A High Performance Transit Plan for Austin

Presented as an alternative to Capital Metro's rail plan by

Austin High Performance Transit

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In 1997, the Capital Metro Board of Directors voted to increase Vanpool fares, from $10 to $25 per month. At the time of this decision, the Authority had 130 vanpools operating, with an average of ten passengers per van. An additional 1467 persons were on a waiting list for vans. To accommodate these would have required an addition of 146 vans at an annual cost of less than $800,000. Since the trips carried by vanpools are, by design, all peak-hour work trips, and since market research indicates that nearly all of the passengers on vanpools would otherwise make their trips in single occupancy automobiles, placing the 1467 wait-listed vanpoolers in vans would have taken more than 1200 cars out of peak-hour traffic: 1200 cars out of the morning peak and 1200 cars out the evening peak. This prospect was not sufficiently compelling to the Board, and the fare was increased. In consequence, 500 persons already participating in the vanpools abandoned the program and returned to their cars for their daily commute.

At the time this decision was made, no one argued that Capital Metro needed more revenue. This was, after all, an organization that was collecting, in 1997, $80 million in sales taxes and rapidly stockpiling what today amounts to more than $100 million of cash in the bank. Nor was it argued that the vanpools were too expensive - the cost per rider of the vanpools was lower than that of the bus system as a whole, lower, in fact, than all but a handful of the Authority's best-performing routes. Rather, the sole argument for increasing the fares was that the vanpools were "too good a deal for the riders."

There is something disconcerting about a transit authority worrying that its services offer too good a deal for its riders, charged as it is with a legislatively-mandated, voter-approved mission to reduce traffic congestion and improve air quality, in a city with a crippling vehicular traffic problem, and on the verge of being found in non-compliance with Federal air quality standards.

Disconcerting too is the recent statement of Capital Metro's general manager that "Nothing we do will reduce traffic congestion." Since putting those 1467 persons in vanpools would have done precisely that, the statement should be more accurately rephrased: "Nothing we do will reduce traffic congestion as long as we refuse to offer our riders a better deal."

The Light Rail Problem

Whatever criticism one might make of Capital Metro's rail plan, no one could ever accuse it of giving too good a deal to the riders. The rail line would serve no area of town that is not already served by the Authority's best bus routes. Nor is there any improvement in the frequency of service: the proposed 10 minute headways are identical to those on the current

North Lamar and South Congress bus routes. There would, it is true, be an improvement in operating speeds, but 75% of the time savings is accomplished on city streets, by reserving for the train its own traffic lane and by transit-prioritizing signalization - whenever a train approaches an intersection, the light turns green. This could just as easily be done for the bus routes, in the next 18 months, at a cost not of $1 billion, but of $3 million. The light rail plan does, however, entail a fare increase.

The failure of the light rail plan to provide significant improvement over the current quality of service has one obvious consequence: minimal increases in transit ridership. The most recent ridership forecast prepared by CAMPO, the area's Metropolitan Planning Organization, shows an annual growth rate over the next 25 years of 2.5% in Capital Metro's system-wide weekday ridership with a complete implementation of the rail plan. But since this 2.5% is lower than the expected growth rate of the Service Area population, the annual per capita transit ridership would be lower in 2025 than it is today. Contrast this meager rate of ridership growth with the 30% increase spurred by the 1986 frequency improvements, and the subsequent 10% annual increases through 1988. Or with the 80% gain in transit boardings when fares were eliminated in October, 1989, and the subsequent 20% annual growth rate experienced through 1990.

With the ridership gains so small, proponents for the Light Rail plan have cited land-use impacts as the ultimate benefit to be achieved. Light rail, it is argued will spur a more intensive development of the "Urban Core" and will shape the city's future growth, thwarting urban sprawl and creating a more compact city. But since roughly 75% by acreage of all our metropolitan developed real estate is presently occupied by the transportation system itself, by roadways and parking lots, negligible impacts can be made by a plan that fails to produce significant reductions in vehicular traffic. Such reductions require dramatic increases in per capita transit ridership.

Planning for Performance

One could, on the other hand, design a transit system that did not seek to limit the benefits offered to its riders, one that aimed at being competitive with our personal automobiles for an ever larger share of the trips we make. This is what we have attempted to do in drafting the "High Performance Transit Alternative."

The High Performance Alternative seeks to deploy the Authority's tax monies in those improvements that yield the greatest increases in ridership, or, in the jargon of economists, in improvements with the lowest marginal subsidy per trip. To do so it aims at making sure that every tax dollar spent will yield the maximum possible benefit to the riders, who, in the end, will vote with their feet. The plan is, to a great extent, based on past experience, on an evaluation of what has worked and what has not, but it is also avowedly experimental. Given the transit industry's history of failure, we will need to try new strategies, and we must judge the success or failure of our experiments by the numbers.

Highlights of the Plan

The principal features of the High Performance Transit Plan are:

- New high-frequency express routes to correct critical freeway congestion problems, operating on major arterials with transit-priority signalization to achieve better-than-freeway operating speeds.
- New high-frequency cross-town routes to address system connectivity problems.
- System-wide frequency improvements to achieve UT Shuttle-style quality of service.
- Aggressive promotion of Van Pools.
- Elimination of all transit fares.
- Creation of high-density Urban Centers in newly developing areas, served by local shuttle bus systems and connected to existing system hubs by high-frequency express service.
- An immediate reduction in the Authority's sales tax rate to ¾ cent, with a commitment not to collect more revenue than can effectively be expended in pursuit of its mission.
- Elimination of all advertising from the exterior of the buses, and the design of a more handsome exterior.

The plan does not include HOV lanes or rail lines.

- HOV lanes, like the light-rail plan, are designed to accommodate current levels of service under conditions of worsening traffic congestion. Rather, the plan is designed to achieve the significant reductions in vehicular traffic that will make HOV lanes superfluous.
- Rail lines, either light-rail or commuter rail, currently entail marginal subsidies per trip far too high to warrant consideration. The Plan does, however, describe decision-making criteria for rail development at such a point in the future when the ability of the Authority to plan and deploy successful new fixed-route service has been sufficiently well demonstrated.

It is a goal of the High Performance Transit Plan to create for Austin the nation's best-planned and best-operated transit system, and to lead the nation toward a solution for the intractable traffic problems that burden our lives and our economy with ever-increasing transportation costs.

General Policy

The transit system shall do no harm to the motorist.

Throughout, this plan focuses on producing transit services that are competitive with the personal auto. The plan proposes that this goal be achieved by improving the quality of service offered the transit riders, and not by imposing, or encouraging, additional burdens on the motorist. It is the expectation of this plan, as it was of the voters who authorized the creation of the transit authority, that reductions in vehicular traffic will produce more convenient and less costly trips for motorists.

Revenues shall not be collected which cannot be effectively deployed.

If the Authority attempts to deploy the full amount of authorized revenues before achieving major improvements in the effectiveness with which tax monies are used, we run the risk of committing resources to unproductive projects that will ultimately impair the Authority's long-term ability to succeed.

Moreover, in the past, the collection of excess revenues have served to encourage other local governmental bodies to seek fiscal assistance from the Authority, and the Board accession to such entreaties has diminished the Authority's focus on its narrowly defined mission.

The Authority's enabling legislation (Transportation Code, Chapter 451) provides "that the taxes levied and the rates, fares, tools, charges, rents and other compensation for the use of the facilities of the system shall not be in excess of what may be necessary to fulfill the obligations imposed upon the authority by this Act." The accumulation of undesignated reserves is in no way an obligation imposed on the Authority by its enabling legislation.

To ensure the long-term effectiveness of the Authority and to comply with State law, revenue should be reduced by a cut in the sales tax rate ¾ cent, by the elimination of all transit fares, and by discontinuing the sale of advertising.

A ¾ cent tax rate, without fares or advertising revenues, provides ample financial resources for aggressive improvement of the existing system and deliberate careful experimentation to achieve service expansion.

The transit system shall improve the urban image.

Consistent with other major public works, the Authority should strive to give the transit system an appearance that contributes to a handsome visual image of the city. In particular, with the elimination of advertising from the exterior of the buses, the Authority should redesign the bus exteriors to make a positive contribution to the appearance of our city streets. The bus system can "dress up" the city every bit as much as the 'Dillo has done for

Downtown Austin, or as a light rail line has been promised to do for the arterials on which it has been proposed to operate.

Land Use Impacts and Urban Sprawl

Since the potential land use impacts of our future transit system have received prominent mention in the discussion of current transit options, it is important, at the outset, to distinguish between two types of land use impacts that may be associated with transit improvements:

- ***Spatial Impacts*** occur when transit improvements reduce the amount of urban space required by roadways and parking facilities.
- ***Location Impacts*** occur when transit improvements encourage decisions to locate economic activities near transit routes.

Urban sprawl can be curbed only by realizing the spatial impacts that result from large increases in transit usage.

Urban sprawl results from the real estate-intensiveness of a transportation system that relies on the single-occupancy personal auto for most metropolitan trips, particularly peak-hour home-to-work trips. Roughly 75% by acreage of Austin's metropolitan developed real estate is now occupied by the transportation system, by roadways and parking lots. This is the sole reason for the low densities found in newly developing areas. Absent the parking lot, the modern regional mall is a far denser concentration of retail activity than was ever found in the Central Business District, and homes in new residential subdivisions are likely to sit on smaller, not larger, lots than are found in older neighborhoods. But while a neighborhood such as Hyde Park can be served by a two-lane Duval and a two-lane Speedway, the roadway systems serving newer subdivisions comprise 5- and 7-lane arterials. Only by reducing the sheer volume of vehicular traffic can sprawl be reversed.

By misdiagnosing urban sprawl as a location phenomenon, transit planners will pursue land-use strategies that are at best ineffectual, and at worst counter-productive.

Planners frequently confuse sprawl with suburbanization, the universal tendency of cities to grow at their outskirts, where real estate prices are lower. In an attempt to combat suburbanization, incentives are then provided for intensifying development in the inner city. This is the land use strategy pursued in Capital Metro's Light Rail plan. Rather than solve the problem, such strategies completely abandon outlying areas to sprawl and at the same time risk introducing it into the older core area. Without significant improvements in the competitiveness of the transit system, such efforts will increase the vehicular traffic on already congested roadways in the core area, and pressure will build for widening inner city arterials and for increased parking. It is for precisely these reasons that residents in the core area protest the intensification of inner city land use.

Location impacts are critical for the efficient expansion of the transit system's coverage.

For a given number of vehicle miles of service, there is a trade-off between the frequency of service and the coverage the system offers. The greater the number of route miles, the lower must be the frequency of service on each route. Capital Metro planners have consistently favored coverage over frequency. But since frequency is a critical determinant of the competitiveness of a transit route, the result has been a proliferation of uncompetitive, unproductive service. The competitive necessity of providing high-frequency service precludes serving all parts of the metropolitan area with transit routes. Conversely, by adding fewer but maximally competitive routes, the Authority will make use of the location impacts of those routes to attract its customer base to the transit system's cachement.

Location impacts will be stronger and more immediate for competitive service introduced in previously undeveloped areas than for improvements to existing transit corridors. This stems not only from the diminishing returns that may be expected in corridors already reflecting years of transit impacts, but also from the tendency of landowners, tenants and other stakeholders to resist displacement from locations that continue to serve their needs.

The land use impacts projected for Capital Metro's light rail plan are little distinguishable from the effects that may be expected if no improvements at all are made to the area's transit service.

Under conditions of increasingly burdensome traffic congestion, the development of inner city real estate will intensify, as the result of the transportation advantages offered residents, who, if employed in the core area, have short commutes along local arterials, or, if employed in suburban areas, will enjoy the uncongested "reverse commute". The resultant increase in residential development will, in turn, spur increased retail development aimed at serving the burgeoning inner city market. Light Rail would merely hasten commercial development insofar as the construction of the rail line prompts the closing of existing businesses in the corridor.

Some transit improvements will show "promotional" location impacts unrelated to the competitiveness of the service offered. Promotional effects, common to other kinds of public works, are the result of the higher visibility and greater "cachet" a location may derive from the improvement. Such effects are an invaluable tool for encouraging location impacts when introducing service in a newly developing area, but are likely to be counterproductive when improvements are made along an already congested corridor. Location impacts independent of actual ridership increases result in increased vehicular traffic that may impair the efficiency of transit operations.

In order to reap the maximum benefit of its land-use impacts, the Authority needs to track vehicular traffic counts and parking usage in its cachement.

To ensure that actual increases in transit ridership will yield improvements to the compactness of the city, such statistics need to be collected regularly to establish objectively the direct land-use impacts of the transit service. Roadway planners making decisions on lane-mile needs and decision makers establishing minimum parking requirements for development, including City Councils, developers, and, most importantly, lenders, will require hard data, not mere promises or aspirations. Transit ridership along a given arterial should be presented alongside vehicular traffic counts to persons making retail location decisions, to

ensure that total passenger traffic is not underestimated and beneficial location effects thereby missed.

Performance Measures

This plan is called a "High Performance" plan because of its reliance on performance measures, performance-based planning and performance-based budgeting to ensure the maximum possible success in pursuing the Authority's mission.

If Capital Metro is successfully to improve air quality and reduce traffic congestion, it must deliver very large increases in transit ridership. And since the Authority's financial resources are limited, how much ridership it can attract depends on how inexpensively it can carry each trip. In other words, the Authority needs to get the greatest "Bang" for every sales tax "Buck".

Two performance measures are mission critical: Annual Riders per Capita and Subsidy per Rider.

- **Annual Riders per Capita** indicates the success of the Authority in attracting ridership, independent of population growth, and is computed by dividing the total number of boardings in a given year by the Service Area population.

- **Subsidy per Rider** indicates the effectiveness with which public monies are used in achieving the system's ridership, and is computed by subtracting the operating (farebox) revenue from the system operating cost, then dividing by the total boardings.

At any given level of tax revenues expended, a transit system maximizes ridership only if it also minimizes the Subsidy per Rider. And in deploying increments of tax monies in the system, systems can only achieve this by adding ridership at the lowest possible Marginal Subsidy per Rider, i.e., the increase in subsidy divided by the increase in boardings.

All proposals for service improvements should be accompanied by an expected marginal subsidy per rider, and all long-range plans should indicate forecasted annual per capita ridership and average subsidy per rider.

Service improvements with high marginal subsidies per rider should be rejected. Moreover, when improvements are implemented, they should be reviewed in light of the actual marginal subsidy per rider achieved.

Capital Metro in its "New Starts" submission to the Federal Transit Administration has identified a marginal cost per rider of between $11.00 and $12.00. This, it should be noted, is comparable to the cost per rider of some of the poorest performing bus routes in our current transit system. Even with generous contributions from the Federal government, the Light Rail line's marginal local subsidy per rider will be considerably higher than the current average subsidy per rider. With such steeply diminishing returns the Authority will run out of funds before ever achieving ridership high enough to make significant impacts on vehicular traffic.

The Capital Metro Board of Directors should annually award the Authority's General Manager incentive compensation based on the total ridership achieved and the cost per vehicle mile of service provided.

Moreover the General Manager should be directed to develop an incentive compensation program, based on the same two factors, for the entire organization. Note that the cost per vehicle mile is the basic unit cost of providing service.

The Authority's Annual Report should include, in addition to the financial statements, the following performance measures, alongside previous year results:

- Service Area population
- Total boardings
- Total linked trips
- Total passenger miles
- Boardings per capita
- Total vehicle miles
- Total vehicle hours
- Average operating speed
- Operating cost per mile
- Cost per rider
- Local subsidy per rider

In this way the public may be fully apprised of the effectiveness of the Authority's efforts.

For an explanation and further analysis of these and other performance measures, see the Appendix.

Free Fare Transit

It costs less to operate a transit system if no fares are charged. This is because the transaction cost is eliminated.

The cost to the Authority of collecting fares comprises a set of line item expenses, including depreciation and maintenance of fareboxes, the printing and distribution of passes and transfers, the operation of the cash-room, hiring of armored car service, the premium charged by the Authority's depository bank for the handling of large amounts of change. It also includes the more difficult to evaluate costs of "dwell" time, the time of the on-board transaction incurred at the hourly rate of operator labor and fringes, while passengers produce the exact change needed for the fare. Without a fare, this time is eliminated and passengers can be more quickly boarded at both doors.

While the cost of operating the service is reduced, the ridership will increase, and not only because of the lower price: the elimination of the transaction represents a significant addition to the convenience of the service.

With a lower operating cost and increased ridership, the cost per rider will clearly decrease if fares are eliminated, yet it does not automatically follow that the subsidy per rider will decrease as well. The subsidy per rider will decrease only if the ridership gain is so strong that the reduction in the cost per rider exceeds the average fare (net of transaction cost).

Capital Metro's 1989-1990 Free Fare program dramatically proved this point. Ridership increased by 80% in the first of the five Free Fare quarters, and then grew by 20% over the remaining four. A performance audit of the Authority performed in 1993 by John T. Doolittle and Associates noted that the ridership increase was "unprecedented in the history of the American transit industry."

Consequently the fully-loaded (i.e.. including depreciation) subsidy per rider dropped from $2.25 to $1.07, and with continued strong ridership growth forecast by staff for 1991, would have continued to drop had the program not been discontinued.

Even with the expense of roughly $1.5 million in frequency improvements deployed to alleviate overcrowding, the marginal subsidy per rider for the Free Fare program totaled a mere $0.33.

It is unlikely that any alternative use of the approximately $4.7 million dollar subsidy allocated to Free Fare could have produced ridership at anywhere near this efficiency.

As a result of the decision to reimpose fares, the system lost 20,000 boardings from the average weekday ridership in 1991 and 1992, a drop of nearly 20%. Ridership growth resumed in 1993, but the expected total boardings of 31.3 million for the fiscal year now ending still fall short of the 1990 level of 31.8 million. With the strong growth in the service area population over this period, we now have annual per capita ridership 15% lower than in 1990.

The decision to reimpose fares hinged on the need for revenues, with fare proponents arguing that the capital requirements of a light rail line would necessitate revenue streams that could not be met solely by local sales taxes. In hindsight, this was an erroneous assumption. Growth in the sales tax base has been so strong that total fare revenue now amounts to less than half of the annual *increase* in the Authority's sales tax revenues. The loss of revenue today would be recouped by tax base growth in less than six months.

Not only the subsidy per rider, but virtually every other measure of transit system performance improved during Free Fares. On-time performance, passenger complaints per 1000 boardings, and transit safety measures all improved. On-board surveys found customer satisfaction at extraordinarily high levels with 93% of passengers expressing approval for free fares. A market research firm that conducted telephone surveys tallied the reasons former riders gave for leaving the system during the Free Fare period and found that there was no evidence that anyone had discontinued riding as the result of Free Fares.

Although there was a significant increase in on-board security incidents during the first three quarters of the program, particularly during the 2nd quarter of 1990, when overcrowding problems became severe, by the 3rd quarter of 1990, incidents per 1000 boardings dropped and by the last quarter, incidents per 1000 boardings were lower than in the period prior to the elimination of fares. This was true for all categories of incidents except one: those involving intoxicated passengers. And while it would be a reasonable ambition for the Authority to carry *all* of the service area's intoxicated trips, fixed-route bus service is probably not the best way to accommodate these. Thus a return to Free Fare operation should include a para-transit strategy to service the intoxicated, comparable to the programs taxicab companies presently undertake for holiday weekends.

Free Fares dramatically improve not only the performance of existing transit service, but will lower the marginal subsidy per rider incurred by all future service improvements.

Van Pools

The Capital Metro Vanpool program was begun in 1987 to accommodate riders of two bus routes that had served Tracor and Texas Instruments, but had proved unproductive and were slated for discontinuation. In 1988, the Board decided to promote vanpooling aggressively, and budgeted monies not only for more vans, but also for a salesperson to do presentations for major employers on the values of vanpooling. The program grew slowly at first, but with the inauguration of Free Fares in 1989, ridership increased dramatically. The 500% increase was the largest, percentage-wise, of all Capital Metro services during Free Fares.

The cost per rider of a vanpool is significantly lower than that of the average bus route.

This is for two reasons. First, the cost of the van, both capital and operating, reflects the economies of scale inherent in the use of a mass-produced vehicle using mass produced parts. Secondly, there is no wage and benefit cost incurred by the driver, which on a bus route represents roughly 50% of the direct operating expense. Rather the vanpool driver is compensated by the personal use of the van evenings and weekends. The cost of the van is paid by the Authority and that share of the cost attributable (by mileage) to the driver's personal use is billed back to the driver. In 1989, Board members noted that at the then-current cost per rider, the Authority could afford, at a 1% tax rate, to carry all of the Service Area's peak hour work trips on free vanpools.

The cost per rider on a vanpool is determined by the average load of the van (by policy, between 8 and 12 persons), the efficiency of the routing of the van in traversing its riders' origins and destinations, and the cost per mile (including depreciation) of operating the van. The average load and route efficiency are characterized by economies of scale: the larger the total number of program participants, the more efficient will be the allocation of passengers to vans and the routing of each van.

No other service provided by Capital Metro offers such a direct impact on vehicular traffic as the Van Pool program.

By design, vanpools carry peak-hour home-to-work trips exclusively, and thus address the most intractable of the area's traffic problems. Market research indicates that the overwhelming majority of vanpoolers would otherwise commute in a single-occupancy automobile, with a residual number in small 2, 3, or 4-passenger car-pools. Thus the yield of auto trips eliminated for each transit boarding is extremely high. At a 10-person average load, each van trip represents approximately 8 auto trips removed from the roadway system. No other service offers anything so close to a 1-for-1 return. Factoring in the vanpool's low cost-per-rider, the program offers taxpayers an extraordinarily low-cost means of reducing vehicular traffic.

While there are no location land-use impacts from vanpools, the spatial impacts can be dramatic. Vanpools are Capital Metro's most powerful tool for achieving a more compact city.

It would be a reasonable and achievable goal for Capital Metro to add 200 new vanpools each year over the next five years. 200 vanpools remove nearly 1800 vehicle trips from peak hour traffic. 1800 vehicles occupy 20 lane-miles on a congested freeway for the duration of their trip, and 15 acres of parking space throughout the workday.

Fixed Route Service

The Market

It is a commonplace among transit officials that we need to attract new riders, to "get people out of their cars." But demographically, current riders comprise a disproportionately large number of young people. 18-34 year-olds make up the lion's share of ridership, total ridership showing a steeply diminished contribution from 34-65 year-olds, with increases again for those over 65.

Since the current ridership is strongest among young people, the focus of marketing should be not on attracting new ridership, but on retaining the ridership we have.

The popular adage of marketing executives is that it costs five times more to win a new customer than to keep an old one. With a new cohort of young people joining the ranks of transit riders each year, we can realize enormous gains in total ridership simply by inducing them to stay with the transit system as they grow older.

According to Capital Metro's market research, the rider who has left the system has done so for one of three reasons: they bought a car, they moved to a different residence, or they got a new job. The first of these reasons needs to be addressed by improved Competitiveness of the service. The other two require improved Coverage.

Improving Competitiveness

Only a few factors affect the competitiveness of service: price, reliability, convenience and comfort.

Price competitiveness and passenger comfort are the easiest to achieve. Free fares offers competitiveness gains at the lowest possible marginal subsidy per rider. When we speak of passenger comfort, we need to examine both on-board comfort and the pedestrian-friendliness of the access to the bus route. On board comfort is rarely a problem, provided that overcrowding problems are addressed, when they appear, with provision of additional capacity, and barring occasional aberrant Authority decisions (such as, recently, the fielding of vehicles without seat cushions.) . On the other hand, the comfort, and safety, provided the rider in accessing many of the system's routes is seriously deficient. Capital Metro will need to create a more pedestrian-friendly environment for its riders.

All bus routes should be furnished with sidewalks. In residential areas and along commercial arterials where there is no on-street parking separating traffic lanes from sidewalks, these sidewalks should be tree-lined. Amortized over the life of these assets, the cost per rider of these improvements is negligible. Moreover it will have a positive location impact, making the route cachement a more desirable location for businesses, residences and new development.

If there is one competitive factor that the transit industry has been most ineffective in providing, it is convenience. With the elimination of the transaction cost associated with fare collection the convenience offered by the transit system depends on three factors: trip times, frequency of service, and the system connectivity.

To improve operating speeds and reduce passenger trip times, equip all major trunk lines with transit-priority signalization.

The cost per mile of bus operation comprises three components: costs that are incurred on a per-mile basis (e.g., maintenance and depreciation), costs that are incurred on a per-hour basis (operator labor and fringes), and overhead. By increasing the miles per hour of vehicle operation, the per-hour based costs decline and with them the total cost per mile. Most of the cost of signalization improvements will thus recouped by operating costs savings.

Transfer centers must be located so as to minimize the impact on the operating speeds of the vehicles that serve them. In particular, the North Lamar transfer center is prohibitively expensive to access and should be expeditiously relocated.

More than 50 vehicles enter the North Lamar transfer center during a peak hour, at a cost of 4 minutes per entry.

A one-mile per hour improvement in average system operating speed will produce a $2 million savings in annual operating expense.

It may be noted that at current levels of freeway traffic congestion, transit-priority signalization can produce operating speeds on some major arterials (e.g., South Congress) that are significantly better than peak-hour freeway speeds. Thus Park-and Rider express service can be offered off-freeway with better trip times than motorists experience with their freeway commutes.

Generally speaking, the savings in operating expense derived from improvements in operating speeds will be realized as the lower cost of maintaining or improving service frequency.

Improved frequency is the improvement most often requested by riders in ridership surveys and public hearings.

Frequency is a critical measure of the convenience of a transit route. Empirical research indicates that at a 12-minute headway, half of the riders will have consulted a schedule before arriving at the bus stop, and half will have simply walked to the bus stop preparing to wait for the next bus that comes along. At a 10-minute headway, few people will consult the schedule and at seven minutes or better (UT Shuttle levels of service), riders pay no attention to schedules at all.

It should be noted that for any given time increment, the cost of improving service frequency by that increment becomes larger, the higher the already existing frequency. It costs twice as much to improve service from a 15 minute to a 10-minute headway (from 4 to 6 arrivals per hour), as to improve service from a 20 minute to a 15-minute headway (from 3 to 4 arrivals

per hour). Noting this serves to emphasize the need to make all efforts to improve operating speeds to reduce the cost per vehicle mile of service. But it should also be noted that when frequency improvements are driven by demand, in response to overcrowding, the marginal cost per rider will approach the average cost per rider of the route, and, realistically, there are likely to be few if alternative service improvements funds that will yield a lower marginal cost per rider than the average cost per rider on a fully loaded bus. Consequently, the traditional transit industry approach of responding to overloading by increasing the size of the vehicle rather than improving frequency is harmful to ridership growth. Assuming a fleet in which the 35 ft bus is standard, 40 ft buses should not be deployed on any route where headways are greater than 10 minutes.

To achieve improved system connectivity, cross-town routes should be implemented at headways no greater than 10-minutes.

Whenever a transfer is involved, frequency becomes doubly important in determining the convenience of the service. A trip requiring a transfer will require two waits at a bus stop, lengthening the total trip time correspondingly. Additionally the penalty for even a slight failure in on-time performance can be unacceptably high, when a connection is missed. Fortunately, route lengths for cross-town routes can be very short, and routes can be selected that maximize operating speeds, to minimize the number of vehicles needed to perform the service at the needed frequency.

Improving Coverage

In the expansion of coverage, the transit system has recorded its most consistent record of failure. Capital Metro has not introduced one successful new bus route in the past ten years. There are two reasons for this failure.

The Authority has consistently made the mistake of introducing new service at low frequencies, promising improvements if demand warrants. Properly, all new routes should be introduced at 7-10 minute headways, and then "backed off" to reflect demand.

Capital Metro commonly introduces new routes with 20-30 minute headways. This is not even remotely competitive with the automobile. Moreover, in areas previously unserved by bus service, we find virtually no transit-dependent riders. The result is extremely poor ridership and consequently unacceptably large cost-per-rider. Such routes are doomed from the start. The repeated addition and subsequent elimination of new routes has been a constant feature of Capital Metro's service planning over the past decade.

Even if the ultimate demand for a new route will prove not to warrant a 10 minute frequency, demand will prove to be "sticky," and most riders will continue riding if the initial 10 minute headway is later increased to 15 minutes. Through experience, the planning staff must develop evaluation skills to determine quickly whether a new route will eventually prove viable.

The second reason for failure lies in the attempt to serve areas where the design of the roadway and pedestrian facilities makes them wholly unsuited, for operational reasons, for transit service. Since the late 1950's, with the personal auto dominating the market for trips of all types, and the corresponding growth of vehicular traffic, developers have increasingly planned subdivisions with street systems designed to deter through traffic. The traditional gridded pattern of streets has been abandoned in favor of a "cul-de-sac" approach to neighborhood design. The buffering of neighborhoods from arterial traffic has the additional effect of denying convenient pedestrian access to possible transit routes on the arterial system. Transit planners have thus introduced service onto the neighborhood streets themselves, with buses meandering through the neighborhood in search of potential riders. The operating speeds under such conditions are very low, and the cost per mile of service correspondingly high.

To attempt to serve areas where the local street system discourages through-traffic and impairs pedestrian access to arterials is an exercise in futility. Coverage should be expanded only in those areas where a reasonably low cost-per-rider can be expected.

Such poor performing routes are sometimes justified on grounds of equity, that since the residents pay the sales tax, they are entitled to service. But in paying the sales tax, what the citizens are entitled to is cleaner air and reduced traffic congestion, and to assume that all citizens are entitled to fixed-route bus service, regardless of their choice of residence, will so voraciously consume the Authority's resources as to deny these intended benefits to all.

While there are some developed areas, presently unserved by fixed-route transit, which may be retrofitted for bus service, most new coverage must be added at the time an area is developed.

Historically, this is the way transit systems grew. The transit operator bought the raw land, introduced the transit route, and then sold the subdivided homesites. The profitability of the enterprise relied entirely on the competitiveness of the service offered. (In the age of the streetcars, from the 1890's to the 1930's and then of buses, from the 1930's to the 1950's, competitiveness could be achieved at relatively low, and inexpensive, levels of service - the alternative for most commuters was to make the trip on foot.)

Such land use impacts are touted by promoters of rails systems today, though in fact the rail lines for which they are sought are generally built in already developed transit corridors where the impacts are not likely to be dramatic. Land use may already reflect decades of transit impact and any redevelopment will be slowed to the extent that existing land uses continue to be economically viable. A far more dramatic modern example of such impacts was the introduction, by the U.T. Shuttle Bus Committee in 1970, of the East Riverside shuttle route. Within a year of its inauguration, the entire hillside was under development with apartment complexes seeking the competitive advantage the UT Shuttle brought to the area.

The introduction of service in a newly developing residential area circumvents the problems associated with deploying service in already developed neighborhoods. Routing decisions can be made entirely on the basis of operating efficiency and current transit riders seeking new residences have an abundant supply to select from. Note that since the presence of

transit service will be viewed as a stronger selling point by transit riders than by non-riders, apartment rentals and home sales will be made disproportionately to the transit riders. A large population of riders will be assembled far more quickly in such a neighborhood than in one retrofitted for bus service, where homes and apartments will trickle onto the market.

Provision of competitive transit routes to a newly developing area can be conditioned on a roadway and pedestrian infrastructure friendly to bus operations and pedestrian access.

While the historic practice of the early transit companies and the more recent experience of the UT Shuttle system relies on the development of real estate on the origin (residential) end of the transit trip, location impacts are also available on the destination end. In the streetcar era, this occurred when the transit system developed an "anchor" at the outlying terminus of the route, typically an amusement park which could boost ridership in otherwise under-performing evening and weekend periods. In recent years, Toronto has famously made commercial development the hallmark of its transit system, which, with more than 200 annual trips per capita, is the most successful in North America. By partnering with commercial developers Toronto has planned routes around high-density "hubs" in newly developing areas. The incentive for the developer is obvious, a significant savings in the project acreage that must be allocated to parking. It is interesting to note that over the last 40 years the Toronto Transit Commission has steadfastly discouraged new public incentives for "Downtown Revitalization," preferring that such incentives be directed to its Transit Centers.

By partnering with commercial developers, the Authority can promote the development of high-density Urban Centers, each forming the hub of a shuttle bus system that serves transit-friendly, pedestrian friendly residential neighborhoods.

The Authority's success in accomplishing this depends on the clear demonstration of its ability to provide highly competitive, high-ridership transit service on its existing routes. To the extent that it succeeds it will have provided a growth alternative to urban sprawl, while expanding the residential and employment coverage of the fixed-route transit system.

Proprietary Shuttle Bus Systems

The University of Texas Shuttle Bus System is an example of a proprietary system. Capital Metro operates the system under contract with the University of Texas, which maintains control over routes and schedules and pays Capital Metro a negotiated fee for providing the service. It is useful to look at the history of this involvement.

The UT Shuttle began operation in the Fall of 1969. Over the course of the previous decade, with University enrollment expanding, and with on-campus parking increasingly at a premium, access to the campus became a serious issue among the student body. Austin Transit, the city's bus system, had studied the problem, under an agreement with the University, and attempted to provide specially designed UT bus service, at a reduced fare for students, but such efforts at their best could manage to attract only 160 trips per day. The Shuttle was the brainchild of a student, Jerry Irwin, whose lobbying for the plan, caught the attention of the University's Parking and Traffic Division, who deemed the plan feasible,

including free fares and minimum 12-minute headways. The Board of Regents approved the levying of a student fee to support the system. Within several weeks, the system was carrying nearly 10,000 trips per day.

The Shuttle was overseen by a committee of a student-faculty shuttle bus committee, and the University contracted with a bus operator (at first, Transportation Enterprises, Inc. and later Laidlaw Transportation) to operate the service.

In 1988, Capital Metro negotiated a contract with the University to operate the Shuttle for the same price, $3.2 million, that the University had been paying Laidlaw, but agreeing to provide the Shuttle with lift equipped, air-conditioned buses, beginning in the second year of the contract . For the University, "lift-equipped" was the major selling point, facing threatened litigation on behalf of disabled persons for whom the Shuttle System, then operating with Bluebird school buses, was inaccessible. For Capital Metro, the agreement enabled it to meet obligations it had accepted with a 1986 Federal Grant, which had required the Authority to undertake a demonstration project in "privatization." By subcontracting the Shuttle operation to Laidlaw, these obligations were deemed by the Federal Department of Transportation to have been met.

In the first year of the contract, the Authority acted simply as a middleman, passing the University's payment on to Laidlaw. But in the second year, when the school buses were replaced by the Authority's transit coaches, the cost of operating the system nearly doubled. Costs have continued to rise since then, and today the Shuttle Bus costs more than $10 million annually to operate. Slightly less than half of this cost is paid by the University (and ultimately by the student shuttle bus fee) under the current contract. The remainder of the cost represents an implicit subsidy to the Shuttle Bus system. The current subsidy per rider is roughly $1.00, half funded by the student fees, and half by the Authority's tax base.

It seems unlikely, had the University sought itself to lift-equip the Shuttle Bus fleet in 1989, that it would have doubled the cost of operation.

It would be far better, financially for both sides, and as a matter of public policy, for the Authority to redesign its relationship with the UT Shuttle, first to make explicit the subsidy provided by the Authority, and second, to remove itself as the superfluous middleman. This can be accomplished simply by contributing a $0.50 subsidy per rider to the University, an offer that can be made similarly to other institutions, e.g. major employers, who might wish to develop their own shuttle systems. In exchange, the Authority can impose only minimum easily met requirements: that the service be open to the public, free of charge and accessible by the disabled, that its stops be accessible by Capital Metro's own routes to facilitate transfers between the Shuttle System and the Metropolitan transit system as a whole, that it meet minimum average load requirements, and that its operating results be audited in compliance with Federal reporting requirements.

A Note on Rail Planning

A Light Rail system such as proposed by Capital Metro's Board comprises three separate kinds of improvements: dedicated right of way, electric power, and rail. It is useful to examine these improvements separately and identify the economic benefits each might offer so that planners can establish the specific conditions under which they would contribute positively to the mission of the Authority. All three depend upon economies of scale, in that they become economically viable the greater the number of vehicles the system operates along a given route. The order in which they can be expected to become viable, and thus the order in which they should be implemented, is as follows:

- Dedicated Right of Way
- Electric Power
- Rail

Dedicated Right of Way

This is the only one of the three that has a demonstrated ability to attract new ridership insofar as it permits improved operating speeds and shorter trip times. By improving operating speeds it also reduces the cost per vehicle mile of service. Dedication of the right of way can be achieved at great cost by grade-separation, such as in heavy rail, subways or busways, or it can be achieved at lower cost with diamond-lanes or merely by implementing transit-priority signalization. It is likely that on several of Capital Metro's current routes, transit-priority signalization will yield savings in the cost per rider.

It must be noted that a diamond lane will deny use of the lane to motorists, with adverse impacts and that the benefits to transit operations come at the expense of those otherwise using the arterial. It is for this reason that we have not included them in this plan.

Electric Power

Shifting from internal combustion engines to electric power will reduce the maintenance costs of the vehicles, and may, depending on the source of the electricity used, produce improvements in pollutants emitted. In 1989, the Authority examined the feasibility of electrifying bus routes, as part of an evaluation of alternative fuels options. At that time, it appeared that the cost per mile would be increased, rather than decreased, by electrification on even the most intensively served route (North Lamar). The principal cost problem with electrification is the small market for electric buses in the U.S. Without economies of scale in the production of vehicles, the capital cost per vehicle proved to be too high to warrant their

use. However, subsequent increases in the cost of transit coaches have made it worthwhile to reexamine the issue.

There have been notable efforts in recent years to develop battery powered electric transit vehicles. Such vehicles would offer the maintenance cost advantage of electric power without the capital cost of the infrastructure. These developments should be examined to determine if participation in pilot projects is warranted.

The singular economic advantage offered by rail is the ability to "train" cars together, thus permitting the system to add capacity to a route without adding operator labor.

However, unless the route is already operated at highly competitive frequencies (under 7 minutes), there will be a sacrifice in the competitiveness of service. In the era of the streetcar, when competitiveness required only that the service be more attractive than the trip made on foot, this was invariably the correct decision. Today, for routes with headways 10 minutes and greater, this is probably not the case. Like route electrification, the cost advantages that may be garnered from rail are diminished by the small production runs and consequently high costs of rail vehicles. If any current bus route were a likely candidate for rail, it would certainly be the UT's IF Shuttle Bus route, with its 3-minute headways.

It is sometimes argued that land-use impacts (location impacts) are afforded by rail that are unachievable with bus service, that the "fixed guideway" assures developers that the service will be there for the long term. This needs to be qualified. It is hardly conceivable that a real estate developer will view a South Congress – Guadalupe – North Lamar rail line as more permanent than the current bus routes operating on those facilities. These routes existed 50 years ago and they will exist 50 years from now, whatever kind of wheel, steel or rubber-tired, is used on the vehicles. Only the most deranged transit planner would realign this service.

There may, however, be a location-impact advantage for rail where service is introduced into a newly developing area. Nonetheless, the experience of the U.T. Shuttle has shown that even very low-cost bus routes can have dramatic location impacts when the planners have a demonstrated track record of designing successful service.

Appendix: Analyzing Performance

Subsidy per Rider = Cost per Rider - Average Fare

Cost per Rider = Cost per Vehicle Mile / Riders per Mile

Cost per Mile is the basic unit cost of service.

Riders per Mile is a measure of the effectiveness of that service in attracting ridership.

Every performance measure comes with caveats. In using riders (i.e., boardings) as the measurement of ridership, we will draw conclusions that are unduly biased against those express services where Riders per Mile are lower but where each boarding results in a longer trip, and, most likely, a greater impact on vehicular traffic, than for local service. To avoid this problem, we can measure "passenger miles," rather than boardings. We would then speak of Subsidy per Passenger Mile and Passenger Miles per Capita. The advantage of boardings as a measure of ridership is that they are easy to count. They are, in fact, counted by the drivers daily. Passenger Miles are available, however, both from the semi-annual Boarding and Alighting Counts, and from the statistical sampling performed and audited for submission to the National Transit Database.

From Passenger Miles, we can derive two helpful measures:

Average Trip = Passenger Miles / Boardings

Average Load = Passenger Miles / Vehicle Miles

If we have readily available the average trip distance for each of the different kinds of service provided, we can guard against the bias that will result from examining simply the boarding counts.

Passenger miles are critical for intermodal comparisons. Highway planners are now accustomed to computing passenger miles for the roadway system, by taking VMT (vehicle miles of travel) and multiplying by estimates of average vehicle occupancy, currently about 1.1.

Two measures, which are used almost universally in the American transit industry, must be counted among the industry's bad habits: Cost per Hour and Farebox Recovery Ratio.

Cost per hour is frequently treated as if it were a unit cost of service, but the unit of service is the mile, not the hour. Given a route of a certain length and the established frequency of service, we have completely determined the number of vehicle miles to be operated. The number of vehicle hours incurred in the operation of the route then depends upon the average speed of the vehicle. The slower the operating speed, the greater the cost of providing that level of service - operator labor cost is incurred by the hour. But other costs (e.g., maintenance and depreciation) are incurred by the mile and will therefore be distributed over a larger hour-base at low MPH. Thus, if operating speeds slow, say because of increasing traffic congestion, the cost of maintaining existing levels of service will increase.

But the Cost per Hour will drop, giving the mistaken appearance of improved performance. Conversely, a transportation system that delivered its passengers to their destinations instantly, would have an infinitely high Cost per Hour.

The Farebox Recovery Ratio is a vestige of an era when the subsidy provided to the transit system was the residual of the cost over the fare revenues. When it was the mission of the transit system to maintain those levels of service needed by the transit-dependent with the minimal burden on the taxpayers, the Farebox Recovery Ratio was an indicator of the social welfare expense. For a transit system with a dedicated tax subsidy, however, the Farebox Recovery Ratio is simply a measure of the degree to which the system is maximizing revenue, and for any public agency, maximizing revenue is equivalent to maximizing cost. Note that unproductive increases in operating costs, as long as they are recovered from the farebox, will produce an increase in the Recovery Ratio but an increase in the Subsidy per Rider as well.