

## Feasibility study

Draft 1

High Wycombe to Bourne End rail line reopening feasibility study.

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|                                                           |           |
|-----------------------------------------------------------|-----------|
| <b>1. Introduction</b>                                    | <b>7</b>  |
| <b>2. Executive summary</b>                               | <b>8</b>  |
| <b>3. The route</b>                                       | <b>12</b> |
| 3.1. History                                              | 12        |
| 3.1.1. OVERVIEW                                           | 12        |
| 3.1.2. CONSTRUCTION                                       | 12        |
| 3.1.3. PARTIAL CLOSURE                                    | 12        |
| 3.2. Current situation                                    | 14        |
| 3.2.1. PROPOSED MASS RAPID TRANSIT (MRT) ROUTES / NETWORK | 14        |
| 3.2.2. HIGH WYCOMBE TO BOURNE END ROUTE                   | 14        |
| 3.2.3. MAIDENHEAD TO BOURNE END AND/OR MARLOW ROUTE       | 14        |
| 3.3. Route protection                                     | 16        |
| <b>4. Route assessment</b>                                | <b>17</b> |
| 4.1. Background                                           | 17        |
| 4.2. Assessment process                                   | 19        |
| 4.3. Route reopening options                              | 19        |
| 4.3.1. STOPS                                              | 19        |
| 4.3.2. DEPOTS                                             | 20        |
| 4.3.3. BRIDGES                                            | 21        |
| 4.3.4. ROUTE ACCESSIBILITY FOR TRAVELLERS                 | 22        |
| 4.3.5. IDENTIFIED ISSUES                                  | 23        |
| 4.3.6. TRACK-BED                                          | 25        |
| 4.4. Option analyses                                      | 26        |
| 4.4.1. OPTION 1                                           | 27        |
| 4.4.2. OPTION 3                                           | 30        |
| 4.4.3. OPTION 6                                           | 34        |
| 4.4.4. OPTION 7                                           | 38        |
| 4.4.5. OPTION 8                                           | 42        |
| 4.4.6. OPTION 9                                           | 45        |
| <b>5. Operation</b>                                       | <b>49</b> |
| 5.1. Service                                              | 49        |
| 5.2. Vehicle technology                                   | 51        |
| 5.3. Operational cost                                     | 52        |
| <b>6. Investment cost</b>                                 | <b>54</b> |
| 6.1. HULTS ĩ Hybrid Ultra Light Tram system               | 55        |
| 6.2. BRT - Bus Rapid Transit                              | 57        |
| 6.3. Maximum option capital cost comparison               | 59        |
| 6.4. Optimum option capital cost comparison               | 60        |
| 6.5. Capital cost conclusion                              | 60        |
| <b>7. Environmental and Health Issues</b>                 | <b>62</b> |
| 7.1. Environmental Issues                                 | 62        |

|            |                                                |           |
|------------|------------------------------------------------|-----------|
| 7.2.       | Health Cost                                    | 62        |
| 7.3.       | Conclusions                                    | 63        |
| <b>8.</b>  | <b>Trip-ends Survey and Patronage Analysis</b> | <b>64</b> |
| 8.1.       | Methodology                                    | 65        |
| 8.2.       | Trip-end Survey                                | 66        |
| 8.2.1.     | HIGH WYCOMBE                                   | 67        |
| 8.2.2.     | MARLOW                                         | 68        |
| 8.2.3.     | BOURNE END                                     | 69        |
| 8.2.4.     | MAIDENHEAD                                     | 70        |
| 8.4.       | Daily trip ï Origin/Destination trip ends      | 72        |
| 8.5.       | Patronage Analysis                             | 74        |
| <b>9.</b>  | <b>Possible wider route / network</b>          | <b>77</b> |
| <b>10.</b> | <b>Future considerations</b>                   | <b>78</b> |
| 10.1.      | Dual mode vehicles                             | 78        |
| 10.2.      | Monorail                                       | 79        |
| 10.3.      | High Speed Rail                                | 80        |
| <b>11.</b> | <b>Appendixes</b>                              | <b>81</b> |
| <b>12.</b> | <b>References:</b>                             | <b>81</b> |

## List of Figures :

|                                                                                                                                                                                                                                                                                         |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| FIGURE 1 - SHOWS THE ORIGINAL STEAM ENGINES OPERATED ON THE HIGH WYCOMBE TO MAIDENHEAD LINE TILL 1962. ....                                                                                                                                                                             | 13 |
| FIGURE 2 - SHOWS THE ORIGINAL DIESEL ENGINES OPERATED ON THE HIGH WYCOMBE TO MAIDENHEAD LINE TILL 1970 AND THEN BETWEEN<br>BOURNE END / MARLOW AND MAIDENHEAD. ....                                                                                                                     | 13 |
| FIGURE 3 - SHOWS NEW DIESEL ENGINES OPERATED ON THE BOURNE END / MARLOW TO MAIDENHEAD LINE FROM 2000. ....                                                                                                                                                                              | 13 |
| FIGURE 4 - SHOWS THE CLASS 165 DMU ENGINE OPERATING ON THE MAIDENHEAD TO BOURNE END / MARLOW LANE. ....                                                                                                                                                                                 | 15 |
| FIGURE 5 - SHOWS THE CONSERVATION AREA AND FOOTPATH BETWEEN THE SCHOOL AND LOUDWATER STATION. ....                                                                                                                                                                                      | 16 |
| FIGURE 6 - SHOWS THE ORIGINAL RAIL ALIGNMENT WITH ALL STOPS, CROSSING ROADS, AND CONSERVATION AREA OR CYCLE/ FOOTPATHS AND<br>CONSERVATION AREA OR FOOTPATHS. ....                                                                                                                      | 16 |
| FIGURE 7 - SHOWS BUCKINGHAMSHIRE DISTRICT WITH WYCOMBE DISTRICT COUNCIL (LOCATION OF HIGH WYCOMBE AND BOURNE END ARE<br>HIGHLIGHTED IN RED CIRCLES) AND BERKSHIRE DISTRICT WITH ROYAL BOROUGH OF WINDSOR AND MAIDENHEAD (LOCATION OF<br>MAIDENHEAD IS HIGHLIGHTED IN GREEN CIRCLE) .... | 17 |
| FIGURE 8 - SHOWS THE ROAD AND RAIL NETWORK IN CONNECTION TO THE PROPOSED REOPENING OF THE LINE BETWEEN HIGH WYCOMBE AND<br>MAIDENHEAD. (BLACK INDICATES RAILWAYS, BLUE MOTORWAYS, GREEN AND RED A CLASS ROADS AND RED DOTTED LINE POSSIBLE FUTURE<br>LINK TO HEATHROW AIRPORT) ....     | 18 |
| FIGURE 9 - SHOWS THE LOCATION OF BRIDGES, WHICH NEEDS TO BE CONSTRUCTED FOR SAFE MTR OPERATION. ....                                                                                                                                                                                    | 21 |
| FIGURE 10 - SHOWS THE PROPOSED HULTS ALIGNMENT WITH PROPOSED NEW STOPS, REQUIRED BRIDGES, PROPOSED DEPOT LOCATIONS AND<br>PUBLIC ACCESSIBILITY DIAMETER. ....                                                                                                                           | 22 |
| FIGURE 11 - SHOWS THE PROPOSED HULTS ALIGNMENT WITH PUBLIC WALKING ACCESSIBILITY DIAMETER AND IDENTIFIED GREEN AREAS. ....                                                                                                                                                              | 23 |
| FIGURE 12 - SHOWS THE PROPOSED HULTS ALIGNMENT SPLIT INTO SECTIONS, RECOGNISING POSSIBLE CONSTRUCTION ISSUES(RED COLOUR) AND<br>ISSUES-FREE SECTION (GREEN). ....                                                                                                                       | 24 |
| FIGURE 13 - SHOWS IDENTIFIED ISSUES LOCATIONS, WHICH NEED TO BE ADDRESSED BEFORE THE LINE REOPENING. ....                                                                                                                                                                               | 25 |
| FIGURE 14 - SHOWS THE PROPOSED HULTS ALIGNMENT AND IDENTIFIED OPTIONS BETWEEN HIGH WYCOMBE TRAIN STATION AND LONDON ROAD.<br>.....                                                                                                                                                      | 27 |
| FIGURE 15 - DESCRIBES IDENTIFIED OPTIONS, THEIR ISSUES, DISADVANTAGES / ADVANTAGE AND POSSIBLE MRT VEHICLE USED ON THEM. ....                                                                                                                                                           | 28 |
| FIGURE 16 - SHOWS THE PROPOSED HULTS ALIGNMENT IN GORDON ROAD AREA WITH EXISTING RAIL BRIDGE. ....                                                                                                                                                                                      | 29 |
| FIGURE 17 - SHOWS THE PROPOSED HULTS ALIGNMENT IN GORDON ROAD AREA FROM PRINCESS GATEWAY RESIDENTIAL DEVELOPMENT. ....                                                                                                                                                                  | 29 |
| FIGURE 18 - SHOWS THE PROPOSED HULTS ALIGNMENT AND IDENTIFIED OPTIONS BETWEEN BASSETSBURY LANE AND THE WYCOMBE MARSH.<br>(ORIGINAL ALIGNMENT ON THE END OF DEANGARDEN RISE) ....                                                                                                        | 30 |
| FIGURE 19 - DESCRIBES IDENTIFIED OPTIONS, THEIR ISSUES, DISADVANTAGES / ADVANTAGE AND POSSIBLE MRT VEHICLE USED ON THEM IN THE<br>BASSETSBURY LANE AND WYCOMBE MARSH AREA. ....                                                                                                         | 31 |
| FIGURE 20 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BASSETSBURY LANE ORIGINAL RAIL EMBANKMENT. ....                                                                                                                                                                                       | 32 |
| FIGURE 21 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BASSETSBURY LANE AREA AND DETAIL OF THE GARDENS WHICH WOULD NEED TO<br>NEGOTIATED FOR THE ROUTE DIVERSION. ....                                                                                                                       | 32 |
| FIGURE 22 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BASSETSBURY LANE AREA AND DETAIL OF THE GARDENS WHICH WOULD NEED TO<br>NEGOTIATED FOR THE ROUTE DIVERSION. ....                                                                                                                       | 33 |
| FIGURE 23 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BASSETSBURY LANE AREA AND DETAIL OF THE BACK GARDENS ON DEANGARDEN RISE<br>FROM THE WYCOMBE MARCH, WHERE WAS THE ORIGINAL TRACK ALIGNMENT. ....                                                                                       | 33 |
| FIGURE 24 - SHOWS THE PROPOSED HULTS ALIGNMENT AND IDENTIFIED OPTIONS IN TREADAWAY TECHNICAL CENTRE AREA. ....                                                                                                                                                                          | 34 |
| FIGURE 25 - DESCRIBES IDENTIFIED OPTIONS, THEIR ISSUES, DISADVANTAGES / ADVANTAGE AND POSSIBLE MRT VEHICLE USED ON THEM. ....                                                                                                                                                           | 35 |
| FIGURE 26 - SHOWS THE PROPOSED HULTS ALIGNMENT IN TREADAWAY TECHNICAL CENTRE AREA, IN DETAIL IS THE UNDER-MOTORWAY PASSAGE<br>AND THE BACK OF THE TECHNICAL CENTRE WHERE THE NEW TRACK SHOULD BE LOCATED. ....                                                                          | 36 |
| FIGURE 27 - SHOWS THE PROPOSED HULTS ALIGNMENT IN TREADAWAY TECHNICAL CENTRE AREA AND DETAIL OF THE END TO THE RAIL ALIGNMENT<br>PROTECTED AREA. ....                                                                                                                                   | 37 |
| FIGURE 28 - SHOWS THE PROPOSED HULTS ALIGNMENT IN TREADAWAY TECHNICAL CENTRE AREA AND DETAIL OF THE TREADAWAY HILL ROAD AND<br>OPPOSITE IS THE TREADAWAY TECHNICAL CENTRE BUILDINGS. ....                                                                                               | 37 |
| FIGURE 29 - SHOWS THE PROPOSED HULTS ALIGNMENT AND IDENTIFIED OPTIONS IN JUNIPER LANE AREA. ....                                                                                                                                                                                        | 38 |
| FIGURE 30 - DESCRIBES IDENTIFIED OPTIONS, THEIR ISSUES, DISADVANTAGES / ADVANTAGE AND POSSIBLE MRT VEHICLE USED ON THEM. ....                                                                                                                                                           | 39 |

|                                                                                                                                                                                                                              |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| FIGURE 31 - SHOWS THE PROPOSED HULTS ALIGNMENT IN TUDOR DRIVE AREA AND DETAIL OF TUDOR DRIVE IN THE DIRECTION OF JUNIPER LINE.                                                                                               | 40 |
| FIGURE 32 - SHOWS THE PROPOSED HULTS ALIGNMENT IN TUDOR DRIVE AREA AND DETAIL OF TUDOR DRIVE IN THE DIRECTION OF HIGH WYCOMBE.                                                                                               | 40 |
| FIGURE 33 - SHOWS THE PROPOSED HULTS ALIGNMENT IN TUDOR DRIVE AREA AND DETAIL OF JUNIPER LANE AND TUDOR DRIVE JUNCTION.                                                                                                      | 41 |
| FIGURE 34 - SHOWS THE PROPOSED HULTS ALIGNMENT AND IDENTIFIED OPTIONS IN WHITEPIT LANE AREA.                                                                                                                                 | 42 |
| FIGURE 35 - DESCRIBES IDENTIFIED OPTIONS, THEIR ISSUES, DISADVANTAGES / ADVANTAGE AND POSSIBLE MRT VEHICLE USED ON THEM.                                                                                                     | 43 |
| FIGURE 36 - SHOWS THE PROPOSED HULTS ALIGNMENT IN WHITEPIT LANE AREA AND DETAIL AT THE BACK OF THE NEW DEVELOPMENT LOCATED ON THE ORIGINAL RAIL TRACK. THE DIVERSION WOULD NEED TO USE THE GREEN FIELD SHOWN IN THE PICTURE. | 44 |
| FIGURE 37 - SHOWS THE PROPOSED HULTS ALIGNMENT IN WHITEPIT LANE AREA AND DETAIL OF WHITEPIT LANE.                                                                                                                            | 44 |
| FIGURE 38 - SHOWS THE PROPOSED HULTS ALIGNMENT AND IDENTIFIED OPTIONS IN BOURNE END TRAIN STATION AREA.                                                                                                                      | 45 |
| FIGURE 39 - DESCRIBES IDENTIFIED OPTIONS, THEIR ISSUES, DISADVANTAGES / ADVANTAGE AND POSSIBLE MRT VEHICLE USED ON THEM.                                                                                                     | 46 |
| FIGURE 40 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BOURNE END AREA AND DETAIL IS SHOWN OF THE END OF THE PROTECTED CORRIDOR AT THE EDGE OF THE TOWN.                                                                          | 47 |
| FIGURE 41 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BOURNE END AREA AND DETAIL OF THE BOSTON DRIVE BUSINESS CENTRE BUILT ON THE ORIGINAL RAIL ALIGNMENT.                                                                       | 47 |
| FIGURE 42 - SHOWS THE PROPOSED HULTS ALIGNMENT IN BOURNE END AREA AND DETAIL OF THE BOSTON DRIVE BUSINESS CENTRE BUILT ON THE ORIGINAL RAIL ALIGNMENT.                                                                       | 48 |
| FIGURE 43 - SHOWS THE POSSIBLE COMBINATION OF SERVICES, DISTANCES, NUMBER OF STOPS, STOPS PER KM, MAXIMAL SPEED, AVERAGE SPEED AND EXPECTED TRAVEL TIME.                                                                     | 49 |
| FIGURE 44 - SHOWS THE POSSIBLE COMBINATION OF SERVICES, DISTANCES, NUMBER OF STOPS, STOPS PER KM, MAXIMAL SPEED, AVERAGE SPEED AND EXPECTED TRAVEL TIME.                                                                     | 50 |
| FIGURE 45 - SHOWS NEW TDI S DESIGN OF THE HULTS POWERED BY BATTERIES AND ULTRA-CAPACITOR OR FLYWHEEL TECHNOLOGY.                                                                                                             | 51 |
| FIGURE 46 - SHOWS NEW HYBRID / ELECTRIC BUSES, FTR BUS FOR BRISTOL BRT AND TDI'S EG MINITRAM IN ARTICULATED WIDER-BODIED DESIGN.                                                                                             | 51 |
| FIGURE 47 - OPERATIONAL COST OF HYBRID BUSES (2007 YEAR SURVEY OF BUS OPERATORS).                                                                                                                                            | 52 |
| FIGURE 48 - SHOWS THE INVESTMENT TRAM COST IN SELECTED UK CITIES.                                                                                                                                                            | 54 |
| FIGURE 49 - SHOWS BREAK DOWN OF THE CONVENTIONAL TRAM SCHEME CONSTRUCTION COST SPLIT IN THE CITIES.                                                                                                                          | 55 |
| FIGURE 50 - SHOWS THE INVESTMENT COST FOR THE HULTS OPTIMAL SYSTEM DEPLOYMENT (2007 PRICES).                                                                                                                                 | 56 |
| FIGURE 51 - SHOWS THE INVESTMENT COST FOR THE BRT OPTIMAL SYSTEM DEPLOYMENT (2007 PRICES).                                                                                                                                   | 58 |
| FIGURE 52 - SHOWS OPTIMAL ROUTE COMPARISON OF INVESTMENT COST.                                                                                                                                                               | 59 |
| FIGURE 53 - SHOWS OPTIMAL ROUTE COMPARISON OF INVESTMENT COST.                                                                                                                                                               | 60 |
| FIGURE 54 - COMPARISON OF PATRONAGE GROWTH BETWEEN TRAMS AND BUSES IN THE UK                                                                                                                                                 | 64 |
| FIGURE 55 HIGH WYCOMBE MAIDENHEAD AREA                                                                                                                                                                                       | 66 |
| FIGURE 56 HIGH WYCOMBE OVERVIEW                                                                                                                                                                                              | 67 |
| FIGURE 57 TRAVEL TO WORK                                                                                                                                                                                                     | 67 |
| FIGURE 58 MARLOW                                                                                                                                                                                                             | 68 |
| FIGURE 59 TRAVEL TO WORK                                                                                                                                                                                                     | 68 |
| FIGURE 60 BOURNE END                                                                                                                                                                                                         | 69 |
| FIGURE 61 TRAVEL TO WORK                                                                                                                                                                                                     | 69 |
| FIGURE 62 MAIDENHEAD                                                                                                                                                                                                         | 70 |
| FIGURE 63 COMMUTING FLOW AND PERCENTAGE OF HOUSEHOLDS WITH CARS                                                                                                                                                              | 71 |
| FIGURE 64 DAILY TRIP BY MODE IN THE HIGH WYCOMBE AND MAIDENHEAD AREA                                                                                                                                                         | 72 |
| FIGURE 65 TRIPENDS BY CAR AVAILABILITY                                                                                                                                                                                       | 73 |
| FIGURE 66 PRELIMINARY DAILY TRAFFIC FLOW BETWEEN HIGH WYCOMBE AND MAIDENHEAD                                                                                                                                                 | 74 |
| FIGURE 67 POTENTIAL DEMAND ALONG THE ROUTE BETWEEN HIGH WYCOMBE AND BOURNE END                                                                                                                                               | 75 |
| FIGURE 68 - PATRONAGE ANALYSIS AND FLEET CALCULATION                                                                                                                                                                         | 76 |

|                                                                                                                                                                       |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| FIGURE 69 - SHOWS POSSIBLE EXTENSION OF THE PROPOSED ROUTE FORM RUGBY STADIUM IN HIGH WYCOMBE TO THE M4 AND / OR TO HEATHROW. ....                                    | 77 |
| FIGURE 70 - SHOWS THE DUAL MODE VEHICLE RUNS ALONG THE TRACKS OF THE GAKUNAN RAILWAY LINE DURING A TRIAL RUN IN FUJI, SHIZUOKA PREFECTURE.....                        | 78 |
| FIGURE 71 - SHOWS THE VON ROLL MONORAIL AT ALTON TOWERS, UK (ORIGINALLY BUILT FOR EXPO 86 IN CANADA) AND IMPLEMENTED IN THE MOSCOW MONORAIL. ....                     | 79 |
| FIGURE 72 - SHOWS CTRL CORRIDOR WITH THE GNER-RENTED CLASS 373 UNIT (UK) AND GERMAN TRANSRAPID SYSTEM HAS BEEN DEPLOYED IN SHANGHAI AS AN AIRPORT TRANSIT SYSTEM..... | 80 |

## 1. Introduction

Egis Mobilité UK Ltd. has been commissioned by Summerleaze Ltd. to perform a feasibility study focused on deployment of Mass Rapid Transit (MRT) system connecting High Wycombe and Bourne End utilizing the original rail alignment, with possible future extension to Maidenhead.

The study should compare and assess potential benefits of different modes of MRT suitable for deployment in the High Wycombe to Maidenhead, Buckinghamshire area with detail focus on BRT and HULTS systems. The consideration should be taken on currently available technology and systems for sustainable urban mobility and modes of transport which have generally been chosen by a number of City Councils in the UK in order to improve their public transport network.

The feasibility study is structured in the way that gives an original route overview and description of current situation during which identify possible problem location along the route. Based on the problem location the alternative route option tables are developed.

The capital (investment) costing is based on the preferred route option utilizing maximum, optimal and minimum investment cost alternatives for both vehicle technology and identifying the route alternatives. No detail operational costs are being considered in this first stage of the study and should be considered in the second part, where vehicle life cycles, future patronage predictions, cost sensitivity testing, vehicle technology should be considered.

Based on the preferred route, vehicle type and technology used the new possible stops, depots & warehouse and bridges are being identified, with operational overview provided for the service.

A broader view of the technology available and the environmental and health impact is being analysed, where MRT have been assessed as a important concept for environmental and health issues mitigation. Rapid transit schemes have the advantage of having higher average speeds compared to conventional public transport due to their total or partial segregated routes.

The trip-end and patronage analysis followed a thorough survey of households' travel pattern between the High Wycombe and Maidenhead areas. The feasibility study was based on official origin/destination (O/D) matrices highlighted in the Department for Transport (DfT) reports mentioned - National Transport Model - Analysis for Delivering Better Transport<sup>2</sup>, 2003, and 'Fitting On of Regional Growth and Elasticity' (FORGE) to The Road Capacity and Cost Model, 2005. Such improvements in turn allow closer compliance with DfT directives.

The conclusion of the Feasibility study will summarize the feasibility of the original rail alignment reopening as a MRT scheme, where two different schemes were considered, where one is the HULTS and second is BRT. Future extension of the route was sketched on the top level and will need to be considered in the second stage, where more detail cost benefit analyses should be undertaken.

The second stage of the feasibility study will provide input data into the Business case, which need to be discussed with Local authorities, current bus / rail operator and possible investors.

## 2. Executive summary

This feasibility study focused on alternative Mass rapid transport (MRT) systems deployment on the route between High Wycombe and Bourne End. This route could utilize remaining parts of the original rail alignment and therefore avoid interaction with general traffic and provide a good quality MRT scheme possibly connecting Maidenhead and High Wycombe areas in the future.

The study focused only on the route between Bourne End and High Wycombe, but considers a possible extension to Maidenhead and other destinations in the future. From the general transportation modes, there were two preferred modes selected:

- HULTS ĩ Hybrid Ultra Light Tram System
- BRT ĩ Bus rapid transit

The mass rapid transit system selection is in accordance with the terms of reference evaluated from the Health and Environmental issues and detailed patronage analyses were performed to identify possible numbers of passengers. More detailed sensitivity testing needs to be performed in the second stage of the study, where future scenarios (modal shift level testing, extension of the route etc.) will need to be considered.

In addition to this route analyses were performed and problem locations identified along the corridor. Based on the problem locations, alternative route options were defined and analysed from the deliverability point of view. There are currently nine problem locations, from which six are medium or difficult to address. The capital costing takes into account addressing all the identified problem locations.

An initial operational analysis was performed identifying possible stops, bridges and depots & warehouse locations, number of services operating, journey times and travel distances were defined for both preferred MRT systems.

The capital cost of the possible routes were calculated, where maximum and optimum route options were considered and financially evaluated. The minimum route options cost significantly vary between HULTS (minimum, optimum and maximum routes are the same from this system) and BRT (where the minimum route option would use existing road infrastructure and does not meet the brief of the study to use the maximum extent of the original route alignment) and therefore was not considered in greater detail.

The possible route extension was identified and proposed for further analyses as well as alternative vehicle solution were highlighted.

This feasibility study does not identify a cost benefit analysis considering the capital costs for different routes, vehicle technologies, possible revenue streams, operational cost including the life cycle period for each system (vehicles and routes). These analyses should be done in the second stage of the feasibility study, which will provide initial inputs into the business case development.

## Conclusions and suggestions:

- Based on the technology overview we identified two preferred options for MRT system service between High Wycombe and Bourne End. These systems are HULTS and BRT. For the purpose of the client requirement the fully electric or hybrid electric vehicles were considered.
- It is feasible to implement an MRT scheme with a maximum utilization of the original rail alignment for both HULTS and BRT systems.
- The capital cost vary based on the preferred route and identified issues at locations, which were split into three sections, where:
  1. *first section* is easy to address issue (construction of new bridge using existing / modified embankments). There are three bridges to be build under this section.
  2. *second section* is medium/hard to address including bridge construction, land or property negotiation, but small resistance from local residence is expected. There is one bridge to be built in this section with a possible additional bridge in Bassetsbury lane.
  3. *third section* is the most difficult to address, where land or property will need to be purchased, bridge constructed and there is a high risk of local residence or private companies resistance and objection to the scheme, which could seriously affect the deliverability of the scheme. These problems are similar for both MRT modes for the maximum route option, but BTR can avoid most of these issues by joining the existing road network. There is one bridge to be built in this section.
- Based on this split we have identified 3 easy to address issues, 3 medium to address issues and 3 difficult to address issue locations. The total length of the identified issues section is only 1.87 km, which is approximately 21% of the total length.
- The proposed route alignment and 500m walking radius, which creates 10 ÷ 15 minutes walking distance to the MRT service, were analysed. It was identified that about 60% of the land is in built-up area and the remaining 40% is green-land areas, which could be possibly developed in the future.
- Identified patronage is 3609 passengers based on assumptions using all residents in a 500m walking distance from the MRT will use the service and on 25% modal shift from cars to the MRT service. This assumption will generate about 2900 passengers in peak hour which will require 10 vehicle operations with 60 passenger capacity. This passenger analyses will require sensitivity testing, including consideration of discount tickets etc.
- During the Feasibility study development we have liaised with a manufacturer of the HULTS rail track bed (Dow Rail - the track bed is similar to light rail systems implemented e.g. in Manchester) and designers of a HULTS vehicle (TDI Transport Design International, who are currently in the process of developing/testing a HULTS vehicle powered by Li-ion batteries).
- The general approach for finding the alternative route was based on an MRT ~~vehicle-~~neutral criteria, which should allow either a HULTS or BRT vehicle to be used on the alternative route, but in some locations this condition could not be met and therefore the indication of which vehicle type used is in the last column.

- The capital cost was identified for the maximum route option (comparable route solution) for HULTS route at £41.74 million, which is £4.6 million per kilometre. The total investment cost for maximum BRT route is in this case £37.35 million, which is £4.1 million per kilometre. The main difference between these technologies is in the cost of the track construction, vehicle capital cost, stops, signalling and telecommunication. The maximal route option can have deliverability issues caused by identified problem locations identified above.
- The investment cost comparison for the optimal HULTS route (not able to avoid identified issues on selected sections) is £41.74 million, which is £4.6 million per kilometre. The total investment cost for optimal BRT route (can avoid identified issues on selected sections) is £24.45 million, which is £2.7 million per kilometre. The optimal BRT option could be the easiest to deliver in terms of the time.
- The proposed MRT route would be 9.04 km long and with 6 bridges, allowing a dedicated MTR lane along the whole route, with minimum traffic interference in the Bourne End area. This dedicated MRT lane would deliver a journey-time-reliable service, with a journey time from High Wycombe to Maidenhead of 18 ÷ 20 minutes, with an average speed of 30km/hour (including acceleration / deceleration and loading time for 10 proposed stops).
- The vehicle capacity calculated (based on initial patronage analyses done in this study) is up to 2900 passengers in the peak hour per direction. The journey time is assumed to be approximately 18 minutes, resulting in a requirement for a fifteen minute service requiring approximately 10 vehicles with a vehicle capacity of approximately 60 people, with spares.
- Operational cost benefits would be provided by HULTS compared to BRT, based on the life-cycle of the vehicles - where HULTS is likely to be 30 years whereas BRT will need to be replaced after approx 8-10 years. This replacement will cause additional capital cost, not calculated in this study.
- The BRT vehicles are available in both power-train alternatives, but HULTS vehicle are not operational at the moment in the electric version - the hybrid is based on the PPM vehicle tested in Stourbridge.
- 10 Possible locations for new stops were identified in total (Including HW and BE), which would provide stops every 0.9 km. The locations of the proposed stops were carefully selected based on the criteria of public accessibility, connection to the stop and on the electricity availability.
- Part of the consideration was Depot & Warehouse location; three suitable locations have been identified, High Wycombe train station, M40 underpass and Bourne End train station, where the Bourne End location is preferred for the new depot & warehouse.
- Three of four original bridges have been demolished and in order to reopen the route on its original alignment the original bridges would need to be restored and new bridges would need to be built instead of original level crossings to mitigate any safety issues during the operation. We have analysed 6 bridges to be built with one more possible bridge on Bassetsbury Lane dependent on the preferred route alignment.

- Both possible MRT vehicles would be operating on similar principles using purely electric or hybrid electric engines. Both vehicle systems should use the low floor platform for easy access and the capacity should be between 50 and 60 passengers. (there is no detailed specification for seated and standing passengers at the moment)
- More detailed analyses of possible patronage and usability of the proposed MRT scheme needs to be undertaken to be able to fully evaluate the business case issues, where the biggest issue is financial viability of the scheme. The original rail line needed to be closed due to lack of financial self efficiency and there would need to be a carefully assessment of changes (population, behaviour change, public transport acceptance, quality, service etc.) between 1970 and 2009 to get a valid current view for a business case.
- There is a requirement for an engineering study considering the bridge constructions, existing rail alignment condition, gradients of the route and more detailed analyses of proposed alternative routes based on the deliverability and cost of the scheme.
- Cost benefit analyses including patronage sensitivity testing, pricing policy, detailed operational issues (vehicle, route, buildings etc.) and utilizing outcomes from this and previous studies in the business case development. This business case should address in more detail funding requirements including UK, EU or PPP funding opportunities.
- As a part of the Engineering study and cost benefit analyses there would be a requirement to meet with National Rail and Great Western representative in conjunction with bus operators in the area and regional / local assemblies to discuss future join policy and setup common objectives identified in LTPs.

### 3. The route

#### 3.1. History

##### 3.1.1. OVERVIEW

The Wycombe Railway's main line was opened between Maidenhead and High Wycombe in 1854 by Brunel. The original High Wycombe Railway station had to be replaced because the extension of the line to Aylesbury and Oxford required a new station on a different alignment. The original station was converted into a goods depot and the building is still in commercial / industrial use. The line between Bourne End (Marlow Road) and High Wycombe was closed in 1970.

The Marlow Branch Line is a short single track railway line between Maidenhead and Bourne End and Marlow, but the original Maidenhead to High Wycombe branch line had stops at:

- Maidenhead (latterly renamed Boyne Hill and effectively replaced by the current Maidenhead station)
- Cookham
- Bourne End (Marlow Road)
- Wooburn Green
- Loudwater
- High Wycombe

In 1873 an extension was added connecting Marlow station to Bourne End station. In 1937 Furze Platt station was added on the outskirts of Maidenhead (before Cookham station).

##### 3.1.2. CONSTRUCTION

The Wycombe Railway Company was incorporated by an Act of Parliament in July 1846. The act authorized the construction of a single line from the original Great Western Railway (GWR) station at Maidenhead to High Wycombe. Construction began in 1852 and the line was opened on 1st August 1854. The line left the GWR main line at the site of the present Maidenhead station, the first stop of which was Maidenhead (Wycombe Junction), renamed in the 1860s, Boyne Hill. This station was closed on 1 November 1871 upon the opening of the present Maidenhead station. The Wycombe Railway Company was taken over by GWR on 1 February 1867. The Marlow line was opened on 23 June 1873, with a no. 522, 0-4-2 saddle tank locomotive and remained in service until 1935. The GWR acquired the capital and operated the line from 1897.

##### 3.1.3. PARTIAL CLOSURE

The steam locomotive was replaced with a Diesel multiple unit in 1962 (Figure 1). The service was gradually cut back through to 1969, by which time Marlow station had been demolished and replaced by a smaller one on the site of the former goods yard. Loudwater and Wooburn Green lost their ticket offices, Loudwater had been reduced to a single track halt and

Cookham lost its passing loop. Finally, on 2 May 1970 the stretch of line from Bourne End to High Wycombe was closed to passengers after the Ministry of Transport refused to include it on the list of unprofitable routes to receive *Grant Aid* funding from central government (the precursor of the Public Service Obligation grant system introduced in 1974 to provide subsidies for loss-making but 'socially necessary' lines).



Figure 1- shows the original steam engines operated on the High Wycombe to Maidenhead line till 1962.

Source: <http://www.geocities.com>



Figure 2 - shows the original diesel engines operated on the High Wycombe to Maidenhead line till 1970 and then between Bourne End / Marlow and Maidenhead.

Source: <http://www.geocities.com>



Figure 3 - shows new diesel engines operated on the Bourne End / Marlow to Maidenhead line from 2000.

Source: Martin Volny

## 3.2. Current situation

### 3.2.1. PROPOSED MASS RAPID TRANSIT (MRT) ROUTES / NETWORK

This feasibility study has been undertaken against the background of the proposed MRT route which is being considered. This would mean a reopening of the original rail line between Maidenhead and High Wycombe train stations. The approach selected for this feasibility study is based on the requirements of reopening the original rail line between Bourne End and High Wycombe only as a first stage of the study. Reopening and modification of the original line for future MRT system (HULTS or BRT are being considered from the technology side) would then split into three stages, where:

- First stage of the reopening is focused on the route between High Wycombe and Bourne End.
- Second stage would be focused on integration of the existing rail line from Marlow / Bourne End to Maidenhead.
- Third stage should consider a possible extension of the High Wycombe – Maidenhead line and creation of the regional MRT network.

### 3.2.2. HIGH WYCOMBE TO BOURNE END ROUTE

For the purposes of this feasibility study and the comparison of different options, the following details of the High Wycombe to Bourne End route were used:

- The High Wycombe to Bourne End route is approximately 9.04 km long, with no existing railway alignment.
- The route is proposed to run from the existing High Wycombe train station via the original rail alignment through Loudwater and Wooburn Green to the existing train station in Bourne End.
- There are identified sections of the original track alignment, which have been sold off and where a number of buildings were built on the path of the old railway during the 1970s and 1980s.
- Three of its four original bridges were demolished (Abbey Barn Lane continues to carry the road over the site of the old line).
- To prevent future incursion, the original track-bed through Bourne End, Wooburn Green, Loudwater and the Wycombe Marsh area of Wycombe, is now listed in the local plan as *set aside* as a footpath/cycle route or bus route.

The system would be required to provide a maximum capacity in the order of 3,000 passengers per direction per hour.

### 3.2.3. MAIDENHEAD TO BOURNE END AND/OR MARLOW ROUTE

The Marlow branch line is a single track railway line between Maidenhead and Bourne End and Marlow. Passenger services are operated by First Great Western using Class 165 DMUs. (see Figure 4) The line connects to the Great Western main line at Maidenhead, and uses a section of the former Great Western Railway branch line to High Wycombe.



**Figure 4** - shows the Class 165 DMU engine operating on the Maidenhead to Bourne End / Marlow line.  
Source: <http://www.peterclarkkits.com>

The length of the route from Maidenhead to Bourne End is approximately 7.2 Km long and the route between Bourne End and Marlow is approximately 4,3 Km long, which makes the distance between Marlow and Maidenhead approximately 11.5 Km.

The existing journey time is 12 minutes between Maidenhead and Bourne End and 7 minutes between Bourne End and Marlow, which makes the total journey time from Marlow to Maidenhead 19 minutes.

The route includes 5 stops and the average speed on this line is 36 km/h.

The off-peak service is normally one train per hour, in each direction, between Maidenhead and Marlow. During the morning and evening peaks the train frequency is increased. A half-hourly service is achieved by using two trains: one shuttling between Marlow and Bourne End, and one between Bourne End and Maidenhead. This is possible because Bourne End station still has two platforms that may be used simultaneously.

All 'through' trains must stop and reverse at Bourne End, as the line to Marlow has a trailing connection, and the driver must change ends for the second part of the route. Most trains on the line begin and terminate at Maidenhead, but some run through to London Paddington.

The following towns and villages are served by the branch line:

- Maidenhead
- Furze Platt (North Maidenhead)
- Cookham
- Bourne End
- Marlow

### 3.3. Route protection

The future of the route was raised at a planning hearing in November, at which Wycombe District Council identified the prospect of reinstatement as a reason for refusing a planning application to construct housing over the track-bed at Wycombe Lane, Wooburn Green. A previous application for the same development was rejected in 2006 and the Council's decision was upheld on appeal to the planning inspector. In January 2009, the second attempt to build on the route of the railway line was rejected by the Planning Inspectorate which specifically cited the possible future reinstatement of the line as a reason for refusing consent.



Figure 5 - shows the conservation area and footpath between the school and Loudwater station.

Source: Martin Volny



Figure 6 - shows the original rail alignment with all stops, crossing roads, and conservation area or cycle/footpaths and conservation Area or footpaths.

source: Marlow & Maidenhead passengers association

## 4. Route assessment

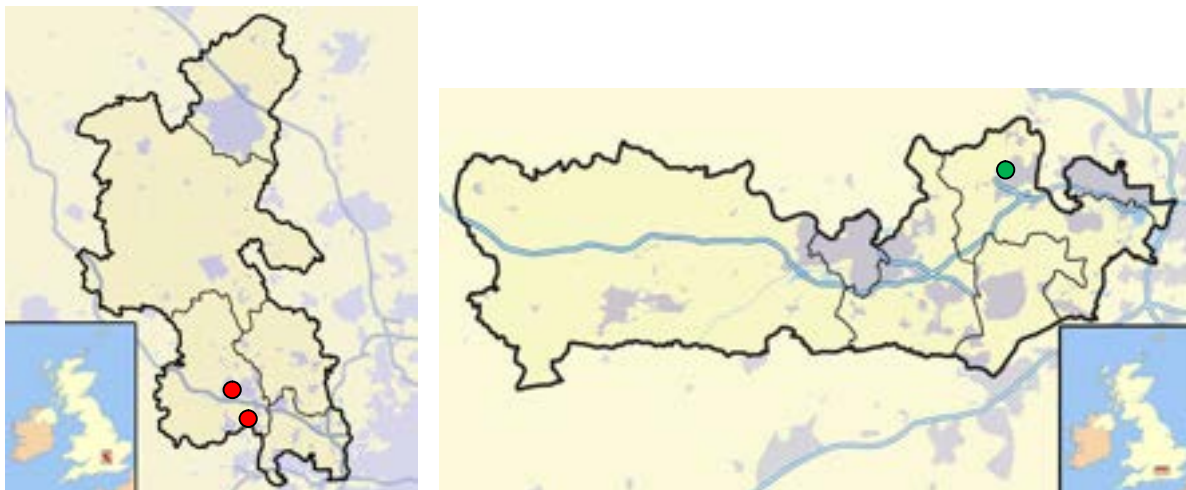
### 4.1. Background

Mass Rapid Transit (MRT) schemes are being deployed across the UK and we understand this term to mean the following:

MRT is a transportation system designed to allow passenger travel within or throughout an urban area, usually employing surface, elevated, or underground railway systems or some combination of these. Rapid transit systems are generally considered to be mass transit systems, capable of moving large numbers of passengers in a single train. The large capacities of such systems make them potentially more efficient, in terms of cost and environmental effects, than automobile transportation.

Based on this definition we have analysed the original rail route and identified possible usability for a newly proposed MRT scheme. The benefit of the proposed MRT scheme is that both end stations, High Wycombe and Bourne End, are located in the Wycombe District Council area in Buckinghamshire. Planned extension of the route to Maidenhead would involve discussions with Royal Borough of Windsor and Maidenhead in Berkshire. (Figure 7)

Meetings took place with planning department officers of WDC and RBWM during which the possibility of the line reopening and a new MRT scheme was introduced. The response from both authorities was generally positive, but concerns related to funding, operation, inter regional planning issues and mostly the economical viability were raised. The feasibility study addresses some of the questions, by analysing investment cost of the scheme and identifying possible patronage. The more detailed patronage sensitivity testing would need to be performed for the business case analysis together with detailed analysis of preferred routing, vehicle technology and related operational issues.

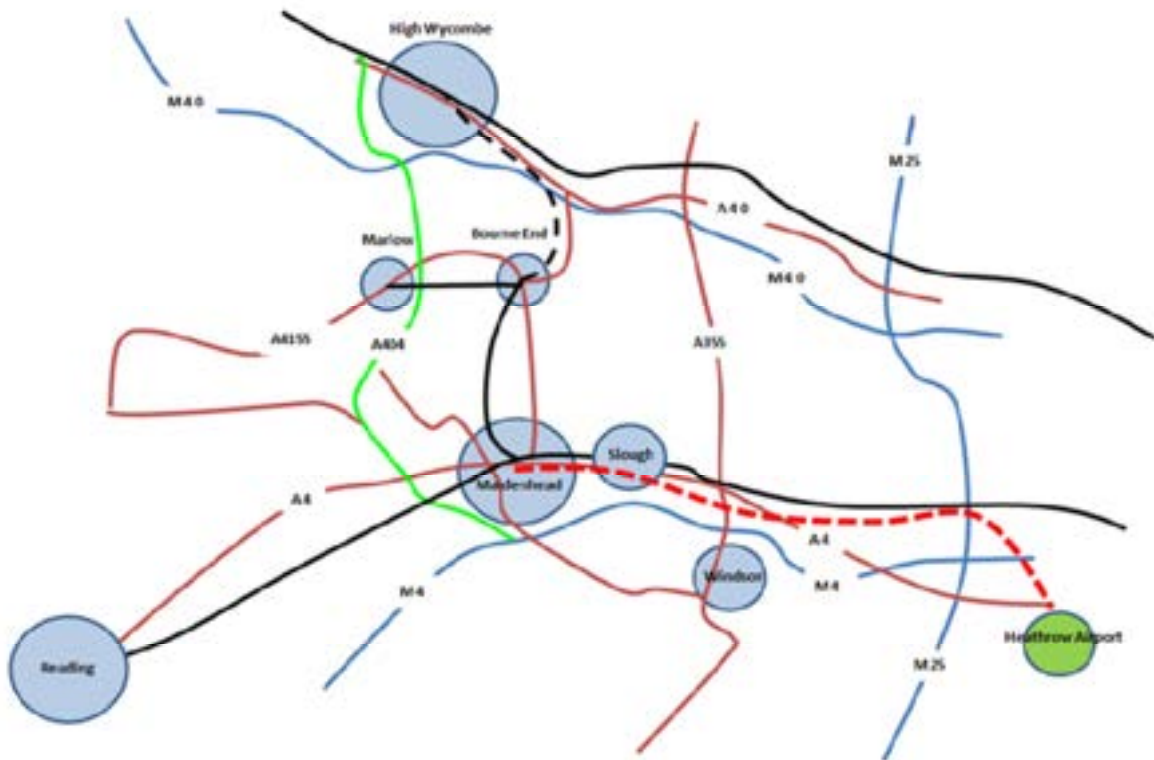


**Figure 7** - shows Buckinghamshire district with Wycombe District Council (location of High Wycombe and Bourne End are highlighted in red circles) and Berkshire district with Royal Borough of Windsor and Maidenhead (location of Maidenhead is highlighted in green circle)

Source: Wikipedia

The road and rail network in the area of possible MRT scheme deployment is very dense, generally it can be said that the network is split vertically (includes A40 London road, A4 road, motorways M40 and M4 with parallel train corridors towards Birmingham and Bristol) and horizontally (including A4155, A355, A404 and motorway M25, with local railway branch from Maidenhead to Bourne End / Marlow). The entire network could be seen in the Figure 8. Generally it could be said that in the MRT deployment there is not good vertical connection by quality public transport services. The route between Maidenhead and High Wycombe is operated by local bus services (travelling through Bourne End) and using a very congested road network, especially during the peak hours.

The MRT scheme could provide quality service connecting High Wycombe and Maidenhead and provide good connection to existing Great Western Railways and Chiltern Railways on each side of the route. In addition to this, a possible extension of the route could be introduced to each end, where on the High Wycombe side the route could continue toward the new rugby stadium / housing development side and on the Maidenhead side the route could make a circular service serving the city centre and then continue towards the M4.



**Figure 8** - shows the road and rail network in connection to the proposed reopening of the line between High Wycombe and Maidenhead. (Black indicates railways, blue motorways, green and red a class roads and red dotted line possible future link to Heathrow airport)

Source: Martin Volny

## 4.2. Assessment process

In undertaking assessments of the appropriateness of different route options for the development of MRT schemes, different guidance documents and accepted professional practices advocate a similar approach in that they propose assessment of a range of different options against a set of criteria which includes:

- Suitability for different technology used in MRT vehicles
- Current problems and future challenges
- Scheme deliverability
- Operation issues

The process undertaken in this feasibility study has been:

- **High Level Strategic Review** of technology options i consideration of all the different public transport options for a MRT for the preferred route.
- **A Technical Review** of the individual route options i looking at their implementation, operation, opportunities and constraints of the MRT line deployment in the future.
- **A Comparative Assessment** of the HULTS and Bus MRT technologies looking at the application of the technology to the High Wycombe to Bourne End route to provide in particular a cost comparison of the track deployment and technologies when applied to a specific route.

## 4.3. Route reopening options

By analysing the original rail line for the purpose of the route reopening we have focused on possible stops, depot and bridges locations. These three areas are described in this paragraph in more details.

### 4.3.1. STOPS

The original track had four stops including High Wycombe (HW) and Bourne End (BE), which makes the stops every 2.25km. This distance is not acceptable for new quality MRT system and therefore we have identified ten possible locations for new stops (Including HW and BE), which makes the stops every 0.9 km. The locations of the proposed stops were carefully selected based on following criteria:

- **Public accessibility**, focused on possible traveller demand based on the housing density and walking distance of 10 -15 minutes.
- **Connection to the stop**, the stop location should be connected to the existing road / pavement infrastructure to provide clear and safe access from both sides around the corridor.
- **Electricity availability**, the stops would need to be equipped for example by ticket machines, security and surveillance CCTV cameras, lighting etc. Therefore the electricity availability was considered.

The proposed stops locations are shown on the Figure 10 below together with proposed depot & warehousing locations. The proposed stops were named in reference to the nearest road so the route would have stops on High Wycombe, London Road (A40), Bassetsbury Lane, Spring Lane, Tradeaway Hill, Tudor Drive, Whitepit Lane, Thomas Road, Trees Road and Bourne End.

The stops location was evaluated as vehicle type and technology free solutions, which should be able to be implemented for HULTS or BRT systems. The HULTS vehicle can be produced as a low or medium floor height version with a boarding height between 300 and 450mm, which is comparable with 330 mm for tram and with 340 mm without kneeling for a bus. New kneeling buses could achieve a boarding height about 150mm.

Based on the preferred vehicle and its technology the stops would need to be equipped with relevant platforms to be able to provide gap and step free access to the vehicles. The expected MRT system should have as minimum possible high in order to be implemented in the street environment. This requirement would need a modification of existing platforms in High Wycombe and Maidenhead railway stations to be compatible with the rest of the stops. The minimum length of the platform should be about 20 meters and width 2 meters, but consideration of other local aspects (e.g. existing road/pavement width etc.) would need to be evaluated in each location.

#### 4.3.2. DEPOTS

Part of the consideration was Depot & Warehouse location; three suitable locations have been identified, which are:

- **High Wycombe train station** where part of existing car park could be utilized together with the Brunel Heritage Engine shed. This could provide sufficient space to accommodate the vehicle fleet and provide technological / servicing background. In addition to this the Brunel engine shed could possibly provide an opportunity to open a visitor centre for mixed old and existing tram / train vehicles and could promote similar schemes across the UK. This depot would have good accessibility for employees (drivers, technicians etc.)
- **M40 underpass**, the tunnel under the M40 motorway was designed for double track operation and it could provide 100 meters of covered rail / depot. It could be designed such that one track would be permanently used for depot purposes and the second track would be operational during the day and become virtual depot during non operational hours. This alternative could save investment money on depot, but Warehouse would need to be built on the southern site of the passage. The accessibility for employees is similar to HW location, but this location is better from operational point of view. If the operational corridor would be only between HW and BE then this depot would be conveniently located in the middle of the route and in case of vehicle break down could be equally accessible for both directions.
- **Bourne End train station**, there is an opportunity to utilize an existing car park to build a new depot & warehouse. This location would be ideal for the corridor operation from Maidenhead to High Wycombe, because it would be in the middle of the route and in case of vehicle break down could provide equal journey time to both directions. In addition to this, it could accommodate the vehicle operating between BE and Marlow as well. The location would be comfortably accessible for employees.

Based on analyses we would recommend the Bourne End location for the depot & warehouse.

#### 4.3.3. BRIDGES

Three of four original bridges have been demolished, only Abbey Barn Lane continues to carry the traffic over the original track alignment. In order to reopen the route on its original alignment the original bridges would need to be restored and new bridges would need to be built instead of original level crossings to mitigate any safety issues during the operation.

The construction of the bridges at Treaday Hill and Whitepit Lane would be required due to possible safety issues related to the level crossing. Both level crossings did not need the bridges at the time of original scheme due to the very low level of traffic in this area, but recent traffic trends and intensities on these two roads would require bridges for safe operation.

The original level crossings are on the steep gradient hampered by poor visibility of the level crossing in advance to allow safe stopping distance for HGVs. If advanced Intelligent transport systems could be implemented, then the level crossing could be considered, but more detailed analyses of current traffic intensities would need to be carried out in the future in a more detailed study.

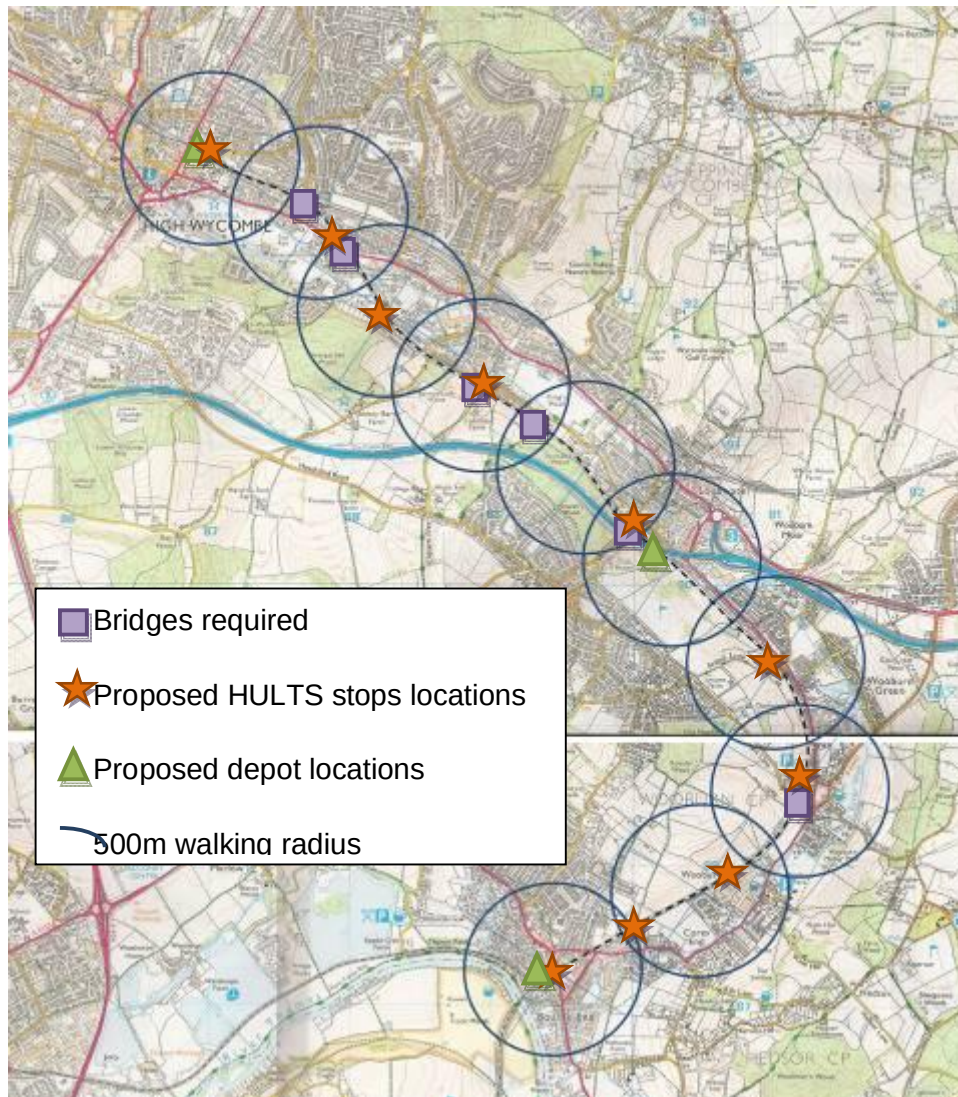
The list of bridges, which need to be constructed, is shown in the Figure 9.

| Location          | Description                                           | Length       | Price              |
|-------------------|-------------------------------------------------------|--------------|--------------------|
| Gordon Road       | New bridge connecting HW rail line with Princess Gate | 130 m        | £ 3.25 mil         |
| London Road A40   | Original bridge over the A40 road                     | 50 m         | £ 1.25 mil         |
| Spring Lane       | Original bridge over the Lane                         | 30 m         | £ 0.75 mil         |
| Bridge Bank Close | Original bridge over the pedestrian path              | 30 m         | £ 0.75 mil         |
| Treadaway Hill    | New bridge over the road (could be level crossing)    | 150 m        | £ 3.75 mil         |
| Whitepit Lane     | New bridge over the Lane (could be level crossing)    | 90 m         | £ 2.25 mil         |
| <b>Total</b>      | <b>£ 2.5 mil / 100 m</b>                              | <b>480 m</b> | <b>£ 12.00 mil</b> |

**Figure 9** - shows the location of bridges, which needs to be constructed for safe MTR operation.

Bassetsbury Lane would perhaps require construction of a new bridge as well, but this would depend on the final option assessment and recommendation of the preferred scheme in this area. The length of the bridge could vary from 60 to 200 meters depending on the preferred option.

The Figure 10 below shows a combination of stops, depot and bridge locations along the original route alignment.

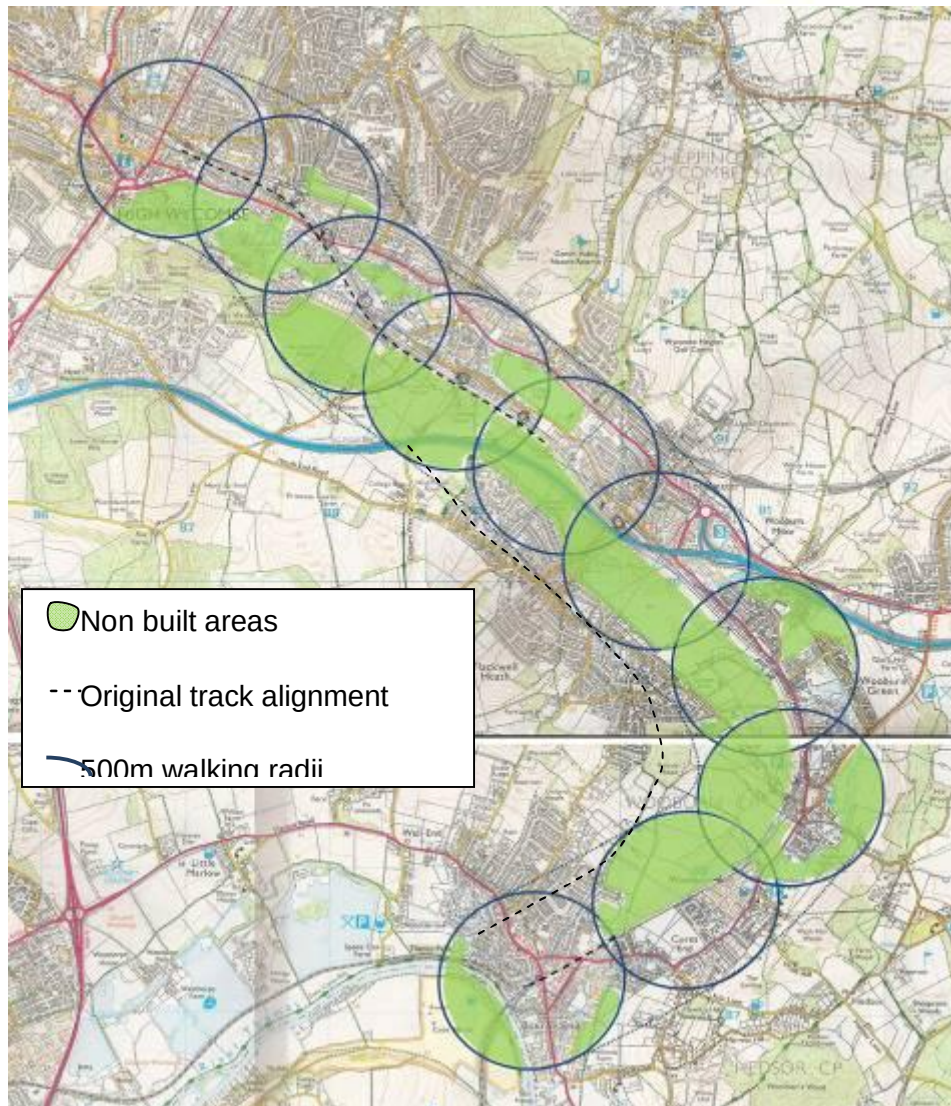


**Figure 10** - shows the proposed HULTS alignment with proposed new stops, required bridges, proposed depot locations and public accessibility diameter.

Source: OS Map 1:25000, 172 Chiltern Hills East

#### 4.3.4. ROUTE ACCESSIBILITY FOR TRAVELLERS

The patronage section was focused on identifying possible MRT users along the corridor based on average density in the High Wycombe area. This section only focuses on identification of currently built-up residential or commercial areas along the proposed corridor. The Figure 11 shows the proposed route alignment and 500m walking radii, which creates 10 to 15 minutes walking distance to the MRT service. The green highlighted areas shows current not developed land (green land) along the corridor and based on the areas comparison is possible to say, that 60% of the land is in built-up area and the remaining 40% is green-land areas, which could be possibly developed in the future. This building density could raise questions in relation to MRT implementation, but considering that this link would not only serve the catchment area along the corridor for commuting purposes, but would as well create regionally significant public transport connection link between High Wycombe to the North and Maidenhead to the South allowing additional connections towards Bristol, London Paddington or Heathrow international airport.



**Figure 11** - shows the proposed HULTS alignment with public walking accessibility diameter and identified green areas.

Source: OS Map 1:25000, 172 Chiltern Hills East

The walking time together with waiting time are usually critical criteria for the preference of public transport and therefore the maximum of 30 minutes, which could be applied on this corridor, may not attract an expected 25% of car users. The detail sensitivity analyses would need to be performed in order to fully evaluate the MRT business case.

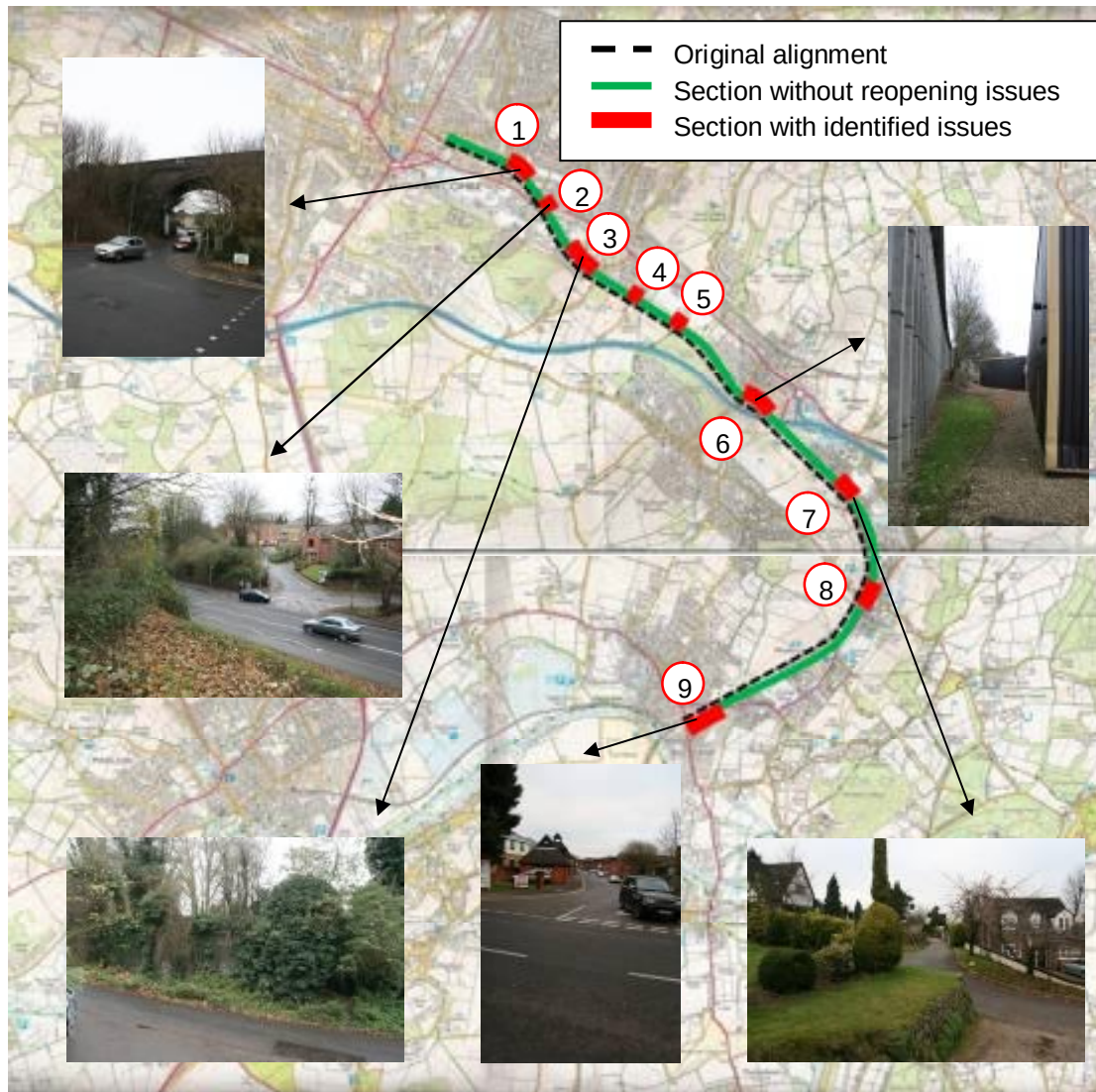
#### 4.3.5. IDENTIFIED ISSUES

Reopening of the original Brunel rail line as an MRT scheme, would require more detailed analyses of the proposed routes including structure surveys of the existing bridges, embankments, utilities etc. These identified issues are based on desktop study analyses of possible route options and technological solutions.

The proposed MRT route would be 9.04 km long and with 6 bridges allowing a dedicated MRT lane along whole route. We have identified 9 locations where possible issues would need to be addressed. ( see Figure 12 below). The issues are not prioritised at the moment, because the assessment criteria have not been agreed with the client. Despite this we can separate the

problems as *easy to address* (no need for land / property purchase, no private third parties involved etc.), *medium* (some land / property purchase, other party possible involvement but negotiable results could be achieved) and *difficult* (the most complicated land / property purchase, third party negotiations etc.) The Figure 13 shows the locations of identified section of the route with issues, their length, description and possible issue resolution difficulties.

**Based on this split we have identified 3 easy to address issues, 3 medium to address issues and 3 difficult to address issues locations. The total length of the identified issues section is only 1.87 km, which is approximately 21% of the total length.**



**Figure 12** - shows the proposed HULTS alignment split into sections, recognising possible construction issues (red colour) and issues-free section (green).

Source: OS Map 1:25000, 172 Chiltern Hills East

| Number       | Section           | Length | Issues                                                            | Issues tackling |
|--------------|-------------------|--------|-------------------------------------------------------------------|-----------------|
| 1            | Gordon road       | 130 m  | Build new bridge                                                  | Medium          |
| 2            | London Road A40   | 50 m   | Build new bridge (utilize existing embankments)                   | Easy            |
| 3            | Deangarden Rise   | 420 m  | Alternative route alignment, land & property negotiation required | Difficult       |
| 4            | Spring Lane       | 100 m  | Build new bridge                                                  | Easy            |
| 5            | Bridge Bank Close | 100 m  | Build new bridge                                                  | Easy            |
| 6            | Teadaway Hill     | 370 m  | Build new bridge, property negotiation required                   | Difficult       |
| 7            | Juniper Lane      | 320 m  | Alternative route alignment, land & property negotiation required | Difficult       |
| 8            | Whitepit Lane     | 200 m  | Build new bridge, land & property negotiation required            | Medium          |
| 9            | Boston drive      | 300 m  | Land & property negotiation required                              | Medium          |
| Total length |                   | 1870 m | 21% of the total length                                           |                 |

**Figure 13** - shows identified issues locations, which need to be addressed before the line reopening.

#### 4.3.6. TRACK-BED

During the Feasibility study development we have liaised with a manufacturer of the HULTS rail track bed (Dow Rail - the track bed is similar to light rail systems implemented for e.g. in Manchester) and designers of a HULTS vehicle (TDI Transport Design International, who are currently in the process of developing/testing a HULTS vehicle powered by Li-ion batteries).

Ultra light rail vehicles run on light railway, roads or through pedestrian areas with no required electrification, overhead wires or track insulation, which makes the construction requirement very similar to roads construction.

The track bed would be placed 230 mm (or in special constructions only 192 mm) under the surface (either tarmac, concrete or original rail bed) which makes them easy to install even on bridges. The special construction of the track bed supports a noise reduction of 40% compared to standard light rail versions. The gauge is an international standard of 1.435 mm and would be compatible with most of the UK railways.

The weight issue is related to axle weight and it is possible to say that a normal tram is about 8-9 tonnes and the HULTS would be about 70% of that weight which would be about 5-6 tonnes. The design could take in account future tram usage and therefore the higher figure should be used for the construction of the rail track. Despite this, the feasibility study only considers the rail for a HULTS system and therefore uses a construction cost of £1 million per kilometre. (use of the tram rail would be more expansive)

The need to move utilities would not driven by issues of electrification and stray current, but it is driven by the need for utilities access for connection, maintenance and repair. The new track bed system would offer a rib-cage construction, which would allow utility access without a need to relocate them. The only issue related to the utility access is the operation of the tram, because it would need an alternative route to avoid a work area. To this end, utility access

could be done during the night when the operation of the services would be limited or stopped. In the case of this scheme proposal we could identify only 2 places (Bourne End and Deangarden Rise / Bussetsbury Lane), where there could be utilities directly interfering with the proposed route.

#### 4.4. Option analyses

The following section of the study looks at more detailed analyses of the identified problem locations raised in the section no 2.3.5. and shown in the Figure no. 37. The analyses are performed on all problem locations except Spring Lane and Bridge Bank Close (where there are no issues related to alternative route – only new bridges on existing alignment are required). Each of the identified critical locations was considered from the point of finding an alternative route for the new HULTS scheme in place, where the original track bed was used for other purposes and is not available at the moment.

The satellite imagery was used for sketching each alternative route (different colours used) and the identified alternative routes are identified by numbers (identifying the location) and letter for future easy reference. Each option is described in the table below and identified issues are highlighted together with advantages and disadvantages.

The general approach for finding the alternative route was based on the MRT vehicle-free decision, which should allow either HULTS or BRT vehicle to use the alternative route, but in some locations this condition could not be met and therefore the indication of which vehicle type is used in the last column.

Additionally, selected images from ground level are attached for a better understanding of the issues described in the tables.

#### 4.4.1. OPTION 1



**Figure 14** - shows the proposed HULTS alignment and identified options between High Wycombe train station and London Road.

Source: Google Earth map

| Option | Description                                                                                                                                                                                                                                                                                                       | Issues                                                                                                          | Advantage / Disadvantage                                                                                                                                                                                              | Mode      |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 1a     | Build new bridge on A40 London road, utilize existing embankments on both sides of the road, build new bridge over Gordon Road and use original alignment next to existing rail line to the train station.                                                                                                        | Build new bridges over A40 and Gordon Road, land and property negotiation on Princes Gate.                      | <ul style="list-style-type: none"> <li>- Would avoid all traffic issues on A40.</li> <li>- Direct access to the station platform</li> </ul>                                                                           | Tram, Bus |
| 1b     | Use existing A40 London Road, build new T-junction to allow access toward Bowden Lane with MRT priority, modify the layout of existing junctions (Chestnut Ave, Bussetsbury Ln, Gordon Rd, Queen's Rd, Harlow Rd, Stuart Rd) to allow MRT priority and use Saffron Rd / car park for access to the train station. | Traffic restriction on MRT priority sections could cause bigger delays on A40, build new signalized T junction. | <ul style="list-style-type: none"> <li>- No need to build two bridges.</li> <li>- Negative traffic impact on A40.</li> <li>- No need of land and property negotiation.</li> </ul>                                     | Bus       |
| 1c     | Similar to 1b, but the MRT route would be diverted via Queen's Road toward original route alignment.                                                                                                                                                                                                              | Land and/or property negotiation between Queen's Road and original alignment.                                   | <ul style="list-style-type: none"> <li>- Less traffic impact close to the city centre.</li> <li>- Negative impact on the A40.</li> </ul>                                                                              | Bus       |
| 1d     | Could be used in combination with options 1a and 1c to minimise negative traffic impact on the A40.                                                                                                                                                                                                               | No need to negotiate land and/or properties on Princess Gate, existing road could be used.                      | <ul style="list-style-type: none"> <li>- No need for new signalized T-junction.</li> <li>- Little negative traffic impact.</li> <li>- Longer route (by making U move)</li> <li>- Building bridge over A40.</li> </ul> | Bus       |
| 1e     | Could be used as an alternative to 1b in combination of 1a, when the route would be diverted from Princess Gate via Gordon Road, exiting car park to Crendon Rd and access to the station car park.                                                                                                               | Land and/or property negotiation with the car park owner on the Gordon Rd.                                      | <ul style="list-style-type: none"> <li>- Building bridge over A40</li> <li>- No need for new signalized T-junction.</li> <li>- Little negative traffic impact on A40, Gordon Road and Crendon St.</li> </ul>          | Bus       |

**Figure 15** - describes identified options, their issues, disadvantages / advantage and possible MRT vehicle used on them.



Figure 16 - shows the proposed HULTS alignment in Gordon Road area with existing rail bridge.

Source: Martin Volny



Figure 17 - shows the proposed HULTS alignment in Gordon Road area from Princess Gateway residential development.

Source: Martin Volny

#### 4.4.2. OPTION 3



**Figure 18** - shows the proposed HULTS alignment and identified options between Bassetsbury Lane and the Wycombe Marsh. (original alignment on the end of Deangarden Rise)

Source: Google Earth Map

| Option | Description                                                                                                                                                                                                                                                           | Issues                                                                                                                                                                      | Advantage / Disadvantage                                                                                                                                                                                                                                    | Mode      |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 3a     | The original route alignment cannot be used, because new housing development is located on the track-bed route. The route would need to be diverted via sewerage plant, new land development site and gardens . toward the original track bed close to Wycombe Marsh. | Land negotiation with sewerage plant owners and land developers. (Lloyds Bank)<br>Purchase of min. two houses to allow connection with original alignment on Kings mead Rd. | <ul style="list-style-type: none"> <li>- Easiest way for HULTS route to be built.</li> <li>- Negotiations with land and property owners.</li> <li>- Little traffic impact.</li> </ul>                                                                       | Tram, Bus |
| 3b     | Use Deangarden Rise road for MRT route and build new signalized junction on Bassetsbury Ln. New embankment would need to build on the Busetsbury Ln. On the south side would connect the original alignment on Wycombe Marsh.                                         | Possible noise and traffic issue on the Bassetsbury Lane.                                                                                                                   | <ul style="list-style-type: none"> <li>- Easiest option for delivery.</li> <li>- Negative resident acceptance.</li> <li>- Bus may not have noise issues.</li> <li>- No need for land and property negotiation.</li> <li>- Little traffic impact.</li> </ul> | Tram, Bus |
| 3c     | Divert the route behind the house gardens on the southern side of the development, purchase of two properties to allow Busetsbury Ln crossing on new signalized junction. New embankment would need to implemented.                                                   | Land and/or house purchase and negotiation. Steep hill could make the new track bed construction complicated.                                                               | <ul style="list-style-type: none"> <li>- Purchase of land and houses.</li> <li>- New signalized junction would need to implement.</li> <li>- Little traffic impact.</li> </ul>                                                                              | Tram, Bus |
| 3d     | Tunnel could be build under the housing development to follow the original track bed.                                                                                                                                                                                 | Expensive.<br>Time consuming.                                                                                                                                               | - Expansive                                                                                                                                                                                                                                                 | Tram, Bus |

**Figure 19** - describes identified options, their issues, disadvantages / advantage and possible MRT vehicle used on them in the Bassetsbury Lane and Wycombe Marsh area.



**Figure 20** - shows the proposed HULTS alignment in Bassetsbury Lane original rail embankment.

Source: Martin Volny



**Figure 21** - shows the proposed HULTS alignment in Bassetsbury Lane area and detail of the gardens which would need to be negotiated for the route diversion.

Source: Martin Volny



**Figure 22** - shows the proposed HULTS alignment in Bassetsbury Lane area and detail of the gardens which would need to be negotiated for the route diversion.

Source: Martin Volny



**Figure 23** - shows the proposed HULTS alignment in Bassetsbury Lane area and detail of the back gardens on Deangarden rise from the Wycombe March, where was the original track alignment.

Source: Martin Volny

#### 4.4.3. OPTION 6



**Figure 24** - shows the proposed HULTS alignment and identified options in Treadaway Technical Centre area.

Source: Google Earth Map

| Option | Description                                                                                                                                                                                                                                                                                                                                                                                | Issues                                                                                                                                                               | Advantage / Disadvantage                                                                                                                                                                                                                                                                        | Mode      |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 6a     | The original track bed would continue from the railway line conservation area by bridge crossing of Treadaway Hill road and continue between the motorway M40 and the Treadaway Technical Centre. The last building of the centre would need to be demolished to allow track connection with existing passage under the motorway.                                                          | Building the bridge close to motorway and Treadaway Technical Centre. Purchase and negotiation with commercial building owner. Motorway regulation could not be met. | <ul style="list-style-type: none"> <li>- Would almost follow the original alignment.</li> <li>- Build bridge.</li> <li>- Purchase of the property.</li> </ul>                                                                                                                                   | Tram, Bus |
| 6b     | Connect original alignments on the north (railway line conservation area) and south (passage under the motorway) by level crossing and utilization of the existing car parking in front of the Treadaway Technical Centre. New signalized junction would need to be implemented.                                                                                                           | Steep gradient of Treadaway Hill road could cause safety issues. No need for building purchase. No motorway regulation issues.                                       | <ul style="list-style-type: none"> <li>- Would almost follow the original alignment.</li> <li>- No new bridge required..</li> <li>- No need to purchase property.</li> <li>- Safety issues on the Treadaway Hill road level crossing.</li> </ul>                                                | Tram, Bus |
| 6c     | To avoid safety issues on Treadaway Hill road level crossing the route would be diverted down toward to the roundabout and then would follow Boundary road. Or alternatively the route could be utilizing 6b and 7c options and for northbound traffic use link from Boundary Rd (before roundabout with Knaves Beach Way) and join the original route alignment to avoid two roundabouts. | Traffic impact on Treadaway Hill and Boundary Road roundabout. Traffic impact on Boundary road. Need to MRT priorities (signalized junction, dedicated lines etc.)   | <ul style="list-style-type: none"> <li>- No need to purchase property.</li> <li>- Safety issues on the Treadaway Hill road level crossing.</li> <li>- No new bridge required.</li> <li>- Better patronage opportunities.</li> <li>- Possible delays due joining the general traffic.</li> </ul> | Bus       |
| 6d     | Tunnel could be build under the Treadaway Technical Centre to follow the original track bed.                                                                                                                                                                                                                                                                                               | Expansive. Time consuming.                                                                                                                                           | <ul style="list-style-type: none"> <li>- Expensive</li> </ul>                                                                                                                                                                                                                                   | Tram, Bus |

**Figure 25** - describes identified options, their issues, disadvantages / advantage and possible MRT vehicle used on them.



**Figure 26** - shows the proposed HULTS alignment in Treadaway Technical Centre area, in detail is the under-motorway passage and the back of the technical centre where the new track should be located.

Source: Martin Volny



**Figure 27** - shows the proposed HULTS alignment in Treadaway Technical Centre area and detail of the end to the rail alignment protected area.

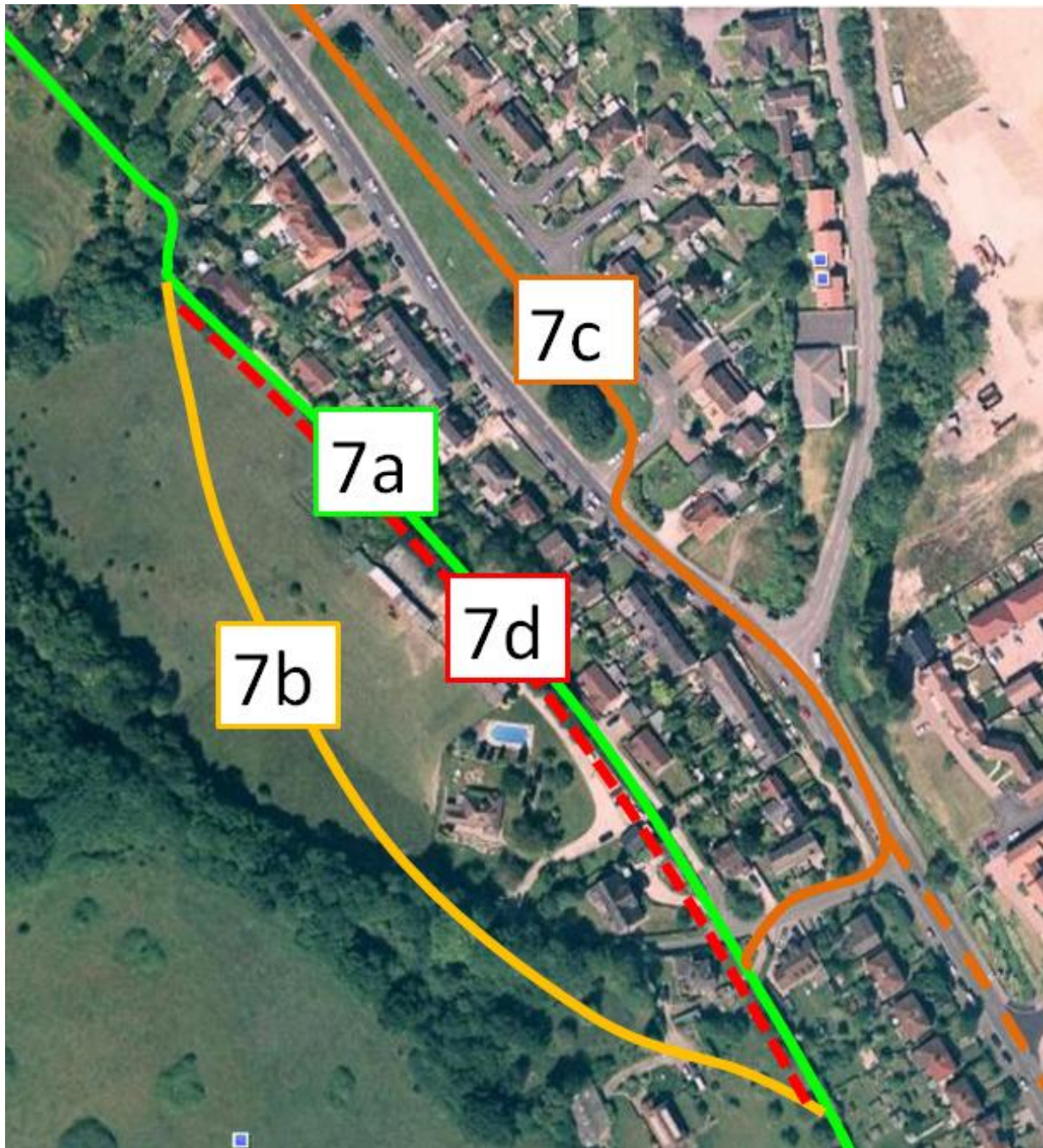
Source: Martin Volny



**Figure 28** - shows the proposed HULTS alignment in Treadaway Technical Centre area and detail of the Treadaway Hill road and opposite is the Treadaway Technical Centre buildings.

Source: Martin Volny

#### 4.4.4. OPTION 7



**Figure 29** - shows the proposed HULTS alignment and identified options in Juniper Lane area.

Source: Google Earth Map

| Option | Description                                                                                                                                                                                                                                                                                                                                                                          | Issues                                                                                                                                                                                                                                                                                             | Advantage / Disadvantage                                                                                                                                                                                                                                                                                                                                                            | Mode      |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 7a     | Utilize the original rail line by using Tudor Drive, which is a residential access-only road. The extension of Tudor Drive width of additional 3 to 4 meters would need to be made. Level crossing on the junction with Juniper Lane would be introduced. The route would follow through the front garden of the house south of Juniper Lane and continue in the original alignment. | Possible negative approach from local residents. Property and land negotiations. Level crossing on Juniper line.                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>- Low traffic impact on Juniper Lane or Tudor Drive.</li> <li>- Resident opposition.</li> <li>- Purchase of land and property is required.</li> </ul>                                                                                                                                                                                        | Tram, Bus |
| 7b     | The original rail track on the north would be diverted through the open fields on the West side. The diversion would as well avoid any possible issues with taking part of the front garden of the residential property on the south side of the Juniper Lane or other property negotiation.                                                                                         | <p>Would not require property negotiations.</p> <p>Would require land purchase.</p> <p>Would avoid the residential opposition.</p> <p>The gradient of diverted route could cause operational issues.</p>                                                                                           | <ul style="list-style-type: none"> <li>- Would avoid taking front gardens.</li> <li>- Would avoid demolition of the stables.</li> <li>- Would need level crossing with Juniper Lane.</li> <li>- Possible operational issues due to the gradient on diverted route.</li> </ul>                                                                                                       | Tram, Bus |
| 7c     | Continuation of the 6c option, where the route would follow Boundary Road (on which approximately 500m could be MRT dedicated lane) The route would join original alignment on Juniper Lane. One front garden would need to be purchased.                                                                                                                                            | <p>Only one front garden would need to be purchased.</p> <p>The golf club would not interfere with the track-bed.</p> <p>The diverted route could provide better public access to the MRT service. Possible negative opposition from local residents.</p> <p>MRT development on separate line.</p> | <ul style="list-style-type: none"> <li>- Opposition of local residents.</li> <li>- MRT line separate to the general traffic.</li> <li>- One front garden purchase.</li> <li>- Non-negative golf club opposition.</li> <li>- Better service provision for residents.</li> <li>- Signalized junction on Juniper Lane and Boundary Road would be required for MRT priority.</li> </ul> | Bus       |
| 7d     | Tunnel could be built under Tudor Drive to follow the original track alignment.                                                                                                                                                                                                                                                                                                      | Expensive. Time consuming.                                                                                                                                                                                                                                                                         | - Expensive                                                                                                                                                                                                                                                                                                                                                                         | Tram, Bus |

**Figure 30** - describes identified options, their issues, disadvantages / advantage and possible MRT vehicle used on them.



**Figure 31** - shows the proposed HULTS alignment in Tudor Drive area and detail of Tudor drive in the direction of Juniper Line.

Source: Martin Volny



**Figure 32** - shows the proposed HULTS alignment in Tudor Drive area and detail of Tudor drive in the direction of High Wycombe.

Source: Martin Volny



**Figure 33** - shows the proposed HULTS alignment in Tudor Drive area and detail of Juniper Lane and Tudor drive junction.

Source: Martin Volny

#### 4.4.5. OPTION 8



**Figure 34** - shows the proposed HULTS alignment and identified options in Whitepit Lane area.

Source: Google Earth Map

| Option | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Issues                                                                                                                                                                                                                                                                        | Advantage / Disadvantage                                                                                                                                                                                                                                                                                                                                                            | Mode      |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 8a     | The original track alignment cannot be used in this part of the route, because new residential development was built along Red Lion Way and Old Station Way. The original track would need to be diverted to the West side through the open field and follow the fencing of the residential development towards Whitepit Lane - this could be about 190m. Then, the proposed track would need to be curved more on the west side (about 40 meters from the development into the field) to allow a bridge crossing on Whitepit Lane and following a diversion around existing residential properties on south side of Whitepit Lane. The route would then continue via the front garden of the caravan home to the farm access road, where there would be a curve back to the original rail alignment. | Property and land negotiations with the farmer. Bridge over the Whitepit Lane would be required to avoid safety issues.                                                                                                                                                       | <ul style="list-style-type: none"> <li>- Resident opposition.</li> <li>- Purchase of land and property is required.</li> </ul>                                                                                                                                                                                                                                                      | Tram, Bus |
| 8b     | A tunnel could be built under Tudor Drive to follow the original track alignment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Expansive. Time consuming.                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>- Expensive</li> </ul>                                                                                                                                                                                                                                                                                                                       | Tram, Bus |
| 8c     | Continue the 7c and/or 6c options, where the route would follow Boundary Road (space for MRT dedicated lane would need to be investigated) The route would join original alignment on farm access road.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>No need for property purchase.</p> <p>Land purchase / negotiation would be required.</p> <p>The diverted route can provide better public access to the MRT service.</p> <p>Possible negative opposition from local residents.</p> <p>MRT development on separate line.</p> | <ul style="list-style-type: none"> <li>- Opposition of local residents.</li> <li>- MRT line separate to the general traffic.</li> <li>- One front garden purchase.</li> <li>- Non-negative golf club opposition.</li> <li>- Better service provision for residents.</li> <li>- Signalized junction on Juniper Lane and Boundary Road would be required for MRT priority.</li> </ul> | Bus       |

**Figure 35** - describes identified options, their issues, disadvantages / advantage and possible MRT vehicle used on them.



**Figure 36** - shows the proposed HULTS alignment in Whitepit Lane area and detail at the back of the new development located on the original rail track. The diversion would need to use the green field shown in the picture.

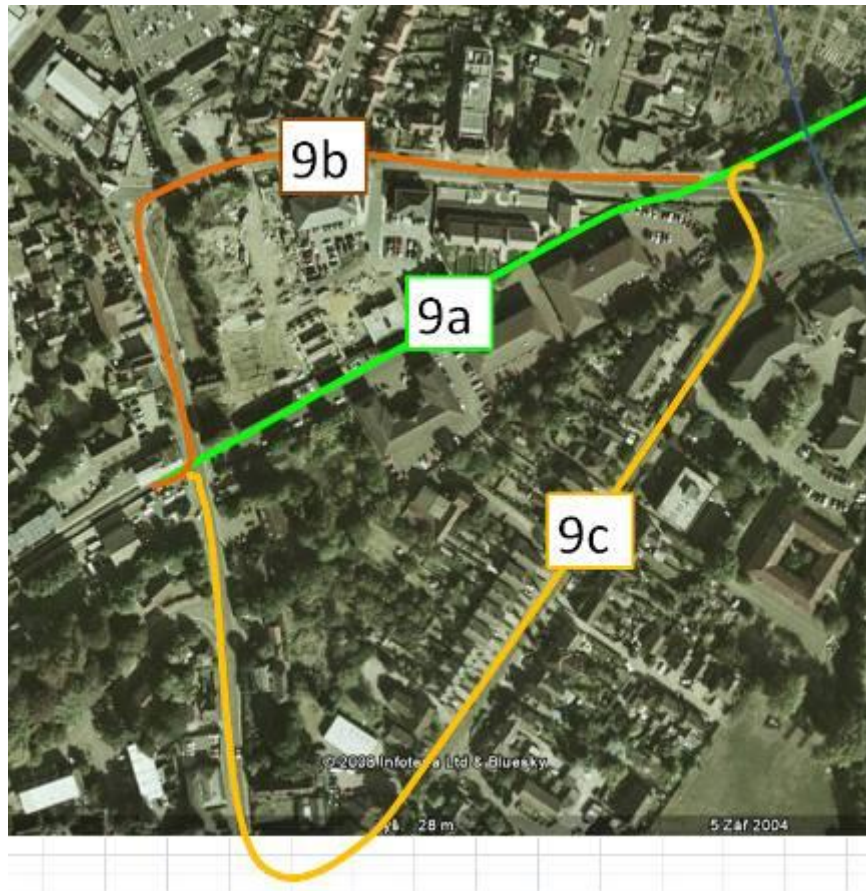
Source: <https://discused-rllys.fotopic.net>



**Figure 37** - shows the proposed HULTS alignment in Whitepit Lane area and detail of Whitepit Lane.

Source: <https://discused-rllys.fotopic.net>

#### 4.4.6. OPTION 9



**Figure 38** - shows the proposed HULTS alignment and identified options in Bourne End train station area.

Source: Google Earth Map

| Option | Description                                                                                                                                                                                                                                                                              | Issues                                                                                                                                                        | Advantage / Disadvantage                                                                                                                                                                                                                                                                                                         | Mode      |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 9a     | The original track alignment could not be used in this part of the route, due to new office development. A possible option would be to utilize the office access road to be shared with MRT scheme. The level crossings on Cores End Road and Station road would need to be implemented. | Land negotiations with the office managers.<br>Signalized level crossing implemented.                                                                         | <ul style="list-style-type: none"> <li>- Resident opposition.</li> <li>- Land negotiation would be required.</li> <li>- Direct connection to existing route alignment and train station.</li> <li>- Going through office development i safety issues.</li> <li>- Possible traffic issues on the signalized crossings.</li> </ul> | Tram, Bus |
| 9b     | Route would be diverted via Cores End Road and Station road to the station. This could be done without implementation of signalized junction. If the bus option were used no need for greater road improvements.                                                                         | Could cause traffic issues in peak hours.<br>Tram would require space, which could lead into closing one lane for general traffic.<br>Residential opposition. | <ul style="list-style-type: none"> <li>- No need for negotiation with office manager.</li> <li>- No need for signalized junction implementation.</li> <li>- Possible negative traffic impact in peak hours.</li> <li>- More difficult access to the station.</li> </ul>                                                          | Tram, Bus |
| 9c     | Route would utilize Furlong Road and could be used as option 9b or in conjunction with 9b, when one- way system could be introduced for general traffic and dedicated MRT lanes could be implemented.                                                                                    | One way system may cause traffic issues in peak hours.<br>Opposition from residents.<br>Better public transport access.                                       | <ul style="list-style-type: none"> <li>- Opposition of local residents.</li> <li>- MRT line separate to the general traffic.</li> <li>- Better service provision for residents.</li> <li>- Signalized junction on Cores End Road would be required for MRT priority.</li> </ul>                                                  | Tram, Bus |

**Figure 39** - describes identified options, their issues, disadvantages / advantage and possible MRT vehicle used on them.



**Figure 40** - shows the proposed HULTS alignment in Bourne End area and detail is shown of the end of the protected corridor at the edge of the town.

Source: Martin Volny



**Figure 41** - shows the proposed HULTS alignment in Bourne End area and detail of the Boston Drive business centre built on the original rail alignment.

Source: <https://discused-riys.fotopic.net>



**Figure 42** - shows the proposed HULTS alignment in Bourne End area and detail of the Boston Drive business centre built on the original rail alignment.

Source: <https://discused-rlys.fotopic.net>

## 5. Operation

The proposed MRT route would be 9.04 km long and with 6 bridges, allowing a dedicated MTR lane along whole route, with only small traffic interfering in the Bourne End area. This dedicated MRT lane would deliver a journey-time-reliable service, with a journey time from High Wycombe to Maidenhead of be 18 i 20 minutes, with an average speed of 30km/hour. (including acceleration / deceleration and loading time for 10 proposed stops).

The vehicle capacity calculated (based on initial patronage analyses done in previous section) is up to 2900 passengers in the peak hour per direction. The journey time is assumed to be approximately 18 minutes, resulting in a requirement for a fifteen minute service providing a capacity of approximately 10 vehicles with a vehicle capacity of approximately 60 people would be required to provide the service, with spares.

### 5.1. Service

The proposed intensity of the service would require a double track route in selected sections, which needs to be carefully assessed based on the preferred route and operation. Capacity increase could be delivered by coupling the vehicles and creating capacity for 120 passengers per direction. This coupling would be done only in peak hours, when 60% of all passengers are expected to travel.

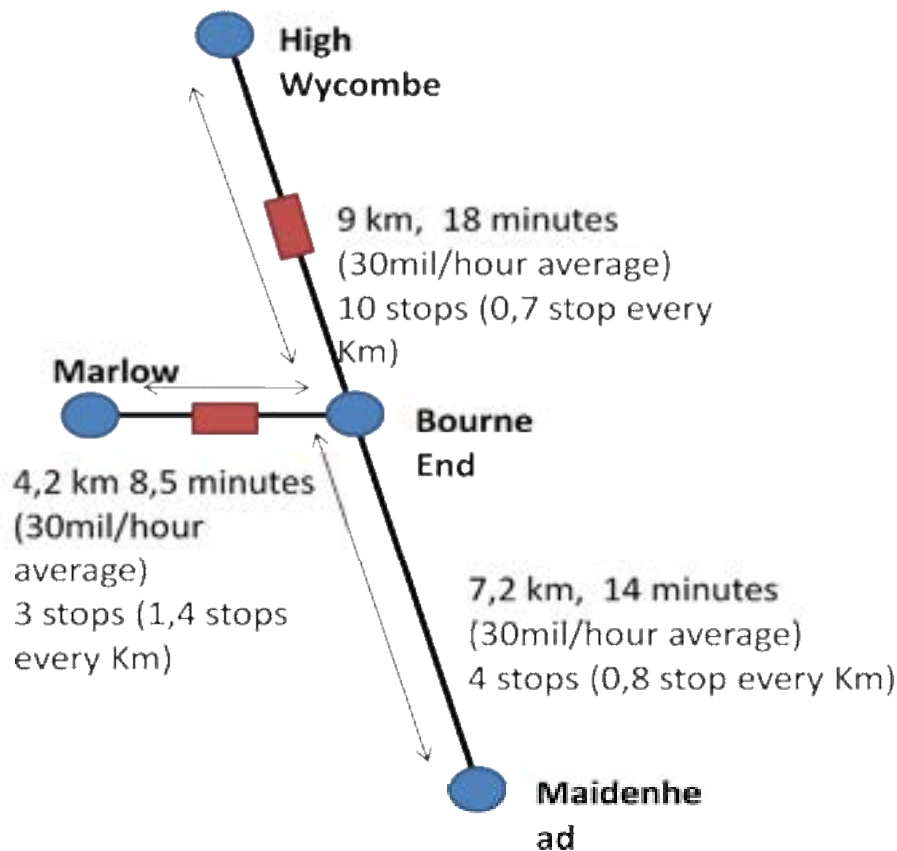
The operation of the MRT services were considered only for the route from High Wycombe to Bourne End, but the possible number of stops, length of route and expected journey time was calculated for all possible combination between High Wycombe, Bourne End, Marlow and Maidenhead. (see Figure 43). From the table it is clear that the average speed would be about 30 km/h (18 m/h) including vehicle acceleration, deceleration and 20s waiting time on each stop.

|           | Section                   | Distance (km) | Number of stops | Stops every km | Max. speed (km/h) | Average Speed (km/h) | Time of travel (min) |
|-----------|---------------------------|---------------|-----------------|----------------|-------------------|----------------------|----------------------|
| Stage I.  | High Wycombe - Bourne End | 9,04          | 10              | 0,90           | 65                | 30                   | 18,0                 |
| Stage II. | Bourne End - Maidenhead   | 7,2           | 4               | 0,80           | 65                | 30                   | 14,3                 |
|           | Bourne End - Marlow       | 4,26          | 3               | 1,42           | 65                | 30                   | 8,5                  |
|           | Marlow - Maidenhead       | 11,46         | 6               | 0,96           | 65                | 30                   | 22,8                 |
|           | Marlow - High Wycombe     | 13,30         | 12              | 1,02           | 65                | 30                   | 26,5                 |
|           | High Wycombe - Maidenhead | 16,24         | 13              | 0,85           | 65                | 30                   | 32,3                 |

**Figure 43** - shows the possible combination of services, distances, number of stops, stops per km, maximal speed, average speed and expected travel time.

Detail runtime, headway and timetable would need to be prepared in accordance with future operation during weekdays and weekends, incorporating routine and emergency maintenance and improvements. This timetable would need to be discussed / modified with other service providers (for example Great Western Railways, Chilton railways, coach / bus operator etc) in order to allow service exchange and provide good connection to the preferred destinations.

The possible future extension of the High Wycombe to Bourne End service is shown on the Figure 44. below, where by integration of existing service (Great Western Railways) between Maidenhead and Bourne End / Marlow could create MRT services from High Wycombe to Maidenhead, Marlow to High Wycombe or Maidenhead. The routes from Maidenhead to Bourne End / Marlow have not been considered in this feasibility study.



**Figure 44** - shows the possible combination of services, distances, number of stops, stops per km, maximal speed, average speed and expected travel time.

Source: Martin Volny

## 5.2. Vehicle technology

For the purpose of this Feasibility study two vehicle systems were considered:

- **HULTS** ĩ Hybrid Ultra Light Tram System
- **BRT** ĩ But rapid transit

Despite the fact that one vehicle is using rail track only and the second could use ordinary road network of segregated routes both of the vehicles will be operating in similar principles using purely electric or hybrid electric engines. Both vehicle systems should use the low floor platform for easy access and the capacity should be between 50 and 60 passengers. (there is no detail specification for seated and standing passengers at the moment)

The advantage of the BRT system is that the hybrid and purely electric buses are already operational in the UK or in the world and there is no HULTS fully operational vehicle available at the moment, but the indication shows that some vehicles are being manufactured and should be tested and operational by end of 2009.

More detail description of these systems is in the APPENDIX 1.



**Figure 45** - shows new TDI's design of the HULTS powered by batteries and ultra-capacitor or flywheel technology

Source: TDI



**Figure 46** - shows new Hybrid / Electric buses, FTR bus for Bristol BRT and TDI's EG Minitram in articulated wider-bodied design.

Source: TDI, frt

### 5.3. Operational cost

The vehicle operational cost could be divided into following:

- Cost of people
- Fuel & Lubricants
- Repairs and Maintenance
- Insurance & Registration Cost
- Capital Cost
- Other Cost
- 

Based on bus operator experience, the following table shows perceptual split of the operation cost for cost divisions. From the table it is clear that almost 50% of total cost is spent on personnel expenses (Salaries, compensations, payroll taxes and superannuation), the capital vehicle cost is only 16% of total cost. There is an assumed capital cost of £500.000, which is similar to proposed MRT buses and HULTS. More details are shown in the Figure 47 below. **The total vehicle operational cost is about £3 million per year.** Based on the fleet of 10 vehicles there would be a yearly cost approximately of £30M.

| Cost parts                                        | Cost in %      | GBP             |
|---------------------------------------------------|----------------|-----------------|
| People Costs                                      |                |                 |
| Salaries & Wages                                  | 40.24%         | £1236631        |
| Workers Compensation                              | 3.56%          | £109403         |
| Payroll Tax                                       | 2.19%          | £67301          |
| Superannuation                                    | 2.43%          | £74677          |
| <b>Total People Costs</b>                         | <b>48.42%</b>  | <b>£1488014</b> |
| Bus Fuel & Lubricants                             |                |                 |
| Fuel - Diesel Cost                                | 12.58%         | £386601         |
| <b>Total Bus Distillate Cost</b>                  | <b>12.58%</b>  | <b>£386601</b>  |
| Bus Repairs and Maintenance                       |                |                 |
| Tyres & Tubes                                     | 0.97%          | £29809          |
| Service                                           | 4.75%          | £145974         |
| <b>Total Bus Repairs and Maintenance Cost</b>     | <b>5.72%</b>   | <b>£175783</b>  |
| Bus Insurance & Registration Cost                 |                |                 |
| Bus Registration                                  | 0.65%          | £19975          |
| Bus Comprehensive Insurance                       | 1.31%          | £40258          |
| Green Slips                                       | 1.75%          | £53780          |
| <b>Total Bus Insurance and Registration Costs</b> | <b>3.71%</b>   | <b>£114013</b>  |
| Capital Cost - Bus                                |                |                 |
| <b>Total Capital Cost - Bus</b>                   | <b>16.27%</b>  | <b>£500000</b>  |
| Other Cost                                        |                |                 |
| <b>All Other Costs</b>                            | <b>13.30%</b>  | <b>£408727</b>  |
| <b>Total</b>                                      | <b>100.00%</b> | <b>£3073140</b> |

Figure 47 - operational cost of hybrid buses (2007 year survey of bus operators).

In addition to vehicle operational cost, the cost of depot & warehouse operation (including maintenance and staff cost) must be considered.

This feasibility study does not have yet have an objective for developing a business case for the scheme implementation and therefore the sensitivity analyses of possible income (based on patronage and ticket price policy), real operational cost for preferred scheme etc. are not yet calculated.

More detailed analyses (including HULTS operational information or Light rail information) of the operational cost would need to be undertaken to provide comparable information for buses and HULTS system.

## 6. Investment cost

To be able to provide cost comparison between two preferred technologies (HULTS and BRT) based on the development of the route from High Wycombe and Bourne End we have worked with the assumption that the route would be considered as a single track operation with defined double track passing sections.

The tram systems investment cost varies based on the location of the deployed route, where the easiest and cheapest option is to start building on the green-fields where there are no associated costs related to traffic management, utilities movement etc. Unfortunately the MRT schemes are being implemented in urban areas and the main objective is to bring passengers from the city suburban areas into the city centre in the shortest possible time, which would provide a high quality service supported by a high level of public acceptance. The principle of MRT is to build dedicated vehicle lanes, which allow over-passing of all traffic on roads in conjunction with priority at traffic signals to allow minimum delays and provide reliable journey times. By implementing the MRT schemes in the city centres, the implementation of dedicated lanes is more difficult and many issues need to be addressed. This would bring the cost of the investment close to £11M per km. The Figure 48 shows the Tram investment cost in selected UK cities.

| System                | 2007 Price  | Length / km | £m / km       |
|-----------------------|-------------|-------------|---------------|
| Midland Metro         | £144        | 20.4        | £7.04         |
| Croydon               | £181        | 28          | £6.46         |
| Sheffield             | £225        | 29          | £7.75         |
| Manchester            | £251        | 37          | £6.78         |
| Nottingham            | £142        | 14.3        | £9.91         |
| Merseytram (estimate) | £334        | 16.8        | £19.89        |
| Edinburg              | £432        | 18          | £23.50        |
| <b>Average</b>        | <b>£244</b> | <b>23</b>   | <b>£11.62</b> |

**Figure 48 - shows the investment tram cost in selected UK cities.**  
Source: SDG report West of England Rapid Transit, technology review

Based on these facts, our proposed MRT route would be utilizing original rail track-bed and would be avoiding existing road infrastructure as much as possible, we would expect that the investment cost would be much lower than shown in the Figure 73 above.

The following document sections describe investment cost for HULTS and BRT for:

- **The maximal route option** would provide the most comparable figures for both HULTS and BRT solutions, because this route is based on the original rail alignment with no other alternative solutions on the identified problem locations. (same route solution for both systems), but this option will not consider deliverability issues in identified problem locations.
- **The optimal route option** (would minimise investment cost, for example avoid bridge constructions, etc.). This option would take into consideration deliverability issues and would promote the easiest options for physical delivery for each vehicle technology.

- **The minimal route option**, is not being describe in this report because the minimal route option will utilize the existing road network in a maximal scale and this will not fit with the MRT objectives. The existing roads are very narrow in some places and the traffic intensities are high especially during the peak hours. In addition to this the existing road network is being currently used by the bus service between Maidenhead, Bourne End and High Wycombe.

## 6.1. HULTS Hybrid Ultra Light Tram system

The indicative capital cost estimates for HULTS infrastructure costs for the High Wycombe to Bourne End route are shown in Figure 48. This cost split is based on construction of conventional tram schemes indentified in Figure 49. The vehicle cost is shown in the Figure 50 and is based on a pricing received from suppliers (assumed that HULTS will be using existing proven technology from bus and light rail industry) in conjunction with the design company information for an electric based (battery and/or ultra capacitor and/or flywheel) low floor vehicle. The vehicle cost is very comparable with the hybrid and/or electric bus vehicle. The cost is estimated based on new HULTS vehicle development (using proven technology), unfortunately there are no purely electric HULTS vehicles operational in the UK at the moment.

Figure 49 shows a typical breakdown of a conventional tram scheme, with an average cost of £12M per km identified in the table above. For the HULTS technology proposed in this scheme, electrification is not required and utilities cost can be disregarded - therefore we could reduce the cost by 33% in the construction.

| Description                       | Percentage | Cost Base on £ 1 mil per km Track work |
|-----------------------------------|------------|----------------------------------------|
| Site preparation                  | 13%        | £1.56 mil                              |
| Highway Works                     | 7%         | £0.84 mil                              |
| Utilities                         | 20%        | £2.40 mil                              |
| Track work                        | 22%        | £2.64 mil                              |
| Stops                             | 7%         | £0.84 mil                              |
| Traction Power                    | 13%        | £1.56 mil                              |
| Signalling and Telecommunications | 18%        | £2.16 mil                              |
| Total                             | 100%       | £12.00 mil                             |

**Figure 49 - shows break down of the conventional tram scheme construction cost split in the cities.**

Source: SDG report West of England Rapid Transit, technology review

In addition to this, the significant difference between tram and HULTS could be seen in the track work, where for the convention tram system the cost is £2.64M, for the HULTS construction the cost is £1M per kilometre (including site preparation). The table above exclude any structures.

The following table was created based on the High Wycombe to Bourne End route split into sections whereby there are identified construction cost (single track and bridges), road works, signalling, bridge construction, depot and warehouse construction and all stops.

| Element                                                     | Investment cost<br>GBP | Comments                                                         |
|-------------------------------------------------------------|------------------------|------------------------------------------------------------------|
| Single track<br>(1mil per kilometer + utilities / services) | £9,580,000             | With 1 kilometer for double track for passing                    |
| 4 bridges<br>(2.5 mil per meter)                            | £6,000,000             | Need to be build                                                 |
| 2 additional bridges<br>(2.5 mil per meter)                 | £6,000,000             | Could be level crossing                                          |
| 3 level crossings                                           | £600,000               | Including traffic lights                                         |
| Property purchase<br>(500.000 GBP per property)             | £3,000,000             | 6 properties                                                     |
| Vehicle cost<br>(60 people capacity)                        | £5,000,000             | 10 vehicles would be required for 15 min interval                |
| Depot and warehouse                                         | £1,500,000             | Bourne End location is preferred                                 |
| Stops                                                       | £2,860,000             | Includes 10 stops                                                |
| Signalling and Telecommunications                           | £7,200,000             | Need to be applied in regards to the rail operational standards. |
| <b>Total</b>                                                | <b>£41,740,000</b>     | <b>£4.6 mil per km</b>                                           |

**Figure 50** - shows the investment cost for the HULTS optimal system deployment (2007 prices).

From the table above is clear, that the total investment cost is £41.7 million, including new bridge constructions at all suggested locations. The figure could be grater if double track were implemented along the whole length of the corridor. This would depend on the corridor capacity, passenger demand and regular time of the service. At the moment we are proposing a 15 minutes interval, which is reflected in this cost.

The implementation of the HULTS scheme would benefit modal shift, by extending the travel choice and also encourage shift to public transport. The new transport route would generate modal shift by introducing reliability, quality and image to the service. With a larger vehicle and a service frequency providing similar capacity to that of a tram, the technology could achieve a mode shift close to that of a tram system. The interchange penalty could significantly affect the level of mode shift generated by integration of the route in High Wycombe and Maidenhead train stations.

The HULTS system would help reduce traffic congestion and would improve safety along the route by removing the bus services from the road network. The proposed route is completely segregated from the general traffic (except the Bourne End side, where 2 level crossings would need to be introduced).

New HULTS service could contribute towards economic growth and promote sustainable development along the corridor. The provision of another transport mode within the network would contribute towards the growth of the local economy. With the mode focused within a dedicated corridor the wider benefits of the system may be reduced and would be reliant on its integration with other modes.

The HULTS affordability and deliverability of the scheme is based on the capital costs of the construction of the route and on the technology of the vehicle used. There is only one similar scheme operational in the UK - the Stourbridge vehicles operated from December 2008, but we do not have access to any performance indicators, currently. Operation of the first rapid transit route is programmed for 2013. Development of a ULR vehicle and track is in our opinion likely to be outside these timescales.

The contribution from Central Government is identified as 25% as it is a tram scheme, but other funding options could be used for this scheme. For example the DfT would like to support the pilot schemes of the HULTS system in the UK and special treatment in terms of the funds allocation could be agreed. Other opportunity is to utilize EU funding or private public partnership cooperation / funding. The funding opportunities would need to be identified once the preferred route and vehicle technology is chosen and the business case finalized.

## **6.2. BRT - Bus Rapid Transit**

Bus Rapid Transit (BRT) aims to deliver the characteristics of fixed rail systems but with bus-based technology. It consists of a variety of physical measures in conjunction with operational and system elements such as a segregated alignment, high quality dedicated vehicles, improved stop infrastructure, on-street priority, improved passenger information and high frequency services. The BRT concept benefits significantly from its flexibility and is both adaptable at inception and over time to meet the changing needs of urban conurbations.

The costs calculated for the High Wycombe to Bourne End route using a BRT scheme could be of the order of £24M (Figure 51) when utilising an standard diesel powered vehicle. This price is based on the optimum deliverability of the scheme, where alternative routes (utilizing exiting road network) are being used in conjunction with delivery of proposed MRT principles. (Dedicated BRT lanes, priority at signalized junctions etc.) This proposed route is classified as a optimal solution for the route using BRT (not deliverable in this scale for HULTS). The negative impact on the traffic on existing road network, especially in the peak hours, was not analysed. It will be essential to undertake these traffic impact analyses in the future if this scheme will be identified as a preferred route. We have not reviewed the cost estimate provided other than to compare the cost per kilometre based on other schemes and the scope of works involved, we have not carried out a site inspection or engineering review of the feasibility.

| Element                                          | Investment cost GBP | Comments                                                         |
|--------------------------------------------------|---------------------|------------------------------------------------------------------|
| Single track<br>(£0.8M per kilometer + services) | £8,068,000          | Includes road improvements                                       |
| 2bridges<br>(£2.5M per meter)                    | £1,500,000          | Need to build two bridges ( Spring Lane and Bridge Bank Close)   |
| 2 additional bridges<br>(£2.5M per meter)        | £0                  | No need to build                                                 |
| 6 level crossings                                | £1,200,000          | Including traffic lights                                         |
| Property purchase<br>(£0.5M per property)        | £0                  | No need to purchase                                              |
| Vehicle cost<br>(60 people capacity)             | £4,000,000          | 10 vehicles would be required for 15 min interval                |
| Depot and warehouse                              | £1,500,000          | Bourne End location is preferred                                 |
| Stops                                            | £2,290,000          | Includes 10 stops                                                |
| Signalling and Telecommunications                | £5,890,000          | Need to be applied in regards to the road operational standards. |
| <b>Total</b>                                     | <b>£24,449,800</b>  | <b>£2.7M per km</b>                                              |

**Figure 51** - shows the investment cost for the BRT optimal system deployment (2007 prices).

BRT has the benefit over rail based modes in that it can be more flexible, with BRT routes making use of segregation out of the city and then continuing to cover elements of the general network, leveraging greater benefits from capital investment. It is also possible to provide the priority for both the core and general network incrementally to either counter the effects of congestion or improve the journey time and reliability of the routes.

BRT, in able to operate on the existing road network without infrastructure works (generally), and could operate on the M32, A38 to Bristol International Airport and A4 to Bath where other rail based modes would need additional infrastructure built, significantly increasing the cost.

Capacity can be a constraint on BRT schemes with a vehicle capacity of an articulated bus based vehicle approximately half that of a tram. The capital cost difference between the two modes though is also significant.

The BRT scheme would support the modal shift by extending the mode choice and encourage shift to the public transport. The development of a BRT route within a corridor would both provide an additional mode similar to HULTS and the potential for service from the wider network to join the corridor and benefit from the segregation and priority. Such an arrangement has the potential to provide greater mode shift due to the wider network although fixed rail systems do, to date, provide a greater mode shift than BRT systems.

The BRT would support reduction of traffic congestion and improve safety along transport routes, the development of a high capacity transport route on segregated alignments, encouraging mode shift would improve safety. BRT can also increase the network capacity by operating high capacity vehicle in both dedicated corridors and the wider network.

BRT would contribute towards economic growth and promote sustainable development by provision of additional mode in the existing network (passage where there is no segregated lane available).

The scheme affordability and deliverability is based on the capital costs of the scheme implementation and analyses of the preferred route layout (where traffic impact need to be assessed). Historically is possible to say, that the BR Central Government. The risks attributed to the construction and technology are similar to major highway schemes and therefore more familiar to Local Authorities. The local council contribution is usually set of 10% of the scheme cost and the Central Government will pay 90% for bus related schemes.

### 6.3. Maximum option capital cost comparison

Maximum option provide only real and objective comparison of the proposed technologies based on the cost comparison of the same selected route (have same issues to tackle, same number of bridges to be build etc.). The only visible difference is the cost of the single track contraction, vehicle capital cost, stops, signalling and telecommunication, which is total make a difference only of £4.39 millions. Bearing on mind that the life cycle for HULTS type vehicles is about 30 years compare to the buses, which needs to be replaced every 8-10 years. The capital cost of the vehicles than will be higher for the BRT scheme.

Despite the HULTS live cycle advantages, the BRT could use existing road network in problem places and avoid the additional capital cost during the construction. This option will be described in the Optimal option capital cost comparison. Unfortunately the HULTS system will not be able to used the existing road network in the same extend as the BRT, because of the space availability on some road network locations.

| Capital cost in £ millions (2007) |              |         |                    |                |                 |              |                   |       |                                  |               |
|-----------------------------------|--------------|---------|--------------------|----------------|-----------------|--------------|-------------------|-------|----------------------------------|---------------|
| Vehicle type                      | Single track | Bridges | Additional Bridges | Level crossing | Property / Land | Vehicle cost | Depot & warehouse | Stops | Signalling and telecommunication | Total         |
| HULTS                             | £9.58        | £6.00   | £6.00              | £0.60          | £3.00           | £5.00        | £1.50             | £2.86 | £7.20                            | <b>£41.74</b> |
| BRT                               | £8.07        | £6.00   | £6.00              | £0.60          | £3.00           | £4.00        | £1.50             | £2.29 | £5.89                            | <b>£37.35</b> |

Figure 52 - shows optimal route comparison of investment cost

The investment cost comparison can be seen in the Figure 78 above where the total investment cost for optimal HULTS route is £41.74 million, which is £4.6 million per kilometre. The total investment cost for optimal BRT route is in this case £37.35 million, which is £4.1 million per kilometre. The main difference between these technologies is in the cost of the track construction, vehicle capital cost, stops, signalling and telecommunication

## 6.4. Optimum option capital cost comparison

Optimum route cost is considered for both HULTS and BRT in relation to the preferred route and future deployment feasibility. The advantage of the BRT service is the option to use existing road network in identified issues locations and avoid the additional cost related to property purchase, bridge construction etc. But in the sections, where the BRT would join ordinary traffic, the service could lose its MRT benefits (may need implementation of dedicated lanes construction, priority at traffic lights etc.) and could not be reliable with regard to journey time. Therefore a maximum of dedicated BRT lanes would need to be implemented by using the original track bed. This could be achieved in the comparison by using segregated bus lane cost along the whole length of the route. So even in places where the BRT would join the road network the cost for building potential segregated or dedicated bus lane is included.

| Capital cost in £ millions |              |         |                    |                |                 |              |                   |       |                                  |               |
|----------------------------|--------------|---------|--------------------|----------------|-----------------|--------------|-------------------|-------|----------------------------------|---------------|
| Vehicle type               | Single track | Bridges | Additional Bridges | Level crossing | Property / Land | Vehicle cost | Depot & warehouse | Stops | Signalling and telecommunication | Total         |
| HULTS                      | £9.58        | £6.0    | £6.0               | £0.6           | £3.0            | £5.0         | £1.5              | £2.86 | £7.20                            | <b>£41.74</b> |
| BRT                        | £8.07        | £1.5    | £0.0               | £1.2           | £0.0            | £4.0         | £1.5              | £2.29 | £5.89                            | <b>£24.45</b> |

Figure 53 - shows optimal route comparison of investment cost.

The investment cost comparison can be seen in the Figure 77 where the total investment cost for an optimal HULTS route (not able to avoid identified issues on selected sections) is £41.74 million, which is £4.6 million per kilometre. The total investment cost for optimal BRT route (can avoid identified issues on selected sections) is £24.45 million, which is £2.7 million per kilometre.

## 6.5. Capital cost conclusion

The costs provided in this section are only capital costs and does not take into account different whole-life periods for each vehicle / technology, where for HULTS it is expected that a whole-life period of up to 30 years in comparison with BRT which needs to be exchanged after 8 to 10 years. This periods are proven for conventional engines (diesel, electric), but there are no available data for periods for electric vehicles only (using batteries and/or ultra capacitor and / or flywheels). We can only assume that the body work would last as indicated above and the batteries would need to be exchanged after 2000 recharges (manufacturer guaranteed for advanced Li-ion batteries).

The infrastructure for rail systems would have higher operating and maintenance cost and would require additional costs for the replacement of tight curves due to rail wear. If the numbers of curves are minimal this could be covered by the general operating and maintenance costs over a 30 year period.

Bus based system, depending on the construction, would, over a 30 year period, require resurfacing of elements of dedicated routes due to rutting and surface deterioration which is a significant cost.

The remainder of the operational, road signalling, stop and maintenance requirements would be similar for both modes.

Taking account of the differences in the capital costs and the replacement and renewal costs over thirty years, the whole life cost for a bus based system could be lower than rail mode.

This feasibility study has preliminary focused on the route between High Wycombe and Bourne End where possible original rail alignment could be used for MRT utilizing either HULTS or BRT systems.

The advantage of the HULTS system is possible extension of the routed form High Wycombe to Maidenhead via Bourne End, where between Bourne End / Marlow and Maidenhead could be used an existing railway and therefore there will not be great capital cost required to extend this route.

Using the BRT option for the extended route will require removal of existing rails in the section between Bourne End to Marlow and to Maidenhead and replacing by dedicated BRT road corridor. This will cause more capital cost investment than HULTS system.

Detail engineering surveys need to be performed to analyse existing rail condition and evaluate future maintenance and operation cost, because this could be higher in the long term perspective than building new track for either system.

**The more detailed analyses of possible patronage and usability of the proposed MRT scheme needs to be undertaken to be able to fully evaluate the business case issues, where the biggest issue is financial viability of the scheme. The original rail line needed to be closed due to lack of financial self efficiency and there would need to be a carefully assessment of changes (population, behaviour change, public transport acceptance, quality, service etc.) between 1970 and 2009 to get a valid current view for a business case.**

## 7. Environmental and Health Issues

Since the 1990s, when countries around the world agreed to the International Environmental Treaty, informally known as Kyoto Protocol, environmental and health issues have been the centre of the argument for reducing human made pollution.

One of the main sources of human pollution comes from transport accounting for around 20% of the mankind's CO<sub>2</sub> emissions.

A number of strategies may be adopted to reduce the impact of emissions caused by transport upon urban air quality, for example:

- restricting vehicles in urban areas through road charging
- investment in rapid transit corridors to give car users the benefit of fast run, reduced costs and reliability
- new vehicle technologies such as particulate traps, alternative sustainable fuels and electric or hybrid electric traction like HULTS.

### 7.1. Environmental Issues

In the UK, car ownership has been increasing dramatically over the years, with vehicle emissions accounting for about one fifth of the UK's carbon dioxide (CO<sub>2</sub>), half of the emissions of nitrogen oxides (NOx) and volatile organic compounds (VOC), and almost all emissions of Particles and CO (carbon monoxide).

The UK pollution caused by transport is not isolated from the rest of the world. Urban air pollution has been a major environmental problem in countries throughout the world. Scientists have been analysing results from the Global Environment Monitoring System, which has been monitoring over 50 cities in 35 developing and developed countries over the past 15-20 years.

These results have indicated that air pollution has caused concentrations at levels where serious health effects are reported in 20 of the 24 mega-cities of the world with over 10 million people. Thus, urban population growth, combined with change in land-use due to the increase of urban areas, has been one of the major causes of the rise in pollution to dangerous levels. This has occurred even with vehicle changes, cleaner fuels and engines combustion improvements.

### 7.2. Health Cost

According to BTS report, respiratory conditions are now the most common long-term illness among children. They are also responsible for most emergency hospital admissions in the UK. Cases of chronic obstructive lung disease and pneumonia, including acute lower respiratory infections, take up more than 2,800,000 hospital bed days a year.

The average of hospital cost for admission of patients with lung diseases at the NHS is between £2000 and £4000 depending on the gravity of the illness and the age of the patient.

Based only on hospital admissions, assuming these figures are correct, and that most of them were caused due to long term exposure to fuel combustion emissions, the additional cost on NHS for hospital treatments because of lung diseases could be counted in Billions of pounds per year.

### 7.3. Conclusions

Health cost due to transport is a direct cost and a burden on any Health Department budget which can be avoided if local transport authorities considered more funds for public transport within urban and rural areas.

The implementation of rapid transit corridors in urban centres could increase the percentage of people using public transport and, therefore, it could reduce the impact of transport in the air quality.

Savings generated by reducing hospital admissions cost due to illness related to cardiovascular and lung diseases could be the source for public transport investments.

The use of environmentally friendly vehicles, such as HULTS, could help to mitigate the environmental impact caused by conventional diesel and petrol powered vehicles.

## 8. Trip-ends Survey and Patronage Analysis

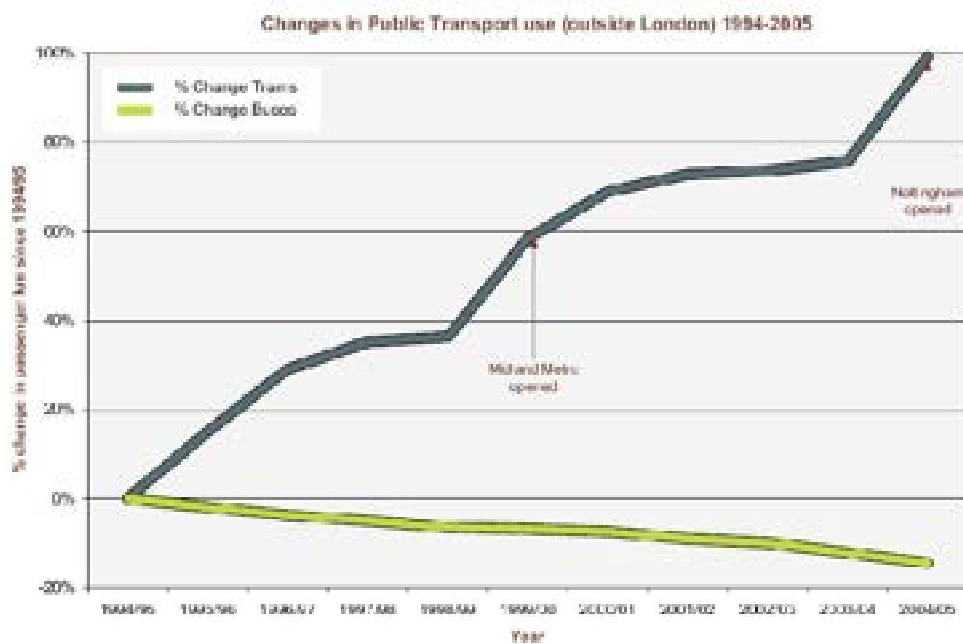
Effective significant shifts from cars to public transport would reduce congestion and improve efficiency of vital road based transport operations, as well as securing important environmental and health benefits.

Local Transport Plans (LTPs) for each local council, replaced the previous Transport Policies and Programmes (TPPs) in 2000/01. LTP funding by Government is more generous at an average level 89% higher than for TPPs. Although LTPs cover all transport modes, most authorities spend more on road construction, maintenance and lighting than on public transport.

The Government, therefore, could use some of its surplus from the Road Tax Fund to increase LTP fundings with more emphasis on public transport capital expenditure.

In the UK, Local Transport Plans (LTP) do not appear to contain extensive studies or surveys about patronage, which is regarded as an operator issue rather than a logistics matter which should be assessed by transport planners.

In 2006, Transport for London (TfL), however, carried out a patronage survey comparing the growth between modes. The growth in tram patronage between 1994/95 and 2004/05 is compared in the Figure 54, with bus passenger trends. London is excluded from both sets of data.



**Figure 54 - Comparison of patronage growth between trams and buses in the UK**

Source: TfL, London Trams - 2006

This patronage survey comparing modes of transport is an example of travellers' preference which should guide future investment in public transport. This survey highlighted that the growth in tram patronage is due to the fact that trams are more:

- Reliable
- Fast
- Comfortable
- Promote safe ride

## 8.1. Methodology

Patronage studies could adopt several distribution models. However, in order to follow the main sources of data available, this report will follow the methodology which has been applied to develop TEMPRO software following the Department for Transport (DfT) guidelines. Temprow uses a gravitational model which has been used to develop the National Trip End Model (NTEM) which is a more specific model for the UK. NTEM is now a fully integrated part of the National Transport Model (NTM) framework currently being developed by the DfT, incorporating components of the 1997 National Road Traffic Forecasts (NRTF97), and a substantial amount of new modelling work. NTEM provides the demand growth inputs to the NTM, thus forming the starting point for national forecasting work, which is increasingly concerned with policy-sensitive forecasts. Publication of these inputs through the medium of TEMPRO allows local models to be developed on a fully consistent basis.

The NTEM model is based on the assumption that each one-way trip by any mode of transport has two trip ends. As the gravitational law, the generation rate of trips within zones is proportional to their mass, which in the NTM case is measured through variables, such as:

- shopping (23.5%)
- work (19.5%)
- visit friends and relatives at home (13.5%)
- recreation & leisure (13%)
- personal business (9%)
- education (9%)

The convention adopted in NTM is that for Home Based purposes, one production and attraction trip end give rise to one return journey (2 origins and 2 destinations), whereas for Non Home Based (NHB) purposes, one production and attraction give rise to a one-way journey (1 origin and 1 destination). TEMPRO, therefore, converts those trip production and attraction trip ends into Origin-Destination (O/D) matrices.

The number of trips produced in each NTEM zone will depend on the number of people living there. Also the number of trips attracted to a particular zone will bear some relationship to employment in the zone, among other factors.

The NTEM model, nevertheless, adopts people as the unit for trip making rather than households. However, the population is segmented into categories based on the characteristics of the households in which they reside as well as characteristics of the individual. The traveller type disaggregation used internally within the model includes:

- age (under 16, 16-64, 65+)
- gender
- employment status (for 16-64 age group)
- household car availability
- household size (number of adults)

Zones where employment or population are growing rapidly will experience a higher rate of trip end growth than other zones which are already developed or waiting for development. NTEM, consequently, is a forecast of trip ends by purpose, mode and time of day, based on these sorts of relationships.

TEMPRO trip ends, therefore, are based on National Travel Survey (NTS) trip rates applied to projections of the GB household population. The total therefore includes all journeys made by people living in households in Britain, including trips where part of the journey is made by air. For each trip purpose the total number of trip attractions is controlled to be equal to the number of productions at the level of balancing areas

## 8.2. Trip-end Survey

The area surveyed is show in Figure 12..



Figure 55 ĩ High Wycombe ĩ Maidenhead area  
Source: Google map

This area is well served by A roads and two motorways, the M4 and M40. Maidenhead and High Wycombe are also served by two main railway lines which link the West of England and the Midlands with London.

There is also railway link between Maidenhead – Bourne End and Marlow. The railway track between Bourne End and High Wycombe was deactivated in 1970. This naturally gave rise to concern locally about the future of the remaining service between Marlow and Maidenhead. In 1972, however, local communities met in Bourne End and the outcome of this meeting was the formation of the Marlow - Maidenhead Railway Passengers' Association with the primary objective of keeping open and promoting use of the line for the benefit of the community.

In High Wycombe, nevertheless, there are organised movements towards the re-opening of the railway service between High Wycombe – Bourne End using the existing railway bed. This time, however, the community want to use Hybrid Ultra Light Tram System (HULTS) due to its appeal to the environment and lower cost than light rail systems.

This survey therefore has been concentrated on trip end between these towns, ie, High Wycombe, Marlow, Bourne End and Maidenhead, and analyses the potential patronage.

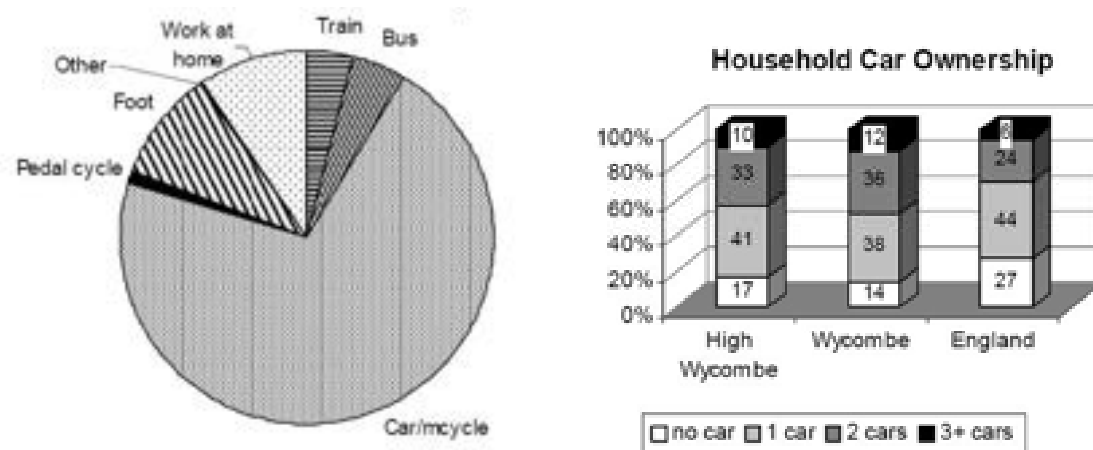
### 8.2.1. HIGH WYCOMBE

An overview of High Wycombe, according to the 2001 census is shown in Figure 56.

|                                    |        |
|------------------------------------|--------|
| Total Population                   | 92,300 |
| Population in Households           | 90,550 |
| Population Economically Active (%) | 72     |
| Total Households                   | 36,350 |
| Area (ha)                          | 2,651  |
| Density (persons/ha)               | 35     |
| Unemployment (%)                   | 3.5    |

**Figure 56** High Wycombe overview  
Source: Census 2001

Transport accessibility is considered good in High Wycombe with private cars and public transport. Public transport, however, accounts for only around 9% of the travels of the population economically active as shown in Figure 57.



**Figure 57** Travel to Work  
Source: Census 2001

Figure 14 shows the dependency of commuters on cars accounting for about 72% of work related trips. These household car ownership shows how the population relies on their cars for commuting within and without the town.

According to Buckinghamshire City Council LTP, traffic flows in High Wycombe are already at or beyond their theoretical maximum capacities (e.g. London Road, High Wycombe) or on corridors that will experience major growth (e.g. Bicester, Oxfordshire and Buckingham Roads, Aylesbury).

Handy Cross junction has been seen by Highways Agency as a location of environmental concern due to heavy traffic. On average, approximately 29,000 vehicles pass through Handy Cross junction every day.

Local traffic is required to merge with long distance traffic in High Wycombe, often resulting in driver frustration and unreliable and increased journey times. Congestion is already a major problem at the junction and is predicted to get worse in the near future.

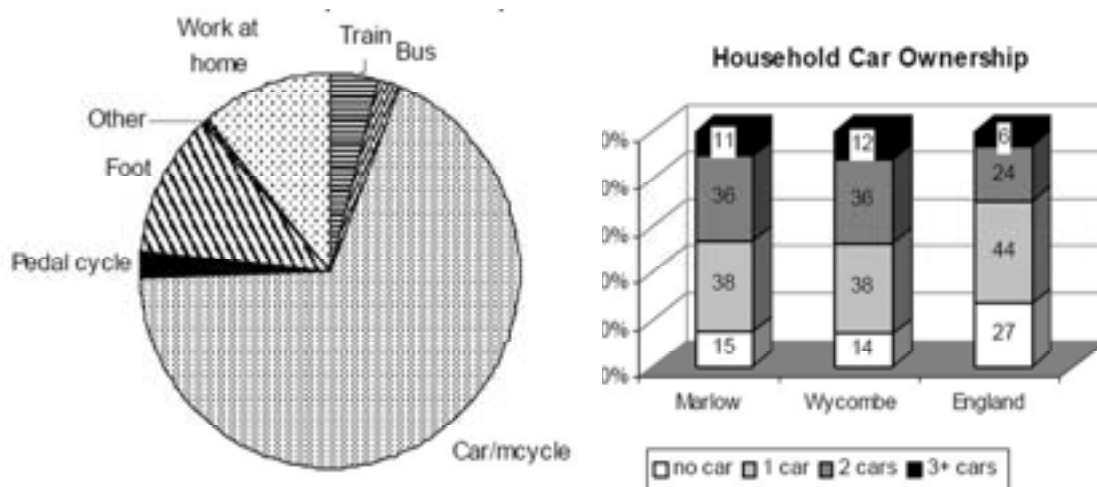
### 8.2.2. MARLOW

An overview of Marlow is shown in Figure 58.

|                                    |        |
|------------------------------------|--------|
| Total Population                   | 13,950 |
| Population in Households           | 13,900 |
| Population Economically Active (%) | 72     |
| Total Households                   | 5,950  |
| Area (ha)                          | 450    |
| Density (persons/ha)               | 34     |
| Unemployment (%)                   | 3.5    |

**Figure 58** Marlow  
Source: Census 2001

Transport accessibility, by bus is generally good in Marlow, although below the average for urban areas in Wycombe District. However, Marlow train station provides access by public transport to Maidenhead and London. The proportion of households without access to a car is similar to the District average but lower than the national average.



**Figure 59** Travel to Work  
Source: Census 2001

The dependency on cars accounts for about 70% with public transport taking only 6% of the total commuters. Although bus accessibility is considered good in Marlow, the bus system accounts with only 1.7% of travels to work.

### 8.2.3. BOURNE END

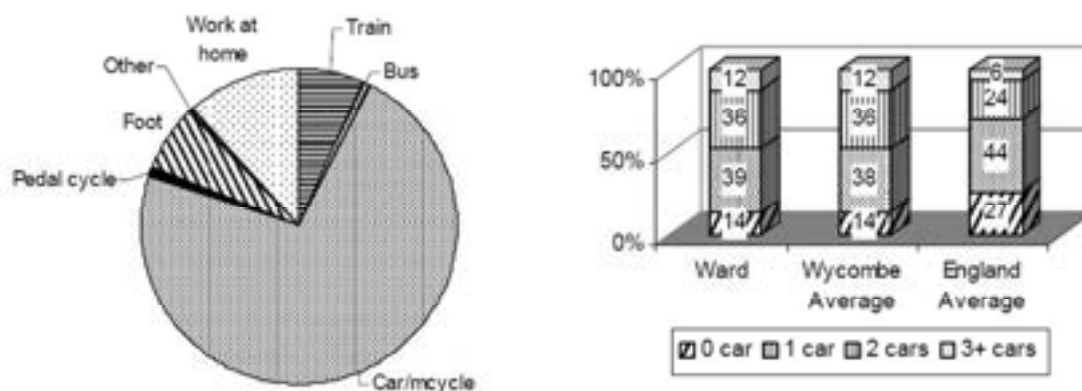
Bourne End Cum Hedsor includes the urban area of Bourne End and the largely rural area of Hedsor. The south western boundary of the ward is the River Thames. The River Wye crosses the ward to its confluence with the Thames. Almost two-thirds of the ward is in the Green Belt and much of the rural area is in Areas of Attractive Landscape.

A Bourne End overview is shown in Figure 60.

|                                    |       |
|------------------------------------|-------|
| Total Population                   | 5,404 |
| Population in Households           | 5,382 |
| Population Economically Active (%) | 72    |
| Total Households                   | 2,382 |
| Area (ha)                          | 510   |
| Density (persons/ha)               | 11    |
| Unemployment (%)                   | 2.1   |

**Figure 60** Bourne End  
Source: Census 2001

Transport accessibility, by bus is low which accounts for only 0.97% of commuting journeys. Train journeys however, are about 6.63% of the choices for travelling to work. Bourne End railway station connects to Paddington Station in London and to Reading via Maidenhead. The ward includes the parish of Hedsor and also part of Wooburn parish.



**Figure 61** Travel to Work  
Source: Census 2001

The dependency on cars accounts for about 72%. Bourne End, however, is considered an area with attractive landscape with 63% of the ward in the Green Belt. There are several buildings and areas listed in the conservation area along the River Thames, which runs along the southern boundary of the ward.

The landscape conservation is probably one of the reasons that made the local community strong about keeping the railway link with Maidenhead open. This conservation area has reflected on population growth because, according to the Census 2001, which stated that the Bourne End population decreased by 1.5% since 1991 in comparison with 6% increase in High Wycombe.

#### 8.2.4. MAIDENHEAD

Maidenhead is part of the Royal Borough of Windsor and Maidenhead which provides statistics data based for the area rather than target the town itself. Maidenhead is well served of accessibility.

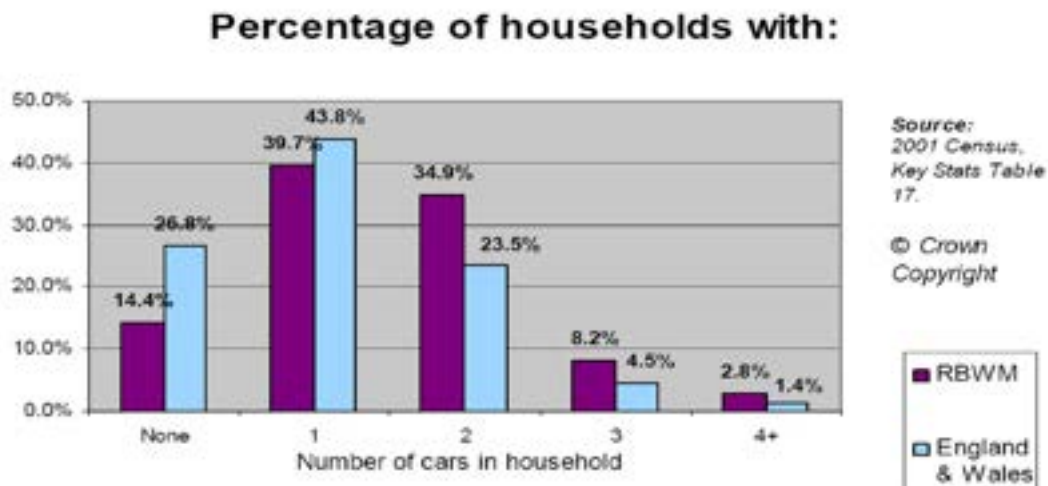
The A4 runs through the town crossing the Thames over Maidenhead Bridge. Maidenhead lies along the M4 which is accessed via A404 and A308. Many residents commute to work in London, or to the towns of Slough and Reading.

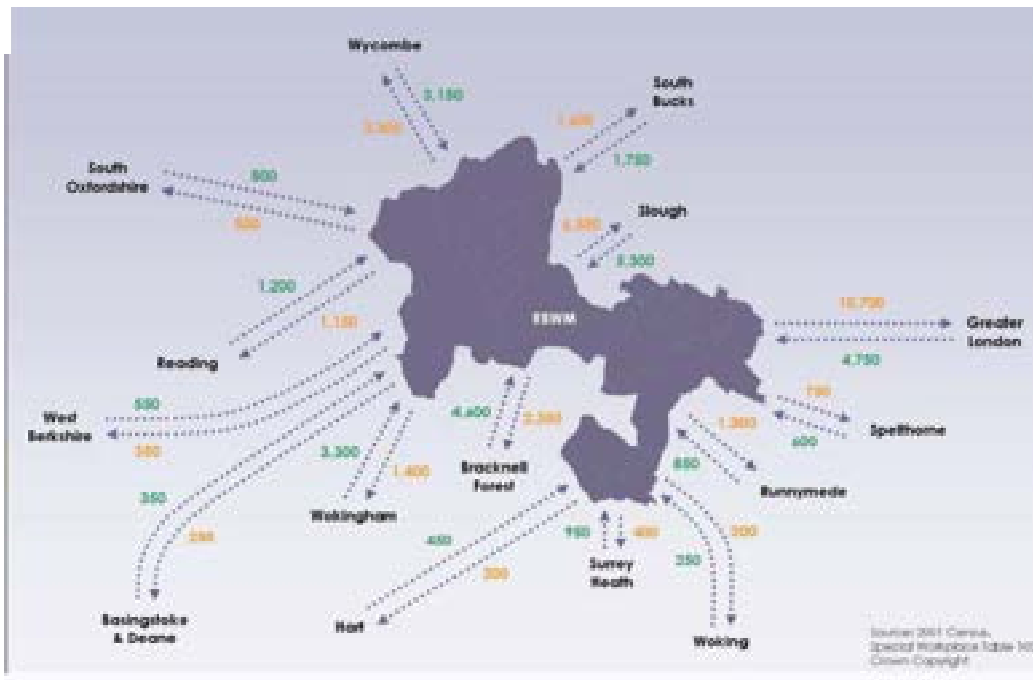
A Maidenhead overview is shown in Figure 61.

|                                    |        |
|------------------------------------|--------|
| Total Population                   | 58,840 |
| Population in Households           | 57,136 |
| Population Economically Active (%) | 72     |
| Total Households                   | 21,161 |
| Area (ha)                          | 8,405  |
| Density (persons/ha)               | 7      |
| Unemployment (%)                   | 2.6    |

**Figure 62** Maidenhead  
Source: Census 2001

Figure 20 shows the percentage of households with zero and one plus cars, and the commuting flow in the Royal Borough of Windsor and Maidenhead.





**Figure 63** Commuting flow and percentage of households with cars  
Source: The Royal Borough of Windsor & Maidenhead LTP 2006-2011

## 8.4. Daily trip Origin/Destination trip ends

Figure 64 shows the daily trip origin destination trip ends between High Wycombe and Maidenhead area.

Weekdays 7- 10am

2006

| Study Purpose                     | Walk ALL |             | Cycle ALL |             | Car Driver ALL |             | Car Passenger ALL |             | Bus/ Coach ALL |             | Rail/ Underground ALL |             | Combined ALL |
|-----------------------------------|----------|-------------|-----------|-------------|----------------|-------------|-------------------|-------------|----------------|-------------|-----------------------|-------------|--------------|
| Area                              | Origin   | Destination | Origin    | Destination | Origin         | Destination | Origin            | Destination | Origin         | Destination | Origin                | Destination | Origin       |
| STOKE POGES (Zone)                | 532      | 361         | 54        | 32          | 1415           | 1535        | 532               | 431         | 170            | 63          | 49                    | 52          | 2754         |
| MAIDENHEAD(PART OF) (Zone)        | 113      | 72          | 12        | 8           | 364            | 424         | 112               | 107         | 35             | 19          | 13                    | 33          | 649          |
| HIGH WYCOMBE (Zone)               | 12192    | 12406       | 1136      | 525         | 25467          | 28723       | 10887             | 11856       | 4186           | 4066        | 1015                  | 995         | 54882        |
| BOURNE END/FLACKWELL HEATH (Zone) | 1630     | 1285        | 165       | 74          | 4146           | 3599        | 1576              | 1170        | 525            | 215         | 152                   | 158         | 8195         |
| MARLOW (Zone)                     | 2503     | 2699        | 244       | 169         | 6027           | 6223        | 2315              | 2171        | 756            | 347         | 221                   | 254         | 12065        |

Weekdays 10am-16pm

| Study Purpose                     | Walk ALL |             | Cycle ALL |             | Car Driver ALL |             | Car Passenger ALL |             | Bus/ Coach ALL |             | Rail/ Underground ALL |             | Combined ALL |
|-----------------------------------|----------|-------------|-----------|-------------|----------------|-------------|-------------------|-------------|----------------|-------------|-----------------------|-------------|--------------|
| Area                              | Origin   | Destination | Origin    | Destination | Origin         | Destination | Origin            | Destination | Origin         | Destination | Origin                | Destination | Origin       |
| STOKE POGES (Zone)                | 1355     | 1206        | 69        | 75          | 2410           | 2391        | 1030              | 1067        | 193            | 230         | 63                    | 63          | 5120         |
| MAIDENHEAD(PART OF) (Zone)        | 325      | 254         | 17        | 18          | 648            | 642         | 253               | 255         | 51             | 56          | 25                    | 24          | 1320         |
| HIGH WYCOMBE (Zone)               | 31542    | 31091       | 1203      | 1294        | 42118          | 41716       | 21649             | 21168       | 6256           | 6497        | 1175                  | 1125        | 103944       |
| BOURNE END/FLACKWELL HEATH (Zone) | 3877     | 3736        | 178       | 192         | 6153           | 6143        | 2719              | 2771        | 573            | 675         | 172                   | 171         | 13673        |
| MARLOW (Zone)                     | 6808     | 6729        | 304       | 316         | 9668           | 9574        | 4440              | 4377        | 906            | 1018        | 274                   | 262         | 22399        |

Weekdays 16 - 19pm

| Study Purpose                     | Walk ALL |             | Cycle ALL |             | Car Driver ALL |             | Car Passenger ALL |             | Bus/ Coach ALL |             | Rail/ Underground ALL |             | Combined ALL |
|-----------------------------------|----------|-------------|-----------|-------------|----------------|-------------|-------------------|-------------|----------------|-------------|-----------------------|-------------|--------------|
| Area                              | Origin   | Destination | Origin    | Destination | Origin         | Destination | Origin            | Destination | Origin         | Destination | Origin                | Destination | Origin       |
| STOKE POGES (Zone)                | 492      | 532         | 48        | 61          | 1749           | 1649        | 631               | 654         | 62             | 103         | 54                    | 46          | 3036         |
| MAIDENHEAD(PART OF) (Zone)        | 111      | 116         | 12        | 14          | 479            | 431         | 157               | 153         | 19             | 23          | 29                    | 14          | 807          |
| HIGH WYCOMBE (Zone)               | 12453    | 11988       | 787       | 1197        | 31562          | 29241       | 13624             | 12964       | 2856           | 2637        | 992                   | 873         | 62274        |
| BOURNE END/FLACKWELL HEATH (Zone) | 1489     | 1613        | 112       | 175         | 4194           | 4634        | 1608              | 1779        | 181            | 319         | 149                   | 133         | 7734         |
| MARLOW (Zone)                     | 2722     | 2585        | 219       | 267         | 6957           | 6849        | 2704              | 2719        | 298            | 466         | 244                   | 196         | 13143        |

**Figure 64** Daily trip by mode in the High Wycombe and Maidenhead area

Source: DfT, Temprow

Figure 65 shows the trip end by car availability in Buckinghamshire region.

### Buckinghamshire - Year Data (2008)

|                  | households with no cars | households with 1 adult and 1 car | households with 2+ adults and 1 car | households with 2+ adults and 2+ cars |
|------------------|-------------------------|-----------------------------------|-------------------------------------|---------------------------------------|
| walk             | 362,363                 | 143,249                           | 627,194                             | 863,544                               |
| cycle            | 19,199                  | 8,982                             | 46,750                              | 74,770                                |
| car drive        | 38,479                  | 495,278                           | 923,561                             | 2,701,803                             |
| car passenger    | 84,818                  | 135,581                           | 551,425                             | 1,187,306                             |
| bus/coach        | 104,596                 | 14,925                            | 104,062                             | 127,151                               |
| rail/underground | 12,942                  | 8,310                             | 30,251                              | 53,308                                |
| combined modes   | 622,398                 | 806,827                           | 2,283,243                           | 5,007,882                             |

### SE Region

|                  |           |           |            |            |
|------------------|-----------|-----------|------------|------------|
| walk             | 5,606,736 | 1,780,422 | 8,224,825  | 8,860,929  |
| cycle            | 282,056   | 106,887   | 566,133    | 736,084    |
| car drive        | 552,820   | 5,771,966 | 11,546,196 | 26,658,262 |
| car passenger    | 1,239,543 | 1,593,250 | 6,981,356  | 11,828,819 |
| bus/coach        | 1,735,650 | 194,543   | 1,428,619  | 1,318,200  |
| rail/underground | 244,362   | 119,232   | 461,147    | 659,474    |
| combined modes   | 9,661,166 | 9,566,299 | 29,228,275 | 50,061,768 |

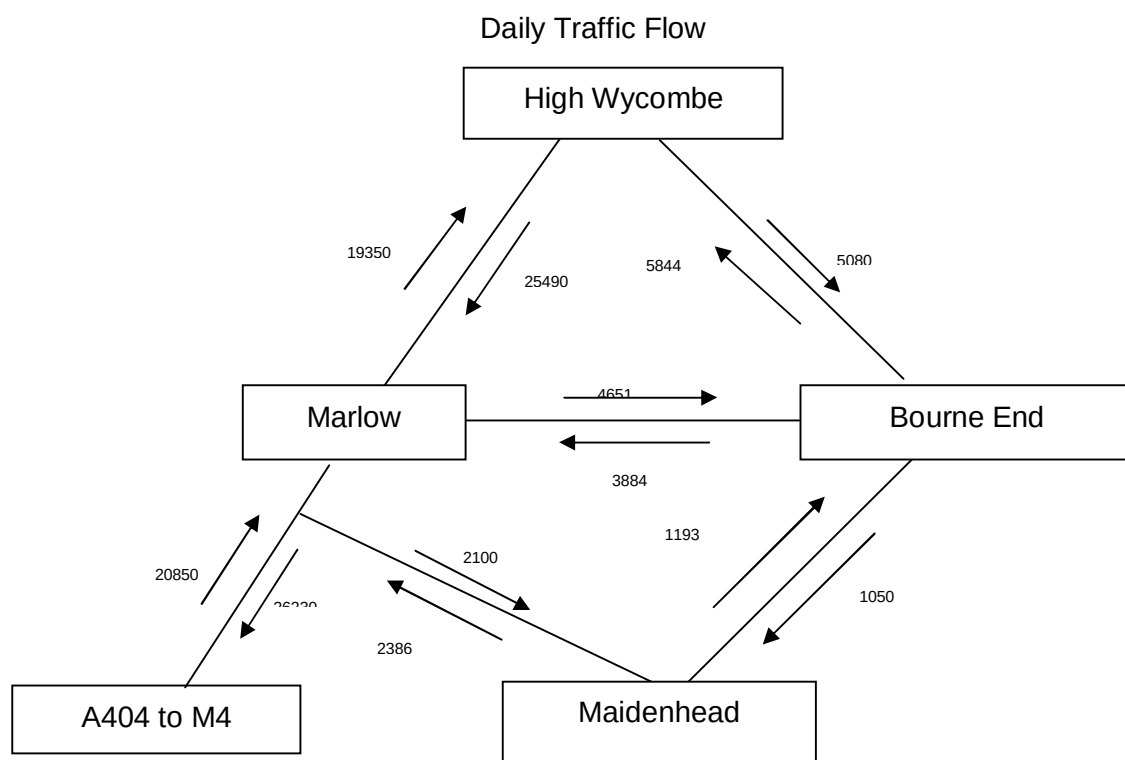
### County vs Region (%)

|                  |      |      |      |       |
|------------------|------|------|------|-------|
| walk             | 6.46 | 8.05 | 7.63 | 9.75  |
| cycle            | 6.81 | 8.40 | 8.26 | 10.16 |
| car drive        | 6.96 | 8.58 | 8.00 | 10.13 |
| car passenger    | 6.84 | 8.51 | 7.90 | 10.04 |
| bus/coach        | 6.03 | 7.67 | 7.28 | 9.65  |
| rail/underground | 5.30 | 6.97 | 6.56 | 8.08  |
| combined modes   | 6.44 | 8.43 | 7.81 | 10.00 |

**Figure 65** Tripends by car availability  
Source: Census 2001 and TEMPRO (DfT)

The numbers show a massive concentration on car trips throughout the region which accounts for increased traffic congestion, dependency on carbon fuels and impact on the environment.

The analysis of the daily trip end statistics and road traffic counting in the study area, is shown in Figure 65, has contributed to give an estimative of the average daily traffic flow between High Wycombe and Maidenhead. Car mode shift will be the principal target for increasing patronage on public transport if the proposed HULTS is applied to the region.



**Figure 66** Preliminary daily traffic flow between High Wycombe and Maidenhead

Source: Census 2001 and DfT Temprow

The traffic flows in Figure 66 were estimated assuming household car availability, and data collected in TEMPRO (DfT) for these towns. Traffic counts at Handy Cross Junction at High Wycombe and London Road/Knaves Beech Way roundabout, and Maidenhead Local Transport Plan traffic flow statistical data have also been taken into consideration.

Percentages of these traffic flows will be considered in the 2<sup>nd</sup> part of the Feasibility Study as potential patronage when a sensitivity analysis will be carried out.

## 8.5. Patronage Analysis

Patronage depends on several aspects which have to be considered carefully due to the impact on fleet investment. Another important variable is vehicle capacity, ie, number of passengers per vehicle. However, due to commuting needs in the region, patronage will be dealt with carefully, considering mode shift between car users to public transport.

Nevertheless, important actions promoted by County Councils have demonstrated effectiveness in reducing car journey trips, such as:

- increase in car sharing schemes
- reduction or discounts on public transport
- real time passenger information
- public transport priority schemes and car parking charges

In Buckinghamshire County Council's areas in Aylesbury and High Wycombe, a travel plan that included discounts of 30% on local buses and trains secured a reduction of 20% in vehicle trips to work by staff over an 18 month period.

Wycombe District Council reduced the proportion of its staff driving alone to work from 79% in 1998 to 59% in 1999 due to an increase in cycle use and car sharing and the introduction of parking charges.

In many countries, the most common category of household car ownership is the one-car household. According to Census 2001, this number in Britain accounts for 46% of all households, for example. A complementary pattern of car and public transport use may exist within such households, and the 'other' driver may make only limited use of the car. As the proportion of households with two or more cars rises (22% in Britain - Census 2001) some of the driver trips made in the second car are diverted from the first car. Therefore, the impact on public transport use tends to be lower than the initial shift from zero to one car ownership.

What has been demonstrated with the Wycombe District Council and Buckinghamshire County Councils measures was the increase of car passengers and car sharing rather than patronage on public transport.

According to a TRL public transport demand study, patronage and public transport fares are inversely related. It states that when fare prices increase patronage tends to fall and vice-versa. So, therefore, it is important to study patronage as a function of ticket prices rather than just assume that improvements in, for example, bus priority schemes or guided buses, will increase patronage.

In the UK, bus systems have neither attracted the expected patronage nor car mode shift. According to Metro reports from Leeds, this happens because either they are not fully implemented throughout the local network or the fares are still not cheap enough.

HULTS patronage, therefore, will be assessed in an analysis of scenarios assuming that car mode shift will increase in the High Wycombe area due to the tram system attractiveness and the convenience for linking two main railway lines at High Wycombe and Maidenhead. Besides, HULTS has also the advantage of promoting a less environmental damaging transport mean which will reduce not only greenhouse emissions but also other ones related to transport.

Figure 67 shows the potential demand along the existing alignment between High Wycombe and Bourne End. The average population around the tram stops has been calculated through the average population density, 23 inhabitants/ha, for High Wycombe-Bourne End area.

| Average population density (popul/ha) | Area around the tram stop m <sup>2</sup> (500m radius) | Area around the tram stops in ha (1ha = 10,000 m <sup>2</sup> ) | Average population around the tram stops | Number of tram stops | Demand in the catchment area |
|---------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------|----------------------|------------------------------|
| 23                                    | 785398                                                 | 79                                                              | 1806                                     | 10                   | 18064                        |

**Figure 67** Potential demand along the route between High Wycombe and Bourne End  
Source: Census 2001

However, according to the Census 2001, more than 70% the economic active inhabitants are cars users and about 8.6% are already using public transport. The economically active population was considered as the main target for patronage analysis.

Figure 68 shown below, describes the expected patronage for HULTS and the amount of vehicles needed to supply this demand.

#### Patronage Analysis i Travel to work

| Population economically active | Patronage public transport |          | Private transport  |                     | Patronage considering mode shift from cars | Total |
|--------------------------------|----------------------------|----------|--------------------|---------------------|--------------------------------------------|-------|
| (72% of Demand)                | rail (2%)                  | bus (7%) | cars drivers (69%) | car passengers (6%) | 25%                                        |       |
| 13006                          | 260                        | 910      | 8974               | 780                 | 2439                                       | 3609  |

#### Fleet Calculation

| Total Patronage/day         | Patronage @ peak hour | System Capacity |                                |                     | Demand/Offer | Drive Cycle | Number of trams needed | K1 (maintenance) | K2 (Safety coefficient) | Total Fleet            |
|-----------------------------|-----------------------|-----------------|--------------------------------|---------------------|--------------|-------------|------------------------|------------------|-------------------------|------------------------|
| Considering 25% modal shift | 60% patronage/day     | Passcapacity    | Frequency Trams/hour/direction | Total Capacity/hour |              | (hour)      |                        | 20%              | 10%                     | Trams needed x K1 x K2 |
| 3609                        | 2887.2                | 60              | 4                              | 480                 | 6            | 0.82        | 7                      | 1.2              | 1.1                     | 10                     |

**Figure 68 - Patronage Analysis and Fleet Calculation**

Source: Cencus 2001

Fleet formula:

$$\text{Fleet} = \frac{\frac{\text{Patronage}}{\text{Veh. Capacity} \times \text{N. of trams direction}} \times 2}{\text{Drive Cycle}} \times k1 \times k2$$

Where:

k1 = 20% of vehicles in maintenance

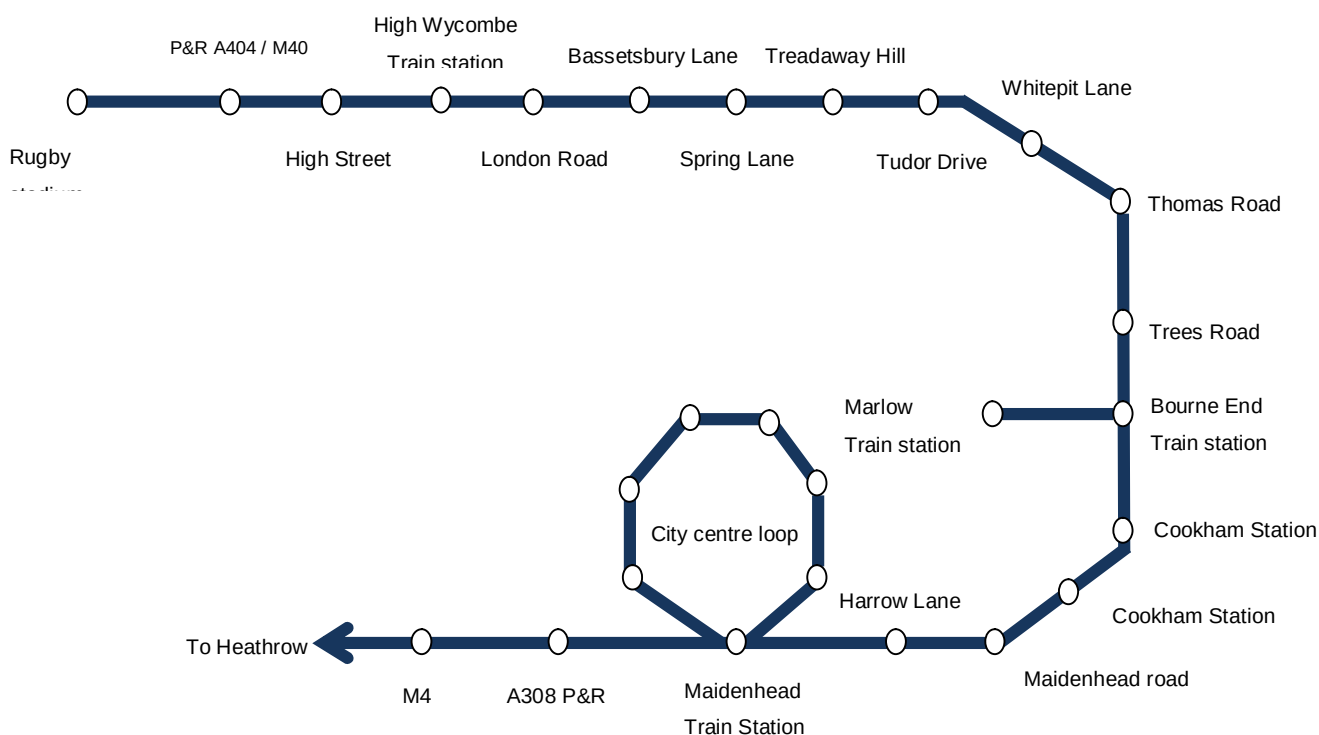
k2 = 10% safety coefficient

## 9. Possible wider route / network

A possible MRT network is shown in Figure 79. This identifies three possible route extensions to the proposed corridor from High Wycombe to Bourne end. The Northern extension from High Wycombe train station through the A404 Park & Ride to the new Rugby stadium and new housing development. On the southern side from Bourne End to Maidenhead and then internal city centre loop and/or connection through A308 with the M4 motorway. The latest plans consider construction of a new corridor connecting transport hubs in Reading with Heathrow international airport terminals. The extended Mass Rapid Transit corridor from Maidenhead could lead into a new interchange on the M4 or connect directly to services from High Wycombe, Marlow, Bourne End and Maidenhead with the Heathrow international airport.

The proposed route extension could be used for both types of vehicles, HULTS and/or bus MRT. The bus alternative would require less investment cost, especially in the city centres where new rail construction, traffic restriction, utilities moves, need to be considered.

A possible further city centre loop in High Wycombe could be considered, but unfortunately the location of the city is creating natural barriers (steep slopes & significant gradients) for HULTS system, therefore the city centre might be considered for the bus option only.



**Figure 69** - shows possible extension of the proposed route from Rugby Stadium in High Wycombe to the M4 and / or to Heathrow.

## 10. Future considerations

### 10.1. Dual mode vehicles



**Figure 70** - shows the dual mode vehicle runs along the tracks of the Gakunan Railway Line during a trial run in Fuji, Shizuoka Prefecture.

Source: [www.pinktentacle.com](http://www.pinktentacle.com), [www.japanrail.com](http://www.japanrail.com)

The dual mode vehicle (DMV) developed by Hokkaido Railway Company (JR Hokkaido) was selected for "The 2008 Good Design Sustainable Design Award" of The Japan Industrial Design Promotion Organization (JIDPO) on October 8, 2008. The DMV is a vehicle capable of running on both roads and rails. JR Hokkaido succeeded in developing this vehicle in 2004, and began trial services in April 2007.

As identified in the paragraph 8.5 the possible extension of the route from High Wycombe to Maidenhead could be made, where between Maidenhead and Bourne End / Marlow is existing railway which is being used by First Western Group services. If the section of the route between High Wycombe and the Bourne End will be rail less (BRT system will be used) than this DMV could be and feasible option how to minimise the capital cost and provide MRT service in required quality. The estimated cost of this vehicle (is only 12 -15 passengers) was \$145,000 in 2006, which is about £100.000 and makes it 5x cheaper than proposed HULTS and 4x cheaper than proposed BRT vehicles.

If there will be vehicle with 60 passenger capacity available on the market than this option could be financially the most viable. The operation will be proposed on to other vehicles closed system and therefore the railway will be used only by this vehicle.

The DMV is designed based on a microbus. When compared with conventional trains, the use of this vehicle can cut costs with regard to purchasing, fuel and maintenance, and ensures energy-saving operations. It is possible to reduce the size and weight of the car body in accordance with transportation volume. In addition, it takes only about 15 seconds for the vehicle to change from roads to rails (or vice versa) with passengers onboard. Therefore, large-scale infrastructure is not necessary because the vehicle can use existing roads and rails.

The DMV drives on the road like an ordinary bus with front and rear rubber tyres. It runs on the rails with steel wheels called "guide wheels" and driving rear tyre (inner wheel). The guide wheels, which are stored in the front and rear parts of the car body, come down for positioning on the track when the vehicle change from road to rail mode. As a technology for practical use,

the hydraulic control system was adopted to distribute the rear axle weight to both the driving rear tyre and the rear guide wheels at an optimal ratio. This system prevents tire wear and improves running stability.

About seventy five years ago, countries such as Great Britain and Germany tried to develop DMV-type vehicles, but no one was able to make the design practical. Now, local public transport services in Japan are facing worsening business conditions, resulting from a decline in passengers because of the recent motorization as well as declining birth-rates and the aging of rural communities. The features of the DMV, such as low operational costs, energy conservation and convenience, are expected to help these regional transport services reorganize to tailor routes and services to the communities they serve.

## 10.2. Monorail

A **monorail** is a rail-based transportation system based on a single rail, which acts as its sole support and its guide-way. The term is also used variously to describe the beam of the system, or the vehicles travelling on such a beam or track. The term originates from the contraction of the words *mono* (single) and *rail*, from as early as 1897, as early systems used metal rails. The transportation system is often referred to as a railway. In contrast, a light rail system has two rails sharing support of the train which also share the responsibility of guiding the train.



**Figure 71** - shows the Von Roll monorail at Alton Towers, UK (originally built for Expo 86 in Canada) and implemented in the Moscow monorail.

Source: [www.Wikipedia.com](http://www.Wikipedia.com)

This existing and in reality proven technology will be addressing most of the identified issues with the corridor between High Wycombe and Bourne End. Unfortunately this is not the preferred solution for this project and we are listening it just for the completion of the possible public transport solutions used in the practical live.

Monorail systems have found shared applications in the transportation market in airport transfer and some medium capacity metro systems.

Monorails are often but not exclusively elevated, sometimes leading to confusion with other elevated systems such as the Docklands Light Railway, Vancouver SkyTrain and the JFK AirTrain. Monorail vehicles are often at first glance similar to other light rail vehicles, and can be both manned and unmanned. Monorail vehicles can also be found in singular rigid format, articulated single units, or as multiple units coupled into 'trains'. In common with other

advanced rapid transit systems, some monorails are driven by linear induction motor. In common with other dual rail systems, the vehicle bodies are connected to the beam via bogies, allowing curves to be negotiated.

Unlike some trams and light rail systems, modern monorails are always partitioned from other traffic and pedestrians. Monorails are both guided and supported via interaction with the same single beam, in contrast to other guided systems such as Rubber-tyred metros, such as the Sapporo Municipal Subway; or guided buses or trams, such as Translohr. Monorails do not use pantographs.

### 10.3. High Speed Rail

High-speed rail is a type of passenger rail transport that operates significantly faster than the normal speed of rail traffic. Specific definitions include 200 km/h (125 mph) and faster ð depending on whether the track is upgraded or new ð by the European Union, and above 90 mph (145 km/h) by the United States Federal Railroad Administration, but there is no single standard, and lower speeds can be required by local constraints.



**Figure 72** - shows CTRL corridor with the GNER-rented Class 373 unit (UK) and German Transrapid system has been deployed in Shanghai as an airport transit system.

Source: [www.wikipedia.com](http://www.wikipedia.com)

On 2 December 2007 The Sunday Times reported that engineering group Arup, one member of the consortium behind High Speed One, was to put forward a plan for a second UK high-speed line to the North of England and Scotland via Heathrow Airport. This would enable direct transfers between flights and trains to Continental Europe and British regions.

A new electrified high speed rail line linking London, Birmingham and Heathrow would form the centrepiece of a major government transport initiative today that would include a third runway at Britain's largest airport.

The exact route need to be confirmed for the High Speed Train alignment, but the future possible connection from High Wycombe are could be provided by the new proposed MRT system in the future.

## 11. Appendixes

- **APPENDIX 1** - Rapid Transit Background ĩ An overview of the UK and overseas
- **APPENDIX 2** - Presentation of the project outcomes

- **APPENDIX 3** - Scott Wilson feasibility study
- **APPENDIX 4** - High Wycombe to Bourne End MRT corridor scheme  
(including alternative routes on issue identified locations)

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