Chapter 11 - Monument Preservation Surveys

Policy Statement

Any survey which involves monument preservation shall conform to the specifications as defined in this document.

General Statement

The following document outlines the procedures to be followed when performing monument preservation surveys, and is to be used in conjunction with the **California Business and Professions Code (Land Surveyors' Act)** as cited below:

8771 Setting of monuments in general; monument perpetuation

(b) When monuments exist that control the location of subdivisions, tracts, boundaries, roads, streets, or highways, or provide horizontal or vertical survey control, the monuments shall be located and referenced by or under the direction of a licensed land surveyor or licensed civil engineer legally authorized to practice land surveying prior to the time when any streets, highways, other rights-of-way, or easements are improved, constructed, reconstructed, maintained, resurfaced, or relocated, and a corner record or record of survey of the references shall be filed with the county surveyor.

(c) A permanent monument shall be reset in the surface of the new construction or a witness monument or monuments set to perpetuate the location if any monument could be destroyed, damaged, covered, disturbed, or otherwise obliterated, and a corner record or record of survey shall be filed with the county surveyor prior to the recording of a certificate of completion for the project…

Pre-Construction Procedures

Prior to the commencement of construction activities, existing monuments shall be referenced (tied out) following the procedures outlined below:

Horizontal Control Network:

Monument conservation surveys shall be tied to the California Coordinate System of 1983 (CCS83). The horizontal control network may be based upon CGPS stations or published legacy control, and may be established by GPS (Static or RTK), conventional traverse, or a combination thereof, provided GPS and traverse procedures are in compliance with ***Chapter 1 – Static GPS***, ***Chapter 2 – RTK GPS***, and ***Chapter 5 – Boundary Surveys***. Specific policy relevant to the field survey shall include, but are not limited to the following points:

- Monuments positioned by GPS must adhere to minimum spacing requirements as defined in Chapters 1 and 2.
- All roadway monuments, boundary monuments, reference points ("tie points"), and control points must be either traversed through or double determined, in compliance with Chapter 5. (Note: The "double backsight" method as defined in Chapter 5 may only be employed when use of the double determination method would result in a decrease in the strength-of-figure. In these instances, the instrument setup must be broken-down and re-erected between measurements.)

- Found monuments which are included in the survey must be tied to at least one, but preferably two or more adjacent found monuments along the roadway or boundary line. This is strictly for the purpose of verifying the location of a monument and its reference points, not an effort to re-establish a roadway centerline or a boundary line.
- All points tied to the survey must be occupied by a tripod/tribrach assembly; with the exception of a "peanut prism" fitted with a level bubble, layout rods are not to be used.

Network Processing:
Network processing shall be performed using Star*Net (or equivalent) least squares adjustment software. The network processing style shall be at the discretion of the party chief, provided the processing is in compliance with ***Chapter 12 – Network Processing***. Processing options follow:

- Multi Stage Adjustment: Static GPS observations are adjusted, and these values are then fixed in subsequent adjustments containing RTK and/or conventional measurements
- Hybrid Adjustment: Static GPS, RTK GPS, and conventional traverse observations are adjusted simultaneously, constrained to CGPS or legacy control stations

Note: RTK observations shall not be adjusted as a stand-alone network - RTK must be combined with conventional observations in a hybrid adjustment.

Accuracy Standards:
Analysis of the network adjustment must be performed in order to ensure that OC Survey's accuracy standards have been met. All monument connections within the network must meet a minimum relative positional accuracy standard (local accuracy) of **1:10,000**, or **0.033 feet** for connection distances less than 330 feet. This computation is to be made at the 95% confidence level. In the event one or more pairs of monuments fails to meet these relative positional accuracy criteria, the network adjustment shall be reviewed and a determination made by the Senior Land Surveyor (or Project manager) as to whether or not additional observations will be made in order to improve network geometry, increase redundancy, or further isolate errors.

Pre-Construction Corner Records:
Per the ***California Business and Professions Code***, the results of the survey shall be documented in the form of a **Corner Record (or Record of Survey)**, which is to be filed with the County Surveyor. In addition to the minimum statutory requirements, pre-construction Corner Records shall include the following information:

- Indication that this is a pre-construction corner record
- Measured bearings and distances from tie points to the monument in question (Note: measured bearings and distances are derived by inverse between the final coordinate positions established by the network adjustment)
- Measured bearings and distances from the monument in question to adjacent found monuments along the roadway or boundary line
- Record distances from tie points to the monument in question (if applicable)
- Record distances from the monument in question to adjacent found monuments along the roadway or boundary line (removed record bearings)
- Corner Record numbers for adjacent found monuments along the roadway or boundary line (if applicable)

- A listing of references for all found monuments, tie points, and record distances
- A monument designation from historic records, e.g. “PI #7” (if applicable)
- A statement as to the origin of measured bearings, e.g. “Bearings shown hereon are assumed and are displayed for angular relationship only”

Post-Construction Procedures

After construction activities have been completed, any monuments which have been destroyed shall be reset following the procedures outlined below:

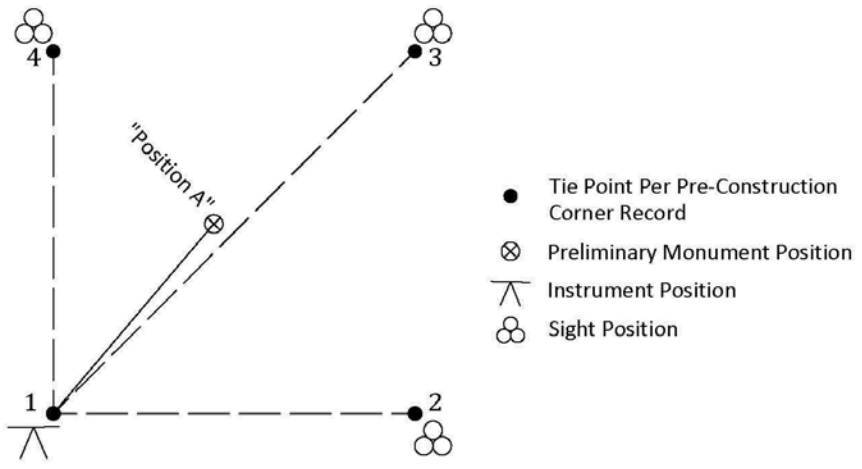
Field Procedure:

Coordinate values established by the pre-construction network adjustment are used to identify the physical position of a monument to be reset, and to verify the positions of the tie points. This is accomplished using a total station. Under no circumstances is GPS to be used to reset a monument. A minimum of two independent total station occupations must be made to complete this process. As was required in the pre-construction survey, all points, including the monument to be reset, must be occupied with a tripod/tribrach assembly or peanut prism. The example procedure detailed below represents the minimum effort necessary to ensure proper positioning of the new monument:

Step 1 (See Figure 1)

One of the tie points is occupied and sights are placed on the other three tie points. A backsight observation is made to one of the tie points; the backsight point and each of the remaining tie points are staked out, measured, and stored. If all computed coordinate deltas are **≤ 0.033 feet****, the monument position is staked out and marked on the ground (“Position A”).

Figure 1
Establishing "Position A"

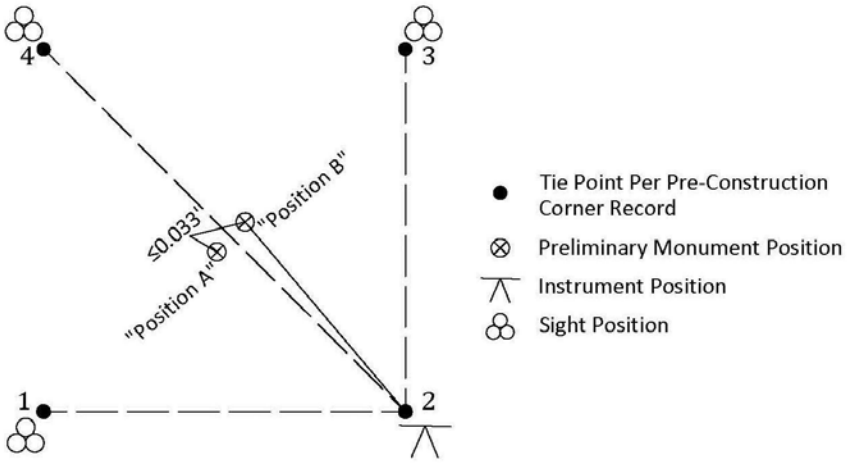


**In the event one or more of the coordinate deltas is greater than 0.033 feet, a determination must be made as to which tie point is in error. If a single tie point can be identified as the outlier, the process can be completed using the remaining three tie points and excluding the outlier. If it cannot be determined as to which point(s) are in error, all of the tie points must be re-tied to the original control network, a new network adjustment performed, and the field process repeated as outlined above.

Step 2 (See Figure 2)

After verification of all tie points in Step 1, a second tie point is occupied and sights are placed on the other three tie points. A backsight observation is made to one of the tie points; the backsight point and each of the remaining tie points are staked out, measured, and stored. If all computed coordinate deltas are **≤ 0.033 feet**, the monument position is again staked out and marked on the ground ("Position B"). A measurement is made between the two preliminary ground positions. If the measured distance is **≤ 0.033 feet**, the monument is set at the mid-point between the two preliminary positions. The position of the monument itself is then measured and stored.

Figure 2
Establishing "Position B"



Final Network Processing and Verification of Monument Position:

After completion of Steps 1 and 2 above and the setting of the monument, the process which was employed to determine the physical positioning of the monument must be documented as defined below:

- A new network adjustment is performed, processing backsight readings and stakeout data against the fixed coordinate values from the pre-construction network adjustment.
- An analysis is performed to ensure that the resultant misclosures, which are reported as either coordinate deltas or angle/distance residuals, do not exceed **0.033 feet**.

- New coordinate values are assigned to tie points which were determined to be in error, and new bearings and distances are computed and reported in the post-construction Corner Record

Post-Construction Corner Records:
Per the ***California Business and Professions Code***, the results of the survey shall be documented in the form of a **Corner Record (or Record of Survey)**, which is to be filed with the County Surveyor. In addition to the minimum statutory requirements, post-construction Corner Records shall include the following information:

- Indication that this is a post-construction corner record, with a reference made to the pre-construction corner record number
- Record and measured bearings and distances from tie points to the monument in question (Note: Unless an outlier is identified in Step 1 above, bearings and distances will be reported as "record and measured", using the original inverse data shown on the pre-construction corner record)
- Record and measured bearings and distances from the monument in question to adjacent found monuments along the roadway or boundary line (Note: Unless an outlier is identified in Step 1 above, bearings and distances will be reported as "record and measured", using the original inverse data shown on the pre-construction corner record)
- Corner Record numbers for adjacent found monuments along the roadway or boundary line (if applicable)
- A listing of references for all found monuments, tie points, and record distances
- A monument designation from historic records, e.g. "PI #7" (if applicable)
- A statement as to the origin of measured bearings, e.g. "Bearings shown hereon are assumed and are displayed for angular relationship only"

Monumentation (reformatted to match Monumentation document)

Monuments set during the course of a monument preservation survey shall meet the following criteria:

Boundary Corners
Monuments set at boundary corners for Tract Maps or Parcel Maps, or on any interior lot or parcel lines to be further subdivided, or for future subdivision Records of Survey:

- Monuments which fall in the surface of concrete paving shall consist of a tag secured in a lead plug or set in epoxy.
- Monuments which fall in the surface of asphalt paving shall consist of a durable spike (minimum 4 inches in length) with a washer.
- Monuments which fall in non-paved areas shall consist of a 2 inch diameter iron pipe with a tag or disk.
- All tags/washers/disks referenced above shall be stamped with the agency name or the license number of the surveyor in responsible charge.
- Tags set in iron pipes shall be of a diameter less than that of the inside diameter of the pipe. Disks affixed to iron pipes shall be of a diameter equal to that of the outside diameter of the pipe.

- Under no circumstances are plastic plugs to be used with iron pipe.

Lot and Parcel Corners
Monuments set at lot and parcel corners for Tract Maps, Parcel Maps, Records of Survey, Corner Records, Lot Line Adjustments, and Certificates of Compliance:

- Monuments which fall in the surface of concrete paving shall consist of a tag secured in a lead plug or set in epoxy.
- Monuments which fall in the surface of asphalt paving shall consist of a durable spike (minimum 4 inches in length) with a washer.
- Monuments which fall in non-paved areas shall consist of a 1 inch diameter iron pipe with a tag.
- All tags/washers referenced above shall be stamped with the agency name or the license number of the surveyor in responsible charge.
- Tags set in iron pipes shall be of a diameter less than that of the inside diameter of the pipe.
- Under no circumstances are plastic plugs to be used with iron pipe.

Street Centerline Points
Monuments set at street intersections, the controlling points along the centerlines of streets, and where boundary lines are produced to intersect street centerlines:

- Monuments which fall in the surface of concrete paving shall consist of a tag secured in a lead plug or set in epoxy.
- Monuments which fall in the surface of asphalt paving shall consist of a durable spike (minimum 4 inches in length) with a washer. A Survey Monument Type "A" (monument well), per OC Public Works Standard Plan 1405, may be set in lieu of spike and washer described above. The number and location of Type "A" monuments shall be as directed by the County Surveyor.
- Monuments which fall in non-paved areas shall consist of a 1 inch diameter iron pipe with a tag. A Survey Monument Type "B", per OC Public Works Standard Plan 1406, may be set in lieu of iron pipe and tag described above. The number and location of Type "B" monuments shall be as directed by the County Surveyor.
- All tags/washers referenced above shall be stamped with the agency name or the license number of the surveyor in responsible charge.
- Tags set in iron pipes shall be of a diameter less than that of the inside diameter of the pipe.
- Under no circumstances are plastic plugs to be used with iron pipe.

Reference Points (Tie Points)
Monuments which represent tie points set for the purpose of monument perpetuation and/or preservation:

- Monuments which fall on concrete curbs or in the surface of concrete paving shall consist of a tag secured in a lead plug or set in epoxy and countersunk so as to be flush with the concrete surface.

- Monuments which fall on asphalt dikes or in the surface of asphalt paving shall consist of a spike or "MAG" nail with a washer.
- Monuments which fall in non-paved areas shall consist of a 1 inch diameter iron pipe with a tag. (rebar option removed)
- All tags/washers referenced above shall be stamped with the agency name or the license number of the surveyor in responsible charge.
- Tags set in iron pipes shall be of a diameter less than that of the inside diameter of the pipe.
- Under no circumstances are plastic plugs to be used with iron pipe.

Control Points

Monuments set as control points during the course of a survey:

- Monuments which fall on concrete curbs or in the surface of concrete paving shall consist of a tag secured in a lead plug or set in epoxy.
- Monuments which fall on asphalt dikes or in the surface of asphalt paving shall consist of a spike or "MAG" nail with a washer.
- Monuments which fall in non-paved areas shall consist of an iron pipe with a tag or disk, or a rebar with an aluminum cap. Rebar must be set a minimum of 3 inches below the ground surface.
- All tags/washers/disks/caps referenced above shall be stamped with the agency name or the license number of the surveyor in responsible charge, and shall also be stamped "CP" or "CONTROL POINT".
- Tags set in iron pipes shall be of a diameter less than that of the inside diameter of the pipe. Disks affixed to iron pipes shall be of a diameter equal to that of the outside diameter of the pipe.
- Under no circumstances are plastic plugs to be used with iron pipe or rebar.