Development of Louisiana-Specific Highway Safety Crash Calibration Factors

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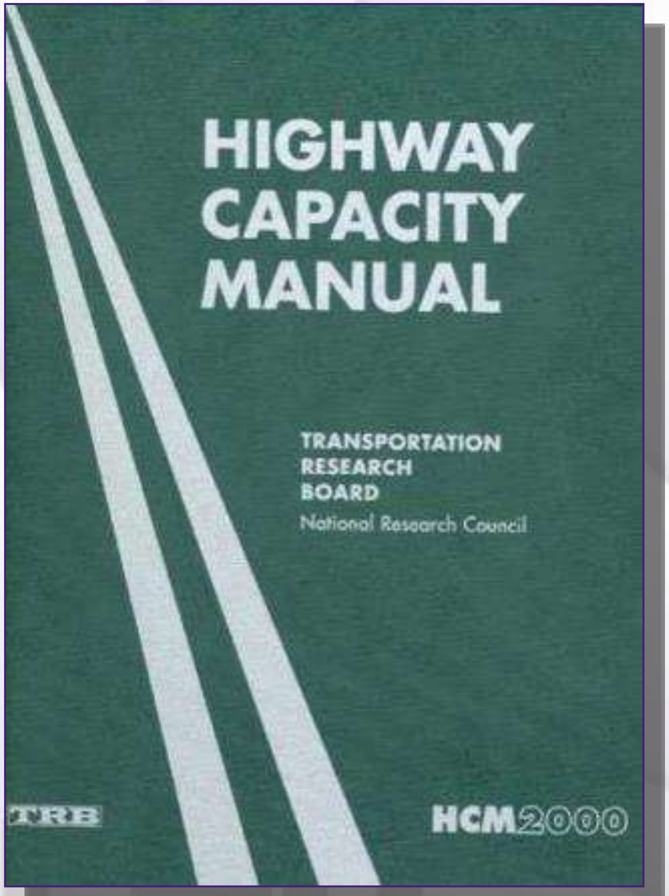
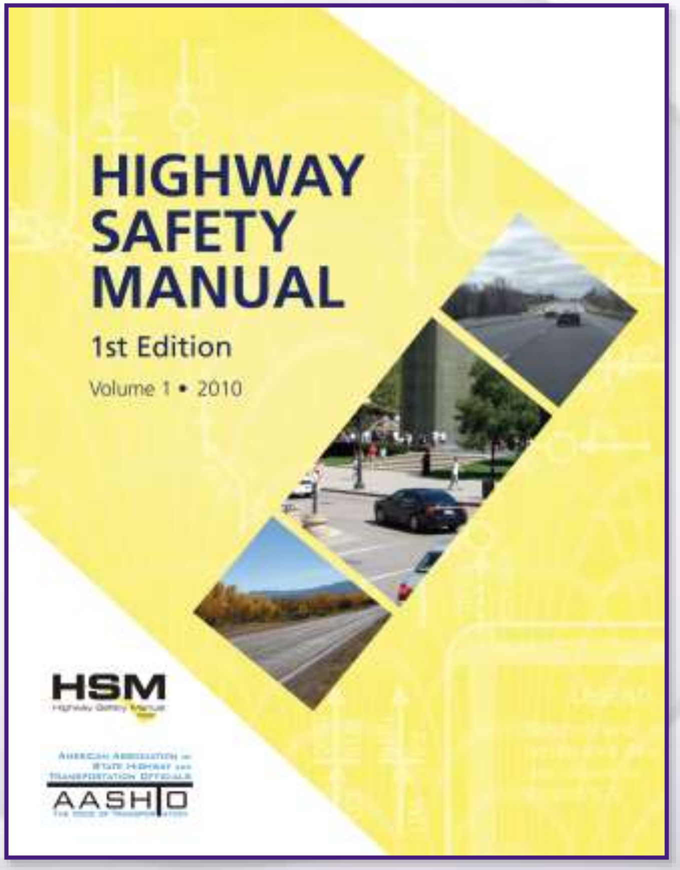
Highway Safety Manual

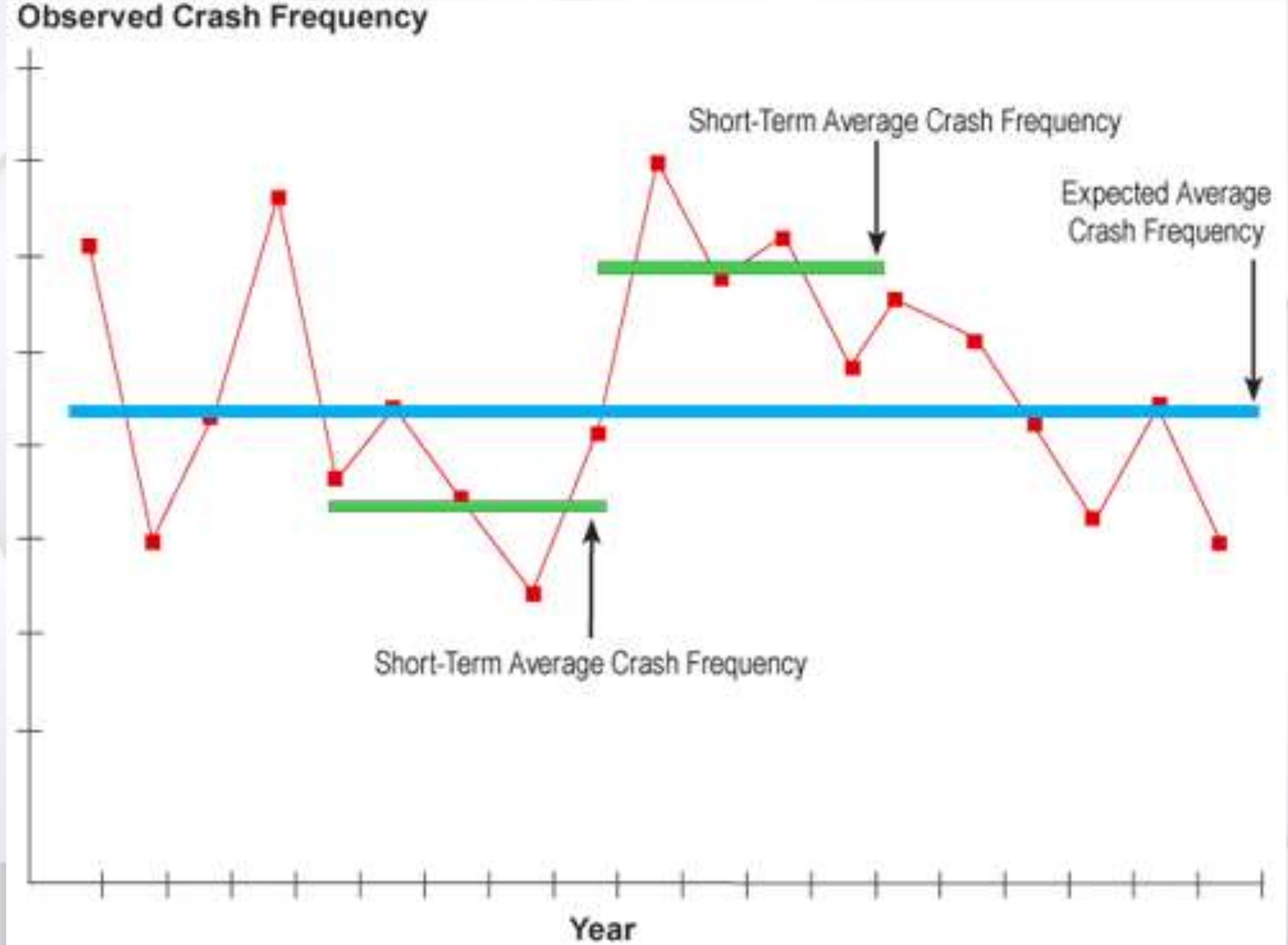
- Published by AASHTO in 2010
- Provides a quantitative method of predicting highway safety
- Can be used for a variety of purposes, most notably, to forecast crash frequency based on various traffic and roadway characteristics
- Also useful for identifying “hot spots” - the locations that are most in need of safety improvements

Highway Safety Manual



- Quantify
- Predict
- Analyze alternatives
- Inform Decision-making





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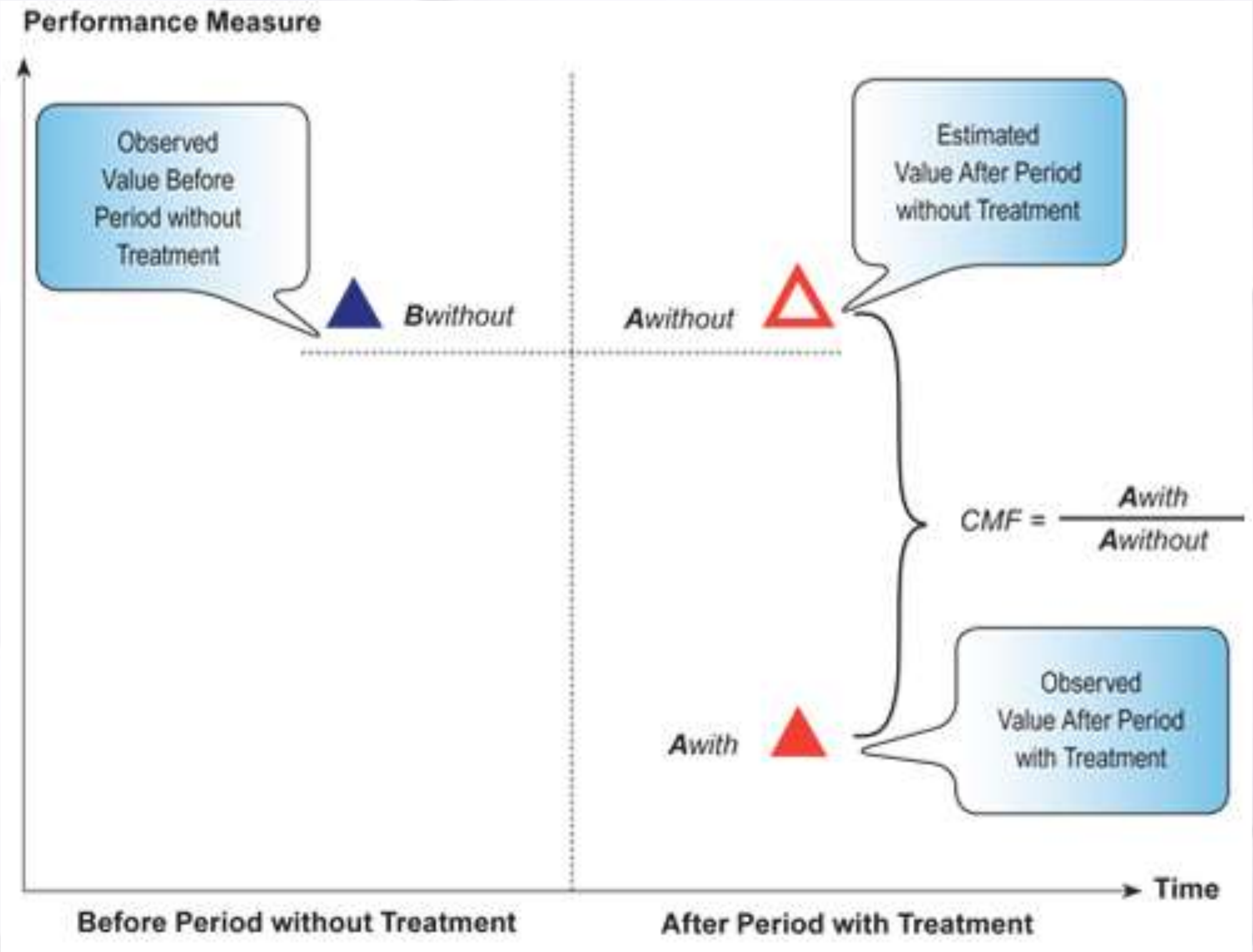
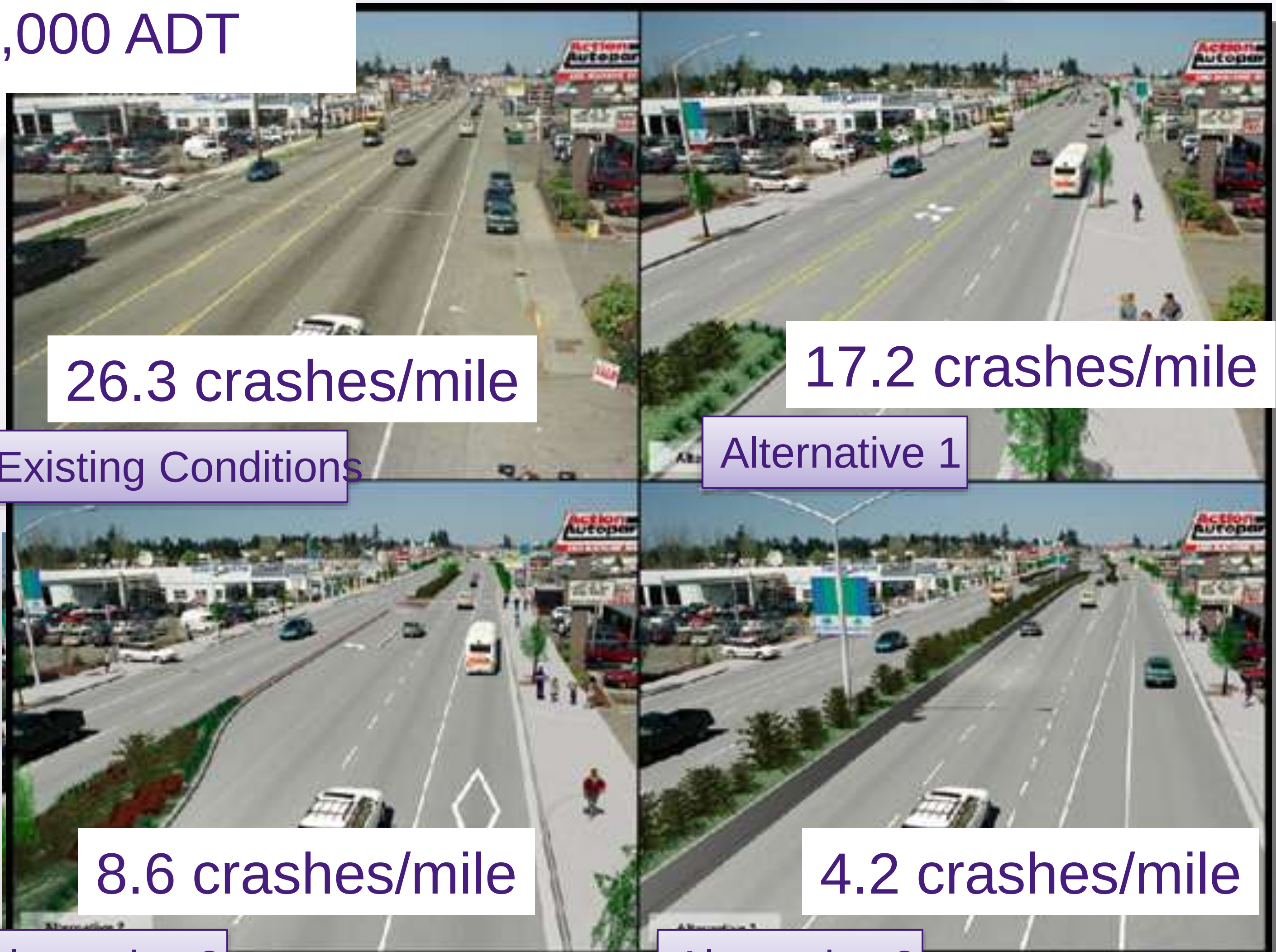
(Source: FHWA Highway Safety Improvement Program Manual)



(Source: FHWA Highway Safety Improvement Program Manual)

SUBSTANTIVE SAFETY MAY VARY
Even when meet NOMINAL Geometric Requirements

At 20,000 ADT



26.3 crashes/mile — Existing Conditions

17.2 crashes/mile — Alternative 1

8.6 crashes/mile — Alternative 2

4.2 crashes/mile — Alternative 3

Highway Safety Manual

- Part A: Introduction, Human Factors, and Fundamentals
- Part B: Roadway Safety Management Process
- **Part C: Predictive Method**
  - Rural Two-Lane Roads
  - Rural Multilane Highways
  - Urban and Suburban Arterials
- Part D: Crash Modification Factors

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Part C Predictive Method

- Safety Performance Functions (SPFs) are used to predict average crash frequency under base conditions
- Crash Modification Factors (CMFs) are selected and multiplied by the SPFs to account for local variations from base conditions
- Because SPFs and CMFs were developed using national data, they must be calibrated to better reflect local conditions.

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Analytical Steps

- **Step 1: Data Acquisition** – crashes, road geometry, site characteristics, traffic volumes, etc.
- **Step 2: Create Homogeneous Sections -** facility type, lane #'s/width, shoulder type/width, alignment, etc.
- **Step 3: Identify and Apply SPFs (safety performance functions)** – equations used to predict the expected average crash frequency under "base conditions"

Analytical Steps

- **Step 4: Apply CMFs (crash modification factors)** – numeric adjustments to account for differences from the base conditions
- **Step 5: Apply local Calibration Factor** – adjusts each SPF to local conditions

National Equations (based on AADT)

$$\frac{\text{Expected crashes with treatment}}{\text{Expected crashes w/o treatment}}$$

>1, increase; <1 decrease, 1 no effect

$$\frac{Crashes_{observed}}{Crashes_{predicted}}$$

>1, more than predicted;
<1 less than predicted,
=1 as predicted

$$N_{predicted} = SPF * (CMF_1 * CMF_2 * \ldots.) *C$$

Primary Project Tasks

- Identify facility types to be calibrated
- Select sites for calibration for each facility type (30-50 sites with 100 annual crashes, minimum)
- Obtain crash data for each facility type for calibration period (2009-2011)
- Obtain road data
- Apply Part C model to predict crash frequency for each site during calibration period
- Compute calibration factors for each facility type – observed crashes/predicted crashes

Segment Types to Calibrate

- Rural two-lane undivided
- Rural multilane undivided
- Rural multilane divided
- Urban/Suburban two-lane undivided
- Urban/Suburban three-lane with TWLTL
- Urban/Suburban four-lane undivided
- Urban/Suburban four-lane divided
- Urban/Suburban five-lane with TWLTL

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HSM Required Data Elements

- Segment length
- AADT
- Horizontal curve data (rural two-lane)
- Lane width
- Shoulder type & width (rural)
- Presence of lighting (rural multilane)
- Posted speed (urban/suburban)
- Driveway density (and type)
- Among others

Data Limitations

- Coding errors in road data and crash reporting (intersection vs. non-intersection)
- HSM required data elements are not always available in the DOTD statewide database
- Used Google Earth to collect information on lighting, posted speed, driveways, fixed objects, etc. segment-by-segment (time-consuming)
- DOTD database references locations by control section and log-mile. These must be converted by individual segment latitude and longitude to correspond to Google Earth

Example Equations for Rural Two Lane Road

- $N_{spf\ rs} = AADT * L * 365 * 10^{-6} * e^{(-0.312)}$
  - $N_{spf\ rs}$: predicted total crash frequency under base conditions
  - AADT: average annual daily traffic volume
  - L: length of segment in miles
- $CMF_{1r} = (CMF_{ra} - 1.0) * p_{ra} + 1.0$ (Lane Width)
  - CMF_{1r}: CMF for lane width on total crashes
  - CMF_{ra}: CMF for lane width on related crashes
  - p_{ra}: proportion of total crashes constituted by related crashes

Initial Results

- The first set of calibration factors that were calculated based on applying the HSM "by the book" to the extent possible with available data

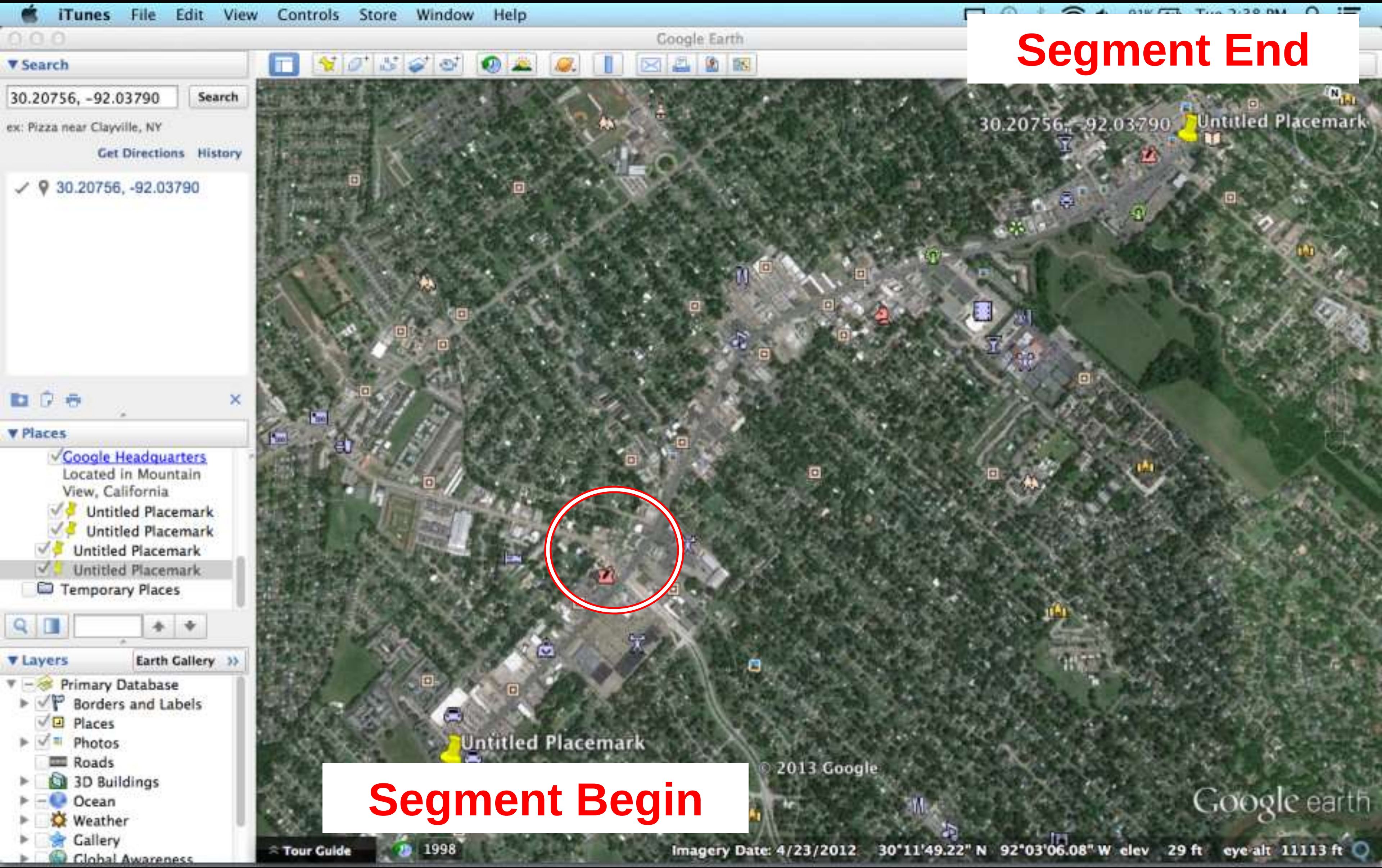
Facility Type	Initial	
	Calibration Factor (C)	# of sites
Rural Two Lane	**2.71**	50
Rural Multilane Undivided	**1.43**	50
Rural Multilane Divided	**2.88**	50
Urban Two Lane	**1.54**	50
Urban Three Lane TWLTL	**4.53**	32
Urban Four Lane Undivided	**4.08**	50
Urban Four Lane Divided	**6.04**	50
Urban Five Lane TWLTL	**0.38**	50

These numbers were large b/c of large amounts of missing data

Results (Revised)

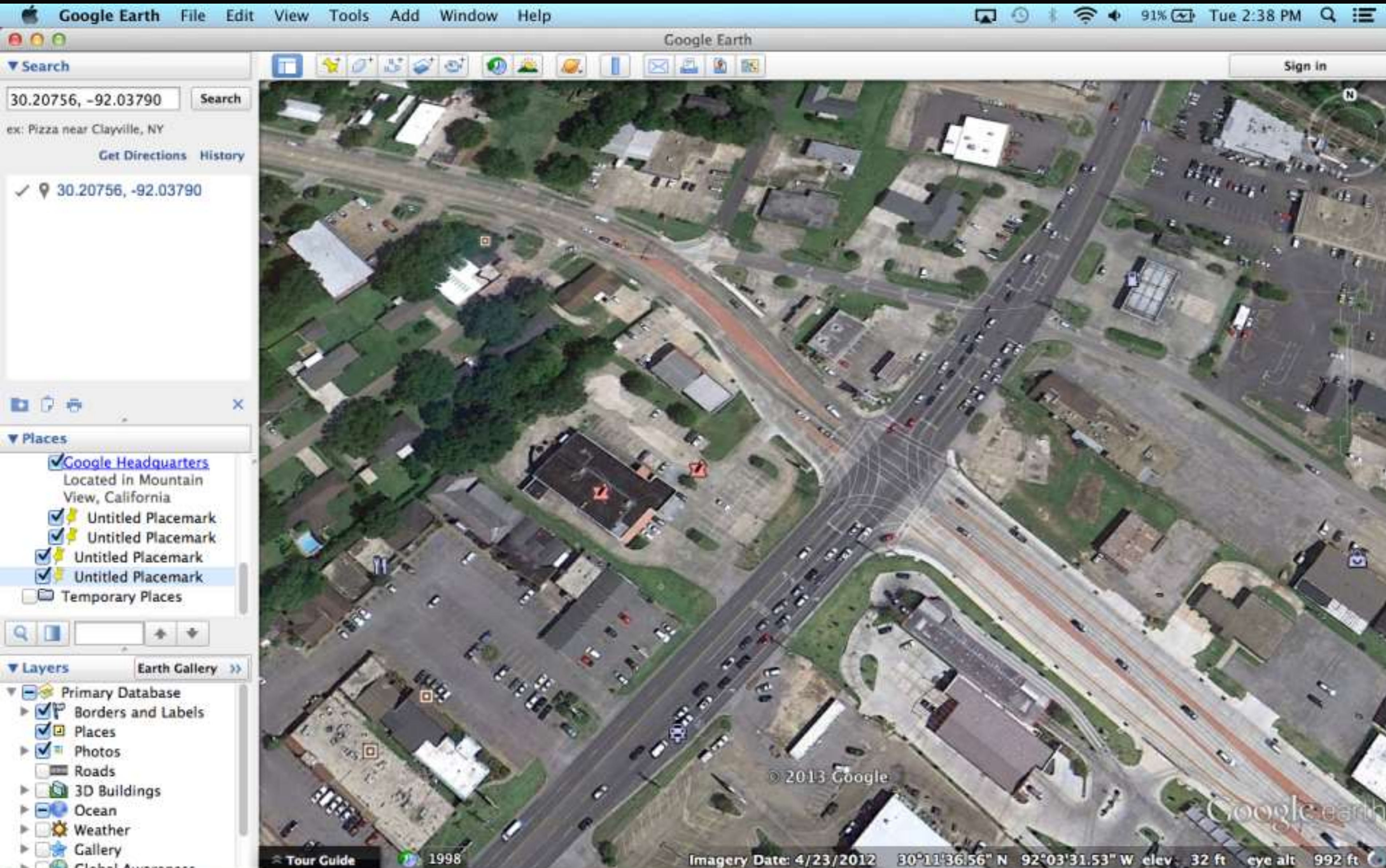
- In Iteration 2, crashes within 250’ of intersections and those on curves were removed from the data set

Facility Type	Initial		Iteration 2		Change
	C	# of sites	C	# of sites	
Rural Two Lane	2.71	50	**1.11**	100	-59.0%
Rural Multilane Undivided	1.43	50	**0.48**	150	-66.4%
Rural Multilane Divided	2.88	50	**1.68**	50	-41.7%
Urban Two Lane	1.54	50	**1.43**	50	-7.1%
Urban Three Lane TWLTL	4.53	32	**0.14**	32	-96.9%
Urban Four Lane Undivided	4.08	50	**1.35**	50	-66.9%
Urban Four Lane Divided	6.04	50	**2.77**	50	-54.1%
Urban Five Lane TWLTL	0.38	50	**0.02**	226	-94.7%



Segment End

Segment Begin



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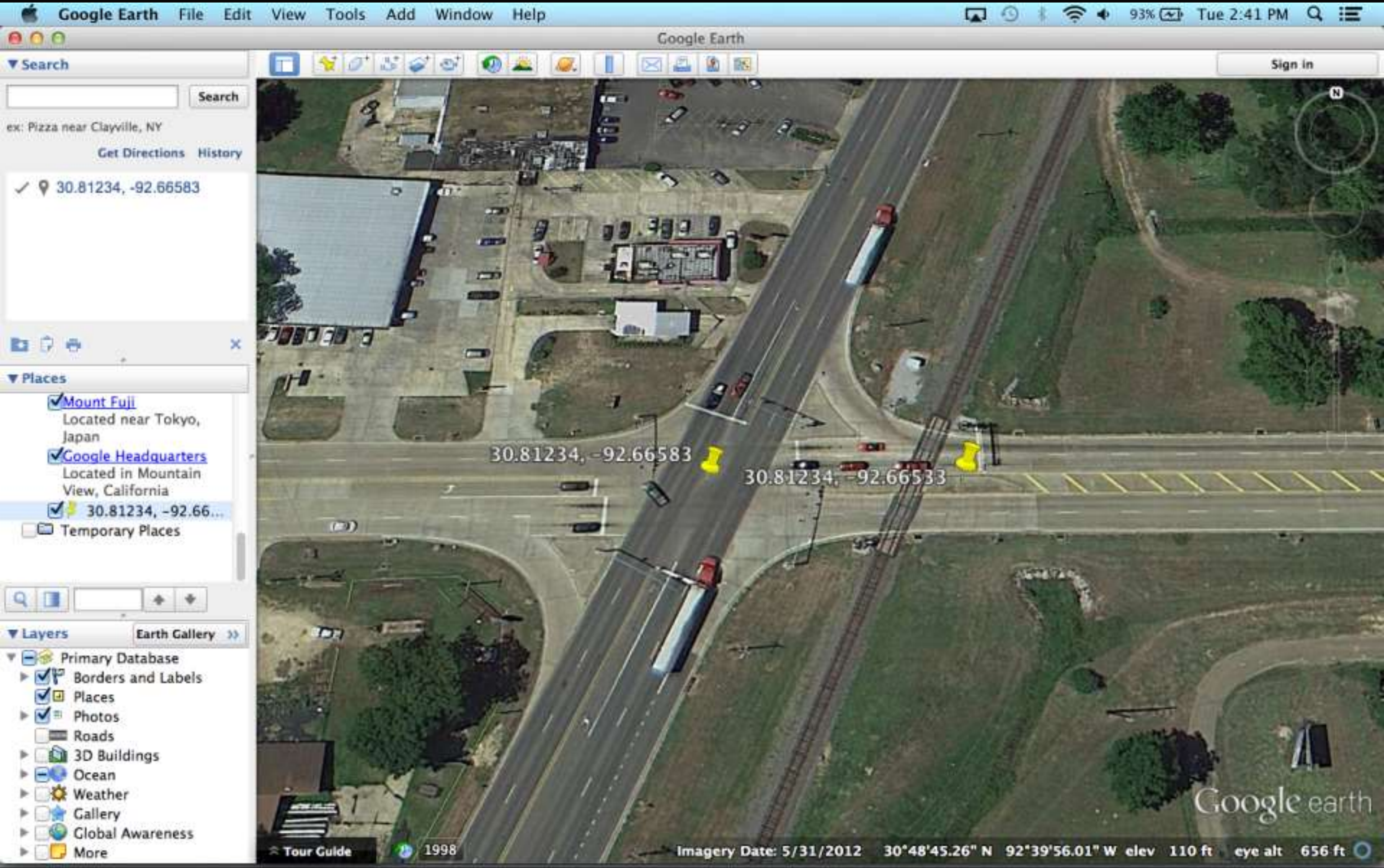

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Results (re-Revised)

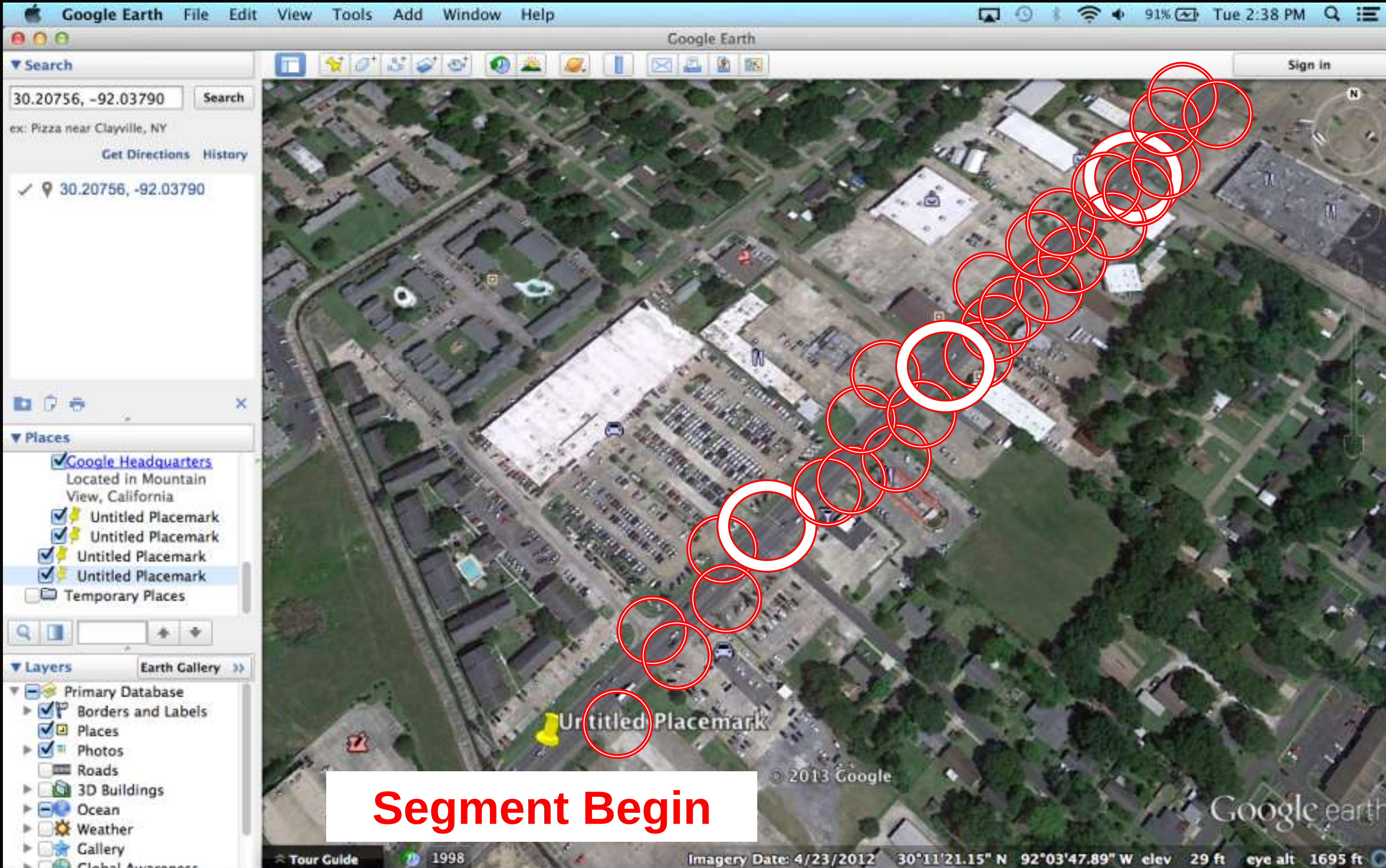
- To examine the effect of sampling the entire statewide data-base for comparison:

Facility Type	Iteration 2		Iteration 3		Change
	C	# of sites	C	# of sites	I2 -> I3
Rural Two Lane	**1.11**	100	**1.16**	6,188	-57.2%
Rural Multilane Undivided	**0.48**	150	**0.52**	219	-63.6%
Rural Multilane Divided	**1.68**	50	**1.48**	521	-48.6%
Urban Two Lane	**1.43**	50	**2.38**	1,403	54.5%
Urban Three Lane TWLTL	**0.14**	32	**0.14**	32	-96.9%
Urban Four Lane Undivided	**1.35**	50	**1.37**	469	-66.4%
Urban Four Lane Divided	**2.77**	50	**2.87**	553	-52.5%
Urban Five Lane TWLTL	**0.02**	226	**0.02**	226	-94.7%

Final Results

- For comparison, the fourth iteration includes the additional data collected using Google Earth with crashes removed within 50', 150', and 250' of an intersection:

	Fourth Iteration					
	50' Removed		150' Removed		250' Removed	
Facility Type	Calibration Factor	Number of Segments	Calibration Factor	Number of Segments	Calibration Factor	Number of Segments
Rural Two Lane	1.18	99	1.04	99	0.97	99
Rural Multilane Undivided	1.04	80	0.68	80	0.49	80
Rural Multilane Divided	3.27	50	2.39	50	1.73	50
Urban Two Lane	3.23	30	2.00	30	1.48	30
Urban Three Lane with TWLTL	0.25	32	0.14	32	0.03	32
Urban Four Lane Undivided	3.72	49	1.70	49	1.03	49
Urban Four Lane Divided	6.20	49	3.73	49	2.54	49
Urban Five Lane with TWLTL	0.05	145	0.04	145	0.02	145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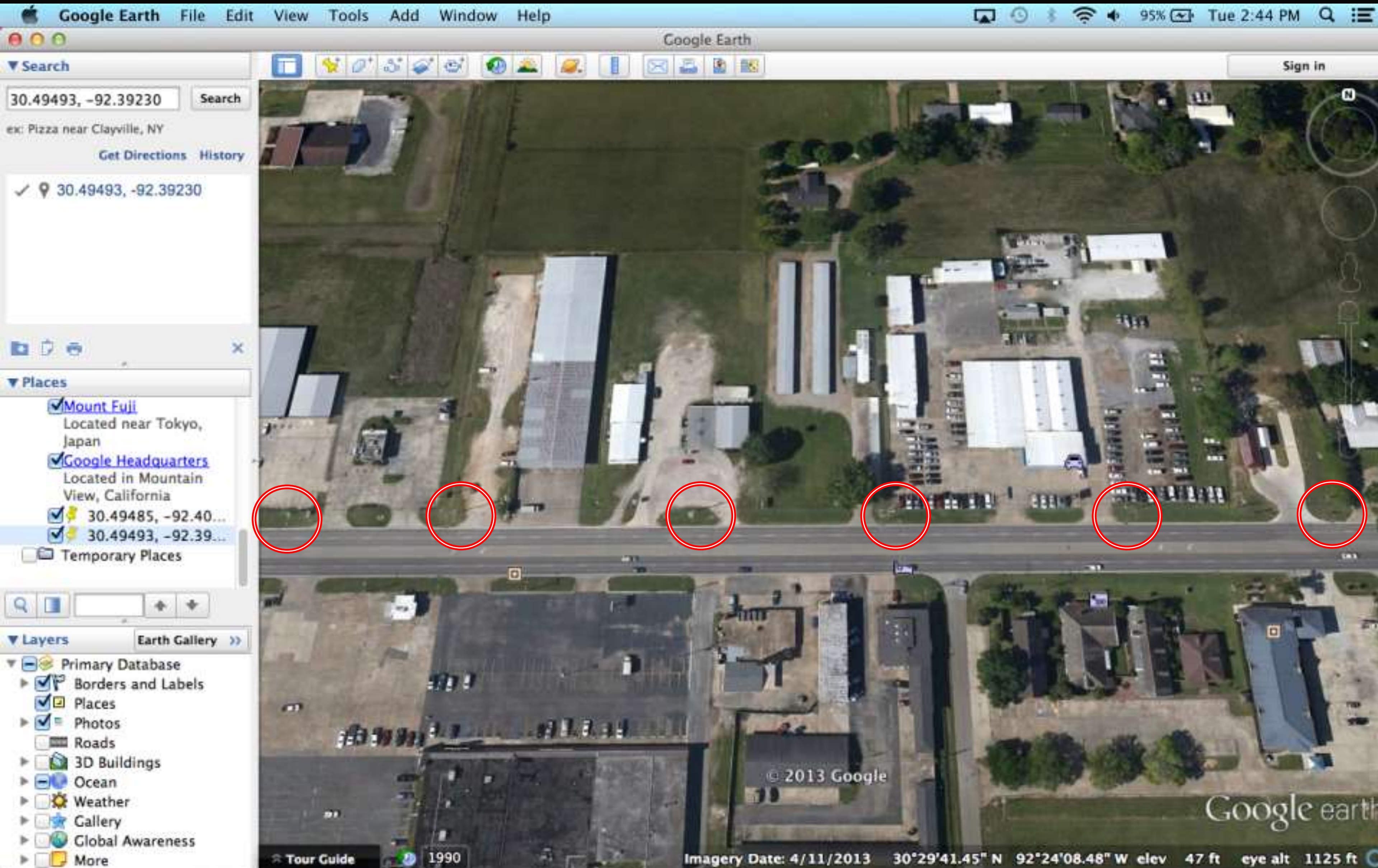
Segment Begin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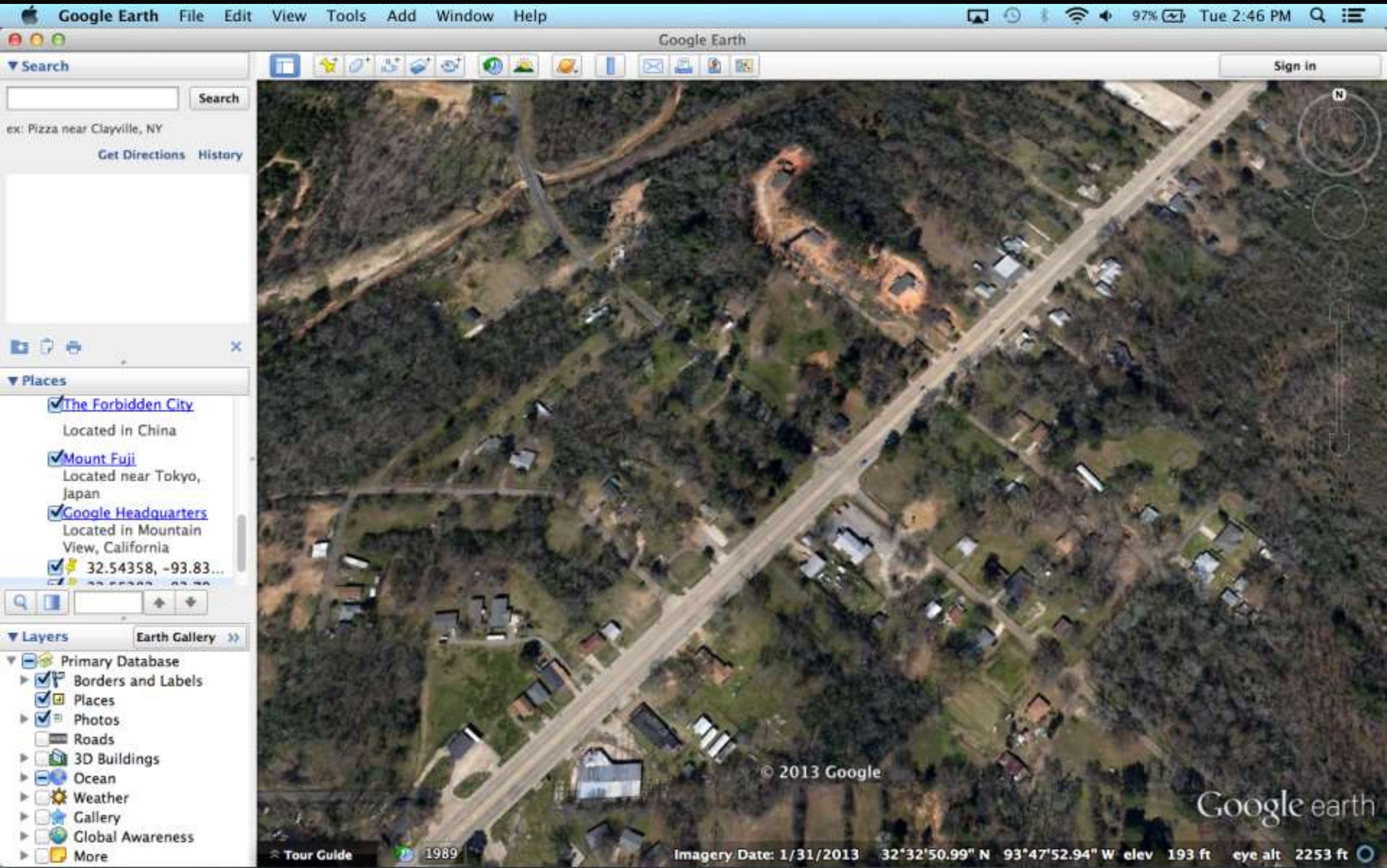
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Lat, Long From	Lat, Long To	Driveways: Major = 50+ parking spots							Lighting	Speed Limit	On-Street	Roadside Fixed Objects: 4" diameter	
		Major Commercial	Minor Commercial	Major Industrial/Institutional	Minor Industrial/Institutional	Major Residential	Minor Residential	Other	Yes/No	≤ 30? Y/N	Parking? Y/N	Distance from edge of lane (ft.)	Spacing (mi)
32.44263, -93.93481	32.44242, -93.92421			3		2	1		n	y	n	15	0.03
30.81239, -92.65742	30.81239, -92.65154					3			n	y	n		
30.81234, -92.66533	30.81237, -92.65978					2	3		n	y	n		
32.147, -91.70569	32.15361, -91.70936	2	1	1			8		n	y	n		
32.62635, -93.25008	32.62764, -93.24802	1							n	y	n	20	0.02
32.54358, -93.83540	32.55282, -93.79237	1	2	7	2	4	54		y	y	n	15	0.02
30.29165, -89.71979	30.29373, -89.72055	3				1			y	y	n	25	0.01
29.90758, -89.98795	29.90604, -89.98644								y	y	n	10	0.03
29.90182, -89.97864	29.90408, -89.97879								y	y	n		
30.477, -90.45714	30.48237, -90.45694	3	4						n	y	n	5	0.02
30.26868, -91.24440	30.26801, -91.24527					2	2		y	y	n	10	0.03
30.26482, -91.24939	30.26241, -91.25252		2	2	1		3		y	y	n	15	0.04
32.162, -91.71897	32.1646, -91.72084		1	1		1			y	y	n	10	0.03
31.74991, -93.11228	31.75054, -93.11074								y	y	n	20	0.05
30.0735, -90.50114	30.07769, -90.52770	6	5	4	10		10		y	y	n	40	0.03
30.87047, -93.28487	30.88078, -93.28495	3	19	1	3	3	9		n	y	n	10	0.02
30.49485, -92.40623	30.49493, -92.39230	4	8	1	8	2	7		n	y	n	15	0.03
30.72637, -90.52746	30.72659, -90.51773	5	16		1	1	1		n	y	n	30	0.03
32.4485, -93.78106	32.47031, -93.77997	4	16			13	28		y	y	n	10	0.03
30.28411, -89.78014	30.2859, -89.77945	1	2						y	y	n	10	0.02
30.43224, -91.07519	30.43682, -91.05719	1	5	2	1	8	16		n	y	n	10	0.03
31.56184, -91.42228	31.56461, -91.42516								y	y	n	5	shoulder
31.56461, -91.42516	31.56525, -91.42584								y	y	n	15	0.02
32.54839, -93.72367	32.5553, -93.72572		2			2	15		y	y	n	5	0.03
32.52578, -93.71857	32.54839, -93.72367	4	16	1	1		18		n	y	n	5	0.02
32.45054, -93.72198	32.4536, -93.72206	1	3	1					y	y	n	10	0.03
30.17605, -93.17987	30.17925, -93.17988								y	y	n	15	0.04
32.57578, -93.71425	32.58302, -93.71435				3		3		y	y	n	20	0.04
32.54297, -93.70855	32.54859, -93.70932	4	3		2				n	y	n	5	0.03
30.42901, -91.10785	30.43095, -91.10934	1	2		1				n	y	n	10	0.01

Methodological Issues

- Data outliers
- The HSM method permits (purposefully or inadvertently) the ability to significantly change (lower or higher) calibration factors
- This can occur by:
  - selecting different data sets of 50
  - Including/excluding certain data elements

Next Steps

- Use calibration factors to predict 2012 crashes and see how well they predicted them
- In the future others will compare these results with those obtained by developing state-specific SPFs (by others, if available)
- Research - compare the effects of sample selection and data inclusion/exclusion

Next Steps

- Research – Examine the effect of removing “intersection crashes” differently urban to rural (or does that bias the results?)
- Research - compare Louisiana results to those of other states

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Conclusions

- Good data is vital
- Calculations are relatively straightforward and can be done with a spreadsheet
- However, actual process was considerably more difficult and time consuming than expected
- More conclusions forthcoming once all available data is included and analyses are complete

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How Do We Evaluate Safety?

- We use safety that we can see
- We count and classify crashes
  - Lots of Crashes = “Not Safe” or “Bad”
    - How bad? Bad compared to what?
    - Where is it bad? When is it bad?
  - No or Few Crashes = “Safe” or “Good”
    - How good? Good compared to what?
    - Where is it good? When is it Good?

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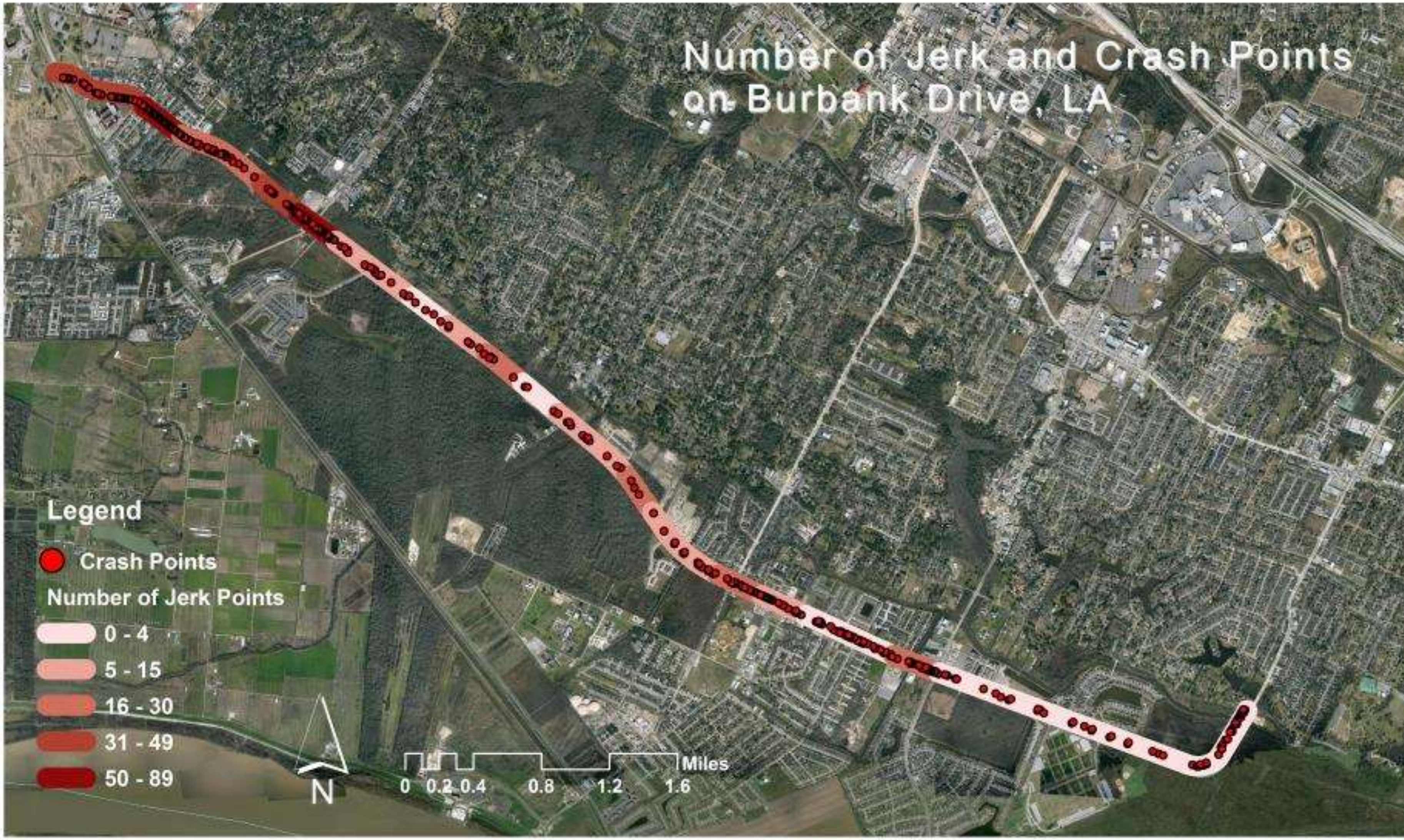
Crash Quantification

- **Frequency**
  - Numeric count, % of total, by type, vehicle, etc.
- **Rate**
  - as a function of exposure (100MVMT)
- **Rate/Frequency**
- **Severity**
  - Fatal, Injury A/B/C, PDO
- **Cluster/Concentration**
  - Intersection, access points, road features

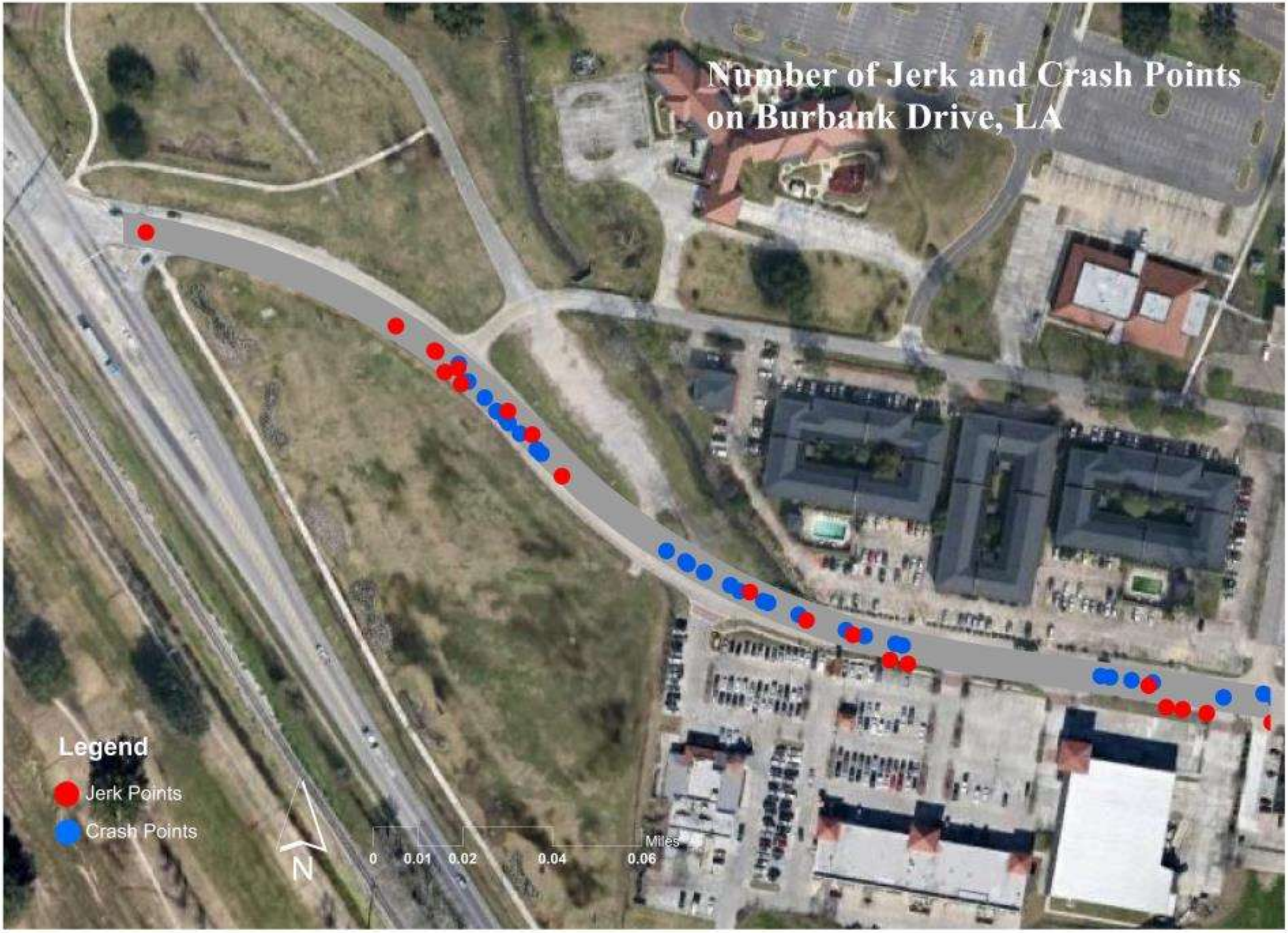
What about the “safety” we don’t see?

- What data don’t we collect?
  - Aggressive driving
  - Near misses/near collisions
  - The “almost crashes”

- How many near misses happen before we have one crash? One severe crash? One fatal crash?


Number of Jerk and Crash Points
on Burbank Drive, LA
Legend
Crash Points
Number of Jerk Points
0 - 4
5 - 15
16 - 30
31 - 49
50 - 89
N
Miles
0 0.2 0.4 0.8 1.2 1.6


"Location of Sample on Burbank Drive"
Baton Rouge
Baton Rouge, LA
Burbank Drive
Burbank Drive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Questions?