THE TYNE AND WEAR METRO DEVELOPMENT PROPOSAL – 2011

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CONTENTS

THE SUMMARY

Metro is the main mode of public transport of Tyne and Wear Conurbation. During last 5 years there was steady growth of passenger traffic volume. But now 350 000 inhabitants of the Tyne and Wear, and 290 thousand inhabitants of Northumberland and Durham, who work, rest, study, shop, use the airport, port and railway stations do not have easy access to Metro. There is objective need for the existing Tyne and Wear Metro network expansion.

Currently potential of existing surface Metro system completely exhausted. Need to move on to the Modern passenger transport system, off-street transportation, which allows you to cater for the increasing flow of passengers.

The optimal solution to the problem at this stage – the creation of advanced network of the Metro. The Basis of this process is the Conception of formation of the Developed network of the Tyne and Wear Metro.

THE INTRODUCTION

The Urban development of a system involves the coherent development of all sectors of human activity. To ensure normal functioning of a person in need well-developed and coordinated system of transportation services, which affect the whole of the city. Improvement of existing transport schemes has a social value, expressed in the quality of life and improving the health of citizens, increases employment, preserving the environment. The urban transport systems should be considered as solid education, with the general principles of operation and management tools.

Current economic conditions, integration, population growth and number of vehicles of different types of urban transport, the increase in harmful emissions pose new problems to improve technology and organization of transport service cities.

The Her Majesty's Government has identified strategies and policies for future development of transport [1]. Recommended to combine planning and transport at national, regional and local level. The following objectives:

- To provide a viable transport option for transporting people and goods;
- Ensure access to jobs, shops, facilities and services using public transport, walking and cycling;
- Reduce the need to travel short distances, especially by car.

To achieve these objectives, local authorities have in planning to ensure the full use of Public transport. High priority should be given to pedestrians, cyclists and public transport in urban centers. It should also be guaranteed to meet the needs of people with disabilities through the creation of the Full Barrier-free environment.

Accordingly, in view of the intended policy of optimizing of cities transport scheme with the Public transport priority in terms of interaction between different modes of transport is particularly relevant.

In the context of solving these problems, the Tyne and Wear Conurbation is of great interest. The territory of the Metropolitan area is located in the most densely populated part of the United Kingdom, and the Population of the Tyne and Wear Conurbation is the sixth largest in the Country.

Historically, Tyne and Wear Conurbation formed as an important center for the Wool trade and later the Main area of coal mining. Actively developing the Port with shipyards complex was one of the world's largest shipbuilding and repair centers. Currently, these industries restructured, reduced and mostly eliminated. Currently, major areas of economic activity – it's trade, business services, office and educational activities.

The Public transport system is actively developing since the beginning of the Twentieth century, when the first tram line laid. By mid-century they have been completely replaced by buses. Well enough of cycling message, the route which the majority of sites are separated from the road. Newcastle Airport – is the main airport of the North-East of the Country. It is the tenth largest in passenger traffic and is the fastest growing regional airport of the United Kingdom. The Railway station is a major transit station on the East Coast. The Tyne and Wear Metro system combines underground and ground areas, which formed on the basis of commuter Rail lines [2; 3; 4; 5; 6]. Over the past five years in the Metro is steadily growing volume of traffic [7]. Through the Conurbation area are several highways. Passengers have access to the international Ferry terminal.

The Tyne and Wear Metro development is part of the Plan to improve the economy of the Country and Region – Multi-billion pound push on UK Infrastructure Projects. – BBC Newcastle, Tyne Website, Monday 28th November 2011:

Location of Infrastructure projects

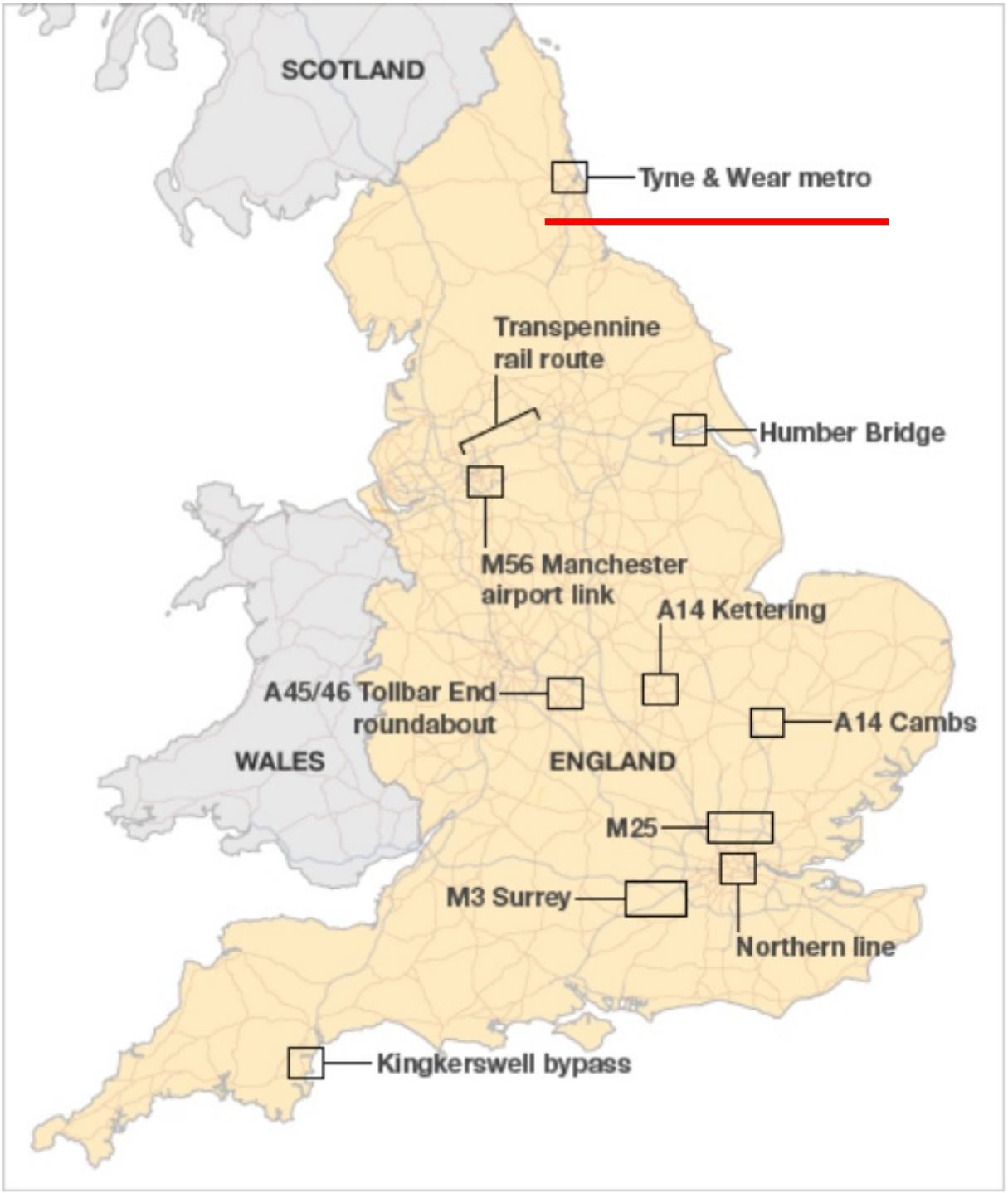

Figure 1.
Location of Infrastructure projects.

Images source: http://www.bbc.co.uk/news/uk-15914145 (28 November 2011)

“The 40 highlighted projects for support from the plan include the Metro system in Tyne and Wear, in the North East of England. The government wants to “accelerate the development” of the Tyne and wear Metro. BBC business editor Robert Peston said the move to aid investment in major infrastructure projects was “important for improving the productive potential of the British economy, making it more competitive” [8]. Location of Infrastructure projects is demonstrated on the Figure 1.

The development of the Regional Network of Metro discussed in neighboring counties (for example, Northumberland – “PETITION – BRING METRO TO SOUTH EAST NORTHUMBERLAND” / Northumberland COUNTY COUNCIL, 5th October 2011 [9]).

Taken together, the transport system of the Tyne and Wear Conurbation is of considerable interest, and its improvement in the priority of Public transport is an important task. Environmental aspects of the optimization of the transport scheme of agglomeration is crucial, since according to the program adopted by Newcastle will make “the first Carbon Neutral town”.

Main provisions of this work were published in articles, drawings with comments and presented for discussion at the specialized Internet forums (The List of Author’s publications on the topic of this Project).

THE DEVELOPMENT OF THE TYNE AND WEAR CONURBATION METRO

1. The Determination of the Optimal Metro scheme

The issue of comfortable public transport links Tyne and Wear Conurbation with each passing year becomes more and more complicated. It needs to be addressed.

The distribution of passengers in various types of public transport is shown in a special Research Agenda “State of the Region / Transport” (by NORTH EAST Research & Information Partnership, 2010): “Travel to work in the North East in 2009 is dominated by the car, with almost three quarters (74%) of commutes in the North East done by private transport, 4% higher than the national average. In the urban centre of Tyne and Wear, there is a greater tendency to use public transport and the results are much more in line with the national average. Particularly, in Tyne and Wear and 13% of workers use the bus to commute to work, compared with 7% nationally. While rail use is much less than the national average, Tyne and Wear compares with the national average with regard to “Other Rail”, reflecting the existence of the Metro system” [7].

Metro is the main mode of public transport of Tyne and Wear Conurbation. During last 5 years there was steady growth of passenger traffic volume. Tyne and Wear Metro Passenger ride – 47 million (2008) – is on 97th place of 132 in the World; on 34th place of 43 in the Western and Central Europe; on 3rd place of 4 in the United Kingdom (Metro systems by annual passenger rides [10]). According to other sources – “Tyne & Wear Metro Journeys Trends” [7] – passenger traffic is 41-42 million per year.

Since the late 1960s in all phases of Metro appeared a large number of proposals that addressed the various options to improve the tracing [11; 12]. For various reasons they were not detailed and implemented.

The Metro - is the most convenient form of public transport. There is objective need for the existing Tyne and Wear Metro network expansion.

The world practice of Metro systems operation shows that convenient for passengers distance to Metro station – 1.00 km / 0.62 miles. This corresponds to: 15 minutes walking; 5 minutes on a scooter; 3 minutes on a bike; 2 stops by bus. However, the existing network of Tyne and Wear Metro does not cover all potential passengers (Figure 2).

Firstly, more than 300 thousand inhabitants of certain areas of Tyne and Wear County (Newcastle upon Tyne, Castle Ward, Longbenton, Gateshead, Sunderland – partly, New Byrn, Ryton, Blaydon, Whickham, Chester-le-Street, Washington, Houghton-le-Spring, Easington, Hetton – completely) denied from easy access to Metro.

Secondly, about 280 000 of integrated to public transport system Tyne and Wear (working, studying, shopping, recreation, airoport, port, railway stations) residents of Nortumberland and Durham (Seaham, Peterlee, Durham, Chester-le-Street, Consett, Stanley, Prudhoe, Ponteland, Cramlington, Blyth) are deprived of a convenient connection to the Metro.

Thirdly, some large residential and industrial areas, shopping centers and places of public entertainment do not have easy and fast connection between them. Providing this connection will increase the quantity of trips.

In addition, in the existing network have a number of problems in the area of operation and environmental protection.

**THE ZONE OF OPTIMAL ACCESSIBILITY
OF THE TYNE & WEAR METRO EXISTING NETWORK
(1,0 km / 0,62 mi to the station)**

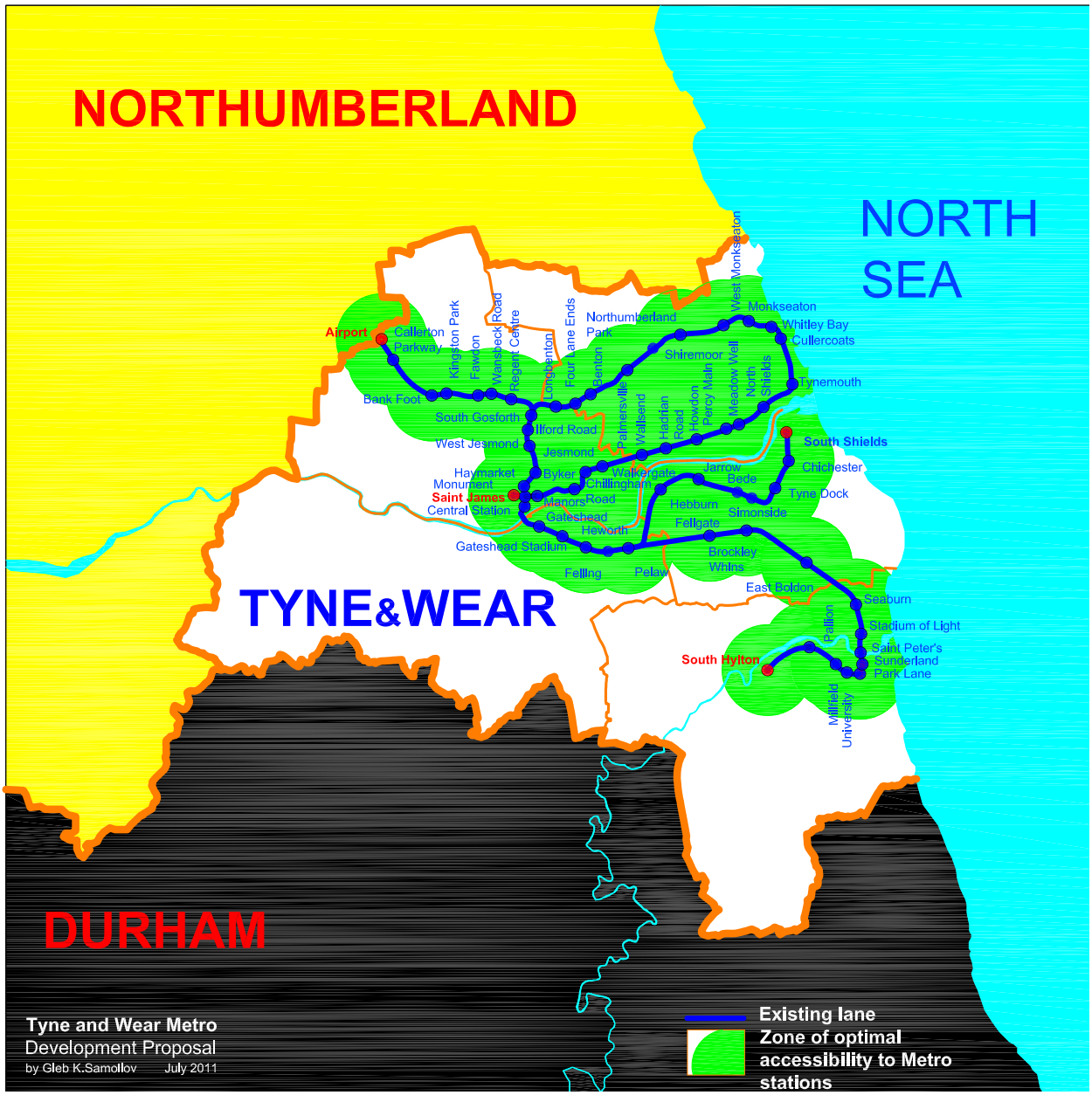

Figure 2.
The Zone of optimal accessibility of the Tyne and Wear Metro Existing network (1,0 km / 0,62 mi to the station).

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

Ramiform solution of the lines and one metro bridge across the River Tyne can not provide a stable work of the system during the repair and maintenance works on some parts of routes and stations. The current practice of these works on weekends and holidays is limiting the Metro network. At the same time, on weekends and holidays the number of visits to places of personal and public recreation, visiting shopping centers and entertainment significantly increases. Surface location of most sites complicates the solution of environmental issues (noise, electromagnetic radiation of the line).

The existing built-up of Tyne and Wear Conurbation the provision of additional territory for new metro routes impractical. Now occupied by terrestrial lanes 4.5 square kilometers of the most valuable territory in the densely built-up areas. Further development of land lines would require a further 10 – 12 square kilometers of territory. It will be necessary to demolish the houses and public buildings in the band width of 50 meters along the route. The cost of demolition of structures and compensation many times exceed the cost of underground lanes. Will be very great damage to the Cultural, Historical and Moral spheres. From the standpoint of saving money to do all the lines underground.

Underground installation of new lines is expensive. During the construction of existing lines in the centers of Newcastle, Gateshead and Sunderland were made as tunnels. Then, in early development, partial layng of lines as underground solved the operational problem.

Now the situation with the availability of public transport in the Conurbation became much more complex. In the new phase of development, I think that the entire network of Tyne and Wear Metro must be underground. First, the new lines, and then, gradually, all now existing ones. It's expensive, but other attempts to solve the problem are even more expensive. In addition, the lines laid underground allow making stations in those places where they are needed most to residents.

The existing network of Tyne and Wear Metro distance between the stations is too short. This technology is not convenient for the train. This is inconvenient for passengers.

Bridges are a very important aspect. Now the only metro bridge makes it impossible to carry out repairs without disrupting the right bank and left bank of the Tyne River.

In this situation, it is expedient to intensive development of the Metro. It will be the basis of all types of Internal and External Public Transport Integration.

Geographical features of the location of key elements of the external and internal public transportation, residential districts and working areas, places of mass recreation and entertainment, shopping and educational facilities, stadiums and health-sports centers, historical sites and precious natural landscapes of the Tyne and Wear Conurbation determine the acceptable type of Metro scheme.

In international practice for similar situations with a polycentric location of objects successfully applied Complex Loop-shaped schemes and Ring-Radial schemes.

Complex Loop-shaped and Ring-Radial schemes are often used in the international practice of metro building. In most cases the Metro – it's a combination of ground and underground lines. Ground and underground lines have different lengths.

In World practice metros with ring-radial scheme the train with passengers runs only on one line. There are technological maneuver trains from one line to another without passengers. The movement of the train with passengers from the line to line is possible in principle, but its practical application – is a rare phenomenon. The motion of

THE CONCEPTION
OF THE TYNE & WEAR METRO DEVELOPMENT

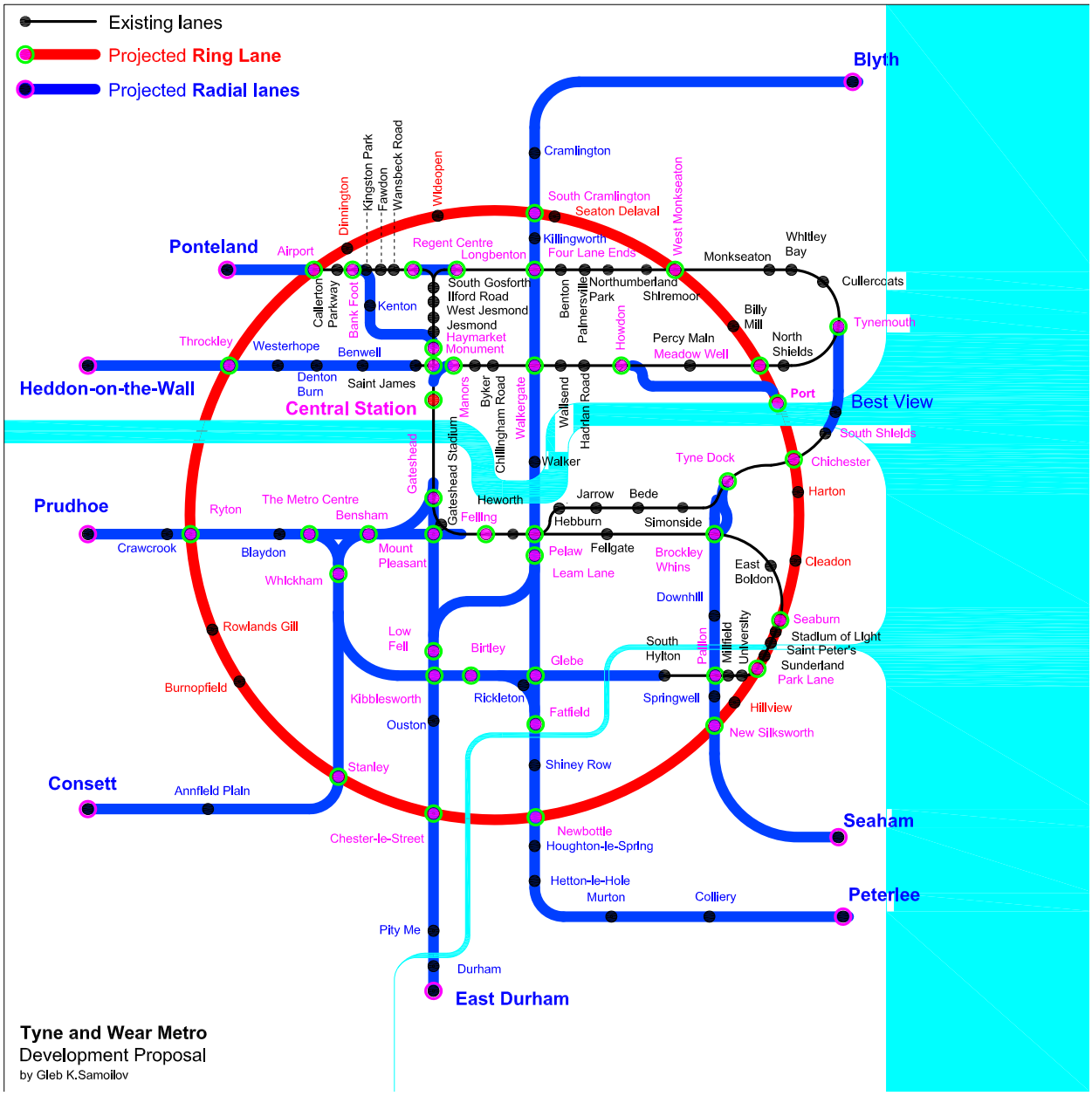

Figure 3.
The Conception of the Tyne and Wear Metro Development

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

the train with passengers on the entire Metro network does not apply. The partial overlapping of individual radial routes and the ring route is used in the Melbourne metro.

In contrast to these examples, the proposed scheme of Tyne and Wear Metro allows to combine Rings and Radial lines (Figures 3, 4). The developed network of the Metro has four overlapping rings, and eight radial branches, that connect to rings and each other in the central part:

- **THE RING LANE**: *Airport, South Cramlington, West Monkseaton, Meadow Well, Port, Chichester, Seaburn – Park Lane, New Silksworth, Newbottle, Chester-le-Street, Stanley, Ryton, Throckley, Airport*;
- **DIAMETRAL AND RADIAL LANES**: Blyth, South Cramlington, Four Lane Ends, Walkergate, Pelaw, Leam Lane, Glebe, Fatfield, Newbottle, Peterlee*; *Heddon-on-the-Wall, Throckley, Saint James*; *Prudhoe, Ryton, The Metro Centre, Bensham, Mount Pleasant, Felling*; *Consett, Stanley, Whicham, Bensham, Central Station / Newcastle railway station*; *South Hylton, Glebe, Birtley, Kibblesworth, Whickham, The Metro Centre*; *East Durham, Chester-le-Street, Kibblesworth, Low Fell, Mount Pleasant, Gateshead*; *Tyne Dock, Brockle Whins, Pallion, New Silksworth, Seaham*; *Birtley, Fatfield*; *Low Fell, Leam Lane*, *Airport, Ponteland*, *Bank Foot, Kenton, Haymarket*; *Ragent Centre, Longbenton*; *Central Station / Newcastle Railway station; Manors*; *Howdon, Port*; *South Shields, Best View, Tynemouth*.

This allows for the delivery of passengers from any station to any without stopping. Movement of trains is carried out in one direction. An exception is the line that connects the Blyth, Cramlington, South Cramlington, Killingworth, Four Lane Ends, Walkergate, Walker, Pelaw. To move from this area on the integrated network you must change the direction of the train. This change is made on the detour section or deadlock section after stations Pelaw or Leam Lane.

In the proposed system, Tyne and Wear Metro all new lines are underground. In the future, it is necessary to make the existing lines also underground. The Proposed scheme has three tunnels under the River Tyne and the New Bridge.

The current system of Tyne and Wear Metro lanes formed on the basis of delivery of coal from mines to port facilities. Subsequently, in order to save money, these same freight lanes have been transformed into the passenger lane. Further development, to save money, followed the path of conversion of these lanes in the Light Metro. Currently, potential freight transport system, in a converted passenger, completely exhausted.

Need to move on to the Modern Passenger Transport System, off-street transportation, which allows you to cater for the increasing flow of passengers. The formation of the developed network of Metro not only provides ease of travel, but also significantly increases the mobility of the population.

2. The Formation of the Ring-Radial Metro scheme

In proposed extensive Metro scheme the interchanges of two kinds are applied – “Parallel” and “Perpendicular”. All the new stations have “Island” platform type. Reconstructed stations have platforms of “Island” type and “Coastal” type.

“Perpendicular” interchange node provides the passenger transition from station to station in three versions: “Side-Side”, “Middle-Side” or “Side-Middle”, “Middle-Middle”. Interchange node of this type organized on 10 new stations (South Cramlington, New Silksworth, Newbottle, Chester-le-Street, Stanley, Ryton, Throckley, Glebe,

THE GEOGRAPHICAL POSITION OF THE TYNE AND WEAR METRO DEVELOPED NETWORK LINES

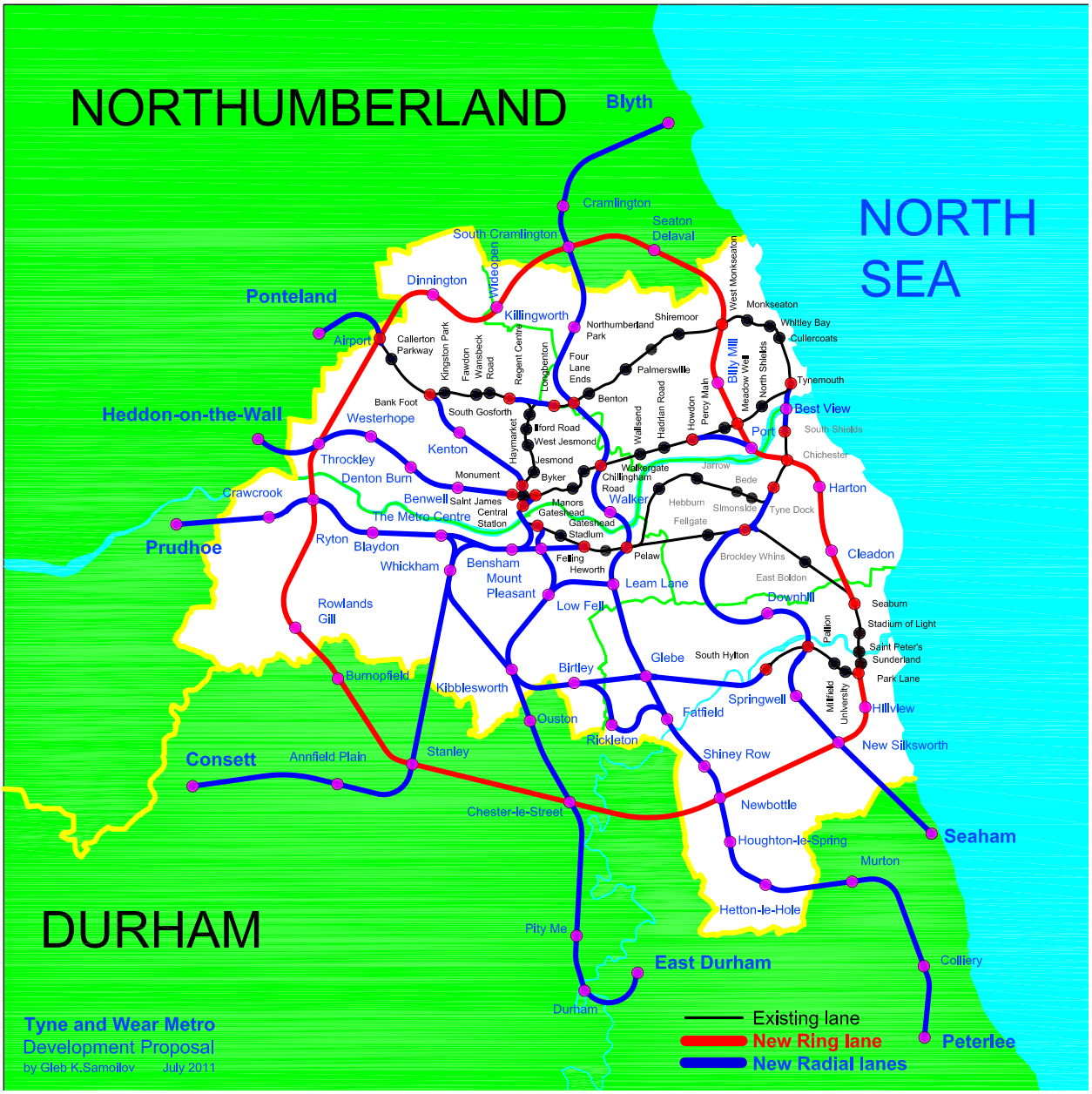

Figure 4.
The Geographical position of the Tyne & Wear Metro Developed Network lines.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

Kibblesworth, Mount Pleasant) and on 7 reconstructing (Airport, West Monkseaton, Meadow Well, Chichester, Four Lane Ends, Walkergate, Pallion).

At the “Monument” station the interchange node of “Perpendicular” type remains unchanged.

“Parallel” interchange node provides the transfer on the station in two ways: “On the same platform” with the transfer of passengers in the forward direction, or “Over the platform” for transfer of passengers in the opposite direction. Interchange node of this type organized on 8 new stations (Port, The Metro Centre, Bensham, Whickham, Low Fell, Birtley, Fatfield, Leam Lane) and on 15 reconstructing (Bank Foot, Haymarket, Regent Centre, Longbenton, Manors, Central Station, Howdon, Tynemouth, South Gosforth, Tyne Dock, Brockley Whins, Felling, Gateshead, Seaburn, Park Lane).

At the “Pelaw” station there is the Combination interchange node: Parallel / Perpendicular.

To ensure reliable operation of underground lines between stations located detour sections and deadlock sections.

The length of detour sections allows overtaking, parking and change of direction. In the scheme three types of detour are used.

- Detour-1: the detour to the left of main tracks, the detour between of main tracks, the detour to the right of main tracks. The Detour-1 provides the ability to maneuver for five trains.
- Detour-2: the detour to the left of main tracks or the detour to the right of main tracks, the detour between of main tracks. The Detour-2 provides the ability to maneuver for four trains.
- Detour-3: the detour between of main tracks. The Detour-3 provides the ability to maneuver for three trains.

The length of deadlock sections allows parking and change of direction. Used three types of deadlock.

- Deadlock-1: the deadlock to the left of main tracks, the deadlock between of main tracks, the deadlock to the right of main tracks, ends of main tracks. The Deadlock-1 provides the ability to maneuver for five trains.
- Deadlock-2: the deadlock to the left of main tracks or the deadlock to the right of main tracks, the deadlock between of main tracks, ends of main tracks. The Deadlock-2 provides the ability to maneuver for four trains.
- Deadlock-3: the deadlock between main tracks ends of main tracks. The Deadlock-3 provides the ability to maneuver for three trains.

All new stations lobbies for inputs and outputs from streets (antechambers or anterooms) are located below ground. An exception is the station “Best View”, which located on the New Bridge.

The First Stage of Development.

The Ring line: “SEABURN – PORT – SOUTH CRAMLINGTON – AIRPORT – RYTON – NEWBOTTLE – PARK LANE”.

Distances between stations: Seaburn (the Rebuild operating station – the Interchange node) – *1,275 km / 0,79 miles* – Cleadon (the New station) – *1,445 km / 0,90 miles* – Harton (the New station) – *0,985 km / 0,61 miles* – Chichester (the Rebuild operating station – the Interchange node) – *0,915 km / 0,57 miles* – Port (the New station – the Interchange node) – *0,550 km / 0,34 miles* – Meadow Well (the Rebuild operating station – the Interchange node) – *1,000 km / 0,62 miles* – Billy Mill (the New station) – *1,330 km / 0,83 miles* – West Monkseaton (the Rebuild operating station – the Interchange node) – *2,460 km / 1,53 miles* – Seaton Delaval (the New

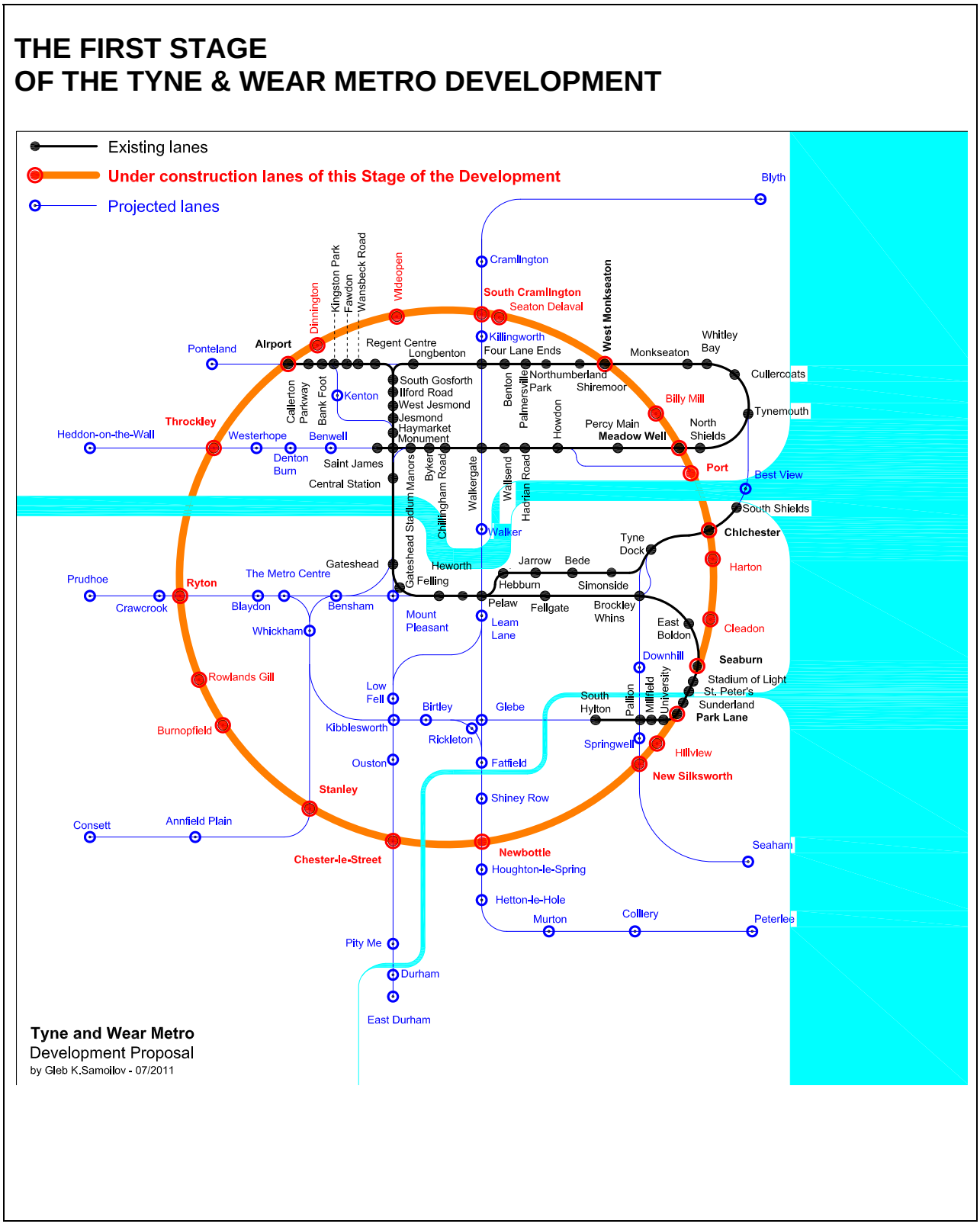

Figure 5.
The First Stage of the Tyne & Wear Metro Development.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

station) – *1,980 km / 1,23 miles* – South Cramlington (the New station – the Interchange node) – *2,135 km / 1,33 miles* – Wideopen (the New station) – *1,680 km / 1,04 miles* – Dinnington (the New station) – *1,710 km / 1,06 miles* – Airport (the Rebuild operating station – the Interchange node) – *2,700 km / 1,68 miles* – Throckley (the New station – the Interchange node) – *1,275 km / 0,79 miles* – Ryton (the New station – the Interchange node) – *3,040 km / 1,89 miles* – Rowlands Gill (the New station) – *1,470 km / 0,91 miles* – Burnopfield (the New station) – *2,570 km / 1,060 miles* – Stanley (the New station – the Interchange node) – *3,560 km / 2,21 miles* – Chester-le-Street (the New station – the Interchange node) – *3,425 km / 2,13 miles* – Newbottle (the New station – the Interchange node) – *2,870 km / 1,78 miles* – New Silksworth (the New station – the Interchange node) – *1,085 km / 0,67 miles* – Hillview (the New station) – *0,765 km / 0,48 miles* – Park Lane (the Rebuild operating station – the Interchange node).

The location of detour sections and deadlock sections: Seaburn – (Deadlock-3) Cleadon (Deadlock-3) – (Deadlock-3) Harton – (Detour-1) – Chichester – Port – Meadow Well (Deadlock-3) – (Deadlock-3) Billy Mill (Deadlock-3) – (Deadlock-3) West Monkseaton (Deadlock-3) – (Deadlock-3) Seaton Delaval (Deadlock-3) – (Deadlock-3) South Cramlington (Deadlock-3) – (Deadlock-3) Wideopen – (Detour-1) – Dinnington – (Deadlock-3) Airport (Deadlock-3) – (Deadlock-3) Throckley – Ryton (Deadlock-3) – (Deadlock-3) Rowlands Gill – (Detour-1) – Burnopfield (Deadlock-3) – (Deadlock-3) Stanley (Deadlock-3) – (Deadlock-3) Chester-le-Street (Deadlock-3) – (Deadlock-3) Newbottle (Deadlock-3) – (Deadlock-3) New Silkworth (Deadlock-2) – (Deadlock-2) Hillview – Park Lane.

Placements of inputs and outputs from streets to underground antechambers of new stations: Cleadon (*on the Whitburn Road, between the Laburnum Grove and the Meadowfield Drive*), Harton (*on the Saint Mary's Avenue, between the Hight Road and the Fairholme Avenue*), Port (*on the Hayhole Road, near the Royal Quays Oulet Shopping*), Billy Mill (*on the Coast Road, between the Prestwick Avenue and the Cornhill Crescent*), Seaton Delaval (*on the Elsdon Avenue, between the Whitfield Road and the Ridds Dalec*), South Cramlington (*on the Greenlaw Road, near the Winster Place*), Wideopen (*on the Stalks Road, between the Blanchland Avenue and the A1 High Way*), Dinnington (*on the Site, between the North View and the Front Street*), Throckley (*on the Newburn Road, between the Hexham Road and the Post Office*), Ryton (*on the Main Road, between the Tower Gardens and the Dene Crescent*), Rowlands Gill (*on the Hookergate Lane, between the Hightfield Road and the Woodlea Road*), Burnopfield (*on the Syke Road, near the Brich Crescent*), Stanley (*on the Humber Hill, near the Brooks Close*), Chester-le-Street (*on the South Approach, near the Hall*), Newbottle (*on the Coaley Lane, between the Beechwood Terrace and the Staddon Way*), New Silksworth (*on the Tunstall Village Road, near the Fair Ways*), Hillview (*on the B1405 High Way, near the Playing Fields*).

Basic data on the line of the First Stage of Development.

The length of the line – 40,230 km / 24,99 miles.

The number of stations – 23:

- new stations – 17 (Cleadon, Harton, Port, Billy Mill, Seaton Delaval, South Cramlington, Wideopen, Dinnington, Throckley, Ryton, Rowlands Gill, Burnopfield, Stanley, Chester-le-Street, Newbottle, New Silksworth, Hillview);
- rebuild operating stations – 6 (Seaburn, Chichester, Meadow Well, West Monkseaton, Airport, Park Lane);
- expand operating stations – 0.

The number of interchange nodes – 14:

- at new stations – 8 (Port, South Cramlington, Throckley, Ryton, Stanley, Chester-le-Street, Newbottle, New Silksworth);

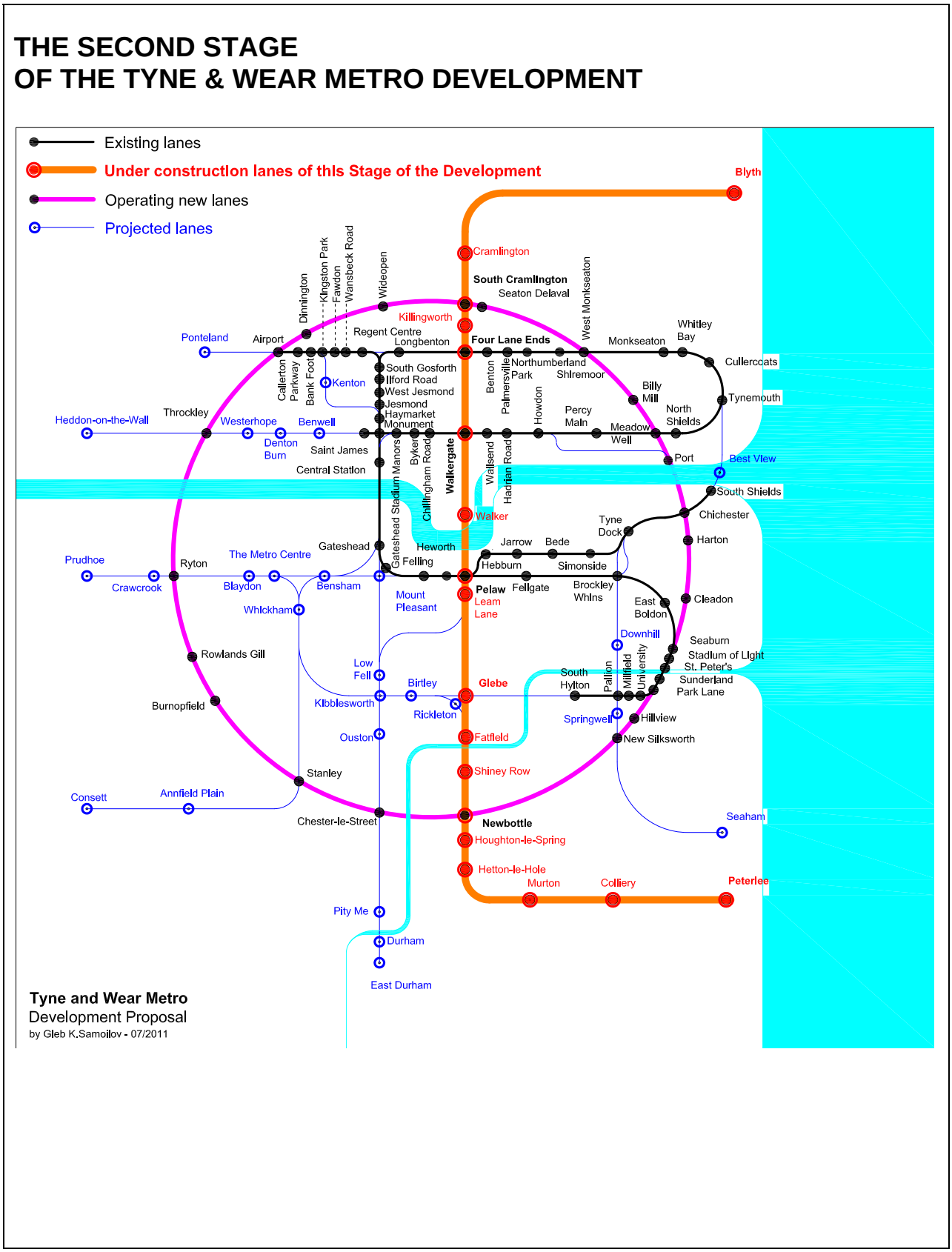

Figure 6.
The Second Stage of the Tyne & Wear Metro Development

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

- at operating stations – 6 (Seaburn, Chichester, Meadow Well, West Monkseaton, Airport, Park Lane).

The average distance between stations – 1,89 km / 1,14 miles.

The maximum distance between stations – 3,560 km / 2,21 miles (Chester-le-Street – Stanley).

The minimum distance between stations – 0,550 km / 0,34 miles (Meadow Well – Port).

The scheme of the First Stage of Development is demonstrated on the Figure 5.

The Second Stage of Development.

The Radial line: "BLYTH – SOUTH CRAMLINGTON – PELAW – NEWBOTTLE – PETERLEE".

Distances between stations: Blyth (the New station) – *3,155 km / 1,96 miles* – Cramlington (the New station) – *0,935 km / 0,98 miles* – South Cramlington (the Expand operating station – the Interchange node) – *1,865 km / 1,16 miles* – Killingworth (the New station) – *1,905 km / 1,18 miles* – Four Lane Ends (the Rebuild operating station – the Interchange node) – *1,690 km / 1,05 miles* – Walkergate (the Rebuild operating station – the Interchange node) – *1,200 km / 0,75 miles* – Walker (the New Station) – *0,980 km / 0,61 miles* – Pelaw (the Rebuild operating station – the Interchange node) – *0,930 km / 0,58 miles* – Leam Lane (the New station – the Interchange node) – *2,155 km / 1,34 miles* – Glebe (the New station – the Interchange node) – *1,055 km / 0,66 miles* – Fatfield (the New station – the Interchange node) – *1,325 km / 0,82 miles* – Shiney Row (the New station) – *0,800 km / 0,50 miles* – Newbottle (the Expand operating station – the Interchange node) – *0,995 km / 0,62 miles* – Houghton-le-Spring (the New station) – *1,320 km / 0,82 miles* – Hetton-le-Hole (the New station) – *1,940 km / 1,21 miles* – Murton (the New station) – *2,810 km / 1,75 miles* – Colliery (the New station) – *1,590 km / 0,99 miles* – Peterlee (the New station).

The location of detour sections and deadlock sections: (Deadlock-1) Blyth – (Deadlock-3) Cramlington(Deadlock-3) – (Deadlock-3) South Cramlington (Deadlock-3) – (Deadlock-3) Killingworth (Deadlock-3) – (Deadlock-3) Four Lane Ends (Deadlock-3) – (Deadlock-3) Walkergate – (Detour-1) – Walker – Pelaw – (Detour-3) – Leam Lane (Deadlock-2) – (Deadlock-3) Glebe (Deadlock-3) – (Deadlock-3) Fatfield (Deadlock-3) – (Deadlock-3) Shiney Row – (Detour-1) – Newbottle(Deadlock-3) – (Deadlock-3) Houghton-le-Spring (Deadlock-3) – (Deadlock-3) Hetton-le-Hole (Deadlock-3) – Murton (Deadlock-3) – (Deadlock-3) Colliery (Deadlock-3) – Peterlee (Deadlock-1).

Placements of inputs and outputs from streets to underground antechambers of new stations: Blyth (*on the Broad Way, between the Plessey Road and the Kingsway*), Cramlington (*on the B1326 High Way, near the Newlyn Drive*), Killingworth (*on the Killingworth Way, between the Woodvale Road Close and the Bannockburn*), Walker (*on the Saint Anthony's Road, between the Wigmore Avenue and the Lancefield Avenue*), Leam Lane (*on the Colegate, between the Wealcroft and the Meresyde*), Glebe (*on the Parkway, between the Roche Court and the Newstead Court*), Fatfield (*on the Fallowfield Way, between the Broadmeadows and the Fernlea Close*), Shiney Row (*on the South View, near the Henry Street*), Houghton-le-Spring (*on the Durham Road, between the Dunholm Close and the Bishops Wyrd*), Hetton-le-Hole (*on the Houghton Road / the Station Road, between the Logan Street and the Station View*), Murton (*on the Barnes Road, between the Webb Avenue and the Toft Crescent*), Colliery (*on the Seaside Lane, between the Whickham Street and the Milton Lane*), Peterlee (*on the Burnhope Way, between the Passfield Way and the Burnhope Close*).

Basic data on the line of the Second Stage of Development.

The length of the line – 26,650 km / 16,56 miles.

THE THIRD STAGE
OF THE TYNE & WEAR METRO DEVELOPMENT

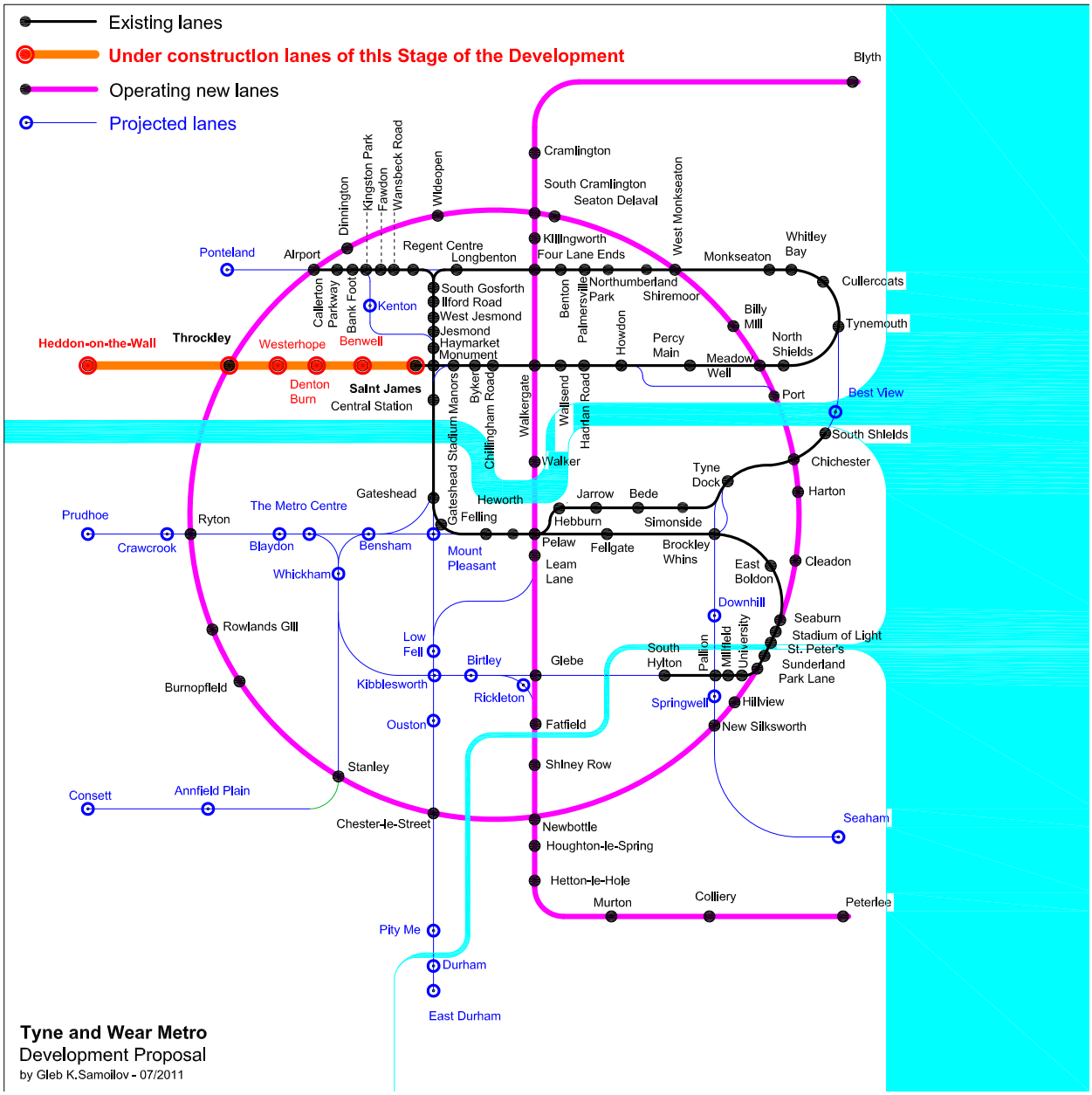

Figure 7.
The Third Stage of the Tyne & Wear Metro Development

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

The number of stations – 18:
- new stations – 13 (Blyth, Cramlington, Killingworth, Walker, Leam Lane, Glebe, Fatfield, Shiney Row, Houghton-le-Spring, Hetton-le-Hole, Murton, Colliery, Peterlee);
- rebuild operating stations – 3 (Four Lane Ends, Walkergate, Pelaw);
- expand operating stations – 2 (South Cramlington, Newbottle).

The number of interchange nodes – 8:
- at new stations – 3 (Leam Lane, Glebe, Fatfield);
- at operating stations – 5 (South Cramlington, Four Lane Ends, Walkergate, Pelaw, Newbottle).

The average distance between stations – 1,568 km / 0,97 miles.

The maximum distance between stations – 3,115 km / 1,96 miles (Blyth – Cramlington).

The minimum distance between stations – 0,800 km / 0,50 miles (Newbottle – Shiney Row).

The scheme of the Second Stage of Development is demonstrated on the Figure 6.

The Third Stage of Development.

The Radial line: “SAINT JAMES – THROCKLEY – HEDDON-ON-THE-WALL”.

Distances between stations: Saint James (the Expend operating station) – *1,205 km / 0,75 miles* – Benwell (the New station) – *1,165 km / 0,72 miles* – Denton Burn (the New station) – *1,125 km / 0,70 miles* – Westerhope (the New station) – *1,245 km / 0,77 miles* – Throckley (the Expend operating station – the Interchange node) – *1,460 km / 0,91 miles* – Heddon-on-the-Wall (the New station).

The location of detour sections and deadlock sections: Saint James – (Detour-1) – Benwell (Deadlock-3) – (Deadlock-3) Denton Burn (Deadlock-3) – (Deadlock-3) Westerhope (Deadlock-3) – (Deadlock-3) Throckley (Deadlock-3) – Heddon-on-the-Wall (Deadlock-1).

Placements of inputs and outputs from streets to underground antechambers of new stations: Benwell (*on the West Road, between the Hoyle Avenue and the Condercum Road*), Denton Burn (*on the West Road, near the East Denton Hall*), Westerhope (*on the Hillhead Perkway, between the Caversham Road and the Frenton Close*), Heddon-on-the-Wall (*on the Hexham Road, between the Towne Gate and the Military Road*).

Basic data on the line of the Third Stage of Development.

The length of the line – 6,190 km / 3,84 miles.

The number of stations – 6:
- new stations – 4 (Benwell, Denton Burn, Westerhope, Heddon-on-the-Wall);
- rebuild operating stations – 0 (-);
- expand operating stations – 2 (Saint James, Throckley).

The number of interchange nodes – 1:
- at new stations – 0 (-);
- at operating stations – 1 (Throckley).

The average distance between stations – 1,238 km / 0,77 miles.

The maximum distance between stations – 1,460 km / 0,91 miles (Throckley – Heddon-on-the-Wall).

The minimum distance between stations – 1,165 km / 0,72 miles (Denton Burn – Benwell).

The scheme of the Third Stage of Development is demonstrated on the Figure 7.

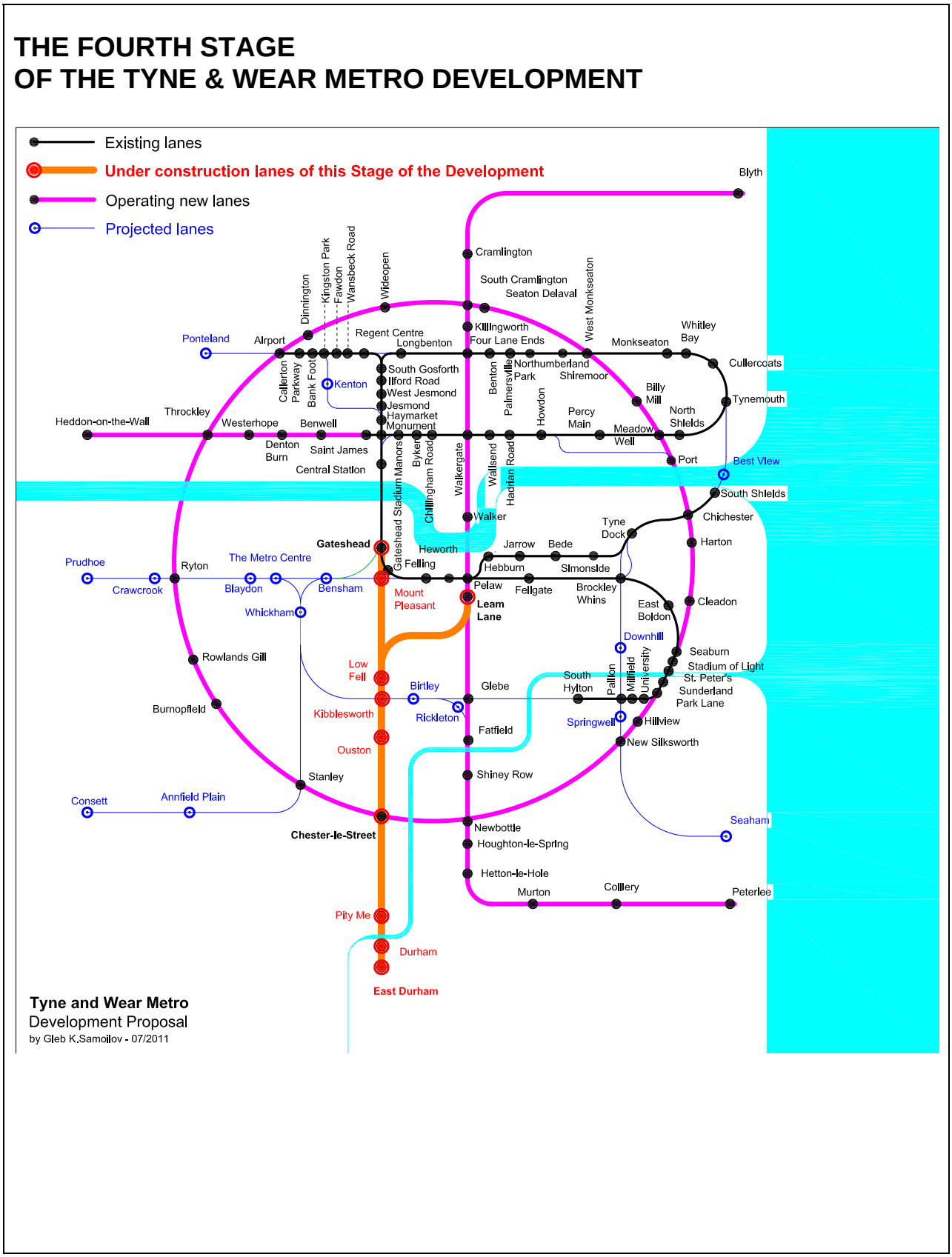

Figure 8.
The Fourth Stage of the Tyne and Wear Metro Development.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

The Fourth Stage of Development.

The Radial line: "EAST DURHAM – CHESTER-LE-STREET – LOW FELL (branch on LEAM LANE) – GATESHEAD".

Distances between stations: East Durham (the New station) – *1,615 km / 1,00 miles* – Durham (the New station) – *1,230 km / 0,76 miles* – Pity Me (the New station) – *3,005 km / 1,87 miles* – Chester-le-Street (the Expand operating station – the Interchange node) – *1,990 km / 1,24 miles* – Ouston (the New station) – *1,200 km / 0,75 miles* – Kibblesworth (the New station – the Interchange node) – *1,950 km / 1,21 miles* – Low Fell (the New station – the Interchange node) – *1,105 km / 0,96 miles* – Mount Pleasant (the New station – the Interchange node) – *0,600 km / 0,37 miles* – Gateshead (the Rebuild operating station – the Interchange node). Low Fell (the New station – the Interchange node) – *1,520 km / 0,94 miles* – Leam Lane (the Expand operating station – the Interchange node).

The location of detour sections and deadlock sections: (Deadlock-1) East Durham – (Deadlock-3) Durham (Deadlock-3) – (Deadlock-3) Pity Me (Deadlock-3) – (Deadlock-3) Chester-le-Street (Deadlock-3) – (Deadlock-3) Ouston (Deadlock-3) – (Deadlock-3) Kibblesworth (Deadlock-3) – (Deadlock-3) Low Fell – (Detour-1) – Mount Pleasant – Gateshead. Low Fell – (Detour-1) – Leam Lane.

Placements of inputs and outputs from streets to underground antechambers of new stations: East Durham (*on the Broomside Lane, near Community Centre*), Durham (*on the New Elvet, near New Elvet Bridge*), Pity Me (on *the Carr House Drive, between the Bek Road and the Alnwick Road*), Ouston (*on the Bradley Close, near the Leyburn Close*), Kibblesworth (*on the Kibblesworth Bank, near the Post Office*), Low Fell (*on the Engine Lane, between the Kells Lane and the A167 High Way*), Mount Pleasant (*on the Edendale Terrace, near the Art Gallery*).

Basic data on lines of the Fourth Stage of Development.

The length of the line – 14,220 km / 8,83 miles.

The number of stations – 10:

- new stations – 7 (East Durham, Durham, Pity Me, Ouston, Kibblesworth, Low Fell, Mount Pleasant);
- rebuild operating stations – 1 (Gateshead);
- expand operating stations – 2 (Chester-le-Street, Leam Lane).

The number of interchange nodes – 6:

- at new stations – 3 (Kibblesworth, Low Fell, Mount Pleasant);
- at operating stations – 3 (Chester-le-Street, Gateshead, Leam Lane).

The average distance between stations – 1,580 km / 0,98 miles.

The maximum distance between stations – 3,005 km / 1,87 miles (Chester-le-Street – Pity Me).

The minimum distance between stations – 0,600 km / 0,37 miles (Mount Pleasant – Gateshead).

The scheme of the Fourth Stage of Development is demonstrated on the Figure 8.

The Fifth Stage of Development.

The Radial line: "SOUTH HYLTON – GLEBE – BIRTLEY (branch on FATFIELD) – KIBBLESWORTH – THE METRO CENTRE – RYTON – PRUDHOE".

Distances between stations: South Hylton (the Expand operating station) – *2,775 km / 1,72 miles* – Glebe (the Expand operating station – the Interchange node) – *1,585 km / 0,98 miles* – Birtley (the New station – the Interchange node) – *1,560 km / 0,97 miles* – Kibblesworth (the Expand operating station – the Interchange node) – *2,565 km / 1,59 miles* – Whickham (the New station – the Interchange node) – *0,815 km / 0,51 miles* – The Metro Centre (the New station – the Interchange node)– *1,505 km / 0,94 miles* – Blaydon (the New station) – *1,560 km / 0,97 miles* – Ryton

THE FIFTH STAGE
OF THE TYNE & WEAR METRO DEVELOPMENT

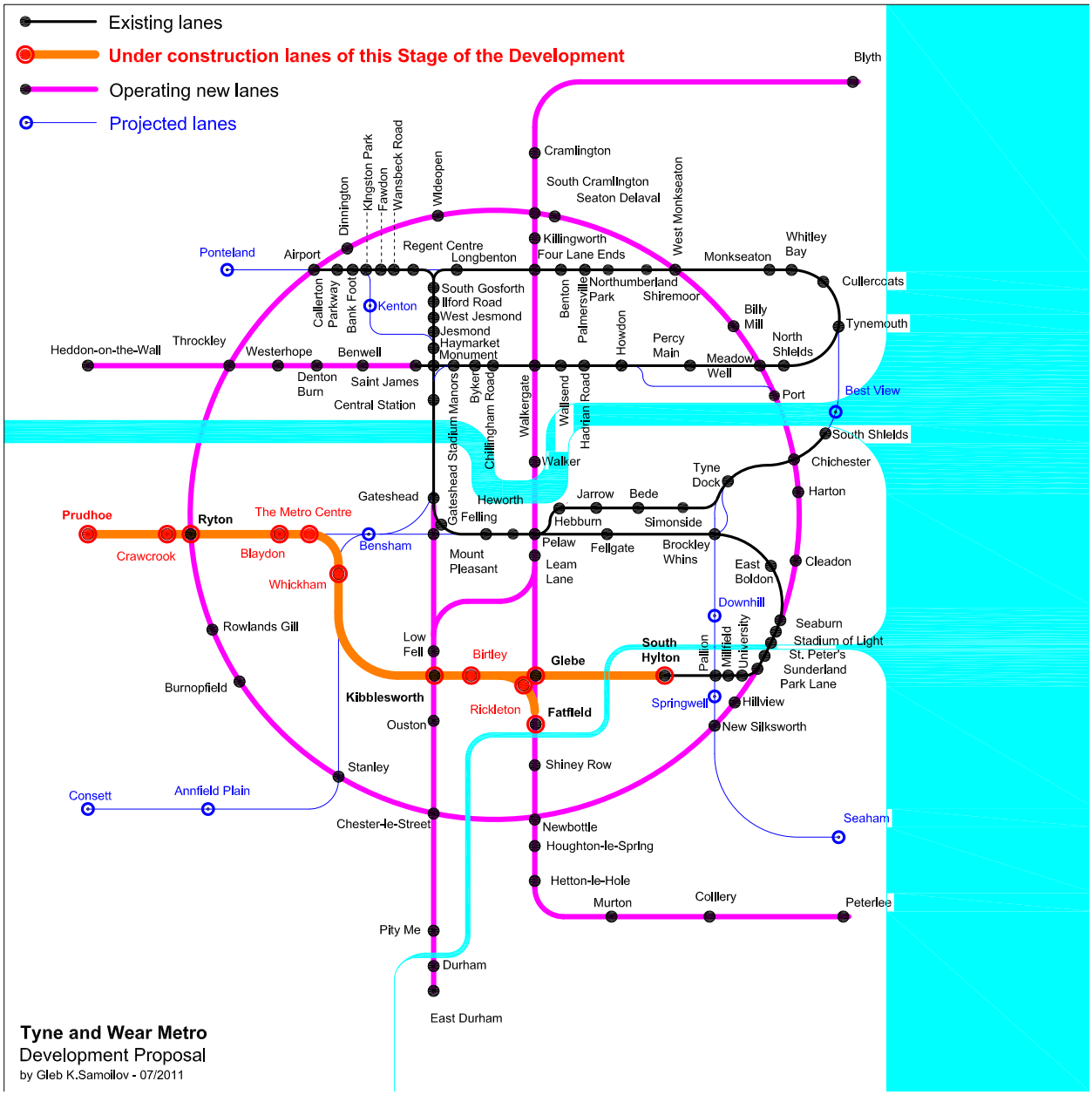

Figure 9.
The Fifth Stage of the Tyne & Wear Metro Development

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

(the Expand operating station – the Interchange node) – *1,075 km / 0,67 miles* – Crawcrook (the New station) – *2,040 km / 1,27 miles* – Prudhoe (the New station). Birtley (the New station – the Interchange node) – *1,450 km / 0,90 miles* – Rickleton (the New station) – *1,660 km / 1,03 miles* – Fatfield (the Expand operating station – the Interchange node).

The location of detour sections and deadlock sections: South Hylton (Deadlock-3) – (Detour-1) – Glebe – (Detour-1) – Birtley (Deadlock-3) – (Deadlock-3) Kibblesworth (Deadlock-3) – (Deadlock-2) Whickham – The Metro Centre – (Detour-1) – Blaydon (Deadlock-3) – (Deadlock-3) Ryton (Deadlock-3) – (Deadlock-3) Crawcrook (Deadlock-3) – Prudhoe (Deadlock-1). Birtley – (Deadlock-3) Rickleton (Deadlock-3) – Fatfield.

Placements of inputs and outputs from streets to underground antechambers of new stations: Birtley (*on the Durham Road, between the Edward Road and the Mitchell Street*), Whickham (*on the Whickham Highway, between the Washingwell Lane and the Coniston Avenue*), The Metro Centre (*inside The Metro Centre*), Blaydon (*on the Pine Road, between the Sycamore Road and the Maple Road*), Crawcrook (*on the Kapier Chare, near the Main Street*), Prudhoe (*on the Station Road, betweeb Western Avenue and the Cranleigh Grove*), Rickleton (*on the Rickleton Way, between the Coquet and the Alwin*).

Basic data on lines of the Fifth Stage of Development.

The length of the line – 18,850 km / 11,85 miles.

The number of stations – 12:

- new stations – 7 (Birtley, Whickham, The Metro Centre, Blaydon, Crawcrook, Prudhoe, Rickleton);
- rebuild operating stations – 0 (-);
- expand operating stations – 5 (South Hylton, Glebe, Kibblesworth, Ryton, Fatfield).

The number of interchange nodes – 7:

- at new stations – 3 (Birtley, Whickham, The Metro Centre);
- at operating stations – 4 (Glebe, Kibblesworth, Ryton, Fatfield).

The average distance between stations – 1,689 km / 1,05 miles.

The maximum distance between stations – 2,775 km / 1,72 miles (Glebe – South Hylton).

The minimum distance between stations – 0,815 km / 0,51 miles (The Metro Centre – Whickham).

The scheme of the Fifth Stage of Development is demonstrated on the Figure 9.

The Sixth Stage of Development.

The Radial line: “SEAHAM – NEW SILKWORTH – PALLION – TYNE DOCK”.

Distances between stations: Seaham (the New station) – *2,865 km / 1,78 miles* – New Silkworth (the Expand operating station – the Interchange node) – *1,380 km / 0,86 miles* – Springwell (the New station) – *1,225 km / 0,76 miles* – Pallion (the Rebuild operating station – the Interchange node) – *1,435 km / 0,89 miles* – Downhill (the New station) – *2,525 km / 1,57 miles* – Brockley Whins (the Rebuild operating station – the Interchange node) – *1,205 km / 0,75 miles* – Tyne Dock (the Rebuild operating station – the Interchange node).

The location of detour sections and deadlock sections: (Deadlock-1) Seaham – (Deadlock-3) New Silkworth (Deadlock-3) – (Deadlock-3) Springwell (Deadlock-3) – (Deadlock-3) Pallion – (Deadlock-3) Downhill (Deadlock-3) – (Deadlock-3) Brockley Whins – (Detour-1) – Tyne Dock.

Placements of inputs and outputs from streets to underground antechambers of new stations: Seaham (*on the North Railway Street, between the Henry Street and*

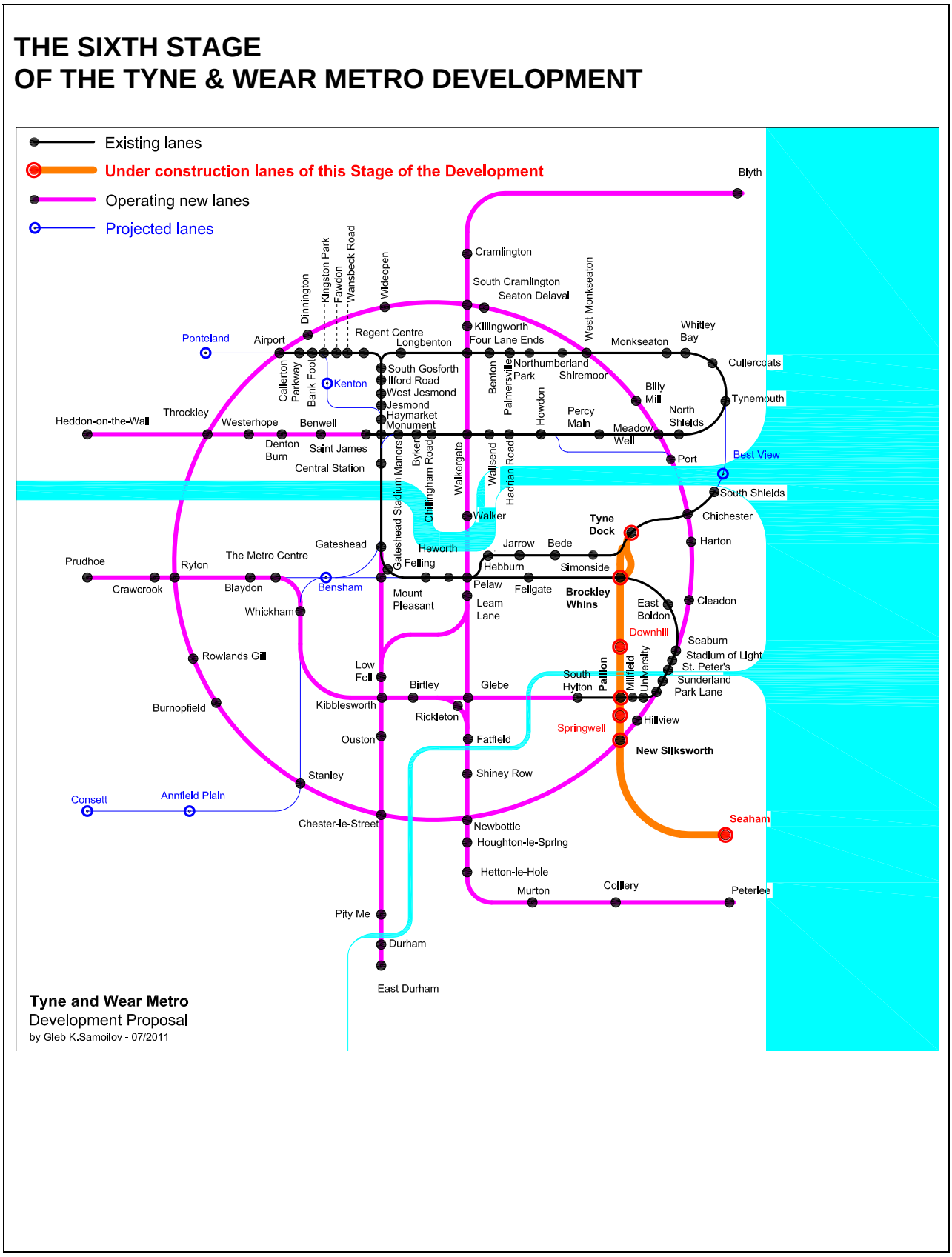

Figure 10.
The Sixth Stage of the Tyne & Wear Metro Development

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

Back North Terrace), Springwell (*on the Springwell Road, between the Somerset Road and Sutherland Drive*), Downhill (*on the Hylton Lane, near the Council Office*).

Basic data on the line of the Sixth Stage of Development.

The length of the line – 10,635 km / 6,61 miles.
The number of stations – 7:
- new stations – 3 (Seaham, Springwell, Downhill);
- rebuild operating stations – 3 (Pallion, Brockley Whins, Tyne Dock);
- expand operating stations – 1 (New Silkworth).

The number of interchange nodes – 4:
- at new stations – 0 (-);
- at operating stations – 4 (New Silkworth, Pallion, Brockley Whins, Tyne Dock).

The average distance between stations – 1,773 km / 1,10 miles.

The maximum distance between stations – 2,865 km / 1,78 miles (Seaham – New Silksworth).

The minimum distance between stations – 1,205 km / 0,75 miles (Tyne Dock – Brockley Whins).

The scheme of the Sixth Stage of Development is demonstrated on the Figure 10.

The Seventh Stage of Development.

The Radial line: "CONSETT – STANLEY – WHICKHAM – CENTRAL STATION – MANORS (the Branch on THE METRO CENTRE – BENSHAM – FELLING)".

Distances between stations: Consett (the New station) – *3,180 km / 1,98 miles* – Annfield Plain (the New station) – *1,830 km / 1,14 miles* – Stenley (the Expand operating station – the Interchange node) – *4,535 km / 2,82 miles* – Whickham (the Expand operating station – the Interchange node) – *1,530 km / 0,95 miles* – Bensham (the New station) – *0,805 km / 0,50 miles* – Central Station (the Rebuild operating station – the Interchange node) – *0,600 km / 0,37 miles* – Manors (the Rebuild operating station – the Interchange node). The Metro Centre (the Expand operating station – the Interchange node) – 1,605 km / 1,00 miles – Bensham (the New station) – 0,630 km / 0,39 miles – Mount Pleasant (the Expand operating station – the Interchange node) – 0,945 km / 0,59 miles – Felling (the Rebuild operating station – the Interchange node).

The location of detour sections and deadlock sections: (Deadlock-1) Consett – (Deadlock-3) Annfield Plain (Deadlock-3) – (Deadlock-3) Stenley (Deadlock-3) – (Deadlock-3) Whickham – (Detour-1) Bensham – Central Station – Manors. The Metro Centre – Bensham – Mount Pleasant (Detour-2) – Felling.

Placements of inputs and outputs from streets to underground antechambers of new stations: Consett (*on the Manse Street, near the Park Street*), Annfield Plain (*on the New Front Street, near the Queens Parade*), Bensham (*on the Hazel Road, between the Kyle Road and the Bensham Crescent*).

Basic data on lines of the Seventh Stage of Development.

The length of the line – 15,115 km / 9,39 miles.
The number of stations – 10:
- new stations – 3 (Consett, Annfield Plain, Bensham);
- rebuild operating stations – 3 (Central Station, Manors, Felling);
- expand operating stations – 4 (Stenley, Whickham, The Metro Centre, Mount Pleasant).

The number of interchange nodes – 8:
- at new stations – 1 (Bensham);
- at operating stations – 7 (Stenley, Whickham, Central Station, Manors, The Metro Centre, Mount Pleasant, Felling).

The average distance between stations – 2,159 km / 1,34 miles.

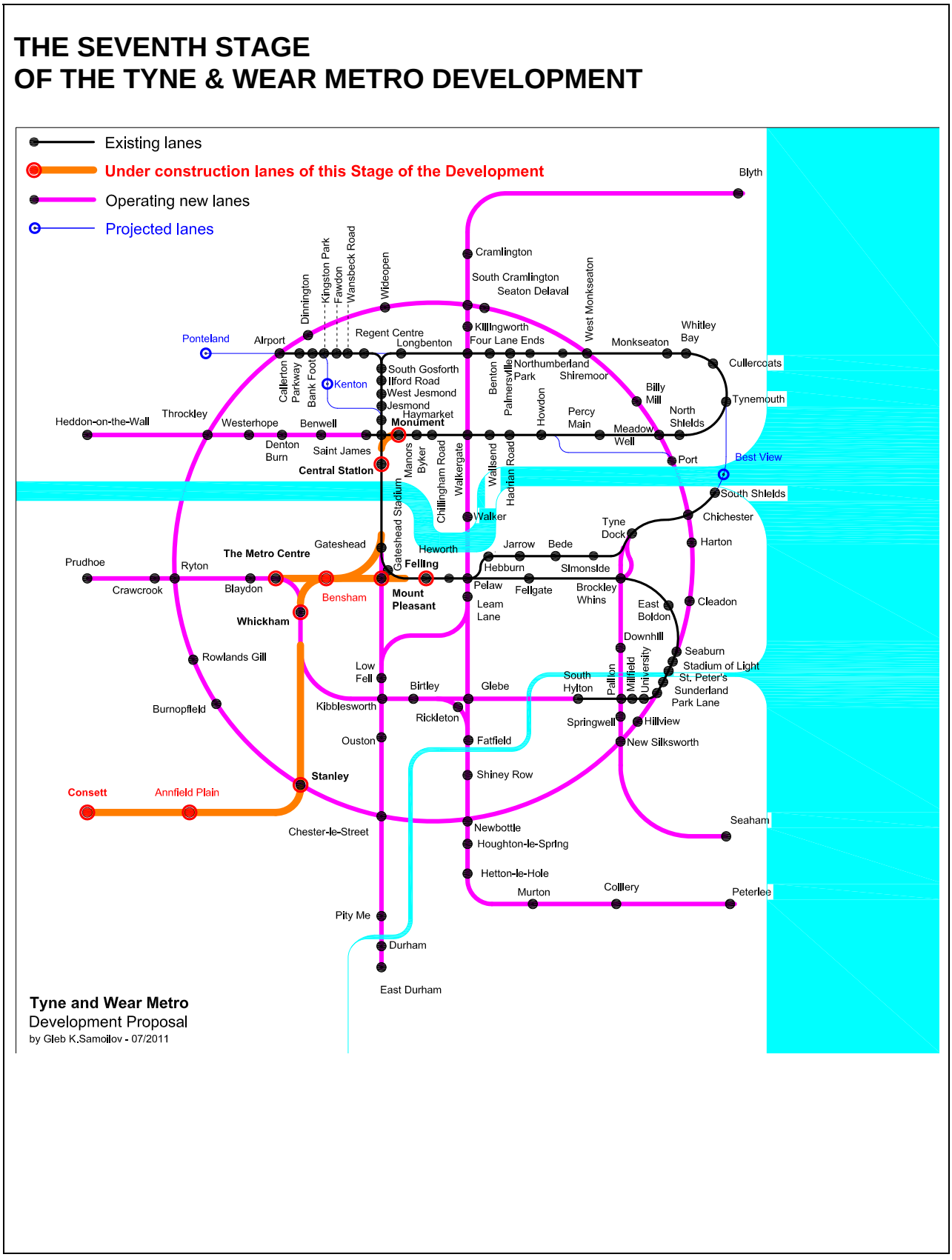

Figure 11.
The Seventh Stage of the Tyne & Wear Metro Development.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

The maximum distance between stations – 4,535 km / 2,82 miles (Whickham – Stanley).

The minimum distance between stations – 0,600 km / 0,37 miles (Central Station – Manors).

The scheme of the Seventh Stage of Development is demonstrated on the Figure 11.

The Eighth Stage of Development.

Branches of radial lines:
”AIRPORT – PONTELAND”;
”BANK FOOT – HAYMARKET”;
”HOWDON – PORT”;
”SOUTH SHIELDS – TYNEMOUTH”;
“REGENT CENTRE – LONGBENTON”.

Distances between stations: Airport (the Expand operating station – the Interchange node) – *1,600 km / 0,99 miles* – Ponteland (the New station). Bank Foot (the Rebuild operating station – the Interchange node) – *1,115 km / 0,69 miles* – Kenton (the New station) – *1,875 km / 1,17 miles* – Haymarket (the Rebuild operating station – the Interchange node). Howdon (the Rebuild operating station – the Interchange node) – *0,850 km / 0,53 miles* – Port (the Expand operating station – the Interchange node). South Shields (the Expand operating station) – *0,495 km / 0,30 miles* – Best View (the New station) – *0,490 km / 0,31 miles* – Tynemouth (the Rebuild operating station – the Interchange node). Regent Centre (the Rebuild operating station – the Interchange node) – *0,825 km / 0,51 miles* – Longbenton (the Rebuild operating station – the Interchange node). On this site (stations and track) produced minimal reconstruction, because there is a connection of stations through the existing Depot.

The location of deadlock sections and detour sections: Airport (Deadlock-3) – Ponteland (Deadlock-1). Bank Foot (Deadlock-3) – (Deadlock-3) Kenton – (Deadlock-1) – Haymarket. Howdon – (Deadlock-3) Port. South Shields – Best View – Tynemouth. Regent Centre – (Detour-1) – Longbenton.

Placements of inputs and outputs from streets to underground antechambers of new stations: Ponteland (*on the Middle Drive, between The Wynde and Sycamore Avenue*), Kenton (*on the Houghton Avenue, near the Community Centre*), Best View (*on the New Tyne Bridge*).

Basic data on the lines of the Eighth Stage of Development.

The length of lines – 8,175 km / 5,08 miles.
The number of stations – 12:

- new stations – 3 (Ponteland, Kenton, Best View);
- rebuild operating stations – 7 (Bank Foot, Haymarket, Howdon, South Shields, Tynemouth, Regent Centre, Longbenton);
- expand operating stations – 2 (Airport, Port).

The number of interchange nodes – 8:

- at new stations – 0 (-);
- at operating stations – 6 (Airport, Bank Foot, Haymarket, Howdon, Port, Tynemouth, Regent Centre, Longbenton).

The average distance between stations – 1,022 km / 0,64 miles.

The maximum distance between stations – 1,875 km / 1,17 miles (Haymarket – Kenton).

The minimum distance between stations – 0,475 km / 0,30 miles (South Shields – Best View).

The scheme of the Eighth Stage of Development is demonstrated on the Figure 12.

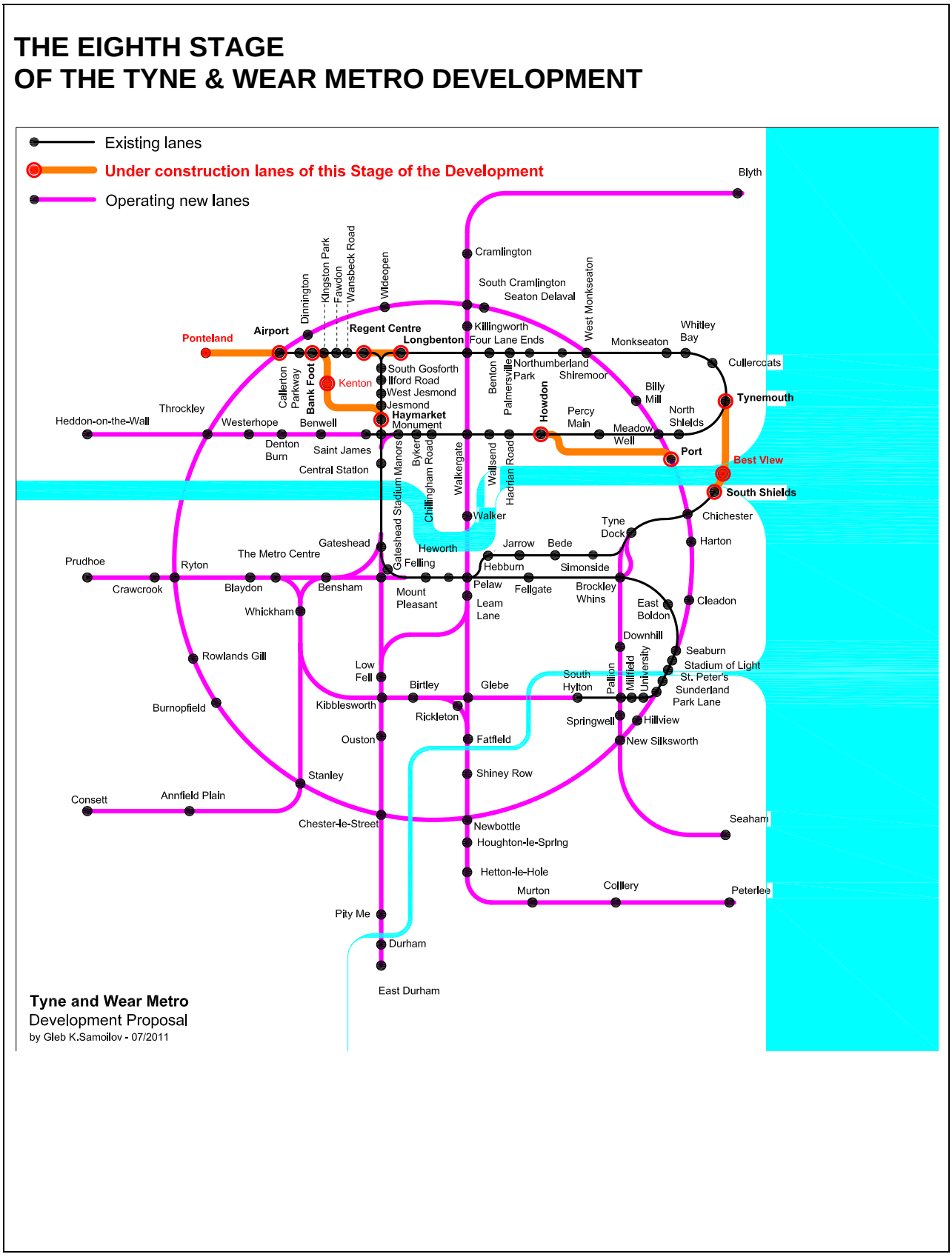

Figure 12.
The Eighth Stage of the Tyne & Wear Metro Development

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

After completing the bulk of the work on the Eighth stage of the Tyne and Wear Metro Development appropriate to make underground and most of the existing Metro lines. It can be classified as the **Ninth Stage of the Development or the Final Part of the Eighth Stage.**

In this trace does not change.

Underground will be the following sites: AIRPORT – Callerton Parkway – Bank Foot – Kingston Park – Fawdon – Wansbeck Road – REGENT CENTRE; SOUTH GOSFORTH – Ilford Road – West Jesmond – JESMOND; LONGBENTON – Four Lane Ends – BENTON; PALMERSVILLE – Northumberland Park – Shiremoor – West Monkseaton – Whitley Bay – Cullercoats – Tynemouth – North Shields – Meadow Well – Percy Main – Howdon – Hadrian Road – Wallsend – Walkergate – Chillingham Road – Byker – MANORS; HEBBURN – Jarrow – Bede – Simonside – TYNE DOCK – Chichester – SOUTH SHIELDS; PELAW – Fellgate – BROCKLEY WHINS – East Boldon – Seaburn – Stadium of Light – SAINT PETER'S; MILLFIELD – Pallion – SOUTH HYLTON.

No change in ground situation will remain the following sites: REGENT CENTRE – LONGBENTON – SOUTH GOSFORTH – REGENT CENTRE (connection to the Depot); BENTON – PALMERSVILLE, GATESHEAD STADIUM – Felling – Heworth – PELAW (connections with the Railway network).

The tunnels are performed in small depth with underground stations and lobbies. On the surface leaving only the pavilions for Entry & Exit. The construction of new tunnels directly on the route of the old land routes is of great social and economic importance. Economic benefits include the possibility for building works "open way" on a prepared site. Social benefits include preservation of the usual location for the residents of Metro stations.

The scheme of the Ninth Stage of Development is demonstrated on the Figure 13.

The result of consistent implementation of the Project is the Developed Network of the Tyne & Wear Metro. It allows you to solve the problem of convenient transportation access to the entire North-East Region.

GENERAL INDICATORS OF THE TYNE & WEAR METRO DEVELOPED NETWORK:

The total length of new lines – 138.810 km / 85.25 miles.

The total number of new stations – 57.

The average distance between stations – 1.633 km / 1.01 miles.

The maximum distance between stations – 4.535 km / 2.82 miles.

The shortest distance between stations – 0.475 km / 0.30 miles (the original Station "Best View" at the New Bridge).

The total number of stations after the Eighth stage of Development – 117 (before the First stage of Development – 60).

The average distance between stations – 1.491 km / 0.92 miles (before the First stage of Development – 1.359 km / 0.84 miles).

The total number of developed operating stations – 24.

The number of interchange nodes – 40:

- at new stations – 18;
- at developed operating stations – 22.

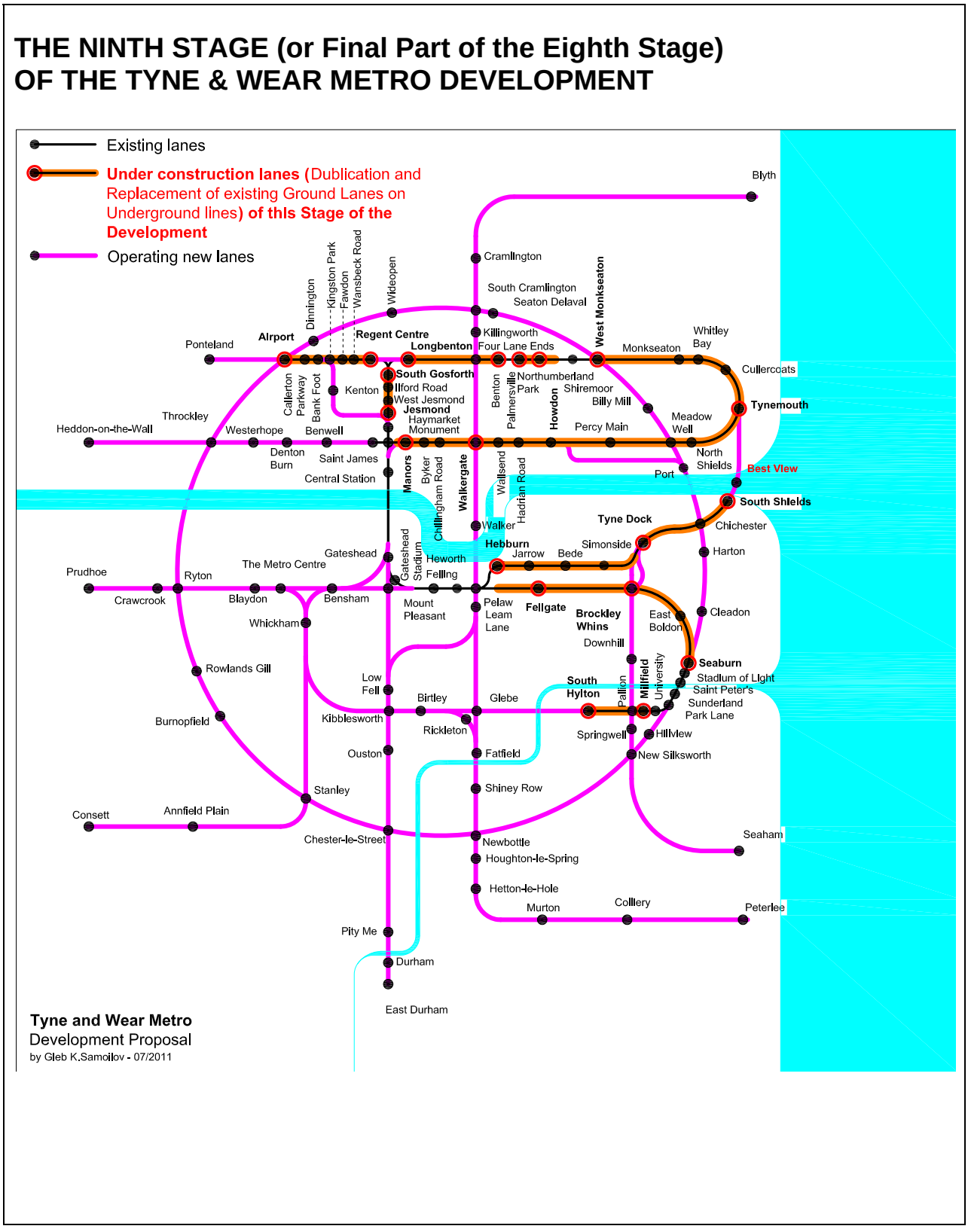

Figure 13.
The Ninth Stage (or the Final Part of the Eighth Stage) of the Tyne & Wear Metro Development.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

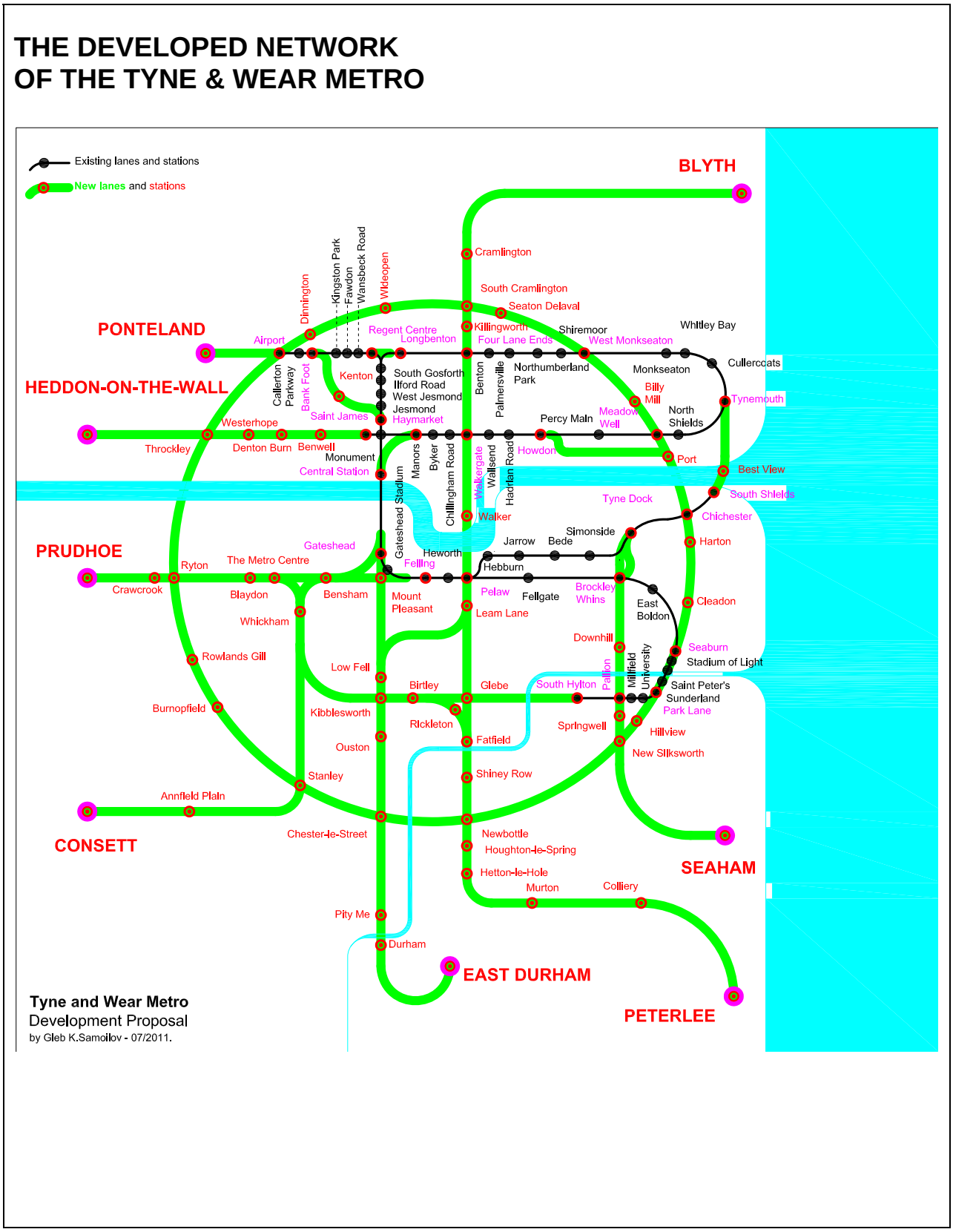

Figure 14.
The Developed Network of the Tyne & Wear Metro.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

Indicated implementation period is 15 years (10 km / 6.2 miles per year).

Finance the First phase can be carried out on the basis of a loan guaranteed by the Government. After the First phase will gradually increase the investment attractiveness of the Tyne & Wear Conurbation. You will be able to organize Joint-Stock Company, for example.

The scheme of the Tyne & Wear Metro Developed network is demonstrated on the Figure 14.

3. The Determination of the optimal Fare system in the Metro

The existing Tyne and Wear Metro system uses the Zone-Time-based fare collection system. Passengers are several types of payment for transport services [13].

In the Developed network of Metro may use the zone system of fare payment. The scheme of the Tyne & Wear Metro Developed network Fare zoning is demonstrated on the Figure 15.

But in operation extensive network of Tyne and Wear Metro with the Ring-Radial scheme pattern conservation zone-time-based fare collection system is impractical.

Set of ring, ring-radial and radial routes in the presence of multiple interchanging nodes complicated zoning. The complex zoning of inconvenience for passengers and personnel of the Metro:

- Confusion in determining the cost of travel in a few areas;
- In the growth of many types of tickets;
- Significantly more complex control is correct fare at the exit of the metro station;
- When necessary to change the route the passenger is unable to pay the fare, which leads to a formal violation of the rules of a passenger fare to travel.

To develop a network of Tyne and Wear Metro is optimal transition from zone-time payment to get to the same price, regardless of trip distance and travel time. This ensures the delivery of a passenger from any station to any station at any time of day and night.

As a single price is advisable to apply the value of £ 2.00. This value is reasonable for the following reasons.

Firstly, the passenger need not rely on entering the fare, which provides psychological comfort.

Secondly, the price of £ 2 is close to the average ticket price all zones: (£ 1.50 + £ 3.00):2 = £ 2.25.

Thirdly, the price increase for the first zone and a decrease in prices for the second and third zone does not reduce the total income from ticket sales. Ease of use ensures revenue growth due to the increased attractiveness of the underground, because the level of comfort and speed of movement of the subway is more convenient for the transfer with the route on the route is no need to pay for further travel.

Fourthly, the price can be applied as a token to pass through the turnstile coin “£2” (Given the possible increase in fares for the planned project for 15 years – eight stages of development – two coins “£2”).

Fifthly, use as a token in the turnstile coin “£2” (or, potentially, two coins for “£2”) accelerates the passage of passengers through the anteroom (this is important in providing patrol a large number of participants in events at stadiums and concerts, shopping centers and in places of public entertainment).

Sixthly, the transition to the Coin payment of the entrance (1 for “£2” or 2 for “£2”) provides significant cost savings due to not having to print a paper ticket.

Seventhly, for the convenience of passengers simplified system of exchange of coins and banknotes.

THE POSSIBLE FARE ZONING
OF THE TYNE & WEAR METRO DEVELOPED NETWORK

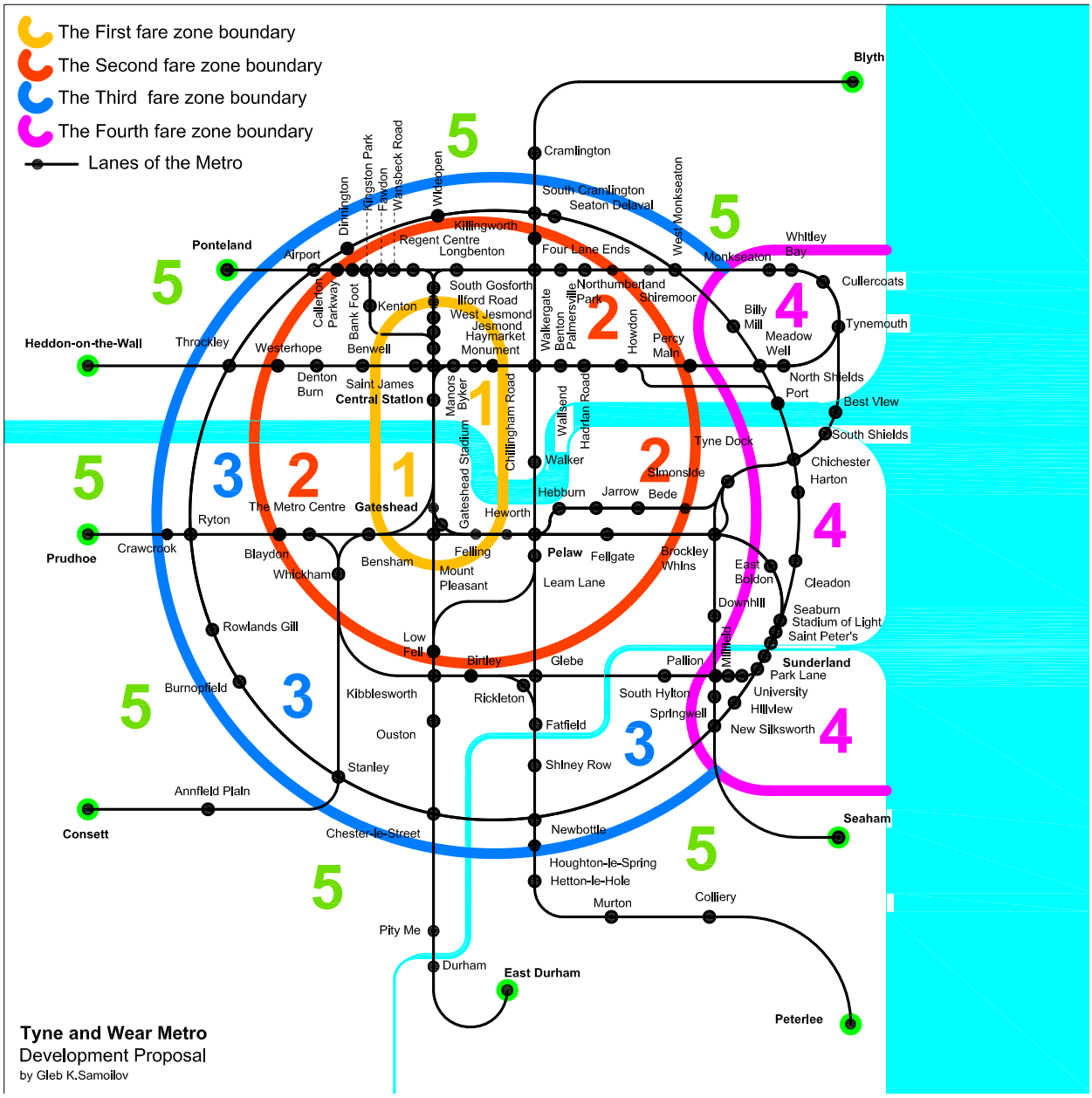

Figure 15.
The possible Fare Zoning of the Tyne & Wear Metro Developed Network.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

Eighthly, reduced cost of travel, as a simplified system of exchange of coins and bills provided less intelligent machines that have less value and require a less complex service system.

Ninthly, much simpler and cheaper system of entry control passengers.

Tenthly, the need to monitor fare payment at the exit of passengers is eliminated.

Eleventhly, there is no need to restrict the use of single ticket time (90 minutes). Most of the passengers travel on a particular route. The number of “metro-tourists”, which riding the Metro three or four hours, is minimal.

If necessary, documentary evidence of travel on the Metro to the financial or legal accountability (not more than 1% of passengers) can be printed from the existing surveillance cameras data in places of entry and exit of the Metro and landing, the entering the train with time.

The use of the Coin system of payment of travel does not exclude the presence of a developed system of “Only Metro” or “All Conurbation Transport” multiple, daily, weekly, monthly, seasonal and annual tickets. Passengers with these electronic tickets get to the station through the turnstiles, or the common portals of the Barrier-free environment system.

4. The Route set of the Metro

Work of the integrated Ring-Radial network of Tyne and Wear Metro is based on a set of several dozens of routes. As a result of the extensive network of Tyne and Wear Metro, forming a Ring-Radial scheme, is a possibility of over a hundred routes. Routes are used in various combinations, depending on time of day, day of week or the season.

The existing four routes of operating Metro system is an integral part of the set of possible routes of the developed Metro network. The position of existing routes in the Developed Metro network is shown in Figure 16. They are the basis for the formation of new routes, which will appear as the implementation of the First, Second, Third, Fourth, Fifth, Sixth, Seventh and Eighth stages of the Development.

From the set of possible 56 routes were selected, which are optimal for the smooth operation of Metro. All these routes are for the one-direction movement of trains. The routes are named by approximately configurational associations. Route numbers are given in order of their mention in the text. Results indicated:

- “The Ring” type – 4 routes;
- “The Big Loop” type – 4 routes;
- “The Complex Loop” type – 8 routes;
- “The Simple Loop” type – 16 routes;
- “The Radial Wave” type – 24 routes.

5. Special and Complex routes of the Metro

Complemented to regular daily routes there are periodic or occasional routes, which are organized to serve the participants of public gatherings in stadiums, racetracks, concert halls, shopping malls, places of public recreation, marine and river embankments, parks, streets and squares. If necessary it is can organize one-time emergency routes.

A separate group is “long” loop-shaped and ring-shaped night routes. They depart once an hour or a half an hour, and allow passengers to serve in such situations as:

EXISTING ROUTES
IN THE TYNE & WEAR METRO DEVELOPED NETVORK

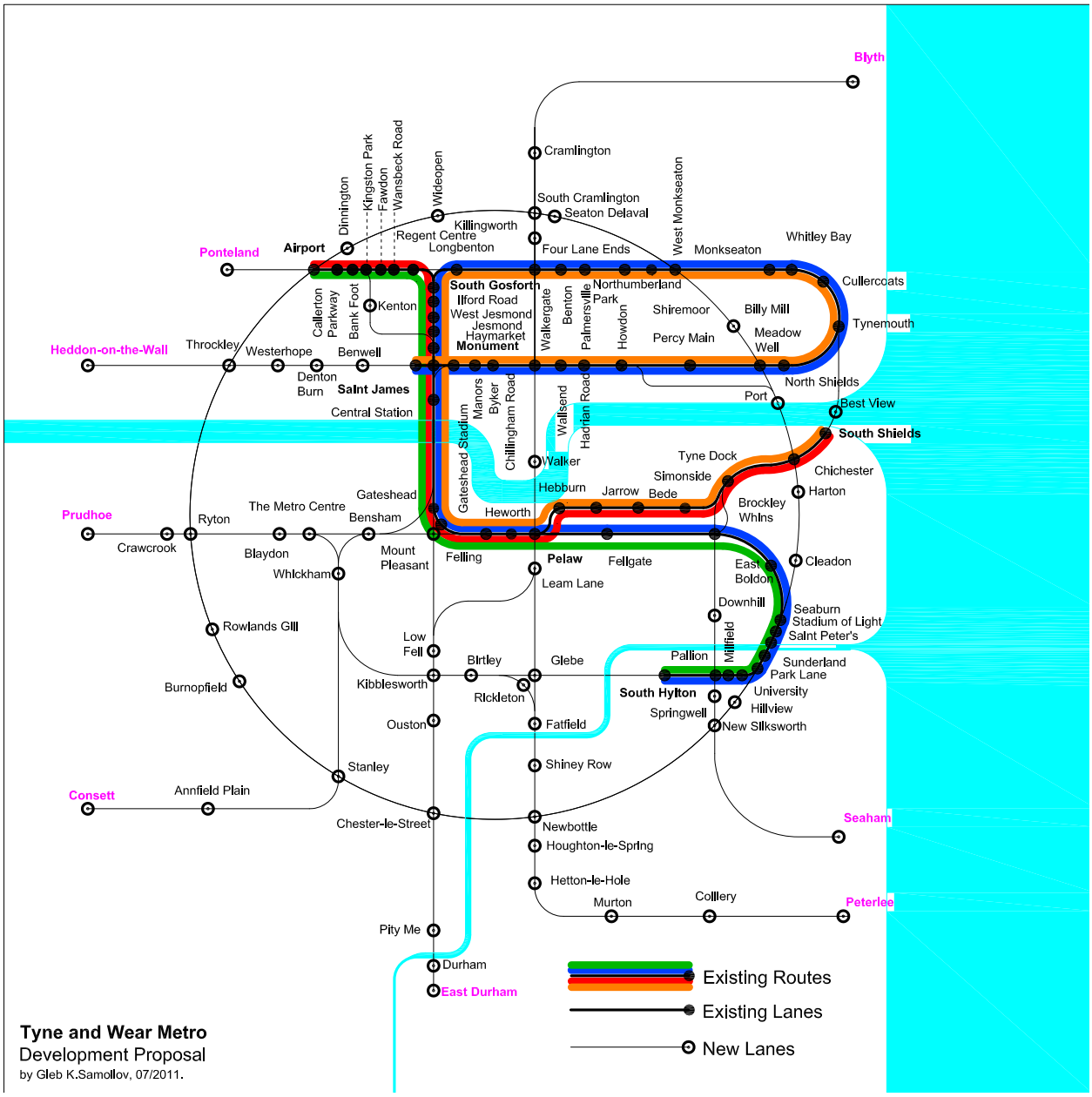

Figure 16.
Existing routes in the Tyne & Wear Metro Developed Network.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

THE COMPLEXLY RING ROUTE
IN THE TYNE & WEAR METRO DEVELOPED NETWORK

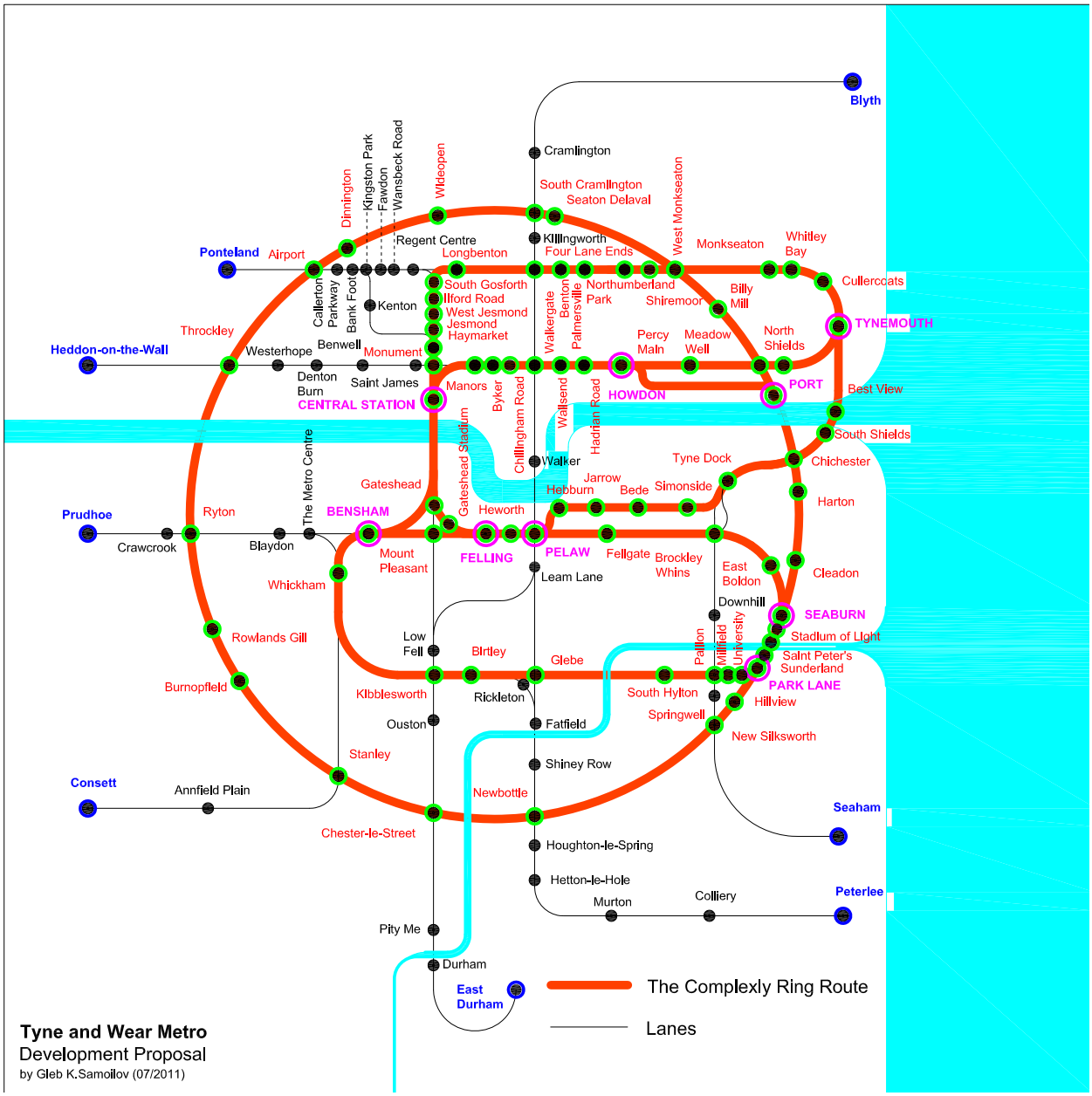

Figure 17.
The Complexly Ring Route in the Tyne & Wear Metro Developed Network.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

- the arrival or the departure with rail stations, airport, port, bus stations;
- the later end of work or leisure activities;
- the early start of work;
- various other situations.

Features of this Ring-radial system allow you to combine multiple routes into one.

For example, the four ring routes – can be combined:

- "The Grand Ring" – (*SUNDERLAND – SOUTH CRAMLINGTON – RYTON – CHESTER-LE-STREET – SUNDERLAND*);
- "The North Tyneside Ring" – (*SOUTH SHIELDS – WEST MONKSEATON – SOUTH GOSFORTH – PELAW – SOUTH SHIELDS*);
- "The Small Ring" – (*PELAW – SEABURN – GLEBE – WHICKHAM – PELAW*);
- "The South Tyneside Ring" – (*CENTRAL STATION – PORT – GLEBE – WHICKHAM – CENTRAL STATION*).

These Ring routes intersect and overlap, so it is possible to make "The Grand Passage" around the four rings. May can be organized "THE SUPER ROUTE": "The Grand Ring" – **Park Lane** – "The Small Ring" – **Park Lane** – "The South Tyneside Ring" – **Central Station** – "The North Tyneside Ring" or in reverse order. The scheme of this Complex Route is shown in Figure 17.

The journey can be started or finished on the Radial line in Seaham or Peterlee, or Consett, or Prudhoe, or Heddon-on-the-Wall, or Ponteland, or East Durham. And from East Durham it is possible to reach Blyth through Pelaw, Wallsend, and Cramlington.

The proposed scheme of lines with deadlock section and detour sections at most stations can organize the Stable Day-and-Night work of the Tyne and Wear Metro.

6. The Improving of the environmental protection system in the aspect of the Metro Development

Surface location of the Tyne & Wear Metro lines has a negative impact on the environment and complicates the normal operation of road transport: Electromagnetic radiation; Noise impact; Single-level crossings create traffic delays and increase the level of emissions due to the acceleration of vehicles after the intersection.

Tyne & Wear Metro operating lines occupy about 4.0 square kilometers of territory. Part of this territory is located among residential areas. Further development of the Tyne & Wear Metro location at ground lines still require 10.0 – 12.0 square kilometers of territory.

Laying the lines on existing streets is impossible. Demolition of houses and public buildings, the destruction of historical monuments and parks, changing the natural landscape for the construction of new lines in principle unacceptable. The Tyne & Wear Metro network only involves the construction of underground lines.

After completion of the Tyne & Wear Metro line of the existing ground leaving only the following sites:

- Regent Centre – Longbenton – South Gosforth (exit metro-trains in tunnels at the Depot);
- Benton – Palmersville and part of the site of the Northumberland Park – Shiremoor (exit metro-trains to Regional rail system);
- Gateshead Stadium – Felling – Heworth – Pelaw – a bifurcation in Hebburn and Fellgate (exit metro-trains to Regional rail system and the site of joint operation of the Tyne & Wear Metro and Regional railways);

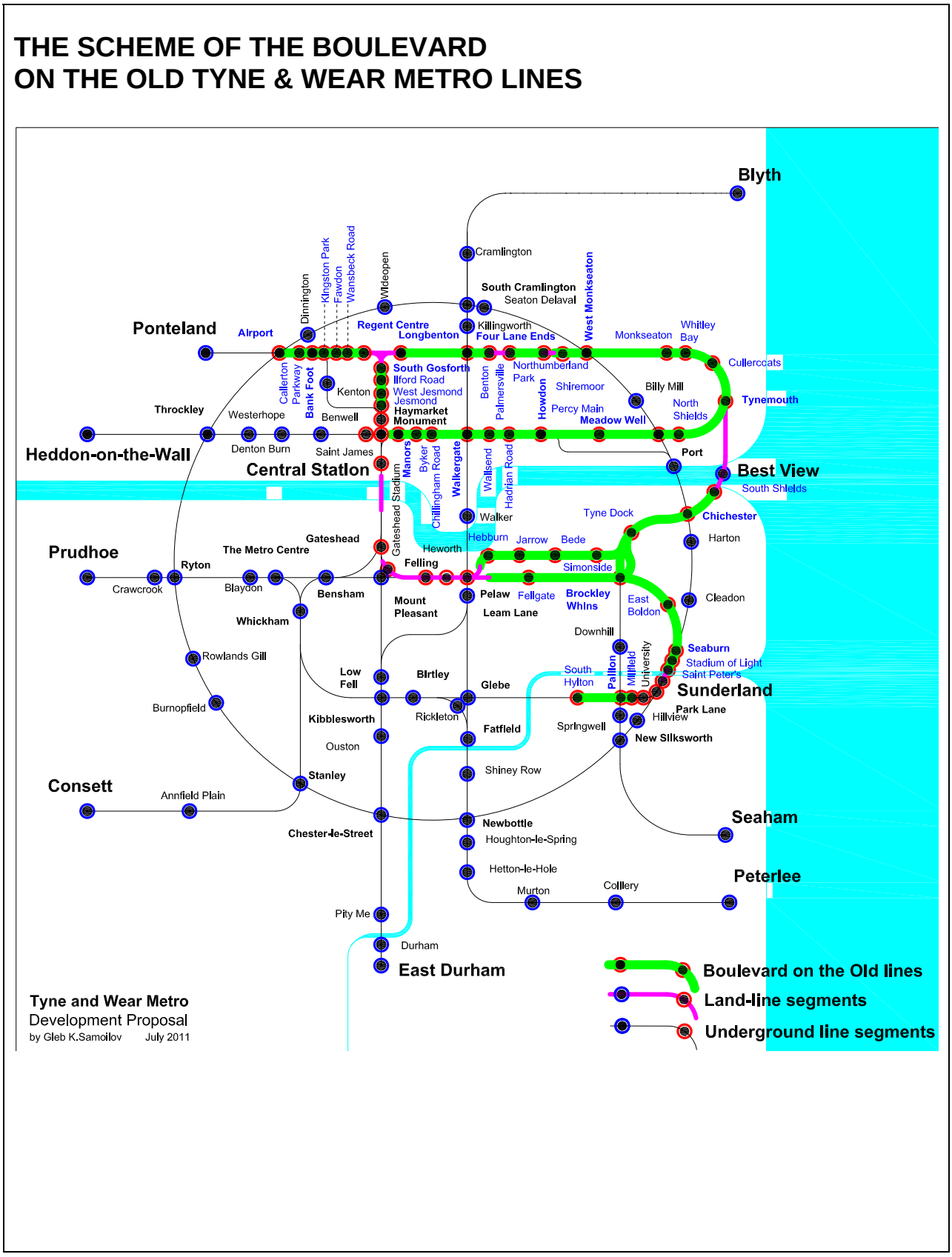

Figure 18.
The Scheme of the Boulevard on the Old Tyne & Wear Metro lines.

Images source:
Drawing of the Author of the Tyne & Wear Metro Development proposals – Gleb K.Samoilov (July, 2011).

- the Existing Bridge over the River Tyne (Central Station – Gateshead segment);
- the Existing Bridge over the River Wear (segment near the station Sunderland);
- the New Bridge over the River Tyne with the Best View Station at South Shields – Tynemouth segment.

Other sites that prior to the intensive construction of the TYNE & WEAR METRO lines were occupied land, I consider it expedient to turn to beautiful parks charming boulevards:

- *AIRPORT – Callerton Parkway – Bank Foot – Kingston Park – Fawdon – Wansbeck Road – REGENT CENTRE*;
- *SOUTH GOSFORTH – Ilford Road – West Jesmond – JESMOND*;
- *LONGBENTON – Four Lane Ends – BENTON*;
- *PALMERSVILLE – NORTHUMBERLAND PARK*;
- *SHIREMOOR – West Monkseaton – Monkseaton – Whitley Bay – Cullercoats – TYNEMOUTH*;
- *MANORS – Byker – Chillingham Road – Walkergate – Wallsend – Hadrian Road – Howdon – Percy Main – Meadow Well – North Shields – TYNEMOUTH*;
- *HEBBURN – Jarrow – Bede – Simonside – Tyne Dock – Chichester – SOUTH SHIELDS*;
- *FELLGATE – Brockley Whins – East Boldon – Seaburn – Stadium of Light – SAINT PETER'S*; - *MILLFIELD – Pallion – SOUTH HYLTON*.

Here, between the entrances to the underground subway station will be built convenient pedestrian paths and bicycle paths, planted trees and shrubs, lawns and arranged flower beds, put benches and light pavilions, playgrounds for children and places of quiet rest. The scheme of this Boulevard is shown in Figure 18.

3.5 square kilometers the most valuable territory in the form of beautifully landscaped green spaces will be return to the Tyne and Wear Conurbation. These plots of land alienation Tyne & Wear Metro lines previously used inefficiently and are environmentally harmful.

The Beautiful BOULEVARD ON THE OLD TYNE & WEAR METRO LINES will decorate of the Tyne and Wear County area.

THE CONCLUSION

The existing system of Tyne & Wear Metro should develop. Now 350 000 inhabitants of the Tyne & Wear County, and 290 thousand inhabitants of County Northumberland and County Durham, who work, rest, study, shop, use the airport, port and railway stations do not have easy access to Metro. This is according to 2001 census. By 2025 this figure could reach 2,5 million.

I propose a phased development of the network of the Tyne & Wear Metro in the form of a complex of new lines, which are combined with the current ones.

1. The Ring line (Seaburn – Chichester – Port – Meadow Well – West Monkseaton – South Cramlington – Airport – Throckley – Ryton – Stanley – Chester-le-Street – Newbottle – New Silkworth – Park lane). The Ring line length 40,23 km / 24,99 miles .
2. Radial lines and connecting sections. End stations Blyth, Ponteland, Heddon-on-the-Wall, Prudhoe, Consett, East Durham, Peterlee, Seaham. The total length of Radial lines and connecting sections 98,58 km / 61,26 miles.

Bridges are a very important aspect. Now the only Metro Bridge makes it impossible to carry out repairs without disrupting the right bank and left bank of the Tyne River. The proposed scheme has three tunnels under the River Tyne and the New Bridge.

Option is convenient for passengers and the maintenance of the Radial-Ring System is proposed for the Tyne & Wear Metro. In the proposed scheme is able to organize 56 convenient routes. Different combinations of these routes by time of day, weekdays, seasons allow most comfortable for passengers work of Metro.

Also in the proposed scheme is the possibility of organizing a one-time or occasional combination of routes. This need may arise during the evening festivities, night or holidays.

Implementation should be divided into 8 or 9 stages. Indicated implementation period is 15 years (10 km / 6.2 miles per year).

Considering environmental issues, minimizing land use, the convenience of the construction and operation works, the possibility of optimal track routes usage, I consider it necessary to make all new lines as underground.

Ease of passenger communications will increase the investment attractiveness of individual settlements and the region as a whole. In combination with an 250% increase in passenger traffic in Metro network, which will offset the costs of construction and operation.

The **Development Strategy of Bus service** [14] does not interfere with the development of the Metro. Convenient delivery of passengers to the nearest metro station makes it possible to reduce the number of "long" bus routes. From the standpoint of economic efficiency it is more profitable.

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