masterconcept understanding projects

Project "Greening 2014 Sochi Olympics: A Strategy and Action Plan for the Greening Legacy"

Stage II – Transport Improvements & Systems

August 31st, 2012_FINAL

CONTENTS

1 DESCRIPTION AND JUSTIFICATION OF PROJECT PROPOSALS

Name of the project

"GREENING 2014 Sochi Olympics: A Strategy and Action Plan for the Greening LEGACY"

Subtask

Quantitative assessment of the current Sochi transport situation and the proven sustainable improvement steps on operational and technical levels.

Problem Statement on transportation & mobility related issues

Transportation and especially motorized transport causes dramatic pollution and reduction of life quality in Sochi. The development of increasing traffic will get worse in the coming years and radical measures need to be implemented on various fronts.

The collapse of individual traffic on the main corridors will force a change of philosophy of how mass mobility is handled in Sochi.

The project's targeted solutions will have a large positive impact on reducing GHG emission.

It is of high importance to visualize and state the current (2012 transport analysis) dramatic transport situation, including the anticipated outcome if no effective counter measures are taken.

It is necessary to have a close look at the current daily "driven km" in the Sochi region mainly caused by an inefficient public transport system and unlimited access for every individual vehicle to each part of the city.

Alternative, sustainable concepts have to be proposed to avoid complete traffic collapse.

2 TECHNICAL DESCRIPTION OF ALTERNATIVE TRANSPORT SCENARIOS

The city of Sochi is located in an attractive area surrounded by the Black Sea and the mountains of the Caucasus. Every year **more than 4 million tourists** visit Sochi because of the sandy and gravel beaches, the subtropical climate and its vegetation, its spas, numerous parks and monuments. Beyond this Sochi will be the host city for the **Olympic & Paralympic Winter Games** in 2014, the FIFA **World Cup** in 2018 and the **Formula 1 Grand Prix of Russia from 2014 onwards**.

Nowadays the city of Sochi is one of the most popular resorts in Russia. At the same time, these years the City is being positioned and gradually moves towards the world class tourist center. The changes became even more rapid after Sochi became the Host City for the 2014 XXII Olympic Winter Games and XI Paralympic Winter Games.

This positive evolution will require adjustments in the management of transport infrastructure. In addition to the various number of road and rail construction projects it is of great importance to develop and optimize neighborhood areas in the main districts of Sochi with focus on parking and pedestrian traffic.

The city of Sochi has grown dramatically in the past years and due to its topographical limitations the increasing traffic volume cannot be managed any more at several periods of the day.

This means that the Municipality of Sochi needs to implement fundamental changes in the city in terms of parking management, traffic restrictions and intermodal public transport offers.

Sochi faces similar problems as hundreds of touristic cities of same size around the world. This report is an explanation of latest international experiences, conclusions and possible recommendations for urban mobility and city management.

A summary of objectives and proven solutions should lead the Sochi city administration to an understanding of the necessary steps. Some of these steps will be unpopular and require good implementation, communication and education.

But Sochi will remain a tourism hot spot in the coming decades and the current (Olympic) city leaders need to design for the future.

<u>On site studies and work in Sochi consist of:</u>

- defining centres and areas of managed restrictions,
- providing solutions for residential, touristic and commercial traffic,
- improving urban space, mobility and accessibility,
- developing a well thought parking and mobility plan through “push & pull” measures.

2.1 CHANGE OF TRANSPORT PHILOSOPHY

Best results towards sustainable transport could be achieved by using policy combinations, i.e. “push” and “pull” measures that consist of car pricing policies, improvements of public transport and support of land use policies. Policy combinations generate synergies and therefore produce better results than the sum of the individual policies applied alone.

“Push” measures are those imposed on travelers with a view to influencing individual travel decisions. These can be divided into financial instruments (e.g. higher fuel taxes, car parking charges and road tolls) and technical and regulatory constraints (e.g. traffic orders, removal of parking space and ban of vehicles). “Push” measures are closely related to more efficient and equitable transport pricing which seeks to require transport users to bear a greater proportion of the real costs of their journeys, including costs of pollution, accidents and infrastructure.

“Pull” measures are designed to encourage a reduced usage of the car by making alternatives more attractive. These measures include a better coordination of buses, trams or trolleybuses, and rail systems and also proper integration with transport planning. But, on their own, “pull” measures alone are not always sufficient to effect a change in transport patterns and a mix of “push” and “pull” measures is, therefore, often needed.

“Pull” measures generally increase people’s opportunities: the alternatives improve or new alternatives are created, which implies that individual freedom of choice is not restricted and even enlarged. For example, cheaper public transport services increase people’s opportunities to travel by this mode, while the opportunities to travel by car are not affected. “Push” measures, on the contrary, regulate people’s behaviour in such a way that their options and freedom to move are restricted to some extent, since car use becomes less attractive. Social acceptability may often depend on whether the proposed strategy comprises “push” of “pull” measures. On the one hand, “pull” measures tend to be popular, and may encourage, for example, an increase in the use of more sustainable modes of transport. On the other hand, many people are reluctant to give up the perceived freedom associated with owning and using private car and thus “push” policies tend to be unpopular. Appropriate “push” and “pull” measures can be applied at regional, national and local levels. At national and local levels “push” measures could focus on fiscal disincentives for the use of private cars in urban areas and on measures to internalize external costs (user pays principle). “Pull” measures could include provision of funds for public transport infrastructure, the application of fiscal incentives for public transport services and awards for best practice in modal shift to public transport in terms of sustainable urban transport plans.

A total overhaul and change of the transport philosophy is required in order to be able to manage the challenges of the future. The Stage I report has depicted a regional transport system that does not correspond to advanced, international standards and is not capable to cope with current and especially future transport demand in the region of Sochi.

As Sochi aspires to become one of the prime touristic leisure centers, a change in philosophy is even more required. Guests search for relaxation, clean air and physical activity when they choose their holiday destination; not traffic jams and air emissions.

For any city that aspires to be an important tourist destination an attractive walkway and pedestrian area network is of a high importance and value. In Sochi it is necessary to improve the current situation of the pedestrian network. The pedestrian traffic concept will make recommendations for the following development areas.

Current society is characterized by the desire of maximum mobility. There is the idea of being free means being mobile. The current situation leads sometimes to the opposite of freedom as people get caught up in traffic jams. Without protest the society has been spending large amounts of money for fuel, insurances and taxes. Slowly we become aware of how high the price of our "freedom" really is and how deep this desire had influenced the past infrastructure and transport planning.

In an increasing part of the population the factor ‘time’ is being valued higher than it used to be, so that consequently spending time in a traffic jam becomes less acceptable.

PULL and PUSH measures

Ecological awareness campaigns improve the chance for successful political measures relating to traffic. Furthermore it is important to develop a Sochi traffic concept for avoiding and redirecting of traffic. There are different approaches for this concept. In inner-city areas the measures of “push and pull” support the use of pedestrian zones and (e-) bicycles for transportation and gives financial aid to public transport systems. New pricing policies may strengthen such systems (Transport association systems). The system consists of restrictive measures against private transport (PUSH) on the one hand and restorative measures for public transport (PULL), as well as speed-reduced traffic (pedestrians, (e-bicycle, etc.) on the other hand.

Measures with PUSH-Effects

- area–wide parking management
- reduction and cultivation of parking space including access restrictions and fees
- car limited zones
- permanent or time-of-day car bans
- congestion management
- selective speed limits
- road pricing
- extension and increasing the attractiveness of public transport

Measures with Pull-Effects

- design of intermodal linked public bus and rail systems
  (Feeder bus & Spine Line system linked with regional railway systems → intermodal networks)
- priority for buses
- high service frequency
- easy-to-read time tables and clear fare structures
- passenger friendly stops and surrounding structures
- more comfort in travelling and mode transfers
- Park & Ride facilities
- Bike & Ride facilities
- attractive pedestrian connections
- extensive network of bicycle paths
- residential participation processes
- car-sharing initiatives

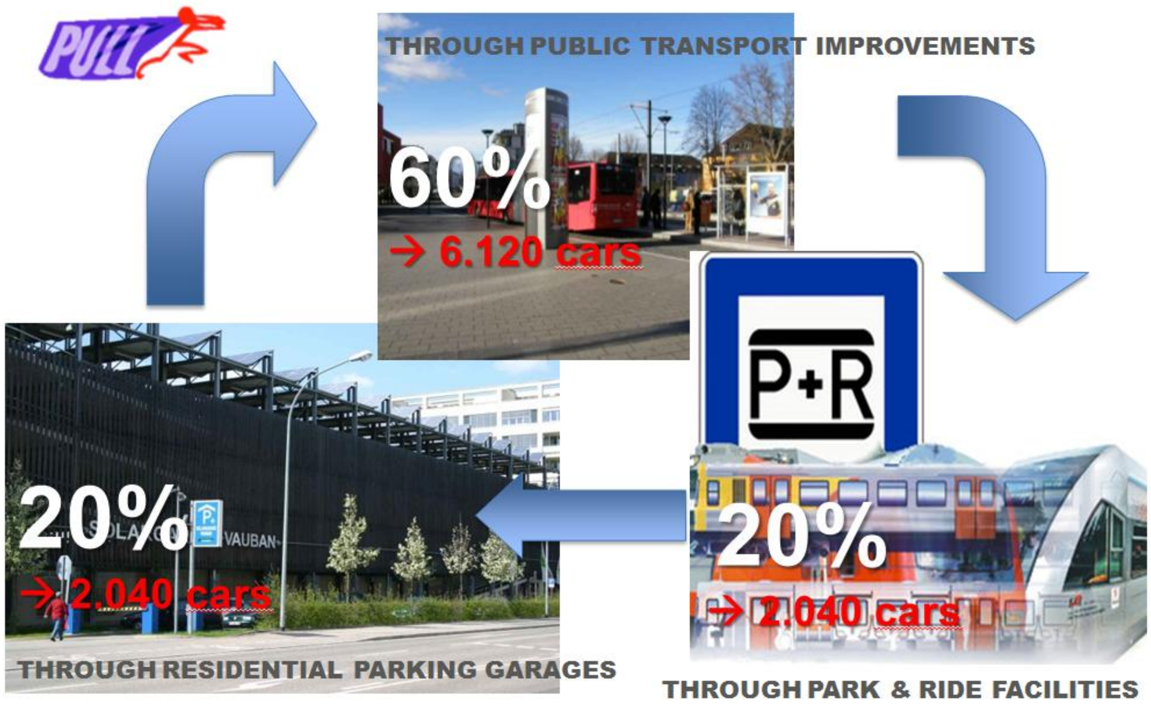

Figure 1: Pull factors

As shown in Figure 1, new measures through combined multi modal systems (e.g. transport improvements, park & ride facilities and residential parking garages) could reach 80% of Sochi residents and passengers. This would significantly improve the overall traffic situation.

2.2 DEVELOPING A SUSTAINABLE INTERMODAL TRANSPORT CONCEPT

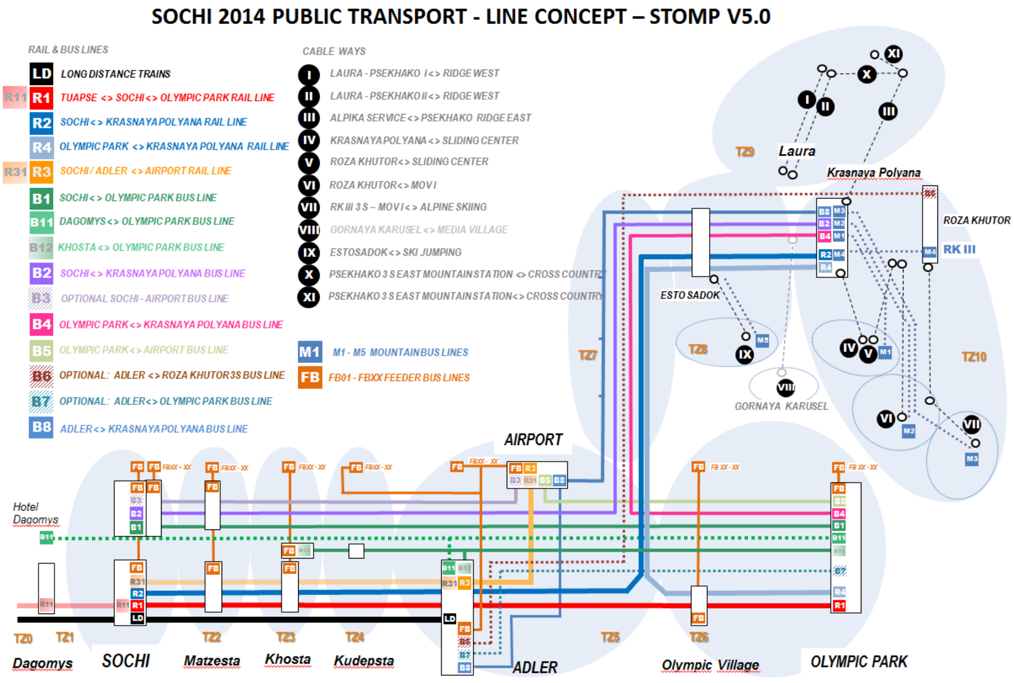

Figure 2: Integrated public transport line concept for Sochi 2014

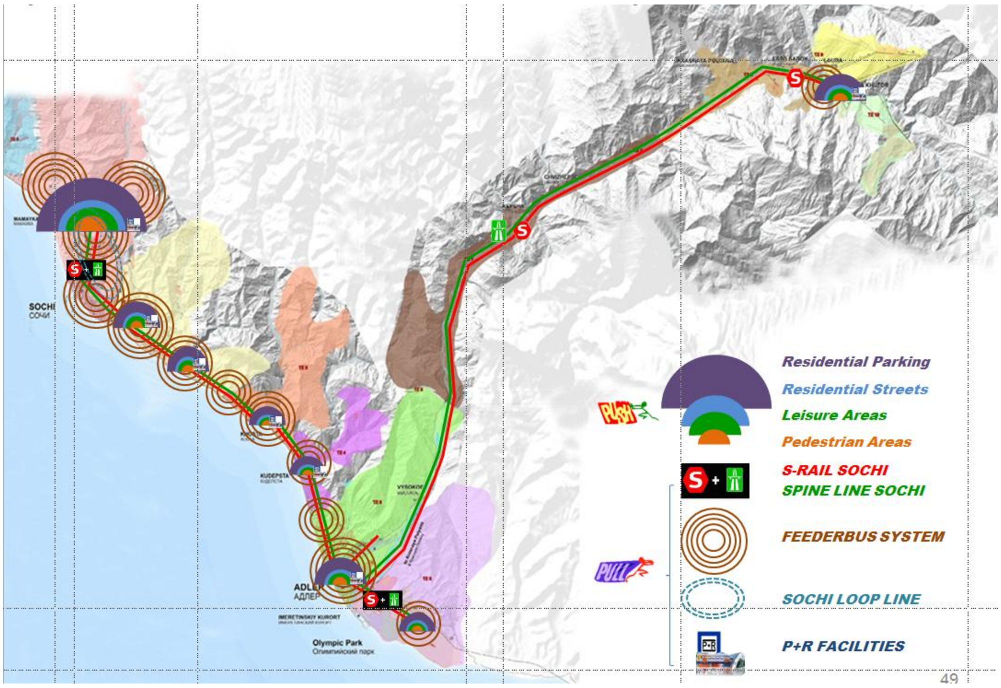

Figure 3: Integrated public and private individual transport for Sochi

2.3 TECHNICAL SOLUTIONS FOR THE IMPLEMENTATION OF A SUSTAINABLE CONCEPT

2.3.1 Detection of peak loads, critical periods and transport system sections

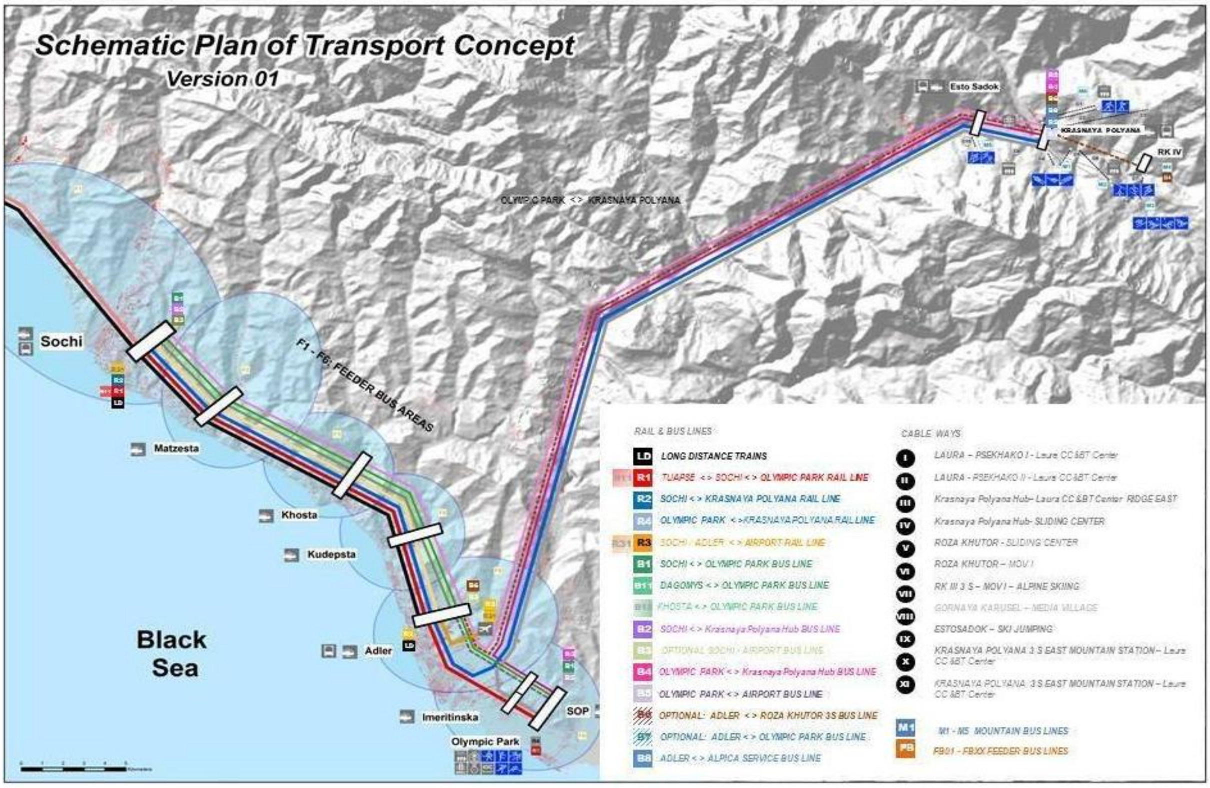

Figure 4: Schematic Plan of Sochi Public Transport Concept

Olympic Public Transport Operational Concept

The major principle of the overall operational concept for the Sochi Olympic Winter Games public transport system is to keep the concept easy and capable. A dual system between train and bus lines will provide a constant flow of passengers.

Furthermore a separation of the rail lines is needed to avoid cumulating delays having a negative influence and may lead to a breakdown of the sensitive parts of the system.

The Adler – Krasnaya Polyana rail connection is mainly a single track line and it is necessary that every train departs from each station within the designed time frame in order to guarantee the designed operational quality. The interval needed to fulfil the Olympic demands on the Adler-Krasnaya Polyana will be a 20 minutes departure interval from Adler mixed with the 60 minute departure interval from Olympic Park with a 15 minute arrival interval in Krasnaya Polyana.

The Sochi – Krasnaya Polyana rail connection is based on long single track sections, which lead to a very sensitive time schedule. Therefore it is necessary that every train departs from each station within the designed time frame in order to guarantee the designed operational quality.

The maximum possible interval based on the planned infrastructure on the Adler-Krasnaya Polyana Line will be 15 minutes and will be determining the capacity.

The base line (connecting Sochi – Adler – Olympic Park) will be operating with a 10 minutes interval. A peak hour increase up to a 4 minutes interval might be necessary for the Sochi-Adler part of the line. It is important that the operating concept of this line will be similar to concepts of metro or underground operation. Having a fully double tracked line (Sochi – Adler) the only critical points will be the turn-around of trains in the end stations and the handling of potential delays when stopping in stations with only one directional platform. Therefore the infrastructure in Sochi, Adler and Olympic Park is being adapted currently.

Direct bus lines will be operating from Sochi Center to the mountains and from Olympic Park to the mountains. There will be another bus line operating parallel to the rail line from Sochi Center to Olympic Park. The buses stop at different points and only connect at certain points to the rail hubs in order to achieve a maximum of a network characteristic.

Between Sochi and Olympic Park there will be feeder bus lines to connect all rail hubs to the area around. They will be operating according to the time table of the trains and spine buses, as well as the size of the catchment area.

For peak hours an additional bus line running parallel to the Adler-Krasnaya Polyana rail line will be established. At Krasnaya Polyana there will be a bus hub, where coastal bus passengers will be transferred to a mountain bus and cable car service system connecting the different mountain venues.

Along the coastal area and in the mountain region a general bus interval of 15 minute is proposed from 6am to 1am. In this base system the spectators and the workforce always know that they can go by bus all over the day without a specific schedule. During peak times the interval of a bus line could be increased to a 1 minute interval at most. These 1 minute intervals always depend on the capacity of the hubs and the venue load and unload zones.

Sochi Public Transport Communications Concept

Visitors' perspective

The key issue for the visitors of Olympic events is:
"How do I get to my event in the fastest and most convenient way?"

With the purchase of the ticket the visitor receives all the necessary information (directions and timetable) in paper and / or electronic format.

Ticket purchase options are:

- Internet,
- travel agency,
- ticket office on the venue,
- vending machines.

Communication to the costumer:

The information on directions consists of:

- a general path network map,
- an individual public network plan to the selected Olympic sporting event based on the visitor's accommodation address.

The schedule consists of:

- a general schedule for rail and bus,
- an individual public schedule for rail and bus to the selected Olympic event based on the visitor's accommodation address.

Technical requirements

- Occupational Mobility Centre
- Schedule-graphics software solutions for all (train- and bus lines, cable cars, roads)

2.3.2 Detailed transport planning of the hubs

The schematic roles of the main coastal and mountain hubs (Sochi main station, Khosta, Matsesta, Adler, Olympic Park, Estosadok, Krasnaya Polyana) have been discussed with the main stakeholders (RzhD, City, Directorate) and the recommendations to use these as points of change from bus to train have been adopted. The necessity of the railway to work as a **regional** transport system has been agreed.

2.3.2.1 Sochi main station hub

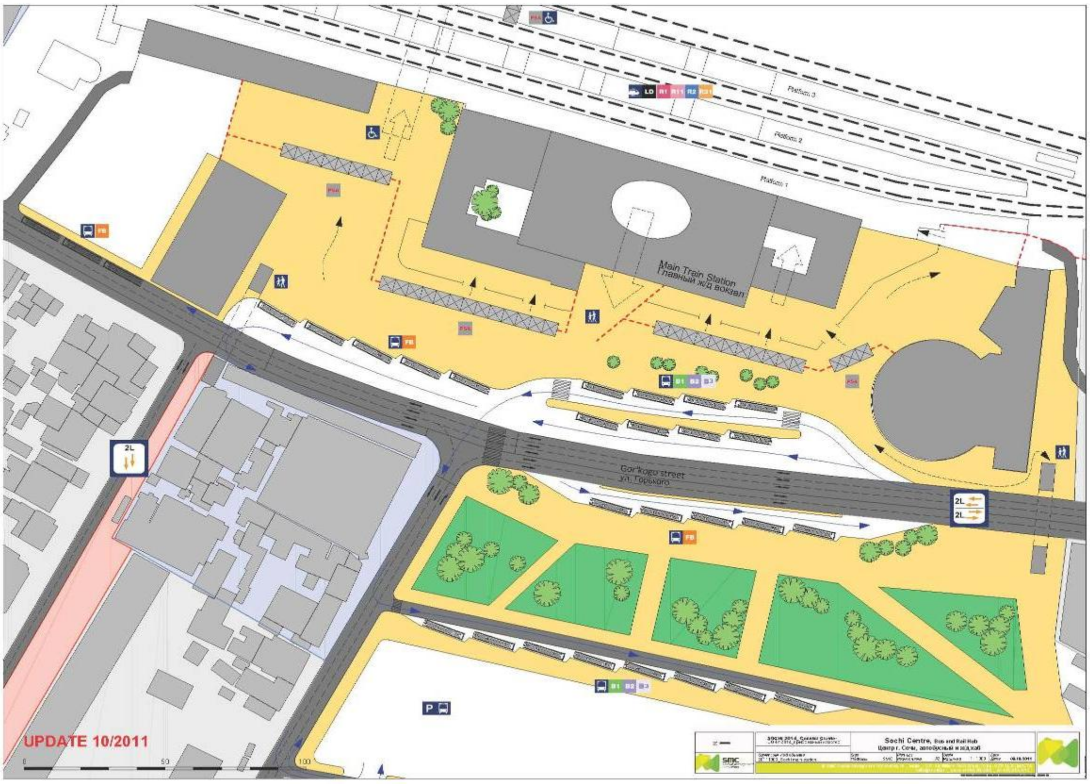

Figure 5: Sochi main station (planned intermodal principles)

Sochi hub works as the main city hub for rail, spine and feeder buses. Due to the security restrictions and the space limitations this hub requires careful studies, e.g. people flow and queuing area simulations.

2.3.2.2 Matsesta hub

Figure 6: Matsesta hub (planned intermodal principles)

The passengers arriving with the feeder bus system at Matsesta hub can either change to the spine line or to the railway. To increase the resident and tourism service quality it is recommended to improve the connection between the railway station, feeder and spine bus lines.

2.3.2.3 Khosta hub

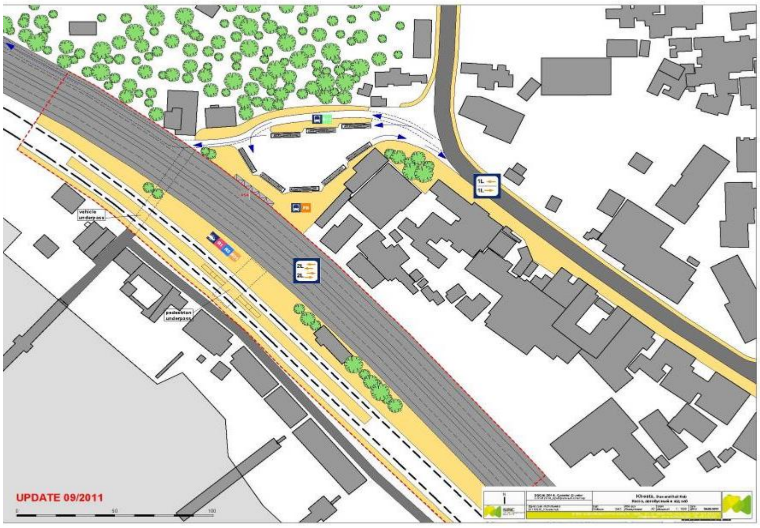

Figure 7: Khosta hub (planned intermodal principles)

Spine buses moving from Sochi do not have a possibility to stop at Khosta hub. For this case a bus line B11 Khosta – Olympic park will be organized.

2.3.2.4 Adler hub

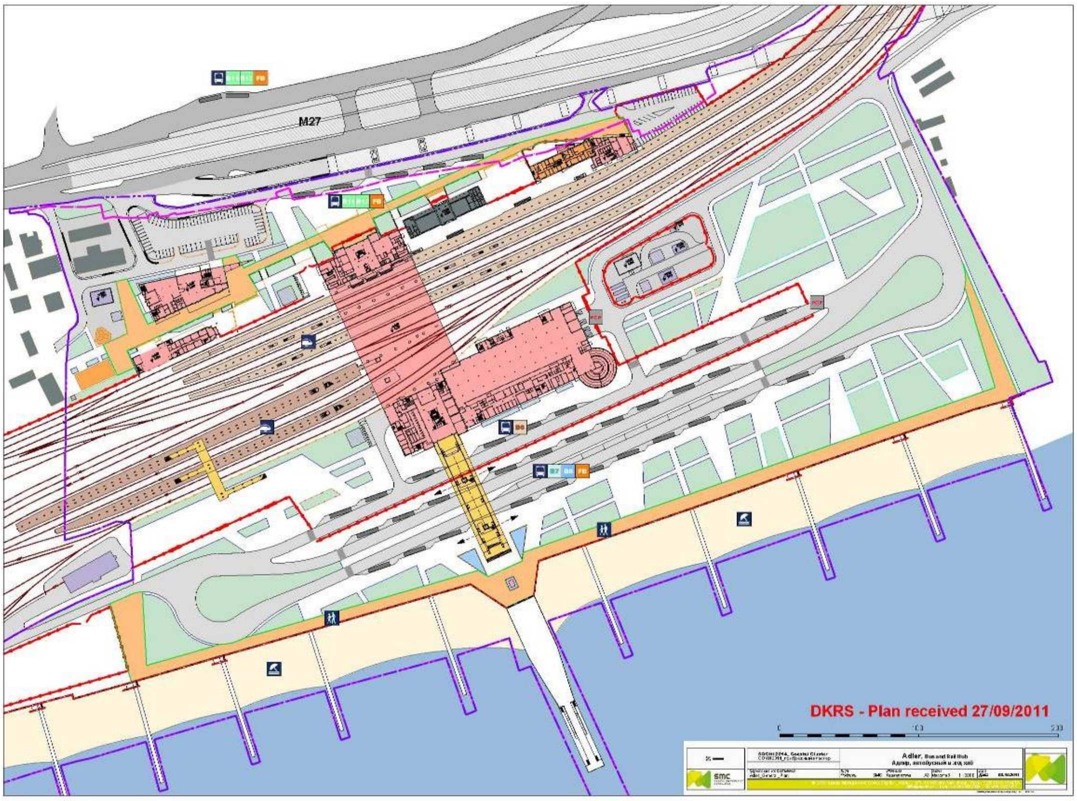

Figure 8: Adler hub (planned intermodal principles)

Adler hub is a combination of a bus and railway terminal.

The main train station is the only railway station that operates in 4 directions (Sochi Centre, Olympic Park, Airport and Krasnaya Polyana) and is therefore the most difficult hub in the coastal system. It is the main transport interchange node for spectators moving among the 3 destinations of Sochi Center, Olympic Park and the Mountain Cluster. It also serves the airport and the residents of the wider Adler region.

The access road system to the Adler hub is limited, because of the traffic intensity (Bus lines B1, B2, B3, B6, B7, B8, B11, B12, FB). Therefore a good traffic management must be organized at the peak Games time.

2.3.2.5 Olympic Park hub

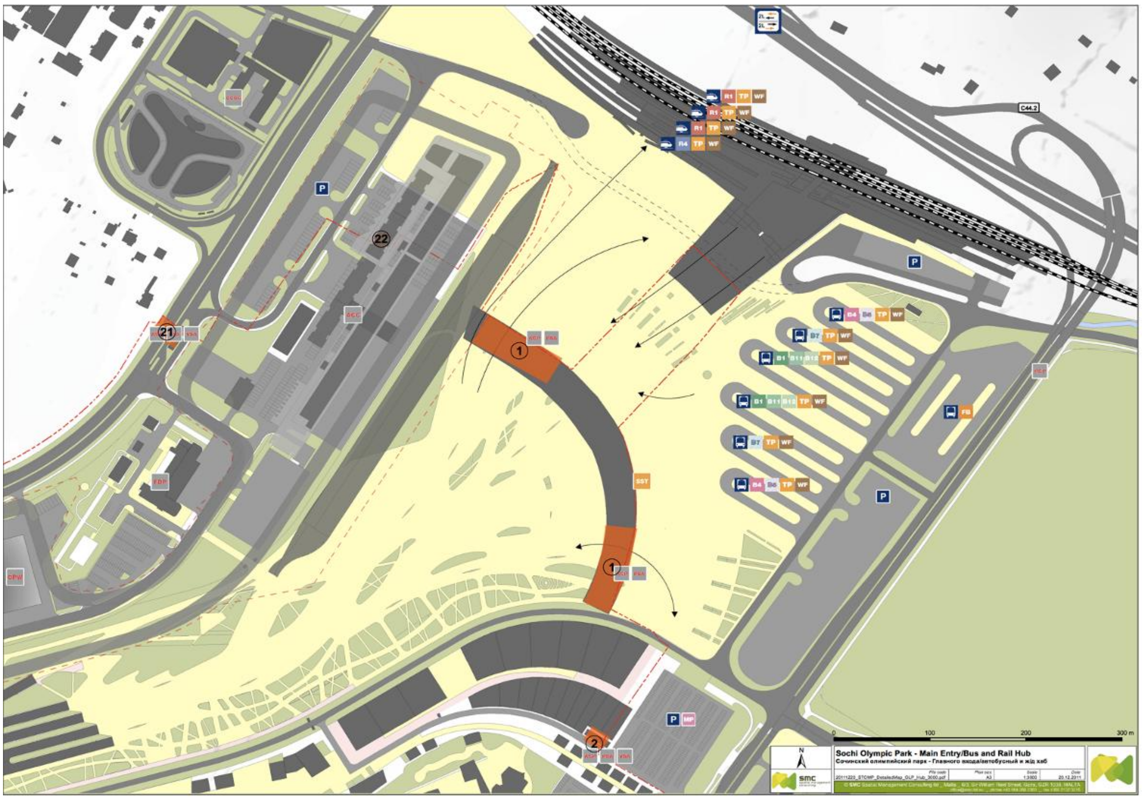

Figure 9: Olympic Park hub (planned intermodal principles)

Olympic Park hub is a combination of a high density bus and railway terminal for spectators, sponsors and workforce. It is not planned that other clients frequent the hub in big numbers. Spatial circumstances are sufficient for Games time operations.

2.3.2.6 Estosadok hub

Figure 10: Estosadok hub (planned intermodal principles)

This hub comprises a train and bus station used by spectators and workforce to access the ski jumping complex.

At this hub also a T3 interchange node (system for IOC members) is located for clients of the Olympic Family. These clients change from luxury coach services coming from the coast to minibuses, which take them to the individual competition venues, villages and MMSC (mountain media sub center). In front of the hub there are several parking lots for sponsor buses.

2.3.2.7 Krasnaya Polyana hub

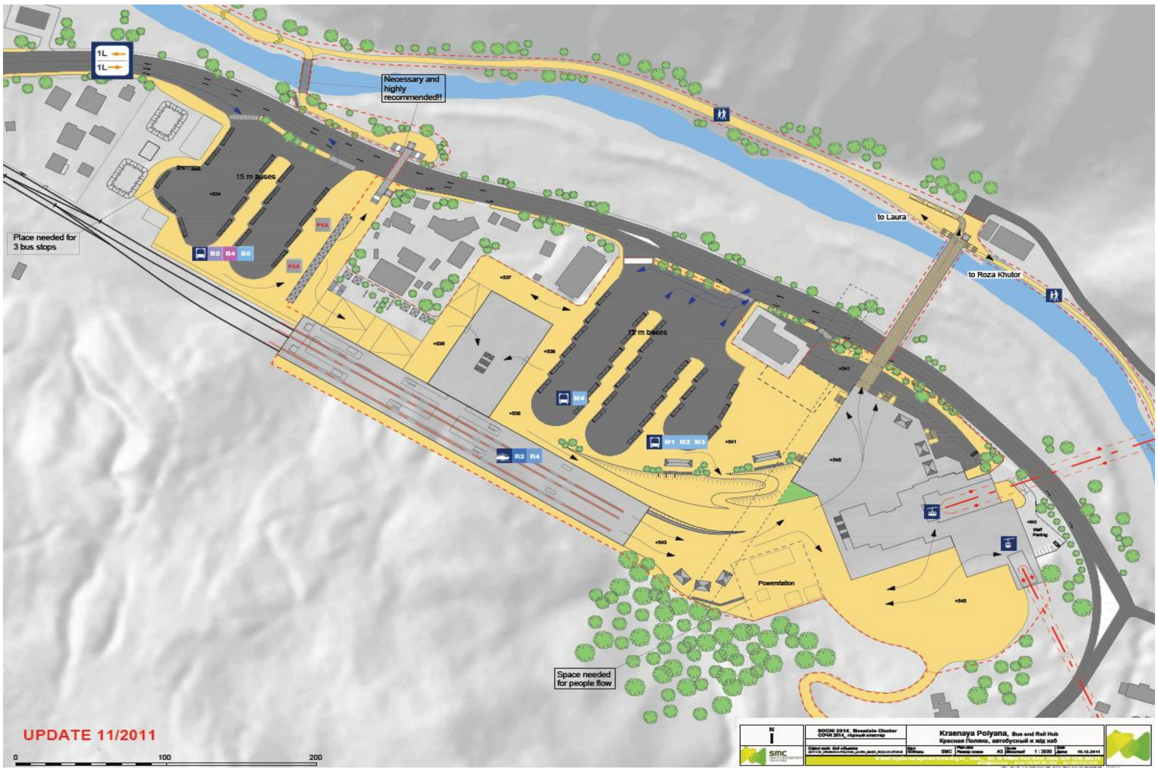

Figure 11: Krasnaya Polyana hub (planned intermodal principles)

Krasnaya Polyana Hub is the main interchange node for spectators and workforce in the mountain cluster. The hub comprises Krasnaya Polyana train station (Lines R2 and R4), the coastal bus (un-)load zones (for buses of lines B2, B4 and B8), the mountain bus (un-)load zones (for buses to Roza Khutor venues M1, M2, M3 and M4) and two base stations for cable cars.

2.4 REGIONAL ENVIRONMENTAL IMPACTS

The most effective way of environmental protection is to avoid motorized traffic. An essential part of this way is to strengthen the local economic circuit that has to support a mixed offer of goods and services within one district in consideration of the common practice of separation.

An integrated regional rail and bus network can reach a **reduction of up to 25**% of individual traffic along the coast from Dagomys to Imeritinskij lowland. This equals a reduction of **5,723 million driven kilometers /year.**

There are two major tasks to reach the anticipated result: The implementation of the Olympic Transport Master Plan and the subsequent implementation of the City Public Transport Master Plan.

3 SOLUTIONS FOR FUTURE USE OF LOW CARBON AND LOW COST FUELS

In the following chapter various transport systems are compared in order to provide solutions for the future use of low carbon and low cost fuels. Therefore a raw cost calculation for a fictive line has been taken as a basis and has been calculated using the results of a detailed study done by the Forschungsgesellschaft für Straßen- und Verkehrswesen FGSV (2008). This calculation requires a detailed study of all factors. The basic costs are in accordance with European standard costs 2011.

Assumptions:

- Compared are two fictional, inner-city diameter lines
- 20 km route length
- 5 minute interval on own route
- Holding distances 500m
- Annual capacity 60.000 km / 3,500 hours of operation
- Travel speed 20km / h
- Vehicle needs 28 vehicles and 4 vehicles contingency
- Vehicles: 50 seats and 95 standing rooms (4p/ m); derivation of dimension listed
- Vehicles are fully air conditioned, modern information technology
- Driver costs € 38 € / hour
- At intersections with individual traffic there is priority
- Calculations are valid as long as the potential passenger can be transported effectively by bus

To show the operational and monetary differences three of the most efficient transport systems have been taken into account:

- diesel bus
- trolley bus
- tramway

DIMENSIONS OF VEHICLES	15m x 2,55m	18m x 2,55m	28,0m x 2,3m	40,0m x 2,56m
COST OF 1 VEHICLE	€ 500.000		€ 2.500.000	
VEHICLE COSTS	DIESEL BUS	O-BUS	TRAM	TRAM
FIXED COSTS	€ 64.731	€ 58.258	€ 146.748	
VARIABLE COSTS	€ 171.200	€ 154.080	€ 166.850	
Σ VEHICLE OPERATING COSTS	€ 235.931	€ 212.338	€ 313.598	
PER VEHICLE KM	€ 3,93	€ 3,54	€ 5,23	
PER PLACE KM	€ 0,027	€ 0,024	€ 0,036	
INFRASTRUCTURE COSTS	**BUS**	**O-BUS**	**TRAM**	
FINANCIAL PROVIDE	€ 86.954	€ 104.345	€ 144.597	
MAINTENANCE	€ 54.688	€ 65.626	€ 105.531	
Σ INFRASTRUCTURE COSTS	€ 141.642	€ 169.970	€ 250.128	
PER VEHICLE KM	€ 2,36	€ 2,83	€ 4,17	
PER PLACE KM	€ 0,016	€ 0,019	€ 0,029	
SYSTEM (FULL) COSTS	**€ 377.573**	**€ 445.536**	**€ 563.726**	
PER VEHICLE KM	€ 6,29	€ 6,37	€ 9,40	
PER PLACE KM	€ 0,0430	€ 0,0511	€ 0,0650	€ 0,0537
COST PROPORTION	**1**	**1,18**	**1,49**	**1,24**
INTERVAL	**5'**	**5'**	**5'**	**8'**
AMORTIZATION TERM, 3% RATE BASE	**12 YEARS**	**25 YEARS**	**30 YEARS**	**30 YEARS**
ENERGY CONSUMPTION 100km	**72L DIESEL**	**3,5 KW/km**	**3,5 KW/km**	
PRICE	**1 €URO LITER**	**8,5 Cent 1 KW**	**8,5 Cent 1 KW**	
TOTAL INVESTMENT	**€ 210.000.000**	**€ 247.800.000**	**€ 354.000.000**	

Figure 12: Cost Estimate

The confrontation of costs shows that the trolleybus system (factor 1,18) and the tram (factor 1,49) are more expensive than the diesel bus system. In this calculation the environmental costs are not included.

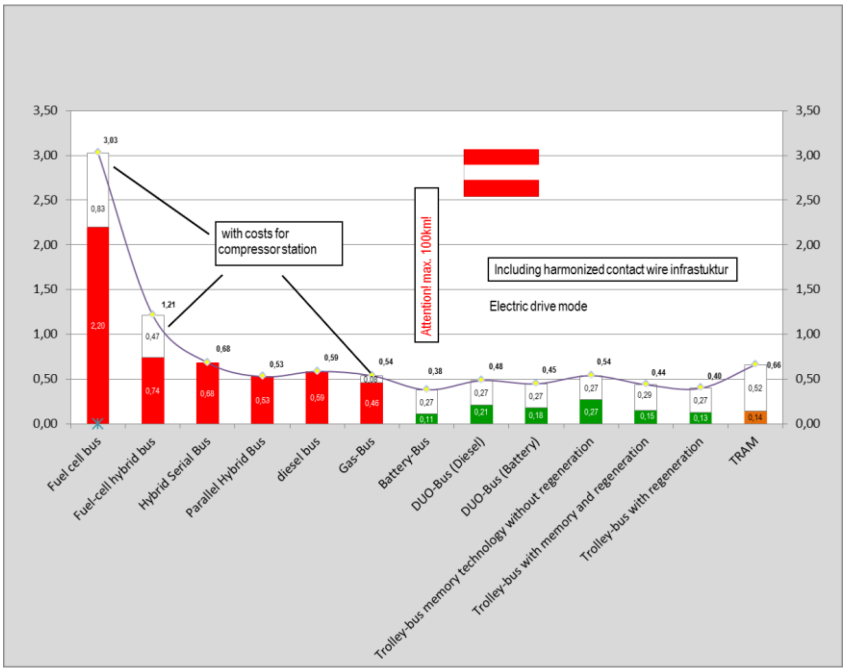

Figure 13: Energy consumption of city bus & tram systems

		DIESEL BUS	GAS BUS NATURAL GAS	GAS BUS BIOGAS 2002	TROLLEY BUS HYDROPOWER	TRAM HYDROPOWER
EMISSIONS	CO2	☹	☹	☺	☺	☺
	NOX	☹	😐	☺	☺	☺
	SO2	😐	😐	☺	☺	☺
	PARTICULES	☹	☹	😐	☺	☺
	LIFETIME	😐	😐	😐	☺	☺
COSTS	STAFF COSTS	☺	☺	☺	☺	☺
	VARIABLE OPERATING COSTS	☺	😐	😐	☺	☺
	FIXED OPERATING COSTS	☺	☺	☺	😐	😐
	CAPITAL COSTS VEHICLE	☺	😐	😐	😐	☹
	INFRASTRUCTURE COSTS	☺	😐	😐	😐	☹

Figure 14: Suggestions for a public system

4 OPTIMIZATION AND ALTERNATIVE ACCESS MODES TO MOUNTAIN VENUE & RESORT AREAS

The assessment of the assumed results of the Sochi cluster public transport operational scheme includes the following improvements in socio-economical effects for the whole society:

- Economizing time for passengers
- Decreasing operational costs for ground transport
- Increasing the level of road safety
- Enhancing the ecological situation in the city
- Optimization of budget expenses in terms of road maintenance

At the same time, it is necessary to keep in mind that meeting the goals in quality has an economic measure which increases the aspiration and readiness towards cooperation of all the stakeholders.

During the Olympic Winter Games a system of **traffic filters** will be implemented to ensure that traffic can flow smoothly at all times in the entire mountain region. Each vehicle requires an appropriate pass to continue beyond a filter. The Vehicle Access and Parking Permit Scheme applies to buses of the public transport system, Olympic transport system vehicles, dedicated fleet vehicles and private vehicles of residents and businesses of the mountain cluster.

Various types of restrictions and permits will be implemented:

- **Mountain cluster filter** for background traffic from Sochi: Any vehicle accessing the mountain cluster needs a permit. This filter is active 24hrs and applied to any deliveries and all residents, who need a resident vehicle permit.
- **Traffic restricted zone filters** for mountain cluster residents: The access to mountain roads leading from the valley to venues is also controlled during a pre-agreed timeframe through several Vehicle Permit Checkpoints (VPC). Only specific permits (to park or load/unload and venue specific) are allowed to pass these VPC's.
- **Venue specific controls**: The final vehicle permit checks are conducted on reaching the venue zone and again the final destination at the venue, either accessing a load zone or a parking area inside or outside the venue secure perimeter.

Within the mountain cluster the following **traffic perimeters** require additional access permits:

- Mountain Media Center & Media Accommodation Cluster – Gornaya Karusel
- Laura VIP Accommodation

- Roza Khutor Media Village
- All Sport Venue perimeters
- Both Mountain Olympic Villages

4.1 NATURAL RISK POTENTIAL (HAZARDS LIKE LANDSLIDES, AVALANCHES, FLOODINGS)

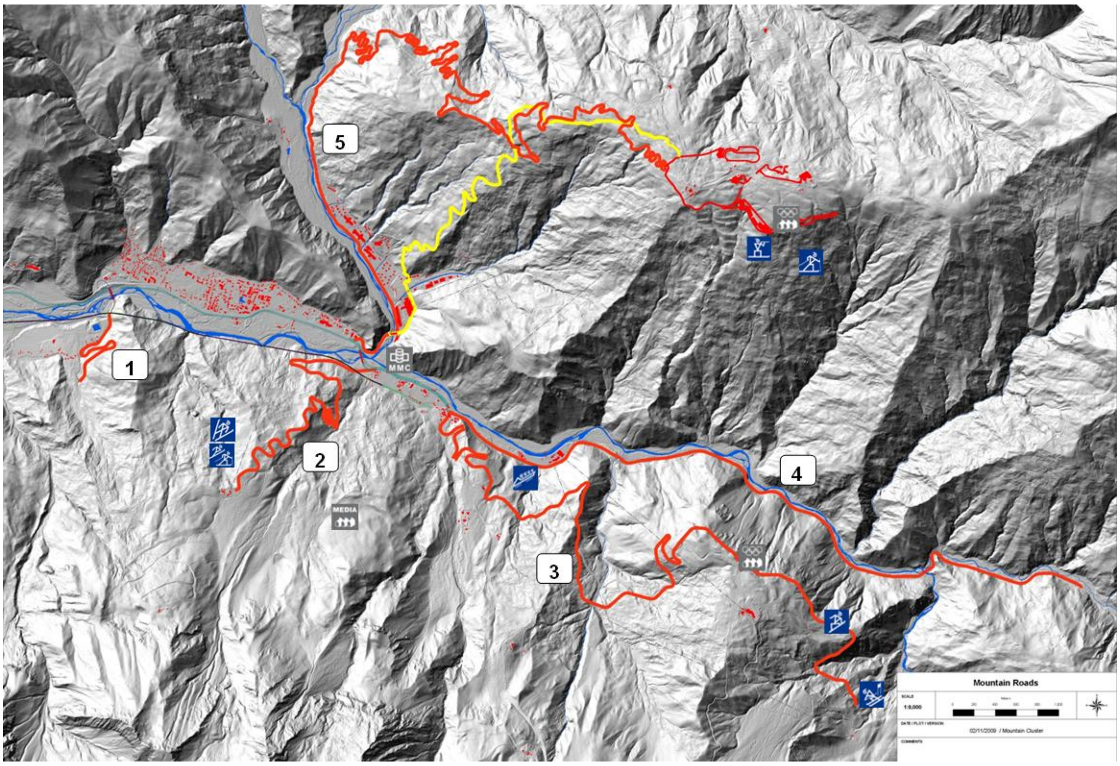

Figure 15: Overview of the Krasnaya Polyana mountain region and its (planned) mountain roads

Mountain roads:

1. Road to the Ski Jumping Area
2. Road to Mountain Media-Village (+960)
3. Road from Krasnaya Polyana Crossing (C11) to Alpine Finish Area
4. Road from the Sulimovsky-bridge to the Mzymta-Valley
5. Road from Laura to Psekhako Ridge (Cross country and Biathlon Venue)

4.1.1 Road to Ski Jumping Area

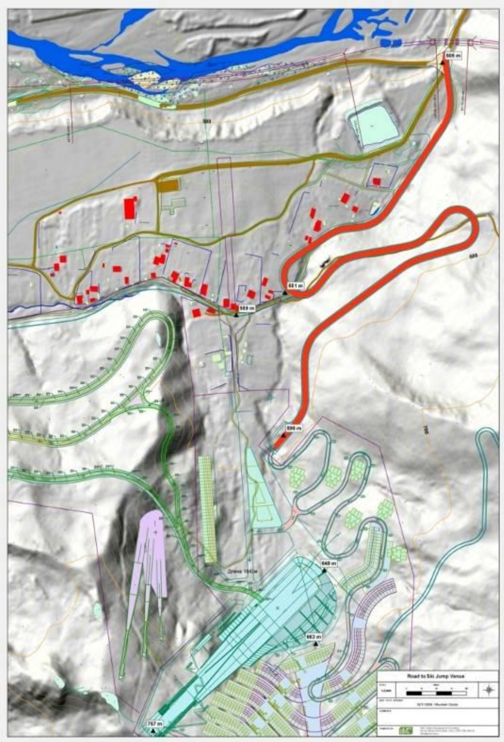

Figure 16: Road to Ski Jumping Area

The road to the ski jumping and Nordic combined venue starts at the roundabout no. 7 near the road which is leading to the Esto Sadok train and bus hub.

The geological units in the area of the venue consist – as far as they are exposed (weathered and soft-plastic clay-dominated material) or present in the form of boulders – of sandstones and black shale. Due to the clay-dominated soils the surface is vulnerable to erosion in case of run-off events. Also small springs (as seen during the field investigation) can cause deep erosion gullies with an inundation of up to 2,0 m.

Figure 17: Spring horizon in the upper section of the road connection to the ski jump complex

The site around the venue and the road is morphologically dominated by an alluvial fan which shows a low inclination and several sub parallel creeks.

The creeks are capable of developing small debris flows including small driftwood and organic material (leaves, soil, branches ….). Because of these small deposits in case of heavy precipitation new channels can easily evolve due to blocked active channels.

The slope east of the planned parking area shows significant run-off channels potentially endangering the roads and the eastern part of the parking area there.

Conclusion/solutions

To avoid a jamming of the planned under passing construction of the creek under the venue (tube, culvert) and parts of the road a debris retention basin has to be realized upstream of the venue.

Figure 18: Example of a debris retention basin and its runoff-channel downstream

Crossings of roads can be covered by concrete slabs. This solution would enable a realization of a natural flow of the water on the surface and could provide an environment for water-prone ecosystems.

Figure 19: Typical design of reinforced run-off channel for torrential waters on debris-cone

4.1.2 Road to Mountain Media-Village (+960)

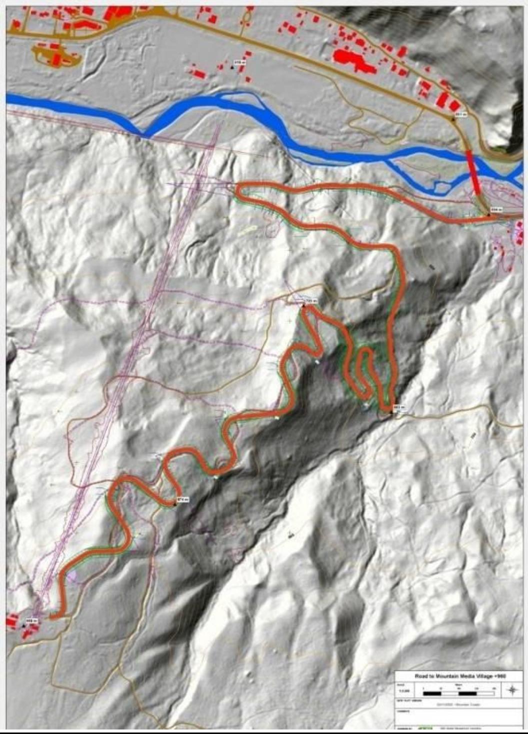

Figure 20: Originally planned road to Mountain Media Village (+960)

This road starts after the Laura-Mzymta bridge on the opposite side of the under construction gas power plant.

From the geological point of view this area did not show any bigger problems. In the area near the small creek at the left side (elevation m) heavy constructions against erosion at the road base have to be done. Water capturing and drain at the whole road up to the media village (+960) has to be done carefully and to existing creeks. Otherwise big erosion areas, downhill the road body, will increase to heavy handle hazard zones.

4.1.3 Road from Krasnaya Polyana Crossing (C11) to Alpine Finish Area

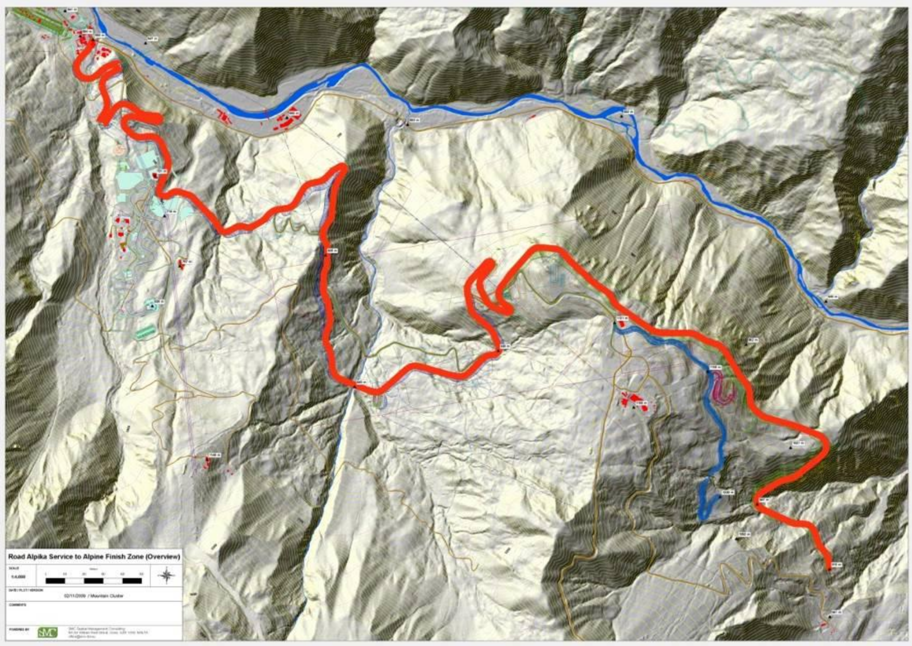

Figure 21: Originally planned road from Krasnaya Polyana (C11) to Alpine finish zone

This road has a total length of about 10km. For planning and construction of the road from Krasnaya Polyana (C11) to the Roza Khutor Mountain Olympic Village it is necessary to pay special attention to the slope of the road, which should not increase more than 8.0%. The safety of the busses has to be guaranteed when they will drive downhill under winter conditions. In switchbacks the slope has to be reduced to 5.0%.

The vertical curves should be as big as possible, for the sag-curve in particular not smaller than 900m and for the crest-curve not smaller than 1200m.

At the west part of the Sulemovsky-creek on a length of about 700m the road is cutting into the unstable and very steep hillside. To make this cutting safer, they should be constructed with berms. Especially in this area it is important to drain off the arising water.

At high cuttings and embankments it is necessary to immediately green and replant this area. At the street embankments the rainwater should not be derived plain but specific in rain mouldings into the ground.

At high cuttings the rainwater should not be drained off over the embankment but over a basin at the embankment into the surrounding ground.

It will be essential to find a save and an effective way to capture the water from the embankment and the road to bring it to small existing creeks downhill and destroy the energy of quick flowing water.

In consideration of the bad geology in many parts of this road it is important to take care where the water will be brought uphill. It is recommended that only existing creeks should be used. To stabilize the bed of the creeks cascades have to be used for the energy conversion. The energy conversion is carried out largely in the cascades due to a strong turbulence of the water, to reduce the speed also at bigger drains.

The road part from Roza Khutor Mountain Olympic Village to the Alpine finish zone passes in wide areas very steep and geological very unstable area. It is recommended to find for some parts, together with all stakeholders, a new marked out route to save money. It is essential to make this route more effective and safe against natural hazards! Many parts of this planned road have to be protected by snow nets and wooden constructions against snow, which is slipping down from steep forest areas.

Water capturing and draining could be a problem in wide areas and must be given high attention, because of the high embankments and the partly unstable creek beds, which could react very sensitive to higher drain.

To avoid all this problems it would be worth to consider finding a cheaper and safer marked out route in different parts.

Generally the slopes are built up by flyshoid lithological units. These rocks are characterized by shale and rocks with very low rock strength and weathering resistivity. Such rocks tend to develop slopes with low inclinations, the talus material (weathering material) of this lithologies are dominated by a high contents of clay minerals.


Figure 22: Shales strongly deformed by tectonic processes, forming the slope-cuts along the mountain road (left), high slope-cut without reinforcement or berm (right)

 

Figure 23: Examples for slope stabilization measures by coverage with steel net against instable slope-cuts (source: Geobrugg brochure)

Location of the crossing of the mountain-road and the Sulemovsky-creek:

At the planned road crossing (bridge) major debris-flow deposits are located. The Sulemovsky-riverbed shows a typical cross-section for debris flow activities.

Figure 24: Erosional cross section of Sulemovsky-creek caused by high energy debris-flow (U-shape and levee-deposits)

The freeboard of the planned bridge has to be sufficient for debris flows to underpass. In case of a pylon in the riverbed the construction has to be dimensioned for debris flow pressures.

Avalanche expertise

At the junction of the Sulemovsky avalanche path central basin and eastern basin at 850m asl. a bridge with at height of 30m is planned. The slope angle is 12° and the avalanche track is strongly canalized. There are no evident signs in the vegetation of big powder snow avalanches. The deciduous trees have strong branches on the avalanche exposed side. Hence powder snow avalanches are a minor problem for the safety of the bridge, but still extreme events can reach this point. Therefore the bridge railing should be reinforced for a pressure of about 4-6kPa to provide protection in case of big powder snow avalanches. Dense flow avalanches can pass the bridge underneath if built as planned.

4.1.4 Area around Sulemovsky creek and Mzymta valley

Torrent analysis

The torrent delivers substantial amounts of debris by high energy debris flows down to the valley-floor of the Mzymta river. The current solution defining the crossing of the torrent under the road gives sufficient protection against pure water run-off; excessive debris contents might cause severe problems for the road due to the erosion of existing gabions by high energy debris flows. The torrential debris cone shows partially coarse sediments being accumulated by debris flows obviously (levees, u-shaped profile, no sorting by fluvial processes).


Figure 25: Coarse debris-flow deposits upstream of road crossing (left), narrow underpass below road, riverbank reinforced by gabions (right).

The routing of the torrential path by the new bridge results in a deviation of the torrent to the right side. This deviation might cause major event massive erosion at the outside curve at the riverbank in the case of a debris flow event. The sedimentation of solid runoff could cause a breakout of the torrent to the left side.

A special focus should be given to the new built gas power plant near the Sulemovsky bridge.

Avalanche exposure

An inspection of the Sulemovsky alluvial cone was done on site. Measurements showed an inclination of app. 8°. Measurements in the GIS displayed an inclination below 10° for 200m from the road upwards. According to unconfirmed reports the Sulemovsky avalanche reached the Mzymta river a couple of years ago and jammed the river with mud, snow and debris. More information must be collected by local people and by eye witness.

Taking this report into account it is necessary to provide sufficient space (freeboard) for possible wet snow avalanches, especially underneath the bridge of the main road for a safe run-off. Further it is necessary to protect the ongoing construction of a planned power station on the orographic left side of the avalanche path with a suitable deflecting dam (dam height about. 6m).

First avalanche simulations of the Sulemovsky avalanche path conducted with SamosAT (simulation software) showed, that major powder snow avalanches cannot reach the valley bottom of the Mzymta river, because of the strong canalization, the low slope angle in the lower part, multiple changes of the direction (6) and no evident signs of big avalanches in the vegetation etc. could be found in the run out zone. Furthermore it is necessary to collect data on the snow and avalanche parameters to adjust the simulation setup for the local properties. The data should include information on actual avalanche events to calibrate the model.

The avalanche exposure of the Sulemovsky avalanche path is in the run out zone at the valley bottom (590m a.s.l.). Small, though very wet snow and mud flows could reach the bottom.

Figure 26: Runout zone Sulemovsky creek

Possible solutions

- Avalanche processes: Avalanche catchment dams can be combined with the debris catchments.
- Torrential processes: Debris catchment basins above existing road track. Dependant on the longitudinal profile an additional driftwood catcher can be an option, working as energy dissipating construction in case of a debris flow.

Figure 27: Series of successive debris catchment basins on debris cone of a torrent (Tyrol, Austria)

Road Track Mzymta Valley: Geology and Torrential analysis

The characteristics of the torrents originating from the orographically left valley-side are strongly influenced by the extreme relief energy (steep slopes) and vulnerable geology (weak lithology, weathered rock, highly tectonically fractured).

Figure 28: Shales strongly deformed by tectonic processes, slope orograhically left of Mzymta river

This leads to an erosion processes along the torrent paths and alluvial fans at the bottom of the Mzymta valley. The dimension of the torrential processes depends heavily on the amount of the liquid runoff from upslope.

Figure 29: Debris cone along Mzymta valley road (left) and debris-flow/runoff channel on the slope (right)

Figure 30: Landslide and debris-cone on slope orographically left of Mzymta valley road

Remark: The snow slabs (small avalanches) eminent on this slope usually will be concentrated along existing channels. These channels are also potential debris-flow and water run-off paths. So the mitigation measures against avalanches can be combined with those against torrential processes (i. e. galleries).

Design recommendations for galleries (avalanche and debris flow):The design of the avalanche galleries should be based on the European guidelines for avalanche galleries published by "Bundesamt für Strassen ASTRA, Bern, Switzerland".

In addition special emphasis has to be given to the construction of the riverside-foundation of the galleries to be sufficiently protected against erosion of the running water of Mzymta-river (see example from Austria 2005).

Figure 31: Erosion of road and avalanche gallery by river in Paznaun-Valley 2005 after undercutting of heavy bedded rock fill

Avalanche exposure

The valley in the investigation area can be characterized as following: Deciduous forest with a mean slope angle of 35-40° (measured), a total fall height of about 400 m (vertical), with total length of 2, 5 km of the surveyed track. The relevant scenario is a snow fall event of in average 1m snow on the upper slope at about 1050m a.s.l. Increasing temperatures can lead to the release of snow slabs and snow slides, which can easily slide down on the leaves of the deciduous trees. Average values for the released snow are between about 15.000m³ and 20.000m³. This scenario does not include extreme values. Information exists of 10m snow deposition on the road each year. In this area are no historic avalanche data existing, because the road is usually out of use in winter.

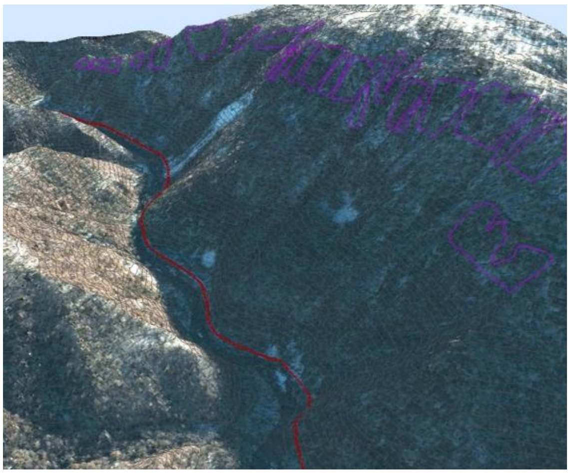

Figure 32: Investigation area Mzymta valley with road project (red line)

Simulations with the model SamosAT and Elba+ displayed the slab avalanche prone tracks. Therefore the set up for both models was adjusted to rather gliding processes than turbulent avalanche behavior. Both models showed good agreement on the results. The simulations as well as the field survey are the basis for the recommendation for mitigation measures.

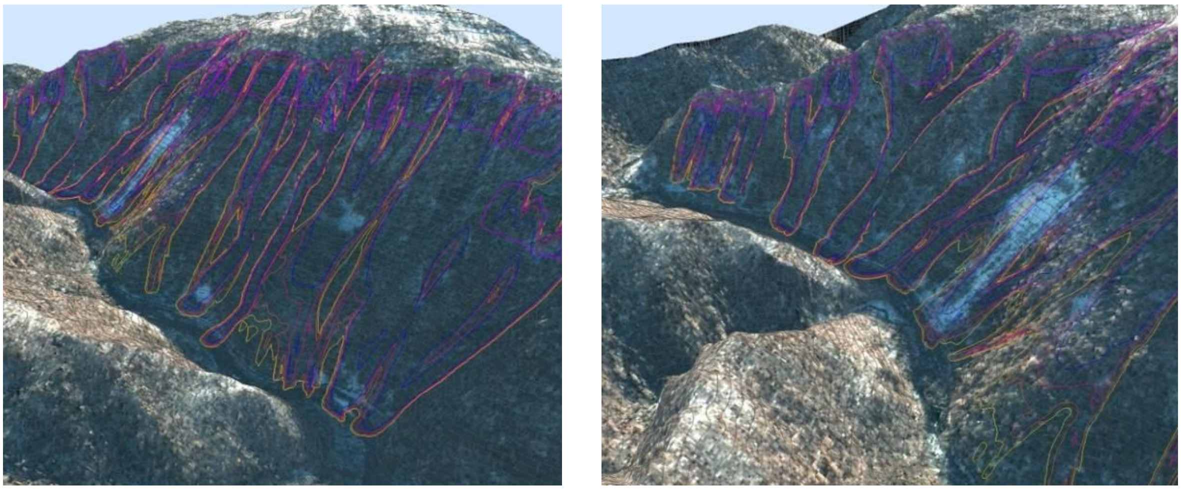

Figure 33: 3D-view with simulation results west (left picture) and east (right picture).

3 possible mitigation measures:

- 0-Variante: no measures with the acceptance of high risk potential
- Combination of 1-3 rows of flowing snow catcher: one row of snow deflector (rigid construction of wood and steel to catch small snow slabs; wall height ca. 5-6m) aside the whole endangered road (about 1.800-2.200m) and 1-2 flexible rows of snow-slab-catchment-nets to break the dynamic of faster snow slabs at places, where higher velocities of the slabs are expected and to meet the mass balance requirements (horizontal length of about 1,2km), this second row has to

be placed about 15-20m above the planned road in a suitable area with a construction height of 4-5m. In gullies with flowing snow masses a third row is necessary for additional snow retention. In some places cross-cut timber can assist this catching effect of flowing snow. These constructions need regular monitoring and maintenance to ensure the operability. In extreme weather situations the protection measurements provide not enough capacities to catch all snow mass movements.

- Avalanche galleries: A roofing of the road to ensure the mobility through the avalanche prone valley. This is an expensive protection measurement, but provides an enormous reduction of the risk potential, not only for avalanches and gliding snow, but also for rock fall, debris flows, etc.

The recommended solution is a combination of avalanche galleries to lead the flowing snow over the street and outside these areas walls to catch the flowing snow.

According to the field survey and the simulations a total length of about 1,0 km (minimum value) avalanche galleries is needed. The construction can be rather open on the river side. The roof of the gallery should have a steep roofing to minimize the load of snow and debris. A guideline for the construction of avalanche galleries was made by the “Schweizer Bundesamt für Strassen ASTRA, Einwirkungen infolge Lawinen auf Schutzgalerien, 2007”. Outside the galleries at a length of 1300m walls (rigid construction of wood and steel to catch small snow slabs; wall height ca. 5-6m) above the road are needed to catch the smaller amounts of sliding snow. The release areas (are defined by expertise with the assistance of aerial photographs, elevation and slope angle maps. The red line indicates the recommended locations for the avalanche galleries.

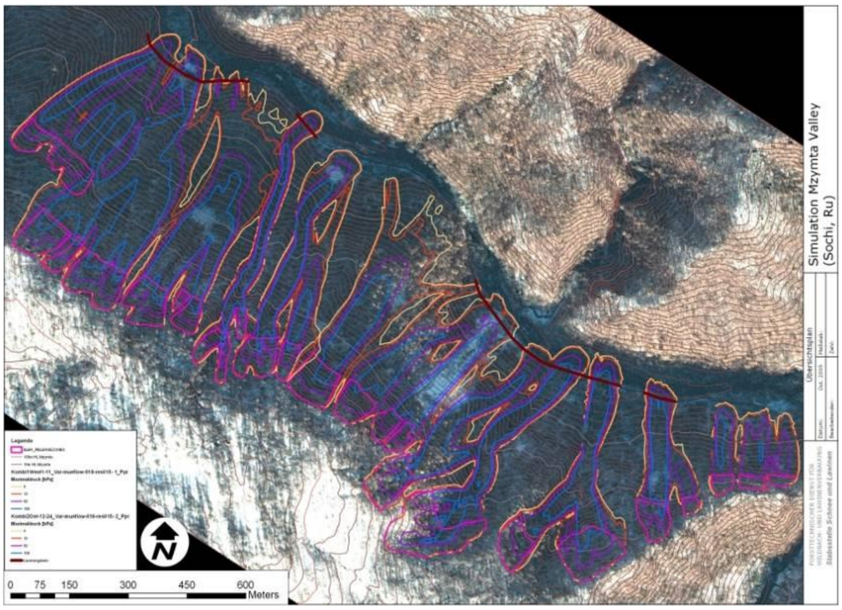

Figure 34: Map of the simulation results Mzymta valley

Due to this natural hazard risk analysis, done in 2009 for SC Olympstroy, the construction of the Mzymta valley road has been canceled.

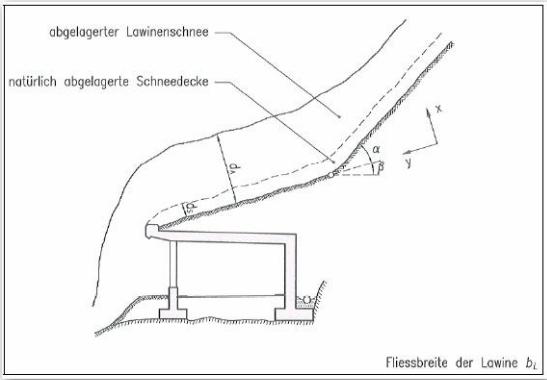

Figure 35: Example of an avalanche gallery in the Alps (left). Typical drawing for avalanche and torrent gallery (from Swiss guidelines for the design of Avalanche galleries, ASTRA 2007, right).

Supporting structures in the avalanche (slab) release zones are due to the undefined release areas not advisable. The cost-effectiveness is not sufficient. Partial supporting measures do not lead to significant danger reduction. Furthermore the problems with other hazards as mud flows and rock fall still remain.

Figure 36: Avalanche gallery constructed as open pit (Kaunertal, Tyrol, Austria)

4.1.5 Road from Laura to Psekhako Ridge (Cross country and Biathlon Venue)

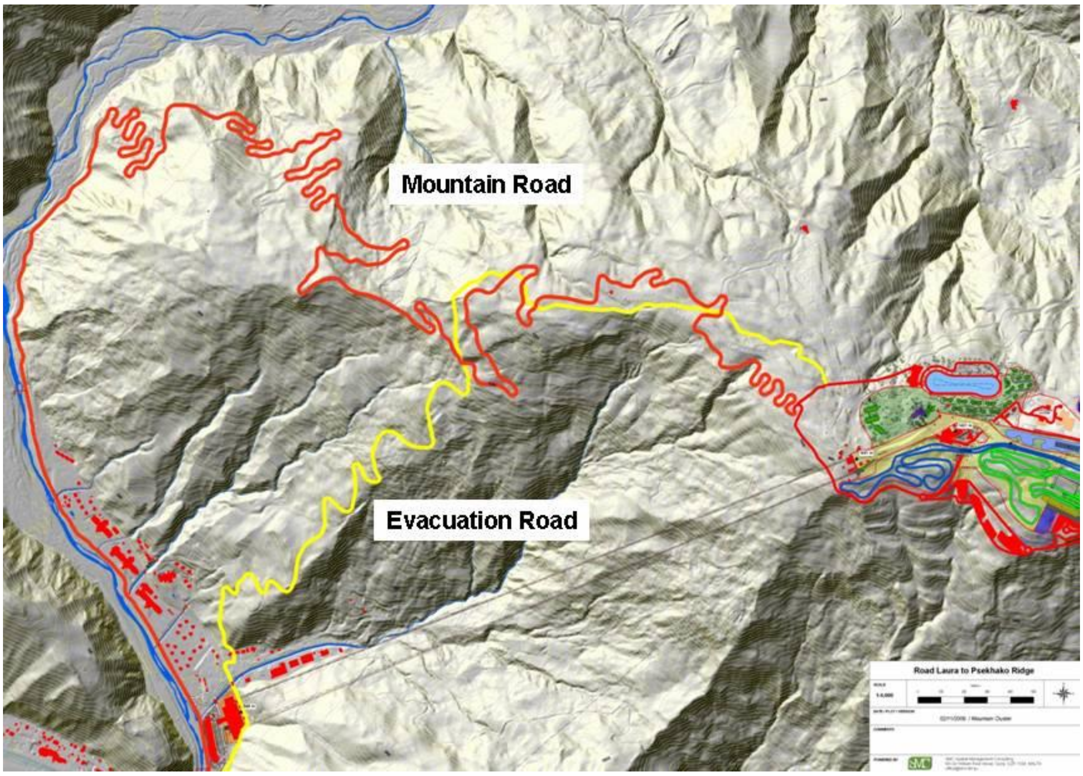

Figure 37: Psekhako Ridge mountain road

Psekhako mountain road has a length of approximately 16,9 km. The whole marked out route is from the geological side not so problematic then many road sections to Psluch creek or the road to the Alpine finish zone. For planning and construction of this road parts special attention needs to be paid the slope of the road, which should not increase more than 8.0%. The safety of the busses has to be guaranteed when they will drive downhill under winter conditions.

In switchbacks you have to reduce the slope to 5.0%. The vertical curves should be as big as possible, for the sag-curve in particular not smaller than 900m and for the crest-curve not smaller than 1200m. For the whole mountain road a special attention has to be given to water capturing, water drain and to the stabilisation of the embankment. It will be very important to start with the construction work as soon as possible; because of the length and seasonal limitations the time to finish this work in time could be a problem. It should be said that bypass sections along the whole 2 lane road are recommended to guarantee effective transport safety.

4.2 URBAN / REGIONAL DEVELOPMENT (PUBLIC SERVICE, ACCESS, SOCIAL BARRIERS)

4.2.1 Effects of Today's Traffic Structure

Combustion engines produce a high amount of air pollution that is harmful in many different ways to human health. Between 1990 and 2001 CO2emissions in Europe caused by CO2-producing industries decreased by 18% while the **emission caused by traffic increased by 9%**. In consideration the driven kilometers increased by 37% which stands for a high improvement in combustion engines and the efforts of automobile industry to reduce pollution. Attention needs to be paid to the increasing NOx–emissions since the implementation of catalytic converters. NOx–emission causes acidification of air and increases ozone formation. The increasing number of traffic-related diseases highlights the need for action.

A lot of people suffer from diseases caused by traffic noise. Noise protecting systems become necessary and generate further costs. In addition most noise protecting systems were built along the road or tracks and highly restrict the freedom of movement for local fauna and also for the adjacent residents.

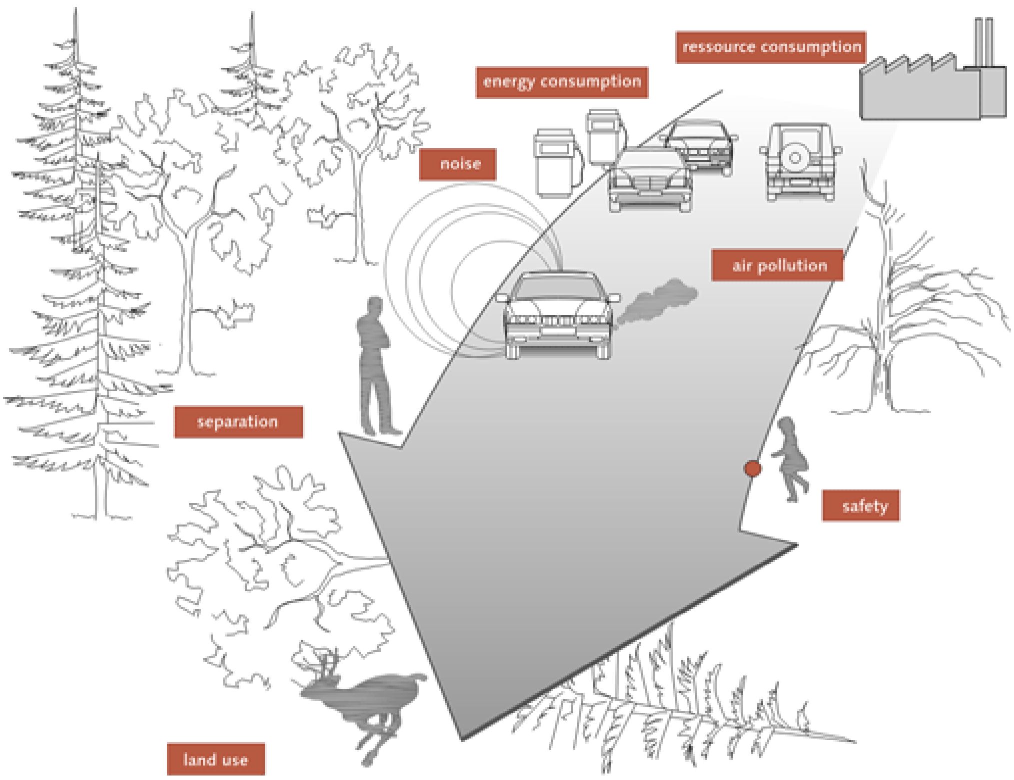

Figure 38: Effects of traffic

High volumes of traffic and high speeds of road traffic lead to a critical environment. Especially the mixture of different speed ranges results in accidents with serious consequences. Generally the amount of traffic accidents in Europe is decreasing considering the increasing number of bicycle and pedestrian accidents with partly deadly consequences. This demonstrates that there are a lot of safety measures for car occupants. But despite of road safety education like wearing helmets, safety clothing and directives there is a growing number of accidents at the interaction of different speed ranges.

The demand for total accessibility by car results in a high degree of land use. The resulting costs can hardly be recuperated. Every new street increases the degree of soil sealing. Not only the extensions of the road network but also regulations for parking spaces accelerate soil sealing and take away more and more living space.

Regulations of the parked cars pose a logistic challenge for communities. By these regulations, the responsibility is placed on the owners. The regulations are reduced to a common denominator that means changes or improvements are not stimulated (even in the ecological sense). At best, it regulates the planting of trees or flowerbeds.

Due to inefficient road systems and inefficient vehicles the energy consumption of the motorized traffic in cities is extremely high.

The frequency and the length of our travel distances covered have changed during the last 40 years, but not the reason for covering these distances. This is the obvious effect of urban sprawl and economic segregation which results in high-energy consumption.

4.2.2 Objectives to change the common status of infrastructure

The most effective way of environmental protection is to avoid motorized traffic. An essential part of this way is to strengthen the local economic circuit that has to support a mixed offer of goods and services within one district in consideration of the common practice of separation.

Lots of parked cars and the high amount of road traffic interfere with public space and decrease the quality of life. Unfortunately this is fact in many residential areas where the density of residents and the number of owned cars are both high. The negative effects of the present system need to be translated into objectives for a sustainable development of transport including the change of infrastructure.

Objectives to Change the Common Status of Infrastructure

- separate life sphere free from motorized traffic
- increasing the quality of habitation of districts
- reduction of road areas and sealed areas
- rebuilding of road areas into residential areas
- reduction of energy consumption
- using ecological vehicles and transport systems
- reduction of transport efforts (quantity, transport route and packaging)
- support a mixed infrastructure within certain districts

  → **THE COMPACT CITY**

The following sub items help to define the objectives to invent an ecological transport concept:

- covering a short distance (<1, 5 km) in particular within neighbourhoods solely on foot, by bicycle and/or by equal-zero-emission vehicles and special noise-reduced vehicles
- reducing of energy consumption by 30%
- using regenerative energy sources (biogas, biodiesel, hydrogen etc.)

- reducing emissions generated by motorized traffic by 80% in cities
- 90% of transportation of cargo in cities can be handled by using innovative distribution systems
- reducing inactive and useless road and sealed areas up to 50%
- separating modes with different speeds (bikes & pedestrians ⇔ motorized vehicles) by 80% within cities

4.2.3 Mobility Management

Mobility centers are coordinating the measures of public transport based on the evaluation of traffic data in urban areas. Ideally mobility centers are evenly spread across the urban area. The spatial proximity guarantees a social and environmental-friendly traffic flow. The centers facilitate forms of mobility other than car transport and provide an efficient utilization of public transport.

Different means of transportation are linked with each other by connecting services, training, additional services like bike stations, car rentals (car-sharing, parking and others) and individual pricing policies.

Mobility management covers the minimization of construction costs for the infrastructure individual transport (roads, traffic lights) and the reduction of maintenance costs. This savings can be invested in projects like *car-free districts* and in context with reduction of public transport fares.

4.2.4 New Urban Qualities

The efficiency of the above-mentioned measures for the reduction of private transport and for the increased usage of public transport, presupposes the interdisciplinary cooperation of different departments. Regional and spatial planning, urban development and urban design, open-space planning or landscape architecture, as well as infrastructure planning and traffic planning should work closely together. Additional measures like a special structuring of organization, information politics, improved automotive engineering and, last but not least, price-conscious equipment contributes to success. Price political instruments include housing politics, housing management, tax laws and the law of financial compensation.

The new urban quality is measured by which degree a reduction of motorized traffic has taken place. Less cars mean more of an ecology-friendly environment, more freedom of action, living space, safety, quality of life, functional density, service, social contacts; more working places within the city, more attractive urban space, and a higher quality of urban development.

4.2.5 Living in Car-free or Car-Reduced Districts

The development of a car-free district might be a step-by-step process and may include the perceptions of participants. It is important to prepare the local administration department for the introduction of flexibility into the parking space question. This flexibility assumes that its first step should be a cost-oriented separation of parking space and accommodation units, with consistent parking space management concerning the structure of essentials and the additional supply of parking spaces. The customization of changing demands can be realized by underground or on the surface constructions or if necessary by the reduction of parking spaces. Additional costs correlate with profits from the recovered land and costs saved by reduced maintenance of car traffic. The car continues to be available for use outside the district.

Car-free projects reach far beyond districts free of parked cars. They not only contribute to the quality of living but also have an effect on the mobility behavior of the residents. Instead of relocating traffic locally, reducing the private transport comes to the fore. The basic idea of car-free districts is: "People who abstain from using a car should live in a car-free environment and benefit from its advantages."

4.2.6 Roads as a Designed Space – Shared Spaces

Street planning within built-up areas is part of urban development and cannot be considered separately. All concerned parties like planners, politicians and citizens have to know that street planning always involves design. Street planning means that the street is designed and planned according to holistic principles. This process includes -technical aspects related to local traffic conditions, as well as design, urban development and social aspects to the same degree. The result should be a public space which will be shared by all participants with equal rights.

Figure 39: Reorganization of the public space

4.2.7 Walking and Cycling Improvements

Walking and Cycling (Non-motorized, Active or Human Powered transport) improvements support transport and parking management strategies in several ways ("Walking and Cycling Improvements," VTPI 2005):

- Improving walkability (the quality of walking conditions) expands the range of parking facilities that serve a destination. It increases the feasibility of sharing parking facilities and use of remote parking facilities.

- Improving walkability increases “park once” trips, that is, parking in one location and walking rather than driving to other destinations, which reduces vehicle trips and the amount of parking required at each destination.
- Walking and cycling improvements allow these modes to substitute for some automobile trips.
- Walking and cycling improvements encourage transit use, since most transit trips involve walking or cycling links.

4.2.8 Legal Basics for Private & Commercial Parking

In Austria and Germany there are legal requirements for minimum and maximum numbers of parking spaces for planned buildings and facilities. The minimum requirement should assure that there is no additional parking demand in public spaces through planned buildings. Generally the **minimum requirement of parking spaces** should be built on the land plot of the planned building, e.g. using underground garages or parking lots. It is also possible to locate the required parking spaces within acceptable walking distances of up to 300m. This regulation allows concentrating parking demand for different user groups and to get a more attractive home environment free of driving and parking vehicles.

Parking maximums means that an upper limit is placed on parking supply like in Austria for shopping malls. This can be placed either at individual sites or in an area. Area-wide limits are called Parking Caps. These can be implemented in addition to or instead of minimum parking requirements. Excessive parking supply can also be discouraged by reducing public parking, imposing a special parking tax, and by enforcing regulations that limit temporary parking facilities. Maximums often apply only to certain types of parking, such as long-term, single-use, free, or surface parking, depending on planning objectives.

5 ASSESSMENT OF POSSIBLE IMPACTS ON SUSTAINABILITY OF THE OLYMPIC GAMES

The major principle of the overall operational concept for the Sochi Olympic Winter Games public transport system is to keep the concept simple and effective. Therefore a clear definition of the rail lines and regular operation on a high quality level is needed to avoid cumulating delays resulting in negative feedback on other and may lead to a breakdown of the sensitive parts (mountain line) of the Olympic transport system.

5.1 NEGATIVE IMPACTS

Games Client and Resident Correspondence

The major correspondence of Games Client and Resident mobility is a timely **overlap** of large numbers of ticketholders **travelling to Olympic events** with the normal morning or evening **rush hour**. Another correspondence is the **priority** that needs to be given to the mobility of **Accreditation holders** among the Games Clients over resident and Ticket holder traffic.

These correspondences result in conflicts, which will be resolved by two sets of measures: the **optimal dimension of transport infrastructure** and the **frequency of transport services** in order to cope with Olympic transport demand for all groups. Such measures include:

- Enhanced public transport, including regional buses and feeder buses to rail services
- Enhanced pedestrian and cycling infrastructure

In situations where these measures are not sufficient, **restrictions** will be implemented in order to shift and influence transport demand for the groups with the lowest priority.

These restrictions include shifts to alternative modes of transport, shifts of travel time or altogether cancel the need for a trip. Such measures may include:

- Olympic lanes will be established, dedicated to Olympic vehicles
- No spectator parking at venues, rail stations and along major Olympic routes
- Odd/even plate restrictions along the Sochi Coast
- Resident access and parking permit schemes will apply in the vicinity of Sochi Olympic Park
- Change in business hours and promotion of working from home
- Change of hours for educational facilities
- Restrictions for deliveries to local businesses in sensitive areas
- No construction traffic during the Olympic Games period

- Modifications to traffic flows (one-way, left turns etc)

5.2 POSITIVE IMPACTS

5.2.1 Decrease in fuel expenses

Nowadays the public transport in Sochi operates mainly in low-capacity buses that account for more than a thousand units. Apart from that, about 500 buses with higher capacity do not fulfill modern standards.

The average fuel consumption of a low capacity bus makes about 19 litres of gasoline per 100 km[1], for modern Russian LiAZ-type buses – about 35 litres diesel fuel per 100 km[2]. Average gasoline price in 2010 is about 26 roubles per litre, diesel fuel – about 20 roubles per litre.

Average day haul per unit now accounts for about 300 km. By means of higher capacity bus operations and optimized route organization there are grounds to expect that an average day haul will make 200 km.

Thereby, if a transfer will be done from the existing bus fleet structure to a proposed organized system with more environment-friendly, comfortable and contemporary higher-capacity buses, that will result in an estimated 33% decrease which will have an effect of **300,4 mln roubles** a year (= difference between 1,5 thousand units X 300 km X (19 l /100 km) X 26 roubles X 1 year and 1 thousand units X 200 km X (35 l / 100 km) X 20 roubles X 1 year; in 2010 prices).

5.2.2 Decrease in road maintenance costs

The length of road network (in terms of main roads) equals 393 km.

Normative term between the capital repairs for automobile roads with asphalt-concrete covering for the IV-V climatic zones is 8 years[3].

Considering the average cost of the repairs for 1 km of the road in Sochi is about 6,9 mln roubles[4], the annual expenses for the repairs may make up to **338,9 mln roubles.**

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[1] Fuel and lubricants consumption normative for automobile transport, approved by the Ministry of Transport of Russian Federation

[3] Construction rules and normatives 2.05.02-85 “AUTOMOBILE ROADS”

[4] State order notification № 090626/001445/106 – http://www.zakupki.gov.ru/Tender/ViewPurchase.aspx?PurchaseId=420029

Realization of the proposed public transport operations scheme that leads to a decrease in overall fleet numbers as well as average day haul will affect the decrease in road maintenance costs directly. Standing on conservative grounds, the extension of term between repairs may be estimated at about 33% to a normative. Thereby, annual repair costs will decrease to **226 mln roubles.** The cumulative effect of the resources for an annual road repairs economy may make up to **112,9 mln roubles a year** (in 2010 prices).

5.2.3 Optimization of operational expenses

The transfer to a new passenger transport operations system will allow to approach the issue of hiring highly qualified drivers and technical staff hiring with great caution and attention.

At present, the average driver wages per month is about 20 thousand roubles. At the same time, there is an abundance of drivers with basic training in the city, while a deficit in highly-qualified personnel can be observed.

A decrease in bus fleet by 1000 units will allow the passenger transportation organizations to reorganize their staff by means of the human resources, that will be available on the labor market because of downsizings, that will lead to a quality increase in a whole system operations. At the same time, the pressure that will be made by the significant increase in labor supply from the drivers will allow to keep the average wages for transportation workers and will not result in an increase of primecosts for services in terms of personnel expenses.

An average driver demand for a 1000 units fleet may be estimated at 1000 drivers minimum. Thereby, a 1/3 personnel decrease will result in a comparable 1/3 expenses' decrease, or **120 million roubles** (in 2010 prices): 500 people X 20 thousand roubles X year.

Another special thing about public transport operations organization is the requirement for monthly tire changings.

The set of tires for both low-capacity and high-capacity buses is 6 pieces. Thereby, annually 72 tires are required for one vehicle. With an average price of the tire as 2 thousand roubles, the expenses will be 144 thousand roubles per bus. The decrease in bus numbers will lead directly to a decrease in tire demand for about **72 million roubles** (in 2010 prices): 500 buses X 72 tires X 2 thousand roubles/tire.

As well there will be a positive effect from a decrease in operator's expenses for used tires utilization.

The price of a set of tires utilization for "Gazelle"-type buses is 280 roubles, for LiAZ-type – 320 roubles. Therefore, cumulative utilization expenses will decrease by **1,2 million roubles** (in 2010 prices): 500 sets X 320 roubles X year.

Moreover, this aspect of transport companies operational expenses' decrease has a special importance from the environmental point of you, as the ecology improvement is one of the major factors of world class tourist center development.

Increase in tax incomes

The reorganization of public transport operations will allow to increase the transparency of the transport complex operations from the tax discipline of the operators, that, estimated, will lead to a state income increase to **112,8 mln roubles** (in 2010 prices)/

On the basis of cumulative personnel of 1000 drivers and their average monthly wages of 20 thousand roubles, and the amount of insurance contributions on the 34% rates (that are to be paid until the wage funds rises up to 415 thousand roubles during a year), overall amount of paid taxes will make **81,6 million roubles** (in 2010 prices): 1000 people X 12 months X 20 thousand roubles (wages) X 34% (insurance contributions).

The amount of paid income tax will be **31,2 million roubles** (in 2010 prices): 1000 people X 20 thousand roubles X 13% (income tax).

6 DETERMINE COMPATIBILITY OF OLYMPIC TRANSPORT PLAN WITH SOOC OBJECTIVES TO DELIVER SUSTAINABLE OLYMPIC GAMES

The target of Sochi-2014 is to develop an optimized sustainable transport concept for Olympic and Paralympic Games time transport where people mass movements are achieved by public transport as the main part of the modal split. The transport system will operate with low emission and low-carbon technologies and delivers sustainable legacy to urban and mountain areas.

The strategy consists of three main pillars:

(1) On one hand a strong back bone railway network which will be upgraded and updated, connecting the main urban areas of Sochi and Adler as well as the heart of the Mountain Cluster Krasnaya Polyana hub.

(2) All necessary Games shuttle buses will be equipped with state of the art technology to minimize air pollution, noise and GHG-emissions to the lowest level.

(3) Furthermore, a maximum of spectators, workforce and other clients are will travel by modern cable ways, with lowest transport-related energy input .

Sochi 2014 Organizing Committee is working on the most compact Games concept in Olympic Winter Games history to minimize total transport kilometers produced by the Games.

Targets of the Sochi 2014 Sustainable Transport concept:

- Change of long term modal split in favour of public transport along the coast and in the urban centers of Adler and Sochi.
- Improvement of traffic flows along the coast with optimized solutions for intersections and junctions
- Implementing a region wide traffic management system
- Design of barrier free accessible train / bus stations to increase comfort and acceptance of public transport in Sochi and mountain areas
- Alternative transport solutions for Games Time Transport Operations
- Assessment of transport alternatives along sustainability criteria
- Minimizing local environmental impacts (air quality, noise, demand for land use, impacts on natural resources and landscape)
- Low carbon transport system: reducing greenhouse gas emissions by changes of modal split and promoting alternative transport technologies
- Sustainable urban and regional development (public service, access, social barriers)
- Setting new standards for low-carbon vehicle technologies for sustainable urban transport
- Technical and management solutions to reduce congestions, noise and transport related air pollution in urban and mountain areas.

Transport Legacy

One of the primary Games objectives is to leave a lasting legacy of operations systems and knowledge to serve the city, region and nation for future events

All key Olympic infrastructure locations have been selected to ensure maximum sustainability and legacy after the Games by addressing existing sport, tourism and commercial infrastructure needs.

The preparation for the delivery of Olympic Transport systems and services will include the development of major transport infrastructure works such as track for the commuter and the gondola systems, upgrading of Sochi International Airport, the construction of new roads and underpasses along with the purchase of new transport rolling stock.

These projects will leave a lasting legacy for Sochi and have positive impact on Sochi's transport systems, services and infrastructure.

Sochi's new infrastructure will also be constructed with the highest accessibility standards, serving as a model for the rest of Russia. In close consultation with international experts, new facilities and transportation solutions will be established and existing infrastructure will be modified to create a world-class resort destination that accommodates the needs of guests with disabilities.

The transport book Nr. 3 "Public Transport" shows the new structure of public transport in the greater Sochi region, improved as a consequence of the Olympic Transport Development. The public transport system uses rail services as a backbone of fast and reliable transport. Totally redesigned bus lines feeding into the rail network and covering all population and business areas. Hubs have been designed to become effective interchange nodes between different modes of transport.

The main benefits and improvements of the public transport system redesign area:

Massive simplification of the public transport network

- less comprehensive lines
- less strategic hubs
- less overlapping traffic
- Synchronized timetables throughout transport systems
- consistent fare system

Circuit lines instead of line routes

- Higher efficiency
- Better coverage of the residential and tourist zones

Concentration on the Spine Line / Rail service between Sochi & Adler

- feeder lines to collect passengers
- high capacity coastal system

Simple communication

- principle of easy learning schedule
- customer friendly solution

7 QUANTITATIVE CHARACTERISTICS OF THE PROPOSED TRANSPORT SOLUTIONS NEEDED TO ASSESS POTENTIAL REDUCTION OF TRANSPORT-RELATED GHG EMISSIONS

7.1 RAILWAY SYSTEM

7.1.1 Requirements of the new system

Separation of Lines:

There will be trains running on the “base line” (Sochi to Olympic Park), on an own “mountain line” (Adler to Krasnaya Polyana) and “airport line” (Adler to Sochi Airport). This highly increases the chance that the trains on the overall tracks are running in time – especially on the operational-sensitive single track section between Adler and Krasnaya Polyana.

The schedule consists of a periodical interval (e.g. one train varies 30, 20, 15, 10 or 5 minutes). There will be schedules for “low demand“, “regular operation” and “peak hour” times, build on a similar base-periodicity. This procedure allows an arrangement with the time table of the competitions but creates also the possibility to react on delays, cancellations and postponements of the sport events.

Following these principles and recommendations the following railway transport concept has been developed:

Separate Sochi - Olympic Park Line:

- double track
- 10-minute interval
- only commuter trains
- between the 10 minute interval long distance trains until Adler

Separate Adler - Krasnaya Polyana Line:

- single track with 3 double track sections
- 20-minute interval from Adler mixed with the 60 minute interval from Olympic Park (4 trains arriving in Krasnaya Polyana as 15 minute interval)

Separate Adler - Sochi Airport Line:

- single track
- interval: on demand

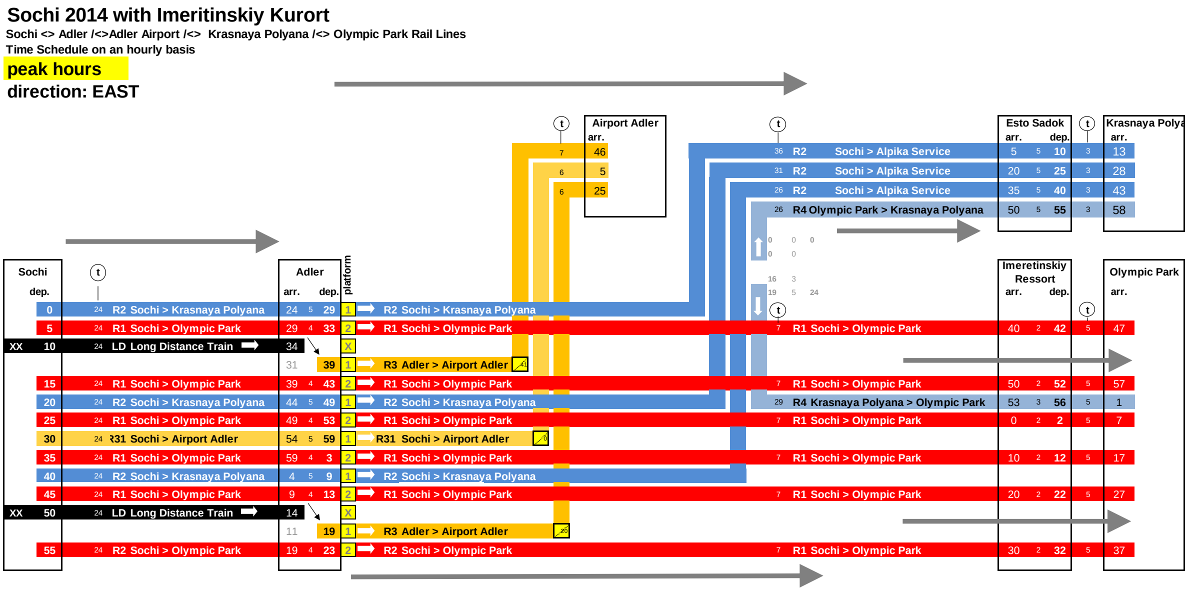


Figure 40: Sochi Railway System (peak hours, direction east)

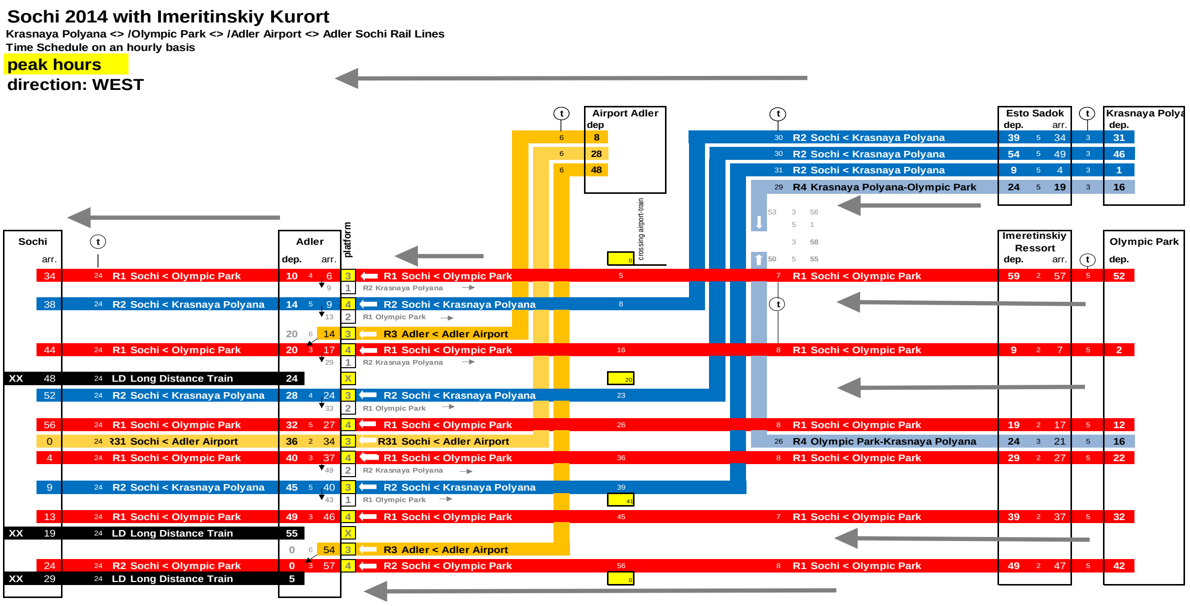


Figure 41: Sochi Railway System (peak hours, direction west)

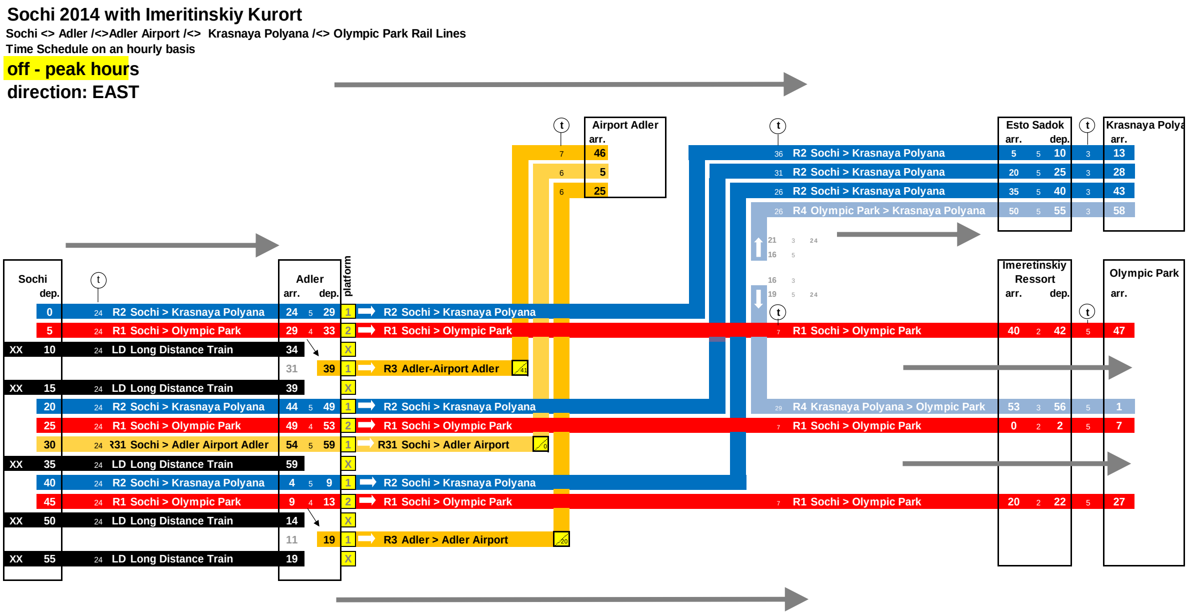


Figure 42: Sochi Railway System (off-peak hours, direction east)

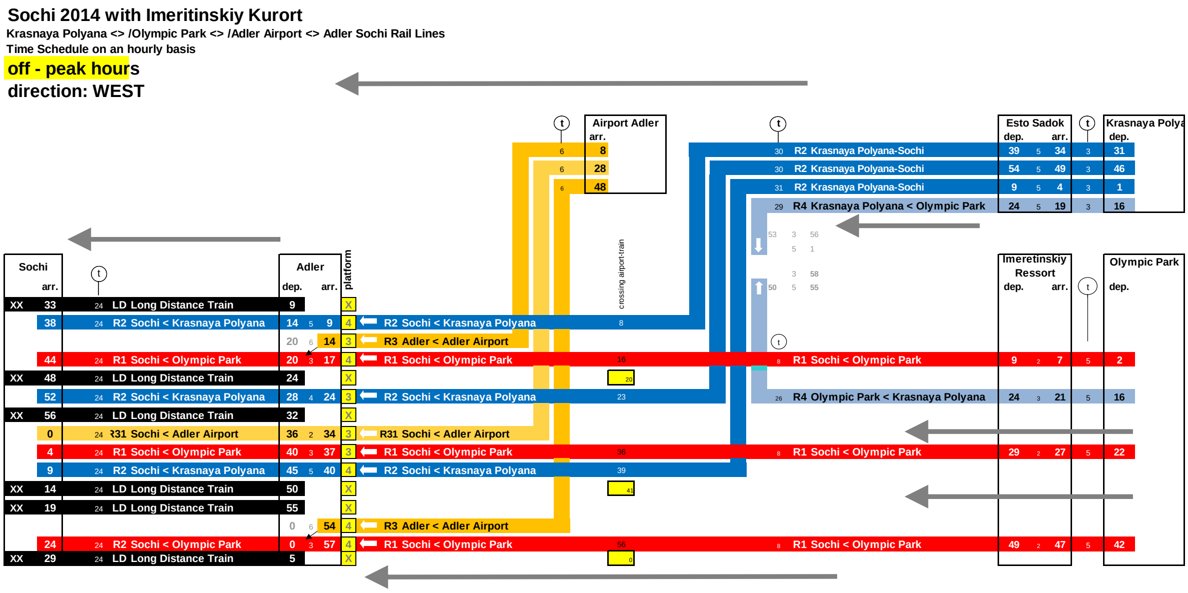


Figure 43: Sochi Railway System (off-peak hours, direction west)

Figure 44: “Desiro RUS” Train

As a reliable, versatile regional train or airport shuttle, the Desiro RUS (for Sochi 2014 named as Lastochka - Swallow) offers impressive comfort and optimal safety.

The Desiro RUS is a five-unit, single-deck, single-car multiple unit that can be used in double traction. In terms of technology, the Desiro RUS for Sochi is based on the reliable Desiro ML vehicle platform. The vehicles have been further developed to meet the needs of the Russian market: they have been designed to withstand temperatures as low as – 40 °C and have been given a car body which is 3,480 wide, a floor 1,400 mm high and a bogie with a track gauge of 1,520 mm. It was designed to comply with both international (IEC, UIC, etc.) and Russian (GOST, etc.) standards.

Thanks to the flexibility of the interior partitioning adopted from the Desiro ML, the train is in a position to deal with the special demands which will be placed on it during service for the Sochi Olympic Games in 2014.

7.1.2 Description of Transport Infrastructures and their maximum hourly capacities

Railway:

a. Railway Sochi - Adler to Krasnaya Polyana: 8208 passengers per hour (15' interval arriving in Krasnaya Polyana)
b. Railway Sochi to Adler to SOP: 12.312 passengers per hour (10'interval)

7.1.3 Train Station Functionality Analysis

a) Olympic Park Station

Olympic Park station is the final station of the Sochi - Olympic Park double-track line. For rail operational issues the station has to fulfil the following functions:

- possibility to let trains end and turn
- one directional operation
- during Olympic conditions double train sets of commuter trains will stop at this station
- after the Olympic Games commuter trains and long distance trains will stop at this station

For operating the people flows on the platform and in/around the building, the station has to fulfil the following functions:

- specified platforms for the boarding and de boarding process (clearness under chaotic Olympic Conditions
- separation of people flows because of the high number people arriving or departing at the same time
- avoid to many people on the platforms (waiting zones)

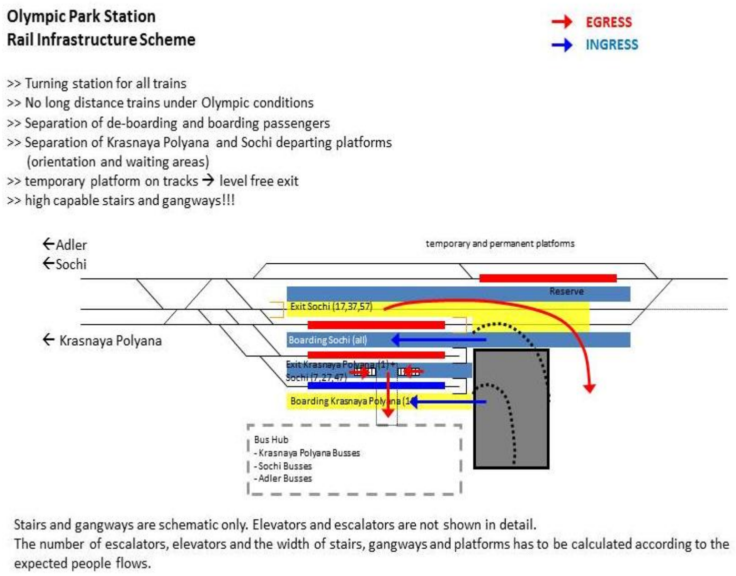


Figure 45: Olympic Park Station – Rail Infrastructure Scheme

The previously planned platform situation would have led to a bottle-neck of the walkway capacity and would have been a potential risk for all passengers and a definite barrier for PRM (persons with reduced mobility) and therefore didn't conform to PRM regulations. Having in mind that this event is the Olympic Winter Games and many events will take place open-air, spectators should be well prepared for the weather conditions. When facing high people flow scenarios, the heating of station buildings will not be possible anyway. It was recommended to define certain heated zones within the station building, which do not interfere with the main routes and where automatic doors can be used.

All elevators will be transparent and visible from outside. There will be no extra doors in front of elevators and they will be prominently situated so that they can be reached easily. All elevators will be designed according to international regulations and standards for PRM.

During the Olympic Games there won't be any ticket-control or entrance control machines, which decrease the capacity of the gangways and lead to a bottle-neck. Ticketing procedures during the Olympic Games will not be necessary due to the existence of an overall ticketing concept.

The development of emergency plans and potential additional security control procedures or concepts was highly recommended.

The development of a static and dynamic routing system is of vital importance in order to avoid chaotic situations and to be able to handle event postponements due to weather conditions.

b) Olympic Village Station

Olympic Village Stopping Point is a station of the Sochi - Olympic Park double-track line. For rail operational issues the station has to fulfil the following functions:

- possibility to change the operating directions on the tracks (break down scenarios)
- during Olympic conditions double trainsets of commuter trains will stop at this station
- after the Olympic Games only single trainsets in favour will stop at this station

For operating the people flows on the platform and in/around the building, the station has to fulfil the following functions:

- specified platforms for the boarding and deboarding process (clearness under chaotic Olympic Conditions
- The station is mainly serving Workforce transport to Olympic Village, Media Centre and IOC hotels as well as local feeder buses

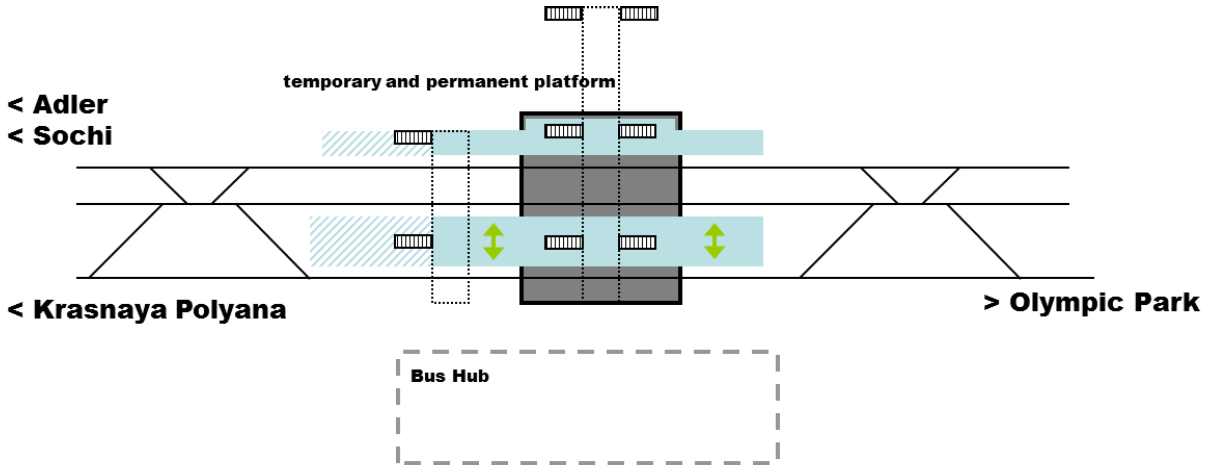


Figure 46: Olympic Village Resort Stopping Point, Rail Infrastructure Scheme

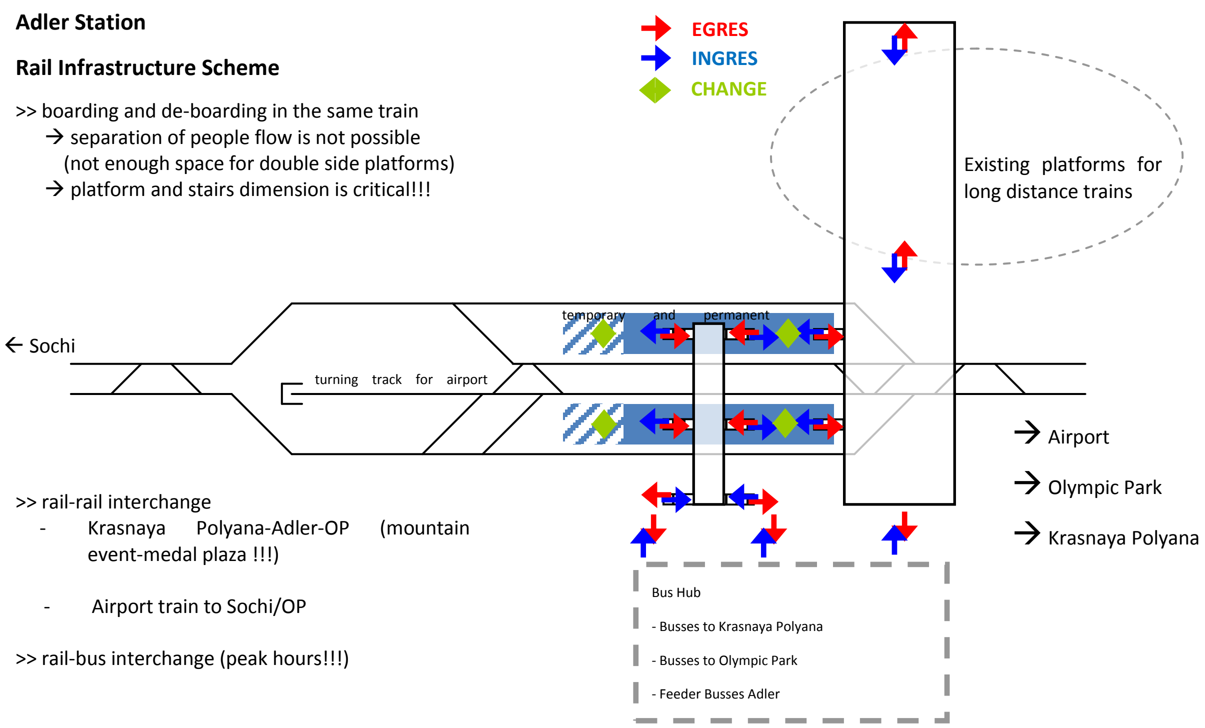
c) Adler Main Train Station

Adler is the crossing station of the Sochi- Adler – Krasnaya Polyana single-track line, the Sochi - Olympic Park double track line and the Adler – Adler Airport single track line. For rail operational issues the station has to fulfil the following functions:

- possibility to let trains stop, end and turn
- directional operation of new platforms
- no route conflicts between the continuous and turning rail lines
- integration of the airport line

- during Olympic conditions double train sets of commuter trains in favour will stop at this station

For operating the people flows on the platform and in/around the building, the station has to fulfil the following functions:



Stairs and gangways are schematic only. Elevators and escalators are not shown in detail.

The number of escalators, elevators and the width of stairs, gangways and platforms has to be calculated according to the expected people flows.

Figure 47: Adler Station – Rail & Bus Infrastructure Scheme

The bus hub was re-dimensioned according to the Olympic demands and the bus platforms were designed in a "saw-tooth" pattern.

The track design was adapted in order to plan turning tracks on the west-side of the new Adler station platforms. This will be necessary to operate all trains according to the estimated schedule, which is part of the overall Olympic Transport Master plan.

Shunting procedures (long distance trains, locomotives) on the Adler station east-side must be clearly identified and interfering movements must be integrated in the time schedule.

7.2 PUBLIC BUS SYSTEM

7.2.1 Feeder Bus System

NEW SYSTEM*		AREAS TZ1 - TZ6	people living there	No. hotel rooms	No. Privat beds
all number of 1x1 km Areas for TZ1 in TZ 6	**AREAS TZ1 - TZ6**	300 areas	289.818 people	36.172 hotels	18.038 privat beds
All number of feederbuses in 300m strip left and in TZ1 - TZ6	**ALL FEEDERBUS LINES - 300m STRIP**	182 people	236.114 people	24.603 hotels	17.204 privat beds
All number of feederbuses in 100m strip left and in TZ1 - TZ6	**ALL FEEDERBUS LINES - 100m STRIP**	144 people	212.431 people	24.011 hotels	17.075 privat beds
All number of feederbuses without strip left and in TZ1 - TZ6	**ALL FEEDERBUS LINES - no STRIP**	130 people	205.010 people	16.777 hotels	17.065 privat beds

- Buffer left and right of the feeder bus line means, that all residents, hotel beds and private rooms in this distance are analysed.

- for example:
  the way for the residents by a buffer of 300m = 300m +1000 m
  the way for the residents by a buffer of 100m = 100m +1000 m
  the way for the residents by a buffer of 0m = 1000 m

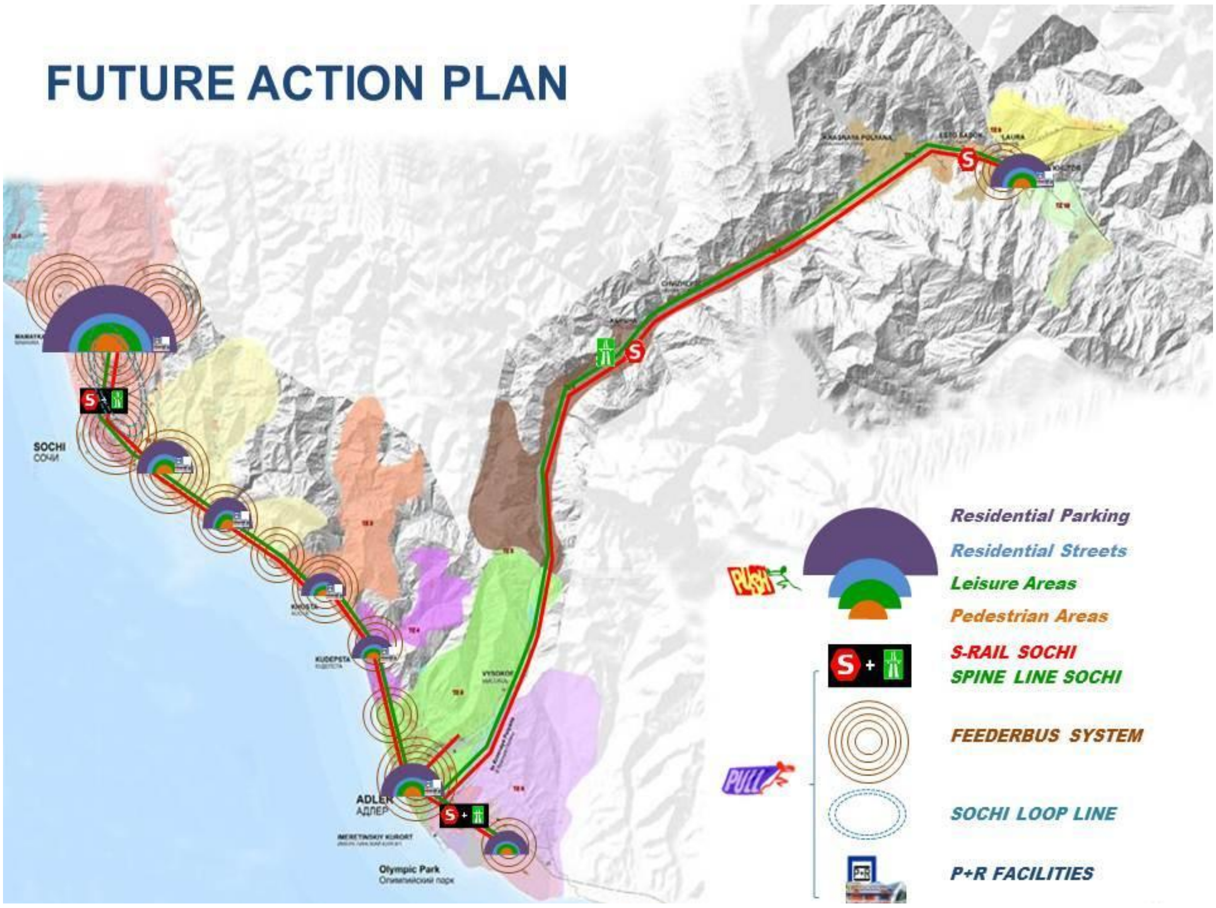


Figure 48: Feeder Bus System

One of the proposed system solutions is the reorganization of the public transport network from the chaotic environment with large numbers of doubling routes into a well organized intermodal system with spine bus routes and a network of feeder bus lines. Together with a successive organization of railroad operations as a commuter railway system that will lead to effectiveness, safety and comfort increase of the Sochi public transport system.

The replacement of the existing outdated buses that currently operate within the public transport market will lead to a more environmental-friendly system with higher capacities and a significant decrease in Sochi passenger transportation fleet numbers.

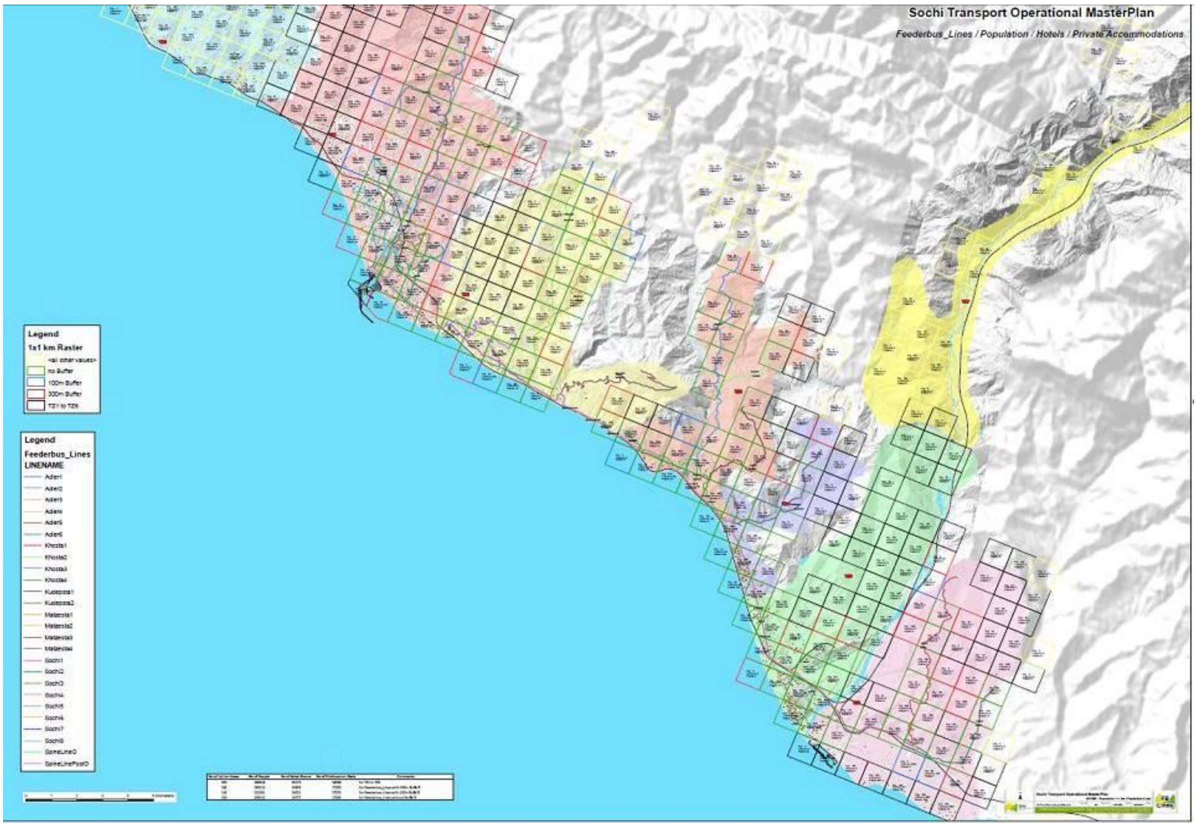


Figure 49: 1x1 km Area Demographic Analysis

A decrease in Sochi passenger transportation fleet numbers, as expected, will result in following:

- Decrease in fuel expenses
- Decrease in road maintenance (repairs) costs
- Optimization of operational expenses
- Increase in tax incomes

As part of the Strategic Transport Olympic Management Plan (STOMP) in 2011 a total redesign of the public bus system for the Sochi area has been proposed. Instead of running hundreds of direct mini bus lines, essentially a group taxi system, a feeder bus system needs to be implemented, interconnecting the bus and railway system. Under this concept local bus lines feed passengers into the closest station of the high capacity rail system. Only such an integrated system allows utilizing the rail to its full potential. Furthermore the requirements of buses, driven bus kilometers and ultimately fuel consumption also decreases.

In STOMP all important details, such as demographic characteristics, population distribution and road data were integrated into GIS and ITSOS.

Analyzing the current bus system the doubling of lines on the same routes was eliminated. Therefore, the integral interval in the timetable was increased significantly. Higher frequency means higher passenger comfort.

Through the GIS system accurate calculations of the driven km and the number of bus lines are available.

The new public bus system is structured according to principles of an intermodal system, with interchanges among connecting lines and with other transport modes, especially the commuter train system. There are 7 links of the railway lines with feeder bus lines and 10 links to the spine lines. Furthermore the load factor in the hubs and as consequence congestion was significantly reduced.

The public bus system has the following characteristics:

CITY CONCEPT	
NO. of lines	***110****
NO. of buses	***568****
15m buses	*103**
12m buses	*102**
medium buses	*230**
mini buses	*133**
service km peak day 24 hours	51528,8km/24 hours **

*SOURCE: LETTER OF SOCHI ADMINISTRATION Nr. 211/ 18-46 of 08.02.2011
**SOURCE: SMC CALCULATION WITH DATA FROM THE PRÄSENTATION SOCHI ADMINISTRATION

SMC CONCEPT	
NO. of lines	***59****
NO. of buses	***283****
15m buses	*58***
12m buses	*25***
medium buses	*193***
mini buses	*8***
service km peak day 24 hours	83509,415km/24 hours **

**SOURCE: CALCULATION SMC AUGUST 2011/ COORDINATION WITH SOCHI ADMINISTRASTION MAI 2011

Figure 50: Public Bus System Parameters 2011 – Comparison of options

Further optimization of the public bus system has been proposed in 2011 as outlined below:

- Integration of the existing and city proposed bus routes into the GIS Transport data base
- Sochi Household questionnaire to verify residential and business mobility behaviour (minimum 2.000 people)
- Analysis of the revised Sochi Bus Network and station concept (status 3/2011)
- Verification of all bus routes, implementation, schedules and bus number demand
- Integration of the draft joint bus network into ITSOS (Intermodal Transport Simulation Operation System)
- Development of a principle bus schedules and overall bus demand
- Integration of ITSOS data into VISUM and matching of household questionnaire results
- Development of a full bus schedule including vehicle turnover and driver plan

7.2.2 Spine Bus System

The spine bus system will operate from Sochi Rail & Bus hub to Sochi Olympic Park (B1), Krasnaya Polyana hub (B2) and Adler Airport (B3) . The following figures show how the spine bus system works.

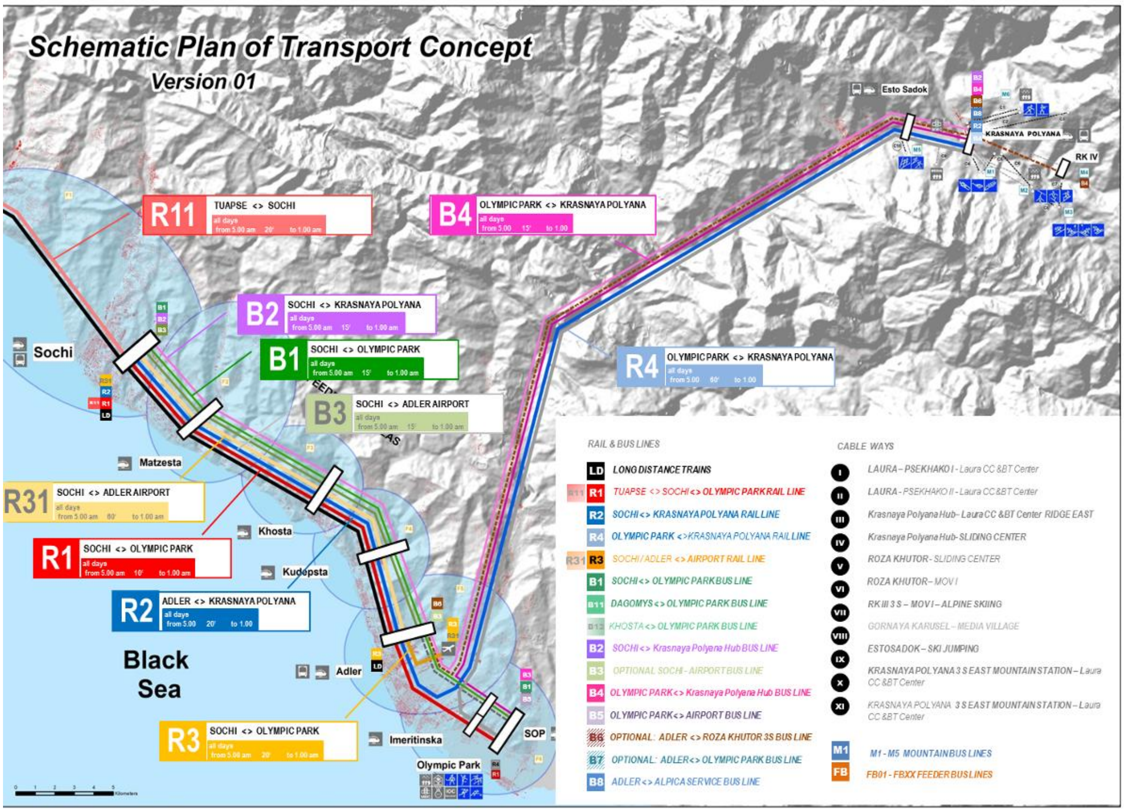


Figure 51: Dual System - Rail & Spine Bus System

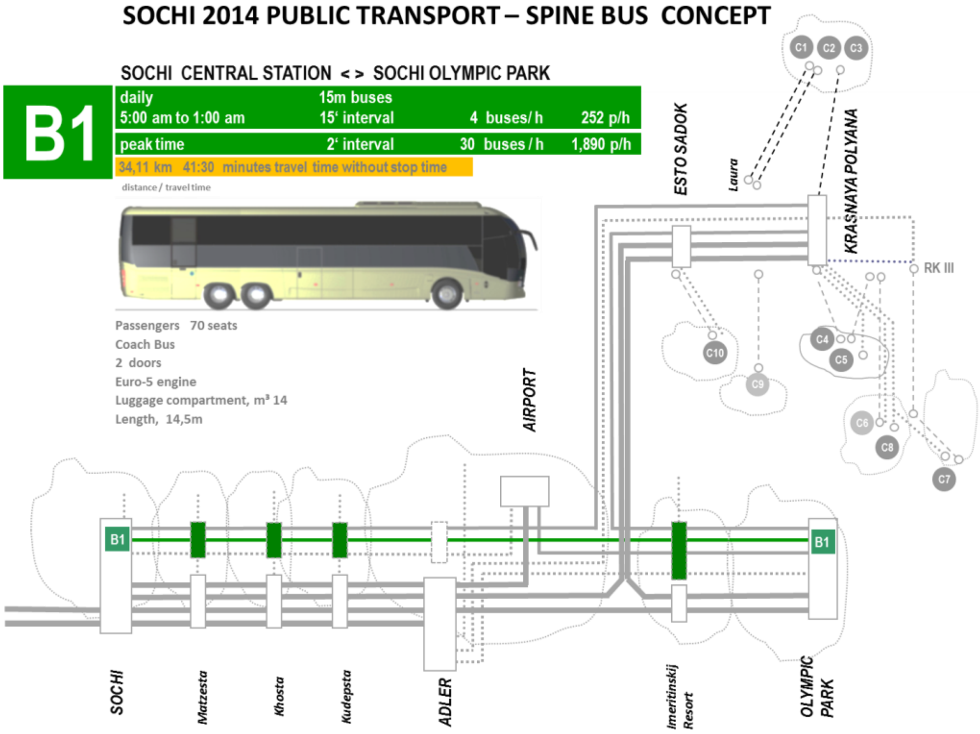


Figure 52: Spine Bus Line B1

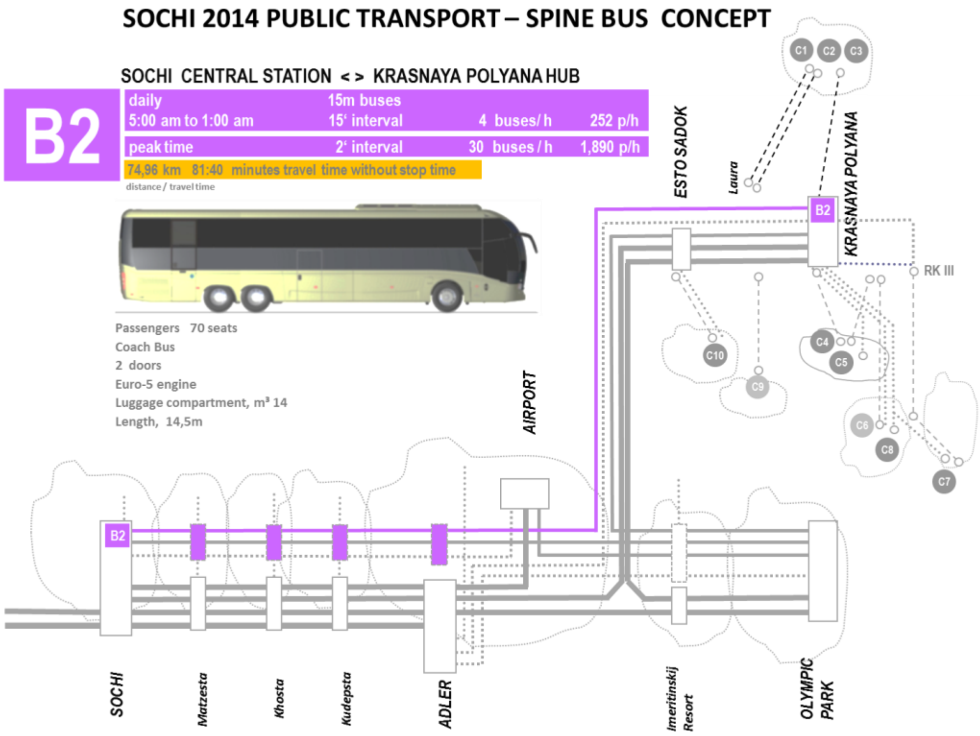


Figure 53: Spine Bus Line B2

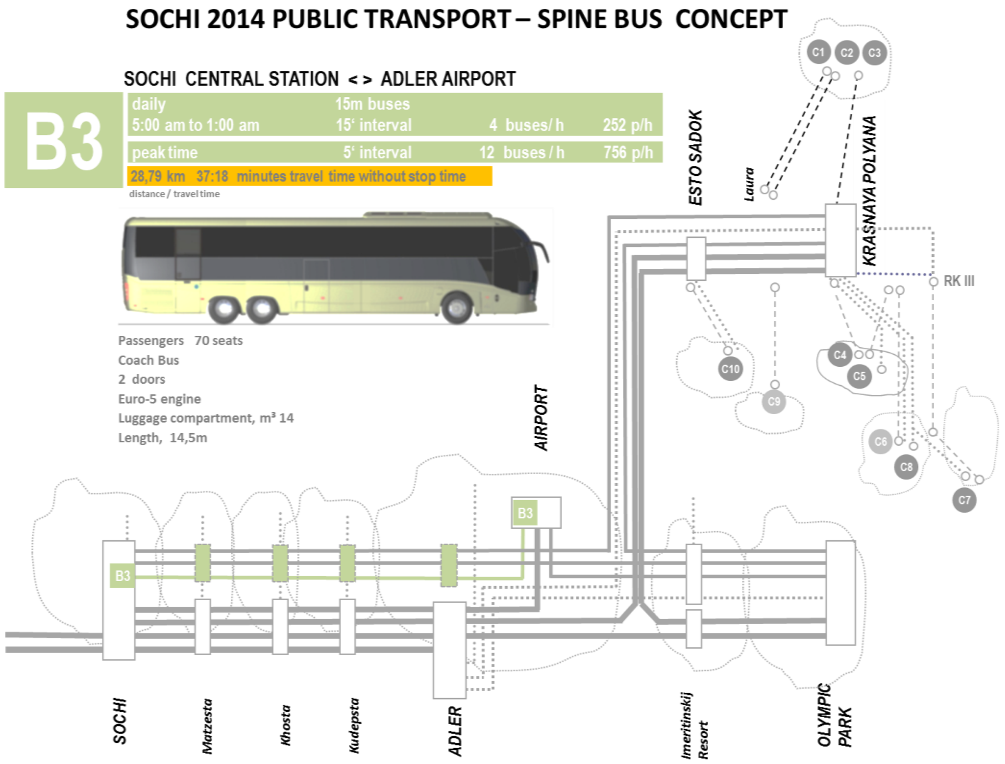


Figure 54: Spine Bus Line B3

7.2.3 Planned Bus Terminal Capacities

Sochi Main Station:

Figure 55: Sochi Rail & Bus hub - current situation

Terminal I: 48 buses (15m) per hour (Line B1, B2& B3)

Terminal II: 30 city buses (Feederbuses)

Terminal III: 48 buses (15m) per hour (Line B1, B2& B3)

Terminal IV: 30 city buses (Feederbuses)

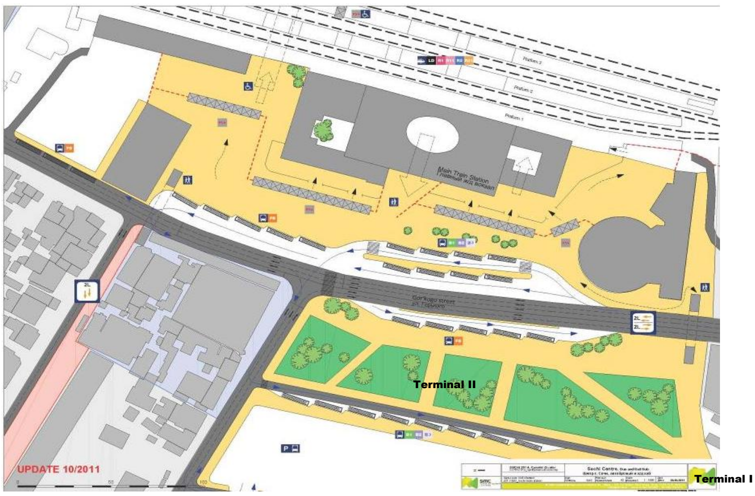


Figure 56: Sochi Rail & Bus hub (planned intermodal principles)

Terminal IV

Adler Station:

Figure 57: Adler train station - stage of construction in June 2012

Platform I: 54 coach buses (15m) per hour

Platform II: 60 coach buses (15m) per hour

Platform III: 72 Local Feeder buses (Transport Zone 5)

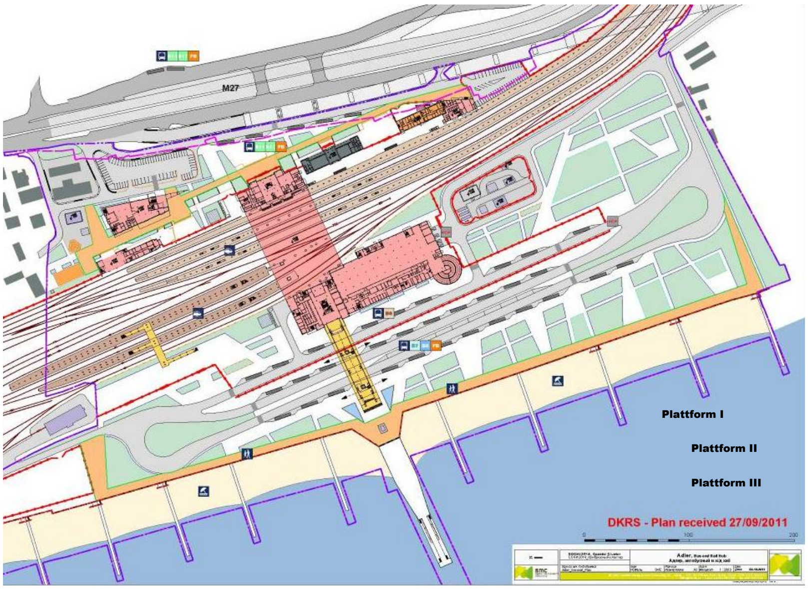


Figure 58: Adler station (planned intermodal principles)

Olympic Park Station:

Figure 59: Planned Olympic Park Station in 2010

Platform I:	7 charter buses (15m)
Platform II:	20 coach buses per hour
Platform III:	60 coach buses per hour
Platform IV:	60 city buses per hour

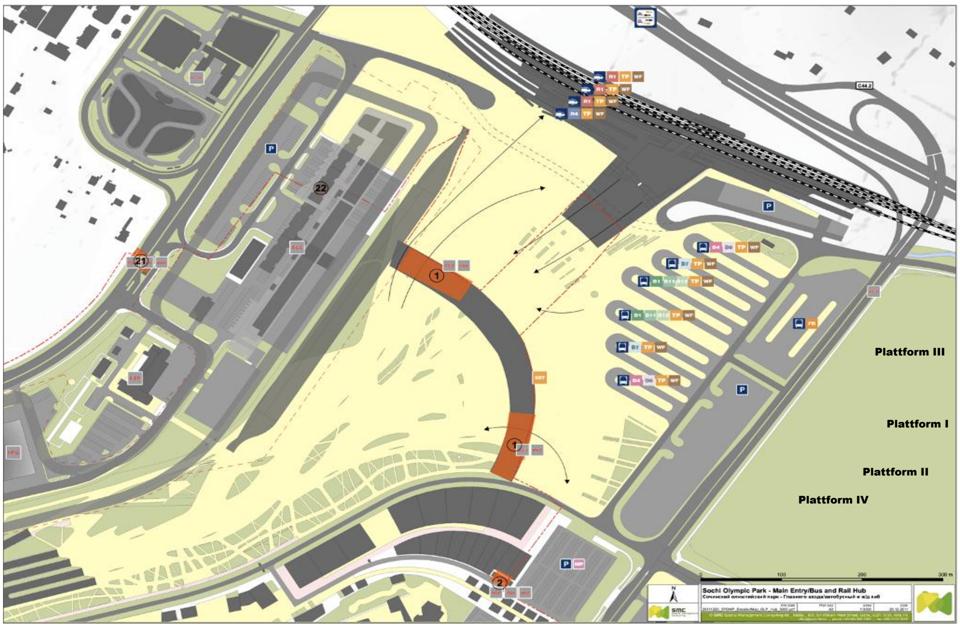


Figure 60: Olympic Park station (planned intermodal principles)

7.2.4 Road Network (capacity per hour and per direction)

Road (A 148) Adler to Krasnaya Polyana:	3.300 vehicles (2 lanes up / 2.400 2 lanes down)
Coastal Road Sochi to Adler:	3.300 vehicles
Road (25) to Rus Ski Gorki:	420 vehicles
Road to Psekhako Ridge:	420 vehicles
Road (21) to Rosa Khutor Alpine Center:	420 vehicles
Road (23) to Roza Khutor 3S cable road station Mzymta Valley:	685 vehicles

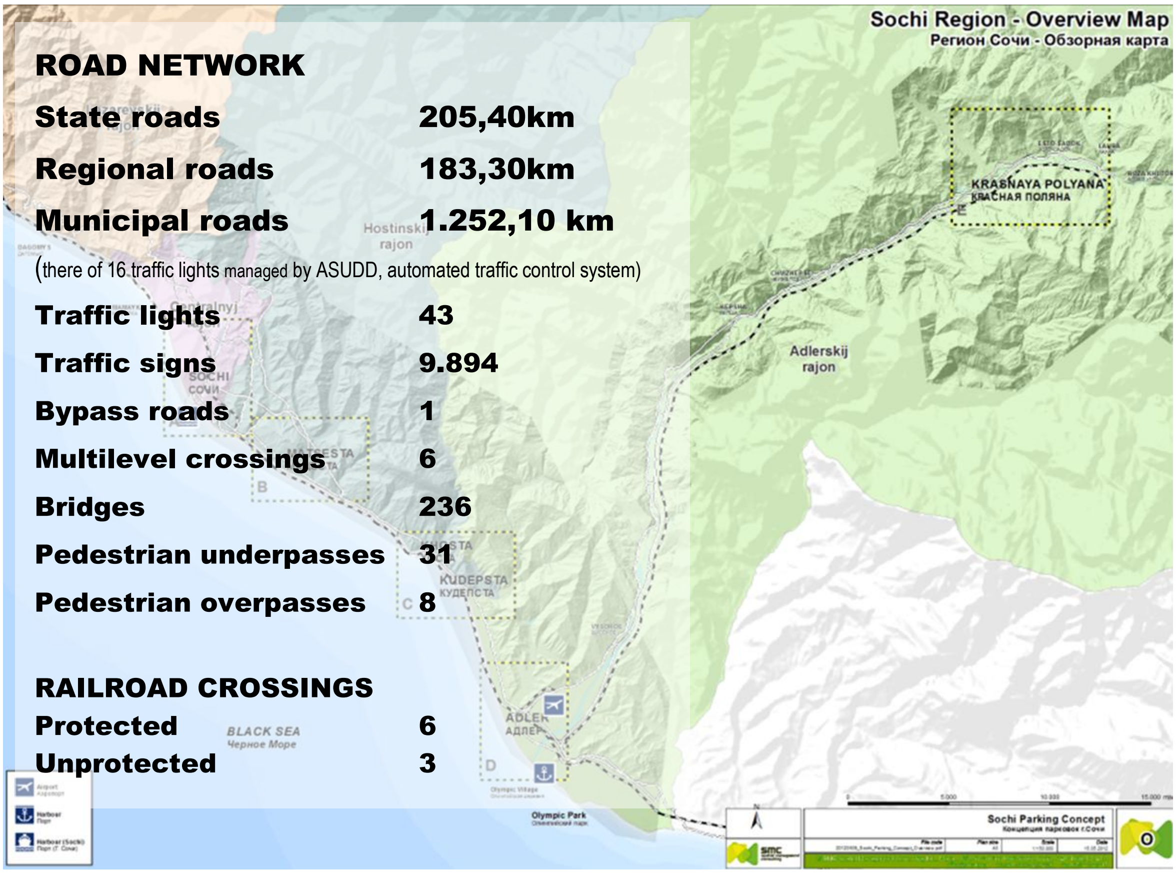


Figure 61: Road Network

7.3 TRANSPORT ZONES

Figure 62: Overview of proposed transport zones

7.4 PROPOSED INTERMODAL CONNECTIVITY'S

7.4.1 Interconnected pedestrian walkways

Integrating pedestrian infrastructure into public transport projects is key to achieve sustainable transport. Of major importance are safe and well organized walkways that allow to change among transport modes and also to reach public transport stops.. The lack of pedestrian infrastructure impedes to change from one transport mode to the other.

Figure 63: Efficient Matsesta hub

Figure 64: Efficient Matsesta hub – proposed

7.4.2 Transport interchange hubs

Another priority project is the currently planned hub in the mountains, Krasnaya Polyana. Only an efficient connection of train, bus and cable ways can guarantee a sustainable transport system that is not based on individual cars.

Figure 65: Krasnaya Polyana hub today under construction

Figure 66: Krasnaya Polyana hub as planned for Olympic operations

Accessibility and walkable connections (bridges, promenades) are the key to success of Krasnaya Polyana as a mountain touristic cluster.

7.5 RE-ORGANIZATION OF PARKING AND TRAFFIC MANAGEMENT

7.5.1 Sochi Centre

The main part of the area of Sochi is characterized by a low quality of the public space structure. It is of high importance to restructure the public space to be able to provide the necessary space for each user group – pedestrians & cyclists as well as motorized & parking traffic.

A main part of the possible solution for Sochi Center should be a strict rearrangement in case of pedestrian and residential areas and parking restrictions. The individual solution for Sochi Center can be characterized in 2 classes and different sub-classes which consist of different individual measures considering the present state of the design of the public space, the parking situation and the current situation of pedestrian and un-motorized road spaces. The mentioned classes for the future development are defined below.

Parking Development and Management

- **Reorganization of Public Spaces & Parking**
- **Residential Parking**
- **Residential Streets**
- **Park&Ride-Facilities**
- **Parking Facilities**

Pedestrian Traffic

- **Pedestrian Areas**
- **Leisure Areas**

Proposed Sochi Loop Line

To be able to change the present parking situation and to increase the living and recreation quality of the central area of Sochi one of the core requirement is a redesigned public transport system and a strict redesign of different roads which currently absorb main shares of the Sochi through-traffic. This traffic has to be transferred onto the new built M27.

To provide an attractive public transport offer it is recommended to introduce a “Sochi-Loop-Line” which connects points of interest within the central area with the surrounding public traffic systems and Park&Ride infrastructures. The following figure is showing a supposable solution for the routing of such a loop-line.

This route could be an attractive alternative instead of the present used car for

- 30.000 residents within a catchment area of 300m
- 41.000 residents within a catchment area of 500m

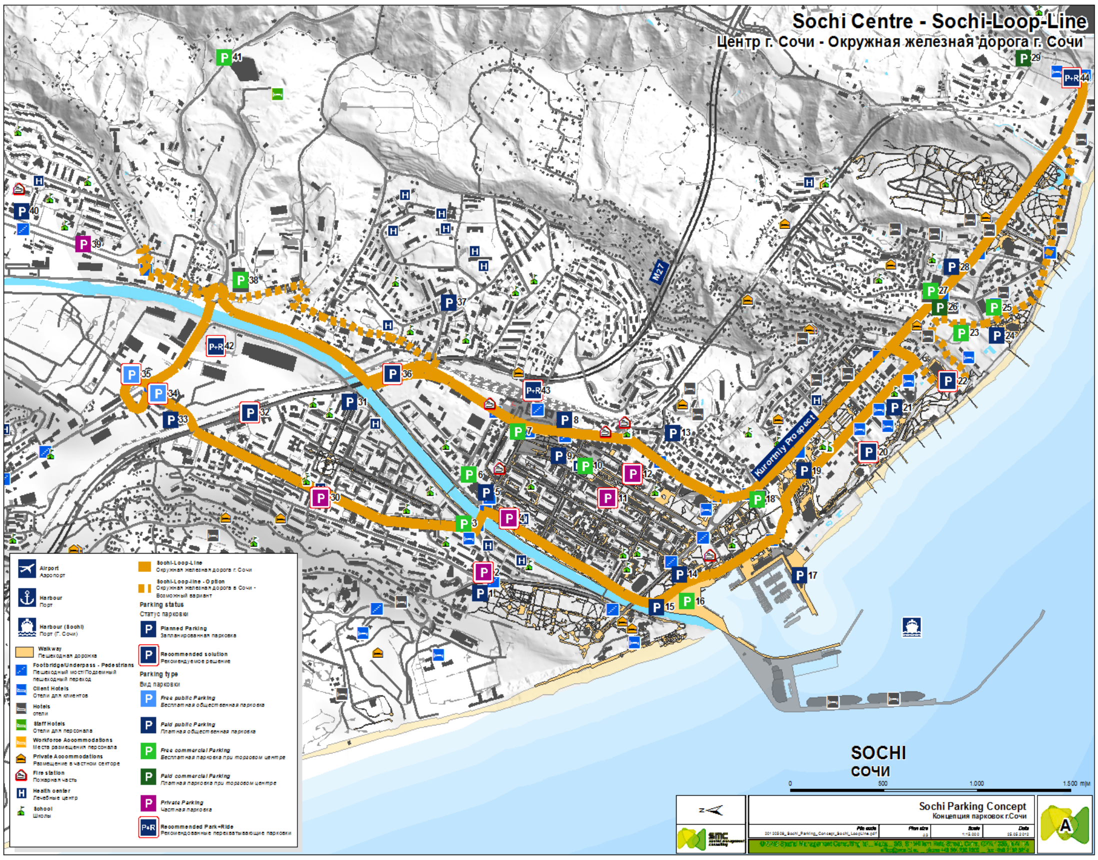


Figure 67: Recommended Sochi-Loop Line

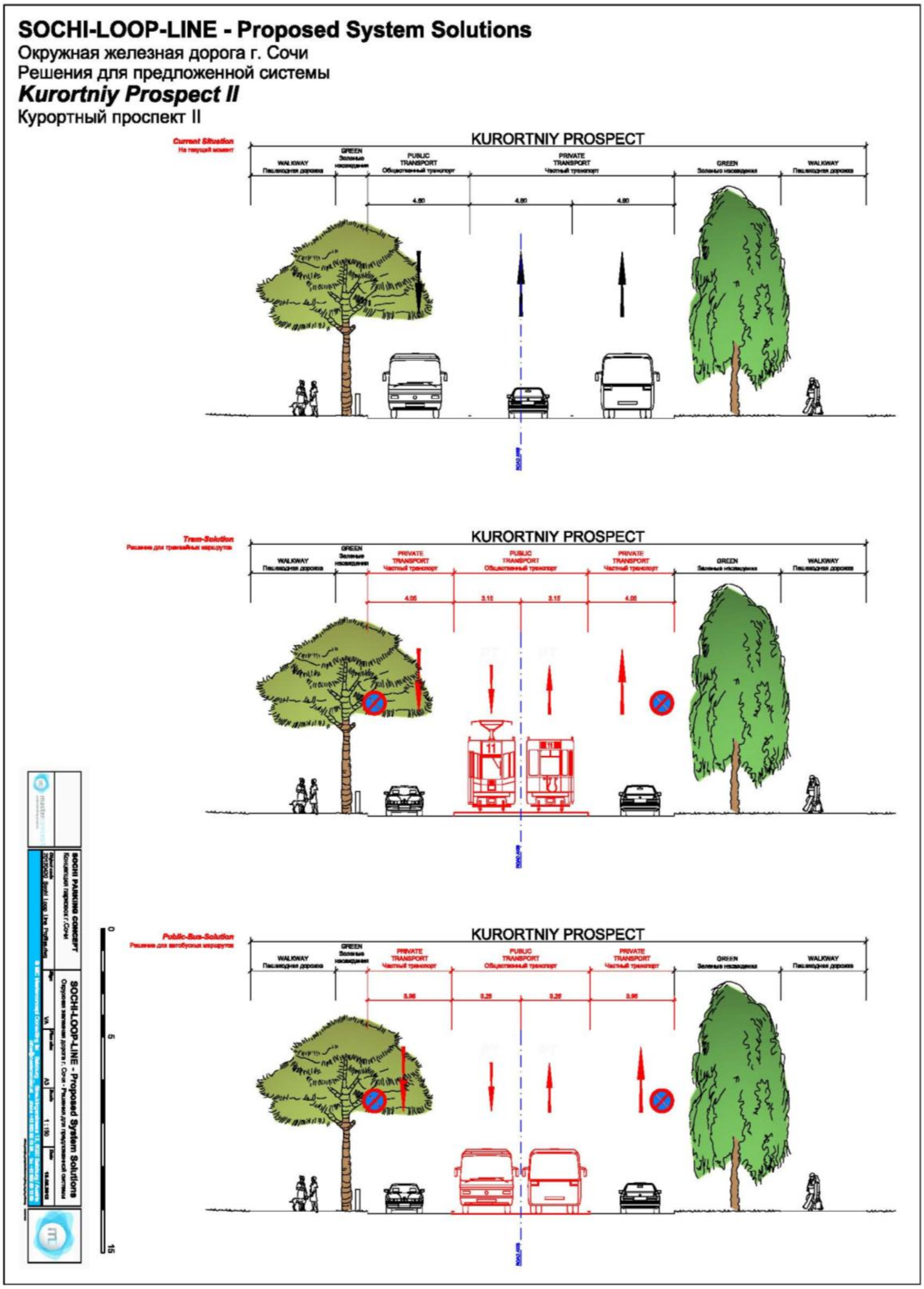


Figure 68: Recommended Sochi-Loop Line

Proposed Residential Parking Management

The main share of the central area of Sochi Center is characterized the same way. The main usage, which is living, requests a high amount of parking spaces for local residents. Additionally there is a high demand on parking spaces due to small and big business facilities. To be able to reserve an adequate number of parking spaces in the public space for residents it is proposed to establish parking restrictions. For the areas A11 & A12 and A16 & A17 of Sochi Center the following measures should be approached.

- **Parking Restriction**
  Overall parking restriction:
  - 08:00 AM – 20:00 PM valid
  - 20:00 PM – 08:00 AM free
- **Parking Charge**
  Parking charge for all public parking spaces. The amount of charge has to be approached based on the local classifications.
- **Short term parking**
  Max. parking duration: 2 hours
- **Residents Parking Permit**
  Residents should be able to get a parking permit for that area which he is living at. For each household there should be provided only one parking permit for each zone for free. Additional parking permits for more than one vehicle only should be available by charge. The amount of this charge has to be conformed taking into account the local classifications of charge.

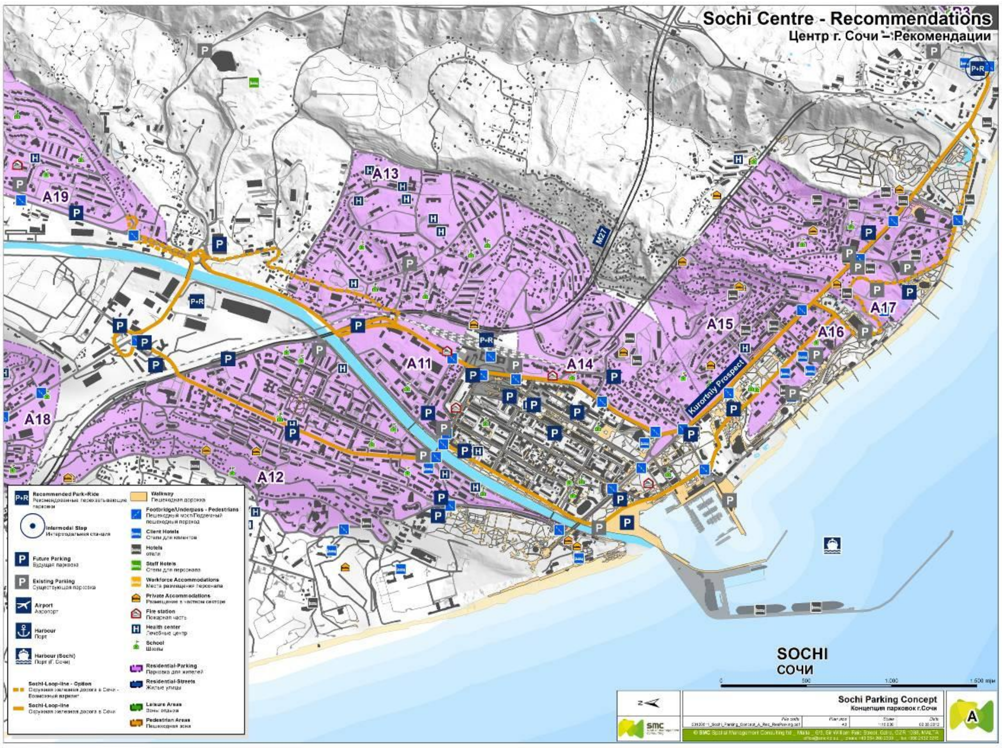


Figure 69: Sochi Center – Residential Parking

Pedestrian Traffic

Pedestrian Areas

Within and surrounding the central district of Sochi Centre there are a few areas which are very attractive. Due to unattractive connections to the residential areas by pedestrian infrastructure they are used in a very minimal degree. For future development it is proposed to invent large scale pedestrian areas in the central area of Sochi.

- **Sochi Centre (A1)**

  The area of Navaginskaya connects the attractive areas along the coast and the central Sochi area surrounding the Sochi Rail Station. Along this area there are different shopping centers and other points of interest which could be embedded in this pedestrian area.

  There should be an attempt to a fundamental redesign of the whole area. It is of high importance to provide a pedestrian friendly design to reach the requested impact on pedestrian traffic and residential behavior.

- **Sochi Coastal Strip (A2)**

  The present areas between coast and road Kurortniy Prospect are suitable for reorganization and a further usage as pedestrian areas. With this measure it is possible to extend the very narrow coastal promenade up to the more accessible areas. The proposed pedestrian area could include main parts of the roads ul. Ordjonikidze, ul. Primorskaya and ul.Chernomorskaya. It is conceivable to redesign these roads and get attractive additional promenades.

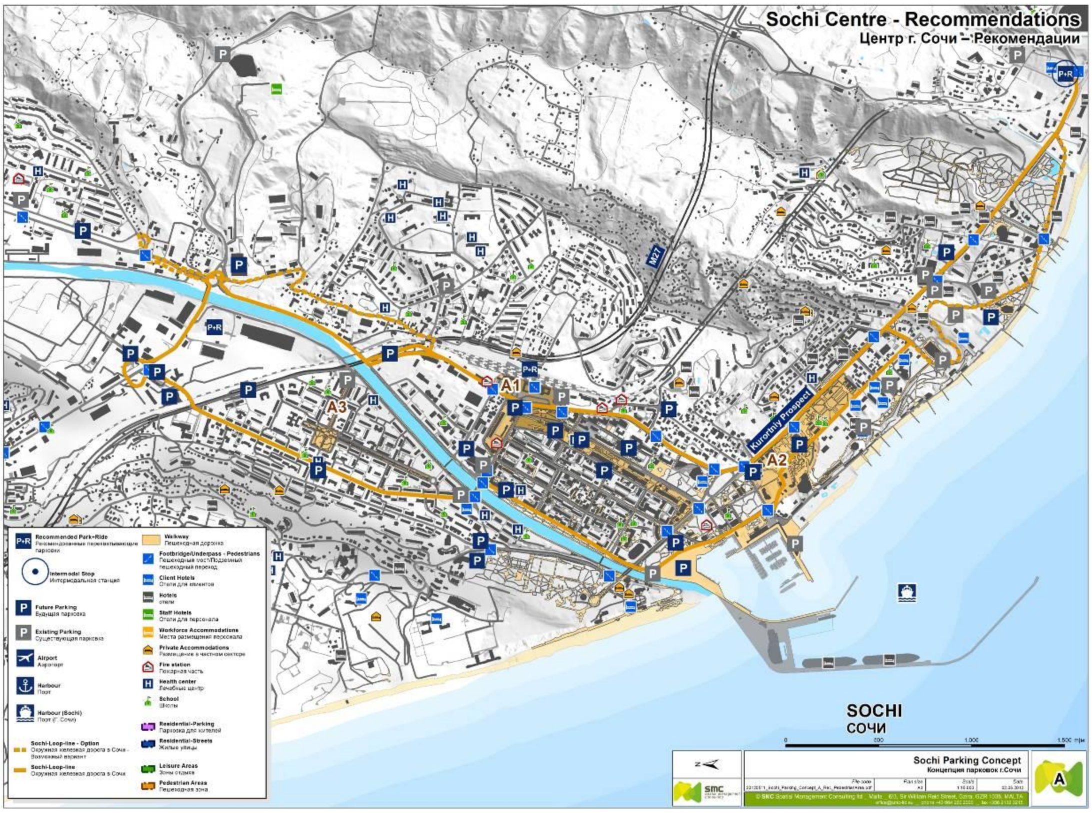


Figure 70: Sochi Center – Pedestrian Areas

Leisure Areas

Additionally there are existing different **leisure areas along the coast** and in areas of the city like the **Botanic** Garden whose accessibility should be improved for pedestrians. These areas can be connected with each other and with the center of Sochi in a very attractive way by the recommended pedestrian areas.

- **Sochi Harbor (A4)**

For the surrounding area of Sochi Harbor it is proposed to develop a leisure area connecting the adjacent leisure areas in the north and south and the eastern pedestrian area which is connected to the very center of Sochi. Considering the future usage of cruise liners Sochi harbor would be the representative flagship for Sochi. Connecting to the Sochi-Loop-Line this area will be well connected to the further points of interest in Sochi Center.

- **Sochi River (A5)**

The area north of the Sochi River should be developed as an attractive leisure area. It could connect to the northern sanatorium area and to the southern leisure area surrounding Sochi harbor. Last mentioned area could be connected by using the existing pedestrian bridge.

- **Sochi Promenade (A6 & A7)**

The existing promenade with its present amusement facilities is connected to the harbor in the north but is still ending very soon in the south of Sochi Centre. The coastal promenade should be expanded to the south until the connection to the Sochi Botanic Garden. The main expand should be reserved for recreational usage. Including some extensions up to the road Kurortniy Prospect this area will be well connected to the Sochi Coastal Strip pedestrian area and the public transport systems.

- **Sochi Botanic Garden (A8)**

This existing point of interest has to be well connected to the existing or proposed public transport systems. This can be done by connecting to the proposed intermodal transport hub at Sochi Botanic Garden. Additionally it should be considered an additional stop at Botanic Garden itself. This station should be frequented by the proposed Sochi-Loop-Line-.
In addition it is proposed to optimize the connection of Sochi Botanic Garden to the coastal promenade.

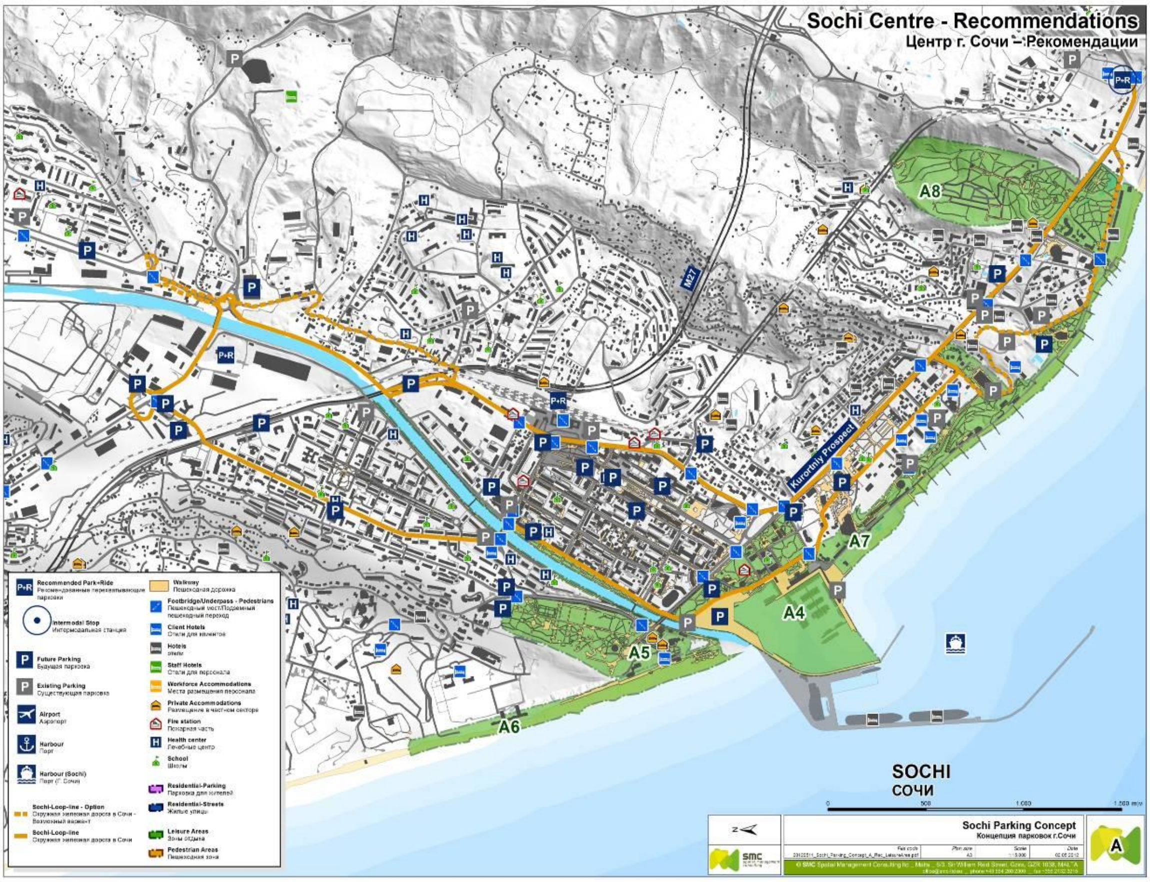


Figure 71: Sochi Center – Leisure Areas

Sochi Center – Summary of the main areal improvements

Residential Parking

- ✓ Redesign of the public space
  - Leisure
  - Walking
  - Biking
  - Motorized Traffic
  - Parking
- ✓ Overall parking restriction:
  - 08:00 AM – 20:00 PM valid
  - 20:00 PM – 08:00 AM free
- ✓ Parking Charge
- ✓ Short term parking
- ✓ Residents Parking Permit

Residential Streets

- ✓ General restriction of motorized traffic except
  - destination traffic
  - deliveries, emergency
- ✓ Allowed cycling
- ✓ Allow walking and children to play on the road areas
- ✓ Priority to pedestrians and un-motorized traffic
- ✓ Motorized traffic speed: onto pedestrian level (4 – 10 km/h)
- ✓ Redesign of the public space → resident-friendly

Pedestrian Areas

- ✓ Fully restricted motorized traffic, except
  - deliveries, emergency
  - bicycles
- ✓ Allowed traffic needs to give priority to pedestrian traffic
- ✓ Allowed traffic at maximum speed of 6 km/h
- ✓ Redesign of the public space
- ✓ Improved connection to leisure areas and living districts using
  - Improved public transport network
  - Improved pedestrian infrastructure

Leisure Areas

- ✓ Fully restricted motorized traffic, except deliveries & emergency
- ✓ Allowed traffic needs to give priority to pedestrian traffic
- ✓ Allowed traffic at maximum speed of 6 km/h
- ✓ Redesign and/or improvement of the public space
- ✓ Improved recreational facilities (beach, promenade, recliners, etc.)
- ✓ Improved touristic attractions
- ✓ Improved connection to pedestrian areas and living districts using
  - Improved public transport network
  - Improved pedestrian infrastructure

Parking recommendations

- ✓ Amend the use of existing/proposed parking facilities
- ✓ Develop additional Park&Ride-Facilities

7.5.2 Krasnaya Polyana

Krasnaya Polyana is located in the mountain area of the wider Sochi area. Due to its very rural location and the present parking situation there is no need for outstanding infrastructure changes. Currently the design of the public space is very undersized. A main part of the local roads is in a very bad condition, pedestrian infrastructure is missing. Due to this fact it is necessary to redesign the present infrastructure to reach the present state of art of urban and rural design. The focus should be put on the development of pedestrian infrastructure and an optimized design of living districts to reach an increased living quality.

Reorganization of Public Spaces & Parking

In the main area of Esto Sadok (E1) and Krasnaya Polyana (E2) a reorganization of the public space and especially the pedestrian areas is very important to lead to a more attractive design of the public space.

The most important areas of public spaces are

- Leisure
- Walking
- Biking
- Motorized Traffic
- Parking

A modification of residential-streets is the usage of traffic calming designed roads. This method can be used especially in the present rural living districts of Krasnaya Polyana and Esto Sadok. The vehicle traffic has to underlay the living and leisure use and of course the pedestrian and un-motorized traffic. A concrete example to use this design of public space would be the backwards connection of Krasnaya Polyana and Esto Sadok. Beginning in the east of Krasnaya Polyana there should developed a road connecting Esto Sadok in the west and expanding up to the eastern crossing with the road to Laura.

An exemplary design for this road is given in the following figures. This design can be used for each road in both villages.

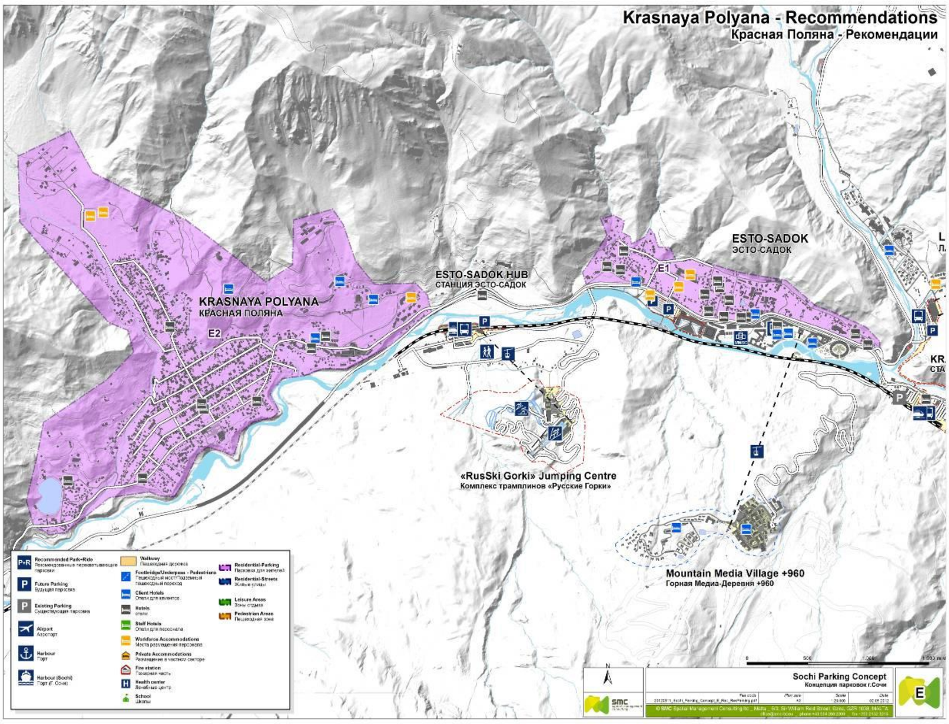


Figure 72: Krasnaya Polyana – Reorganization of Public Spaces & Parking

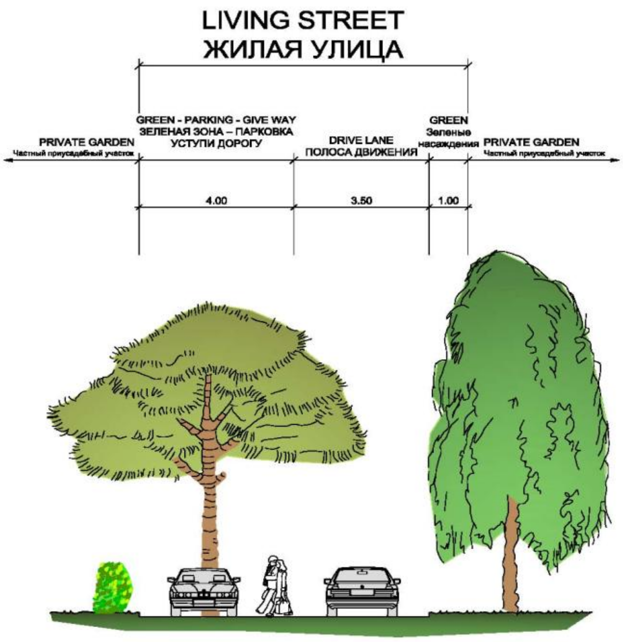


Figure 73: Krasnaya Polyana – Design of living streets

Parking Facilities

In Krasnaya Polyana and Esto Sadok there is only few number of parking facilities which are expected for private or commercial use (cablecar station, hotels, etc.). Due to the mentioned low parking demand frm today’s point of view there is no need for additional parking facilities.

But it has to be noted that it has to be managed by legal measures to avoid the usage of public parking spaces by planned private and/or commercial constructions. Rather legal measures have to request a number of parking spaces according to the usage and dimension of the construction provided on its own land plots.

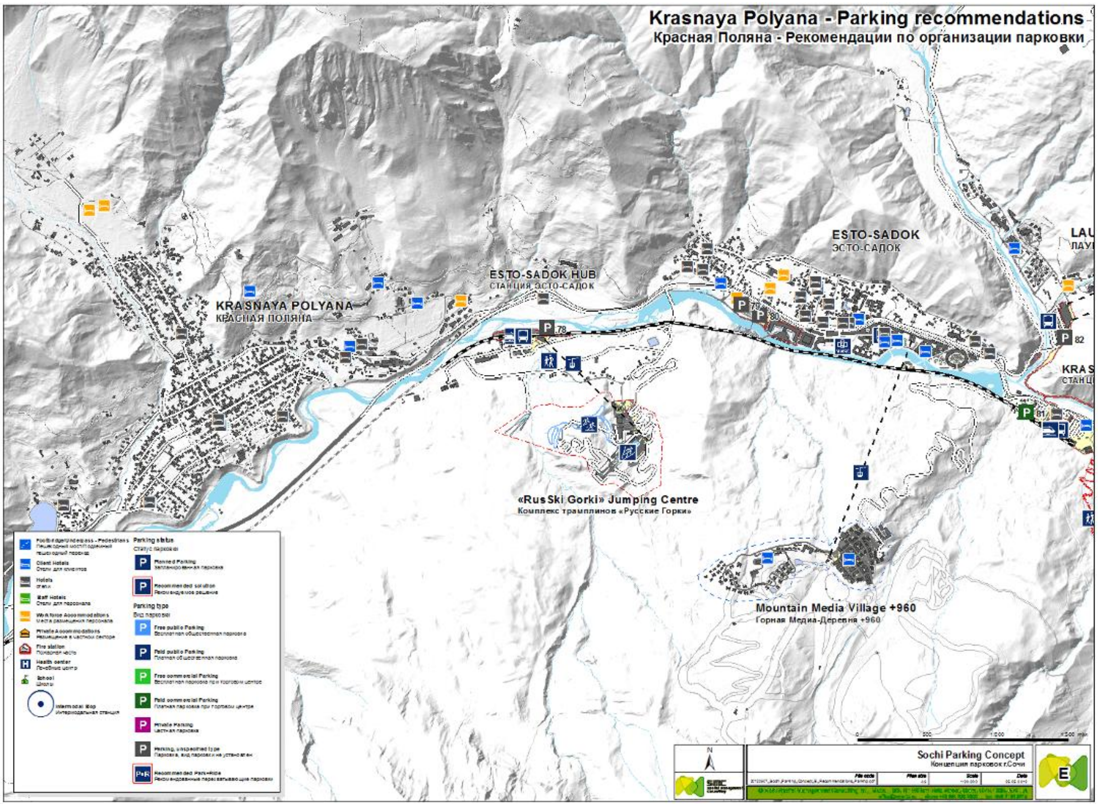


Figure 74: Krasnaya Polyana – Park&Ride- and Parking Facilities

7.5.3 <u>Relocation of parking spots in public areas</u>

Lots of parked cars interfere with public space and decrease the quality of life. Unfortunately this is the case in residential areas where the density of residents and the number of owned cars are both high. The negative effects of the present system need to be translated into objectives for a sustainable development of transport including the change of infrastructure.

Parking Relocation Potential

➢ Sochi Center	~ 80% of 12.700 cars	~	10.200
➢ Matzesta	approx. like Khudepsta	~	120
➢ Khosta	~ 50% of 1.119 cars	~	560
➢ Khudepsta	~ 50% of 243 cars	~	120
➢ Adler Center	~ 80% of 5.679 cars	~	4.550
Total:	~ 78%	~	15.550

Figure 75: Parking Relocation Potential

7.5.4 Park & Ride

The scope of the management of parking spaces for private vehicles is to make proposals for parking locations, usage during the post-Olympic period with consideration of reorganization of city public transport system and its integration with rail transport.
Sochi Administration has identified potential Park & Ride locations, which are indicated in the map below. These are mainly north of the city and not yet connected to the City Feeder Bus Network.

7.5.5 Traffic Management

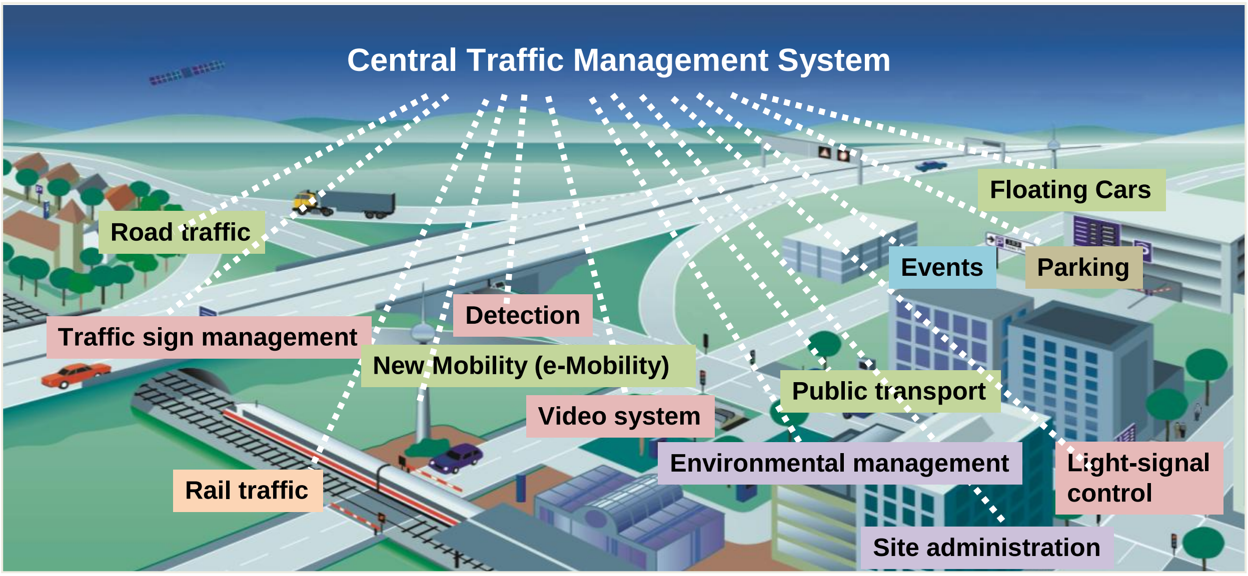


Figure 76: Traffic Management System

Figure 77: Traffic Management Center

No proper Transport Management System is existing at the moment and furthermore no synchronized line system is existing with coordinated integrated bus / rail schedules.

Crossings and junctions are not managed properly at this point and cause numerous bottle necks due to unregulated traffic prioritization.

STOMP (Sochi Transport Operational Master Plan) therefore set the following primary aims in terms of traffic management and performance:

- Deliver safe and secure transport to all constituents at all times, provided by well-trained and courteous staff;
- Ensure that all transport is delivered on time and absolutely reliably;
- Keep traffic freely flowing for all Olympic constituents and the people of Sochi;
- Establish and perfect transportation measures, such as and allocated lanes fot Olympic routes, as well as transport demand management and limit of transport traffic, that meet the needs of the Games without disrupting unacceptably the needs of the populace;
- Ensure that transportation schedules and dimension of transport services meet the needs and exceed the expectations of all Games constituent groups;
- Provide comfortable, dependable, effective and efficient TP transport system for all spectators;

- Provide transport management (services) that has thoroughly planned, trained and rehearsed, under the guidance of experienced Olympic Transport experts, to respond effectively to any contingency and emergency;

- Provide sufficient back-up of drivers and vehicles to provide flexible, rapid response to shifts in demand or circumstances;

- Provide accessible transport as needed for all constituents to all Games venues;

- Provide environmentally friendly, low emissions transport systems; and

- Leave a lasting legacy of operations systems and knowledge to serve the city, region and nation for future events.

Olympic Transport Command Center (OTCC)

Traffic command and control forms a very important part of the Traffic Management plan. The plan agreement and enforcement will require cooperation and integration with the Traffic Police and other traffic enforcement agencies. A key success factor will be ensuring adequate resources and efficient command and control to implement the Games-time traffic measures

In accordance with the principles of STOMP the OTCC must be designed and established to manage transport infrastructure and the choice and order of vehicles. Correspondingly, the control system must provide the required level of quality of transport services.

Control system for intermodal transportation (ITMS, Intermodal Transportation Management System) will be developed on the basis of STOMP, infrastructure and vehicle characteristics.

The first step is to identify the main ITMS processes. Infrastructure and vehicle characteristics are unchanged. The only variable parameters are part of the ITMS system management mode of transport in view of the regulated interaction between different modes of transport, having the flexibility to play a role in the overall transport process.

The Principles for the Integration of Intermodal Transport Simulation & Operations System in the OTCC

The basic element for all processes will be the Olympic Transport Plan, which has been developed based on the Olympic event schedule considering the different locations of venues, accommodation and other Olympic infrastructure. One of the major outputs of the STOMP (Sochi Transport Operational Master Plan) is the definition of the Olympic Origin-Destination-Relations (O-D), which will lead to the expectation of passenger flows.

The infrastructure is designed and built according to the principles of the STOMP as well as the selection and ordering of vehicles.

Operational concepts are accordingly developed and handled as a final indicator of capacity and system quality.

Based on the STOMP, the infrastructure and vehicles characteristics of a general and intermodal Sub Management System (ISMS) are developed. According to each level of progress certain parts of the operational concept and vehicle characteristics can still be adjusted within this stage in order to optimise the process.

The second step includes major processes for the operation of ISMS. The infrastructure and the vehicles characteristics are fixed. The only variable parameters during operation of the ISMS are parts of the operational concepts, which are flexible enough so that they can play a role in the traffic management operation.

When developing these complex processes it is of vital importance to separate between processes, which are related to the development and can only be adjusted during the project development phase, and processes which are mainly related to the operation of the system, which are considered for the optimisation of the final traffic management.

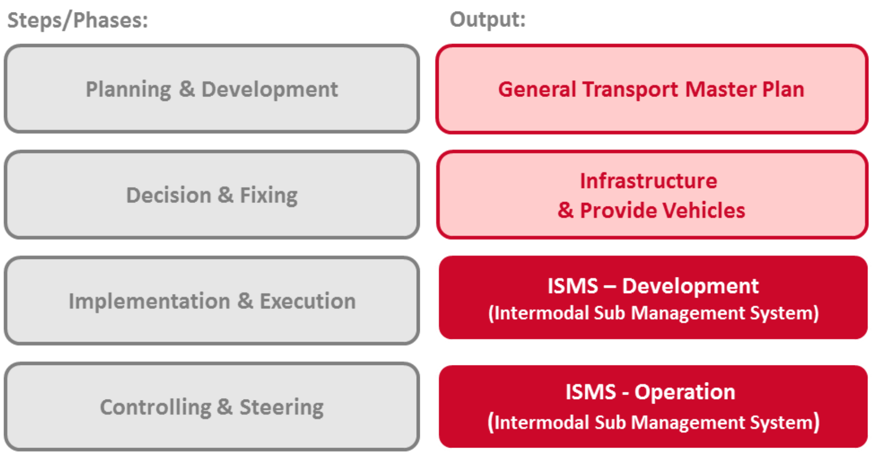


Figure 78: Intermodal Sub Management System (ISMS) – Steps and Output

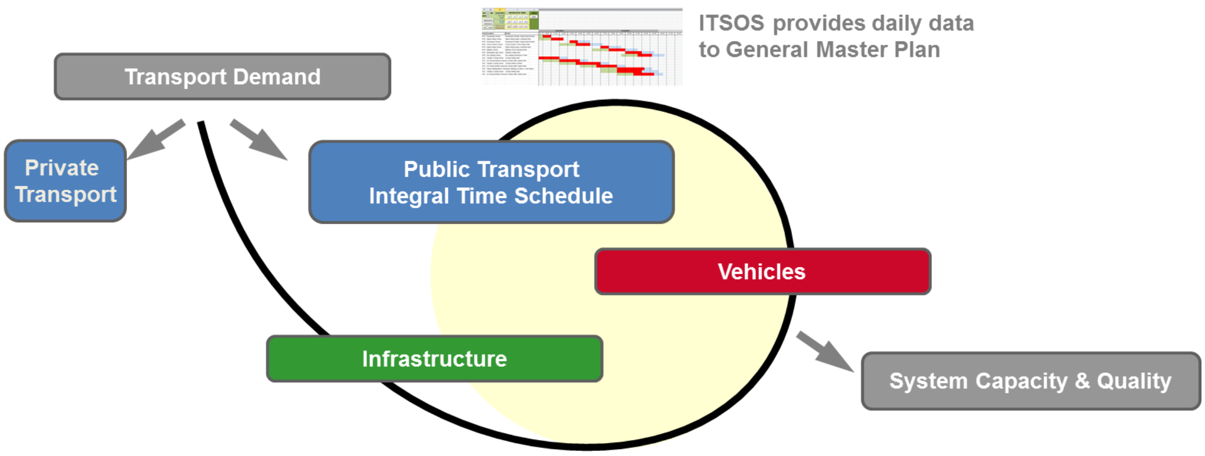


Figure 79: Principle of Transport Planning – Iterative Procedure

Managing the interaction between the operational concept, the infrastructure and the vehicles is the key process in developing efficient transport infrastructure projects.

Based on the defined transport demand it is necessary to find an appropriate principle time schedule for each relevant transport mode within a first approach. Further development of the infrastructure and selection of vehicles is based on this basic operational concept, particularly when they are built or ordered new.

Having in mind that there will be a lot of pre-conditions and specifications (e.g. technical, economical and legal aspects) defining the framework, there is the need of an iteration process in order to find the optimum between the operational concept and the vehicle and infrastructure specifications. The final output is a time schedule according to the defined transport demand which defines, together with the vehicle characteristics, the general system capacity and quality.

8 APPENDIX

8.1 LIST OF FIGURES

August 31th, 2012 – Masterconcept Consulting GmbH

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