Follow the Yellow Striped Road But Watch Out for that Manhole

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ARIZONA PAVEMENTS/MATERIALS CONFERENCE

Dibble Engineering

Presentation Outline

- Background
- Sewer Manhole & Roadway Data
- Summary Statistics
- Study Methods
- Results
- Analysis
- Analysis Conclusions
- Recommendations

Background

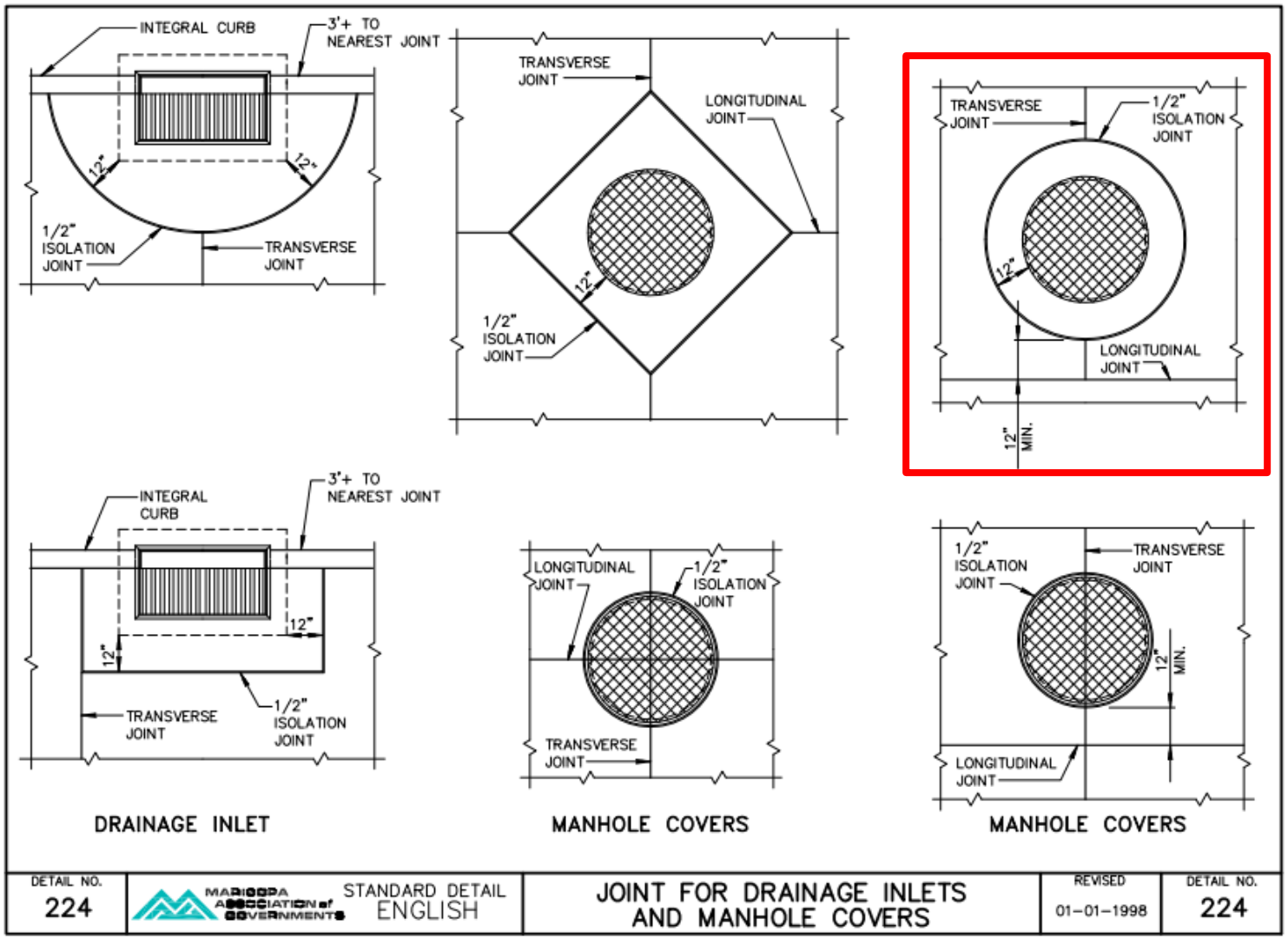
How the Study Began

- ASU Masters Courses & Applied Project
  - Pavement Courses
- Internship
  - Transportation Projects
  - Infrastructure Rehabilitation Projects

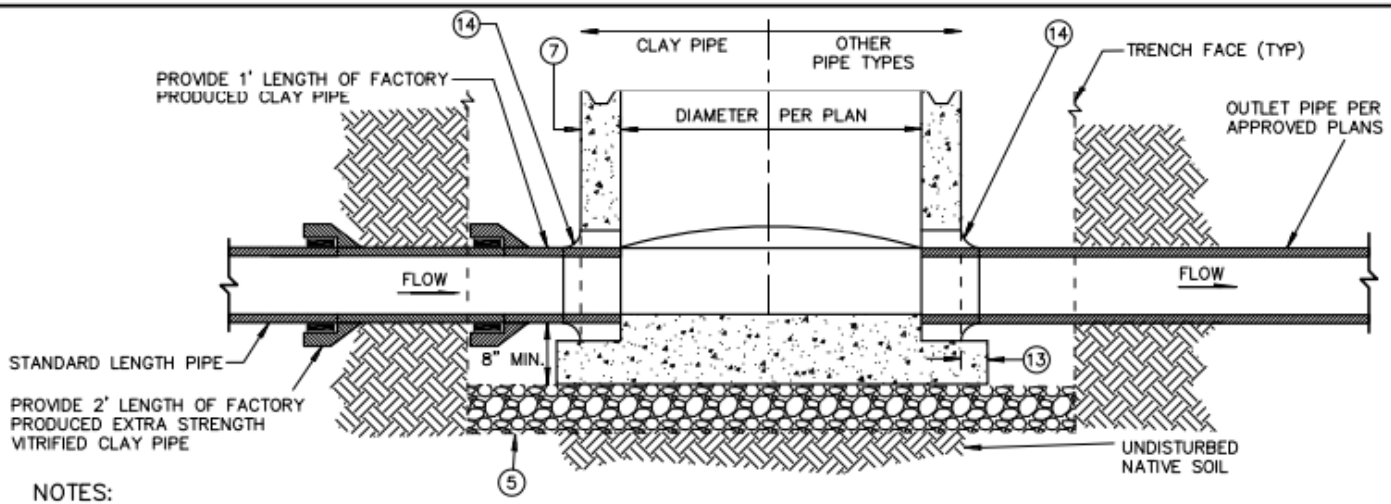
Manhole Installation

- Maricopa Association of Governments
  - Uniform Standard Details for Public Works Construction
- MAG Detail No.
  - ✓224
  - ✓420-2
  - ✓422

Manhole Installation



Manhole Installation

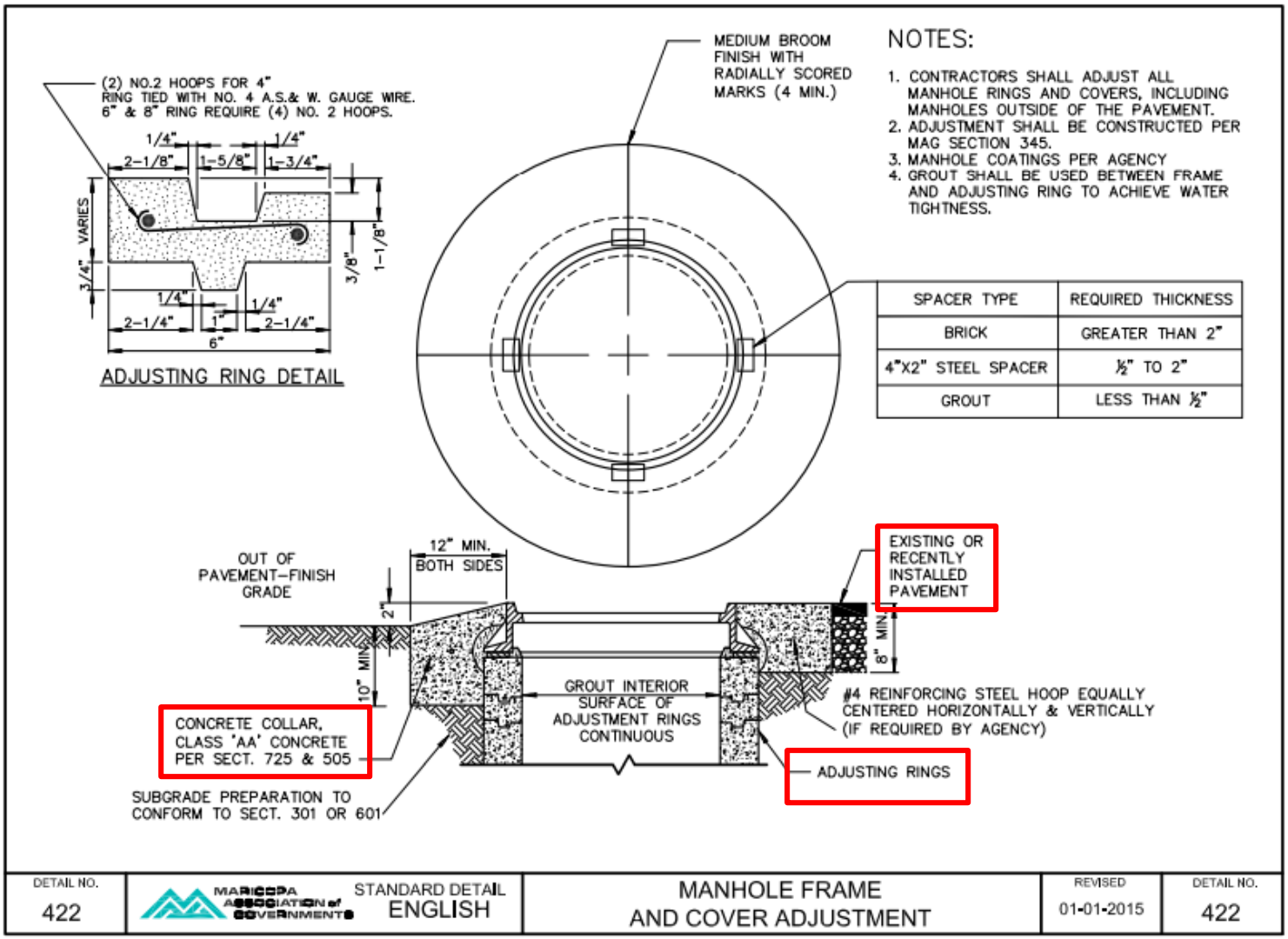


NOTES:

1. PRECAST, MANUFACTURER SHALL BE AN NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA) CERTIFIED PLANT. ENTIRE PRECAST BASE SHALL BE MANUFACTURED AT THE PLANT PER ASTM C478.
2. MAG "AA" 4000 PSI CONCRETE SHALL BE USED FOR PRECAST MANHOLE BASES.
3. SPRING LINE OF CAST-IN-PLACE BELL SHALL STOP AT INSIDE FACE OF MANHOLE.
4. JOINTS FOR BARREL SECTION SHALL BE TONGUE AND GROOVE TYPE. ALL LIFTING HOLES SHALL BE SEALED WITH GROUT.
5. ALL PRECAST MANHOLE BASES SHALL BE PLACED ON 8" MINIMUM OF ABC PER SECTION 702 COMPACTED TO 100% MAXIMUM DENSITY.
6. ALL MODIFICATIONS SHALL BE APPROVED BY THE ENGINEER.
7. MINIMUM WALL THICKNESS SHALL BE PER ASTM C478 (MIN 5").
8. REINFORCEMENT SHALL BE DESIGNED BY AN ARIZONA REGISTERED PROFESSIONAL ENGINEER.
9. CHANNEL TRANSITION SHALL BE CONSTANT FROM INLET TO OUTLET OF MANHOLE TO FACILITATE SMOOTH TRANSITIONS AND ACCOMMODATE CORRESPONDING MANDREL.
10. THERE SHALL BE NO HARD CONNECTIONS (GROUTED) INTO THE MANHOLE BASE UNLESS APPROVED BY THE ENGINEER.
11. ALL SEWER SERVICE CONNECTIONS SHALL HAVE THE SAME CONNECTION TYPES IN THE PRECAST MANHOLE BASE.
12. ALL CORE HOLES INTO THIS STRUCTURAL PRECAST BASE SHALL BE COATED WITH AN APPROVED COATING MATERIAL.
13. THE MANHOLE BOTTOM SHALL EXTEND OUTSIDE THE MANHOLE WALL A MINIMUM 6" WIDE ON 48" BASES, 7" WIDE ON 60" BASES, AND 8" WIDE ON 72" BASES. EXTENDED BOTTOM SHALL BE A MINIMUM OF 5" THICK.
14. ALL PIPE CONNECTIONS SHALL BE IN COMPLIANCE WITH ASTM F477 OR ASTM C425. AN EXTRA STRENGTH VCP BELL WITH A POLYURETHANE JOINT THAT MEETS ASTM C425 MAY BE USED WITH VCP.

DETAIL NO.			REVISED	DETAIL NO.
420-2	MARICOPA ASSOCIATION of GOVERNMENTS STANDARD DETAIL ENGLISH	PRECAST CONCRETE MANHOLE BASE	01-01-2015	420-2

Manhole Installation



Sewer Manhole Data

Chandler Manhole Ring and Cover Assessment

- The City of Chandler hired the Dibble Engineering Infrastructure Rehabilitation Team

- Ring and Cover Assessment
  - Manholes within Arterial Roadways

Chandler · Arizona

Dibble Engineering®

Manhole Investigation with ArcGIS Collector

- The ArcGIS Collector Application
- Bad Elf GPS
- Windows Surface

Manhole Investigation with ArcGIS Collector

- Based on the NASSCO Pipeline Assessment, the following data was collected:
  - Ring and Cover Conditions
  - Collar Condition
  - Recess Distance
  - If the Cover Moves
  - If in Wheel Track, Turn Lane, or Not

Manhole Investigation with NASSCO PACP

- Using Conditions put forth by NASSCO PACP Section 8, the Conditions documented consisted of the following:
  - Ring and Cover Conditions
    - ✓Sound, Damaged, Corroded
  - Collar Condition
    - ✓Sound, Cracked, Fractured

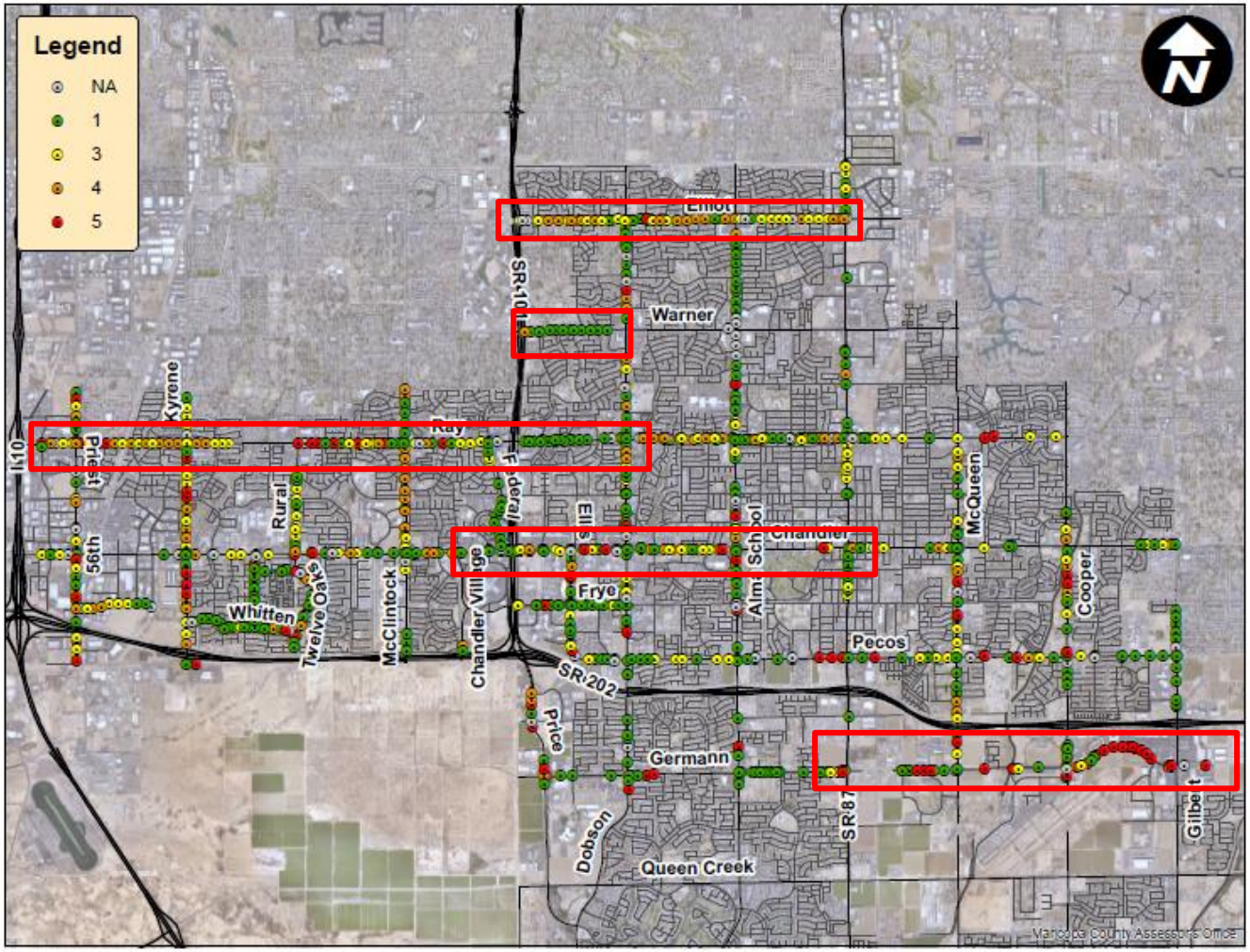
Manhole Investigation with NAASCO Rating System

- The condition information graded based on NAASCO grading system
  - Appendix C – PACP Condition Grading System
  - The higher the grade, the worse the condition
- The grades were applied to each manhole based on conditions
- Overall Grade was applied

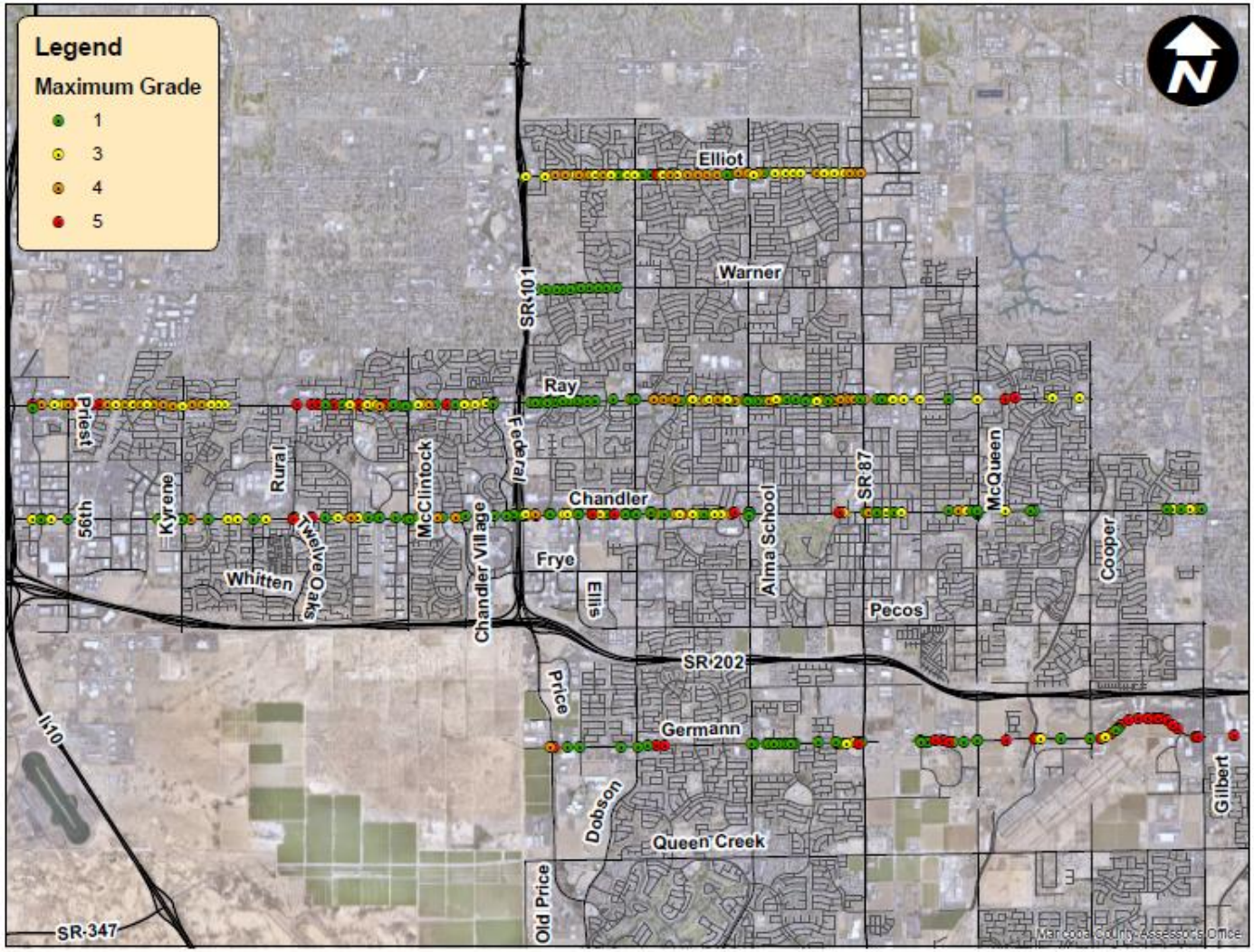
In Wheel Track Grading System

- No NASSCO grading system for manhole location
- Similar hierarchy coding value was applied representing manhole location
  - Not in Wheel Track: 1
  - In Turn Lane Wheel Track: 3
  - In Wheel Track: 5

Manhole Investigation - ArcGIS Collector



Manhole Investigation - ArcGIS Collector



Roadway Data

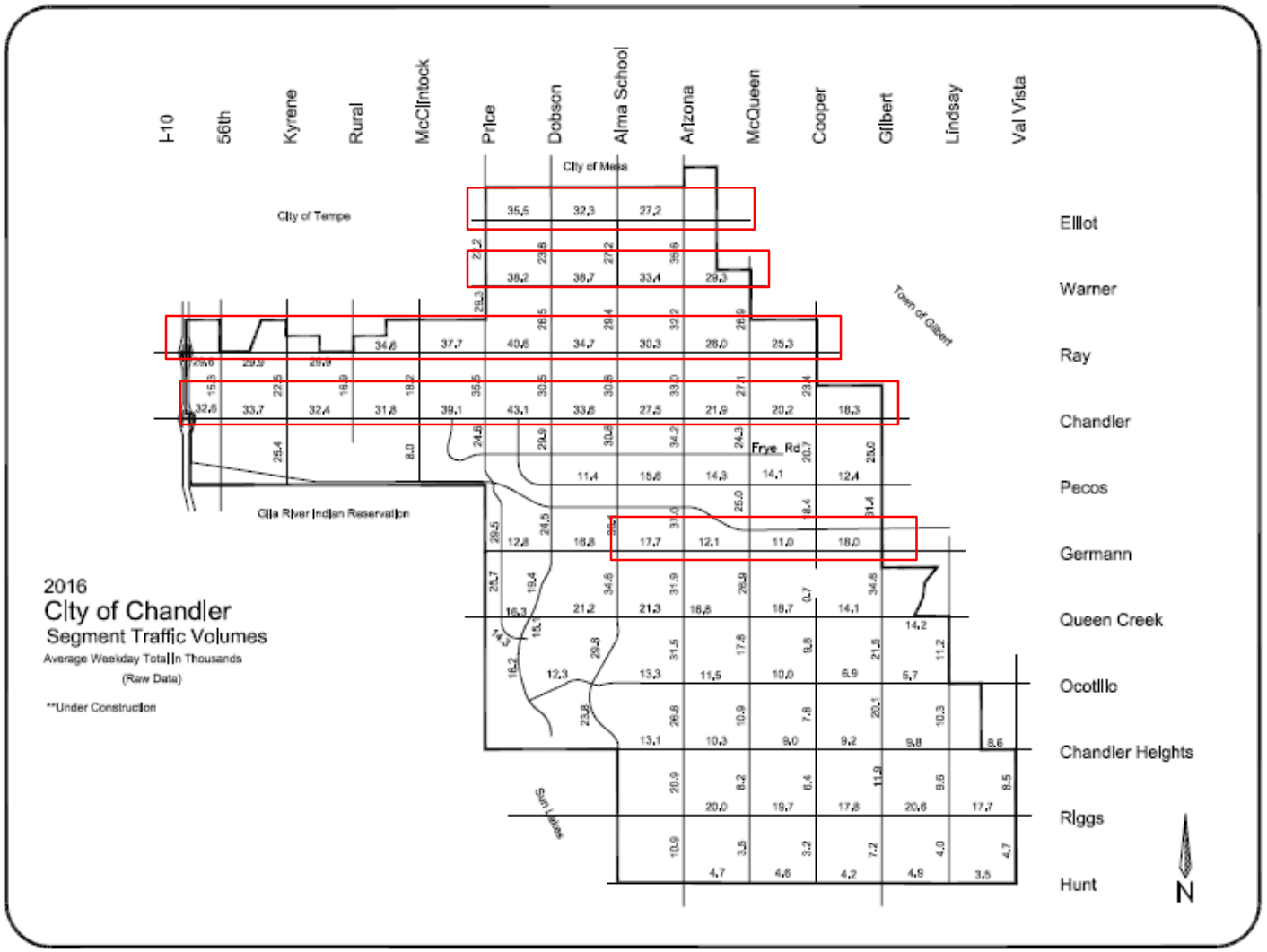
Roadway Data from City of Chandler

1	Germann Road	Spring 09	spring 10	spring 11	spring 12	spring 13	spring 14	spring 15	spring 16	spring 17	2016 **Surveyed Average PQI
1a	Alma School Rd to Arizona Avenue	HIP				TRMSS					72.08
1b	Arizona Ave to Hamilton Street (County Until 2016)									M/I*	*98.00
1c	Hamilton ST to McQueen RD		HIP				TRMSS				71.90
1d	McQueen RD to Cooper RD		HIP				TRMSS				78.13
1e	Cooper RD to Gilbert RD				TRMSS						72.90
2	Elliot Road										
2a	Alma School Rd to Arizona Ave		S/S							TRMSS	70.60
2b	Arizona Ave to RR Track		S/S							TRMSS	70.05
3	Warner Road										
3a	Alma School Rd to Arizona Ave				S/S						60.26
3b	Arizona Ave to McQueen Road				S/S						59.30
3c	McQueen RD to Cooper RD (Town of Gilbert Jurisdiction)										
4	Ray Road										
4a	Alma School Rd to Arizona Ave						S/S				79.80
4b	Arizona Ave to McQueen Road					S/S					64.00
4c	McQueen RD to Cooper RD					S/S					56.67
4d	Cooper RD to Gilbert RD (Town of Gilbert Jurisdiction)										

Abbreviations	
HIP	Hot in place
TRMSS	Tire Rubber Modified Surface Seal
M/I	Mill and Inlay
S/S	Slurry Seal
AC	Asphalt Concrete
ABC	Asphalt Base Course
PQI	Pavement Quality Index
MAG	Maricopa Association of Governments
Cross Section	Standard City Pavement Structure/MAG is 17" Thickness all new construction or repave to attempt to meet this criteria. 2"AC (1/2"mix) - tack coat- 3" AC (3/4"mix) - 12" ABC, on subgrade.
*	Not part of 2016 Survey, work completed March 2017
**	CoC uses and outside consultant to survey condition of roadways. Survey results are used as a base point, but PQI's referenced need to be field verified by City Staff and treatments/programmed years may be adjusted accordingly.
***	All Data and information presented herein is an attempt to provide accurate information for use in an ASU assigned Applied Project to ASU Representative "Hunter Venne" and its intended use is for that such. While accuracy is attempted it is not guaranteed. Future Budgets, Programs, Treatments, and Treatments years requires City Upper Management and Mayor/Council Approvals.

Traffic Data

City of Chandler Traffic Counts



City of Chandler
Traffic Counts Summary

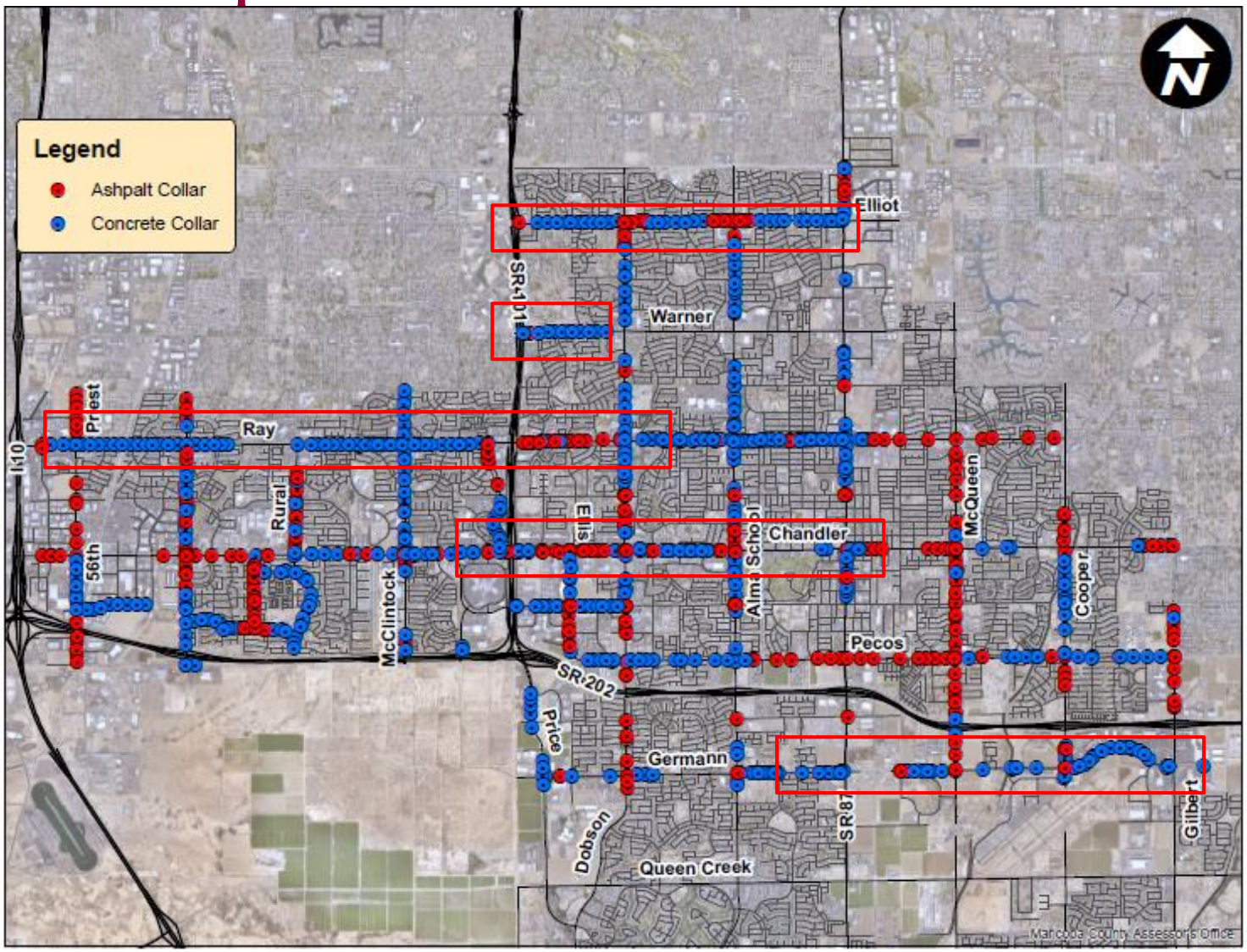
City of Chandler 2016 AADT Data					
Road Segment	**Elliot Rd**	**Warner Rd**	**Ray Road**	**Chandler Rd**	**Germann Rd**
I-10 to 56th	-	-	29600	32600	-
5th - Kyrene	-	-	29900	33700	-
Kyrene - Rural	-	-	29900	32400	-
Rural to Mcklintock	-	-	34600	31800	-
McClintock - Price	-	-	37700	39100	-
Price - Dobson	35500	38200	40600	43100	12800
Dobson - Alma	32300	38700	34700	33600	16800
Alma - Arizona	27200	33400	30300	27500	17700
Arizona - McQueen	-	29300	26000	21900	12100
McQueen - Cooper	-	-	25300	20200	11000
Cooper - Gilbert	-	-	-	18300	18000

Summary Statistics

Summary Statistics

- 791 Manholes Investigated by Dibble
- 432 Manholes Assessed in this Study

Asphalt vs. Concrete Collar



Summary Statistics for Asphalt vs. Concrete Collars

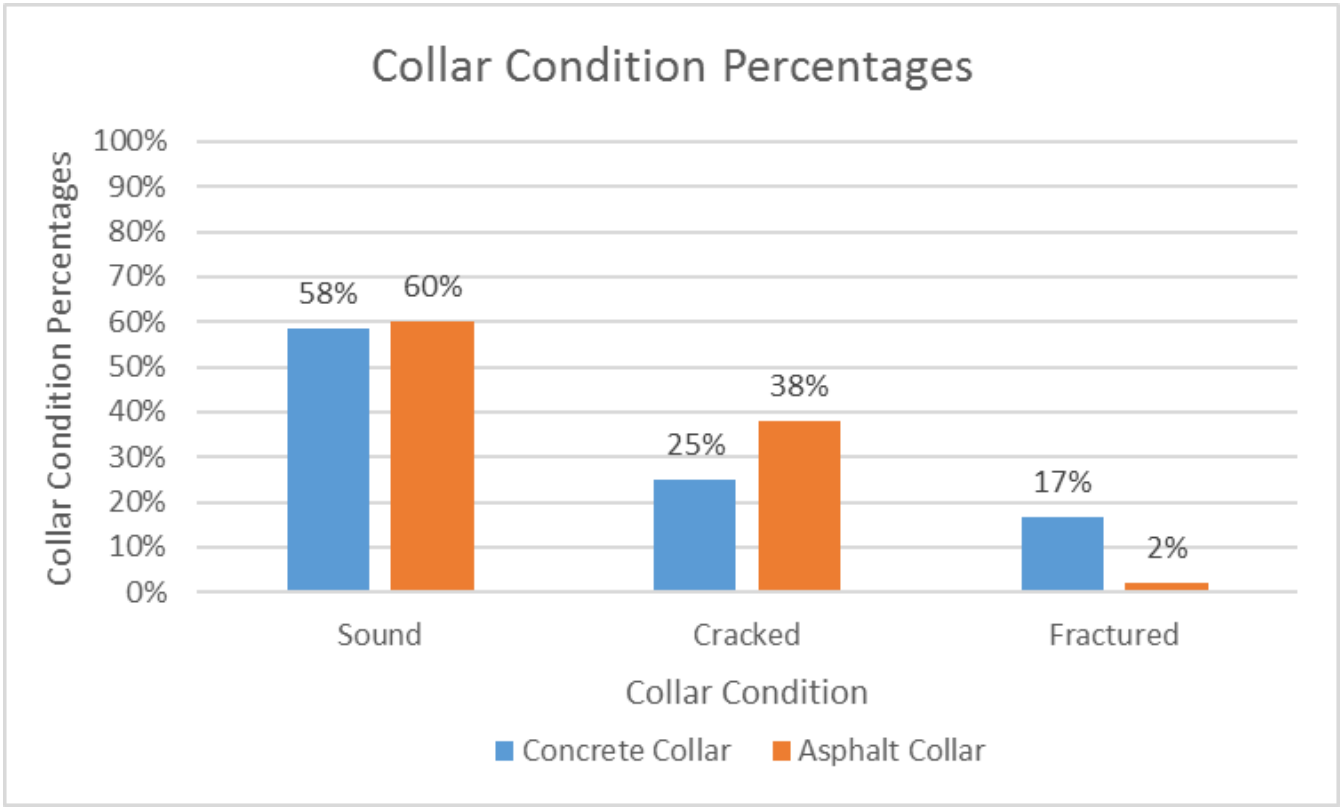
Sound

Cracked

Fractured

Summary Statistics for Asphalt vs. Concrete Collars

- 556 Concrete Collars, 235 Asphalt Collars



Wheel Track Summary Statistics

Recessed Distance (in)	Total Number	In Wheel Track	In Turn Lane	Not in Wheel Track
-1	16	10	2	4
-0.875 to -0.5	233	152	20	61
-0.5 to 0	522	244	98	180
>0	20	4	6	10
Total	791	410	126	255

Recessed Distance (in)	In Wheel Track	In Turn Lane	Not in Wheel Track
-1	63%	13%	25%
-0.875 to -0.5	65%	9%	26%
-0.5 to 0	47%	19%	34%
>0	20%	30%	50%
Total	52%	16%	32%

Study Methods

Study Methods

- Performed statistical analysis on the Ring and Cover Data
- Determined Correlation Matrices between the following
  - Ring and Cover Conditions in relation to AADT
  - Ring and Cover Conditions in relation to location within lane (i.e. in wheel track)
- Perform Literature Review

Study Results and Analysis

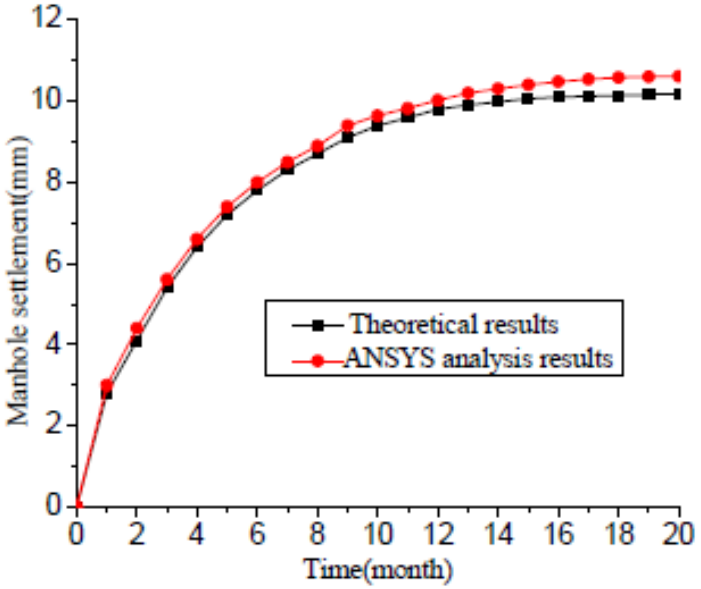
Study Results

- Correlation Matrix
  - Ring and Cover Condition in relation to AADT
  - Ring and Cover Condition in relation to location within lane (i.e. in wheel track)

	AADT	*In Wheel Track Factor*	*Recessed Distance*	*Concrete Collar Grade*	*Asphalt Collar Grade*	*Ring Condition Grade*	*Cover Condition*	*Cover Moves*	*Overall Grade*
AADT	1								
In Wheel Track Factor	0.0936	1							
Recessed Distance	0.0088	0.0941	1						
Concrete Collar Grade	0.1643	**0.2796**	0.0529	1					
Asphalt Collar Grade	0.1252	**0.2796**	0.0302	0.0458	1				
Ring Condition Grade	0.0601	**0.2803**	0.0028	**0.3487**	**0.3278**	1			
Cover Condition	0.0994	**0.2544**	0.0221	0.2101	0.1849	**0.4336**	1		
Cover Moves	-0.1121	0.1758	-0.0347	0.0992	0.1620	0.1593	0.0436	1	
Overall Grade	0.0320	**0.3619**	0.0275	**0.5977**	**0.3464**	**0.4198**	**0.4102**	**0.6836**	1

Other Studies

- ASCE Study: Effects of traffic on manhole settlement (Longitudinal Vibration) *(4)*
  - The model was not perfect, and they recommend further studies



Other Studies

- Manhole rehabilitation techniques Compared to How they:
  - Withstand traffic
  - Weather
  - Chemicals within the manhole *(5)*
  - All of the techniques held up to traffic loads, when implemented properly
    - ✓ i.e. proper materials and methods

Other Studies

- One study tested strains on soils due to:
  - Manhole structures
  - Vehicle loading *(6)*
- The trucks loads had smallest effect on soils stresses & settlement
  - The weight of the manhole and surrounding soils had the largest effect

Analysis Conclusions

Conclusions

- The correlations between AADT and the Manhole conditions are minimal
- Manhole location within roadway does show higher correlations with most of the manhole conditions
  - Concrete and Asphalt Collar Conditions
  - Ring and Cover Conditions
  - Overall Condition

Recommendations

Recommendations

- With more time, more detailed data could be obtained for a more thorough analysis using this same framework
  - More Detailed Traffic Data
  - PQI Data for Smaller Sections of Roadways
  - Age of manhole components
  - Age of Pavements
  - Further Breakdown of Comparisons and Correlations

Recommendations

- Composite Manholes (Manganaro Lift Station in the City of Chandler)
  - Makes the manholes lighter
  - Comes in one piece
    - ✓ Less possibility for installation errors and leaking
- 3-D Printing Options
  - Some studies are being conducted

References

1. Maricopa Association of Governments. 2017. "Uniform Standard Details for Public Works Construction." Maricopa Association of Governments.
2. 2016. Pipeline Assessment Certification Program. NASSCO.
3. 2016. "City of Chandler Segment Traffic Counts." Chandler: City of Chandler.
4. Du, Jian, Nanguo Jin, and Xianyu Jin. "Application of Longitudinal Vibration Theory in Manhole Settlement Study." In *ICPTT 2009: Advances and Experiences with Pipelines and Trenchless Technology for Water, Sewer, Gas, and Oil Applications*, pp. 922-933. 2009.
5. Falk, Christian. "Rehabilitation of manhole covers." *Tunnelling and Underground Space Technology* 14 (1999): 39-46.
6. Sabouni, Reem, and M. H. El Naggar. "Circular precast concrete manholes: experimental investigation." *Canadian Journal of Civil Engineering* 38, no. 3 (2011): 319-330.

Questions?

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