STATE OF IDAHO

Control Point Standard

For the Geodetic Control Framework Theme

Version 1.0
Effective September 15, 2016

Revision History
5/6/19 - Removed individual definitions from the Glossary and replaced with reference to ITA Guideline G105 (ITA Glossary of Terms)
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1. Introduction to the Standard

A statewide Geodetic Control Framework is a critical source of information for all geospatial professionals including both the geographic information systems (GIS) community and professional land surveyors (PLS).

This Control Point standard is intended to improve both horizontal and vertical positional accuracy of Idaho's geospatial data using established control points that tie together the National Spatial Reference System (NSRS), public land survey system (PLSS), and other geographic features/markers to precise coordinates on the earth. Through the use of the resulting control point database both the horizontal and vertical positional accuracy of numerous geospatial datasets (e.g., parcels and roads) can be improved. This standard will also facilitate sharing of current control point data and access to these data by the broader geospatial community. This standard is not a tutorial and does not instruct on how the control point database is to be used.

This standard was developed based on the Federal Geographic Data Committee (FGDC) Geospatial Positioning Accuracy Standards. The standard was reviewed by the Idaho Geodetic Control Technical Work Group (GC TWG) for The Idaho Map (TIM) and will be updated as needed.

1.1. Mission and Goals of the Standard

The purpose of this data standard is to specify a common method for identifying and recording control point features for application in Idaho by mapping professionals, land surveyors and engineers, and GIS professionals. Since it is based on national models, the geospatial data maintained according to this standard can be exchanged with entities in other states and the federal government.

This control point standard supports a statewide infrastructure that is consistent with applicable state and national standards. It establishes minimum horizontal and vertical accuracies following existing Federal standards. This standard communicates with and may have similar attributes to other Idaho Framework data standards. Furthermore, this standard encourages all Idaho agencies with geospatial data to contribute to Idaho's spatial data infrastructure.

1.2. Relationship to Existing Standards

This standard follows FGDC guidelines for geospatial positional accuracy reporting:

> "Horizontal: The reporting standard in the horizontal component is the radius of a circle of uncertainty, such that the true or theoretical location of the point falls within that circle 95-percent of the time.
>
> Vertical: the reporting standard in the vertical component is a linear uncertainty value, such that the true or theoretical location of the point falls within +/- of that linear uncertainty value of 95-percent of the time.
>
> Coordinate values should be based on National datums. If coordinate values are not referenced to the National datum but their relationship to the national datum is known, identify the datum and its relationship to a National datum."

When providing geodetic point coordinates, the FGDC recommends inclusion of a statement that these data meet a particular accuracy standard for both *local accuracy* and *network accuracy*. Local accuracy is a value that represents uncertainty at the 95-percent confidence level in the coordinates of the control point relative to the coordinates of other directly connected or adjacent control points. The reported local accuracy is an approximate average of the individual local accuracy values between this control point and other observed control points used to establish the coordinates of the control point.

FGDC defines network accuracy as a value that represents the uncertainly in the coordinates of the control point with respect to the geodetic datum (and not adjacent control points) at the 95-percent confidence level. Network accuracy for the National Spatial Reference System (NSRS) is determined using geodetic values from Continuously Operating Reference Stations (CORS) recognized by National Geodetic Survey (NGS).

The FGDC also developed the National Standard for Spatial Data Accuracy (NSSDA) by defining a statistically-based testing methodology for estimating the positional accuracy of geospatial data. The NSSDA applies to fully georeferenced maps and digital geospatial data, in either raster or vector format, derived from sources such as aerial photography, satellite imagery, and ground surveys. NSSDA uses root-mean-square error (RMSE) to estimate and report positional accuracy. RMSE is the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points. RMSE accuracy statistics and user guidelines are given in Appendix A.

The accuracy of spatial data can be reported in various ways; 1) local or network accuracy expressed as a measurement relative to a 95-percent confidence interval for control points (FGDC), and 2) RMSE (NSSDA) for mapping data. NSSDA overrides the accuracy measures based on map scale or contour interval such as that used by the American Society for Photogrammetry and Remote Sensing (ASPRS) (cf., Accuracy Standards for Large-Scale Maps). To assist the geospatial professional, a cross-reference between NSSDA and the ASPRS standard is given in Appendix B to ensure users can assess positional accuracy of spatial data.

1.3. Description of the Standard

This standard includes the elements necessary to accurately identify geospatial features which will act as control points for other geospatial datasets. In addition, this standard describes the data structure for control points in the state of Idaho. This standard is designed to be:

- Simple, easy to understand, and logical
- Uniformly applicable, whenever possible
- Flexible and capable of accommodating future expansions
- Dynamic in terms of continuous review

1.4. Applicability and Intended Uses

This standard can be applied to all control point data in Idaho and the digital representation of these geospatial features. When implemented, it will enable access to both the geometry and attribution information describing Idaho's control points to support both mapping and surveying activities. It will increase interoperability between geographic information systems (GIS) and enable sharing and efficient transfer of information for aggregation. Further, this standard will encourage partnerships between government, private sector, and the public in order to avoid duplication of effort and ensure effective management of information resources. Finally, this Control Point standard will help improve cartographic and engineering data quality as errors will be more easily identified and resolved[1].

1.5. Standard Development Process

The National Standard for geospatial positional accuracy was adopted by the Federal Geographic Data Committee in 1998 to support the needs of the geospatial community relative to understanding and documenting accuracy of horizontal and vertical coordinate values for geodetic control points as well as to support positional accuracy for mapping, surveying, and engineering programs. The Idaho Geodetic Control Technical Working Group (GC-TWG) was formed in 2011 following an FGDC CAP grant (Multi-State Planning and Implementation of Geodetic Control Framework Components). The GC-TWG began development of the Control Point Standard in November 2015.

2. Body of the Standard

2.1. Scope and Content

The scope of the Control Point Standard is to improve the relative and absolute horizontal and vertical positional accuracy of geospatial data for the State of Idaho. This will be accomplished through the development and use of control points which will act as absolute references for cadastral fabric, right-of-ways, aerial imagery, LiDAR data collection, or other GIS data layers that identify the physical location of surface features in Idaho.

2.2. Need

The Control Point Standard is a key standard for city and county GIS managers, land managers, community and business development, infrastructure management, and research. This standard provides an elemental foundation for not only the consistent depiction of mapping and engineering features, but information describing those features as well as centralized access to existing control points and their stewardship.

2.3. Participation in the Standard Development

The development of the Control Point Standard adheres to FGDC Standards. This standard will be reviewed in accordance with technology updates and the requirements of the geospatial community. Broad participation and input by stakeholders in the development of this standard is encouraged. The process will be equally broad for input regarding updates and enhancements to the standard. As with all Idaho Framework standards, public review and comments on the Control Point Standard is encouraged.

2.4. Integration with Other Standards

The Control Point Standard follows the same format as other Idaho geospatial framework data standards. The standard may contain some of the same attributes as other framework standards and may adopt field names, definitions, and domains from other standards to promote consistency.

2.5. Technical and Operational Context

[1] This standard does not consider data sharing agreements, contracts, transactions, privacy concerns, or any other issues related to the acquisition and dissemination of Geodetic Control Point data.

2.5.1. Data Environment

The data environment is a digital model, containing vector point features with a specific, standardized set of attributes pertinent to the geodetic control point framework. Control point data shared under this standard must follow this format[2].

2.5.2. Reference Systems

Control points will be published in Idaho Transverse Mercator (IDTM), North American Datum of 1983 (NAD 83) as the horizontal datum and North American Vertical Datum of 1988 (NAVD 88) as the vertical datum. IDTM is the State of Idaho's single-zone coordinate system. Data is not required to be submitted in the ITDM spatial reference system but must have a defined coordinate system clearly described in the metadata.

2.5.3. Global Navigation Satellite Systems (GNSS)

Much of the geospatial control point data will contain geometry developed from Global Navigation Satellite Systems (GNSS; e.g., GPS, Glonass, and Galileo) methods, and the provided metadata will describe this, where applicable. Where GNSS is used, it is important that the most current geoid model be used for all surveys involving GNSS, and that attribution of those points correctly describes the geoid model and epoch used. Geometry from GNSS is not required to meet this standard.

2.5.4. Accuracy

Accuracy is the measure of the degree of uncertainty relative to the position of a control point. The Idaho control point standard requires +/-10 cm horizontal accuracy, and +/-20 cm vertical accuracy following the FGDC definition of network accuracy. Control points not meeting this accuracy standard may be submitted and included in the control point database, and will be identified accordingly in the Accuracy Assessment field (cf. table 1).

2.5.5. Local Construction Control

All control points must be referenced to the National Spatial Coordinate System and have a fully defined spatial reference system. Local coordinates will not be accepted as control points.

2.5.6. Attributes

Required and optional attributes for all control points are described in Section 3 of this standard.

2.5.7. Stewardship

Perpetual maintenance and other aspects of lifecycle management are essential to Idaho's spatial data infrastructure. The GIS Training and Research Center at Idaho State University currently hosts and maintains the Multi-State Control Point Database (MCPD) which contains control points submitted by professional land surveyors. These points are typically collected during cadastral boundary and construction surveys, and later submitted

[2] To assist in the preparation of control points, a spreadsheet template has been developed by the GC-TWG and is available from http://giscenter.isu.edu/research/Techpg/GC/

to the MCPD. The Geodetic Coordinator/Geodetic Advisor for Idaho, or his/her delegate shall act as the data steward for the current MCPD. The data steward will review all control points submitted for inclusion in the MCPD relative to this standard, and work with the submitter to resolve all issues prior to upload and inclusion of each control point into the MCPD. The MCPD, until made obsolete by later standards, shall be the authoritative source for control points in the state of Idaho.

In the event that a national control point database is created, the control points within the MCPD shall be exported for inclusion in the national database. Currently, the MCPD shall be considered the authoritative source for control points in Idaho.

3. Data Characteristics

3.1. Minimum Attributes for Control Point Database

The following attributes are required to be met for point data to be considered a control point and included in the control point database:

3.1.1. Lineage, or data source must be specified. This is the surveyor name and surveyor ID

3.1.2. The horizontal coordinate attribute values must be reported in latitude and longitude (optional easting/northing values along with a full spatial reference system description (WKID or EPSG code) may be included using the AltNORTHING and AltEASTING fields).

3.1.3. Positional accuracy of +/-10 cm (horizontal) and +-/20 cm (vertical) is expected but not required for database submittal. All points meeting this accuracy will be noted in the AccuracyAssesment field.

3.1.4. Spatial reference system shall be clearly identified (datum, projection, and coordinate unit of measure). WKID or EPSG code may be used.

3.1.5. For temporal consistency, date of data collection as well as the datum and epoch needs to be specified.

The following attributes are required for control points to be added to the Multi-State Control Point Database (MCPD).

Table 1. Required documentation fields for Idaho control points

Field Name	Data Type	Length	Description	Examples
ControlPoint_ID	String	68	Point Identifier for Survey Controls	ID****
ProviderID	String	25	Surveyor License Number	ID****
SurveyorProjectID	String	68	Unique Identifier for Submitted Project	ID****-SPT-**
DateEntered	Date		The day the data was collected in the field.	11/7/2013 1:46:34 PM
DateUpdated	Date		The Day the data was updated in MCPD database.	11/7/2013 1:46:47 PM

Latitude	Double		Northing Y-Coordinate value, , expressed in decimal degrees with sufficient number of decimal digits to support the horizontal positional accuracy estimation	42.85504314
Longitude	Double		Easting X-Coordinate value, expressed in decimal degrees with sufficient number of decimal digits to support the horizontal positional accuracy estimation	-112.42319923
Horizontal Accuracy	Double		Estimated network accuracy for the horizontal coordinates.	0.01 (meters)
HDatum	Short Integer		Horizontal Datum. For example, specify North American Datum 1983 (NAD83) with Adjustment Epoch such as, NAD83 (2011) or NAD83 (2007), NAD83(CORS96).	NAD83(CORS96)
HUnits	Short Integer		Horizontal Units in Geographic or Projected Coordinates Units.	US Survey Feet
HMethod	Short Integer		Specify the method used to create horizontal coordinate.	OPUS
HAccuracyUnits	Short Integer		Horizontal Accuracy Units. Specify the unit for horizontal accuracy	US Survey Feet
CoordSys	Short Integer		Reference System that is used to define the point	GRS80
CoordSysRealizationEpoch	Short Integer		Adjustment Epoch such as, NAD83 (2011) or NAD83 (2007), NAD83(CORS96).	NAD83(2011)
Vertical Coordinate	Double		Elevation or Orthometric Height	5951.917
VUnits	Short Integer		Vertical Units. Specify units of the vertical coordinate.	US Survey Feet
VDatum	Short Integer		Vertical Datum. US vertical datum for elevation. North America Vertical Datum of 1988 (NAVD 88).	NAVD88
VMethod	Short Integer		Vertical Method. Select the method used to generate the vertical coordinate.	GPS and Geoid Model 2003
VerticalAccuracy	Double		Estimated network accuracy for the vertical coordinate	0.15 (meters)
VAccuracyUnits	Short Integer		Vertical Accuracy Units. Specify units of the vertical accuracy. International Feet, US Survey Feet or Meter	US Survey Feet
AccuracyAssesment	Short Integer		Results of evaluation by the data steward describing if the point satisfied minimum horizontal and vertical accuracy	Both horizontal and vertical accuracy requirements met

The data steward will evaluate all control points submitted for inclusion to the control point database and determine if each control point satisfies the horizontal (+/- 10 cm) and vertical accuracy (+/- 20 cm) requirement within 95-percent confidence intervals. The results of the evaluation will indicate whether the point satisfied “horizontal accuracy only”, “vertical accuracy only”, “both horizontal and vertical accuracy requirements were met”, or “horizontal and vertical accuracy requirements were not met”.

3.2. **Additional Attributes for Control Point Database**

The following attributes exist in the current MCPD and are considered optional.

Table 2. Additional/optional documentation fields for Idaho control points

Field Name	Data Type	Length	Description	Examples
MCPD_ID	Integer	4	Unique ID for the Point	
GCDBPOINTID	Text	25	The full unique GCDB ID for the point.	ID080160S0430E0_540500
GCDB_PtLab	Text	10	GCDB 6 digit code point label.	540500
PT_Name	String	50	Surveyor's name for the Point	Q 49 RESET 1935
DataID	Short Integer		Dataset ID	CPP
HAccuracyConv	Short Integer		Horizontal Accuracy Convention. Network horizontal accuracy is expected	Network Horizontal Accuracy
VAccuracyConv	Short Integer		Vertical Accuracy Convention. Network vertical accuracy is expected	Network Vertical Accuracy
ALTNORTHING	Double	8	Alternate northwards coordinate in the point positioning	132027.880
ALTEASTING	Double	8	Alternate eastwards coordinate in point positioning	179034.079
Alt_Coord_System	Short Integer		Reference System that is used to define the point such as UTM	Idaho State Plane East US Feet
Alt_Coord_System_zone	Short Integer		Universal Transverse Mercator (UTM) Zones for Idaho	Idaho State Plane East
Alt_Coord_System_Code	Text	10	WKID or EPSG code	
AltHorizontal accuracy	Double	8	Relative accuracy of alternate horizontal coordinate	0.1
AltHUnits	Short Integer		Alt Horizontal Units. Units of alternate horizontal coordinates.	Decimal Degrees
AltHAccUnits	Short Integer	5	Alt Horizontal Accuracy Units	US Survey Feet
Field ScaleFactor	Double	8	Ground Scale Factor. Surveyor's Project Scale Factor	
STATE	String	2		ID

COUNTY	String	25		BEAR LAKE
T	Short Integer		Township	16
TDir	Short Integer		Locates the township North or South in relation with a PLSS baseline	S
R	Short Integer	5	Name of the Range in which the monument falls. If more than one, enter the Range that was the focus of the survey, or the lowest number Range, Enter only one Range number.	43
RDir	Short Integer	3	Locates the Range East or West in relation with the PLSS meridian	E
S	Short Integer		Section in which the monument falls. If more than one, enter the Section that was the focus of the survey, or the LOWEST number Section. Enter only one section number.	27
Corner	Short Integer		PLSS Corner	Yes
MonDesc	String	125	A description of the physical monument	BRCAPF
Meridian	Short Integer		Public Land (USPLS) meridian	Boise
PtType	Short Integer		Type that this point represents.	Horizontal and Vertical Control Station
MonType	Short Integer		Type of material of which the monument is constructed.	Rebar
Cap	Short Integer		Monumentation Cap Type. Select the type of cap that is on the monument.	Brass Cap
ControlPt Status	Short Integer		Describes the condition at which point was found. This includes the existing condition or the point is missing/not found.	Public
CornerDes	String	20	Corner Designation. Specifying what is the corner	N 1/4
HorizontalAccuracy Assessment	Boolean	Y/N	Results of evaluation by the data steward describing if the point satisfied minimum horizontal accuracy	horizontal accuracy requirements met
VerticalAccuracyAssessment	Boolean	Y/N	Results of evaluation by the data steward describing if the point satisfied minimum vertical accuracy	vertical accuracy requirements met

Appendix A: Accuracy Statistics for Geospatial Data according to NSSDA

1. Determine Horizontal Accuracy
   The test involves 20 check points distributed to reflect the area of interest, and the accuracy is reported at the 95% confidence level which allows one point (5%) to fail accuracy threshold given in the product specifications.

   Let:
   $RMSE_x = sqrt[\sum (x_{data,i} - x_{check,i})^2 / n]$
   $RMSE_y = sqrt[\sum (y_{data,i} - y_{check,i})^2 / n]$
   Where $x_{data,i}$ $y_{data,i}$ are the coordinates of the i th check point in the dataset,
   $x_{check,i}$, $y_{check,i}$ are the coordinates of the i th check point in the independent source of higher accuracy,
   n is the number of check points tested,
   i is the integer ranging from 1 to n.

   Horizontal error at point i is defined as, $sqrt[(x_{data,i} - x_{check,i})^2 + (y_{data,i} - y_{check,i})^2]$.
   Horizontal RMSE is,
   $$RMSE_r = sqrt[\sum ((x_{data,i} - x_{check,i})^2 + (y_{data,i} - y_{check,i})^2)/n]$$
   $$= sqrt[RMSE_x^{\,2} + RMSE_y^{\,2}]$$

   When RMSE in both X- and Y-coordinates are equal, horizontal radial accuracy at the 95-percent confidence level was established as,
   $Accuracy_r = 1.7308 * RMSE_r$.

   When RMSE in both X- and Y-coordinates are not equal, horizontal radial accuracy at the 95-percent confidence level was established as,
   $Accuracy_r = 2.4477 * 0.5 * (RMSE_x + RMSE_y)$.

2. Determine Vertical Accuracy
   Let:
   $RMSE_z = sqrt[\sum (z_{data,i} - z_{check,i})^2 / n]$
   Where $z_{data,i}$ are the coordinates of the i th check point in the dataset,
   $z_{check,i}$ are the coordinates of the i th check point in the independent source of higher accuracy,
   n is the number of check points tested,
   i is the integer ranging from 1 to n.
   Vertical accuracy at the 95-percent confidence level, $Accuracy_z = 1.9600 * RMSE_z$.

Appendix B: Relationship between NSSDA and ASPRS Accuracy Standards

1. Horizontal Accuracy
   ASPRS horizontal map accuracy is evaluated by the RMSE for the x-component and y-component individually, and positional accuracy is reported at ground scale.
   Assuming $RMSE_x = RMSE_y$, the x- and y-component can be estimated according to NSSDA:
   $RMSE_x = RMSE_y = Accuracy_r / 2.4477$
   The limiting RMSE for Class 1 map is shown in the table B1.

Table B1. ASPRS Accuracy Standards for Large-Scale Maps Class 1 horizontal (x or y) limiting RMSE for various map scales at ground scale

Planimetric Accuracy Limiting RMSE (meters)	Typical Map Scale
0.0125	1:50
0.025	1:100
0.050	1:200
0.125	1:500
0.25	1:1,000
0.50	1:2,000
1.00	1:4,000
1.25	1:5,000
2.50	1:10,000
5.00	1:20,000

2. Vertical Accuracy
   ASPRS vertical map accuracy is evaluated as the RMSE in terms of project's elevation datum for well-defined points only. For class 1 maps, the limiting RMSE is set at 1/3 of the contour interval.
   The vertical error component can be estimated according to NSSDA:
   $RMSE_z = Accuracy_z / 1.9600$

The ASPRS horizontal and vertical accuracy standards are both relaxed by factors of 2 and 3 for class 2 and class 3 maps, respectively.

Appendix C: References

American Society for Photogrammetry and Remote Sensing (ASPRS) Specifications and Standards Committee, 1990, ASPRS Accuracy Standards for Large-Scale Maps: Photogrammetric Engineering and Remote Sensing, v. 56, no. 7, p. 1068-1070.
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Appendix D: Glossary

See ITA Guideline G105 (ITA Glossary of Terms) for definitions.

Appendix E: Acronyms

ASPRS: American Society for Photogrammetry and Remote Sensing
BLM: Bureau of Land Management
FGDC: Federal Geographic Data Committee
FGCS: Federal Geodetic Control Subcommittee
GC-TWG: Idaho Geodetic Committee-Technical Working Group
GNSS: Global Navigation Satellite System
IDTM83: The Idaho coordinate system of 1983, single zone as described in 55-1705 (4) Idaho Code
IGC: Idaho Geospatial Council
IGC-EC: Idaho Geospatial Council Executive Committee
ITA: Idaho Technology Authority
MCPD: Multi-state Control Point Database
NGS: National Geodetic Survey
NSRS: National Spatial Reference System
NSSDA: National Standard for Spatial Data Accuracy
P5030: Idaho Technology Authority Framework Standards Development Policy 5030
PLS: Professional Land Surveyor
PLSS: Public Land Survey System
S4220: Idaho Technology Authority Geospatial Metadata Standard 4220
SDI: Spatial Data Infrastructure
TIM: The Idaho Map
USDA: United States Department of Agriculture – Forest Service
USDI: United States Department of the Interior – Bureau of Land Management
USFS: United States Forest Service