


SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

SHRP2 R15B Identifying and Managing Utility Conflicts

SHRP2 Peer Exchange Webinar

February 5, 2019

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Welcome and Agenda

- Introduction and Opening Remarks
- Overview and Status of R15B Product
- IAP State Challenges and Strategies
  - Updates from IAP States
- Use of Bentley SUE/SUDA at State DOTs
  - SUE/SUDA Implementation Strategies Presentation by Bentley Systems
  - SUE/SUDA at TXDOT Presentation by TXDOT
  - Implementation of SUE/SUDA at Utah DOT Presentation by Utah DOT

Agenda

5 minutes	**Introductions & Opening Remarks**	
	• Introductions • Objective of Call • Opening Remarks	All Ross Gray AASHTO/FHWA
10 minutes	**Overview and Status of R15B Product**	
	• Implementation closeout/end of technical support • Update on technical assistance activities by FHWA/AASHTO/SME	FHWA Cesar Quiroga
30 mins	**IAP State Challenges and Strategies**	
	• Update from all IAP States, with a focus on the following: • Leadership buy-in • IT support • Logistical challenges • Plan for upcoming months	Cesar Quiroga IAP States: California, Delaware, Iowa, Kentucky, Maryland, Michigan, Montana, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Texas, Utah, Vermont, Washington
45 minutes	**Use of Bentley SUE/SUDA at State DOTs**	
	• Presentation by Bentley Systems • SUE/SUDA Implementation Strategies • Presentation by TxDOT • Use of SUE/SUDA at TxDOT • Presentation by Utah DOT • Implementation of SUE/SUDA at Utah DOT	Sonya Pieterse Ab Maamar-Tayeb Bob Peterson
	Adjourn	

Overview and Status of R15B Product

- Implementation closeout/end of technical support (Julie Johnson)
- Update on technical assistance activities by FHWA/AASHTO/SME (Cesar Quiroga)

IAP State Challenges and Strategies

- California
- Delaware
- Iowa
- Kentucky
- Maryland
- Michigan
- Montana
- Oklahoma
- Oregon
- Pennsylvania
- South Carolina
- South Dakota
- Texas
- Utah
- Vermont
- Washington

Subsurface Utilities

Sonya Pieterse, Senior Application Engineer

Bentley Systems Inc.

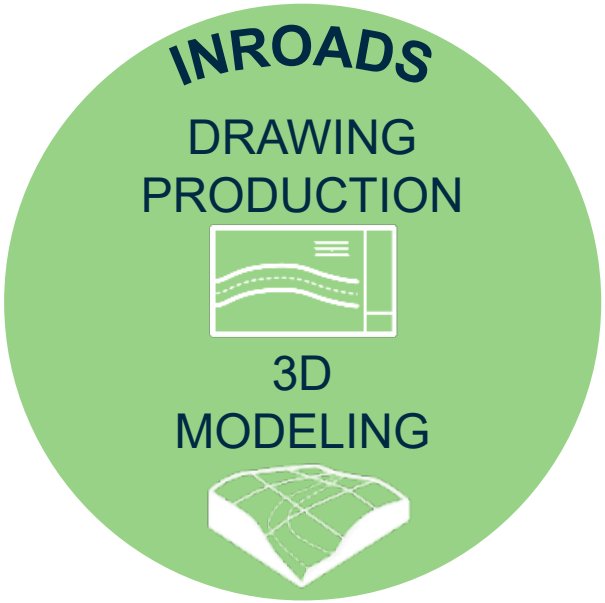
Bentley Advancing Infrastructure

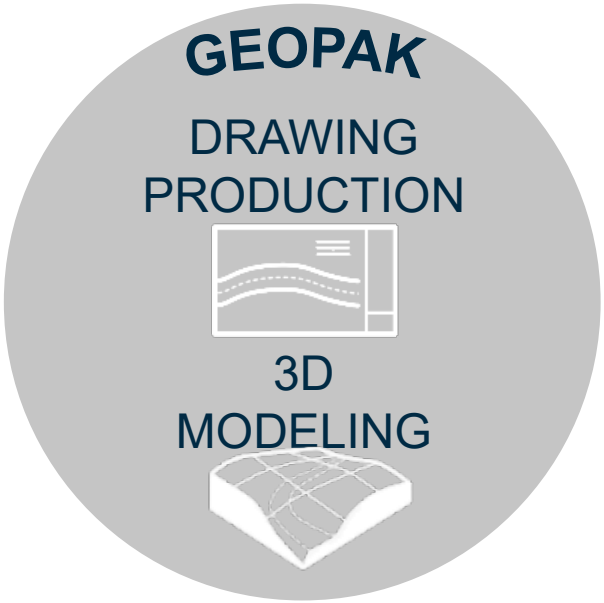
Agenda

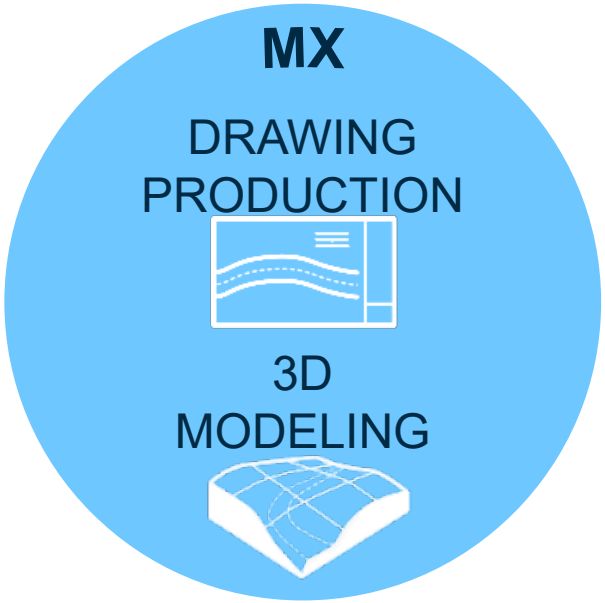
- OpenRoads Designer and Subsurface Utilities
- Licensing
- Subsurface Utility Capabilities
- Importing from other data
- Clash Detection
- Constructability
- Subsurface Utility Configuration: Cells, Element Templates, and Hydraulic Properties
- How to get setup – options

Please make a note of your questions and we will do our best to answer them after Bob Peterson's presentation.

V8

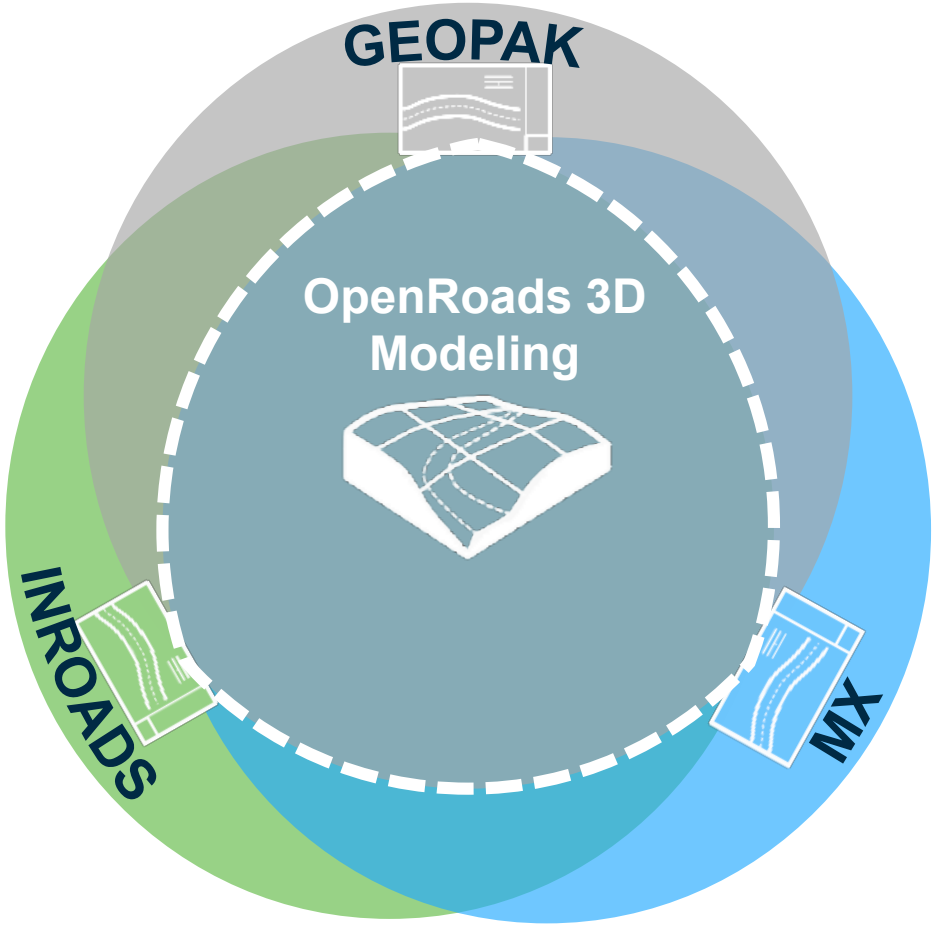






Bentley

V8i



Descartes

Subsurface Utility Engineering

StormCAD

Bentley

The CONNECT Edition

OpenRoads Designer

3D Roadway Design

InRoads GEOPAK MX

Descartes

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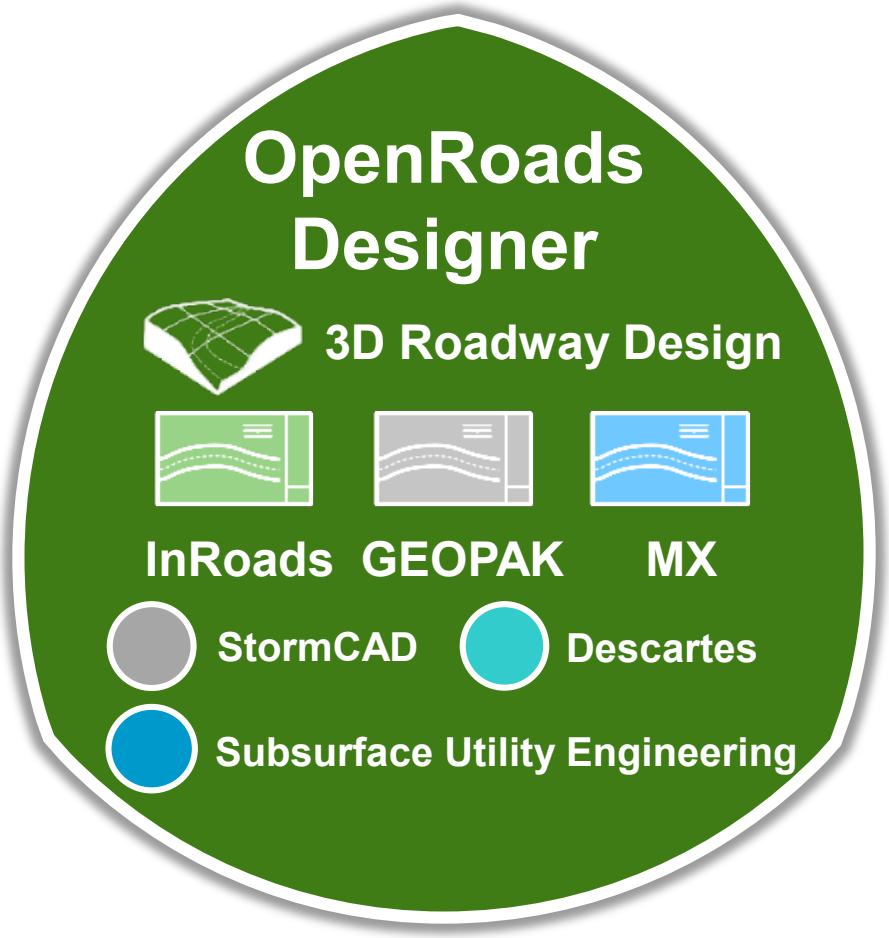

Subsurface Utilities

Subsurface Utilities is the nom du jour

- You may see it abbreviated as SU
- Replaces the name “Subsurface Utilities Design and Analysis (SUDA)”
- And “Subsurface Utility Engineering (SUE)”
- Any point or linear utility that needs to be modeled
- It’s part of OpenRoads Designer
- Encompasses the OpenFlows products StormCAD/CivilStorm/SewerCAD/SewerGEMS

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Subsurface Licensing

If you own this license:	Drainage Functions	Utility Functions
Any OpenRoads Technology (SS4): • GEOPAK • PowerGEOPAK • InRoads • PowerInRoads • MX	• StormCAD which includes storm water design and analysis. • Maximum of 100 inlets per drainage model. • Storm water attributes.	• Utilities can be modeled in 3D.
Any of the OpenRoads technology in SS4 above plus a **SUE** license.	• Same hydraulic calculation capabilities as above.	• Utilities can be modeled in 3D. • Unique Utility Attributes. • Utility conflict tools/Clash Detection
OpenRoads Designer CONNECT Edition	• StormCAD which includes storm water design and analysis. • Maximum of 100 inlets per drainage model. • Storm water attributes.	• Utilities can be modeled in 3D. • Unique Utility Attributes. • Utility conflict tools/Clash Detection
OpenRoads Designer CONNECT Edition plus the following additional licenses: • StormCAD Unlimited • SewerCAD • CivilStorm • SewerGEMS	• Additional hydraulic calculations depending on which license is activated.	• Utilities can be modeled in 3D. • Unique Utility Attributes. • Utility conflict tools/Clash Detection

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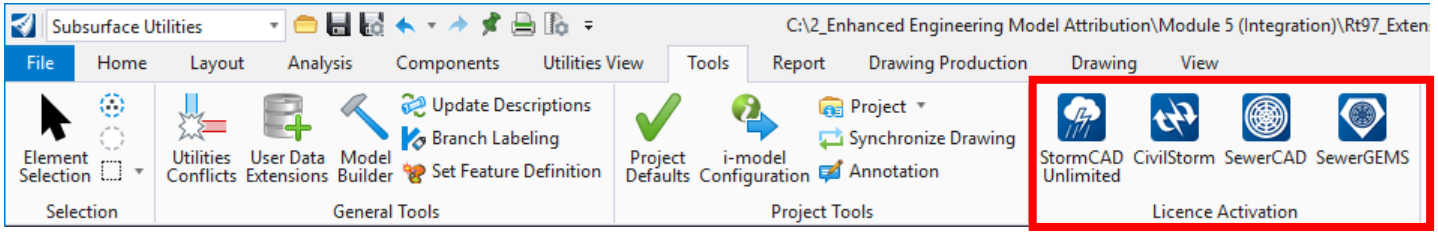
Subsurface Product Activation

- To activate an additional product go to **Subsurface Utilities > Tools > License Activation**.



- If activated, an alert that an additional license usage will be logged which may result in incremental cost.

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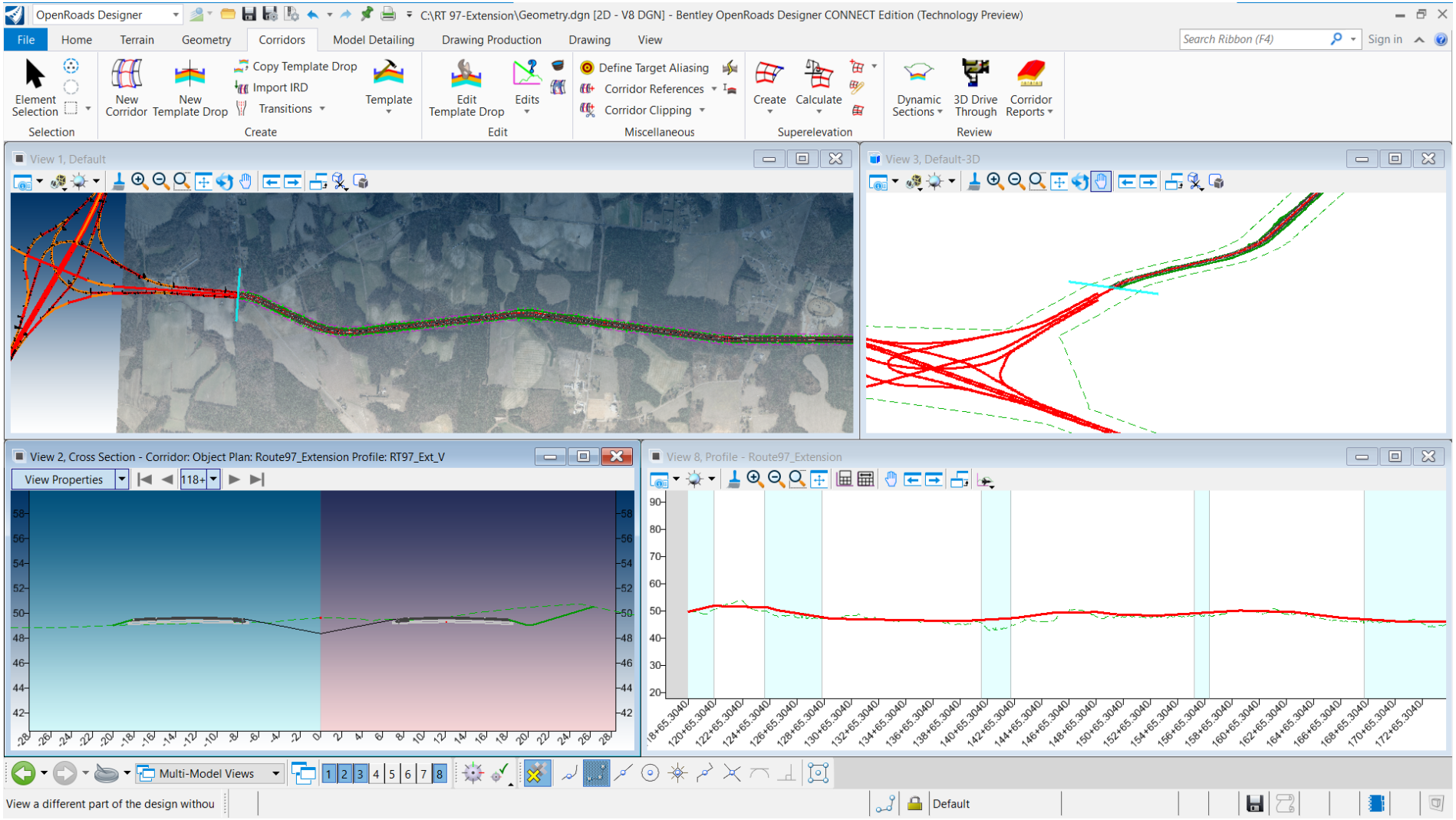
OpenRoads Designer CONNECT Edition Environment



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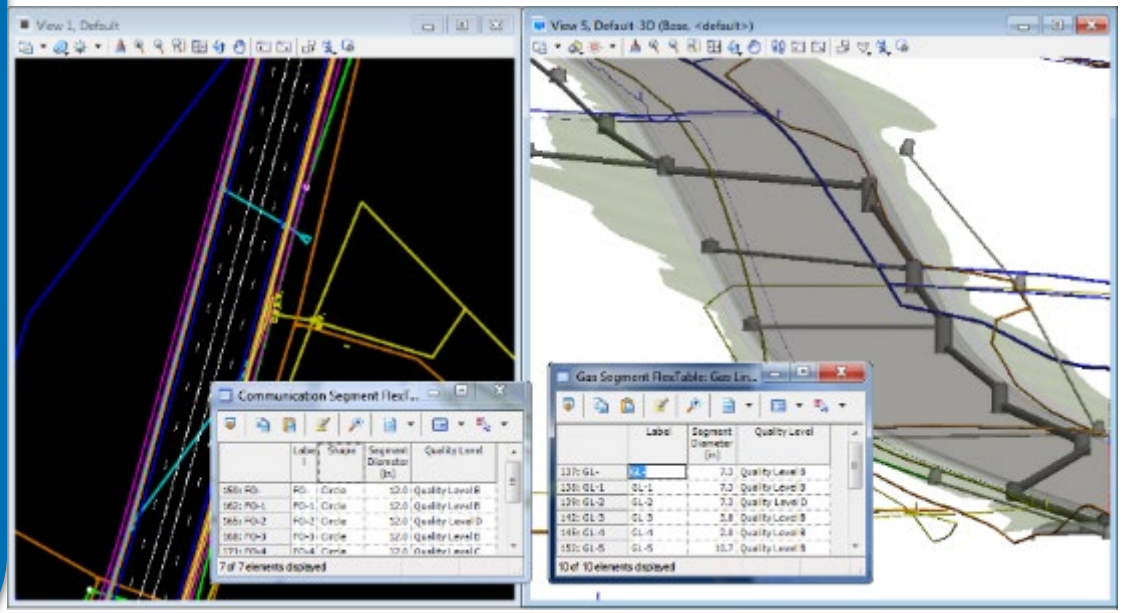
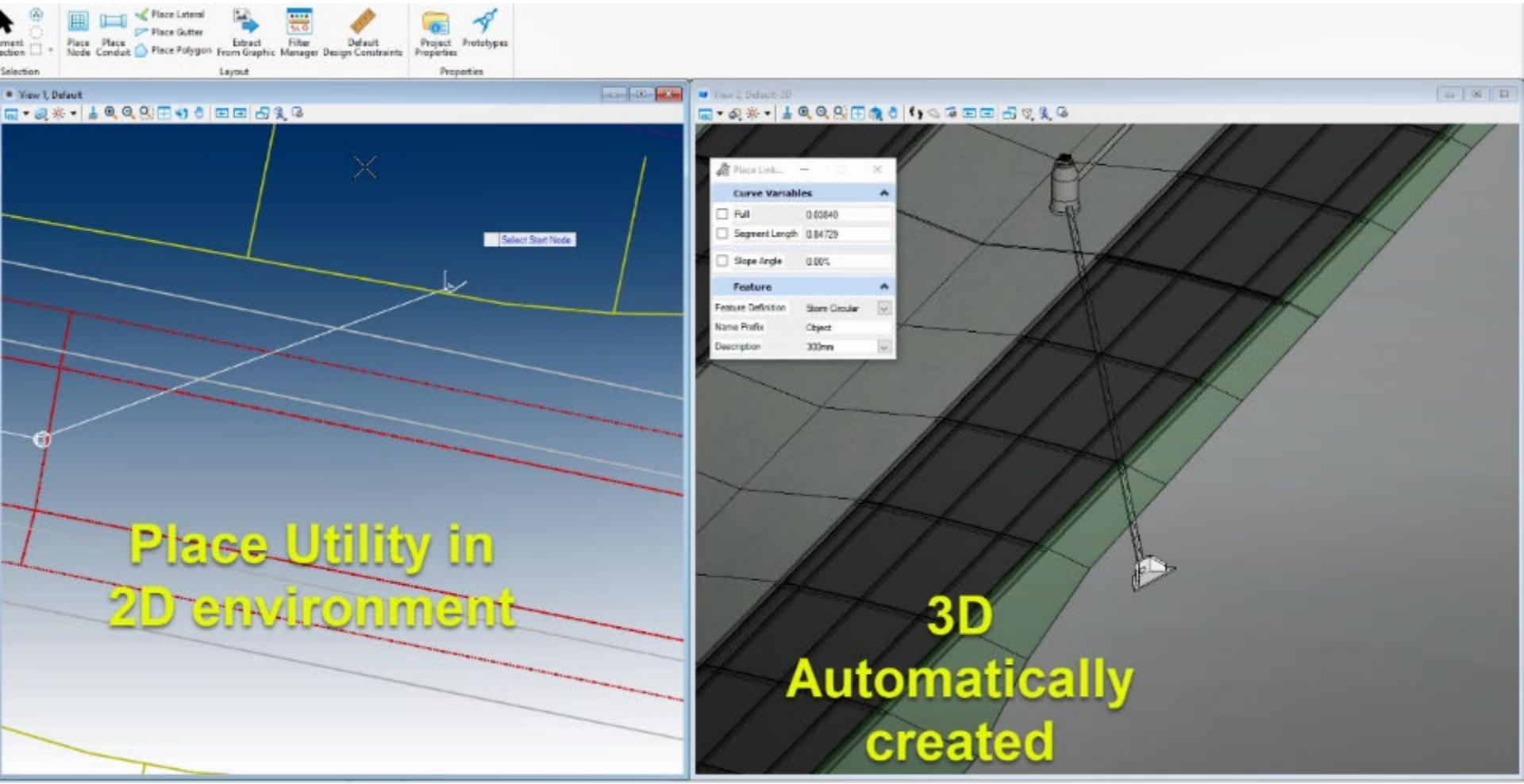
Subsurface Utility Capabilities

- Based on OpenRoads Modelling
- 3D modeling of all underground assets, existing or proposed.
- Hydraulic Design of Storm and Sanitary Utilities.
- Advanced Conflict Detection / Conflict Management.



Creating the model



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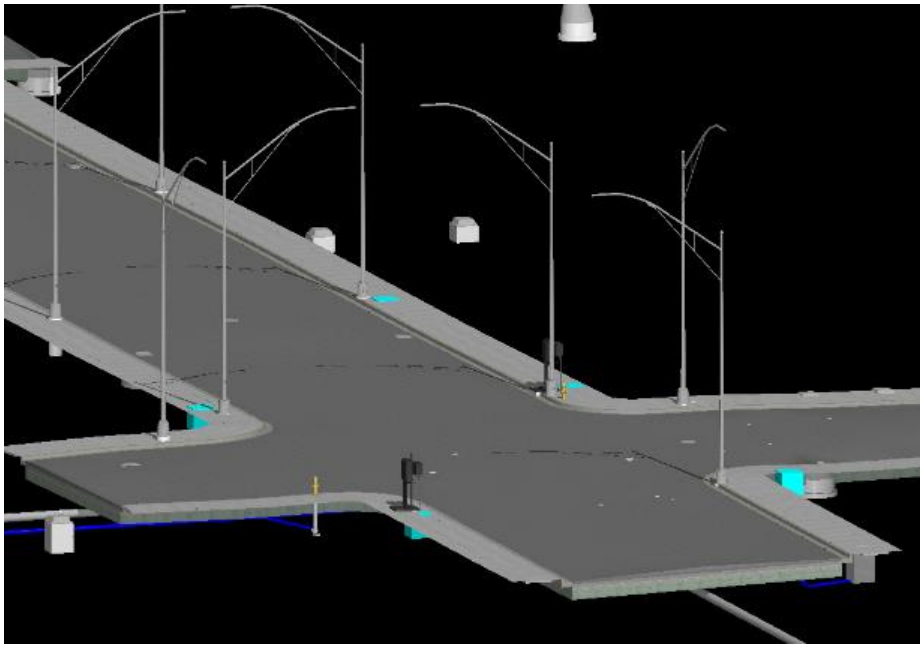
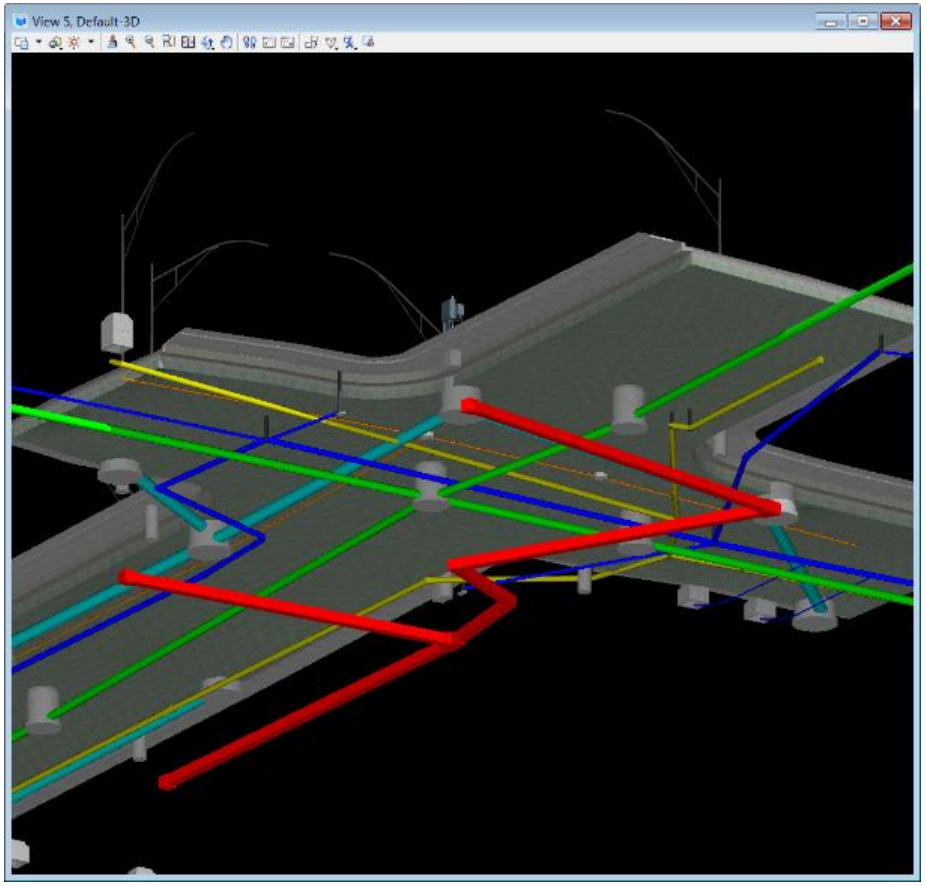
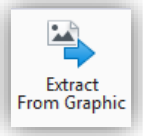
All Utilities can be modeled





Extracting from Existing Graphics



- **Subsurface Utilities > Layout > Extract from Graphics**
  - The Extract Utilities from Graphics tool provides the ability to create 3D drainage elements from graphic elements. These elements may result from survey processes, GIS graphic data, OpenRoads Geometry or other sources. But, in every case the elements are DGN graphic elements.

2D Graphics → 3D Model

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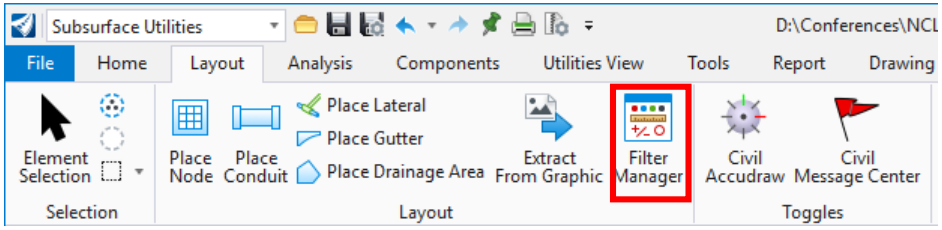
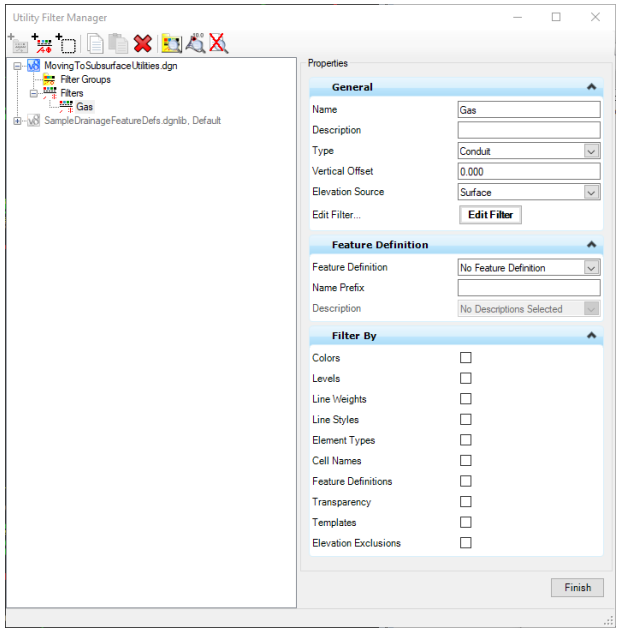
Utility Filter

- Created in the dgnlib.
- Extracts Graphics based on stored search parameters.





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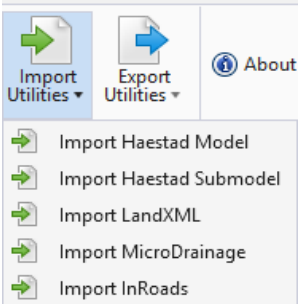
Importing from other Data Sources

- **Subsurface Utilities > Home > Model Import/Export > Import Utilities**
  - Haestad
  - LandXML
  - MicroDrainage
  - InRoads S&S



- The following products using SHP files:
  - StormCAD
  - CivilStorm
  - SewerCAD
  - SewerGEMS
  - WaterGEMS
  - WaterCAD

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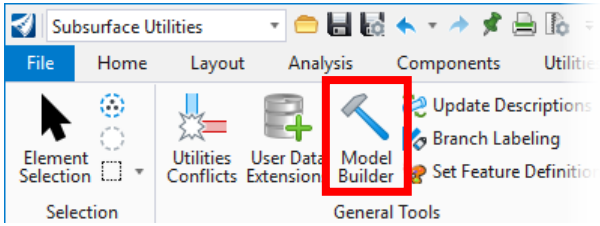
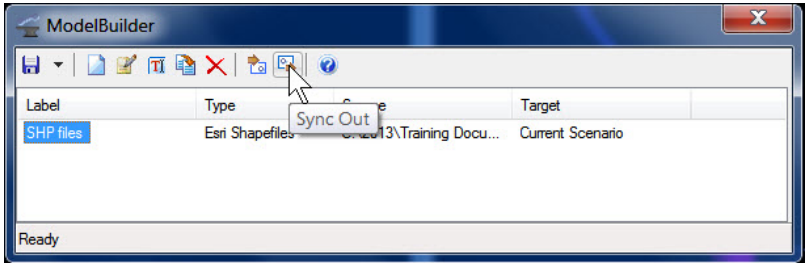
Model Builder

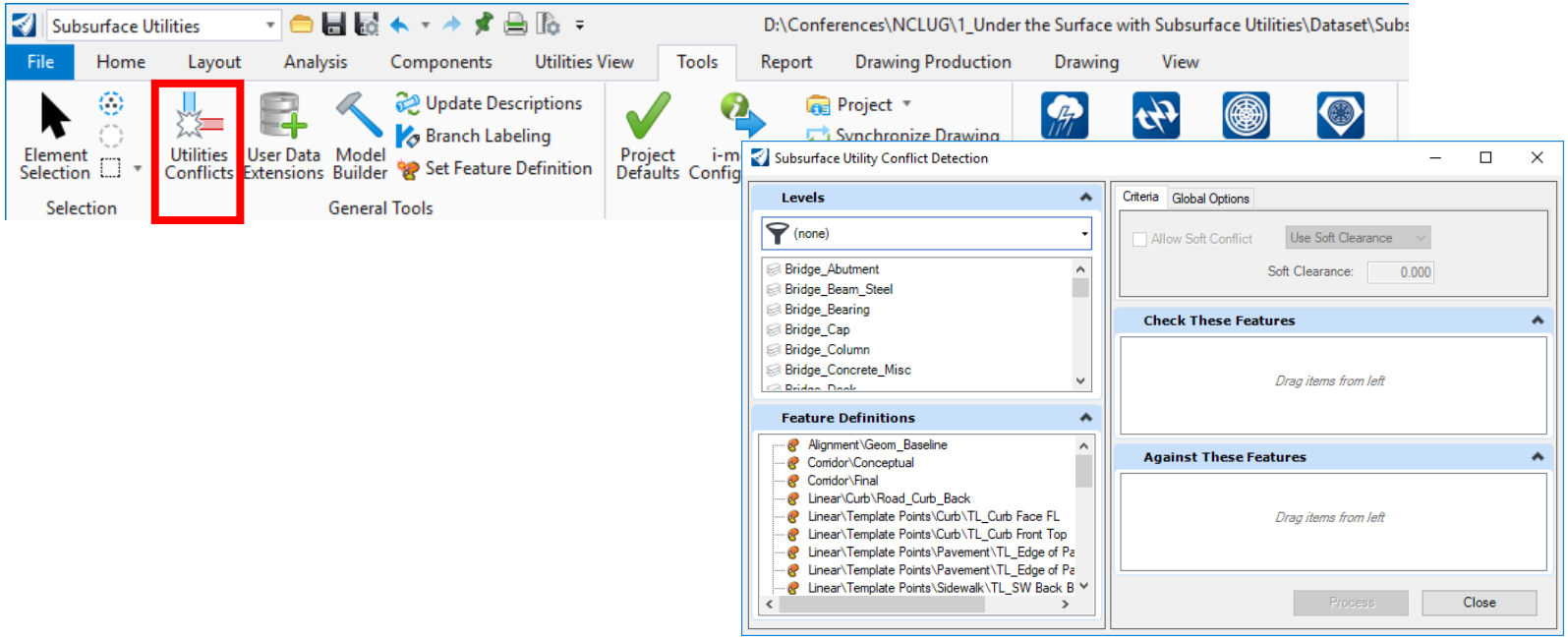
- Connects to any data source, including:
  - SHP
  - XLS
  - TXT, CSV
  - Oracle Spatial
- Geospatial sources are preferred.
- Creates 2 way link for import, export and update





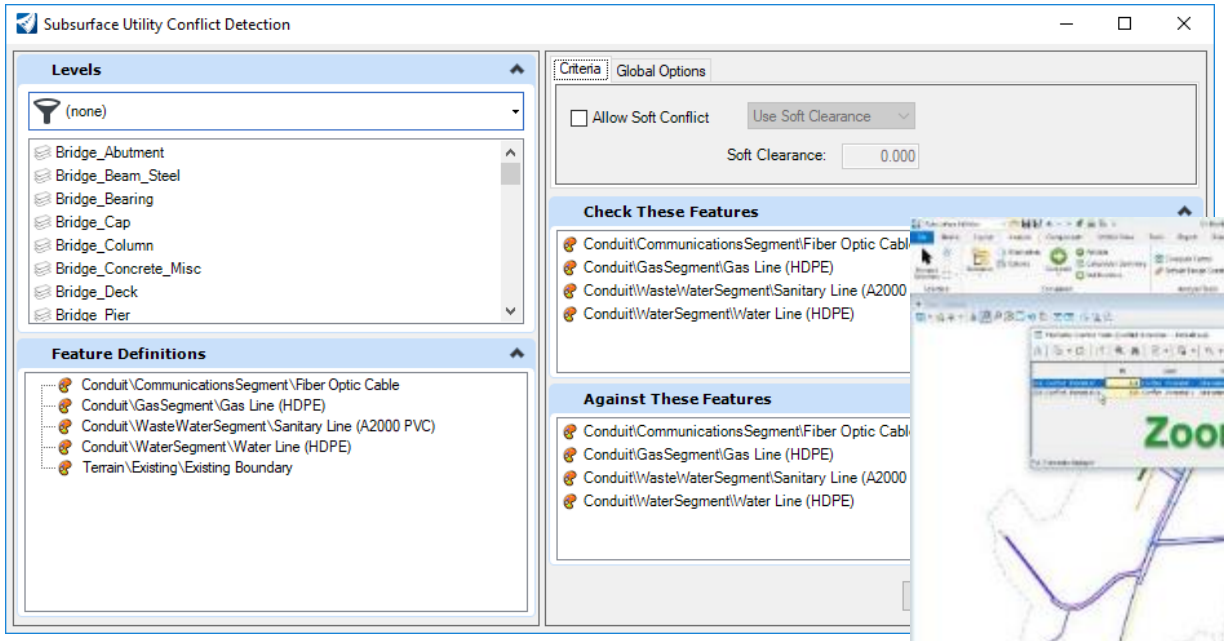
Clash Detection

- **Subsurface Utilities > Tools > Clash Detection**
  - Requires the SUE License in SS4



Detecting and Managing Utility Conflicts

- Training available on Learn Server.



1. Select Feature or Level to check
2. Select Feature or Level to check against
3. Review Flex Table

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Setting up a Workspace to include Subsurface Cells, Element Templates, Feature Symbologies & Feature Definitions

Bentley Sustaining Infrastructure

Workflow: Creating Subsurface Nodes

1. Have Linestyles, Levels, and Materials created.
2. Create 2D plan cells for Plan View of structures.
3. Create 3D top cells for the 3D top portion of the structures.
4. Create 3D bottom cells for the 3D bottom portion of the structures.
5. Create Elements Templates for:
   - Plan – Points to level for the structure and the 2D cell.
   - Profile – Points to level for the profile of the structure.
   - 3D Top – Points to level for the structure and the 3D top cell.
   - 3D Bottom – Points to level for the structure and the 3D bottom cell.
6. Create Feature Symbologies
7. Create Feature Definitions

The Parts of a Subsurface Element

- **Feature Definition** – the container which holds all the other parts and defines function.
- **Feature Symbology** – points to element templates for symbology information.
- **Element Templates** – defines the symbology, material, and cells to be used.
- **Cell Library:**
  - 2D cells are used for plan view presentation.
  - 3D cell for modeling the top and bottom of the utility structures.
  - Can be stored in one or multiple files.

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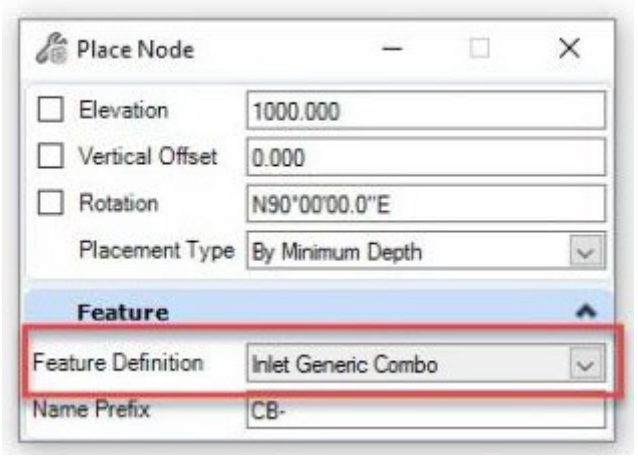
What is a Feature Definition

Feature Definitions link to Feature Symbolgies which link to MicroStation element templates, that define the symbology in the various view spaces:

- Plan
- Profile and
- 3D

OpenRoads:
It starts with the Feature Definition



Subsurface Feature Definitions

- **Types of Subsurface Features:**
  - Nodes → Structures (inlets, manholes, headwalls, etc.)
  - Conduit → Pipes (elliptical, circular, box, arch, etc.)
  - Catchments → Drainage Areas

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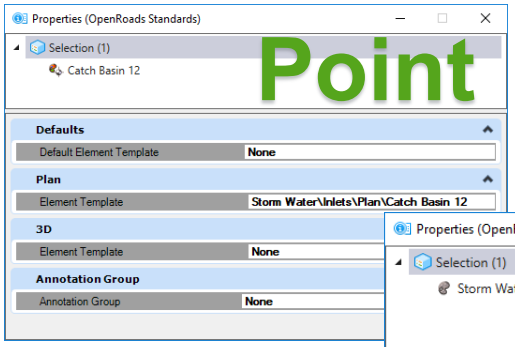
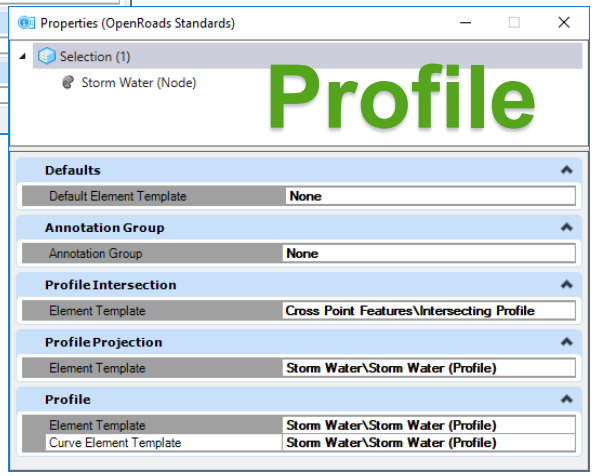
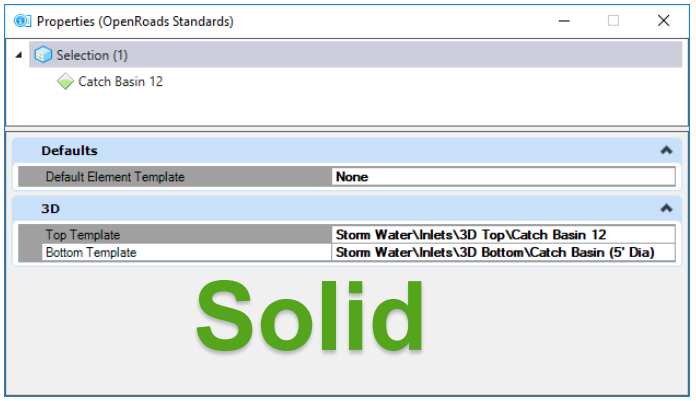
Node Feature Symbology

- Feature Symbolgies:
  - Point → Plan
  - Profile
  - Solid → 3D Element
- Defines the symbology for all 4 views.
- Links to MicroStation **Element Templates**.
- Feature Symbologies for subsurface nodes typically require 2 3D templates (Top and Bottom).







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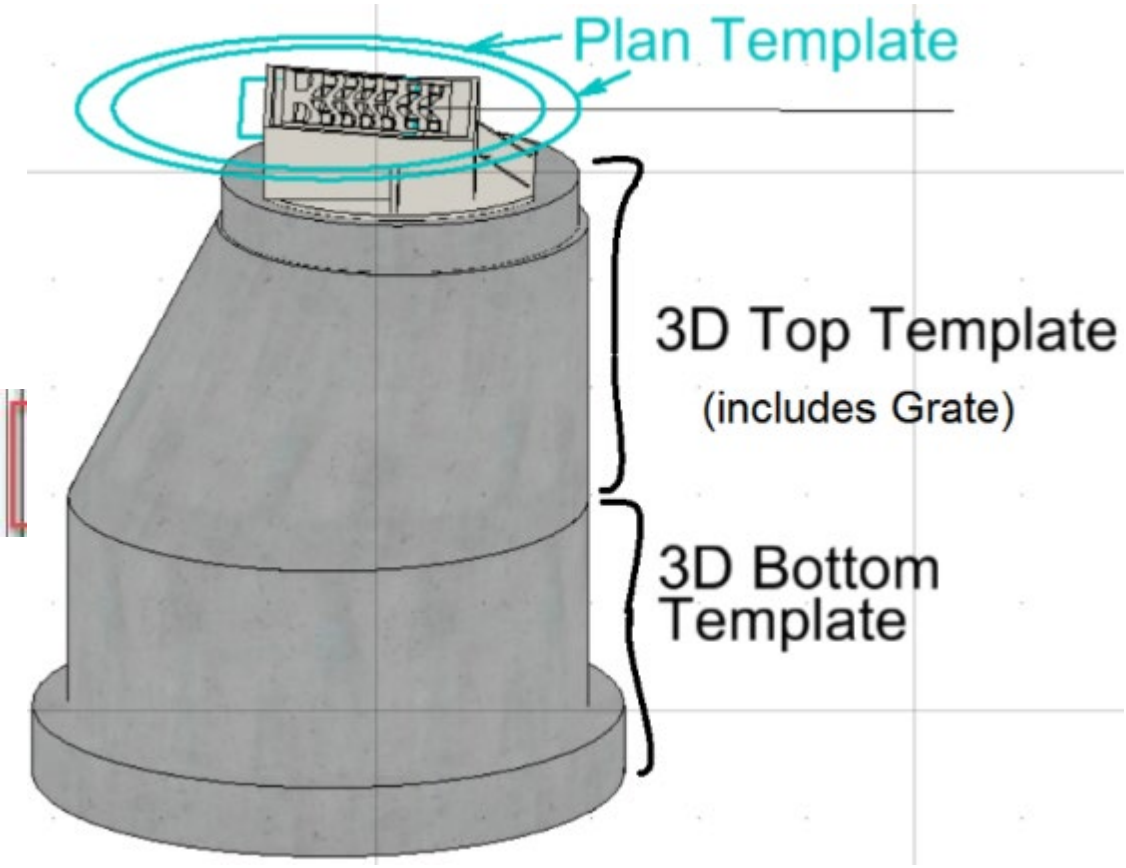
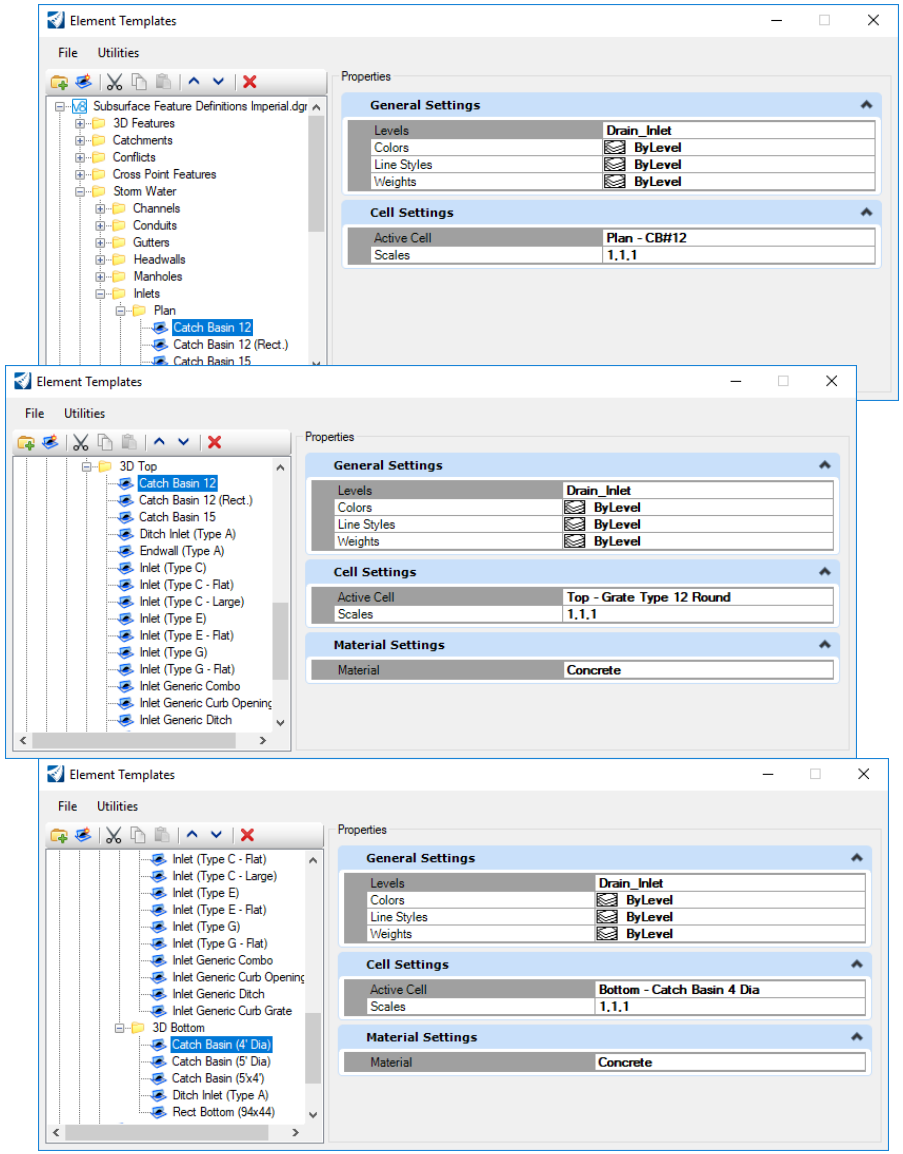
Node Feature Symbology



Creating Element Templates

- Element Templates define symbology, cells, and materials to be used for feature symbologies.
- One Element Template can be used in multiple features.
- Define Element Templates in dgn library file (*.dgnlib*).
- Separate Element Templates for:
  - Plan
  - Profile
  - 3D Top
  - 3D Bottom



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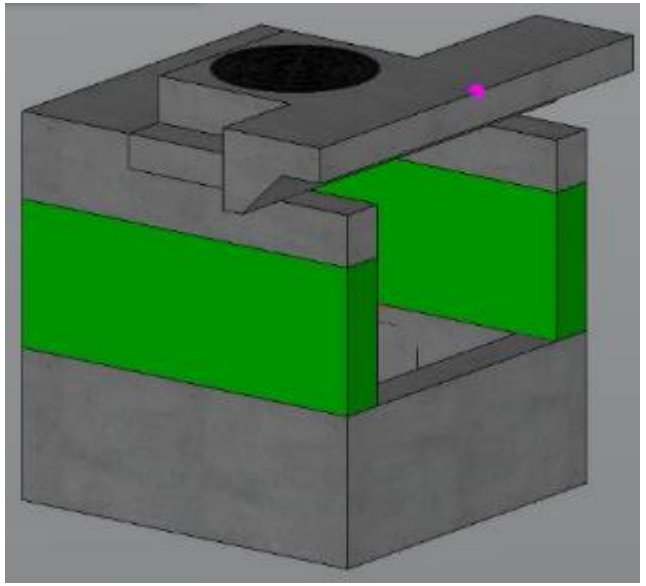
Subsurface Node Creation

- When a Subsurface node is placed, the 3D top and bottom cells are merged.
- Including an extrusion in middle to vary the height.



Extrusion Config Variables:

- SU_3D_Structure_ExtrudeMethod = UP
- SU_3D_Structure_ExtrudeMethod = DOWN

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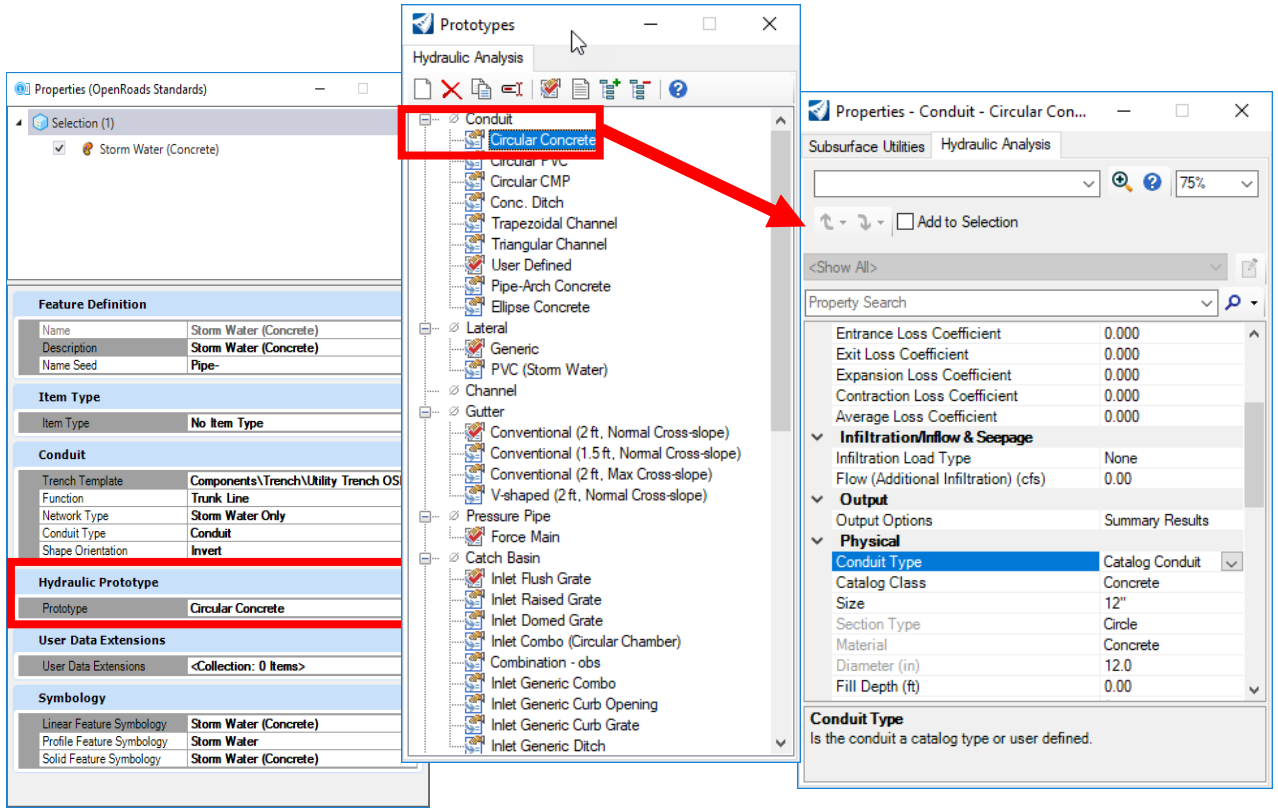
Water Feature Definitions and Hydraulic Properties

- For storm or waste water utility types, you define the hydraulic characteristics by linking to a hydraulic prototype.
- The Conduit sizes are defined in the Conduit Catalog.



Subsurface Utilities Workflow > Components Tab > Catalog or Prototype

Subsurface Configuration Variables

Node and Conduit Feature definition libraries:

- CIVIL_CONTENTMANAGEMENTDGNLIBLIST > $(_USTN_PROJECTDATA)/dgnlib/Sample Drainage FeatureDefs*.dgnlib
- CIVIL_CONTENTMANAGEMENTDGNLIBLIST > $(_USTN_PROJECTDATA)/dgnlib/*Conduit Library.dgnlib

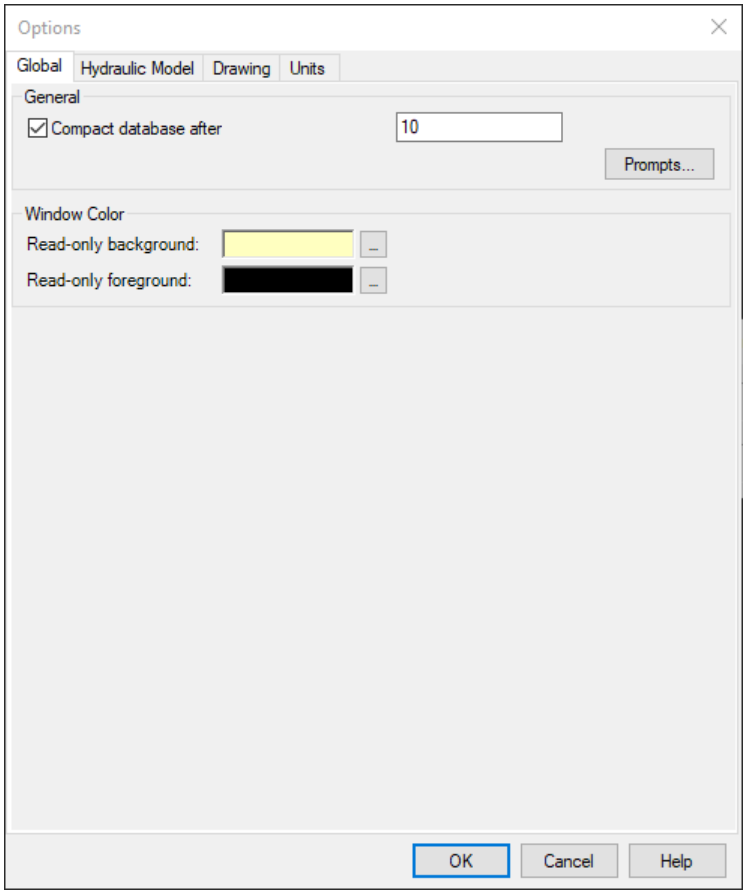
The utility libraries also contains the levels, element templates and additional line styles needed for utilities:

- MS_DGNLIBLIST > $(_USTN_PROJECTDATA)/dgnlib/Sample Drainage FeatureDefs*.dgnlib
- MS_DGNLIBLIST > $(_USTN_PROJECTDATA)/dgnlib/*Conduit Library.dgnlib

Utility and Drainage cell libraries are loaded with the workspace.

Project Defaults

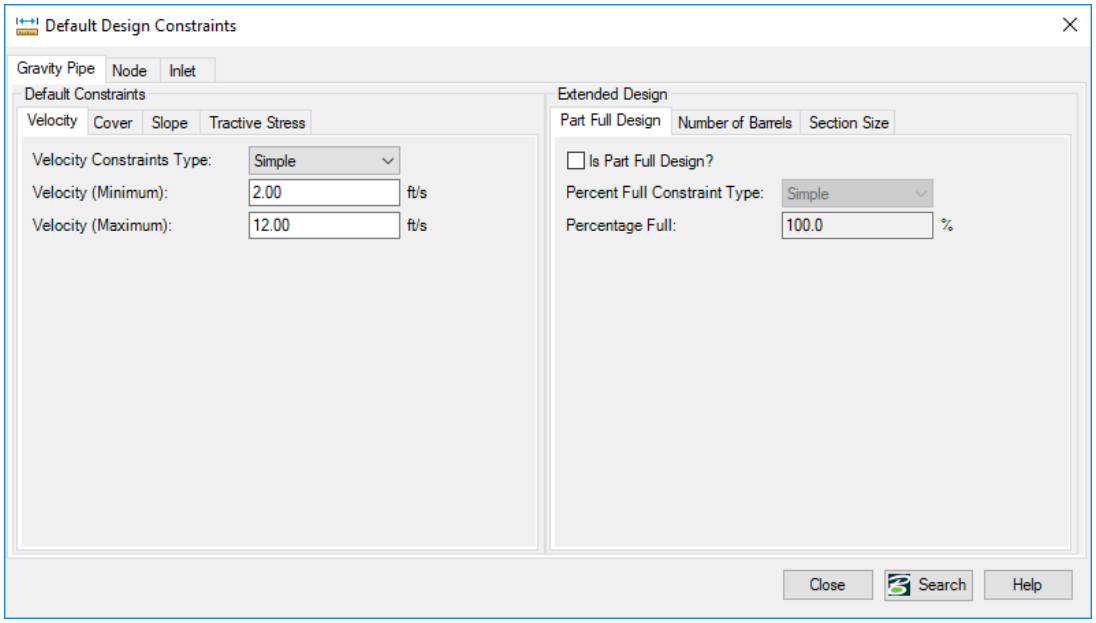
- Should be created and stored in the dgnlib.
- Stores the following parameters
  - Hydraulic Model Preferences
  - Default drawing scale
  - Units
  - ProjectWise (Optional)
- Can be changed in the design file. This is just a “starting point”.



Subsurface Utilities Workflow > Tools Tab > Project Defaults

Default Design Constraints

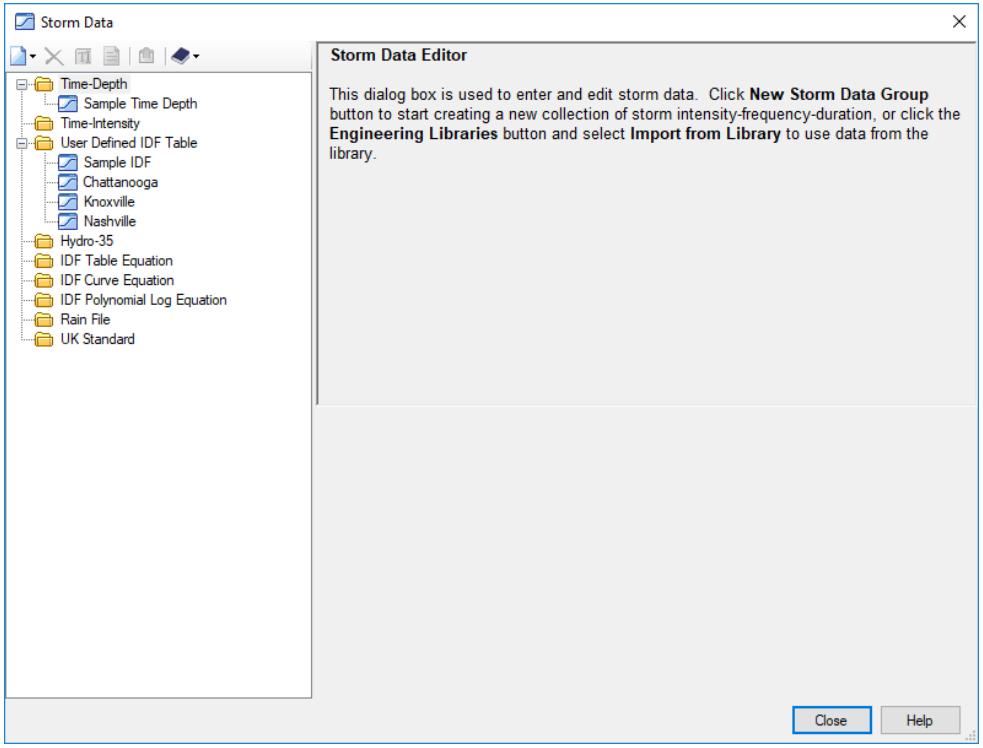
- Stored in the dgnlib.
- Sets default constraints for Gravity Pipes, Nodes, and Inlets.



Subsurface Utilities Workflow > Analysis Tab > Default Design Constraints

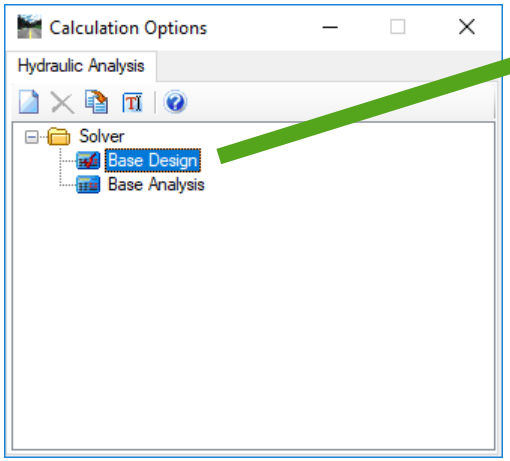
Storm Data

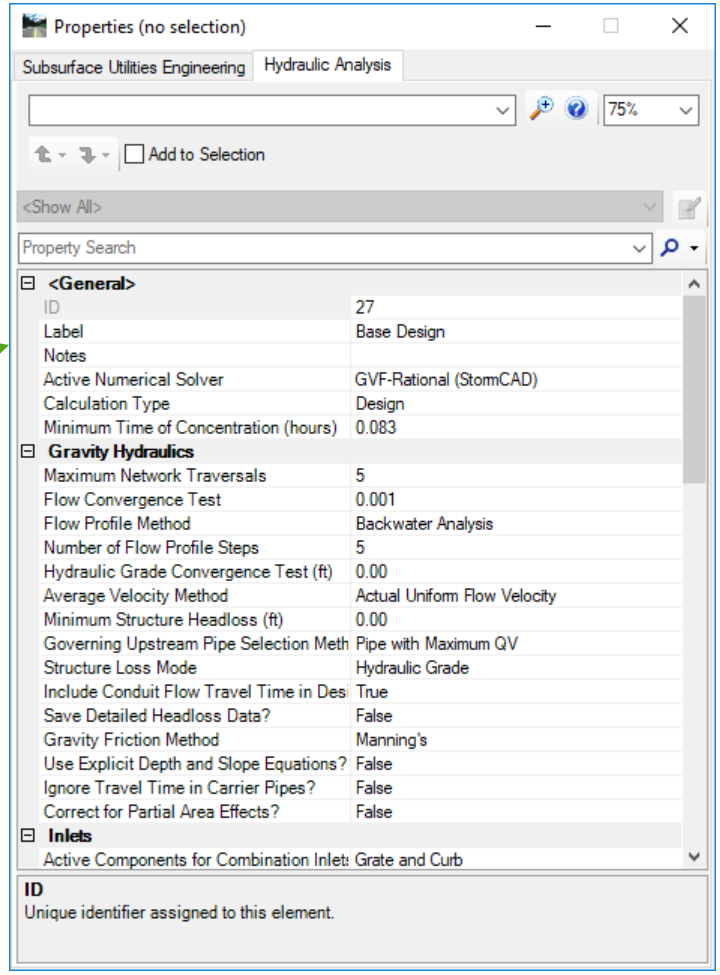
- **Subsurface Utilities > Components > Storm Data**
- Stored in a the dgnlib
- Storm Data formats:
  - Time-Depth
  - Time-Intensity
  - IDF Tables
  - Hydro-35
  - IDF Curves
  - Etc.



Calculation Options

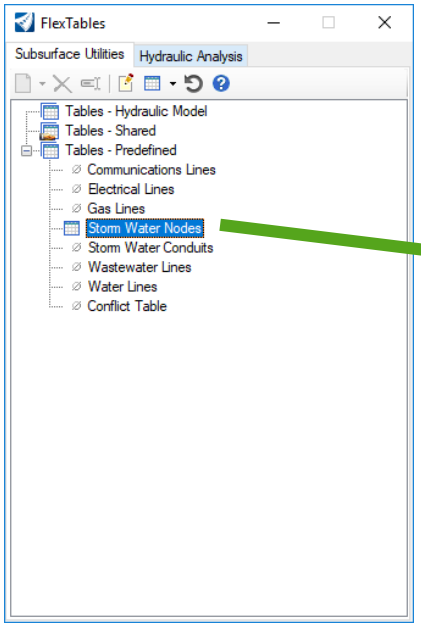
- **Subsurface Utilities > Analysis > Calculation > Options**





Flex Tables

- **Subsurface Utilities > Report > Tables > Flex Tables**



FlexTable: Storm Water Nodes (SubsurfaceUtilities -- Default.sue)

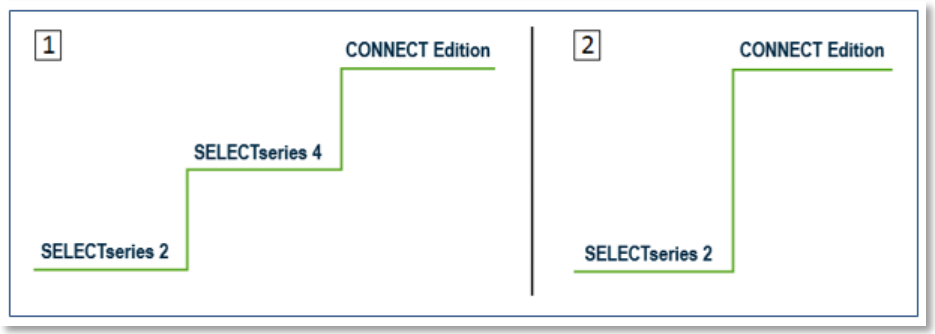
	Label	X (ft)	Y (ft)	Elevation (Top) (ft)	Elevation (Bottom) (ft)	Storm Water Node Type	Utility Investigation Level (Current)
10: INLT-	INLT-	2,006,800.52	402,990.99	31.44	27.80	Inlet Grate	Undetermined
11: CB-	CB-	2,006,610.01	403,076.13	32.67	28.62	Inlet Grate	Undetermined
12: CB-1	CB-1	2,006,846.05	402,863.98	34.67	28.90	Inlet Grate	Undetermined
13: INLT-1	INLT-1	2,006,948.02	403,105.89	31.14	27.86	Inlet Grate	Undetermined
14: MHSW-	MHSW-	2,006,679.90	403,002.38	31.27	27.65	Manhole	Undetermined
15: MHSW-1	MHSW-1	2,006,697.98	402,954.62	30.97	25.72	Manhole	Undetermined
16: HW-	HW-	2,006,450.31	403,060.49	-2.75	-2.75		Undetermined

7 of 7 elements displayed

Bentley

What does Bentley offer

- A number of DOTs are adopting SU as part of their migration to ORD, what needs to be done:
  - Create 2D and 3D cells
  - Setup Pipe Catalogues
  - Define Hydraulic Properties
  - Create Element Templates
  - Create Feature Symbology
  - Define Annotation
  - Create Feature Definition
  - Setup Defaults and Design Standards
  - Setup Configuration Variables



- Bentley can provide the services to do all or any portion of the above
- Consultants

Subsurface Library Creation

Tasks	Time Estimate (min)	Notes
Set Default Units and Formatting	15	
Create 2D Cells	15	Per cell
Create 3D Top Cells	30-45	Per cell
Create 3D Bottom/End Treatment Cells	30-45	Per cell
Create Element Templates	5	Per feature to be created
Create Item Types	1-5	Per item type
Create Catalog	1	Per catalog item
Create Prototypes	1	Per prototype
Create Feature Symbologies	1-2	Per feature symbology
Create Feature Definitions	1-2	Per feature definition
Create Text Favorites and Annotation Groups	120	
Set Default Design Constraints	5	
Set Storm Data	60	
Set Default Calculation Options	15	
Create Utility Filters (optional)	480-960	Depends on the number of Filters to be created
Create Customized Flex Tables (optional)	480-960	Depends on the number of Tables to be created

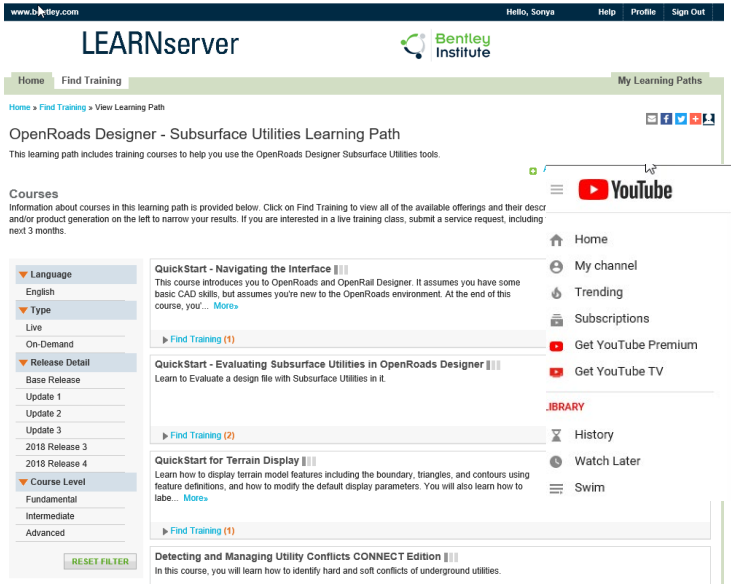
Bentley

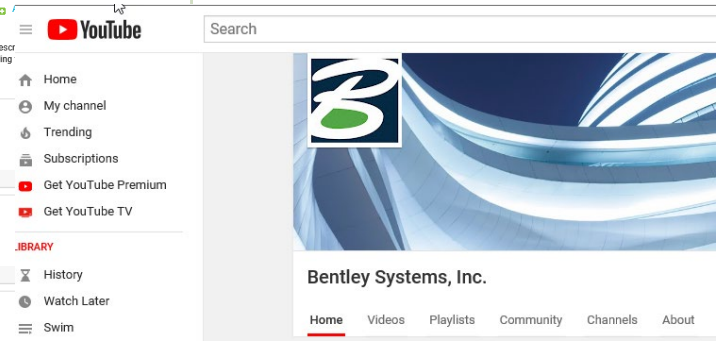
Things needed to start creating the Subsurface Library

- Standard Details for all Structures to be created.
- Information on standard pipes:
  - Type, materials
  - Sizes
  - Wall thicknesses
- Hydraulic Information on each Inlet:
  - Inlet Type
  - Structure Width and Length
  - Grate Type
  - Grate Information
- Storm Data Information
- Hydraulic Design Standards
- 2D and 3D Seed file.
- Current 2D cell library (if any)
- Levels, Linestyles, and materials DGN libraries

Bentley Communities, Learn and more

- http://communities.bentley.com/products/road___site_design/w/road_and_site_design__wiki/12600.subsurface-utilities-sue-and-suda-video-clips-technotes-faqs
- https://learn.bentley.com/app/Public/ViewLearningPathDetails?lpId=111748
- https://www.youtube.com/BentleySystems

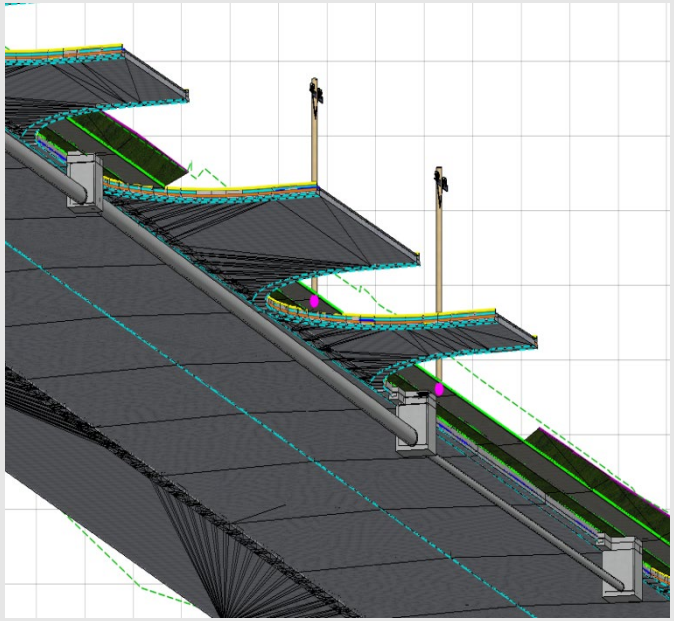




Thank you for your time.

Ab will now give you an overview of what Texas DOT is doing with Subsurface Utilities.

Bentley



TXDOT AND SUDA/SU IMPLEMENTATION

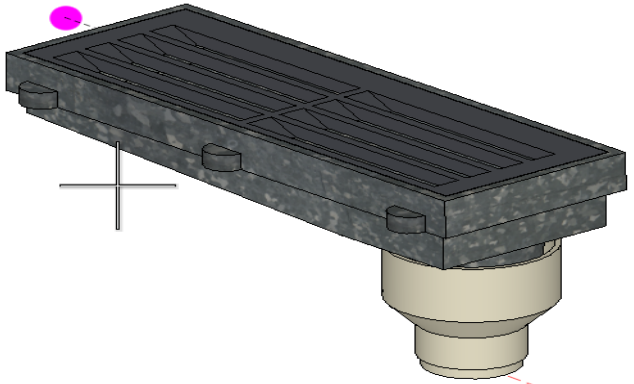
Ab Maamar-Tayeb, P.E., C.F.M TxDOT Design Division,
Hydraulics Branch

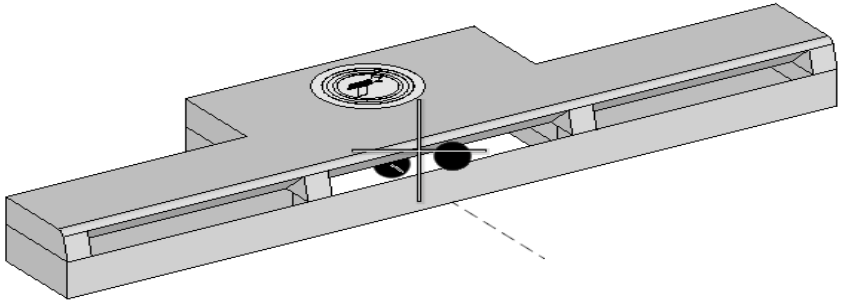
Greg Faber, S.I.T., CTCM
Utility Specialist - South

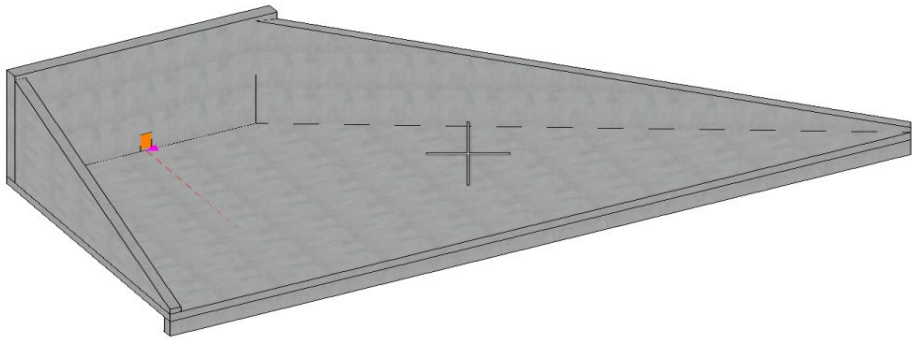
Table of Contents

SUDA Project Setup

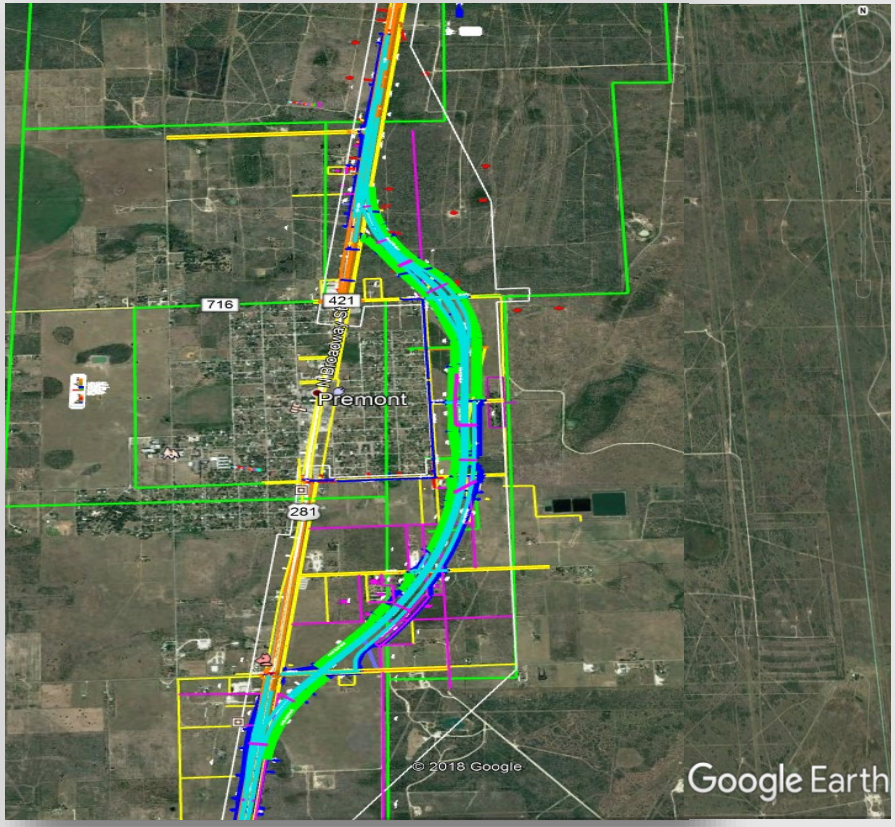
- 2,762 3D Cells were completed
  - Feature Definitions
  - Element Templates
  - Prototypes (Hydraulic Losses)
  - Service Request for Parametrics







Premont Relief Route CRP District



PEPS Work Authorization Scope

EXHIBIT B

SERVICES TO BE PROVIDED BY THE ENGINEER

CSJ No.: 0255-02-050
Highway: US 281 By-Pass
County: Jim Wells
District: Corpus Christi

The SUE information obtained from an investigation in 2013 provided by TxDOT will be incorporated into the 3D mapping deliverables. Additional Quality Level B and a Quality Level C/D survey of existing overhead facilities will be performed to the new project limits, including:

- approximately 700 LF along existing US 281 to the new south project limit;
- approximately 2,100 LF along existing US 281 to the new north project limit;
- approximately 600 LF along NW 8th Street from existing US 281 towards the proposed US 281 By-Pass;
- any new utilities installed within the project limits that were not identified during the original SUE investigation in 2013.

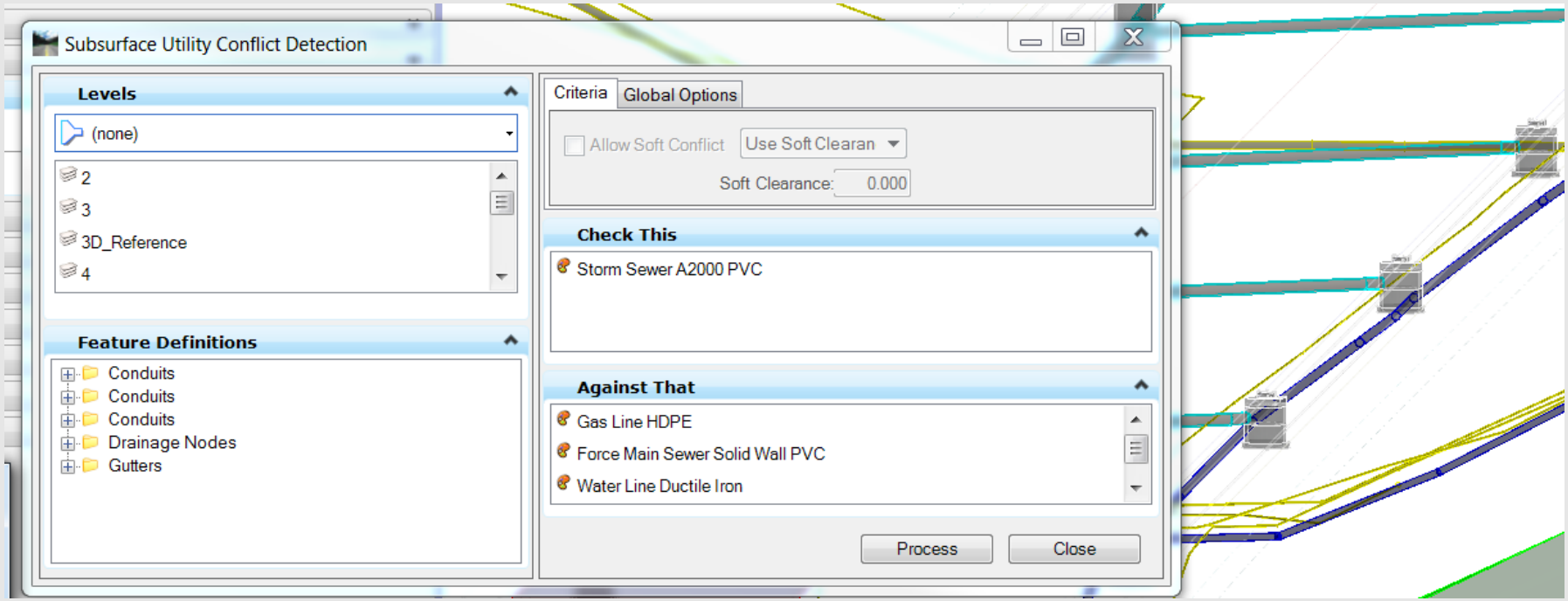
Quality Level A test holes will be excavated at sixty (60) locations as determined by the State.

an hourly rate basis as directed by the State. Quality Level A test holes to locate wells will be excavated and billed on a unit cost basis.

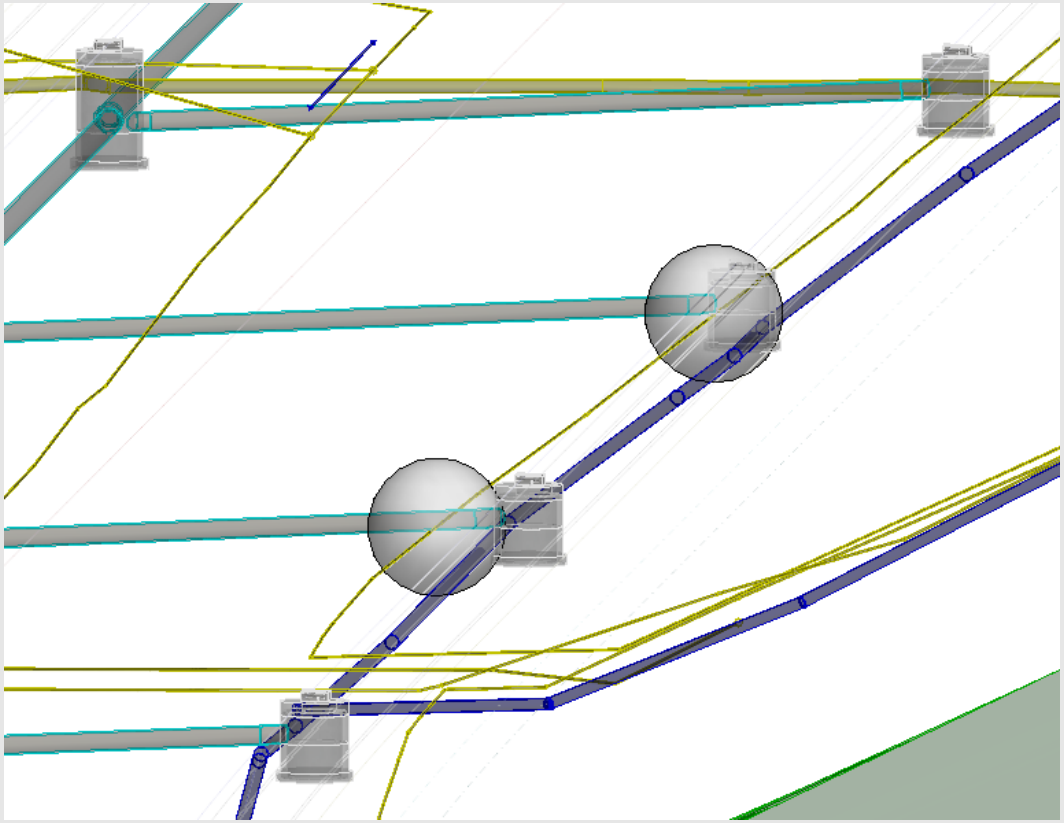
Premont Relief Route CRP District – Clash Detection

- 3-D SUE can be incorporated into the 3-D Roadway Design file
- Clash Detection
  - Allows the user to identify 2 separate sets (Set A and Set B) of 3-D graphical elements and detect clearance and physical “clashes” between the 3-D elements sets.
  - Allows the user to interactively and graphically review these clashes, annotate particular clashes and assign the clashes as a conflict.
  - Criteria Tab
    - Specifies “clearance window” around 3-D elements in either of the 2 sets
    - Example, if the elements in Set B get closer than the 6 inches or within the “clearance window” from Set A, then a clash will be reported, this is considered a “clearance clash”
    - If elements in Set B physically touch elements in Set A, the clash is considered a “hard clash”

SUDA Clash Detection Tool

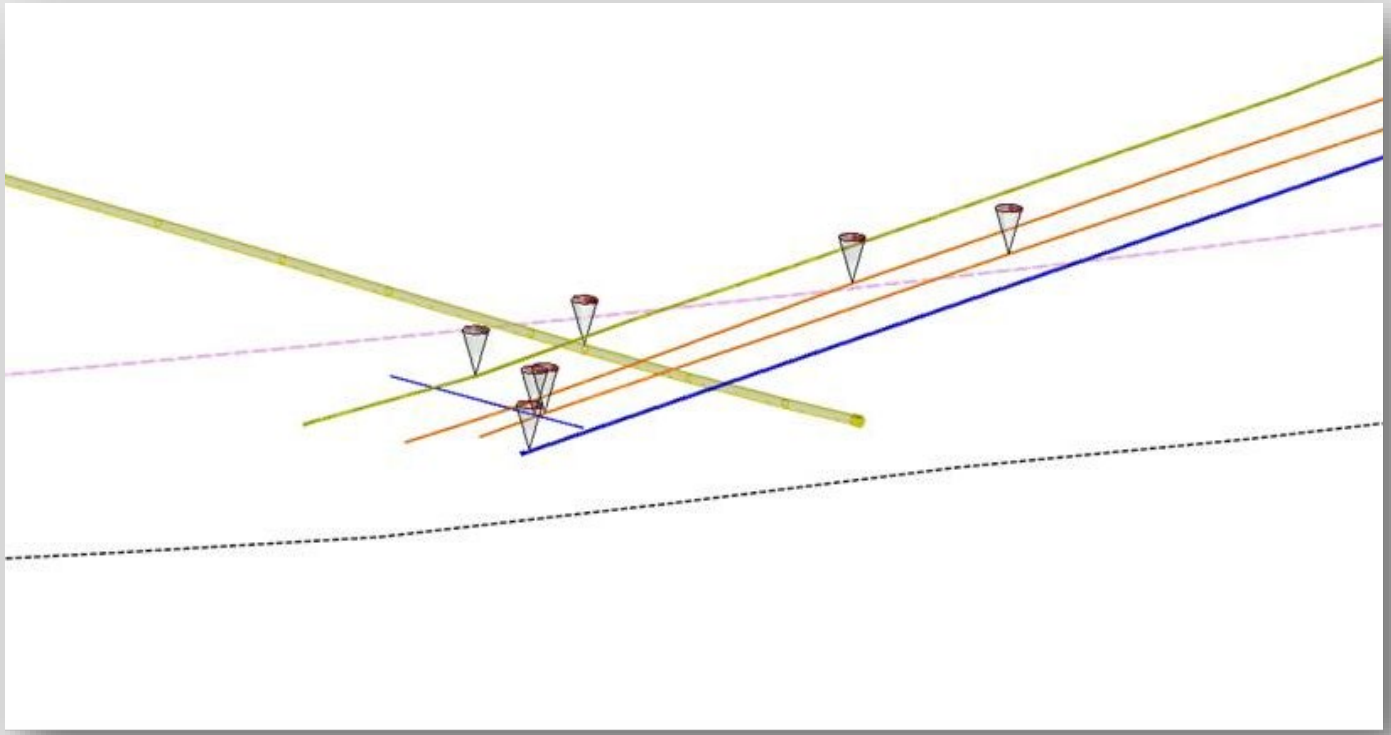


Clash Detection Nodes



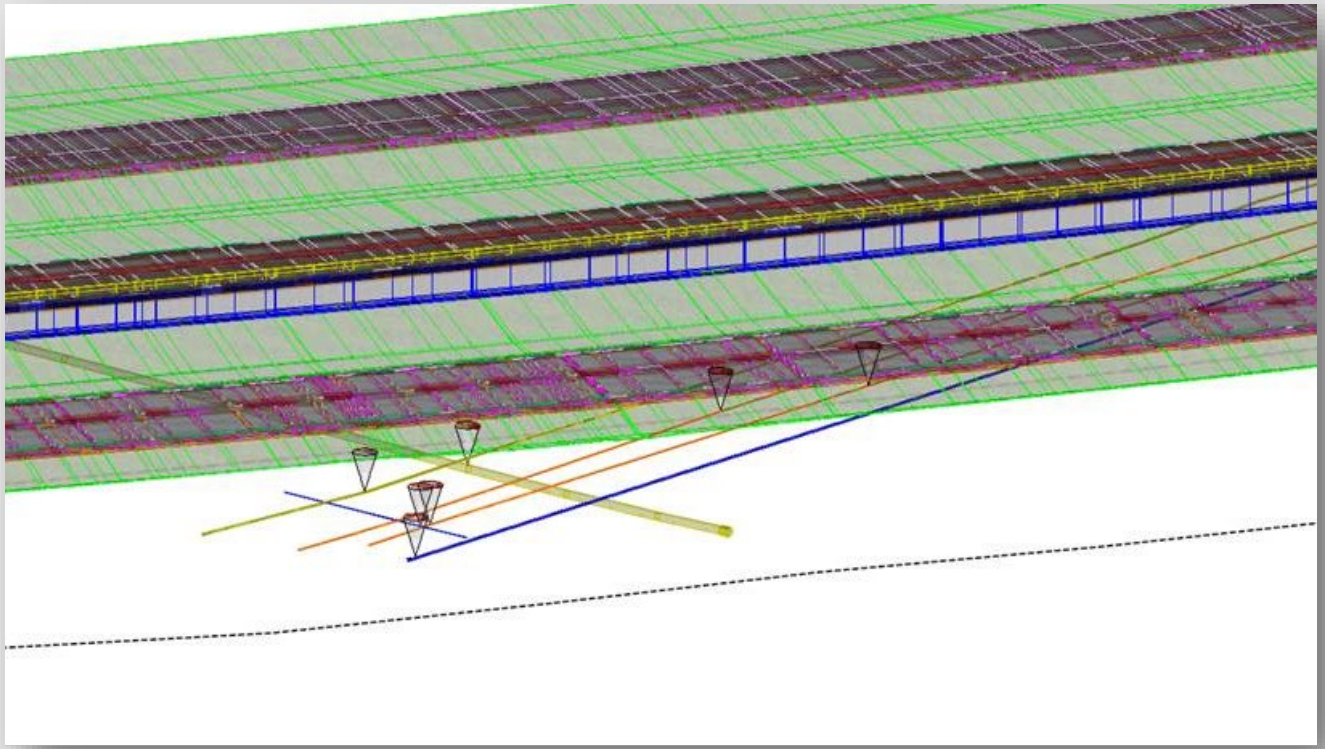
Premont Relief Route CRP District – 3-D Deliverable

- Consultant – 3-D Deliverable



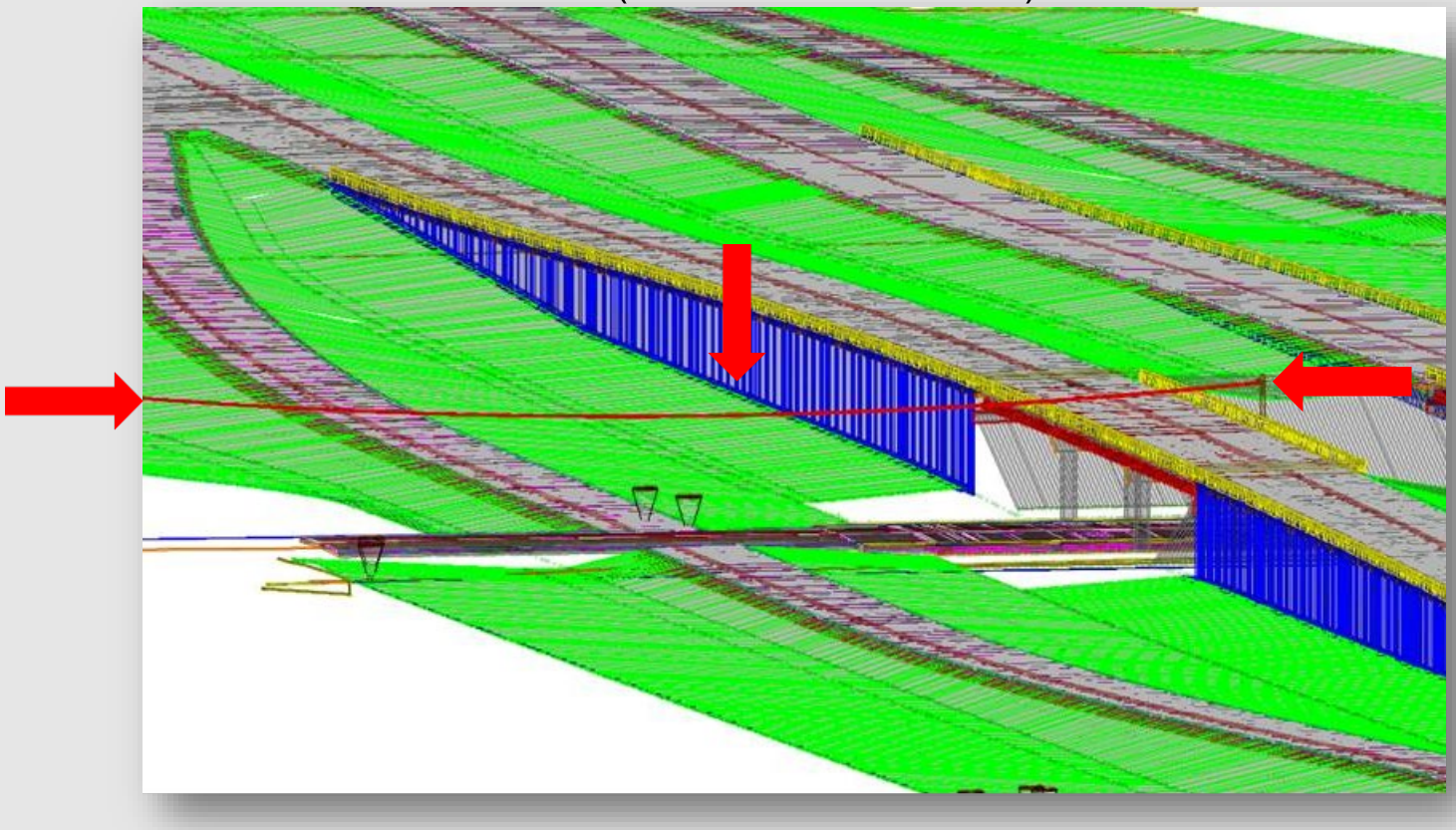
Premont Relief Route CRP District – 3-D Deliverable

- Consultant – 3-D Deliverable with road overlay



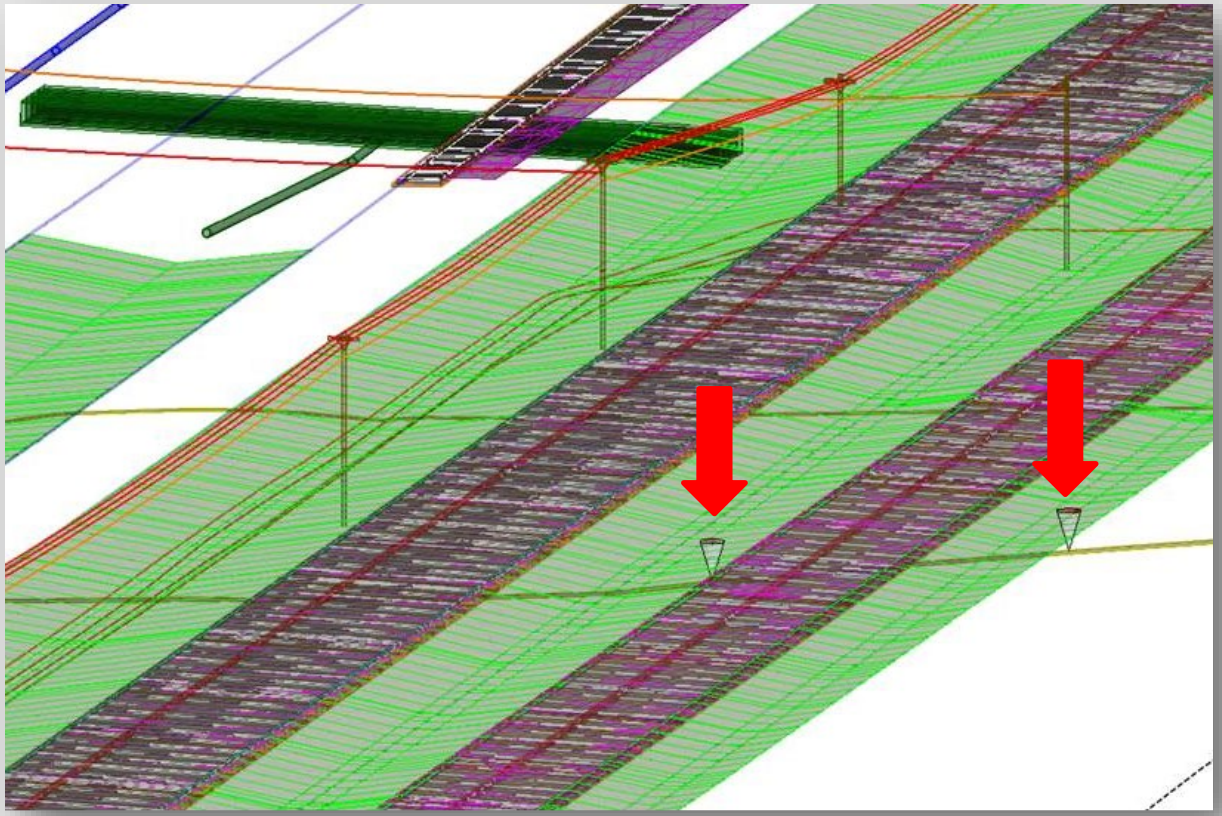
Premont Relief Route CRP District – 3-D Deliverable

- Consultant – 3-D Deliverable (Conflict Identified)



Premont Relief Route CRP District – 3-D Deliverable

- Consultant – 3-D Deliverable Level A Test Holes



Premont Relief Route CRP District – Clash Detection Deliverable

- Design Division - Clash Detection Deliverable

The following utilities are in conflict for sure and we need to verify if they will be moved:

- Fiber Optic Cable at 161+86.23, 23.18' LT with the drill shaft and columns
- Fiber Optic Cable at 161+91.29, 27.62' LT with the drill shaft and columns
- Fiber Optic Cable at 163+05.30, 57.42' LT with the drill shaft and columns
- Fiber Optic Cable at 181+37.85, 258.63' RT with retaining wall
- Water line at 263+80.07, 233.34' RT; 263+81.40, 273.65' RT with 1st ST channel
- Pole at 263+93.38, 248.94' RT with the 1st ST channel
- Gas Line at 264+16.21, 172.42' RT; 264+56.98, 178.64' RT with the 1st ST channel
- Fiber Optic Cable at 329+19.67, 50.29' LT; 330+38.77, 19.14' LT; 331+57.27, 7.25' RT with the drill shaft and columns

The following utilities are those that may conflict. If these are not moving, we need test holes to make sure there is no conflict:

1. Fiber Optic Cable at 157+14.49, 68.68' RT with the culvert
   a. The culvert is buried 2.55' below existing where the fiber optic cable is. The electronic depth shown is 2.87' for the top of cable.
2. Fiber Optic Cable at 157+16.55, 65.26' RT with the culvert
   a. The culvert is buried 2.74' below existing where the fiber optic cable is. The electronic depth shown is 4.2' for the top of cable.
3. Fiber Optic Cable at 157+50, 148.69' LT with the culvert
   a. The culvert is buried 2.21' below existing where the fiber optic cable is. The electronic depth shown is 2.5' for the top of cable.
4. Fiber Optic Cable at 157+50, 142.88' LT with the culvert
   a. The culvert is buried 2.25' below existing where the fiber optic cable is. The electronic depth shown is 3.16' for the top of cable.
   b. If this will not be moved, we should get a test hole
5. Fiber Optic Cable at 162+36.00, 54.70' RT with the culvert
   a. The culvert SET is buried 2.58' below existing where the fiber optic cable is. The electronic depths near it show a depth of about 3.92'.
   b. If this will not be moved, we should get a test hole
6. Gas Line at 162+36.00, 44.37' RT with the culvert
   a. The culvert SET is buried 2.3' below existing where the gas cable is. The electronic depths near it show a depth of about 2.58'.
   b. If this will not be moved, we should get a test hole
7. Fiber Optic Cable at 162+36, 54.70' RT with the culvert
   a. The culvert is buried 2.30' below existing where the fiber optic cable is. The electronic depth shown is 1.94' for the top of cable.
8. Fiber Optic Cable at 164+60.79, 17.25' LT with retaining wall
   a. The bottom of the wall is 6" from the top of the fiber optic line
9. Fiber Optic Cable at 165+93.61, 67.93' LT with retaining wall
   a. The bottom of the wall is 6" from the top of the fiber optic line

Places where there may or may not have a conflict but we don't need a test hole. Should see if these are moving or come up with ways of protecting them:

- Gas Line at 164+30.40, 16.38' LT; 165+69.11, 67.65' LT with retaining wall
  - Pipe is shown 3" below the retaining wall bottom
- Gas Line at 326+29.53, 58' LT; 327+81.18, 5.30' LT with the retaining wall
- Gas Line at 326+47.88, 58' LT; 328+00.50, 5.90' LT with the retaining wall
- Water Line at 327+30.51, 7' LT; 327+46.90, 60.70' LT with the retaining wall

Lessons Learned

- Execute PEPS WA as early as possible – schematic phase or 30% PS&E
- Scope additional Quality Level A Test Holes

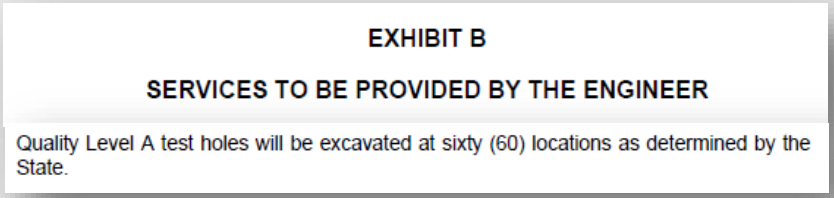


EXHIBIT B

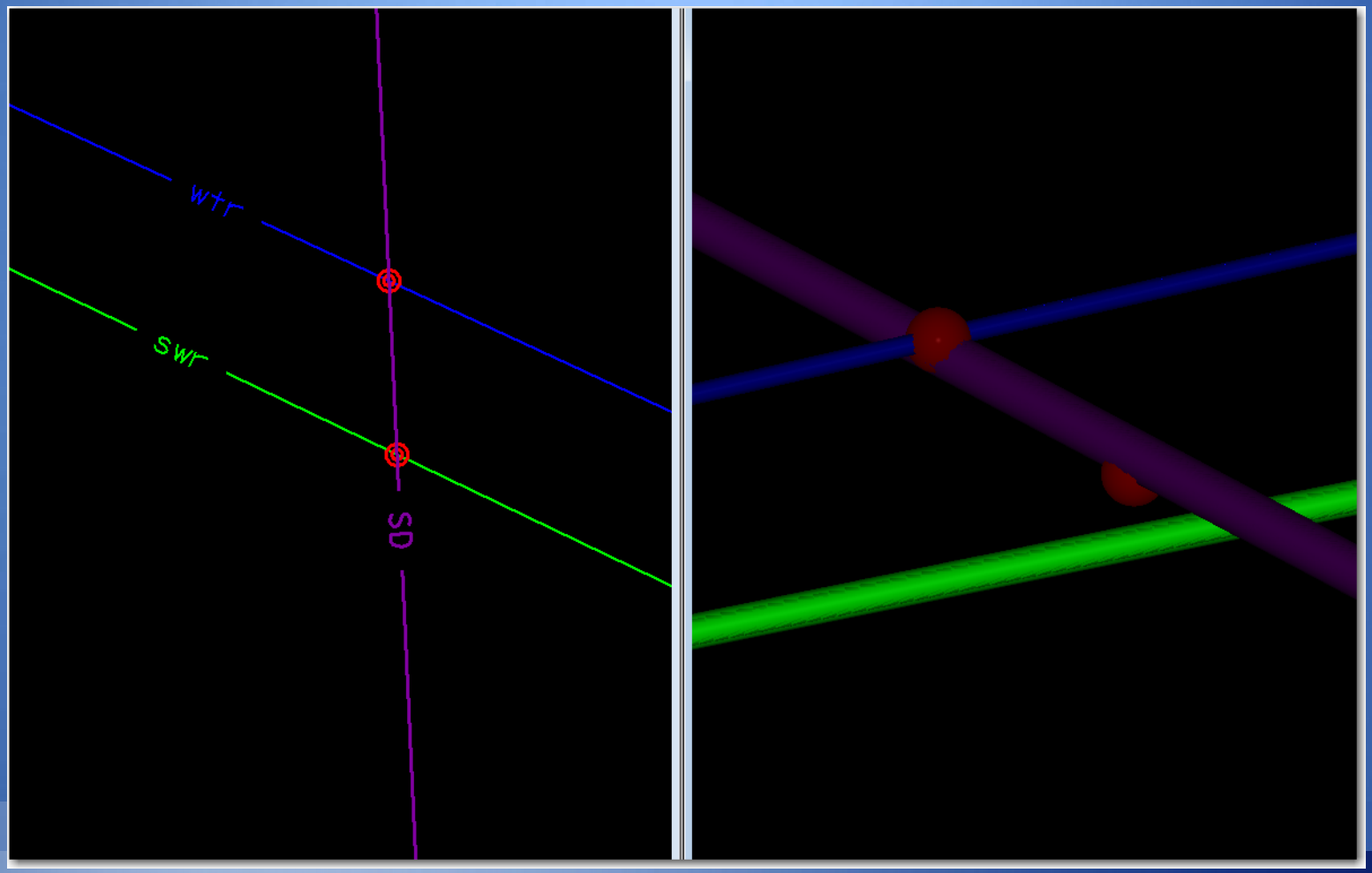
SERVICES TO BE PROVIDED BY THE ENGINEER

Quality Level A test holes will be excavated at sixty (60) locations as determined by the State.

- Utilize Level A Test Holes in initial investigation in areas of high conflict (ditches, bridges, channels, areas of cut, etc.)
- Minimum Level B on crossing utilities/utilities in high conflict areas
- For 3-D Deliverables, using electronic locating devices depths, checking elevations with Level A potholes.
- Scope in the WA, survey grade/as-built data on utility adjustments.

Implementation of Bentley SUDA

Bob Peterson, PE
Methods Engineer



Implementation

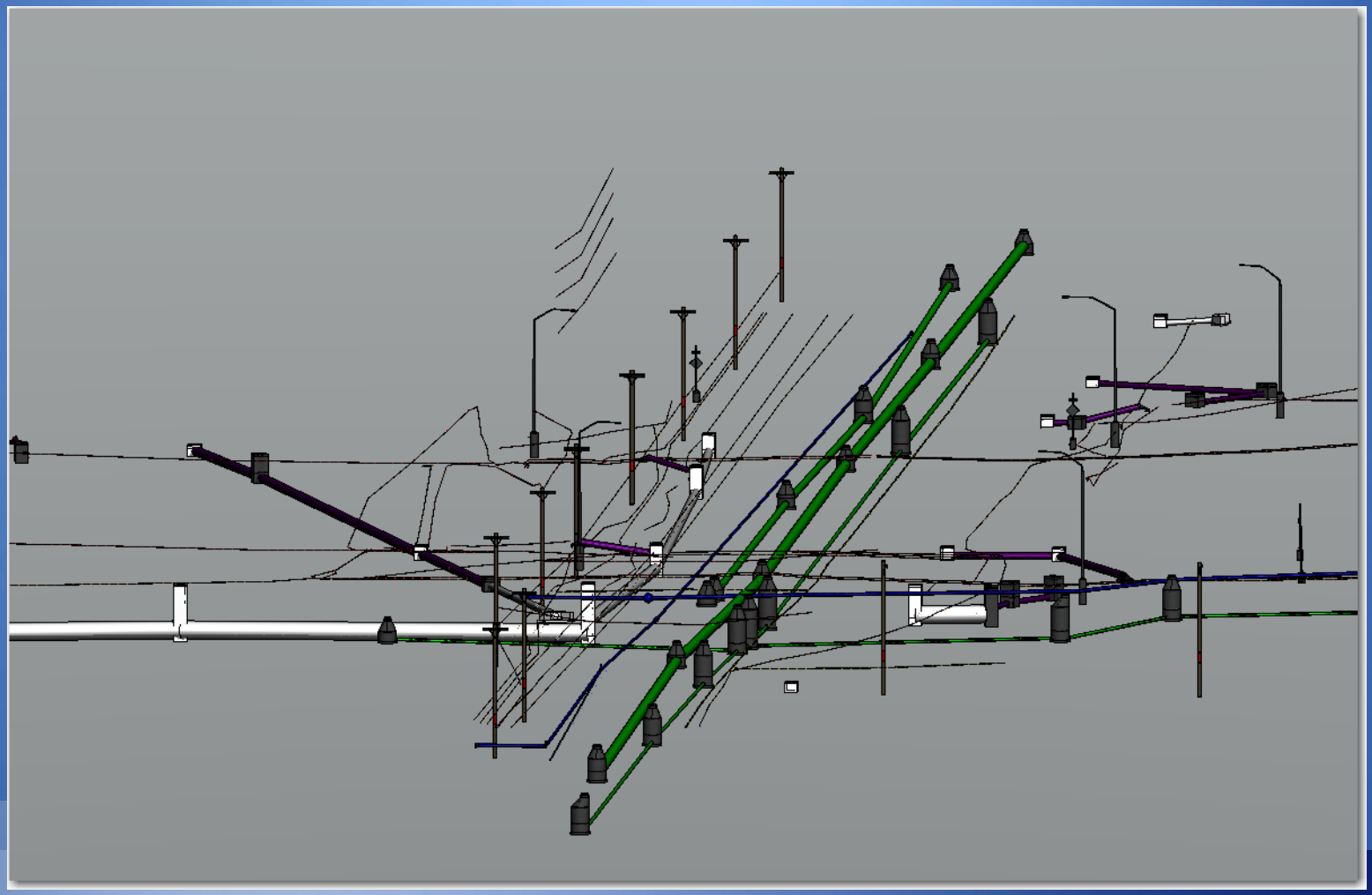
Implementation

Timeline

- September 2014 – UDOT Implements InRoads SS3
- February 2015 – UDOT moves to SS4 version with SUE functionality
- July 2017 – UDOT slowly (cautiously) moves to Open Roads Designer

Reasons for Implementing

- Development of statewide utility Oracle database
  - SUE integration with Oracle database
  - Want to use as 3D graphic display
- Clash detection functionality



Workspace Development

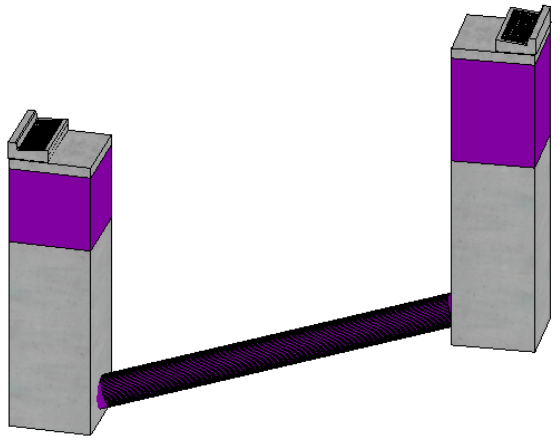
Workspace Development

- Used resources (3D cell, feature definitions) from Bentley workspace
- Created cells for drainage boxes and manholes
- Drainage features developed but don't have prototype values assigned for drainage design
  - Design in SS2 version and either display as solids or import the SDB file into SS4/ORD and assign features
  - Consultant firm on project establishing prototype values that will be incorporated
- Using program for placing non-utility objects (sign posts, signals, delineators, etc)
  - Places object at surface elevation (design or existing)
  - Created objects that go below grade for clash detection

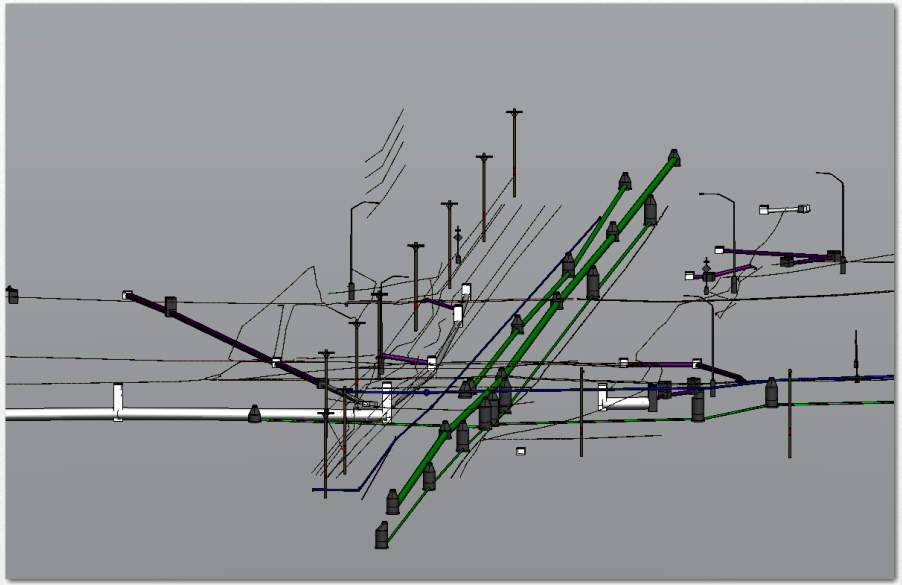
Challenges

Challenges

- Cells loose symbology/materials when placed with SUDA (cell has multiple material assignments – element template only has one available)

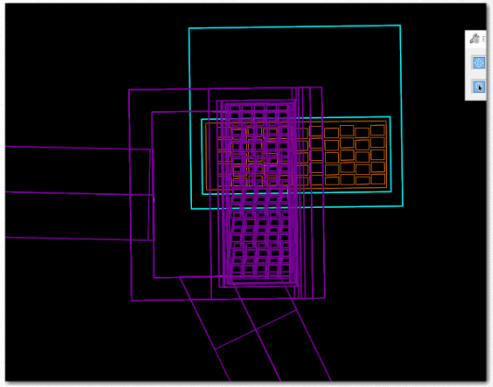


- Generic 3D representation vs. realistic visual (power poles, hydrants)



Challenges

- ORD Problems – Slowness, limitation of profiles cut
- 3D cells may be too detailed – What level of detail is needed?
- Product releases changing schema/functionality
  - Cell rotation problem (just fixed)



  - Database compacting – message that dgn graphic didn't match database elements removed (what elements?)

Challenges

- Connecting to database – securities, format
- SUE providers giving 3D data (only accurate at pothole location)
  - Concern of liability if elevation incorrect
  - Learn 3D layout tools

Future

Future

- Dgnlib that contains clash detection scenarios (soft clearance values for different utilities, testing criteria setting)
- Connectivity with Oracle database that is refreshed when new data I updated – define feature mapping with SUDA
- Fully functioning drainage design workspace

For More Information

Julie A Johnston, Utility & Value Engineering Program Manager

FHWA Office of Infrastructure Preconstruction Team, HICP-10, MI

Julie.johnston@dot.gov 202-591-5858

Cesar Quiroga, Sr. Research Engineer

Texas A&M Trans. Institute - Reseach & Implementation, San Antonio

C-Quiroga@tamu.edu 210-321-1229

Ross Gray, Project Manager

Jacobs

Ross.Gray@Jacobs.com 240-650-2194

AASHTO Web Page: http://shrp2.transportation.org

FHWA Web Page: https://www.fhwa.dot.gov/goshrp2