Mole Solutions Submission of Evidence to the National Infrastructure Commission.

Executive Summary

This submission of evidence to the NIC is that the Mole Solutions Limited freight pipeline concept can bring innovation and benefits to future UK and global transport systems in general and that of London in particular.

DEFRA, Innovate UK, Future Railway and the Nuclear Decommissioning Agency have already invested in Mole Solutions' R and D projects that have proved both the concept and demonstrated the technology. A Feasibility Study of the Mole Urban Concept was completed for Northampton in 2015 and showed that it is technically, economically, socially and environmentally viable at comparatively low volumes. Examples are given as to how the concept could be used in a number of current scenarios within future London transport schemes.

The next step is to embrace the concept as a significant input to future transport planning and integrate it as a complimentary feature with existing transportation infrastructure.

Introduction.

Mole Solutions Limited (MSL) evidence to the NIC is based on the potential impact that freight pipeline technology can have on the freight strategy needs of the UK and London specifically.

Underground passenger transport has been commonplace in London, and many other global cities, since the 19th century but underground freight transport of solid goods within cities does not exist anywhere in the world. Freight pipelines are currently limited to the transport of liquids and gases and also play an important role in the delivery of clean water to, and dirty water from, most properties in the civilised world.

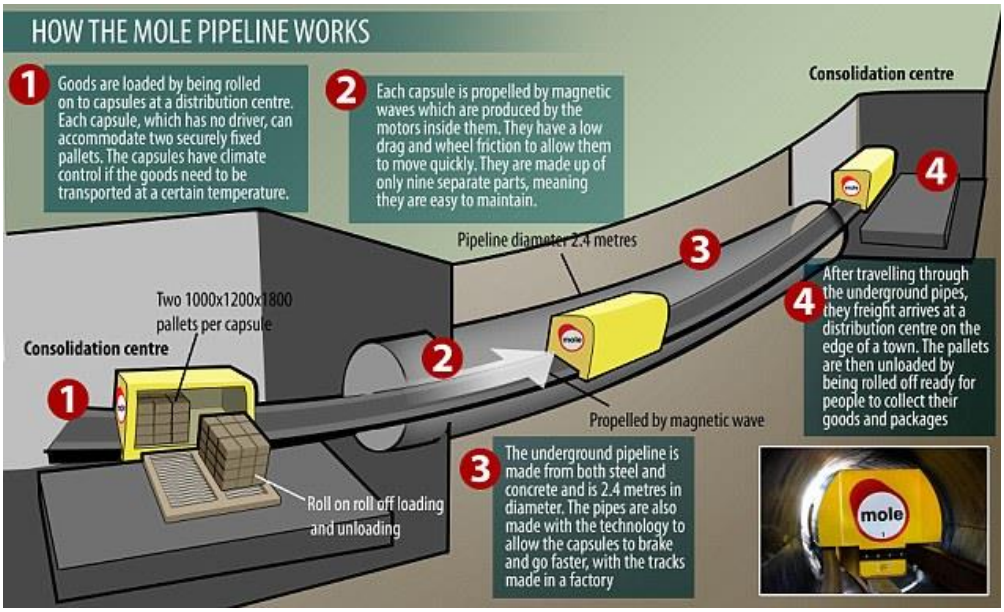
MSL was established in 2002 with the business objective of developing and commercialising the concept of freight pipelines designed to carry unitised and non-unitised goods: tote bins, pallets, roll cages, shipping containers; bulk products: minerals, building spoil, aggregates, biomass, etc. See www.molesolutions.co.uk

MSL's research has shown that the major applications of freight pipelines in London can be:

1. In major regeneration projects where a freight pipeline could be used for the removal of spoil and the delivery of a large percentage of building products to the regeneration site

2. On completion of the building project the freight pipeline can be readily converted to provide a goods delivery system to the site's new function

3. In the use of consolidation centres where freight is delivered to an out of area consolidation point avoiding HGV's in the congested city centre. Freight is then transported in a freight pipeline to its point of use or to a substation for last mile delivery by appropriate eco-friendly transport. See illustration



Principles of the Mole Freight Pipeline concept are:

- SIMPLE and MATURE technology to provide high reliability, availability and maintainability
- ELECTRICALLY POWERED to be sustainable and have low environmental impact
- ENCLOSED to be safe and secure
- HIGHLY AUTOMATED to allow 24x7 unmanned operation
- MODULAR CONSTRUCTION to minimise time and cost of installation
- LAID BESIDE/UNDER EXISTING TRANSPORT INFRASTRUCTURE to simplify installation and integrate with existing supply chains

Benefits of the Mole system are:

- VERY LOW DIRECT OPERATING COSTS: automated, energy efficient, simple maintenance and repair offers direct operating costs of approximately 15% of road costs
- COST EFFECTIVE INCREASE IN INFRASTRUCTURE CAPACITY: modular construction using the total 3D footprint of existing and disused transport infrastructure shortens the construction time and provides attractive investment returns at low capacity utilisation
- INDIRECT COSTS: resilient transport infrastructure enables reliable Just-In-Time services allowing the full JIT benefits to be realised
- SOCIAL: freight only, separate system offers intrinsically the lowest accident rates of any mode; transferring freight from the roads releases capacity and contributes to a reduction in congestion
- ENVIRONMENTAL: lowest environmental impact of all the transport modes - power is as green as the electricity supply; low carbon, air pollutants and noise, significant reduction in road damage.

Freight Pipeline projects since 2010

The Freight Pipeline concept has been recognised as an emerging and viable transportation system by DEFRA/DfT, the Technology Strategy Board, Innovate UK and Future Railway all of whom have grant funded research and development projects by MSL over the last five years. Additional support in these projects has come from a number of partners including DHL, Laing O'Rourke, Morgan-Sindall, PA Consulting Group, Arup, Force Engineering, WGH Engineering, Lafarge-Tarmac and Urban and Civic. MSL have shown in the following projects that the concept is applicable to a wide range of freight transport:

1. 2015 completed on time and budget four projects:
    a. An Innovate UK 'Proof of Concept' project to establish the viability of the Mole Urban Freight System in Northampton. The conclusion is that the concept is viable and it is planned to begin in 2016 the development of a comprehensive Business Plan for Northampton. The project has also developed the methodology that can be used to evaluate the concept in any conurbation anywhere in the world.
    b. A Pre-Feasibility Project of the Mole Urban Freight System for Transport for Greater Manchester. The proposed system could be used: to extract spoil from the major regeneration of the Manchester Piccadilly Station area; the delivery of most of the building products to the site; a legacy goods delivery system from Port Salford into Manchester. An outline Feasibility Study proposal was produced and is being considered by TfGM as part of their total transport strategic plan.
    c. In conjunction with ARUP, an evaluation for Radioactive Waste Management of the use of the Mole system in the development of Deep Storage Facilities. The conclusion reached was that the concept offered significant benefits for much of the freight transportation required in the development and operation of the proposed facility. Outline designs for the components of the system were produced which would provide the basis for a detailed Feasibility Study when required.
    d. MSL were successful in a Future Railway competition to study the use of Linear Induction Motors (LIMS) to provide independent braking to trains when the conventional wheel on rail braking fails due to circumstances such as leaves on the track. The study showed, using computer simulation and physical trials on a modification to our development track, that the Mole concept met the competition brief. The next stage is to submit a proposal for second stage funding to scale up the components and evaluate a full size pilot system. If MSL are successful with their proposal, work will begin in the middle of 2016.
2. In addition, in July 2015 MSL were selected by the University of Texas (UoT) to be a member of the Stakeholder Group for the Feasibility Project into the potential use of freight pipelines in Texas. This 3M$ study is financed by the State of Texas and is focussed on evaluating the use of LIM powered freight pipelines to transport thousands of shipping containers over distances in excess of 250 miles. We have reached an agreement with UoT that MSL will provide technical input on the design of the hardware and software in the development of the concept.
3. 2013/14 designed, commissioned and demonstrated to more than 70 organisations a bulk system capable of carrying 10m tonnes per annum in a pipeline of 1.3m internal diameter. The project was part funded by a TSB 'Development of Prototype' grant.

4. 2012 completed a 'Proof of Concept' project, partly funded by the TSB 'Smart Grant Scheme', the objective of which was to: produce outline designs for the components of a bulk freight pipeline system; compare the financial viability of a Mole system with long haul conveyors; produce an animated video explaining the concept. The project outputs are: the outline designs; a financial analysis that showed for volumes greater than 750ktpa and distances greater than 750m, a Mole system offered a better investment than conveyors and would be much safer and cleaner; the video can be viewed at our website: www.molesolutions .co.uk
5. 2010 Completed a DEFRA funded/DfT managed Feasibility Study: *'Assess the feasibility of using freight pipelines to transport aggregates in England'.* The conclusions reached are that: the individual technologies are well proven - the innovation is in the manner in which they are combined; at relatively low levels of capacity utilisation (~ 10%) the return on investment was calculated as 10% and this increased with utilisation; major social and environmental benefits would be generated; simple routes could be developed in less than three years

Technology Readiness Level (TRL).

The recent projects have shown the individual components of the Mole Concept are all well proven technologies; the innovation that Mole Solutions has developed is combining these individual technologies into a world leading Freight Pipeline system with extensive global applications.

Global potential.

MSL have attended and presented papers at the last three International Society Underground Freight Transport Conferences: University of the Ruhr, Shanghai and University of Texas. Attendance at these events came from the UK, USA, China, Japan, Germany, The Netherlands, Italy, Canada, Belgium and Turkey.

In April 2015, MSL were interviewed by the FT and the subsequent article produced a tsunami of publicity both in the UK and from around the world. The level of interest in this innovative approach to the global issue of road congestion is considerable. Further press releases are planned for the first quarter of 2016.

Specific evidence for London's transport infrastructure.

Mole Solutions evidence is focussed on the potential of underground freight pipelines within London and its commuter hinterland.

Q1. What are the major economic and social challenges facing London and its commuter hinterland over the next two to three decades?

The major challenges facing London and its commuter hinterland are summarised in the Roads Task Force report published in July 2013.

The key issues are:

- Population growth. The population of London is expected to increase by 2.06 million by 2036
- Limited space: the challenges of meeting the conflicting demands of the capital call for innovative transport solutions that make a significant contribution to maintain and increase the quality of life in the capital.
- Road congestion: costs in excess of £4bn per annum and has been increasing by approximately 1% per annum whilst traffic levels have fallen by a similar rate. Freight accounts for 30% of London's peak traffic and any scheme which can reduce this will lessen the predicted increase in congestion in Central London.
- Safety: the removal of a significant number of freight vehicles from the streets of London will help to remove the perceived danger of these vehicles by inexperienced cyclists thereby aiding the ambition to increase the planned growth in cycling within London
- Pollution: Unless London's air quality improves, the EU is expected to fine the Capital £300 million. MOLE has the potential to be part of a solution which will improve London's air quality, particularly the reduction of NOX and $C0_2$.
- Cost: the DfT's value for infrastructure damage from HGV's in conurbations are 28p/truck mile for 'A' roads and 171p/truck mile for other roads. Trucks are therefore a major contributor to road maintenance and a reduction of road freight miles should be reflected in lower road maintenance costs.

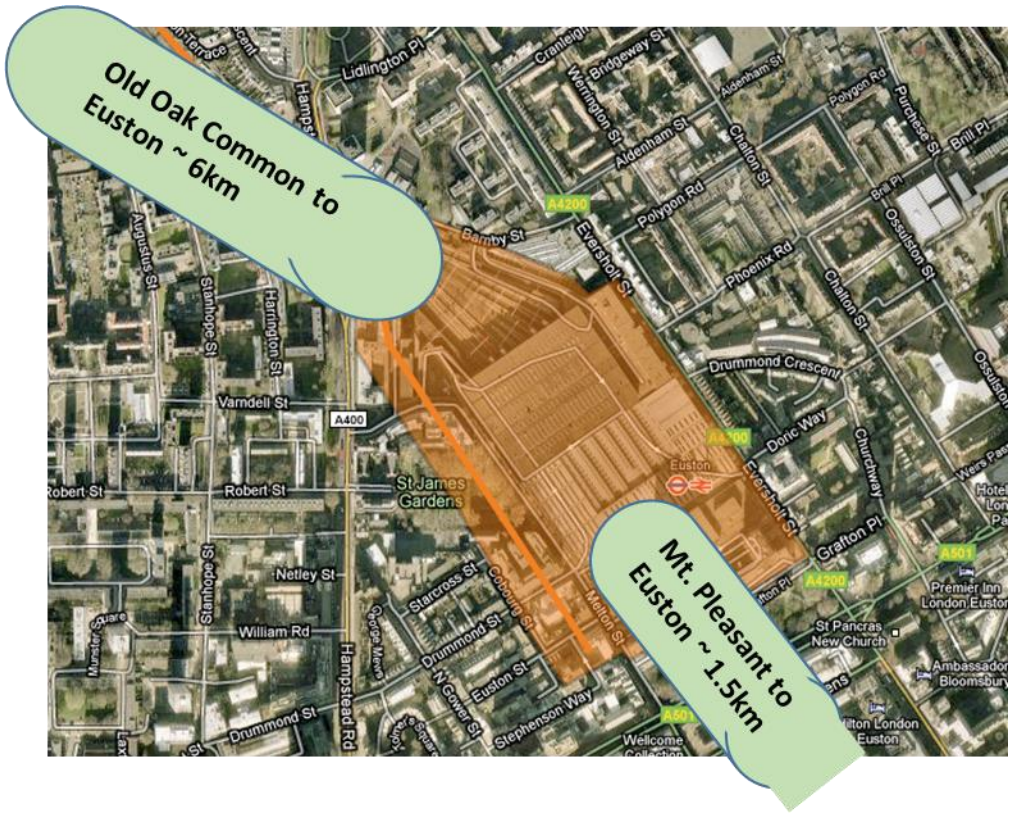
Q2. What are the strategic options for future investment in large-scale transport infrastructure improvements in London - on road, rail and underground - including, but not limited to Crossrail 2?

Our submission is based on the development of underground freight pipelines to take a significant volume of road freight off of London's streets and transfer the goods to capsules travelling on rails in pipelines of approximately 2.4m internal diameter.

"I've seen the Mole Solutions demonstrator and therefore seen how much of freight can be transported in the 21st century; anyone involved in designing transport infrastructure should understand what role the Mole concept can, and can not, perform within their plans". Darryl Stephenson, Head of Value Engineering, HS2, July 2014.

Examples of how a freight pipeline system could fit with the planned and existing transport infrastructure projects for London are given below. The examples are suggestions only, there are many other applications where the freight pipeline concept would be part of, if not all of, the solution.

Example A – HS2 and Euston Station.



Possible pipeline routes to/from Euston

It is planned to make the new Euston Station a major retail complex and for the goods for the total station to be delivered by road via an access from the Hampstead Road to an under croft of four acres, the construction cost of which is estimated as £100m. Delivering the goods and removing the dry waste by means of a Mole system would reduce the need for such a large under croft and reduce congestion on one of the busiest routes into the centre of London.

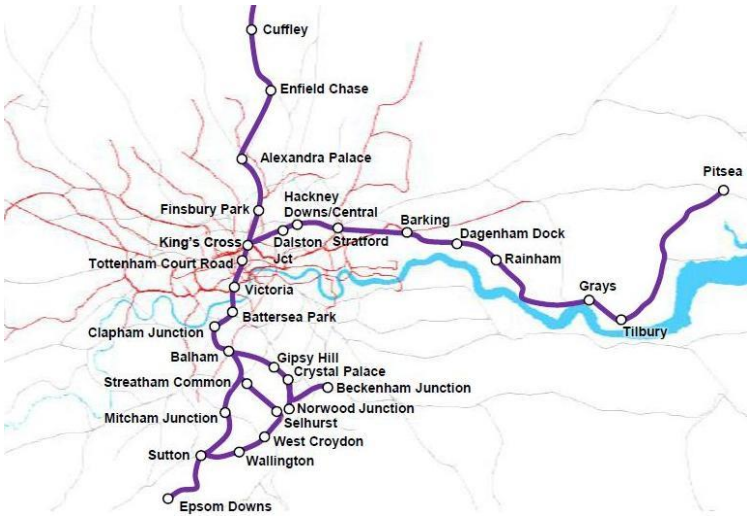
Two routes are possible:

1. Towards the Old Oak Common / Park Royal area where goods destined for Euston would be delivered to a consolidation centre. Here the goods would be transferred to a pipeline constructed largely under the canal network.
2. Developing a short tunnel from Euston to the Mail Rail system near Mount Pleasant; a modernised and extended Mail Rail system could then be used to connect to the Park Royal area, again using a pipeline under the canal network.

Example B – Crossrail 2 – Option 12.

The Mole Solutions approach would involve:

1. Designing CrossRail 2 to incorporate 2.4m internal diameter freight pipelines beside the 7.0m internal diameter tunnels of Cross Rail 2
2. These pipelines could be used as a safer, more reliable spoil removal system in the construction of the tunnels
3. Extending CR2 to Pitsea and including Mole freight pipelines in the construction would provide a pipeline link to London Gateway Container Port and Logistics Park and offer a freight route into London avoiding one of the most congested sections of the M25, The Dartford Crossing. Again, the system can be designed to deliver goods into London and for the removal of much of the dry waste products.



In addition to the benefits mentioned in Q1 the use of a Mole system that provides a reliable, regular delivery service throughout the working day enables stock to be held remotely in areas where rents are typically 10% of central London, Approximately 25% of the area of a typical retail store is non-selling space including back room storage space. The ability to convert this storage space into retail would be of significant benefit to retailers.

Sectors served by the freight pipeline system are largely those served by road: retail, commercial, public sector, etc.

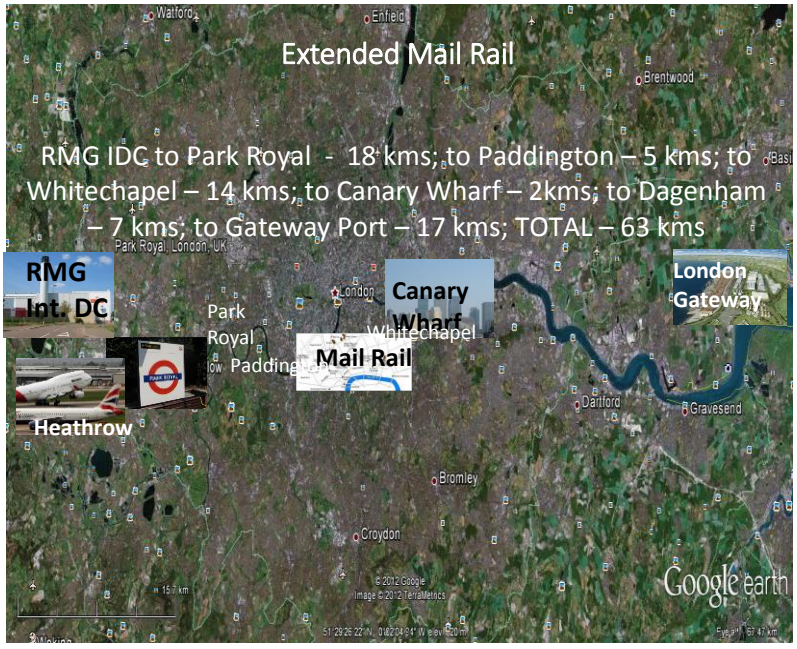
As in Example A, goods destined for the centre of London would be delivered to strategically located consolidation centres (e.g. the logistics park co-located at London Gateway Container Port) from where the loaded capsules would travel to a number of locations within London. These locations would be located in, or very close to, centres of high demand which would also be the operational base for low impact 'Last mile' delivery vehicles.

Example C – Modernised and Extended Mail Rail.

London is fortunate to have had the only extensive goods freight pipeline in the world, Royal Mail's Mail Freight system that operated under the streets of London from Whitechapel, via the City, Mount Pleasant and under Oxford Street to Paddington. The system operated reliably and cost effectively from 1927 to 2003 when the system was mothballed. Although a section around Mount Pleasant is being converted into a postal museum, the remainder of the nine mile long system is considered to be in a good condition and could be made operational at a comparatively low cost and in a matter of months.

The Mole Solutions approach would involve:

1. Modernising the existing mothballed system
2. Tunnelling round the Mount Pleasant area to re-establish the Paddington to Whitechapel route
3. Tunnelling from Mount Pleasant approximately one kilometre north to provide a link to Euston and St. Pancras Kings Cross
4. Extending the system to the west to beyond the M25 to serve Heathrow and beyond. The route for this could either be from Paddington, the existing western end of Mail Rail, using the route of the Grand Union Canal system to Slough or via a Euston – Park Royal pipeline and then the Grand Union Canal. In the east, the system could be extended from the current terminus at Whitechapel out to London Gateway using either the route of CR2 Option 12, or a new route laid predominantly under the Thames.

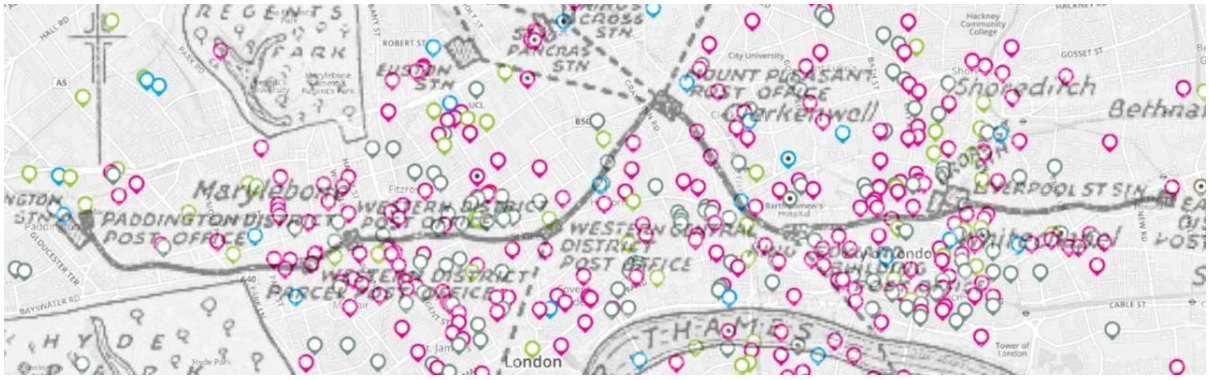


When fully operational, Mail rail had nine stations with street level access, at most of these the street access has been closed although the underground station still exists. New access methods would need to be designed and constructed.

A principle of the Mole concept mentioned in the introduction is that of modular construction. This entails constructing the key components of the system (track, propulsion and control) in 12m length modules off site in the form of a sleeve that is delivered to the construction site where it is slid into the tunnel sequentially.

It is assumed that the existing Mail Rail tunnels are still covered by a Transport Works Act (TWA) but clearly any extensions and new street level access points will need a TWA and Planning Approvals

Example D – London Building Projects.



Route of Mail Rail and Major Building Projects

The major building sites in the centre of London contribute significantly to the congestion problems of the capital. The Mole Solutions approach would involve:

1. Designing and constructing short tunnels to connect each major site in the form of a ring main
2. This ring main would be linked to the eastern section of the Mail Rail system which would then be used to remove spoil and deliver building products to the sites
3. On completion, the capsules and intermodal facilities would be converted to carry much of the goods destined for the City.

Ideally a comprehensive evaluation of the potential for freight pipelines within London needs to be undertaken to ensure that full account of planned and existing disused tunnels are included. In terms of prioritisation clearly the first priority should be to understand the potential of Mail Rail. The potential for using a Mole system to alleviate much of the traffic congestion caused by goods vehicles during the construction and operation of a regenerated Euston Station should also be examined as a matter of urgency given the recent publication of the High Speed 2 Bill.

Q3. What opportunities are there to increase the benefits and reduce the costs of the proposed Crossrail 2 scheme?

Utilising the route to incorporate freight pipelines and multi utility trunking will provide new income from tolls paid for use of the pipeline, an increase in retail space from converting ‘back store’ storage space into retail, a reduction in the number of accidents, an improvement in the air quality and a reduction in road damage.

Q4. What are the options for the funding, financing and delivery of large-scale transport infrastructure improvements in London, including Crossrail 2?

- *What is an appropriate local and regional contribution - given the potential distribution of benefits to business, residents, transport users and the wider economy - and how could this be achieved?*
- *What innovative funding mechanisms could be considered to support delivery of key schemes?*

This question is to be addressed in the next stage of the Northampton Project, the comprehensive Business Plan. At this stage we are proposing to examine the concept of 'who benefits pays'.

Q5. How have major metropolitan areas in other countries responded to similar challenges and priorities? Are there any lessons to be learned and applied in London?

London's Mail Rail exemplified the benefits of freight pipelines from 1927 until the network was mothballed in 2003. It acted as inspiration for academic research in the concept in Germany, The Netherlands, New York, Beijing and Shanghai. It was designed in 1909 when congestion was a major issue but largely from horse drawn transport. The major west – east commercial axis that the system was designed to serve is still very important but it is essential to recognise the change and growth of London's commerce. Therefore any development of the underground freight pipeline concept should begin with an understanding of what, and where, freight pipelines could be beneficially installed and the stages necessary to develop a fully functioning network.

Summary and Conclusions

This paper submits evidence to the NIC that the MSL freight pipeline concept can bring innovation and benefits to future UK and global transport systems in general and that of London in particular. UK government agencies have already invested in R and D projects that have proved both the concept and demonstrated the technology. A study of Northampton has shown that the business case for its use can be sound. Examples are given as to how the concept could be used in a number of current scenarios within future London transport schemes.

The next step is to embrace the concept as a significant input to future transport planning and integrate it as a complimentary feature with existing transportation infrastructure.