PROPOSED TE PŪTAHI LADIES MILE PLAN VARIATION

SUMMARY OF EVIDENCE OF COLIN ROBERT SHIELDS ON BEHALF OF THE QUEENSTOWN LAKES DISTRICT COUNCIL

1. As directed by paragraph 12.2 of Hearing Minute 1, I set out below a summary of the key points of my evidence.

2. I have prepared a statement of evidence in chief (**EIC**) dated 29 September 2023, and a statement of evidence in rebuttal (**EIR**) dated 10 November 2023. I have provided answers to written questions from submitters dated 24 November 2023.

3. **Appendix A** of this summary provides a written response to the transport related Hearing Panel Minute: Pre-Hearing Questions dated 21 November 2023.

Succinct summary of key points of my evidence

4. Key existing transport conditions and context relevant to the Hearing Panel's consideration of the TPLM Variation are:

   (a) AM peak period westbound queuing from the Shotover Bridge to east of Howards Drive (except during the school holidays).

   (b) Essential community services are located west of the Shotover Bridge.

   (c) There is high car ownership rates and high dependency on car use.

5. A mode share target of 57% of the external trips from the TPLM Variation area by non-car modes of transport has been identified. TPLM Variation also offers the opportunity for mode shift from Shotover Country and Lake Hayes Estate with the provision of community facilities within easy walk, cycle and bus distance at TPLM, thus avoiding the need for these residents to drive across the Shotover Bridge for some trips.

6. In order to achieve this target, a number of transport interventions are included in the TPLM Variation provisions. A key intervention is the required installation of specified transport infrastructure works prior to development, including provision of a westbound bus lane on SH6, upgrades to SH6/Stalker Road and SH6/Howards Drive intersections and a new eastern roundabout. Other interventions include internal street cross sections providing a safe, healthy and attractive urban environment to promote walking and cycling, SH6 cross sections to promote walking, cycling and bus use, a bus routing strategy, maximum on site car parking rates and minimum cycle parking and end of trip facilities.

7. These would complement Way to Go (**W2G**) partners wider investment in active and public transport modes and transport demand management (**TDM**) measures.

8. Based on the modelling work carried out, the TPLM Variation will not give rise to adverse effects on the adjacent and wider road network and can be appropriately mitigated as development at the TPLM Variation area progresses.

9. Through conferencing with the transport and urban design experts, a number of agreements have been made and, where possible, incorporated in the updated TPLM Variation provisions including:

   (a) The key principle of 'urbanisation' of SH6 including that the speed limit should be reduced to 60 km/h, provision of signalised intersections at Stalkers Road and Howards Drive and provision of at grade signalised pedestrian and cycle crossings of SH6.

   (b) A density of at least 40 dwellings/Ha is required to achieve the critical mass for the required public transport mode share. I remain of the view that a density of 40-60 dwellings/Ha is required for effective mode shift.

   (c) Provision of a bus lane on Stalker Road.

   (d) Removal of a pedestrian underpass at SH6/Howards Drive intersection

Latest position on the matters remaining in dispute

10. Mr Smith's EIC (on behalf of Waka Kotahi) requested that no development at TPLM Variation can take place until the NZUP works on SH6/6A west of Shotover Bridge are completed. Since these works are remote from, and not directly related to, the TPLM Variation I do not agree with this. Furthermore, in subsequent discussions with Mr Smith, I understand that some but not all of the NZUP works are assumed to be in place to the west of the Shotover Bridge and as such the modelling work has demonstrated in my opinion that the TPLM Variation is not dependent on these works.

11. Glenpanel Developments Ltd consider that they can develop up to 180 residential units without the need to provide the transport infrastructure included in the TPLM Variation provisions. There is no agreement in place with ORC or Waka Kotahi to allow this development and I consider the transport infrastructure included in the Variation needs to be in place before development occurs within TPLM, for the reasons set out in my EIC and EIR.

12. I do not support the proposal by Anna Hutchinson Family Trust (**AHFT**) to extend TPLM Variation to the 'Hutchinson land' from a traffic perspective since this land would be much further away from the proposed TPLM Variation local centre, high school and sports hub. I do not agree with the submitter's proposed public transport proposal since this does not comply with the W2G partners public transport strategy.

13. Mr Smith, Mr Pickard and I do not consider the bus provision proposed on SH6 would be a Rapid Transit Service (**RTS**). As such I consider that a walkable distance of 400 to 500m to a bus stop is an appropriate bus stop catchment area along with the QLDC defined 'walkable catchments' of 600-800m. I do not accept the walkable catchment of 1200m as defined by AHFT.

Dated: 4 December 2023

Appendix A - Response to Hearing Panel Minute: Pre-Hearing Questions

14. Upon reviewing the questions put forward by the Panel, I sought the input of Mr Smith (transportation expert for Waka Kotahi) and Mr Sizemore (Principal Transport Planner, System Design of Waka Kotahi) on matters relating to Waka Kotahi, State Highway performance and transportation modelling matters. Mr Smith and Mr Sizemore provided me with a combined response received from Mr Smith on 26th November 2023 which I have attached as **Appendix B**. I understand that the red responses have been prepared by Mr Sizemore and the blue responses by Mr Smith. Where I refer to Waka Kotahi in the below paragraphs I am referring to the responses provided to me in **Appendix B**. I also sought the input of Mr Pickard on matters relating to QLDC, which I have also included in my responses below.

Question 1.4: The planners agreed that the LM SH6 corridor will be a RTS under the NPS-UD. The system is not existing so given the definition of "planned" in the NPS-UD, can the planners confirm that it is a form or feature of transport within "a regional land transport plan prepared and approved under the Land Transport Management Act 2003." If so, could more information be provided on the RLTP provisions relevant to the LM SH6. If not, then can the LM SH6 be considered a RTS and how?

15. While this question is directed to the planners, I have also considered it. Based on subsequent discussions, both Mr Pickard (QLDC) and Mr Smith (Waka Kotahi) do not consider LM SH6 is a RTS. Mr Smith quotes the following from the NPS – UD section 1.4:

> **rapid transit service** means any existing or planned frequent, quick, reliable and high-capacity public transport service that operates on a permanent route (road or rail) that is largely separated from other traffic
>
> **rapid transit stop** means a place where people can enter or exit a rapid transit service, whether existing or planned

16. The TPLM Variation includes a westbound bus lane on SH6 Ladies Mile (between Howards Drive and the Shotover Bridge) with the TPLM Transport Strategy referring to 10-minute frequency services. Mr Smith does not consider that this facility is high-capacity and is not 'largely separated' from other traffic. A RTS in Mr Smith's view is a BRT or MRT service much like the North Shore busway in Auckland, rail services such as those in Auckland and Wellington, or light rail (which is not established in New Zealand).

17. I agree with Mr Smith and Mr Pickard that the proposed Ladies Mile SH6 corridor is not a RTS. As detailed in my response to Question 19b of the joint questions on behalf of Glenpanel Developments Ltd and Anna Hutchinson Family Trust, I stated that should this be considered to be a RTS, it is still a bus based form of transport unlike a rail or light rail

RTS in other cities such as Auckland and Wellington. As such, I consider that a walkable distance of 400 to 500m to a bus stop is still appropriate as defined in the TPLM Transport Strategy. However, 800m is accepted within MfE guidance documents on the implementation of the NPS UD[1] as the maximum typical 'walkable catchment' area. I also note that QLDC[2] use 600-800m as a walkable catchment to bus stops, shops and services. Therefore, subject to the walkable catchment being over a relatively flat terrain, I agree that a walkable catchment of up to 800m could potentially be adopted should SH6 be defined as a RTS. I would not accept 1,200km walk distance to a bus stop as a walkable catchment since this clearly exceeds NPS UD and QLDC guidance on walkable attachments.

Question 1.5: Road speeds, traffic lights and provision of public transport (and other SH6 upgrades beyond TPLM) are beyond the ability of the Variation (and the council and developers) to control. The evidence is that funding for and delivery of these 'wider initiatives' is not guaranteed and has no defined timeframe associated with it. On that basis what are:

(a) *The transportation implications of the schools and commercial developments not occurring until significant development has occurred within TPLM (which could be a 'gap' of a decade or more);*

18. Waka Kotahi have indicated that this would likely induce more traffic demand on SH6 with more private vehicle trips to the high school and commercial activities within the Frankton Flats. This will exacerbate the existing problems on SH6, particularly at the Shotover Bridge. This will increase the need for the 'wider initiatives' (which are the W2G partners network wide active mode and public transport and Transport Demand Management (**TDM**) measures) to be implemented which may assist in prioritising them with regard to funding, but this would still not provide certainty in delivery timeframes. In terms of exacerbating existing problems, this relates to:

a) A worsening of the current westbound congestion, delays and queuing on the east side of the Shotover Bridge adjacent to Ladies Mile.

b) A worsening of the current eastbound congestion, delays and queuing on the west side of the Shotover Bridge adjacent to Frankton Flats.

c) A worsening of network performance during the peak period shoulders or during other times of day as the capacity of the merges either side of the Shotover Bridge is reached for longer periods and/or is reached at other times.

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1 Understanding and implementing intensification provisions for the NPS on urban development (environment.govt.nz)

2 Joint Housing Action Plan | Let's Talk Queenstown Lakes District Council (qldc.govt.nz)

19. I agree with Waka Kotahi's comments above

(b) *The transportation implications of Way 2 Go strategies not being delivered; and*

20. First, I assume that this question is aimed at strategies (e.g. Mode Shift Plan "Better Ways To Go"), rather than infrastructure provision. I note that TPLM Variation provisions specify the transport infrastructure works that are required to be completed before "development". These works include the provision of the westbound bus lane, and upgrades to Stalkers Road and Howards Drive intersections. Therefore, development within the TPLM cannot occur without these works being in place and my evidence is provided on this basis.

21. Mr Pickard has indicated TDM measures such as parking restrictions can be imposed, but other TDM will be advocacy based. Approving the TPLM Variation will give certainty to the level of development which must be addressed by the three W2G transport partners.

22. Waka Kotahi have indicated that the wider transport initiatives (i.e. the W2G partners network wide active mode and public transport and TDM measures) are a part of the W2G programme so the same comment applies as in Q1.5 (a) above.

23. I agree with both Mr Pickard and Waka Kotahi's comments that the TPLM Variation will give certainty on the level of development in the Eastern corridor which will assist the W2G partners to deliver their wider programme. As detailed in my EIC, the strategic transport modelling work undertaken only takes into account public transport improvements and does not take into account the wider W2G initiatives such as active mode, Travel Behaviour Change and TDM measures. As such, an element of the implications of not all of the W2G strategies being implemented has been assessed.

(c) *The transportation implications of target modes shares not being achieved, and*

24. As detailed in paragraph 53 d) of my EIC, the Strategic transport model is based on a AM and PM peak bus mode share of 21% to 22%. For the reasons outlined in the Transport Strategy, this is considered to be an underestimate of the expected non car mode share at TPLM since it does not take into account mode shift arising for example, from the proposed TPLM Variation and W2G partners active mode, Travel Behaviour Change or TDM measures. It is therefore considered that the model is showing a worst case assessment and I consider, for the reasons detailed in the Transport Strategy, that it will actually be a much higher public transport mode share. However, the model indicates that even with this lower PT mode share, that there will be limited capacity issues on the adjacent road network.

(d) *Have the effects, effectiveness and efficiency, and overall appropriateness of the TPLM been considered from the point of view of necessary passenger transport services not eventuating?*

25. As this is more relevant to planning., I understand this question is being addressed by Mr Brown.

(e) *How can an integrated transportation solution, particularly for walking and cycling modes, be achieved as individual sub areas are developed when there does not appear to be any consideration within the zone provision of relative staging of TPLM?*

26. As this is more relevant to planning., I understand this question is being addressed by Mr Brown.

(f) *How could TPLM be planned to mitigate such risks / effects? For example:*

(i) *zoning options (such as deferred zones);*

(ii) *development thresholds or mode shift / active mode, / public transport targets; or*

(iii) *staging options,*

to deliver a well-functioning urban environment with growth aligned with the developing transport network (and/or reducing adverse effects on it, for example through the commercial area/schools) and what provisions would be required to provide for that?

27. As this is more relevant to planning., I understand this question is being addressed by Mr Brown.

Question 1.6: Would Council-led delivery of transport infrastructure (noting of course the role of Waka Kotahi as the road controlling authority for SH6) be appropriate / provide a better outcome than seeking individual landowners to coordinate delivery and why? What mechanisms might be applied to allow the Council to recover costs from developers, if appropriate?

28. As this is more relevant to planning., I understand this question is being addressed by Mr Brown.

Question 1.7: Will TPLM on its own justify a public transport system or is greater density required along the whole SH6 corridor (and including Queenstown Country Club, Lake Hayes estate, Shotover Country Estate)? If the latter:

(a) What is the Council doing along the corridor to support / speed up the delivery of public transport?

29. As detailed in response to question 1.5d, and in the TPLM Transport Strategy, the intention is to improve the existing bus services 2 and 5 rather than provide bespoke TPLM bus services. Details of the planned physical works along the corridor have been provided in the TPLM Transport Strategy and Variation provisions. The improvements required are not reliant on greater density on the whole SH6 corridor.

30. Mr Pickard has indicated that QLDC is actively engaged in the forward planning of Public Transport alongside Waka Kotahi and ORC. The ongoing provision of PT lies with ORC.

(a) How important is the density of TPLM compared to the rest of the corridor?

31. As detailed in my EIC and EIR, medium and high density at TPLM is required for effective mode shift and the Variation provisions enable this level of density and supporting TDM, active mode and public transport measures. As such, density at TPLM is important when compared to the rest of the corridor where density is low.

Question 1.8: What is the minimum density needed to initiate and sustain a high frequency public transport system needed for TPLM? How does the existing housing to the south of TPLM also affect this?

32. As detailed in my EIC and EIR I consider that 40 dwellings/Ha is the minimum density needed to initiate and sustain a high frequency public transport. This is agreed by the Transport Experts. This is not affected by the housing to the south of TPLM.

Question 1.9: Given our density question below, how does a delay and potential reduction of high-density development within TPLM affect the ability to provide the frequency of public transport needed to support TPLM?

33. Based on the EIC and EIR of Ms Fairgray, I understand that there could be a delay and potential reduction in the scale of high density development (in particular relating to apartments). I do not consider that this will significantly affect the ability to provide the frequency of public transport needed since the minimum required density level of 40 dwellings/Ha will be delivered. Furthermore, as detailed in response to Question 1.5 c) above, the strategic transport model was based on a much lower non car mode share than the TPLM Transport Strategy target and therefore the model is showing a worst case assessment.

Question 1.10: While the transport evidence does mention it briefly, please provide more information on how TPLM may reduce traffic on SH6 (for example by providing a commercial area, open space and potential school etc outside of the Shotover bridge).

34. It is assumed that this question is referring to existing trips from Lake Hayes Estate and Shotover Country accessing schools and community facilities on the west side of Shotover Bridge. In terms of the existing trips from Lake Hayes Estate and Shotover Country to schools west of the Shotover Bridge, paragraph 21c of my EIC and section 3.9 of the TPLM Transport Strategy indicates that approximately 870 students reside east of Shotover Bridge and attend schools to the west. This represents approximately 19% of the existing AM peak westbound traffic flow on Shotover Bridge. With the provision of a High School at TPLM, then this has the potential to dramatically reduce traffic flows across the bridge in the critical AM peak period.

35. Other than a small convenience store and a pharmacy there are no other retail developments within Lake Hayes Estate and Shotover Country, with residents having to drive across the Shotover Bridge to access key retail facilities such as supermarkets. Provision of a supermarket and other supporting commercial developments at TPLM will reduce the need for existing residents to drive over the bridge.

36. Likewise, as detailed in section 3.10 of the Transport Strategy, residents from east of the Shotover Bridge use the Queenstown Events Centre for recreation purposes. Provision of the TPLM Sports Hub will reduce the need for existing residents to drive over the bridge to access sports facilities.

37. The updated strategic transport modelling reported in section 6.3.1 of Appendix C of my EIC indicates that up to 20% of AM TPLM peak trips and 19% of PM TPLM peak trips will be to/from Lake Hayes Estate and Shotover Country. This demonstrates how TPLM will reduce traffic flows across the bridge to/from these communities.

Question 1.11: What is the 2053 Base Model 1,100 households within the TPLM area founded on (including assumptions) and does this provide a genuine basis for assessing traffic effects of the anticipated 2,400 TPLM households at 2053 and if so, why?

38. Waka Kotahi have indicated that the 1,100 households was the preferred option from QLDC's Housing Infrastructure Fund (HIF) business case. At that time, it was considered that 1,100 households was an appropriate level of development for the Ladies Mile. There was an assessment of traffic effects undertaken using a spreadsheet-based demand model and some intersection modelling of the SH6 intersections. The HIF funding was never activated and the associated Special Housing Area application was unsuccessful. The 2053 growth forecasts received from QLDC in August 2022 includes 1,070 households in Ladies Mile by 2053. These forecasts provide the future base for the transport model and are consistent with other recent transport planning assessments using the model including the Queenstown-Lakes Spatial Plan and Otago Regional Council public transport Detailed Business Case work. From an RMA perspective, 1,100 households is not a permitted baseline and therefore Waka Kotahi consider that this should not be used as a basis for accessing the effects of 2,400 households.

39. I consider that the full effects of TPLM have been assessed since the assessment of effects is based on 2,400 residential units plus the TPLM Variation commercial and education land uses. The outputs from this modelling of the full development have been used to assess the impacts on the wider transport network and the more detailed Sidra intersection modelling.

Question 1.12: Given the car parking controls proposed, how would an application for a car parking building within the commercial centre be treated? What consent requirements and policy tests would apply? How would an application for a car parking building outside of the Ladies Mile zone - say Hawthorne / Glenda Drive be treated? What would happen if a group of landowners purchased a vacant residential lot within TPLM and simply used it for car parking?

40. As this is more relevant to planning., I understand this question is being addressed by Mr Brown.

Question 1.13: Given the different transport patterns and lifestyles in Queenstown, how realistic are the mode shift and travel assumptions made, noting that commuting to work or school is only one small part of travel needed by a household?

41. Waka Kotahi have indicated that they consider the TPLM targets (detailed in section 6.3.3 of the Transport Strategy consisting of 43% bus, 9% car share/car pool and 5% ebike) to be aspirational and that these are unprecedented in the New Zealand context. In response to Question 1.5 c) above, it should be noted that the strategic transport model was based on a much lower non car mode share (21% to 22%) than the TPLM Transport Strategy target. However, as detailed in paragraph 26 of my EIC, Waka Kotahi have stated that the overall alternative mode share (including public transport, walking and cycling, ride sharing and working from home) across the Queenstown network will need to be in the order of 40% by 2028 to maintain a functional transport network. Therefore, substantial mode shift needs to take place not just at TPLM but across the whole Queenstown network and hence why network wide investment by the W2G partners in public transport, active modes, TDM and Travel Behaviour Change is required.

42. When combined with the high density and mixed use development at TPLM, I consider that there is significant scope for residents and visitors to choose to use active and public transport modes as well as a reduction in Lake Hayes Estate and Shotover Country residents needing to drive across the Shotover Bridge to access key community facilities. As such, with the appropriate investment by the W2G partners, I consider that the targets can be achieved and help to contribute to the network targets identified by Waka Kotahi.

43. Noting all the transport experts are in agreement that the transport network problems are in the peak periods, I consider that the commute to work and education are the key trip purposes. Noting that outside of the peak periods other trip purposes (such as recreation, shopping etc) maybe more prevalent, I consider that the mode shift targets are appropriate to these types of trips since they can be made by active and public transport modes. Should a private vehicle be required (eg for recreation areas not accessible by bus or equipment needs to be transported) then these would be possible through use of a private vehicle (where a parking space is provided at a dwelling) or

through use of the car share/car pool initiatives identified in the TPLM Transport Strategy.

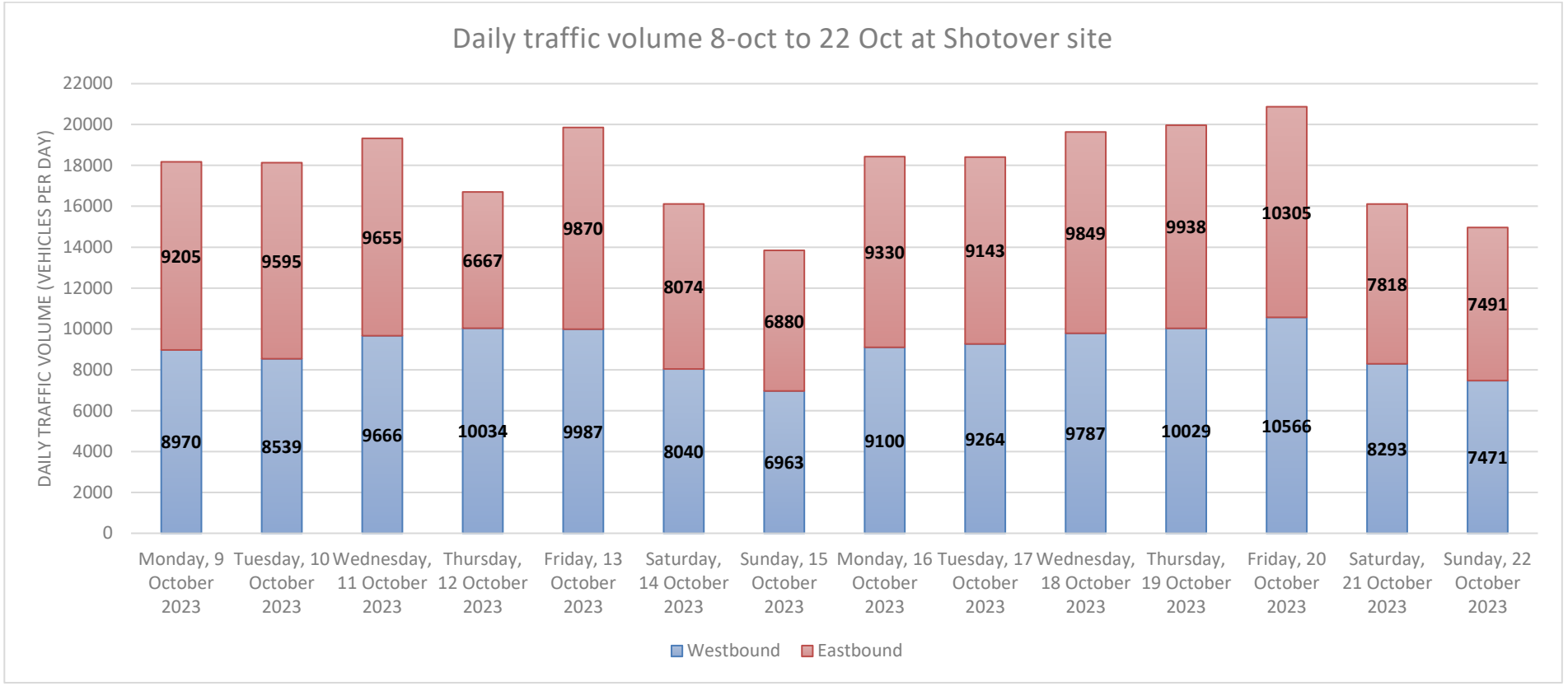
Question 1.14: Is there a point where vehicular congestion along SH6 and the bridge becomes so severe drivers seek out either a) alternative routes or b) alternative destinations (i.e. Arrowtown / Cromwell)? Or is it the case that traffic will always and without exception seek to add loading to the bridge?

44. Waka Kotahi have indicated that if the destination is Queenstown, then some drivers may consider using the Malaghans Road route, but it is quite a bit longer and they still need to access Lower Shotover Road so the time saving would be minimal. No matter how bad the delays get it is highly unlikely that those traveling from Ladies Mile to Frankton would do so via Queenstown, unless it was absolutely necessary. Alternative destinations are not considered to be a viable option.

45. The most likely scenario is deferred or cancelled trips and also trip retiming or avoiding travel such that residents would not be required to travel at peak times is the most likely outcome. It is worth noting that as congestion increases it is not necessarily just the extent of congestion that would worsen but also the length of time over which the congestion is experienced.

Question 1.15: What is the existing daily variation in traffic volumes on SH6?

46. As detailed in section 2 of Appendix A of my EIC, there is a Waka Kotahi Permanent count site on SH6 located between Stalker Road and Howards Drive. Recent data has been extracted covering the period 8 October to 22 October 2023. The daily variations are summarised below:



As can be seen from the above, Fridays have the highest weekday flow and weekend flows are, as expected much lower.

Question 1.16: Please provide more information in relation to the international research on housing density and a reduction in vehicle trips.

47. A number of research articles were reviewed including Smart Growth -- As Seen From the Air Convenient Neighborhood, Skip the Car John W. Holtzclaw (AWMA00-1.PDF (psu.edu)). This is attached as **Appendix C**.

Question 1.17: Please provide SIDRA modelling for signalised versions of the key roundabout intersections currently assessed.

48. This was provided in paragraphs 11 to 21 and Appendix A of my EIR.

Question 1.18: Please expand the assessment that the comparability of the Aspen and Queenstown transportation environments indicate that the mode share targets, are, as the Panel understands it, in your view achievable.

49. Section 2.2 of the TPLM Transport Strategy included details from the W2G partners Queenstown Transport Business Case and the compatibility of Queenstown with its sister city of Aspen. The Business Case noted that Aspen has achieved a 68% non-car driver mode share for commuting. Key to the success of achieving such a high non car mode share in Aspen was for the four pillars of the intervention hierarchy (integrated planning, demand management, best use of existing network and new infrastructure) to work seamlessly together. I consider that the mode share targets are achievable at TPLM on the assumption that the four pillars work together as follows:

    (a) Integrated planning – through TPLM Variation medium to high density, mixed uses on site and providing community facilities for existing adjacent communities.

    (b) Demand Management - through the provision of TPLM Variation provisions including maximum off street car park spaces, minimal on street car parking and, minimum cycle parking and end of trip facilities.

    (c) Best use of existing network – through utilising existing roading network and active mode links, TDM and Travel Behaviour Change initiatives.

    (d) New infrastructure – through the TPLM Variation provisions including SH6 bus lanes, new traffic signal intersections, new pedestrian/cycle controlled crossings, new active mode links and Stalker Road bus lane, enhanced bus services and new bus stops.

Question 1.19 Please provide further detail on the PT modelling methodology at 4.1 of the Abley Technical Note.

50. Mr Smith indicates that Section 3.1 of Queenstown PT Business Case Demand Forecasting Technical Note v3 states the following: "*The PT model is essentially a generalised cost and logit model built in Excel, comprising a demand and network element. It has been adapted from the original PT model developed as part of the QTBC project but simplified to make the process easier (both from a build, option testing and sense/error checking basis). The network element of the model is a representation of the spatial nature of the actual road (and PT) network of the area of interest, which allows the demand matrix to be assigned onto the network, and travel time measures to be determined, as well as a shortcut to establish which Origin-Destination (O-D) movements assign onto which part of the modelled network. The spreadsheet element of the model then takes these network-based inputs and carries out the allocation of generalised cost to each journey (by different modes), to output the mode share and PT usage within the network."*

Question 1.20: Please provide a comparison of the assumptions, and if there is variation between the two, the significance and implications of that variation, of the Tracks transportation model and the retail economic assessment around the number of jobs available within the TPLM area.

51. As this is more relevant to economics, I understand this question is being addressed by Ms Hampson.

Question 1.23: Is 2,400 dwellings seen as a minimum, maximum or something in between? What are the implications of the answer in terms of transportation and urban design? Do the TPLM provisions as proposed provide suitable clarity of intentions in relation to those same development limits? Would 2,400 dwellings, predominantly consisting of 1-2 bedroom dwellings, have different traffic and infrastructure effects to 2,400 dwellings predominantly consisting of 3-4 bedroom dwellings?

52. As detailed in my EIC, 2,400 dwellings is the maximum number based on the transport modelling assessment. A development consisting of 3 to 4 bedroom dwellings would have a different transport impact than a development consisting of 1 to 2 bedroom dwellings since this would have a higher rate of car ownership (given more off street car park spaces would be provided). Although this scenario has not been modelled I would expect this to result in higher volumes of private vehicles and would result in a lower level of service on the adjacent road network than the scenario of 1 to 2 bedroom dwellings.

Question 1.24: If TPLM is only one small part of a much bigger passenger transport and traffic management solution, how essential is it that it achieves the identified density targets?

53. As detailed in my EIC, the density targets are critical for TPLM in order to provide the critical mass of population to support public transport and in turn achieve the mode shift required for the transport network to operate efficiently. I acknowledge that with the amendments to the high density TPLM variations overall household numbers may be lower than that assumed in the strategic transport modelling. However, it is my opinion that even at the lower end of the 40 to 60 dwellings per Ha range there will still be the quantum of population required to support high frequency public transport services.

Appendix B - Waka Kotahi response to Panel transport related questions dated 26th November 2023

Queenstown Lakes District Council

Variation to Queenstown Lakes Proposed District Plan: Te Pūtahi Ladies Mile

Hearing Panel Minute: Pre-Hearing questions

1.1 The Hearing Panel has been reviewing the evidence and material provided to date. In advance of the hearing, to assist the council and all parties, we set out below a number of high-level questions / requests that we would like the council team (and all parties as they wish) to consider in advance of the hearing and to be ready to address at the hearing.

1.2 These questions are focused on parts of a few of the many matters the Hearing Panel will need to consider and will not replace questions at the hearing. Rather, the intent is to allow greater time to consider more fulsome responses / obtain information.

1.3 For ease we have set the questions under headings, but we recognise there is overlap of expertise required to answer them all.

Transport

1.4 The planners agreed that the LM SH6 corridor will be a RTS under the NPS-UD. The system is not existing so given the definition of "planned" in the NPS-UD, can the planners confirm that it is a form or feature of transport within "a regional land transport plan prepared and approved under the Land Transport Management Act 2003." If so, could more information be provided on the RLTP provisions relevant to the LM SH6. If not, then can the LM SH6 be considered a RTS and how? It is not considered an RTS. The following is an excerpt from the NPS – UD section 1.4:

Commented [CS1]: Tony P, Tony S, Dave S - any comments?

> **rapid transit service** means any existing or planned frequent, quick, reliable and high-capacity public transport service that operates on a permanent route (road or rail) that is largely separated from other traffic
>
> **rapid transit stop** means a place where people can enter or exit a rapid transit service, whether existing or planned

It is understood that the proposal includes bus lanes along a length of Ladies Mile with the Transport Strategy referring to 10-minute frequency services. This facility is not considered to be high-capacity and is not largely separated from other traffic. A RTS in my view is a BRT or MRT service much like the North Shore busway in Auckland, rail services such as those in Auckland and Wellington, or light rail (which is not established in New Zealand).

1.5 Road speeds, traffic lights and provision of public transport (and other SH6 upgrades beyond TPLM) are beyond the ability of the Variation (and the council and developers) to control. The evidence is that funding for and delivery of these 'wider initiatives' is not guaranteed and has no defined timeframe associated with it. On that basis what are:

(a) The transportation implications of the schools and commercial developments not occurring until significant development has occurred within TPLM (which could be a 'gap' of a decade or more); This would likely induce more traffic demand on SH6 with more private vehicle trips to the high school and commercial activities within the Frankton Flats. This will exacerbate

the existing problems on SH6, particularly at the Shotover Bridge. This will increase the need for these 'wider initiatives' to be implemented which may assist in prioritising them with regard to funding, but this would still not provide certainty in delivery timeframes. Agree – however I would like to add that in exacerbating existing problems, this relates to:

(i) a worsening of the current westbound congestion, delays and queuing on the east side of the Shotover Bridge adjacent to Ladies Mile,

(ii) a worsening of the current eastbound congestion, delays and queuing on the west side of the Shotover Bridge adjacent to Frankton Flats, and

(iii) worsening of network performance during the peak period shoulders or during other times of day as the capacity of the merges either side of the Shotover Bridge is reached for longer periods and/or is reached at other times.

(b) The transportation implications of Way 2 Go strategies not being delivered; and These 'wider initiatives' are a part of the W2G programme so the same comment applies as in (a) above. Agree – as above.

Commented [CS2]: Tony P, Tony S, Dave S - any comments?

(c) The transportation implications of target modes shares not being achieved, Same comment as per (a) and (b). Agree – as above.

and

(d) Have the effects, effectiveness and efficiency, and overall appropriateness of the TPLM been considered from the point of view of necessary passenger transport services not eventuating? The Regional Council is nearing completion of its Public Transport Business Case which is considering the investment in future PT services based on demand modelling. There is an existing bus route on SH6 along the Ladies Mile and it very likely that this service would be improved in terms of frequency in line with increased demand. Again there are no certainties, but the Regional Council has indicated they have included additional funding for Queenstown PT services in the 24-27 RLTP.

Commented [CS3]: Tony P, Tony S, any updates on the PT DBC?

(e) How can an integrated transportation solution, particularly for walking and cycling modes, be achieved as individual sub areas are developed when there does not appear to be any consideration within the zone provision of relative staging of TPLM?

(f) How could TPLM be planned to mitigate such risks / effects? For example:

(i) zoning options (such as deferred zones);

(ii) development thresholds or mode shift / active mode, / public transport targets; or

(iii) staging options,

to deliver a well-functioning urban environment with growth aligned with the developing transport network (and/or reducing adverse effects on it, for example through the commercial area/schools) and what provisions would be required to provide for that?

1.6 Would Council-led delivery of transport infrastructure (noting of course the role of Waka Kotahi as the road controlling authority for SH6) be appropriate / provide a better outcome than seeking individual landowners to coordinate delivery and why? What mechanisms might be applied to allow

the Council to recover costs from developers, if appropriate? This is primarily for Council to answer. Waka Kotahi has no mechanisms to recover costs from developers. Agree.

1.7 Will TPLM on its own justify a public transport system or is greater density required along the whole SH6 corridor (and including Queenstown Country Club, Lake Hayes estate, Shotover Country Estate)? If the latter:

(a) What is the Council doing along the corridor to support / speed up the delivery of public transport? See response to 1.5 (d). QLDC to comment further.

(b) How important is the density of TPLM compared to the rest of the corridor?

1.8 What is the minimum density needed to initiate and sustain a high frequency public transport system needed for TPLM? This is primarily How does the existing housing to the south of TPLM also affect this?

1.9 Given our density question below, how does a delay and potential reduction of high-density development within TPLM affect the ability to provide the frequency of public transport needed to support TPLM?

1.10 While the transport evidence does mention it briefly, please provide more information on how TPLM may reduce traffic on SH6 (for example by providing a commercial area, open space and potential school etc outside of the Shotover bridge).

1.11 What is the 2053 Base Model 1,100 households within the TPLM area founded on (including assumptions) and does this provide a genuine basis for assessing traffic effects of the anticipated 2,400 TPLM households at 2053 and if so, why? The 1100hh was the preferred option from QLDCs HIF business case. At that time, it was considered that 1100hh was an appropriate level of development for the Ladies Mile. There was an assessment of traffic effects undertaken using a spreadsheet-based demand model and some intersection modelling of the SH6 intersections. The HIF funding was never activated and the associated Special Housing Area application was unsuccessful. From an RMA perspective 1100hh is not a permitted baseline and therefore should not be used as a basis for accessing the effects of 2400hh. Further to the above from Tony, the 2053 growth forecasts received by Abley from QLDC in August 2022 includes 1070 households in Ladies Mile by 2053. These forecasts provide the future base for the transport model and are consistent with other recent transport planning assessments using the model including the Queenstown-Lakes Spatial Plan and Otago Regional Council public transport business case work. I agree that from an RMA perspective these should not be considered in a permitted baseline.

1.12 Given the car parking controls proposed, how would an application for a car parking building within the commercial centre be treated? What consent requirements and policy tests would apply? How would an application for a car parking building outside of the Ladies Mile zone - say Hawthorne / Glenda Drive be treated? What would happen if a group of landowners purchased a vacant residential lot within TPLM and simply used it for car parking? This is a matter for the applicant to address.

1.13 Given the different transport patterns and lifestyles in Queenstown, how realistic are the mode shift and travel assumptions made, noting that commuting to work or school is only one small part of

Commented [CS4]: Tony P, Tony S, - any comments?

Commented [CS5]: Tony P, Tony S, Dave S - any comments?

Commented [CS6]: Tony P, Tony S, Dave S - any comments?

Commented [CS7]: Tony P, - any comments?

travel needed by a household? Aspirational! Agree – to the best of my knowledge these mode shifts are unprecedented in the New Zealand context.

1.14 Is there a point where vehicular congestion along SH6 and the bridge becomes so severe drivers seek out either a) alternative routes or b) alternative destinations (ie Arrowtown / Cromwell)? Or is it the case that traffic will always and without exception seek to add loading to the bridge? If the destination is Queenstown, then some drivers may consider using the Malaghans Rd route, but it is quite a bit longer and they still need to access Lower Shotover Rd so the time saving would be minimal. No matter how bad the delays get, I can't imagine anyone traveling from Ladies Mile to Frankton via Queenstown, unless it was absolutely necessary. I cannot think of any scenario where alternative destinations would be a viable option. The most likely scenario is deferred or cancelled trips. Agree that trip retiming or avoiding travel such that residents would not be required to travel at peak times are the most likely outcomes. It is worth noting that as congestion increases it is not necessarily just the extent of congestion that would worsen but also the length of time over which the congestion is experienced.

Commented [CS8]: Dave S - any comments?

1.15 What is the existing daily variation in traffic volumes on SH6?

1.16 Please provide more information in relation to the international research on housing density and a reduction in vehicle trips.

1.17 Please provide SIDRA modelling for signalised versions of the key roundabout intersections currently assessed.

1.18 Please expand the assessment that the comparability of the Aspen and Queenstown transportation environments indicate that the mode share targets, are, as the Panel understands it, in your view achievable.

1.19 Please provide further detail on the PT modelling methodology at 4.1 of the Abley Technical Note. Section 3.1 of Queenstown PT Business Case Demand Forecasting Technical Note v3 states the following: "*The PT model is essentially a generalised cost and logit model built in Excel, comprising a demand and network element. It has been adapted from the original PT model developed as part of the QTBC project but simplified to make the process easier (both from a build, option testing and sense/error checking basis).*

The network element of the model is a representation of the spatial nature of the actual road (and PT) network of the area of interest, which allows the demand matrix to be assigned onto the network, and travel time measures to be determined, as well as a shortcut to establish which Origin-Destination (O-D) movements assign onto which part of the modelled network. The spreadsheet element of the model then takes these network-based inputs and carries out the allocation of generalised cost to each journey (by different modes), to output the mode share and PT usage within the network."

Commented [CS9]: Dave S - any comments?

1.20 Please provide a comparison of the assumptions, and if there is variation between the two, the significance and implications of that variation, of the Tracks transportation model and the retail economic assessment around the number of jobs available within the TPLM area.

Density

1.21 How is the development of TPLM (LD, MD, HD, commercial, open space) intended to occur over time? Is it sufficiently coordinated and managed to minimise inefficient outcomes (including a reduction in typologies) and adverse environmental effects (including on and for infrastructure)?

1.22 How is the development of TPLM housing (LD, MD and HD) intended to occur over time and how will that link to the development of the commercial precinct? If it is not coordinated and managed then could that result in inefficient outcomes (including a reduction in housing variety) and deliver adverse environmental effects (including on infrastructure)?

1.23 Is 2,400 dwellings seen as a minimum, maximum or something in between? What are the implications of the answer in terms of transportation and urban design? Do the TPLM provisions as proposed provide suitable clarity of intentions in relation to those same development limits? Would 2,400 dwellings, predominantly consisting of 1-2 bedroom dwellings, have different traffic and infrastructure effects to 2,400 dwellings predominantly consisting of 3-4 bedroom dwellings?

1.24 If TPLM is only one small part of a much bigger passenger transport and traffic management solution, how essential is it that it achieves the identified density targets?

1.25 How robust is the likely delivery of the density levels, especially given the uncertainty as to when or if the highest density outcomes will occur? Is it likely that (here and now) low and medium density will be more attractive to the market – and if more is included then how will overall density levels be achieved? How would minimum density requirements (whether gross or net) be affected by potentially land-intensive non-residential activities such as schools, churches, stormwater systems and other infrastructure locating in areas subject to those requirements? Is more medium density required elsewhere in TPLM (or on land owned by submitters subject to scope issues) to make up the slack?

1.26 In terms of minimum density and typology requirements, particularly relating to higher densities, where examples of these within Queenstown have been identified and used to substantiate market demand or feasibility, are those locations comparable to the TPLM site (ie is high density in central Queenstown or on a prime lakefront site fairly comparable adjacent to SH6 at Ladies Mile)?

1.27 If lower density development occurs in the short term, with higher density in the longer term (if at all) what happens if, at a point in time, the low and medium density opportunities have been maximised, the zone is part-implemented, but there is market rejection of higher density housing and applications for inadequate density are being refused consent. When (if at all) would it become better for the part-implemented zone to 'freeze', even if it means failure to achieve some commercial and other non-residential outcomes due to a lack of sufficient local catchment? Further, when (if at all) would it be better to accept lesser-than-hoped-for densities if that helps provide more on-site non-residential activities such as shops to provide as much public transport support as may be achievable? Do the Plan provisions allow such trade-offs to be made, should they, and if so, how?

Stormwater / ESC

1.28 Are there sufficient planning provisions (objectives, policies and rules) for stormwater and ESC to avoid additional adverse effects on Lake Hayes? If not, what changes are required?

1.29 The Candor3 report notes that the Council has made it clear that landowners are expected to manage stormwater within the development areas with no discharges to Lake Hayes:

(a) Is that achievable?

(b) What will the stormwater receiving environments be when the stormwater system capacity is exceeded?

1.30 The Candor3 report comments the "the magnitude of the rainfall event that will generate surface water flows from the masterplan area is unknown". Has further work been done to quantify the event size?

1.31 If the development in TPLM increases the risk of surface water runoff to Lakes Hayes, what could be done to avoid increased sediment and other contaminants entering the Lake?

1.32 Are potential overland flow paths and treatment systems sufficiently provided for, including for first flush events, in particular towards Lake Hayes? Is there sufficient provision to keep the overland flow from Slope Hill away from TPLM?

1.33 Would further investigation as to priority of flows east/west to avoid impacts on Lake Hayes be beneficial?

1.34 Given the reliance on multiple landowners, what is the risk of a non-integrated stormwater system being delivered? Are there examples of a proposed 'integrated' stormwater system, and its associated planning provisions involving neighbours working together / written approval / limited notification and, if so, how well have they worked, especially with a sensitive and significant receiving environment? In particular, what lessons would the examples provide for the proposed provisions?

1.35 How could the development of TPLM be best staged to deliver an 'integrated' stormwater system (and could this align with potential transport related staging above, and if so how)?

1.36 Would Council-led delivery of stormwater infrastructure be appropriate / provide a better outcome than seeking individual landowners to coordinate delivery and why? Was this considered as an option as part of the s.32 evaluation? What mechanisms might be applied to allow the Council to recover costs from developers, if appropriate?

Urban design

1.37 Please explain in its entirety the 'gateway' into Queenstown from 'end to end', including with reference to the setback along the southern side of SH6 adjacent to Frankton Flats? How important is the 'gateway' and is it referred to in any District Plan objectives or policies? Other than a landscaped setback, what other ways can a gateway be expressed and were these considered? (This is particularly relevant to the Panel's consideration of what form of development and development setback might be most appropriate.)

1.38 Simplistic modelling of the visual impact of development on the Anna Hutchinson Family Trust land has been provided. Can a similar assessment for the TPLM area for the viewpoints be readily provided? If so, please could that be done.

1.39 With the potential 60km/h speed for SH6, please consider further the amenity and building setbacks appropriate to that speed (including to maintain that speed rather than promote faster speeds) and liaise with the transportation experts as to what the SH6 transportation corridor cross section should contain to support a 60km/h speed limit. Please consider the combined width of SH6 and landscaped setbacks either side of that, and comment on the extent to which this may become a severance rather than an integrator for north-south pedestrian travel and integrating the two communities either side of SH6.

David Allen, Gillian Crowcroft, Hoani Langsbury, Judith Makinson and Ian Munro.

Independent Hearing Commissioners

21 November 2023

Appendix C - *As Seen From the Air Convenient Neighborhood, Skip the Car*

John W. Holtzclaw

Smart Growth -- As Seen From the Air

Convenient Neighborhood, Skip the Car

John W. Holtzclaw

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(Presented at the Air & Waste Management Association's 93rd Annual Meeting & Exhibition, 23 June 2000, Salt Lake City, UT)

ABSTRACT

The design of our urban areas and their transportation systems strongly influences emissions of urban air pollutants. Smart Growth can increase neighborhood convenience, consequently reducing driving to one-fourth or less, by:

- increasing neighborhood density to raise the number of nearby destinations,
- including markets, restaurants and other commerce and services in residential neighborhoods (mixed-use),
- locating neighborhoods close to job centers,
- providing safe, attractive and convenient pedestrian and bicycle conditions,
- limiting parking, and
- providing frequent, convenient, affordable and safe public transit.

Such neighborhoods encourage walking, bicycling and use of transit for most trips. Equations developed from research using all these variables except parking in the Chicago, Los Angeles and San Francisco regions predicts 79 to 96% of the variance in auto ownership and 80 to 94% of the variance in driving (vehicle miles traveled -- VMT) for neighborhoods within those regions. Residential density is the most effective urban variable in predicting auto ownership and driving. The next most effective variable is the amount of nearby public transit. Finally comes pedestrian and bicycle friendliness, including the fineness of the street grid, provision of public sidewalks and weather protection, location of buildings close to the sidewalk rather than behind parking lots, and traffic safety. Center proximity slightly improved the prediction of VMT in the San Francisco area, the only area where data was available. We had no measure of the amount of private and public parking by neighborhood. The success of these neighborhoods in attracting and retaining residents also depends upon:

- nearby parks, creeks, recreation areas, and other open spaces and wildlife habitat,
- attractive, quality architecture of the neighborhood and buildings,
- quality construction, built to last much longer than housing or shopping centers located in sprawl.

INTRODUCTION

Motor Vehicle Pollution

Motor vehicles are the single largest source of urban air pollution and a major source of water pollution. In the San Francisco Bay Area, for instance, on-road vehicles emit 49% of the reactive

organic gases[1], 52% of the nitrogen oxides[1] and 69% of carbon monoxide[2]. In Los Angeles, motor vehicles and their fuels account for about 90% of the cancer risk[3]. These toxins, along with dumped motor oils, wash into our streams and bays, becoming major water pollutants.

Nevertheless, U.S. vehicle miles traveled (VMT) grew at well over 3 percent per year during the 1980s, and is forecast to increase another 25 percent per capita between 1990 and 2010.[4, 5] What drove this growth and what can be done to rein it in? These questions have stimulated vigorous discussions in the transportation community.

Research on How Urban Design Impacts VMT

How does sprawl drive up VMT? Low density areas are designed to force residents to drive for most trips. Their zoning requires front and side yard setbacks, wide streets and two or more off-street parking places, reducing densities and separating destinations. Many suburbs prohibit sidewalks and convenient nearby markets, restaurants and other commerce. These government mandates force destinations farther apart, lengthening trips to where non-automotive modes become less viable.

Contrast this with traditional cities which grew up around pedestrians, allowing residents to walk, bicycle or take transit to jobs, corner markets and other nearby commerce. They have relatively high densities: ranging from row houses on narrow lots through 3 to 4 story walk-ups to high-rise elevator apartments, condos and co-ops--at 20 to 200 households/residential acre. They are proximate to major job and shopping centers, but have their own local shopping and services, and sidewalks and other amenities to encourage walking. They have excellent access to transit. They were so complete that many residents seldom left them. These areas are now the central and adjacent areas of our older cities and some of the older suburbs. Smart growth replicates traditional city form.

But can we measure the reductions in driving sufficient to provide reproducible emission credits to smart growth? Some progress is evident.

In a survey of 32 major cities around the world, Peter Newman and Jeffrey Kenworthy found that the residents of American cities consumed nearly twice as much gasoline per capita as Australians, nearly four times as much as the more compact European cities and ten times that of three compact westernized Asian cities, Hong Kong, Singapore and Tokyo.[6] However, they lacked measurements of VMT, or data for neighborhoods rather than whole metropolitan areas, split into central cities and suburbs. Their data suggest that driving is reduced 30 percent every time density doubles. If so, sprawling suburban areas would benefit from modest increases in density. A few 3 to 5 story limited-parking condos or apartment houses replacing parking lots or other underused land along major streets could double their density, cutting household mileage 30 percent. If this relationship, a reduction in driving of 30% every time density doubles, holds up to the density of Manhattan, its families would drive only 8%, or 1/12, as much as nearby suburbanites.

Travel surveys, where household residents log each trip, give more direct estimates of VMT. Newman and Kenworthy reported results of a travel survey of United Kingdom cities, which

give a 25 percent reduction in per capita VMT as density is doubled.[6] Similarly, a travel survey in the Greater Toronto Area suggested that doubling density results in a decrease in per capita VMT of about 25 percent.[7] A comparison of cities in Washington state found housing density, population density, jobs-housing balance and retail-housing balance to co-vary and to be associated with reduced driving.[8]

But the cost of such surveys limits them to too few households to provide a statistical analysis of all the important variables at neighborhood level. The above studies were for much larger areas than neighborhoods, limiting their ability to measure the effects of neighborhood characteristics like density, transit service and pedestrian and bicycle friendliness. A 1990 study of five communities, ranging from traditional to suburban, in the San Francisco region used actual odometer readings.[9] The study found that high residential density, nearby shopping, good transit and a good walking environment go together, while low density zones lacked all these. The co-variance of these variables increases the difficulty of disentangling their effects, but does allow density to capture much of the effects of the others. The residents of higher density communities drove 20 to 30 percent per household less every time neighborhood density doubled. Nob Hill, at 32 times higher household density as San Ramon, had 1/4 its household auto ownership and VMT. However, the limited number of communities studied prevented disentangling the effects of residential density, nearby shopping, transit and the walking environment.

Using a household travel survey in the Seattle area, Frank and Pivo found that employment density, population density, land-use mix and jobs-housing balance are associated with less auto use.[10] These relationships held up even when household demographics, car ownership and transit are controlled.

A study of 27 neighborhoods in San Francisco, Los Angeles, San Diego and Sacramento, using odometer readings, found that doubling residential density cut auto ownership 16%, while doubling public transit service reduced VMT an additional 5%.[11] With density as a surrogate for all the variables, doubling residential density cut VMT 20%.

Kara Kockelman, in a study of over 1000 travel analysis zones and 1,200 census tracts in the San Francisco Bay Area, found that the following influence household VMT: household size, auto ownership, income, weighted jobs within 30 minutes, dissimilarity of the zone's major land use from its neighbors, and the balance of land uses within each zone within a half mile.[12]

Robert Dunphy and Kimberly Fisher calculated the average VMT from the 1990 National Personal Transportation Survey (NPTS) for households whose ZIP codes had the same population density.[13] For the five density ranges above 4000 persons/square mile (about 5 households/residential acre), their Table 4 shows a decrease of 38% in daily driving as density doubles.

These studies have shown a strong relationship between urban form and driving. Of course it makes intuitive sense that people living in neighborhoods originally built for the convenience of residents without private automobiles would have lower auto ownership and driving. But which

of the mix of variables that comprise these neighborhoods are the most crucial? If we can identify which of the variables is most effective, and measure their effects, then architects and developers can incorporate them into smart growth, and air quality analysts can credit such design with emissions reductions.

Our location efficiency study explores the hypothesis that the average household's auto ownership and driving decrease measurably as likely trip destinations become more convenient, especially by non-automotive modes. Further, it tests the assumptions that residential density, center proximity, local shopping, public transit accessibility and the pedestrian and bicycle friendliness of the neighborhood are good measures of that convenience.

Which variables do we test?

- Density - a measure of the number of nearby destinations. Residential density, the number of households per residential acre, seems to be the best measure, probably because it focuses on the developed area and is not diluted by farmland or parks within the zone but outside the everyday neighborhood. But other measures of density are also tested.
- Center proximity - a measure of the neighborhood's access to concentrations of jobs and shopping.
- Local shopping - a measure of the amount of restaurants, markets, retail stores, insurance agents, and of course video rental stores, nearby.
- Public transit - important as an alternative to driving.
- Pedestrian and bicycle friendliness - how attractive are areas to these alternatives to driving.

We would also have liked to test the impacts of parking supply, but were barred by the lack of detailed zonal data on parking. Traditional dense areas have narrow streets and limited parking. In addition, the land required by on-site parking itself reduces the density. In the Bay Area, a 3-story apartment house's density could range from 28 units/acre to 64 due only to differences in parking requirements of existing zoning laws.[14] Consequently, to some extent density captures parking tightness.

This study also sought to quantify the statistical relationship of such locational variables to auto ownership and driving to facilitate the Location Efficient Mortgage℠ (LEM). The LEM allows a household to buy a more expensive home in a location efficient area by committing its auto savings to repaying the mortgage, interest, taxes and insurance. I reported preliminary results of this study in the 1997 AWMA meetings.[15]

THIS LOCATION EFFICIENCY STUDY

This study, sponsored by the Natural Resources Defense Council (NRDC), the Center for Neighborhood Technology (CNT) in Chicago, and the Surface Transportation Policy Project in Washington, DC, includes every neighborhood in the San Francisco, LA and Chicago areas.

The zones analyzed are the Chicago Area Transportation Study's 316 Dram-Empal zones covering the Chicago metropolitan area, the Southern California Association of Governments' 1700 Travel Analysis Zones covering the Los Angeles metropolitan area and the Metropolitan Transportation Commission's 1099 Travel Analysis Zones in the San Francisco metropolitan area.

Zones comprised primarily or wholly of parks, military bases, prisons, airports or industrial facilities are outside the scope of this analysis and were eliminated from the data base.

The Variables

The dependent variables are **vehicles available per household** and **vehicle miles traveled** (VMT). Average vehicle availability for each zone is from the 1990 U.S. Census. VMT per vehicle is derived from odometer readings recorded when owners take their vehicles in for emission systems inspections (smog checks) in California and Illinois. Average VMT per household is calculated as the VMT per vehicle times the number of vehicles per household for each zone.

The dependent variables were tested against a wide range of potential explanatory variables, including the most important socio-economic factors of household income and household size. Locational variables tested were: density, transit service and access to jobs by transit, availability of local shopping, pedestrian and bicycle friendliness, and proximity to jobs.

The **density** measures tested were households/residential acre, population/acre and population/residential acre. Households/residential acre (Hh/RA) had the strongest correlation to vehicle ownership, while households/total acre (Hh/TA) had the strongest correlation to VMT/vehicle. Total acreage includes residential, commercial, industrial, agricultural, parks and open space, and any other categories reported. The data were compiled from the census and regional planning organizations.

Household and per capita **income** ($/Hh, $/P) and **household size** (P/Hh) were derived from 1990 census data.

The measure of **transit** accessibility is zonal transit density (Tr), which is the daily average number of buses or trains per hour times the fraction of the zone within 1/4 mi of each bus stop (or ½mi of each rail or ferry stop or station), summed for all transit routes in or near the zone. There is some double counting where stops are less than 1/4 mile apart, but correcting for this would not substantially alter the order of the TAZs nor the relative differences between zones. Therefore this measure provides a robust assessment of transit service. An alternative measure, the zonal transit density times the number of jobs reached within 30 minutes by transit (TrJ), provided no better correlation with auto ownership or driving than the zonal transit density alone. So the simpler zonal transit density is reported. Routes, schedules and stop locations are from the transit agencies or the metropolitan planning organizations, who also calculated the number of jobs accessible by transit.

The measure of **center proximity** (CP) is the number of jobs within a 30 minute drive, calculated by the Metropolitan Transportation Commission for the San Francisco region. An alternative measure is the number of jobs within a 15 minute drive divided by the number of jobs within a 30 minute drive (E15/E30). This provides a measure of the relative availability of jobs locally. Including CP in the VMT/vehicle analysis provided a marginally higher R^2, but was available only in San Francisco and therefore not included in the general analysis. E15/E30 did not improve R^2 as much as CP did.

Local shopping (Sh) is the number of service and retail jobs per developed area within the zone, from the U.S. Census. Zones with centroids less than 1/4 mi apart were combined for this calculation. Local shopping is strongly correlated with density and transit, and did not add to the R^2 after they were taken into account.

The measure of **pedestrian/bicycle friendliness** (Ped) is the number of census blocks per hectare (scale of the street grid), plus an adder based upon the mean year the housing was built, both from the U.S. Census, with bonuses for traffic calming, good pedestrian conditions, bike lanes, paths, and bike parking, whether as part of the initial design or added later. Had direct measurements of the continuity, width and quality of sidewalks, nearness of buildings to the sidewalk, and traffic safety been available, we would have preferred using them to using the mean year the housing was built. A fine street grid shortens routes and offers more alternatives, and the frequent intersections slow traffic. The measure works because older neighborhoods tend to have a fine street grid, sidewalks, narrow streets, slower traffic and buildings closer to the sidewalk.

We also tested socioeconomic variables available at the zonal level: average **household size**, average **household income** and average **per capita income**. These were derived from the U.S. Census. However, we were not able to explore any independent impact of neighborhood **parking supply** or **cost**.

Analysis of vehicles available and driving

The correlation of each individual independent variable (locational and socio-economic) with auto ownership and VMT was tested. In the San Francisco area, for instance, Hh/RA explained 63% of the variance in Veh/Hh, followed by transit-job access at 55%, Hh/TA at 52%, transit service at 49%, income/household at 43%, shopping at 35% and household size at 28%. In each of the three metropolitan areas, Hh/RA explained the most variance in Veh/Hh and VMT/Hh, see Figure 1. These correlations show a very strong relationship of residential density to auto ownership and driving in all three regions studied, even before evaluating the other variables--income, household size, transit service, pedestrian/bicycle friendliness, etc. When tested against each other, density, transit, local shopping, center proximity and pedestrian/bicycle friendliness prove to be highly correlated. While this makes it harder to pick apart the separate influences, it means that density to some extent captures the effects of local shopping, transit and pedestrian and bicycle friendliness.

As much as possible, we based the forms of our fits on simple modeling of the physical situations. For instance, since doubling density doubles the number of nearby destinations, and doubling transit service doubles the number of destinations you can easily reach, it is reasonable to expect that for both each doubling would decrease auto ownership and VMT by a similar percentage--a log-log or power fit. However, there are limitations on how many cars a household can own, and how many miles even the most auto-entranced folk can drive, therefore we modified the power fit form to be bounded as the density goes to zero. Similarly, since more people in the household increase the number of drivers and people to be driven around, we expected a linear relationship of household size with autos and VMT. However, we had less reason to anticipate a particular mathematical form (linear, power, bounded power, root, polynomial, exponential, etc.) for the relationship between income or pedestrian/bicycle friendliness and auto ownership or VMT. So we tested various mathematically simple forms that had appropriate behavior over the ranges of

the independent variables. We derived the forms of the equations using the San Francisco data and then used these forms to derive the equations for the other two regions.

Using the data available in all three geographical regions and the same equation forms, the variables which consistently explain the most variance in vehicles/household (Veh/Hh) are net residential density (Hh/RA), per capita income ($/P), household size (P/H) and transit accessibility (Tr), see Table 1. For vehicle miles traveled/vehicle (VMT/Veh) the best variables are total residential density (Hh/TA), P/H, pedestrian/bicycle friendliness (Ped) and $/P. These are the equations which when applied in the same form in all three regions give the highest R^2.

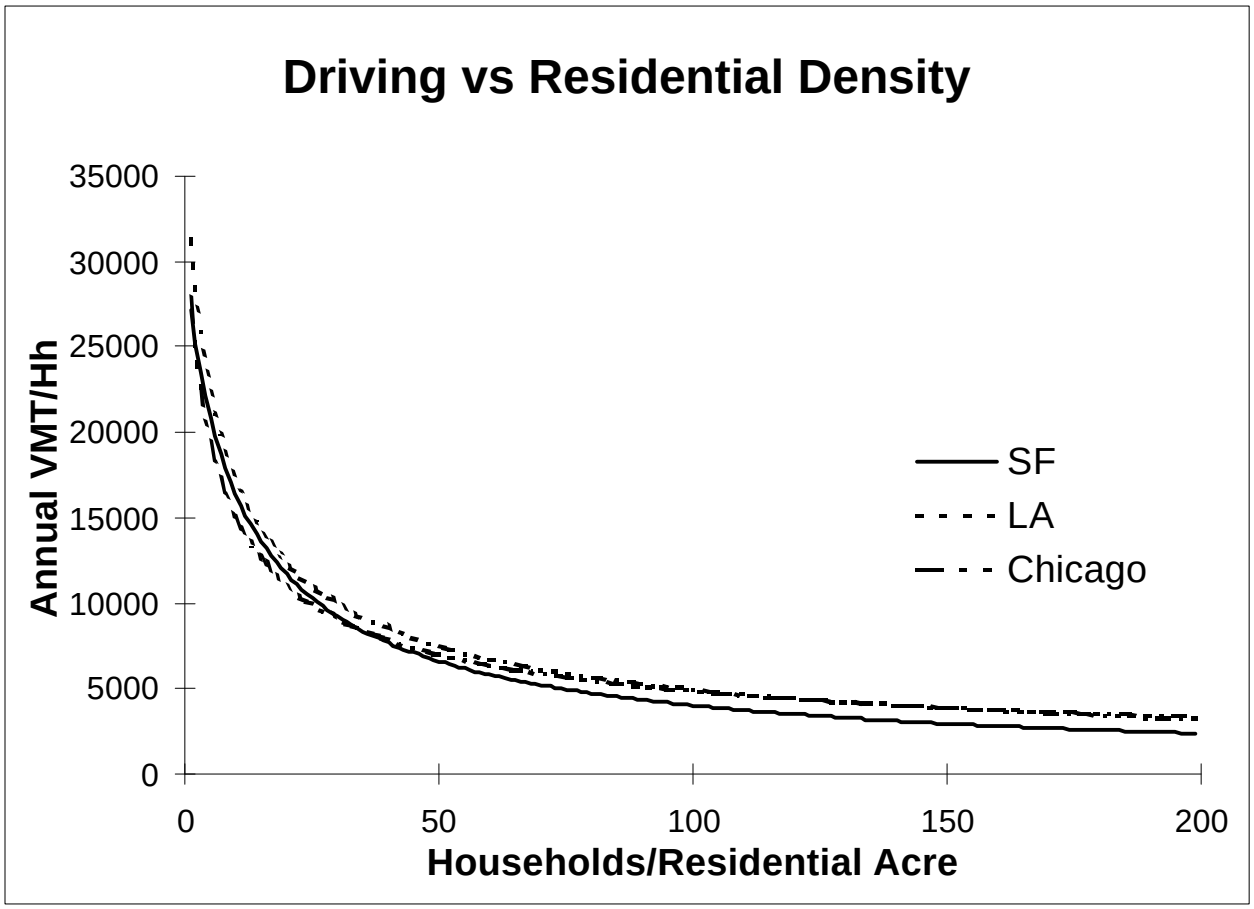
In both the Veh/Hh and VMT/Veh models, density is raised to a negative power, so doubling density causes a fixed decrease in Veh or VMT. In the Veh/Hh model, transit service is raised to a negative power, so doubling Tr causes a fixed decrease in Veh. Household size acts as expected, each additional person adds a fixed increase in Veh or VMT. Improvements in pedestrian and bicycle friendliness reduce VMT/Veh, but with the square root of Ped. The impact of per capita income is a little less straight-forward. It increases with ownership by declining increments as income increases. But VMT/Veh decreases as income increases. The result is that up to an annual income of $25,000 to 30,000, VMT/Hh increases with income as expected, but levels off and falls slightly at higher incomes up to $100,000 per person.

The best San Francisco model for VMT/Veh using variables available in all three regions is the same as in Table 1, but with a function for Zonal Transit Density in place of that for Households/Total Acre. Tr gives an R^2 of 44.1%, which is slightly better than the 43.8% in the above table. But in the other two regions, Tr in place of H/RA reduced the R^2 to 40.0% for Chicago and 37.6% for LA, substantially poorer than the Hh/Tot Acre fit. So the recommended equations use Hh/Tot Acre.

In all three cities, the R^2 for VMT/Veh is much lower than the R^2 for Veh/Hh, indicating that neighborhood conditions more strongly impact the decisions on how many vehicles to have available than they do each decision to use the vehicles on hand. However, since Veh/Hh varies much more from zone to zone (1 s.d. equals ±25% for San Francisco) than does VMT/Hh (±9%), Veh/Hh is more important, and the R^2 for the resulting VMT/Hh is almost the same as for Veh/Hh.

Data for center proximity was only available for the San Francisco region, so none of the fits in Table 1 are based on it. The Veh/Hh fit in Table 3 is already highly significant, and center

Figure 1. The reduction in vehicle miles traveled per household as residential density increases.



proximity added no significance. However, for vehicle use, center proximity added about 5% to the total variation explained, giving a total R^2 of 53.9% for the San Francisco region. This suggests that the impacts of CP, while not measured in Chicago and Los Angeles, should be further explored. The equations in Table 2 provide a high explanation of variation.

Figure 2 shows the impact of residential density and transit on VMT/Hh using the equation for the San Francisco area. This shows that a household with regional average income and family size living in a 2 Hh/RA neighborhood with zero transit service, for instance, would average over 23,000 miles annually. Raising the density to 150 Hh/RA would reduce the mileage to 10,300. But it also shows that more modest increases in density reduce driving. It also shows that at each level of transit service increases of density reduce driving. Similarly, it shows that an increase in Tr to 300 would reduce annual driving to under 15,400. And it shows that more modest increases in transit service reduce driving. At the highest density and transit service in this example, annual mileage is 3,700.

Extending These Analyses

These equations allow the use of available neighborhood locational and demographic

Table 1. The best equations (1 - 9) to predict Veh/Hh, VMT/Veh and VMT/Hh in all three regions.

									R^2

Chicago

$$\frac{Veh}{Hh} = 1.902\left(9.955 + \frac{H}{RA}\right)^{-0.2797}\left(1 - e^{-\left(0.000142\frac{\$}{P}\right)^{1.2915}}\right)\left(1 + 0.4893\frac{P}{H}\right)\left(Tr + 2.960\right)^{-0.0685} \quad 96.3\%$$

$$\frac{VMT}{Veh} = 11620\left(0.1662 + \frac{H}{TA}\right)^{-0.0547}\left(1 + 0.00653\frac{P}{H}\right)\left(1 - 0.0249\sqrt{Ped}\right) - 0.0818\left(\frac{\$}{P} - 22136\right) \quad 46.8\%$$

$$\frac{VMT}{Hh} = \frac{Veh}{Hh} \times \frac{VMT}{Veh} \quad 93.5\%$$

Los Angeles

$$\frac{Veh}{Hh} = 1.732\left(6.155 + \frac{H}{RA}\right)^{-0.0925}\left(1 - e^{-\left(0.000131\frac{\$}{P}\right)^{0.8278}}\right)\left(1 + 0.7936\frac{P}{H}\right)\left(Tr + 30.796\right)^{-0.1865} \quad 78.6\%$$

$$\frac{VMT}{Veh} = 11624\left(0.3432 + \frac{H}{TA}\right)^{-0.0681}\left(1 + 0.01555\frac{P}{H}\right)\left(1 - 0.1078\sqrt{Ped}\right) - 0.04095\left(\frac{\$}{P} - 22136\right) \quad 42.0\%$$

$$\frac{VMT}{Hh} = \frac{Veh}{Hh} \times \frac{VMT}{Veh} \quad 80.0\%$$

San Francisco

$$\frac{Veh}{Hh} = 4.722\left(22.520 + \frac{H}{RA}\right)^{-0.3471}\left(1 - e^{-\left(0.000112\frac{\$}{P}\right)^{1.2386}}\right)\left(1 + 1.0519\frac{P}{H}\right)\left(Tr + 60.312\right)^{-0.2336} \quad 90.2\%$$

$$\frac{VMT}{Veh} = 10386\left(0.5041 + \frac{H}{TA}\right)^{-0.0419}\left(1 + 0.02759\frac{P}{H}\right)\left(1 - 0.0704\sqrt{Ped}\right) - 0.01743\left(\frac{\$}{P} - 22136\right) \quad 43.8\%$$

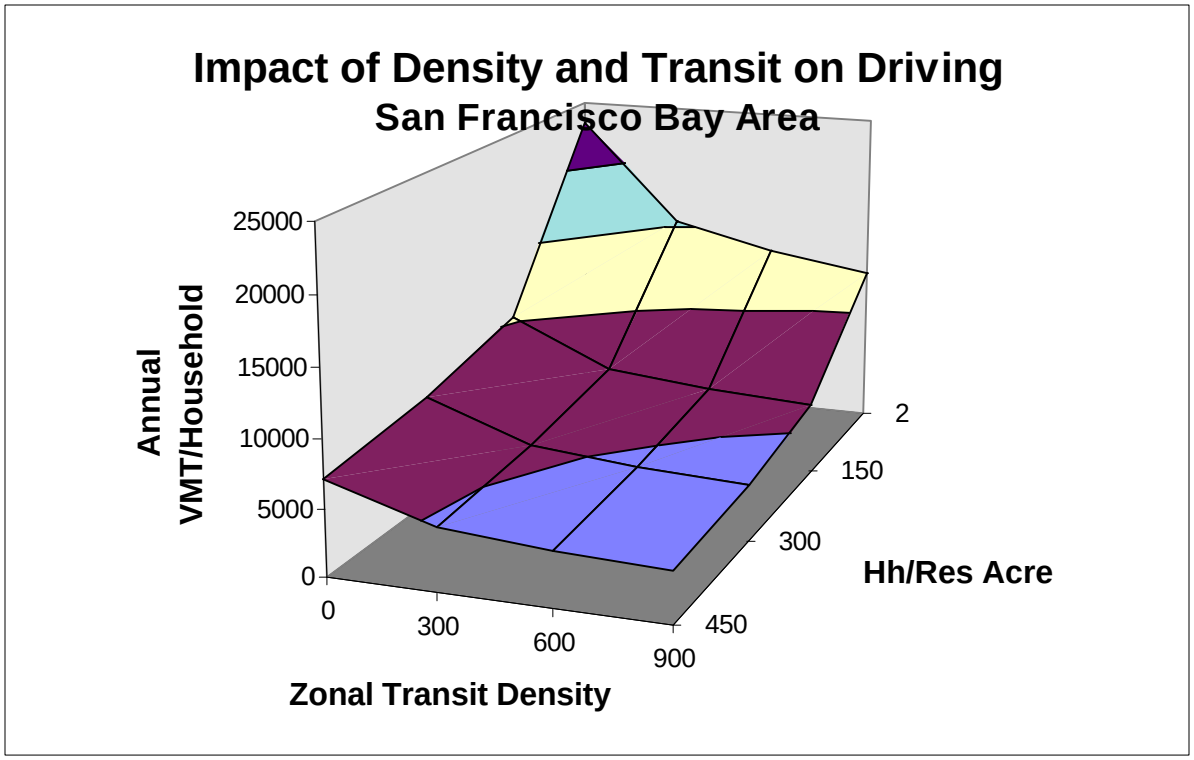
$$\frac{VMT}{Hh} = \frac{Veh}{Hh} \times \frac{VMT}{Veh} \quad 87.1\%$$

* H/RA is Households/Residential Acres, H/TA is Households/Total Acre, $/P is Income/Capita, P/H is Persons/Hh, Tr is Zonal Transit Density and Ped is Ped/Bicycle Friendliness.

characteristics to predict average auto ownership and mileage by neighborhood in three of major U.S. regions. Extending the analyses to other metropolitan areas is a first step. Extending the analysis from vehicles and VMT to vehicle trips and vehicle starts would increase its applicability to air quality analysis. Expanding the analysis from just the characteristics of residential neighborhoods to the concentration or dispersal of jobs or commerce would extend its utility to air quality analysis.

This study was made in order to quantify the transportation savings of average families living in convenient location efficient neighborhoods, allowing them to qualify for Location Efficient Mortgages[SM]. LEMs allow families to apply these transportation savings to qualifying for a higher

Figure 2. How residential density and transit impact VMT/Hh using the San Francisco area equation.



mortgage. Location Efficiency analysis is already being extended to allow LEMs in Seattle, Washington and Portland, Oregon. In neither of these are mileage readings for vehicles available. The dominance of Veh/Hh in the calculations of VMT/Hh facilitated these extensions. Veh/Hh, available from the U.S. Census in all cities, along with densities, income, household size, transit service and pedestrian and bicycle friendliness, allow the Veh/Hh equation to be calibrated. Average VMT/Veh is calculated by state departments of transportation based upon fuel use, screenline monitoring and other gross measures. This allows the VMT/Veh equation to be calibrated to the regional average VMT/Veh.

Extending the analysis to other important dependent variables - vehicle trips and vehicle starts - would require localized measures of these. The closest available measures are household travel surveys, but as with VMT analysis these contain insufficient data. For instance, in the San Francisco region there average less than ten households per zone. The scarce data problem is aggravated by the lack of any households in many zones, especially the denser zones, which are scarcer to begin with. Since fewer trips commence in denser zones, and are consequently less critical to transportation planning, planners have tended to slight them. But aggregating zones by residential density provides more respectable household numbers, allowing derivation of a gross relationship of trips to VMT by residential density. This relationship could be used to extend the predictions of VMT/Hh to trips/household. Similarly, the time between trips, if reported in the household travel survey, could be used to extend the predictions to cold starts.

Similarly, the impacts on trips and VMT of job and commerce concentrations could be estimated by use of household travel surveys. Jobs and local shopping employees are known by zone. Grouping the zones by local shopping density or job ranges would allow shopping trips

terminating in these zones to be measured. A crude relationship of shopping or job density with trips would allow evaluation of their impacts on air quality. Similarly, the analysis could be extended to cold starts and trip lengths.

SO WHAT IS SMART GROWTH, AS SEEN FROM THE AIR?

Smart growth, defined as that which minimizes the emissions of air pollutants per capita or per household, looks quite similar to that defined by smart growth advocates. It creates convenient neighborhoods, new or traditional, and using auto ownership and VMT as its measures, its characteristics are:

- increasing neighborhood density to raise the number of nearby destinations,
- including markets, restaurants and other commerce and services in residential neighborhoods (mixed-use),
- locating neighborhoods close to job centers,
- providing safe, attractive and convenient pedestrian and bicycle conditions,
- limiting parking, and
- providing frequent, convenient, affordable and safe public transit.

While not discussed in the foregoing analysis, the success of these areas in attracting and retaining residents depends upon their satisfaction with these neighborhoods. Since these neighborhoods encourage walking and meeting neighbors on the sidewalk, at the market or at recreation, a sense of community and neighborhood satisfaction is built up. But attention to other factors is also necessary to these neighborhoods ultimate success:

- nearby parks, creeks, recreation areas, and other open spaces and wildlife habitat,
- attractive, quality architecture of the neighborhood and buildings, and
- quality construction, built to last much longer than housing or shopping centers located in sprawl.

This study suggests the following actions to reduce our dependence on the automobile, afford us more transportation options, reduce congestion buildup and reduce air pollution:

1. reform our restrictive (big government) zoning policies in residential and commercial areas to allow higher residential densities, eliminate front- and side-yard setbacks and off-street parking requirements, narrow roadways, and promote neighborhood commerce.
2. design our residential, commercial, office and industrial areas to promote walking, bicycling and public transit, including traffic calming.
3. improve public transit service, convenience, safety, attractiveness and affordability.
4. prohibit highway expansion.
5. prohibit residential growth outside developed neighborhoods.
6. implement the LEM.

While not analyzed in this study, VMT reductions would also be facilitated by elimination of such subsidies to driving as free parking (subsidized by higher property taxes, rents, goods and service prices), pollution and noise damages, global warming, wars in the Mid-East, police/fire/ambulance to motorists, road construction and maintenance (property taxes) and congestion.

Some resources to help you achieve Smart Growth can be found at:
Sierra Club www.sierraclub.org/sprawl
Victoria Transport Policy Institute http://www.vtpi.org
Center for Neighborhood Technology http://www.cnt.org/
Surface Transportation Policy Project http://www.transact.org/stpp.htm
Congress for New Urbanism http://www.cnu.org/
American Planning Organization http://www.planning.org/index.html
American Farmland Trust http://www.farmland.org/

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KEY WORDS

auto emissions
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motor vehicle emissions
pedestrians
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public transit
urban planning