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SAN BERNARDINO
COUNTY

Modernizing Infrastructure Management
Street Level Imagery/LiDAR &
AI-enabled Asset Extraction

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Department of Public Works

Company Overview

40 YEAR OLD
GLOBAL CORPORATION

FOUNDED IN
THE NETHERLANDS

GROUND LEVEL
IMAGERY AND LIDAR
MARKET LEADER

EVOLVED FROM
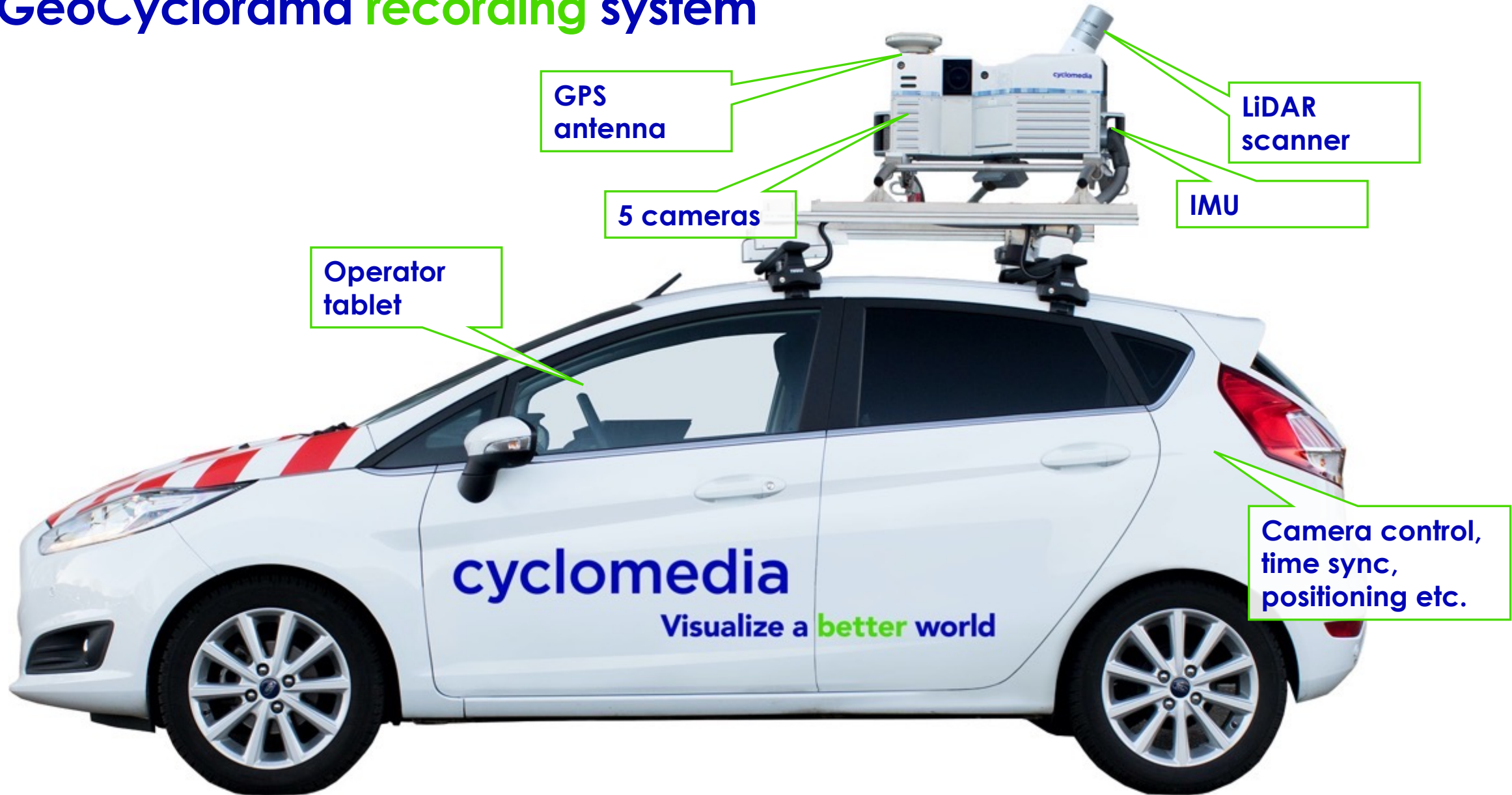STOP AND SHOOT
TO OUR MOST
ADVANCED SYSTEM

HIGH RESOLUTION IMAGERY
CAN SAVE CUSTOMERS
TIME, MONEY AND
IMPROVE EMPLOYEE SAFETY

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Remote Sensing Revolution

Visualize a better world

Oblique

Street Level

Ortho

GeoCyclorama recording system

GPS antenna

LiDAR scanner

5 cameras

IMU

Operator tablet

Camera control, time sync, positioning etc.

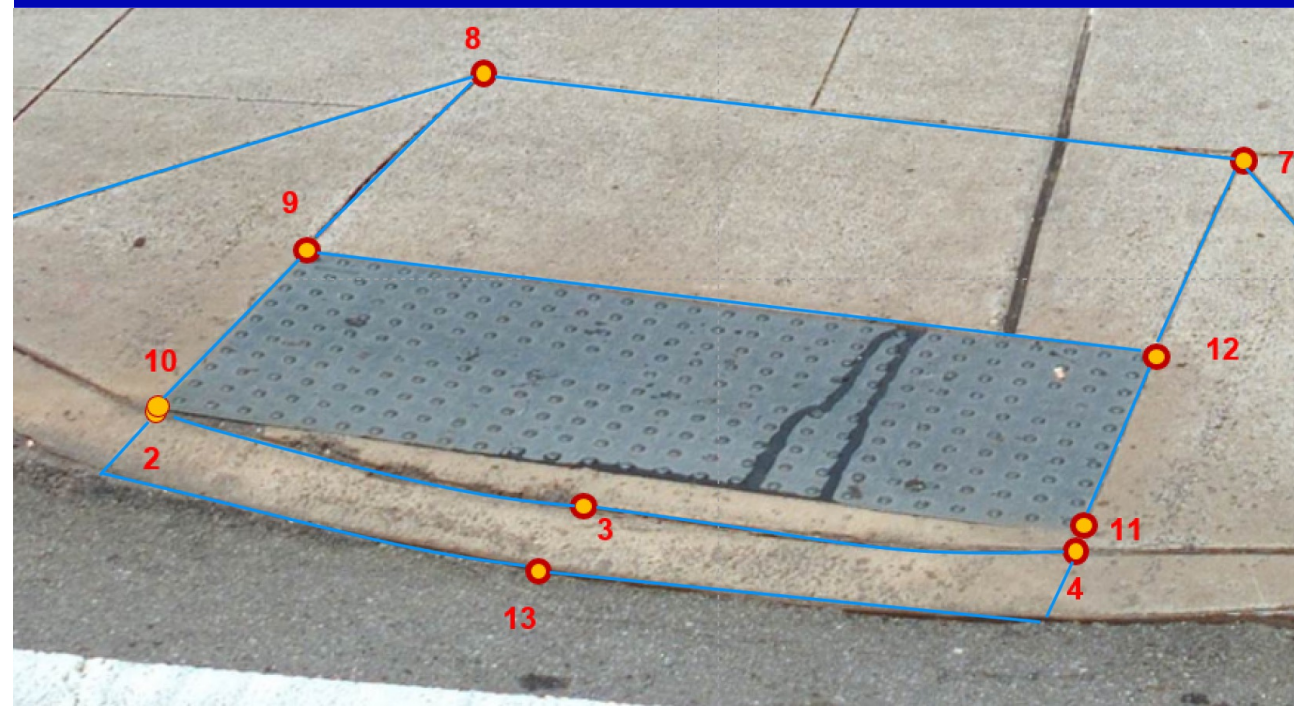cyclomedia

Visualize a better world

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GeoCyclorama resolution

- 100mpx and 250mpx options

- Horizontal Field of View: 360°

- Vertical Field of View: 180°

- Parallax free

  - No image distortion or glare

- Includes date, time, location

- Sub-inch geometric accuracy (0.4 in)

  - Measurement of heights, lengths or widths

- High positional accuracy (4 in)

Robust Measurement Tools

- *Measurement types*

  - Point locations

  - Distance

  - Surface

  - Orthogonal

  - Height

- Measurement accuracy within 2cm

- Includes X, Y, Z values and coordinates

- Automatic calculation of distances, deltas, areas, slope angles and sigma values for accuracy

Mass Appraisal of Real Property

- IAAO MARP Standard (Collecting and Maintaining Property Data)
- 3.3.5 Alternative to Periodic On-Site Inspections

"..jurisdictions may employ a set of digital imaging technology tools to supplement field re-inspections with a computer-assisted office review. These imaging tools should include the following:"

Current high-resolution street-view images (at a sub-inch pixel resolution that enables quality grade and physical condition to be verified)

http://www.iaao.org/media/standards/MARP_2013.pdf

Monroe County, FL – Annual Image Capture Example

- 90,000 total parcels; 50,000 taxable parcels
  - $29.5 billion in value

- Currently using desktop review
  - Property sketches, aerial photography, street level imagery

- Each parcel imaged yearly in December
  - Key for the office because Jan 1 is reassessment date

- All historic imagery stored in cloud with new yearly project
  - Yearly capture going back four years

- Imagery integrated into CAMA system
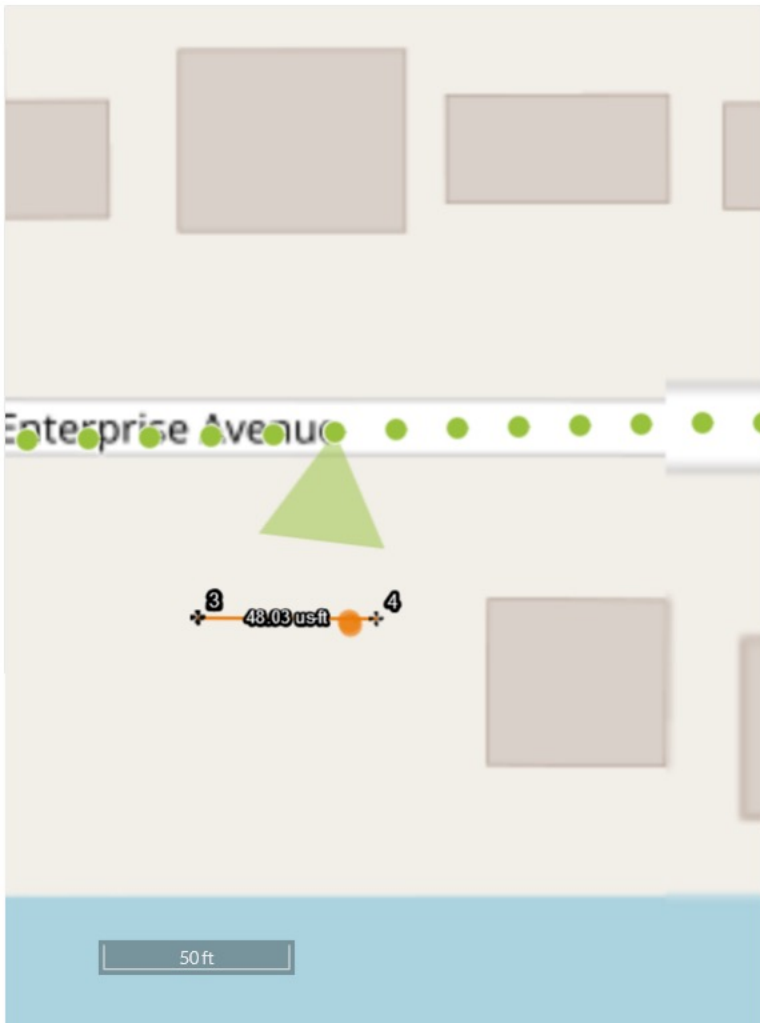 - Each parcel has new image in CAMA every January

Virtual Street Level Inspection – 2018

Virtual Street Level Inspection – 2019

12/17/2019

Virtual Street Level Inspection – 2020

Inspection of assets

- Grade/condition

- Measurements and ID Tags

- Developing/maintain geodatabases
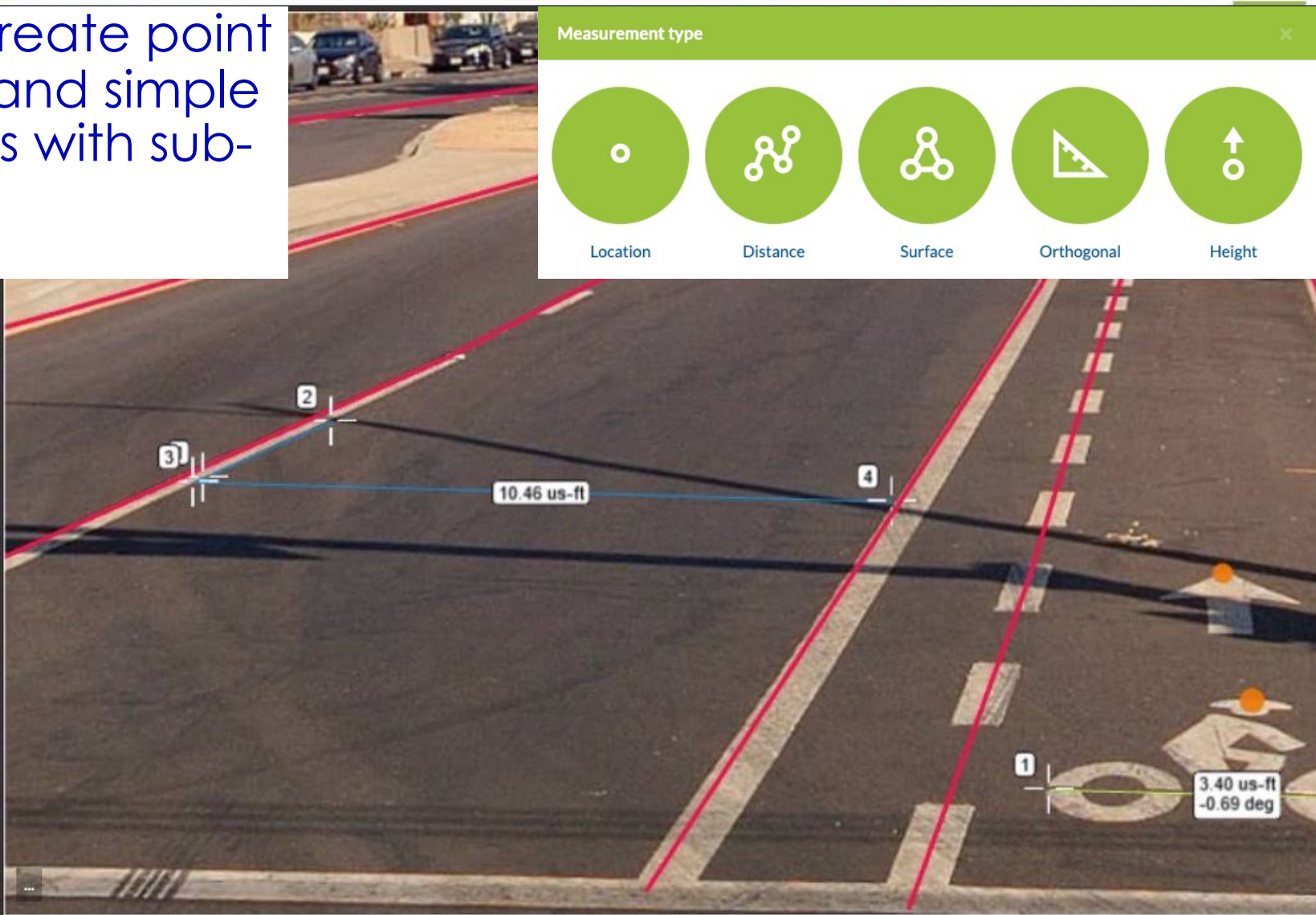
Interact with imagery to create point locations, linear features, and simple to complex measurements with sub-inch accuracy
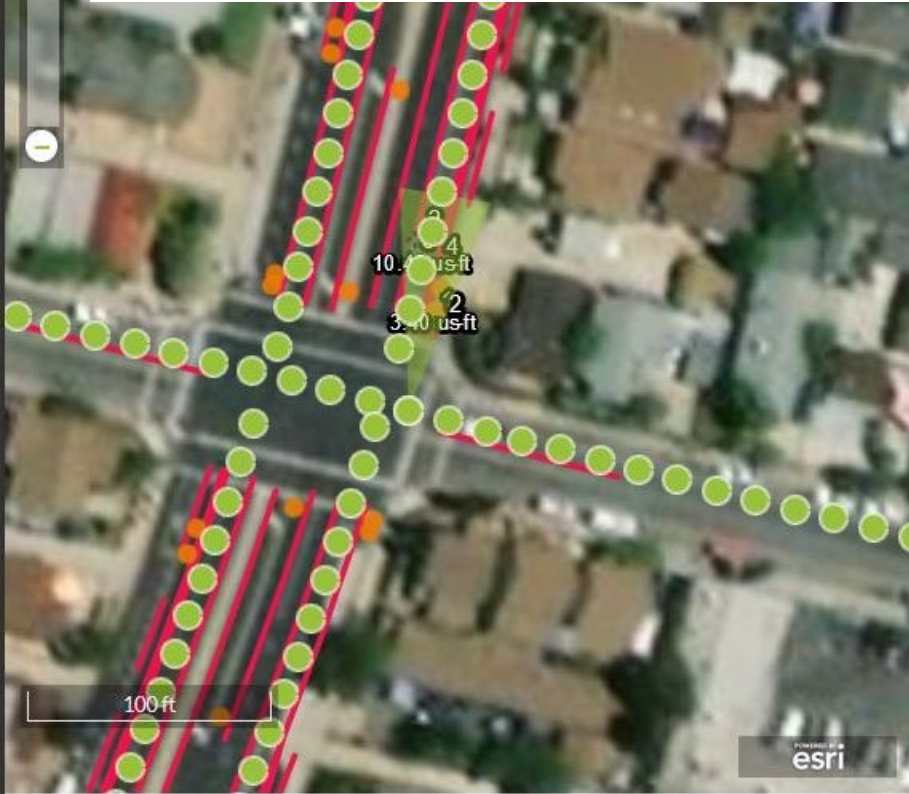
Street Smart Elevation Tool

- LiDAR data visualizing roadway ponding

- Potential impact of flood events

- First floor flood elevation
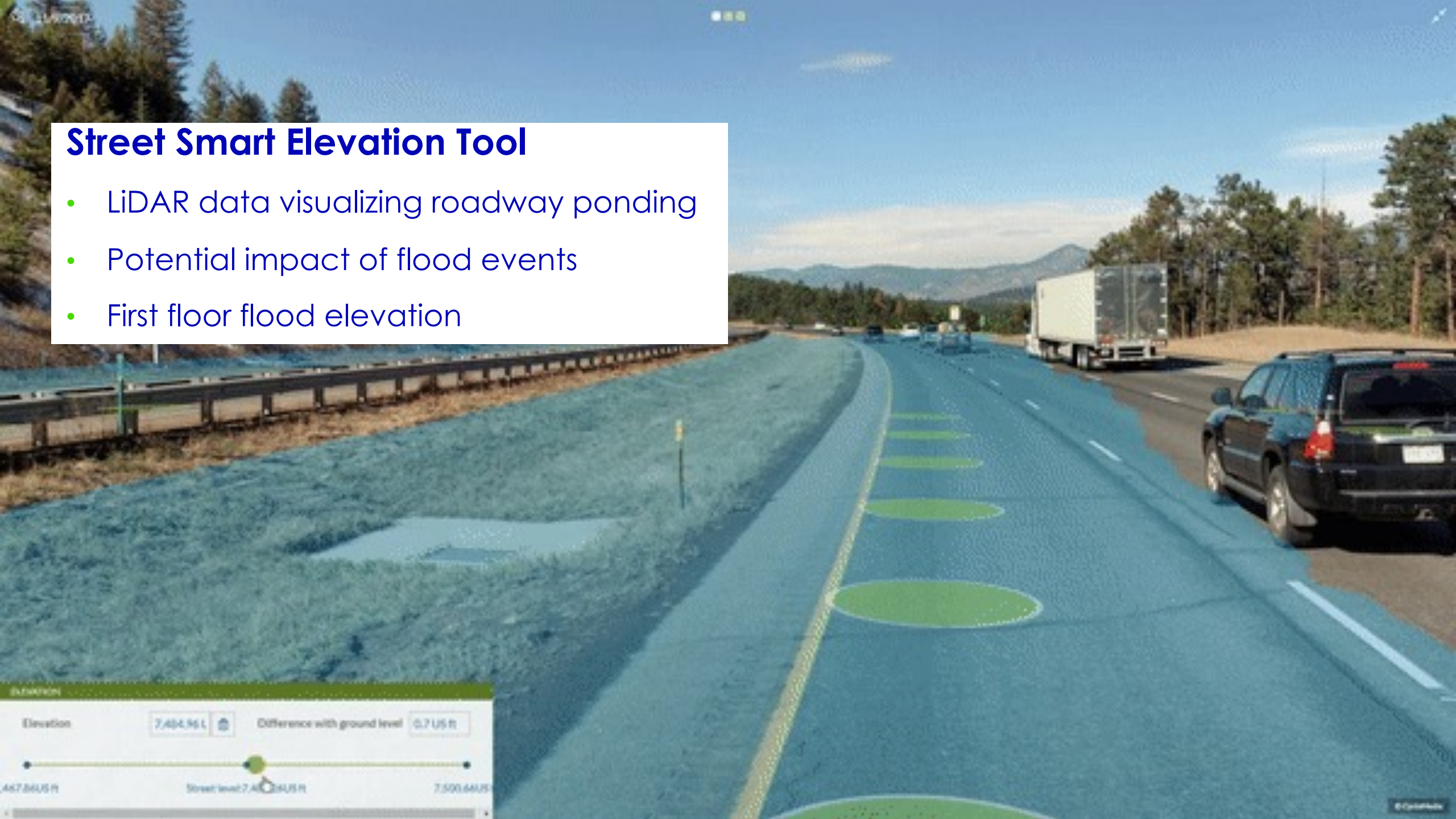
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Data Analytics: AI-Enabled Asset Extraction

Cyclomedia's internal software processes imagery, 3D point clouds, and uses **machine learning models (AI)** to automate the extraction of asset features and their attributes
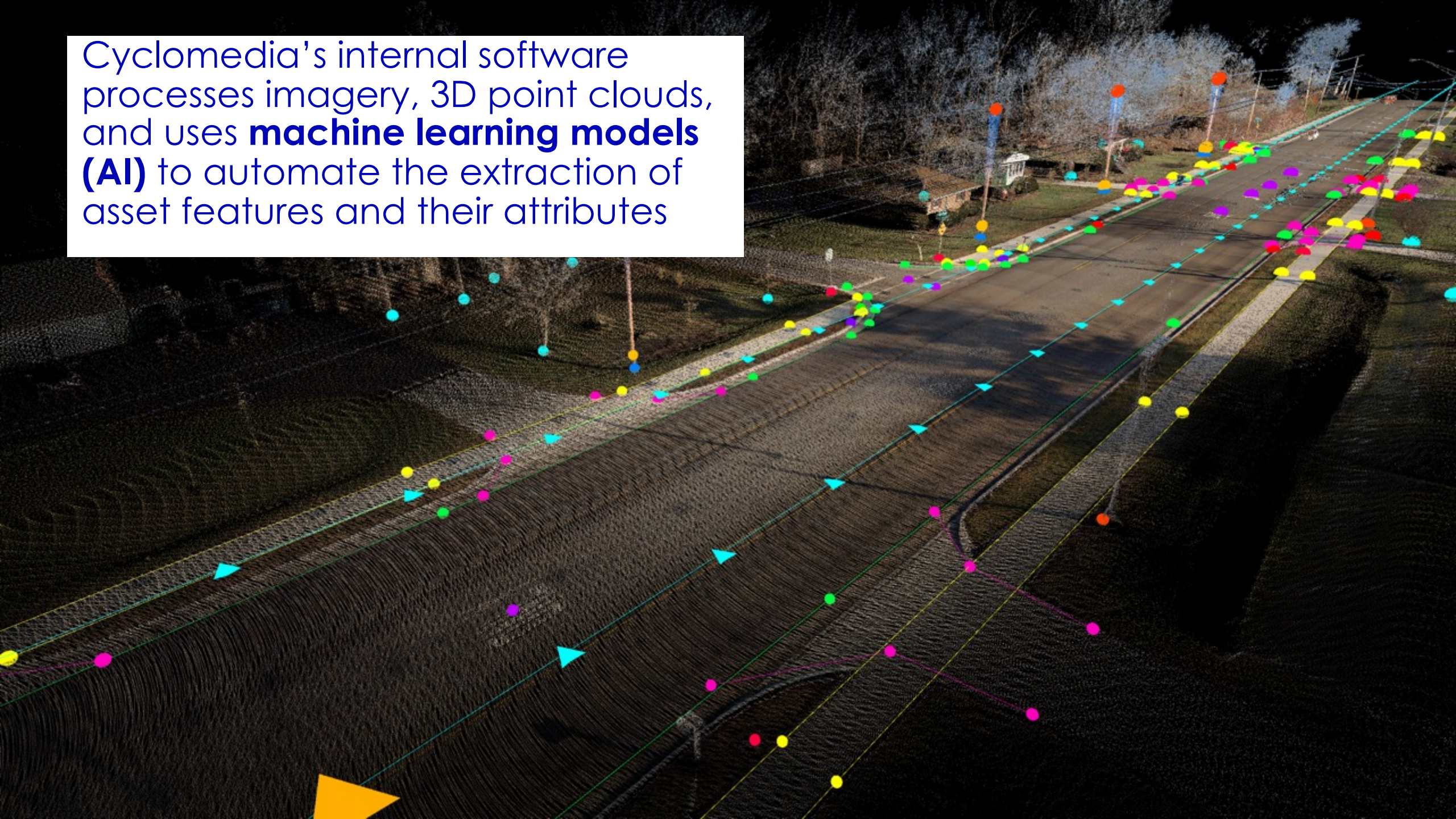
Asset types commonly extracted

- Traffic control devices
  - Street signs + MUTCD codes
  - Traffic Signals
  - Paint striping & symbols
  - Medians
- Boundary features
- Streetlights
- Manholes / storm drains
- Hydrants
- Valves
- Tree Inventory
- ADA pedestrian ramps
- Utility poles and attachments

Ramp Assessment Example

- 3D reconstruction of ramp structure and geometry based on LiDAR

- Identification of key points and attributes

- High accuracy algorithmic measurements

- 25+ attributes and compliance indicators
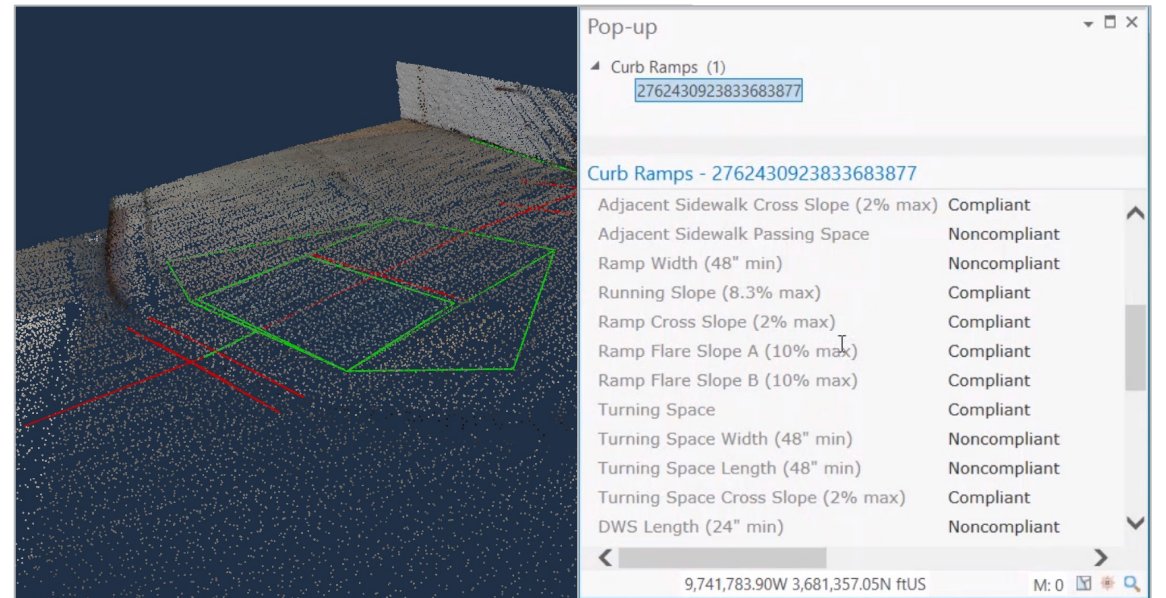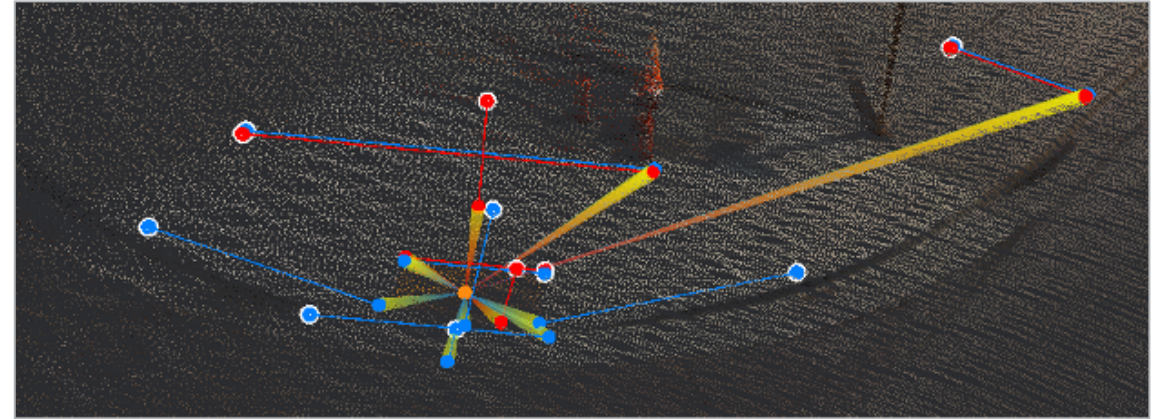
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Asset Inventory Extraction

**Click to learn about our
data extraction process**

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Project Summaries
San Bernardino County & East LA

Drive Planning & Execution
Flexible Rolling Delivery

- Review and refine centerlines for tailored drive files

- EPSG: 2229
  - NAD83 / California Zone 5 (ft)

- Road Access & Special Driving Instructions
  - Private Roads
  - Alleys
  - Unpaved Roads
  - Parking Lots

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Asset Inventory Extraction
Database Deliverable Design

1. **Final Data Dictionary**
   - Potential items for review:
     - Master GDB
     - Collector Apps
     - Schemas

2. **Schema Design & Review**

3. **Extract Sample Data**
   - ~10-20 miles of sample data
   - Refine for final extraction
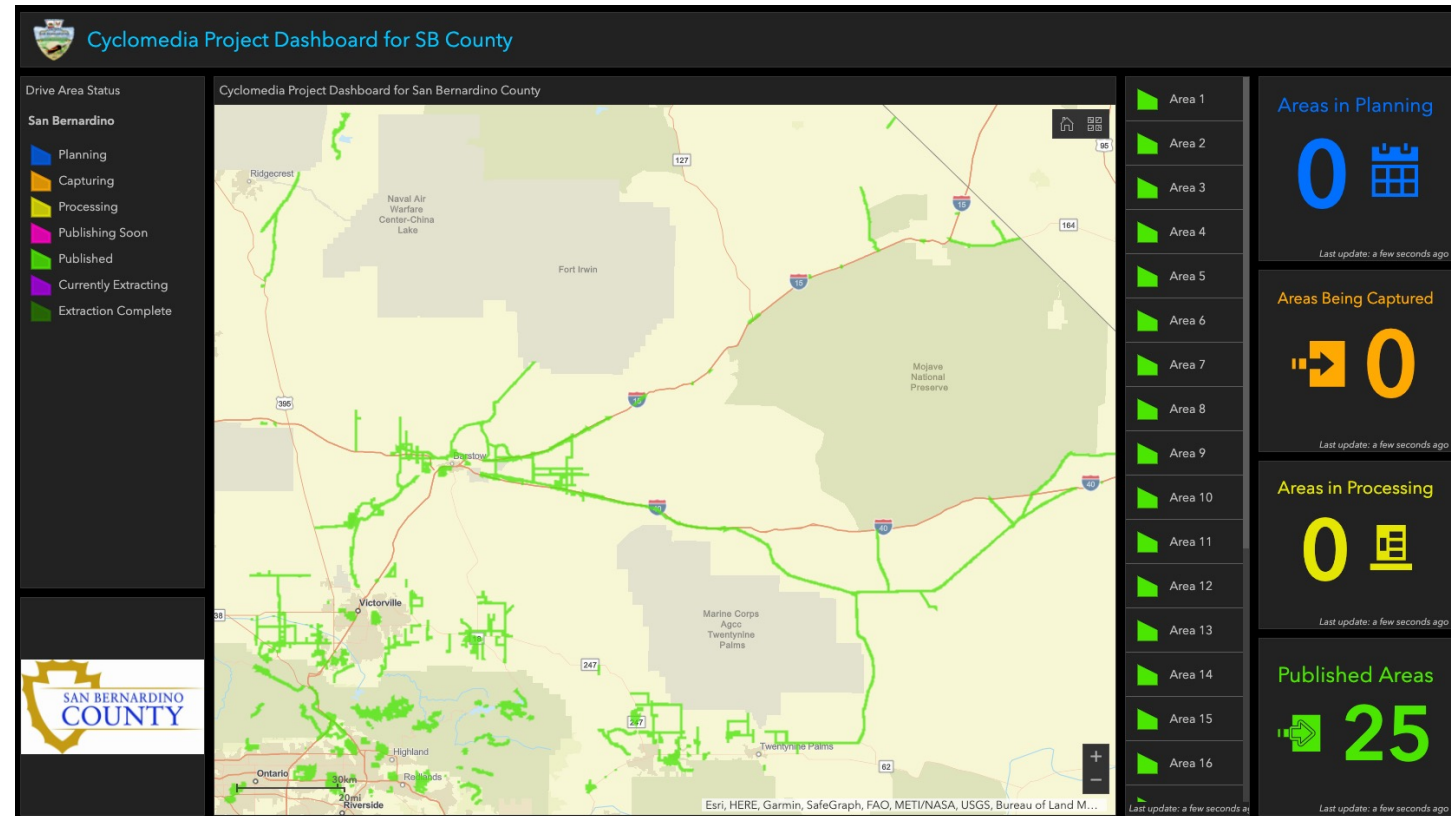
4. **Phased Extraction**
   - Delivered in phases depending on scope

Feature Name	Feature Type	Field Name	Field Alias	Field Type
PavementStriping	Line	ID	Unique ID	Text
		RouteID	Route ID	Text
		X_start	Longitude (start)	Double
		Y_start	Latitude (start)	Double
		Z_start	Altitude (start)	Double
		X_end	Longitude (end)	Double
		Y_end	Latitude (end)	Double
		Z_end	Altitude (end)	Double
		Condition	Condition	Text
		Color	Color	Text
		Length_ft	Length (ft)	Double
		Type	Pavement Stripe Type	Text
		RecordedAt	RecordedAt	Double
Curbs	Line	ID	Unique ID	Text
		RouteID	Route ID	Text
		X_start	Longitude (start)	Double
		Y_start	Latitude (start)	Double
		Z_start	Altitude (start)	Double
		X_end	Longitude (end)	Double
		Y_end	Latitude (end)	Double
		Z_end	Altitude (end)	Double
		Condition	Condition	Text
		Gutter	Gutter Attached	Text
		Length_ft	Length (ft)	Double
		RecordedAt	RecordedAt	Double
Guardrails	Line	ID	Unique ID	Text
		RouteID	Route ID	Text
		X_start	Longitude (start)	Double
		Y_start	Latitude (start)	Double
		Z_start	Altitude (start)	Double
		X_end	Longitude (end)	Double
		Y_end	Latitude (end)	Double
		Z_end	Altitude (end)	Double
		Condition	Condition	Text
		Length_ft	Length (ft)	Double
		PostType	Post Type	Text
		Type	Guardrail Type	Text
		RecordedAt	RecordedAt	Double
Sidewalk	Line	ID	Unique ID	Text
		X_start	Longitude (start)	Double
		Y_start	Latitude (start)	Double
		Z_start	Altitude (start)	Double
		X_end	Longitude (end)	Double
		Y_end	Latitude (end)	Double
		Z_end	Altitude (end)	Double
		Condition	Condition	Text
		Length_ft	Length (ft)	Double
		RecordedAt	RecordedAt	Double

Project Coverage
San Bernardino County

2,424 miles (780,114 images)
captured, published & extracted
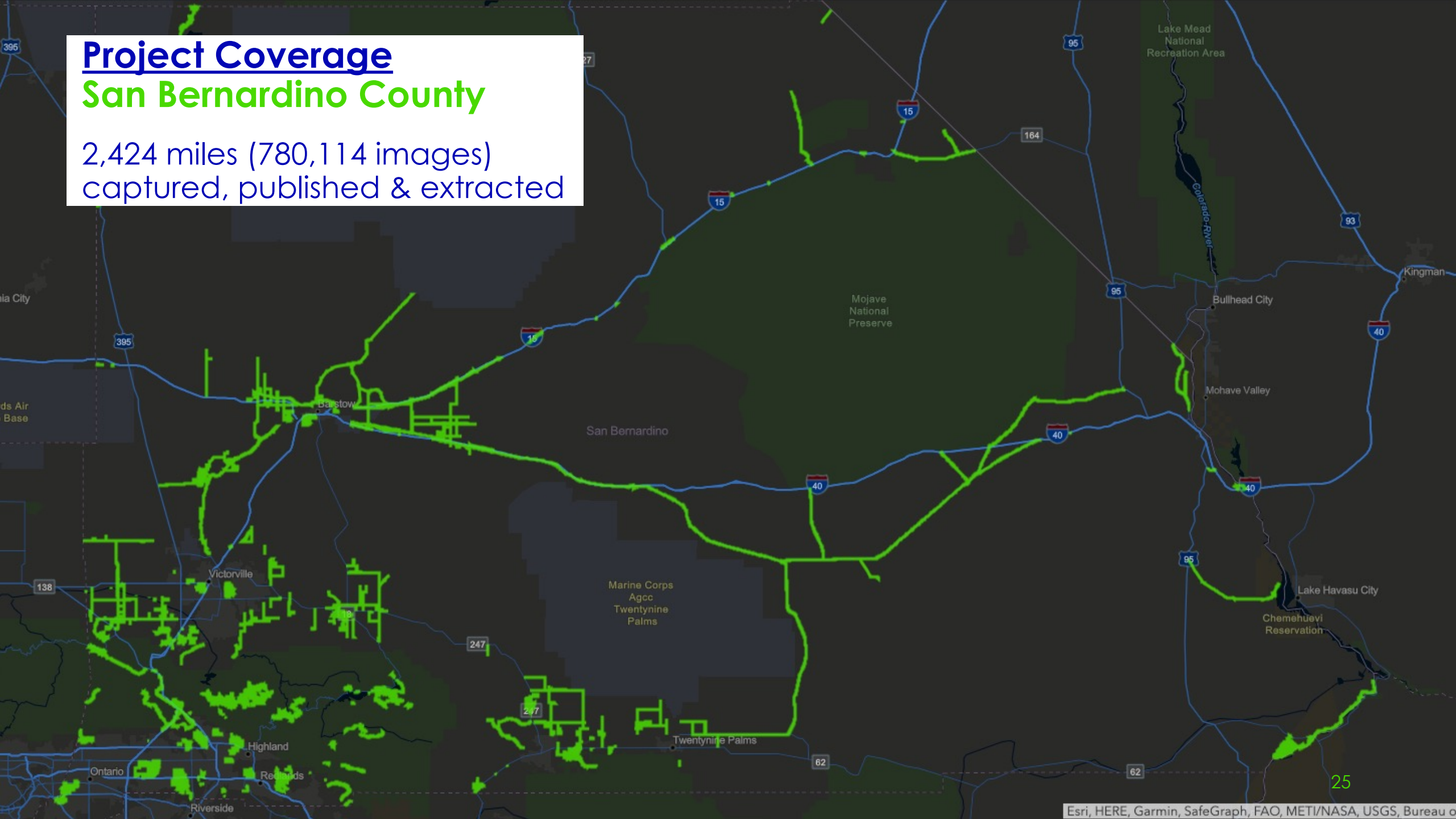
Asset Data: Topline Metrics for San Bernardino County

Feature	Count	Linear Feet	Assets Per Mile
Streetlights	4,327		1.79
Signs	88,082		36.34
Signals	4,086		1.69
Poles	1,537		0.63
Pedestrian Ramps	3,547		1.46
Pavement Markers	22,281		9.19
Intersections	9,185		3.79
Culverts	1,574		0.65
Catch Basins	2,937		1.21
Cabinets	212		0.09
Bus Stop Signs	341		0.14
Beacons	673		0.28
Sidewalks	4,479	3,732,994	1.85
Pavement Striping	17,339	16,980,736	7.15
Guardrails	1,358	163,813	0.56
Curbs	16,650	6,584,460	6.87
Bridges	217	26,183	0.09
AC Dike	19,659	2,357,899	8.11
Total	**198,484**	**29,846,085**	**81.88**

Note: all asset data extracted and delivered **5 months** after imagery publication

Project Highlights: Professional-Grade Imagery & LiDAR

3D Virtual Twin of the County

- High resolution imagery and LiDAR supports detailed inspection of properties and assets

  - 100 mpx imagery
  - 360° x 180°
  - No distortion or glare

- High positional accuracy (4-inches)
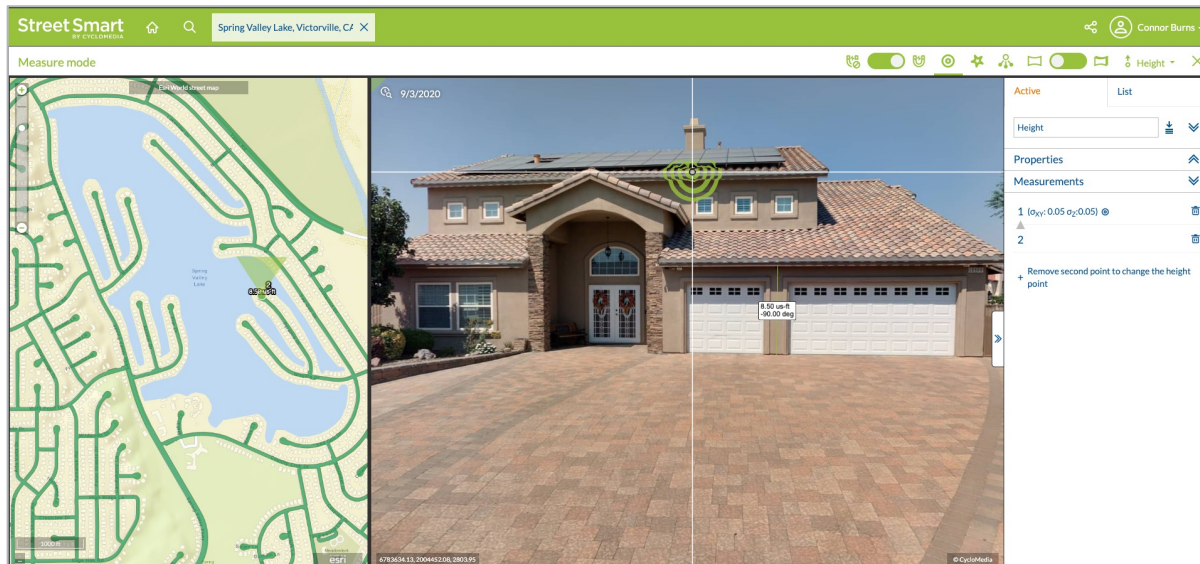
StreetSmart Enables Virtual Field Visits

- Measurement types

  - Point Locations, Distance, Surface, Orthogonal, Height

- Measurement accuracy within 2cm

- Date, time, location
  (X, Y, Z values and coordinates)

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Project Highlights: Asset Data Extraction

Enterprise Geodatabase Delivery

- 20 assets with detailed attribution extracted for 2,424 miles of county-maintained roads

  - Common attribution include condition, height, length, and type

  - Specifications include county-specific traffic signs and pavement markings

- Positional accuracy certified by county-approved, 3rd party surveyors
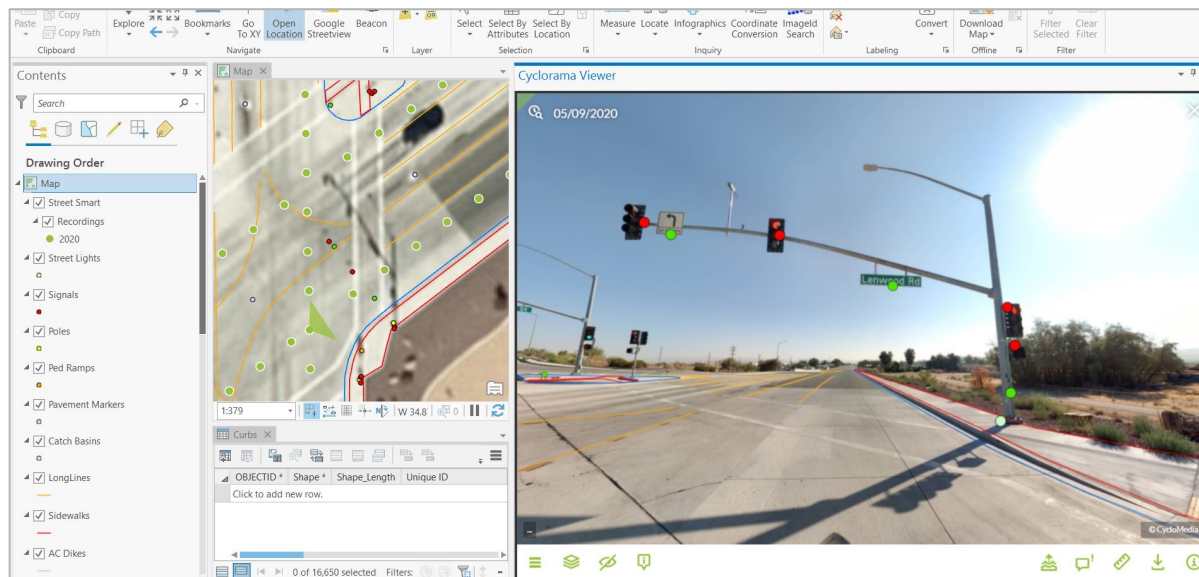
Complete, Integrated Asset Data

- Asset data and imagery are GIS compatible with pre-built integrations and an open API to support data use in other platforms

- All data and images of assets implemented into Operations Management System

- Asset data used to support asset management, capital planning, service requests and more

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East Los Angeles Pilot

22 assets (90k data points) collected over 159 drive miles:

- Signs (+ MUTCD)
- Utility Poles
- Other Poles
- Traffic Lights
- Street Lights
- Trees
- Back of Curb
- Edge of Pavement
- Driveways
- Sidewalks
- Pavement Striping

- Paint Symbols
- ADA Ramps
- Bus Stop and Pads
- Cabinets
- Fire Hydrants
- Manholes
- Storm Drains
- Substructures
- Valves
- Pedestals
- Vaults

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Find address or place
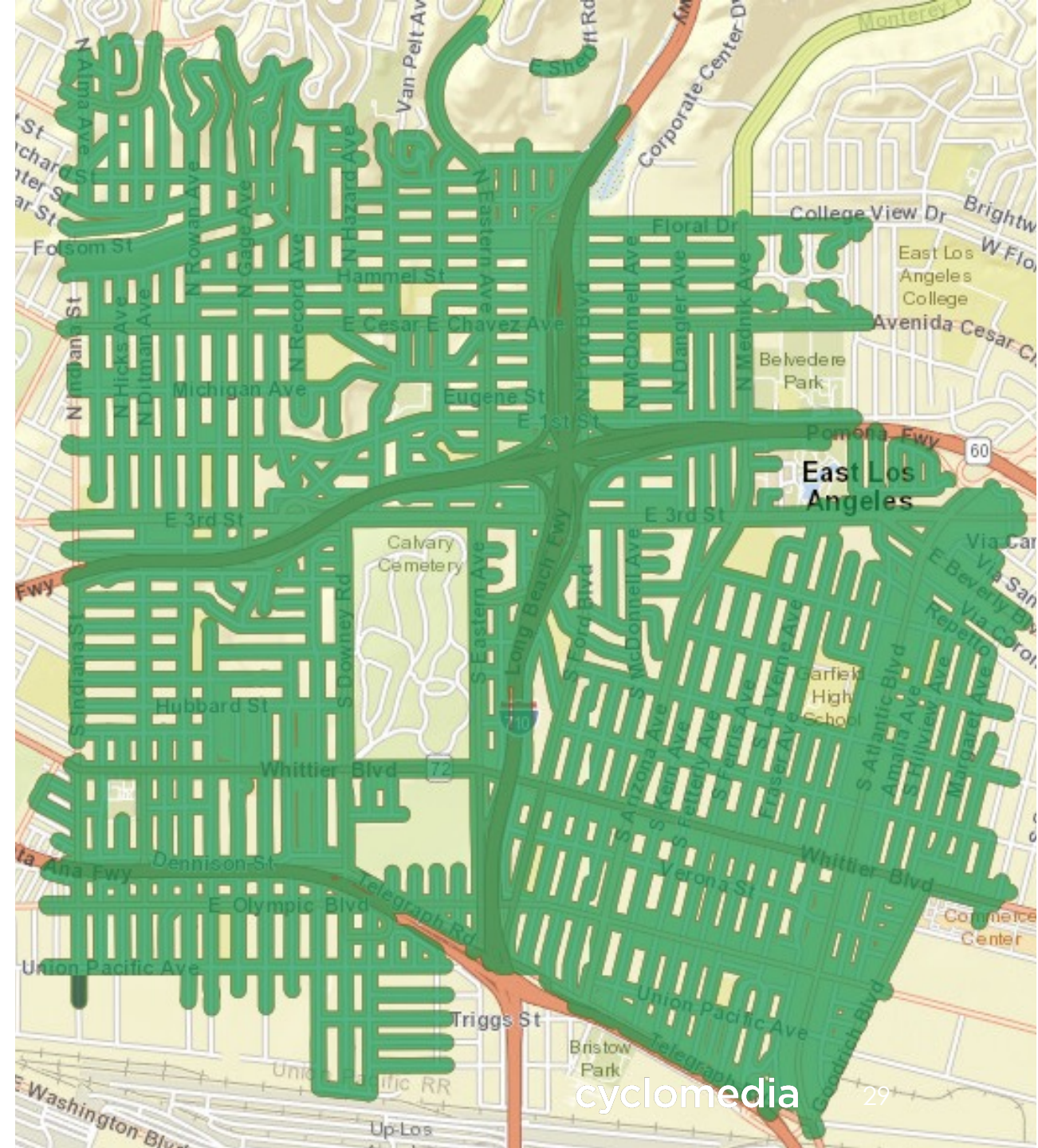
Legend

Traffic_Lights

Street_Lights

Storm_Drains

Paint_Symbols

Manholes LARIAC

ADA_Ramps

Fire_Hydrants LARIAC

Cabinets

Sidewalk

Signs

S Ford Blvd

S Ford Blvd

S Ford Blvd

E 3rd St

E 3rd St

E 3rd St

E 3rd St

E 3rd St

E 3rd St

+

−

S Ford Blvd

S Ford Blvd

E 3rd St

E 3rd St

E 3rd St

-118.169 34.033 Degrees

20ft

POWERED BY esri

Esri Community Maps Contributors, County of Los Angeles, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI...
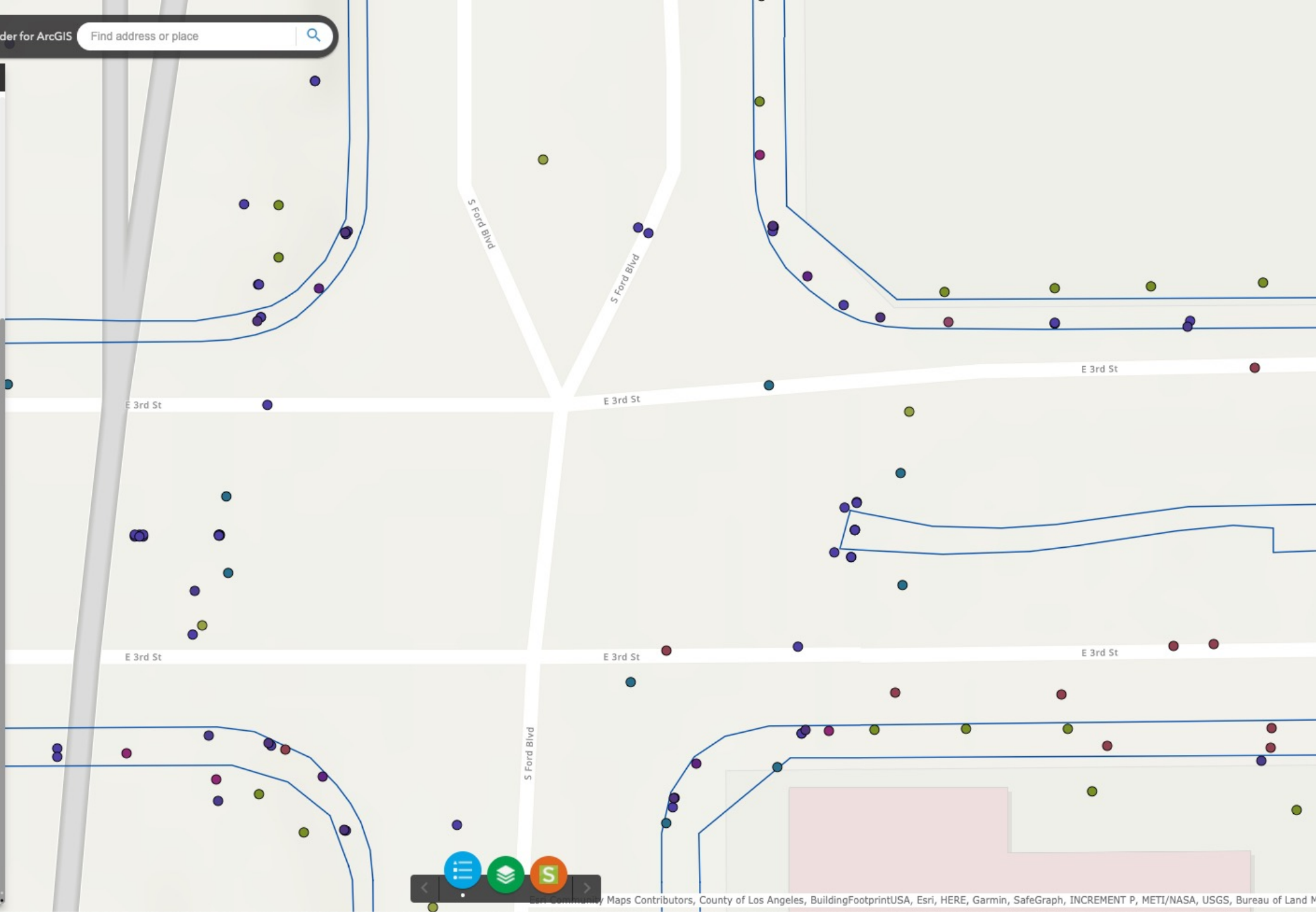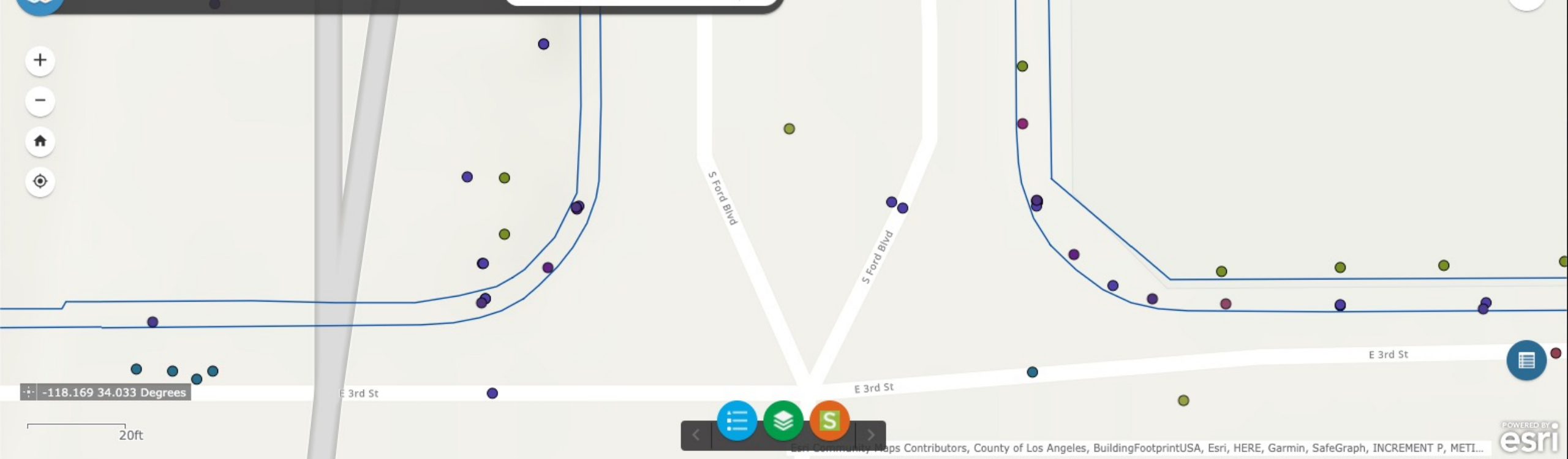
| alves LARIAC | Trees LARIAC | Traffic_Lights | Street_Lights | Storm_Drains | Paint_Symbols | Manholes LARIAC | ADA_Ramps | Fire_Hydrants LARIAC | Cabinets | Sidewalk | Signs |

⊞ Options ▾   Filter by map extent   ⦿ Zoom to   ✕ Clear selection   ⟳ Refresh

OBJECTID ^	Latitude	Longitude	Altitude	MUTCD Code
61	34.03	-118.17	93.25	G27-1 (CA)
62	34.03	-118.17	92.82	G27-1 (CA)
861	34.03	-118.17	93.08	G77-4 (CA)
1464	34.03	-118.17	91.32	R10-3B
1465	34.03	-118.17	91.39	R10-3B
1467	34.03	-118.17	95.02	R3-4
1468	34.03	-118.17	95.72	G7-1 (CA)
1470	34.03	-118.17	92.99	G77-4 (CA)
7487	34.03	-118.17	103.82	OM2-1V
7714	34.03	-118.17	92.50	W34C (CA)
7715	34.03	-118.17	92.60	D11-1
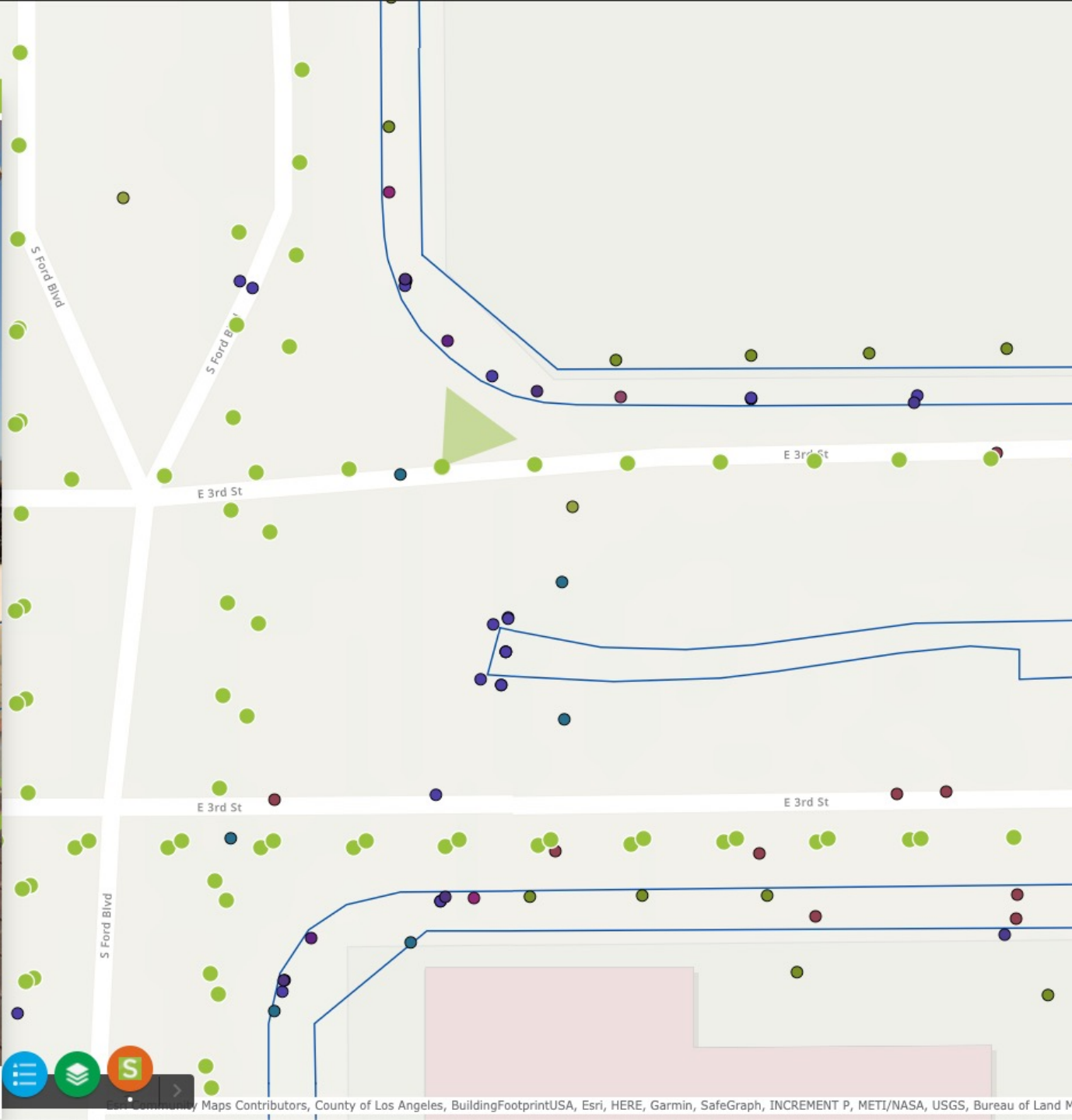
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Delivery Model
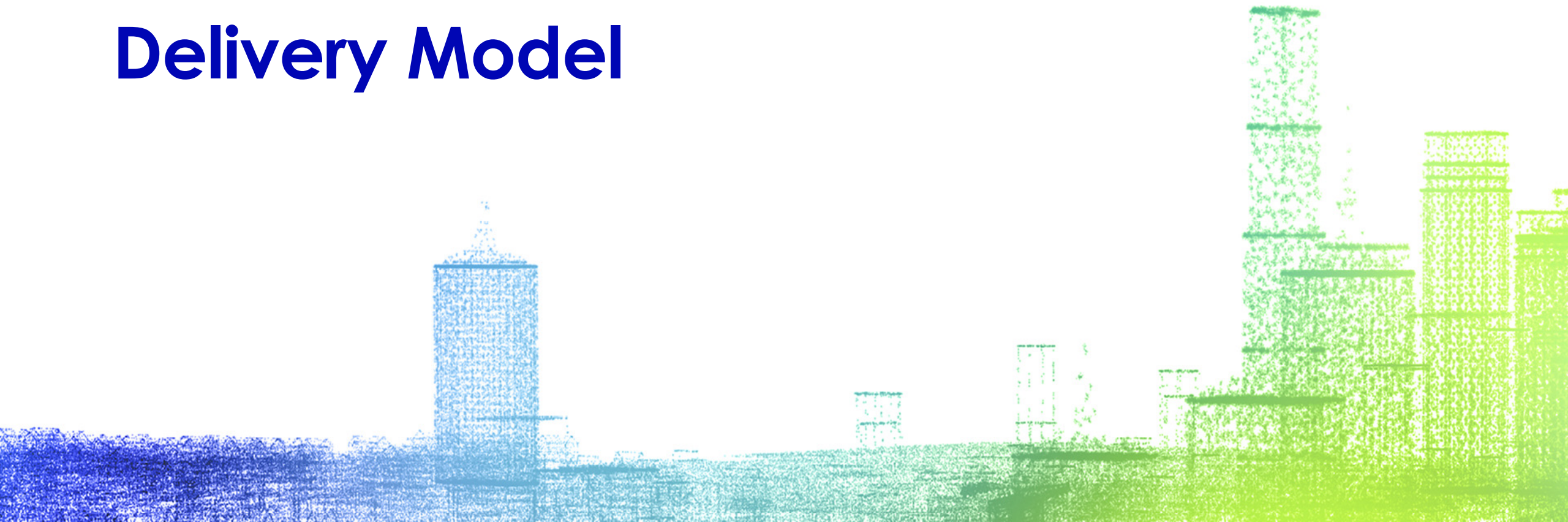
Street Smart: Enterprise SaaS Platform

Street Smart: Delivery of Imagery, LiDAR, and Measurement

Integrations: Street Smart Viewer via ESRI Add-In

Cyclomedia data can be readily integrated into CAMA systems and GIS environments.

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Integrations: Street Smart Viewer via Open API
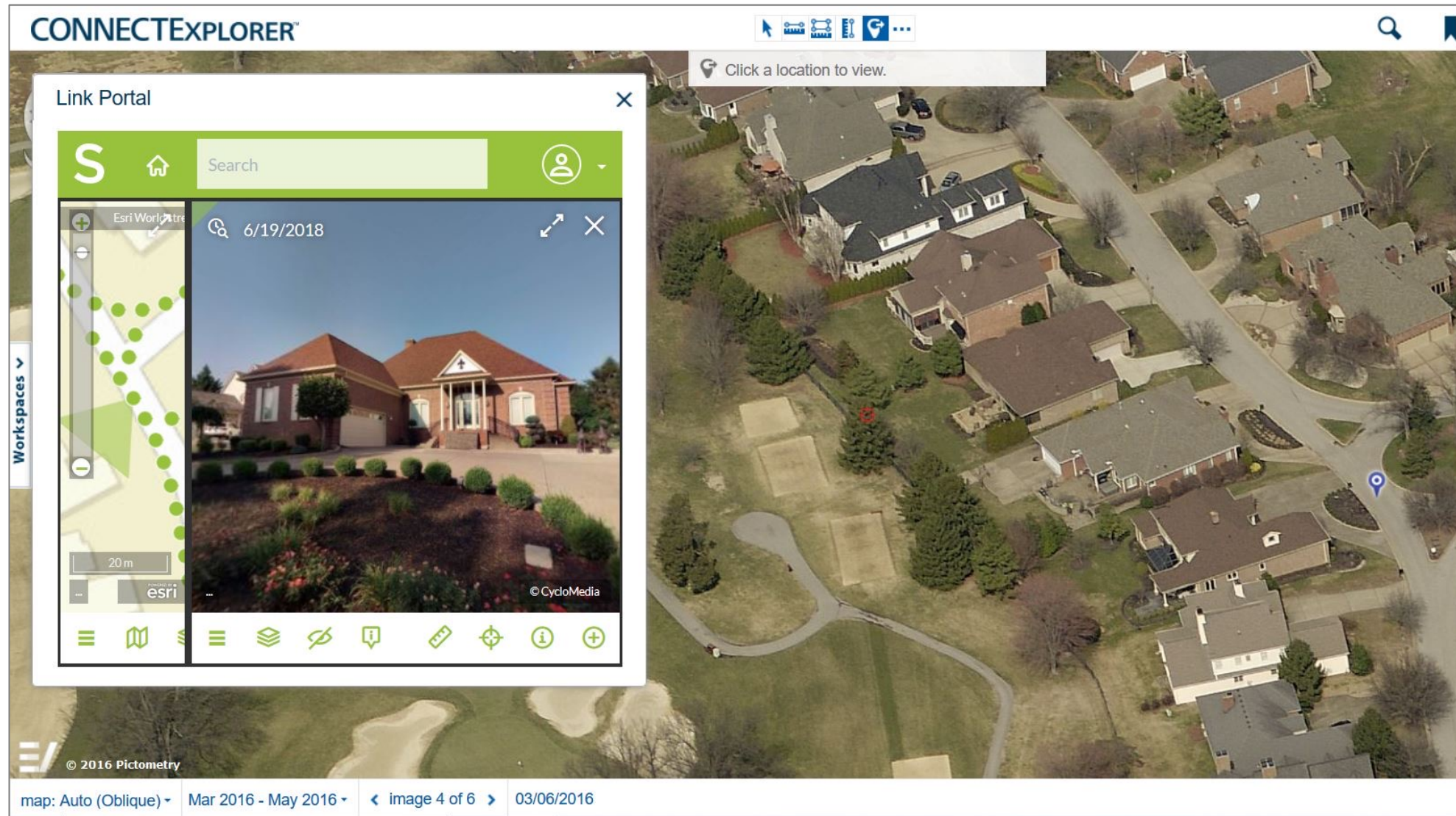
Street Smart: Asset Data Visualization

ArcGIS Pro: Street Smart Viewer & Asset Data

GDB Deliverable: Features, Metadata, & Attribution

Sign

OBJECTID *	Shape *	ID	MUTCD Code	Non-MUTCD Legend	Condition	X	Y	Z	RecordedAt	Street Smart URL
1	Point Z	2740457060412028347	W16-1P		Good	-122.293016	37.872271	59.672584	12/18/2020 9:54:09 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044106.876673163;2144983.43
2	Point Z	3085745845305536937	W11-1		Good	-122.293016	37.872271	62.323497	12/18/2020 9:54:09 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044106.880610171;2144983.37
3	Point Z	5511902058832248551	R3-18		Good	-122.293205	37.872474	56.753954	12/18/2020 9:54:12 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044053.840033833;2145058.27
4	Point Z	2719547080276132462	R1-5		Fair	-122.293074	37.872443	57.211959	12/18/2020 9:54:11 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044091.4383838335;2145046.2
5	Point Z	7061226487812352217	SW24-2 (CA)		Good	-122.293093	37.872511	57.828755	12/18/2020 9:54:12 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044086.33439141 9;2145071.12
6	Point Z	186590495317539999	SW24-2 (CA)		Good	-122.293227	37.872494	58.63584	12/18/2020 10:04:58 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044047.492277509;2145065.80
7	Point Z	5460565384514833613	R5-2		Fair	-122.293068	37.872558	56.163076	12/19/2020 7:27:19 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044093.82814284 4;2145088.30
8	Point Z	6875885442726 7739	R6-1R		Good	-122.293205	37.872475	58.590565	12/18/2020 9:54:12 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044053.752107503;2145058.68
9	Point Z	5927925884827740271	SW24-2 (CA)		Good	-122.293227	37.872493	58.538728	12/18/2020 10:04:58 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044047.5503482595;2145065.3
10	Point Z	4886350484411090389	D3-1		Good	-122.293148	37.872678	56.566947	12/18/2020 9:54:14 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044071.77790093;2145132.44
11	Point Z	4508126443413106571	SW24-3 (CA)		Good	-122.293225	37.87292	55.819573	12/18/2020 9:54:17 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044051.030000097;2145220.87
12	Point Z	3753592660142462255	R7-2a		Fair	-122.293247	37.872976	53.986243	12/18/2020 9:54:17 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044045.240641583;2145241.48
13	Point Z	8219765285519968494	R6-1R		Good	-122.293483	37.873336	52.634868	12/18/2020 9:54:22 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043979.59740018;2145373.791
14	Point Z	1655560326299206872	NA	No Left Turn 7-9AM 3-6PM Sundays Holidays Excepted	Fair	-122.293484	37.873336	50.393075	12/18/2020 9:54:22 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043979.22072847;2145373.69
15	Point Z	5227616468785537346	R28D (CA)		Fair	-122.293352	37.873302	51.794319	12/18/2020 9:54:21 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044017.02941915;2145360.47
16	Point Z	6022520838191124577	R1-5		Good	-122.293362	37.873333	51.77693	12/18/2020 9:54:22 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044014.585519168;2145371.85
17	Point Z	226295617528999131	SW24-2 (CA)		Good	-122.293376	37.873385	52.17752	12/18/2020 9:54:22 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6044010.883754932;2145390.92
18	Point Z	2410111488385809660	SW24-2 (CA)		Good	-122.293507	37.873363	53.259867	12/18/2020 10:04:50 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043972.820838913;2145383.58
19	Point Z	9037318612275725089	SW24-2 (CA)		Good	-122.293429	37.873551	54.827449	12/18/2020 9:54:24 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043996.640017009;2145451.70
20	Point Z	5530016555822316888	SW24-2 (CA)		Good	-122.293564	37.873585	51.57844	12/18/2020 9:54:25 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043957.890422584;2145464.85
21	Point Z	4997944724388581329	R32 (CA)		Good	-122.293441	37.873581	50.306461	12/18/2020 9:54:25 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043993.270273092;2145462.48
22	Point Z	1489786274888541025	R1-5		Good	-122.293724	37.873601	49.532512	12/18/2020 10:04:48 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043911.847863751;2145471.64
23	Point Z	639115840320701781	R7-108		Good	-122.293514	37.873813	48.939009	12/18/2020 9:54:28 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043973.922870836;2145547.62
24	Point Z	2472923096123557450	SW24-3 (CA)		Good	-122.293869	37.874047	52.095171	12/18/2020 10:04:44 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043873.116313924;2145634.51
25	Point Z	8161820018004720524	R7-108		Good	-122.293814	37.874743	49.258891	12/18/2020 9:54:52 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043893.942387749;2145887.85
26	Point Z	1231588744900175930	R7-108		Good	-122.293868	37.874913	50.268731	12/18/2020 9:55:01 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043879.383361762;2145949.94
27	Point Z	5103295260851438357	NA	BUS STOP 72 72M 800 G	Good	-122.293929	37.875116	49.64242	12/18/2020 9:55:04 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043863.21478086;2146024.02
28	Point Z	2265268472069832849	R7-108		Good	-122.29401	37.875358	47.597805	12/18/2020 9:55:08 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043841.698069664;2146112.72
29	Point Z	2150341863771096355	W11-2		Good	-122.294122	37.875713	52.654225	12/18/2020 9:55:12 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043811.707228335;2146242.5
30	Point Z	7265128797936761107	R7-108		Good	-122.294112	37.875657	51.031525	12/18/2020 9:55:11 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043814.290972255;2146221.99
31	Point Z	3788942432259250996	R7-108		Good	-122.294164	37.875828	50.731985	12/18/2020 9:55:13 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043800.403204759;2146284.54
32	Point Z	4912608006545752290	R7-108		Good	-122.294164	37.875828	52.345827	12/18/2020 9:55:13 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043800.32315242 7;2146284.58
33	Point Z	6089305497093458362	R7-108		Good	-122.294249	37.876093	51.343204	12/18/2020 9:55:16 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043777.78251508;2146381.492
34	Point Z	3927415720211437936	W11-2		Good	-122.294456	37.876306	55.079417	12/18/2020 9:55:20 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043719.63630591 7;2146460.22
35	Point Z	2209857668799263445	W11-2		Good	-122.294318	37.876316	54.430780	12/18/2020 9:55:20 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043759.526974177;2146463.07
36	Point Z	6232296167315158103	R1-5a		Good	-122.294304	37.876262	52.717217	12/18/2020 9:55:18 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043763.063056337;2146443.52
37	Point Z	779516219254139437	R1-1		Good	-122.294319	37.87648	52.873713	12/19/2020 9:10:33 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043760.20348201;2146522.974
38	Point Z	940272473659423457	W11-2		Good	-122.294379	37.876496	58.672258	12/18/2020 9:55:22 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043743.033568832;2146529.00
39	Point Z	6239342855798175976	W11-2		Good	-122.294509	37.876517	55.567605	12/18/2020 9:55:23 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043705.769535757;2146537.37
40	Point Z	3383280130537456806	R6-1R		Fair	-122.294514	37.876570	50.686709	12/18/2020 9:55:23 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043704.378790502;2146545.63
41	Point Z	5062341820383952027	W16-9P		Good	-122.294509	37.876909	53.470496	12/18/2020 9:55:26 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043708.325633005;2146680.25
42	Point Z	5910566209936048739	R7-108		Good	-122.294532	37.876966	54.339261	12/18/2020 9:55:27 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043702.26965344;2146700.99
43	Point Z	4155156766568225522	W11-2		Good	-122.294509	37.876909	55.807762	12/18/2020 9:55:26 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043708.310541169;2146680.32
44	Point Z	3585101161598752560	R7-108		Good	-122.294595	37.877158	53.694249	12/18/2020 9:55:29 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043685.4726603385;2146771.2
45	Point Z	1440561986076055456	W11-2		Good	-122.294925	37.878194	57.818913	12/18/2020 9:55:38 PM	https://streetsmart.cyclomedia.com/streetsmart/?mq=6043597.31666868;2147150.117

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Use Cases: Data Analytics

Idaho Transportation: Statewide Asset Inventory Web Map

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Idaho Transportation: Signs & Support Dashboard

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San Bernardino Asset Management: Guardrail
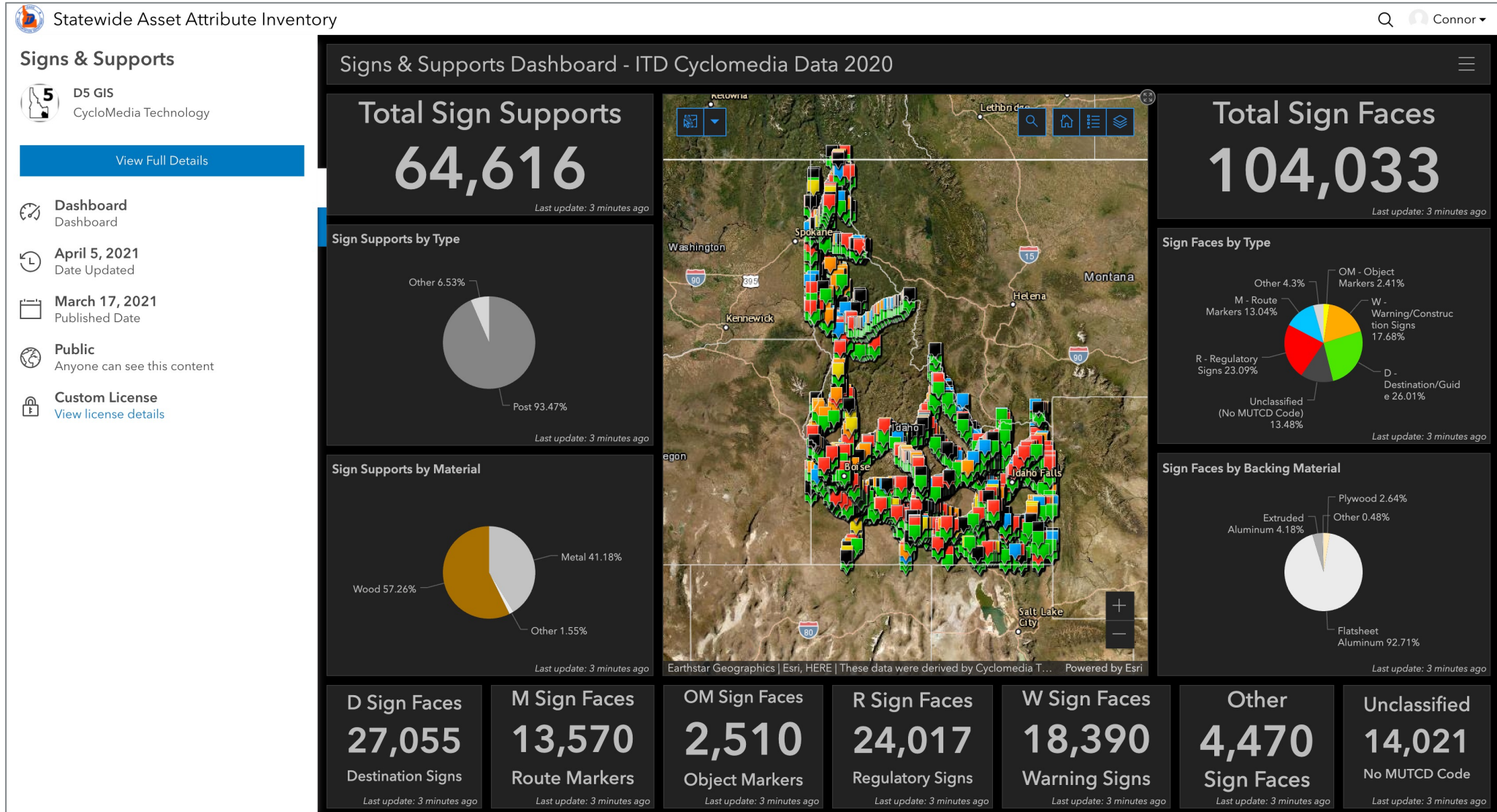
San Bernardino Asset Management: Guardrail

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Example use cases: End-user Poll

- Inventory data to help with **preventative maintenance** and appropriate **funding**

- Assessing/measuring the **limits of the public right-of-way**

- **Measurement**; pavement/lane widths

- **Land use** planning

- Identifying **ownership**

- Transportation; **accessibility and safety**

- **Verifying properties** and addresses

- **Stormwater infrastructure** management

- **Sidewalk** and condition inventory

- Appropriate response to **311 requests**

- Viewing **labels/tags**

- **Situational awareness** (public safety)

  - Evacuation routes & fire truck access
  - Locating 911 callers

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Questions?

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