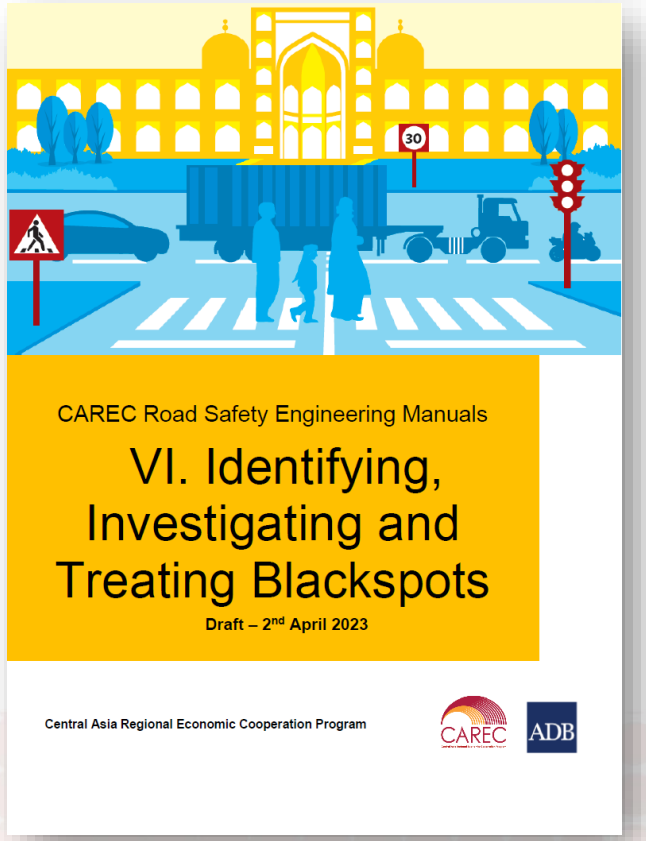
CAREC
Central Asia Regional Economic Cooperation Program

Highways Workshop

22–23 May 2023 • Tbilisi, Georgia

Семинар по автомобильным дорогам

22–23 мая 2023 года • Тбилиси, Грузия



Blackspots - identification, investigation and treatment

Phillip Jordan
International Road Safety Engineering Consultant

- An introduction to the new CAREC RSE Manual 6- Identifying, Investigating and Treating Blackspots.

  Break out session : how useful is your crash data?

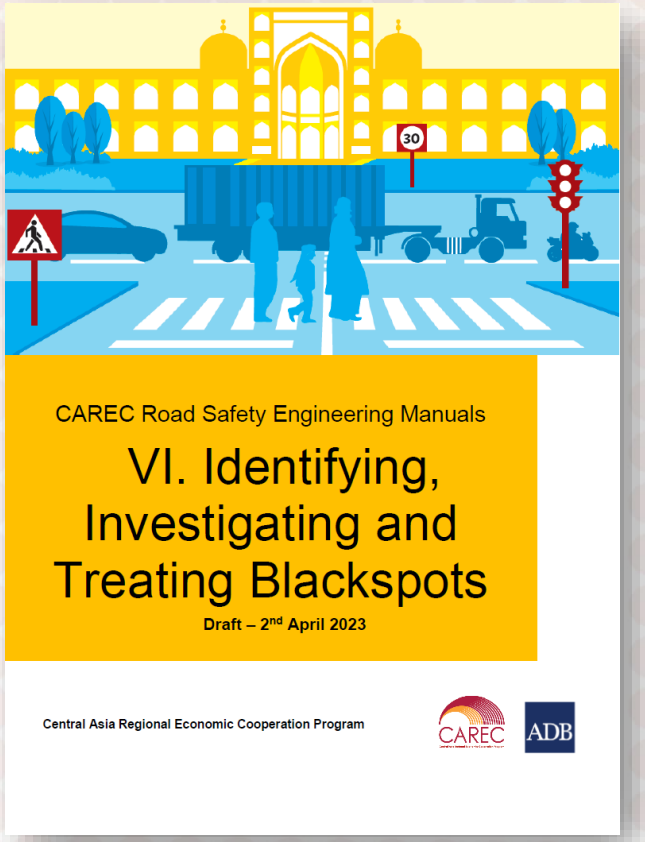
- Investigating a blackspot

  Break out session: are your national standards holding back safety?

- Treating the blackspot

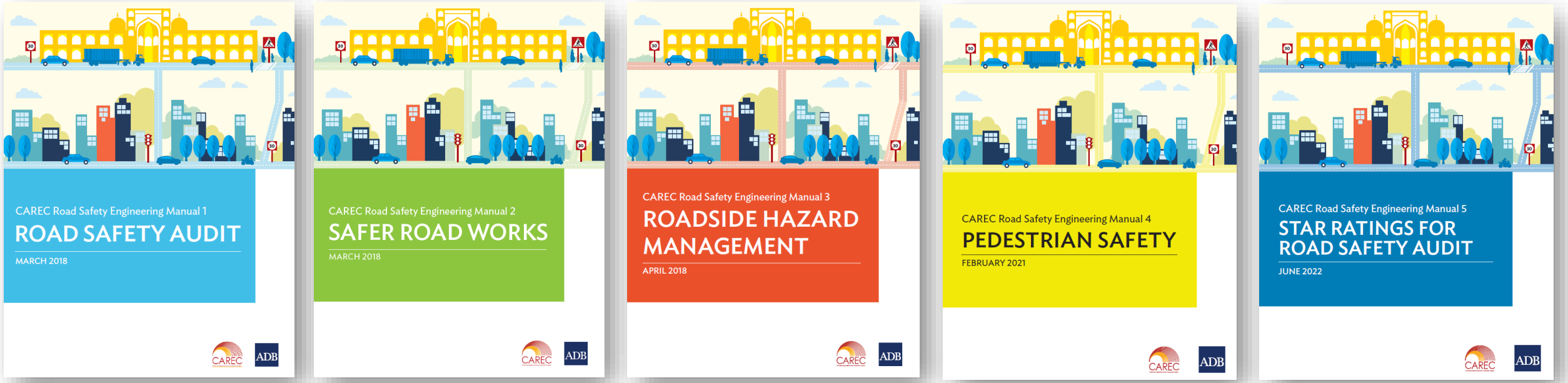
  Break out session: what is needed for a successful national Blackspot Program?

An introduction to the new CAREC Blackspot manual.



This is the 6th manual in the CAREC Road Safety Engineering series

The first 5 CAREC Road Safety Engineering Manuals



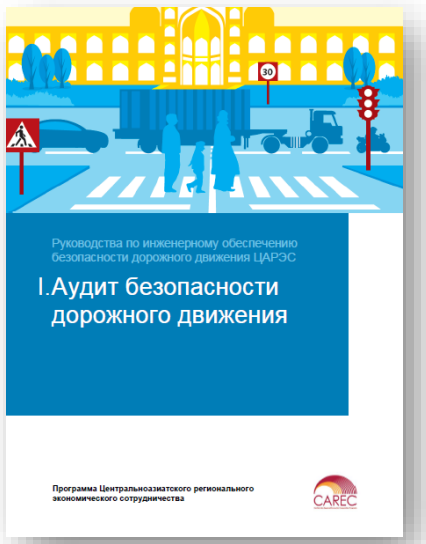
Do you have these 5 CAREC road safety engineering manuals?

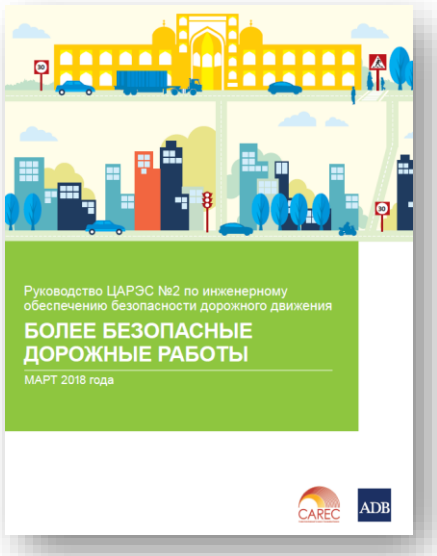
They are useful to help you make your roads safer.

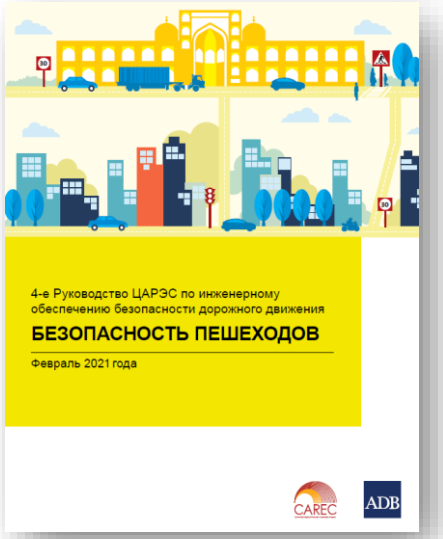
Go to the ADB website

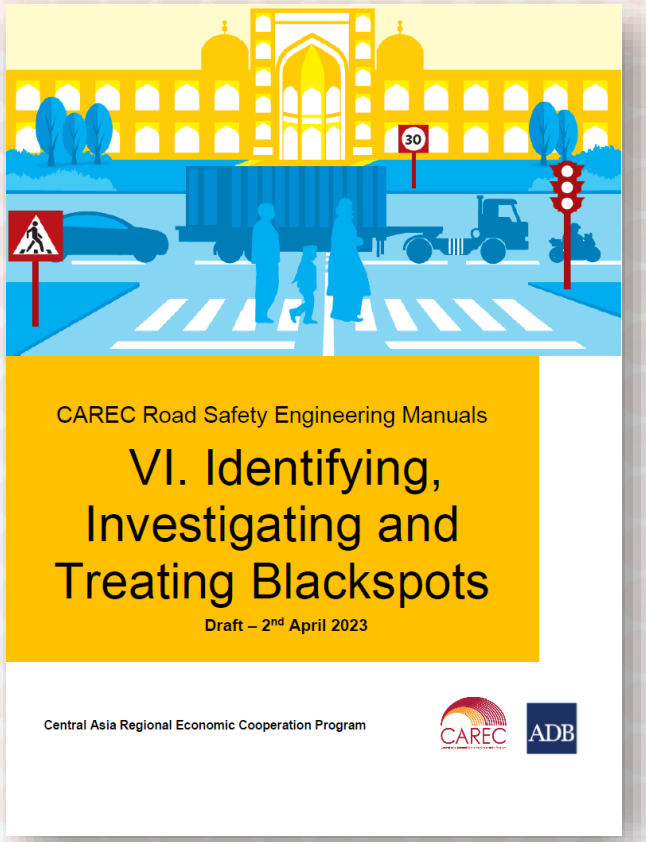
Руководства по инженерному обеспечению безопасности дорожного движения ЦАРЭС:

- ✓ Имеют непосредственное отношение к автомагистралям ЦАРЭС.
- ✓ Предоставить практическую, современную инженерную информацию по безопасности дорожного движения для использования в дорожных агентствах ЦАРЭС.
- ✓ Может использоваться для университетских курсов.
- ✓ Поощрять инженеров автодорог в регионе ЦАРЭС делать больше в области безопасности дорожного движения.









The new manual is for:

- ✓ highway and road safety engineers,
- ✓ project managers,
- ✓ planners,
- ✓ municipal engineers,
- ✓ Traffic Police,
- ✓ consultants
- ✓ design institutes and road agencies.

- It explains the blackspot process for practitioners, and it offers full information about establishing a national blackspot removal program for policy makers.

- It encourages road authorities and Traffic Police to share crash data.

- It also encourages CAREC road authorities to devote more resources to the removal of blackspots.

Road crashes impose a heavy cost on CAREC countries

The new CAREC Blackspot manual has 8 chapters:

I. Engineers have an important role in road safety
II. Overview of the blackspot process
III. Identifying blackspots
IV. Investigating a blackspot
V. Treating a blackspot with suitable countermeasures
VI. Determining which blackspot treatments to fund
VII. Blackspot case studies
VIII. The next steps

Chapter 1 Engineers have an important role in road safety

A. What is a road crash?
B. Breaking the chain of events leading to a crash
C. The Safe System approach to road safety
D. Applying the Safe System

Chapter 2 Overview of the blackspot process

A. Identification
B. Investigation
C. Treatment

Chapter 3 Identifying blackspots

A. What is a blackspot?
B. Overview of the blackspot process
C. Traffic Police and engineers working together
D. The need for good crash data
E. What if crash data is lacking?

Chapter 4 Investigating a blackspot

A. The steps in the investigation stage
B. Diagnosis
    i. collision diagrams,
    ii. crash factor matrices,
    iii. crash charts
C. Site inspection
D. List potential countermeasures
E. Concept plan
F. Economic assessment
G. Prepare the blackspot report

Chapter 5 Treating a blackspot with suitable countermeasures

A. Intersection collisions
B. Mid-block collisions
C. Rural run-off-road crashes
D. Pedestrian crashes
E. Mass action treatments

Chapter 6 Determining which blackspot treatments to fund

A. Economic assessment of blackspot treatments
B. Benefit cost ratio
C. Crash reduction factors
D. Writing a blackspot report
E. Interim Countermeasure Treatments

Chapter 7 Blackspot case studies

- An urban crossroad intersection.
- A highway passing through a village.
- A rural blacklength within a series of curves on a highway in a hill area.
- A rural complex intersection.
- Mass action treatments

Chapter 8 The next steps

A. Establishing a national blackspot removal program

B. Monitoring the treated blackspots

Chapter 1 Engineers have an important role in road safety

A. What is a road crash?

B. Breaking the chain of events leading to a crash

C. The Safe System approach to road safety

D. Applying the Safe System

Chapter 2 Overview of the blackspot process

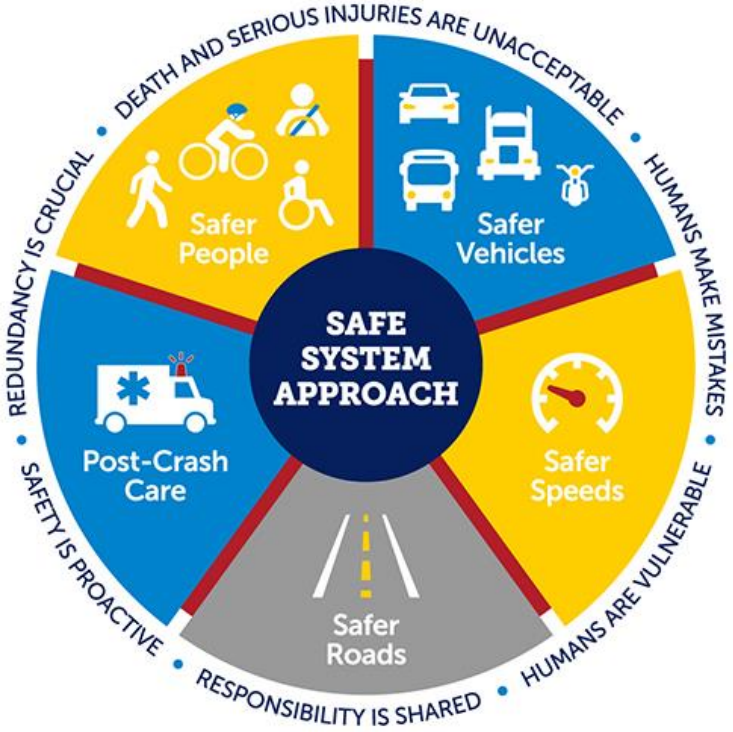
A. Identification

B. Investigation

C. Treatment

The Safe System approach to road safety

What is the Safe System Approach?



- Holistic approach
- Underlying principles:
    - we make mistakes
    - human body has physical limits
- Aims to ensure these mistakes do not result in deaths or injuries

The Safe System

Key Principals

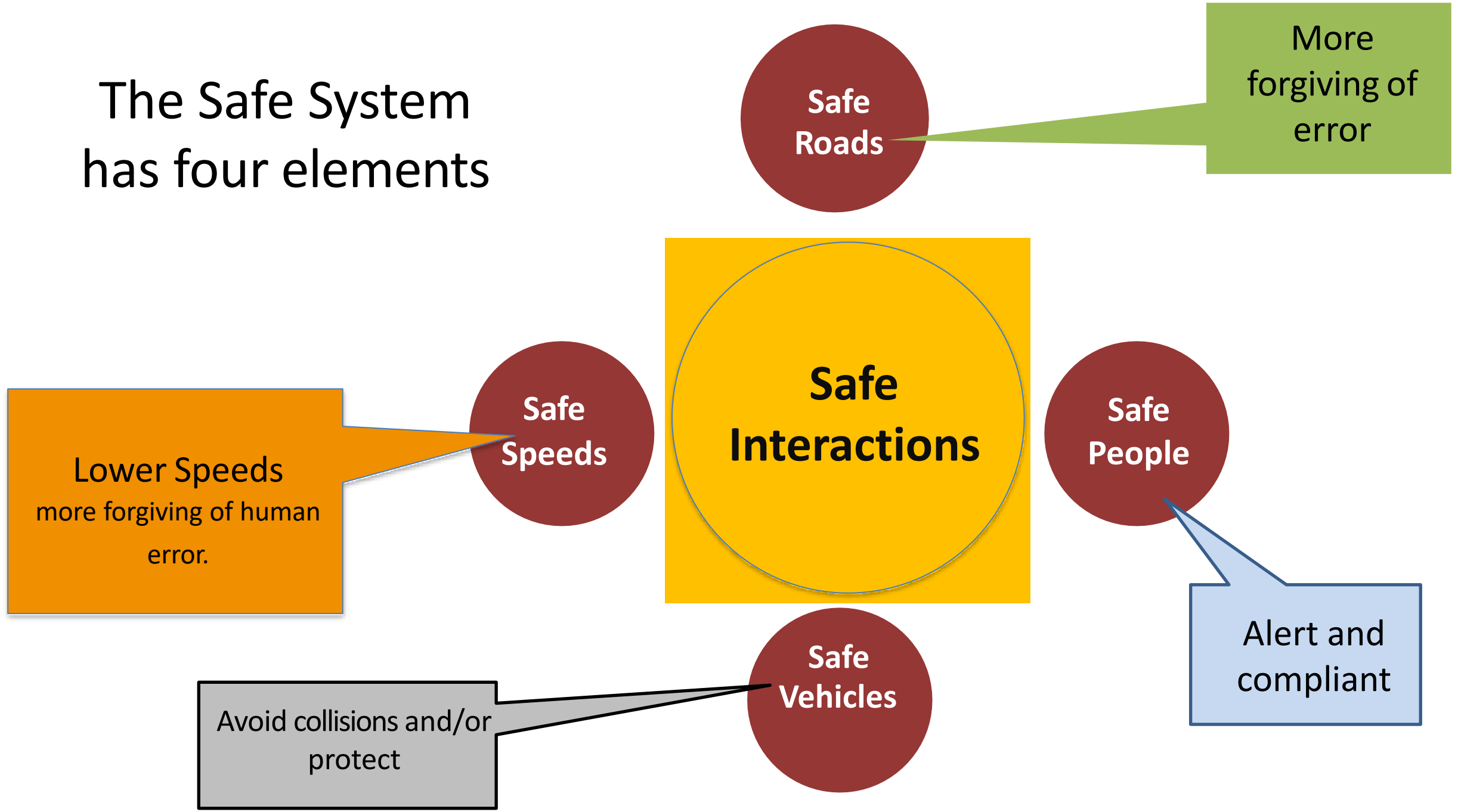
- No death or serious injury
- People make mistakes
- People are vulnerable
- Shared responsibility

What is the Safe System Approach?

- The goal is to create a transport system which is more human-proof

- The safety of the system is everyone's responsibility

The Safe System has four elements



There is a need to change thinking about road safety

	Traditional Thinking	Safe System Thinking
What is the problem?	Crashes	**Fatalities and serious injuries**
What causes the problem?	Human Factors	**People make mistakes, people are fragile**
Who is ultimately responsible?	Road users	**System designers**
What is the major planning approach?	Incremental approach to reduce the problem	**Systematic approach to build a safe road system**
What is the appropriate goal?	Optimum number of fatalities & serious injuries	**Zero fatalities & serious injuries**

Towards Zero Foundation website (http://www.towardszerofoundation.org/thesafesystem/)

Chapter 3 Identifying blackspots

A. What is a blackspot?
B. Overview of the blackspot process
C. Traffic Police and engineers working together
D. The need for good crash data
E. What if crash data is lacking?

A. Identifying a blackspot

Accurate crash data is essential!

"KNOWING EXACTLY WHERE A BLACKSPOT IS REQUIRES ACCURATE CRASH DATA"

WHAT IS A BLACKSPOT?

A blackspot is a road location which has a high number of casualty crashes.

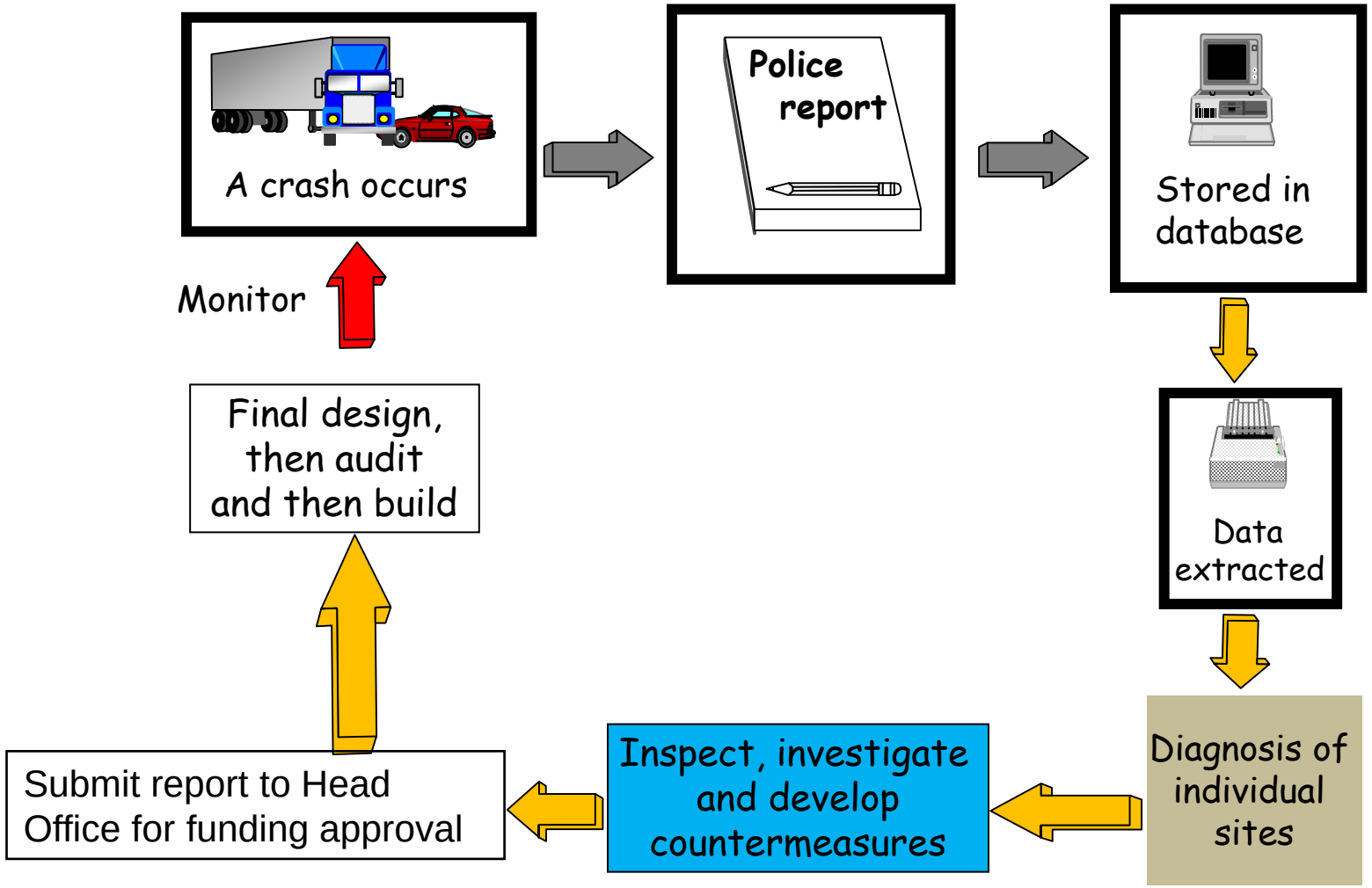
It may be:

- An individual site (such as an intersection, or a curve)
- A length of road (urban or rural)
- An area of a road network (such as a local traffic area)
- Locations with a common hazardous feature (such as Y-junctions) and/or a common crash type (such as young pedestrians).
- These we treat with mass action treatments

The manual recommends that a blackspot be an agreed number of casualty crashes reported in the last 3 years

12 casualty crashes in 3 years is suggested, but the number is for each national road authority to decide.

The “blackspot process”



WHEN A CRASH HAPPENS, THE POLICE GATHER CRASH DATA……

Date/time/location/directions

Names/addresses/ages/gender of all involved

Alcohol/drugs

Vehicle types/registration

Injury levels

Other information to prosecute the offender.

Best international practice is when Police record the crashes, store the crash data in a database, and share it with government stakeholders

ENGINEERS NEED *GOOD* CRASH DATA

Engineers <u>do need</u> to know:

- Where and when the crash happened (accurately)
- The type of road user involved (direction, type)
- Conditions at the time – rain, wind, fog, snow, sun

ENGINEERS NEED *GOOD* CRASH DATA

Engineers do not need:

- Names, addresses of people involved
- Vehicle registration details
- Police prosecution information (alcohol, speed, drugs)

Police investigate a serious crash in detail.

But engineers look for patterns in the crashes at a site.

Police and engineers co-operating can eliminate blackspots.

BREAK OUT SESSION 1 CRASH DATA

15 minutes to discuss your access to and use of crash data.

- Is it accurate, reliable?
- Is it shared with stakeholders?
- What changes in your crash data system are needed for an effective national blackspot program?

B. Investigating a blackspot

Chapter 4 Investigating a blackspot

A. The steps in the investigation stage
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    i. collision diagrams,
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C. Site inspection
D. List potential countermeasures
E. Concept plan
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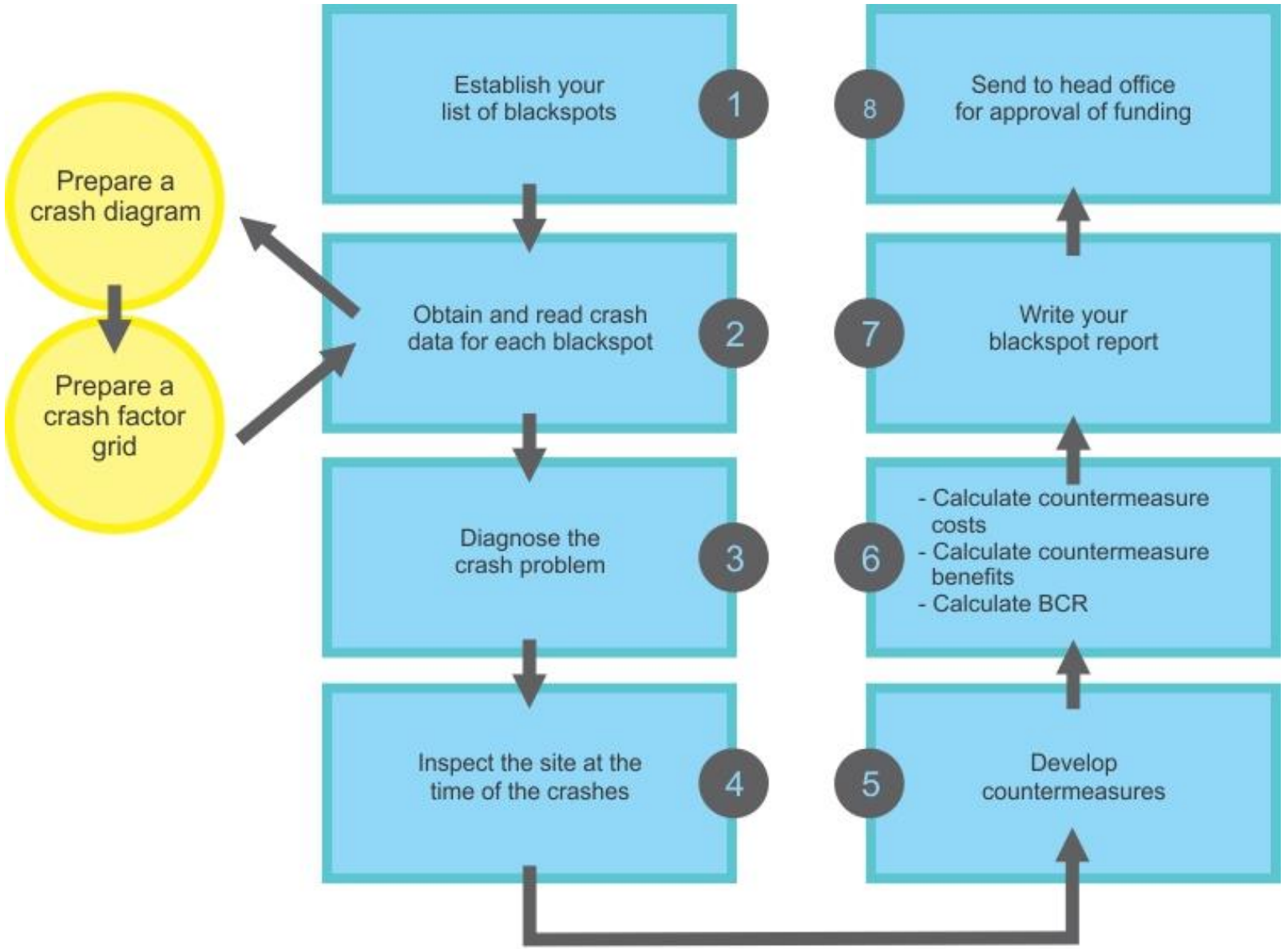
G. Prepare the blackspot report



Steps in the blackspot process

1 Decide the list of blackspots

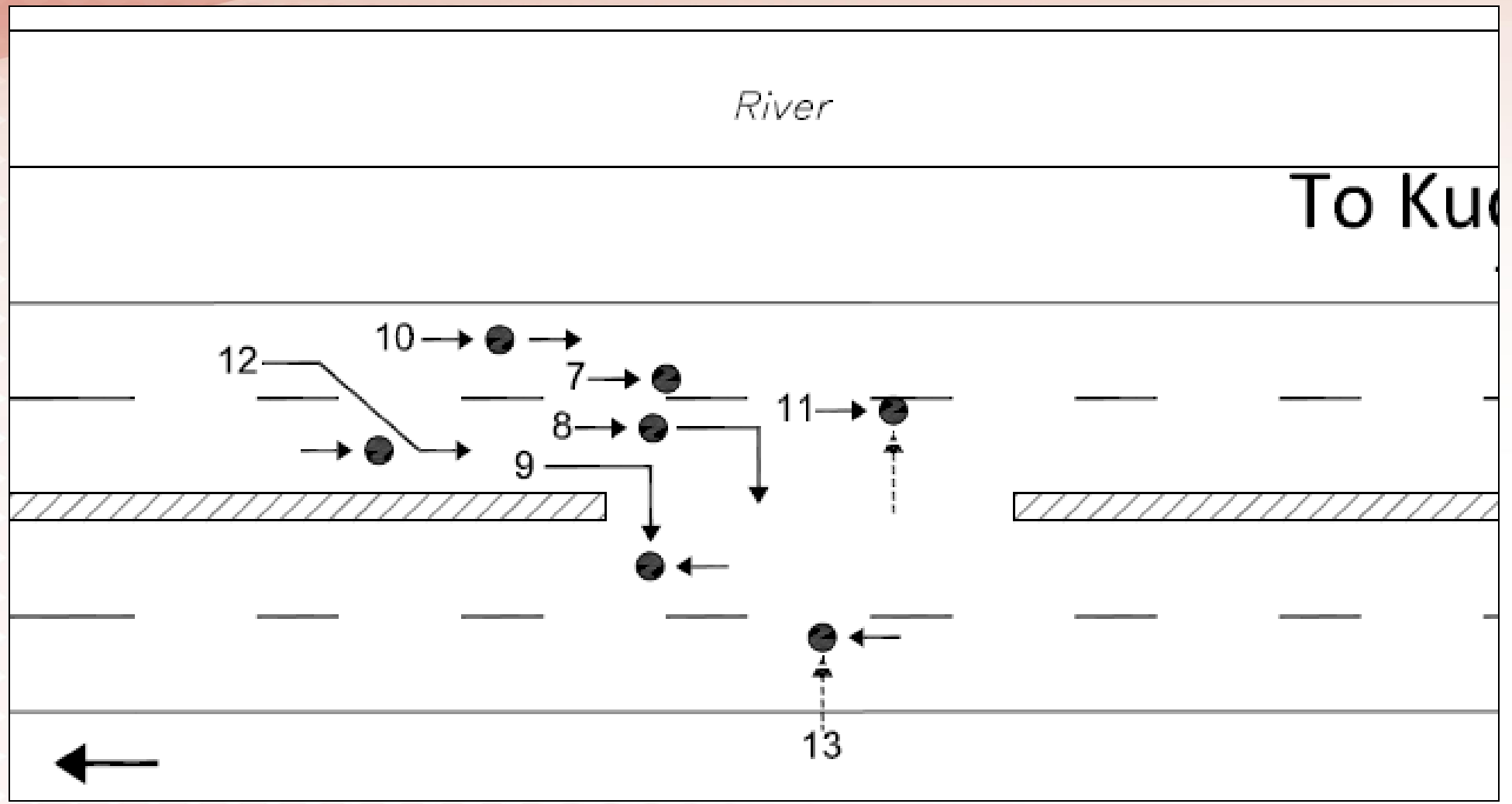
- Locations with most casualty (fatal and injury) crashes
- Always have more sites than funds can treat as some sites will not be able to be treated.

2 Draw a collision diagram and a crash factor matrix

- For each user, draw an arrow to show its direction during the crash
- Show pedestrians, cars, trucks, buses differently
- Give the point of impact accurately

- For each crash, use one column to summarise the crash data
- Microsoft Excel
- Sort by various factors – look for patterns

A Collision Diagram



A Collision Diagram

A Crash Factor Matrix

Accident Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date: day: month	1307	0409	1912	0806	0307	0711	3012	2702	0305	2407	1804	2105	1406	2008
Date: year	17	17	17	18	18	18	18	19	19	19	19	19	19	19
Day of week	Sat	Wed	Thu	Sun	Thu	Fri	Tue	Fri	Sun	Fri	Sun	Fri	Mon	Fri
Time of day	1700	1855	1530	1900	1345	2145	1900	1220	1800	2000	1845	1610	1735	1855
Severity	3	3	2	3	2	4	3	3	4	2	3	2	2	3
Light conditions														
Road Conditions	W	W	D	D	D	D	D	D	D	D	D	D	W	D
DCA Code	101	101	101	101	101	101	101	101	101	101	101	101	101	101
Object 1	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Car	Van	Car
Object 2	Car	Car	Truck	Car	Car	Car	Car	Truck	Car	Car	Car	Car	Car	Car
Object 3					Car			Car			Car			
Direction 1	N	S	N	S	N	S	S	S	S	S	N	S	N	S
Direction 2 (& 3)	E	W	E	W	W,E	W	E	W,N	E	W	W,E	W	W	W
Other														

3 Diagnose the crash problem

Examine the Collision Diagram and the Crash Factor Matrix

Look for *patterns*?

- Day time vs nighttime?
- Wet vs dry?
- Type of crash - head on, or run-off-road, pedestrian etc
- Type of road user?
- Direction of travel?

3 Diagnose the crash problem

- Engineers are like a doctor – diagnosing a “sick” part of the road (a blackspot).
- The blackspot cannot speak – the engineer must look, listen, read crash data, speak with Police, ask locals.
- This takes time, skill, and logic.
- The blackspot needs the correct treatment (“medicine”)

4 Inspect the site – look for contributing factors to the pattern of crashes

Engineers should inspect the site at the time of the pattern of crashes

They put themselves in the shoes of those involved.

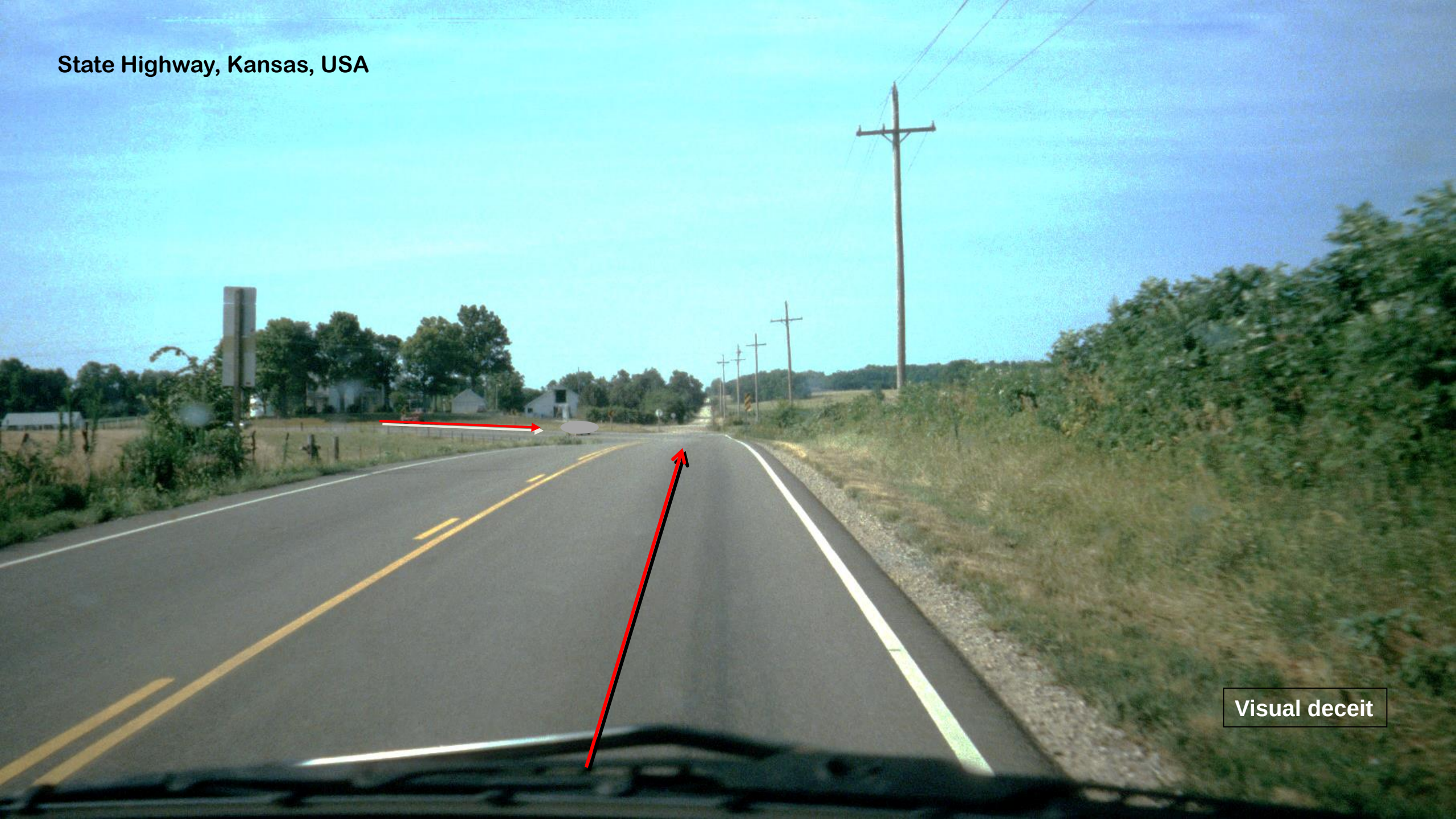
They ask ….. why did this crash happen?

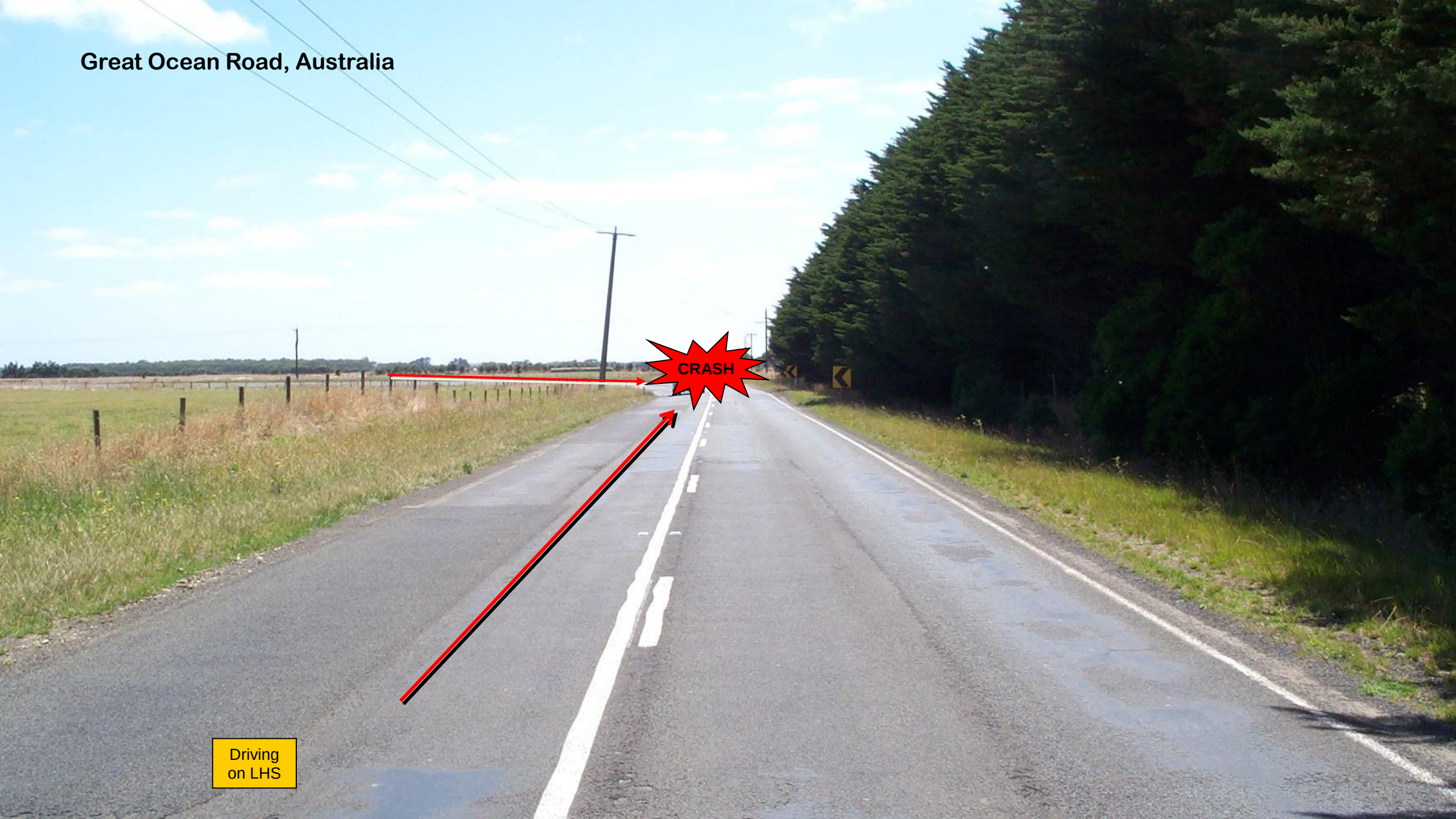
Visual deceit

- Not all drivers/riders see the road the same way.
- Look at the road as others “might”

Tips for your site inspection

(NOTE: some crashes have nothing to do with the road!!)


State Highway, Kansas, USA
Visual deceit


Great Ocean Road, Australia
CRASH
Driving
on LHS

TIPS FOR THE SITE INSPECTION

(SOME CRASHES HAVE NOTHING TO DO WITH THE ROAD!!)

With intersection right angle crashes – decide if the crash is an *overshoot* or a *re-start*.

Why?

Because the countermeasure(s) may be quite different.


A car failed to give way at a rural crossroads.
But why?
Was it overshoot, or re-start?


A car failed to give way at a rural crossroads.
But why?
Image © 2023 Maxar Technologies

Overshoot or re-start?

Four killed


Police

Overshoot **– the driver did not know the intersection was there**

Countermeasures include:

- Improve Approach Sight Distance
- Make intersection more conspicuous
- Advance warning signs
- Advance direction signs
- Duplicate GW or Stops
- Lighting (only if crashes are at night)
- Roundabout or traffic signals

Re-start **– driver knew intersection was there, slowed, maybe stopped, but selected a "wrong" gap**

Countermeasures include:

- Improve Safe Intersection Sight Distance
- Maximise sight lines
- Reduce speeds
- Geometric changes
- Cut trees/grass – improve sight distances
- Reduce speed limits
- Roundabouts or traffic signals

Chapter 5 Treating a blackspot with suitable countermeasures

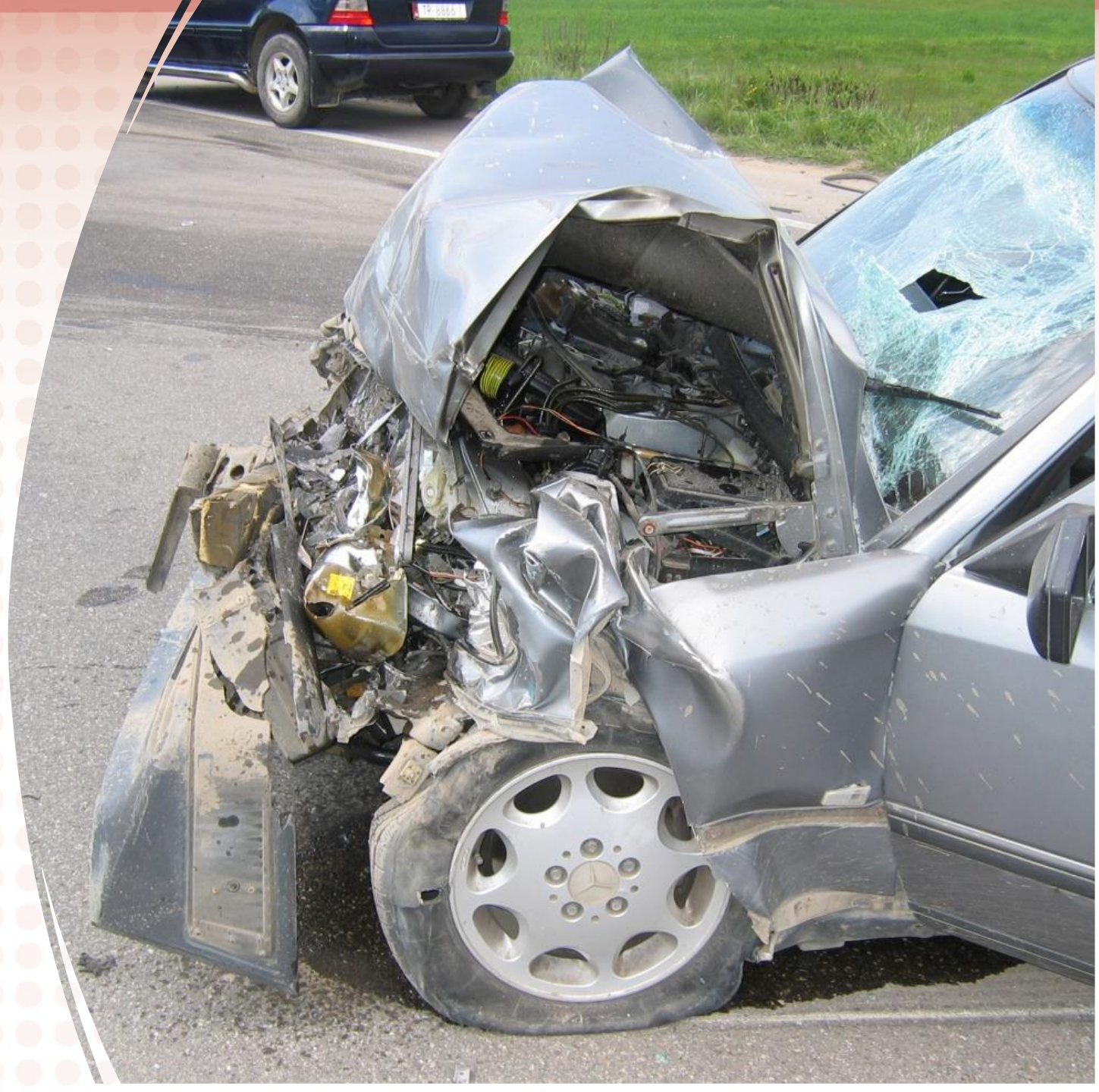
A. Intersection collisions
B. Mid-block collisions
C. Rural run-off-road crashes
D. Pedestrian crashes
E. Mass action treatments

Logic ……

- Recommend only countermeasures that will reduce the crashes.
- Do not replace anything old or rusty, unless it played a direct role in the crashes.
- $ are always limited – so look first for low-cost options.

COMMON LOW-COST COUNTERMEASURES

- Signs – warning, regulatory, direction
- Line marking
- Delineation
- Shoulder sealing
- Roadside hazard management
- Geometric changes
- Sight lines (remove vegetation)
- Speed limits
- Traffic signals
- Roundabouts
- Lighting



Chapter 6 Determining which blackspot treatments to fund

A. Economic assessment of blackspot treatments
B. Benefit cost ratio
C. Crash reduction factors
D. Writing a blackspot report
E. Interim Countermeasure Treatments

5 Calculate a benefit/cost ratio for recommended treatments

WHY?

There will be competition for funding within a national blackspot program.

The national road authority will need to rank all the blackspot treatments so that funds are spent on those sites that will return the “best value” to the country.

TO DETERMINE BENEFIT/ COST RATIO

1We need the benefits of the countermeasures (in $)

2We need the cost of the countermeasures (in $)

3Then we can calculate the benefit/ cost ratio

HOW TO ESTABLISH THE BENEFITS OF A TREATMENT

Benefits = the number of crashes you expect to save, times how much would each one costs your country (in $).

For this we rely on before/after crash data of past treatments.

Another important reason for accurate crash data

CRASH REDUCTION FACTORS

PAVEMENT WORKS	%	YEARS
Road reconstruction	25%	20
Duplication short length	30%	20
Install raised median	30%	20
Add median strip	20%	20
Widen pavement	10%	20
Construct overtaking lane	25%	20
Add lane	10%	20
Widen road for Right Turn lane	50%	20
Widen road for Left Turn lane	15%	20
Lane widening - 0.3m	5%	20
Lane widening - 0.6m	12%	20
Widen shoulder not seal - 0.3m	3%	20
Widen shoulder not seal - 0.6m	7%	20
Widen shoulder not seal - 1m	10%	20
Widen shoulder and seal - 0.3m	4%	20
Widen shoulder and seal - 0.6m	8%	20
Widen shoulder and seal - 1m	12%	20

CAREC needs crash reduction factors?

CRASH REDUCTION FACTORS BASED ON REAL EXPERIENCE FROM THE VICTORIAN (AUSTRALIA) BLACKSPOT PROGRAM SINCE 1980

DELINEATION		
Reflectorised guideposts	30%	20
Advance Curve Warning signs - static	20%	15
Advance Curve Warning signs - vehicle activated	75%	15
Install chevron signs (CAMS) - normal	35%	15
Install chevron signs (CAMS) - electronic	50%	15
Painted centrelines	30%	5
Tactile centrelines	40%	5
Painted edge lines	25%	5
Tactile edge lines	35%	5
Barrier lines	30%	5
Raised reflectorised pavement markers (RRPM)	20%	5

ROADSIDE HAZARD MANAGEMENT		
Wire Rope Safety Barrier (WRSB)	45%	20
Guardrail	35%	20
Median barriers (any type including centreline WRSB)	20%	20
Guard rail at culvert	25%	20
Guardrail for bridge end post	20%	20
Crash Cushions	15%	20
PEDESTRIANS & CYCLISTS		
Refuges, Channelisation, Kerb extension	30%	20
Pedestrian signals	25%	15
Bicycle paths, threshold treatments	10%	20
Upgrade pedestrian signals	20%	15
Pedestrian overpass	10%	20
MOTORCYCLISTS		
New roundabouts	75%	20
Intersection signal remodel	50%	15
Fully Controlled Right Turn	55%	15
Shoulder sealing	50%	20
STREET LIGHTING		
Provision of street lighting general	25%	15
Improve lighting at intersections	25%	15
Improve lighting at roadway segment	25%	15
Improve lighting at PEDESTRIAN CROSSING	40%	15
Improve lighting at railway crossing	10%	15

Benefits – use the largest Crash Reduction Factor and multiple by its lifespan

- 20 reported crashes in 5 years
- A roundabout will reduce 70% (14) of these crashes
- 20 years = 4 x 14 = 56 fewer crashes due to the proposed roundabout
- One casualty crash = $150,000
- 56 x $150,000 = $8,400,000 benefits in 20 years

BREAK OUT SESSION 2 STANDARDS and PRACTICES

15 minutes to discuss your present design standards.

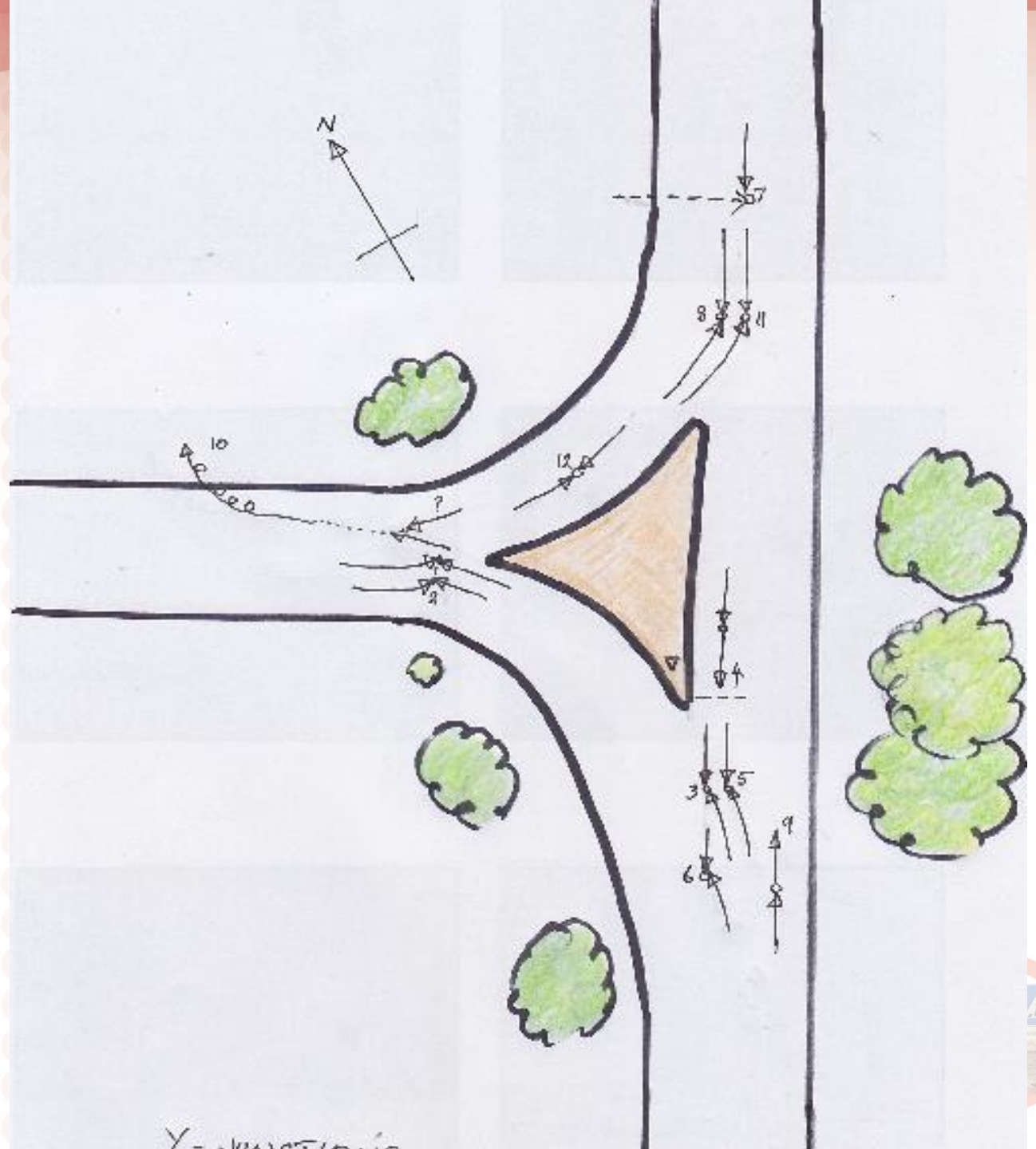
- How are your standards established?
- Are they reviewed and updated based on international best practice?
- How are changes shared with stakeholders?
- Are your standards and practices leading to “safe” roads?

Chapter 7 Blackspot case studies

- An urban crossroad intersection.
- A highway passing through a village.
- A rural blacklength within a series of curves on a highway in a hill area.
- A rural complex intersection.
- Mass action treatments

Blackspot One

12 casualty crashes in 3 years


N
10
12
7
8
11
3
5
6
9
4

CRASH NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
DATE	12/3	14/5	11/7	29/1	28/3	1/4	5/9	8/2	31/4	26/6	10/8	7/9
DAY OF WEEK	SUN	FRI	WED	WED	WED	SUN	WED	SAT	MON	TUES	SUN	SAT
TIME OF DAY	13.00	23.30	20.30	16.50	23.00	18.30	22.00	17.40	04.00	04.00	23.30	20.30
SEVERITY	1	2	2	3	1	2	2	1	1	2	1	3
LIGHT CONDITION												
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	WET	DRY	WET	DRY	WET	DRY	DRY
CRASH TYPE	202	202	202	301	202	202	001	202	301	802	202	102
VEHICLE 1	CAR	CAR	BUS	BUS	CAR	M/C	CAR	CAR	CAR	TRUCK	M/C	CAR
VEHICLE 2	BUS	TRUCK	TRUCK	CAR	M/C	BUS	PED	CAR	M/C	?	TRUCK	CAR
VEHICLE 3										?		
DIRECTION VEH.1	E	E	S	S	S	S	S	E	N	NW	E	E
DIRECTION VEH.2	N	N	NW	S	NW	NW	E	S	N	?	S	W
DIRECTION VEH.3												
OBSERVATIONS			SPEED	SPEED						MAY HAVE BEEN ANOTHER VEH INVOLVED	SPEED	

12 crashes in 3 years

5 fatal crashes (8 lives lost)
5 serious injury crashes (12 people injured)
2 minor injury crashes

Estimated cost of these 12 crashes

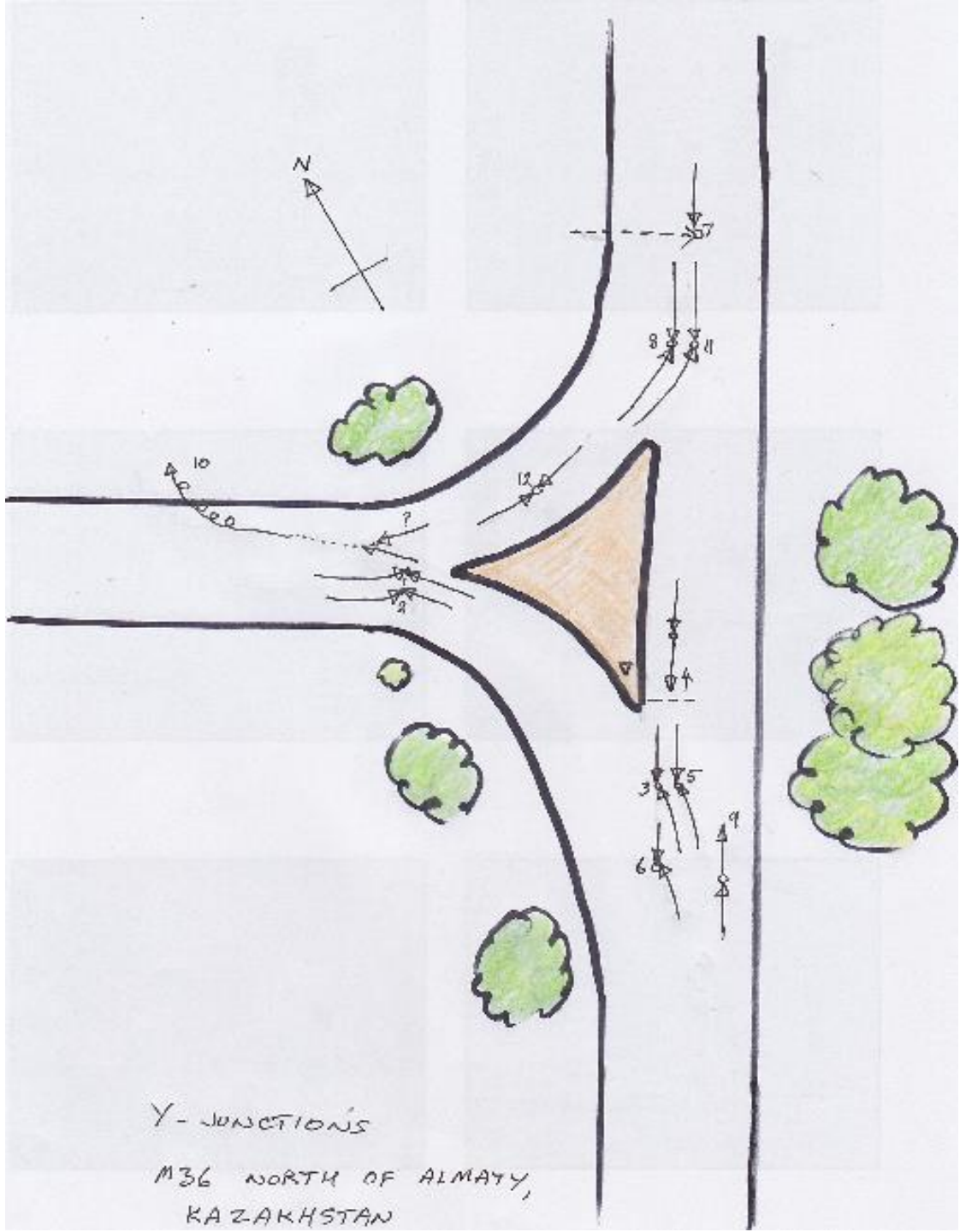
- 8 deaths x $600,000 (fatalities)
- 12 injuries x 0.25 x $600,000

TOTAL $6,600,000 in 3 years or av. $2,200,00 pa.

What patterns do you see?

What will you recommend?

What is the BCR?



Y-JUNCTION BLACKSPOT ON M36

Y-JUNCTION BLACKSPOT ON M36

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ON M36

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Y-JUNCTION BLACKSPOT ON M36

What countermeasures do you suggest?

- Remove Y junctions?
- Roundabout, T junction?

- Lighting
- Signs – warning, direction both?
- Lower speed limit?

- Paved shoulders?
- Delineation?

Something else? Interchange? Flyover?

A two-stage package of treatments

Stage 1

- new diagrammatic advance direction signs on all approaches.
- oversized (900mm) “Intersection” warning signs on both approaches of NH.
- tactile centre line and edge lines on NH.
- duplicate Give Way signs and marking for minor road traffic.
- advance warning sign “Give Way Ahead” on the minor road.
- pave all shoulders through the intersection (1.5m wide, at least 200m each side of intersection).

Stage 2

- square up the minor road to intersect the NH at a T-junction.
- widen the NH; channelise it. Include a sheltered left turn lane for traffic turning from the NH to the minor road.
- install lighting at the intersection.

Treatments	Crash Reduction Factors	Treatment Life
INTERSECTION		
New roundabout	**80%**	20
Modify roundabout (approach deflection)	**55%**	20
New traffic signals	**45%**	20
Convert intersection signals to roundabout	**30%**	20
Staggered T low volume (<2000 AADT of through road)	**70%**	20
Removal of Y-intersection	**85%**	20
Splitter islands/median, urban	**20%**	20
Splitter islands rural, low volume	**45%**	20
Linemarking to improve intersection definition	**10%**	5
Improve sight distance	**50%**	20
Improve signage	**30%**	15
Rumble strips on approaches	**30%**	5
Install Stop signs	**30%**	15
Install signs	**30%**	15
Change to Stop signs	**5%**	15

BCR

Stage 2

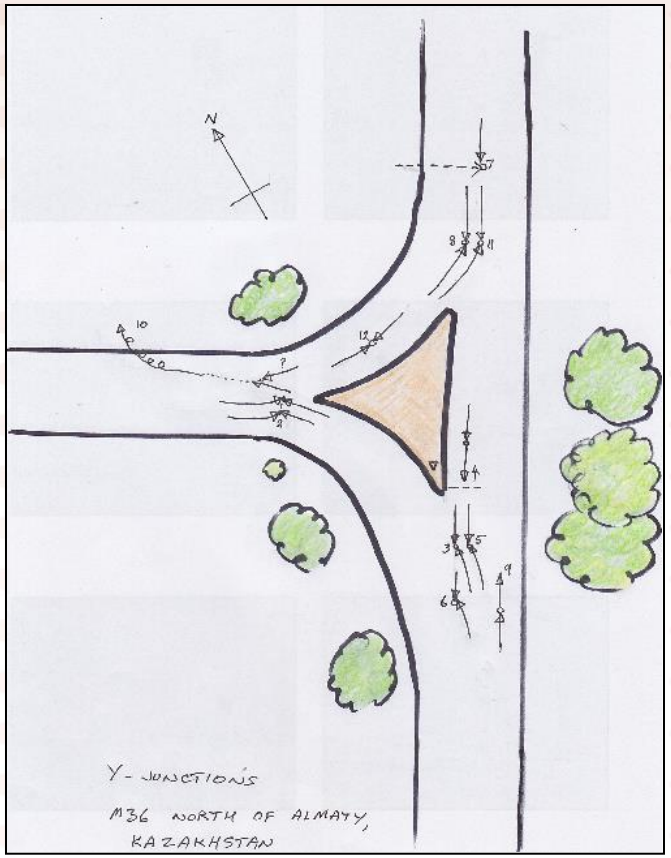
Crash reduction factor 85% for 20 years

Crash savings = 85% of $44,000,000
= $37,400,000

The removal of the Y junction, signs, lines and lighting will cost $2,900,000

Benefits = $37,400,000
Costs = $2,900,000

BCR = 12.9



Blackspot Two

Six pedestrian fatalities, many other serious casualty crashes in 2 years.


Image © 2019 DigitalGlobe
Google Earth


КАДУЧИ
KADUCHI

What countermeasures do you suggest?

- More lighting
- Signs – warning, direction both?
- Lower speed limit

- More Zebra Crossings

- Something else?


ISUZU


40
PAINSWICK
Fairtrade
40
40

Recommended treatments:

- traffic calming
- large gateway signs each end of village
- 40km/h speed limit
- road humps each 100m
- Zebra Crossings (only on humps) near mosques, schools

Crash reduction factor 30% for 20 years

Crash savings = $2,675,000

The humps, sealing, signs and line marking will cost $225,000

Benefits = $2,675,000
Costs = $225,000

BCR = 11.9

This project will be compared with all other blackspots in the country – those with the highest BCR's will be treated first. The others will wait for next year.....

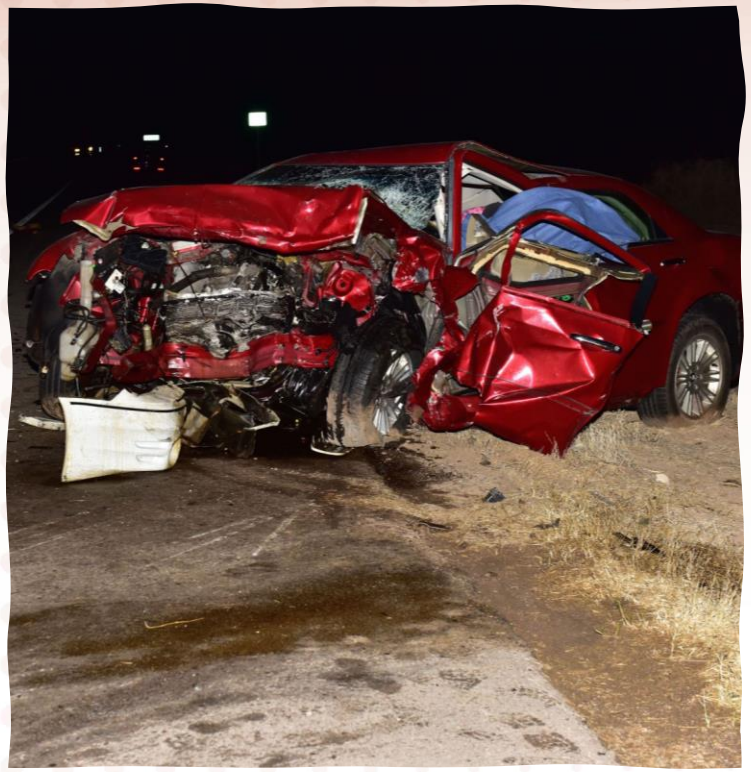
BCR

Chapter 8 The next steps

A. Establishing a national blackspot removal program
B. Monitoring the treated blackspots

“A blackspot removal program is a positive investment in safety that returns big dividends for a country”.

- Prepare a national road safety strategy that includes action to identify, investigate and treat blackspots.
- Commit to a country-wide program of blackspot removals.
- Work closely with Traffic Police. Share crash data.
- Monitor the performance of treated blackspots.



I LOOK FORWARD TO YOUR QUESTIONS

BREAK OUT SESSION 3 FUTURE BLACKSPOT PROGRAM

15 minutes to discuss what your country needs to establish an on-going blackspot program.

- Better data?
- Trained engineers?
- Funding?
- What else is needed for an effective national blackspot program?