# Overview of Options to Reduce Motorway Congestion - A Case Study of the Pottstown Expressway

## Final Report

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## Executive Summary

The Pottstown-King of Prussia corridor on the outskirts of Greater Philadelphia, Pennsylvania, has a congestion problem and commuters have little other option but to wait it out in their cars. The Pottstown Expressway is an ideal site for the investigation into congestion relief options as it has a combination of a clear and obvious congestion issue, it experiences both high and low temperature extremes, there is both a railway and water way running parallel to it, there is adequate verge space. This coupled with the potential for the community of Pottstown to benefit from additional economic development and job creation options that can flow from appropriately designed transit services means it is worthy of serious consideration. For instance a key feature of shared transit is that it aggregates travelers to create nodes of economic and social activity around station precincts, along with increasing the value of surrounding land. This is important as rather than just a congestion management issue the provision of effective transit services can be an economic development opportunity, however what option best suits the 422?

In order to inform efforts to answer this question, the Pottstown Area Health & Wellness Foundation provided a grant to allow a team of researchers led by Internationally Renowned Expert and Author, Professor Peter Newman, the IPCC Coordinating Lead Author for Transport, to undertake a high-level overview of congestion relief options. The team identified 10 possible congestion relief options and undertook an investigation based on the following criteria: cost, effectiveness, development potential, environmental benefits, and job creation potential, as summarized in Table 1.

**Table 1**: Summary of Findings of Research into Congestion Options

| Options | Overall Cost | Effectiveness | Development Potential | Environmental Benefits | Job Creation Potential |
|---|---|---|---|---|---|
| **A. HOV Lanes** | *Low* | *Little* | *None* | *Minor* | *None* |
| **B. Shuttle Bus** | *Low* | *Low* | *Very little* | *Some* | *Small* |
| **C. Fast Ferries** | *High* | *Low* | *Some* | *Some* | *Medium* |
| **D. Air Transport** | *High* | *Low* | *None* | *Negatives* | *Small* |
| **E. Monorail** | *High* | *High* | *Some* | *Considerable* | *Medium* |
| **F. Trackless Trams** | *Low* | *High* | *Considerable* | *Considerable* | *Large* |
| **G. Commuter Rail** | *Low* | *High* | *Considerable* | *Considerable* | *Large* |
| **H. Car Pooling** | *Low* | *Some* | *None* | *Some* | *None* |
| **I. Tele-commuting** | *Low* | *Some* | *None* | *Some* | *None* |

Based on the findings, including discussions with various stakeholders, it seems that the most promising option for the Pottstown Expressway would be a combination of 'Commuter Rail' along the corridor supported by a system of 'Trackless Trams' feeding passengers into the train stations from each side of the corridor (or even a complete Trackless Tram system along the 422 if the rail option is not available). In order to build on this finding, it is recommended that further investigation be undertaken to explore implementation considerations with stakeholders, including identify innovative financial models.

## Summary of Key Findings

Based on a review of case studies and reports around the implementation of congestion relief options the following lessons have been distilled as relevant to informing options for the Pottstown Expressway:

1. The option to provide an additional lane for traffic in both directions rarely delivers lasting congestion relief and comes at a very high cost (some $30 million per mile) compared to other more effective options and as such it was not investigated. Such a response may provide short term benefits to reducing congestion but in a very short time it simply moves the congestion problem further down the highway network to create further bottle necks, with congestion levels building back up over time to where it was before.

2. Although HOV lanes and shuttle buses are widely used they seem to provide little value as an option along a heavily congested corridor. HOV lanes for instance are often underutilized or are not properly policed leading to limited congestion relief and complaints of higher congestion in non-HOV lanes. Shuttle buses are commonly used for transit services such as airport transfers however have not been successfully used for mainstream commuter travel other than in cities like Manilla and Jakarta where their jitneys provide demand-responsive services but leave most city streets highly chaotic.

3. Fast Ferries have been shown to have a minor ability as an option for peak congestion relief if there is a river running alongside the motorway, such as the Schuylkill River that runs along the 422 all the way into Philadelphia. However ferries rarely come close to land based transit services in their ability to attract passengers and in this particular case it would be capital intensive as bridges and dams along the waterway would need to be upgraded to allow the ferry to pass by.

4. Air Transport options using new technology electric planes and drones are likely to be an expensive and risky option with minimal impact on congestion. Despite a recent focus in this area current options would create negative environmental issues along with noise and air traffic control concerns. Regarding development potential this form of transit is more likely to scatter development than aggregate it.

5. Elevated Monorail, Trackless Trams and Commuter Rail on the freight line are all good options worth further consideration in terms of the time savings value they can create, their ability to shape development around stations, and provide a range of environmental benefits, while creating jobs due to their ability to create density where it can help create jobs. However the capital cost varies with an Elevated Monorail costing around $80m per mile due to its elevated concrete and steel construction; Commuter Rail around $8m per mile for carriages and station upgrades, as the rail track is already there; and the Trackless Tram around $5m per mile as it does not require much infrastructure other than adequate road space.[1]

6. Car Pooling and Tele-commuting have long been advocated as if implemented effectively they can deliver some value and should be encouraged as a complementary measure to the provision of more direct transit services such as those mentioned above. These non-infrastructure options are focused on reducing car use and provide some benefits in terms of reduced greenhouse gas emissions but are likely to do little to attract development and help create jobs in the corridor.

[1] These are estimates only for comparison purposes.

## Part 1: Background

The Pottstown Expressway is the section of US422 between Pottstown and King of Prussia, and this is part of the commuter route from Pottstown to Philadelphia as shown in Figure 1. The Pottstown Expressway is an ideal site for the investigation into congestion relief options as it has a combination of a clear and obvious congestion issue, it experiences both high and low temperature extremes, there is a railway and water way running parallel, and the verge is not fully built out.

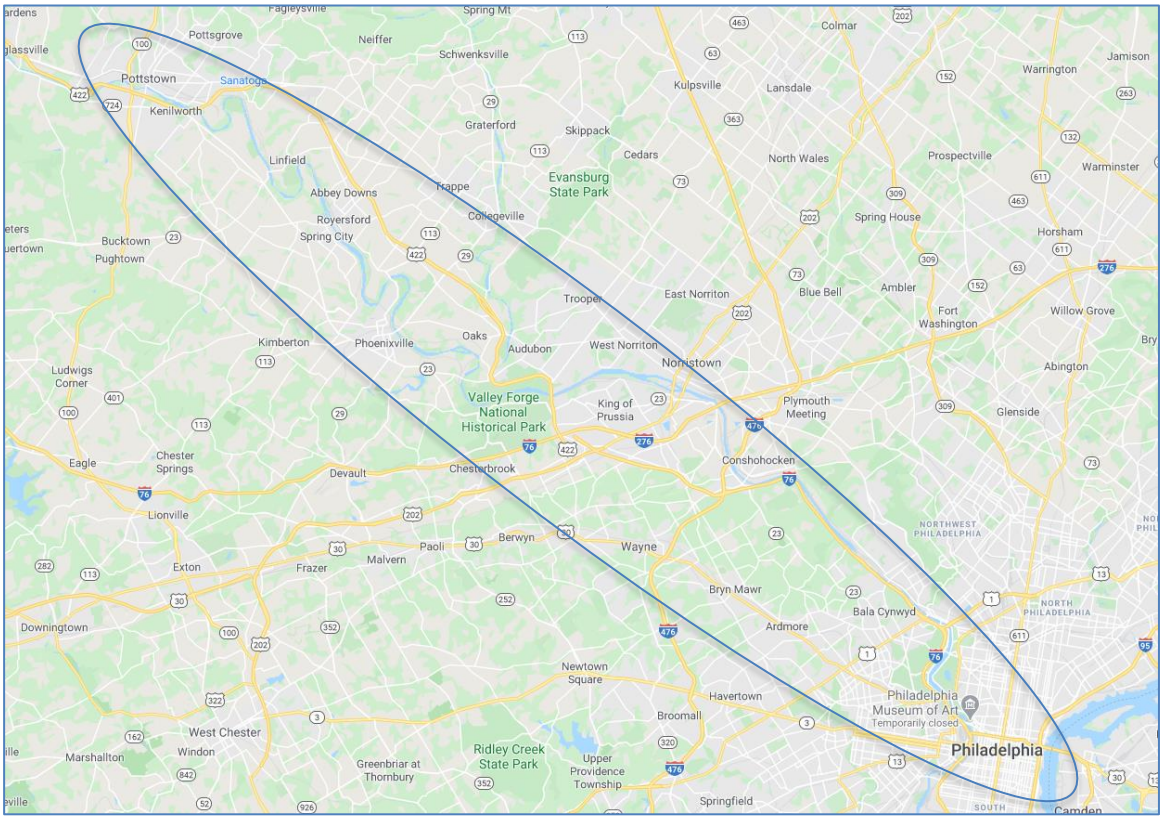


**Figure 1**: The Pottstown-Philadelphia Corridor

The following factors have an influence on the type of congestion management methods used on the Pottstown Expressway:

- *Clear and obvious congestion issues*: The Pottstown experiences high traffic volumes during morning and evening peak hours, causing extensive delays across the two general-purpose lanes in each direction. The 25.3 mile strip can take commuters up to 2 hours to travel during periods of heavy congestion creating significant community pressure to investigate potential technological and policy-based solutions in reducing traffic congestion along the expressway.
- *Experiences both high and low temperature conditions*: In January on average the coldest temperatures can reach as low as -15˚F (-28˚C) with snow experienced between November and March, and in July on average the warmest temperatures can reach as high as 115˚F (46.1˚C). This presents an opportunity to consider the full range of likely temperatures from sub-zero conditions in winter (with the route being salted and plowed when snowfall reaches a height of 3-inches) to sweltering heat in summer, a successful solution would need to work in extreme weather conditions, conversely this presents an opportunity to investigate a strategy that is seasonally flexible. The need

to consider such weather conditions increases the likelihood of this case study to be applicable in locations with similar issues.

- *A private railway running alongside*: The established private railway line provides the potential for congestion relief without constructing a new rail line, assuming suitable arrangements can be agreed with the private operator. This presents the opportunity to develop mutually beneficial public private partnerships which may encourage urban innovation and development in the region, this would be in addition to reducing congestion and travel times along the expressway. The Pottstown Expressway could provide a leading example of how both private and public interests can be met to both improve mobility and attract new development to the area. Such outcomes are just not possible with options which have a limited long term effect on private vehicle use and as such have an upper limit to their value, for example increasing the number of lanes, or encouraging off peak travel times.
- *A river running alongside*: The Schuylkill River runs through Pottstown, Norristown and then directly into Philadelphia. The length between Pottstown and Norristown is just under 30 miles. Assuming appropriate infrastructure, a non-stop transit with an average ferry speed of 28 knots would take approximately 55 minutes and is closely comparable to current transit times along the US422 by car. There are a number of bridges, dams, and narrow pathways within this section of the river that would need to be assessed as part of consideration of a ferry service.
- *The motorway is not built out*: This presents the opportunity to investigate additional vehicle lanes, say for the provision of a dedicated tram or shuttle service, without requiring compensation to private land owners surrounding the expressway, and weighing the efficiency gains this strategy could produce against the economic and environmental costs through flora and fauna damage or habitat destruction. The expressway does have a series of bridges that would need to be augmented should such services be provided.

Given the range of factors that need to be considered the Pottstown Expressway presents an ideal case study to inform similar congestion relief investigations across the United States. Coupled with the potential for the communities across the Country to benefit from additional economic development and job creation options that can flow from appropriately designed transit services means it is worthy of serious consideration. For instance a key feature of shared transit is that it aggregates travelers to create nodes of economic and social activity around station precincts, along with increasing the value of surrounding land. This is important as rather than just a congestion management issue the provision of effective transit services can be an economic development opportunity, however what options are best suited?

## Part 2: Overview of Potential Congestion Relief Options

Given the range of factors summarized above there are a number of potentially viable options for congestion relief along the Pottstown Expressway. Such options are focused on reducing the number of commuters travelling along the corridor at peak times, or increasing the efficiency of travel along the corridor even without a reduction in demand, as such most options are not mutually exclusive, whilst they have been analyzed as separate options, as is often the case the most effective solution is likely to incorporate a combination of strategies that work in synergy. The options chosen for consideration as part of this study are:

- Option A: High Occupancy Vehicle (HOV) Lanes
- Option B: Shuttle Bus Services
- Option C: Shared Water Transport (Fast Ferries)
- Option D: Shared Air Transport
- Option E: Single Rail Overhead Service (Monorail)
- Option F: Trackless Trams
- Option G: Restoration of passenger rail services
- Option H: Car-pooling
- Option I: Tele-commuting

In order to investigate each of the options the research team selected four key criteria: cost and effectiveness, development potential, environmental benefits and employment potential:[2]

- *Cost and Effectiveness*: Cost is always going to be an issue in transport planning and infrastructure delivery, especially when capital is heavily dependent on government. Hence the cost of various congestion relief options needs to be clearly understood and justified. Benefits of transport related expenditure are typically expressed in terms of time savings which directly translate into economic and social outcomes. Along with this, there are multiple benefits related to health and safety related to reducing car dependence that are increasingly being considered.

- *Development Potential*: In addition to direct economic benefits and social outcomes, transit is also being recognized as a shaper of cities in ways that not only reduce car dependence but enable urban regeneration to create vibrant economic centers around stations and along corridors. If done with early developer involvement transit corridors can activate development potential in synergy with the transit services. Referred to as a 'Transit Activated Corridor' approach effectively the transit stations increase the value of development sites and the development attracts travelers on the transit system, working together to create economic development and jobs.

- *Environmental Benefits*: The importance of local and global environmental issues has grown to the extent that they now must be addressed in any transport strategy. Local environmental issues are usually about destruction of local places to make way for transport infrastructure, noise created by construction and vehicles, and negative impacts on air quality that affect community health, while globally the main issue is reducing growing volumes of greenhouse gas emissions.

[2] For a detailed explanation refer to: Newman, P. and Kenworthy, J. (2015) *The End of Automobile Dependence: How Cities are Moving Beyond Car-based Planning,* Island Press, Washington DC.

- *Employment Potential*: It is essential that any investment in infrastructure enables longer term job creation, especially in the wake of the impact of the COVID-19 pandemic. If done effectively, providing transit services can create new development, as outlined above, that will create new ongoing jobs, rather than just construction, as in road widening. Hence, transit options are particularly good at enabling employment through activating urban regeneration which is a large source of job growth in design, building and construction and then afterwards in attracting knowledge economy jobs due to the agglomeration activity around density of centers.

This document provides an overview of each option, examples of case studies, a summary of pros and cons, and the findings as relevant to eh Pottstown Expressway.

## *Option A: High Occupancy Vehicle (HOV) Lanes*

### *Overview*

High Occupancy Vehicle, or HOV, lanes are commonly used to reduce traffic congestion and encourage carpooling and shared transit. This is done by allocating a specific lane, often at particular times of the day, for vehicles with a high number of passengers, typically greater than 3 people. In Pennsylvania, HOV lanes are used on Interstate 279 in Pittsburgh that require 2 or more passengers from 6:00am to 10:00am and 3:00pm to 7:00pm, Monday through Friday.

In theory HOV lanes can help reduce congestion, however often in practice they are either underutilized or improperly utilized and this can create additional problems. For instance it is well documented that if the HOV lane is underutilized this can lead to extending queues in non HOV lanes that can stretch over long distances along a motorway.[3] HOV lanes can also encourage single rider vehicles to use them if they are underutilized diminishing the benefit of the lane. Given these issues, HOV lanes are often found to be only slightly more effective than a general purpose lane,[4] and in order to improve their effectiveness additional mechanisms such as fees or fines are needed (often allowing tolled vehicles with single passengers to also access the lane as in US36 in Colorado.[5]

### *Case Studies*

In 1976, a High Occupancy Vehicle (HOV) lane was introduced to the US101 route along a 3.7-mile section in Marin County. This section has three general purpose lanes of which one lane is utilized as an HOV lane during three-hour peak traffic periods between 6:00 - 9:00am and 4:00 - 7:00pm. This HOV lane is not separated by barriers and is open to buses and carpooling of more than three passengers. The most recent survey reported in April 1984 showed use of the HOV lane had reduced travel-time in one direction by a mere 2 minutes through the morning period in comparison to the general-purpose lanes.[6]


Highway 101 carpool lane, Marin County

[3] Daganzo, C. and Cassidy, M. (2008) Effects of high occupancy vehicle lanes on freeway congestion, Transp. Res. B 42 (10) (2008) 861–872.
[4] Dahlgren, J. (1998) High occupancy vehicle lanes: not always more effective than general purpose lanes, Transp. Res. A 32 (1998) 99–114
[5] Plotz, J., Konduri, K., and Pendyala, R. (2010) To What Extent Can High-Occupancy Vehicle Lanes Reduce Vehicle Trips and Congestion?: Exploratory Analysis Using National Statistics, Transportation Research Record, 2178(1), 170–176.
[6] Southworth, F. and Westbrook, F. (1985) Study of current and planned high occupancy vehicle lane use: performance and prospects. United States: N. p., 1985.

The Metropolitan Transit Authority of Harris County operates 120 miles of HOV lanes and while initially designed for buses it now offers an HOV-2 lane for vehicles with 2 or more passengers, and HOV-3 lanes for vehicles with 3 or more passengers both during peak times. In 2006 the system was estimated to provide access to some 36,400 multi-occupant vehicles each week, saving the average commuter 12–22 minutes per trip.[7]

*Pros & Cons*

Pros:

- Encourages carpooling and multi-passenger vehicle trips which is intended to reduce the number of cars using the motorway during peak times, reducing vehicle emissions.
- Results vary depending on the level of appropriate utilization and vehicle flow rates, however it can be expected to achieve between 2 percent and 10 percent reductions to trip times
- If underutilized this presents the potential to include tolled vehicles and other charging mechanisms to access shorter trip times on public motorways.

Cons:

- In the case were a new lane is being considered making it an HOV lane will likely be of benefit under very specific conditions and is unlikely to perform much better than a general-purpose lane.
- HOV lanes can exacerbate congestion issues when underutilized as this leads to increased queuing in other lanes that can stretch out over long distances, affecting other parts of the transport system also.
- Compliance with either 2 or 3 passenger minimums can be difficult to enforce often leading to vehicles disregarding restrictions and reducing the congestion relief benefits.

*Findings*

The research suggests that in the case of the 422 which is a dual carriageway the use of a designated HOV lane during peak periods is unlikely to have a noticeable impact on congestion levels as it is likely to be underutilized or incorrectly utilized. Steps to increase the effectiveness would likely need to involve some form of economic incentive or penalty that is consistently and predictably applied. However with the more recent increase in uptake of shared vehicles (as opposed to ride-sharing which on average does not reduce the number of vehicles on the road) the utilization rates may increase in future to a level that makes an HOV lane viable. In short HOV lanes are 'good in theory - but not always in practice'.

| Cost and Effectiveness | Development Potential | Environmental Benefits | Job Creation Potential |
|---|---|---|---|
| Low capital expenditure (where existing lanes are co-opted), with little impact on congestion. | No change to behaviors to support development along the corridor. | Minor benefits unless high utilization rates of shared vehicles. | Low, apart from a potential demand in carpooling services. |

[7] US DOT (2015) High-Occupancy Vehicle Lanes (Online), US Department of Transportation, Washington DC, USA.

## *Option B: Shuttle Bus Services*

### *Overview*

A shuttle bus service could run from various places leading to the Pottstown Expressway and then run down it to King of Prussia and Philadelphia. Shuttle bus services are typically an underused transit option that is often only used for short, fixed routes with variable stops such as airport shuttles or between hotels and other popular destinations. The value of a shuttle service is that up to 15 passengers can share a vehicle rather than the smaller numbers in demand responsive shuttles. For instance, a shuttle bus service in Emeryville, California, called the 'Emergy-Go-Round' service, provides a shared transit link for up to 5,000 passengers a day between the regional light rail system and Emeryville. Further to the vehicle trips that the service displaced in 2009, the shuttles were upgraded to hybrid electric vehicles, resulting in a 30% fuel and emissions saving.[8]


The 'Emergy-Go-Round' Shuttle Service in Emeryville, California

As with HOV lanes this option is dependent on the level of utilization and increasing ridership is likely to involve a shift in perception from seeing shuttle services as either just for airport hotel transiting or only as a low socio-economic option.

### *Case Studies*

The 'Emery Go-Round' in Emeryville, California, is a hybrid shuttle bus service that was introduced in 1995 to connect Emeryville and surrounding communities to popular locations within the town, running between the regional light rail system and the town's centre. The service is free and is funded by business property owners and it quickly gained popularity once opened, increasing ridership from 300 passengers to 3,000 per day within its first six months of operation.[9] The shift to a hybrid service has increased the environmental and health benefits by reducing Particulate Matter by 85%, Nitrogen Oxide emissions by 35%, Carbon Dioxide by 24%, and an improvement of fuel economy by 32%.[10] However, 3,000 passengers per day is a very small proportion of the numbers that are generally carried on rail systems; even bus systems would carry more than this each hour.

[8] PR Newswire (2009) IC Bus Helps Emeryville, California Go Green With New Hybrid Commercial Buses, [Online], PR Newswire; New York, 12 May 2009.
[9] Gonales, R. (2013) 'How a free bus shuttle helped make a small town take off', [Online], NPR, November 13, 2013.
[10] PR Newswire (2009) IC Bus Helps Emeryville, California Go Green With New Hybrid Commercial Buses, [Online], PR Newswire; New York, 12 May 2009.

*Pros & Cons*

Pros:

- Reduces the number of individual vehicles travelling to regular destinations such as hotels or other attractions with the ability to be demand responsive reducing unnecessary mileage.
- Provides effective feeder services to other forms of shared transit such as train stations given the smaller services are demand responsive and have similar driving profiles to other vehicles on the road (i.e. not as slow as bigger buses in navigating the transport network).
- By aggregating people in to a shared mode this will reduce equivalent emissions from the use of taxi's or private personal vehicles, especially when using hybrid or electric vehicles.

Cons:

- There is often cultural stigma around the use of shuttle buses, seen as a low socio-economic option.
- Low ridership will diminish environmental returns in comparison to most transit systems.
- If progressed to scale, such as the jitney services in Manila and Jakarta, despite providing some aggregation of passengers, shuttles using main corridors can cause disruption to traffic flow compared to corridor commuter options such as off-road rail or an on-road tram.
- Given their low capacity (just a step up from taxis) this would decrease the potential for development opportunities to be created (and associated job creation) around station areas designated for shuttle stops.

*Findings*

The research suggests suggest that shuttle buses have some potential to aggregate travelers and provide a reasonably competitive service to private cars moving down the Expressway, especially if a truly effective HOV lane was provided. However, given current views on their use they may not always be a faster or more environmentally friendly option. Shuttles do have the potential to provide effective feeder services to other shared transit modes. In order to make an impact on the Pottstown Expressway, efforts will need to be made to increase ridership and avoid underutilization (such as coupling with a peak time HOV restriction). Ultimately the effectiveness of a shuttle service will be dependent on people's willingness to use them and how much they can reduce or compete with private car commuter travel times.

| Cost and Effectiveness | Development Potential | Environmental Benefits | Job Creation Potential |
|---|---|---|---|
| Low capital, given existing infrastructure, low impact and possibly therefore marginal benefit. | Stations are designated but low demand means virtually no development potential as is found with most bus services. | There are some benefits from aggregating passengers but is likely to be and hence low environmental benefits. | Apart from shuttle operators there is a low potential for job creation. |

*Option C: Shared Water Transport (Fast Ferries)*

*Overview*

River transport includes traditional ferries, modern catamarans and other new e-boats that are able to transport passengers along or across waterways. This form of shared transit is used in a number of cities around the world especially in high density cities built around waterways. More recently commuter friendly linear ferry systems have become popular that offer services that "*connect waterfront locations along a river or coast*".[11] These services are characterized by "*frequent regular scheduled services, a public transport focus, and the use of medium to high-speed vessels*." Such waterfront services are offered in cities such as Brisbane (Australia), London, (UK), Toulon (France), Bangkok (Thailand), Hamburg (Germany), and Gothenburg (Sweden) and New York, Washington, and Seattle (USA).

The Hamburg system carries 8 million passengers a year with 22 terminals and a total length of 24km; the Bangkok ferry system carries 13.5 million passengers a year with 38 terminals and a total length of 31km; and the New York ferry system carries 1.2 million passengers a year with 8 terminals and a total length of 11km where ferry services were subsidized to reduce demand for the overcrowded rail system.[12]

The new electric ferry being used in Bangkok

These numbers of passengers have no comparison to the numbers carried by rail and even buses in these cities, for example New York carries 5.7 million a day (1.8 billion a year which is 1500 times the ferry numbers).

*Case Studies*

Water transit is particularly effective in cities such as in Nigeria where road based travel across the city of Lagos can take many hours whereas a 'Metroferry' now takes 30 minutes and services some

[11] Tanko, M., and Burke, M. (2016) 'Transport innovations and their effect on cities: the emergence of urban linear ferries worldwide', World Conference on Transport Research - WCTR 2016, Shanghai, 10-15 July 2016.
[12] Tanko, M., and Burke, M. (2016) 'Transport innovations and their effect on cities: the emergence of urban linear ferries worldwide', World Conference on Transport Research - WCTR 2016, Shanghai, 10-15 July 2016.

18,000 passengers per day and growing.[13] Bangkok has a relatively successful ferry for similar reasons. Once established, the ferry system in Brisbane, Australia, saw an increase in property value near ferry stations suggesting that the development potential may contribute to system costs, "*Ultimately it appears property developers were justified in seeking to secure ferry terminals to service their developments. Governments may also be justified in bringing in land value capture mechanisms to help pay for terminals, vessels or operating costs in appropriate locations."*[14]

*Pros & Cons*

Pros:

- Fixed ferry terminals provide long term assurance of passenger traffic that will contribute to increased land value and residential development potential, activating new waterfront properties and sites.
- Allows for station precinct development around stations to achieve value capture and create jobs, although often competing with high value land that has otherwise low accessibility rather than in well-connected urban areas as with other options, such as trackless trams.
- During peak periods it is likely that a ferry service could marginally help relieve congestion levels especially if the service continues to Philadelphia or if there is a quick connection to the train in Norristown.
- Ferries can also carry freight and commercial parcels which may reduce heavy vehicle use on the motorway if shipped to a distribution center down river.

Cons:

- Use on the Schuylkill River would require construction of interchanges or locks in order to allow continued ferry routes. This would also slow the travel time.
- Construction of facilities would be made more expensive due to construction sites being inundated with water at times.
- Ferries are typically quite slow to onboard and off load passengers compared with a tram or a train system that can off load a large number of passengers quickly.
- Variations in depth of the river may cause issues with ferry passing.
- Although faster than peak vehicle travel, the ferry would be slower than other alternatives.
- Ferries currently use fossil fuel-based technology with some use of electric or hybrid options potentially available as in Bangkok which is moving to electric ferries in 2021.
- Potential for damage to the river ecosystem from construction and operation of the service.

*Findings*

Germany and Brisbane provide good examples of how waterways can operate ferry systems that can alleviate some of the congestion experienced in either railway or road networks. However, theses successful systems have had to overcome challenges suggesting careful consideration be given to the utility of such a system on the Schuylkill River. Such a system is likely to encourage development in waterfront areas that are otherwise poorly accessible which may compound

[13] Wortman, M. (2017) Forget Flying Cars: We need floating ones, Bloomberg CityLab
[14] Yen, B. (2014) What Brisbane's ferries can teach us about funding public transport, The Conversation, October 22, 2014.

| | | | | |
|---|---|---|---|---|
| | congestion issues. The system may have an additional review source from the carriage of goods and parcels. In the case of the Schuylkill River it is likely that civil works for the system will be more expensive than other shared transit options that stand to deliver greater patronage and development potential. | | | |
| | **Cost and Effectiveness** | **Development Potential** | **Environmental Benefits** | **Job Creation Potential** |
| | High capital expenditure due to inundation and dams, with low impact on congestion. | Some development potential will be generated however this is likely to be in residential property. | Some benefits from reducing the use of vehicles, especially if low emission options are used. | Given the need for new stations and the operations of the system there will be some job creation. |

*Option D: Air Transport*

*Overview*

Apart from the very rich, urban air transport applications are a relatively new concept for standard daily commutes, however recent advances in technology have seen a number of technology and aerospace companies, such as Airbus, Boeing and Uber, invest heavily into research and development of such vehicles, referred to as 'electric vertical takeoff and landing vehicles' (eVTOL), starting with emergency rescue vehicles and aspiring to provide shared transit service vehicles (however maximum occupancy is likely to be 5-6 persons in initial vehicles).[15]

For instance, Uber is conducting air taxi trials and hope to begin commercial operations in 2023,[16] and this type of progress calls for government to create supporting frameworks and instruments such as urban air traffic regulations, safety certification programs for new vehicles, accredited training for operators, and assessment of the environmental impacts from local noise. As recently as August 2020, Vertical Aerospace released the VA-1X, which is an all-electric eVTOL which is some 30 times quieter than a regular helicopter, but will be able to transport a maximum four passengers, and is aimed to be at market in 2024.[17]


Concept Uber air taxis designed by French aerospace company Safran

This type of system would involve creating designated landing and parking spaces upon buildings and open land, however it is unclear how air traffic control would function for a fleet of urban airborne "taxis" and it raises a number of safety concerns. This would call for government to create supporting frameworks and instruments such as urban air traffic regulations, safety certification programs for new vehicles, accredited training for operators, etc. For the purpose of this report it is included as an option given the recent spike in interest, however it is not considered to be a viable

[15] Trimble, S. (2018, Feb). Cheap at half the cost. Flight International, 193, 33-34.
[16] ABC News (2019) 'Uber Air set to take off in Australia with flying taxi trial in Melbourne', ABC, 12 June 2019.
[17] Alcock, C. (2020) 'Vertical Aerospace Unveils VA-1X Fixed Wing eVTOL', AIN Online, 26 August 2020.

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|---|---|
| | option in the short term. In addition, due to the severe weather conditions in the local area, air transport will likely not be suitable throughout the entire year, both current (helicopter and light aircraft) and new technologies (eVOTL vehicles) would likely be grounded in reduced visibility, and the compact nature of the vehicles renders them vulnerable to strong winds and rain.<br><br>However, in the not too distant future in comparison to other shared transit services such as Uber, over long-term distances, the compound helicopter design could be cheaper than car rides over the same distances. For instance a study by researchers at MIT in 2018 suggested that with technology innovation the cost per seat for a compound helicopter (the most expensive option) could reach as low as $0.60 per mile and that "*For comparison, the average prices of UberX (car ridesharing, where the ride is paid for by one passenger) and UberPool (in which the ride is shared between multiple paying passengers) rides in the United States in 2016 were $2.34 per mile and $1.38 per mile respectively*."[18] These cost issues are very early to be estimated. |
| | *Case Studies* |
| | Cities such as South Hampton, NY and Canberra, Australia where helicopter transit and drone delivery services have been trialed respectively, there has been significant community pushback due to both visual and noise disturbances. Using aircraft as a shared transit option has yet to be fully trialed however efforts are underway by a number of companies around the world and it is anticipated that such trials will be deployed in the near future. The value in urban air transport is significantly reliant on recent technological developments, due to the large numbers of aircraft needed to have a meaningful impact on congestion reduction, the light aircraft and helicopters currently in use are likely to cause noise pollution, environmental damage and have a negative visual impact on the skyline if used in large numbers. |
| | *Pros & Cons* |
| | <u>Pros:</u><br>- Urban air space is relatively unutilized and may provide a multi-layered transit route that could substantially reduce road congestion (at least until ridership levels grow substantially in the future).<br>- Given the technical nature of the vehicle and difficulty involved in piloting this would create a number of high-tech jobs along with those involved in system operation and maintenance.<br>- Small air transport vehicles are beginning to use battery technologies to power the aircraft, creating a more environmentally sustainable mode of transport.<br>- Studies are starting to suggest that electric compound helicopter options could be cheaper for long distances than road based shared transit options.<br>- There is likely to be further high-tech innovation that may be applicable to a range of air transport technologies.<br><u>Cons:</u><br>- Air traffic in urban areas will create new forms of safety and environmental issues with potentially |

[18] Brown, A. and Harris, W. (2018) A Vehicle Design and Optimization Model for On-Demand Aviation, AIAA/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference. January 2018.

heavy vehicles being suspended above public areas with high densities of pedestrians or valuable infrastructure as well as above residential areas.

- Allowing such vehicle travel in urban areas will also create new security concerns with increased access to buildings at all heights with only last-minute detection of threats.
- Although much of the technology is ready there are insufficient standards and regulations in place.
- Along with space allocation issues, landing sites will need to be carefully considered not to exacerbate congestion in connecting modes when operating in dense urban areas.
- Operation of aircraft is loud - further design development is needed to reduce noise.
- The vehicles are likely to accommodate small passenger numbers, similar to cars, compared with shared options like buses, rail and trams, including the new trackless trams.
- A system for managing air traffic control in urban areas involving multiple aircraft travelling in various directions is not established. However, a fixed route along a motorway may reduce this complexity.
- As with any new system that has yet to be trialed there will be unforeseen risks and issues.

*Findings*

Although shared air transport services is now an exciting space for research and development, there are a number of significant hurdles to overcome before it is likely to be a serious consideration for congestion management. It has the potential to create high-tech and operational jobs, if battery operated they will be an environmentally-friendly alternative to cars until these also become electric. Although, large amounts of infrastructure will need to be installed for safe landing spaces, air traffic control systems will need to be created, carriage numbers are small at around 5 people, and operation is loud. Some findings suggest that for longer distances, an air-taxi option could be cost-effective for the consumer and would be competitive against standard shared transit or taxi services.

| Cost and Effectiveness | Development Potential | Environmental Benefits | Job Creation Potential |
|---|---|---|---|
| High capital involved in vehicles and landing sites with initially low impact on congestion. | Given destinations are likely to vary it will be unlikely for development hubs to be created. | If battery operated there will be some benefit, low to begin with due to low capacity vehicles. | Jobs will be created in vehicle manufacture and operation with minimal local job creation. |

*Option E: Single Rail Overhead Service (Monorail)*

*Overview*

Single rail overhead services, often referred to as a 'Monorail', differ from traditional rail services in that they are typically elevated, have much less local impact locally as they are light construction taking much less space than elevated roads and heavy rail. As they are separate from roads or pedestrians, they are well suited to areas with space constraints and can have substantial ability to take people out of cars due to their speed and capacity. Monorails originally were used for short journeys, such as Amusement Parks or inner CBD precincts, but in recent years a commuter monorail developed in Japan has been applied successfully in other crowded Asian cities. They can accommodate between 15,000 to 35,000 persons per hour which is equivalent to 6 lanes of traffic being removed. [19]

Tokyo Monorail passing through Tennōzu in Shinagawa

For instance the Tokyo monorail is an 11.1 mile line with 11 stations which carries over 300,000 passengers a day, as shown in the image above.

*Case Studies*

In Auckland, an investigation into the Skycabs Monorail System found that travel times had reduced an average of 7 percent compared to private vehicles and 40 percent compared to bus services. A study on the impact of a monorail in Colombo suggests that, *"The results show that for a monorail running at an average speed of 40 km/h a length of 26.8 km from the CBD will optimize investment*

[19] Longhurst, J. and Brebbia, C. (2012) Urban Transport XVIII: Urban Transport and the Environment in the 21st Century, WIT Press.

*and contribute travel time savings of 105 million Rs. per day or 189 million USD per year to the Sri Lankan economy, resulting in the CO2 emission reduction by 42%."*[20]

In an effort to reduce congestion and pollution, the city of Mumbai in India has constructed a 9 km monorail system at an estimated cost of $13m/km[21] that can access areas that require sharp turns due to topographical restrictions while travelling at speeds of up to 80km/h.[22] The elevated rails allow for complex and curved pathways to be made not restricting routes to following existing roads which can completely avoid areas of high traffic volume. As seen with the Mumbai Monorail, the elevated structure can pass over multiple story buildings and bridges, and can be built near dense and congested infrastructure, encouraging citizens to use shared transport. When considering the cost of a monorail system most systems have an average payback period of 20-25 years and an internal rate of return of around 7 percent, due to the low maintenance and running costs.[23]

*Pros & Cons*

Pros:

- Similar construction cost compared to conventional on-ground rail systems with faster construction times and less disruption.
- Minimal land footprint required making urban applications particular valuable in crowded corridors.
- Higher ride quality than shuttle buses or other bus services.
- Minimal interruptions to existing traffic operations given the elevated route (however it will require elevated stations).
- Allows for station precinct development from fixed stations to achieve value capture and create jobs, typically incorporated into overhead walkways or buildings.

Cons:

- Carrying capacity not as high as heavy rail, but can be made equivalent to light rail.
- Further investigation and consideration is needed to suppress effects of vibration on the system.
- Higher capital costs compared to rail services where the lines are already in existence or space is available in roads for a trackless tram, due to the need for elevation of the rail line and construction of elevated platforms and stations.

*Findings*

A monorail is typically a more expensive construction than railways that currently exist or road space that can be used for a trackless tram but can provide an equivalent high capacity form of transport with multiple economic, social and environmental benefits to communities around the stations. It can carry the equivalent of around 6 lanes of traffic without interruptions to surface activity. Although they are environmentally appealing, there are few monorail systems yet in American cities.

[20] Manoratna, D., Kawata, K., and Yoshida, Y. (2017) Environmental impact and travel time savings of a new monorail system in Colombo's commuting traffic, Transportation Research Part D: Transport and Environment, Volume 51, 2017, Pages 122-128.
[21] MMRDA (2013) Mumbai Monorail Project, Mumbai Metropolitan Region Development Authority.
[22] Live Mint (2014) 'India's first monorail readies for take-off', Live Mint, 29 January 2014.
[23] Drawn from 'Hargroves, K. and Gaudremeau, J. (2017) Pre-Feasibility Study to Identify Suitable Mass Transit Options in the Kingdom of Bhutan, Report to the United Nations Centre for Regional Development (UNCRD), Tokyo, Japan'.

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|---|---|---|---|---|
| | It would require 25.5 miles of track and at an approximate cost of $40 million USD per mile would mean a capital cost of around $1.2b. | | | |
| | **Cost and Effectiveness** | **Development Potential** | **Environmental Benefits** | **Job Creation Potential** |
| | High capital costs with high impact on congestion. | Some potential for development with developer early engagement. | Considerable benefits in reduced car use especially due to electric system. | High job creation around stations and in agglomeration benefits. |

## *Option F: Trackless Trams*

### *Overview*

A Trackless Tram based system blends the best features of bus and train systems, both in the carriage technology and the system configuration to deliver a substantially more affordable option than a rail system but with a capacity equivalent to a light rail system, i.e. around 6 lanes of traffic equivalent. It does this because of its use of 21st century guidance and autonomous technology to create a high ride quality with speed and capacity. Trackless Trams are effectively the same as traditional light rail except they run on rubber tyres avoiding disruption from construction for Light Rail, but they retain the electric propulsion (with batteries) and have high ride quality due to rail-type bogeys, with special hydraulics and precision guidance from the autonomous optical guidance systems - with costs reduced to around one tenth of a Light Rail system.

A Trackless Tram System uses a dedicated corridor to provide rapid transit services that is supported by fixed stations and a Control Centre much like light rail or traffic management centers. This means with a strong rationale for fixed routes and stations that there is potential to attract development around stations as it will unlock development potential for easy access to such services. However, it is also able to be diverted around blockages or quickly recalled should the need arise unlike a rail service. Although this study focuses on the Trackless Tram manufactured in China there are electric buses in Europe that are increasingly developing some of the extra character of the Trackless Tram.

Trackless Tram in Yibin, China (Compliments D. Conley)

The Trackless Tram is a mid-tier transit system that works best as a connector to heavy rail and as a regenerator of urban development along its corridor, but it can be used as a medium capacity option along a highway as well. It is not possible to estimate the road construction required as the routes for Trackless Trams could be across town to Commuter Rail stations (see next option) or it could be introduced along the Pottstown Expressway and be given right-of-way in the break-down lane. This would cost around $5m per mile mostly for the costs of Trackless Tram carriages (plus some recharge services) as it does not require much infrastructure other than adequate road space. Thus a Trackless Tram could be enabled for around $128 million along the Expressway corridor.

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| | *Case Studies* |
| | The Trackless Tram is in its early stages of development with the first pilot project in Zhuzhou, China on a straight 3.6 km line with 4 stations. The first Trackless Tram to be put into service was also in China in Yibin and is 17.7km, commencing operation on December 5th, 2019, with some 150km of additional track planned across the city. The initial stage route has 9 stations, and traverses urban areas varying from outer highways with adjacent industrial complexes, across the Chongjiang Bridge, and into the urban centre which is mixed use and high density. The ART's run at a frequency of every 15 minutes between 7:30am and 8:00pm. Trackless Trams both from China and Europe and their performance along with design considerations, are well documented.[24] European electric buses with similar performance are being trialed in a range of cities. |
| | *Pros & Cons* |
| | <u>Pros:</u><br>- Cheaper than traditional trams and quicker to implement as there is no need for a physical rail or overhead wires and gantry.<br>- Electric carriages recharges quickly and can be recharged at each station though their range has been expanded by higher efficiency Li-ion batteries so they can be charged at the end of the route (if less than 50 km) and overnight at Depots.<br>- Powered by electricity and lithium-ion batteries which will reduce fossil fuel emissions.<br>- Adaptable as it is not limited by track and therefore can easily be altered in case of emergencies or other instances such as obstructions to the path or the need to swap out carriages.<br>- Potential to be driverless in the future with a number of autonomous safety and guidance features used in pilot mode.<br>- Can take 300 people or even 500 if a five-carriage set so that at peak times it will carry the equivalent of 6 lanes of traffic.<br>- As it is attractive to build around stations for residential and business activity it is possible to use value capture mechanisms to create partnerships between private developers and transit operators.<br><u>Cons:</u><br>- For effective service it requires a dedicated path and regular services which may be hard to justify in the transition to shared commuter transit though it is possible to begin with special space provided at stations while travelling with traffic between stations.<br>- May require strengthening of pavements though trials show so far they are not more damaging than buses to the road surface.<br>- Implementation is limited to a few cities in China (however it is likely to rapidly be deployed in cities around the world, with usage in Qatar for the Soccer World Cup and a trial being developed for Perth, Australia. |

[24] Mouritz, M., Newman, P., Davies-Slate, S., Jones, E., Hargroves, K., Sharma, R. and Adams, D. (2018) Delivering Integrated Transit, Land Development and Finance – a Guide and Manual: With Application to Trackless Trams, SBEnrc, Curtin University.

| | *Findings* | | | |
|---|---|---|---|---|
| | Based on initial trials and implementation the Trackless Tram appears to be a transformative shared transit mode that takes the best elements of light rail to deliver a cost effective and highly efficient form of shared transit. The Trackless Tram is an adaptable mode of transport - cheaper than traditional trams or light rail systems as there is no need to install rails or overhead wires, and because it is electric it is environmentally friendly. The fast and reliable transit option makes a great argument for regular commuters to shift out of their cars, and can be a major facilitator of urban regeneration around stations, and is easily built into new future areas of development. | | | |
| | **Cost and Effectiveness** | **Development Potential** | **Environmental Benefits** | **Job Creation Potential** |
| | *Lower capital than new rail or road options with much higher impact on congestion.* | *Considerable potential for land development with developer early engagement.* | *Considerable benefits due to displacing a significant number of cars and to its electrification.* | *Large potential given the development potential at stations and along corridors.* |

*Option G: Commuter rail services*

*Overview*

Typically, freight operations are hesitant to welcome passenger services onto their railways due to interference with their freight delivery times.[25] Hence restoring passenger services on freight rail lines would require both freight trains and passenger trains to operate on the same line with minimal disruption to each other. This will require appropriate management to ensure both freight and passenger services are operated efficiently and new technology is increasingly enabling this to occur. Given that a railroad does not share the road way with vehicles it is an effective passenger transport option to reduce congestion on parallel motorways given the potential for high capacity services that significantly reduce travel times. Commuter rail can carry the equivalent of 8 lanes of traffic or more.


Brightline, a new private-public partnership commuter rail line in Florida[22]

There are many successful examples of freight and passenger line partnerships throughout the United States, such as the Capitol Corridor in California which experienced increases in annual ridership by some 4 times over 14 years while achieving the highest on-time performance of 94 percent by an American Intercity Passenger Rail route.[26] Commuter Rail would cost around $8m per mile for carriages and station upgrades, as the rail track is already there, hence a capital cost of around $204 million would enable a passenger service to be restored.

*Key Considerations*

A key consideration for shared freight and passenger rail services is the provision of appropriate insurances for passengers which is typically at a higher cost to freight services. The introduction of

[25] Prozzi, J (2006) Issues Related to Public Support of Passenger Rail Services on Existing Freight Rail Lines and/or Rights-of-Way: Creating Win-Win Agreements, Center For Transportation Research, The University of Texas at Austin.
[26] Bardo, K. (2013) Relationship Building with Freight Railroads Critical to Support Intercity Passenger Rail Development, Transportation Policy & Methods, University of Illinois at Chicago.

passenger services brings with it potential liability from injury or other causes related to people using platforms and travelling on rail cars. This cost would need to be incorporated into the business plan for a shared service line. Another key consideration is to identify the required passenger capacity and freight capacity to inform assessment of the feasibility of the shared line.[27]

*Case Studies*

A study prepared for the Berks Alliance and Greater Reading Chamber Alliance in July 2020 suggests that the freight line that runs through Pottstown to Philadelphia currently has 8 trains per day each way and this could be increased by a further 10 passenger services without significant delay to the freight trains and if implemented effectively would deliver a 7 percent return on investment in combination with other extensions. Stopping at stations starting in Reading, then Pottstown, Royersford Phoenixville, Norristown and Philadelphia and travelling at a speed of up to 80 mph the time from Pottstown to the 30th Street Station in Philadelphia would be just over one hour in total. The study suggests that the increase in property value along the entire corridor would be over 1 billion dollars and in Pottstown alone it would be in the order of 100 million dollars up to 2054. Further the findings of the study suggest that the system could run without subsidies while creating significant job opportunities with an expansion of tax base able to cover the cost of the project once the core infrastructure is in place.[28] A Commuter Rail service along the entire corridor could also include a Trackless Tram linkage leading to each station and have a doubly significant impact on reducing congestion as it would bring people from a wide area around the rail line, and at the same time increase urban regeneration along the tram corridors and even more around the rail stations.

*Pros & Cons*

<u>Pros:</u>

- Most of the infrastructure is already in place, reducing associated costs, including original train stations in many instances.
- Passenger transport has previously been in operation and is therefore familiar with local residents.
- Commuter Rail can take large amounts of people on carriages - would be effective in mass evacuations – and can be linked to mid-tier transit leading to the stations.
- Creates jobs for transit operations but many more jobs in the urban regeneration enabled along the corridor.
- Regular transit is convenient for commuters and passengers seeking urban services along the corridors and in Philadelphia; and it provides independence for school children or those who do not have a car or license. Also reduces the demand for parking thus freeing up considerable land for urban development.

<u>Cons:</u>

- Will require negotiations with freight companies to seek win-win solutions though multiple precedents exist for freight operations converting to enable passenger rail systems along their tracks.

[27] NASEM (2010) Guidebook for Implementing Passenger Rail Service on Shared Passenger and Freight Corridors, The National Academies Press.
[28] TEMS (2020) Restoring Passenger Rail Service to Berks County, PA, Prepared for Berks Alliance & Greater Reading Chamber Alliance, by Transportation Economics & Management Systems, Inc.

- Insurance will be a major point to resolve and liability will need to be appropriately allocated or shared.
- Commuter rail is mostly diesel operated as the freight system does not often use electric trains and electric catenaries cannot be used as freight needs to have the possibility of double stacking of containers. However should new passenger carriages be purchased they could be electric through use of batteries as these costs are now much reduced and they enable much better development options around stations.

*Findings*

There are many case studies that provide strong examples of good relationships between freight companies and public agencies who share the same rail system with passenger services, as well as private lines that carry both types of service (as in Japan). With the new Commuter Rail study coming from the Berks Alliance, it is clear that a strong case can be developed for the whole corridor to be given a passenger service. The Pennsylvanian Government should help to create the common good community outcomes and private benefits from this historic opportunity. Passenger train services can provide a convenient, cost-effective and attractive mode of transport if on-time performance and reliability is held at a high-standard. While diesel trains emit greenhouse gases into the atmosphere, the environmental impact is reduced for a well-utilized service as cars on the road are reduced, with emerging electric train options. Thus, it is essential to ensure that passengers can rely on the service to maintain high numbers of patronage. Additionally, by re-introducing this service in Pottstown, many school students, people without a car and those who do not have a license gain a level of independence with increased accessibility to other areas of the region. Further, this operation would create a large number of jobs, including train drivers, ticket officers, general management and maintenance workers, but most of all in the urban regeneration opportunities created along the corridor. These will be considerably enhanced if a series of Trackless Tram connecting services are introduced along main roads linked to each station of the Commuter Rail service.

| Cost and Effectiveness | Development Potential | Environmental Benefits | Job Creation Potential |
|---|---|---|---|
| *Low capital given existing infrastructure with high impact on congestion and multiple benefits.* | *Considerable potential for development at stations and along feeder routes.* | *Considerable benefits from reducing car use and transitioning to electric systems.* | *Large potential for station precinct development and associated jobs.* |

## *Option H: Car-pooling*

### *Overview*

Carpooling traditionally involves a driver picking up multiple people that have destinations along the same or similar route (typically commutes) in order to reduce the need for the use of private vehicles, resulting in reduced fuel consumption and travel costs. In effect car-pooling "*works to reduce total distance travelled per vehicle by sharing vehicles to travel the same route, resulting in reduced emissions and cost saving for commuters*".[29] Typically passengers are picked up say at home and dropped off at or near work if it is along or near to the drivers intended route.


A typical collection point in San Francisco for commuter car pooling

The definition of carpooling traditionally includes two or more passengers, but for the benefits to be significant, a vehicle should replace at least two others travelling along the same route; carpooling is considered here to have at least three or more passengers (including the driver). The option is growing due to new technology but at this stage is only a minor consideration for reducing congestion significantly.

### *Key Considerations*

In order for a car-pooling system to be implemented along the Pottstown Expressway into Philadelphia a user-friendly mobile phone app would need to be available that can easily link up drivers with passengers along the route and handle payment details, insurances and security concerns. Car-pooling is not to be confused with 'Ride-Share' services such as UBER or Lift which are actually just another form of taxi and operate in the same manner. However, such taxi and private transport services can pool customers with similar locations and routes to avoid additional trips with Uber developing its Uber Pool option. The key distinction between private transit services and car-pooling is that the driver does not expect to make a profit but merely contribute to the cost of running the vehicle.

[29] Shaheen, S., Cohen, A. and Bayen, A. (2018) The Benefits of Carpooling: The Environmental and Economic Value of Sharing a Ride, UC Berkeley.

*Case Studies*

A car-pooling system is in use between East Bay and downtown San Francisco during morning peak hours that utilizes the HOV lanes across the San Francisco-Oakland Bay Bridge. This system not only reduces toll charges for the passengers it also reduces the wait time on the bridge. A study in 1998 suggests that over 8,000 commuters per day used the service.[30]

An MIT study found that New York City's traffic congestion problem can be drastically improved by incorporating a passenger pooling capability into its private transit service fleet (such as taxi and Uber). Using sophisticated trip pooling algorithms the study suggested that just 3,000 vehicles, compared to 13,000, could cater for 98 percent of NYC taxi demand with an average wait time estimated to be just below 3 minutes (assuming proper scheduling is achieved).[31]

*Pros & Cons*

Pros:
- Reduction in number of vehicles on the road resulting in lower emissions and reduced congestion.
- With an appropriate mobile phone based application, potentially advertised on signs along the expressway, the uptake could be rapid.
- Demand responsive allowing pick up and dropped off close to intended destinations depending on the driver's route and appetite for diversion and can make use of HOV and other shared lanes.

Cons:
- Drawing passengers away from other shared transport options.
- Requires a user friendly platform to link drivers and passengers.
- Safety concerns for travelling with strangers need to be addressed.
- Does not contribute to development potential.

*Findings*

A carpooling system is a growing method to reduce the amount of cars on the road, especially along a clear route like commuting along a motorway, reducing congestion while providing a cost effective method of travel. Environmental benefits can be found in a reduction of emissions from cars since less will be on the road. In order to be effective a platform needs to be offered to link drivers with passengers and suggest routing along with taking care of fare negotiation and payment. However, at this stage the option is probably just supplementary to the bigger opportunities discussed above.

| Cost and Effectiveness | Development Potential | Environmental Benefits | Job Creation Potential |
|---|---|---|---|
| *Low capital to create booking app with some impact on congestion.* | *Given the origins and destinations vary there is little development potential.* | *Some benefits from reducing the need for private vehicles.* | *Little job creation given its inability to enable urban regeneration* |

[30] MTC (1999) Casual Carpooling 1998 Update. Prepared by RIDES for Bay Area Commuters, Metropolitan Transportation Commission.
[31] Coner-Simons, A. (2017) How ride-sharing can improve traffic, save money, and help the environment, Computer Science and Artificial Intelligence Laboratory (CSAIL), MIT News, January 4, 2017.

| *Option I: Tele-commuting* | |
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| | *Overview* |
| | It has long been suggested that traffic congestion during peak periods can be reduced by using telecommuting (or working-from-home) options. However it was not until the COVID-19 crisis in 2020 that this option became a mainstream reality with organizations around the world quickly shifting to work from home as part of shelter-in-place and self-isolation orders. This crisis also led to a substantial improvement in the number of, and associated functionality of, online meeting options such as MS Teams and Zoom. Whereas in the past people wishing to work from home or call into meetings were seen as less committed to the organization, in the space of just 6 months it has become a dominant work mode and it is likely to continue as a primary mode long after the crisis abates. If this is the case it will be important for organizations to set up appropriate structures to ensure that a critical mass of staff is engaged in onsite activities, remote work spaces are properly set up and used effectively, and general work productivity is maintained. |
| | *Case Studies* |
| | A 2020 study by the Australian Road Research Board (ARRB) identified that traffic congestion reduced by over 90 percent on Melbourne's Monash Freeway through the COVID-19 period after a reduction of just 28 percent of the vehicles. This suggests that commuters are becoming more efficient with travel and that significant congestion reductions can be gained from a much smaller reduction of vehicle usage than may be anticipated.[32] Similar experiences have been shown across the world's cities in 2020. |
| | *Pros & Cons* |
| | <u>Pros:</u><br>- A significant reduction in business and organizational cost due to staff utilizing home offices.<br>- A reduction in travel (both vehicles and air travel) resulting in lower emissions, reduced congestion and less air pollution.<br>- A relatively small level of uptake can have large congestion relief benefits.<br>- Tele-commuting encourages greater localization of activities, such as local shopping, local recreation and greater active transport.<br><u>Cons:</u><br>- Not all types of work are suited to working from home so will have a limited impact on overall congestion levels.<br>- Less ability to influence productivity and accountability of staff if working from home.<br>- Staff may find it difficult to work in a home environment due to distractions and a lack of comradery with other staff. |

[32] ARRB (2020) What are the impacts of the COVID-19 Pandemic on our Tranpsor Systems, Australian Road Research Board.

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|---|---|---|---|---|
| | *Findings* | | | |
| | Although for many years telecommuting has been advocated as an alternative to travel, especially air travel, the experience of the COVID-19 pandemic has shown that working from home can be a primary work mode that is very likely to become part of ongoing work habits, which is likely to have an overall impact on congestion levels in the worlds cities. The option is mostly a complementary activity for congestion relief. | | | |
| | **Cost and Effectiveness** | **Development Potential** | **Environmental Benefits** | **Job Creation Potential** |
| | *Low capital other than home office set up with some impact on congestion post COVID.* | *There will be no development potential other than an increase in local shopping.* | *Some benefits from the reduced usage of cars and air travel.* | *There will be little job creation potential other than to service local activity.* |

## Part 3: Conclusion and Recommendations

### *Selection of congestion relief options*

Based on the findings it seems that the option best suited for further investigation for the Pottstown Expressway would be a combination of Commuter Rail along the corridor supported by a system of Trackless Trams feeding passengers into the train stations from each side of the corridor (or even a complete Trackless Tram system along the 422 if the rail option is not available); such a system could be complemented by appropriate non-infrastructure options to reduce overall demand. Together such a portfolio of options stands to not only be an effective response to growing congestion levels but also an economic development mechanism, a model that would likely be of interest in other areas of extreme congestion along motorways.

The combination of a rapid commuter rail service with fixed stations that are interconnected with 21st century tramlines bringing in commuters, stands to not only provide effective commuter travel but also provide significant opportunities to raise land values at stations, attracting new development. The resulting land developments can enable both short- and long-term job creation in a range of sectors with residents having ready accessibility to a range of services and attractions built around station precincts and along the tram route (much like Paris over the centuries such a boulevard approach may be the economic renewal option that many cities have been looking for).

Hence the opportunity to create a Trackless Tram corridor leading to a rapid Commuter Rail service along the corridor, thought Norristown, and right into Philadelphia, will provide an historic urban regeneration opportunity. And rather than being developed just by transit authorities such an approach can be created with a range of stakeholders from the start, such as developers, businesses in the corridor, government agencies, and community groups to create mutual benefits. This combination of options should enable a public private partnership's approach that can provide the funding and financing for delivering the infrastructure. These issues should be discussed publicly to enable the strength of the arguments to be refined and a detailed Master Plan can then be created to enable delivery.

### *Consideration of innovative financing options*

In order to finance such a Trackless Tram corridor it will be important to work closely with developers along the route in order to attract private funding given the greater transit services can activate greater development opportunities. This is done by harnessing the available land development opportunities and stakeholder expertise in the corridor and integrating new transit services to create station precincts that generate new value from enhanced land development opportunities. This may involve a route that runs from the train station along East High Street, around into Beech Street then back to the station along Mannatawny Street. This initial route would service a number of shops, shopping centers (Wawa…) schools (Wyndcroft, Hill School, Government Agencies (DoT, Postal Service, etc), the Hospital, etc. while also increasing the development potential of lots along the route.

There are several existing procurement mechanisms that can be used or adapted to this model of transit development with different components of the procurement process (for example, real estate development, infrastructure delivery) able to be either internal to the overall planning entity or procured through contracts with an external parties. For instance a private sector dominated approach involves delivering transit projects in a manner that takes advantage of land development and draw on other forms of own-source revenue as a source of capital funding and profitability for the project. This approach was

the early history of rail, for example in Japan's railway-centred conglomerates,[33] many of the tramways and street car lines laid down in the late nineteenth and early twentieth centuries,[34] and substantial parts of the London Underground.[35] There has been a re-emergence of co-developed real estate and tranisst services, with two recent examples being the Brightline in Florida and the CLARA proposal in Australia.

- *Brightline, Florida:* Leveraging the private sector opportunities around new stations the Brightline rail project in Florida is 100% privately funded[36] and has been developed in partnership with the local and county governments and the local community. The project links Miami to Fort Lauderdale and West Palm Beach using a relatively fast train (160 km/h). The first phase of the project opened in late 2017, with plans to extend the line to Orlando Airport. Project finance was raised through a mixture of debt, bonds and equity. Private developers did not seek public subsidies or grants other than federal low-interest bonds in order to provide a risk guarantee.
- *Private Fast Rail, Australia:* A private sector consortium has proposed a new rail project in Australia to link a number of capital cities on the east coast with a fast rail service. The consortium, 'Consolidated Land and Rail Australia' (CLARA), proposes to raise finance for the transit infrastructure solely through real estate sales at the various regional station locations. CLARA's proposal is to initially connect Sydney, Canberra and Melbourne with a high speed rail line with eight stations.[37] The company has begun to acquire rural farming land around the intended stations locations and anticipates that the sale of such land will avoid the need to request public funding.

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[35] Levinson, D. (2008) Density and dispersion: The co-development of land use and rail in London. J. Econ. Geogr, 8, 55–77.
[36] Renne, J. L. (2017). Make Rail (and Transit-Oriented Development) Great Again. Housing Policy Debate, 27(3), 472-475. DOI: 10.1080/10511482.2017.1298213
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