

How we leveraged our GIS to improve data consistency and completeness

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MSD St. Louis: Brief Overview

- Fourth Largest Sewer District in USA based on miles of pipe and sewage collected/treated.
- Nearly 9600 miles of pipe in the Sanitary and Storm Collection System
- 356 million gallons of sewage treated per day.
- 520 square mile service area.
- Serves 1.3 million people.

MSD St. Louis Location



The Problem:

- Some very old data
- A mishmash of data sources
- Varying standards
- Migration from: Stone Tablets -> Papyrus -> Parchment -> Paper -> CAD -> GIS

Assets and the attributes we looked at

Line assets (Sewers)

- Diameter or Width and Height
- Material
- Elevation
- Cross Section
- Ownership

Point assets(Manholes,Inlets)

- Top Elevation
- Invert Elevation
- Ownership

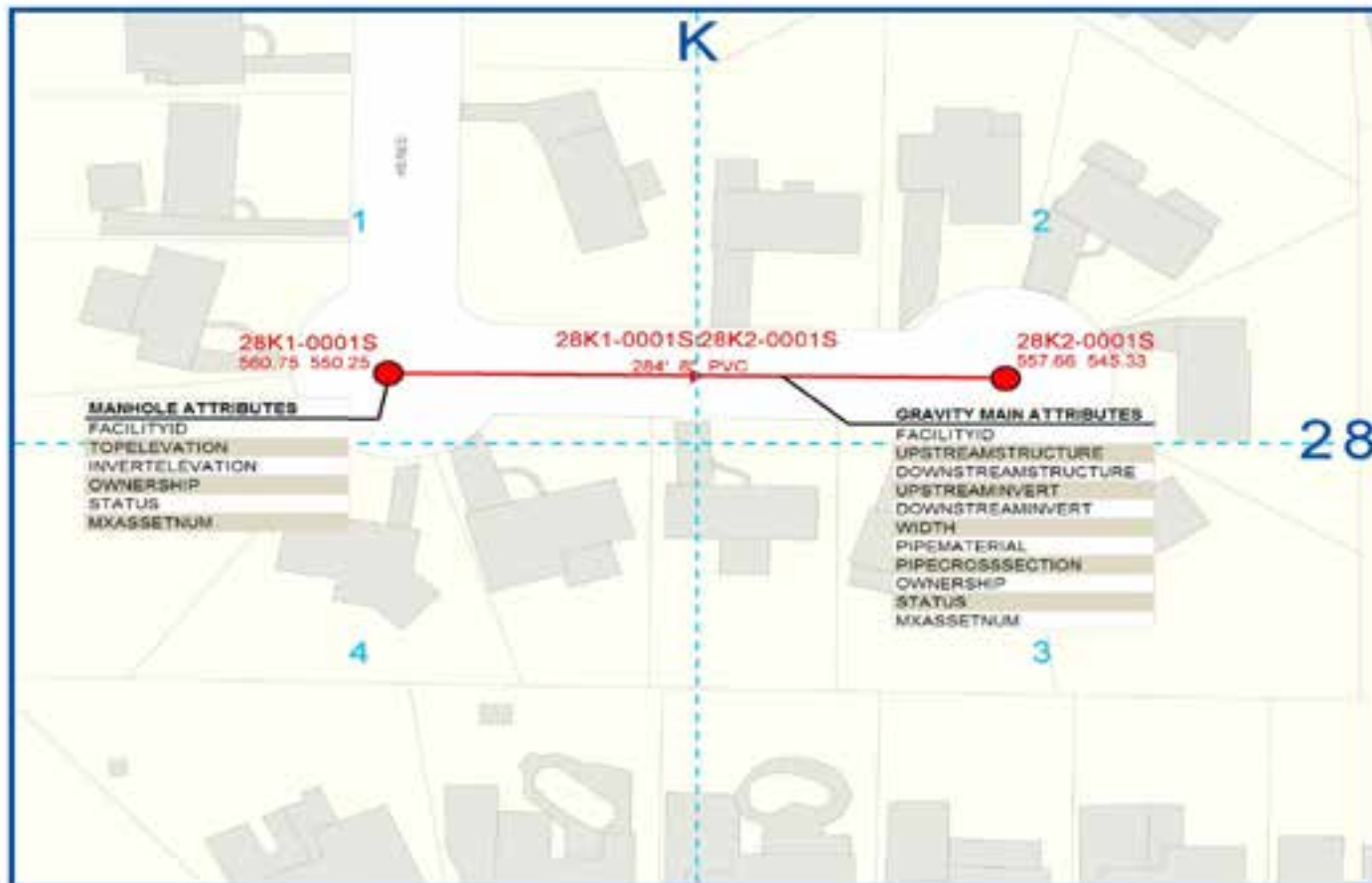
Types of situations that provide an opportunity for updates

- Missing Attribute Data
- Potentially Inconsistent Attribute Data

on

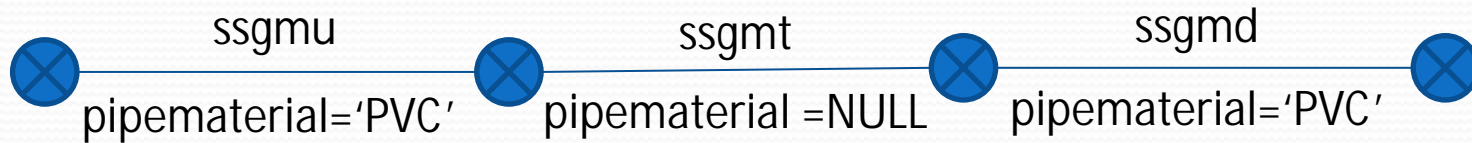
- Linear Assets (Sewer pipes)
- Point Assets (Manholes and Inlets)

Assignment of Asset Identifier



Missing attribute data on a linear asset

Example 1: Pipe with null, or unknown material is flanked by pipes with known material:

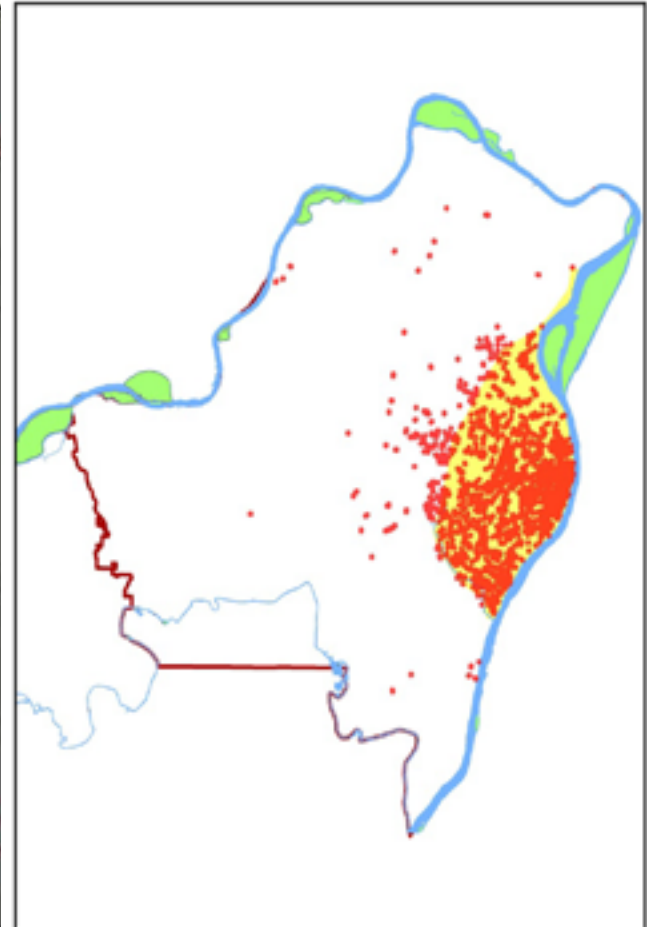


```
select ssgmu.facilityid upstr_pipe_id, ssgmu.pipematerial u_mtr,  
ssgmt.facilityid target_pipe_id, ssgmt.mxassetnum, ssgmt.pipematerial t_mtr,  
ssgmd.facilityid downstr_pipe_id, ssgmd.pipematerial d_mtr  
from ssgravitymain ssgmt, ssgravitymain ssgmu, ssgravitymain ssgmd  
where ssgmu.downstreamstructure = ssgmt.upstreamstructure  
and ssgmd.upstreamstructure = ssgmt.downstreamstructure  
and (ssgmt.pipematerial is null or ssgmt.pipematerial = 'UNK' or ssgmt.pipematerial = ' ')  
and (ssgmu.pipematerial is not null and ssgmu.pipematerial <> 'UNK' and  
ssgmu.pipematerial <> ' ')  
and (ssgmd.pipematerial is not null and ssgmd.pipematerial <> 'UNK' and  
ssgmd.pipematerial <> ' ')  
and ssgmt.status = 1;
```


Subset of Results:

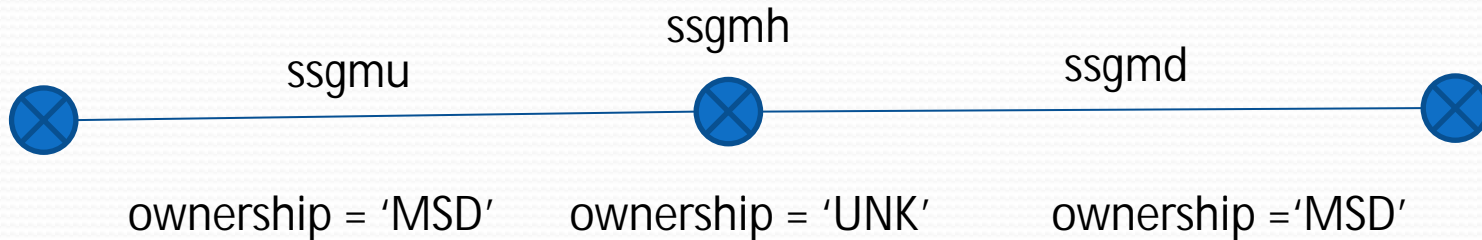
UPSTR_PIPE_ID	U_MTR	TARGET_PIPE_ID	MXASSETNUM	MTR	DOWNSTR_PIPE_ID	D_MTR
21G1-170C:21G1-171C	VCP	21G1-171C:21G1-173C	GIS-2423163	UNK	21G1-173C:21G1-174C	VCP
06H4-084S:06H4-085S	VCP	06H4-085S:06H4-0182S	GIS-6929108		06H4-0182S:06H4-086S	VCP
07G2-053S:07G2-006S	RCP	07G2-006S:07G1-038S	GIS-2340597	UNK	07G1-038S:07G1-053S	RCP
22E1-417C:22E1-418C	VCP	22E1-418C:22E1-419C	GIS-2490024	UNK	22E1-419C:22E1-276C	BRK
22E1-144C:22E1-418C	VCP	22E1-418C:22E1-419C	GIS-2490024	UNK	22E1-419C:22E1-276C	BRK
08J3-059S:08J2-096S	NCP	08J2-096S:08J2-095S	GIS-2508860	UNK	08J2-095S:08J2-0181S	NCP
09D3-021S:09D3-033S	RCP	09D3-033S:09D3-025S	GIS-2345180	UNK	09D3-025S:09D3-022S	RCP
09D3-021S:09D3-033S	RCP	09D3-033S:09D3-025S	GIS-2345180	UNK	09D3-025S:09D3-024S	RCP
09K3-071S:09K3-055S	VCP	09K3-055S:09K3-054S	GIS-2509166	UNK	09K3-054S:09K3-053S	VCP
23E2-070C:23E2-267C	VCP	23E2-267C:23E2-269C	GIS-2441212	UNK	23E2-269C:23E2-086C	RCP

Locations of pipes with missing pipematerial attribute



Missing attribute data on a point asset

Example 2: Manholes with null, blank, or unknown ownership flanked by incoming and outgoing pipes with known, and the same, ownership:

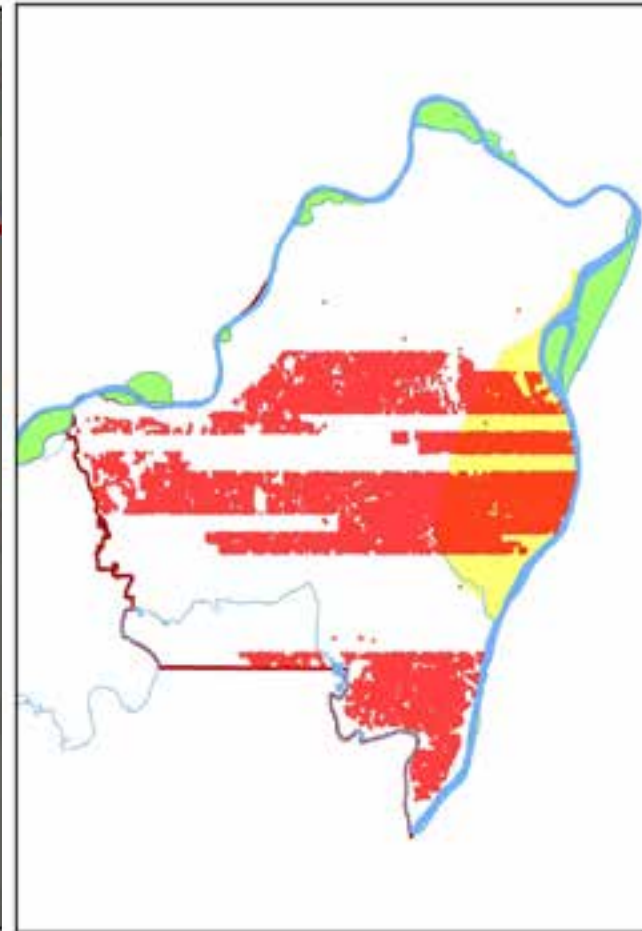
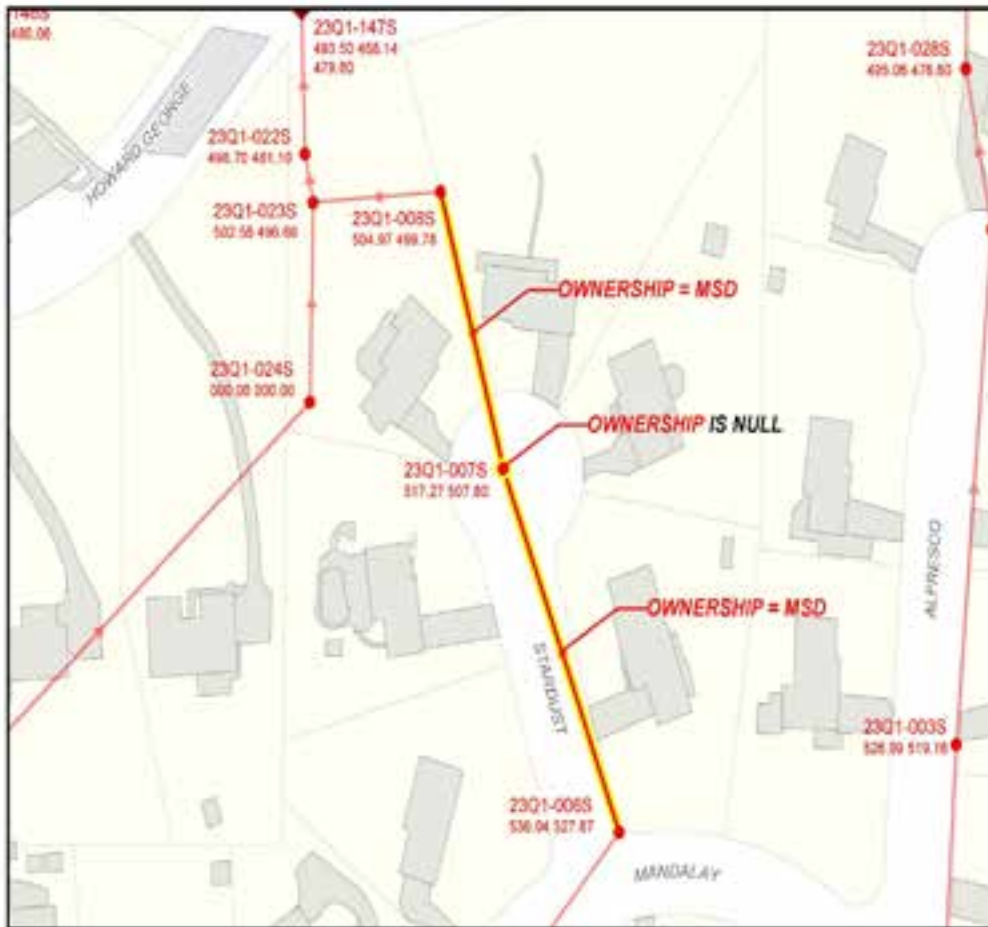


```
select ssgmu.facilityid upgmid, ssgmu.ownership upgmown, ssmh.mxassetnum,  
ssmh.facilityid mhid, ssmh.ownership ownership, ssgmd.facilityid dngmid,  
ssgmd.ownership dngmown from ssmanhole ssmh, ssgravitymain ssgmu, ssgravitymain  
ssgmd  
where (ssmh.ownership is null or ssmh.ownership = '' or ssmh.ownership = 7)  
and ssmh.facilityid = ssgmd.upstreamstructure  
and ssmh.facilityid = ssgmu.downstreamstructure  
and (ssgmu.ownership is not null and ssgmu.ownership <> '' and ssgmu.ownership <> '7')  
and (ssgmd.ownership is not null and ssgmd.ownership <> '' and ssgmd.ownership <> '7')  
and ssgmu.ownership = ssgmd.ownership  
and ssmh.status = 1  
order by ssmh.facilityid;
```

Subset of results:

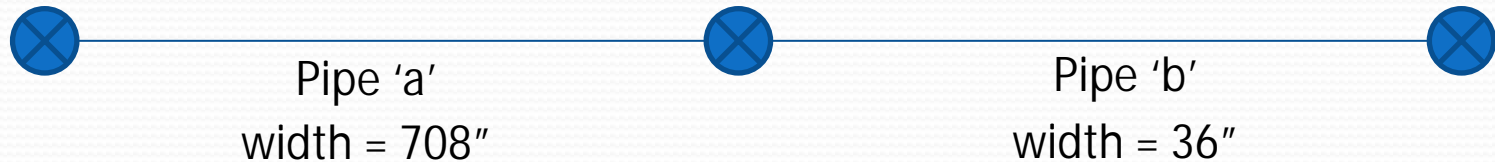
UPGMID	UPGMOWN	MXASSETNUM	MHID	OWNERSHIP	DNGMID	DNGMOWN
11F3-036S:11F3-040S	1	GIS-1505055	11F3-040S	NULL	11F3-040S:11F3-192S	1
11N4-0074S:11N1-080S	1	GIS-1641052	11N1-080S	NULL	11N1-080S:11N1-081S	1
13H3-037S:13H3-038S	1	GIS-1634151	13H3-038S	NULL	13H3-038S:13H3-006S	1
13K1-108S:13K1-187S	1	GIS-1634516	13K1-187S	NULL	13K1-187S:13K1-103S	1
14H2-068S:14H2-069S	1	GIS-1519057	14H2-069S	NULL	14H2-069S:14H2-074S	1
14H2-085S:14H2-070S	1	GIS-1479002	14H2-070S	NULL	14H2-070S:14H2-071S	1
14H2-070S:14H2-071S	1	GIS-1519055	14H2-071S	NULL	14H2-071S:14H2-072S	1
14H2-071S:14H2-072S	1	GIS-1519054	14H2-072S	NULL	14H2-072S:14H2-076S	1
14H2-074S:14H2-073S	1	GIS-1505720	14H2-073S	NULL	14H2-073S:14H3-001S	1
14H2-076S:14H2-074S	1	GIS-1519056	14H2-074S	NULL	14H2-074S:14H2-073S	1

Locations of manholes with missing ownership attribute



Potentially inconsistent attribute data on a line asset

Example 3: Upstream pipe width is greater than downstream pipe width

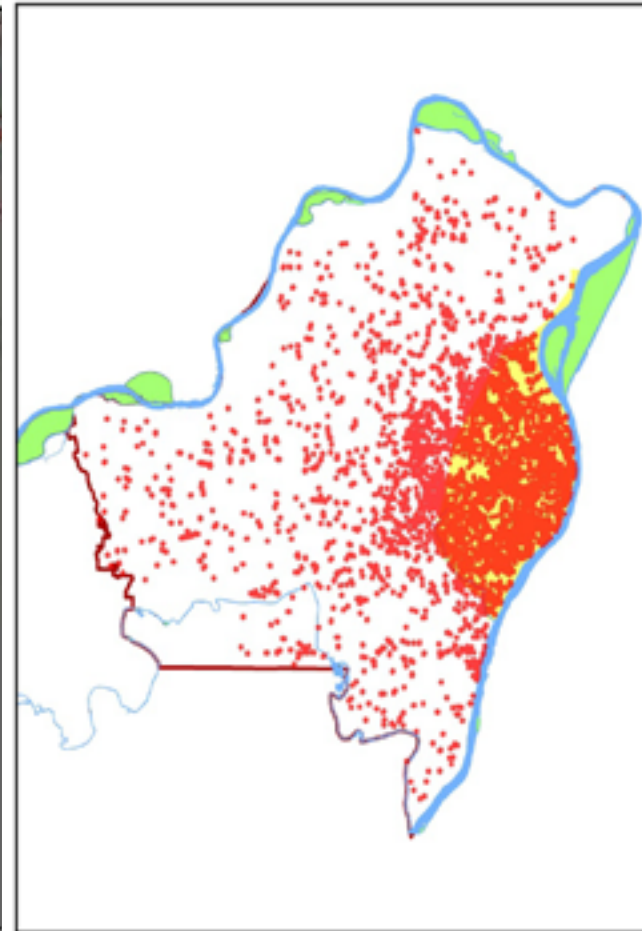


```
select a.facilityid UpStreamPipe, a.mxassetnum, a.width Up_W, b.facilityid  
DownStreamPipe, b.width Dn_W, a.width - b.width D_W  
from ssgravitymain a, ssgravitymain b  
where a.downstreamstructure = b.upstreamstructure  
and (a.width - b.width) <> 0  
and a.width > 0  
and b.width > 0  
and a.pipecrosssection = 'CIRC'  
and b.pipecrosssection = 'CIRC'  
and a.width > b.width  
and (a.status = 1 or b.status = 1)  
order by (a.width - b.width) desc;
```

Subset of Results:

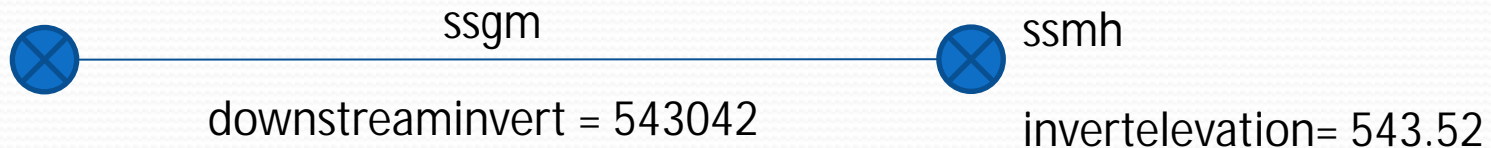
UPSTREAMPIPE	MXASSETNUM	UP_W	DOWNSTREAMPIPE	DN_W	D_W
23F1-106C:23F1-105C	GIS-2443146	708	23F1-105C:23F1-093C	36	672
18H3-121C:18H3-099C	GIS-2393712	420	18H3-099C:18H3-100C	18	402
17H4-142D:17H4-061C	GIS-2543485	300	17H4-061C:17H4-068C	18	282
16K2-122S:16K2-127S	GIS-2376985	257	16K2-127S:16K2-091S	8	249
20K3-029S:20K3-028S	GIS-2415891	240	20K3-028S:20K3-027S	8	232
19H1-166C:19H1-168C	GIS-2537117	384	19H1-168C:19H1-167C	168	216
18E1-082C:18E1-083C	GIS-2388767	228	18E1-083C:18E1-078C	18	210
16L4-039S:16L4-040S	GIS-2376895	214	16L4-040S:16L4-043S	8	206
20D2-482C:20D2-481C	GIS-2410102	240	20D2-481C:20D3-166C	42	198
21J3-240C:21J3-233C	GIS-2425429	204	21J3-233C:21J3-241C	21	183

Locations of gravity pipes constricting downstream.



Inconsistent attribute data on a point asset

Example 4: Manholes and pipes with elevations that do not match at their junction.

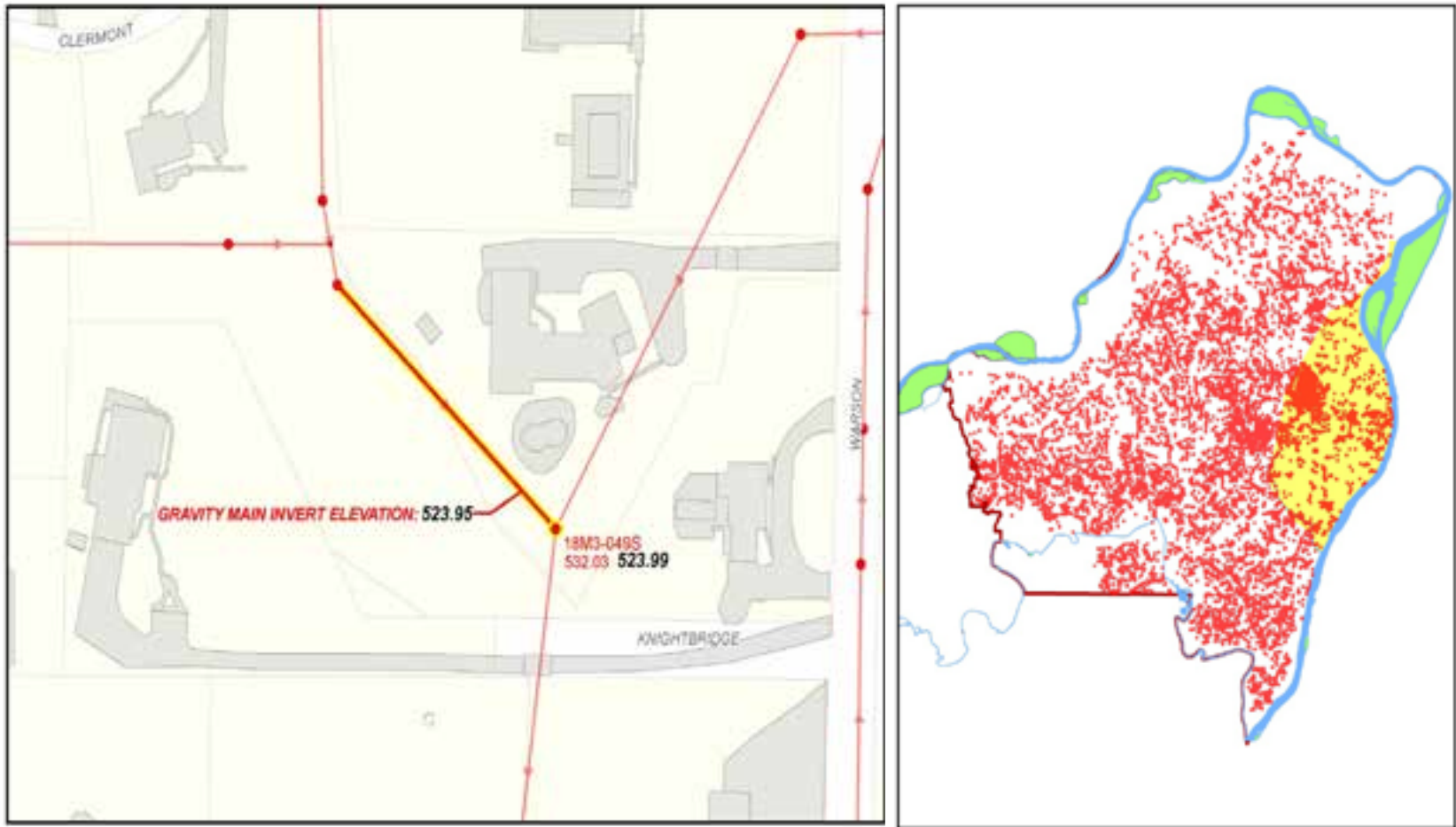


```
select ssmh.facilityid ManholeID, ssgm.facilityid GravityMainID, ssmh.invertelevation  
MH_INV, ssgm.downstreaminvert GM_INV, ssmh.topelevation MHTOP,  
ssgm.downstreaminvert - ssmh.invertelevation GM_MH_INV,  
ssmh.topelevation - ssmh.invertelevation MH_TOP_INV  
from ssmanhole ssmh, ssgravitymain ssgm where  
ssgm.downstreamstructure = ssmh.facilityid  
and ssgm.downstreaminvert <> 0  
and ssmh.invertelevation <> 0  
and ssgm.downstreaminvert <> ssmh.invertelevation  
and ssgm.status = 1  
and ssmh.status = 1  
order by GM_MH_INV;
```

Subset of Results:

MANHOLEID	GRAVITYMAINID	MH_INV	GM_INV	MHTOP	GM_MH_INV	MH_TOP_INV
23T2-068S	23T2-067S:23T2-068S	68,749	687	0	-68,062	-68,749
12H1-067S	12H1-069S:12H1-067S	5,482	482	0	-5,000	-5,482
12H1-067S	12H1-066S:12H1-067S	5,482	482	0	-5,000	-5,482
22R4-053S	22R4-052S:22R4-053S	605	1	0	-604	-605
24M4-073S	24M4-102S:24M4-073S	585	5	596	-580	10
17L3-023S	17L3-022S:17L3-023S	577	0	586	-577	9
13K4-012S	13K4-013S:13K4-012S	637	64	647	-573	10
16N4-042S	16N4-151S:16N4-042S	616	80	625	-536	9
17O4-119S	17O4-103S:17O4-119S	536	5	546	-531	10
18N2-052S	18N2-109S:18N2-052S	585	55	590	-530	5

Locations of manholes with elevations that do not match the invert elevation on the pipe to which they connect.



Some additional queries we are pursuing:

- Pipe with null, blank, or zero width is flanked by pipes with known widths.
- Pipe with null, blank or unknown ownership is flanked by pipes with known ownership.
- Pipe with null, blank, or unknown cross section is flanked by pipes with known cross sections.
- Pipes with no elevation ending in manhole with known elevation.
- Pipes with no elevation ending in inlet with known elevation.
- Manhole with no elevation connecting to pipe with known elevation.
- Inlet with no elevation connecting to pipe with known elevation.

- Inlets with null, blank, or unknown ownership with incoming and outgoing pipes that have known ownership.
- Upstream pipe elevation is lower than downstream pipe elevation.
- Pipe cross section is circular but width not equal to height.
- Pipe cross section is not circular but width equal to height.
- Pipes with private ownership that have incoming and outgoing pipes that are not privately owned.
- Manholes with top elevation less than invert elevation.
- Inlet with top elevation less than invert elevation.
- Inlets and pipes with elevations that do not match at their junction.



Questions?