Integrating Database Systems

Towards Validating Pavement Performance Models

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Research Questions

- What databases does TxDOT maintain?
- Useful for pavement engineering?
- Can these be integrated?
- What determines sustainability?
- Lesson's learnt?
- What does the future hold?

Pavement Databases in Texas

- Design & Construction (DCIS)
- Pavement Management (PMIS)
  - Texas Reference Marker (TRM)
  - Maintenance Management (MMIS)
- SiteManager
  - Laboratory Management (LIMS)
- TxHMA PathFinder
- Flexible Pavements Databases (TxFlex)
- Excellent Performing & Experimental Sections
- Cartographic Information System (TxCIT)

Design & Construction (DCIS)

- Details all construction projects
- Construction and estimated completion dates
- Location (limited)
- Items specified
- Quantities & Prices listed

Pavement Management (PMIS)

- Details network level performance for all state maintained roads
- Section performance and condition data

PMIS Data (per section per year)

- Traffic (AADT & 18 kip)
- Maintenance costs
- Location
  - Route
  - Lane (roadbed)
  - Beginning & Ending Reference Markers
- Performance measures (Visual & Profiler)

PMIS Performance Measures

- Condition Scores/Indices
- International Roughness Index (IRI)
- Visual Rutting (Shallow, Deep, Severe)
- Visual Cracking (Block, Alligator, Longitudinal, Transverse)
- Visual Patching
- Automated rutting & cracking + video
- Falling Weight Deflectometer (FWD)
- Skid & Texture

SiteManager

- Construction diary
- Construction quality control & assurance (QC/QA)
- Materials design data
- Pay Factors

Sitemanager QCQA Lessons

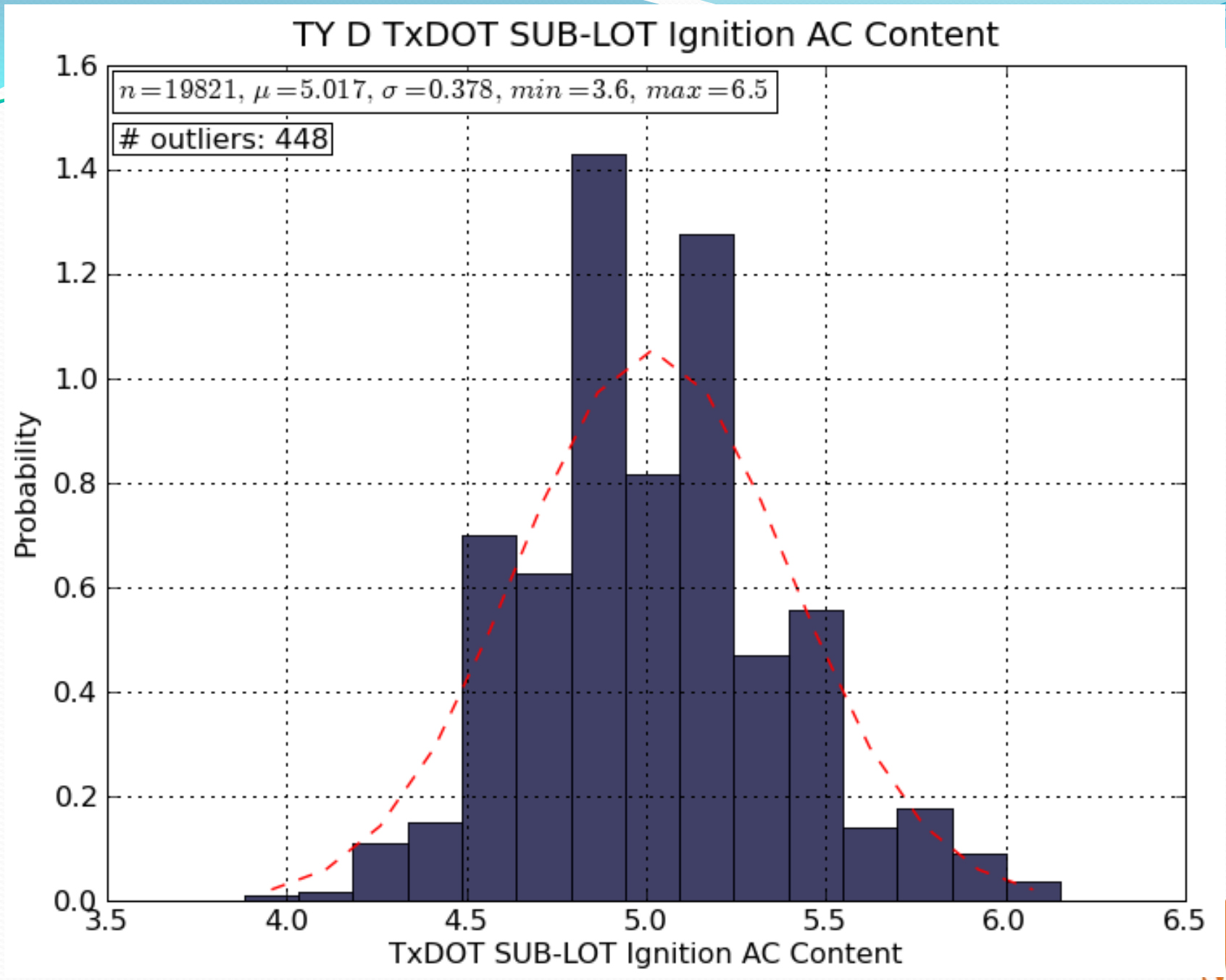
- No input validation/verification
- No calculated fields
- Inefficient database structure

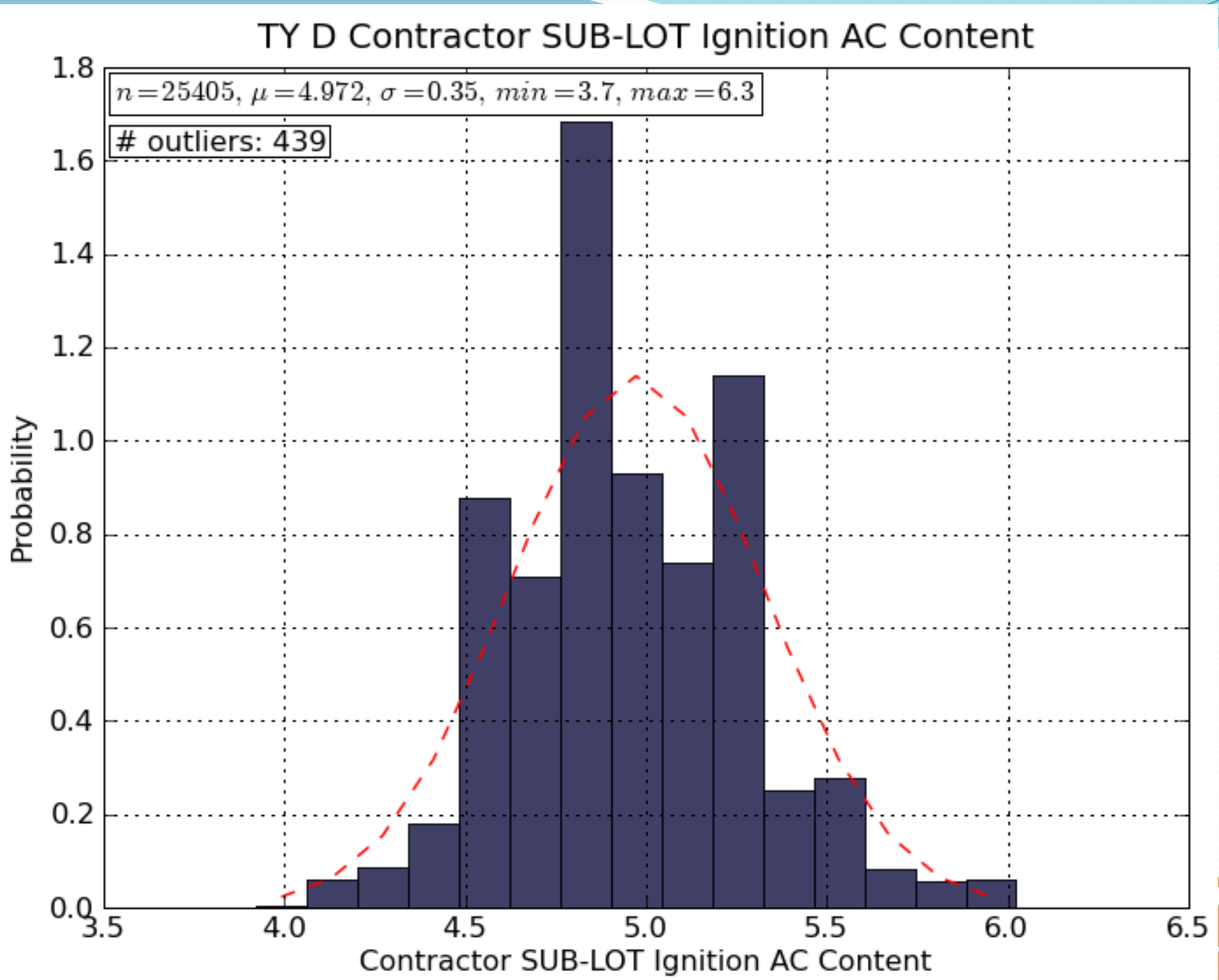
JMF AC Contents

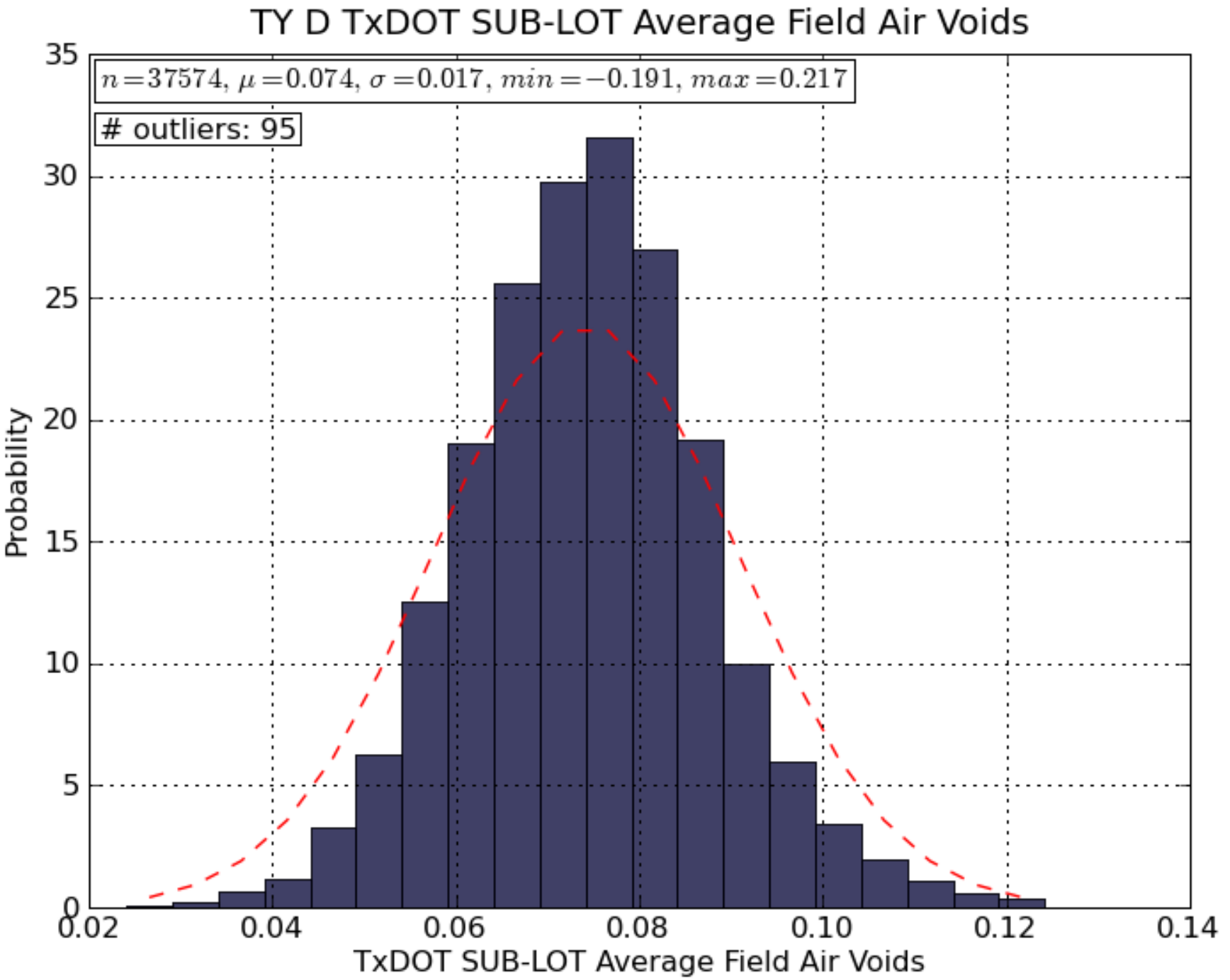
Mix Type	N	Mean	SE Mean	StDev	Variance	Minimum	Maximum
A	3077	3.975	0.005	0.294	0.087	3.200	4.900
B	7172	4.414	0.005	0.427	0.182	3.100	6.400
C	12148	4.581	0.003	0.303	0.092	3.400	5.900
D	9173	5.012	0.004	0.400	0.160	4.200	8.000
F	116	5.878	0.059	0.636	0.405	4.900	8.500

Type D JMF AC

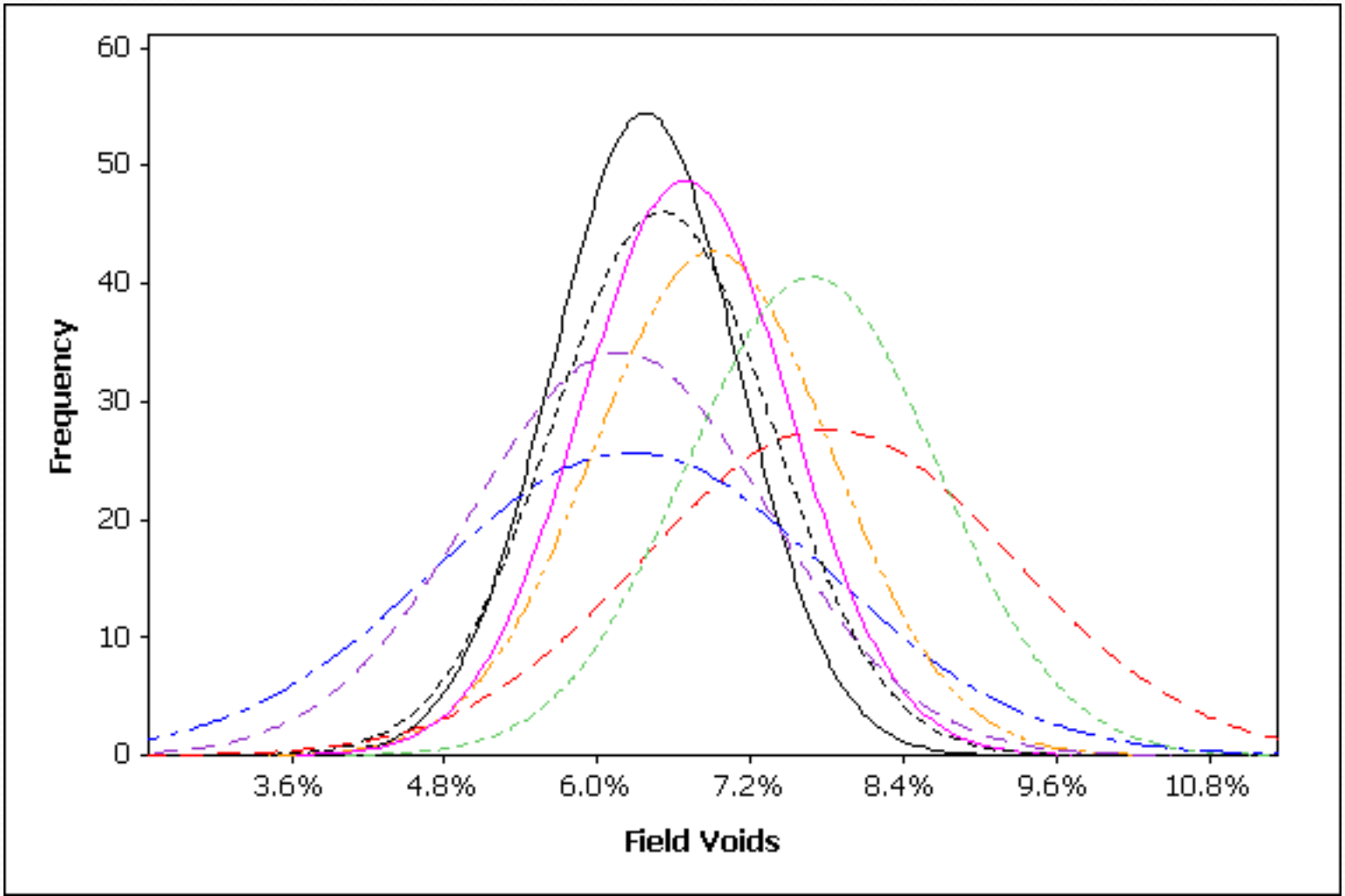
Binder Grade	N	Mean	Stdev
PG 64-22	1376	5.02	0.48
PG 64-28	20	4.95	0.05
PG 70-22	1655	4.96	0.31
PG 70-28	895	5.28	0.54
PG 76-16	17	5.45	0.19
PG 76-22	3816	4.98	0.35
PG 76-28	269	5.13	0.39


TY D TxDOT SUB-LOT Ignition AC Content
$n=19821,\ \mu=5.017,\ \sigma=0.378,\ min=3.6,\ max=6.5$
outliers: 448
Probability
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
3.5
4.0
4.5
5.0
5.5
6.0
6.5
TxDOT SUB-LOT Ignition AC Content

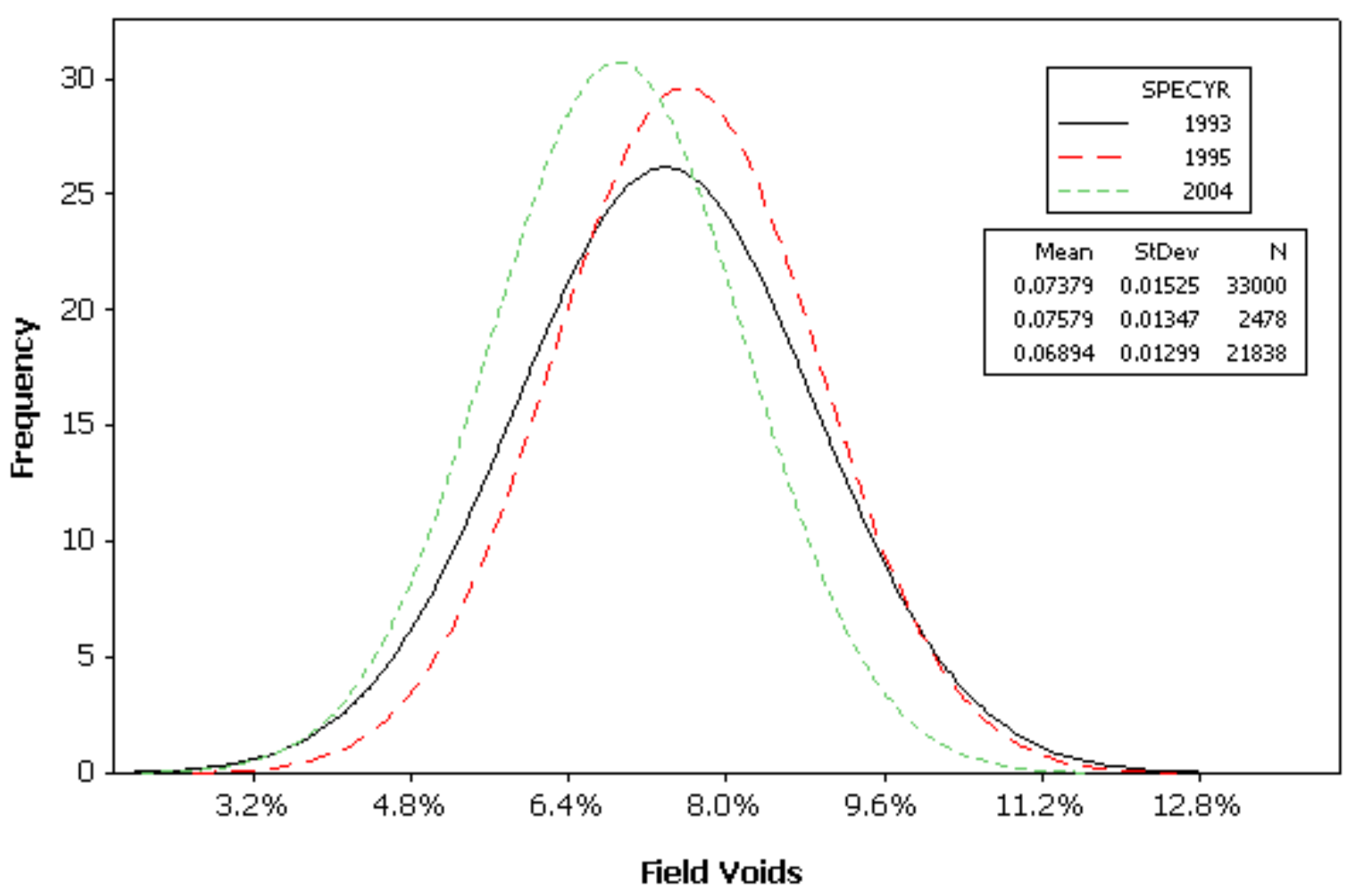

TY D Contractor SUB-LOT Ignition AC Content
$n=25405$, $\mu=4.972$, $\sigma=0.35$, $min=3.7$, $max=6.3$
outliers: 439
Probability
Contractor SUB-LOT Ignition AC Content
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
3.5
4.0
4.5
5.0
5.5
6.0
6.5


TY D TxDOT SUB-LOT Average Field Air Voids
$n=37574,\ \mu=0.074,\ \sigma=0.017,\ min=-0.191,\ max=0.217$
outliers: 95
Probability
0
5
10
15
20
25
30
35
0.02
0.04
0.06
0.08
0.10
0.12
0.14
TxDOT SUB-LOT Average Field Air Voids

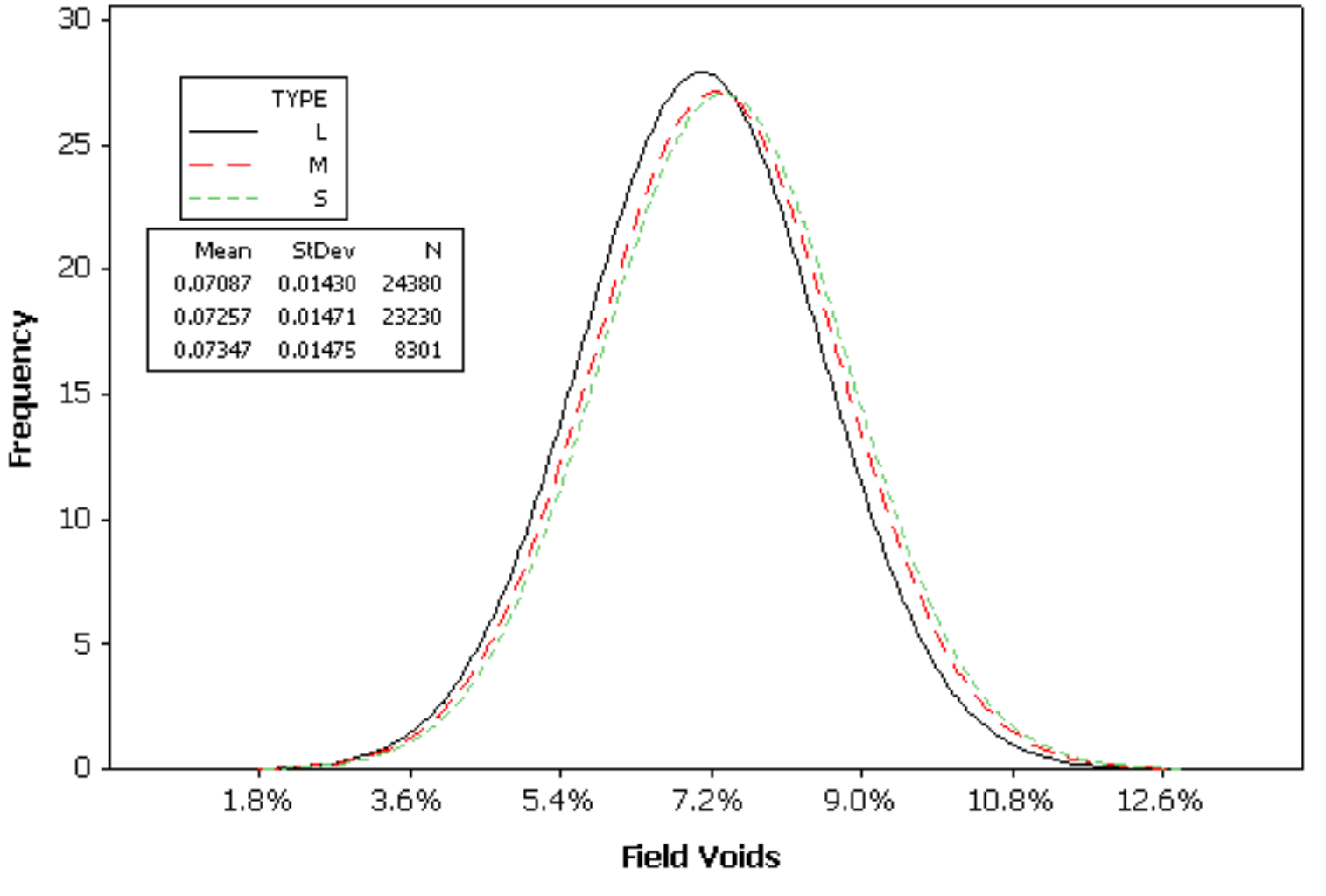
Distribution of Sub-lot Field Voids for Type C Mixes from Different Producers



Distribution of Sub-lot Field Air Voids for Type C Mixes in Different Specification Years



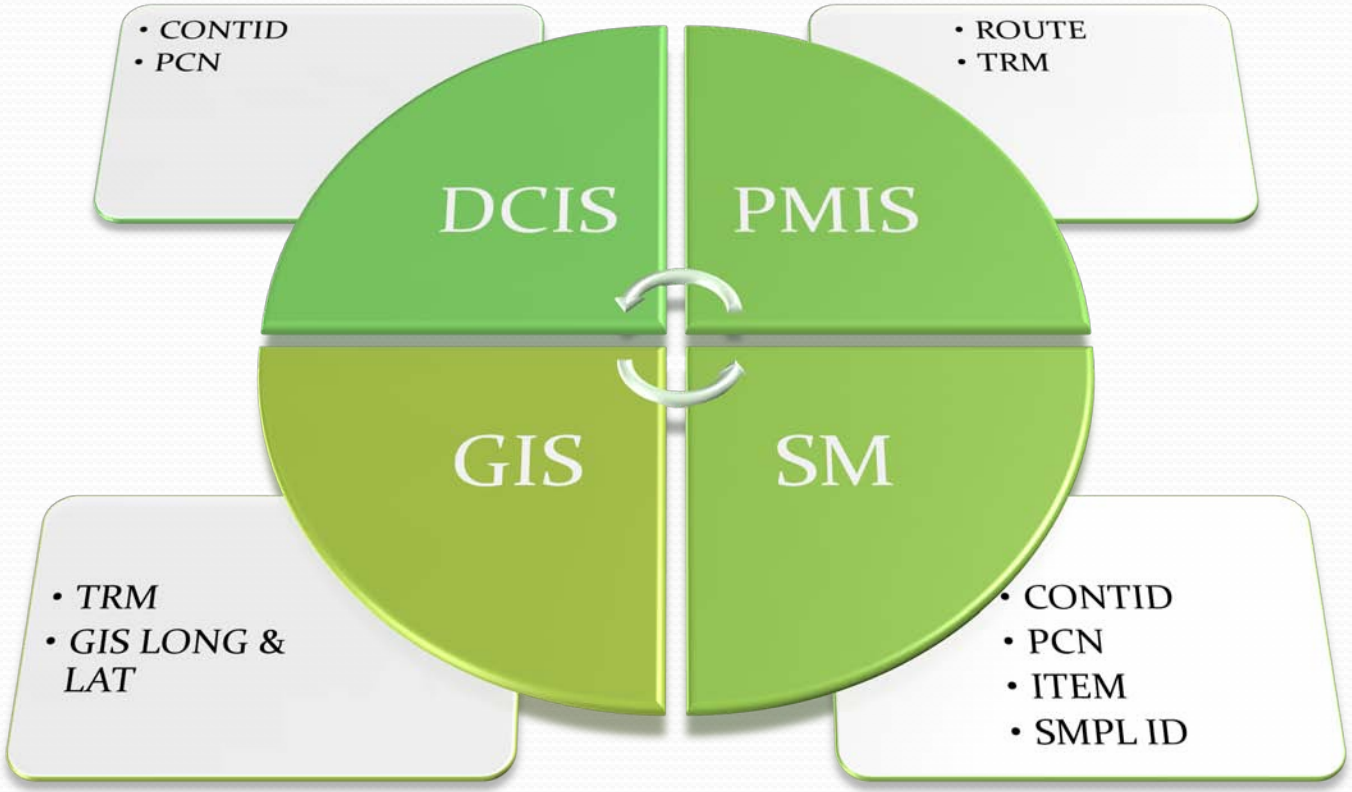
Field Voids Variation of Type C Mixes Related to Project Quantities



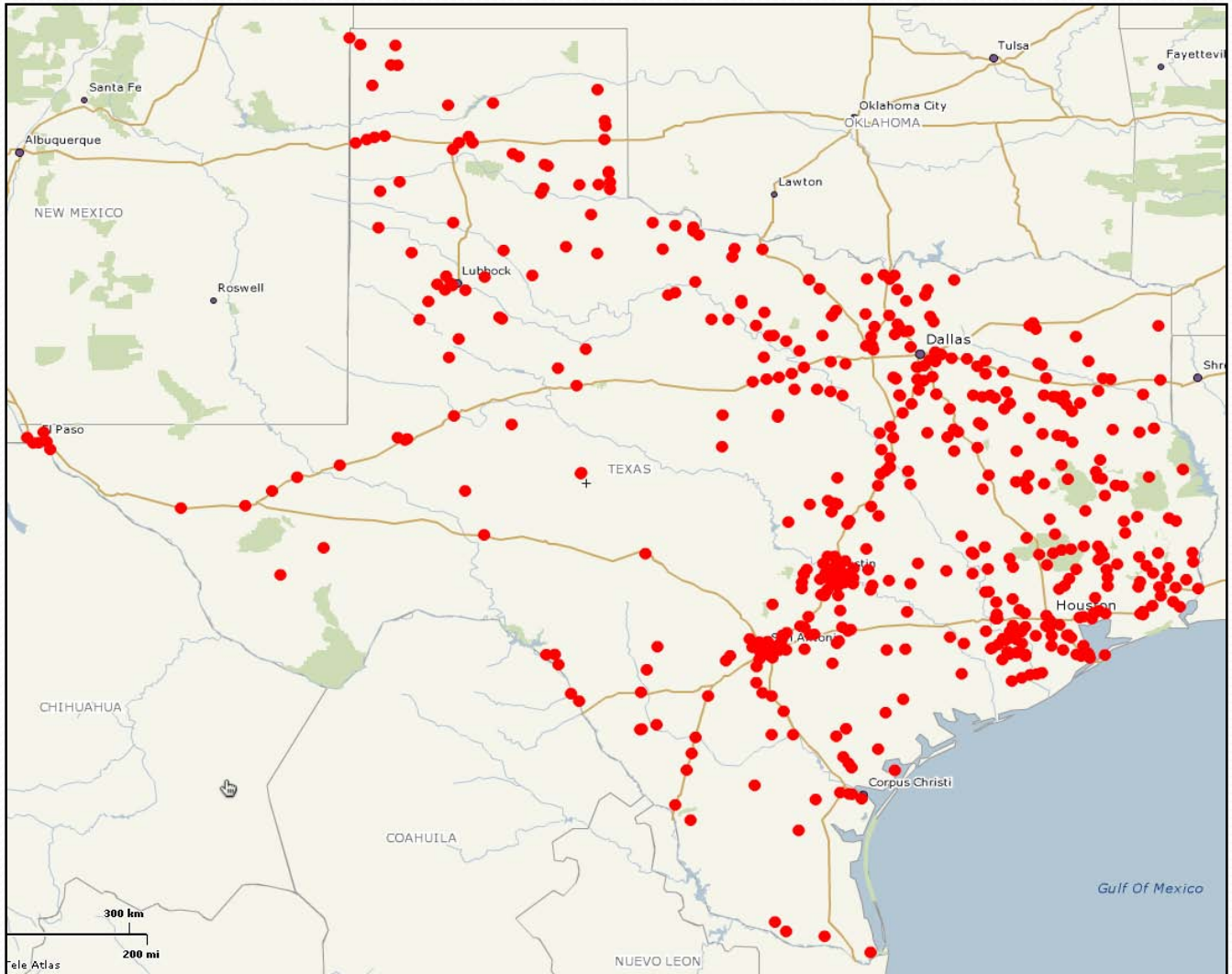
PathFinder (Network level)

- Web-based RIA
- Geographical Information System
- Originally developed to track the performance of Superpave in Texas
- Expanded to track the performance of all HMA in Texas

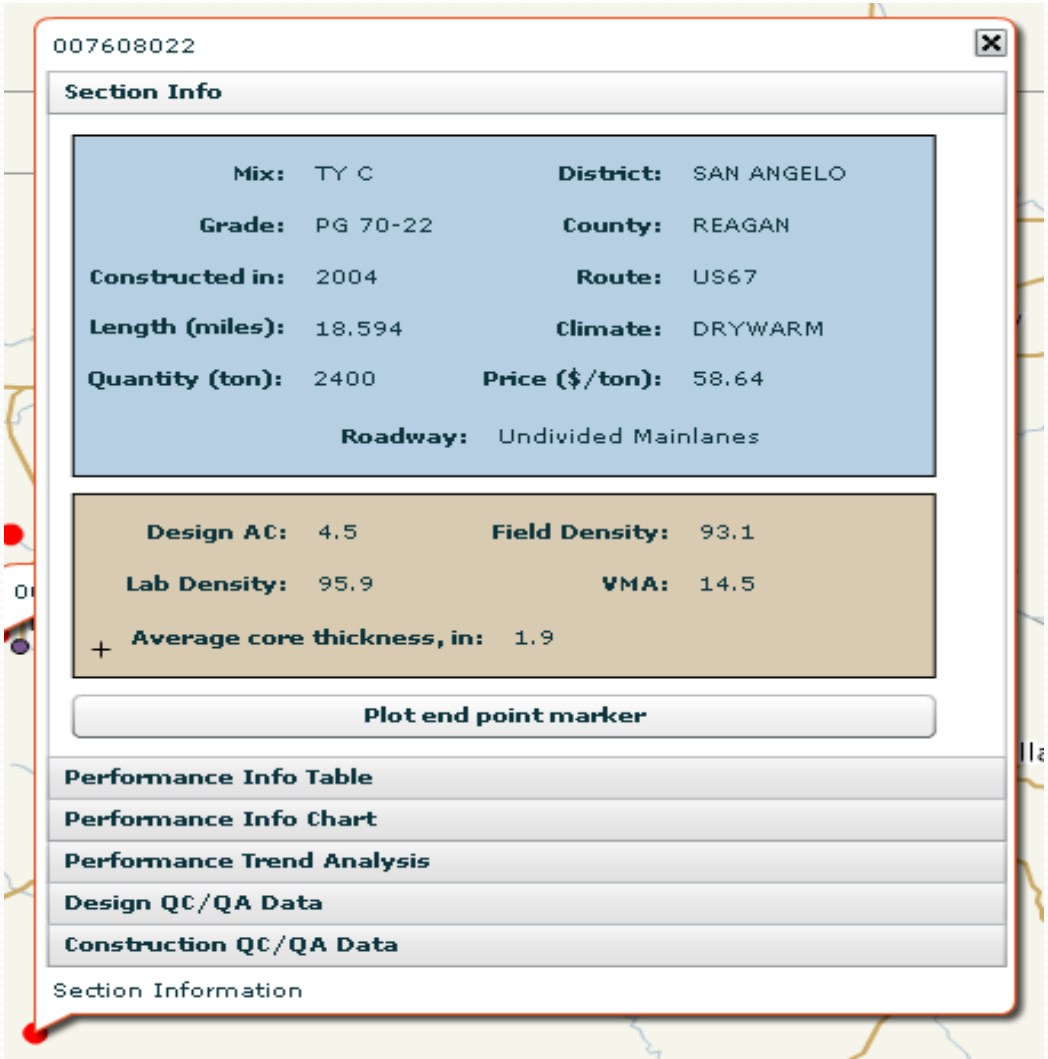
Database Integration



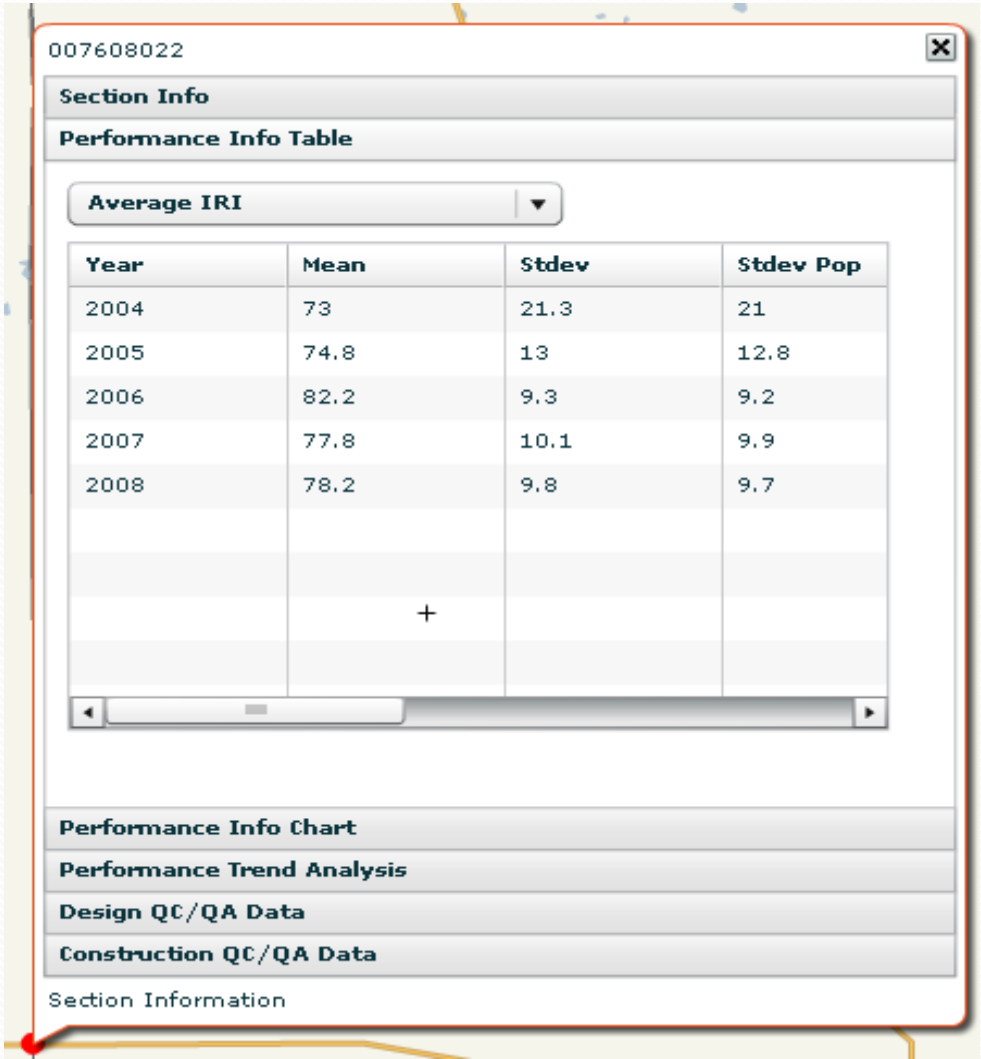
GIS Location of HMA Projects



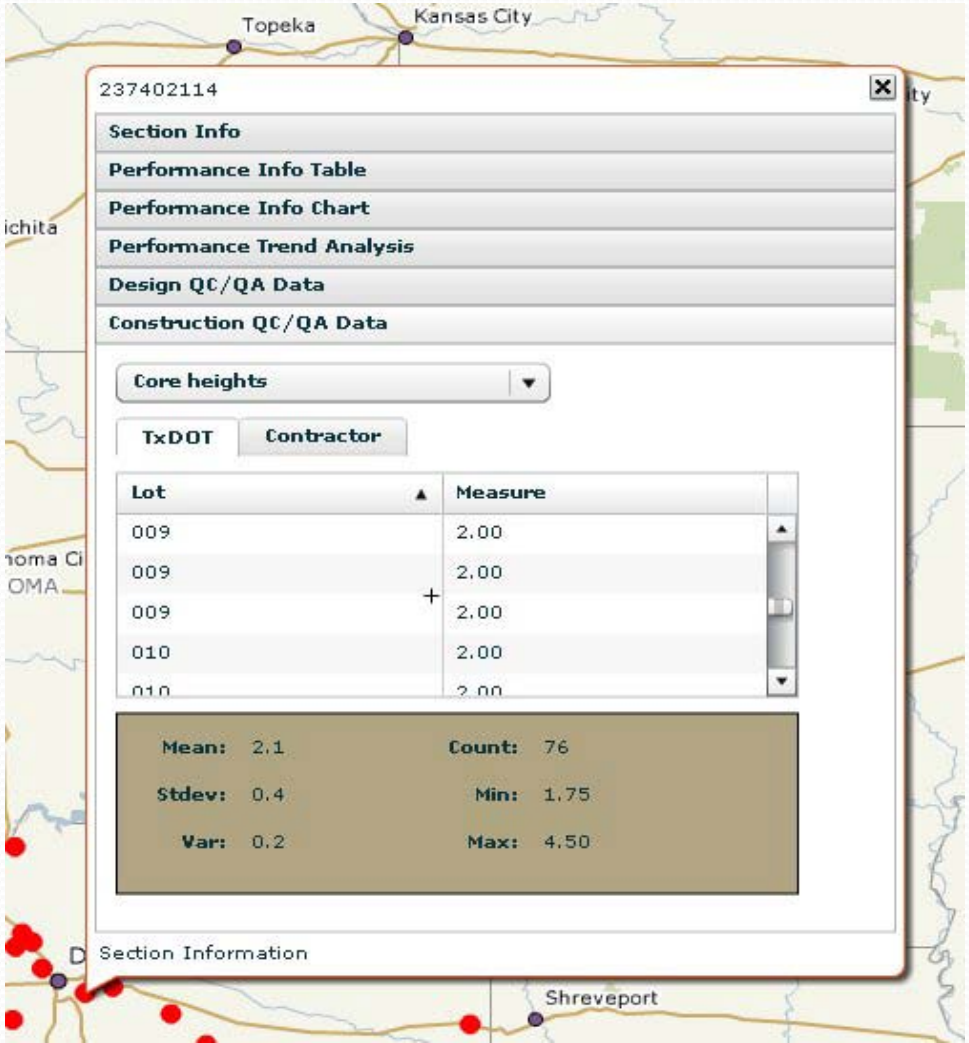
Section Info



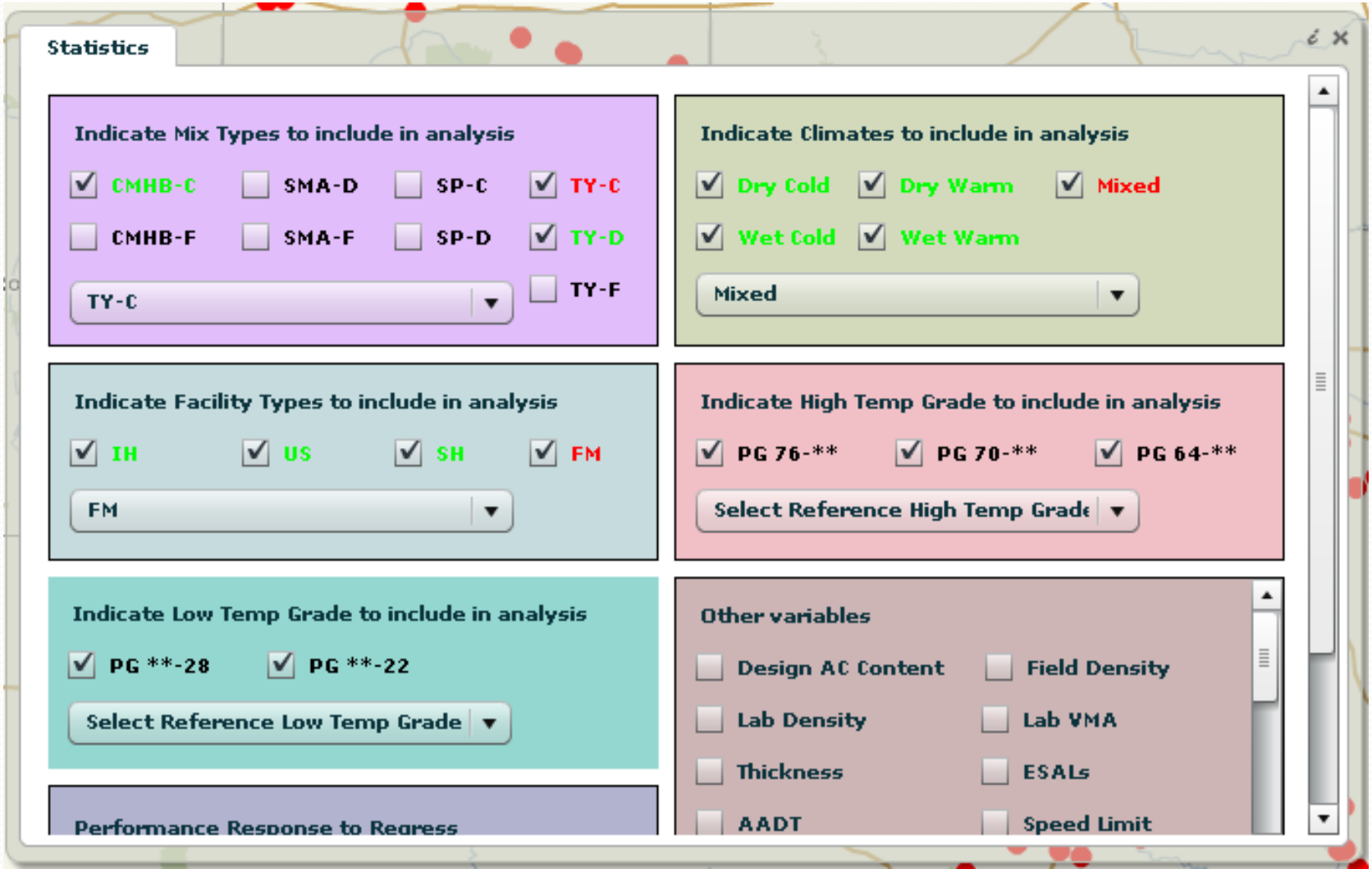
Performance Info



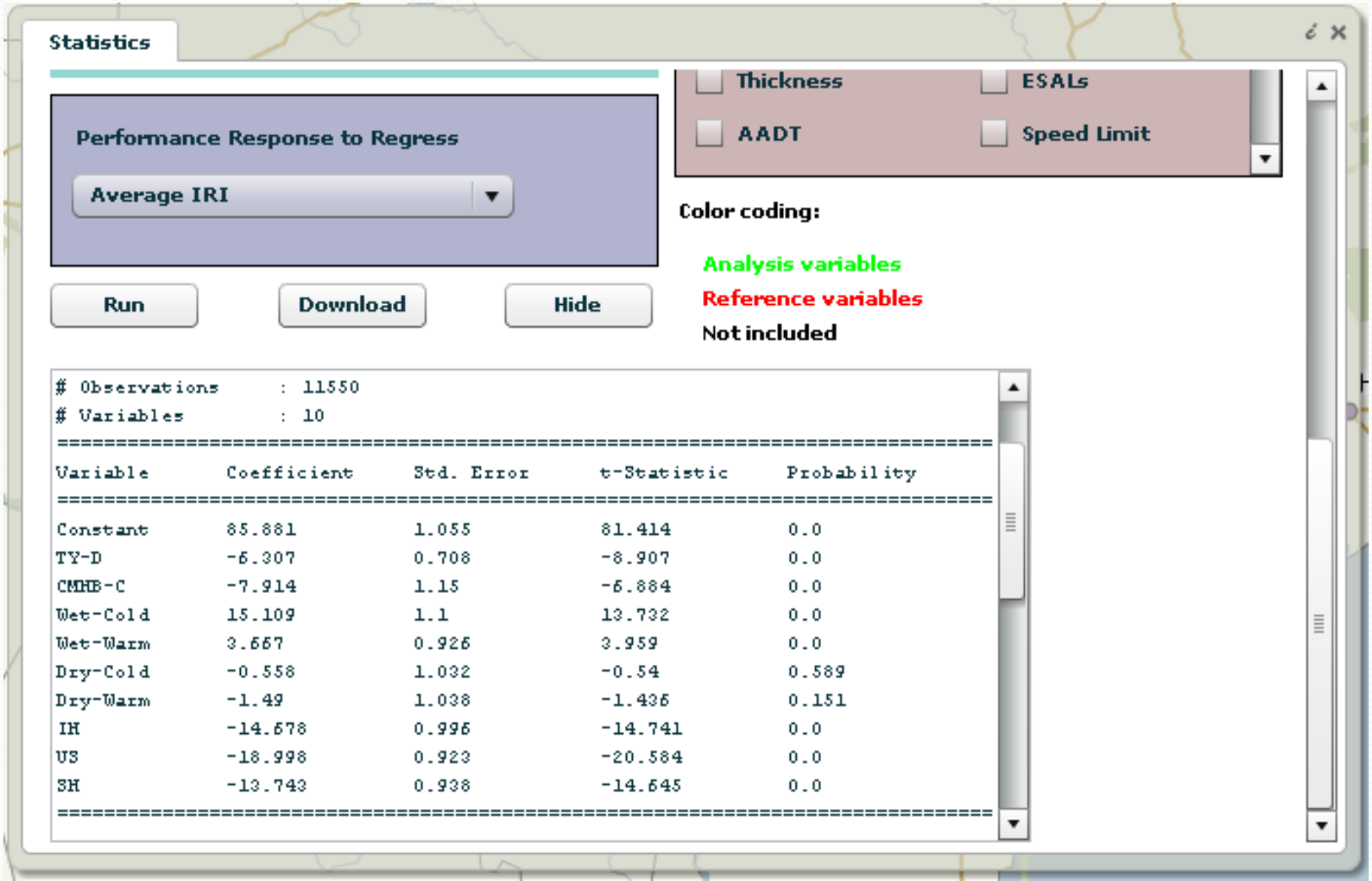
QCQA Data


Topeka
Kansas City
237402114
Section Info
Performance Info Table
Performance Info Chart
Performance Trend Analysis
Design QC/QA Data
Construction QC/QA Data
Core heights
TxDOT
Contractor
Lot
Measure
009 2.00
009 2.00
009 2.00
010 2.00
Mean: 2.1
Count: 76
Stdev: 0.4
Min: 1.75
Var: 0.2
Max: 4.50
Section Information
Shreveport

Statistical Function



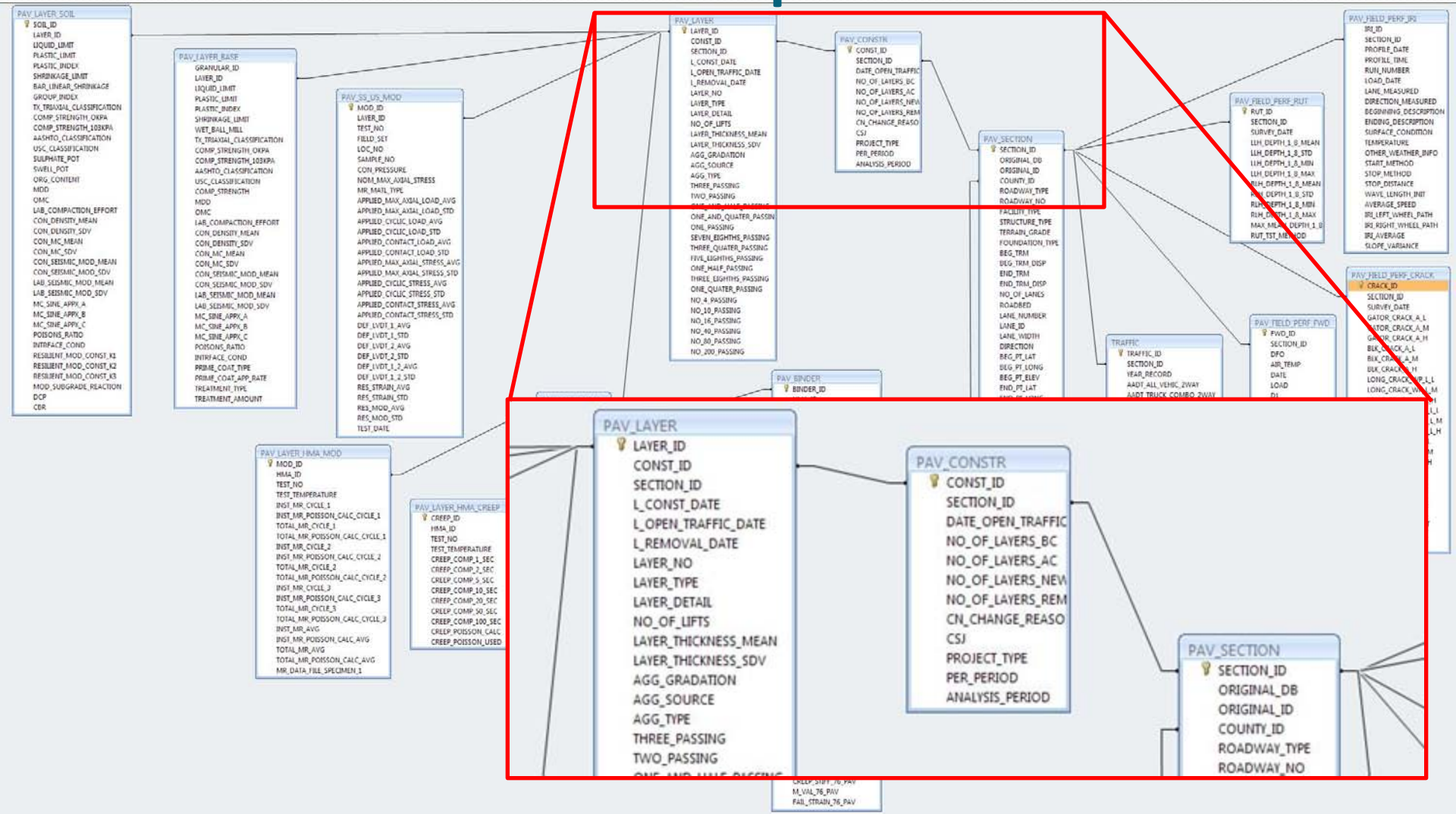
Regression Analysis



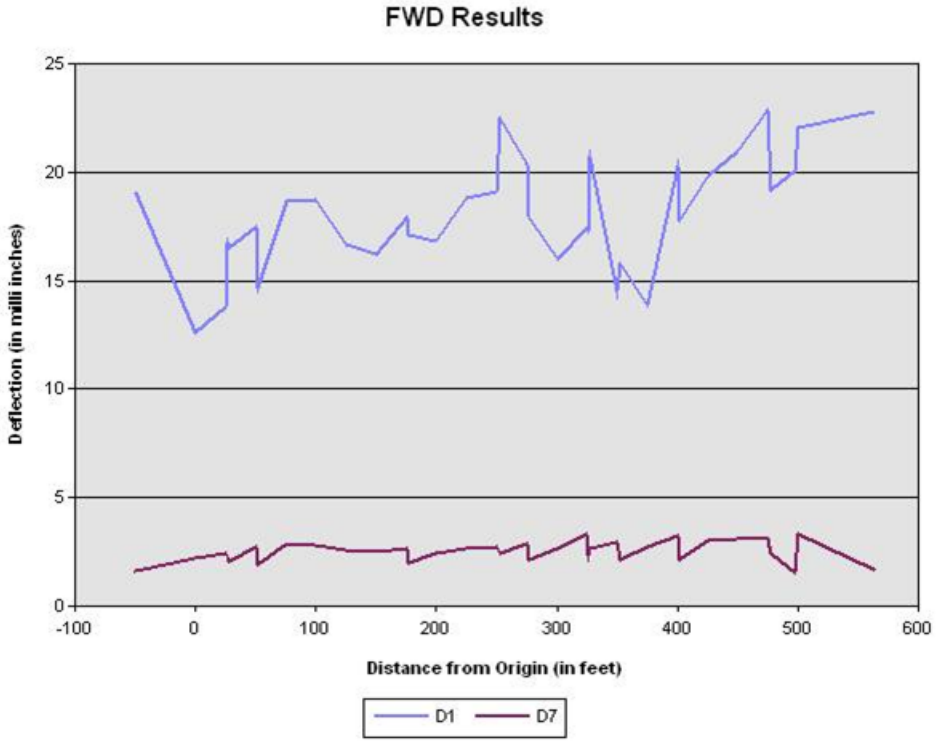
TxFlex/FPD (Project Level)

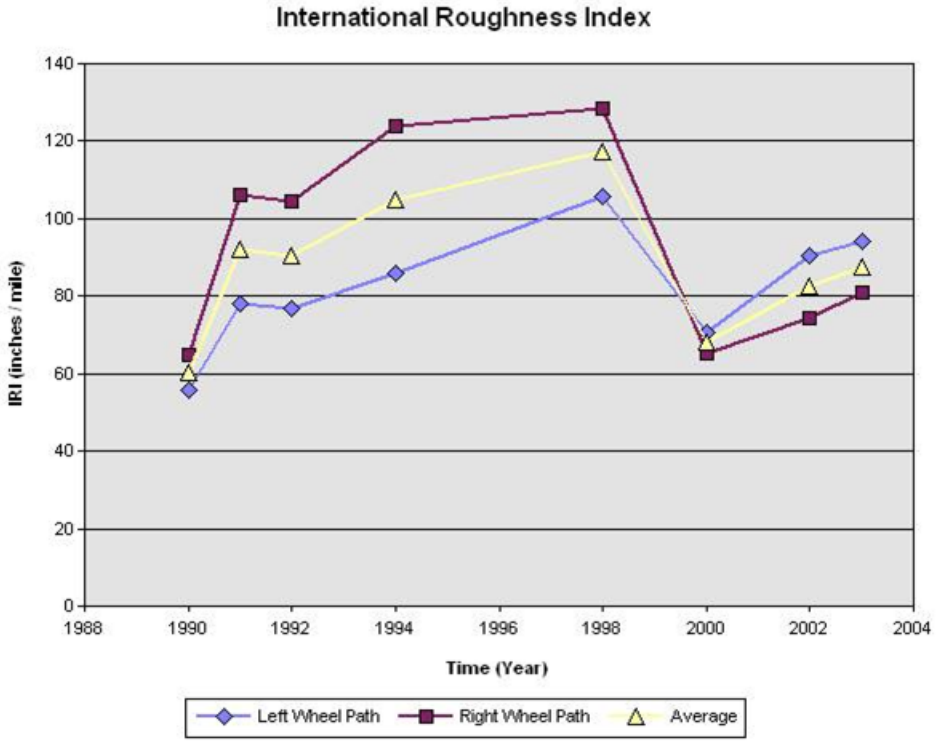
- Experimental Design
  - 3 Pavement Types
  - 5 Environmental zones
  - 2 Traffic Volumes
  - Replication
- Scope
  - 50 LTPP Sections
  - 100 Texas Sections (over 5 years)
- Data
  - Level 1 MEPDG
  - TxMEPDG

Table Relationships

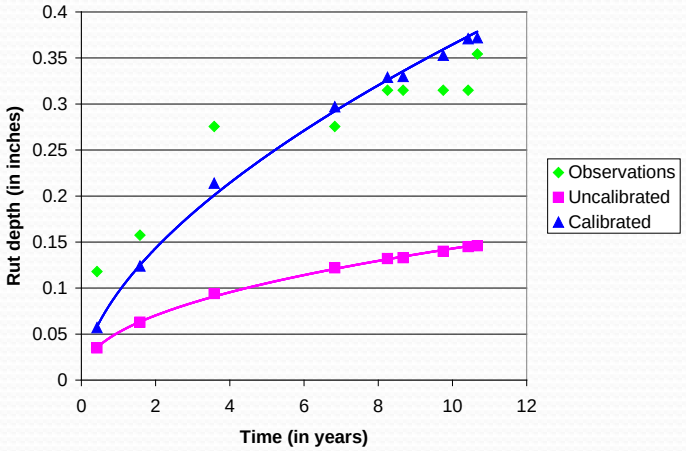


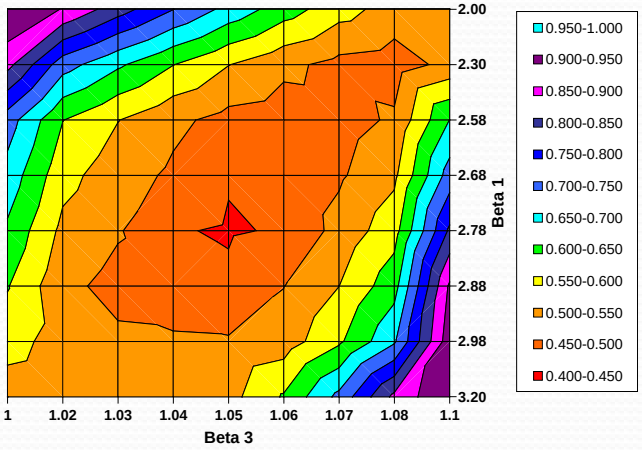
Data Visualization





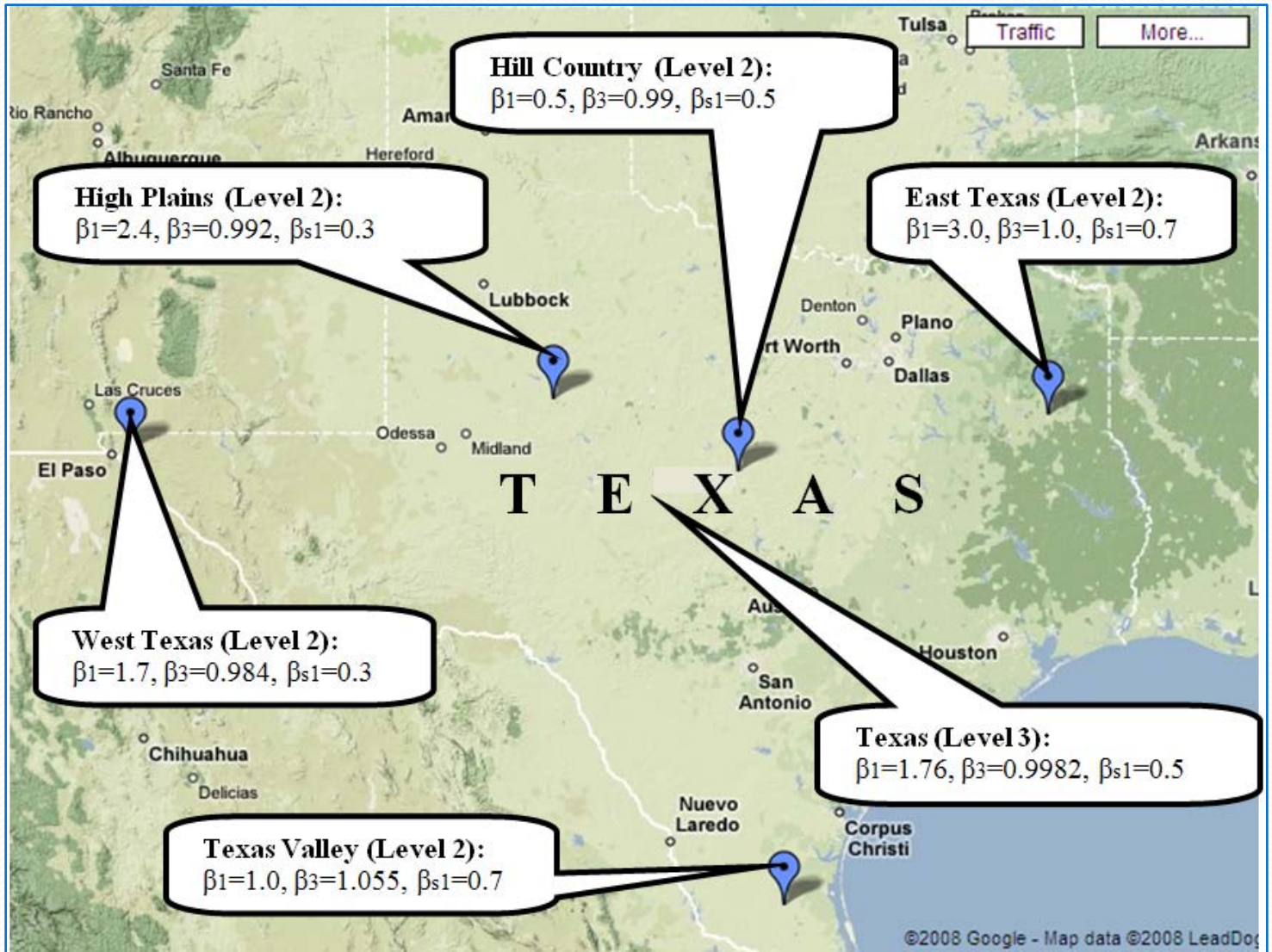
MEPDG Calibration Approach





- Initialize with all betas = 1.0
- Calculate SSE (observations vs. un-calibrated)
- Modify the betas and recalculate SSE
- Continue until SSE is minimized

Texas MEPDG calibration



The future - TxCIT

In Summary

- Growth in database applications
- Overcoming obstacles towards integration
- Sustainability is the key
- Future – GIS web-based infrastructure

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IRI – PMIS vs. TxFLEX