REGION 1 BOUNDARY MANAGEMENT CONTRACT SPECIFICATIONS

This Region 1 Boundary Management Contract Specifications booklet contains the specifications and exhibits that will apply to all Forest Service Region 1 Cadastral Survey projects.

Please retain this booklet in a permanent file. All Region 1 cadastral solicitations will include the enclosed material by reference only, except for project specific exhibits which will be furnished with each particular project, such as Exhibits 1, 2, and 3.

USDA FOREST SERVICE
ADMINISTRATION (CONTRACTING)
340 N. PATTEE
P.O. BOX 7669
MISSOULA, MONTANA 59807

4/01

REGION 1 BOUNDARY MANAGEMENT CONTRACT SPECIFICATIONS

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REGION 1 BOUNDARY MANAGEMENT CONTRACT SPECIFICATIONS

C-1 - SCOPE OF CONTRACT

The intent of this contract is to obtain the land surveying services listed in the schedule of items in accordance with the specifications and exhibits. The contractor shall furnish all labor, supervision, transportation, equipment, supplies and materials, except the Government furnished property specified in Section C-4 below, necessary to complete the work as specified.

C-2 - DESCRIPTION OF SERVICES. See Special Project Specification. Refer to EXHIBIT 3.

C-3 - LOCATION. See Special Project Specifications. Refer to EXHIBIT 1.

C-4 - GOVERNMENT FURNISHED PROPERTY. See Special Project Specifications for a list of Government furnished property and the time and location where it will be made available.

TECHNICAL SPECIFICATIONS - CADASTRAL SURVEYS

C-5 - SURVEYS.

All surveys necessary to define National Forest boundaries shall comply with applicable state laws and regulations. Where state laws and regulations are less restrictive than the specifications contained herein, the specifications contained herein shall apply. In Public Land Survey System (PLSS) States, the principles and practices, as set forth in the Bureau of Land Management publications "Restoration of Lost or Obliterated Corners and Subdivision of Sections" and the "Manual of Surveying Instructions, " hereinafter called the Manuals, as well as applicable state laws, shall be followed. Where these specifications differ from the Manuals, these specifications shall apply.

.100 RESEARCH

.110 Records Research It is the Contractor's responsibility to research the real property records of public agencies to obtain the title and survey history of the subject property and relevant adjoining properties. The Government will provide the Contractor access to Government ownership, corner search and survey files at the time of award.

.120 Adjoiner Notification See Special Project Specifications.
Refer to Exhibits .120 and .121 for example letter to adjoiners and example reply card.

.130 Conflicts The contractor will be informed by the Government of any known conflicts of survey, possession, or title along the boundary lines to be surveyed. Any conflicts discovered by the Contractor in the course of the project shall be reported to the COR. verbally as soon as practical, followed within five (5) days after verification with written documentation in a format similar to that in Exhibit .130. The Contractor shall not undertake any additional work resulting from the discovery of a conflict unless authorized to do so by the Contracting Officer. An equitable adjustment of contract performance time or contract price, may be made for any additional survey work authorized by the Contracting Officer resulting from a conflict.

.200 CORNER SEARCH, EVALUATION AND DOCUMENTATION

.210 Field Search The contractor shall investigate and search for monuments and other physical evidence as indicated on Exhibit 2 and included in Section B – SERVICES AND PRICES. This may include, but is not limited to, original monuments and accessories, such as bearing trees, line trees, and reference objects. The Contractor shall notify the COR prior to reestablishing any lost or obliterated PLSS corner.

.220 Corner Documentation Corner search efforts shall be documented in the field book. The documentation shall include a description of the process that was used to determine the position of each corner.

.230 Corner Card Form FS-7100-52 All applicable sections of the corner card shall be completed in accordance with Exhibit .230. Two original, or one original and one copy on 5 x 8 inch card stock, of Form FS-7100-52, shall be

completed for each corner required by section B and Exhibit 2. See Special Project Specifications for alternative forms.

.300 CONTROL SURVEY, FIELD DATA COLLECTION AND COMPUTATIONS

.310 Survey Methods and Procedures The Contractor shall select the methods and procedures to be used for field data collection and boundary line location. The method selected must comply with the following criteria and the applicable survey standards in this section.

.311 The position of each corner established or tied must be determined as part of a traverse which forms a closed loop or begins and ends on geodetic control stations, an acceptable radial tie, an acceptable point positioning procedure, or combinations thereof. Acceptable radial techniques are illustrated in Exhibit .311.

.312 Determination of Distance All distance measuring equipment to be used in conjunction with this contract shall have been calibrated within one year prior to use on this contract. Proof of calibration test on a National Geodetic Survey Calibration Base Line shall be submitted to the COR prior to the use of the equipment on this project. Exhibit .312 shall be completed and submitted to the COR prior to the use of the equipment on this project. Lack of calibration within this time frame will constitute unacceptable work.

.313 Marking the Survey Point Survey points shall be marked with the minimum of a 60 d nail firmly anchored and identified with appropriate point number written on attached flagging. A guard stake or lath shall be placed alongside.

.314 Clearing for Control Lines Survey operations will be conducted on Government land, and clearing of vegetation shall be confined to that absolutely necessary for the survey. No trees larger than 6 inches diameter breast height shall be cleared without the permission of the COR. When this is not possible or practical, the contractor shall contact adjoining landowners in accordance with Exhibit .120.

.320 Survey Standards Survey standards consist of two parts, both of which must be met.

.321 Corner Standard The position of each corner set as the result of a control survey must meet the following standard:
R = 2 ft. or R = .25 ft. + 0.0008d, whichever is smaller
Where R is the radius of a circle centered on the theoretical true point for the corner.
Where d is the distance to the nearest controlling corner

.322 Control Survey Standards Control Surveys must meet the following standards:

.1 The control survey must establish bearing within 2 minutes of either the astronomic or geodetic meridian.

.2 Conventional traverse measurements used to establish or re-establish corners shall be analyzed by the contractor using a least squares procedure. Least squares adjustment default values for standard errors shall not exceed those shown on Exhibit . 324. The analysis method must pass the 95% confidence level or meet the approval of the COR.

.3 Conventional traverse measurements used to establish or reestablish corners shall comply with the following minimum angle, distance and closure requirements:
Direct Reading of Instrument: 1'
Number of Angular Observations Per Station: 1 Direct and 1 Reverse
Spread from Mean of Direct and Reverse not to exceed: 30"
Angular Closure (where N = No. of Stations) Not to Exceed: 30" $\sqrt{N}$
Linear Closure: 1:5000
Distance measurement: EDM or Steel tape

If estimated angular or linear closures are not met, blunders are indicated and must be resolved to the satisfaction of the COR.

.4 For Global Positioning Survey Standards refer to GPS Appendix.

.330 Field Notes shall be recorded in writing, in a standard waterproof field book, or by electronic data collectors. Either method shall provide a complete, legible, and unambiguous record of all field work and items listed under section .311.

.331 Field Books The original field books or legible photo copies of each book shall be furnished to the Government upon completion of the project. Errors shall be lined out and not erased. Field books shall contain, at a minimum, the following data:

.1 The contract number and name shall be printed in ink on the cover of each book and each book shall be sequentially numbered.

.2 Each book shall contain a small sketch and index page in the front of the book which shall include a brief description of work and the corresponding page number.

.3 Names and duties of each party member, weather conditions, instruments used, the location of the work performed, and the date shall be recorded each day work is performed.

.4 Field data collection and boundary layout notes shall be recorded in such a fashion as to allow another technically qualified person to retrace the survey without consultation with the Contractor.

.5 Basis of bearing data shall be recorded in sufficient detail to permit an independent check.

.6 Statements by adjoining landowners or other knowledgeable persons relative to boundary line and corner locations.

.7 Corner search and monumentation documentation. It shall include a description of search efforts, monument placement and marking information, description of accessories used and their relationship to the corner.

.8 Surveyor's Certificate - The following certification is to be made immediately following the last page used in the notebook :

I hereby certify that the foregoing notes represent work done under my direct supervision.

_____

Name State Registration No. Date

.332 Electronic Data Collectors If the Contractor uses an electronic data collector, the following shall be furnished to the Government:

.1 A paper print of the original field measurements, including erroneous data, prior to any editing, manipulation or adjustment. A Surveyor's Certificate similar to that shown in section .331. 8 shall be made immediately following the last page of the paper print.

.333 Global Positioning Systems If the Contractor uses a Global Positioning System, documentation shall comply with GPS Appendix.

.340 Survey Control Diagram and Computations Prior to any monuments being set, corners being established or re-established, the Contractor shall provide a control diagram and the final computations to the COR for review.

.341 Survey Control Diagram The Contractor shall provide a legible copy of a control diagram which consists of a scaled and annotated plot of the survey. Each sheet shall contain the following:

.1 Project name and contract number.

.2 Contractor's name.

.3 Project Location.

.4 Dates of each revision.

.5 Linear Scale.

.6 Plotted position with the unique name or number of all control stations and monuments.

.7 Final coordinate values of control survey stations, and all corner monuments used, established, or re-established.

.8 Fieldbook number and page reference of all corner ties annotated adjacent to the plotted corner position.

.9 Sight lines between control stations and Public Land Survey System lines shall be shown by separate and unique line type or weight.

.342 Computations An original paper print or a legible copy of all computations shall be furnished to the government. The computations shall include the following as applicable:

.1 Reductions of field survey measurements to coordinate values for all control survey points and Public Land Survey corners before any adjustment scheme is applied.

.2 A formatted ASCII file of all final coordinates [point #, northing, easting, descriptor]

.400 CORNER MONUMENTATION AND ACCESSORIES

.410 Monumentation All corners required to be monumented by this contract shall use a monument provided by or specified by the Government in accordance with Special Project Specification C-4 GOVERNMENT FURNISHED PROPERTY. Monuments set by survey shall be located to standards described in section .321.

.411 Monument Placement Monuments shall be placed as illustrated in Exhibit .411. Physical evidence of earlier surveys should be preserved when possible. The contractor should bury original stones upside down in the hole alongside the new monument and place original wood posts near the new monument for inspection by COR Brush and logging debris within a radius of 6 feet of the corner shall be cleared away when the monument is set.

.412 Reference Monuments Where it is impossible or impractical to place a monument at the true corner position refer to the current version of The Manual. When the monument is liable to destruction, a reference monument shall be established.

.413 Monument Caps Monument caps and tablets shall be stamped as prescribed in the current version of The Manuals and Exhibit .413.

.414 Tree Monuments When the corner position is coincident with a live, healthy tree, the tree shall be marked as prescribed in the current version of The Manuals. Painting and signing of tree monuments shall be in accordance with Exhibit .414.

.420 Bearing Trees and Other Accessories

.421 Selection The Manual is the basic guide except that all corners shall be referenced by at least two accessories. If suitable trees are not available, bearing objects or reference monuments may be substituted. Bearing trees shall be 4 inches d.b.h. or larger, and preferably located at not less than 30 degrees apart in angle as measured from the corner. Where conditions permit, bearing trees or objects shall be on Government land.

.422 Measurements Measurements of bearing and distance from the corner position to the accessories shall be made and recorded by the contractor in the following manner. Distance shall be from the corner position to the center of bearing trees or to the specified point on witness objects. Distance measurement shall be horizontal and reported to the nearest .1 ft. Bearing shall be measured and reported to the nearest whole degree and must be within ± 2 degrees of the astronomic or geodetic meridian. Basis of bearing shall be recorded in the field notes and / or on the Corner Record Card. Compass bearings shall include the declination used and method of determination. The species and diameter of bearing trees at breast height shall also be measured and recorded.

.423 Blazing, Painting and Scribing Blazing, painting and scribing of bearing trees shall be in accordance with Exhibit .423.

.424 Signing Signing of bearing trees shall be in accordance with Exhibit .423. Available signs with identifying numbers are illustrated by Exhibit .424. Sign 54-3, "Bearing Tree," shall be placed on all newly created bearing trees and on all existing bearing tree remnants. Sign 54-9 "Land Survey Monument" shall be placed on the back of all standing bearing trees - dead or alive. A post with sign 54-9 attached shall be placed at all corner monuments in accordance with Exhibit .521.

.430 Corner Card Form (FS-7100-52) All applicable sections of the corner card shall be completed in accordance with Exhibit .230. Two original, or one original and one copy on 5 x 8 inch card stock, of Form FS-7100-52, shall be completed for each corner required by Section B – SERVICES AND PRICES and Exhibit 2.

.440 Corner Recordation Form The Contractor shall complete, in typewritten and / or electronic form, as specified by the Government in accordance with Special Project Specification, a Corner Recordation Form for each corner required by Exhibit 2. After approval by the COR, the Contractor shall file the original in the appropriate jurisdiction. A copy of the original form with completed filing information shall be furnished to the Government. Refer to Exhibit .440 for completion guidelines and sample of a completed form.

.500 BOUNDARY LINE LOCATION, MARKING AND POSTING

The Contractor shall locate, mark, and post the boundary lines shown on Exhibit 2 in accordance with the following specifications.

.510 Locating the Property Line The property boundary line shall be located by survey methods that ensure that the line is within ± 1 ft. of the theoretical straight line between the corners that define the ends of the line. Posts shall be placed on this line as located. This specification shall not be interpreted as allowing posts or line monuments to be placed off the calculated line between property corners.

.520 Marking the Property Line Property lines are marked by placing line posts, line monuments and blazes on trees. In addition, clearing and painting may also be used to identify the line.

.521 Placing objects to mark the property line Posts, line monuments and line blazes shall be placed only on the true property line located to the standard specified above. Posts shall be set as per Exibit .521, without deforming or degrading the usefulness of the post.

.522 Blazes Blazes shall be made in accordance with Exhibit .522. Previously marked trees shall not be reblazed.

.523 Clearing Trees of 6 inches d.b.h. or greater shall not be cleared. Small trees and brush shall be removed from within 1.5 ft. of the line.

.524 Painting Painting shall be in accordance with Exhibit .522. Paint shall be a durable, water based, red enamel. Old paint (not applied under this contract) found in the correct location shall be repainted. Paint placed by the Contractor in an improper location shall be corrected, at the Contractor's expense, by painting over with a durable, water based, neutral colored enamel.

.530 Posting the Property Line Posting is the act of placing signs and posts along the property line so it is recognizable. Some of the signs that are available are shown in Exhibit .424. Other signs may be specified for special projects.

.531 Sign Placement Placement of signs and posts along the boundary line shall be in accordance with Exhibits .521 and .522. All signs and posts placed in improper location shall be removed or relocated at the Contractor's expense.

.532 Sign 54-2 or 54-7 "Property Boundary Sign," Decal P54-1 or P54-2 Property Boundary Decal or signs shall be placed on line posts or trees on the boundary line. Signs or posts shall be placed at ridge, stream, road, trail crossings intervisible or maximum of 300 ft. from each other. See Special Project Specification for spacing and visibility requirements between signs.

.533 Sign 54-5, 54-6, or 54-8, "Location Posters" shall be placed where all marked boundary lines cross roads and trails. Sign 54-5 is for section and township lines. Sign 54-6 is for section subdivisional lines. Sign 54-8 is for metes and bounds survey lines. These signs may be placed on either posts or trees. The Contractor shall stamp or etch the required information on the sign. Some additional special posts at road crossings may be required. When required, they will be shown on Exhibit 2 and included in the Special Project Specifications.

.534 Sign Attachment The Contractor shall firmly attach signs to posts and appropriate line trees in accordance with Exhibits .521 and .522 and Special Project Specifications. If a fence consists of wire and steel fence posts is within 1 ft. of line, signs will be attached to the top wires with hog rings at the four corners of the sign and placed next to the steel fence post. If a fence consists of wood fence posts and wire, the sign will be wrapped around the fence post and nailed to the post at all four corners of the sign with galvanized nails. See Special Project Specification for spacing and visibility requirements between signs.

.535 Obliteration of Erroneous Lines The Contractor shall notify the COR upon the discovery of Government signs and sign posts previously placed which are not on the boundary line, and not evidence of an encroachment. When deemed by the COR, the Contractor shall remove these signs and / or sign posts. They shall remain the property of the Government.

.600 PLATS The Contractor shall prepare a plat(s) in accordance with Section B - SERVICES AND PRICES - of this contract which meets the State law and county requirements similar to that illustrated by Exhibit .600.

.610 Content All appropriate information contained in Exhibit .600 shall be included on the plat.

.620 Review Prior to filing, all items on the plat checklist contained in Exhibit .620 shall be reviewed and initialed by the Contractor and submitted with two paper copies of the plat to the COR for review and approval.

.630 Filing or Recording of Plats The final plat(s) shall be submitted to the COR for review prior to filing or submitting to the local review authorities. After the required reviews, approvals and signatures, the Contractor shall be instructed to file the plat(s) and furnish the required copies to the Government as follows:

.631 Recorded copies The Contractor shall file or record the survey plat(s) in the appropriate jurisdiction in accordance with the State and Local Statutes. Filing fees and any other costs involved shall be borne by the Contractor.

.632 Government copies One reproducible copy of the plat, consisting of a permanent image on a stable base polyester (mylar), with proof of filing, shall be furnished to the Government.

.700 CORNER MAINTENANCE The following maintenance operations shall be performed at each corner indicated on Exhibit 2 and required by Section B - SERVICES AND PRICES.

.710 Adjoiner Notification Refer to Special Project Specifications.
Refer to Exhibits .120 and .121 for example notification letter.

.720 Monument Maintenance Maintenance of the monument shall consist of the following:

.721 Brushing Brush and debris within a 6 ft. radius of the corner shall be cleared away.

.722 Mounds and Monument The Contractor shall ensure that the corner monument is firmly and securely set in place in the ground. Loosely set or badly tilted monuments shall be reset. Scattered mounds shall be rebuilt and corners without mounds and with rock available within a radius of 100 feet shall require that a mound be constructed similar to that illustrated in Exhibit .411. The Contractor shall notify the COR. of any damaged or missing monuments.

.730 Bearing Tree and Accessory Maintenance Bearing trees and other accessories shall be maintained as follows:

.731 Visibility, Painting and Signing The Contractor shall ensure that all existing bearing trees are clearly visible from the monument, are properly painted, and have the required signs attached.

.732 Establishment of new accessories The Contractor shall establish new bearing trees or objects, to replace dead, damaged, dying, or missing bearing trees or objects.

.740 Selection, Measurements, Blazing, Painting, Scribing and Signing Refer to Section .420.

.750 Corner Record Cards (Form FS-7100-52) Refer to Section .430

.760 Corner Recordation Form Refer to Section .440

.800 LINE MAINTENANCE The Contractor shall maintain the boundary lines shown on Exhibit 2 in accordance with the following specifications. It is assumed that the boundary line is retraceable without extensive survey. The boundary line should be obvious from previous marking and posting. In the event that the line is not obvious, the contractor should immediately notify the COR. Original markings on line trees (corner, witness, line, etc.) shall not be destroyed.

.810 Marking and Posting the Property Line,Clearing,Blazes, Painting Refer to Section .500

.811 Posts The Contractor shall ensure that existing posts on the property line are firmly and securely set. Posts that are in damaged or deteriorated condition shall be replaced by a new post.

.812 Signs The Contractor shall ensure that existing signs on posts and trees are securely attached and legible. Signs that are damaged or deteriorated shall be replaced with the appropriate sign.

.813 Damaged Signs and Posts Damaged or deteriorated signs and posts shall be disposed of as directed by the COR.

.900 MISCELLANEOUS SERVICE

.910 SURVEYOR'S REPORT The Contractor shall furnish the Government a Surveyor's Report similar to that shown in Exhibit .910. The report shall contain any information the contractor considers pertinent to the project. It is not necessary to repeat the detailed information contained in other records created and filed as part of this contract. At a minimum, the report shall contain the following:

.911 The information contained on Exhibit .910.

.912 Results of search for all corners.

.913 Visible signs of encroachment or trespass.

.914 Statements relevant to the project made by adjoining landowners or other interested parties.

.920 GEODETIC POSITION

.921 Plats for cadastral projects shall show a geodetic position on a minimum of one corner. A statement shall be placed on the plat as to the method used to determine the position. The plat shall also show the datum and date established. The accuracy of the geodetic position shall be generated at minimum by a differentially corrected resource grade GPS receiver capable of 2-5 m circular error probability.

EXHIBIT INDEX

EXHIBIT 1 – VICINITY MAP

EXHIBIT 2 – CORNER AND OWNERSHIP STATUS

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EXHIBIT .120 – EXAMPLE LETTER TO ADJOINERS

EXHIBIT .121 – EXAMPLE REPLY CARD

EXHIBIT .130 – EXAMPLE CONFLICT REPORT

EXHIBIT .230 – EXAMPLE CORNER CARD (FORM 7100–52)

EXHIBIT .311 – EXAMPLE RADIAL TECHNIQUES

EXHIBIT .324 – DEFAULT VALUES FOR STANDARE ERRORS

EXHIBIT .411 – PLACEMENT OF CORNER MONUMENTS

EXHIBIT .413 – TYPICAL STAMPING OF MONUMENTS METES AND BOUNDS

EXHIBIT .414 – CORNER TREES

EXHIBIT .423 – BEARING TREES

EXHIBIT .424 – SIGNS

EXHIBIT .440 – EXAMPLE MONTANA, IDAHO AND NORTH DAKOTA CORNER FORMS

EXHIBIT .521 – SIGN PLACEMENT

EXHIBIT .522 – MARKING AND POSTING THE BOUNDARY LINE

EXHIBIT .600 – EXAMPLE PLAT

EXHIBIT .620 – CADASTRAL PLAT CHECKLIST

EXHIBIT .910 – EXAMPLE SURVEYOR'S REPORT

R1(01/00)

VICINITY MAP

THIS EXHIBIT WILL BE CONTAINED IN THE CONTRACT PACKAGE

R1(01/00)

EXHIBIT 1

CORNER & OWNERSHIP STATUS

THIS EXHIBIT WILL BE CONTAINED IN THE CONTRACT PACKAGE

R1(01/00)

EXHIBIT 2

WORK TO BE ACCOMPLISHED

THIS EXHIBIT WILL BE CONTAINED IN THE CONTRACT PACKAGE

R1(01/00)

EXHIBIT 3

EXAMPLE LETTER TO ADJOINERS

SAMPLE SURVEYS, INC.

January 1, 2001

E.F. Black
Rte. 2, Box 2
Rapid City, SD 57701

Dear Mr. Black:

Our firm has been contracted by the USDA Forest Service to re-trace the boundary lines of the Custer National Forest in the the area adjoining your property. We will be in your area during the month of December doing this work.

If you have any information concerning the boundary line that you would like us to be aware of, or any desires you wish to ex-press, please contact our firm to arrange a date and time for a meeting.

Surveying and marking Forest Service boundaries include the following standards:

...Clear underbrush 3 feet on either side of the line,
...Blazes on trees within 3 feet of the line.
...Boundary line signs within 1 footof the line.
...Set new Forest Service monuments and mark new bearing trees where applicable.

We ask your permission to perform this work on your side of the boundary line. Please fill out the enclosed card, either granting or denying us permission to mark your side of the boundary line, and return the card to our office in the enclosed addressed envelope.

Thank you in advance for your cooperation.

Sincerely yours,

Thomas Washington

R1(01/01)

EXHIBIT .120

REPLY CARD

OWNER: E. F. Black
Address: P.O. Box 1326
Little Rock, AR.
Phone: (800) 123-4567

Project Name: Phill Creek
Contract # 12345
Legal Desc. NE1/4 Sec. 14
T00N., R000W., P.M.M.

Do we have your permission to mark your side of the property line? Yes No

Do we have your permission to cross your land for project access? Yes No

Remarks:_____

_____
_____
_____
_____
_____

Signature: _____ Date:_____

From

_____
_____
_____

Stamp

SAMPLE SURVEYS, INC.
RTE 2, BOX 17
ENIAT, CO 80224

R1(01/01)

EXHIBIT .121

EXAMPLE CONFLICT REPORT

Sample Surveys, Inc.

Registered Land Surveyors

Identification of Possible Conflict

Contract Number: 53-67T0-6-05 Date Discovered: 1/1/2001

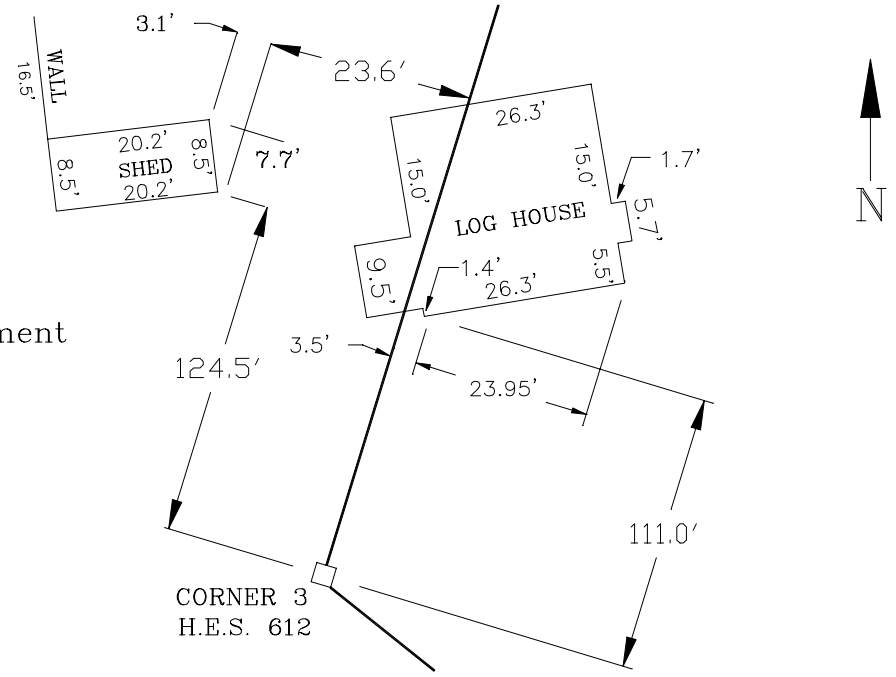
Location: Vicinity of Corner 3 of H.E.S. 612, Section 14 T5S, R45E PMM

Name\Location of Adjoining Landowner: C.D. Green
320 Ryan Road
Ashland, MT 12345

Nature of Conflict: Structures located on National Forest Land.

Remarks:

Sketch



SubmittedBy: Date:

Received By: Date:

R1(01/01)

EXHIBIT .130

SAMPLE CORNER CARD

FRONT

USDA–FOREST SERVICE

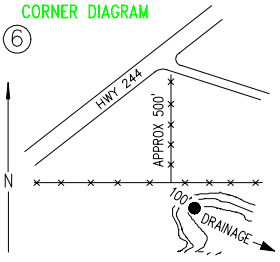
CORNER RECORD (SEARCH) (Ref. FSM 7151.4)

Index File No. C–18 (sections only) | Tract or Survey No. HES 000 | Cor. No. 1 (1)

T. 0 S | R. 0 E | R.D. PACTOLA | County PENNINGTON | ALSO CW 1/16 SECTION 2

Meridian BLACK HILLS | N.F. BLACK HILLS | State SOUTH DAKOTA | (if applicable, note) 1

CORNER DIAGRAM (6)



6

PHOTO IDENTIFICATION DATA (7)

Photo No. _____

Filed At. _____

Object Ident. _____

Ident. by _____ Signature 7

PLANE COORDINATE POSITION DATA (8)

State _____ Zone _____

X _____

Y _____

Estab. By _____ Agency 8

DESCRIBE CORNER MONUMENT FOUND (2)

FOUND THE BASE OF THE ORIGINAL LIMESTONE 12"x 6" x8" FIRMLY SET, FLUSH WITH GROUND, OVER A BROKEN POTTERY MEMORIAL. TOP SECTION WITH SCRIBING GONE. (description of monument found: type, material, size, how set (loose or firm), above ground dimensions, how marked or scribed, any other related facts)

2

DESCRIBE BEARING TREES OR OTHER OFFICIAL ACCESSORIES FOUND (3)

A SCATTERED MOUND OF STONE BEARS SW, 4 FT.
A 16" PINE; SCRIBING HEALED OVER; BEARS N 63 E, 18.5 FT. MATCHES RECORD
A 10" PINE SNAG, 5 FT. TALL; SCRIBED "HES 000 BT"; BEARS S 60 E, 65 FT.
RECORD CALL IS N 60 W, 65 FT.

3

DESCRIBE CORNER LOCATION RELATIVE TO NEAR-BY FEATURES, ALSO HOW TO REACH CORNER (4)

FROM CARSON DRIVEWAY INTERSECTION WITH HWY 244, FOLLOW FENCE LINE SOUTH ALONG FOREST EDGE TO THREE WAY FENCE CORNER, APPROX 500 FT. THE CORNER SETS 100 FT SE IN THE BOTTOM OF A SMALL DRAINAGE, RUNS SE, IN SCATTERED PINES.

4

Signature	Title	Division	Headquarters	Date
	R.L.S.	AAA SURVEYS	PRINGLE SD	10–9–91

(5) FS–7100–52 (3/68) 5

INSTRUCTIONS–Numbers refer to those indicated on the card.

1. Self–explanatory. R.D. denotes Ranger District and N.F. denotes National Forest.
2. Describe the monument found.
3. Describe the accessories found.
4. Describe general location, how to reach, local witnesses and general information.
5. The person or contractor, and date of recovery.
6. Sketch showing major topographic features and B.T.'s in approximate relationship to corner.
7. Identify aerial photograph and tie to picture point. Required when corner record card (7100–52) and photo identification of corners are both required by the contract.
8. Self–explanatory. Required only if the contractor uses state plane coordinates in survey comutations.

R1(01/01)

EXHIBIT .230

SAMPLE CORNER CARD

BACK

CORNER RECORD (PERPETUATION)

(9) MONUMENT: DESCRIBE NEW MONUMENT SET, OR WORK DONE TO PRESERVE EXISTING MONUMENT

SET A STANDARD USFS ALUMINUM MONUMENT, 30" LONG, 22" IN THE GROUND, OVER A "DEEP ONE" MAGNETIC MEMORIAL. BURIED ORIGINAL STONE AND POTTERY ALONGSIDE.
USED OLD STONE MOUND TO BUILD A 3' FT DIA. COLLAR AROUND MONUMENT.
SET LAND SURVEY MONUMENT AND BOUNDARY SIGN ON RED STEEL POST 1 FT NE.

CAP MARKED: HES 1 000 / LS 1234 1991

9

(10) ACCESSORIES: DESCRIBE NEW BT's WITNESS OBJECTS ETC. ESTABLISHED, OR WORK DONE TO PRESERVE EXISTING EVIDENCE

A 6" PINE; SCRIBED "1 HES 000 BT"; BEARS N 46 W, 10.2 FT.
FOUND A 5/8" REBAR; 6" ABOVE GROUND; BEARS N 47 W, 98.2 FT. SEE REMARKS
PUT TAGS ON BT's AND SNAG.

10

(11) Work Done By J. SURVEYOR Title SDRLS Date 9-8-91 State Registration No. or Agency 1234
Certified Cor. Record Prepared? (Yes) No Filed At: PENNINGTON COUNTY COURTHOUSE Date 10-00

11

(12) REMARKS

REBAR NOTED WAS SET BY LS 66 IN 1965 DURING A PRIVATE SURVEY OF HES-000. THE PLAT ON FILE INDICATES THIS CORNER WAS SET BY IMPROPER METHODS. HAVING FOUND AND CONFIRMED THE ORIGINAL MONUMENT, I REJECT THIS REBAR.

12

(13) Index File No. C-18 T. 0 S R. 0 E M. B.H. Tract of Survey No. HES 000 Cor. 1

13

INSTRUCTIONS—Numbers refer to those indicated on the card.

9. Describe work done in remonumenting, refurbishing, or remarking the corner. Fully describe any new monument set.
10. Describe work done to preserve old bearing trees, and fully describe all new bearing trees and objects set.
11. The registered surveyor who accomplished the work, or who supervised it.
12. May be used for information from front of card or other comments.
13. Self-explanatory.

Note: Cards may be typed or completed neatly in ink.

R1(01/00)

EXHIBIT .230

EXAMPLE RADIAL TECHNIQUES

Control Station

Radial Point

Temporary Point

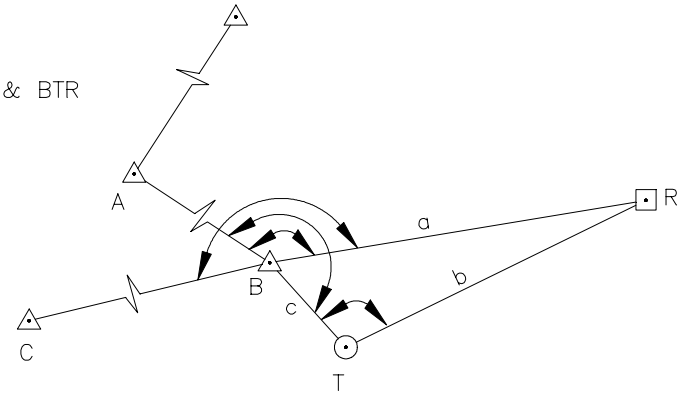
c and e are short offset distances (e.g. 10.0' – 49.0')

METHOD 1 (PREFERED)

Observed Values
Four Angles: ABR, ABT, CBR & BTR
Three Distances: a, b, c

Computed Values
Coordinates of R
(using brng & dist. of a)

Coordinates of T
Check Coordinates of R
(From T using brng. & dist. of b)



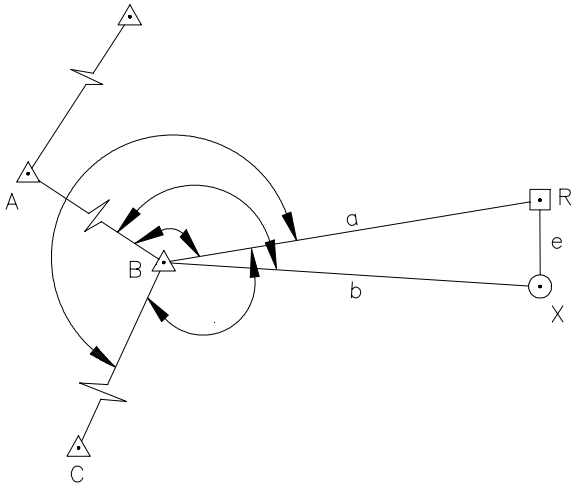
METHOD 2 (ACCEPTABLE)

Observed Values
Four Angles: ABX, ABR, CBR & RBC
Three Distances: a, b, e

Computed Values
Coordinates of R
(using brng & dist. of a)

Coordinates of X
(using brng & dist. of b)

Check Coordinates of R
(From X using brng & dist. of e)



For either method, reobserve if coordinates disagree by more than allowable positional tolerance

R1(01/01)

EXHIBIT .311

BASE LINE USER REPORT

Base Line Name _____ County _____
Instrument owner _____ Date _____
Crew _____ Weather _____

	INSTRUMENT	REFLECTOR
Make		
Model		
Serial No.		
Constant		

Instrument Station Reflector Station	0 m to 150 m	0 m to 430 m	0 m to 1400 m	150 m to 430 m	150 m to 1400 m	430 m to 1400 m
Height Instrument = HI (1)	m	m	m	m	m	m
Height Reflector = HS (1)	m	m	m	m	m	m
Temp./Pres.	/	/	/	/	/	/
↗ PPM						
Elevation Difference = Z(1)						
Measured Distance (average of 5 readings)	m	m	m	m	m	m
Measured Distance	ft	ft	ft	ft	ft	ft
Met. Correction and Prism offset (2)	m	m	m	m	m	m
Mean Slope Distance = X	m	m	m	m	m	m
$\sqrt{X^2 - (HI - HS)^2}$ Obs. mark to mark dist. (3)	m	m	m	m	m	m
Difference From Standard	m	m	m	m	m	m
Horiz. Distance $\sqrt{X^2 - Z^2}$ (4)	m	m	m	m	m	m
Difference from Standard	m	m	m	m	m	m

Comments: _____

NOTES:

1) Make all measurements including HI and HS in meters except for one Slope distance check in feet.
2) Meteoroligical corrections and prism offsets may be hand calculated or pre set in the EDM.
3) For correction of Slope distance to Mark to Mark distance use the difference between HI & HS.
4) For correction of Slope distance to Horizontal distance use the difference in instrument and reflector elevations.
5) U.S. survey foot conversion: 3.280833... feet = one meter

R1(01/01)

EXHIBIT .312

DEFAULT VALUES FOR STANDARD ERRORS

TABLE 1

MAXIMUM ANGLE ERROR (TYPICAL 2 SIGMA VALUES)

NUMBER OF D & R PAIRS	LEAST DIVISION OF INSTRUMENT MICORMETER			
	1"	5"	10"	20"
1	10.5"	11.1"		
2	8.9"	9.3"	9.5"	
3	8.0"	8.4"	8.6"	12.0"

TABLE 2

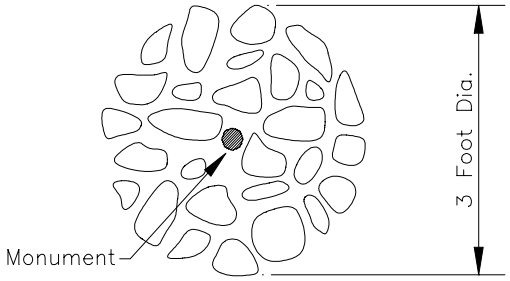
MAXIMUM DEFAULT VALUES FOR INSTRUMENT/TARGET CENTERING ERRORS
95% (2 SIGMA) CONFIDENCE LEVEL

MM	(FT)	METHOD OF PLUMBING TARGET
2.7	(0.009)	FORCED CENTERING (TRIBRACH TO TRIBRACH)
13.7	(0.045)	INDEPENDENT TRIPODS WITH OPTICAL PLUMMET
20.6	(0.068)	INDEPENDENT TRIPODS WITH PLUMB BOB
27.4	(0.090)	WAIST HIGH, HAND HELD PLUMB BOB
27.4	(0.090)	TOP OF 1M LATH WITH TACK OVER POINT
27.4	(0.090)	TOP OF 1.3 M PLUMBED RANGE POLE
41.1	(0.135)	HEAD HIGH, HAND HELD PLUMB BOB
67.2	(0.220)	TOP OF 3 M HIGH PLUMBED RANGE POLE

R1(01/00)

EXHIBIT .324

PLACEMENT OF CORNER MONUMENTS



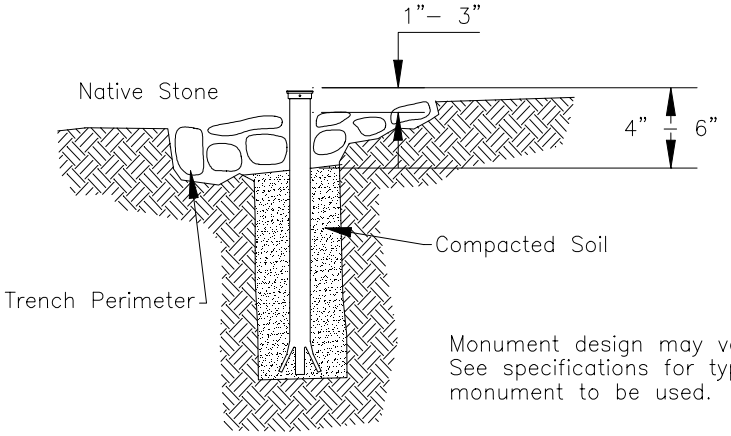
Monument w/Mound of Stone – Typical
PLAN VIEW

NOTES:

1. Native stones within 100' of the corner shall be used to construct a mound around the monument. Where the number of available stones is insufficient to construct a 3 foot diameter mound, the contractor shall construct a mound as large as the available stones will permit.

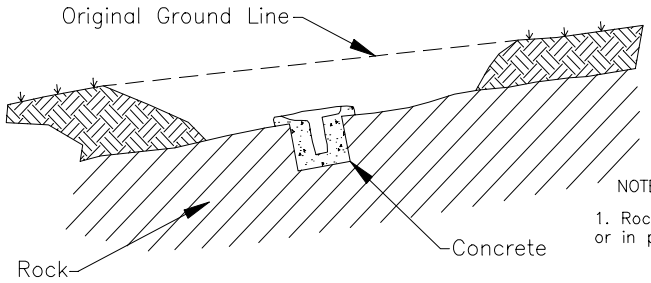
2. Monuments shall be plumb with the backfill soil compacted to 4" to 6" layers.

3. Only those monuments designed to be driven shall be driven.



Monument design may vary.
See specifications for type of monument to be used.

TYPICAL SECTION VIEW



TYPICAL ROCK TABLET INSTALLATION

NOTES:

1. Rock tablets shall be used in solid rock or in place stones impractical to remove.

2. The contractor shall clean the rock surface and provide for drainage.

3. Rock tablets shall be flush to surface.

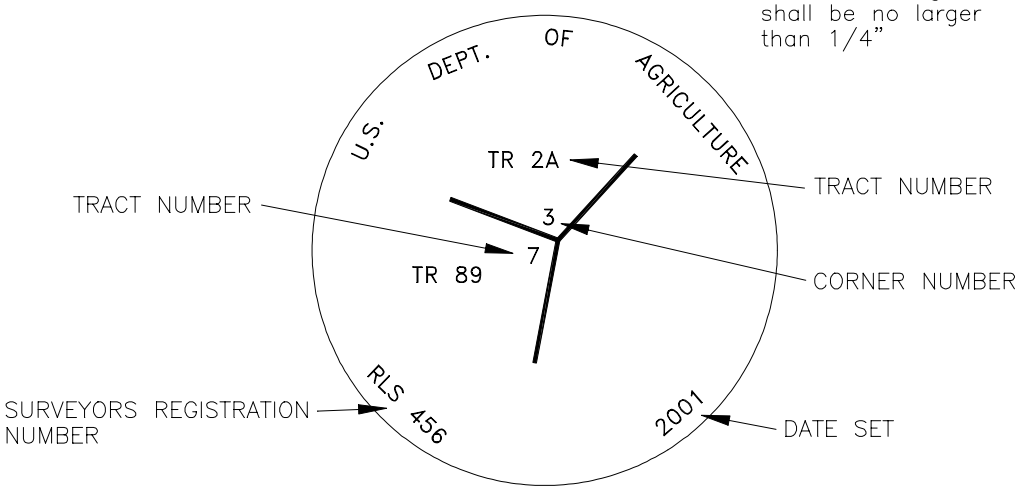
R1(01/01)

EXHIBIT .411

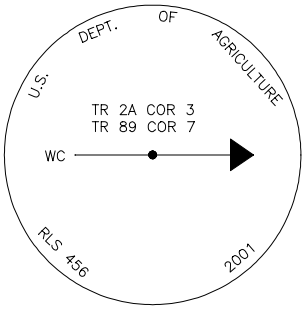
TYPICAL STAMPING OF MONUMENTS METES AND BOUNDS

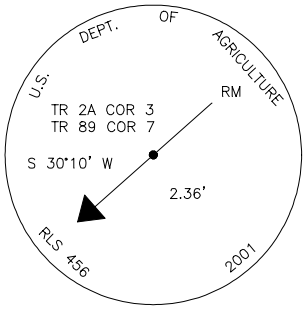
CORNER MONUMENT

NOTE: Lettering size shall be no larger than 1/4"



WITNESS AND REFERENCE MONUMENT



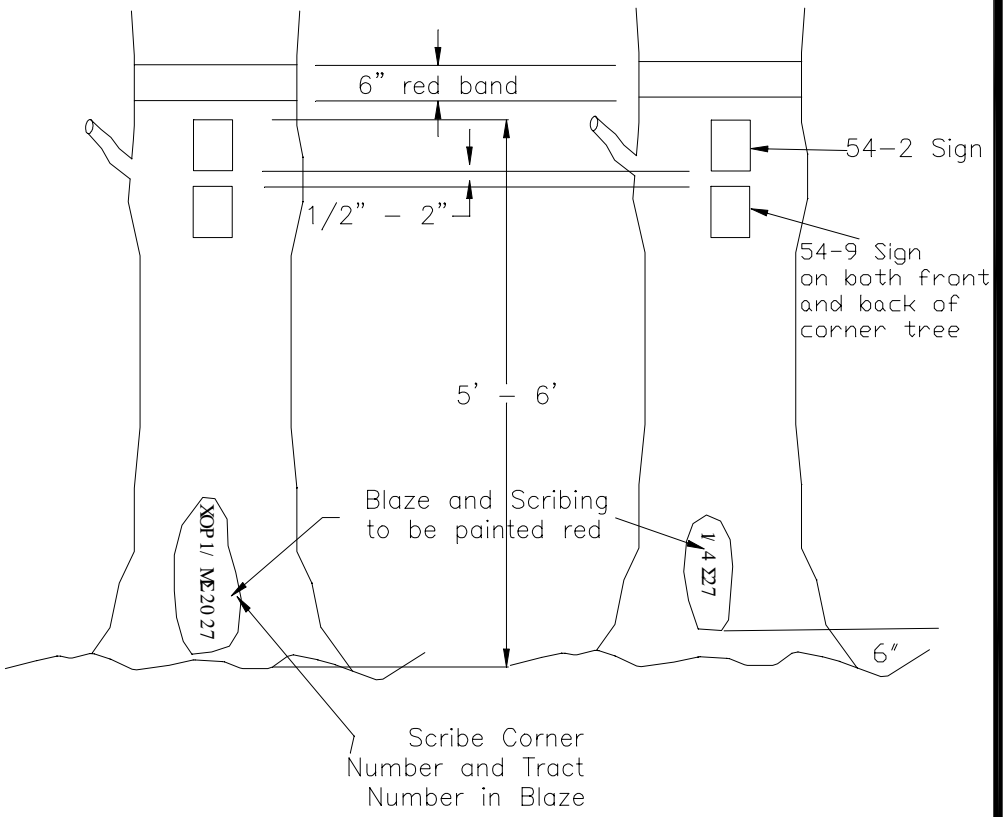


Bearing and distance from reference monument to corner.

R1(01/01)

EXHIBIT .413

CORNER TREES



TYPICAL FRONT VIEW OF A CORNER TREE

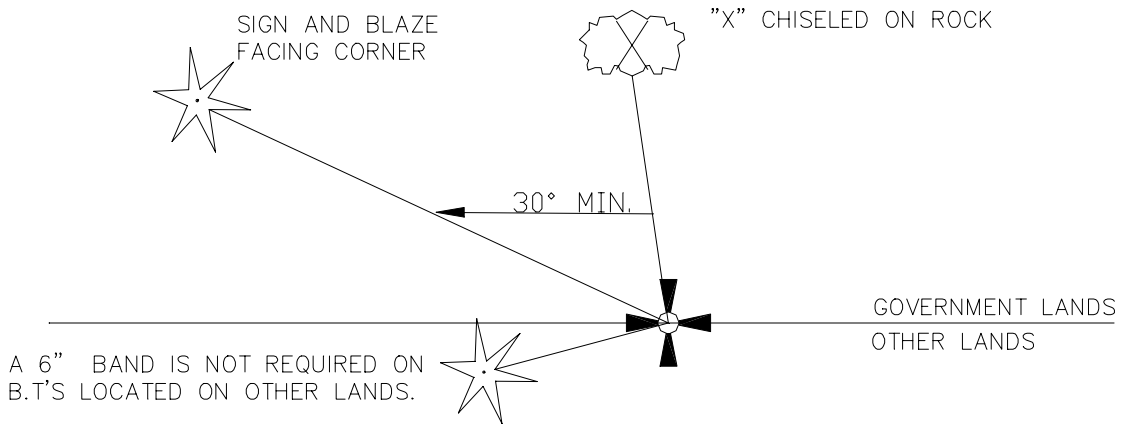
Notes:

1. For blazing and scribing on sectionalized land, see the Manual.
2. Smooth bark Maple, Alder, Aspen, etc..., shall not be blazed, but shall be scribed and painted as if blazed (bark scribed).
3. Original corner trees shall not be rescribed.
4. All corner trees are to be painted with a 6" red band. The band shall be located around the trunk of the tree approximately 6' above the ground. Rough bark trees shall have the area of the 6" band smoothed before painting.
5. Paint shall be neatly applied.
6. Signs shall be attached to corner trees with 2 Aluminum nails per sign. Leave nails protruding at least 1/2" on trees to allow for growth.
7. An Aluminum, Brass, or Stainless Steel washer bearing the Surveyor's registration number shall be nailed to the center of the blaze.
8. Paint shall be applied to the axe marks and healed marks on healed blazes.

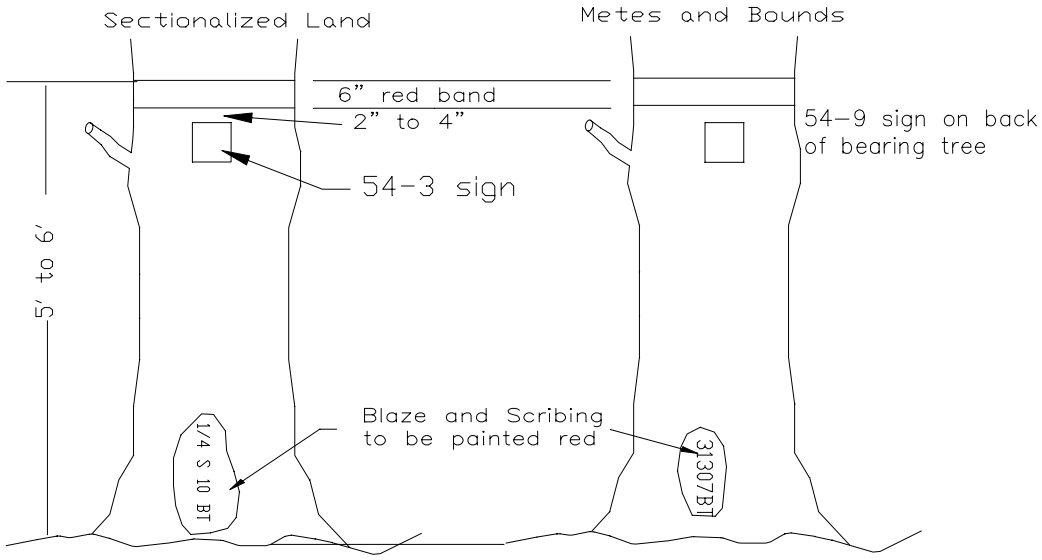
R1(01/01)

EXHIBIT .414

BEARING TREES



TYPICAL BEARING TREES ON GOVERNMENT LANDS



Notes:

1. See Manual for Specific markings.
2. Smooth bark Maple, Alder, Aspen, etc..., shall not be blazed, but shall be scribed and painted as if blazed (bark scribed).
3. Orginal corner trees shall not be rescribed.
4. All corner trees are to be painted with a 6" red band. The band shall be located around the trunk of the tree approximately 6' above the ground. Rough bark trees shall have area of the band smoothed before painting.
5. Paint shall be neatly applied.
6. The contractor shall stamp or etch the required information on the 54-3 sign.
7. Signs shall be attached to corner trees with 2 Aluminum nails per sign. Leave nails protruding at least 1/2" on trees to allow for growth.

R1(01/01)

EXHIBIT .423

STANDARD SIGNS

54–7

54–2

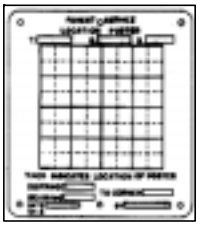
54–9

P54–3
(Decal)

P54–2
(Decal)

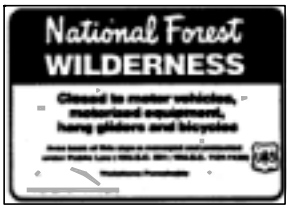
P54–1
(Decal)

54–9
(Decal)



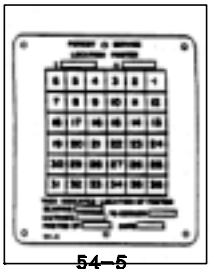
54–6

54–8



27–6A

54–3



54–5

EXHIBIT .424

MONTANA CORNER RECORDATION

INSTRUCTIONS

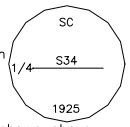
1. Original and/or subsequent record used to evaluate the corner position.
2. Description of evidence found, note discrepancies in the record, state method of establishing lost or obliterated corners.
3. Description of monument and accessories set to perpetuate the corner position.
4. Sketch of corner, show all pertinent data which can best be shown in a sketch example, corner marking, topography ties, position of accessories, etc.
5. Certification must be signed and sealed by Land Surveyor registered in the state of Montana.
6. Fill in Cross Index & Section Diagram at bottom of sheet.

CERTIFIED CORNER RECORDATION

Corner SC South 1/4 Section 34 T. 5S R. 44E P.M.M. Rosebud County

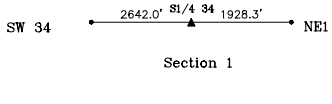
(1925 R.L. Cumming & C. F. Warner)

1. Set an iron post 3 ft. long, 1 in. in diam., 25 ins. in the ground, for standard 1/4 sec. cor. for sec. 34, with brass cap marked and raise a mound of stone, 2 ft. base, 1 1/2 ft. high, N. of cor. from which
   A pine, 16 ins. diam., bears N33°W., 107 lks. dist. marked 1/4 S 34 S C B T
   A pine, 16 ins. diam., bears N40°E., 112 lks. dist. marked 1/4 S 34 S C B T



2. Found a 2 1/2" brass cap on a 1" iron pipe, 10" out of ground, marked as shown above. Mound of stone 2' base 1' high North of corner. Fire has been thru area. A stump hole at N33°W, 70.6'. A stump hole at N40E, 73.9'.

3. Established a new bearing tree: a 16" pine bears N65°E, 63.3', scribed "SC1/4S34BT". Attached 54-9 and 54-3 signs and painted 6" band and scribing red and placed a nail in side of BT for measurement. Placed a 5' red angle iron post with LSM decal at south edge of cap.



SKETCH OF CORNER

N

N.T.S.

I, Mark Aughtman certify the information shown hereon is true and correct.

Signature Ground Party Chief

I, Curtis W. Glaser certify that this corner was accurately represents work performed by me or under my supervision in compliance with the "Corner Recordation Act" (70-22-101 et seq., M.C.A.)

Signature of Surveyor

Date: 9/10/03 ES

Employer: USDA Forest Service

MONTANA CURTIS W. GLASER 9100 ES REGISTERED PROFESSIONAL ENGINEER & LAND SURVEYOR

Office of Clerk and Recorder, County of Rosebud. This "corner record" was filed for record on _____ was noted on the cross-index plat and is assigned page No._____ in book No. _____

_____
County Official

Sec. 34

●—corner this sheet

Cross-Index No. 34 T. 5S R. 44E P.M.M.

Adopted July 1, 1981, Montana Board of Professional Engineers & Land Surveyors

R1(01/01)

EXHIBIT .440

IDAHO CORNER RECORDATION

STATE OF IDAHO
CORNER PERPETUATION AND FILING RECORD

(In compliance with Title 55, Chapter 16, Sections 1601-1612 CORNER PERPETUATION AND FILING ACT.)

RECORD OF ORIGINAL CORNER: Date of Survey 1970 Surveyor BLM
Corrective Dependent Resurvey by BLM in 1987.

0.00 Chs. The witness cor. of secs. 27 and 28, monumented with an iron post, 2 1/2 ins. diam., firmly set in the ground and in a mound of stone, 4 ft. base, to top, with brass cap, from which 1970 bearing trees
A pine, 9 ins. diam., bears S. 20° W., 80 lks. dist., with a partially healed face.
A fir, 24 ins. diam., bears N. 75° W., 33 lks. dist., mkd. X BT.

2.10 Chs. True point for the 1/4 sec. cor. of secs. 27 and 28, determined on a line projected through the witness cor., at the 1970 record. This point falls in Lake Pend Oreille where it is impracticable to establish a permanent monument.

DESCRIPTION OF CORNER EVIDENCE FOUND:

A 2 1/2" diam. iron pipe, with a 3" diam. brass cap, in a mound of stone, from which
A pine snag, 14 ins. diam., at record bearing, 44.2 ft. dist., with a healed face.
A Douglas fir, down, 24 ins. diam., bears N. 57° W., at record dist., marked BT.

DESCRIPTION OF MONUMENT AND ACCESSORIES ESTABLISHED TO PERPETUATE THE LOCATION OF THIS CORNER.

Two new bearing trees:
A Douglas fir, 27 ins. diam., bears S. 86° W., 16.5 ft. dist., marked "X" in the snow blaze and BT in the base.
A Douglas fir, 26 ins. diam., bears N. 34° W., 42.1 ft. dist., marked WC 1/4 S28 BT.
B.T.'s were signed and blazes painted red.
A steel fence post, with Land Survey Monument and Property Boundary decals attached, adjacent to monument.

Date of Work 5/22/2000 Mag. Decl. 18° E.

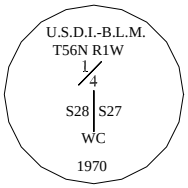
SURVEYOR'S CERTIFICATE

The fieldwork was performed and corner record prepared by me or under my direction in conformance with the Corner Perpetuation Act.

Name Frank S. Wratni
R.L.S. No. 4343
Employer U.S.D.A. Forest Service

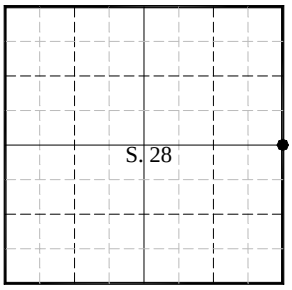
SEAL, SIGNATURE, DATE:

MARKS ON MONUMENT SET:



For County Use Only

DIAGRAM



SUBD. INDEX NO. (if applicable)

COUNTY Bonner
SECTION 28
56N1W_T13_0522_00
IPNF - Kaniksu N.F.

TOWNSHIP 56N
RANGE 1W
BOISE MERIDIAN
CROSS INDEX T13

R1(01/01)

EXHIBIT .440

NORTH DAKOTA CORNER RECORDATION

NORTH DAKOTA LAND SURVEY MONUMENT RECORD

(Report only one monument per form)

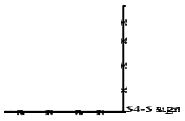
1. The S 1/4 Corner of Section 2 , Township 142 North, Range 101 West of the 5th P.M.
   Or other corner as described _____

2. DESCRIPTION OF ORIGINAL MONUMENT (From GLO notes or deed description):
   If original call is not known, explain. (1903 Dike & Veigel) Set a Sandstone 24 X 13 X 6 inches, 18" in the ground for 1/4 section corner marked 1/4 on north face: dig pits 18 X 18 X 12 inches east and west of stone 3' distance and raise a mound of earth 3 1/2' base, 1 1/2' high north of corner.

3. DESCRIPTION OF CORNER EVIDENCE FOUND:
   Also describe the method used to verify or contradict evidence found.
   Found a 12" X 6" X 4" sandstone, 4" below the surface of the ground. Stone was badly deteriorated, no marks were visible. Accepted the sandstone after measuring to the southwest and southeast section corners of section 2.

4. DESCRIPTION OF METHOD USED TO RESTORE OR RE-ESTABLISH THIS CORNER:
   ☐ Measure from accessories, ☐ Testimony ☐ Lines of occupation, or ☐ Proportionate measure from other corners.
   ☐ Other (Explain below)
   Accepted the sandstone as the original monument.

5. SKETCH SHOWING MONUMENTATION:
   Describe monument set, accessories, and dimension a minimum of 3 permanent ties to the corner.
   Indicate angles and distances to nearest government corner, if determined.

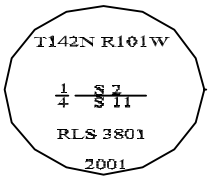


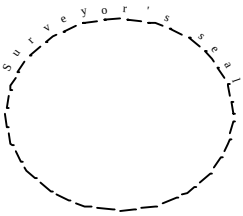
Set an SSP. 30" L X 2 1/2" diameter, 22" in the ground, with a 3 1/4" brass cap marked as shown. Buried original stone alongside SSP. Raised a collar of stone 3' base to cap. Placed a 5' red angle iron post with LSM decal at north edge of cap. 54-5 sign N45°W 30.2' on wood corner post.

SW 2 — 2640.7' — 2641.8' — SE 2

01/01/2001
Date of Survey

Mark Aughtman
Party Chief





6. CERTIFICATION

I hereby certify that under the requirements of NDCC 47-20.1-03 and as permitted by NDCC 47-28.1-04, this corner record correctly represents work performed by me or under my direct supervision and is in compliance with the current BLM "MANUAL OF SURVEYING INSTRUCTIONS".

DATE: ____02/21/2001____ APPROVED AND SIGNED BY _____Mark Aughtman_____, ND RLS NO. __3801_____

ACCEPTED FOR FILING

State of North Dakota)
ss
County of Billings)

By: _____

Date: _____

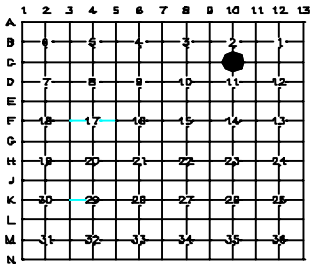
Time: _____

Document No. _____

Fee: $ _____

Record to be filed by index Reference Number, numerically, then alphabetically, under appropriate Township, Range.

7.



8. Township _142N_____ Index Ref. No. _C-10_____Township _____ Index Ref. No. _____

R1(01/01)

EXHIBIT .440

SOUTH DAKOTA CORNER RECORDATION

CERTIFIED LAND CORNER RECORD

County of PENNINGTON, State of South Dakota

Section 21, Township 2S, Range 13E, Meridian BLACK HILLS

CERTIFICATION:

I hereby certify that on the 12th day of NOVEMBER, 19 91, that I did find/establish the Southeast corner of Section 21

which was evidenced by original corner destroyed by road construction. Corner set by double proportion measurement between the Northeast of Section 21 and Southeast corner Section 28 and the South ¼ of Section 21 and South ½ Section 22.

I further certify that to perpetuate the location of said corner I did, at the exact location thereat, place a permanent monument consisting of an aluminum post 30"L x 2½" diameter 22" in the ground with a 3½" aluminum cap marked, placed 10" inside post.

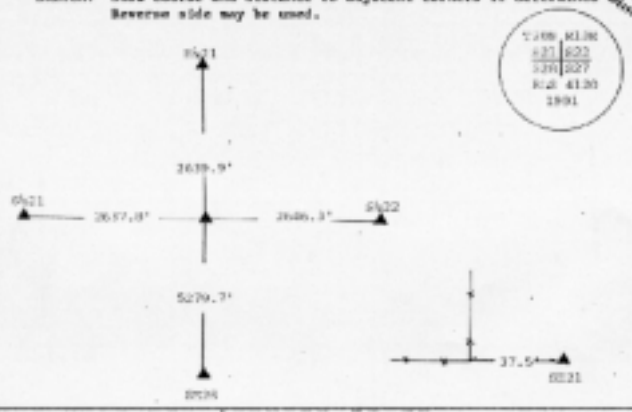
I further certify that I did establish the following references Raised a pile of stone 4' base to cap. Attached 54.5 wire to wood brace post bears S45°W, 42.6'. Placed a 5' red angle iron post with LCM decal at North edge of cap.

Date 1-15, 19 92

Registered Land Surveyor No. 4120

REGISTERED PROFESSIONAL LAND SURVEYOR REG. NO. 4120 CURTIS W. L. GLASOE SOUTH DAKOTA

SKETCH: Show course and distance to adjacent corners if determined by this survey. Reverse side may be used.



SECTION 21 DIAGRAM
(To be completed by Surveyor)

LEGEND

OFFICE OF REGISTER OF DEEDS

County of PENNINGTON

State of South Dakota

Filed for the record this 23 day of Dec, 19 92

in Corner Record Book No. 1 Page 367 and noted on the following cross-index plats:

Cross Index No. _____, T ___, R ___, Mer. _____

_____, T ___, R ___, Mer. _____

_____, T ___, R ___, Mer. _____

_____, T ___, R ___, Mer. _____

Register of Deeds: Grace Smith By: _____

380

R1(01/01)

EXHIBIT .440

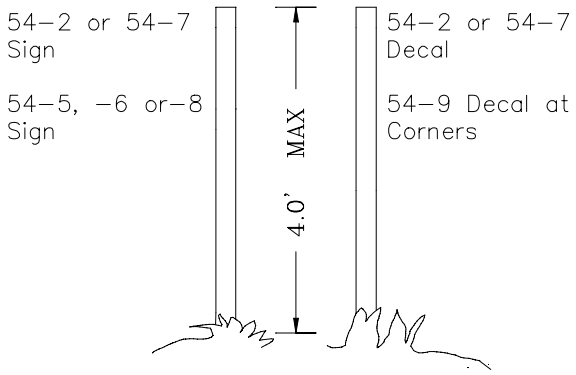
SIGN PLACEMENT

Notes:

1. Posts shall be plumb and solidly planted with a minimum of 2.0' in the ground or a supported to 2.0' above the base with a rock mound.

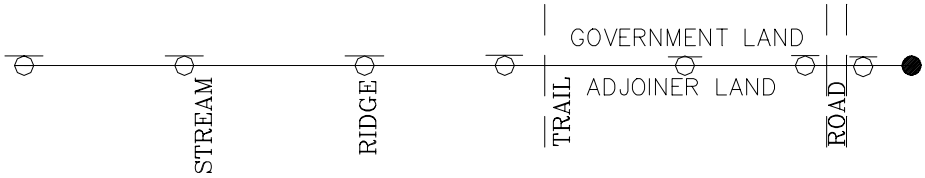
2. Posts with attached decal shall be set per manufactures recommendations.

3. Sign 54-5, 54-6, or 54-8, "Location Poster" shall be placed where all marked boundary lines cross roads and trail.

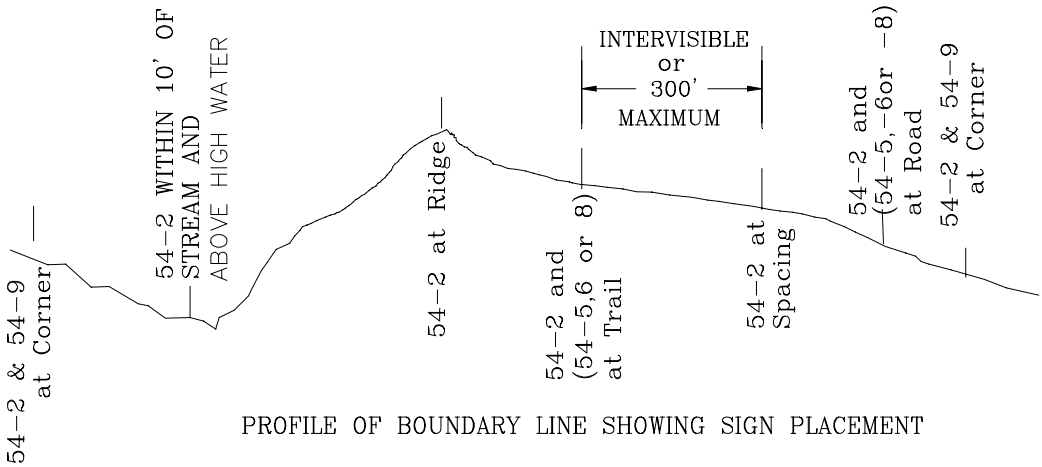


TYPICAL SIGN
AND POST INSTALLATION

Note: Post shall be set on the cut side of the road, off the maintained surface.



PLAN VIEW OF BOUNDARY LINE SHOWING SIGN PLACEMENT



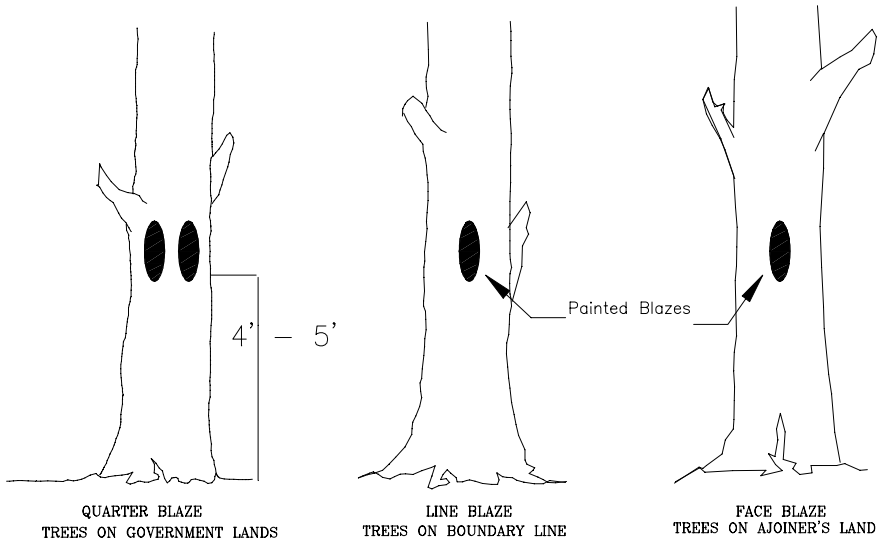
PROFILE OF BOUNDARY LINE SHOWING SIGN PLACEMENT

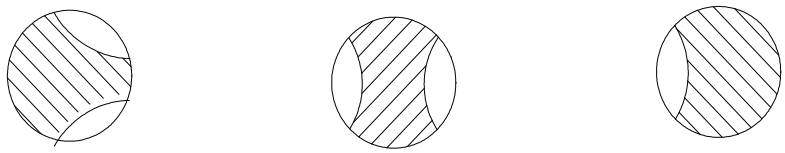
R1(01/01)

EXHIBIT .521

BLAZES / MARKING THE BOUNDARY LINE

GENERAL APPEARANCE





ORIENTATION OF BLAZES

NOTES

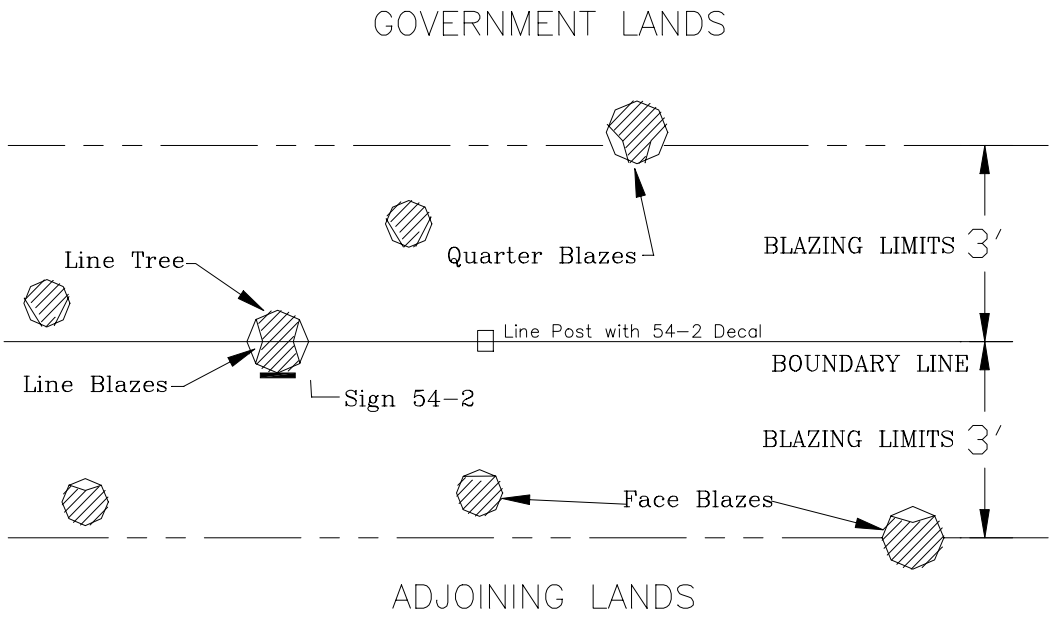
1. The three types of markings used on trees along the Forest Service boundary lines are referred to as Quarter Blazes, Face Blazes and Line Blazes. The markings are used at the locations shown on page 2 of this Exhibit.

2. A blaze is made by cutting off a vertical strip of bark and a very thin layer of the underlying wood tissue. The strip shall be about 6 to 8 inches long, 2 to 4 inches wide, and the top and bottom ends shall be smoothed out.

3. A durable, water base, red enamel pain shall be neatly applied to all blazes.

EXHIBIT .522

MARKING AND POSTING THE BOUNDARY LINE



Notes:

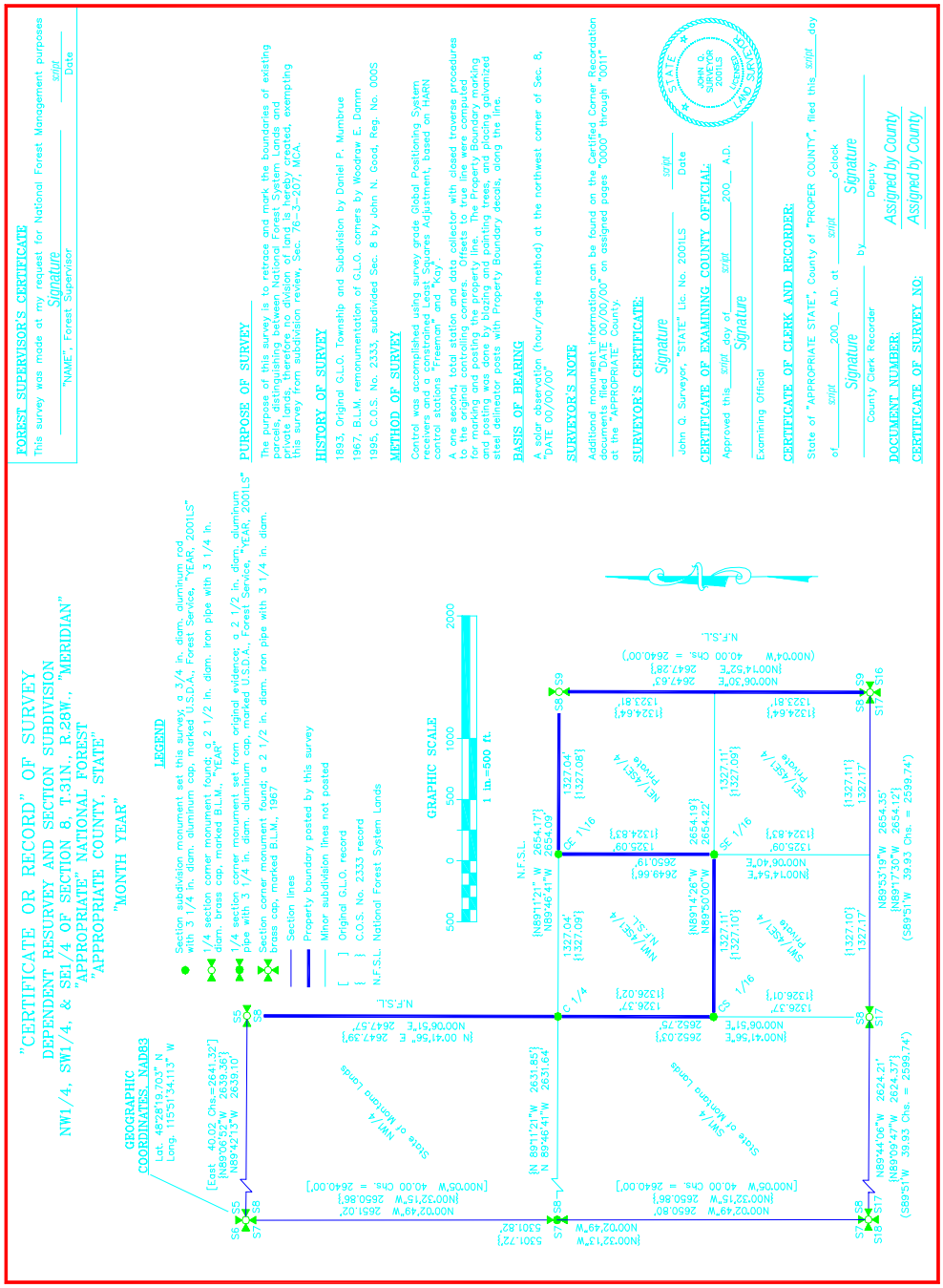
1. Permission shall be obtained from adjoining landowners before their side of the boundary line is cleared or blazed.
2. Trees on Government land within 3 feet of the boundary line shall be quarter blazed as shown.
3. Trees on adjoining land within 3 feet of the boundary line shall be face blazed as shown.
4. Trees on the boundary line shall be line blazed on both sides of the line tree along the direction of the line as shown above.
5. Posts, line monuments and line blazes shall be placed only on the boundary line after it has been located to the standard specified in the contract.
6. Decals 54-2 or 54-1 shall be placed on all line posts after being thoroughly cleaned.
7. Sign 54-2 or 54-7 shall be attached to all line trees, at the spacing specified in the special project specifications, with 2 aluminum nails. The nails shall be left protruding at least 1/2 inch on trees to allow for growth.

R1(01/01)

Page 2 of 2

EXHIBIT .522

EXAMPLE PLAT



R1(01/01)

EXHIBIT .600

CADASTRAL PLAT CHECK LIST

This list shall be checked, signed and dated by a reviewer through all phases of preparing the record. A copy shall be sent with the draft plat submitted for review. Items denoted with a * are mandatory.

T._____, R._____, Sec.(s)_____, _____ Mer._____

_____ National Forest

_____ Reviewer

_____ Date

LAYOUT
* ___Proper sheet size
* ___Plat paper size
* ___Border size
* ___Line weights adequate
* ___Lettering legible

HEADER
* ___Title conforms to state law
* ___Subtitle reflects type of survey
* ___Legal identifier (section, township, range, meridian, etc.)

ORIENTATION
* ___Scale bar
* ___North arrow
  ___Declination
  ___Geographic Position (1 max)
    ___Method used to determine
    ___Tie to geodetic control shown
    ___Name of control station used
    ___Data control station established
    ___Position used for control station

PLAT MEMO
* ___Purpose of survey
* ___Date of survey
* ___Project name/contract number
* History of surveys
    ___Township(s)
    ___Section(s)
    ___Subdivision(s)
    ___Other(s)
* ___Methods and instrumentation
* ___Basis of bearing
* ___Data available in other sources (corner files, adjoining plats)
    ___Special circumstances
    ___Disclaimer (representation of unsurveyed features)

THE SURVEY
* ___Neat, professional overall appearance
* ___Boundary clearly portrayed
* ___Record units of measure shown
* ___Reported measurements (proper precision)
* ___Adequate information to determine and check survey methods
* ___Corner status evident
* ___Legend complete
* ___Aliquot parts, lots, parcels labeled
* ___Ownership labeled properly
    ___Acreage properly reported
    ___Topography shown and labeled

<u>ITEMS REQUIRED AFTER FINAL REVIEW</u>

SIGNATURES
* ___Surveyor Certification (appropriate), seal, date
* ___Forest Supervisor Signature
* ___County Certification/approval/recording information

R1(01/01)

EXHIBIT .620

EXAMPLE SURVEYOR'S REPORT

PURPOSE: The purpose of this contract was to perform professional land surveying services. This contract included:

_____
_____
_____
_____
_____

(List each required service, which will normally correspond to the contract pay items)

AUTHORITY: The project was performed under U.S.D.A. Forest Service Contract No._____ hereby incorporated within this report.

HISTORY OF ORIGINAL OFFICAL GOVERNMENT SURVEYS: Briefly state the dates and surveyors name(s) of each survey that affects this survey.

HISTORY OF PRIVATE SURVEYS: Briefly state the name and date of any private surveys that affect this survey. The report should detail why the private survey was or was not used in the conduct of this survey.

PROCEDURE:

RESEARCH CONDUCTED: Briefly cite the source and results of any research conducted.

CORNER SEARCH CONDUCTED: State the result of corner search efforts. It is not necessary to repeat the detailed information contained in the corner record forms, but the minimum information required is (1) which corners were located by original physical evidence, (2) which corners were located by parole evidence, (3) other surveyor's monuments were accepted, and (4) which corners were considered lost and a brief explanation of the extent of search efforts for the original physical evidence of the monument and accessories.

REMONUMENTATION ACCOMPLISHED: State which corners were remonumented, the size, material and markings that were used for each.

CONTROL SURVEY: Briefly describe the method or combination of methods that were used to (1) obtain the position of the controlling corners,(2) layout the position of lost corners and any new corners required to be established by the contract, and (3) locate the position of points on the boundary necessary for marking and posting the line.

R1(01/01)

EXHIBIT .910

Standards and Guidelines

For

CADASTRAL SURVEYS

Using

Global Positioning System Methods

Version 1.0
April 28, 2000

Prepared by

Carl Sumpter, USFS
Mike Londe, BLM
Ken Chamberlain, USFS
Ken Bays, BLM

-

United States Department of Agriculture- Forest Service

United States Department of the Interior- Bureau of Land Management

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        Cadastral Project Control
        Cadastral Measurements
    3. Section Three: Data Processing and Analysis
    4. Section Four: Project Documentation

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    1. 1. Definitions
    2. 2. Computation of Accuracies
    3. 3. References

Forward

These Standards and Guidelines provide guidance to the Government cadastral surveyor and other land surveyors in the use of Global Positioning System (GPS) technology to perform Public Land Survey System (PLSS) surveys of the Public Lands of the United States of America.

Many sources were consulted during the preparation of this document. These sources included other GPS survey standards and guidelines, technical reports and manuals. Opinions and reviews were also sought from Public and private Professional Land Surveyors who use GPS for boundary and Cadastral Surveys.

The static and fast static survey procedures in these guidelines follow long established and well-documented industry and government survey practices. However, guidelines for real-time kinematic surveys of all types are in the early stages of development.

Manufacturer's technical manuals describe real-time kinematic GPS surveys as a topographic surveying method for small areas. It was not intended for surveying legal land boundaries or for large project areas. Therefore, the guidelines for performing land surveys using real-time kinematic GPS techniques require greater observational and occupational redundancies and checks than specified by the manufacturers.

These standards and guidelines do not require that Cadastral Surveys be performed to the higher accuracy and methodology requirements of geodetic control surveys. They are intended to provide sufficient observational and occupational redundancy to detect blunders and quantitatively demonstrate the stated accuracy of a survey has been achieved.

Cadastral Surveys are an important part of the National Spatial Data Infrastructure. The accuracy reporting requirements of this document are in accordance with accuracy reporting requirements of the Federal Geographic Data Committee's "Geospatial Positioning Accuracy Standards", July 1997.

Disclaimer Statement

This document is intended only for the purposed of providing the user with guidelines for planning, execution, and classification of PLSS surveys performed using GPS carrier phase methodology.

Note: Italicized words in bold font, i.e., ***independent occupation,*** indicate that a definition for that word appears in Appendix 1, Definitions.

Part One

Standards for Positional Accuracy

The following standards are for GPS technology only and shall be used to define the minimally acceptable levels of differential relative positional accuracy required of a Government cadastral survey.

TABLE ONE**: Local Accuracy Standards**

Local Accuracy	95% Confidence Circle	Application
0.050 meters (m)	Less than 0.050 (m)	*Cadastral Project Control*
0.100 meters (m)	Less than 0.100 (m)	*Cadastral Measurements*

Local Accuracy is an average measure (e.g. mean, median, etc.) of the relative accuracies of the coordinates for a point with respect to other adjacent points at the 95% confidence level.

TABLE TWO: **Network Accuracy Standards**

Network Accuracy	95% Confidence Circle	Application
0.100 meters (m)	Less than 0.100 (m)	*Cadastral Project Control*
0.200 meters (m)	Less than 0.200 (m)	*Cadastral Measurements*

The ***Network Accuracy*** of all Cadastral Measurements should be reported per the Federal Geographic Data Committee (FGDC) Geospatial Positioning Accuracy Standards to show the relationship of the cadastral survey relative to the National Spatial Reference System.

A least squares adjustment or other multiple baseline data analysis is performed to produce a weighted mean average to verify the required level of positional accuracy has been achieved.

Part Two

Guidelines

The guidelines outlined in this document consist of field data acquisition methods, field survey operations and procedures, data processing and analysis methodologies, and documentation. The use of these guidelines and the manufacturer's specifications provide a means for the surveyor to evaluate the survey and to verify the specified accuracy standard has been achieved.

These guidelines are designed to ensure a survey performed with GPS technology is repeatable, legally defensible and referenced to the ***National Spatial Reference System (NSRS)*** by providing the following:

- Elimination or reduction of known and potential systematic error sources.
- Occupational (station) and observational (baseline) redundancy to clearly demonstrate the stated accuracy.
- Baseline processing, data adjustment and data analysis to clearly demonstrate the stated accuracy.
- Documentation demonstrating verification of the results.
- Compliance with the Bureau of Land Management Manual of Instructions for the Survey of the Public Lands of the United States, 1973 and state laws.

GPS survey guidelines continually evolve with the advancements in equipment and techniques. Changes to these guidelines are expected as these advancements occur. The size, scope and site conditions of a project may also require variations from these guidelines.

Any variations from these guidelines should be designed to meet the above criteria and to achieve the accuracy standard of the survey as required by this document. All variations shall be documented in the project report.

Section One

Field Data Acquisition Methods

A variety of GPS field data acquisition methods may be used for ***Cadastral Measurements*** and ***Cadastral Project Control***.

Static Positioning:

Static positioning typically uses a network or multiple baseline approach for positioning. It may consist of multiple receivers, multiple baselines, multiple observational redundancies and multiple sessions. A least squares adjustment of the observations is required. This method provides the highest accuracy achievable and requires the longest observation times.

Static positioning is primarily used for ties to the National Spatial Reference System (NSRS) when observing Cadastral Project Control. This method may also be used for the Cadastral Measurement portion of a cadastral survey.

Fast-Static Positioning:

This method requires shorter occupation times (i.e. 5 to 20+ minutes) than static positioning and may use a radial baseline technique, network technique, or a combination of the two. Fast static requires a least squares adjustment or

other multiple baseline statistical analysis capable of producing a weighted mean average of the observations. Fast-static positioning may be used for observing both the Cadastral Project Control and the Cadastral Measurements of a cadastral survey.

Post-Processed Kinematic (PPK) Positioning:

> Post processed kinematic survey methods provide the surveyor with a technique for high production Cadastral Measurements and can be used in areas with minimal obstructions of the satellites. PPK uses significantly reduced observation times compared to static or fast-static observations. This method requires a least squares adjustment or other multiple baseline statistical analysis capable of producing a weighted mean average of the observations. PPK positioning is used for observing the Cadastral Measurements of a cadastral survey.

Real-time Kinematic (RTK) Positioning:

Real-time kinematic positioning is similar to a PPK or a total station radial survey. RTK does not require post-processing of the data to obtain a position solution. This allows for real-time surveying in the field. This method allows the surveyor to make corner moves (stake out) similar to total station / data collector methods. RTK positioning is used for the Cadastral Measurement portion of a Cadastral Survey.

Real-time surveying technology may utilize dual-frequency (L1 / L2) techniques for initialization, but the subsequent RTK survey is accomplished using the L1 carrier phase frequency. Therefore, all RTK surveys are currently subject to the limitations of the L1 frequency.

NOTE: Operations under a forest canopy using PPK or RTK methods are not recommended. However, these methods are acceptable if they result in a solution, which meets the survey standards. The surveyor must make an informed decision when choosing the appropriate methodology to be used in a particular project area. For survey projects in a forest canopy environment with marginal sky visibility, static, or fast-static GPS methods or even conventional optical methods should be considered in-lieu of using RTK or PPK.

Section Two

Field Survey Operations and Procedures

Field survey operations should be performed using the manufacturer's recommended receiver settings and observation times. Operations under adverse conditions, such as under a forest canopy, may require longer observation times than specified by the manufacturer.

Preset fixed height antenna tripods / bipods should be used for all rover GPS observations.

All plumbing / centering equipment should be periodically checked for proper adjustment.

The following topics are recommended procedures when using GPS measurement techniques for Cadastral Surveys.

Cadastral Project Control

Cadastral Project Control is the network of the GPS stations, tied to the NSRS, which is surveyed to control all subsequent GPS Cadastral Measurements.

A Cadastral Project Control network shall be established by either static or fast-static survey methods.

The Cadastral Project Control network may be established at the same time the Cadastral Measurements are made. However, the points and resulting baseline vectors used in the Cadastral Project Control network shall be processed to derive the baseline solutions and be adjusted by least squares independently of the observed Cadastral Measurements.

The Cadastral Project Control network is designed to meet the following purposes:

- Provides a framework to reference the survey to a datum, a mapping projection, and the NSRS.
- Supports registration of the Cadastral Measurements into the ***Geographic Coordinate Data Base (GCDB)***.
- Serves as the basis for all subsequent GPS Cadastral Measurements.
- Allows for reporting of the Network Accuracy for the Cadastral Measurements per FGDC Geospatial Positioning Accuracy Standards.

A well-designed Cadastral Project Control network will offer the surveyor more flexibility for using fast static, kinematic, and RTK survey methods for the Cadastral Measurement portion of a survey. It provides an adequate amount of reference (base) station locations, ties the Cadastral Measurement points together, allows for expanding area of the survey and provides accurate checks throughout survey project.

The number of stations in the Cadastral Project Control network depends upon factors such as project size, topography, positioning method used, and access. A minimum of two or more Cadastral Project Control stations should be established as a reference for the Cadastral Measurements.

All Cadastral Project Control networks should be referenced (tied) to at least two High Accuracy Reference Network (HARN) stations/ High Precision Geodetic Network (HPGN) or Continuous Operating Reference Station (CORS), of the NSRS.

In the absence of HARN/HPGN or CORS stations, other GPS control stations which are referenced to the NSRS and published by or available through other Federal, state, or local agencies may be used. The use of such stations shall be evaluated by the surveyor regarding the relationship to the NSRS before inclusion into the Cadastral Project Control network and prior to any Cadastral Measurements occurring.

The current national reference datum is the North American datum of 1983 (NAD83) of 1986. All control and project information should be referenced to the most current epoch of NAD 83 for example: Wyoming NAD 1983 (1993).

All Cadastral Project Control networks shall conform to the following:

- Be referenced to two or more NSRS or other published horizontal control stations, located in two or more quadrants, relative to the cadastral project area.
- Points are established by two or more ***independent baselines***.
- Contain loops of a minimum of three baselines.
- Baselines have a fixed integer double difference solution or adhere to the manufacturer's specifications for baseline lengths exceeding the fixed solution criteria.
- Any station pair used as azimuth or bearing reference for use with conventional survey measurements during the course of a cadastral survey should be included in a network or measured with a minimum of two independent vectors.
- All stations in the cadastral project control network shall have two or more ***independent occupations***.
- The Cadastral Project Control network must be a geometrically closed figure; therefore, single radial (spur) lines or side shots to a point are not acceptable.

Cadastral Measurements

Cadastral Measurements are the measurements used to define the location of Public Land Survey System (PLSS) corners and boundaries. Cadastral Measurements are referenced to the Cadastral Project Control coordinates or by direct ties to the NSRS.

All Cadastral Measurement observations, except RTK, shall conform to the following:

- • Be constrained to two or more Cadastral Project or NSRS stations which are located in two or more quadrants relative to the cadastral project area.
- • Points are established by two or more independent baselines.
- • Contain loops of a minimum of three independent baselines.
- • Baselines have a fixed integer double difference solution or adhere to the manufacturer's specifications for baseline lengths exceeding the fixed solution criteria.
- • Any station pair used as azimuth or bearing reference for use with conventional survey measurements during the course of a cadastral survey should be included in a network or measured with a minimum of two independent vectors.
- • All stations in the cadastral measurements shall have two or more independent occupations.
- • Single radial (spur) lines or side shots to a point are not acceptable.

Static Survey Methods

When using static methods as the sole measurement method for Cadastral Measurements, then the Cadastral Project Control and the Cadastral Measurements are considered to be the same. There is no need to establish a separate Cadastral Control Network. The ties the NSRS should be processed and adjusted independently of the Cadastral Measurements.

Static survey methods for Cadastral Measurements, uses a network or a multiple baseline observational scheme.

Fast-static Survey Methods

When using Fast-static methods as the sole measurement method for Cadastral Measurement, then the Cadastral Project Control and the Cadastral Measurements are separate.

One method uses one or more reference (base) receivers usually two located in two or more different quadrants and one or more rover receivers with adjustable fixed height antenna tripods/bipods for Cadastral Measurements.

Another method uses two or receivers in traverse or leapfrog observational scheme.

Post-Processed Kinematic (PPK) Survey Methods

When using PPK survey methods, which include stop and go, continuous, leapfrog and other observation schemes as the sole measurement method for Cadastral Measurements, then the Cadastral Measurements and Cadastral Project Control are separate

This method uses one or more reference (base) receivers usually two located in two or more different quadrants and one or more rover receivers for Cadastral Measurements.

ematic (RTK) Survey Methods

When using RTK survey methods, as the sole measurement method for Cadastral Measurement, then the Cadastral Project Control and the Cadastral Measurements are separate.

RTK uses a radial style survey scheme with one or more reference (base) receiver and one or more rover receivers for Cadastral Measurements.

e of RTK requires additional redundant measurements be made as part of the field survey operations and procedures as discussed in these guidelines.

arts of an RTK survey which include:

- System check
- Corner measurements
- RTK calibrations
- Corner moves (stake-out)

RTK System Check

A RTK system check shall be made prior to any RTK Cadastral Measurements.

A RTK system check may also be made at any time during the course of each RTK survey session or at any time the base receiver(s) and rover receiver(s) are setup and initialized per the manufacturer's recommended procedures.

This check is a measurement from the RTK base setup to another Cadastral Project Control station or a previously observed Cadastral Measurement point.

When observing these measurements, the rover will be set to manufacturer's specifications for ***duplicate point tolerance*** for the measurement of a known point and existing point name.

This check consists of re-observing a known position within the survey. The resulting observed position is then compared by inverse to the previously observed position for the known point. This inverse should be within the manufacturer's recommended values for duplicate point tolerance measurements.

This RTK system check is designed to check the following:

- The correct reference base station is occupied.
- The GPS antenna height is correctly measured and entered at the base and rover.
- The receiver antennas are plumb over station at base and rover.
- The base coordinates are in the correct datum and plane projections are correct.
- The reference base stations or the remote stations have not been disturbed.
- The radio-communication link is working.
- The RTK system is initialized correctly.
- RMS values are within manufacturer's limits.

RTK Corner Measurements

Corner measurements are usually made with RTK using one or more base and one or more rover receiver configurations.

RTK corner measurements shall be made after the system setup check procedures have been completed.

Specified observation times for the highest level of accuracy using RTK for corner measurements as per manufacturer's recommendations are recommended, (for example, 180 seconds of time or when the horizontal (0.02m) and vertical (0.050m) precision has been met for a Trimble kinematic control point).

Under optimal conditions (clear sky, low RMS) a deviation from the manufactures suggested times is appropriate, (for example, a corner may be observed using 30 seconds of time and 20 epochs of measurement data). However, observation times should be set to account for field conditions, measurement methods (i.e. Trimble "topo point" or "kinematic control point") and the type of measurement checks being performed.

Recommended methods for RTK corner measurement:

One method is to observe the unknown point two or more times with the same point name (e.g. 100700) and use a duplicate point tolerance measurement criteria of 2.5 cm. When observing these measurements, the antenna shall be dumped between observations.

Another method at each found corner location or temporary point (unknown position), two baselines measurements (M1 and M2) are stored to the data collector or receiver for a specified number of seconds or epochs to meet a specified level of precision, (for example, the time requirement for a Trimble kinematic control point) depending upon manufacturer's recommended procedures.

Observation time may be increased due to the constraints of on-the-fly (OTF) post-processing kinematic (i.e. 200+ sec) if the field data is post-processed as a check.

- • The antenna should be inverted to force a loss of satellite lock, in between the M1 and M2 measurements, to force the system to reinitialize. The point values resulting from the first baseline measurement is stored and labeled (e.g. 100700M1), and the point resulting from the second baseline measurement is stored and labeled (e.g. 100700M2)

- • A field check of the level of accuracy between the measurements may be done by an inverse between M1 and M2. The resulting inverse distance should be less than the Duplicate Point Tolerance of 2.5 cm.

Note: The ***Cadastral Measurement Tolerance*** of 8.6 cm is the maximum acceptable distance for M1 – M2 inverse. It should be accepted only under extremely poor GPS conditions due to tree cover, multi-path, etc. This worst-case condition should only be encountered in the most marginal field conditions for RTK surveys.

The Cadastral Measurement Tolerance value of 8.6 cm is derived from standard error propagation relationships. It is based on the following formula, the square root of the sum of the squares of the Cadastral Measurement Tolerance (8.6 cm) and the maximum allowable error of the Cadastral Project Control (5cm) should approximately equal the maximum allowable error budget of the Cadastral Measurements (10cm).

The baseline measurements (i.e. M1/M2) to the found corner locations or temporary points shall be verified by at least one of the following methods (i.e. static, fast-static, PPK or RTK).

Perform a check measurement (M3) from the same Cadastral Project Control station at a time at least 15 minutes after the M1 and M2 measurements are taken.

An example of one of the many possible observation schemes is described below:

- • Using RTK, make a new measurement (M3) to the unknown point (e.g. 100700) from the same base receiver setup separated in time by a minimum of 15 minutes.

- • Perform a check measurement (M3) from another Cadastral Control Project Station taken either simultaneously with the M1 and M2 measurements or at least 15 minutes after the M1 / M2 measurements. An example of one of many possible observation schemes is listed below:

- • Using PPK, FS or static, make a new measurement (M3) to the unknown point (e.g. 100700) with the base

receiver setup on another Cadastral Project Control station operating simultaneously.

RTK Calibrations

In real-time surveying (RTS) to relate GPS positions measured in terms of the World Geodetic System of 1984 (WGS-84) ellipsoid and coordinates, to local map coordinates, some type of a calibration is required. This calibration may be done in the field in the data collectors or it may be done in the office and uploaded to the data collector.

A calibration is similar to a least squares adjustment, which establishes or refines a transformation of the WGS-84 coordinates to local Northing, Easting, and Elevation (NEE) coordinates. This transformation consists of a datum transformation, between the WGS-84 ellipsoid and the local ellipsoid, a mapping projection and horizontal and vertical adjustment.

The set of derived WGS-84 coordinates must be homogeneous (all in terms of each other) for use in a calibration to establish the relationship between WGS-84 data collected by GPS receivers and local control positions, expressed as a local map grid with elevations above sea level. This relationship is defined by a series of mathematical transformations.

A calibration may be a minimum of one point up to twenty points depending upon the size of the project. When using calibrations, the manufacturer's recommendation should be followed.

The accuracy of points staked out depends on the accuracy of the calibration. Always use known Project Cadastral Control and ties to the NSRS for this reason.

RTK Corner Moves (stakeout)

RTK technology allows the surveyor to make a corner move or stakeout from a known position to an unknown (calculated) position relative to the controlling corners for a PLSS survey or resurvey.

The system check should be done any time throughout the survey to detect for blunders and the initialization quality of the survey prior to making any RTK observation for Cadastral Measurements and prior to making any corner moves.

Note: Caution should be exercised when using grid coordinated for stakeout. It is important to insure the appropriate corrections for convergence, elevation and distance are accounted for relative to the rules of the PLSS.

To make a corner move using RTK the following is a recommended procedure:

- • Navigate to the calculated corner location (e.g. 140700CP) using coordinates. For example, navigate "from" station number (100700) and "to" station number (140700CP).

- • Take a measurement (e.g. 140700M1), inverse between M1 and compare to the calculated position (e.g. 140700CP) and move the remaining distance and direction to the true (calculated) location as necessary. Repeat as required until satisfied you are at the position then store M1 and overwrite previously stored point.

- • Force loss of satellite lock and initialization by inverting the rover antenna. Reinitialize and take another measurement (e.g. 140700M2) and store.

- • Inverse between the measured one (140700M1) and the measured (140700M2). If the measured positions (M1 and M2) are within the duplicate point tolerance of the calculated position then the initializations and measurements are correct. Note, these M1 and M2 measurements are of a shorter duration (30 seconds).

- • Set the monument at the true corner location.

- • Take a measurement on the set monument (e.g. for 180 seconds) and store the position with a different name (e.g. 140700). Optionally, set the receiver or data collector to store data for subsequent post-processing.

- As a check, inverse from the stored position (e.g. 140700) to the calculated corner position to determine the set true corner location, next inverse to the controlling corners and check the bearing and distance to insure the correct procedures were followed. The established corner location should be within the defined local spatial accuracy standards required of the survey.

Section Three

Data Processing and Data Analysis

All data processing (baseline solutions) and data analysis (least squares or weighted mean average) shall follow the manufacturer's recommended procedures.

A double difference fixed integer solution is required for all cadastral measurements regardless of the positioning technique used.

Project Control network shall be processed to derive the baseline solutions and be adjusted by least squares independently of the observed Cadastral Measurements.

When integrating GPS observations into conventional terrestrial survey procedures it is imperative the surveyor verify the following:

- The State Plane or local plane horizontal scale factors, angular rotation factors, zone and units of measure are applied correctly.
- The combined scale factors for elevation, to determine ground distance at project elevation or an average project elevation are applied correctly.
- The appropriate datum has been used.
- A check to insure no hidden transformation or double transformations of the data has occurred.
- If using GPS with terrestrial data, then a check (e.g. measure the distance between two know points with an EDM) should be done to insure the computation of the combined scale factors are correct. This is done to insure the ***ground distances*** are appropriate.
- A check to insure the computation and reporting of basis of bearing are appropriate.

Section Four

Documentation

The use of GPS surveying methods to establish geodetic Project Cadastral Control and / or Cadastral Measurements for survey and resurvey of Public Lands is considered the practice of Professional Land Surveying in all states. Therefore, all GPS surveying projects must be performed under responsible charge of a federally authorized Land Surveyor or a Professional Land Surveyor licensed to practice Land Surveying in the applicable state.

A surveyor's narrative report shall be prepared and submitted to the project file by the surveyor in responsible charge as documentation of the successful completion of the land survey or cadastral survey project.

A surveyor's narrative report should include:

Make and Model of the GPS receiver, Antenna, and related equipment.

- A processing generated report or summary of all RTK field operations, including calibrations, duplicate point measurements.

- • A processing generated report regarding the baseline processing results and the software and version number used.
- • A processing generated report regarding the Network adjustment results including a summary of covariance's, standard deviation or RMS values and the software and version number used.
- • A network diagram, true line diagram or map showing the network configuration as designed.
- • A list of the HARN, CORS or reference stations used in the survey.
- A list of coordinates by station including the datum, geoid model, epoch, and measurement units used.
- Local and Network Accuracies.
- A GMM .LZH file for inclusion into GCDB.
- Document any variations from these guidelines.

Reporting bearings and Distances:

A Basis of Bearing for a Government Cadastral Survey, when using GPS technology shall be expressed as "Geodetic Bearing or Azimuth". This bearing or azimuth shall be determined at the midpoint of the observed line as the "mean" between the Normal Section Forward Azimuth (NSFA) and the Normal Section Back Azimuth (NSBA) between points.

All ground distances shall be determined at elevation, except where the requirements are for sea level, using the appropriate geoid model to determine the geoid separation. For a cadastral survey, the height above the geoid and the orthometric height shall be considered the same.

Appendix A

DEFINITIONS

Cadastral Project Control is the network of the GPS baselines tied to the NSRS, which is surveyed to control all subsequent GPS Cadastral Measurements. The Project Control is adjusted independently of other cadastral measurements.

Cadastral Measurement Tolerance is the maximum acceptable distance for inverse between two measurements to the same point. This value is 8.6 cm. When measurements are made within this tolerance is in an RTK survey the two observations may be recorded as the same point number. These redundant measurements can then be included in a least squares or multi-baseline analysis. This worst-case condition should only be encountered in the most marginal field conditions for RTK surveys. These points should be noted in the RTK report.
The Cadastral Measurement Tolerance value of 8.6 cm is derived from standard error propagation relationships. It is based on the following formula, the square root of the sum of the squares of the Cadastral Measurement Tolerance (8.6 cm) and the maximum allowable error of the Cadastral Project Control (5cm) should approximately equal the maximum allowable error budget of the Cadastral Measurements (10cm).

Cadastral Measurements are the measurements used to define the location of ***Public Land Survey System (PLSS)*** corners and boundaries. Cadastral Measurements are based on the Cadastral Project Control coordinates or direct ties to the NSRS.

Duplicate Point Tolerance is the maximum distance in an RTK system setup check that two observations of the same point can differ by. It also the desired distance in an RTK survey that two observations of the same point should differ by and still be recorded as the same point for least squares or multi-baseline analysis. The duplicate point tolerance for these guidelines is 2.5 cm.

The **Geographic Coordinate Data Base (GCDB)** is a database containing geographic coordinates, and their associated attributes, for all corners of the Public Land Survey System.

Ground distance is the horizontal distance measured at the mean elevation between two points.

Independent (Non-Trivial Baseline): For each observing session there are n-1 independent baselines where n is the number of receivers collecting data simultaneously during a session.

Independent Occupation: Two or more independent occupations for the stations of a network are specified to help detect instrument and operator errors. Operator errors include those caused by antenna centering and height offset blunders. When a station is occupied during two or more sessions, back-to-back, the antenna pole or tripod will be reset and plumbed between sessions to meet the criteria for an independent occupation.

Local Accuracy, as defined in Part 2, Standards for Geodetic Networks, FGDC Geospatial Positioning Accuracy Standards, is an average measure (e.g. mean, median, etc.) of the relative accuracies of the coordinates for a point with respect to other adjacent points at the 95% confidence level. For horizontal coordinate accuracy, the local accuracy is computed using an average of the radii of the 95% relative confidence circles between the point in question and other adjacent points. This indicates how accurately a point is positioned with respect to other adjacent points in the local network. Based upon computed relative accuracies, local accuracy provides practical information for users conducting local surveys between control monuments of known position. Local accuracy is dependent upon the positioning method used to establish a point. If very precise instruments and techniques are used, the relative and local accuracies related to the point will be very good.

The reported Local Accuracy for cadastral survey purposes will be computed from the error ellipses generated by a least squares or other multiple baseline statistical analysis, which is fully constrained to the Cadastral Project Control.

National Spatial Reference System (NSRS) is defined and managed by the National Geodetic Survey (NGS). It is a consistent national coordinate system that specifies latitude, longitude, height, scale, gravity, and orientation throughout the Nation, as well as how these values change with time. NSRS consists of the following components:

- The National CORS, a set of Global Positioning System Continuously Operating Reference Stations meeting NOAA geodetic standards for installation, operation, and data distribution;
- A network of permanently marked points including the Federal Base Network (FBN), the Cooperative Base Network (CBN), and the User Densification Network (UDN); and
- A set of accurate models describing dynamic geophysical processes affecting spatial measurements.
- High Accuracy Reference Network or High Precision Geodetic Network stations established by GPS observations.
- Vertical control marks, which define elevation and are referenced to NGVD 29 or NAVD 88.
- All other horizontal and vertical marks established to define the NSRS.

NSRS provides a highly accurate, precise, and consistent geographic reference framework throughout the United States. Only stations or marks established by GPS or High order levels should be used with GPS survey projects

Network Accuracy is the absolute accuracy of the coordinates for a point at the 95% confidence level, with respect to the defined reference system. Network accuracy can be computed for any positioning project that is connected to the National Spatial Reference System (NSRS).

The network accuracy of a control point is a number, expressed in centimeters, that represents the uncertainty in the coordinates, at the 95% confidence level, of this control point with respects to the geodetic datum. For NSRS network accuracy classification, the datum is expressed by the geodetic
values at the Continuously Operated Reference Site (CORS) supported by National Geodetic Survey (NGS). By this definition, the local and network accuracy values at CORS sites are considered to be infinitesimal, i.e., to approach zero.

Network accuracy for cadastral survey reporting purposes will be computed from the error ellipses generated in a least squares adjustment fully constrained to CORS or HARN stations.

APPENDIX B

COMPUTATION OF ACCURACIES

The local accuracies of the PLSS corners are based upon the results of a least squares adjustment of the survey observations used to establish their positions. They can be computed from elements of a covariance matrix of the adjusted parameters, where the known NSRS control coordinate values have been weighted using their one-sigma network accuracies.

95% Confidence Circle

The 95% confidence circle representing a local accuracy can be derived from the major and minor semi-axes of the standard relative ellipse between two selected points. The 95% confidence circle is closely approximated from the major (a) and minor (b) semi-axis parameters of the standard ellipse and a set of coefficients. For circular error ellipses, the circle coincides with the ellipse. For elongated error ellipses, the radius of the circle will be slightly shorter than the major semi-axis of the ellipse. The radius r of the 95% confidence circle is approximated by:

$r = K_p\, a$

Where

$K_p = 1.960790 + 0.004071\, C + 0.114276\, C^2 + 0.371625\, C^3$,

$C = b / a$.

Note that the coefficients in the above expression are specific to the 95% confidence level, such that when the major semi-axis of the standard ellipse is multiplied by the value of K_p, the radius of the 95% confidence circle is obtained directly, and no further conversion is required.

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Appendix C

References

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