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# Roads
## International Case Studies

September 2012



# Introduction

Transport for London is currently undertaking a major strategic review of London's road network which aims to identify long-term solutions to improve the capital's roads and tackle some of London's most congested junctions.

The purpose of this report is to gather examples of road strategy practice that can inform the development of London's road strategy. The examples of road strategy practice have been chosen to illustrate how other cities have addressed challenges faced by London's road network such as: congestion; conflict between users along links; conflicts between movement and place activities; and how they have made air quality, physical accessibility, noise and public realm improvements.

Transport for London's review of London's road network covers the entire Greater London area and is therefore considering a wide range of road issues in both inner London and the outer London town centres. One area of interest is where cities have been able to obtain more space – space for increased highway capacity or urban space that can be used for development, green places or alternative links for walking and cycling.

This report identifies a sample of 37 projects where cities have delivered projects with highway and urban realm benefits and sought to use innovation in their design and delivery. In the examples gathered we have provided a range of projects which exhibit some of the characteristics above, and where possible, quantified the benefits delivered. The examples are not intended to be representative of all possible options and more extensive reviews of international practice (including broader understanding of city/transport strategy context) could be undertaken if felt worthwhile. This report does not attempt to draw any conclusions from these examples in relation to London's road network.

# Summary of Projects

| No. | Project & location | Primary challenge addressed | Short description | Project Impacts/ outcomes | Cost (GBP 2011 purchasing power equivalent)* | Impact on road capacity (+ = increase, o = neutral - = decrease) |
|---|---|---|---|---|---|---|
| **A PROJECTS TO PRIMARILY ADDRESS "LIVING ISSUES" – I.E. IMPROVE ENVIRONMENT/QUALITY OF LIFE** | | | | | | |
| **New Planning Philosophy** | | | | | | |
| **A1** | **Hammersby Sjostad**<br>Stockholm<br>**Population:**<br>2,100,000<br>**Mode Share (2009):**<br>Walking: 23%<br>Cycling: 11%<br>Public Transport: 24%<br>Private motor vehicle: 42% |  | » Environmentally sustainable new urban development on brownfield site. | Hammarby Sjöstad is a 160 hectare brownfield redevelopment with mixed retail, residential and business spaces located 3km to the south of the city centre of Stockholm. The development includes, amongst other sustainable development features, a transport network characterised by car-sharing, bike-sharing, good public transport access and high quality bicycle infrastructure. | » 52% of trips made by public transport and 27% by walking and cycling. Only 21% are by car, compared to 32% for the whole of Stockholm.<br>» Around 70% of the residential units have a car.<br>» Some criticism of the social balance of the development and failure to address social segregation. | **£0.5 million** | **0** |
| **A2** | **Vauban**<br>Freiburg<br>**Population:**<br>200,000<br>**Mode Share (2007):**<br>Walking: 23%<br>Cycling: 27%<br>Public Transport: 18%<br>Private motor vehicle: 32% |  | » Environmentally sustainable new urban development. | Vauban is a suburb in the south of the city of Freiburg, and has been developed as a car-free, parking free, sustainable model district. The neighbourhood consists of 5,000 residents. It is the world's first housing development where all homes produce more energy than they use. The Vauban tram extension is being completed. | » 75% of trips to work by bicycle.<br>» 70% of Vauban residents claim not to own a car.<br>» Reduction in air pollutants and CO2 levels. | **£430 million** | **0** |

## Primary challenge addressed

 Reduce congestion

 Improve quality of life

 Improve safety/environment

 Support development

* Local currencies were converted to GBP using Purchasing Power Parity (PPP) data from the OECD. These figures were then converted to 2011 prices using GDP deflators from the Office of National Statistics.

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| **A PROJECTS TO PRIMARILY ADDRESS "LIVING ISSUES" – I.E. IMPROVE ENVIRONMENT/QUALITY OF LIFE** | | | | | | | |
| **Area development and enhancement** | | | | | | | |
| **A3** | **A7 autobahn covering**<br>Hamburg<br>**Population:** 1,800,000<br>**Mode Share (2008):**<br>Walking: 11%<br>Cycling: 13%<br>Public Transport: 30%<br>Private motor vehicle: 46% |  | » Reduce noise levels from traffic.<br>» Remove the physical barriers between neighbourhoods.<br>» Reduce air pollution from HGV traffic.<br>» Facilitate motorway widening. | The green canopy will cover a 3.5km of the A7 Autobahn in three sections to the west of Hamburg. It will be 34 metre wide and planted with parks, trees and allotments. The motorway is set below the level of surrounding developments with the canopy filling the gap between neighbourhoods on either side. The canopy also allows the widening of the road from six lanes to eight lanes without a negative impact on surrounding neighbourhoods. | » The project is under construction.<br>» Up to 2,000 new houses will be built alongside the new canopies. | **£550-650 million (estimated)** | **+** |
| **A4** | **Périphérique covering**<br>Paris<br>**Population:** 12,000,000<br>**Mode Share (2009):**<br>Walking: 32%<br>Cycling: 2%<br>Public Transport: 21%<br>Private motor vehicle: 45% |  | » Reduce noise for residents and businesses in the immediate vicinity.<br>» Reduce air pollution by limiting the amount of 'exposed' dual-carriageway.<br>» Contribute to urban regeneration and unification by landscaping newly created public spaces. | Paris's Boulevard Périphérique carries around 250,000 vehicles per day. As part of a programme to undertake major infrastructure projects in Paris, three sections of the Périphérique were identified for 'roofing' with the areas above the road landscaped to provide green spaces and to reconnect the city with the suburbs. | » To date noise levels reduced (by 5 dB(A) at Lilas).<br>» Creation of 275,000 square metres of public open space. | **£214 million** | **0** |
| **A5** | **Dublin Port Tunnel**<br>Dublin, Ireland<br>**Population:** 1,800,000<br>**Mode Share (2011):**<br>Walking: 10%<br>Cycling: 3%<br>Public Transport: 9%<br>Private motor vehicle: 78% |  | » Facilitate future growth in Port trade through additional capacity.<br>» Removal of HGV traffic from Dublin city centre.<br>» Release of road space to allow the introduction of a range of public transport and amenity measures in the city centre. | Prior to the completion of the Dublin Port Tunnel, access between Dublin Port and the national motorway network was via a series of city centre roads within Dublin. The Dublin Port Tunnel is a twin bore tunnel of 4.5km in length which is now part of the M50 motorway and completes the northern part of the C-Ring around Dublin city. | » 5 million journeys made through the Dublin Port Tunnel in 2011.<br>» 88-96% reduction in 5+ axle vehicles in Dublin city centre (2009). | **£650 million** | **+** |

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| **Area development and enhancement** | | | | | | | |
| **A6** | **Bjørvika Tunnel**<br>Oslo, Norway<br>**Population:**<br>1,400,000<br>**Mode Share:**<br>Walking/Cycling: 35%<br>Public Transport: 20%<br>Private motor vehicle: 45% |  | » Facilitation of new development<br>» Improved permeability through removal of road 'barrier' to the city centre.<br>» Reduced congestion. | The Bjørvika tunnel is the first immersed tunnel built in Norway. It links the Festning tunnel in the west with the Ekeberg tunnel in the east, redirecting the E18 motorway away from the Oslo waterfront and facilitating its redevelopment. The once heavily industrial port is now being developed into a public space for living, working and recreation. | » Surface traffic reduced by 70%.<br>» Project has released approximately one million m² of development floor space. | **£486 million** | + |
| **A7** | **Calle M30**<br>Madrid, Spain<br>**Population:**<br>6,500,000<br>**Mode Share (2009):**<br>Walking: 31%<br>Cycling: 0%<br>Public Transport: 32%<br>Private motor vehicle: 37% |  | » Improved permeability through removal of road 'barrier' in the city centre.<br>» Reduced congestion – noise and air pollution. | The Madrid Calle 30 upgrade project was undertaken to refurbish the motorway and to reroute major sections of it through tunnels under the city. These works created opportunities to reconnect the city with the Manzanares river, redevelop surface areas into green parks, footpaths, cycle paths and build new affordable housing. | » Improved traffic flow in the city.<br>» 26% reduction in Nitrogen oxide emissions between 2006 and 2009.<br>» Creation of new public spaces for sport and leisure.<br>» Project has had widely accepted positive outcomes but criticism remains about the cost. | **£3,369 million** | + |

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| **A PROJECTS TO PRIMARILY ADDRESS "LIVING ISSUES" – I.E. IMPROVE ENVIRONMENT/QUALITY OF LIFE** | | | | | | | |
| **Street re-design** | | | | | | | |
| **A8** | **Urban street design**<br>Paris<br>**Population:** 12,000,000<br>**Mode Share (2009):**<br>Walking: 32%<br>Cycling: 2%<br>Public Transport: 21%<br>Private motor vehicle: 45% |  | » Reduce both car use and air pollution.<br>» Rearrange the public space to favour more sustainable modes of transport. | The Paris urban street design project is a series of initiatives originating from the regional transport plan for the city of Paris, designed to encourage more sustainable travel around the city, and ultimately reduce motor vehicle traffic and air pollution. These initiatives include development of a new integrated bus network, entitled Mobilien, and the concurrent creation of widened, dedicated bus lanes, changes to freight and delivery policies, and removal of on-street parking, in particular free on-street parking. | » Between 2000 and 2007, the number of hourly vehicle kilometres (i.e. the average total distance travelled by cars in Paris in a given hour) fell by 22%, an average of a 3.5% decrease each year.<br>» The amount of on-street parking in Paris fell by 6.6% between 2003 and 2007.<br>» The number of private cars recorded in Paris fell by nearly 15% in the same period.<br>» The number of bicycles has increased from 23,300 in 2002 to 57,800 in 2007, | **Unavailable** | - |
| **A9** | **Frankfurter Strasse redevelopment**<br>Hennef<br>**Population:** 50,000 |  | » Completion of a city bypass in 1990 meant that Franfurter Strasse was no longer needed as a main general traffic route. This project was undertaken to take advantage of this opportunity to redefine the street for residents and shoppers. | Frankfurter Strasse is Hennef's main retail street. Before the project began, the road was a dual carriageway and part of the national road network. It was designed to serve traffic travelling through the town, rather than to serve people living and shopping there. Following the completion of the city bypass Frankfurter Strasse was redefined to improve the attractiveness of the street for walking, cycling and socialising. Public realm improvements were also used to manage volume and speed of vehicle traffic. | » There is less traffic now driving through the centre and on average the City Council judge that traffic flow has improved.<br>» However, it is recognised that traffic levels on the centre ring road has increased.<br>» The street is now a much busier pedestrian environment with more active building fronts, including cafes and seating areas. | **£5.2 million** | - |

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| **Street redesign** | | | | | | |
| **A10** | **Orchard Road electronic road pricing (ERP) and public realm improvements**<br>Singapore<br>**Population:** 5,100,000<br>**Mode Share (2011):**<br>Walking: 22%<br>Cycling: 1%<br>Public Transport: 44%<br>Private motor vehicle: 33% |  | » Manage demand and reduce congestion.<br>» Reinvigorate this major shopping street to improve its standing as an international tourist destination. | As a very dense island city Singapore was the first city to successfully adopt road user charging.<br>Charges are highly demand responsive, varying every half hour in peak times. The system is fully automated.<br>In addition, in 2008 major public realm improvements took place on Orchard Road, in order to improve the profile of the street as an international shopping and entertainment destination. | » ERP has achieved target speeds of 45 to 65 km/h on expressways and 20 to 30 km/h on arterials.<br>» Introduction of the Orchard Road ERP cordon in 2005 reduced through traffic on the street by 20%.<br>» No data available on impacts of the public realm improvements. | **£40 million** | **0** |
| **A11** | **Noordersingel, Nieuwehuizen and Groningerstraat Street redesign**<br>Assen<br>**Population:** 70,000 |  | » To address growing vehicular congestion and associated air pollution in the city.<br>» To create a more attractive city centre and more enjoyable experience for pedestrians and cyclists. | The Assen government began excluding car traffic from a number of inner-city streets in 1972 to create a pedestrian-only zone. More recently, they redefined the entire city's road network, creating a hierarchy of distributors, through-routes and local streets. The majority of streets were designated as local streets, and were redesigned to prioritise pedestrian and cycle movement. | » Cycling mode share increased from 32% in 2005 to 41% in 2011. | **Unavailable** | **-** |
| **Road space reduction** | | | | | | |
| **A12** | **Pompidou Expressway closure**<br>Paris<br>**Population:** 12,000,000<br>**Mode Share (2009):**<br>Walking: 32%<br>Cycling: 2%<br>Public Transport: 21%<br>Private motor vehicle: 45% |  | » Reduce car use and encourage a modal shift, by improving pedestrian and cyclist access to the river banks.<br>» Make the banks of the Seine in central Paris a hub of cultural, leisure and sporting activity.<br>» Raise the profile of the river banks' world heritage status. | For the last 11 years the left bank of the Seine has transformed into 'Paris Plage' for one month in the summer, with approximately 4km of sandy 'beach' food stalls and deck chairs.<br>In September 2012, a plan to permanently transform both banks of the Seine was approved, with a 2.5km car free zone along the left bank and a shared space on the right bank with a narrower road for cars, and wider routes for pedestrians and cyclists. | » Contribution to a decrease in private vehicle traffic by 20% between 2001-2006 in Paris.<br>» Contributions to air pollution improvement in Paris. 6% of the overall 32% reduction in nitrogen oxides (NOx), as well as all 9% of the reduction in carbon dioxide ($CO_2$) emissions were attributed to a reduced number of cars and trucks in the city. | **Paris Plage = £1.4million/ year**<br>**Permanent Banks of the Seine project = £34 million** | **-** |

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| **Road space reduction** | | | | | | |
| **A13** | **Cheonggye Expressway removal**<br>Seoul<br>**Population:** 23,500,000<br>**Mode Share (2006):**<br>Walking/Cycling: 13%<br>Public Transport: 52%<br>Private motor vehicle: 35% |  | » Solve safety and structural issues with existing motorway and infrastructure.<br>» Restore the watercourse and habitat of the Cheonggyecheon stream.<br>» Revitalise historic downtown and further develop the economy in Central Seoul. | Rapidly deteriorating infrastructure, high levels of pollution and low property values in the areas surrounding the Cheonggye Elevated Motorway prompted the Government to remove the motorway and open the original seasonal waterway that flows through Central Seoul and that had been buried under the motorway. New two lane one-way streets line either side of the waterway park and an extensive BRT system and and other bus improvements were implemented to compensate for the reduction in vehicle lanes. | » Contributed to a 15.1% increase in bus patronage and 13.7% increase in subway ridership between 2003 and 2008.<br>» Conflicting reports about vehicle journey time.<br>» Reduced NO2 by 35% and PM10 by 19% between 2003 and 2006.<br>» Land values of adjacent parcels increased by an average of 30% between 2003 and 2006. | **£285 million** | - |
| **A14** | **Embarcadero Freeway redevelopment**<br>San Francisco<br>**Population:** 7,600,000<br>**Mode Share (2009):**<br>Walking: 11%<br>Cycling: 3%<br>Public Transport: 34%<br>Private motor vehicle: 52% |  | » Redevelop the waterfront area of San Francisco.<br>» Help reconnect the area to the rest of the downtown region.<br>» Removing the double decker freeway was assessed to be less costly than repairing it. | The Embarcadero Freeway Redevelopment project was undertaken following the collapse of the original freeway caused by earthquake in 1989. The previous elevated freeway was replaced with a ground-level "boulevard" to encourage redevelopment of the San Francisco waterfront area. The new boulevard is a six-lane general traffic road that runs along the waterfront along with the metro line F. | » 100 acres of land converted into new public spaces; improved access to the city's ferry terminal which was renovated as a mixed use facility of 65,000 sq.ft of marketplace and 175,000 sq.ft of office space<br>» Emergence of a new neighbourhood, Rincon Hill.<br>» Traffic reduced to 26,000 vehicles per day (less than half of the 70,000 previously carried). Remaining traffic was displaced onto alternate routes to and from the Bay Bridge.<br>» | **£49 million** | - |

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| **B** | **PROJECTS TO PRIMARILY ADDRESS "MOVING ISSUES" – I.E. REDUCE CONGESTION** | | | | | | |
| **Road space creation** | | | | | | | |
| **B1** | **Sydney Harbour Tunnel, Cross City Tunnel & Lane Cove Tunnel**<br>Sydney, Australia<br>**Population:** 4,600,000<br>**Mode Share (2010):**<br>Walking: 18%<br>Cycling: 2%<br>Public Transport: 11%<br>Private motor vehicle: 69% |  | » Reduced congestion on the Sydney Harbour Bridge.<br>» Reduced congestion in Sydney city centre through provision of by-pass routes. | The Sydney Harbour Tunnel, Cross City Tunnel and Lane Cove Tunnel are all twin tube tunnels crossing either under Sydney Harbour or the city centre area providing connections to key areas of Sydney and the motorway network without the need for travel through the city centre. An integral part of the three schemes was increased public transport provision as a result of released capacity on existing roads. | » All three tunnels carry between 170,000 and 178,000 vehicles daily.<br>» Extra public transport lanes delivered on roads where tunnels released road capacity. | **Harbour = £492 million,**<br>**Cross City = £531 million,**<br>**Lane Cove =£548 million** | + |
| **B2** | **Paris A86**<br>Paris, France<br>**Population:** 12,000,000<br>**Mode Share (2009):**<br>Walking: 32%<br>Cycling: 2%<br>Public Transport: 21%<br>Private motor vehicle: 45% |  | » Reduced congestion and improved traffic links between the suburbs of Paris. | The A86 is a 10km motorway toll tunnel consisting of two sections, and is the final link of the A86 ring road around Greater Paris. It connects Rueil-Malmaison and Jouy-en-Josas in the Hauts-de-Seine and Yvelines districts of Paris. | » Around 20,000 vehicles using the tunnel daily.<br>» Journey times reduced by around 80%. | **£1,862 million** | + |
| **B3** | **Clem Jones Tunnel – M7 Motorway (CLEM7 Tunnel)**<br>Brisbane, Australia<br>**Population:** 3,000,000<br>**Mode Share (2006):**<br>Walking: 4%<br>Cycling: 1%<br>Public Transport: 14%<br>Private motor vehicle: 81% |  | » Reduced congestion on city centre roads, particularly through the central business district. | The CLEM7 tunnel is a 4.8km north-south tunnel that bypasses the city centre and crosses under the Brisbane river. It is the city's first toll road with toll collection via electronic tags or automated vehicle number plate recognition. The tunnel is part of a proposed new underground motorway (M7) through Brisbane which includes the Airport Link tunnel opened in July 2012. | » Around 32,000 vehicles using the tunnel daily.<br>» Minimal change to air quality and noise pollution.<br>» Project has received some criticism over the cost of tolls. | **£1,415 million** | + |
| **B4** | **Fraser River Toll crossings**<br>Vancouver, Canada<br>**Population:** 2,300,000<br>**Mode Share (2006):**<br>Walking/Cycling: 8%<br>Public Transport: 17%<br>Private motor vehicle: 74% |  | » Reduced congestion.<br>» Increased highway capacity for future growth. | Two new toll bridge crossings of the Fraser River (Golden Ears Bridge and Port Mann Bridge) as well as public transport, walking and cycling improvements. | » Golden Ears Bridge had 2.4 million bridge crossings over first three months of 2012.<br>» 20 to 30 minute journey time reductions for users.<br>» The Port Mann Bridge is still under construction. | **Golden Ears = £461 million,**<br>**Port Mann = £922 million** | + |

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| **Road space creation** | | | | | | | |
| **B5** | **Free flow road user charging**<br>Santiago, Chile<br>**Population:** 7,000,000<br>**Mode Share (2006):**<br>Walking/Cycling: 4%<br>Public Transport: 54%<br>Private motor vehicle: 42% |  | » Increased highway capacity. | The Costanera Norte is the first tolled urban highway in Santiago. The project consists of two main roads: East – West Road running 35km across the city from east to west along the north shore of the Mapocho River; and Kennedy Road, an existing 7.4km road . The tolling system is fully automated. | » Reduced congestion in central Santiago.<br>» Creation of over 40 hectares of new public spaces. | **£811 million** | + |
| **B6** | **Mexico Urban Highways**<br>Mexico City, Mexico<br>**Population:** 21,200,000<br>**Mode Share (2002):**<br>Walking/Cycling: 16%<br>Public Transport: 73%<br>Private motor vehicle: 11% |  | » Reduce journey times.<br>» Reduce emissions from road vehicles.<br>» Improve quality of life. | A series of toll roads constructed as a second level above the alignment of existing highways. Some sections also provide new links away from the current highway. | » Under construction.<br>» Anticipated large savings in travel time. | **£407 million** | + |
| **B7** | **The Central Artery/ Tunnel Project "The Big Dig"**<br>Boston, USA<br>**Population:** 7,600,000<br>**Mode Share (2009):**<br>Walking: 14%<br>Cycling: 2%<br>Public Transport: 34%<br>Private motor vehicle: 50% |  | » Increased highway capacity.<br>» Improved permeability between the North End and Waterfront neighbourhoods and Boston city centre. | The "Big Dig" project consisted of replacement of a six-lane elevated highway with an 8 to 10-lane underground expressway directly underneath the previous highway and extending the I-90 (the Massachusetts Turnpike, Boston Extension) through a tunnel beneath South Boston and the Boston Harbour to Logan Airport. The area previously occupied by the highway was redeveloped to provide local access and a series of linear parks. | » Travel times for residents from the south and west of Boston reported to have decreased by 42% to 74%.<br>» City-wide carbon monoxide levels have reduced by 12%.<br>» Project has received much criticism over its cost overruns and the length of construction. | **£990 million - £1,627 million** | + |

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| **Road space creation** | | | | | | | |
| **B8** | **LBJ/I-0365 managed lanes**<br>Dallas, USA<br>**Population:** 6,400,000<br>**Mode Share (2009):**<br>Walking: 2%<br>Cycling: 0%<br>Public Transport: 4%<br>Private motor vehicle: 94% |  | » Congestion relief.<br>» Safety.<br>» Air quality. | The LBJ Express, I-635 in Dallas/Fort Worth was designed to carry 180,000 vehicles per day, currently carries 270,000 vehicles and forecast demand is estimated at 450,000 vehicles. The project will introduce managed lanes - drivers will have the choice of paying a toll to use the managed lanes or travel for free on the general purpose lanes. Tolls will be variable, based on a number of factors including the time of day, traffic volumes, vehicle type and vehicle occupancy. | » Under construction. | **£2,170 million** | + |
| **B9** | **Göta Tunnel**<br>Gothenburg, Sweden<br>**Population:** 900,000<br>**Mode Share (2004):**<br>Walking: 12%<br>Cycling: 14%<br>Public Transport: 21%<br>Private motor vehicle: 52% |  | » Reduced congestion.<br>» Improved permeability – removal of the barrier to development particularly in the southbank riverside area of central Gothenburg. | The Göta tunnel is 1.6km long and part of a new 3km road link on Highway 45 under the historic centre of Gothenburg. | » Around 65,000 daily vehicles using the tunnel. | **£272 million** | + |
| **B10** | **Hovenring, suspended cycle roundabout**<br>Eindhoven<br>**Population:** 300,000<br>**Mode Share (2004):**<br>Walking: 3%<br>Cycling: 24%<br>Public Transport: 8%<br>Private motor vehicle: 65% |  | » An intersection on the A2 motorway needed changing in order to cope with growing vehicular, cycle and pedestrian traffic.<br>» Introduction of segregated design requirement.<br>» Opportunity to create a new city landmark, at a key entrance to the city of Eindhoven | The Hovenring is a circular cable-stayed bridge that carries pedestrians and cyclists above the road traffic at a busy junction on the edge of Eindhoven. The intersection is strategically located in between future high-graded residential areas, business areas and high tech campuses that make an important contribution to the development of Brainport Eindhoven. | » The project has only recently opened so data regarding impacts is relatively limited.<br>» Usage is being monitored. | **£5.3 million** | + |

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| **Road space re-allocation** | | | | | | | |
| **B11** | **C99 Cycle Superhighway**<br>Copenhagen<br>**Population:** 1,900,000<br>**Mode Share (2004):** Walking/Cycling: 59% Public Transport: 13% Private motor vehicle: 28% |  | » Provision of alternative option for longer distance commuters.<br>» More co-ordinated, high quality cycle route network.<br>» Congestion and pollution reduction.<br>» Improved health and well-being. | The C99 Cycle Super Highway is the first of 28 planned routes for the Greater Copenhagen area and links central Copenhagen with the suburb of Albertslund. The project forms part of the Cykel Superstier project which aims to create over 400km of cycleways and implement a range of infrastructure improvements to increase the modal share of cycling in Copenhagen. | » Aim to increase the number of riders on the route by 15% and cycle mode share to 50% by 2015.<br>» Actual figures not yet available. | **£1.2 million** | **0** |
| **B12** | **Carrera 7 reversible corridor**<br>Bogota<br>**Population:** 10,100,000<br>**Mode Share:** Walking: 28% Cycling: 5% Public Transport: 44% Private motor vehicle: 23% |  | » To ease congestion travelling northbound along Carrera 7 during the evening peak. | Carrera 7 is the route linking the downtown area to the north of the city, which is where many of the wealthier suburbs are located.<br><br>The reversible corridor along Carrera 7 was first implemented in 1993, and allows all lanes of traffic on the road to flow out of the city centre in the evening peak. There were also diversions put in place for those travelling in the reverse direction to use alternative corridors. | » The corridor was found to improve travel times for people using both private and public transport traveling out of the city towards the suburbs in the north.<br>» Travel times have increased for the minority travelling in the opposite direction. | **Unavailable** | **0** |
| **B13** | **City centre pedestrianisation and LRT system**<br>Strasbourg, France<br>**Population:** 700,000<br>**Mode Share (2000):** Walking: 28% Cycling: 7% Public Transport: 15% Private motor vehicle: 50% |  | » Reduced city centre congestion and improved air quality.<br>» Improved public transport use and reliability. | A network of LRT lines has been constructed from the suburbs into and through Strasbourg city centre. The LRT project was used as an opportunity to reprioritise the use of streets and recover public space through the emphasis of pedestrian and cycle access. Cars have been removed completely from many streets and restricted on others with park-and-ride sites provided on the outskirts of the city. | » Transformation of public realm in the city centre.<br>» Significant increase in public transport use.<br>» Project widely acclaimed for improvements to urban realm and alternative modes. | **Unavailable** | **-** |

| No. | Project & location | Primary challenge addressed | | Short description | Project Impacts/ outcomes | Cost (GBP 2011 purchasing power equivalent)* | Impact on road capacity (+ = increase, o = neutral - = decrease) |
|---|---|---|---|---|---|---|---|
| **B** | **PROJECTS TO PRIMARILY ADDRESS "MOVING ISSUES" – I.E. REDUCE CONGESTION** | | | | | | |
| **Road space re-allocation** | | | | | | | |
| **B14** | **Cycling network and hire scheme,** Strasbourg<br>**Population:** 700,000<br>**Mode Share (2000):** Walking: 28% Cycling: 7% Public Transport: 15% Private motor vehicle: 50% |  | » Reduce city centre congestion.<br>» Improve air quality.<br>» Improve quality of life. | Strasbourg's bicycle network has been developed as part of a multi-modal plan for changing car dependency in central Strasbourg. Cycling network improvements include expanding the network and provision of new cycle stands at bus, tram and train stations.<br>Strasbourg's bicycle hire scheme 'Velhop' enables locals and visitors to rent bikes on a short or long term, occasional or regular, basis.<br>There is currently a total of 4,400 bikes available . The scheme has been in operation since September 2010. | » In 2009 8% of trips were by bike in the CUS (Urban Community Strasbourg) and 14% within the City of Strasbourg. This is 2% higher than the rest of France. | **Cycle hire scheme costs £1.2 million/ year** | - |
| **B15** | **Mobilien Bus Network** Paris<br>**Population:** 12,000,000<br>**Mode Share (2009):** Walking: 32% Cycling: 2% Public Transport: 21% Private motor vehicle: 45% |  | » Reduce car traffic and noise/air pollution.<br>» Provide a consistent service, seven days a week from 6:30am to 0:30am, including public holidays.<br>» Increase operating speeds on lines by at least 20%. | The Mobilien project is a radical upgrade of the Parisian bus service into a Bus Rapid Transit (BRT) network. The Mobilien network consists of 150 bus routes (most of which already operate), and 150 multimodal public transport hubs. The bus routes are moved to dedicated bus lanes to ensure faster, more reliable journey times. The eventual aim is for the network to operate a number of radial bus routes towards the centre of Paris supported by circular routes in the suburbs maximising interchange with other forms of public transport. | » Passenger journeys on Mobilien services was 178.8 million in 2007, half of all bus journeys.<br>» Significantly less congestion for BRT vehicles, while congestion for private vehicles has increased. | **£561 million** | - |

| No. | Project & location | Primary challenge addressed | Short description | Project Impacts/ outcomes | Cost (GBP 2011 purchasing power equivalent)* | Impact on road capacity (+ = increase, o = neutral - = decrease) |
|---|---|---|---|---|---|---|
| **B** | **PROJECTS TO PRIMARILY ADDRESS "MOVING ISSUES" – I.E. REDUCE CONGESTION** | | | | | |
| **Road space re-allocation** | | | | | | |
| **B16** | **Ciclovía & Ciclorutas**<br>Bogotá<br>**Population:** 10,100,000<br>**Mode Share:** Walking: 28% Cycling: 5% Public Transport: 44% Private motor vehicle: 23% |  | » Reduce congestion.<br>» Promote environmental benefits and improve access across the city.<br>» Promote cycling as a means of recreation, sports and transport.<br>» Create opportunities for social interaction. | Ciclovía and CicloRuta are both policies aimed at promoting a cycling culture in Bogotá. Ciclovía is a public recreation programme whereby the city centre street are closed to traffic on Sundays and public holidays. CicloRuta is the bicycle path network for the city of Bogotá. | » Ciclovía attracts more than 1 million people.<br>» Bicycle use has increased to 5% of trips in 2011 (compared to 3% in 2005).<br>» Particulate matter (PM10) along a segment of Bogotá's Ciclovía19 PM10 was 13 times higher on a regular week day than on a Sunday. | **Ciclovía: £0.3 million - £1.3 million/ year**<br>**CicloRuta: £0.1 million** | - |
| **B17** | **Traffic Circulation Plan Spui Street**<br>The Hague<br>**Population:** 1,000,000<br>**Mode Share(2004):** Walking: 5% Cycling:22% Public Transport: 30% Private motor vehicle: 43% |  | » Reduce through traffic in the city centre while maintaining access.<br>» Ameliorate air quality and noise pollution.<br>» Transform the city in an area of high outdoor quality.<br>» Encourage use of public transport and bicycles, while maintaining economic activity. | Spui is one of several streets in the centre of The Hague which has been made largely car-free. Buses and trams, which once occupied separate lanes, now share the same space, leaving more space for pedestrians and café areas and speeds are restricted to 15km/hour. | » The innermost area of the city saw a reduction in NOx of 30% after the traffic circulation was introduced.<br>» However, there is some controversy regarding the air quality impact of redirected traffic. | **£1 million** | - |
| **B18** | **MIRACLES, Multi-Use Lanes**<br>Barcelona<br>**Population:** 5,000,000<br>**Mode Share (2009):** Walking: 44% Cycling: 1% Public Transport: 20% Private motor vehicle: 35% |  | » Trial changes to the delivery management in parts of the city to reduce the impact on general traffic congestion. | The MIRACLES project aimed to improve the distribution of goods across the city in the face of continued traffic growth. The project consisted of: the introduction of variable, multi-use lanes allocated for different purposes depending on the time of day; roadside delivery management involving local delivery/logistic businesses; and a web-based information service providing locations and numbers of spaces available. | » Journey times reduced by between 12% and 15%.<br>» Lower emissions from fewer deliveries, reduced journey times, less circulation and less congestion. | **£1.4 million** | - |

| No. | Project & location | Primary challenge addressed | | Short description | Project Impacts/ outcomes | Cost (GBP 2011 purchasing power equivalent)* | Impact on road capacity (+ = increase, o = neutral - = decrease) |
|---|---|---|---|---|---|---|---|
| **B** | **PROJECTS TO PRIMARILY ADDRESS "MOVING ISSUES" – I.E. REDUCE CONGESTION** | | | | | | |
| **Road Space demand management** | | | | | | | |
| **B19** | **N-VI HOV Lane**<br>Madrid<br>**Population:**<br>6,500,000 | |  | » Reduce travel times by reducing congestion, increasing car occupancy rates, and encouraging mode shift to bus.<br>» Reduce the environmental impact of travel in Madrid.<br>» Improve public transport. | The HOV/bus system within the N-VI highway stretches for just over 15km between Laz Rozas, a suburban village, and a multimodal interchange in an urban district of Madrid. For most of its length the system provides two concrete-separated high occupancy vehicle lanes, which are accessible to both buses and high-occupancy cars, and switch direction between the morning and afternoon peaks. | » In the morning peak period the HOV lanes carry more passengers than other lanes on the N-VI.<br>» Mode shift to bus has been significant up from 17% of all journeys in 1991 to 27% in 2005. | **For the bus/ HOV lane £56.6 million** | **-** |
| **B20** | **SpitsScoren, 'Profit from the Peak'**<br>Rotterdam, Netherlands<br>**Population:**<br>1,300,000<br>**Mode Share (2004):**<br>Walking: 5%<br>Cycling: 14%<br>Public Transport: 25%<br>Private motor vehicle: 56% | |  | » Reduced peak hour traffic travelling to the Port of Rotterdam.<br>» Reduced car travel.<br>» Preparing motorists for the potential introduction of road pricing. | Encouraging drivers to avoid driving during the peak period on the A15 motorway, which runs through the Port of Rotterdam, through financial incentives to individual car drivers. | » 800 daily car trips avoided on the A15 with daily peak time traffic reduction of between 5% and 7.5%.<br>» On average 60% of participants changed their travel behaviour. | **£8 million** | **0** |
| **Road space re-allocation** | | | | | | | |
| **B21** | **Pico y Placa**<br>Bogotá, Colombia<br>**Population:**<br>10,100,000<br>**Mode Share:**<br>Walking: 28%<br>Cycling: 5%<br>Public Transport: 44%<br>Private motor vehicle: 23% | |  | » To reduce the number of cars on the network to free up space for public transport. | Pico y Placa is a traffic congestion mitigation policy set up in 1998 to help regulate traffic in the city centre during rush hour periods. The system operates by restricting vehicles with certain licence plate numbers from travelling on the most heavily congested streets at specific times. | » 40% reduction in private vehicle use at peak times.<br>» Possible contribution to growth in number of registered vehicles (in 2010, 190,000 vehicles were registered, compared to 145,000 the previous year.) | **Unavailable** | **0** |

| No. | Project & location | Primary challenge addressed | | Short description | Project Impacts/ outcomes | Cost (GBP 2011 purchasing power equivalent)* | Impact on road capacity (+ = increase, o = neutral - = decrease) |
|---|---|---|---|---|---|---|---|
| **B** | **PROJECTS TO PRIMARILY ADDRESS "MOVING ISSUES" – I.E. REDUCE CONGESTION** | | | | | | |
| **Road space re-allocation** | | | | | | | |
| **B22** | **Incentivising travel off-peak - 'INSTANT'**<br>Bangalore, India<br>**Population:** 8,400,000<br>**Mode Share (2011):**<br>Walking: 26%<br>Cycling: 7%<br>Public Transport: 35%<br>Private motor vehicle: 32% |  | » Reduce commute time.<br>» Reduced peak time overcrowding. | The "INSTANT" project was aimed at a specific out of town trip generator. The scheme gave credits to commuters moving their journey out of the peak period which gave them a chance to win a monetary reward. | » Reduced bus journey times.<br>» Reduced bus overcrowding. | **£0.04 million** | **0** |
| **B23** | **Go520 real time ride sharing**<br>Seattle<br>**Population:** 3,400,000<br>**Mode Share (2009):**<br>Walking: 8%<br>Cycling: 3%<br>Public Transport: 21%<br>Private motor vehicle: 68% |  | » Reduce congestion and $CO_2$ emissions.<br>» Test the viability and feasibility of real time ridesharing. | Go520 is a real time ride sharing scheme where drivers and potential passengers sign up and download an app for their smartphone . A system automatically matches people based on their location and time of travel, which could vary from day-to-day. The pilot was originally timed to coincide with the introduction of tolling on the SR 520 state highway although the tolling was slightly delayed. | » Over 1,100 participants (46% of which are repeat users). | **£0.3 million** | **0** |

# A

## Projects to primarily address 'Living Issues'

### NEW PLANNING PHILOSOPHY

**A1** Hammersby Sjostad, Stockholm
**A2** Vauban, Freiburg

### AREA DEVELOPMENT & ENHANCEMENT

**A3** A7 Covering, Hamburg
**A4** Perepherique Covering, Paris
**A5** Port Tunnel, Dublin
**A6** Bjorvika Tunnel, Oslo
**A7** Calle M30, Madrid

### STREET RE-DESIGN

**A8** Urban Street Design, Paris
**A9** Frankfurterstrasse, Hennef
**A10** Orchard Road, Singapore
**A11** Street Re-Design, Assen

### ROAD SPACE REDUCTION

**A12** Pompidou Expressway Closure, Paris
**A13** Cheonggye Expressway Removal, Seoul
**A14** Embarcadero Freeway Removal, San Francisco

Project: **Hammarby Sjöstad**
Location: **Stockholm, Sweden**
Year: **1999 – 2018**
Cost: **SEK 35 billion**

# A1

## Reasons for the project

The redevelopment of Hammarby Sjöstad has its roots in Stockholm's bid to host the 2004 Olympics - the site was meant to be part of an ecological Olympic Village. When Stockholm did not win the bid, the plans were adapted and construction of the project began in 1999, converting the site from an industrial area into a modern, environmentally sustainable, mixed-use district with good public transport connections. Its aims were:

- 50% lower emissions than the corresponding level for housing areas constructed since the early 1990s.
- 80% of residents' and workers' journeys to be made by public transport, bike or foot by 2010.
- At least 15% of households to have carsharing memberships by 2010.
- At least 5% of workplaces to have carsharing memberships by 2010.

## Short project description

Hammarby Sjöstad is a 160 hectare brownfield redevelopment with mixed retail, residential and business spaces located 3km to the south of the city centre of Stockholm. Its environmental features include low-emission building material, use of alternative energy sources, a revolutionary waste disposal system and a transport network characterised by car-sharing, bike-sharing, good transit access and high quality bicycle infrastructure. Hammarby Sjöstad is also recognised for having implemented an integrated approach to district planning, incorporating sustainable resource use, ecological design and low-carbon transport.

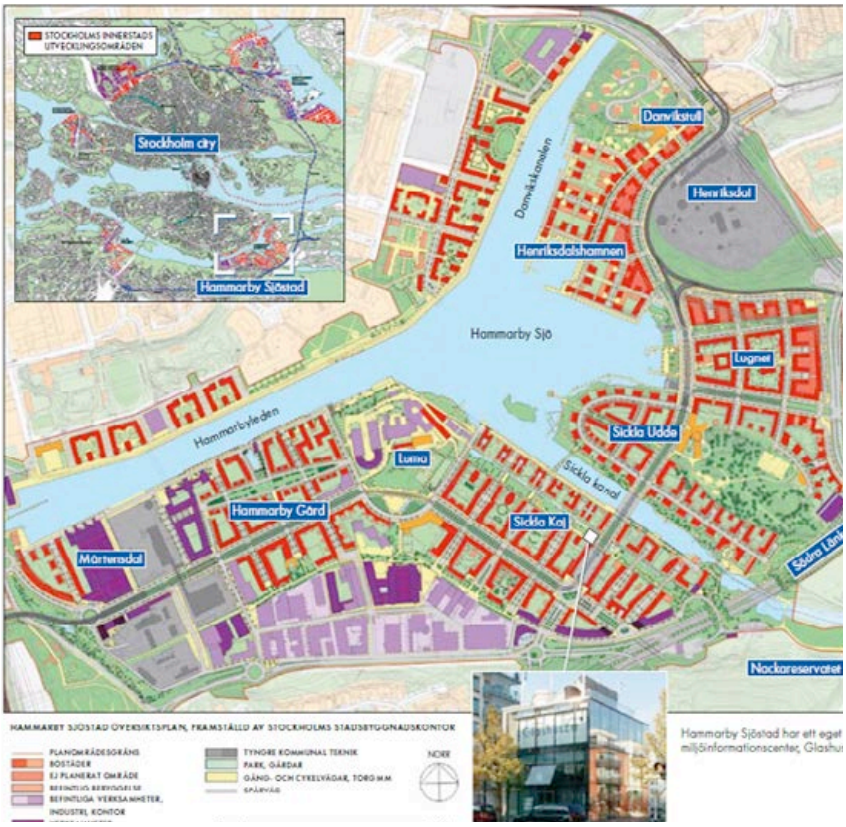


**FIGURE A1.0**
MAP OF HAMMARBY SJÖSTAD

### CITY CONTEXT

Stockholm is the capital and the largest city of Sweden. Located on the country's south-east coast, the city is home to just under 1 million people whilst the wider metropolitan area accommodates 2.1 million people. Stockholm was founded in early 1200, on a strategic location between Sweden's largest lake and the Baltic Sea. It has historically been an important trade port and industry town.

Stockholm is one of the cleanest capitals in the world: in 2010 it was granted the European Green Capital Award by the EU Commission. The city has reduced carbon emissions by 25% per resident since 1990 and has established a target of reducing emissions from 4 tonnes of $CO_2$ per capita (2010) to 3 tonnes by 2015 (The average emission in Europe is 8 tonnes per capita). Stockholm introduced congestion charging in 2007 after a successful test in 2006.

### TRANSPORT POLICY CONTEXT

The integration of transportation and land use planning was recognised as a key component of the project. Expansion of the district has been complemented by transport investments including increased bus service, cycle paths, pedestrian bridges, a ferry service, and an extension of the tram line. Development has been focused on a dense settlement structure, concentrated along main transit corridors. The local authority had leadership from development of the masterplan to construction, but involved multiple private companies in the process (41 developers and 29 architectural firms in total), splitting the area into 20 different detailed plans and 95 development sites. The City's sustainability program, which includes targets for decontamination, provision of public transport, energy consumption, water conservation and recycling influenced the whole process.

## The Project

The Hammarby Sjöstad district was built on a former industrial and harbour brownfield site located around the Hammarby Lake on the southern edge of Stockholm City. When the development is complete in 2018 it will contain 11,000 residential units and around 25,000 inhabitants. Hammarby Sjöstad was designed to integrate transport, amenities and public spaces. Land use is split between 56% residential, 19% public green space and 25% other.

The spine of the district is two 37.5 metre wide boulevards and transit corridor, Lugnets Allé and Hammarby Allé, which connect key transport nodes and public focal points, and create a focus for activity and commerce. These streets include a tram line, with car and cycle lanes on the outside, followed by parking spaces and then pedestrian walkways. The existing tram line was extended as part of the development.

The district also has bus services to central Stockholm and other parts of the city and a free ferry service connecting the northern and southern part of the development. The area has an extensive cycling and walking network and is part of Stockholm's bike share scheme. In 2006 car share pool companies had 30 cars and 10% of the households were members, although since then the number of members has increased but the percentage has reduced. The area has restricted parking with 0.45 garage spaces per dwelling (to be rented separately) and in additional 0.35 metered on-street parking per dwelling.

A network of parks, quays, plazas and walkways runs through the area, providing space for outdoor activities and connects the development to the waterfront, nearby forest "Nackareservatet" and other green spaces. As far as possible, the natural landscape and vegetation has been preserved.

**FIGURE A1.1**
HAMMARBY WATERFRONT

The ground floors in the buildings along the two transit corridors have been designed as flexible spaces, suitable for commerce, leisure or community use. Businesses that have located to the neighbourhood include book and flower shops, cafés, restaurants and bars, a supermarket and an art gallery. The area has over 100 retail units and restaurants. Community provision in the area includes 12 pre-schools, three primary schools, two high schools, a chapel, a library, a cultural centre/theatre, an environmental centre, health care centres and several sports centres.

The residential districts adjacent to the main roads follow a grid structure with a semi-open block form, which allows for maximum light and views, as well as providing access to the courtyards. Most apartments have balconies, which overlook onto the streets, waterfront walkways and open spaces. The architectural style is intentionally urban and follows standards for Stockholm's inner city in terms of street widths, block sizes and density, despite its suburban location. This traditional city structure has been combined with a modern style reflecting the waterside context and use of fully sustainable materials. Some of the buildings have green roofs.

Alternative energy sources like biogas and solar panels, as well as excess heat from nearby industry and waste burning (distance heating), are used to provide heat and electricity. 50% of the electricity and heat used within the development comes from locally recycled organic and combustible waste.


**FIGURE A1.2**

HAMMARBY SJÖSTAD PRIOR TO REDEVELOPMENT


**FIGURE A1.3**

HAMMARBY SJÖSTAD TODAY

The development also benefits from a revolutionary waste disposal system, Envac, which uses large underground pneumatic tubes to distribute pre-sorted waste to a centralised processing facility where the waste is collected for correct disposal. Refuse is sorted/collected via separate 'inlets' located in courtyards, entrance halls or refuse rooms within apartment blocks.

Wastewater and rainwater is handled locally, with natural filtration/sedimentation for less polluted water and purification for more polluted water (including rainwater from heavily trafficked roads). Fertiliser and biogas is produced from the wastewater.

## Funding and implementation

**1990** – Designs drafted for redeveloping the site.

**1992** – Construction began on the northern shore.

**Post 2000** – Majority of the residential buildings constructed (11,000 units) and connected to the Envac automated waste collection system.

**2012** – 8000 units to be completed.

**2018** – Anticipated completion.

The City of Stockholm joined forces with private companies to finance the district, with the latter contributing 85% of the cost of the housing development. Some infrastructure, like the extension of the tram and the rerouting of the Southern Link ring road, was funded and built by national and local infrastructure authorities. By now the private sector has invested over 30 billion SEK.

The residents pay a monthly fee to the resident association, as well as fees to the local authority which pays for the maintenance of the area, waste collection, etc.

**FIGURE A1.3**

ENVAC INLETS ARE COLOUR CODED TO HELP RESIDENTS IDENTIFY WHICH WASTE TYPES SHOULD BE DEPOSITED IN THEM.

## Impacts of the project

*Mode share:* 52% of trips are made by public transport, of which 33% are by tram, while 27% are made by walking and cycling. Only 21% are made by car, compared to 32% for the whole of Stockholm. For work trips the public transport share is even higher, at 78% for Hammarby Sjöstad residents. Around 70% of the residential units have a car.

*Highway and Public Transport Journey times:* 39% of residents live less than 5 km from their work place and 82% less than 10 km away, giving an average commute time of 33 minutes. Tvärbanan light rail takes approximately 18 minutes to Stockholm centre.

*Air quality and environment:* Transport-related emissions are 50% lower in the development area than in comparable reference districts or the city as a whole. The bypass road (Southern Link) has been lowered to minimise impact of noise and air pollution.

50% of the electricity and heat used within the development comes from locally recycled organic and combustible waste, with additional energy from solar panels and solar collector.

*Public realm:* Of the 160 hectare development 19% is public green space, this gives on average 15m² private garden per dwelling and 25m² public open space per dwelling.

*Road safety:* Pedestrians have priority (as is normal in Sweden). Segregated cycle paths, low car usage and speed restrictions reduce the risk of accidents.

*Crime/security*: Streets are well lit and overlooked by shops, balconies and front doors onto the street.

*Economic impact:* The project is considered to be a success in terms of redevelopment of a brownfield area, providing housing and business opportunities, as well as having a limited impact on the environment. There is no affordable housing provided as part of the project, but the area includes 46% rental accommodation (a bit under the aim of 50%), as well as student housing, homes for elderly with 24 hour care and assisted residential care. Around 5500 people work in the area.

*Physical accessibility:* Due to its goal of becoming an exemplary district for the future, Hammarby Sjöstad paid special attention to satisfying the requirements of the Disability Policy Program (2004) which had the aim of making Stockholm the most accessible city in the world by 2010.

*Servicing access:* The waste collection system is an innovative method and to date is working efficiently. This also saves emission from waste collection vehicles which have to travel much shorter distances. The development trialled a central delivery unit with subsequent internal delivery using environmentally friendly vehicles, but this was stopped after a couple of years.

## Public acceptance/reaction

The development has received several awards including awards for good landscape architecture.

Critics have highlighted the area's high earning and homogenous residential group, and failure to address Stockholm's social segregation issues.

The local council runs a website where they try to encourage and support local residents to achieve the district's high environmental goals. The site is also used for to consult local residents on issues and investment priorities.

The local residents are active and have started a project to identify improvements they would like to see by 2020. These include extension of the metro, cleaner water in the lake, more recycling, electric cars, and a year round ski slope.

Some residents have complained of noise from the tram and the waste collection vehicles, as well as lack of privacy due to the use of large windows.

Project: **Vauban**
Location: **Freiburg, Germany**
Year: **1995-2008**
Cost: **€500 million**

# A2

## Reasons for the project

The main objectives of the project were to develop a housing district within the city of Freiburg in collaboration with the city's inhabitants and to ensure that the social, cultural and economic needs of the community were integrated into the development proposals in an environmentally sustainable way.

## Short project description

Vauban is a suburb in the south of the city of Freiburg, and has been developed as a car-free, parking-free, sustainable model district. The neighbourhood consists of 5,000 residents, together with employment for 600 people. All houses are built to a low energy specification with solar collectors or photovoltaic cells on each roof. It is one of the world's first housing development where all homes produce more energy than they use.

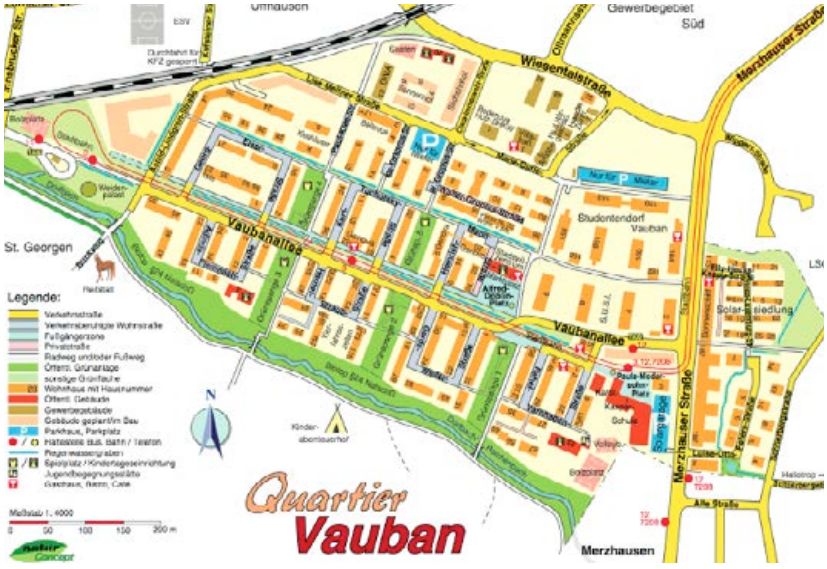


**FIGURE A2.0**
MAP OF VAUBAN

**CITY CONTEXT**

Freiburg is located close to the border with France and Switzerland in south-west Germany. The city has approximately 230,000 residents (as of December 2011).

The city has developed a reputation as one of the greenest cities in the world. The Mayor of the city, Dieter Salomon, belongs to the Green Party, making Freiburg the largest city in Germany to have an elected mayor from the party. As a result Freiburg has attracted a number of key industries, particularly solar industries and research, as well as the German Federal Office for Radiation Protection (Bundesamt für Strahlenschutz).

## The Project

The idea to create a new, eco-friendly suburb of Freiburg was developed in the early 1990s. A former French army barracks site in the south of the city was bought by the city council, with the majority of land plots being assigned to the Vauban project. A project group, consisting of the local authority, city council, and the local citizens association (Forum Vauban) worked collaboratively to develop the concepts and masterplan for the new development between 1995 and 1999.

The original masterplan anticipated a total of 2,000 new homes and apartments would be constructed between 1998 and 2006, equating to approximately 5,000 inhabitants in the new neighbourhood.

The majority of individual plots of land were sold to co-housing groups (Baugruppen) whose bids were assessed against criteria favouring families with children, older people and Freiburg residents. These groups were a mixture of architects and potential residents looking for self-build projects.

All housing was required to meet low energy standards outlined by the city council. All new buildings are built with at least 65 kWh per square metre. The average energy standard in Germany for newly houses built between 1995 and 2000 is about 100 kWh per square metre, the standard of older houses is about 200 kWh per square metre.

There is a combined heat and power plant burning wood chips and gas which provides electricity for around most of the district, and a sustainable urban drainage system that covers the whole of Vauban. Around 15% of housing in Vauban is designated as “passive housing”, using passive solar heating with heat exchangers. Many residential and commercial blocks have solar collectors or solar cells on their roofs.

**FIGURE A2.1**
VAUBAN NEIGHBOURHOOD

Vauban was designed to be a car-free, parking-free district. The road network is minimal, and all local streets are laid out either in a crescent shape or as cul-de-sacs with many connecting pedestrian and cycle routes, thus creating a continuity for journeys made by sustainable modes that is not possible for cars. The district is served by Line 3 on the Freiburg tram network, which connects Vauban to Freiburg city centre, and the main railway station. Services run up to every 7 minutes at peak times.

The streets of Vauban are designated as "stellplatzfrei" – meaning that no parking is allowed, with only pick-up and deliveries permitted. Vehicles are allowed to travel at walking pace on these roads (approx. 3 mph). Residents are allowed to own cars, but there are only two car parks, located on the outskirts of the district, and there is a one-off charge of 17,500 Euros, plus monthly maintenance fees to use these car parks.

In addition to the construction of residential units, a small area of Vauban was designated for commercial use, consisting almost entirely of small shops and local businesses, as well as two medium-sized supermarkets. There is a much larger commercial district adjacent to Vauban.

## Funding and implementation

The duration of the project was approximately 13 years, from the initial development of the proposals in 1995, following the land acquisition. The detailed project planning took place between 1997 and 1999, with the first residential developments completed in 2000. The project was initially scheduled for completion in 2006, but the final developments were completed in 2008.

The cost of purchasing the land in 1992 was €20 million. Plots were then sold off, predominantly to the co-housing groups. Total investment in the district is estimated to be approximately €500 million.

**FIGURE A2.2**

FREIBURG TRAMWAY LINE THROUGH THE VAUBAN NEIGHBOURHOOD

### TRANSPORT POLICY CONTEXT

Freiburg's transport strategy focuses on five key areas:

- Further development of the public transport network.
- Greater promotion of cycling.
- Restraining traffic within the city.
- Channelling of private vehicles.
- Improved management of parking facilities.

The public transport network has been gradually expanded and modernised over the past 40 years. The current tram network comprises four lines totalling 30 km and is well connected to the 168 km of city bus routes as well as to the Deutsche Bahn rail stations in the city. Approximately 70% of the population live within 500m of a tram stop. The city council have also sought to keep fares as low as possible on the public transport network to encourage local residents to use the service. Currently monthly passes cost €47 and cover all public transport across the city, including rail.

The city council have also developed over 400km of cycle paths, and approximately 9,000 cycle parking spaces (including bike-and-ride facilities at rail stations) in the city.

On most streets (with the exception of major streets) the speed limit is 30 kmh. On certain residential streets (such as many streets in Vauban) cars can travel no faster than walking speed, and children are allowed to play in the streets. Residents are able to apply directly to obtain this status for their street.

A large section of Freiburg city centre is a pedestrian-only zone, with no cars permitted. Multi-storey car parks are located only at the edge of residential districts and at key transport interchanges.

The use of car sharing and car clubs is also actively encouraged, with members offered free public transport annual passes, as well as discounted rail travel.

## Impacts of the project

*Mode share:* Surveys carried out in 2000 found car ownership at 54% among residents, although car use (16% of trips) was very low. Another survey in 2003 found that 57% of those living in Vauban without cars had given them up on moving to the area. Both surveys found cycling to be the predominant mode, in particular around 75% of trips to work were made by bicycle. Public transport use was low in both instances, however both surveys were carried out prior to the Vauban Line 3 tram extension being completed and it is likely that some of the cycling and private car mode shares have been reduced in favour of using the tram.

Currently 70% of Vauban residents claim not to own a car. However, a number of Vauban residents have developed strategies to reduce the expense of owning a car, either by registering the car in a relative's name, making agreements with residents living on the outskirts of Vauban to use their parking spaces, or by parking on as yet undeveloped land.

*Highway and Public Transport Journey times:* Though the opening of the tram extension to Vauban has not dramatically improved public transport journey times to city centre destinations (travel by bus from Vauban to the main railway station takes approximately 19 minutes, compared to 17 minutes by tram), a number of locations, particularly to the north and east of the city, are now much more easily accessible. Service frequency has also improved (with services running up to every 7 minutes at peak times).

**FIGURE A2.3**
VAUBAN RESIDENTIAL STREET

*Air quality:* The Öko-Institut (Institute for Applied Ecology) undertook an examination of the ecological impacts of the Vauban project. It concluded the following:

- Energy savings per year: 28 GJ.
- Reduction of CO2-equivalents per year: 2100 tonnes.
- Reduction of sulphur-dioxide (SO2-) equivalents per year: 4 tonnes.
- Saving of mineral resources per year: 1600 tonnes.

*Road safety:* Although vehicle speeds are significantly reduced in the district, enforcement of speed limits is minimal and there is some evidence that speed limits are sometimes ignored.

## Public acceptance/reaction

The majority of residents in Vauban fully support the idea of a traffic-free neighbourhood, but have issues with the implementation of the scheme. 87% said that they were attracted to Vauban because of the idea, but 39% expressed disapproval about how it is run. Some of the highlighted issues included the relative lack of enforcement of parking regulation, residents who claim not to own a car, but in fact do, and issues around the lack of visitor parking.

The scheme, together with a similar one in the suburb of Riesenfeld in the city, was reviewed by The Guardian newspaper in 2008. It noted that many residents living in other areas of the city view residents living in these areas negatively, seeing the area as whole to be somewhat militant in its attitude. There is also criticism from residents of these neighbourhoods that they have not done enough for group ownership and particularly social housing. The Guardian article also criticised the level of social control in Vauban, and the lack of diversity among its residents.

Project: **A7 Autobahn Green Roof Canopy**
Location: **Hamburg, Germany**
Year: **2012-2024***
Cost: **€600-700 million (estimated)**

# A3

## Reasons for the project

The main objectives for the A7 Autobahn project are to:

- Reduce noise levels from traffic on the motorway.
- Remove the physical barriers between neighbourhoods adjacent to the motorway.
- Reduce air pollution from heavy goods traffic.
- Meet legal requirements to enable the motorway to be widened.

## Short project description

The A7 Autobahn green canopy will involve covering a total of 3.5km of the motorway in three sections in the Schnelsen, Stellingen and Bahrenfeld districts to the west of Hamburg. The green canopy will be 34 m wide and planted with parks, trees and space for allotments. The motorway is set below the level of surrounding developments, and the canopy will therefore 'fill in' the gap between neighborhoods on either side. The canopy allows the federal government to widen the road without having a negative impact on surrounding neigbourhoods. The widening will be from from six lanes to eight lanes.

**FIGURE A3.0**
A7 MOTORWAY MAP WITH CANOPY SECTIONS IN BLUE

* section one to be completed in 2016, section two in 2020 and section three in 2024.

### CITY CONTEXT

The city of Hamburg is located in northern Germany, and has a total of 1.8 million inhabitants, making it the country's second largest city, after Berlin. The location of the city, on the banks of the River Elbe, makes it one of Europe's most important port and maritime cities. It is also a major media and industrial centre, and is a vital transport hub for northern Germany, as well as a key tourist destination.

In 2011, Hamburg was the winner of the second European Green Capital award, which is an accolade given out by the European Union recognising cities in Europe with the best environmental record. One of the key areas that the award is based on is the provision of new green areas within the city – the A7 canopy was the major project cited by Hamburg as an example of the development of these new green areas.

### TRANSPORT POLICY CONTEXT

The A7 autobahn is the longest national motorway in Europe, and runs the entire length of the country from north to south, providing an important trade route between Germany to Scandinavia, Austria and Southern Europe. As such, traffic, particularly on the stretch that travels through Hamburg, suffers from significant congestion and pollution problems. An estimated 150,000 vehicles use the road each day in the Hamburg area. Traffic forecasts for the A7 anticipate that this number will increase to around 165,000 by 2025.

In order to ease current and future congestion, the road will be widened to eight lanes (four lanes in each direction). German law requires provision of sufficient measures to address additional noise pollution for motorway expansion in the middle of residential areas. Traditional approaches to reduce noise pollution (specialised road surfaces, noise barriers, etc..) would not reduce traffic noise to the required level specified by law, hence the more radical plan of a canopy.

## The Project

The A7 autobahn is a significant national motorway running the length of Germany, providing a major trading route with its European neighbours and the port of Hamburg. To the west of Hamburg city centre, the A7 autobahn runs adjacent through the Hamburg neighbourhoods of Schnelsen, Stellingen and Bahrenfeld. The A7 autobahn is situated below the level of the surrounding streets and is crossed by road bridges. Since being built 40 years ago, the A7 has caused significant issues for these neighbourhoods including noise and air pollution and severance of the local communities.

The motorway is highly congested and traffic is projected to increase. As a result the government has agreed to widen the A7 autobahn from six to eight lanes. The widening has only been deemed to be acceptable on the basis that the canopy will minimise its impact on local residents and will in fact dramatically improve quality of life in the area. The proposed "green canopy" will cover the motorway in the three neighbourhoods Schnelsen, Stellingen and Bahrenfeld.

**FIGURE A3.1**
GREEN CANOPY OPEN SPACE

The canopy will be 34 metres wide, two to three metres deep, and will be approximately 3.5 kilometres in length. Once complete it will be at the same level as the surrounding streets. The canopy will be completed in three sections. The Stellingen section will be completed first and will include 893 metres of wooded parkland and garden plots for local residents. The second section to be completed will be the 400 metre section in Schnelsen which will have a tree-lined promenade to offset the noise caused by the six lanes of traffic underneath. The final section in Bahrenfeld will be the longest (approx. two kilometres) and will include the construction of 1,700 new residential apartments. Each section is estimated to take around four years to complete.

## Funding and implementation

Construction of the project began in 2012. The first section of the canopy is due to be completed in 2016, with the remaining two sections completed by 2020 and 2024 respectively.

The total cost of the project is estimated to be between €600 and €700 million. The majority of these costs is expected to be met by the federal government, with approximately €150 to €170 million recovered by selling city-owned land adjacent to the A7 autobahn that is currently being used by gardeners to private housing developers. Gardeners will be provided with alternative plots on the canopy.

**FIGURE A3.2**
AUTOBAHN BELOW THE CANOPY


**FIGURE A3.3**
ARTIST'S IMPRESSION OF THE COMPLETED PROJECT


**FIGURE A3.4**
BEFORE THE CANOPY IS BUILT OVER THE AUTOBAHN

## Impacts of the project

As the project has only just started the forecast impacts are:

*Air quality:* In addition to the general improvement in air quality resulting from the construction of the canopy, the city of Hamburg and federal government are currently working on a pilot project that aims to reduce levels of nitrous oxide emissions. A titanium dioxide solution is to be added to the road surfacing material and is expected to help reduce the nitrous oxide concentration in the air.

*Public realm:* Up to 2,000 new houses (of which 1,700 will be built in Bahrenfeld) will be built alongside the new canopies – buildings will not be built on the canopies themselves.

*Economic impact:* Garden plots that were previously located adjacent to the motorway will be moved onto the canopies themselves to make way for the housing developments that will be located close to the canopies.

## Public acceptance/reaction

General concerns of the public are the likely implications of the construction on traffic congestion, particularly due to the length of the construction period.

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Project: **Covering sections of the Boulevard Périphérique**
Location: **Paris, France**
Year: **2005-present**
Cost: **Current projected total: €247.4 million**

# A4

## Reasons for the project

The project objectives were to:

- Reduce noise for residents and businesses in the immediate vicinity.
- Reduce air pollution by limiting the amount of 'exposed' dual-carriageway.
- Contribute to urban regeneration and unification by landscaping the newly created public spaces above the covered sections of road.

## Short project description

Paris's Boulevard Périphérique is a 35km dual-carriageway ring road encircling the city. Built in the 1970s, it is generally accepted as the boundary between the city of Paris and its suburbs. The speed limit is 80km/h (50mph) and, with the number of vehicles travelling on the Périphérique reaching approximately 250,000 per day, it is one of the busiest stretches of road in Europe.

Noise generated by the dual-carriageway regularly exceeds the regulatory limit of 68dB(A) (62 dB(A) at night). In addition, higher than average levels of air pollution in the areas adjacent to the road are attributed to the large quantity of vehicles circling the city. Subsequently, and as part of a programme to undertake major infrastructure projects in Paris, three sections of the Périphérique were identified for 'roofing'. All three are major intersections:

- Porte des Lilas in the north-east.
- Porte de Vanves in the south-west.
- Between Porte des Ternes and Porte de Champerret in the north-west.

The areas above the road are landscaped to provide green spaces and to reconnect the city with the suburbs, both physically and visually.

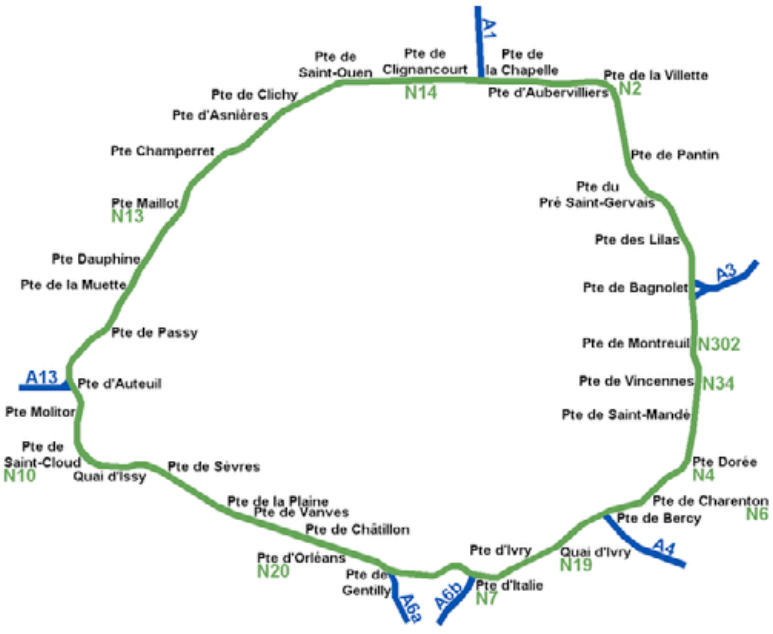


**FIGURE A4.0**
MAP OF THE PÉRIPHÉRIQUE

### CITY CONTEXT

Paris, situated in the Île-de-France region, is the capital and largest city of France. The population of the city is approximately 2.1 million and the entire population of the Paris metropolitan area is calculated to be in excess of 11.5 million inhabitants. The city is divided into 20 administrative districts (arrondissements) arranged in the form of a clockwise spiral starting in the middle on the Right Bank of the river Seine.

Home to La Défense, the largest business district in Europe, Paris produces more than a quarter of the gross domestic product of France. The city is also a major tourist destination.

### TRANSPORT POLICY CONTEXT

The transportation system in Paris is very diverse, with a number of different modes providing extensive connectivity not only across the city centre, but also in the city's outer-lying suburbs and districts.

The city has a total of 14 Metro lines, of which 12 operate as routes connecting the city centre to outer suburbs, and 2 that operate as lateral routes around the city centre. The Metro is supplemented by a number of other modes, including 5 RER (Réseau Express Régional) urban transit lines, that serve the outer parts of the Ile-de-France region (i.e. beyond the Metro termini), 6 Transilien suburban rail lines that serve areas not served by Metro or RER lines, 4 tramway lines in the outskirts of the city connecting to Metro and RER stations, and a large network of bus routes. In addition, 2007 saw the arrival of Velib, the city's cycle hire scheme, which, with over 16,000 bicycles and 1,200 bicycle stations, is the second largest in the world.

Paris has a series of inner and outer ring roads (similar to the North and South Circular routes in London) that supplement a series of diametrically aligned motorways that feed into the city. Roads in the city, particularly the Boulevard Périphérique ring road, have suffered from significant congestion. (*cont'd)*

## The Project

The project to 'roof' three sections of the Boulevard Périphérique aimed to cover more than a kilometre of road in an attempt to reduce noise and air pollution. The areas above the carriageway were to be landscaped to provide a better quality of life for local residents, promote a more attractive urban environment and build an urban link between the city and surrounding suburbs. The tunnels were built in accordance with safety standards introduced in the wake of the Mont Blanc Tunnel accident (1999) and include centralised traffic management systems, automatic incident detection technology, CCTV surveillance, increased ventilation in case of fire, and emergency lighting.

The Lilas and Vanves roofs were built between 2005 and 2008. The final stage of the project at Porte des Ternes and Porte de Champerret is yet to begin due to a combination of lengthy public consultations and, most recently, the withdrawal of previously promised state funding.

**FIGURE A4.1**
THE PÉRIPHÉRIQUE AFTER REDEVELOPMENT

## Funding and implementation

The project has been publicly funded by the City of Paris with the participation of the government and the Île-de-France administration. Initially, a €173.8 million budget was provide as follows:

- €51.8 million from the City of Paris.
- €61 million from the State.
- €61 million from the Île-de-France region.

However, the overall cost is expected to be €247.4 million:

- Porte des Lilas: €99 million (outturn).
- Porte de Vanves: €58.4 million (outturn).
- Porte des Ternes and Porte de Champerret: €90 million (projected).

The work completed to 2012 includes:

### 2005 to 2007: Porte des Lilas (2 parts)

- Linear length of section(s): 320m and 360m (including existing structures).
- Covered length: 260m and 140m.
- Surface area created: approximately 17,500 square meters.
- Cost: €99 million.
- Funding:
  - City of Paris – €47.4 million.
  - State – €22.6 million.
  - Île-de-France – €29 million.

### 2006 to 2008: Porte de Vanves

- Linear length of section: 410m (including existing structures).
- Covered length: 275m.
- Surface area created: approximately 10,000 square meters.
- Cost: €58.4 million.
- Funding:
  - City of Paris – €29.2 million.
  - Île-de-France – €29.2 million.

### Pending: Porte des Ternes (section between Avenue des Ternes and Stade Paul Faber) and Porte de Champerret (section between Rue du Caporal Peugeot and Rue de Courcelles)

- Linear length of section: 440m and 985m respectively (including existing structures)
- Prospective covered length: 180m and 280m respectively
- Potential surface area: approximately 9,700 and 14,000 square meters respectively.
- Projected cost: €90 million
- Proposed funding:
  - City of Paris – €45 million.
  - State – €35.7 million (withdrawn due to shortage of resources).
  - Île-de-France – €9.3 million.


**FIGURE A4.2**

THE PÉRIPHÉRIQUE, PRIOR TO AND AFTER REDEVELOPMENT

**TRANSPORT POLICY CONTEXT (CONT'D)**

In spite of the public transport provision available in the city, transport surveys carried out in the late 1990s highlighted an alarming trend of increased private transport use, particularly in the inner and outer suburbs of the city. At the same new laws came into force in France, stipulating that all conurbations with populations greater than 100,000 must prepare a form of urban travel plan, entitled a Plan de Déplacements Urbains or PDU. The Paris PDU was adopted at the end of 2000 for a five year period. At this time 61% of all trips within the city of Paris were made by public transport and 31% by car. However trips made between suburban locations were dominated by the car, which was used for 82% of them.

The primary aim of the PDU was to achieve a 5% reduction in private vehicle use for travel inside Paris and the inner suburb departments and between Paris and the other departments, and a 2% reduction for travel within the outer suburbs and between the inner and outer suburbs. In order to achieve this aim, the PDU targeted an increase of 2% in public transport use in the city as well as doubling the number of cyclists on the roads by 2006.

The Mobilien project is an initiative of the Plan de Déplacements Urbains Île-de-France (PDUIF).

Contract de projects État-région (CPER) are documents produced in France in which the state and the region agree to fund and undertake major infrastructure projects. In the Île-de-France CPER 2000-2006, the covering of three sections of the Périphérique was included in the environmental chapter under "urban renewal". The project was part of a wider initiative to improve urban spaces and quality of life for Parisians. It is separate from the city's transport policy which is focused on providing alternatives to the car as the primary mode of travel.

## Impacts of the project

*Mode share:* Dedicated cycle routes have been put in place in the areas above the road and walking greatly encouraged by enlarging areas accessible to people on foot. In 2010, modal split of journeys to work in the city centre were: 3% cycling, 12% private vehicle, 32% public transport, 52% walking and 1% other.

*Public realm:* Noise levels reduced (by 5 dB(A) at Lilas) and 275,000 square metres of space opened up in total for public use so far.

*Crime/security*: Prior to the project, some of these areas were neglected and the low footfall contributed to a reduced sense of safety. Redeveloping the areas above the roads has enabled residents to 're-claim' the spaces and facilitated safer passage.

*Economic impact:* Linking the city of Paris to the suburbs was intended to stimulate social and economic regeneration.

## Public acceptance/reaction

A survey of 1,400 residents carried out in 2001 to gauge opinion on the covering of the Périphérique found that 61% were satisfied with the plans, 25% either not satisfied or did not see this as a priority and 15% had not heard of it or had no opinion.

These figures suggest that members of the public were predominantly in favour of the project at inception. The mayor of the 17th arrondissement, where the final roof is pending (Porte des Ternes/Champerret), is firmly committed to persuading Parisian officials to finish the project.

Name of project: **Dublin Port Tunnel**
Location: **Dublin, Ireland**
Year: **2001-2007***
Cost: **€752 million, forecast cost approximately €580 million**

# A5

## Reasons for the project

Prior to the completion of the Dublin Port Tunnel ("the Tunnel"), access between Dublin Port and the national motorway network was via a series of city centre roads within Dublin. The Tunnel was designed to:

- Facilitate future growth in trade through Dublin Port without restrictions imposed by traffic congestion thereby contributing to the health of the local and national economy.
- Deliver benefits to Dublin City through the removal of HGV traffic from inappropriate city streets and contribute to the regeneration of the proposed Docklands Development Area.
- Release the necessary road space to allow the implementation of a range of public transport and amenity measures such as Quality Bus Corridors, LRT, pedestrianisation and traffic calming in residential areas.

## Short project description

The Dublin Port Tunnel is a twin bore tunnel of 4.5km in length which is now part of the M50 motorway and completes the northern part of the C-Ring around Dublin City.

The Tunnel is toll-free for Heavy Goods Vehicles (HGVs) and coaches with over 25 seats. A toll is charged for all other vehicles. The Tunnel has reduced the travel time between Dublin Port and the motorway to six minutes and (along with the introduction of the HGV Management Strategy) removed HGV traffic from Dublin city centre.

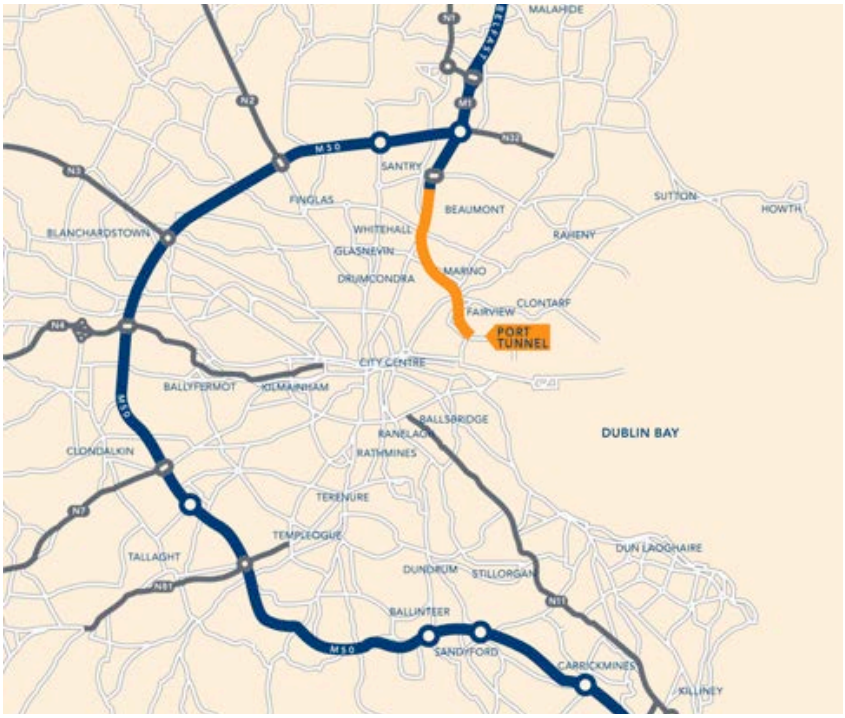


**FIGURE A5.0**
DUBLIN PORT TUNNEL

* Construction started in June 2001. The tunnel opened in December 2006 to HGVS and all traffic in January 2007. A complementary Heavy Goods Management Strategy was introduced in February 2007.

### CITY CONTEXT

Dublin is the capital city of Ireland and is situated near the midpoint of Ireland's east coast, at the mouth of the River Liffey and the centre of County Dublin. It encompasses a land area of approximately 115 km2. The Greater Dublin Area consists of two main areas: the existing built up area of Dublin and its immediate environs, referred to as the Metropolitan Area, and a Hinterland Area with extensive areas of countryside and a range of towns of various sizes.

The population of Dublin City is around 0.5 million with 1.2m people living in the Greater Dublin Area. Although a slowdown in population growth has recently taken place associated with the economic downturn, forecasts estimate that by 2030 the population of the Greater Dublin Area will grow from a current 1.8 million to 2.29 million.

Located in the centre of Dublin is Dublin Port, a key strategic access point for Ireland and the Dublin area. Dublin Port handles almost 50% of Ireland's trade, two thirds of all containerised trade and is the largest of the country's three base ports. Dublin Port handles over 1.76 million tourists through ferry companies operating at the port and cruise vessels calling to the port.

## The Project

The Dublin Port Tunnel is a twin bore tunnel of 4.5km in length with a height clearance of 4.65m. It is part of the M50 motorway and completes the northern part of the C-Ring around Dublin city. It is a dedicated route for Heavy Goods Vehicles between the Port, located in the heart of the city and the greater road network via the Coolock Lane Interchange (M50).

All traffic, arriving at, or heading to, Dublin Port had to previously travel through Dublin city centre. There were approximately 50 traffic lights between Dublin Port and the motorway, via the Quays. The introduction of the tunnel has seen that reduced to three with a direct link to the motorway and national road network in six minutes.

HGVs and buses travel free, but there is a toll charge for non-HGVs of €3 (non-peak periods) and €10 (peak periods: 06:00 to 10:00 southbound and 16:00 to 19:00 northbound, weekdays, excluding public holidays).

Planning for the Tunnel started in the 1990s as part of the 1995 Dublin Transportation Initiative (DTI) although the constructed scheme differs from the original concept (the DTI recommended a single bore tunnel).

The objectives of the Dublin Port Tunnel were to:

- Create a high quality link from Dublin Port to the M50 in six minutes.
- Reduce the number of Heavy Goods Vehicles in the city.
- Aid improvement of public transport, pedestrian and cycle facilities in Dublin City.
- Reduce traffic congestion and promote safer streets in residential areas.
- Reduce noise in Dublin City.
- Improve air quality.
- Facilitate the continued development of Dublin Port.

**FIGURE A5.1**
DUBLIN PORT TUNNEL ENTRANCE

## Funding and implementation

The project was largely publicly funded through the National Roads Authority (NRA) under the National Development Plan and Transport 21, and by the European Union from the Cohesion Fund at 85% Aid. The client for construction was Dublin City Council.

A design and build contract was awarded in December 2000 to the Nishimatsu, Mowlem, and Irishenco consortium for the sum of €448 million (against an anticipated cost of €353 million).

The total cost was forecast to be in the region of €580m including land acquisition, construction supervision and all other costs.

The final, overall cost is reported as €752 million. This includes the final cost of the construction at €448 million and €304 million for other project costs.

Construction difficulties were partly responsible for the overspend. The method used (New Austrian Tunnelling method, NATM) led to a collapse during construction.

The National Roads Authority is now directly responsible for the tolling and barrier system. The tunnel is managed by Transroute Tunnels Operations Limited on a fixed fee contract for operations and maintenance with the NRA.

## Impacts of the project

The National Roads Authority reported a total of five million journeys through the Dublin Port Tunnel in 2011, which is evenly split between HGVs and passenger vehicles.

*Usage:* In 2007, Dublin City Council reported an initial take up by 5+ axle vehicles of the order of 3,330 5+ axle vehicles per day and that the introduction of the HGV ban increased the number of 5 axle vehicles by 44% to 4,831 5+ vehicles per day. The current average daily figure is 5,246 vehicles representing an increase on pre ban introduction figures of 57%.

The Tunnel is reported as carrying less traffic than forecast.

*Congestion:* In 2009 Dublin City Council reported that the introduction of the HGV Management Strategy had resulted in a significant reduction of 5+ axle vehicles within the city centre area of between 88-96%. This was reflected in the fact that over 3,582 5+ axle vehicles used the tunnel per day in 2009.

*Mode share:* The Council also reported that this shift "made it possible to reallocate valuable road space to public transport, an example of this is the bus lane along the North Quays at Arran Quay".

### TRANSPORT POLICY CONTEXT

The road network in Ireland is primarily focused on Dublin. The M50 motorway, a semi-ring road which runs around the south, west and north of the city, connects important national primary routes to the rest of the country. The Greater Dublin Area, Draft Transport Strategy reports estimates of over 4.5 million journeys being made by people in the Greater Dublin Area on a typical weekday (2006). Approximately 80% of vehicles on roads were cars or taxis, and 20% were vans, lorries or buses.

The Dublin Transportation Office published its strategy for the period up to 2016 – A Platform for Change – in 2001. The Dublin Port Tunnel was proposed by this strategy as part of an integrated series of road improvements, intended to improve orbital movement and connections to the rest of Ireland.

Dublin City Council introduced a Heavy Goods Vehicle (HGV) Traffic Management Strategy in February 2007 to encourage maximum use of the Tunnel by port-related traffic and to enhance the city centre environment through a ban on 5+ axle vehicles in Dublin city centre during the hours of 07.00-19.00, seven days a week, from a designated cordon area. A limited permit scheme for 5+ axle vehicles that need to load/unload within the city centre area also exists. The objectives of the HGV Strategy were:

- Maximise the use of the Tunnel and minimise use of the city streets by HGVs travelling to/from Dublin Port.
- Minimise the conflicts between delivery and service requirements of businesses and the needs of all other road users.
- Manage, for a limited period, the small number of 'over height' HGVs, that cannot use the Tunnel, on the city's streets.
- Manage diverted HGVs under partial or full Tunnel closure conditions.
- Operate an East Link rebate scheme for affected hauliers, whereby HGVs can be refunded the toll at the East Link Toll Bridge.

Other schemes brought forward by Dublin City Council as a result of the Tunnel and HGV scheme include the Liffey corridor traffic plan - a potential rearrangement of traffic on the Liffey Quays in Dublin (from Phoenix Park to the O2). The purpose of this project is to maximise facilities for cyclists and pedestrians whilst maintaining priority for buses. Options currently being considered include taking traffic off the north quays, limiting one side of the river to buses and cyclists and reversing traffic flows. Measures being considered include segregated cycle lanes, wider footpaths and optimising cycle, pedestrian and bus "wait times" at junctions, physical segregation of bus lanes, contra-flow bus lanes, junction priorities and turning bans.

## Public acceptance/reaction

Information not obtained.

Name of project: **Bjørvika (E18) Tunnel**
Location: **Oslo, Norway**
Year: **2005-2015**
Cost: **NOK 6.48billion**

# A6

## Reasons for the project

The Bjørvika (E18) Tunnel enabled the European Route E18 (E18 motorway) to be relocated to the Bjørvika Tunnel, facilitating the largest city development project in Oslo's history, Fjordcity. The tunnel project was planned to: reduce surface traffic in Bjørvika (thereby also reduce local air and noise pollution): create a new street network connecting Bjørvika to the rest of Oslo (thereby providing Oslo with access to the fjord): and facilitate the development of a new city district, Bjørvika.

## Short project description

The Bjørvika tunnel is the first immersed tunnel built in Norway. It links the Festning tunnel in the west with the Ekeberg tunnel in the east, redirecting the E18 motorway away from the Oslo waterfront and facilitating redevelopment of the Oslo waterside. Construction of the tunnel started in 2005 and the tunnel opened in 2010. The once heavily industrial port is now being developed into a public space for living, working and recreation. The surface road section will be completed in 2015.

**FIGURE A6.0**
ROUTE OF THE BJØRVIKA TUNNEL UNDER THE HARBOUR

### CITY CONTEXT

Oslo is the largest city and capital of Norway. It is the Norwegian economic and governmental centre and an important European base for maritime industries and trades. It occupies an arc of land at the northernmost end of the Oslofjord. The city itself has a population of around 0.6 million with the Greater Oslo Region population being around 1.4 million.

Fjord City is a long term urban development project for the waterfront part of the centre of Oslo. The area comprises 30,000m², from Frognerstranda to the west to Ormsund in the southeast. It is a residential, commercial and mixed use redevelopment focusing on public space and linking the existing city centre to the new waterfront areas.

The Bjørvika development, of which the Bjørvika tunnel project plays an important part, is the largest of the nine urban areas comprising the Fjord City Plan. The Bjørvika project covers an area of 7,000m² between the fjord and the Oslo Central Rail Station, previously dominated by infrastructure and industry. The new development will consist of 40% parks, walkways and squares, 20% street surface and 40% mixed use buildings. This will provide approximately 1 million m² of additional floor space. Several large cultural institutions have or will be located to Bjørvika, including the Oslo Opera House and Oslo Public Library, with others being discussed. The Bjørvika development is likely to be completed in 2020.

## The Project

The Bjørvika tunnel links the Festning tunnel in the west with the Ekeberg tunnel in the east. The three tunnels together make up the Opera tunnel, with an unbroken length of six kilometres from Framnes (Kiel ferry terminal) to Ryen, under Oslo city centre.

Complex work from the quay side and into the existing tunnels was carried out from both directions, and an underground road intersection was built in the rock at Ekeberg with exits and slip roads in both directions.

The section of the Festning tunnel adjacent to the new Bjørvika tunnel was lowered in order for the road level to be aligned with the immersed tunnel road level. A 100m basement was excavated under the existing tunnel and a new floor was cast with a profile that met the immersed tunnel road.

The Oslo fjord mainly consists of clay and in some places the bedrock is as deep as 50m below the top of the clay layer. An immersed tunnel was therefore chosen. The immersed tunnel was built on land and submerged under water to its final position on the seabed, approximately 20m below sea-level. Six tunnel elements were built in a dry dock in Hanoytangen in Western Norway, and floated the 800km to Oslo over five days by tugboat. Each element was 112.5m long and weighed approximately 37,000 tonnes.

The immersed tunnel consists of two tubes, each carrying three lanes of traffic, and sufficient height inside the tunnel for signs, fans, surveillance systems and lighting. The tunnel has sufficient strength and built-in flexibility which enables it to withstand earthquakes.

The Bjørvika tunnel project also includes surface roads and will provide:

- 1,100 metres of tunnels, 675m of which is immersed.
- 8,000 metres of roads (including tunnels).
- 4,500 metres of pedestrian and cycle paths.
- 1,200 metres of public transport lanes.

A new road network linking Bjørvika to the rest of Oslo is under construction and a new main avenue, Dronning Eufemias Gate, is to be constructed and will serve as a main route for public transport. With through-traffic being moved below ground, the main focus of the new road network is to create an efficient public transport system and walking and cycling routes.

## Funding and implementation

Construction of the tunnel elements was started in 2005 in a dry dock outside Bergen, and completed in 2008. These were then towed to Oslo and anchored alongside the Bjørvika quay-side by the spring of 2008. The submersion and installation work then began, taking around two weeks per element. The tunnel was opened and operational in 2010, and the surrounding street network is due for completion in 2015.

The cost of building the Bjørvika tunnel and improving the surrounding road network was NOK 6.48billion (€888.6 million at current exchange rate). The project was funded through a mix of finances including state grants, toll road revenue, Oslo municipality funding and property sales.

### TRANSPORT POLICY CONTEXT

During the 1970s car traffic greatly increased in Oslo, and there was a political desire to speed up investments in motorways and tunnels in the city. The 'Oslo Package' was created, a political agreement and plan for investing in road infrastructure in Oslo and Akershus. The main objectives were to move road traffic to the ring roads, reducing the amount of traffic in the city centre and freeing up capacity in the main arteries. The first project was to build the Festning tunnel, which redirected the E18 motorway and allowed the City Hall Square to become car free.

Congestion charging plays an important role in financing the infrastructure improvements. The current "Oslo Package 3" includes the Bjørvika tunnel.

As for all major infrastructure projects in Norway, the Bjørvika tunnel was included in the national transport plan framework, a 10-year rolling plan that lays out the government's cross-modal infrastructure strategy. As part of the development of this plan every fourth year, a large consultation exercise is undertaken where all levels of government, interest organisations and the general public (direct through a website or representation) get to have their say.

**FIGURE A6.1**

TUNNEL ELEMENT UNDER CONSTRUCTION IN A DRY DOCK IN WESTERN NORWAY – SPECIALIST EQUIPMENT CARRIED OUT THE MARINE BASED OPERATIONS, LAYING A GRAVEL FOUNDATION ON THE EXCAVATED FJORD BOTTOM

## Impacts of the project

As the project is still underway, no surveys of the effects of the development have been undertaken.

*Usage:* It is calculated that approximately 100,000 vehicles will use the tunnel daily.


**FIGURE A6.2**
OSLO WATERFRONT BEFORE THE OPENING OF THE BJØRVIKA TUNNEL

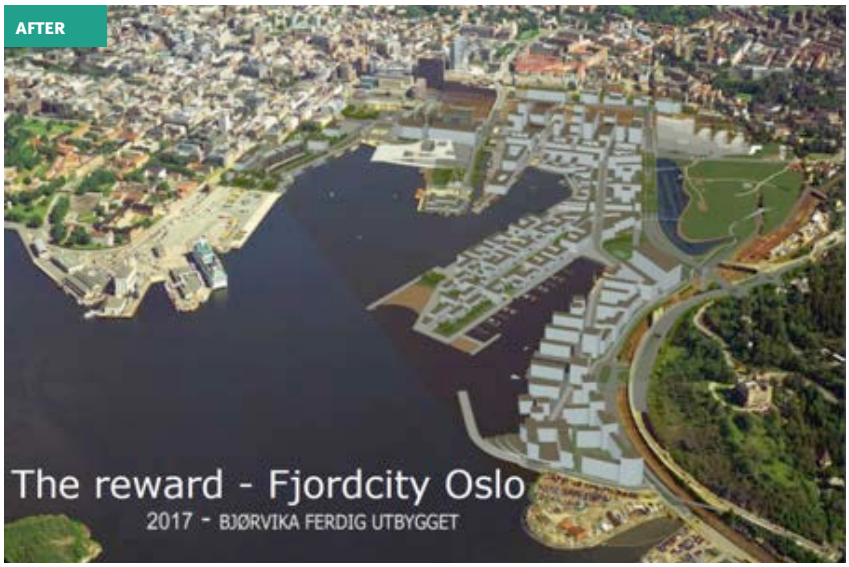


**FIGURE A6.3**
FUTURE VISION OF OSLO WATERFRONT

*Mode Share:* The overall development will lead to an increase in local traffic, however 30% of trips are estimated to be walking or cycling, and there will be a much higher percentage of public transport usage than if the development took place at a less central location in Oslo. Parking in the development area will be limited.

*Highway and Public Transport Journey Times:* The travel distance on the E18 motorway through Oslo is reduced by approximately 30% for traffic using the tunnel. The remaining surface traffic will be dispersed more on the new and better linked roads, so individual roads will have a reduction in traffic. For instance the current main north-south route from Bjørvika will have around 50% reduction in traffic.

A new, more direct, east-west corridor with dedicated lanes for public transport (tram, bus and cyclists) will improve journey times and reliability for public transport users.

*Congestion:* Surface traffic in Bjørvika has reduced by 70% since the E18 was moved underground.

*Air quality and environment:* The tunnel will provide improvements in local air quality through shortening the travel distance on E18 through Oslo, regular cleaning of the tunnel interior and leading the tunnel air out at a sufficient high over the city for it to be dispersed. Modelling show the air quality in 2015 will be better than today and within national and European Commission limits.

As part of the project 1,170,000 tonnes of contaminated sediments from the Bjørvika harbour have

been excavated and removed to secure storage. The sediments contained heavy metals, oil and organic compounds. This is the most extensive harbour clean-up project ever carried out in Norway.

*Public Realm:* The project has had a strong focus on public realm, and of the 7,000m² development 40% will be walkways, parks and squares. This includes seven corridor parks connecting the development and the fjord to the city. These will provide local recreational areas, connecting walkways through the city centre and vistas of key features in the city. Existing rivers and waterways will be opened up to form part of some of these corridor parks, as well as a beach and allotment gardens. A 3.5km pedestrian walkway along the water edge will be connected to a longer walkway system along the fjord.

New streets, which are being built as an extension of the existing street network will form 20% of the development space, with the main east-west road planned as a "boulevard"-style street with plantings and wide pavements.

Noise pollution will be halved as around 100,000 vehicles daily will be removed from the area, and moved underground.

*Road Safety:* A safety analysis of the tunnel concluded that road safety and security will be improved. This was based on the provision of a more segregated road network, a clearer road hierarchy providing better legibility, and existing risk levels based for surface and tunnel traffic in Norway. The analysis took fire safety into account.

*Regeneration/Redevelopment:* The project will release approximately 1 million m² of additional floor space, which will be used for 4,000-5,000 new dwellings as well as office, cultural, trade and service uses. The overall development is planned to provide 15,000-20,000 work places.

The development does not include any social housing, but the public spaces and cultural institution will be open for all.

*Physical Accessibility:* Relocating the motorway from the surface, has removed the main barrier between the city and the fjord, and created newly available waterside surface space. As mentioned, the seven corridors connecting the fjord and the development with the city will improve pedestrian access through the area. The new street structure will make the areas significantly easier to navigate.

Accessibility for disabled, as required by Norwegian law, was an important premise for the development and has influenced the design of walkways, public transport access and outdoor areas, as well as the new buildings.

*Other:* Construction work is being followed closely by archaeologists as the area was Norway's most important port over several hundred years and lies between the two first settlements in Oslo. The archaeologists have found a magnitude of relics which provide insight into the use of the port and historic life in Oslo.

## Public acceptance/reaction

The tunnelling of the E18 and redevelopment of the Bjørvika waterfront underwent a standard policy consultation process as part of the national transport plan development process and as part of the local Fjord City plan development process. Consultation has been undertaken at all stages of the planning process. Some details of the Bjørvika development are still under discussion and consultation.

Due to the size of the tunnel and road project, the national road authorities have invested considerably in providing information to the general public. An information centre has been built on site with a permanent staff presence and an education centre that welcomes school and community groups.

Overall, the Bjørvika development has been very well received. For the transport part of the project the only issues have been concerns about fire safety due to the length of the overall tunnel combined with the very high traffic volumes, the suggested rerouting of the tramway and the design of the main east-west corridor, Dronning Eufemias Gate.

With regard to the overall Bjørvika development there has been/are discussion about the potential relocation of cultural institutions to Bjørvika, the design of the buildings and criticism that the accommodation is too expensive, resulting in a homogenous residential group.

Project: **Madrid Calle 30**
Location: **Madrid, Spain**
Year: **2004 -2007***
Cost: **€3.9 billion, forecast €1.7 billion**

# A7

## Reasons for the project

Madrid's inner ring road, the M30 motorway – constructed over a 30 year period and completed in the early 1990s – had become a serious barrier to movement in Madrid's urban areas and, as the country's busiest road, suffered from long traffic jams and congestion. It was also the cause of serious air and noise pollution and contributed to the contamination of the adjacent Manzanares River.

## Short project description

The Madrid Calle 30 upgrade project was undertaken with two main objectives: to refurbish the motorway, which was badly in need of structural work; and to reroute major sections of it through tunnels under the city. These works created opportunities to reconnect the city with the Manzanares river, improve air and river water quality, reduce noise pollution for residents in the surrounding areas, redevelop surface areas into parks, footpaths, cycle paths and build new affordable housing. The new sections of road construction total 99 km, of which 56 km are in tunnels.

**FIGURE A7.0**
M-30 CURRENT SITUATION

* Construction started in September 2004 and was completed by the second quarter of 2007.

### CITY CONTEXT

Madrid is the capital and largest city of Spain. The population of the city is roughly 3.3 million and the entire population of the Madrid metropolitan area is calculated to be 6.5 million. It is the third largest city in the European Union, after London and Berlin, and its metropolitan area is the third largest in the European Union after London and Paris.

The city is located on the Manzanares river in the centre of both the country and the Community of Madrid (which comprises the city of Madrid, its conurbation and extended suburbs and villages). As the capital city of Spain, seat of government, and residence of the Spanish monarch, Madrid is also the political centre of Spain.

### TRANSPORT POLICY CONTEXT

This project falls within the Planning Policy for the period 2003 – 2011.

This large scale remodelling of the city (the biggest remodelling of a major city in Spain) had the following goals:

- Remove the barrier to movement that the M-30 had become.
- Reduce air pollution due to traffic congestion.
- Curb pollution and damage caused to the Manzanares river.
- Create a new development area dedicated to green parks, footpaths, cycle paths and new affordable housing.

## The Project

The motorway reconstruction took place in sections and was divided into 15 separate projects across four different regions – north, south, east and west, as seen in Figure A7.1.

Project objectives included: an increase in the capacity of the M-30; environmental and public realm improvement of land surrounding the old sections of the M-30; and the regeneration and clean-up of the Manzanares River. There were also improvements to radial connections and to Madrid's surrounding secondary roads which have significantly reduced intra-city travel times.

All new surface area freed up has been used as green areas, rather than for development.

## Funding and implementation

The project was promoted by Madrid Calle 30. Initially Madrid Calle 30 was a public company backed by Madrid City Council but in December 2004 the Council agreed to turn the agency into public private partnership (PPP) funded with 20% private capital from the construction companies involved in the project. The partnership includes maintenance, refurbishment and operational responsibilities over a 35 year period.

The new sections of road totalled 99km, 56km of which is in tunnels. Construction started in September 2004 and was completed by the second quarter of 2007. The motorway reconstruction took place in sections and was divided into 15 separate projects across four regions – north, south, east and west – tunnelled sections were constructed using either bored or cut and cover techniques.

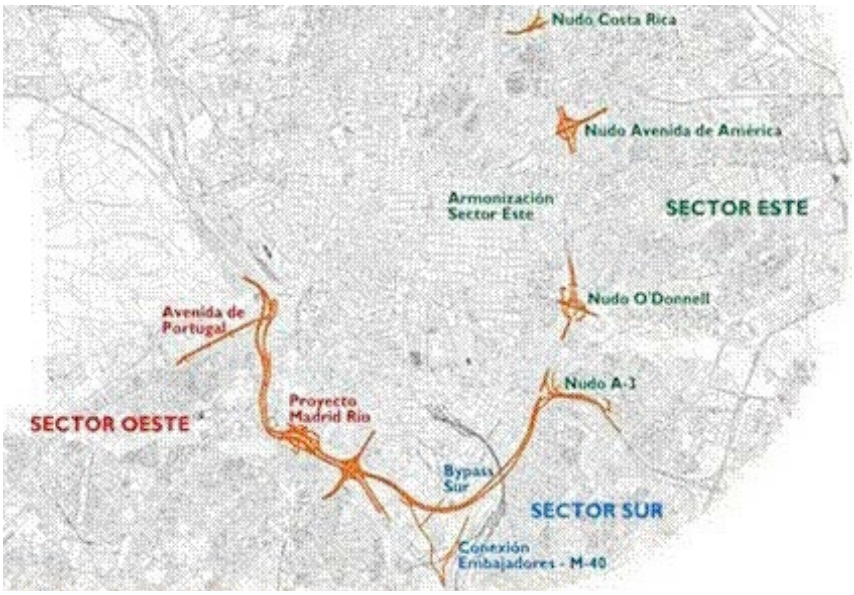


**FIGURE A7.1**
M-30 PROJECT

The second stage, from 2007-2011 focused on the creation of a new development called "Madrid Rio" on the west side of the city.

The tunnels created for the M-30 project were:

### M-30 NORTH TUNNELS

- **By-pass Norte:** overall length 10,525m (4,817m of cut and cover tunnel, 4,187m of conventional tunnel), term of contract 30 months, estimated cost €722m (west tunnel €293 million, east tunnel €429m).
- **Conexión by-pass Norte con A-I:** overall length 5,479m (4,463m of conventional tunnel), term of contract 30 months, estimated cost €474m.

### M-30 SOUTH TUNNELS

- **By-pass Sur:** overall length 8,344m (7,212m of conventional tunnel, 632m of cut and cover tunnel), term of contract 30 months, total estimated cost €792m (north tunnel €340 million, south tunnel €429m).
- **Conexión Embajadores con M-40:** overall length 5,800m (2,460m of cut and cover tunnel), term of contract 18 months, total estimated cost €74m.

### M-30 EAST TUNNELS

- **Nudo de la Paloma:** overall length 5,508m (1,546m of cut and cover tunnel, 175m of conventional tunnel), term of contract 24 months, estimated cost €56m.
- **Nudo de Costa Rica:** overall length 2,078m (892m of cut and cover tunnel, 175m of conventional tunnel), term of contract 15 months, estimated cost €27m.
- **Nudo de la A-2:** overall length 4,460m (510m of cut and cover tunnel, 140m of viaduct), term of contract 16 months, estimated cost €25m.
- **Nudo de O'Donnell:** overall length 6,800m (150m of cut and cover tunnel, 150m of viaduct), term of contract 18 months, estimated cost €18m.
- **Nudo de la A-3:** overall length 4,800m (1,400m of cut and cover tunnel, 430m of conventional tunnel), term of contract 24 months, estimated cost €187m.

### M-30 WEST TUNNELS

- **Excavation av. de Portugal Hasta Gta. San Vicente:** overall length 2,983m (2,674m of cut and cover tunnel), term of contract 36 months, estimated cost €159m.
- **Excavation M-30 between paseo Marqués de Monistrol and puente de San Isidro:** overall length 12,759m (12,719m of cut and cover tunnel, 40m of traditional tunnel), term of contract 36 months, estimated cost €618m.
- **Excavation between the bridge of San Isidro and the bridge of the Princess:** overall length 12,212m (11,852m of cut and cover tunnel, 360m of traditional tunnel), term of contract 26 months, estimated cost €450m.

## Impacts of the project

*Congestion:* A positive outcome is the redistribution of metropolitan traffic, reducing congestion in central Madrid. Trips on the M-30 have increased by 3% since the tunnel was opened and traffic on other routes has decreased by 2%. There has been an overall reduction of traffic in the city, but this may in part reflect the economic crisis.

*Air Quality:* There have been reductions in air pollution with the city authorities reporting a 26.3% reduction in nitrogen oxides (NOx) emissions between 2006 and 2009. The city also reported that noise pollution has been significantly reduced for 60,000 people since the road was buried.

The lack of an environmental impact study was one major shortfall of the project and could have resulted in reduced noise and pollution levels during construction.

*Public realm:* The project resulted in the creation of over 30 hectares of new public space. Madrid City council opened an international design competition to generate creative solutions for these spaces, one of them being 'Madrid Rio' where the underground diversion of the M-30 along the river basin led to the greatest urban-realm rebalancing operation in Madrid's recent history. There is now a large green corridor that stretches along the river – previously dominated by the M-30 and cars – linking forests, parks, and historic gardens, which were once fragmented by the road network.

*Economic impact:* Although the project did not release new land for commercial development it has been reported that the value of the houses near the river has increased about eight per cent.

## Public acceptance/reaction

The project has been surrounded by controversy from the start.

On one side the local government emphasised the overall benefits of the project; improving traffic flow in the city and the creation of new public spaces for sport and leisure. On the other side some environmental groups and opposition groups were against the project due to the lack of an environmental impact study and high costs.

While Madrid City Council tried to promote the environmental benefits of the project, environmental activists raised the issue that,

**FIGURE A7.2**
MADRID RIO

although large sections of the M-30 would be rerouted underground, the amount of traffic using the motorway would increase and therefore pollution problems would remain. The council responded by releasing figures of projected reduction in emissions.

In 2006 when the project was nearing completion, a survey was conducted with residents to gauge the public reaction to the works. Almost 70% of residents stated that they had been affected in some way by the construction works. Reasons given included: living in close proximity to the works; having to find alternative routes to/from work; and, congestion of the alternative routes used. Interestingly, the same percentage of people surveyed stated that the benefits of the overall project were worth the short-term issues faced. The main reasons for this were:

- Reduction in congestion.
- Creation of green areas.
- Fewer traffic accidents.

Although the project has had widely accepted positive outcomes, many people are still concerned about the cost of the project to the city taxpayers – over €6 million.


**FIGURE A7.3**
M-30 BEFORE TUNNELLING


**FIGURE A7.4**
THE NEW DEVELOPMENT AFTER TUNNELLING

Project: **Paris urban street design**
Location: **Paris, France**
Year: **2000-ongoing**
Cost: **Unknown**

# A8

## Reasons for the project

The main aims of the Paris urban street design project are to ultimately reduce both car use and air pollution and to rearrange the public space to favour more sustainable modes of transport.

## Short project description

The Paris urban street design project is a series of initiatives originating from the regional transport plan for the city of Paris, designed to encourage more sustainable travel around the city, and ultimately reduce motor vehicle traffic and air pollution. These initiatives include development of a new integrated bus network network, entitled Mobilien, and the concurrent creation of widened, dedicated bus lanes, changes to freight and delivery policies, and removal of on-street parking, in particular free on-street parking.


**FIGURE A8.0**
BUS LANE WITH CYCLES ALLOWED

### CITY CONTEXT

Paris, situated in the Île-de-France region, is the capital and largest city of France. The population of the city is approximately 2.1 million and the entire population of the Paris metropolitan area is calculated to be in excess of 11.5 million inhabitants. The city is divided into 20 administrative districts (arrondissements) arranged in the form of a clockwise spiral starting in the middle on the Right Bank of the river Seine.

Home to La Défense, the largest business district in Europe, Paris produces more than a quarter of the gross domestic product of France. The city is also a major tourist destination.

### TRANSPORT POLICY CONTEXT

Paris's transportation network is highly connected and multi-modal, featuring buses, trams, suburban trains, Metro, RER (réseau express regional), autoroutes and cycle lanes. It is also the only city in France where policy is decided at a national level rather than at a regional or city level.

This series of initiatives form part of the plan for the Île-de-France region, the Plan de Déplacements Urbains Île-de-France (PDUIF). All French conurbations with populations greater than 100,000 have to prepare a Plan de Déplacements Urbains (PDU), or Urban Travel Plan. These plans must contain appropriate measures for reducing traffic, developing public transport and encouraging walking and cycling as alternative means of environmentally friendly travel. The PDUIF was adopted at the end of 2000 for a five year period. It did not seek explicitly to curb car traffic, but to reorganise public space in favour of sustainable modes of transport. Certain objectives were quantified, such as reducing car traffic by 3% and increasing the use of public transport by 2%, as well as doubling the number of cyclists on the roads by 2006.

## The Project

The Paris urban street design project is a series of initiatives to help ultimately reduce the levels of pollution not just in the centre of Paris, but throughout the city as a whole.

The first of these initiatives was to create a 41km network of widened bus lanes that would be separated from other traffic lanes with raised pavements. The initial phase of this work involved widening approximately 7km of existing bus lanes and protecting these with newly constructed pavement barriers. This initiative was continued and further developed as part of the new Mobilien bus network in the city (see Case Study B15).

All of these widened bus lanes are open to emergency vehicles and taxis across the city. Taxis are also allowed to pick up and drop off passengers within these lanes.

Cyclists are allowed to use the majority of the bus lane network (approximately 83%) – the policy being to allow shared use where it is safe to do so. Motorcyclists are not allowed to use the lanes, in spite of numerous campaigns to allow them to do so. The only instances where private vehicles are allowed to use the bus lanes are for access to property on a particular route.

Removing on-street parking spaces, in particular free-of-charge spaces, was another aim of this project and much of the area needed to widen existing bus lanes or create new ones was reclaimed from on-street parking. In addition to creating space for bus lanes, on-street parking was removed in 2007 to make way for Velib cycle docking stations (the city's cycle hire scheme), and on request from the city's fire department, who wanted to remove on-street parking on narrow streets to ensure easier access for fire vehicles. Of the


**FIGURE A8.1**
BUS LANE, NO CYCLES ALLOWED

on-street parking that remained, nearly all spaces that previously operated free-of-charge were changed to pay and display spaces.

Another initiative was to encourage less frequent deliveries, and more night-time deliveries outside peak hours for private vehicles by making regulations for delivery and servicing vehicles simpler and easier to comprehend.

The principle behind the regulations remained the same (i.e. the bigger the vehicle, the greater the time regulation, with vehicles defined by the amount of road space they occupy). It was determined that vehicles occupying less than 16m² were allowed to deliver goods at all times in the city, but were not allowed to use bus lanes at peak times. Those between 16m² and 24m² were allowed to deliver at all times, except for between 4.30pm and 7.30pm on weekdays, and those greater than 24m² allowed to deliver only between 7.30pm and 7.30am.

These size limits were themselves increased from 12m² to 16m² and from 20m² to 24m², to encourage delivery companies to better consolidate their loads and increase the length of their delivery rounds, which would ultimately reduce the number of journeys being made.

There was also a change in restrictions on loading bays to allow overnight residential parking in delivery bays that would otherwise remain empty.


**FIGURE A8.2**
BUS LANE SIGNAGE

## Funding and implementation

Funding for both the individual schemes and for the project as a whole is unknown. Details of Mobilien costs are supplied on the Mobilien case study.

The initial phase of the bus lane widening scheme was started in 2000, and continued as part of the Mobilien project which started in 2000/01. The scheme is now part of the on-going construction of the Mobilien network.

The change in freight and delivery policies were also established in 2000 and 2001, in part following the implementation of the new widened bus lanes.

Changes in on-street parking began in the early 2000s, with large scale changes occurring in 2006/07 because of the construction of the cycle hire network.

## Impacts of the project

*Daily usage:*

- Between 2000 and 2007, the number of hourly vehicle kilometres (i.e. the average total distance travelled by cars in Paris in a given hour) fell by 22%, an average of a 3.5% decrease each year.
- During the same period, the number of hourly vehicle kilometres travelled by cars on the Paris ring road fell by 8% (an average of 1.2% each year).
- The number of private cars. recorded in Paris fell by nearly 15% in the same period, from 787,000 in 2000 to 673,600 in 2007. The number of trucks fell by a similar rate, from 136,000 in 2000 to 117,700 in 2007.
- In contrast, the number of bicycles has increased from 23,300 in 2002 to 57,800 in 2007, in part due to the introduction of Velib, the Parisian equivalent of the Barclays Cycle Hire scheme. In addition, the total amount of cycle paths has increased from 180.5km in 2000 to 399.3km in 2007. This includes the agreement in 2001 to allow cyclists to travel in bus lanes.

*Mode share:* In terms of the composition of traffic, the share of private vehicles fell from 69% in 2000 to 60% in 2006, with much of the change attributable to an increase in the mode share of motorcycles, buses and commercial vehicles.

*Air quality and Environment:* Monitoring of four key pollutants in the Paris area (nitrogen dioxide, Ozone O3, Sulphur dioxide, and PM10 fine particles) between 2000 and 2007 showed that nitrogen and sulphur dioxide levels had noticeably improved(by 26% and 64% respectively), where Ozone O3 levels have been gradually increasing since 2000, and PM10 fine particle levels have stayed almost constant since 2000.

*Public realm:* The amount of on-street parking in Paris fell by 6.6%, from 170,000 to 158,700, between 2003 and 2007. In particular, the number of free spaces fell from 36,000 in 2003 to 2,700 in 2007. Much of this parking remains, but parking charges now apply. Restrictions on who can use parking spaces are also much stricter, with nearly 90% of spaces open to all cars but for a maximum of two hours.

Resident permit holders however, can park for an unlimited time. Roughly 4,000 on-street parking spaces were removed to make way for Velib cycle docking stations.

*Road safety*: The number of accidents recorded on the streets of Paris fell by 21% between 2000 and 2006. The number of accident victims on Parisian roads fell by nearly 25% in the same time period, though the number of fatalities remained constant.

*Servicing access:* An initial issue with servicing access, which arose as a result of the reduction in highway lanes for the construction of bus lanes, was that delivery vehicles were required to stop in regular lanes adjacent to the bus lanes. This resulted in significant traffic jams and a safety risk for delivery personnel who had to transport goods across bus lanes.

As a result of pressure from the Police, the city centre zones where this issue caused significant problems were reorganised to allow delivery vehicles to park safely away from traffic. Delivery zones lay partially in the bus lanes, with some pavement space reclaimed to make space for these vehicles.

## Public acceptance/reaction

The main issue with delivery of this project was the extension of timescales (also highlighted in the Mobilien case study) and the extent of delays to project completions, which were the result of protracted discussions as to who had ultimate responsible for project delivery.

In terms of encouraging more travel by sustainable modes, a survey of cyclists in 2007 (both Velib and private cycle users) found that 60% of cyclists found that the increase in green areas have made life easier for cyclists, with 50% saying that increase in traffic calming measures have made it easier. Around 44% said that pedestrian zones have made it easier for cyclists. There is also greater understanding of the change in laws that allows cyclists to use bus lanes during their journey.

With regards to the removal of on-street parking and the heightened restrictions on the remaining parking spaces, significant complaints have arisen as a result of drivers parking illegally, either in disabled spaces, on pavements, or in loading bays. In total, around 50% of all parked vehicles in the city in 2007 were seen to be compliant with parking regulations, which has improved from 40% in 2003, but remains low. The number of penalties and citations handed out to car drivers for illegal parking has also reduced significantly, having stood at over 88,000 in 2003, before falling to around 28,000 in 2007. Another issue was the timing of the initial implementation of the widening bus lanes. The initial phase was undertaken during the summer, when a large number of Parisians were on holiday, who then returned to find the new bus lanes in operation.

**FIGURE A8.3**
DELIVERY VEHICLE, SHARED BUS LANE & PAVEMENT

Project: **Frankfurter Strasse Redevelopment, Hennef**
Location: **Frankfurter Strasse, Hennef, Germany**
Year: **Completed 1990 - 1991**
Cost: **5.1 million DM**

# A9

## Reasons for the project

Completion of a city bypass in 1990 meant that Franfurter Strasse was no longer needed as a main general traffic route. This project was undertaken to take advantage of this opportunity to redefine the street for residents and shoppers.

## Short project description

Frankfurter Strasse is Hennef's main retail street. Before the project began, the road was a dual carriageway and part of the national road network. It was designed to serve traffic travelling through the town, rather than to serve people living and shopping there. Following the completion of the city bypass, Frankfurter Strasse was redefined to improve the attractiveness of the street for walking, cycling and socialising. Public realm improvements were also used to manage the volume and speed of vehicle traffic.


**FIGURE A9.0**
FRANKFURTER STRASSE REDESIGN

### CITY CONTEXT

Hennef is a town of over 46,000 residents in the Rhein Sieg district of North Rhine-Westphalia, Germany. It lies next to the river Sieg and is surrounded by villages and countryside. Bonn is 15km West of Hennef, and Cologne is 30km Northwest. Hennef railway station is on the Cologne-Siegen main line. The track divides the town into northern and southern halves. Frankfurter Strasse cuts through both.

The town hall, marketplace, and majority of the town's retail activity is centred around the 4km long Frankfurter Strasse.

### TRANSPORT POLICY CONTEXT

The last stretch of the 560 highway which bypasses the bulk of the town was completed in March 1990, with significant sections having been completed earlier. The bypass, funded by the federal transport improvement programme meant that Frankfurter Strasse was no longer required as a main link in the national road network and could be redefined.

Hennef has a car ownership level of 0.52 registered cars per person, (compared to 0.5 for Germany as a whole) but the town is also regarded as being good for cycling and walking, and is connected to 100km of hiking trails.

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## The Project

A 1.5km long section of Frankfurter Strasse was converted from a busy, dual carriageway predominantly serving through-traffic, to a pedestrian orientated shopping street. The redesign has created a safer and more pleasant high street by prioritising pedestrian and cyclist movements.

Lane widths for cars were reduced to 5.2m wide and pavements were widened. A 1m wide strip of granite cobbles was added between the carriageway and the pavement to visually reduce the width of the road and provide pedestrians with an extra buffer against the traffic. Overhanging trees also visually narrow the road. All parking is in defined, metered bays.

Cars avoid the cobbled part of the road and slow down as they approach narrowed sections. A flush, cobbled median with street lighting was also added down the centre of the road to help pedestrians to cross at any point. By locating the street light columns in the central median, the designers avoided conflicts between lights and tree canopies, allowing a bold, continous line of trees to be planted down either side of the carriageway. Parking bays are marked out with paving, and are level with the footway.

Cyclists can choose to use either the carriageway or are permitted to use the widened footway if travelling at walking speed.

High quality materials and a consistent palette were used throughout the design. The street has been split into several zones, breaking out into a seating area and formal plaza at one end. Access to residential apartment buildings creates a thriving atmosphere.

**FIGURE A9.1**
PARKING BAY

## Funding and implementation

The project was carried out between 1990 and 1991 and cost 5.1 million DM in total.

## Impacts of the project

*Mode share*: The road is still open to traffic but has been completely reoriented to favour walking and cycling.

*Highway and Public Transport Journey times:* Through car journeys on the road are slower than via the ring road, providing a disincentive toward through-trips.

*Congestion:* There is less traffic now driving through the centre and on average the City Council judge that traffic flow has improved. However, it is recognised that traffic levels on the centre ring road has increased.

*Public realm:* Public realm improvements have taken place along the street by using higher quality materials, increasing the space available for walking and cycling, planting and renovating public realm facilities in the plaza at the end of the street.

*Road safety:* Many of the design features of the street aim to provide pedestrians and cyclists with more space, to slow traffic and to improve crossing safety for pedestrians.

*Crime / security*: The street is now a much busier pedestrian environment with more active building fronts, including cafes and seating areas. This improves the liveliness of the street and good passive surveillance greatly improves the perceptions of security for users.

*Servicing access:* Impact on servicing and access for deliveries.

## Public acceptance/reaction

No information available.

Project: **Electronic Road Pricing and Orchard Road public realm redevelopment**
Location: **Singapore**
Year: **1998 on-going (Electronic Road Pricing)**
**2008 to 2009 (Orchard Road public realm redevelopment)**
Cost: **Electronic Road Pricing:***
**Orchard Road public realm redevelopment:**
**$40 million Singapore Dollars**

# A10

## Reasons for the project

Singapore is one of the most densely populated countries in the world and its geography has resulted in the need for proactive measures to manage congestion. In 1975 an Area Licensing Scheme was established to manage demand and reduce congestion. In 1998 this was replaced with Electronic Road Pricing (ERP), which is fully automated, more efficient and allows for more demand responsive pricing.

A separate ERP cordon for the Orchard Road area was implemented in 2005. The primary aim was to reinvigorate this major shopping street to improve its standing as an international tourist destination through removal of traffic and delivering public realm improvements.

## Short project description

As a very dense island city Singapore was the first city to successfully adopt road user charging. The ERP is in operation as a cordon in the centre of Singapore, as well as on expressways and outer ring roads. Charges are highly demand responsive, varying every half hour in peak times and being adjusted every three months to maintain optimum flow conditions. The system is fully automated and relies on obligatory in-vehicle units where a charge card is inserted and debited on passing gantries.

In addition, in 2008 major public realm improvements took place on Orchard Road in order to improve the profile of the street as an international shopping and entertainment destination. The improvements included pavement widening in places, replacing concrete surfaces with granite and planting along pedestrian areas.

**FIGURE A10.0**
IMPROVED PEDESTRIAN ENVIRONMENT

* $25 million Singapore Dollars overhead costs, equivalent to 20% of gross revenue in 2008.

### CITY CONTEXT

Singapore has a population of 5.1 million and is one of the most densely populated countries in the world (second after Monaco). Its geography as an island city-state severely limits capacity for physical growth and has resulted in the government taking proactive measures to manage congestion since the 1970s.

Orchard Road is 2.2 kilometre-long one-way street and is the high end retail and entertainment hub of Singapore. Orchard Road leads into the Central Business District of Singapore and was therefore susceptible to severe congestion.

### TRANSPORT POLICY CONTEXT

Due to the population density in Singapore and the physical constraints to expansion, the focus of the country's transport policy is to manage demand of private car trips and to promote public transport. There are three main strands to this approach:

**1 Promoting public transport**

Singapore has a invested in a well-integrated system of public transport including bus and rapid transit, with distance based tickets. Recent policy changes have allowed folding bikes on peak-time trains and have improved integration of cycle routes with MRT stations. There are also 13 park and ride sites around the city.

There are three major Mass Rapid Transit (MRT) stations situated in the Orchard Road vicinity: Orchard, Somerset and Dhoby Ghaut. Buses also serve the area and in 2005 a full-day bus lane scheme was launched along Orchard Road. This resulted in faster travelling speeds for buses and an associated increase in ridership, both on weekdays and weekends.

## The project

### ERP

Singapore's key tool in tackling congestion over the last 35 years has been Electronic Road Pricing (ERP) which replaced the previous Area Licensing Scheme (ALS) in 1998. ERP was implemented in the Orchard area in 2005 to reduce through traffic travelling further into the down town areas.

The current scheme is completely automatic and allows drivers to pass control gantries at normal speeds. Drivers must install an 'In-vehicle Unit', which costs S$150 in their car. A cash card, is inserted into the IU and charges are automatically debited from this when the vehicle passes under the gantries. Since 2008, motorists have been able to have the charges billed to a credit card.

The fee structure varies by time of day, location, and vehicle classification. The charges change every half hour during peak periods. Prices are reviewed quarterly and set in order to maintain an optimal speed range for 85% of vehicles of 20-30 km/h on arterial roads and 45-65 km/h on expressways.

ERP prices can vary for a passenger car from zero to about SG$3 (US$2) per cordon crossing and are in effect from 7 a.m. to 8 p.m. on weekdays. In addition, ERP hours of operations for the Orchard District include Saturdays from 10 a.m. to 8 p.m.

To discourage motorists from speeding up to avoid paying higher ERP charges in the next half hour slot, graduated ERP rates have been introduced for the first five minutes of the time slot with a higher rate. If the next period has a lower ERP rate, the new rate is introduced for the last five minutes. The initial penalty for not having enough credit on the cash card, or for not having an IU, is the ERP charge plus an administrative fee of S$10.


**FIGURE A10.1**
WEBSITE SHOWING ERP GANTRIES

## ORCHARD ROAD PUBLIC REALM DEVELOPMENT

In 2008-9 Orchard Road was redesigned, primarily to improve the experience for pedestrians and to create a world-class shopping district. The project was led by the Singapore Tourism Board, in recognition that Orchard Road was already a major tourist attraction, with 7 million tourists visiting it each year.

The project involved redesigning the public space, using a consistent palate of granite rather than concrete and including themed planting and the creation of on street oases or 'green rooms' that are used for public entertainment and art exhibitions.

A significant part of the project involved widening pavements along a 300 metre stretch of the road. This required the removal of one of two right-turn lanes, reducing the road width to three lanes.

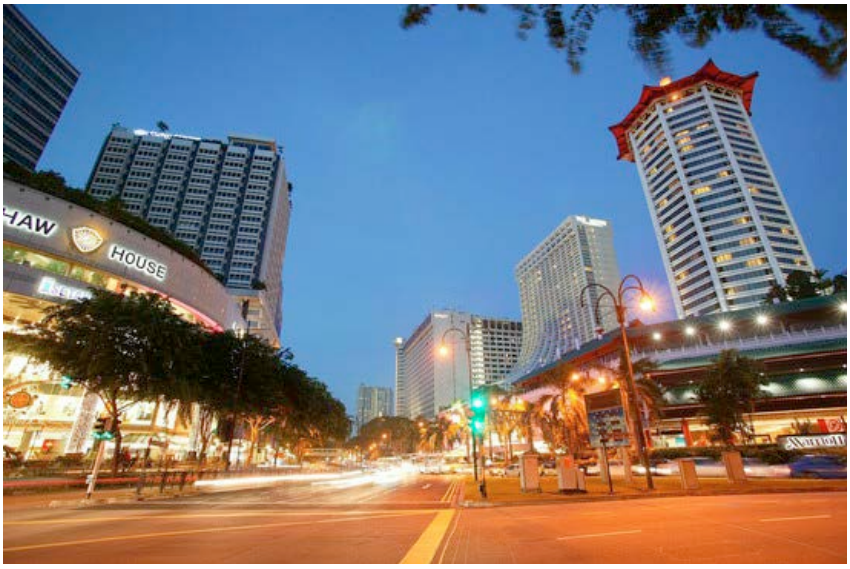


**FIGURE A10.2**
ORCHARD ROAD AT NIGHT

### TRANSPORT POLICY CONTEXT (CONT'D)

**2 Managing car ownership**

Car ownership has been closely controlled by a quota on the number of vehicle licenses permitted each year since 1990. Permits, called Certificates of Entitlement (COE), are acquired through an open online auction. In November 2009, the cost for a COE ranged from about SG$16,500 (US$11,800) to SG$18,300 (US$13,100). These permits increase the cost of new vehicles by three to four times.

**3 Demand management**

The Singapore Area Licensing Scheme (ALS) was introduced in 1975 and involved charging drivers entering the downtown area. This was the first urban road user charging scheme to be successfully implemented in the world. The scheme was replaced in 1998 by the Electronic Road Pricing.

In addition, there are new Parking Guidance System signboards along Orchard Road which have been added to direct drivers to car parks with spaces, thereby reducing the number of vehicles circulating while looking for a parking space.

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## Impacts of the project

*Highway and Public Transport Journey times:* According to a 2010 US Department for Transport study the ERP has achieved target speeds of 45 to 65 km/h on expressways and 20 to 30 km/h on arterials and net revenue of SG$100 (US$75 million) in 2008.

*Congestion:* The LTA reported that in the first 5 years of the ERP (1998- 2003) the city grew by 5% in terms of development investment, but due in large part to the ERP flow conditions were maintained without construction of new roads. The LTA also found that the introduction of the Orchard Road cordon in 2005 reduced through traffic on the street by 20%.

A major review of the ERP system was conducted as part of the Land Transport Master Plan in 2008 and a number of enhancements were proposed as part of this plan, including 16 new ERP gantry locations and rate changes. Traffic analysis by the LTA showed that these enhancements resulted in a 7% to 21% decrease in the traffic on Orchard District on Saturdays.

*Public realm:* The Orchard Road redevelopment was specifically targeted at improving the public realm to provide a destination for pedestrians.


**FIGURE A10.3**
ORCHARD ROAD AS AN INTERNATIONAL SHOPPING DESTINATION

## Public acceptance/reaction

As part of an effort to generate support for demand management policies, the Land Transport Authority recently opened a Transportation Gallery, with free interactive installations to educate the public about the transport challenges and solutions.

# A11

Project: **Noordersingel, Nieuwehuizen & Groningerstraat**
Location: **Assen, Netherlands. Noordersingel, Nieuwehuizen are streets within the city centre, while Groningerstraat is a busy access route from the north**
Year: **2007-2008**
Cost: **Noordersingel, Nieuwehuizen - unknown**
**Groningerstraat - €100,000**

## Reasons for the project

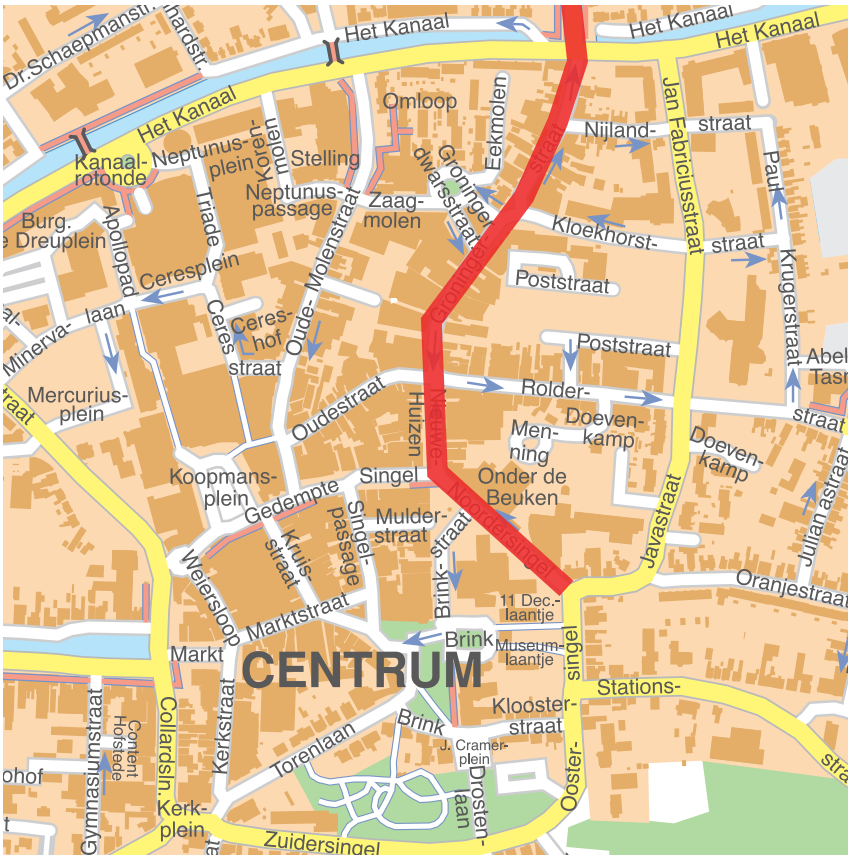
- To address growing vehicular congestion and associated air pollution in the city, following the construction of the A28 to Assen in the early 1970s, and a dramatic post-war growth in population (from 25,000 inhabitants in 1955 to 65,000 today).
- To create a more attractive city centre that was safer and more enjoyable experience for pedestrians and cyclists.

## Short project description

The Assen government wished to create a vibrant city centre that was designed for people rather than cars. They began in 1972 by excluding car traffic from a number of inner-city streets to create a pedestrian-only zone. Secondly, they redefined the entire city's road network, creating a hierarchy of distributors, through-routes and local streets. The majority of streets within the inner core of downtown Assen were designated as local streets, and were thus redesigned to prioritise pedestrian and cycle movement and restrict motor-vehicle access to local traffic.

As a result cyclists are able to take a direct and fast route through the inner city and connect to a larger network of safe, good quality and direct cycle routes throughout the wider region. Vehicular traffic has been reduced, footpaths have been widened and more trees have been planted, creating a more people-friendly environment whilst maintaining car and service vehicle access to businesses within the town centre.

**FIGURE A11.0**
INNER CITY STREET LAYOUT, SHOWING ONE-WAY TRAFFIC FLOWS. NOORDERSINGEL, NIEUWEHUIZEN & GRONINGERSTRAAT SHOWN IN RED



### CITY CONTEXT

Asssen is a small city of 65,000 people in the north-eastern Netherlands, which saw a rapid rate of expansion post World War II (due to the development of the city's industry and health care sectors). It is the capital city of Drenthe, a province famous for recreational cycling, and cycling events are held there regularly. Most destinations within the city can be reached within 15-20 minutes by bicycle.

### TRANSPORT POLICY CONTEXT

The Assen Municipality has a goal for Assen to become a 'cycle city' by 2015, where most journeys in the city are made by bicycle. In particular, they are focused on encouraging citizens to cycle rather than drive when travelling short distances. Increasing the number of people using bikes in Assen is integral to the city's commitment to being carbon neutral by 2020.

The streets that were redesigned in Assen in 2007-8 were identified for refurbishment in the Nota Fietsverkeer Assen (Assen Cycling Policy) produced in 2005.

## The Project

All three streets are connected to each other. Groningerstraat leads directly to Nieuwehuizen and then on to Noordersingel. The latter two are in the centre of the town.

### NOORDERSINGEL, NIEUWEHUIZEN

Prior to redevelopment, the streets within Assen city centre were dominated by motor-vehicles, with wide traffic lanes, pedestrian barriers, large areas of parking and very few trees. The city grew dramatically following World War II, and the construction of the A28 in the early 1970s made the city more accessible to visitors.

The ensuing traffic congestion problems within the city centre prompted the Assen municipality to reorganise the road network: to define distributors, through-routes and local streets. A network of distributors and through-routes were to continue to prioritise vehicular movement to and around the city centre, while 'local' streets within the inner city core were to be redesigned to prioritise pedestrians and cyclists and only provide local vehicle access. This was achieved by converting a number of streets, including Noordersingel and Nieuwehuizen to single, one-way lanes for vehicles, eliminating through-routes across the centre. Paid car parking and


**FIGURE A11.1**
BICYCLE LANES IN BOTH DIRECTIONS IN THE CITY CENTRE, WITH ONLY ONE-WAY TRAFFIC LANE

service access have been retained to allow businesses within the city centre to function; however driving in to the city centre has become much less convenient.

Conversely, two dedicated lanes, one in each direction, were provided for bicycles. Traffic lights have been removed allowing free and continuous movement across the city centre for cyclists and improving journey times. Furthermore, cyclists are provided with free, secure, covered parking for their bicycles.

The designated pedestrian zone established in the 1970's was extended. The physical space required for the carriageway on other streets was significantly reduced, enabling the creation of wider footpaths for pedestrian movement, outdoor dining and tree planting. Vehicular movement is controlled through signage. There are no physical barriers cluttering the streetscape and pedestrian barriers have been removed. Many of the asphalt carriageways have been resurfaced with the same paving used in the footpaths, reinforcing the sense of a pedestrian- and cycle-friendly environment.

### GRONINGERSTRAAT

To maintain its function as a through-route for motor-vehicles, Groningerstraat was redesigned to physically separate modes of transport. Vehicles, cyclists and pedestrians move exclusively within the carriageway, cycle path and footway respectively. The cycle path is given priority at all side street junctions, and has been repaved in smooth, red asphalt. Cycle paths have been widened to 2.5m, parking and footways have been retained and new trees have been planted, all within the existing road width.

**FIGURE A11.2**

GRONINGERSTRAAT, SHOWING CYCLE PATH PRIORITY AT SIDE STREET

## Funding and implementation

The budget for creating car-free cycling on Groningerstraat in 2008 was €100,000, although it is not known if this is what was actually spent. No figures were found for the redevelopment of Noordersingel & Nieuwehuizen, however Assen spends €1.8 million each year on cycling infrastructure, and has additional budgets for maintenance and school training programs.

Funding for cycling projects comes from various local government budgets, as well as from grants received from the Province of Drenthe and the Rijk of the Recreatieschap Drenthe (Recreation Board Drenthe).


**FIGURE A11.3**
NIEUWEHUIZEN IN THE 1970'S


**FIGURE A11.4**
NIEUWEHUIZEN IN 2007

## Impacts of the project

*Mode share:* The cycling mode share increased from 32% in 2005 to 41% in 2011.

*Journey times:* The changes have been designed to improve journey times for cyclists while preventing vehicles from driving through the centre.

*Daily usage:* 8,700 cyclists per day cycle down Nieuwehuizen (measured on 6 July 2011). This represents 13% of the population of Assen.

*Servicing access:* There is limited impact on servicing and access for deliveries, as the streets are still fully accessible to motor-vehicles. Access to the centre has been maintained, while the design has made it less conducive for through-traffic.

*Safety:* Giving priority to cyclists at side street junctions has been cited as potentially dangerous, as not all vehicles abide and there is a risk of visitors not knowing the rules.


**FIGURE A11.5**
THE BRINKSTRAAT/ NORODERSINGEL/ NIEUWEHUIZEN JUNCTION, IN THE 1960S AND IN 2007

## Public acceptance/reaction

No information available.

steer davies gleave

Project: **Pompidou Expressway Closure: Paris Plages* & Bernes de la Seine****
Location: **Paris, France**
Year: **Paris Plages: July 20th to August 20th each year from 2002**
**Bernes de la Seine: from September 2012**
Cost: **Paris Plages: €1.5 million each year**
**Bernes de la Seine: €40 million total**

# A12

## Reasons for the project

The project objectives were to:

- Reduce car use and encourage a modal shift, by improving pedestrian and cyclist access to the river banks, creating a continuous route for pedestrians and cyclists along the Seine and improving the environmental habitat of the river and its surroundings.
- Make the banks of the Seine in central Paris a hub of cultural, leisure and sporting activity by diversifying amenities so that they are more accessible to Parisians, and contribute to an economic uplift in neighbouring areas.
- Raise the profile of the river banks' world heritage status, reconnecting the river to the city, and instilling national pride.

## Short project description

The Mayor of Paris, Bertrand Delanoë, was elected in 2001 on a platform promising to reduce car use in the city centre and make drastic improvements in public transport, walking and cycling infrastructure in the city. He has seen through the success of Paris's short-term cycle hire and car hire schemes and transformed streets in the city, with a network of bus, taxi and cycle-only streets.

Another key initiative is the transformation of the banks of the river Seine. For the last 11 years the left bank of the Seine has transformed into 'Paris Plage' for one month in the summer- with approximately 4km of sandy 'beach', free activities, workshops, food stalls and deck chairs.

In September 2012, a plan to permanently transform both banks of the Seine was approved. The plan included a 2.5km car free zone along the left bank and a shared space on the right bank with a narrower road for cars, and wider routes for pedestrians and cyclists. The first improvements on the right bank are currently being implemented.

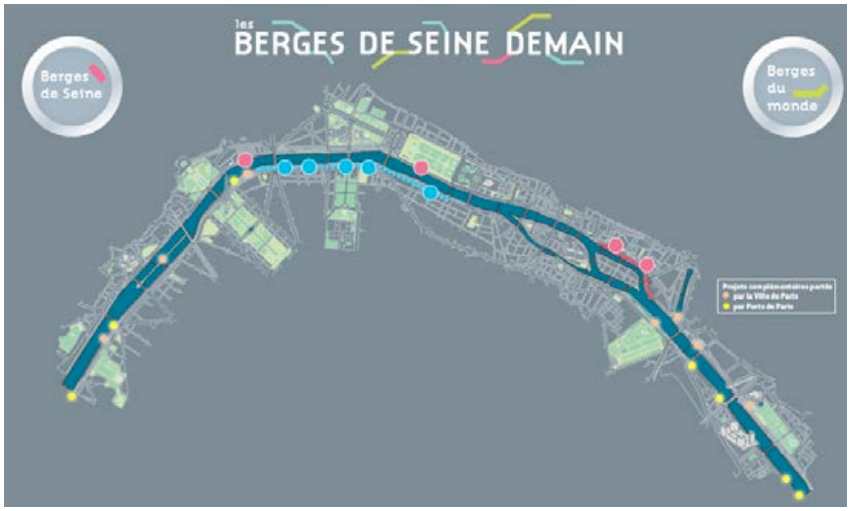



**FIGURE A12.0**
BERGES DE SEINE DIAGRAM

* (Paris Beaches): temporary/seasonal closure: 4 weeks each summer from 2002 to 2012
** (Banks of the Seine): Permanent closure of left bank expressway (including the Paris Plage section) and narrowing of right bank starting September 2012.

### CITY CONTEXT

Paris, situated in the Île-de-France region, is the capital and largest city of France. The population of the city is approximately 2.1 million and the entire population of the Paris metropolitan area is calculated to be in excess of 11.5 million inhabitants. The city is divided into 20 administrative districts (arrondissements) arranged in the form of a clockwise spiral starting in the middle on the Right Bank of the river Seine.

Home to La Défense, the largest business district in Europe, Paris produces more than a quarter of the gross domestic product of France. The city is also a major tourist destination.

### TRANSPORT POLICY CONTEXT

The transportation system in Paris is very diverse, with a number of different modes providing extensive connectivity not only across the city centre, but also in the city's outer-lying suburbs and districts.

The city has a total of 14 Metro lines, of which 12 operate as routes connecting the city centre to outer suburbs, and two operate as lateral routes around the city centre. The Metro is supplemented by a number of other modes, including 5 RER (Réseau Express Régional) urban transit lines, that serve the outer parts of the Ile-de-France region (i.e. beyond the Metro termini), 6 Transilien suburban rail lines that serve areas not served by Metro or RER lines, 4 tramway lines in the outskirts of the city connecting to Metro and RER stations, and a large network of bus routes. In addition, 2007 saw the arrival of Velib, the city's cycle hire scheme, which, with over 16,000 bicycles and 1,200 bicycle stations, is the second largest in the world.

Paris has a series of inner and outer ring roads (similar to the North and South Circular routes in London) that supplement a series of diametrically aligned motorways that feed into the city. Roads in the city, particularly the Boulevard Périphérique ring road, have suffered from significant congestion. (*cont'd*)

## The Project

The Mayor of Paris, Bertrand Delanoë, was elected in 2001 promising to reduce car use in the city centre and make drastic improvements in public transport, walking and cycling infrastructure in the city.

Just a few months after he was elected he controversially closed the Georges Pompidou Expressway for one month in the summer between 6:00am and 11:00pm. The following year, in the summer of 2002, City Hall decided to completely close the Expressway along the left bank for one month, but in order to both raise the profile (so motorists were not caught out by the changes) and attract more people to the river banks, 2,000 tonnes of sand were installed on the left bank and 'Paris Plage' was created. The scheme was overwhelmingly successfully with over 2 million visitors in the first year.

**FIGURE A12.1**
BERGES DE SEINE ILLUSTRATION

**FIGURE A12.2**
PARIS PEDESTRIANISATION ILLUSTRATION

It has maintained that popularity with a strong theme of social equity and inclusivity by providing a beach for all Parisians, but particularly those not able to leave the city during the summer. A new 'beach' location was added in 2010 called the 'Bassin de la Villette' located in the 19th arrondissement, a more deprived part of eastern Paris.

The Paris Beach demonstrates a commitment to sustainability, through recycling the majority of the materials used for its construction and partnering with Greenpeace to deliver sustainability workshops at weekends.

The Paris Beach has been timed to coincide with the summer holidays when many Parisians leave the city and road traffic is lower than usual. Local media reactions suggest that the remaining traffic has been easily absorbed into alternative routes without significant disruptions.

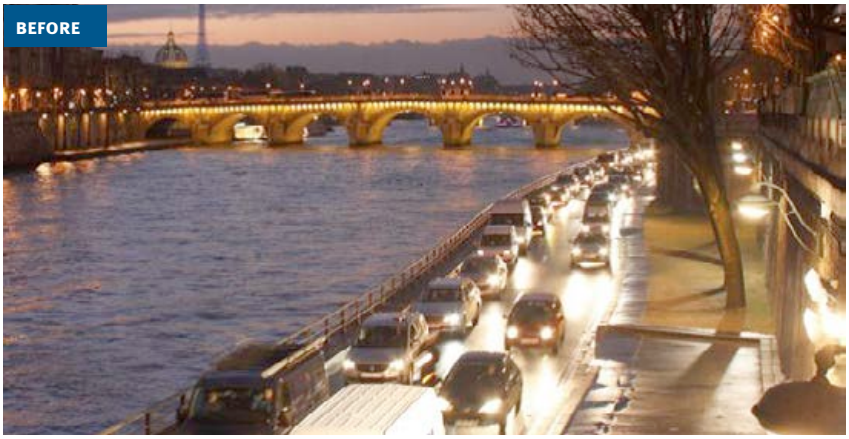



**FIGURE A12.3**

THE POMPIDOU EXPRESSWAY, PRIOR TO CLOSURE


**FIGURE A12.4**

THE POMPIDOU EXPRESSWAY. CLOSED TO TRAFFIC AND WITH THE PARIS PLAGES INSTALLED

**TRANSPORT POLICY CONTEXT (CONT'D)**

In spite of the public transport provision available in the city, transport surveys carried out in the city in the late 1990s highlighted an alarming trend of increased private transport use in the city, particularly in the inner and outer suburbs of the city. At the same time new laws came into force in France, stipulating that all conurbations with populations greater than 100,000 must prepare a form of urban travel plan, entitled a Plan de Déplacements Urbains or PDU. The Paris PDU was adopted at the end of 2000 for a five year period. At this time 61% of all trips within the city of Paris were made by public transport and 31% by car. However trips made between suburban locations were dominated by the car, which was used for 82% of trips.

The primary aim of the PDU was to achieve a 5% reduction in private vehicle use for travel inside Paris and the inner suburb departments, and between Paris and the other departments, and a 2% reduction for travel within the outer suburbs and between the inner and outer suburbs. In order to achieve this aim, the PDU targeted an increase of 2% in public transport use in the city as well as doubling the number of cyclists on the roads by 2006.

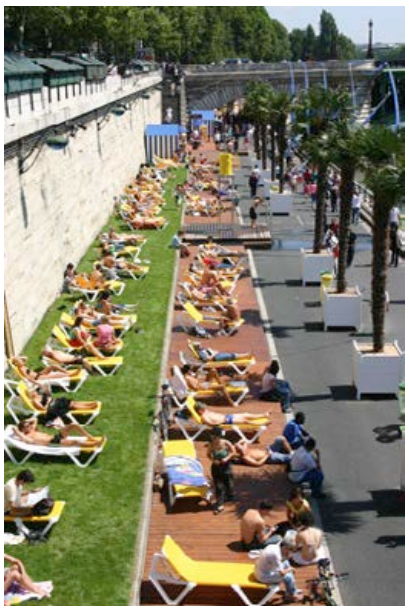


**FIGURE A12.5**
PARIS PLAGES

In September 2012, Mayor Delanoë's proposal to permanently close a portion of the left banks' Expressway, and narrow a portion of the right bank was approved and works have begun. From November 2012, a stretch of more than 1km (0.6 miles) on the right bank near the Hôtel de Ville will see the first narrowing of the road to make way for pedestrian corridors, riverside walkways, bars and cafes. Then, in the spring of 2013, a 2.5km car-free zone will be implemented on the left bank, between the Musée d'Orsay and the Pont de l'Alma, with a riverside park, pedestrian promenades, floating botanic gardens, flower-market barges, sports courts, restaurants and an archipelago of artificial islands.

## Funding and implementation

The expected total cost for the Bernes de la Seine which has been approved by the Parisian and French governments, is €40 million. This consists of:

- €12.4 million road works and reduced mobility access for the two banks.
- €8.6 million for the 'archipelago' (a string of new articficial islands in the Seine).
- €2 million for landscaping and greenery on both banks.
- €2.5 million for marketing
- €6.8 million for resources, equipment and servicing areas (e.g. public toilets).
- €2.7 million for cross-sectional studies, coordination and contingency for risks.
- €5 million per year for on-going maintenance and running of the site.

The roads where the Paris Beaches are installed are closed three days before opening and re-open three days after the beach closes. Installing the beaches takes place overnight. The sand (approximately 6,000 tonnes) and other materials are transported to the site by river boat which avoids the 200 heavy goods vehicles estimated would be required to transport the materials by road. Similarly, materials are dismantled and removed the day the beach is closed.

The Banks of the Seine is publicly funded in a partnership between the City of Paris, the Prefecture of Paris and Ile-de-France, the Prefecture of the Police (the Parisian Police), the Ports of Paris and the Water Agency of Seine-Normandy, the latter of which gives a financial contribution for upkeep and restoration of heritage sites along the river banks.

Although 70% of the Paris Beaches projects were funded by private sponsors, corporate branding is kept to a minimum and is for the most part contextualised. For example in 2011, Disneyland Paris sponsored sculptors to build Sleeping Beauty's castle from sand.

The Banks of the Seine is expected to be implemented in two phases, over a six month period. The first phase, on the right bank, is due to finish in Autumn 2012, and the second phase is due to be completed in Spring 2013.

## Impacts of the project

Much of the impact data published to date is related to Paris as a whole and reflect the impacts of wider modal shift measures, including the Paris Plage initiative.

*Mode share:* Between 2001 and 2006, Paris saw:

- Decrease in private vehicle traffic by 20%.
- Decrease in HGV/LGVs by 11%.
- Decrease in tourist buses by 11%.
- 12% increase in Metro ridership
- With the completion of the first Mobilien (BRT) corridors, bus ridership is also growing rapidly.

For the Banks of the Seine project, a 16% to 26% decrease in vehicle trips is expected along the right bank on the whole. However a slight increase, of less than 10% is expected on the left bank (for the area that will not be closed to traffic).

Modal share for cycling and walking is expected to increase as well as public transport usage.

*Highway and Public Transport Journey times:* The project site includes the square in front of City Hall and other key employment locations (most of central Paris). It is likely to improve access to these areas by sustainable modes whilst reducing car access.

City Hall argues that motorists would see only six minutes added to their journey (via alternative routes) under the plans.

*Air quality and Environment:* Between 2001 and 2006, all indicators of air pollution in Paris improved, with the exception of summer ozone levels. 6% of the overall 32% reduction in nitrogen oxides (NOx), as well as all 9% of the reduction in carbon dioxide ($CO_2$) emissions, were attributed to the reduced number of cars and trucks in the city.

Air quality is expected to improve with the reduction of road traffic for the Banks of the Seine project. A quantification of the improvement was not included in the impacts assessment consultation document.


**FIGURE A12.6**
PLACE HOTEL DE VILLE - BEFORE


**FIGURE A12.7**
PLACE HOTEL DE VILLE - AFTER

*Public realm:* The improvements to the public realm are, and will be, significant. Increased pedestrian access to the river will be the main improvement.

Noise levels will be significantly diminished in the area of the left bank which will be pedestrianised, with a 20 decibel reduction expected. Other areas will not be significantly affected by noise levels.

*Road safety*: Total road injuries in Paris overall decreased by 25% between 2001 and 2005.

Road safety is expected to be improved further by reducing traffic flows and speeds for the Banks of the Seine project.

*Economic impact:* The beach attracts 2 million visitors annually, and up to 300,000 daily for a location that does not usually receive this flow of people.

*Physical accessibility:* The project's impact assessment reports significant generally increased accessibility, and specific improvements for those with mobility impairments through better pedestrian access, reductions in traffic speeds and pedestrianisation of the left bank. The entire site is designed to be accessible for those with reduced mobility.

*Daily usage:* On the first day the Paris Plage was open, it attracted approximately 600,000 visitors. Throughout the rest of the month, it attracted a total of 2 million visitors. No significant traffic problems in the surrounding area were evident during this time; however traffic is normally lower between July and August because of the summer holiday season.

*Servicing access:* Access to parking and servicing/waste collection is affected but has been identified in the impacts assessment and planned for. During the summer, the beach is cleaned nightly and the sand washed and oxygenated weekly. Riverside access was utilised wherever possible for transporting materials including waste. For the new permanent changes, a number of measures have been put in place including placement of waste bins and measures to prevent waste entering the river.

### Public acceptance/reaction

In the first year of the Paris Beach, there was vocal opposition from motorists and some politicians - but once the Paris Beach was open, and traffic disruptions were proven to be minimal, this criticism subsided.

Extensive public consultation was undertaken for the Banks of the Seine project in January 2011, with 71% approval ratings. However, the then-Prime Minister Francois Fillon blocked the approval for the project. When the Socialist party gained power in 2012, the new Prime Minister removed the block and the project was approved to proceed.

The Paris Beaches have gained extensive media coverage and drawn worldwide attention.

Project: **Cheonggye Elevated Motorway Removal and Waterway Restoration**
Location: **Seoul, South Korea**
Year: **2003 – 2005**
Cost: **US$386 Million**

# A13

## Reasons for the project

- To solve safety and structural issues with existing motorway and infrastructure.
- To restore the watercourse and habitat of the Cheonggyecheon stream.
- To revitalise historic downtown and further develop the economy in Central Seoul.

## Short project description

The Cheonggyecheon (Clear Valley Stream) is a former seasonal waterway that flows through Central Seoul. As development began to intensify around the stream it became increasingly contaminated. It became so polluted that in 1958, the government initiated a program to bury the stream under a roadway. An elevated motorway system was subsequently built from 1967 to1976. These roads combined carried approximately 168,000 vehicles per day.

Rapidly deteriorating infrastructure, high levels of pollution and low property values in the surrounding areas prompted the Seoul Metropolitan Government to remove the motorway and open the stream. Demolition work began in 2003 and a 3.6 mile linear park was officially opened to the public in 2005. New 2 lane one-way streets line either side of the park. An extensive BRT system and other bus improvements were implemented to compensate for the reduction in vehicle lanes.


**FIGURE A13.0**
MAP SHOWING THE LOCATION OF THE CHEONGGYECHEON (IN RED) RELATIVE TO THE CITY AND THE HAN RIVER

**CITY CONTEXT**

This project was completed in the centre of Seoul, the capital of South Korea. The metropolitan area had a population in 2010 of over 23.5 million people and an extremely high population density of 16,000 people/km². The Cheonggyecheon stream flows west east through the city and into the Han River including 3.6 miles through heavily populated urban environments.

In 2009 63% of motorised journeys were by public transport (28% by bus and 35% by rail). Cars were used for 26% of motorised trips. Data for walking is not available.

## The Project

The Cheonggyecheon area of Seoul, South Korea encompasses the Central Business District, Dongdaemun and Outer (north-eastern) areas of the city. Comprised of office, retail and residential, this area was formerly the economic centre of the city and an industrial hub. The Hawanghak-dong market with over 500 shops is also located in the area. The defining feature of this area is the Cheonggyecheon stream. As development intensified around the stream, it became increasingly polluted, acting as an open air sewer. Plans for the installation of underground sewers and the burying of the stream began in the 1950s. Completed in 1976, the Cheonggye Elevated Motorway and Cheonggye Street changed the area drastically.


**FIGURE A13.1**
ELEVATED MOTORWAY COVERING THE STREAM


**FIGURE A13.2**
THE RESTORED STREAM

At first, this project was seen as a symbol of Korean development. By 2003, more than 168,000 vehicles per day were travelling through the area and air pollution, traffic congestion and economic decline were becoming increasingly problematic. In the early 2000s, the Cheonggye road system was in need of repair and restoration if it was to keep functioning as a major thoroughfare. It was estimated that the cost to repair the structure would be over 100 billion South Korean Won and would require closure of the highway for over three years.

Policies and the vision for the city had changed significantly since the roadway was built. There was a shift from growth at all cost to sustainability. This was capitalised on by mayoral candidate Lee Myung-bak who won the election on the basis of a plan to demolish the roadways and restore the stream. This project began in 2003 with the closure and subsequent demolition of the motorway. Construction was completed in 2005 when the 3.6 mile linear park and creek was officially opened to the public.

Between September 2003, a few months after the freeway's closure, and October 2004 the volume of traffic passing through central Seoul declined by 9.1%. Over the same period, during which fuel prices also increased, citywide traffic was reduced 5.9%.

## Funding and implementation

This project was initiated and managed by the Seoul Metropolitan Government. It was entirely publicly funded. Demolition and construction works were divided into three sections, each with their own bidding process and design.

The budget for the project was US$357 million (2003), and the actual cost US$386 million. However these figures were provided by the Seoul Metropolitan Government, and external sources claim that the costs were actually much higher.

## Impacts of the project

The following impacts have been reported by the Seoul Metropolitan Government:

*Mode share:*

- Contributed to a 15.1% increase in bus patronage and 13.7% increase in subway ridership in Seoul between 2003 and 2008.
- The number of vehicles passing through downtown decreased by 9%. Before and after traffic counts for the corridor are unavailable.

*Highway and Public Transport Journey times*: There are conflicting reports about vehicle journey time. Some research claims that vehicle travel times are slightly slower than pre-implementation, while other research claims that they are slightly faster.

**FIGURE A13.3**

THE CHEONGGYECHEON RIVER, SHOWN HERE IN 2008, IS A POPULAR DESTINATION FOR OVER 60,000 VISITORS PER DAY, BOTH LOCALS AND TOURISTS ALIKE

### TRANSPORT POLICY CONTEXT

This project was a component of a much larger city wide planning policy to encourage sustainability in the transport network. This was to be achieved by managing demand and expanding the public transit network.

Demand management initiatives implemented prior to the removal of the roadway:

- Private vehicles with fewer than three occupants were charged 2000 won to entering the CBD (1996).
- 'No driving day' introduced to encourage resident to leave their car at home one day per week. Incentives include half-price tolls, 10-20% discounts at public car parks, a 5% reduction in taxes, fuel, maintenance and car wash discounts (2003).
- Parking management including regular fee increases for public parking (1997), reducing the supply of public parking downtown (2004), lowering parking requirements for commercial development, and establishing a residential parking permit program.
- Increasing fuel taxes.
- Implementing an incentive-based TDM program for employers.

Public transit improvements:

- Built a BRT network with median bus-only lanes and stations (1996).
- Expanded BRT in 2005 and again in 2007 to a total of seven routes (42 miles).
- Currentl plans to expand the BRT network to 12 routes (73 miles).
- Fundamentally restructured City's bus system (2004).
- Kerbside bus-only lanes expanded for regular services (2004).
- Other improvements to public transit including integrated fares, scheduling and branding and introduction of a smart card and ITS technology.

*Air quality:* Reduced NO2 by 35% and PM10 by 19% (2003-2006).

*Public realm*: Urban heat island effect was reduced as summer temperatures in the park are 3.3 to 5.9 degrees (C) lower than at locations a quarter-mile away.

*Economic impact:*

- Land values of adjacent parcels increased by an average of 30% (2003-2006) (Kang & Cervaro, 2009).
- Two historic bridges restored (the Gwanggyo Bridge had been hidden under the highway, while the Supyogyo Bridge had been relocated to a park).
- Economic benefits of $8.5 to $25 billion (USD) and approximately 113,000 new jobs.

*Ecology:* From 2003-2006, overall biodiversity increased by 639%: plant species increasing from 62 to 308, fish species from 4 to 25, bird species from 6 to 36, aquatic invertebrate species from 5 to 53, insect species from 15 to 192, mammals from 2 to 4, and amphibians from 4 to 8.

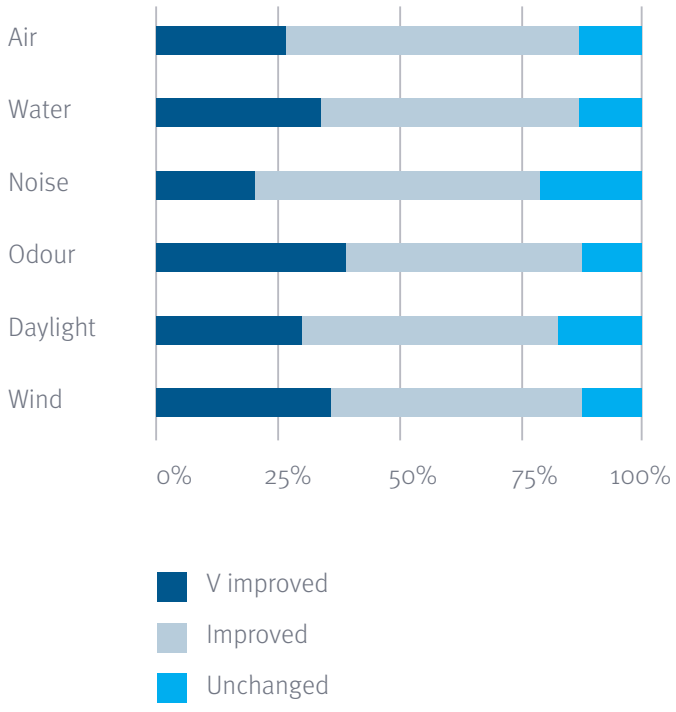
*Daily usage:* Attracts approximately 90,000 visitors per day, 30% from outside the metropolitan area.

## Public acceptance/reaction

Public acceptance of the project is reported as being overwhelmingly high with a government survey claiming that 79.1 per cent of residents supported the plan. However, there was opposition to the project as it displaced a market and numerous street vendors. (approximately 1,200 businesses). The market was relocated to a nearby stadium. The former mayor was also very opposed to the project due to concerns over the potential gentrification of the area.

Overall the public reaction to the project appears to have been very positive. A public survey was undertaken after completion and improvements were acknowledged by over 75% of respondents in all categories.

**FIGURE A13.4**
PUBLIC SURVEY (NOV 2005)



Project: **Embarcardero Freeway Re-development**
Location: **San Francisco, USA**
Year: **1991-2000**
Cost: **$50 million**

# A14

## Reasons for the project

The main reasons for the Embarcardero Freeway Re-development project were to:

- Redevelop the waterfront area of San Francisco
- Help reconnect the area to the rest of the downtown region, which was previously separated by the Embarcardero Freeway in its original form.

Removing the double decker freeway was also assessed to be less costly than repairing it.

The re-development project also resulted in:

- Around 100 acres of land converted into new public spaces.
- Improved access to the city's ferry terminal which was renovated as a mixed use facility of 65,000 sq.ft of marketplace and 175,000 sq.ft of office space.
- emergence of a new neighbourhood, Rincon Hill, at the southern end of the Embarcadero.

Other sections of the promenade to the north of the Embarcadero were also re-developed at the same time.

## Short project description

The Embarcadero Freeway Re-development project was undertaken following the collapse of the original freeway that was caused by an earthquake in 1989. The previous 1.2 mile elevated freeway (part of State Route 480) was demolished and replaced with a ground-level "boulevard" to encourage re-development of the San Francisco waterfront area. The new boulevard is a six-lane general traffic road that runs along the waterfront along with the metro line F (Market and Wharves).

**FIGURE A14.0**
THE REDEVELOPED EMBARCARDERO FREEWAY WITH TRAM LINES

### CITY CONTEXT

San Francisco is the financial and cultural centre of Northern California. It is the 4th most populous city in California (and 14th in the USA), with just over 800,000 inhabitants. The metropolitan area has 7.6 million inhabitants. It is the second most densely populated city in the USA, behind New York City. Famous for its architecture and landscape, San Francisco is a popular tourist destination, and was rated 35th in the 100 most visited cities in the world. The city is a primary finance and banking centre, lying in 12th place in the top 20 global financial centres.

San Francisco is notorious for its earthquake activity, given its location above the San Andreas and Hayward Fault. The 1989 earthquake was the last major earthquake that resulted in fatalities, though smaller scale tremors occur at least once a year. As a result of this, the city's building regulations have been significantly upgraded, with older buildings retrofitted and new developments subject to tighter engineering constraints, to ensure the city is as "earthquake proof" as possible.

## The Project

The Embarcadero Freeway was a double-decked, elevated highway, built in 1959, and was originally intended to link the two main bridges of San Francisco, the Golden Gate and Bay bridges, via the waterfront, but construction never reached all the way to Golden Gate. Until 1989 the freeway was one of the busiest roads in San Francisco, with 70,000 vehicles using the road each day at its peak. The Embarcadero Freeway effectively cut off the city from the waterfront and resulted in long ramps running deep into the surrounding areas.

In 1989, the Loma Prieta earthquake struck San Francisco, causing billions of dollars' worth of damage to the city's infrastructure, and irreparably damaging the Embarcadero Freeway. The cost of reconstructing the freeway was thought to be too costly for the city. It was decided that the freeway would be demolished and a new ground-level boulevard built in its place.


**FIGURE A14.1**

EMBARCARDERO FREEWAY BEFORE REMOVAL OF THE DOUBLE-DECKER HIGHWAY

The new boulevard is a six-lane road that runs along the waterfront. In between the two directions of traffic, the metro line F (Market and Wharves) serves the area. The F line was opened in 1995, with the Embarcadero extension completed in 2000. It is the only line to be operated in the city as a heritage street car service. It is run by the city's municipal railway authority, but is also supported by a group of streetcar enthusiasts that raise funds and help to restore vintage streetcars for use on the service.

In total, around 100 acres of land previously occupied by the freeway and feeder roads were made available by the demolition of the freeway. This land was converted into a new public plaza and waterfront promenade. The new, open layout of the road allowed for improved access to the city's ferry terminal, the Ferry Building. The Ferry Building is a 2.8 acre site which, as part of the development, underwent significant renovation works between 1999 and 2003. The site operates now a mixed use facility, featuring a 65,000 sq ft marketplace with a further 175,000 sq ft of office space on upper floors, whilst continuing to operate as a ferry terminus. Other sections of the promenade to the north of the Embarcadero, in particular Fisherman's Wharf, were also re-developed at the same time.

The re-development of the freeway also resulted in the emergence of a new neighbourhood, Rincon

Hill, at the southern end of the Embarcadero, where previously the land had been part of the freeway link to the Bay Bridge. Nearby there is a new baseball venue, AT&T Park, which was opened in 2000 and currently holds nearly 42,000 spectators.

## Funding and implementation

The demolition of the damaged freeway began in 1991. Construction of the new boulevard began in 1993 and was fully completed by 2000. The cost of demolishing the old freeway, and then building a new ground level highway, together with landscaping of the new boulevard, cost approximately $50 million – this compares to the $69 million it was initially estimated that reconstruction of the former Embarcadero Freeway would have cost.

## Impacts of the project

*Usage:* As of 2000, traffic on the Embarcadero was approximately 26,000 vehicles per day, less than half of the 70,000 daily vehicles that the old freeway carried.

*Mode share:* The introduction of the F-Market and Wharves streetcar along the Embarcadero and replacement of the old bus route on the street has seen transit ridership in the corridor increase significantly, to over 20,000 passengers per day. Ferry service and ridership has also increased in recent years.

*Congestion:* Following the 1989 closure of the freeway, counts indicated that much of the remaining traffic was displaced onto alternate routes to and from the Bay Bridge.

*Pubic realm:* More than 100 acres of land along the waterfront that had once been dominated by the elevated freeway gave way to a new public plaza and waterfront promenade.

*Regeneration:* The removal of the freeway and its ramps in the South of Market district in part allowed significant residential development to take place. As of 2008, approximately 7,000 additional housing units were under construction or planned in the Transbay and Rincon Hill neighborhoods, many of them in former freeway rights-of-way.

Dense commercial development has lined the street, housing in the area increased by 51% and jobs have increased by 23%.

Following the demolition of the freeway and the subsequent reclamation of the waterfront, downtown San Francisco's tourism industry grew impressively. Between 1995 and 2000, visitor spending citywide increased 39%. Though tourism declined following 9/11, the re-opening of the Ferry Building on the waterfront also resulted in increased visitor spending.

*Physical accessibility:* Physical accessibility to the waterfront was greatly improved following the project, with the old freeway having acted as a major barrier to the waterfront buildings and the Ferry Terminal. The re-development allowed also for the new streetcar line to be developed, linking the Embarcadero to the rest of Downtown San Francisco.

### TRANSPORT POLICY CONTEXT

When the original freeway was constructed in the 1950s, it was the view of the city council that the construction of new freeways in the city would lead to greater economic prosperity. San Francisco's 1948 Trafficways Plan proposed a complex network of eight freeways crossing San Francisco to complete the regional highway system and to respond to growing traffic congestion. However, the large scale freeway construction programme was significantly scaled down as a result of the public opposition to the plan (often referred to as "The Freeway Revolt"), meaning that the Embarcadero Freeway never did reach the Golden Gate Bridge as it was intended to do.

In 1973, the San Francisco adopted the "Transit First Policy", giving priority to public transport as the centerpiece of transportation policy and adopting street capacity and parking policies to discourage increases in car use. During the 1970's and 1980's the Bay Area Rapid Transit System (BART) began services.

In 1985, $171 million proposals were agreed by the city council to demolish the road in order to construct a surface boulevard and streetcar extension (as was eventually built), but by this point the city's residents (and sections of the council) believed that without the freeway, the road network would be unable to cope with traffic levels, and the project was called off.

Following the 1989 earthquake, the cost of demolishing the freeway and replacing with a surface-level boulevard was estimated to be cheaper than rebuilding it, and so the decision was taken to proceed with demolition, in spite of concerns from the nearby Chinatown businesses, who feared it would result in them losing their livelihoods.

The San Francisco General Plan now sets out objectives and policies for transport and development in the area.

## Public acceptance/reaction

The initial construction of the double-deck freeway caused significant controversy in the local area in the 1950s – and when extensions to the freeway were proposed in 1964, 200,000 marched in protest in Golden Gate Park. The wave of anti-freeway sentiment in part caused the proposed extensions to be shelved.

In the 1980s there were discussions about the freeway's future, and in 1985 the San Francisco Board of Supervisors voted to demolish the freeway. However, when the decision was put to voters in 1987, a clear majority voted for the freeway to be preserved. Following the 1989 earthquake, the California Department of Transport (Caltrans) began to plan the re-development of the double-deck freeway, however support grew within the city to demolish the freeway once more.

The main opposition to the demolition came from businesses in Chinatown, who had lost significant business following the closure of the freeway and feared that it would not return if it were not restored to its original state. Nonetheless the city's Mayor continued to negotiate with city officials, and the demolition began in 1991. However, the Mayor was defeated in his bid for re-election later in 1991, in part due to the switch in support of Chinatown residents following the demolition.


**FIGURE A14.2**
AFTER REDEVELOPMENT OF THE HIGHWAY