Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Strategic Asset Management Plan

Tunnels, Motorway Operations Control Centre, and Motorway Service Areas

Version 1.1

Document Versions

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Abbreviations

2G	Second Generation
AA	Administrative Authority
ADT	Average Daily Traffic
AI	Artificial Intelligence
AIM	Asset Information Management
AM	Asset Management
AMP	Asset Management Plan
ANPR	Automatic Number Plate Recognition
ATMS	Advanced Traffic Management System
BEV	Battery Electric Vehicles
BIRT	Business Intelligence and Reporting Tools
CAP	Climate Action Plan
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
CEMAR	Contract Event Management and Reporting
C-ITS	Cooperative Intelligent Transport System
CMMS	Computerised Maintenance Management Systems
DBFO	Design, Build, Finance, Operate
DFB	Dublin Fire Brigade
DKI	Dunkettle Interchange
DT	Dublin Tunnel
ECS	Electrical Control System
eMOS	Enhancing Motorway Operations Services
EPS	Emergency Procedure Strategy
ERT	Emergency Roadside Telephone
ERTO	Egis Road and Tunnel Operation
ETC	Electronic Toll Collection
EU	European Union
EUD	European Union Directives
FMECA	Failure Mode, Effects, and Criticality Analysis
FWCP	Forward Capital Works Programme
GHG	Greenhouse Gas
GI	General Inspection
GIS	Geographic Information System
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicles
HVAC	Heating, Ventilation, and Air Conditioning
HVO	Hydrotreated vegetable oil
IAM	Institute of Asset Management
IE	Inspection Entity
IMS	Incident Management System
IoT	Internet of Things
ITS	Intelligent Transport System
JLT	Jack Lynch Tunnel
KPI	Key Performance Indicators
LCC	Life Cycle Cost

Abbreviations

LDV	Light Duty Vehicle
LIDAR	Light Detection and Ranging
LT	Limerick Tunnel
LV	Low Voltage
LVD	Loop Vehicle Detectors
M&E	Mechanical and Electrical
MMaRC	Motorway Maintenance and Renewals Contract
MOCC	Motorway Operations Control Centre
MOR	Minimum Operating Requirements
MSA	Motorway Service Area
MTFO	M50 Traffic Flow Optimisation
MV	Medium Voltage
NIA	North In-situ Approach
NIFTI	National Investment Framework for Transport in Ireland
NIMS	Network Intelligence and Management System
NM	Network Management
NR	National Road
NRA	National Roads Authority
OHVDS	Overheight Vehicle Detection System
OMTTCC	Operation and Maintenance of Tunnels and Traffic Control Centre
OT	Operational Technology
PA	Public Address
PABX	Private Automatic Branch Exchange
PAMS	Pavement Asset Management System
PAVA	Public Address and Voice Alarm
PDCA	Plan-Do-Check-Act
PM	Predictive Maintenance
PI	Principal Inspection
PPP Co.	Public Private Partnership Company (Private Party)
PSCS	Project Supervisor for the Construction Stage
PSDP	Project Supervisor Design Stage
RMMS	Routine Maintenance Management System
RTMS	Radar Traffic Monitoring Sensors
SAGS	System and Asset Group Status
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SI	Statutory Instrument
TBM	Tunnel Boring Machine
TCAS	Tunnels Contract Administration Services
TCMS	Traffic Control Management System
tCO2	tonnes of Carbon Dioxide
TEN-T	Trans-European Transport Network
TERN	Trans-European Road Network
TERT	Tunnel Emergency Roadside Telephones
TII	Transport Infrastructure Ireland
TRV	Tunnel Response Vehicle
TSO	Tunnel Safety Officer
UPS	Uninterruptible Power Supplies
V2V	Vehicle to Vehicle
V2I	Vehicle to Infrastructure
VBI	Voice Break In
VMS	Variable Message Sign
ZEHDV	Zero-Emission Heavy Duty Vehicle
ZEVI	Zero Emission Vehicles Ireland

CONTENT

1. Overview

As an integral part of its role in the development and operations of the national roads network and light rail systems throughout Ireland, Transport Infrastructure Ireland (TII) is responsible for the long-term stewardship of a wide range of infrastructure assets. To meet the challenges of providing transport services efficiently and sustainably while supporting economic growth and respecting the environment, TII is developing and implementing a systematic approach to infrastructure asset management. It has, therefore, produced a suite of asset management documents that clearly define its policy, strategy and objectives for the operation, maintenance and renewal of assets in supporting the delivery of transport services. The purpose of this Strategic Asset Management Plan (SAMP) is to set out how TII applies its asset management principles and approach to the following asset groups:

- Tunnels (Dublin Tunnel, Jack Lynch Tunnel Cork, and Limerick Tunnel)
- Motorway Operations Control Centre (MOCC)
- Motorway Service Areas (MSAs)

Each of these assets play a critical role in the national road network. It is vital that they are operated and maintained to a standard that does not negatively impact the national road network. As well as day-to-day maintenance and repairs, this requires the renewal, replacement and upgrade of key equipment and systems to ensure that they continue to function reliably, safely and efficiently.

TII Asset Management Hierarchy – Line of Sight

Effective asset management involves clear alignment between an organisation's statement of strategy and the asset management activities delivered by staff and strategic partners. This alignment, also known as 'Line of Sight', enables everybody to understand their role in achieving success. 'Line of Sight' translates organisational objectives into asset management policy, strategy, and objectives, which cascade down into more detailed asset management plans and activities.

TII's Asset Management Framework outlines the key strategic objectives to be attained through effective asset management practices. This SAMP details how these objectives will be achieved for TII's major Tunnels, the MOCC and MSAs. Developed collaboratively with input from stakeholders, the SAMP reviews current asset management practices for Tunnels, the MOCC and MSAs, presents gap analyses, and proposes improvement plans to meet framework objectives and performance measures.

The following hierarchy sets out the structure in which TII proposes to achieve its overall asset management objectives in line with an ISO 55000 integrated asset management system approach.

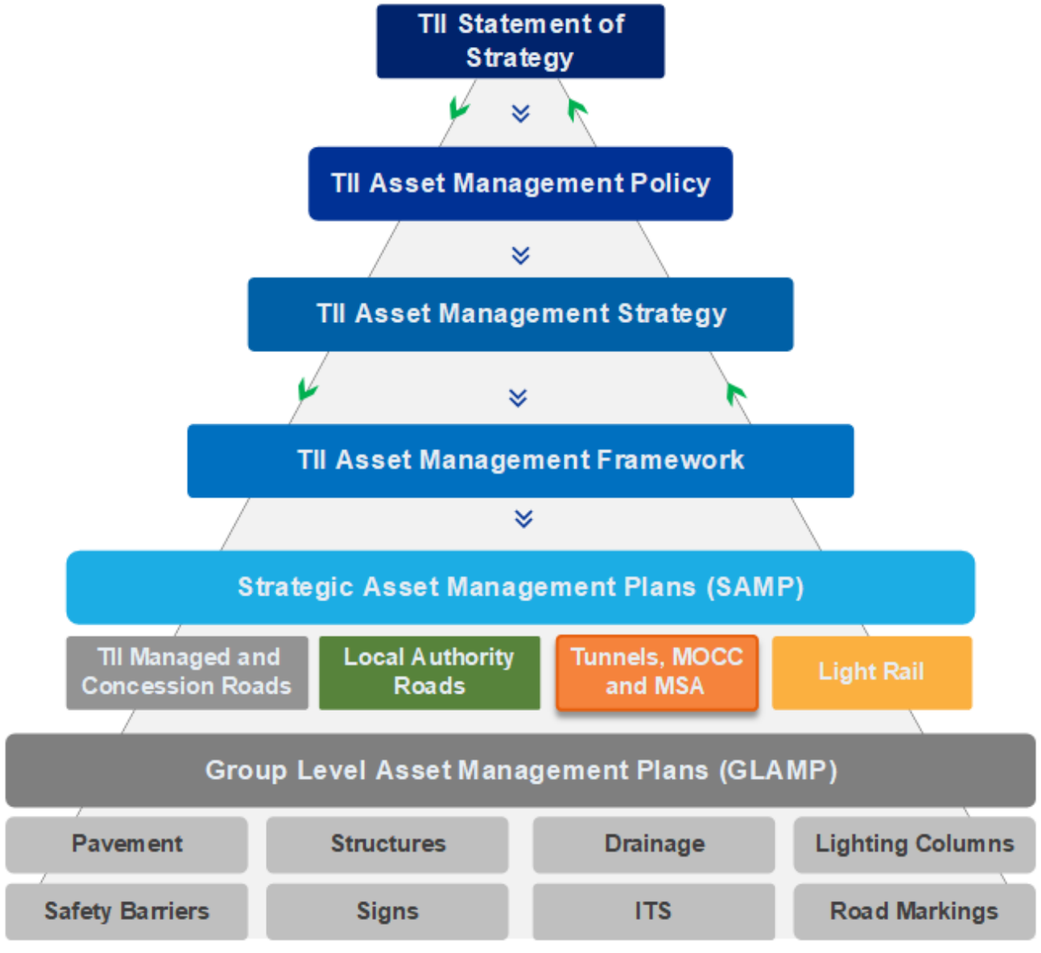


Figure 1: TII's Asset Management Hierarchy-Line of Sight.

Governance, Management and Operations

Network Management/Role of TII

TII is organised into mutually supportive divisions, departments and project teams, some dedicated to particular business or project outcomes and others providing administrative or technical specialist support across the spectrum of TII activities. The Network Management (NM) division of TII is responsible for the management, operation and maintenance of the national roads network, including TII's Tunnels, MOCC and MSAs. Activities within the NM division are divided into regional network operations and functional asset management activities. Asset management activities are typically planned and co-ordinated by specialist engineering teams organised by asset type.

TII engages Technical Advisors to assist in providing oversight, monitoring, and supervisory services in connection with the TII's Tunnel operations and maintenance activities, its MOCC operation and management activities and its MSA programme. TII, as the owner of these assets, has ultimate responsibility for their long-term stewardship and in overseeing their operation and maintenance.

As the routine delivery of the operation and maintenance is through third parties, under Public Private Partnership (PPP) contract or outsourcing arrangements, TII's principal role is overseeing and directing the performance of the service providers and, in the case of TII's tunnels (DT and JLT) and MOCC planning, for medium to long term capital investment requirements. Figure 2 gives an overview of the management hierarchy, including the key functions of TII and their Technical Advisors in overseeing TII Tunnels, MOCC and MSA operations.

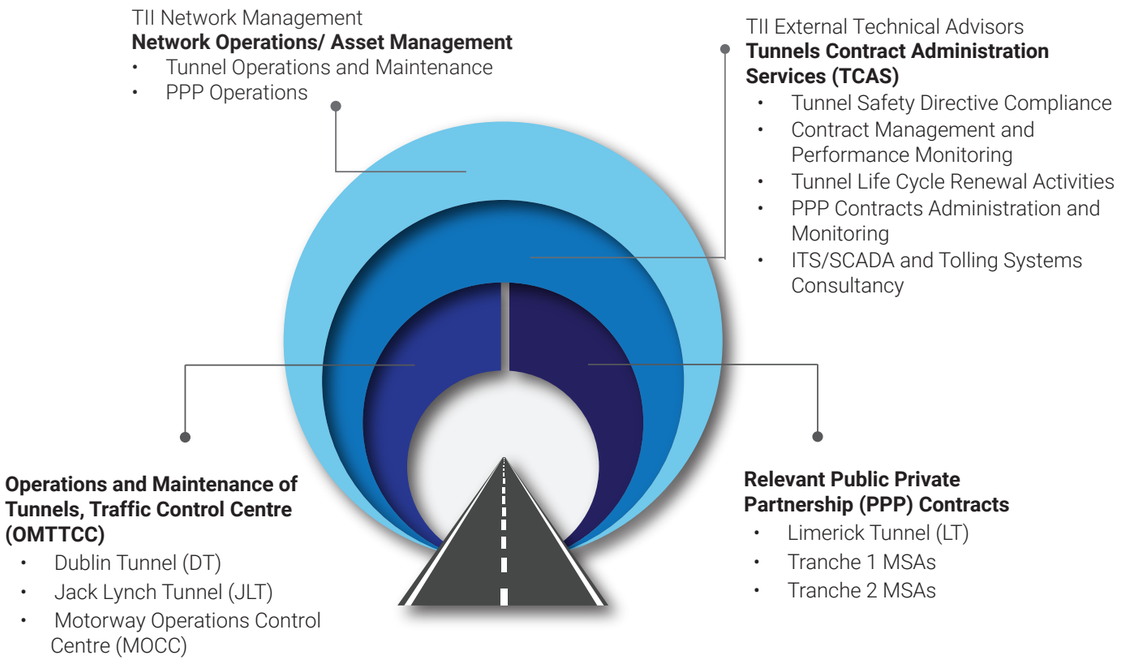


Figure 2: Governance and Management Structure for Tunnels, MOCC, and MSAs.

Tunnels

TII is responsible for three road tunnels with a collective value of €1.9 bn[1] as part of the managed motorway and dual-carriageway road network: the Dublin Tunnel (M50), the Jack Lynch Tunnel (N40), and the Limerick Tunnel (N18). The Dublin Tunnel and the Jack Lynch Tunnel are operated and maintained by Egis Road and Tunnel Operation (ERTO) Ireland on behalf of TII.

ERTO's prime responsibility is to manage all processes associated with tunnel operation and maintenance including Toll Collection, Traffic Management, Tunnel Safety Management, Emergency and Contingency Planning, Equipment and Infrastructure Inspection and Maintenance. Direct Route (Limerick) Ltd. is responsible for the operation and maintenance of the Limerick Tunnel as part of the N18 Limerick Southern Ring Phase II PPP.

1. TII Asset Management Strategy | Dec 2021 www.tii.ie/tii-library/assetmanagement/documents/AM-Strategy(Dec2021)V1.3-08-09-2023.pdf

Tunnel	Description	Operations	Contract Award/Expiry
Jack Lynch Tunnel	The 610m immersed tube construction that takes the N40 Cork Southern Ring Road under the River Lee. Features two traffic bores and a central bore for emergency escape and service access.	Opened in 1999 and was initially managed by Cork City Council. TII took stewardship in 2015, and it has been operated by ERTO Ireland since then.	The first generation OMTTCC contract formally began on 20th October 2014, with services starting on 20th February 2015. The second generation OMTTCC2G contract will started in 2025 for an initial period of 8 years, with potential extensions up to 16 years at TII's discretion.
Dublin Tunnel	Tolled tunnel that runs 4.5Km, taking the M50 under the city from the Coolock interchange to River Tolka near the entrance to Dublin Port. It includes a bored centre section and cut and cover sections at both ends, built to reduce congestion, noise, and improve air quality. It also supports the development of the port.	Opened in 2006, it is operated by ERTO Ireland on behalf of TII.	
Limerick Tunnel	The 675m long immersed tube tunnel carrying the N18 Limerick Southern Ring Road beneath the River Shannon. It contains two cells, each with two traffic lanes.	Built as part of a PPP scheme between the NRA and Direct Route (Limerick) Ltd (DRL), it is a tolled tunnel that opened in 2010 and continues to be operated and maintained by DRL.	The Limerick Tunnel Scheme contract was awarded to the DirectRoute consortium on 18th August 2006 and has a total duration of 35 years (2006-2041).

Motorway Operations Control Centre (MOCC)

The MOCC is situated at the Tunnel Control Building in Dublin, serving as the focal point for round-the-clock coordination of combined motorway and tunnel operations. The MOCC operates several services including variable message signs, network management CCTV and the Network Intelligence and Management System. Operated by ERTO Ireland, the centre was developed in 2020 as part of the enhanced Motorway Operation Services (eMOS) project.

With a dedicated team of 37 control room staff, the MOCC is equipped with cutting-edge technology for continuous and real-time monitoring of the Motorway network, Dublin Tunnel, and Jack Lynch Tunnel. A video wall measuring 3 meters in height and 15 meters in width is employed to display live feeds from the motorway CCTV camera network, tunnels, and other Intelligent Transportation Systems (ITS).

The MOCC exercises control over various critical functions, including Tunnel ventilation, fire safety, over-height detection, and traffic control, through the implementation of a Supervisory Control and Data Acquisition (SCADA) System. Solar powered Emergency Roadside Telephones (ERTs) located on the motorway network are operated through the MOCC.

This comprehensive setup ensures efficient and secure management of motorway and tunnel operations, reinforcing the commitment to safety and operational excellence.

Congestion Management
Monitor vehicles journeys utilising advanced traffic management system (including NIMS, CCTVs, and other roadside equipments)

Incident Management
Communication hub for incident management and oversees response

Provision of Network User Information
Gather and distribute relevant information to assist the road user and other stakeholders

Management of Planned Events
Inform public of information that may affect their journey time

Support Services
Customer care service, liaison with emergency services and operational partners

Motorway Service Areas (MSAs)

Motorway Service Areas (MSAs) are provided on dual carriageways (including motorways) to afford convenient and safe places for road users to stop, rest and access facilities. Service Areas provide:

- Areas for commercial vehicles to park allowing drivers take their mandatory break and rest periods;
- Areas for all road users to park and rest in order to reduce fatigue; and
- Access to facilities for road users – such as fuel stations, toilets, food outlets, etc.

To ensure high quality service levels for users of the motorway network and meet EU requirements for routes on the Trans-European Transport Networks (TEN-T), TII plays a pivotal role in managing and coordinating its MSAs, which are integral components of Ireland's extensive transportation network, and has established policy to sustain the service levels for these facilities[1]. These have been procured and are being operated through two tranches of Public Private Partnership (PPP) contracts.

1 *TII Service Area Policy 2023 (Motorway and Dual Carriage way Networks) December 2023*

Tranche 1

It was awarded in **2009** to **Superstop Ltd.**, on a **"Design, Build, Finance, and Operate" (DBFO)** basis, with a 25-year duration (2009 - 2034). The NRA contributed to the capital construction costs while Superstop is responsible for the operation and maintenance costs. This tranche comprises **M1 North Castlebellingham, M1 South Lusk and M4 Enfield** service areas which commenced operations in 2010.

Tranche 2

It was awarded in **2018** to **Beech Hill Gateway Services DAC**, for the design, construction, operation and financing of two service areas and the fit-out, operation and maintenance of a third, also with a 25-year duration (2018-2043). This tranche consists of **M6 Athlone, M9 Kilcullen and M11 Gorey** service areas which came into operation during 2019.

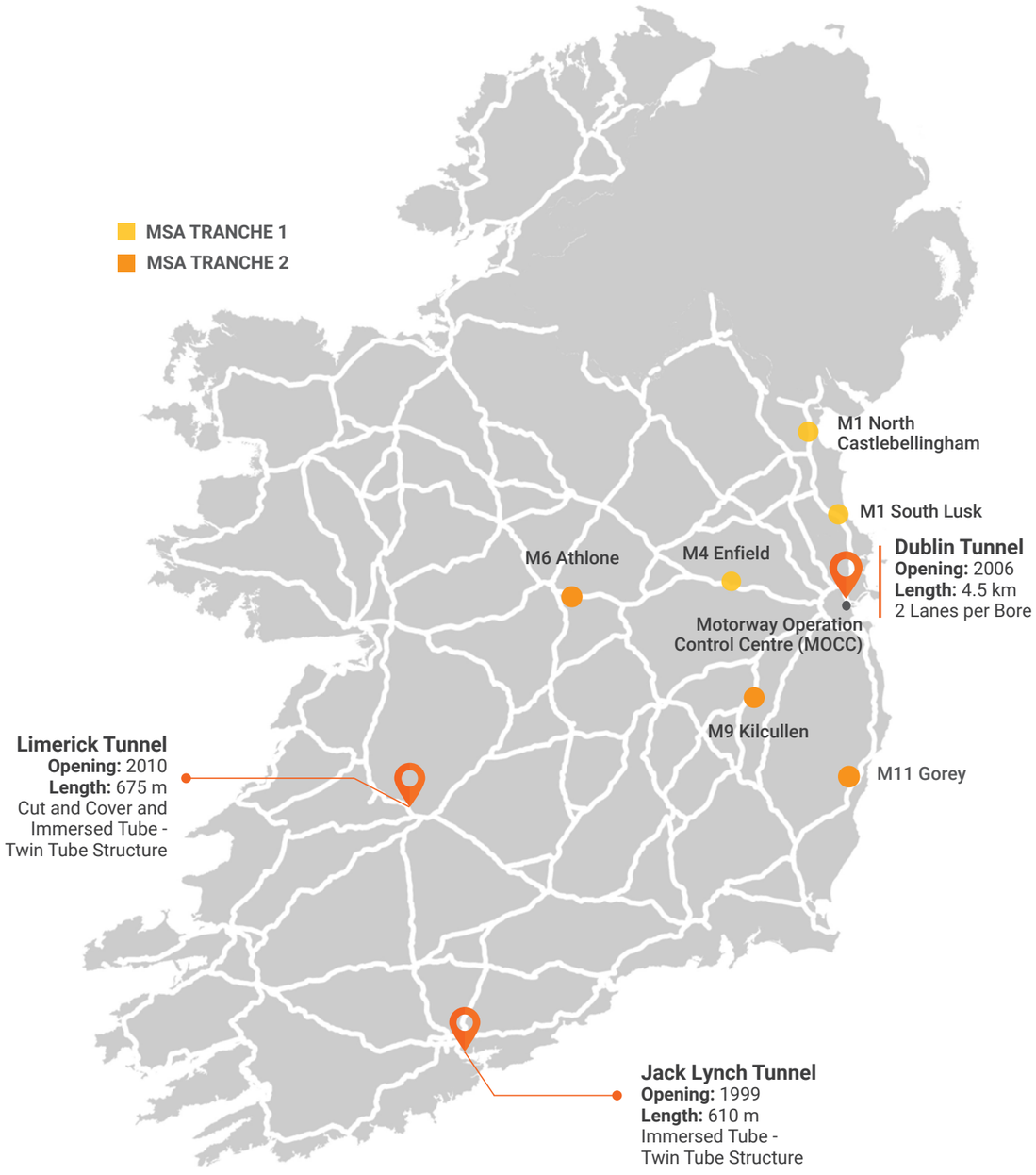


Figure 3: TII's Major Tunnels, MOCC, and MSAs.

Contractual Framework and Funding Arrangement

Operation and Maintenance of Tunnels and Traffic Control Centre (OMTTCC) Contract

TII, as Contracting Authority, appointed a single contractor for the provision of operation and maintenance services for the Dublin Tunnel (DT), Jack Lynch Tunnel Cork (JLT), and MOCC. Egis Road and Tunnel Operation Ireland (ERTO) was awarded the first-generation OMTTCC contract which commenced in 2015. Egis (ERTO) had an O&M contract for the Dublin Tunnel only, prior to the OMTTCC, which brought the Jack Lynch Tunnel and MOCC into scope

The second-generation contract (OMTTCC2G) was re-tendered in 2024, with a duration of up to 16 years. The scope of the OMTTCC2G contract is anticipated to involve (but may not be limited to) provision of the services listed below:

- Operation and management of tunnels and MOCC, coordinate activities and undertake administrative functions
- Operation and maintenance of the tunnel equipment and MOCC systems
- Management, operation and maintenance of the tolling system at Dublin tunnel
- Provision of customer response services and emergency response capability
- Operation and maintenance of an average speed enforcement system
- Improvements, renewals, and upgrades to equipment and systems as instructed by TII
- Instigation, maintenance and operations under the Quality Management System
- Appointment as Project Supervisor for the Construction Stage (PSCS), Project Supervisor Design Stage (PSDP) and principal contractor for works

TII's tolling operations collect user charges every year from a broad customer base using the Dublin Tunnel. Net revenues collected are invested in the operation and maintenance of the national road network, thereby reducing the pressure on Exchequer funding requirements. While TII receives toll income from the Dublin Tunnel, ownership of the asset rests with the relevant Local Authority (Dublin City Council). TII covers payments related to the tunnel operational costs, toll collection costs and local authority charges of the Dublin Tunnel; and operational costs of the Jack Lynch Tunnel.

Public Private Partnership (PPP) Contracts

The Limerick Tunnel, along with the first and second tranches of the MSAs, have been procured and are being operated under PPP contracts, overseen by TII. Under Cooperation Agreements between the road authorities and TII, the PPP Concession companies hold the full responsibility for the operation and management of the national roads or service areas within their remit. This includes the full range of day-to-day operational, maintenance and management responsibilities. In addition, the PPP Concessions are also responsible for the life cycle management of assets, ensuring that the handback condition of the various road or service area assets meet the specified requirements of the PPP contract.

Funding arrangements for Limerick Tunnel and MSA Tranche 1 and 2 PPP's are as follows:

- Limerick Tunnel PPP Co receives operational payments from TII as tendered by the PPP Co in 2006. In addition to this the PPP Co receives Traffic Guarantee payments where traffic levels on the toll road do not meet certain tendered threshold levels. Commercial property rates payable to the Local Authority are a matter for PPP Co.
- MSA Tranche 1 PPP Co received construction payments from TII and pays TII revenue share payments. The cost of operating and maintaining the services areas are met by PPP Co and its operators in accordance with the Contract.
- MSA Tranche 2 PPP Co did not receive any construction payments from TII and pays TII revenue share payments. The cost of operating and maintaining the services areas are met by the PPP Co and its operators in accordance with the PPP Contract.

The nature of TII's oversight role differs in the case of PPP concessions as compared with the management of the OMTTCC or MMaRC contracts. Planning and delivery of lifecycle asset management and renewal activities are undertaken by the PPP Co. in addition to day-to-day operations. TII's role is primarily focused at ensuring compliance with the PPP Contract obligations, but unlike the OMTTCC and MMaRC contracts does not typically involve direct input into the planning of lifecycle renewal activities.

However, as the contract periods for the various PPP concessions mature, there is a requirement for an increased focus on ensuring that the condition of the assets comply with the handback provisions of the contracts. The PPP contract expiry for Limerick Tunnel, MSA Tranche 1 and Tranche 2 PPPs, are shown in the table below and all are scheduled to revert to public operation in the period from 2034 to 2043.

Asset	Award date	Handback	Type	Operator
Limerick Tunnel	2006	2041	PPP Concession	Direct Route (Limerick) Ltd.
Tranche 1 _MSA	2009	2034	PPP Concession	Superstop Ltd.
Tranche 2 - MSA	2018	2043	PPP Concession	Beech Hill Gateway Services DAC

2. Assets and Resources

As stated in our Asset Management Framework, the performance of an asset management organisation is strongly dependent on the quality and availability of asset data and information, including good inventory and condition information and a comprehensive understanding of the costs associated with replacing or renewing infrastructure. The decisions we make are informed by robust and readily accessible asset data and information. Our asset management systems provide a repository for this data and information to support the enhancement, operation, and maintenance of our assets.

While the three tunnels vary in scale and form of construction, a consistent classification of asset systems is utilised for the purpose of managing the TII tunnel asset stock. The following section outlines the asset classification system which applies across all three tunnels.

This section also describes the MOCC suite of hardware and software systems that support various operations of the MOCC, and principal inventory items for the MSA Tranche 1 and Tranche 2 PPP facilities which provide services and amenities to road users, such as fuel, food, restrooms, parking and information. The asset information systems and datasets that are used to manage these assets are also described in this section.

Tunnel Asset Groups and Principal Inventory

The DT and JLT assets are managed in System and Asset Groups (SAG) structure categories, that divide the assets into various interconnected systems. This structure is used for the purposes of monitoring and reporting on the asset condition and performance. The LT asset register hierarchy follows a comparable structure.

Civil and Structures

Tunnel and Other Structures

This asset group covers the main tunnel structure and cross-passages, niches, ducts and chambers where present within the tunnel structure. As described previously, the scale and form of construction employed varies between the three tunnels. It also covers the range of buildings that accommodate associated services at each site and tolling operation.

Asset Group	Jack Lynch Tunnel	Dublin Tunnel	Limerick Tunnel
Tunnel Structure	610m immersed tube includes five precast concrete units (122m x 23.8m x 8.4m) connected by immersion joints. The northern approach comprises a 75m North In-situ Approach (NIA) and a 120m Boat Unit 1 (BU1), while the southern approach features three in-situ sections of 60m, 95m, and 5m.	4.5 km long tunnel, with a 2.65km twin bored centre section bored by a Tunnel Boring Machine (TBM) and cut-and-cover sections of 1.3 km to the north and 575 m to the south. Tunnel joints spaced at 12m c/c; 19 cross passages and 229 niches	600m twin bore immersed tube tunnel. The central immersed tube construction comprises 5 no. 100m long precast elements. The "cut and cover" portals and approach ramps at either end bring the overall length to 675m. 5,225m expansion joints.
Buildings	There are three associated buildings: • Tunnel Management Building • North Substation • South Substation	There are five associated buildings: 1. Tunnel Control Building 2. Northern Operations Building 3. Southern Operations Building 4. Modular Office Facility 5. Storage Building	There are six associated buildings: 1. North Tunnel Services Building 2. Generator Building 3. South Tunnel Ventilation Building 4. South Tunnel Services Building 5. North Tunnel Ventilation Building 6. Fire Water Pump House
Other Structures	• The tunnel is not tolled; • 3 tunnel sump structures	• Toll plaza at the southern portal • 9 toll booths and toll canopy; • 6 structures including bridges & cable/access tunnels • 2 tunnel sump structures	• The road is tolled between Junction 2 and Junction 4 (2 toll plazas) • 33 structures • 5 tunnel sump structures

Roads and Associated Infrastructure

The tunnel sites have extensive paved areas including car parks, storage yards and internal roadways and walkways as well as the principal carriageways. This asset group also covers the road traffic signage and the safety barriers and crash cushions associated with the trafficked areas.

Asset Group	Jack Lynch Tunnel	Dublin Tunnel	Limerick Tunnel
Road Pavement	• c.9,000m^2 paved area (tunnel) • c. 3,700m road markings (tunnel) • c. 300 no. road studs (incl. LED)	• c.90,000m^2 paved area, incl. mainline, slips and toll lanes • c. 41,000m road markings • c. 600 road studs (incl. LED)	• c.10,000m^2 paved area (tunnel) • c. 4,000m road markings (tunnel) • c. 350 no. road studs
Associated Infrastructure	• 25 manholes • 213 duct covers • 18 no. safety barrier/crash cushions • 21 signs • 2 sign gantries	• 361 manholes • 57 safety barrier incl. crash cushions, box girder barriers • 238 signs • 4 sign gantries	• safety barriers • signs • 6 sign gantries

Jack Lynch Tunnel, Northbound Bore
Photo © David Dixon (cc-by-sa/2.0)

Mechanical, Electrical and Piped (MEP) systems

Ventilation Systems

Monitoring and maintaining air quality within the tunnels, and risk sites such as the tunnel sumps, is an essential function to ensure a safe and comfortable environment for users and operatives. Each tunnel is equipped with a system of sensors which monitor, depending on the tunnel, some or all of: air speed, visibility, carbon monoxide, nitrous oxide, and hydrogen sulphide. These sensors are linked to arrays of ventilation fans in the tunnel bores that drive air circulation through the tunnels. Extraction fans are provided in tunnel sumps to prevent build-up of noxious gases.

Lighting Systems

Each tunnel has general overhead lighting and also emergency systems comprising orientation lights, illuminated exits signs, SOS signs and emergency door lighting to facilitate evacuation in case of incident. Street lighting is provided for the tunnel approaches and other roads on the sites while flood lighting is provided for external areas such as car parks, walkways and the toll plazas. Both general and emergency lighting systems are maintained for the buildings on the tunnel sites.

Asset Group	Jack Lynch Tunnel	Dublin Tunnel	Limerick Tunnel
Ventilation systems	• Main fan assemblies: 24 jet fans, 4 pitched axial fans • 19 environmental monitoring sensors/ arrays • 1 H2S detection system c/w 6 sensors • 6 tunnel sump ventilation bifurcated fans	• Main fan assemblies: 32 jet fans • 26 environmental monitoring sensors/arrays • 2 H2S detection systems incl. extractor fans • 4 tunnel sump ventilation fans	• Main fan assemblies: 10 Fresh air fans • 4 anemometers, 6 environmental sensors • 12 tunnel sump ventilation fans
Lighting System	• 1348 tunnel overhead luminaires • 116 orientation luminaires • 73 emergency lighting units inc SOS lights, exit light, rope/chaser lights • 43 column-mounted streetlights	• 1490 tunnel overhead luminaires • 784 orientation luminaires • 244 emergency lighting units incl. SOS lights, exit light, rope/ chaser lights • 24 high mast lights, 7 streetlights • Flood & LED lighting to toll plaza, car parks & crash yard	• 569 tunnel overhead luminaires • 26 exit sign lights, 26 SOS sign lights • 134 emergency door chaser lights • 763 pole mounted luminaires

Drainage System

Each tunnel has a drainage system to manage the ingress of water to the tunnel and the flow of surface and ground water around the site. The tunnels have sumps equipped with mechanical pumps for the removal of water.

Interceptors and chemical dosing units are installed to safeguard the quality of the water that is discharged from the sites.

Fire System

Fire protection, detection, alarm and suppression systems along with comprehensive firefighting equipment are installed in each tunnel and the associated buildings. These systems are designed to ensure safety by promptly identifying, controlling, and mitigating fire risks.

Electrical and emergency power system

Incoming mains electricity feeds are transformed and distributed through medium and low voltage systems to power the full range of tunnel services. The systems include surge protection, with power continuity ensured by generators and uninterruptible power supplies (UPS) at each site.

Asset Group	Jack Lynch Tunnel	Dublin Tunnel	Limerick Tunnel
Drainage System	• 11 submersible pumps • 1,240m carrier drain/ surface water drain • 4500m piped drainage (incl. gullies) • 6 tidal flaps • 1 hydrocarbon interceptor	• 3 pumping stations, 6 tunnel sump pumps, • 4 niche dewatering systems • 10,230m carrier drain/ surface water drain • 4 tidal flaps; • 2 invert drain (48x50m NB & SB) • 2 calcite inhibitor systems • 10 hydrocarbon interceptors	• 4 tunnel sump pumps, 4 pumping stations • 8531m positive drains • 19 hydrocarbon interceptors
Fire Systems	• 3 temperature sensor cables (1 per bore) • 3 alarm panels & associated devices • Fire main, 18 hydrants, 24 hose reels, 85 extinguishers • 11 automatic fire suppression systems covering buildings & tunnel sumps • 26,600 m2 tunnel cladding • 14 emergency doors	• 2 temperature sensor cables (1 per bore) • 615 fire detectors, 174 sounders • Water tank & ring main. 3 pumps, 86 hydrants, 164 hose reels, 275 extinguishers • 4 no. automatic fire suppression systems • 26 emergency doors	• 2 temperature sensor cables (1 per bore) • Fire alarm system, FM200, sump fire suppression, tunnel fire water system • 1 water tank, 3 Pumps, 52 hydrants, 26 hose reels, 52 extinguishers • 11 automatic fire suppression systems installed in critical service building rooms & tunnel sumps • 13 emergency doors
Electrical and Emergency Power System	• 4 transformers, 3 earthing systems • 1 generator • 4 uninterruptible power supply • 1 ESD	• 15 transformers, 11 surge protection • 3 generators • 43 uninterruptible power supply • 13 Essential Services Distribution Boards (ESDs)	• 4 transformers, 8 MV switchboards, 19 distribution panels, 4 earthing systems, 2 surge protection • 2 generators • 6 uninterruptible power supply • 2 ESDs

Communications, IT, and Operational Technology Systems

Communication systems

The tunnel sites are monitored by digital CCTV cameras, and Emergency Roadside Telephones (ERTs) are provided to enable the public to notify incidents. Systems are in place for radio transmission through the tunnels covering both public channels for users and channels dedicated for tunnel operations. Dublin Tunnel also has a public address (PA) system installed in the tunnel bores and some of the associated buildings.

Traffic control and SCADA system

Traffic control at the tunnel sites is coordinated and operated through integrated systems of hardware and software. These systems control: variable message signs, speed limit signs, traffic signals, lane control signs, and traffic information. The tunnel supervisory control and data acquisition (SCADA) systems provide the equipment and functionality to monitor and operate key asset sub-systems including: ventilation; lighting; power supply; fire detection & extinguishing; intercom and intruder detection; drainage and firefighting sub-system.

Asset Group	Jack Lynch Tunnel	Dublin Tunnel	Limerick Tunnel
Communication Systems	• Radio system, leaky feeder • 50 CCTV digital cameras. • 5 ANPR • 45 ERTs	• Radio system incl. main hub and leaky feeders, • Public Address (PA) system • 155 CCTV digital cameras, 8 ANPR/ average speed cameras • 47 ERTs, 134 PABX maintenance phones • 42 Niche control units	• 2 Radio systems, Tetra and VHF • 93 CCTV digital cameras • 26 ERTs and 2 PABX maintenance phones
Traffic Control and SCADA System	• Traffic signals: 24 VMS, 36 lane control signs, 4 wig-wags • 5 over height detectors, 4 barriers • Servers and workstations: 2 TCMS, 7 SCADA • 2 emergency override panels	• Traffic signals: 66 signal lights, 42 VMS, 196 lane control lights, 8 speed signs • 6 over height detectors, and 296 vehicle loops • Servers and workstations: 2 TCMS, 11 SCADA • 2 emergency override panels	• 43 VMS, 92 lane control signs, 14 speed control signs, 18 gantry warning signs, 6 over height guidance, 4 pairs of wig-wags • 6 over height detectors, 8 barriers • 4 servers and 36 remote units • 1 emergency override panel

Toll System

Dublin and Limerick Tunnels both operate tolling systems which require the provision and maintenance of equipment and systems for collection of toll payments. This includes: toll lane signage and barriers/lane dividers; toll fare signage; toll fare collection points; revenue management for cash and electronic payments.

IT Systems

This asset group covers the essential hardware, firmware and software utilised in the operation and maintenance of the tunnels. A key element for each tunnel is the Asset Data System, which holds detailed records of the items across the full range of asset groups to support planning for maintenance and renewal.

Asset Group	Jack Lynch Tunnel	Dublin Tunnel	Limerick Tunnel
Toll System	Not applicable	• 13 lane controllers • 7 height restrictors • 13 automatic, • 12 manual barriers • 12 toll fare indicators • 10 ETC (Electronic Toll Collection) beacons • 3 workstations	• 32 lane controllers and computers, 16 lane traffic lights, 8 height restrictors, 10 traffic dividers • 24 automatic, 24 manual barriers. • 32 canopy signs, 12 toll fare indicators. • 64 treadles and 274 Induction loops • 16 ETC • 12 workstations, 2 coin counters, 2 dumb waiter
IT Systems	• 9 servers, 27 workstations • Maximo System (ERTO)	• 425 IT hardware units • TII fibre communications network • Maximo System (ERTO)	• 3 servers, 32 workstations, 110 network switches and routers • 1 video wall • PEMAC System (Direct Route)
MOCC Systems		• 22 screen video wall (MOCC) • 3 meters high and 15 meters wide) • Suite of hardware and software systems that support various operations of the MOCC	

MOCC IT Systems

The MOCC IT Systems are a suite of hardware and software systems that support various operations, such as traffic management, incident management, roadworks scheduling, and network intelligence. These sub-systems include:

Network Intelligence and Management System (NIMS):

NIMS is an overarching, adaptive system that receives and processes information from multiple roadside traffic monitoring devices and allows TII to manage all ITS systems operating on the motorway network. This replaces the Advanced Traffic Management System (ATMS) and Incident Management System (IMS) legacy system in place in the MOCC.

Emergency Roadside Telephone (ERT) System:

Solar-powered phones placed on the road network for emergency calls, manned 24/7 from the MOCC. This system uses a software-based phone system from 3CX.

TII Fibre Communications Network:

TII fibre network connects MOCC with TII ITS equipment located on the M50, southern M1, M4, and northern N7. A separate, dedicated fibre connection exists between the MOCC and Dublin City Council (DCC), independent of the TII fibre network.

CCTV Systems:

The MOCC accesses live CCTV feeds from both DCC and TII's systems, covering the greater Dublin and Cork road network areas , including M50, N7, Dublin Tunnel, and Jack Lynch Tunnel. The CCTV software is based on an open platform architecture developed by Genetec.

Roadworks Scheduling:

All roadworks on the Primary Road Network are scheduled and coordinated through a centralised Road Space Booking (RSB) system, allowing for effective planning and minimisation of traffic disruption. This system is currently undergoing updates to enhance operations.

Weather Software:

This software is provided by Vaisala and provides road weather data for the ITS and NIMS systems.

The implementation of the NIMS marks a significant advancement for TII, replacing the legacy ATMS and IMS systems previously used in the MOCC. NIMS is an overarching, adaptive system that receives and processes information from multiple roadside traffic monitoring devices, enabling TII to manage all ITS systems operating on the motorway network. Currently, there are over 3,600 ITS assets on the motorway network that are controlled from the MOCC, including Variable Message Signs (VMS), Portable Signs, Vehicle Detectors, Radar Traffic Monitoring Sensors (RTMS), Loop Vehicle Detectors (LVD), CCTV Traffic Cameras, Automatic Number Plate Recognition (ANPR) Cameras, Emergency Roadside Telephones (ERT), and Road Weather Information Sensor(s) (RWIS).

The NIMS also manages the technology used in TII's Cooperative Intelligent Transport Systems (C-ITS) pilot. This pilot involves the deployment of C-ITS, enabling vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, thereby enhancing the overall traffic management capabilities of NIMS.

Additionally, a key component of the eMOS programme is M50 Traffic Flow Optimisation (MTFO) which is the deployment of additional ITS technology on the M50, such as lane control signals, VMS, CCTV, incident detection loops, and other equipment to monitor traffic speed, manage traffic flows and conditions, all of which are integrated into the NIMS system. While these ITS assets are controlled via the NIMS system, the physical infrastructure is managed by TII and contracted maintaining organisations for the motorway network, as outlined in TII's Managed and Concession Roads SAMP, published in March 2024.

In addition to these functions, the MOCC is equipped for the roll out of future developments on the network. It is anticipated that the level of equipment monitored by the MOCC will increase progressively as facilities extend across the whole of the TII network.

MSA Asset Groups and Principal Inventory

MSA facilities provide a range of services and amenities to road users, including fuel, food, restrooms, parking, and information. Strategically positioned along motorways, these areas ensure that users have access to these essential services during long journeys, thereby enhancing road safety and overall comfort.

MSAs have various asset groups that require regular maintenance and management, such as electrical installations, fuel station facility, amenity buildings, paved areas, markings, signs and barriers, drainage, structures, and earthworks and landscaping. The schedule of principal inventory items under these categories is shown in the following table.

Asset Group	Description	MSA Tranche 1	MSA Tranche 2
Land and Earthworks			
Includes all the land and landscaping elements, such as embankments and verges.	Land Area	760,000 sq. m (76 ha)	224,900 sq. m (22.5 ha)
	Embankments and Cuttings	124,600 sq.m	33,511 sq. m
	Grass Verge	48,000 sq.m	15,850 sq. m
Pavement			
Encompasses all paved areas such as carriageways, parking areas, hardstanding, footways and kerbs.	Paved Areas	153,000 sq. m	47,800 sq. m
	Footways and Kerbs	18,900 sq. m	7,300 sq. m
Structures			
Includes various structural elements like bridges, culverts, headwalls, and other supporting infrastructures.	Structures	13 no.	12 no.
Drainage			
Comprises drainage systems such as gullies, manholes, rainwater storage tanks, and linear drainage channels to manage water flow and prevent flooding.	Attenuation Ponds and Wetlands	6,900 cu. m	4,700 cu. m
	Drainage Features	1,109 No.	987 No.
	Linear Drainage	5,820 m	7,350 m
	Piped Subsurface Drainage	8,000 m	5,100 m
	Foul Treatment Works & Pump Stations	8 no.	4 no.
	Rain Water storage tanks	8 no.	3 no.
Markings, Signs and Barriers			
Encompasses all road markings, safety barriers, fencing, guardrails, bollards, and signs ensuring safety and guidance for road users and pedestrians.	Linear Road Markings	14,700 m	16,200 m
	Hatched Road Markings	2,750 sq. m	1,950 sq. m
	Fencing, Barriers and Guardrails	5,300 m	9,250 m
	Traffic Signs	504 no.	325 no.
Electrical Installations			
Covers external lighting points, road lighting columns, traffic counters, EV charging points, and all related electrical installations including power distribution panels and photovoltaic systems.	Lighting	890 no.	630 no.
	EV Charging Points	34 no.	22 no.
	EV Publicly Accessible Charging Points	18 no.	22 no
	ESB Sub Stations	5 no,	6 no.
	Control Panels & Controllers	32 no.	19 no.
Fuel Station Facilities			
Includes fuel dispensers for both retail and HGV, vapour recovery systems, underground vent lines, and fuel tanks.	Fuel Dispensers	88 no.	22 no.
	Tank Submersible Pumps	88 no.	24 no.
	Fuel Tanks	67 no.	24 no.
	Fuel Volume Stored on Site	2,480,000 cu. m	830,000 cu. m
Amenity Buildings			
Comprises internal amenities like seating, toilets, security systems and various other customer and staff facilities.	Total Floor Area	7,800 sq. m	4,100 sq. m
	Internal Lights	208 no.	646 no.
	Seating capacity	1533 no.	411 no.
	Fire alarm system	9 no.	3 no.
	CCTV system/Cameras	329 CCTV Cameras	82 CCTV Cameras
	Gas Detection system	6 no.	5 no.
Heating Ventilation and Air Conditioning (HVAC)			
The HVAC system includes components such as AC units, heat recovery units, air handling units, extractors, air curtains, water heaters, storage vessels, water softeners, pressurisation units, radiators, pumps, expansion vessels, boilers, and supply/extract/return grilles.	AC unit internal/external	77 no.	50 no.
	Air Handling Unit (AHU)	19 no.	21 no.
	Water Heater	11 no.	4 no.
	Hot Water Storage Vessel	8 no.	6 no.
	Pressurisation Unit	6 no.	4 no.
	Booster/Pump	63 no.	15 no.
	Boiler	12 no.	7 no.

Asset Information and Management Systems

TII has considerable asset management capability developed over many years as well as a number of established asset information systems and datasets that are used to manage the network assets. These systems support the management, operation, and maintenance of national roads network and light rail infrastructure. They are used for planning and coordinating asset management activities and include systems like the Pavement Asset Management System (PAMS) and Bridge Management System called EIRSPAN. The Operators of the Tranche 1 and Tranche 2 MSAs are required to use a computerised Maintenance Management System (MMS) as an asset and defects management system.

GIS technology is utilised through Desktop GIS, Web GIS, and Mobile GIS applications, which are integrated with PAMS and other Asset Management systems for enhanced visualisation and management. These systems are part of TII's strategic approach to asset management, ensuring effective service delivery and operations across Ireland's transport infrastructure.

Tunnel Information Systems

The current data and information systems for tunnels are set out below. Data and information are valuable assets in themselves and TII have ensured that it retains ownership of all such data.

Computerised Maintenance Management Systems – DT & JLT

IBM Maximo is an industry leading asset lifecycle and workflow process management system utilised for DT and JLT. Maximo is cloud based and has been recently upgraded to MAS-8 (Maximo Application Suite 8) while retaining legacy data. A 'Fingertip Mobile Working Solution' is also being implemented as part of the upgrade for use by technicians in the field using mobile devices.

All processes and procedures are compliant with ISO27001 to ensure that data is kept secure while being hosted within the cloud. Annual Disaster Recovery testing protocols test simulated failure and the architecture design's ability to maintain business continuity. Currently Maximo records over 25,000 assets across DT and JLT. These assets are subject to 1,100 active Preventative Maintenance (PM) routines. In the last 12 months, 6,800 preventative and 2,550 corrective maintenance interventions have been made, enabling the maintenance team to deliver in line with the contractual requirements and keep the tunnels safe while maintaining high levels of availability for the public.

Maximo has integrated modules which capture data, work processes and overall equipment reliability. They include;

- Asset Condition Tracking;
- Condition Based Monitoring Tools;
- Cost Capture;
- Reporting on assets failures (for Reliability and Resilience strategies); and
- Maintain (and record) Regulatory Compliance via Planned Preventative Maintenance Module

Maximo Reporting and Analytics

Maximo provides a range of Information Management tools including Start Centre dashboards (configurable and tailored according to user roles), BIRT (Business Intelligence and Reporting Tools) operational reporting, standard boiler-pate reports and ad-hoc report builders. Maximo also allows data to be easily exported in a range of formats for use in external reporting and business intelligence tools. Reports can be generated on demand or automatically and sent to recipients via email.

Maximo MAS8 offers robust data analytics capabilities that can significantly enhance asset management and maintenance operations. By leveraging AI (Artificial Intelligence), IoT (Internet-of-things), and advanced analytics, Maximo MAS8 can provide deep insights into asset performance, enabling Predictive Maintenance (PdM) and reducing unplanned downtime. If required in the future, the system can analyse real-time sensor data to detect anomalies and predict potential failures before they occur.

Additionally, it can offer comprehensive asset health monitoring, combining historical data with current operational data to provide a 360-degree view of asset conditions. These analytics can help organisations optimise maintenance schedules, extend asset lifecycles, and improve overall operational efficiency.

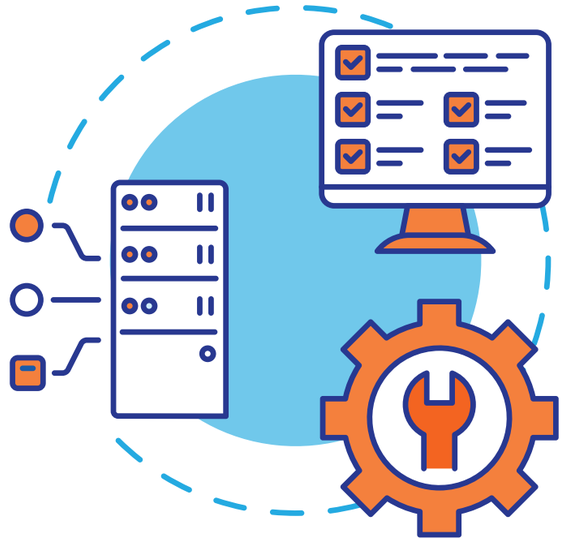
Computerised Maintenance Management System (CMMS)- LT

The PEMAC Computerised Maintenance Management System (CMMS) utilised by LT offers comprehensive support for asset management services by streamlining maintenance activities and optimising asset management. It can be integrated with various systems like ERP, SCADA, and IoT devices, allowing for seamless data flow and enhanced decision-making. The system's analytics and reporting tools provide real-time insights into asset performance, helping organisations make data-driven decisions that improve efficiency and extend asset lifecycles. By offering a centralised platform for all maintenance-related activities, PEMAC CMMS enhances visibility, compliance, and overall asset management effectiveness. At the end of the current PPP Co contract TII will determine whether to continue with two separate tunnel CMMS or move to a single platform. In light of the rapid changes to the functionality of the systems this decision will be made close to the time of hand back.

EIRSPAN Bridge Management System

The EIRSPAN Bridge Management System is used by TII to coordinate and integrate activities such as inspections, repairs and rehabilitation work to ensure optimal management of the national road bridge and structure stock. It is also used by the Tunnel Operators to manage the maintenance of structures and produce inputs for general reports from TII's EIRSPAN database.

The Tunnel Operators input details of any new structures into EIRSPAN in accordance with the requirements of the EIRSPAN manual or otherwise as required by TII standards, and it is used to capture and report the results of independent structural integrity inspections, both on an asset and on a portfolio level. For LT there are two-monthly Operations and Maintenance Reports, six-yearly Principal Inspection Reports, and two-yearly Structural Visual Inspections in accordance with the EIRSPAN System Manual.



CEMAR Contract Management System

Administration of the OMTTCC contract is automated using the CEMAR (Contract Event Management and Reporting) software system by ThinkProject. Automation offers several advantages that can significantly benefit asset management, including streamlining contract administration by providing a centralised platform for all contract-related activities, which enhances collaboration and transparency among stakeholders.

For asset management, the analytics and reporting tools provide real-time insights into contract performance and project progress. This allows for better decision-making and proactive management of project works, ultimately leading to improved efficiency. Additionally, CEMAR supports cultural change by promoting trust and collaboration, which is essential for successful asset management.

Computerised Maintenance Management System (CMMS)- MSAs

The computerised Maintenance Management Systems (MMS) is used as both an asset and defect management system to manage the maintenance requirements of the MSAs. This includes the structure and fabric of the amenity buildings, mechanical & electrical installations, communication systems, drainage installations, paved areas, and landscape areas. The MMS also encompasses facilities to store and manage inventory data, details of inspections, cyclical activities and details of defects recorded and rectified.

Asset Protection and Renewal

National Roads 2040 (NR2040), TII's long-term strategy for planning, operating, and maintaining the national roads network, aligns with national policy aims set out in the Climate Action Plan 2024 (CAP24) and the Department of Transport's National Sustainable Mobility policy, as well as the four investment priorities from the National Investment Framework for Transport in Ireland (NIFTI): Decarbonisation, Protection and Renewal, Mobility of People and Goods in Urban Areas, and Enhanced Regional and Rural connectivity.

Protection and Renewal covers various programmes and projects to maintain the network in an acceptable steady-state condition. This includes tunnel operations and maintenance, and other asset management activity essential for securing the safety and upkeep of the Tunnels, MOCC and MSAs.

Tunnel Maintenance & Renewal Activities

For DT, a maintenance team supported by specialist subcontractors is based on site to undertaken both planned / cyclical and corrective maintenance. Also based on site are the Operations Team, who provide first-response to incidents as part of their patrolling duties. Dublin Fire Brigade (DFB) provide a dedicated Tunnel Response Vehicle (TRV) and crews on site for DT, with support from the Emergency Services in the event of serious incidents. TII bears the costs of this dedicated team, including the costs of specialty training, equipment and paying the crews. As with DT, the JLT is operated 24 hours per day 365 days per year with staff monitoring and controlling the traffic management, engineering and life safety system from dedicated desks in the MOCC in Dublin. Staff are also available to respond to incidents on the affected property.

A maintenance team, supported by the team in Dublin and specialist subcontractors, is based on site to undertake both planned and corrective maintenance. The tunnel is closed typically for one or two nights every quarter to enable systems in the running bore to be maintained and serviced. For LT, the respective PPP Companies are responsible for the ongoing operation, maintenance and lifecycle works for the contract period.

At the end of the contract the PPP Company will have to carry out and fund the necessary renewal works to bring the infrastructure to the required handback standard. LT is usually closed for one or two nights each quarter for scheduled maintenance. The tunnels are designed for a 125-year productive life, however the various Mechanical and Electrical (M&E) systems typically last 20-25 years, with Operational Technology (OT) systems having an even shorter lifespan due to obsolescence. Consequently, TII have invested heavily in asset renewals and improvements over the years.

The nature of the tunnel assets (linear, with large quantities of similar sub-systems) is ideal for reliability data harvesting and analysis, and state-of-the-art Computerised Maintenance Management systems (CMMS), including Maximo and PEMAC, are leveraged for this purpose. TII's overall objective is to ensure that the tunnels, continue to function safely and effectively as critical elements of Ireland's national infrastructure.

MSAs Maintenance & Renewal Activities

The MSA PPP Contracts stipulates the Operations and Maintenance (O&M) requirements for the MSAs, encompassing routine and cyclic maintenance, inspection requirements and the recording and rectification of defects. Maintenance activities at the MSAs are conducted year-round. The MSA Operators are required to perform routine periodic inspections to address safety and maintenance needs, with specific intervals for inspections to cover all elements of the MSA assets. Defect rectification timelines are categorised based on safety impact, as specified in the O&M Requirements.

Category 1 defects, which pose immediate or imminent hazards or risks of structural deterioration, require prompt attention. MSA Operators must make safe all Category 1 defects as quickly as practicable and complete permanent repairs within 20 working days of identification.

The contracts also define Handback Requirements, which outlines the process for transferring assets back to TII, including the residual life criteria at the end of the PPP Contract period. Renewal activities which include renewal, reconstruction, repair or reinstatement are carried out to ensure that the MSAs will, at the end of the contract period, satisfy the Handback Requirements.

Additionally, new and revised regulations such as Part M of the Building Regulations and the Alternative Fuels Infrastructure Regulation (AFIR) are recent significant drivers of renewal and enhancement of activities at the MSAs. These regulations drive MSAs to continuously improve and adapt their facilities to meet evolving standards and support sustainable practices.

MSA Enfield West

3. Asset Performance Management

The TII Asset Management Framework defines eight overarching objectives, founded on its Asset Management Policy, which guide the management approach for a particular asset, or asset groups to fulfil TII's stated aims for the performance of its transport networks. TII's established asset management approach for the tunnels, MOCC, and MSAs aligns with and supports the delivery of these objectives.

Figure 4: TII Asset Management Objectives

TII's established asset management approach for the Tunnels, MOCC and MSAs aligns with and supports the delivery of these objectives.

1. Safety

Safety in tunnel operations is paramount, given that tunnels present unique challenges such as restricted access, limited visibility, and confined spaces that can complicate emergency responses. Ireland has incorporated the EU Directive (EUD) on Minimum Safety Requirements for Tunnels into national law, applicable to all tunnels greater than 500m in length.

Key asset systems are provided and maintained to ensure safety both during routine operation and in the event of an incident. These include:

- **Fire systems**

  Systems and equipment for fire protection, detection, suppression and firefighting.
- **Ventilation systems**

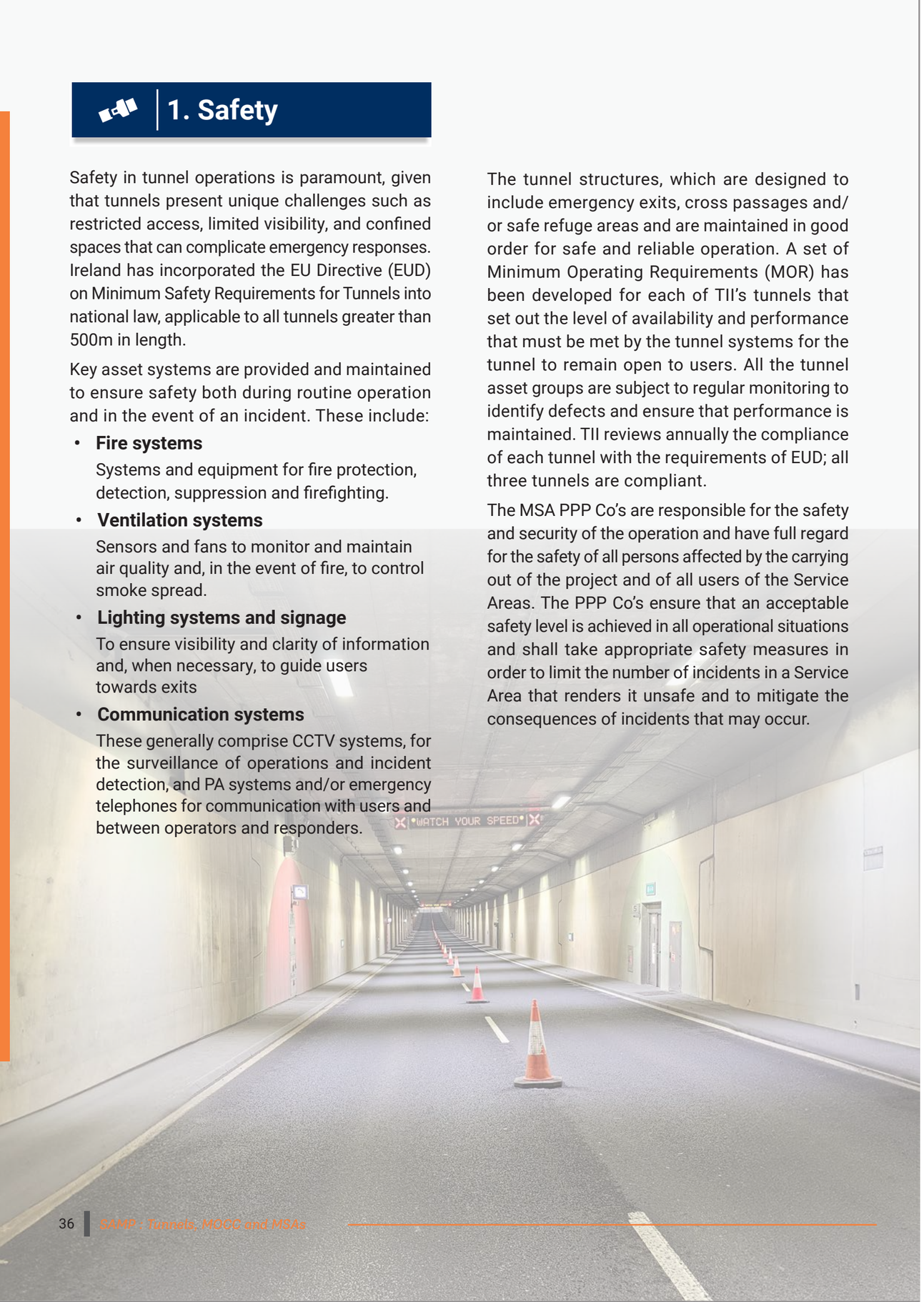
  Sensors and fans to monitor and maintain air quality and, in the event of fire, to control smoke spread.
- **Lighting systems and signage**

  To ensure visibility and clarity of information and, when necessary, to guide users towards exits
- **Communication systems**

  These generally comprise CCTV systems, for the surveillance of operations and incident detection, and PA systems and/or emergency telephones for communication with users and between operators and responders.

The tunnel structures, which are designed to include emergency exits, cross passages and/or safe refuge areas and are maintained in good order for safe and reliable operation. A set of Minimum Operating Requirements (MOR) has been developed for each of TII's tunnels that set out the level of availability and performance that must be met by the tunnel systems for the tunnel to remain open to users. All the tunnel asset groups are subject to regular monitoring to identify defects and ensure that performance is maintained. TII reviews annually the compliance of each tunnel with the requirements of EUD; all three tunnels are compliant.

The MSA PPP Co's are responsible for the safety and security of the operation and have full regard for the safety of all persons affected by the carrying out of the project and of all users of the Service Areas. The PPP Co's ensure that an acceptable safety level is achieved in all operational situations and shall take appropriate safety measures in order to limit the number of incidents in a Service Area that renders it unsafe and to mitigate the consequences of incidents that may occur.



An Emergency Procedure Strategy (EPS) is in place for each MSA to ensure that resources necessary to make safe and/or deal with situations in the first instance are available to respond to emergencies at the MSAs at all times

Some of the key asset systems and licensing requirements pertaining to fuel forecourt safety are as follows:

- **Fire Systems**

  Emergency shut-off systems, and strategically placed fire extinguishers to quickly and effectively address any fire-related incidents at the fuel forecourts
- **Fuel systems grounding and Bonding Systems**

  Grounding and bonding systems to prevent static-related incidents, minimising the risk of sparks that could ignite fuel vapors.
- **Fuel Leak Detection Systems**

  24/7 monitoring of the fuel leakage detection system to detect fuel leaks early, allowing for prompt action to prevent accidents.
- **Fuel Ventilation Systems**

  Proper ventilation to manage flammable vapors and prevent the buildup of hazardous fumes.
- **Licensing and inspections**

  Motorway service areas are subject to licensing and inspection processes to ensure safety and compliance with regulations including the Dangerous Substances Act.

In defining KPIs to reflect the safety performance of tunnels and MSAs operations, TII has defined two key themes. These are:

Accident rate	A focus on incidence of accidents causing injury to users or operatives
Rectification of hazards	A focus on identification and repair of potentially hazardous defects

2. Reliability

TII's three tunnels represent a significant investment in infrastructure for societal and economic benefit, both for the local areas and the wider population served by the improved network access.

Reliable, and safe operation of the tunnels is therefore essential to maintain the benefits of this investment. Maintaining safe operation is a prime objective for TII's tunnels, and the current operation and asset management strategy has minimised the frequency of unplanned closures of TII's tunnel due to asset failure in the previous ten years. Tunnels are complex assets requiring a blend of proactive and reactive approaches, robust procedures, and effective communication systems to handle both expected and unexpected events.

Regular inspection and timely maintenance, particularly for those assets and systems cited above in relation to safety, are essential for reliable operation. Other aspects include communication and preparation for planned events, such as maintenance closures, and response capability for unplanned incidents. The complex assets in tunnels include many mechanical and electrical systems and wherever possible the following approaches to reliability are employed:

- The use of tried and tested technologies
- The avoidance of the early adoption of technologies unproven elsewhere
- The homogenisation of technologies across the three tunnels wherever possible

In defining KPIs to address the objective of reliability in asset management for tunnels on the managed road network, TII has defined two themes as shown below.

Availability	A focus on the impact of planned and unplanned maintenance on tunnel availability
	A focus on the impact of planned and unplanned maintenance on toll lane availability
Incident Response	A focus on response times to incidents

The facilities at the Service Areas (MSAs) are designed to provide continuous availability of essential services. These services include the provision of fuel, EV recharging and air & water, all of which are accessible 24 hours a day, throughout the year. The availability of the MSA facilities is set out in the O&M Requirements of the MSA PPP Contracts. Public toilet and shower facilities are also available 24 hours per day throughout the year. In addition to these essential services, other facilities such as point of sale (POS) terminals, restaurants, children's play areas, convenience shops, and road and parking infrastructure are maintained to ensure their availability. To support this, robust service level agreements are in place to manage the timely repair and maintenance of all critical facilities, including fuel pump dispensers, restaurant amenities, public restrooms, showers, and play areas for children.

In defining KPIs to address the objective of reliability in asset management on MSAs, TII has defined the two themes of Availability and Level of Service as shown below.

Availability	A focus on the availability of MSA Facilities
Level of Service	A focus on response times to defects

3. Condition

As detailed in Section 2, tunnels comprise a range of asset types and TII requires that the tunnel operators carry out regular inspections of all tunnel elements and systems to ascertain their condition and identify the need for repair or replacement. The inspection regime must, as a minimum, comply with 'CS 452 - Inspection and Records for Road Tunnel Systems' and 'CM 430 - Maintenance of Road Tunnels'.

This inspection regime produces regular reports on the residual life, issues and risks to performance for each tunnel system and sub-system with recommendations and costs for remedial works. Tunnel maintenance is currently mainly executed on a preventative maintenance plan where assets are inspected and maintained on a periodic basis, where necessary, in accordance with the original equipment manufacturer's recommendations. Under such a regime, replacement is normally considered at the end of the expected service life. However, due to the excess capacity and limited operation of much of the plant in the tunnels this may lead to uneconomic replacement costs as asset life may, in general, be extended. Decisions on timings for renewal are, therefore, based on the basis of robust condition monitoring data. In defining KPIs to address the objective of Condition in asset management for tunnels, TII has defined four metrics under two themes. These are:

Asset Performance	A focus on operational performance of tunnel lighting
	A focus on reported condition measures for pavements
Asset Condition	A focus on measures of asset condition across the range of asset types
	A focus on incidence of asset defects

The MSA PPP Co's are required to remedy all defects occurring or manifesting themselves in the MSAs. In the event of any damage to or destruction of the MSA, the PPP Co carries out as soon as possible such works as are necessary to reinstate the MSA to its condition immediately prior to the occurrence of such damage or destruction.

The PPP Co's are also required to conduct routine periodic inspections for safety and maintenance needs. The inspections can identify defects and maintenance requirements. As well as a robust fix and repair service for public toilets and showers, a regular rigorous inspection and cleaning regime including sampling and testing for microbial infection is also implemented at all of the MSAs.

In defining KPIs to address the objective of Condition in asset management on MSAs, TII has defined the three themes of Inspections, Cleaning & Microbial Testing and Recording of Defects as shown below.

Inspections	A focus on the completion of inspections in accordance with the O&M Requirements
Cleaning & Microbial Testing	A focus on the public toilets and shower facilities cleaning and microbial testing programme
Recording of Defects	A focus on the recording of defects in accordance with the O&M Requirements

4. Maximising Value

One of the primary reasons for adopting a systematic, strategic approach to infrastructure asset management is to drive efficiencies in the investment required to maintain performance and serviceability over the whole life of the asset. Essential to any asset management strategy is a life cycle analysis that seeks to balance the ongoing costs of maintenance and repair against the generally significant investment required for asset renewal.

Tunnels comprise a range of asset groups, from the long-life civil engineering structure of the tunnel itself to the technology systems for traffic monitoring and control, that may require upgrade or replacement due to obsolescence or difficulties with continued support rather than deterioration or failure. Thus, any strategy and analysis must be tailored to the nature of the asset groups and consider appropriate regimes for planning and investment.

Lifecycle analysis has traditionally focused on optimizing discounted financial costs over asset life. However, as the perspective and application of asset management has broadened through the consideration of strategic objectives, in the case of TII, such as Customer, Environment and Sustainability, the scope of the lifecycle analysis may consider 'value' in a broader sense. Hence factors such as carbon footprint (which can be stated in financial terms) may also be considered. In developing a KPI for the objective of Maximising Value, TII has emphasised the importance of timely maintenance to delay or avoid the need for significant intervention with consequent impact in terms of cost and or carbon through a single, key theme.

Planned Maintenance Activities	A focus on timely delivery of maintenance

Preventative maintenance has an important role to play for the MSAs in maximising value as intervening early to treat defects can prevent more costly repairs in the long term. A robust operation and maintenance programme throughout the lifetime of the PPP Contract helps ensure that the residual life requirements for the assets at the end of the PPP Contract is achieved. Another aspect of maximising value of the MSA assets are the social impacts over the life cycle of the asset such as measures and impacts on accessibility and inclusivity.

In defining KPIs to address the objective of Maximising Value in asset management on MSAs, TII has defined a single theme of Planned Maintenance Activities as shown below.

Planned Maintenance Activities	A focus on timely delivery of maintenance

5. Customer

A focus on customer service and user satisfaction is a key goal for TII, and this is reflected in the priority given to safety and journey reliability. For tunnels, provision of accurate and timely information on operation or the impact of any disruption is essential to allow users to plan and manage their journeys. TII operates contact centres to receive and handle inquiries and complaints from customers. In addition to identifying specific problems or issues to be addressed, this service accumulates customer feedback which can be evaluated to direct improvements in the service offered. In defining KPIs to address the objective of Customer in tunnels asset management, TII has defined two themes. These are:

Customer Information	A focus on the accuracy and timeliness of information provided to users
	A focus on response to enquiries
Customer Satisfaction	A focus on customer experience

For the MSAs, the PPP Co's ensure that users experience a high level of customer service in a comfortable environment. All MSA facilities including the fuel station facilities, public toilet and shower facilities, restaurant facilities, convenience shop, children's play areas and parking areas are available in accordance with the O&M Requirements. This includes provision of facilities and services in the condition, safety, cleanliness and standard of food hygiene required by the O&M Requirements.

There is no charge to customers for use of public toilets and no charge to customers for use of the children's play areas. The PPP Co's deal with any complaints received relating to or in connection with the MSAs in a prompt, courteous and efficient manner.

The PPP Co's record an account of and report on the number and type of complaints and queries received from customers and others in respect of the MSAs. The PPP Co's are also required to implement and maintain a Mystery Shopper Programme (MSP) to monitor the services and facilities provided within the MSAs.

In defining KPIs to address the objective of Customer in asset management on MSAs, TII has defined two themes of Complaints and MSP as shown below.

Complaints	A focus on the accuracy and timeliness of information provided to users
Mystery Shopper Programme (MSP)	A focus on compliance with contractual obligations for conducting MSP surveys

6. Environment

Provision of transport infrastructure generates significant social and economic benefits. However, the construction, operation and maintenance of that infrastructure will invariably impact the local environment and natural systems.

Moreover, it is recognised that the cumulative effect of these impacts across all infrastructure contributes to widescale issues such as climate change and degradation or loss of habitats and biodiversity.

TII is committed to managing its transport infrastructure to reduce adverse environmental effects and, where possible, to bring about improvement such as through management of soft estate to support its goal of no net loss of biodiversity. For tunnels, there are a number of areas where there necessarily needs to be a focus on managing environmental impacts.

- **Air Quality**

  Tunnels can trap vehicle emissions, leading to potentially high concentrations of pollutants like carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter.

- **Water Management and Pollution Control**

  Tunnel operations generally involve managing water, whether from rain, drainage, or groundwater. Effective water management is essential to prevent flooding and control pollutants that can be introduced into local water systems.

- **Noise and Vibration Control**

  Noise pollution and vibrations from tunnel operations potentially affect tunnel users, nearby communities and local wildlife and habitats. Strategies for control are required to focus on reducing operational noise and vibration and minimising noise escape into the environment.

- **Biodiversity and Habitat Protection**

  Tunnel construction and operations can disrupt local ecosystems. Habitat restoration can protect local flora and fauna.

In defining KPIs to address the objective of Environment in asset management for tunnels TII has defined six themes. These are:

Air Quality	A focus on managing emissions from tunnel operations and maintenance activities
Water quality	A focus on managing the impact of tunnel operations and maintenance on water quality
Biodiversity	A focus on maintaining ecology systems for local flora and fauna
Noise	A focus on control and mitigation of noise from tunnel operation and maintenance
Litter & Cleanliness	A focus on maintaining standards of cleanliness
Landscape & Ecology	A focus on managing soft estate to maintain operational functionality while preserving biodiversity and ecology

For the MSAs, the PPP Co ensure that the risk of adverse effects on the environment, on the amenities enjoyed by the owners and occupiers of adjacent areas, and to users of the MSAs is minimised. This includes monitoring the water quality of outfall discharges at the MSAs. Landscape maintenance and management manuals that detail the landscape establishment and maintenance activities are prepared. The O&M Requirements also provide for the control of litter and refuse at the MSAs.

A pollinator-friendly plan has been implemented at the MSAs to improve the landscape management for pollinators and also for overall biodiversity. As part of grassland management, the frequency of grass mowing has been reduced in certain areas in order to enhance the value of the grass areas for wildlife and biodiversity.

In defining KPIs to address the objective of Environment in asset management on MSAs, TII has defined the two themes of Water Quality and Litter & Cleanliness as shown below.

Water Quality	A focus on compliance with contractual obligations for water quality sampling and testing
Litter & Cleanliness	A focus on compliance with contractual litter collection activities

Climate Adaptation and Asset Management

Climate change is causing extreme weather events to become more frequent and severe, as well as contributing to sea level rise and coastal erosion. TII's tunnels and motorway service areas are vulnerable to extreme weather events. Flooding, storms, and heatwaves can damage assets and cause service disruption, resulting in significant safety, financial, and reputational impacts. TII is adopting a climate adaptation approach, anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause. Taking this proactive approach means TII will be prepared for the increasingly frequent and extreme weather events that are projected to occur in the future. The seven key Strategic Objectives in the TII Climate Adaptation plan (CAP) are:

- Observe fewer network disruptions during climate-related events
- Rapidly recover from any climate-related events.
- Have a robust, flexible, and equitable organisation that responds effectively during climate events.
- Enhance the climate resilience of lifeline roads in order to maintain community accessibility
- Engage with the wider adaptation efforts across Ireland through partnerships and wider research.
- Embed climate adaptation within TII's operations, policies, and procedures in order to ensure a safe and resilient network.
- Adopt a low-carbon approach in TII's designs, standards, and processes when considering climate adaptation, while also considering wider social and environmental benefits.

The Climate Action Roadmap sets out TII's plans to reduce Greenhouse Gas (GHG)emissions and meet decarbonisation and energy efficiency targets.

Through planned projects, and the continued decarbonisation of Irelands electricity grid, TII is targeting a reduction of between 61-73% GHG emissions reduction and between 46-53% improvement in energy efficiency by 2030. Effective delivery of the GHG emissions reductions outlined in the Roadmap is founded on:

- Empowering staff to identify innovative approaches to emissions reductions while providing support and training
- Monitoring and evaluation: High quality data, monitoring, and reporting supporting improved measuring and monitoring of progress with responsibility to achieve the targets being distributed across the organisation.
- Funding and resources: Meeting emissions reduction targets is contingent upon TII receiving additional capital and operational funding and resources to deliver the necessary projects whilst overcoming challenges and uncertainties within and out of TII's control.

Strategic asset management contributes to a circular economy by extending the life of assets while ensuring the safety, resilience, availability, and efficiency of TII's transport networks. This approach in turn will strive to minimize the total lifecycle cost to TII while preserving the asset value and maintaining services for road users. The TII AM Strategy contributes to enabling circular economy principles whilst managing TII's complex transport network.

In this Strategic Asset Management Plan, the key objectives of Sustainability and Resilience are aligned with the objectives of the TII Climate Adaptation plan and the requirements of the Climate Action roadmap. Under Sustainability, KPIs relating to Carbon Emissions, Energy Consumption, Waste Management and Water Consumption for tunnels are introduced. Under the Resilience objective, KPIs relating to Flooding Incidents, Winter Service and Recovery Time from Extreme Events have been developed.

7. Sustainability

Asset management practices must be closely connected with sustainability principles. When a commitment to evaluating alternatives with a long-term and life-cycle perspective is made explicit, sustainability becomes an ingrained value in asset management.

A life cycle analysis has always been fundamental to good asset management procedures and decision- making and is increasingly being broadened to take account of non-financial factors that better consider the social and environmental implications of how TII manages the asset base. Construction, operations, and eventual decommissioning of assets all contribute to greenhouse gas emissions, but by careful lifecycle management, these emissions can be minimised. Waste prevention through design and re-use enhances key sustainability performance by preserving raw materials and maintaining ecological balance.

Over recent years energy consumption and carbon emissions are increasingly managed within the tunnel operations, for example by adopting energy-efficient technologies such as LED lighting. A circular economy approach allows for the maximisation of resource efficiency and minimisation of waste generation throughout the entire lifecycle of the asset. Additionally, by implementing circular economy concepts, TII can reduce the environmental impact and contribute to a more sustainable future.

Furthermore, regular monitoring and evaluation of both emissions and embodied carbon in materials used in construction, maintenance and operation allows for continuous improvement and the identification of areas where further reductions can be made. In defining KPIs to address the objective of Sustainability in asset management on the managed road network, TII has defined four themes.

These are:

Carbon Emissions	A focus on reducing carbon emissions generated in tunnel asset management activities
Energy Consumption	A focus on reducing energy consumption from tunnel operation and maintenance
Waste Management	A focus on re-use and recycling of materials and products
Water Consumption	A focus on reduction in consumption of treated water in tunnel operation and maintenance

For the MSAs, all planted and seeded areas, along with features such as ponds, open ditches and wetlands are managed to encourage sustainable development and the conservation and enhancement of biological diversity. The PPP Co also proposes and implements sustainability initiatives at each of the MSAs. Energy consumptions and carbon emissions at the MSAs are measured, monitored and reviewed. Opportunities to reduce carbon emissions and improve energy use are explored.

In defining KPIs to address the objective of Sustainability in asset management on MSAs, TII has defined the two themes of Sustainability Initiatives and Energy Consumption as shown below.

Carbon Emissions	A focus on reducing carbon emissions generated in MSA asset management activities
Energy Consumption	A focus on reducing energy consumption from MSA operation and maintenance

8. Resilience

Coastal and river flooding, as well as storm surges, are projected to worsen as sea levels continue to rise and storms increase in intensity and frequency. While the effects of climate change in Ireland may not be as severe as those expected for other European countries, they nonetheless will increase the frequency and severity of problems including flooding, landslides, disruption to power supplies for tunnel and MSA operation, and storm damage. The costs of these disruptions can be mitigated by investing in resilience to support the objectives of TII's Climate Adaptation Plan. A highly resilient network can also reduce economic losses and minimise disruptions to essential services during natural disasters or other emergencies. By investing in resilience, TII can ensure the continuity of critical infrastructure and protect the well-being of their users. There are two approaches to addressing resilience in asset management. The first evaluation takes into account the public impact of a network outage, such as when a tunnel is closed due to a traffic, operational or extreme weather incident.

The traveling public and society as a whole will feel minimal repercussions from a highly resilient network. The second way to evaluate resilience is to think about how well prepared you are to recover from an extreme event, such as flooding. Supply chains and recovery and restoration strategies must be in place, and these must be verified as part of the asset management process.

It is crucial to establish and implement winter service guidelines for the tunnels and MSA paved areas to provide safety and predictability for all users. In order to successfully restore service on the network, a schedule of suitable contractors that have the resources to mobilise with appropriate materials and replacement parts may be developed. Backup systems for crucial components, availability of resources (such as salt for winter maintenance), and backup systems for supporting data systems and processes are all important aspects of resilience readiness at the asset level.

In addition, a thorough familiarity with emerging dangers (such as cyber security) and plans to evaluate and implement suitable steps to combat the impacts, mitigate the effects on the traveling public, and set up recovery programmes in the event of extreme incidents. These measures ensure that assets can continue to function effectively and efficiently even in the face of unexpected disruptions. Furthermore, regular training and drills for staff members can help enhance their preparedness and response capabilities, enabling them to effectively handle any emergency situation that may arise.

In defining KPIs to address the objective of Resilience in asset management for tunnels, TII has defined three themes. These are:

Flooding Response	A focus on incidence of flooding
Winter Service	A focus on treatments carried out to contractual requirements
Recovery from Extreme Events	A focus on recovery of operational functionality following extreme events

The MSAs provide resilient services and facilities for their users, ensuring their availability for users. Any damages or defects identified are addressed and reinstated within the specified timeframe, adhering to the contractual requirements.

The MSA PPP Contract's level of service requirements include for robust fix and repair service level agreements that limit the fix and repair time for such facilities to minimise any disruption to the availability of facilities. MSA winter maintenance plans are implemented to ensure the safe movement of traffic and users within the MSAs and minimise delays caused by adverse weather. An Emergency Procedure Strategy (EPS) is also in place for each MSA to ensure that resources necessary to make safe and/or deal with situations in the first instance are available to respond to emergencies at the MSAs at all times.

A Service Area Operating Plan is also implemented by the MSA Operators to ensure that all necessary arrangements are in place to safely operate the MSAs. These strategies and plans help ensure that when incidents occur such as adverse weather, emergency incidents, loss of energy supplies etc which may require temporary arrangements including temporary closure of an MSA while incidents are made safe or services restored to normal operation, the necessary resources and plans are in place to respond to such incidents. Such incidents may often require liaison and coordination with the Emergency Services, Road Maintaining Organisations, the Motorway Operations Control Centre (MOCC) and TII. In the event of a temporary closure of an MSA, customers are diverted to the nearest alternative MSA on or adjacent to the National Road Network. In defining KPIs to address the objective of Resilience in asset management on MSAs, TII has defined the two themes of MSA Temporary Closure Incidents and Winter Maintenance as shown below.

MSA Temporary Closure Incidents	A focus on efficiency of response to major incidents requiring temporary closure of MSAs
Winter Service	A focus on treatments carried out to contractual requirements

Tunnels: KPI Themes and Potential Metrics

AM Objectives	Themes	Potential Metric	Implementation
Safety	Rectification of hazards	Response time for repair of Cat 1 defects	Present
	Accident Rate	No. of Personal Injury Accidents	Present (LT) / Future (DT & JLT)
Reliability	Availability	Impact of planned and unplanned maintenance on tunnel availability	Present
		Impact of planned and unplanned maintenance on toll lane availability	Present (DT)
	Incident Response	Incident clearance times	Present
Condition	Asset Performance	Number of tunnel lighting outages	Present
	Asset Condition	Condition of pavement as measured by TII	Present
		Condition of tunnels assets / remaining service life (based on Tunnels PI Reports)	Present
		Number of defects	Present
Maximising Value	Planned Maintenance Activities	Achievement of planned and cyclical asset management activities	Present

Dublin Port Tunnel
Photo © Coolan Park (cc-by-sa/2.0)

AM Objectives	Themes	Potential Metric	Implementation
Customer	Customer Information	Application of VMS signs within required response times	Present (LT)
		Customer Calls answered within required timescale	Present (MOCC)
	Customer Satisfaction	Number of customer complaints	Present
Environment	Air Quality	Impact of tunnel operations and maintenance on air quality	Present
	Water Quality	Impact of tunnel operations and maintenance on water quality	Present (LT) / Future (DT & JLT)
	Biodiversity	Impact of tunnel operation and maintenance on biodiversity	Future
	Noise	Impact of tunnel operation and maintenance on noise	Present
	Litter and Cleanliness	Standard of cleanliness	Present
	Landscape & Ecology	Compliance with Landscaping Maintenance Plan	Present
Sustainability	Carbon Emission	Carbon Emissions from asset management activities (Scope 1)	Present (DT & JLT) / TBC (LT)
	Energy Consumption	Energy consumption from asset management activities	Present (DT & JLT) / TBC (LT)
	Waste Generation & Management	Amount of waste generated from asset management activities	Present (DT & JLT) / TBC (LT)
	Water Consumption	Volume of water consumed by asset management activities	Future
Resilience	Flooding Incidents	Number of flooding incidents	Future
	Winter Service	Compliance with Winter Service requirements	Present
	Recovery from Extreme Events	Recovery time from flooding and other extreme weather events	Future

MSAs: KPI Themes and Potential Metrics

AM Objectives	Themes	Potential Metric	Implementation
Safety	Rectification of hazards	Compliance with response times for repair of Cat 1 defects	Present
	Accident Rate	No. of lost time injuries reported	Present
Reliability	Availability	Compliance with availability of fuel station, parking and amenity facilities	Present
	Incident Response	Compliance with fix and repair timelines for facilities	Present
Condition	Inspections	Compliance with frequency of inspections as per the O&M Requirements	Present
	Cleaning & Microbial Testing	Compliance with O&M Requirements for cleaning and microbial testing of public toilets and shower facilities	Present
	Recording of Defects	Compliance with recording and categorisation of defects as per the O&M Requirements	Present
Maximising Value	Planned Maintenance Activities	Achievement of planned and cyclical asset management activities	Present

AM Objectives	Themes	Potential Metric	Implementation
Customer	Complaints	Number of customer complaints	Present
	Mystery Shopper Programme (MSP)	Completion of Mystery Shopper Programme (MSP) as per O&M Requirements.	Present
Environment	Water Quality	Compliance with water quality testing as per O&M Requirements	Present
	Litter and Cleanliness	Compliance with standard of cleanliness in O&M Requirements	Present
Sustainability	Sustainability Initiatives	Number of sustainability initiatives implemented	Present
	Energy Consumption	Measure of energy consumption by the MSAs	Present
Resilience	MSA Temporary Closure Incidents	Number of incidents requiring temporary closure of MSAs	Present
	Winter Maintenance	Compliance with Winter Maintenance requirements	Present

Potential Metrics (Present) are based on data that are typically currently collected within or on behalf of TII. It is envisaged that, in general, Potential Metrics (Present) can be generated either immediately or within a reasonably short time frame.

Potential Metrics (Future) are based on data that is typically not currently collected within or on behalf of TII. In order to generate these metrics, additional activities such as Customer Satisfaction surveys, condition surveys or data generated through vehicle or communications telematics would need to take place. The Potential Metrics (Future) may also be revised as technology and standards evolve.

Castlebellingham Service Area M1
Photo © Chris Morgan (cc-by-sa/2.0)

4. Continuing Improvement

Section 2 of this SAMP outlines the scale and variety of the Tunnel, MOCC and MSA assets under the management of TII. The tunnels, including the Dublin Tunnel, Jack Lynch Tunnel, and Limerick Tunnel, are vital elements of Ireland's national infrastructure. They are managed by TII to ensure they function safely and effectively. The MOCC, located at the Tunnel Control Building in Dublin, is the central hub for 24/7 coordination of motorway and tunnel operations. MSAs are provided on motorways to offer convenient and safe places for road users to stop, rest, and access facilities. They are integral components of the national road network, ensuring good service levels for users and meeting EU requirements for routes on the Trans-European Transport Networks (TEN-T). Overall, these assets are crucial for the efficient and safe operation of the TII road network, supporting economic growth and ensuring the reliability of transport services.

Section 3 sets out the alignment of Tunnels, MOCC and MSA operations and output with the eight AM objectives set by TII in the organisation-wide AM Framework document. Key Performance Indicators were defined in this Section for different themes under each of the eight objectives. Some of the KPIs are based on existing data that is currently collected and reported, with the remainder based on data intended to be collected and reported in the near future.

Section 4 and 5 take a forward-looking, medium to long-term view of issues that need to be examined and addressed for the Tunnels, MOCC and MSAs. To date, there has been a strong emphasis on the operational and maintenance (O&M) aspects with effective contract execution and contract supervision reporting. By their nature, O&M activities are focused on delivery within the calendar year. However, for a comprehensive approach to asset management to be achieved, it is necessary that a longer term horizon to asset management is also considered across all asset groups, and this may lead to a different approach in asset management delivery in some asset classes.

Age and Traffic Profile

In 2025, the JLT has been in service for 26 years, DT for 19 years and LT for 15 years, and many of the Mechanical and Electrical asset systems will be approaching end-of-life. The Tunnels are designed for a 125 year productive life. However, the various Mechanical and Electrical (M&E) asset systems have a far shorter useful life, typically 20 to 25 years, and shorter again for Operational Technology (OT) systems due to obsolescence, and consequently TII have invested heavily in asset renewals and improvements over the years.

Average Daily Traffic (ADT) through the DT in 2023 was 26,285 with 35% of vehicles using the DT being HGVs. The corresponding figures for the JLT were 64,587 and 4.7%. For Limerick Tunnel in 2023 the ADT was 28,508 vehicles processed through the Toll Station, with 9.03% being classed as heavy vehicles.

Tunnel EU Directive and Minimum Operating Requirements (MOR)

EU Directive No. 2004/54/EC & S.I. No.213 of 2006 on Minimum Safety Requirements for Tunnels (EUD) applies to all EU countries and all tunnels longer than 500 m in the Trans-European Road Network (TERN). In Ireland the Directive this was transposed into national law by Statutory Instrument (SI) No. 213 of 2006, which applies to all tunnels of over 500m on all our national roads. For each tunnel a set of Minimum Operating Requirements (MOR) have been developed that set out for each of the tunnel systems the level of availability and performance that must be met for the Tunnel to remain open to users.

The MORs have been specified in the contracts between TII and the Operators. A breach of any MOR obliges the Operator to close the tunnel to users immediately. The MORs most especially apply to minimum acceptable performance levels of Ventilation, Lighting, Drainage, Fire Safety, Communication, Traffic Control, SCADA, Electrical and Emergency Power systems, and CCTV coverage within the tunnels.

In adapting the EUD to the national context, TII has been identified as the body responsible for fulfilling the roles of Administrative Authority and Inspection Entity. These MORs drive the need for Asset Management and high reliability / availability of critical systems. The EUD defines the key roles and associated obligations:

- **Administrative Authority (AA) –** Responsible for taking the necessary measures to ensure compliance with the EUD. TII is defined in the S.I. as the AA for Ireland. TII has power to suspend or restrict the operation of a tunnel if the safety conditions are not met.
- **Tunnel Manager –** The AA identifies as Tunnel Manager the public or private body responsible for the management of each tunnel. ERTO is Tunnel Manager for DT & JLT and Direct Route Ltd for the Limerick Tunnel.
- **Tunnel Safety Officer (TSO) –** The Tunnel Manager, with the approval of the AA, nominates an independent Safety Officer for each tunnel. The TSO coordinates all preventive and safeguarding measures to ensure the safety of users and operations staff.
- **Inspection Entity (IE) –** SI 213:2006 Regulation 11 designates the NRA (i.e. TII) as the Inspection Entity for the purposes of the EUD. The Inspection Entity ensures that inspections, evaluations and tests are carried out in accordance with the requirements of the Regulations. In this role, TII undertakes annual reviews compliance of all tunnels with requirements of the Directive. Principal Inspections of all tunnel assets are undertaken every 4 years (at least) for the DT and JLT and every 6 years at the Limerick Tunnel. These inspections assess adequacy of structure and safety systems and confirm that assets are being maintained.

A review of EUD compliance is undertaken annually by TII. All three tunnels are compliant with TII's objective to ensure that the tunnels continue to function safely and effectively as critical elements of Ireland's national infrastructure.

The nature of the assets (linear, with large quantities of similar sub-systems) is ideal for reliability data harvesting and analysis, and state-of-the-art Computerised Maintenance Management systems (CMMS), including Maximo (DT,JLT), PEMAC (LT) and Service Now (MSA's) are leveraged for this purpose.

Asset Management Organisation

TII provides Asset Management direction and leadership supported by the DT and JLT Tunnel Operator for delivery of the asset management service. To this end, the Operator provides dedicated resources and are certified to ISO 55001, with their Asset Management process interlocking with TII's Asset Management Policy, Strategy and Framework. They also provide dedicated asset management resources, under TII governance process. Embedded in the Dublin Tunnel, Jack Lynch Tunnel, Limerick Tunnel and MSA's Asset Management system is a Continuous Improvement ethos, based on an annual plan-do-check-adjust cycle promulgated by ISO and the IAM (Institute of Asset Management).

Figure 5: Asset Management Cycle

The Asset Management cycle is active and continuously evolving, consisting of the process as shown in the figure below:TII mandates that on the DT, JLT, LT, and MSA schemes, the Operator must provide services in a manner that ensures no detrimental impact on the health and safety of Users, Road Users or Staff, the affected property, asset performance and capability, and the assets service life and whole-life asset value for money.

To achieve this, the Operator's objectives include ensuring that long-term strategic planning and schemes are initiated, progressed and completed before any asset related adverse impact affects service provision or road user safety. On the LT and MSA PPP schemes, the Operator sets objectives and performance targets which are reviewed and revised annually, including those related to availability, asset condition and residual life, and similar factors. These objectives are closely aligned with TII's published objectives for the operation of the national road network.

Asset Management, Climate and Sustainability

TII's Climate Adaptation aim is to be an organisation that is adaptive to the impacts of climate change and maintain its commitment to sustainability. In this regard, TII has set out seven climate adaptation strategic objectives in the Climate Adaptation Strategy (Dec 2022).

- Observe fewer network disruptions during climate-related events.
- Rapidly recover from any climate-related events.
- Have a robust, flexible, and equitable organisation that responds effectively during climate events.
- Enhance the climate resilience of lifeline roads in order to maintain community accessibility.
- Engage with the wider adaptation efforts across Ireland through partnerships and wider research.
- Embed climate adaptation within TII's operations, policies, and procedures in order to ensure a safe and resilient network.
- Adopt a low-carbon approach in TII's designs, standards, and processes when considering climate adaptation, while also considering wider social and environmental benefits

The first four objectives all speak to the issue of resilience, with the first three objectives central to the strategic approach to asset management of the Tunnels and MSAs.

A key part of the TII approach to Climate Adaptation is a data-driven understanding of climate risk. TII's asset management approach and systems facilitate the development and embedment of these approaches to climate risk estimation. Climate Mitigation activities are being addressed through the development of TII's Climate Action Roadmap. The Climate Action Roadmap 2024 sets out TII's plans to reduce emissions and meet decarbonisation and energy efficiency targets.

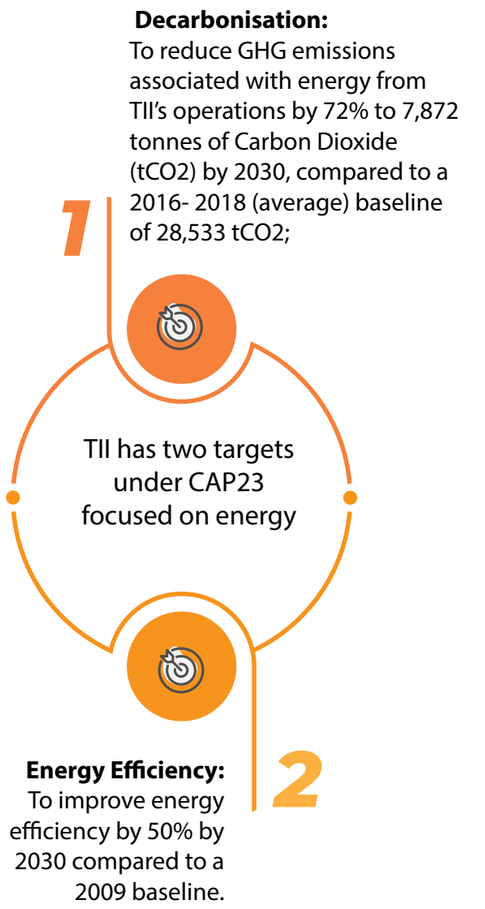


Figure 6: TII's Decarbonisation and Energy Efficiency Targets

Management Systems

In providing the service, the DT and JLT operator is required to operate an environmental management system certified to ISO 14001:2015 and an energy management system certified to ISO 50001:2018, aligned with TII's stated environmental and energy policies and strategies. The MSA and LT Operator's are required to comply with Quality Management Systems standard ISO 9000 and the Environmental Management Systems standard ISO 14001.

Climate and Sustainability Benefits

The main benefits from a climate and environmental point of view arising from the Tunnels occur due to the diversion of traffic away from relevant city centre areas, particularly by continuing to allow freight traffic to be removed from Dublin, Cork and Limerick city centres. This not only contributes to reduced congestion and transport emissions, but it allows for space to be reallocated for public transport (bus lanes) and active travel (cycle lanes) within these cities. Additionally, the TII MSAs contribute positively by integrating sustainable practices, such as the installation of electric vehicle (EV) charging stations at these service areas which encourages the adoption of electric vehicles, thereby reducing emissions from traditional combustion engines. Implementing renewable energy sources, such as solar panels at service areas, provides a sustainable power supply and reduces reliance on non-renewable energy.

This aligns with the Climate Action Plan 2024 (the third annual update to Ireland's Climate Action Plan), targeting a 50% reduction in Ireland's greenhouse gas emissions by 2030, and the Department of Transport's updated National Sustainable Mobility Policy (April 2022) that outlines a strategic framework for active travel and public transport journeys up to 2030, helping to reduce the risk to vulnerable road users such as pedestrians and cyclists, as well as reducing congestion for the passage of more bus routes and other forms of public transport.

Carbon Impacts

In terms of carbon impacts, the ongoing high availability of the Tunnels and MSAs provides significant benefits from avoided emissions as Tunnel routes and strategically located MSAs contribute to freer flowing traffic compared to congested city centres. This allows for more efficient travel and reduced fuel consumption which in turn reduces carbon emissions for traffic. However, the exact quantity of avoided carbon emissions over the lifetime of the assets is difficult to assess.

The activities carried out under the operations and programme of renewals including those at the MSA's, will also directly generate operational and embodied carbon emissions. Carbon impacts will vary significantly according to the specific activity and other factors such as energy sources and technologies deployed.

The Tranche 1 MSA sites are currently exploring the use of solar photovoltaic (PV) arrays. They are also considering the replacement of existing external light fittings with more efficient LED technology. TII has commissioned energy assessments at several Tranche 1 sites to identify potential energy reduction opportunities. These assessments are aimed at pinpointing specific areas where energy savings can be achieved, thereby contributing to a reduction in carbon footprint. The Tranche 2 MSA sites installed solar photovoltaic (PV) arrays and LED lighting during construction, contributing to their carbon reductions. Since October 2024, the operator reported that 168 of their sites, including the TII MSAs, are powered by three solar farms, further reducing their carbon footprint.

The Limerick Tunnel has recently enhanced its energy efficiency by installing photovoltaic (PV) arrays across four locations, covering an approximate area of 956 m². Additionally, existing light fittings along the project road, toll plaza buildings, and tunnel have been replaced with more efficient LED technology. These improvements have significantly reduced the carbon footprint and energy costs associated with the tunnel's operation.

Given the varied potential scope of works, these carbon impacts are again difficult to estimate and monetise. However, despite carbon emissions from ongoing operation, maintenance, and renewal activities, it should be noted that investment in keeping infrastructure assets, including tunnels and MSAs, in optimal condition ultimately mitigates against more carbon-intensive deep renewals or premature replacement of these assets.

Other Environmental Impacts

The asset renewals, beyond carbon impacts, also mitigate against issues created by local air and noise pollution exposure. This includes exposure to Nitric Oxides and Particulate Matter generated by vehicles. The ongoing maintenance and renewal investment in the DT, JLT and LT will also help ensure the assets are adapted to meet changing environmental challenges and related regulatory requirements. The increased efficiency of the transport network as a result will have positive impacts on Green House Gas (GHG) emissions from vehicles using the assets.

Risk Management

Good asset management enables decisions to be made to produce the right intervention, on the right asset at the right time, to maintain performance. This entails understanding of the optimal time to intervene, and as our asset information and data matures we will seek to understand the risk associated with the assets, enabling us to plan interventions prior to asset functional failure, and even in some cases to enable asset life extension beyond the normal design life considerations. As our M&E assets progress toward the end of their original design lives this approach will also seek to implement condition monitoring to enable our teams to intervene proactively before failure occurs, reducing reactive maintenance, and associated downtime and cost. In PPP contracts, such as the MSA's and LT, effective risk management is crucial. The PPP companies are responsible for routine and non-routine maintenance, defect remedies and self-certification of compliance with all contractual obligations.

TII employs a multi-tiered assurance system that encompasses review of deliverables including test results, conduction spot checks and inspections, and referencing national asset management programmes for road markings, signage, pavement, and structures. This comprehensive approach ensures that assets are well-maintained, risks are appropriately managed, and the public's interests are safeguarded.

EU Directive and Tunnel Risk Management

The EU Directive mandates an analysis of risks for a given tunnel, accounting for all design factors and traffic conditions that affect safety, notably traffic characteristics and type, tunnel length and tunnel geometry, as well as the forecast number of heavy goods vehicles per day. Furthermore, these risk analyses are required to be carried out by a body which is functionally independent from the Tunnel Manager. A well-defined Risk Assessment methodology, corresponding to the best available practices, is used. As the Administrative Authority under the EUD, TII ensures these Risk Management tasks are performed including:

- Testing and inspecting tunnels on a regular basis and drawing up the related safety requirements
- Establishing organisational and operational schemes incl. emergency response training
- Defining the procedures for immediate closure of a tunnel in an emergency
- Implementing the necessary risk reduction measures

Figure 7: Risk Management Tasks

Asset Level Risks

Specific risks related to the assets as well as operational risks likely to impact a programme have been identified. The following key risks apply:

- In the context of PPP contracts and more specifically for the MSAs, many operational and financial risks are transferred to the private entity responsible for the MSA. Specific risks at the asset level for MSAs include facility maintenance, service quality, customer satisfaction, and adherence to health and safety regulations.

  The operator must ensure that the MSAs are well-maintained, providing high-quality services to motorists, including the upkeep of amenities and availability of services.

- The operation of the tunnels faces a significant risk from climate adaptation and climate change. Extreme weather events can severely affect the operation and upkeep of these assets. The JLT is potentially vulnerable to flooding, but adverse weather may also indirectly impact the DT and LT with the possibility of structural damage and power failures among other issues.

  To address these challenges, proactive mitigation strategies and robust contingency plans are needed to ensure the resilience and continuity of operations under such conditions. Current mitigation includes comprehensive cyclical / preventative maintenance and winter maintenance strategies. In addition, as part of this risk management process, the design of the road drainage layout at both ends of the JLT, dating from the 1990's, has been updated and enhanced in the last few years.

- These are risks of cost escalations, subject to change due to the precise specifications of the works, the timing of maintenance, inflation and other external future factors that are outside the Operator's control. TII has sought to help manage this risk for the DT and JLT by competitively tendering a contract with a fixed price for the core services with options to extend for up to 16 years. While including an allowance for inflation the Operator shares some of this risk with TII. In PPP contracts for MSAs, cost escalations due to increased maintenance requirements or unforeseen operational expenses can arise. The private operator bears the risk of these cost variations but can mitigate them through efficient management practices and planned preventative maintenance.

- There is also a risk associated with the impact of technological advancements on the delivery and operation of the Asset Management programme.

  As technology rapidly evolves, equipment can become obsolete, necessitating early replacements. Similarly, technological upgrades could trigger early equipment replacement, potentially increasing costs for both TII and the Operator. These factors could significantly impact the programme's overall cost and potentially reduce the effective life of investments. For MSAs under PPP contracts, the private operator may need to invest in new technologies, such as electric vehicle (EV) infrastructure, to meet user expectations.

- Other potential risks which have been identified relate to the impact of legal and regulatory change and safety risks. These risks can be mitigated through timely renewal investments, and regular monitoring and reporting on the condition of assets by the Operator. Cybersecurity threats have also been identified as a material risk and TII has amended the existing requirements for the tunnels to include mitigations of this growing threat. The nature of the improvements includes active penetration testing of the systems on a regular basis.

Organisational Level Risks

Operator Insolvency: At the contract level, this risk is mitigated by, for example, requiring Parent Company Guarantees, Change in Control protections, provision of Collateral Warranties (and Undertakings), step-in rights, ensuring key sub-contacts provide for novation, and similar. At the enterprise level, TII is exploring options in their Business Continuity Planning to enable their immediate step-in in the event of a sudden and unforeseen Operator insolvency, applicable to the wider asset portfolio. Business Continuity Plans are in place for DT and JLT, to have preparations in place for incidents of extended service outages (due to internal risks such as technical failures, or external risks such as environmental or physical threats) and to restore services to the widest extent possible in a minimum timeframe. For the MSA's there are a range of operators in Ireland who could be contracted to step in if an operator was unable to deliver the service due to insolvency.

Lifecycle Planning

Lifecycle Cost

Lifecycle Costing takes into account the cost of an asset throughout all stages of the asset lifecycle, including capital investment and subsequent maintenance and operational costs associated with a typical Asset life.

An understanding of asset Life Cycle Cost (LCC) enables an organisation to prioritise and select interventions, thereby creating efficiency, and creating a more financially sustainable operation. In line with the requirements in OMTTCC2G2 contract, the service provider will use their understanding of asset cost and reliability to identify a group of lowest LCC interventions for prioritised asset types. For LT, this understanding ahead of the hand back will enable us to focus our interventions toward receiving back the tunnel in the required condition for future financial sustainability.

TII adopts a proactive approach to managing the asset portfolio in terms of monitoring and analysis, risk management, implementation of actions and interventions, and reviewing, developing and updating policies, procedures and plans, utilising both short- and long-term planning horizons. The asset lifecycle planning process uses an in-depth analysis and understanding of the assets (condition, performance, expected useful life, economies, obsolescence, etc.) as an input to develop the output, in the form of a rolling works program.

The key inputs to the lifecycle planning process are the EUD mandated independent Principal Inspection (PI) reports, plus the related System and Asset Group Status (SAGS) reports, and General Inspection (GI) reports for DT and JLT. The process output for DT and JLT is the Forward Capital Works Programme (FCWP) that sets out the near-term (3-year) asset renewal and improvement priorities and objectives.

For assets on PPP schemes like the LT and the MSA's, lifecycle planning is the responsibility of the PPP Co and its Operators. These entities manage and maintain the assets throughout the concession period. At the end of the contract period, the PPP company must transfer the project to the authority in a safe and serviceable condition, appropriate to its remaining design life. This transfer includes all associated equipment, plant, and stock in use for the operations, along with all related records and documentation required by the PPP agreement, ensuring the infrastructure is handed back in suitable condition for continued use.

Outputs: Forward Capital Works Programme (FCWP)

In relation to tunnels, the Operator develops, with TII collaboration, the Forward Capital Works Programme (FCWP) from the SAMP. TII and the Operator use the FCWP to programme any Project Works, such as renewals, investigative studies, and Business Cases, both in the short term (36 months with high level of granularity) and the long term (25 years into the future) with less detail, developed from PI reports and sources of industry standard expected operational life of assets such as DN-STR-03015).

Supply Chain Obsolescence

For tunnels, TII monitors the level of manufacturers' support available for essential equipment and systems to identify obsolescence issues before they risk having an impact on Operations. Obsolescence mitigation measures can include enhanced Spare Parts strategies, investment in stand-by assets, asset renewal, or similar.

Expected Lifecycle Duration

TII gauges the end of asset operational working life by the condition assessments described above, and by reference to published asset life-expectancy guidelines, such as BDF 78/99 App G Life Expectancy (TII Publications (Standards) DN-STR-03015 – Design of Road Tunnels, December 2000). Service life for planning purposes is defined in BDF 78/99 as "the period of duty after which replacement, rather than continued use, is anticipated to be justifiable on an economic or operational basis, either due to a greater risk of failure or to an unacceptable increase in unreliability, operating and maintenance costs."

Asset	Life Expectancy
Mechanical Plant	
Ventilation	
Jet Fans	18 years
Axial Fans	30 years
Electrostatic filters	10 years (estimated)
Drainage	
Pumps	15 years
Water level detectors	10 years
Fire Fighting	
Hand Extinguishers	7 years
Hydrants	28 years
Hose reels	20 years
Fire main pipework	30 years
Sprinkler System	20 years
Fire detectors (Services Building)	10 years
Automatic Gas Discharge System	20 years
Electrical Equipment	
Power Supply and Distribution	
Switchgear	20 years
Transformers	30 years
Cables HV	50 years
Cables LV, Comms	40 years

Asset	Life Expectancy
Standby Supplies	
Diesel generators	20 years
UPS sets	15 years
Batteries	
-valve regulated lead acid	5 Years
-vented nickel cadmium	20 years
Lighting	
Luminaires	18 years
Ballasts and control gear	
- Conventional	20 years
- Electronic	10 Years
Lamps	Refer to Chapter 6
Guide Lighting (emergency)	10 years
Control Systems	
CO, NO2 sensors	13 years
Visibility Monitors	15 years
Anemometers	20 years
Photometers	15 years
Computer and PLC systems	18 years (but may be obsolescent earlier).

Asset	Life Expectancy
CCTV System	
Cameras	15 years (but maybe obsolescent earlier).
Monitors	10 years (but maybe obsolescent earlier).
Control equipment	20 years (but maybe obsolescent earlier).
Cables	20 years
Traffic Monitoring and Control Systems	
Inductive loop systems	13 years
Signs and signals	14 years (but maybe obsolescent earlier).
Control equipment	15 years (but maybe obsolescent earlier).
Closure gates	15 years (13 years if automatic type).
Height detector	15 years
Communications	
Telephones	15 years
Telephone cabinet	20 years
Switch equipment	20 years (but maybe obsolescent earlier).
Radio antenna cables	15 years
Transmitter/receiver equipment	15 years (but maybe obsolescent earlier).
Fire Alarm and Detection system	
Detectors	
- in tunnel	5 years
- eleswhere	20 years
Control Equipment	20 years

Asset	Life Expectancy
Tunnel Panels	
Enclosure cabinets (stainless steel)	35 years
Distribution Boards	20 years
Firefighting equipment	See above
Fixings and support systems	
Stainless steel	100 years
Hot-dip galvanised steel	15 years

Lifecycle Optimisation

Lifecycle optimisation aims to achieve the highest whole-life value from the asset. For these tunnels at this stage of service life the focus is on determining strategies for end-of-life asset systems, comparing options such as increased maintenance regime, versus renewal / refurbishment, versus like-for-like replacement, versus design upgrades / modification, all within the given operational context. It also involves decisions on optimum timing given constraints on resources and access availability during planned closures. For example, it may be optimum to bring forward an asset renewal project to coincide with other works, or to delay and maximise the asset life through increased maintenance (and other possible risk reduction measures).

It also may be optimum to take a wider view and implement new technologies in parallel across the asset and site portfolio. The prioritisation of common technologies across different TII tunnels provides synergies in spares management, shared knowledge and skills. In general, the use of technologies tried and tested elsewhere in similar applications, while avoiding the early adoption of unproven technologies will result in higher whole lifecycle value.

Lifecycle Optimisation decisions are typically based on, in order of priority: Safety / EUD Compliance; Maintainability (incl. obsolescence drivers), Reliability and Availability of the asset system; Economic factors; Constructability / Portfolio considerations (incl. the need for tunnel closures and impact on tunnel users, and the possibility to combine with other planned interventions).

Asset Management Investment

For DT and JLT there has been a steady investment in asset renewal and improvement over the period since the Operational Commencement Date of the OMTTCC contract in February 2015. There is an expectation that this spend will continue in close agreement with the historic trend into the future, given TII's commitment (and obligations) to ensuring that the tunnels continue to function safely and effectively as critical elements of Ireland's national infrastructure. In general, the level of CAPEX spend is anticipated to continue at approximately €8m yearly (excluding adjustments for inflation). Actual expenditure is somewhat constrained by accessibility (limited number and duration of planned closures), and by availability of personnel with in-depth knowledge of these complex infrastructure assets (often coming from abroad given the small scale of the Irish market). The major upgrade and renewals works that were of a greater scale than envisaged included a full replacement of the Dublin Tunnel communications network with a full-fibre system (at a cost of €4.5 million), the upgrading of the tunnel Public Address Voice Alarm and Radio Rebroadcast systems to more advanced higher-transmission quality equipment at a cost of €5.5 million and improvements to the Overheight Vehicle Detection Systems (OHVDS) on the approach to the tunnel (€5.5 million).

All these improvements aim to increase the safety of tunnel users.

Revenue: Toll revenue from the DT is used to substantially offset costs of its maintenance and operation so that there is no draw on treasury funding. Toll revenue in 2023 amounted to €27m and in 2024, revenues are projected to be circa €30m. Toll revenue is expected to contribute at least four-fifths of the total costs of operations and asset management going forward. Toll rates may increase in the future also depending on Government and TII policy.

A reduction in asset renewals due to, for example, funding constraints, will likely yield negative results from sub-optimal operation of the maintenance and replacement programmes. This will result in increased emissions and hence negative climate action outcomes. There would be an increased likelihood of tunnel closures and motorway inefficiencies, which will force vehicles into city centres. This will have a negative impact on air quality and noise levels, including increasing the exposure of pedestrians and cyclists to harmful exhaust emissions.

For assets under PPP schemes such as LT and MSA's, the PPP Co is responsible for asset management and investment throughout the concession period. However, TII retains the right to implement variations when necessary. While the PPP Co manages and maintains the assets, TII can initiate investments or modifications to enhance asset performance, safety, or meet new regulatory requirements. This collaborative approach balances responsibilities between the private and public sectors, ensuring the assets continue to meet evolving infrastructure needs and public expectations.

Handback Preparation and Planning – MSAs and LT

When a PPP Contract reaches its Expiry Date, the process for handing back the assets to the Contracting Authority is known as the Handback process. MSA assets typically include all elements of the amenity buildings, fuel stations, road pavements, structures, drainage elements, fencing, road restraint systems, signs, road lighting and ITS infrastructure all of which are within the limits of the MSA. When the assets are handed back, the Contracting Authority will either take direct responsibility for the management, operation and maintenance of the assets or else procure an alternative arrangement for the management, operation and maintenance of the assets. The Expiry Date for Tranche 1 MSA PPP Contract will occur in 2034, Tranche 2 MSA PPP Contract will occur in 2043 and Limerick Tunnel will occur in 2041.

Key Elements of TII PPP Contracts	Description
Handback Procedure	This procedure is developed by the PPP Co and agreed prior to the Handback process. This procedure shall ensure that the transfer proceeds smoothly and without avoidable disruption to the level of service provided to Users.
Inspection Requirements	Initial Inspection, Second Inspection and Handback Inspection. All inspections are to be joint inspections and the cost borne by the PPP Co.
Minimum Residual Life Requirements	The minimum period specified in the Handback Requirements for each element at Expiry Date remaining until the element will require renewal or replacement.
PPP Co Notices on the condition of all elements	The PPP Co's Proposals (or any subsequent revisions or additions) to the Renewal Works, Renewal Programme and Renewal Amount.
Final Handback Acceptance	The Handback Certificate. The Authority may refuse to issue if the PPP Co fails to complete all of the Renewal Works or the Project Road for any reason does not comply with the Handback Requirements in all respects.

The following are some key Considerations for Managing Handback:

Planning for Handback

- Ensuring the asset meets the contractual requirement for Handback.
- Ensuring continuity of the service provided by the asset.

Asset Maintenance During the PPP Contract

- Maintenance obligations
- Maintenance risk
- Planned maintenance/asset replacement
- Maintenance/lifecycle funds.

Condition of Assets on Expiry

- Handback condition and useful life
- Importance of surveys
- Timing of surveys
- Costs of survey and remediation
- Maintenance retention fund
- Release of maintenance retention fund
- Performance bond alternative
- Warranties
- Other maintenance/lifecycle funds

Risks associated with Contract Expiry

- Dispute
- Service Disruption
- Legal and regulatory compliance e.g. TUPE
- Increased/unforeseen impact on Contracting Authority's budget.

International best practice advises initiating handback planning at least seven years before contract expiry. A clear plan should be established for contract expiry including the future use of the assets and integration with future procurement plans and commercial strategies. Knowledge of the assets and regular condition and performance monitoring throughout the PPP Contract are key to achieving a successful handback process.

Tunnel Asset Group: Forward View

As an output of the Lifecycle Planning Process described above, the following table summarises the proposed planned interventions for DT and JLT extracted from the 2023 FCWP. These interventions are subject to a selection and lifecycle optimisation process, and larger scale works required justification on their own merits as documented in a Business Case.

Dublin Tunnel

Critical System	Short-Term (1 to 3 years)	Long-Term (10 years)
Lighting	• Renew Photometers • Orientation Lights (LEDs) • Building & External Lights (LEDs)	
Fire Detection	• Upgrade Building FM200 Gas Suppression Systems • Fire Doors – replace closers	
Emergency Power		
Ventilation Systems	• Jet Fan Control Panel Equipment • H2S detection – replacement (obsolete)	• Staggered Jet Fan replacement works • Tunnel Sump Ventilation
Electrical	• Surge Protection • Lightning Protection Systems	• MV/LV Switchgear replacement • LV Air circuit Breakers
Drainage	• Renew Pumping stations / Pumps	• Positive Drains (Scoping, for replacement works)
Communication	• Radio system	
Tolling	• Major upgrade project underway for Tolling and all associated systems.	
SCADA	Servers, workstations, including: • CCTV • Tunnel Emergency Roadside Telephones(TERT) System • Maintenance Phones • Overheight Detection (SCADA interface) • Traffic Vehicle Loops • Traffic Signals - Variable Message Signs, Lane Controller Luminaries, Speed Indicator Signs, Signal Lights, etc.	
Roads and Pavements	• Road markings and chevrons • Access to Sign Gantries (safety improvements)	
Tunnel Civil and Structural	• Repainting of the tunnel lining	
Niches and Cross Passages	• Review doors for compliance with latest best practices and guidelines	

Jack Lynch Tunnel

Critical System	Short-Term (1 to 3 years)	Long-Term (10 years)
Lighting	• Replace main bore lighting with dimmable LED system • Upgrade central bore to LED • Replace photometers • Emergency/Orientation/Directional Lighting Renewal	
Fire Detection	• Fire Alarm and Detection System upgrade / replacement • Manual Call Points & associated assets Replacement • Hose Reels replacement	• Fire Extinguishers replacement • Fire Hydrants & Ring Main renewal
Emergency Power	• Fuel Tank Replacement	
Ventilation Systems	• Upgrade Jet Fans, incl. vibration monitoring • Air Quality Sensors • Central Bore Control Panels	
Electrical	• MV/LV Upgrade project currently underway	
Drainage		• Sump Pumps
Communication	• Radio / Leaky Feeder System • Public Address System	• Emergency Telephone System
Tolling	N/A	
SCADA	• CCTV – upgrade to digital	
Roads and Pavements	• Road Markings refresh • Road Studs (LED replacement) • Covers & Gratings	
Tunnel Civil and Structural	• Immersion Joint Refresh • Condition Monitoring / Investigation	
Emergency Exit Doors	• Door Refurbishment/Replacement	

Major projects (in terms of expenditure, complexity and constructability challenges) that are currently underway or recently completed include the following:

Dublin Tunnel

- Complete renewal of the SCADA system (and associated monitoring and control devices, e.g. CCTV systems and traffic control devices, needed due to interdependency with the SCADA system);
- Complete renewal of the Tolling system (including all field equipment);
- Public Address and Voice Alarm (PAVA) & Radio Voice Break-In (VBI) system upgrade;
- Tunnel Comms System upgrade;
- UPS replacement;
- Over-Height Vehicle Detection System;
- Electrical Control System (ECS) Improvement Works;
- Pavement Works.

Jack Lynch Tunnel

- MV/LV Electrical System renewals;
- SCADA integration with DKI (Dunkettle Interchange) works and CCTV improvement works;
- Tunnel Management Building upgrade;
- Sump Fire Suppression System replacement works;
- Tunnel Drains (improve capability for extreme weather events);
- UPS Replacement;
- CO2 Suppression System Renewal Works;
- Sump Covers renewal (on road pavement).

N40 Approach to Jack Lynch Tunnel, Cork
Photo © David Dixon (cc-by-sa/2.0)

Motorway Services Areas : Forward View

TII currently operates online service areas, through concessions, at 6 locations on the M1, M4, M6, M9 and M11 as indicated in Section 1.

Transition to Zero-Emission Vehicles

The transition from carbon-emitting to low carbon and zero-emission vehicles is underway and will be expected to accelerate in the next years and decades. This transition will be possible through a number of enabling technologies, both existing and in development. Shifting demands for refueling and recharging infrastructure will require new technologies, systems, and new maintenance strategies to be deployed in MSAs.

Transitional Technologies

Several transitional technologies will be critical in the period up to 2030 at least. These include:

Biofuels: Blending renewable fuels into liquid fossil fuels is a key transitional measure. Ireland has set a target to achieve a 20% mix of renewable fuel in biodiesel by 2030. In addition, the option for 100% biofuel is becoming increasingly available at MSAs using Hydrotreated Vegetable Oil (HVO). While Biofuels can provide transitional carbon reductions, two primary zero-emission technologies are emerging:

- **Battery Electric Vehicles (BEVs):** Expected to meet the needs of the majority of use cases by the 2035 and 2040 phase-out dates for diesel. BEVs already form a significant cohort of the LDV fleet, and are expected to become increasingly available for HDVs.
- **Hydrogen Fuel Cell Vehicles:** Likely to play an important role in harder-to-decarbonise applications, such as long-range transport or where rapid refuelling is necessary.

Charging and Refuelling Infrastructure

To support the transition, significant infrastructure development is required, and the EU is focusing on improving charging and refuelling infrastructure for zero-emission vehicles.

Alternative Fuels Infrastructure Regulation

Implementation of the EU Alternative Fuels Infrastructure Regulation (AFIR) will significantly impact the extent and configuration of the refuelling/recharging services at MSAs in the coming years.

The AFIR mandatory targets for the capacity of Electric Vehicle Charging Infrastructure (EVCI) deployed along the TEN-T network will require significant upgrades in the number of recharging points and their power output capacity to be provided at MSAs.

While AFIR sets out the minimum mandatory targets for EVCI, the Zero Emission Vehicles Ireland (ZEVI) National Road Network EV Charging Plan 2024-2030 provides for more ambitious targets, and implementation within a shorter timeframe. These targets will apply progressively over the years 2025 to 2030, both to Light Duty Vehicles (LDV) initially and increasingly to Heavy Duty Vehicles (HDV).

EVCI Maintenance

There will be a requirement for strategic planning of the rollout of the EVCI at MSAs, and an increasing requirement for maintenance of these facilities to ensure a high level of availability at all times. The high availability levels required for EVCI will demand monitoring of KPIs for uptime and response times, as well as ensuring an adequate supply chain for skilled maintenance personnel and replacement parts. Current EV recharging stations are designed to provide self-monitoring and diagnostics, which can assist with preventive and un-planned maintenance. Remote monitoring systems will assist in maximising the efficiency of maintenance operations.

Hydrogen

In addition to EVCI, AFIR envisages hydrogen refuelling stations along the TEN-T network, principally for HDVs, but also allowing for availability to LDVs. The mandatory target for hydrogen infrastructure in AFIR requires publicly available refuelling stations in each urban node and at 200km intervals along the TEN-T Core Network by the end of 2030. This will introduce further maintenance requirements for this significantly different fuel distribution technology.

Transition to zero-emission Heavy Duty Vehicles (HDVs)

The transition to zero-emission heavy goods vehicles (HGVs) by 2035 is a significant focus for many countries and regions, with various strategies and regulations in place to achieve this goal. The fuel transition for HGVs involves a shift from traditional fossil fuels to cleaner alternatives, with an emphasis on zero-emission technologies. The EU has set ambitious targets for reducing CO_2 emissions from HGVs:

45% by 2030 — **65%** by 2035 — **90%** by 2040

These targets apply to new HDVs registered in the EU and cover a wide range of vehicles, including medium lorries, city buses, coaches, and trailers. Ireland has signed the Global Memorandum of Understanding on Zero Emission Medium- and Heavy-Duty Vehicles and the Road Haulage Strategy 2022-2031 aims for 30% of new HGV sales to be zero-emission vehicles by 2030.

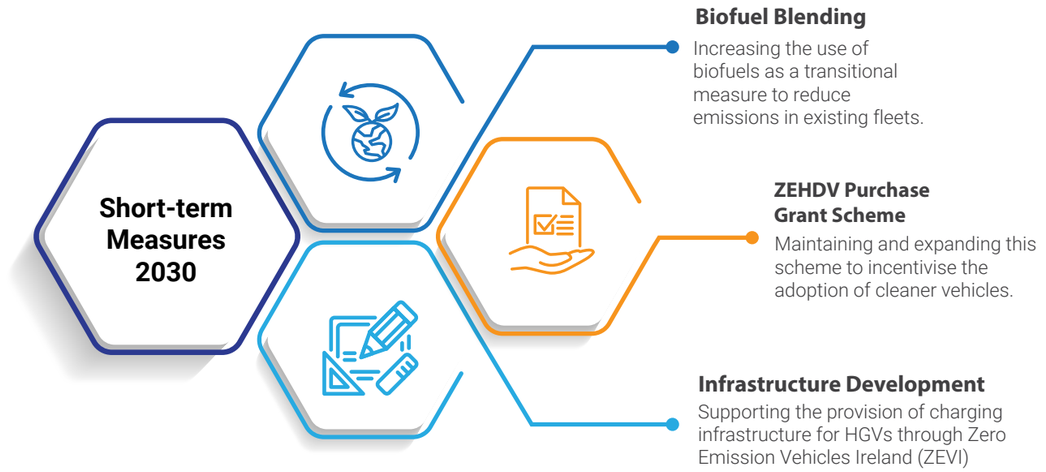


Figure 8: Short-term Measures 2030 for Development of Charging and Refuelling Infrastructure

The fuel transition for heavy goods road vehicles to 2035 is a complex process involving a mix of transitional and zero-emission technologies, supported by evolving regulations and infrastructure development. While challenges remain, the industry is moving steadily towards a cleaner, more sustainable future for road freight.

Safe and Secure Truck Parking Areas

In the future, online service areas will have regard to the Commission Delegated Regulation (EU) 2022/1012 in relation to: level of service; provision of safe and secure parking areas for commercial vehicles; and the spacing of the same. Such safe and secure parking areas may also be integrated with electric HDV recharging facilities to take advantage of longer vehicle dwell times. TII may identify potential to develop a pilot scheme, in regard to the provision of safe and secure parking areas for the haulage sector at an online service area.

Despite these efforts, diesel HDVs are still expected to make up the majority of the fleet in 2030. The transition to zero-emission HDVs in Ireland is not expected to be rapid, with battery-electric HDVs taking time to become widely available and affordable.

MSA Landscaping

TII has developed a comprehensive Landscape Strategy that integrates biodiversity into transport infrastructure operations through several key initiatives:

- Ecological Design Approach: TII's landscape strategy is based on an 'ecological design approach' that prioritises:
  - Using native species and species with high ecological value
  - Developing functional, cost-effective, and healthy landscapes that align with road and rail safety objectives
  - Implementing a limited intervention and self-sustaining management approach once landscapes are established
- Biodiversity Integration: The TII Landscape Plan integrates policy objectives from their Biodiversity Plan, applying these to all projects along National Road and light rail networks. Key aspects include:
  - Promoting habitat connectivity across the wider landscape
  - Enhancing ecosystem services such as carbon sequestration and flood management
  - Striving for no net loss of biodiversity in new projects, with an aim for net gain1
  - Pollinator-Friendly Management

TII has collaborated with the All-Ireland Pollinator Plan to improve landscape management for pollinators and overall biodiversity:

- Reducing grass mowing frequency in certain areas to enhance wildlife value
- Implementing pollinator-friendly management practices along transport corridors
- Installing 'Bee friendly' signs to promote awareness of these initiatives
- Selective tree management for long-term health of tree belts and safety considerations

By implementing these strategies, TII aims to create transport infrastructure that not only serves its primary function but also contributes positively to Ireland's biodiversity and landscape quality.

MSA Building and Facility Enhancements

Aligned with the TII Service Area Policy, the strategic asset management approach for the Motorway Service Areas (MSAs) focuses on continually enhancing services and facilities to meet the evolving needs of the public. The private operator, under the PPP contract, closely monitors market trends and responds to customer demands by investing in significant upgrades and innovations. This approach may include updating food offerings to cater to a range of dietary preferences. The operator also considers modernising amenities such as shower and toilet facilities, incorporating the latest technologies, comforts, and accessibility features to enhance the visitor experience. Investments are made to ensure the long-term sustainability of the service areas while aligning with public expectations and regulatory requirements.

The Tranche 1 MSAs are currently undergoing significant accessibility enhancements. These improvements aim to bring the existing facilities, which were constructed over 14 years ago, into compliance with the latest building regulations. These enhancements will ensure that all visitors, regardless of their mobility needs, can access and use the services provided at these motorway service areas comfortably and safely. The enhancements include modifications to amenity buildings, parking areas, and other essential facilities to meet modern accessibility standards. Renewal works have recently been carried out at the convenience shop and food offer areas as well as the public toilet and shower facilities of the Tranche 2 MSA Amenity Buildings. These enhancements help ensure that the Tranche 2 MSA facilities also remain compliant with the current building regulations

Motorway Operations Control Centre : Forward View

Worldwide, Motorway Operations Control Centres (MOCCs) are set to undergo significant technological advancements by 2035, enhancing their ability to manage and monitor motorway networks more efficiently and safely. Among the key developments expected are:

Artificial Intelligence and Machine Learning

AI will play a crucial role in traffic management, offering:

- Real-time data analysis
- Predictive modelling
- Adaptive decision-making

Machine learning algorithms will process vast amounts of historical and real-time data, identifying patterns and trends to optimize traffic flow and predict congestion hours in advance. It may also in time play an enhanced role in speed enforcement if there is greater roll-out of the average speed safety camera system across more substantial lengths of the network.

Vehicle-to-Everything (V2X) Communication

Vehicle-to-Everything (V2X) Communication

The widespread adoption of V2X technology will enable:

- Real-time data exchange between vehicles and infrastructure
- Enhanced safety through immediate hazard warnings
- Optimized traffic flow through coordinated movement

Connected Vehicle Integration

The implementation of 5G networks will support:

- Ultra-low latency communication
- Improved real-time decision-making capabilities for connected vehicles
- Sustainable and Efficient Operations
- Net Zero Initiatives

Overall, it is anticipated that there will be a shift towards reducing or eliminating roadside technology that requires on-site maintenance. MOCCs will expand their capabilities to provide real-time, personalised travel information to road users while offering enhanced customer experience through a range of information channels and media platforms for customers.

By 2035, the Motorway Operations Control Centre will continue to evolve into a highly sophisticated hub, leveraging cutting-edge technology to manage motorways more efficiently, safely, and sustainably. The integration of AI, connected vehicle technology, and advanced data analytics will enable proactive traffic management and personalised services for road users, marking a significant leap forward in motorway operations. The timing and scale of investment required to upgrade or replace current technologies is difficult to estimate due to the rapid changes in technology supporting MOCC tasks, but significant investment will be required to keep the MOCC at the leading edge of operations control and customer support on the TII high speed road network.

5. The Way Forward

The continuing improvement cycle for this TII SAMP includes applying the Plan-Do-Check-Act (PDCA) methodology, which involves TII planning improvement actions, executing them, checking results against desired outcomes, and acting on that feedback. In relation to DT and JLT, TII is implementing an eight (plus eight) year contract with our main supplier to give continuity of Asset Management accountability for the medium to long term.

Through this approach TII aim to facilitate application of a long-term asset management approach that maintains performance whilst creating a sustainable investment roadmap through a key stage of the lifecycle of these assets.

The Way Forward

Asset Management Maturity and roadmap to ISO 55001 accreditation

Create a roadmap using gap analysis, quick wins, and long-term plans to enhance asset management and achieve ISO 55001 accreditation

Asset Management Information and Systems

Develop an approach within the AIM Strategy to collect, store, and integrate asset data from various systems, ensuring a "single version of the truth"

Improved Asset Maintenance Strategy

Refine the Asset Maintenance Strategy for improved effectiveness and operational flexibility while prioritizing older assets using lifecycle analysis

Asset Management Capability and Culture

Promote a culture of good asset management practice by providing training to TII and Operator staff, enhance understanding and commitment to asset management principles across the organisation

Business Continuity

Ensure continuous tunnel operation amid rising traffic and assess resilience to evolving conditions and refine operational strategies

Criticality

Develop a unified criticality scoring methodology for tunnel assets, prioritising those with the highest impact in case of failure

Improved Asset Information Strategy

Optimise asset data collection and usage and implement standards for asset data management, integrate systems, and explore future technologies like AI.

Prioritisation Tool

Refine the existing asset prioritisation tool using the PDCA cycle to align decision-making with Asset Management objectives

Improvement Asset Management Plans – DT and JLT

Revise and update Asset Management Plans (AMPs) annually, incorporating lifecycle analysis and investment planning, to better assess residual risk and prioritise future works

Innovation in Inspection and Maintenance

Leverage technological advancements in inspection and maintenance, such as LIDAR scanners and remote monitoring devices, to improve efficiency and reduce costs

Figure 9: Alignment of Asset Management Processes: The Way Forward

Asset Management Maturity and roadmap to ISO 55001 accreditation

In order to target the enhancement of our asset management capability, TII will have a Gap Analysis completed to understand our level of maturity. Through this we will aim to identify 'quick wins' that will deliver the most benefit and longer-term programmes of change and development to drive our Asset Management maturity forward. This could ultimately culminate in supporting the achievement of ISO55001 accreditation.

Improved Asset Maintenance Strategy

The current maintenance strategy as implemented has minimised closures of the three tunnels required due to asset failure in the previous ten years. However, a review and potentially improvement of the Asset Maintenance Strategy on a regular frequency will provide a base for improved maintenance effectiveness and show good practice. TII has developed Minimum Operating Requirements for each of the tunnels that from part of the contractual obligations on the Operators, to support the requirements of the EU Directive in ensuring safe operation of the tunnels. In the coming period TII intends to test the MORs (for DT and JLT) through a series of workshops to see if greater flexibility to operate in degraded mode can be achieved while maintaining a satisfactory level of safety. While a programme of asset renewals is underway as tunnel assets near their 'end of life', prioritisation of maintenance on the older assets is required through asset information systems (Maximo) coupled with good lifecycle analysis and associated decision-making framework.

Business Continuity

Maintaining tunnel operation is paramount, and whilst performance to date has been good, it is important that as the traffic demands increase and as assets begin to age, that we are fully prepared to undertake work whilst maintaining tunnel operation, even in a degraded state. Analysis of the options for contraflow and tidal flow through the tunnels has been undertaken for both DT and JLT to determine if greater levels of access for maintenance and renewals work could be achieved without impact on tunnel availability for the public. Contraflow operation does not appear to be possible at the DT but tidal flow is being further explored to determine if it represents opportunities during major refurbishments or a serious included that effects a single bore. We will continue to work towards these solutions throughout the next stage of our delivery including assessing the resilience of the tunnel assets to changing conditions.

Improved Asset Information Strategy

TII is collecting a large volume of asset data currently through the use of IBM's Maximo system (Maintenance Management System) and also the regular and ad hoc inspections undertaken by independent engineers. In the coming years it is planned to "mine" this data to maximise the efficiency of its use and also assess if the correct data is being collected. Good asset information should provide the right information, in the right location, at the right time, to support the right decision. TII will develop an Asset Information Strategy aiming to identify exactly what data needs to be collected and utilised and how this data should be stored and managed as an asset. This will identify key actions to be implemented, such as:

Improvement Asset Management Plans – DT and JLT

AMPs are written for all asset classes to include background, asset information, lifecycle analysis, whole life costing and investment planning. The current AMPs will be developed and revised based on the approaches set out within the SAMP and reviewed on an annual basis to enable utilisation of the latest decision-making information. This approach will enhance understanding of residual risk and support prioritisation of future works.

Asset Management Information & Systems

The tunnel maintenance and asset renewals programmes are a material factor in the achievement of a high level of Tunnel Availability. Such programmes cannot be delivered without sophisticated use of Asset Management information and systems, described below. Within the AIM Strategy we will identify how we will collect and store the asset information and seek to develop an approach to connecting data and information from across systems. This approach is intended to provide a 'single version of the truth' drawing data form across all sources to enable decision making in line with good practice asset management.

Asset Management Capability and Culture

In order to establish a culture of good practice in Asset Management, efforts should be made to encourage education in Asset Management across all key stakeholders, as experience shows that putting Asset Management into practice can be challenging if practitioners do not receive relevant training.

TII intend to take the opportunity of the new OMTTCC contract starting in 2025 to roll out training for key TII staff involved with the tunnel asset management together with the key staff from within the Operator's organisation, providing understanding the 'why' and 'how' of asset management to increase buy in and aid development of an Asset Management Culture throughout the organisation.

Criticality

Asset Criticality provides an understanding of the relative importance of an asset to achieving our objectives. A clear understanding of asset criticality will be key to realising lifecycle value by enabling us to focus our attention on the asset with the greatest impact if they should fail. This scoring will also support reliability practices (such as Reliability Centred Maintenance studies utilising FMECA risk assessments). To help achieve this TII has specified that a dedicated reliability engineer is to be included in the structure of the tunnel Operators team under the new OMTTCC contract. Together with the Operator, TII will develop an aligned criticality scoring methodology and apply this across our tunnel asset base.

Prioritisation Tool

The assessment of competing investment options must be considered to identify how works are prioritised to maximise value from our work. This is an essential process to delivering the right intervention on the right asset at the right time. An existing asset prioritisation tool was developed at the start of the OMTTCC contract, and TII intend to refine this tool using the PDCA cycle.

We will revisit this decision support tool seeking to align the approach to our Asset Management objectives and engage across stakeholders to create an agreed aligned approach to decision making.

Innovation in Inspection and Maintenance

Technological advancement in the field of inspection and examinations can provide significant cost reduction, or performance benefit across the asset lifecycle, whilst also facilitating tunnel availability, for example by collecting information quickly and efficiently for assessment without the requirement to close tunnels. As we continue to improve we will identify our areas of higher risk and of need for improvement and identify clear problem statements.

Against these statements we will work to identify technological solutions to enhance our asset management capability. This may include the use of data collection devices such as LIDAR scanners or remote condition monitoring devices for critical assets such as jet fans.

Summary of Improvement Actions

Areas	Actions	Climate	Sustainability	Risk
Asset Management	Asset Management Capability – assessing Asset Maturity within the organisation, assessing the AM culture and undertaking Asset Management training.	✓		✓
	Review and update the Asset Management Information Strategy to reinforce line-of-sight with the Asset Management framework and objectives			✓
	Apply Reliability Engineering techniques and analysis to update the Asset Maintenance Strategy , with a focus on Risk and resilience.			✓
Lighting	Further expand the use of LED lighting throughout the estate to improve energy efficiency, and thereby reduce carbon emissions (and reduce hazards by improving lighting levels/controls).	✓	✓	✓
Ventilation	Install real time condition monitoring data collection and reporting as an early warning system and as an input to predictive maintenance (PdM) strategies, to reduce unplanned downtime durations.		✓	✓
	Maintain air quality limits in the tunnels in line with latest international good practice.		✓	
Asset Management Information and Systems	Enable Maintenance Management System data analytics by leveraging AI (Artificial Intelligence) capabilities, to improve maintenance effectiveness, reduce unplanned downtime, and extend asset life.		✓	✓
	Implement live data collection from condition monitoring sensors to enable real-time Predictive Maintenance (PdM) strategies to warn of potential catastrophic failures, allowing proactive intervention before users are impacted.			✓
Energy	Increase the use of smart meters as part of the ISO 50001 Energy Management System, to act as early warning system for energy (and water) wastage due to asset malfunction or operational issues.	✓		✓
Lifecycle Planning	Explore the use of Lifecycle Value Optimisation software for use in asset management portfolio decision making.	✓	✓	
Reporting	Develop a reliability dashboard utilising Maintenance Management System data, to visualise and communicate maintenance strategy effectiveness, and highlight opportunities for improvement.			✓
	Develop an automated process for measurement of Greenhouse Gas (GHG) Protocol Initiative scope 1 and 2 value-chain emissions associated with operations and maintenance of the tunnels, to enable targeted reductions.	✓		✓
Tunnel Civil and Structural	Reduce the carbon impact of pavement renewal through use of Recycled Asphalt Production and other technologies.	✓	✓	✓

The Way Forward - MSAs

Innovation in Scheme Inspections

TII carries out regular on-site inspections to monitor MSA's operations and asset condition. TII intends to leverage emerging technologies such as drones, handheld/mobile devices and AI, to improve the effectiveness of inspections in the coming years at the MSAs.

Asset Management Information and Systems

The MMS manages all maintenance needs and records asset condition of the systems at the MSAs. TII intends to enhance the mining and analysis of the data that is available in the MMS systems to assess where improvements to the asset life can be achieved.

Improvements to Asset Inventory Gathering.

As noted above, by availing of the advances in technology, TII will continue to seek ways to improve the asset data collection processes at the MSAs.

Asset Management Capability and Culture

To build-on the established asset management culture TII will be looking to encourage joint training in asset management involving TII staff and PPP Co staff to encourage a collaborative working to improve asset stewardship and foster a win-win approach to bring benefits to both organisations.

Business Continuity

For business continuity, robust service level agreements are in place to ensure timely repairs and upkeep of all critical facilities, enhancing reliability of the facilities at MSAs. These agreements support the reliable operation of MSAs to meet public needs. Climate adaptation measures will be assessed to improve resilience and ensure continuity of service following significant weather events.

Handback Processes

The T1 PPP Contract ends in 2034 and the T2 PPP Contract ends in 2043. At these dates, the operation and maintenance of the MSAs will be handed back to TII. The expiry phase of these contracts presents risks such as operational disruption, lack of service continuity, financial loss, and reputational damage, making effective management crucial.

TII is already considering the challenges for the handback of our PPP schemes in other areas and will apply the lessons learnt to the handback of the MSAs. The process taken for Tranche 1 will inform the process and steps for Tranche 2.

Alternative Fuel

The EU Alternative Fuels Infrastructure Regulation (AFIR) will significantly transform MSAs by mandating increased Electric Vehicle Charging Infrastructure (EVCI) along the TEN-T network. This includes a substantial rise in recharging points and their power output.

Additionally, Ireland's ZEVI EV Charging Plan 2024-2030 sets more ambitious targets than AFIR, accelerating implementation from 2025 to 2030 for both Light and Heavy Duty Vehicles. Monitoring and maintenance of EVCI will be assisted by EV recharging stations which are designed to provide self-monitoring and diagnostics information. Combined with EVCI management software currently available, this can contribute significantly to the reliability and availability of EVCI.

Image: Athlone MSA

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