3D Spatial Utility Database at CALTRANS

Donna Rodrick, Transportation Surveyor – CADD Support
California Dept. of Transportation

Speaker Bio

I graduated from CA State University, Fresno with a BS degree in Surveying Engineering and Applied Mathematics. I have worked for the California Department of Transportation as a Transportation Surveyor for over 25 years; working in San Luis Obispo and Fresno for the first 4 years in the Surveys department. Next I accepted a position in the Photogrammetry department in Sacramento, where I worked the next 4 years. For the last 17+ years, I have worked in the "Office of CADD and Engineering GIS Support". My duties include software support for the users, writing manuals, writing applications in C, vb.net and VBA to enhance software for Caltrans needs and standards and working on the utility database.

When not working, I volunteer at our local animal shelter and spend time with my husband and our 3 dogs.

Background information:

The California Department of Transportation (CALTRANS) was awarded a federal grant to create a 3D spatial database for the purpose of collecting utility data and locations. Bentley Map Enterprise V8i (SELECTseries4) was chosen as the graphical display software. Oracle 12c was chosen as the spatial database. Bentley Map Enterprise V8i (SELECTseries 4) will be referred to as Bentley Map and Oracle 12c spatial database will be referred to as Oracle DB.

Creating and maintaining a utility database with a standardized set of data attributes will ensure that the utility infrastructure can be accurately identified during project planning and for conflict resolution during design and construction. Our Utility Engineering Workgroup (UEW) will enter and update the data. Caltrans Office of CADD and Engineering GIS Support will administer and maintain the database structure.

California State Plane Coordinates

Information below is from the CALTRANS Surveys Manual

- Section 8817 of the CA *Public Resources Code* requires that all new surveys and new mapping projects, which use State Plane Coordinates, must use the **California Coordinate System of 1983 (CCS83)**, which is based on the North American Datum of 1983 (NAD83).
- The CCS83 grids are fixed to the NAD83 datum. As tectonic shifts move the actual monuments, they don't move the grids. Think of dots slowly moving across a sheet of graph paper. Even though the points are moving, the graph paper grid does not. Even if the monuments still hold their relative positions, eventually they have moved too far to be accepted for their original location. They must then be updated to a current datum/epoch.
- The initial NAD 83 coordinates resulted from a nationwide least squares adjustment of the original terrestrial observations that had incrementally built up the NAD 27 network. The adjustment results were published in 1986, so that the first realization of the reference frame was called NAD 83 (1986). The term in parentheses, e.g. (1986), is the Datum Tag, which denotes a specific realization, or adjustment, of the NAD 83 datum.

California State Plane Coordinates

- There have been multiple realizations (major adjustments) of the North American Datum of 1983 (NAD83).
- To fully specify the realization and timeframe, the datum tag must be followed by an epoch date, for example “NAD 83(2011) Epoch 2010.00.” **The published coordinates are valid for the epoch date displayed.** The epoch date is in deciyear format, where the numbers to the right of the decimal point are derived from the Julian day of the year. For example, to determine the Julian day for 1991.35, multiply 0.35 times 365 (days, for a non-leap year) to ascertain that .35 year equates to the 128th day of the year, or May 8. The datum tag date (year) and the epoch date can be coincident or different.
- Once an adjustment with its datum tag is established, there can be several epochs associated with the adjustment.

For example: **NAD 83 (2007) Epoch 2007.00 Western states** and Alaska

NAD 83 (2007) Epoch 2002.00 North American plate

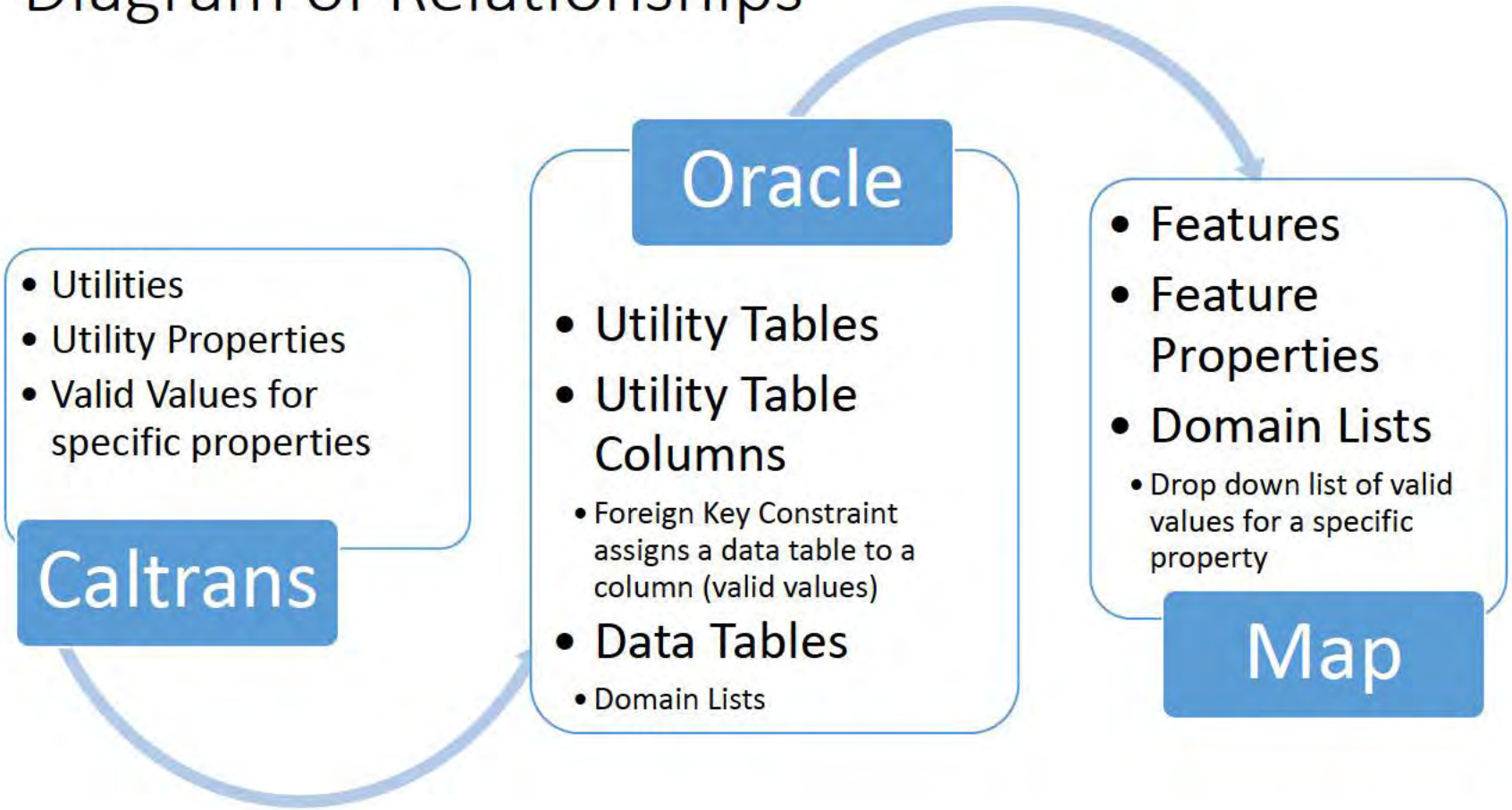
California State Plane Coordinates

CCS83 consists of 6 zones as shown in the Map.

Caltrans has 12 district offices and a headquarters office.

Some districts have assigned counties that are located in the same zone; while other districts have assigned counties that are located in different zones.

Diagram of Relationships



Agenda / Objectives

- Functionality of a multitenant database
  - Pluggable databases (PDB) and tablespaces
- 3D spatial database for utilities
  - Ability to create compound coordinate systems
- Users with different privileges and roles to limit their access to the database
- Creating the utility tables and corresponding geometry spatial indexes
- Connecting to database from other applications
  - Importing database features into a CADD file, enables us to assign symbology
  - Utility layout sheets are easily created for the existing utilities

A Multitenant Container Database is being utilized

- Oracle 12c gives us the ability to create a container database (CDB) with multiple pluggable databases (PDBs).
- We are utilizing pluggable databases to separate and maintain information for the different realizations (major adjustments)of the North American Datum of 1983 (NAD83).
  - NAD83 (Pre HPGN/HARN) shown as NAD83(1986)
  - NAD83(HPGN/HARN)
  - NAD83(NSRS 2007) also shown as NAD83(2007)
  - NAD83(2011) – no SRID or EPSG values
- Each pluggable database consists of 6 tablespaces; one for each of the 6 zones in the California Coordinate System of 1983 (CCS83).

A Multitenant Container Database is being utilized

- Compound coordinate reference systems were created in each of the pluggable databases for the horizontal coordinates of specific NAD83 Realization - CCS83 zones and for NAVD 88 (North American Vertical Datum 1988) elevations .

- Creating a user for each tablespace is important for the registration of Oracle tables in the Bentley Map projects. A user that has an assigned tablespace will limit which tables are found for the Map – Oracle registration process.

Compound Coordinate Reference System (CRS)

- State plane datums are horizontal datums, 2D geometry in X and Y coordinates. And accordingly, Oracle defines them as 2D geometry.
- A Spatial Reference System Identifier (SRID) is a unique value used to identify the projected spatial coordinate system definitions.
- Oracle contains tables that define the state plane datums and list the SRID values. Vertical datums are also assigned an SRID and listed in tables.
- In Oracle 12c, an SRID for a state plane datum (2D) can be used with 3D data. This can be done by not defining sdo_indx_dims in the spatial index parameters. (However, a fence or view can not be used in a CADD application to define an area to search for data.)

```
CREATE INDEX ELECUG_SIDX ON UTELECUG(OGC_GEOMETRY) INDEXTYPE IS MDSYS.SPATIAL_INDEX PARAMETERS('layer_gtype=multicurve');
```

Compound Coordinate Reference System (CRS)

- NOTE: Geographic coordinates are 3D geometry (such as: Lat. and Long. with Ellipsoid heights), however, we chose not to save in this format. If you choose to save your data in this format, the SRID numbers are within a system Oracle table.
- We decided to create customized compound coordinate reference systems that combine a horizontal CRS with a vertical CRS that are defined in the Oracle tables.
- Oracle suggests that for any user-defined coordinate system, the SRID value should be 1000000 (1 million) or higher. I chose to start at 1000000000 where the last 4 digits are the SRID of the 2D state plane datum

Example: The SRID for NAD83(HARN) / California zone 1 (ftUS) is 2870, so I created SRID 1000002870 for the compound CRS 'NAD83 HARN/California zone 1 ftUS + NAVD88'

The table below was created from information stored in the MDSYS.SDO_COORD_REF_SYSTEM Oracle table, this information was then used to create the necessary user-defined compound reference systems.

Note: the coordinate reference systems listed in the table all have the same COORD_REF_SYS_KIND, which is PROJECTED

SRID	COORD_REF_SYS_NAME	COORD_SYS_ID	GEOG_CRS_DATUM_ID	SOURCE_GEOG_SRID	PROJECTION_CONV_ID
2225	NAD83 / California zone 1 (ftUS)	4497	6269	4269	15307
2226	NAD83 / California zone 2 (ftUS)	4497	6269	4269	15308
2227	NAD83 / California zone 3 (ftUS)	4497	6269	4269	15309
2228	NAD83 / California zone 4 (ftUS)	4497	6269	4269	15310
2229	NAD83 / California zone 5 (ftUS)	4497	6269	4269	15311
2230	NAD83 / California zone 6 (ftUS)	4497	6269	4269	15312
2870	NAD83(HARN) / California zone 1 (ftUS)	4497	6152	4152	15307
2871	NAD83(HARN) / California zone 2 (ftUS)	4497	6152	4152	15308
2872	NAD83(HARN) / California zone 3 (ftUS)	4497	6152	4152	15309
2873	NAD83(HARN) / California zone 4 (ftUS)	4497	6152	4152	15310
2874	NAD83(HARN) / California zone 5 (ftUS)	4497	6152	4152	15311
2875	NAD83(HARN) / California zone 6 (ftUS)	4497	6152	4152	15312
3490	NAD83(NSRS2007) / California zone 1 (ftUS)	4497	6759	4759	15307
3492	NAD83(NSRS2007) / California zone 1 (ftUS)	4497	6759	4759	15308
3494	NAD83(NSRS2007) / California zone 1 (ftUS)	4497	6759	4759	15309
3496	NAD83(NSRS2007) / California zone 1 (ftUS)	4497	6759	4759	15310
3498	NAD83(NSRS2007) / California zone 1 (ftUS)	4497	6759	4759	15311
3500	NAD83(NSRS2007) / California zone 1 (ftUS)	4497	6759	4759	15312

Where were the definitions of the values for columns in the previous table found?

MDSYS tables/views

COORD_SYS_ID is defined in MDSYS.SDO_

4497 - Cartesian 2D CS. Axes: easting, northing (X,Y).
Orientations: east, north. UoM: ftUS.

GEOG_CRS_DATUM_ID is defined in MDSYS.SDO_DATUM_GEODETIC

6269 – North American Datum 1983

6152 – NAD83 (High Accuracy Regional Network)

6759 – NAD83 (National Spatial Reference System 2007)

SOURCE_GEOG_SRID is defined in MDSYS.SDO_CRS_GEOGRAPHIC2D

4269 – NAD83

4152 – NAD83(HARN)

4759 – NAD83(NSRS2007)

Compound Coordinate Reference System (CRS) code

SQL code to create the compound CRS for:
NAD83 HARN/California zone 1 ftUS + NAVD88
where 6152 is NAD83(HARN) Projected and 5703 is NAVD 88

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
  SRID,
  COORD_REF_SYS_NAME,
  COORD_REF_SYS_KIND,
  COORD_SYS_ID,
  DATUM_ID,
  GEOG_CRS_DATUM_ID,
  SOURCE_GEOG_SRID,
  PROJECTION_CONV_ID,
  CMPD_HORIZ_SRID,
  CMPD_VERT_SRID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE,
  LEGACY_WKTEXT,
  LEGACY_CS_BOUNDS)
VALUES (
  1000002870,
  'NAD83 HARN/California zone 1 ftUS + NAVD88',
  'COMPOUND',
  null,
  null,
  6152,
  null,
  null,
  2870,
  5703,
  NULL,
  'EPSG',
  'FALSE',
  NULL,
  NULL,
  NULL);
```

SQL code to create the compound CRS for:
NAD83(NSRS2007)/California zone 1 ftUS + NAVD88
where 6759 is NAD83(NSRS2007) Projected and 5703 is NAVD 88

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
  SRID,
  COORD_REF_SYS_NAME,
  COORD_REF_SYS_KIND,
  COORD_SYS_ID,
  DATUM_ID,
  GEOG_CRS_DATUM_ID,
  SOURCE_GEOG_SRID,
  PROJECTION_CONV_ID,
  CMPD_HORIZ_SRID,
  CMPD_VERT_SRID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE,
  LEGACY_WKTEXT,
  LEGACY_CS_BOUNDS)
VALUES (
  1000003490,
  'NAD83(NSRS2007)/California zone 1 ftUS + NAVD88',
  'COMPOUND',
  null,
  null,
  6759,
  null,
  null,
  3490,
  5703,
  NULL,
  'EPSG',
  'FALSE',
  NULL,
  NULL,
  NULL);
```

Shown in the **SDO_COORD_REF_SYS** table located under Other Users/MDSYS are the user-defined compound coordinate systems which will be assigned to the geometry (SDO_GEOMETRY) column of each table within the different tablespaces. (Pluggable DB)

Oracle SQL Developer

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Connections | DBA

SDO_COORD_AXIS_NAME
SDO_COORD_OP_METHO
SDO_COORD_OP_PARAM
SDO_COORD_OP_PARAM
SDO_COORD_OP_PARAM
SDO_COORD_OP_PATHS
SDO_COORD_OPS
SDO_COORD_REF_SYS

NAD83HARN_CCS83ZONES | SDO_COORD_REF_SYS

Columns | Data | Constraints | Grants | Statistics | Triggers | Flashback | Dependencies | Details | Partitions | Indexes | SQL

Sort... Filter: Actions...

	SRID	COORD_REF_SYS_NAME	COORD_REF_SYS_KIND	COORD_SYS_ID	DATUM_ID	GEOG_CRS_DATUM_ID	SOURCE_GEOG_SRID	PROJE
1	1000026973	Local CRS	ENGINEERING	4495	1000009300	1000009300	(null)	
2	1000003005	NAD83 / BC Albers	PROJECTED	4400	(null)	6269	4269	
3	1000002875	NAD83 HARN/California zone 6 ftUS + NAVD88	COMPOUND	(null)	(null)	6152	(null)	
4	1000002874	NAD83 HARN/California zone 5 ftUS + NAVD88	COMPOUND	(null)	(null)	6152	(null)	
5	1000002873	NAD83 HARN/California zone 4 ftUS + NAVD88	COMPOUND	(null)	(null)	6152	(null)	

Oracle SQL Developer : Table MDSYS.SDO_COORD_REF_SYS@NAD83HARN_CCS83ZONES

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Connections | DBA

SDO_COORD_AXIS_NAME
SDO_COORD_OP_METHO
SDO_COORD_OP_PARAM
SDO_COORD_OP_PARAM
SDO_COORD_OP_PARAM
SDO_COORD_OP_PATHS
SDO_COORD_OPS
SDO_COORD_REF_SYS
SDO_COORD_SYS
SDO_CRS_GEOGRAPHIC_
SDO_CS_CONTEXT_INFOF
SDO_CS_SRS

NAD83HARN_CCS83ZONES | SDO_COORD_REF_SYS

Columns | Data | Constraints | Grants | Statistics | Triggers | Flashback | Dependencies | Details | Partitions | Indexes | SQL

Sort... Filter: Actions...

	PROJECTION_CONV_ID	CMPD_HORIZ_SRID	CMPD_VERT_SRID	INFORMATION_SOURCE	DATA_SOURCE	IS_LEGACY	LEGACY_CODE	LEGACY_WKTEXT	LEGACY_CS_BOUNDS	I
1	(null)	(null)	(null)	(null)	EPSG	FALSE	(null)	(null)	(null)	TR
2	19984	(null)	(null)	-	-	TRUE	(null)	PROJCS["NA...	(null)	TR
3	(null)	2875	5703	(null)	EPSG	FALSE	(null)	(null)	(null)	tr
4	(null)	2874	5703	(null)	EPSG	FALSE	(null)	(null)	(null)	TR
5	(null)	2873	5703	(null)	EPSG	FALSE	(null)	(null)	(null)	tr
6	(null)	2872	5703	(null)	EPSG	FALSE	(null)	(null)	(null)	tr
7	(null)	2871	5703	(null)	EPSG	FALSE	(null)	(null)	(null)	tr
8	(null)	2870	5703	(null)	EPSG	FALSE	(null)	(null)	(null)	tr

Bentley MAP Requirements for an Oracle table:

In order for an Oracle table to be recognized in Map as a feature, the following minimum criteria must be met:

- The feature table must have a primary key constraint consisting of a single numeric or string/character column to represent the feature ID.
- The table must have a geometric (SDO_GEOMETRY) column specifying the feature geometry, and this geometry column must be registered in the Oracle Spatial metadata table (ALL_SDO_GEOM_METADATA or the related USER_SDO_GEOM_METADATA view for the user).
- The table fields must be of a common type, not a user defined type.
- Geometry must be of similar types, meaning all geometries must be of point, line, or polygon type, not a mixture of these.

Bentley Map connection to Oracle – User rights requirements:

Rights for Registering Features:

- Role — Connect, Resource
- System — Create View (if creating topology objects and tables) Unlimited tablespace (optional)
- Object — Grant the following privileges on the “LIVE” or other Oracle workspaces to extract from or commit to: ACCESS_WORKSPACE, CREATE_WORKSPACE, MERGE_WORKSPACE, REMOVE_WORSPACE

Rights for Intent to View Only:

- Role — Connect, Resource
- Object — Grant the following privileges on the “LIVE” or other Oracle workspaces to read from it: ACCESS_WORKSPACE

Rights for Extract/Modify/Post and Post Only Workflows:

- Role — Connect, Resource
- Object — Grant the following privileges on the “LIVE” or other Oracle workspaces to extract from or commit to it: ACCESS_WORKSPACE, CREATE_WORKSPACE

Outline for the Creation of the Caltrans Utility Database

1. The Database Configuration Assistant was used to create the container database (CDB)
2. The Database Configuration Assistant was also used to create 4 pluggable databases. Same administrator for all pluggable databases.
    a) NAD83_CCS83ZONES (Pre-HPGN/HARN)
    b) NAD83HARN_CCS83ZONES
    c) NAD83_2007_CCS83ZONES
    d) NAD83_2011_CCS83ZONES
3. Oracle SQL Developer was used to create the 6 tablespaces within each pluggable database (PDB). One tablespace for each CCS83 zone.
4. In Oracle SQL Developer, user-defined 3D Coordinate Reference Systems (CRS) were created.
5. In Oracle SQL Developer, a user was created for each tablespace with the corresponding tablespace set as its default tablespace, this is important for registration of Oracle tables in Bentley Map.
6. Users with import and query rights were created, per Bentley Map Requirements.
7. Then, domain list tables and utility tables were created.

To ensure that valid values are set for certain columns in the utility tables, 40 data tables, domain lists were created; each contain a primary key. The data tables must be created prior to creating the utility tables, since there are foreign key constraints on columns in the utility tables. The constraints force a column to reference the specified data table in the constraint.

A foreign key constraint makes certain that the values in the foreign key correspond to values of a primary key; in other words, **it specifies the only valid values for the column**.

SQL Code to create the LUT_ACCURACYLEVEL table

```
CREATE TABLE LUT_ACCURACYLEVEL (ACCURACYLEVEL VARCHAR2(2 CHAR) CONSTRAINT
LUT_ACCURACYLEVEL_PK PRIMARY KEY, DESCRIPTION VARCHAR2(80 CHAR)) TABLESPACE HARN83_ZONE5 ;

INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES (' ', ' ');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('1', '[+/-25 mm (+/-0.1 feet) Vertical] and [+/-50 mm (+/-
0.2 feet) Horizontal]');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('2', '+/-50 mm (+/-0.2 feet) - X, Y and Z data');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('3', '+/-150 mm (+/-0.5 feet) - X, Y and Z data');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('4', '+/-300 mm (+/-1 foot) - X, Y and Z data');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('5', '+/-1000 mm (+/-3+ feet) - X, Y and Z data');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('6', '+/-1000 mm (+/-3+ feet) - X and Y data');
INSERT INTO LUT_ACCURACYLEVEL (ACCURACYLEVEL, DESCRIPTION) VALUES ('9', 'Indeterminate');
```

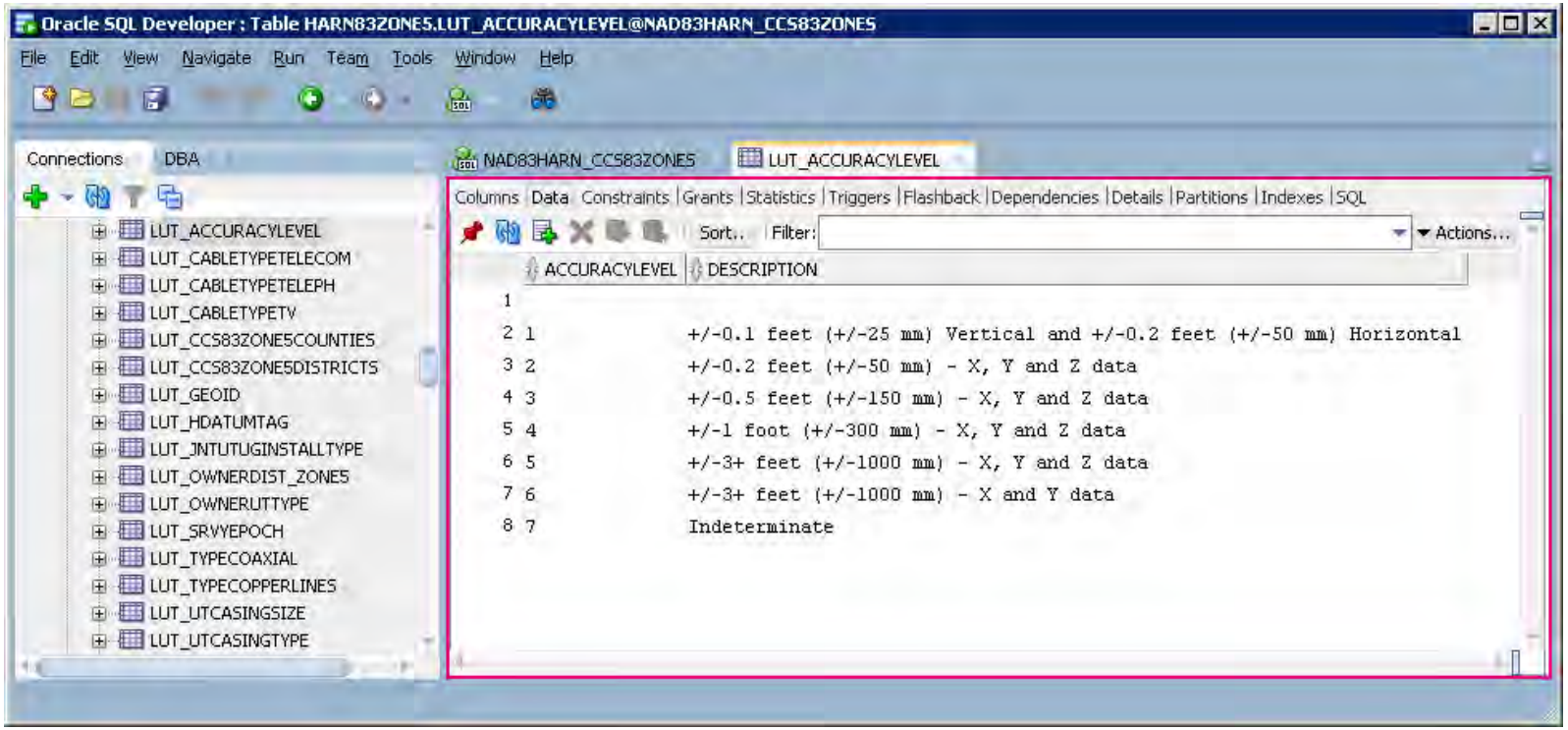
Abandoned Electrical Utility line – SQL code for creating the Oracle table

```
CREATE TABLE HARN83Z5_ELECABN
    (OGC_GEOMETRY MDSYS.SDO_GEOMETRY,
    XFM_ID NUMBER(10,0) NOT NULL ENABLE,
    HDATUM VARCHAR2(20 CHAR) DEFAULT 'NAD83(HARN)' NOT NULL ENABLE,
    DATUMTAG VARCHAR2(10 CHAR),
    SRVYEPOCH VARCHAR2(10 CHAR),
    CCSZONE VARCHAR2(6 CHAR) DEFAULT '05' NOT NULL ENABLE,
    COORDUNITS VARCHAR2(20 CHAR) DEFAULT 'U.S. SURVEY FEET' NOT NULL ENABLE,
    VDATUM VARCHAR2(16 CHAR) DEFAULT 'NAVD 88' NOT NULL ENABLE ,
    GEOID VARCHAR2(16 CHAR),
    STATUS VARCHAR2(15 CHAR),
    OWNER VARCHAR2(50 CHAR),
    OWNERUTILITYTYPE VARCHAR2(25 CHAR),
    OWNEROTHER VARCHAR2(100 CHAR),
    NUMBEROFCONDUCTORS VARCHAR2(7 CHAR),
    RATING VARCHAR2(7 CHAR),
    UNITS VARCHAR2(10 CHAR),
    HIGHPRIORITY VARCHAR2(7 CHAR),
    SUEQUALITY VARCHAR2(2 CHAR),
    INSTALLATIONTYPE VARCHAR2(25 CHAR),
    INSTALLATIONTYPEOTHER VARCHAR2(25 CHAR),
    INSTALLATIONSIZE VARCHAR2(7 CHAR),
    INSTALLATIONSIZEOTHER VARCHAR2(7 CHAR),
    INSTALLATIONHEIGHT VARCHAR2(7 CHAR),
    INSTALLATIONWIDTH VARCHAR2(7 CHAR),
    INSTALLATIONNUMBERDUCTS VARCHAR2(10 CHAR),
    INSTALLATIONMATERIAL VARCHAR2(60 CHAR),
    INSTALLATIONMATERIALOTHER VARCHAR2(60 CHAR),
    CASINGSIZE VARCHAR2(7 CHAR),
    CASINGSIZEOTHER VARCHAR2(7 CHAR),
    CASINGTYPE VARCHAR2(60 CHAR),
    CASINGTYPEOTHER VARCHAR2(60 CHAR),
    PERMITNO VARCHAR2(20 CHAR),
    PROJECTNO VARCHAR2(10 CHAR),
    YEARINSTALLED VARCHAR2(4 CHAR),
```

```
COMMENTS VARCHAR2(255 CHAR),
USERNAME VARCHAR2(12 CHAR),
DATEEDITED DATE,
DISTRICT VARCHAR2(5 CHAR),
COUNTY VARCHAR2(25 CHAR),
ROUTE VARCHAR2(4 CHAR),
POSTMILEBEGIN VARCHAR2(20 CHAR),
POSTMILEEND VARCHAR2(20 CHAR),
ORIGINOFDATA VARCHAR2(60 CHAR),
HDATUM_EPSG VARCHAR2(12 CHAR) DEFAULT '2874' NOT NULL ENABLE,
ACCURACY_LEVEL VARCHAR2(2 CHAR),
CONSTRAINT HARN837Z5_ELECABN_PK PRIMARY KEY (XFM_ID) ENABLE,
CONSTRAINT ELECABN_Z5_ACCRCYLEV_FK FOREIGN KEY (ACCURACY_LEVEL) REFERENCES LUT_ACCURACYLEVEL (ACCURACYLEVEL) ENABLE,
CONSTRAINT ELECABN_Z5_CASINGSIZE_FK FOREIGN KEY (CASINGSIZE) REFERENCES LUT_UTCASINGSIZE (CASINGSIZEVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_CASINGTYPE_FK FOREIGN KEY (CASINGTYPE) REFERENCES LUT_UTCASINGTYPE (CASINGTYPEVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_CCS83CNTIES_FK FOREIGN KEY (COUNTY) REFERENCES LUT_CCS83ZONE5COUNTIES (COUNTYNAME) ENABLE,
CONSTRAINT ELECABN_Z5_CCS83DISTS_FK FOREIGN KEY (DISTRICT) REFERENCES LUT_CCS83ZONE5DISTRICTS (DISTRICTVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_DUCTMAT_FK FOREIGN KEY (INSTALLATIONMATERIAL) REFERENCES LUT_UTDUCTBANKMAT (DUCTMATVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_GEOID_FK FOREIGN KEY (GEOID) REFERENCES LUT_GEOID (GEOIDVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_HDATUMTAG_FK FOREIGN KEY (DATUMTAG) REFERENCES LUT_HDATUMTAG (HDATUMTAGVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_HIPRIORITY_FK FOREIGN KEY (HIGHPRIORITY) REFERENCES LUT_UTRISK (UTRISKVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_INSTALLNUMDUCTS_FK FOREIGN KEY (INSTALLATIONNUMBERDUCTS) REFERENCES LUT_UTNUMBEROFDUCTS (NUMOFDUCTS) ENABLE,
CONSTRAINT ELECABN_Z5_INSTALLSIZE_FK FOREIGN KEY (INSTALLATIONSIZE) REFERENCES LUT_UTPIPEDIA (PIPEDIAVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_INSTALLTYPE_FK FOREIGN KEY (INSTALLATIONTYPE) REFERENCES LUT_UTINSTALLATIONTYPE (INSTALLTYPEVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_OWNERDIST_FK FOREIGN KEY (OWNER) REFERENCES LUT_OWNERDIST_ZONE5 (OWNERVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_OWNERUTTYPE_FK FOREIGN KEY (OWNERUTILITYTYPE) REFERENCES LUT_OWNERUTTYPE (OWNERUTTYPE) ENABLE,
CONSTRAINT ELECABN_Z5_SRVYEPOCH_FK FOREIGN KEY (SRVYEPOCH) REFERENCES LUT_SRVYEPOCH (EPOCHVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_STATUS_FK FOREIGN KEY (STATUS) REFERENCES LUT_UTSTATUS (UTSTATUSVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_SUEQUALITY_FK FOREIGN KEY (SUEQUALITY) REFERENCES LUT_UTQUALITY (UTQUALITYVALUE) ENABLE,
CONSTRAINT ELECABN_Z5_UNITS_FK FOREIGN KEY (UNITS) REFERENCES LUT_UTUNITS (UTUNITSVALUE) ENABLE
) TABLESPACE HARN83_ZONE5 ;
```

The ACCURACY_LEVEL column in the utility table is restricted to the values in the ACCURACYLEVEL column in the LUT_ACCURACYLEVEL table.

CONSTRAINT ELECABN_Z5_ACCRCYLEV_FK FOREIGN KEY (ACCURACY_LEVEL) REFERENCES LUT_ACCURACYLEVEL (ACCURACYLEVEL) ENABLE,



/ Code to define geometry to be stored and SRID (user-defined compound coordinate reference system) (SRID can be null)

```
INSERT INTO USER_SDO_GEOM_METADATA (TABLE_NAME, COLUMN_NAME, DIMINFO, SRID)
   VALUES (‘HARN83Z5_ELECABN', 'OGC_GEOMETRY',
   MDSYS.SDO_DIM_ARRAY
   (
  MDSYS.SDO_DIM_ELEMENT('X', 0.0, 7000000.0, 0.00000005),
  MDSYS.SDO_DIM_ELEMENT('Y', 0.0, 5000000.0, 0.00000005),
  MDSYS.SDO_DIM_ELEMENT('Z', -500.0, 10000.0, 0.00000005)),
   1000002874);
COMMIT;
```

/ Code to create spatial index for table’s geometry - OGC_GEOMETRY (MDSYS.SDO_GEOMETRY table) and define spatial parameters

```
CREATE INDEX HARN83Z5_ELECABN_SIDX ON HARN83Z5_ELECABN (OGC_GEOMETRY) INDEXTYPE IS
MDSYS.SPATIAL_INDEX PARAMETERS ('layer_gtype=multicurve sdo_indx_dims=3');
```

The **SDO_GEOM_METADATA_TABLE** located under Other Users/MDSYS stores the geometry information for every table in the different tablespaces within the NAD83HARN_CCS83ZONES pluggable database.

Oracle SQL Developer

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Connections DBA

- SDO_FEATURE_USAGE
- SDO_GEOM_METADATA_TABLE
- SDO_GEOR_DDL__TABLE$$
- SDO_GEOR_PLUGIN_REGISTRY
- SDO_GEOR_SYSDATA_TABLE
- SDO_GEOR_XMLSCHEMA_TABLE
- SDO_GR_MOSAIC_0

SDO_GEOM_METADATA_TABLE

Columns | Data | Constraints | Grants | Statistics | Triggers | Flashback | Dependencies | Details | Partitions | Indexes | SQL

Sort... Filter: Actions...

	SDO_OWNER	SDO_TABLE_NAME	SDO_COLUMN_NAME	SDO_DIMINFO	SDO_SRID
1	HARN83ZONE1	HARN83Z1_ELECABN	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002870
2	HARN83ZONE1	HARN83Z1_ELECOH	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002870
3	HARN83ZONE1	HARN83Z1_ELECUG	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002870
4	HARN83ZONE1	HARN83Z1_FIBEROPTABN	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002870

Oracle SQL Developer : Table MDSYS.SDO_GEOM_METADATA_TABLE@NAD83HARN_CCS83ZONES

File Edit View Navigate Run Team Tools Window Help

Connections DBA

- SDO_FEATURE_USAGE
- SDO_GEOM_METADATA_TABLE
- SDO_GEOR_DDL__TABLE$$
- SDO_GEOR_PLUGIN_REGISTRY
- SDO_GEOR_SYSDATA_TABLE
- SDO_GEOR_XMLSCHEMA_TABLE
- SDO_GR_MOSAIC_0

SDO_GEOM_METADATA_TABLE

Columns | Data | Constraints | Grants | Statistics | Triggers | Flashback | Dependencies | Details | Partitions | Indexes | SQL

Sort... Filter: Actions...

	SDO_OWNER	SDO_TABLE_NAME	SDO_COLUMN_NAME	SDO_DIMINFO	SDO_SRID
141	HARN83ZONE5	HARN83Z5_ELECABN	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002874
142	HARN83ZONE5	HARN83Z5_ELECOH	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002874
143	HARN83ZONE5	HARN83Z5_ELECUG	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002874
144	HARN83ZONE5	HARN83Z5_FIBEROPTABN	OGC_GEOMETRY	MDSYS.SDO_DIM_ARRAY([MDSYS.SDO_DIM_ELEMEN...	1000002874

/ Code to create sequence of XFM_ID in table

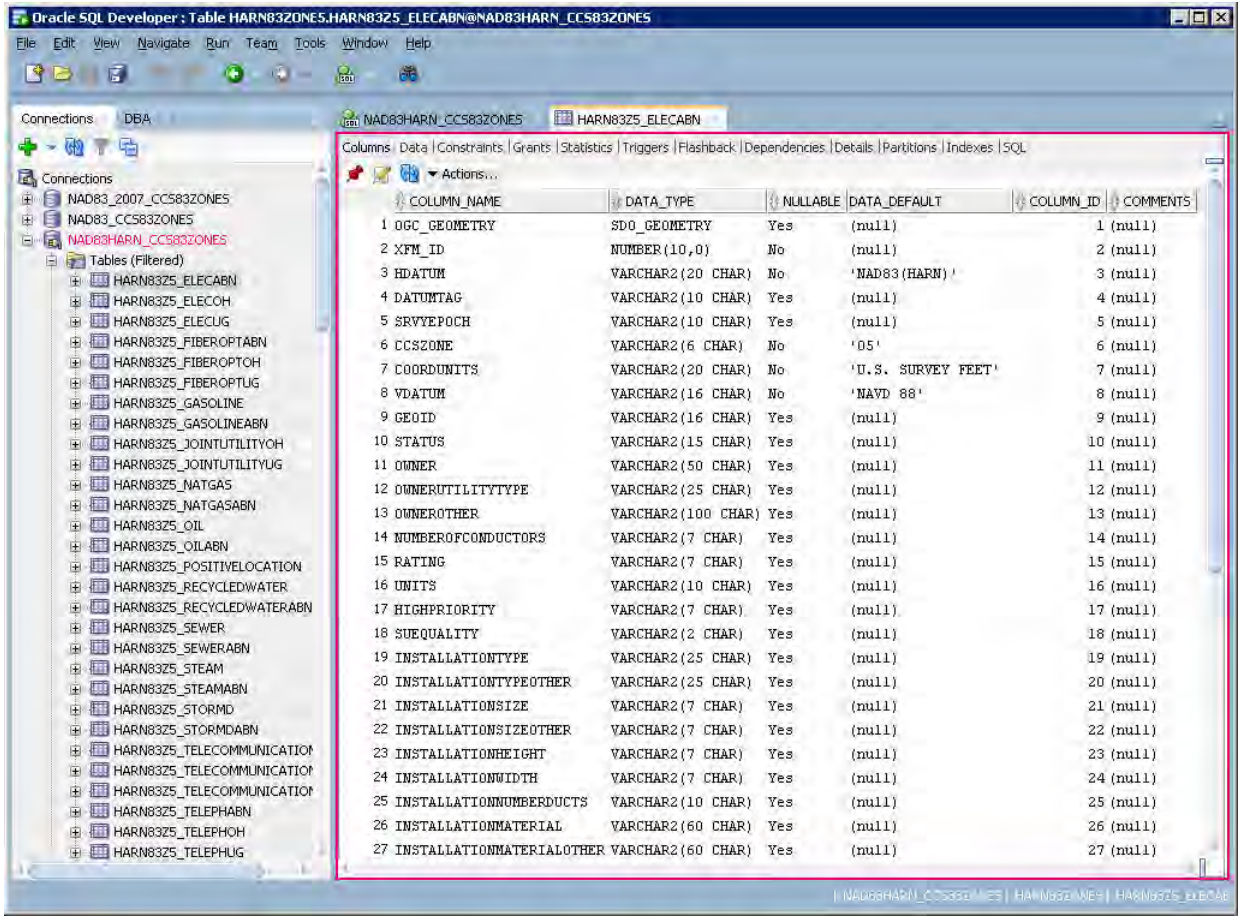
```
CREATE SEQUENCE HARN83Z5_ELECABN_XFM_ID_SEQ  MINVALUE 1 MAXVALUE 9999999999 INCREMENT BY 1
START WITH 100 CACHE 20 NOORDER  NOCYCLE ;
```

/ Code to create trigger for sequence increment

```
CREATE OR REPLACE EDITIONABLE TRIGGER “HARN83ZONE5".“HARN83Z5_ELECABN_ID_TR"
  before insert on " HARN83ZONE5 "."HARN83Z5_ELECABN"
  for each row
begin
  if inserting then
    if :NEW."XFM_ID" is null then
      select HARN83Z5_ELECABN_XFM_ID_SEQ.nextval into :NEW."XFM_ID" from dual;
    end if;
  end if;
end;
/
ALTER TRIGGER “HARN83ZONE5".“HARN83Z5_ELECABN_ID_TR" ENABLE;
```

Overview of the columns in the ELECABN utility table created using Oracle SQL Developer:

- You can quickly view the columns in a table for data type, default values, find out if column is nullable, etc..
- View the selected table's
  - ❖ Constraints
  - ❖ Indexes
  - ❖ Triggers
  - ❖ Data
  - ❖ Etc. …
- Ability to edit the table
- More information shown then running commands in SQL Plus



	COLUMN_NAME	DATA_TYPE	NULLABLE	DATA_DEFAULT	COLUMN_ID	COMMENTS
1	OGC_GEOMETRY	SDO_GEOMETRY	Yes	(null)	1	(null)
2	XFM_ID	NUMBER(10,0)	No	(null)	2	(null)
3	HDATUM	VARCHAR2(20 CHAR)	No	'NAD83(HARN)'	3	(null)
4	DATUMTAG	VARCHAR2(10 CHAR)	Yes	(null)	4	(null)
5	SRVYEPOCH	VARCHAR2(10 CHAR)	Yes	(null)	5	(null)
6	CCSZONE	VARCHAR2(6 CHAR)	No	'05'	6	(null)
7	COORDUNITS	VARCHAR2(20 CHAR)	No	'U.S. SURVEY FEET'	7	(null)
8	VDATUM	VARCHAR2(16 CHAR)	No	'NAVD 88'	8	(null)
9	GEOID	VARCHAR2(16 CHAR)	Yes	(null)	9	(null)
10	STATUS	VARCHAR2(15 CHAR)	Yes	(null)	10	(null)
11	OWNER	VARCHAR2(50 CHAR)	Yes	(null)	11	(null)
12	OWNERUTILITYTYPE	VARCHAR2(25 CHAR)	Yes	(null)	12	(null)
13	OWNEROTHER	VARCHAR2(100 CHAR)	Yes	(null)	13	(null)
14	NUMBEROFCONDUCTORS	VARCHAR2(7 CHAR)	Yes	(null)	14	(null)
15	RATING	VARCHAR2(7 CHAR)	Yes	(null)	15	(null)
16	UNITS	VARCHAR2(10 CHAR)	Yes	(null)	16	(null)
17	HIGHPRIORITY	VARCHAR2(7 CHAR)	Yes	(null)	17	(null)
18	SUEQUALITY	VARCHAR2(2 CHAR)	Yes	(null)	18	(null)
19	INSTALLATIONTYPE	VARCHAR2(25 CHAR)	Yes	(null)	19	(null)
20	INSTALLATIONTYPEOTHER	VARCHAR2(25 CHAR)	Yes	(null)	20	(null)
21	INSTALLATIONSIZE	VARCHAR2(7 CHAR)	Yes	(null)	21	(null)
22	INSTALLATIONSIZEOTHER	VARCHAR2(7 CHAR)	Yes	(null)	22	(null)
23	INSTALLATIONHEIGHT	VARCHAR2(7 CHAR)	Yes	(null)	23	(null)
24	INSTALLATIONWIDTH	VARCHAR2(7 CHAR)	Yes	(null)	24	(null)
25	INSTALLATIONNUMBERDUCTS	VARCHAR2(10 CHAR)	Yes	(null)	25	(null)
26	INSTALLATIONMATERIAL	VARCHAR2(60 CHAR)	Yes	(null)	26	(null)
27	INSTALLATIONMATERIALOTHER	VARCHAR2(60 CHAR)	Yes	(null)	27	(null)

Each tablespace currently contains:

- 35 utility tables; each includes a geometry column
- 40 look-up-tables

Utility Lines (existing utilities)

ELECOH
ELECUG
FIBEROPTOH
FIBEROPTUG
GASOLINE
JOINTUTILITYOH
JOINTUTILITYUG
NATGAS
OIL
RECYCLEDWATER
SEWER
STEAM
STORMD
TELECOMMUNICATIONOH
TELECOMMUNICATIONUG
TELEPHOH
TELEPHUG
TVOH
TVUG
WATER

Abandoned Lines (abandoned utilities)

ELECABN
FIBEROPTABN
GASOLINEABN
NATGASABN
OILABN
RECYCLEDWATERABN
SEWERABN
STEAMABN
STORMDABN
TELECOMMUNICATIONABN
TELEPHABN
TVABN
WATERABN

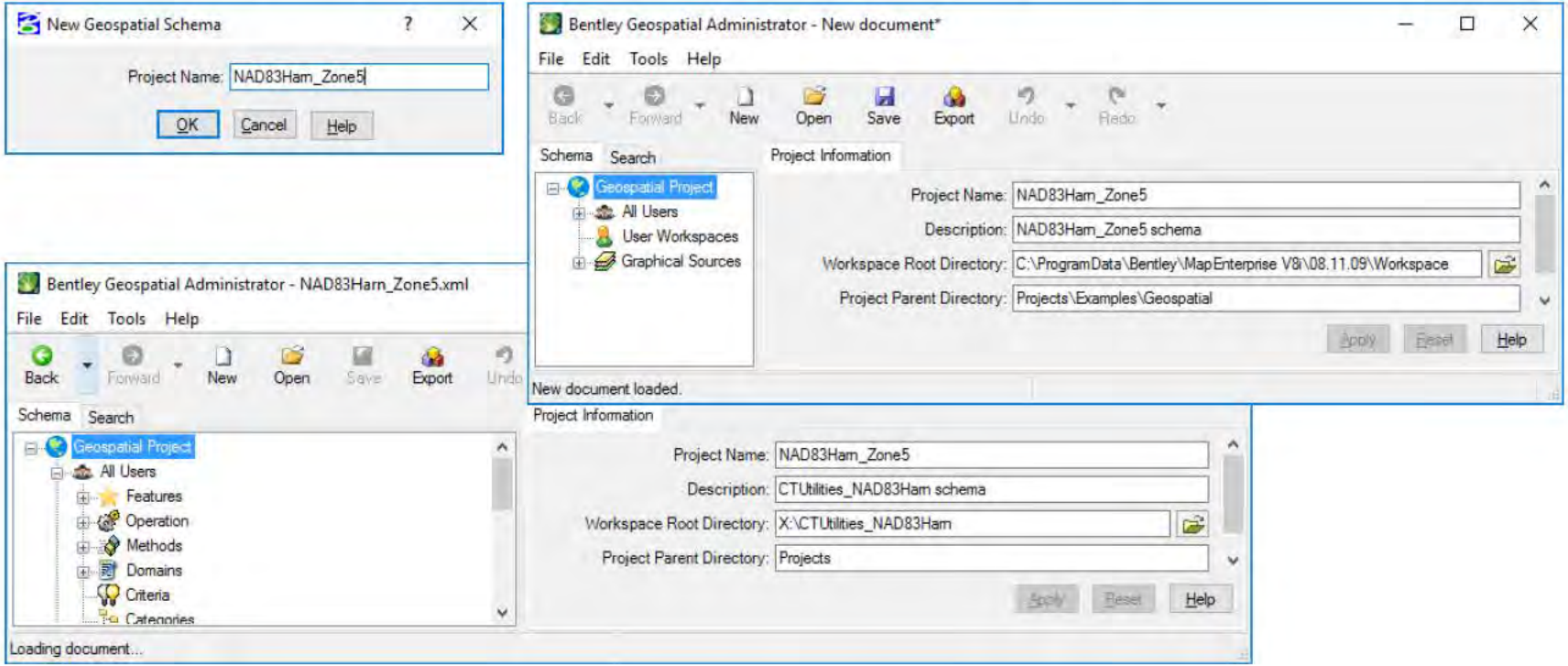
Non-linear Utilities (Points)

POSITIVE LOCATION
UTILITY FEATURE

Creating a Bentley Map project in the Geospatial Administrator

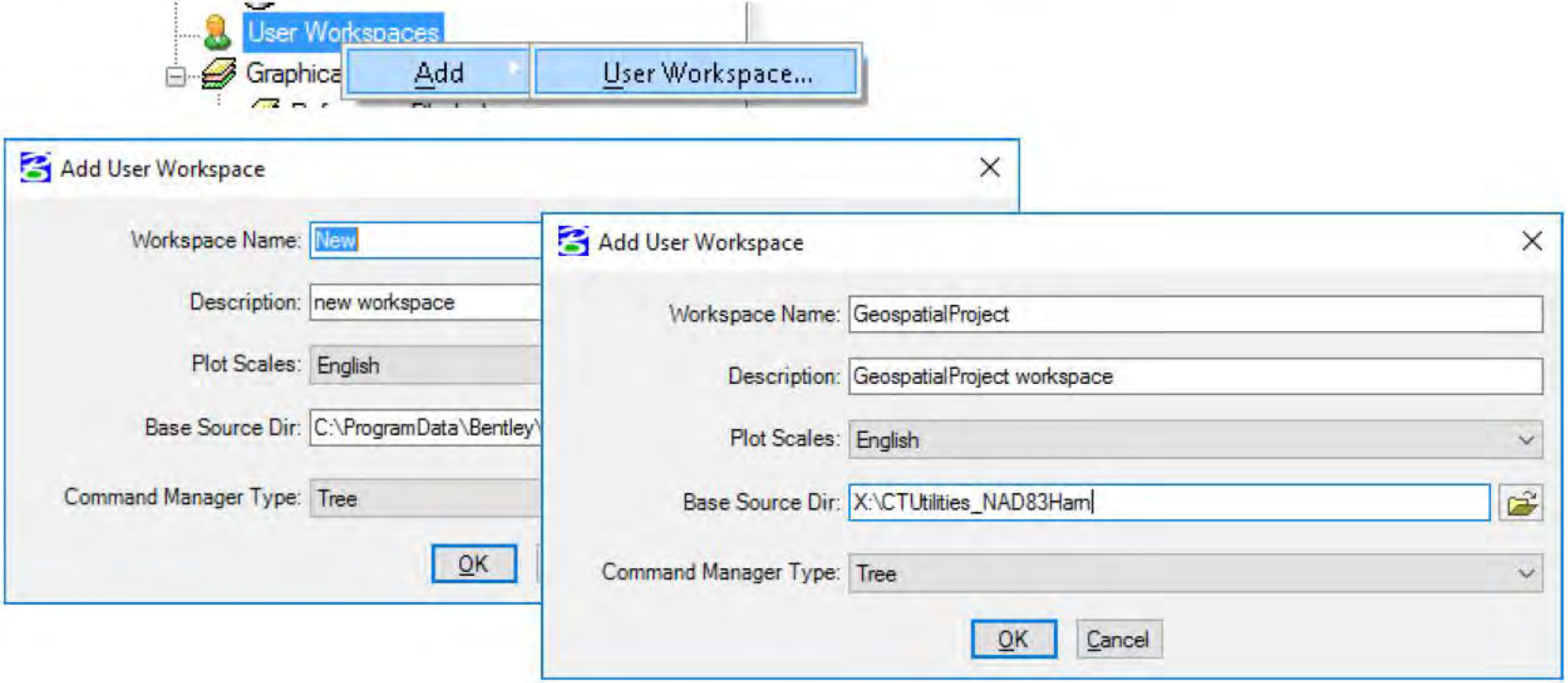
Use the Geospatial Administrator (GSA), to create a Map project.

Default directory is initially entered; enter your directory information for the project.

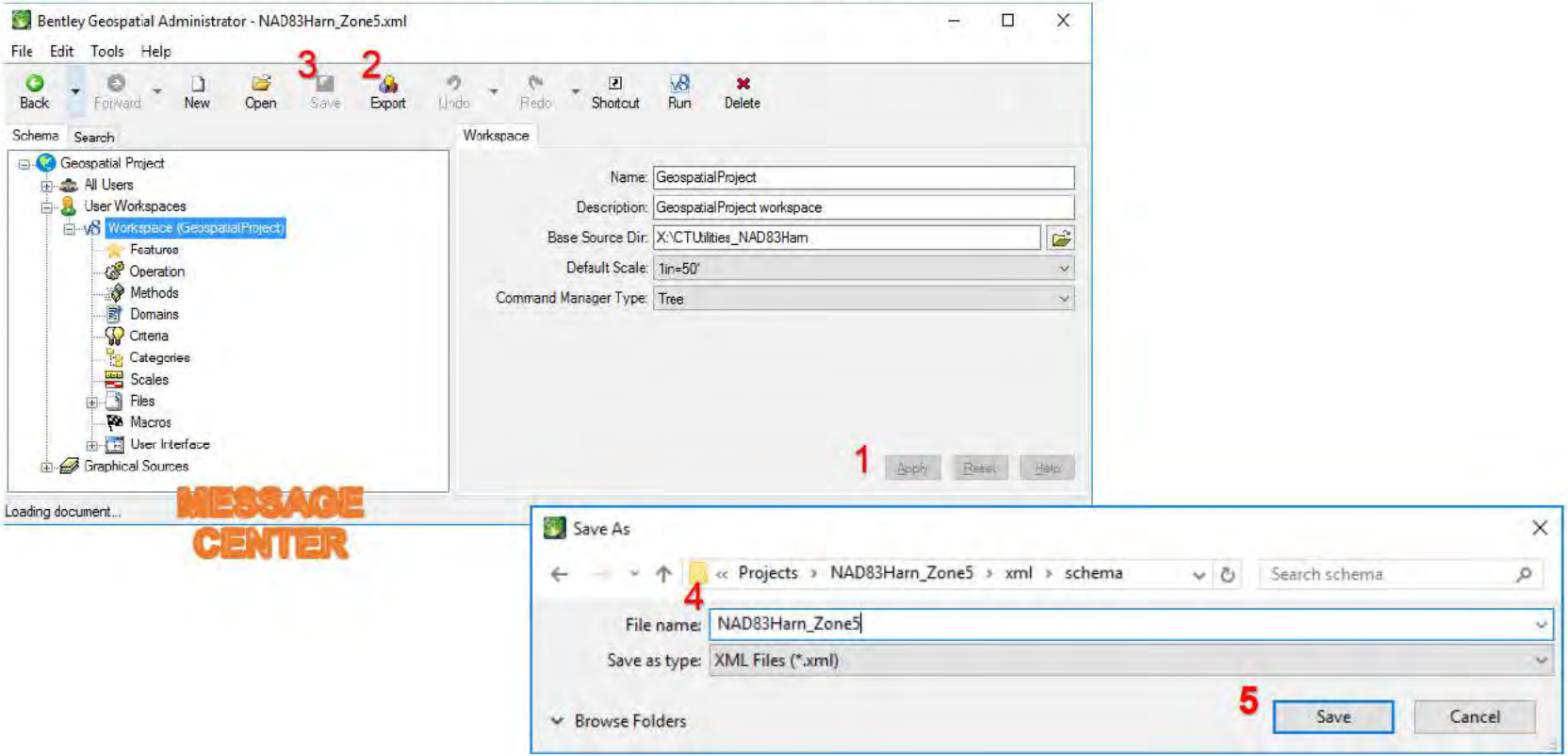


Next, the User Workspace needs to be defined. Enter your project's workspace information in the "Add User Workspace" dialog. Click OK.

Note: The workspace is a folder under the Base Source Dir (parent project directory).



Click Apply (1). Click the Export (2) icon, once the Message Center (lower left) displays "CommandInvoke finished successfully", click the Save (3) icon. The Save As dialog will open. This is the project xml. The message "Document exported to ……" will display in the Message Center. The project folders are created, as is an xml project file.

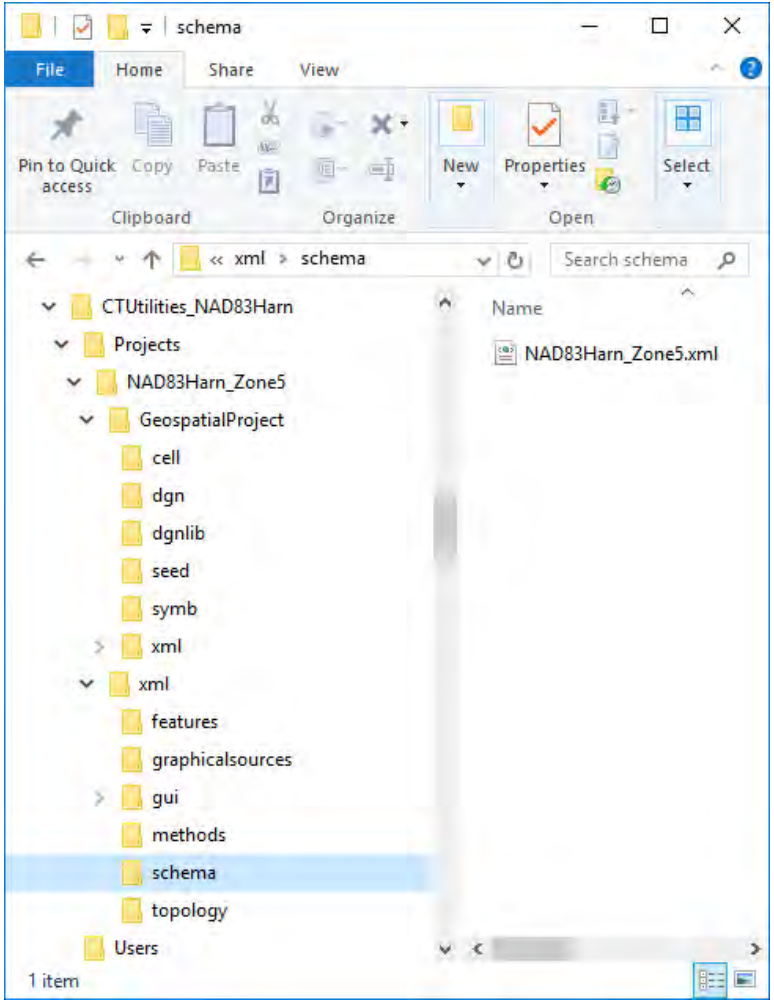


Within the Map project, Caltrans standard resources are defined, as are some Map configuration variables.

<u>Directory structure of the Map project</u>.

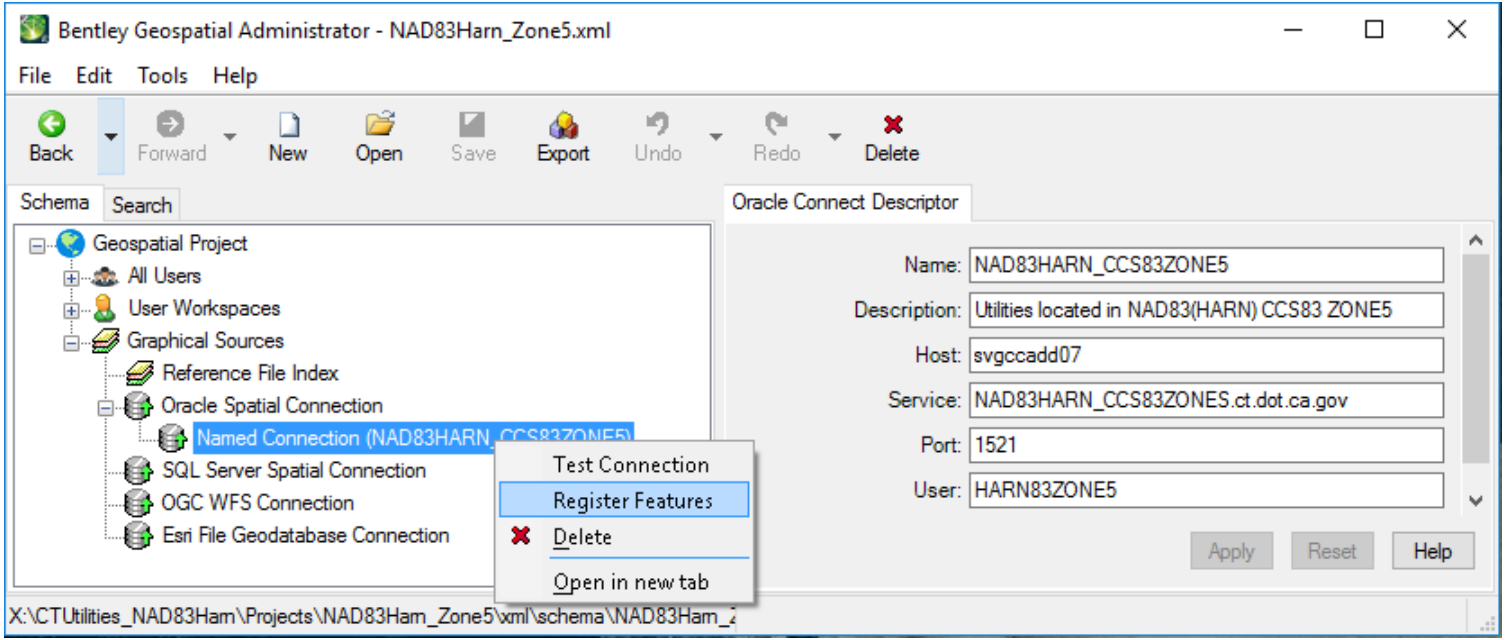
The sub-folders under the “GeospatialProject” folder are where the Caltrans standard resource files are placed.

The sub-folders under the “xml” folder are populated by Map when “Export” is run. This is the data that is brought into the project when the Oracle tables are registered.



Registering Oracle Spatial Features/Tables in Bentley Map

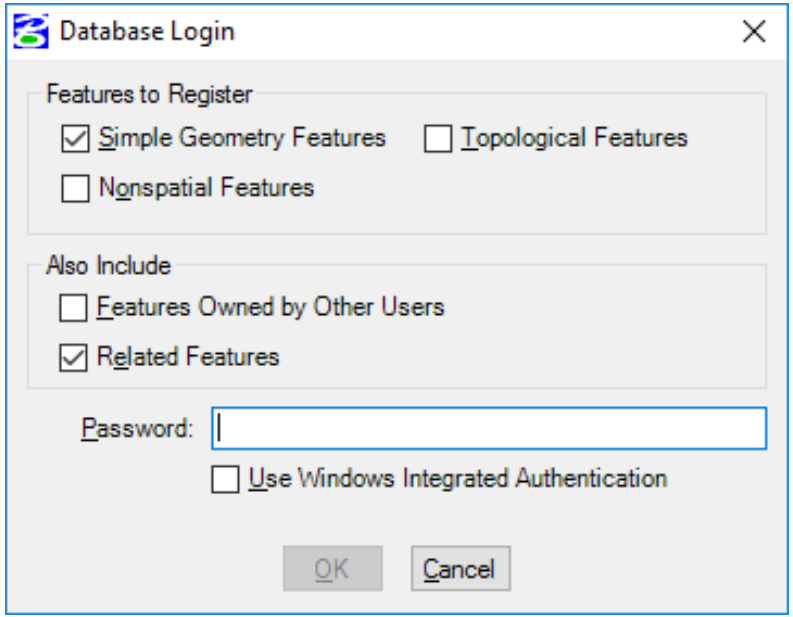
1. Under Graphical Sources, right-click Oracle Spatial Connection. Select Add > New. Shown below is the information required to establish a connection to the Oracle database. The User determines which tablespace and thus which tables can be registered for this project. Click on Apply button to save the information entered and then right-click the Named Connection node and select Register Features.



2. A dialog opens providing options to customize the registration process. The registration process displays tables belonging to the current user that meet the options as described below:

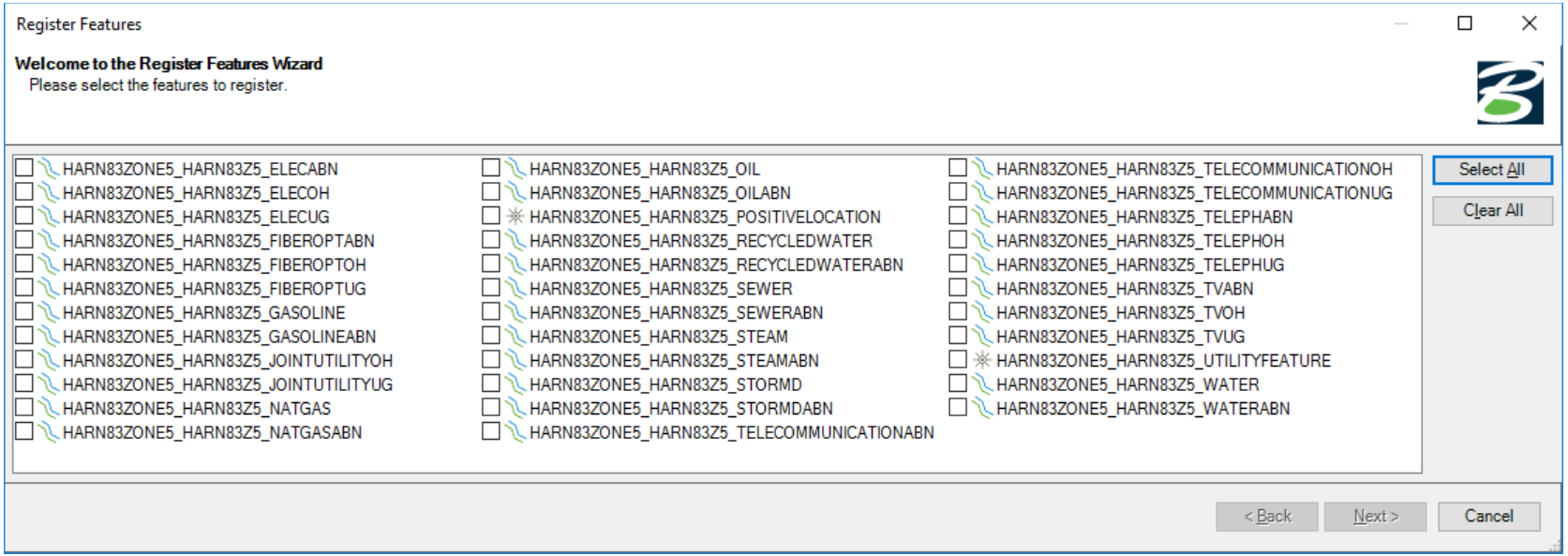
- Simple Geometry Features - tables with a geometry column that meet the requirements for Bentley Map and owned by the current user
- Topological Features - any table that is part of an Oracle topology layer.
- Non-spatial features - any table in the database owned by the current user.
- Raster Features - tables with a geo-raster column that meet the requirements for Bentley Map and owned by the current user.
- Features owned by other users - other tables to which the current user has access but are not owned by that user.
- Related features - tables that are related to other selected tables by a referential constraint. These are typically tables that store annotations and domain lists. Such as the LUT_ tables created in the Oracle 12c spatial utility database
- Password - the current user password used to create the Oracle Connection. Bentley Map does not save passwords for security reasons.
- Windows Integrated Authentication - enable that option if implemented.

Select applicable items and then enter Password for current user. Click OK



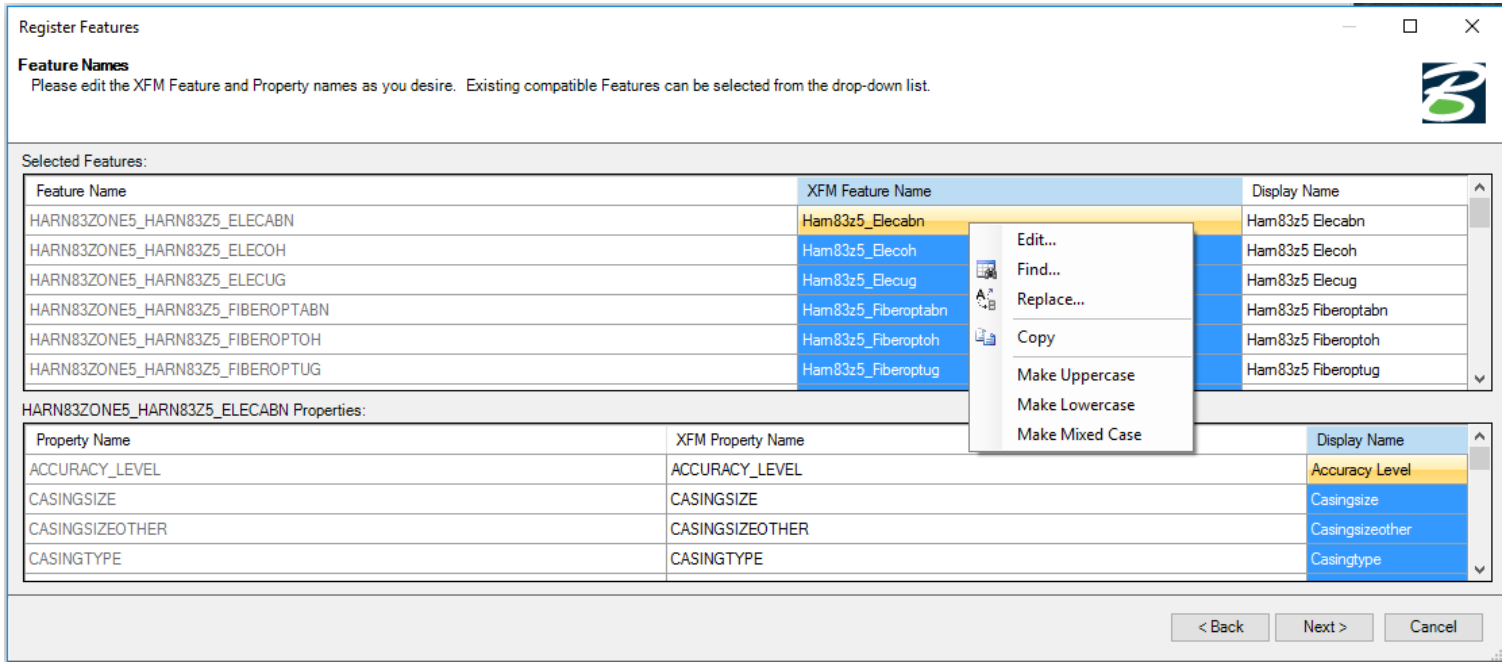
3. A list of valid tables displays in the Register Features List dialog. In the Registered Features List dialog, select the tables to register and then select “Next”.

➢ If the tablespace and user were created correctly, all the tables displayed should be for a specific NAD83 realization and a specific CCS83 zone in that realization. Select All, then Next



4. The next dialog allows the administrator to change the name of the feature and the display name that users will see when operating Bentley Map. The XFM Feature Name should respect the XFM feature naming conventions. The interface will not permit an invalid feature to be named. Properties can also be adjusted in the lower pane. Existing features that match the selected feature can be selected from the list under XFM Feature Name. Those features will be replaced in the project by the newly registered features.

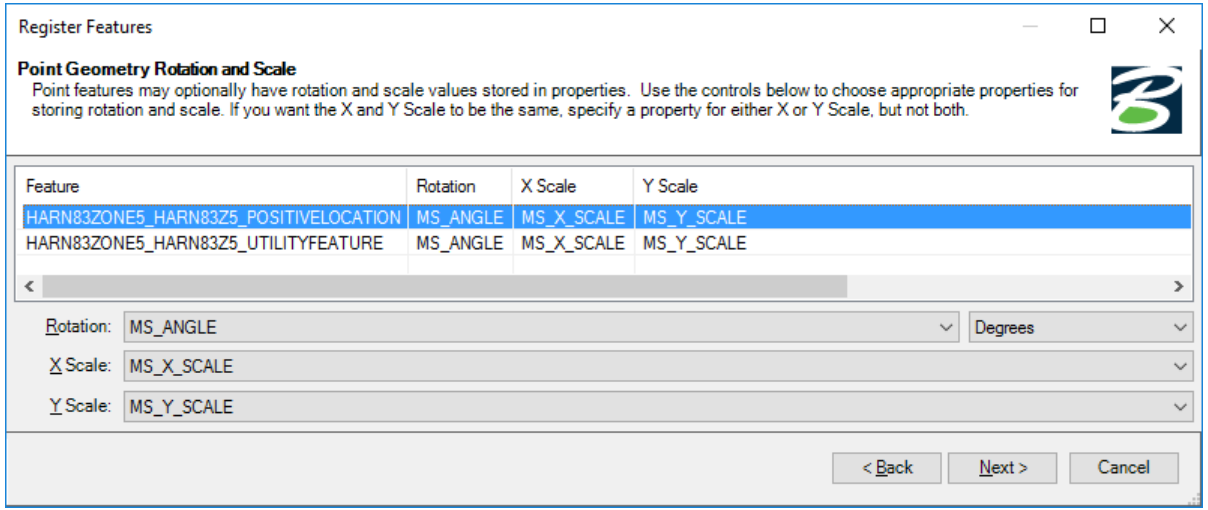
- Columns can be sorted and filtered by right-clicking on the column headers and selecting the appropriate sorting and filtering option.



5. Point features, there will be an option to define a column that can be used to store the angle of the feature as well as columns to store the X and Y scale value. The angle and scale of cells and text will be stored in the selected columns. The registration wizard automatically looks for columns named MS_XSCALE, MS_Y_SCALE, and MS_ANGLE. If these columns are present in the data table then they will automatically be populated in the appropriate fields for the point feature. Enter the appropriate settings and click “Next”.

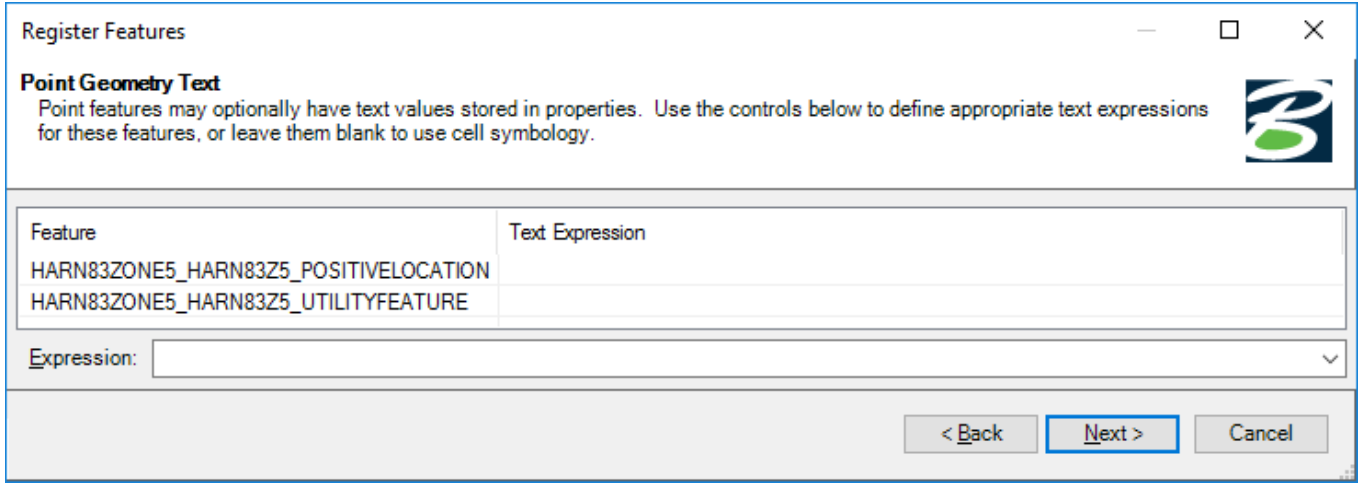
   X Scale and Y Scale are unit less values that simply magnify (scale > 1.0) or shrink (0.0 < scale <1.0) or leave unchanged (scale = 1.0) the default dimensions of the element used to represent the point feature.

   Leave these columns blank if scale and angle are not required per feature. The values defined in the feature definition will be used when the features are queried from Oracle.



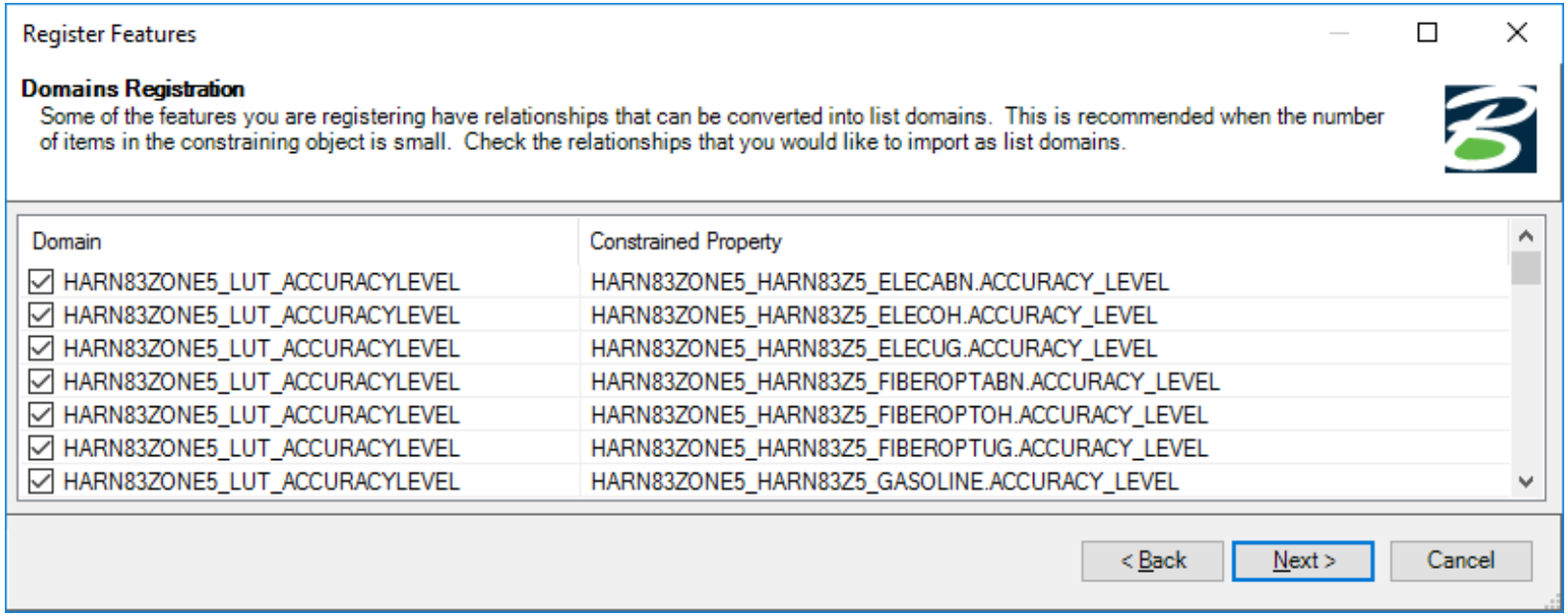
6. Point features can also be placed with a cell or with text. To place text when the feature is queried, then select the property that should be used to define the value for the text string. To place a cell for this point feature, then leave the Expression entry blank. The cell name is defined after the feature is registered in the symbology section of the feature definition. Enter the appropriate settings and click “Next”.

➢ Both of our point features (POSITIVELOCATION AND UTILITYFEATURE) are placed with cells, which is set in the symbology section of the registered feature. Click Next.

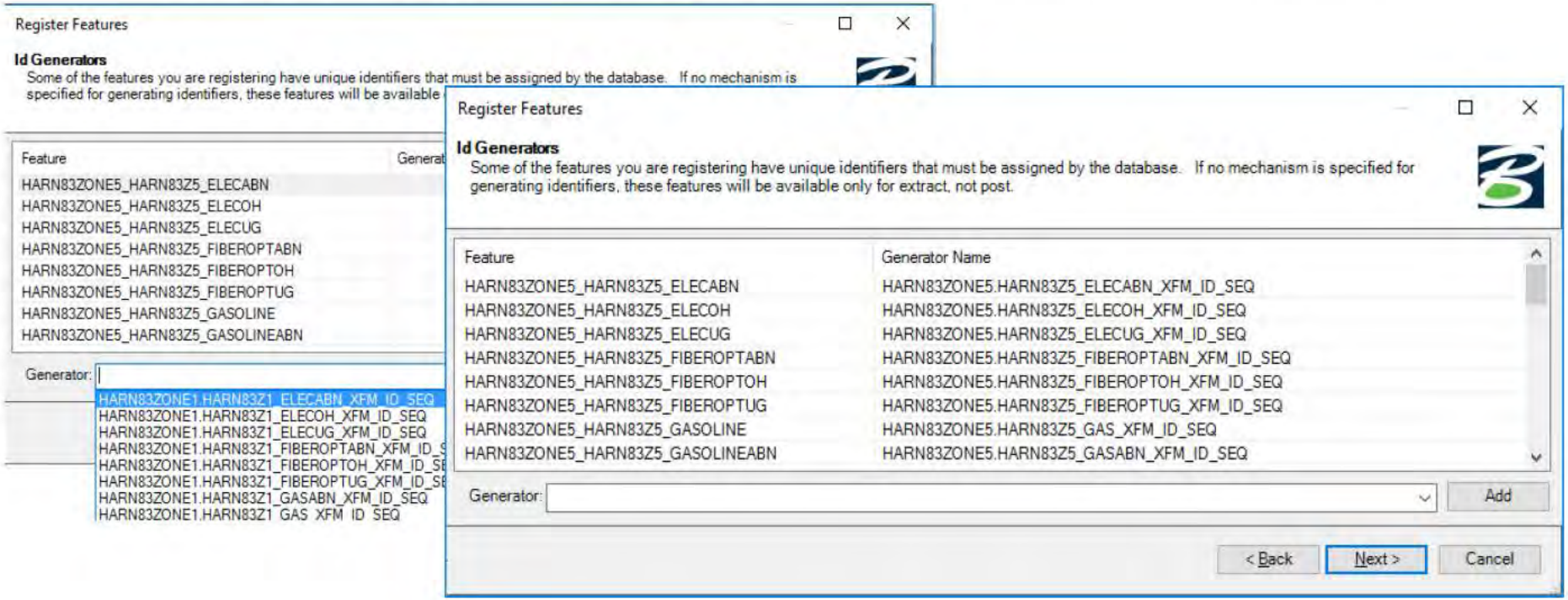


7. Features that will get registered as list domains – click Next

These are the valid values from which a column/property can select, defined by the foreign key constraints on columns in the utility tables. The constraints force a column to reference the specified data table.

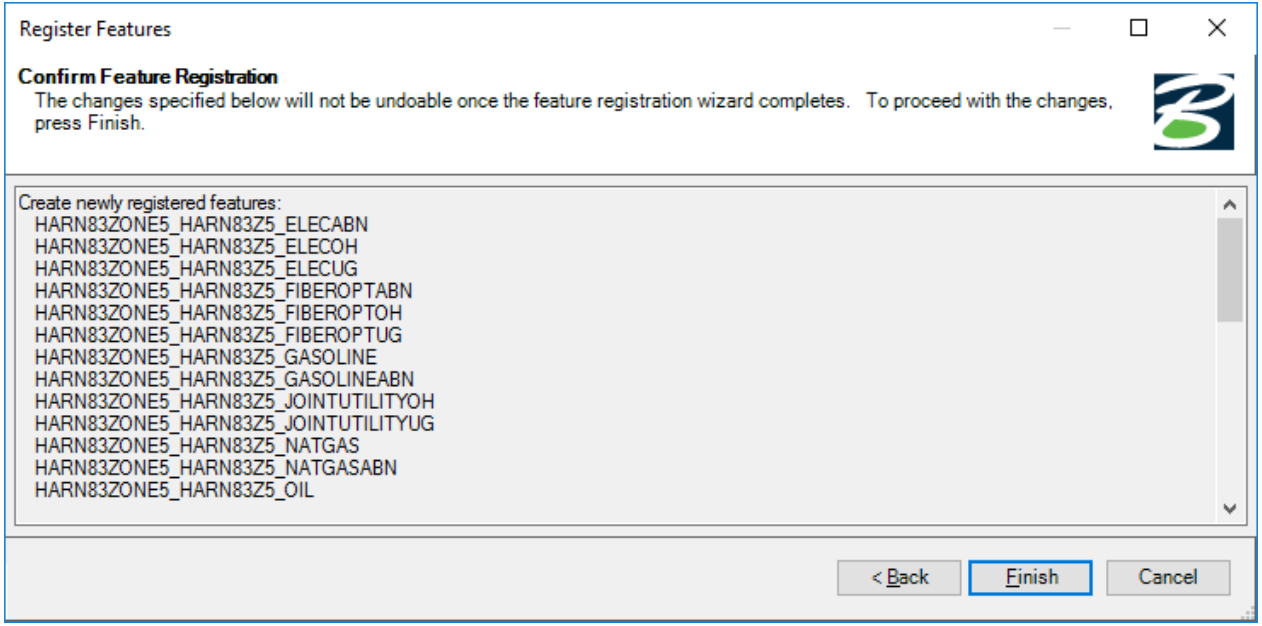


8. In order to properly insert new features in Oracle Spatial in a multi-user environment, a sequence generator needs to be defined to create new ID numbers at post time. For each registered feature, select the appropriate sequence generator from the list. If a sequence generator for that feature is not available, one can be created by entering a name in the Generator field and selecting Add. When done assigning the correct sequence generator, click Next.

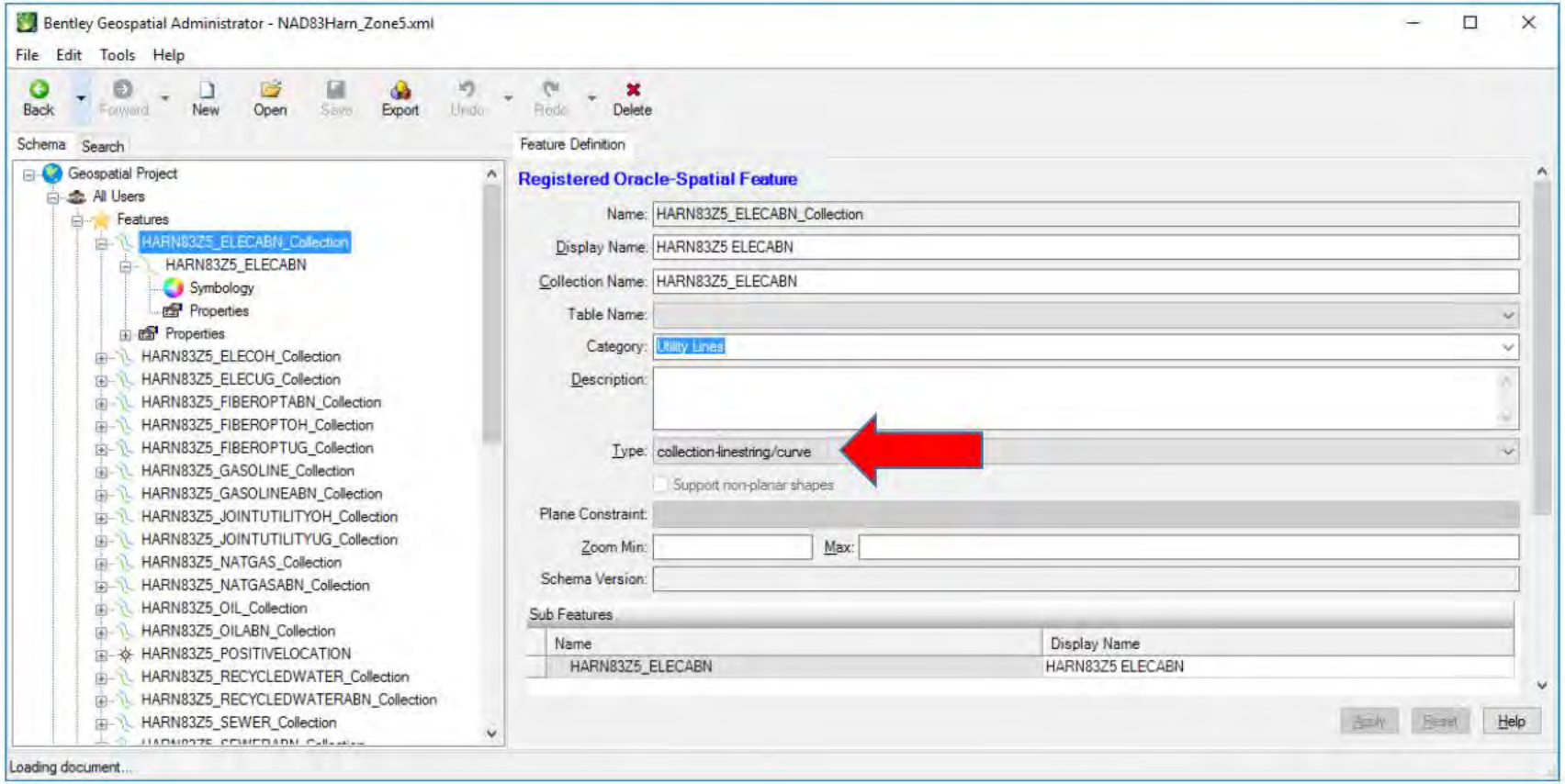


9. A list of features to be registered is presented. Click Finish.

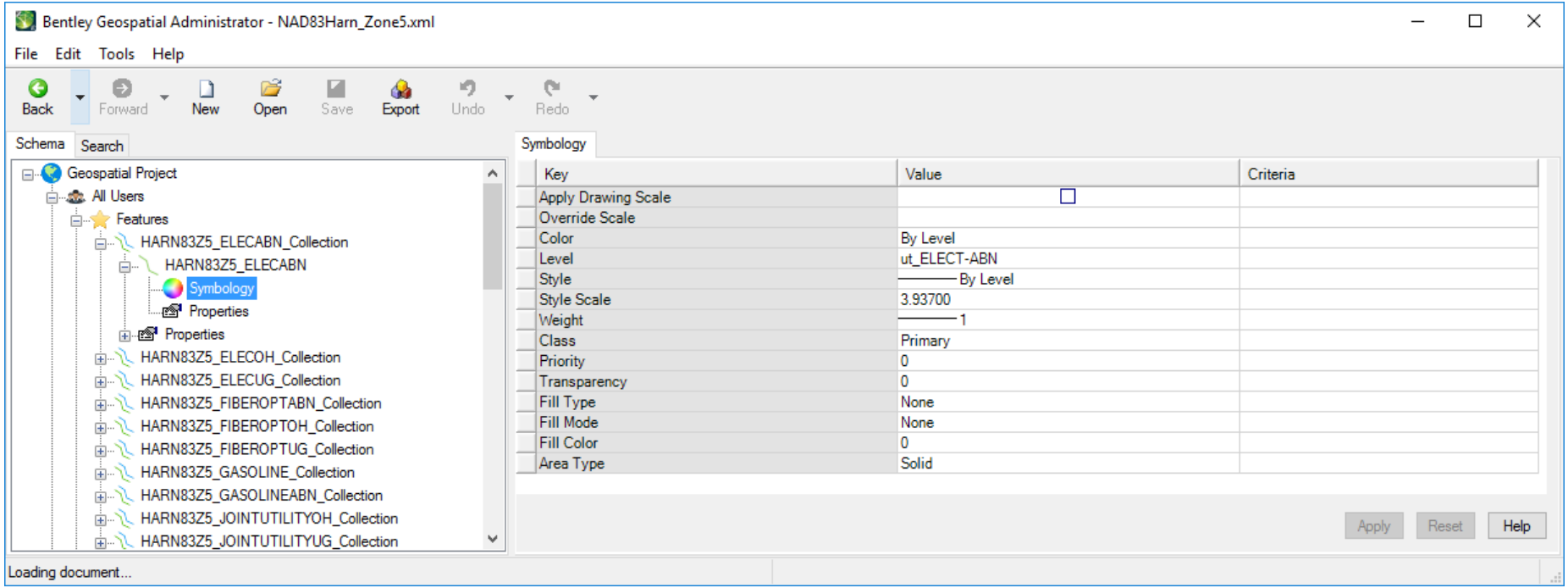
I am sure that you have already noticed that the user name gets added to the table name in the registration process.



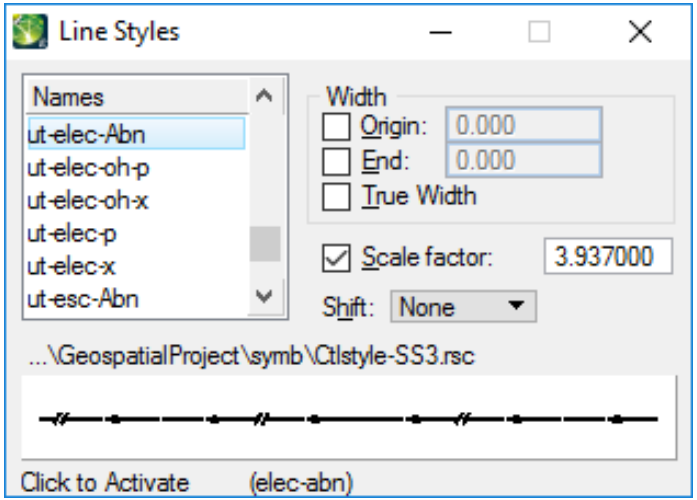
10. The selected features will be registered in the “All Users” section of the Map project.

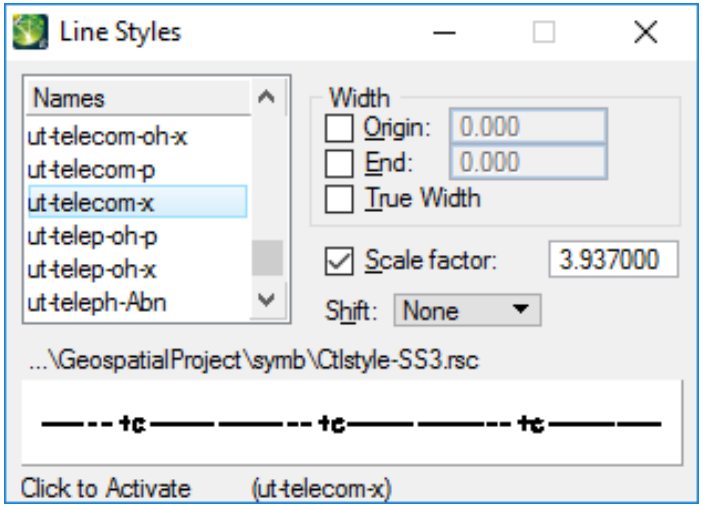


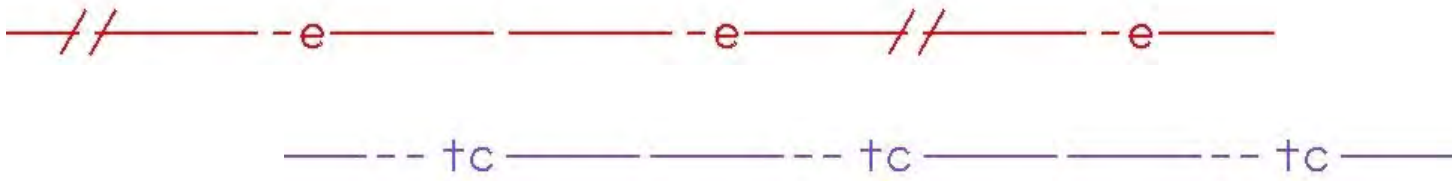
11. Define the appropriate symbology and placement methods for each feature in the symbology node of each feature. Each utility line has its own level and custom linestyle so that it can easily and quickly be spotted or isolated in a view.



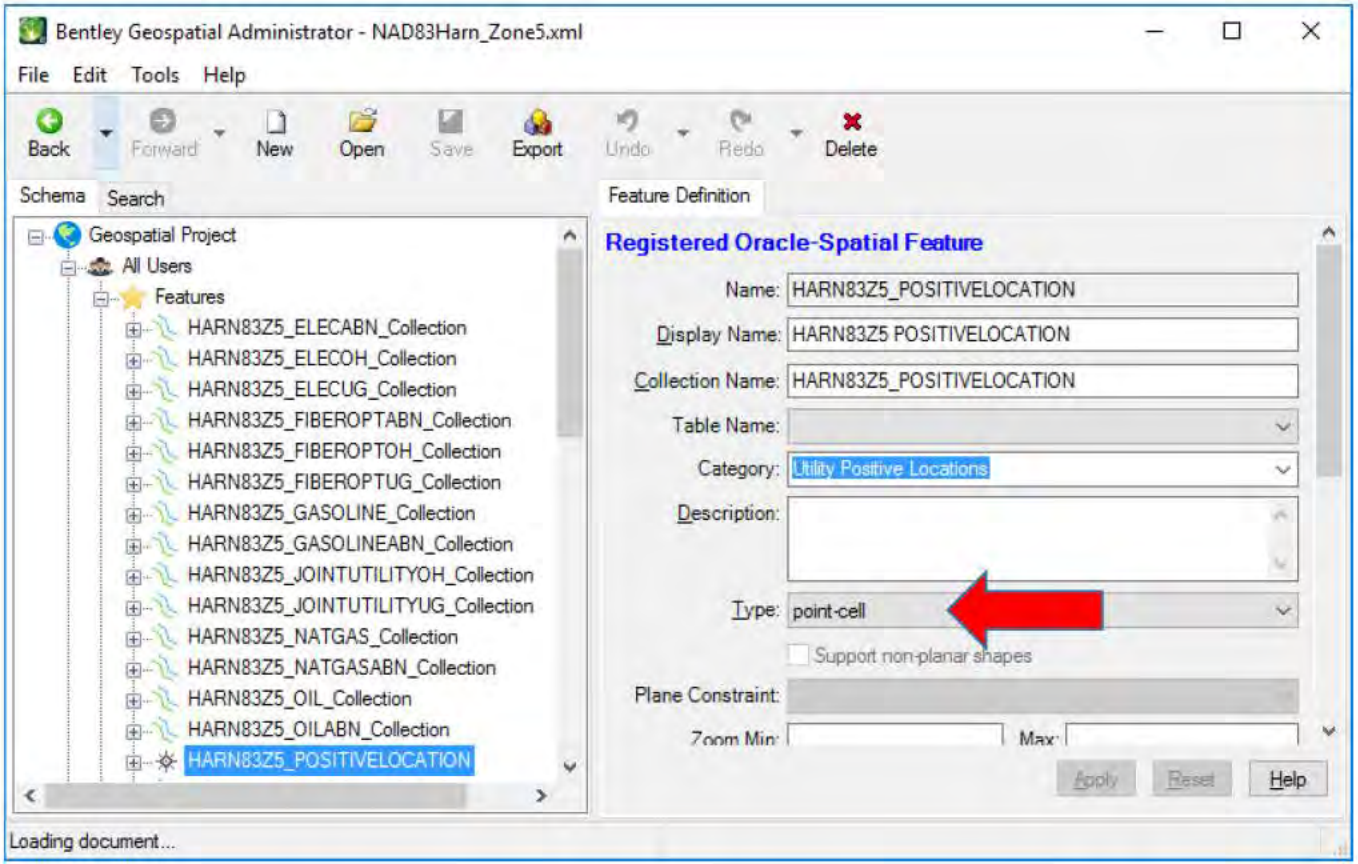
Caltrans has custom line styles for all the utility lines, which are stored in a resource file.





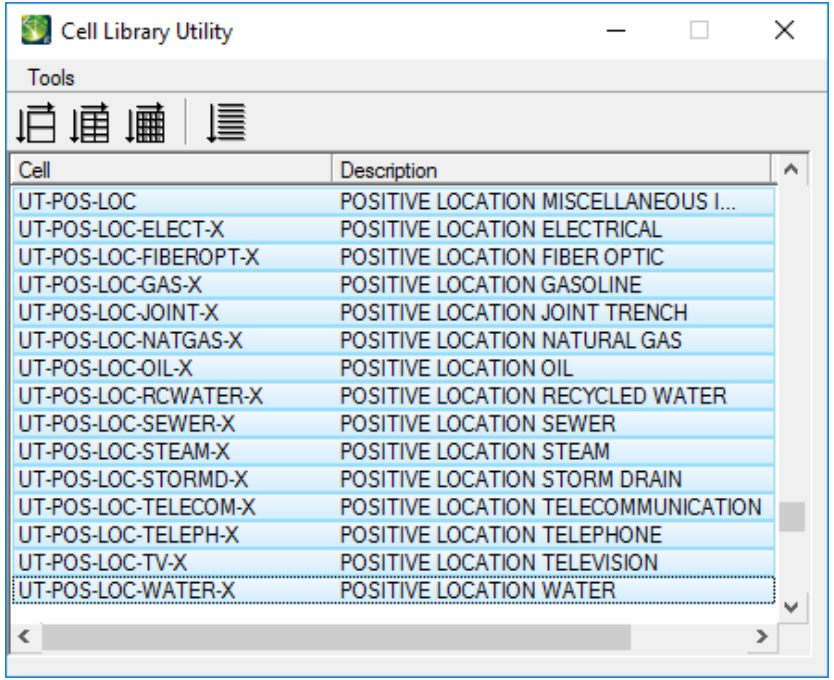


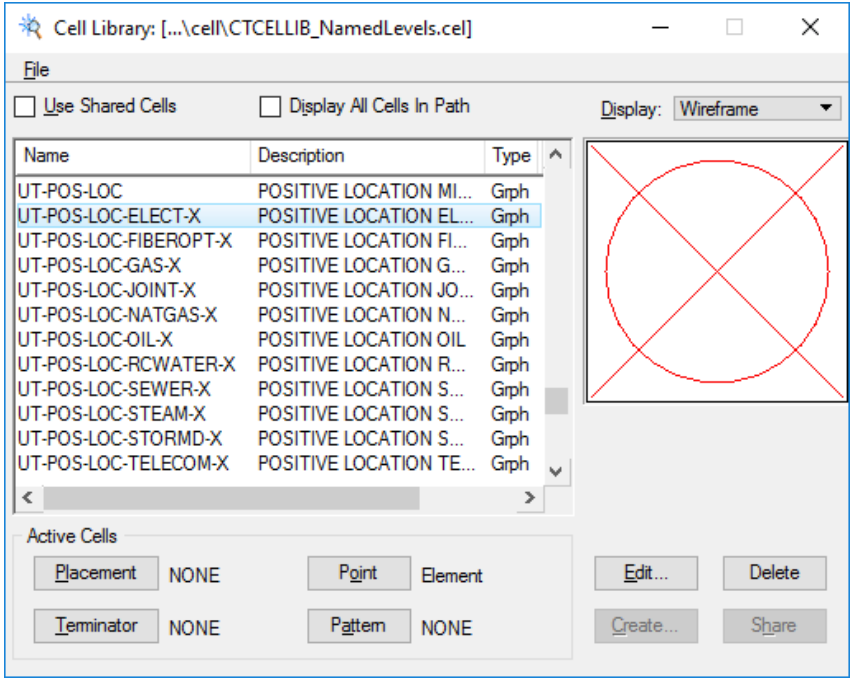
A point-cell feature “POSITIVELOCATION”



Point features are placed in the file as cells, which are pre-created elements stored in a library.

Criteria checks are run to determine which cell should be placed for the feature.





12. Geospatial Administrator: the Criteria sub-section under “All Users” there are compare expressions that are used to determine if a specific feature’s property or a specific property equals a value or one of the given values. There are a number of predefined criteria used in the symbology section of the property.

13. An Operation is created for each feature. There are 2 sections: “Properties” and “Dialogs”

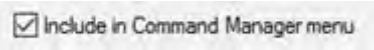
14. The Operation “User Form” has to be setup. It is used in the Place, Edit and Promote dialogs.

15. A Method is created for each feature. The default methods can be used or a custom method can be written in C (MicroStation mdl program), VB.net or VBA.

Promote method converts an element in the design file to an XFM feature. Of course, the existing element would have to meet the type requirement.

Place method places the selected feature in the design file as the type of geometry defined in the table.

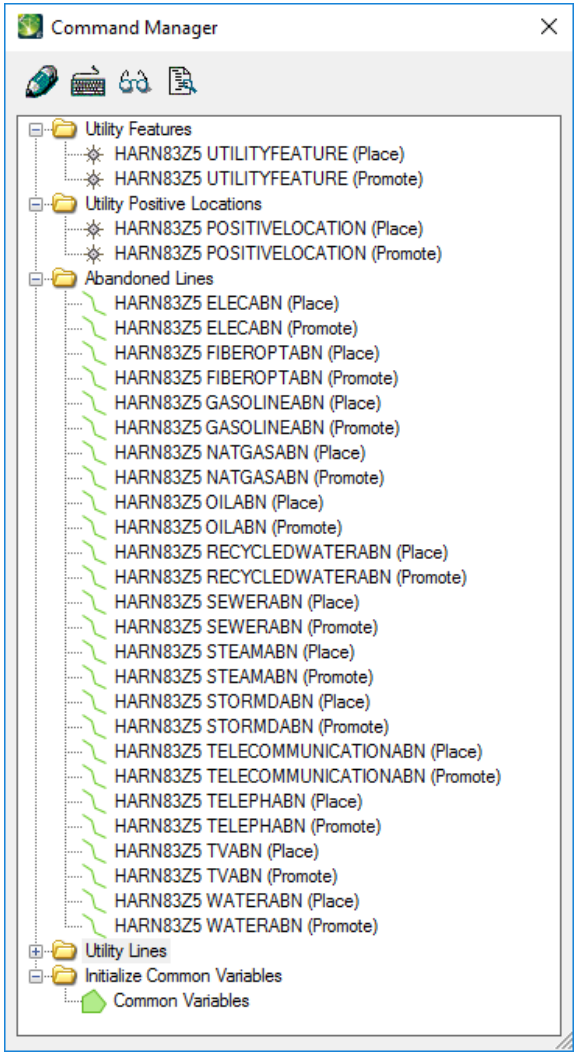
Methods that were checked to be included in the Command Manager, will be listed in the Bentley Map “Command Manger”.



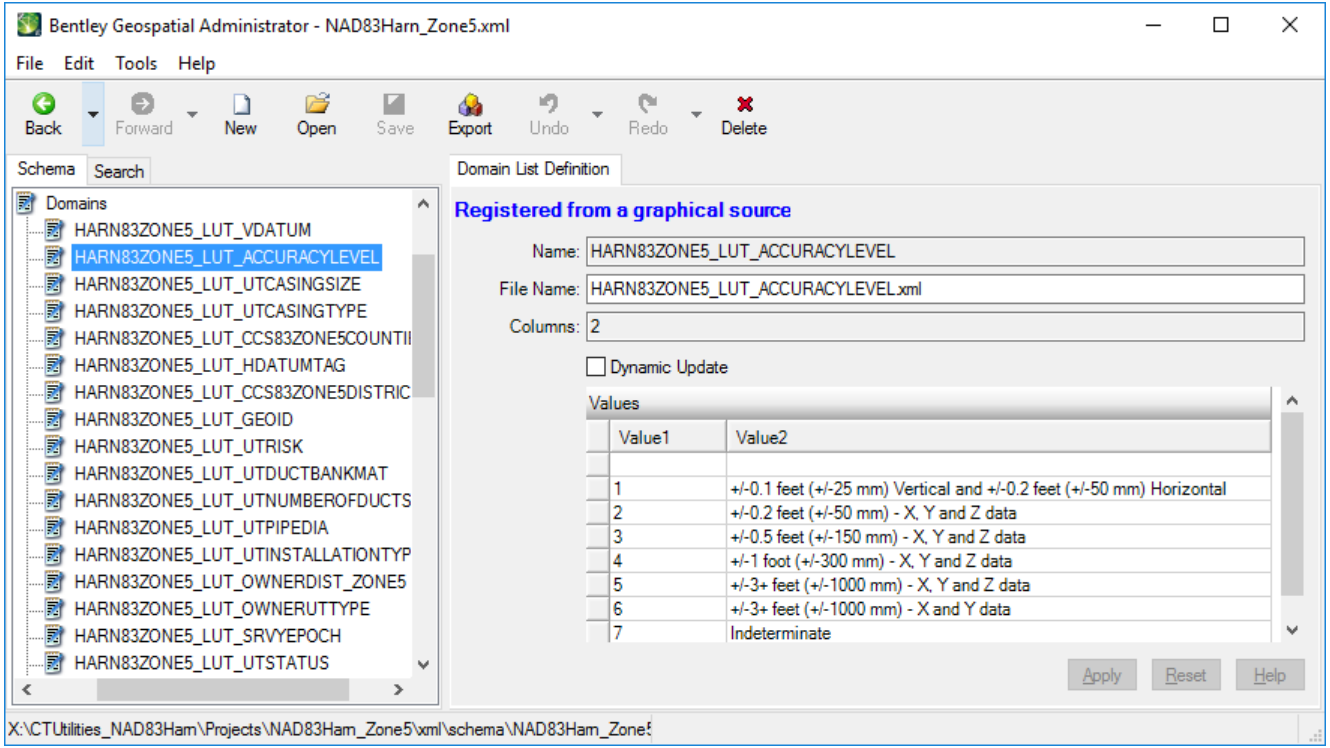
Command Manager located under “All Users/User Interface” is used to create categories and labels for displaying and separating the methods to be listed in Bentley Map’s Command Manager dialog.

Every utility feature has a Place and Promote method. Generally, we have a design file that already includes the utilities that Surveys collected in the field. They come in as elements of varying types. The Promote method would be used to promote these elements to Map XFM Features.

(There is an additional listing, Initialize Common Variables. A vba runs when the Map project opens; it creates temporary environment variables for the common properties that are included in all features. The user will then run the “Common Variables” VBA utility to select/enter values of variables that pertain to the project.)



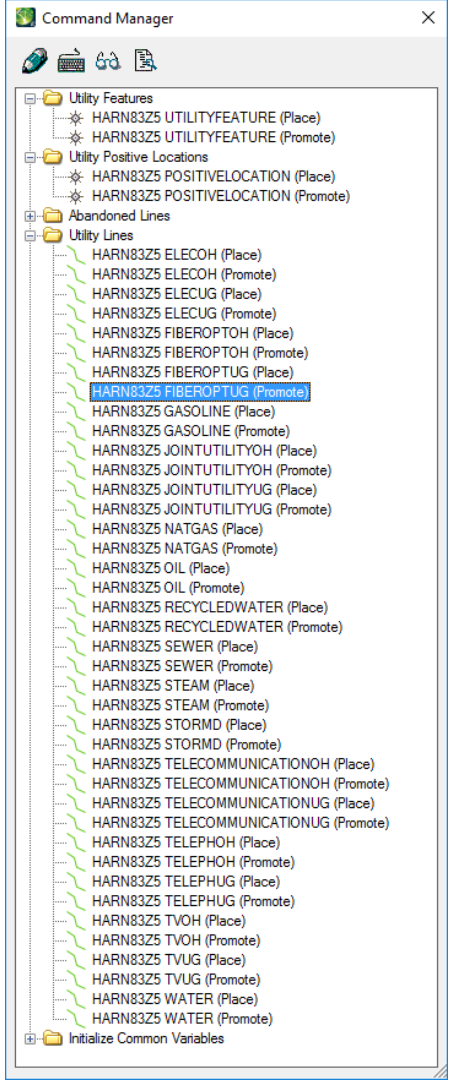
16. The Domains sub-section under “All Users” contains the valid value lists for the columns with foreign key constraints.



Bentley Map Enterprise (SS4)

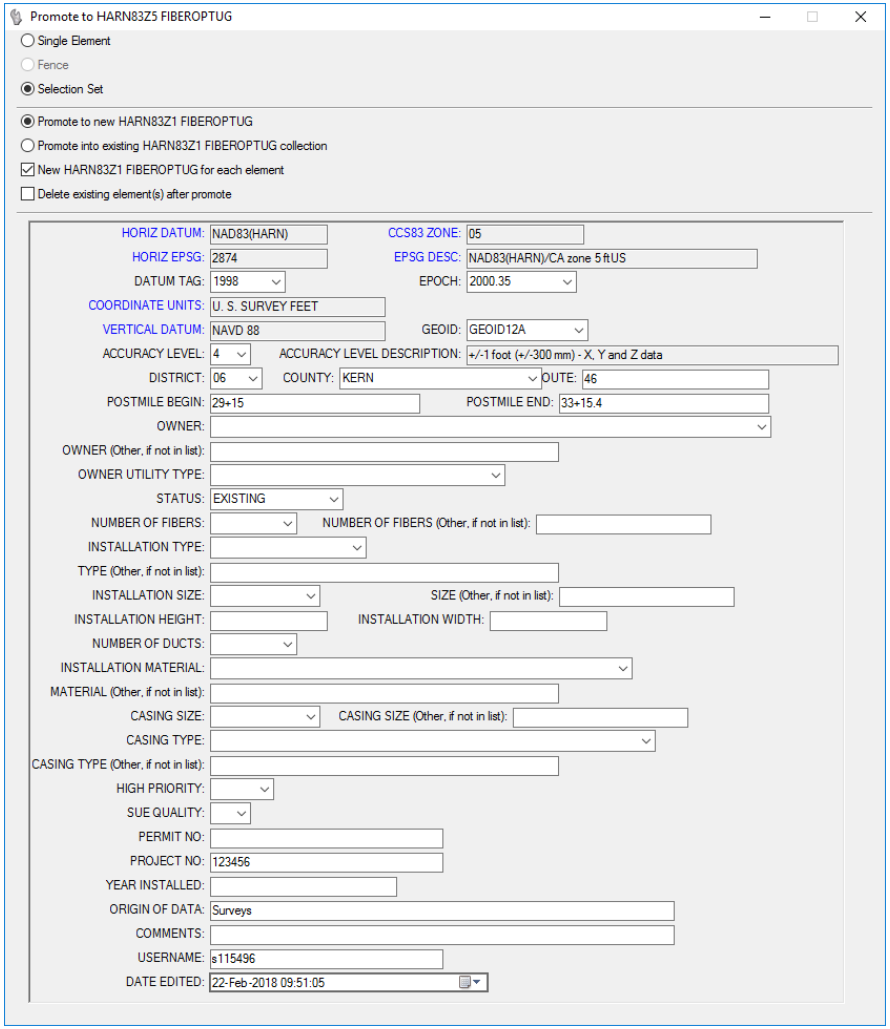
Bentley Map Enterprise/MicroStation - The Command Manager dialog contains a list of features from an XML schema (Utility Project). The dialog contains 4 icons (Place, Edit, Analyze and Data Browser) and it lists the methods that are used to “Promote” elements or features to intelligent XFM features and the methods that are used to “Place” intelligent XFM features.

It also contains the Caltrans’ Initialize Common Variables > Common Variables utility.



Example, if you wish to promote a selection set of underground fiber optic utility lines, select feature **HARN83Z5_FIBEROPTUG (Promote)** from the Command Manager dialog.

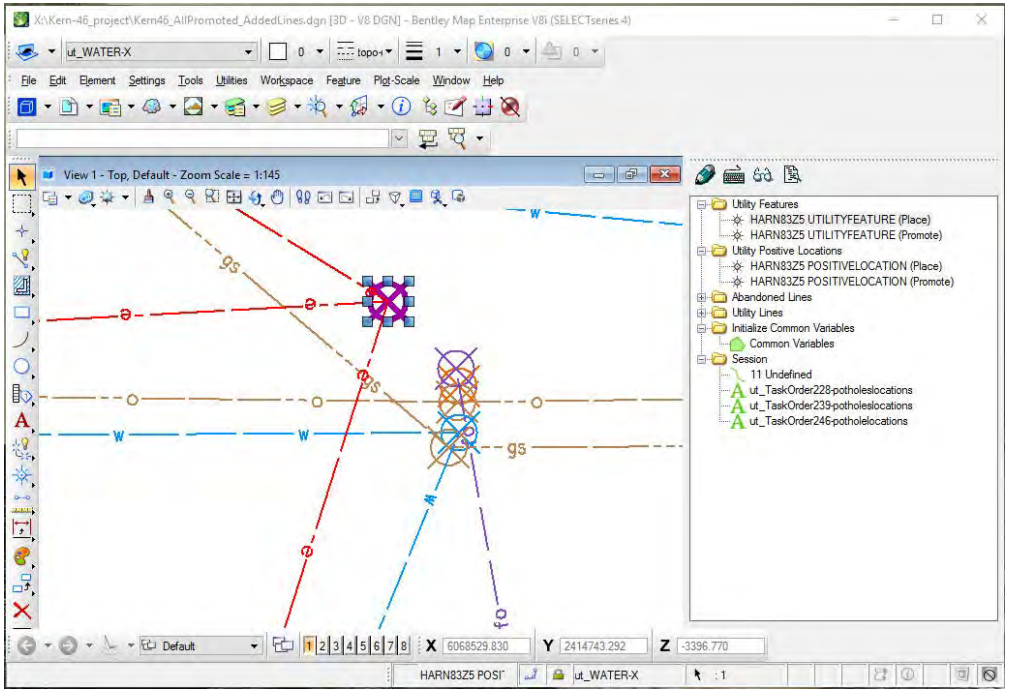
The following dialog opens, if any other properties are the same for the selection set, enter information. Otherwise, you will need edit each promoted feature so as to add its unique data.

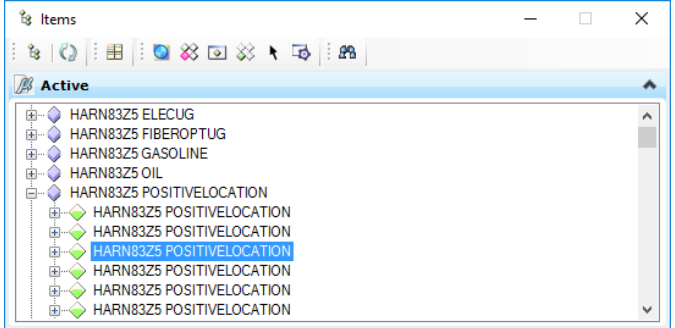


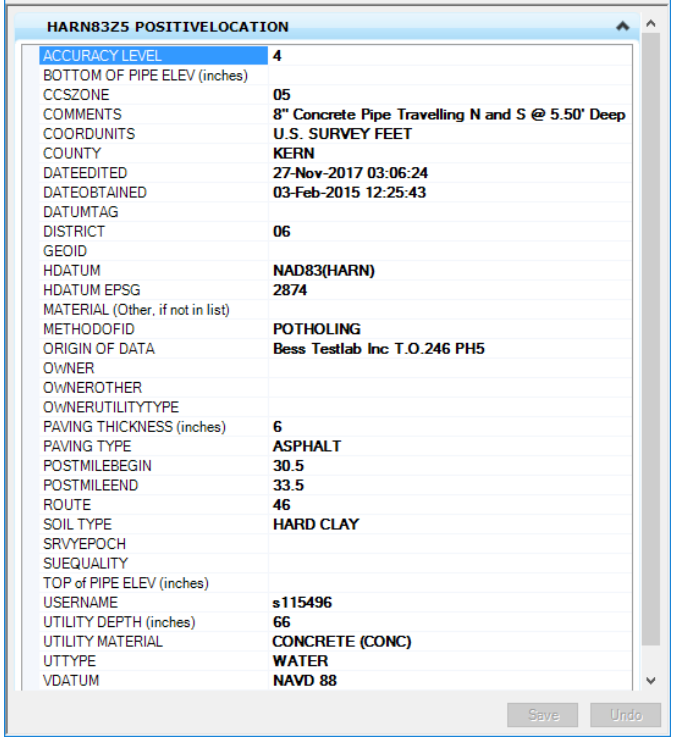
- I would say that 90% of the utility data we collect or we are given from utility companies or other entities, will be given to the Utility Engineering Workgroup (UEW) specialists in the form of a dgn or dwg CADD file.

- The UEW specialist will Promote the utility elements to the corresponding XFM features, and then they will Post the XFM features to the utility database.

Utility elements Promoted to XFM features in Bentley Map







HARN83Z5 POSITIVELOCATION

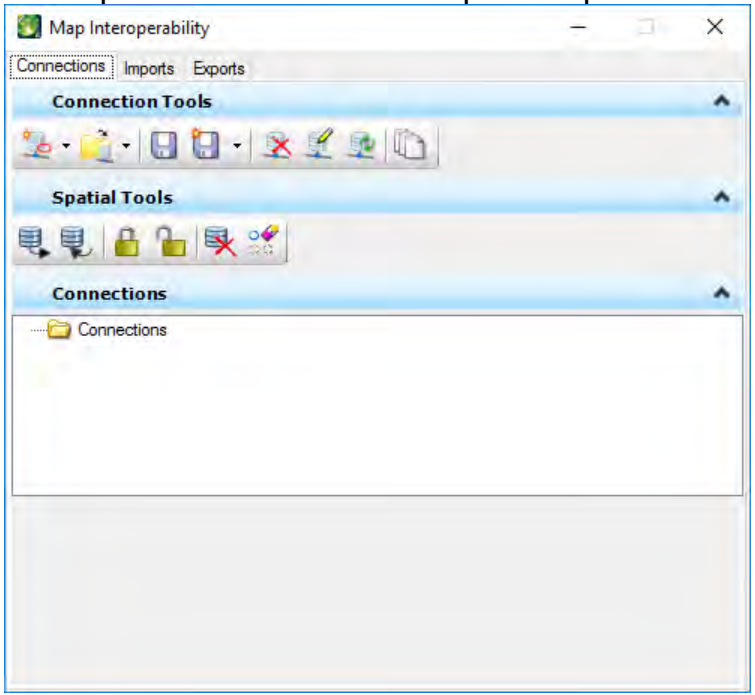
ACCURACY LEVEL	4
BOTTOM OF PIPE ELEV (inches)	
CCSZONE	05
COMMENTS	8" Concrete Pipe Travelling N and S @ 5.50' Deep
COORDUNITS	U.S. SURVEY FEET
COUNTY	KERN
DATEEDITED	27-Nov-2017 03:06:24
DATEOBTAINED	03-Feb-2015 12:25:43
DATUMTAG	
DISTRICT	06
GEOID	
HDATUM	NAD83(HARN)
HDATUM EPSG	2874
MATERIAL (Other, if not in list)	
METHODOFID	POTHOLING
ORIGIN OF DATA	Bess Testlab Inc T.O.246 PH5
OWNER	
OWNEROTHER	
OWNERUTILITYTYPE	
PAVING THICKNESS (inches)	6
PAVING TYPE	ASPHALT
POSTMILEBEGIN	30.5
POSTMILEEND	33.5
ROUTE	46
SOIL TYPE	HARD CLAY
SRVYEPOCH	
SUEQUALITY	
TOP of PIPE ELEV (inches)	
USERNAME	s115496
UTILITY DEPTH (inches)	66
UTILITY MATERIAL	CONCRETE (CONC)
UTTYPE	WATER
VDATUM	NAVD 88

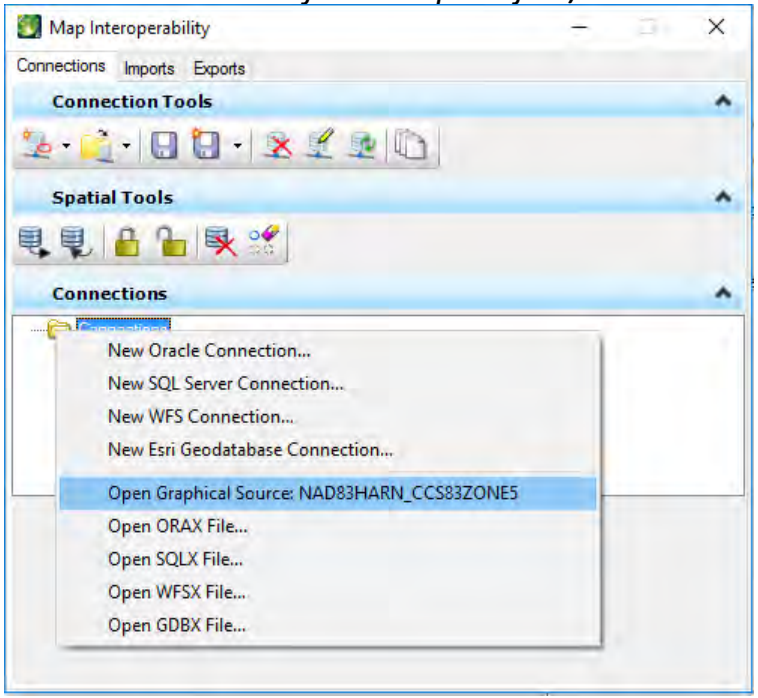
Save Undo

Posting to Utility Database

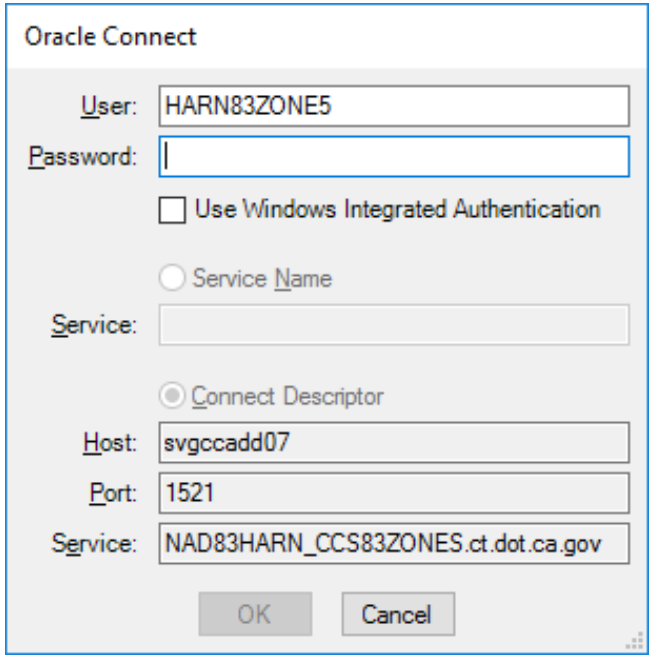
Open the Map Interoperability dialog located under the File menu In Bentley Map Enterprise (SS4). The first page “Connections” is used to manage connections. Only one database connection can be active in a session.

- Place the cursor over the Connections folder in the list window, then right-mouse click to display the drop-down menu. Select Open Graphical Source: *Connection Name from Map Project/Schema*





The Oracle Connect dialog opens, enter the password to create the connection to the Oracle database. Click OK.

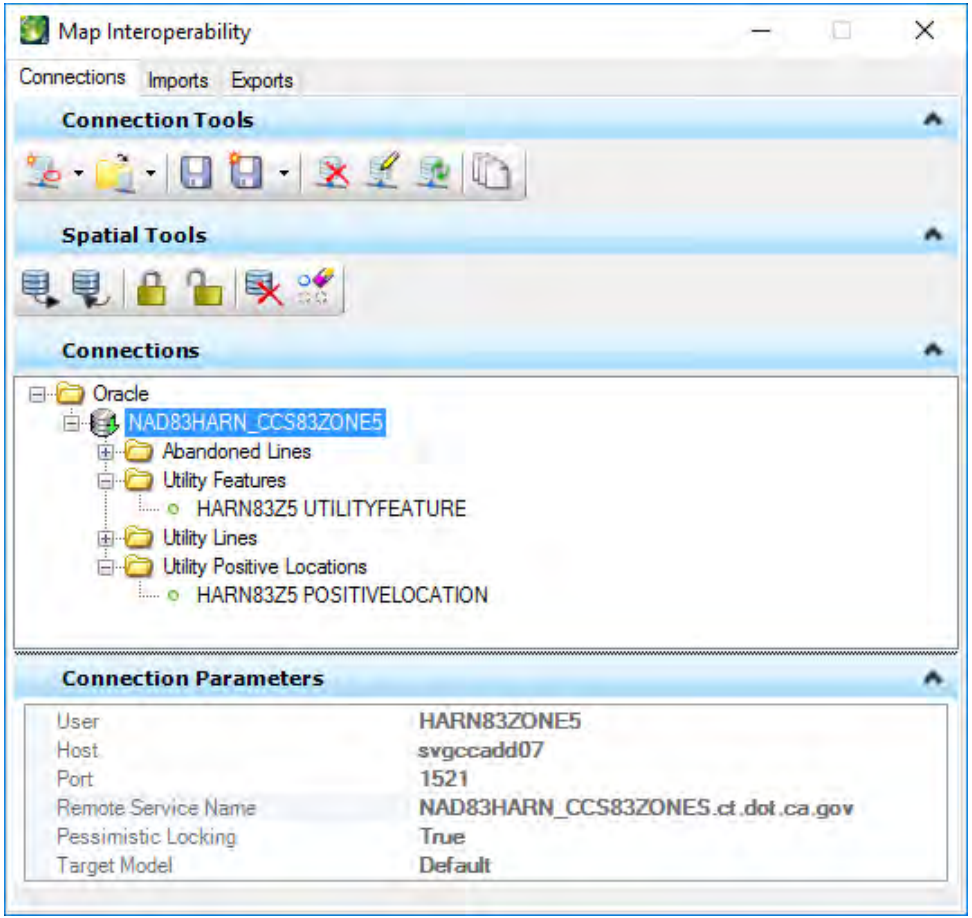


The Map schema sets most of the information in the dialog.

User: HARN83ZONE5
Password: <*user enters*>

Host: svgccadd07
Port: 1521
Service: NAD83HARN_CCS83ZONES.ct.dot.ca.gov

The Map Interoperability dialog will look similar for all projects once the connection is established.



Spatial Tools:

1st icon: Query - Opens the Query form to perform a query. The last selected feature(s) will be active.

2nd icon: Post Changes - Posts any modified features to the database.

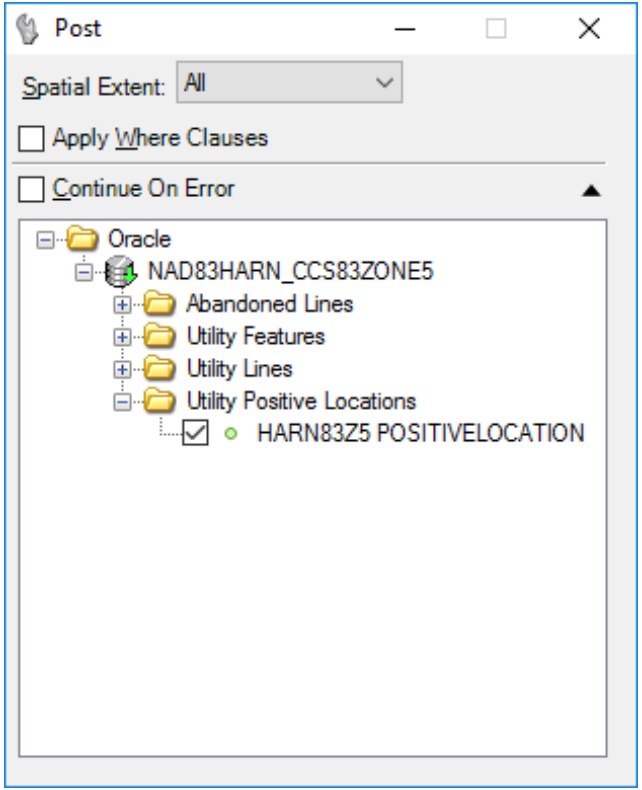
3rd icon: Lock - Locks the selected features based on the selected spatial extent.

4th icon: Unlock - Unlocks the selected features based on the selected spatial extent.

5th icon: Discard Changes - Discards any edits made in the current session.

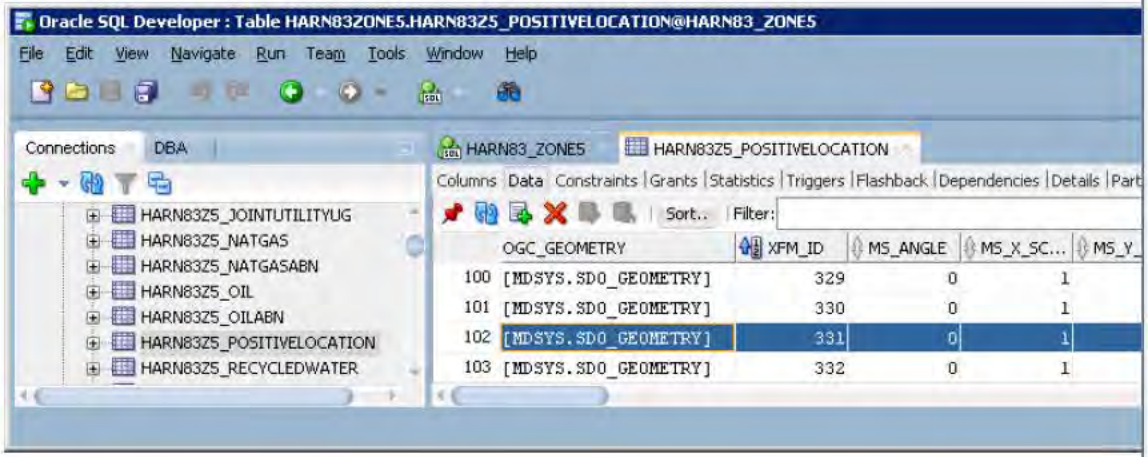
6th icon: Erase Cached Instances - Erases any spatial features from the session based on the selected spatial extent. Note: this does not delete features, it only removes them from the current session.

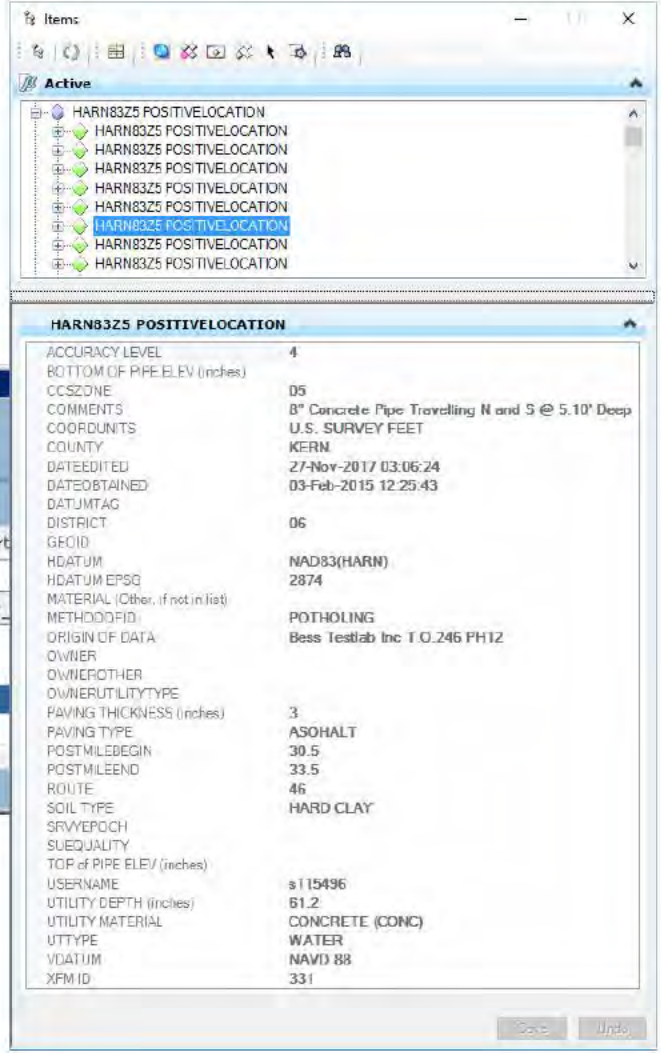
- Spatial Extent of XFM features to be posted can be set to “All or View”.
- XFM Features – all the features are checked in the window are of the dialog, note the check mark next to POSITIVELOCATION. If you select the other categories, you will find all of the features checked.
- You can uncheck features you don’t want to post.
- When ready to Post, accept by placing the cursor in the window/view and clicking the data mouse button.
- The Message Center in Map will display the number of features that were posted to the database.



Once the features are posted to the database, open the Item Browser. The last property XFM ID (utility table's primary key) now has a value.

This is the unique identifier used to find the row of data in the utility database table.

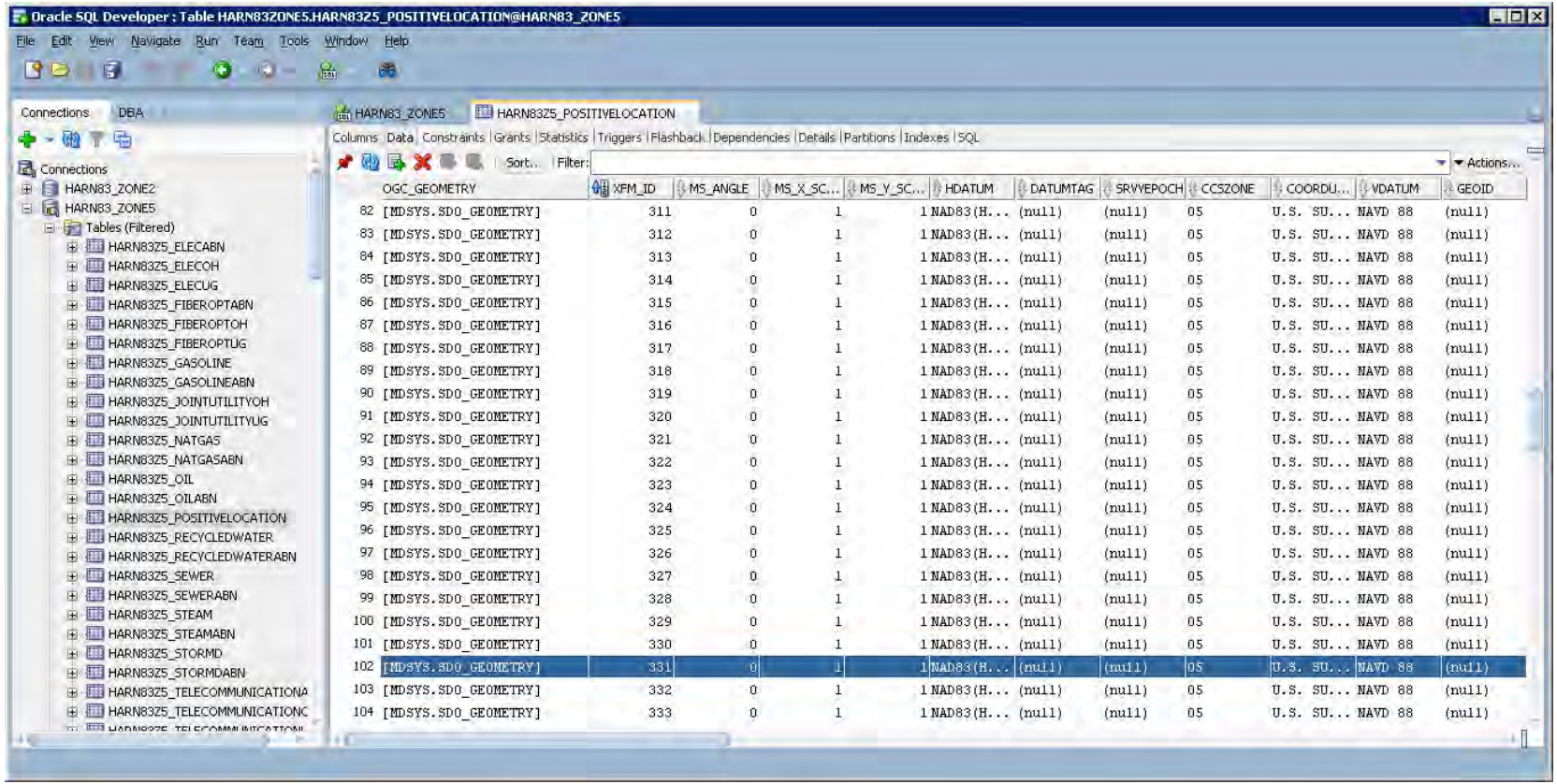




Container DB: svgccadd07, Pluggable DB: NAD83HARN_CCS83ZONES

Tablespace: NAD83HARN_CCS83ZONES

Utility table: HARN83Z5_POSITIVELOCATION - data row XFM_ID 331

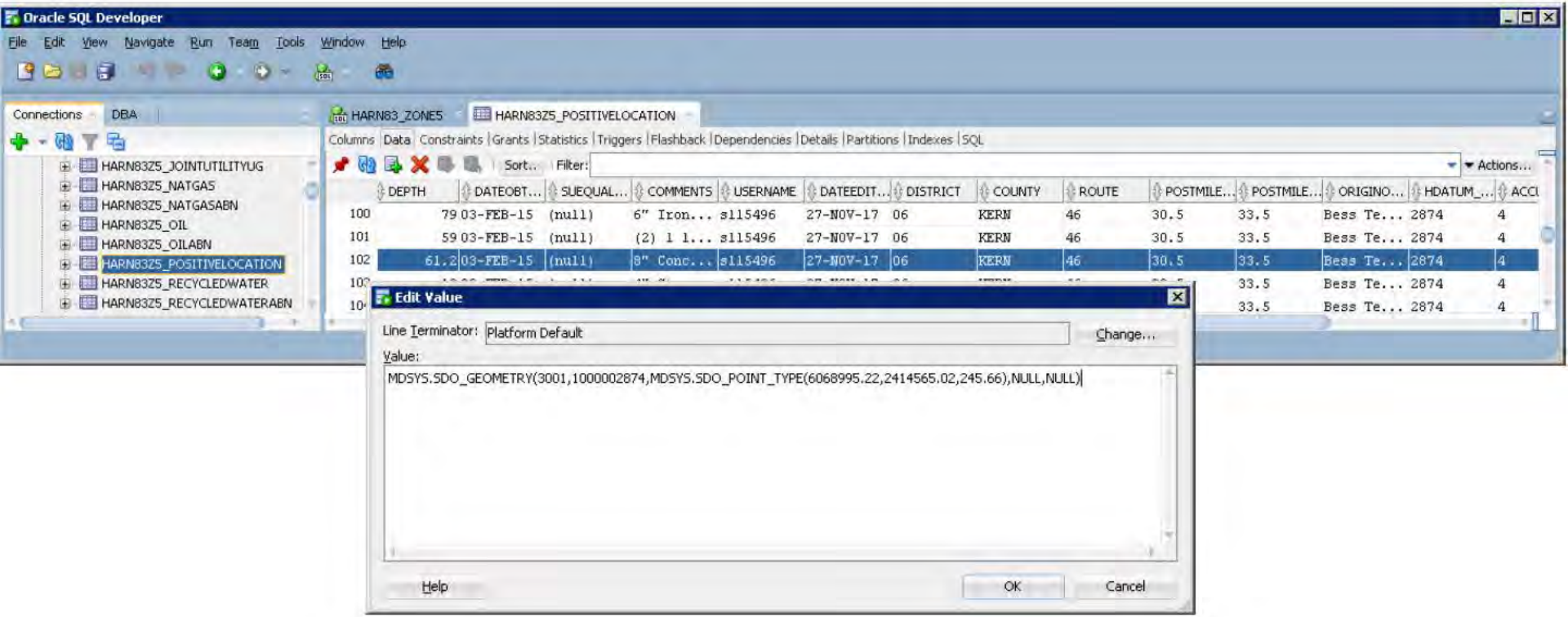


	OGC_GEOMETRY	XFM_ID	MS_ANGLE	MS_X_SC...	MS_Y_SC...	HDATUM	DATUMTAG	SRVYEPOCH	CCSZONE	COORDU...	VDATUM	GEOID
82	[MDSYS.SDO_GEOMETRY]	311	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
83	[MDSYS.SDO_GEOMETRY]	312	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
84	[MDSYS.SDO_GEOMETRY]	313	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
85	[MDSYS.SDO_GEOMETRY]	314	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
86	[MDSYS.SDO_GEOMETRY]	315	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
87	[MDSYS.SDO_GEOMETRY]	316	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
88	[MDSYS.SDO_GEOMETRY]	317	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
89	[MDSYS.SDO_GEOMETRY]	318	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
90	[MDSYS.SDO_GEOMETRY]	319	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
91	[MDSYS.SDO_GEOMETRY]	320	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
92	[MDSYS.SDO_GEOMETRY]	321	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
93	[MDSYS.SDO_GEOMETRY]	322	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
94	[MDSYS.SDO_GEOMETRY]	323	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
95	[MDSYS.SDO_GEOMETRY]	324	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
96	[MDSYS.SDO_GEOMETRY]	325	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
97	[MDSYS.SDO_GEOMETRY]	326	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
98	[MDSYS.SDO_GEOMETRY]	327	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
99	[MDSYS.SDO_GEOMETRY]	328	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
100	[MDSYS.SDO_GEOMETRY]	329	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
101	[MDSYS.SDO_GEOMETRY]	330	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
102	[MDSYS.SDO_GEOMETRY]	331	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
103	[MDSYS.SDO_GEOMETRY]	332	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)
104	[MDSYS.SDO_GEOMETRY]	333	0	1	1	NAD83(H...	(null)	(null)	05	U.S. SU...	NAVD 88	(null)

Container DB: svgccadd07, Pluggable DB: NAD83HARN_CCS83ZONES

Tablespace: NAD83HARN_CCS83ZONES

Utility table: HARN83Z5_POSITIVELOCATION - data row XFM_ID 331



Key Takeaways

- Many different configurations are capable in a multitenant database
  - For CA, the ability to add additional pluggable databases with ease is a plus
  - Use of compound coordinate systems enables on the fly re-projection from one coordinate system to another
- Create SQL scripts for your Oracle tablespaces, tables, indexes, sequences, triggers and compound coordinate systems
  - Your initial setup may not work well for your needs, be flexible
- Using a CADD program(s) to connect to a database is essential
  - Symbology distinguishes the different types of features (utilities)
- 3D data is essential for existing and forthcoming technology
  - Aids in finding conflicts and in their resolution
- Thank you for attending!

Questions & Answers


ANALYTICS AND DATA SUMMIT
2018
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March 20–22, 2018