STANDARD ON
Digital Cadastral Maps and Parcel Identifiers

A criterion for measuring fairness, quality, equity and accuracy

(Approved January 2015)

IAAO
INTERNATIONAL ASSOCIATION of ASSESSING OFFICERS
Valuing the World

Standard on Digital Cadastral Maps and Parcel Identifiers

Approved January 2015

International Association of Assessing Officers

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Standard on Digital Cadastral Maps and Parcel Identifiers

1. Scope

This standard provides recommendations on the development and maintenance of a digital cadastral mapping program for the purpose of assessing real property. It describes a digital cadastral mapping system program, its components, cadastral data, content, design, creation, maintenance, contracts, and administrative controls within the context of a multipurpose cadastre. It also discusses the processing of title records, and parcel identifiers, and parcel identification systems. This standard also addresses the interaction between the creators and maintainers of cadastral map data layers, users of broader geospatial information systems, and consumers of multipurpose cadastral data, and provides context for those interactions. State mapping functions not related to the construction of cadastral layers are not addressed in this standard. Technical aspects and recommendations may also be applicable to contractual services and state and provincial systems provided for local assessor use. International aspects are addressed in the paper "Guidance on International Mass Appraisal and Related Tax Policy," issued by IAAO in January 2014. For information on manual cadastral mapping see the *Standard on Manual Cadastral Maps and Parcel Identifiers* (IAAO 2004).

2. Introduction

Cadastral maps for the entire jurisdiction, regardless of taxable status or ownership, are essential to the performance of assessment functions. Digital cadastral maps enable the assessor to more efficiently access parcel location and information, reveal geographic relationships that affect property value, and provide a platform for the visualization of data layers and analytical results. Digital cadastral maps also aid the assessor in meeting the digital demands of other local government users, such as planning and public works departments, and private business users.

The assessor is often recognized as the authoritative source of valuation and cadastral spatial data, which are integral to many nonassessment functions of other governmental agencies and the private business sector. Data aggregation companies acquire, manipulate, rebrand, and resell assessor valuation and spatial data. Companies in the finance, insurance, and real estate sector incorporate assessor data into their business model for data validation and cost savings because the granularity of assessor data exists nowhere else. A comprehensive digital cadastral program enables the assessor to fulfill this expanded data provider role.

Some nations are likely to embrace different divisions of cadastral mapping responsibilities, that is, among multiple national agencies and levels of government (e.g., the cadastral agency, the ministry of finance, and local levels of government).

2.1 The Role of the Assessor

The assessor may assume many different roles in the management, maintenance, and stewardship of a jurisdiction's digital cadastral mapping system. The assessor, or an authorized agent, should be the data steward for parcel and assessment data and possess the ultimate authority to inventory, create, and define all parcels and other cadastral layers. The assessor should maintain parcel identifiers for assessment purposes. The assessor may be involved in creating and maintaining data related to the parcel map, such as street centerlines, zoning, and other multipurpose layers. In contrast, the role of the assessor may be limited to maintaining all cadastral layers and parcel identifiers, leaving responsibility for other noncadastral data layers to other offices or to a jurisdiction-wide geographic information system (GIS) agency or information technology (IT) department. Additionally, the assessor should work closely with GIS or IT agencies that creates and maintain GIS data, including cadastral data, to ensure continuity and standardization for business processes.

The assessor should track current ownership of all parcels via the recording of deeds and other documents conveying title so that the responsible party can receive assessment and tax notices. The function of processing title documents may be performed by cadastral mappers. In larger jurisdictions this function may be performed by a separate department. Nevertheless, deed processing and cadastral mapping are functionally related through the review of ownership and the interpretation of property descriptions and should be organizationally linked in the assessor's office.

The assessor should address policy-level matters, such as how the overall mapping program is integrated in a multipurpose data-sharing environment. Policies for program financing, stewardship or ownership of data, communication frequency, and sharing and transferring of data, for example, should be documented.

2.2 The Value and Importance of Digital Cadastral Maps

Users working with digital cadastral maps and tabular parcel-related data in a digital cadastral mapping system can selectively retrieve and manipulate layers of parcel and spatial information to produce composite maps displaying only the data layers desired or the results of assessment analysis. Digital cadastral maps and systems are an integral part of a comprehensive assessment system, without which a complete picture of the interests and value of the land and improvements to the land is not possible. Digital cadastral maps allow file-sharing over a network to make parcel data widely available. Data-sharing allows users to download data, prepare maps, and design and deploy sophisticated queries. Digital cadastral map systems are increasingly important as a source of data that extends beyond local assessment. Locally maintained data are increasingly recognized as the best available, most authoritative data source for many applications. Aggregating locally maintained data from many jurisdictions creates a valuable resource for regional, state, and national uses.

2.2.1 Value to the Assessor

Examples of the benefits of digital cadastral maps to the assessor qare as follows:

- Provides a complete inventory of real property.
- Aids in equitable valuation.
- Provides accurate land area using coordinate geometry.
- Allows for the capture of cadastral genealogy.
- Enables complex queries, analysis, and visualization of results.
- Provides for speed, production, and ability to disseminate geographically referenced information.
- Provides ease of use for the generation of reports and mailing lists.
- Provides a base for mobile applications and interactive web applications.
- Provides a base for additional value-added products and software.

2.2.2 Value to Other Users in a Multipurpose Cadastre Environment

Examples of the benefits of digital cadastral maps to other users are as follows:

- Provides a spatially accurate resource upon which to build value-added noncadastral data layers.
- Facilitates emergency response and disaster management services.
- Provides economies of scale through data aggregation and sharing.
- Provides a base for citizen access web applications.

3. Core Components of a Digital Cadastral Mapping System

A digital cadastral mapping system in a multipurpose environment should have the following core components:

- A geodetic control network based in a mathematical coordinate projection.
- A cadastral parcel layer delineating the boundaries of real property in the jurisdiction.
- A unique parcel identifier assigned to each parcel.
- Other cadastral layers related directly to the parcel layer, such as subdivision, lot and block, tract, and grant boundaries.
- Digital aerial orthophotographs.
- A computer system that links spatial data and parcel attribute data.

3.1 Geodetic Network

A geodetic network consists of monument points whose locations on the surface of the earth are defined with certainty. For the purpose of creating cadastral layers, these points are typically monument survey points, such as a U.S. Public Land Survey System (PLSS) corner or subdivision/plat corner. These points may be described in terms of latitude and longitude but are more commonly projected to a coordinate system, such as state plane coordinates. Density and placement of control points should be related to map scale, population density, property value, accuracy specifications, and anticipated product life span. Professional land surveyors use Global Navigation Satellite Systems (GNSS) and real time kinematic (RTK) satellite navigation to locate points with accuracy in the subcentimeter range.

The assessor and cadastralist should work closely with other professionals, such as engineers and surveyors, or with contract professionals if necessary, to assess the quality and completeness of data points that may already exist in a geodetic network and that relate to the creation of cadastral layers. If necessary, geodetic coordinates may need to be collected on additional data points to ensure densification of the network sufficient for the creation of cadastral layers. The geodetic network, and data points consisting of monument corners contained therein, must be associated with the cadastral elements being mapped. In other words, corners collected as part of the network should correspond directly to a cadastral corner, a PLSS corner, a subdivision monument, or a specific parcel corner. The assessor and cadastralist should be aware that many monuments on the ground have no relationship to land ownership. If new geodetic coordinates are being collected, both the assessor and the data collector must have an understanding of the points that will serve the creation of the cadastral data.

3.2 Imagery

Vertical aerial photographs have long been an essential imagery product for developing the cadastral map. Imagery has greater value when all distortions have been removed, it is tied to a geodetic control network, can serve as a base map, and meets the measurement tolerances required for use with a cadastral layer or as a base for the construction of the cadastral layer. Such images are called orthophotos, orthorectified images, or *orthos*. Orthophotos are most commonly provided in a digital form either in black and white or in color. Digital color orthophotos are the standard imagery product of most assessment agencies with digital mapping programs. At a minimum, jurisdictions should acquire new imagery of urban areas every five years and of rural areas every ten years. Jurisdictions experiencing rapid or slow growth or without construction permitting requirements should adjust this timetable. Partnering with other agencies that also derive a benefit from aerial imagery, such as law enforcement, fire rescue, emergency management, public works, engineering, utilities, planning, economic development, and aviation authorities, may allow for acquisition on a shorter timetable (annually in some cases), reduced costs, and a higher image resolution.

Oblique imagery has many uses for the assessor and geospatial professionals, but measurements from oblique imagery should not be used in the construction of cadastral data such as subdivision, lot, and parcel lines.

In some areas, orthoimagery can serve as a base or "base map" for the construction of both cadastral and noncadastral map layers. Any imagery used as a base for the construction of cadastral map layers should be tied to a geodetic network. The term *base map* also has a more traditional meaning. Traditional base maps locate major physical features of the landscape and are typically prepared by professional photogrammetry firms using photogrammetric methods and may include attributed lines (e.g., roads, edge of pavement, curbs, ditches, and fences, and so on), polygons (e.g., elevation contours, water bodies, building footprints, and so on), and points (e.g., power poles, fire hydrants. and the like). This traditional form of base map production can be costly when used solely for purposes of assessing. Because of rapid advancements in the quality, resolution, and production of digital color orthophotos, few assessors still contract for the traditional base map containing photogrammetrically derived features.

In more rural and remote areas, base map needs may be met by a national mapping program's digital topographic maps or orthophotoquads or by other orthoimages. Examples are the U.S. Geological Survey Digital Raster Graphics (DRGs) or Digital Line Graphs (DLGs), the National Aerial Photography Program (NAPP), and the National Agricultural Imagery Program (NAIP).

An advanced digital cadastral mapping system should contain a digital terrain model (DTM) or digital elevation model (DEM) that will enable a three-dimensional representation of the ground. This allows the assessor to visualize geographic features, such as flood plains or lot views. The DEM/DTM will also provide the foundation for development of orthophotos (orthorectification). The traditional DEM/DTM product was developed through stereo image models obtained in conjunction with aerial orthophotography. However, jurisdictions may now acquire high-resolution digital elevation data through a separate remote sensing process that employs airborne LIDAR (light detection and ranging) technology. Assessors acquiring or updating digital elevation data should review and consider the costs and benefits of LIDAR for this purpose. Aerial imagery and any photogrammetric work performed to delineate or extract surface features should meet industry-recognized standards for scale, positional accuracy, resolution, and other requirements (URISA and IAAO 1999; U.S. Geological Survey 1986; FGDC 1998a, b; and American Society of Photogrammetry and Remote Sensing 1990).

3.3 Core Cadastral Map Layers

Core cadastral map layers are layers relating directly to the ownership and description of property. All core cadastral layers should be constructed as polygons, attributed with its unique associated data, and tied to the geodetic network.

At a minimum, core cadastral map layers should consist of the following:

- A PLSS layer, if geographically applicable
- Subdivision, plat, and condominium boundaries as recorded or filed
- Block and lot boundaries as recorded or filed
- Parcel boundaries; platted and unplatted, both taxable and nontaxable.

Cadastres may include layers containing data referenced in property descriptions and related to property ownership boundaries. Examples include PLSS section, township and range lines; government lot lines; government grant lines; road right-of-way ownership; street centerlines; railroad right-of-way ownership; hydrography; and normal high water lines.

3.4 Parcel Identifiers

Each parcel polygon should be attributed with a unique identifier. The parcel identifier provides a common index for all property records. Each parcel should be keyed to a unique identifier or code that links the cadastral layer with files containing such data as ownership, building and land value, use, and zoning. Parcel identification systems are detailed in Section 7.

3.5 Elements of a Digital Cadastral Mapping System for Use in a Multipurpose Cadastre Environment

A digital cadastral mapping system within a multipurpose cadastre environment includes the data supporting the creation of the cadastral data layers, the cadastral map layers, accompanying records, and the resources for all cadastral mapping functions. In the digital environment, the system should be designed to work seamlessly as a key component within a larger geospatial system. The map projection used should produce the least amount of distortion and be the most appropriate for the jurisdiction. The system should be well documented with metadata that explain how it was created and how it will be maintained. Metadata should conform to the Federal Geographic Data Committee (FGDC) *Geospatial Metadata Standard*.

3.6 Additional Map Layers in a Multipurpose Cadastre

A multipurpose cadastre should have a variety of layers that support the work of the assessor and other users such as municipalities or taxing authorities and school districts. Examples of layers are as follows:

- Taxing districts
- School districts
- Economic districts
- Appraisal neighborhoods and market areas
- Zoning, future land ue
- Street centerlines
- Soil types, floodplains
- Billboards, cellular towers
- Land line layer delineating various assessment land uses and valuations of multiuse parcels.

Examples of additional layers that typically rely upon the cadastral parcel foundation, or that can be tied to or integrated with the digital cadastral mapping system through either a common spatial reference or related attribute to serve a multipurpose cadastre function are as follows:

- Political boundaries
- Jurisdictional boundaries
- Utility and transit infrastructure
- Points of interest such as locations of fire and police stations, public buildings, parks, schools, and hospitals
- Layers supporting public safety, emergency management, site and occupancy address information, broadband Internet access, public land records coordination, energy development, planning, and economic development.

Metadata that are machine readable, as well as human readable, should exist for all layers.

3.7 Map Products

The assessor should be capable of providing cadastral data in a variety of formats. Providing access through the Internet, either as a map viewer or data download, allows for easy public access. An internal Intranet can provide similar access to all offices in the jurisdiction. A virtual private network (VPN) can facilitate data dissemination and sharing with stakeholders at remote sites. A geospatial personal document format (PDF) provides the user with the ability to control data layers inside the PDF.

Regardless of the level of technological capabilities of the office, the assessor should be capable of providing printed cadastral maps. At a minimum, digital cadastral maps should include and be capable of displaying or printing the following elements:

- Boundaries of all parcels as polygon features
- Parcel identifiers
- Parcel dimensions as platted, deeded, or where otherwise known
- Parcel area
- Subdivision or plat boundaries as originally platted
- Subdivision or plat names and book and page number where recorded
- Block and lot lines as originally platted and block and lot numbers
- Boundaries and names of political subdivisions, such as counties, towns, townships, and municipalities
- Boundaries and names of geographic subdivisions such as section, township, and ranges, government lots, land districts, and land lots or grants
- Locations and names of streets, highways and right-of-ways, alleys, railroads, rivers, lakes, and other geographic features
- Situs addresses
- Appraisal boundaries such as market areas, neighborhoods, zoning/use, soils, floodplains, and so forth.

Cadastral maps in printed form should include other basic information and cartographic elements such as map scale, map legend, north arrow, map sheet number if applicable, title block, key or link to adjoining maps, quality standard achieved, date of publication, date of last update, and a disclaimer, caveat, or notice of intended use.

3.8 Program Management

Mapping program management includes supervision or coordination of the following:

- Cadastral and associated map layers (e.g., spatial, image, and text data)
- Ownership records
- Parcel genealogy
- Quality control
- Archival processes
- Data changes for annual tax roll
- Contractual mapping services
- Data stewardship responsibilities
- Sharing and selling of map products
- Metadata files
- Hardware and software acquisition
- Review, testing, and maintenance of software
- Procedure manual
- Training
- Public relations
- Budget.

3.9 Staff and Training

A digital cadastral mapping program requires trained staff to administer the cadastral mapping function. When sufficient staffing levels are being determined, the following should be taken into consideration:

- Functions and tasks
- Efficiency of mapping automation, processes, and workflows
- Economies of scale
- Quantity of vertical parcels (e.g., condominiums, mineral rights) and land parcels
- Geodetic densification
- Volume and complexity of deeds and plats filed that require mapping action
- Public requests
- Use of contracted mapping services
- Creation and maintenance of layers for nonassessment purposes
- Interaction with other agencies and/or users of the data.

All mapping personnel should receive training in procedures appropriate to their tasks and job descriptions. At a minimum, mapping and deed-processing staff should understand the engineering basis of highway and railroad right-of-ways; the surveying basis of boundary creation and description throughout the history of the jurisdiction and appropriate legal principles of boundary and title law; and survey bearings and angles, correction angles, closure error, and closure tolerances. Once these basic competencies have been achieved, staff should be trained in techniques of mapping with coordinate geometry (COGO), computer-aided drafting (CAD), and/or digital cadastral mapping systems.

Data stewards who maintain and contribute data for purposes other than basic cadastral functions may require supplemental training and resources on how to use and understand digital cadastral mapping systems and geospatial data.

3.10 Procedures, Standards, and Records

A procedure manual should be developed and kept current to ensure the work is accomplished in a timely and uniform manner. At a minimum, manuals should provide jurisdictionally acceptable detailed explanations of deed processing, production and maintenance of cadastral layers, maintenance and stewardship of noncadastral layers, data schema diagrams, workflows, and procedures for obtaining, referencing, and retaining records in accordance with applicable statutes and ordinances. Map creation and maintenance processes should be included in metadata associated with the map layers.

4. Preparation for a Digital Cadastral Mapping Program

Preparation, planning, and testing are essential before a new or extensively revised digital mapping program can be fully implemented. *GIS Guidelines for Assessors* (URISA and IAAO 1999) is an introductory level guide to many of these issues; the following documents provide additional information on the subject matter:

- National Geospatial Data Asset Management Plan
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- Geographic Information Framework Data Standard Part 5: Governmental Unit and Other Geographic Area Boundaries
- Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy

4.1 Needs Analysis

The assessor must first evaluate the mapping needs of the jurisdiction and other stakeholders. Outside assistance may be required to perform a comprehensive needs analysis. The following factors should be considered:

- Applicable laws, rules, regulations, and standards
- Institutional responsibilities
- Institutionalized office functions, practices, and workflows that may have been necessary in a previous or manual mapping environment but that may not be necessary in the new or digital environment
- Project timeline
- The type of finished product and technical specifications
- Existing and future resources including personnel, facilities, software, hardware, and operating systems
- Funding availability, including funding from stakeholders invested in using the data system
- Existing infrastructure
- Infrastructure required to meet the needs of stakeholders.

4.2 Digital Cadastral Map Creation

Based on the needs analysis, a digital cadastral map can be created using one of these six general methods:

- Scanned
- Scanned and georeferenced with data points
- Trace-digitized
- Best-fit-to-ortho
- COGO
- Data model

The type of digital cadastral map selected will affect quality, accuracy, maintenance, and usability. Maps created in a data model are the most sophisticated and recommended.

4.2.1 Scanned Maps

Existing legacy paper maps or drafting film sheets can be scanned into a raster image. These maps are inexpensive to produce, require minimal training, and can be easily accessed and shared. Maintenance and rescanning of paper maps are required for updates. Legacy maps can create maintenance difficulties and perpetuate issues such as lack of geodetic reference points and original compilation errors. For small jurisdictions, in particular, these maps may be useful as an interim solution. These maps are valuable historical records that document the end of manual map maintenance and the start of digital mapping.

4.2.2 Scanned and Georeferenced with Data Points

Maps can be scanned and referenced to a geodetic control network for display with other georeferenced data layers. These maps are difficult to maintain but easy to share. Paper maps must still be maintained, rescanned, and georeferenced following revisions, resulting in cumbersome workflows. Scanned maps can have a data point placed in each parcel's approximate center (centroid). Centroid attributes such as owner name, situs address, assessed value, and property characteristics can be displayed and queried.

4.2.3 Trace-Digitized

Maps can be created with digital polygons by tracing cadastral boundaries, from orthophotographs or hard copy maps, using a high-resolution monitor and/or a digitizing table. The resulting cadastral layer can be adequate for many appraisal, planning, and analysis functions; however, parcel boundary lines have less accurate bearing and distance attributes than those created by using COGO methods. Trace digitization methods provide the benefit that vector data (such as parcel lines) can be displayed over raster images (aerial photographs).

4.2.4 Best-Fit-to-Ortho

Best-fit-to-ortho is a process in which a combination of available dimensions and orthophotos evidence are used in tandem to achieve a dimensionally and spatially accurate digitized map option. The cadastralist constructs the parcel lines using available dimensions and verifies the location using ortho imagery. Typically, this approach requires a dimensional tolerance to be established as a guideline for positioning lines to match the ortho evidence. If the ortho evidence is beyond the dimensional tolerance, lines should be left as is and an error note placed for further review. If the parcel does not have any dimensions, then ortho evidence becomes the primary source for adjustment. During this process, care must be taken not to change the parcel profile as per the original source maps. This method does not provide COGO-level accuracy; however, it is considered a valid methodology and in most cases provides a higher level of accuracy than scanned or digitized processes. Assessors should be cautioned that ortho imagery used for this method of cadastral creation should be tied to a geodetic network of sufficient density.

4.2.5 Coordinate Geometry (COGO)

Metes and bounds descriptions on source documents, such as deeds and plats, can be used to create parcels using coordinate geometry methods that utilize bearing, distance, and curve attributes to describe lines. Maps created using coordinate geometry provide more accurate land areas and are designed to retain bearings and distances as attributes to the parcel lines.

4.2.6 Data Model

The most sophisticated digital cadastral map systems use a data model that defines spatial relationships (topological rules) between different components and layers, creating an integrated suite of layers. An example would be a subdivision in which first the subdivision boundary is mapped using coordinate geometry; then blocks are mapped, which must fit within the boundary; finally, lots are mapped, which must fit within the blocks. Rules may also be set for individual parcels, which must topologically close. The publication *Cadastral Core Data Set Standard* is available and describes the FGDC parcel data model (Von Meyer and Stage 2007).

4.3 Technical Specifications

Specifications define technical aspects of the aerial imagery and/or digital mapping project and should include the following:

- Regulatory requirements and specifications
- Quality and quantity of the mapping products
- Layers and associated data to be delivered
- Positional accuracy requirements
- Geographic areas to be flown or mapped
- Tiling scheme for data
- Naming standards for data in adherence with state or national standards for data headings, columns, and fields
- Preliminary flight ground control establishment
- Map layers to be produced
- Data to be captured as attributes or annotation
- Sources of data to be used
- Topology rules for use in data models
- Procedures for quality control and product acceptance
- Designs for printed products and format for digital map files
- Documentation of processes
- Metadata to be provided
- Integration requirements

Detailed information can be found in the map portions of the *Cadastral Core Data Set Standard* of the FGDC (Von Meyer and Stage 2007). Layer and data field names should adhere to the FGDC *Cadastral Data Content Standard for National Spatial Data Infrastructure* (FGDC 2008).

4.4 Pilot Project

Any major mapping or remapping program should begin with a pilot project. The project should be representative of all levels of complexity within the jurisdiction. Completing a pilot project provides guidance on technical specifications, training needs, suitability of hardware and software, need for outside assistance, program costs, effectiveness of quality control, and work schedule.

4.5 Assembling Source Data

The first step in creating a new digital cadastral map layer or revising an existing one should be to assemble all relevant and available information, for example,

- Geodetic control network information
- List of the parcels to be mapped
- Taxing district and municipal boundaries
- Original source documents, such as government surveys
- Railroad, highway, and utility route surveys or plats
- Subdivision, town site, township, and town plats and surveys
- Condominium and timeshare plats
- Private land surveys and associated corner records
- Most recent orthophotography
- Deed descriptions for unplatted parcels and for parcels that vary from the originally platted lot and block boundaries
- Court decisions affecting parcels to be mapped
- Planimetrically derived base map data
- Previous maps and archival images
- Other sources of information to confirm names of roads and places
- Sources of geographic names
  - National map series topographic maps, such as U.S. Geological Survey topographic quadrangles
  - Geographic name databases (e.g., U.S. Geographic Names Information System [GNIS])

4.6 Contracting for Mapping Services

Consideration should be given as to whether the new map layers will be prepared in-house or obtained from an outside source. Many assessing offices may not have the expertise or resources necessary to plan for and create digital cadastral maps and implement a digital cadastral mapping program. Other governmental agencies may be able to provide assistance. If this is not possible, the jurisdiction must either acquire experienced personnel and the necessary equipment or contract with a professional geospatial firm. Staff resources, staff training on the new product, and quality assurance mechanisms must be in place to receive and verify the delivered map product.

5. Mapping System Maintenance

Map and ownership data represent a substantial capital investment. Assessors must manage and maintain this investment to maintain the system's relevance. Digital cadastral map layers and ownership databases should be maintained and published in a timely manner and on a continual basis as part of the assessment roll production cycle, and they should be fully integrated into the sales review, exemption review, and assessment review and analysis functions of the assessor's office through workflow processes. Other noncadastral map layers should be maintained by the assigned data stewards in a timely manner and on a continual basis following the publication of updated cadastral data.

5.1 Ownership Maintenance

The current owner and parties of interest for each parcel should be identified. In addition, the basis of ownership (recorded deed, contract, court decree, and so on) should be documented, should cite an instrument number, record book, page, volume, and so on of the source document, and should be linked to the cadastral parcel via a unique parcel identifier. A record of prior ownership (ownership history) should be maintained. Deeds and other ownership documents should be processed within two weeks of recording. Ownership information should then be published. Procedures manuals should provide detailed step-by-step instruction. At a minimum, maintenance of ownership databases involves the following steps:

- Collecting all relevant deeds, trusts, judgments, contracts, plats, court cases, owner requests, and other muniments of title
- Identifying the parcels affected by these documents
- Determining the effect of the documents through an interpretation of the property description, such as a simple ownership change or a change affecting parcel boundaries through splits, combinations, property line adjustments, new subdivisions, right of takings, or other map edits
- Interacting with property owners, surveyors, attorneys, title insurance companies, and other land information professionals to resolve problems when necessary
- Entering changes in the appropriate databases
- Controlling the quality of the data
- Integrating the database.

5.2 Cadastral Layer Maintenance

Procedures manuals should provide detailed step-by-step instruction; at a minimum, maintenance of the cadastral map layer involves the following steps:

- Obtaining all relevant documents
- Editing the database to effect changes of parcel lines, identifiers, and associated cadastral data layers
- Editing any noncadastral data layers for which the assessor may possess stewardship
- Performing quality control measures
- Archiving all changes affecting parcel geometry and parcel genealogy
- Distributing or publishing map data
- Collecting geodetic network data points (densification) on a contiual basis
- Correcting and improving the cadastral layer when new and more accurate data become available
- Performing daily backups of map data and periodic backups for remote site storage.

5.3 Multipurpose Map Layer Maintenance

Spatial, image, and text data for multipurpose layers comes from many sources (e.g., clerk of courts, planning, zoning, law enforcement, assessors, tax collectors, water management districts, taxing districts, emergency management agencies, fire response agencies, utility providers, public works departments) and may be used by multiple entities. Therefore, the concept of data management consortiums or data stewards is important. These collaborative groups consist of a policy-making component and a technical component to manage an intergovernmental data-sharing system. The primary entity responsible for maintaining individual multipurpose map layers must be clearly identified, as well as how the data are incorporated into a digital cadastral mapping system.

6. Quality Control

In both the creation and the maintenance of digital cadastral maps and ownership databases, accuracy must be ensured through adequate quality control.

6.1 Horizontal Spatial Accuracy

Digital cadastral map layers should be tested for horizontal spatial accuracy, and the results should be documented in metadata. Map horizontal spatial accuracy is typically expressed in one of three ways:

- The *National Map Accuracy Standard* (NMAS) (U.S. Geological Survey 1947) for large-scale maps typically requires that 90 percent of all well-defined points on a printed map should vary no more than 1/30 of an inch from their true location. Thus, if a map is drawn or compiled at a scale of 1 inch equals 100 feet, then an easily identified point on the ground should be within 3.33 feet of its true location. The NMAS is most appropriate for paper maps that are viewed only at the printed scale. This standard would be applicable only to the digital mapping environment if accuracy was described for a particular map scale (e.g., "This map layer meets NMAS at a scale of 1 inch equals 100 feet").

- The American Society of Photogrammetry and Remote Sensing (ASPRS 1990) has developed standards that define three classes of positional accuracy, based on limiting root mean square error. The quality standard is based on full (ground) scale and is well suited to large scale base maps prepared through digital orthoimagery.
- The *National Standard for Spatial Data Accuracy* (NSSDA) (FGDC 1998b) presents a rigorous statistical methodology for evaluating the positional error observed when a sample of well-defined map points varies from their true geospatial location. However, the standard does not provide positional accuracy thresholds; it merely provides a way of describing the accuracy of a digital map.

A major problem with any cadastral map, manual or digital, is that positional accuracy tends to vary within a single map layer. For example, in the township, range, and section environment, parcels close to a section corner may tend to be mapped more accurately than parcels in the center of a section; unless the center of section is a monumented control point. In the metes and bounds environment, parcels in a new subdivision with known monumented corners may be very accurate, whereas nearby parcels described by fields, fences, creeks, and roads may tend to be less accurate. Thus, while accuracy should be field tested and documented in metadata, accuracy measures must be used judiciously; their greatest value may be in pointing to areas where additional survey work or map effort should be employed. No one accuracy standard meets all needs. In an urban environment, accuracies of 1 foot or less (0.30 meters) is usually desired or necessary, whereas in rural areas, it may be sufficient to specify an accuracy of 8 feet (2.4 meters).

Assessors should be aware that the cadastralist may not possess the equipment, skills, training, qualifications, and possibly even legal authority to conduct a field test for spatial accuracy. Assessors should consider consulting with a county surveyor or engineer or with professional geospatial firms to conduct and report on matters of spatial accuracy within their cadastre.

6.2 Quality Control Processes

In both the creation and the maintenance of digital maps, cadastralists must establish and adhere to quality control processes. Cadastral layer construction processes should be documented, adhered to, and structured to facilitate topological analysis and promote quality control and correctness at each touch point. Processes can be either manual or embedded within the software. Software should be designed and configured with built-in testing for parcel topology, data integrity, and validity; this is easier in the parcel data model environment. Assessors should be aware that add-on software that works in conjunction with mapping system software may streamline quality control.

Checklists should be reviewed, tests conducted, and queries performed to ensure that all relevant documents have been gathered and properly processed and that correct ownership and map changes are reflected in the appropriate databases and map data layers.

Queries should be run to identify parcels with *null* attributes and to identify any holes or *slivers* between parcels that may not be visible to the eye. Queries should be run to ensure that all parcels in tabular databases are found in the digital cadastral map layer, and vice versa. A one-to-one correlation must be maintained between parcels in tabular databases and parcels in a digital map layer. Parcel areas, as generated and stored in the parcel polygon, should be compared to areas stored in tabular databases for review and correction of significant differences. If geospatial data edits are performed by a state oversight agency, queries should be structured and run to match the edits of the state.

Parcel polygons should be viewed with orthoimagery and older scanned maps, if necessary, in the background to visually inspect for misregistration or areas of change.

Workflows should be structured to promote accountability, timeliness of review, and coordination with tax roll production to ensure accuracy of processing.

6.3 Other Quality Control Considerations

For a cadastral map to function as a representation of the legal documents that define land title and ownership, the boundaries of parcels, lots, blocks, subdivisions, plats, government lots, land lots, land grants, and the like should be drawn as legally defined by the source document, and the map product should be capable of displaying and publishing the information.

6.3.1 Trimming

Many mapping program procedures include *trimming* of subdivision, lot, and block lines to match the ownership boundary of the parcel in situations in which an action has altered the parcel, such as when an acquisition for right-of-way purposes takes a portion of a parcel, and the parcel boundary no longer matches the original source deed, plat, block, or lot line. In these cases, the newly altered parcel should be displayed to the user and the original parcel should be archived. The practice of trimming any applicable subdivision, lot, and block lines and polygons to match the newly altered parcel is acceptable as a cadastral procedure only when the assessor also maintains the original legally defined plat, block, and lot boundaries. This practice usually requires a more complex data schema and the maintenance of multiple layers or lines for all data elements subject to trimming (a layer for the original legally defined location of the boundary and a layer for the trimmed or relocated boundary).

When trimming is deemed necessary, required, or institutionally implemented, an explanation of the practice should be included in the metadata and in the map disclaimer for other users in a multipurpose environment who may rely on, or require, the location of subdivision, lot, and block boundaries as originally defined, and for the end-user of the map product.

In the digital environment in which the cadastralist or other geospatial technician has the ability to easily control, share, view, and publish individually desired data layers or elements, the practice of trimming is unnecessary and weakens the validity of the cadastral map product as a representation of the legal source documents and the confidence level of the user. Extreme prudence should be exercised when the practice of trimming is used.

6.3.2 Parcel Area and Dimensioning

Caution should be exercised when parcel area data are published. A parcel may have multiple areas:

- System generated
- Surveyed
- COGO
- Deeded
- PLSS sectional breakdown.

A parcel attribute table may store all these areas. Great caution should be used in publishing the deeded area because of potential discrepancies. For example, a PLSS sectional breakdown parcel may be described in a deed as being 10 acres (660 feet × 660 feet). However, 30 feet may have been taken from one side for right-of-way; rendering the parcel to be only 9.54 acres (most attorneys and title companies will continue to use the description from the chain of title even in such cases), and the system-generated area based on the proportional breakdown of the section can produce a completely different (third) area.

Metadata should define the areas, and any area measurement published on a map product should be defined and distinguishable as to the type of area (system, surveyed, COGO, deeded, or sectional) for the end user. It is not recommended to publish only one type of area and exclude all others. For example, it is not recommended to publish only those parcels with a deeded area and exclude from publication areas determined by COGO, areas surveyed, areas from PLSS sectional breakdown, or areas only known to be system generated. Doing so presents an incomplete picture of the work of the assessor and could deprive end users of desired information. It is recommended the assessor provide the user with parcel table data containing all stored areas, rather than graphically labeling a parcel area through attribution or annotation, unless the source of the area is clearly indicated in the attribution or annotation and defined for the user.

Parcel boundary lines should be attributed or annotated with distance data when known from recorded documents such as plats, deeds, and right-of-way maps or from private documents such as land surveys prepared by licensed professionals. Private surveys should be copied and filed or scanned and stored. Any distance data, either attributed or annotated, that is not known by document and is generated by the mapping system software should be noted as such for the end user.

6.3.3 Edge-Matching to Adjacent Jurisdictions

Both the assessor and cadastralist must recognize that cadastral data in a multipurpose environment are shared among users and agencies that compile cadastral data on a multijurisdictional, state-wide, and national level for a variety of uses. One such use is analysis during disasters such as wildfires or weather events such as hurricanes. Events such as wildfires and hurricanes do not stop at township or county lines. State emergency managers and the Federal Emergency Management Agency (FEMA) compile cadastral data for events spanning numerous jurisdictions. Cadastral data should edge-match as coincident lines and polygons between adjacent jurisdictions to facilitate these types of uses.

Another use of coincident jurisdictional polygons is state-wide analysis. Geospatial analysis using parcel data is performed by state property tax oversight agencies, economic and demographic research agencies, and state universities.

The assessor and cadastralist should work with adjacent jurisdictions to review all parcels along their township or county boundaries. Monumented points shared by multiple jurisdictions should be agreed upon and adhered to in the geodetic network and cadastral data so that no gaps or overlaps exist between each agency's respective cadastral polygons. This will also ensure no lands are omitted from assessment or double assessed among the jurisdictions.

6.3.4 Parcel Discrepancies

Digital cadastral layers (subdivision, lot, block, parcel) of individual parcels or groups of parcels often have gaps, overlaps, closure errors, or nonconformity compared to ground occupation. Decisions on addressing such discrepancies should be based on the following:

- Mapping and boundary law, such as principles of junior and senior rights, priority of 'calls' in a property description, latent error verses patent error, water boundaries, and adverse possession
- Surveying techniques and technology, such as the need to rotate descriptions to a common basis of bearing
- Land division systems affecting the jurisdiction, such as the evolving PLSS and/or Spanish, French, Dutch, or English colonial practices (Price 1995) in North America
- Capabilities and limitations of the software being employed, such as the ability to snap, extend, trim, generalize, adjust closure by compass rule, and use of topological rules
- Intent of the description
- Good judgment and common sense.

The goal should be to produce a final cadastral map product with seamless polygons. Gaps or overlaps between parcels should not be displayed. Parcel polygons should not overlap, creating a double assessment, either real or perceived, and no gaps should exist between jurisdictions, creating a situation whereby land escapes assessment.

The assessor or mapper should bring significant parcel discrepancies to the attention of the property owner, the attorney or title company, or other party involved in the property conveyance, private surveyors, and if necessary, the county surveyor for resolution.

Discrepancies should be documented and include recommendations from the cadastralist on how to address the issues and reasons for the visual display the parcels to the public. Documentation should include annotations attached to points, lines, or areas on the map and stored in a data layer specifically for such purpose.

7. Parcel Identifiers

Parcels in a digital cadastral map layer must be linked to assessment data. The key link between parcels and tabular data is the parcel identifier (also referred to as the PIN (parcel identification number) or the PID (parcel ID). A PIN or PID can consist of numbers, alpha characers, code(s), or combinations thereof to identify one parcel. For the purpose of this standard, PIN is used.

The PIN should be defined and recognized as the official reference to all documents or data for each parcel. All jurisdictions in a state or province should use the same primary system of parcel identification. Various secondary identifiers also may be used to index parcel data; however, all the secondary identifiers must be cross-indexed to the PIN.

7.1 Desirable Characteristics

Many formats of parcel identifiers are in use. Whether in use or proposed, a PIN should be judged based on six attributes: compliance with standards, uniqueness, permanence, simplicity and ease of use, ease of maintenance, and flexibility.

7.1.1 Compliance with Standards

If a state, regional, or local parcel identifier format has been adopted, a jurisdiction should follow it. In addition, various national PIN formats have been proposed (PRIA 2003), but not yet mandated.

In the United States, at the federal level, the National Academy of Science suggests a *national parcel number* could simply add an appropriate Federal Information Processing Standards (FIPS) code, developed by the National Institute of Standards and Technology, to the front of each jurisdiction's existing PINs (National Academy of Science 2007). In 1995, the FGDC Cadastral Subcommittee developed the *Cadastral Data Content Standard for National Spatial Data Infrastructure* (2008), which identifies parcel core data useful to many stakeholders and suggests that this information be captured and maintained by assessors. The core data elements are described the Appendix.

7.1.2 Uniqueness

Uniqueness is the most important attribute of a PIN. Ideally, there should be a one-to-one relationship between a parcel and its identifier. This relationship may not be achievable because of assessment limitations *caps*, taxing district boundaries, tax increment financing areas (TIFs), and physically divided single-use properties, among other situations.

7.1.3 Permanence

Parcel identifiers should be permanent and change only when absolutely necessary, such as when the boundaries of a parcel change. (see Section 7.3).

7.1.4 Simplicity and Ease of Use

Parcel identifiers should be easy to use and understand with as few digits as possible. A parcel identifier that is uncomplicated and easily understood helps to reduce errors in its use.

7.1.5 Ease of Maintenance

The parcel identification system should be easy to maintain and should efficiently accommodate changes, such as the subdivision or consolidation parcels.

7.1.6 Flexibility

The parcel identification system should be reasonably flexible. It should be capable of serving a variety of uses, not only land parcels but also multistory condominiums, subsurface rights, air rights, easements, leases, and so on.

7.2 Types of Parcel Identifiers

There are five basic types of parcel identifiers, described as follows. The first two types, which incorporate clues to a parcel's geographic location, are recommended for assessment purposes.

7.2.1 Geographic Coordinate System Identifiers

The geographic coordinate system is a method of locating a point on the Earth's surface based on its distance from each of two intersecting grid lines known as *x* and *y* axes. These grid lines can be based on latitude and longitude, the Universal Transverse Mercator (UTM) system, or state plane coordinates. Parcel identifiers using this system comprise the coordinates for a single point, usually the parcel centroid.

Parcel identifier systems based on geographic coordinates are easy to maintain, because new numbers are quickly assigned by picking parcel centroids. They are easy to use in the field, because the PIN can help locate the parcel when a global positioning system (GPS) is used.

These PINs meet the desired characteristic of uniqueness. However, geographic coordinate-based PIN's may not meet the criteria of simplicity because a complete parcel identifier could be a lengthy numeric character string containing *x, y,* and *z* coordinates. The *z* coordinate is required for multi-story condominiums and apartments, where parcels at different levels could have the same x–y centroid. The elevation problem could also extend to subsurface parcels, such as underground parking or mineral rights. In addition, the desired characteristic of permanence can be problematic. Assessors should be aware that minor map edits, corrections, or adjustments can alter the *x, y*, and possibly *z* coordinates of the parcel centroid, thereby breaking the link with the number stored in tabular databases and undermining the *permanence* aspect. An alternative to the centroid may be the use of coordinates associated with a separate *point* or *label* within each parcel polygon. Points or labels are less likely to have their *x* and *y* locations altered due to minor edits of the parcel polygon.

7.2.2 Rectangular Survey System Identifiers

This system of parcel numbering is based on section/township/range systems such as the PLSS. Parcel identifiers based on a rectangular survey system are developed by using the section/township/range, quarter-section, and quarter-quarter-section numbers, along with individual parcel identifiers assigned to each tract or subdivided lot and block. This kind of PIN provides an approximate geographic location of each parcel that is easy to understand and maintain and meets the criteria of uniqueness and permanence; however, it is not applicable in geographic locations not subject to the PLSS.

7.2.3 Map-Based System Identifiers

This system is based on the incorporation of the cadastral map into the parcel identifier. This PIN consists of a map (or page) number, block (or group) number, and parcel location as numbered within a block or group of parcels. For example, a PIN of 32–02–16, indicates 32 represents the map on which the parcel is found, 02 the block on the map, and 16 the parcel location within the block. Map-based identifiers may reference a geographic area and are convenient for use with printed maps in the field. However, they have limited usefulness in the digital cadastral mapping environment in which the map exists in a seamless environment rather than as individual map sheets.

7.2.4 Name-Related Identifiers

Name-related identifiers use the names of individuals claiming an interest to a parcel as the parcel identifier. A common example of this is the use of name codes in the grantor–grantee index. Use of such identifiers is discouraged because they do not meet the criteria of permanence reference to geographic location, and ease of use.

7.3 Assignment and Maintenance of Parcel Identifiers

PINs established in accordance with the guidance in this section should be assigned to all parcels during the initial phase of a digital cadastral mapping program. These PINs should be considered provisional until the mapping program has been completed and all maps have been formally approved.

The assessor should maintain parcel identifiers, ownership information, and property descriptions as new parcels are created. Two methods exist for the process of maintaining *parent* and *child* parcels when existing parcels are being divided (split) or combined (joined). One method is to retire or delete the PIN of the existing parent parcel that has been divided or split into two or more child parcels. The other method is to retain the original PIN of the parent parcel and to assign a new PIN to each new child parcel. Both methods exist because of system configurations, workflows, and other processes tied to the PIN. Such other processes include researching the history of a PIN, retaining assessment limitations or caps, or *base- values* in the case of TIFs. Both methods are acceptable when applied consistently. However, once a PIN has been retired, it should not be reused unless absolutely required by the parcel-numbering schema limitations. Notations should exist in the parcel record regarding its reuse. A review of the records should be performed to ensure there are no outstanding taxes or liens on the retired PIN before its reuse.

Parcel identifiers should change only when the geometry of the parcel changes due to the subdivision of the parcel, the consolidation of two or more parcels, the recordation of a plat affecting the parcel, or other governmental actions affecting parcels or the property descriptions of parcels, such as the vacating of a recorded plat. The assessor should notify the property owner(s) when a change to a PIN occurs. This is especially important given the Dodd-Frank Wall Street Reform and Consumer Protection Act, which addresses the listing of a PIN on mortgage documents in which real property is being pledged. Documentation of the change should be maintained in the assessor's notes or digital cadastral mapping system.

Glossary

This glossary defines mapping terms used in this standard and its appendix and other commonly used mapping expressions. Some of these definitions were compiled from the textbook, *Definitions of Surveying and Associated Terms* (ACSM 2005), and are used with permission of the publisher.

Assessment Map—(See **cadastral map**.)

Base Map—A map containing the background upon which geographic data are overlaid. Contains basic survey control and reference framework for integrating all the other map features of a particular area. Orthophotos are commonly used as a cadastral base map.

Bearing—Direction of a line measured from north or south to east or west, not exceeding 90 degrees.

Cadastral Map—A map showing the boundaries of subdivisions of land for the purposes of describing and recording real property ownership.

Cadastral Genealogy—A graphic depiction of the lineage or history of parcel.

Compilation—(1) Cartography: The production of a new or revised map from an existing map, aerial photograph, survey, or other source material (see **delineation**). (2) Photogrammetry: The production of a map or chart, or portion thereof, from aerial photographs and geodetic control data, by means of photogrammetric instruments, also called stereocompilation.

Computer-Aided Design (CAD)—A digital software technology used for the design, drafting, and presentation of graphics. It is commonly employed in drafting work for engineering and manufacturing and may also be used to design maps.

Contour Line—A line drawn on a topographic map connecting points with equal terrain surface elevation.

Control (ground and geodetic)—A system of points that are used as fixed references of position (horizontal) or elevation (vertical) or both. Ground control points are obtained from ground surveys. These points can be used to rectify the accuracy of cartographic products to the actual area on the ground that is represented. Geodetic control takes the size and shape of the earth into consideration.

Coordinates—Linear or angular quantities that designate the position of a point in a given reference frame or system. The x and y values, or three-dimensional x, y and z values that define a location in a planar or three-dimensional coordinate system.

Data Model—A generalized, user-defined view of data representing the real world. A description of the structure of a database. It describes how data are represented and accessed.

Data Steward—A term commonly used to identify an entity responsible for maintaining data in various map layers.

Delineation—The visual selection and distinguishing of map-worthy features by outlining on a map or manuscript (as when operating a stereoplotting instrument); also, a preliminary step in compilation.

Digital Elevation Model (DEM)—A digital representation of bare-earth elevations (z values) that is referenced to a common datum. DEMs are typically used to represent terrain relief without vegetation, buildings or improvements.

Digital Terrain Model (DTM)—A digital representation of the Earth's surface. Its construction includes a basic elevation model (i.e., a DEM) that is typically enhanced with breakline data to accentuate abrupt changes in terrain features, such as pavement edges, road crowns, riverbanks, ridgelines, creek beds, and so on.

Feature—Points, symbols, lines, and areas on a map representing natural and man-made geographic features. An object in a geographic or spatial database with a distinct set of characteristics.

Geocode—A code (usually numerical) used to locate or identify a point on a map, such as the center of a parcel.

Geodetic Coordinates—The quantities of latitude and longitude that define the position of a point on the surface of the earth with respect to the reference spheroid, frame, or system. (See also **coordinates**.)

Geodetic Densification—The augmentation of additional ground or geodetic control points to an existing control network of data points.

Geographic Information System (GIS)—(1) A database management system used to store, retrieve, manipulate, analyze, and display spatial information. (2) One type of computerized mapping system capable of integrating spatial data and attribute data among different layers on a cadastral map. Additional definitions can be found in the Internet at National Geographic, Dictionary.com, and Wikipedia.

Georeferenced—To associate something with locations in physical space. The term is commonly used in the GIS field to describe the process of associating a physical map or raster image of a map with spatial locations on the ground.

Government Lot—A partial section of land established, measured, and computed by the PLSS. Often used synonymously with *fractional lot* or *fractional section*.

Grid—A uniform system of rectilinear lines superimposed on an aerial photograph, map, chart, or other representation of the Earth's surface; used in defining the coordinate positions of points.

Index Map—(1) A map of smaller scale on which are depicted the locations (with accompanying designations) of specific data, such as larger scale topographic quadrangles or geodetic control. (2) Photogrammetry: A map showing the location and numbers of flight strips and frame images.

Land Information System—A system for capturing, retaining, checking, integrating, manipulating, analyzing and displaying data about land and its use, ownership, and development.

Layer—Set of related geographic features, such as streets, parcels, or rivers, and the attributes (associated characteristics of those features) logically organized into groups that can be displayed independently.

Light Detection and Ranging LiDAR—A remote sensing tool for generating very accurate digital surface models. It uses an aircraft-mounted sensor that emits rapid pulses of infrared laser light to determine ranges to points on the terrain below. The point data may be used to construct a digital surface model (DSM), digital elevation model (DEM), or digital terrain model (DTM).

Lot—A plot of land, generally a subdivision of a city, town, or village block, or some other distinct tract, represented and identified by a recorded plat.

Map—A representation (usually presented on a two-dimensional medium) of all or a portion of the earth or other celestial body, showing relative size and position of features to some given scale or projection. A map is a model that may emphasize, generalize, or omit the representation of certain features to satisfy specific user requirements.

Map Projection—An orderly system (mathematical model) to portray all or part of the Earth, which is an irregular sphere, on a planar or flat surface. Some distortions of conformality, distance, direction, scale, and area always result from this fitting process. Examples include the Mercator and the Lambert Conic Conformal Map Projection.

Monument—A permanent physical structure marking the location of a survey point or boundary line. Common types of monuments are inscribed metal tablets set in concrete posts, solid rock or parts of buildings; distinctive tone posts; and metal rods driven in the ground.

Multipurpose Cadastre—A digital cadastral map rich in cadastral data and associated land data and features to support the mission-critical functions and advanced analytics of the assessor as well as to provide a comprehensive platform for the spatial framework for the geospatial data of other governmental agencies and private entities.

Noncadastral—Spatial data that are typically dependent on and reside upon cadastral parcel data. Examples of noncadastral data layers are zoning, future land use, and municipal boundary layers.

Orthophotograph—A photograph having the properties of an orthographic projection. It is derived from a conventional perspective vertical photograph (for mapping purposes) by simple or differential rectification so that image distortions caused by camera tilt and relief of terrain are removed.

Parcel—A single cadastral unit with defined physical boundaries and capable of being separately conveyed from one owner to another by record instrument.

Parcel Polygon—A sequence of vectors forming a closed shape that defines parcel boundaries. Parcel polygon objects include information about the parcel such as the parcel identification number and the parcel area.

Photo Delineation—The selection and identification of map-worthy features on a photograph or digital image.

Photogrammetry—The art, science and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring and interpreting images and patterns of electromagnetic radiant energy. (See also **orthophotography.**)

Plane Rectangular Coordinates—A system of coordinates in a horizontal plane used to describe the positions of points with respect to an arbitrary origin by means of two distances perpendicular to each other. (See also **coordinates**.)

Planimetric Map—A map that presents only the horizontal positions for the features represented; distinguished from a orthophoto or topographic map by the omission of relief in measurable form.

Plat—A diagram drawn to scale showing all essential data pertaining to the boundaries and subdivisions of a tract of land, as determined by survey or protraction.

Point—Single x, y (optionally z) location points in space. Dimensionless geometric feature having no other spatial properties except location. Many different natural and man-made features are modeled as points in a spatial database including trees, hydrants, poles, buildings, parcel centroids, and so on.

Positional Accuracy—The degree to which the coordinates define a point's true position on the earth's surface.

Public Land Survey System (PLSS)—A rectangular survey system used in much of the United States dividing land areas into townships of 36 1-square-mile sections. Sections can be further subdivided into quarter sections, quarter-quarter sections, or irregular government lots.

Raster—a set of horizontal lines comprising individual pixels, used to form an image on a CRT or other screen. Examples of raster image file types are: BMP, TIFF, GIF, and JPEG files.

Rectification—The process of projecting the image of a tilted aerial photograph onto a horizontal reference plane to eliminate the image displacement caused by tile of the aerial camera at the time of exposure.

Remote Sensing—The process of obtaining information about an object while physically separated from it. Practically, this term is used to describe the process of using sensors mounted on satellites to capture images and to observe the Earth's geology, surface, and atmosphere.

Resolution (Spatial Resolution)—(1) The minimum distance between two adjacent ground features that can be detected by remote sensing. (2) The smallest possible map feature that can be accurately displayed at a specified map scale.

Scanning—Capturing an image using an optical or video input device that uses light sensing technology. A process by which photographs, printed data, or drawn maps are converted to a digital format.

Spatial—Relating to space or a space. Refers to the shapes, location, proximity, and orientation of objects with respect to one another in space.

State Plane Coordinate Systems—A series of grid coordinate systems prepared by the U.S. Coast and Geodetic Survey for the entire United States, with a separate system for each state. Each state system consists of one or more zones. The grid coordinates for each zone are based on, and mathematically adjusted to, a map projection. (See also **coordinates**.)

Topology—A set of defined relationships between links, nodes, and centroids. Topology describes how lines and polygons connect and relate to each other. Among the topological properties of concern in a GIS are connectivity, order, and neighborhood.

Topological Rules—An instruction to a spatial database defining the permissible relationships of features.

Vector—The storage of *X*, *Y*, and *Z* coordinates connected to form points, lines, areas, and volumes. A vector can be a straight line joining two data points.

Vertical Parcel—Parcels contained in the structure of two or more stories such as a condominium tower. For purposes of cadastral mapping, these may be represented by stacking or pancaking the parcel polygons on top of one another.

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Appendix. Parcel Core Data Elements

Land record/GIS integration makes strong economic and business sense. The land records, GIS, tax/assessment/valuation, and addressing data of an assessing jurisdiction are more valuable when integrated. Collective records are much more useful to more people. With key record cross-referencing beginning before instrument recordation, land record/GIS integration begins near the start of many key workflow processes. To allow for such integration, assessors should consider capturing parcel core data to the extent practical.

Parcel core data describes the minimum set of attributes and associated reference data about land parcels that can provide essential information to meet business needs without publishing the complete set of parcel characteristics.

Background

The FGDC Cadastral Subcommittee completed the Cadastral Data Content Standard1 in 1995. This information was published in the May 2003 FGDC Cadastral Data Content Standard version 1.3. ((Cadastral Subcommittee 2003).

In 2000 the subcommittee began a series of studies on the uses for and applications of cadastral data. Many business needs were identified, including hurricane and wildland fire response, energy management, uses by federal agencies, and most recently mortgage and real estate analysis. From this body of work the subcommittee defined a limited set of attributes (parcel core data) that provide a platform supporting multiple business needs.

It is important to recognize that publication data are not the same as operation and maintenance data or production data. Production data are structured to optimize maintenance processes, are integrated with internal agency operations, and contain much more detail than publication data. Publication data are a subset of the more complete production data and are intended to be integrated across jurisdictional boundaries and be presented in a consistent and standard form nationally. To the extent that assessors consistently capture and make available parcel core data, this goal will be attainable.

Parcel core data provide a platform that recognizes a basis upon which many other themes and data sets are referenced. For example, land parcel data could be used to spatially enable business license information, voter registration, or health statistic information.

Parcel core data speak to the standardization of the small, but most crucial set of attributes. Jurisdictions may expand upon the minimum set and some applications may need additional attributes, but with a short list of standardized attributes, linkage or other data sets become possible and allow for the expansion and individualization of published data.

There are two other important notes about the cadastral data platform. First, parcel data change frequently and need to be updated regularly. Many of the initial needs of the business applications studied can be met with annual parcel updates, but in the end all business applications need current data. Therefore, even though assessor records may be updated on an annual cycle to accommodate property tax needs, unlike many other spatial framework data sets, cadastral information that will be used to satisfy multiple business needs should be continually updated. Second, all spatial data should have accompanying metadata describing the source agency, contact information, and spatial referencing, and be accurate and current.

The following is the list of attributes defined in the core data set. (This list was developed by FGDC, and assessors should try to capture this information and make this core data set available.) In the physical file structure the address elements are defined as individual components and as a single concatenated field.

Metadata—The metadata contains information about the entire data set such as the data steward, the parcel contact, a description of the basis for the assessment system (sale price, use, market value, and the like), the date of the file, information on interpretation of the assessment classifications, and any other metadata supporting the use and application of the information.

Parcel Outline (Polygon)—The geographic extent of the parcel, the parcel boundaries forming a closed polygon. The parcel geometry may be a polygon or a point. The parcel centroid and the polygon are not both required.

Parcel Centroid (Point)—This is a point within the parcel to which related information can be attached. This may be a visual centroid or a point within the parcel. It may not be the mathematical centroid because this point needs to be contained within the parcel polygon.

Parcel ID—A unique identifier for the parcel as defined by the data steward or data producer. The parcel identifier should provide a link to additional information about the parcel and should be unique across the geographic extent of the data steward.

National Parcel ID—This is a nationally unique identifier constructed from either the Geographic Names Information System (GNIS) code for the jurisdiction or the Census codes plus the local identifier.

Source Reference—This field is often called the volume/page or liber/page in local records. This is a pointer to or an attribute describing the source reference for the parcel. This could be a deed, plat, or other document reference.

Source Reference Date—The date of the source reference, which is essentially the last update date for this parcel. The entire data set may have a last updated date or an "unloaded for publication" date that is different from the specific currency or update date for each individual parcel.

Owner Type—The type of ownership is the classification of owner. In some local governments tax parcels are tagged as either taxable or exempt and the owner classification is not known.

Improved—This attribute indicates whether there is an improvement on the parcel.

Owner Name—An indication of the name of the primary owner, recognizing that there may be multiple owner names, that some owner names may be blocked for security reasons, or that some jurisdictions may not allow the distribution of owner names. For publicly held lands, the owner name is the surface managing agency, such as Bureau of Land Management, Department of Transportation, and so forth.

Assessment/Value for Land Information—This is the total value of the land only. The basis of the value, such as market value, resale value, sale price, or use value, should be described in the metadata.

Assessment/Value for Improvements Information—This is the total value of improvements on the parcel. The basis of the value, such as market value, resale value, sale price, or use value, should be described in the metadata.

Assessment/Value Total—This information is the total value of the land and improvements. The basis of the value, such as market value, resale value, sale price, or use value, should be described in the metadata.

Basis of the Values—An indication of the type of values that are provided (taxable, market, assessed, or other). This may be included in the metadata if it is the same for all the records in a data set.

Assessment Parcel Use Code—This is the parcel use classification for the tax parcel based on the classification of the parcel for the purposes of valuation.

Tax Bill Mailing Address—This is the U.S. Postal Service address for the tax bill mailing.

Site Address—This is the street address (site address) for the parcel. If there is more than one, the first or primary site address is used.

Parcel Area—The area of the parcel expressed in acres.

Reference

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Assessment Standards of the International Association of Assessing Officers

Guide to Assessment Standards

Standard on Assessment Appeal

Standard on Automated Valuation Models

Standard on Contracting for Assessment Services

Standard on Digital Cadastral Maps and Parcel Identifiers

Standard on Manual Cadastral Maps and Parcel Identifiers

Standard on Mass Appraisal of Real Property

Standard on Oversight Agency Responsibilities

Standard on Professional Development

Standard on Property Tax Policy

Standard on Public Relations

Standard on Ratio Studies

Standard on Valuation of Personal Property

Standard on Valuation of Property Affected by Environmental Contamination

Standard on Verification and Adjustment of Sales

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