



# GIS STANDARDS

# GEOGRAPHIC INFORMATION SYSTEM STANDARDS

GIS is a spatial information system used at NDOT for planning, analysis, and resource grade maps. GIS map products are not to be used for engineering purposes. Engineering data can be used in the department GIS, but the nature and standards for the GIS data are not as stringent as those in engineering. The GIS at NDOT is an enterprise system; flexibility and integration of the system are key components critical to ongoing operations.

GIS consist of two primary data areas: The geographic component or geometry graphics, and the information system or data attribute components. Each of these primary data areas can be further subdivided. The following discussion will outline the various components of the two primary data areas, and describe existing NDOT Geographic Information System standards. Basic GIS hardware and software standards will also be discussed. When using this document, it is useful to keep in mind that Information Systems today are dynamic. As such, user requirements and technology dictate that standards change. This is especially true in the world of Geographic Information Systems. The standards for Geographic Information Systems at NDOT will be under constant scrutiny and changes will be implemented as necessary. Therefore, consultants shall follow this document for any GIS project at NDOT, but should also check with the GIS section for any recent changes, and follow any additional written contract detail specifications. Consultants working on applications should also contact the Information Services Division for current specifications relating to web applications and compliance with Section 508 Disability Requirements.

Divisions within NDOT that have projects with a GIS component must comply with guidelines contained in this document per Transportation Policy 1-9-4. It should be remembered that the success of GIS at NDOT is a team effort and consists of the GIS section, the other divisional staff involved and the vendor if applicable. *The GIS section is here to help GIS related projects be successful.*

# HARDWARE STANDARDS

NDOT has established the Intel-based computer as the Department standard. There are generally two categories of computers, the Business computer and the CAD computer or Workstation.

## **Business Computer Definition (Recommended Configuration)**

1GB RAM  
80GB Hard Drive  
3.0+ GHz Pentium IV  
DVD ROM/CD-R Drive  
3.5" Floppy Drive  
17" Monitor

## **CAD Computer Definition (Recommended Configuration)**

2 GB RAM  
80 GB Hard Drive 7200 RPM or greater  
3.0+ GHz Pentium IV  
DVD-ROM/CD-R Drive  
3.5" Floppy Drive  
19" Monitor (second monitors are recommended for high end users)

## **GIS Computer considerations (Recommendations)**

1 GB RAM (more on machines doing actual analysis or modeling). Sufficient space for GIS data on the local machine should consist of 10 GB for a casual user or a minimum of 40 GB for modeling. Swap space commensurate with the RAM should also be available. Video is a major component of GIS. A minimum of 128 MB of video RAM are recommended for the casual user. Systems used for analysis should have at least a minimum of 256 MB of Video RAM. Processing power is important but primarily for modeling and analysis. 3.0 GHz or faster processors are recommended for such persons. A minimum of 2.0 GHZ is necessary for 'casual' users due to software requirements. Additionally, DVD drives are required for storing, retrieval, or archiving image data. Fast network connections 100MB or greater are necessary for accessing larger files on the servers or for data transfer.

**Note:** These hardware standards are current at the time of this writing but will change with technological innovations. Contact Information Systems for the most recent computer definitions. Each set of the machine specifications is adequate for most end user GIS applications. The CAD computer is adequate for most GIS development and maintenance applications. Specialized GIS applications (such as image processing) may require an enhanced performance computer.

# SOFTWARE STANDARDS

## Operating System Software

NDOT currently uses Microsoft Windows 2000 Professional as the operating system platform for virtually all computers in the department. All application software, including GIS software, must run in this environment. NDOT uses Windows 2000 Professional for workstations and Windows 2000 & 2003 Server for servers.

Current Versions: Microsoft Windows 2000 5.0 – Check for latest Service Pack

## Database Software

The State of Nevada has a licensing agreement with Oracle. NDOT has established Oracle as the Relational Database Management System (RDBMS) for the primary database standard with the other option being SQL-Server database. The GIS section of NDOT has a licensing agreement for the Spatial Data Cartridge from Oracle. Oracle (preferred) or SQL will be used for the Department-wide GIS data warehouse. Microsoft Access is also used for some GIS application development and end user applications. MS Access is used for those applications that require less sophistication and performance demands from the database management system. In all cases, applications **will be** compatible with the NDOT Linear Referencing System and Bentley LRSx product.

Current Versions:

Oracle Enterprise Oracle 9.2.0.7 Oracle Spatial Cartridge is also used.

SQL Server 2000 SP3

Microsoft Access 2000

LRSx 1.x

## GIS Software

GIS software can be divided into two categories, the development/ maintenance products and end user desktop software. NDOT currently uses GeoMedia Professional as the primary enterprise GIS software tool for data editing and analysis. ArcExplorer or GeoMedia will be used as data viewers. It may also be used for data maintenance and development by the end user. Non-technical end user applications will be developed in GeoMedia WebMap Professional.

Current Versions:

Intergraph GeoMedia Pro 5.2 sp.72 or later or GeoMedia Pro 6.0 sp .94 or later

GeoMedia Transportation Manager or Analyst

GeoMedia Transaction Manager

Bentley/TransDecisions LRSx software 1.x

GeoMedia WebMap Pro 5.2 check for service pack. (Migration to 6.x may occur in 2007)

ArcExplorer 2.0

## Applications

Applications **should not be** developed for the desktop software. Applications for end users should be developed in the web software environment. Application developers should keep in mind that some remote offices and public access users still only have limited internet connectivity. Additional requirements on Web, database, network security, and other IS related issues should be investigated with the IS division. The GIS section can furnish you with appropriate points of contact.

# GIS DATA STANDARDS

## Data Types

The Geographic Information System data standards must address two primary data types: the geographic data (geometry) and the informational (attribute) data or database. The data types are created & maintained by either the enterprise or local end user.

It is the responsibility of the GIS section, in coordination with the Cartographic Section, to establish and maintain standards for the digital base map data, both the geographic and the attribute data types (TP 1.9.4). The GIS and Cartographic sections jointly establish and maintain standards for the digital base map data. The GIS and Cartography sections will also coordinate Oracle or SQL database activities with the IS Division.

Generally, the creator of a particular set of data is responsible for developing and maintaining standards that meet his or her data needs within the greater enterprise-wide concept. The GIS standards pertaining to data formats, minimum attributes, coordinate system, accuracy assessment, and metadata must be adhered to. Attribute information and database fields are left to the discretion of the data collector and specific project needs, except those specified by the GIS section. It is strongly recommended for any groups (internal or external) developing data to consult with the GIS section early in the process.

## Data Formats

Listed below are the data types, formats, attribute information, and minimum metadata information. All data presented to NDOT for inclusion in the GIS **will be** in NAD83 - HARN, GRS 1980, UTM (Zone 11, meters).

## Accuracy Issues

The accuracy issue is always of concern when developing standards. However, accuracy can have many different meanings in the GIS. First there is the geographical or positional accuracy and equally important is the informational or attribute accuracy. Then there is the issue of how precise the specific data is. Unknowns in either case could potentially render unacceptable results in the GIS. This document is primarily concerned with the standards on accuracy relative to the NDOT digital base map data. Positional Accuracy assessment or validation of data is the responsibility of the Geodesy Section. There may also be other data that is used as a Department-wide resource that the standards in this manual will be applied to. However, in general, it is the responsibility of the source organization to provide the accuracy information as part of the metadata included with all GIS data. Map accuracy standards are in the section titled "Map Content Requirements." **Any data provided by vendors will have appropriate metadata reflecting accuracy.** Compilation of that value will follow the guidelines set forth in this document under the Geodesy standards accuracy requirements.

## Geographic Data Standards

The geographic data, or map, is one of the two primary data components of a Geographic Information System. Geographic data can generally be subdivided into two categories, the base map geographic data and the mapping data for end user applications. The following discusses

the various data and the standards that apply. Geographic standards already exist at NDOT for graphic data, such as Survey and Cartography standards. It is not the intent of this document to replace these standards but to maintain those standards where appropriate. In fact, it is the goal at NDOT that all base map geographic data be verified using Survey standards or to be attributable to an appropriate authoritative source.

## **Base Map Standards**

The following describes the standard that applies to the Digital Cartographic Reference Base Map (DCRB). Generally this standard parallels the Mapping standard that has been established by the Cartography Section at NDOT. However, there may be differences in the way the two standards are structured. It is important to note that the base map standard applies only to the digital base map data and not necessarily to other data (end user data) that may be displayed as part of a GIS map presentation. **End user data or application data standards will depend on the requirements of the users and the objectives of the application. These standards will be set in the Requirements Specification for a project.** However, as stated earlier, certain minimum standards will be adhered to. The Base Map standard is feature based. This means that each map feature may have its own defined standard that may be different than other map features. Each feature is also associated with a particular category. Currently, categories that are of concern for the digital base map standard consists of Transportation, Public Land Survey System (PLSS), hypsography/Digital Elevation Models (DEM), Hydrology, and Political Boundaries. Each category has a spreadsheet that contains a list of features for that category and information describing their standards. Associated with each spreadsheet is a description of the features and the attributes used to define the standard.

Vendors who collect data using GPS will also provide the information on hardware, metadata on the data collected, and post processing. (Use of WAS enabled or other real time correction method, GPS units is strongly encouraged). Features should be occupied when collected. Proper safety considerations should be taken into account when doing this. “Drive by” data is not acceptable unless collected in accordance with approved ‘road viewer’ technology. It is also recommended to capture a digital photograph of the feature at this time to ensure the proper feature was collected. The photo number should be included in the database for the feature. **A full understanding by the vendor of the customer needs and collection requirements should be obtained before data is collected.**

# GIS BASE MAP FEATURES

## Transportation Category

Feature Name	Feature Type	Horizontal Position	Vertical Position	Attribute Verification
Major Highway CL	Linear	2.394 m +/- @ 95%	2.394 m +/- @ 95%	NDOT Verified
Major Highway EO	Linear	2 m +/- @ 95%	2 m +/- @ 95%	NDOT Verified
Minor Roads CL	Linear	15 m +/- @ 90%	tbd	Application Verified
Mileposts	Point	15 m +/- @ 95%	tbd	NDOT Verified
Railroads	Linear	10 m +/- @ 90%	tbd	Application Verified
Engineering District	Area	tbd	n/a	NDOT Verified
Maintenance District	Area	tbd	n/a	NDOT Verified

*tbd - to be determined*

*n/a - not applicable*

*Other point, or line information of a transportation nature should adhere to the positional standards for the examples listed above.*

## Feature Description

Major Highway CL	<i>Centerline for Interstate, US and Nevada State Highways</i>
Major Highway EO	<i>Edge of Oil for Interstate, US and Nevada State Highways</i>
Minor Roads CL	<i>Centerline for all other roads, e.g. County, rural and local roads</i>
Mileposts	<i>Mileposts for Interstate, US and Nevada State Highways</i>
Railroads	<i>Centerline for major rail lines</i>
Engineering District	<i>Nevada DOT Engineering District Boundary</i>
Maintenance District	<i>Nevada DOT Maintenance District Boundary</i>

## Standards Attribute Description

Feature Name	<i>Name of feature in the GIS database</i>
Feature Type	<i>Type of graphical representation - point, line, area</i>
Horizontal Position	<i>Horizontal positional accuracy stated as distance and percentage</i>
Vertical Position	<i>Vertical positional accuracy stated as distance and percentage</i>
Attribute Verification	<i>Informational data confidence level based on verifying entity</i>
Datasource Origin	<i>of the information i.e. GPS, DOQ, DRG or other.</i>

## Hydrology Category

Feature Name	Feature Type	Horizontal Position	Vertical Position	Attribute Verification
Water Area	Area	~20 meters @ 90%	tbd	Source Verified
Major Rivers	Linear	~10 meters @ 90%	tbd	Source Verified
Major Drainage	Linear	~10 meters @ 90%	tbd	Source Verified

*tbd - to be determined*

*n/a - not applicable*

## Feature Description

Water Area	<i>Major bodies of water to include lakes, ponds, and reservoirs</i>
Major River	<i>Rivers considered to be navigable</i>
Major Drainage	<i>Drainage considered to be in place year-round</i>

## Standards Attribute Description

Feature Name	<i>Name of feature in the GIS database</i>
Feature Type	<i>Type of graphical representation - point, line, area</i>
Horizontal Position	<i>Horizontal positional accuracy stated as distance and percentage</i>
Vertical Position	<i>Vertical positional accuracy stated as distance and percentage</i>
Attribute Verification	<i>Informational data confidence level based on verifying entity.</i>
Datasource Origin	<i>Origin of the information i.e. GPS, DOQ, DRG or other.</i>

## Political Boundaries Category

Feature Name	Feature Type	Horizontal Position	Vertical Position	Attribute Verification
State Boundary	Area	PLSS	n/a	NDOT Verified
County Boundary	Area	PLSS	n/a	NDOT Verified
Military Reservation	Area	tbd	n/a	Source Verified
National Forest	Area	tbd	n/a	Source Verified
Wilderness Area	Area	tbd	n/a	Source Verified
Indian Reservation	Area	tbd	n/a	Source Verified
National Parks	Area	tbd	n/a	Source Verified

*tbd - to be determined*

*n/a - not applicable*

## Feature Description

State Boundary	<i>Nevada State boundary</i>
County Boundary	<i>Boundaries for the counties of Nevada</i>
Military Reservation	<i>Any boundary defining a military facility</i>
National Forest	<i>Any boundary defining a National Forest area</i>
Wilderness Area	<i>Any boundary defining a Wilderness area</i>
Indian Reservation	<i>Any boundary defining an Indian land area</i>
National Park	<i>Any boundary defining a National Park</i>

## Standards Attribute Description

Feature Name	<i>Name of feature in the GIS database</i>
Feature Type	<i>Type of graphical representation - point, line, area</i>
Horizontal Position	<i>Horizontal positional accuracy stated as distance and percentage</i>
Vertical Position	<i>Vertical positional accuracy stated as distance and percentage</i>
Attribute Verification	<i>Informational data confidence level based on verifying entity</i>
Datasource Origin	<i>Origin of the information ie. GPS, DOQ, DRG or other.</i>

# GIS DATABASE STANDARDS

The database is the heart of an Information System. In a GIS, the database actually serves two purposes. It is the mechanism by which the vector graphics (map) takes on intelligence and it is the system that stores, manages, and retrieves all informational data. The database is the component that makes the GIS a system. It is also the component that requires the most time and effort both in design and implementation.

## NOTE:

**This section of the GIS Standards document is still under development.  
There will be both additions and changes to the information presented here.**

## Oracle Database Tables:

- RN.SDS\_SOURCE\_MONSTER Properties
- LOC.MPMARKERS Properties
- LOC.MPMARKERS\_GREEN Properties

## LRSx Requirements Fields

- Oracle with spatial cartridge
- LRSx – LRS – Metadata – user defined tables
- LRSx – event metadata – user defined event tables
- A schema for TD SYS TABLES- stores feature class metadata
- LRS DATUM- underlying geometry, naming & measure
- LRS DATUM-ID- feature ID
- LRS DATUM-street code- LRS route identifier
- LRS DATUM-measurement-begin & end segment values

**For other fields used in points or lines see next page. Additional Requirements may exist in Information Services Division.**

# END USER DATA STANDARDS

End user data should meet two criteria for implementation into the NDOT GIS. The GIS data format standard and the minimum metadata standard are defined below.

## GIS Data Format Standards

The following GIS data formats are currently acceptable at NDOT.

<b>MGE data format</b>	<b>.DGN files and Oracle database</b>
<b>GeoMedia data format</b>	<b>Microsoft Access .MDB file format</b>
<b>Arc Info data format</b>	<b>arc coverage</b>
<b>ArcView data format</b>	<b>Shapefile format (.SHP/.SHX/.DBF/.PRJ files)</b>
<b>MapInfo data format</b>	<b>(.MAP/.DAT/.TAB/.ID/.IND files)</b>
<b>GeoTiff image</b>	<b>with world file (if not written in header)</b>
<b>Mr. Sid image</b>	<b>with .sdw worldfile</b>
<b>Autocad</b>	<b>DXF format</b>
<b>Arc GIS</b>	<b><u>Geo database format is not acceptable</u></b>

## GIS Metadata Standards

The following is a list of the minimum required information that will accompany all GIS data. This information is required in electronic form and as a part of the deliverable to NDOT.

<b>Geodetic Datum</b>	<b>Coordinate System</b>	<b>Zone</b>
<b>Vertical Datum</b>	<b>Coordinate Units</b>	<b>Coordinate Value</b>
<b>Horizontal Accuracy</b>	<b>Attribute Definition</b>	
<b>Vertical Accuracy</b>		

(Note: Has the data set been modified to reflect grid to ground inconsistencies?)

Data source origin of the information, i.e. GPS, DOQ, DRG or other.

**Data Source (Name / Address of agency or firm)**

**Contact Name:**

**Position:**

**Phone:**

**Fax:**

**E-mail:**

**Collection Method (GPS / survey / digitizing, etc.)**

**Accuracy Information (attribute and positional)**

**Data Collection Data**

If modified from an original source a description of the modifications and software used to perform the modifications including version and the original data source must be listed. List of attributes and data types. *Preferred content is Sections 1-7 of the FGDC standard.*

## Data Transfer procedures

For files under 150MB compressed FTP is acceptable.

For files over 150MB CD-Rom, DVD-Rom, or Portable USB hard drive (NTFS format) as appropriate.

## GIS DATABASE STANDARD FIELDS

Field Name	Field Type	Field Size	Notes	Status
Northing	Number	Double	UTM Coordinate	Point Features#
Easting	Number	Double	UTM Coordinate	Point Features#
GPSHeight_M *	Number	Double	Metric units	Point Features#
Latitude	Text	50	D:M:SSSS	Point Features&
Longitude	Text	50	D:M:SSSS	Point Features&
GPSHeight_FT *	Number	Double	English units	Optional
MileReferencePost	Number	Double	Mileage Number	Preferred
CountyCode	Text	3	Abbreviated county string	Optional
CountyString	Text	20	County full name	Preferred
FIPSCode	Text	10	County FIPS code	Required
DOTDistrict	Text	2	NDOT Maintenance District	Optional
Direction	Text	3	Cardinal travel direction	Preferred
Prefix	Text	3	E/W/N/S/NE/NW	Optional
System	Text	20	IR/US/SR/FR/Other	Preferred
Route	Text	20	Route number/Street name	Required
Suffix	Text	2	RD/AV/ST	Optional
Offset	Number	Long Interger	Distance from E.O.	Optional
SideOfRoad	Text	10	LT/RT/N/S/E/W	Optional
Name	Text	50	Data collected issue	Preferred
Type	Text	50	Data collected issue	Optional
Status	Text	20	Active/Inactive	Preferred
DataSource	Text	50	Source data collected from	Preferred
DataSourceMethod	Text	20	GPS/Digitized	Required
DataSourceDate	Date/Time	Date	Date data collected	Preferred
PhotoNumber	Text	20	Name or number of photo	Preferred

Sample	Prefix	System	Route	Suffix
		IR	80	
	S	Other	Virginia	St

\* *ellipsoid height* # *Required Field* & *Preferred*

## **GIS DELIVERABLES**

The following are the minimum deliverables expected for GIS related projects. It is the responsibility of the consultant to ensure they understand the deliverables for the contract and to make this a part of the proposal. Given the potential complexity of scope and scale of a project the consultant should actively communicate with NDOT to ensure deliverables are properly understood and correctly delivered. Projects will not be considered complete for payment until all deliverables are received and approved.

Application documentation will be reviewed by the GIS and appropriate IS staff for completeness and readability in draft and final form. Reports will be reviewed by appropriate project related personnel including internal NDOT customers and GIS staff. Sufficient time (not less than 10 business days) for documentation review should be allowed for in the scope of work. Drafts should be delivered in a timely manner to facilitate review.

### **Reports**

1. Preliminary draft documents will be presented in NDOT's word processing package format (Microsoft Word 2000 v9.0) editable for review, updates and changes by NDOT staff.
2. An electronic copy of the final deliverable document will be delivered in PDF file format.
3. A minimum of 4 hard copies of the printed report, in color if appropriate.

### **Applications**

Two copies of Program files and data are to be delivered on CD-Rom(s)

### **Data files**

Any data generated for the project will be returned in the proper coordinate system (NDOT Standards) and acceptable data format(s) with appropriate metadata. Time should be allotted for review and acceptance of both GIS data and metadata.

### **Documentation**

Items will be clearly labeled in a single document(s) folder presented in NDOT's word processing package format (Microsoft Word 2000 v9.0) editable for review, updates, and changes by NDOT staff. This may include a programmers guide, a users guide, application specifications, or any other documentation as required or requested in the contract. All documentation will be reviewed prior to project acceptance. Metadata should be in FGDC or ISO compliant format and delivered in HTML format.

### **Application**

Items will be in separate folders for maximum clarity.

1. All source code.
2. A final installation version of the installed application
3. Any other associated files for the program.

### **Databases or other data**

Data will meet the contractually specified requirements listed in either the GIS or Cartographic Section for accuracies and type.

It is expected that all applications will be thoroughly tested prior to deployment. However experience indicates that minor fixes may be required after installation. NDOT expects the contractor to support these applications for a minimum of 30 days. Repairs necessitated by factors outside the original contract (such as operating systems changes and items of related nature with the exception of security patches) will not be reasons to request corrections.