THE CIVITAS INITIATIVE
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COMPETITIVE AND SUSTAINABLE GROWTH
&
ENERGY, ENVIROMENT AND SUSTAINABLE DEVELOPMENT
PROGRAMMES

MIRACLES Project GRD1 – 2001 – 40047

Rome Winchester Barcelona Cork

MULTI INITIATIVE
FOR RATIONALISED
ACCESSIBILITY
AND CLEAN LIVEABLE
ENVIRONMENTS

Deliverable D4.2

REPORT ON EVALUATION RESULTS

Version N°6.0
16th August 2006

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EXECUTIVE SUMMARY

This deliverable (D4.2) describes the implementation and evaluation results of the CIVITAS MIRACLES project. The CIVITAS initiative is an EU initiative which aims to promote sustainable urban transport through the use of technology and policy based instruments and measures. The MIRACLES project is a cluster of four cities (Rome, Winchester, Barcelona and Cork) which sits under the umbrella of CIVITAS together with three other projects (VIVALDI, TRENDSETTER and TELLUS). The measures that were implemented within MIRACLES were grouped into eight Workpackages, and most measures involved more than one city.

The MIRACLES evaluation methodology was based on Deliverable D4.1 (the Evaluation Plan), which was developed during 2003. Each of the four MIRACLES cities are very different in character, scale and degree of sustainable development and initially a 'bottom-up' approach in choosing the impacts and indicators to be measured was used. This bottom-up approach was based upon MAESTRO and CONVERGE evaluation guidelines. In parallel, guidance from METEOR (a horizontal EC-funded project with the objective of evaluating all CIVITAS cities) led to the top-down infusion of METEOR core indicators into the evaluation plans.

Evaluation results were reported at two levels: the measure-level and the city-level. A common template was developed for each level with their structure and content based on discussions between METEOR and the CIVITAS Projects. The templates ensured both a common reporting format and that all evaluation relevant information was reported and disseminated in a concise manner. The approach also aided the interpretations and key findings of each measure, and enabled a series of 'headline results' and lessons learned to be identified across the project.

The MIRACLES evaluation approach focused on providing the results in accordance with the template format. All templates containing the evaluation results are gathered as Annexes 1-4 to this Evaluation Report. These annexes constitute the "MIRACLES Implementation Report No. 2".

The main report of D4.2 consists of six sections (or chapters). ***Section 1*** provides a general overview of the project high-level objectives, and outlines which Workpackages and measures were implemented at each of the four MIRACLES demonstration sites. The cities are introduced in ***Section 2*** in terms of geography, economy and their current transport situation as well as a brief description of the measures that were implemented within the project. In addition, the anticipated targets are also outlined for each city.

Section 3 provides a general overview of the evaluation process undertaken within MIRACLES, which predominantly focused on the baseline and ex-post scenarios (i.e. the 'before' and 'after' effects). The baseline scenario defined the reference case while the ex-post phase assessed the actual impacts of the implementation at each of the demonstration sites. Wherever possible, data collection was consistent between the two scenarios so as to provide accurate and comparable scenarios for the evaluation process, and was based upon the indicators presented in the Evaluation Plan.

Section 4 provides a concise interpretation of each Measure-Level Template (MLT), typically summarising the key points of each measure within one page. The MLT summaries for Rome, Winchester, Barcelona and Cork are reported in sub-sections

4.1 to 4.4, respectively. As previously described, the templates themselves are bundled as ***Annexes 1-4*** for the respective sites of Rome, Winchester, Barcelona and Cork. For additional information the reader should refer to the relevant MLT. Similarly, ***Section 5*** summarises the City-Level Templates (CLTs) for each site in terms of the five key areas of economy, energy, environment, society and transport. The CLT summaries for Rome, Winchester, Barcelona and Cork are reported in sub-sections 5.1 to 5.4, respectively.

Section 6 provides, for each Measure, a tabular overview of the original objectives (as defined within the Technical Annex) compared with the objectives of the actual implementation. In addition, the originally anticipated targets (again, as defined within the Technical Annex) are compared with the relevant evaluation results. It should be noted that some measures evolved during the course of the project, and hence a direct comparison is not always feasible in such situations.

Section 7 describes the cross-site project interpretation of findings and conclusions by drawing together the main findings of the evaluation using a “light-touch” approach. Whilst there are several measures in each Workpackage that address the same issues, the site-to-site variations in the measures themselves are considerable and single cross-site headline results are generally not possible. Instead, for each Workpackage, a series of headline findings were devised based on the results provided within the templates and summaries. These findings were split into “impact evaluation”, “process evaluation / lessons learned” and “content / scaling”. Finally, a series of concluding comments are provided in terms of the evaluation process, physical and awareness measures and future work. Finally, ***Section 8*** provides a glossary of the abbreviations used within this document.

1 INTRODUCTION

1.1 Background

A clear challenge facing European authorities at all levels is the reduction of environmental problems such as congestion, poor air quality, excessive noise levels, and growing energy consumption. Due to the complexity and crosscutting impacts of transport, targeted measures have produced positive results in the short term, but have often been quickly offset by growth in transport volumes. Therefore, CIVITAS (CIty-VITAlity-Sustainability) was initiated with the main objectives of:

- Promoting and implementing sustainable, clean and (energy) efficient urban transport measures;
- Implementing integrated packages of technology and policy measures in the field of energy and transport in eight categories of measures; and
- Building up critical mass and markets for innovation.

The CIVITAS-I initiative started in early 2002 within the 5th Framework Research Programme. MIRACLES (Multi Initiative for Rationalised Accessibility and Clean Liveable EnvironmentS) was one of the four projects within CIVITAS-I, the others being TELLUS, TRENDSETTER and VIVALDI. The four projects involved a total of 19 cities, in which 212 innovative measures on sustainable transport were implemented.

In CIVITAS-I, there were eight 'policy fields'. All measures were proposed to be implemented in relation to one of the following fields:

- Access restrictions;
- Integrated pricing policies;
- Collective passenger transport;
- New forms of vehicle use;
- New concepts for the distribution of goods;
- Innovative soft measures;
- Integration of transport management systems; and
- Clean public and private fleets.

1.2 The MIRACLES Consortium

MIRACLES was a four year project involving four European cities: Rome (I), Barcelona (E), Winchester (UK) and Cork (IRL). Their location in the context of the EU is shown in Figure 1.1.

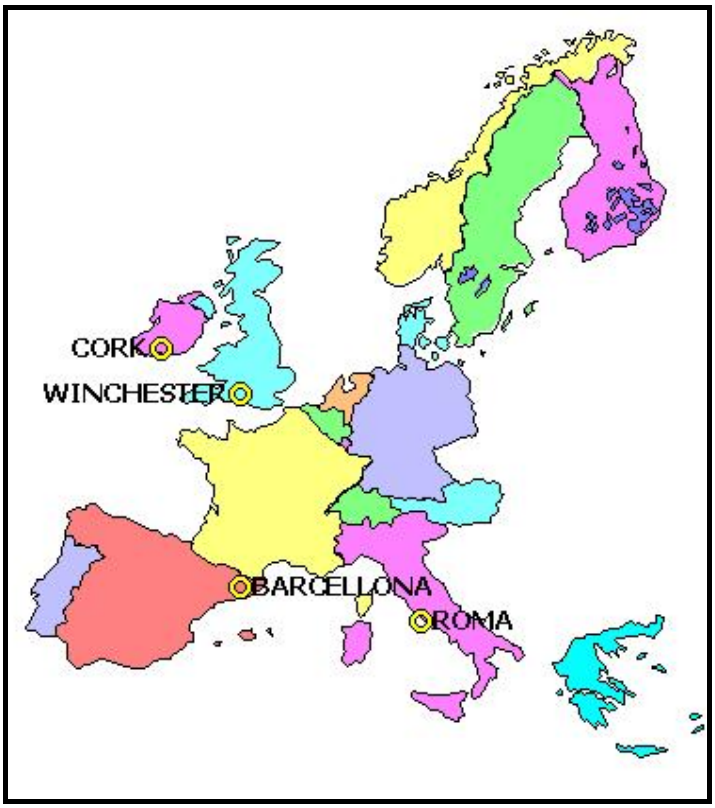

Figure 1.1: Map showing location of the MIRACLES cities

1.3 Project objectives

Within MIRACLES, the four sites all aimed to achieve the following **four strategic goals**:

- Reduction of transport-related environmental impacts at the local level;
- Increased urban accessibility;
- Enhanced economic efficiency through better transport management; and
- Overall improvement of citizens' quality of life;

These goals led to the following specific **objectives and targets** reflecting the specific measures adopted:

i) Significant reduction in transport-related emissions:

- Link urban transport pricing to environmental vehicle performance;
- Ensure substantial air quality improvement in Laboratory area; and
- Identify high emitting vehicles and target for enforcement.

ii) Significant reduction in congestion:

- Improve the co-ordination of urban goods delivery service;
- Rationalise road space use via road pricing schemes for passenger mobility; and
- Rationalise road space use via parking reservation systems for goods delivery.

iii) Demonstration and uptake of clean transport vehicles:

- Demonstration and uptake of state-of-the-art clean transport vehicles, Euro IV standard;
- Uptake of targeted clean vehicles (esp. buses, e-scooters and vans), Euro III and IV standard; and
- Widen business exposure to clean vehicle technology and develop the market.

iv) Modal shift for trips having their origin or destination in the clean area:

- Improve mode share of bus, cycling and walking through an integrated policy package;
- Manage mobility demand through the application of new ITS technology and through education, consultation and stakeholder involvement; and
- Resulting from application of access control and road pricing scheme to Clean Area and provision of attractive alternatives.

v) Added-value integrated services:

- Personalised real-time access to multi-modal traveller information; and
- Management of mobility demand through the application of new ITS technology and through education, consultation and stakeholder involvement.

The project consisted of 12 interrelated Workpackages, which were structured as shown in Figure 1.2.

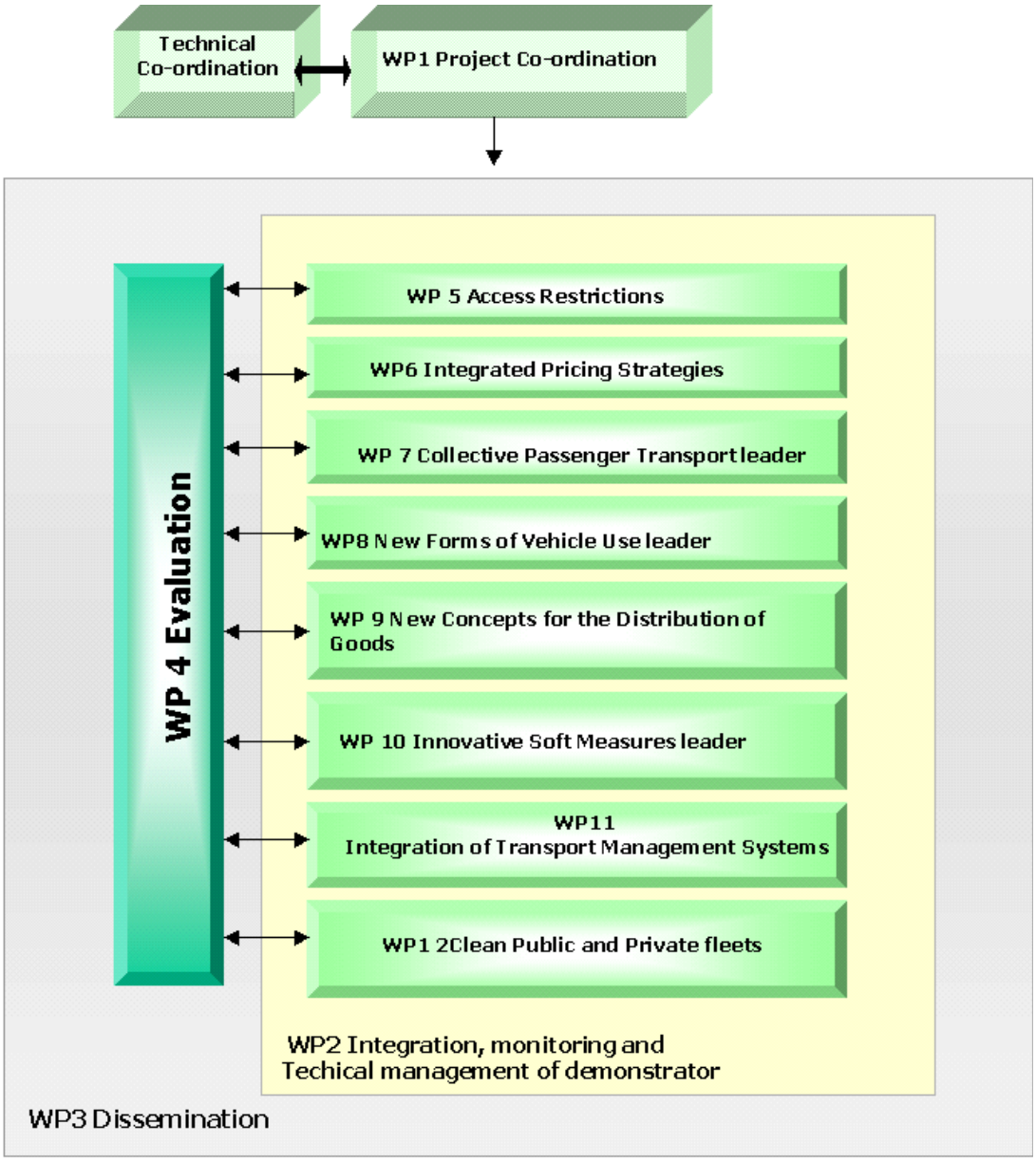

Figure 1.2: Structure of the Workpackages within MIRACLES

1.4 Overview of Measures

The measures that were implemented within MIRACLES were grouped into the eight Workpackages numbered 5 to 12. Table 1.1 details the measures implemented in each city and it can be seen that most measures involved more than one city.

WP description	*Rome*	Winchester	*Barcelona*	*Cork*
WP 5 Access Restrictions	✓	✓	✓	✓
5.1 Set-up of city centre clean zone	✓	✓	✓	✓
5.2 Set-up of green corridors/zones	✓			
WP 6 Integrated Pricing Strategies	✓	✓		
6.1 Time based entrance/ road pricing policies	✓			
6.2 Adoption of flexible parking policies and environmentally linked parking charges	✓	✓		
WP 7 Collective Passenger Transport	✓	✓	✓	✓
7.1 Improving PT service quality		✓		
- security and safety	✓			
7.2 Information		✓	✓	
- distribution of multi modal information	✓			
- on board information	✓			
7.3 Introduction of new lines	✓			✓
7.4 Improved integration of public transport	✓			
7.5 Tram in integrated CPT			✓	
WP 8 New Forms of Vehicle Use	✓	✓		
8.1 Establishment and improvement of new service	✓			
8.2 New cycling opportunities		✓		
WP 9 New Concepts for the Distribution of Goods	✓	✓	✓	
9.1 Kerbside deliveries with improve of logistic support	✓		✓	
9.2 Fleet Efficiency and Home delivery		✓		
WP 10 Innovative Soft Measures	✓	✓		✓
10.1 Awareness measures	✓	✓		✓
10.2 Mobility Management measure	✓	✓		✓
WP 11 Integration of Transport Management Systems	✓	✓		
11.1 Improved Multi modal travellers services	✓	✓		
11.2 Improved network management	✓	✓		✓
WP 12 Clean public and private fleets	✓	✓	✓	✓
12.1 Clean vehicles buses	✓	✓	✓	
12.2 Municipal fleet vehicles		✓		✓
12.3 Clean fuel support services	✓	✓	(✓)	

Table 1.1: Summary of the measures implemented at each site

1.5 Structure of this report

The main objective of this report is to describe the implementation and evaluation at each of the four MIRACLES demonstration sites, predominantly focusing on the 'before' and 'after' effects (i.e. baseline and ex-post evaluation). Where possible, the results are reported as quantifiable assessments and grouped into the five 'key areas' of energy, environment, economy, society and transport. The results are interpreted and the main findings of the evaluation drawn together using a "light-touch" approach to internal project cross-site evaluation.

Section 2 of the report provides a brief description of the four MIRACLES cities. The measures implemented at each site are summarised in terms of their objectives and aims. In addition, the anticipated targets are also outlined for each city. These were previously defined within the MIRACLES Evaluation Plan (D4.1).

Section 3 provides an overview of the evaluation process undertaken within MIRACLES.

For each city, each measure that was implemented and evaluated was described in some detail within a Measure-Level Template (MLT), the format of which was devised by METEOR to ensure a consistent reporting style across the CIVITAS projects. In addition, the city-level results were reported for each city within a City-Level Template (CLT); this format was again produced by METEOR. The MLTs and CLTs are bundled as four substantial annexes to provide a supporting tool for the main document. These annexes (numbered as 1-4) also form the "MIRACLES Implementation Report No.2".

Section 4 provides a 'high-level' interpretation of the MLTs, typically summarising the key points of each measure within one page. The MLT summaries for Rome, Winchester, Barcelona and Cork are reported in sub-sections 4.1 to 4.4, respectively.

Section 5 provides a 'high-level' interpretation of the CLTs. The CLT summaries for Rome, Winchester, Barcelona and Cork are reported in sub-sections 5.1 to 5.4, respectively.

Section 6 provides, for each Measure, a tabular overview of the original objectives (as defined within the Technical Annex) compared with the objectives of the actual implementation. In addition, the originally anticipated targets (again, as defined within the Technical Annex) are compared with the relevant evaluation results.

Section 7 describes the cross-site project interpretation of findings and conclusions.

As previously described, *Annexes 1-4* are the detailed templates for the respective sites of Rome, Winchester, Barcelona and Cork.

2 SITE DESCRIPTIONS

The general objectives of the MIRACLES project are reported in the Technical Annex (MIRACLES, 2001) and the Inception Report (MIRACLES, 2002). There is considerable coherence as would be expected from cities focused on developing sustainable urban environments. However, the base levels of relevant activity, physical/social/economic conditions, and political aspirations have led to the common initiatives being focused and described in slightly different ways. These are brought together again by selection of common impacts and the development of both common indicators and survey methods (see Local Annexes).

The four cities are very different in character and scale, and the detailed specifications and applications of the CIVITAS measures varied considerably. However, at all four sites the MIRACLES overall strategy was to:

- reduce the pollution levels produced from transport modes;
- increase the overall accessibility levels, by improving supply of road space;
- provide more rational transport management; and
- improve the life quality of citizens.

This section provides a brief description of the four MIRACLES cities. The measures implemented at each site are summarised in terms of their objectives and aims. In addition, at the start of the project, each city identified targets that it was anticipated the MIRACLES project would meet. These targets are again set out for each city, as defined within D4.1 (Evaluation Plan). It should be noted that not all measures were implemented as originally foreseen at the start of the project.

2.1 Rome

Rome is located on the west coast of the centre of Italy in the Lazio Region. The number of inhabitants in the city itself is about 2.6 million, and the Rome Metropolitan Area has about 4 million residents over an area of 5300 km^2. A map of Rome is shown in Figure 2.1. Private cars are the most prevalent mode of transport for Romans despite the roads often being narrow, with uneven surfaces and intermittent pavements. In recent times, general improvements have been made to improve the transport supply, especially in relation to the needs of pedestrians and bus/underground users. However, as with most cities, the last 40 years have seen an increasing reliance on the private motor car. For instance, during this time the kilometres travelled in Rome have tripled, but the public transport supply increased only by 90%. In the 1960's, the public transport modal share was 56% of all the motorised trips, whilst nowadays it is around 34%.

To reverse such trends, prior to MIRACLES, the Rome Municipality issued the Urban Traffic General Plan (PGTU). This was to manage the increasing problem of unsuitable public transport, and related mobility and transport pollution issues. PGTU is a complex tool, but of the key elements, two are especially relevant to the MIRACLES philosophy:

- *updating the road classification according to the function (pedestrian, local traffic, mean traffic)*

- *definition of transport demand policies (i.e. controlled access zones, parking pricing, etc.).*

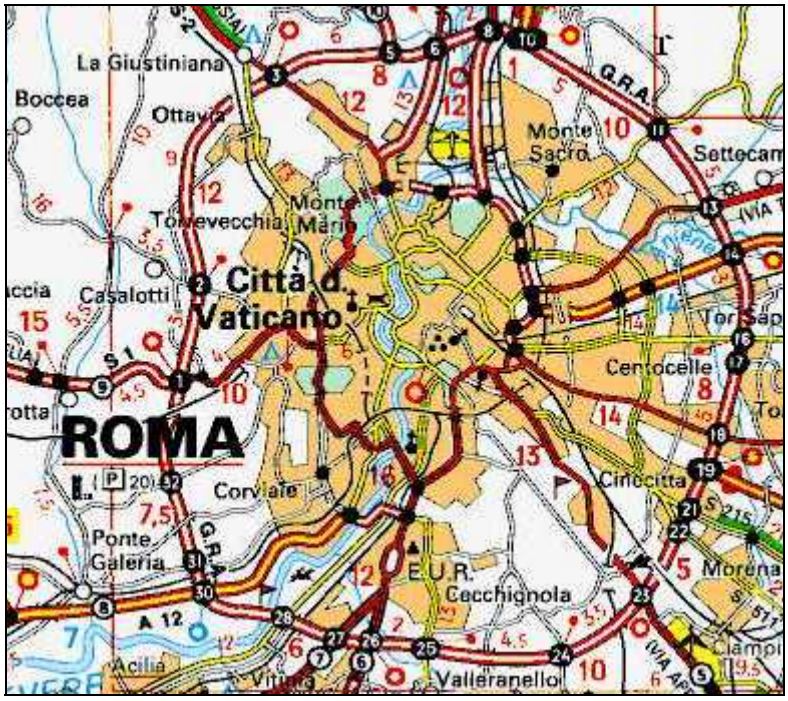

Figure 2.1: Map of Rome and the surrounding area

2.1.1 MIRACLES Measures

A brief description of the MIRACLES measures implemented at the Rome site now follows.

<u>Measure 5.1: Set up of city centre clean zone</u>

This measure combined tasks 5.1a (Restriction of the whole Laboratory Area to catalysed vehicles only) and 5.1b (Access control systems in urban areas). The objectives were to:

- re-arrange public areas, in order to accomplish clean zones through an improved set up of the public transportation system, supporting sustainable transportation modes such as the pedestrian mode, and creating areas where pollution is minimised and controlled.
- reduce the impact of traffic on the environment by reducing the number of poorly maintained vehicles;
- increase the protection levels in the city centre, according to the aims of the General Urban Traffic Plan that divides the City of Rome in concentric zones with increasing constraints on private traffic;
- set up access control limitations in the whole Laboratory Area to allow entry to catalysed vehicles only and, in particular zones, to keep the majority of private cars away from pedestrianised areas and on selected pathways within the inner zones of the Laboratory Area;

- reduce the peak hour traffic in the laboratory area by decreasing the number of high-polluting vehicles in the Limited Traffic Zone (LTZ), reducing the number of illegal entrances in the LTZ, and encouraging a shift in modal split towards sustainable modes (such as eco-bus and walking).

According to the above mentioned framework, a multiple type action has been implemented in Rome. Regarding access control, the main effort was oriented towards the introduction of a new Electronic Access Control System (E-ACS) and the improvement of the existing scheme; in fact:

1. the access to the whole Laboratory Area has been limited to catalysed vehicles since 2002/3;
2. concerning pollution control of private fleet vehicles, the yearly check-up of vehicle emissions has been extended in 2005 to include the compulsory tune–up of motorcycles and mopeds;
3. in the central part of the Laboratory Area, the existing Access Gate System (AGS) has been completed and integrated through the installation of a new access gate in via Dei Fori Imperiali with the aim of converting the whole limited traffic zone inside the I District (i.e. First District) into a “closed area”;
4. in the Trastevere district a new E-ACS is to be completed after the approval of the financing plan (RESCACOR-ZTL Project) including funds from the Municipality and the Ministry for the Environment and an experimental phase with urban police control. The electronic system includes access gates with an Automatic Number Plate Recognition (ANPR) system (Optical Character Recognition - OCR - plates analysis) and integration with a new gates road signalling system;
5. under the same framework as Trastevere (RESCACOR-ZTL Project and experimental trial) a new E-ACS is also under implementation in the S. Lorenzo district, including access gates with an ANPR system (OCR plate analysis) and integration with a new gates road signalling system, for evening control of the private traffic flow; the gates at Trastevere were installed in January 2006 and at S. Lorenzo the installation will be completed by April 2006;
6. The pedestrian mode is now a reality in the Centre of Rome, mainly with the completion of the “Tridente” pedestrian area and “LTZ D2” in the city centre, supported by the presence of mobile bollards. These have been installed to protect the Campidoglio hill, that is the Municipality headquarters, as described in Task 5.2.

<u>Measure 5.2: Implementation of pedestrian areas and Local Urban Traffic Plans</u>
This measure combined tasks 5.2a (Implementation of pedestrian areas) and 5.2b (Urban traffic plans). The pedestrianisation aspect centred on the conversion of the TRIDENTE area into a pedestrian precinct during weekdays. In addition, Green Areas, including the implementation of retractable bollards, were completed within the City Centre. The main goals of the measure were to increase the environmental safeguard of the city centre and pedestrian areas in the Laboratory area, and to improve the overall safety. Another aim was to extend the Green Zones supply in the city, especially downtown, and to create a continuous network of pedestrian paths across the city centre. In addition, there were other implementations aimed at re-organizing the parking supply and re-shaping crossing areas to increase pedestrian safety.

Measure 6.1: Time-based road pricing

Since October 2001, Access Control System (ACS) and Road Pricing (RP) policies have been implemented in Rome. These have successfully led to congestion reduction during operating hours. However, congestion levels remained high during non-operating hours and so three extra tasks for RP were evaluated in MIRACLES. There were three priorities to solve: RP for evening and night hours, RP schemes for tourist coaches, and the choice of Best Available Technology to control 2-wheeled vehicles in the Central LTZ. The main objectives of the measure were aimed at improving traffic mobility conditions and decreasing traffic related pollution in the LTZ.

Measure 6.2: Environmental parking charges

This measure combined two sub-tasks: the extension of the on-street parking places, in the whole Rail Ring Area, and a feasibility study for future implementation of a new parking policy based on the introduction of different parking charges. The goal of the measure was to increase the on-street payment parking supply in the Laboratory Area and to generally improve the overall availability of on-street parking areas, including parking meters.

Measure 7.1: Improving PT quality and security

The general objective was to improve safety and security on the metropolitan railways by monitoring passengers on subways and platforms. This was implemented using a video surveillance system, which comprised a “Supervisory Computer” (consisting of a user front-end, logging/replay facilities, video capture and routing of video signals to the video processors), appropriate software and video equipment. The anticipated results included a decrease in security costs, the optimal use of existing infrastructure and improved efficiency of the video operator.

Measure 7.2: Multi-modal and on-board information

This measure was based on the enhancement of the INFOPOINT database, regarding bike & ride information and news on accessibility to PT services for the disabled. In addition, it concerns the implementation of a “counterpart” system on-board (MOBY), which provides information on transit and news to bus passengers, during their travels. The objective of this task was to improve information in transit to make the PT network more accessible to the disabled, due to the provision of useful data, and to increase the attractiveness of PT, due to more comfortable travel conditions.

Measure 7.3: Introduction of new lines

This measure involved the implementation of two new lines operated by electric buses and a new trolleybus line, as well as the conversion of a former bus depot into a new one for trolleybus recovery operations. Electric bus lines were implemented in synergy with the LTZ policy. Line nr 90, i.e. the trolleybus service, operates regularly, while the electric bus lines operate a more restrictive night shuttle service within the LZT, connecting P&R facilities.

Measure 7.4: Improved integration of PT

The main objective was to increase the supply and use of both flexible services and Taxibus lines to implement “home-bus” services. The measure aimed to improve the actual service of Taxibus, and study the possibility to design and develop new lines

serving different zones near the city centre offering a transverse shuttle service connecting residential areas, commercial centres, and sports centres.

Measure 8.1: New forms of vehicle use – car pooling and car sharing

The objective of the car-pooling task was to improve alternative transportation habits and to change the current habits relating to private vehicle use and to raise awareness about Home-to-Work Trip Plan alternatives. Car-pooling is a simple way to implement a sustainable mobility measure; it consists of a car shared among colleagues, in order to reach the workplace. The scheme offered participants initiatives such as dedicated parking areas. The car-sharing task was the first such scheme implemented in Rome and created an alternative to the purchase of a private car, while indirectly enhancing the use of PT services. The car sharing service is currently operated with 10 cars, spread over seven parking areas and is active 24 hours per day, and offers season ticket discounts to participants.

Measure 9: Kerbside-doorstep delivery

This was targeted at improving the dialogue between city authorities and goods operators, improving the organisation of the city logistic support, and facilitating the start up of e-commerce based activities. This was a “soft measure” to develop a feasibility study to improve goods delivery conditions in the Laboratory Area. The study covered:

- Localisation and establishment of load/unload areas inside pedestrian precincts within well defined time-windows;
- Determination of main streets with bans on loading/unloading procedures within well defined time-windows; and
- Evaluation of possibilities to increase the attractiveness of night loading/unloading operations.

Measure 10.1: Awareness

The goal of the measure was to promote specific awareness campaigns during the project, with specific regards to the single tasks supported by MIRACLES in Rome. Outcomes from the measure are: to encourage modal shift towards Collective Transport as well as to raise awareness on Sustainable Mobility issues and initiatives.

Measure 10.2: Mobility management measures

The objective was to achieve modal shift providing new forms of vehicle use and to raise awareness about Home-to-Work Trip Plan alternatives through implementing commuter planning and integrated mobility management tools. Mobility managers were appointed to optimise commuting plans, muster participants for car pooling, and provide information on opportunities and initiatives aimed at stimulating the use of collective transport.

Measure 11.1: Improved multi-modal traveller services

The objectives of the measure were to enlarge the supply of PT-related information using three main services: e-ticketing (also called PAGOBIT, formerly TELEPAY), the internet accessible tool developed by ATAC (also called INFOPOINT) and the development of a telematic platform to deliver information via mobile phones (SMS, WAP, i-mode, XHTML).

Measure 11.2: Improved network management – Information and Environment

This was a multi-task measure based on the implementation of ITS technologies, to improve the quality of data and information required to control transit, traffic and the

related pollution phenomena. In particular, the application concerned the improvement of the "OCTOPLUS" system, which gives selective priority to trams that are delayed. It works with a "real time" information system for travellers, reporting news on electric panels at stops, mobile phones or on the internet. Field surveys collected additional data on driving patterns and speed profiles along routes to allow use of a dynamic emission model and to acquire additional information regarding the local concentration levels of the more critical air pollutants in key locations. An environmental analysis of Traffic Demand Management Strategies (TDMS) was undertaken using a suite of simulation models.

Measure 12.1: Clean vehicles - buses

This measure was concerned with the renewal of some of the bus fleet. The upgrading involved the purchase of 908 Euro III buses and 30 "new generation" bi-modal trolleybuses, plus 10 electric buses.

Measure 12.3: Clean fuel support

The objectives were to increase awareness, satisfaction and usage of electric scooters, (or e-scooters) and to set up suitable recharging points in the Laboratory Area. Rome Municipality has managed a fleet of 398 e-scooters since 2000. In 2001, a dissemination activity was undertaken with tourist services, non-profit organisations and the general public and the results were encouraging. In addition, implementation of a network of recharging stations identified 15 priority points partially located in the MIRACLES Laboratory Area. This measure aimed to prioritise eight of these recharging stations based upon the results of an O/D trip analysis for scooters to target the greatest number of potential e-scooter users.

2.1.2 Targets

In Rome, since the area of application was wide, the goals of the MIRACLES measures were separated into general, Limited Traffic Zone (LTZ), or the laboratory area. The anticipated targets were as defined within the Evaluation Plan (D4.1):

General targets:

- Increase the Index of Customer Satisfaction (ICS) with public transportation service by 2%;
- Enhancement of the public transportation service by 6%, due to improved comfort, ICS, environmental operating conditions;
- Increase public awareness on sustainable transportation by 20%;
- Increase the share of electric buses by 200.000 pax/month;
- Increase modal shift of 45% from private to collective modes of transportation, because of the new management scheme and flexible service;
- Replacement of about 25% of the bus fleet with clean vehicles to Euro III standard and electrical vehicles; and
- Improvement of the provision of multi-modal traveller information.

LTZ targets:

- Reduce illegal entrances by 33%, due to the enforcement of the electronic control access system;
- Reduce transport related emissions by 13%;
- Increase walking by 25 %; and
- Increase the share of electric scooters by 10% compared to conventional types.

Laboratory area targets:

- Reduce peak hour car traffic by 3%;
- Reduce transport related emissions by 5%;
- Increase walking by 6%; and
- Increase the level of vehicle occupancy for workers on the trip home-to-work from specific zones by 20%.

2.2 Winchester

Figure 2.2: Map of Winchester and the surrounding area

Winchester is the county town of Hampshire with a population of around 30,000 people. A further 80,000 reside in the main country towns and villages of Alresford, Bishops Waltham, Denmead and Wickham and the rural areas surrounding them. Winchester itself is on the main London – south coast rail line and is well connected by the primary road network (namely M3 and A34), to London and the Midlands, as well as the major ports at Southampton and Portsmouth and the south's international

airports. A map detailing Winchester's geographical setting is given in Figure 2.2. The central area of the city experiences the classic problems associated with an historic city: high volumes of traffic using narrow ancient streets, pedestrians and traffic in close proximity, and lorry movements being perceived as intrusive and problematic. Prior to MIRACLES, a limited city centre clean zone had been developed as part of the Winchester Movement and Access Plan (WMAP), which had received a national award for developing ClearZone initiatives.

2.2.1 MIRACLES Measures

A brief description of the MIRACLES measures implemented at the Winchester site now follows.

Measure 5.1: Set up of city centre clean zone

The objectives were to reduce the impact of traffic on the environment, and to reduce the number of poorly maintained vehicles in Winchester. Using a portable Remote Sensing Device (RSD), CO, HC and NO_x emissions from vehicles entering the city on main arterial routes were measured. The RSD measures emissions without the need to stop the passing vehicles. The results were used to determine if an individual vehicle was deemed a 'high polluting vehicle'. Based on this information, there is then potential to feed the information back to the drivers and implement various enforcement levels.

Measure 6.2: Adoption of flexible parking policies and environmentally linked charges

The objectives were to promote energy efficiency of the vehicle fleet parking in Winchester city centre by implementing a variable tariff at several car parks and to promote an optimal pricing policy and internalise external costs.

A variable tariff was implemented at several 'Pay and Display' car parks in Winchester city centre and offered a discount of 75% or 50% on the usual cost of a season permit for those vehicles in the road tax bands with the lowest CO_2 emissions. In addition, owners of electric vehicles or hybrid (i.e. petrol/electric or diesel/electric) vehicles were offered free season permits. The discounts were only offered to season permit holders. The rationale behind the revised pricing policy was to deter long-stay parking in the city centre and to encourage more use of the P&R system.

Measure 7: Improving bus service quality and information

This measure sought to improve the quality of the bus service along three main city centre bus routes (X1, X5 and P&R) in Winchester in terms of waiting facilities, re-branding of buses, discount ticketing schemes, improved routes and greater integration of bus and rail.

The implemented package of mini-measures included the introduction of new cleaner buses to operate on X1 and X5, increased frequency of X5, better information for passengers at bus stops and in timetables, and easier integration between rail and bus travel. In addition, a new cross city route was established linking passengers from the Park and Ride car parks to the hospital on the north-east side of the city.

Measure 8.2: New cycling opportunities

The main objectives were to increase the level of cycling in Winchester in terms of modal spit and number of journeys made. As a result of increasing the level of cycling it was hoped that there would be an increase in both the levels of awareness

and acceptance of cycling as a sustainable transport mode. Several improvements were made to the existing cycling facilities. These were:

- *Bikeabout:* the concept of the Bikeabout scheme was to enable members of the public to borrow city-owned bicycles to make various journeys around the city;
- *Installation of new cycle parking*: 75 additional cycle stands were available for installation throughout the city centre;
- *A revised pocket cycle map*: This provided cyclists with an up-to-date map of Winchester's safe and recommended cycle routes, the location of Bikeabout and city wide cycle parking.

Measure 9.2: Sustainable urban distribution

This measure was implemented through three mini-measures:

- *the Collectpoint scheme* – this trial aimed to reduce the number of missed home deliveries by using a chain of local convenience stores as a delivery point;
- *a freight map* – this was developed and published for Winchester, and given out to organisations or companies receiving deliveries to improve the efficiency of urban freight delivery;
- *a waste recycling scheme* - an electric vehicle was used within a waste cardboard and paper recycling service for Winchester city centre businesses. This scheme was run by a local company, Dove Recycling.

Measure 10: Innovative soft measures

The main objectives were to raise public awareness of the developments and achievements of the MIRACLES initiatives, encourage the development of work place travel plans, and to encourage a change in modal choice for business related travel and working practice in order to minimise the impact of business travel. WP10 was a supporting measure to raise awareness and acceptance of the measures being implemented in MIRACLES. A variety of dissemination methods were used including leaflets, radio advertisements, a Winchester MIRACLES website, special demonstration days and a school art competition.

Measure 11.1: Improved multi-modal traveller information

The objectives were to provide better information for travellers through the introduction of ITS, and to provide public transport users with real-time travel information. This measure involved the improvement of multi-modal traveller information by the installation, at strategic locations, of a variety of displays including Bus Departure Information System (BDIS) displays, electronic information kiosks, Variable Message Signs (VMS), real-time Information Display Units (IDU) and traffic and traveller information from the ROMANSE website accessed by mobile devices.

Measure 11.2: Improved network management

The main objective was to estimate real-time journey times using ANPR technology on the radial routes into Winchester city centre. This was then to be exported to the Traffic and Travel Information Centre (TTIC) for dissemination to travellers though a number of media (see measure 11.1). In addition, this information was to be used to develop an Origin-Destination (OD) matrix for inbound Winchester routes.

Measure 12.1: Cleaner vehicle buses

The main objective was to reduce the environmental impact of the bus fleet owned by Stagecoach (the main bus operator in Winchester). This was undertaken by

improving the emissions of 27 buses operating in Winchester. 13 new Euro III buses were introduced on Services 1 and 5, 10 buses were re-powered from Euro I to Euro III standard, and 4 Euro II buses were fitted with Continuous Regenerative Traps (CRTs).

A secondary aim was to introduce the public to different vehicle fuel types and demonstrate that the buses could operate with the same drive performance as conventional fuels. An electric hybrid bus was demonstrated during two week-long trials in 2003 and 2004 along the Park and Ride route.

Measure 12.2: Cleaner municipal fleets
The objective of this measure was to reduce the environmental impact of Hampshire County Council (HCC) activity in the Winchester area and beyond. HCC purchased 27 new Euro IV vehicles for their company car fleet, setting an example to other companies. In addition, HCC employed the services of the company "Motorvate" to make recommendations in reducing unnecessary business mileage and carbon dioxide emissions.

Measure 12.3: Clean fuel support services
The objectives were to establish a business case for the introduction of clean engine technology, and to overcome barriers to the introduction of new engine technologies. A fleet of six clean vehicles was purchased and one vehicle was loaned to participating businesses for a duration of up to one month to aid business community exposure to alternative fuelled vehicles. There were two LPG/petrol dual fuel vehicles (Vauxhall Zafira and Volvo S40), two petrol/electric hybrid vehicles (Honda Civic and Toyota Prius) and two battery electric panel vans (both were Citroen Berlingos).

2.2.2 Targets

The general objectives and targets for MIRACLES in Winchester were expected to translate into the following measurable city level technical achievements (as defined in D4.1):

- Reduce the overall absolute level of car traffic by 2%;
- Reduce peak period car travel by 7% on the key arterial route;
- Improve public transport patronage by 8% overall;
- Improve the satisfaction rating of public transport by 8%;
- Increase walking by 20%;
- Increase the level of cycling by 30%;
- Increase public awareness and support for sustainable transport by 8%;
- Achieving the fastest uptake rate for clean engine technology nationally;
- To reduce the number of high polluting vehicles on the network by 5%;
- To increase the provision of traveller information both in fixed and real-time;
- To increase citizen awareness of the need, potential and ability to change to more sustainable transport patterns; and
- To stimulate co-operative urban goods delivery services using environmentally friendly vehicles.

2.3 Barcelona

Barcelona is located on the east coast of Spain and has a population of 1.5 million, with 4.2 million inhabitants in the metropolitan area. Like most Mediterranean cities,

its central area is very densely populated. The urbanised area stretches beyond the two rivers that flank the city, the Llobregat and the Besòs. Barcelona is the capital of Catalonia, a long-established autonomous region in the NE of the Iberian Peninsula, with a population of 6 million and its own regional government, the Generalitat de Catalunya. An underground system comprises 7 lines, 129 km of track and 138 stations. Demand is greatest for the lines that run parallel to the sea and mountains, because they cover the longest routes. Some 726 million passengers used public transport in 1999.

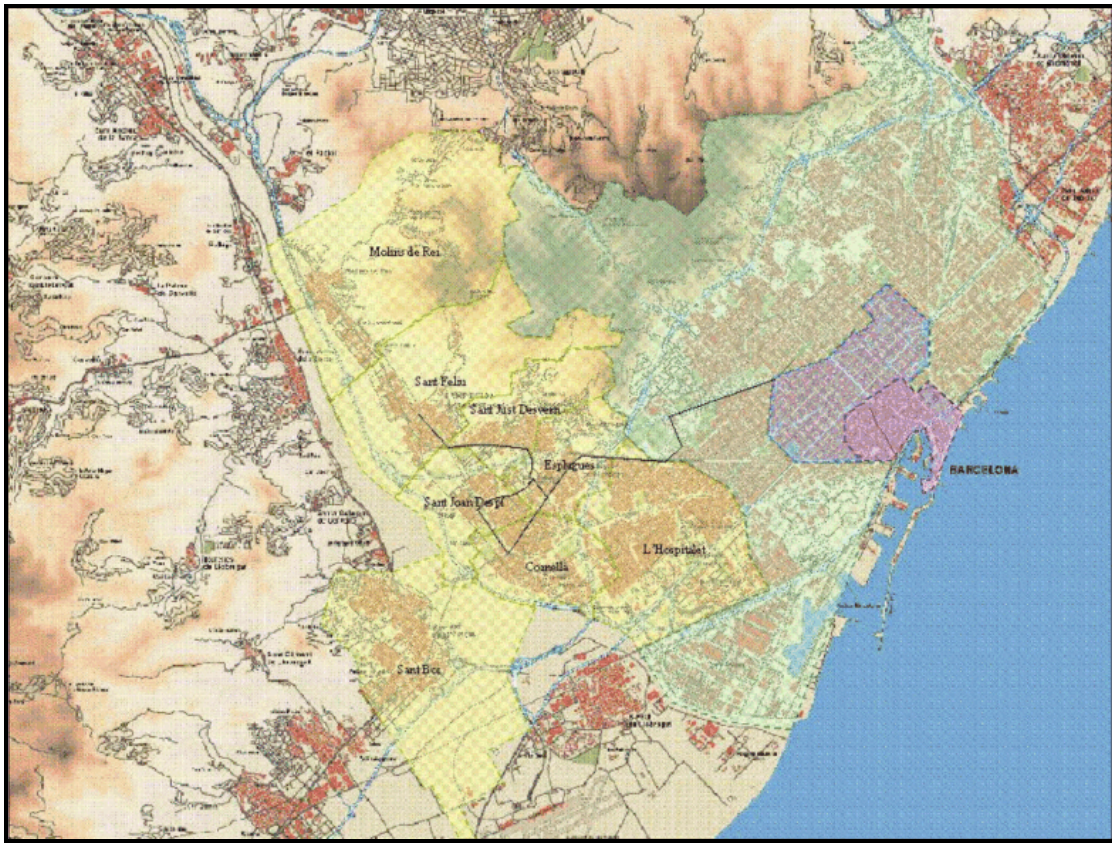

Figure 2.3: Map of Barcelona and the surrounding area

For MIRACLES evaluation purposes, the city can be divided into four sub-areas, as shown in Figure 2.3:

- The *purple area* is the district of Ciutat Vella, where the city centre closure (WP 5) was implemented. The Rambla are marked on the map.

- The *blue area* is the district of Eixample, where the demonstrations of goods delivery measures (WP 9) took place. The multi use lane of Travessara de Gràcia (marked in green) politically belongs to Sarrià Gervasi district, but it can be considered to be part of Eixample, because it is adjacent to Eximple and the street layout is similar.

- The *green area* shows the other eight districts of the city (citizens awareness and acceptance were monitored over these first three sub areas).

- The *yellow area* identifies the municipalities affected by the tramway (WP 7) installation (marked in black): El Prat de Llobregat, Sant Boi de Llobregat, L'Hospitalet de Llobregat, Cornellà de Llobregat, Esplugues de Llobregat, Joan Despí, Sant Just Desvern, Sant Feliu de Llobregat and Molins de Rei.

The WP 12 activity (CNG buses demonstration) extends over all the *purple* (Rambla) and *yellow* (tramway) sub-areas.

2.3.1 MIRACLES Measures

A brief description of the MIRACLES measures implemented at the Barcelona site now follows.

Measure 5: Access restrictions

The general objective was to close the Ramblas boulevard to non-motorised traffic, thereby improving the pedestrian amenity and demonstrating the viability of restricting traffic on this type of primary road. The inbound movement (from Pg Colon to Pça Catalunya) was the one subject to access restrictions as part of MIRACLES.

The Ramblas access control evaluation plan was revised to incorporate indicators relating to the trials of ANPR equipment, and to assess the scheme implemented that uses this technology to both control access and limit speeds to 30km/h along the controlled road section.

Measure 7.2: Real-time multi-operator passenger information

The objective was to improve the quality of passenger information by demonstrating real-time messaging based on a multi-operator system; AVM (Automatic Vehicle Monitoring System) and standard information panel. The installation of a 3rd-generation AVM system covering more than 20 operators (with small, medium and large bus fleets) within the metropolitan area provides the information that has been used to provide better messages about bus arrivals and service variations at four bus stops in the tramway corridor. Information panels were installed on the buses as well as at the interchange points.

Measure 7.5: Integration of the tramway in the CPT network

The objectives were to integrate the new tramway service within the Barcelona metropolitan Collective Passenger Transport (CPT) network, quantify the operational, energy and environmental benefits of the tramway, and develop best practice guidelines regarding tramway implementation.

The *Diagonal-Baix Llobregat tramway scheme* ("Trambaix") combined the latest tram vehicle technologies with a radical re-allocation of street space to offer accessibility for all Barcelona's citizens whilst reducing future reliance on petroleum. The tramway comprised three suburban spur lines that join to serve a single radial route into Barcelona, and have a total length of 15km and (currently) 25 stops. The trains are equipped with AVM equipment and signal priority is given at some of the 25 junctions along the route.

Measure 9: New concepts for the distribution of goods

The objectives were to:

1. Improve Municipal management of vehicle circulation on the main and local road networks.
2. Reduce delivery times and costs.

3. Develop mechanisms to self-finance the successful scheme elements

These were addressed through four mini-measures:

- *A multi-use lane* – this was installed along Travessera de Gràcia Street, a primary road comprising 4 lanes, having a total length of 1500m. One lane was converted into a lane allocated to bus priority during peak hours, and to goods deliveries during between peak hours (with on-street parking allowed overnight). Variable Message Signs (VMS) were installed along the section to clearly communicate the regulations to road users.
- *Night-time deliveries* - a goods operator (Mercadona) trialled adapted 30T lorries and special equipment and operations for quiet deliveries at night. To do this, the Municipality introduced experimental traffic regulations. Traffic police collaborated with the Municipality to measure noise levels in residences close to the supermarket sites.
- *Loading / Unloading (L/U) active guide* – 8 supermarket operators and 3 distribution companies exchanged information via the web with the Municipality. The Municipality produces aggregated information to registered operators to enable them to plan to avoid hot spots (times and locations of congested delivery) and to enable agencies to enforce regulations so as to reduce problems. The pilot area covered some 0.5 sq. km. (with 230 reserved spaces serving a potential demand of 1085 premises).
- *PICT trials* – this consisted of temporary short-term loading / unloading spaces with special regulations restricting access to the kerbside directly in front of the supermarket to vehicles 'authorised' by the three participating operators. The supermarkets were located more than 25m from the existing reserved spaces.

<u>Measure 12.1: Extension of the CNG bus fleet</u>
The main bus and metro operator in Barcelona is TMB (Transportes Metropolitanos de Barcelona), and they are motivated to integrate Compressed Natural Gas (CNG) buses into the public transport fleet to contribute to the improvement of a more sustainable transport for the city. In 2001/02, a fleet of 70 CNG buses was acquired in two batches of 35 vehicles, the latter forming part of the MIRACLES project. These are standard length (12 m.) vehicles (and are referred to as the first generation of CNG buses in the fleet). One part of the measure concerned the demonstration and evaluation of the first generation of CNG buses in terms of environmental and energy performance, and under real operating conditions. A second part of the work involved infrastructure improvements to support the operation of the CNG buses as a normal part of the company's bus operations. Further CNG bus acquisition is a part of the measure, depending upon the demonstration and infrastructure preparation.

2.3.2 Targets

Implementation of the MIRACLES measures in Barcelona was anticipated to achieve the following technical targets (as defined in D4.1):

- Achieve at least a 40% reduction in circulating traffic during the hours of restricted access (restrictions will operate when pedestrian street activity is highest so as to maximise the environmental gain);
- Achieve a 20kph tramway running speed and passenger volume targets (this performance is expected to produce a 7% mode shift and annual emission/energy savings of 150 tonnes of CO_2 and almost 70000 GJ);
- Increase the provision of traveller information both in fixed and real-time;

- Achieve an increase as large as possible in the CNG bus fleet - based upon an evaluation of benefits and performance associated with the first 70 vehicles (up to 250 CNG buses by 2006); and
- Demonstrate measures that can reduce delivery times.

2.4 Cork

Cork City, situated on the south coast of Ireland, is the commercial, cultural, educational and industrial capital of the province of Munster. Cork City is the second largest city in the Republic of Ireland with a city population of about 124,000 and an extended area population of 345,000. A map of the city of Cork and its surrounding area is given in Figure 2.4. Traffic congestion is endemic in the city centre and along the main radial and circumferential roads, particularly during peak periods. Many narrow streets in the central area are completely inappropriate for the volumes of traffic carried. The Cork Strategic Plan 2001-2020 includes proposals for reviving the city centre and has a major emphasis on public transport including a suburban rail system, quality bus corridors and park and ride. However, its implementation is dependent on the provision of adequate financial support.

Figure 2.4: Map of Cork and the surrounding area

2.4.1 MIRACLES Measures

A brief description of the MIRACLES measures implemented at the Cork site now follows.

<u>Measure 5.1: Set up of city centre clean zone</u>

The general objective was to provide a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre. This was achieved by

redesigning the main arterial route (St. Patrick's Street) to reduce the existing four lanes to two. The pavements were considerably widened providing new bicycle-parking facilities and textured paving for the visually-impaired to guide them along the street towards the new audible pedestrian crossings. All on-street parking was removed from St. Patrick's Street and access to nearby multi-storey car parks was redirected via alternative routes. Retractable bollards were placed on side streets off the "Clean Zone" at their entry/exit points. Mid-way through the MIRACLES project it was decided to extend the Clean Zone to include the upper portion of Grand Parade at the Western end and the pedestrianisation of Oliver Plunkett Street, which runs parallel to St. Patrick's Street.

Other associated objectives included increasing citizen awareness of the need, potential and ability to change to more sustainable transport patterns, and to promote access to the city centre by public transport, thereby reducing the number of such trips made by car.

Measure 7.3: Park and Ride

The main objective was to develop a Park and Ride (P&R) site at Blackash with a capacity of at least 450 spaces, and to achieve and maintain Park and Ride patronage at near full capacity. Such a P&R site was established and indeed the site was later expanded to provide approximately 900 Park and Ride spaces. The intention was thereby to reduce the volume of motor traffic entering the city from the southeast and to lessen the demands on inner city parking.

Other applications were installed at this facility including Variable Message Signs (VMS) on the approaches to promote the P&R site, security fencing, CCTV surveillance systems, entry/exit control barriers, landscaped parking areas, pedestrian walkways, and lighting signage. MIRACLES also helped to promote the whole development in the context of trying to encourage a more sustainable modal split. For example, families were encouraged to use public transport, by offering a cheaper alternative to the regular public transport services on offer to families, and people were encouraged to abandon the motor car entirely, in favour of "cycle and ride" (or walk and ride).

Measure 10.1: Awareness measures

The overall objective was to raise awareness about sustainable transport modes by providing facilities to cater for the needs of cyclists and pedestrians. This included the provision of safer routes for cyclists and pedestrians accessing the city and additional cycle parking facilities within the city centre. This measure raised awareness about sustainable transport issues through publicity campaigns (e.g. in conjunction with European Car Free Day). It also promoted sustainable transport in consultation with specific user groups and the implementation of bye-laws and incorporation of plans to encourage cycling and walking (e.g. designating pedestrian priority areas, ensuring that all future planning applications must consider cycle facilities).

Measure 10.2: Mobility management measures

The objectives were to: promote greater awareness of the need and potential for more sustainable transport commuting habits and demonstrate methods for reducing peak-hour traffic congestion, such as carpooling. The aim was to reduce the number of vehicle trips (and their associated emissions) incurred by employees of Cork City Council. This was undertaken by initiating a car-pool register with council employees and by the promotion of other sustainable modes of transport. The experience

gained in measure 10.2 was also used in mobility management initiatives in local schools. A Travel to School Survey was undertaken and a programme of cycle safety training was initiated in schools.

Measure 11.2: Improved network management
The objective was to implement a 'Park by Phone' trial, which was an innovative parking management scheme accessed by mobile phone technology. Members of the public were able to subscribe to the scheme and then were able to pay for on-street parking using their phones.

Measure 12.2: Clean vehicles
The objectives were to promote the use of clean fleet vehicles in Ireland and to investigate the pros and cons associated with using less polluting vehicles. This was undertaken by converting 17 council vehicles to run on bio-fuel (rapeseed). The clean fleet options were monitored in terms of socio-environmental, economic and technical sustainability. MIRACLES assessed the opportunities, government policy and likely economic costs associated with electric vehicles being used for goods distribution.

2.4.2 Targets

Cork City set the following targets to be achieved through the implementation of the MIRACLES measures (as defined in D4.1):

- Reduce lane capacity by 50% on the city's main arterial route which cuts through the heart of the city's primary shopping district;
- Provide a new Park and Ride service and maintain at near full capacity;
- Increase the numbers of cycle parking facilities within the city centre by at least 40%;
- Increase the number of cyclists in the city centre by at least 10%;
- Realise at least a 5% decrease in the use of cars by Cork City Council employees;
- Convert at least 2-5% of the City Council fleet of light vans and estate cars to run on lower emission fuel;
- Promote the more widespread use of lower emission fuels throughout the City Council vehicle fleet; and
- Increase citizen awareness of the need, potential and ability to change to more sustainable transport patterns.

3 OVERVIEW OF EVALUATION FRAMEWORK

3.1 General

The evaluation methodology was defined according to four steps:

- the ***baseline scenario*** (i.e. the definition of the starting point for the application of the measures);
- the **business as usual *scenario*** (the estimated future effects if MIRACLES had not existed, but additional local initiatives had been implemented. These estimates were based on existing data, modelling tools and surveys);
- the ***ex-post phase*** (an after implementation of MIRACLES measures assessment compared to the results achieved in the previous phases); and
- the ***cross-site phase*** (where results of the local evaluations are drawn together).

At each site, the initial evaluation of the MIRACLES project involved the identification of the ***baseline scenario***. This scenario defined the reference case against which the MIRACLES projects can be measured. Wherever possible, the data collection for the baseline scenario was consistent with the data collected for the ex-post scenario so as to provide accurate and comparable scenarios for the evaluation process. Each site produced an internal baseline report, which identified, for each measure, the indicators to be used, the proposed method of collection, and the source of the information.

The intention of the ***business as usual scenario*** was to enable an indication to be made of which ex-post results could be attributable solely to the MIRACLES measures, and which may have occurred naturally in any case (e.g. changes in fleet emissions due to natural fleet renewal) or as a consequence of implementing other initiatives at a local level outside the MIRACLES project. A secondary aim was also to estimate the foreseen impacts of the ex-post phase with the expectation that this would enable the maximum likelihood of identifying statistical significance of the ex-post findings.

The business as usual scenario was to be developed using data sources such as public transport patronage counts, congestion measures, fuel efficiency, fleet composition, cycling and walking, freight movements, parking profiles, public opinion and public awareness. The anticipated modelling tools included emission inventories, a meteorological model, microscopic and macroscopic simulation and other models (e.g. spreadsheet energy use models and fleet profiles). However, in practice, there were concerns about the value of the model (ITEMS) and in some cities, not all the originally anticipated data could be collected in time to use in the survey planning. In addition, the business as usual scenario is arguably not useful where there are no measurable differences between the ex-post and baseline results. (In some situations, this was due to a delay in the implementation of the measure meaning that the ex-post surveys were not undertaken for a fully working application). Together, the baseline and business as usual scenarios are often classified as the ***ex-ante phase*** of evaluation.

The ***ex-post phase*** is the most important evaluation phase, and assesses the actual impacts of the implementation at each of the demonstration sites. Data was gathered from a variety of sources and the main findings were interpreted and drawn together to make recommendations for the project's wider implementation within the city areas and at other sites.

The ***cross-site phase*** draws together the results of the local evaluations for a 'light-touch' approach to internal project cross-site evaluation. The task was responsible for linkages to the accompanying measure project and ensured that the local evaluation plans collated data in a consistent manner with the cross-project evaluation where appropriate. Within MIRACLES, similar indicators were used wherever possible at those sites which had comparable measures.

The MIRACLES Evaluation Plan (Deliverable D4.1) was developed in 2003, and this defined a common evaluation methodology to be used across the four sites to ensure that each site managed its own evaluation work under a consistent framework. This document consisted of a main report and four substantial annexes representing each of the four cities. The annexes provided detailed descriptions of the individual measures to be implemented, including the planned timing of implementation and the indicators to be used in their assessment. This measure level evaluation essentially consisted of before and after studies relating to the specific mode and spatial area affected by the measure with time intervals of data collection being assigned as appropriate.

At each site, a larger study covering the wider city area (i.e. the city level evaluation) was undertaken to assess key impacts such as air quality and average traffic speeds. The city level evaluation covered the city as a whole or city centre, depending on the site, with some data being collected at more regular intervals than others (depending on availability and cost of data collection). The annexes to D4.1 described the indicators that would be used at the city level to assess the impact of the integrated nature of the project.

3.2 METEOR Activities

The METEOR evaluation activities are directed to producing a comparable reporting of impacts across all CIVITAS cities and as such can be said to be an evaluation of the CIVITAS project at the European level (METEOR/CIVITAS level evaluation). Within CITIVAS, the evaluation related activities may be considered in the form of a pyramid, with individual city level applications forming the base and the integrated core indicator results forming the apex. The latter provide an overall measure of success of the programme at the European level and are the responsibility of METEOR. The lower level evaluations are the responsibility of the cities and city projects. In addition, outcomes of the evaluation activities must include appropriate contributions to the core indicators identified by METEOR in conjunction with the projects. The MIRACLES project iterated with METEOR in the development of the METEOR 'Core Indicators' and participated actively in the Evaluation Liaison Group set up by METEOR.

The indicators can be classified into five key areas: economy, energy, environment, society and transport, described as follows:

- **Economy -** Indicators typically relate to costs relating to purchase, installation, operation and maintenance, as well as associated labour costs in terms of staff resource. For some measures, the revenue generated is a relevant indicator.

- **Energy -** Information relating to energy consumption has often been derived from modelling work used to determine the emissions.

- **Environment -** Air quality has been assessed using both measured records and measurement of public perception of air quality and, at some sites, a model has been used to estimate quantifiable values. For some scenarios, noise levels have been measured.

- **Society –** The indicators for public awareness, knowledge and acceptance of the MIRACLES project and the individual measures have generally been determined through questionnaire surveys. Perceptions of various transport related issues in city centres have also been collected in this way. At some sites, business acceptance of the project has been assessed through appropriate questionnaires and interviews with target groups.

- **Transport** – These indicators cover a broad range of transport related areas such as modal split information survey, city centre and arterial traffic flow and speeds, levels of cycling, number of cars per household, the age and emissions control technology of the vehicle fleet, the number of road traffic accidents, pedestrian flows, vehicle occupancy information and parking profiles.

The MIRACLES project was committed to supporting the production of a small number of robust 'headline' indicators that could be actively promoted throughout the EC to encourage sustainable urban transport development. However, in practice, the list of METEOR indicators grew considerably, and METEOR used a 'top down' approach, whereas MIRACLES used a 'bottom up' process applying MAESTRO and CONVERGE guidelines, with each city deciding what impacts and indicators were relevant and feasible to its specific case. The matching of the indicators brought to the fore issues regarding different indicators being used to assess similar impacts and that the required indicator format may not always be available.

Nevertheless, the indicators that were utilised by each city were matched (wherever possible) to those required by METEOR. There were instances where similar impacts were considered but very different indicators were used to measure them by the MIRACLES city and METEOR. The ability of each MIRACLES city to deliver the required data for the current METEOR core indicators is shown in Table 3.1. (Note that even if a box is ticked, it does not necessarily imply that the specific city measurements provided results compatible with METEOR request). Not all indicators were satisfied by all cities, and in many instances the indicators were not collected at a city level but at the measure level (though not necessarily for every measure).

Evaluation Category	METEOR indicators		MIRACLES City			
	No.	Name	Barcelona	Cork	Rome	Winchester
Economy	1	Operating revenues	✓	✓✓	✓	✓✓
	2	Operating costs	✓	✓✓	✓	✓✓
Energy	3	Vehicle fuel efficiency	✓	✓	✓	✓✓
	4	Fuel mix	×	✓	×	✓✓
Environment	5	CO levels	×	✓✓	✓✓/✓	✓✓
	6	NOx levels	×	✓✓	Substituted with C6H6 ✓✓/✓	✓✓
	7	Particulate levels	×	✓✓	✓✓/✓	✓✓
	8	CO2 emissions	×	✓	×	✓✓
	9	CO emissions	✓	✓✓	✓✓	✓✓
	10	NOx emissions	✓	✓✓	Substituted with C6H6 ✓✓/✓	✓✓
	11	Small particulate emissions	Awaiting info about COPERT	✓✓	✓✓	✓✓
	12	Noise perception	✓	✓✓	Substituted with noise level ✓✓/✓	✓✓
Society	13	Awareness level	✓✓	✓✓	✓✓/✓	✓✓
	14	Acceptance level	✓✓	✓✓	✓✓/✓	✓✓
	15	Perception of PT accessibility	×	✓✓	✓✓/✓	✓✓
	16	PT services relative cost	✓	×	×	×
	17	Perception of PT security	×	✓	×	✓✓
Transport	18	Accuracy of PT timekeeping	×	✓	×	✓✓
	19	Quality of PT service	✓	✓✓	✓	✓✓
	20	No. of injuries and deaths caused by accidents	×	✓✓	✓✓	✓✓
	21	Vkm by vehicle type - peak	✓	×	×	✓✓
	22	Vkm by vehicle type – off peak	✓	×	×	✓✓
	23	Average vehicle speed - peak	✓	✓	×	✓✓
	24	Average vehicle speed – off peak	✓	✓	×	✓✓
	25	Total no. of goods vehicles moving in demo areas	✓	×	×	✓✓
	26	Average modal split-PAX	✓	✓✓	✓✓	✓✓
	27	Average modal split-vehicles	×	✓✓	✓✓	✓✓
	28	Average occupancy	×	×	×	✓✓

Key: × = Not measured, ✓ = Application measured (partial), ✓✓ = City-wide measured

Table 3.1: Outline comparison of METEOR and City indicators

3.3 Templates

As previously described, evaluation results were reported at two levels: the measure-level and the city-level. Separate templates were developed for each of the two evaluation levels; their structure and content were based on discussions between METEOR and the CIVITAS Project Evaluation managers. The agreed formats for the Measure-Level template (MLT) and City-Level template (CLT) are shown in Tables 3.2 and 3.3, respectively.

The templates were developed to serve several purposes, including:

- Facilitate information storage;
- Ensure reporting of all evaluation relevant information;
- Ensure common reporting format;
- Facilitate analysis of evaluation results for the CIVITAS projects and METEOR;
- Disseminate evaluation results in a clear and concise manner.

Within the templates, a balance had to be struck between reporting the results in a comprehensive manner, and providing information in a non-technical, easy to understand manner. The suggested “length” of a completed evaluation template was 5 pages, although this was not a formal requirement and in practice this was often exceeded by many of the templates. It was not intended that the MIRACLES sites include any raw data within the templates. The MIRACLES evaluation approach focused on providing the results in accordance with the template format, and used the guidance note devised by METEOR as a basis. All templates containing the evaluation results are gathered as Annexes 1-4 to this Evaluation Report. These annexes constitute the (second) MIRACLES Implementation Report.

MEASURE-LEVEL RESULTS	
Measure title: **Measure number:**	**Project:** **City:**
The Measure – what is it about?	
M1: Measure objectives:	
M2: Measure description:	
The Implementation – how was the measure implemented?	
M3: Innovative aspects:	
M4: Situation before CIVITAS:	
M5: Design of the measure:	
M6: Actual implementation:	
M7: Deviations from the plan:	
The Evaluation – how was it done and what are the results?	
M8: Method of measurement:	
M9: Achievement of quantifiable targets:	
M10: Achievement of evaluation-related milestones:	
M11: Report on the measure results:	
Lessons Learned – what do other cities, other actors and the EC have to consider?	
M12: Barriers and drivers of the measure implementation / process evaluation:	
M13: Interrelationships with other measures:	
M14: Lessons learned:	

Table 3.2: Template used for reporting of measure-level results

CITY-LEVEL RESULTS	
Indicator title: **Indicator number:** **Evaluation Area:**	**Project:** **City:**
The Indicator – what is it about?	
C1: Local objectives and quantifiable targets:	
C2: Indicator description:	
C3: Context and relevance:	
The Evaluation –what are the results?	
C4: Method of measurement:	
C5: Achievement of quantifiable targets:	
C6: Report on results:	
Lessons Learned – what do other cities, other actors and the EC have to consider?	
C7: Lessons learned:	

Table 3.3: Template used for reporting of city-level results

4 MEASURE-LEVEL EVALUATION

For each site and MLT, a consistent reporting format was used to produce a concise summary and interpretation of the evaluation results. These summaries are essentially a high-level overview of the detailed MLTs, and are reported within this section of the report. For additional information the reader should refer to the relevant MLT within Annexes 1-4.

4.1 Summary of Measure-Level Results for Rome

The summaries for Rome are presented in sections 4.1.1 to 4.1.19. See Annex 1 (2nd Implementation Report for Rome) for additional details of any of the measures.

4.1.1 Measure 5.1a: Set up of City Centre Clean Zone - Measures at Laboratory Area Level

The Measure

The "set-up of city centre clean zone" was a multi-task measure, focusing on access control to central areas. The first set of access control interventions were to allow only catalysed vehicles free access to the MIRACLES Laboratory Area (i.e. the area called Railway Ring), and to extend the yearly check-up of vehicle emissions to compulsory servicing of motorcycles and mopeds. The main objectives of the measure were to decrease traffic related pollution, safeguard citizens' health and preserve the historical and architectural heritage of the city, goals also shared by the twin measure 5.2. Accompanying access control measures were the closure of the Access Gate System (AGS) and the two access restriction trials and consequent implementations at S. Lorenzo and Trastevere districts. These are described within measure 5.1b.

Key Findings

The most important finding was that an appreciable reduction in air pollution was measured (using several monitoring stations). A comparison between the 2001 and 2004 mean values showed that CO concentrations reduced by 21%, PM_{10} by 11% and benzene by 37%. Compared to the estimated business as usual results, these values exceeded expectations. Although these results were a combined effect of all the MIRACLES measures and it was not possible to isolate effects of individual measures, it was considered that the main contributory factor was permitting only clean private vehicles to enter central areas. Another expected headline result was that the number of high polluting vehicles in the Laboratory Area would reduce by 10%. In fact, ex-post results were that the number of non-catalysed vehicles reduced by about 45%, private cars by 37% and commercial vehicles by less than 35%.

Other Results

The prohibition of non-catalysed cars from entering the Railway Ring Area and progressive renewal of the car fleet contributed to a reduction in air pollution. Regarding two-wheeled vehicles, the so-called "Blue Tag" ("Bollino Blu"), interventions increased by 20% during MIRACLES. However, according to 2004 data (based on checks of 50,000 vehicles), about 64% of two-wheeled vehicles were still not compliant with the relevant directive.

Conclusions and Lessons Learned

This measure can be considered as an example of how a regulatory intervention can positively affect the local environment. However, enforcing the Blue Tags on two-wheeled vehicles is crucial for the future success of the measure. Current results were regarded as satisfactory, but additional time for a full implementation of the measure is required.

The issue of restricting polluting vehicles still requires user acceptance, as demonstrated by the only modest decrease in traffic flows. Public compliance with the scheme is essential, but this requires a larger commitment from decision-makers and implementers to make citizens more aware of the scheme.

4.1.2 Measure 5.1b: Set up of City Centre Clean Zone - Access control systems in central areas

The Measure

This part of the wider "set-up of city centre clean zone" measure concerned the second set of access control interventions. These were the closure of the Access Gate System (AGS), and two access restriction trials and consequent implementation at the S. Lorenzo and Trastevere districts. The main objectives were as for measure 5.1a i.e. to improve traffic mobility by improving road safety and decreasing traffic-related pollution, and to re-generate urban spaces by safeguarding citizens' health and quality of life and preserving the cultural heritage.

Key Findings

There were some positive transport impacts. For instance, the baseline urban modal split in 2002 was: 30% transit, 27% private cars, 23% motorbikes / mopeds and 20% pedestrians. The ex-post surveys undertaken in 2005 found that these proportions had changed to 31%, 22%, 24% and 23%, respectively. The five point decrease (percentage) for private cars in favour of three point increase (percentage) for walking was considered a noteworthy result, and suggested that citizens reduced their use of the car for trips of short distances. Access restrictions and pedestrianisation were the main drivers of such achievements: in particular, the former decreased peak traffic flows by 20% during the restriction periods and by 15% in the morning rush hours. (It is also worth noting that just at S. Lorenzo and Trastevere a more than 50% decrease was recorded, thus exceeding the forecast 30%). Regarding through-traffic, surveys found that there was a 50% reduction in the number of vehicles illegally accessing the Central LTZ.

There were small increases in traffic flow along the main axes surrounding the restricted area and an overall increase of PT passengers. In addition, increasing access for those two-wheeled vehicles not restricted by the policy partly limited the benefits provided by the scheme in terms of pollution reduction. In spite of this, pollution levels generally improved, as described in measure 5.1a. There were also positive results regarding noise reduction, especially in the S. Lorenzo district. The ex-post monitoring in those zones without commercial activities observed a reduction of noise pollution of 8-9 dB(A). In zones with commercial facilities (e.g. restaurant, pubs, clubs, etc.), the reduction was more modest, about 3-4 dB(A). It should be noted that these results were obtained without additional interventions on the noise sources.

Other Results

There was some evidence that this measure was perceived by the public as a fundamental limitation on an individual's freedom to travel. In particular, a comparison of the before and after satisfaction survey results for access restriction (according to customer care surveys undertaken within MIRACLES) found that public approval of the measure reduced markedly (more than half a point less on a 1-5 Lickert scale). Nevertheless, the ex-post assessment was still classed as moderately positive. In addition, there were still 20,000 vehicles per week illegally entering the area, which implied there was still a lack of acceptance of the scheme.

Conclusions and Lessons Learned

The interventions within measure 5.1 were all based on a mixture of restrictive actions and flexible responses. This means that the successful outcomes reached so far still require a longer-term consolidation period. Even after a four-year trial, in the context of a complex built environment such as Rome, such innovations should still be regarded as being just at an early stage of implementation. In the longer-term, the positive transport and environmental effects should be strengthened, and agreement processes refined between all the involved parties. This could also have a positive affect regarding public perception of acceptance and awareness.

4.1.3 Measure 5.2.a: Set-up of green corridors and green areas, Implementation of pedestrian areas

The Measure

As with the twin measure 5.1, this was a multi-task action aimed at preserving the cultural heritage (mainly historical sites) and improving conditions within the city centre. It included two measures:

(1) The development of green areas inside the city centre, implementation of retractable bollards to protect areas, the re-design of PT infrastructures located in these areas and the improvement of pedestrian safety.

(2) The design and implementation of the pedestrian precinct at the Tridente area inside the central LTZ. This operated from 08.00 to 20.00 each weekday.

The main goals of this measure were to improve the environment of the city centre and pedestrian areas in the Laboratory area, extend the Green Zones supply in the city, create a continuous network of pedestrian paths across the city centre, and increase the overall safety level. In addition, other interventions aimed at re-organizing the parking supply were also implemented within measure 5.2b.

Key Findings

As with measure 5.1, the most important benefit was the reduced pollution level (see measure 5.1a for detailed results). The ex-post measured values of benzene concentrations at the Tridente area were the lowest surveyed in the whole Laboratory area (4.1 microg/m^3 at the Tridente vs. 5.2 microg/m^3 in the whole Laboratory area – ex-post values), exceeding the predictions of the ex ante simulation. This result was due to the virtually total removal of private traffic from the area for a long period of the day. There was a shift of modal split towards green modes: the number of public transport passengers increased and journey times reduced by about 50%. In addition to the transit and environment improvements, the upgrading of the pedestrianised areas was just as relevant. Indeed, from a qualitative point of view, the creation of a real pedestrian network in the city centre, due to the implementation of car free areas and mobile bollards, met one of the main requirements of MIRACLES, i.e. an increase in standard of living in this area, both for residents and for tourists.

The increased number of pedestrian areas in the city centre meant it was now possible for pedestrians to stroll freely, at least during some hours of the day, without encountering private traffic flows, apart from the exception of some crossing points. Moreover, some specific pedestrian areas were now protected by mobile bollards. The pedestrian space was quantitatively assessed, and increased from 235,023 sqm in 2001 to 280,000 sqm in 2005, a net increase in pedestrian space of 20%. Hence, the target of reducing the road space for cars inside the LTZ by 2% was met. The conversion process was also “magnified” by the provision of aids for physically-challenged people. Indeed, virtually all the pedestrian paths are equipped with ramps for wheelchair users and with tactile tiles for visually-impaired people.

In addition, the City Council approved the new General Plan for Urban Traffic. This plan is currently at the public consultation stage and encourages the pedestrian mode especially in the city centre. It also introduces the concept of "environmental islands", i.e. areas where maximum speed will be limited to 30 km/h and where non-motorised modes are favoured.

Other Results

Despite the predictions of the ex-ante simulation, safety levels did in fact improve noticeably. The forecast effects of the restrictions and pedestrianisation had anticipated an increase of accidents because of the shift from cars to mopeds / motorcycles by those drivers who used to travel through the formerly non-restricted areas, and two-wheeled modes being rated more dangerous than cars. On the contrary, a comparison of the accident rates at a city-level before and after implementation showed a reduction of almost 50% (fatalities reduced from 115.3/10^6 inh. in 2002, to 65.3 deaths/10^6 inh. in 2005). The "modesty" of the measure from an economic point of view should also be emphasised. The operating and maintenance costs were respectively 0.18 Euros and 0.10 Euros per inhabitant, which makes the overall access restriction scheme an affordable measure.

Conclusions and Lessons Learned

Even though pedestrianisation is restrictive from a private traffic point of view, it can be considered a good example of how limits and control policies can achieve positive outcomes. Turning congested areas into safe, clean pedestrian environments can hence be considered as the good facet of restriction policies, whereas bans for cars are experienced just as constraints. The Rome experience showed that pedestrianisation can be considered as the "premium" part of the whole access restriction scheme, but to "gain" it, a strong political will, both in terms of planning activities and making unpopular choices, is required when the goals are to improve sustainability and standard of living. Accordingly, within the overall approach applied by Rome Municipality, access restriction was regarded as the "push" part as a constraint to change driver behaviour, and pedestrianisation the "pull" part to encourage use of green travel modes.

4.1.4 Measure 5.2b: Set-up of green corridors and green areas, Urban Traffic Plans

The Measure

In addition to pedestrianisation, other interventions in WP5 were aimed at re-organizing the infrastructure according to the Local Urban Traffic Plan (LUTP). The LUTPs did not involve new infrastructure, but focused on the re-design and re-shaping of pedestrian crossings and road intersections, so as to increase safety for pedestrians.

Key Findings

The implementation of the re-design of some crossing areas will not be complete until mid-2006, and so no actual ex-post data was available. However, the potential LUTP effects have been simulated and it was found that traffic flows at the demonstration site should be reduced by 50%, particularly during the morning peak hours. In addition, modelling results indicated an anticipated improvement in air quality, with a reduction in pollutant emissions of 4-10%, the largest reductions being for CO and benzene.

Other Results

The re-design of the crossing areas involved the application of some traffic calming measures. At one site, this was because of the elevated landscape and the need to

upgrade the local system of traffic signals. In particular, the design of pedestrian islands was specifically aimed at improving the safety level in areas formerly considered as accident black-spots. The upgraded traffic signals took into account the slow speeds of pedestrians, and it is anticipated that this will contribute to safety improvements.

Conclusions and Lessons Learned

Due to the late implementation of this measure, outcomes from the crossing area redesign are difficult to assess. However, if the simulated positive results (in terms of reduced traffic flows and pollutants) are confirmed, the next step will be to include such re-designed areas within other traffic calming schemes.

Some initial conclusions could be drawn. The improved crossing scheme was based on minor infrastructural modifications and is an example of how the larger problems of safety and pollution can be tackled by starting from a bottom-up approach. This is particularly important for a city such as Rome where, until only a few years ago, most decisions on traffic were made at city level and according to general regulatory directions.

The LUTPs demonstrated that it is possible to activate local mobility governance processes through two key factors: appropriateness of planning/design and of management processes. This means the involvement of all the decision makers and implementers (such as technicians, designers and facilitators) to provide users with traffic solutions where the drivers' needs are not the priorities. Conversely, it is important to select mobility schemes which can be implemented easily and quickly at low cost. Moreover, such an approach allows mere crossing points to be converted into safer areas for pedestrians. The integrated design, based on traffic calming measures, as well as vegetation and urban street furniture, alert drivers that they are accessing a pedestrian-friendly "domain".

4.1.5 Measure 6.1: Time Based Road Pricing

The Measure

The Access Control System (ACS) and Road Pricing (RP) scheme has been implemented in Rome since October 2001, with restrictions on accessing the Limited Traffic Zone (LTZ) during 06:30-18:00 on weekdays and 14:00-18:00 on Saturdays. During the hours of operation, vehicle flows were typically reduced by 20%, while the number of two-wheeled vehicles increased by 20% and public transport use increased by 6%.

MIRACLES aimed to improve the situation when ACS and RP were not in operation, particularly during the evening / night hours, which are times of the day when there are generally still high levels of congestion. The RP application during MIRACLES focused on three tasks: RP during evening and night hours, RP schemes for tourist coaches, and the choice of Best Available Technology (BAT) to control two-wheeled vehicles within the central LTZ. Indeed, before MIRACLES, the restrictions of the ACS and RP schemes were not sufficient to achieve the expected environmental benefits. This was due to an increase in evening/night traffic flows, an increased use of scooters, and the limited control on highly pollutant special fleets, mainly coaches. The main objectives of the measure were hence aimed at solving these issues, with the general goal of improving traffic mobility conditions and decreasing traffic related pollution in the LTZ. All these goals were also shared by WP5.

Key Findings

After a trial period, the "Night Central LTZ ACS + RP scheme" was fully implemented. As already noted within the WP5 measures, the MIRACLES package of applications improved the environment (e.g. CO concentrations reduced by 21%, PM_{10} by 11% and benzene by 37%). It was considered that the combined effects of ACS + RP contributed to this. In addition, it is anticipated that results will improve still further when facilities at the Electronic gates of the ACS+RP are put in place to automatically detect two-wheeled vehicles, with a consequent operation of a new restriction scheme (from January 2007 onwards).

During the first weekend of the scheme (June 2005), a reduction of 60% (from 10,000 to 4,000) in the number of four-wheeled vehicles was recorded, and subsequent results confirmed this (see below). However, regarding two-wheeled vehicles, there was a substantial increase in traffic flow. This was attributed to the summer period and the permitted free access to the area. The measure also contributed to the 10% reduction in the number of high polluting vehicles in the LTZ, especially during the weekend evening / night hours.

Follow-up surveys confirmed what was observed during the first week of implementation. The first goal had been a 25% reduction in the number of vehicles during the weekend nights. In fact, the actual reduction in four-wheeled vehicles was 50% (average values reduced from about 10,000 to 5,000), along with a decrease in the traffic flow in the central LTZ, from 138,000 units/daily (after the enforcement of electronic gates at the end of 2001) to 118,000 (mid 2004). This 17% decrease in flow exceeded the target of the second goal i.e. to reduce the number of vehicles by 10% daily in the LTZ.

Other Results

The test survey to control two-wheeled vehicles used a BAT OCR camera tuned to video-capture images of mopeds and motorcycles number-plates, and this proved a useful study. Recorded flows showed that two-wheeled access was substantial during the morning peak (07:30-10:30) and during night hours (20:00-24:00). Indeed, the proportion of two-wheeled vehicles accessing the LTZ represented about 30% of the whole access demand. Consequently, the implementation of new technology to control access of two-wheeled vehicles is crucial.

Technology also played a major role within the RP schemes for tourist coaches. However, regulatory aspects were also relevant. Indeed, the new Tourist Bus Plan, in force from January 2006 onwards, will improve access control on the LTZ. This will be as a consequence of the innovative rules on new limited-time parking areas, the new structure of charges (e.g. the introduction of a charge for coaches less than 7m in length), the introduction of new weekly, monthly and yearly passes, and eventually the new management of special events.

Conclusions and Lessons Learned

Even though RP is not popular from a public perspective, the achieved and potential benefits mean that such a measure is regarded as essential to increase sustainability in the city. This becomes even more relevant when it is considered that the ACS+RP scheme, the Night Central LTZ scheme, and the introduction of RP policies for two-wheeled vehicles and tourist coach fleets have the general objective of restricting private cars from entering the city centre, so as to improve standards of living. However, these are not no-cost measures and to become a best practice, time and resources must still be spent in tuning and improving the supporting technologies, making the public aware of the achievable benefits (by disseminating the good results achieved thus far), to adjust regulations, and to speed-up the implementation

process. From this point of view, the MIRACLES application can be considered to have been a fruitful starting phase.

4.1.6 Measure 6.2: Environmental Parking Charges

The Measure

This measure was based on two sub-tasks: extending the number of on-street parking spaces in the Rail Ring Area, and a feasibility study regarding future implementation of a new parking policy based on the introduction of different parking charges. The goal was to generally improve the overall availability of on-street parking spaces within the Rail Ring area. The payment system was also improved by the design of new payment methods and devices (such as “Stelio”, an innovative solar-powered meter).

Key Findings

In quantitative terms, during the MIRACLES project the number of (payment) parking spaces increased by about 50% from 52,000 to 78,727 units, with about 11,000 new spaces being added in 2005 alone. The number of payment parking spaces related to Park & Ride facilities also increased (by about 15.5% to 12,089 in 2004). This increase was relevant from an economic point of view. Rome Municipality doubled its net income during the period 2001 – 2005, while the cost of operating the whole system was an affordable 0.10 Euro per parking place. Hence, quantitatively the success of the measure was based on its wide implementation which corresponded to clear economical benefits.

Other Results

From a qualitative viewpoint, an increase in parking supply and a policy to introduce parking charges according to the different uses of a specific urban area can potentially achieve the goal of reducing private car use. Payment parking discourages users from driving around looking for an available parking space or indeed from entering a residential area to seek a space, thereby increasing the local through-traffic level. Such changes can reduce the overall pollution level and the environmental results discussed for previous measures can be partly attributed to the new parking situation. If new parking schemes were to be implemented based on different parking charges according to land use and time occupancy, then further improvements could be expected.

Public perception of the measure was contrasting. For instance, awareness increased slightly (from 91% to 95%), but the satisfaction level reduced from 3.90 to 3.57 points (1-5 Lickert scale) regarding parking policies linked to P&R, and from 3.30 to 2.52 regarding flexible parking rates. This unwillingness to pay and the poor dissemination about future plans for the scheme probably influenced these results.

Moreover, the new P&R facility at Trastevere (providing 221 new parking places) went beyond expectations. Indeed, the discovery of some Roman mosaics during the construction work, compelled the implementers to build a small museum to preserve such archaeological findings.

Conclusions and Lessons Learned

The low general acceptance of the measure emphasises the need to promote integrated mobility measures and to encourage the public to perceive them as a package. In this case, the new parking policy is part of a package aimed at modifying modal split in favour of transit, reducing air and noise pollution, improving safety and security and upgrading the overall standard of living within the city. However, when the public are asked about parking issues, this broader scenario is not considered,

but only those aspects which limit their own freedom. It is considered that this "politically risky" measure would achieve wider public acceptance if there was better communication between citizens and administrators.

4.1.7 Measure 7.1: Improving PT Quality and Security

The Measure

The measure was based on the implementation of an innovative automatic security and safety video surveillance system, capable of analysing user behaviour through the "understanding" of video information. This was then planned to be used to monitor passengers in indoor areas of metro and railway stations within the Laboratory Area. The objectives were to decrease the security costs, optimise use of existing infrastructure and improve efficiency of the video operators.

Key Findings

The video surveillance system was based on the application of a computerised image processor using complex software, and substituted the traditional CCTV system manually managed by an operator. However, this measure was neither comparable to an ex ante situation, nor assessable by usual quantitative indicators. The image processing and data storage were aimed at improving safety and security. Indeed, the system was able to recognize different standard situations and to alert the operators by an audio-video alarm, whenever unexpected events occurred. This procedure allowed an intuitive and efficient interface, not only for prevention and control, but also for the possibility of detecting and monitoring habits of travellers and thereby improving the quality of PT services. The system started operating as a trial at the Termini subway station, which was the most complex location of the network. After the test phase the automatic video surveillance system was assessed as suitable for possible further exploitations; indeed, results achieved so far show that the system is able to recognize and codify a wide range of events (between 81-94%), such as overcrowding, isolated groups of standing people, etc.

Other Results

The public were not asked directly about their opinion on this new video surveillance system. However, public perception of telematics more generally was good. For example, 41% were aware of telematic devices at bus stops, and the related satisfaction level was 3.72 (on a 1-5 Lickert scale). The theoretical costs of the measure per inhabitant were very low.

Conclusions and Lessons Learned

It is expected that regular implementation of the system will lead to positive results, but new methods will be required to assess them. For instance, traditional parameters such as crime rate are virtually useless to assess security, because they are based on quantitative data, which does not take into account the personal perception of security experienced by the users. Moreover, data are usually underestimated since most of the crimes are not officially reported. This can be because of their relatively minor nature (e.g. pick-pockets on buses), the absence of someone to report to, or because of a lack of confidence that the offender will be caught. Hence, image processing will lead to a new interpretation of unpredictable events, in which knowledge of user behaviour becomes the key to detection. Of course, barriers to such an approach are the high costs of investment and implementation and the need to operate the system on a large scale. To this uncertainty must be added the implementers' awareness that this trial period may not be sufficient to assess whether the measure is ready for a full implementation.

In addition to the economic cost, the need to operate the system over a wide area will also require trained personnel e.g. to tune the whole system. Once both the economic, operative and the time issues have been resolved, the system could be able to operate optimally as a core element within a larger security system.

4.1.8 Measure 7.2: Multi-Modal and on-board Information

The Measure

The measure was based on the enhancement of the INFOPOINT database (developed by ATAC), and the implementation of a "counterpart" on-board MOBY system. INFOPOINT provided bike & ride information as well as information regarding accessibility to PT services for the disabled, while MOBY provided en-route transit information and news to bus passengers. The objectives of this task were to improve information on transit, to make the PT network more accessible to the disabled due to the provision of useful data, and to increase the attractiveness of PT due to the more comfortable travel conditions.

Key Findings

From a qualitative viewpoint, the upgrading of INFOPOINT meant that more categories of vulnerable users could access information on transit and thereby be enticed to use it. Moreover, the INFOPOINT improvements were regarded as being virtually accessible for physically challenged people, and could improve the "material" access to transit facilities and vehicles. The quantity of information available via media was increased i.e. 30% more information was offered by phone, internet and ordinary mail. There was a substantial increase in the number of visitors on the INFOPOINT website asking for information and news: from 48,000 (in January 2002, as an average value for the baseline) to 200,000 units (2005 data). It was considered that such an increase would not have occurred unless the information was of a high quality. This can be confirmed by the large number of users visiting the web pages dedicated to cycling information and to accessible bus stops (the maximum number of visitors recorded in June 2005 was 18,000, whereas the corresponding value for June 2006 was 22,000). This website dissemination of information was also an effective substitute for previous time-consuming dissemination methods. (For instance, in 2001 ATAC distributed 100,000 cd-roms with PT information for disabled people).

In addition to the relevant increase in the supply of telematic information, the number of accessible buses doubled during the MIRACLES project. 100 buses were equipped with Braille dots and accessible to visually impaired people. Regarding the MOBY system, real-time information and news were provided via 200 new video units; before MIRACLES no on-board information had been available. Moreover, the quality of information itself was considered to be very good, with information relating to continuously updated news, events (exhibitions, entertainments, etc), horoscopes, and relevant routes, timetable and connections to reach main public and private facilities (such as hospitals, museums, public offices). The service was aimed not only at regular users but also at tourists, and was therefore implemented on the most popular tourist routes.

Other Results

As with measure 7.1, the general public perception of telematics was encouraging, but users were not directly asked their opinion about INFOPOINT. There appeared to be some scope for developing commercials on the INFOPOINT and MOBY systems since according to initial marketing research, more than 70% of passengers stated that they would favour advertisements on MOBY. The role of advertisements should not be under-estimated since they could cover the cost of the whole measure.

Conclusions and Lessons Learned

The improvement of web-based information (e.g. INFOPOINT) leads to improved equity and social inclusion for vulnerable users, who often cannot participate within decision processes, or have enough power to create pressure groups to influence them. Therefore, the INFOPOINT upgrading is especially relevant because as well as indirectly attracting users to transit and promoting alternative modes of cross-city travelling (e.g. cycling), it allows physically challenged people to have similar opportunities to able-bodied people. New directions of improvement could take into consideration the involvement of other categories of vulnerable users, not only blind or deaf people, but also the elderly and children. The MOBY system represents a new way to supply traditional information both to regular and occasional users, using on-board videos. Both INFOPOINT and MOBY are hence aimed at increasing attractiveness to transit by reaching types of users such as the disabled and tourists, who had previously been excluded.

4.1.9 Measure 7.3: Introduction of New PT lines

The Measure

This measure improved the transit network by implementing two new electric bus lines and a trolleybus line, and converting a former bus depot to a Trolley depot. The electric bus lines were implemented in the Trastevere and San Lorenzo districts in accordance with the LTZ policy to reduce traffic and pollution in those areas. The trolleybus line nr 90 operated along one of the main corridors (Via Nomentana) linking the suburbs to the city centre. In addition, the electric bus lines operated a night shuttle service within the LTZ, connecting P&R facilities.

Key Findings

The two types of new lines were considered a “niche”, although still contributed to the overall improvement of the transit network. Thus, from a quantitative point of view, they were regarded as just an addition to the current transit supply, dedicated to special events (such as the electric bus night shuttle service in the LTZ) or to the improvement of city centre accessibility (such as the trolleybus service along the Via Nomentana). The trolleybus line substituted a connection, formerly operated by common buses, and currently transports about 2,500 passengers per hour. The number of passengers transported was regarded as the most important indicator for this measure. Some 10,000 – 12,000 passengers were transported daily by the overall electric fleet (five lines), and about 32,000 by the trolleybuses, thereby achieving 670,000 passengers/month in 2004 alone, exceeding the original target of increasing the number of electric bus users to 200,000 passengers/month. In addition, trip travel times were reduced by an average of 50%.

It is also important to emphasise the achievement of another important goal, i.e. to increase by 25 km the electric network inside the Laboratory area. The “e-network” has become 52 km long due to 22.8 km of the trolleybus line and the two new electric bus lines. Such success complements the general improvement of the transit supply, which increased by 6.1% in the surface network and by 5.5% in the number of operating lines.

Public awareness of the need to use clean transit increased from 53% to 76%, and satisfaction increased from 3.6 to 3.96 (1-5 Lickert scale). Indeed, it was the most “satisfactory measure” among the Rome MIRACLES measures. Another survey to understand users’ perception and acceptance of the system found that 86% of the interviewees were in favour of the extension of the trolley line. This was due to the good performance of the line nr 90 in terms of environmental friendly operations, low

noise level, and quality of service (in terms of timekeeping, frequency, speed, and capacity).

Other Results

An important issue for the implementation of the trolleybus line (no. 90) was that it was located in a complex built environment, and some barriers needed to be overcome. For instance, about half of the route was located along a boulevard, tree-lined on both sides; this required a special design of the wire lines and new posts needed to be integrated with the public lighting ones so as to preserve the old features of the boulevard. Moreover, the final leg of the route was in the historical city centre where, because of landscape preservation, no aerial wires were allowed. This meant that the final leg (3.2 km) of the line had to be operated by batteries. Thus, the implementation of line 90 was a good example of how barriers such as landscape preservation, integration with existing infrastructure and involvement of more bodies, can be successfully overcome.

Conclusions and Lessons Learned

The implementation of the new electric bus lines combined with the restriction on private cars appeared to work well, especially when the aim was to provide incentives for transit to access “sensitive” areas. In addition, the substitution of gas-fuelled buses by trolleybuses was easy to implement. However, such a scheme can be hindered by the community (both in the context of a built environment and as administrators and users). During the design and implementation processes, stakeholder and public participation were crucial for the progress of the measure, but this did cause some delays. For example, some retailers in one of the areas served by electric buses claimed that their business would decrease as a consequence of the restriction policy. In spite of such claims, a 20% increase in business was recorded within a short period of time. This demonstrates the importance of communicating with end-users and stakeholders, even if the transit measures to be implemented are only of modest relevance compared to the overall network.

4.1.10 Measure 7.4: Improved Integration of PT

The Measure

The integration with Public Transport was based on the implementation of a new “collective taxi” service, which consisted of a fleet of cars, each with a capacity of eight passengers. Eight operating lines were implemented, and the service connected northern districts of the city to central areas. The service was based upon the Taxibus scheme, which had been operating along three privately operated lines since 2000.

Key Findings

The most relevant finding was the development of the measure itself, and its performance skyrocketed during most of the MIRACLES project lifetime. During 2002-05, the total number of trips per day more than quadrupled (from 160 in 2002 to 752 in 2005). In addition, journey times reduced significantly: from 1 hour in 2002 to 20 minutes in 2005. This was attributed to a slight increase in average speed and to more direct connections. The total distance travelled per day almost trebled (from 2270km in 2002 to 5989km in 2005). Such improvements were supported by a decreased service cost from 0.9 euro/inh to 0.60 euro/inh, despite the1.28 euro/inh, forecast within the business as usual scenario. Users showed both a good appreciation of the service and a strong awareness of the need to implement this type of measure. Moreover, the collective taxis were the most popular among the “less well-known-but-operating” MIRACLES measures, according to the ex post

survey results. This situation was aided by the in-depth customer satisfaction survey undertaken at an early stage of implementation, which helped to identify user needs and possible new trends for the operations, as well as the "willingness to pay". Such findings were also useful to plan the service extension, which was based mainly on the core objective of increasing the frequency of existing lines.

Other Results

Despite their current user success, collective taxis remain a "niche" transit without a strong impact on travel patterns in Rome. For instance, 100,000 passengers per year travel on collective taxis (and cover 3 million vkm/year) whereas 873 million people travel on buses each year (and cover 133 million vkm/year). Clearly, the scale of these two transit options was not comparable. In fact, collective taxis were more relevant to neighbourhoods, rather than the overall community, but it was considered that these positive results could pave the way for major implementation at an urban level.

Nevertheless, the measure goal was to contribute to the achievement of a collective modes' higher occupancy rate; the initial target was 20%. Regarding the collective taxis occupancy, the rate was about 35 % (compared to a 30% baseline value) for most of the implementation period, whereas in the last few months it decreased to 15%. It is difficult to explain this sudden recent trend and a longer survey period could help to provide sound interpretations of the phenomenon.

Conclusions and Lessons Learned

The "collective taxi" service was a successful measure, but it should be noted that the measure was applied in a context in which traditional PT supply was not tailored to specific needs or to specific user groups. The Taxibus service, which operated along selected routes, provided a good option for home-to-work or to downtown shifts at reasonable prices (even if more expensive than the PT single ticket), with comfortable travel conditions and reliability.

Factors that can negatively influence any further implementation rely mainly on the lengthy timescale needed within the tender process when new lines are required. The fulfilment of bureaucratic and administrative tasks can become a hindrance in terms of time needed to the implementation. In addition, if the travel price increases beyond a certain threshold (3 Euros per single trip), customers stated they would no longer use the service.

A measure such as Taxibus can be adopted in any other city where PT supply is perceived by users as unsatisfactory in terms of comfort and reliability. Indeed, it represents a type of "business class" for bus/metro users who are disposed to pay a little more (but less than a taxi fare) just to arrive in time, close to their destination and in a comfortable manner, especially in poor weather conditions. However, the service could be less attractive in cities that already have high quality PT systems.

4.1.11 Measure 8.1: New Forms of Vehicle Use – Car Pooling and Car Sharing

The Measure

The measure was divided into two parts: car pooling and car sharing. The former involved the shared use of private vehicles for home-to-work trips, and was managed by the Municipality, supporting the participant companies. The latter was a car-fleet available for rent, currently operated with 10 cars, at seven parking areas and active 24 hours per day. The implementation area for car sharing was the III district and a call centre was set up to receive reservations. Both activities were aimed at creating new alternative mobility habits among the citizens.

Key Findings

Both initiatives were "niche" measures, and played only minor roles within the overall scheme of improving environmental and traffic conditions. The most important finding was their increased attractiveness among users. Despite a restricted implementation, both measures resulted in an increase of the number of participants. Concerning car poolers, the numbers increased during the project lifetime from 750 units to 1180 and 360 crews. Regarding car sharing, the first experimental phase (since March 2005) involved 140 users, but in June 2006 an average of 247 pass-holders was recorded, which included 62 regular users.

Concerning the ''traffic levels'' indicator, the city value was 2.5 trips per vehicle. The corresponding values for the car pooling and car sharing were 2.5 and 1.12, respectively. The latter result was considered quite impressive when viewed within the context of the short implementation timescale, but from a longer period of implementation (March 2005 – June 2006) 0.44 is reported as an average daily value.

As for collective taxis, the measure goal was to contribute to achieving a collective modes' higher occupancy rate. The increased number of car poolers and related crews resulted in a very high occupancy rate, about 75%, which exceeded expectations. Facts regarding the number of car sharers are useful to introduce a similar key-parameter for the service, the so-called "monthly utilisation coefficient per user", which according to ATAC data shows that at least 2.57 users per month in average prefer this travel option, far above the national rate.

Other Results

Car sharing was still not well known among the public. Moreover, it had to compete against the popular prejudice of regarding cars as a place of intimacy and solitude, not to be shared with other people. In addition, the service managers chose not to advertise the service extensively during its trial phase. This was partly due to the need for new funding to expand the service as well as uncertainty regarding the funding sources at that stage. This partly explained the small index of awareness (14%) among the ex post sample of interviewees. On the contrary, perception of the scheme among users was very positive and the value of the "satisfaction level" indicator was quite high (3.6 points, on Lickert scale 1-5).

The initial car pooling scheme was well accepted by the participants and so Rome Municipality supplied 10 additional vehicles to the car fleet, making the service applicable to other districts. In addition, the role of technology, especially for the car sharing call centre, was crucial, even if this aspect was not quantitatively measurable.

Conclusions and Lessons Learned

Both the car sharing and pooling measures can be viewed as a useful integration to the current transit supply, and both were dedicated to specific types of users (occasional drivers for the former, and workers and employees for the latter). They also benefited from a series of incentives to increase their attractiveness. For instance, parking places were guaranteed for car poolers and a discount in the car sharing pass was offered to transit yearly pass holders. It is not possible to estimate what the results would have been without such incentives or whether both activities could have been self-standing, although it is important to note that the theoretical cost for operating per inhabitant is one of the lowest of the MIRACLES measures.

As with the access restriction measures in WP5 (measure 5.2a), car pooling and sharing can be viewed as the necessary "pull" part of a "push and pull" approach, in which the constraints are, in this case, represented by the attempts to make people change their reliance on the use of their own private cars.

Another critical issue is the method of monitoring the development of such measures, which are difficult to control, especially regarding the number of car poolers. Possible answers include the increasing role of technology to improve the management conditions of the services, as well as the need to continuously support such initiatives with awareness campaigns.

4.1.12 Measure 9: Kerbside-Doorstep Deliveries

The Measure

The "kerbside-doorstep delivery" scheme was a "soft measure" based on the development of a feasibility study to improve goods delivery conditions in the Laboratory Area. Core objectives were the location of loading/unloading areas, especially inside pedestrian precincts of the historical city centre; the identification of unsuitable streets for loading/unloading operations, and the possibility to locate loading/unloading areas for night operations.

Key Findings

As a pre-requisite to the initiatives to be implemented to solve delivery problems on an urban scale, the feasibility study focused on the comparison between place performances and user demands to assess the real need of loading/unloading areas in the city centre. This approach was innovative, since former studies assessed quantitative data concerning modes and delivery features in the delivery system. The first estimate was an increase of approximately 10% (from 186 to 201) in the number of load/unload areas over a four year period as a result of natural growth in supply (the business as usual scenario), which seemed unsatisfactory. It was therefore necessary to develop a real comparison between operator requirements and availability of space. To estimate the number of lots required in a representative street of the city centre, a coefficient was used to evaluate the daily attraction of commercial vehicles. On a given street the number of lots ranged from 3 to 14, and a count survey of commercial vehicles confirmed the results obtained by the attractiveness coefficient. By expanding the results obtained to the downtown level, it was estimated that about 600 new lots were required, in accordance with the current development of the city and consistent with the commercial high-density nature of the area. This number of lots was then confirmed by informal municipal planning results.

Other Results

Such an increase of lots should provide sufficient capacity to enable night-time deliveries. However, this is not practical on tourist streets, which are still busy during night-times. Therefore, these were considered "no night delivery operations" zones. Moreover, residents' parking requirements were taken into account in light of the fact that the creation of new bays for deliveries often results in fewer parking lots for residents. This meant that although the amount of 600 new lots is appropriate in terms of infrastructure supply, discussions among citizens, operators, retailers and administrators are still required.

Conclusions and Lessons Learned

The feasibility study was specifically concerned with the city of Rome, and it is difficult to assess an overall transferability of the study results to other sites. However, an important consideration is the parking requirement. Once this basic requirement is met, any other intervention or large-scale strategy (as developed

within the upscaling exercise for instance) is possible. In Rome, given the poor supply of load/unload areas, any extra action in terms of fleet renewal, e-commerce development, logistic platforms location, etc. must be postponed. Another point to consider is the wariness of the local operators, which makes it difficult to obtain a proper knowledge of their requirements.

Historical urban features and dense land use greatly complicate delivery system networks in historical centres. Political will is required, in terms of measures to implement, but political measures are not sufficient when the built environment has premium value. Typically in this case, the provision of loading/unloading areas is poor and conflicts between residents and operators are likely to arise. Therefore, only a relative optimum can be attained.

The aim of the focus on this soft measure is, hence, to prompt local administrators to go on with new, more in-depth studies so to achieve sounder parameters prior to any political decisions or interventions.

4.1.13 Measure 10.1: Awareness

The Measure

Dedicated awareness campaigns to inform citizens about specific measures and their benefits (e.g. implementation of the new trolley line, purchase of low emission vehicles, “clean zones”, electric scooters, and new information systems) were undertaken throughout the project lifetime. The goals of the measure were to raise general awareness of sustainable mobility issues and initiatives, and to encourage modal shift towards greener transport modes. Dissemination activities were held by organising public meetings and participating in special events related to mobility.

Key Findings

The awareness campaigns were targeted at specific categories of citizens (pupils, employees, mobility managers, residents of area affected by specific measures, etc.). Such an approach was quite innovative since, prior to MIRACLES, mobility awareness campaigns had been very general.

There were many promotional events including the official presentation of the car sharing service, the campaign for the launch of the PAGOBIT system, information on the Tridente pedestrianisation, public meetings arranged especially during “Green Sundays”, the opening ceremony of the first four recharging stations for e-vehicles, and the award of ten e-scooters to University students. A specific brochure (in Italian) was created to promote the concept of the Sustainable Mobility, and distributed during these events. Other special conferences and workshops took place such as an event to explain sustainable mobility initiatives to school-children, and a video of the new Trolleybus was produced to be shown at the UITP world conference in Rome.

Efforts were also directed at disseminating the results achieved thus far within the scientific community. The innovative features of many implemented measures have been presented in national and international meetings, conferences, and workshops.

Other Results

All the measures had good media coverage at a city level. Moreover, the ATAC website provided information on MIRACLES and the MIRACLES/CIVITAS logos were added to the sections on “Safety and Security”, “WAP”, “Sustainable Mobility” and the new section of the “Cycle lanes”.

Conclusions and Lessons Learned

In spite of all this effort, increasing awareness of sustainability mobility is a never-ending process. People need to be clearly informed and continuously kept up-to-date with project activities, and stakeholders need to be reminded that communication is essential when pursuing the goals of sustainability, equity and social inclusion.

Raising awareness levels is a very difficult task because local administrators have to persuade citizens to change their car-based habits and move away from their reliance on private vehicles. This can explain why citizens seem to be more aware and satisfied with those measures that do not limit their freedom to drive, and also why such attitudes have traditionally prevented decision-makers from looking for options other than car-based ones.

Therefore, a key lesson learned from the MIRACLES project is that the more car-restrictive a measure is, the greater the commitment needed to inform citizens about the potential benefits. This implies a total revision of the measure implementation processes, increasing the importance of communication and dissemination at every stage.

4.1.14 Measure 10.2: Mobility Management Measures

The Measure

This measure was concerned with the promotion of alternative forms of vehicle use for commuters, and raising the awareness of the need to rationalize home-to-work trips among employees, decision makers, private transport companies and administrators. Mobility managers were responsible for developing commuting plans, mustering crews for car pooling, providing information on all the opportunities and initiatives aiming at stimulating the use of collective transport. In this context, the task of ATAC was to coordinate and to support Mobility Managers appointed by the companies, under the legal, administrative and technical points of view.

Key Findings

By the end of 2005, ten Home-To-Work Plans (HTWPs) were in operation, involving a mixture of private companies, administrative and research bodies. The success of the measure can therefore be assessed by the hugely increased number of participants, which exceeded the results foreseen in the ex-ante evaluation. In 2002, there were 2,391 regular participants of HTWPs and they belonged to just two bodies (a private company and a university). As of October 2005, the average user number was 41,805 units, “consuming” 15772 vkm. About 1,400 users shared HTWP daily. During MIRACLES, the service increased year by year. In 2003, there were about 23,000 users per month, which increased to about 28,000 per month during the first half of 2004. There was also an increase in the number of managers involved in the creation of new HTWPs; during the MIRACLES project 25% of new nominees were appointed to such task, exceeding one of the goals: i.e. to have 15% of nominees developing HTWPs.

Other Results

The results related to the impacts on traffic and the environment were difficult to assess, although it was estimated that the measure should enable a reduction of 7,5 million of vehicles/km year, a decrease of CO emissions of about 67,2 t/year and of benzene emissions of 239,2 t/year. A reduction in fuel consumption of about 244 t/year was estimated. Such results should prompt private companies to invest more on this aspect.

Conclusions and Lessons Learned

This was a measure in which regulations, funding and the requirement to increase the awareness of the need to use more collective modes all played major roles. On the one hand, a strong political direction aimed at supporting sustainability as a national issue was the "trigger" that both enabled initiatives such as HTWPs to be implemented and granted the funding to financially support them. It is very difficult to assess whether HTWPs would have been implemented, without such a political will. On the other hand, a general consensus from the users is needed to match these efforts.

Currently, such acceptance still seems to be missing, at least concerning the end-users. Indeed, the regular 41,805 users represent just 2.7% of all the potential participants. This means that even though decision makers (local administrators and mobility managers) are fully aware of the potential benefits offered by this measure (as the several new requests to apply future HTWPs demonstrate), potential users still appear to need strong reasons to stop driving to work. Therefore, future work should promote campaigns to increase the perception among the employees that driving alone to work is not the best habit/solution. This means that traditional transit and its innovative forms such as car pooling or collective taxis, must increase the attractiveness of their endorsing campaigns. These should be especially targeted towards commuters, to make them aware not only of the personal benefits derived from using collective modes but also of the positive outcomes that can affect the environment as a consequence of their changed behaviour.

4.1.15 Measure 11.1: Improved Multi-Modal Traveller Services

The Measure

The measure broadened the availability of PT-related information through the use of three services: e-ticketing (formerly called TELEPAY, currently PAGOBIT), the INFOPOINT internet accessible tool, and the development of a telematic platform to deliver information via mobile phones (SMS, WAP, i-mode, XHTML).

Key Findings

The telematics-based initiatives were aimed at providing public transport information, with the emphasis on real-time, availability and user-friendliness. It was a complex task to make the service reliable and widely implemented, and required an in-depth knowledge of telematics and user / operator needs, as well as the study of legal and organisational constraints. Regarding PAGOBIT, customer care data showed that the user satisfaction rate for the service was 95%, and 97% of users would recommend it. Its main advantages were based on time-savings and 24h-availability. (It should be noted that the system average transaction time was about 30 seconds, with a capacity of 10 tickets/min). About 300 tickets were sold on a daily basis via mobile phones. In addition, the number of people accessing the INFOPOINT web pages increased by 30%, and there were approximately 10,000 queries per month by the "mobile/wireless users" since implementation of the wireless system. Together, these indicated the success of the measure. Regarding the INFOPOINT service for tourists, the website has become multilingual; moreover foreign visitors are served by five kiosks, where they can collect information, make reservations and purchase tickets.

Regarding the development of a telematic platform to deliver information via mobile phones, results could not be assessed by the usual indicators or parameters used for other measures where the infrastructure or regulatory facets were the key aspects to evaluate. The evaluation therefore focused on the applicability of the platform, which proved to be appropriate and operated well during the demonstration period.

Other Results
The user-friendliness of INFOPOINT and the telematics platform relied on the service interface being made as simple as possible and easy to download by mobile devices. Information promptness was also a key parameter within the interface development process. Hence the services were designed to allow users to use them as they would any other internet page.

Conclusions and Lessons Learned
The best available telematic technologies and associated knowledge were essential pre-requisites for implementation of this measure. For instance, concerning the development of the telematic platform, the need to provide information via new media led to the design of an open platform, capable of using all the different communication protocols used in the mobile communication market and of displaying the information (texts and maps) according to the graphic functionalities of each tool. Thus, the results should be considered not only from a user satisfaction point of view, but also in relation to the technical and operational issues. In this case, the reliability of the service could have been unsatisfactory if the implementers had not been able to use data on public transport information demand, collected both from the ATAC website and other previous research (mainly the project CAPITALS ITTS).

It is anticipated that greater benefits will result when the measure (i.e. all the provided services) operates on a larger scale, not just at the local level. Indeed, only when such services enter the mobile communications market at a European level, will the financial and legal barriers (due to a limited area of implementation) be overcome. Decision-makers will then see all the advantages of integrated information, and trial schemes such as the one studied in MIRACLES will translate into wider implementations.

4.1.16 Measure 11.2a: Improved Network Management – Information

The Measure
"Improved Network Management" was a multi-task measure based on the implementation of ITS technologies to improve the quality of data and information required to control traffic, including public transport, and the associated pollution. In particular, the applications concerned:

i) the improvement of the so-called "OCTOPLUS" system, which was aimed at planning the selective priority of single vehicles (trams) in response to any delays. It worked with a real-time traveller information system, with news accessed via electric panels at stops, mobile phones or the internet;
ii) the AVM project provided real-time information regarding the newly created "express bus" line n.60 (a route across the project Laboratory Area). Dynamic information was disseminated via electronic signs at bus stops. On-Board Units (OBUs) used GPS satellite-based technologies to provide the positioning of the bus to the Central Agency System which then dispatched the messages to the bus stop signs.

Key Findings
The most important aspect of the two subtasks was the increased quantity and quality of information that could be achieved due to implementation of both systems. For example, regarding OCTOPLUS, users were informed at bus stops about the arrivals (updated in real time) of the trams, and such information was very innovative for Romans, who previously used to just wait for the bus and to read bus routes on poles. In addition to end-users, there were also advantages for operators. For instance, information regarding service regularization increased substantially, as did the recording of service performance, supervision of the automatic procedure, and

information system management. AVM also allowed passengers waiting for the bus to know how long they have to wait before boarding, for the next two approaching buses of the same line.

Other Results

The express line n.60 was a prototype, and a decision will be taken whether to implement the dynamic information system across the whole PT network. (2572 buses and 50 trams have so far been equipped with OBUs and all the 12 depots have been wired). Consequently 189 bus lines are now monitored. The Municipality of Rome also successfully tested 300 electronic bus stops along other major bus lines in the city centre in April 2006.

Conclusions and Lessons Learned

It was considered that the indirect benefits to the community were clear and so both subtasks should move from the one-off status of the MIRACLES project to become systematic features within the overall urban management. Moreover, as with the other telematics-based measures, the public appreciated the innovation, and therefore it is likely that this measure would be supported under a wider implementation.

However, before the system is applied on a larger scale, it is important to analyse the type of information to be managed. Indeed, processing information involves many actors, especially more PT operators. This requires security and administration policies to be taken into account and problems related to the reliability of the information system itself may need to be overcome.

4.1.17 Measure 11.2b: Improved Network Management – Environment

The Measure

The applications within this part of the multi-task measure focused on environmental analyses, and concerned:

i) the environmental analysis of Traffic Demand Management Strategies (TDMS) using a mapping of the air pollutant concentration levels by means of a suite of simulation models including a traffic model, an emissions model and an atmospheric dispersion model;

ii) some additional on-street measuring surveys using a “floating van” (a mobile laboratory) to collect data on driving patterns and the relevant speed profiles along specific routes, and to acquire additional information about the local concentration levels of the more critical air pollutants.

Key Findings

The model ‘Traffic Environmental Model Chain’ (TEMC) was developed, implemented and validated. The main purpose of the system was to provide a real-time description of traffic flows, pollutant emissions and concentrations within the Laboratory Area, and improved the frequency of the pollutant calculations. For example, before MIRACLES, measurements of CO, particulates and benzene emissions occurred only once a year, for inclusion within the local Air Quality Report. The pollutant dispersion maps are now calculated at hourly intervals for each pollutant. In addition, the new EU Directive on Air Quality, to be published in 2006, requested large cities to assess pollution dispersion maps and this system complies with this request.

The operator interface (front end) was completely redesigned from its initial development as a client-server system to a web-oriented front end. Further analysis of the traffic algorithm (developed, implemented and validated by ATAC) meant it

was possible to define a general "traffic index". This enabled the city congestion level to be assessed and weekdays to be classified according to traffic indicator values such as traffic flows and speeds on the primary network. Real-time images of traffic flows and traffic events area were also provided on the ATAC website, and updated every five minutes.

In addition, the concept of the "floating van" was innovative and was used to integrate speed profile measurement with on-line measurements of the particulate matter smaller fractions (2.5 and 10).

Other Results

The application of the TEMC model was very relevant for forecast and comparison activities. For instance, during a specific day in the summer holidays, traffic data was analysed in response to a detected increase in PM_{10} values. It was found that peak traffic flow took longer to disperse that day, compared to a typical day in the winter period. Moreover, the unexpected closure of a main road produced congestion during the evening hours that, in conjunction with poor weather conditions, caused the PM_{10} alert. The theoretical system operating cost was low, only 0.05 Euro per inhabitant.

Conclusions and Lessons Learned

Both the design and implementation processes were very complex because many steps were required to ensure the model was appropriate within the context of the application. A continuous revision of the relevant evaluation process meant that an iterative approach was taken within the development and calibration of the model, interpretation of the model outcomes in relation to the implemented measures, and dissemination of the results. The results can be considered a fruitful starting point in the overall process of real-time monitoring of the city pollution level. Further implementations will further refine the results.

4.1.18 Measure 12.1: Clean Buses

The Measure

The measure was based on the renewal of the bus fleet, which involved the purchase of 908 Euro III buses, 200 EURO III CRT buses, 30 "new generation" bi-modal trolleybuses, and 10 electric buses.

Key Findings

The purchase of the buses essentially met the requirement of upgrading the fleet to the latest environmental standards. The new buses were equipped with Continuous Regenerative Traps (CRTs), which reduced PM_{10} emissions and meant that the bus was compliant with Euro IV standards. This meant the planned goal of reducing transport-related emissions by 13% inside the LTZ was exceeded; indeed within the Rail Road area – 28% for dusts, - 15% for VOC, - 16% for NOx and eventually – 18% for CO emissions were recorded by the ex post measurements.

The old generation of buses (Euro 0 standard) were both high-polluting and noisy. Therefore, another important improvement concerned the noise reduction. To assess the benefits arising from the implementation of the new vehicles, a survey monitored traffic noise before and after the implementation of trolleybuses, comparing the increase of noise due to the passage of a Euro 0 bus with one produced by a trolleybus. Even though the "white noise" (i.e. the combination of all the sounds of all different frequencies in that given urban environment) was very high, a Euro 0 bus passing by increased such noise by about 10 dB(A). On the contrary, a trolleybus only increased it by about 5 dB(A). This represented a substantial reduction, especially considering that dB(A)s are measured according to a logarithmic scale. However, other

factors also contributed, including the change of the road surface from block pavement to asphalt and/or concrete.

Other Results

The purchase of the new vehicles meant that the bus fleet was renovated (1107 Euro III buses replaced at least 44% of the previous vehicles) and "rejuvenated". By late 2005, 38% of the entire fleet was composed of new, eco-compatible vehicles, which lowered the average age of the fleet (from 12 to 5.75 years). This exceeded the original goal of replacing at least 25% of the PT fleet with Euro III Standard clean vehicles and electrical vehicles. Euro 0 and Euro 1 buses now make up just 12% of the whole fleet. Such a renovation process can be considered as one of the main drivers towards achieving the planned goal of reducing the number of polluting vehicles by 10%.

As with WP7, accessibility and comfort were crucial factors for the purchase of the new set of buses. All the buses were equipped with air conditioning and low floor, two seats were disabled-accessible, and on-board videos provided information and news to the passengers. Public awareness and acceptance of clean vehicles increased (as reported in measure 7.3).

Another interesting facet concerns the energy consumption issues. Indeed, it is worth noticing a substantial reduction for both "energy efficiency" (0.08 MJ/pkm) and "vehicle efficiency" (3,3 MJ/vkm) indicators related to trolleybuses as ex post values (respectively, 0.1 MJ/pkm and 3.8 MJ/vkm as baseline values). The vehicle efficiency indicator shows a good reduction also for e-buses (3.6 MJ/vkm), whereas the energy efficiency seems not to have met expectations, being 0.2 MJ/pkm higher. However, such an apparently contrasting result is due to the modest capacity of each electric bus, which holds only 27 passengers. However, the small size of the bus is essential for accessing the narrow streets of the city centre.

Conclusions and Lessons Learned

This measure was based on a "purchase" procedure and the main difficulties came from the process itself, and not from the purchased "product". For instance, during the implementation of the plan for the fleet renewal, the call for tender needed to be re-written, which caused delays. In addition, the tender bid for 36 electric buses failed because no supplier submitted a tender. In 2003, the same reason caused the failure of the tender bid for 70 diesel buses (Euro III compliant and CRT-equipped). These complications illustrate the need to change procedures to enable the purchase of 'special' items.

4.1.19 Measure 12.3: Clean Fuel Support

The Measure

Within Rome, a fleet of 391 electric scooters (e-scooters) were formerly available for rental and are currently at disposal for no-profit organizations. The fleet was originally acquired by Rome Municipality before MIRACLES in order to promote the use of e-scooters. Subsequently, some were transferred to administrative units of the Municipality to be used for specific, regular urban trips, while 200 were transferred or donated to non-profit organisations such as Universities or Local Health Units. Within MIRACLES, a set of recharging points was located in the Laboratory Area. The aim of the measure was to promote and facilitate the use of e-scooters, and encourage a shift away from the traditional motorcycles, which are highly polluting, especially regarding PM_{10} emissions.

Key Findings

In quantitative terms, this measure can be considered a "niche" intervention since the fleet of e-scooters only represented approximately 0.001 of the entire two-wheel fleet in Rome. Hence, its contribution to the reduction of the overall pollution rate was very modest and barely affected the modal split. However, e-scooters must be framed in a larger picture concerning the promotion of clean mopeds and motorcycles at urban level. For instance, in 2001 there were 441,110 non-catalysed two wheelers; in 2006 there are just 242,140 units (at whole city level); i.e. a decrease of 45%. Hence, the goal of reducing the number of polluting scooters by 1% in the LTZ can be considered as fully achieved. This aspect affected also the emissions level since positive results can be recorded for COVNM and dusts (respectively – 22% and – 50%).

The most important aspect related to how users perceived this new type of vehicle. Discussions with representatives of the companies and non-profit organizations found that users were generally satisfied with e-scooters, but complained about the limited autonomy of the batteries.

Other Results

The largest barrier to the implementation of e-scooters in Rome was the limited autonomy of the batteries, which casts doubt on the possibility of implementing these vehicles on a wider scale. Another difficulty was the implementation of the on-street recharging stations because of the poor market supply of such items. Recharge operations proved to be a limit themselves: indeed, the time (roughly 6 – 8 hours) required to recharge batteries prevents the measure from becoming more popular.

Conclusions and Lessons Learned

The concerted effort spent by the Municipality in examining all possible options to counteract pollution starts from apparently "minor" interventions, such as the implementation of e-scooters. The Municipality advertised the benefits of electric vehicles in general by dedicated campaigns and allocated funds to prompt people to purchase e-bicycles, e-scooters and electric vehicles. However, take-up was slow because the public were sceptical about such modes.

New modes call for in-depth educational campaigns as a pre-requisite to any promotional initiative, so as to involve the public in local policies. This transfers the problem to the lack of a long-term culture on new forms of mobility. In this case, e-scooters were a typical example of an innovation in the field of mobility, applied in a context in which the majority of users are still strongly convinced that their private cars are the only available option to be used for all types of trips, and that any other possible option must generate the same performance as their own cars. This does not mean that such initiatives should be stopped, but highlights that the challenge is to continue implementing them in synergy with more information campaigns aimed at changing the strong car-based culture.

4.2 Summary of Measure-Level Results for Winchester

The summaries for Winchester are presented in sections 4.2.1 to 4.2.11. See Annex 2 (2nd Implementation Report for Winchester) for additional details of any of the measures.

4.2.1 Measure 5.1: Set-up of city centre clean zone

The Measure

The objective was to investigate the impact of high polluting vehicles to improve air quality in Winchester city centre, which was declared an Air Quality Management Area (AQMA) during the lifetime of the MIRACLES project. The NO_x and PM_{10} emissions were particularly problematic in Winchester and not accounted for under the UK MOT emissions test. Emissions from passing cars were measured using a roadside remote sensing device (RSD). Using these measurements it was possible to estimate the number of high polluting vehicles passing through the chosen measurement sites, which were selected on main radial routes leading into Winchester.

Practical use of the results was intended with a number of feedback strategies to vehicle drivers, which aimed to encourage voluntary maintenance of high polluting vehicles or to restrict them from the city centre. These strategies were:

i) Use of mobile VMS at the roadside to inform drivers of the levels of their emissions (e.g. GOOD, FAIR or POOR);
ii) Use of a website based database to list emission readings from individual vehicles;
iii) Provide a subsidised emissions check and repair service to high polluting vehicles.
iv) Instruct high polluting vehicles to use Park and Ride instead of travelling into the city centre.

Unfortunately, although the necessary technology was available, this measure was severely delayed due to continual technical problems with the measurement equipment. This ultimately meant that the strategies could not be implemented on the road. Instead, a detailed stated preference survey was undertaken as well as more general surveys to understand the support and potential take up of the various feedback strategies.

Key Findings

A vehicle was considered a high polluting vehicle based on a number of pollutant concentration thresholds. The percentage of vehicles measured that could be classed as high polluters was very low (approximately 0.1% for CO, 0.4% for HC and 0.01% for NO_x). It is possible that this low number of observed high polluters may be due to poor sensitivity of the equipment (e.g. in capturing the vehicles exhaust plume correctly). Alternatively, it may be due to the measured vehicle fleet being newer than average or being well-maintained. In addition, a number of measurements will have been taken when the vehicle did not have sufficient load on the engine and so are not truly representative; by removing these readings from the analysis it is likely that the percentage of gross polluters will increase.

The cost effectiveness of monitoring an individual vehicle's emissions using roadside RSD was £0.21 per measurement if the fixed equipment cost was excluded, or £3.75 per measurement (based on 35,000 measurements) if the cost was included.

Some general questions relating to roadside emissions testing were included in a questionnaire circulated amongst the general public. Approximately 1000 responses

were received. 80% of respondents strongly agreed or tended to agree with the monitoring of vehicle emissions to assist and advise vehicle owners to help reduce pollution in Winchester city centre. 73% of respondents indicated they would like to be informed of the level of their vehicles emissions, whilst 76% of respondents would be interested in a subsidy to inspect and repair their vehicle if it were suspected of having an emissions fault. 72% of respondents agreed that vehicles producing high levels of emissions should be encouraged to use Park and Ride instead of entering Winchester city centre.

Regarding the stated preference questionnaire survey, the majority of respondents (~80%) would arrange for their car to have an emissions check voluntarily if their emissions readings, which were fed back to them at the roadside via a VMS, indicated their vehicles emissions had deteriorated to the POOR band. An exemption from the emissions element of the MOT test for vehicles which had been measured to have low emissions would seem to be a potentially successful incentive at increasing the numbers of drivers who would deliberately drive out of their way to drive through the site (increase from ~10% to ~35%).

Of those that would check the web service, most (~60%) would check it every month or less frequently. The web service would seem to be more useful as a support tool for vehicle owners rather than a stand alone service operated instead of the use of the roadside sign, thus allowing vehicle owners to check their vehicle emissions if their reading on the sign had changed recently. The offer of a free emissions check only slightly increased the proportion of respondents who would have their vehicle checked compared to them having to organise their own check voluntarily and the additional offer of a repair subsidy again only slightly increased the proportion taking up the offer. 6% of the respondents stated that they would not be willing to have their vehicle checked under any circumstance based on the RSD measurement.

Diverting people to Park and Ride would seem to have chance for limited success at preventing drivers of POOR vehicles entering the city (between 13% and 23%) although those who had used the Park and Ride previously were more likely to divert if asked to do so.

Conclusions and Lessons Learned

NO_x and PM_{10} are key pollutants causing declarations of AQMA's in the UK, and this is likely to be the case elsewhere in Europe. Any measure of this type should use an RSD unit capable of accurately detecting these pollutants (such systems are available on the US market, but are expensive). The unit used in this trial gave only an indication of NO_x/CO_2 (due to lack of sensitivity of the equipment to this pollutant) and there was no facility to measure particulates.

Links to vehicle records held by regional or national agencies (e.g. in the DVLA in the UK) would allow enrichment of the captured RSD records with fuel type, age, emissions standard etc. and enable a more targeted approach towards contacting the owners of the identified high polluting vehicles.

A rigorously proven RSD unit with the capability of detecting 90% of vehicle emissions accurately should be used for such trials.

Questionnaire results and anecdotal evidence from the public indicates that regular feedback to vehicle owners on their emissions would be welcomed. It is not known what subsequent actions would be taken to repair a faulty vehicle, although further results will become available after the end of the project.

4.2.2 Measure 6.2: Adoption of Flexible Parking Policies and Environmentally Linked Parking Charges

The Measure

The main objective was to promote energy efficiency of the vehicle fleet parking in Winchester city centre by implementing a variable tariff at several 'Pay and Display' car parks. Discounts of 75% or 50% were offered on the usual cost of a season permit for those vehicles in the road tax bands (A or B) with the lowest CO_2 emissions. In addition, owners of electric or hybrid vehicles were offered free season permits at these car parks. In parallel, four multi-storey car parks were converted to a 'Pay on Foot' payment system. This enabled the public to more accurately pay for the parking time used and had the added benefit of cutting costs by removing the need for parking wardens. However, this consequently meant that such car parks were not included in the discount scheme.

Another aim was to implement a parking policy to discourage long stay parking in the city centre and encourage use of the Park & Ride (P&R). This involved a significant cost increase in all-day parking at selected car parks, significant price differences in parking charges for car parks on the outskirts of the city, converting selected long stay car parks to short stay, reducing the minimum stay period at selected car parks and removing free car parks from the city centre area.

Key Findings

The proportion of vehicles that qualified for a discount was low. Of the 359 vehicles issued with a season permit at participating car parks, only 29 (8.2%) were eligible for a discount as of October 2005 (although this had increased to 35 (9.7%) by the end of 2005). Considering the city-wide area, there are approximately 770 season permit holders. Based on the October 2005 data, a desktop up-scaling study estimated that the expansion of the discount scheme to a city-wide level would result in the equivalent of 37 small/medium sized vehicles being removed from the road. (However, it is likely that the actual value is lower since some people will have transferred to the city centre car parks to take advantage of the scheme).

A questionnaire was distributed to the season permit holders and 165 responses were received. Only three respondents owned a 'qualifying' car and the two who had purchased a low-polluting vehicle since the start of the measure stated that the scheme had not influenced their decision. It should be noted that this survey was undertaken less than a year into the scheme and some of the more recent qualifiers may have had their purchasing decisions influenced.

During the project lifetime, ticket sales for the seven busiest city centre car parks, decreased by 16% (about 235,000 tickets), but increased at the P&R sites by 43% (43,000 tickets). Revenue at the city centre car parks increased by 11% (due to general fare increases) but only by 6% at the P&R sites. The latter is largely due to the increased take-up of the P&R smart card discounted ticketing system. There is therefore evidence that the parking policy/charging measures led to more drivers parking at the outskirts of the city centre area or the P&R site.

Other Results

75% of questionnaire respondents were aware of the scheme. This high awareness level was to be expected since all permit holders were sent information on the scheme with their permit renewal notice, although some of the respondents did not receive the information as their employer paid for their parking space. (Awareness among the general public was much lower, at 11%). 58% of the sample (and 70% of the public) generally agreed with the scheme and 31% stated that the parking ticket

discounts would encourage them to purchase a more environmentally friendly car in the future.

An additional aspect was to offer people renewing their season permits the option of trialling the P&R service for free for two weeks. It was reported that 51 people took up this offer. Of these, 47 did not renew their season ticket possibly implying that they continued to use the P&R site.

Conclusions and Lessons Learned

Low-polluting vehicles currently constitute only a small percentage of the vehicle fleet in Winchester, and so no quantifiable impacts could be directly measured, although the number of qualifying vehicles has steadily risen during the project lifetime (e.g. from 17 vehicles in May 2005 to 35 in December 2005). In hindsight, the scheme could have been demonstrated at a wider level, by targeting more vehicles e.g. those LPG vehicles or those with tax bands just below the A and B levels. However, the target audience is linked to the wider city-wide political and financial decisions that have to be made by the local authorities. For instance, the P&R site in Winchester is heavily subsidised by the parking revenue generated from the city centre car parks.

The limited application showed that there is some potential for a greater shift in future years as the vehicle technology becomes accepted. The public generally agreed with the scheme, and there was some indication that it would influence future purchases of low CO_2 emitting vehicles, although it is acknowledged that 'stated preference' results should be treated with caution.

It had been intended to also implement the scheme at the 'Pay on Foot' car parks by using ANPR (Automatic Number-Plate Recognition) technology to allow discounted tariffs to be assigned on an ad-hoc basis for non-season ticket holders. However, operational problems with the introduction of the 'Pay on Foot' system meant that the ANPR function was not added to the system within the MIRACLES timeframe.

4.2.3 Measure 7: Improving Bus Service Quality and Information

The Measure

A range of mini-measures included the purchase of 13 new buses serving two city centre routes, and improved infrastructure and bus information. In addition, the P&R route was incorporated within the newly developed Bus Quality Partnership (BQP) and another cross-city P&R service to the hospital was trialled. The objective was to increase bus patronage and improve user satisfaction.

Key Findings

On the three MIRACLES routes, patronage increased by an average of 6%, but this varied between routes. For example, patronage on one city centre route increased by 19%, but decreased on the other by 12%, predominantly due to the change in service frequency. Two non-MIRACLES 'control' routes saw an average decrease in patronage of 6%, which was in line with the reported national 2% reduction in bus passengers per annum during 2002-05. Passenger satisfaction ratings on the MIRACLES routes were very high, with 87% of passengers rating the service as 'good' or 'very good'. However, it should be noted that the corresponding baseline result was at an already high level of 83%.

Other Results

For the two MIRACLES city centre routes, revenue increased by an average of 27% whilst the revenue generated on the two control routes increased by 16%, mainly

attributable to the fare increase of 20% during 2001-05. Ticket sales at the P&R site also increased substantially (by 43%) as a consequence of the car park extension.

Factors were used to estimate changes in emissions along the two city centre routes as a result of replacing the older vehicles with new Euro III buses. There were significant reductions (43%, 62%, 47% and 52% for NO_x, PM_{10}, CO and HC, respectively), although the average age of the overall bus fleet only reduced slightly (from 7.27 years in 2002 to 6.71 years in 2004). There was also evidence of improved reliability: the number of early/late bus journeys reduced from 0.95% in 2002/3 to 0.34% in 2004/5.

It was estimated that the investment in the 13 new buses by the bus operator Stagecoach was justified as it should be recovered within 12 years due to the additional revenue generated by the increased patronage. This is well within the expected life of the vehicles (15 years). If user and non-user benefits are also included, it was estimated that the investment by both Stagecoach and HCC would be recovered in 4 years.

Additional revenues from ticket sales will not be enough to recover the investment made in extending St Catherine's P&R car park. At present, a subsidy is also required to cover the operating costs (bus and site) although the recent increase in the daily charge to £2 should help to reduce this amount.

Conclusions and Lessons Learned

The 19% increase in patronage along the MIRACLES-affected commercial route was attributed to it being a route with potential for passenger growth and including destinations with high passenger demand. This specific service was also influenced by an increased frequency (from 4 to 6 times per hour) and there was evidence that the physical improvement of the interchange area outside the railway station contributed to the success. Indeed, passengers stated that comfort and frequency were two important factors influencing their use of the service. The significantly lower price for the P&R service (£1.50 / day in September 2005) compared to the cost of parking at a city centre car park (£6 / day) is likely to have been a key factor in the success of the P&R service.

The cross-city P&R service was set up to provide an alternative mode of travel for staff working at the hospital. It was abandoned at the end of the seven-month trial because it attracted few passengers, predominantly because of the higher cost in parking at the P&R car parks compared to the comparable cost of parking at the hospital. In future, it is recommended that a detailed survey of passenger demand and relevant parking policies is undertaken to establish whether such a service would have a viable passenger base.

4.2.4 Measure 8.2: New Cycling Opportunities

The Measure

This aimed to increase the level of cycling within Winchester and stimulate the use of sustainable transport by tourists and residents. The main initiative was the introduction of the Bikeabout scheme. This was a pool of 50 bicycles situated at two main locations, available for the public to borrow for a one-day period (or longer). The scheme was free of charge although for security, each participant had to join the Bikeabout scheme beforehand and pay a membership fee of £15. Other mini-measures were the installation of additional cycle stands and the redesign of a Pocket Cycle map for Winchester.

Key Findings

As of August 2005, the Bikeabout scheme had 160 members and peak usage resulted in almost all the bicycles being used at any one time. A small number of travel diaries were completed, and the average trip length was 2.7 miles (4.3 km approx) with 57% of journeys being round trips. Most users usually travelled by bicycle or foot within Winchester, although three people stated that they had switched from car. The majority (83%) of members thought that the scheme was generally good. Cycle parking surveys found that the peak number of cycles parked in Winchester increased by 46% during 2002-05, although this was influenced by the additional Bikeabout bicycles. Cycle count data at eight sites showed a 12% decrease in the number of cyclists during 2002-2004, which implies that the Bikeabout scheme may have had a positive influence on the levels of cycling within the city centre itself.

Other Results

Bikeabout users were fairly evenly split in terms of age, gender and journey purpose. The general MIRACLES awareness and acceptance surveys found that 38% of the public were aware of the Bikeabout scheme and 66% generally agreed with it. There was some indication that people already travelling by sustainable travel modes were more inclined to agree with the concept. 28% of members stated that they did not have access to another bicycle. 6% of the public were aware of the Pocket Cycle map.

Conclusions and Lessons Learned

Winchester is a relatively small city with most facilities being within walking distance of the City Centre thus reducing the attractiveness of cycling. The overall cost of the Bikeabout scheme was about £100k (€150k approx), split equally between manpower and equipment. The manual operation of the scheme meant that the operators could actively promote it and also provided a visual contact for the service. A more flexible approach would have been to use an automated system accessed by smart cards, but this proved too expensive. As expected, demand for Bikeabout grew during the summer months.

In terms of infrastructure, there is only limited scope within Winchester to develop and install new cycle lanes due to the lack of road space and high cost. It proved difficult to find additional locations to install cycle hoops (Winchester has nearly 200 already) and only 11 new ones were installed. Although the Pocket Cycle map identified safe routes, better integration and installation of new routes would have been an ongoing benefit to cycling in the City. Cycle stands could have been installed at workplace premises where a demand was identified, but the demand was not deemed to be sufficient to make installation viable.

4.2.5 Measure 9.2: Sustainable Urban Distribution

The Measure

This was implemented through three mini-measures:

- *the Collectpoint trial*, which aimed to reduce the number of missed home deliveries by using a chain of local convenience stores as a delivery point;
- *a Winchester freight map*, which was distributed to freight companies and venues such as petrol stations to improve the efficiency of urban freight delivery;
- *a waste recycling scheme*, which used an electric vehicle to undertake a waste cardboard and paper recycling service for Winchester city centre businesses.

Key Findings
A 10-week Collectpoint trial was undertaken and heavily promoted, including the prior distribution of flyers to 20,000 households. However, response was disappointing with only 75 people registering on the Collectpoint website and eight using their voucher. This was partly attributable to technical difficulties with the website and the voucher system. A second, more comprehensive trial was planned but this did not materialise due to the disbanding of the relevant sector within the company.

As of August 2005, the waste recycling service serves 30 businesses in Winchester, each month collecting around 1 tonne of recyclable waste (predominantly cardboard and paper). In addition to the environmental benefits, there was some indication that the use of an electric van was an incentive to local businesses to sign up to the scheme since they perceived it as being a useful Public Relations exercise.

Other Results
In parallel with the initial Collectpoint trial, questionnaires were distributed to 1600 households. From the responses, it was estimated that the average first-time failure rate of a typical home delivery was 20%, and that the majority of respondents stated that they would consider using the scheme. Simulation also found that if a fully operational scheme had been implemented, potential benefits could be gained in terms of reduced time and distance travelled. Awareness surveys found that 10% of the general public and 3% of businesses were aware of the Collectpoint scheme.

Conclusions and Lessons Learned
The initial Collectpoint trial was marred by technical difficulties and only a few people used the service. This lack of data means it is difficult to assess whether the Collectpoint scheme would have been commercially viable, although this trial indicates it is not. For such a scheme to be successful, internet retailers would need to incorporate it into their system as an alternative delivery option. A successful demonstration may be needed for this to happen.
Awareness of the freight map with Winchester businesses was low (3%). No evidence was collected to show that the freight map was used by freight companies, although some subjective comments suggested that the simplified map was useful. Whilst such a map could have been a useful tool for freight drivers, most likely picked up at service areas and filling stations, it was considered that the maps sent to businesses, which were generally not sent to a particular person, may not have reached those who might have benefited most.

Within the waste recycling collection trial, only a relatively small amount of recyclable waste was collected, typically about one tonne per month. Nevertheless, this appears to be an economically viable venture for the company running the scheme since the service is operated on a full-time basis. A client base of 35 Winchester businesses has been established and the scheme has been expanded to other towns in Hampshire. In addition, the participating Winchester businesses saw the use of an electric van as a worthwhile public relations exercise to enforce the impression that they are a ‘green’ company.

4.2.6 Measure 10.1: Innovative Soft Measures

The Measure
The main objective was to raise public awareness and acceptance of the measures being implemented within MIRACLES among visitors and residents of Winchester and businesses in the city centre. A variety of dissemination methods were used including leaflets, radio advertisements, a Winchester MIRACLES website,

demonstration days and a school art competition. In addition, businesses, organisations and schools were encouraged to develop green travel plans.

Key Findings

Public awareness and acceptance of MIRACLES initiatives was assessed through five sets of questionnaire surveys: "Winchester Travel" (baseline and final), "Winchester Transport", "MIRACLES Awareness", and "Business". Awareness of the MIRACLES logo increased from 3% during the baseline survey to 20% in the final survey (and 24% in the business survey undertaken in 2005). The dissemination methods that generated the highest awareness levels of the project were a local newspaper (13%), a leaflet or poster (13%) and Bikeabout bicycles (11%). Impersonal methods (such as radio advertisements in particular) were less often cited as being the main method of promotion.

A comparison was undertaken regarding awareness of individual project initiatives. The highest levels of awareness were for those initiatives that had a high visual presence e.g. the demonstration days (57% for Bike Week and 51% for Alternative Transport Day), Bus Departure Information Systems or BDIS (49%) and VMS (42%), Bikeabout (38%) and improved appearance of bus stops (38%). Initiatives such as websites, maps, competitions, discounted parking, and Collectpoint had lower awareness ratings, but were targeted more towards specific groups of people and were therefore less visible to the public in general.

Other Results

The percentage of respondents that generally agreed with the council policy of encouraging people to reduce car use and travel by sustainable methods increased from 69% in the baseline survey to 71% in the final survey.

Conclusions and Lessons Learned

The demonstration days were particularly successful as they were highly visual with Bikeabout bicycles and electric vans on show. However, the public did not necessarily associate such events with MIRACLES. A demonstration day purely for MIRACLES may have changed this situation.

In parallel to MIRACLES, the Winchester Movement and Access Plan (WMAP) has been a local sustainable transport initiative, ongoing for the last 10 years. Awareness of WMAP increased from 20% in 2003 to 25% in 2005 (and 41% in the business survey undertaken in 2005). This indicates that although awareness of sustainable transport issues should increase in the longer term, even then it may not produce 'high' ratings.

Awareness and (stated preference) acceptance of an initiative does not necessarily influence travel behaviour. For instance, 71% of the public agreed that it was important to travel by sustainable transport, but only about 25% used a mode of sustainable transport in Winchester on a daily basis (based on all responses to the final questionnaire survey).

Staff resistance to car sharing or restricted workplace parking can reduce the effectiveness of green workplace travel plans. Hampshire County Council (HCC) could become more pro-active in their supporting role to encourage more companies to develop travel plans. As with schools, during the life of MIRACLES companies were eligible to apply for matching funds (up to £5,000) to support sustainable measures.

4.2.7 Measure 11.1: Improved Multi-Modal Traveller Information

The Measure

The objective was to install a variety of information display systems to provide better multi-modal information for travellers, especially public transport users. The systems included Bus Departure Information Systems (BDIS), information kiosks, real-time Information Display Units (IDUs), Variable Message Signs (VMS), and the use of mobile devices to access the ROMANSE website. Delays in the installation of some of these systems and technical problems in collecting the website's visitor statistics meant that the evaluation of some aspects of this measure was somewhat limited.

Key Findings

Two kiosks (located indoors at the Tourist Information Centre (TIC) and the Hospital) were installed in September 2004 and an average of about 500 users per month was recorded. When a third kiosk was installed outside on a pedestrian precinct in January 2005, the total number of users quadrupled to about 2000 per month. A fourth kiosk was installed outside the railway station in October 2005. This resulted in over 3500 users during November 2005. At each kiosk, the average usage time was about 4 minutes. In addition to traveller information, the kiosk provided other channels including email, jobs, news, tourist information and games. These other channels were accessed more frequently by the public than the 'intended' traveller information category.

On-screen and on-street surveys were undertaken. Not surprisingly, results from the on-street surveys were more favourable to the kiosks than the on-screen survey. With the on-street survey, the kiosks were rated more highly (94% to 85%), more people stated that the found the information they were looking for (97% to 72%), more found them easy to use (94% to 83%) and more agreed with the aim of improving sustainable transport (89% to 62%). However, a much larger proportion of the sample for the on-screen survey were younger people. An on-street survey of non-users was also undertaken. Many respondents had not noticed the presence of the kiosks, which were rebranded in a brighter colour in late 2005.

Other Results

Two small interview surveys were undertaken to evaluate public opinion of the BDIS systems, which provide passengers with a list of arriving buses. The majority of respondents had noticed the BDIS and found the screens easy to read and the information understandable. However, only 14% regarded the information as accurate, probably because they (not unreasonably) perceived the information displayed to be real-time.

In terms of awareness, 49% of the general public were aware of the BDIS, 42% of the VMS, 23% of the kiosks and 19% of the ROMANSE website. (It should be noted that the website and some of the VMS were in existence before MIRACLES). About £40k was spent on staff resource, £109k on BDIS, £44k on the kiosks, £155k on VMS and £22k on the IDUs.

Conclusions and Lessons Learned

The two kiosks located outdoors attracted approximately four times as many users as the other two kiosks, primarily because there were many more potential users. There was also evidence that people felt uncomfortable using the kiosk in the confined indoor location of the TIC. The kiosks were highly rated by the majority of users although a high proportion of kiosk usage was spent playing games (subsequently removed from some kiosks) and sending emails. There were also comments that the kiosks were dirty with coffee and food stains. Regular cleaning may increase their usage.

Many passengers were reluctant to switch to the BDIS from printed timetables. From the questionnaire surveys, it is likely that the BDIS screens would have been more effective had they provided bus information in real-time. (An updated real-time information system is due to be installed in May 2006). Due to their late implementation, the IDUs and VMS were not directly evaluated within MIRACLES. The installation of such systems on third-party land (as with the IDUs) can result in significant delays.

4.2.8 Measure 11.2: Improved Network Management

The Measure

The main objective was to use an Automatic Number-Plate Recognition (ANPR) system to collect real-time journey times on radial routes into Winchester city centre and then disseminate this to travellers using Variable Message Signs (VMS) and the ROMANSE website. In addition, it was planned to use the data to provide information on Origin-Destination (O-D) flows to improve the longer-term planning process.

Key Findings

A thorough evaluation of this measure was not undertaken. This was predominantly due to the delayed implementation of the VMS. As of October 2005, the VMS were not fully operational and did not have the ability to display validated journey time information from the ANPR system for more than one route. There were also communication problems with some ANPR cameras and a longer period of journey time validation was required to verify their accuracy. An initial validation exercise showed that the system was performing well, although one of the cameras failed.

Other Results

From the general MIRACLES awareness questionnaire survey, 42% of respondents stated that they were aware of VMS displaying traveller information. (There were four VMS (including two car park signs) in Winchester prior to MIRACLES).

Journey time data was collected along inbound routes from the outer to inner cordon, meaning that some approximate inbound O-D information was collected. However, no data for the corresponding outbound routes was collected due to the lack of cameras.

Conclusions and Lessons Learned

An ANPR system of this type requires an extensive validation process in order to verify that the information disseminated to the public is accurate. This can delay the system ‘going live’. In addition, the siting of ANPR cameras in a historical city such as Winchester proved difficult. The camera locations were partly chosen to minimise visual intrusion. As with measure 11.1, delays in implementation particularly occurred when equipment was sited on third-party land or property.

For this measure, approximately £150k was spent on the ANPR (phase one) system and £20k on staff resources. Additional resource and finance would have been required to establish O-D movements from the inner to outer cordons (i.e. along the outbound routes) and thereby generate a full O-D matrix for Winchester.

4.2.9 Measure 12.1: Cleaner Vehicle Buses

The Measure

The objective was to reduce the environmental impact of the bus fleet owned by the main operator in Winchester. Of the fleet of 60, 13 new Euro III buses were introduced on two city centre routes, 10 buses were re-powered from Euro I to Euro

III standard and four Euro II buses on the Park & Ride (P&R) route were fitted with Continuous Regenerative Traps (CRTs). A secondary aim was to introduce the public to different vehicle fuel types and a diesel/electric hybrid bus was demonstrated during two week-long trials along the P&R route.

Key Findings

The purchase of the new Euro III buses meant that maintenance costs decreased by 60%, although fuel consumption of the new buses increased (from about 10 miles per gallon (mpg) to 7.5 mpg), which was attributable to the fact that the new buses were one tonne heavier and used only in the city centre area. For those buses that were re-powered to Euro III standard, fuel consumption remained constant. In addition, 'before' and 'after' smoke tests were undertaken on seven of these buses. As expected, the re-powered Euro III engine buses had lower smoke test readings than when fitted with Euro I standard engines.

The percentage of 'lost miles' (due to vehicle breakdown) for the overall bus fleet decreased from 0.07% to 0.06% during the project timeframe. This was partly due to the introduction of the 13 new Euro III buses which were seen by the operator as far more reliable with less likelihood of overheating. Each new Euro III bus cost approximately £120k, re-powering each Euro I bus to Euro III standard cost £16k, and adding CRT to each P&R Euro II bus cost £3.5k.

Other Results

A desktop study focusing on a key street within Winchester centre estimated the pollution reductions that could be achieved for a range of bus scenarios. Comparing the 2005 emission factors to those of 2002, emissions of CO, HC, NO_x, PM and CO_2 were reduced by 44%, 42%, 26%, 53% and 2%, respectively. If all the buses passing along this street had been upgraded to Euro IV (i.e. a hypothetical up-scaling scenario), there would have been additional reductions of 19%, 29%, 36%, 76% and 1.5%, respectively.

A questionnaire survey was undertaken to assess user acceptance of the two new electric hybrid buses, which were each trialled for a 1-week period on the P&R route. 63% of respondents perceived that the hybrid bus was more comfortable than the usual P&R bus (Euro II with traps) and 81% thought it was quieter. However, a few people commented that the whining noise was discomforting, particularly if sat at the back. In addition, the smaller size of the hybrid bus meant that it could become overcrowded during peak periods. 24% stated that the permanent introduction of such a hybrid bus would make them use the P&R service more frequently.

Conclusions and Lessons Learned

Re-powering buses to a higher Euro emissions standard is a cost effective and energy effective way of reducing the pollutants of city centre buses. However, re-powering a Euro II bus to Euro III standard is about five times more expensive than fitting CRT. As Euro II buses + CRT have lower emission factors than Euro III for all gases except NO_x, it is not cost effective to re-power Euro II buses to Euro III unless reducing NO_x is a major priority (as in the Winchester Air Quality Action Plan).

The 13 new Euro III buses were to be fitted with Selected Catalytic Reduction (SCR). However, technical problems with the conversion of the first vehicle resulted in the programme being delayed. This, in addition with the anticipated introduction of the Euro IV standard in 2006, meant that it became less economic to add SCR to Euro III engines in 2005 when they could be re-powered to Euro IV standard a year later, should this option be provided by suppliers and economically viable.

The use of four new electric hybrid buses on the P&R route was considered, but due to financial and contractual factors, this was not pursued. The benefits of hybrid buses in terms of their emissions, noise levels and comfort are currently often outweighed by their cost, although they are preferred by passengers in terms of their quietness and comfort. (Even without using alternatively powered buses, the P&R service already requires a substantial cross-subsidy).

Receiving funding from the Energy Savings Trust (EST) for a bus clean-up programme can be problematic, particularly as eligibility rules can change in addition to EU laws regarding 'state aid'.

4.2.10 Measure 12.2: Cleaner Municipal Fleets

The Measure

The objective was to reduce the environmental impact of Hampshire County Council (HCC) activity. 27 new Euro IV diesel vehicles were purchased for the council's own car fleet. In addition, the "Motorvate" green fleet programme was joined to help make recommendations to reduce unnecessary business mileage and emissions. It was hoped that other companies in Hampshire would follow this example. Four new library buses (or discovery centres) were purchased, each fitted to Euro III standard with CRT, although these were not operational until late 2005.

Key Findings

In 2003, some HCC fleet vehicles were due for replacement and the more expensive, early production models of Euro IV vehicles were purchased instead of cheaper Euro III models. As a result of using the Euro IV vehicle, it was estimated that a 2.3% reduction in CO_2 was made. This reduction is small since HCC were already in the process of buying Euro III vehicles. Companies with older vehicles would see much greater reductions, particularly in CO_2 as well as the other pollutants.

Each of the Euro IV Vauxhall Astra vehicles cost about £9.8k, about £300 more than the Euro III equivalent. MIRACLES also contributed £53k for the library buses (with an additional £10,500 for the fitting of CRT). Maintenance costs for the new vehicles remained similar as for the Euro III vehicles.

Other Results

The CO_2 emissions of HCC's transport operation were estimated. In 2003-04, the Hampshire Transport Management (HTM) fleet (under 3.5 tonnes) travelled 1.03 million miles producing a total of 326 tonnes of CO_2. The 'grey fleet' of privately owned staff cars travelled about 18.5 million miles (increases of 4% from 2002-03 and 9.5% from 2001-02) producing 4920 tonnes of CO_2. Motorvate set targets of a 12% reduction in CO_2 and 3% mileage reduction for both the HTM and the grey fleet. In September 2005, HTM were on target to meet these reductions but this will not be confirmed until early 2006. Using the data collected, HCC were able to contribute to a joint County Council mileage benchmarking study at the end of the project and share the experience gained in developing and implementing the measure.

Conclusions and Lessons Learned

The price differential between 'normal' and 'cleaner' vehicles is still high and is a major deterrent in companies purchasing such vehicles. In addition, the technology is still fairly new and it may take a while for companies as well as individuals to become more familiar with them. Companies with pre-Euro, Euro I or Euro II vehicles would gain most by an upgrade to Euro IV vehicles in terms of their emissions (g/km).

No companies in Hampshire joined the Motorvate scheme. This was partly attributed to the high subscription cost (a rising scale up to £2k), and the EST providing an alternative 'fleet health check' free of charge. In addition, the Motorvate website was unavailable for several months while it was being re-designed. (A re-launch of Motorvate is planned for 2006). There was a one day seminar, but otherwise there has been little promotion material so far regarding HCC cleaning up its company fleet or about the benefits of joining the Motorvate scheme. The benefits of subscribing to such a scheme would only have a limited time-span. After making reductions in vehicle mileage in the first few years, there may be little scope for further improvement, thereby reducing the benefits of continuing to subscribe to the Motorvate scheme. Although HCC set a good example in cleaning up its company fleet of vehicles, a more pro-active approach would be necessary to encourage other companies to follow. See also measure 12.3.

4.2.11 Measure 12.3: Clean Fuel Support Services

The Measure

The objective was to encourage the use of alternative fuel vehicles by businesses by overcoming barriers and establishing a business case for the introduction of clean engine technology. A fleet of six clean vehicles was purchased: two vehicles were LPG/petrol dual-fuel, two were petrol/electric hybrid and two were battery electric. Each participating business was loaned one vehicle for a period of up to one month.

Key Findings

Prior to each one-month trial, participating businesses were asked which factors would influence their decision to purchase a clean vehicle. The three most important factors cited were operating costs, reliability and purchase cost. During the trial, about half the respondents used the clean vehicle on a daily basis, and over 70% used it at least three days per week. After the trials, respondents were asked to rate the trial vehicle. 82% rated the trial vehicle as generally good, 55% thought it was generally better than their usual fleet vehicle, and 65% stated that they were likely to purchase a clean vehicle in the future for business use. Follow-up interviews found that one business had actually purchased a clean vehicle and three businesses stated that an employee had bought one for private use. (In all cases, the trial had been a major influence). In addition, 11 businesses stated that they would purchase a clean vehicle in the future.

However, for acceleration, road handling in the wet, and availability and ease of refuelling, the respondents generally perceived that their own fleet vehicle was better than the clean vehicle. This may be in part due to their familiarity with the operation and performance of their own vehicle.

Other Results

Route data from the vehicle trials was analysed (based on data collected from an in-car tracking unit and a vehicle routing computer program) and resultant emissions were estimated. These results were then compared with the corresponding emissions if the usual business vehicle had been used. For the petrol/hybrid clean vehicle type, CO_2 emissions reduced by an average of 40%, CO by 20% and $HC+NO_x$ by 70%. There were also energy reductions of 37%. For the LPG/petrol dual fuel vehicle type, average CO_2, CO, and $HC+NO_x$ emissions reductions ranged from 9-18%, 30-78%, and 58-74%, respectively, and the energy reduction was in the range of 1-5%. The battery powered electric vehicles produced no tailpipe emissions, and therefore resulted in emission reductions of 100%. However, it should be emphasised that this analysis excluded those trials where the usual business vehicle was more than five years old (since no emission figures are available for vehicles

manufactured before 2000). If all vehicles had been included, than the emission savings would have been greater.

In terms of fuel cost per km compared to the usual vehicle, petrol hybrid vehicles and LPG/petrol dual fuel vehicles provided average savings of about 40% and 20%, respectively. (These comparisons may not be representative of the general car population, since most of the 'usual' vehicle fleet were new vehicles, and relatively fuel-efficient). As before, since the battery electric vehicles do not require fuel, cost savings of 100% were attained. However, such vehicles are about £5k more expensive than a similar petrol vehicle and they require a £10k battery every five to eight years.

The cost of each of the six clean vehicles ranged from £11k to £14.5k, operational costs of the trial were £7.5k and insurance was £3.5k per year.

17% of the public were aware of the clean vehicles and 83% generally agreed with the measure objectives (from MIRACLES Transport final questionnaire).

Conclusions and Lessons Learned

The clean vehicle trial required substantial resource to clean and maintain the vehicles. Problems were encountered such as lost keys, broken windscreens, damage to bodywork and vehicle breakdown.

The perceived higher purchase cost and unproven technology associated with a cleaner vehicle, together with a limited range of models, is off-putting for many companies. In addition, the lack of refuelling places for LPG and electric vehicles is still a deterrent to more widespread use of such vehicles. (For instance, there are only two filling stations in Winchester that sell LPG).
Businesses tend to renew their company vehicles at set times over cycles of several years. Therefore, the effect of the trial in encouraging businesses to purchase clean vehicles may not be evident for a number of years.

4.3 Summary of Measure-Level Results for Barcelona

The summaries for Barcelona are presented in sections 4.3.1 to 4.3.5. See Annex 3 (2nd Implementation Report for Barcelona) for additional details of any of the measures.

4.3.1 Measure 5.1: Access restrictions (Rambla)

The Measure

Barcelona Municipality sought to reduce the flow of vehicles passing along the Rambla, and thus improve the pedestrian amenity of this world-famous promenade. The scheme originally envisaged controlling not only the type of vehicle that travels the section from Pg. Colom to Pça Catalunya, (with exemptions for residents, buses, taxis, and other public services), but also movements to off-street car parks and hotels. The decision to base the scheme on camera-based enforcement was taken after considering options based on retractable bollards. It was further decided to use the cameras to detect and enforce vehicles passing the section at speeds exceeding 30 km/h.

The rules proposed were derived from observations of the concentrations of pedestrians and vehicles over the hours of the day, (restricted access from 11.00 to 20.00), but the control of exemptions (to car parks) and the application of trajectory speed add to the complexity of the scheme. Car park exemptions were designed to make the scheme acceptable to parking operators inside the controlled zone, and consultations were realised to agree the scheme proposals. The limitation of speed reinforces the safety feature and safeguards against higher speeds following the reduction of circulating traffic. Both of these aspects required considerable investigation to determine the legal integrity of the scheme, and more software development than initially planned.

Key Findings

The scheme was implemented in two phases, with full implementation dependent upon the initial trial of Automatic Number Plate Recognition (ANPR) technology. The first phase involved camera control at two points (where vehicles entered and left the section) with fibre-optic connections to the Municipal Traffic Control Centre. Four different suppliers of ANPR trialled their systems, and car plate reading levels exceeding 90% at a point were achieved (with cameras installed at provisional locations), but only a small fraction of Powered Two-Wheelers (PTWs) could be recognised (the more recent motorcycles with the larger plate). The full scheme (cameras at 5 control points) is being implemented following an open tender awarded to SICE in late November of 2005.

In addition, surveys quantified the pedestrian activity, and indicated that pedestrian crossing volumes were more than 6 times the vehicular traffic, and that flows along the busiest sections exceeded 77,000 pedestrians per day. In order to ensure a notable reduction in the delay affecting pedestrians crossing, the traffic restriction must limit circulating vehicles to below 60 vph. This means that PTWs must also be subject to access restriction – something new for Barcelona (and implying manual enforcement until use of larger plates for PTWs is achieved). A projected reduction in circulating vehicles (from 11,600 vpd to 5,000 vpd) is being implemented.

Conclusions and Lessons Learned

It was clear from the start that restricting access along a road carrying 10,000+ vpd was never going to be easy. That the scheme is being implemented is a statement of confidence in ANPR technology (both from the point of view of handling complex

rules of movement, as well as from the ability to enforce infringements and ensure that camera control is respected).

A greater control of movements by Powered Two-Wheelers is necessary and desirable, in order to ensure the promotion of more sustainable and less dangerous modes of transport. It is therefore recommended that large registration plates be adopted. Since this will take time, tags may be required to recognise authorised entry by PTW users who are residents of the controlled central area.

It is important that efforts are made to quantify tangible benefits for pedestrians. The difficulties of defining indicators to reflect improvements in amenity were overcome by measuring crossing times of pedestrians and applying published values of savings in travel time; it was estimated that the scheme produced first year benefits exceeding scheme installation costs.

4.3.2 Measure 7.2: Multi-operator real-time passenger information

The Measure

ATM, the Metropolitan Transport Authority promotes the integration of passenger information across the metropolitan region of Barcelona. Within MIRACLES this meant:

- Acquiring and implementing a common AVM (Automatic Vehicle Monitoring) system for the 20+ private medium bus operators active in the area;
- Controlling bus regularity (which would not be possible without AVM);
- Processing information from AVM and other information sources and disseminating messages about the arrival times of next buses via display panels at certain stops;
- Installing information panels at 4 stops, selected to promote bus – tram interchange.

To achieve the primary objective of demonstrating a full integration of real-time arrival times of all services, this “de facto” standard had to be linked with the information of the main operator TMB. The system architecture finally adopted to achieve this involved ATM accessing information of TMB bus arrivals using a mobile GPRS-based SMS web service. This agreement included the design of the bus stop panels and the protocol for rotation of messages. ATM also entered into agreement with the local municipalities within which selected bus stops along the tram corridor are located. 3 municipalities have made agreements relating to information panel installation, electricity supply and maintenance. The first bus stop commenced operation in September 2005, with 2 more operational in November, and another one under commission. Transactions from the integrated ticketing system provided the basis for assessing the impact of information upon stop / service usage.

Key Findings

ATM’s AVM system enabled each operator to use the GPS location system to track its own vehicles, with messaging supported by a radio trunking system with capacity for up to 450 buses. An implementation on this scale ensured the participation of smaller operators (and overcame the initial barrier that smaller operators would otherwise not acquire and install AVM equipment), and served as a “de facto” common specification for information interchange. In this sense, following testing, a key finding was that most medium-sized operators were already operating this system for fleet management, and the smaller operators (Soler & Sauret, Mohn, Oliveras and Rosanbus) in the tramway corridor have also installed and use the system. The growth at the bus stop with the demonstrated information amounted to 48 extra passengers per working day (an increase of about 2%).

Other Results
Surveys of tram passengers indicated that "information about times of next tram arrival" ranked only 6th in customers' views on tram system features that motivated them to use the service (1.3% of 1,818 responses). It was ranked lower than features regarding the tram system itself "faster" (52.7%), "adapted access" (12.6%) etc. or integrated service features such as "less interchanges" (8.1%).

Conclusions and Lessons Learned
The implementation of an AVM system for small / medium bus operators required a large-scale commitment that can only be assumed by an authority with responsibilities for integrating passenger services across a metropolis or a region.

Such a system achieves fleet management benefits for operators in the short-term, but the authority only sees benefits in the medium and long term. Installing information panels and communicating bus arrival times at interchange stops has been demonstrated to have a positive impact on passenger levels. The effort expended in equipping smaller operators, and from the full integration with TMB, needs to be exploited via web and SMS media to reach passengers before they reach a bus stop.

4.3.3 Measure 7.5: Tramway – Collective Passenger Transport (CPT) Integration

The Measure
ATM, the Metropolitan Transport Authority, has promoted the re-introduction of the modern tramway in Barcelona. The "Trambaix" scheme combines the latest tram vehicle technologies with a radical re-allocation of street space to offer accessibility for all Barcelona's citizens in a way that reduces the city's future dependency on petroleum. The tramway has a total length of 15km, and 25 stops. MIRACLES provided ATM with additional resources to oversee design aspects and integration with other modes, and to monitor this new mode of transportation (according to key performance indicators such as passenger volumes and running speeds, and through surveys with over 1,800 passengers).

Key Findings
The service started operation on 3rd April 2004. Based on the ticket validations, the levels of use show a general pattern of progressive growth with average working day volumes rising, from around 20,000 in the first month of operation, to over 41,000 passengers/day (as of October, 2005). Whilst passenger levels exceed original forecasts, the average tram running speed realised after 12 months of operation was 17.9 km/h; slightly below the target of 20 km/h. Around half of the trips involve a combination of walking (of more than 5 minutes) plus tram; multimodality with tram+metro and tram+bus each account for 10% of trips, and about 8% are tram+other means. The remaining 22% being tram single-stage trips.

Other Results
The on-tram passenger surveys reveal that slightly more than one-third of passengers are making trips they did not previously make. Land redevelopment associated with the tramway project is estimated to have generated over 11,000 passenger trips per day. Of the two-thirds of tram users who previously made the same journey, 18% used to travel by car, and 3% by motorcycle. The remaining 79% are previous bus and metro users. The weekday saving in motorized travel associated with this considerable switch is estimated to be 25,000 veh-km. (The switch is primarily from bus services that have since been re-organised).

The passenger survey responses identify that, each day:

- some 17 wheelchair users travel by tram unassisted,
- around 50 cyclists use the tram to extend their trip-making distance,
- parents push some 385 baby chairs into and out of the trams,
- and an even greater number catch the tram with trolleys.

53% of surveyed passengers cited the higher speed as the main motivation for using the tramway, (followed by features of accessibility; “close-by” cited by 13%, “easy-boarding”; 12%).

Conclusions and Lessons Learned

The tramway is performing well, with ticketing and automatic vehicle monitoring systems providing key indicators of passenger volumes and running speeds. Although perceptions of tram speed are positive, additional efforts should be made to improve running speeds (re-design of signal junctions, improved pedestrian separation, etc.)

Trambaix has achieved a substantial car switch to CPT, promotes walking and extends cycling, enables social inclusion of those with mobility difficulties, improves street amenity and captures a substantial trip generation for public transport.

4.3.4 Measure 9.1: Innovative Goods Delivery

The Measure

Within MIRACLES; and under the goals of the local Mobility Pact, Barcelona Municipality has sought to achieve an agile and orderly distribution of goods throughout the city. Various measures have been demonstrated, namely:

- extension of multi-use lanes
- night -time deliveries
- Loading/Unloading (L/U) active guide: web info and targeted enforcement
- special (PICT) kerbside regulations.

Key Findings

The Traverssera de Gracia multi-use lane demonstrates peak bus priority, improved off-peak unloading and better traffic circulation. By suppressing daytime car parking (over 40 spaces) the possibility that the second (of four) lane(s) becomes blocked is very much reduced. As a result, the journey times of general traffic are reduced by 12 to 15% according to the time of day. Furthermore the bus operator has perceived improvements in bus running speeds.

Operator Mercadona has demonstrated that quiet delivery is possible with a 40T lorry serving supermarkets with a rather large capacity and with substantial refrigeration facilities. Noise measurements, comparing ambient noise levels on nights when the delivery was / was not being made, show that the maximum values recorded in the street varied by only 0.1 dB(A), average with unloading of 52.2 dB(A). Mercadona estimates that investment in vehicle adaptation is recoverable within 3 years.

In setting up the L/U Active Guide trial, based on data aggregated from a dozen operators it was found that only 36% of the deliveries could be made using reserved spaces within 25m distance of the store. For the (smaller) pilot area, with 230 spaces available, street observations quantified the demand/supply ratio to be 112% (after taking into account levels of illegal parking by cars). The detailed reporting of delivery

problems via the web, found that operators encountered difficulties on 553 of the 1772 occasions when deliveries were made during the 17 weeks of the trial. Enforcement, targeted at 3 “hot spots” where particularly high levels of problems had been reported, achieved an average reduction in problem-reporting of 19%.

Special kerbside regulations were trialled at 3 locations: (primary road, secondary road + free parking lane, and secondary road + free parking lane + bike lane). One supermarket showed that, by eliminating a 30m delivery distance (and using roll-containers instead of pallets) total delivery time was reduced from 27 to 8 minutes. Operators’ reports show deliveries to be concentrated in the early morning (some 36% of all deliveries are made between 07.00 and 09.00), and more than a third of incidence (problem) reporting occurs in this time period; MIRACLES has quantified a problem that current regulations do not address.

Conclusions and Lessons Learned
Although the Municipality provides enough spaces to satisfy city-wide demand, operators experience considerable problems at microscopic level. The exchange of information via the Active Guide web shows how targeted enforcement can resolve some short-term problems. It also highlights the pressure on supermarket deliveries during early morning. Operators, and enforcement agencies have collaborated with the Municipality to demonstrate a range of practical solutions; quiet night-time and off-peak delivery (multi-use lanes and PICT kerbside regulations) have been demonstrated to be effective solutions for several different road / delivery situations.

Another lesson learned is that the road authority needs to do more than better match spaces supply with demand at the dis-aggregated level; operators will invest in solutions that are customised to their requirements.

4.3.5 Measure 12.3: Extension of the CNG bus fleet

The Measure
The main bus operator in Barcelona, TMB, has integrated Compressed Natural Gas (CNG) buses into the public transport fleet as part of its corporate strategy to achieve the highest environmental standards, and to contribute to the improvement of a more sustainable transport for the city. A significant demonstration involving 70 CNG (standard 12m. long) buses was realized in 2002 (models from both MAN and IVECO). Infrastructure improvements were then carried out, and a further 90 vehicles were acquired in 2005.

Key Findings
It was shown to be feasible to establish a strategic partnership with an important gas utilities provider. This partnership established the possibility for running CNG buses with lower operating costs than diesel buses, such that the higher investment costs are recovered within 5 years. However, the demonstrated CNG buses consumed more energy, especially on hilly routes where the fuel consumption increased by about 50% compared to a standard diesel bus, with one model of gas bus performing better then the other.

Substantial savings in pollutant emissions were estimated, based on measures of fuel consumption and using models to estimate emissions compared to diesel buses running on the same (three) lines. Emissions from the initial batch of 70 CNG buses were reduced by 88% - 94% (depending on the particular type of emission).

Other Results
Infrastructure improvements were able to refuel the buses within 3 minutes (part of the specification, this performance has been demonstrated during site visits). The infrastructure improvements also minimise the higher cost of gas bus maintenance.

Surveys of users (drivers and passengers) showed high levels of CNG bus acceptance in terms of lower pollution levels, less smell from fumes, and reduced noise. Different models of bus varied in popularity between different types of user.

Conclusions and Lessons Learned
A strategic partnership with a utilities provider is a good way of extending CNG bus fleets. In addition to fuel supply at a reasonable price, this should include infrastructure improvements for vehicle maintenance as well as adequate refuelling stations.

The demonstrated CNG buses (standard 12m length) consumed higher energy than the diesel reference. It is recommended that the model with the weaker performance is allocated to flatter service routes. In addition, subsequent CNG bus acquisition has targeted larger vehicles (not previously available) and newer models with lower weight.

Direct (on-bus) measurement of pollutant emissions has become feasible during the project, and this offers improvements (over modelling) for further assessments of bus performance.

4.4 Summary of Measure-Level Results for Cork

The summaries for Cork are presented in sections 4.4.1 to 4.4.6. See Annex 4 (2nd Implementation Report for Cork) for additional details of any of the measures.

4.4.1 Measure 5.1: Set-up of City Centre Clean Zone

The Measure

The city centre main thoroughfare, St. Patrick's Street, was re-designed to reduce the number of lanes, and the pavements were considerably widened to provide new bicycle-parking facilities and textured paving for the visually-impaired. All on-street parking apart from taxi ranks and loading zones was removed. The Clean Zone (CZ) was then extended covering two adjacent streets. Retractable bollards were installed on the inbound side streets to restrict access into the expanded CZ. The objectives of measure 5.1 were to provide a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre.

Key Findings

The CZ gave more prominence to sustainable modes of transport, with better public transport alighting facilities and cycle stands provided. The number of lanes was reduced from 4 lanes to 2 on St. Patrick's Street. The increase in cycling parking facilities provided 316 cycle parking places in the city centre. The redesign would also seem to make the city centre safer. During 2002 – 2004, the reported number of personal assaults on St. Patrick's Street declined by 33%. An increase in pedestrian numbers was also observed in the CZ.

Other Results

The user acceptance of this measure was very positive. Over 80% of survey respondents in the 2005 user acceptance survey rated the widened footpaths as "much better" or "slightly better". Opinions on accessibility to the CZ were also positive with over half of respondents reporting that the facilities were "much better" or "slightly better".

The representatives of business organisations strongly approved of this measure. However, they also are not satisfied with the enforcement of the loading time restrictions and illegal parking. Restrictions on access by retractable bollards were implemented in late 2005. Some objections have been raised and discussions are ongoing.

Conclusions and Lessons Learned

The wider pedestrian areas and the modern more disabled friendly surfaces, tactile guidance, etc. were expected to be easier and safer for the disabled. However, representatives of visually disabled organisations stated that some aspects are unsatisfactory, in particular the new lamp standards and the use of steel bollards in tactile paving to prevent illegal parking. They consider that improved consultation with representatives of disabled groups is required during each aspect of the detailed design.

The bus service operator reported additional bus service delays in the CZ due to the reduction of the St. Patrick's Street green signal times as part of the redirection of traffic. Some problems also exist with bus stop space and layouts. However, the principal problems resulted from the poor enforcement of loading time restrictions on delivery vehicles and of illegally parked taxis.

In summary, this measure is considered to have been very successful and to have met its objectives. The redesign created space for cultural events and recreational activities which have since attracted many visitors to the city centre. The CIVITAS funding provided a catalyst both for the implementation and the expansion of the original scheme. Post MIRACLES the CZ will be retained and, due to its success, expanded to a further adjacent area. It is suggested that restricting all motor traffic except public transport, taxis and delivery vehicles would be desirable.

4.4.2 Measure 7.3: Introduction of New Lines (Park and Ride)

The Measure

This measure established a new Park and Ride (P&R) service approximately 3.3 kilometres southeast of the City Centre and provided approximately 900 P&R spaces. Cork was the first city in Ireland to provide a P&R service. The objective was to reduce congestion and promote sustainable modes of transport by achieving and maintaining P&R capacity at near full capacity.

Key Findings

450 P&R spaces were originally planned, but over 900 spaces were actually provided. By November 2005, the daily patronage was of the order of 500 vehicles per day, saving approximately 450/475 trips each way to the City Centre. The patronage had steadily grown since the opening of the P&R and is now covering its operating costs. The presence of the P&R facility not only lessens the demand on inner city parking but also encourages the use of more sustainable modes of transport.

The awareness raising activities undertaken for CIVITAS played an important role in promoting the use of P&R, the VMS signs in particular were important tools. The overall quality of the P&R service was rated by user opinion questionnaires as 83% “very good”, with the remaining 17% rating it as “good” or “satisfactory”. 99% of survey respondents said that they would use P&R again.

Other Results

The user acceptance and operator acceptance of this measure were very positive. It was found that 90% of respondents were drivers and 9% were passengers. The female usage is very high (79%) and 71% of respondents were travelling alone.

Sources of P&R information were examined with advertising signs (37%) and word of mouth (38%) the most prominent; the ease of finding out about P&R is very positive with 96% rating it as very good, good or satisfactory.

The disabled parking spaces and the cycling stands provided were only used to a very limited extent, the provision of increased facilities in the city centre for these two groups may have affected the uptake at the P&R facility.

Conclusions and Lessons Learned

Reliability, cost, perception of security and frequency of the bus service were all significant factors in the success of this service. The cost of using the P&R is €5/vehicle/day, users should be offered a significant saving compared with inner city parking (in Cork they save if they park for over 2 hours and even greater savings if they availed of discounted monthly or annual tickets). The journey time of the bus service was one of the key operator performance indicators and further efforts in improving journey times as buses approach the city centre will be needed in the future to counteract the worsening effects of congestion. (The mean journey time was 7 minutes which can increase by an additional 5 minutes during peak periods).

Advertising of the scheme is vital, with road signs, newspaper advertisements and radio adverts found to be effective. The City Council also ran a number of "free days" on which usage peaked and which attracted new customers. After each of these days the number of car drivers availing of the service began to increase at a steeper rate for about 10 weeks.

Due to the success of this measure Cork City Council are committed to continuing the P&R service at Blackash as well as providing a second P&R site (accommodating up to 500 vehicles) on the North side of Cork City in 2006.

4.4.3 Measure 10.1: Awareness measures

The Measure

The overall objective was to raise awareness about sustainable transport modes through the provision of facilities which highlight and cater for the needs of cyclists and pedestrians. This measure encouraged more sustainable transport choices through publicity campaigns, the design of infrastructure and the provision of facilities in consultation with specific user groups. Other measures to improve conditions for pedestrians, such as improvements to the footpaths were carried out as part of measure 5.1.

Very limited cycle parking facilities were provided in the city centre pre-MIRACLES. MIRACLES support helped provide 264 cycle parking places by October 2005. The number of cycle spaces is expected to reach 316 by the end of the MIRACLES project. Additionally, a Cycle Safety Training Programme was introduced to all city primary schools and the response was overwhelmingly positive.

Key Findings

This measure gave more prominence to sustainable modes of transport, in particular with the provision of new cycle parking stands. The overall rating of these cycle stands was 61% "very good" compared to pre-MIRACLES, with a further 29% rating them as "good". The operator acceptance was "very positive".

67% of cycle user survey respondents stated that the locations of the cycle stands were very convenient or convenient and 61% stated that cycle parking spaces were easily available in the city centre. However, 25% of respondents stated that they sometimes had difficulty finding an available space.

The target increase in the number of cyclists was at least 10%. The actual increase was identified from LUTS classified traffic counts in October 2005, which identified a 47% increase in cycling across the inner cordon.

Other Results

The number of cycles parked in the city centre increased substantially since the Baseline survey in 2002, where only 7 parked cycles were recorded. There was an average of 105 parked cycles in the city centre in the September 2005 surveys. Over 60% of the cycles observed during the 2005 surveys were parked at cycle stands.

Publicity campaigns such as "In town without my car day" and European Mobility Week also helped to raise awareness of sustainable transport.

Conclusions and Lessons Learned

This measure resulted in a very substantial increase in the number of cycle parking facilities in the city centre. Cyclists were very satisfied with the facilities provided as a

result of this measure. Without the improved facilities provided as part of this measure, cycling rates would have further declined.

The access restrictions on St. Patrick's Street (WP5.1) are complemented by better facilities for pedestrians and cyclists. The Green Routes Project (a parallel project which forms part of the business as usual scenario) will provide a network of cycle lanes. It is hoped that the combination of this project with the MIRACLES project will further help to increase the number of cyclists.

This MIRACLES measure also ensured that cyclists were provided with a more integrated infrastructure by the coordination with parallel projects which compliment this measure with the provision of cycle lanes and cycling promotion campaigns. The measure has also resulted in the requirement for the consideration of cycle parking in planning permission applications. Cork City Council will continue to encourage cycling post-MIRACLES with an emphasis on the provision of a cycle network.

4.4.4 Measure 10.2: Mobility Management Measures

The Measure

The objectives of this measure were to promote greater awareness of the need and potential for more sustainable transport commuting habits, through the implementation of a car-pooling scheme for Cork City Council employees in order to reduce the number of vehicle trips. A Travel to Work survey established the commuting patterns of City Council employees and a car pool register was set up.

The experience gained through the implementation of the Mobility Management measure was used in a schools mobility management initiative. A 'Travel to School Survey' was designed to identify the potential for change and to prompt discussion about transport in schools.

Key Findings

In the baseline surveys, 70% of employees commuted by private cars (42% travelled alone), while the remaining 30% used sustainable modes (i.e. public transport, cycling, walking, and train). Within the 2004 surveys, 61% used private cars (34% travelled alone) and 36% used sustainable modes. The number of people travelling in private cars with sole occupancy decreased from 42% in 2002, to 35% in 2004.

However, the change in modal split resulted largely from the increased access restrictions in the city and from the reduction in parking spaces available to City Council employees (approximately a 20% reduction in parking spaces over 3 years).

The number of responses from employees relating to possible participation in the City Council car pooling scheme was very poor. Those using car pooling at the time of the survey preferred car pooling privately with friends and/or relatives rather than the workplace initiated scheme.

Other Results

User acceptance of the car pooling scheme was 'very negative'. People were concerned about issues such as insurance and restrictions on the use of vehicles for work. Others stated that car pooling could not be relied upon because their journey patterns varied with school drop offs, site visits, different activities after work, etc.

Conclusions and Lessons Learned

MIRACLES has influenced policy on planning permission by the requirement that all large developments in Cork City have to consider mobility management. The official

City Council car pooling scheme was not a success. Other mobility management measures such as parking restrictions were found to be more effective. The experience gained from this measure will aid in the formation of Cork City's Councils' own mobility management plan.

Car pooling alone cannot achieve a substantial shift in modal split and the combination of the promotion of sustainable modes along with car restrictions (such as a reduction in parking, increase in cost) are likely to achieve a more prominent change towards sustainable modes of travel.

It is suggested that other cities wishing to promote sustainable mobility management should place a heavy emphasis on promoting sustainable mobility before and during the establishment of formal schemes.

4.4.5 Measure 11.2: Improved Network Management (Park by Phone)

The Measure

This measure established an innovative parking management/parking payment scheme which could be accessed by mobile phone technology. Subscribers can pay for on-street parking using their phones and access system information. The system administrator is able to send a selection of messages to the subscribers. For example, users can be reminded when their parking time is nearly up. The initial opening of Park by Phone commenced in August 2005, and full implementation occurred in October 2005, when 60 streets were available for parking by mobile phone. It may be possible to expand the system to: discriminate in favour of environmentally friendly vehicles, pay for Park and Ride, pay for Pay and Display parking, or pay for multi-story car parks. The objective was to reduce congestion and provide parking information.

Key Findings

In the first two months of operation; 500 people registered and another 1000 had received registration packs. Although less than 35% of those who received registration pacts have registered, it is hoped that the number of users will rise in response to the multi-media marketing campaign developed by the Park-by-Phone consortium. 30% of those registered use the Park by Phone service "frequently" (i.e. once a week or more) with another 30% using the service "occasionally" (i.e. over two weeks between use). However 35% of those registered had never used the service in the first three months of operation.

Approximately 100 Park by Phone parking instances occurred per day in February 2006, with the number increasing since the start of operation. In September 2005 1256 parking instances occurred by Park by Phone, this remained consistent with 1,231 parking instances occurring in October when the system was fully implemented and charging occurred. By February 2006 1,634 parking instances occurred by Park by Phone.

A key result of this measure was the introduction of technology updates which resulted in the launch of web and automated phone based payment of parking fines, it also allows parking fines to be processed more quickly. These benefits not only effect parking using mobile phone but also disc parking areas.

Other Results

Signs designating "Park by Phone" zones were erected throughout the city centre from January to March 2005. Several requests have been received to extend the

Park by Phone area outside the city centre. Following a review in January 2006, the Park by Phone area will triple in size in Spring 2006.

Park by Phone was rated by 69% of users to be 'very easy' to use with a further 10% rating it as 'fairly easy'. Comments received suggested that people were a little apprehensive the first time they tried it but then found it straightforward. The main reason for use by respondents was; faster/easier than disc parking 79% and ability to top-up remotely 18%. 42% rated the ease of finding out about Park by phone as 'very good', an additional 39% rated it as 'fairly good' with 8% rating it as 'satisfactory' and 10% as 'poor'.

The overall rating of Park by phone was rated at 'very good' by 59% of respondents, an additional 4% rated it as 'fairly good' with 14% rating it as 'satisfactory' and 3% as 'poor'. 99% of respondents said they would use Park by Phone again.

Conclusions and Lessons Learned
Park by Phone has proven to be popular with motorists who value the quick and convenient payment method for on-street parking. The implementation schedule proposed by Cork City Council proved to be too ambitious and did not fully take into account the time required to enact changes in legislation and to overcome technological issues. Since the system has gone live, it has become evident that a planned sustained marketing campaign is required in order to promote the wider use of Park by Phone among Cork motorists. Cork City Council will continue to promote and expand this scheme post-MIRACLES.

4.4.6 Measure 12.2: Municipal Fleet Vehicles

The Measure
The objectives were to investigate and promote the use of lower emission vehicles in Ireland. Cold pressed rapeseed oil was chosen as the most promising alternative fuel. The engines of 17 Cork City Council vehicles were converted to permit the use of rapeseed oil (11 Fiat Ducatos, 4 Ford Couriers, 1 VW Transporter and 1 Isuzu NQR).

This measure also assessed the opportunities, government policy and likely costs implications associated with electric vehicles being used for goods distribution in Cork City. In addition, the Council decided to trial a rapeseed-methyl-ester fuelled vehicle in late 2005.

Key Findings
The conversion of diesel engines to rapeseed oil involves technical complexities. These were successfully resolved in Cork after some initial difficulties. Technical problems relating to the cold starting of engines were experienced, one vehicle (the Isuzu NQR) had to have its conversion reversed due to the position of the engine, and five others temporarily dropped out of the project due to technical problems, but were later reinstated.

An excise duty waiver was applied for from the government. This was granted in late 2005, this resulted in the cost of rapeseed oil being cheaper than diesel.

Other Results
Driver surveys and focus groups found that the acceptance of the measure was "negative" to "neutral". The drivers initially recommended the use of a mix blend (of diesel and rapeseed oil) which, in their opinion, produced better power and an

improved smell (a mixture of 25% diesel and 75% rapeseed oil was considered to be optimum). By November 2005 pure rapeseed oil was being used.

Emission testing was carried out, but the results were difficult to quantify and the tests were not considered to be reliable. More reliable tests would require them to be carried out by vehicle manufacturers.

The initial reliability of the converted vehicles was poor due to starting difficulties and gauze filter problems. Following modifications, the reliability of the converted vehicles increased.

Conclusions and Lessons Learned

The conversion of diesel engines to rapeseed oil is possible despite some technical complexities. Valuable insights were gained which will be of use to any city contemplating a similar project. Involvement of the drivers throughout the process is considered essential. In spite of the problems experienced during the implementation of this measure, Cork City Council intends to convert more vehicles.

Cork City Council is also going to experiment with the use of bio-diesel. If the bio-diesel trials yield positive results, the City Council may decide to use bio-diesel for its new fleet which it will be purchasing in 2007.

5 CITY-LEVEL EVALUATION

As for the MLTs, summaries of the city-level results were provided by each site, in terms of the five key areas of economy, energy, environment, society and transport. These city-level summaries now follow within this section. The detailed city-level template results for Rome, Winchester and Cork are provided in Annexes 1, 2, and 4, respectively.

5.1 Summary of City-Level Results for Rome

The city-level summary for Rome is presented below. See Annex 1 (2nd Implementation Report for Rome) for additional details.

5.1.1 Objectives

Table 5.1 describes the general objectives of the Rome assessment of the combined impacts of the MIRACLES measures (see also section 2.1.2 for more detailed local targets).

Key Area	Objectives
Economy	• Assess costs per inhabitants and operating revenues of the MIRACLES measures.
Energy	• Reduce energy consumption of the city centre traffic, due to the implementation of clean vehicles and new forms of transit.
Environment	• Improve the air quality (assessed using actual measurements from air pollution monitoring stations and passive sampler methods). • Reduce the noise levels in the city centre (assessed using on-the-spot measurements). • Reduce vehicle emissions (estimated using a model). • Reduce the number of polluting vehicles.
Society	• Increase public awareness and satisfaction of MIRACLES measures, along with the support for sustainable transit, using the ETA – Emotional Text Analysis method. • Increase accessibility to transit.
Transport	*In the LTZ (Limited Traffic Zone)* • Reduce private traffic flows by 4%; • Reduce space for private cars by 2%; • Increase e-vehicles PT fleet by 20%; • Increase purchase of e-scooters by 10%. *In the Demonstration Area* • Reduce the number of unauthorised vehicles accessing the LTZ, Trastevere and San Lorenzo by 30%; • Increase users of car pools by up to 1,000; • Increase the number of Mobility Managers by 15%; • Reduce transport related emissions by 5%; • Increase walking by 5%; • Increase collective vehicle occupancy by 20%.

Table 5.1: Summary of City-level objectives for Rome

5.1.2 Key Findings

Economy

The data describing the economic effects of the MIRACLES measures were divided into two types: cost of operating and/or maintaining a given measure, and revenues generated by the implementation of a given measure. Regarding the WP5 before and after implementation, a comparison of operating and maintenance costs was not wholly appropriate. For the baseline, only costs related to the whole urban transportation system were available, whereas after implementation of the measures the single costs due to the implementation of the measure itself were available. On the contrary, those measures (7.1 7.2, 8.1 and 11.2) that had not been implemented had no associated baseline costs, and so a before and after comparison was not possible for these measures. In addition, measures 10.2 and 11.1 were only at a trial or one-off status during the baseline, but only reached a full implementation within the ex-post phase. Therefore, before and after comparisons for these measures were considered unsuitable.

Ex post evaluation

Ex post scenario

Measures such as access restriction or pedestrianisation were implemented at a modest cost. Indeed, operating and maintenance costs were regarded as minimal if they were linked to the costs of the whole urban transportation system (only about 1%, or 0.22 Euro/inh, of the whole transportation system costs). Similar results applied to transit measures. For instance, regarding the implementation of collective taxis, the theoretical cost per inhabitant was 0.6 Euro. However, if the same cost was divided among the actual users of the service, it was estimated that this would increase to, a still affordable, 16 Euros/user.

The increase of infrastructure supply is also a relevant consideration from an economic point of view. Rome Municipality doubled its net income from parking charges during the period 2001-05, whereas the cost for operating the whole system was only 0.10 Euro per parking space. Hence, quantitatively there are clear economic benefits corresponding to the wide implementation of the infrastructure measures.

The telematics measures seem to be the least expensive ones. For instance, the costs of operating and maintaining the new video-surveillance system are very low (respectively 0.05 Euro/inh and 0.0089 Euro/inh). However, this is not sufficient to prompt administrators to continue with the implementation of the measure, since more relevant is the economic support needed to train personnel and to integrate the measure into the general security system. On the other hand, in case of higher costs, as for the INFOPOINT measure (cost for operating € 0.21Euro/inh), the “nature” of the measure itself provided other avenues to explore to fund it. In this case, the entire operating cost (600,000 Euro/year) is paid for by the external company that manages the service, which in turn benefits from the advertising income.

It should be emphasised that for some “niche” measures such as car sharing, the indicators relating to operating cost and income are very modest, reflecting the “youth” of the service until now. In particular the theoretical cost for operating car sharing per inhabitant is one of the lowest of the MIRACLES measures but it is clear that a wider implementation is requested to fully assess the economical facet of the service.

Ex ante evaluation

It was considered that the costs and revenues before implementation of the MIRACLES measures were too general and therefore not particularly relevant for an evaluation of the cost-effectiveness of a given measure. However, there was a need to investigate the potential effects of implementing those measures where the economic factors are critical e.g. the business as usual scenario for the road pricing measure.

Business as usual scenario

For the baseline year (2001), economic data provided a reference of comparison for the business as usual studies. In general, no variations were foreseen for frozen and trend scenarios (see METEOR, Del. 2 - Assessment Framework and Evaluation Guidelines for Data Collection, for details of the scenarios methodology), using data provided to ITEMS and recalculated by DITS, because of the basic assumption of a modest socio-economics trend (due to the short period of simulation). Very modest variations of "total income from pricing" (€/inh) were obtained, only in the trend scenario, by assuming a proportional relation between it and the expected variation in population and employers in the city centre. For "Cost for operating the infrastructure" (€/inh) no variations were foreseen for the trend and frozen scenarios since without infrastructure interventions, operating and maintenance costs are unchanged. Given the peculiarity of some measures (e.g. electric scooters) where the demonstrations were very small-scale or time periods too short, no reliable business as usual scenarios were possible. Moreover, no possible scenario was applicable for the Mobility Management measure because there were no reliable assumptions regarding the number of participants eligible for subscription discounts. For "costs of maintenance", no variations were foreseen for the trend and frozen scenarios because without infrastructure interventions such costs could not plausibly change, which is especially relevant for the access restrictions, pedestrianisation and video-surveillance measures. In addition, "Investment costs" for telematic-based measures were considered as "one-off" costs, and hence not able to affect the business as usual scenario.

A scenario was also developed to assess the amount of possible revenue generated by road pricing charges. Simulation found that, as predicted, the highest revenue was achieved when all users (residents, non residents, drivers and two-wheelers) were charged with very high rates (e.g. 6 Euros per hour). However, there were differences depending on different times of the day and seasonality. Indeed, in some cases, the highest charges did not generate the highest incomes if not all the users were chargeable.

Simulation estimated that, for collective taxis, the business as usual indicator "cost for operating" increased from 0.9 Euro/inh to 1.28 Euro/inh. This was attributable to the strong improvement of service. In the baseline period, it was used by about 190,000 people annually for a total of 2,270 km/day, whereas in the business as usual scenario it was used by more than 1 million people annually for a total amount of 5,724 km/day.

Energy

Energy consumption indicators were mainly relevant to WP5 (set up of city centre clean zone and Set-up of Green Corridors/zones) and WP6 (Road pricing policies and Adoption of flexible parking policies/Environmentally linked parking charges)

measures, as well as the taxibus (7.4), car-pooling (8.1), clean buses (12.1) and e-scooters (12.3).

Ex post evaluation

Ex post scenario

The indicators "Energy efficiency of transport modes" and "Vehicle fuel efficiency" referred only to private cars and showed a strong decrease. This was due to the improved modal split, in which transit and walking increased, and to the reduced number of circulating polluting vehicles. The latter was due to a renewal of the private car fleet, as a consequence of national funding to provide incentives for less-polluting vehicles. Both values were theoretically determined, by processing 2004 fuel consumption data according to several parameters provided by STA including the circulating fleet, average occupancy and the vkm rates. However, STA observed a decreasing trend for fuel consumption since 1999. This analysis indicated a very strong reduction for "Vehicle Fuel Efficiency" to almost 50% of the baseline value, and an appreciable decrease (about 17%) for "Energy efficiency of transport modes". It should be noted that the energy consumption for the niche measures such as collective taxis (measure 7.4) or shared use of vehicles (measure 8.1) and e-scooters (measure 12.3) were not comparable to the overall values, because of the very small proportion of vehicles involved with the measures.

Regarding transit, it is worth noting the substantial reduction for both "energy efficiency" (0.08 MJ/pkm) and "vehicle efficiency" (3,3 MJ/vkm) indicators related to trolleybuses as ex post values (respectively, 0.1 MJ/pkm and 3.8 MJ/vkm as baseline values). The vehicle efficiency indicator showed a good reduction also for e-buses (3.6 MJ/vkm), whereas the energy efficiency seems to not meet expectations, being 0.2 MJ/pkm higher. However, this apparently contrasting result is due to the modest capacity of each electric bus, which is just 27 passengers. The vehicle efficiency of diesel-fuelled buses was also calculated (21.7MJ/vkm). To explain the different "Vehicle efficiency" values between electric vehicles and diesel buses, it is worth remembering that the energy consumption of the latter is influenced by the low efficiency of combustion engines. On the contrary, for e-buses and trolleybuses the efficiency in the power generating plants should also be taken into account.

Ex ante evaluation

Business as usual scenario

A comparison of the baseline values for both indicators (Energy efficiency of transport modes and Vehicle fuel efficiency) with the corresponding values from the frozen and trend scenarios found that there were no significant differences for the measures concerning access restriction, pedestrianisation, road pricing and flexible parking charges. For private cars a very minor variation was reported for the trend scenario (a 0.1 decrease in comparison to frozen and baseline situations), whereas for the PT system there were no variations at all. Using the general ITEMS results as a basis, the recalculated values of both indicators also showed only minor variations. For instance, considering the trend scenario, a 0.2 decrease was reported for the collective taxis measure and a 0.3 decrease for car pooling. However, regarding transit, it is noted that the ex post / ex ante comparisons provided by the ITEMS simulation results are not fully appropriate, since ITEMS provided only overall values concerning energy efficiency and vehicle efficiency for the whole transit fleet.

Considering its application to the road pricing measure, six scenarios were investigated in which the charges became progressively higher and therefore more restrictive for drivers. It was found that the consumed fuel rate was higher in the "cheapest scenario", and consequently reduces as the scenario becomes more expensive. This can be explained in terms of modal split, whose changes correspond to different fares: as expected, transit progressively increases and cars strongly decrease as road pricing fares increase, thereby resulting in greater savings in fuel consumption.

Environment

Prior to MIRACLES, concentrations and emissions measurements were already in use in Rome to report the annual air quality status. Historically, the worst situation concerned dust. Indeed, for particulates (mainly PM_{10}), the values were very high and above the national quality standard (40 $\mu g/m^3$) as well as the European standard (20 $\mu g/m^3$). The reasons for such poor performance were linked to traffic and weather conditions. The former was mainly responsible for the poor air quality, while the latter was attributable to long winters with few rainy days and lack of wind, which meant that pollution levels remained high. Pollution was due to the increased reliance on private cars, the high number of non-catalysed cars and buses and the old-generation mopeds and motorcycles. In addition, many of the private vehicles were old, inefficient and highly polluting, causing particularly severe problems in the city centre where pollution affected negatively not only citizens' health but also the state of conservation of historical monuments.

Regarding noise levels, until 1995 (when the national law on urban acoustic recovery called the Acoustic Recovery Plan was implemented), no surveys had been undertaken on a regular basis. Since then, even up until the baseline survey in 2002, noise levels in the whole urban area highly exceeded the maximum values. This was due to difficulties with enforcing the law and intervening with the noise sources.

Ex post evaluation

Ex post scenario

The ex-post values showed a substantial reduction in emissions. CO emissions reduced by about 76% during both peak and off-peak times of the day. This was due both to the renewal in the circulating private car fleet and to the general introduction of the whole package of MIRACLES measures, in which Access Restrictions and limitations on the use of the most polluting cars appeared to be the main reasons for improvement. For particulates and C6H6 emissions values, the reduction was about 38%. Such results exceeded the expectations concerning transport-related emissions, where reductions of 13% had been estimated inside the LTZ and 5% in other parts of the Laboratory area. The percentage reduction of CO and C6H6 concentrations (respectively - 21% and – 37%) was greater than for particulates (-11%), as already described in chapter 4, probably due to the improvement in petrol-fuelled new cars.

The number of polluting vehicles was therefore crucial in this scenario. Values achieved in the ex-post phase showed a reduction in the number of non-catalysed vehicles e.g. non-catalysed mopeds reduced by about 45%, private cars by 37% and commercial vehicles by less than 35%.

Ex-post results concerning noise levels were very positive, with an overall reduction at the city level, due mainly to the implementation of LTZ in the Laboratory Area.

Indeed, the MIRACLES interventions succeeded in reducing noise by 3.5 dB(A) on average, even without any interventions on the noise sources. For the Access Restriction measure, the anticipated reductions of 2 dB(A) were easily achieved. However, it will not be possible to meet, in general, the larger reductions (7 - 10 dB(A)) required by the clean vehicles and pedestrianisation measures, unless there are substantial interventions and targeting of the offending noise sources. It is also important to remember that dB(A) units are based on a logarithmic scale, so even a reduction of 1 dB(A) represents a good improvement.

Ex ante evaluation

Business as usual scenario

The business as usual scenario considered the general situation of emissions and concentrations according to the frozen and trend sub-scenarios. The ITEMS model was used to compare the baseline with frozen/trend scenarios, and estimated emission reductions of 31% for PM10, 42% for CO, and a very small decrease (1%) for CO2 (the latter was not among the Rome MIRACLES indicators). ITEMS did not provide data for benzene, and so emissions were calculated assuming a linear relationship, which provided a trend scenario in which C6H6 decreased rapidly. However, these strong reductions, without any MIRACLES intervention / measures, can be obtained only if a large renewal of the vehicle fleet is assumed.

Needless to say, polluting cars affect the urban environment very negatively and a variation in the number circulating the city can help to explain the variation of pollutant factors. For the baseline, frozen and trend scenarios, variations were detected only for some classes of vehicles; the most relevant one was a substantial decrease in the number of petrol cars under 1.4 tonnes between the ITEMS baseline and frozen scenarios. In contrast, very small variations were reported between the frozen and trend scenarios, meaning that there is a trend linking technical and economics factors whereby one counterbalances the other.

It is not easy to make comparisons, in terms of forecasting values, in an urban environment in which noise sources are so manifold and not only linked to mobility reasons. In addition, the modelling results generally cannot be considered as fully reliable when they involve such large areas as the Laboratory area, with a range of different uses of land.

Nevertheless, using the baseline data gathered from on-site surveys, as well as the progressive enforcement of the Acoustic Recovery Plan, it can be forecast that in the year 2006, noise levels can be up to 65 dB(A) during the day and 55 dB(A) at night. Any variations above these limits are unacceptable, but values much below these levels cannot be realistically achieved, unless real changes can be made in the typology of the noise sources.

From an environmental viewpoint, the most relevant targets in the MIRACLES scenario were achieved by simulating the application of ACS in the S. Lorenzo and Trastevere Areas and to the pedestrianisation of the Tridente area.

The scenario referred only to the application of ACS and to the renewal of a part of the PT fleet, but the simulation outcomes referred to the whole city of Rome, and so it was not surprising that no significant changes were found. An increase of CO and VOC was due to an increase in the use of mopeds, while the decrease of NOx, CO_2 and PM was due to the decrease in car use (assuming that drivers who can no

longer use their cars tend to switch to two-wheeled vehicles). In contrast, the forecast to substitute just over 10% of the PT fleet with clean vehicles led to a reduction of all the pollutant factors.

Society

The set of indicators for the "society" key area comprised awareness, acceptance, and satisfaction levels as well as motivation and expectations of the involved parties towards the implemented MIRACLES measures. (This group of indicators targeted perception, and will henceforth be termed 'awareness indicators'). The general aim was to assess the degree to which sensitivity towards sustainable mobility had been raised.

In addition to the awareness indicators, others were used to assess "material" changes such as the improvement of travel conditions for disabled (measured by the indicator: "Provision for disabled people"), and the media support (measured by the indicators: "Availability of information via media", "Number of e-tickets sold via SMS" and "Visitors on web sites"). Both can be regarded as quantitative measurements in terms of service accessibility (i.e. the opportunity for all to access services and places), and can be defined as 'accessibility indicators'. The analysis of how the public perceived the mobility pattern and accessibility changes was undertaken before and after the implementation of the MIRACLES measures through the use of questionnaires, interviews and focus groups, involving a sample size of 1400 citizens. Therefore, results on the society impacts of the measures came from a "before-and-after" comparison. The business as usual scenario was not considered since the relevant measures were unique to MIRACLES and no equivalent application was in place before the project.

Ex post evaluation

Ex post scenario

Regarding accessibility, there was clearly an increased provision for tourists and physically challenged people, and it met the requirements of all disabled users (including visually-impaired people). There was also an increase in service access via media. These improvements should be considered in conjunction with the general improvement of the transit supply (described within the transport indicators).

The awareness indicators were analysed on two levels: the assessment of the relevance of the MIRACLES measures (mainly in terms of awareness and satisfaction), and then a more detailed study of the feelings behind the replies.

The first part of the study revealed that among the MIRACLES measures, those perceived as being most satisfactory were clean buses, telematics applications (mainly VMS displays at bus stops) and parking facilities related to P&R. Awareness of these measures also increased, as well as for those measures such as collective taxis, that had not been fully implemented before MIRACLES and hence were less well-known. Paying for parking was the measure with the highest score of awareness, but before the MIRACLES implementation, despite its "popularity", the satisfaction rate with this service had dropped below average, along with the satisfaction value of access-restricted areas. A common finding from these assessments was that successful measures are those from which everyone can benefit (e.g. the use of transit or telematics) and do not limit the personal freedom (and the possibility to travel by car).

However, the second part of the study showed that the common feeling was not unequivocal. Citizens were grouped into different clusters, and it was considered that each cluster had developed over the years their own way to perceive the mobility situation. The clusters (or Cultural Patterns) were: Control, Confidence, Mistrust, Anarchy and Efficiency, each defined as follows:

- Control - a shared need to control the traffic situation, which becomes worse each day because of people's misbehaviour;
- Confidence - a positive feeling towards the community and its administrators, but negative towards the other citizens;
- Mistrust - the opposite feeling of confidence;
- Anarchy - is an attitude synthesized by the motto "the worst, the better!"; and
- Efficiency - a positive assessment on how mobility is governed in Rome (for instance, LTZs, pricing and restrictions in general, are perceived as expressions of efficiency).

The proportion of interviewees in the ex-post scenario was as follows: Confidence (48% of the interviewees), Anarchy (20%), Control (18%), Efficiency (9%), and Mistrust (4%).

Ex ante evaluation

Ex ante scenario

Before MIRACLES, accessibility was not a priority, and provisions for the disabled or a wide access to media for transit information had traditionally been assessed just as one-off activities or special events. Access to buses and tram was very limited for physically challenged people, with less than 40% of vehicles having a low-floor or equipped with a swivelling platform. This approach was very discriminating, not only for wheelchair users, but also for visually impaired people. From this point of view, the provision of signs with Braille dots on 100 buses was a very important ex post result. In addition, it was considered that, prior to MIRACLES, media played only a modest role in disseminating travel information. For instance, there were about 48,000 visitors to the local transit company (ATAC) web site during January 2002, but a monthly average of 200,000 during 2005.

For awareness, the survey identified, for the first time, the cultural models used by Roman citizens when regulating and planning their behaviour in the urban traffic context, as reported above. These results were evidence of a general positive attitude towards the community, but about a quarter of respondents viewed city life (and its problems of traffic and pollution) negatively. The awareness and the satisfaction levels also reflected such attitudes. Parking policies, access restrictions and clean buses were the most satisfactory measures and also those of which most people were aware.

Transport

Ex post evaluation

Ex post scenario

The transport indicators were chosen so as to assess the general improvement of the overall transport situation in the city after the implementation of the MIRACLES measures, with the "modal split" parameter being of most relevance. Considering the whole city area (in comparison to the 2001, the base year), for all transport modes, no significant diversions were recorded, apart from walking which increased from

21% to 27%. In contrast, data from the Rail Ring Area (where all the measures are implemented) showed a large decrease (5%) in the use of private cars in favour of walking (3%) and transit (1%). Needless to say, the measures that contributed the most to such a change were the access restriction ones (WP5). This effect was also forecast by the business as usual scenario, where the local restrictions in the S. Lorenzo and Trastevere areas showed similar trends. Small "niche" measures also contributed to this result; although interventions such as car pooling or car sharing were too modest to provide quantitative evidence. In addition, support towards collective modes was provided by Mobility Management measures, which involved about 42,000 users, and by collective taxis.

The increase of the transit option was also supported by an overall improvement of the PT supply in terms of two key elements: more trips e.g. buses per day and more passengers. The daily number of trips per line increased by 53% (referring only to the express and electric lines), whereas for collective taxis the number of units increased from 160 to 752 units. In general, the number of passengers per vehicle doubled for clean vehicles (electric buses and trolleybuses) and car pooling/sharing. In addition, positive outcomes were achieved from an operating point of view; for instance, travel times were shortened and additional routes were provided for clean vehicles and collective taxis.

The parking supply also increased, meeting the general requirements of re-organization and improving the parking resources. The achieved objectives were to increase the number of parking spaces by 50% and to study and develop parking policies based on flexible charges.

There were safety benefits, with the accident fatality rate reduced by almost 50%. This unexpected finding had not been supported by the business as usual forecasts.

The above results were just part of the overall positive achievements of MIRACLES. Other innovative measures such as the pedestrianisation, the mobility management, and the new forms of collective transit contributed to accomplishing the local objectives, as defined at the onset of the project. Amongst these, the reduction of private traffic flows by 4% and the reduction of space for private cars by 2% in the LTZ were considered as fully achieved, when viewed in the context of the new modal split and the extension of the pedestrianised areas, which increased in size by 20%.

Positive changes in traffic were also observed by a change in habits of the users. For instance, the number of car-poolers increased to more than 1000 users (above expectation) and the traffic flow in the LTZ during periods of free access reduced by 25% during 2001-05.

Ex ante evaluation

The ex ante evaluation started from data collected in the base year of 2001, and was developed according to the study of the business as usual scenario. The approach taken was to use general outcomes provided by the application of the ITEMS model, which were revised and re-calculated so to obtain data comparable with the ex post evaluation. In addition, the most relevant measures and outcomes of the modelling work were considered as local applications of what was actually planned and implemented.

Business as usual scenario

As with the study concerning the environment indicators, the business as usual scenario was built to depict the general situation of traffic according to two sub-scenarios: the frozen and the trend. In general for all measures there was a lack of relevant variation between the baseline and the business as usual scenario. The reason was due mainly to two factors: the simplified representation of the network made by the model (which provided differences only if there were major variations in socio-economics and/or transport related indicators such as number of trips, vehicular fleet renewal etc) and the short timescale of the scenario (just four years). In general, according to the business as usual scenario results, no changes would have occurred in the city traffic pattern without the MIRACLES measures. This was viewed as a consolidated outcome, and confirmed by the revision of the scenario in relation to each single measure.

However, for two priority indicators, the model provided some contrasting results, which were not considered totally reliable. The situation without the application of the MIRACLES measures was based on a modal split (at whole city level) in which the transit share was 22%, private cars (including mopeds and motorcycles) 53% and walking 25%. Within the simulation, these values corresponded to a decreased amount of trips for the whole city, and also a decreased amount for the Rail Ring Area. This appeared to be too general and not really tailored for a city like Rome, and led to many uncertainties in the results. For instance, considering modal split, it was not realistic to assess a transit share improvement in the business as usual scenario when it was hypothesised that there was a lack of measures to develop it. A modest socio economic trend would not be sufficient to explain such an outcome. A similar criticism could be levelled at the result showing an apparent decrease in private traffic (which in the base year was 59%), even though it had been assumed that there were no measures to control and restrict it.

These results show that a wide approach is not always suitable to assess the impact of very specific measures (such as the ones implemented within the MIRACLES project), and that in some cases it can provide misleading results at a general level.

A Geographic Information System (GIS) designed for planning management and analysis of transport systems was also used to build a scenario focused on new access regulatory acts and access control systems, different road pricing policies, introduction of different parking tariffs, low emission buses and new PT lines. The most interesting results came from simulating the access restriction and road pricing policies. In general, access restriction on a given area produced relevant changes in the modal options. For instance, for the application of the simulated access restriction to the Trastevere district, in the “without” scenario (i.e. without restrictions), the majority (58%) reached Trastevere by private cars, but in the “with-restriction” scenario, the majority chose an alternative to cars (37% travelled by mopeds and 25% parked at boundaries). Analysis of the traffic assignment results showed that the simulated restriction produced a decrease of flows inside the area and a corresponding increase of flows on the streets nearby, which was caused by drivers (who used to cross the area) diverting. The role played by mopeds is very important, since this type of vehicle is one of the main causes of CO and VOC pollution. The widespread use and high speed of mopeds also increased the number of predicted accidents (represented by the KSI (Killed and Seriously Injured) parameter), as mopeds are more dangerous than cars. However, as mentioned previously, the result contrasted with reality, in which safety actually improved at the urban level.

Road pricing policies were also able to affect modal split, and modal split variations were assessed on the basis of two hypotheses: the first was based on the integrated approach between access restriction and road pricing, while the second was based on a "pure" application of road pricing, with different pricing levels. In the former, it was found that modal split overall variations were minor especially in the cases of low charges and free access for mopeds, largely due to the low number of cars that would be charged. However, it should be highlighted that about 10% of authorized car users switched to Public Transport in the event of a 3 € per-trip fare, whereas an additional 3 € charge is required to move 10% more. About 7% of residents switched to transit when charged an annual fare of 300 €. The effects of charges on mopeds were noticeable as a result of the reduction of through-traffic linked to this category of users. Indeed, an analysis of through-traffic trip variations observed that mopeds were the only mode that significantly reduced when charged to use the road. In the second case (i.e. a "pure" road pricing application), changes in modal split corresponded to different charges. As expected, transit progressively increased and cars strongly decreased as road pricing charges increased. However, these changes occurred only in the event of very high (and unrealistic) charges.

A simulation of different parking charges confirmed the trend reported above. Results showed that the introduction of payment parking would produce a modal shift from private car to other transport modes (mopeds and public transport). This shift would vary from a minimum of 4% (corresponding to a parking charge of 1 Euro/h) to a maximum of 20% (parking charge of 5 Euros/h). Of these, most of the users would move to public transport. In particular, it was considered that the introduction of high parking rates (3€ and 5€) would produce a substantial reduction in the use of private car (of about 12% and 20%, respectively).

The simulations therefore confirmed what was actually achieved later with the implementation i.e. that restrictions and pricing can be useful tools to aid a change in modal shift from cars to transit.

5.1.3 Conclusions and Lessons Learned

Economy

It is difficult to draw unequivocal conclusions because of the large number of measures and their different grades of implementation. However, it is interesting to note that if the operating/maintenance costs of the measures were theoretically divided per capita, there is a threshold which is just less than 1 Euro per inhabitant. Of course, this value was not what users paid directly, but it is clear that for many measures, the wider the implementation, the greater the benefits for everyone. This is especially so for administrators who can save resources and increase incomes by enlarging the small-scale MIRACLES implementations. Conversely, the value may represent a limit for the feasibility of further measures: any intervention more expensive than this threshold could be assumed as affordable only if it achieved added values.

Energy

It is clear that the fuel consumption decreased during the project timescale. However, in addition to the MIRACLES measures, there were other opportunities to achieve this goal. In particular, the most important were the general renewal of the private car fleet supported by national policies, and by local emergency measures. The former supported the main national car factory during a crisis period, while the latter was

aimed at protecting the local environment. Indeed, it is likely that the incentives provided by the state for scrapping old cars and replacing them with new ones that were less polluting and more energy efficient, affected the observed trend on fuel consumption more than the MIRACLES measures, where the conservation of energy was generally regarded as an added value to the more pressing environmental problems in Rome.

Environment

For the majority of the MIRACLES measures the solution of environmental problems was a priority, and all the goals in terms of reduction of concentrations and emissions were successfully achieved. Of particular relevance were the access restriction measure, which permitted only clean, catalysed private vehicles to enter the central areas, along with enforcement of the extension of the yearly inspection of vehicle emissions and of compulsory servicing of motorcycles and mopeds. In addition, the purchase of about 900 clean buses contributed to the improved environmental conditions. This means that for large cities such as Rome, where there are environmental problems due to the massive use of private cars, weather conditions that do not allow the ready dispersion of emissions, and no fully suitable regulations for safeguarding the environment, a great effort is required to intervene and implement measures (as in MIRACLES) if positive results are to be pursued. Furthermore, to continue this positive start, all the wide-implementation measures (access restriction, controls on polluting vehicles, increase of clean transit, etc.) need to be even more widely applied, both in terms of enlarging the implementation area and in improving the relevant control and enforcement procedures (e.g. the regular inspection of two-wheeled vehicles). In parallel, the so-called “niche” measures (e.g. taxibus, e-scooters, car sharing/pooling, etc.) require more effort for a fuller implementation to enable a greater level of effectiveness.

Society

Regarding awareness indicators, a main finding from the before and after data comparison was that the success of a given measure relies on the possibility to continue using private cars to some degree. Indeed, the most restrictive measures were the least well accepted, which explains why the Control Cultural Pattern reduced considerably (from 23.16% to 18.76%) and the Anarchy one increased (from 15.58% to 20.23%) during the time between the two surveys.

A lesson to learn is that citizens judge the disincentives of using private cars as being less positive than the incentives to attract passengers to transit, even though environmental benefits were evident from the business as usual simulation and confirmed by ex post surveys. One reason could be that car culture habits are still strong, which previously prevented decision-makers from exploring options other than car-based ones. Consequently, citizens had no real modal choice. Other issues to be resolved in the future concern how to discourage the use of private cars at a political level, and whether the approach taken should be based on restrictions, as currently applied, or in supporting more popular incentives to attract passengers to transit. The challenge could be based on the creation of more attentive behaviour among the private car drivers, as a result of an overall increase of sustainability.

Transport

Each measure was meant to solve a particular challenge by utilising a “push and pull” approach. The “push” part had its positive results especially in terms of the increase of transit and walking in the current modal split, whereas the pull “part” had positive outcomes in terms of supply of diversified forms of transit, some of which were very

innovative. Within the transportation domain, the achievements that could be regarded as being the most successful (e.g. the reduction of private traffic flows and the increased space for pedestrians in the LTZ) mainly involved restrictive measures. However, this assessment was affected by the large scale of implementation of such measures relative to others. Additional time is required to really assess the benefits of new forms of transit or the use of telematics on the transport usage patterns. Only afterwards will it be possible to fully comprehend how the whole package of MIRACLES measures is able to affect transportation patterns.

5.2 Summary of City-Level Results for Winchester

The city-level summary for Winchester is now presented. See Annex 2 (2nd Implementation Report for Winchester) for additional details.

5.2.1 Objectives

Table 5.2 summarises the general objectives of the Winchester assessment of the combined impacts of the MIRACLES measures (see also section 2.2.2 for more detailed local targets).

Key Area	Objectives

Economy	• Assess change in the economy of the city centre regarding:
	  • Business (number of employees);
	  • Tourism (accommodation bookings); and
	  • Travel (operating revenues of local bus operator).

Energy	• Changes in sales by local petrol stations of alternative fuel (e.g. LPG).
Environment	• Improve the air quality, using actual measurements from air pollution monitoring stations, and perceived ratings from questionnaire surveys. • Reduce the perceived noise levels in the city centre.
Society	• Increase public and business awareness and acceptance of MIRACLES, thereby increasing awareness of the need, potential and ability to change to more sustainable transport patterns. • Increase perceived ease of access to the city centre. • Assess change in numbers of crime-related incidents and public perception of security.
Transport	• Reduce the overall absolute level of car traffic by 2%; • Reduce peak period car travel by 7% on the key arterial routes; • Improve the satisfaction rating of public transport by 8%; • Increase walking by 20%; • Increase the level of cycling by 30%;

Table 5.2: Summary of City-level objectives for Winchester

5.2.2 Key Findings

Economy

Data regarding the total number of employees was available for the period 1998-2003 (none was available for 2004-05). There were about 34,000 people employed in Winchester in 2002 and 2003, which was a small increase (of about 5%) from the corresponding 2001 value. However, since 2003 represents the beginning period of the MIRACLES project, this increase is unlikely to be due to MIRACLES. Considering the period 2002-04, there was a small reduction (of about 3%) in the number of hereditaments (separate business premises) in Winchester, but an increase (16%) in the floor space used.

Data was available regarding monthly accommodation bookings made through the Tourist Information Centre (TIC). The total TIC bookings for 2004 increased by 12% compared to 2002. However, it is uncertain whether TIC bookings are necessarily representative of the total number of accommodation bookings made in general. (For instance, there may be an increasing trend for people to book for themselves online). As expected, the TIC bookings peaked in each year during the summer months. Generally, there was no evidence that MIRACLES measures changed the number of Winchester accommodation bookings.

Operating revenues for four city centre bus services were obtained (and expressed as yearly percentage changes due to commercial sensitivity). Of the two MIRACLES routes, there was a noticeable increase in revenue for one service (20% for 2003-04 and 19% for 2004-05). The main reason for this increase was likely to be the increased frequency of this particular service (from 4 to 6 times per hour), but the introduction of new cleaner buses along the route also helped. This route was also the only one of the four where the passenger numbers increased during the project lifetime. The revenue generated on the other MIRACLES city centre service increased in line with the two 'control' routes (about a 5% to 8% increase year on year during 2003-04 and 2004-05). During 2002-05, there was a general fare increase of 20%, which contributed to the increase in operating revenues.

Energy

The relative change in fuel sales per year (using 2002 as the baseline) was analysed from the records of one filling station in Winchester. As of October 2005, there were only two in Winchester that sold Autogas (LPG) and sales of this fuel increased by 136% during 2002-05, although this still only represented about 3% of total fuel sales of the petrol station. The relatively small quantity of LPG sold could have been affected by the two dual fuel (petrol/LPG) clean vehicles bought by Hampshire County Council (HCC) for use by Winchester businesses.

The sale of diesel increased by about 50% since 2002, and represented 54% of all fuel sales at that petrol station in 2005, compared to 42% in 2002. Conversely, revenue generated from unleaded petrol accounted for only 36% of the total in 2005, compared to 49% in 2002. However, revenue generated from unleaded petrol sales still increased by 8% during this time, due to the general increase in petrol prices. The proportion of sales of Optimax unleaded petrol (which is claimed to be a 'cleaner' fuel than standard unleaded) remained constant at 8%. Analysis of the DVLA records for 2004 and 2005 showed that Winchester had a higher than average percentage of diesel vehicles in its fleet.

The above results were compared with fuel sale figures collected from an equivalent petrol station in Southampton. Here, the data has remained more constant since 2002. Unleaded petrol remained the most popular fuel, each year representing about 53% of all fuel sales, while the proportion of diesel sales only increased slightly (from 35% of all sales in 2002 to 38% in 2005). The proportion of LPG fuel sold remained unchanged, and represented about 4% of all fuel sales in 2005. It should be noted that there are three filling stations in Southampton that sell LPG.

Environment

There are two permanent monitoring stations in Winchester: one to provide 'background' measurements and one to provide 'roadside' measurements. Data from 1997-2004 was collected for the emissions PM_{10}, NO_x and CO. Air quality targets

were met for PM_{10} and CO throughout 1997-2004. However, Winchester city centre has a problem with the levels of NO_x and these roadside measurements exceeded the mean and maximum air quality targets during three of the years (1997, 2002 and 2003). Most of these failures occurred between October and February, a time of year where there is cold still air containing non-dispersing pollutants, thereby resulting in poor air quality. Such weather was particularly prevalent during the three 'failure' years. In Winchester, traffic emissions are the only source of NO_x and so any measures to reduce traffic flows or clean up vehicles in the city centre area would contribute to an improvement in air quality. The data showed that weather conditions were a major factor in whether such pollutants are dispersed.

The Winchester Travel baseline and ex-post questionnaire surveys asked the public their opinions of air quality and road traffic noise levels within the city centre. Concerning air quality, there were no statistically significant differences between the two sets of data, although in 2005, 45% of the respondents rated the air quality as generally being good, which was a reduction from the baseline 49% in 2003. However, there was evidence that the traffic noise levels were perceived to have worsened significantly. For example, in 2005, 13% of respondents rated the road traffic noise levels as generally being quiet, although this was only a small reduction from 15% in 2003.

Society

Within MIRACLES, questionnaire surveys were undertaken of Winchester residents and businesses, as well as Winchester non-residents, to assess public awareness and acceptance of the measures. A total of five batches of surveys were carried out:

- Winchester Travel 'Baseline' (July / August 2003);
- Winchester Transport (January / February 2005);
- MIRACLES Awareness (January / February 2005);
- Business (May 2005); and
- Winchester Travel 'Final' (July / August 2005).

Awareness of the MIRACLES logo increased significantly from 3% during the baseline survey to 20% in the final survey (and 24% in the business survey undertaken in 2005). Similarly, awareness of the CIVITAS logo increased significantly among the public during the project duration: from 3% in 2003 to 14% in 2005 (and 33% among businesses). In parallel to MIRACLES, the Winchester Movement and Access Plan (WMAP) has been a local sustainable transport initiative, ongoing for the last 10 years. Awareness of WMAP increased from 20% in 2003 to 25% in 2005 (and 41% in the business survey).

Respondents to the two sets of Winchester Travel questionnaires were asked to what extent they agreed with the council policy of trying to persuade people to reduce the number of journeys made by car, and encouraging them to shift to more environmentally friendly forms of transport. A high proportion of people supported this statement with 69% of baseline respondents and 71% of ex-post respondents generally agreeing. In addition, respondents in the ex-post survey were significantly less likely to disagree with the policy.

Regarding ease of access to a nearest form of public transport, a substantial majority of the public had no problems. For example, 81% of Winchester residents in the baseline survey and 85% in the ex-post survey rated it as easy or very easy to reach their nearest form of public transport. In addition, the ex-post survey respondents were significantly less likely to state that they found it difficult or very difficult.

Within the Travel baseline and final questionnaires, respondents were asked three questions regarding ease of travelling into, around, and out of Winchester using various forms of transport modes. The responses from the two surveys were compared. For all three questions, a significantly higher proportion of ex-post respondents (compared to the baseline respondents) rated it easy to travel by car or Park & Ride (P&R). There were no differences between the two survey samples for cycling, train, and bus (excluding P&R) modes. However, a higher proportion of ex-post respondents rated it as difficult to travel into the city by walking (although 82% regarded it as easy).

The questionnaires also assessed public perception of security, as applied to a number of transport situations in Winchester. There were no significant differences between the two survey samples in terms of perceived daytime safety of walking, cycling, driving a car, or waiting for / travelling on a bus or train. However, when night-time safety was considered, a significantly higher proportion of ex-post survey respondents (compared to the baseline respondents) rated driving a car, and waiting / travelling on a train as being more secure. The contribution that MIRACLES made to this increase was unclear. In general, respondents were noticeably less secure after dark. Typically, about 80% perceived a transport scenario as being secure during the daytime, but this reduced to about 40% during the equivalent night-time scenario. Crime figures from 2001-04 for Central Hampshire were analysed, although data specifically for Winchester city centre was not available. The area of Central Hampshire has a lower crime rate than Hampshire and the Isle of Wight as a whole, with only about 5% of vehicle crime and 7% of all crime occurring in this region. Generally, there was no evidence that MIRACLES measures changed the number or type of crimes in the Winchester area.

Transport

The Travel baseline and final questionnaire surveys were targeted at both city residents and non-residents, although the proportion of responses received was not equally split between the two sets of surveys: the ex-post survey contained a significantly higher proportion of Winchester residents. The questionnaires asked respondents their usual daily means of travel within Winchester to their place of work or study. From the ex-post results, 49% stated that they drove a car (the equivalent baseline results was 51%), 14% walked (16%), 8% travelled by train (5%), 6% by bus (6%), 7% by car + bus (5%), and 5% by bicycle (3%). The ex-post respondents were significantly more likely to travel by train, bicycle or motorbike, and less likely to travel by car + train or walk. The analysis was repeated considering just the two subsets of Winchester residents only. Only 40% of ex-post respondents stated that they drove (compared to 51% of the equivalent baseline respondents), 23% walked (15%), 8% by bicycle (5%), 7% travelled by bus (5%), 6% by train (6%), and 0% by car + bus (4%). Compared to the baseline results, Winchester residents in the ex-post survey were significantly more likely to state that they walked or cycled, and less likely to travel by car or car + train.

Total traffic flows for the arterial roads decreased slightly by 1.4% from 2002 to 2004. There was a significant decrease to the outbound flow on Chesil Street (reduced by 16%) which could be partly due to the fact that this arterial road is on the P&R route which has seen a 43% increase in ticket sales since the start of MIRACLES due to the extension of the P&R St Catherine's car park.

Respondents were also asked how safe they felt, in terms of road safety and accidents, when using various transport modes in Winchester. 82% of ex-post respondents rated travelling by car as 'very' or 'quite' safe, a significant increase from the corresponding baseline value (77%). However, further investigation found that there was no statistical difference in this proportion between those respondents who were aware of MIRACLES and those who were unaware, which implied that the MIRACLES measures did not influence people's perception of road safety. There were no significant differences between the two survey samples for cycling, walking and bus (including P&R) modes.

There was a 12% decrease in the average cycling flows on the arterial routes from 2002 to 2004. The fall was greatest for inbound flows (-16%) compared to outbound flows (-9%). However, there was evidence of increased cycling within the city centre area with the maximum number of bicycles parked in the city centre increased by 46% from 2002 to 2005, partly attributable to the presence of 50 extra Bikeabout bicycles in the city centre area.

There was a significant increase in the number of households owning at least two cars. The average number of cars per household was 1.29 in 2003 and 1.44 in 2005. DVLA records showed that the average age of the Winchester fleet increased slightly from 5.42 to 5.58 years from 2004 to 2005, although the difference was not significant.

There was a 16% decrease in ticket sales at the seven most popular city centre car parks. In contrast, there was an increase of about 43% at the P&R car parks. This was attributable to the St Catherine's P&R site extension in February 2004, which increased its capacity by 420 spaces (see measure 7) as well as the large price differential between all day parking at the P&R (£1.50 throughout MIRACLES) and parking in the city centre (£3.50 - £15 in 2005).

Lost miles for the Winchester bus fleet (not split by route) were assessed and showed that the majority were due to congestion, breakdowns or having no driver. The percentage of failures (buses not running to schedule defined to be more than 1 minute early or 5 minutes late) reduced from 0.95% to 0.34%. The number of late running buses in 2002/3 was particularly high in July/August 2002 due to congested conditions because of extensive road works in the city centre area. If this data is removed, the percentage of failures is 0.68%, still noticeably higher than the two subsequent years. The data highlights the problem of how congestion in the city centre can adversely affect the punctuality and frequency of the bus service, reducing the positive effects of the improvements made.

Overall bus passenger (satisfaction) rating of very good or quite good increased from 2003 to 2005 by 4% (83% to 87%) on the three Bus Quality Partnership routes supported by MIRACLES. They were already at a relatively high level on all three routes (particular the P&R on 92%) as some of the mini-measures had already been implemented before the 2003 survey took place and had helped to improve the service (see measure 7 for more details).

Journey speeds for the five arterial link roads showed no significant differences during MIRACLES; any differences could be accounted for by an incident or random variations. Journey speeds in the city centre highlighted congestion hotspots at two signalised junctions (City Road/Andover Road and High Street/Southgate Street).

Journey speeds were much higher on the east side of the city where no traffic signals are present.

Generally, there was no evidence that MIRACLES influenced the average age of the car fleet or the public perception of safety. A lack of data prevented an assessment of whether MIRACLES had affected pedestrian flows, HGV flows, number of road traffic accidents and average vehicle occupancy. However, if such data had been available, it is anticipated that they would not have been affected by MIRACLES.

5.2.3 Conclusions and Lessons Learned

Economy

There was no evidence that the MIRACLES measures influenced the number of employees (or hereditaments) or accommodation bookings in the Winchester area. However, bus company revenues did increase. This was partly attributable to an increase in fare rises, but also because of the grant from HCC to assist the purchase of cleaner low-floor buses (also resulting in lower maintenance costs) and the other MIRACLES improvements made to the quality and information of the services. This basis needs to be built upon, both to meet passengers rising expectations of the service and also to attract new passengers to the service.

Energy

Fuel sales from one petrol station in Winchester showed an increase in the proportion of diesel sold, and therefore indicated a move towards more widespread use of environmentally friendly fuels. The quantity of LPG sold at the particular filling station more than doubled during the MIRACLES lifetime, and the proportion of LPG sold represented about 3% of overall fuel volume sales at that garage. Even though LPG is less than half the price of diesel or unleaded petrol, it still seems that the public is reluctant to purchase an LPG vehicle (or convert their existing vehicle). This option may become more attractive over time, particularly in light of the recent increase in fuel prices. However, a major disadvantage of LPG is the limited number of garages that currently sell the fuel.

Environment

Air pollution levels in Winchester are greatly affected by weather conditions. This means that any reductions due to the MIRACLES measures are very difficult to measure. There is evidence that the city centre has a problem with the levels of NO_x. Emissions from buses have improved as a result of measure 12.1, but the scale only matches the reductions in car emissions (as a consequence of evolution of general car fleet) over the same period. Future measures concentrating on reducing NO_x from HGVs, LGVs and high-polluting passenger cars could produce significant benefits.

Generally, there was no evidence that the MIRACLES measures changed people's perceived views regarding air quality or road traffic noise in Winchester city centre.

Society

In parallel to MIRACLES, the Winchester Movement and Access Plan (WMAP) has been a local sustainable transport initiative, ongoing for the last 10 years. Awareness of WMAP increased from 20% in 2003 to 25% in 2005 (and 41% in the business survey). This indicates that although awareness of sustainable transport issues should increase in the longer term, even then it may not produce 'high' ratings.

It is important to note that awareness and (stated preference) acceptance of an initiative does not necessarily influence travel behaviour. There is a huge difference between accepting the objectives of an initiative in a theoretical way and for that individual to be then prepared to change travel behaviour as a result. For instance, 71% of the public supported the broad objective of MIRACLES to promote and influence travel by sustainable transport, but only about 25% used a mode of sustainable transport in Winchester on a daily basis. Businesses were generally more aware of MIRACLES than the general public but were less accepting of the MIRACLES aims. This may be due to the fact that they feel that some of the measures could harm their business financially.

Generally, there was no evidence that the MIRACLES measures changed people's perceived access to the city centre, their perception of security or the crime figures.

Transport

The extension of the St Catherine's P&R car park enabled ticket sales to increase by 43% during the lifetime of MIRACLES. The associated parking charging policy also helped to encourage the use of more sustainable transport (P&R) and deter city centre parking.

Although cycle flows on the arterials decreased by 12%, cycle parking saw an increase of 46% during MIRACLES showing that the Bikeabout initiative (measure 8.2) may have had success in encouraging more cycle use specifically within the city centre area.

MIRACLES did help to increase bus passenger patronage by 5% and satisfaction rating by 4%, and significantly improve bus punctuality in the Winchester fleet (see measure 7).

The MIRACLES measures had little effect in reducing overall traffic flows on the arterial roads in Winchester, although there was a 16% flow reduction on one particular road (Chesil Street), which was attributed to the P&R extension. There was an encouraging significant reduction of 10% in the percentage of residents travelling by car from the stated preference questionnaire. It is thought that the P&R service may have contributed to this result.

Traffic congestion hotspots still exist within the city centre, particularly at traffic signal junctions (e.g. City Road/Andover Road and Jewry Street/High Street). This reduces journey speeds on these links for all vehicles (including buses) as well as producing more emissions. A re-assessment of these junctions may lead to a more optimal design which could reduce queues and delays.

The results show that although people are aware and accept the MIRACLES measures, this does not necessarily translate into positive impacts on the network. Some indicators directly related to specific measures have shown an impact (e.g. an increase in cycle parking), but the city-wide indicators generally have not.

5.3 Summary of City-Level Results for Barcelona

With a population of 1.6 million, Barcelona was one of the largest cities within the CIVITAS I initiative. Unlike leader cities (like Rome for MIRACLES), only a limited number (WPs 5, 7, 9 and 12) of the CIVITAS measures were implemented, and these measures were concentrated at specific locations across the city. For these reasons, city-wide monitoring was limited to those indicators regarding citizens' awareness and acceptance of the implemented measures.

The MIRACLES project was the first time that the key actors in Barcelona (the Municipality, ATM and TMB) had participated in a clean transport demonstration project. Agreement on data exchange, and supporting the demonstration of real-time information for bus services (including those beyond the limits of the city), was considered to be a city-level achievement, which was only achieved after a lengthy collaboration between ATM and TMB.

MIRACLES helped to plan and monitor aspects of the re-introduction of the tramway to Barcelona's streets. The results demonstrated that this mode of transport achieved a high level of usage in combination with walking, with a high appreciation of features such as high running speed and easy access.

The project provided a significant impetus to the expansion of the city's CNG bus fleet (35 buses at the onset). By the end of 2005, there were 160 CNG buses out of a total fleet of 1004 vehicles. To reach this level of operation, the refuelling infrastructure was expanded and special workshops put into operation to minimise maintenance costs of the new types of vehicles.

Of the various innovations introduced to improve goods delivery, the measure most appreciated at the site technical audit concerned the integration of peak-hour bus priority in the scheme of multi-use lanes.

Following the first trials of ANPR technology in the city, the Ramblas access control scheme is being implemented. Although this technology was not able to capture a sufficient proportion of number plates of powered two-wheelers, the regulations must be applied to the large number of such vehicles in order to ensure a real improvement in pedestrian amenity. This will be the first time that powered two-wheelers are subject to access restrictions, and full operation of the scheme will only be possible once metro station works are complete. The key findings of relevance at the city level achieved by specific measures are now highlighted.

5.3.1 Key Findings

Economy

Concerning the integration of Barcelona's first modern tramway within the collective transport network, over the first 18 months of operation, the passenger volumes of the tramway increased from around 20,000 to over 41,000 passengers/day (as of October 2005), which exceeded original forecasts.

Improving operators' ability to deliver goods to supermarkets demonstrated economic benefits. The operator Mercadona's investment in quieter vehicles and unloading methods achieved operational savings that were estimated to lead to a return on investment within 3 years. Other supermarkets also achieved significant reductions in

delivery times, and there is continued interest from operators to further innovate based on concepts demonstrated in MIRACLES.

The introduction of camera-based access control was seen as a means of avoiding the maintenance costs associated with retractable bollard technology. Although the results were promising, it is too early to say whether bollard locations will be progressively substituted by ANPR technology.

Energy

An 18% shift of person trips from car to tramway was recorded, which was estimated to represent a saving of between 57,000 and 163,000 litres of fuel per annum (the higher figure included a projected car use for generated trips).

The higher energy consumption achieved with the standard 12-metre CNG buses was not as apparent with the articulated 18-metre CNG buses, which were finally procured as part of the fleet expansion to 160 CNG buses.

Environment

Substantial savings in pollutant emissions were reported for the initial enlargement of the CNG bus fleet (to 70 buses). Interestingly, the quieter performance of the CNG buses was highly valued by both passengers and drivers.

The implementation of access control along the Rambla was designed to achieve an improvement in pedestrian amenity. For the 77,000 pedestrians crossing the vehicle traffic each day, daily delay reductions as a consequence of halving the traffic were calculated to total more than 15 hours.

Society

Of the four measures implemented, citizens rated them on a 1 to 10 scale. The CNG buses were rated highest (7.9) and the tramway lowest (4.6). The low rating of the tramway differed from the high ratings achieved for other indicators of tram performance and was attributed to the timing of the city-wide survey. (The tramway was still under construction, causing disruption to local access and major diversions of traffic due to works).

Transport

The Traverssera de Gracia multi-use lane demonstrated peak bus priority, improved off-peak unloading and better traffic circulation. By suppressing daytime car parking (over 40 spaces) the possibility that the second (of four) lane(s) became blocked was very much reduced.

There were indications that the provision of real-time information at bus stops helped to increase the number of passengers, but further monitoring is planned to incorporate information from a larger number of stops.

53% of surveyed tramway passengers cited the higher speed as the main motivation for using the tramway. (This was followed by features of accessibility; “close-by” cited by 13%, “easy-boarding”; 12%). Around half of the trips involved a combination of walking (of more than 5 minutes) plus tram; and, each day:

- some 17 wheelchair users travelled by tram unassisted,
- around 50 cyclists used the tram to extend their trip-making distance,
- parents pushed some 385 baby chairs into and out of the trams.

5.4 Summary of City-Level Results for Cork

The city-level summary for Cork is presented below. See Annex 4 (2nd Implementation Report for Cork) for additional details.

5.4.1 Objectives

Table 5.3 describes the general objectives used to assess the combined impacts of the Cork MIRACLES measures in each key area (see also section 2.4.2 for more detailed local targets).

Key Area	Objectives
Economy	• Assess costs and operating revenues of the MIRACLES measures.
Energy	• Reduce energy consumption due to city centre traffic, by the implementation of Clean Vehicles, Park and Ride and the Clean Zone. • Implement a system allowing travellers to check the availability of off-street parking and to optionally pre-book parking space. • Convert 2 – 5% of the City Council's fleet to lower emission vehicles.
Environment	• Improve the air quality and reduce the noise levels in the city centre. • Reduce vehicle emissions by redirecting motor traffic away from the city centre and onto the ring roads or into the park and ride centres. • Provide a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre. • Demonstrate the conversion of vehicles to run on lower emission fuels such as rapeseed oil.
Society	• Increase public awareness and satisfaction of MIRACLES measures, along with increasing citizen awareness of the need, potential and ability to change to more sustainable transport patterns. • Promote access to the city centre by public transport, particularly, as a viable alternative to making all such trips by car. • Demonstrate potential methods for reducing peak-hour traffic congestion such as carpooling.
Transport	• Reduce lane capacity by 50% on the city's main arterial route (from 4 lanes to 2 lanes). • Increase the numbers of cycle parking facilities within the city centre by at least 40% • Reduce traffic levels through the Clean Zone by at least 2%, as compared with the business as usual scenario. • Provide at least 450 Park and Ride spaces at a new facility; increase and maintain uptake of Park and Ride to near full capacity. • Achieve a 5% decrease in the use of the private car among employees of Cork City Council.

Table 5.3: Summary of City-level objectives for Cork

5.4.2 Key Findings

Economy

The Cork MIRACLES budget was €0.5 million from the EU for approximately €1.5 million worth of eligible expenditure.

Of the six Cork MIRACLES measures only the Park and Ride (measure 7.3) and Park by Phone (measure 11.2) generated operating revenues. The revenue from the Park and Ride service is currently more than covering its operating costs and is making a substantial contribution towards the city economy, particularly at peak shopping periods such as Christmas, when over 1,000 additional shoppers access the city each day. The Park by Phone measure has slightly reduced parking revenues earned by the City Council (due to incorporating the phone call cost charge) but is expected to have benefits such as reducing the probability of illegal parking and the quantity of paper used for making parking discs as well as the more efficient processing of parking fines.

The Cork MIRACLES measures definitely aided the city economy by acting as a catalyst for advancing the implementation of planned major city improvements such as the very successful redesign of St. Patrick's Street and the construction of the new Park and Ride facility. The success of the city centre Clean Zone centred on St. Patrick's Street also led to its expansion during the MIRACLES project

Initially only St. Patrick's Street was to be re-designed (WP5.1). However, in 2004 the Clean Zone was extended to include Oliver Plunkett Street and the upper section of the Grand Parade. This is the largest of the Cork measures. The expanded Clean Zone total cost was about €30 million, with St. Patrick's Street costing approximately €12million, Oliver Plunkett Street €4million and the Grand Parade €14 million.

The infrastructure purchase cost for St. Patrick's Street was approximately €4.7 million with approximately €1.2 million of this being part MIRACLES funded. Labour costs were in the region of €6.7 million and plant costs €2 million. 25 people were employed temporarily on the scheme.

For WP7.3, a new Park and Ride scheme was implemented with contract costs of €1.8 million over 3 years, power costs are approximately €40,000 per year and maintenance costs €75,000 per year. 5 people are employed on a long term basis for this measure. No operating subsidy is required as it is self-financing, the users paying €5 per day for use of the service (Park and Ride bus, parking and up to 4 passengers included).

The cost of the Park and Ride service (WP7.3) was found to be a significant demand factor (current cost €5/day for a vehicle and up to 4 passengers); 56% of the users surveyed in 2004 cited the cheaper price as the reason for using Park and Ride. Users should be offered a significant saving compared with inner city parking for long stay parking (in Cork, users start saving if they park for over 2 hours and even greater savings if they avail of discounted monthly or annual tickets)

Measure 10.1 provided new cycling facilities in the city centre; the infrastructure purchase costs were over €230,000 due to the expansion of this scheme to provide extra cycle parking facilities. Administrative costs were €68,000 which included

various promotional schemes. 0.4 of a person was temporarily employed on this measure.

The promotion of sustainable commuting habits in WP10.2, through Travel to Work and Travel to School projects, at a cost of €37,000 and one person was employed temporarily on the measure.

In WP12.2, seventeen Cork City Council fleet vehicles were converted from diesel to run on rapeseed oil; infrastructure purchase costs were €17,000 and operating costs were €52,000. A blend of 25% diesel and 75% rapeseed oil was initially used in the converted vehicles, by November 2005 pure rapeseed oil was being used. The cost of fuel was a major issue in the cost-effectiveness of this measure. In early 2004, the Irish government Finance Act was amended to allow for a tax exemption on the use of rapeseed oil in certain projects. By then the rapeseed oil was around 50% more expensive than the diesel being purchased by Cork City Council. This amendment was approved in Autumn 2005 with the result that diesel then cost €0.995/L and rapeseed oil €0.87/L.

The MIRACLES measures aided the economy of the city centre regarding business, tourism and travel. There were no specific economic indicator targets but it was expected that the improvements in sustainable transport and the improved environment would result in a more prosperous and pedestrian friendly city. The economic benefits for the city from MIRACLES were difficult to identify since parallel projects such as the City of Culture 2005 and Green Routes (quality bus corridors) made an important contribution to the economy of Cork City.

The MIRACLES measures promoted inner city shopping and tourism. Pedestrian counts on Patrick's Street pre and post MIRACLES showed a significant increase in pedestrian numbers; up to a 15% increase per annum seen in the afternoon peak hour.

The provision of new cycle stands, seats and benches in the Clean Zone should improve the citizens' quality of life. The footpath widths were widened substantially, and this was greeted very positively; over 80% of user survey respondents rating them as "much better" or "slightly better". The overall opinions on the redesign and on the visual improvement were very positive with over 60% rating it as "much better". The reduction in the number of traffic lanes and the provision of cycling parking facilities could have been a factor in the increased number of cyclists.

Representatives of business organisations strongly supported the Clean Zone. The redesign was seen as supporting the retention and expansion of businesses in the city centre, which was important due to the recent expansion in suburban shopping centres. The city centre was made more accessible by the use of Park and Ride, Park by Phone, the increase in cycling facilities, improved public transport facilities, and a more attractive shopping environment.

The wider pedestrian areas and the modern more disabled friendly surfaces, tactile guidance, etc., are considered easier and safer. Extra space for hosting cultural events/recreational activities has been created (e.g. a street fair was held on the new streetscape to mark the "Day of Welcomes" when Cork celebrated the expansion of the EU). Many visitors have come to the city centre during the many open air cultural events hosted on the street. However, the increase in tourist numbers partly resulted

from the European City of Culture 2005 activities; many of these were dependent on the use of the Clean Zone and the expanded pedestrian areas.

The operating costs and revenues of the local bus company are commercially sensitive and could not be obtained.

Energy

The MIRACLES measures such as the city centre Clean Zone (including improved pedestrian and cycle facilities) and Park and Ride should contribute to reductions in energy use by encouraging a mode shift towards sustainable travel modes. The conversion of 17 vehicles of the City Council's fleet to run on rapeseed oil reduced the use of mineral oil based fuel.

The local objectives and quantifiable targets were to increase in the diversification of the types and quantities of fuels used in the city. A general objective was to encourage sustainable commuting.

A principal objective was to convert at least 2 – 5% of Cork City Council's vehicle fleet (approximately 250 vehicles, of which 97.5% were diesel and the reminder petrol in 2002) to run on lower emission fuel. 17 vehicles were converted during the course of the MIRACLES project (~7% of the fleet) to run initially on a rapeseed oil (75%) and diesel (25%) blend, by November 2005 pure rapeseed oil was being used.

Information related to energy consumption of the City Council fleet vehicles was provided by the City Council. In 2003, 441,727 litres of diesel (approximately 8,550 litres per week) were used for 250 vehicles. For 2004, a total quantity of 493,360 litres was consumed (approximately 9,675 litres per week). Based on the 2003 and 2004 use, it is predicted that in 2005 the diesel consumption will be 540,000 litres and for the first month of 2006 it will be 47,000 litres. Approximately 50,000L of rapeseed oil has been used in the course of the measure.

A study by the University of Limerick compared the exhaust emission profiles, torque and power of the vehicles while running on vegetable oil and diesel. This was presented to the Cork City Council in May 2004. Although fuel efficiency was not specifically measured, it was found that the power of the engines was 7-20% higher when running on vegetable oil, the relative increase decreasing gradually with increasing engine speed. Similarly, the torque of the engines was 11-20% higher when running on vegetable oil. The relative increase decreased irregularly with increasing engine speed. In both cases, the results for pure rapeseed oil and the blended fuel were very similar, with the pure rapeseed oil slightly better in most instances.

The fuel consumption for the Cork City and Suburban Bus Fleet was 2.5 million litres of diesel in 2002, 2.7 million litres of diesel in 2003 and 2.8 million litres of diesel in 2004. This increased use mainly resulted from increased service provision. The use of bio-fuels is one of the most efficient ways to reduce the greenhouse gas emissions associated with transport. It is also a good way to help boost the indigenous economy in places where there are few if any fossil fuels. However, for the use of bio-fuel to be sustainable, there must be political support to ensure that the cost of the fuel is competitive with fossil fuels. Emissions testing of the converted vehicles proved to be difficult and unreliable.

Environment

The MIRACLES measures resulted in a safer, healthier and more comfortable environment for pedestrians and cyclists in the city centre.

Although the measured noise levels in the city centre increased slightly, the public perception of the noise level pollution in the Clean Zone improved (see WP5.1 user survey results). The air pollution levels in the city centre also improved; this was quantified by modelling and by public perception surveys.

There was a substantial upgrading of the appearance of the city centre as a result of vehicle restrictions and the provision of wide paved areas for pedestrians in the new Clean Zone.

The quantifiable target was to reduce traffic levels through the access-restricted zone by at least 2%. The reduction in the overall level of car traffic through the inner cordon was 3.3% on the business as usual scenario; this was identified from traffic volume counts carried out in December 2005.

The quantifiable target to increase the numbers of cycle parking facilities within the city centre by at least 40% was exceeded; the actual percentage increase achieved was closer to 4000%. The Baseline surveys indicated that prior to MIRACLES there were only 8 bicycle parking spaces in the city and this increased to 316 by the end of the project.

Air pollution levels in Cork City are in general in accordance with the EU limits, it has not been possible to determine whether the MIRACLES measures had an effect on air pollution at city level.

The perception of air quality at city level was measured by the CIVITAS questionnaires. The main drainage works being carried out in the city may have influenced the respondent's answers. Satisfaction with air pollution at the city level decreased from 58% in 2002 to 44% in 2005. However, the number of those "very unsatisfied" reduced from 14% to 8%. Additionally, the perception of air quality in the Clean Zone was rated by 54% as 'about the same'; 24% rated it as 'better' and a further 15% rated it as 'much better'.

Noise measurements were carried out in the Clean Zone pre and post MIRACLES. Noise levels increased slightly since 2002 at three of the measurement locations on St. Patrick's Street. The average noise increase was 3 dB(A), which is just noticeable.

The acceptance of city noise levels was measured by the CIVITAS questionnaires. The main drainage works being carried out in the city may have influenced the respondents' answers. Satisfaction with noise levels at the city level decreased slightly from 46% in 2002 to 44% in 2005. However, the number of those "very unsatisfied" reduced from 18% to 10%. Opinions on noise levels inside the Clean Zone were much improved in 2005, with 39% rating it as 'about the same', 35% rating it as 'better' and a further 20% rating it as 'much better'.

The overall opinions on the St. Patrick's Street redesign and on the visual improvement were very positive with over 60% rating it as "much better".

Society

The MIRACLES measures promoted an awareness of the need for sustainable transport in Cork. They also encouraged a modal shift from the car by traffic and lane restrictions in the city centre, Park and Ride provision, cycle facilities, publicity campaigns, etc.

There was a reduction in the reported rate of assaults in the city centre. From 2002 to 2004, the reported personal assaults on St Patrick's Street reduced by 33%. Additional information was provided through surveys of perceptions relating to the individual MIRACLES measures, details of these indicators can be found in the Measure Level Templates. (Safety rating - C7.3/Saf2a, C10.2/Saf1a, Incident levels - C7.3/Saf2b).

Throughout the MIRACLES project, awareness raising activities for sustainable modes of transport were carried out. Activities of particular note were participation in the annual European Car Free day, during which the clean zone was closed to private vehicles, European Mobility Week through the promotion of the Blackash Park and Ride (free of charge for these occasions), and the new cycle parking facilities in the city centre.

The access restrictions on St. Patrick's Street have been complemented by the improved facilities for pedestrians and cyclists, which is hoped to encourage people to reappraise their travel arrangements. Continuing consultation with representatives of disabled groups was found necessary during both scheme design and implementation. The Park and Ride scheme has been very useful for people wishing to access the Clean Zone for work or recreation, particularly for major events which close the clean zone to cars (such as the Awakening Ceremony to inaugurate Cork's reign as European Capital of Culture in 2005 when Park and Ride operating hours were extended to accommodate the demand).

The redesign of Patrick's Street, created extra space for hosting cultural events/recreational activities (e.g. a street fair was held on the new streetscape to mark the "Day of Welcomes" when Cork celebrated the expansion of the EU).

CIVITAS questionnaires measured the public awareness of CIVITAS. 97% of respondents had not heard of the CIVITAS initiative in 2002 and 96% did not know that Cork was participating in CIVITAS/MIRACLES. This had improved somewhat by 2005 when 16% had heard of the CIVITAS initiative and 14% knew that Cork was participating in CIVITAS/MIRACLES.

The 2005 CIVITAS surveys also found that the awareness of the various individual MIRACLES measures had increased with the number of people aware of "no measures" decreasing to 11.9% in 2005. The awareness for one, two or three measures had also increased (to 28.2%, 29.6% and 19.3% respectively) with the largest increase being in the awareness of two measures (a 10.6% increase on the baseline of 19%). However, the awareness of four or five measures had decreased to 3.7% and 7.4% respectively in 2005.

Acceptance of each of the individual Cork measures was measured separately. The user and operator acceptance level of each measure was gauged by means of questionnaire/discussion for each of the six Cork measures. Details of these indicators can be found in the Cork Measure Level Templates. Acceptance of the

MIRACLES project at the city level was positive with the measures in general being considered a success.

Transport

The redesign of St. Patrick's Street and the expansion of the Clean Zone aided in creating a safer environment for vulnerable road users and pedestrians. The reduction in traffic due to WP5.1 and WP7.3 should reduce accidents, although the scale of the accident data is too small to accurately quantify the impact.

The modal split for Cork City will not be available until the 2006 Census information is published. However, the increases in pedestrian numbers in the Clean Zone as well as the increase in cyclist numbers provide promising evidence of an alteration in modal split; also the success of the new Park and Ride service. The Cork City Council employee modal split has changed towards more sustainable modes of transport during the course of MIRACLES. While the city wide impact on the modal split cannot be identified until the next Census, it is hoped that the provision of the Park and Ride service, increased cycling facilities and promotion of sustainable transport will all aid in the change towards more sustainable modes.

The achievement of quantifiable targets for the MIRACLES measures:

- Lane capacity was reduced by 50% on the city's main arterial route from 4 lanes to 2 lanes.
- Traffic levels through the access-restricted zone were to be reduced by at least 2%, as compared with the business as usual scenario. A historic growth rate of 3.5% per annum was assumed to form this scenario. The reduction in the overall level of car traffic through the inner cordon was 3.3% on the business as usual scenario; this was identified from traffic volume counts carried out in December 2005.
- The target increase in the numbers of cyclists crossing the inner cordon was at least 10%. The actual increase was identified from LUTS classified traffic counts in October 2005, which identified a 47% increase in cycling across the inner cordon, when compares to the Baseline figures.
- It was originally planned to provide at least 450 Park and Ride spaces at a new facility at Blackash; more than 900 Park and Ride spaces have been provided.
  By November 2005 Blackash Park and Ride had an average of 500 users/day. The pre-Christmas period increased this patronage substantially (weekly figures can more than double).
- The target of a 5% decrease in private car use by employees of Cork City Council was achieved (42% solo car users in 2002). The MIRACLES car pooling project may have indirectly influenced this change in modal split. However, reduced parking availability was probably the main reason.

Public user perceptions regarding public transport are measured on a national basis by the local public transport company. This indicated a 91% satisfaction rating with the public transport services in 2002. A similar study at the end of 2004 indicated that there was no change in the satisfaction rating. The April 2005 user survey of the Blackash Park and Ride service (WP7.3) rated the quality of the Park and Ride service as 82% 'very good' and the remaining 18% rated it as 'good' or 'satisfactory'.

The introduction of the Green Routes, the completion of the Cork Main Drainage works and the renovation of St. Patrick Street have greatly improved the ability of buses to maintain peak hour bus schedules according to the local public transport

company. Detailed results of these improvements will not be known until March 2006 (Post Green Route Introduction Survey results).

In 2002, an average morning peak hour vehicle speed of 14 km/h resulted from the journey times measured over the entire length of St Patrick's Street. The average off-peak journey time was observed to be 20-25 km/h. The 2005 surveys showed that the average morning peak hour vehicle speed had decreased to 9.6km/h while the average off-peak journey time remained at 20-25 km/h.

- An increase in the number of pedestrians in the city centre was expected from the MIRACLES measures. The ex-post surveys in May 2005 showed a substantial increase. In May 2005, the evening peak was a total of 5430 pedestrians per hour, a 53% increase on December 2002.
- The number of cycles parked in the city centre increased substantially since the Baseline 2002 survey and the usage of the cycle facilities is increasing, although approximately 30% parked elsewhere.
- Classified traffic volumes on St. Patrick's Street in Winter 2005/2006 showed that traffic volumes on the street had declined by approximately a third on the 2002 levels.
- No private car parking places were provided in the St. Patrick's Street redesign; space was provided for loading bays and taxi ranks. Approximately 900 Park and Ride spaces were made available at Blackash. In November 2005, MIRACLES support provided parking for up to 264 cycles; by the end of the project 316 cycle spaces will be provided.
- The Park by Phone parking management/parking payment scheme accessed by mobile phone was not introduced until September 2005. Usage of the system in February 2006 was 100 parking instances per day.

It is difficult to quantify the effect of the six MIRACLES measures on Cork City as these were implemented in parallel with major projects, such as the Green Routes (quality bus corridors) and the European City of Culture 2005. However, they were considered to have definitely contributed to sustainable transport in Cork City.

5.4.3 Conclusions and Lessons Learned

Economy

The Cork MIRACLES measures definitely aided the city economy by acting as a catalyst for advancing the implementation of planned major city improvements such as the very successful redesign of St Patrick's Street and the construction of the new Park and Ride facility. The success of the city centre Clean Zone centred on St Patrick's Street also led to its expansion to two adjacent streets during the MIRACLES project.

There has been a significant increase in the number of pedestrians using St. Patrick's Street and a substantial increase in the numbers of tourists visiting Cork; the designation of Cork as European Capital of Culture 2005 contributed to the increased tourism.

Energy

Overall, the project demonstrated that the use of alternative fuels such as rapeseed oil was feasible for Cork City Council and provided a good demonstration for others.

Cork City Council intends to continue using alternative fuels and expanding the clean fleet post-MIRACLES.

Sustainable commuting was further encouraged through a package of other MIRACLES measures which promoted cycling, walking, Park and Ride and car-pooling. Park and Ride was very successful while car pooling was not; it was found that people preferred to organise private car sharing arrangements.

Environment

The substantial upgrading of the Cork city centre was significantly assisted by MIRACLES. The reduction in traffic levels due to the Clean Zone, the provision of the Park and Ride service, the increase in cycle facilities in the city centre and awareness raising activities of sustainable transport all aided in the improvement of the city environment.

Public perception of air and noise pollution in the city centre improved due to the expansion of the Clean Zone. This should particularly benefit street traders and buskers and encourage people to relax, sit, talk or enjoy entertainment on the street. This should make the city centre safer and more attractive to pedestrians of all abilities, promoting inner city shopping and tourism.

The Clean Zone also created city open spaces for hosting cultural events / recreational activities (e.g. a street fair was held on the new streetscape to mark the "Day of Welcomes" when Cork celebrated the expansion of the EU).

Society

Public awareness and knowledge of the MIRACLES project and of the individual measures were determined through the CIVITAS/MIRACLES questionnaires. These showed that while there was a good knowledge of the individual measures and of the need for sustainable transport, relatively few were aware of CIVITAS or the MIRACLES project.

The MIRACLES measures promoted an awareness of the need for sustainable transport in Cork. They also encouraged a modal shift from the car through traffic and lane restrictions in the city centre, Park and Ride provision, cycle facilities, publicity campaigns, etc.

The public were very satisfied with the MIRACLES measures as evidenced by the high level of satisfaction expressed in the specific measure surveys.

Advertising and a prolonged media campaign for many measures (particularly Park and Ride) along with the integration of MIRACLES with existing sustainable transport promoting activities increased the awareness and acceptance of the various MIRACLES measures.

Diverse methods were employed to promote sustainable transport options including cycle safety training, advertisements, competitions, free days website promotion etc. It was found that a mix of methods is best at reaching a range of different audiences.

User feedback from measures, questionnaire surveys, etc., was helpful in identifying problem areas as well as aspects of the measures that were working well. A continual liaison with disability groups during the design and implementation of new traffic management measures is considered necessary.

Transport

The redesign of the St. Patrick's Street and the expansion of the Clean Zone aided in creating a safer environment for vulnerable road users and pedestrians. The public and operators are very satisfied with the upgrading of the city centre and appear to have accepted the necessary traffic restrictions. There is also a very high level satisfaction with the Park and Ride service.

The modal split for Cork City will not be available until the 2006 Census information is published, only then will the overall change in modal split be identifiable. However, the increases in pedestrian numbers in the Clean Zone as well as the increase in cyclist numbers provide some evidence of an alteration in modal split. The success of the new Park and Ride service also provides evidence for this. Also, Cork City Council employees have changed towards more sustainable modes of transport during the course of MIRACLES.

The difficulties in getting people to change mode were especially apparent in WP10.2 (car pooling) and, as previously noted, parking restrictions were found to be far more effective. Other cities wishing to promote sustainable mobility management should place a heavy emphasis on promoting sustainable mobility before and during the establishment of formal schemes to support sustainable commuting. These campaigns should be highly visible and use a variety of media. It is important to emphasise the environmental, social and financial benefits of switching to more sustainable modes of transport.

When new technology is introduced, it was found that the amount of training and consultation with the operators was more than expected, both before and during measure implementation.

6 COMPARISON OF ORIGINAL MEASURE OBJECTIVES AND TARGETS VS ACTUAL RESULTS

This section provides, for each Measure, an overview of the original objectives, the objectives of the actual implementation, the original targets, and a summary of the relevant evaluation results. The original objectives and targets were those defined within the Technical Annex, written before the project began. For consistency, the same 'snapshot' in time was used for all four cities. However, for some measures it is not feasible to directly compare the actual results with the original targets, since the measure objectives and targets were redefined at a very early stage of the project. For example, in some cases, the Inception Report (D1.4, submitted in late 2002) differs markedly from the Technical Annex. In addition, due to the innovative nature of many of the measures trialled within MIRACLES, implementation did not always go smoothly and in hindsight, some of the anticipated targets were perhaps overly ambitious.

Nevertheless, it is worthwhile to provide a tabular summary for each Measure. Sections 6.1 to 6.4 summarise the results for the respective cities of Rome, Winchester, Barcelona, and Cork.

6.1 Comparison of Measure Results, Targets and Objectives for Rome

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 5.1 – Clean zones	▪ To reduce the impact of traffic on the environment ▪ To reduce the number of pollutant and poorly maintained vehicles in the study area ▪ To increase the level of protection of the city centre ▪ To establish new access control systems (Trastevere and in S. Lorenzo districts);	❖ Set-up of access control limitations in the whole Laboratory Area to allow entry to catalysed vehicles only; ❖ Fleet pollution control to increase environmental performance of the allowed vehicles; ❖ Implementation of the last electronic Access Gate to the central LTZ (Fori Imperiali project); ❖ Implement a new LTZ in Trastevere neighbourhood; ❖ Implement a new LTZ in San Lorenzo neighbourhood; ❖ Optimise the ACS system in Rome	***Original Target:*** Contribute to: 1. Reduce transport related emissions in the LTZ by 5%; 2. Reduce peak hours car traffic by 3% in the Demonstration Area; 3. Reduce the number of polluting vehicles by 10% in the Demonstration Area; 4. Reduce unauthorised entrances by 30% in the LTZ, S. Lorenzo and Trastevere; 5. Increase walking by 5% in the Laboratory Area; 6. Reduce private peak traffic flows by 4% in the LTZ. ***Actual Results:*** *1. CO emissions values reduced by about 76%, particulates and C_6H_6 emissions values, reduced by about 38%;* *2. Traffic flows in Laboratory decreased by 5% daily, (2001-2005), but the trend is to be monitored because during peak hours still congestion phenomena occur;* *3. The number of non-catalysed vehicles e.g. non-catalysed mopeds reduced by about 45%, private cars by 37% and commercial vehicles by less than 35%;* *4. Traffic flows accesses at S. Lorenzo and Trastevere decreased more than 50% - In Central LTZ the illegal entrances were 15% of the traffic total flow end 2001. End of 2005, they are about 7-8%, i.e. 50% reduction;* *5. Inside the Laboratory Area, use of private cars decreased by 5%, mainly towards walking mode (3%).* *6. Reduced by 20% during the whole restriction period and by 15 % in the morning peak hour (8.30-9.30).*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 5.2 – green areas (pedestrian spaces)	▪ To increase environmental protection of the city centre ▪ To implement extension of Green Zones and pedestrian areas in the Laboratory area in Rome. ▪ To improve the information on PT and integrate PT service within the Green Corridors.	❖ Creation of the "Tridente" pedestrian area inside the central LTZ; ❖ Creation of a pedestrian network inside the LTZ; ❖ Implementing retractable bollard systems to physically protect pedestrian areas ❖ Interventions in individual neighbourhoods, which can bring in the short term period (1-3 years) visible and measurable benefits in mobility conditions: their name is Local Urban Traffic Plan (LUTP – PUT in Italian Language). ❖ modifications to road sections and crossings in order to better distribute existing space between the different road users' categories	***Original Target:*** 1. Reduce the road space for cars inside the LTZ by 2%; 2. Raise citizen awareness by 10% in specific areas inside the Laboratory areas. ***Actual Results:*** 1. *Conversion into pedestrian areas of: TRIDENTE (12 hours per day) D2 Zone, Piazza dell'Orologio, Piazza del Parlamento, other minor zones with increase of pedestrian zone about 20%, in terms of square meters.* 2. *Awareness level did not appreciable variations (from 90% - baseline value to 89% ex post value)*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 6.1 – time based entrances - RP	▪ To introduce flexible road pricing measures, according to different situations and periods of the day/month/year. ▪ To reduce the traffic flows converging to the centre of the city (LTZ), ▪ To increase the usage of Public Transport; ▪ To reduce traffic related air-pollution.	❖ To study the adaptations to the Automatic Access Control System and Road Pricing policy in place (ACS+RP) to introduce a night access restriction scheme; ❖ Perform a feasibility study on a Road Pricing policy for tourist coaches. ❖ Analyse the Best Available Technology to automatically detect two-wheeled vehicles to prevent them entering the Central LTZ.	***Original Target:*** "Quantified results will be set up once completed the feasibility studies" - these results have been set out as follows: 1. Reduce the number of vehicles in weekend nights by 25%. 2. Reduce the number of vehicles by 10% during 24 hours period every day of the year in the LTZ. ***Actual Results:*** *1. With the new Central Night LTZ scheme, a mean reduction of 50% (from about 10,000 to 5,000) in the number of four-wheeled vehicles was recorded.* *2. Traffic flow in the Central LTZ decreased during the 24 hour period from 138.000 end 2001 (after the opening of electronic gate system) to 118.000 mid 2004, i.e. with a traffic flow decrease of 17% even outside the enforcement time band*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 6.2 – Flexible parking policies	▪ To increase the number of on-street parking places inside the Laboratory Area. ▪ Feasibility study to evaluate flexible parking charge measures, according to different situations and periods of the day/month/year.	❖ To increase the number of on-street parking places inside the Laboratory Area (2nd District). ❖ To perform a feasibility study to evaluate flexible parking charge measures, according to different situations and periods of the day/month/year.	***Original Target:*** Surveys will be carried out to verify the different steps of the process - these results have been set out as follows: 1. Increase the number of on-street parking places inside the Laboratory Area up to 65.000; 2. Increase the number of the Park & Ride facility in serving Laboratory Area by 15%; 3. Complete the feasibility study for the future implementation of a new parking policy; 4. Increase the number of on-street parking meters and set-up of new payment method. ***Actual Results:*** *1. The number of (payment) parking spaces increased from 52,000 to 78,727 units.* *2. The number of payment parking spaces related to P&R facilities also increased by about 15% up to 12,089.* *3. Completed but the measure is suffering the negative opinion of the City Council.* *4. The innovation plan for parking meters achieved during MIRACLES saw the implementation of 400 STELIO powered by solar cells.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 7.1 – safety and security	To improve safety and security of PT service within the laboratory area.	❖ Trial of an innovative automatic security and safety video surveillance system in the Termini metro station (the main PT interchange point in Rome), capable to analyse user behaviours through the "understanding" of video information, in order to monitor passengers in the in-door areas of metro and railways stations of the Laboratory Area. ❖ Verification of the system performances	***Original Target:*** 1. Improve safety and security of PT service within the laboratory area by an optimal use of existing infrastructures, enhancement of video operator efficacy; 2. Increase the overall Customer Satisfaction Index by 6%. ***Actual Results*** *1. The score of events detected by the video surveillance system was between 81-94%, which makes the system assessable as reliable;* *2. The amount of answers provided by interviewees was not sufficient to build a consistent sample - However, public perception of telematics more generally is good.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 7.2.1 – multi modal on line information (Infopoint)	▪ To improve PT information and mobility facilities for multimodal journeys; ▪ To increase the number of PT facilities/services users; ▪ To improve information for disabled people.	❖ The provision of detailed information on the existing cycling tacks and paths; ❖ The provision of information on accessible bus stops for the mobility impaired	***Original Target:*** Increase the number of visits to ATAC website by 3,000 per month. ***Actual Results:*** *The number of visitors more than trebled.*
Rome: 7.2.2 – on board information	To provide PT customers with innovative on board information.	As original The innovative system is called MOBY.	***Original Target:*** Increase overall Customer Satisfaction Index (CSI) by 6%. ***Actual Results:*** *The amount of answers provided by interviewees was not sufficient to build a consistent sample - The system is anyway assessed as successful and has been implemented beyond the original target.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 7.3 – New lines	To extend the PT network supply within the Laboratory area.	❖ Design and Implementation of an electric bus line in the Trastevere LTZ; ❖ Design and Implementation of an electric bus operated line in San Lorenzo LTZ; ❖ Design and Implementation of a new Trolley line to substitute n° 90 express bus line. ❖ Re-styling and adaptation of a former bus depot to a Trolley depot (called "Montesacro").	***Original Target:*** 1. Increase by 25 km the electric network inside the Laboratory area; 2. Increase the number of e-buses users by 200.000 pax/month at city level; 3. Increase overall Customer Satisfaction Index (CSI) by 6%. ***Actual Results:*** *1. 22,8 Km trolleybus line + 2 new electric bus lines which enlarge the electric bus network up to 52 km;* *2. About 670.000 pax/month on the new lines;* *3. Public awareness of the need to use clean transit increased from 53% to 76%, and satisfaction increased from 3.6 to 3.96 (1-5 Lickert scale).* *Furthermore, it has been recorded at city level, an increase of 6.1% of the PT surface network, and an increase of 5.5% of the number of PT lines.*
Rome: 7.4 – Integration of PT - Taxibus	To increase supply and use of flexible collective transport services/Taxibus lines	❖ To increase the accessibility to the PT services; ❖ To implement a collective taxi service, in an area of the city where the PT supply is poorer	***Original Target:*** Increase collective vehicles occupancy by 20%. ***Actual Results:*** *Collective taxis occupancy was about 35 % (baseline 30%) for most of the implementation period - Too short period of surveys to formulate sound interpretations of the phenomenon.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 8.1. car pooling and car sharing	▪ To provide new forms of vehicles use ▪ To promote car sharing and car pooling services	❖ Increase awareness on the opportunities of taking advantage of car pooling; ❖ Experiment car pooling with a group of some 1000 employees; ❖ Understand if and how car pooling can be implemented. ❖ Implementing the first car sharing scheme in Rome	***Original Target:*** 1. Increase collective vehicles occupancy by 20%; 2. Broaden up to 1,000 the car pooling user's group in the Demonstration Area; 3. Increase Public awareness and support for sustainable mobility by 25%. ***Actual Results:*** *1. Occupancy rate of the vehicles during the car pooling trial: 75%;* *2. Car-poolers addressed during the trial have been 1,180;* *3. A good index of awareness on car sharing (14%) was surveyed, along with a positive perception of the scheme.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 9.1 – Freight	Perform the **design** concerning the following: ❖ Re-organisation of the city logistic; ❖ Improve the dialogue between city authorities and goods operators; ❖ Facilitate the start up of e-commerce based transactions.	❖ Improve the communication between city authorities and goods operators ❖ Improve the city logistic support, under the infrastructural point of view	***Original Target:*** 1. Reduced delivery times (rationalised planning/enforcement); 2. A set of solutions (output of the simulations), tuned on funding available, acceptability by users, calibrated on the user needs and ready to be implemented by Municipality. 3. Increase freight operators satisfaction index related to loading/unloading facilities by 10%; 4. Goods operator coordination and cooperation, including willingness to subscribe rates. ***Actual Results:*** *3 different scenarios/strategies have been identified to pursue the objectives*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 10.2 – Mobility Manager	• Implement commuter planning and integrated mobility management tools • Raise awareness about HWTP (Home-to-Work Trip Plans) alternatives.	❖ Encourage the companies to appoint Mobility Managers, in order to increase their number in Rome; ❖ Provide support to the Mobility Managers in implementing commuter plans and integrated mobility management tools; ❖ Provide the Mobility Managers with support to catch opportunities for funding; ❖ Raise awareness about commuter plans alternatives;	***Original Target:*** 1. Increase nominations of Mobility Manager by 15%, and contribute to: 2. Increase Public awareness and support for sustainable mobility by 25%; 3. Increase modal shift from private cars to collective means by 5% in the Laboratory Area; 4. Increase collective vehicle occupancy by 20%; 5. Reduce car traffic by 3% in the LTZ. ***Actual Results:*** 1. *The number of mobility managers has increased by 25% (140 to 189);* 2. *Participants increased from 2,391 units in 2002 to 41,805 in 2005, anyway awareness was difficult to assess;* 3. *Although results on modals split are good it is difficult to assess at city/laboratory level; and* 4. *and 5) Has provided minor support to main measures in WP5 and 6.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 11.1- Multi modal traveller services	▪ To improve the number of the occasional PT users, decreasing the maintenance costs of the stamping machines; ▪ To improve the multi-modal shift of citizen and tourists towards PT; ▪ To improve the access to the mobility information via new media and mobile devices; ▪ To enhance flexible transport services;	❖ Full scale implementation of the TELEPAY system in Rome (ticket payment by sms); ❖ To improve the access to the information on mobility-related issues via new media and mobile devices ❖ To improve the multi-modal shift of citizen and tourists towards PT Extension of the delivery of the information through specific multilingual website and kiosks; ❖ To improve information provided via web through the INFOPOINT [ref. task 7.2.1] and to experiment mobile devices to distribute the INFOPOINT information on	***Original Target:*** Contribute to: 1. Increase the number of PT tickets sold by 1% (about 1 million more); 2. Increase the number of visits to ATAC gateway by 3.000 per month; 3. Increase public awareness and support by 10%; ***Actual Results:*** *1. The number of PT single tickets sold (BIT) from 2002 until 2005 passed from 95.446.000 to 98.991.000;* *2. The number of visitors to the web services of ATAC has more than trebled [ref 7.1.2], furthermore there are 10.000 queries/month to the mobile pages of the Infopoint;* *3. More than 95% of the users recommend the innovative system to pay a PT ticket by SMS.*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 11.2.1 – Improved network management - Information	▪ To implement ITS management system features on the n°8 tramway line; ▪ To implement ITS management system features on the 60 Express bus line;	❖ As original	***Original Target:*** Contribute to: 1. Increase the number of PT tickets sold by 1% (about 1 million more); 2. Increase public awareness and support by 10%; 3. Reduce peak hours car traffic by 3%; 4. Reduce transport related emissions by 5%; 5. Increase walking by 5%; 6. Increase modal shift from private cars to collective transport by 5%; 7. Increase collective vehicle occupancy by 20%. ***Actual Results:*** 1. *The number of PT single tickets sold (BIT) from 2002 until 2005 passed from 95.446.000 to 98.991.000;* 2. *Difficult to quantify, anyway generally citizens are happy with telematics to provide good quality information.* 3. *to 7) see other measures [WP 5, WP6, WP 7, WP8, WP12]*
Rome: 11.2.2 - Improved network management - Environment	▪ To extend the coverage and functionalities of the Traffic Control Centre of Rome Municipality; ▪ To implement a system for the environmental control and scenario analysis.(ENEA trial)	❖ To develop a system (TDMS) to evaluate the benefits related to the adoption of traffic demand measures and available for all the subjects involved in the city mobility system, ❖ To acquire a good knowledge of the air quality in the Laboratory Area as well as of the effects on the air pollution of the planned measures. ❖ To extend the coverage and functionalities of the TCC of Rome Municipality and to implement a system for the environmental control and scenario analysis. ❖ ENEA: ❖ To collect additional data on the driving patterns and relevant speed profiles along specific typical routes; ❖ to acquire additional information about the local concentration levels of the more critical air pollutant	

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 12.1 – Clean vehicles Buses	• To increase the number of the electric buses; • To renew the traditional bus fleet with Euro 3 compliant buses; • To reduce the environmental impact of the PT fleet within the Demonstration area. • To introduce the trolleybus.	1) To extend the electric buses fleet; 2) To introduce 30 bi-modal Trolleys; 3) To renew the traditional bus fleet, according to the best emission standards and to lower, up to halving, the average age of the bus fleet according to the best emission standards and to lower, up to halving, the average age of the bus fleet; As original and beyond (programme to acquire 400 CNG buses)	***Original Target:*** Contribute to 1. Increase e-vehicles PT fleet by 20% in the LTZ; 2. Reduce the number of polluting vehicles by 10%; 3. Reduce transport related emissions by 5%; 4. Increase the replacement of old buses with e-buses by 25%; 5. Increase the number of PT tickets sold by 1% (about 1 million more); 6. Reduce peak hours car traffic by 3%; 7. Increase modal shift from private cars to collective transport by 5%; ***Actual Results:*** *1. By late 2005, 38% of the entire fleet was composed of new, eco-compatible vehicles;* *2. 1107 Euro III buses replaced at least 44% of the previous fleet (mostly EURO O).* *3. transport-related emissions reductions by 13% inside the LTZ) [ref to WP5 also];* *4. 52 e-buses + 30 trolleybuses, about 5% of the replacement.* *5. The number of PT single tickets sold (BIT) from 2002 until 2005 passed from 95.446.000 to 98.991.000* *6. Reduced by 20% during the whole restriction period and by 15 % in the morning peak hour (8.30-9.30) [ref to WP5 also];* *7. Inside the Laboratory Area it has been recorded a 5% decrease in the use of private cars, mainly towards walking mode (3%) [ref to WP5 also];*

Measure	Original Objectives (from Technical Annex)	Objective of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Rome: 12.3 – Clean fuel support services	• To increase awareness and usage of electric scooters • To monitor the Customer satisfaction index towards electric scooters • To set up suitable recharging points in the Laboratory Area	❖ Increase awareness and usage of electric scooters (or e-scooters); ❖ Monitor the level of acceptance of the e-scooters; ❖ Implement new recharging stations for the scooters inside the Laboratory Area	***Original Target:*** 1. Increase e-vehicles recharging stations 8 new locations; 2. Reduce the number of polluting scooters by 1% in the LTZ; 3. Increase share of e-scooters by 50% in the LTZ. Contribute to: 4. Reduce transport related emissions by 3% in the LTZ; ***Actual Results:*** *1. Task delayed. The implementation will be completed during 2006.* *2. In 2001 there were 441.110 non-cat. two wheels; in 2006 there are just 242.140 units (at whole city level); i.e.45% less.* *3. 391 e-scooters (formerly for rental) are now at disposal for no profit organization, and incentives are in place for e-scooters, but The biggest barrier to the implementation is the limited autonomy of the batteries. E-scooters are well accepted if the purpose for the shift is well defined in time and space (max 10 km/day distance covered). Thus the desirable level of usage on large scale could not be achieved.* *4. Achieved [ref to WP5];*

6.2 Comparison of Measure Results, Targets and Objectives for Winchester

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 5.1: Set up of city centre clean zone	1) To reduce the impact of traffic on the environment 2) To reduce the number of poorly maintained vehicles in the study area	As original.	***Original Target:*** The headline indicator is to reduce the number of high polluting vehicles on the network by 5%. The highest decile of highest polluting vehicles will be identified through this measure and initiatives put in place to improve the maintenance of the vehicles or to identify the vehicles as regularly failing the UK emission standards and subsequently removed from the fleet. Emission savings of about 40% of total fleet CO have been estimated by one-off studies to date. This outcome will be validated and expanded to include hydrocarbons. ***Actual Results:*** *This measure was significantly delayed due to late delivery of the Remote Sensing Device (RSD) and subsequent technical problems. This meant that indicators based on decile pollutant concentration values and actual RSD measurements to detect reductions in high-polluting vehicles were removed. This was partly due to the percentage of vehicles that could be classified as gross polluters being much lower than expected (less than 0.5% compared with the 5% envisaged above). The lack of instrument sensitivity to accurately report low decile values was also a factor. Use of mobile VMS to inform drivers of their levels of emissions was the only on-road feedback strategy implemented. Comprehensive questionnaire surveys were undertaken to capture public attitudes to the other two strategies originally proposed.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 6.2: Adoption of flexible parking policies and environmentally linked parking charges	1) To promote an optimal pricing policy and internalise external costs. 2) To promote energy efficiency of the vehicle fleet parking in Winchester city centre.	1) As original. 2) To promote energy efficiency of the vehicle fleet parking in Winchester city centre by implementing a variable tariff at several car parks.	***Original Target:*** The target of the measure is to reduce the fuel consumption of the fleet using the parking facilities by 5% over and above natural improvements. ***Actual Results:*** *As of December 2005, there were 359 vehicles with a season permit at car parks within the scheme. Of these, 35 (9.7%) were 'qualifying' vehicles (21 hybrid / electric and 14 'B' category vehicles). Up-scaling results showed that with only natural changes to the vehicle fleet 154gCO_2/km would be saved (equivalent to one small/medium-sized car being removed from the road). In the WP6 fleet, this saving is 5698 gCO_2/km; equivalent to 37 vehicles being removed from the road.* *In March 2006, the number of qualifying vehicles had risen to 41 (11%) (21 hybrids and 20 'B' category vehicles). The scheme is also to be extended to include P&R car parks and residential parking permits.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 7.1 and 7.2: Improving bus service quality and information	1. To contribute to an 8% increase in bus patronage during the project. 2. To improve the satisfaction rating of public transport by 8%.	1) As original. 2) As original. 3) To integrate public transport services.	***Original Target:*** The measures will contribute to the achievement of an 8% increase in bus patronage during the project and an improvement in the satisfaction rating of public transport by 8%. ***Actual Results:*** *1) Patronage increase on the three MIRACLES routes (X1, X5 and P&R) of 6% (from 2001/2 to 2004/5); X5: +19%, X1: -12% and P&R: +43% (car park ticket sales).* *2) Overall passenger (satisfaction) ratings were already very high: very good or quite good increased from the interim survey to the final survey by 4% (83% to 87%): X1: +3% (75% to 78%), X5: +6% (81% to 87%) and P&R: 0% (remained at 92%).* *3) Better integration of the public transport services due to physically improving the interchange area outside the railway station with a 97% increase in passengers boarding bus services X1 and X5 from 2002/3 to 2004/5 at this bus stop.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 8.2: New cycling opportunities	1) To contribute to the goal of quadrupling cycling by 2012 (compared to 1996 base). 2) To stimulate the use of sustainable transport for tourists and residents. 3) To support the uptake of electric bicycles.	1) As original. 2) As original. 3) No longer relevant.	***Original Target:*** The outputs due directly to CIVITAS funding will be a 100% increase in safe storage facilities, a 25% increase in the length of cycle routes in the city and a bike-about scheme with 50 bicycles. ***Actual Results:*** *A Bikeabout scheme involving 50 bicycles (and 170 members) was initiated using several secure compounds around Winchester. Surveys found that there was an increase of 46% in the number of bicycles parked in Winchester, but a decrease in flows of 12%. Three new secure cycle stores with a total capacity of 30 cycles were implemented, additional facilities were introduced at Winchester University and 11 additional cycle stands were installed, bringing the total number of stands in the city to nearly 200. During MIRACLES, two new short sections of cycle track were installed: at the railway station and at Bar End leading to St Catherine's P&R car park.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 9.2: Fleet efficiency and home delivery	1) To develop a clean urban delivery service which will become self-sufficient at the end of the project. Update freight delivery map. 2) To encourage take-up of vehicle efficiency programs for local businesses.	1) Collectpoint scheme: to reduce the number of missed home deliveries. 2) freight map: to increase the efficiency and use of urban freight delivery. 3) Dove recycling scheme: to initiate an urban waste recycling service using environmentally friendly vehicles.	***Original Target:*** A fully operational clean urban delivery service will be demonstrated during the project. A 100% reduction in tailpipe emissions for every tonne-km of freight shifted by the new system will be delivered. Key measures of success are the number of businesses participating, the % of time in operation and the commercial viability of the scheme. Hampshire County Council will involve all businesses with fleets of over 20 vehicles in the Motorvate scheme providing support in the establishment and monitoring process. Reductions of 12% in CO_2 emissions will be obtained from participating businesses. Guidance maps will be provided and new freight operating regimes developed in partnership with local business. ***Actual Results:*** *Following a comprehensive round of surveys with businesses, carriers and hauliers, the original objective of developing a clean urban delivery service was dropped The take-up of vehicle efficiency programs (Motorvate) was partly incorporated within Measure 12.2.* *In addition to the original objective of updating the freight map, two new sub-measures were introduced. The Collectpoint alternative home delivery service was trialled for ten weeks in the summer of 2004 and Dove Recycling used an electric vehicle to trial a waste-recycling service for local businesses. The target number of freight maps was distributed.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 10.1 and 10.2: Innovative soft measures and awareness programs	1) To increase public support of sustainable transport by 25%. 2) To encourage a change in modal choice for business related travel and working practice in order to minimise the impact of business travel. 3) To achieve the fastest uptake rate for clean vehicle technology nationally.	1. Raise public awareness of the developments and achievements of the MIRACLES initiatives to 5% by promoting the benefits to both residents and visitors. 2. Encourage the development of work place travel plans with an increase of at least 2,000 employees covered by such a plan in the Winchester area by the end of MIRACLES. 3. Encourage a change in modal choice for business related travel and working practice in order to minimise the impact of business travel. This included increasing public support of the aims of MIRACLES including sustainable transport by 25%.	***Original Target:*** The air quality forecasting model will be enhanced and new delivery mechanisms including a web site will be demonstrated. Public surveys will demonstrate the increased awareness of sustainable transport in the area. Extra consultation will be undertaken to ensure that new environmental access management strategies are supported by the public. To increase public support of sustainable transport by 25%. Achieving the fastest uptake rate for clean engine technology nationally measured through the national database of car ownership. ***Actual Results:*** *1. Awareness of MIRACLES at 20% (32.6% for businesses);* *2. 11,835 employees now covered by a workplace travel plan (an additional 7,722 since MIRACLES began);* *3. Agreement of the general public with the objectives of MIRACLES was 70.9% who either strongly agreed or tended to agree (59.4% for businesses). However, the equivalent baseline result was 68.9%;* *4. The new air quality forecasting model was introduced.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 11.1: Improved multi-modal traveller information	To provide better information for travellers through the introduction of ITS which assist in managing the network, the management of transport demand and to provide travellers with real-time information enabling them to make informed travel choices – contributing to achieving modal split targets for Winchester.	1. Use ITS to provide better information to travellers. 2. Provide public transport users with real-time travel information.	***Original Target:*** Enhancement of new information systems will contribute to the following targets: • Reduce the overall absolute level of car traffic by 2% • Reduce peak period car travel by 7% on the key arterial route • Improve public transport patronage by 8% overall • Improve the satisfaction rating of public transport by 8% • To increase the provision of traveller information both in fixed and real-time. ***Actual Results***: *From the city (transport) template, total traffic flows for eight arterial routes decreased by 1.4% during 2002 to 2004.* *The extension to the P&R car park reduced peak hour car travel by 7% on Bar End Road. The average speed on this link also increased.* *From Measure 7 template, bus patronage increased on the three MIRACLES routes by 5%, and bus passenger satisfaction rating increased by 4%.* *The provision of traveller information was increased by installing BDIS, information kiosks, VMS and IDUs, and improving the traffic and travel information service on ROMANSE On-line.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 11.2: Improved network management	To provide better information for travellers through the introduction of ITS which assist in managing the network, the management of transport demand and to provide travellers with real-time information enabling them to make informed travel choices – contributing to achieving modal split targets for Winchester.	1) Collect real-time journey times on the radial routes into Winchester city centre and export this information to the ROMANSE Traffic and Travel Information Centre (TTIC) at HCC for further dissemination to travellers via the media described (see Measure 11.1). 2) Assess opportunities to extend the system for Origin-Destination (OD) information to aid time-based models of traffic movements in Winchester to assist with future traffic and transport planning. 3) Use the capabilities of the Automatic Number Plate Recognition (ANPR) system in conjunction with the new parking control measures described in Measure 6.2 and with the air quality monitoring activities described in Measure 5.1.	***Original Target:*** Real-time journey time estimates will be provided for bus and cars through VMS and the internet. New indicators regarding traffic performance will be developed based on journey time on key links in the city. The longer-term planning process will be enhanced by origin-destination matrices which will be an element of the Hampshire County Council annual review of travel patterns. ***Actual Results***: *Implementation of this measure did not happen as smoothly as planned, delaying the validation and evaluation of journey times collected by the ANPR system. The accuracy of the system and suitability of ANPR data for OD measurement was assessed as planned. However, due to limited resources and finance, this did not include the longer-term ambition of developing enhanced OD matrices to aid modelling and longer-term planning.* *Technical problems meant that the proposed dual use of the ANPR cameras could not be demonstrated in conjunction with the parking control measures (see Measure 6.2)* *A mobile ANPR system was interfaced successfully with the emissions monitoring system, automatically linking vehicle registration numbers to emission records and providing the ability to display the number on a mobile VMS.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 12.1: Cleaner vehicle buses	To reduce the environmental impact of the public transport fleet.	1) To reduce the environmental impact of the bus fleet owned by Stagecoach (the main bus operator in Winchester). This was undertaken by re-powering (i.e. improving the engine technology) some of the fleet to meet a higher Euro emissions standard as well as replacing some older vehicles with new buses. 2) To introduce the public to different vehicle fuel types and demonstrate that the buses could operate with the same drive performance as conventional fuels.	***Original Target:*** Every Euro IV bus will produce the following emissions relative to a Euro II bus: Particulates – 12%, Oxides of Nitrogen – 50%, Hydrocarbons – 42% and Carbon Monoxide – 34%. These emissions savings will apply to over 1000 arrivals and departures from the bus station every day. Clean engine technology (over a minimum EURO III standard) of Euro IV/ Alternative fuel vehicles will be used on the P&R route. Conversions from EURO III to EURO IV will be undertaken for the existing bus fleet serving Winchester. ***Actual Results:*** *15 new Euro III buses were introduced on Services X1 and X5, 10 buses were re-powered from Euro I to Euro III standard, and diesel/electric hybrid buses were demonstrated during two week-long trials in 2003 and 2004 along the P&R route.* *Technical problems meant that only a limited number of Euro III vehicles were successfully fitted with SCR (Selected Catalytic Reduction). 4 Euro II P&R buses were fitted with CRT and will be replaced by new Euro IV buses in July 2006.* *Smoke tests results showed a significant decrease in the average smoke test results of seven buses that were re-powered from Euro I to Euro III emissions standard.* *An up-scaling desktop study used a vehicle activity model to estimate that emission reductions of 44%, 42%, 26%, 53%, and 2%, could be respectively achieved for CO, HC, NOx, PM, and CO_2, along a major street.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 12.2: Cleaner municipal fleets	To reduce the environmental impact of public authority vehicle activity in the Winchester area and beyond.	As original.	***Original Target:*** Every Euro IV vehicle will produce the following emissions relative to a Euro II car: *Diesel* Particulates – 50%, Oxides of Nitrogen – 45% *Petrol* Oxides of Nitrogen – 50%, Hydrocarbons – 33% and Carbon Monoxide – 57% In addition, CO_2 emissions from a Euro IV compared to a Euro III vehicle can be expected to be at least 10% less. Alternative fuelled vehicles will have different CO_2 and toxic emission trade offs. ***Actual Results***: *HCC replaced 27 vehicles in its car fleet with Euro IV vehicles (instead of the cheaper Euro III models) and 7 LPG. Initially, vehicle mileage / fuel consumption records estimated only modest emission reductions (e.g. CO2 reduced by 2.3%) compared to the Euro III vehicles that would originally have been purchased instead. However, HCC are well on their way to meeting the targets set down by Motorvate of a 12% reduction in CO_2 and a 3% reduction in annual mileage, over five years. HCC joined the Motorvate scheme, but no other companies in Hampshire followed this example. This was due to Motorvate's operators redesigning the scheme, offering free fleet health checks and not promoting membership of the original scheme.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Winchester: 12.3: Clean fuel support services	1) To establish a business case for the introduction of clean engine technology. 2) To overcome barriers to the introduction of new engine technologies.	As original.	***Original Target:*** 200 person months of exposure to clean engine technology vehicles will be achieved. The business case for introducing clean vehicle technology to businesses will be developed and disseminated as a case study best practice guide. 200 person months of low emission and low fuel consumption driving will have significant emission savings dependent on the model used. ***Actual Results***: *A fleet of six clean vehicles was purchased, with each vehicle loaned to each participating local business. As of March 2006, a clean vehicle had been lent out on 97 occasions, the majority of one month duration (showing that the original target was overly optimistic).* *Overall, energy use by the clean trial vehicles was lower than that of triallist's 'usual vehicles' (with one exception). Emissions were generally lower for the trial vehicles than that of the triallists 'usual vehicles', although some exceptions were for HC or NOx from a small number of usual vehicles. The electric Berlingo van had no tailpipe emissions and therefore resulted in the largest emission reduction. It should be noted that assessments could only be made for those triallists whose usual vehicle was included in the VCA vehicle database (i.e. built after the year 2000 with an emission standard of at least Euro II). Therefore, many trials could not be compared and the general savings were likely to have been under-estimated.*

6.3 Comparison of Measure Results, Targets and Objectives for Barcelona

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Barcelona: 5.1: Set up of city centre clean zone	Close the Ramblas boulevard to non-essential and high-pollutant motorised traffic – improve street liveability & raise awareness of actions to protect environment / energy diversification.	Barcelona Municipality seeks to reduce the flow of vehicles passing along the Rambla, including motorised two-wheelers, and thus to improve the pedestrian amenity of this world-famous promenade. The aim is to control the time, speed and type of vehicle that travels the section from Pg. Colom to Pça Catalunya, using a system of cameras to ensure an efficient enforcement. The success of this scheme is expected to determine whether cameras can replace existing control points using retractable bollard and thus reduce maintenance costs.	***Original Target:*** - Achieve consensus for restrictions giving preferential access to clean vehicles; acceptance results from Before surveys - Implementation; reduction in emissions due to lower daily traffic entering zone and switch to clean vehicles - Enforcement performance - Confirmation of rules / system operability, perceived improved liveability; acceptance results from After surveys ***Actual Results:*** *As agreed at the Site Technical Review, this Measure focused on the trial of Automatic Number Plate Recognition (ANPR) technology and, in order to proceed with full scheme implementation, satisfactory read levels must be demonstrated. The ANPR trials showed that camera-based enforcement could automatically capture sufficient data to enable access control and speed control to be enforced. Car plate reading levels at a single point exceeded 90%, at least two systems were able to demonstrate a reliable detection of speeding vehicles, and one system showed promising results (30%) for reading plates of motorcycles. Based on these results, Barcelona Municipality has commissioned the installation of a permanent system (supplied by SICE-Imagina).* *In setting up the trials, Barcelona municipality installed an operator work station at the Traffic control Centre, with new fibre Optics connections to locations at the entry and exit points. In the implementation of the permanent scheme, considerable difficulties in connecting the full set of control points with Fibre optics have been overcome, and special vandal-resistant roadside cabinets have been installed.*

			The following estimates have been made from further field surveys: - *daily traffic reduction of 43% (from 11,656 vpd), and* - *pedestrian delay savings 3,800 hours each day, resulting in annual benefits of 7.92 M Euro (travel time savings at 9 Euro/hour).* *Although the scheme has been installed, it cannot become operational until the temporary works for improving metro Liceu station access are finalised (Sept 2006). Realising the restrictions will then be a gradual process, taking account of municipal elections in May 2007. A first idea of possible maintenance cost savings will be possible once the deterrent of ANPR fines is proven (by the end of 2006).*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Barcelona: 7.2 Improving collective passenger transport (real-time passenger information)	The objectives were to: ▪ improve the quality of passenger information; ▪ demonstrate real-time messaging based on a multi-operator system; AVM (Automatic Vehicle Monitoring System) and standard information panel; and ▪ demonstrate how integration with an improved trip planner can deliver added-value customised messages.	The objectives were to: ▪ improve the quality of public transport information; ▪ demonstrate real-time messaging based on a multi-operator system using (6) standardised information panels; and ▪ display messages at bus stops to promote usage of bus services integrated with a new tramway.	***Original Target:*** Passengers become involved in the exploitation of Barcelona's real-time CPT information systems. Measure of the differential benefit of personalised cf. fleet-level messaging in terms of improved user acceptance, mode shares and propensity to use multi-modal travel solutions. ***Actual Results:*** *The Site Review accepted that, with the postponement of the local Guides Plan project, the wider diffusion of integrated public transport information (beyond that displayed at bus stops) moved outside the scope of the project. Instead, there was a need to demonstrate the interchange of information between the different AVM systems, and to install information panels at six bus stop locations. Additional resources were dedicated to upgrading the mobile communications of the AVM system (GPRS and digital radio), and in developing a common database of bus stops for the metropolitan area.* *Information about the arrival times of TMB buses is shown (alongside information from the AVM systems of other operators) at the Pont d'Esplugues bus stop. Three more bus stop installations are now operational; two are in delay due to other street works.* *All the operators serving the stops where the four panels have been displayed, have installed AVM equipment (Soler & Sauret, and Mohn, Oliveras & Rosanbus) or have made bus arrival times available (TMB) in an integrated, automated way.* *The increase in passenger usage at the Pont d'Esplugues stop (equipped with panels showing real-time bus arrivals) is 2.2%. This compares with an overall growth in multi-stage journeys of 1.6% for all tramway stops. Taking account of the general growth in multi-stage usage, the growth at the stop with demonstrated information amounts to some 48 extra passengers per working day.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Barcelona: 7.5 Improving collective passenger transport (integrating tramway)	The objectives were to: ▪ integrate the new tramway service within the public transport and road network management systems to ensure high running speeds; ▪ review the performance of an innovative Public/Private Partnership (PPP); ▪ quantify the operational, energy and environmental benefits of the tramway; ▪ disseminate best practice associated with tramway schemes.	The objectives were focused on: ▪ integrating the new tramway service within the Barcelona metropolitan Collective Passenger Transport (CPT) network; ▪ achieving an operational performance in running speed of at least 20 km/h; ▪ quantifying the operational, energy and environmental benefits of the tramway; and ▪ reporting of best practice regarding tramway implementation.	***Original Targets:*** Measures of running speeds, actual (cf. expected 7%) mode shift, patronage (forecast 20% increase) and emission / energy savings (annual forecasts of 67000GJ and 150 tonnes CO_2). ***Actual Results:*** *The tramway commenced operation in April 2004. The Trambaix line is the first modern tramway implemented in Barcelona. It operates within 6 municipalities and represents a new solution for public transport (both in and beyond the central area served by metro)* ***Running speeds**: After 6 months of operation, the overall average was 16.5 km/h. this increased to 18.5 km/h by the end of the MIRACLES project. 53% of surveyed passengers cited the higher speed (then 16.5 km/h) as the main motivation for using the tramway, showing that the achieved speed is appreciated by citizens, and contributes to achieving other performance indicators (passenger volumes).* ***Passenger volumes**: The tramway has exceeded expectations in terms of passenger volumes and the share of generated trips, with latest figures showing a peak of over 41,000 passengers/day.* ***Promoting shorter trips & mode switch**: The on-tram passenger surveys reveal that slightly more than one-third of passengers are making trips they did not previously make. Of the two-thirds of tram users who previously made the same journey, 18% used to travel by car, and 3% by motorcycle. The forecast modal shift from car was 7%. The Tramway has achieved a shift of at least 3,800 car journeys, based on May 2005 passenger volumes, and this represents a saving of 14,000 motorised veh-km per weekday.* ***Social inclusion**: Each day, 17 wheelchair users travel by tram unassisted, 50 cyclists use the tram to extend their trip-making distance, and parents push 385 baby chairs in and out of the trams.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Barcelona: 9.2: Innovative goods delivery	Demonstrate a city-wide delivery information service that enables goods operators to identify the appropriate kerbside location for door-step deliveries, and to plan delivery itineraries based on real-time congestion information. A successful uptake by goods operators will improve enforcement efficiency and better balance demand with supply. Identifier units that automate the system will be demonstrated with a view to determining the potential for self-financing of the packaged service.	The objectives were focused on: ▪ Improving Municipal management of vehicle circulation on the main and local road networks. ▪ Reducing delivery times and costs. ▪ Developing mechanisms to self-finance the successful scheme elements.	***Original Target:*** Goods operator acceptance of the service, including willingness to subscribe and visit rates. Reduced delivery times (rationalised planning/enforcement); ability to operate as a self-financing scheme. ***Actual Results:*** *During the project's lifetime, MIRACLES has been the focus of actions to meet the Barcelona Mobility Pact objectives related to goods distribution; a dozen operators participated in the design and demonstration phases. A survey of user needs indicated the need to revise the original work proposal. The trials were designed through the full participation of all stakeholders. Amendment 1 included changes to the original trip planner approach (for a user-driven GIS analysis and web- guide) &, introduced quiet night-time delivery trials (instead of electronic on-street parking device); the multi-use lane element remained unchanged.* *The Trav de Gracia multi-use lane demonstrated new Variable Message Signs promoting bus priority during peak hours. The observations goods show that incidences of illegal goods unloading are reduced to below 10 vehicles per period of observation (continuous on-street counting) from previous levels of around 25 vehicles during the late morning and 20 vehicles during the afternoon. Improved circulation speeds are achieved for all traffic. In addition to Trav de Gracia, two more multi-use lanes have been implemented; at 6.5km total length,* *The concept of quiet night-time deliveries has been successfully demonstrated at larger supermarkets using big (40T) lorries. Achieved with no discernable difference in noise levels, Operator Mercadona estimates that full investment in vehicle adaptation is*

			recoverable within 3 years (fewer delivery trips, realised more rapidly). The quiet night-time delivery solution has been implemented nationally by operator, Mercadona at over 100 outlets. *A dozen goods operators participated in the web guide trial; lasting 16 weeks, it included actions by police agents to improve enforcement and to trial new regulations for local roads (at 3 supermarket locations). As a result of the enforcement an average reduction in problem-reporting of 18.6% was achieved at these location / time periods during the second phase of the trial. The three operators participating in the "PICT" trials achieved overall delivery times reduced from 27 to 8 minutes).*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Barcelona: 12.3: Clean Public Fleets	Realise a significant demonstration of (at least 70) standard (12m long) gas buses with a view to making a decision for accelerated vehicle acquisition according to a timetable that could realise gas bus deployment up to 50% of the fleet by 2006 (over 300 vehicles). Integrate gas bus demonstration with the measures to restrict access to the Clean Zone.	TMB (Transportes Metropolitanos de Barcelona), the main bus and metro operator in the city of Barcelona, is motivated to integrate Compressed Natural Gas (CNG) buses into the public transport fleet as part of its corporate strategy to achieve the highest environmental standards, and to contribute to the improvement of a more sustainable transport for the city. The objectives focused upon making a significant demonstration of (at least 70) standard gas buses with a view to making a decision for accelerated vehicle acquisition (up to 250 vehicles by 2006).	***Original Target:*** Pollution emission savings of accelerated fleet renewal will be quantified. Customer perceptions of gas buses will be quantified for fleet renewal. ***Actual Results:*** *Achieved and implemented according to the plan, the overall result (favourable reductions in pollutant emissions, noise and vibration plus good passenger and driver acceptance, and economic investment recovery within 5 years, against poorer energy consumption – 42% more on flat routes) led to recommendations to extend the CNG bus fleet.* *By the end of 2005, 90 more CNG vehicles had been acquired; 40 standard 12m length buses (lighter aluminium tanks), and 50 new articulated, 18m-long buses (not available at the time of first procurement).* *TMB has achieved an integrated action supporting the new bus acquisition with infrastructures that convert one of its depots into a base for operating bus running on new fuels (CNG, hydrogen).* *By the end of 2006 it is expected that the total number of CNG buses will reach 250 units. (The original ambition of achieving 300 CNG buses by 2006 was modified to 250 in Amendment 1).* *In terms of investment and performance, the fleet acquired by the end of 2005 includes 50 articulated buses, with both higher cost and better energy performance than the 12m standard CNG buses used in the demonstration phase.*

6.4 Comparison of Measure Results, Targets and Objectives for Cork

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Cork: 5.1: Set up of city centre clean zone	1. Provide a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre. 2. Redirect motor traffic away from the city centre and onto the ring roads or into the park and ride centres.	1. Provide a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre. 2. Reduce lane capacity by 50% on the city's main arterial route, which cuts through the heart of the city's primary shopping district. 3. Redirect motor traffic away from the city centre and onto the ring roads or into the park and ride centres. 4. Increase the numbers of cycle parking facilities within the city centre by at least 40%. 5. Increase citizen awareness of the need, potential and ability to change to more sustainable transport patterns. 6. Promote access to the city centre by public transport, particularly, as a viable alternative to making all such trips by car. 7. Reduce traffic levels through the access-restricted zone by at least 2%, as compared with the Do-Nothing scenario.	***Original Target:*** A 50% reduction in the volume of traffic otherwise expected to travel through the centre of the city. ***Actual Results:*** *The number of lanes on St. Patrick's Street was reduced from 4 to 2 (achieving the 50% reduction in lane capacity), thereby encouraging a decrease in car traffic levels through the City Centre.* *The reduction in the overall level of car traffic through the inner cordon was 3.3% on the Do-Nothing Scenario which exceeded the objective of a 2% reduction.* *Increased urban accessibility and an improvement of citizens' quality of life should be partially achieved through the provision of extra cycle racks, seats and benches along St. Patrick's Street.* *The footpath widths were widened substantially, thereby increasing the number of pedestrians in the City Centre.* *The reduction in lanes and provision of cycling parking facilities (encouraged the increase in cyclist numbers (the 226 spaces provided far exceeded the 40% increase planned).*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Cork: 7.3: Introduction of new lines	1. Reduce the volume of motor traffic coming into the city from the southeast. 2. Encourage families to use public transport together, by offering a cheaper alternative to the regular public transport services on offer to families. 3. Lessen the demands on inner city parking. 4. Encourage people to abandon the motor car entirely, in favour of "cycle and ride" (or walk and ride). 5. Integrate the new ring road system with public transport into the city.	1. Reduce the volume of motor traffic coming into the city from the southeast. 2. Provide at least 450 Park and Ride spaces at a new facility at Blackash. 3. Achieve and maintain a doubling in Park and Ride patronage as compared to the baseline before provision of the new lines. 4. Encourage families to use public transport together, by offering a cheaper alternative to the regular public transport services on offer to families. 5. Lessen the demands on inner city parking. 6. Encourage people to abandon the motor car entirely, in favour of "cycle and ride" (or walk and ride). 7. Integrate the new ring road system with public transport into the city.	***Original Target:*** A doubling in the use of Park and Ride services in the city. ***Actual Results:*** *The use of park and ride in the city was doubled in the 1st full year of operation of the new service (2004): In 2001, 41,122 passengers used the Victoria Cross Park and Ride. In 2004, 131,807 people used Cork Park and Ride Services.* *Over 900 Park and Ride spaces were actually provided.* *By October 2005, around 500 cars / day used the site, saving approximately 475 / 450 trips each way into the City Centre.* *The presence of the Park and Ride facility not only lessens the demand on inner city parking but also encourages the use of more sustainable modes of transport.* *The provision of cycle parking and pedestrian access ways may also encourage people to abandon the motor car entirely, in favour of "cycle and ride" or "walk and ride".* *To encourage families /friends car sharing (and travelling independently to and fro with shopping etc) "free bus tickets" are issued to passengers accompanying paying drivers.* *The awareness raising activities undertaken for CIVITAS played an important role in promoting the use of Park and Ride, the VMS signs in particular were important tools.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Cork: 10.1 Awareness measures	1. Provide safer routes for cyclists and pedestrians accessing the city. 2. Provide secure places for cycles to be locked, in locations that provide the most benefit for cyclists and nearby residents/businesses. 3. Provide for the sustainable integration of cycling and walking with other urban transportation systems.	1. Provide safer routes for cyclists and pedestrians accessing the city. 2. Provide secure places for cycles to be locked, in locations that provide the most benefit for cyclists and nearby residents/businesses. 3. Provide for the sustainable integration of cycling and walking with other urban transportation systems. 4. Raise awareness about sustainable transport issues. 5. Facilitate and encourage more sustainable commuting practices. 6. Invite, assess and respond to feedback about measures to promote sustainable transport. 7. Increase the numbers of cycle parking facilities within the city centre by at least 40% 8. Increase the numbers of cyclists in the city centre by at least 10%,	***Original Target:*** Increase the numbers of cycle-parking facilities within the city centre by at least 40%. Increase the numbers of cyclists on the roads by at least 10%. Increase citizen awareness of the need, potential and ability to change to more sustainable transport patterns. ***Actual Results:*** *264 cycle parking spaces were provided in the City Centre as part of this Measure (an increase of over 2000% in the availability of cycle parking in the city centre) by October 2005; this far exceeded the 40% increase in City Centre cycle parking facilities promised as part of the MIRACLES project. By the end of the MIRACLES project 316 cycle spaces will be provided.* *The redesign of St. Patrick's Street also encouraged more people to walk, cycle and use public transport. This increased citizen awareness of the need, potential and ability to change to more sustainable transport patterns.* *The target increase in the numbers of cyclists was at least 10%. The actual increase was identified from LUTS classified traffic counts in October 2005, which identified a 47% increase in cycling across the inner cordon.* *A Cycle Study was also carried out as part of this Measure to examine the provision of safer routes for cyclists and pedestrians accessing the city.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Cork: 10.2: Mobility Management Measures	1. Demonstrate methods for reducing peak-hour traffic congestion. 2. Reduce the number of vehicle trips (and their associated emissions) incurred by employees of Cork City Council. 3. Promote greater awareness of the need and potential for more sustainable transport habits	4. Promote greater awareness of the need and potential for more sustainable transport commuting habits. 5. Demonstrate methods for reducing peak-hour traffic congestion, such as carpooling. 6. Reduce the number of vehicle trips (and their associated emissions) incurred by employees of Cork City Council. It was hoped that a 5% decrease in the use of the private car amongst employees of Cork City Council would result.	***Original Target:*** A 5 % decrease in the use of the private car amongst employees of Cork City Council was expected as a result of the MIRACLES project. ***Actual Results:*** *In 2002 42% of employees drove to work alone. By 2004 this had dropped to 34%. This decrease was achieved largely due to the increasing access restrictions in the city and the reduction in parking spaces available to City Council employees (approximately a 20% reduction in parking spaces over 3 years). Travel to Work Surveys and Leaflets about the negative impacts of driving were designed and disseminated to stimulate discussion about employees commuting habits and to focus minds on more sustainable commuting methods.* *The 10.2 resource was also invested into schemes to make Travel-to-School surveys were used to stimulate discussion and to identify schools for Walking Bus Pilots. All primary schools partook in safe cycling Training for Senior Classes.*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Cork: 11.2: Improved network management	1. Reduce the inner city traffic congestion caused by motorists driving around searching for a parking space. 2. Implement a system allowing travellers to check on the availability of parking and optionally pre-book parking space. 3. Implement a parking system capable of discriminating in favour of more environmentally friendly vehicles. 4. To begin to manage the allocation of Loading Bays or parking spaces in the city centre for the use of Goods Delivery vehicles.	1. Reduce the inner city traffic congestion caused by motorists driving around searching for a parking space. 2. Implement a parking system capable of discriminating in favour of more environmentally friendly vehicles. 3. Launch a system for registering to use the pay by phone system in addition to initiatives to enable online or phone-based payment of parking fines and residence parking permits. 4. Utilize the new procedures to enforce greater compliance with parking by-laws, better turnover of spaces and incentives to reduce traffic congestion.	***Original Target:*** To increase citizen awareness of the need, potential and ability to change to more sustainable transport patterns. To reduce the overall absolute levels of traffic by 2%. ***Actual Results:*** *Loading bay provision was surveyed and assessed and new loading bays were created to facilitate the new access restrictions. Consultants were hired to develop better loading bay policies and it is hoped to integrate these with some sort of timed use monitoring in future, which may avail of Park by Phone. Unfortunately, the Park by Phone implementation had to be delayed until August 2005. As of February 2006 there were typically 100 daily users. However the specific effects of Park by Phone on traffic flows were not measured.* *That said, it was clearly stated in the original TA that the above targets were to be achieved by a range of measures- including WP5/7/10 and 11, and as stated above the overall level of car traffic through the inner cordon was 3.3% lower than the Do-Nothing Scenario (thus exceeding the stated objective of a 2% reduction.)*

Measure	Original Objectives (from Technical Annex)	Objectives of the Actual Implementation	Originally Expected Quantified Results (from TA) Compared with Actual Results
Cork: 12.2: Cleaner municipal fleets	Investigate the current and future benefits accruing from the use of less polluting vehicles in an Irish context.	1. Investigate the current and future benefits accruing from the use of less polluting vehicles in an Irish context. 2. Promote the use of clean fleet vehicles in Ireland. 3. Assess the pros and cons associated with a range of lower emission vehicle technology options in an Irish context. 4. Convert at least 5-10 vehicles (2 – 5% of fleet vehicles) to lower emissions. 5. Monitor the socio-environmental, economic and technical sustainability of the clean fleet options being investigated. 6. Promote the use of lower emission vehicles locally, nationally and internationally.	***Original Target:*** At least 2-5 % of the corporation's vehicle fleet will be converted to run on lower emission fuel. ***Actual Results:*** *It was proposed to convert at least 5 vehicles to run on lower emission fuel (rapeseed oil). 17 vehicles underwent the conversion process, unfortunately 1 of these vehicles dropped out during the course of the project due to technical reasons. This achieved a 7.4 % conversion of City Council fleet vehicles running on lower emission fuel. For various technical reasons some vehicles stopped using the biofuel at various stages during the project. However at any given time after conversion, at least 10 vehicles were running on PPO (4.6% of the fleet) and by the end of the project all 16 of the originally converted fleet were using PPO and 2 vehicles were using biodiesel. In other words, 8.4% of the fleet were running on Biofuels by the end of the project and it is hoped to make biodiesel use fleet-wide by 2007.*

7 CROSS-SITE INTERPRETATION AND CONCLUSIONS

Whilst there are several measures in each Workpackage that address the same issues, the site-to-site variations in the measures themselves are considerable. For that reason, single cross-site headline results are generally not possible. Instead, for each Workpackage, a series of headline findings have been devised based on the results provided within the templates and summaries. These have been split into "impact evaluation", "process evaluation / lessons learned" and "content / scaling". For additional details, see the relevant template / Annex.

7.1 WP5: Access Restrictions

Access Restrictions were found to reduce pollution and improve the pedestrian environment more generally. Overall there were traffic reductions and the displaced traffic was not found to cause additional congestion elsewhere in the network. Whilst the enforcement of powered two-wheeled vehicle traffic remains a problem, the concepts and applications of access restrictions are readily understood and appreciated, and have generated a level of public and political support.

7.1.1 Impact Evaluation

1. **Access Restrictions have been found to lead to significant environmental improvements.**
   One of the largest measures within MIRACLES was the "***set-up of a city centre clean zone***" in ***Rome*** (see measure 5.1a). The scheme included the restriction of the Laboratory Area to catalysed vehicles only, compulsory yearly check-up of two-wheeled vehicles and closure of the Access Gate System. The most important benefit was a reduction in the pollution level, both in terms of emissions and concentrations. A comparison between the measured mean values in 2001 and 2004 showed a reduction of concentrations (CO:- 21%, PM10: - 11% and benzene: -37%) and emissions (PM10 and benzene: - 38 %, CO:- 76%). This was a consequence of a 40% reduction in the number of polluting vehicles within the central area. Although these findings were derived from a combined effect of all the MIRACLES measures in Rome, it was considered that the greatest benefits came from restricting non-catalysed private vehicles from the central area.

   Other key results concerning the clean zone were that the restriction of non-catalysed cars from entering the Laboratory Area caused no decrease in traffic flows accessing the area, but led to a progressive renewal of the car fleet. Access restrictions decreased traffic flows during the restriction periods by 20% and illegal through-traffic in the central area reduced by 25%. There was also a significant impact on modal split. For instance, there was a five-point percentage decrease in private cars (from 27% in 2002 to 22% in 2005) and a three-point increase in walking (from 20% to 23%).

   The creation of ***a pedestrian network in the city centre*** in ***Rome*** involved the implementation of car-free areas and retractable bollards, and improved the overall quality of life both for residents and tourists (see measure 5.2a), as well as increasing the walking space by 20%. Safety levels also improved noticeably with a 50% reduction in fatalities (from 115 per million inhabitants in 2002 to 65 in 2005). Pedestrianisation was considered as the "premium"

part of the whole access restriction scheme, but to "gain" it, a strong political will is required to achieve the sustainability goals. In the overall approach applied by the Rome Municipality, access restriction can be considered as the "push" part, as a constraint to change drivers' behaviour, and pedestrianisation as the "pull" part to encourage soft modes.

In ***Barcelona***, the measure related to ***access restrictions along the Rambla*** improved the pedestrian environment by controlling the type of vehicle travelling along the route and enforcing speed limits (see measure 5.1). Surveys quantified that pedestrian activity was substantial, with daily flows in the region of 77,000, and that pedestrian crossing volumes were more than six times that of vehicles. Observations of 200 pedestrian crossing movements enabled estimates showing daily delay savings of 3,800 hours, with annual benefits of almost 8 million Euros, which exceeded the scheme installation costs. However, it was not known if there were any associated delays to vehicular traffic. Further work to quantify pedestrian amenity impacts is contemplated with "soundwalks" (a technique being developed in the SILENCE project) programmed for realisation in late Spring 2006.

In ***Cork***, the ***set up of a city centre clean zone*** provided a safer, healthier, more comfortable environment for pedestrians and cyclists in the city centre by halving the number of lanes on the main thoroughfare (St. Patrick's Street), widening pavements, and providing new bicycle-parking facilities and better public transport alighting facilities (see measure 5.1). During 2002–2004, the reported number of personal assaults on St. Patrick's Street declined by 33%. User acceptance was very positive with over 80% of respondents rating the widened footpaths as better than before and over 50% that the facilities in the clean zone had improved. In addition, redesign created space for cultural events which have since attracted many visitors to the city centre.

2. **Access Restriction of powered two-wheeled vehicles presents particular enforcement problems.**
In ***Rome***, check-ups on powered two-wheeled vehicles (the so-called "Blue Tag" interventions) increased by 20% during MIRACLES (see measure 5.1a). However, according to 2004 data (based on checks of 50,000 vehicles), about 64% of powered two-wheeled vehicles were still not compliant with the relevant directive. Enforcing the Blue Tags on two-wheeled vehicles was seen as crucial for the future success of the measure. In addition, a test survey within the so-called "Night Central LTZ ACS + RP scheme" to control two-wheeled vehicles using a video camera proved very useful to study the motorcycle flows in the Limited Traffic Zone (LTZ) (see measure 6.1). Recorded flows showed that two-wheeled access was substantial during the morning peak and the late evening, with motorcycles accounting for about 30% of all traffic accessing the LTZ. Consequently, the implementation of technology to control their access is crucial.

In ***Barcelona***, the ***Rambla enforcement scheme*** was trialled using Automatic Number Plate Recognition (ANPR) technology (see measure 5.1). Two cameras were located, one at each of the entry and exit points of the route, and four different suppliers of ANPR trialled their systems. Although over 90% of number plates on cars were legible, only a small fraction of powered two-wheeled vehicles could be recognised (the more recent

motorcycles with larger number plates). It was concluded that enforcement of motorcycles was necessary, but ANPR technology could only be used if larger registration plates were adopted as the norm. In the meantime, the scheme is being implemented, using manual enforcement. In addition, tags may be utilised to recognise entry by powered two-wheeled users who are residents of the controlled central area.

3. **The correct mixture of limiting measures, flexible solutions and technology support must cope with the everyday problems.**
   In general, private demand management is critical: even though the hybrid ACS+RP scheme using ITS technologies was a success in ***Rome***, it can only be extended by tailoring the solution in each different zone. The integration of ACS, RP and clean zones in "Sustainable Mobility" policies has to be carefully evaluated beforehand and requires an experimental period to develop the particularity of the measure itself with all the involved actors and stakeholders. There is also a need to consider new technology development and the application of the European Directive on automatic charging systems.
   A lengthy timescale is required to consolidate the implementation and acceptability of the scheme. The EU RTD Projects can add value in supporting analysis and choices, even if the four year duration of MIRACLES is just the "beginning" of these types of measures in a complex city.

4. **The technology relating to the particular environmental access control device used is not yet sufficiently advanced to be used for comprehensive access control based on the pollution generated by individual vehicles in a traffic stream. However, the approach has been supported by the local authority.**
   In ***Winchester***, the objective was to ***set-up a city centre clean zone***, by estimating the proportion of high polluting vehicles by measuring emissions using a roadside remote sensing device (RSD) (see measure 5.1). However, the measurement equipment was beset by technical problems, which meant that the measure was severely delayed and that the planned strategies (such as encouraging voluntary maintenance of high polluting vehicles or restricting them from the city centre) could not be implemented on the road. The percentage of vehicles measured that could be classed as high polluters was very low (approximately 0.1% for CO, 0.4% for HC and 0.01% for NO_x), although this may have been due partially to poor sensitivity of the equipment. In addition, the equipment could not measure PM_{10}, which is one of the two main pollutants in Winchester (the other being NO_x).

5. **Local Urban Traffic Plans (LUTPs) based on a mix of small interventions at specific intersections of the road network, and their implementation can reduce traffic speed and improve pedestrian safety.**
   In ***Rome***, it was estimated from a simulation model developed for access control that the redesign of crossing areas will result in a 50% decrease in traffic flows and a 5-10% reduction in emissions (see measure 5.2b). In addition, the upgrading of traffic signals at some accident blackspots should improve pedestrian safety. The concept of improving crossing schemes using minor infrastructure interventions is an example of how larger scale issues such as safety and pollution can be influenced by starting from a bottom-up approach.

7.1.2 Process Evaluation / Lessons Learned

6. **Implementation of environmental access control schemes should be undertaken in conjunction with the creation of tangible benefits for the public.**
   In ***Cork***, parallel improvement of the streetscape (e.g. widening pavements and making the surface more user-friendly) made the new street layout more attractive to pedestrians of all abilities. There was a 15% increase per annum in pedestrian numbers and high-profile activities such as pedestrianisation of a main street can raise the awareness of the associated benefits.

7. **Location of access control and enforcement control points may be partly dictated by the road network conditions and this may require some flexibility in determining access control boundaries and hence areas of impact.**
   The use of retractable bollards is a common feature of the access control schemes in ***Rome***, ***Barcelona***, and ***Cork***. They provide effective enforcement without limiting essential access for priority vehicles. In Cork, the bollards had been implemented after discussions with business representatives. While successful some enforcement issues remain on loading time restrictions and illegal parking, which had also caused additional delays to the bus service. Consultation with business representatives is ongoing. In Barcelona, the use of ANPR technology can provide a potentially more flexible solution for controlling traffic than retractable bollards.

8. **The use of roadside exhaust pollution measuring equipment for environmental access control should relate to statutory vehicle tests and local air quality measures for enforcement and greater acceptance.**
   The number plates of polluting vehicles must be able to be uniquely identified so that their owners can be contacted subsequently. Many vehicle owners in ***Winchester*** indicated that they would welcome feedback on the emissions of their vehicles. This measure relates to awareness raising and, if properly handled, is more likely to be seen as positive than had been initially envisaged by the local authority.

7.1.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.1.

WP5: Access Restrictions		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	Compared to baseline, predictions were: • decrease in non-catalysed cars of about 15%; • decrease in emissions of CO and particulates of about 40%; • no change in modal split; • no change in no. of trips; • no change in noise levels.	Potential to expand the Laboratory Area restriction zone for non-catalysed vehicles further afield to other metropolitan areas. Similarly, pedestrianisation and urban traffic plans can also be expanded to rest of city.
Winchester	Not relevant – technology demonstration only.	Not considered within MIRACLES. Once technology is proven, there is potential to expand to other routes or target other vehicle categories (e.g. large-engined vehicles).
Barcelona	Continuation of the actual dis-benefits of 10,000+ vpd passing along the Rambla.	If the ANPR technology can successfully discriminate between those vehicles accessing off-street car parks and those making inappropriate use of road, then the 'outbound' movement can also be controlled. In addition, ANPR could eventually replace existing access control systems.
Cork	Compared to baseline, predictions were: • increase in pollution levels of 10-20%; • modal split unchanged; • increase in journey times; • increase in pedestrian flow of 10% max; • static / declining cycle flows.	The local authority considered the pedestrian priority scheme such a success that it was extended outwards from St. Patrick's Street to adjacent streets.

Table 7.1: Summary of business as usual and up-scaling scenarios for WP5

7.2 WP6: Integrated Pricing Strategies

Although fiscal parking policies can influence car parking behaviour, they are not popular with the public and there is a need to more clearly promote their potential benefits.

7.2.1 Impact Evaluation

1. **Even if not directly affected, a sizeable proportion of the public do not agree with road pricing and environmental parking charges.**
   In ***Rome***, the general public did not perceive ***time based road pricing*** to be a popular measure, although the benefits associated with the scheme meant

it increased sustainability (see measure 6.1). In addition, during the course of the project, public satisfaction of the ***environmental parking charge*** scheme reduced from 3.90 to 3.57 points (on a 1-5 Lickert scale) regarding parking policies linked to P&R, and from 3.30 to 2.52 regarding flexible parking rates (see measure 6.2). Similarly, public satisfaction of the measure relating to ***Access Control systems in central areas*** was less encouraging (see measure 5.1b). Approval reduced markedly (by more than half a point on a 1-5 Lickert scale) and indicates that the public perceived the scheme as infringing on their freedom to travel.

In ***Winchester***, a measure included ***environmentally linked parking charges*** (see measure 6.2). Amongst the general public, awareness of the discounted parking scheme was low (11%), but 70% of the respondents generally agreed with it. However, considering just the subset of season permit holders, awareness was high, but a smaller proportion (58%) agreed with the scheme. This indicates that about half the people who did not drive a low-polluting vehicle disagreed with the discount scheme, perhaps because they resented others benefiting from reduced parking charges. 31% of permit holders stated that the discounts would encourage them to purchase a more environmentally friendly car in the future. Although it is acknowledged that 'stated preference' results should be treated with caution, this shows that there is some potential for a greater shift in future years as the vehicle technology becomes accepted.

2. ***There is a need to clearly disseminate the potential benefits of 'restrictive' measures.***
   In ***Rome***, it was concluded that for ***time based road pricing*** to become a best practice, additional time and resources were required to make the citizens aware of the potential benefits, and hence to disseminate the good results already achieved. It was also considered that the low general acceptance of the ***environmental parking charge*** measure was probably influenced by a general unwillingness to pay for parking and emphasises the need to promote integrated mobility measures and to make people perceive them as a whole (see measure 6.2). The parking policy was part of a package of measures aimed at modifying modal split in favour of public transport, decreasing air and noise pollution, improving safety and security, and upgrading the general quality of life. However, when the public were questioned about parking issues, they tended to only focus on the aspects which limited their own freedom. Therefore, there should be greater communication between citizens and administrators, and better dissemination about the scheme.

3. ***Fiscal parking policies can influence car parking behaviour.***
   In parallel to the parking discount scheme, car park charges in ***Winchester*** were generally revised so as to develop a ***parking policy to discourage long stay parking in the city centre*** and encourage use of the Park & Ride site (see measure 6.2). It was found that ticket sales for the seven busiest city centre car parks decreased by 16% (about 235,000 tickets) during 2002-05, but increased at the P&R sites by 43% (43,000 tickets). There was therefore evidence that the parking policy/charging measures led to more drivers parking at the outskirts of the city centre area or the P&R site, producing benefits in terms of less circulating traffic and reduced pollution in the city centre. Revenue at the city centre car parks increased by 11% (as a

consequence of the increased parking charges) but only by 6% at the P&R sites, a result biased by the increased take-up of the P&R smart card discounted ticketing system.

In ***Rome,*** the "***environmental parking charge***" measure increased the number of payment parking lots from 52,000 to 79,000 units during the project lifetime (see measure 6.2). The quantity related to Park & Ride facilities increased by about 15%. Overall, there were clear economical benefits: Rome Municipality doubled its net income during the period 2001–05. From a qualitative viewpoint, it was considered that the increase in parking supply in conjunction with a policy to introduce parking charges according to the different uses of a given urban area reduced the use of private cars. Payment parking discouraged circulating traffic looking for an available space, particularly in residential areas, and such changes contributed to reducing the overall pollution level. During the first weekend of the ***Night ACS+RP*** scheme in ***Rome***, the number of four-wheeled vehicles reduced by 60% Follow-up surveys confirmed what was observed during the first week of implementation; the first target was met i.e. a 25% reduction in the number of vehicles during the weekend nights, which corresponded to a real 50% reduction (from about 10,000 to 5,000) in the number of four-wheeled vehicles (see measure 6.1).

4. ***Even though Road Pricing is not popular, its potential benefits mean it is an essential scheme to increase sustainability in the city.***
In ***Rome***, the ACS+RP scheme, the Night Central LTZ scheme, and the introduction of RP policies for two-wheeled vehicles and tourist coach fleets had the general objective of restricting private cars from entering the city centre, so as to improve standards of living. However, these are not no-cost measures and to become a best practice, time and resources must still be spent in tuning and improving the supporting technologies, adjusting regulations, and speeding-up the implementation process (as well as disseminating the results to the public, see also point 2).

7.2.2 Process Evaluation / Lessons Learned

5. **Implementation of the environmentally linked parking charge scheme could have been demonstrated at a wider level.**
In ***Winchester***, a measure included ***environmentally linked parking charges*** (see measure 6.2). This involved the implementation of a variable tariff that offered a discount of 75% or 50% on the usual cost of a season permit for those vehicles belonging to the A or B road tax bands, which affected those vehicles with the lowest CO_2 emissions (<120 kg CO_2/km). In addition, owners of electric or hybrid vehicles were offered free season permits. However, of the 359 vehicles issued with a season permit at participating car parks, only 37 (10%) were eligible for a discount (as of January 2006). This low number of 'qualifying' vehicles in Winchester meant that no quantifiable impacts could be measured directly, although there were indications that the scheme is having a positive influence. The scheme could have been demonstrated at a wider level by targeting additional vehicles (for example, those in road tax band C or LPG vehicles), but this would have reduced the parking revenue generated from the city centre car parks, which

subsidises the P&R site. One possibility for the future is to revamp the overall charging regime, which might then make this measure worth following further.

6. **Implementing a variable parking tariff at 'Pay on Foot' car parks presents particular problems.**
   Car parks in ***Winchester*** city centre were 'Pay and Display' types before MIRACLES i.e. they were operated using pay-on-entry parking machines where the driver had to estimate the parking duration and pay for this time in advance. During the lifetime of MIRACLES, the ticketing systems at several major car parks were converted to the more flexible 'Pay on Foot' system, where the parking duration is calculated more accurately. (Season tickets are not issued at 'Pay on Foot' car parks). It had been intended to also implement the ***environmentally linked parking charge*** scheme (see measure 6.2) at the 'Pay on Foot' type car parks by using ANPR technology to recognise vehicles entering the car park and assigning the appropriate tariff to the dispensed ticket and check that the correct vehicle was being driven with the associated card. However, operational problems with the introduction of the 'Pay on Foot' system meant that the discounted parking scheme was not implemented at any 'Pay on Foot' car parks.

7. **An urban Road Pricing scheme is very complex and requires a great deal of communication to promote understanding.**
   In ***Rome***, the complexity of the ***time based urban road pricing*** scheme required a substantial amount of communication, more than originally estimated (see measure 6.1). The provision of information to the public regarding sustainable mobility was considered of fundamental importance, especially in view of the lack of a general policy or directives relating to road pricing at the national level.

8. **Expanding the number of paid on-street car parking places to the whole city should be integrated with a package of sustainable mobility policies.**
   In Rome, on-street road parking policy is a driven element of the environmental parking charge scheme to encourage a sustainable development. The main lesson learned was that the system can only work if it is integrated with a package of sustainable mobility policies to be progressively extended to the whole city. Such a large scale implementation depends greatly on political willingness, public participation and awareness of the benefits.

7.2.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.2.

WP6: Integrated Pricing Strategies		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	Compared to baseline, predictions were: • decrease in non-catalysed cars of about 15%; • decrease in emissions of CO and particulates of about 40%; • no change in modal split; • no change in no. of trips.	Not considered exclusively within MIRACLES. Regarding modal split in a road pricing application: within the frame of the whole urban context, transit progressively increases and cars strongly decrease as charges increase, but only in the event of very high charges.
Winchester	Compared to baseline, it was predicted that, as a result of only natural changes to the vehicle fleet, CO_2 emissions of the 770 season permit holders would reduce by 0.1% (or 154g CO_2/km). This is equivalent to one small / medium-sized car being removed from the road.	If the measure was upscaled to all 770 season permit holders, it was estimated that the CO_2 emissions would reduce by 4.4% (or 2736g CO_2/km). This is equivalent to 37 small / medium-sized cars being removed from the road.

Table 7.2: Summary of business as usual and up-scaling scenarios for WP6

7.3 WP7: Collective Passenger Transport

Improved Public Transport services and information, particularly Park & Ride schemes, can encourage a small modal shift, but service frequency, reliability and cost are critical. Larger-scale impacts on mode share require more radical interventions. New tramways can generate new CPT trips, can achieve a significant switch from car usage and, (with attention to design) can induce high usage of tram combined with walking and feeder bus.

7.3.1 Impact Evaluation

1. **Improving bus service quality and information can contribute to an increase in bus patronage**.
   A range of mini-measures to ***improve bus service quality and information*** were implemented in ***Winchester***, including the introduction of new cleaner buses on two city centre routes and a P&R route, better information for passengers at bus stops, discount ticketing schemes, greater integration of bus and rail, and access to real-time passenger information through kiosks and the internet (see measures 7 and 11.1). On the three 'MIRACLES routes', patronage increased by an average of 5%, but this varied between routes. For example, patronage on one city centre route increased by 19% (although this was also influenced by an increased frequency of service from 4 to 6 times per hour), and decreased on the other by 12% (again, this was partly attributable to a decrease in service frequency from 5 to 4 times per hour). There was evidence that the physical improvement of the interchange area outside the railway station contributed to the success of one route since

the number of passengers boarding the two MIRACLES bus services increased by 97% at this stop. Two non-MIRACLES 'control' routes saw an average decrease in patronage of 6% during 2002-05, which implies the real gain in Winchester was nearer 10%. Passenger satisfaction ratings on the MIRACLES routes were already very high, and the percentage of respondents rating the service as good increased slightly during 2002-05 from 83% to 87%.

Along the two MIRACLES city centre routes, revenue increased by an average of 27% whilst the revenue generated on the two control routes increased by 16%. Analysis of emissions estimated significant reductions of NOx, PM10, CO and HC (43%, 62%, 47% and 52%, respectively) on the two MIRACLES city centre routes as a consequence of replacing the older vehicles with new Euro III buses. There was also evidence of improved reliability: the number of early/late bus journeys reduced from 0.95% in 2002/3 to 0.34% in 2004/5.

In ***Barcelona***, ***multi-operator real-time passenger information*** was integrated across the metropolitan area (see measure 7.2). This involved the acquisition and implementation of a common Automatic Vehicle Monitoring (AVM) system for the 20 private medium bus operators, processing the AVM information, and the installation of information panels at three bus stops along a tram corridor. The AVM system enabled each operator to use GPS to track its own vehicles, with capacity for up to 500 buses. Analysis of ticket sales at one bus stop (Pont d'Esplugues) equipped with information panels compared transactions in October and November 2004 with equivalent months in 2005. A similar comparison was undertaken for the overall tramway network. It was found that ticket sales across the overall tram network increased by 1.63%, and by 2.03% at Pont d'Esplugues (a statistically significant higher increase equivalent to 48 extra passengers per weekday). This positive impact on ***feeder bus*** patronage contrasted with a much lower perceived value recorded by surveys with passenger of the tram service, with "information about times of next tram arrival" being ranked only 6th (1.3% of all responses) in customers' opinions on features that motivated them to use the ***tram*** service.

In ***Rome***, the ***multi-modal information measure*** updated the INFOPOINT website, and improved the mobility information provided, particularly concerning cycle paths and accessible bus stops for the mobility impaired (see measure 7.2.1). The average number of monthly visitors to the INFOPOINT website increased from 48,000 in 2002 to 200,000 in 2005. During MIRACLES, the number of accessible buses doubled, and 100 buses are now accessible to visually impaired people, being equipped with Braille dots. In addition, the MOBY on-board system was implemented to provide real-time transit information to bus passengers on 200 buses (see measure 7.2.2). This was very innovative; before MIRACLES no on-board information was available. Public perception of PT telematics in general was good. 41% were aware of telematic devices at bus stops, and the satisfaction rating was 3.72 (on a 1-5 Lickert scale). It was considered that the INFOPOINT upgrading indirectly attracted users to transit, by promoting alternative forms of travelling across the city e.g. cycling, and it enabled a broadening of opportunities available to physically challenged people.

Another related measure in ***Rome*** was the ***introduction of new PT lines*** (see measure 7.3). The transit network was improved by implementing two new lines operated by electric buses one operated by a trolleybus, as well as the conversion of a former bus depot to a trolleybus depot. In quantitative terms, the two types of PT lines were viewed as an addition to the current transit supply, dedicated to special events or improved city centre accessibility. The overall electric fleet (five lines) carried about 10,000 – 12,000 passengers daily. The trolleybus line upgraded a service previously operated by common buses, and now transports about 32,000 passengers per day, with consequent reductions in travel times of about 50%. Such improvement can be detected also by the enlargement of the electric transit network up to 52 km (22,8 km from the trolleybus line alone). In qualitative terms, public awareness of the need to use clean transit increased from 53% to 76% and satisfaction increased from 3.6 to 3.96 (1-5 Lickert scale). This was the Rome measure that achieved the highest satisfaction rating. 86% of the people interviewed were in favour of the trolley line extension, primarily because it was environmentally friendly, had a low noise level, and operated frequently and punctually.

2. **Park and Ride sites have been shown to be well-utilised and popular with the public.**
   In ***Cork***, a ***Park and Ride (P&R) service was established*** about 3 km from the city centre, which provided approximately 900 P&R spaces (double the amount originally planned). The objective was to reduce congestion and promote sustainable modes of transport by achieving and maintaining P&R capacity at near full capacity (see measure 7.3). By October 2005, daily patronage was of the order of 500 vehicles per day, which meant the site covered its operating costs, and saved approximately 450 trips each way to the City Centre. The overall quality of the P&R service was rated very highly (e.g. 83% of survey respondents rated it as “very good”) and 99% said that they would use P&R again. Female usage was very high (79%) and car occupancy of P&R users was very low, with 71% of respondents travelling alone. Public perception regarding ease of obtaining P&R information was very positive, with 96% of respondents rating it as satisfactory or better. Due to the success of the measure, a second P&R site (accommodating up to 500 vehicles) will be provided on the north side of Cork in 2006.

   Within ***Winchester***, prior to MIRACLES, two P&R sites were in operation and they provided a total of 360 spaces (see measure 7). In February 2004, ***one of the sites was substantially extended***, providing a total of 780 spaces. Although the capacity increase was not a specific MIRACLES application, P&R buses and bus shelters were re-branded with the MIRACLES logo. P&R ticket sales increased by 43% during the project lifetime. As in Cork, the majority of the survey respondents rated the Winchester P&R service very highly (e.g. 92% rated it as “very good” or “good”) and female usage was high (72%). In addition, 43% of the P&R passengers were aware of MIRACLES, more than any other passenger group.

3. **Introduction of a tramway scheme can remove a substantial proportion of vehicles from the road.**
   In ***Barcelona***, one measure involved the ***integration of the tramway in the CPT network***, with MIRACLES work focusing on the overseeing of design aspects, integration with other modes, and performance monitoring (see

measure 7.5). The "Trambaix" scheme combined the latest tram vehicle technologies with a radical re-allocation of street space. Based on ticket validations, a general pattern of progressive growth was found, with average weekday passenger numbers increasing from around 20,000 in April 2004 to over 46,000 in March 2006, a result exceeding original forecasts.

On-tram passenger surveys revealed that two-thirds of tram users had previously made the same journey. Of these, 18% used to travel by car, and 3% by motorcycle. The remaining 79% were previous bus and metro users. The weekday saving in motorized travel associated with this considerable switch was estimated to be 25,000 veh-km. In addition to this substantial car switch to CPT, Trambaix also promoted walking and cycling, enabled social inclusion of those with mobility difficulties, improved street amenity and captured a substantial trip generation for public transport (see also point 8).

4. **A "business class" service provides a good option for some trips.**
   Although initially implemented in 2002, the performance of the ***Taxibus service*** in ***Rome*** improved substantially during MIRACLES (see measure 7.4). By 2005 the number of trips per day had more than quadrupled (from 160 to 752), journeys became faster (from 1 hour to 20 minutes), and the total daily distance travelled more than doubled (from 2270 km to 5989 km). The improvement to the Taxibus service did not necessitate a cost increase (so the overall cost reduced from 0.9 Euro/inh to 0.6 Euro/inh). Users still showed a good appreciation of the service and a strong awareness of the need to implement this type of measure. It was concluded that a service such as Taxibus, operating on selected routes, provides a good option for some trips at reasonable prices (even if more expensive than PT), with comfortable travelling conditions and reliability. It represents a type of "business class" for bus/metro users who are disposed to pay a little more (but less than a taxi fare) to arrive in time, close to their destinations and in a comfortable way, especially in poor weather conditions. However, such a scheme may not be as effective in a city where there is already a high quality PT system.

5. **An innovative automatic video surveillance system was successfully trialled.**
   In ***Rome***, an ***automatic video surveillance system*** was based on the application of a computerised image processor and substituted a traditional CCTV system manually managed by an operator (see measure 7.1). The objective was to monitor passengers in indoor areas of metro and railway stations. The trial at the Termini subway station was focused on the functional evaluation and was not tested in a real public transport environment. The system was shown to be able to recognize different standard situations and to alert the operators by an audio-video alarm, when unexpected events occurred. This should enable the possibility of detecting and monitoring traveller behaviour, and thereby improve the quality of PT services, and it was assessed as suitable for possible further exploitation. However, it should be noted that the trial period was not considered to be a sufficient basis to assess whether the measure was ready for a full implementation.

7.3.2 Process Evaluation / Lessons Learned

6. **The cost of the Park & Ride service is a significant factor in its success.**
   In both ***Cork*** and ***Winchester***, it was considered that reliability, cost, perception of security and frequency of the bus service were all significant factors in the success of ***the P&R service***. The cost of using the P&R in Cork and Winchester was relatively cheap (daily vehicle rates of €5 and £1.50, respectively), which meant that users obtained a significant saving compared with the tariffs in city centre car parks. In Cork, 56% of users surveyed in 2004 cited the cheaper price as the reason for using P&R, and limited parking space in the city centre was the next most important consideration. Indeed, a successful P&R scheme may require a subsidy (as in measure 6.2 in Winchester, this can be achieved by maintaining significantly higher city centre parking charges). Conversely, the 'failure' of the trial cross-city P&R service to the hospital in Winchester was due largely to the significant price difference in the cost of the service compared to the relatively low cost of parking at the hospital.

7. **A key driver in improving bus service quality is the setting up of a Bus Quality Partnership (BQP).**
   In Winchester, the key driver to improving the bus service quality and information was the setting up of a Bus Quality Partnership (BQP) covering two city centre bus routes and the P&R service. The BQP brought together the key stakeholders of the local bus company and the local authorities. The local bus company were responsible for the new buses, a marketing campaign and discounted tickets whereas the local authorities sought to introduce cleaner buses by allowing bidders to submit bids for hybrid / electric vehicles and extended the Park & Ride site. Research elsewhere has shown that passenger growth is linked to the extent of the BQP with predicted general increases in patronage of 5% for minimal infrastructure improvements, 15% for a comprehensive route upgrade and 30% for high quality schemes. The same research found that passenger numbers take up to two years to peak after implementation of improvements. After this time, if further improvements are not made then patronage can either level off or decline, and so it is important that the BQP continually refresh the quality bus product to meet rising passenger expectations.

8. **It is important that PT journey times are not impeded by other traffic.**
   The speed of the bus service was one of the key operator performance indicators in ***Cork***, and journey times were minimised by careful route and site selection, as well as bus prioritisation at traffic lights and junctions. However, it was considered that further efforts will be needed to counteract the worsening effects of congestion in the future. (In 2005, the mean journey time of 7 minutes can almost double during peak periods). Similarly, in ***Winchester***, the improved frequency of one of the MIRACLES city centre bus routes was not always matched by improved punctuality. In peak periods, particularly, buses were delayed as a result of city centre congestion. Bus priority measures at selected junctions may have alleviated this, but bus lanes may be necessary for the improvements to be fully effective. In ***Barcelona***, concerning the re-introduction of the modern tramway, the average tram running speed in 2005 was 17.9 km/h, just below the target of 20 km/h, and higher than reference bus speeds (between 12 and 15 km/h). Although perceptions of tram speed were positive, additional efforts are being

made to improve running speeds. These could include segregating tram and pedestrians and reducing cycle times at key signalised junctions, but the movement conflicts caused by introducing the tram are not easily resolved and require changing some streets to one-way so as to relocate car queues. In ***Rome,*** the journey times of the collective taxis service reduced significantly: from 1 hour in 2002 to 20 minutes in 2005, due to a slight increase in average speed and to more direct connections, as well as the partial use of dedicated lanes along the routes.

9. **Integrating relevant real-time bus arrival time information from all operators is difficult (but can, and should be, achieved).**
   The integration of relevant information from all bus operators was the main challenge in providing real-time ***bus arrival time information*** to travellers in the ***Barcelona*** metropolitan region (see measure 7.2). The approach taken was based on equipping smaller operators with a common modern AVM system. However, this caused institutional difficulties during the initial stages of the project with larger operators (with older AVM systems). Solutions were found (information exchange based on XML and GPRS) and a full-set of real-time bus arrivals of all operators was demonstrated at bus-stops. Indeed, a key lesson learned is that the implementation of an AVM system for small / medium bus operators requires a large-scale commitment that can only be assumed by an authority with responsibilities for integrating passenger services across a metropolis or region. In addition, it is not recommended that bus arrival time information is demonstrated in conjunction with other PT implementations that cause a rationalisation of the bus services (e.g. the tramway) since such service changes undermine the basic co-operation of operators.

10. **The introduction of a street-running rail-based transport mode is complex, and the attention given to achieving an integrated design will not be popular during the implementation phase.**
    In ***Barcelona***, the ***re-introduction of the tramway*** provoked much debate and considerable initial resistance to the scheme (see measure 7.5). One aspect concerns the disruption caused by roadworks. Another aspect was private vehicle drivers' initial intolerance of movement restrictions. At some traffic signals, the banned turning movements and clearway regulations within junctions were disobeyed by some drivers; this behaviour caused several accidents in the latter stages of system commissioning and initial weeks of operation. However, lane segregation and attention to signal timings and traffic queue management are important design factors to ensure the higher tram running speed.

11. **Advertising is vital when implementing a new Park & Ride scheme.**
    There was a risk that the P&R service in ***Cork*** would not attract sufficient passenger numbers and so much thought was put into site selection, and advertising via diverse forms of media. Road signs, newspaper advertisements and radio adverts were found to be especially effective. In addition, the service was integrated with other mobility management and awareness measures and Park by Phone. The City Council also ran a number of "free days" on which usage peaked and which attracted new customers.

12. **Implementation of new technology within historical city centres presents particular challenges.**
The implementation of the ***new PT lines*** in ***Rome*** is a good example of how obstacles were successfully overcome (see measure 7.3). An important consideration regarding the implementation of the trolleybus line was that it required a special design of the wire lines, and required an integration of new and old street furniture to preserve the historical features of the boulevard. Moreover, no aerial wires were allowed to be used on the final part of the route (where the line entered the historical city centre) and so, on this section, the trolleybus had to be powered by batteries. It is also important that the views of end-users and stakeholders are included within the scheme design, although such participation can cause delays. For instance, retailers in one of the areas where electric buses were operative claimed their turnover would decrease as a consequence of the restriction policy, but soon found that their business activities had in fact increased by 20%.

13. **The collective Taxibus service remains a "niche" transit option without a strong impact on travel patterns.**
Despite an impressive take-up within ***Rome***, the ***Taxibus service*** still remains a "niche" transit option without a strong impact on travel patterns (see measure 7.4). The collective taxi service carries about 100,000 passengers annually, covering a distance of about 3 million vkm/year. By comparison, the buses carry some 873 million passengers annually over a distance of about 133 million vkm/year. Therefore, in absolute terms, the two transit options are not comparable, but the current positive results can pave the way for major implementation at an urban level.

14. **The development of innovative surveillance systems will require new methods of evaluation.**
In ***Rome***, a more thorough implementation of the ***video surveillance system*** will require new methods of evaluation (see measure 7.1). For instance, traditional parameters such as crime rate cannot be used to assess security since they are based on quantitative data which does not take into account the personal perception of security, experienced by the users. Moreover, data are usually underestimated since the crimes are often not officially reported. It is anticipated that image processing will lead to a new interpretation of unpredictable events, in which knowledge of user behaviour becomes the key to detect them. However, barriers to such an approach are the high costs of investments and implementation, the need to operate the system on a large scale to attain the greatest benefits, and time to tune the system on a wider area.

7.3.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.3.

WP7: Collective Passenger Transport		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	*Video surveillance system*: not considered, technical trial only. *Multi-modal information*: not considered. *New PT lines*: compared to baseline, predictions were: • decrease in emissions of CO and particulates of about 40%. *Taxibus*: not considered.	*Video surveillance system*: not considered, results too uncertain (even though positive). *Multi-modal information*: scheme already at citywide level. *New PT lines*: not considered. *Taxibus*: although up-scaling possibilities are high, traffic and environmental benefits are difficult to assess. Indeed, if the collective taxis were not integrated with buses (in terms of operation management and energy consumption) then the mobility situation could be negatively affected, with Taxibuses adding to the circulating traffic in the city.
Winchester	Compared to baseline, predictions were: • decrease in patronage on 'MIRACLES routes' of 2% – 6% (c.f. 5% in 'after' scenario); • increase in operating costs of 8% - 12% (c.f. 7% - 12% in 'after' scenario); • increase in operating revenue of 8% - 19% (c.f. 12% - 46% in 'after' scenario)	No up-scaling was undertaken because it was considered that only one city centre route (one of the two 'MIRACLES routes') would increase patronage even if improvements were made to other bus services.
Barcelona	The electronic ticketing system enables the passenger volumes at stops with information to be compared with a baseline of all bus services along the tram line. Forecasts of tram patronage were made; recorded levels exceeded these forecasts after the first year of operation.	Bus arrival information panels have currently been installed at 10 bus stops (including 3 in MIRACLES). It is planned that such panels will eventually be installed at 50 bus stops. The Trambaix scheme is one of two tramway schemes. (The second, Besòs, opened one month later). A key future proposal is to link the two schemes by running trams along the Diagonal (one of the primary roads in Barcelona). Street-running is the more natural scenario, although grade-separation in tunnel is a more costly alternative. A political decision is pending.
Cork	Without MIRACLES no Park and Ride would have operated in Cork since 2004, as the existing temporary service was closed due to development.	Cork City Council are committed to providing a second P&R site to the north of the city in 2006. This will accommodate 500 vehicles.

Table 7.3: Summary of business as usual and up-scaling scenarios for WP7

7.4 WP8: New Forms of Vehicle Use

The cycle and car pooling / sharing initiatives were "niche" measures, and played only minor roles within the overall scheme of improving environmental and traffic conditions.

7.4.1 Impact Evaluation

1. **The cycle and car pooling / sharing schemes were popular with users, but did not significantly affect modal split.**

A major initiative to ***increase the level of cycling*** within ***Winchester*** was the introduction of the ***Bikeabout*** scheme, which had 160 members by the summer of 2005 (see measure 8.2). Peak usage resulted in almost all the 50 bicycles being used at any one time, particularly during the summer months, although during the winter, demand reduced substantially and so the scheme operating times were reduced. The average trip length was 2.7 miles and most users stated that they had previously travelled by bicycle or foot within Winchester, although three people stated that they had switched from car. The majority (83%) of members thought that the scheme was generally good and 28% of members stated that they did not have access to another bicycle. Among the general public, 38% were aware of the Bikeabout scheme and 66% agreed with the concept. During 2002-05, cycle parking surveys found that the peak number of cycles parked in Winchester increased by 46%, although cycle count data at eight sites on arterial routes outside the city centre showed a 12% decrease in cycle flows.

The ***car pooling / car sharing*** measure in Rome consisted of two activities: the former involved the shared use of private vehicles for home-to-work trips, and the latter was the implementation of a rental car fleet scheme (of 10 cars) at seven parking areas and active 24 hours per day (see measure 8.1). The aim was to create new alternative mobility habits among the citizens. For the car pool scheme, during MIRACLES the number of participants increased from 750 units to 1180 and 360 crews. Regarding car sharing, an experimental phase began in March 2005, which involved 140 users, however in June 2006 an average of 247 pass-holders was recorded, to which corresponded about 62 regular users. A key indicator was the 'number of trips', for which the city value was 2.5 trips per vehicle. The corresponding values for the car pool and car sharing schemes were 2.0 and 1.12, respectively. After a longer period of implementation, the latter value has fallen to about 0.44, as an average daily value. Facts on the number of car sharers are also useful to introduce a key-parameter for the service, the so-called "monthly utilisation coefficient per user", which according to ATAC data shows that at least 2.57 users per month in average prefer this travel option, far above the national rate.

Public perception of car sharing is still in its infancy, which partly explains the small index of awareness (14%) among the ex-post sample of interviewees. However, the "satisfaction level" was quite high (3.6 points, on Lickert scale 1-5), which implies that the initial scheme was well accepted by the participants. This was despite only modest advertising of the scheme by the service managers and the Roman habit of regarding cars as vehicles not to be shared with other people.

7.4.2 Process Evaluation / Lessons Learned

2. **A more distributed and technically advanced cycle pooling / sharing scheme would have provided a more flexible approach, but was too expensive.**

   The ***Bikeabout*** scheme in ***Winchester*** was operated manually (see measure 8.2). Although this meant it could be actively promoted, a more flexible approach would have been to use a multi-modal automated system, which would allow key nodes to be installed throughout Winchester and its residential areas. Access to the bicycles registered through smart cards would allow 24 hour access and the ability to make point-to-point journeys without the need to return the bicycles to a single location. However, the cost of such a scheme was prohibitive: approximately £250,000 for three sites and 75 bicycles. It was originally planned to site the Bikeabout scheme at the railway station, but permission was not given to install a node there, reducing the convenience for commuters. Another major barrier was the topography and road layout within Winchester; there is only limited scope to develop and install new infrastructure such as cycle lanes.

3. **Despite the active promotion and attractiveness of the cycle pooling scheme, only a small proportion of the public participated.**

   The ***Bikeabout*** scheme consisted of a pool of 50 bicycles situated at two main locations in ***Winchester*** city centre, available for the public to borrow free of charge (although there was a membership fee of £15). In addition, the scheme was extensively promoted through leaflet distribution and by the Bikeabout operators providing face to face and telephone contact to both members of the public and Bikeabout members. The operators were able to deal with issues as they arose and undertake maintenance on the bicycles. Despite this active promotion, within the context of the overall number of trips in Winchester, take-up of the scheme was low.

   It is worthwhile noting that increasing the levels of cycling is a national problem within the UK. Indeed, new government targets no longer focus on quadrupling cycling between 1996 and 2012 since this was considered to be unachievable at a national level. The revised targets simply aim to increase walking and cycling over the next 20-30 years and make it a more convenient, attractive and realistic choice for many short journeys at the local level.

4. **It is important to offer incentives and promote the benefits of a car pooling / sharing scheme.**

   In ***Rome***, users of the car pooling / sharing scheme benefited from a series of incentives. For instance, parking places were guaranteed for car-poolers, and a car-sharing permit was offered to transit season permit holders at a discounted cost. However, it was not possible to estimate how these incentives influenced the ex-post results. It is also important to monitor the development of such measures, which are difficult to control, especially for car pooling. Possible solutions are to increase the role of technology to improve the management conditions of the services, and to continuously support such initiatives with awareness campaigns.

7.4.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.4.

WP8: New Forms of Vehicle Use		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	Compared to baseline, predictions were: • decrease in emissions of CO and particulates of about 40%; • no change in modal split; • no change in no. of trips.	Not considered, results were of too small a scale. In addition, the car pooling scheme already covered the citywide area, in terms of trip origins.
Winchester	Not considered.	No up-scaling was undertaken as the Bikeabout scheme already covered the citywide area.

Table 7.4: Summary of business as usual and up-scaling scenarios for WP8

7.5 WP9: New Concepts for the Distribution of Goods

A number of small-scale trials were undertaken, with varying degrees of success.

7.5.1 Impact Evaluation

1. **A feasibility study found that it was possible to increase the number of delivery bays to provide sufficient capacity for night-time deliveries.**
   In ***Rome***, the "***kerbside-doorstep delivery***" soft measure was based on the development of a feasibility study to improve goods delivery conditions in the Laboratory Area (see measure 9.1). Core objectives included the identification of suitable loading / unloading areas, especially inside pedestrian precincts of the historical city centre, and to assess the possibility of undertaking night-time loading / unloading operations. The feasibility study focused on assessing the real need of loading / unloading areas in the city centre as a pre-requisite to the other initiatives to be implemented. The first estimate representing an increase of approximately 10% on lot availability ('business as usual' scenario) increased the number of loading areas from 186 to 201 in four years as a result of natural growth in supply, which seemed unsatisfactory. It was therefore necessary to develop a real comparison between operators' requirements and availability and it was estimated that about 600 new lots were required. Such an increase should provide sufficient capacity to enable night-time deliveries. However, this is not practical on tourist streets, which are still lively during night-times, and these were therefore considered "no night delivery operations" zones.

2. **Although modelling indicated that a Collectpoint system would be beneficial, it was not possible to develop a trial to assess whether a fully working scheme was commercially viable.**
   The ***sustainable urban distribution*** measure in ***Winchester*** included the ***Collectpoint trial***, which aimed to reduce the number of missed home deliveries by using a chain of local convenience stores as a delivery point

(see measure 9.2). Questionnaire surveys of 1,600 households found that the average first-time failure rate of a typical home delivery was 20%, and the majority of respondents stated that they would consider using a Collectpoint-type scheme. Simulation also estimated that a fully operational scheme would provide potential benefits in terms of reduced time and distance travelled. However, when a 10-week Collectpoint trial was undertaken and heavily promoted, including the prior distribution of flyers to 20,000 households, it was marred by technical difficulties and only a few people used the service (75 registered and eight used their voucher). This meant it was difficult to assess whether a fully working Collectpoint scheme would have been commercially viable, although this trial indicates it would not.

3. **The waste-recycling service (using an electric vehicle) was commercially viable, and about one tonne of recyclable waste per month was collected.**
   In Winchester, a ***waste recycling scheme*** was managed by Dove Recycling who used an electric vehicle to undertake a waste cardboard and paper recycling service for Winchester city centre businesses (see measure 9.2). A questionnaire survey of 100 Winchester businesses had previously assessed the demand for such a service and gathered information about the type of waste being produced and recycled. By late 2005, the waste recycling service served 30 businesses in Winchester, although only a relatively small amount of recyclable waste was collected (about one tonne per month, predominantly cardboard and paper). Nevertheless, this appears to be an economically viable venture for the company running the scheme since the service is operated on a full-time basis and has been expanded to other nearby towns in Hampshire.

4. **A multi-use lane resulted in journey time reductions of about 15%, primarily because of a decrease in illegal parking.**
   The ***multi-use lane*** was part of the '***new concepts for the distribution of goods'*** measure, which aimed to achieve an efficient distribution of goods throughout the city of ***Barcelona*** (see measure 9). One lane was allocated to bus priority and goods deliveries during peak hours, with on-street parking allowed overnight. The multi-use lane resulted in the journey times of general traffic being reduced by 12 to 15% depending on the time of day. The bus operator also perceived improvements in the bus running speeds. The delay reductions were mainly as a result of a decrease in overall illegal parking activity for both cars and goods vehicles, thereby reducing the possibility that the second lane became blocked due to double parking.

5. **The *night-time delivery* demonstration showed that quiet deliveries to supermarkets were possible and reduced the number of day-time deliveries required.**
   In Barcelona, the ***night-time delivery*** demonstration used adapted 40T lorries and special equipment to make night-time deliveries to supermarkets with a large capacity and substantial refrigeration facilities (see measure 9). Noise measurements recorded on-street showed that the maximum values recorded varied by only 0.1 dB(A), so residents were not unduly affected by the night-time deliveries. The delivery characteristics in this trial indicated that two trips per week at night could save seven trips using smaller lorries during day-time traffic. It was estimated that investment in vehicle adaptation was recoverable within 3 years.

6. **The exchange of web-based information demonstrated that congested delivery problems can be resolved in the short-term using targeted enforcement.**
   In ***Barcelona***, the '***Loading / Unloading' (L/U) Active Guide*** involved the exchange of web-based information between the Municipality and distribution companies to enable "hot spots" (such as times and locations of congested delivery) to be avoided (see measure 9). The information was then used by the municipal police to prioritise on-street enforcement. The detailed reporting of delivery problems via the web, found that operators encountered difficulties on 553 of the 1772 occasions when deliveries were made. Enforcement, targeted at three "hot spots" where particularly high levels of problems had been reported, achieved an average reduction in problem-reporting of 19%, thereby demonstrating that short-term problems can be resolved using targeted enforcement.

7. **Restricting kerbside access substantially reduced delivery times to supermarkets.**
   Special kerbside regulations were trialled at three locations in Barcelona, and consisted of temporary short-term loading / unloading spaces with special regulations restricting access to the kerbside directly in front of the supermarket to "authorised" vehicles only (see measure 9). One supermarket showed that by eliminating a 30m delivery distance (and using roll-containers instead of pallets) total delivery time was reduced from 27 to 8 minutes.

7.5.2 Process Evaluation / Lessons Learned

8. **The creation of new delivery bays must be balanced against the loss of residential parking spaces.**
   In ***Rome***, the "***kerbside-doorstep delivery***" feasibility study found that the creation of new bays for deliveries would result in fewer parking lots for residents. It was concluded that although the number of delivery bays was appropriate in terms of infrastructure supply, talks among citizens, operators, retailers and administrators were required. Due to the uniqueness of the historical urban features and dense land use in Rome, the study findings cannot be easily transferred to other cities. However, an important consideration is the parking requirement. Once this basic requirement is met, every other intervention is possible. In Rome, given the poor supply of loading / unloading areas, any extra action in terms of fleet renewal, e-commerce development, etc. must be postponed. In addition, the local operators were wary about the initiative, which meant it was difficult to obtain a proper knowledge of their requirements.

9. **The initial trial of the Collectpoint delivery service was not a great success.**
   The initial Collectpoint trial in Winchester was marred by technical difficulties with the Collectpoint website and voucher system, and only a few people used the service. It was also considered that unfamiliarity of the staff at the local convenience stores with the system affected public perception and ease of use. For the Collectpoint scheme to be successful, Internet retailers need to incorporate it into their system as an alternative delivery option. However, they would first need to see the scheme being demonstrated successfully.

10. **The use of an electric van encouraged businesses to sign up to the waste-recycling scheme.**
    Many of the local businesses signed up to the ***waste-recycling scheme*** in ***Winchester*** primarily because an electric van was used to collect the service. The businesses believed that their involvement with such a scheme created a good impression with the public and was therefore a useful public relations exercise in addition to the environmental benefits of having their waste recycled. Another consequence of using an electric vehicle is that it had relatively low running costs.

11. **It was difficult to find evidence that the freight map was used by freight companies.**
    In ***Winchester***, a ***freight map*** was developed and published and distributed to organisations or companies receiving deliveries to improve the efficiency of urban freight delivery. There was no evidence that the freight map was used by freight companies, although this was partly attributable to the monitoring / evaluation process since there was no easy way for genuine users to provide feedback. Some subjective comments suggested that the map was being used as a basis for providing directions to the public or as a simplified parking map. The freight map may have been a useful tool for freight drivers, but the map could have been distributed to this audience more effectively.

12. **The road authority needs to do more than provide a number of un/loading spaces that broadly meets the overall demand.**
    In ***Barcelona***, the initial user survey identified the main problem as being a lack of reserved spaces. For example, analysis of the data supplied about operators' deliveries found that only 36% of deliveries could be made using reserved spaces within 25m distance of the store, and in half of these cases the operator using the reserved space would have to cross a street. Therefore, a lesson learned is that analysis using GIS tools can facilitate a more precise relationship between spaces provided by authorities, and operator's demands for loading spaces.

13. **The web is an effective means of collecting information, and registering the times and locations where operators' delivery problems are most severe.**
    In ***Barcelona***, approximately one third of all deliveries and reported incidents were concentrated during 07:00 to 09:00, highlighting the pressure of supermarket deliveries during early morning. This type of information became available thanks to the web-based pilot. To ensure strong operator participation in the short-term, authorities are advised to use the web information to carry out targeted enforcement of the "hot spots"; this can reduce the level of problem-reporting by operators significantly (around 20% in the case of the Barcelona MIRACLES trial). In order to address "structural problems" regarding the improved location of unloading spaces, medium-term actions such as the 'special kerbside regulations' trials can be incorporated in the collective initiative to good effect.

7.5.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.5.

WP9: New Concepts for the Distribution of Goods		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	Compared to baseline, it was predicted that number of loading areas would increase by 10%.	An up-scaling exercise simulated how the upgrading of the parking supply can be achieved in other urban areas, and developed strategies to improve the overall delivery process. The study focused on an area at the border of the city centre (Piazza Fiume) by estimating the feasibility of implementing strategies, once the basic parking requirements were met, using on-spot surveys, Delphi questionnaires and brainstorming sessions. Local operators supplied data on the delivery habits and procedures. The steps of the up-scaling exercise were: a) Data collection on the local field of application, in particular along the most relevant street of the area; b) Individuation of the proper number of loading/unloading lots along Via Salaria; c) Development of strategies to improve the overall delivery system in the area Piazza Fiume area; d) Evaluation of the most successful strategy.
Winchester	Not considered.	No up-scaling was undertaken since the waste-recycling scheme and freight map distribution was already at a citywide level, and the Collectpoint delivery scheme was not trialled in sufficient detail.
Barcelona	Not considered.	*Multi-use lanes*: will be extended across the city's primary roads. Since each scheme will be designed to meet varied local conditions, a simple extrapolation of the demonstrated MIRACLES impact is not recommended. *Quiet night-time deliveries*: the initial MIRACLES trial at one location has been extended to four locations across Barcelona and to over 100 outlets across Spain. However, from the city view point, the up-scaling can only be achieved when similar positive results are obtained from the 15T lorries generally used to service the more prevalent smaller supermarkets of other operators. *L/U Active Guide*: cannot be up-scaled until the useability of the application is improved. An automated solution based on PDAs needs to be offered to operators instead of the manual logging and entry of reports.

Table 7.5: Summary of business as usual and up-scaling scenarios for WP9

7.6 WP10: Innovative Soft Measures

Although public awareness and acceptance of sustainable transport issues increased during the project, this did not necessarily impact on actual travel behaviour, particularly where the measures were perceived as being car-restrictive.

7.6.1 Impact Evaluation

1. **Public awareness of MIRACLES and CIVITAS increased during the project duration.**
   In all cities, the main objective of the ***innovative soft measures*** was to raise public awareness and acceptance of MIRACLES among residents, businesses and visitors to the city. A variety of dissemination methods were used and public awareness and acceptance were assessed through questionnaire surveys. With regards to the aim of raising awareness of MIRACLES / CIVITAS at a general level, this objective was met, although the numbers grew relatively slowly. For instance, the proportion of survey respondents in ***Cork*** who knew that the city was participating in MIRACLES / CIVITAS significantly increased from 3% to 16% during the course of the project (see Society). Similarly, the proportion of survey respondents in ***Winchester*** who recognised the CIVITAS and MIRACLES logos significantly increased during 2002-05 from 3% to 14% and from 3% to 20%, respectively (see measure 10).

2. **There were relatively high levels of public awareness of the individual MIRACLES measures.**
   Public awareness of individual project initiatives varied between measures, but generally ranged from 10% - 50%. For example, in ***Cork***, the number of respondents aware of one, two, or three MIRACLES measures, was 28%, 30% and 19%, respectively (see Society). In ***Winchester***, the highest levels of awareness were for the Bike Week (57%), Alternative Transport Day (51%), BDIS (49%), VMS (42%), Bikeabout (38%) and improved appearance of bus stops (38%) (see measure 10). Initiatives such as the website, discounted parking scheme, and Collectpoint had lower awareness ratings, but were targeted more towards specific groups of people and were therefore less visible to the public in general.

3. **The number of employees covered by a travel plan increased during the project.**
   In ***Winchester***, one objective of the ***innovative soft measures*** was to encourage the development of ***workplace and school travel plans*** (see measure 10). A green workplace travel plan is focused particularly on employees and aims to widen travel choices by all modes of transport and reduce unnecessary car use. A School Travel Plan aims to alleviate problems with respect to school travel and includes an action plan of measures to help achieve these and a strategy for monitoring and reviewing the progress made. By the end of the MIRACLES project, 11,835 employees (or approximately 35% of the total Winchester workforce) were covered by a travel plan in the Winchester area (excluding staff at schools), which was an increase of 7,772 since 2002.

In ***Rome***, the ***mobility management*** measure was concerned with the promotion of alternative forms of vehicle use for commuters and to raise awareness of the need to limit home-to-work trips (see measure 10.2). Ten Home-To-Work Plans (HTWPs) were in operation by the end of MIRACLES, and the total number of participants increased substantially during the project lifetime, exceeding the predictions of the ex-ante evaluation. In 2002, there were 2,391 regular participants of HTWPs, belonging to just two organisations (a private company and a university). By October 2005, there were 41,805 users, "consuming" 15772 vkm. About 1,400 users share HTWP daily. However, this still only represented 2.7% of all the potential participants. It was estimated that the measure reduced distance travelled by 7.5 million vehicle km/year, fuel consumption by 244 tonnes/year, CO emissions by 67 tonnes/year and benzene emissions by 239 tonnes/year.

4. **Improved cycling facilities resulted in an increase in the number of cyclists.**
   In ***Cork***, the overall objective of the ***awareness measure*** was to raise awareness about sustainable transport modes by providing ***improved cycling facilities*** (see measure 10.1). The cycling improvements involved the provision of about 300 additional cycle stands in the city centre, and these were well-accepted. For instance, 90% of cyclists rated these cycle stands as better than the pre-MIRACLES infrastructure, 67% stated that the locations of the cycle stands were very convenient or convenient, and 61% stated that cycle parking spaces were easily available in the city centre. However, 25% of respondents stated that they sometimes had difficulty finding an available space. Nevertheless, traffic count surveys in late 2005 identified a 47% increase in cycling across the inner cordon. (The target increase in the numbers of cyclists was at least 10%). In addition, the number of cycles parked in the city centre increased substantially (from seven to 105) during MIRACLES, with the majority parked at cycle stands.

5. **The car pooling scheme was not popular and did not achieve a substantial shift in modal split.**
   In ***Cork***, the ***mobility management*** measure implemented a ***car-pooling scheme*** for Cork City Council employees to reduce the number of commuter trips (see measure 10.2). A Travel to Work survey established their commuting patterns and a car pool register was established. In 2002, 70% of employees commuted by private cars, which reduced to 61% in 2004. (The remainder used sustainable transport modes). In addition, the proportion of people travelling in private cars alone decreased from 42% to 35% during this timeframe. However, it was considered that the main factors influencing this change in modal split were the increased access restrictions in the city and the reduced number of parking spaces available to City Council employees (approximately a 20% reduction in parking spaces over 3 years).

   Indeed, the number of responses from employees relating to possible participation in the car pooling scheme was very poor. There was evidence that people preferred car pooling privately with friends and/or relatives rather than the workplace initiated scheme. User acceptance of the car pooling scheme was negative. People were concerned about issues such as insurance and restrictions on the use of vehicles for work. Others stated that car pooling could not be relied upon because their journey patterns varied with school drop offs, site visits, different activities after work, etc.

6. **Awareness of an initiative does not necessarily influence travel behaviour.**
   It is important to note that awareness and (stated preference) acceptance of an initiative does not necessarily influence travel behaviour. Many survey respondents were aware of an initiative without it affecting them personally. In addition, there is a huge difference between accepting the objectives of an initiative and for that individual to then change travel behaviour as a result. For instance, in ***Winchester***, 71% of the public supported the broad objective of MIRACLES to promote and influence travel by sustainable transport, but only about 25% used a mode of sustainable transport on a daily basis (see measure 10).

7.6.2 Process Evaluation / Lessons Learned

7. **A mixture of promotional methods was best at reaching a range of different audiences.**
   Within MIRACLES, sustainable transport options were promoted by using methods as diverse as demonstration days, cycle safety training, advertisements, competitions, leaflets, posters, website promotion etc. Public awareness and acceptance were assessed through questionnaire surveys. It was generally found that a mixture of methods was best at reaching a range of different audiences. For instance, in ***Cork***, advertising and a prolonged media campaign for many measures (particularly Park and Ride) along with the integration of MIRACLES with existing sustainable transport promoting activities increased awareness and acceptance (see Society). In ***Winchester***, of those people aware of MIRACLES, 13% stated that they had been informed of the project through the local newspaper, 13% by a leaflet / poster, 11% by the Bikeabout bicycles, and 7% through Bike Week (see measure 10). In terms of individual project initiatives, there was some indication that events with a high visual presence resulted in the highest levels of awareness in Winchester, although they were not as effective in raising awareness of MIRACLES as a whole. For instance, 57% and 51% of survey respondents were respectively aware of the Bike Week and Alternative Transport Day demonstration events. These events were strategically located in the precinct area of the city and had Bikeabout bicycles and electric vans on show, and MIRACLES stalls / staff providing information to the public. It should also be noted that some publicity methods had only limited success in raising awareness, particularly impersonal methods of promotion such as radio advertisements.

8. **Incentives may be required to encourage effectiveness of workplace travel plans or car pooling schemes.**
   Regarding workplace travel plans in ***Winchester***, staff resistance to car sharing or restricted workplace parking can reduce their effectiveness (see measure 10). As with schools, a more pro-active role could be undertaken by the local authority in encouraging companies to develop green travel plans, perhaps by providing financial incentives subject to travel plan approval. In ***Rome***, despite strong political pressure at the national level to support sustainability, take-up of the HTWPs represented just 2.7% of all the potential participants. It was concluded from this that even though decision makers were fully aware of the potential offered by this measure, users still required strong reasons to stop driving to work. It was recommended that future work should target employees

to promote the concept that driving alone to work is not the best solution. In ***Cork***, the official City Council car pooling scheme did not achieve a substantial shift in modal split on its own. A more prominent change towards sustainable modes of travel is likely to be achieved only in conjunction with a heavy emphasis of promoting sustainable modes as well as restrictions to car use.

9. **There is a particular need to actively promote the potential benefits of car-restrictive measures to the public.**
   In ***Rome***, there were many dedicated awareness campaigns targeted at various categories of citizens (e.g. pupils, employees, mobility managers, residents of areas affected by specific measures etc). This was an innovative approach since prior to MIRACLES, mobility awareness campaigns had only been presented at a very general level. However, despite such efforts, increasing awareness is a never-ending process, and people need to be continuously informed and kept up-to-date. In particular, persuading the public to change their car-based habits is extremely difficult, and such attitudes explain why decision-makers have traditionally been reluctant to move away from car-based options. A key lesson learned is that the more car-restrictive a measure is, the greater the need to inform the public about the potential benefits. This requires a total revision of the measure implementation process with an increased need for communication and dissemination at all stages.

10. **Awareness of sustainable transport issues is likely to increase in the longer-term.**
    In parallel to MIRACLES, the ***Winchester*** Movement and Access Plan (WMAP) has been a local sustainable transport initiative, ongoing since 1995. Awareness of WMAP increased from 20% in 2003 to 25% in 2005, which indicates that there is scope to increase awareness of sustainable transport issues in the longer term, although even then it may not produce 'high' awareness ratings.

7.6.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.6.

WP10: Innovative Soft Measures		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	Not considered.	Not considered or relevant, since this was an awareness raising measure.
Winchester	Not considered.	Not considered or relevant, since this was an awareness raising measure.
Cork	Compared to baseline, predictions were: • a small increase in the number of cycle parking spaces. • static / decreased cycle flows through inner cordon.	Initially only a small number of cycle parking spaces were to be provided, but this was up-scaled during MIRACLES to 316 spaces, partly as a consequence of extending the clean zone in measure 5.1.

Table 7.6: Summary of business as usual and up-scaling scenarios for WP10

7.7 WP11: Integration of Transport Management Systems

All WP11 measures were successfully implemented within MIRACLES, although reported impacts were generally sparse. The Park by Phone scheme and information kiosks proved particularly popular with users.

7.7.1 Impact Evaluation

1. **The Park by Phone scheme was popular with users who valued the quick and convenient payment method for on-street parking.**
   The ***Park by Phone*** measure in ***Cork*** established an innovative parking management / payment scheme where subscribers can pay for on-street parking using their phones and access system information (see measure 11.2). Cork City Council had previously operated a parking disc system for on-street parking, which required considerable effort to enforce. Full implementation of the Park by Phone scheme (across 60 streets) commenced in October 2005. Approximately 100 Park by Phone parking instances occur per day (as of February 2006) with the number increasing weekly since the start of operation. A user of the Pay by Phone scheme pays no more for parking than a user using the traditional disc system.

   Park by Phone was rated by 69% of users to be 'very easy' to use with a further 10% rating it as 'fairly easy'. 79% of respondents stated that the main reason for using the scheme was that it was faster / easier than disc parking, and 18% cited the ability to top-up their parking fee remotely. The overall rating of Park by Phone was rated as 'very good' by 59% of respondents, an additional 4% rated it as 'fairly good' with 14% rating it as 'satisfactory' and 3% as 'poor'. No respondents rated the overall rating as 'very poor' and 99% of respondents said they would use Park by Phone again.

2. **Information kiosks, providing a wide range of real-time information, were highly rated by the majority of users.**
   In ***Winchester***, ***information kiosks*** were installed with the aim of providing ***improved multi-modal information for travellers***, especially public transport users (see measure 11.1). The first two kiosks were installed in September 2004 in indoor locations, and an average of 500 users per month was recorded. When a third kiosk was installed outside on a pedestrian precinct in January 2005, the total number of users quadrupled to about 2000 per month. This increase was primarily because of the much greater footfall at the outdoor site, but there was also evidence that people felt less comfortable using the kiosk in the confined indoor location of the Tourist Information Centre. At each kiosk, the average usage time was about four minutes. In addition to traveller information, the kiosk provided other channels including email, jobs, news, tourist information and games. These other channels were accessed more frequently by the public than the 'intended' traveller information category. On-screen and on-street surveys were undertaken and the kiosks were highly rated by the majority of users, who stated that they found the kiosks easy to use and that the information was readily accessible. An on-street survey of non-users was also undertaken: many respondents had simply not noticed the presence of the kiosks.

In **Rome**, five information kiosks providing PT information were installed (see measure 11.1.3). The functionality, including a new interface, was tested within a small scale trial, although no surveys were undertaken.

3. **The provision of estimated bus arrival time information to passengers would likely have been more effective if the information had been real-time.**
   Three BDIS (Bus Departure Information Systems) were installed at the railway and bus stations in ***Winchester*** (see measure 11.1). BDIS provide passengers with a list of the next arriving buses together with their estimated arrival times (based on the standard timetable). Two small interview surveys were undertaken to evaluate public opinion of the BDIS systems. The majority of respondents had noticed the BDIS and found the screens easy to read and the information understandable. However, only 14% regarded the information as accurate and many passengers were reluctant to switch to BDIS from printed timetables. It is likely that the BDIS would have been more effective if the information provided was updated more regularly or in real-time (as shown in Barcelona), and this is planned for 2006.

4. **Services to improve PT-related information increased user satisfaction.**
   In ***Rome***, the ***improved multi-modal traveller service*** measure aimed to improve PT-related information using three main services: e-ticketing (PAGOBIT, formerly TELEPAY), the development of a telematic platform to deliver information via mobile phones, and the internet accessible tool (INFOPOINT). All were successfully implemented (see measures 11.1.1 – 11.1.3, respectively). Regarding PAGOBIT, 95% of the users were satisfied with the service, and 97% stated that they would recommend it. The main advantages of the system were time savings and 24h-availability. About 300 tickets were sold everyday via mobile phone and the number of visitors accessing the webpage hosting INFOPOINT increased by 30%. The user-friendliness of the INFOPOINT services was crucial for the success of the measure. Indeed, users can now take advantage of the information offered by the INFOPOINT through a wide range of devices such as pc, mobile phones, PDA, and information kiosks.

5. **The "*Improved Network Management*" measure was successfully implemented.**
   In ***Rome***, the "Improved Network Management" measure was sub-divided into ***information*** and ***environment*** (see measures 11.2.1 and 11.2.2). The ***information*** applications concerned the implementation of the "OCTOPLUS" (AVM on tram vehicles) and the AVL project that provided information displayed via electronic bus stop signs along the "express bus" line n.60. The most important aspect was the increased level of control over the service level provided and the information that can be provided to the PT users. Even though the AVL on the express line n. 60 was a trial based on the application of the GPS/On-Board Units - OBU technology, the whole bus fleet was equipped with the devices and the 12 depots wired accordingly. This enabled the monitoring of 189 bus routes.

   The ***environment*** application concerned the environmental analysis of Traffic Demand Management Strategies (TDMS) with mapping of the air pollutant concentration levels using a suite of simulation models. In addition, additional field measuring activities were undertaken using a mobile laboratory (a

"floating van") to collect data on driving patterns and relevant speed profiles along specific routes, and also to acquire local concentration levels of the more critical air pollutants. Within MIRACLES, the Traffic Environmental Model Chain (TEMC) model was developed, implemented and validated. Prior to MIRACLES, measurements of CO, particulates and benzene emissions occurred only once a year, but the application of the TEMC model means that pollution is now measured once an hour based on pollutant dispersion maps. A general "traffic index" was also developed to enable assessment of city congestion levels and the classification of weekdays according to traffic indicator values. It was considered that the one-off MIRACLES trial provided clear and positive indirect benefits to the community and it was recommended that both sub-tasks should become systematic features of overall urban management.

7.7.2 Process Evaluation / Lessons Learned

6. **A marketing campaign is required to promote the wider use of Park by Phone.**
   The implementation schedule for the ***Park by Phone*** scheme in ***Cork*** was very ambitious and did not fully take into account the time required to enact legislation changes and overcome technological issues. By the end of 2005, less than 35% of those Cork motorists who received registration packs had registered, although it is hoped that the numbers of users will rise in response to the multi-media marketing campaign developed by the Park by Phone consortium. This includes press-releases to newspapers and newsletters, local radio advertisements and dissemination of Park by Phone information leaflets. As of February 2006, the market share of Park by Phone stood at 1.5%, and Cork City Council are confident this will increase to between 5% and 7% by the end of 2006.

7. **It is important to maintaining a good working relationship with those involved in implementing a new system such as Park by Phone.**
   Initially, the traffic wardens in ***Cork*** were concerned about the impact of the ***Park by Phone*** working procedures on their terms and conditions of employment. However, their concerns were alleviated once it had clearly been explained how the enforcement of phone-based parking fitted into their normal duties. Indeed, the handheld computers resulted in many significant improvements; it allowed the launch of web and automated phone based payment systems for parking tickets, as well as the instant upload of a parking fine notification to the system. (It had previously taken up to four weeks for a ticket to be entered onto the computer system manually). 30% of all parking fines are now paid through one of the two automated systems. It was also found the ticket printers used by the wardens to enforce the system had to be upgraded to optimise the efficiency of printing tickets in rainy conditions.

8. **The location of information systems on third-party land or property can cause significant delays to their installation.**
   The main objective of the ***improved network management*** measure in ***Winchester*** was to use an Automatic Number Plate Recognition (ANPR) system to collect real-time journey times on radial routes into the city centre and then disseminate this to travellers using Variable Message Signs (VMS)

and the ROMANSE website (see measure 11.2). However, implementation of this measure did not happen smoothly, and delays particularly occurred when equipment was sited on third-party land or property. For example, the siting of ANPR cameras in a historical city such as Winchester proved difficult since the camera locations were partly chosen to minimise visual intrusion. Similar installation problems were faced in measure 11.1: installation of the fourth information kiosk at the railway station was delayed, as were the three IDUs (Information Display Units) sited at the local authorities and the hospital to provide employees with the real-time information available on the ROMANSE website.

9. **There is a need to develop a standardised decision support system using integrated data sources to compare the effects of various measures, and to disseminate the findings effectively to the public.**
   In ***Rome***, a number of lessons were learned from the simulation modelling of Traffic Demand Management Strategies (***TDMS***). There is a general lack of information regarding the quality of the models currently being used, and a primary step is for all involved parties to define a standardised working model, including the integration of traffic data with air quality, noise and safety aspects. There is a particular need to improve emissions factors for air pollution caused by urban traffic since they are currently based upon EU-standardised test-cycles, which are not always representative of urban traffic characterised by "stop-and-go" driving and cold catalysts. The development of such a model would then enable various traffic measures (such as speed control or vehicle restrictions) to be developed, their potential effects evaluated, and action plans stored within a decision support system. There is also a need to develop effective public information approaches regarding the impact of noise and air pollution caused by urban traffic. Such information may be disseminated via a website or by the media, and may include recommendations on preferred public response to it.

10. **It is important to overcome the local field of application to achieve more benefits.**
    From the PAGOBIT trial in ***Rome***, it was found that information based on mobile communication needs to operate on a larger scale before benefits from integrated information systems can be achieved. For Rome, this means overcoming the local financial and legal barriers that prevent such a service from entering the mobile communications market at a European level, and so enabling improvements and better customisation to be achieved.

11. **Public perception of telematics-based measures is tangible, especially for products that are innovative.**
    In ***Rome*****,** telematics measures were readily appreciated by the citizens, as demonstrated by the overall satisfaction rate of 3.72 (on a 1 – 5 Lickert scale), which meant tit was the measure with the second highest rating. Even though such success was partly attributable to the measure not limiting an individual's personal freedom, it is undeniable that, in the local experience, "innovation" was a key feature in contributing to such assessment. Indeed, most of the telematic-based measures were implemented for the first time or enhanced during MIRACLES.

7.7.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.7.

WP11: Integration of Transport Management Systems		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	Not considered.	No up-scaling was undertaken because some measures (e.g. INFOPOINT and PAGOBIT) were already implemented at city level; the trial results of some other measures could prompt administrators to enlarge the implementation.
Winchester	Not considered.	No up-scaling was undertaken since the kiosks, BDIS, VMS and ANPR were all already located in strategic citywide locations.
Cork	Not considered.	Geographical coverage of the Park by Phone scheme will be expanded. The region currently encompasses 60 streets, but this will triple in size by spring 2006.

Table 7.7: Summary of business as usual and up-scaling scenarios for WP11

7.8 WP12: Clean Public and Private Fleets

The clean vehicle fleet demonstrations were generally popular with the users and, at a localised level, emission reductions were estimated. In several cases, the CIVITAS funding, combined with strategic investments by other stakeholders, led to radical implementations that contributed to significant reductions in pollutant emissions from city bus fleets. In some instances, the innovative nature of the applications meant that several were affected by technical problems.

7.8.1 Impact Evaluation

1. **The clean-up of the bus fleet reduced the bus emissions, and the size of reductions varies according to the reference case, but is generally small within the context of overall traffic emissions.**
   The ***cleaner vehicle bus*** measure in ***Winchester*** succeeded in reducing the emissions of 27 buses (of the fleet of 60 vehicles). A desktop study using a vehicle activity model estimated that, compared to the baseline, bus emissions of CO, HC, NO_x, PM and CO_2 along a key city centre street reduced by 44%, 42%, 26%, 53%, and 2%, respectively. However, when placed in the context of the overall traffic emissions, these reductions were small. It is acknowledged that a fairer comparison of buses and the rest of the vehicle fleet would have been based on emissions per passenger km, but it would be difficult to estimate a weighting for the 'freight mileage' to enable goods vehicles to be compared to non-goods vehicles. Decreases in the proportion of NO_x and PM emissions from buses had the most noticeable impact.

   In ***Barcelona***, the ***extension of the CNG bus fleet*** integrated Compressed Natural Gas (CNG) buses into the public transport fleet of the main bus

operator (see measure 12.3). Substantial savings in pollutant emissions were estimated based on measures of fuel consumption and emission models. For the initial batch of 70 CNG buses, reductions of polluting emissions (CO, HC, NOx, particulates) of between 82% and 98% were calculated (based on fuel consumption measurements and CORINAIR emissions models, and these sizeable savings were achieved with respect to the replaced EURO 1 diesel buses). Emissions from the initial batch of 70 CNG buses were reduced by about 7%. This equated to monthly decreases in CO of 4.8 tonnes, HC of 1.2 tonnes and NO_x of 7.3 tonnes. However, CNG buses consumed more energy compared to a standard diesel bus, especially on hilly routes where the fuel consumption increased by about 50%. This varied according to the model being trialled, and it was therefore recommended that the model with the weaker performance was allocated to flatter service routes. Other impacts concern the implemented infrastructure improvements and these made important contributions to the overall satisfactory CNG bus fleet operation (refuelling of a standard 11m bus within 3 minutes, reduced maintenance costs associated with special-purpose workshops).

2. **Trials of the alternatively powered buses were popular with the public, although they are significantly more expensive than standard buses.**
   In ***Winchester***, a secondary aim of the ***cleaner vehicle bus*** measure was to introduce the public to different vehicle fuel types by demonstrating a diesel/electric hybrid bus along the P&R route (see measure 12.1). Surveys found that 63% of passengers perceived that the hybrid bus was more comfortable than the usual P&R bus (Euro II with CRT) and 81% thought it was quieter. However, a few commented that the smaller size of the hybrid bus could cause overcrowding and that the whining noise on one of the buses was discomforting. 24% stated that the permanent introduction of such a hybrid bus would make them use the P&R service more frequently. The benefits of hybrid buses (compared to standard buses) in terms of their emissions, noise levels and comfort should be balanced against their increased cost.

   In ***Barcelona,*** user acceptance surveys showed high levels of CNG bus acceptance in terms of lower pollution levels, less smell from fumes, and reduced noise (see measure 12.3). Different models of bus varied in popularity between different types of user (drivers and passengers).

   In ***Rome***, the ***clean bus measure*** (electric buses and new generation trolley buses) was popular among the public. Awareness of the need to use clean transit increased from 53% to 76%, and satisfaction increased from 3.6 to 3.96 (1-5 Lickert scale) thereby being the most “satisfactory measure” within the Rome MIRACLES applications.

3. **Re-powering older city centre buses is a cost-effective and efficient way of reducing their pollutants.**
   The objective of the ***cleaner vehicle bus*** measure was to reduce the environmental impact of the bus fleet owned by the main operator in ***Winchester*** (see measure 12.1). In addition to the purchase of 13 new Euro III buses, 10 buses were re-powered from Euro I to Euro III standard and four Euro II buses on the Park & Ride (P&R) route were fitted with Continuous Regenerative Traps (CRTs). The re-powering of the older buses to a higher Euro emissions standard was considered to have been a cost-effective and

energy efficient way of reducing their pollutants. However, for the slightly newer Euro II buses, it was less expensive to fit CRTs than to re-power to Euro III standard, and even resulted in lower emission factors (apart from NO_x).

The cleaner bus fleet meant that maintenance costs decreased by 60%, although fuel consumption of the new buses increased (from about 10 mpg to 7.5 mpg) because they were one tonne heavier and used only in the city centre area. For those buses that were re-powered to Euro III standard, fuel consumption remained constant. The percentage of 'lost miles' (due to vehicle breakdown) for the overall bus fleet decreased from 0.07% to 0.06% during the project. This was partly due to the introduction of the 13 new Euro III buses which were seen by the operator as far more reliable with less likelihood of overheating.

4. **The rapeseed-fuelled clean vehicles were not initially popular with the drivers.**
   Within the ***clean vehicles*** measure in ***Cork***, 17 council-owned diesel-engine vehicles were converted to permit the use of rapeseed oil as an alternative fuel (see measure 12.2). Driver surveys and focus groups found that the acceptance of the measure was "negative" to "neutral" at the beginning of the project due to initial problems. The chief concerns raised related to the possible health impacts on drivers, extra visible smoke, exhaust smell, power losses, and concerns that the converted vehicles were more likely to cut out abruptly. Upon investigation, it was found that some of the vehicles required an oil filter change, and adjustments to the idle speed and injectors. The drivers initially recommended the use of a mix blend (of diesel and rapeseed oil) which, in their opinion, produced better power and an improved smell (a mixture of 25% diesel and 75% rapeseed oil was considered to be optimum). By November 2005 pure rapeseed oil was being used, and the driver opinions had improved. Involvement of the drivers throughout the process was considered essential and it was vital to explain the advantages and disadvantages of the scheme to any drivers involved in the trials.

5. **Cleaner municipal fleet vehicles resulted in modest emission reductions.**
   In ***Winchester***, the ***cleaner municipal fleets*** measure involved the purchase of 27 new Euro IV diesel vehicles for the Hampshire County Council (HCC) company car fleet (see measure 12.2). As a result of using these clean vehicles, a 2.3% reduction in CO_2 per vehicle was estimated. This reduction was small since they were derived from a comparison with Euro III vehicles (which HCC would have purchased instead). Companies with older vehicles (e.g. pre-Euro, Euro I or Euro II) would see greater reductions in emissions and fuel costs.

   In ***Rome*** the renovation of the bus fleet (currently, just 12% of vehicles are still Euro 0 or 1) can be considered one of the main drivers to the achievement of the reduction of transport-related emissions. Ex-post surveys within the Rail Road area found reductions of 28% for dust, 15% for VOC, 16% for NOx and 18% for CO emissions. In addition, energy consumption was reduced as a consequence of the fleet renewal. For example, for trolleybuses, "energy efficiency" reduced from 0.1 MJ/pkm to 0.08 MJ/pkm, and "vehicle efficiency" reduced from 3.8 MJ/pkm to 3.3 MJ/vkm. For e-buses,

the vehicle efficiency indicator also reduced, but energy efficiency increased by 0.2 MJ/pkm. This was attributed to the modest capacity of each electric bus, just 27 passengers, with the small bus size being necessary to access the narrow city centre streets.

6. **The loan of a clean vehicle proved popular with local businesses.**
   Within the ***clean fuel support services*** measure, participating businesses in ***Winchester*** were loaned a clean vehicle (either a LPG/petrol dual-fuel, a petrol/electric hybrid or a battery electric vehicle) for a period of up to one month (see measure 12.3). Prior to the trial, each business was asked which factors would influence their decision to purchase a clean vehicle. The three most important factors cited were operating costs, reliability and purchase cost. After the trials, 82% of respondents rated the trial vehicle as generally good, 55% thought it was generally better than their usual fleet vehicle, and 65% stated that they were likely to purchase a clean vehicle in the future for business use. However, the respondents perceived some performance aspects (acceleration, road handling in the wet, and availability and ease of refuelling) of the clean vehicle as being worse than their usual fleet vehicle. Follow-up interviews later found that one business had actually purchased a clean vehicle and three businesses stated that an employee had bought one for private use. (In all cases, the trial had been a major influence). In addition, 11 businesses stated that they would purchase a clean vehicle in the future.

7. **An analysis of the vehicle trial data estimated significant reductions in emissions and energy for clean vehicle types.**
   The vehicle trial data collected within the ***clean fuel support services*** measure in ***Winchester*** was analysed (see measure 12.3). A comparison with the corresponding data if the usual business vehicle had been used estimated significant reductions in emissions and energy for all three clean vehicle types. The battery powered electric vehicles resulted in emission, energy and fuel cost reductions of 100%. However, such vehicles are about £5,500 more expensive than a similar petrol vehicle and they require a £10,000 battery every 5-8 years. The petrol hybrid vehicles and LPG/petrol dual fuel vehicles provided average fuel cost savings of about 40% and 20%, respectively.

8. **The rental fleet of electric scooters was a niche measure and barely affected the overall pollution rate or modal split.**
   In ***Rome***, the aim of the ***clean fuel support*** measure was to better manage the rental fleet of nearly 400 electric scooters, thereby reducing the pollution caused by the increasing use of conventional motorcycles (see measure 12.3). About half the scooters were used by the Municipality and the remainder were transferred or donated to non-profit organizations. In addition, a set of recharging points was located in the Laboratory Area. In quantitative terms, this was only a “niche” measure since the fleet of e-scooters only represented approximately 0.001 of the powered two-wheelers in Rome. Hence, the contribution to the reduction of the overall pollution rate was modest and hardly affected the modal split.

9. **The clean buses were shown to be less noisy than the older buses.**
   In ***Rome***, the ***clean bus*** measure involved the renewal of the bus fleet, including the purchase of 908 Euro III buses, 30 “new generation” bi-modal trolleybuses, and 10 electric buses (see measure 12.1). As of late 2005, 38%

of the bus fleet was composed of new, eco-compatible vehicles, lowering the average age of the fleet (from 12 to 6.9 years). The old generation of buses was noisy and an important improvement concerned noise reduction. A survey monitored traffic noise before and after the implementation of trolleybuses. Even though the "white noise" (i.e., the combination of all the sounds of all different frequencies in that given urban environment) was very high, a Euro 0 bus (i.e. an old-style bus) passing by increased such noise by about 10 dB(A), whereas a trolleybus only led to an increase of about 5 dB(A). This result was especially striking given that dB(A)s are measured according to a logarithmic scale. However, other factors also contributed to the noise reduction, including a change of the road surface from block pavement to asphalt and/or concrete.

10. **By implementing special-purpose maintenance workshops, the CNG bus maintenance costs were minimised, and economic performance improved.**
In ***Barcelona***, ***CNG buses*** had lower operating costs (due to new maintenance workshops and lower maintenance costs, plus fuel cost parity under the strategic partnership) compared to the diesel buses being replaced (see measure 12.3). It was calculated that the higher investment cost in bus acquisition could be recovered within 5 years.

7.8.2 Process Evaluation / Lessons Learned

11. **The conversion process of clean vehicles is often untried, and technical difficulties can be experienced.**
In ***Cork***, the conversion process (from diesel to rapeseed) of the ***clean vehicles*** measure was initially technically complex (see measure 12.2). The conversion was eventually considered generally successful, although there were some initial difficulties. For example, technical problems relating to the cold starting of engines and gauze filter problems were experienced, and one vehicle had to have its conversion reversed due to the position of the engine. However, the reliability of the converted vehicles increased following modifications, and Cork City Council intends to continue the use of bio-fuel. The Council is also going to experiment with the use of bio-diesel. Valuable insights were gained which will be of use to any city contemplating a similar project.

In ***Winchester***, the 13 Euro III buses purchased within the cleaner vehicle bus measure were to be fitted with Selected Catalytic Reduction (SCR) (See measure 12.1). However, this was an untried process and technical problems with the conversion of the first vehicle resulted in the programme being delayed, although it is still anticipated that SCR conversions of all 13 vehicles will occur during 2006. For any bus operator wishing to clean up their bus fleet, the lowest cost option is to re-power, but in some situations (i.e. when a new Euro standard is imminent) it may be more cost-effective in the longer term to purchase a new vehicle whose engine is compliant with the more recent emissions standard.

12. **A strategic partnership with a utility provider proved to be a good way of extending CNG bus fleets, although there is still a high economic cost of investment and other bus technologies are also improving.**
In ***Barcelona***, the ***extension of the CNG bus fleet*** yielded positive results that justified the effort made in establishing the strategic partnership with the utility provider. With the gas supplier subsidising fuel costs in the initial years, the main barrier concerned the high economic cost of investment required to set up the refuelling and maintenance infrastructure as well as the acquisition of more expensive vehicles. However, the CNG buses had lower operating costs than diesel buses and the investment cost was estimated to be recovered within five years. Indeed, the economic performance could be further enhanced if values are attributed to the environmental benefits of reduced pollution and noise. The fleet of CNG buses has already been expanded to 160 buses (including 50 18m articulated buses with improved energy performance – not available at the first phase of bus procurement) and is expected to be further extended to 250 vehicles before the end of 2007.

13. **Emissions testing of the converted vehicles proved difficult and unreliable.**
In Cork, emission test results concerning the vehicles converted to rapeseed were difficult to quantify and the tests were not considered to be reliable. Control tests questioned the reliability of the "start-up emissions" test results because during equipment initialisation, pure air sometimes tested higher in pollutants than exhaust fumes. More reliable tests could only be undertaken by the vehicle manufacturers.

14. **For the use of bio-fuel to be sustainable, political support is essential to ensure that the cost of the fuel is competitive with fossil fuels.**
At an early stage of the project, ***Cork*** City Council raised concerns about the running costs of the converted vehicles since the alternative fuel was 33% more expensive than diesel, and a case for a tax reduction on this type of CO_2 was submitted. The issue of bio-fuel taxation was raised at various discussions in the Irish parliament and in early 2004, the Finance Act was amended to allow for an exemption on the use of rapeseed in certain projects. By then it cost about 50% more than diesel. Accordingly, Cork City Council supported the fuel supplier's application for permission to sell duty-free rapeseed oil as a vehicle fuel.

15. **Businesses were reluctant to commit to the purchase of a clean vehicle.**
Although the participating ***Winchester*** businesses appreciated the loan of a clean vehicle as part of the ***clean fuel support services*** measure, they were reluctant to commit themselves to actually purchasing such a vehicle. The perceived higher purchase cost and unproven technology associated with a cleaner vehicle, together with a limited range of models, was off-putting for many companies. In addition, the lack of refuelling places for LPG and electric vehicles is still a deterrent to more widespread use of such vehicles. However, businesses tend to renew their company vehicles at cycles of several years, and so it is likely that the effects of the trial in encouraging businesses to purchase clean vehicles may not be evident in the short-term.

16. **Take-up of the Motorvate scheme was low.**
    Within the ***cleaner municipal fleets*** measure in ***Winchester***, HCC joined Transport Energy's "Motorvate" scheme to receive recommendations in reducing unnecessary business mileage and carbon dioxide emissions (see measure 12.2). It was hoped that other companies in Hampshire would follow HCC's example, but no others joined the scheme. This was partly attributed to the high subscription cost and the lack of promotional material e.g. the Motorvate website was unavailable for several months while it was being re-designed. In addition, the benefits of subscribing to such a scheme would likely only have a limited time-span. Although HCC set a good example in cleaning up its company fleet of vehicles, a more pro-active approach is necessary to encourage other companies to follow.

17. **The limited range of the batteries casts doubt on the large-scale implementation of electric scooters.**
    In ***Rome***, users were generally satisfied with the e-scooters, but complained about the limited range of the batteries. Indeed, this represented the largest barrier to the implementation of e-scooters, which casts doubt on the possibility of implementing these vehicles on a wider scale. Another difficulty was the implementation of the on-street recharging stations because of the poor supply of such items on the market.

18. **Initiatives such as electric scooters should be implemented in conjunction with promotional campaigns.**
    In Rome, the benefits of electric vehicles were advertised by dedicated campaigns and funds were allocated to provide incentives to people to purchase e-bicycles, e-scooters and electric vehicles. Despite this, response was slow and such modes of travel were regarded with caution. A key challenge is to implement such initiatives in synergy with more in-depth educational campaigns, so as to involve citizens in local policies. The e-scooter measure was a typical example of an initiative applied in a context where the majority of users were still strongly convinced that their private cars were the only available option for all types of trips, and that any alternative should generate the same performance as their own vehicle.

19. **Other bus technologies are improving and some of the CNG bus emission results are dependent upon the sustained performance of catalysers. Further evaluation is recommended.**
    Progress is being made concerning the direct measurement of emissions during bus operation. These techniques are particularly useful for evaluating the continued performance of vehicles using catalysers, but can also be applied to evaluate vehicle types that were not available at the time of demonstration in MIRACLES (e.g. the 18m articulated bus vehicles, recently acquired in Barcelona).

7.8.3 Context / Scaling

A summary of the business as usual and up-scaling scenarios is shown in Table 6.8.

WP12: Clean Public and Private Fleets		
City	**Business as usual scenario**	**Up-scaling scenario**
Rome	*Clean vehicle bus*: compared to baseline, predictions were: • decrease in emissions of CO and particulates of about 40%; • no change in noise levels. *Clean fuel support services*: not considered.	*Clean vehicle bus*: it is planned to increase the number of trolley lines and to implement new lines for electric buses beyond the current LTZ system. In addition, the Municipality of Rome will continue the clean vehicles strategies with the forthcoming introduction of CNG buses. *Clean fuel support services*: not considered.
Winchester	*Clean vehicle bus*: compared to baseline, predictions were: • increase in operating revenue of 8% - 19% (c.f. 12% - 46% in 'after' scenario); • increase in labour cost of 19% (c.f. 19% in 'after' scenario); • no change in maintenance cost (c.f. 60% reduction for new buses in 'after' scenario); • no change in vehicle fuel efficiency (c.f. reduction of about 25% for new vehicles in 'after' scenario); • no change in vehicle reliability (c.f. improvement of about 15% in 'after' scenario).	*Clean vehicle bus*: a desktop study using a vehicle activity model estimated that, compared to the baseline, bus emissions of CO, HC, NO_x, PM and CO_2 along a key city centre street reduced by 44%, 42%, 26%, 53%, and 2%, respectively. If all buses passing through this street had been replaced by Euro III vehicles, the model estimated a small increase in CO, HC and PM (because Euro II + CRT results in lower emission factors for CO, HC, PM and CO_2 than a Euro III bus) and a decrease in NO_x. If all buses passing through this street had been replaced by Euro IV vehicles, the model estimated reductions in all pollutants i.e. CO (-19%), HC (-29%), NO_x (-36%), PM (-76%), and CO_2 (-1.5%).
	Cleaner municipal fleets: not considered.	*Cleaner municipal fleets*: not considered since no other company followed HCC's example by replacing their company fleet with cleaner vehicles or by joining Motorvate.
	Clean fuel support services: not considered.	*Clean fuel support services*: not considered since only a limited trial.
Barcelona	Not considered.	The test fleet of 70 CNG buses is in process of expansion to 250 vehicles. An up-scaling study estimated that this would lead to a 23% reduction in emissions (compared to the baseline).
Cork	Compared to baseline, predictions were: • increase of about 30% in the cost of diesel.	Continuation of use of rapeseed oil and investigation into use of bio-diesel.

Table 7.8: Summary of business as usual and up-scaling scenarios for WP12

7.9 City-Level Results

Economy

In general, it was difficult to draw unequivocal conclusions because of the large number of MIRACLES measures and their different grades of implementation. In ***Rome***, the objective was to assess operating / maintenance costs of the MIRACLES measures per capita, and a value of just less than 1 Euro per inhabitant was estimated. For many measures, the benefits increased as the scale of implementation grew. This was especially so for administrators who can save resources and increase incomes by enlarging the small-scale MIRACLES implementations. Conversely, the value of 1 Euro per person may represent a limit for the feasibility of further measures: any intervention more expensive than this could be assumed to be affordable only if it achieved added value.

In ***Winchester***, there was no evidence that the MIRACLES measures influenced the number of employees or accommodation bookings, although bus company revenues did increase. This was partly attributable to the MIRACLES improvements made to the quality and information of the services, but an increase in fare rises, frequency (of one service) and lower maintenance costs were also partly responsible.

In ***Barcelona***, patronage of the tramway doubled during the first 18 months of operation. In addition, the supermarket operator's investment in quieter vehicles and unloading methods achieved operational savings estimated to lead to an investment return within three years. Regarding the access restriction measure, it was considered that ANPR technology (if fully implemented) will reduce the maintenance costs associated with the traditional bollard technology.

In ***Cork***, it was considered that the MIRACLES measures definitely aided the city economy regarding business, tourism and travel, although any economic benefits were difficult to quantify in isolation from parallel projects such as the City of Culture 2005 and Green Routes (quality bus corridors). MIRACLES acted as a catalyst for advancing the implementation of planned major city improvements such as the successful redesign of St Patrick's Street and the construction of the new Park and Ride facility, and to promote inner city shopping and tourism. For instance, there were significant increases in the number of pedestrians using St. Patrick's Street and the numbers of tourists visiting Cork.

Energy

It was again difficult to provide incontrovertible evidence that MIRACLES resulted in a city-wide energy reduction at any of the sites. In ***Rome***, although fuel consumption decreased during the project timescale, this was largely as a result of other parallel measures such as the general renewal of the private car fleet supported by national policies and by local emergency measures. Incentives were provided by the state for scrapping old cars and replacing them with new ones that were less polluting and more energy efficient.

In ***Winchester***, fuel sales from one filling station showed increases in the proportions of diesel and LPG sold, but LPG sales still only represented about 3% of total fuel sales. It seems that the public is still reluctant to purchase an LPG vehicle (or convert their existing vehicle). This may be because of the high conversion cost, but other potential factors may be perceived limitations with the technology, and the small number of petrol stations that currently sell the fuel.

In ***Barcelona***, an 18% shift from car to tramway was estimated to represent annual savings of between 57,000 to 163,000 litres of fuel. Regarding the extension of the CNG bus fleet, the standard CNG buses consumed more energy than the diesel reference, but this was not so apparent when the articulated longer CNG buses were used.

In ***Cork***, the use of alternative fuels such as rapeseed oil was demonstrated to be feasible for Cork City Council. 7% of the fleet were converted, and the council intends to continue using alternative fuels and expanding the clean fleet post-MIRACLES. Sustainable commuting was further encouraged through the other MIRACLES measures which promoted cycling, walking, Park and Ride and car-pooling. Park and Ride was very successful while car pooling was not; it was found that people preferred to organise private car sharing arrangements.

Environment

In ***Rome***, the environmental objectives were to improve air quality, reduce noise levels in the city centre, reduce the number of polluting vehicles, and reduce vehicle emissions. All goals were considered to have been met. For instance, CO emissions reduced by about 76%, particulates and C6H6 emissions by 38%, and the numbers of non-catalysed vehicles by about 40%. Although this was partly attributable to a renewal in the circulating private car fleet, it was considered that the whole package of MIRACLES measures also had some effect. Of particular relevance was the access restriction measure, which permitted only clean, catalyzed private vehicles to enter the central areas, along with enforcement of the extension of the yearly inspection of vehicle emissions and of compulsory servicing of motorcycles and mopeds. In addition, the purchase of about 1000 clean buses contributed to the improved environmental conditions. It was recommended that for even greater benefits, all the wide-implementation measures need to be even more widely applied, both in terms of enlarging the implementation area and in improving the relevant control and enforcement procedures.

In ***Winchester***, air pollution levels are greatly affected by weather conditions, which meant that any reductions due to MIRACLES were very difficult to measure. The city centre has a problem with the levels of NO_x, and it is likely that this could be improved if the number of high-polluting vehicles entering the city centre was reduced. There was no evidence that the MIRACLES measures changed people's perceived views regarding air quality or road traffic noise in Winchester city centre during the period of the project, but as a result of the project they are more aware of the issues involved.

In ***Barcelona***, substantial reductions in pollutant emissions were reported for the CNG bus fleet, and their quieter performance was highly valued. The Rambla access control implementation was calculated to reduce pedestrian delays (when crossing the vehicle traffic) by 15 hours per day.

In ***Cork***, the traffic levels through the access-restricted zone reduced by 3%. The combination of the Clean Zone, Park and Ride service, increase in cycle facilities (from 8 to 316 cycle stands) in the city centre and awareness raising activities of sustainable transport all aided in the improvement of the city environment. Public perception of air and noise pollution in the city centre also improved, which should make the city centre safer and more attractive to pedestrians thereby promoting inner city shopping and tourism.

Society

An objective of all the cities was to increase awareness of the MIRACLES measures and support for sustainable transport in general. This objective was met: for instance, all cities reported significant increases in awareness of the MIRACLES and CIVITAS logos (as reported within the relevant Measure Level templates), although the numbers were still relatively small (typically 15-20% of the ex-post survey sample). There were higher levels of awareness of the individual measures. For example, in ***Cork***, the number of respondents aware of one, two, or three MIRACLES measures, was 28%, 30% and 19%, respectively. In general, the public were very satisfied with the MIRACLES measures as evidenced by the high level of satisfaction expressed in the specific measure surveys.

However, it is important to note that awareness and (stated preference) acceptance of an initiative does not necessarily influence travel behaviour. There is a huge difference between accepting the objectives of an initiative and for that individual then prepared to change travel behaviour as a result. For instance, in ***Winchester***, 71% of the public supported the broad objective of MIRACLES to promote and influence travel by sustainable transport, but only about 25% used a mode of sustainable transport on a daily basis.

There was also evidence from parallel initiatives (e.g. the Winchester Movement and Access Plan, which has been ongoing since 1995) that awareness of sustainable transport issues should increase still further in the longer term. In Winchester, there was little evidence that the MIRACLES measures had affected broad transport issues such as ease of access to city centre or road safety (for non-car modes). In addition, broader societal issues such as public perception of security or crime rates / types in the city centre were not influenced by MIRACLES.

Diverse methods were employed to promote sustainable transport options including demonstration days, cycle safety training, advertisements, competitions, leaflets, posters, website promotion etc. It was generally found that a mixture of methods was best at reaching a range of different audiences. For instance, in ***Cork***, advertising and a prolonged media campaign for many measures (particularly Park and Ride) along with the integration of MIRACLES with existing sustainable transport promoting activities increased awareness and acceptance. In ***Winchester***, there was some indication that events such as demonstration days with a high visual presence resulted in the highest levels of awareness.

Cork reported that the MIRACLES measures encouraged a modal shift from the car through traffic and lane restrictions in the city centre, Park and Ride provision, cycle facilities, publicity campaigns, etc. In Winchester, compared to the baseline survey, a significantly higher proportion of respondents in the ex-post survey rated it easy to travel to Winchester city centre using the Park & Ride service.

In ***Rome***, the survey respondents were grouped into five clusters of citizens regarding their perception of the mobility situation. These clusters were control, confidence, mistrust, anarchy and efficiency. The proportion of ex-post citizens within the “control” category reduced significantly from the baseline sample, while the proportion of people within the “anarchy” cluster increased. This was attributed to the introduction of the “non-popular” measures such as paying for car parking. Indeed, a main finding from the before and after data comparison was that the most successful measures were those which benefited everyone (e.g. the use of public transport or

telematics), and do not limit an individual's personal freedom and ability to use private cars. Indeed, it was recommended that the more restrictive a measure, the greater the communication required by the stakeholder to promote the potential benefits of sustainability and over-ride the traditionally strong car-based culture of Rome. A future issue to consider is whether the approach taken to discourage the use of private cars at a political level should be based on restrictions, as currently applied, or in supporting more popular incentives to attract passengers to transit.

Of the ***Barcelona*** implemented measures, the CNG bus was rated the highest and the tramway the lowest (possibly because the city-wide survey was undertaken at a time when the tramway was still under construction).

Transport

The MIRACLES measures had negligible transport impacts at the city-wide level. For instance, in ***Winchester***, although was a significant reduction of 16% at Bar End / Chesil Street due to the opening of the extended P&R, the overall traffic flows were not significantly reduced on the arterial roads. In addition, journey speeds along five arterial roads did not change appreciably during the project timescale. There was an encouraging significant reduction of 10% in the number of ex-post residents stating that they used their car for their daily commute to the city centre. The results again generally imply that although the public are aware and accept the MIRACLES measures, this does not necessarily translate into positive impacts on the transport network. However, it should be borne in mind that, for many of the measures, the demonstration period was relatively short, and quantifiable transport impacts may only become apparent in the longer term. Traffic flow within the Rome LTZ (during periods of free access) reduced by 25% during 2001-05. There were also safety benefits in Rome, with the accident fatality rate reduced by almost 50%.

In ***Cork***, the reduction in lane capacity of St. Patrick's Street from four to two lanes and the expansion of the Clean Zone aided in creating a safer environment for vulnerable road users and pedestrians, although the modal split will not be available until the 2006 Census information is published. However, the number of pedestrians in the Clean Zone increased (by 53% compared to the baseline), as did the number of cyclists (by 47% across the inner cordon), and so it is anticipated that there will be some alteration in modal split. In Winchester, the number of cycles parked in the city centre increased by 46% during MIRACLES, but cycle flows on the arterials decreased by 12%. In Rome, data from the Rail Ring Area (where all the measures were implemented) showed that there had been a decrease of 5% in use of private cars, with a 3% increase in walking and a 1% increase in public transport. This effect was mainly attributed to the access restriction measure, although other "niche" measures also contributed.

Encouragingly, compared to the baseline results, ***Winchester*** residents among the ex-post questionnaire survey respondents were significantly more likely to state that they walked or cycled to the city centre, and less likely to travel by car. In Cork, City Council employees changed towards more sustainable modes of transport during the course of MIRACLES, but it proved difficult to persuade people to participate in the car pooling scheme, and parking restrictions were found to be far more effective. Other cities wishing to promote sustainable mobility management should place a heavy emphasis on promoting sustainable mobility before and during the establishment of formal schemes to support sustainable commuting. These campaigns should be highly visible and use a variety of media. It is important to

emphasise the environmental, social and financial benefits of switching to more sustainable modes of transport.

In both ***Cork*** and ***Winchester***, the Park and Ride services were regarded as being very effective. In Cork, it was originally planned to provide 450 spaces at the Blackash Park and Ride, but in fact more than 900 spaces were provided. By November 2005, there were an average of 500 users per day, and this more than doubled during the pre-Christmas period. Public satisfaction levels with the Park and Ride service were very high: 82% rated the service as very good, and the remaining 18% rated it as good or satisfactory. In Winchester, the extension of the St Catherine's Park and Ride car park by 420 spaces enabled ticket sales to increase by 43% during the lifetime of MIRACLES. One contributory factor was the associated parking charging policy, which also helped to deter city centre parking. Bus passenger satisfaction ratings increased by 4% during the MIRACLES timescale, and bus punctuality in the Winchester fleet improved.

In ***Rome***, the achievements that could be regarded as being the most successful (e.g. the reduction of private traffic flows and the increased space for pedestrians in the LTZ) mainly involved restrictive measures. However, this assessment was affected by the large scale implementation of measures and additional time is required to really assess the benefits of new forms of transit or use of telematics on the transport pattern. Such a requirement is also shared by the so-called "niche" measures, which were demonstrated successfully during the MIRACLES period and hence their implementation can be expanded, both in terms of area and in operating times.

In ***Barcelona***, the Traverssera de Gracia multi-use lane demonstrated peak bus priority, improved off-peak unloading and better traffic circulation, and there were indications that the provision of real-time information at bus stops helped to increase the number of passengers. Of the surveyed tramway passengers, 53% cited the higher speed as their main reason for using the tramway (followed by features of accessibility).

7.10 Concluding Comments

7.10.1 Evaluation Process

There was a fundamental difference in approach to the evaluation between METEOR and the sites. Both parties began the evaluation process at the same time, but the emphasis of the METEOR evaluation was on a top-down approach, with the objective of maintaining overall consistency in evaluation processes between CIVITAS sites, thereby enabling cross-site comparisons to be made. It proved difficult to reconcile this with the focus of the individual sites, which was on a bottom-up evaluation approach towards each measure.

Although the results reported by some measures were encouraging, for many measures, it was not possible to identify significant differences between the 'before' (i.e. baseline) and 'after' (i.e. ex-post) scenarios. In such situations, it was not possible or practical to identify the intermediate findings (such as the business as usual scenario), which were therefore regarded as being less relevant. In addition, there were significant misgivings about the methodology of the ITEMS model used to generate these results. Nevertheless, the sites had all expended a great deal of effort

and resource in collecting the requested data for the ITEMS scenario, but the resulting output was regarded as being of only limited value for the sites.

Another difficulty in interpreting the 'before' and 'after' effects related to the definition of the MIRACLES baseline scenario. For example, regarding the access restriction measures in Rome, a substantial amount of infrastructure had already been implemented prior to MIRACLES, and the additional effects of the MIRACLES applications were sometimes difficult to assess. In Barcelona, measure 7.5 was based on the implementation of the tramway, which occurred in parallel to the MIRACLES project, and the MIRACLES baseline case was difficult to define. In Winchester, the Winchester Movement and Access Plan (WMAP) had been initiated several years before MIRACLES commenced. Therefore, compared to other CIVITAS cities, a higher proportion of Winchester residents in the baseline scenario may have formerly been aware of sustainable transport issues.

In some cities, particularly in Rome, several measures had been installed and implemented concurrently, which meant it was not possible to sub-divide their combined effects in terms of specific individual measures. In other cases, it was sensible to measure 'global' indicators, such as reduced environmental pollution, at the city-wide level only. This also meant it was not possible to attribute the city-wide impacts to individual measures.

It should also be noted that, despite the 'common' templates and evaluation process devised by METEOR, there were still differences between the four sites, both in terms of the level of detail used in the completion of the templates and in the evaluation approach used. For example, Rome generally gave some very modest credence to the ex-ante evaluation results (obtained from the ITEMS model), and this lack of confidence was later supported by the measured effects often differing significantly from the predictions. Conversely, Winchester focused mainly on the ex-post results directly obtained from field measurements and questionnaire surveys.

There were some differences between sites, and even within sites in the cases where different partners compiled different templates, within the process of completing the templates. This process was perhaps not as prescriptive a process as anticipated by METEOR. For instance, there was some degree of subjectivity in assigning the information to the different headings, and different levels of detail and emphasis on specific indicators, were provided per measure. Overall, the process of reporting via templates was considered to be very useful and more consistency in approach was maintained between sites than by using a traditional Evaluation Report. The templates led to a flexible approach in completing the evaluation (e.g. templates could be completed for individual measures without having to wait for the later measures). However, the tabular format of the templates caused some formatting difficulties, and it is recommended that future use of templates avoid the use of tables.

7.10.2 Physical Measures

Some of the applications tested were innovative in nature and therefore, by definition, these had not previously been demonstrated in real-life scenarios. For example, in the "set-up of city centre clean zone" measure in Winchester, there were many technical problems with the roadside emissions monitoring equipment, a product that, until MIRACLES, had only been tested at the laboratory level and had been claimed

by the manufacturers to be working successfully. In addition, some measures had very ambitious targets, which were much too high and not realistic.

Perhaps the most critical factor influencing the success of a measure was a willingness to succeed at a local level. Many of the measures were dependent on the involvement of a third party and those with a higher level of interest (for instance, the local public transport operators), generally led to greater impacts. A political willingness to succeed was also crucial. For instance, the implementation of some of the Rome measures involving access restrictions were delayed until political acceptance had been finalised. In Winchester, in measure 6.2 ("adoption of flexible parking policies and environmentally linked parking charges"), drivers of vehicles within the lowest polluting categories were given substantial discounts on car parking fees. This only affected a small percentage of the vehicle fleet in Winchester, and there would have been greater impact if other vehicle bands had also been targeted. However, this would have resulted in some reduction for the local council in the total parking revenue generated, some of which is used to subsidise the Park and Ride sites, and illustrates the 'balancing' act that is needed to control the measure impacts at a city-wide level.

It should also be emphasised that many of the measures were only regarded as "niche" measures, with little impact on travel patterns. For instance, the collective taxi service in Rome served 100,000 passengers annually, compared to 873 million bus passengers. Similarly, the fleet of e-scooters only represented 0.001 of the entire fleet of two-wheeled vehicles in Rome.

7.10.3 Awareness Measures

Public awareness of the project and CIVITAS initiatives increased markedly throughout the project lifetime. For instance, in Cork, awareness of the CIVITAS initiative increased from 3% to 16%, while in Winchester, awareness of the CIVITAS and MIRACLES logos increased from 3% to 14%, and from 3% to 20%, respectively. Awareness of individual project initiatives varied between measures, but it seemed that the more successful promotional events were those with a high visual presence e.g. the demonstration days in Winchester (57% for Bike Week and 51% for Alternative Transport Day).

In a similar manner, public acceptance of a specific initiative varied according to the measure in question. Generally, people rated those measures that they perceived as being as a 'benefit' to them much higher than the more restrictive measures. For example, in Cork, 80% rated the widened footpaths on St Patrick's Street (measure 5.1) as better than before, and 83% rated the overall quality of the Park and Ride service (measure 7.3) as very good. In Rome, a key lesson learned was that the more car-restrictive a measure is (i.e. the more it limits a person's freedom to travel), the more effort is required by the stakeholder to communicate to the public the potential benefits of implementing such a measure. It was considered that this required a total revision of the measure implementation process with an increased need for communication and dissemination at all stages.

The majority of the awareness surveys used the stated preference approach, which indicates how respondents might behave in hypothetical scenarios. However, the main limitation of such an approach is that in a real-life situation, users may not necessarily respond in the way they stated. For example, subjects may not be able to perceive the differences in alternate trip scenarios (such as commuting or leisure

trips). In some situations, it may have been more useful to use revealed preference surveys, which indicate how travellers behave in real-life scenarios, but due to the late implementation of many of the MIRACLES measures, this was not always possible.

It is also important to note that awareness and (stated preference) acceptance of an initiative does not necessarily influence travel behaviour. For instance, in Winchester, 71% of the public agreed that it was important to travel by sustainable transport, but only about 25% actually used a sustainable transport mode on a daily basis.

7.10.4 Future Work

The implementation timescales for many of the MIRACLES measures were postponed beyond those originally foreseen at the start of the project. This was mainly due to the innovative nature of the schemes being trialled, with unexpected technical and/or political problems often arising. Consequently, the evaluation generally occurred much later in the project lifetime than initially planned, and the evaluation of some measures was based on only a few months, or even weeks, worth of data.

Some indicators originally proposed within D4.1 (Evaluation Plan) were superfluous. In some cases, this was because the iterative nature of the project meant that the implementation of the measures or even the design of the actual measure itself changed, which meant that the indicators identified in D4.1 were now redundant. In other cases, the data originally proposed to collect in D4.1 proved difficult to obtain in reality, or the process of collecting it changed during the project lifetime, which meant that it was not possible to directly compare the results year on year.

Although the majority of measured impacts did not change significantly in the short-term, it is likely that the effects of a project such as MIRACLES will become more significant in the longer-term. A potential strength of the project is that it proves to be a catalyst in raising awareness of issues among the general public now and perhaps influencing future actions, rather than in the public reacting to measures in the short-term. For example, within the ‘clean fuel support services’ measure in Winchester, a significant number of respondents said that the loan of a ‘green’ vehicle would influence their car purchase in future.

It is recommended that in future, the EC consider a process for longer-term evaluation. Terminating the evaluation now may have led to a lack of subtlety in the interpretation of findings. Encouragingly, almost all the measures implemented at the four cities will be continued in some way, and several will be expanded as a result of their success within MIRACLES.

8 GLOSSARY

ACS	Access Control System
AGS	Access Gate System
ANPR	Automatic Number-Pate Recognition
AQMA	Air Quality Management Area
AVM	Automatic Vehicle Monitoring
BAT	Best Available Technology
BDIS	Bus Departure Information Systems
BQP	Bus Quality Partnership
CCTV	Closed Circuit TeleVision
CLT	City-Level Template
CNG	Compressed Natural Gas
CPT	Collective Public Transport
CRT	Continuous Regenerative Trap
CZ	Clean Zone
EST	Energy Savings Trust
GIS	Geographic Information System
HCC	Hampshire County Council
HTM	Hampshire Transport Management
HTWP	Home-To-Work Plan
ICS	Index of Customer Satisfaction
IDU	Information Display Unit
LTZ	Limited Traffic Zone
LUTP	Local Urban Traffic Plan
METEOR	Monitoring and Evaluation of Transport and Energy Oriented Radical strategies for clean urban transport
MIRACLES	Multi Initiative for Rationalised Accessibility and Clean Liveable EnvironmentS
MLT	Measure-Level Template
OBU	On-Board Unit
OD	Origin-Destination
P&R	Park and Ride
PT	Public Transport
PTW	Powered Two-Wheeler
RP	Road Pricing
RSD	Roadside Sensing Device
SCR	Selected Catalytic Reduction
TDMS	Traffic Demand Management Strategies
TEMC	Traffic Environmental Model Chain
TIC	Tourist Information Centre
TMB	Transportes Metropolitanos de Barcelona
TTIC	Traffic and Travel Information Centre
VMS	Variable Message Sign
WMAP	Winchester Movement and Access Plan