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Chittenden County Regional
Planning Commission

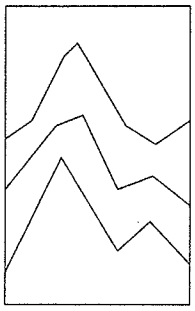
Increasing Multimodal Travel in Downtown Burlington

RESOURCE
SYSTEMS
GROUP
INC.

Norwich, Vermont

Prepared for:

CCRPC
City of Burlington
September 1993



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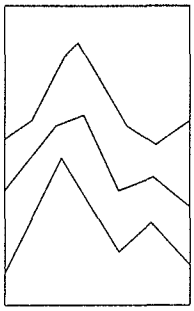

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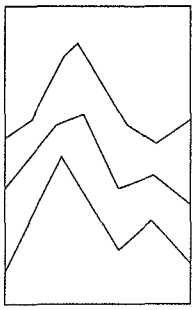


INTRODUCTION

The purpose of this project identified in the Request for Proposals (RFP) was to study the feasibility of a comprehensive transportation center in the vicinity of the proposed Champlain Park Way terminus in downtown Burlington. Components considered for the transportation center include:

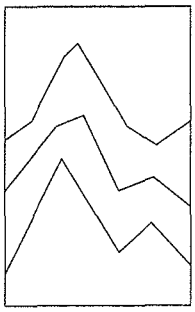
- intercity, interstate, and intracity bus,
- passenger rail station,
- light rail station,
- taxi dispatch terminal,
- ferry transportation,
- bicycle storage facilities,
- travel information
- parking facilities, and
- pedestrian access.

The RFP was issued in May of 1991 and events since that time have led to a slightly different focus for this project. These events include:

- adoption of the Burlington Municipal Development Plan,
- enactment of the Intermodal Surface Transportation Efficiency Act of 1992 (ISTEA), and
- initiation of a larger study focused on planning for the waterfront area including planning for a transportation center.

The City of Burlington's Municipal Development Plan was adopted by the City Council in June 1991. It lays out a vision of transportation in the City.

> This document envisions Burlington in the future as . . . a city where mobility and access are safe, affordable, and efficient. Reliance on the automobile has decreased through the use of public transportation, ridesharing programs, and other alternatives to drive alone. Land use and transportation incentives encourage walking and use of alternatives. Transportation systems management, access control, and other programs allow efficient use of the transportation network. New construction is the least-desired solution for transportation problems.
>
> Walking is safe and easy. Cars yield to pedestrians at unsignalized intersections; signalized intersections have



> pedestrian phases. Traffic on local streets has lessened, as has the acreage used for roads and parking.[1]

When this project began in 1992, discussions with City of Burlington staff indicated that a broader scope was important. The real goals were encouraging alternatives to single occupancy vehicles and working towards the high-quality urban environment envisioned in the Municipal Plan. We were encouraged to go beyond the partial solution of a transportation center toward the at the transportation system.

Intermodal connections are a major theme of the Intermodal Surface Transportation Efficiency Act of 1992 (ISTEA). The Act states:

> The National Intermodal Transportation System shall consist of all forms of transportation in a unified, interconnected manner, including the transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the Nation's preeminent position in international commerce. . .
>
> The National Intermodal Transportation System shall provide improved access to ports and airports, the Nation's link to world commerce.[2]

In this context intermodal transportation includes pedestrian walkways, bicycle transportation, highways, major ports, airports, railways, and bus systems.

In 1993, funding derived from ISTEA was used to begin a larger study with the transportation center concept again being a major focus.

Our project has been conducted within this changing environment, and the focus of the project has changed over time. In the first phase of the project, a considerable amount of data was assembled regarding current and anticipated multi-modal activity in the City of Burlington. These data are summarized in the next two sections, and are being used in the other waterfront/transportation study.

We have focused the second phase of our project on developing recommendations for increasing automobile occupancy rates and transit ridership in downtown Burlington. These recommendations are based on a systems approach to regional transportation which is described in the middle sections of this report. The recommendations are designed to work as a package, and would also greatly enhance the effectiveness other proposals including the transportation center, commuter rail service, and light rail service.

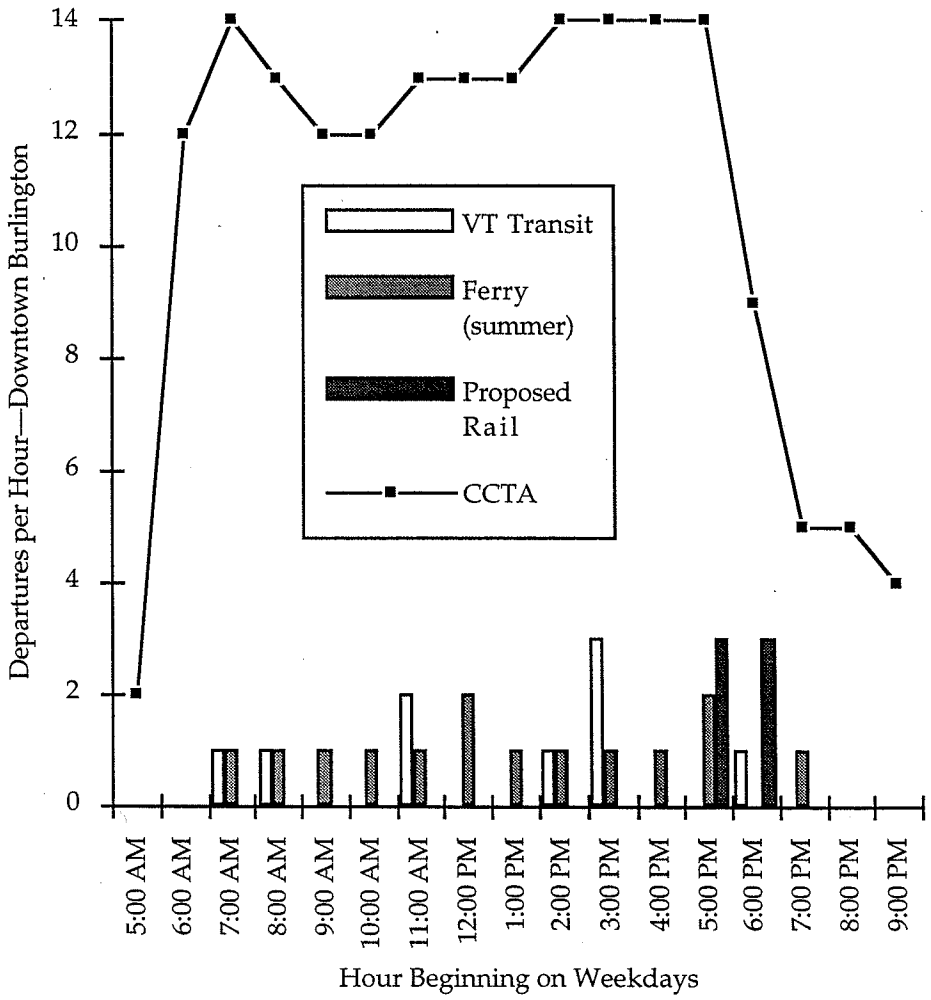
[1]City of Burlington. *Burlington Municipal Development Plan*, p. 7-8. Burlington, VT: 1991.
[2]*Declaration of Policy: Intermodal Surface Transportation Efficiency Act*, Section 2, 1992.

EXISTING SITUATION

TRANSIT

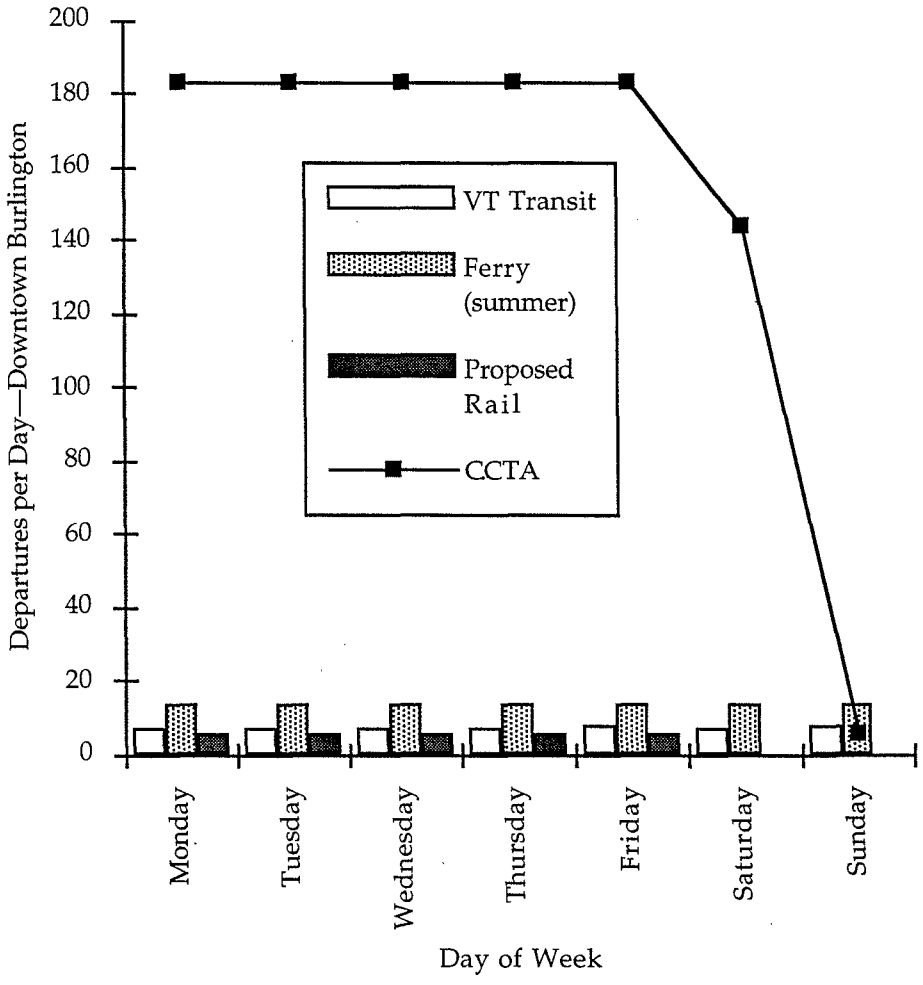
The success of a transportation center would be measured by increases in the use of public transportation, and decreases in automobile traffic in downtown Burlington. The ability to estimate potential increases in public transportation

Figure 1: Downtown Burlington Public Transportation Weekday Departures



use requires a good understanding of current public transportation use and of automobile trip patterns. Public transportation has a small modal share in the City of Burlington at this time. In trying to increase its share, it is important to keep current riders and to build on the factors that now attract riders.

Figure 2: Departures from Downtown Burlington: Day of Week Variation



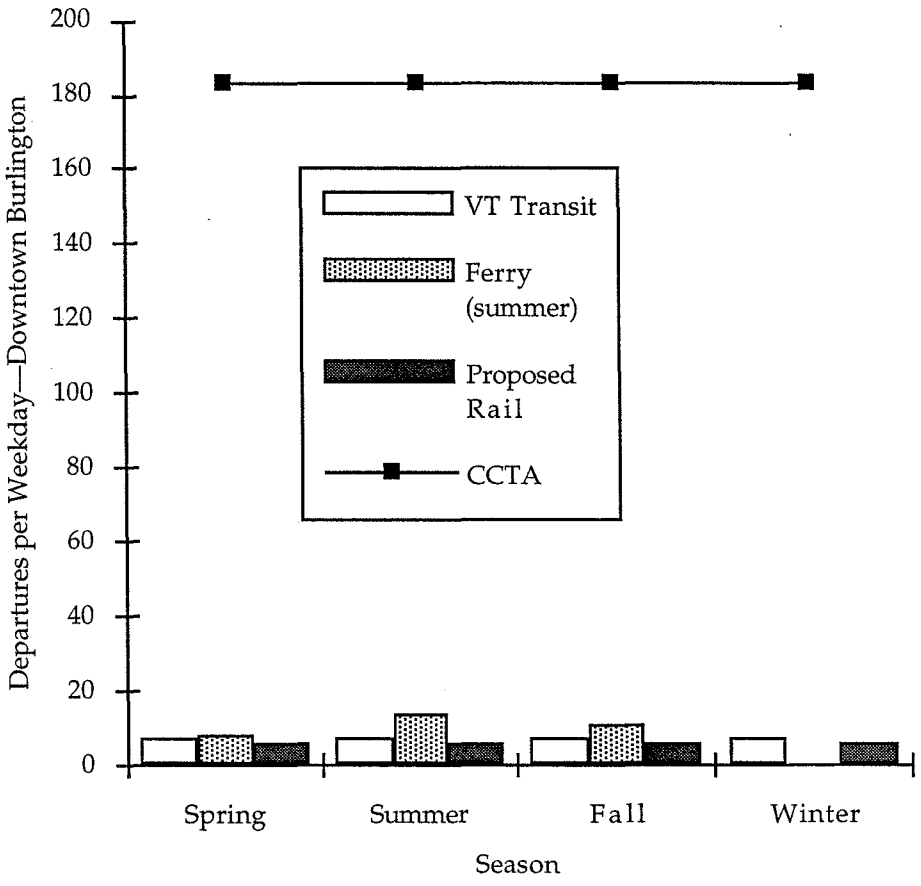
Current public transit providers serving downtown Burlington include:

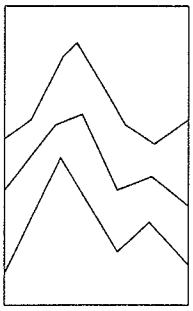
- Chittenden County Transit Authority (CCTA),
- Vermont Transit/Greyhound, and
- Lake Champlain Transportation Company.

Commuter rail from the south (Shelburne and Charlotte), north (St. Albans), and east (Barre and Montpelier) is being studied. Figure 1 shows weekday departures from the Burlington downtown area by time of day, including possible commuter rail service. A study of light rail transit (LRT) from the Union Station area of Burlington towards the airport and/or Essex Junction is in process.

Figure 2 shows the number of departures from the Burlington downtown area per day, and Figure 3 illustrates the seasonal variation in the number of transit departures.

Figure 3: Daily Departures from Downtown Burlington: Seasonal Variation





CCTA

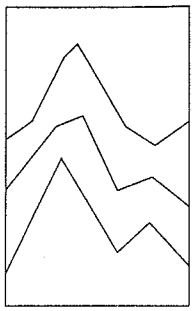
As shown in Figures 1, 2, and 3, CCTA has at least six times as many daily departures as the other modes combined, even with the maximum level of proposed commuter rail service. CCTA runs Monday through Saturday, with a few runs on Sunday serving shoppers. There is no seasonal variation. It serves, and is expected to serve, the great majority of downtown Burlington transit riders. Even if commuter rail were established, many of its riders would necessarily connect on the lakefront to bus service. This service would probably be operated by CCTA. Therefore, any multimodal transportation center in Burlington must emphasize CCTA's intercity bus service.

CCTA is in the process of performing its first comprehensive review of routes and schedules since the bus company was founded in 1973.[1] Findings in the review indicate that in the most recent year where national comparable data were available (1988), "CCTA performed slightly more efficiently and considerably more effectively than the average system in comparably sized urban areas."[2] Specifically CCTA's cost per passenger was $1.57 as compared to the national average for similarly sized urban areas of $1.60; and it served 24 passengers per service hour as compared to 16.3 passengers per service hour for comparable areas nationally.

The Chittenden County Regional Planning Commission (CCRPC) maintains a regional transportation planning model. The route study used this model to evaluate the routes in terms of how they serve the region's important origins and destinations. Burlington's CBD leads in both the origin and destination categories, and CCTA's Cherry Street terminal is the "system's major origin and destination."[3]

Similarly, CCTA "appears to provide effective coverage of the larger transportation analysis zone (TAZ) origins and destinations, running through or adjacent to nearly all zones generating or receiving 200 or more trips."[4] Two areas are noted as under-served, both in South Burlington. These are the Williston Road area between Dorset Street and Hinesburg Road and the industrial area south of Route 2 including Digital Equipment Corporation. Possibly over-served areas relative to their regional trip-making were also noted. These are the Shelburne Village area, which would also be served by the proposed commuter rail service area, and most of the Essex Center route.

1Work has been prepared in three phases by Chittenden County Regional Planning Commission and Pacific Transit Management Corporation under contract to the Vermont Agency of Transportation. Reports for the phases of the CCTA Comprehensive Route Analysis are dated January 1992, May 1992, and June 1992.
[2]CCTA Comprehensive Route Analysis, Phase 1, January 1992, p 3.
[3]CCTA Comprehensive Route Analysis: Phase 1, January 1992, p 27.
[4]CCTA Comprehensive Route Analysis: Phase 1, January 1992, p 27.



CATS

The Campus Area Transportation Systems (CATS) loops from the University of Vermont (UVM) campus into the CBD during evening hours. This service is limited to those with valid UVM student or faculty I.D. Since the service is not available to the general public, it was not included in the analyses.

VERMONT TRANSIT/GREYHOUND

Vermont Transit and Greyhound provide service north to Montreal, south to Rutland, Bennington, and New York City, and southeast to White River Junction and Boston. There are seven departures from downtown Burlington on Monday, Tuesday, Wednesday, Thursday, and Saturday, and eight departures Friday and Sunday. There is no seasonal variation. This service now uses diagonal parking on Main Street which creates some traffic problems, especially during periods of poor winter weather.

LAKE CHAMPLAIN TRANSPORTATION COMPANY

The Lake Champlain Transportation Company operates ferry service from the King Street dock to Port Kent, NY on a seasonal basis. In the summer there are 14 daily departures. In the spring there are 8 departures per day, and in the fall there are 11. There is no service between mid-October and mid-May.

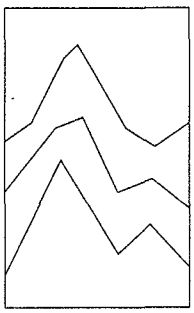
The crossing time is about 1 hour. This ferry route primarily serves recreational travelers. There are a mix between those making a day trip to Burlington, and those completing longer trips taking their cars on the ferry. Observers of the Wednesday, August 25, 1993 12:00 noon ferry arrival (a fine summer day) noted 16 cars and 19 pedestrians exiting (no cyclists). All pedestrians clearly looked like sightseers (shorts, cameras, shopping bags, etc.)

PARKING

A major parking study for the downtown area was performed in 1990.[1] It used information from a 1986 study indicating that two thirds of the Burlington CBD parking demand is long-term employees.

In this study, a parking accumulation survey was conducted. On Wednesday, May 16, 1990, "maximum parking accumulation for the public parking spaces throughout the study area occurred at 1 PM with a total

[1]McDonough & Scully, Inc. *Downtown Employees Parking Study*: Burlington, Vermont. Prepared for City of Burlington, Vermont Public Works Department. Framingham, MA: October, 1990.



occupancy of 3664 out of a possible 5296 spaces, or a maximum occupancy rate of approximately 70 percent."[1]

Utilization varied greatly by locations, with 19 blocks exceeding 90 percent occupancy at some time during the survey.[2] The most heavily used areas included free parking spaces relatively close to the CBD, and metered spaces (particularly 3-hour spaces) in the heart of the CBD where substantial numbers of "meter feeders" were observed. Although large numbers of employees make use of the downtown parking garages at costs of $50-$60 per month, large numbers of spaces remain empty. The Department of Public Works estimates that more than 1,000 downtown employees park in free on-street spaces.[3]

In a recent update of the parking study, the conclusions remain the same. There is currently a surplus of parking, especially in downtown parking garages.[4]

These findings indicate that the City of Burlington is part way through a transition from inexpensive street and surface lot parking towards increased reliance on expensive structured parking. The current parking problems are not an absolute shortage of parking. Rather, they are problems of long-term employee parkers occupying free on-street spaces in residential areas, and "meter feeding" in the CBD making it more difficult for short-term visitors to park.

BICYCLES

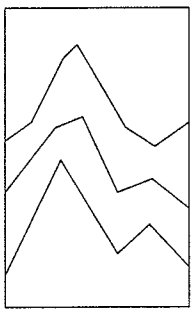
There is a bicycle path near the lakefront from the north end of Burlington to the south end. An interconnected bike path system that would serve the eight communities in the Burlington area is in the planning stages. Therefore, bicyclists would have some access to any facilities at a waterfront-area transportation center.

FUTURE SITUATION

FUTURE LAND USE

The lakefront area is under consideration for development of a transportation center for several reasons. These include: location of the ferry

[1]McDonough and Scully, Inc., 1990, p 8.
[2]McDonough and Scully, Inc., 1990, Table 2, p 10.
[3]City of Burlington 1991, p 70.
[4]Resource Systems Group, *Downtown Parking Study*, Prepared for Chittenden County Regional Planning Commission and the City of Burlington, September 1993



dock, potential commuter and light rail stations, the proposed construction of the Champlain Park Way, and expected development in the waterfront area.

The Burlington Municipal Plan (1991) calls for careful development in the waterfront area.

> Any development on the waterfront will require a major investment in public infrastructure and will strongly affect the downtown and surrounding neighborhoods, so the city needs to assess these costs and benefits carefully as it proceeds. (p 19)
>
> The waterfront must have strong pedestrian connections to the neighborhoods and the central business district, but it must not become the site of a major through street. To keep it active, the waterfront must contain different uses, including housing as part of mixed use structures. (p 20)
>
> The City of Burlington will . . . develop a master plan and economic incentives for the integration of the downtown waterfront with the central business district (CBD) . . . (p 22)
>
> Additional development such as that on the waterfront may require some additional parking. (p 72)

Transportation has been seen by all parties as a key question in the waterfront development. For example, CCTA in 1989 developed a plan for an "auto-free, pedestrian-oriented waterfront" with "intra-park transit service" and "loop transit service between the waterfront and the CBD."[1]

TRANSIT

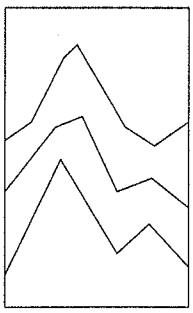
CCTA

Recommendations now under consideration by CCTA are designed to maintain the strengths of the current system, to standardize headways on some routes, and to shift some service towards the under-served areas. All bus routes would serve the Cherry Street terminal. Almost all routes would operate on 30-minute headways. Service between Cherry Street and University Mall, and between Cherry Street and Champlain Mill would be provided every 15 minutes.[2]

CCTA's Cherry Street hub provides good pedestrian access to a very large number of origins and destinations. It also serves as an attractive transfer location for passengers, because of its proximity to shopping and services. A proposal under consideration is a liberalized transfer policy that would encourage ridership by making it easier to make stopovers to conduct errands.[3]

---

[1]Chittenden County Transportation Authority. *Waterfront Park.*, p 17. Burlington, VT: February, 1989.
[2]CCTA Comprehensive Route Analysis: Phase 3, June 1992, p 1.
[3]CCTA Comprehensive Route Analysis, Phase 2, May 1992, p 17.



For these reasons the Cherry Street hub (or another location in the core of the CBD) serves CCTA better than any waterfront location could.

VERMONT TRANSIT/GREYHOUND

Intercity bus service has been in gradual decline in the region and throughout the United States for many years. The industry has responded by eliminating services that lose money and by minimizing investment. Very high gasoline prices might cause an increase in ridership, but otherwise, no significant change in these trends are anticipated. Therefore, intercity bus will, at best, be a secondary player in development of a transportation center.

No data are available on current transfers between transit modes. However, the nature of the separate services suggests that most current transfers are between the CCTA intracity buses and the Vermont Transit/Greyhound intercity buses. Therefore it is desirable that the hub areas, if separate as they now are, are as close together as possible.

Discussions with Vermont Transit's General Manager indicate that they would be interested in relocating to a transportation center in the waterfront area "if the price were right." Pluses from their perspective include: eliminating the current traffic problems on Main Street, proximity to the end of the Champlain Park Way, and more intermodal trips.

LAKE CHAMPLAIN TRANSPORTATION COMPANY

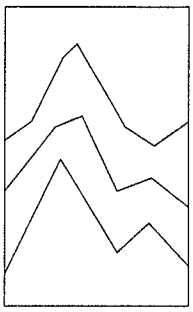
No significant changes are anticipated in this service. The nature of the ferry service indicates that there are probably few ferry customers transferring to and from the other modes.

TAXI SERVICES

There are several private taxi companies operating in Burlington, including some older companies and some newer ones. This is a market-responsive business where service will be provided if there is a demand. In planning a transportation center, space for taxis should be considered.

COMMUTER RAIL

Commuter rail service to Burlington and Essex Junction is currently being studied as part of a state-funded project. There are four proposed services under consideration, all of which include stops at or near Union Station. The four proposed services originate as A.M. commuter trains in the following places: St. Albans; Barre/Montpelier; ; and Charlotte (possible Rutland). Two P.M. peak hour trains would return commuters within each corridor.



A preliminary analysis of ridership and capital costs for the four proposed commuter rail services concluded that the Charlotte-Shelburne-South Burlington-Burlington peak hour commuter service was the most feasible of the four proposals.[1] The attractiveness of this proposal is increased through the fact of planned improvements to Shelburne Road scheduled to take place in 1996. An implemented commuter rail service during reconstruction of Shelburne Road will attract more ridership due to the anticipated travel delays caused by construction.

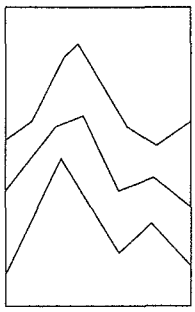
Approximately 300 daily one-way peak hour trips are anticipated for the Charlotte-to-Burlington service in 1996, which is around 6% of the total peak hour travel market using this corridor. A key factor to the success of commuter rail is the ability of commuters to walk from the egress station, in this case Union Station, to their workplace. A one-half mile walk, or the distance one can comfortably traverse in about 10 minutes, defines this area of "walk access". Of the total number of workplace commuters traveling the Shelburne Road corridor and working within a 10 minute walk of Union Station, approximately 15% are likely candidates for riding the commuter train, a mode share significantly higher than the 6% share for the total commuting market. This underscores the importance of pedestrian access--to residences, to shopping, to employment--in creating a favorable environment for transit. One of the big problems for commuter rail in Burlington, then, is the small number of employers within a 10 minute walk of Union Station.

Without an efficient and timely transit connection, potential ridership on the Shelburne Road commuter rail service would be significantly less. Large employers, such as the University of Vermont, may implement a direct shuttle service from the commuter rail station. For those rail passengers whose destination is beyond a 10 minute walk, and for whom no direct shuttle service is provided, CCTA is the ideal option for getting to their ultimate destinations. Most of CCTA's routes already pass through the intersection of Main Street and Battery Street.

LIGHT RAIL TRANSIT

Feasibility of light rail transit (LRT) within the municipalities of Burlington, South Burlington, and Essex is currently being studied on behalf of the Chittenden County Metropolitan Planning Organization. LRT uses electric cars that can share utility corridors or railroad rights-of-way, or even operate along highway medians. LRT can provide access to park-and-ride lots and other transit services. Since power typically comes from an overhead source,

[1]Vermont Agency of Transportation. *Vermont Rail Feasibility Study, Draft Final Report.* January, 1993.



passengers can approach LRTs from all directions, even across tracks. Also, stations can consist of very simple ground-level platforms.

Three general alternative corridors are under consideration, all of which terminate or pass through the vicinity of Union Station:

1) Union Station to the Airport through the CBD;

2) Union Station to Essex Junction through Winooski;

3) Union Station south through South Burlington to the Airport.

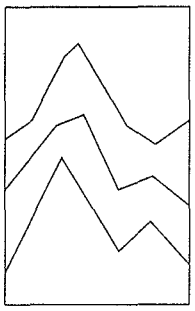
The establishment of LRT within these general corridors presents many challenges, not the least of which is locating a right-of-way. It also presents some important opportunities that distinguish it from commuter rail. For example, LRT is often cited as having beneficial economic development impacts when growth center zoning is implemented coincident with the establishment of the LRT. Also, LRTs typically will run throughout the day where commuter rail focuses on morning and evening peak commuting hours. For this reason, LRT tends to attract a greater percentage of riders who have destinations other than work--travelers going shopping, to entertainment, to school, etc. Further, LRT does present some commuting possibilities if park-and-ride facilities are designed into the system. Thus, the overall potential of LRT capturing a greater share of the existing vehicular travel market can be significantly greater than that of commuter rail.

As with commuter rail, the lifeblood of LRT ridership lies in pedestrian access. To the extent that people can access the LRT--from their homes, workplaces, and from other destinations such as shopping and daycare--ridership on the LRT will be strong. Thus, LRT works well within densely developed mixed use corridors.

PARKING

The 1990 parking study recommended a residential parking permit program that, combined with increase enforcement efforts in the downtown, would shift about 390 employees to different spaces. The report concluded that this demand could be accommodated largely through use of excess spaces in the St. Paul's Place and the Center Garages. Further, a number of intermediate-term options are given for providing surface parking in the CBD area.[1] A recent update of the 1990 parking study suggested that shifting some long-term parking spaces to shorter-term use could provide a better level of service for customers of downtown businesses.[2]

[1]McDonough and Scully, Inc., 1990, p.41.
[2]Resource Systems Group, September 1993.



If all developers are required to add new parking at the levels currently demanded, the parking situation will remain more or less the same as it is now. There will continue to be scarcity in some areas at some times, but not an overall scarcity. There will continue to be free or low cost parking available for those willing to walk a little farther.

Some consideration appears to be given to modifying parking requirements. The Burlington Municipal Plan (1991) states:

> . . . the city should modify its parking ordinance to balance the number of new parking spaces created with other traffic-decreasing options. Instead of building more parking, developers need to decrease the need for parking. Existing parking should be used efficiently; for example, facilities that need parking in the evening or at other off-peak times should be able to use lots provided for daytime use. The city should also explore the feasibility of park-and-ride lots at interstate exits and along major streets. (p. 72)

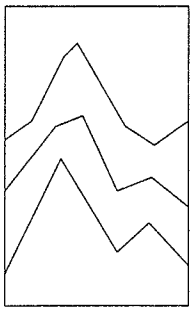
MULTI-MODAL TRANSPORTATION CENTER

A computerized search of the Transportation Research Board's TRIS database found no entries for multimodal or intermodal transit facilities for small urban areas. This is somewhat surprising, but not totally. Most small urban areas have at most one strong transit mode.

In northern New England, transportation centers can be found, depending on how "transportation center" is defined. For example, Manchester, New Hampshire and White River Junction, Vermont have intercity bus stations that are on the routes of local, intracity buses. The City of Rutland and Marble Valley Regional Transit District is planning to construct a transportation center comprised of a intracity bus station and a parking garage.

We had originally planned to develop an trip table of existing multimodal trips. This proved to be impossible. The current transit share is very small. Excluding CCTA's intracity bus service, transit's share is minuscule. There are no data on multimodal trips, and the current number of such trips is so small as to make them virtually undetectable.

Intracity bus will be the dominant public transit mode in Burlington for the foreseeable future, both in terms of ridership and in level of service. The hub for this intracity bus service should be as close as possible to the center of the Burlington CBD. CCTA's Cherry Street hub may serve this purpose better than any lakefront location would. If commuter rail service is implemented and is highly successful, or if the waterfront is developed extensively, there will be a need for good bus service to the waterfront area. This service could be provided through expanded service along CCTA's current routes, given that most routes already serve Battery Street.



SYSTEMS APPROACH TO ENCOURAGING MULTIMODAL TRAVEL

In 1989, a random group of Chittenden County residents recorded all trips made during a 24-hour period.[1] These data provide the best available picture of travel demand in the region. About 95 percent of all trips were made in private automobiles. Over 90 percent of the auto trips were made by a driver with no riders, and it is believed that most ridesharing is among family members and friends traveling together rather than true "carpooling." Of the 5 percent non-auto trips, most are walk trips, totaling about 4 percent of all trips. Intracity bus, intercity bus, ferry, taxi, and bicycle together totaled less than 1 percent of all surveyed trips. These survey data are consistent with the data concerning the transit providers presented above.

Increasing the shares for non-auto modes, or even increasing auto occupancy rates, requires encouraging automobile users to change their behavior. Most efforts throughout the United States to convert automobile users to other modes have met with limited success. The current transportation system combines to make automobile travel most attractive for most travel. No single effort initiative will cause significant changes in behavior. Significant changes could result from systemic changes.

TRAVEL DEMAND TRENDS

Person miles of travel in the United States grew 19 percent between 1983 and 1990. This increase "has been the product of three factors in roughly equal proportion: population growth; increases in per capita tripmaking; and increases in average trip length."[2] Of these three, the population increase was the least important. With no increase in population, the other two factors would still have increased person miles of travel by 14-15 percent.

TRIP GENERATION

In general, tripmaking increases with household size, the number of workers in a household, and auto availability. Although larger households make more trips than smaller households, the increase is less than proportional. If a large household were to split into two households, the total number of person trips generally would increase. Therefore, the drop in

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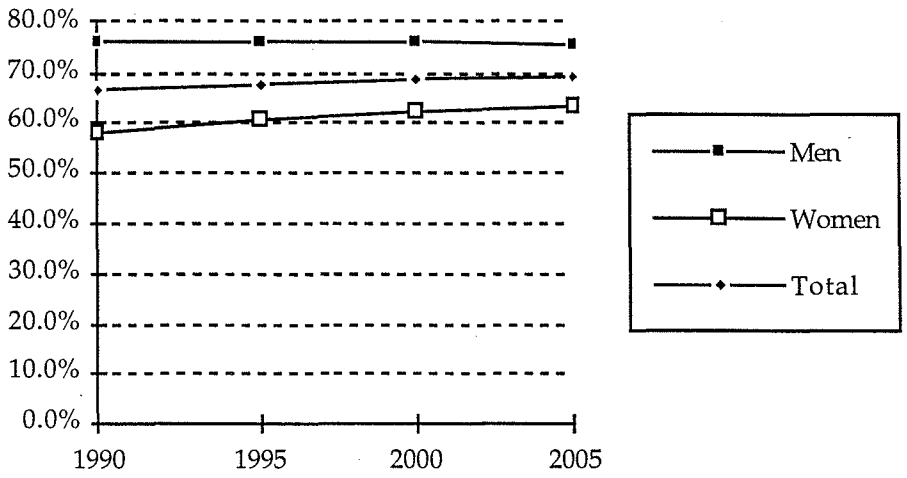
[1] *Development of the Chittenden County Regional Travel Demand Model.* Prepared for Chittenden County Regional Planning Commission by Resource Systems Group, August, 1989.

[2] Pisarski, Alan E. *Travel Behavior Issues in the 90's: Based on Data From the 1990 Nationwide Personal Transportation Survey (NPTS) and the 1985 and 1989 American Housing Surveys (AHS).* Washington, DC: Federal Highway Administration, July 1992.

household size has been a major determinant of increased trip making. Similarly, increases over the past two decades in work force participation and in auto availability have contributed substantially to increases in trip making.

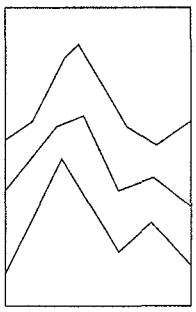
It appears that these demographic trends will be less important in coming years. Every two years, the Bureau of Labor Statistics of the U.S. Department of Commerce publishes a 15-year employment projection based on explicit assumptions of household formation and labor force participation. The most recent issue entitled "Outlook 1990 - 2005," was published in May, 1992.

Figure 4: Bureau of Labor Statistics Projections of Labor Force Participation Rate — Moderate Growth Case



Nationally, the Bureau of Labor Statistics moderate growth projection includes a continued increase in labor force participation, but at a much slower rate than in the period 1975 - 1990. There are two major reasons for the slower increase. First, the rate of increase in women working is expected to begin to level off. Second, the adult population is aging with an increase expected in retired persons. The resulting rates of labor force participation for men, women, and total population aged 16 and over are shown in Figure 4.

Average household size has dropped significantly over the past twenty years. The Bureau of Labor Statistics projections assume that this trend has run its course. They project a further reduction in household size of only 0.6 percent.



Similarly, automobile availability is reaching saturation levels in many rural, suburban, and small urban areas. Nationally, there are now more registered automobiles and light trucks than there are licensed drivers.[1]

In much transportation planning, there is an emphasis on work trips because they are concentrated in peak travel periods, and may be easier targets for transportation demand management programs. However, simple home-to-work and work-to-home trips comprise a declining portion of all trips. In a 1989 survey in Chittenden County, they represented only 25 percent of all trips. The largest number of trips, 41 percent, were home-based-nonwork trips. The remaining 34 percent of trips were nonhome-based.

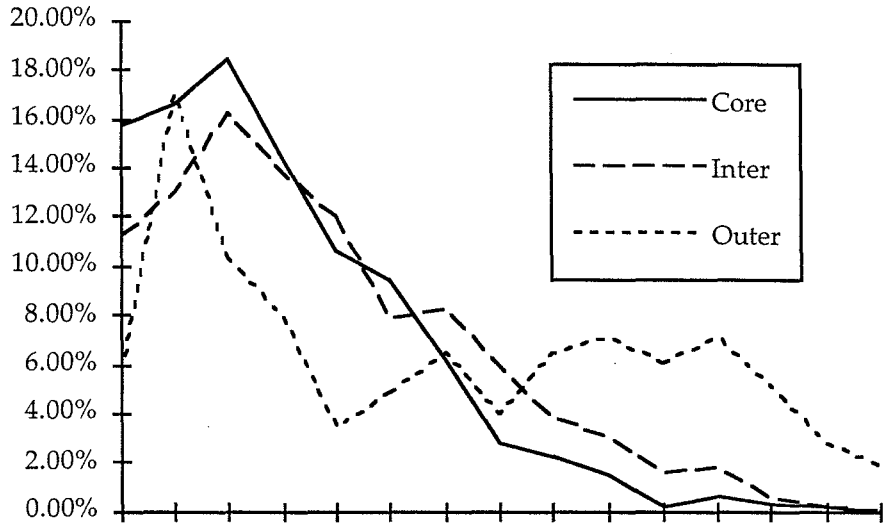
TRIP LENGTH/TRIP DISTRIBUTION

The shift of population to the suburbs has been a major cause of increasing trip lengths. Average trip lengths, especially for work trips, are greatest in the largest metropolitan areas.[2] In a large metropolitan area, the attractiveness of shorter destinations is counteracted strongly by the large number of possible travel attractions at long distances. Los Angeles represents the extreme example of this situation, where a common saying is that "Everything is an hour away."

Land use in Chittenden County is not so disbursed as in Los Angeles, but much of recent population and job growth has been located in peripheral areas. In the 1989 travel demand survey, the number of respondents reporting making an afternoon peak hour work-to-home trip from Burlington and Winooski to the rest of Chittenden County was not much greater than the number reporting a reverse commute, from the rest of the county to Burlington and Winooski. Travel occurs in all directions, independently of the concepts of city centers or major arterials.

Trip length distributions are shorter when more alternative destinations are close at hand, and longer when more alternatives are distant. This effect can be illustrated using results from the 1989 Travel Demand Survey conducted in Chittenden County. Figure 16 below shows the observed trip length distributions for three sets of municipalities: "Core" (Burlington, Winooski), "Inner" (South Burlington, Williston, Colchester, Shelburne), and "Outer" (all other towns).

[1]Hu, Patricia and Jennifer Young. *Summary of Travel Trends: 1990 Nationwide Personal Transportation Survey*, Table 1, p 6. Washington, DC: Federal Highway Administration, March 1992.
[2]Pisarski, 1992.



Trip Length (2 minute intervals)

MODE CHOICE

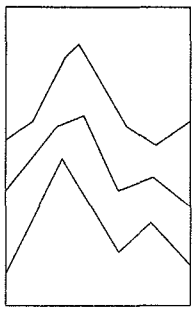
Nationally, transit served 2.0 percent of all person trips in 1990, a decline from 2.4 percent in 1977.[1] While the share has declined, the number of transit riders has actually increased during the period. However, the increase in transit ridership has been much smaller than the increase in trip making.

Carpooling and walking have dropped off to a greater extent that transit. For example, carpooling and walking to work both decreased by about 10 percent between the short period 1985 to 1989.

These changes appear to be primarily a result of the great increase in automobile mobility. Auto availability has reached saturation levels in many areas. The saturation of automobiles has supported suburban growth areas that can only be reached by automobiles. Large investments have been made in transit, but service levels have not increased as much as automobile service levels. The loss of pedestrian trips is probably due more to increases in the automobile level of service than a decrease in pedestrian level of service. However, pedestrian service levels are poor in many areas, especially in suburban growth areas.

The current mode share for bus in Chittenden County is less than 1 percent, and many current riders are "captives," those without access to automobiles. The current low share results primarily from the high level of service

[1]Pisarski, 1992.



available to automobile users. Despite concerns about congestion, the majority of current trips take less than 15 minutes by car. Travel by car is cheap with little perceived costs for most trips more than the cost of gasoline. Cars can go anywhere in the county. By comparison, the bus service, although fairly good but a region of its size, is slow, inconvenient, often not available for a desired trip, and requires out-of-pocket payment.

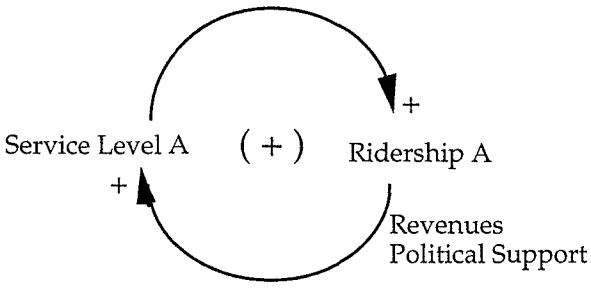
A recent survey of Campus Area Transportation Management Association employees provides confirmation. Survey findings were:

- Most people have between a 10-15 minute commute.
- Most people spend less than $1.50 per trip, with a large amount of people spending between .0-.50/trip.
- Most people live in a 2-person household, and have available 2 vehicles.
- Most people consider their travel route for their commute to NOT be congested.[1]

FEEDBACK FORCES FOR AND AGAINST MULTIMODAL TRAVEL

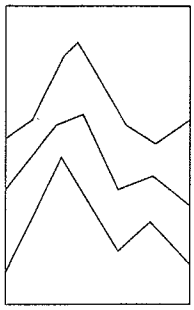
Long-term trends in the transportation system are a result of structural forces. These structural forces feed back and reinforce themselves. A shift towards a reliance on automotive transportation tends to cause pressures for even a larger role for automobiles. In this section, we present several of the most important feedback processes that have generated the increased mode share for single-occupant automobiles.

Figure 5: Reinforcing Spiral



Key: a "+" on an arrow implies a causal increase in the same direction (e.g., an increase in A results in an increase in B), a "-" on an arrow implies a causal relationship in the opposite direction, a "+" inside a feedback loop implies a reinforcing cycle, a "-" inside a loop is a indicates resistance to change.

[1]Survey Says... in *Transportation Letter*, 1:1, August 1993 published by Campus Area Transportation Management Association (CATMA) and Downtown Bound.



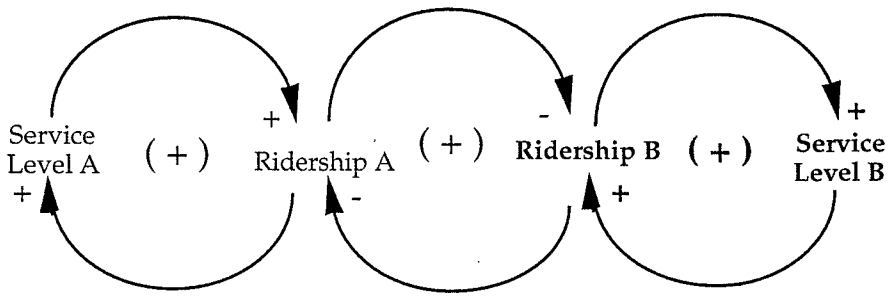
These feedback processes are presented as "causal loop diagrams." In Figure 5, a generic structure is shown where an increase in the service level for a particular mode leads to increased use of the mode. The increased use of the mode leads to increased revenues and/or political support for improvements, as well as requirements for further capacity improvements. This in turn, causes an increase in the service level, reinforcing the original service level increase.

Automobile travel has received enormous investments over the past several decades. These investments include public funding and maintenance of highways, but also all of the investments private citizens make in their automobiles. The increased service level for automobile travel has led to increased use of private automobiles. This has led to increased revenues (gasoline taxes and tolls) and increased political support for further investments in highway infrastructure. The resulting positive feedback loop is an example of what is often called a "vicious cycle."

These cycles can operate in both directions. For public bus, a decrease in service level would lead to a decrease in ridership, leading to a decrease in revenues and political support, leading to a further decrease in service level.

When two modes are competing, gains by one more will generally lead to losses by the other as shown in Figure 6. There will be some induced demand due to the increased service level, but total travel demand is relatively inelastic. Therefore, one mode must take from another.

Figure 6: Competition Between Modes



Some of the urban areas that are working most strongly towards reducing automobile travel are placing renewed emphasis on the auto ownership decision. Automobile travel is very expensive, but much of the expense is incurred through ownership. These expenses include depreciation, insurance, taxes, registration fees, and in some cases, parking/garaging costs. By comparison, the perceived cost of using an automobile is quite small. Cities such as Portland Oregon are working to encourage citizens to forego auto ownership.

Figure 7 below illustrates one of the important structural relationships underlying decisions as to whether to own autos (or a second or third auto). If

the transit service level is better, there will be less perceived need to own an auto, and transit ridership will increase, supporting a higher transit service level.

All modes are interdependent. Figure 8 shows an example of a mutually reinforcing relationship between transit and pedestrian modes. Transit can not provide the type of door-to-door service that we associate with private automobiles. Therefore an increase in transit usage implies an increase in pedestrian activity. An increase in pedestrian activity will lead to increased support of pedestrian facilities, which in turn makes the transit system more accessible.

Figure 7: Auto Ownership Dynamics

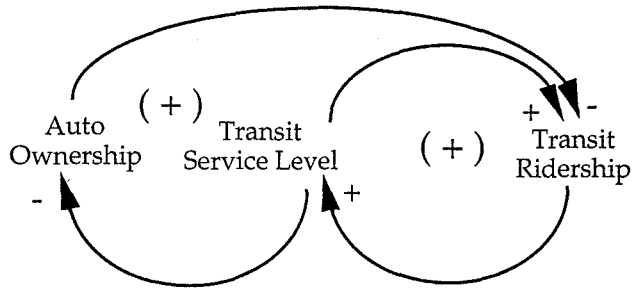
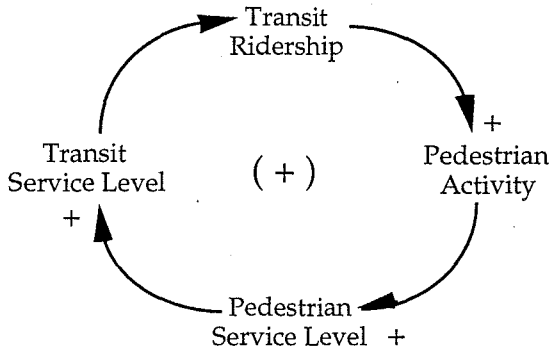


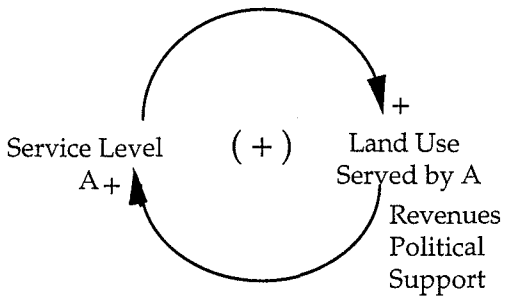
Figure 8: Regional Feedback Effects



The bicycle mode is also mutually supportive of the transit and pedestrian modes because it helps to provide an alternative to auto ownership.

In the long-term, land use effects are very important. The prominence of the automobile mode has led to locational choices over the past several decades that are generally independent of any concern for accessibility by non-auto modes. These locational decisions have made automobile travel more and more essential. This feedback structure is shown in Figure 9.

Figure 9: Regional Feedback Effects



Any of the feedback structures can operate in both directions. The land use structure can be reversed by locating land uses in areas that are particularly accessible to transit. These new land uses would make transit a more significant mode, and would encourage transit use, increases in transit use, and an increased importance of transit in locational choice for new land uses.

RECOMMENDATIONS

POSSIBLE COMPONENTS OF A SUCCESSFUL STRATEGY

The previous section described a set of reinforcing feedback processes that have caused the current reliance on single-occupant private automobiles. It also described the underlying causes of travel demand. There are strong forces present that cause automobile domination. No single intervention in the system will cause a significant reduction in single occupancy vehicles. A successful strategy must influence several parts of the system simultaneously. An ideal policy would:

1) improve the service levels for transit, pedestrian, and bicycle modes,
2) decrease the service level for single-occupant vehicles,
3) encourage ridesharing
4) make car ownership less attractive,
5) encourage land development in areas served by transit, and
6) encourage mixed land use.

Some possible elements of a systemic policy are presented in Table 1.

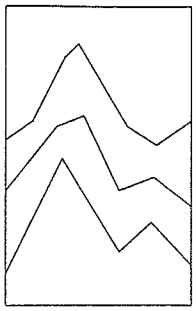
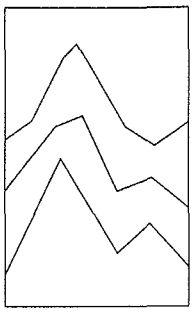


Table 1: A Systems Approach to Reducing Single-Occupancy Vehicles

Improve transit Service Level	expand routes increase frequency lower fares new modes (e.g. light rail) improve multimodal connections (e.g. multimodal center) locate transfer points at activity centers integrate transit system with pedestrian system provide bus shelters eliminate unnecessary transfers
Improve pedestrian service level	use neo-traditional design to shorten crossings, to protect pedestrians behind parked cars, and to quiet streets use traffic calming to quiet streets add trees and other landscaping install islands in major arterials provide adequate lighting
Improve bicycle service level	build bike paths require shower facilities provide bicycle storage facilities avoid one-way streets and free-flow junctions
Decrease auto service level	increase parking costs charge tolls increase gasoline taxes limit parking, especially for single-occupant vehicles resist highway improvements
Encourage ridesharing	develop system of satellite lots provide matching services
Encourage land development that is transit-friendly	increase allowed densities in transit centers or even require high densities in these areas mix residential, service, and service uses allow and encourage compatible service uses in both residential and employment areas build new buildings near to the street/transit



RECOMMENDED THEMES

Systemic solutions to complex problems are also complex. They have too many components to be easily embraced in a political environment. In interviewing public officials about the goals of this project, we were asked to synthesize a some of the many recommendations that have been made into the city into a coherent plan. To this end, we have summarized the most important elements listed in Table 1 into four recommended themes:

1) Transportation Management Association (TMA),
2) pedestrian design focus,
3) intensify land use without proportional increases parking and highway capacity, and
4) enhance attractiveness of area.

TRANSPORTATION MANAGEMENT ASSOCIATION

Transportation Management Associations are a very useful tool in facilitating the types of public-private partnerships required to implement transportation demand management (TDM) measures. They are a relatively new concept. One survey found a total of 72 TMAs in the U.S., but over half of these were still organizing, and only 12 were fully operational. However, those with a track record do show reduced single-auto travel among TMA members' employees compared to non-member employees.[1]

Most of the oldest TMAs are in California. One of the oldest and most successful TMAs in the eastern U.S. is the Greater Princeton Transportation Management Association. Founded in 1984, it has grown to a membership of 27 of the area's largest businesses, developers, and employers. Projects of this TMA include shuttle bus services, a ridesharing program, a flextime program, and the development of transportation management plans for new developments.[2]

The purpose of a TMA is to provide a mechanism for working toward demand reduction, particularly during peak travel periods. Specific purposes include:

1. To act as a forum for the private and public sectors on transportation issues . . .
2. To sponsor studies or plans designed to identify congestion reduction measures . . .

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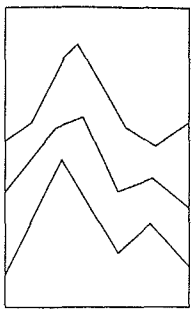
[1]Dunphy, Robert T. and Ben C. Lin. *Transportation Management Through Partnerships*. The Urban Land Institute, Washington, DC 1990, p. 44.
[2]Middlesex Somerset Mercer Regional Council. *Suburban Mobility and Growth Management Initiatives in Central New Jersey: A Report to the Urban Land Institute*. Princeton, NJ, April 4, 1989.



3. To directly provide, organize or promote services . . . and to provide financial support for these activities.
4. To educate and inform citizens and lawmakers . . .[1]

Downtown Bound is the new TMA for the Burlington downtown. It is already achieving several of the purposes described above. It provides a forum for the private and public sectors concerning transportation issues. It manages a rideshare program. It educates the public.

Two other Transportation Management Associations (TMAs) are operating in Chittenden County — the Campus Area TMA (CATMA) which works closely with Downtown Bound, and the Shelburne Road TMA.

It is recommended that Downtown Bound be supported in evolving into a stronger organization that could take a leadership role in implementing the other recommended themes. Under the auspices of the TMA, the public and private sectors should work together to develop pedestrian design objectives and strategies. They should work together to develop transportation strategies that encourage development while minimizing the need for increased parking and roadway capacity. They should work together to increase the attractiveness of the downtown to businesses and customers.

PEDESTRIAN DESIGN FOCUS

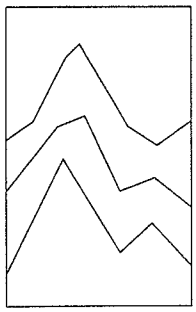
Private automobiles can provide door-to-door service; public transportation generally does not. Therefore, public transportation travel is inherently multimodal and the fundamental mode is walking. Generally, a public transportation trip includes a walk trip on both ends, and the perceived quality of service of public transportation will be strongly affected by the perceived quality of the pedestrian environment.

Shifting travel from automobiles to public transit will require shifting the design emphasis from automobile level of service to pedestrian level of service. Much can be done to improve pedestrian access on the City's streets. Burlington's Municipal Development Plan shows a conceptual diagram with refuge islands on Battery Street that would make the are much more friendly to pedestrians (p 71). Similar designs could be implemented throughout the downtown area, as roadways are repaired and as private development occurs.

The Burlington Municipal Development Plan includes several passages emphasizing the importance of linking the waterfront to the downtown.

> Pedestrian access should be improved . . . An east/west pathway could extend Lawson Lane down to the waterfront and up to Center Street. (p 20-21)

[1]Leiner, Craig T, Chittenden County Regional Planning Commission. Memorandum to South Burlington Planning Commission concerning Transportation Management Organization (TMO) proposal for the L&M Park, dated December 28, 1989. (Included as Appendix 1 of this report).



> Improved pedestrian access across Battery Street can enhance linkages between the downtown waterfront and the central business district. (p 71)

Various transportation connections have been proposed ranging from aerial tramways and underground people movers. Except for buses, all of these mechanical options appear to be prohibitively expensive.

The most fundamental form of transportation is walking. In large urban areas, millions of trips are completed daily with lengths similar to those between the waterfront and the Burlington CBD. Special barriers to walking in this area include:

- poor pedestrian design,
- change in elevation, and
- poor weather.

The change in elevation and poor weather conditions, especially in the winter, can not be fully addressed outside. An alternative approach is to develop an internal pedestrian corridor for an least part of the distance.

This pedestrian "bridge" would be enhanced by inclusion of some of the transportation center elements. Parking that was accessible to both the CBD and the waterfront would create higher pedestrian volumes and help to connect the two areas. A Vermont Transit/Greyhound station could bring people into the facility and help to support a restaurant. A CCTA stop, perhaps at the Battery Street end, would help increase accessibility. An information center also could be a valuable component.

INTENSIFY LAND USE WITHOUT PROPORTIONAL INCREASES PARKING AND HIGHWAY CAPACITY

There is a national trend towards a comprehensive approach to transportation, where efforts to increase transportation capacity are coupled with efforts to reduce travel demand, particularly during peak periods. Transportation demand management (TDM) tools used include growth management, road pricing, auto restricted zones, parking management, site design to minimize traffic, negotiated demand management agreements, ride-sharing, alternative work hours, and trip reduction ordinances.[1] These efforts are receiving increasing attention in both the transportation and planning communities.[2,3]

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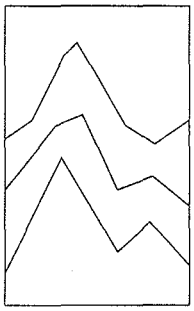
[1]Institute of Transportation Engineers (ITE). *A Toolbox for Alleviating Traffic Congestion.* Washington, DC, 1989.

[2]Orski, C. Kenneth, Can Management of Transportation Demand Help Solve Our Growing Traffic Congestion and Air Pollution Problems? *Transportation Quarterly*, **44**:4 October 1990, p 483-498.

[3]Ferguson, Erik. Transportation Demand Management: Planning, Development and Implementation, *APA Journal* (American Planning Association), Autumn 1990, p 442-456.



A recent review of national experience with travel demand management found that area-wide programs have achieved reductions approximating 20%, and that individual employer programs have achieved reductions in excess of 40%. The most successful programs all include parking restrictions, high prices on parking, or both.[1]

In Burlington, the Campus Area Transportation Management Association (CATMA), has pushed these ideas the furthest. The five member institutions are jointly controlling parking and providing shuttle services.[2] Both the control of parking and the comprehensive planning are essential parts of the programs success.

Two annotated bibliographies have recently been published on the relationships between land use and travel demand.[3] [4]One of these, prepared at the University of Washington for the Washington State Transportation Commission and the U.S. Department of Transportation, is so useful that we have included it as Appendix 1 to this report.

The City of Burlington's planning now calls for both construction of additional parking close to the CBD and reducing automobile trips into the CBD and land used parking . These goals are mutually exclusive. With current parking availability and cost, it will be impossible to get many to shift to satellite lots even if parking and shuttle were both free of charge.

> Previous attempts by the City to institute a park-and-ride program have not been successful, and a plan to introduce free city ridership on the regional bus system was voted down by a large majority during recent elections. To further complicate the matter, future upgrades in the on-street parking enforcement are expected to adversely affect downtown employees currently abusing the short term parking meters.[5]

Increasing automobile occupancies and transit ridership in the downtown will be a gradual, long-term process. It is recommended that the guiding theme be that the total number of parking spaces in the downtown be held constant, and that parking pricing be gradually increased towards the real, marginal costs of providing structured parking. This cost is generally at least $100 per month per space. If parking growth is avoided, increases in roadway capacity

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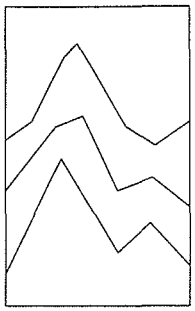
[1]COMSIS , 1990, p 28.
[2]Campus Area Transportation Management Association. *A Joint Institution Parking Plan*, March 1, 1992.
[3]Handy, Susan. *How Land Use Patterns Affect Ravel Patterns: A Bibliography*, CPL Bibliography 279. Chicago IL: Council of Planning Librarians, 1992.
[4]Pivo, Gary, Anne V. Moudon, and Franz E. Loewenherz. *A Summary of Guidelines for Coordinated Urban Design, Transportation and Land Use Planning with an Emphasis on Encouraging Alternatives to Driving Alone*. Seattle, WA: Washington State Transportation Center (TRAC), August 1992.
[5]McDonough and Scully, Inc., 1990, p 3.



will generally be unnecessary, and the urban form of the City of Burlington will be protected.

MARKET ATTRIBUTES OR AREA

One of the possible transportation center elements is a travel information center. The Lake Champlain Regional Chamber of Commerce now operates an information center on Battery Street.

If the waterfront was developed in such a way that it became a significant year round visitors' attraction, this area could be an excellent location for an expanded information center. The center would need short-term parking to accommodate those passing through including arrivals on the ferry and from the Champlain Park Way. The area would need intermediate term parking for those who wished to stay and enjoy the waterfront, dine, or shop.

This parking area could be designed to accommodate tour buses, for which there are few parking options in the CBD. It is impossible to determine the exact number of tour buses visiting Burlington. The Chamber of Commerce referred us to Bob Hopwood of Premier Coach, one of the providers. He estimated that 90% of the buses were in the April- mid-October period, with 60% in a one-month foliage season. At the peak, he believes that there are 12-15 buses spending the night in Burlington, with others visiting during the day.

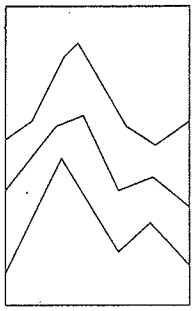
Although the information center/parking facility may be an attractive long-term scenario, planning for it now seems premature. The visitors would be primarily attracted by the other development, not by the information center. Given the current land use in the area, it would likely get few customers. Free parking, combined with free, frequent shuttle service to the downtown would make the parking somewhat attractive to visitors, but it would still have trouble competing with metered spaces in the CBD.

It is probably more important to focus on strengthening the attraction of Burlington, both to employers and to retail customers. The attraction of the downtown area is its urban form. This urban form includes a pedestrian-friendly environment, a wide range of services and cultural opportunities within a compact area, and public spaces and entertainment events. These attractive features of the Burlington downtown can all be strengthened through thoughtful development.

RELATIONSHIP TO THE MUNICIPAL PLAN

The ideas are not new. They are fully consistent with the City of Burlington's Municipal Development Plan which states:

> This document envisions Burlington in the future as . . . a city where mobility and access are safe, affordable, and efficient. Reliance on the automobile has decreased through



> the use of public transportation, ridesharing programs, and other alternatives to drive alone. Land use and transportation incentives encourage walking and use of alternatives. Transportation systems management, access control, and other programs allow efficient use of the transportation network. New construction is the least-desired solution for transportation problems.
>
> Walking is safe and easy. Cars yield to pedestrians at unsignalized intersections; signalized intersections have pedestrian phases. Traffic on local streets has lessened, as has the acreage used for roads and parking.[1]

The compatibility of the recommendations with the municipal plan is demonstrated in Table 2. However, the ideas are not always being used as a consistent guide in the City's day-to-day actions. Systemic change is slow and requires consistent adherence to a plan.

BENEFITS, COSTS AND POTENTIAL FUNDING SOURCES

The criteria goals given in the RFP are:

- travel time saving,
- service efficiency,
- use of public transportation,
- air quality,
- congestion downtown and in adjacent neighborhoods,
- mobility including pedestrian access,
- linkages between downtown and the waterfront, and
- minimizing land used downtown for roads and car storage.

Table 3 illustrates the benefits of the recommended program. There are benefits in all of the targeted areas. Some of these benefits are subtle. Travel time savings are normally associated with an increase in speed, and the proposed program doesn't include increases in speed. However, increasing speed on public highways over the past several decades has not reduced the amount of time spent traveling. Instead, more time is spent traveling than ever before. Increasing pedestrian accessibility is intended to increase the percentage of trips that can be satisfied by the pedestrian mode. Since these trips are generally short (5 minutes or less), there could be travel time savings.

[1]City of Burlington 1991, p 7-8.

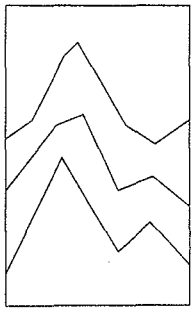


Table 2: Recommendations and the Burlington Municipal Development Plan

Transportation Management Association	work with private sector to expand ridesharing (p 75)
Pedestrian design top priority	human scale, safe for walking (5) improve pedestrian access throughout city (p 22, 34, 75) insure the development of a network of connecting midblock pathways in the downtown (p23, 35) reduce or eliminate setbacks to reinforce urban and pedestrian streetscape (p 35) comprehensive street lighting plan (p 35) maintain, upgrade , or construct accessible sidewalks (p 36) implement pedestrian access programs (p 75) ensure that pedestrian walkways are accessible (p 75)
Intensify land use without proportional increases parking and highway capacity	discourage driver-only car trips through land use policies (p 22) permit mixed use to decrease dependence on automobile (p 23) permit increased densities on the core campuses of Burlington's institutions (p 23) explore increased residential densities along corridors (p 23) pricing transportation at true cost (p 74) limiting construction of new parking (p 74) limiting construction of new capacity (p 74) supporting public transportation (p 74) work with CCTA to improve quality, frequency, and area of bus service (p 75) implement a trip reduction ordinance reduce parking requirements to encourage residential development downtown (p 76, 84) change minimum parking standards to maximums (p 76) reduce transportation energy use by lessening private drive-alone car trips (p 89)
Enhance attractiveness of area	protect local streets from through traffic (p 74) preserve human scale of neighborhoods (p 75)

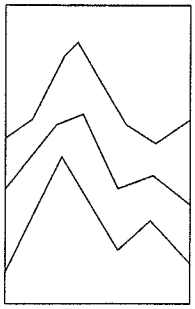
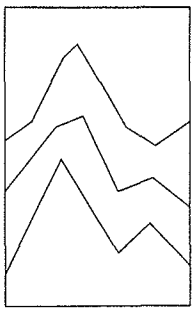


Table 3: Benefits of the Recommended Program

	Transportation Management Association	Pedestrian design top priority	No growth in parking and capacity	Enhance attractiveness
Travel time savings		✔		
Service efficiency	✔	✔		
Use of public transportation	✔	✔	✔	
Air quality	✔	✔	✔	
Congestion	✔	✔	✔	
Mobility including pedestrian	✔	✔	✔	
Link downtown & waterfront	✔	✔		✔
Minimize roads and car storage land	✔	✔	✔	✔

Most of the benefits are more direct. The Transportation Management Association (TMA) would continue to work actively towards most of the objectives. Increasing pedestrian mobility would support transportation efficiency, encourage use of public transportation, help with congestion and air quality, help link the downtown and waterfront, and minimize land used for roads and storage. Limiting growth in parking and capacity would in turn aid pedestrian mobility, while encouraging use of public transportation, and so forth. Because the themes were developed within a systems context, they are mutually supporting.



There are also important regional benefits from the proposed themes. In a recent book, Nadis and MacKenzie wrote:

> Building more roads, or widening existing roadways, has been the traditional response to traffic problems. History shows, however, that this approach leads only to increased traffic and lower air quality. Congestion forces people to alter their travel routes and to avoid, if possible, driving at peak travel times. New roads may initially alleviate congestion, but soon encourage people to shift from other routes, or from other modes of transport, until the new roads are as badly congested as the old ones were.[1]

Over the longer term, new roads encourage increased development that can be served by the roads. In another recent book, Downs argues that local land use controls have also been ineffective in preventing further increases in congestion.

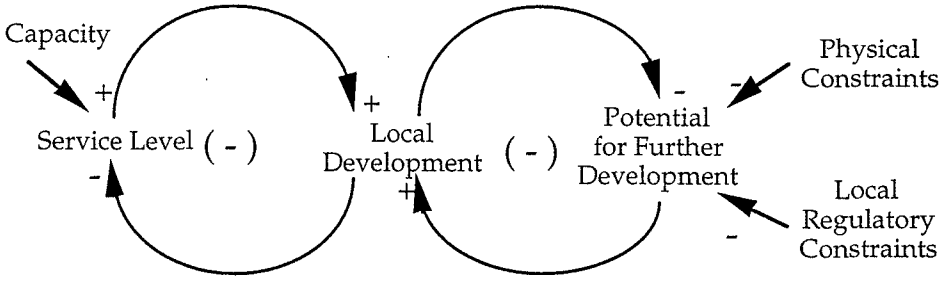
> By diverting future growth to other communities, growth management policies shift future traffic there, too. Finally, by spreading future development of the entire metropolitan area during any period over a larger territory than it would otherwise have occupied, growth-management policies require households to drive longer distances. That adds to the metropolitan area's total traffic flows, probably increasing future traffic congestion.[2]

Some of the feedback structures described in these quotations are illustrated in Figures 18 and 19. Figure 18 shows the feedback as viewed from the perspective of a specific area. The policy resistance to increased capacity loop described by Nadis and MacKenzie is shown on the left. An increase in capacity leads to an increase in service level, leading to an increase in local development, leading to a decrease in the service level.

Part of the dynamic structure involving local regulatory constraints discussed by Downs is included in the loop on the right in Figure 10. Local regulatory constraints are implemented to reduce the potential for further development, and to improve the service level (or at least keep it from declining further).

[1]Nadis, S. and J. J. MacKenzie with L. Ost. 1993. Car *Trouble*, Boston, Beacon Press: 95.
[2]Downs, A. 1992. *Stuck in Traffic: Coping with Peak-Hour Traffic Congestion*. Washington, DC: Brookings Institution and Cambridge, MA: Lincoln Institute of Land Policy: 126.

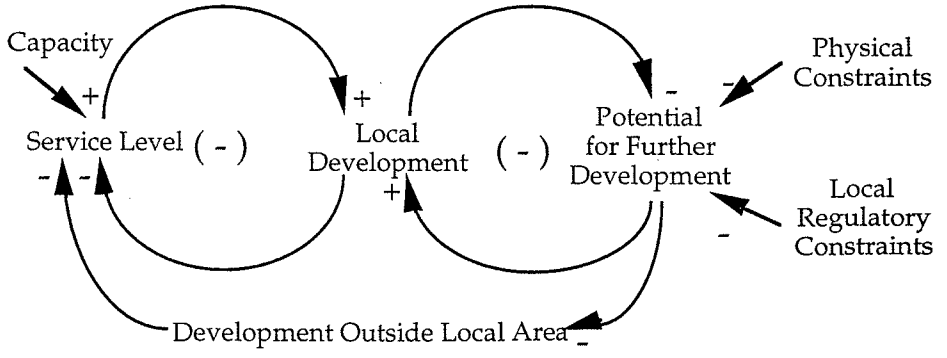
Figure 10: Feedback at the Local Level



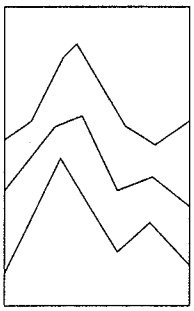
Key: a "+" on an arrow implies a causal increase in the same direction (e.g., an increase in A causes an increase in B), a "-" on an arrow implies a causal relationship in the opposite direction, a "+" inside a feedback loop implies a reinforcing cycle, a "-" inside a loop implies resistance to change.

More of the Downs dynamic structure is added in Figure 11. The desired effects of the local regulatory constraints policy are countered by unplanned regional effects. By reducing development locally, development is pushed to other parts of the region. In most cases in the United States, the unplanned result has been an increase in urban sprawl, and longer trips. These longer trips increase the level of congestion regionally. If major roads pass through the area with the regulatory constraints, the policy may even aggravate congestion there.

Figure 11: Regional Feedback Effects



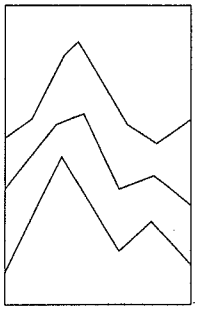
The recommended themes seek to reverse these forces. By concentrating development in the urban core, there would be less pressure for urban sprawl, shorter average trip lengths, and reduced need for increased capacity. Increased automobile occupancies and transit use would reduce the need for increased capacity, and avoid many of the negative effects of increased density on the quality of life.



The benefits of the proposed program are great, but are difficult to quantify. They are intended to reverse historical trends. If the program works, lasting benefits will accrue and grow over time.

The proposed costs of the program are small, relative to the costs of highway projects, passenger rail projects, and parking garages. The Transportation Management Association does not require a large budget. The costs of pedestrian investments although substantial, are small relative to other modes, and also have lower maintenance costs in future years. Pedestrian facilities could be improved gradually in association with reconstruction and development costs, or if money were available. Avoiding the costs of parking garages and increasing capacities of roadways could save large amounts of public funds, and preserve more land as tax base. These activities are directly focused towards the goals of the Intermodal Surface Transportation Efficiency Act of 1992 (ISTEA), and in general, ISTEA funds could be available for them.

The recommended program can achieve significant results by itself. In addition, it would greatly enhance the benefits of other more costly proposals under consideration, such as the light rail system. By enhancing a pedestrian friendly environment that does not unduly promote automobile use, the transit share will be much greater than if the light rail initiative were combined with increased parking and highway capacity.



APPENDIX 1

Bibliography on Transportation and Land Use Planning by Pivo, Moudon, and Loewenherz

RESOURCE
SYSTEMS
GROUP

Final Reference Report

Research Project T 9233, Task 6
Land Use, Transportation, and Urban Design Program-1

A SUMMARY OF GUIDELINES FOR COORDINATED URBAN DESIGN, TRANSPORTATION AND LAND USE PLANNING, WITH AN EMPHASIS ON ENCOURAGING ALTERNATIVES TO DRIVING ALONE

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The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Transportation Commission, Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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INTRODUCTION

That relationships exist among transportation, land use, and urban design has long been recognized by developers, urban and transportation planners, public officials, and the public itself. Only recently, however, has the rising importance of growth management and environmental planning forced the integration of land use, urban design, and transportation interests in actual urban development policies. The popularity of impact fees and concurrency management are just two examples of the current concerns regarding the relationship of these urban system elements.

This report summarizes urban development guidelines that various jurisdictions, professional consultants, and experts have prepared to address the interactive relationship among transportation planning, land use planning, and urban design. The following guidelines have been compiled from the literature surveyed in this project (see references). The aim of these guidelines is to aid in the design of cities and transportation systems that will reduce the necessity of driving alone. For an introduction to the relationships among transportation, land use, and urban design, the reader is referred to "Land Use-Transportation Linkage" (Kestle, Rutherford, and Ishimaru, 1992).

Research for this report included the following steps: (1) the identification of literature sources that provide guidelines related to land use, urban design, and transportation, (2) a compilation of all guidelines provided, which addresses specifically one or several relationships among land use, urban design, and transportation, (3) a classification of the guidelines under broad categories, and (4) the consolidation of guidelines of similar nature in each category. The broad categories into which the guidelines were divided were, therefore, derived directly from what was found in this research's literature review.

These categories include "Location of Land Uses," "Site Planning and Design Standards," "Transit Station Design," "Parking Design and Management," "Site Planning

and Design of Park-and-Ride Facilities," "Bicycle and Pedestrian Planning," "Standards and Procedures for Development Review," and "Implementation Mechanisms."

There are several differences in the amount and level of detail found in the guidelines' different categories. The category "Location of Land Uses" is particularly general, and this indicates a need for future research and policy in this area. "Site Planning and Design Standards" is another category that will require future development. On the other hand, "Bicycle and Pedestrian Planning" offers a number of detailed guidelines that would benefit from further organization into clear subcategories, such as path design, safety considerations, connection with public transit, and connection with automobile systems. The source of each guideline is provided in this report. As noted by the multiple sources quoted in most of the guidelines, the authors found considerable duplication in several literature sources. This overlap indicates a certain level of consensus among writers in the field.

This report only enumerates previously stated guidelines. Examples of applications of each of the guidelines can be found; however, the extent to which they have been applied varies from place to place, and city to city. For instance, the cities of Boulder, Colorado, and Davis, California have extensive pedestrian and bicycle systems. Downtown Portland, Oregon has effective parking management policies. An exposition of exactly where and when these guidelines have been applied is beyond the scope of this report, but this, along with an assessment of the impacts that the guidelines have had on development patterns and transportation behavior, could be the subject of future research.

LOCATION OF LAND USES

These guidelines address the categories of consideration in land use issues to support alternatives to driving alone.

- Require that residential developments and employment and activity centers be developed at densities and in areas that can be served by public transportation. (SNO-TRAN, p. 3-3/4-3) (CUTS, p. 42) (Metro, p.29/33) (Cervero, p. 122) (Walton, p. 2-5) (CUTS, p.40) (Rutherford and Frank, p. 162) (FDOT, p. 17)

- Encourage transportation-sensitive land use policy through the designation of transit corridor districts. (CUTS, p. 24/35)

- Increase employment and residential densities along bus routes and at bus stops. (SNO-TRAN, p. 5-4) (Cervero, p. 122)

- Locate development within existing urban or suburban activity centers. (Walton, p.2-5) (SNO-TRAN, p. 3-2) (Metro, p. 29/33) (Cervero, p. 122)

- Allow convenience stores, services such as daycare, and pharmacies at park-and-ride lots and within residential areas; and allow compatible uses such as restaurants, banks, daycare service, and convenience stores in employment centers. (SNO-TRAN, p. 5-3) (Cervero, p. 124). (SNO-TRAN, p. 5-3) (Cervero, p. 123)

- Encourage in-fill development on bypassed vacant parcels in developed areas adjacent to bus routes and stops. (SNO-TRAN, p. 5-3)

- Locate transit transfer facilities at activity centers. (Rabinowitz and Beimborn, p. TC-9) (Walton, p. 2-5) (Rutherford and Frank, p. 162) (Metro, p. 29)

- For express bus routes, park-and-ride facilities should be located close to major arterials or freeways to promote greater efficiency and travel speed. (Rabinowitz and Beimborn, p. PR-8) (Rutherford and Frank, p. 23)

SITE PLANNING AND DESIGN STANDARDS

A transit agency or municipal government can encourage transit use by adopting specific site design standards or guidelines. Transit use must be accounted for early in the site design process.

- Design sites with direct and safe pedestrian connections to transit stations and adjacent land uses. (Walton, p. 2-5) (SNO-TRAN, p. 3-4) (Metro, p. 29) (Brittle, p. 53)

- Increase residential density in order to increase public transportation ridership potential. (SNO-TRAN, p. 3-5)

- Plan activity centers with a mixture of employment, mid- to high-density housing, and shopping, entertainment, government, cultural, recreational, and educational facilities. (SNO-TRAN, p. 3-2/4-3/5-2) (Walton, p. 2-5) (Rutherford and Frank, p. 163) (Metro, p. 29) (CUTS, p. 66) (SCPD, p. 39)

- Cluster major developments in existing commercial and residential areas and at employment centers. (SNO-TRAN, p. 5-6) (Cervero, p. 123)

- Reduce setbacks for retail, employment, and multi-family land uses on streets with bus facilities to encourage transit use. (SNO-TRAN, p. 5-6)

- Require street level pedestrian uses in buildings in commercial, office, or mixed-use areas with bus routes and nearby bus facilities to stimulate activity and interest. (SNO-TRAN, p. 5-4) (PPS, p. 35-40)

- Place parking behind or to the sides of buildings on transit routes, and orient front building entrances toward the street. (PPS, p. 35-40) (SNO-TRAN, p. 5-6)

- Provide covered walkways between buildings and bus stops, and provide bus stops with shelters. (deChiara and Koppelman '87, p. 253)

- In areas where growth is expected but bus service is not yet available, bus/HOV serviceable site plans should be required so that the use of bus and HOV is practical when it becomes available. (FDOT, p. 80)

- Locate bus stops as close to streets as possible to minimize on-site travel and conflicts between pedestrians, bicycles and automobiles. (Walton, p. 4-49) (Metro, p. 35)

TRANSIT STATION DESIGN

The following are general design guidelines for the construction of activity centers (CBD or other) or neighborhood rail stations, transit malls, bus shelters, and transfer stations. These design guidelines relate details of service design, transit stop features, safety, security, and maintenance.

- Local stations should enhance the local community by providing appropriate plazas and outdoor areas, landscaping, and community information that is compatible with their residential context. (Rabinowitz and Beimborn, p. C-12/ C-20/C-26/N-11/N-20/L-12/TM-15/TM- 28/TC-10) (PLP, p. 62)

- Circulation and orientation of pedestrians within the local stop station environment (to and from vehicles and related services) should be facilitated. (Rabinowitz and Beimborn, p. L-16)

- The transportation center should be an attractive and comfortable environment providing both shopping and waiting areas that incorporate a high degree of passenger safety. (Rabinowitz and Beimborn, p. L-15/L-17/C-28/C-30/TC-23/ TM-26/TM-31/N-19) (CUTS, p. 93-94) (Brambilla and Longo, p. 23/27)

- Design for handicapped access should not merely adhere to minimum standards but should strive for comfort and pleasure. (Rabinowitz and Beimborn, p. TM-20/N-16/TC-15) (CUTS, p. 94)

- Climatic factors (e.g., wind, sun, rain) must be considered as part of site design and transit station location. (Rabinowitz and Beimborn, p. C-13/TM-14/TM-29/ L-9/N-13/TC-10) (Metro, p. 40) (Brambilla and Longo, p. 43)

- The facility should provide opportunities for retail activities at exterior entries to transit stations. (Rabinowitz and Beimborn, p. C-14) (Brambilla and Longo, p. 20)

- Downtown stations should have direct and safe connections to large building developments, such as high-density housing, hotels, office complexes, and shopping centers that provide services and amenities for the transit passenger. (Rabinowitz and Beimborn, p. C-16/C-25)

- To avoid vehicle conflicts and minimize travel time, distinct rights-of-way for rail/bus/auto should be separated where practical. (Rabinowitz and Beimborn, p. C-17/TM-17/TC-16)

- Signing at transit sites should provide clear, easily understood information for all users about the routes and transfers available, the important stops along the route, and the transit system telephone information number. (Rabinowitz and Beimborn, p. C-19/C-27/N-17/N-24/N-30/TC-8/TC-16/TC-22/L-8/TM-19/TM-30) (Jacobs, p. 351)

- Space around the station should be allocated to providing connections with other modes of travel. (Rabinowitz and Beimborn, p. N-9/N-15)

- The facility should accommodate growth and change by providing generous space to accommodate future contingencies. (Rabinowitz and Beimborn, p. N-19/ L-15/TM-23/TC-18/TC-21) (CUTS, p. 89)

- The facility should provide access for emergencies and for necessary deliveries. (Rabinowitz and Beimborn, p. TM-17)

- To reduce conflict and enhance operational efficiency, separate access points should be provided for each travel mode. (Walton, p. 4-49) (Metro, p. 44) (Walton, p. 4-49)

- Design transit facilities, such as bus stops or transfer centers, so they are conveniently integrated into buildings, residential developments, roads, and building entrances. (SNO-TRAN, p. 3-4)

PARKING DESIGN AND MANAGEMENT

Parking management has been recognized as an essential element in modifying travel behavior. Parking management involves public sector strategies that affect pricing by instituting tax laws, and affect parking availability by instituting zoning codes and other regulations regarding the number of parking spaces, and the design and location of parking facilities.

- Develop a regional parking policy that complements the public transportation strategy, the street and highway system strategy, and the land use plan. The parking policy should be developed for off-street, on-street, private, and government-owned parking facilities. (FDOT, p. 93)

- Assure pedestrian friendly parking facilities by providing pedestrian links between parking facilities and office buildings, highways, transit facilities, and green space. (FDOT, p. 94)

- When vehicular, pedestrian, and bicycle accidents occur, some parking removal and street narrowing with landscaping may effectively improve safety. (FDOT, p. 95)

- New developments of rehabilitated parking facilities that contain a significant number of stalls (e.g. more than 40) should be required to designate a portion (e.g., 10 percent) of the stalls for incentive programs such as ridesharing, carpooling, and vanpooling. These designated spaces should be in prime locations. (FDOT, p. 94)

- The size of any single parking lot area should be limited to 2.5 acres made up of smaller (seven vehicles or less) shielded lots. This number can be exceeded if the parking area is divided by a street or building and if 7 percent or less of the area is used for parking. (FDOT, p. 98)

- Create minimum and maximum parking requirements for certain land uses such as offices, employment and industrial centers, and for the total number of parking spaces available for on-street and off-street use. (SNO-TRAN, p. 5-7) (Metro, p. 62) (Brittle, p. 51) (Metro, p. 62/69)

- Require transportation demand management programs to provide alternatives to single-occupancy vehicle travel, and reduce parking requirements to support TDM programs. (SNO-TRAN, p. 5-7)

- Require preferential parking for carpools and vanpools adjacent to major building entrances at employment sites, major event sites, and retail facilities. (SNO-TRAN, p. 5-7) (Rohe, p. 53) (Metro, p. 58)

- Parking requirements in transit corridor districts should reflect the availability of transit services. Reduce parking requirements for land uses near public transportation facilities. (SNO-TRAN, p. 5-8) (Metro, p. 29) (CUTS, p. 30)

- Prohibit peak-hour parking and curbside deliveries on major bus routes. (Brittle, p. 57)

- Establish a residential parking permit program for neighborhoods close to transit facilities. (Brittle, p. 53) (Metro, p. 58)

- Allow commercial businesses to trade SOV parking spaces for conveniently located bicycle storage spaces. (FDOT, p. 88)

- Establish flexible parking requirements allowing businesses that are able to ensure a reasonable chance of success for traffic mitigation to reduce the number of parking spaces they provide. (Brittle, p. 47-48) (Metro, p. 63)

- Establish pricing scales that penalize long-term parking. (Brittle, p. 52) (Metro, p. 68)

- Enact increases in price of parking in given target areas (through rate increase or taxes). (Metro, p. 69)

SITE PLANNING AND DESIGN OF PARK-AND-RIDE FACILITIES

- The park-and-ride facility should be clearly marked, and adequate signing should be placed on all adjacent streets and highways to direct persons arriving by auto. (Rabinowitz and Beimborn, p. PR-8) (Rutherford and Frank, p. 23)

- Locate park-and-ride facilities in places that will maximize their potential for joint development. (Rabinowitz and Beimborn, p. PR-6) (Brittle, p. 53) (Rutherford and Frank, p. 23)

- Locate park-and-ride facilities where ridership potential and access to the site is excellent. (Rabinowitz and Beimborn, p. PR-10) (Rutherford and Frank, p. 37) (PLP, p. 93)

- Auto access points should minimize conflicts between park-and-ride generated traffic and through traffic. (Rabinowitz and Beimborn, p. PR-11) (Rutherford and Frank, p. 110-111)

- Provide safe, auto-free pedestrian circulation paths. (Rabinowitz and Beimborn, p. PR-15) (Rutherford and Frank, p. 37)

- Site design should respond to the climate and weather patterns in the region. (Rabinowitz and Beimborn, p. PR-16) (Rutherford and Frank, p. 23/110-111)

- The design of handicapped access should be considered early in the design process. (Rabinowitz and Beimborn, p. PR-17) (Rutherford and Frank, p. 95/110) (deChiara and Koppelman '87, p. 277)

- An attractive pedestrian shopping/waiting environment should be provided in the park-and-ride facility. (Rabinowitz and Beimborn, p. PR-21) (Rutherford and Frank, p. 23)

- The park-and-ride station environment should be free of criminal activity and should reduce passengers' anxieties about such activity. (Rabinowitz and Beimborn, p. PR-27) (Rutherford and Frank, p. 97/106)

- Facilities should provide an attractive, visible, high-quality environment that meets modern standards of comfort and safety. (Mather, p. 7) (Rutherford and Frank, p. 105)

BICYCLE AND PEDESTRIAN PLANNING

Pedestrian planning has occurred primarily in dense urban areas. Traffic congestion in suburban areas have provided an impetus for reconsidering the provision of pedestrian facilities. Lobbies for bicycle transportation have been strong for a number of years. Lobbyists are increasingly receiving attention as transportation planning seeks to reduce dependence on single-occupancy vehicles.

The following guidelines provide specific details for pedestrian and bicycle pathways.

- Plan and construct a system of bicycle paths and pedestrian walkways connecting residential, employment, shopping, recreational facilities, and public transit within a city. (Brittle, p. 63) (CUTS, p. 83) (SCPD, p. 259) (deChiara and Koppelman '87, p. 274) (deChiara and Koppelman '82, p. 309) (SNO-TRAN, p. 4-3)

- Pedestrian and bicycle paths should be safe, convenient, attractive and comfortable environments. (Brambilla and Longo, p. 23/27) (PPS, p. 35-40) (Cervero, p. 125) (CUTS, p. 83) (Metro, p. 40)

- Promote bicycle access through high-quality pathways and secure storage systems. (CUTS, p. 87) (Brittle, p. 64) (Lowe, p. 6) (SCPD, p. 154) (deChiara and Koppelman '87, p. 273) (deChiara and Koppelman '82, p. 309/ 313)

- Integrate feeder bus, auto access points, and pedestrian systems at regular intervals. (CUTS, p. 88)

- Plans should contain a mix of separate paths, streets marked with bicycle lanes, bicycle-only streets, and streets where traffic volumes and other conditions are compatible with increased bicycle use in mixed traffic. (Brittle, p. 63) (SBMPO, p. 1) (deChiara and Koppelman '87, p. 271) (Brambilla and Longo, p. 17) (deChiara and Koppelman '82, p. 309)

- Avoid constructing one-way roadway systems and free flow junctions that increase the capacity of a road system but direct the cyclist on unnecessary detours and into dangerous maneuvers. (Hudson, p. 1) (deChiara and Koppelman '82, p. 312) (PPS, p. 10)

- Provide continuous walkways with adequate lighting in major developments. (Brittle, p. 64) (Metro, p. 40)

- Use trees and landscaping between streets and sidewalks as a traffic calming technique. (Untermann, 1984)

- Provide islands in the centers of major arterials. (Brittle, p. 64) (Brambilla and Longo, p. 94)

- Provide street light systems where "walk" lights are automatically actuated and provide enough time to traverse the street. (Brittle, p. 64) (Brambilla and Longo, p. 54)

- Stimulate pedestrian access by providing landscaped walkways and arcades between major buildings within a development, adjacent developments or buildings, and major buildings and streets with public transportation facilities. (SNO-TRAN, p. 5-5) (Brittle, p. 64) (PPS, p. 7/ 33)

- At least 12 feet of open space must be provided for emergency vehicles and police surveillance vehicles along the entire length of the pedestrian street, not including existing sidewalks. (Brambilla and Longo, p. 61)

- Provide sidewalks along streets with bus stops and streets leading to bus stops, and safe crosswalks at or near bus stops, using all-weather material. (SNO-TRAN, p. 5-5) (PPS, p. 8) (Brambilla and Longo, p. 47)

- Eliminate barriers that discourage pedestrian access such as walls and beams, large landscaped areas or parking lots between major building entrances and bus stops, walking distances of 750-1,000 feet, and unsafe conditions. (SNO-TRAN, p. 5-5)

- Provide wheelchair ramps and other facilities that conform to barrier-free design standards. (SNO-TRAN, p. 5-6)

- Provide a strong recreational appeal to bicycle and pedestrian paths by allocating spaces and facilities that respond to the needs of its users. (Brambilla and Longo, p. 48) (PPS, p. 35-40)

- Improve the visual environment around bicycle and pedestrian pathways by restoring existing buildings, repaving the street floor to unify the entire space, planting trees and flowers, and promoting wall paintings and informational graphics. (Brambilla and Longo, p. 48)

- Provide places for seating and resting along pedestrian and bicycle pathways. (Brambilla and Longo, p. 48) (PPS, p. 35-40)

- Provide lighting to improve pedestrian safety and security. (SNO-TRAN, p. 5-6) (deChiara and Koppelman '87, p. 253)

- Provide pedestrians and bicyclists with a system of facilities, incentives, and services that fully support home-to-work, home-to-school, and utility trip making, especially in neighborhoods and employment districts. Neighborhoods and streetscapes should be safe, appealing, pleasant, and interesting for foot-speed travel. Such a system includes sidewalks, crossings of no longer than 38 feet between medians or raised islands, recall buttons where pedestrians would naturally like to cross, sufficient signal crossing times and frequency, fully illuminated intersection crossings, and speeds restricted to 25 mph in neighborhoods and 30 mph in commercial areas. (FDOT, p. 85)

- A route is "bicycle friendly" when it has a reasonably direct and continuous roadway design, and operations and maintenance include many of the following: 14-in. wide curb lanes, paved shoulders, bicycle lanes and bike paths, bicycle sensitive traffic signal loop detectors, uniform and trouble free pavement surfaces, and vehicle speeds restricted to below 35 mph. (FDOT, p. 85) (CBTD, p. 24)

- "Pedestrian friendly" streets should be a part of the normal, interconnected street pattern and include on-street parking, few (and narrow) driveways across sidewalks, compressed parking, uses oriented to the street, direct connection between the street and building entries, pedestrian goods and services nearby, grid rather than collector road patterns, interconnected streets, mixed land uses, and no superblocks. (CBTD, p. 24) (Cervero, p. 125)

- Provide enclosed bicycle parking, a shower, lockers, and changing room for walkers and bicyclists at any employment center with 100 or more employees and at all new, redeveloped, or expanded businesses or office complexes. Any employment center with 10 to 99 employees should also provide, or arrange with neighboring businesses to provide these services. (FDOT, p. 89) (Note: The cities of Seattle and Bremerton require bicycle parking facilities at all new development sites.)

- Use neo-traditional and other innovative neighborhood and urban design strategies, where streets are narrower than those presently developed to slow traffic. Such streets also provide for pedestrian and bicycle movement. Also, street cross sections are designed to facilitate pedestrian traffic and provide shorter turn radii for vehicles. (FDOT, p. 29) (CBTD, p. 19-20)

- All roadways designated as bicycle routes in local comprehensive plans within urban and rural areas should be designed, constructed and maintained with consideration to their usage by bicycles. Most roadways will be Class IV bicycle facilities (roadways with no bicycle designation), with bicycles using the roadway like other vehicles. (WSDOT, p. 17)

- Designate an interconnected system of Class II bikeways (a portion of the highway designated by signs and/or pavement markings for preferential bicycle use) on the urban and connecting rural roadway systems as primary bicycling facilities for transportation purposes. This Class II bikeway system should connect major activity centers and provide for continuous travel throughout urban

areas and adjacent rural areas, including linkages with other modes such as transit, ferries, and intercity travel facilities. (WSDOT, p. 18)

- Class I bikeways (separated paths) are appropriate for transportation purposes for system connection or safety reasons. Examples of where separated paths are appropriate are:

    - along or through a limited access corridor.
    - bypassing high traffic or other special conditions where the roadway cannot accommodate bicycles. (WSDOT, p. 18)

- Other transportation modes, such as transit systems and ferries, should design, construct and maintain their facilities with consideration to bicycle use through:

    - provision of secure bicycle parking at park and ride lots, stations and terminals.
    - accommodation of bicycles on bus routes where designated as part of bicycle route system.
    - designing future vessels and vehicles to safely accommodate bicycles. (WSDOT, p. 18)

- Local comprehensive plans should include plans for the bicycle system. The regional transportation planning process should coordinate bicycle facility planning across jurisdictional boundaries. (WSDOT, p.18)

- Encourage bicycling as an alternative to single-occupancy automobile travel by promoting employer provision of bicycle facilities at employment sites. (WSDOT, p. 18)

- Designate touring highway routes that connect with urban bicycle systems. Target bicycle facility improvements on these routes. (WSDOT, p.18)

STANDARDS AND PROCEDURES FOR DEVELOPMENT REVIEW

These guidelines recommend transit agency involvement in the review of development proposals and project designs.

- Establish threshold requirements for the application of transit-compatible standards to redevelopment, to major changes to existing land uses and buildings, and for transit-oriented mitigation as part of the environmental impact assessment process. (SNO-TRAN, p. 5A-8/5-2).

- Provide for transit-sensitive review of site plans and development proposals, and include the transit operator in the review of commercial, residential, industrial, and office applications. (CUTS, p. 26) (SNO-TRAN, p. 5-2)

- Provide a transit requirement checklist for potential developers. (CUTS, p. 28)

IMPLEMENTATION MECHANISMS

These are some of the financial or regulatory tools that can be used to integrate land use, urban design, and transportation objectives.

Negotiated Transportation Agreements	Developers provide transportation improvements in conjunction with new development. (Walton, p. 5-1)
Cost Sharing Arrangements	Construction and modernization of transit facilities are cooperatively financed by developers and local transit authorities. (Walton, p. 5-3)
Special Benefit Assessments	Property owners pay local transit authorities for service by transit providers. (Walton, p. 5-3)
Mitigation Payments	Project developers are required to pay the costs of transit improvements needed to mitigate the impact of individual developments. (Walton, p. 5-3) (Metro, p. 92)
Lease or Sale of Development Rights	Transit authorities lease or sell development rights to air space above or below property owned by the transit authority. (Walton, p. 5-3)
Bonus or Incentive Zoning	Zoning requirements are relaxed for developments that provide transit amenities. (Walton, p. 5-4) (Rutherford and Frank, p. 164) (SNO-TRAN, p. 5-12) (Metro, p. 63/93) (CBTD, p. 14) (Metro, p. 63/ 93)
Conditional Development Approval	Plan approvals, master plan approvals, special use permits, and conditional use permits are used to secure developer involvement in transit provision. (Walton, p. 5-5) (SNO-TRAN, p. 5-13)
Contractual Agreements	A contract between developers and the transit authority or local government specifies the transit improvements to be provided at new developments. (Walton, p. 5-5)
Concurrency Management	Development is prohibited where it causes transit level of service standards to be exceeded. (Cechman, p. 5)
Planned Unit Development	Rather than approving a large development on a lot-by-lot basis, local government approves an entire project or large portions of a project at one time, in exchange for which the developer dedicates various transportation facilities such as bus turnouts, benches, shelters, landing pads, and similar items. (Metro, p. 93)

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