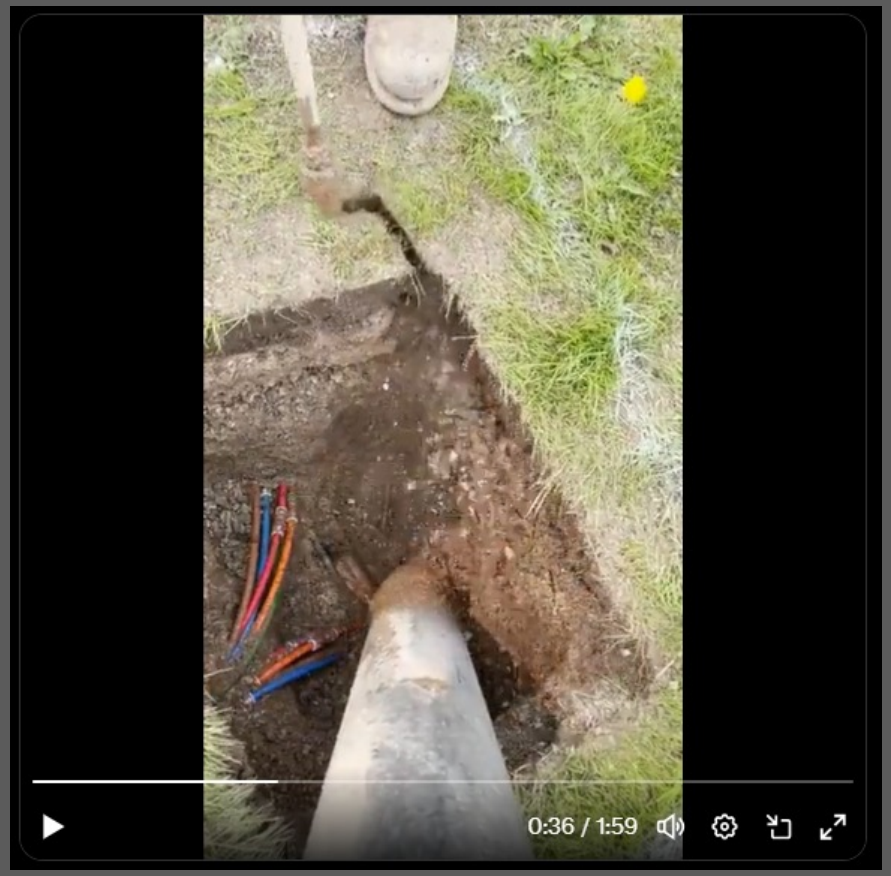
What Lies Beneath?
Automating
Subsurface
Utility
Exploration

What is **Potholing?**

- Also known as:
  - **Subsurface Utility Exploration**
  - Subsurface Utility Engineering
- Mapping **utilities** (three waters, comms, gas, etc.) at appropriate quality levels
- Historically, recording and managing subsurface data has been **widely unregulated**.

What is **Potholing**?

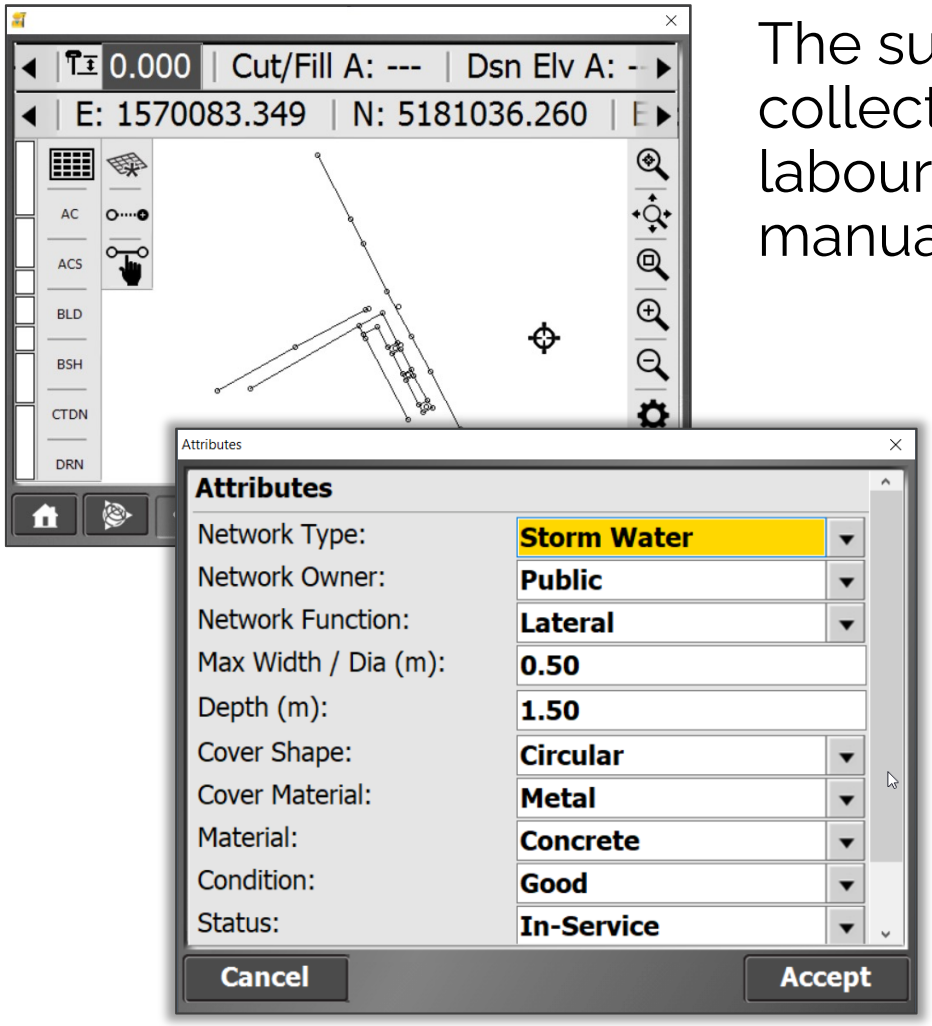


https://twitter.com/Rainmaker1973/status/1659965292427071489

What is **Potholing**?

Survey Pickup

Leica



Trimble

The survey data collection process is labour-intensive, manual and repetitive.

Feature:
Manhole

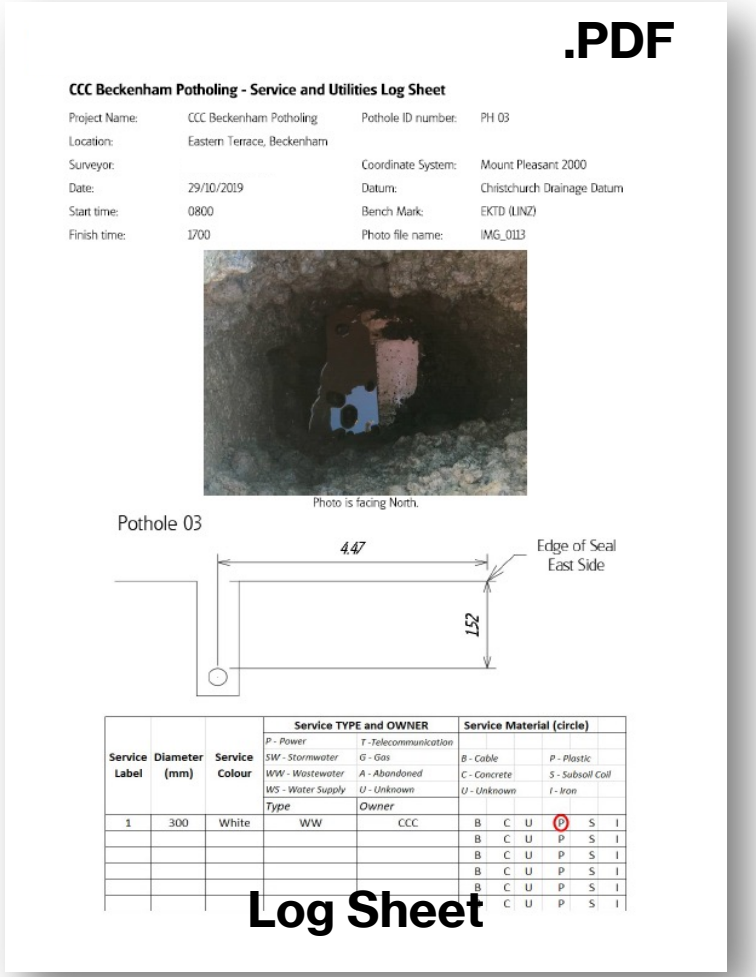
Attributes:
Quality Level A[1]

[1] https://www.kiwirail.co.nz/assets/Uploads/Who-we-are/Innovation/Downloadable-documents/Updated-DE-Framework-Versions/KiwiRail-Digital-Engineering-Subsurface-Utility-Identification-and-Modelling.pdf

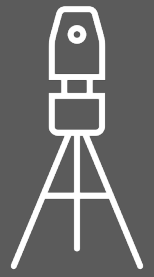
Christchurch City Council (CCC) **Deliverables**

- Log Sheet per Pothole (.pdf)

- Digital
  - Unclear what CCC requires
  - Design firms and Construction firms vary



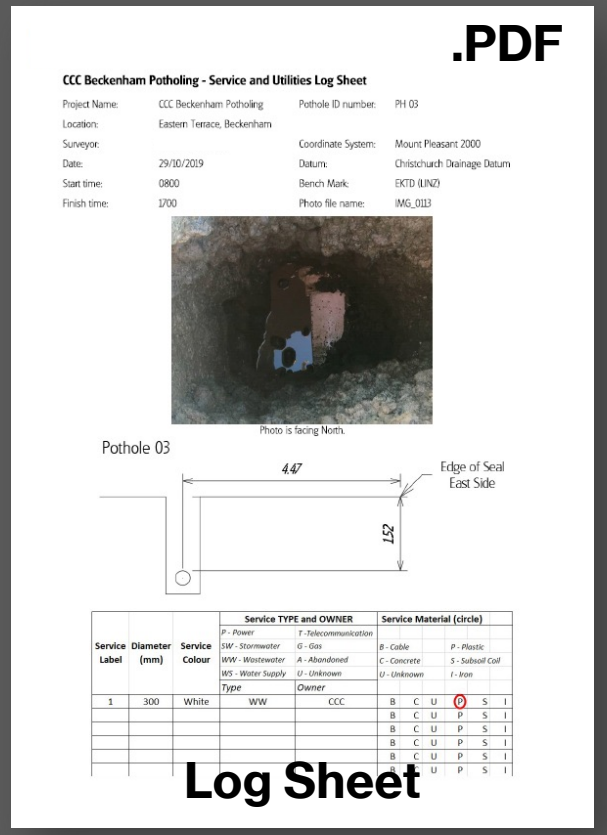
The **Problem**



Survey

Manual log sheets =
~2-3 hours per sheet
in the office

.PDF



CCC Beckenham Potholing - Service and Utilities Log Sheet

Project Name:	CCC Beckenham Potholing	Pothole ID number:	PH 03
Location:	Eastern Terrace, Beckenham		
Surveyor:		Coordinate System:	Mount Pleasant 2000
Date:	29/10/2019	Datum:	Christchurch Drainage Datum
Start time:	0800	Bench Mark:	EKTD (LINZ)
Finish time:	1700	Photo file name:	IMG_0113

Photo is facing North.

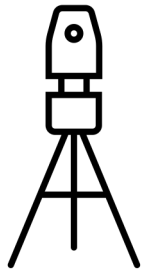
Pothole 03

Service Label	Diameter (mm)	Service Colour	Service TYPE and OWNER		Service Material (circle)
			P - Power SW - Stormwater WW - Wastewater WS - Water Supply	T - Telecommunication G - Gas A - Abandoned U - Unknown	B - Cable, C - Concrete, U - Unknown, P - Plastic, S - Subsoil Coil, I - Iron
			Type	Owner	
1	300	White	WW	CCC	B C U (P) S I
					B C U P S I
					B C U P S I
					B C U P S I
					B C U P S I
					B C U P S I

Log Sheet

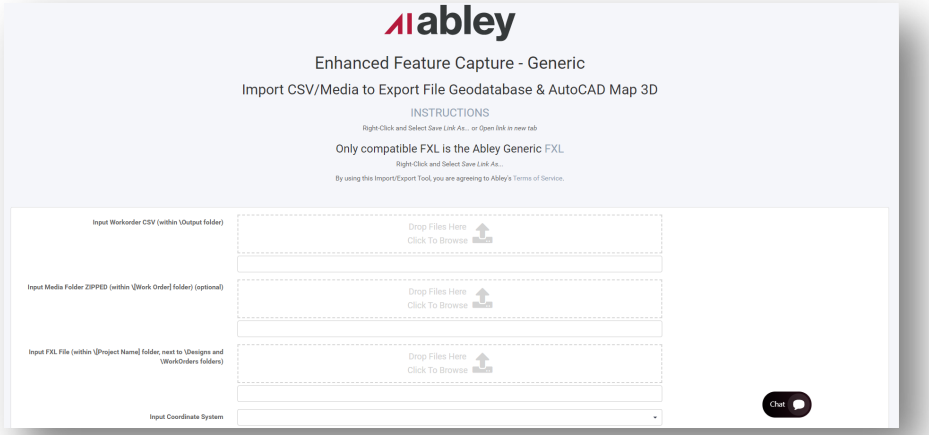
The **Solution**

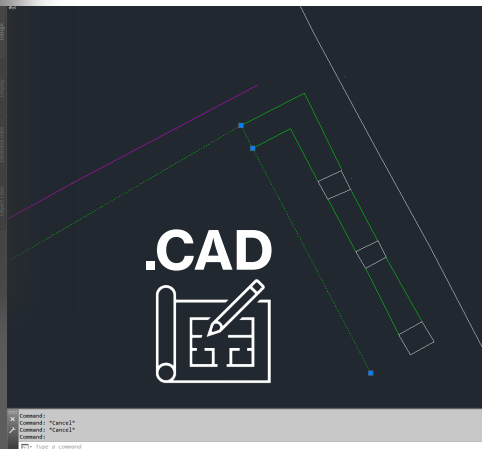
Automate the reporting process end-to-end but **Enhanced**!

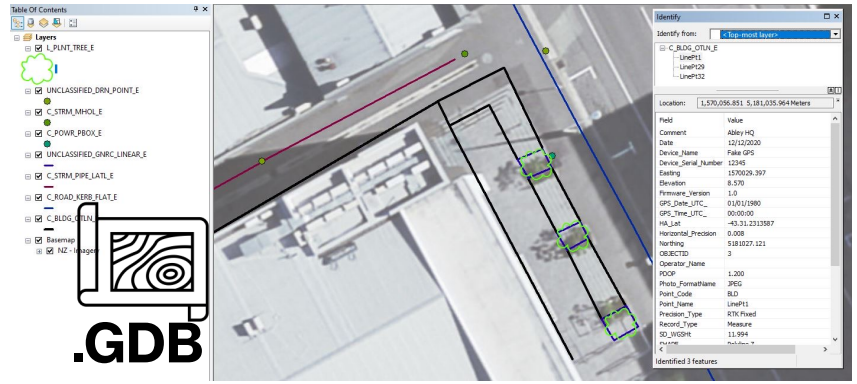


Survey

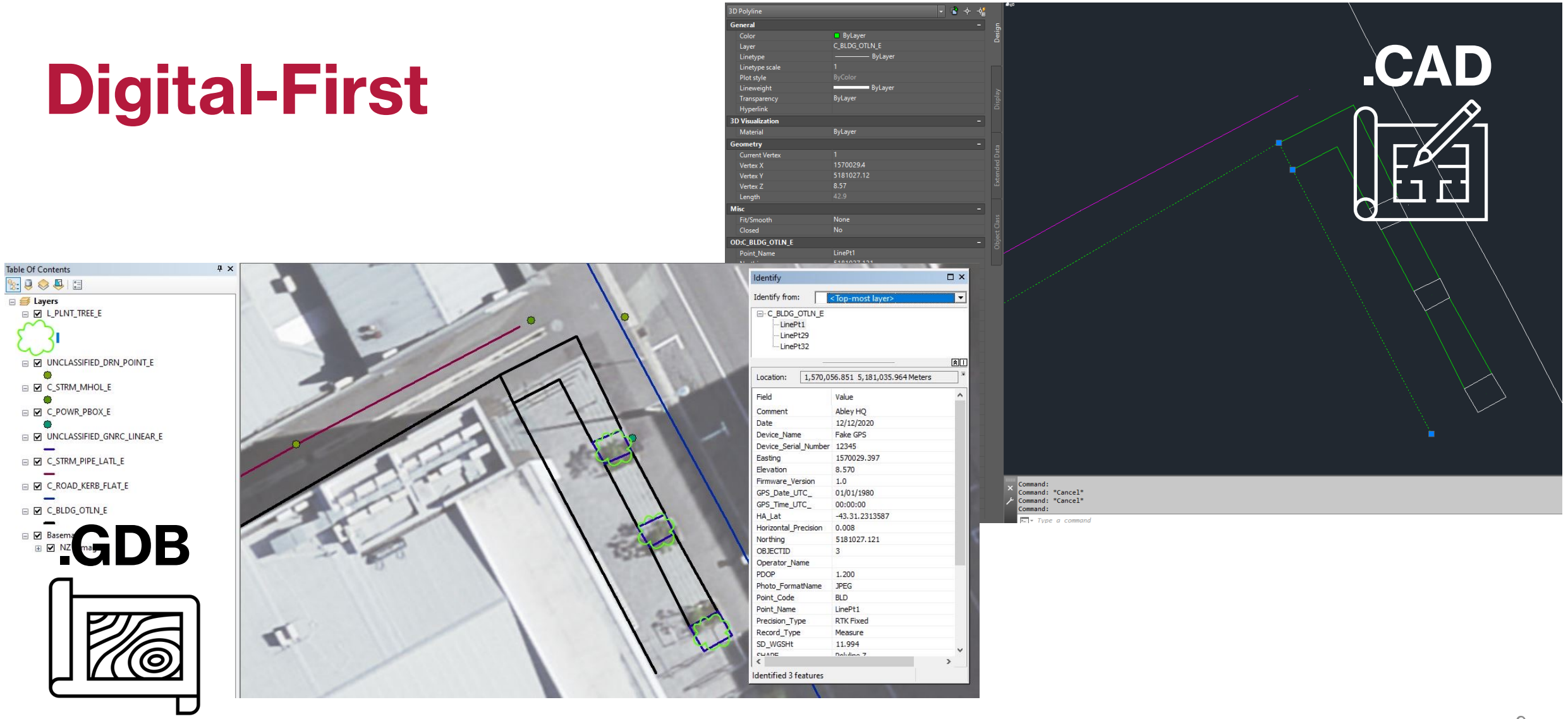
FME





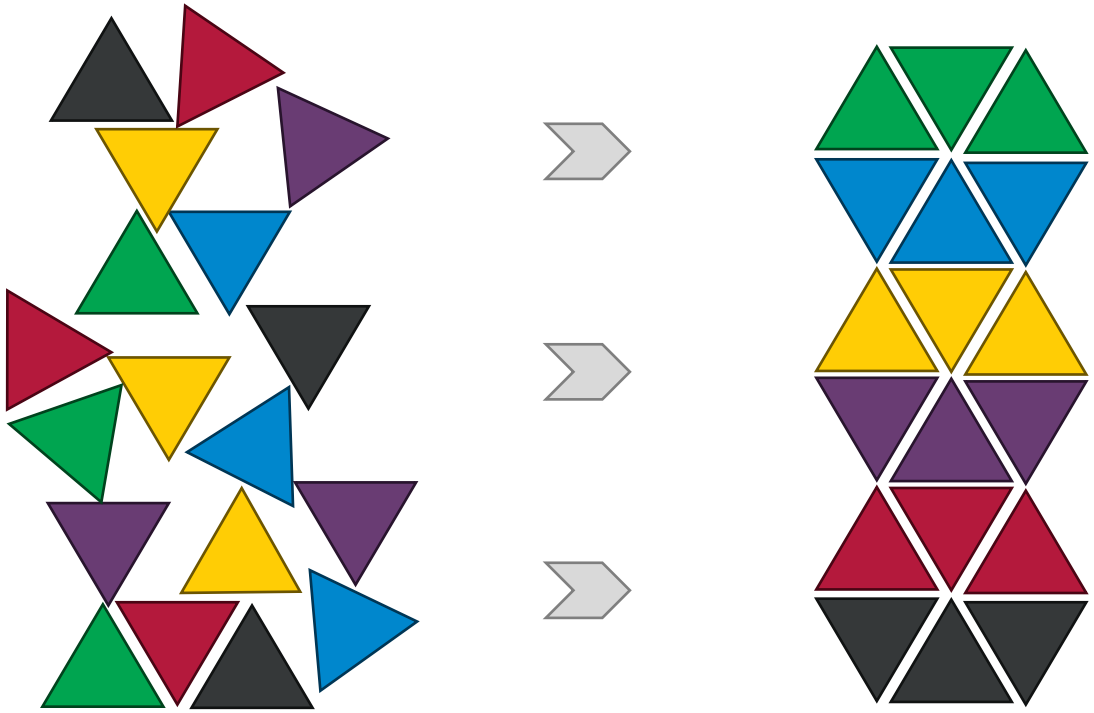


Digital-First



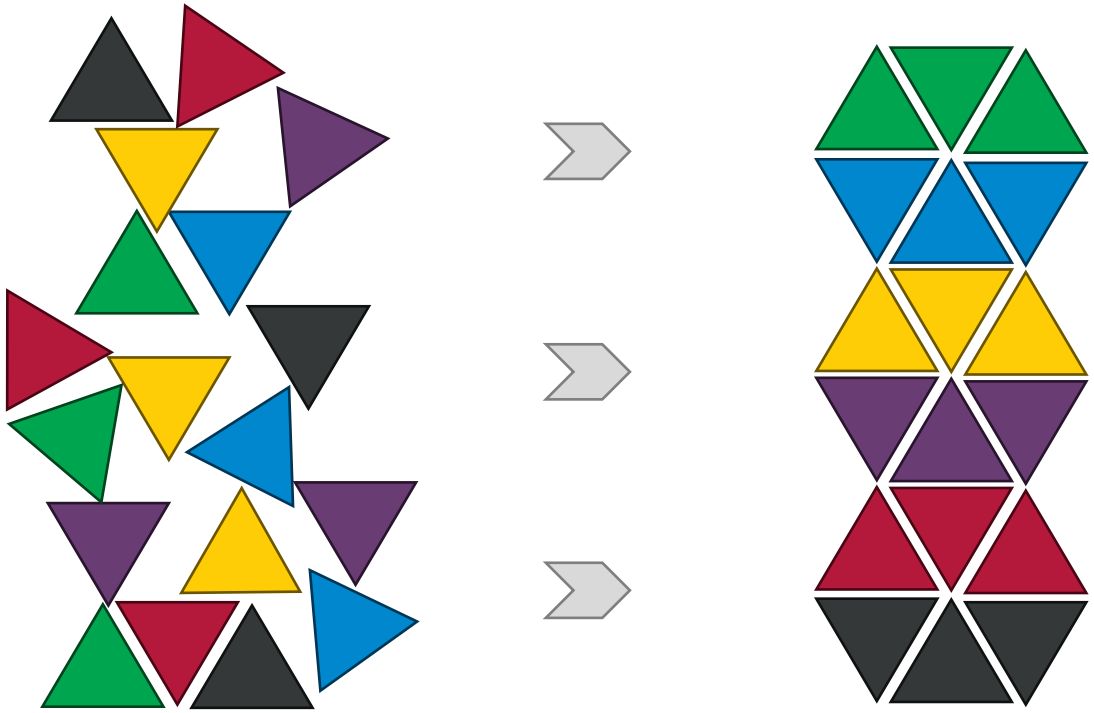
Raw, Structured Data Please

- Trimble
  - Survey Unit Schema
  - CSV Export of Data
  - Photos
- Leica
  - CSV Export of Data
  - LandXML
  - Photos



Raw, Structured Data Please

- Trimble
  - Survey Unit Schema
  - CSV Export of Data
  - Photos
- Leica
  - CSV Export of Data
  - LandXML
  - Photos

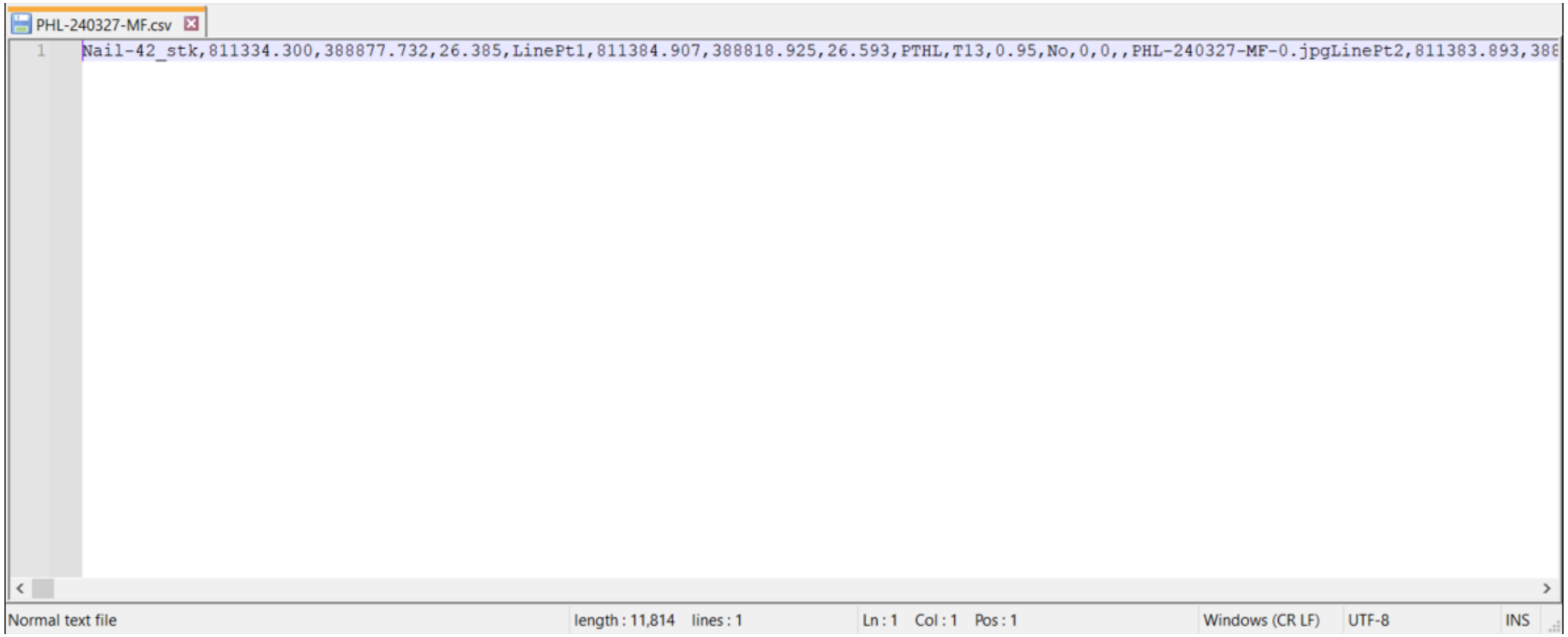


Trimble Unit Photos

- Photos.zip

Trimble CSV Export

That's not so bad!



Trimble CSV Export

oh...

PHL-240327-MF.csv

```
Nail-42_stk,811334.300,388877.732,26.385,LinePt1,811384.907,388818.925,26.593,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt2,811383.893,
388818.098,26.501,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt3,811382.835,388817.230,26.388,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgL
inePt4,811383.039,388816.950,26.386,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt5,811384.051,388817.790,26.465,PTHL,T13,0.95,No,0,0,,PH
L-240327-MF-0.jpgLinePt6,811385.107,388818.642,26.591,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt7,811383.798,388816.076,26.388,PHREF,
T13,KRB,Back of Kerb (KRB),,PHL-240327-MF-1.jpgLinePt8,811382.227,388817.965,26.380,PHREF,T13,KRB,Back of Kerb
(KRB),,PHL-240327-MF-1.jpgLinePt9,811384.718,388818.680,26.292,PIPE,Water Supply,CCC,Sub Main,0.06,Top,1,1,Red,Asbestos,Good,Not
In-Service,,PHL-240327-MF-2.jpgLinePt10,811384.855,388818.566,26.291,PIPE,Water Supply,CCC,Sub Main,0.06,Top,1,1,Red,Asbestos,Good,Not
In-Service,,PHL-240327-MF-2.jpgLinePt11,811384.350,388818.367,26.128,CABLE,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-3.jpgLinePt12,811384.440,388818.213,26.119,CABLE,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-3.jpgLinePt13,811384.019,388818.132,25.907,CABLE1,Communications,Chorus,Co
mms
Trunk,0.04,Top,Yes,1,1,Black,Armor,Fair,In-Service,,PHL-240327-MF-4.jpgLinePt14,811384.125,388817.971,25.901,CABLE1,Communications,Chorus,
Comms
Trunk,0.04,Top,Yes,1,1,Black,Armor,Fair,In-Service,,PHL-240327-MF-4.jpgLinePt15,811383.632,388817.797,25.637,CABLE2,Power,Orion,Unknown,0.
07,Top,Yes,1,1,Orange,PVC,Good,Unknown,,PHL-240327-MF-5.jpgLinePt16,811383.758,388817.666,25.641,CABLE2,Power,Orion,Unknown,0.07,Top,Yes,1
,1,Orange,PVC,Good,Unknown,,PHL-240327-MF-5.jpgLinePt20,811365.009,388838.765,26.395,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt18,811
383.487,388817.677,25.782,CABLE3,Power,Orion,Unknown,0.07,Top,Yes,1,2,Orange,PVC,Good,Unknown,,PHL-240327-MF-6.jpgLinePt19,811383.613,3888
17.534,25.791,CABLE3,Power,Orion,Unknown,0.07,Top,Yes,1,2,Orange,PVC,Good,Unknown,,PHL-240327-MF-6.jpgLinePt21,811365.193,388838.565,26.39
9,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt22,811366.350,388839.464,26.466,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt23,811367.
452,388840.337,26.519,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt24,811367.245,388840.645,26.561,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7
.jpgLinePt25,811365.921,388839.595,26.475,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt26,811364.460,388839.393,26.405,PHREF1,T14,KRB,Ba
ck of Kerb (KRB)LinePt27,811366.201,388837.271,26.405,PHREF1,T14,KRB,Back of Kerb (KRB)LinePt28,811367.066,388840.358,26.041,PIPE1,Water
Supply,CCC,Sub Main,0.06,Top,1,1,Grey,Asbestos,Fair,Unknown,,PHL-240327-MF-8.jpgLinePt29,811367.183,388840.222,26.046,PIPE1,Water
Supply,CCC,Sub
Main,0.06,Top,1,1,Grey,Asbestos,Fair,Unknown,,PHL-240327-MF-8.jpgLinePt30,811366.570,388839.967,25.905,CABLE4,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-9.jpgLinePt31,811366.709,388839.837,25.916,CABLE4,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-9.jpgLinePt32,811366.502,388839.909,25.539,CABLE5,Communications,Enable,Co
```

Normal text file | length : 11,814 lines : 1 | Ln : 1 Col : 1 Pos : 1 | Windows (CR LF) | UTF-8 | INS

Trimble CSV Export

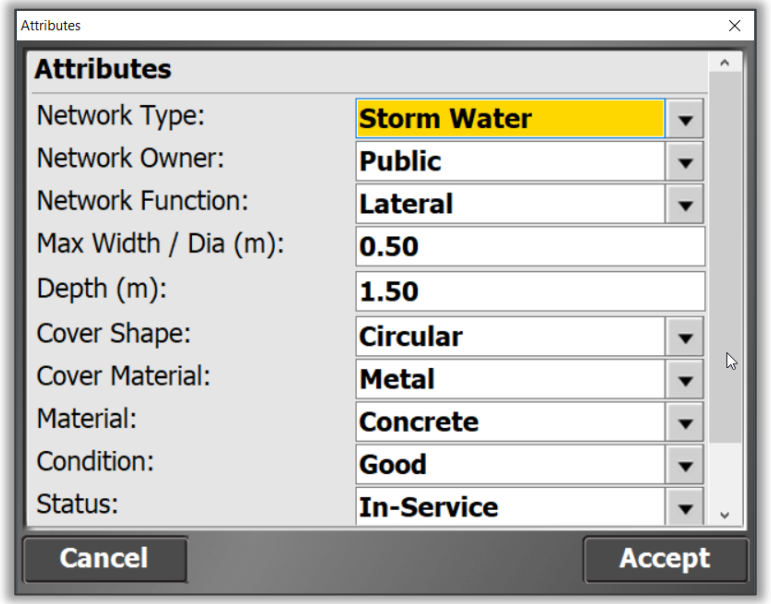
Whew!

PHL-240327-MF.csv

```
Nail-42 stk,811334.300,388877.732,26.385,LinePt1,811384.907,388818.925,26.593,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt2,811383.893,
388818.098,26.501,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt3,811382.835,388817.230,26.388,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgL
inePt4,811383.039,388816.950,26.386,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt5,811384.051,388817.790,26.465,PTHL,T13,0.95,No,0,0,,PH
L-240327-MF-0.jpgLinePt6,811385.107,388818.642,26.591,PTHL,T13,0.95,No,0,0,,PHL-240327-MF-0.jpgLinePt7,811383.798,388816.076,26.388,PHREF,
T13,KRB,Back of Kerb (KRB),,PHL-240327-MF-1.jpgLinePt8,811382.227,388817.965,26.380,PHREF,T13,KRB,Back of Kerb
(KRB),,PHL-240327-MF-1.jpgLinePt9,811384.718,388818.680,26.292,PIPE,Water Supply,CCC,Sub Main,0.06,Top,1,1,Red,Asbestos,Good,Not
In-Service,,PHL-240327-MF-2.jpgLinePt10,811384.855,388818.566,26.291,PIPE,Water Supply,CCC,Sub Main,0.06,Top,1,1,Red,Asbestos,Good,Not
In-Service,,PHL-240327-MF-2.jpgLinePt11,811384.350,388818.367,26.128,CABLE,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-3.jpgLinePt12,811384.440,388818.213,26.119,CABLE,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-3.jpgLinePt13,811384.019,388818.132,25.907,CABLE1,Communications,Chorus,Co
mms
Trunk,0.04,Top,Yes,1,1,Black,Armor,Fair,In-Service,,PHL-240327-MF-4.jpgLinePt14,811384.125,388817.971,25.901,CABLE1,Communications,Chorus,
Comms
Trunk,0.04,Top,Yes,1,1,Black,Armor,Fair,In-Service,,PHL-240327-MF-4.jpgLinePt15,811383.632,388817.797,25.637,CABLE2,Power,Orion,Unknown,0.
07,Top,Yes,1,1,Orange,PVC,Good,Unknown,,PHL-240327-MF-5.jpgLinePt16,811383.758,388817.666,25.641,CABLE2,Power,Orion,Unknown,0.07,Top,Yes,1
,1,Orange,PVC,Good,Unknown,,PHL-240327-MF-5.jpgLinePt20,811365.009,388838.765,26.395,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt18,811
383.487,388817.677,25.782,CABLE3,Power,Orion,Unknown,0.07,Top,Yes,1,2,Orange,PVC,Good,Unknown,,PHL-240327-MF-6.jpgLinePt19,811383.613,3888
17.534,25.791,CABLE3,Power,Orion,Unknown,0.07,Top,Yes,1,2,Orange,PVC,Good,Unknown,,PHL-240327-MF-6.jpgLinePt21,811365.193,388838.565,26.39
9,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt22,811366.350,388839.464,26.466,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt23,811367.
452,388840.337,26.519,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt24,811367.245,388840.645,26.561,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7
.jpgLinePt25,811365.921,388839.595,26.475,PTHL1,T14,1.1,No,0,0,,PHL-240327-MF-7.jpgLinePt26,811364.460,388839.393,26.405,PHREF1,T14,KRB,Ba
ck of Kerb (KRB),LinePt27,811366.201,388837.271,26.405,PHREF1,T14,KRB,Back of Kerb (KRB),LinePt28,811367.066,388840.358,26.041,PIPE1,Water
Supply,CCC,Sub Main,0.06,Top,1,1,Grey,Asbestos,Fair,Unknown,,PHL-240327-MF-8.jpgLinePt29,811367.183,388840.222,26.046,PIPE1,Water
Supply,CCC,Sub
Main,0.06,Top,1,1,Grey,Asbestos,Fair,Unknown,,PHL-240327-MF-8.jpgLinePt30,811366.570,388839.967,25.905,CABLE4,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-9.jpgLinePt31,811366.709,388839.837,25.916,CABLE4,Power,Orion,Low
Voltage,0.02,Top,No,1,1,Black,Armor,Good,Unknown,,PHL-240327-MF-9.jpgLinePt32,811366.502,388839.909,25.539,CABLE5,Communications,Enable,Co
```

Normal text file | length : 11,814 lines : 1 | Ln : 1 Col : 1 Pos : 1 | Windows (CR LF) | UTF-8 | INS

Trimble Unit Schema

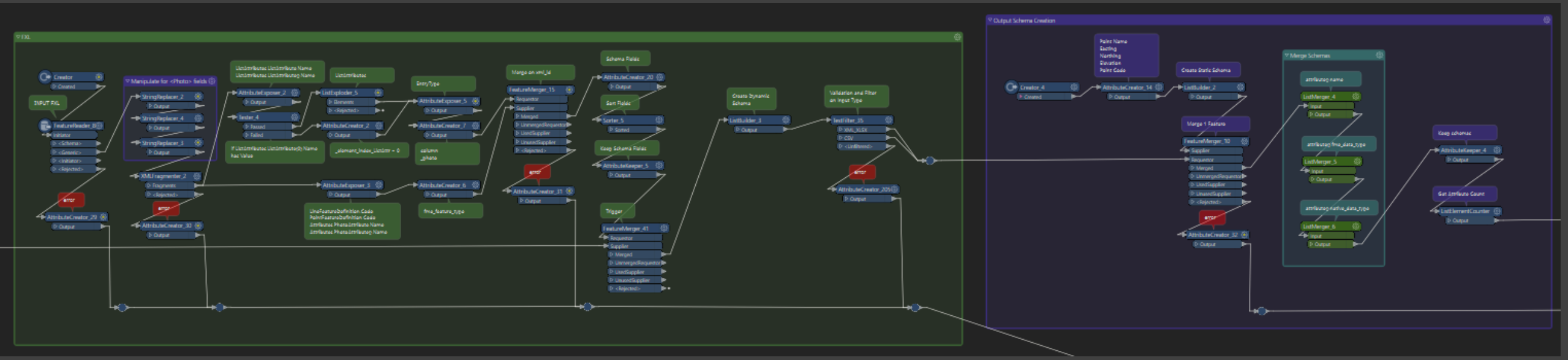


Unit Interface

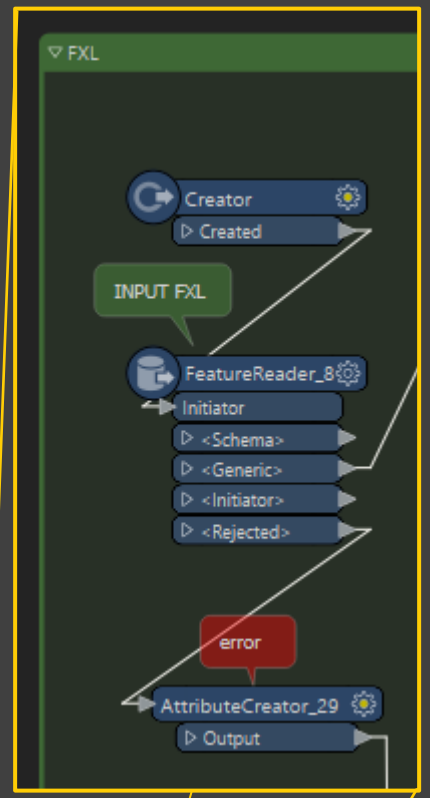
- FXL File
  - XML-Based

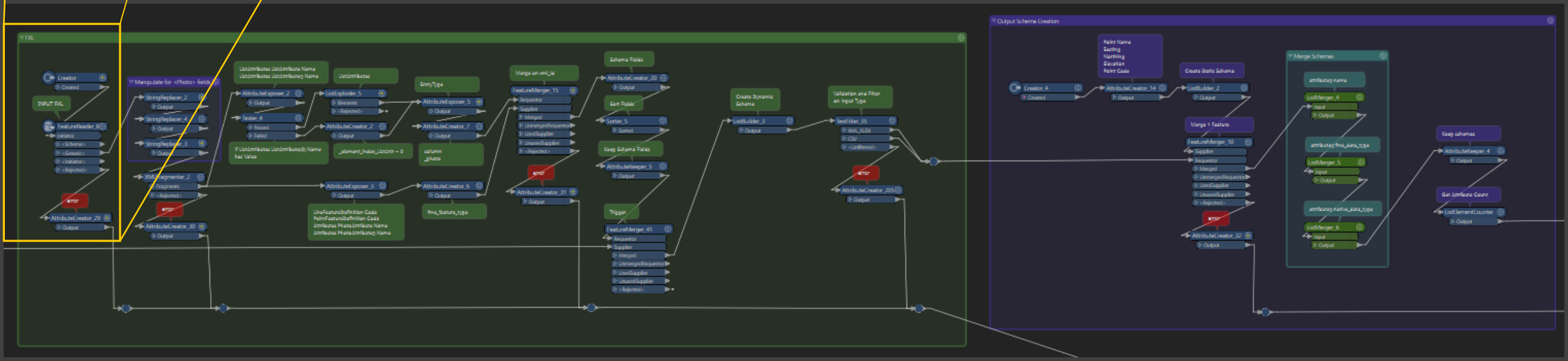
```
<FeatureDefinitions>
  <LineFeatureDefinition Code="CABLE" Name="Cable / Duct" Category="Potholing Linear" IncludeInSurface="false" Color="FF00FF00"
  Layer="SURV_SCS_UTILITIES_E" FieldLineStyle="Solid" LineStyleName="Solid" LineStyleScale="1" LineLabelStyle="Standard"
  PointLabelStyle="Standard" PointLayer="0">
    <Attributes>
      <ListAttribute Name="Network Type" Description="Type of Utility Network" EntryMethod="Required" IsLabelVisible="true">
        <ListItems>
          <Item>Communications</Item>
          <Item>Power</Item>
          <Item>Other</Item>
          <Item>Unknown</Item>
        </ListItems>
      </ListAttribute>
      <ListAttribute Name="Network Owner" Description="Network Owner" EntryMethod="Required" IsLabelVisible="true">
        <ListItems>
          <Item>CCC</Item>
          <Item>Orion</Item>
          <Item>Chorus</Item>
          <Item>One NZ</Item>
          <Item>Enable</Item>
          <Item>MainPower</Item>
          <Item>Other</Item>
          <Item>Unknown</Item>
        </ListItems>
      </ListAttribute>
      <ListAttribute Name="Network Function" Description="Functional type or class" EntryMethod="Required" IsLabelVisible="true">
        <ListItems>
          <Item>Main</Item>
          <Item>Sub Main</Item>
          <Item>Lateral</Item>
          <Item>High Voltage</Item>
          <Item>Low Voltage</Item>
          <Item>Comms Trunk</Item>
          <Item>Comms Local</Item>
          <Item>Traffic Signals</Item>
          <Item>Other</Item>
          <Item>Unknown</Item>
        </ListItems>
      </ListAttribute>
```

Dynamic Schema Creation

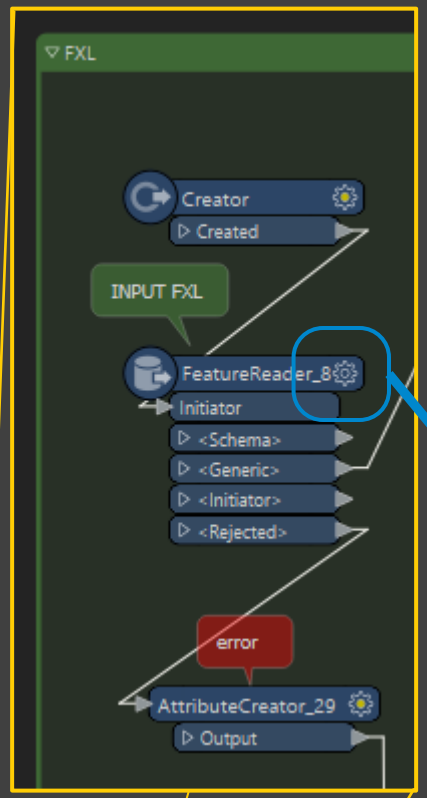


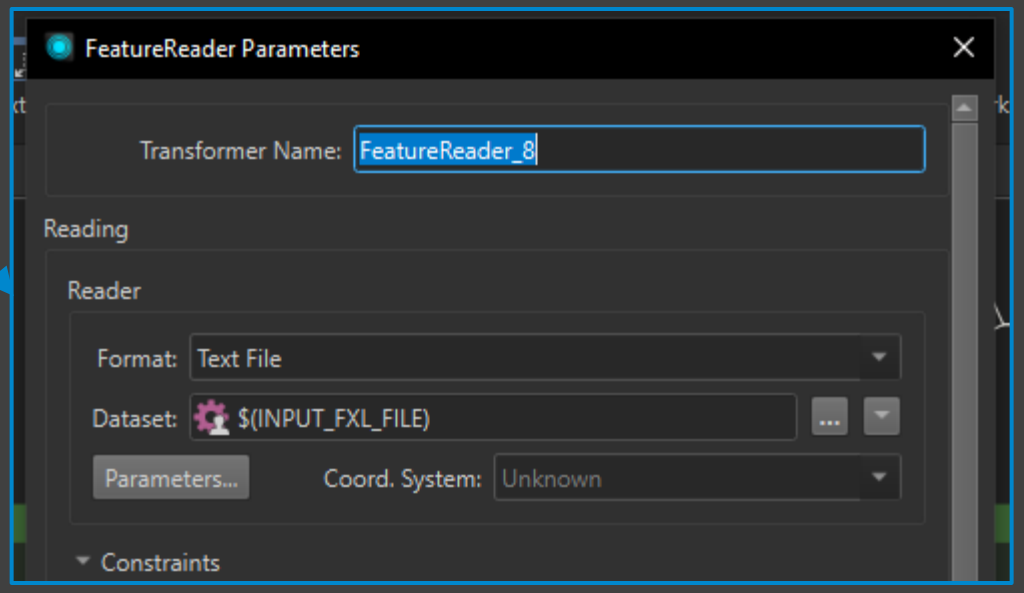
Dynamic Schema Creation



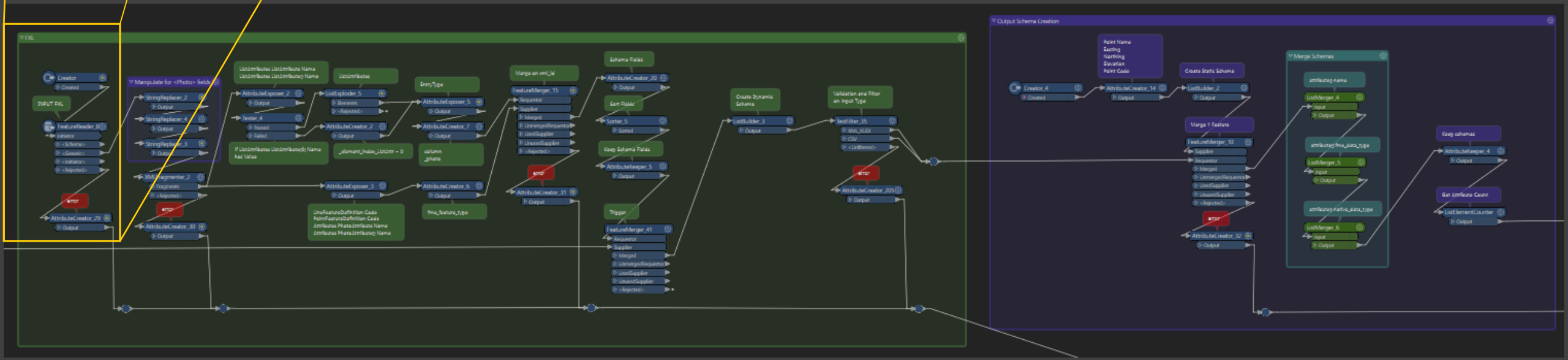


Dynamic Schema Creation

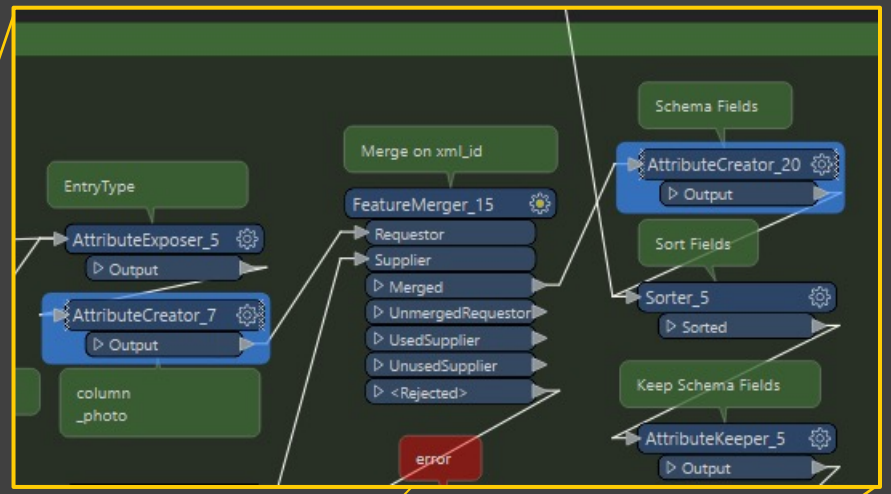


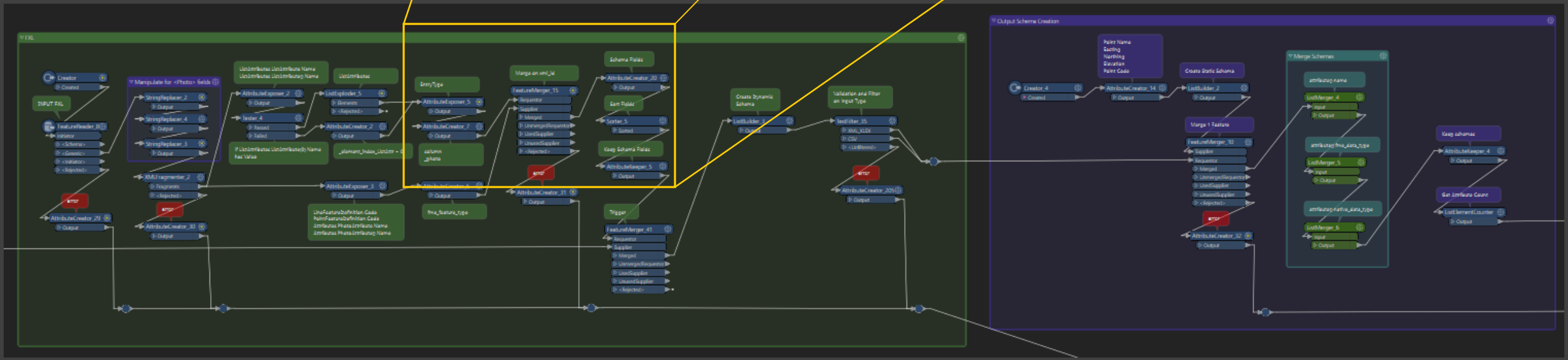


- Text Reader for XML File
- Dynamic Input

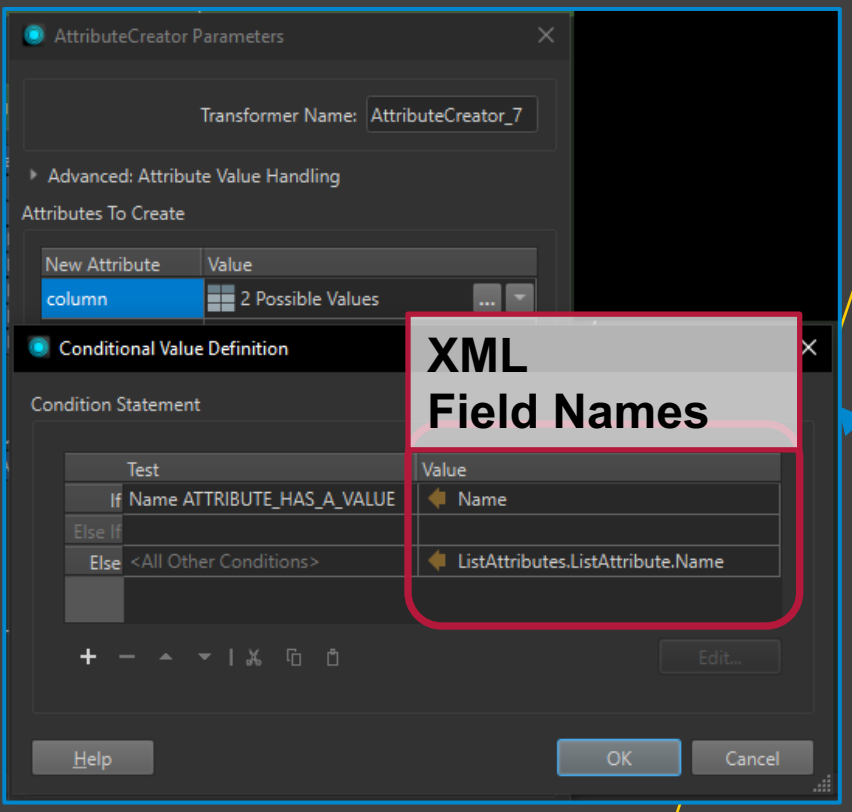


Dynamic Schema Creation

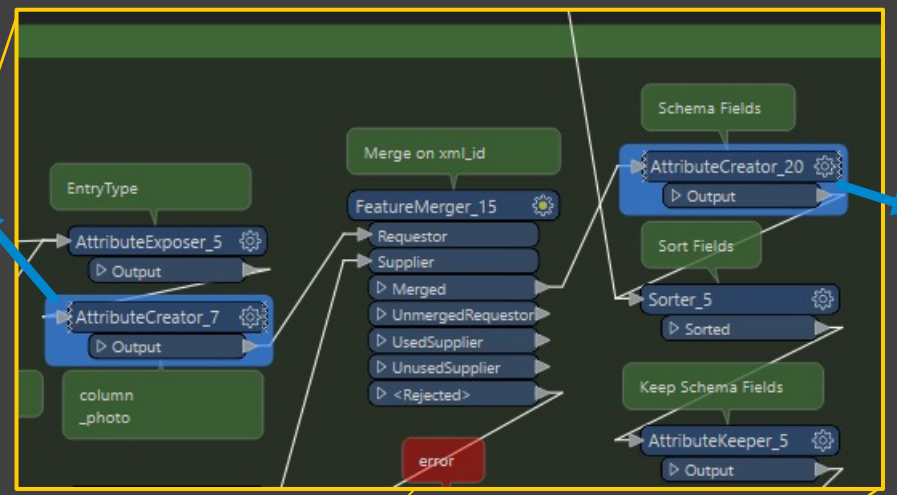


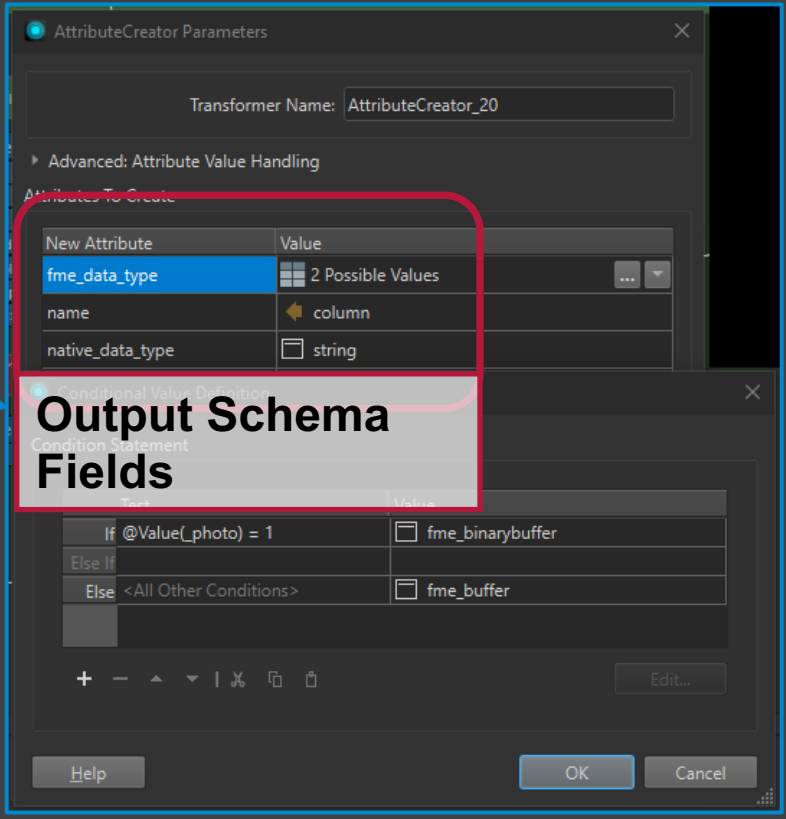


Dynamic Schema Creation

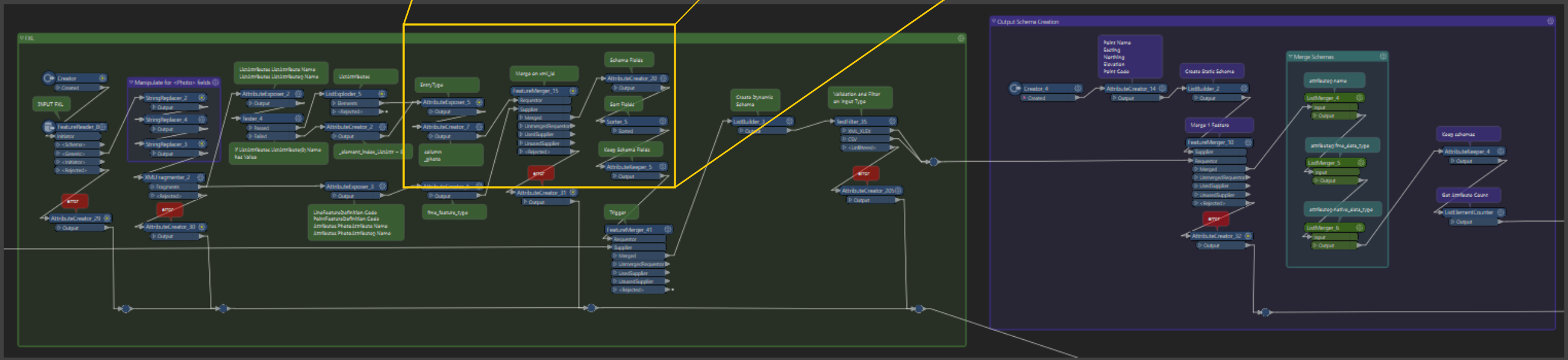


XML Field Names

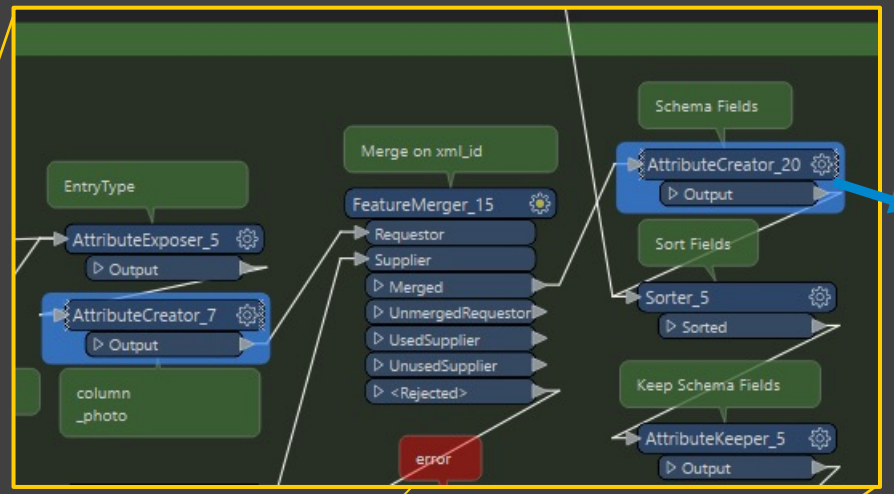


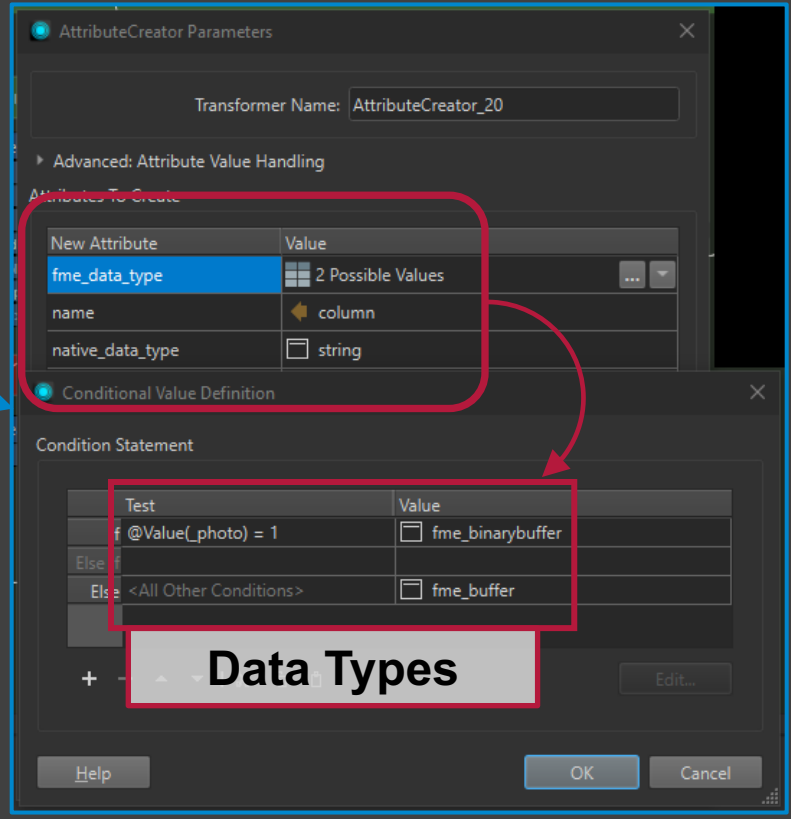


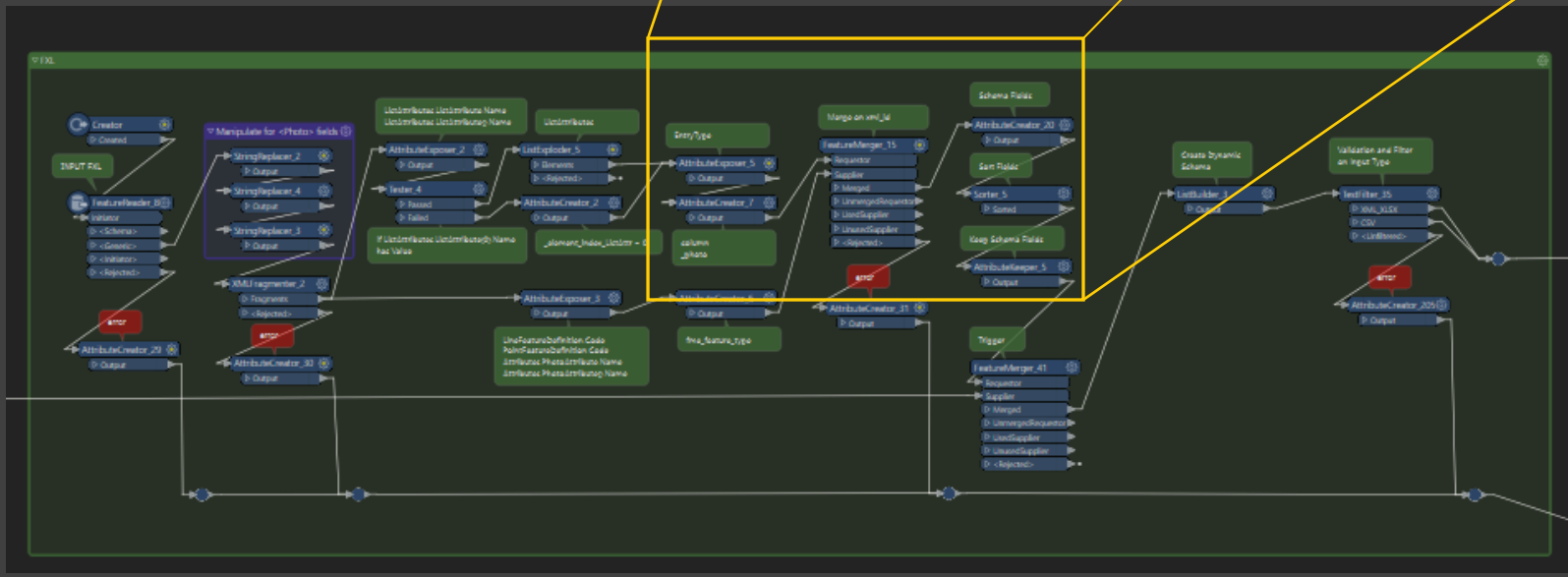
Output Schema Fields

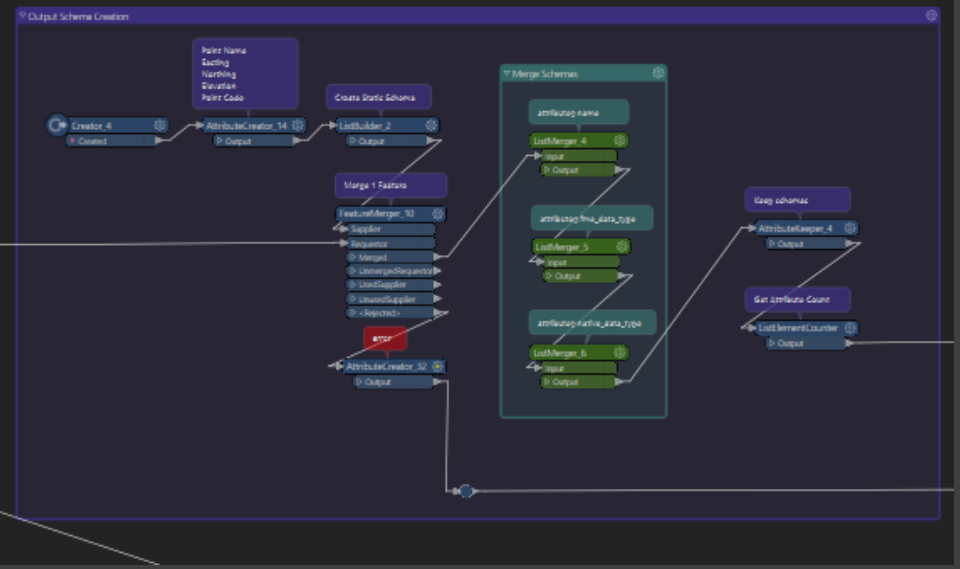


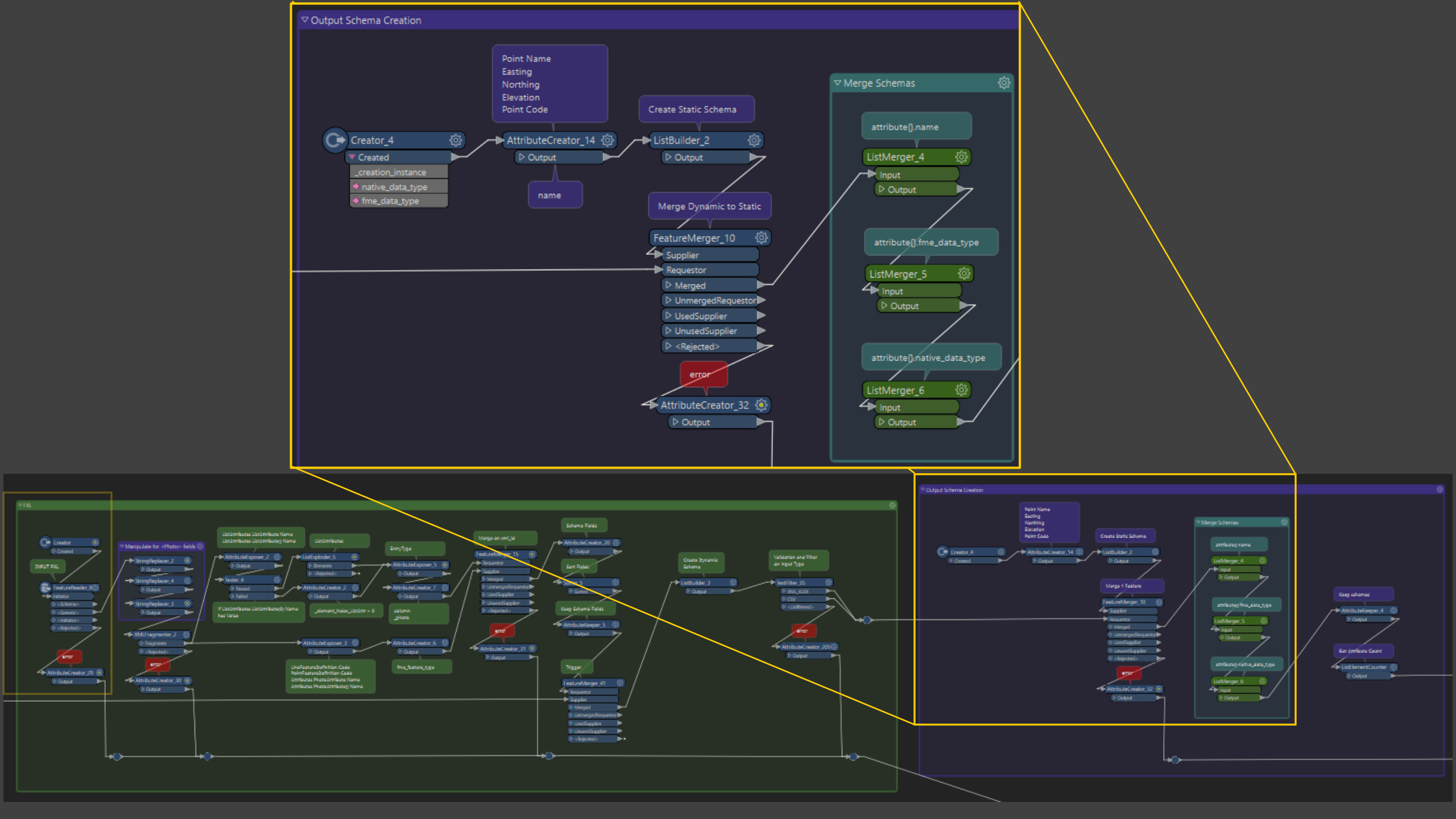
Dynamic Schema Creation

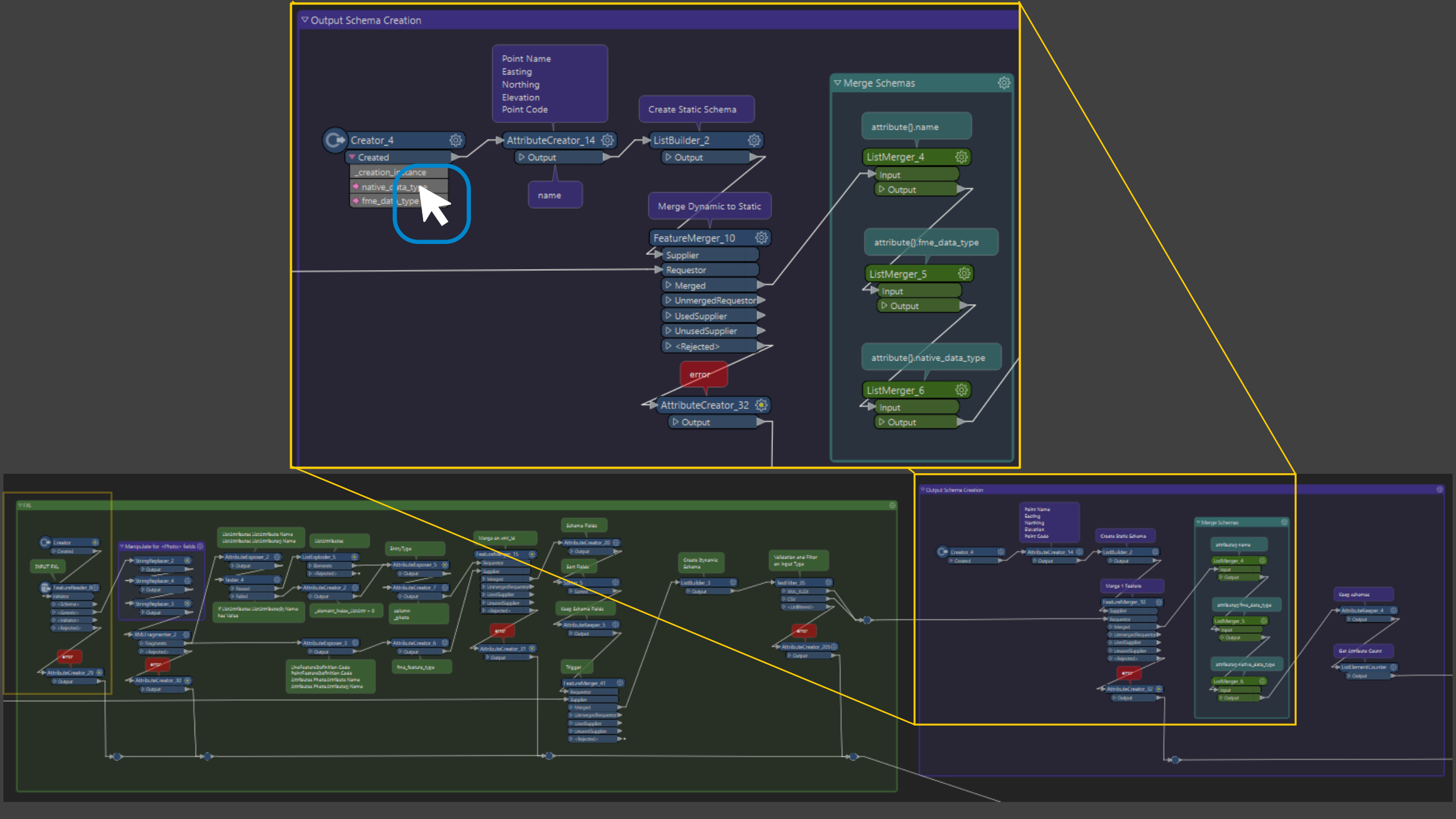


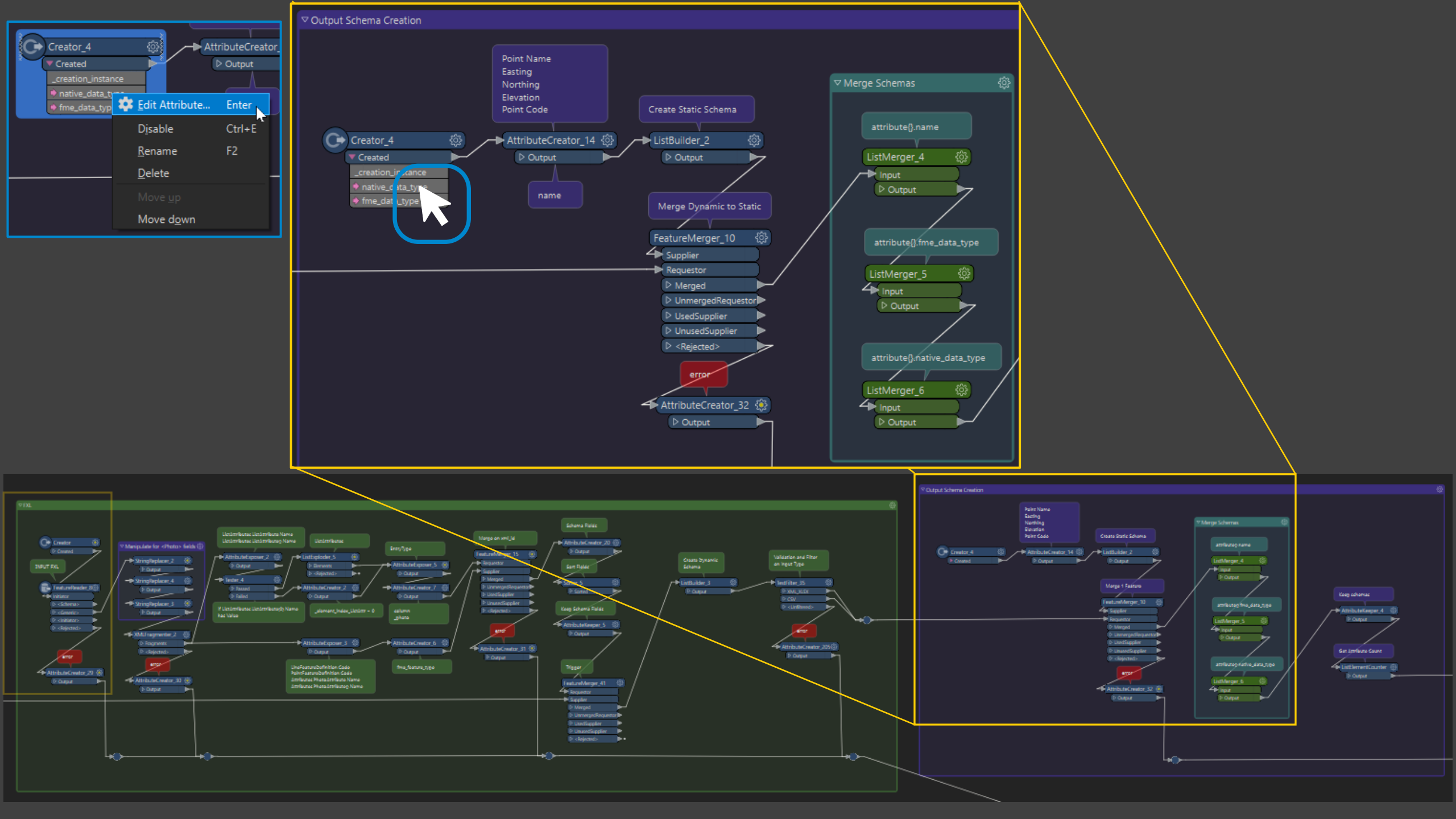


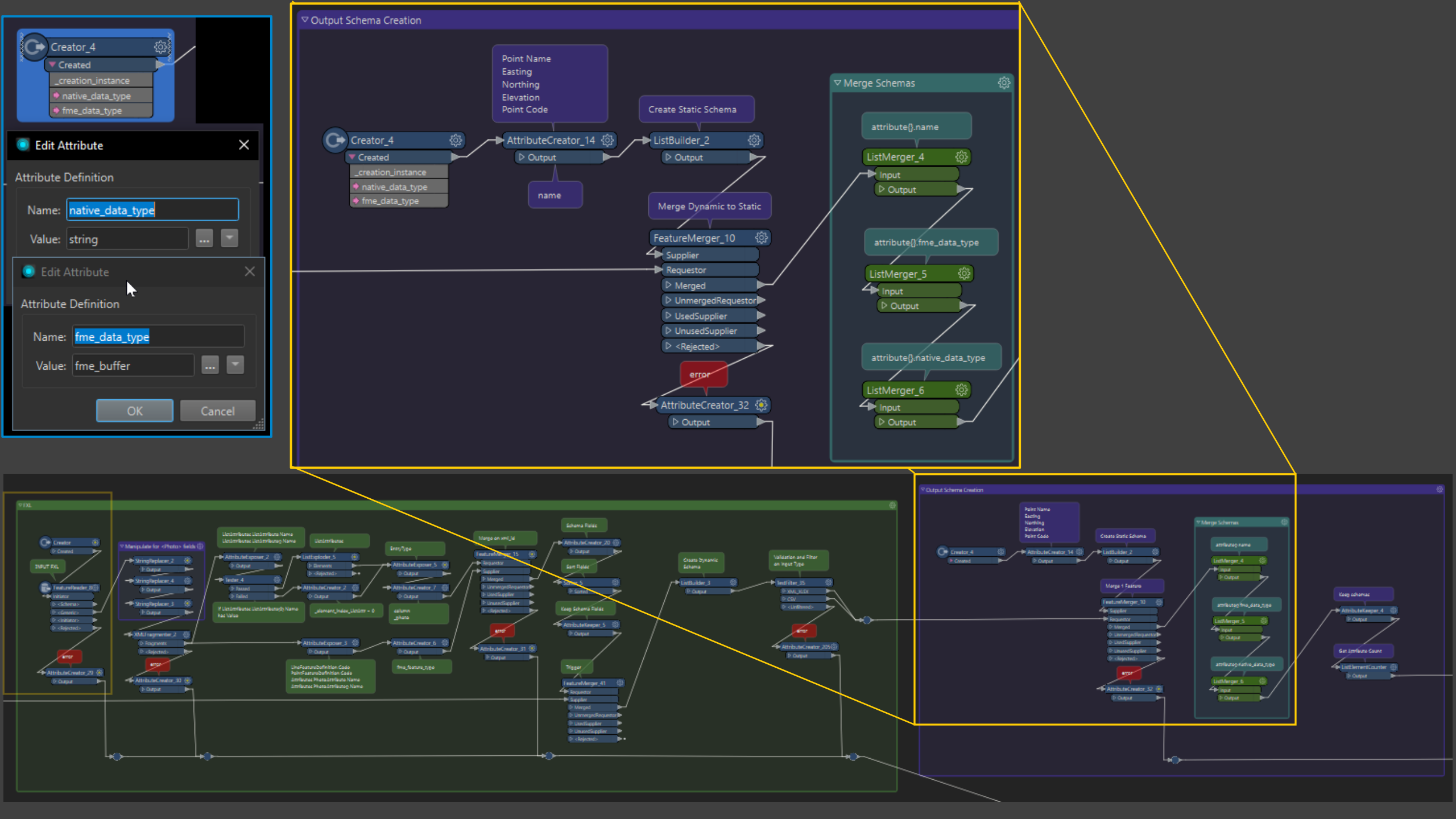


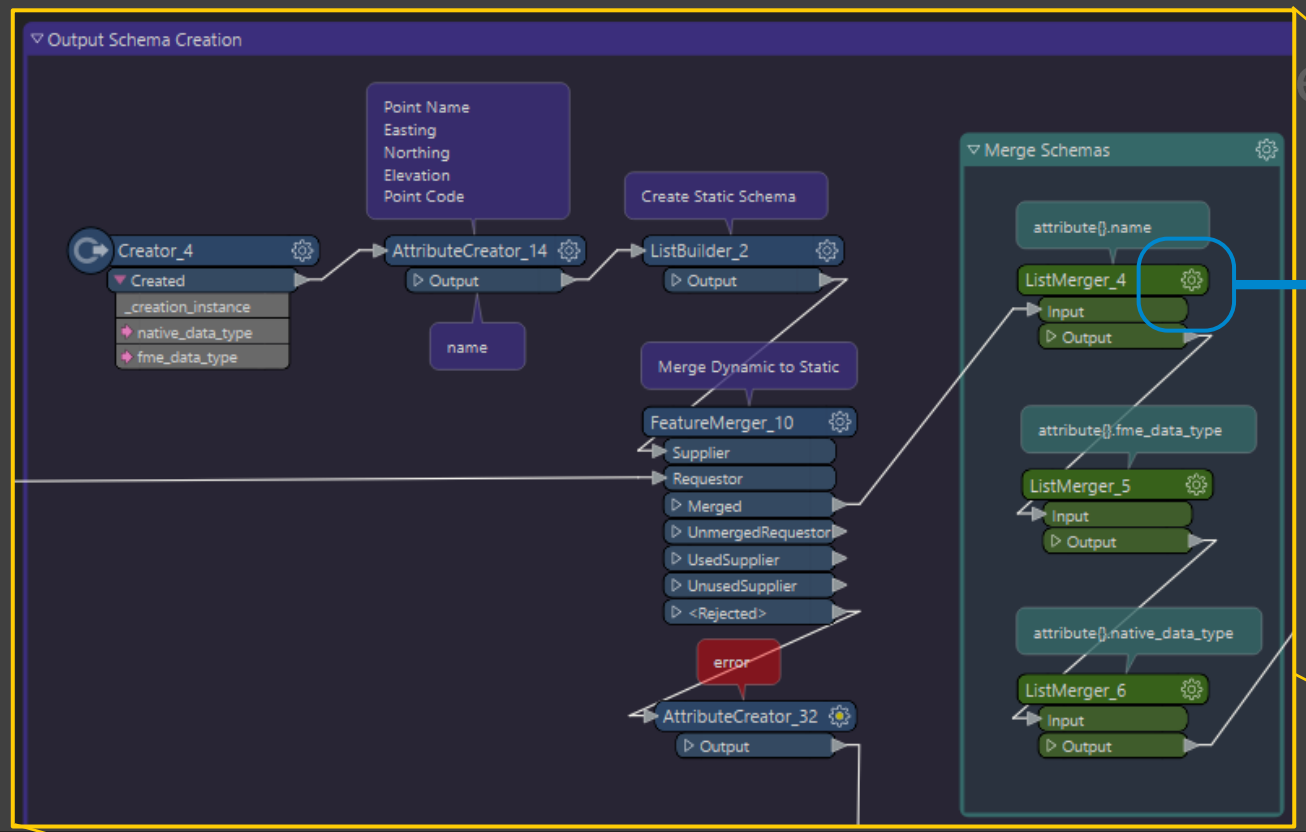


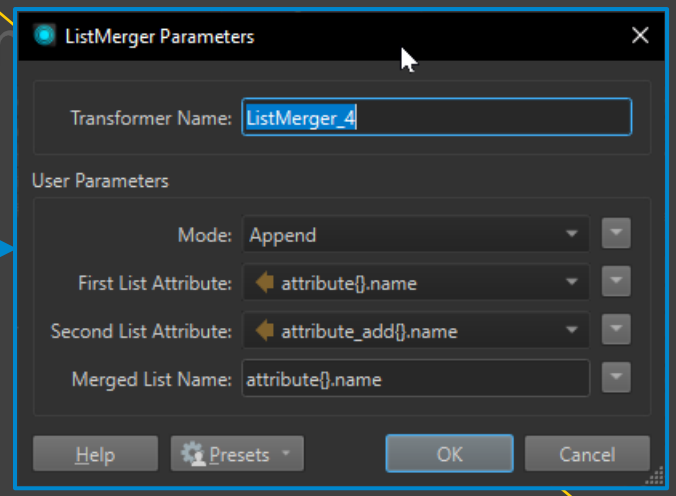

Output Schema Creation
Point Name
Easting
Northing
Elevation
Point Code
Create Static Schema
Creator_4
Created
_creation_instance
native_data_type
fme_data_type
AttributeCreator_14
Output
name
ListBuilder_2
Output
Merge Dynamic to Static
FeatureMerger_10
Supplier
Requestor
Merged
UnmergedRequestor
UsedSupplier
UnusedSupplier
<Rejected>
error
AttributeCreator_32
Output
Merge Schemas
attribute{}.name
ListMerger_4
Input
Output
attribute{}.fme_data_type
ListMerger_5
Input
Output
attribute{}.native_data_type
ListMerger_6
Input
Output


Output Schema Creation
Point Name
Easting
Northing
Elevation
Point Code
Creator_4
Created
_creation_instance
native_data_type
fme_data_type
AttributeCreator_14
Output
name
Create Static Schema
ListBuilder_2
Output
Merge Dynamic to Static
FeatureMerger_10
Supplier
Requestor
Merged
UnmergedRequestor
UsedSupplier
UnusedSupplier
<Rejected>
error
AttributeCreator_32
Output
Merge Schemas
attribute{}.name
ListMerger_4
Input
Output
attribute{}.fme_data_type
ListMerger_5
Input
Output
attribute{}.native_data_type
ListMerger_6
Input
Output

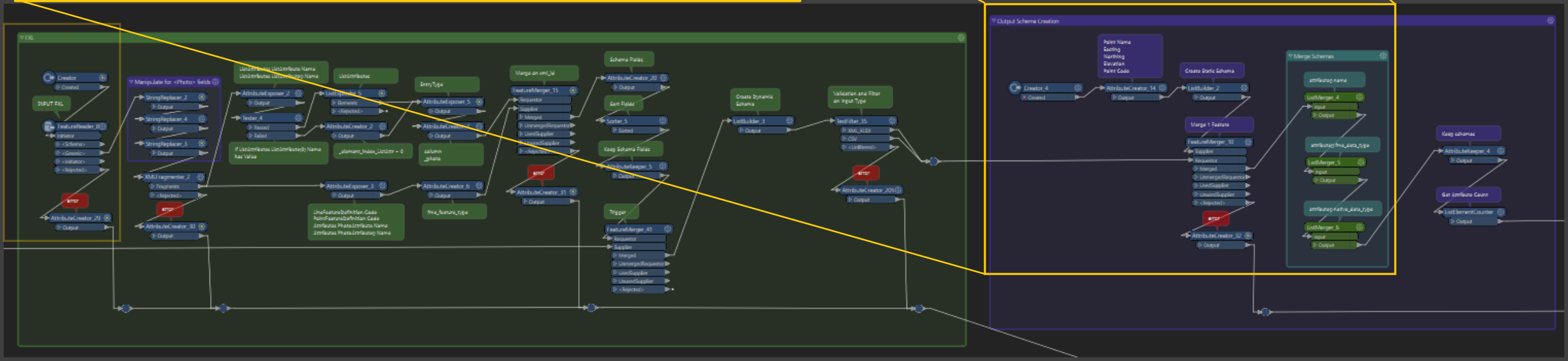

Creator_4
Created
_creation_instance
native_data_type
fme_data_type
AttributeCreator
Output
Edit Attribute... Enter
Disable Ctrl+E
Rename F2
Delete
Move up
Move down
Output Schema Creation
Point Name
Easting
Northing
Elevation
Point Code
Creator_4
Created
_creation_instance
native_data_type
fme_data_type
AttributeCreator_14
Output
name
Create Static Schema
ListBuilder_2
Output
Merge Dynamic to Static
FeatureMerger_10
Supplier
Requestor
Merged
UnmergedRequestor
UsedSupplier
UnusedSupplier
<Rejected>
error
AttributeCreator_32
Output
Merge Schemas
attribute{}.name
ListMerger_4
Input
Output
attribute{}.fme_data_type
ListMerger_5
Input
Output
attribute{}.native_data_type
ListMerger_6
Input
Output


Creator_4
Created
_creation_instance
native_data_type
fme_data_type
Edit Attribute
Attribute Definition
Name: native_data_type
Value: string
Edit Attribute
Attribute Definition
Name: fme_data_type
Value: fme_buffer
OK
Cancel
Output Schema Creation
Point Name
Easting
Northing
Elevation
Point Code
Creator_4
Created
_creation_instance
native_data_type
fme_data_type
AttributeCreator_14
Output
name
Create Static Schema
ListBuilder_2
Output
Merge Dynamic to Static
FeatureMerger_10
Supplier
Requestor
Merged
UnmergedRequestor
UsedSupplier
UnusedSupplier
<Rejected>
error
AttributeCreator_32
Output
Merge Schemas
attribute{}.name
ListMerger_4
Input
Output
attribute{}.fme_data_type
ListMerger_5
Input
Output
attribute{}.native_data_type
ListMerger_6
Input
Output

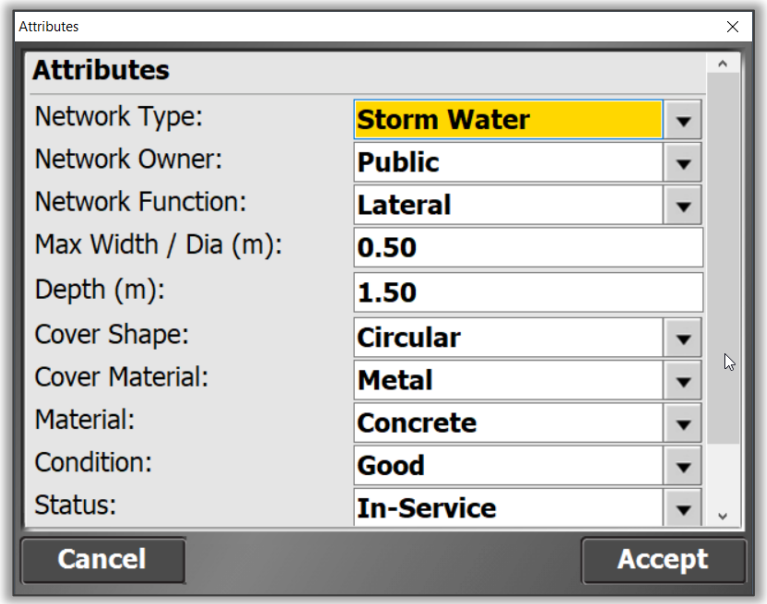




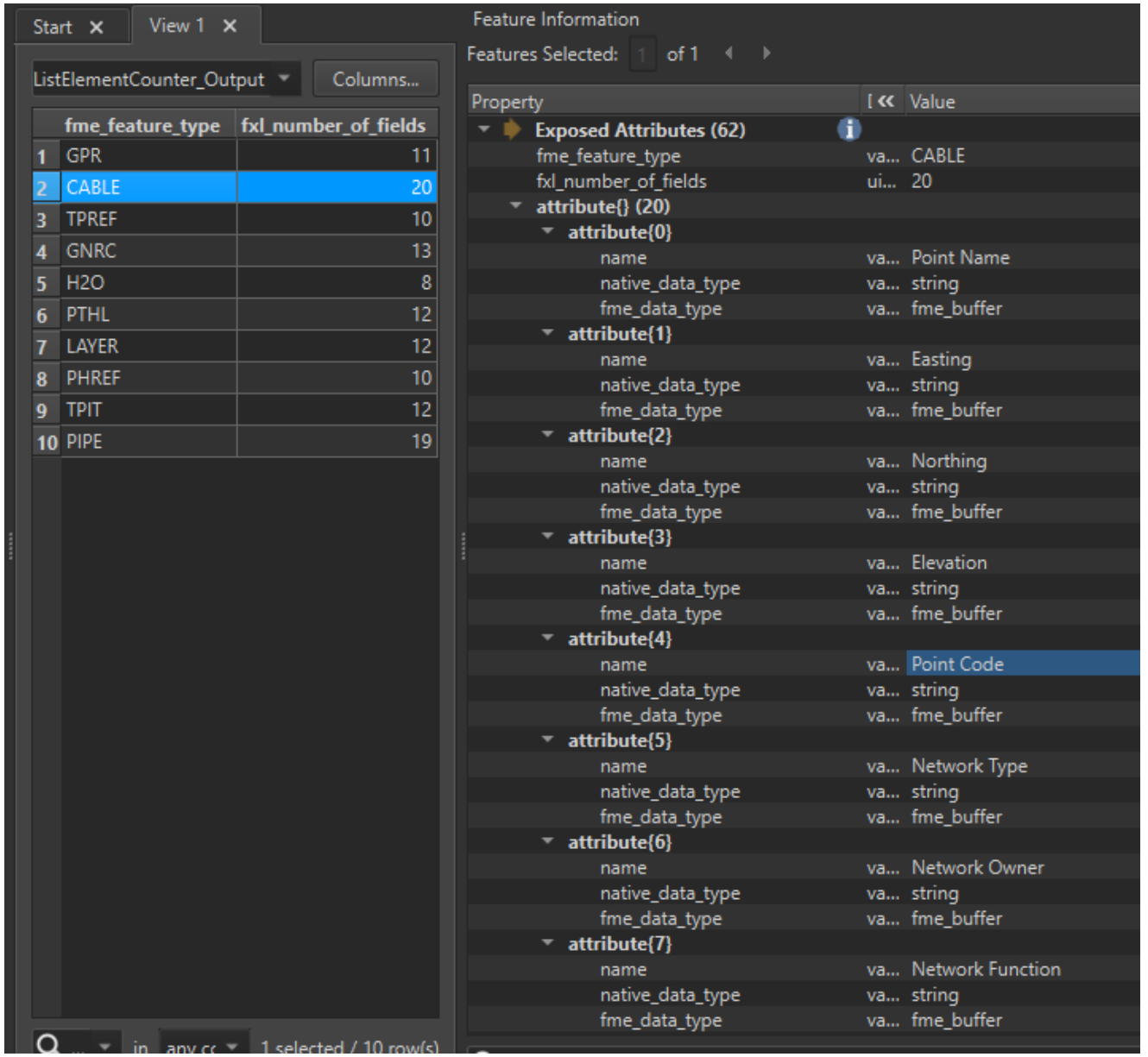
- Merge the Attribute Lists
  - Static Attributes: attribute{}.name
  - Dynamic Attributes: attribute_add{}.name



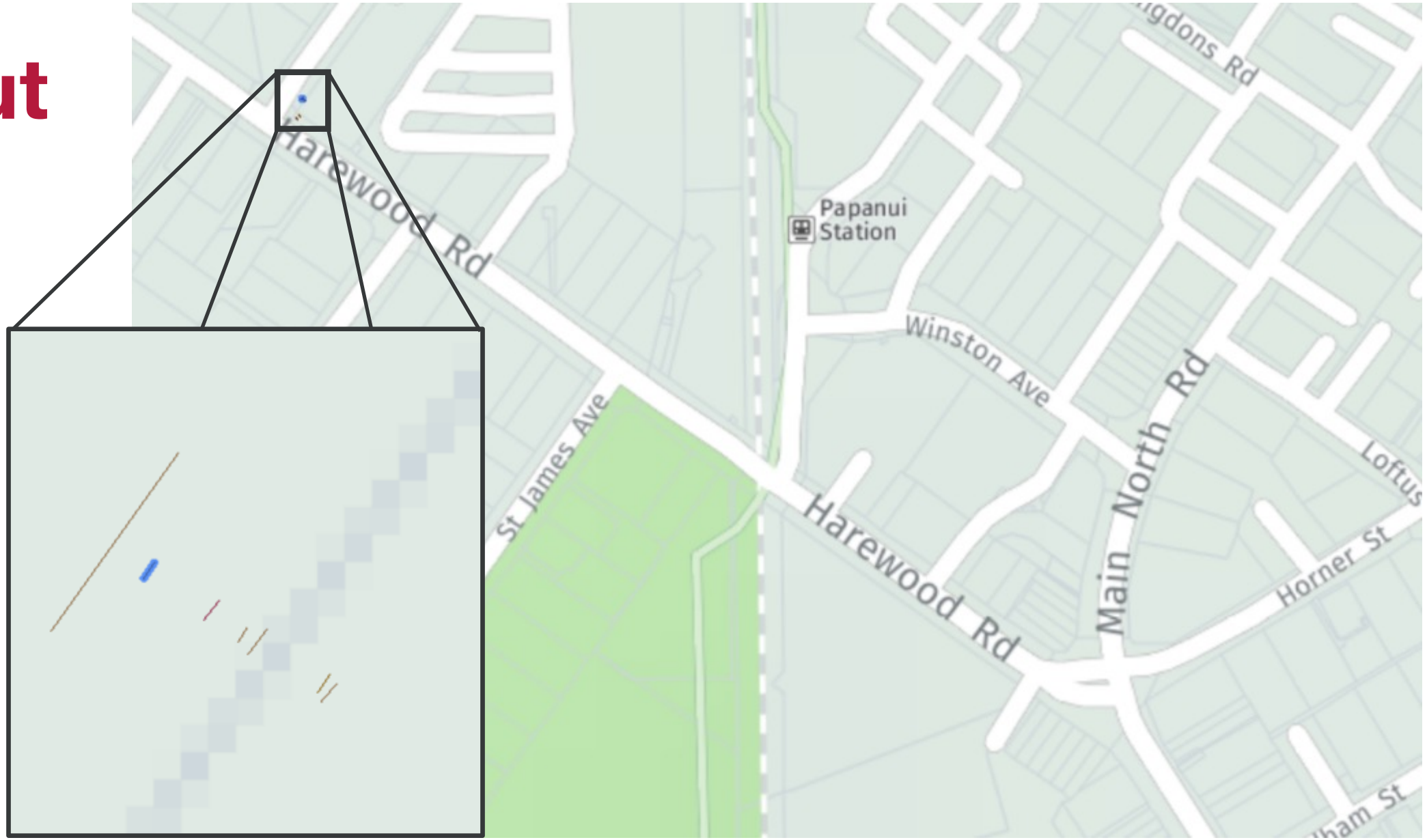
Input to Output Schema



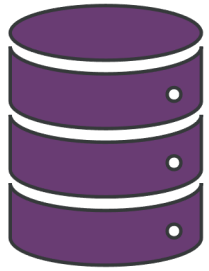
Unit Interface



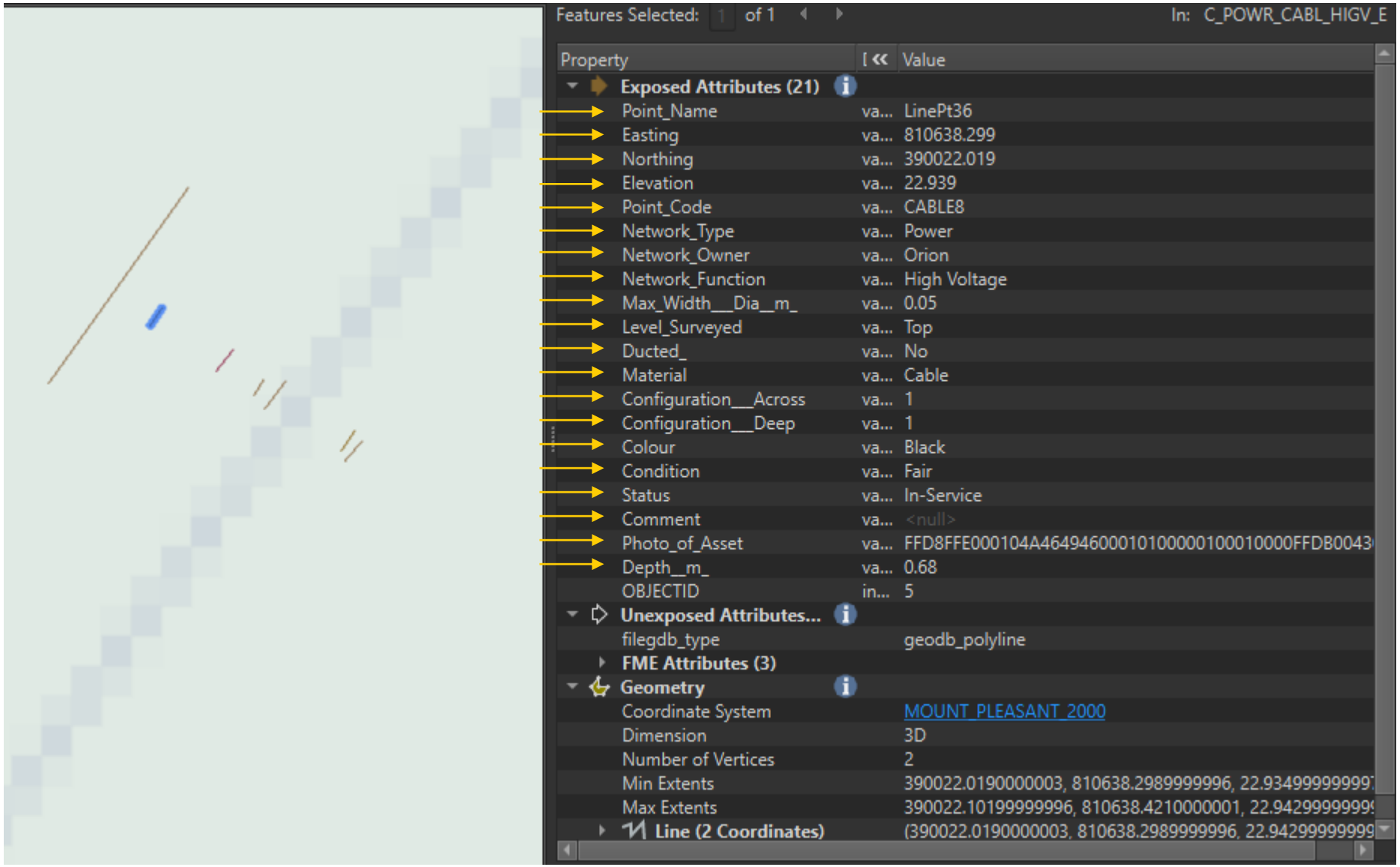
Output Data


Harewood Rd
Papanui Station
Winston Ave
St James Ave
Harewood Rd
Main North Rd
Horner St
Loftus

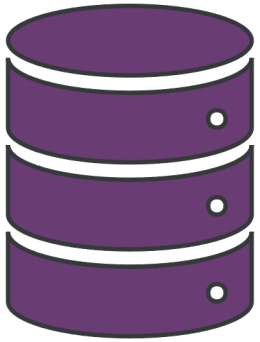
Output Data



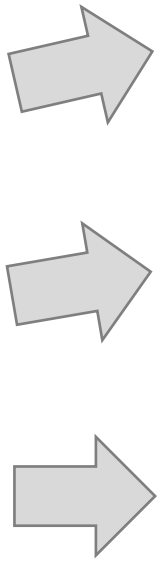
Project Database

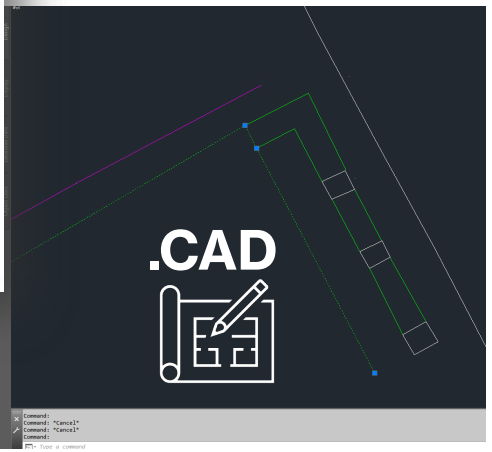


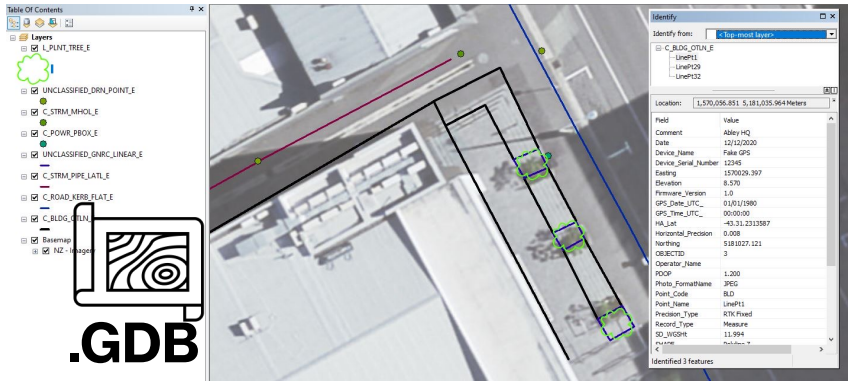
One Database to Rule Them All



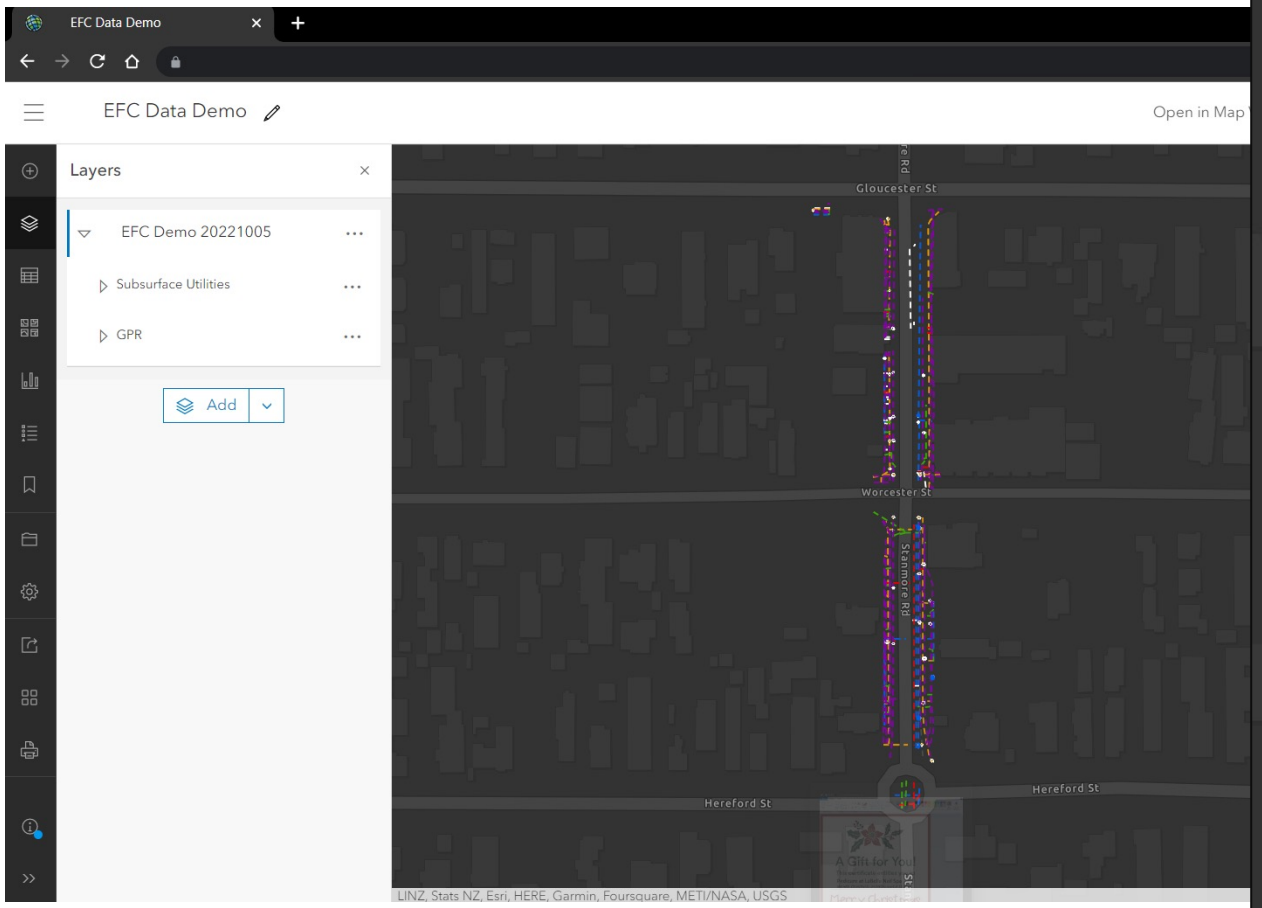
Project Database

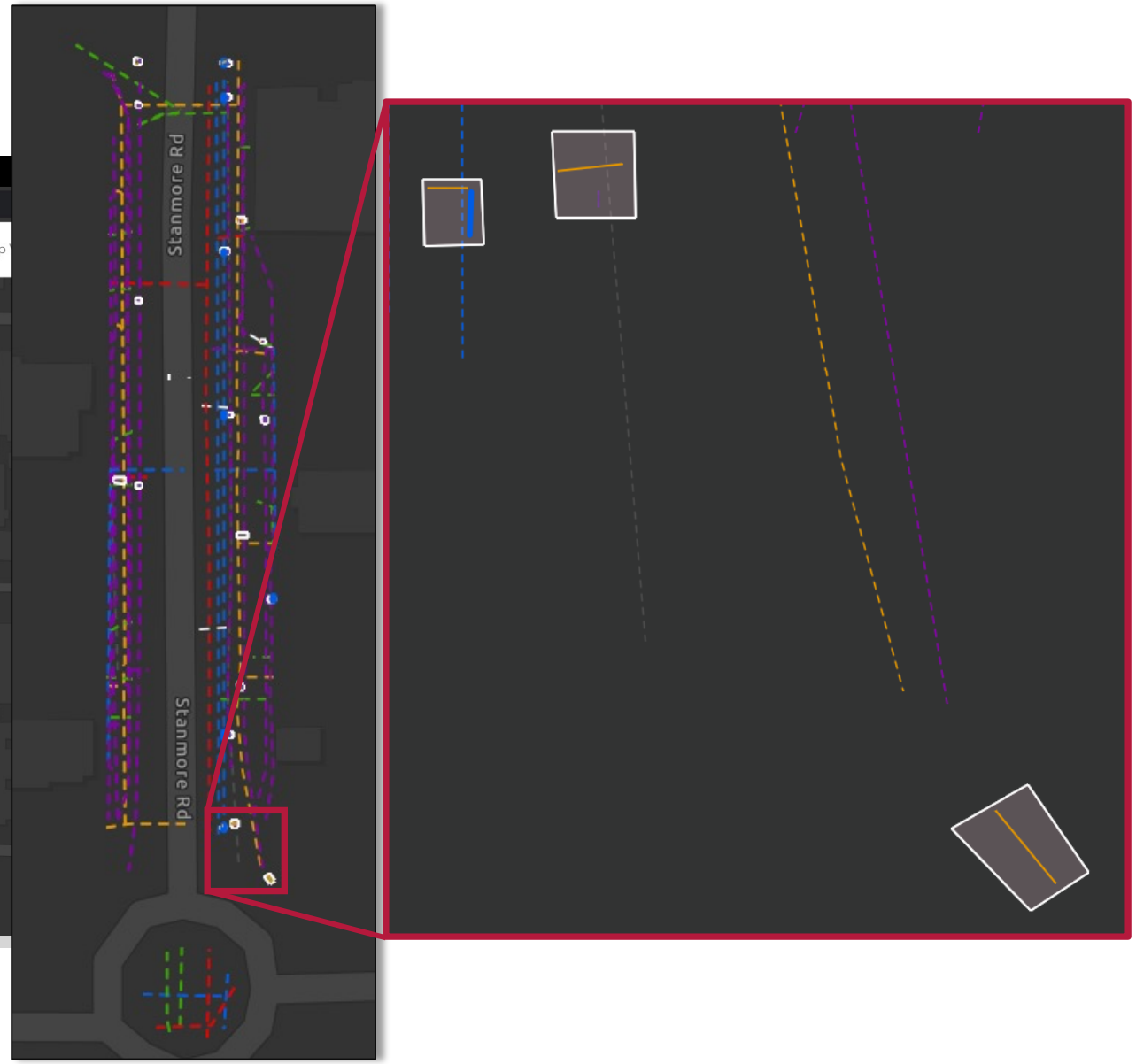






Other Online Solutions





ArcGIS Online

Client Statistics to Date

- 121 Projects
  - 35 with GPR
- ~1137 Potholes
  - ~2250-3400 hours * $150/hr = **$330k-$510k saved**
- ~4000 Features
  - 2750 Utility Service
  - 1250 GPR
- Digital-First, Consistent, Efficient, Safe

Learn More

- ableyc.com/enhanced-feature-capture
- Case Study - ableyc.com/potholing-for-fulton-hogan
- FME
  - HTML Cross-section Diagrams: https://www.youtube.com/watch?v=63JbcW8QRqc
  - FME Fireside: https://www.youtube.com/watch?v=LjG2cIGXXh8

Gavin Jeter
gavin.jeter@ableyc.com

Auckland
Level 1/70 Shortland Street
Auckland 1010
Aotearoa New Zealand

Wellington
Level 1/119-123 Featherston Street
Wellington 6011
Aotearoa New Zealand

Christchurch
Level 1/137 Victoria Street
PO Box 36446, Merivale
Christchurch 8146
Aotearoa New Zealand

hello@abley.com
+64 3 377 4703
abley.com