

GIS for Civil Design

B.S.E Salvatore Macrì

Technical Sales Specialist AEC Infrastructure





About the speaker

Salvatore Macrì is a Technical Sales Specialist for Autodesk Infrastructure Solutions and is responsible for the Italian market. He is based in Milan.

He has a Bachelor's degree in Environmental Engineering and more than 15 years experience including a mix of different profiles such as Surveyor, GIS Specialist, Designer and CAD Manager.

Before joining Autodesk in 2016 he worked as a BIM Specialist and Trainer in the VAR Channel helping customers to implement the BIM process and to adopt AutoCAD Civil 3D, InfraWorks, Revit and Navisworks.

He was a Subject Matter Expert for the translation into Italian of InfraWorks and co-author of the Italian Country Kit for AutoCAD Civil 3D.



<https://www.linkedin.com/in/salvatore-macrì-7278b323>

Agenda

1.Introduction

2.Basics Notion

3.Main Knowledge

1.Alignment as spatial reference

2.Connect Existing GIS Layer

3.Filter Data – Spatial Query

4.Thematic Map

5.Edit Layer

6.New Layer from scratch

7.Layer Files

8.SDF to SHP

9.MapImport

10.MapExport

11.MapExport + ObjectData

12.Geoprocessing Tools: Buffer

13.Expropriation area

14.AGOL Connection

15.WorkFlow 1

16.WorkFlow 2

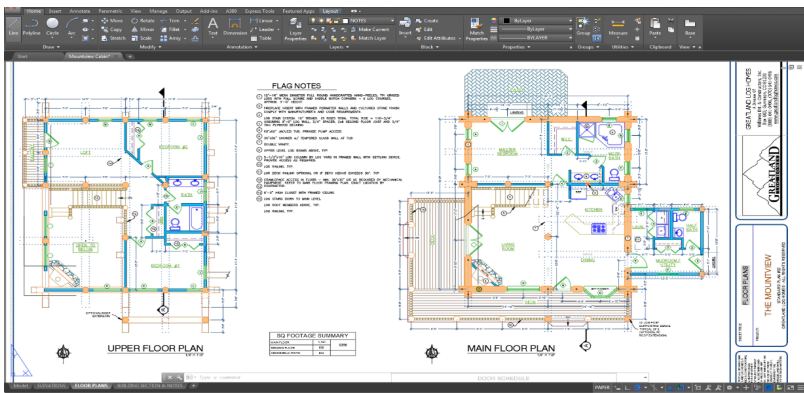
Basic Notion



Definition

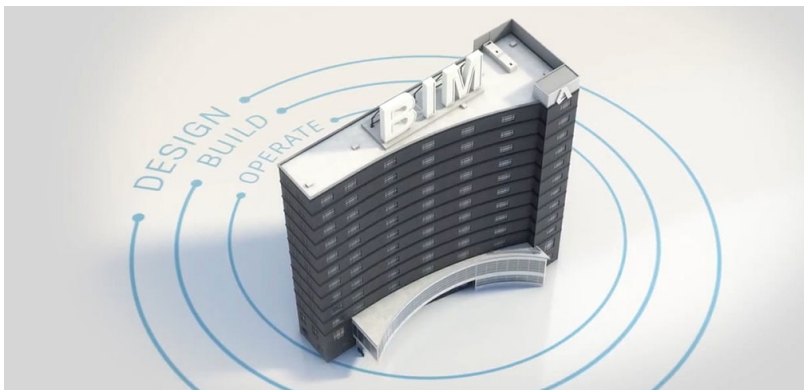
WHAT IS CAD ?

CAD (computer-aided design) software is used by architects, engineers, drafters, artists, and others to create precision ***drawings or technical illustrations***. CAD software can be used to create two-dimensional (2-D) drawings or three-dimensional (3-D) models.



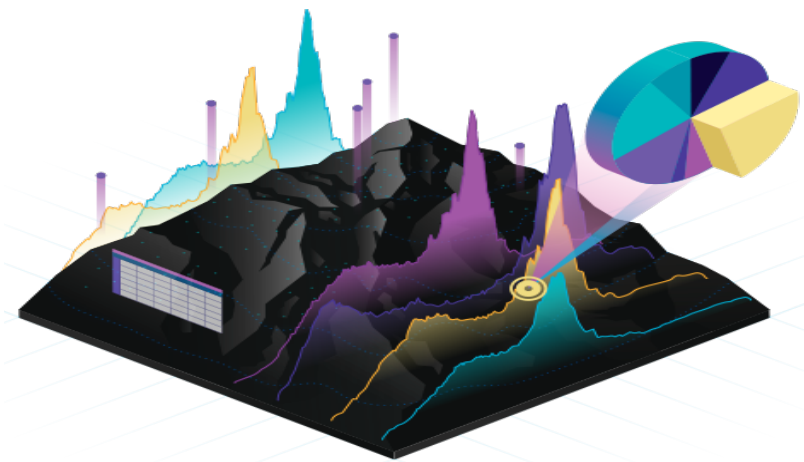
WHAT IS BIM ?

BIM (Building ***Information*** Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure.

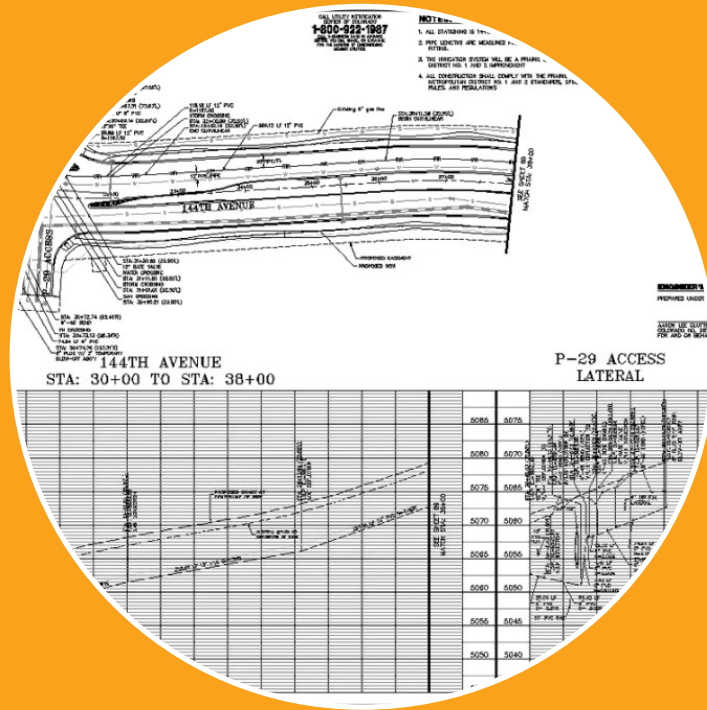


WHAT IS GIS ?

GIS (Geographic ***Information*** System) is a framework to organize, communicate, and understand the science of our world.



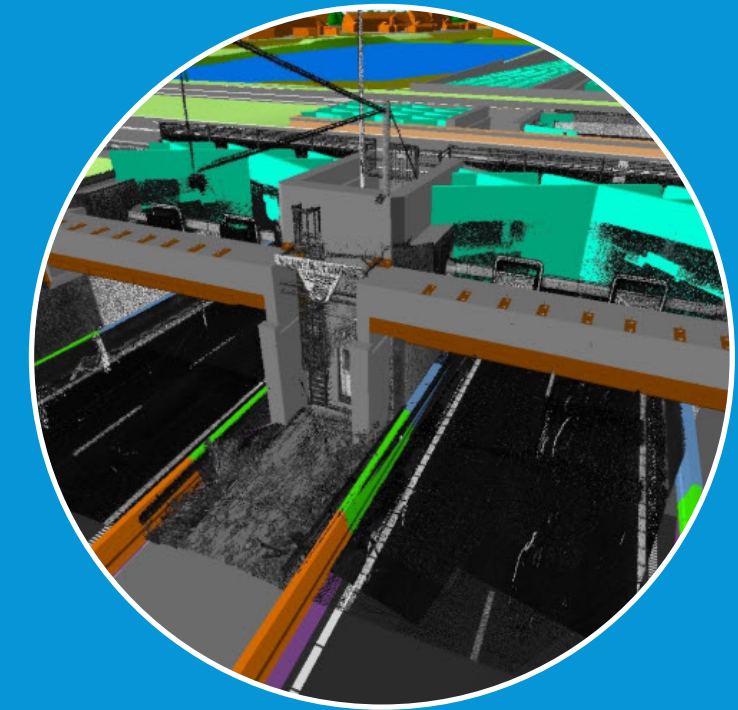
CAD vs GIS vs BIM



CAD
2D/3D Drawing
Geometry



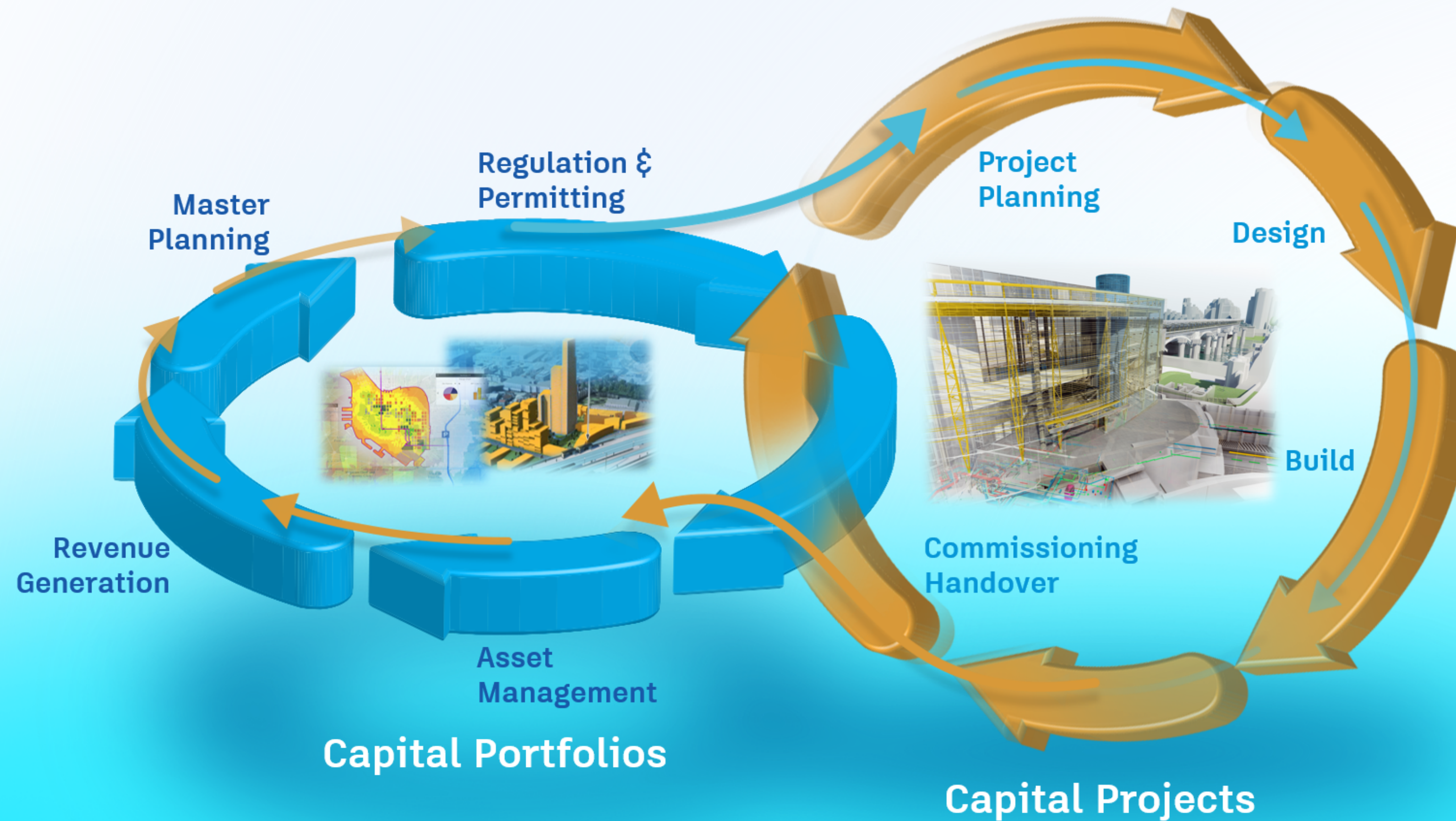
GIS
Geometry
Table



BIM
Geometry
3D Parametric Model

DESIGN INFRASTRUCTURE

GIS Informs BIM - BIM Fuels GIS



Autodesk Solutions for GIS



 **AUTOCAD MAP 3D**

 **AUTOCAD MAP 3D**

 **AUTOCAD RASTER DESIGN**

 **AUTOCAD RASTER DESIGN**

 **INFRAWORKS**

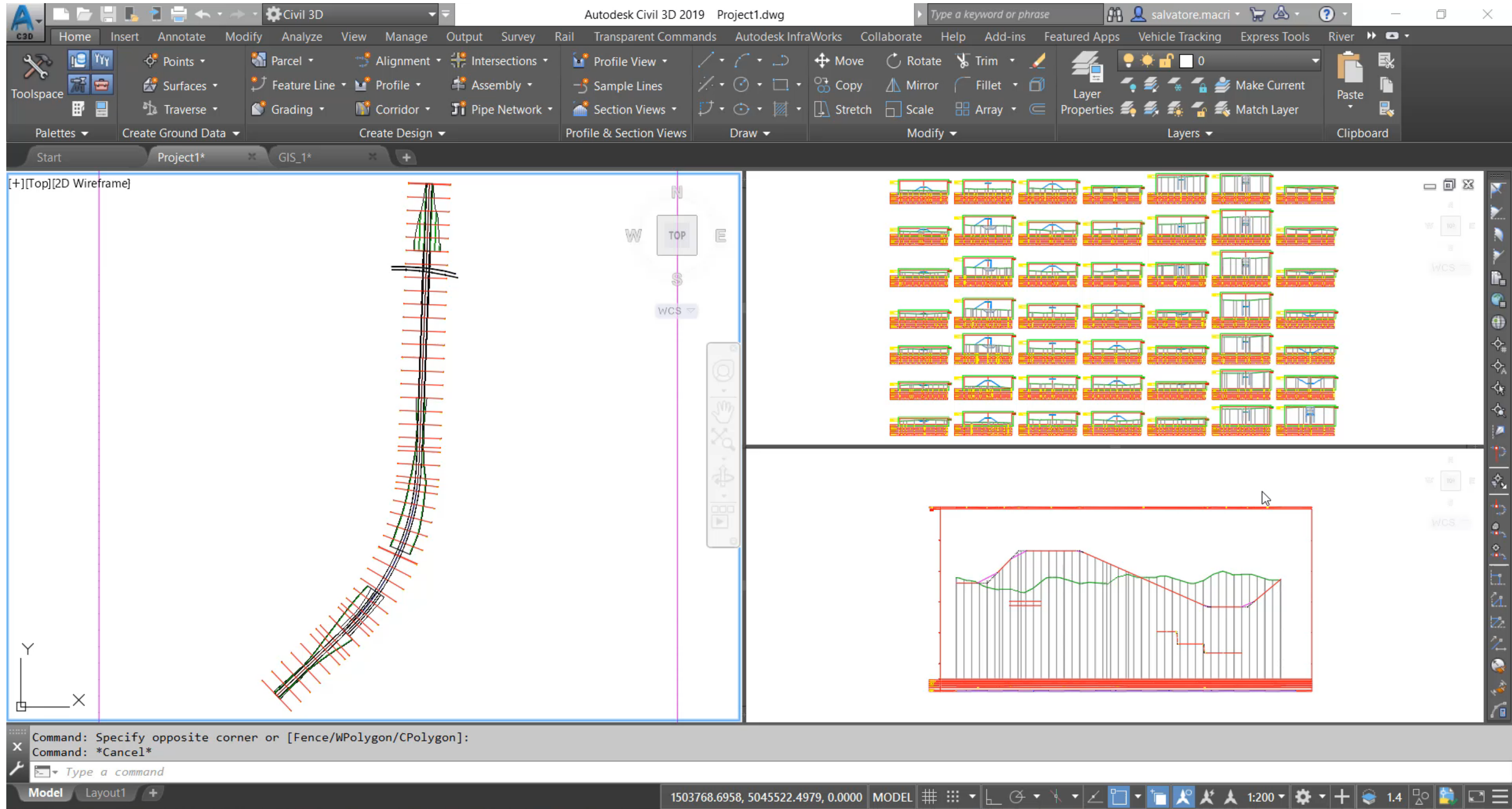
 **AUTODESK® CIVIL 3D®**

GIS for Civil Design

Main knowledge

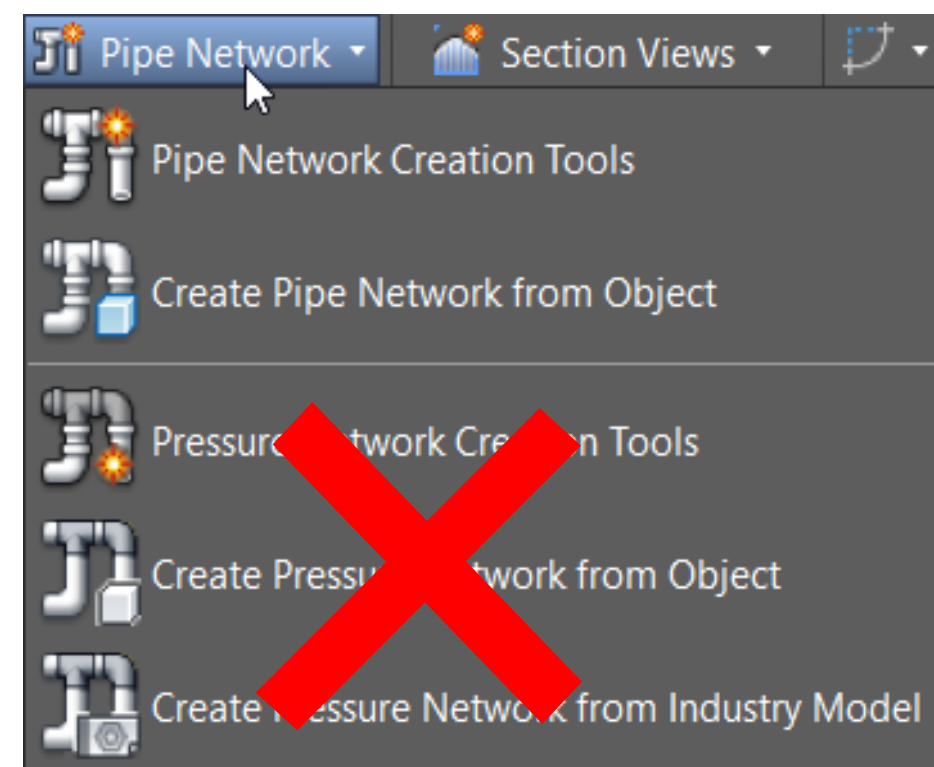


1 – Alignment as spatial reference



C3D Object as SDF

Gravity Pipes



Schema

☐ Civil_Schema

☐ Alignments

☐ Parcels

☐ Pipes

☐ Points

☐ Structures

Alignment

Parcel

Points

SDF vs SHP



Spatial Data File based on SQLite3 developed by Autodesk is a single-user geodatabase file format.

Multy Geometry: Point, Line, Areas or combination in the same structure

One file

Name	Status	Date modified	Type	Size
Buffer500.sdf	✔ 🔒	17/03/2019 01:24	Autodesk Spatial ...	350 KB
Corridor.sdf	✔ 🔒	17/03/2019 00:23	Autodesk Spatial ...	400 KB
Expropriation.sdf	✔ 🔒	17/03/2019 01:05	Autodesk Spatial ...	450 KB
ExpropriationRun.sdf	✔ 🔒	19/03/2019 12:32	Autodesk Spatial ...	450 KB
Lombardia.sdf	✔ 🔒	14/03/2019 14:20	Autodesk Spatial ...	2,200 KB
MainAlignment.sdf	✔ 🔒	16/03/2019 23:50	Autodesk Spatial ...	950 KB
Parcels.sdf	✔ 🔒	17/03/2019 00:35	Autodesk Spatial ...	350 KB
Trees.sdf	✔ 🔒	16/03/2019 23:56	Autodesk Spatial ...	350 KB



ESRI Shapefile format

Only Point or Line or Areas

3 Mandatory Files: SHP, SHX, DBF

Additional files: PRJ, sbx; .atx; .fbn; .fbx; .ain; .aih; .ixs; .mxs; xml; cpg.

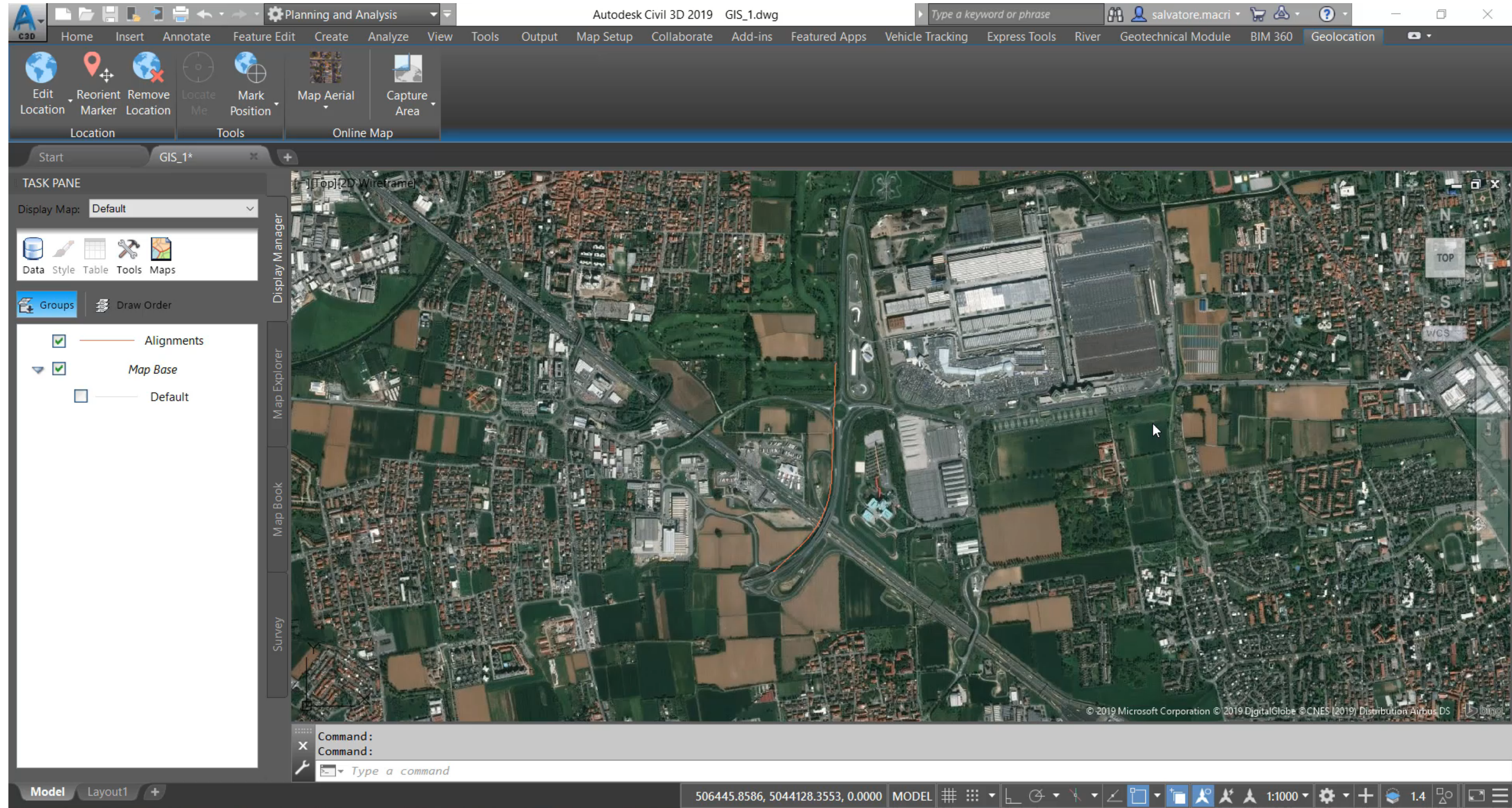
Name	Status	Date modified	Type	Size
Houses.dbf	✔ 🔒	14/03/2019 15:13	DBF File	592,799 KB
Houses.idx	✔ 🔒	09/05/2019 10:43	IDX File	32,104 KB
Houses.prj	✔ 🔒	14/03/2019 15:12	PRJ File	1 KB
Houses.qpj	✔ 🔒	14/03/2019 15:12	QPJ File	1 KB
Houses.shp	✔ 🔒	14/03/2019 15:13	AutoCAD Shape S...	201,517 KB
Houses.shx	✔ 🔒	14/03/2019 15:13	AutoCAD Compile...	4,855 KB
Municipality.dbf	✔ 🔒	14/03/2019 15:09	DBF File	2,765 KB
Municipality.idx	✔ 🔒	09/05/2019 10:41	IDX File	138 KB
Municipality.prj	✔ 🔒	14/03/2019 15:09	PRJ File	1 KB
Municipality.qpj	✔ 🔒	14/03/2019 15:09	QPJ File	1 KB
Municipality.shp	✔ 🔒	14/03/2019 15:09	AutoCAD Shape S...	14,875 KB
Municipality.shx	✔ 🔒	14/03/2019 15:09	AutoCAD Compile...	38 KB
Municipality_Polygon.dbf	✔ 🔒	14/03/2019 17:01	DBF File	377 KB
Municipality_Polygon.idx	✔ 🔒	09/05/2019 10:41	IDX File	47 KB
Municipality_Polygon.prj	✔ 🔒	14/03/2019 17:01	PRJ File	1 KB
Municipality_Polygon.qpj	✔ 🔒	14/03/2019 17:01	QPJ File	1 KB
Municipality_Polygon.shp	✔ 🔒	14/03/2019 17:01	AutoCAD Shape S...	7,936 KB
Municipality_Polygon.shx	✔ 🔒	14/03/2019 17:01	AutoCAD Compile...	13 KB

1

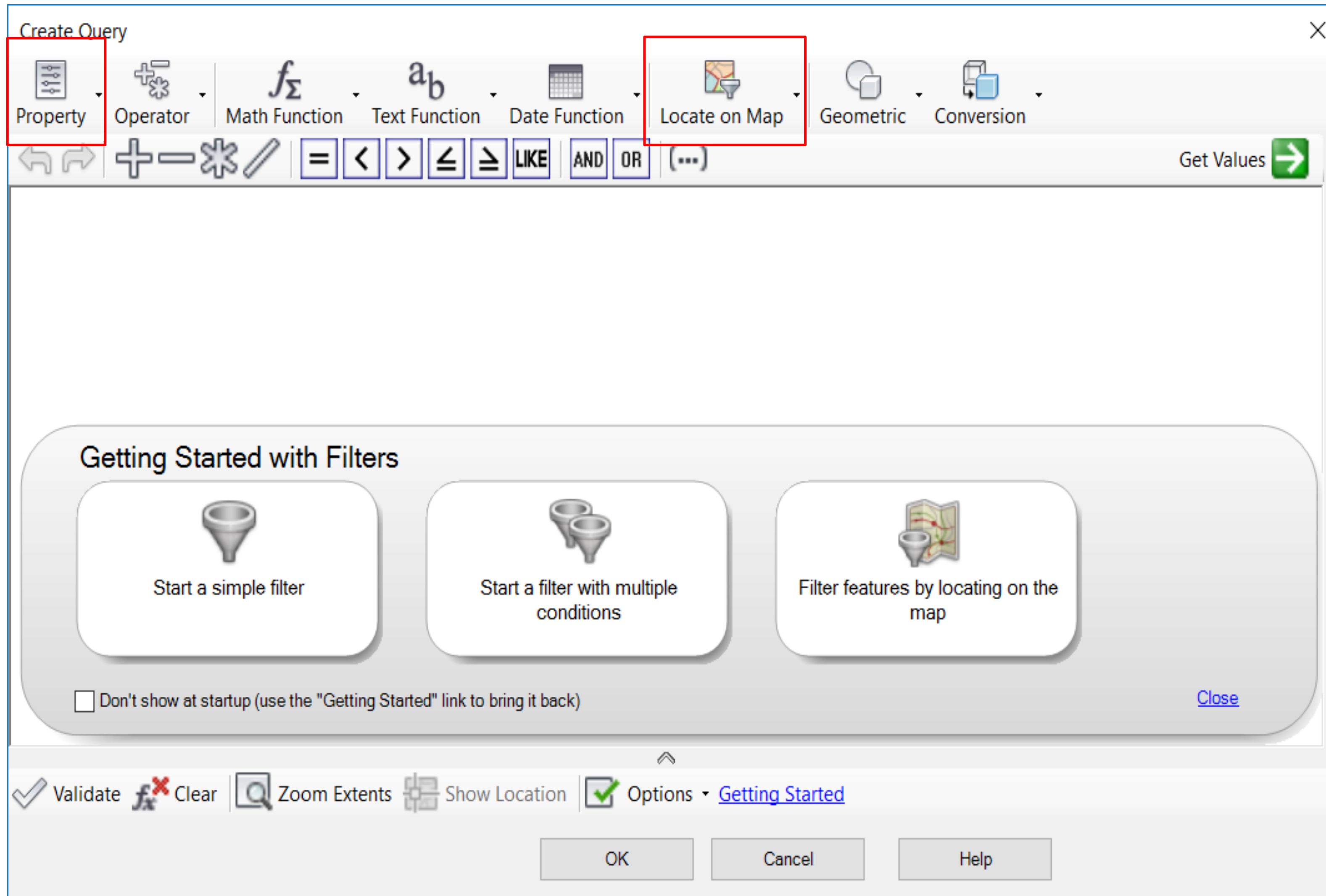
2

3

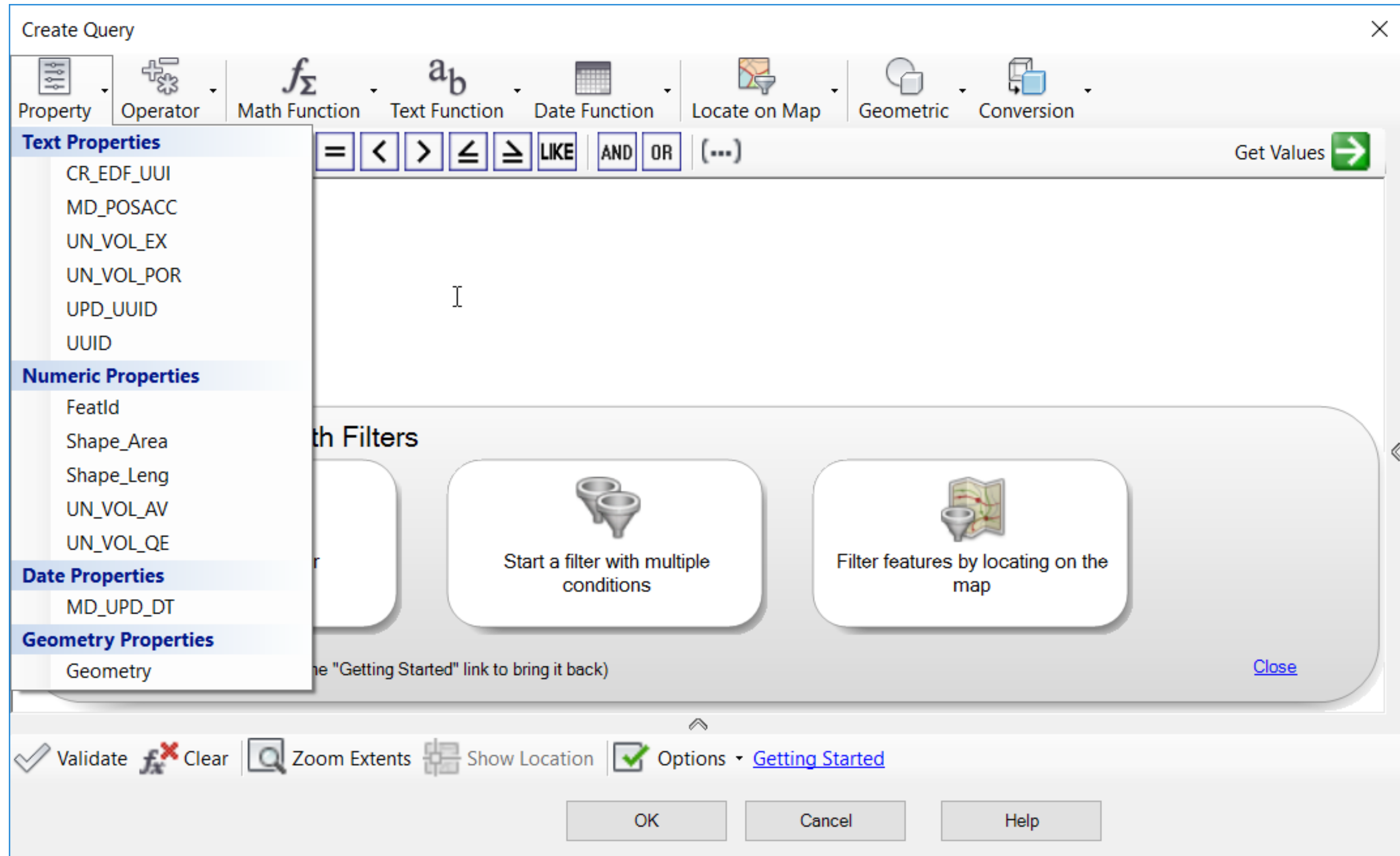
2 – Connect Existing GIS Layer



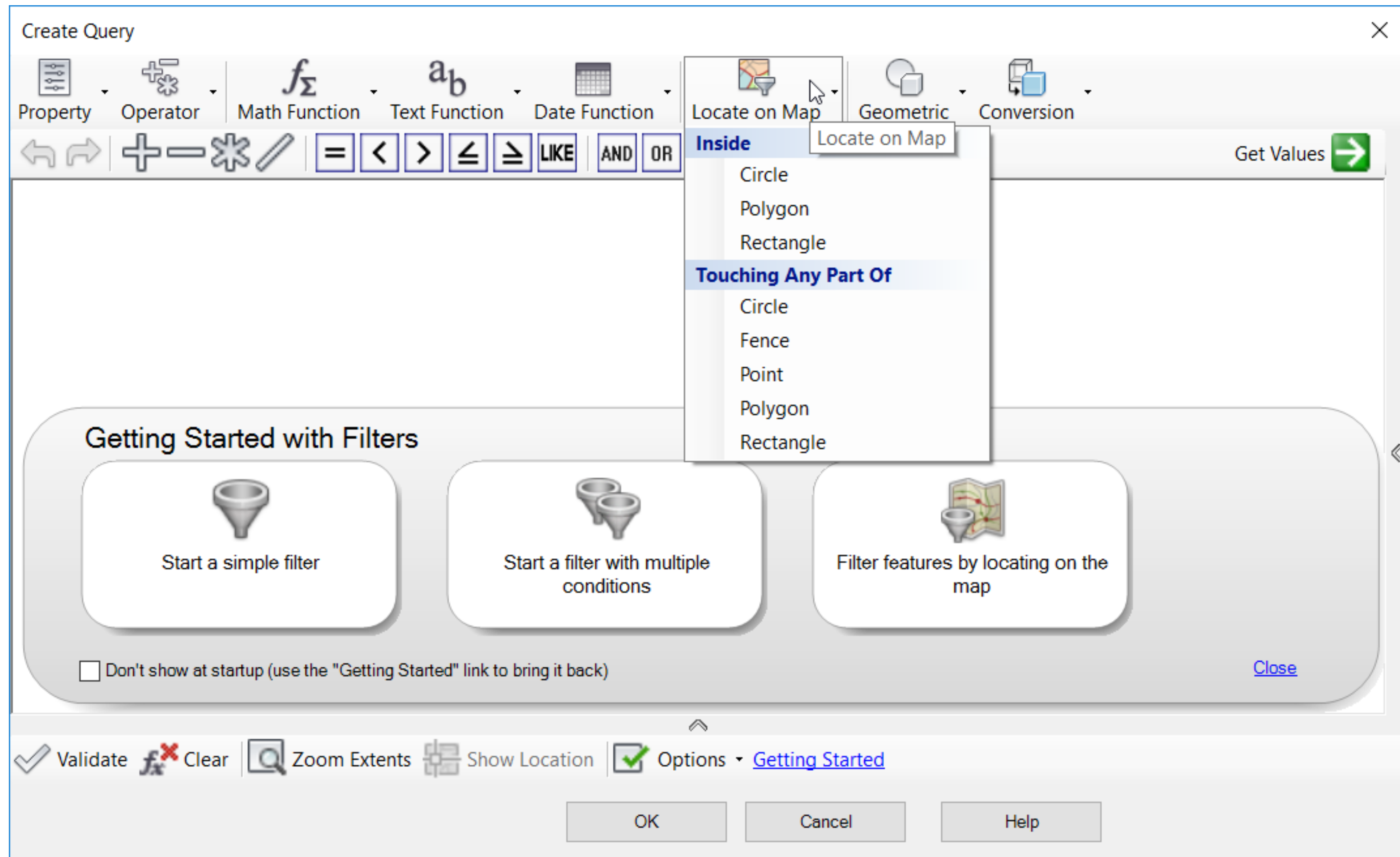
3 – Filter Data



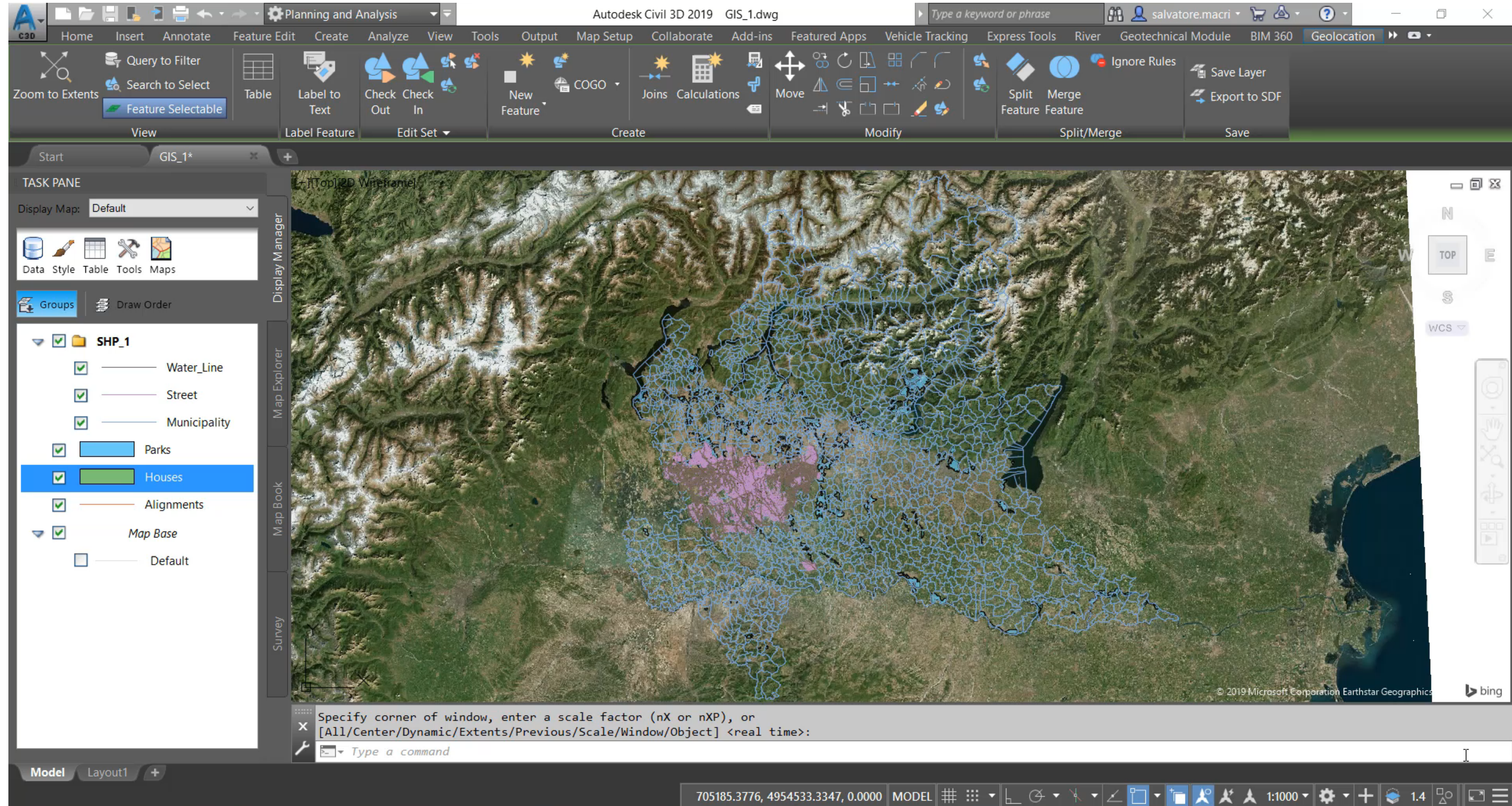
3 – Filter Data – Attribute based



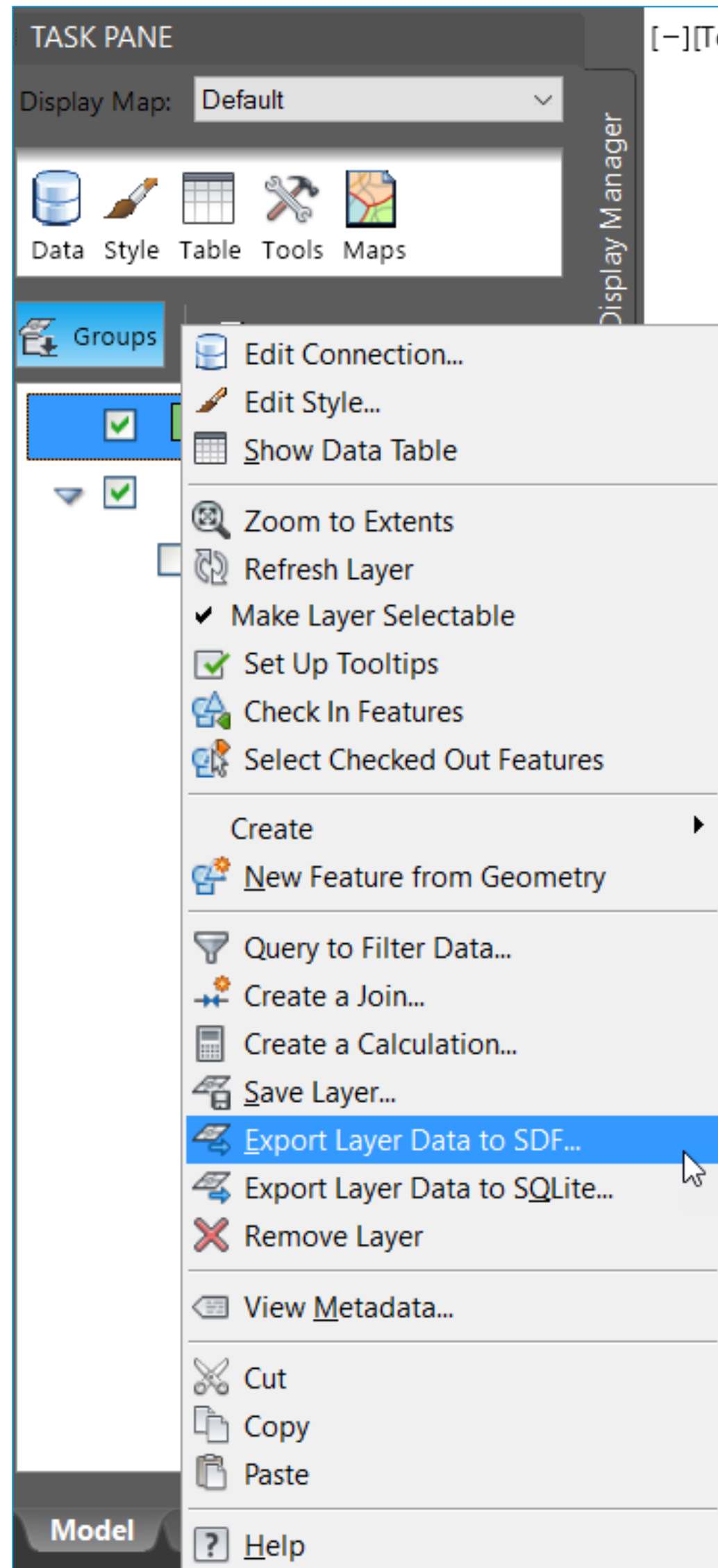
3 – Filter Data – Spatial Query



3 – Filter Data – Spatial Query

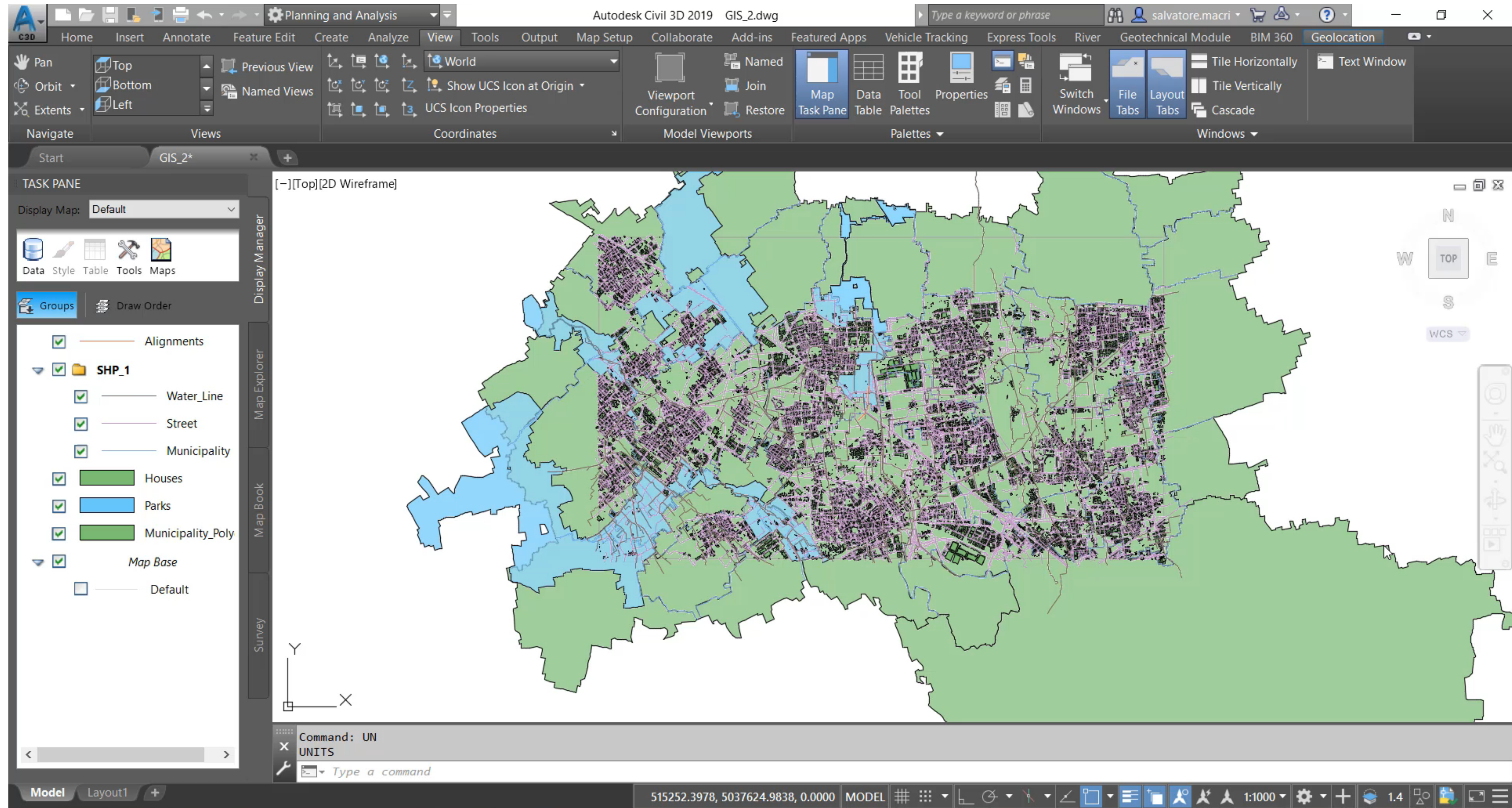


3 – Filter Data – Spatial Query

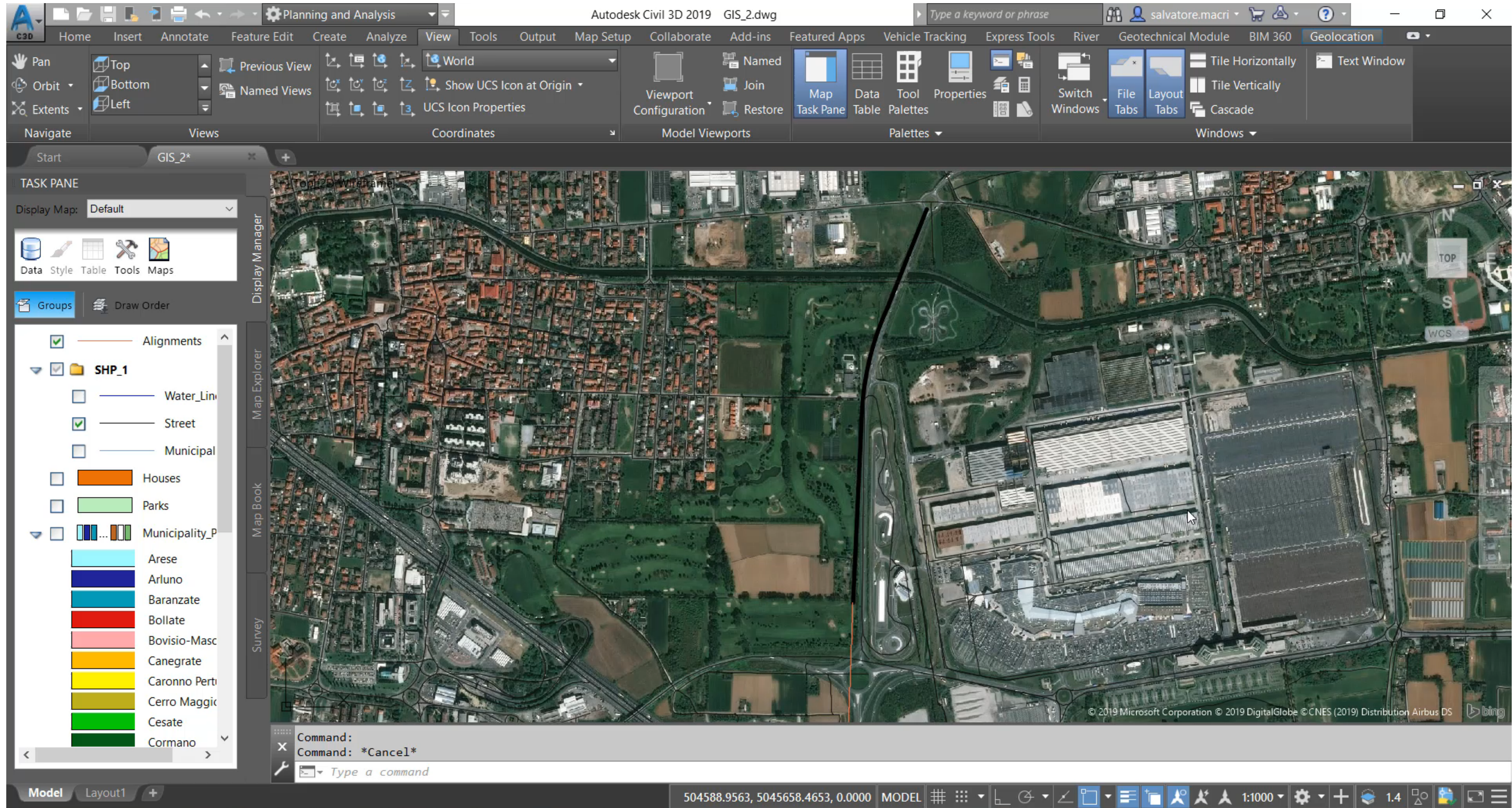


Query data is
always active

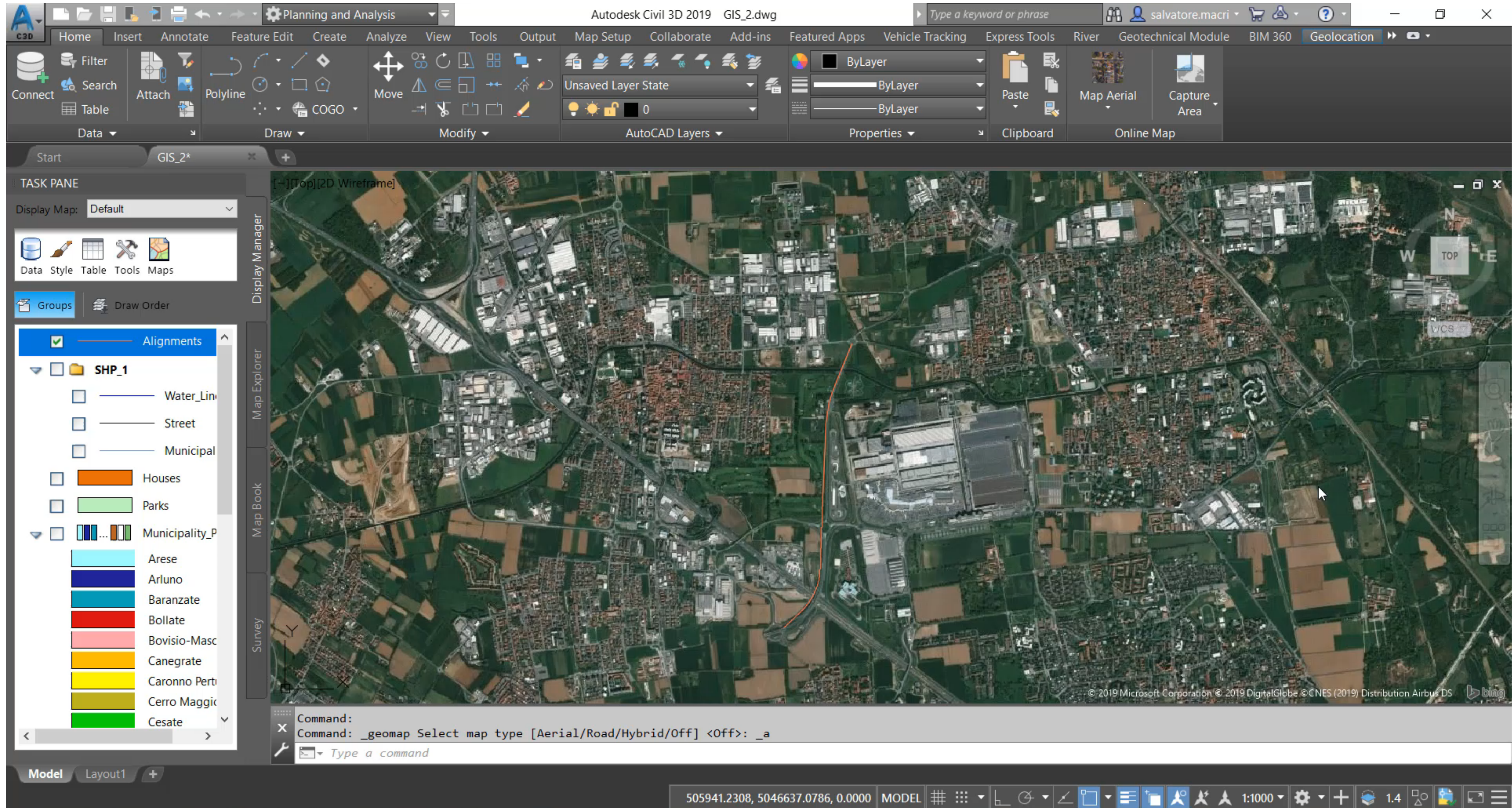
4 – Thematic Map



5 – Edit Layer



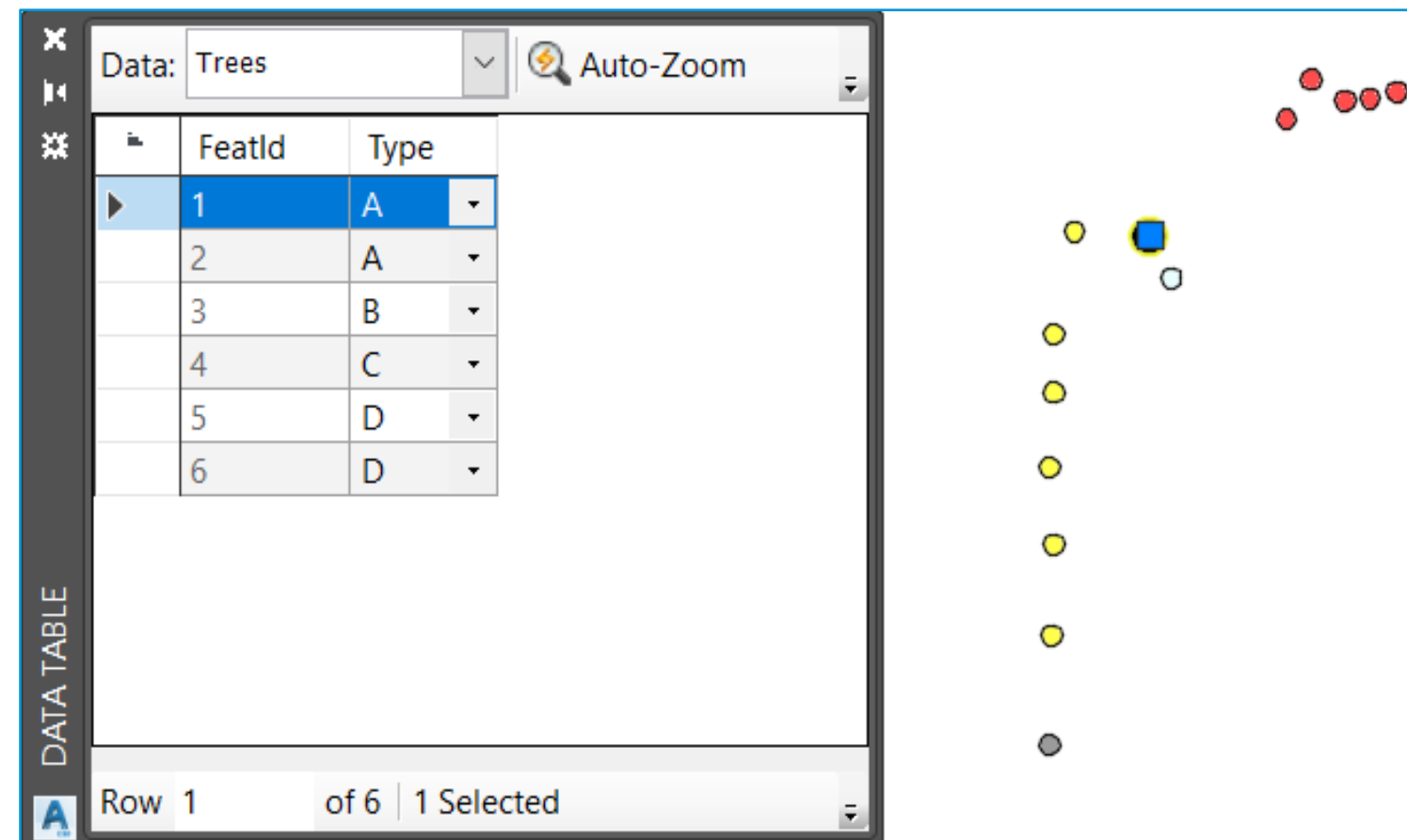
6 – New Layer from scratch



6 – New Layer from scratch

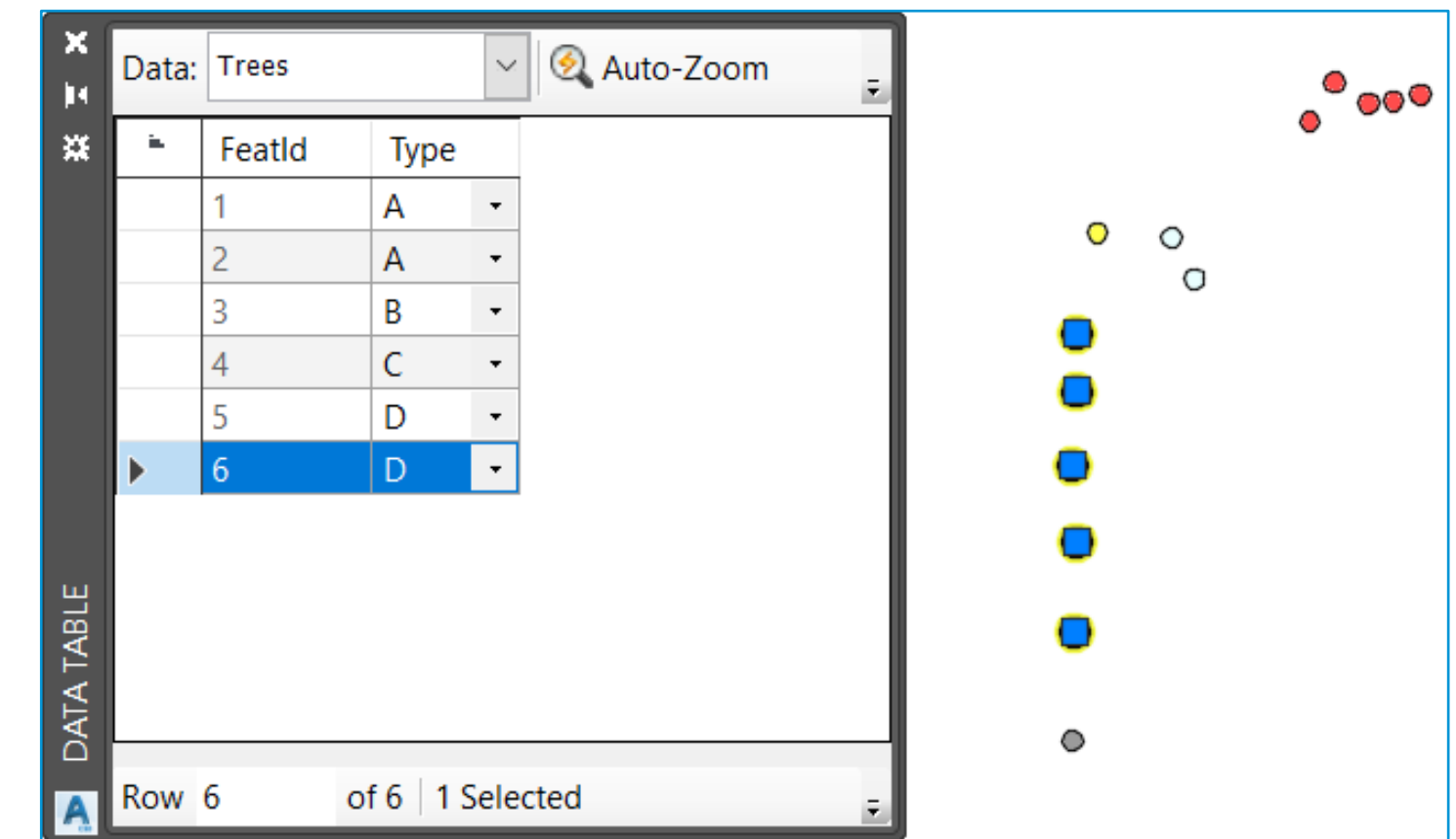
Single part vs Multipart

Single Part



1 geometry
=
1 record

Multi Part



1 geometry
=
n records

7 – Layer Files

The screenshot displays the Autodesk Civil 3D 2019 software interface. The title bar indicates the file is 'GIS_2.dwg'. The ribbon includes tabs for Planning and Analysis, Home, Insert, Annotate, Feature Edit, Create, Analyze, View, Tools, Output, Map Setup, Collaborate, Add-ins, Featured Apps, Vehicle Tracking, Express Tools, River, Geotechnical Module, BIM 360, and Geolocation. The left-hand side contains the TASK PANE with sections for Display Map (Default), Groups, Draw Order, Map Explorer, Map Book, and Survey. The main workspace shows a 2D wireframe view of a map with several colored points (red, blue, yellow, green) and a red line. The bottom status bar shows coordinates (503264.6298, 5045903.3187, 0.0000), the current layer (MODEL), and a scale of 1:1000. The command line at the bottom shows the command '_qnew'.

Autodesk Civil 3D 2019 GIS_2.dwg

Planning and Analysis

Home Insert Annotate Feature Edit Create Analyze View Tools Output Map Setup Collaborate Add-ins Featured Apps Vehicle Tracking Express Tools River Geotechnical Module BIM 360 Geolocation

Connect Filter Search Attach Polyline COGO Move

Data Draw Modify

Unsaved Layer State

AutoCAD Layers

ByLayer

Properties

Clipboard

Online Map

Start GIS_2* Drawing2*

TASK PANE

Display Map: Default

Data Style Table Tools Maps

Groups Draw Order

Threes

A B C D

Alignments

SHP_1

Water_Line

Street

Municipality

Houses

Parks

Municipality_Poly

Map Base

Default

Map Explorer

Map Book

Survey

[~][Top][2D Wireframe]

Y X

Data: Threes

Auto-Zoom Auto-Scroll

Filter by: Apply Filter

FeatId	Type
1	A
2	B
3	D
4	C
5	B
6	D

Row of 6 0 Selected Search to Select Options

Command: _qnew

Command:

Type a command

Model Layout1

503264.6298, 5045903.3187, 0.0000 MODEL 1:1000

7 – Layer Files

```
Trees.layer - Notepad
File Edit Format View Help

<?xml version="1.0" encoding="utf-8"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <rdf:Description rdf:about="Trees:Trees">
    <ns0:FeatureSource xmlns:ns0="http://www.autodesk.com/gis/resource/definitions/"
rdf:resource="fsd://Trees" />
  </rdf:Description>
  <rdf:Description rdf:about="Trees:Trees">
    <rdf:type
rdf:resource="http://www.autodesk.com/gis/resource/
</rdf:Description>
  <rdf:Description rdf:about="Trees:Trees">
    <ns0:name xmlns:ns0="http://www.autodesk.com/gi
rdf:parseType="Literal">Trees</ns0:name>
  </rdf:Description>
  <rdf:Description rdf:about="Trees:Trees">
    <ns0:isURL xmlns:ns0="http://www.autodesk.com/g
rdf:parseType="Literal">no</ns0:isURL>
  </rdf:Description>
  <rdf:Description rdf:about="Trees:Trees">
    <ns0:description xmlns:ns0="http://www.autodesk
xml:lang="en" rdf:parseType="Literal"></ns0:descrip
  </rdf:Description>
```

```
</rdf:Description>
<rdf:Description rdf:about="fsd://Trees">
  <ns0:description xmlns:ns0="http://www.autodesk.com/gis/resource/definitions/"
xml:lang="en" rdf:parseType="Literal"></ns0:description>
</rdf:Description>
<rdf:Description rdf:about="fsd://Trees">
  <ns0:FeatureSourceResourceStream
xmlns:ns0="http://www.autodesk.com/gis/resource/definitions/" xml:lang="en"
rdf:parseType="Literal">
    <FeatureSource xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="FeatureSource-1.0.0.xsd" version="1.0.0">
      <Provider>OSGeo.SDF.3.0</Provider>
      <Parameter>
        <Name>File</Name>
        <Value>C:\_ODrive\OneDrive - autodesk\EVENT\OTx2019\DataSet\SDF\Trees.sdf</Value>
      </Parameter>
      <Parameter>
        <Name>ReadOnly</Name>
        <Value>false</Value>
      </Parameter>
    <ConfigurationDocument></ConfigurationDocument>
  </LongTransaction>
```


8 – SDF to SHP

Autodesk Civil 3D 2019 GIS_2.dwg

Geolocation

Query to Filter
Search to Select
Feature Selectable
Table
Label to Text
Check Out
Check In
New Feature
COGO
Joins
Calculations
Move
Split Feature
Merge Feature
Ignore Rules
Save Layer
Export to SDF

TASK PANE

Display Map: Default

Data Style Table Tools Maps

Groups Draw Order

Trees

- A
- B
- C
- D

Alignments

SHP_1

- Water_Line
- Street
- Municipality
- Houses
- Parks
- Municipality_Poly

Map Base

- Default

[-][Top][2D Wireframe]

WCS

Data: Trees

Auto-Zoom Auto-Scroll

Filter by: Apply Filter

FeatId	Type
1	A
2	A
3	B
4	C
5	D
6	D

Row 1 of 6 | 0 Search to Select Options

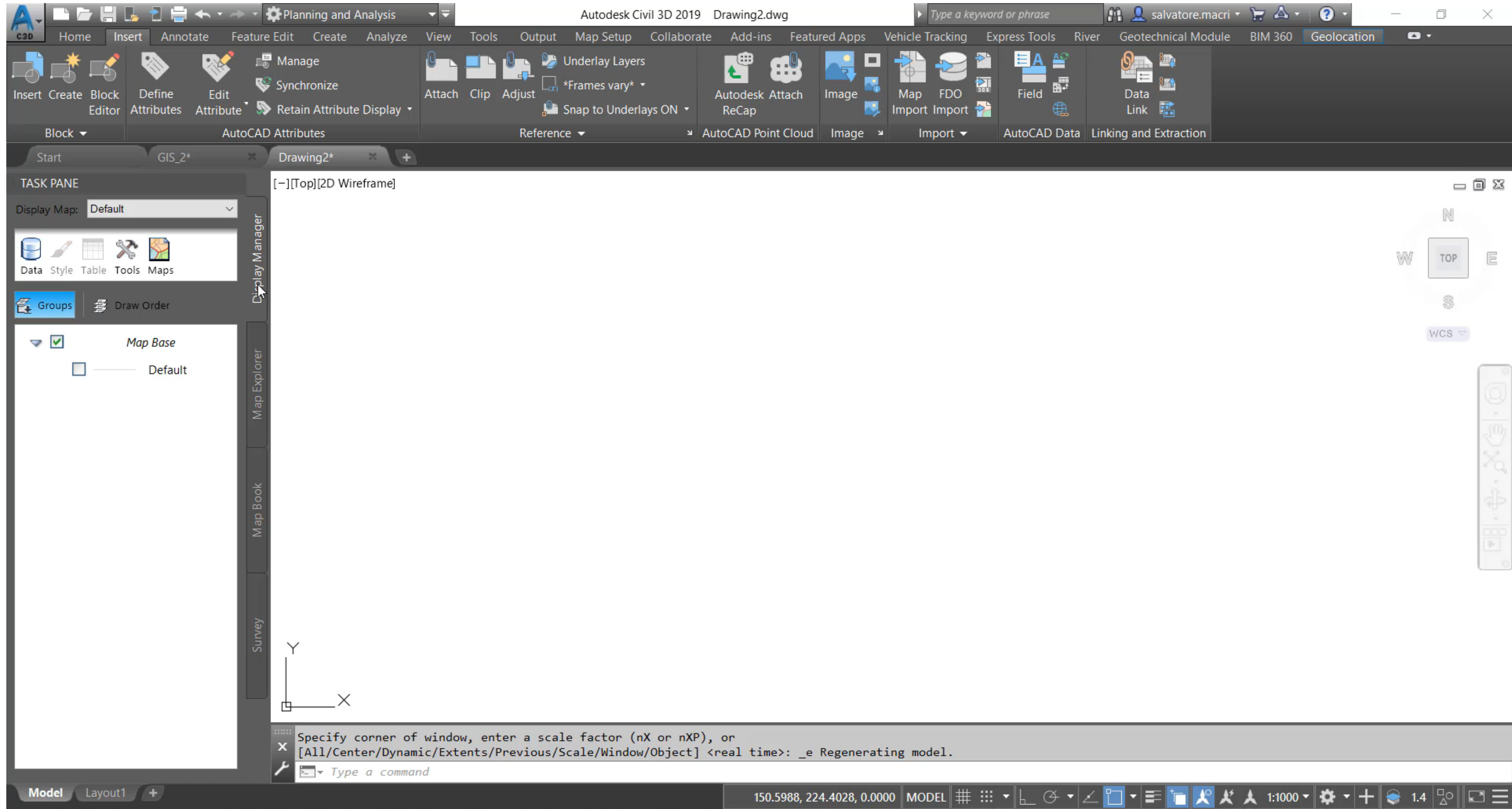
Command: _pasteclip

PASTECLIP Specify insertion point:

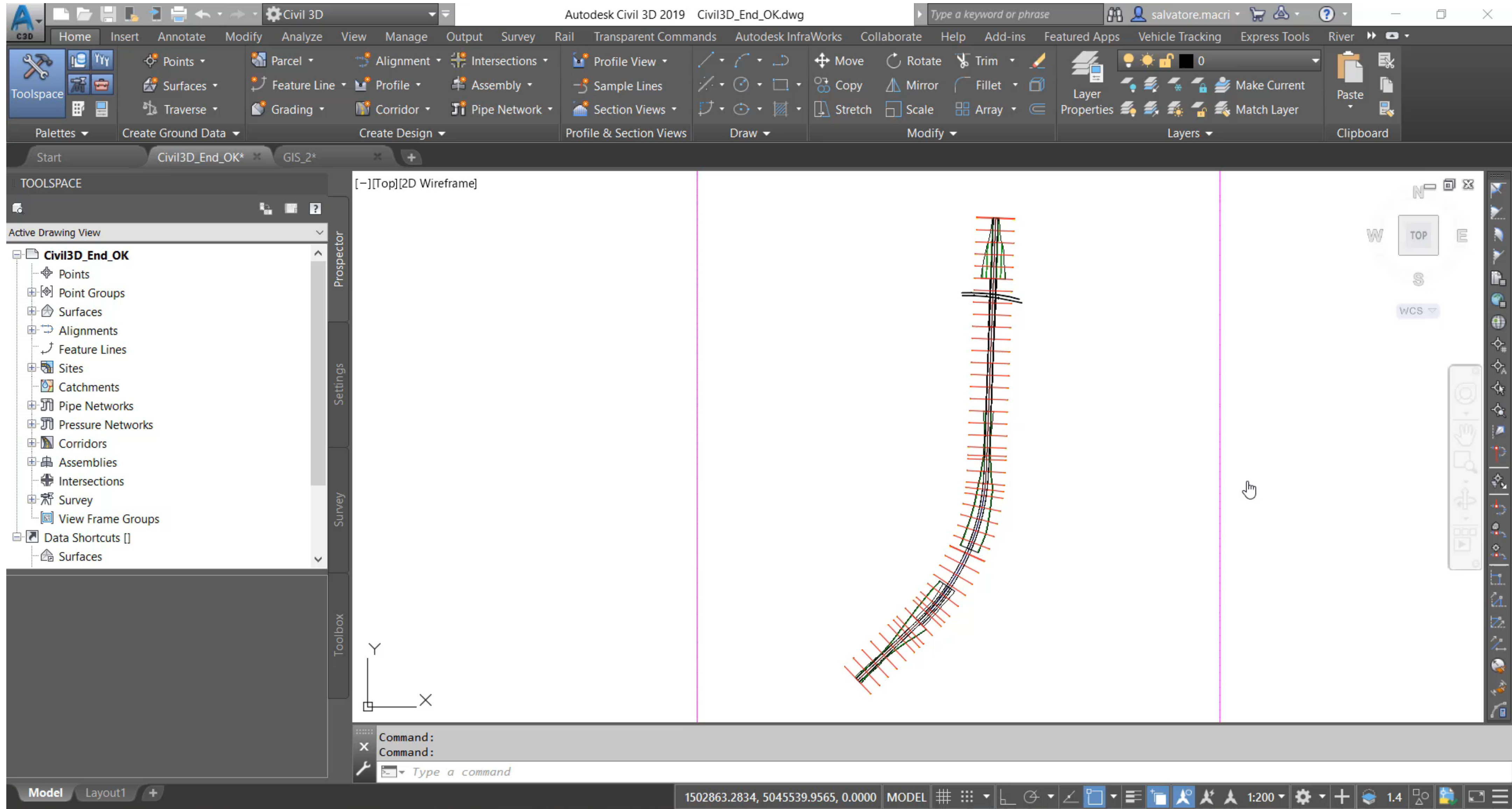
Model Layout1

502429.1110, 5046199.8907, 0.0000 MODEL 1:1000

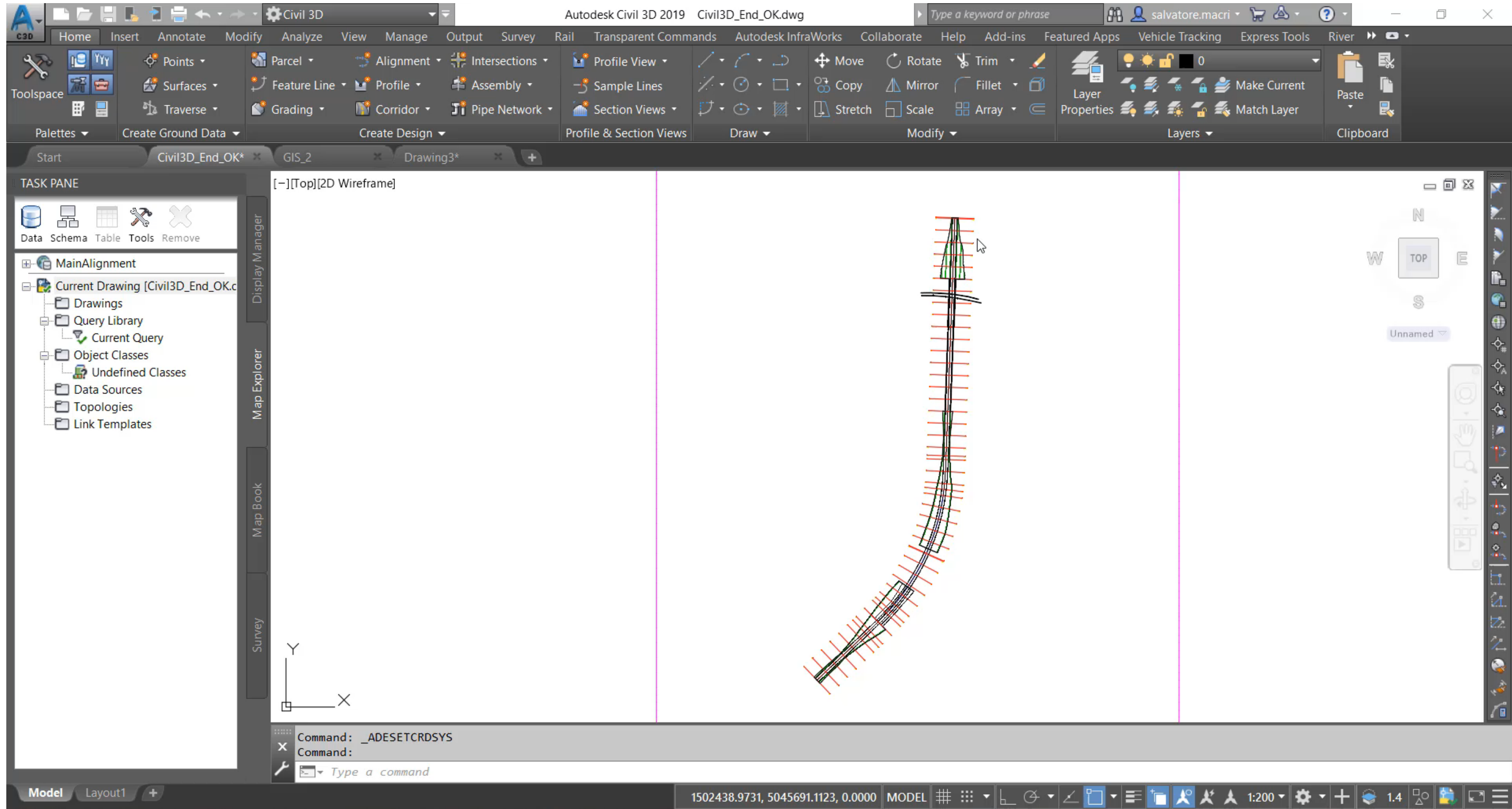
9 – MapImport



10 – MapExport



11 – MapExport + Object Data

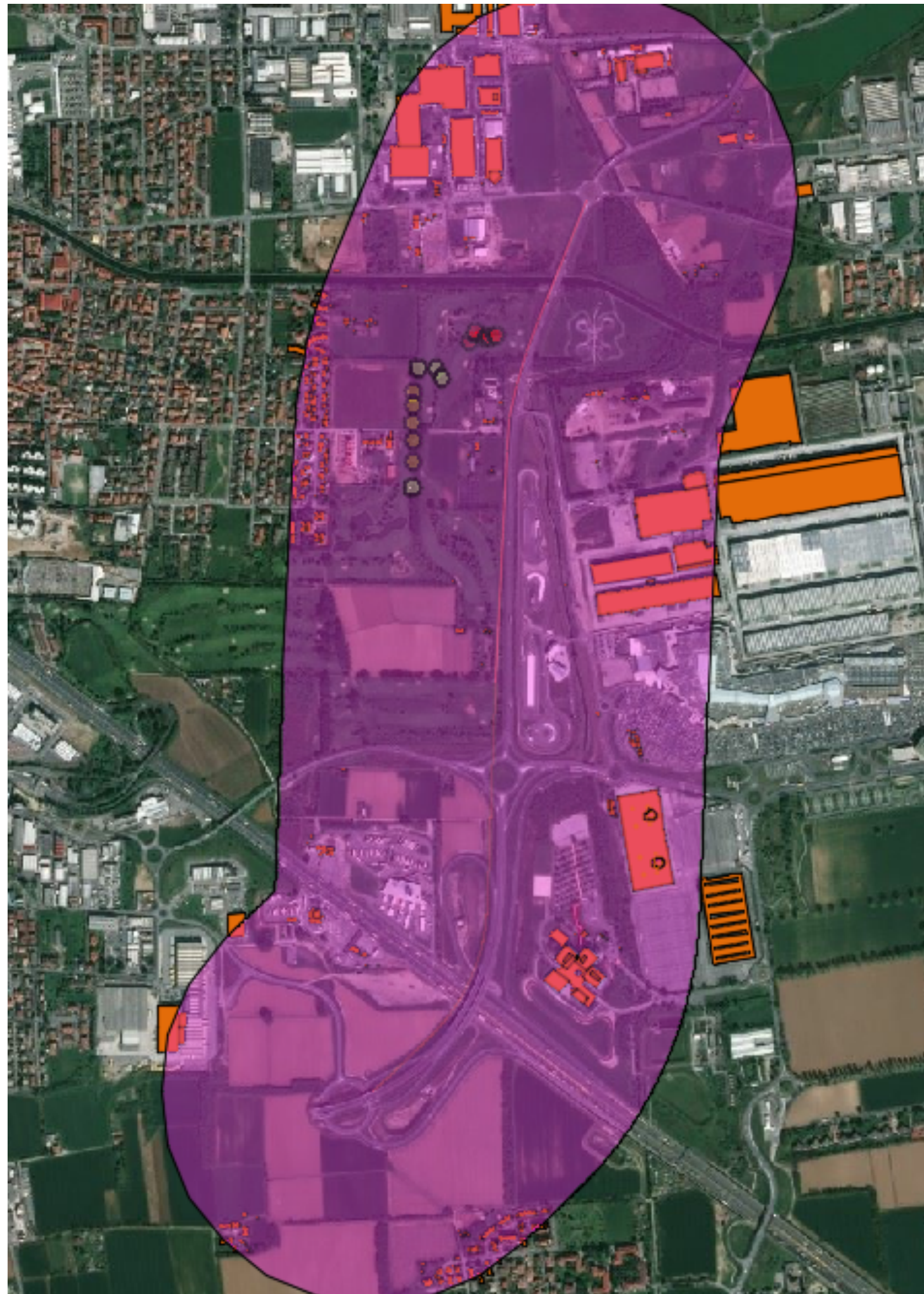


Geoprocessing tools: Buffer

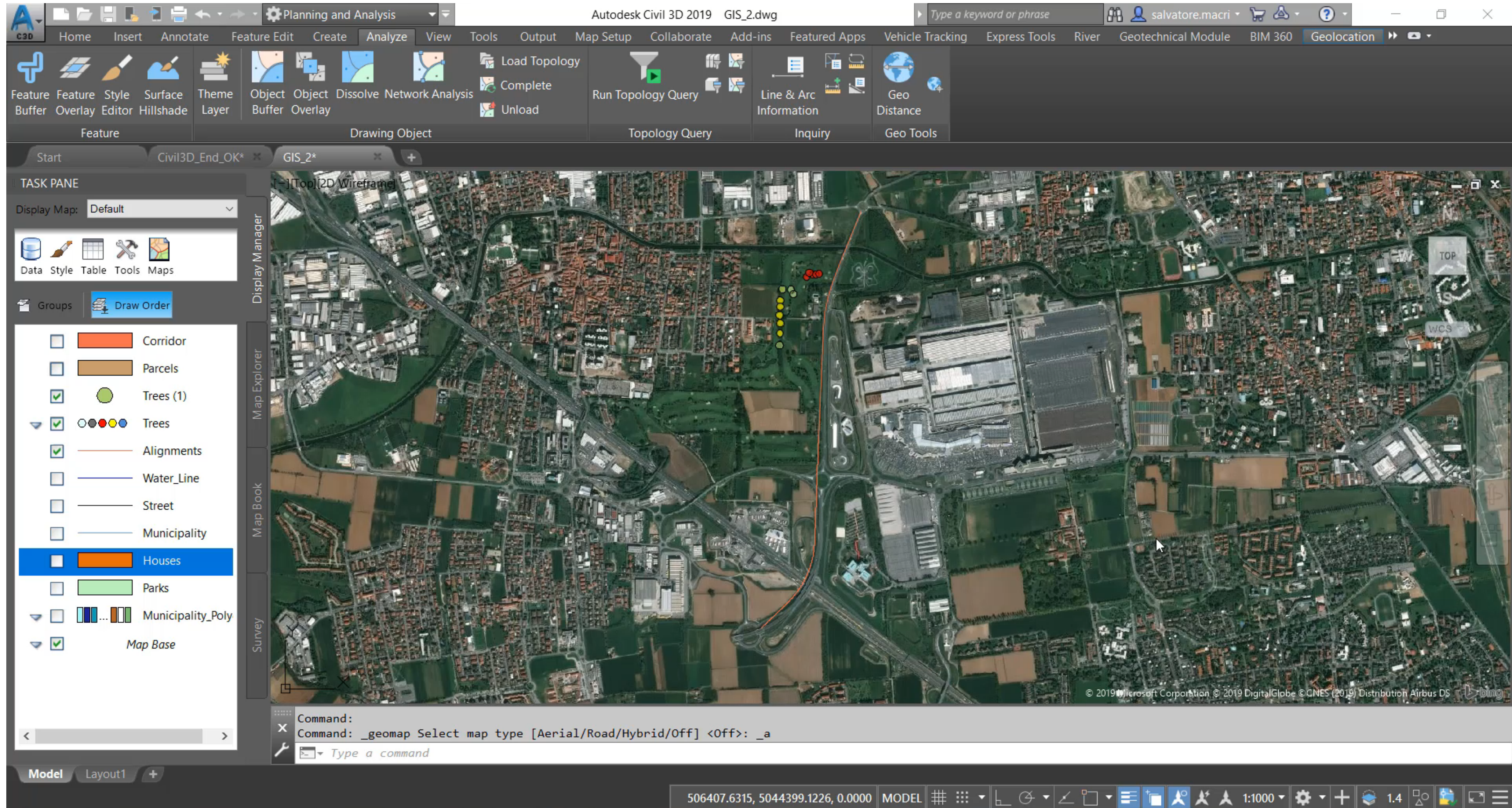
A **buffer** in GIS is a zone around a map feature measured in units of distance or time.

A buffer is useful for proximity analysis

Example: which houses or sensitive target are completely contained inside the area around 100 m measured from the street axis ?



12 – Generic Analysis - Buffer



Geoprocessing Tools: Overlay

Type: Intersect

Line with Line

Line with Polygon

Point with Polygon

Polygon with Polygon

Intersect

Creates features from the overlapping areas of the source and overlay layers. Non-overlapping areas are discarded. Attributes from both the source and overlay are included in the new features.

Type: Union

Polygon with Polygon

Union

Creates features where the geometry of the source and overlay layers intersect. The resulting layer is the sum of the two comparison layers and has the attributes of both the source and overlay features.

Type: Erase

Line with Polygon

Point with Polygon

Polygon with Polygon

Erase

Creates features from the non-intersecting areas of the source and overlay. Only attributes from source are included in new features.

Type: Paste

Polygon with Polygon

Paste

Creates features by pasting the overlay layer onto the source layer. Overlay features become new features in the resulting layer, and areas of the source that do not fall within the geometry of the overlay become features in the resulting layer.

Type: Identity

Line with Polygon

Point with Polygon

Polygon with Polygon

Identity

Creates features from the intersecting areas of the source and overlay layers. Attributes from both the source and overlay are included in the new features.

Type: Clip

Line with Polygon

Point with Polygon

Polygon with Polygon

Clip

Creates features from the overlapping areas of the source and overlay layers. Only attributes from the source are included in the new features.

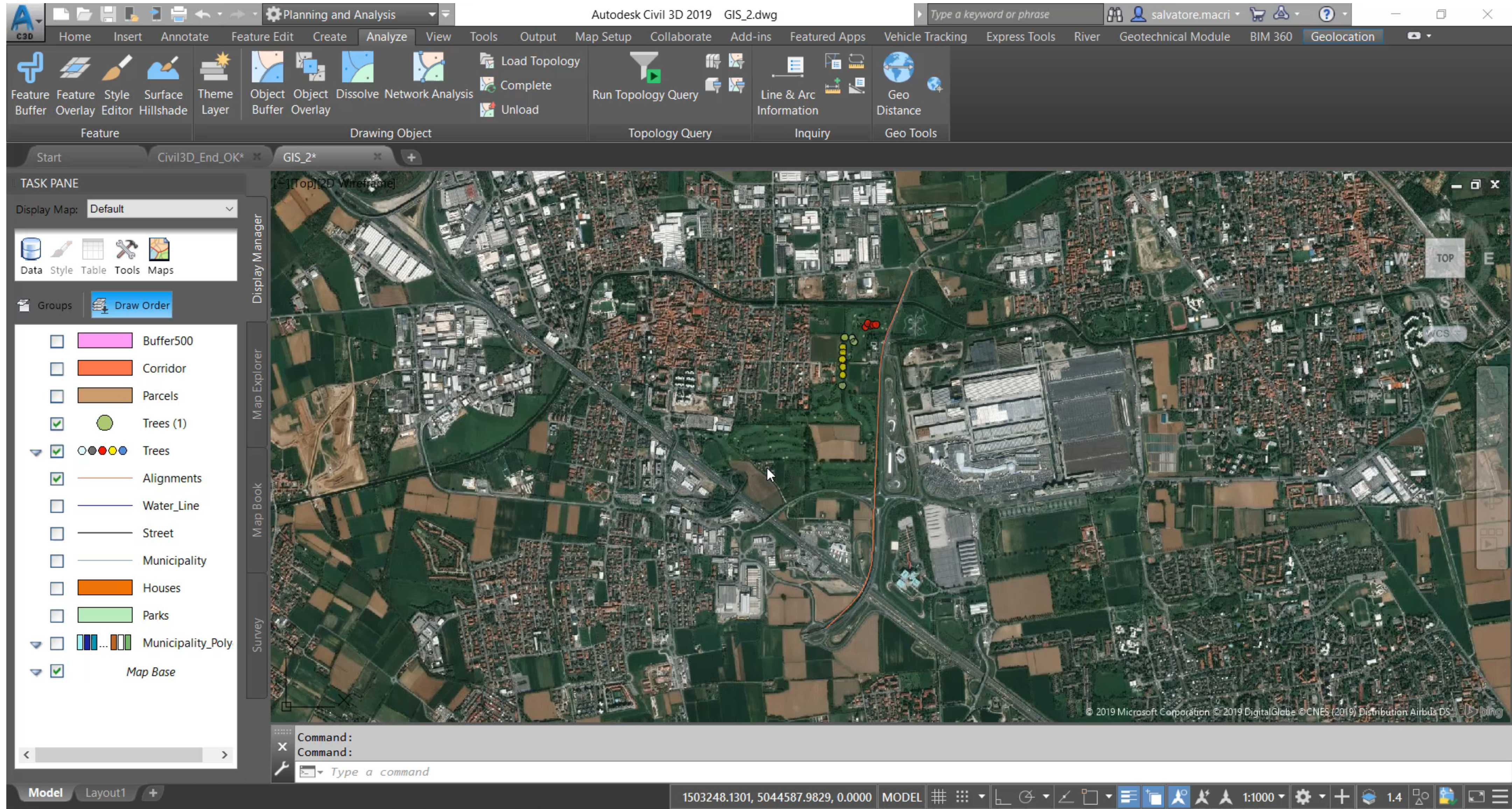
Type: Symmetric Difference

Polygon with Polygon

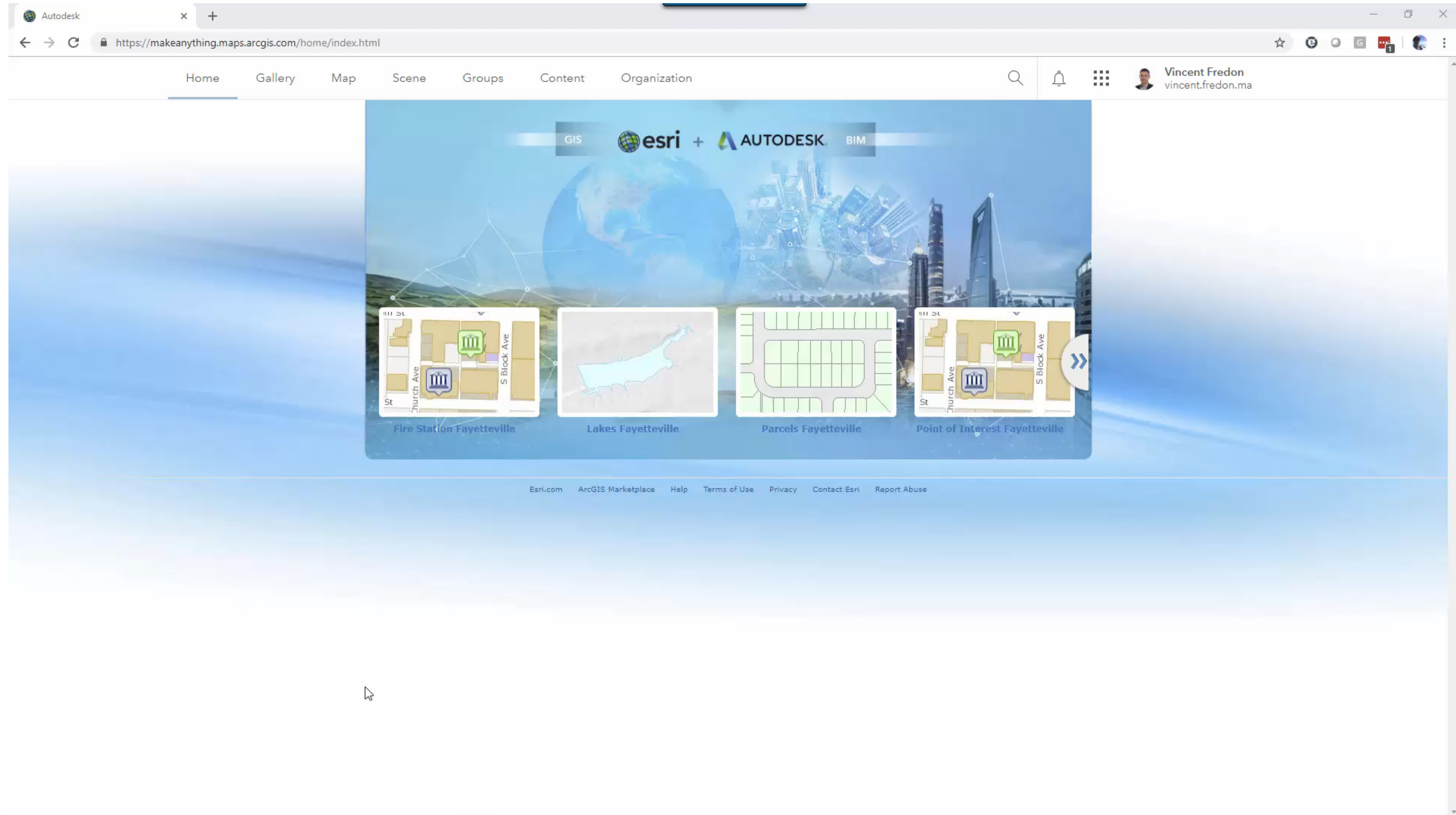
Symmetric Difference

Creates features from the areas of the source and overlay features that do not overlap. Overlapping areas of the features are discarded. In the output layer, features resulting from the source geometry have values for source attributes, but their overlay attribute values are NULL. Features resulting from the overlay geometry have values for overlay attributes, but their source attribute values are NULL.

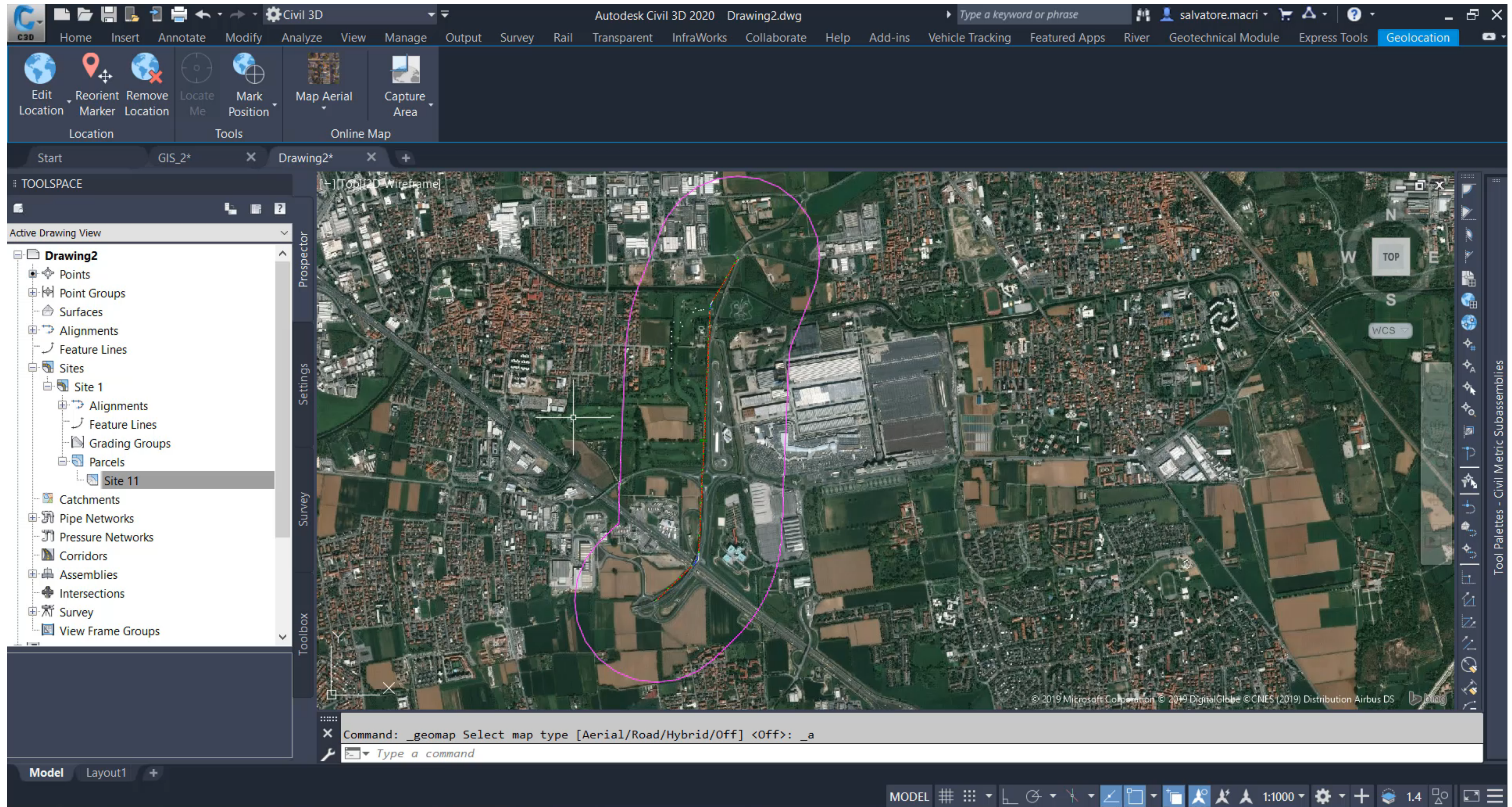
13 – Expropriation Area



14 –ESRI Connection – AGOL to IW



14 – ESRI Connection – C3D to AGOL



ESRI INTEROPERABILITY

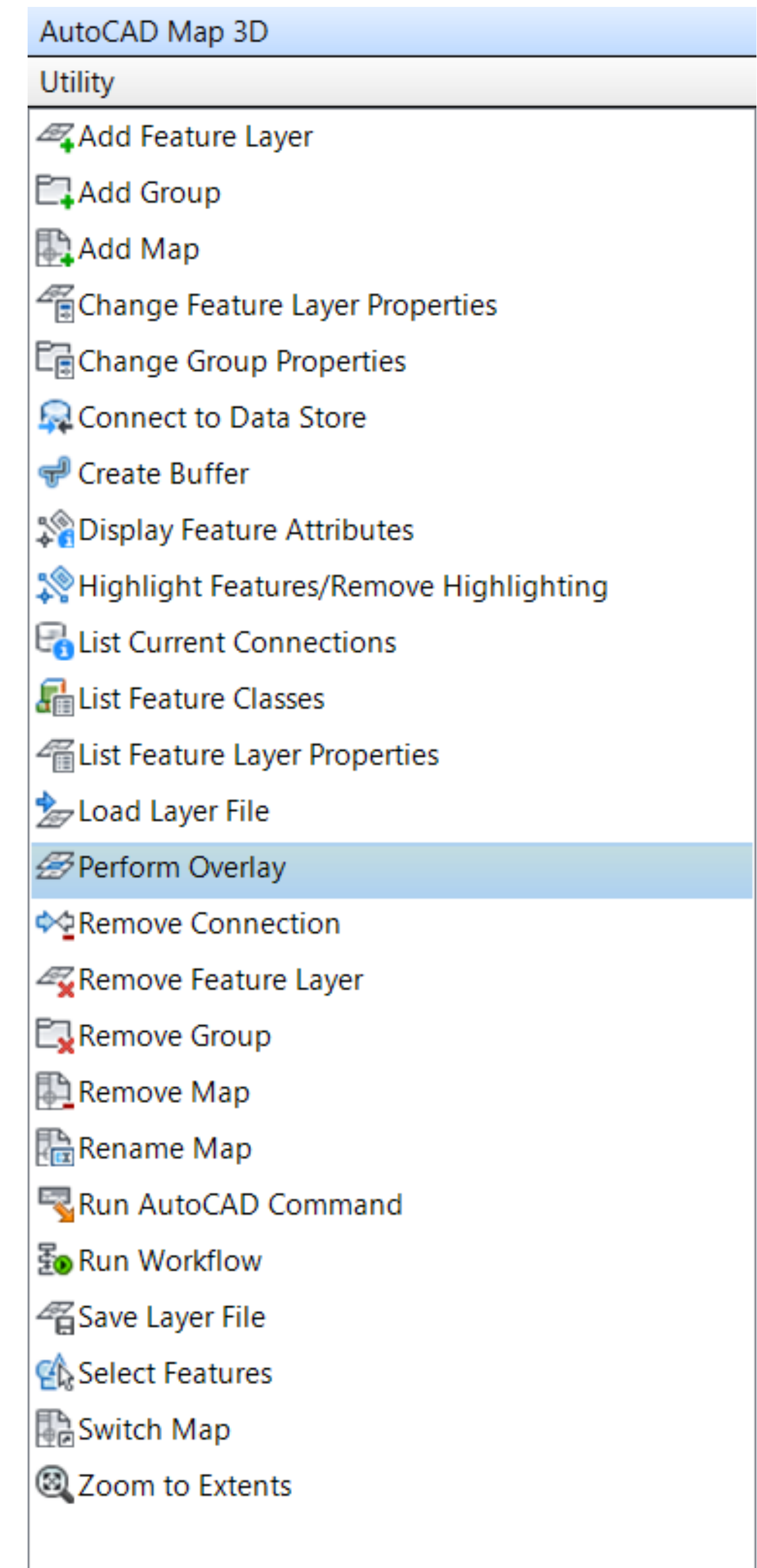
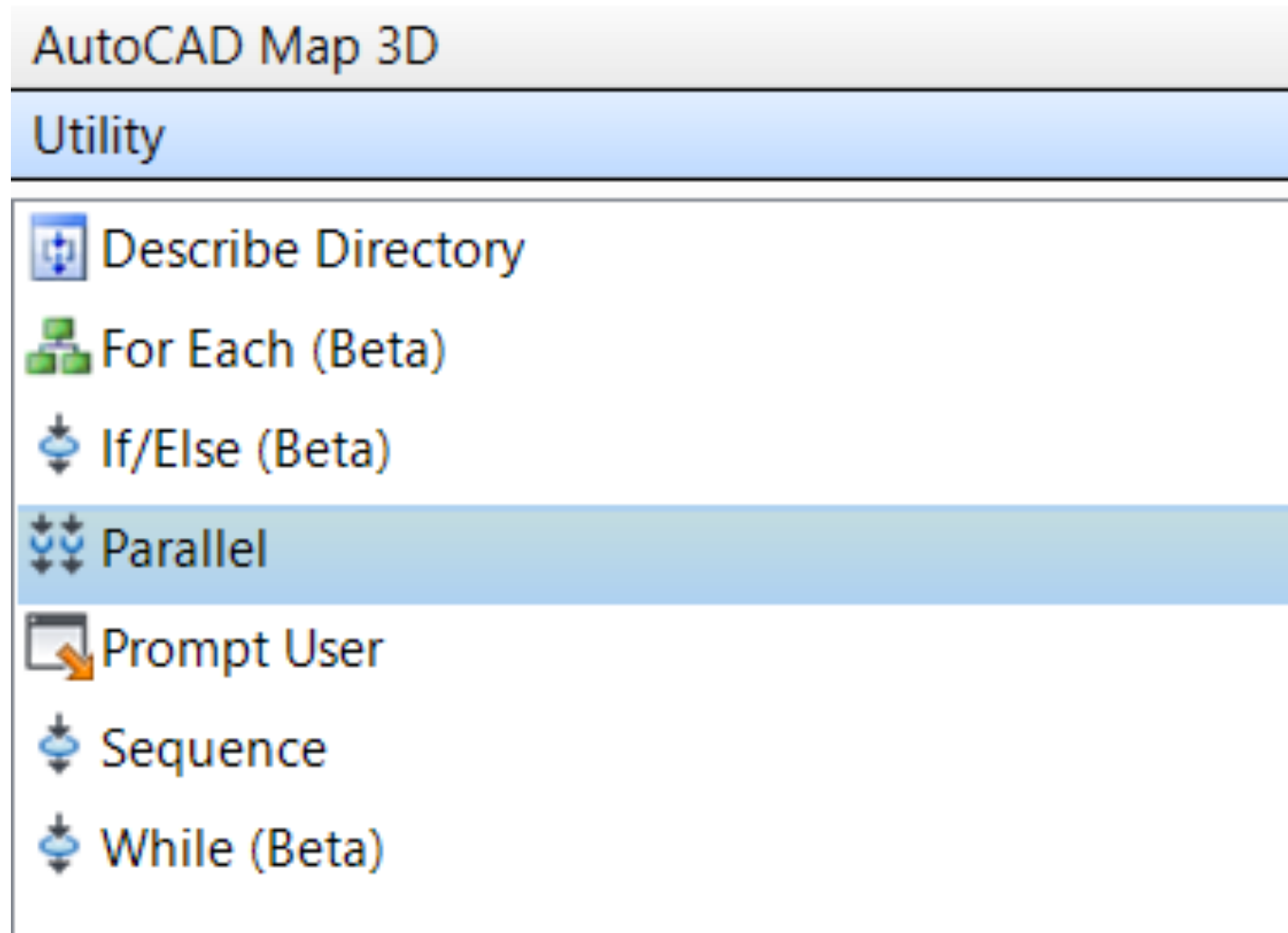
You can publish the following Civil 3D objects to ArcGIS:

- Alignments
- Feature lines
- Parcels
- Pipe networks
- Points

WorkFlow

WorkFlow is a set of instruction that can run automatically

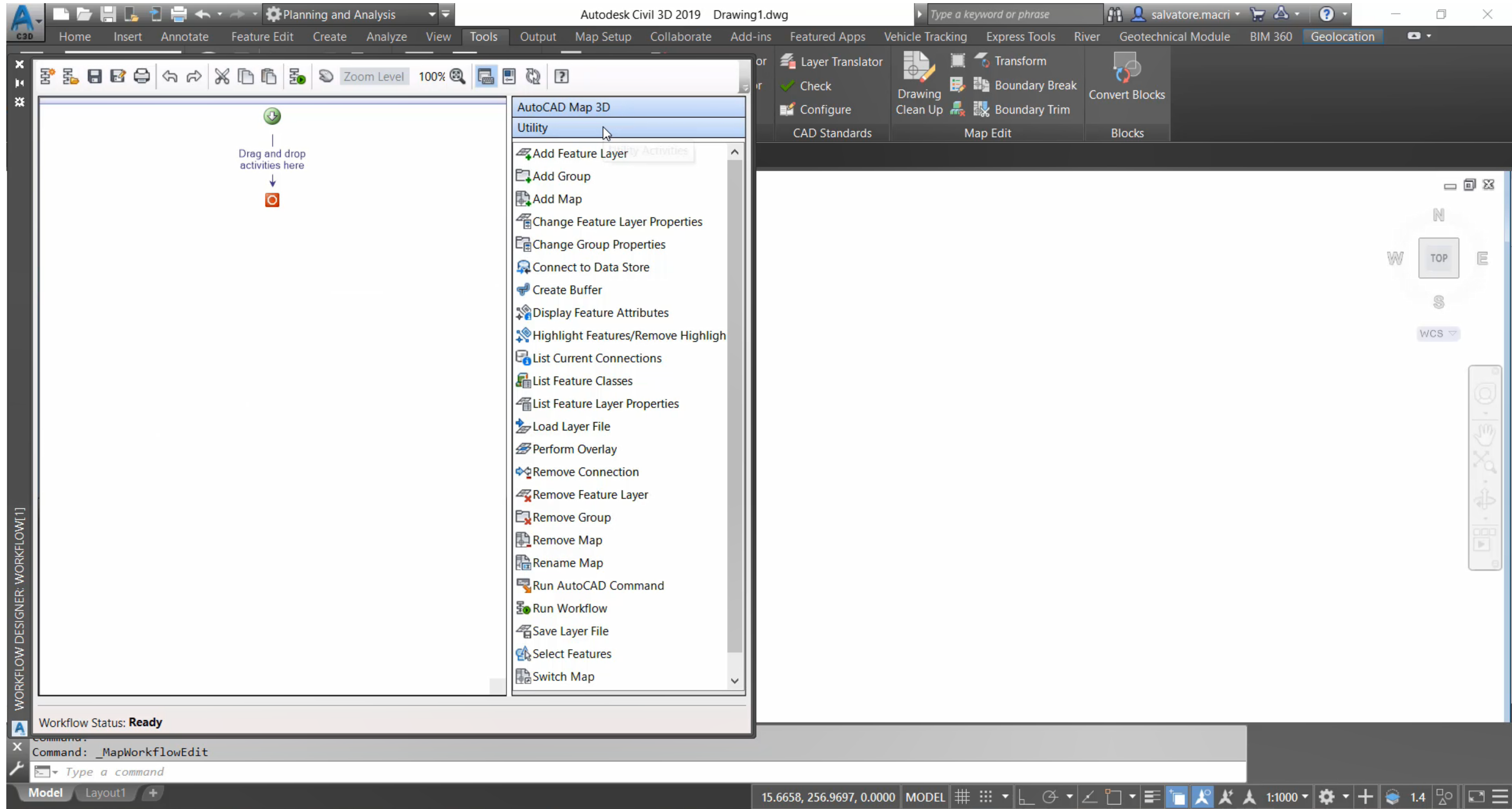
Model is saved as *.xoml



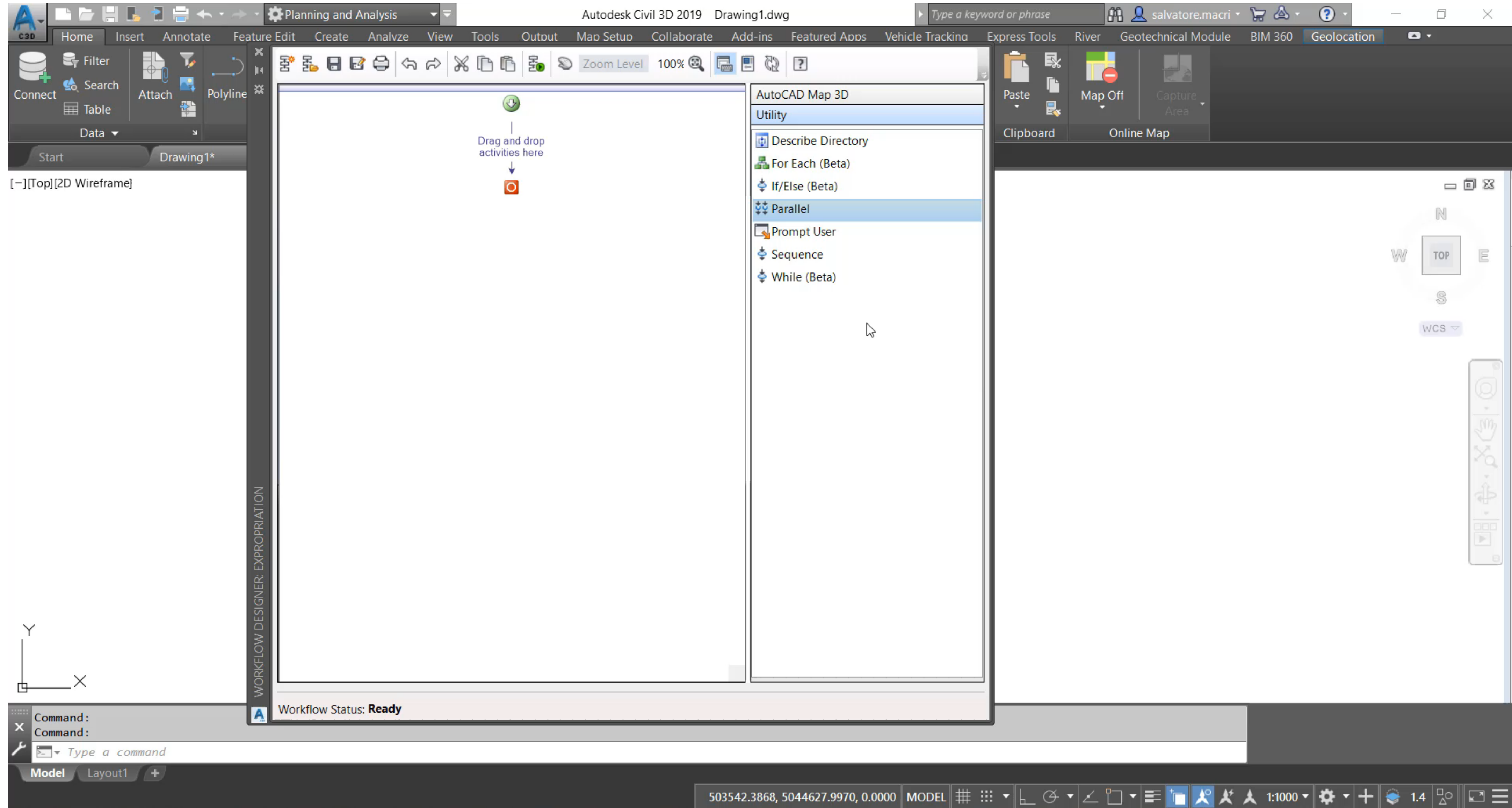
```
Expropriation.xoml - Notepad
File Edit Format View Help

<?xml version="1.0" encoding="utf-8"?><ns0:MapSequentialWorkflow Enabled="True"
DisplayName="Map Sequential Workflow" x:Name="Workflow[2]"
xmlns="http://schemas.microsoft.com/winfx/2006/xaml/workflow" xmlns:ns1="clr-
namespace:Autodesk.Gis.Map.Workflow.Activities;Assembly=Autodesk.Map.Workflow.Activities,
Version=22.0.22.4, Culture=neutral, PublicKeyToken=null"
xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml" xmlns:ns0="clr-
namespace:Autodesk.Gis.Map.Workflow.ComponentModel;Assembly=Autodesk.Map.Workflow.PlatformDep
endentServices, Version=22.0.22.4, Culture=neutral, PublicKeyToken=null">
  <ParallelActivity x:Name="ADD_FDO_LYR">
    <SequenceActivity x:Name="ADD_PARCELS">
      <ns1:ConnectToFdoDataStore FileName="C:\_ODrive\OneDrive - autodesk
\EVENT\OTx2019\DataSet\SDF\Parcels.sdf" DynamicConnectionParameters="" Id="{x:Null}"
Description="Connect to Parcels" NeedLoginInfo="False" Enabled="True" PromptAtRuntime="False"
DisplayName="Connect to Parcels" ProviderName="OSGeo.SDF" x:Name="connectToFdoDataStore1" />
      <ns1:AddGisLayer IsZoomToExtent="True" Id="{ActivityBind
connectToFdoDataStore1.Path=Id}" Description="Create Layer for Parcels.sdf"
PromptAtRuntime="False" Geometry="{x:Null}" LayerName="{x:Null}" DisplayName="Create Layer
for Parcels.sdf" Enabled="True" FeatureClass="{x:Null}" Group="{x:Null}"
x:Name="addGisLayer1" />
    </SequenceActivity>
    <SequenceActivity x:Name="ADD_CORRIDOR_B">
      <ns1:ConnectToFdoDataStore FileName="C:\_ODrive\OneDrive - autodesk
```


15 – WorkFlow 1



16 – WorkFlow 2





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