

NETWORK PLANNING, SWISS STYLE: MAKING PUBLIC TRANSPORT WORK IN SEMI-RURAL AREAS

Author:

Tim Petersen, tpet@unimelb.edu.au, 0428 220 082

PhD Candidate, University of Melbourne. Funded by the Australasian Centre for Governance and Management of Urban Transport.

Faculty of Architecture, Building and Planning
The University of Melbourne
Victoria 3010

Abstract:

In Australia, it is often taken for granted that public transport cannot attract any significant percentage of passengers outside our largest, most densely-populated cities. Instead, smaller towns and settlements are poorly served– if at all– by 'welfare'-style public transport services that have little effect in reducing car use.

Yet Switzerland is able to provide an attractive public transport system in semi-rural areas: in Zurich's Weinland region, public transport mode share for the journey to work exceeds that of Australia's largest capital cities.

Although semi-rural Switzerland is densely populated, it has developed a model of service provision for high quality public transport that makes efficient use of resources. Regular services are planned to make closely-timed connections in multiple directions, creating an effective regional public transport network with convenient links to national services.

This paper outlines the network planning methods and policies applied in Zurich's Weinland. It extends the analysis in Petersen (2009) which compares the sub-region with Victoria's Bellarine Peninsula, and it seeks to draw lessons for public transport service planning in the most densely populated parts of rural Australia.

NETWORK PLANNING, SWISS STYLE: MAKING PUBLIC TRANSPORT WORK IN SEMI-RURAL AREAS

INTRODUCTION

In Australia, it is often taken for granted that public transport cannot attract any significant percentage of passengers outside our largest, most densely-populated cities. Instead, smaller towns and settlements are poorly served— if at all— by 'welfare'-style public transport services that have little effect in reducing car use. Yet Switzerland is able to provide an attractive public transport system in semi-rural areas: in Zurich's Weinland region, public transport mode share for the journey to work exceeds that of Australia's largest capital cities.

This paper examines the planning and provision of public transport in the Zurich Weinland sub-region, as an example of good practice, and seeks to draw lessons for service planning in similar semi-rural areas in Australia. The Weinland was selected because it has high levels of public transport use and is the largest semi-rural area within the Canton of Zurich, which is the area of responsibility for Switzerland's arguably most successful regional public transport agency, the *Zürcher Verkehrsverbund* (ZVV or 'Zurich Transport Federation').

Only a small proportion of Australia's rural land has a similar population density to that found near Zurich: most rural areas approach it only in the closest small towns and semi-rural areas surrounding major cities. This paper extends the analysis in Petersen (2009) that compares the Weinland sub-region with an Australian sub-region of similar density, Victoria's Bellarine Peninsula (which encloses the western side of Melbourne's Port Phillip Bay). That paper found that despite differences between the sub-regions, including fewer but larger towns on the Bellarine Peninsula, the gross population density of both the sub-region and the net urban densities of the settlements themselves were comparable. The frequency of public transport services was also similar (though in some cases higher, and with longer hours of operation in the Weinland); however the public transport mode share for work journeys in the Weinland was seven times higher than on the Bellarine Peninsula (which had a figure of only 3.0% (ABS 2006c)). The paper concluded that strategies and institutions for effective, area-wide service planning in the Weinland were responsible for much of this difference.

BACKGROUND

Small urban settlements in semi-rural areas are usually considered to be impossible to serve by high quality public transport. In criticising low density urban forms that 'encourage and necessitate automobile use', Pucher & Lefèvre (1996: 21-22) cite increasing 'ex-urban' development as the worst example. They describe it as 'the rapid growth of distant towns and rural areas not contiguous to the primary, built-up metropolitan area'. This sounds remarkably similar to development occurring within commuting distance of many major Australian cities. Extremely high levels of car dependence are presumed to be inevitable in such low-density development, and if

any transport at all is provided, it will tend to be a poor quality service for people with no other transport options.

There appears to be little hope for better public transport in these areas, with many commentators having stated that densities of the levels found in most Australian *suburbs* are too low for the provision of high quality public transport (e.g. Newman & Kenworthy 1989: 131). Claims such as this are highly disputed: among other points, Mees (2000: 145-50) argues that public transport use depends on so many factors that few analysts have been able to agree on a universal, minimum density for viable services.

However, some relationship between density and public transport use clearly exists: it seems obvious that if all other factors are equal, a public transport line in a higher density area will be used more than a similar line in a lower density area, because it has more potential users within walking distance. Most analysts would agree that it is impossible to provide a high-frequency public transport service in semi-rural areas, which are much less dense than most Australian suburbs.

The response to this conclusion is mixed. Some, like Newman & Kenworthy (1999: Fig. 4.3), suggest that public transport could be supported through the development of high density sub-centres in semi-rural areas. Yet any significant change to urban form, even if effective in making public transport viable, is likely to be a very slow process. A more common response is to follow various 'improvement' strategies, such as increasing a system's reliance on park and ride (i.e. passengers driving to their nearest station or stop). It is a simple strategy for operators of 'trunk' public transport services, but apart from being of no local environmental benefit, it does little to help people without access to cars. Those people with no other alternatives may be allowed to use school buses, but without a significant restructuring and improvement of services, they are unlikely to find that the school bus meets their needs. The use of smaller buses is sometimes also suggested to cut costs, yet this ignores the fact that the biggest cost of provision tends to be the driver's wages.

With few alternative policies looking promising, more radical commentators suggest that the very nature of public transport must be changed, and that demand-responsive services (such as dial-a-bus) are the answer. However, these tend to be expensive and complex to operate, and achieve only low occupancies (see e.g. Nutley 1990: 97, Cervero 1997: 249-252).

A different approach to lower density areas has been suggested by other authors (Mees 2000; and Nielsen et. al. 2005), who argue that a *network effect* can be harnessed to provide higher quality public transport services. Rather than making vehicles more like cars, the answer is to create an area-wide network of services that is easy to navigate, largely through making transfers quick and convenient. In urban areas, this can be achieved by providing a simple, efficient network of high frequency services. In semi-rural areas, however, there are not enough passengers to support such levels of service, so a different approach must be taken.

The type of network provided to low density suburban and semi-rural areas in Switzerland has been suggested as a possible model for densely populated rural areas (e.g. Cullinane & Stokes 1998: 316-317, Mees 2000: 282). In particular, 'pulse

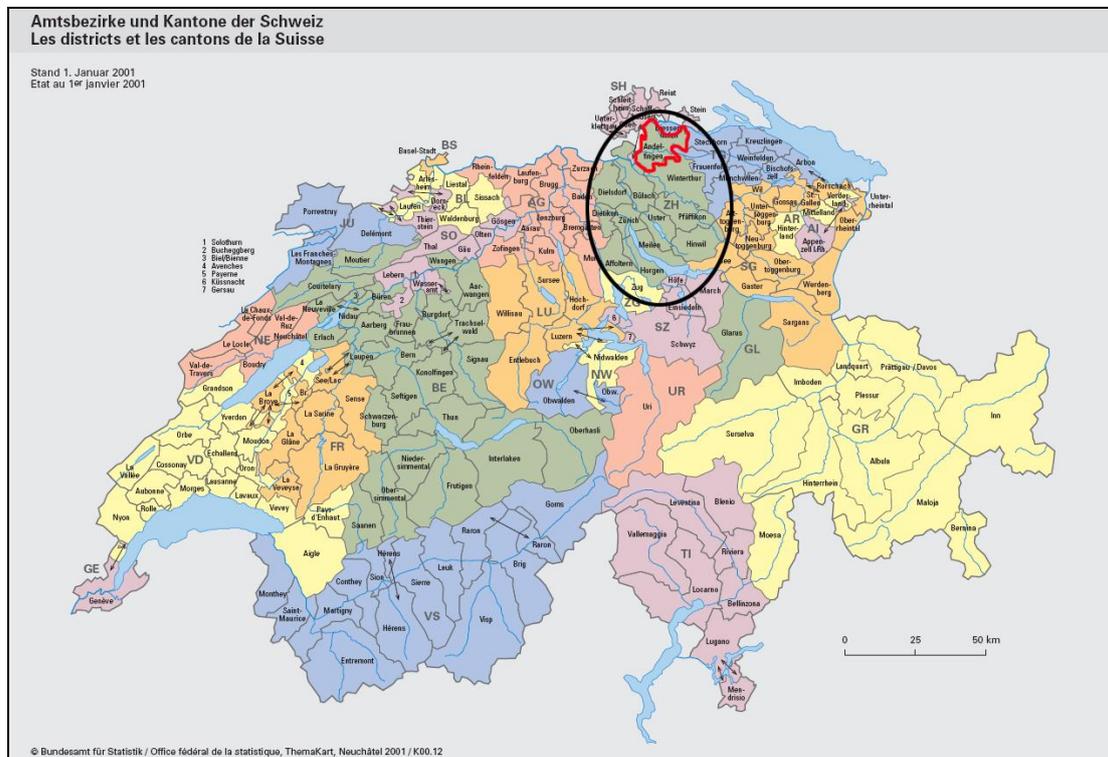
timetabling', which involves the rigorous coordination of regular (but not very frequent) services so that passengers can transfer at interchange points, may be a better approach.

SWISS CASE STUDY: CANTON ZURICH'S WEINLAND

The Canton of Zurich is one of the twenty-six cantons that make up the Swiss Federation. It covers Switzerland's largest urban area, including the cities of Zurich and Winterthur, as well as the network of surrounding towns which have grown to become Greater Zurich's suburban area. The canton has a population of 1.3 million and an area of 1,728 square kilometres (CZSO 2009), a similar area and population to that covered by the ABS's Statistical Division of Adelaide (1.1 million people and 1,827 square kilometres)(ABS 2006b).

The residents of the canton use public transport for the journey to work at very high rates: from the 2000 census, 40.7% of the canton's working commuters used public transport to get to work, compared to 47.2% by 'individual motorised transport' (predominantly car) (Swiss Federal Statistical Office 'SFSO' 2000). The figure for public transport is far higher than that for metropolitan Sydney, the Australian city with the highest journey to work mode share for public transport (21.2%) and the lowest share for car journeys (69.6%) (ABS 2006b, see also Mees et al. 2007). Beyond the journey to work, the canton also achieves the largest share of all trips by public transport, and the lowest share of trips by private motorised vehicles of all the regions of Switzerland (SFSO 2007: 61).

Figure 1: The location of the Canton of Zurich and its Weinland region



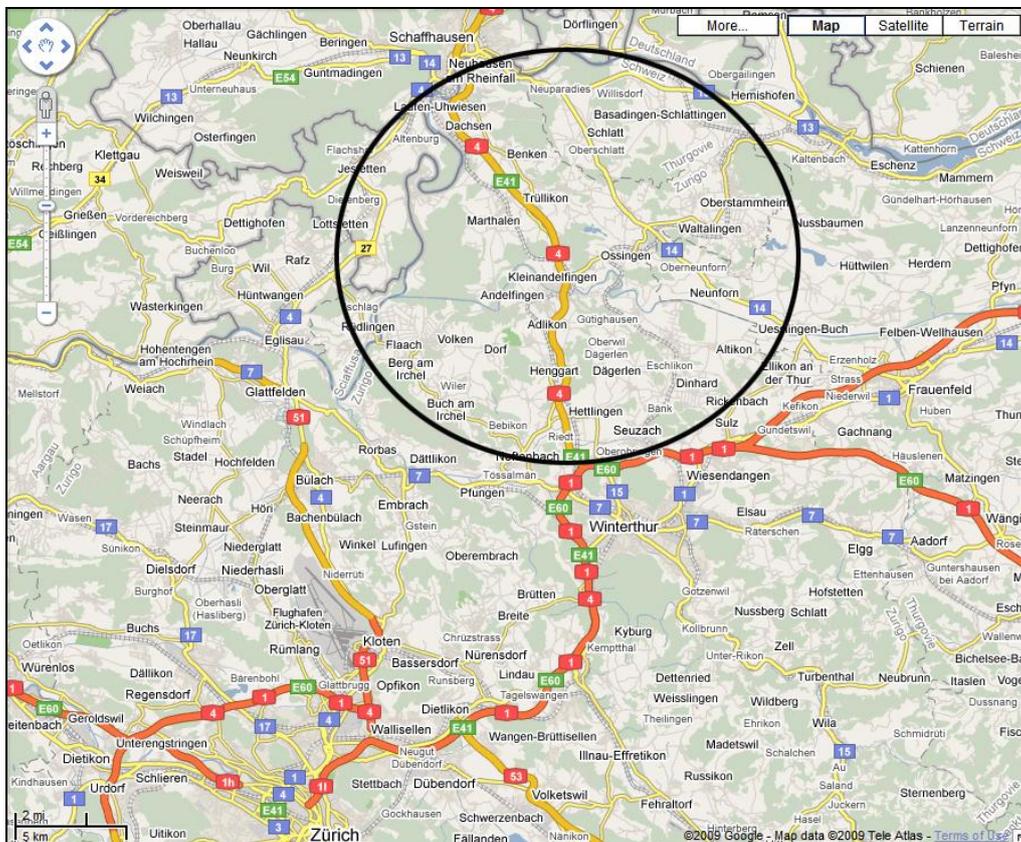
Source: SFSO (2001). Map altered to show the Canton of Zurich (circled in black) and the District of Andelfingen (almost identical to the Zurich Weinland area, outlined in red).

The Canton of Zurich's most extensive semi-rural area is the Weinland (or *Zürcher Weinland*) region, which is located at the northern tip of the canton between the cities of Winterthur and Schaffhausen (which is in its own Canton of Schaffhausen). Named after its vineyards, the region's closely spaced villages are steadily expanding and much of the working population commutes to neighbouring cities.

The Weinland planning region covers 25 small municipalities: all but one have populations of under two thousand, and 13 have populations of less than one thousand. Most are classified by the SFSO (2004) as rural; others, surrounding Winterthur and Schaffhausen, as more urban (or associated with their nearest urban agglomeration). The gross density of the region is less than 1.6 persons per hectare (CZSO 2009, from SFSO 2000). In contrast, the large expanses of urban areas in Australian capital cities have almost ten times the population density (for example, Sydney's urban area has 20.4 persons per hectare; Adelaide, 13.8) (ABS 2006a).

The Weinland's settlements, however, are quite compact: if the surrounding rural land is excluded, their average urban population density can be calculated as 15.9 persons per hectare, although this includes the area of transport infrastructure that extends beyond the settlements (CZSO 2009). An example of one small commune in the heart of the Weinland, Trüllikon, has 13.9 persons per hectare. These urban density figures are remarkably similar to the average urban density figures for larger Australian cities, except that the Australian urban areas are not scattered through rural land.

Figure 2: Location of the Zurich Weinland in relation to Winterthur and Zurich



Source: Google Maps (2009). Map altered to show the approximate area of the Zurich Weinland (circled in black).

The Weinland region is therefore a challenging environment for public transport provision. Nevertheless, an average 21.7% of its commuters travel to work by public transport, and only 64.7% by car (see Table 1). Its rate of public transport use for the journey to work therefore slightly exceeds that of Sydney, and its rate of car use is also lower.

Table 1- Municipalities in the Weinland and their journey-to-work mode share

Municipality	Area, km ²	Population (2000)	Number of Workers Making Journeys	Journeys to work (%) (2000)		
				Foot or Bicycle	Public Transport	Individual Motorised
Adlikon	6.6	587	261	5.7	16.9	77.4
Altikon	7.7	613	261	6.5	15.7	77.8
Andelfingen	6.7	1644	757	19.9	28.1	51.9
Benken	5.7	704	294	7.1	20.7	72.1
Berg am Irchel	7.1	573	263	12.2	15.2	72.6
Buch am Irchel	10.2	728	329	7.3	16.4	76.3
Dachsen	2.7	1533	734	9.1	24.1	66.8
Dorf	5.6	593	266	6.4	21.4	72.2
Feuerthalen	2.5	2973	1440	18.1	24.1	57.8
Flaach	10.2	1164	495	14.7	16.4	68.9
Flurlingen	2.4	1248	627	16.6	12.4	63.2
Henggart	3	1621	796	6.8	28.7	62.2
Humlikon	3.7	408	176	10.2	18.2	71.6
Kleinandelfingen	10.4	1821	857	16.5	19.4	64.2
Laufen-Uhwiesen	6.3	1369	642	9.8	19.6	70.6
Marthalen	14.1	1803	848	14.2	24.3	61.6
Oberstammheim	9.4	1064	431	18.3	23.9	57.8
Ossingen	13.1	1272	524	11.5	24.4	64.1
Rheinau	9	1645	624	24.2	13.5	62.3
Thalheim an der Thur	6.5	637	293	3.8	18.4	77.8
Trüllikon	9.5	989	502	11.0	18.9	70.1
Truttikon	4.4	435	181	4.4	21.0	74.6
Unterstammheim	7.3	845	338	25.7	26.9	47.3
Volken	3.2	268	134	11.9	18.7	69.4
Waltalingen	7.3	684	283	13.4	16.8	71.4
<i>Total / Average %</i>	<i>174.6</i>	<i>27,221</i>	<i>12356</i>	<i>13.6</i>	<i>21.7</i>	<i>64.7</i>

Sources: Journey to work figures from SFSO (2000); Area and population figures compiled by the CZSO (2009) from SFSO data. The municipalities in **bold** are classified as more urban (SFSO 2004).

How are these results achieved? Weinland residents have a fairly high rate of car ownership, with an average of 549 cars per 1000 residents (CZSO 2009), and only 16% of commuters travel to the central City of Zurich (SFSO 2000) where driving could be expected to be genuinely difficult (due to limited road space, priority for on-

road public transport vehicles, parking restrictions, short traffic light cycles and other measures to restrict traffic volumes). Therefore, it seems reasonable that at least part of the explanation for the results must come from the quality of transport services. Yet services in the Weinland are not extremely frequent. Trains serving the Weinland's stations run twice hourly on the line between Winterthur and Schaffhausen (with additional express services making one stop at Andelfingen, and one extra train in the peak); otherwise, buses and trains run only hourly. The answer appears to lie in the way that services are combined together into a network.

NETWORK AND SERVICE PLANNING

The service concept for the Zurich Weinland, as in much of rural or semi-rural Switzerland, is quite simple. Providing that passengers are prepared to wait for up to an hour for a service from their local stop—a task made simpler by easily memorable timetables that repeat every hour—planned connections mean that once they are aboard, they are provided with a remarkably seamless journey to almost any destination across the regional and national public transport networks.

The *Taktfahrplan* and the ZVV network

The Swiss national transport network is designed according to the principles of the (*integraler*) *Taktfahrplan*, which is sometimes known in English as a 'pulse' timetable or integrated timed-transfer system. Since it was introduced to Switzerland in 1982 by the Swiss Federal Railways (*SBB* in German), the concept has meant that services are designed to 'pulse' or connect at designated transport hubs; usually central railway stations in major cities. At pulse point stations, trains arrive before the pulse time, wait a short time to allow passengers to change between services, and then depart afterwards. The pattern repeats every hour (or every half hour for more frequent services). The *Rail 2000* (or *Rail + Bus 2000*) plan strengthened the *Taktfahrplan* concept further by promising at least hourly services nationwide, and also extended the idea to the regional bus network that feeds railway stations (Maxwell 1999: 4-5).

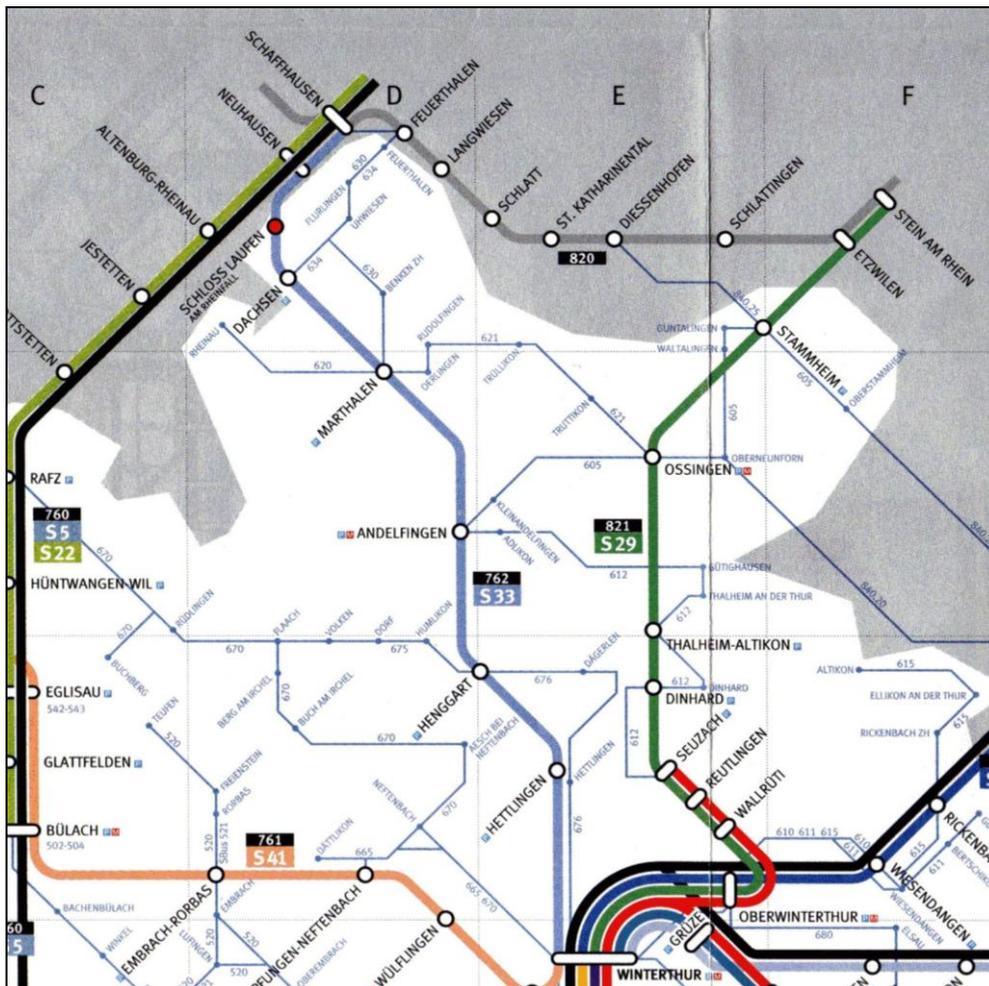
In the Canton of Zurich, the ZVV is responsible for the strategic planning of *S-Bahn* regional services, including those in the Weinland. In accordance with the *Taktfahrplan*, they run at times that repeat every hour between standard service hours. However, some of the other elements of the concept also translate to services in the Weinland, even though the region does not contain any of the major city pulse points in the national network. The closest pulse point for long distance services (where trains arrive before the pulse time, then wait to allow changes in all directions, before departing again) is at Zurich's main station. Nor does the region contain its own pulse point for regional services, like the canton's south-eastern centre of Wetzikon, highlighted by Apel and Pharoah (1995: 143).

Despite this, the region is still able to take advantage of the other network efficiency opportunities provided by regular interval timetables: 'crossing points'. These are locations where rail services in opposite directions regularly meet as they pass each other. Crossing points can be used to maximise the efficiency of transfers from connecting feeder services such as buses, allowing them to arrive at the station just before the trains arrive, and leave just afterwards. They therefore work like pulse

points in allowing travellers to change to any other service (except for changes between trains travelling in opposite directions). When the trains arrive at approximately the same time, passengers can make quick changes to feeder services with minimal waiting time. Where feeder services are designed to connect to main line services in both directions, it also minimises the amount of unproductive time the feeder buses have to spend waiting for passengers from either train.

For services in a strict hourly pulse timetable, crossing points will occur every 30 minutes travel time from the pulse point; similarly, for a half-hourly pulse timetable, crossing points occur every 15 minutes travel time. Winterthur, the major rail interchange for the Weinland, is a rough "crossing point" for services between Zurich and St Gallen (to the east). However, crossing points can also occur with services that are unevenly spaced within the hour, but run at times that repeat every hour. For example, S33 line services through the Weinland run twice every hour during the day, but do not run at exact half hourly intervals due to the restrictions of the single track line with limited passing loops. The service pattern does, however, make Marthalen station a once-an-hour crossing point for S33 services to Winterthur (departing at :59 minutes past the hour) and Schaffhausen (departing at :01 minutes). The ZVV has made good use of this crossing point by scheduling three different hourly bus services to connect to these two trains every hour.

Figure 4: Transport Network in Zurich's Weinland (and immediate surrounds)



Source: ZVV 2008 network map (scanned).

The Weinland region's bus routes are designed to feed the rail system, as provided by the Canton's service planning regulations (Regulation 740.3, section 6). Routes are planned to connect populated areas with places of work and education, and service and retail facilities, and should be arranged to ensure an 'economical enterprise'.

Most of the routes in the Weinland were planned around 1988 in the lead up to the ZVV's establishment, with some input from the local communes. Since that time, the basic structure has been kept intact. The network of bus routes and stations serves fifty of the fifty-five villages in the Weinland; the other five have a total of less than 300 people and jobs combined (see *Role of Service Standards*, below).

The route structure is generally simple: a typical bus route will start at a station (timed to connect to a particular train) and travel outward from the line. It will follow the main roads through towns and villages, and then terminate at another railway station, where the connection to the train is also timed so that it acts as a rail feeder. Only three of the nine bus routes in the Weinland terminate in a village without a station.

Although most of the bus routes are fairly straight, they may not always take the most direct route from the origin station to the final terminus. This is usually to make efficient use of the bus route by serving all the closest villages along the way. Nevertheless, routes rarely 'double back' on themselves, and those that are less direct tend to feed stations at each end of the route, meaning that few passengers are likely to ride the entire length of the line. The simplicity and efficiency of the route structure is helped by the fact that most of the developed areas of the villages are either quite compact or lie along the length of the main road, meaning that route diversions are rarely required.

The canton's regulations- under the sub-heading '*Taktsystem*'- also state that all bus lines should strive for regular services so that they can be coordinated with the *S-Bahn* system (Reg. 740.3, s.7). The regulations do not explicitly mention the principle that timetables should be easily memorable, although it is clearly one of the main concepts behind the *Taktfahrplan*. The head of transport planning at the ZVV, Dominik Brühwiler, insists that the same pattern of services should run on all lines from morning to evening: "It's the worst that can happen if you have to start to look at a timetable... if you don't know the timetable by [heart] you won't use it" (Interview 16 September 2008).

Nevertheless, some quieter routes in the Weinland depart from the ideal: they are combined with others or stop in the later evening (after 8pm). Even so, most villages continue to receive an hourly public transport service until midnight. After midnight on Saturday and Sunday mornings, additional Nightbus routes also operate on similar but distinct routes, although these are clearly separately branded as a separate network.

Role of Service Standards

Strong services standards formed- and still form- the basis for regional transport planning in the canton. The 1988 regulations (passed with the legislation setting up the ZVV) are responsible for setting basic service levels, to be implemented as the Canton provides funding. Many of the principles behind the standards were derived

from the SBB's *Taktfahrplan*, which is at least in part due to the involvement of the planners who worked on Rail 2000 (Interview with Dr. Rolf Bergmaier, 8 September 2008).

The standard for hours of operation is the same across the system, in order to allow transfers to continue to function until the last services, which is required for the operation of a comprehensive timed-transfer network. Almost every service operates from at least 6am until midnight (at least in the main directions of travel) in accordance with the legislation, although services can be shortened if demand is considered too low (Reg. 740.3, s. 8). The minimum suggested headways between services for the different supply zones are clockface times (i.e. they repeat every hour, every 15, 30 or 60 minutes) and they also divide exactly into each other to maximise the potential for connections.

The standard operating hours are divided into three sections for planning purposes: the peaks, (serving peak commuter flows in the morning and the evening); 'normal traffic' time (between the peaks, as well as during the day on Saturdays), and finally the 'side traffic times' (*nebenverkehrszeiten*- early in the morning, later in the evening from Monday to Saturday, as well as all day on Sundays and public holidays) (Reg. 740.3, s. 9). This classification system demonstrates the philosophical difference between 'regular' transit and more 'commuter' oriented transit systems, where peak services are considered the main game and anything else is incidental (see Vuchic 2005: 603, Mees 2000: 125-133). Under the ZVV, normal periods of operation cover most of the day- it is only when patronage is especially high (peaks) or low (at very quiet times) that the service pattern is altered.

The regulations also set out a three-tiered hierarchy of service frequencies or headways for the region. Basic or minimum services are to be supplied to the more rural or remote areas of the canton in *Angebotsbereich 1* ('Offer'/Supply Zone 1'). Where there are combined strong traffic flows from many settlements, services should be designed to capture a strong market share ('Supply Zone 2'). Finally, a 'surface coverage' standard of services applies in large, densely populated settlements ('Supply Zone 3') (Reg. 740.3, s. 2.) The regulations themselves do not specify precisely which routes or geographic areas belong to each classification.

In Supply Zone 1, which covers most villages of the Weinland, regular hourly services (*studenttakt*) are standard (Reg. 740.3, s. 11). If demand is too low outside peak times, services can be reduced to 12 (or fewer) runs per day in each direction. Other forms of operation can be examined, but the ZVV has rejected dial-a-bus services as unworkable for the region (Interview with Brühwiler, 2008).

In Supply Zone 2, half-hourly services (*30-Minuten-takt*) should be offered, reduced to hourly if demand is lacking (Reg. 740.3, s. 12), while operations in the 'close settlements' or urban areas of Supply Zone 3 should run at least every 15 minutes, reduced to half-hourly if demand is low (Reg. 740.3, s. 13). The legislation expressly states that the canton's parliament should determine the medium and long-term development of the standards.

Standards for the geographic coverage of services are also provided by the regulations: all settlement areas with a combination of at least 300 inhabitants, jobs and training

places should be served by at least one public transport stop (Reg. 740.3, s. 2). Services can also be extended to smaller settlements if they can be done at minimal or justifiable cost, and many smaller villages are served because they are *en route* to a larger settlement.

A settlement area is considered to be served by public transport (except in special topographical conditions) if its properties are within either a 400 metre radius of a bus stop, and within a 750 metre radius of a railway station (Reg. 740.3, s. 4). Where the standards are not fulfilled, the regulations provide that a suitable number of car and bicycle parking places should be provided at an appropriate public transport stop.

These standards are not an enforceable right for residents or workers; instead, they are an aim for service provision with legislative backing. Therefore, where the standards are not met, the ZVV is not forced to provide services that comply. However, it does identify the 56 unserved settlements of 300 or more residents or work places in its latest two-yearly strategy document (ZVV 2008), and would generally be expected to make plans to fill those network gaps. It may, however, need to balance the implementation of these improvements against higher priorities elsewhere in the network.

Planning Institutions

The ultimate responsibility for planning services in the Weinland region and across the Canton of Zurich is the canton's regional transport agency, the ZVV. It is responsible for overall 'strategic' planning of transport services, system finances, and marketing in the canton (ZVV ca. 2006: 9-10; on distinctions between planning tasks see also Vuchic 2005: 457). It delegates some of its lower level 'how to' or 'tactical' planning tasks to 8 'market responsible enterprises' (*marktverantwortliche verkehrsunternehmen*) which are responsible for their assigned regions, where they are usually the largest operator of local services; any smaller remaining operators also deal with them. The *SBB* is also a 'market responsible enterprise', although it is responsible for rail services throughout the canton.

The ZVV is overseen by a transport board, made up of representatives from major operators, and federal, cantonal and local governments, and it oversees all business matters not otherwise reserved for the canton's government or parliament. The market responsible enterprises are also responsible for coordinating regional transport conferences with representatives of local municipalities, which also pay part of the costs of services. The conferences are convened by an elected President, and among other local tasks, they discuss proposals for service changes and identify priorities for improvements. The recommendations are then forwarded to the ZVV for consideration.

Overall Results

Despite (or perhaps because of) the provision of attractive, high-quality public transport services, cost recovery across the ZVV's network is quite high: in 2007 the total cost of running services was CHF 760 million a year, partly offset by revenue of CHF 456 million a year, resulting in an overall 'cost recovery' of 60% (ZVV 2007: 23). No cost recovery figures are readily available for individual regions, routes or

services. The idea of providing a comprehensive network across the canton to compete with the car, based on service standards that are set through the political process, is that cross-subsidies are inherent to the very nature of the service provided.

Even so, the vehicles themselves in the Weinland are generally quite well-loaded. The average number of passengers on the S33 and S29 trains through the Weinland was around 80 (at the City of Winterthur's boundaries, across Monday to Friday for the first five months of 2008) (ZVV internal figures). This is just short of the 90 second-class seats in the smaller two-car Turbo train sets which run on the lines. Off peak services appear to carry far fewer passengers (sometimes as low as 30); while in the peak, services can carry more than 250 passengers and a small number have to stand, despite extra train units being added.

The ZVV's internal patronage figures for 2006 also show the busiest hourly bus services in the Weinland carry up to 40-60 passengers in peak hour, although the most lightly loaded services (in the early morning counter peak) carry an average of 1 passenger. The average number of passengers carried throughout the day was around 14 passengers. Full-time bus routes through smaller settlements carry fewer passengers: the average number on buses throughout the day was just under 10, although the busiest peak service carried an average of 40-50. This is an especially good result for towns along one such route, which before the establishment of the ZVV were served by only three buses a day.

LESSONS FOR SEMI-RURAL NETWORKS

Any attempts to apply a similar approach, as used in Switzerland, to a semi-rural area in Australia would need to recognise the key features of the Zurich model.

Firstly, high standards for service frequency and operational hours are required to guide service provision. Without such 'supply-led' service standards, like regular hourly services from early morning until the late evening, there is little chance for demand to manifest itself. A network with irregular and limited services is unlikely to be convenient for a large cross section of potential users.

With standards in place, the transport network must be able to be planned to deliver services efficiently to its geographic area. This requires the establishment of a central body that is capable of undertaking network planning, to ensure connections are coordinated, that all parts of an area are served, and that unnecessary duplication does not occur. Even though the Weinland's buses tend to be planned around the rail network, rail planners planning rail services in isolation could easily make decisions that frustrate bus connections. Furthermore, a central body is also required to ensure that fare revenue is shared: cross subsidies must be available to support less profitable services, such as feeder buses, which are a necessary part of a comprehensive network. In Switzerland, central planning (at a cantonal and national level) has also ensured that measures to encourage public transport loyalty, such as periodical travel passes and widely-held half-price fare cards, are widely valid. However, central authorities can also include mechanisms for substantial community involvement in decision-making, such as through the ZVV's independent board and sub-regional conferences.

Rail is the mode that all local public transport services need to be planned around, at least where it forms the faster, high-capacity backbone of the public transport network and has less timetabling flexibility than local services. Across Switzerland, thanks to strong leadership from the *SBB*, trains always depart stations at the same minutes past the hour: any additional peak services are simply slotted in-between.

This not only makes rail timetables easily memorable, but also makes the planning of bus feeder services much simpler. Regular timetables mean that pulse points or crossing points can be identified and planned as preferred interchanges for feeder buses from the surrounding area. Regular timetables also give buses a consistent amount of time to complete their route, which allows them to follow the same route and timetable throughout the day (presuming little interference from traffic congestion) and also makes departure times much easier for passengers to remember. The bus routes themselves should be planned to serve an area efficiently as possible. Although the structure will change according to the layout of settlements, the general principles used in the Weinland— direct routes following through-roads and feeding stations (or trunk routes) at both ends of the route— seem widely applicable.

In Australia, most comparable regions with similarly high gross population densities (around 1-2 persons per hectare) and reasonably compact clusters of housing are found in the commuter belt surrounding the major cities. In particular, many coastal areas and some other locations fit this description, having attracted significant residential development for their landscape or by offering relatively affordable housing. The Bellarine Peninsula in Victoria, mentioned in the introduction and explored in Petersen (2009), is one example. With some exceptions like South-East Queensland and the Australian Capital Territory (as well as New Zealand cities), State governments are entirely responsible for the provision of public transport in Australia's major cities and their surrounding regions. The establishment of central, multimodal planning authorities, which are essential for a Zurich-style regional public transport system, should therefore be easier than in Zurich, where the major municipalities were originally responsible for running their own local public transport systems, and where the functional metropolitan area extends well beyond the canton's borders.

Any authorities planning regional systems in Australia would, following the Zurich model, need to set basic service levels (for example, hourly services in semi-rural areas between standard operating hours). This is a political question as much as a technical one: Zurich's clear service standards helped to persuade voters to approve the establishment of the new canton-wide authority through a referendum. The standards for rural municipalities, which connected some to the public transport system for the first time, were included partly as a sweetener to gain the support of rural areas. Although approval by referendum would not be required in Australia, service standards would provide a basis for supply-led planning by a new authority, as well as a tangible benefit for the constituents of the politicians approving funding.

Despite the less extensive rail networks in semi-rural Australia, the starting point for network planning in most areas is still likely to still be connections to the rail system (either locally or at stations in nearby regional centres) in order to integrate the regional system with wider transport networks. However, direct trunk bus services may be required in addition to local/feeder bus services, as an equivalent for the

Weinland's rail services, so that the network can offer travel times that are competitive with driving. Regional rail operators would also need to develop a strict adherence to the 'clockface' timetabling of rail services (i.e. departures repeating at the same minutes past the hour) to ensure that buses can connect with trains consistently and efficiently.

A comprehensive local transport network is likely to be most easily and efficiently provided to settlements that are reasonably compact (with densities similar to those of most Australian suburbs) and structured around direct roads which pass within easy walking distance (400m) of the majority of the population. The linear urban forms typical of many smaller Australian towns could be easily served; larger towns might require internal circuit routes with timed connections to trunk services.

CONCLUSION

Public transport in Zurich's Weinland is an example of semi-rural transport success. It is undoubtedly helped, in comparison to many equivalent Australian regions, by having a high-quality public transport network serving destinations in its surrounding cities. Nevertheless, the Weinland example demonstrates that public transport— which people will choose to use— can be provided to a semi-rural area. High service standards and rigorous coordination through central network planning have allowed a network to be created, despite the low frequency of services, in a seemingly public transport-hostile environment. These investigations suggest that a similar approach could be applied in comparable Australian regions, with gains in network efficiency and major improvements in the quality of service provided to passengers.

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