Study of Operational Performance and Environmental Impacts of Modern Roundabouts in Kansas

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PRESENTATION CONTENT

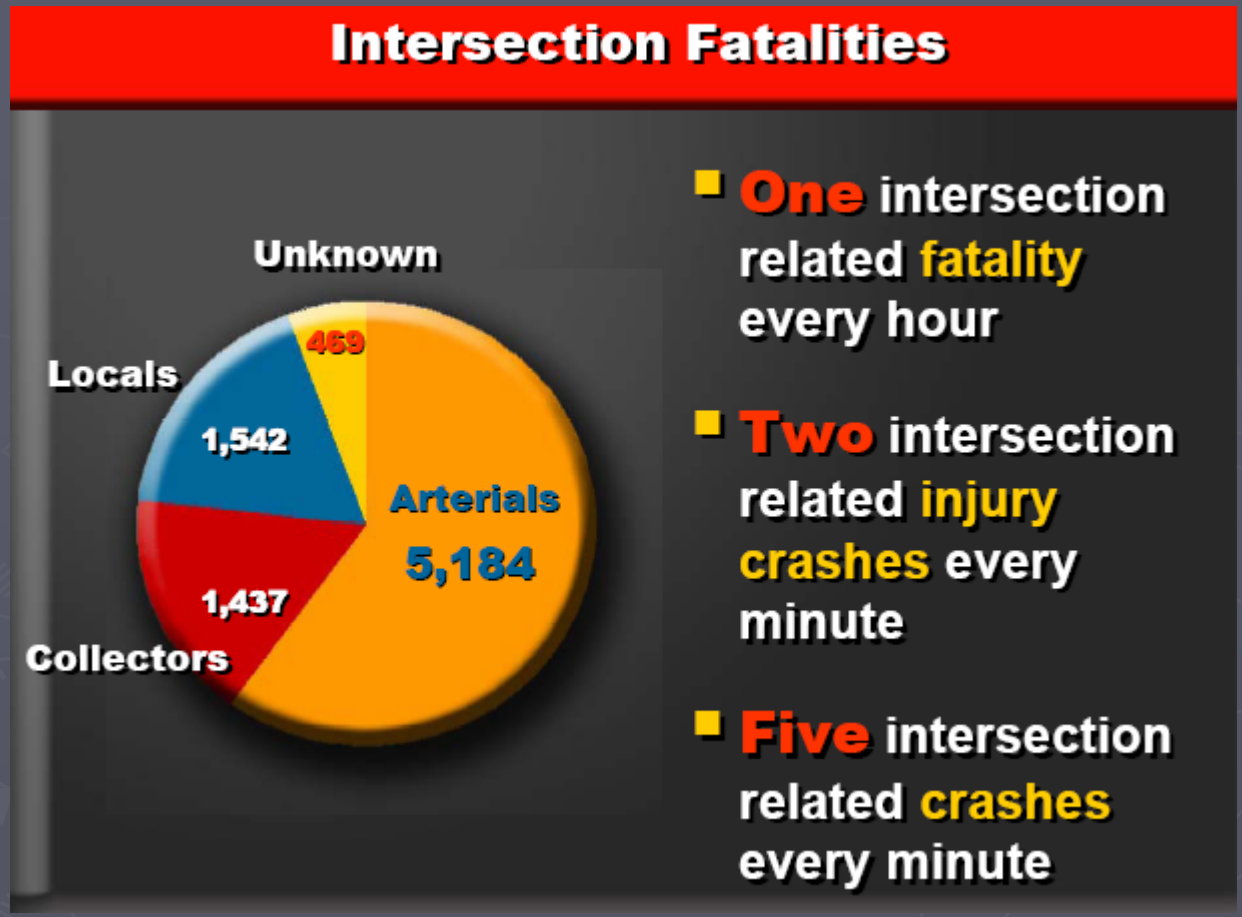
- Quick Overview: Intersection Safety
- Background
- Kansas Roundabout Studies
- Results
- Some Public Comments
- Emissions Overview
- Conclusions
- Caveats

Intersection Crashes:Magnitude of Problem

- Each year, more than 1.8 million intersection crashes occur.

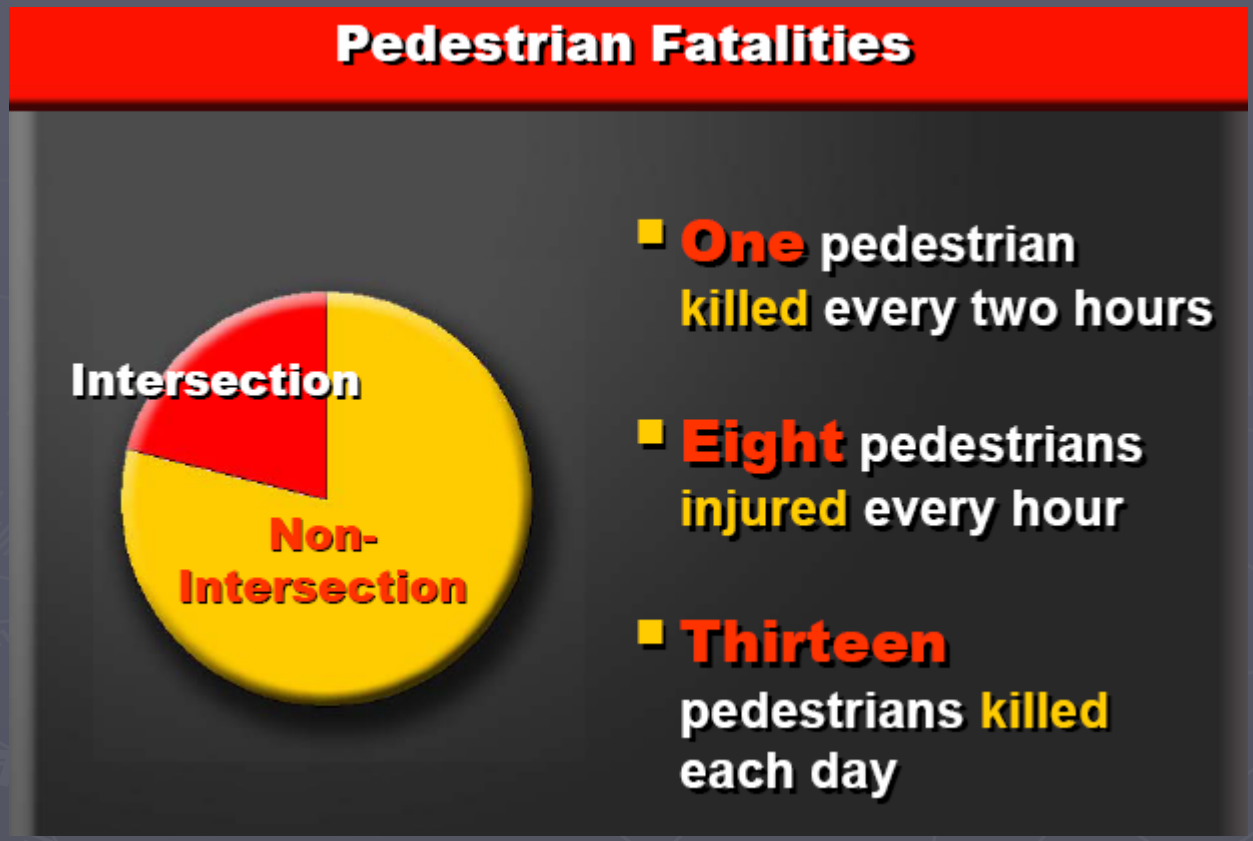
Source: FHWA Safety Website: http://safety.fhwa.dot.gov

Intersection Crashes contd..



http://www.nhtsa.gov/nhtsa/announce/speeches/030503Peters/FHWA-AASHTO030602.pdf

Intersection Crashes contd..



http://www.nhtsa.gov/nhtsa/announce/speeches/030503Peters/FHWA-AASHTO030602.pdf

RED LIGHT RUNNING

- In 2001 there were about 200,000 crashes, 150,000 injuries, and about 1,100 deaths were attributed to red light running.
- These figures have improved some since 2001 but not much

Our Points

- We believe we have an intersection safety problem in the USA, and
- Traffic Signals are not as safe as the general public thinks

U.S Single-Lane Roundabout Crashes- Insurance Institute for Highway Safety (IIHS) Study Results

- (IIHS) study [Persaud, et.al., 2001]
- Highly significant reductions of approximately :
  - 40% for Overall Crashes
  - 76% for Injury Crashes
  - 90% for Fatal and Incapacitating Injury Crashes (predicted)

Using IIHS Figures

- Roundabouts have:
  - Potential to save motorists:
    - Hundreds of thousands of injury crashes
    - Thousands of deaths

Current Roundabout Performance Study

- The primary focus of this research was to study the operational performance of 11 Kansas roundabout
- The research focused on eleven sites with different traffic volume ranges where a modern roundabout has replaced or built instead of a Stop or Signal controlled intersection

Data Collection

1. Video Data Collection
   - Intersection videotaped for two six hour sessions
     - AM Session: 7:00AM-1:00PM
     - PM Session: 1:00PM-7:00PM
2. Manual Data Collection
   - Traffic Counts/movements were taken from the video tapes
     - Counts were collected in 15 minute intervals

Equipment Used

Mounted Camera

Mounting of Camera

Equipment Used contd..

TV/VCR Unit

Cabinet for TV/VCR

Software Used

Software Used: SIDRA (Primarily Version 1.0)

(Signalized and Un signalized Intersection Design and Research Aid)

- Input
  - Road geometry
  - Traffic counts
  - Turning movements
  - Approach Speed of the vehicles

Measures Of Effectiveness Chosen for Operational Performance

1. Average Intersection Delay
   - Average vehicle delay for all vehicles entering the intersection
2. Maximum Approach Delay
   - Average vehicle delay for the approach with highest delay
3. Average Queue Length
   - Value below which 50% of all observed queue lengths fall.

Measures Of Effectiveness for Operational Performance contd..

4. Degree Of Saturation
   - Measure of congestion on the roadway that is being used by traffic
5. Proportion Of Vehicles Stopped at Intersection
   - Proportion of vehicles approaching intersection and required to stop
6. Maximum Proportion Of Vehicles Stopped
   - Highest proportion of vehicles stopped on one approach

Sites Studied

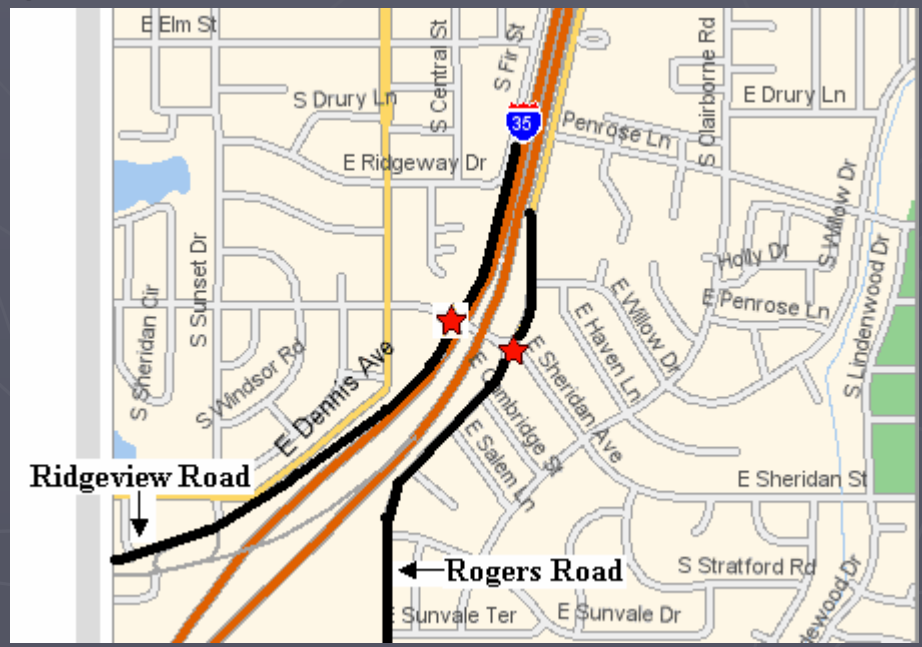
Total 11 sites

- Olathe: Ridgeview/Sheridan, Rogers/Sheridan (Before condition: AWSC) [2 sites]
- Topeka: Rice Road North and South (Before condition: Theoretical TWSC)[2 sites]
- : US-75/NW 46th Street (Before condition: Traffic Signal) [1 site]
- Newton: I-135/Broadway, I-135/First Street (Before condition: Theoretical Traffic Signal) [2 sites]
- Lawrence: Harvard Road/Monterey Way (Before condition: AWSC) [1 site]
- Paola: Old K.C road/K-68 (Before condition: AWSC) [1 site]
- Manhattan: Gary/Candlewood (Before condition: TWSC) [1 site]
- Hutchinson: 23rd street/Severance Avenue (Before condition: TWSC) [1 site]

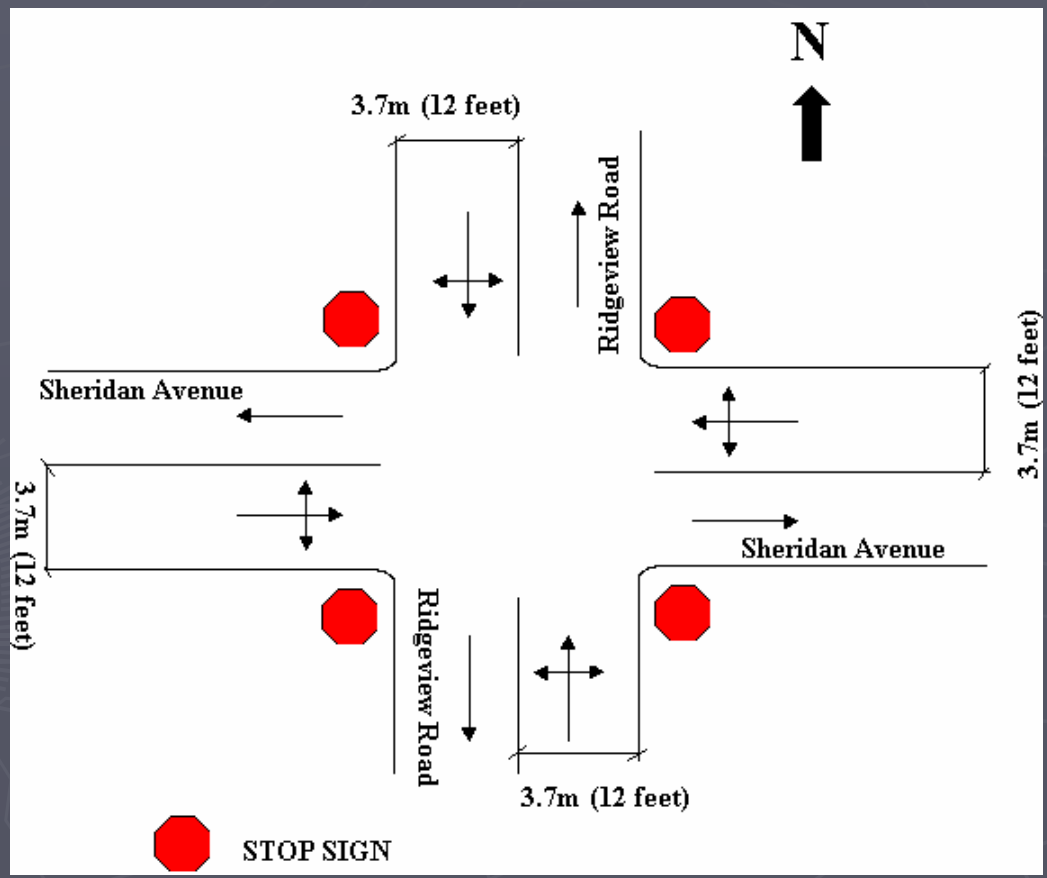
Pictures/Plans of Some Study Sites

Olathe: Ridgeview/Sheridan, Rogers/Sheridan

- Figure showing geographic location of the two roundabouts

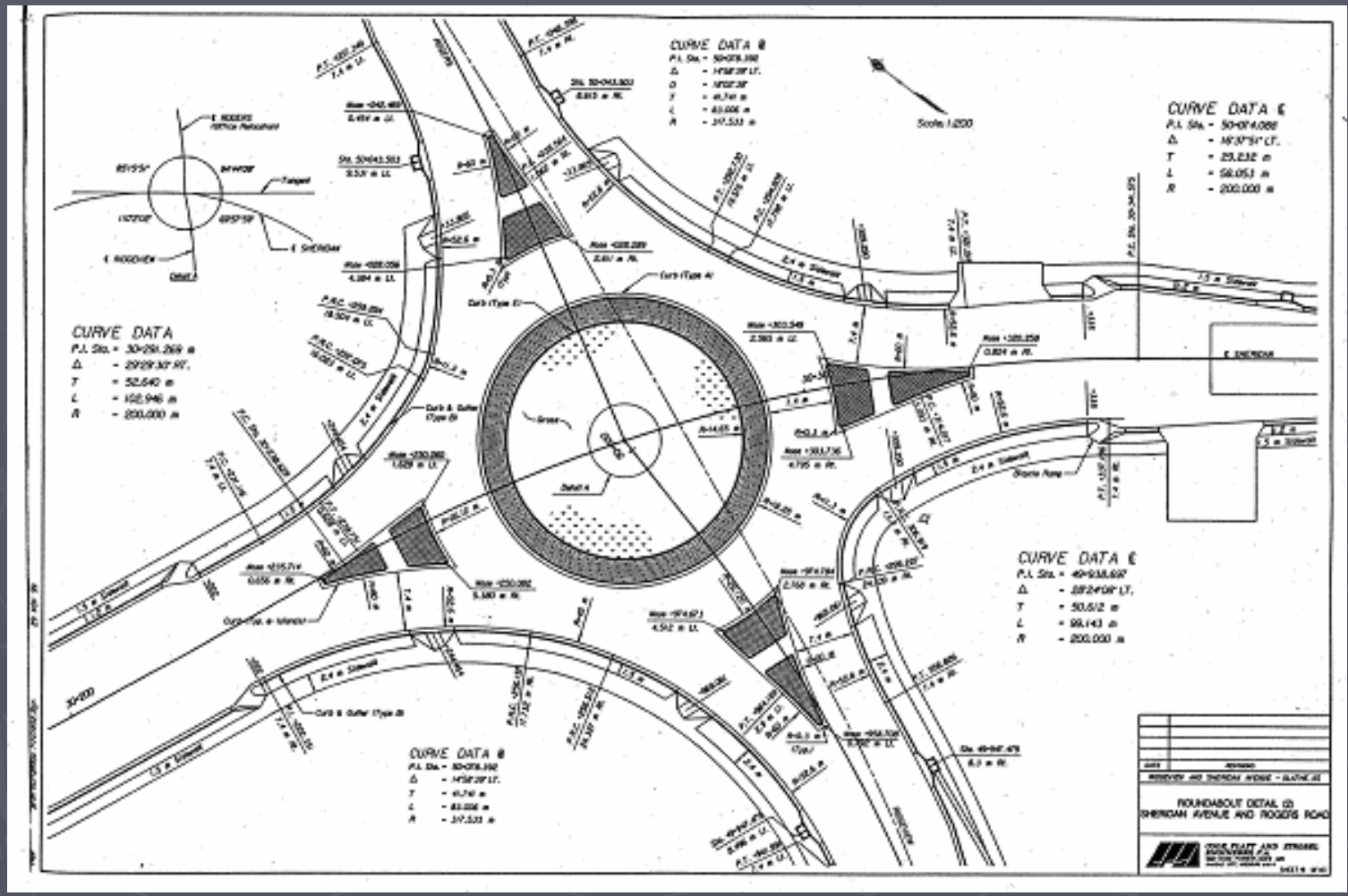


Ridgeview/Sheridan Before Condition

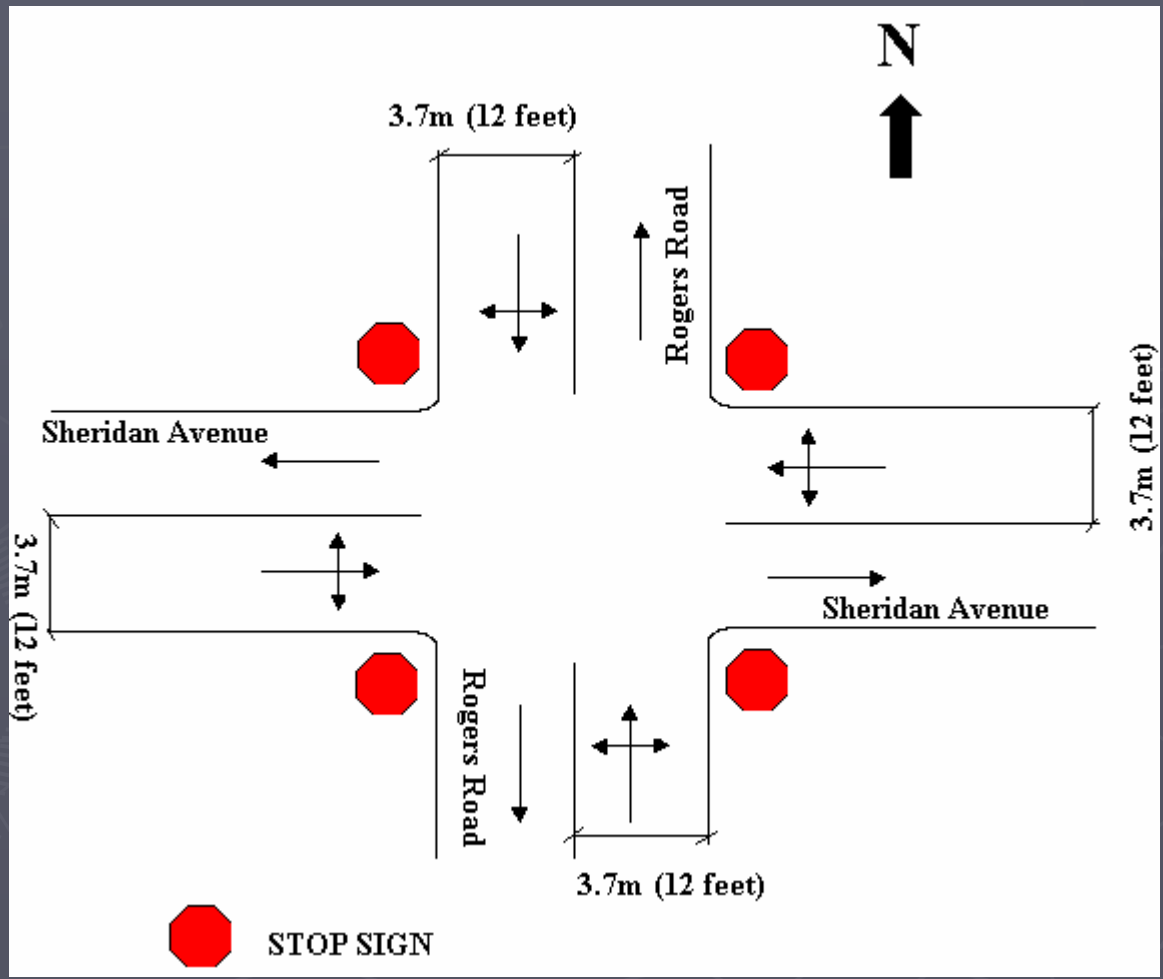


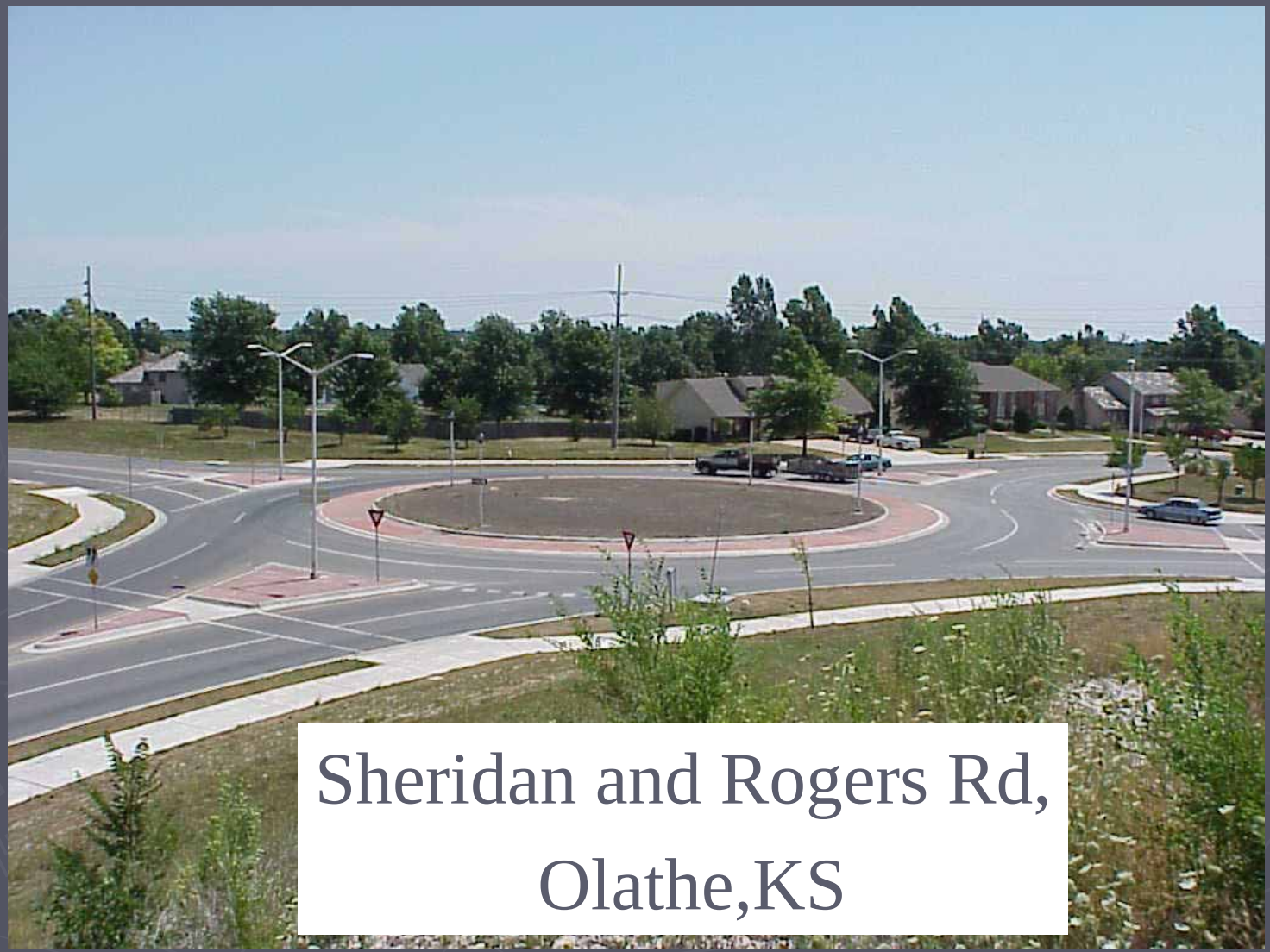
Sheridan Rd and Ridgeview Rd, Olathe,KS

Ridgeview/Sheridan Roundabout Plan



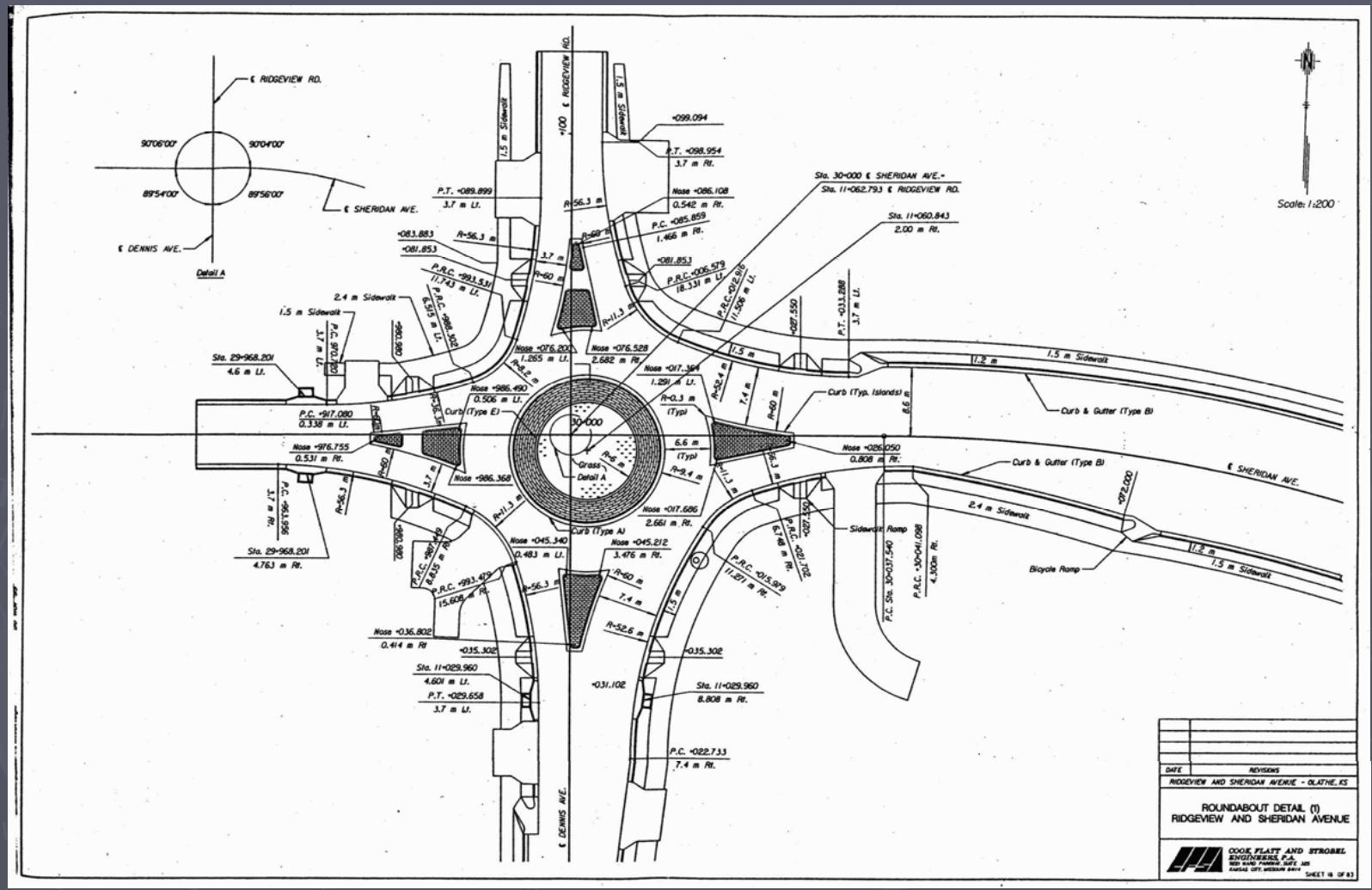
Rogers/Sheridan Before Condition



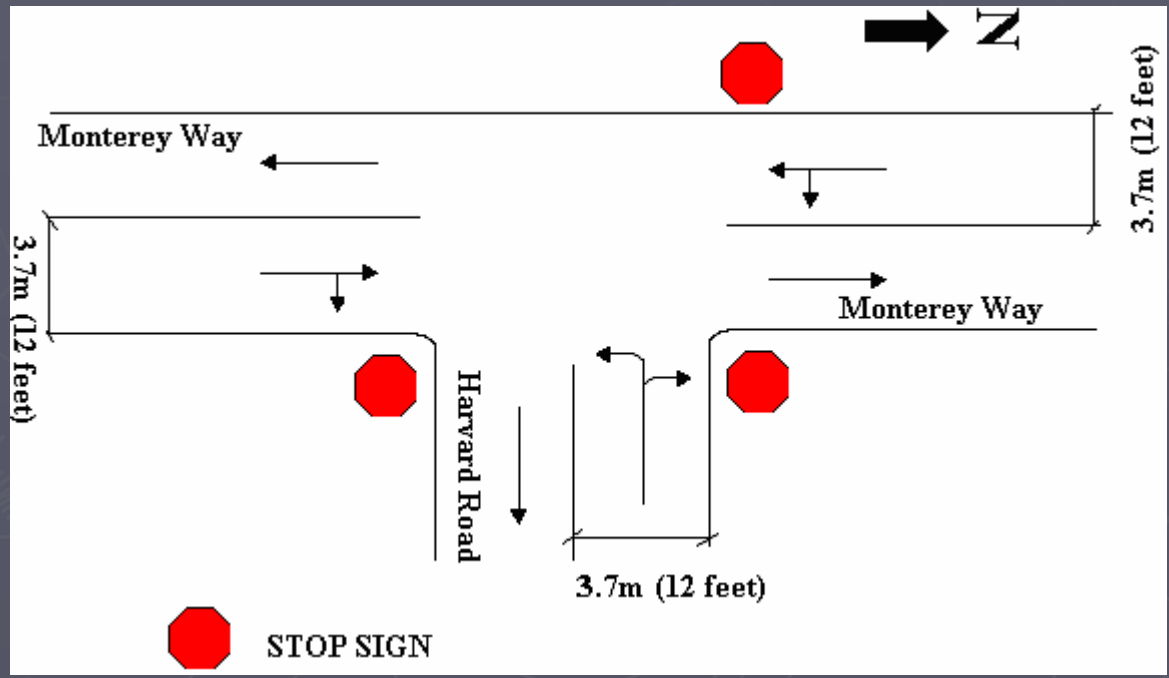


Sheridan and Rogers Rd, Olathe,KS

Rogers/Sheridan Roundabout Plan

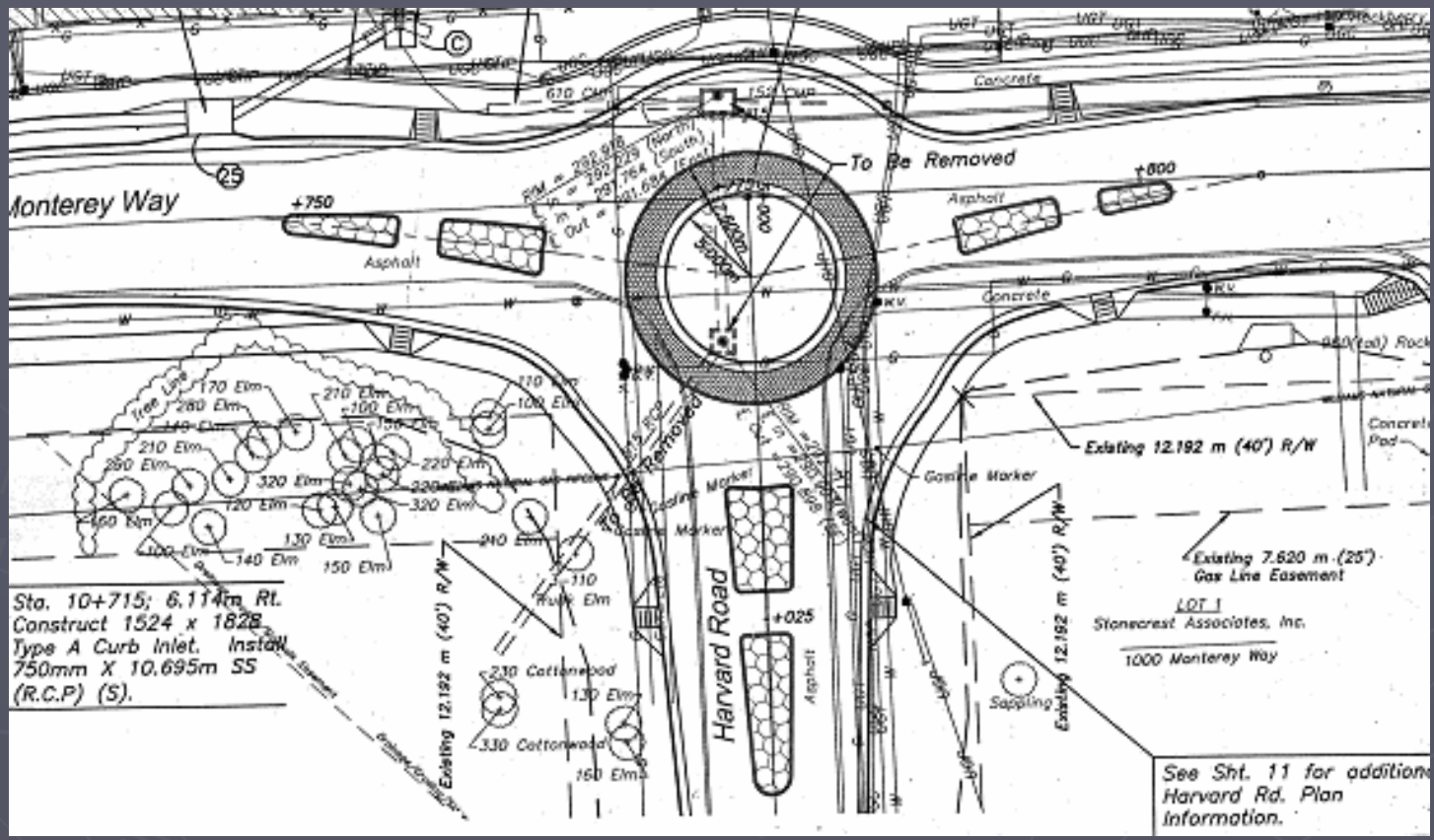


Lawrence Before Condition

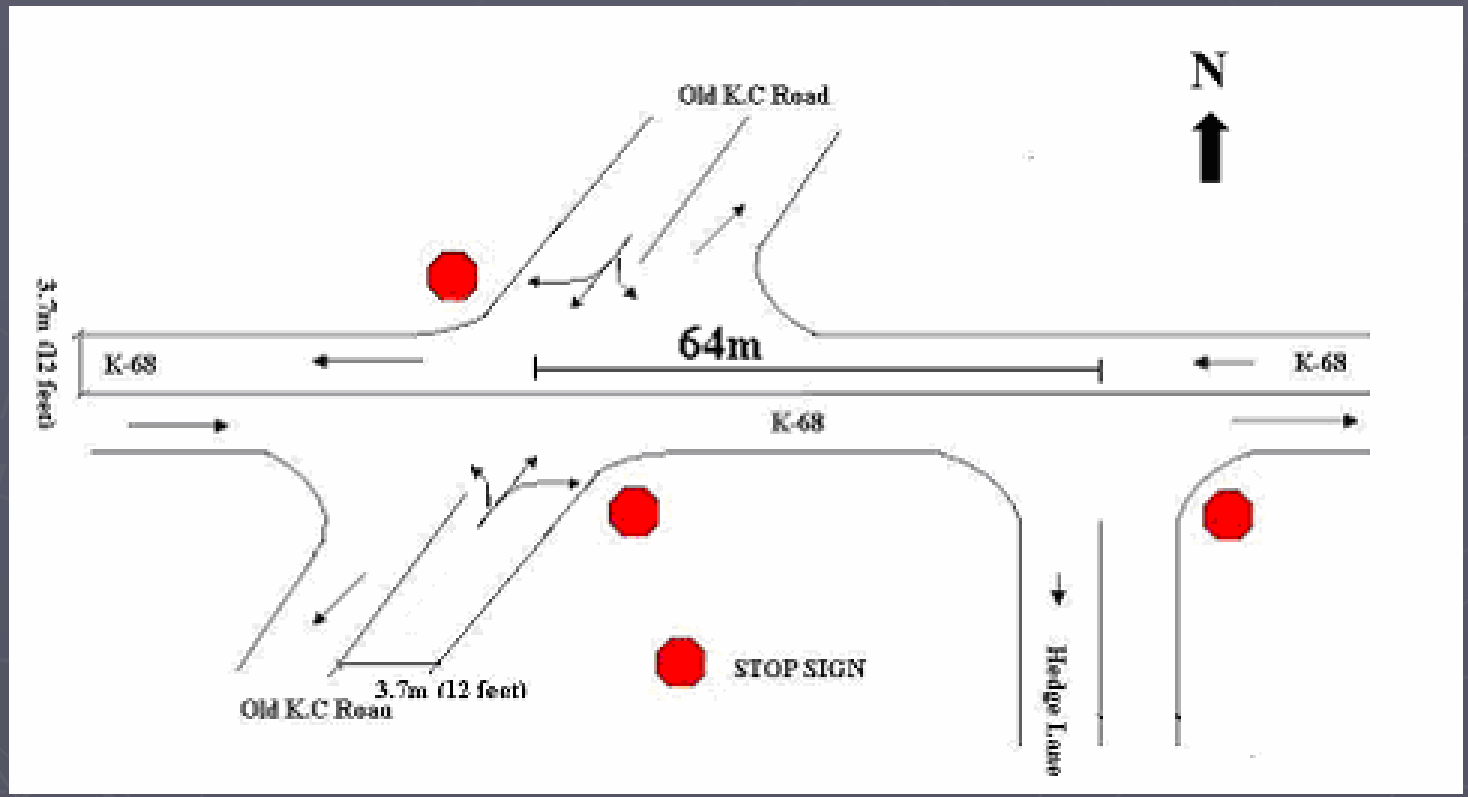


Monterey Way & Harvard, Lawrence,KS

Lawrence Roundabout Plan

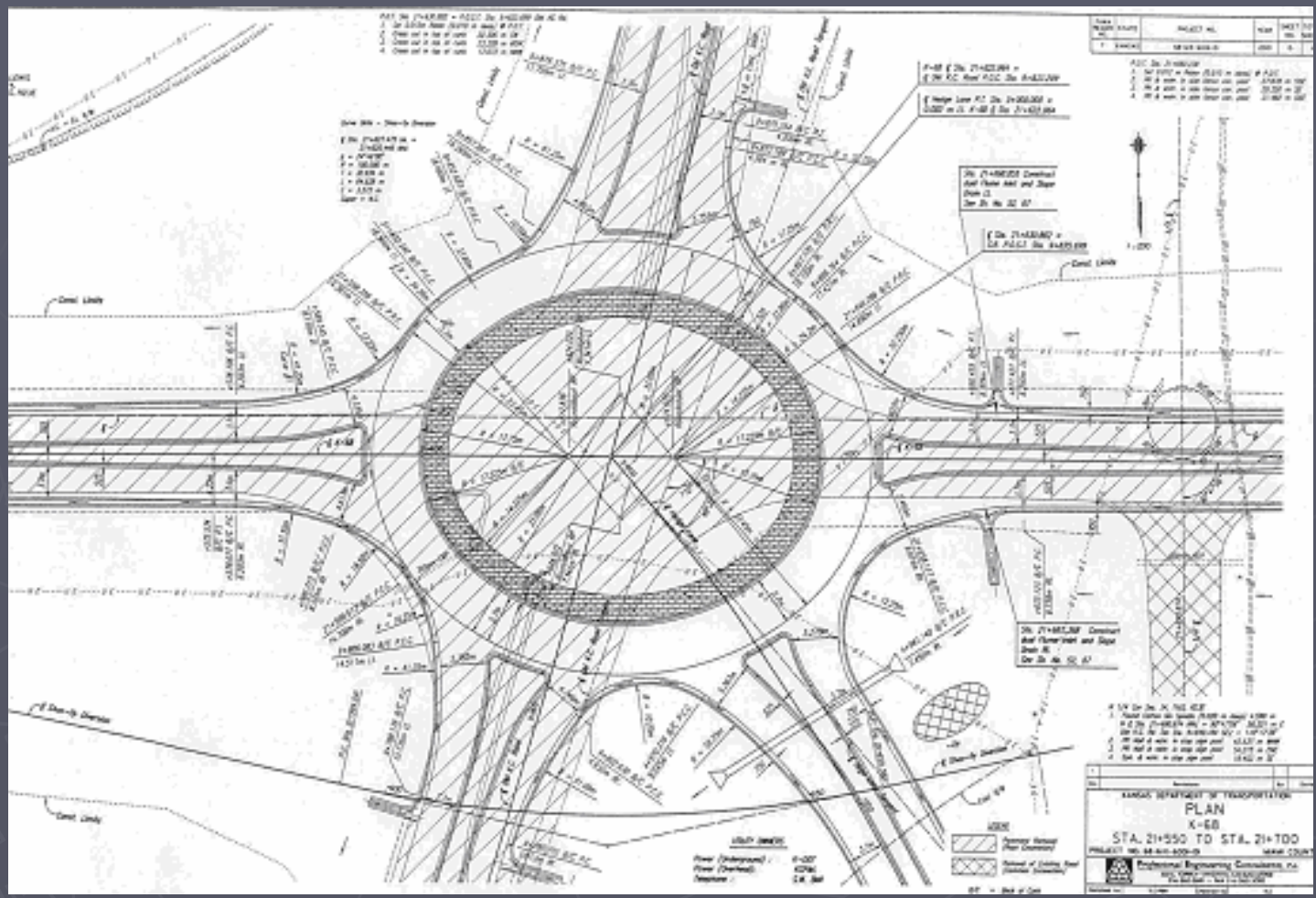


Paola Before Condition




K-68 & Old Kansas City Road
N. Of Paola, KS (Miami County)
National Roundabout Conference 2005 DRAFT

Paola Roundabout Plan



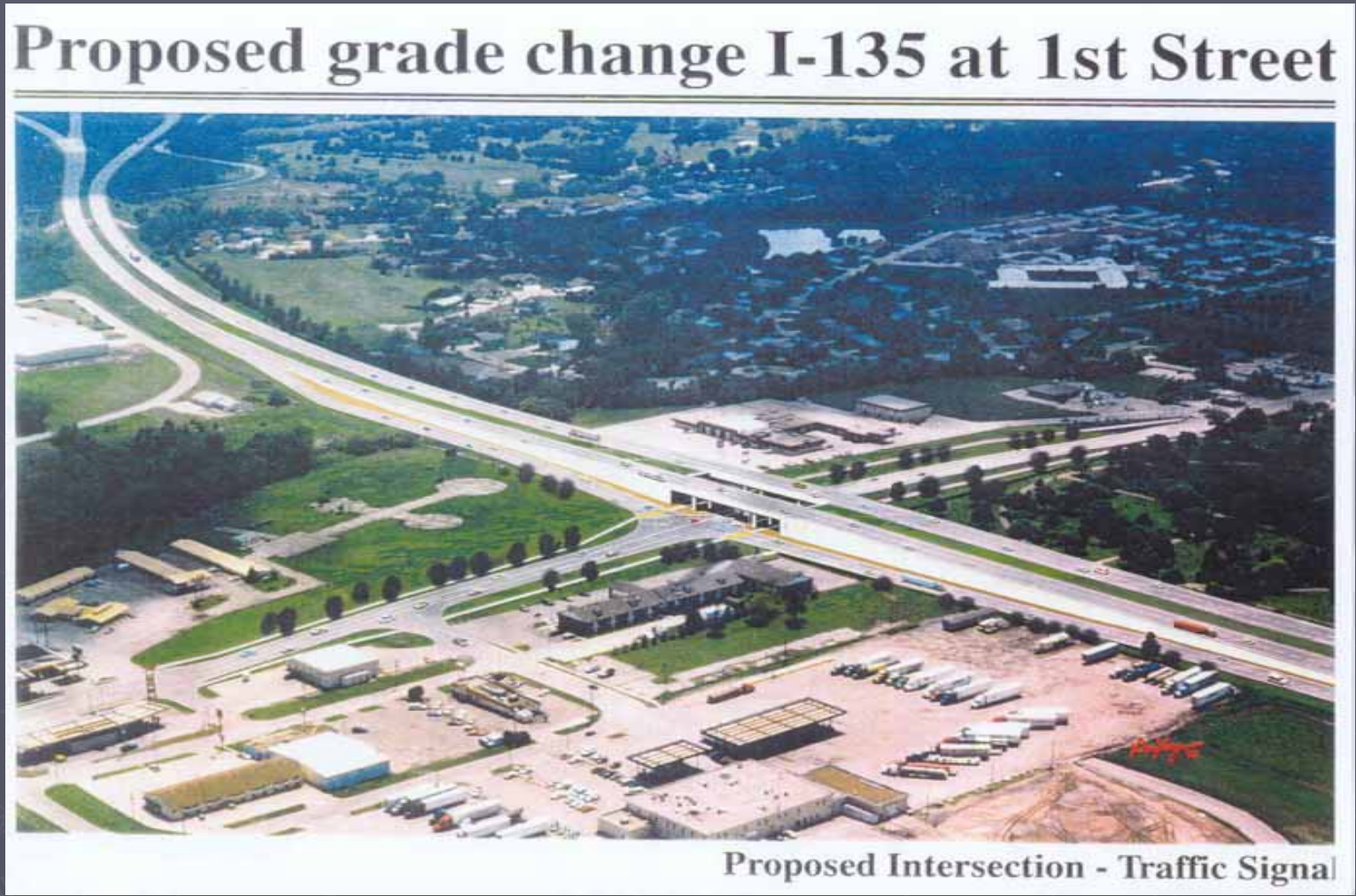
I-70 & Rice Road (East Topeka Interchange)

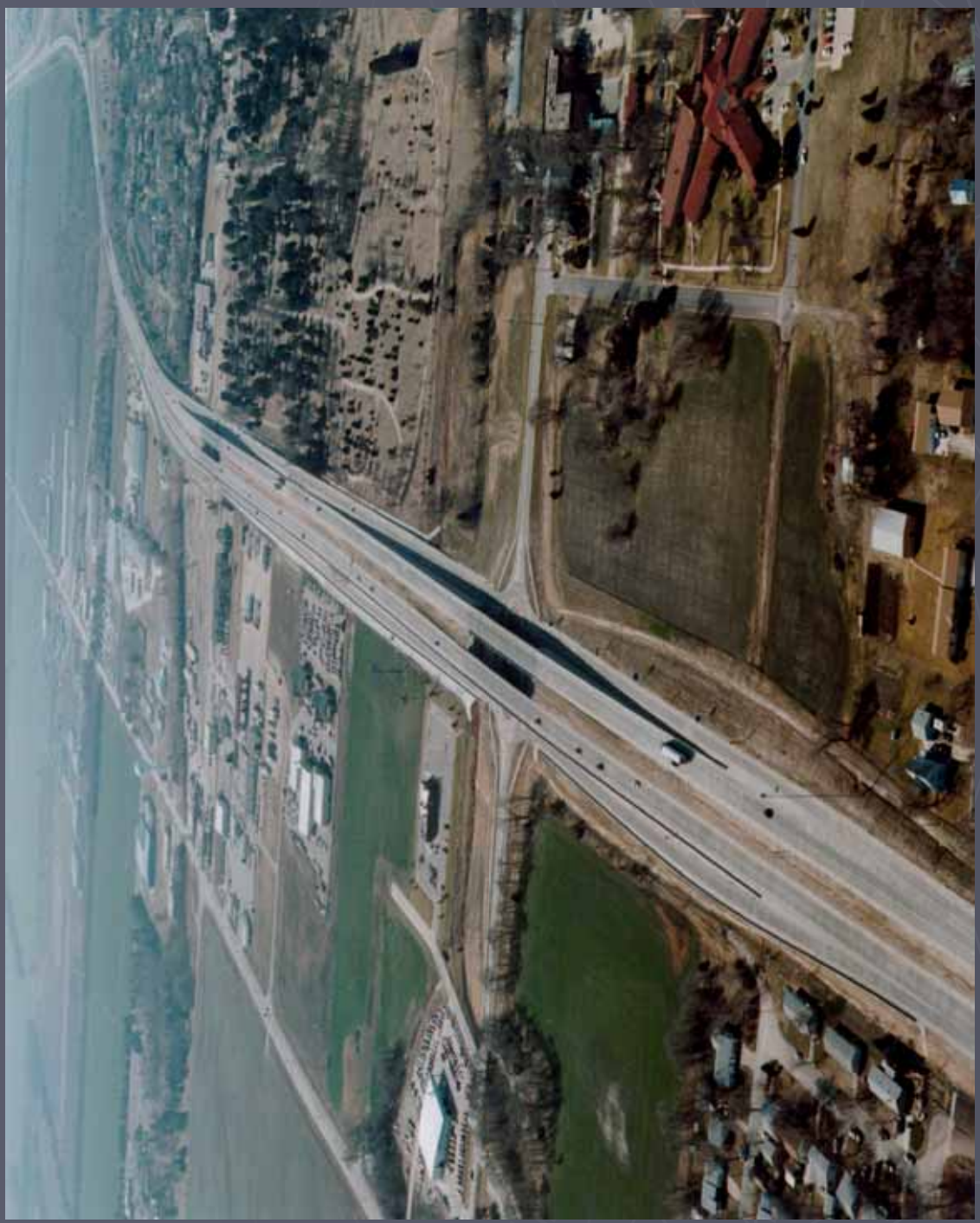
Rice Road

Rice Road

US-75 & 46th St., N. of Topeka, KS (Shawnee County)

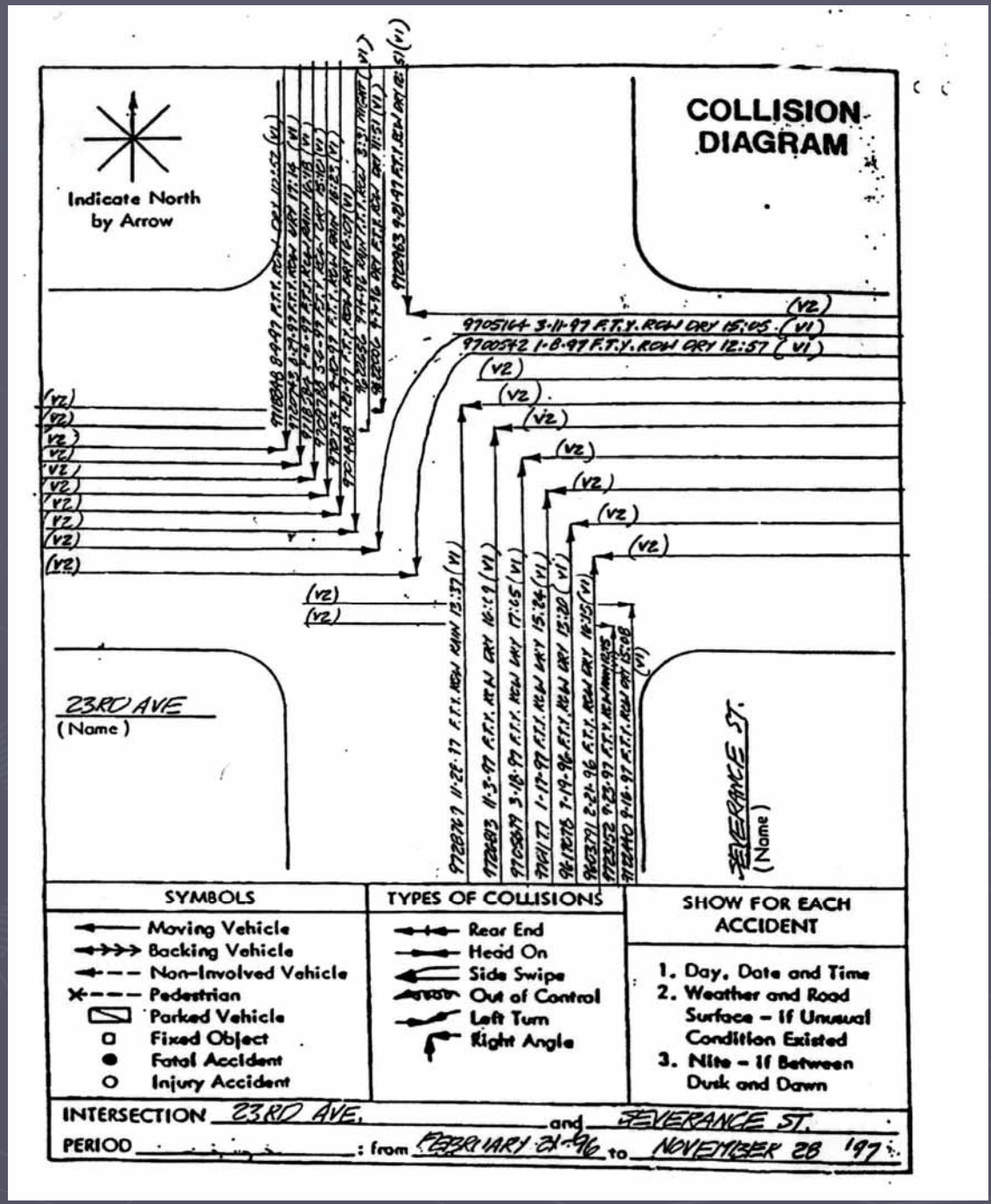
I135 and 1st Street, Newton





Proposed Intersection - Roundabout Alternate

Burns & McDonnell



#3: 23rd & Severence, Hutchinson,KS

Candlewood & Gary, Manhattan, KS

Results

Kansas Average-Operational Performance			
Measures Of Effectiveness	Before	R.A	% Diff.
Average Intersection Delay (Seconds/Veh)	20.2	8	-65%
Max Approach Delay (Seconds/Veh)	34.4	10.4	-71%
95% Queue Length (Feet)	190	104	-53%
Degree Of Saturation- Intersection (v/c)	0.463	0.223	-53%
Proportion Stopped- Intersection (%)	58	29	-52%
Max Prop. Stopped (%)	62	37	-42%

Before: Signal/AWSC/TWSC, RA: Roundabout

Public Acceptance

- Generally poor
- Confusion with
  - Old circles, rotaries
  - Sometimes small circles
- Heard or experienced lots of bad things about large, old circles
- Don’t like speed control (small circles)

Hutchinson, Roundabout
The Hutchinson News

- “If you do build a roundabout it will be the ‘Mother of all Bad Intersections’. We could sell tickets to see it.”
- “They are easy to find; just look for a traffic jam and the ground piled up with broken glass and car parts.”
- CARS Organization

Public Acceptance Improves With Experience

Survey by IIHS

Feeling about Roundabouts

	Before	After
Strongly/Somewhat Favor	31%	63%
Strongly/Somewhat Oppose	55%	28%

Emissions

- Increase in vehicular traffic-major threat to clean air in many of the developed countries like USA
- Vehicular emissions dependent on:
  - Total amount of traffic
  - Intersection controls
  - Driving patterns and
  - Vehicular characteristics.

Emissions contd..

- Major pollutants
  - Carbon monoxide (CO),
  - Carbon dioxide (CO2),
  - Oxides of nitrogen (NOx),
  - Particulate matter (PM_{10} ,$PM_{2.5}$)
  - Hydrocarbons (HC) or Volatile Organic Compounds (VOC)
- Modern Roundabouts cut emissions

Two Emission Studies

- Roundabouts replacing two important signalized intersections in Bern, Switzerland
  - Reduced emissions and fuel savings by about 17%
  - Steadied the driving patterns

Bärenkreuzung/Zollikofen Project

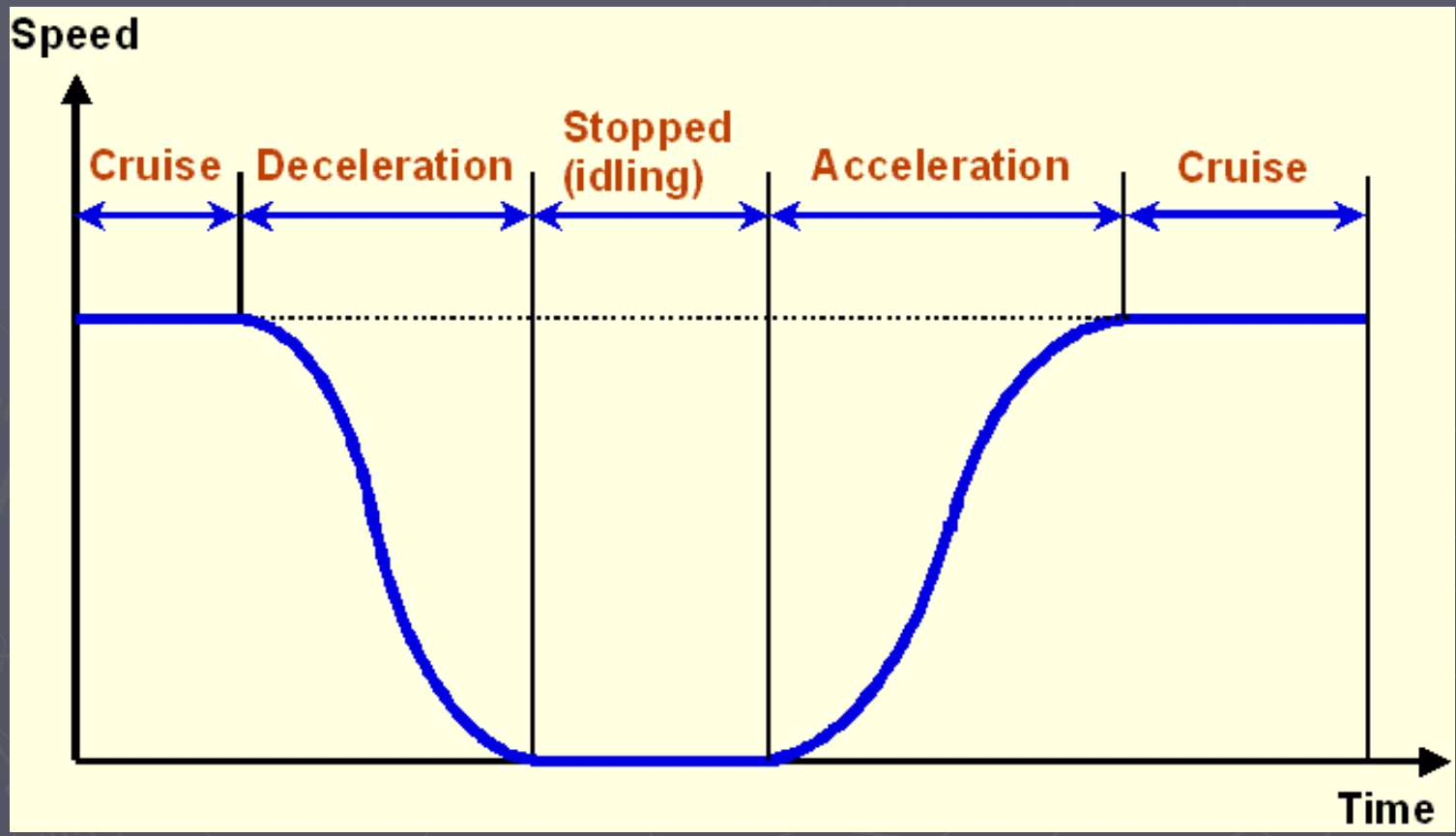
- Roundabout replacing a signalized intersection Sweden found
  - Average decrease in CO emissions by 29%, NO_x emissions by 21% and fuel consumption by 28% per car within the influence of the junction

Varhelyi, Sweden

SIDRA Measures Of Effectiveness Chosen for Kansas Environmental Impact Study

1. Carbon Monoxide (CO) Kg/hr
2. Carbon Dioxide (CO2) Kg/hr
3. Nitrogen Oxides (NOx) Kg/hr
4. Hydrocarbons (HC) or Volatile Organic Compounds (VOC) Kg/hr

Drive-cycle model used by SIDRA



Kansas Average-Environmental Impact			
Measures Of Effectiveness	Before	R.A	% Diff.
Carbon Monoxide (CO) Kg/hr	10.79	7.26	-33%
Carbon dioxide (CO2) Kg/hr	237.30	127.59	-46%
Oxides of Nitrogen (NOx) Kg/hr	0.348	0.225	-35%
Hydrocarbons (HC) Kg/hr	0.446	0.210	-53%

Before: Signal/AWSC/TWSC, RA: Roundabout

Conclusions

- Statistically significant reductions in delay, queueing, stopping and emissions – for all sites studied
- At most intersections with cross traffic and turning movements – a modern roundabout is the most viable alternative for safe, efficient vehicular traffic
- After construction public attitudes change to more positive
- Public needs more education

Statement from Discover Magazine

"The modern roundabout may be the safest most efficient traffic control device available today."

Summary of Emission Studies

- Modern Roundabouts reduce stopping and idling time at intersections thereby;
  - Make traffic flow more orderly
  - Reduce fuel consumption and vehicular emissions

For more information visit our websites:

http://www.ksu.edu/roundabouts

http://trafficdiscussions.com

Caveats

- Keys to safety achieved by a well designed roundabout :
  - Deflection
  - Low-speed

Questions?

Ridgeview/Sheridan Roundabout-Traffic Volumes and Left turn percentages

AM (AWSC)	*AM (Roundabout)*	*PM (AWSC)*	*PM (Roundabout)*
708-1110 (veh/hr)	*776-1124 (veh/hr)*	*1140-1626 (veh/hr)*	*1119-1784 (veh/hr)*
33% Left turns	*33% Left turns*	*35% Left turns*	*38% Left turns*

Rogers/Sheridan Roundabout-Traffic Volumes and Left turn percentages

AM (AWSC)	*AM (Roundabout)*	*PM (AWSC)*	*PM (Roundabout)*
926-1625 (veh/hr)	*931-1738 (veh/hr)*	*1220-1994 (veh/hr)*	*1244-2024 (veh/hr)*
28% Left turns	*28% Left turns*	*21% Left turns*	*22% Left turns*

Paola Roundabout-Traffic Volumes and Left turn percentages

AM (AWSC)	*AM (Roundabout)*	*PM (AWSC)*	*PM (Roundabout)*
257-594 (veh/hr)	*235-559 (veh/hr)*	*192-690 (veh/hr)*	*156-663 (veh/hr)*
28% Left turns	*29% Left turns*	*38% Left turns*	*40% Left turns*

Hutchinson Roundabout-Traffic Volumes and Left turn percentages

AM (TWSC)	*AM (Roundabout)*	*PM (TWSC)*	*PM (Roundabout)*
449-983 (veh/hr)	*415-864 (veh/hr)*	*514-1204 (veh/hr)*	*510-1110 (veh/hr)*
13% Left turns	*12% Left turns*	*13% Left turns*	*15% Left turns*

Lawrence Roundabout-Traffic Volumes and Left turn percentages

AM (AWSC)	*AM (Roundabout)*	*PM (AWSC)*	*PM (Roundabout)*
227-536 (veh/hr)	*263-447 (veh/hr)*	*412-733 (veh/hr)*	*442-692 (veh/hr)*
30% Left turns	*17% Left turns*	*26% Left turns*	*21% Left turns*