Nevada Coordinate Reference System (NCRS) Overview

General Information

The city of Las Vegas has implemented an innovative and efficient approach to survey coordinates. Until recently, surveyors have regarded coordinate systems almost strictly as a project-specific entity. The city desired a more universal approach. This goal resulted in the design of the Nevada Coordinate Reference System, or NCRS. The NCRS enjoys several benefits over typical arbitrary survey coordinate systems: it covers a large area (two zones cover the entire city and almost cover the entire Las Vegas valley), it works seamlessly with GPS and published RTK networks, and it is ready-made to integrate with GIS and other georeferenced data. In the past some of these feats were accomplished, albeit crudely, by scaling State Plane coordinates to correspond to ground distances. This resulted in a coordinate system that only covered a limited area and was not compatible with any other georeferenced data. This ground distance problem is caused by distortion due to the curvature and irregularities of the earth's surface, and was solved with the design of the NCRS. Contrary to State Plane coordinates, that were designed to cover very large areas, the NCRS zones were designed to only be as large as possible without sacrificing accuracy. They can be used in their original form (not scaled) and still be accurate enough to meet the needs of the surveying and engineering community.

One System, Two Zones

The NCRS was originally intended to be one map projection/coordinate system for the entire city; however, the desired distortion/accuracies could not be met due to the size and elevation variance. This was solved by covering the city with two different zones (actually these two zones cover the entire Las Vegas valley). Contrary to State Plane Coordinate System zones which are more horizontally divided (it uses county boundaries), the NCRS zones are more vertically split by elevation. There is a main zone which covers a large majority of the city named the Las Vegas Zone. Another zone was created to cover the areas of higher elevation aptly named the Las Vegas High Elevation Zone. There is significant overlap between zones containing a usable level of distortion to allow for projects that straddle this boundary. The two zones were designed with parallel grids, meaning bearings produced by either zone's coordinates are the same. Below are links to maps and specs for the two zones.

The NCRS and GPS

Since the advent of GPS, surveyors have manipulated their GPS equipment to work with their project coordinate system or vice versa. This has not always been an easy task, and usually sacrifices must be made. Since GPS measures globally (most commonly expressed as latitudes and longitudes) and surveyors and engineers need their projects to live on a flat surface or plane, something has to give. This has traditionally been done by converting our latitudes and longitudes generated by the GPS measurements into State Plane coordinates. The math for this conversion is taken care of by something called a map projection, and there is a different map projection for each State Plane zone. However, those map projections were designed back in the 1930's and were not created to meet the accuracies needed for the surveying of today. The local State Plane zone, Nevada East, differs from actual ground distances by a factor of around one foot in a mile. This issue has traditionally been dealt with by scaling (and in particular stretching) the State Plane coordinates to match the ground distances. This is where the NCRS coordinate system comes in. NCRS coordinates are also derived from map projections that convert directly from latitudes and longitudes. The difference being that these map projections were designed so that the distances between coordinates match ground distances by default, without scaling. The proper parameters found in the citys NCRS Specifications document, found on the Survey & Right of Way section of the city website, www.lasvegasnevada.gov, just need to be used to create the coordinate system within the survey data collector or office software.

The NCRS and Elevations

It should be known that the NCRS coordinate systems do not provide formal elevations. Any surveys requiring elevations within the city of Las Vegas, public or private, should be referenced to the City of Las Vegas Vertical Control Network of published benchmarks. The regional GPS networks (LVVWD Spider and TURN VRS) broadcast ellipsoid heights that can produce orthometric heights (elevations) when used with a geoid model. These resulting elevations can come very close to matching benchmark elevations, but should never be used as a replacement for directly tying surveys to city benchmarks. Generating quality elevations from GPS measurements is in itself a controversial subject within the surveying industry, and is in general not recommended by the city of Las Vegas."

The NCRS and CAD/GIS Software

Due to NCRS coordinates being georeferenced, they are a natural solution for mixing engineering CAD with GIS data. Autodesk products (AutoCAD, Civil 3D, etc.) already include the NCRS coordinate systems in their coordinate system library. Once a drawing file has been associated with the correct coordinate system, GIS data (usually State Plane Nevada East coordinates) can be brought in using the built-in map tools. This allows aerial imagery, parcel linework, shapefiles, etc. to be brought into the CAD file without any manipulation. The coordinate system definitions allow the software to align the different data sets based on their inherent latitudes and longitudes. This can also be done in reverse, bringing CAD or survey points into GIS software. The projection files needed by Esri ArcGIS software can be obtained through the link below. A brief note about datums is warranted here. As mentioned above, the current datum used by the city of Las Vegas is NAD83(2011). However, it has been common practice up until now for the city to use the "generic" NAD83 datum version of both the NCRS and State Plane coordinate systems inside CAD and GIS software due to most GIS data in Clark County already being associated with that datum (right or wrong).

Referencing the NCRS on Formal Survey Documents

Typically the only horizontal reference surveyors provide with their surveys is a basis of bearings. In most cases this would be a reference to a specific prominent line on a previously recorded survey. It is recommended to keep NCRS surveys "real" and not rotate to a record bearing which in turn will require special considerations when it comes to a basis of bearings. Below the city has provided suggested language for a basis of bearings statement. This statement is intended to be universal to both zones, as the two zones are "parallel" to one another. It is also strongly suggested to show coordinates on surveys whenever possible. This provides a direct link between the survey and the coordinate system, providing considerable value to following surveyors for alignment and verification purposes. It is recommended (and required on any survey performed for the city) to include a coordinate definition statement with the basis of bearings whenever coordinates are shown.

Suggested Language

Example 1:

NEVADA COORDINATE REFERENCE SYSTEM
LAS VEGAS AND LAS VEGAS HIGH ELEVATION ZONES
BASIS OF BEARINGS STATEMENT
BASIS OF BEARINGS

GRID NORTH AS DEFINED BY THE CENTRAL MERIDIAN OF THE NEVADA COORDINATE
REFERENCE SYSTEM (NCRS), LAS VEGAS AND LAS VEGAS HIGH ELEVATION ZONES,
NORTH AMERICAN DATUM OF 1983 (NAD83); SAID MERIDIAN BEING COINCIDENT WITH
114°58' WEST OF THE GREENWICH MERIDIAN

Example 2:

NEVADA COORDINATE REFERENCE SYSTEM
LAS VEGAS ZONE – NAD83(2011) EPOCH 2010.0
COORDINATE SYSTEM DEFINITION STATEMENT
COORDINATE SYSTEM DEFINITION
DATUM/REFERENCE FRAME: NAD83(2011) EPOCH 2010.0
MAPPING PROJECTION PARAMETERS:
SYSTEM: NEVADA COORDINATE REFERENCE SYSTEM (NCRS)
ZONE: LAS VEGAS ZONE
PROJECTION TYPE: TRANSVERSE MERCATOR
STANDARD PARALLEL (AND
LATITUDE OF GRID ORIGIN): 36° 15' 00" N
LONGITUDE OF CENTRAL
MERIDIAN: 114° 58' 00" W
LINEAR UNIT: US SURVEY FOOT (SFT)
FALSE NORTHING: 656,166.6667 SFT (200,000.000 m)
FALSE EASTING: 328,083.3333 SFT (100,000.000 m)
SCALE FACTOR AT CENTRAL
MERIDIAN: 1.0001 (EXACT)

Example 3:

NEVADA COORDINATE REFERENCE SYSTEM
LAS VEGAS HIGH ELEVATION ZONE – NAD83(2011) EPOCH 2010.0
COORDINATE SYSTEM DEFINITION STATEMENT
COORDINATE SYSTEM DEFINITION
DATUM/REFERENCE FRAME: NAD83(2011) EPOCH 2010.0
MAPPING PROJECTION PARAMETERS:
SYSTEM: NEVADA COORDINATE REFERENCE SYSTEM (NCRS)
ZONE: LAS VEGAS HIGH ELEVATION ZONE
PROJECTION TYPE: TRANSVERSE MERCATOR
STANDARD PARALLEL (AND

LATITUDE OF GRID ORIGIN): 36° 15' 00" N
LONGITUDE OF CENTRAL
MERIDIAN: 114° 58' 00" W
LINEAR UNIT: US SURVEY FOOT (SFT)
FALSE NORTHING: 1,312,333.3333 SFT (400,000.000 m)
FALSE EASTING: 984,250.0000 SFT (300,000.000 m)
SCALE FACTOR AT CENTRAL
MERIDIAN: 1.000135 (EXACT)