

CREATING A SAFER WORKING AND DRIVING ENVIRONMENT FOR ALL ROAD USERS

HOW TO CREATE SAFE SYSTEM WORK ZONES AND MANAGE RISK

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QUICK INTRODUCTION

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Current positions	
Partner and Senior Specialist on Road Safety and Reliability	Vill Consulting Engineers (Vill ZT-GmbH), Vienna
Senior Road Safety Consultant (external)	World Bank, Washington and UNECE, Geneva
University Lecturer for “(Reliability) assessment of existing structures”	University of Applied Sciences, Vienna
University Lecturer for “Infrastructure safety” and “Transport/road safety policy”	University of Technology, Graz
Member of the Governing Board	Grossglockner High Alpine Road Cooperation
Member of the Governing Board	Railway Infrastructure Service Cooperation
Deputy Chair of the Management Committee	Austrian Research Association for Roads, Railways and Transport
Member of the Supervisory Board	Austrian Standards Institute ASI

CONTENT

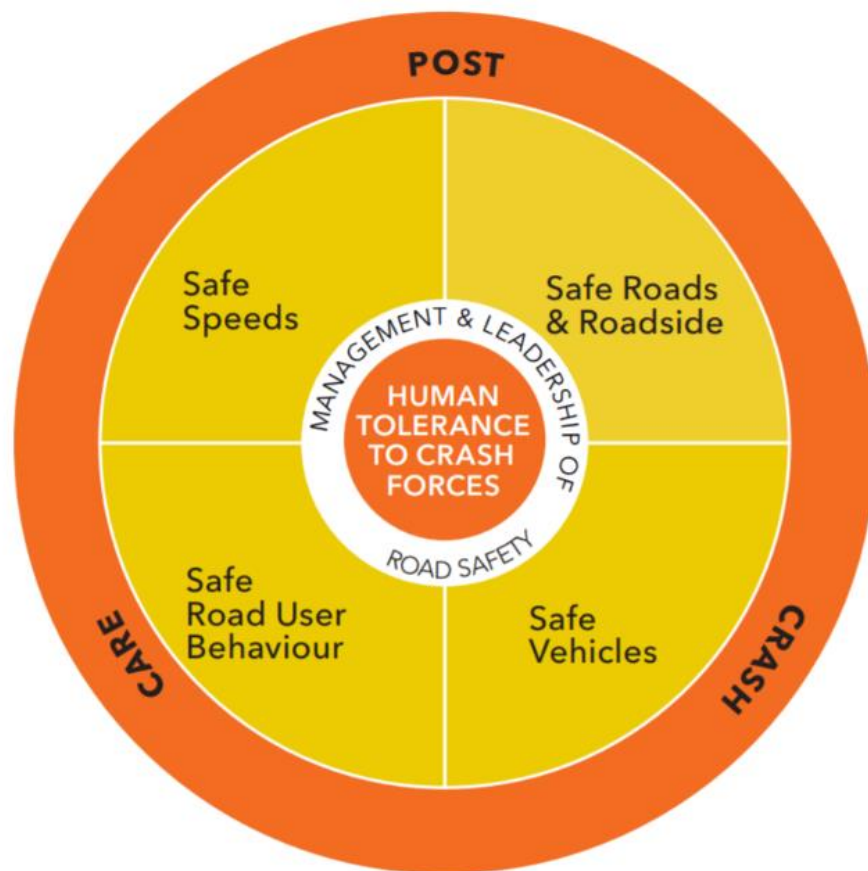
- Safe System approach in work zones
- Speed management and enforcement
- Managing risk in work zones
 - Gap between standards and daily work practice
- Work zone safety process
 - Safety examination methodologies
 - Roles, responsibilities and training of actors in work zones



WHAT SAFE WORK ZONES ARE ABOUT...



SAFE SYSTEM APPROACH IN ROAD SAFETY MANAGEMENT

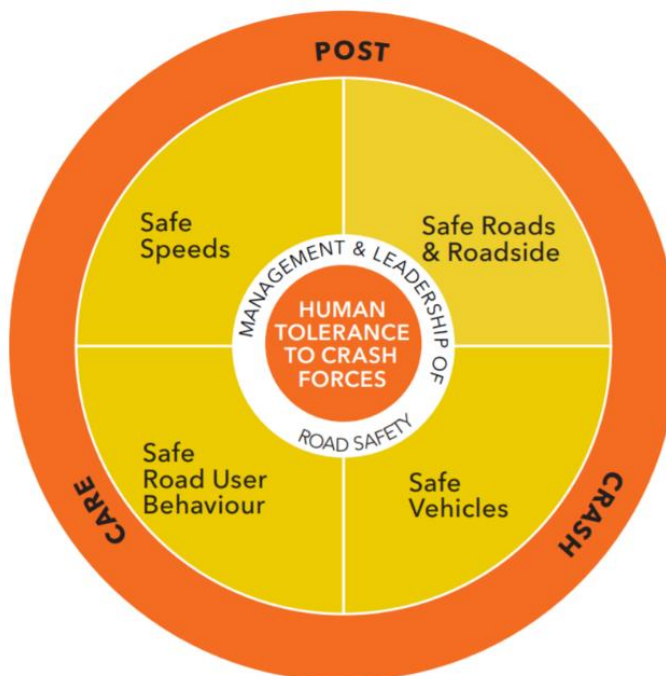


SOURCE: WORLD BANK/GRSF, WRI

SAFE SYSTEM WORK ZONES

Speed limits in work zones must be set for protection of the workers and also of the drivers passing through them along with the requirement of managing traffic flows.

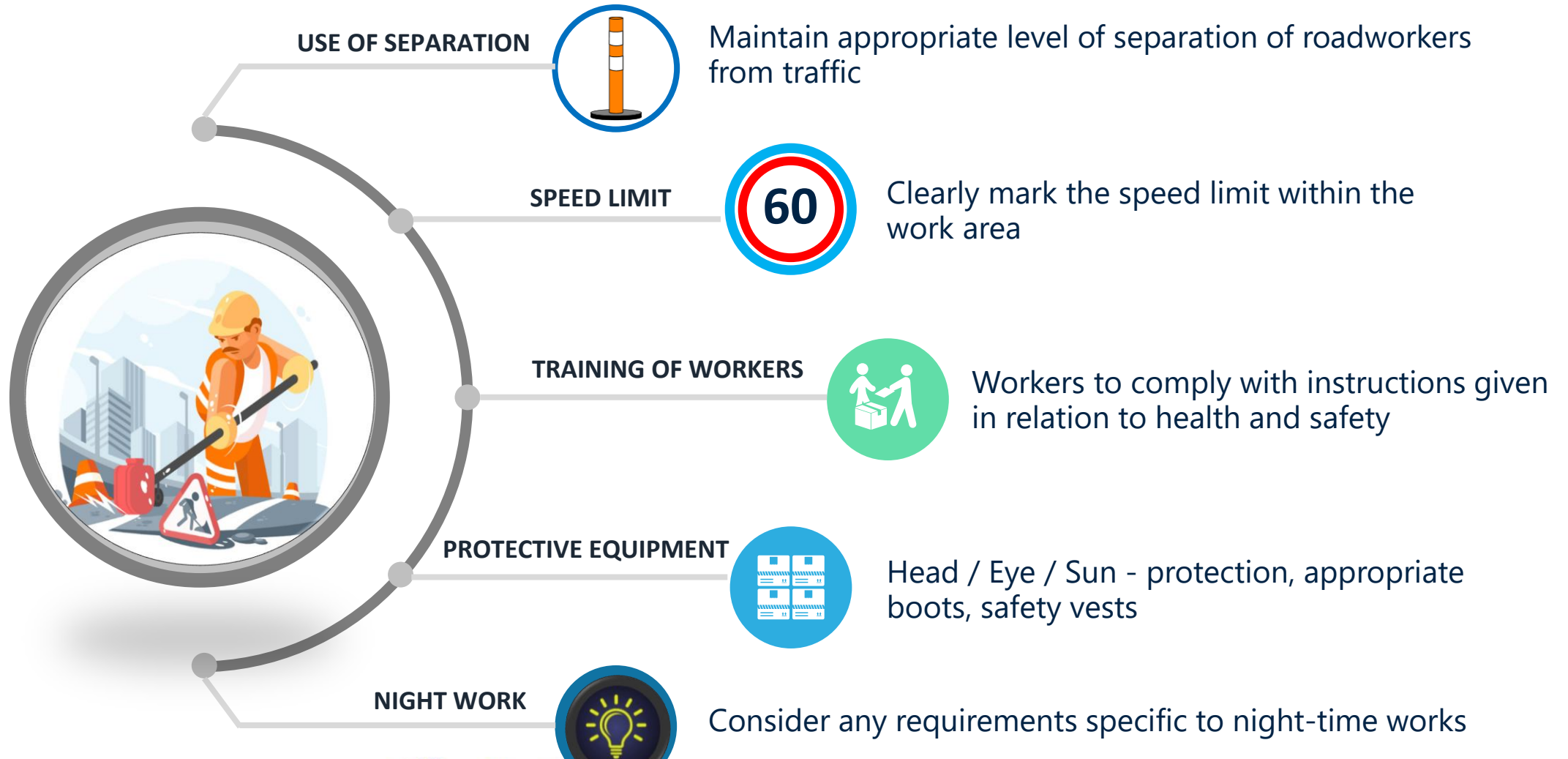
All road users need to understand what to expect and the action they need to take when approaching a work zone.



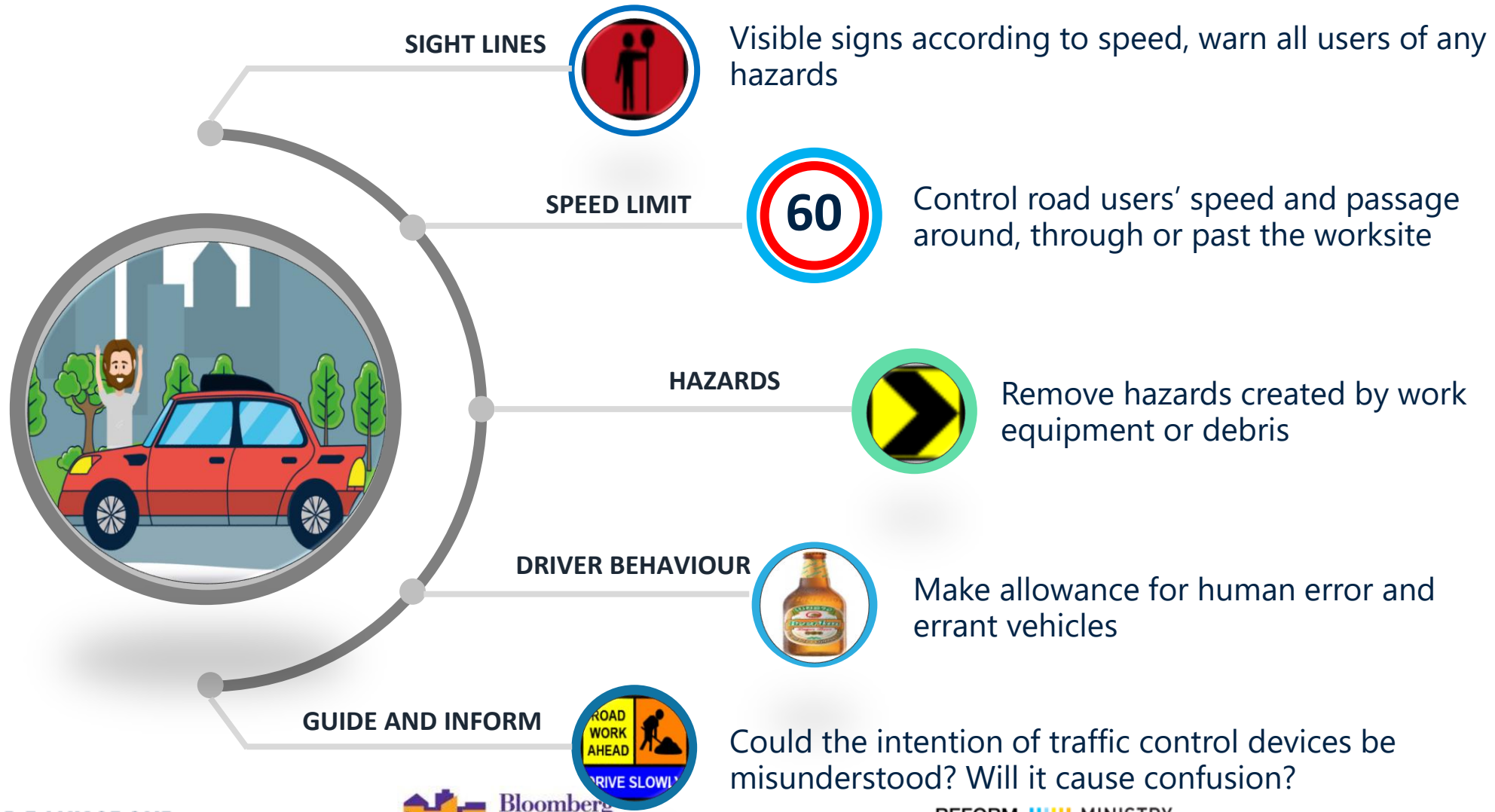
Work zones need to be designed and managed such that the potential for harm to all road users and workers can be eliminated or significantly reduced.

All processes associated with roadworks have to be undertaken using Safe System principles.

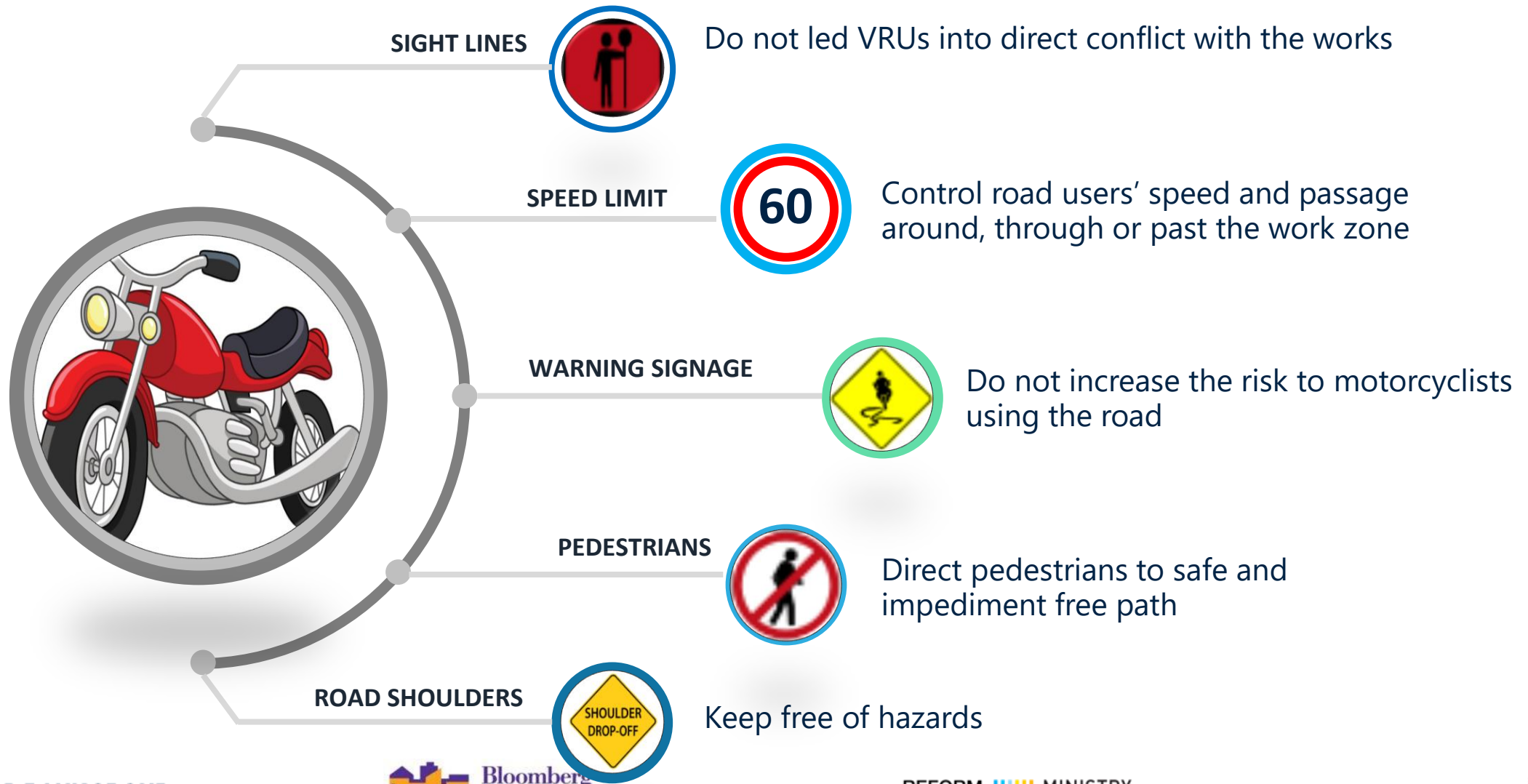
SAFE SYSTEM WORK ZONES - FOCUS ON ROAD WORKERS



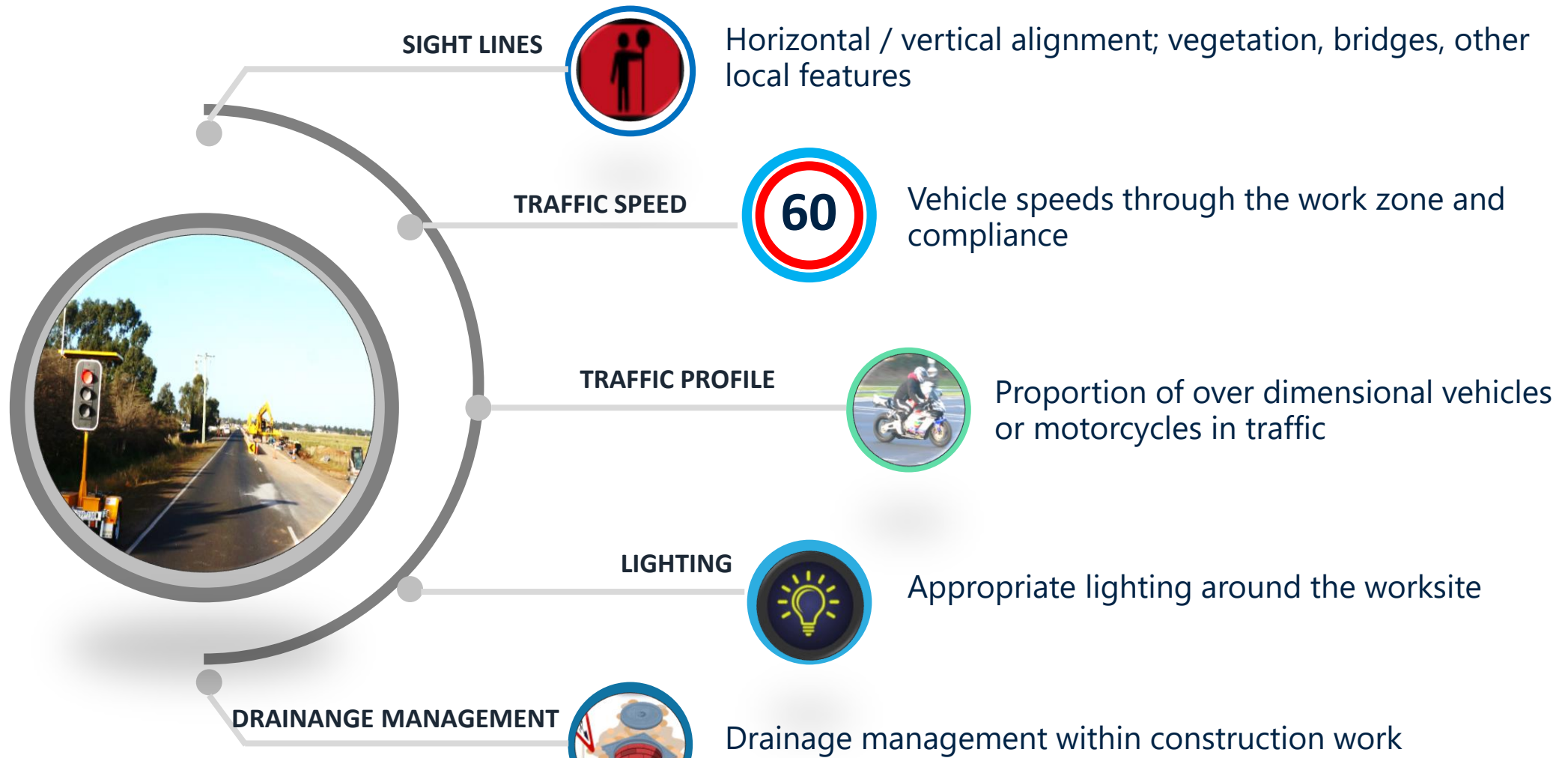
SAFE SYSTEM WORK ZONES - FOCUS ON ROAD USERS



SAFE SYSTEM WORK ZONES - FOCUS ON VULNERABLE ROAD USERS



SAFE SYSTEM WORK ZONES - FOCUS ON SITE CONDITIONS



WHAT DO THEY HAVE IN COMMON?



ROAD WORKER SAFETY



ROAD USER



VULNERABLE ROAD USERS



SITE CONDITION

TRAFFIC SPEED



Vehicle speed through the worksite and compliance – speed must be decreased - also on high-level roads - if sufficient protection (e.g., safety barriers) for road workers and road users is not provided

GENERAL PRINCIPLES OF SPEED MANAGEMENT IN WORK ZONES

- When setting speed limits **Safe System speeds** (30 kph: VRUs – 50 kph: side impact – 70 kph: head-on) should be considered.
- Speed limit signs **should not be placed too far in advance** - drivers may consider them premature and ignore them when reaching the critical point.
- Low speed limits should **not be prolonged through long stretches**.
- Excessively **wide lanes should be avoided** to not induce speeding in times of lower traffic volumes.
- The **number of lanes should be maintained** (altered layouts, narrow lanes, contra-flow, added lanes).
- If a lane on a motorway must be closed, it is preferable to **close the fast lane(s) first** and conduct traffic through the slow lane(s).
- If some limited extra-capacity is needed, **diversions to alternative routes** may be used, provided that these routes can accommodate the new traffic and are carefully controlled.
- Speed limits may be **lowered when the zone is active** and increased when not active (but usually with a lower limit than the regular permanent speed limit).

SPEED CONTROL AND ENFORCEMENT

Non-automatic speed enforcement

- **Spot control:** speed gun equipment alongside the road (visible or hidden)
- **Distance control:** conspicuous or inconspicuous police cars

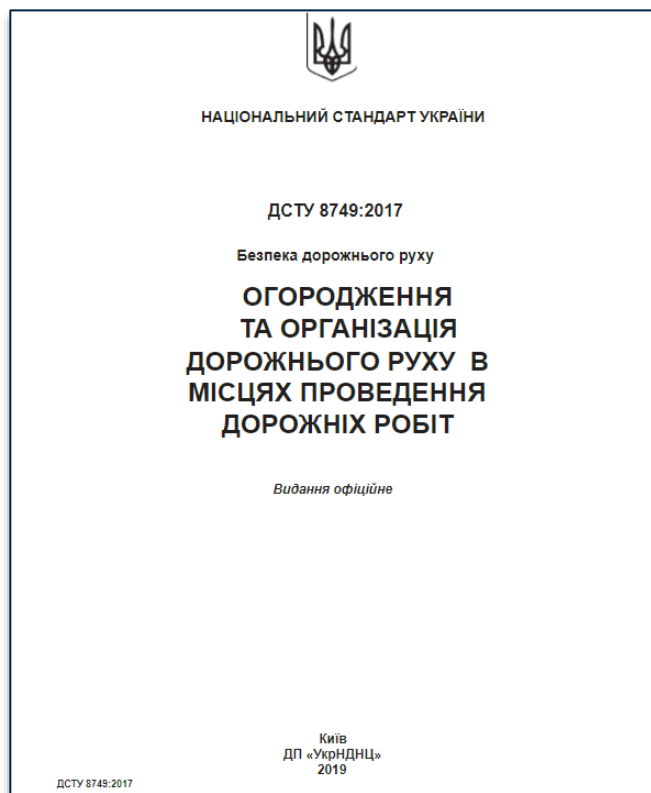


Automatic speed enforcement

- **Spot control:** fixed or mobile speed cameras
- **Distance control:** trajectory or section control (control between two points)



GAP BETWEEN (NATIONAL) GUIDELINES AND DAILY WORK PRACTICE



Main reasons: Lack of clear responsibilities, targeted supervision and technical training/knowledge on all sides (road operator, contractors, traffic police)

WORK ZONE SAFETY PROCESS

To ensure the effectiveness of roadworks safety for all road users and workers the road operator must:

- have clear **policies** that spell out **responsibilities and competencies for ALL parties involved** (road operator, contractors, road workers);
- make **compliance with Roadworks Safety Standards/Guidelines/Manuals** a **mandatory contractual condition** for all organizations involved in undertaking or supervising the work (reject bids for roadworks that do not include an element of cost for Work Zone Traffic Management);
- make sure that the **contractor has assigned a Safety Supervisor** responsible for safe and effective temporary traffic management at all times;
- implement a standardized work zone safety process (including **safety examination methodologies** to be used) to identify **organizational and/or project deficiencies**;
- install a **monitoring program** that regularly evaluates the effectiveness of the road operator's policies and project-level actions.

SAFETY EXAMINATION METHODOLOGIES 1/2

ORGANISATIONAL LEVEL

- **Work zone process reviews:**
 - functionality and effectiveness of road operator's practices and procedures used to audit or inspect work zones (consistency with standards)
- **Work zone self-assessment (WZSA):**
 - Effectiveness of road operator's leadership and policy, project planning, design, construction and operation, communication, education and training
- **Work zone crash data trend analysis:**
 - analysis of aggregated work zone crashes with an emphasis on crash contributory factors and countermeasures

SAFETY EXAMINATION METHODOLOGIES 2/2

PROJECT LEVEL

- **Crash and mobility data analysis:**
 - Evaluation of current or real-time crash events, incidents and mobility issues in an active work zone
- **Work zone road safety audits (WZRSA):**
 - formal safety performance evaluations performed at any stage of a planned work zone by an independent, multidisciplinary team, and considers methods of improving safety in a work zone
- **Work zone road safety inspections (WZRSI):**
 - formal reviews of temporary traffic control devices (TTCD) and safety/mobility strategies deployed according to an approved plan, standards and specifications in an active work zone

CREATING A SAFER WORKING AND DRIVING ENVIRONMENT FOR ALL ROAD USERS



THANKS A LOT FOR YOUR KIND ATTENTION!

WE LOOK VERY MUCH FORWARD TO YOUR QUESTIONS.



Essential Design Principles

FILIP TRAJKOVIC & RAJKO BRANKOVIC



IMPORTANCE OF TRAFFIC SAFETY IN ROAD WORKS ZONES

Work zones require special attention for the following reasons:

- Work zones are most often sections where there are changes in traffic - technical conditions on the road (geometric characteristics, traffic conditions) due to which the risk of traffic accidents is increased
- Workers in the work zone are exposed to traffic all the time
- Transit traffic, especially foreign drivers in the traffic flow, expect the works zones to be marked in accordance with international standards

IMPORTANCE OF TRAFFIC SAFETY IN ROAD WORKS ZONES

Most studies found that crashes rates are higher in Work Zones.

* Rune Elvik and others, „The Handbook of Road Safety Measures“, second edition 2009



IMPORTANCE OF TRAFFIC SAFETY IN ROAD WORKS ZONES

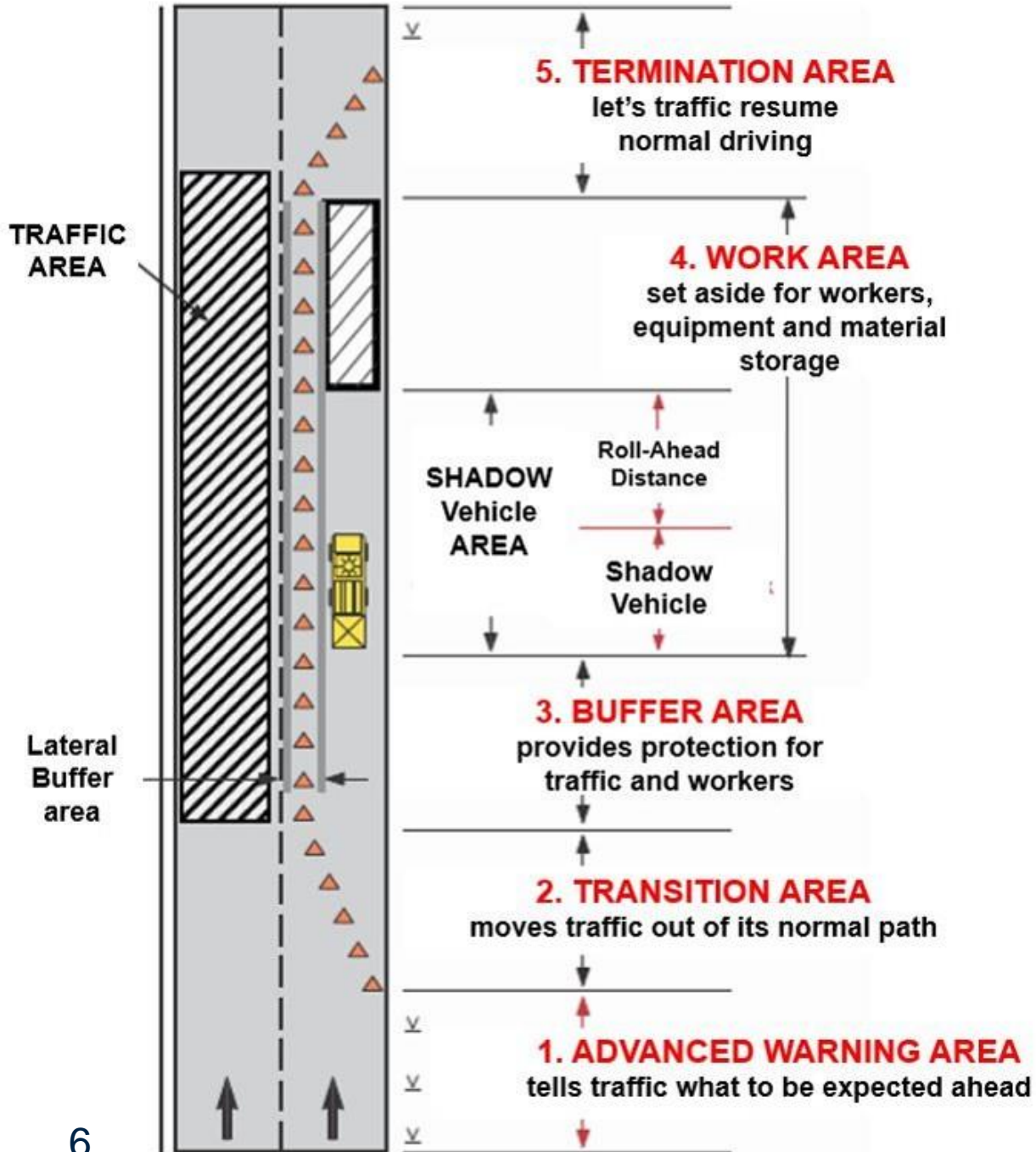
Crash Statistics in Work Zones

- **Austria** – for 2008, on the highway network there were 2 fatalities and 143 motorists injured in work zones, representing about 2.5% of all fatalities and 4% of all injuries.
- **Finland** – From 2003 – 2007, there were 17 fatalities and 442 injuries in work zones in Finland. This yields an average of 3 fatalities and 88 injuries in work zones annually.
- **Netherlands** – Traffic crash statistics show that annually there are 20 fatalities and 165 seriously injuries in work zones.
- **USA** – In 2007, 835 fatalities were reported in work zones. Approximately 85% of fatalities were motorists and 15% were road workers.

* PIARC, „Improvements in safe working on roads“, 2012

PRESENTATION CONTENT

- Work Zone planning - Modern approach
- Construction site markings - **negative** and **positive** examples
- Classification of Work Zones
- Typical Work Zone layout
- Some logical design principals



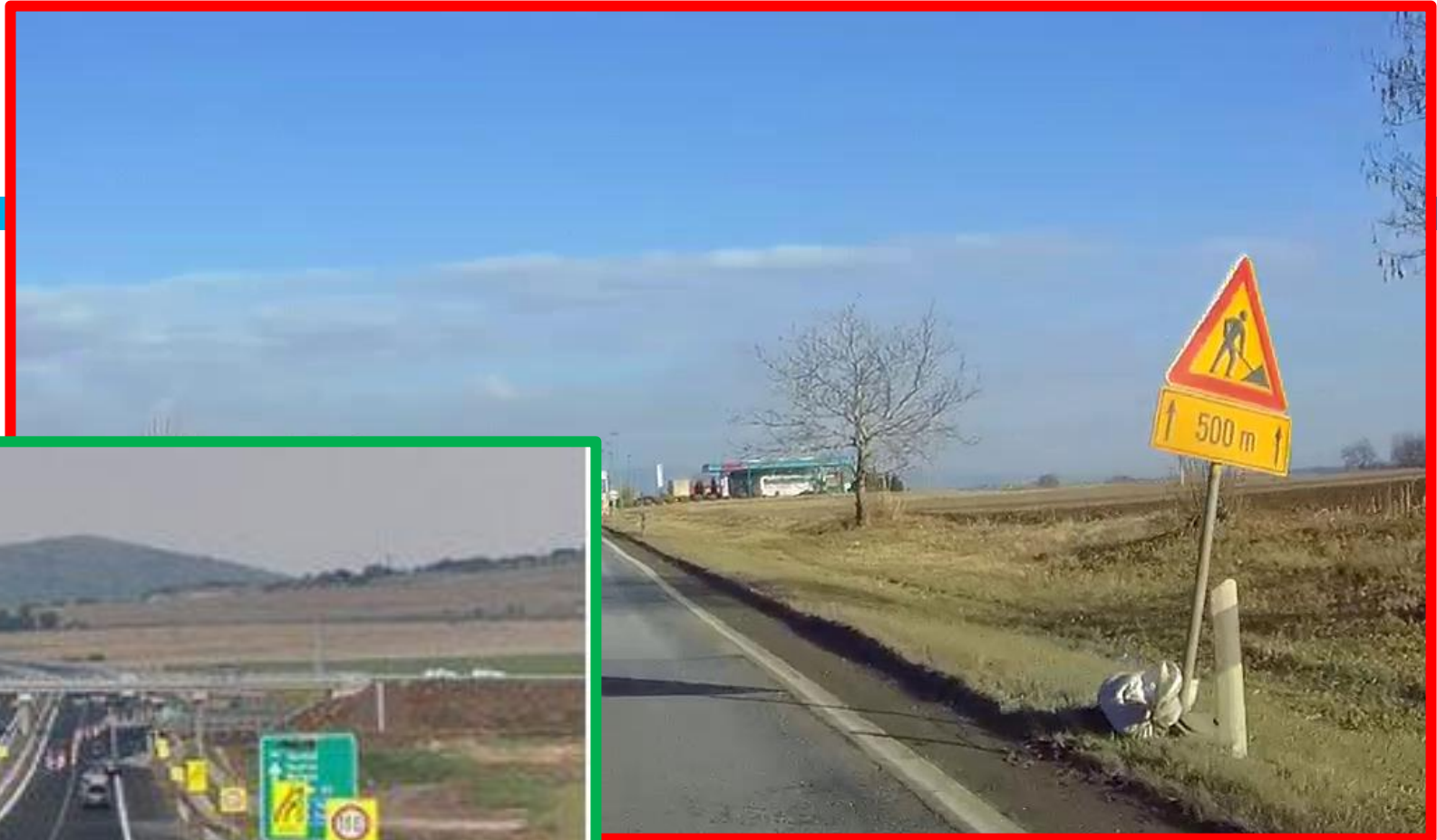
WORK ZONE – MODERN APPROACH

- Advance Warning Area
- Transition Area
- Buffer Area
- Working Area
- Termination Area

WORK ZONE – 5 STAGES

- **Advance Warning Area** – is a part of the road where traffic participants are informed about the oncoming road works zone and adapt their behaviour to the new situation
- **Transition Area** - is a part of the road on which traffic participants are redirected from their route and continue to lead through the areas that make up this zone (area of initial narrowing of the road, area of traffic calming and area of final narrowing of the road)
- **Buffer Area** - is the lateral and longitudinal part of the road on which the traffic flow of vehicles separates from the construction site, enables stopping of vehicles that have lost control, protection of workers from vehicles, protection of traffic participants from workers and machines.
- **Working Area** - is a part of the road, i.e. the road belt, in which construction works are performed, tools, excavated materials and equipment are stored, as well as the space needed for movement during the work
- **Transition Area** - is the part of the road on which the traffic returns to the original route

ADVANCE WARNING AREA



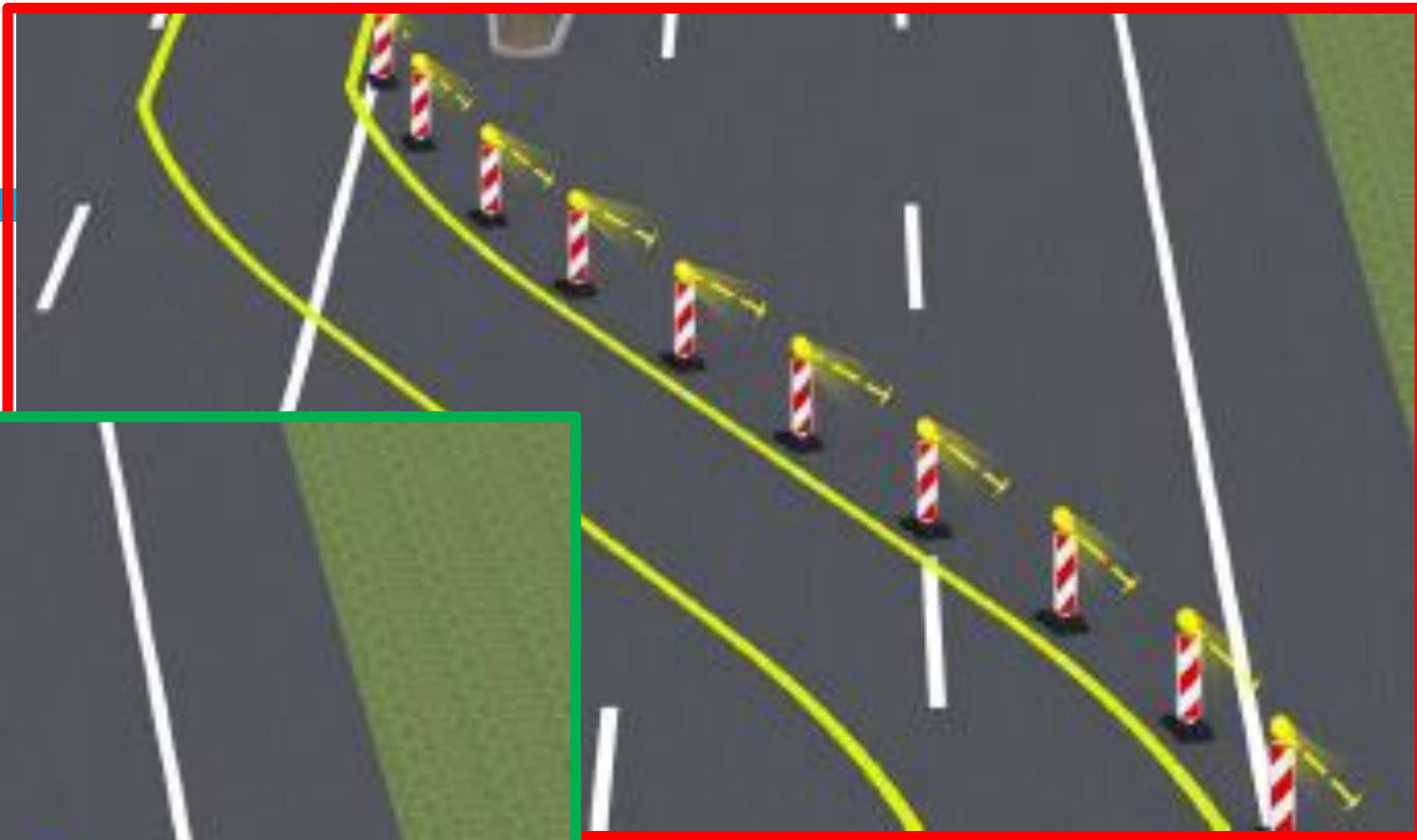
ADVANCE WARNING AREA



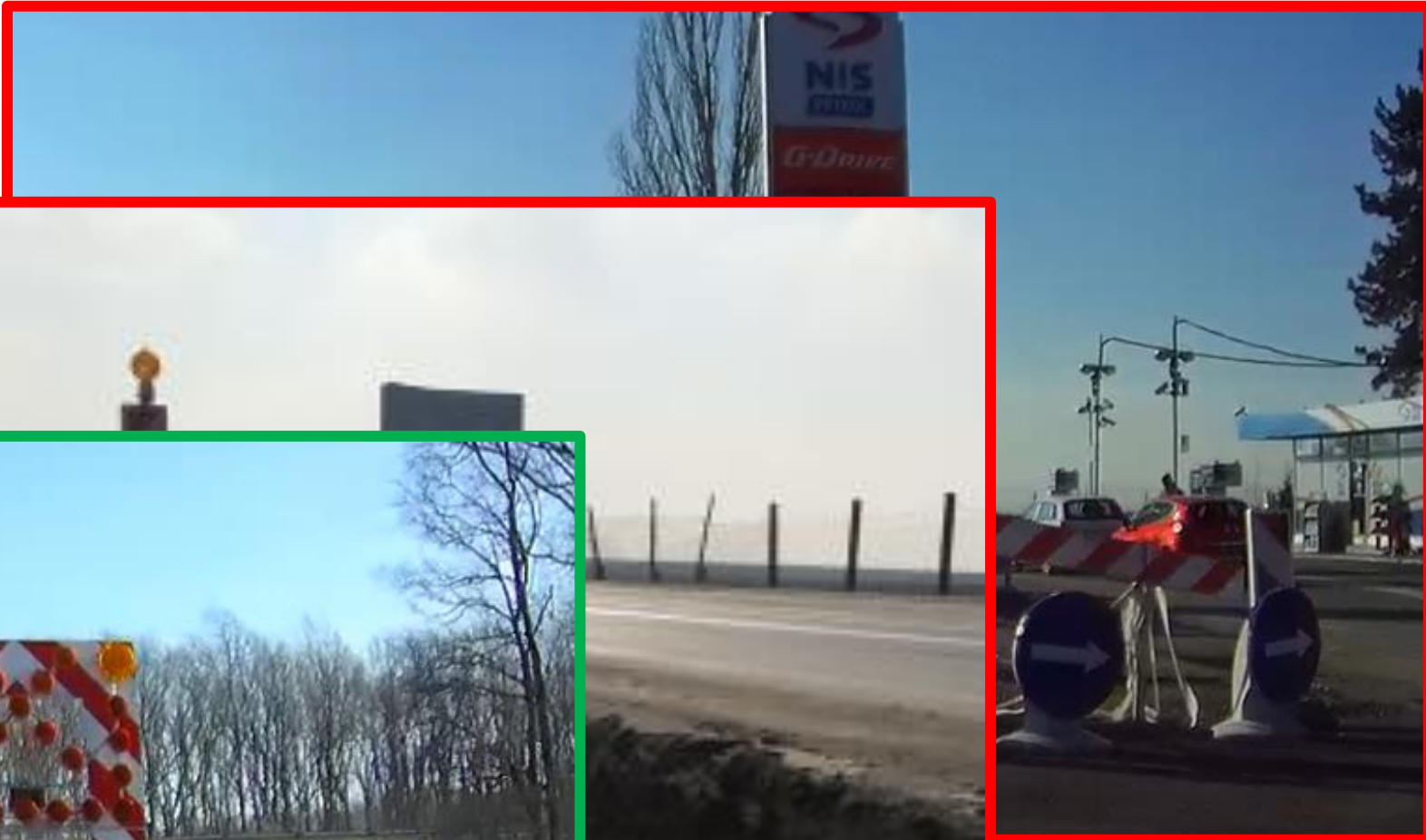
TRANSITION AREA



TRANSITION AREA



BUFFER AREA



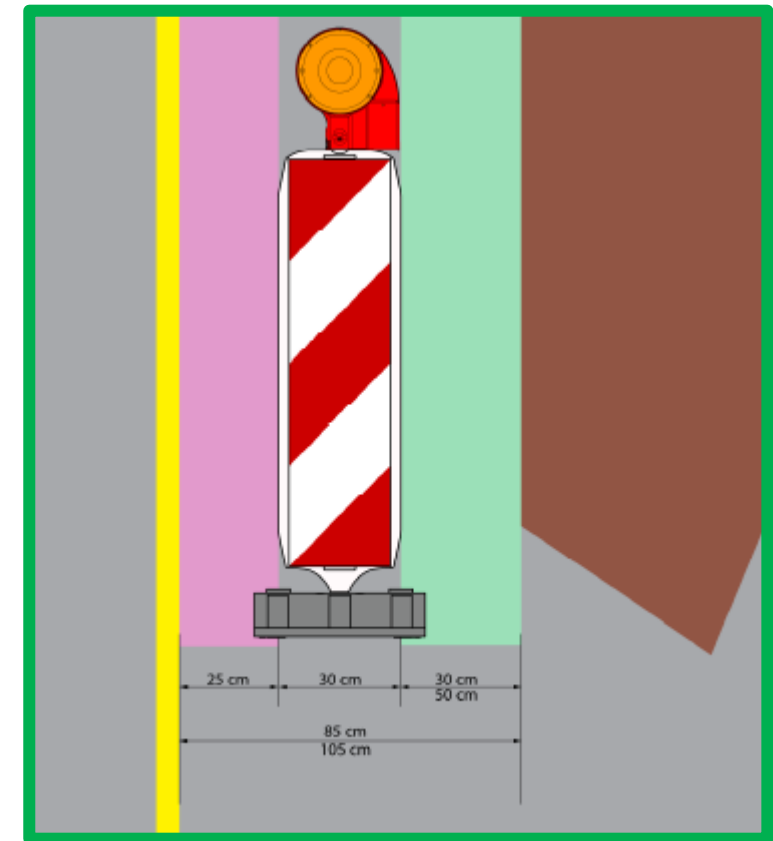
BUFFER AREA

Minimum lengths of the longitudinal buffer area:

Longitudinal Buffer Area (m)	Speed Limit (km/h)
30	40
35	50
40	60
60	80
100	100



Minimum lateral buffer area



BUFFER AREA



WORKING AREA



Speed Limit in Work Zone

Traffic Lane Width (m)	Maximum Speed Limit (km/h)
2.50 – 2.75	40
2.75 – 3.00	50
3.00 – 3.25	60
3.25 – 3.75	80

TERMINATION AREA



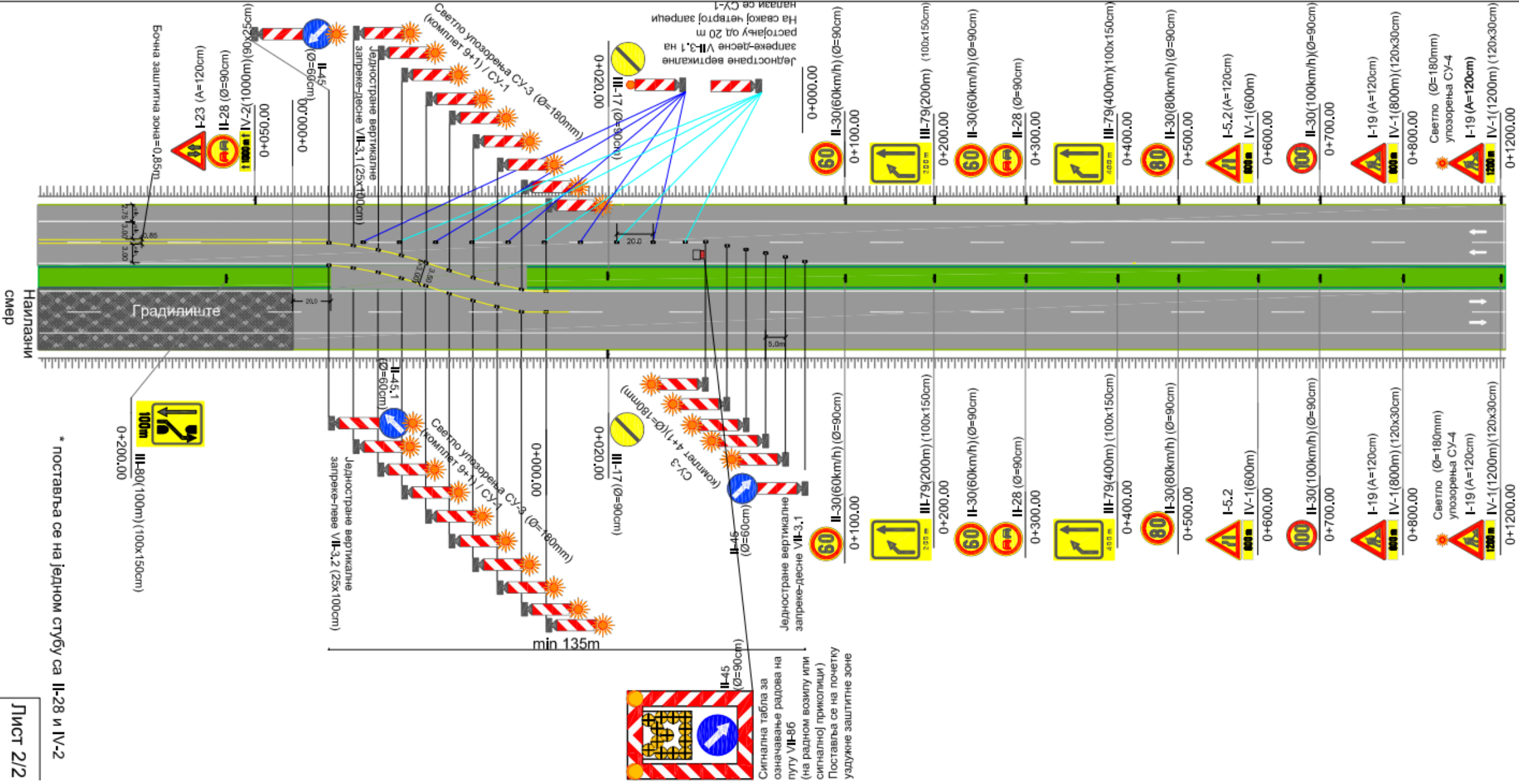
WORK ZONE CLASSIFICATION

Criteria for Work Zones:

- Road type
- Duration and mobility
- Traffic organization and Work Zone Location
- Length of Work Zone
 - Short (< 50 m)
 - Medium (50-300 m)
 - Long (> 300 m)

Duration and mobility:

- Long-term (road works lasting longer than 24h)
- Short-term (works lasting less than 24h and in condition of daily visibility)
- Short-term and mobile – through phases (road works that move in driving direction)
- Mobile short term (road works where vehicle have constant moving maneuver)



DESIGN PRINCIPLES

- Give drivers enough time to change behavior, never surprise the drivers
- Closing lanes from left to right, never from right to left
- Changing road layout on the end of straight section, never in curves
- Traffic lane width in accordance with speed limit, don't allow too wide lanes
- Use TMA and VMS board on high speed roads
- Type and size of Buffer area depending on temporary speed
- Train contractor staff and inform participants



Implementation of a Traffic Management Plan



About me

Principal Road Safety Engineer at Road Solutions in Melbourne, Australia

Specialised in:

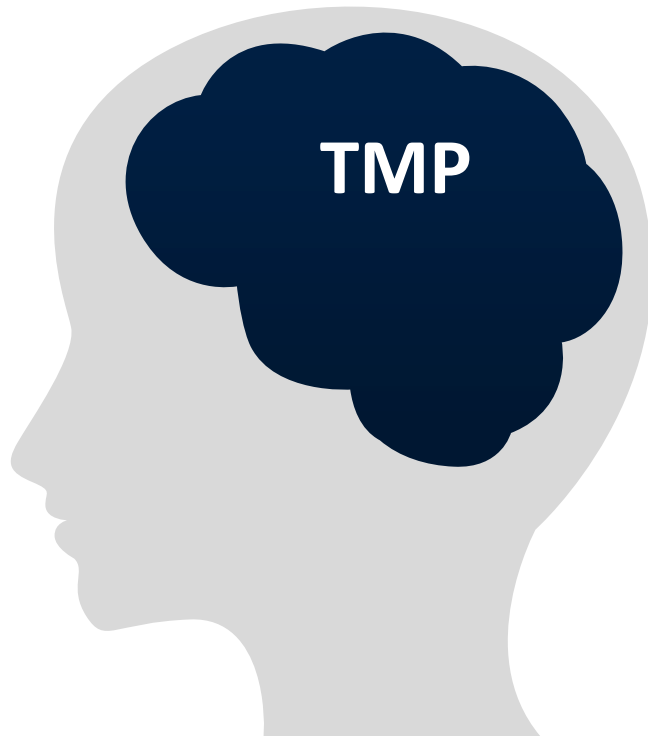
- Road Safety Audits (RSA)
- Safe System Approach (SSA)
- Strategic road safety advice
- Capacity building, and innovative solutions

Experience:

- Over 24 years
- Responsible for managing Victoria's Towards Zero Road Safety Strategy Strategic road safety advice
- Africa, Europe, Middle East, and S.E. Asia

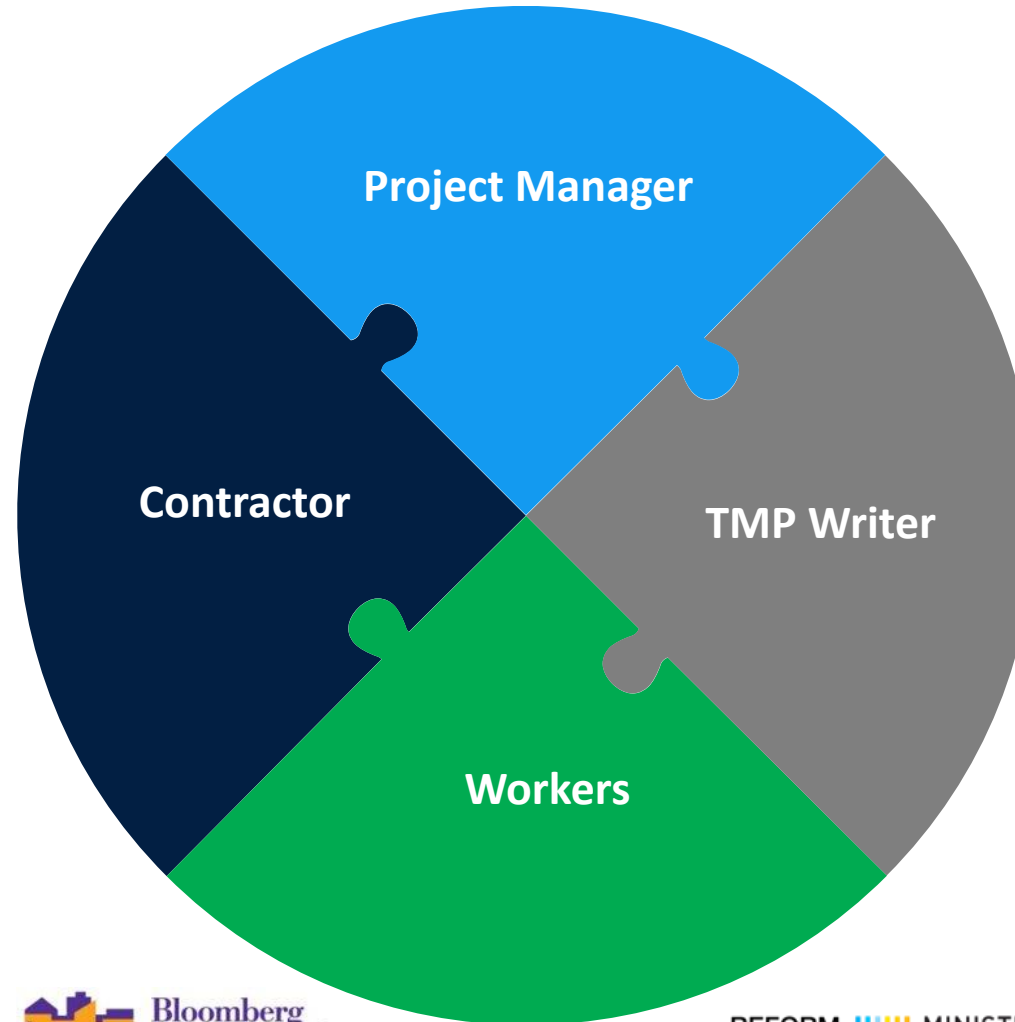


WHAT IS A TRAFFIC MANAGEMENT PLAN (TMP)?



- A comprehensive plan completed prior to commencement of works
- Contains details on how risks associated with the works and vehicle/pedestrian traffic are managed at the worksite

ROLES & RESPONSIBILITIES

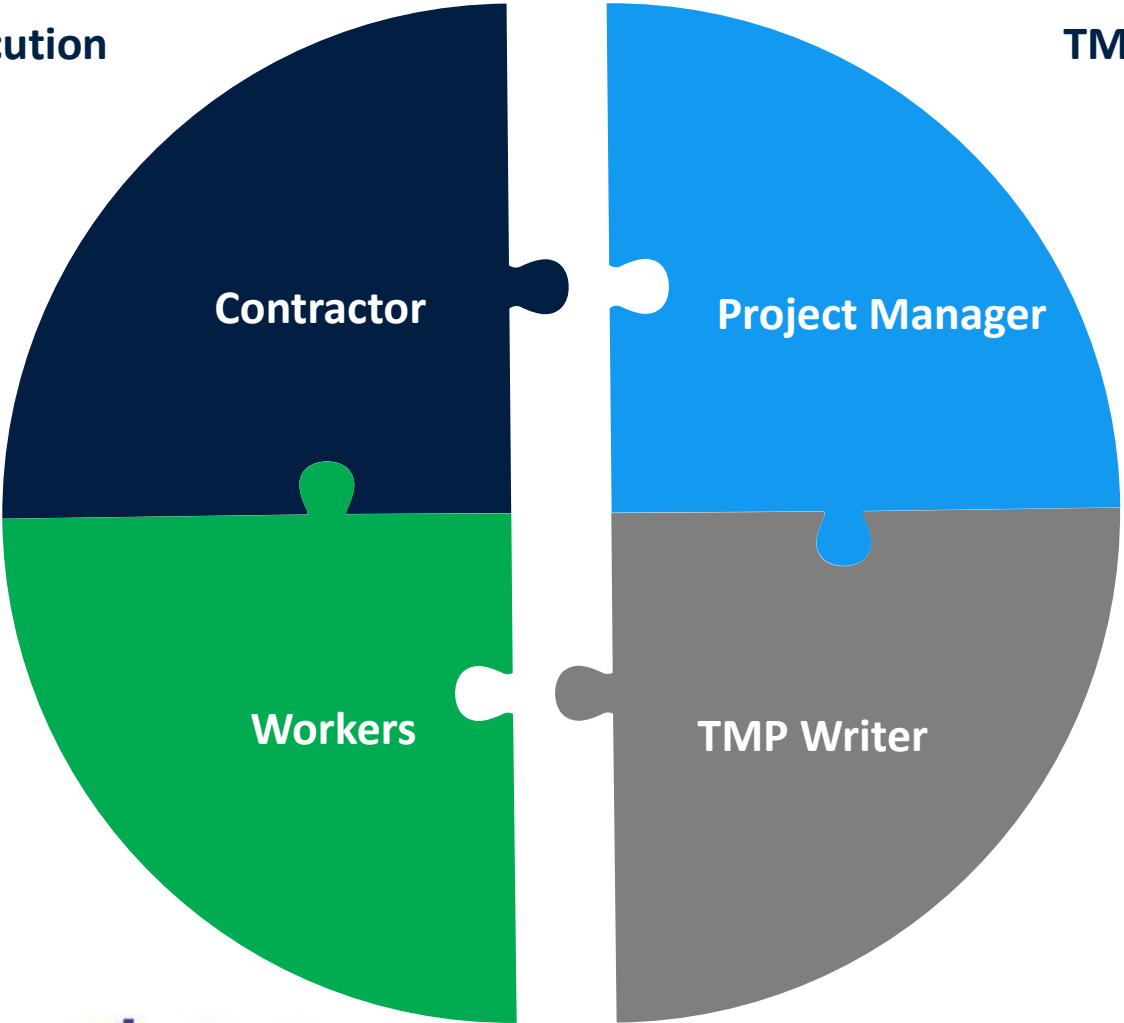


ROLES & RESPONSIBILITIES

TMP Execution

Contractor has responsibility to accurately execute TMP, ensure workers are familiar with TMP and enforce worker compliance

Workers have responsibility to be familiar with TMP and adhere to it



TMP Preparation

Project manager has responsibility to provide accurate details on the works to TMP writer, ensure that contractor is accurately executing TMP

TMP writer has responsibility be aware of project aims and risks, and create a TMP which addresses both within the regulatory framework

WHAT IS CONTAINED IN A TMP?

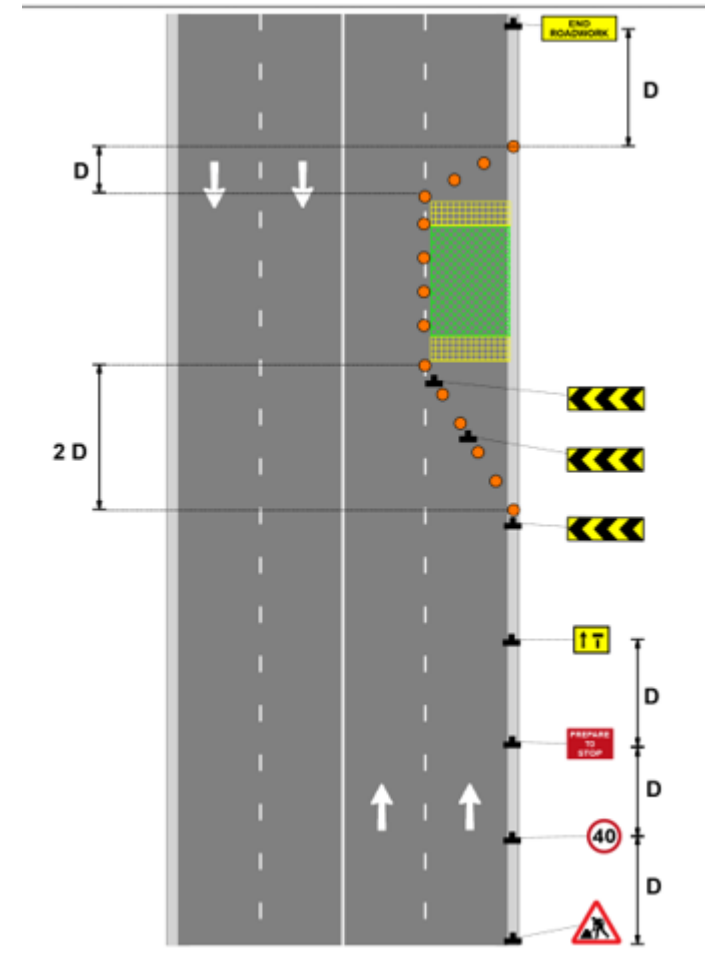
- Project information
- Relevant statutory requirements
- Site assessment
- Risk assessment
- Record keeping methods
- Emergency plan
- TGS

DESIGNING A TGS

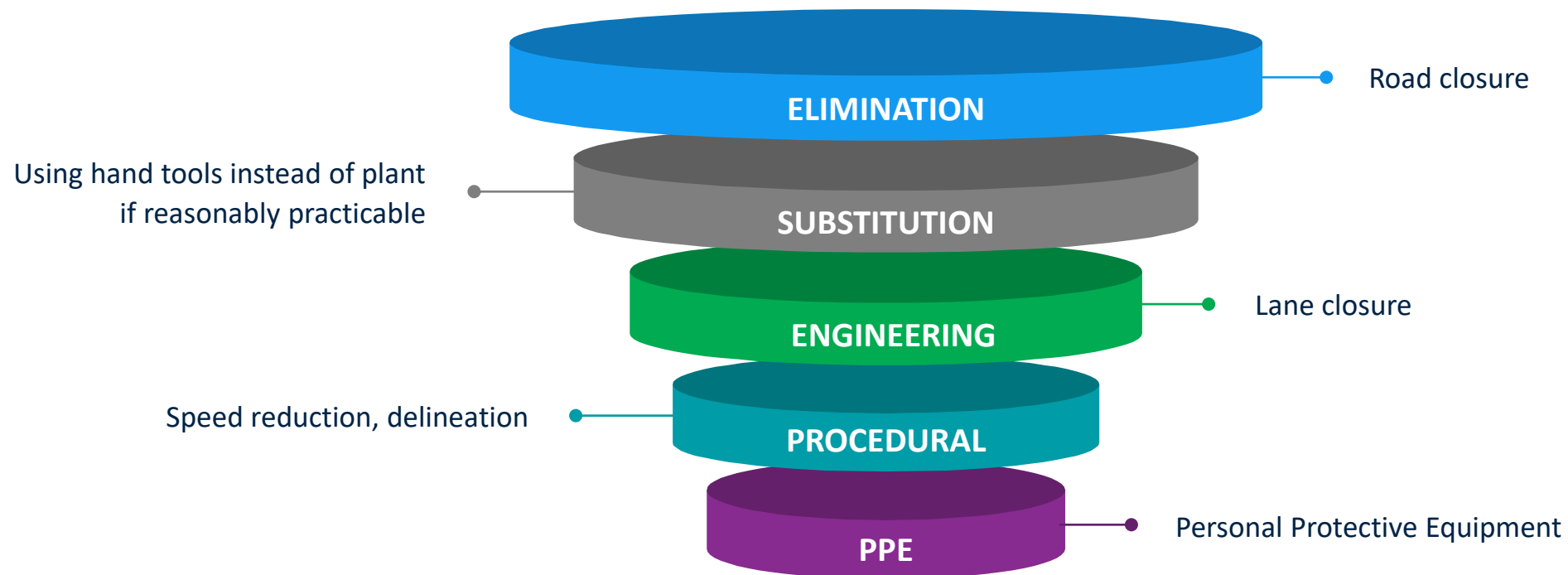


DEFINITION

- A visual representation of the traffic control devices to be implemented to change existing road/footpath conditions so that an area can be isolated for contractors to carry out their works
- Different from a TMP
- The TMP contains all the relevant information which will be used to design the TGS
- An effective TGS is heavily dependent on a comprehensive TMP being completed first

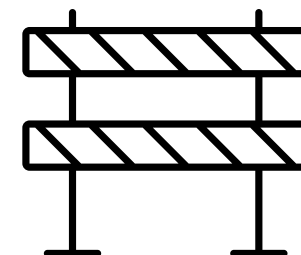
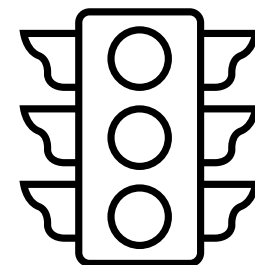
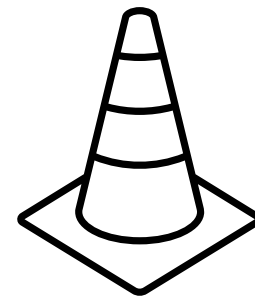


HIERARCHY OF CONTROL



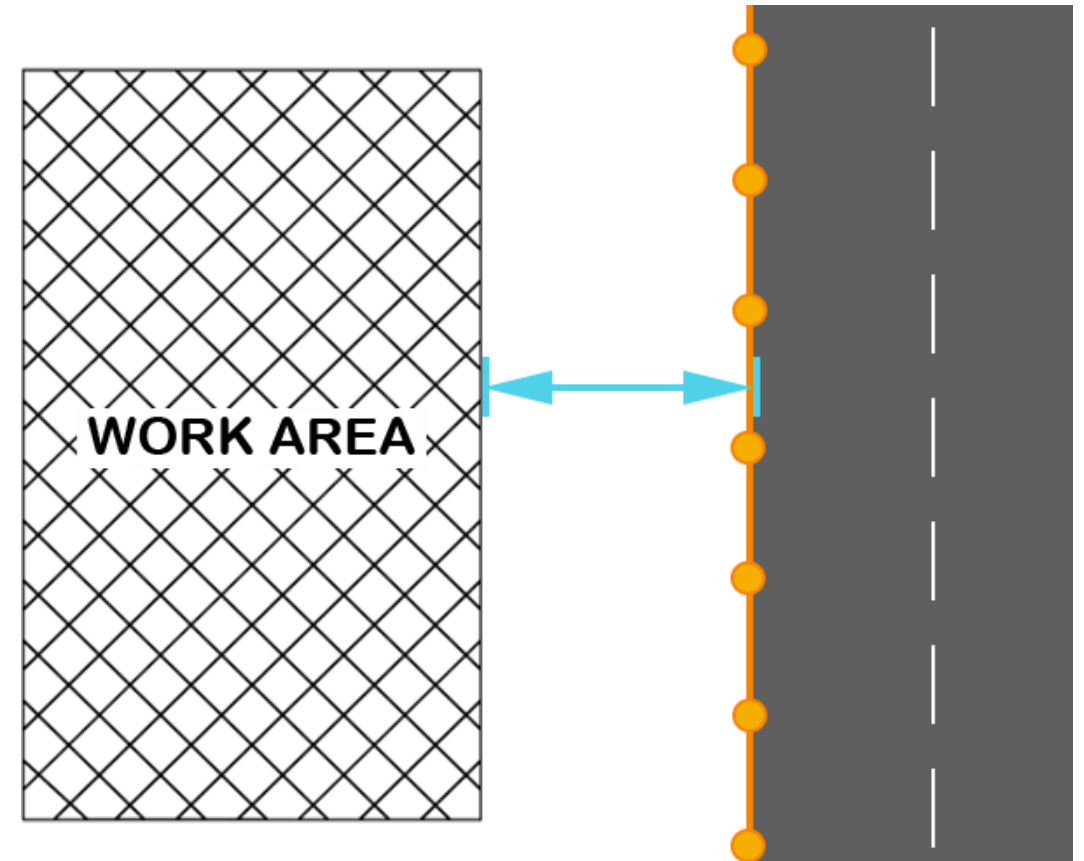
TRAFFIC TREATMENTS

- Lane reduction
- Speed reduction
- Contraflow
- Barrier systems
- Traffic controllers / Portable signals
- Pedestrian management
- Mobile works
- Road closure with detours



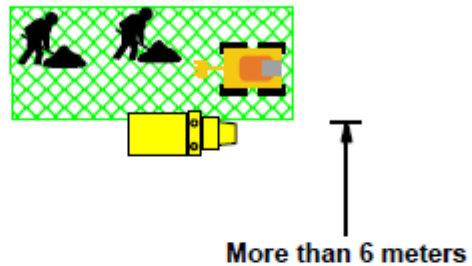
LATERAL SAFETY

- The clearance to the edge of the work area, from the traffic-side edge of the line of delineating devices or barrier whilst work is being completed
- A key element that is considered when designing a TGS
- The following is considered in applying lateral safety:
 - Assessed speed of passing traffic
 - Posted speed of the road, at the work area location
 - Volume of traffic
 - Duration of works



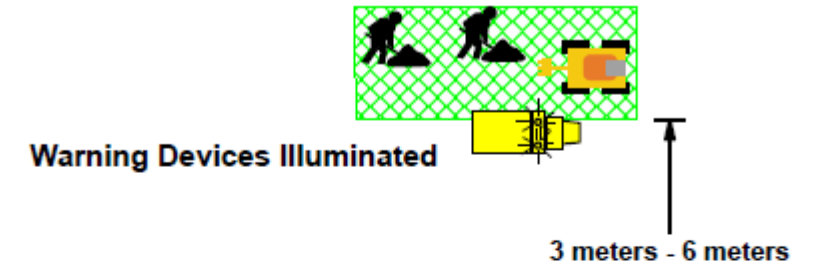
LATERAL SAFETY CONCEPTS


Concept 1



Unrestricted Speed

Concept 2

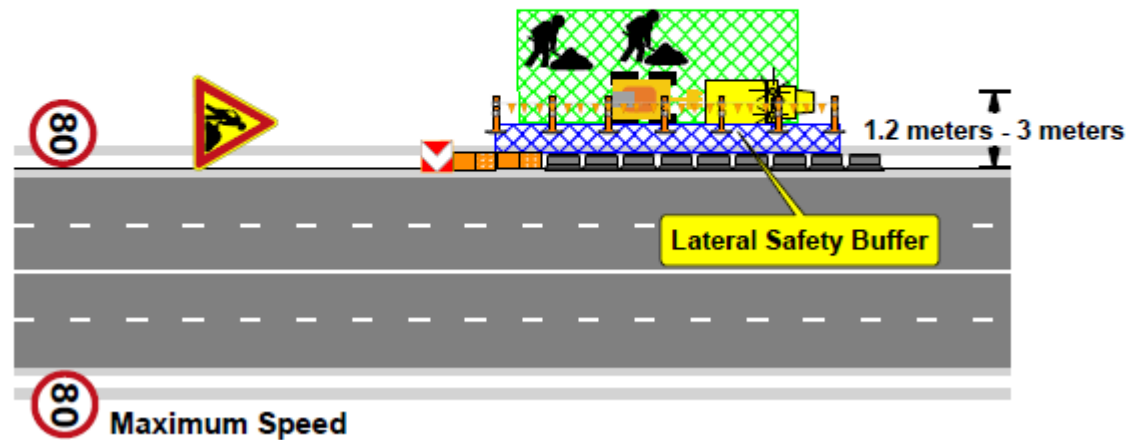


 Maximum Speed

LATERAL SAFETY CONCEPTS

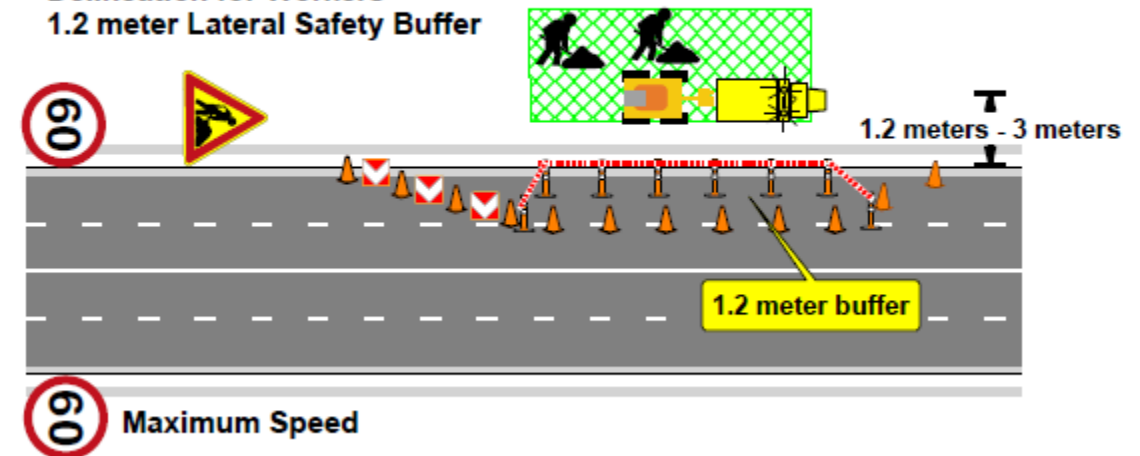
Concept 3

Warning Devices Illuminated
Barrier System Installed
Crash Attenuators Installed
Temporary Fence to create a buffer zone



Concept 4

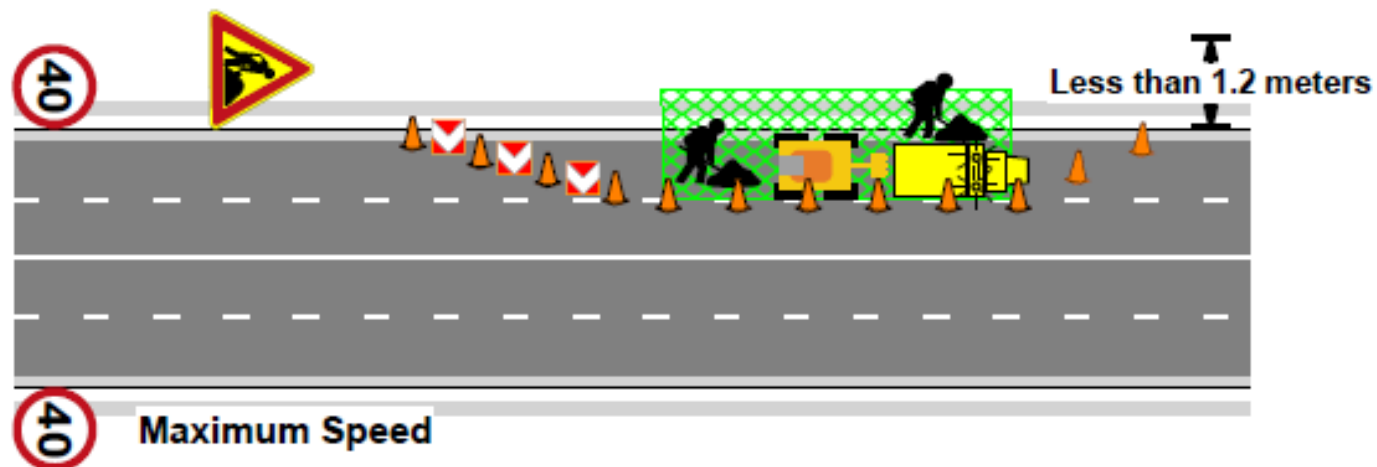
Warning Devices Illuminated
Delineation for Traffic
Delineation for Workers
1.2 meter Lateral Safety Buffer



LATERAL SAFETY CONCEPTS

Concept 5

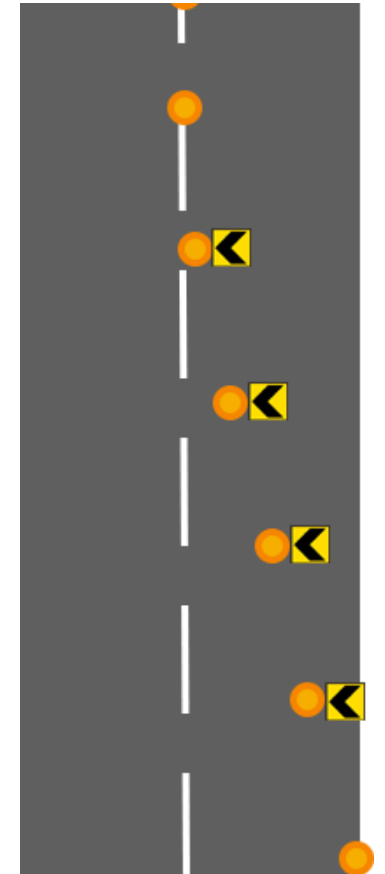
Warning Devices Illuminated
Delineation for Traffic
1.2 meter Lateral Safety Buffer, if possible
40km/h max speed of passing traffic



DELINEATION

Selection of the correct method of delineation is required to ensure that traffic flow is maintained whilst the works are in progress. Key points to be considered when designing appropriate delineation are:

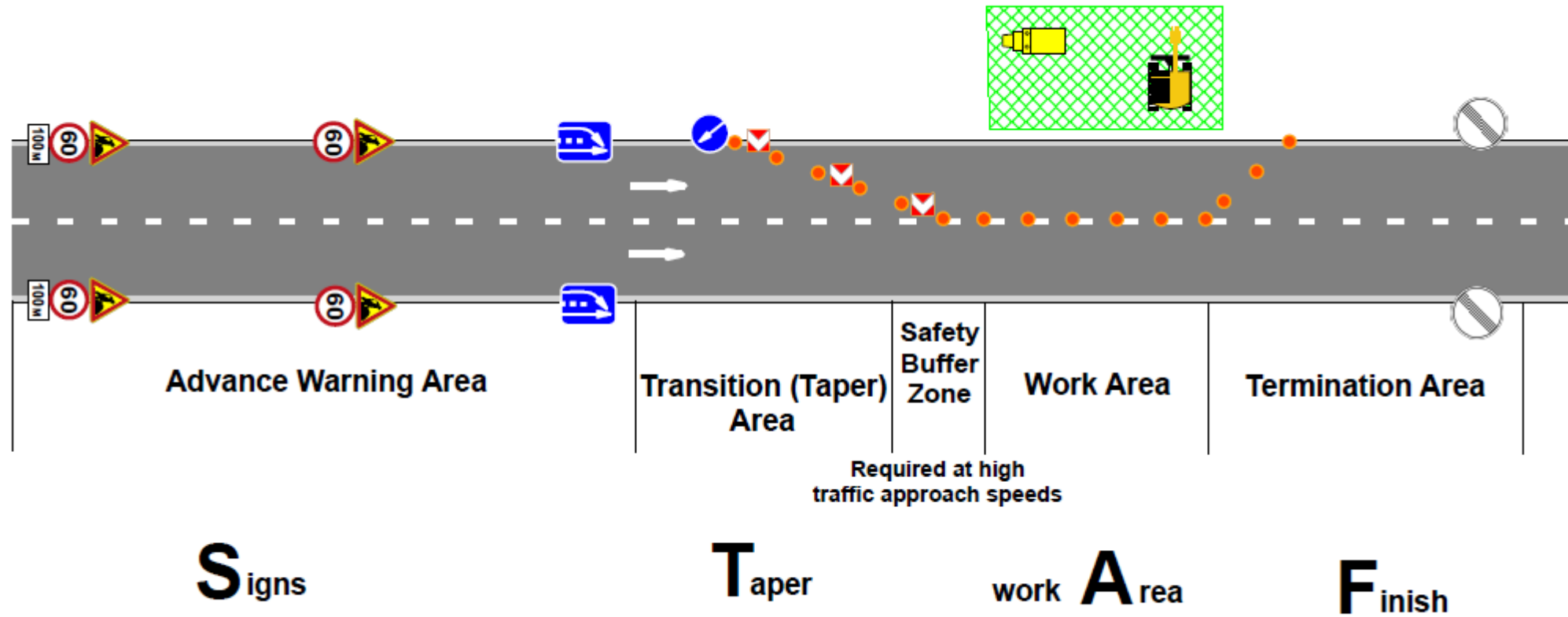
- Types
- Lengths
- Straight sections between tapers
- Tapers for when traffic controllers are used
- Device types



SIGN SELECTION

- Consideration should be given to the most appropriate and economical sign package for the works.
 - Other key points to be considered are:
 - Long/short term works signage requirements
 - Aftercare signs
 - Pedestrian presence
 - Driver behaviour
- **Tip:** When relevant, always introduce speed reduction signage before information signage (e.g. lane status)

COMPONENTS OF A WORK SITE



CONTRAFLOW TRAFFIC MANAGEMENT

- Typically used on dual-carriageway roads
- Involves vehicles crossing over from one carriageway into the reverse-flowing carriageway, which is split into two-way traffic to allow safe passage around worksite
- Useful in locations which require a road section to be closed but do not allow a practical detour via other roads

COMMON ISSUES WITH CONTRAFLOW

- Insufficient advanced warning
- Excessive advanced warning
- Advanced warning does not give adequate and/or clear direction

CONTRAFLOW EXAMPLE TGS



Night works and unattended worksites

FILIP TRAJKOVIC & RAJKO BRANKOVIC



BACKGROUND

- The presence of night-time construction is associated with an 87 percent increase in the accident rate. In addition, the accident rate for the period with lane closures (i.e., the period with work underway) was 75 percent higher than the rate for work without lane closures (Sullivan, E.C. 1989. Accident Rates during Nighttime Construction. UCB-ITS-RR-89-11. Institute of Transportation Studies, University of California at Berkeley);
- A 1978 FHWA study analyzed data from seven states on accidents before and during construction. The construction zones were in place continuously day and night, not only at night. The percentage of total night accidents to total accidents (day and night) remained constant at 30 percent for before and during construction. The implication is that the frequency of nighttime accidents is not increased by the presence of a work zone.

COMMON ISSUES RELATED TO NIGHT CONDITIONS

- Reduced visibility
- Driver impairment or inattention
- Inadequate lighting
- Difficulty in maintaining traffic control devices
- Higher speeds and lower volumes during night
- Worker fatigue
- Glare
- ...

ADVANCE WARNING AREA – COMMON ISSUES

- Invisible/poorly visible traffic signs warning about work zone ahead



Daily conditions



Night conditions

ADVANCE WARNING AREA – COMMON ISSUES



Daily conditions



Night conditions

ADVANCE WARNING AREA – RECOMMENDATIONS

- Using flashing lights on leading warning sign
- Using VMS with specific messages
- Using fluorescent orange/yellow signs
- Using flashing speed limits / lower speeds on trailer



TRANSITION AREA – COMMON ISSUES

- Inadequate traffic control devices used for temporary traffic management
- Inadequate channelization
- Non – usage of flashing lights and inadequate type of flashing lights

TRANSITION AREA – COMMON ISSUES



Daily conditions



Night conditions

TRANSITION AREA – COMMON ISSUES



Daily conditions



Night conditions

TRANSITION AREA – COMMON ISSUES



Daily conditions

TRANSITION AREA – COMMON ISSUES



Night conditions

TRANSITION AREA - RECOMMENDATIONS

- Usage of traffic lights for work zones with lane closure instead of priority signs or flaggers
- Usage of more visible channelization devices instead of cones (signal panels, drums, vertical barriers, etc.)
- Usage of appropriate type of flashing lights for channelization in transition zones (light flow)
- Adjusting of temporary traffic control devices with public lighting

TRANSITION AREA - RECOMMENDATIONS



TRANSITION AREA - RECOMMENDATIONS



WRONG!!!



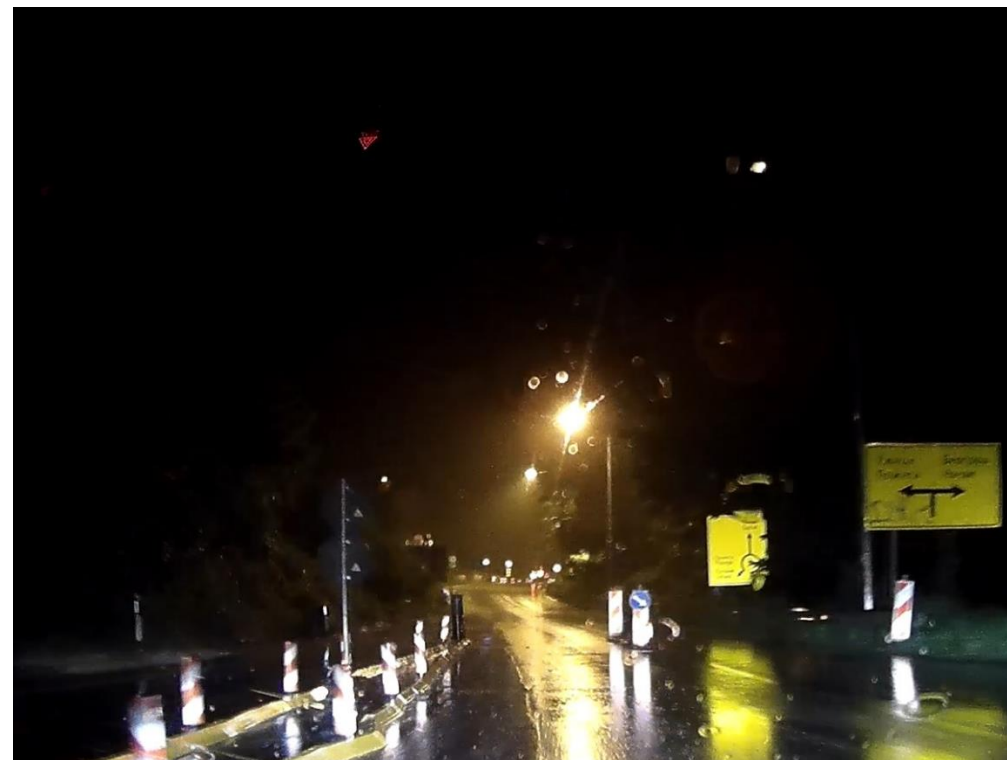
WORKING AREA – COMMON ISSUES

- Poorly visibility traffic signage, especially road markings in work zones
- Non – usage or inadequate type of flashing lights
- Unmarked intersections, bus stops, railway crossings, etc.
- Detours

WORKING AREA – COMMON ISSUES



Daily conditions

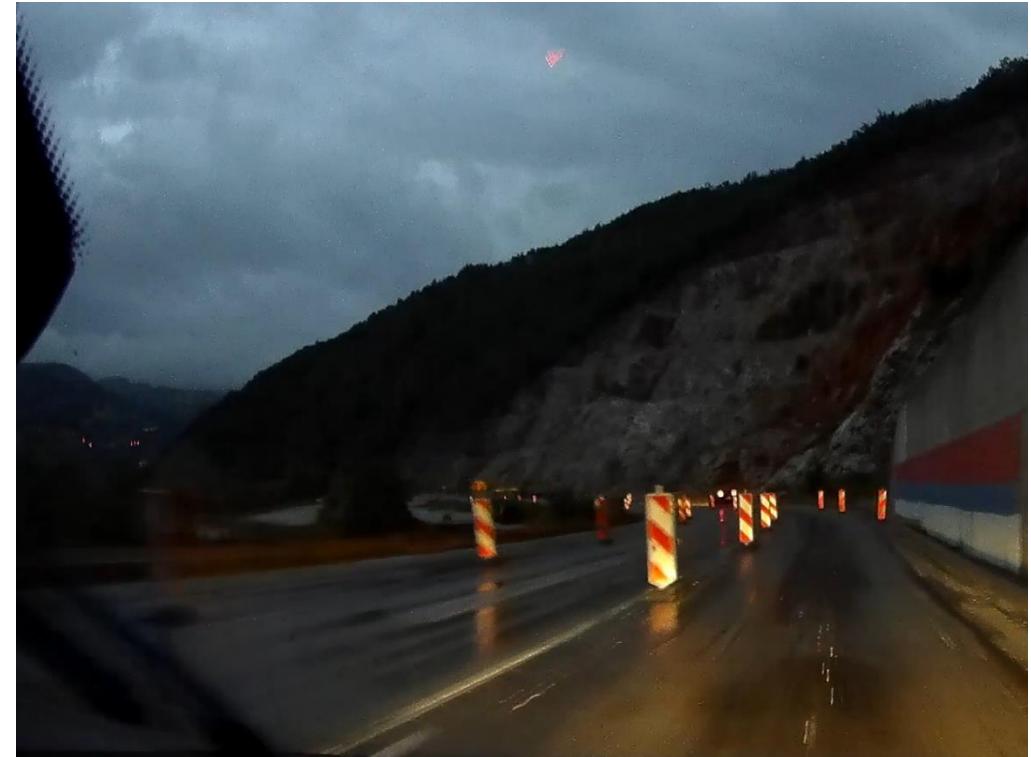


Night conditions

WORKING AREA – COMMON ISSUES



Daily conditions



Night conditions

WORKING AREA – COMMON ISSUES



Daily conditions

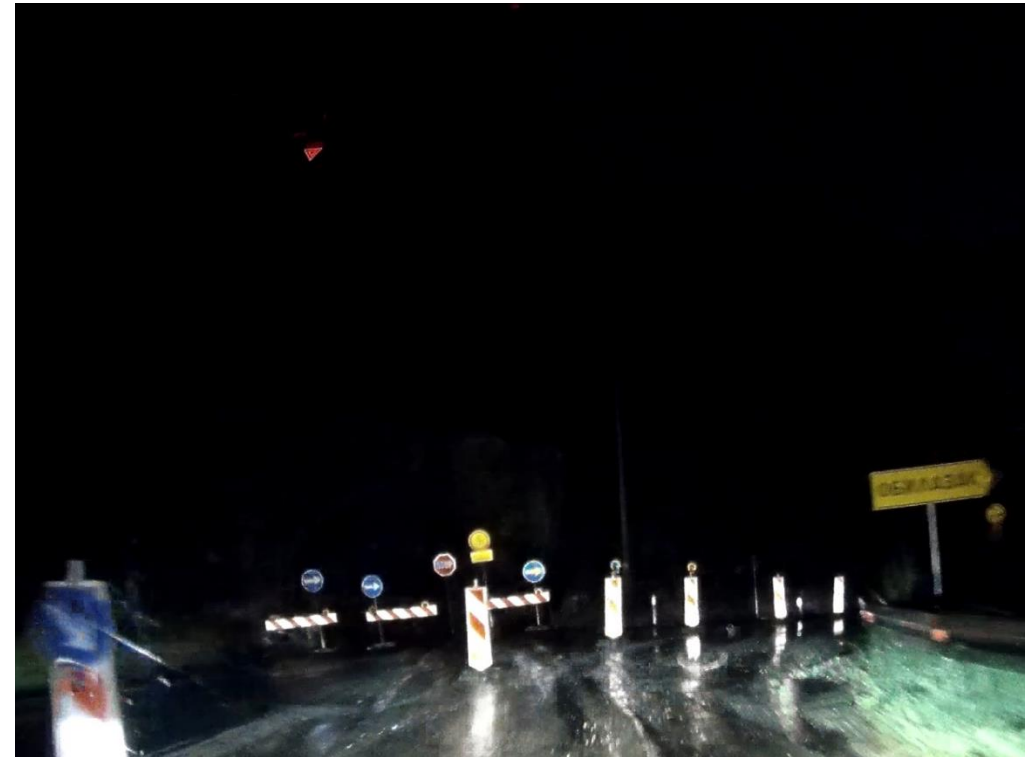


Night conditions

WORKING AREA – COMMON ISSUES



Daily conditions



Night conditions

WORKING AREA – RECOMMENDATIONS

- Road markings in work zones need to have same characteristics as a permanent road markings and need to be properly maintained
- Flashing lights should be installed and properly maintained for the whole period of construction
- Features along the road such as intersections, bus stops, railway crossings, etc., needs special attention during planning and organization of work zones
- Detours needs special attention since they are representing transitions from previous route to the new one
- Traffic control devices such as vertical barriers and flash beacons should be properly organized, to avoid confusing the drivers about the right route they need to take

WORKING AREA – RECOMMENDATIONS



CONCLUSIONS

- Improving visibility of workers
- Using more visible traffic control devices (drums, vertical barriers) in taper
- Using the police
- Maintaining devices
- Using VMS with specific messages
- Using fluorescent orange/yellow signs
- Using flashing beacons on leading warning sign

CONCLUSIONS

- Using flashing speed limits / lower speeds on trailer
- Working where there is highway lighting
- Arranging for delivery of materials
- Illuminating flagger station
- Providing proper delineation
- Using a smaller spacing of channelizing devices
- Using amber revolving lights and flashers on work vehicles

CONCLUSIONS

- Requiring vehicle warning beacons and reflective tape
- Taking care to avoid glare
- Having spare lighting units on hand
- Requiring different types of flashing light on channelizing devices in transition zones (detours as well), within work zone and for isolated signs

