

North Carolina Board of Examiners for Engineers and Surveyors

Survey Ties Guidelines

The North Carolina Board of Examiners for Engineers and Surveyors is providing this document to serve as an interpretative guide for proper ties to comply with Board Rule 21-56.1602(g). The variation in surveys makes it difficult to prepare a finite list of procedures for proper ties. Use of the ties shown and described herein will assure the Professional Land Surveyor (PLS) that a tie will comply with the requirements for tie in the Board Rules. Professional judgment must be used to prepare and document a tie on a plat or report of survey. Variations from the examples given here may be acceptable to the Board if the intent of the rule is met.

The purpose of a tie is to reproduce a boundary when all or most of the property corners have been destroyed, or to verify the position of any given corner without the necessity of resurveying the entire tract of land.

1. TIE TO GRID - North Carolina State Plane Coordinate System (NCSPCS)

Tie to the NCSPCS is required by Board Rule 21-56.1602(g) if the property is within 2,000 feet of a geodetic monument and, in addition, should be used anytime possible. All geodetic control monuments in the NCSPCS are referenced to the National Spatial Reference System (NSRS). A tie to the NCSPCS is the best method for fixing a tract of land or a property corner on the face of the earth. With the completion of the national readjustment of the horizontal control network, the network of horizontal control monuments and Continuous Operating Reference Stations (CORS) provides the PLS access to a network that provides a network accuracy of one (1) centimeter and local accuracy of 1-2 centimeters. Establishing state plane coordinates on the corner(s) of a tract of land will provide the PLS that follows in your footsteps the information to reestablish the corner(s) to the same positional accuracy that the PLS provided when establishing state plane coordinates on the corner(s). This will provide positional information of the subject property that is repeatable, legally defensible and referenced to the NSRS.

In addition to the traditional method [traverse, static or Real Time Kinematic (RTK) Global Positioning System (GPS)] of connecting a survey to the NCSPC using passive horizontal control monuments, the PLS now has additional tools that can be used to establish state plane coordinates on the subject property.

1a. Online Positioning User Service (OPUS)

OPUS-S (static) and OPUS-RS (rapid static) allows users to submit their GPS data files to NGS, where the data will be processed to determine a position using NGS computers and software.).

Each data file that is submitted will be processed with respect to three CORS sites when using OPUS-S and up to nine CORS using OPUS-RS. The sites selected may not be the nearest to your site but are selected by distance, # of obs, site stability, etc. The position for your data will be reported back to you via email in

[http://www.ngs.noaa.gov/CORS/metadata1/the North American Datum of 1983\(NSRS2007\), State Plane Coordinates \(SPC\) northing and easting, Universal Traverse Mercator, and US National Grid.](http://www.ngs.noaa.gov/CORS/metadata1/the%20North%20American%20Datum%20of%201983(NSRS2007),%20State%20Plane%20Coordinates%20(SPC)%20northing%20and%20easting,%20Universal%20Traverse%20Mercator,%20and%20US%20National%20Grid)

OPUS-RS is the latest version of the Online Positioning User Service. OPUS-RS uses a processing engine developed by Ohio State University. OPUS-RS is designed to provide geodetic quality results using short data sets (15-30 minutes).

OPUS-S and OPUS-RS are acceptable methods for obtaining a tie for a survey. When using OPUS or OPUS-RS the PLS shall provide a summary of the results of the OPUS output. The summary should be substantially in the following format.

The State Plane Coordinates (SPC) for this project were produced with static GPS observations and processed with Online Positioning User Service (OPUS). The network positional accuracy of the OPUS derived positional information is

_____.

The following CORS were used by OPUS

<u>PID</u>	<u>DESIGNATION</u>
DE8228	HAYW HAYWOOD CORS ARP
DG5311	NCSW SWANNANOA CORS ARP

Horizontal positions are referenced to NAD83\NSRS (2007)

Vertical positions are referenced to NAVD88 using (GEOID03)

Combined Factor _____

1b. Real Time Kinematic (RTK) Networks

Utilizing a Real Time Kinematic network is an acceptable method for connecting a survey to the State Plane Coordinate System (SPCS). Proper field procedures should be followed to insure the quality of the data obtained from the real time network. Redundant occupations utilizing different satellite configurations and different atmospheric conditions should be used when possible to strengthen the positional information obtained from the real time network.

The State Plane Coordinates (SPC) for this project were produced with RTK GPS observations.

The network positional accuracy of the RTK derived positional information is _____.

Horizontal positions are referenced to NAD83(NSRS2007)

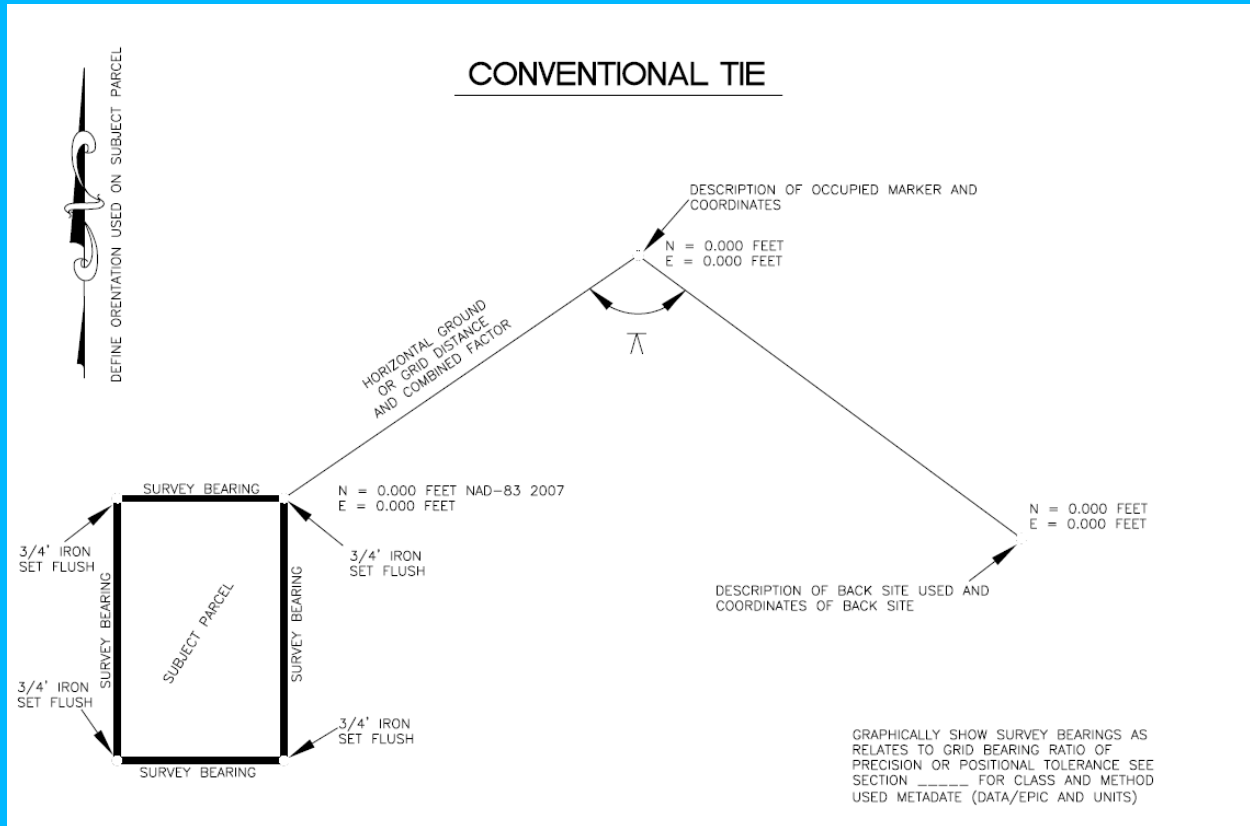
Vertical positions are referenced to NAVD88

Combined Factor _____

1c. Traverse Connection

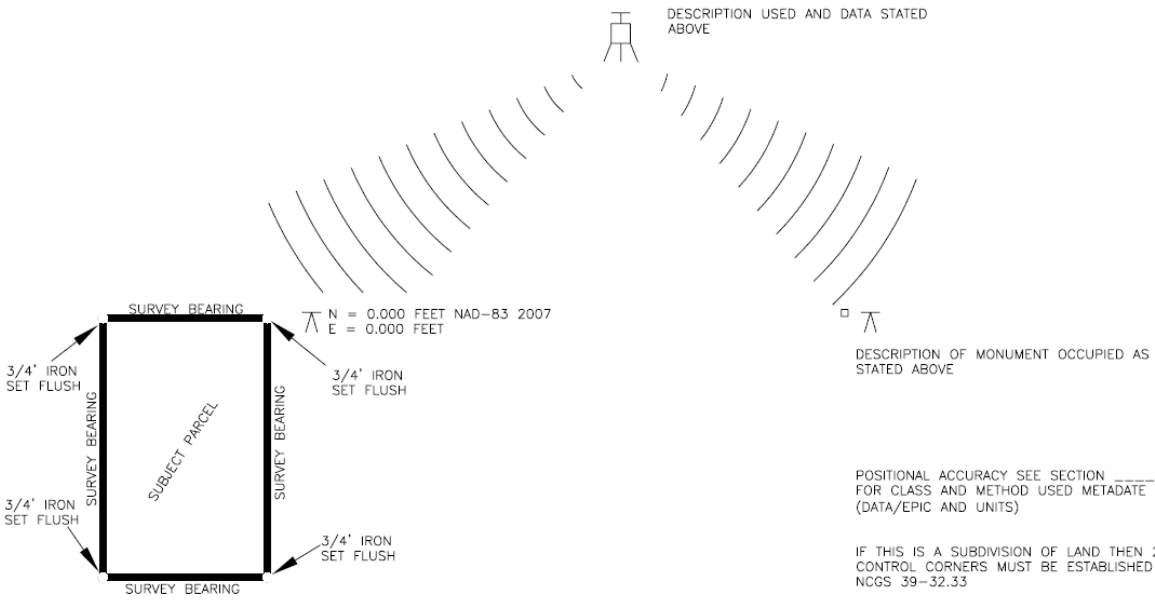
Below is a graphic representation of tie to the NCSPCS using horizontal control monuments. Tie to the NCSPCS is required on all surveys where any portion of the boundary of the tract being surveyed is within 2000 feet of a horizontal control monument whose coordinates are on file with the North Carolina Geodetic Survey. This requirement is for both surveys performed to GS 47-30 and Board rules. Per Board rule 21-56.1602(g) control monuments within previously recorded subdivisions that were connected to the NCSPCS may be used for tie in lieu of a connection to horizontal control monument for surveys of lots within the recorded subdivisions.

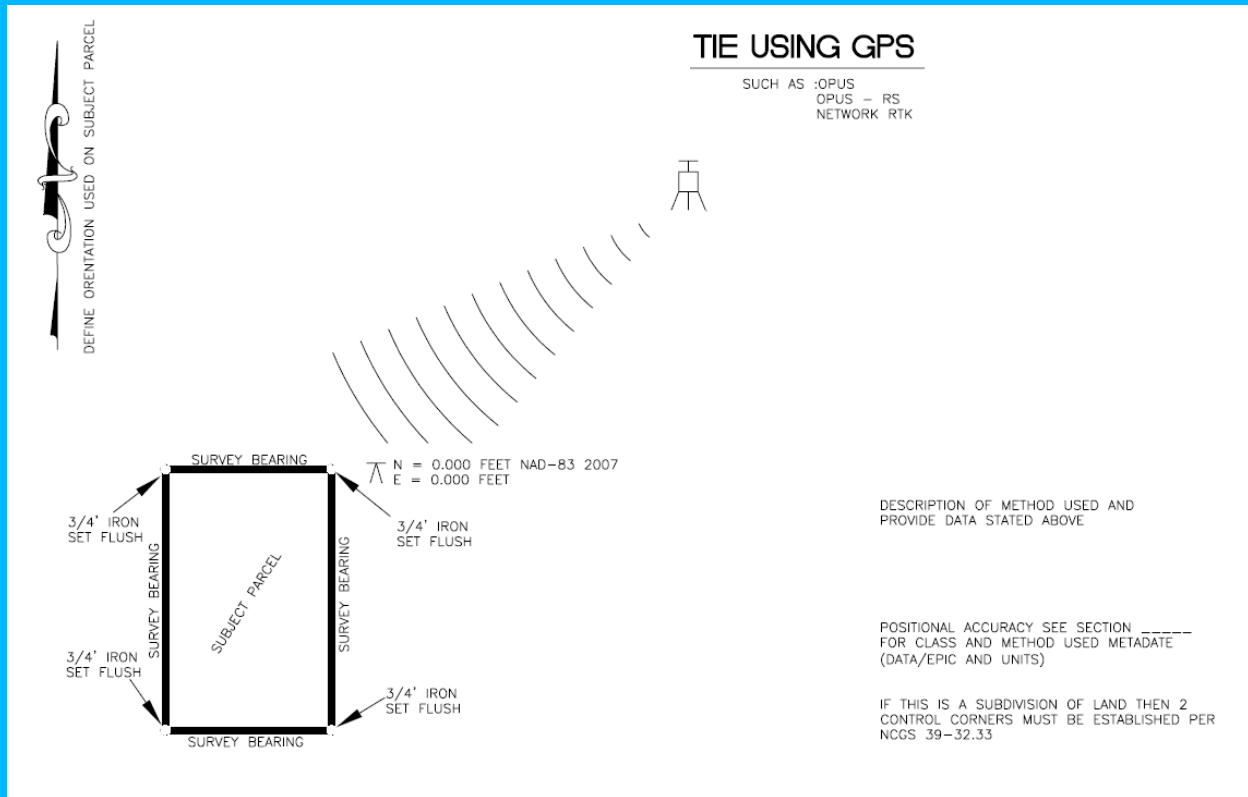
Example of Tie to Grid



TIE USING GPS

SUCH AS :RTK





2. TIE TO CONTROL CORNERS

Control monuments within a previously recorded subdivision may be used in lieu of grid control. Control corners as defined in NC General Statute 39-32.3 may be used for a tie.

GS 39-32.1 “one or more corners of such development to be designated as “control corner” and shall cause two or more street center lines or offset lines within or on the street right-of-way lines to be permanently monumented at intersecting center lines or offset lines, points of curvature or such other control points, which monuments shall also be designated as control corners”

At a minimum one control corner is required at a corner on the boundary of the development and at least two control corners relative to the street center lines must be set, for a minimum of three control corners. It would appear that for the street center lines, if done at the intersection of two streets, that one control corner could establish two street center lines, resulting in a total minimum of two control corners for the subdivision.

3. TIE TO NATURAL OR ARTIFICIAL MONUMENTS

3a. Massive Objects

These are either natural or man-made objects that are easy to identify and have, or can accept, finite points that can be measured to with certainty.

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3b. Other Artificial Monuments

Ad joiner's property corners

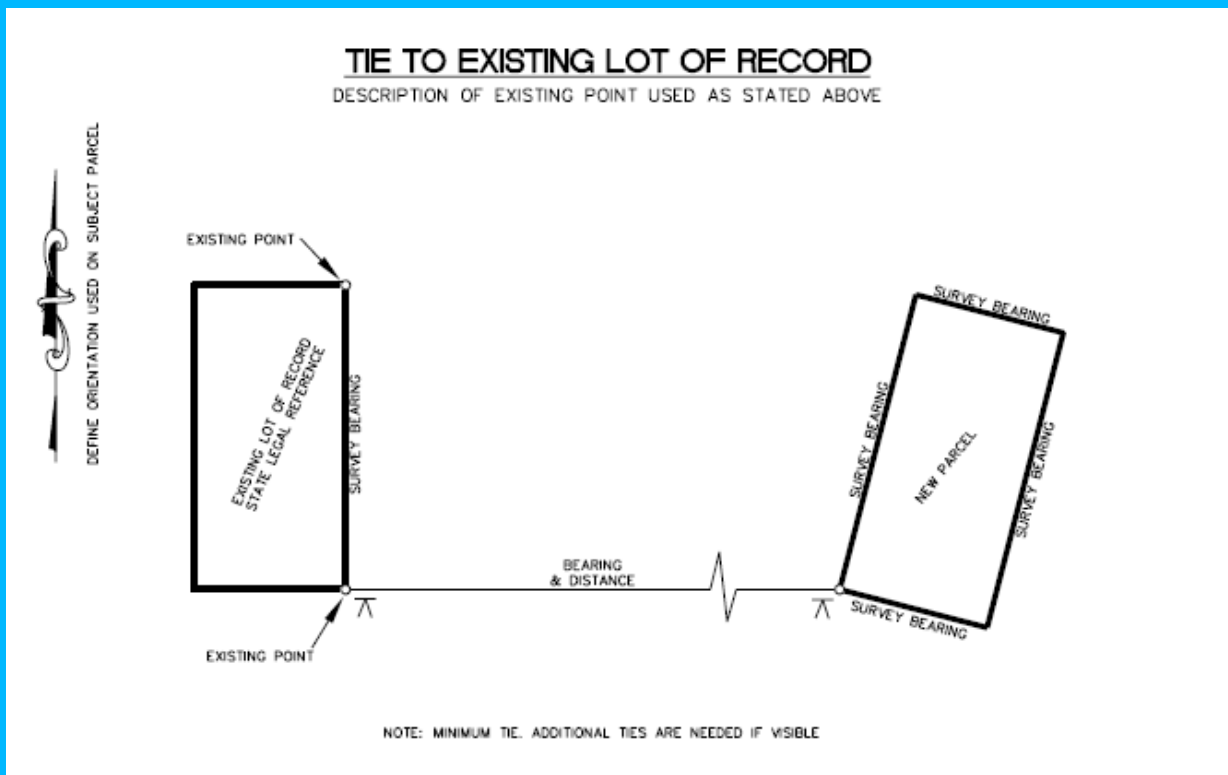
When using property corners for a tie, the property corners must be highest permanent quality and contain metadata to insure that the PLS who utilizes the ties can find and identify what was used for the original tie. Corners identified as control corners would have the highest priority. The use of adjoining property corners requires the use of at least two adjoining record corners, or one record corner and one other point that is visible from the referenced adjoining corner. Corners that are used for ties shall be fully described by providing sufficient metadata (size, type of material and description). EIP (Existing Iron Pipe) or NIP (New Iron Pipe) is not a sufficient description of the referenced corner(s) that is being used for the tie.

Examples:

Found one (1) inch iron pipe extending four (4) inches above ground surface

Found six (6) inch square granite post extending twenty four (24) inches above ground level with no inscription

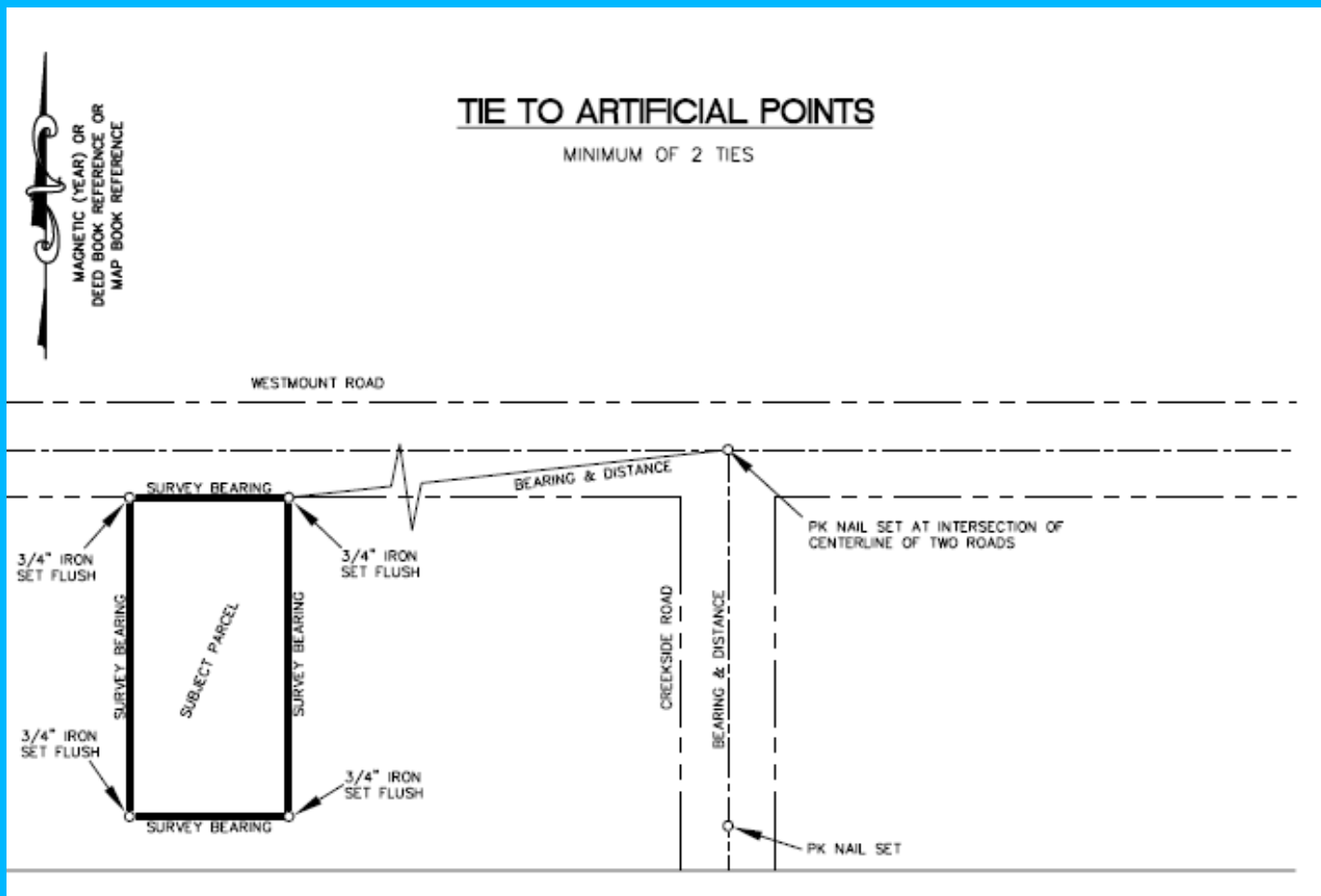
Set new one (1) inch iron rod flush with ground surface



Artificial Points

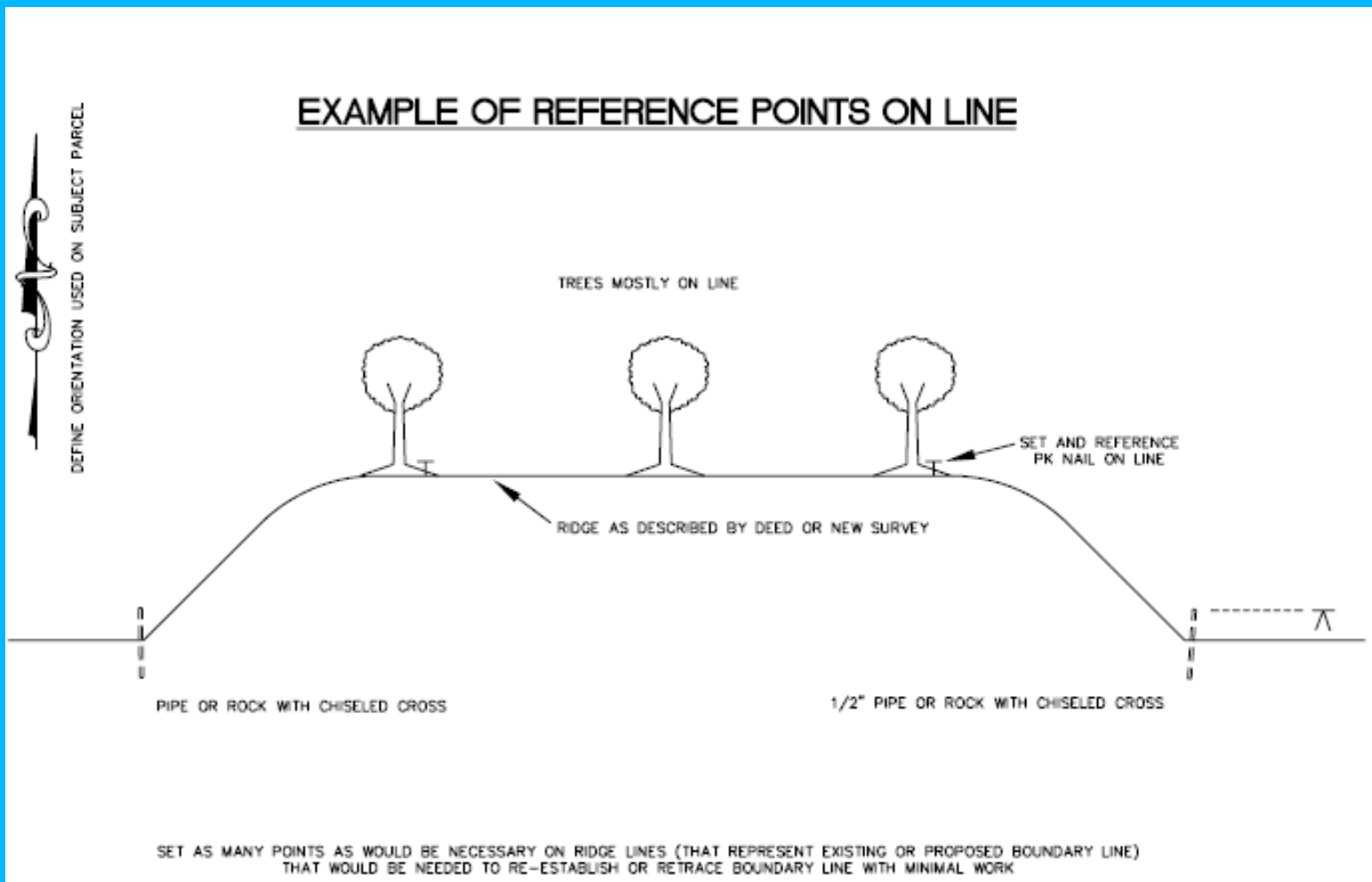
Artificial points such as PK nails and spikes tend to be less permanent and more likely to be destroyed. Artificial points should be used when no other alternative is available. Artificial points established for a tie should be set far enough apart to provide sufficient azimuth orientation for the reestablishment of the property corner(s).

PK nails or spikes at road and street intersections are poor points for ties. The danger of setting marks in active road and road maintenance are two reasons to avoid setting artificial points in road intersections as tie points. Artificial points in road intersections are acceptable, but they are considered to be the lowest preference.

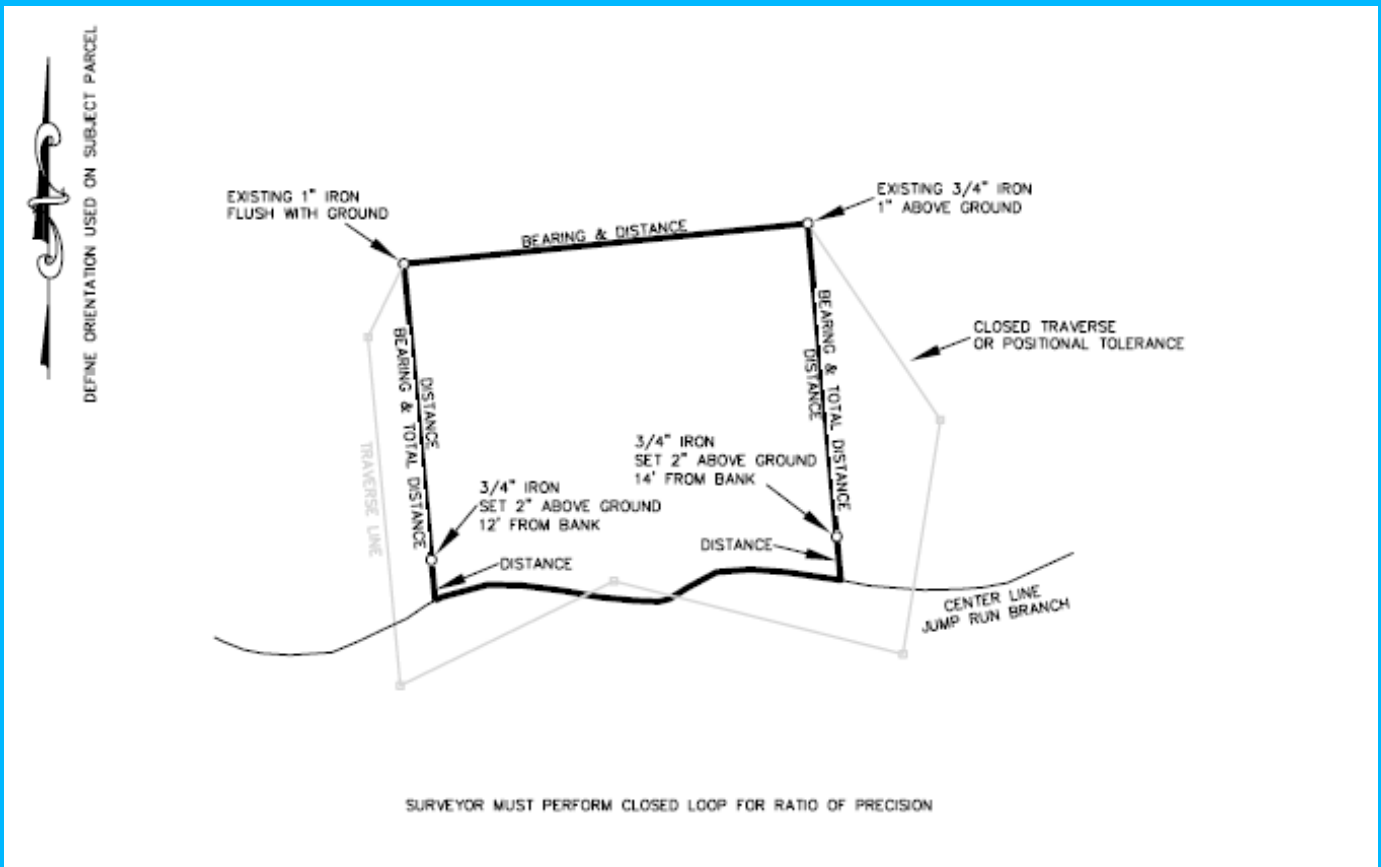


OTHER SURVEY RULES

A. REFERENCE MONUMENTS. Board Rule 21-56.1602(e) states that “Where a corner falls in a right-of-way, in a tree, in a stream, or on a fence post, boulder, stone, or similar object, one or more monuments or metal stakes shall be placed in the boundary line so that the inaccessible point may be located accurately on the ground and the map.



B. RATIO OF PRECISION. Board Rule 21-56.1603 states that “Each map shall contain a statement of the calculated ratio of precision before adjustments.”



C. LEGEND

All symbols, acronyms, and line types used on a plat should be clearly defined in the legend per Board Rule 21-56.1604(e)(11). Other Professional Land Surveyors may be familiar with the symbol or acronym, but the public in most cases will not understand the meaning of the symbols or acronyms.

D. META DATA

Metadata is data about data. Metadata provides a description of the data that is included on the plat and/or in a report. With numerous vertical datum's (National Geodetic Vertical Datum of 1929 and North American Vertical Datum of 1988) and different horizontal datum's it is critical that metadata be provided to the user of the information provided by the Professional Land Surveyor.

Typical metadata that should be included with a survey product are:

- Horizontal or vertical datum
- Units
- Property corner description
 - Material
 - Found or set
 - Above, below or flush with ground level

Metadata Example

All coordinates and bearings are based on the North American Datum of 1983(NSRS2007)
Elevations are based on North American Vertical Datum of 1988 (NAVD88)
Units of measurement are US Survey Feet

Found an 5/8" iron rod projecting 0.5' above the ground surface

Set a 1/2" iron rod flush with the ground

E. SAMPLE CERTIFICATE FOR GLOBAL POSITIONING SYSTEM SURVEYS

The certificate shall be substantially in the following form:

"I, _____, certify that this map was drawn under my supervision from an actual GPS survey made under my supervision and the following information was used to perform the survey:

- (1) Class of survey: _____
- (2) Positional accuracy: _____
- (3) Type of GPS field procedure: _____
- (4) Dates of survey: _____
- (5) Datum/Epoch: _____
- (6) Published/Fixed-control use: _____
- (7) Geoid model: _____
- (8) Combined grid factor(s): _____
- (9) Units: _____

F. SAMPLE CERTIFICATE FOR BOUNDARY SURVEY USING GPS

I, _____ certify that this plat was drawn under my supervision from an actual survey performed under my supervision (deed description recorded in Book ____, page ____, etc.) (other); that the boundaries not surveyed are clearly indicated as drawn from information found in Book ____, page ____; that the ratio of precision as calculated is 1: ____; that the Global Positioning System (GPS) observations were performed to the Geospatial Positioning Accuracy Standards, Part 2: Standards for Geodetic Networks at the _____ accuracy classification (95% confidence) using _____ (Insert type of field procedure used. Static, Real Time Kinematic, RTK Network, OPUS, and or traditional traverse).

That this plat was prepared in accordance with G.S. 47-30 as amended (if the survey is not a G.S. 47-30, remove this sentence).

That this plat meets the requirement of G.S. 47-30 section F-11-__ (insert the section in F-11 that matches this survey if it is a 47-30 survey)

Witness my original signature and seal this the _____ day of _____.