EFMD
Engineering & Facilities Management Division

GIS standards for LAWA projects

Document History

revision letter	release date	major changes	approved by
A	September 2012	new version of standards	

Contents

About this book

This document establishes the data standards for submitting Geographic Information System (GIS) data to LAWA and for organizing GIS data within the LAWA geospatial data repository. These standards help ensure efficient exchange of digital information between LAWA and all authorized users of LAWA GIS data.

Relation to existing standards

This LAWA GIS standard is directly based on the ANSI Spatial Data Standard for Facilities Infrastructure and Environment (SDSFIE), Release 2.60. SDSFIE is developed and maintained by the Federal CADD/GIS Technology Center, Vicksburg, MS.

This document presents the most important aspects of SDSFIE as it applies to LAWA. The LAWA GIS standards are based on SDSFIE, extended in certain areas to handle specific information relevant to LAWA.

For further details on SDSFIE 2.60, use the online browser available at http://tools.sdsfieonline.org/browser/

Who should read this book

This book is intended for all LAWA employees, consultants, and contractors, especially for members of their staff who prepare GIS data; and for local, state, and federal government agencies including city, police, state DOT, FAA, and TSA.

How this book is organized

This book contains the following sections:

Introduction

Why these standards are important, what they are based on, how to suggest extensions or changes, and how compliance is assessed.

Data organization

The five elements of the classification hierarchy: entity sets, entity classes, entity types, attributes, and attribute domains

LAWA SDSFDIE data dictionaries

The two major reference sources to be used when applying the LAWA GIS standards.

File names

How filenames are to be constructed, based on the classification hierarchy.

Coordinate system and property addressing grid

Horizontal and vertical datum references to be used when applying the LAWA GIS standards

Translating CAD layers to GIS layers

Mapping layers in the LAWA *CAD Layering Standard* to the GIS layering standard

Introduction

Standards-compliant GIS data are stored in LAWA's geospatial data repository containing spatial and attribute data. These data standards are critical to supporting the airport infrastructure, because they make it easier to access and maintain the GIS data, throughout the life of the airport infrastructure. Benefits include:

- standardizing requirements for collecting GIS data
- enabling common GIS workflows throughout LAWA
- supporting standard implementation procedures and requirements
- easy sharing of data thanks to a common data model

Except for highly specialised applications, the software packages used for processing GIS data are Autodesk and ESRI. GIS data is stored in an Oracle database.

SDSFIE

SDSFIE provides a standard for the development of a GIS or CAD drawing where all features (that is, "real-world" objects) are geographically referenced. The LAWA GIS standards are based on SDSFIE, extended in certain areas to handle specific information relevant to LAWA. The emphasis is on:

- geospatial referencing of each feature
- collecting and maintaining accurate data concerning each feature, stored in relational database tables

Changes or additions

Any deviation from these standards must be approved by LAWA, in advance and in writing. Requests need to be submitted on the "Request for variance" form, available from the LAWA website http://www.lawa.org/laxdev/Handbook.aspx

Suggestions for improvements or extensions to these standards are encouraged, to meet unforeseen requirements and as a way to improve effectiveness and clarify any ambiguities.

Compliance

Having up to date, accurate, fully compliant data available to the LAWA community is forms an integral part of planning within any project. The aim of these standards is to ensure a smooth data transfer of information into the LAWA geospatial data base and efficient data maintenance through the complete data lifecycle. Accordingly, the terms and conditions of a LAWA contract require compliance with these standards. Failure to comply with these standards may be taken into account when inviting organisations to participate in future LAWA projects.

LAWA or a third party reviewer will perform detailed quality assurance procedures on all data submitted. Files containing significant errors will be rejected and returned to the submitter for correction and re-submittal. To avoid delays to project planning, LAWA maintain the right to rework and make compliant the relevant data and back-charge the supplier.

Files submitted to LAWA electronically must meet *the LAWA Standards for Electronic Digital Data Exchange* (LSEDE), available from the LAWA website. The individual or organisation submitting the files is also responsible for ensuring that all links between non-graphic data and graphic data, and all relationships between database tables, shall be preserved or automatically reconstructed when data is transferred to the LAWA GIS environment.

Data organization

The data organization described in this standard is based upon the ANSI standard Spatial Data Standards for Facilities, Installations and Environment (SDSFIE), Release 2.60.

The SDSFIE standard organizes real world features such as runways, roads and water pipes into a hierarchical structure. The data model for SDSFIE consists of five basic levels of hierarchy:

Entity Sets group data by function, in line with SDSFIE

Entity Classes group data within each entity sets

Entity Types group entities – individual, real world features (such as runways, roads and water pipes) represented on a map or drawing

Attribute tables contain non-graphic information, or attribute data, used to describe entities; **relationships** define which attributes may be used to describe a given entity type

Domains limit possible values for a particular attribute; list domains define a list of valid values for text attributes, range domains set upper and lower limits for numeric attributes.

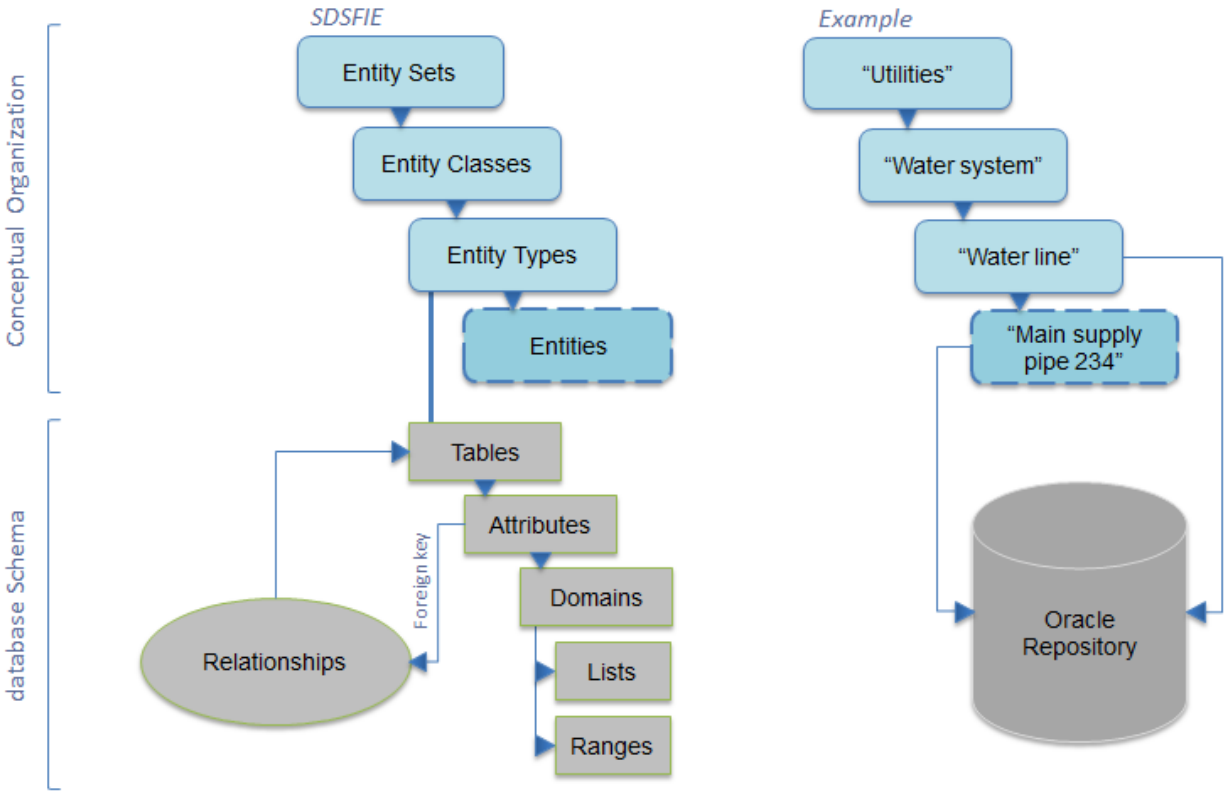

Figure 1. Spatial data standard hierarchy

Implementing SDSFIE at LAWA

Every entity type at the airport, and the entities that belong to it, will have a minimal set of attributes that identify it uniquely, plus a number of other attributes that explain how it fits into the structure of entity types, entity classes and entity sets.

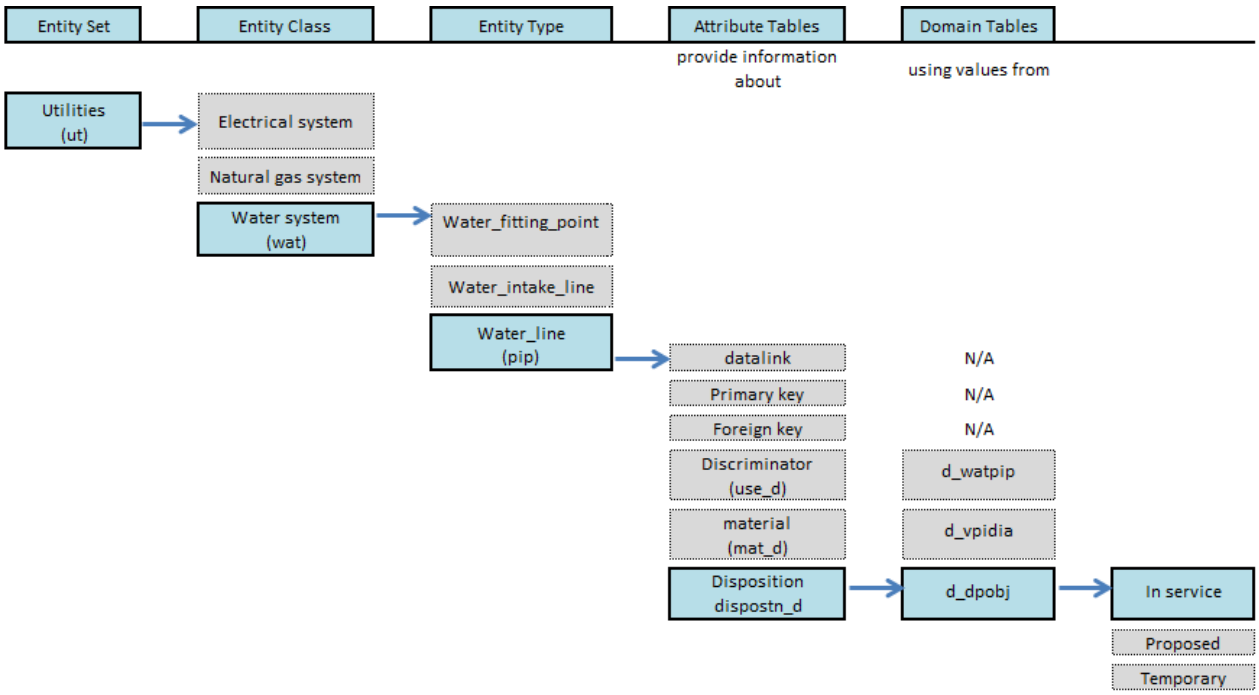

Figure 2. SDSFIE data structure

Attributes common to most entity types include:

datalink

A unique identifier generated by the software, and used to link a database record to a specific graphic feature.

primary key

A unique, LAWA defined identifier for each record or instance of an entity.

foreign key

Used where an entity record held in one database table refers to information held in another table (building, project, owner and so on).

discriminator

When an entity type references a domain table, one of the attributes in the domain table must be identified as the *discriminator*. The default value for this attribute is specified in the attribute table.

Entity set

Entity sets are the highest level of the SDSFIE data model structure and represent data organised at the project level. Each entity set corresponds to a broad, generalized theme, and contains one or more entity classes.

SDSFIE identifies 26 top-level classifications or entity sets. The GIS standards for LAWA use the SDSFIE entity sets relevant to the airport and its surroundings to classify GIS data at LAWA by function

SDSFIE entity sets:

- have a unique name, 2-character code and definition
- determine the entity classes (and related tables) that may be grouped in an entity set

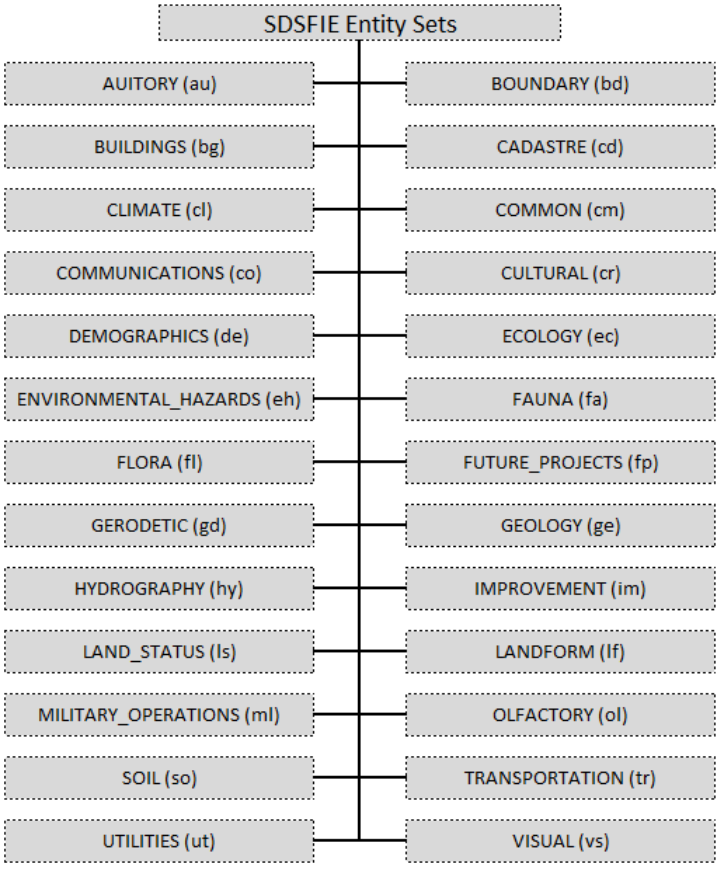

Figure 3. SDSFIE entity sets

Each entity set has an entity set code and definition: see the example in the next table.

Table 1. Example of entity set information

Entity set	Utilities
Entity set code	ut
Definition	The man-made components of a system that provides a service to the public. The components of each utility system in this entity set are located outside the foundation of a structure.

Entity classes

Entity classes are the second level of the hierarchy, and contain a number of entity types. The name of an entity class reflects the entity types the class contains.

In CAD applications, an entity class often corresponds to a drawing file.

Entity set	utilities	Entity class		Entity type	

Name	Code	Definition
Compressed Air System	air	The components of a compressed air system.
Control & Monitoring System	ecm	The components of an electronic monitoring and control (emcs) system, including cables, devices, etc.
Electrical Exterior Lighting	axl	The components of an electrical exterior lighting system, including cables, switches, devices, transformers, etc.
Electrical System	ele	The components of an electrical distribution system, including cables, switches, devices, motors, transformers, etc.
Fuel System	ful	The components of a fuel distribution system, consisting of pipes, fittings, fixtures, pumps, tanks, etc.
General Utility Features	gen	The components of a utility system which are universal in use and purpose and do not belong to a specific utility.
Heating & Cooling System	hcs	The components of a heating and cooling distribution system, consisting of pipes, fittings, fixtures, etc.
Industrial System	inw	The components of an industrial waste collection system, including pipes, fittings, fixtures, tanks, lagoons, etc.
Natural Gas System	gas	The components of a natural gas distribution system, consisting of pipes, fittings, fixtures, etc.
Saltwater System	swt	The components of a salt water collection system.
Storm System	sto	The components of a storm drainage collection system, including pipes, fittings, fixtures, etc.
Wastewater System	wwt	The components of a wastewater collection system, including pipes, fittings, fixtures, treatment plants, collection locations, etc.
Water System	wat	The components of a water system, including pipes, fittings, valves, fixtures, treatment plants, etc.

Figure 4. Examples of entity classes from entity set `utilities`

Table 2. Example of entity class information from entity set `utilities` *(ut)*	
Entity class name	Water system
Entity class code	wat
Definition	The components of a water system including pipes, valves, fixtures, treatment plants, etc.

Entity types

An entity type is a name identifying a type of object that can be represented on a map or drawing. Each SDSFIE entity type has a text definition, a name that clearly identifies the entities it can contain, and a separate table in the database.

Every entity belonging to a particular entity type is represented on a map or drawing as an object type, using a point, a line or a polygon. Where an entity is represented as a point, an agreed symbol may also be used.

The attribute table for an entity type defines the attributes that may be used to describe that entity. One attribute for each entity type may be identified as the discriminator. The discriminator is used to determine which CAD layer is used for this entity type.

Entity set utilities **Entity class** water system Entity type

Name	Object type	Polygon	Line	Point	Attribute table	Discriminator	Definition
water_anode_point	point			utwatand	utwatand	N/A	A material used for water distribution systems that is electrically connected to a less electrolytically active material so that it will oxidize in the place of the less active material.
water_anode_test_station_point	point			utwatant	utwatant	N/A	A central location where anodes are tested for performance in water systems.
water_fire_connection_point	point			utwatfir	utwatfir	con_type_d	An apparatus which dispenses fluids for use in fire management.
water_fitting_point	point			utwatfit	utwatfit	type_d	A fitting is an item used to connect, cap, plug or otherwise alter a pipe carrying water.
water_hydrant_point	point			utwathyd	utwathyd	design_d	An apparatus which dispenses fluids.
water_intake_point	point			utwatsrc	utwatsrc	N/A	The location where water is allowed into the water distribution system.
water_junction_point	point			utwatmh	utwatmh	use_d	A box or small vault (usually concrete, brick, or cast iron) in water systems located below grade with above grade access where pipes intersect. The manhole also houses associated fittings, valves, meters, etc.
water_line	string/chain		utwatpip		utwatpip	use_d	A pipe used to carry water from location to location (main line, service line, vent line, etc).
water_marker_point	point			utwatmrk	utgenmrk	N/A	A sign, concrete monument, etc. installed either directly above or immediately adjacent to underground lines, bends, fittings, etc to indicate the presence of water.
water_meter_point	point			utwatmtr	utwatmtr	N/A	A device installed in a line for measuring the quantity and or rate of water flowing to a facility or through a section of line.
water_pressure_reducing_station_point	point			utwatrst	utwatrst	N/A	A station consists of a box/pit containing one or more pressure regulators and appurtenant shutoff valves and fittings.
water_pump_point	point			utwatpmp	utwatpmp	N/A	A mechanical device for water system that draws material into itself through an entrance port and forces the material out through an exhaust port.
water_pump_station_site	point/polygon	utwatpsa		utwatpst	utwatpst	sta_ty_d	A building in which one or more pumps operate to maintain flow at adequate pressure within a water distribution system.
water_rectifier_point	point			utwatrec	utwatrec	N/A	A device that changes alternating current to direct current for an impressed current cathodic protection system on an element of the water distribution system.

Figure 5. Examples of attributes for entity types in class `water system`

Table 3. Example of entity type information	
Entity set	utilities
Entity class	water system
Entity type	Water line (pip)
Object type	string/chain
Line	utwatpip
Attribute Table	utwatpip
Discriminator	use_d
Definition	A pipe used to carry a substance from location to location (main line, service line, vent line etc.)

Entities

Using GIS effectively at LAWA relies on the ability to distinguish adequately between subtle differences between entities. This permits greater value in output products by displaying entities based on predetermined criteria.

Each entity belongs to one specific entity type. The object type used to represent an entity graphically depends on the entity type it belongs to.

Entity names:

- always begin with a prefix identifying the entity type and entity class the entity belongs to
- have a suffix from the list in the next table

Table 4. Entity name suffixes

non-text entities – each entity uses a layer which is unique within its entity class		
b	Boundary	The line string forming the perimeter of an area
c	Centroid	An electronic point within the boundary to which the attribute table is attached
l	String/Chain	A collection of vertices, when taken as a whole, represent a line string on a map
p	Point	A single point representing the geographical location of a entity
text entities – all text entities for a given entity class use the same layer		
a	Label	The placement and position of a displayable attribute within the attachment attribute code
t	Text	Any annotation relating to the entity that adequately conveys information about the map product

Entity set	utilities	**Entity class**	water_system	**Entity type**	water_line

Entity name	Discriminator value	Discriminator description	CAD layer
utwat_line_abandoned_l	Abandoned	Abandoned piping	C-DOMW-ABND
utwat_line_fire_l	Fire	Fire lines	C-DOMW-FIRE
utwat_line_main_l	Main	Main domestic water piping	C-DOMW-MAIN
utwat_line_service_l	Service	Domestic water service piping	C-DOMW-SERV
utwat_line_sprinkler_l	Sprinkler	Piping (lawn sprinklers)	L-IRRG-PIPE

Figure 6. Examples of entities in entity class `water system`

Table 5. Example of entity information

Set name	utilities
Class name	water_system
Type name	water_line
Entity name	utwat_line_main_l
Discriminator value	Main
Discriminator description	Main domestic water piping
CADD layer	C-DOMW-MAIN

Attribute tables

Attributes are the fields that can be used to describe each individual entity, and depend on the entity type the entity belongs to. The attributes available for each entity type are defined in attribute tables.

Names for attribute tables

The names for LAWA attribute tables always start with the entity set and entity class prefix, for example `utwat`, and are always 8 characters long

Rows in attribute tables

Attribute tables always include contain:

- a Primary Key field; the name of this field ends in `_id`
- a `datalink` field

Attribute names

- end in `_d` if valid values are defined by an attribute domain
- end in `_id` if they contain a primary or foreign key

Each entity type has a corresponding table in the database. The attributes that can be used to describe a particular entity depend on the entity type, so several entities will refer to the same attribute table. For example, while a main water line and a fire water line are different entities, they use the same attribute table because they belong in the same entity type.

A complete list of attribute tables is available from the LAWA website.

UTILITIES WATER SYSTEM	Water line table	
table name	waterline	
table identifier	utwatpip	
table definition	This table contains data about water system pipes	
Attribute	**Oracle type**	**Definition**
size_d	varchar(16)	The manufacturers designated size, or nominal (i.e., rounded to the nearest unit) diameter for the subject item (e.g., 1in gas hydrant, 2in meter, 6in pipe).
type_d	varchar(16)	The kind, class, or group of the subject item.
source_d	varchar(16)	The source type for the origin of a water system's water supply.
use_d	varchar(16)	Discriminator. The use code for water pipes.
watzone_id	varchar(20)	Foreign Key. Used to link the record to the appropriate utility management zone.
watstat_id	varchar(20)	Foreign Key. Used to link the record to an associated station (pump station, pressure reducing station).
watsource_id	varchar(20)	Foreign Key. Used to link the pipe to an optional source.
watsect_id	varchar(20)	Foreign Key. Used to link the record to an associated pipe or cable section.
wattank_id	varchar(20)	Foreign Key. An operator generated identifier used to locally identify the subject item.
watpipe_id	varchar(20)	Primary Key. A unique, user defined identifier for each record or instance of an entity.
watplnt_id	varchar(20)	Foreign Key. The site specific unique identification name or number of the treatment plant.
w_util_d	varchar(20)	FOREIGN KEY - Links the record to UTWATUTI through primary key W_UTIL_ID.
datalink	integer	Graphic Key. A unique identifier generated by Computer-Aided Design and Drafting (CADD) or Geographic Information System (GIS) software that is used to link the database record to a specific graphic feature.

Figure 7. Attribute table

Domain values

Domains place a limit on the values that can be assigned to a specific attribute. SDSFIE contains two tables that define list domains and range domains.

Note: domain tables all have the prefix `d_` in the name of the table, for example `d_dpobj` or `d_headng`

- list domains contain a list of valid values

  When an attribute is associated with a list domain, it is not possible to type in a value directly. The user has to select a pre-defined value from a pull-down.

- range domains apply only to numeric value; they define a maximum value, a minimum value, or both.

The next figure shows an example of a list domain.

Domain table name	d_dpobj
Domain type	list
Domain definition	Allowable input for the disposition of an object.

Value	Definition
ABANDONED	abandoned in place (not in use)
BURIED	buried
IN_SERVICE	in service and being used
INCOMPLETE	incomplete or unfinished
NATURAL	natural
OTHER	other
PERMANENT	permanent
PROPOSED	proposed
RETIRED	permanently retired, or taken out of service
TBD	to be determined
TEMPORARY	temporary
UNKNOWN	unknown

Figure 8. List domain

Table 6. Example of attribute value from list domain

Domain table name	d_dpobj
Domain name	disposition list
Value code	IN_SERVICE
Definition	In service and being used

The next figure shows an example of a range domain.

Domain table name	d_headng
Domain type	range
Domain definition	The limits on directional heading in degrees; e.g. 0 through 360.
Maximum value	360
Minimum Value	0

Figure 9. Range domain

This table gives the acceptable range of values for a directional heading. When an attribute is associated with a range domain, values outside the specified limits are not accepted.

LAWA SDSFIE data dictionaries

The LAWA SDSFIE data dictionary for GIS attribute tables is available from the LAWA website. Only attributes defined in this dictionary can be used. If additional attributes are found to be necessary, a variance form must be submitted and approved before the new attribute can be added to the data dictionary. The variance form is available from the LAWA website.

All LAWA GIS projects use this dictionary. It is organised by attribute table, and each table corresponds to an entity type. For each entity type, the dictionary gives:

- attribute table information
- valid attributes and their data types
- the definition of each attribute

See Figure 7. for an example of an attribute table.

There is a separate LAWA SDSFIE data dictionary for graphical entities. Only entities defined in this dictionary can be used. If additional entities are needed, a variance form must be submitted and approved before the new entity can be used. The data dictionary and the variance form are available from the LAWA website.

Utilities Water System	graphic properties for water_line
Feature type	list
Domain definition	Allowable input for the disposition of an object.
Tablie identifier	utwatpip
Table definition	A pipe used to carry water from location to location (main line, service line, vent line etc.)

Discriminator value	Entity name	Layer	Entity alpha	Line type	Line width	Color	Symbol library	Symbol name
ABANDONED	utwat_line_abandoned_a	10	utwatlnaba	0	1	3	N/A	N/A
ABANDONED	utwat_line_abandoned_l	9	utwatlnabl	41	2	3	tssdslin	N/A
ABANDONED	utwat_line_abandoned_t	10	utwatlnabt	0	1	3	N/A	N/A
FIRE	utwat_line_fire_a	54	utwatfirea	0	1	3	N/A	N/A
FIRE	utwat_line_fire_l	54	utwatfirel	67	2	3	N/A	N/A
FIRE	utwat_line_fire_t	54	utwatfiret	0	1	3	N/A	N/A
MAIN	utwat_line_main_a	2	utwatlnmna	0	1	3	N/A	N/A
MAIN	utwat_line_main_l	1	utwatlnmnl	67	2	3	tssdslin	N/A
MAIN	utwat_line_main_t	2	utwatlnmnt	0	1	3	N/A	N/A
RAW_WATER	utwat_line_nonpotable_a	6	utwatlnnpa	0	1	3	N/A	N/A
RAW_WATER	utwat_line_nonpotable_l	5	utwatlnnpl	53	2	3	tssdslin	N/A
RAW_WATER	utwat_line_nonpotable_t	6	utwatlnnpt	0	1	3	N/A	N/A
SERVICE	utwat_line_service_a	4	utwatlnsva	0	1	3	N/A	N/A
SERVICE	utwat_line_service_l	3	utwatlnsvl	67	2	3	tssdslin	N/A
SERVICE	utwat_line_service_t	4	utwatlnsvt	0	1	3	N/A	N/A
SIPHON	utwat_line_siphon_a	56	utwatsipaa	0	1	3	N/A	N/A
SIPHON	utwat_line_siphon_l	55	utwatsipal	0	1	3	N/A	N/A
SIPHON	utwat_line_siphon_t	56	utwatsipat	0	1	3	N/A	N/A
SPRINKLER	utwat_line_sprinkler_a	8	utwatlnspa	0	1	3	N/A	N/A
SPRINKLER	utwat_line_sprinkler_l	7	utwatlnspl	20	2	3	tssdslin	N/A
SPRINKLER	utwat_line_sprinkler_t	8	utwatlnspt	0	1	3	N/A	N/A

Figure 10. Data dictionary for graphical entities

All LAWA GIS projects use this dictionary. For each entity type, it gives:

- discriminator value
- entity name
- CAD layer
- Entity alpha

  Unique alphabetic code (10 characters) for each entity. These codes always start with the map prefix for the entity class (see Map/file-name prefix, on page 23), and end with the letter corresponding to the entity type suffix (see Entity name suffixes, on page 15).

- Line, color and symbol information

File names

SDSFIE uses a five-character prefix for map names and drawing-file names. This prefix is made up from the entity set code and the entity class code.

Entity set name	Entity set code	Entity class name	Entity class code	Map prefix	Definition
utilities	ut	Compressed Air System	air	utair	The components of a compressed air system.
utilities	ut	Control & Monitoring System	ecm	utecm	The components of an electronic monitoring and control (emcs) system including cables, devices, etc.
utilities	ut	Electrical Exterior Lighting	exl	utexl	The components of an electrical exterior lighting system including cables, switches, devices,
utilities	ut	Electrical System	ele	utele	The components of an electrical distribution system including cables, switches, devices, motors, transformers, etc.
utilities	ut	Fuel System	ful	utful	The components of a fuel distribution system consisting of pipes, fittings, fixtures, pumps, tanks, etc.
utilities	ut	General Utility Features	gen	utgen	The components of a utility system which are universal in use and purpose and do not belong to a specific utility.
utilities	ut	Heating & Cooling System	hcs	uthcs	The components of a heating and cooling distribution system consisting of pipes, fittings, fixtures. etc.
utilities	ut	Industrial System	inw	utinw	The components of an industrial waste collection system including pipes, fittings, fixtures, tanks, lagoons, etc.
utilities	ut	Natural Gas System	gas	utgas	The components of a natural gas distribution system consisting of pipes, fittings, fixtures, etc.
utilities	ut	Saltwater System	swt	utswt	The components of a salt water collection system.

Figure 11. Map/file-name prefix

Entity set name	Utilities (ut)
Entity class name	Water system (wat)
Map prefix	utwat
Definition	The components of a water system including pipes, valves, fixtures, treatment plants, etc.

Each user/installation can use unique suffixes to identify different versions and updates of map and drawing files.

by date	utwat20000516 or utwat51600
by year	utwat2000
sequence number	utwat01

All files submitted must be compatible with LAWA hardware and software as follows:

- GIS data files: ArcView Shape File, ESRI SDE, AutoCAD Map (a recent version)
- vector graphics: AutoCAD (a recent version)
- raster graphics: TIF, ECW, SID
- digital media: CD-ROM, DVD-ROM, Flash drive, USB HD

Coordinate system and property addressing grid

This coordinate system for all AIMS applications, including LUSAD will be the State Plane California Coordinate System (Feet) (CCS83) using the North American Datum of 1983 California Zone 5 (NAD 83) for horizontal data and the North American Vertical Datum of 1988 (NAVD 88) for vertical data. Coordinate references must be compliant with AC 150/5300-18b.

Property addressing grids are available for LAX, ONT, and VNY

Translating CAD layers to GIS layers

The standard for GIS layers is based on the major groups of the SDSFIE data standard. The next figure illustrates how a layer is named from the entity set, entity class, and entity type that it belongs to.

CAD and GIS systems are similar because both of them may contain a mix of graphical and tabular data. In a CAD-based GIS, each entity is assigned a particular set of layers or levels. Each layer represents a particular discriminator and graphic property for that entity, which means there can be a many-to-one relationship between layers and entities. As a result, multiple CAD layers may translate into one GIS layer.

A translation table, in order to ensure proper translation from CAD data to GIS data, is available from the LAWA website. This table maps layers in the LAWA *CAD Layering Standard* to the GIS layering standard.

Example

CAD uses different layers to represent water lines with different functions, for example:

- CAD layer C-DOMW-MAIN for a domestic water main
- CAD layer C-DOMW-FIRE for a fire line

GIS uses the single entity type `utwatpip` (water pipe line) to represent both of these water lines, and uses attributes to identify the difference between them.

LAWA uses the Feature Classification tool in AutoDesk Map to make it easier to convert CAD based drawings into useable GIS features.

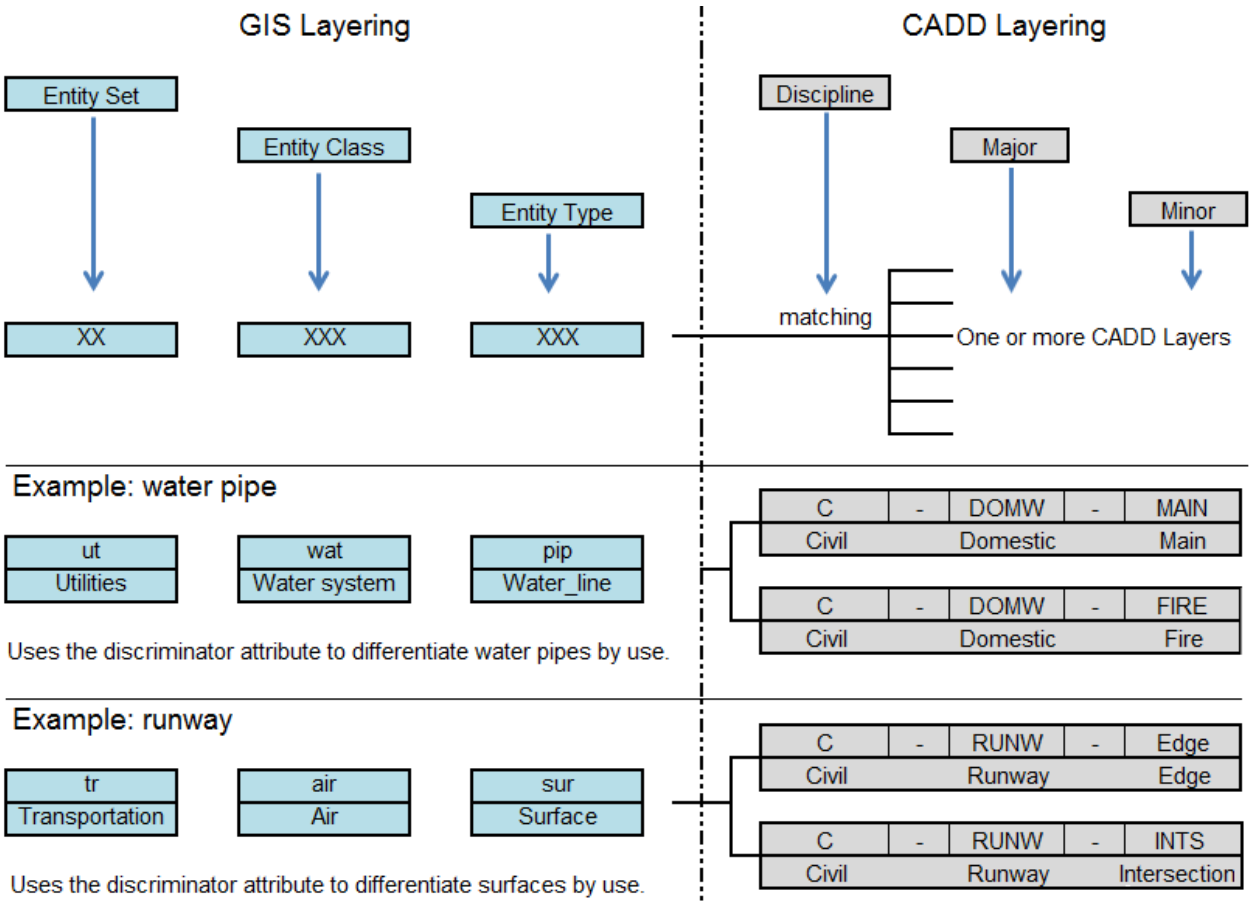

Figure 12. GIS conventions and CAD conventions for layers and naming compared