An ArcGIS™ Address Data Model for the City of Calgary

An ESRI® Technical Paper • April 2003

ESRI 380 New York St., Redlands, CA 92373-8100, USA • TEL 909-793-2853 • FAX 909-793-5953 • E-MAIL info@esri.com • WEB www.esri.com

An ArcGIS Address Data Model for the City of Calgary

An ESRI Technical Paper

Contents

An ArcGIS Address Data Model for the City of Calgary

This technical paper describes an address data model for the city of Calgary, Alberta, Canada. An overview of the city's address management requirements is presented. A conceptual model for addresses within the city of Calgary is presented, the logical model described, and the physical model implemented in a geodatabase. Note that while this paper describes a particular implementation for the city of Calgary, the concepts presented here are generally applicable throughout North America and wherever else a similar system for addressing is employed.

The city of Calgary is located in the southern portion of the province of Alberta, Canada. Calgary is the largest city in Alberta, and the sixth largest in Canada, with a population of more than 840,000. The city limits encompass 2,460 miles of roads and more than 250,000 ownership parcels.

Several hundred users at the city of Calgary create, edit, analyze, or consume the city's geographic information system (GIS) data. The city uses GIS data to support business activities for police, transportation, engineering, parcel maintenance, and land information in a client/server environment.

Conceptual Data Model

The purpose of this data model is to provide a geodatabase repository of address data maintained by the city of Calgary. When used with ESRI® ArcGIS™ and the ArcInfo™ license, this model supports editing and validation of address data across addressable datasets and the validation of external address datasets. This data model also supports applications that provide geocoding and address lookup functionality. Finally, this data model can be implemented using standard relational database management system technology to support legacy applications that are not based on ArcGIS.

The four logical groups in the ArcGIS Address Data Model include addressable objects, addresses, names, and zones.

Addressable Objects

This logical group contains all the entities that can have address information. Note that the ArcGIS Address Data Model is an additive data model that can be used to extend other data models to support address information. Thus, the entities in this logical group can participate in other ArcGIS data models.

Addresses

This logical group contains entities that represent addresses and their derivations, including subaddresses (unit addresses) and address ranges.

Names — This logical group contains names that can be assigned to addresses and the atomic elements that comprise those names.

Zones — This logical group models the zones that can be assigned to addresses, including postal and administrative components. Note that the entities in this logical group can participate in the ArcGIS Administrative Boundaries Data Model.

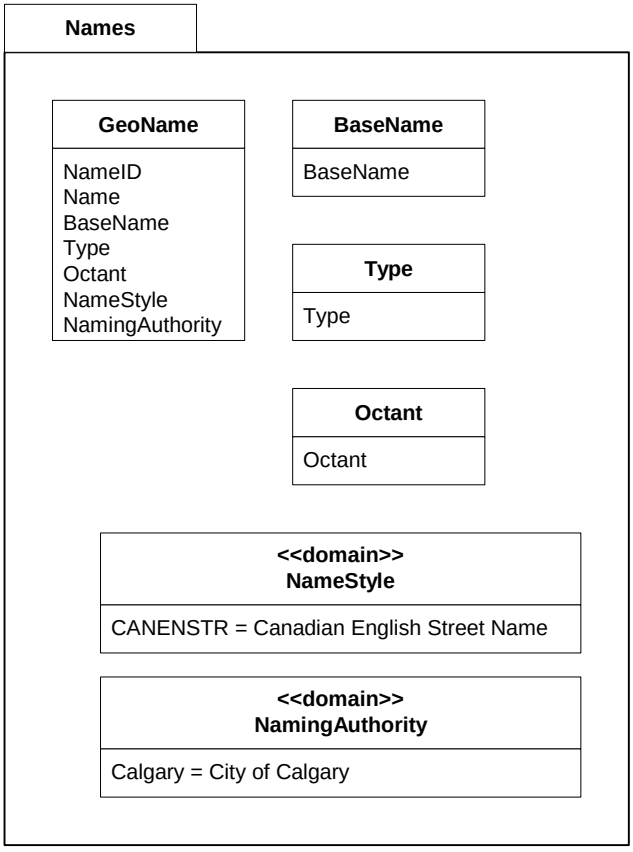
Logical Data Model

This section describes the entities within each of the logical groups defined above and the attributes of and relationships between those entities. A description of each entity is given, along with the descriptions of the relevant attributes. The cardinalities and attributes of relationships between the entities are also defined.

Names

The Names logical group contains classes that define names that can be assigned to addresses and other geographic features within the ArcGIS Address Data Model.

Figure 1
Contents of the Names Logical Group



GeoName

The *GeoName* class contains the set of unique names that can be assigned to addresses and geographic features in the city of Calgary. The *Name* attribute contains the fully qualified name (e.g., MacLeod Trail SE). The *BaseName*, *Type*, and *Octant* attributes contain the components that together comprise the name. The *NameStyle* attribute defines how the name components are assembled to form the name, and its values are members of the *NameStyle* domain. In the city of Calgary, all names contained in the *GeoName* class are Canadian English street names. The *NamingAuthority* attribute identifies the organization that created the name, such that each record in the *GeoName* class has a unique combination of *Name* and *NamingAuthority*. Values for *NamingAuthority* are members of the *NamingAuthority* domain. The *NameID* attribute is a unique identifier for records in the *GeoName* class.

Note that while most names contained in the *GeoName* class are street names, this class can also contain other names that are assigned to geographic features, such as place names, building names, and river names.

BaseName

The *BaseName* class contains the unique set of base components for geographic names. For example, for the name MacLeod Trail SE, the base component is MacLeod. Note that there are no explicit relationships between the *BaseName* class and the *GeoName* class. The *GeoName* class contains a *BaseName* attribute whose values are taken from the *BaseName* class. The *BaseName* class can be used to validate the contents of this attribute.

Type

The *Type* class contains the unique set of types for geographic names. For example, for the name MacLeod Trail SE, the type component is Trail. The set of type components used by the city of Calgary is well defined but cannot be suitably modeled as a domain because of the large number of types available. Note that there are no explicit relationships between the *Type* class and the *GeoName* class. The *GeoName* class contains a *Type* attribute whose values are taken from the *Type* class. The *Type* class can be used to validate the contents of this attribute.

Octant

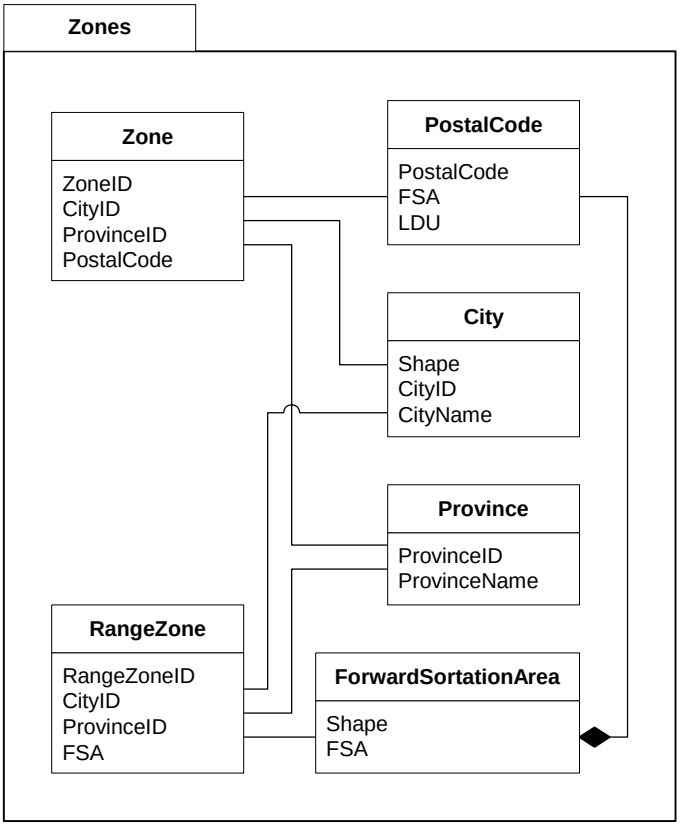
The *Octant* class contains the unique set of octant (directional) components for geographic names. The city of Calgary is divided into four quadrants (northeast, southeast, southwest, and northwest) by a north–south axis and an east–west axis. Each street name has an octant component that identifies the quadrant in which the street is situated. Streets that are coincident with one of the axes have a cardinal direction (north, east, south, or west) as the octant component of their street name. Note that there are no explicit relationships between the *Octant* class and the *GeoName* class. The *GeoName* class contains an *Octant* attribute whose values are taken from the *Octant* class. The *Octant* class can be used to validate the contents of this attribute.

Entity	Spatial Type	Attributes	Related To
Name		NameID Name BaseName Type Octant NameStyle NamingAuthority	Address AddressRange
BaseName		BaseName	
Type		Type	
Octant		Octant	

Zones

The Zones logical group contains classes that define the sets of zones and their components that can be assigned to addresses within the ArcGIS Address Data Model.

Figure 2
Contents of the Zones Logical Group



City The *City* class is a class that contains the administrative boundaries of cities. In the city of Calgary, this class contains only one record for the administrative boundary of the city. The *CityName* attribute contains the common name of the city. The *CityID* attribute is a unique identifier for records in the *City* class.

Province The *Province* class contains records for Canadian provinces. In the city of Calgary, this class contains only one record—for the province of Alberta. The *ProvinceName* attribute contains the common name of the province. The *ProvinceID* attribute is a unique identifier for the *Province* class.

ForwardSortationArea Canadian postal codes are composed of two main components: the Forward Sortation Area (FSA) and the Local Delivery Unit (LDU). The FSA defines a general area to which mail is delivered and sorted, such as an individual post office. The LDU defines a specific delivery point, such as a large building, a block of a city street, or a rural route.

The *ForwardSortationArea* class contains the set of Forward Sortation Areas that can be assigned to addresses in Calgary. The *FSA* attribute contains the three-character FSA code. The *Shape* attribute contains a point geometry that represents the centroid of the FSA. Each FSA is related to many *PostalCode* records.

PostalCode The *PostalCode* class contains the set of postal codes that can be assigned to addresses in Calgary. The *PostalCode* attribute contains the full six-character postal code. The *FSA* attribute contains the three-character Forward Sortation Area, which forms the first three characters of the postal code and is a foreign key to the *ForwardSortationArea* class. The *LDU* attribute contains the three-character Local Delivery Unit, which forms the last three characters of the postal code.

Zone The *Zone* class contains the unique set of zone combinations that can be assigned to addresses. This class is a valid value table (VVT) that contains unique and valid combinations of city, province, and postal code. The *CityID* attribute is a foreign key to the *City* class. The *ProvinceID* attribute is a foreign key to the *Province* class. The *PostalCode* attribute is a foreign key to the *PostalCode* class. The *ZoneID* attribute is a unique identifier for records in the *Zone* class.

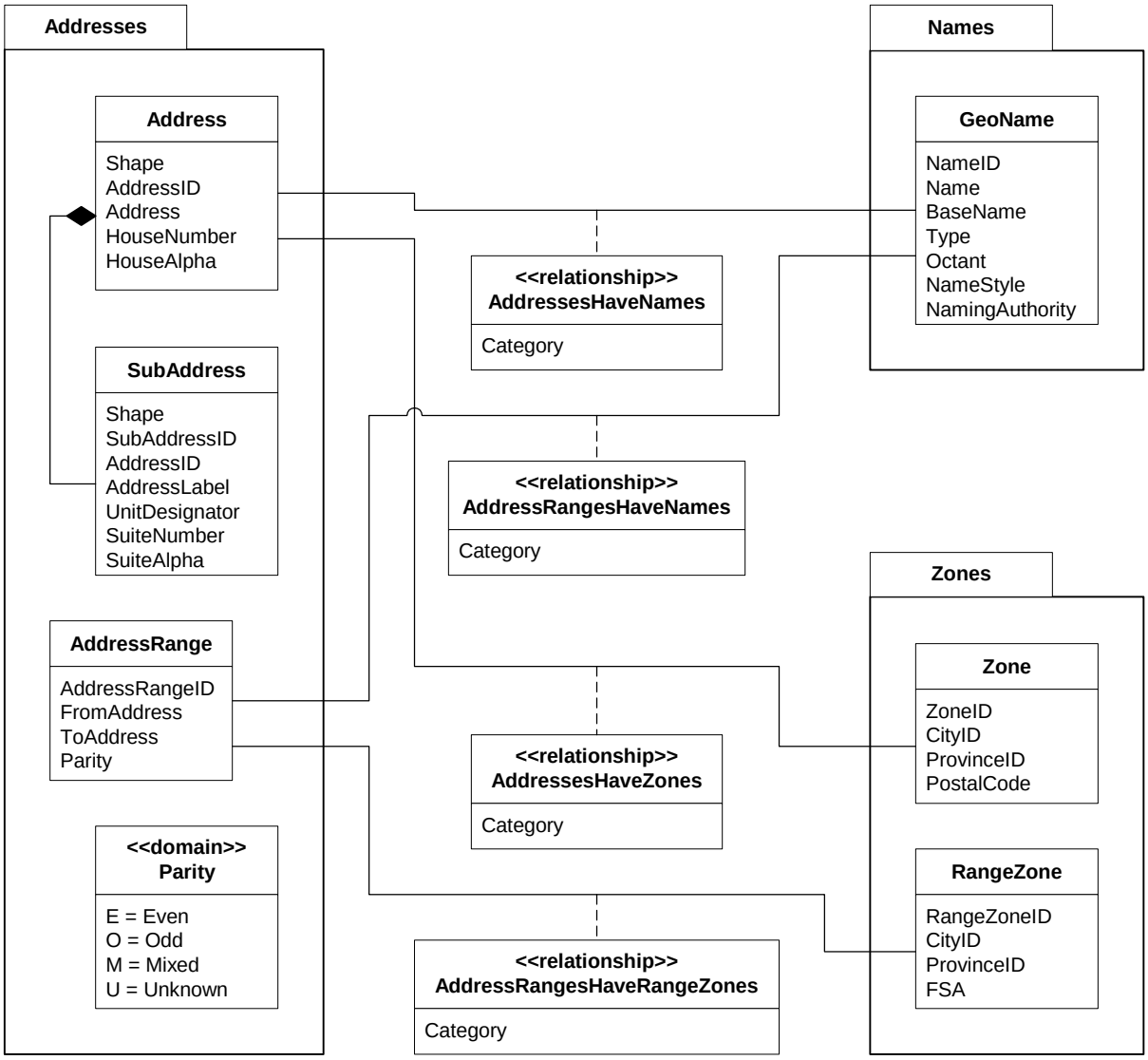
RangeZone The *RangeZone* class contains the unique set of zone combinations that can be assigned to address ranges. This class is also a VVT that contains unique and valid combinations of city, province, and FSA. The *CityID* attribute is a foreign key to the *City* class. The *ProvinceID* attribute is a foreign key to the *Province* class. The *FSA* attribute is a foreign key to the *FSA* class. *RangeZone* records are associated with *FSA* objects rather than *PostalCode* objects because *AddressRange* objects represent a set of *Address* objects, each of which can have its own *PostalCode*. The *RangeZoneID* attribute is a unique identifier for records in the *RangeZone* class.

Entity	Spatial Type	Attributes	Related To
Zone		ZoneID CityID ProvinceID PostalCode	Address City Province PostalCode
RangeZone		RangeZoneID CityID ProvinceID FSA	AddressRange City Province FSA
City	Polygon	Shape CityID CityName	Zone RangeZone
Province		ProvinceID ProvinceName	Zone RangeZone
PostalCode		PostalCode FSA LDU	Zone FSA
FSA	Point	Shape FSA	RangeZone PostalCode

Addresses

The Addresses logical group contains classes that define addresses, their derivations—subaddresses and address ranges—and their associations with names and zones.

Figure 3
Contents of the Addresses Logical Group



Address The *Address* class contains the unique set of addresses that can be assigned to addressable objects within the city of Calgary. The *Address* attribute contains the full address in text form for labeling. The *HouseNumber* attribute contains the numeric part of the street address. The *HouseAlpha* attribute contains the alphabetic part of the street address. Note that storing geometric representations for addresses is not a general requirement for the ArcGIS Address Data Model; however, since the city of Calgary already maintains geometry for each address, it was included in the model. The *AddressID* is a unique identifier for records in the *Address* class.

Address records are related to records in the *GeoName* table. Each *Address* can have multiple *GeoNames*, and each *GeoName* can be assigned to multiple *Addresses*. This relationship has a *Category* attribute to distinguish between multiple *GeoNames* assigned to the same *Address*.

Address records are also related to records in the *Zone* table. Each *Address* can have multiple sets of *Zones*, and each *Zone* can be assigned to multiple *Addresses*. This relationship has a *Category* attribute to distinguish between multiple *Zones* assigned to the same *Address*.

SubAddress

The *SubAddress* class contains a unique set of subaddresses that can be assigned to addressable features. *SubAddresses* are subdivisions of addresses, such as unit addresses in an apartment building. Each *SubAddress* is a part of one *Address*, and each *Address* can have many *SubAddresses*. The *AddressID* attribute is a foreign key to the *Address* class. The *AddressLabel* attribute contains the full address in text form for labeling. The *SuiteNumber* and *SuiteAlpha* attributes contain the numeric and alphabetic parts of the subaddress, respectively, and the *UnitDesignator* attribute contains the description that is used to designate unit addresses, such as Suite, Apartment, or Unit. Note that storing geometric representations for subaddresses is not a general requirement for the ArcGIS Address Data Model; however, since the city of Calgary already maintains geometry for each subaddress, it was included in the model. The *SubAddressID* attribute is a unique identifier for records in the *SubAddress* class.

AddressRange

The *AddressRange* class contains the unique set of address ranges that can be assigned to *Street* features. An *AddressRange* record represents the set of addresses that can be found along one side of a *Street* segment. The *FromAddress* and *ToAddress* attributes indicate the first and last addresses, respectively, that can be found along the *Street* feature as the feature is traversed from its start node to its end node. The *Parity* attribute describes the parity of address numbers found in the address range, and its values are taken from the *Parity* domain. The *AddressRangeID* attribute is a unique identifier for records in the *AddressRange* class.

AddressRange records are related to records in the *GeoName* table. Each *AddressRange* can have multiple *GeoNames*, and each *GeoName* can be assigned to multiple *AddressRanges*. This relationship has a *Category* attribute to distinguish between relationships between one *AddressRange* and several *GeoNames*.

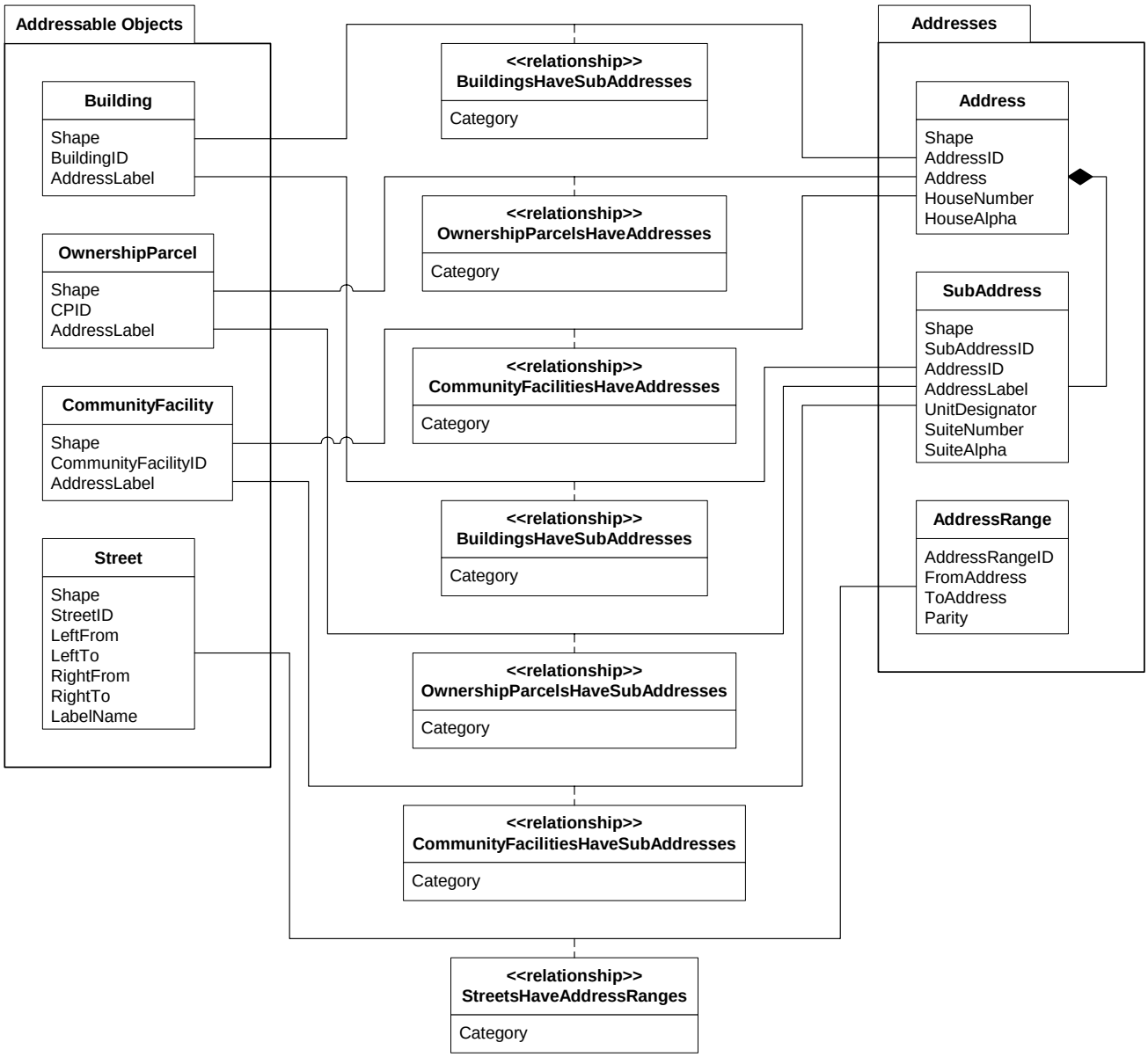
AddressRange records are also related to records in the *RangeZone* table. Each *AddressRange* can have multiple sets of *RangeZones*, and each *RangeZone* can be assigned to multiple *AddressRanges*. This relationship has a *Category* attribute to distinguish between multiple relationships between one *AddressRange* and several *RangeZones*.

Entity	Spatial Type	Attributes	Related To
Address	Point	Shape AddressID Address HouseNumber HouseAlpha	GeoName Zone Building OwnershipParcel CommunityFacility SubAddress
SubAddress	Point	Shape SubAddressID AddressID AddressLabel SuiteNumber SuiteAlpha UnitDesignator	Address Building OwnershipParcel CommunityFacility
AddressRange		AddressRangeID FromAddress ToAddress Parity	GeoName RangeZone Street

Addressable Objects

The Addressable Objects logical group contains entities that can have addresses, subaddresses, and address ranges. In the City of Calgary, these entities are *Building*, *OwnershipParcel*, *CommunityFacility*, and *Street*.

Figure 4
Contents of the Addressable Objects Logical Group



Building The *Building* class contains building rooflines in the city of Calgary. These rooflines were digitized from aerial photography and have polygon geometry representations. The *AddressLabel* attribute contains an address associated with the building in text form for labeling. The *BuildingID* attribute is a unique identifier for records in the *Building* class. Other attributes in this class are maintained by the city of Calgary but are not significant in the context of the Address Data Model.

Because records in the *Building* class are digitized from aerial photography, each record in this class does not necessarily represent an individual building. Records in this class may represent several buildings that share a roofline. Because of this, sometimes it is not possible to associate addresses with records in this class. In cases where this is possible, such as in single-family residential areas of the city, *Building* records can be related to *Address* records and *SubAddress* records. Each *Building* can have several *Addresses* and several *SubAddresses*, and each *Address* and *SubAddress* can be associated with multiple *Building* records. For example, a record for an apartment building might be associated with one *Address* record representing the building entrance and several *SubAddresses* representing the addresses of apartments within the building. Each of these relationships has a *Category* attribute to distinguish between relationships between a single *Building* record and multiple *Address* or *SubAddress* records.

OwnershipParcel

The *OwnershipParcel* class contains land ownership parcels within the city of Calgary. These records are constructed from the land survey framework and have polygon geometry representations. The *AddressLabel* attribute contains an address associated with the building in text form for labeling. The *CPID* attribute is a unique identifier for records in the *OwnershipParcel* class and is the main identifier by which the city of Calgary identifies ownership parcels. Other attributes in this class are maintained by the city of Calgary but are not significant in the context of the Address Data Model.

Each record in the *OwnershipParcel* can be related to *Address* and *SubAddress* records. Each *OwnershipParcel* record can have several *Addresses* and *SubAddresses*, and each *Address* and *SubAddress* can be associated with several *OwnershipParcel* records. Each of these relationships has a *Category* attribute to distinguish between relationships between a single *OwnershipParcel* record and multiple *Address* or *SubAddress* records.

CommunityFacility

The *CommunityFacility* class contains records for facilities, such as day care centers, sports arenas, and religious centers, within the city of Calgary. These records have point geometry representations. The *AddressLabel* attribute contains an address associated with the community facility in text form for labeling. The *POIID* attribute is a unique identifier for records in the *CommunityFacility* class. Other attributes in this class are maintained by the city of Calgary but are not significant in the context of the Address Data Model.

Like *Building* and *OwnershipParcel* records, each record in the *CommunityFacility* class can have several *Addresses* and *SubAddresses*, and each *Address* and *SubAddress* can be associated with several *CommunityFacility* records. Each of these relationships has a *Category* attribute to distinguish between relationships between a single *CommunityFacility* record and multiple *Address* or *SubAddress* records.

Street

The *Street* class contains records for street centerlines within the City of Calgary. These records have polyline geometry. The *LabelName* attribute contains a name associated with the street in text form for labeling. The *LeftFrom*, *LeftTo*, *RightFrom*, and *RightTo* attributes contain the addresses found on each side and end of the street and again are used for labeling. The *StreetID* attribute is a unique identifier for records in the *Street* class. Other attributes are maintained by the city of Calgary but are not significant in the context of the Address Data Model.

Each *Street* record can be related to several *AddressRange* records, and each *AddressRange* record is associated with at most one *Street* record. These relationships have a *Side* attribute that indicates with which side of the street the address is associated, where the side is defined as the street is traversed from its start node to its end node. These relationships also have a *Category* attribute to distinguish between multiple relationships between a *Street* record and an *AddressRange* record for a particular side of the street.

Entity	Spatial Type	Attributes	Related To
Building	Polygon	Shape BuildingID AddressLabel	Address SubAddress
OwnershipParcel	Polygon	Shape CPID AddressLabel	Address SubAddress
CommunityFacility	Point	Shape POIID AddressLabel	Address SubAddress
Street	Polyline	Shape StreetID LabelName LeftFrom LeftTo RightFrom RightTo	AddressRange

Physical Data Model

This section describes how the logical data model described in the previous section was implemented in a geodatabase. The choices made for representing the classes in the logical data model are described, and an overview of the physical implementation in a geodatabase is given.

The information given here is applicable to personal geodatabases and geodatabases on ArcSDE® servers.

Feature datasets

The first step in implementing the Address Data Model for the city of Calgary in a geodatabase was to determine the set of feature datasets that contained the model. Ideally, there should be a one-to-one correspondence between the logical groups in the data model and the feature datasets. However, there were some design limitations that forced deviation from this rule:

- The ArcGIS Address Data Model is an additive data model. This means that this data model is used to extend other data models to support address information. These other data models define their own feature datasets, and thus the classes in the Addressable Objects logical group come from feature datasets defined by these models.
- Object classes cannot be stored inside feature datasets. Thus, the classes in each logical group that do not have geometric representations cannot be stored in a feature dataset representing that group.
- Many of the relationships defined relate classes in different logical groups.

Based on these limitations, the city of Calgary decided to create a geodatabase model that had six feature datasets: *Building*, *Ownership*, *Community*, *Transportation*, *Address*, and *Administration*. The *Building*, *Ownership*, *Community*, and *Transportation* feature datasets correspond to the four classes defined in the Addressable Objects logical model. Each class is contained in its own feature dataset to represent the fact that these classes are likely to participate in other data models that define their own feature datasets. The *Address* feature dataset contains classes from the Addresses logical group, and the *Administration* feature dataset contains classes from the Zone logical group.

Feature classes and object classes

Classes with geometric representations are modeled as feature classes in the geodatabase. Classes without geometric representations are modeled as object classes in the geodatabase. Taking the classes from the logical data model, those classes that have a *Shape* attribute were modeled as feature classes inside their respective feature datasets, and those classes without a *Shape* attribute were modeled as object classes at the root level of the geodatabase.

Relationship classes

Relationships are modeled in the geodatabase as relationship classes. From the logical model, those relationships that related classes within the same logical group were modeled as relationship classes inside the corresponding feature dataset. The relationships that related classes between logical groups were modeled as relationship classes at the root level of the geodatabase.

Geodatabase domains

Finally, domains are modeled in a geodatabase as geodatabase domains. The domains that were defined in the logical model were modeled as geodatabase domains of the geodatabase, and these geodatabase domains were applied to fields to which they applied in the feature classes and object classes.

Figure 5
Geodatabase Domains in the Calgary Address Data Model

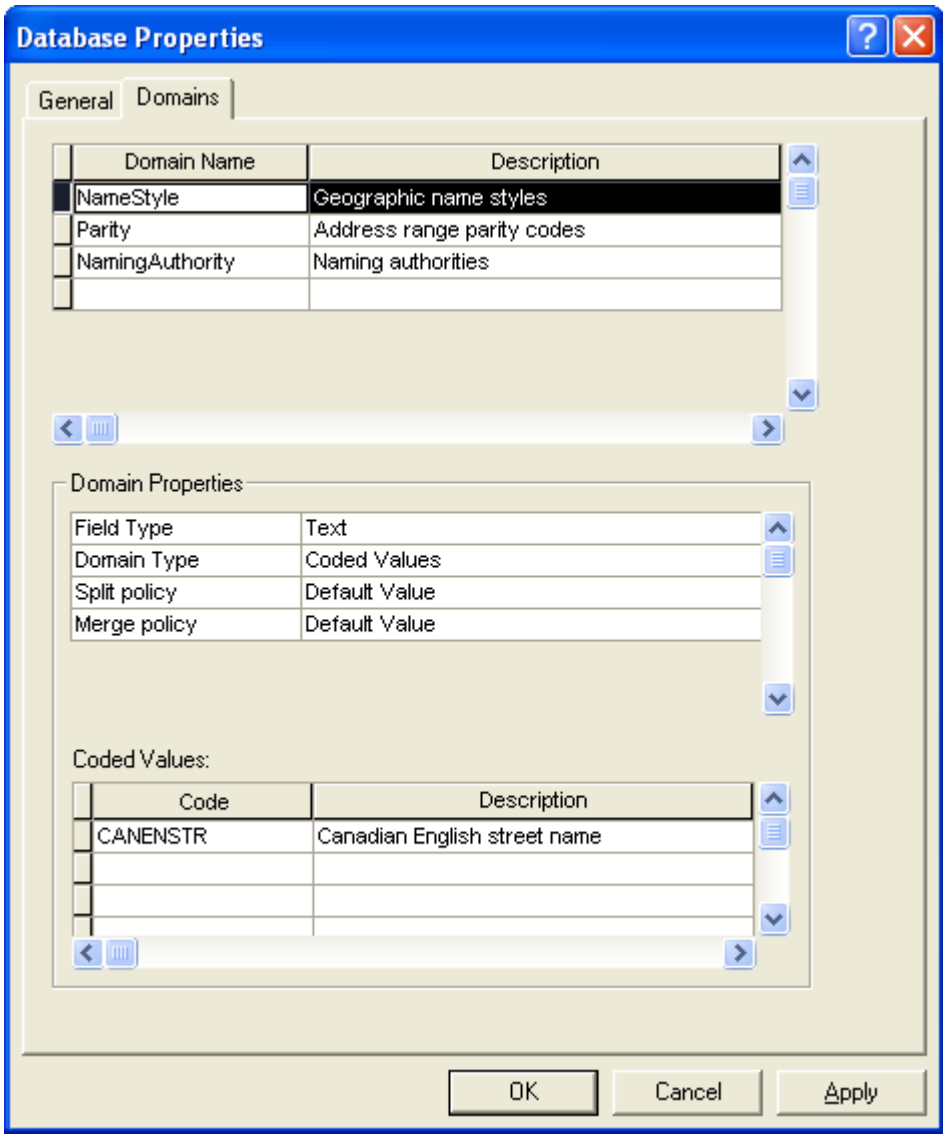
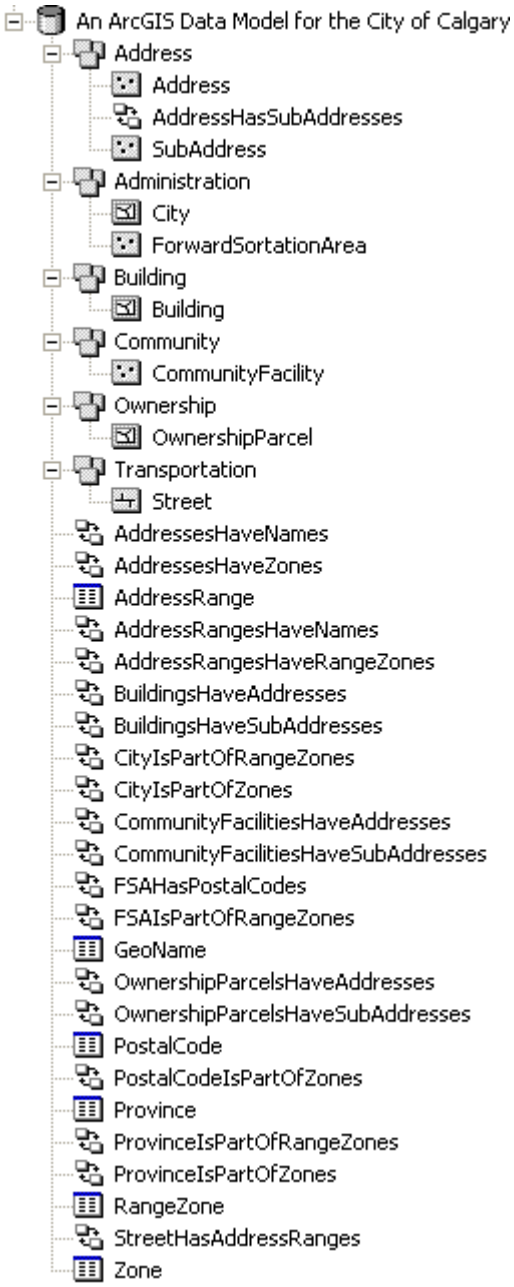


Figure 6
Geodatabase Implementation of the Calgary Address Data Model



References

City of Calgary. *Addressing Reference Guide* (Draft). City of Calgary, Alberta, Canada.

City of Calgary. *The City of Calgary*. Presentation by City of Calgary, Alberta, Canada, December 2000.

ESRI. *Feature Coding Standards and Geodatabase Design*. ESRI, Redlands, California, 2002.

Canada Post. Canada Post—"Householder Counts and Maps". http://www.canadapost.ca/cpc2/addrm/hh/doc/about-e.asp