Enterprise GIS and Asset Management

ESRI Southwest User Conference
April 2018

DENVER WATER | 100 YEARS 1918 — 2018

About Denver Water

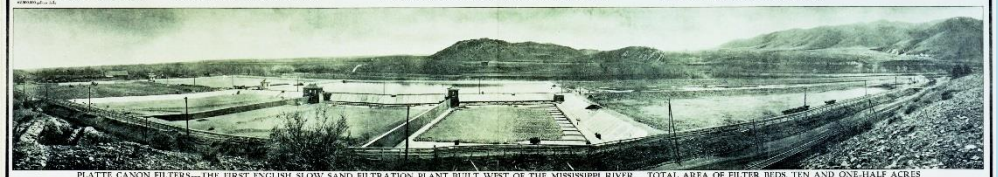
- Established 1918
  - 2018 is our 100 year anniversary!
- Serves 1.4 million customers
- Service area = 335 sq. miles
- Largest and oldest water utility in Colorado
- Denver Water is a separate entity from the City and County of Denver.
- ESRI customer #1640
  - 1st water utility to buy ESRI software?

MAP SHOWING

THE DENVER UNION WATER COMPANY'S

DISTRIBUTING MAINS, FIRE-PROTECTION SYSTEM, PLATTE CANON FILTER PLANT, VIEWS OF CHEESMAN LAKE AND DAM, MARSTON LAKE AND LOCATIONS OF OTHER SOURCES OF SUPPLY AND SUPPLY CONDUITS

463.58 Miles of Mains and Conduits — Eleven Reservoirs—Storage Capacity, 33 Billion Gallons — 2687 Fire Hydrants of Largest Capacity



PLATTE CANON FILTERS—THE FIRST ENGLISH SLOW SAND FILTRATION PLANT BUILT WEST OF THE MISSISSIPPI RIVER. TOTAL AREA OF FILTER BEDS, TEN AND ONE-HALF ACRES

Every Drop of Water Furnished Down by The Denver Union Water Company is Scientifically Filtered and Treated. The Total Capacity of Its Filters is More Than 60 Million Gallons Daily.

Lake Cheesman is the most perfect reservoir for the storage of water for domestic purposes ever built.

Its watershed (1,152,000 acres) is larger than that of any other artificial reservoir used for domestic water service.

The lake is located fifty miles from Denver in an almost inaccessible mountain district.

It is twenty-seven miles from the nearest railroad.

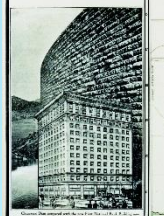
The Denver Union Water Company has the largest and most complete artificial water-storage system in the world for the population served and the demand for water.

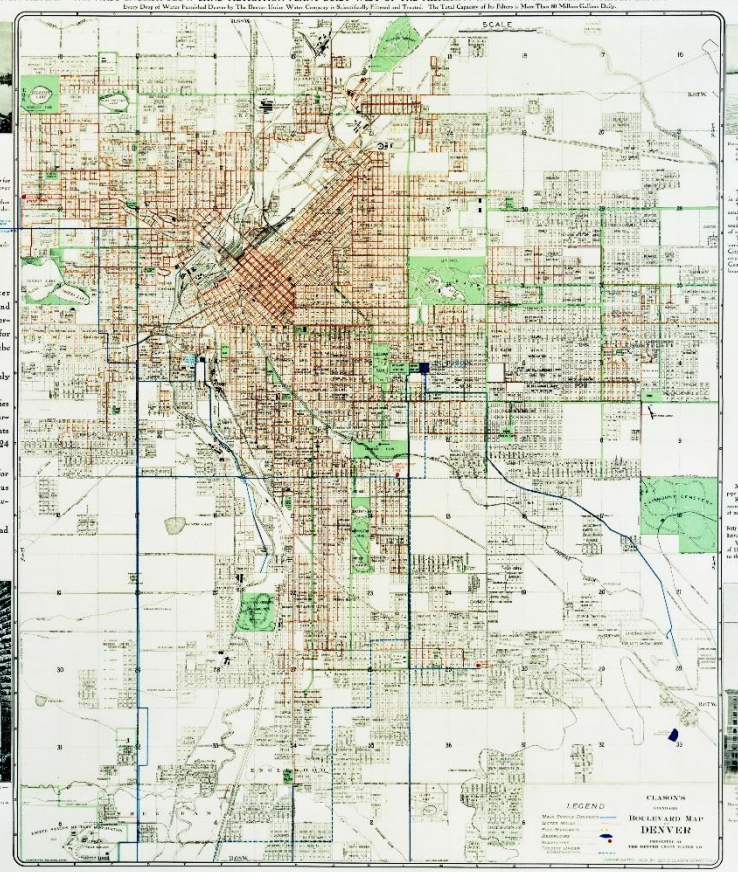
More than two years' supply without replenishing.

Besides its storage facilities the Water Company has purchased and acquired water rights for a year-round supply of 124 million gallons daily.

The average daily demand for water in Denver last year was 44 million gallons, about one-third the available supply.

The maximum summer demand was 60 million gallons daily.





The distributing mains and supply conduits range in diameter from 48 inches to 4 inches.

Within the city 402.12 miles of mains and conduits are used to distribute water to consumers.

Outside the city, 61.46 miles of conduits are used to bring the water from the various sources of supply.

The following table shows the volume of the various sizes of mains and conduits owned by the City and by the Water Company, respectively. The sizes of mains owned by the Water Company, as stated in the inventory for the board of supervisors:

Inside City Limits

	Miles
Less than 4 inch, special service	5.96
4 inch	60.24
6 "	165.04
8 "	65.74
10 "	15.16
12 "	35.04
14 "	0.12
16 "	12.15
18 "	12.15
20 "	1.60
24 "	2.50
30 "	10.25
36 "	5.32
48 "	1.74
60 "	1.65
Total	402.12

Outside City Limits

	Miles
20 inches	2.10
16 "	10.60
12 "	40.40
10 "	5.23
8 "	0.07
6 "	.31
Total	61.46

36 per cent of the whole system is composed of pipe of 12 inches or larger diameter.

Reports from forty of the largest cities in the country show an average percentage of services using of mains as follows:

	10 cubic ft.	8 cu. ft.	6 cu. ft.	4 cu. ft.	175 cubic feet
Forty Cities	12%	12	18	32	26
Denver	11%	13%	7%	12	56%

Work at new outlet was in the construction of 18 miles of new 48-inch supply conduit leading to the Capitol Hill district

Population and Area per Square Mile

of 24 Large Cities Compared with Denver

	Census	Area
Atlanta, Ga.	154,839	37
Louisville, Ky.	234,891	36
Boston, Mass.	748,060	43
Baltimore, Md.	558,485	30
Richmond, Va.	171,667	7.5
Minneapolis, Minn.	301,408	53
St. Paul, Minn.	214,744	29
Kansas City, Mo.	324,410	39
Omaha, Neb.	191,601	23
Grand Rapids, Mich.	137,634	15
Rochester, N. Y.	218,149	15
Cincinnati, O.	401,247	52
Cleveland, O.	560,663	58
Portland, Ore.	258,288	38
Pittsburg, Pa.	533,905	44
Providence, R. I.	224,326	19
Memphis, Tenn.	162,351	19
Milwaukee, Wis.	373,857	29
Los Angeles, Cal.	319,198	43
San Francisco, Cal.	416,912	41
Seattle, Wash.	237,194	31
Tacoma, Wash.	83,743	21
Buffalo, N. Y.	423,715	41
San Francisco, Cal.	416,912	41
Average population, 24 cities	287,578	
Denver population	280,000	
Average area 24 cities, 35.07 sq. m.		
Denver area	39.50 sq. m.	
Average population per square mile, 24 cities	10,173	
Population per square mile, Denver	7,361	

Showing Lake Cheesman full and water flowing over the spillway.

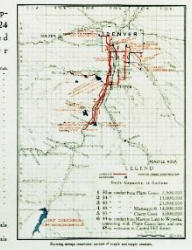
The length of the dam and spillway is 1265 feet.

The masonry contained in the structure would build a wall 22 feet high and one foot thick completely around Denver.

The cement mortar alone would build a wall 83 feet high and one foot thick completely around City Park.

Per Capita Consumption of Water of 24 Cities Compared With Denver

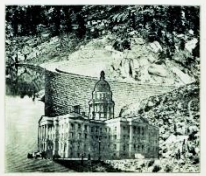
	Gallons
Atlanta, Ga.	70 Gals.
Louisville, Ky.	80
Boston, Mass.	85
Worcester, Mass.	100
Baltimore, Md.	90
Minneapolis, Minn.	90
St. Paul, Minn.	90
Kansas City, Mo.	90
Omaha, Neb.	90
Grand Rapids, Mich.	90
Rochester, N. Y.	90
Cincinnati, O.	100
Cleveland, O.	100
Portland, Ore.	100
Providence, R. I.	100
Memphis, Tenn.	100
Milwaukee, Wis.	90
Los Angeles, Cal.	100
San Francisco, Cal.	100
Seattle, Wash.	100
Buffalo, N. Y.	110
San Francisco, Cal.	100
Average Consumption 24 Cities	106.04 Gals.
Denver Consumption	220 Gals.



Feet of Water Main

Per Inhabitant 24 Cities Compared with Denver

	Feet
Atlanta, Ga.	7.04
Louisville, Ky.	6.93
Boston, Mass.	6.60
Worcester, Mass.	6.60
Baltimore, Md.	6.60
Minneapolis, Minn.	6.60
St. Paul, Minn.	6.60
Kansas City, Mo.	6.60
Omaha, Neb.	6.60
Grand Rapids, Mich.	6.71
Rochester, N. Y.	6.71
Cincinnati, O.	6.71
Cleveland, O.	7.10
Portland, Ore.	6.10
Pittsburg, Pa.	6.10
Providence, R. I.	6.60
Memphis, Tenn.	6.60
Milwaukee, Wis.	6.60
Los Angeles, Cal.	11.60
San Francisco, Cal.	7.00
Seattle, Wash.	6.60
Tacoma, Wash.	6.60
Buffalo, N. Y.	6.60
San Francisco, Cal.	7.00
Average per inhabitant 24 cities	6.71
Denver, per inhabitant	12.54



The Colorado Capitol Building beside Cheesman Dam.

The Capitol Building is 256 feet high to the top of the dome

The dam lacks just 20 feet of that height

The dam and spillway is three and one-half times as long as the Capitol Building.

The structure contains enough granite and cement to build 10 Capitol buildings

Table of Miles of Water Mains

of 24 Cities Compared with Denver

	Miles
Atlanta, Ga.	197
Louisville, Ky.	329
Boston, Mass.	783
Worcester, Mass.	180
Baltimore, Md.	1,000
Minneapolis, Minn.	580
St. Paul, Minn.	300
Kansas City, Mo.	582
Omaha, Neb.	300
Grand Rapids, Mich.	225
Rochester, N. Y.	350
Cincinnati, O.	700
Cleveland, O.	750
Portland, Ore.	350
Pittsburg, Pa.	850
Providence, R. I.	350
Memphis, Tenn.	400
Milwaukee, Wis.	600
Los Angeles, Cal.	900
San Francisco, Cal.	1,000
Seattle, Wash.	600
Buffalo, N. Y.	615
San Francisco, Cal.	1,000
Average 24 Cities	454.42
Denver	463.58

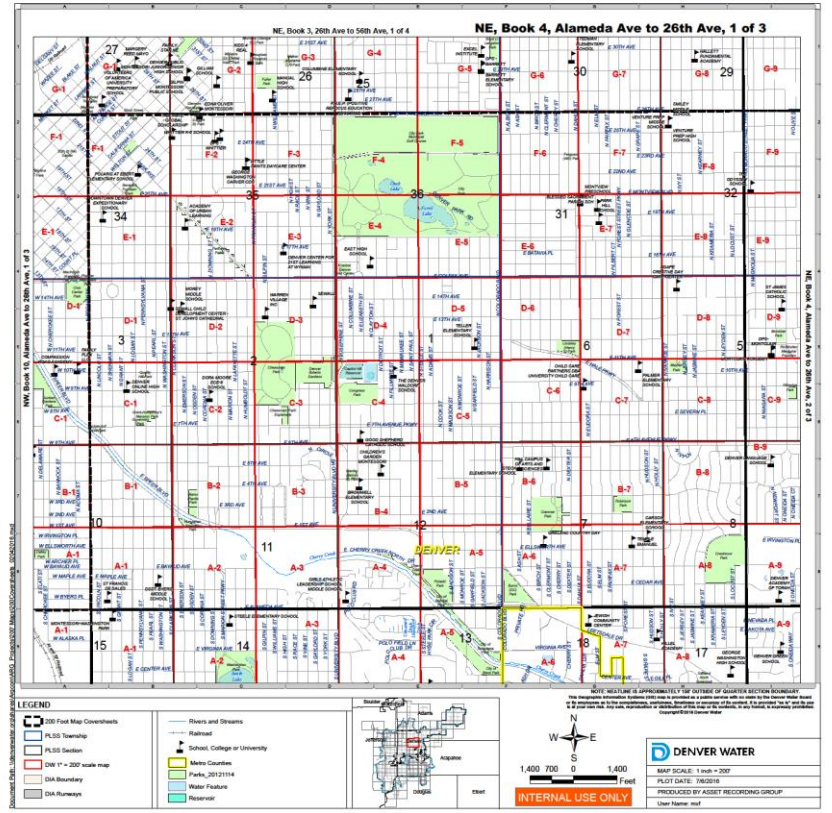
Average population per mile of mains in 24 cities — 785.29 persons

Population per mile of mains, Denver — 451.45 persons

On the basis of Denver's population and mileage of water mains the 24 cities should average 827.77 miles instead of 454.42

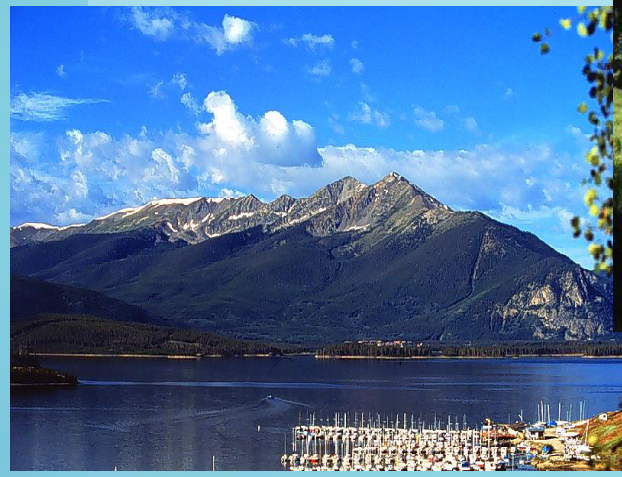
Distribution System

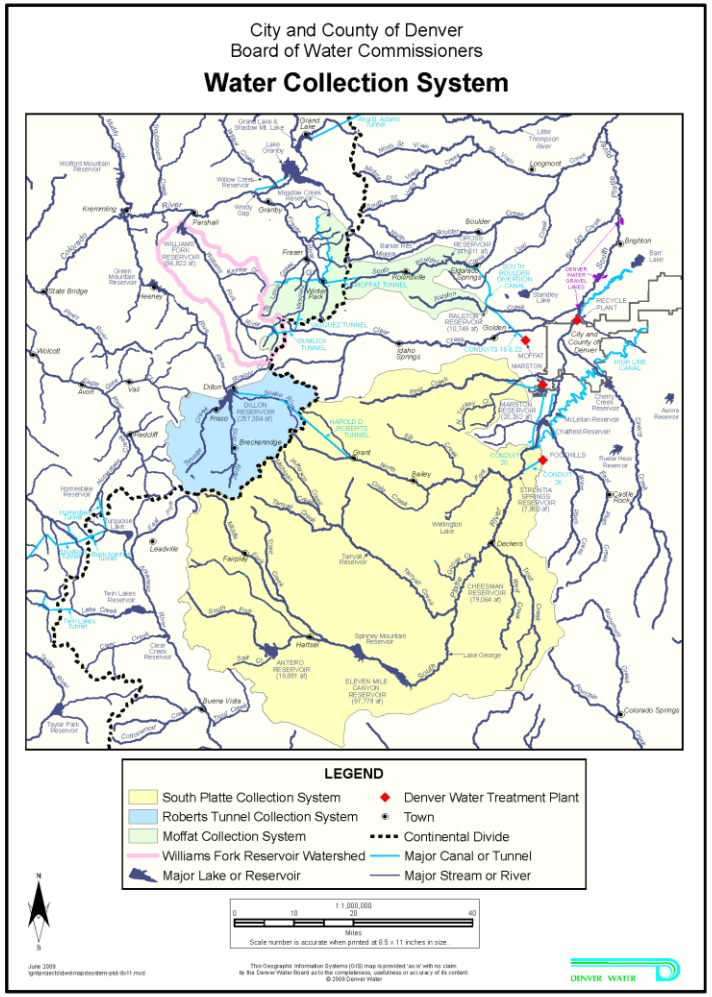
- 3,000+ miles of Mains
  - ✓ More than 1,600 map sheets printed at a scale of 1” = 200 feet
- 500+ miles of Conduits (>24” pipe)
- 23 Pump Stations
- Includes Denver International Airport

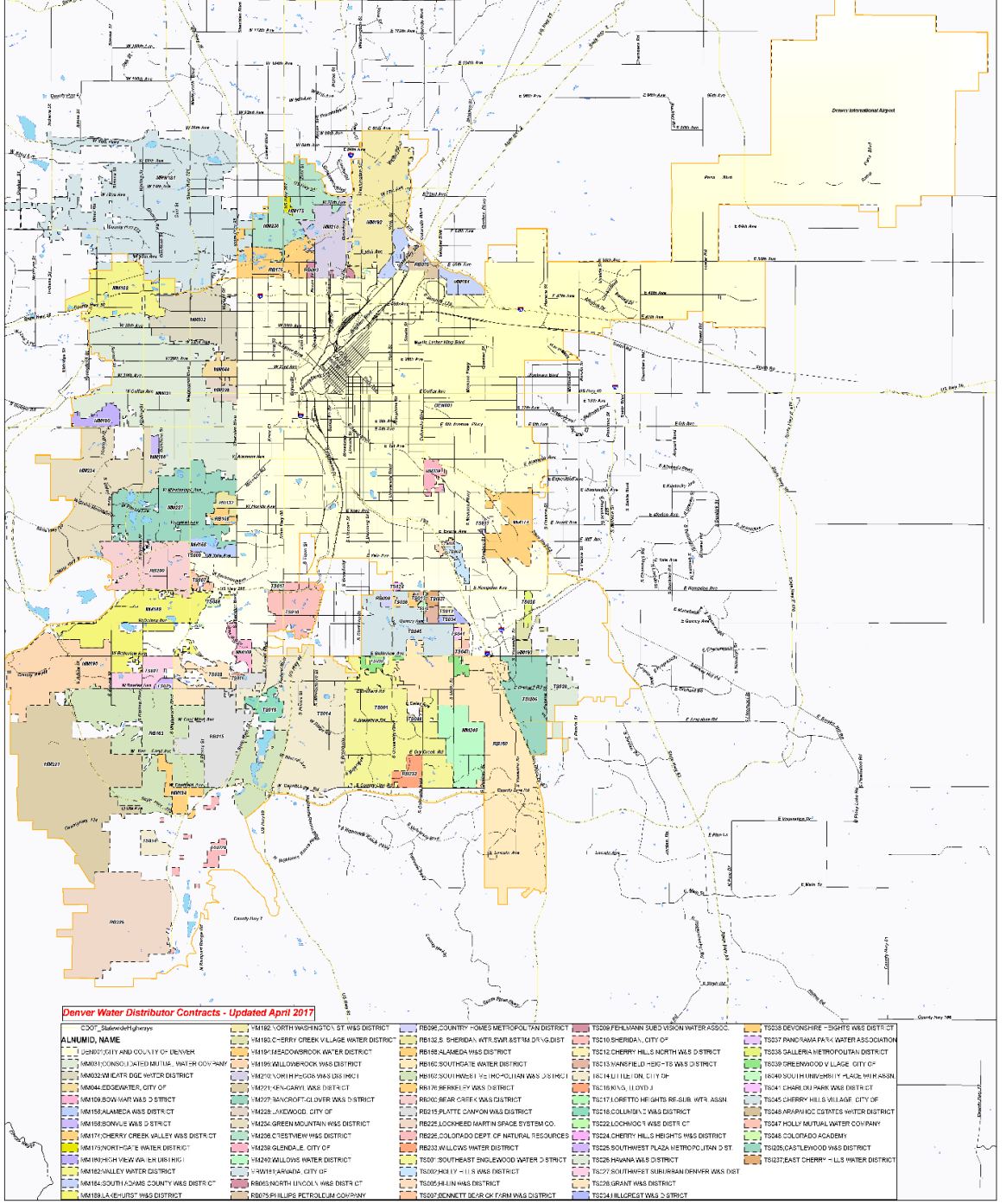


Collection System

- Covers 4,000 sq. miles (2.5M acres)
- Extends into Park, Grand, Jefferson, Gilpin, Summit, Teller, Douglas, Clear Creek counties
- Water = Mostly Mountain Snowmelt



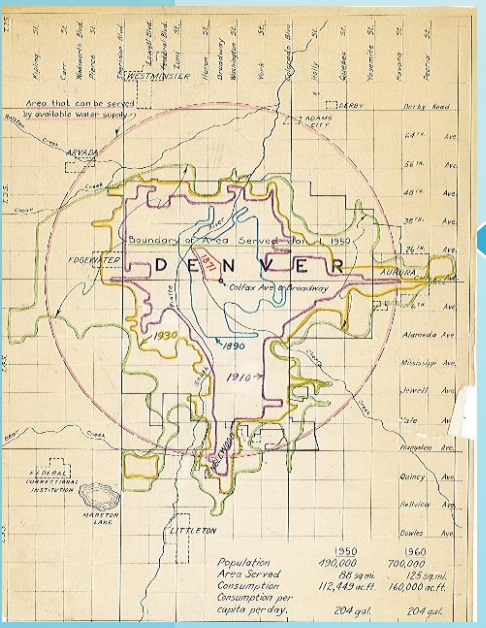




Denver Water Distributors

Denver Water provides clean, treated water to more than 60 smaller water districts. Since all pipes are connected we need to map their assets too.

History of GIS at Denver Water

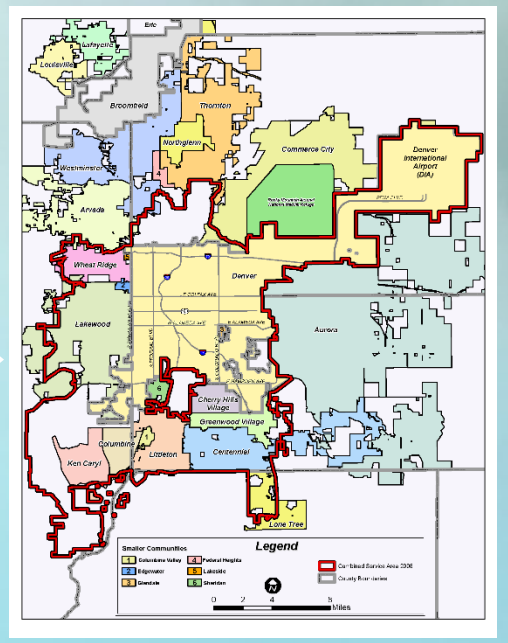


1985 - 1990

- Digital Conversion from Paper
- Attributes Added
- Distribution Facilities Digitized
- Technology Migration

2001 – 2006

- Data Improvements
- 2nd Technology Migration – ESRI/SDE

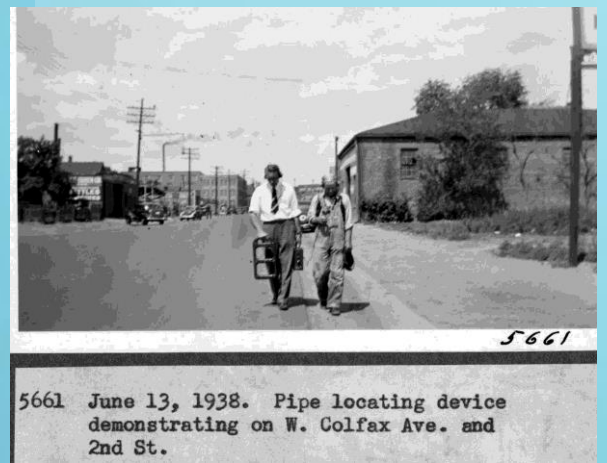


Historically – two GIS Groups:

- ❖Water Resources GIS in Planning
- ❖Distribution GIS in Engineering/IT

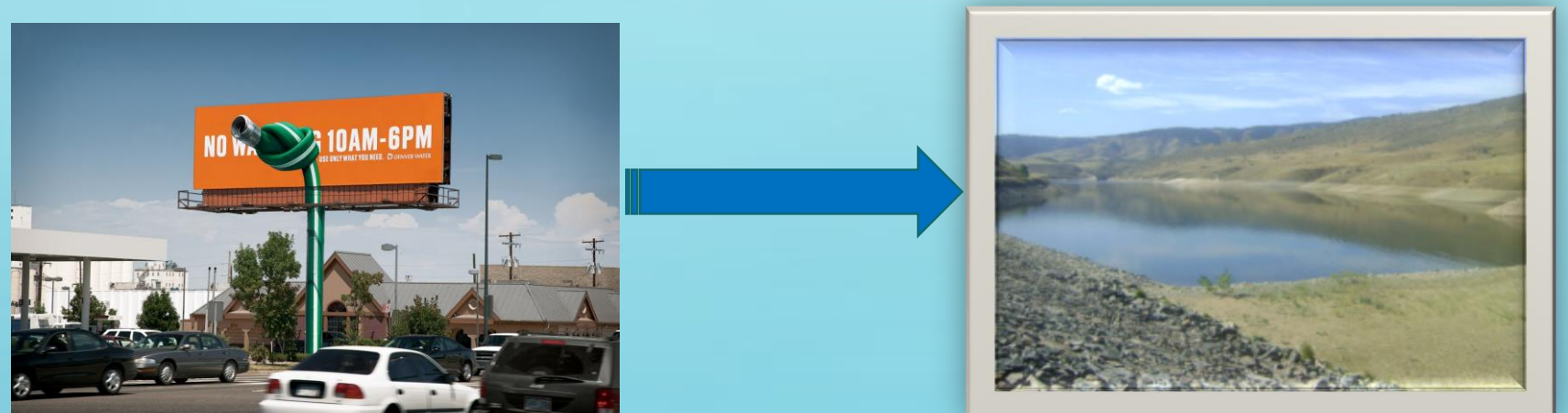
❖Now three groups:

- ❖Engineering/Asset Recording
- ❖Administrative GIS Services
- ❖IT Geospatial Asset Management

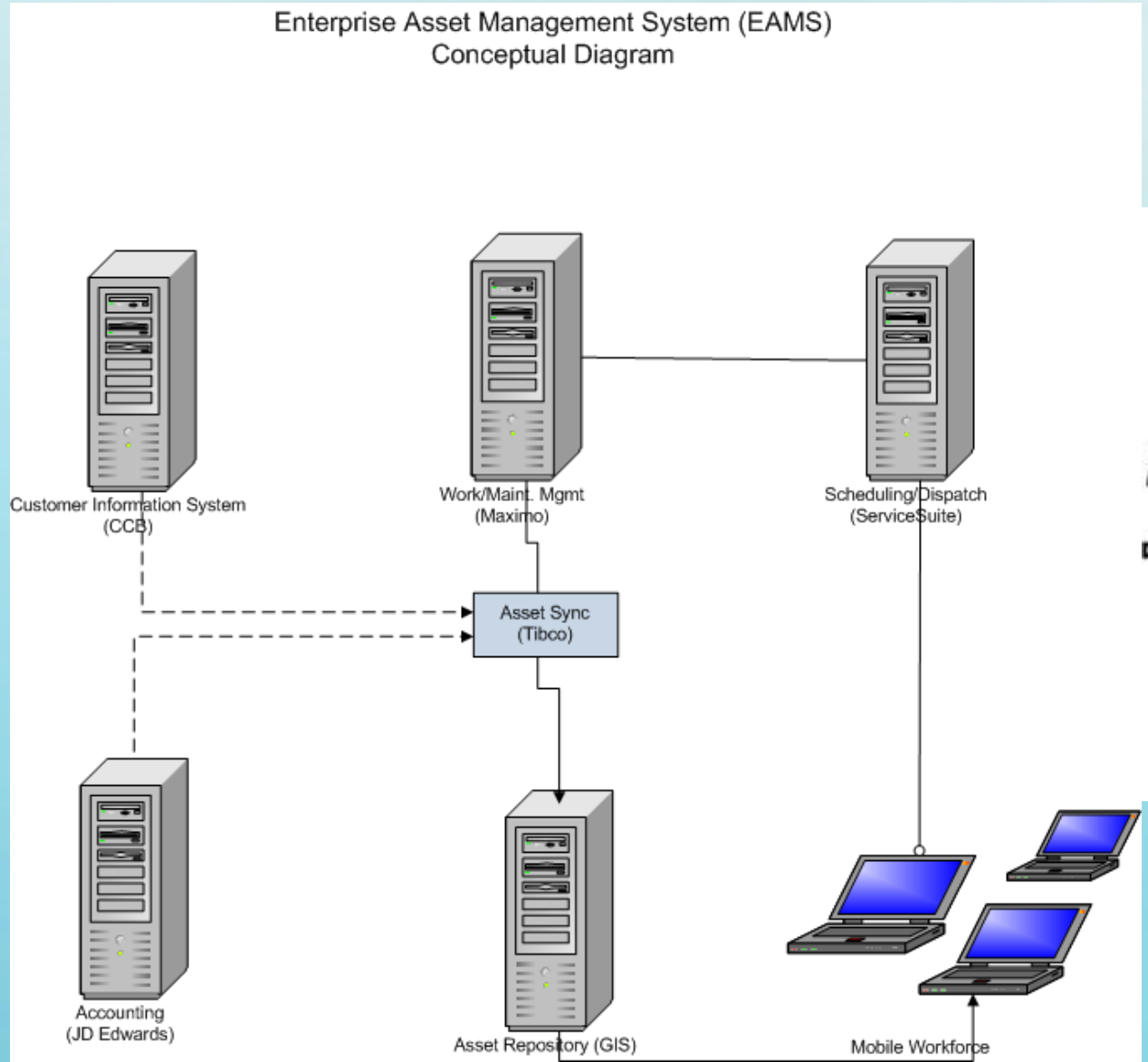


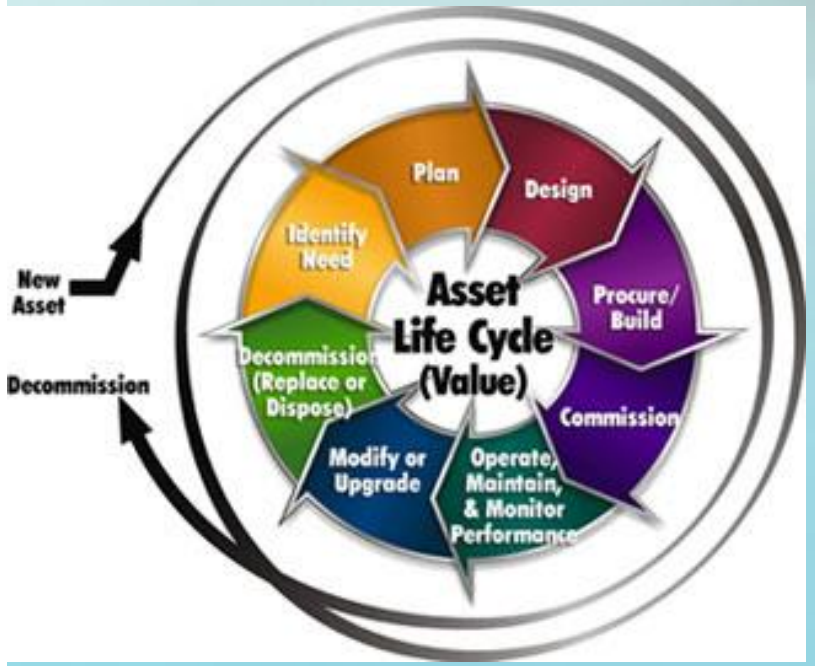
Overview of GIS and Asset Management

- Robust GIS supports many aspects of our business
- Asset management is core to operations, maintenance, finance, planning, and engineering.
- Keeping data current and accurate is an ongoing challenge
- Integrates multiple, legacy systems
- Supports field operations with mobile solution



Enterprise Asset Management

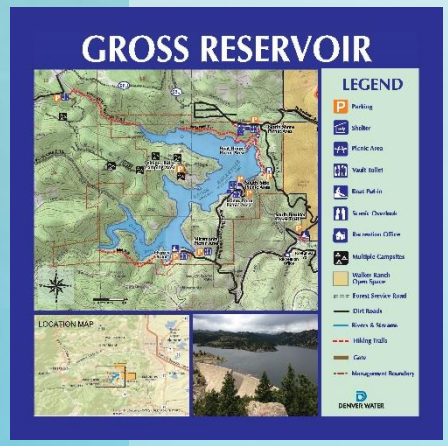


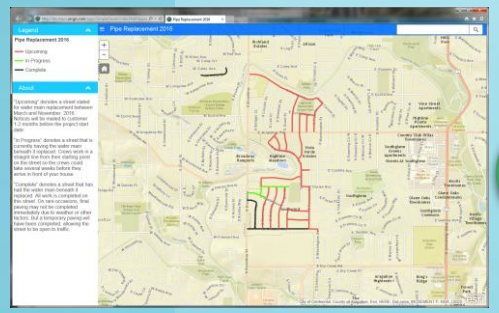


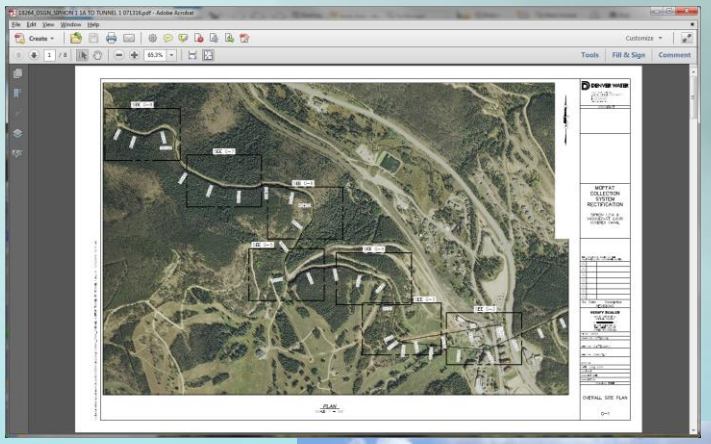
Managing $2B in Water System Assets

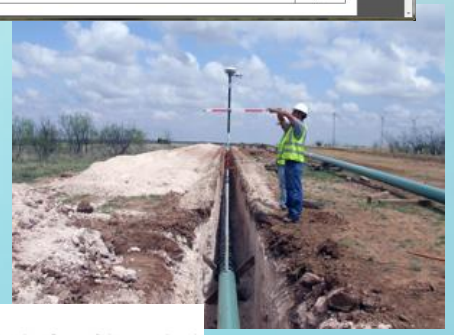
- 3,000+ miles of transmission and distribution mains
- More than 240,000 active taps serving 1.4M customers
- 80,000+ valves used to operate the system
- 23 Pump Stations, 4 Treatment Plants
- Mountain Collection system spans 4,000 square miles across 8 counties
  - with pipes, canals, tunnels, and siphons to maintain

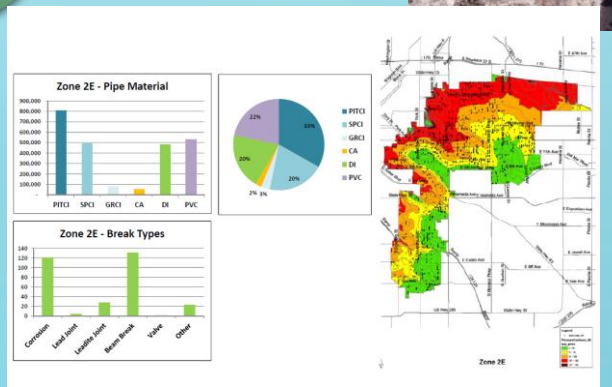
GIS is at the hub of our business











Why do we need GIS?

Capital Projects in 2017

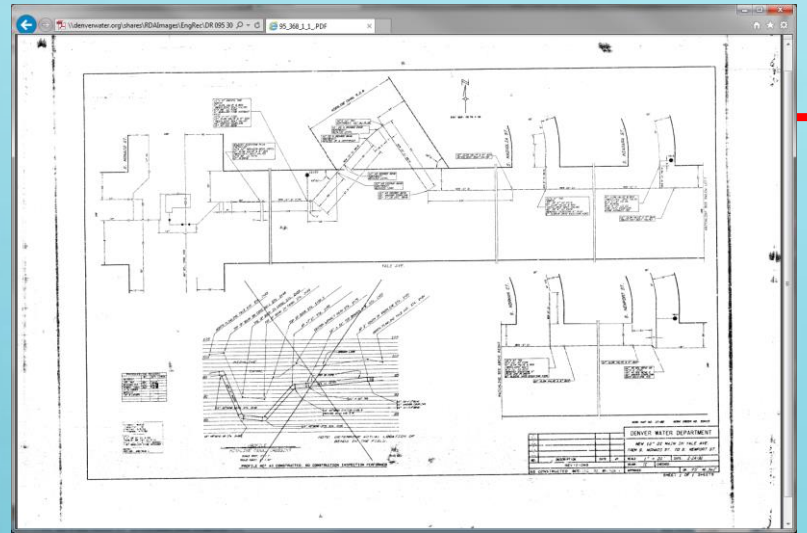
- 130 Projects – $160M budgeted
- 69 Projects in Construction
- 35 Completed Construction Projects
- $107M Construction cost
- 100 year old facilities require maintenance!

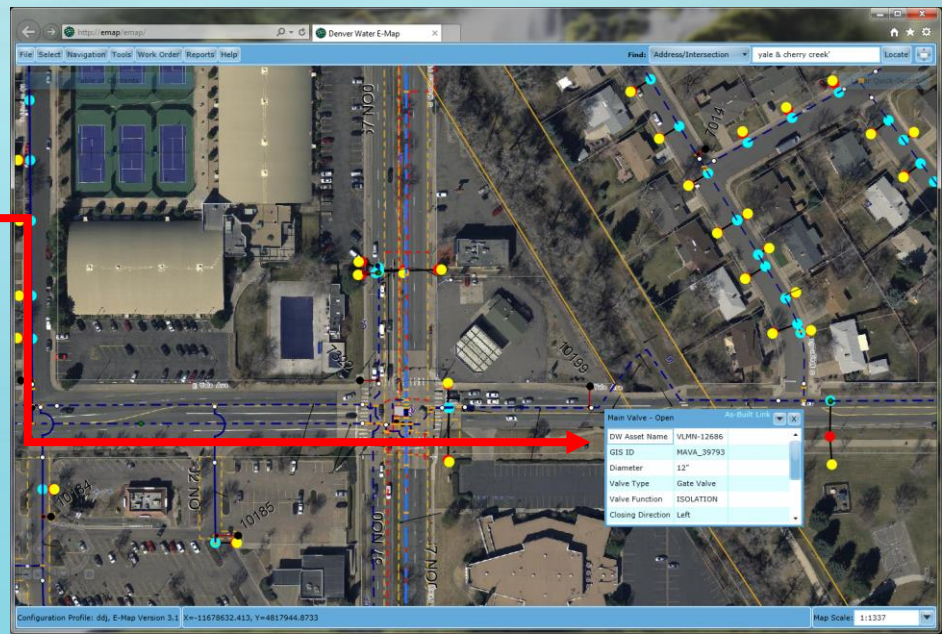
Gross Reservoir Flyover

https://youtu.be/eF0hwI2PySk

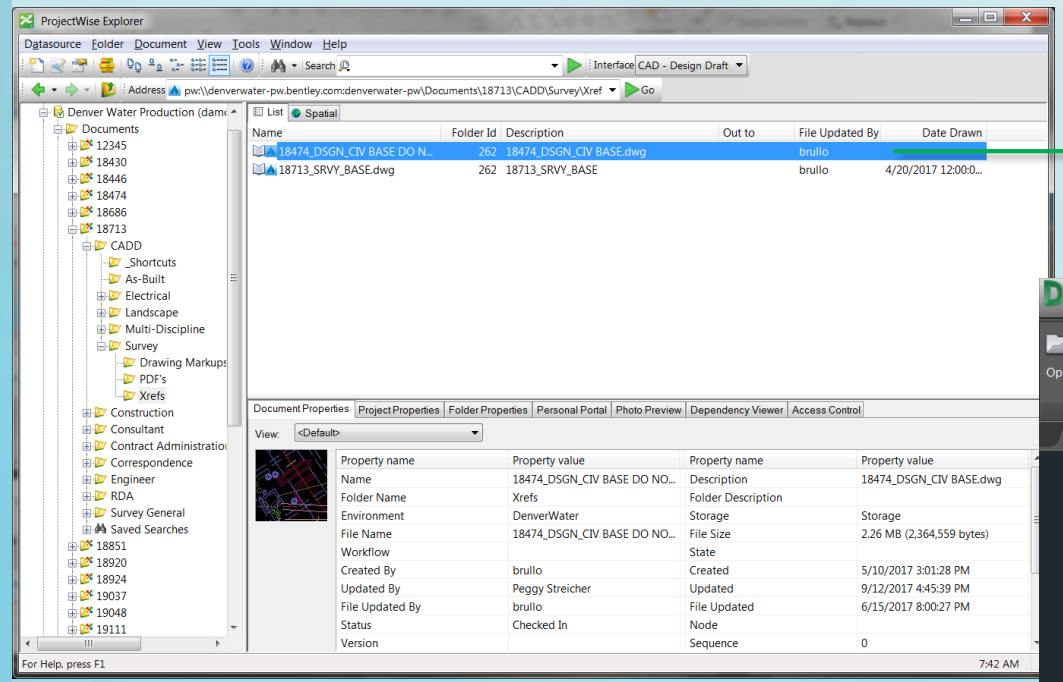
Posting As-Built Drawings to ArcGIS

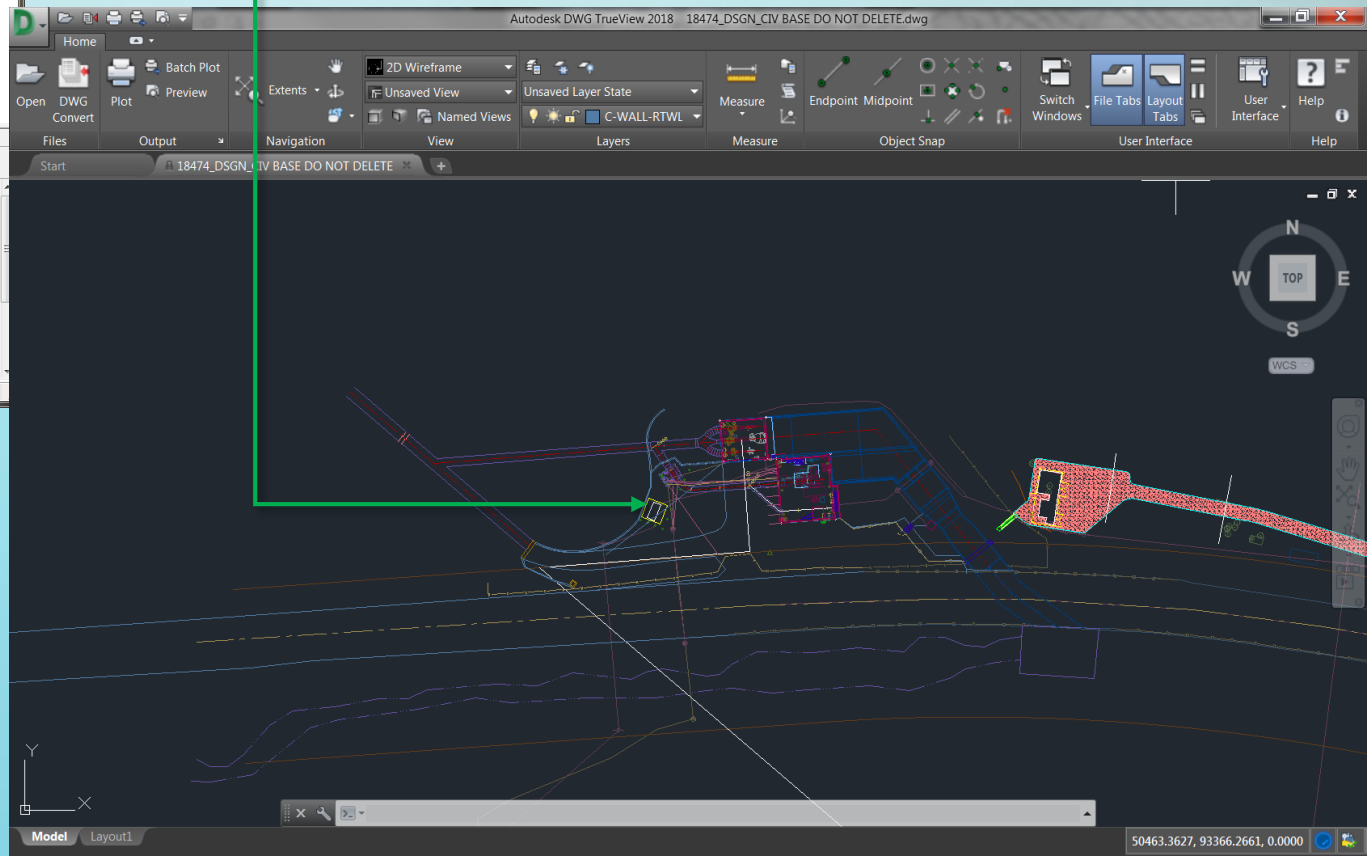
- AutoCAD drawings depict as-built conditions
- E-Map is an ArcGIS Server based intranet GIS (internally developed)
- CAD drawings are used to update E-Map via ArcGIS SDE
- E-Map includes links to the PDF drawings for reference
- Mobile crews can access E-Map in the field



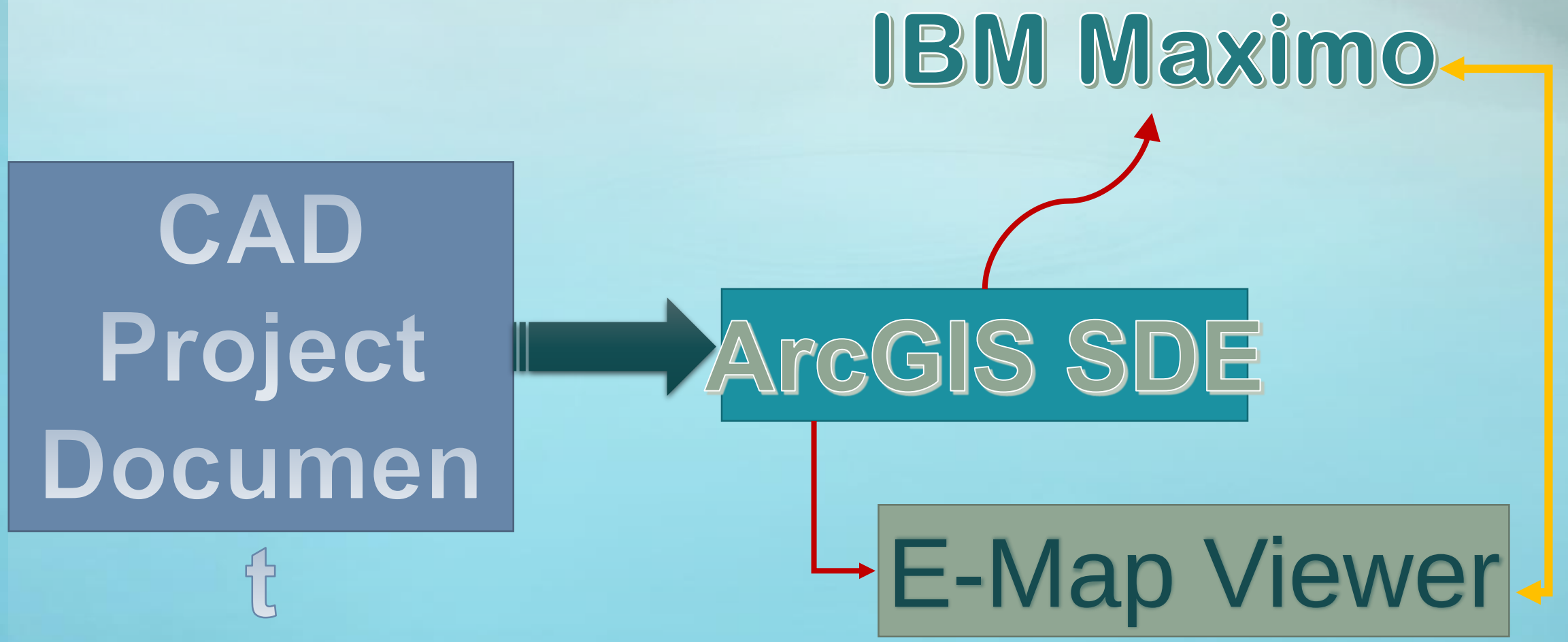


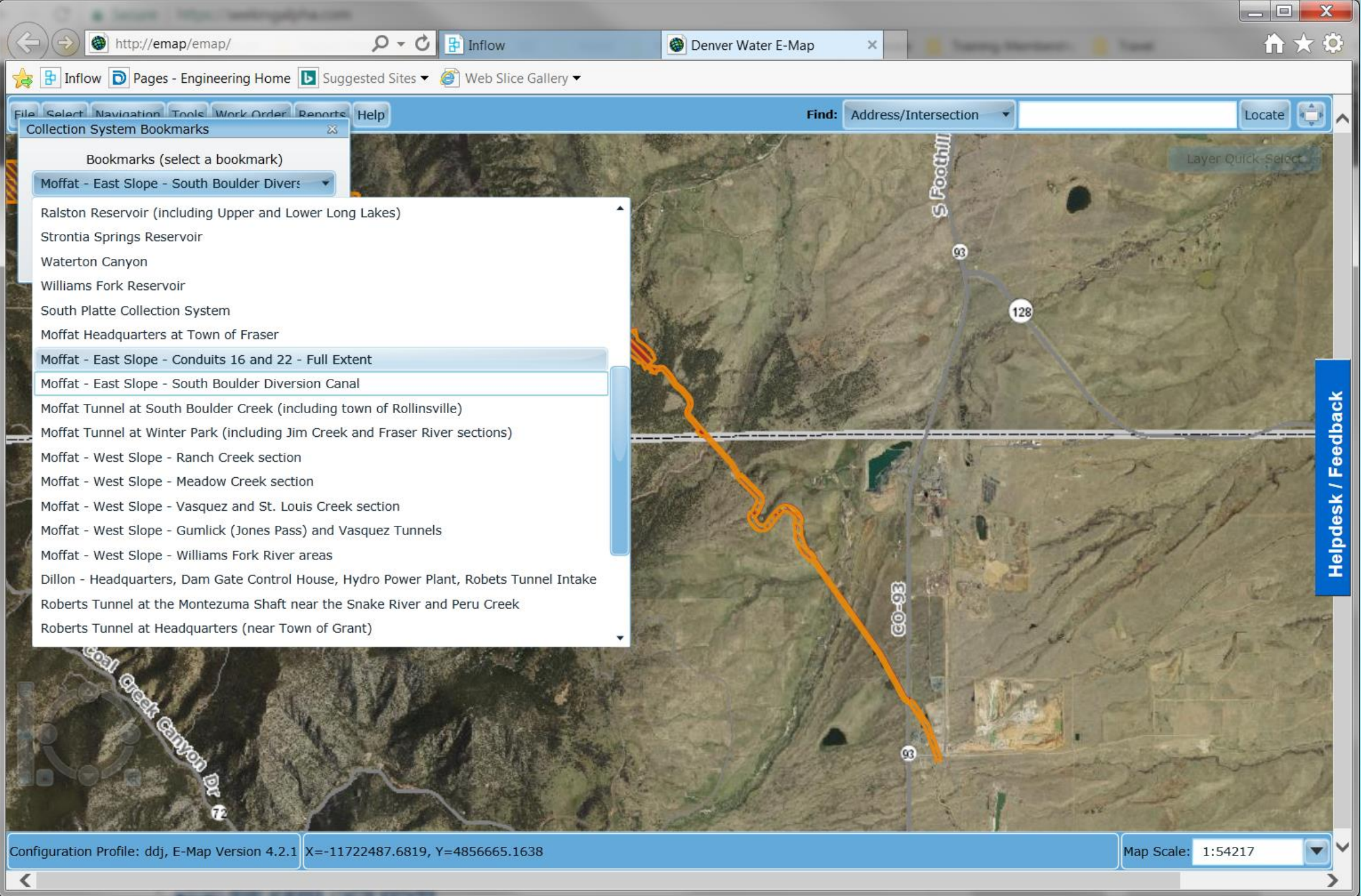
ProjectWise for CAD document management





CAD to GIS to Maximo

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Inflow
Denver Water E-Map
Inflow
Pages - Engineering Home
Suggested Sites
Web Slice Gallery
File
Select
Navigation
Tools
Work Order
Reports
Help
Find:
Address/Intersection
Locate
Collection System Bookmarks
Bookmarks (select a bookmark)
Moffat - East Slope - South Boulder Divers
Ralston Reservoir (including Upper and Lower Long Lakes)
Strontia Springs Reservoir
Waterton Canyon
Williams Fork Reservoir
South Platte Collection System
Moffat Headquarters at Town of Fraser
Moffat - East Slope - Conduits 16 and 22 - Full Extent
Moffat - East Slope - South Boulder Diversion Canal
Moffat Tunnel at South Boulder Creek (including town of Rollinsville)
Moffat Tunnel at Winter Park (including Jim Creek and Fraser River sections)
Moffat - West Slope - Ranch Creek section
Moffat - West Slope - Meadow Creek section
Moffat - West Slope - Vasquez and St. Louis Creek section
Moffat - West Slope - Gumlick (Jones Pass) and Vasquez Tunnels
Moffat - West Slope - Williams Fork River areas
Dillon - Headquarters, Dam Gate Control House, Hydro Power Plant, Robets Tunnel Intake
Roberts Tunnel at the Montezuma Shaft near the Snake River and Peru Creek
Roberts Tunnel at Headquarters (near Town of Grant)
Layer Quick-Select
S Foothill
93
128
CO-93
Helpdesk / Feedback
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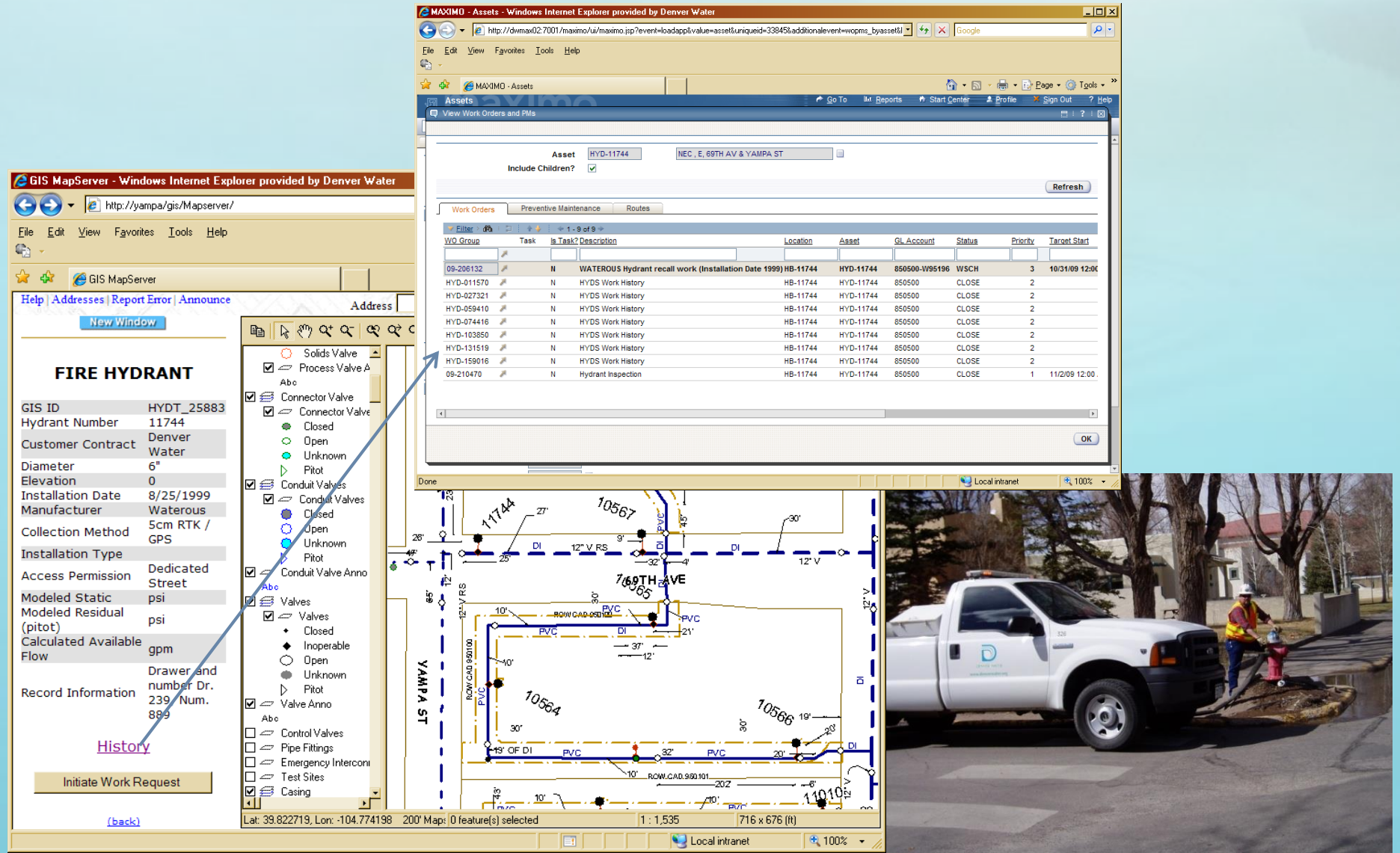
Map Scale:
1:54217

Work Management



ArcGIS | Aerial Pipe Crossings

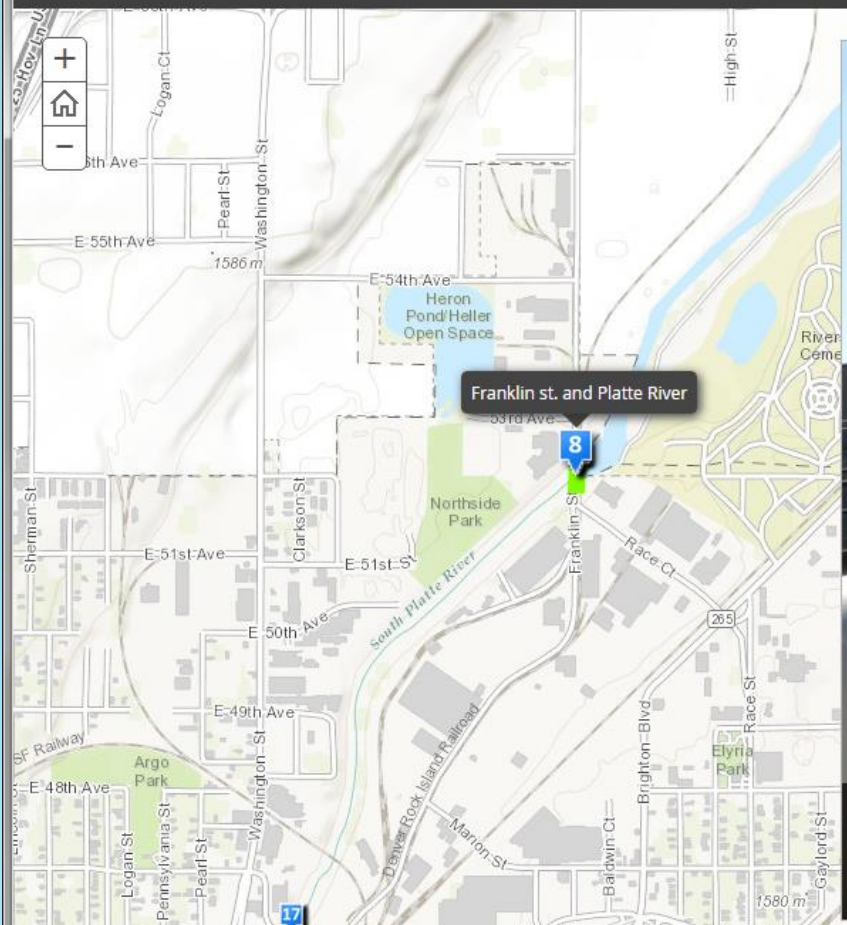
dw.maps.arcgis.com/apps/MapTour/index.html?appid=07acc1eb911c4fe4bd5e526725004cac

Aerial Pipe Crossings

Sharepoint Site

Franklin st. and Platte River

System is relatively new and overall in excellent condition. There are a few dings in the polyurethane coating, most notably on the south side, that could be touched up. The short reach of 1965 pipe on the north side should eventually be re-coated.



1 C81 over Clear Creek

2 C81 over Clear Creek

3 C81 over Clear Creek

4 C81 over Clear Creek

5 C81 over Clear Creek

6 C81 over Clear Creek

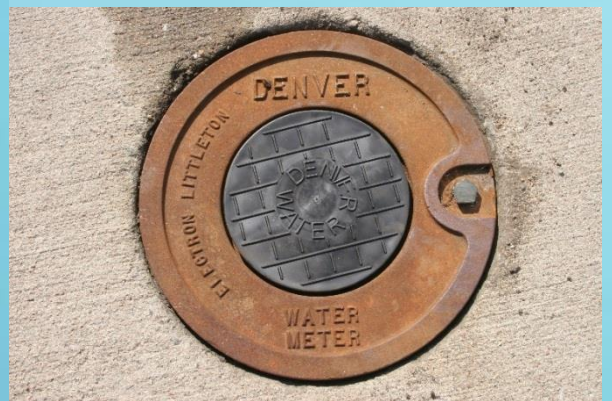
7 Franklin st. and Platte River

8 Franklin st. and Platte River

9 Franklin st. ar

Customer Locations

- More than 320,000 taps and associated meter locations mapped
- Initial data collection using GPS over 3 year period
- Supplemented by visual identification from aerial imagery and Google Street View maps
- New taps located with GNSS survey receivers



All Activated Taps In Denver Water Service Area by Tap Date

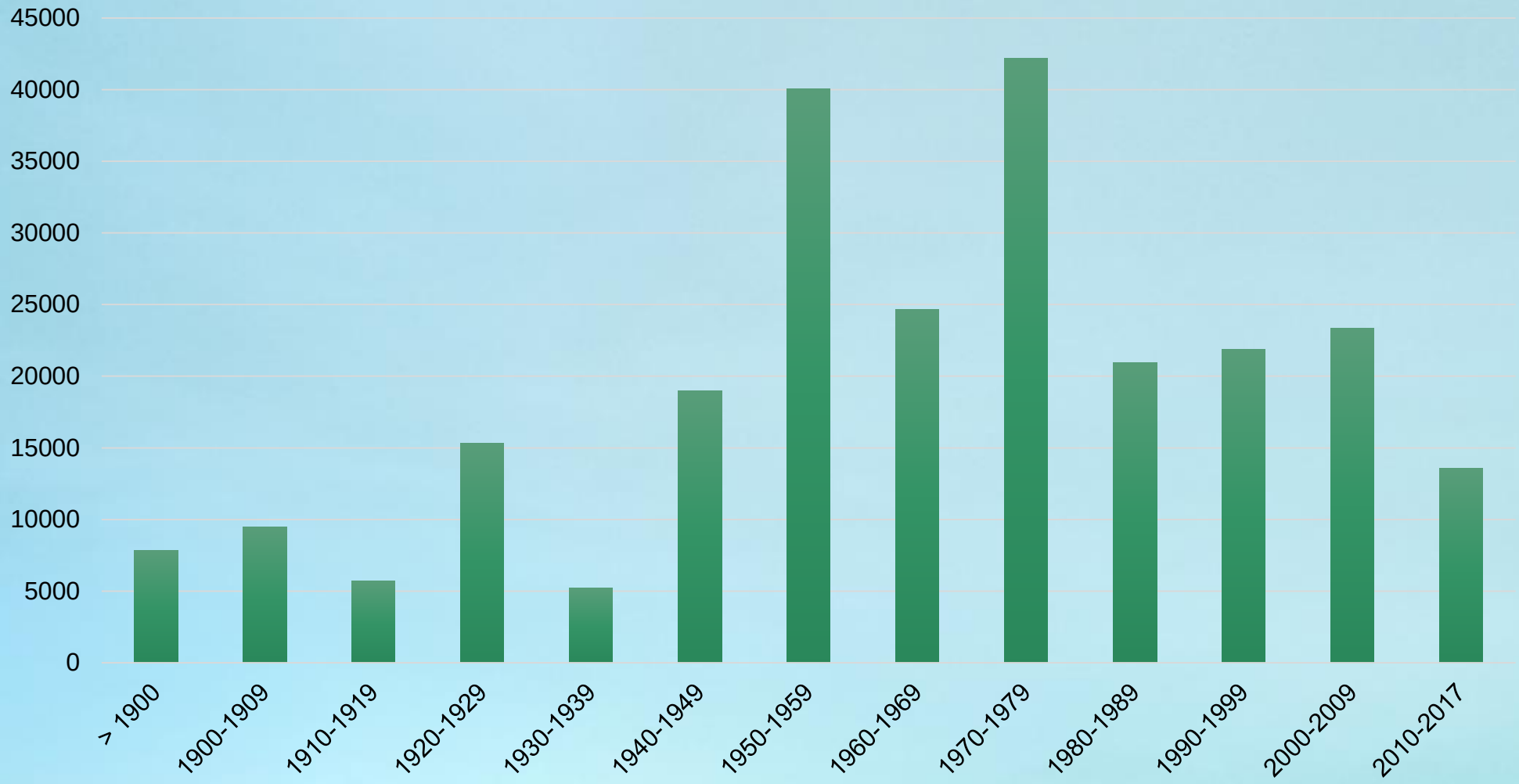
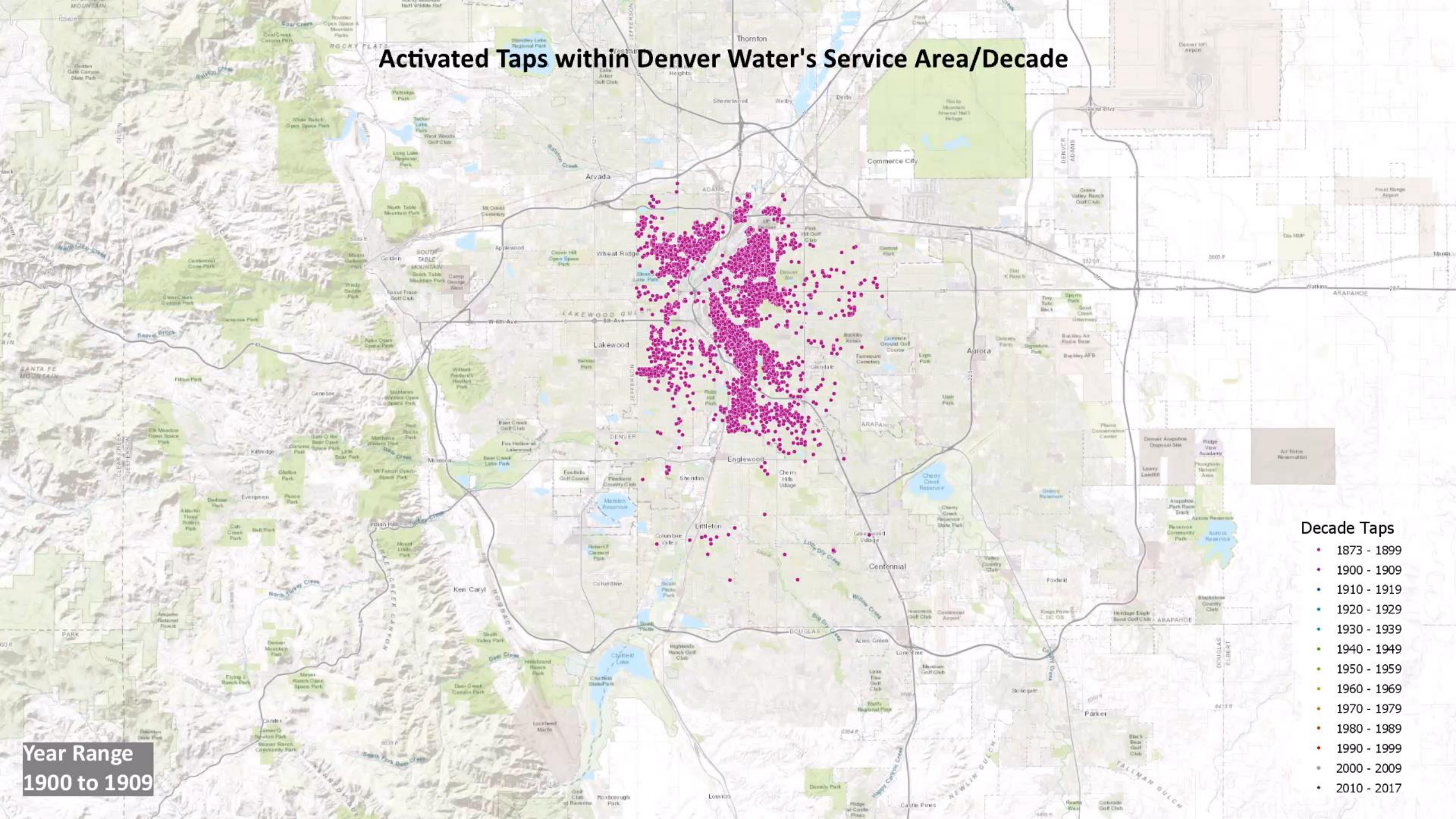


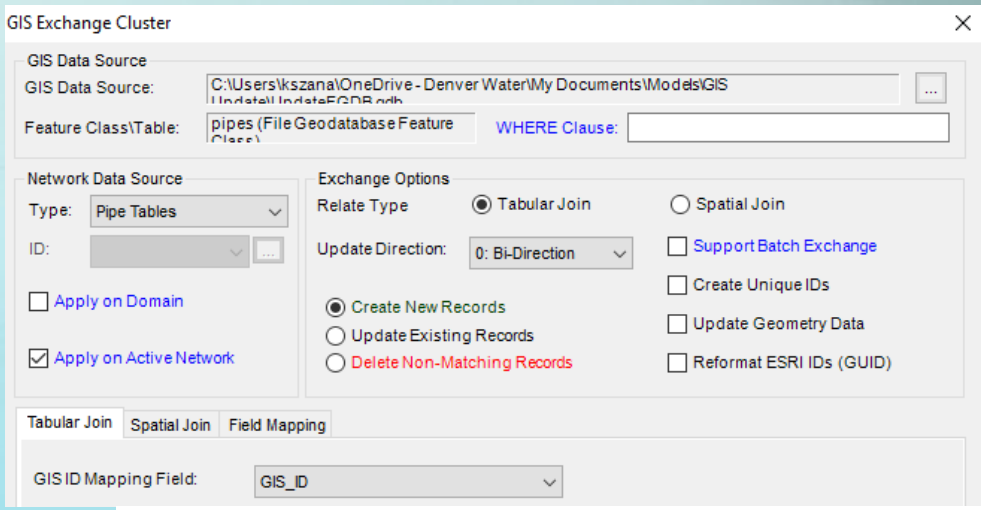
Chart represents all of Denver, total service and read and bill customers.
Master metered customers are not included.

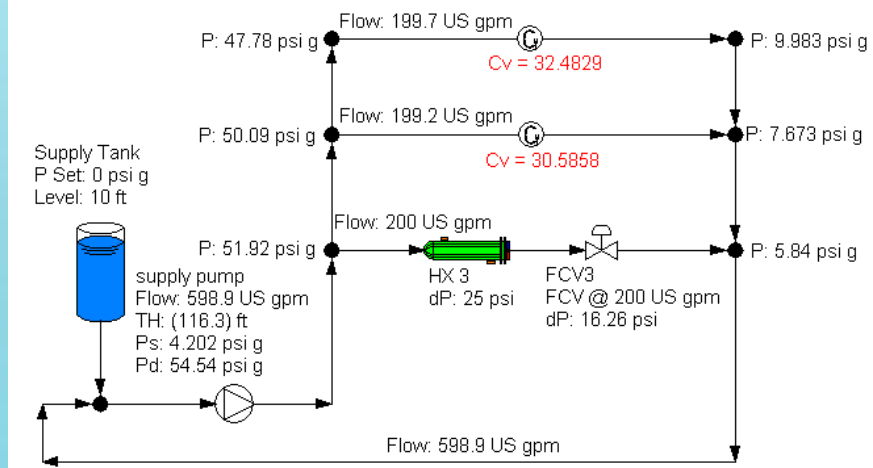
Activated Taps within Denver Water's Service Area/Decade



Hydraulic Model Integration

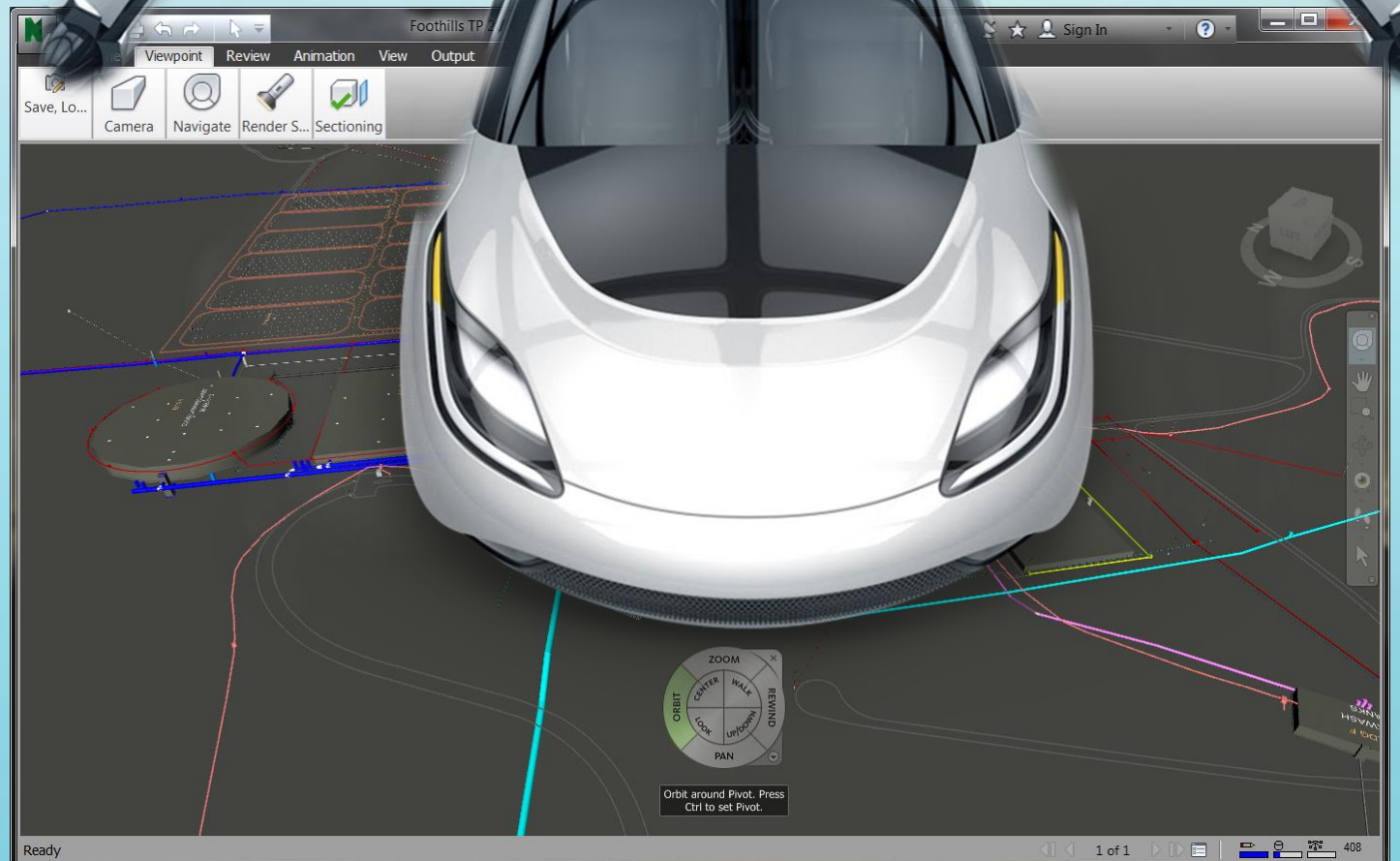
- 1 to 1 GIS to InfoWater all pipes model
- Semi-automated update process for ~357,000 pipe segments
- Excellent GIS data quality supports model integration
- Utilities have *talked* about Model/GIS integration for years. Denver Water is doing it!





Evolving technology for the next 100 years!

- Example: 3-D models of treatmen quire accurate asset mapping
- One benefit of a mature GIS an ement system



Questions?

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