CAREC Road Safety and Sustainable Mobility Course

February 2024

Safer Roads and Roadside Infrastructure

“Investigating High Crash Frequency Sites” (blackspots)

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Objectives of this session:

- For you to work in small teams to investigate some hazardous locations on CAREC roads and to recommend practical countermeasures.
- To learn by doing.
- To appreciate the need for good crash data.

WHAT IS A BLACKSPOT?

- A blackspot is any site with many casualty crashes
- Casualty crash means a fatal crash, or a crash in which at least one person is injured (serious or slight)
- Intersections, short lengths, or curves = blackspot
- Road length of 1km = black length

Engineers need good crash data

Engineers need to know:

Where the crash happened (accurately), when it happened (day/night)

The road users involved (direction, type)

Conditions at the time – rain, wind, fog, snow, sun

Engineers need good crash data

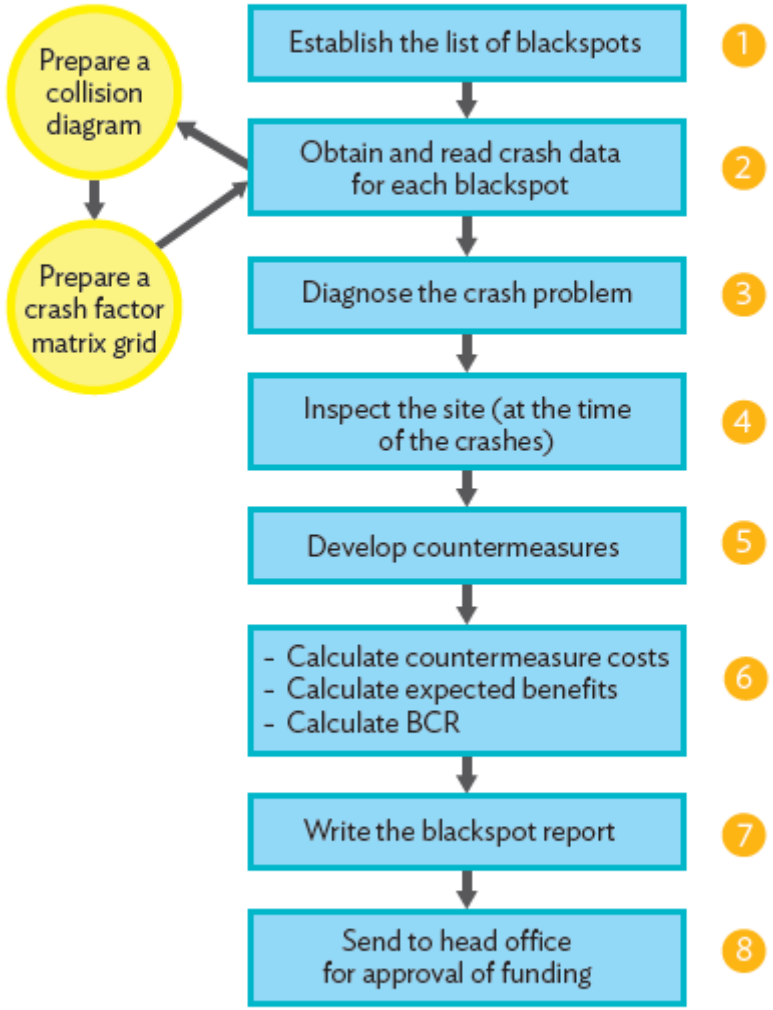
Engineers do not need:

Names, addresses of people involved

Vehicle registration details

Police prosecution information (alcohol, speed or drugs)

Figure 5: The 8 Key Steps in the Investigation Stage of the Blackspot Process

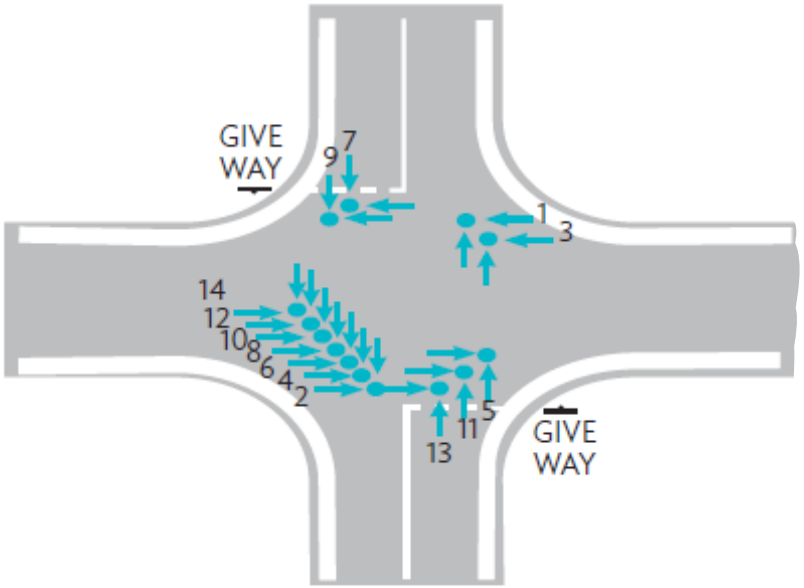


BCR = benefit/cost ratio.
Source: ADB road safety engineering consultant.

Engineers look for *patterns* in the crashes

Draw a collision diagram

Figure 6: A Collision Diagram for a Blackspot at a Crossroad Intersectio



Note: This collision diagram illustrates a clear pattern of right-angle collisions, with 9 out of 14 crashes involving vehicles from the north.

- For each vehicle in the crash, draw an arrow to show its direction
- Show pedestrians, cars, trucks, buses differently

Draw a crash factor matrix

- For each crash – summarize the details in one column.
- This offers patterns such as day/time/light & road conditions

Crash Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date: Month	3/06	04/10	19/11	08/06	03/07	07/11	30/12	27/02	03/05	24/07	18/04	21/05	14/06	20/08
Day of the week	Sat	Wed	Thurs	Sun	Thurs	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	Wet	Wet	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet	Dry
DCC Code	110	110	110	110	110	110	110	110	110	110	110	110	110	110
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)	W	E	W	E	E	E	W	E	W	E	E	E	E	E

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?

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

Put yourself in the shoes of those involved.

Ask yourself ….. why did they have their crash?

If crashes happened at night, inspect at night!

Today, your site inspections will be done from photographs

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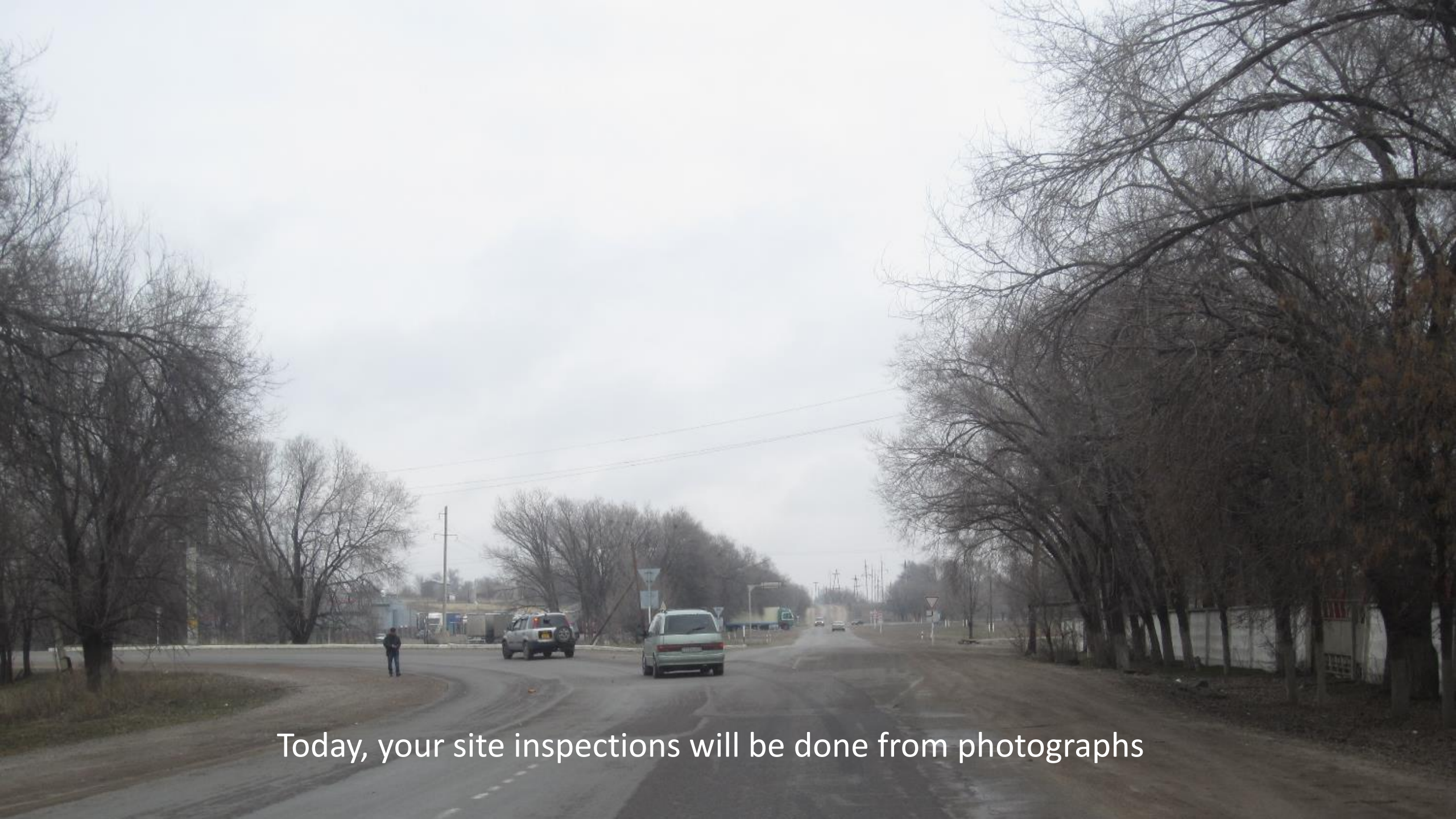

Today, your site inspections will be done from photographs

Be logical .....

Work in your team.

Recommend only countermeasures that will reduce the crashes

(For example, if crashes happened mainly during daytime, do not install street lighting as a countermeasure

And do not replace the nearby barrier simply because it may be old or rusty, unless it played a direct role in the crashes)

Develop countermeasures – discuss them with colleagues.

Keep your ideas simple

Use low-cost options wherever possible

Persevere – some sites are difficult, but most locations will be open to low-cost countermeasures

Finalise a preliminary design, and calculate a benefit/cost ratio for the recommendations

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

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

Next - calculate benefits and costs

Costs are easy!

But how do we calculate the benefits (in $).

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

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

How to determine benefits and costs?

1. Establish your countermeasures
2. Get the Crash Reduction Factor - the *highest CRF* of those in your treatments
3. Agree on a crash cost ($) for your country
4. Calculate the benefits of your treatments ($)
7. Calculate the cost of the works ($)
8. Calculate the benefit/ cost ratio
9. Head Office will approve funding based on BCR's.

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**

	Treatments	Crash Reduction Factors	Treatment Life
	INTERSECTION		
	New roundabout (urban, single lane)	**70%**	20
	New roundabout (rural, single lane)	**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 (remove/relocate obstruction)	**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

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

An example of calculating benefits. Use the largest Crash Reduction Factor from your package of countermeasures

- 20 reported crashes in 5 years
- A roundabout will reduce 70% (14) of these crashes
- 20 years = 4 x 14 = 56 fewer crashes

- One fatality in this CAREC country = $78,000 USD (approx.)
- One serious casualty = $19,500 USD
- Assume a serious *casualty crash* = $27,300

- 56 x $27,300 = $1,529,000 benefits in 20 years

Benefit/ Cost Ratio

BCR

- Benefits of a roundabout = $1,529,000 USD
- Cost of the roundabout = $460,000 USD

BCR = 3.33

(This is a good BCR and will likely receive funding approval)

CASE STUDIES

Four blackspots:

1. A rural junction
2. An urban pedestrian blacklength
3. A rural Y-junction
4. A blacklength through a village

Case study 1 Road section planning

What main planning problems do you see?

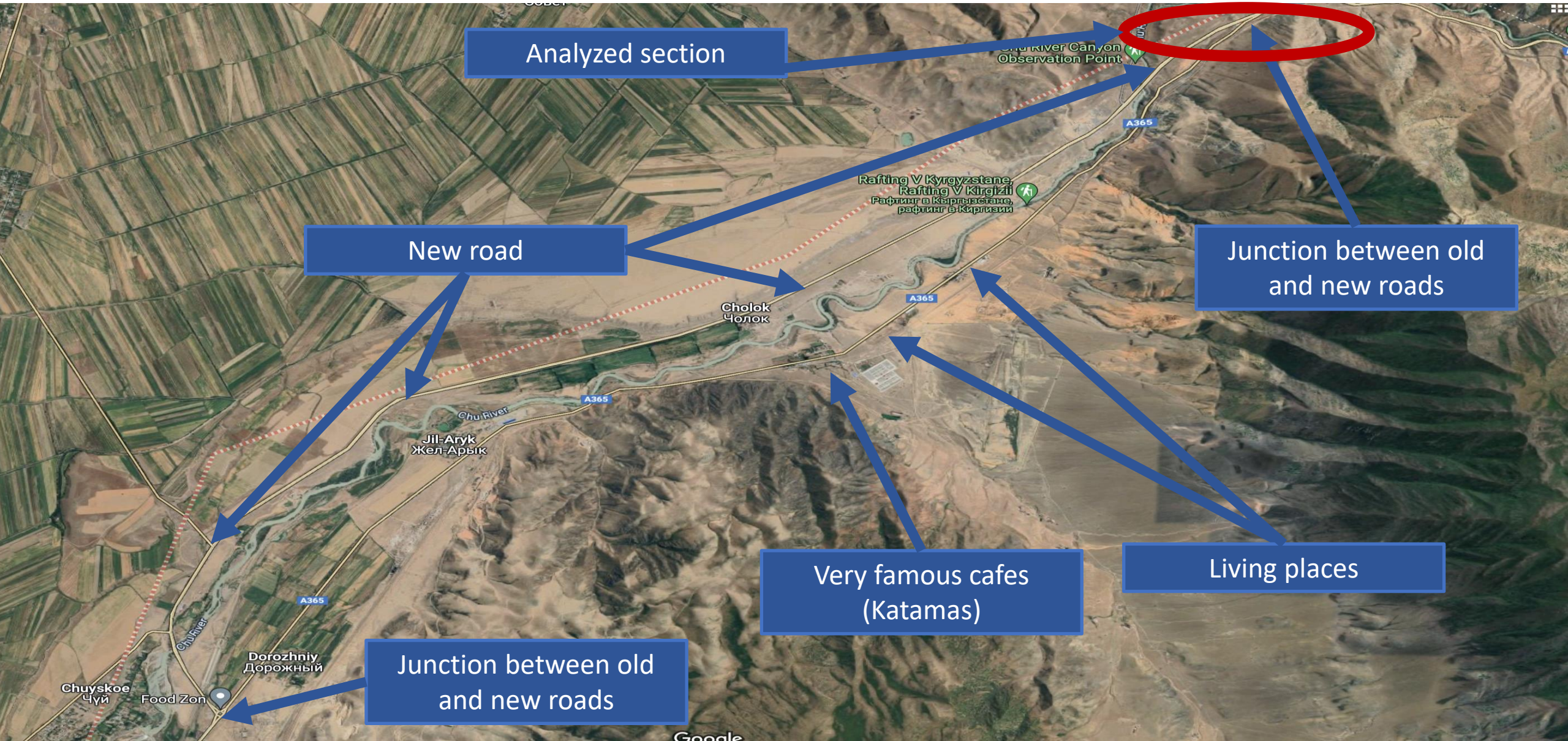
What local crash patterns do you see?

What treatments will you recommend?

What is your estimated BCR?

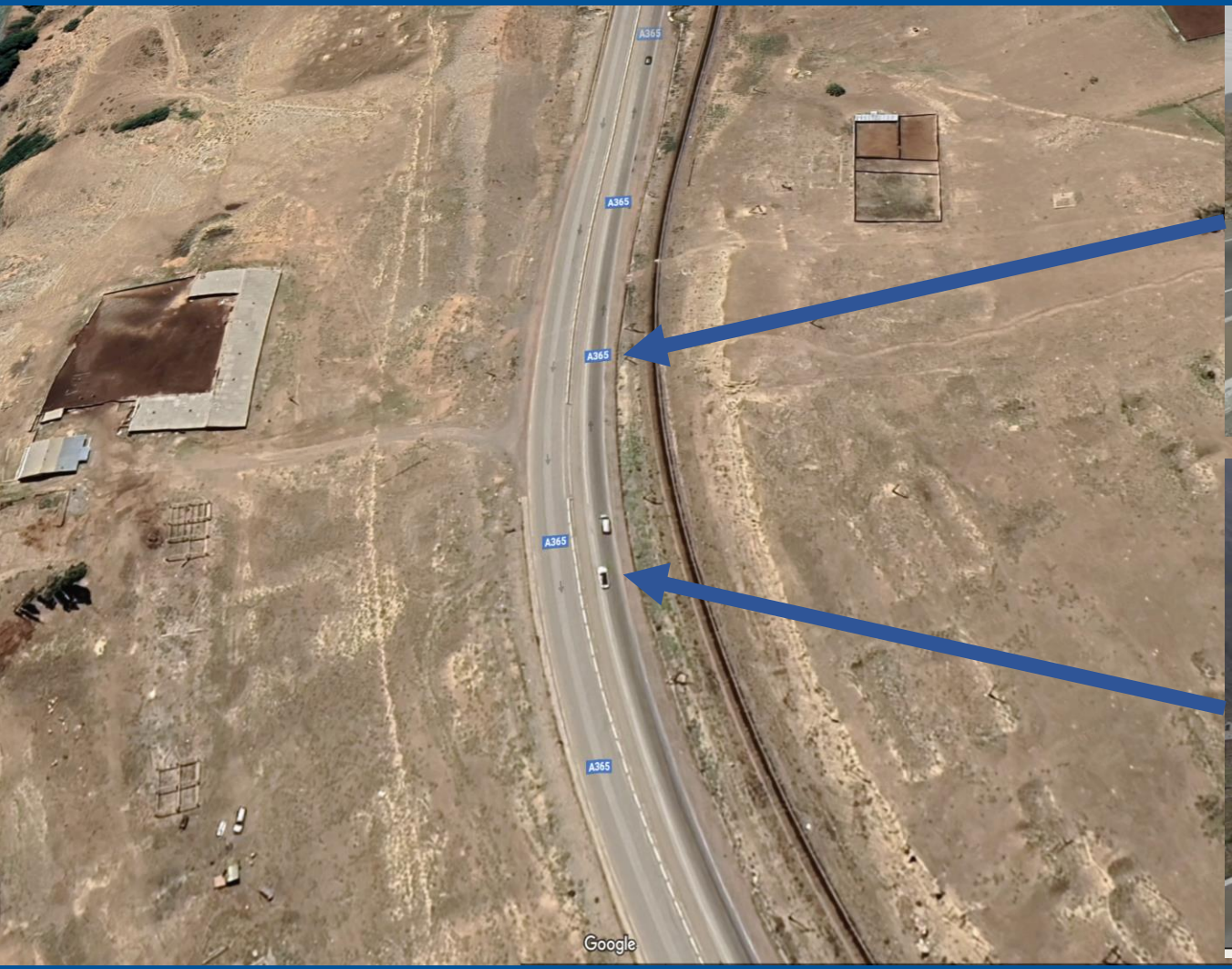
10 minutes

New and old roads connections



Analysed road section

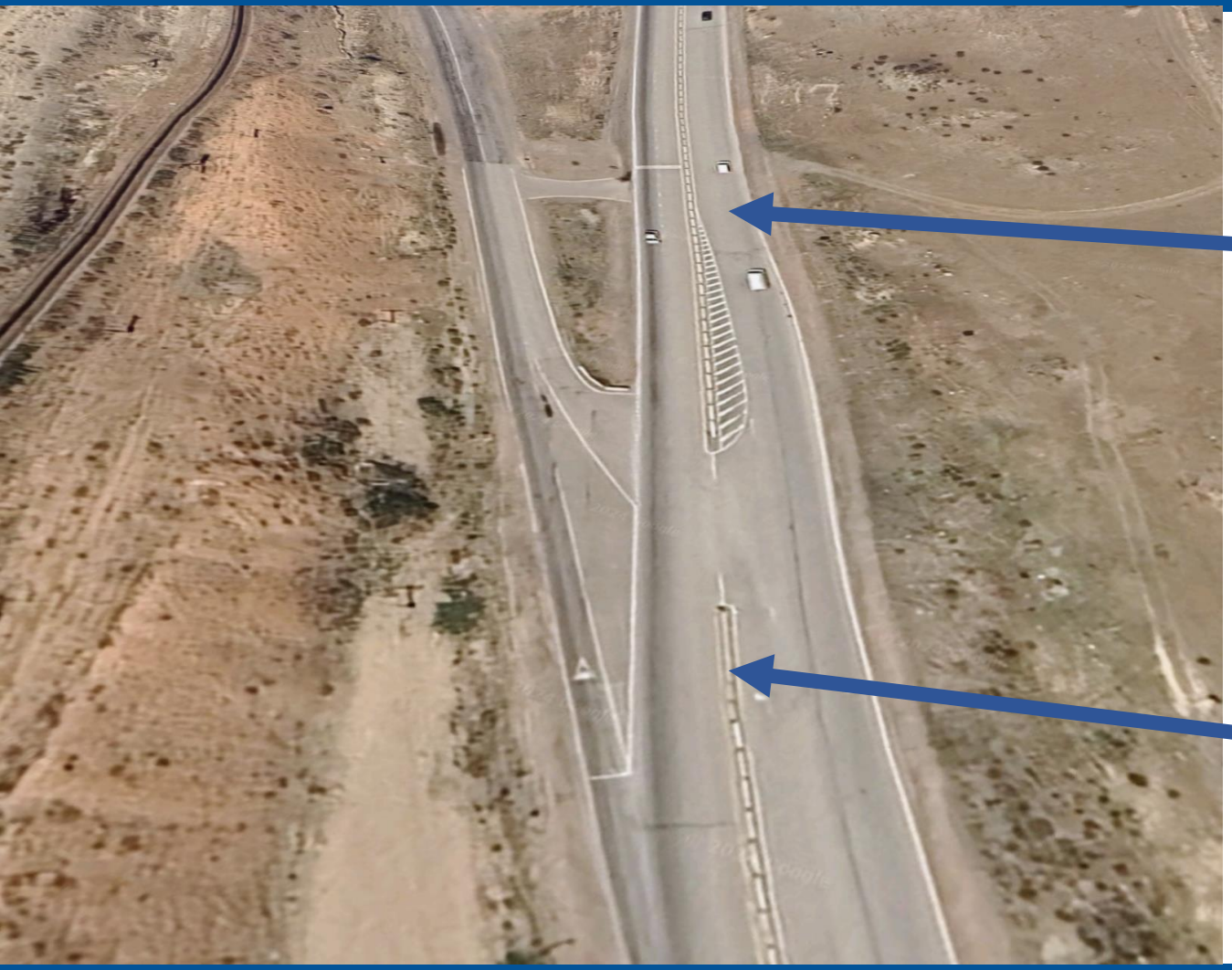
1st. Point. U-turn, turn to the left



2nd. Point. Road view

3rd. Point. Junction of old new roads

3rd. Point. Junction of old new roads



4th. Point. Road view

5th. Point. Junction and pedestrian crossing

5th. Point. Junction and pedestrian crossing

5th. Point. Junction and pedestrian crossing

5th. Point. Junction and pedestrian crossing

5th. Point. Junction and pedestrian crossing

5th. Point. Junction and pedestrian crossing

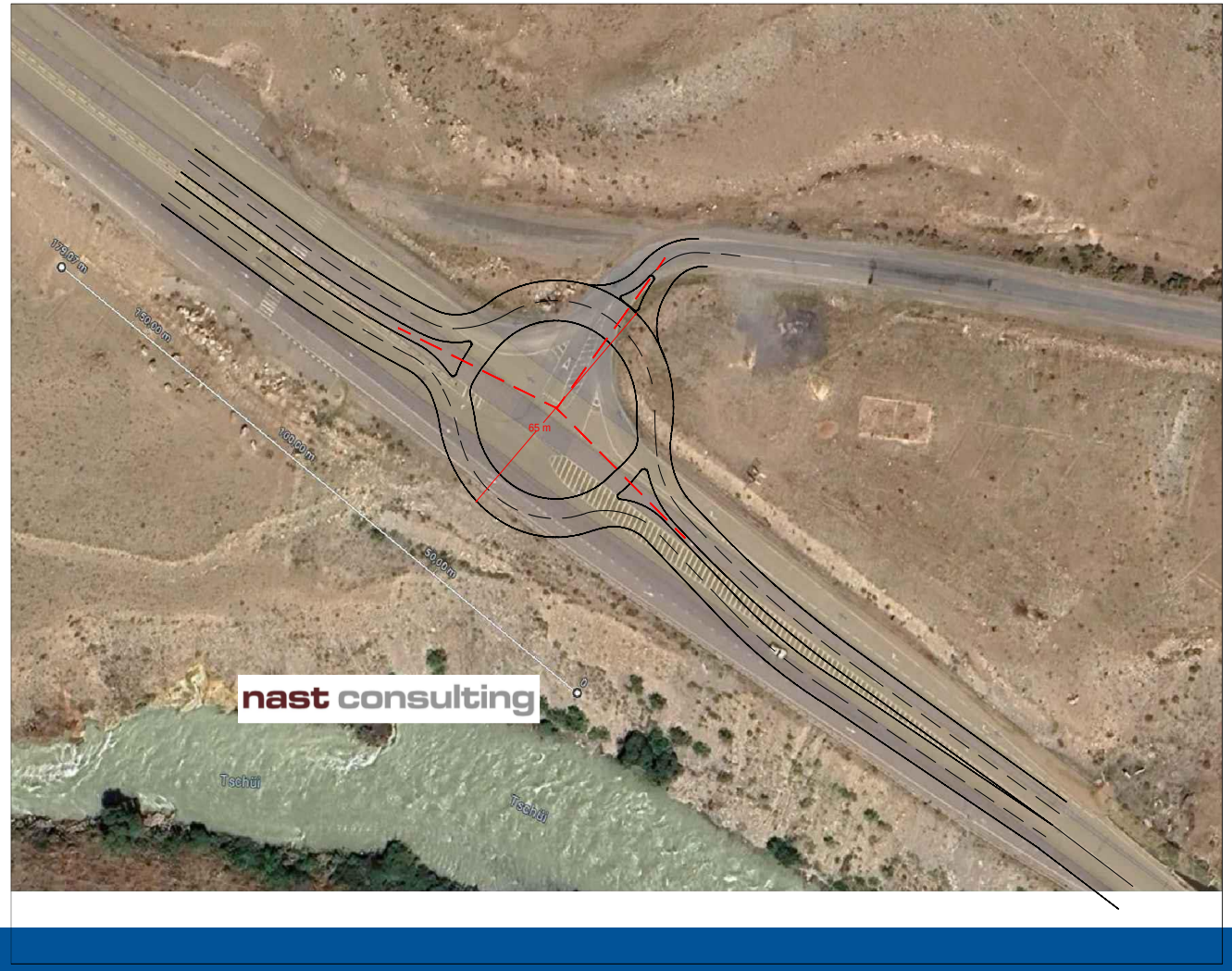
Accidents points

Crash details

CRASH NUMBER	1	2	3	4	5	6	7
DATE	11/6	14/2	11/7	29/7	28/8	1/4	5/9
DAY OF WEEK	SUN	SAT	SAT	SUN	WED	SUN	WED
TIME OF DAY	13.00	23.30	20.30	16.50	23.00	18.30	22.00
SEVERITY	1	2	2	3	1	2	2
LIGHT CONDITION							
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	WET	DRY
CRASH TYPE	207	307	103	103	104	103	001
VEHICLE 1	CAR	CAR	BUS	BUS	CAR	CAR	CAR
VEHICLE 2	CAR	TRUCK	TRUCK	CAR	M/C	BUS	PED
VEHICLE 3							
OBSERVATIONS			SPEED	SPEED			SPEED

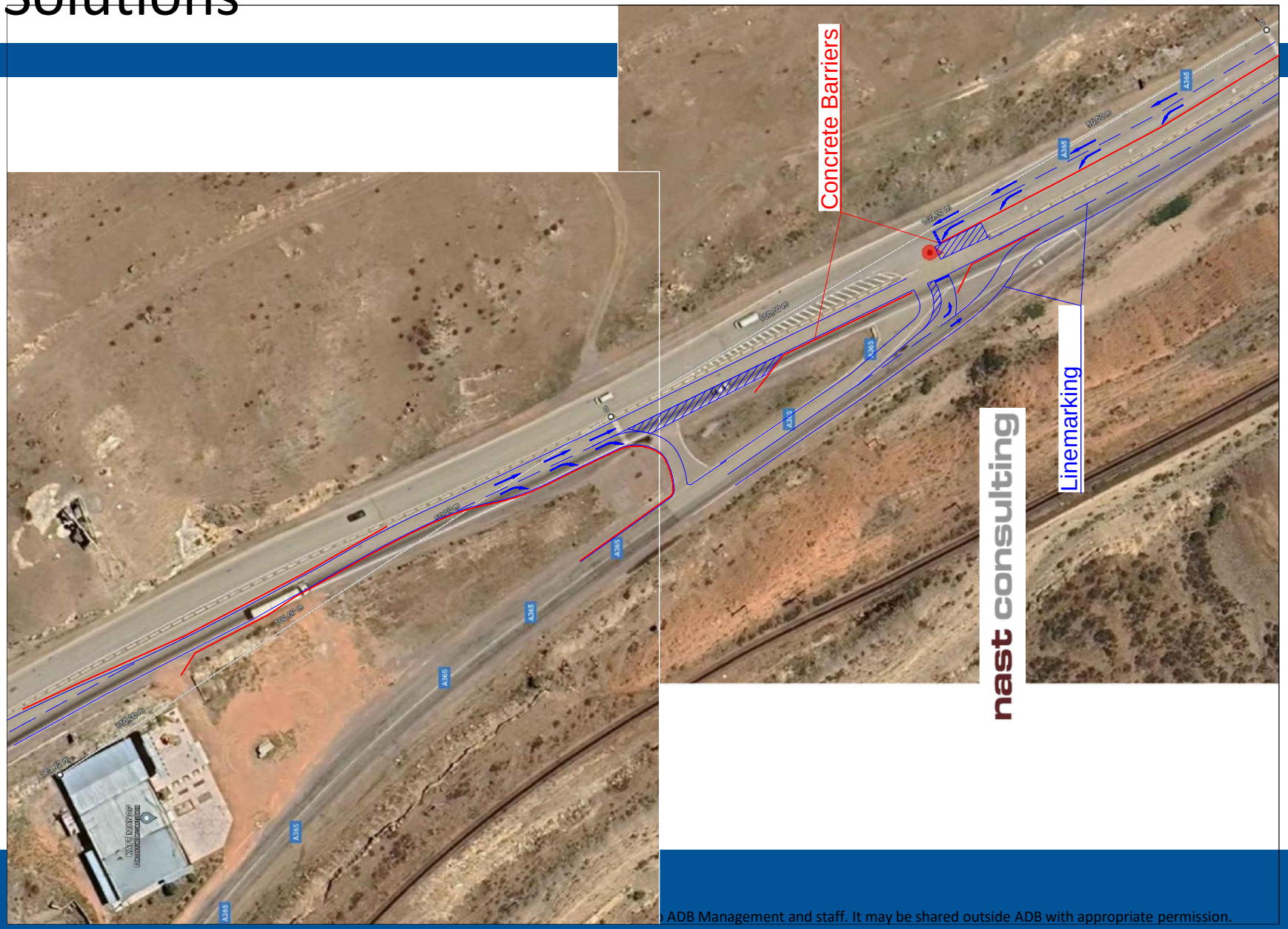
Solution for the section

Solutions



Solutions

Solutions



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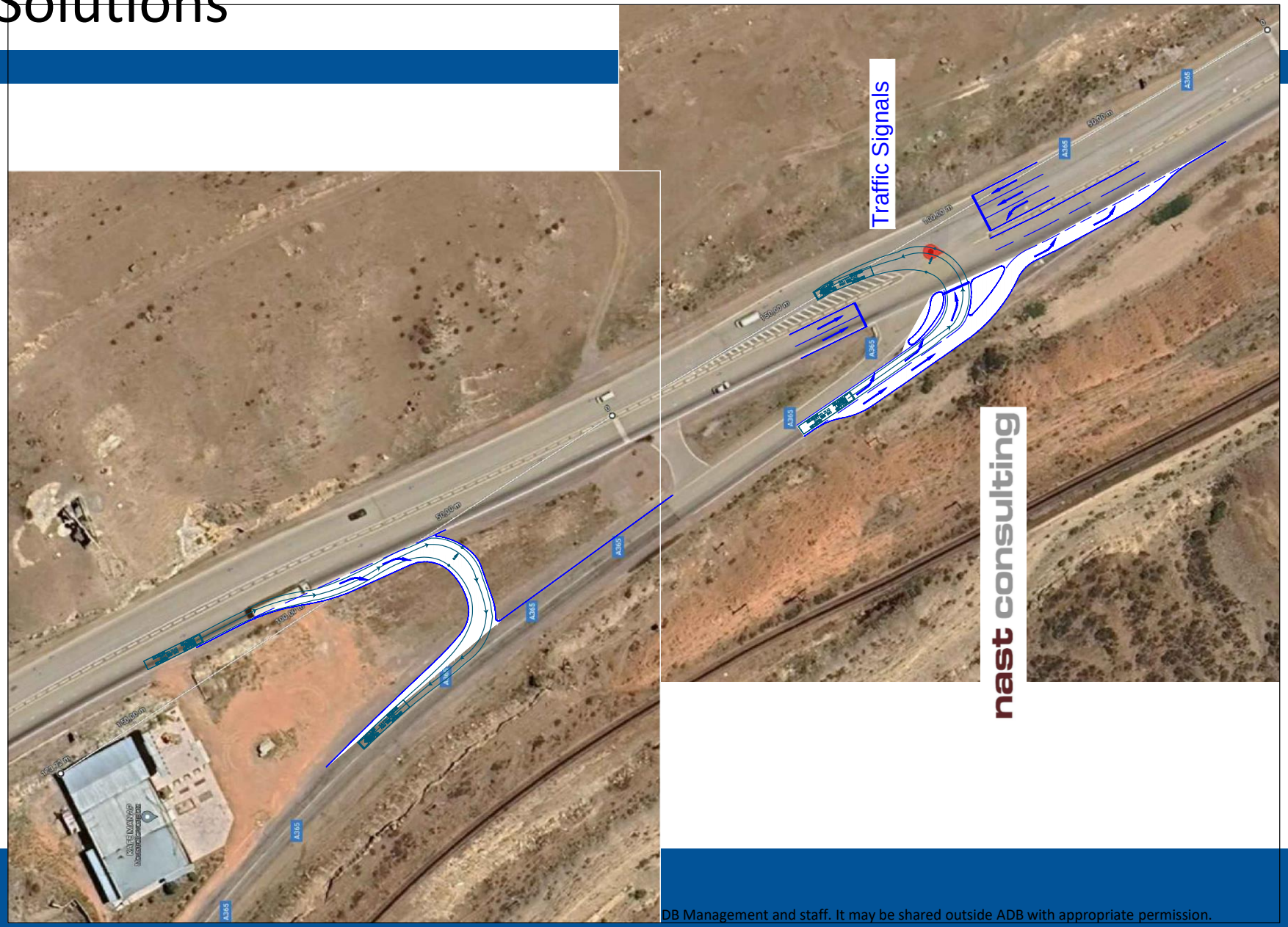
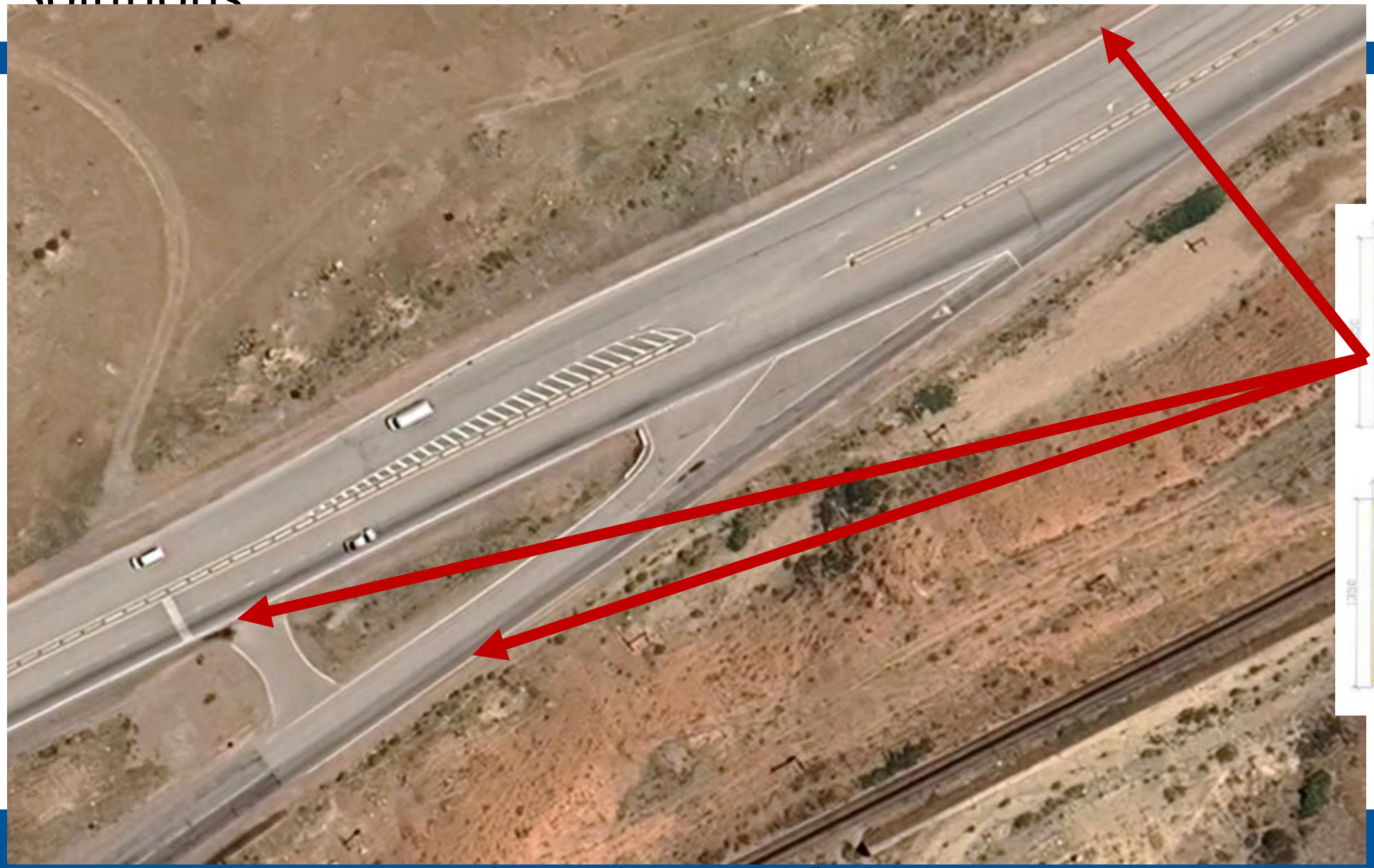
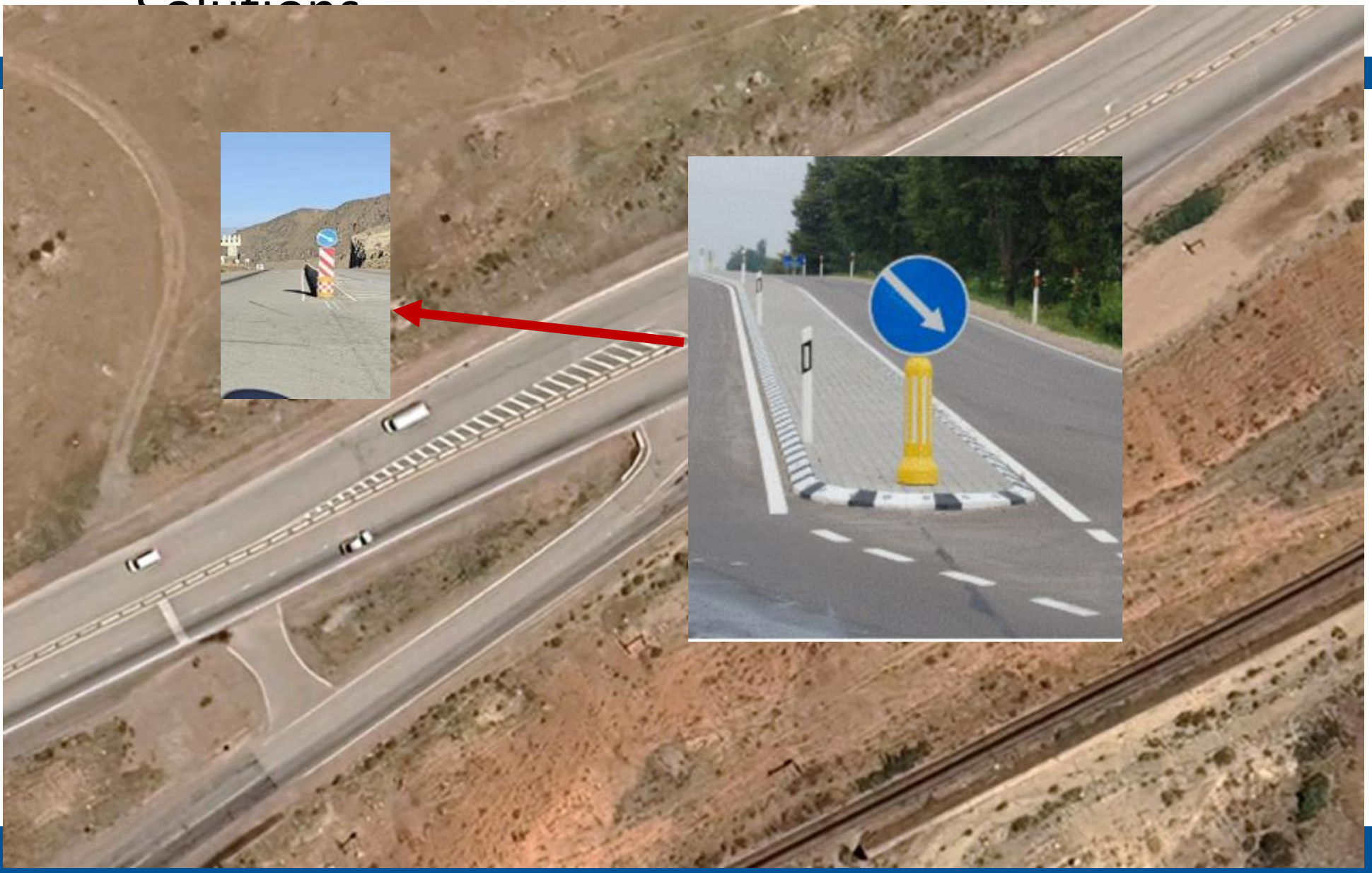
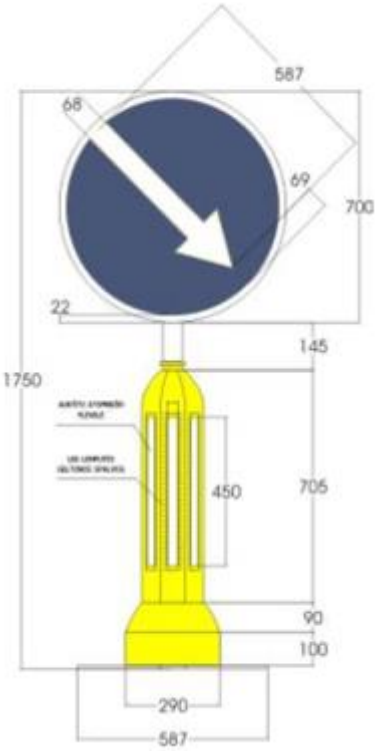


Solutions



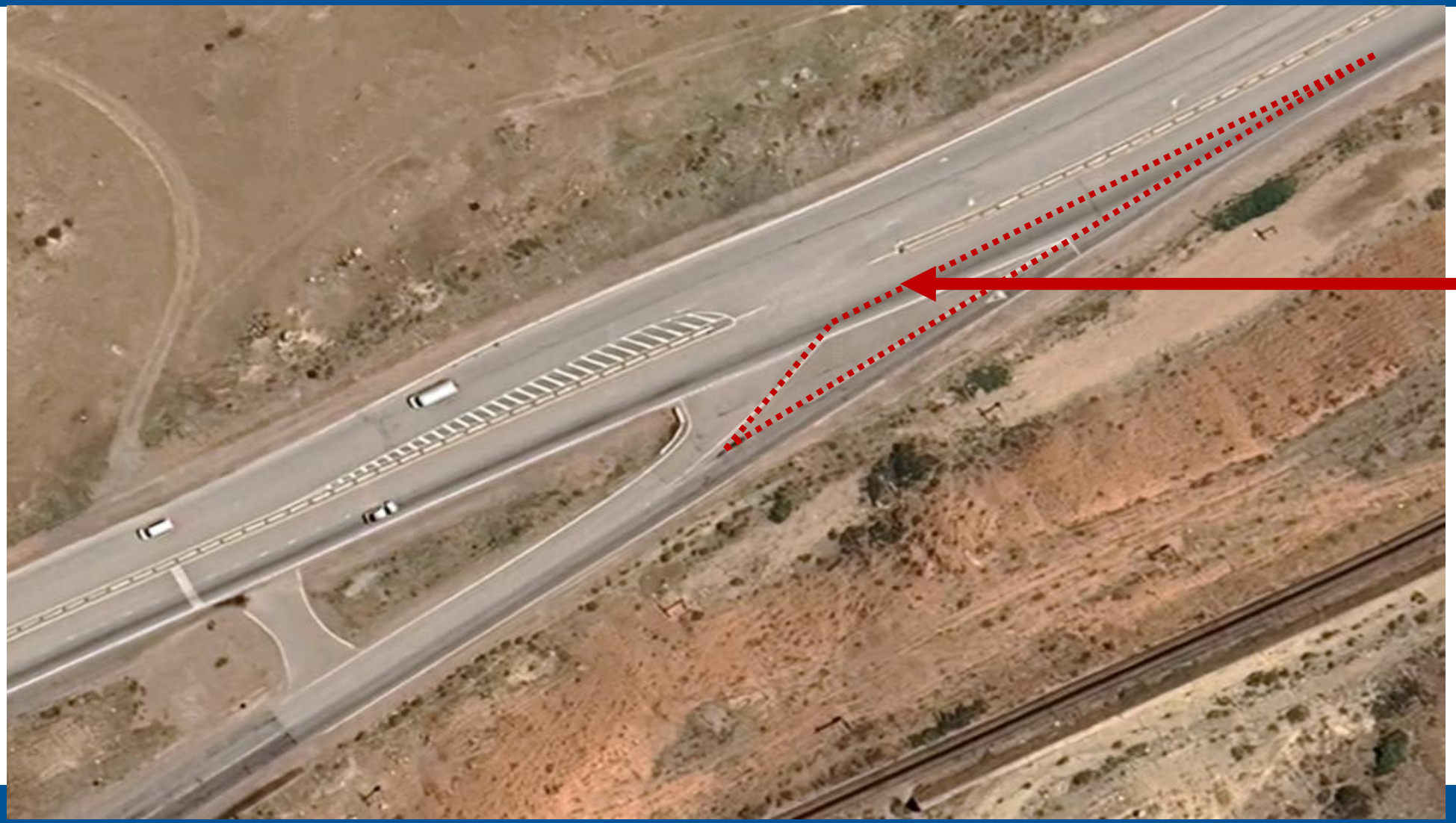
Solutions





Solutions

Solutions



Solutions

Case study 2

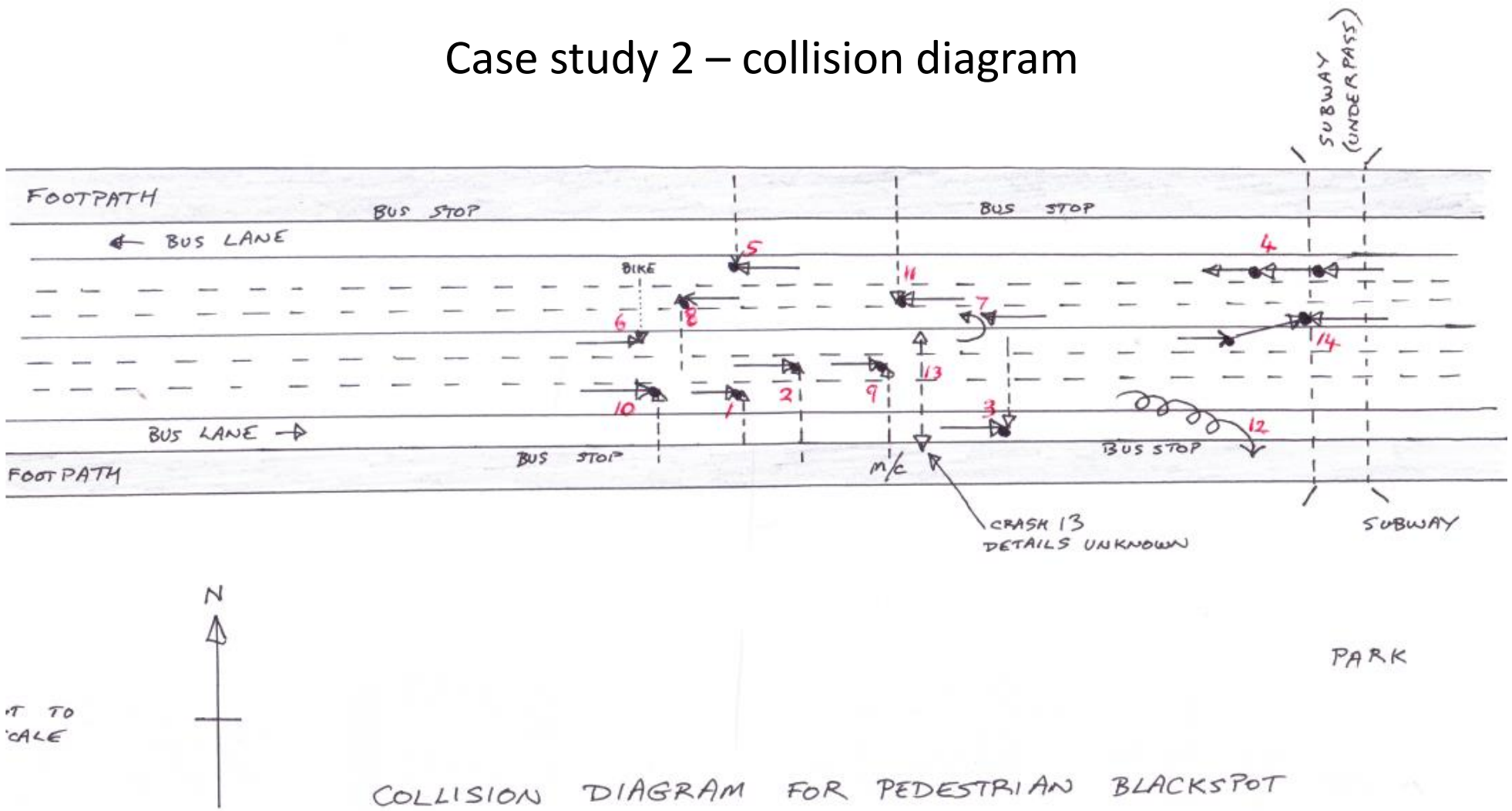
Urban arterial pedestrian blacklength. 14 crashes in past 3 years. Mainly at night.

Case study 2

Case study 2 – crash factor matrix

CRASH NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DATE	12/3	5/5	11/10	29/11	20/1	28/3	1/4	5/9	8/12	31/12	2/2	10/3	5/6	7/9
DAY OF WEEK	SUN	FRI	WED	WED	SAT	WED	SUN	WED	SAT	MON	MON	SUN	WED	SAT
TIME OF DAY	01.15	22.30	19.20	17.50	11.10	20.55	18.30	23.00	14.40	04.00	06.45	23.30	?	20.30
SEVERITY	1	2	2	3	3	3	2	1	3	1	3	1	2	2
LIGHT CONDITION													?	
ROAD CONDITION	WET	DRY	DRY	DRY	DRY	DRY	WET	DRY	WET	DRY	DRY	DRY	?	DRY
CRASH TYPE	003	003	001	303	001	102	207	002	102	004	001	502	?	301
VEHICLE 1	CAR	CAR	BUS	BUS	CAR	CAR	M/C	CAR	CAR	CAR	M/C	M/C	PED	CAR
VEHICLE 2	PED	PED	PED	TRUCK	PED	BIKE	CAR	PED	M/C	PED	PED		?	CAR
VEHICLE 3				CAR										CAR
DIRECTION VEH. 1	E	E	E	W	W	E	W	W	E	E	W	E	?	E
DIRECTION VEH.2	N	N	N	W	S	S	W	N	S	N	S	N	?	?
DIRECTION VEH.3				E										W
OBSERVATIONS	ALC	ALC	SPEED					ALC & SPEED				SPEED		U TURN

Case study 2 – collision diagram



Pedestrian blackspot

Eastern approach

Eastern approach

Western approach

Western approach

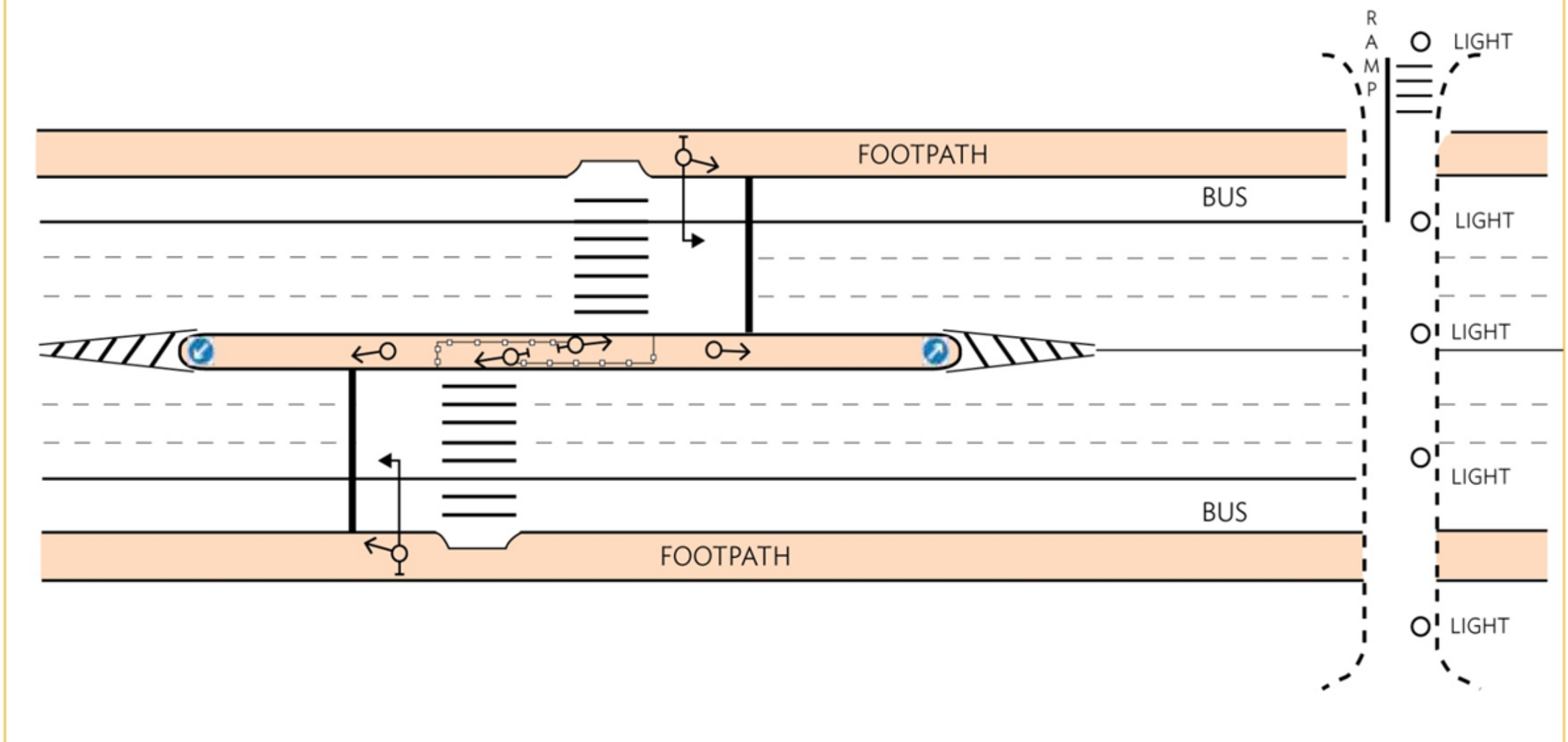
Western approach


A subway is under here

This is the subway

Your turn to present your recommended countermeasures

One recommended treatment




A different package of
treatments was adopted.

A different package of treatments was adopted.


A different package of
treatments was adopted.

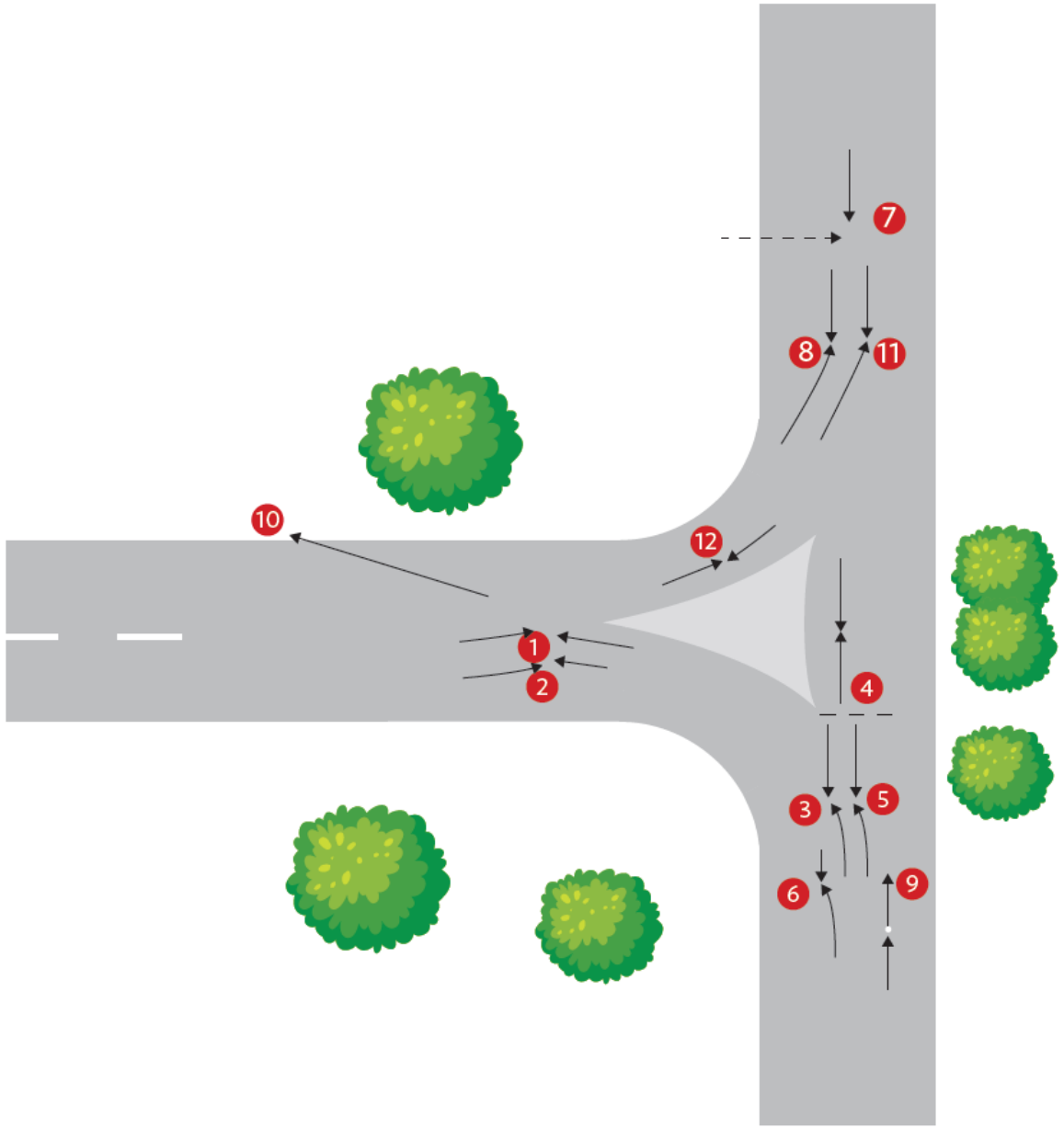
Case study 3

12 casualty crashes in 3 years

Case study 2

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	

Collision Diagram



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

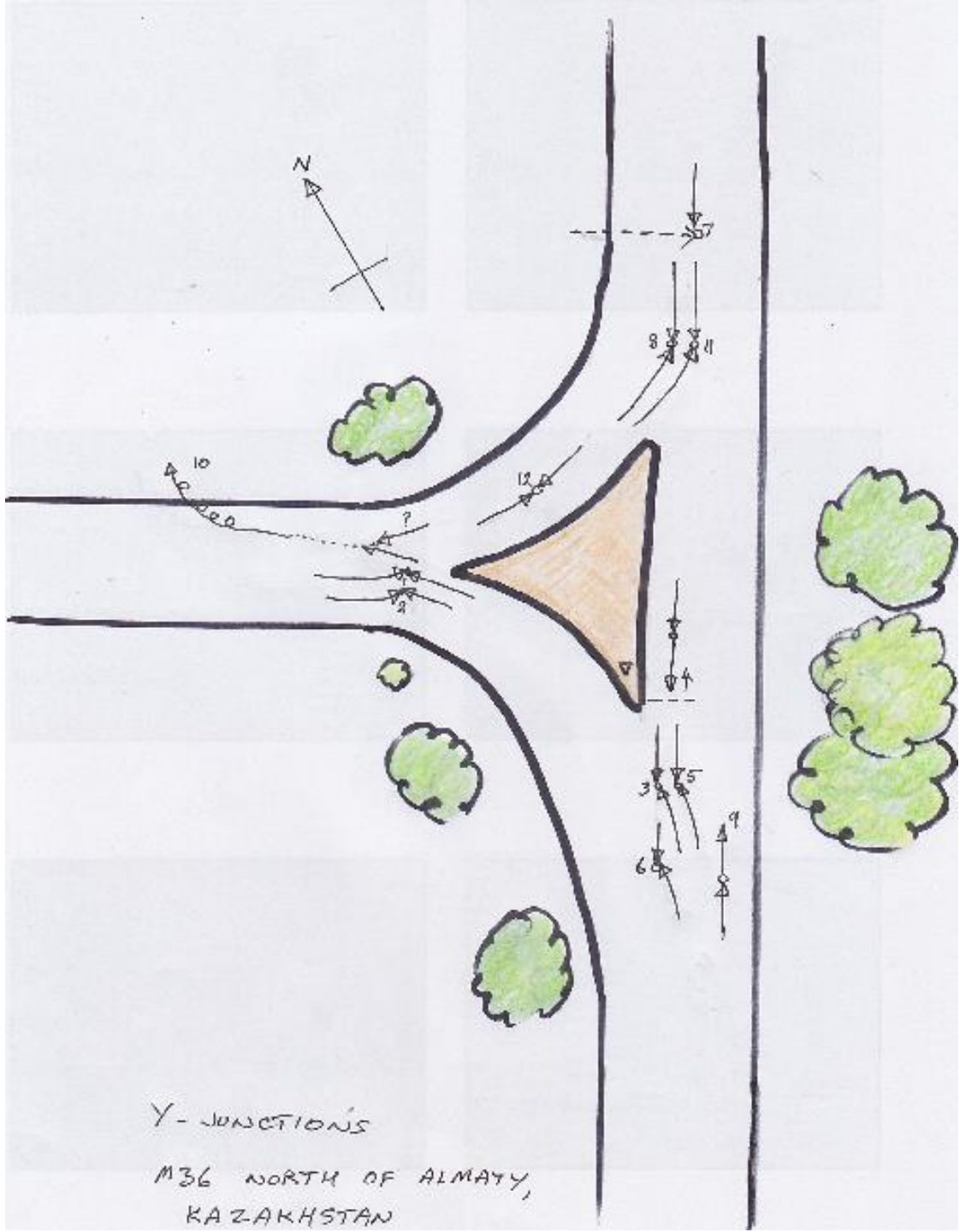
- 8 deaths x $600,000 (fatalities)
- 12 injuries x 0.25 x $600,000

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


ТАЛДЫҚОРҒАН
TALDYKORGAN 260
АЛМАТЫ
ALMATY 59
70


ТАЛДЫҚОРҒАН
TALDYKORGAN 260
АЛМАТЫ
ALMATY 59
50


TRANSPORTE STURM
50


KAMAZ
40 км
телефон: 243-67-66
КАМАЗ Алматы Автоорталығы
Алматинский Автоцентр КАМАЗ

Case study 3

What crash patterns do you see?

What treatments will you recommend?

What is your estimated BCR?

10 minutes

Your turn to present your recommended countermeasures

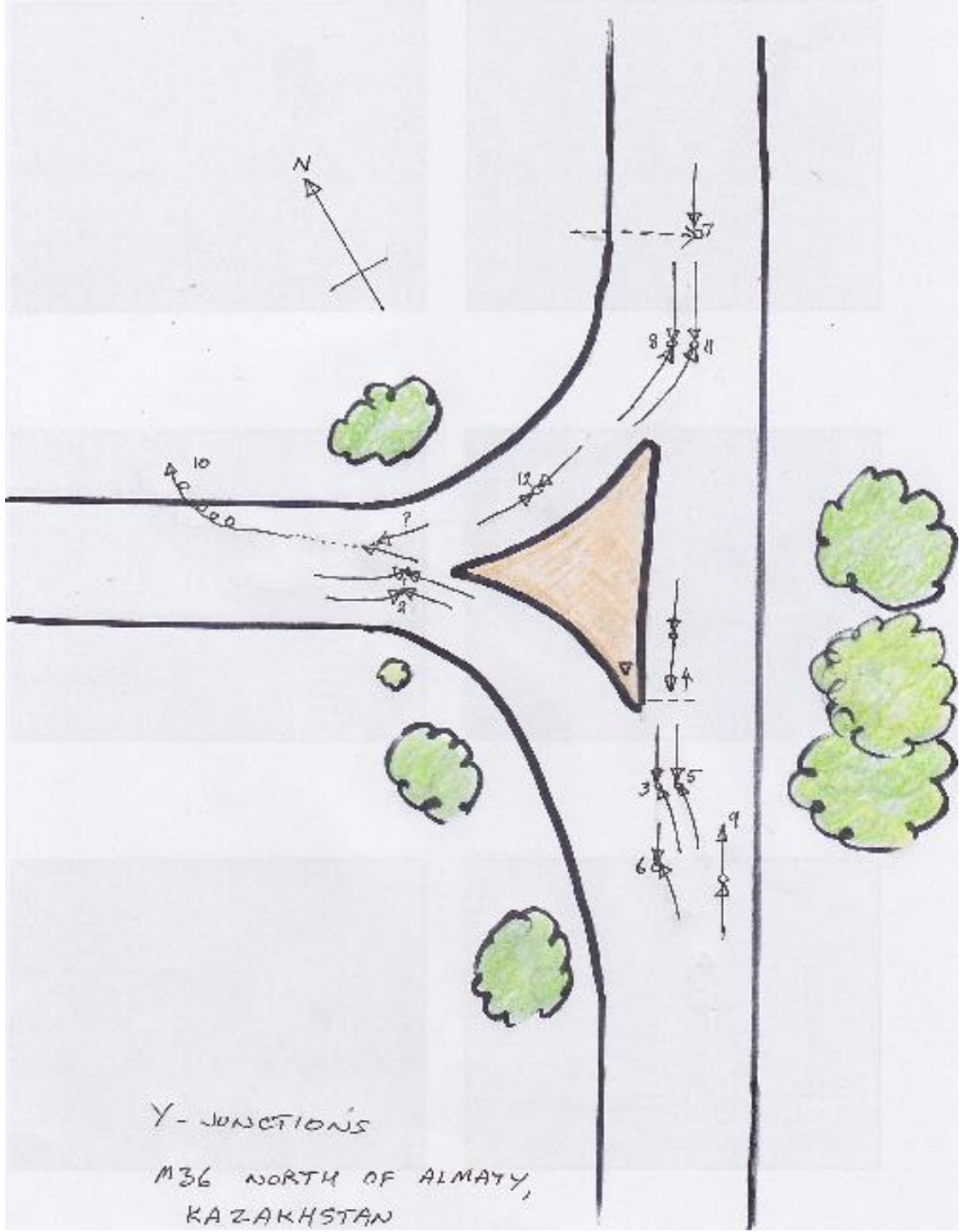
Remove Y junction – 85% crash reduction factor

85% of $2,200,000 pa to be saved for 20 years

= $37,400,000 benefits

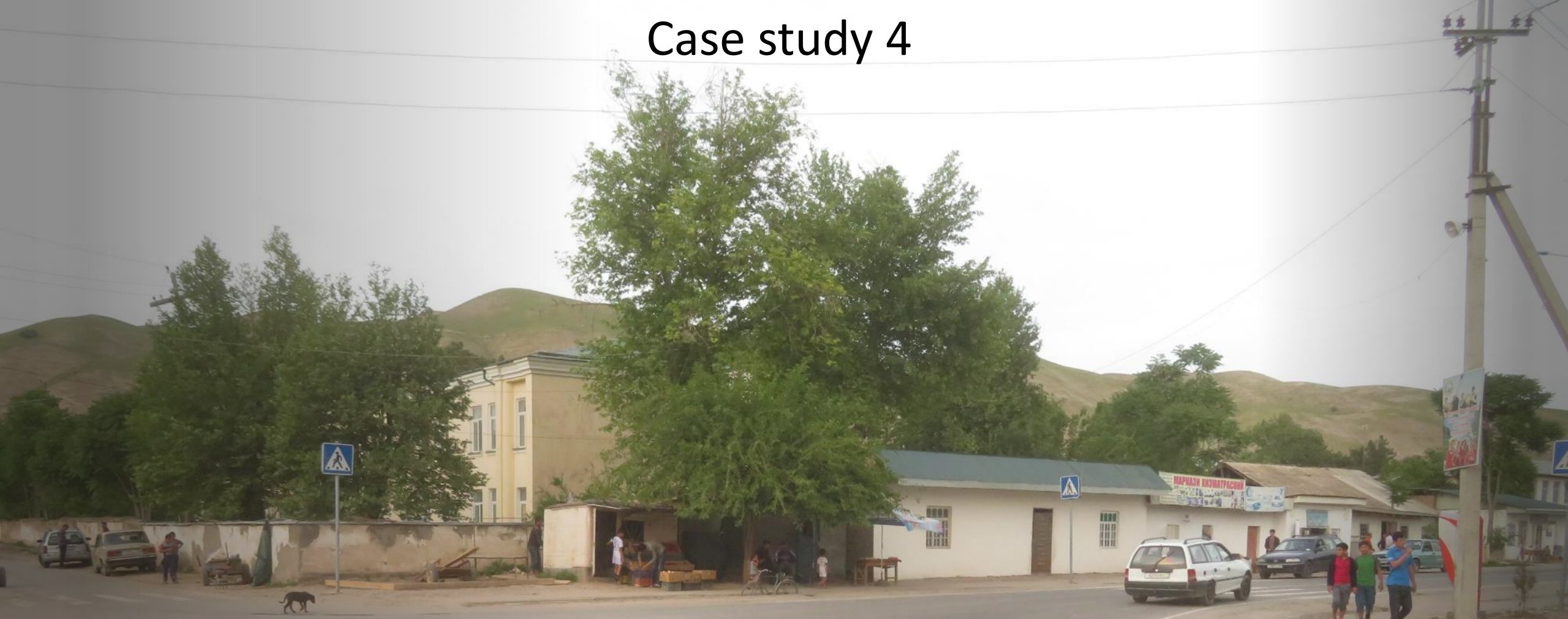
Cost of new intersection = $2,500, 000

BCR = 15




Case study 4
Image © 2019 DigitalGlobe
Google Earth

Case study 4



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

No crash data. Local knowledge only .


1732CB01


КАДУЧИ
KADUCHI

Case study 4

What crash patterns do you see?

What treatments will you recommend?

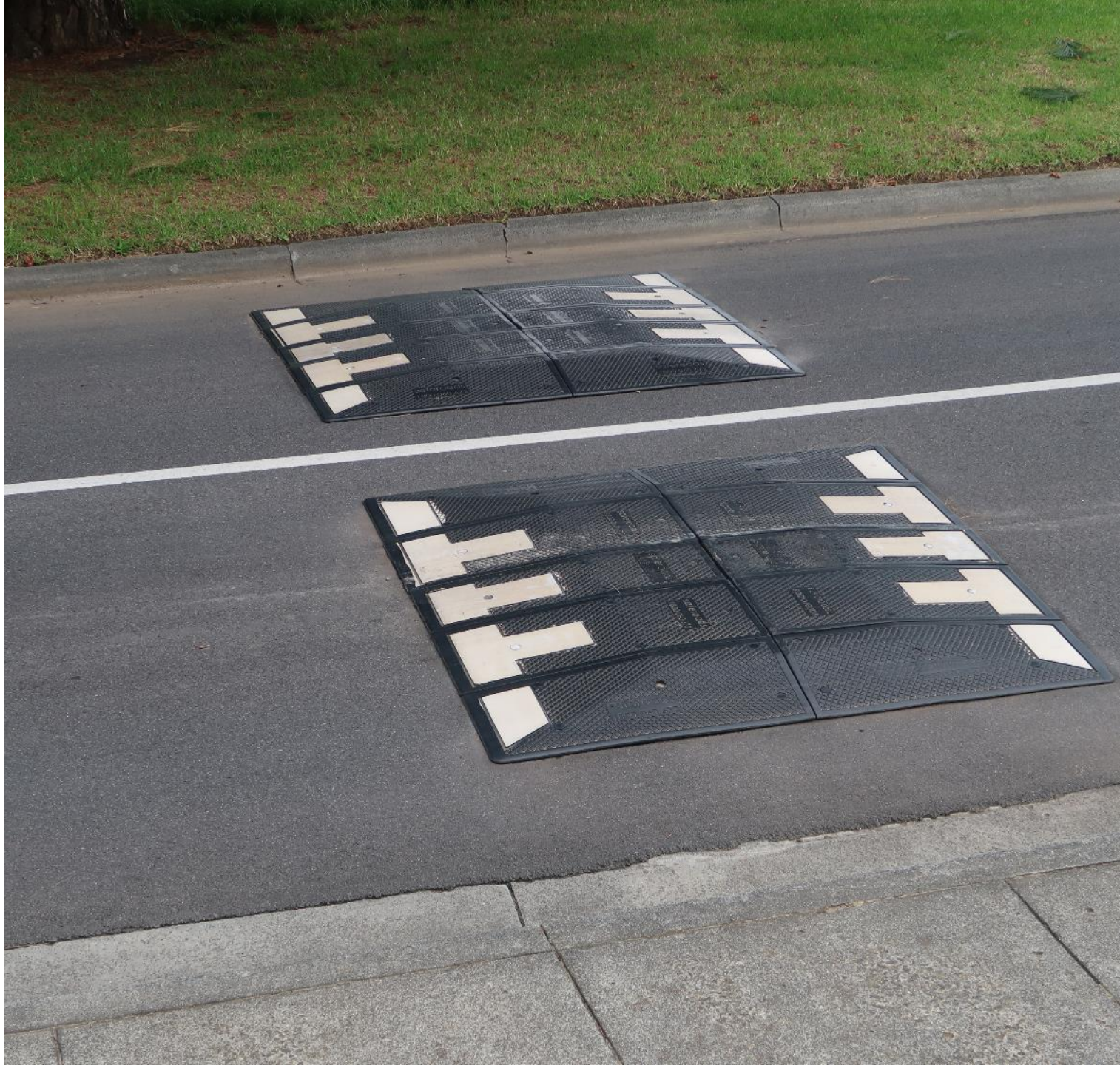
What is your estimated BCR?

10 minutes

Your turn to present your recommended countermeasures

My recommendations:

- Large gateway signs each end of village
- 40km/h speed limit
- Flat top road humps each 100m, with kerb extensions
- Zebra Crossings only on humps near mosques, schools




80
Garston
80
Garston


40
PAINSWICK
Fairtrade
40
40
40

Crash reduction factor 30% for 20 years

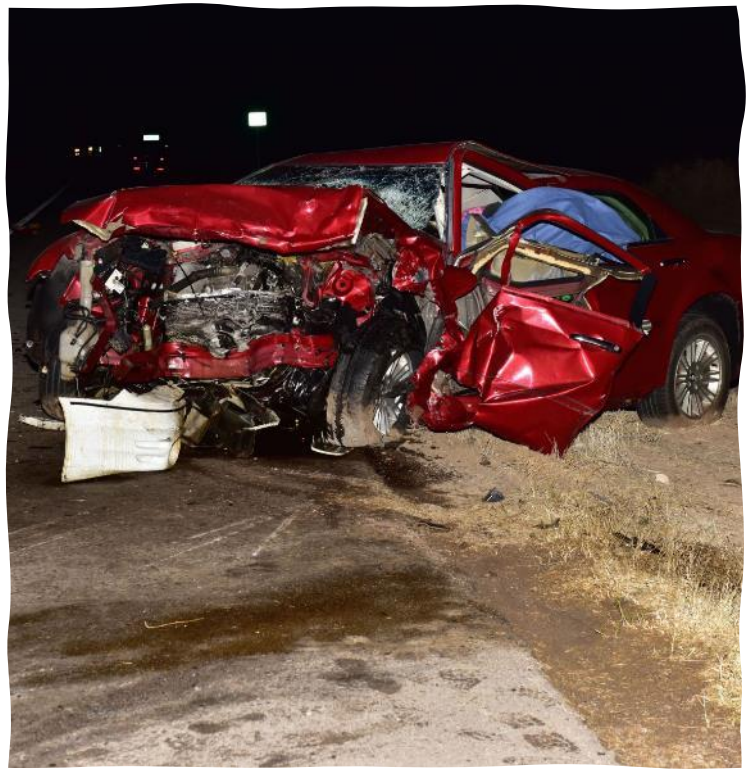
Crash savings = $2,675,000

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.....



We look forward to your questions