

# Getting Started with SQL Spatial Databases

*Terry Sherman*

*Oklahoma South Central Arc-Users  
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# About Terry

## **Work:**

Research Cyberinfrastructure Analyst for OSU High Performance Computing Center – developing research “cloud” resources including ArcGIS Virtual Desktop Infrastructure with 100+ terabyte storage for OSU’s research community.

Application Developer for OSU Facilities Information (2008-2014) – developed and integrated information solutions involving various spatial and non-spatial facilities data, utilizing database and web technologies. Deployed ArcGIS Server.

## **Education:**

Certificate Geographic Information Systems, OSU 2014

B.S. Computer Science Major and Economics Minor, OSU 2007

## **Certifications:**

Esri Certified Enterprise Geodatabase Management Associate 10.1

Esri Certified Web Application Developer Associate 10

# Session Overview

- Review Esri Geodatabase Options
- Installing SQL Server 2008 R2 Express
- ArcSDE Geodatabase vs. Simple SQL Spatial Database
- SQL Spatial Queries in SQL Server Management Studio
- Impacts of ArcSDE Versioning
- Accessing SQL Server Express from other Applications
- Additional Considerations
- Additional Resources



# Comparison of Geodatabase Types

A **file geodatabase** stores datasets in a folder of files on your computer. Each dataset is held as a file and can be up to 1 TB in size (and you can optionally configure a file geodatabase to store much larger datasets). File geodatabases can be used across platforms and can be compressed and encrypted for read-only, secure use.

A **personal geodatabase** stores its datasets in a Microsoft Access .mdb file on disk. The storage sizes of personal geodatabases are effectively limited to between 250 and 500 MB for the entire geodatabase and are only supported on Windows.

An **ArcSDE geodatabase**, sometimes also referred to as a multuser geodatabase, stores datasets in a number of optional DBMSs including the following:

- IBM DB2
- IBM Informix
- Microsoft SQL Server
- Oracle
- PostgreSQL

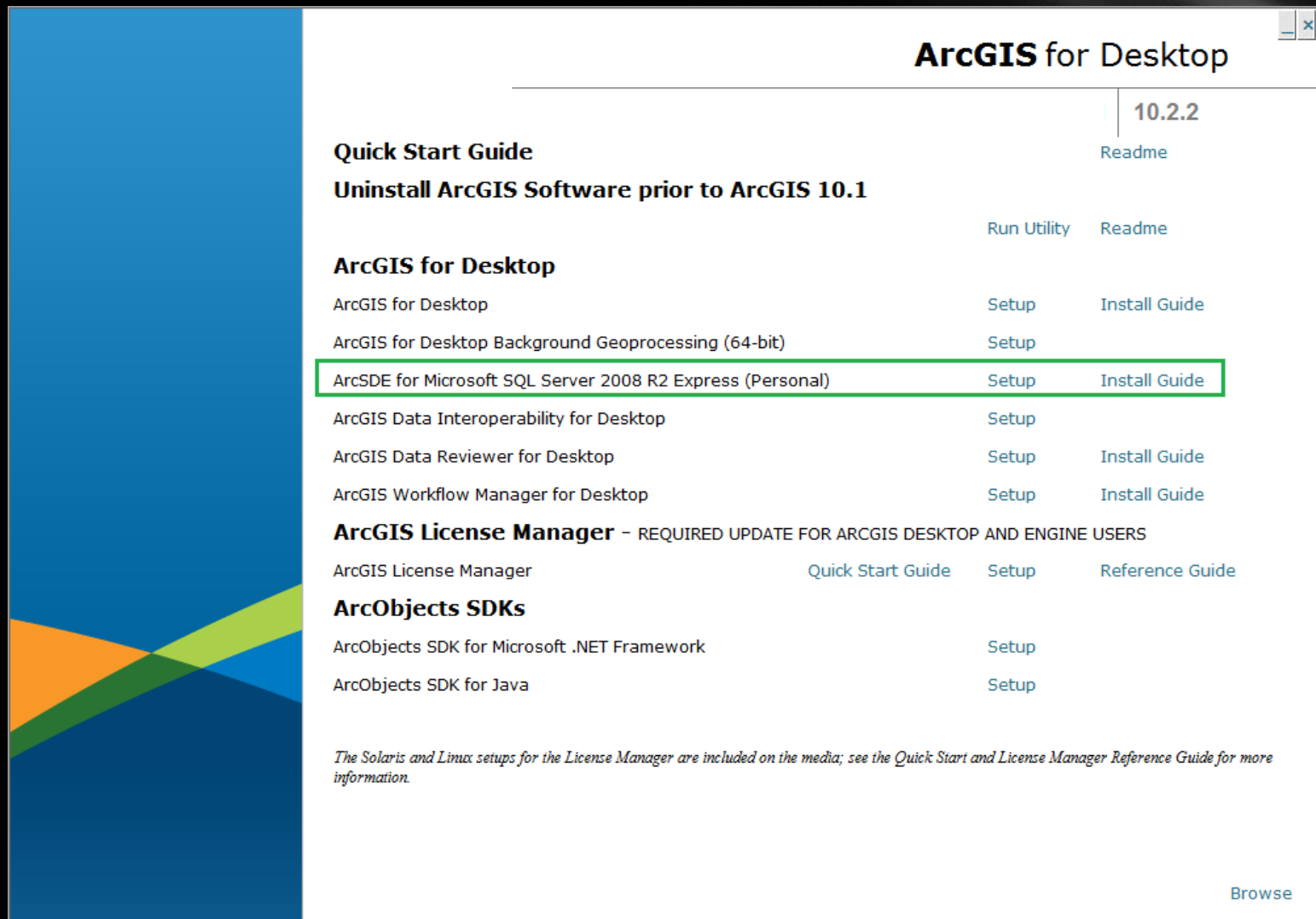
If you want to use historical archives in your geodatabase, replicate your data, access simple data using SQL, or concurrently edit data without locking it, you need to use ArcSDE geodatabases.

# ArcSDE geodatabase options

There are two types of ArcSDE geodatabases:

- **ArcSDE for SQL Server Express**—ArcGIS for Desktop at the Standard and Advanced license levels, ArcGIS Engine, and ArcGIS Server Workgroup edition ship with SQL Server Express. You can install SQL Server Express, which is a lightweight, personal copy of SQL Server, and enable it to store geodatabases. With ArcCatalog, you can set up and administer a SQL Server Express instance as well as ArcSDE geodatabases, so you do not have to be a database administrator (DBA) to use these types of ArcSDE geodatabases.
- **ArcSDE geodatabases licensed under ArcGIS for Server at the Enterprise level**—In addition, ArcSDE can work in enterprise settings across a range of DBMSs using ArcSDE Enterprise geodatabases. ArcSDE Enterprise is purchased as part of ArcGIS for Server and typically requires DBA privileges and skills to set up and administer the underlying DBMS.

# ArcGIS for Desktop Install Options



**ArcGIS for Desktop** 10.2.2

**Quick Start Guide** [Readme](#)

**Uninstall ArcGIS Software prior to ArcGIS 10.1**

[Run Utility](#) [Readme](#)

**ArcGIS for Desktop**

ArcGIS for Desktop	<a href="#">Setup</a>	<a href="#">Install Guide</a>
ArcGIS for Desktop Background Geoprocessing (64-bit)	<a href="#">Setup</a>	
ArcSDE for Microsoft SQL Server 2008 R2 Express (Personal)	<a href="#">Setup</a>	<a href="#">Install Guide</a>
ArcGIS Data Interoperability for Desktop	<a href="#">Setup</a>	
ArcGIS Data Reviewer for Desktop	<a href="#">Setup</a>	<a href="#">Install Guide</a>
ArcGIS Workflow Manager for Desktop	<a href="#">Setup</a>	<a href="#">Install Guide</a>

**ArcGIS License Manager** – REQUIRED UPDATE FOR ARCGIS DESKTOP AND ENGINE USERS

ArcGIS License Manager	<a href="#">Quick Start Guide</a>	<a href="#">Setup</a>	<a href="#">Reference Guide</a>
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**ArcObjects SDKs**

ArcObjects SDK for Microsoft .NET Framework	<a href="#">Setup</a>
ArcObjects SDK for Java	<a href="#">Setup</a>

*The Solaris and Linux setups for the License Manager are included on the media; see the [Quick Start and License Manager Reference Guide](#) for more information.*

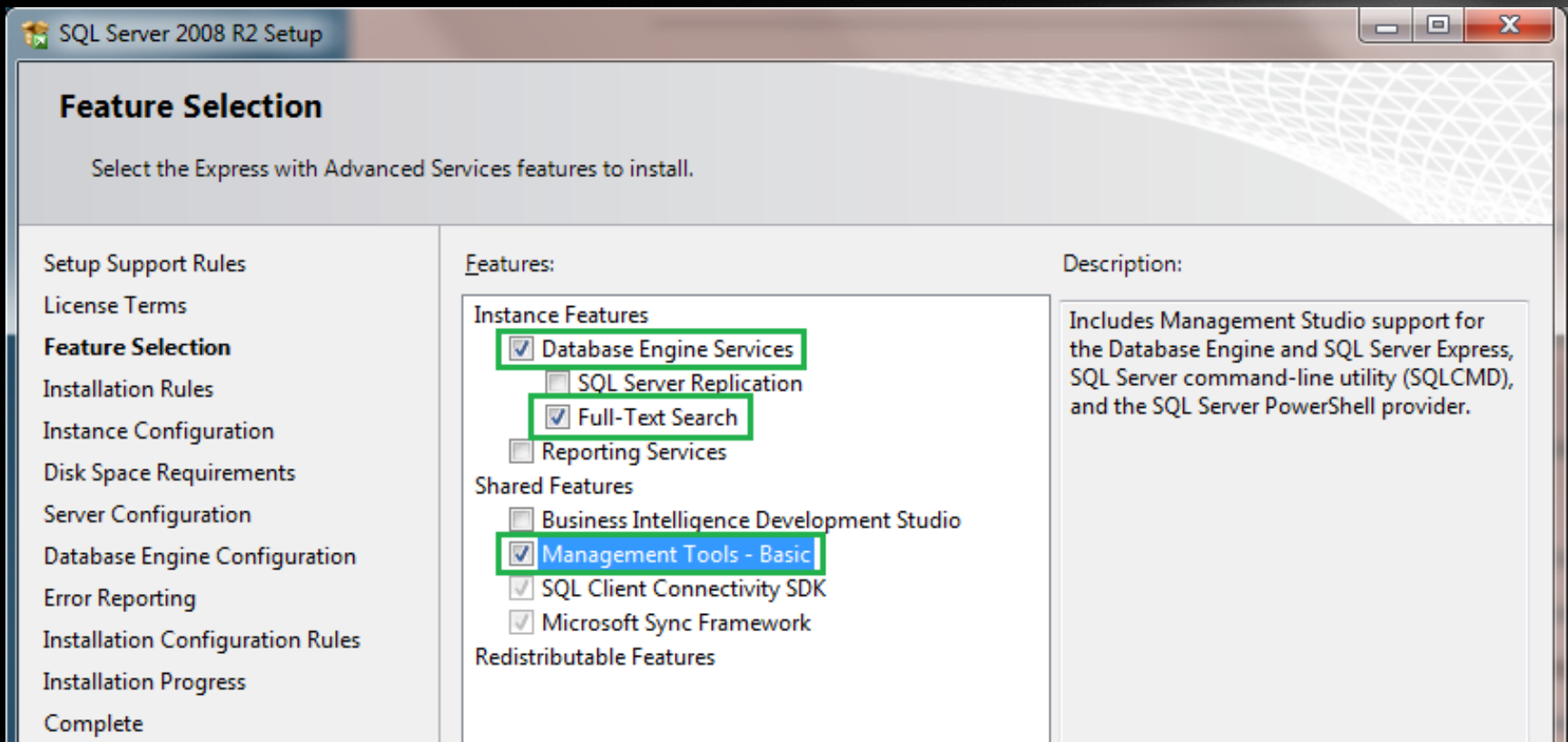
[Browse](#)



# Installing SQL Server 2008 R2 Express

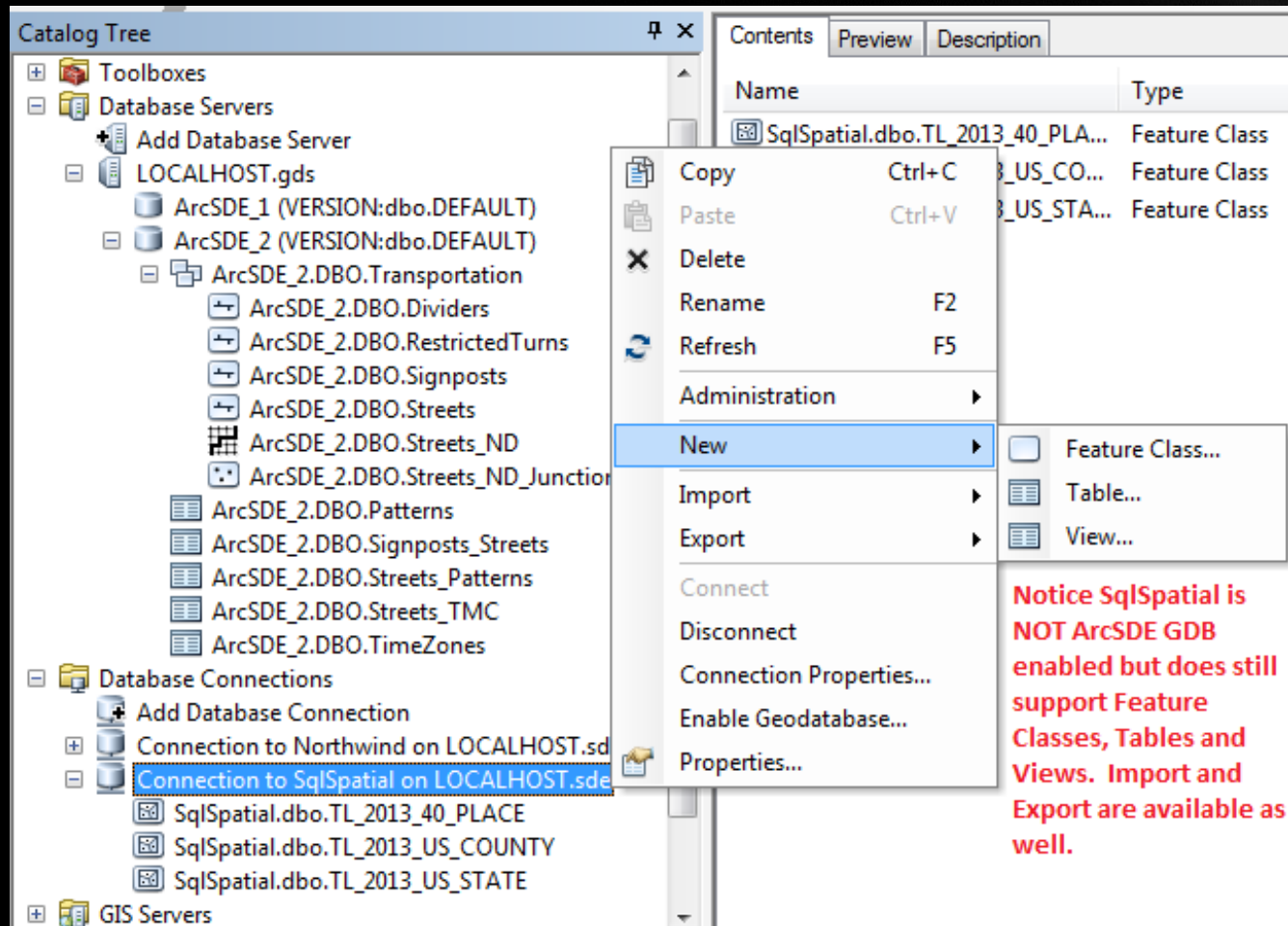
Follow the instructions in the ArcGIS for Desktop 10.x Help

At Feature Selection add a check to “Management Tools – Basic” to install the SQL Server Management Studio GUI and SQLCMD command-line tools



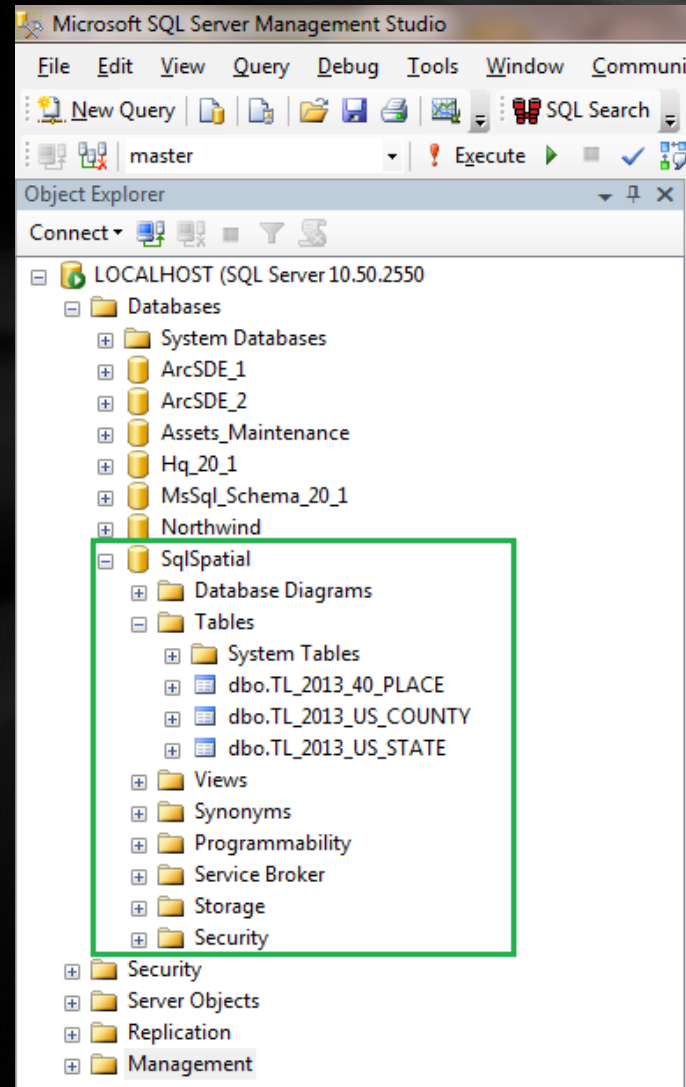
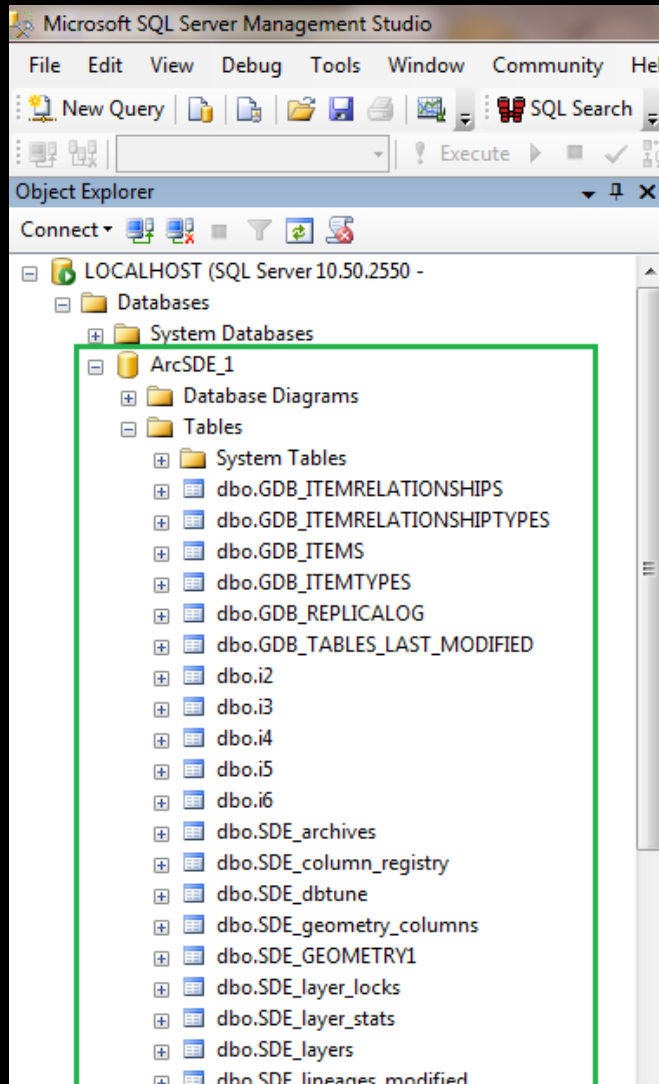
# ArcSDE vs. Simple SQL Spatial

Here the ArcSDE\_x and SqlSpatial databases are all stored on the same local SQL Server Express database, but SqlSpatial was not ArcSDE enabled.

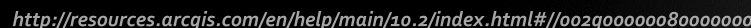




# “Empty” ArcSDE vs. Simple SQL Spatial



- Datasets
- Versioning
- Geodatabase Archives
- Distributed Geodatabases
- ArcSDE XML
- Spatial type tables and views
- System administration
- Locking
- Log Files
- Schematics

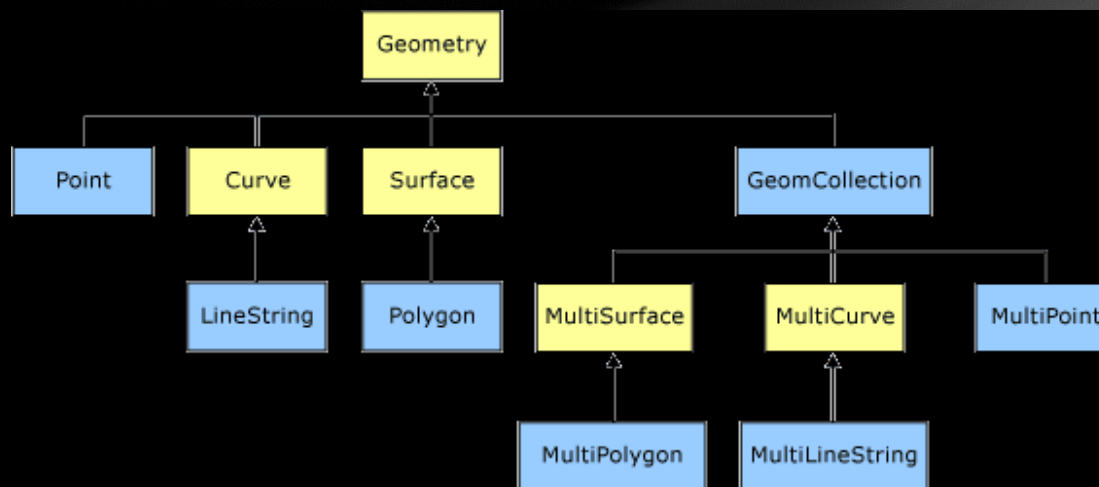


# SQL Server Spatial Data Types

The geometry data type supports planar, or Euclidean (flat-earth), data. The geometry data type conforms to the Open Geospatial Consortium (OGC) Simple Features for SQL Specification version 1.1.0.

In addition, SQL Server supports the geography data type, which stores ellipsoidal (round-earth) data, such as latitude and longitude coordinates.

The figure below depicts the geometry hierarchy upon which the geometry and geography data types are based. The instantiable types of geometry and geography are indicated in blue.





# SQL Server OGC Geometry Methods

- STArea
- STAsBinary
- STAsText
- STBoundary
- STBuffer
- STCentroid
- STContains
- STConvexHull
- STCrosses
- STDifference
- STDimension
- STDisjoint
- STDistance
- STEndpoint
- STEnvelope
- STEquals
- STExteriorRing
- STGeometryN
- STGeometryType
- STInteriorRingN
- STIntersection
- STIntersects
- STIsClosed
- STIsEmpty
- STIsRing
- STIsSimple
- STIsValid
- STLength
- STNumGeometries
- STNumInteriorRing
- STNumPoints
- STOverlaps
- STPointN
- STPointOnSurface
- STRelate
- STSrid
- STStartPoint
- STSymDifference
- STTouches
- STUnion
- STWithin
- STX
- STY

# SQL Server OGC Geography Methods

- STArea
- STAsBinary
- STAsText
- STBuffer
- STDimension
- STDisjoint
- STDistance
- STEndpoint
- STGeometryN
- STGeometryType
- STIntersection
- STIntersects
- STIsClosed
- STIsEmpty
- STLength
- STNumGeometries
- STNumPoints
- STPointN
- STSrid
- STStartPoint
- STUnion

# SSMS – Spatial Method STAsText() Used to Decode Shape Geometry

The screenshot displays the Microsoft SQL Server Management Studio (SSMS) interface. The left pane shows the 'Object Explorer' with the 'LOCALHOST (SQL Server 10.50.2550)' tree. The 'Tables' folder is expanded, showing 'dbo.TL\_2013\_US\_COUNTY'. The 'Columns' folder is also expanded, showing the 'Shape (geometry, null)' column. The right pane shows the 'SQLQuery9.sql' script with the following query:

```
SELECT [OBJECTID]  
      , [STATEFP]  
      , [COUNTYFP]  
      , [GEOID]  
      , [NAME]  
      , [Shape].STAsText() AS [GEOM]  
      , [Shape]  
FROM [Spatial]. [dbo]. [TL_2013_US_COUNTY]  
WHERE [STATEFP] = 40
```

The 'Results' pane shows the query output. The first column is 'OBJECTID', the second is 'STATEFP', the third is 'COUNTYFP', the fourth is 'GEOID', the fifth is 'NAME', the sixth is 'GEOM', and the seventh is 'Shape'. The 'GEOM' column contains the decoded geometry as text, and the 'Shape' column contains the original geometry as a binary value.

OBJECTID	STATEFP	COUNTYFP	GEOID	NAME	GEOM	Shape
1	40	001	40001	Adair	POLYGON ((-94.518265000429381 35.906281000367926, -94.518299000198681 35.9063...	0xAD1000000104F50500
2	40	135	40135	Sequoyah	POLYGON ((-94.629908000253977 35.6382949997145, -94.630069999630734 35.638296...	0xAD1000000104E00500
3	40	017	40017	Canadian	POLYGON ((-97.833675000301014 35.335361999956376, -97.833355999794 35.335201...	0xAD10000001040D0D00
4	40	095	40095	Marshall	POLYGON ((-96.969970999561951 34.046893000111936, -96.969970000415174 34.0464...	0xAD1000000104410500
5	40	059	40059	Harper	POLYGON ((-100.00386900005429 36.769580000416738, -100.00387999966222 36.7681...	0xAD1000000104EC0400
6	40	003	40003	Alfalfa	POLYGON ((-98.540599999890048 36.71978099989326, -98.540606000166747 36.71886...	0xAD10000001046F0400
7	40	081	40081	Lincoln	POLYGON ((-97.1411340003338 35.608481999944388, -97.1411350003799 35.60841799...	0xAD10000001045B0800
8	40	063	40063	Hughes	POLYGON ((-96.408638999690027 34.930673000358752, -96.408615000381928 34.9304...	0xAD1000000104C40600
9	40	101	40101	Muskogee	POLYGON ((-95.40540099986226 35.551921999700596, -95.39729999769644 35.5519...	0xAD1000000104970900
10	40	115	40115	Ottawa	POLYGON ((-94.999572999893985 36.67791299998504, -94.999571999847888 36.67694...	0xAD10000001045F0500
11	40	131	40131	Rogers	POLYGON ((-95.435600000339718 36.466700000404728, -95.435600000339718 36.4672...	0xAD1000000104620900
12	40	015	40015	Caddo	POLYGON ((-98.26871300010481 34.855136000026448, -98.267842999554773 34.85513...	0xAD1000000104F70700
13	40	097	40097	Mayes	POLYGON ((-95.4355000002248 36.336319999868124, -95.435489999763661 36.335279...	0xAD10000001048D0500
14	40	029	40029	Coal	POLYGON ((-96.3463030001833 34.4183420001832, -96.33724099957243 34.418307000...	0xAD1000000104460400
15	40	019	40019	Carter	POLYGON ((-97.562740000350686 34.245663999693875, -97.5626610003049 34.234868...	0xAD10000001049E0600
16	40	055	40055	Greer	POLYGON ((-99.500988000395864 35.116930000219384, -99.5029789995811 35.116930...	0xAD1000000104470600
17	40	033	40033	Cotton	POLYGON ((-98.610152000314542 34.157530000309293, -98.610157999691921 34.1570...	0xAD1000000104540500
18	40	089	40089	McCurain	POLYGON ((-94.96861400035833 33.859118000395426, -94.968589000082261 33.8589...	0xAD1000000104061200
19	40	005	40005	Atoka	POLYGON ((-96.232827000365717 34.4184069995834, -96.2336949999243 34.41842300...	0xAD1000000104AA0500
20	40	111	40111	Oklmulgee	POLYGON ((-95.89053999972117 35.856335000260117, -95.892311999599087 35.85634...	0xAD1000000104760600
21	40	147	40147	Washington	POLYGON ((-96.001250999733827 36.481538000278533, -96.001255999964371 36.4806...	0xAD1000000104350500
22	40	133	40133	Seminole	POLYGON ((-96.776742000143145 35.217394999879389, -96.776742000143145 35.2173...	0xAD1000000104731500



# SSMS – Spatial Results Tab

Microsoft SQL Server Management Studio

File Edit View Query Debug Tools Window Community Help

New Query SQL Search SQL Scripts Manager SQL check

master

Execute

Object Explorer

Connect LOCALHOST (SQL Server 10.50.2550)

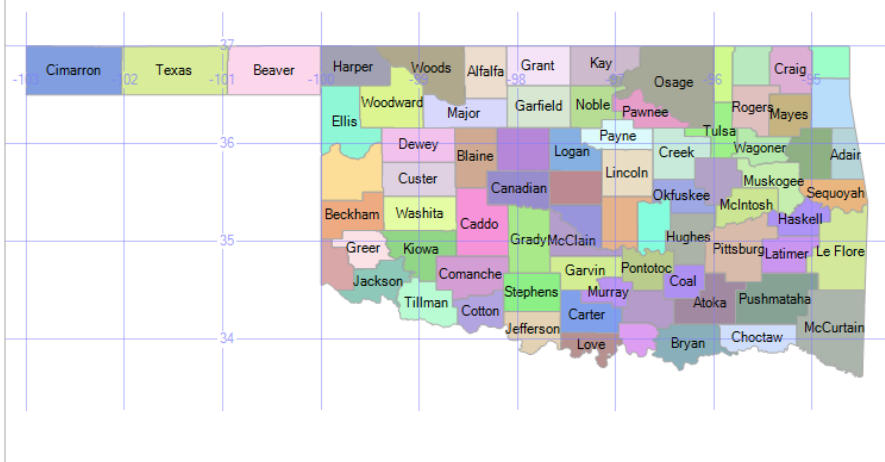
Databases

- System Databases
  - ArcSDE\_1
  - ArcSDE\_2
- Assets\_Maintenance
- Hq\_20\_1
- MsSql\_Schema\_20\_1
- Northwind
- SqlSpatial
  - Database Diagrams
  - Tables
    - System Tables
    - dbo.TL\_2013\_40\_PLACE
    - dbo.TL\_2013\_US\_COUNTY
      - Columns
        - OBJECTID (PK, int, not null)
        - Shape (geometry, null)
        - STATEFP (nvarchar(2), null)
        - COUNTYFP (nvarchar(3), null)
        - COUNTYNS (nvarchar(8), null)
        - GEOID (nvarchar(5), null)
        - NAME (nvarchar(100), null)
        - NAMESAD (nvarchar(100), null)
        - LSAD (nvarchar(2), null)
        - CLASSFP (nvarchar(2), null)
        - MTFCC (nvarchar(5), null)
        - CSAFP (nvarchar(3), null)
        - CBSAFP (nvarchar(5), null)
        - METDIVFP (nvarchar(5), null)
        - FUNCSTAT (nvarchar(1), null)
        - ALAND (numeric(14,0), null)
        - AWATER (numeric(14,0), null)
        - INTPTLAT (nvarchar(11), null)
        - INTPTLON (nvarchar(12), null)

SQLQuery9.sql - L...er-PC\Owner (64)\*

```
SELECT [OBJECTID]  
      , [STATEFP]  
      , [COUNTYFP]  
      , [GEOID]  
      , [NAME]  
      , [Shape].STAsText() AS [GEOM]  
      , [Shape]  
FROM [SqlSpatial].[dbo].[TL_2013_US_COUNTY]  
WHERE [STATEFP] = 40
```

Results Spatial results Messages



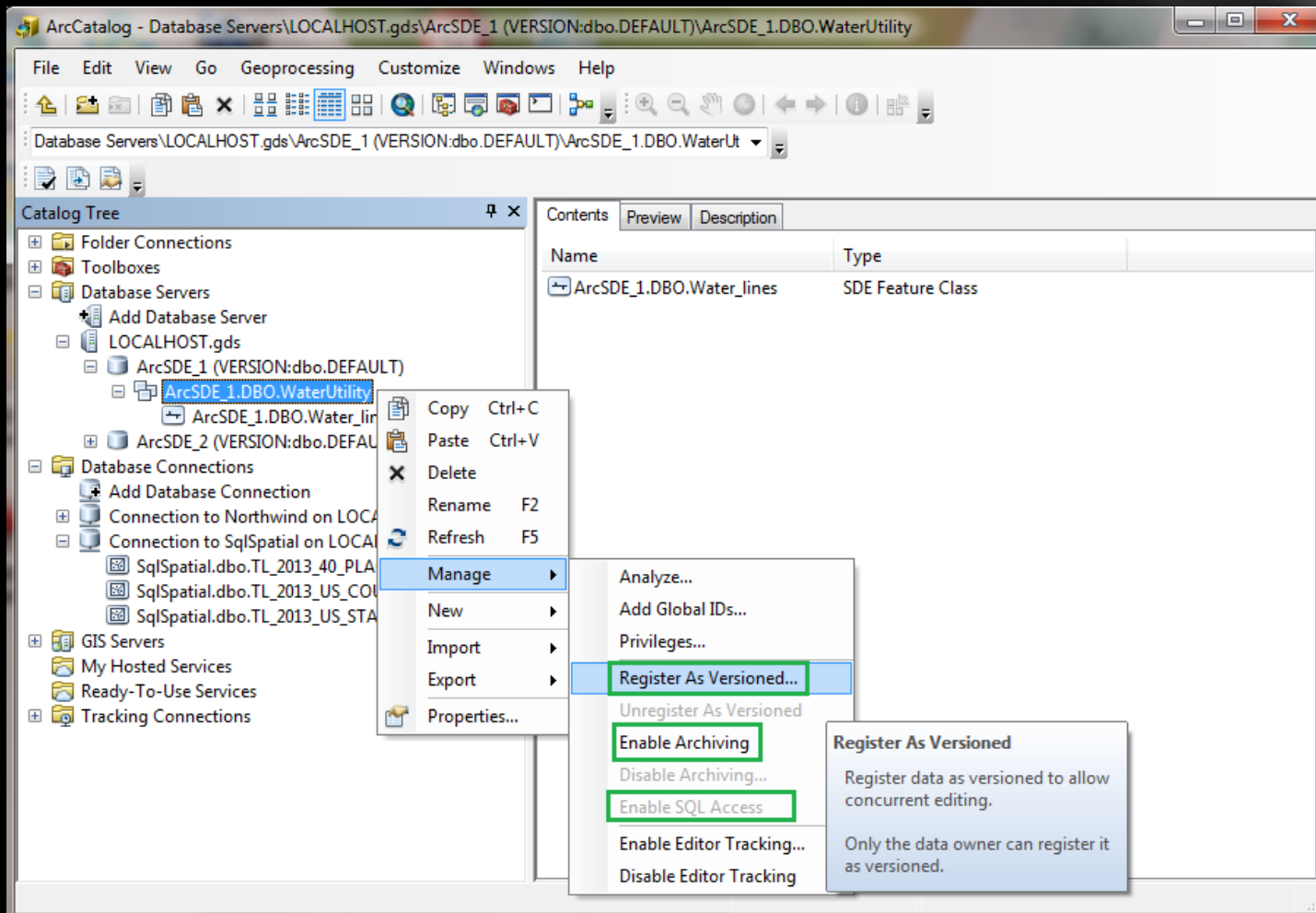
Select spatial column:  
Shape

Select label column:  
NAME

Zoom:  
[Slider]

☒ Show grid lines

# ArcSDE Register As Versioned & Enable Archiving generate SQL Views



# ArcSDE Versioning created SQL View: Merge base & delta tables, Edit triggers

The screenshot displays the Microsoft SQL Server Management Studio interface. On the left, the Object Explorer shows the database structure for 'LOCALHOST (SQL Server 10.50.2550)'. The 'ArcSDE\_1' database is expanded, showing 'Database Diagrams', 'Tables', and 'Views'. The 'Views' folder is expanded, showing 'System Views', 'dbo.dbtune', 'dbo.SDE\_generate\_guid', 'dbo.ST\_GEOMETRY\_COLUMNS', 'dbo.ST\_SPATIAL\_REFERENCE\_SYSTEMS', and 'dbo.WATER\_LINES\_EVW'. The 'dbo.WATER\_LINES\_EVW' view is selected, and its columns are listed: 'OBJECTID (int, null)', 'WaterType (nvarchar(255), null)', 'SHAPE (geometry, null)', and 'SDE\_STATE\_ID (bigint, null)'. The 'Triggers' folder is also expanded, showing 'v7\_delete', 'v7\_insert', and 'v7\_update'.

The main window shows a SQL query in the 'SQLQuery11.sql' file, which is a SELECT statement querying the 'dbo.WATER\_LINES\_EVW' view. The query is as follows:

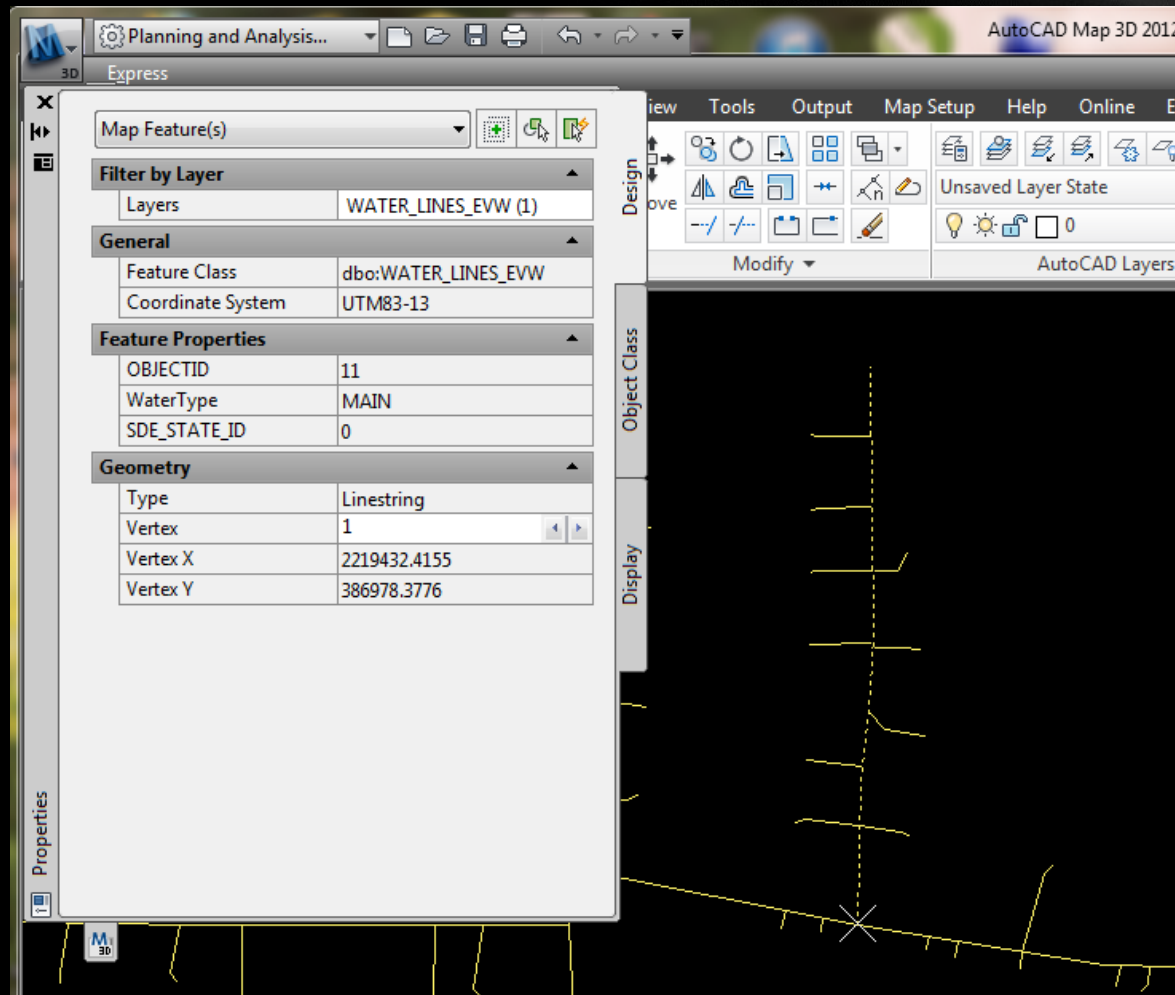
```
SELECT [OBJECTID]
      , [WaterType]
      , [SDE_STATE_ID]
      , [SHAPE].[STAsText() AS [GEOM]]
      , [SHAPE]
FROM [ArcSDE_1].[dbo].[WATER_LINES_EVW]
```

The 'Results' tab shows the output of the query, displaying a table with columns: 'OBJECTID', 'WaterType', 'SDE\_STATE\_ID', 'GEOM', and 'SHAPE'. The table contains 22 rows of data, with the first row highlighted. The 'GEOM' column contains LINestring data, and the 'SHAPE' column contains binary data.

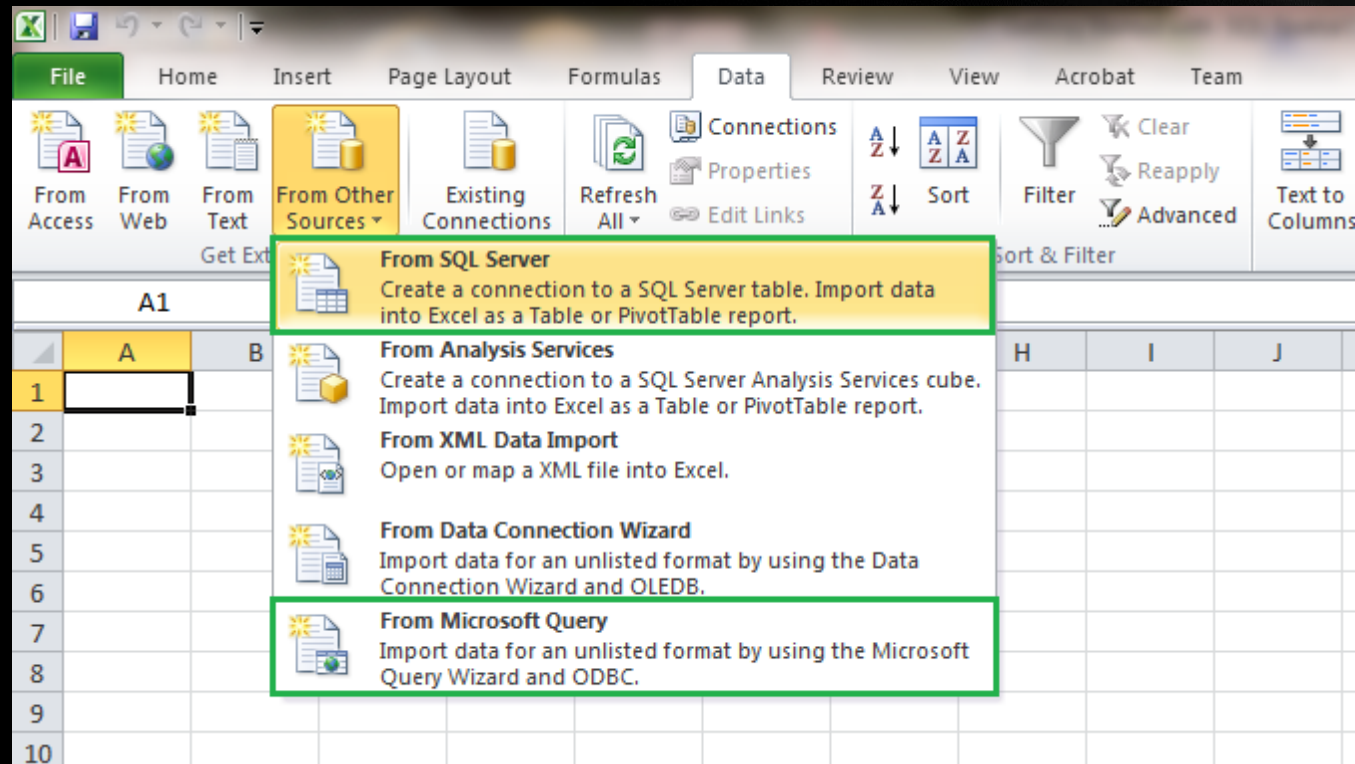
OBJECTID	WaterType	SDE_STATE_ID	GEOM	SHAPE
115	SRV	0	LINestring (2220096.0190532529 386914.62342096824, 2220106.7389296736 386857.66088983323, 222...	0x216900000104030000
284	SRV	0	LINestring (2219783.5287116282 386937.99084615731, 2219798.4145579622 386849.68862844229, 221...	0x216900000104030000
407	SRV	0	LINestring (2219363.1933636656 386991.95881786407, 2219359.0152656347 386974.84983173065, 221...	0x216900000114FE23C0
315	SRV	0	LINestring (2218866.3460736815 386781.23919599387, 2218871.7370618209 386790.77089674614, 221...	0x216900000104030000
3	MAIN	0	LINestring (2219156.3314865045 387032.544521932, 2219432.4154940578 386978.37763575645, 221...	0x21690000011458266E
410	SRV	0	LINestring (2219528.5080016577 386962.74385142163, 2219526.3533744551 386947.51864000683, 221...	0x216900000114C53206
26	SRV	0	LINestring (2219442.8541602581 387181.57588264724, 2219458.6947945612 387164.83553056035, 221...	0x216900000104030000
292	SRV	0	LINestring (2219163.5539273433 386832.99388404744, 2219183.2737297695 386831.03132788476, 221...	0x216900000114581E7A
29	SRV	0	LINestring (2219446.6287150304 387316.25600777211, 2219389.4764557271 387315.77874765097, 221...	0x216900000104030000
152	SRV	0	LINestring (2219159.0883798995 387191.18376376911, 2219211.0269431742 387188.21584683517, 221...	0x216900000104030000
95	SRV	0	LINestring (2218675.9880042742 386979.05912572355, 2218668.0411483324 386931.99345634977, 221...	0x216900000104030000
318	SRV	0	LINestring (2218932.639684211 386828.52340006479, 2218939.0504861223 386839.56422557862, 221...	0x216900000104030000
255	MAIN	0	LINestring (2218843.008324868 386978.37763575645, 2218843.008324868 386781.90858006536, 221...	0x2169000001140ECA10
27	SRV	0	LINestring (2219444.6052590166 387246.34172279609, 2219389.8713047518 387245.88465327711, 221...	0x216900000104030000
319	SRV	0	LINestring (2218976.0906770593 386780.08622689405, 2218989.9451338877 386784.00393917313, 221...	0x216900000104040000
299	SRV	0	LINestring (2219027.5891264766 386978.37763575645, 2219026.3377313656 386902.042524468, 22190...	0x216900000104030000
150	SRV	0	LINestring (2219148.573276185 387105.38313203555, 2219210.5851763966 387096.72830130567, 221...	0x216900000104030000
30	SRV	0	LINestring (2219446.6349753868 387315.50639462855, 2219471.2132790317 387315.71164141205, 221...	0x216900000104030000
316	LAT	0	LINestring (2218932.6394704529 386780.41416015744, 2218932.639684211 386828.52340006479, 221...	0x216900000114F52ADA
167	SRV	0	LINestring (2219160.7171191638 387425.05478831619, 2219218.8835011977 387425.41606887762, 221...	0x216900000104030000
405	SRV	0	LINestring (2219434.5108849118 387073.22040328232, 2219382.8209676328 387079.30966138805, 221...	0x216900000104030000
212	SRV	0	LINestring (2218943.008324868 386978.37763575645, 2218977.6168688843 386843.12521817128, 221...	0x216900000114FE23C0



# AutoCAD Map SQL Spatial Connection to SQL View



# Excel Data Connection From SQL Server or Microsoft Query (ODBC)



# Additional Considerations

- ArcSDE Personal licensed for up to 3 simultaneous users
- SQL Server Express & ArcSDE Personal won't work for Databases over 10GB
- Workflows involving lots of raster processing or use of lots of temporary intermediate datasets may be better suited to file-based datasets.
- Workstation Hardware Requirements for ArcGIS for Desktop + SQL Server Express. SQL Server Express uses 1GB RAM and 1 CPU core.
- Your organization may not allow local database servers or local data storage
- If data will be accessed by more than one person or by web applications the database should be on an IT-managed server, not your local workstation
- For ArcSDE versioning, archiving and shared data consider need for regular database backups
- Consider the need for a Database Administrator with expertise in managing a shared database server



# Additional Resources

**Modeling Our World, Second Edition: The Esri Guide to Geodatabase Concepts**

Chad Cooper ArcUser Article in ArcUser #56

<http://www.esri.com/news/arcuser/0112/real-time-updating-of-arcsde-through-sql.html>

geometry Data Type Method Reference

[http://msdn.microsoft.com/en-us/library/bb933973\(v=sql.105\).aspx](http://msdn.microsoft.com/en-us/library/bb933973(v=sql.105).aspx)

geography Data Type Method Reference

[http://msdn.microsoft.com/en-us/library/bb933802\(v=sql.105\).aspx](http://msdn.microsoft.com/en-us/library/bb933802(v=sql.105).aspx)

SQL Tutorial: <http://www.w3schools.com/sql/>