

2020 HydInfra Discussion

Includes 2019 Drainage Inspection Performance Measure Results

25 years in HydInfra

Culvert Cost WIG on the Road to Drainage Asset Management



HydInfra

HydInfra - MNDOT's Culvert and Storm Drain Inventory and Inspection System

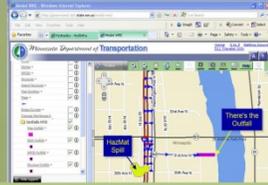
It all began in 1996 when Hydraulics/WRE engineers created HydInfra to improve drainage design and maintenance work. HydInfra was built with GIS tools designed so that people new to ArcMap could query for drainage features, make a map and export the data to a spreadsheet. HydInfra's simple condition rating codes based on explicit criteria for different materials, and flags to record defects make it a versatile framework to build asset management on.

HazMat Spills Response Utility Locations and MS4 Water Quality

Metro WRE and Maintenance partner on MS4 water quality requirements.

Storm drain networking and "Georilla" map service improve response times for hazardous spill capture.

Storm drain networks are also used for Gopher State One Call utility locations.



Recommended Inspection Frequency for Highway Pipes

Inspection Method	Frequency	Notes
Visual	1	Pipes above ground to not under the road
Manholes	2	Manholes to be inspected at least once every 2 years
1/4" ID	3	Pipes with 1/4" ID or larger
1/2" ID	4	Pipes with 1/2" ID or larger
1" ID	5	Pipes with 1" ID or larger
2" ID	6	Pipes with 2" ID or larger
4" ID	7	Pipes with 4" ID or larger
6" ID	8	Pipes with 6" ID or larger
8" ID	9	Pipes with 8" ID or larger
12" ID	10	Pipes with 12" ID or larger
18" ID	11	Pipes with 18" ID or larger
24" ID	12	Pipes with 24" ID or larger

Drainage Performance Measure

In 2008, Maintenance Operations chose HydInfra to track their Drainage Performance Measure for highway culvert inventory and inspection. Soon after, the inventory was completed and highway culverts are now inspected on a regular schedule.

GIS map shows year to inspect each culvert in District 8.




Extreme rainfall and floods cause damage to culverts. GIS and HydInfra help recovery.

Big Storm + bad pipes = wrecked road



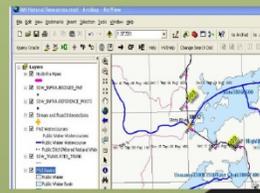
Culvert inspectors record defects that may cause road failure during extreme rainfall events. Pipe defects include road void, piping, and holes.



Drainage Performance Measure

Project Scoping and Pre-design

GIS layers from many sources give context to drainage design work. DNR layers for Public Waters illustrate areas that need environmental permits. HydInfra layers with drainage feature data help speed scoping and pre-design tasks, especially in winter.

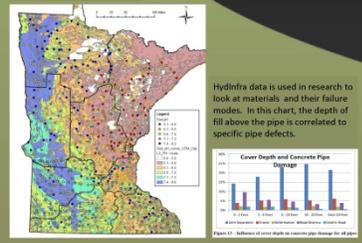



Research on Pipes and Materials

Research focusing on the projected lifespan of steel pipe is underway. The map below shows roadside pH overlaid on NRCS pH data. Acidity, or low pH, is a factor in steel pipe deterioration rates. The research is being done by Barbara Burkholder Heikamp, U of M



HydInfra data is used in research to look at materials and their failure modes. In this chart, the depth of fill above the pipe is correlated to specific pipe defects.



Culvert Cost WIG

Maintenance crews repair or replace culverts and record the labor, equipment and materials in a mobile app based on ArcGIS Collector software.

Repair data can be entered in the Culvert Cost app while in the field on an iPad, or in the office on a PC.

Repair data is available immediately in web-based reports that repair crews can access from the repair sites. Others in MNDOT can find Cost Reports, by searching for "Culvert Cost".

The map shows repairs, cleanings and new installations of culverts recorded in the first season of data collection.

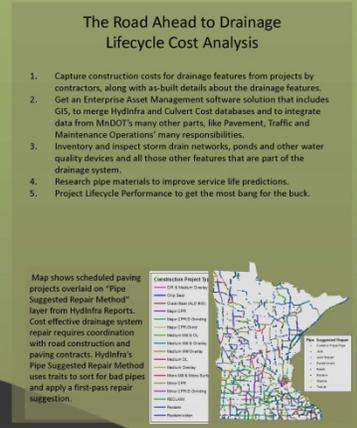
Culvert Repair Cost



The Road Ahead to Drainage Lifecycle Cost Analysis

- Capture construction costs for drainage features from projects by contractors, along with as-built details about the drainage features.
- Get an Enterprise Asset Management software solution that includes GIS, to merge HydInfra and Culvert Cost databases and to integrate data from MNDOT's many other parts, like Pavement, Traffic and Maintenance Operations' many responsibilities.
- Inventory and inspect storm drain networks, ponds and other water quality devices and all those other features that are part of the drainage system.
- Research pipe materials to improve service life predictions.
- Project Lifecycle Performance to get the most bang for the buck.

Map shows scheduled paving projects overlaid on "Pipe Suggested Repair Method" layer from HydInfra Reports. Cost effective drainage system repair requires coordination with road construction and paving contracts. HydInfra's Pipe Suggested Repair Method uses traits to sort for bad pipes and apply a first-pass repair suggestion.



We've only just begun:

**Lifecycle Cost Analysis
in TAMS-HydInfra
Asset Management**

2005 HydInfra

HYDINFRA Ratings Guide

Condition Codes:

1	Good as new condition
2	Some wear, but structurally sound
3	Schedule for repair or replacement
4	May require immediate fix – Inform Maintenance people
0	Not rate-able

Notes:

- 1) The worst condition found in a feature determines its condition rating (see lists).
- 2) The general conditions of the roadway and adjacent area should be used as clues to help determine the condition rating for each hydraulic feature that is inspected. These general conditions can be indicators of concealed structural problems.
- 3) Broken grates or plugged pipes should be reported to Maintenance within 24 hours.

2010 FLH

CHAPTER 2 – CULVERT ASSESSMENT TOOL

FHWA FLH CULVERT ASSESSMENT GUIDE

CONDITION ASSESSMENT RATING CODES

Good	Like new, with little or no deterioration, structurally sound and functionally adequate.
Fair	Some deterioration, but structurally sound and functionally adequate.
Poor	Significant deterioration and/or functional inadequacy, requiring repair action that should, if possible, be incorporated into the planned roadway project.
Critical	Very poor conditions that indicate possible imminent failure that could threaten public safety, requiring immediate repair action.
Unknown	All or part of the culvert is inaccessible, assessment or a rating cannot be assigned.

Notes:

- 1) The lowest elemental rating for the culvert determines the overall rating.
- 2) Culvert conditions are assigned condition ratings, while failing culvert performance is noted in the "Remarks" box if present.
- 3) This guide is used for the rating of culverts with spans less than 20 feet. For larger spans, refer to the "Rating of Roadway Structures" manual published by NCHRP 10.
- 4) Due to the limited background and experience of the inspector, some inherent subjectivity is associated with the condition ratings.

2012 HydInfra

HydInfra Inspection Manual

Culvert and Storm Drainage Systems

Condition Rating Codes:

Like new	1	Excellent – like new condition
Still okay	2	Fair – some wear, but structurally sound
Fix in project	3	Poor – deteriorated, consider for repair or replacement
Fix it sooner	4	Severe – serious deterioration
Unknown	0	Not able to rate, not visible

Notes:

- 1) This guide is used to rate the condition of storm drainage system features or culverts where the pipe (or installation) is one (1) pipe is less than 30 feet wide, as measured along the centerline of roadway.
- 2) The worst condition found in a feature determines its condition rating. (Refer to condition rating criteria on page 13-120)
- 3) Components are rated on structural integrity and ability to perform their functions. Need for cleaning is NOT part of the Overall Condition rating but is noted with a separate "Clean?" flag (Clean? = Y) and a "Sediment % Full" flag.
- 4) Broken grates or plugged pipes or structures should be reported to Maintenance Area Supervisor within 24 hours of inspection.

HydInfra influenced the 2016 NCHRP 14-26 Culvert and Storm Drain Inspection Manual

2016 Federal Manual

RATING SCALE AND ASSOCIATED ACTION

	1	2	3	4	5
	GOOD	FAIR	POOR	CRITICAL	FAILED
CONDITION	Like new, with little or no deterioration, structurally sound and functionally adequate.	Some deterioration, but structurally sound and functionally adequate.	Significant deterioration and/or functional inadequacy, requiring maintenance or repair.	Very poor conditions that indicate possible imminent failure which could threaten public safety.	Failed or non-functional condition.
ACTION INDICATED	No action is recommended. Note in inspection report only.	No immediate action is recommended, but more frequent inspection may be warranted. Maintenance should be informed.	Team Leader (Inspector) evaluates need for corrective action and makes recommendation in inspection report.	Corrective action is required and urgent. Engineering evaluation is recommended to specify appropriate repair.	Emergency action is required to address public safety hazard. Roadway closure is typical.

HydInfra spawned the FLH Culvert Manual (2010) codes and later NCHRP 14-26 Culvert and Storm Drain Inspection Manual (2016)

Get information from the **HydInfra webpages**

- [TAMS-Hydrinfra Agile Assets](#)
- [TAMS-Hydrinfra Collector](#)
- [Hydrinfra Inspector](#)

Georilla Map Service

to see TAMS Drainage Assets on a map

- [Georilla](#) map service
- [Instructions for Georilla](#)
- Contractors with a MnDOT login can use Web Portal to see Georilla and access TAMS Agile Assets, but is not required

Progress in 2019 on Drainage Measures for Highway Culverts

1. Highway Culverts are **inspected** every 6 years or less
2. Less than 10% of Highway Culverts are in **Condition** 3 or 4
3. New --Targets for Maintenance **Repairs** of Highway Culverts

#1 -- Inspection Cycle for Highway Culverts

Drainage Performance Measure for Highway Culvert Inspection		
Recommended Inspection Frequency for Highway Culverts*		
Overall Condition	Inspection Frequency Years	Comments
4 - Very Poor	2	Pipes where problem is not under the road
	1	Pipes where problem requires a repair under the road
3 - Poor	4	Most condition 3 pipes
	2	Condition 3 Pipes with Piping or Road Void **
1 - Like New or 2 - Fair	6	Pipes that do not need repair
0 - Can't be Rated	2	Pipe condition is not visible
Pipes with no inspections		Pipes created in TAMS-HydInfra without an inspection. Goal to inspect Highway Culverts within 6 years of Date Discovered***
Overall Target: 80% of Highway Pipes meet Recommended Inspection Frequency		

*Highway Culverts included in the Drainage Performance Measure are HydInfra pipes where:
 Class Code is Culvert; Roadway Type is Centerline, Collector/Distribut, Mainline, Median or Ramp/Loop;
 Owner is not City, County or Private; Status is Inplace or Proposed

Highway Culvert Inspection Performance Measure 2019

	% Highway Culverts that meet Recommended Inspection Frequency by District – Target is 80%								
Calendar Year	1	2	3	4	6	7	8	Metro	State
2019	74	75	92	92	95	90	88	58	85
2018	72	69	98	93	98	77	75	57	82
2017	78	78	94	96	97	80	87	52	85
2016	78	74	97	99	97	73	75	58	84
2015	77	58	91	94	99	75	71	58	81
2014	84	87	93	90	100	80	82	61	87
2013	85	81	91	77	91	68	86	54	80
2012	88	85	80	68	94	69	93	68	81
2011*	84	81	74	47	89	59	76	72	74

Highway Culverts - Inspections needed in 2020

District	2020 Recommended Inspections
1	1833
2	1171
3	808
4	968
6	1854
7	1695
8	1184
Metro	1731
State	11244

Numbers of Highway Culverts to be inspected for the Drainage Performance Measure -- Year to Inspect is 2020 or before.

Highway Culverts – Last Inspection more than 10 years ago

District	Number of Highway Culvert – Last Inspected 2009 or before
1	331
2	419
3	6
4	8
6	4
7	165
8	84
Metro	723
State	1740

Are these Culverts still valid?

2019 Inspection Season Summary and comparison to 2018

District	2019 Inspections				2018 Inspections			
	Highway Culvert 2019	Storm Drain, Side, Entrance Culvert	Pond, SPCD, Structure	Total 2019 Inspections	Highway Culvert 2018	Storm Drain, Side, Entrance Culvert	Pond, SPCD, Structure	Total 2018 Inspections
1	1479	61	13	1553	936	27		963
2	1762	290	0	2052	0	1		1
3	1054	130	5	1189	838	38		876
4	842	675	47	1554	2429	1357		3786
6	1492	1	70	1563	2061	345	2	2408
7	1115	319	166	1600	1187	2732		3919
8	1023	1	42	1066	167	1	44	212
Metro	403	2378	3604	6385	649	3182	2798	6629
State	9170	3855	3947	16962	8267	7683	2842	18794

Drainage Measure #2:

Less than 10% of Highway Culverts are in Condition 3 or 4

	Total Percent of Poor Highway Culverts by District (Condition 3 or 4) – Target ≤ 10%								
Calendar Year	1	2	3	4	6	7	8	Metro	State
2019	16	11	11	11	20	26	15	14	16
2018	14	7	10	10	20	24	19	13	15
2017	14	7	10	8	20	23	20	11	15
2016	15	7	8	8	19	24	21	10	15
2015	17	7	9	9	19	24	21	10	16
2014	18	8	7	11	19	24	27	10	16
2013	21	11	7	16	22	22	27	10	17
2012	21	11	7	17	24	19	26	11	18
2011	22	11	8	19	26	17	24	11	18

Many of these poor condition pipes need repairs under inslope and not under the road surface.



Highway Culvert Condition Summary -- Percentages of Condition 4 and Condition 3 pipes (shown separately)

	Percent of Condition 4 – Very Poor Highway Culverts by District								
Year	1	2	3	4	6	7	8	Metro	State
2019	6	2	4	3	10	8	8	3	6
2018	6	2	3	3	10	7	10	3	6
2017	5	2	3	3	11	6	10	2	6
2016	6	2	3	3	10	6	10	2	6
2015	8	2	3	3	9	6	9	2	6
2014	8	2	2	4	9	8	11	2	6
2013	9	3	2	7	12	8	10	2	7
2012	8	3	2	7	13	6	9	2	7
2011	9	2	2	7	14	4	6	2	7
	Percent of Condition 3 – Poor Highway Culverts by District *								
Calendar	1	2	3	4	6	7	8	Metro	State
2019	10	8	7	8	10	18	7	11	10
2018	8	5	7	7	9	17	9	10	9
2017	9	5	6	5	9	17	9	8	9
2016	9	5	6	6	9	18	11	8	9
2015	9	5	6	6	10	18	12	8	10
2014	10	6	5	7	10	16	16	8	10
2013	12	8	5	9	10	14	17	8	10
2012	13	8	5	10	11	13	17	9	11
2011	13	9	6	12	12	13	18	9	11

New in 2020

#3 Drainage Measure: Targets for **Maintenance Repairs** of Highway Culverts

- Solsrud: Jan 18, 2020 MBMT consensus to track “MnDOT Maintenance” performed work:
 - Joint Repair
 - Paved Invert
 - Replace Apron
 - Reset Apron

 - Further direction to review data to determine targets, workload implications

Suggested Repair Flowchart

sorting process for **Concrete Highway Culverts**

Repair is needed but is not under traffic

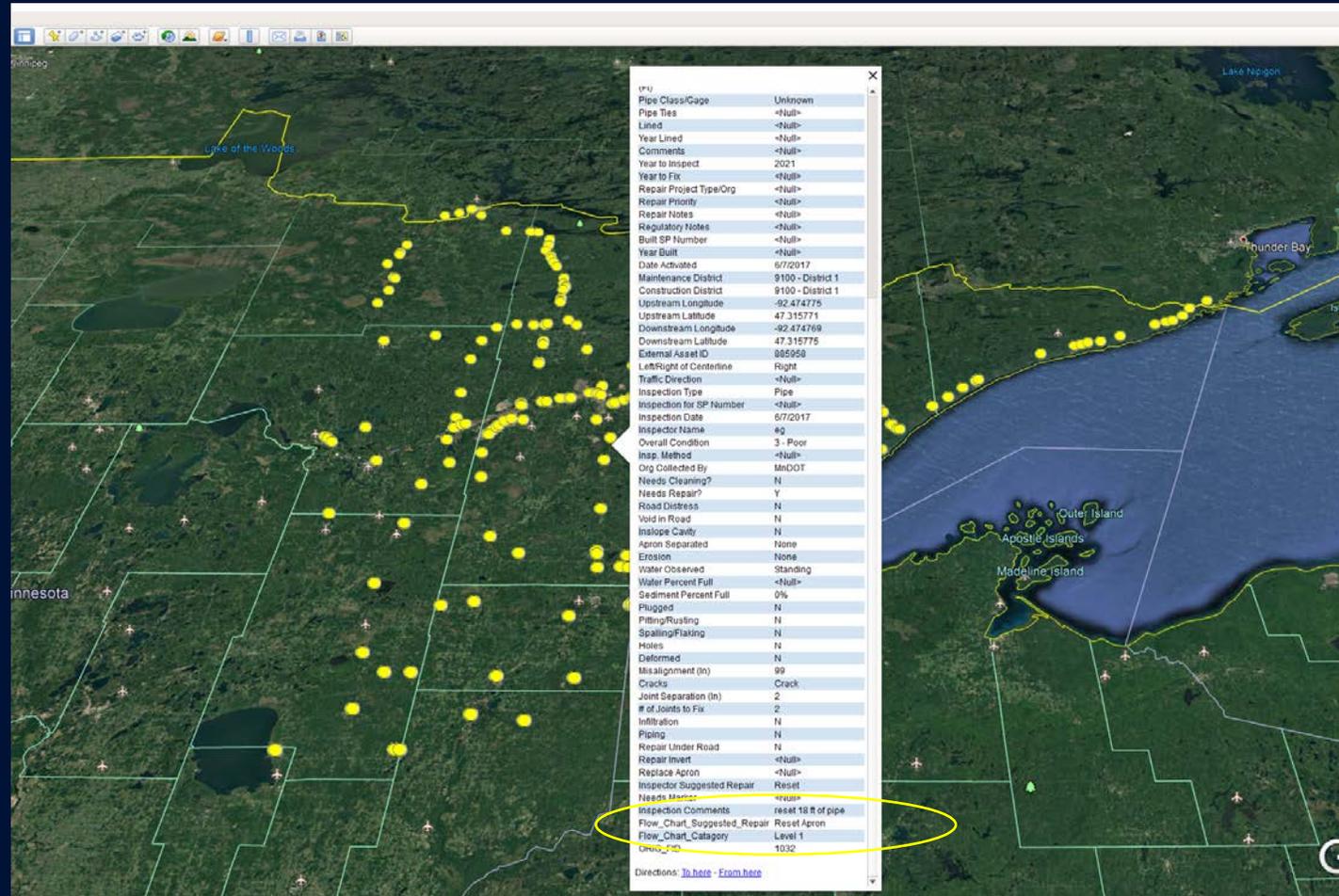


Maintenance Level 1 Repair Totals for Highway Culverts

20% of 1378 Level 1 Repairs to do State-wide = **276**

Level 1 Repairs	7000 - Metro District	9100 - District 1	9200 - District 2	9300 - District 3	9400 - District 4	9600 - District 6	9700 - District 7	9800 - District 8	Grand Total
Joint Repair	11	97	16	29	43	135	122	79	532
Paved Invert	4	8	5	2	6	11	10	1	47
Replace Aprons	3	15	8	7	10	5	4	4	56
Reset	14	129	82	61	78	97	201	81	743
Total Number of Level 1 Repairs	32	249	111	99	137	248	337	165	1378
20% of Level 1 Repairs - Target	6	50	22	20	27	50	67	33	276

Flowchart Suggested Repair kml shows Highway Culverts to repair



TAMS HydInfra pipes are sorted into Suggested Repair by ArcMap model based on Suggested Repair Flowchart ([decision tree](#))

New data attributes added to TAMS by User request:

Attribute added to TAMS	Setup Tables with new attributes
<1	Asset Performance > Setup > Hydraulic Inspections > Counter
Ditching	Asset Performance > Setup > Hydraulic Inspections > Suggested Repair
Roundabout	Asset Inventory > Setup > Hydraulics > Hydraulic Structures > Roadway Type
SpecFeat - Pump Station	Asset Inventory > Setup > Hydraulics > Hydraulic Structures > Structure Type
Safety Apron 1:4, Safety Apron 1:6 Safety Aprons 1:10 Flap Gate	Asset Inventory > Setup > Hydraulics > Pipes > Pipe End Type
Liner Concrete Liner Other	Asset Inventory > Setup > Hydraulics > Hydraulic Structures > Material Structure
AOP - Other AOP - Embedded culvert AOP - Recessed culvert AOP - Bankfull width Internal Bands Paved Invert	Asset Inventory > Setup > Hydraulics > Pipes > Pipe Component Type

Data Integrity:

Inspect with the HydInfra Manual.

Criteria keeps us in sync.

Inspection tells the story

Maintenance Management | Asset Inventory | Asset Performance | Planning | Operations | GIS & Reports

Maintenance Management > Asset Inventory > Hydraulic Infrastructure > Pipe Inventory

Inventory | Inspections

Inspection Elements Actions

* Pipe 2180014	Inspection Type Pipe	Status Completed
* Inspection Date 7/19/2018	Inspector Name Ryan Detloff	Overall Co 4 - Severe
Org Collected By MnDOT	Needs Cleaning? <input type="checkbox"/>	Needs Rep <input checked="" type="checkbox"/>
Void in Road <input type="checkbox"/>	Inslope Cavity <input type="checkbox"/>	Apron Sep None
Water Observed Standing	Water Percent Full 30%	Sediment F 0%
Pitting/Rusting <input checked="" type="checkbox"/>	Spalling/Flaking <input type="checkbox"/>	Holes <input checked="" type="checkbox"/>
Misalignment (In) <input type="checkbox"/>	Cracks 0	Joint Separation <input type="checkbox"/>
Infiltration <input checked="" type="checkbox"/>	Piping <input checked="" type="checkbox"/>	Repair Under Road <input checked="" type="checkbox"/>
Replace Apron <input checked="" type="checkbox"/>	Suggested Repair Liner CIPP	Needs Marker <input type="checkbox"/>
Illicit Discharge Comments <input type="checkbox"/>	Comments Sides rusted out, actual location is RP 88.032, aprons rusted	Documents 0
Date Update 8/1/2018		User Update DETL1RYA

Text Field Editor

Actions

Sides rusted out, actual location is RP 88.032, aprons rusted out,

Condition 4 pipe with
“Sides rusted out”

Flags showed
Piping and Holes

Pipe had
road failure
in 2019,
a year after
inspection

Data Integrity: QAQC Report

Can we trust HydInfra data?

QAQC Report

Highlights fields that don't match HydInfra criteria

L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AH	AI	AJ	AQ
Overall Condition	Insp. Method	Org Collec	Needs Cle	Needs f	Road Dist	Void i	Inslope Ca	Apron Se	Erosion	Water C	Water Perc	Sedime	Plugged	Pitting/Ri	Spallin	Holes	Deformed	Infiltration	Piping	Repair Un	Comments
3 - Poor	End of Pipe	MnDOT	No	Yes	No	No	No	Downstream	None				No	Yes	Yes	No	Yes	No	No	No	Downstream end pipe crushed and ap
3 - Poor	End of Pipe	MnDOT	No	Yes	No	No	No	Upstream	None				No	Yes	Yes	Yes	Yes	No	Yes	No	Bottom gone starting to pipe
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	Upstream	None				No	Yes	Yes	No	Yes	No	No		Rusty bottom but still solid
4 - Severe	End of Pipe	MnDOT	No	Yes	No	No	Yes	Upstream	Downstream				No	Yes	Yes	Yes	Yes	Yes	Yes	No	Bottom gone, piping under culvert big
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	Yes	No	No		
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	Yes	No	No	No	No		
4 - Severe	End of Pipe	MnDOT	No	Yes	No	No	No	Upstream	None				No	Yes	Yes	Yes	Yes	Yes	No	No	Holes in side of pipe
2 - Fair	End of Pipe	MnDOT	Yes	No	No	No	No	None	None				No	Yes	No	No	No	No	No		
3 - Poor	End of Pipe	MnDOT	Yes	Yes	No	No	Yes	Upstream	None			20%	No	Yes	Yes	Yes	Yes	No	No		Upstream apron gone holes in side of
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	Yes	No	No	No	No	No	No	
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	Yes	No	No	No	No	No	No	
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	No	No	No	No	No	No	No	
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No		Bands inside looks good
2 - Fair	End of Pipe	MnDOT	Yes	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	this is not a 4 east apron could use c
1 - Like New	End of Pipe	MnDOT	No	No	No	No	No	None	None	Dry		0%	No	No	No	No	No	No	No	No	safety grates on both ends. 9 internal
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	
1 - Like New	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	No	No	No	No	No	No	No	
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	Internal bands look good
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	this is 60 inch pipe with drop structur
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	Yes	No	No	No	No	No	No	
4 - Severe	End of Pipe	MnDOT	No	Yes	No	No	No	None	None	Standing			No	Yes	No	Yes	No	Yes	No	Yes	Hole in pipe under road infiltrating d
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	Internal bands look good
1 - Like New	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	No	No	No	No	No	No	No	Dip in middle of pipe but looks good
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	Internal bands look good
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	Yes	No	No	No	No	No	No	Internal bands look good
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	Yes	No	No	No	No	No	No	Internal bands look good
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	looks really good concrete looks good
1 - Like New	End of Pipe	MnDOT	Yes	No	No	No	No	None	None				No	No	No	No	No	No	No	No	
1 - Like New	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	No	No	No	No	No	No	No	New pipe
2 - Fair	End of Pipe	MnDOT	Yes	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	west apron 2 inch seperation over all
1 - Like New	End of Pipe	MnDOT	No	No	No	No	No	None	None	Standing			No	No	No	No	No	No	No	No	New pipe
3 - Poor	End of Pipe	MnDOT	No	Yes	No	No	No	None	None				No	Yes	No	No	No	Yes	No	No	10ft in on downstream end there is a
2 - Fair	End of Pipe	MnDOT	No	No	No	No	No	None	None				No	Yes	No	No	No	No	No	No	Bands look good

TAMS Work Order Management module does not change HydInfra asset record

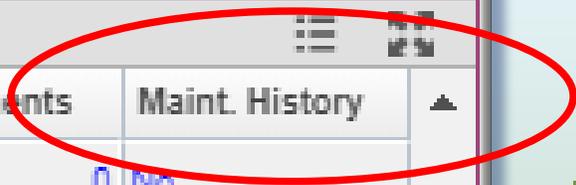


- After repair, Insert a new inspection
- After replacement, change old pipe Inventory record to “Removed” and Insert a new pipe Inventory
- Metro District drainage repairs will be updated in TAMS-HydInfra by WRE.

[How to Update HydInfra from Work Order Drainage Repairs](#)

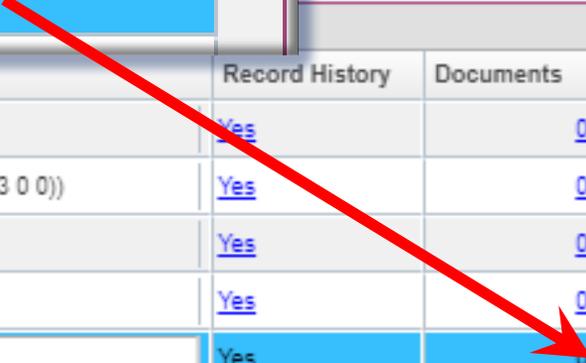
HydInfra Inventory > Maint. History field shows W.O.

Scroll to far right in TAMS table to find linked work orders -- Yes



Record History	Documents	Maint. History
Yes	0	No
Yes	0	No
Yes	0	Yes
Yes	0	No
Yes	0	Yes

WO# 40691



Maintenance Management | Asset Inventory > Asset Performance > Pipe Inventory

Inventory | Inspections

id	Date Update	Geometry	Record History	Documents	Maint. History
YA	8/22/2018	MULTILINESTRING ZM ((-94.7009731528 46.8039133611 0 0, -94.701284289 46.8039078532 0 0))	Yes	0	No
	3/23/2018	MULTILINESTRING ZM ((-94.6958438836509 46.803839050158 0 0, -94.6958374751064 46.8038436447953 0 0))	Yes	0	No
ya	9/16/2019	MULTILINESTRING ZM ((-94.691931566 46.803985133 0 0, -94.69183883 46.803981071 0 0))	Yes	0	Yes
	9/23/2019	MULTILINESTRING ZM ((-94.675627474 46.803919745 0 0, -94.675625705 46.803730625 0 0))	Yes	0	No
	9/23/2019	MULTILINESTRING ZM ((-94.675613317 46.80376758 0 0, -94.675606906 46.803772173 0 0))	Yes	0	Yes
	9/23/2019	MULTILINESTRING ZM ((-94.675603617 46.803913584 0 0, -94.675599462 46.803733803 0 0))	Yes	0	No
YA	8/1/2018	MULTILINESTRING ZM ((-94.6709070826387 46.8037284083442 0 0, -94.6709006719449 46.803733001612 0 0))	Yes	0	No
	9/23/2019	MULTILINESTRING ZM ((-94.670292806 46.803848071 0 0, -94.670294267 46.803740667 0 0))	Yes	0	No
ya	9/10/2019	MULTILINESTRING ZM ((-94.670277727 46.803719598 0 0, -94.670271316 46.803724191 0 0))	Yes	0	Yes
	3/23/2018	MULTILINESTRING ZM ((-94.6603543640571 46.8036480369425 0 0, -94.6603479524581 46.8036526296304 0 0))	Yes	0	No

Work Order needs a TAMS ID

- Repair or line a pipe? – use the existing pipe ID
- Install a new pipe? – create a new TAMS asset for the work order
 - Must have a Latitude-Longitude location -- use Get Coordinates from Map in TAMS)

Get the Handout:
[How to Update a
HydInfra Asset Record
from the Work Order](#)

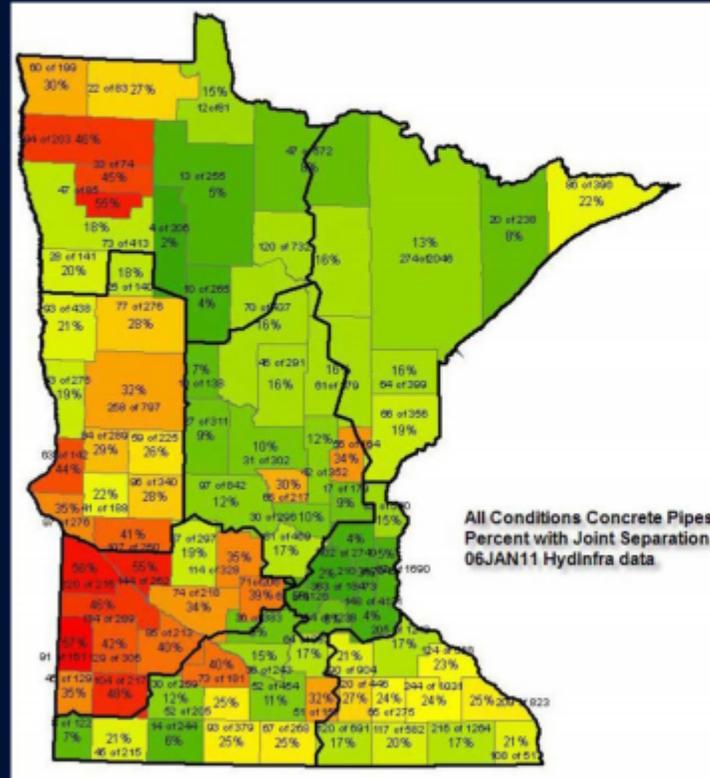
End Goal:

***Lifecycle Cost Analysis
in Asset Management***

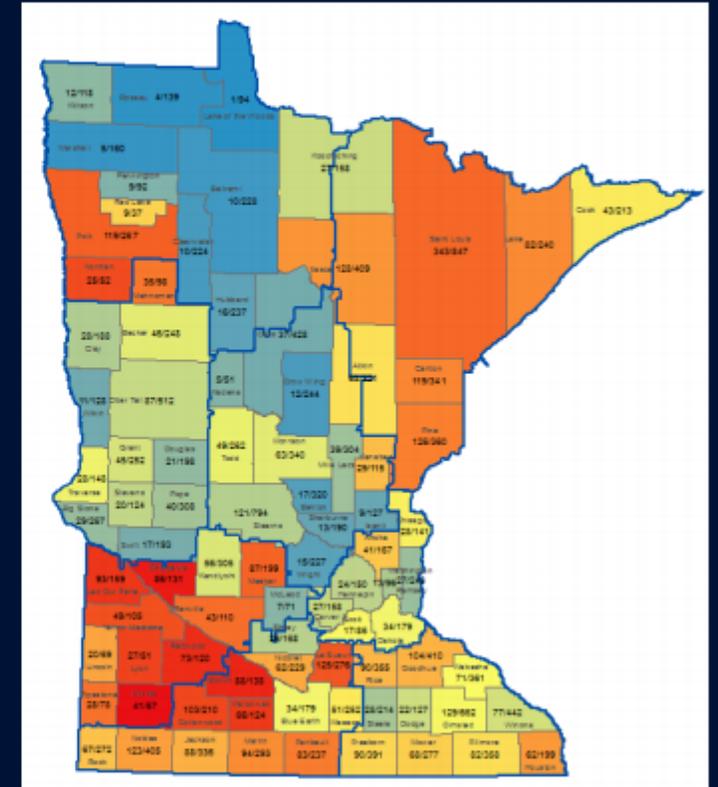
HydInfra Inspections show where hotspots occur

- Concrete pipe joint separations are likely worse in fine soils (frost-heave) or steeper grades.
- Pipe Ties work to prevent some separation
- Inspector feedback furthers understanding of pipe defects

All Concrete Pipe Joint Separation 2011 vs Concrete Culvert Joint Separation 2017 - by County



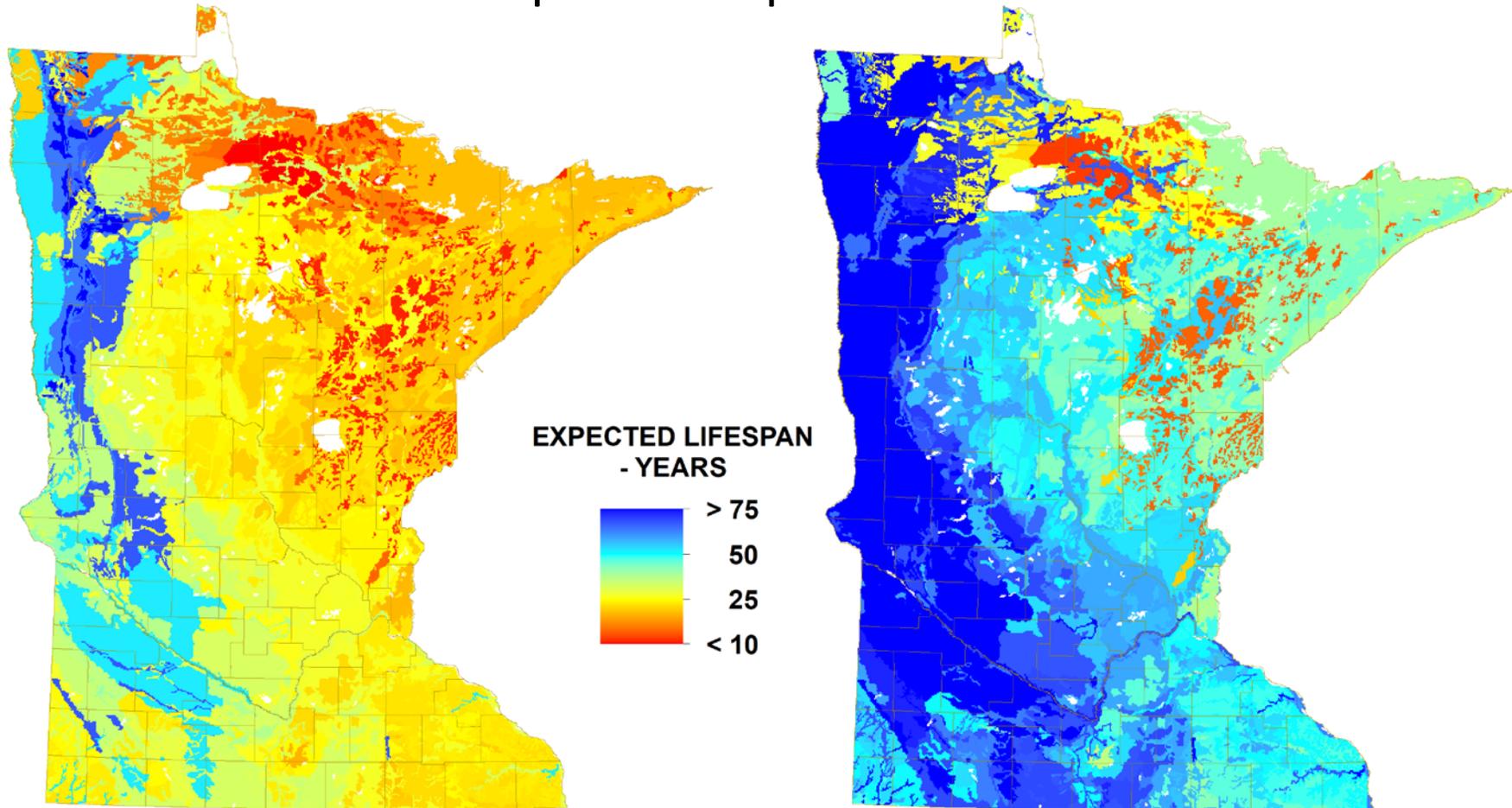
2011 All Concrete Pipes with **Joint Separation**



2017 Concrete Culverts with **Joint Separation**

Research contributes to Lifecycle Asset Management

MnDOT Steel Pipe lifespan research-2015



16 Gage Galvanized Steel Pipe

16 Gage Aluminized Steel Pipe

Most current information says avoid using Aluminized or Galvanized Steel in wet areas, low pH (acidic) soils. For Aluminized steel, also avoid high iron content in soil and avoid limestone or crushed concrete bedding (high pH hotspots). These conditions promote early deterioration. [Minnesota Steel Pipe Service Life Map -- Research Project Final Report 2015-31](#)