.

The State of Arizona joined the Claridge suit. Arizona stood to gain a very considerable area of prime farm lands up and down the river if Claridge's "bluff to bluff" theory were held to be correct.

The bluffs on the Arizona side are in the immediate vicinity of the Claridge lands. On the California side the bluffs are more than 8 miles away. The river approaches the west side of this flood plain in other places so that Arizona would benefit there also (figures 1-62 and 1-63).

The Arizona Land Department had leased the land to Claridge as if it were river bed.

The Courts found the OHWM to be a "natural physical characteristic placed upon the lands by the action of the river. It is placed there, as the name implies, from the ordinary flow of the river and does not extend to the peak flow or flood stage so as to include overflow on the

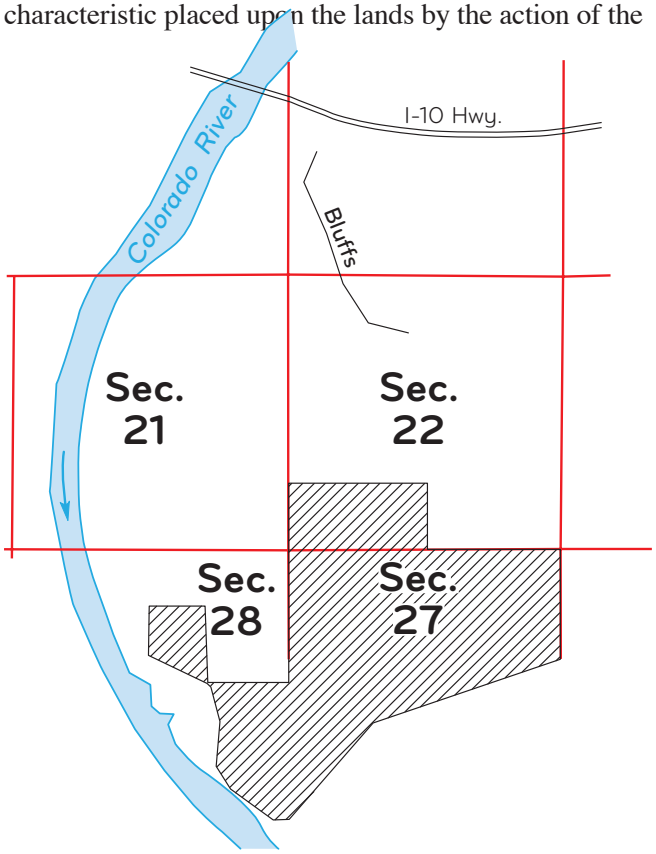

Figure 1-61. The Colorado River had been channelized at the time of the Claridge suit (taken from a 1976 USGS quad).

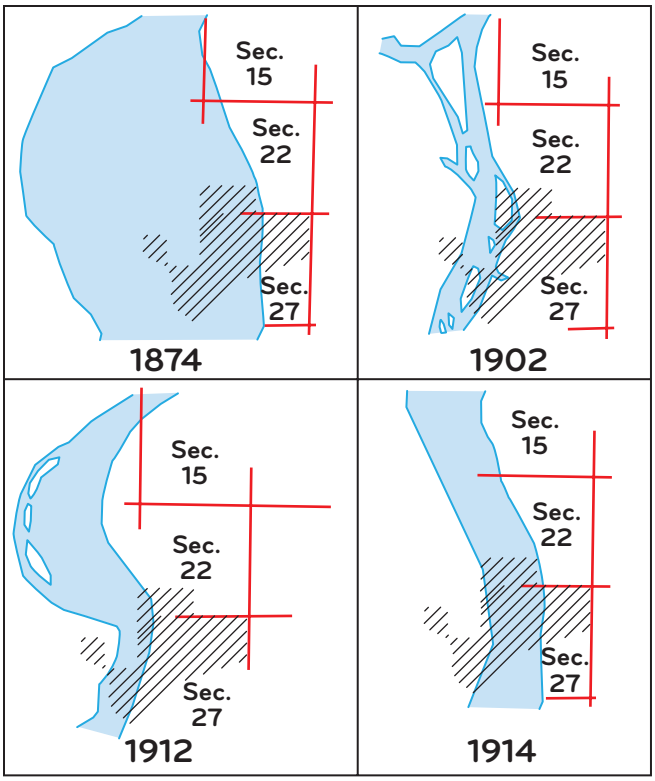

Figure 1-62. Changes in the Colorado River from 1874 to 1914.

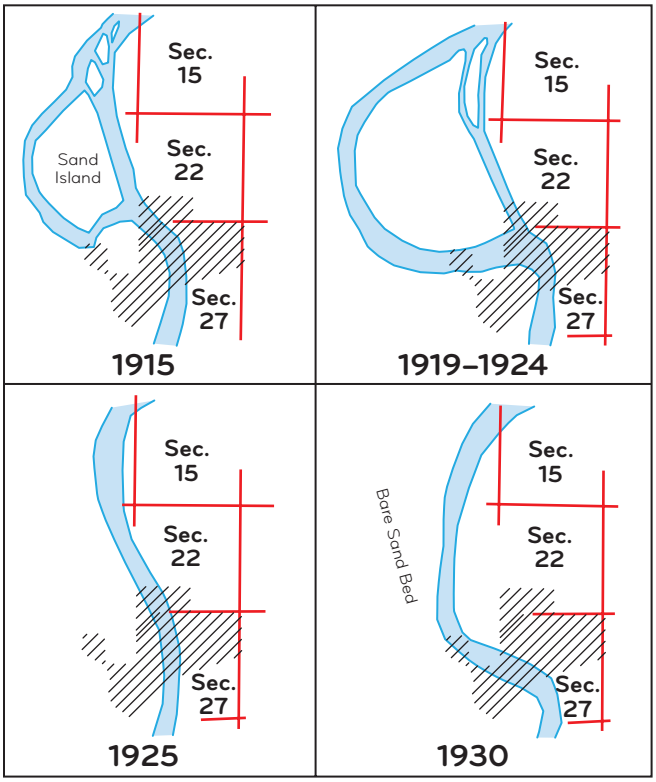

Figure 1-63. Changes in the Colorado River from 1915 to 1930.

flood plain, nor is it confined to the lowest stages of the river flow." (p. 934; quoting *United States v. Claridge*, 279 F.Supp. 87, 91 (D. Ariz. 1966).)

From this finding the Courts went on to say that Arizona was mistaken in assuming that the ordinary high water before the closure of Hoover Dam extended from bluff to bluff. The fact that the dam eliminated the extensive floods was not found to be an avulsive change. The lands in question were Federal.

Claridge appealed the ruling to the Supreme Court of the United States but certiorari was denied so the ruling stands as an important case in the Federal courts.

Zunamon v. United States, Ct. Cl. Docket # 80-78 (Slip opinion filed June 23, 1980)

Figure 3-64. Vicinity map.

Zunamon's property was affected by the pool of water backed up by a new dam on the Black River 30 miles downstream from Jonesville, Louisiana. Zunamon's property was on the Tensas (pronounced Tensaw) River and on Bayou Macon. The new pool level kept the water at elevation 34 feet above mean sea level (MSL) and was expected to remain at that elevation.

Parts of the Zunamon property above elevation 37 feet MSL have remained dry but that part between the 34 and 37 foot elevations is claimed to be so saturated that it is not useful for any purpose.

Again, if the damage occurred within the bed of the river as defined by the OHWM, the Government would not be liable.

This trial focused on whether the area below elevation 37 feet MSL was below the OHWM of the Tensas River and the bayou, both of which were already determined to be navigable.

The elevation of Zunamon's property varied from 25 feet MSL near the confluence of the bayou and the Tensas River to a high of 60 feet MSL in the northern portion. The disputed area was known as "Little Hog Glade," which had been lower than elevation 37 feet MSL (figure 1-65).

Prior to the dam construction Little Hog Glade was normally covered with flood waters during the 6-month-long wet season. It was normally free of flood water and the soil was dry during the dry season except for a small area near the confluence of the bayou and the Tensas River (figure 1-66).

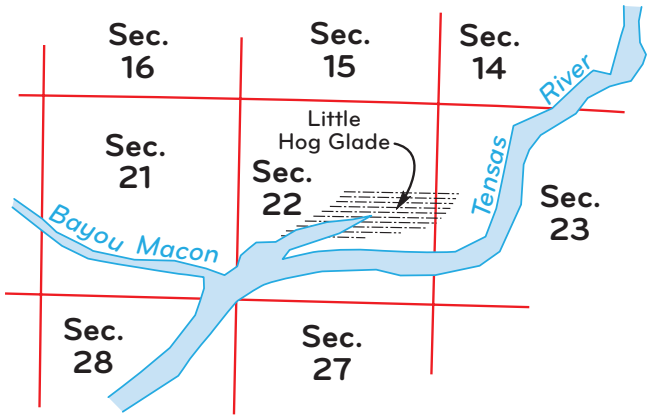

Figure 1-65. Little Hog Glade as shown on USGS maps.

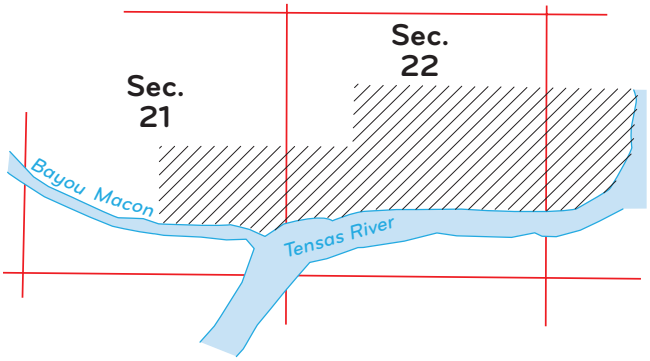

Figure 1-66. The Zunamon property according to patents held from the United States.

A sedge known locally as "nutgrass" and cockleburs grew throughout Little Hog Glade before the dam construction; hogs and cattle grazed there on the nutgrass. Willows, bitter pecan, overcup oak and water locust trees grew there before the dam construction. These trees normally grow in areas flooded no more than 6 months of the year provided that the ground is relatively dry during the remaining part of the year.

After the dam construction the only shrubbery that grew there was swamp privet, buttonwood, and water elms. These species will grow where the ground is flooded 6 months of the year and where it is also saturated with moisture the remaining 6 months.

Nutgrass no longer grows in Little Hog Glade according to the Court's findings and it can no longer be used for pasture. The trees are dead or dying.

The Government contended at trial that the Tensas and the bayou before the dam was constructed had already "visibly asserted their dominion" over the property up to the 37 foot level. (This is wetlands terminology that has little or nothing to do with OHWM location.)

It was also contended that the soil of Little Hog Glade was not suitable for growing crops, even prior to dam construction.

The Court agreed with the Government's claim about "asserting their dominion." The Court would not accept a conclusion that willows, bitter pecan, overcup oak, and water locust trees were aquatic plants simply because they could withstand flooding for 6 months of the year.

Additionally the Judge ruled that the presence of the water at the higher elevation had destroyed the value of the soil for agriculture, noting that forestry is an agricultural occupation. The Government was found liable.

United States v. Harrell, 926 F.2d 1036 (11th Cir. Ala. 1991)

Figure 1-67. Vicinity map.

The Corps of Engineers sided with a group of commercial fishermen in a dispute over access to Lewis Creek, which is a tributary to the Tombigbee River, a navigable river in Alabama (figure 1-68).

Under Alabama law there was no right of access to nonnavigable rivers, so the fishermen tried to get the creek declared to be a navigable waterway of the United States in order to get access. They wanted to fish there during high water times. The property owners objected.

The trial developed that the Tombigbee River flooded the bottom land every year, generally from December through March. The hardwood forests grew commercially valuable stands of tupelo gum, cypress, wild pecan, willow, hickory, and various types of oak. Those types of trees were found to be terrestrial, rather than aquatic; they will grow on land that is subject to intermittent flooding. Some cypress and tupelo will stand heavy flooding once they become established.

The Trial Court found Lewis Creek to be nonnavigable and the Corps appealed. The trial Judge wrote that Lewis Creek was, "a small, narrow, shallow, obstructed, partially dry creek that is incapable of any type of waterborne commerce." The Trial Court stated that the creek "only becomes capable of use for such commerce when the flood waters of the Tombigbee River break out of their banks" into the nonnavigable bed of Lewis Creek (p. 1039).

The Corps claimed that, in the alternative, the bed of the Tombigbee River extended to high, permanent banks that were about 3 miles from the river itself. This 1-mile claim would put the disputed land along Lewis Creek within this extended bed of the Tombigbee River.

The Appellate Court went on to determine whether, if Lewis Creek was not navigable, the Lewis Creek area was within the OHWM of the Tombigbee River. The Court found that the meaning of OHWM does not include land covered by the " 'extraordinary freshets of the winter or spring, or the extreme droughts of the summer or autumn.' Neither does the bed of the river include the ' . . . lateral valleys which have the character-istics of relatively fast land, and usually are covered by upland grasses and vegetation, although temporarily over-flowed in exceptional instances when the river is at flood' " (p. 1041). The lower Court had found that the waters of the Tombigbee did not occupy Lewis Creek long enough to destroy the upland vegetation and that flood marks were not sufficient to establish the OHWM.

The Appellate Court ruled that the District Court was correct in finding for the private owners and against the Federal Government and the commercial fishermen.

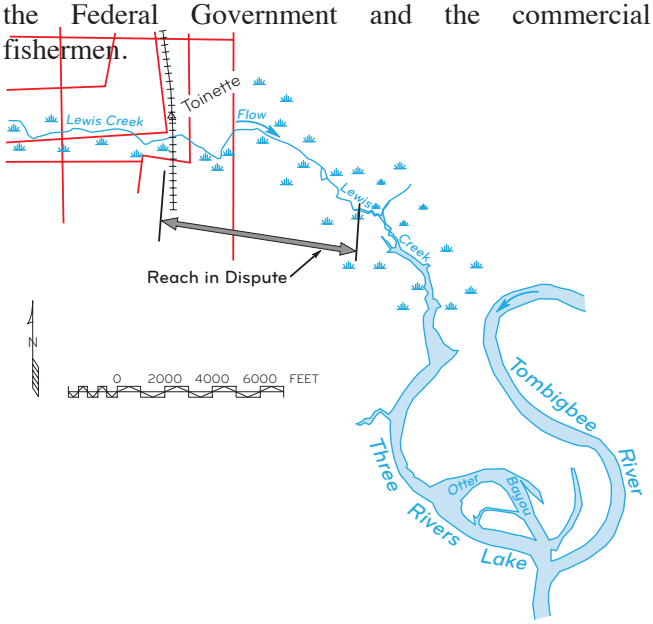

Figure 1-68. Lewis Creek vicinity from USGS mapping. Note that the entire area is within 3 miles of the Tombigbee River.

1. **Under the rectangular system, the unit of survey is the township consisting of how many sections?**
   - 10 sections
   - 36 sections
   - 40 acres
   - 640 sections

2. **The rectangular system was first initiated in 1785, in which state?**
   - Virginia
   - Pennsylvania
   - Ohio
   - New York

3. **The base line is extended _____ from the initial point on a _____ of latitude.**
   - east and west, true parallel
   - east and west, true perpendicular
   - north and south, true parallel
   - north and south, true perpendicular

4. **What are interval lengths of guide meridians?**
   - 2400 yards
   - 2.4 miles
   - 24 miles
   - 240 miles

5. **True or False? The official record contains a complete record of the manner in which township exteriors have been run and established.**
   - True
   - False

6. **What is the allowable deviation for new boundaries from the cardinal for township exteriors?**
   - 14 degrees
   - 1 minute
   - 14 minutes
   - 4 degrees

7. **If the south boundary of the township is defective in alinement and cannot be rectified so that the west boundary is defective in position, what is established?**
   - A sectional correction line
   - A meridian line
   - Any of the above
   - A rectification line

8. **What are created when the defective conditions of the governing boundaries do not create defective conditions along the north and/or west boundaries that would require double corners?**
   - Sectional guide meridian
   - Sectional correction line
   - Governing section lines
   - None of the above

9. **An auxiliary base is used in situations concerning?**
   - Auxiliary townships
   - Regular townships
   - Irregular townships
   - All of the above

10. **Most original surveys that are now to be extended or completed were executed many years ago when the remaining areas were considered wastelands**
    - True
    - False

11. **When irregularity develops, the _____ method of survey that will correct any irregularities and provide an early resumption of regularity in the new subdivisional lines is adopted**
    - proposed
    - simplest
    - subdivision by protraction
    - prescribed

12. **True or False? All new lots are numbered beginning with the next lower number in the series shown on the previously approved plat, and proceeding in the usual order.**
    - True
    - False

13. In the public land survey system, a corner is fixed in position by what?

- Operation of state guidance
- Operation of law
- Operation of litigation
- All of the above

14. Is it essential that original survey corners be found, located, or properly restored, before the actual field work involving the subdivision of section is undertaken?

- Yes
- No
- Maybe, depends on case by case
- Only if required by county law township resides in

15. To subdivide a regular section into quarter-sections, run straight lines from the fixed quarter-section corners to the _____ quarter-section corners.

- opposite corresponding
- same corresponding
- farthest
- closest

16. True or False? A Land Surveyor cannot properly serve the client or the public unless familiar with the legal requirements concerning the subdivision of sections

- True
- False

17. It is unlawful for the surveyor to impair bona fide rights as to location?

- Yes
- No
- Maybe, depends on if surveyor is licensed or not
- Only when not employed by a federal government agency

18. What are intended to provide a basis for the administration and management of unsurveyed Federal lands for all purposes short of conveying title?

- Subdivision sectional charts
- Official protraction diagrams
- All of the above
- Amended plats

19. Amended protraction diagrams represent the plan for extending the rectangular survey system over unsurveyed Federal lands based upon what?

- Assigned latitudes and longitudes for protracted corners
- Designated bearings for lines intersecting previously surveyed boundaries
- Designated random and true lines connecting protracted corners with previously surveyed corners
- All of the above

20. What is considered an actual boundary?

- Ordinary high water mark (OHWM)
- Mean high tide (line of MHT)
- Meander line
- Both A & C

21. For inland waters, the OHWM normally used is the line below which the water impresses on the soil by covering it for sufficient periods to deprive it of what?

- Terrestrial vegetation
- Aquatic vegetation
- Wetland vegetation
- All of the above

22. For tidal water, in the interest of certainty, the line of MHT is the average elevation of all the high tides occurring over a period of how many years?

- 5 years
- 18.6 years
- 48 years
- 100 years

23. Are all navigable lakes are meandered?

- Yes
- No
- Maybe, depends on circumstances
- Yes, only if deemed navigable by the Army Corp of Engineers

24. Why are overflowed lands different from “overflow lands”?

- Overflowed lands are permanent
- They are the same
- Overflowed lands are temporary
- "Overflow" lands are permanent

25. True or False? The regular corners of the Federal land surveys are marked by fixed official monuments.

- True
- False