MEMORANDUM

Subject: Implications of Measure T for CubeTown's Transit Network

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INTRODUCTION

The newly-proposed Measure T could have significant effects on service frequency on CTrans' bus and rail lines. This memo proposes several hypothetical scenarios and uses Cube to estimate their effects on CTrans' ridership figures. Before considering these scenarios, we briefly discuss the current state of the CTrans peak-hour network, the demographics of CTown and general travel behavior of transit riders.

At the moment, CTrans is the proud operator of four transit lines: two local bus lines (the Red and the Blue line), one commuter bus line (the Flash line), and one rail line. Table 1, below, summarizes headways and minimum total trim time on each of these lines, two characteristics that will factor heavily into the scenarios outlined shortly. Of all CTrans' lines, the rail line has the smallest headway and by far the shortest roundtrip time (including a 10-minute driver recovery window). The Flash commuter bus line is the next most frequent with a 10-minute headway. Both local bus lanes operate with similar, fairly large headways of 15 minutes, but the Blue line has a minimum possible roundtrip time roughly 70% longer. As can be seen from the maps below, this is due to the line's much longer distance, which is another important factor in our analysis. Overall, CTrans ' network stretches over a fairly wide area, which is served most frequently by rail and somewhat less frequently by bus.

The current transit routes and service area in CTown generally match the demographics and transit use patterns we have seen in the literature, but there is room for improvement in service frequency and total trip length. The majority of transit trips are work and school trips, whereas some other major trip purposes such as shopping and recreation are less commonly through transit (Black 1995). Household and job density maps of CTown (Figure 1 & 2) show that the transit lines go through somewhat dense residential areas and connect to areas with high job density, serving the demand for work trips on transit. Transit use is also inverse to income level (Black 1995), so it is important to provide reliable services to areas with a high percentage of poverty. The Red line, Blue line and Flash line all serve lower-income communities, but the headways and travel time to downtown are generally longer, creating a transit penalty for these communities.

Looking at American Community Survey data on transit, we can see that transit plays a significant role in commute trips, but there are huge disparities in travel time compared with people that drive alone. On a national level, although transit only accounts for 5% of commute trips, it is the second most common mode to work following drive alone according to American Community Survey 2009 (McKenzie and Rapino 2011). Transit users spend on average 20 minutes longer on commute trips than those that drive alone (Ibid.). As CTrans shifts strategically from road widening to multimodal solutions to manage transportation demand, it is important to align transit with employment access and shorten travel time on transit.

Table 1: CTrans Lines, Current Headways, and Current Roundtrip Times:

Line	Current headway (minutes)	Minimum total time for roundtrip, incl. recovery (minutes)	Actual total time for roundtrip (given headways) (minutes)
Red	15	47	60
Blue	15	80	90
Flash	10	51	60
Rail	8	31	32

Figure 1: CTrans Lines and Household Density (Households/Acre):

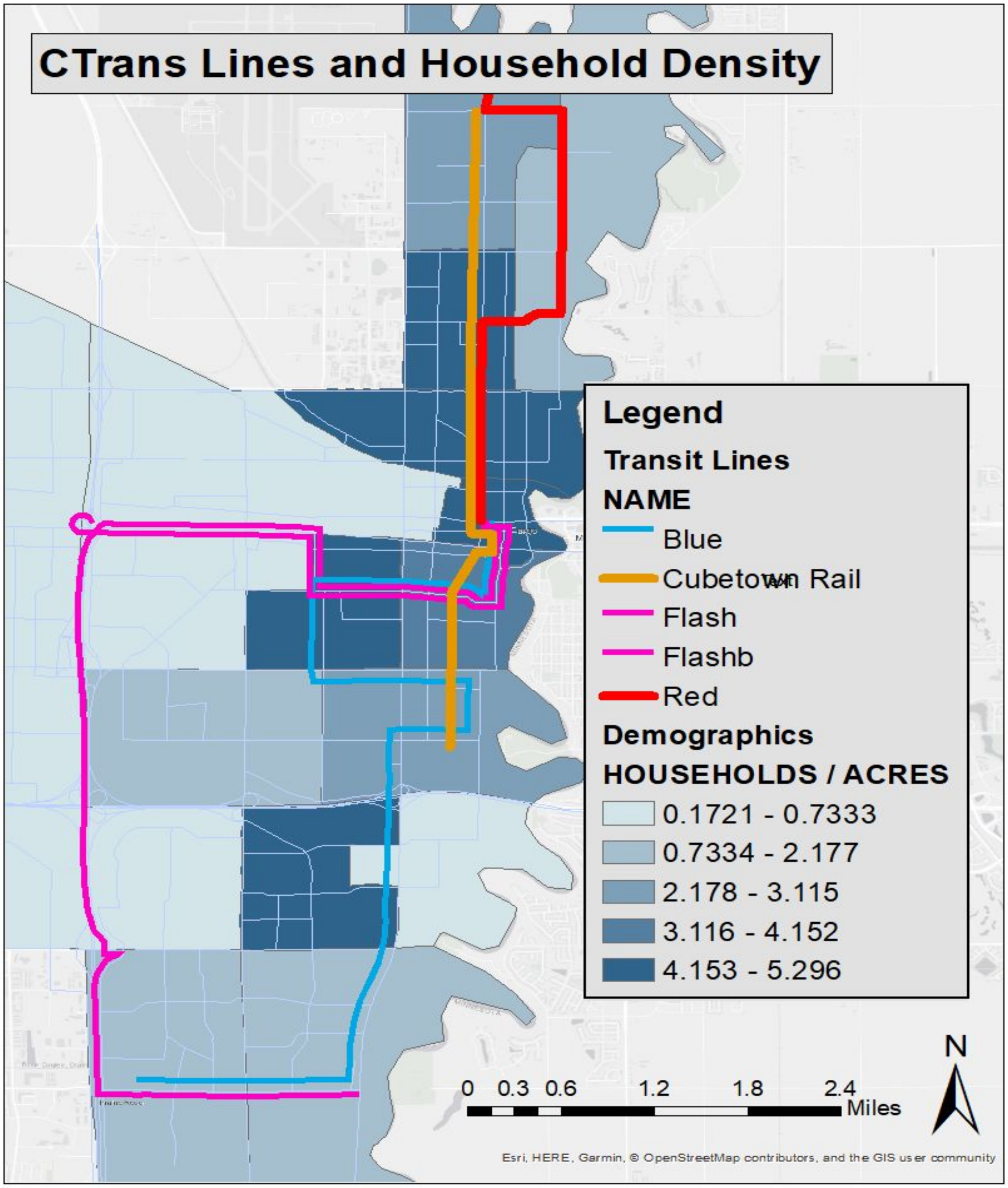


Figure 2: CTrans Lines and Job Density (Employment/Acre):

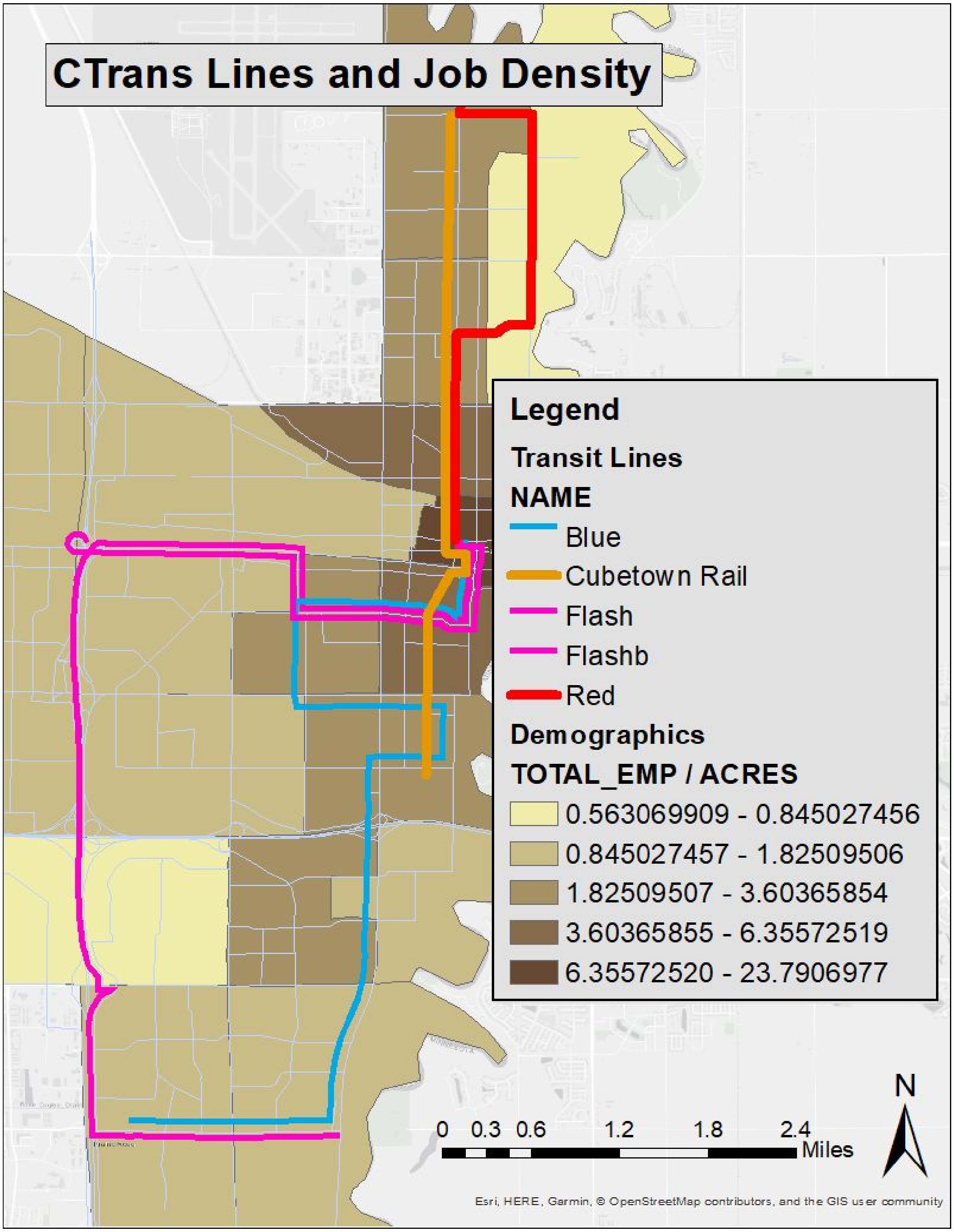
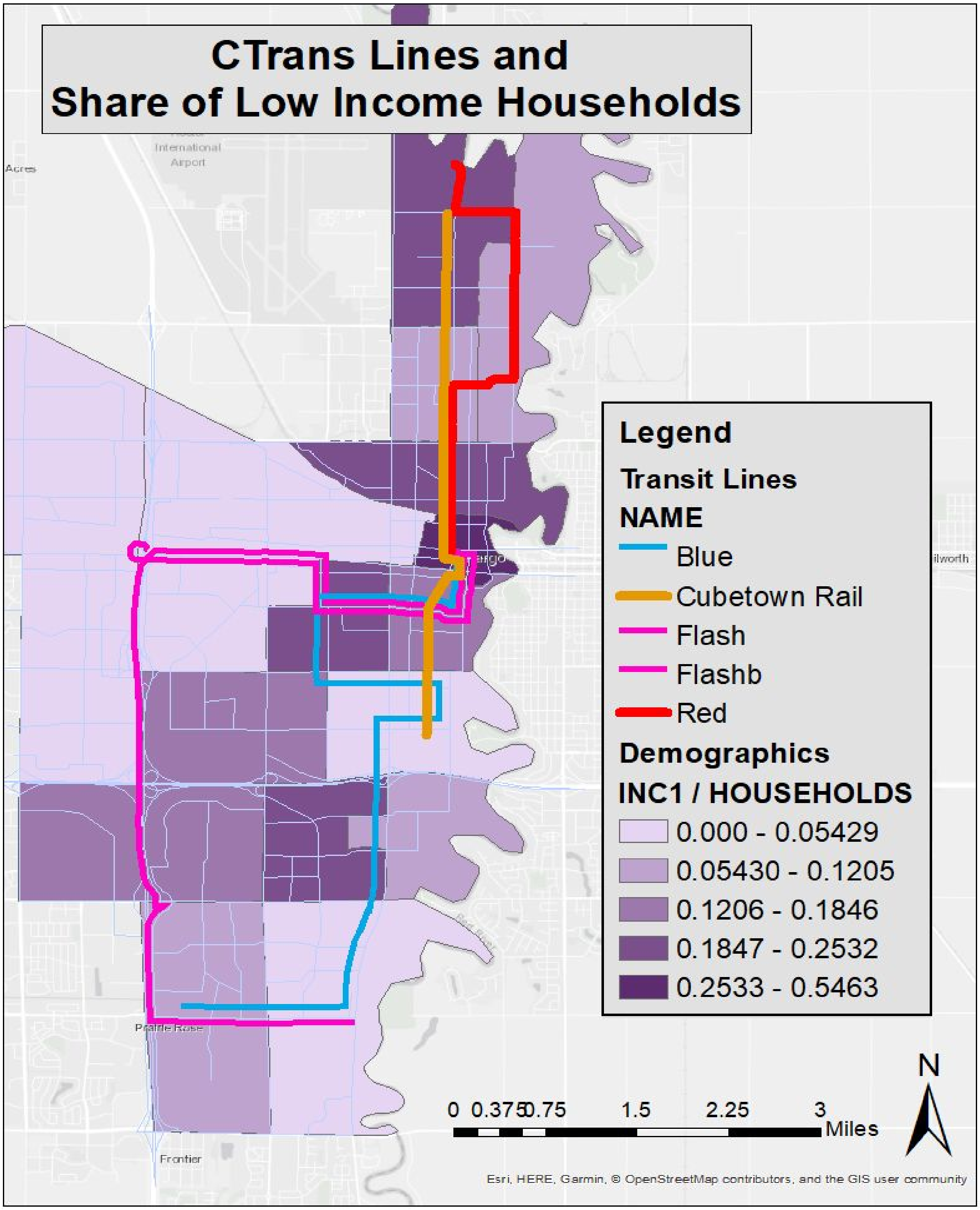


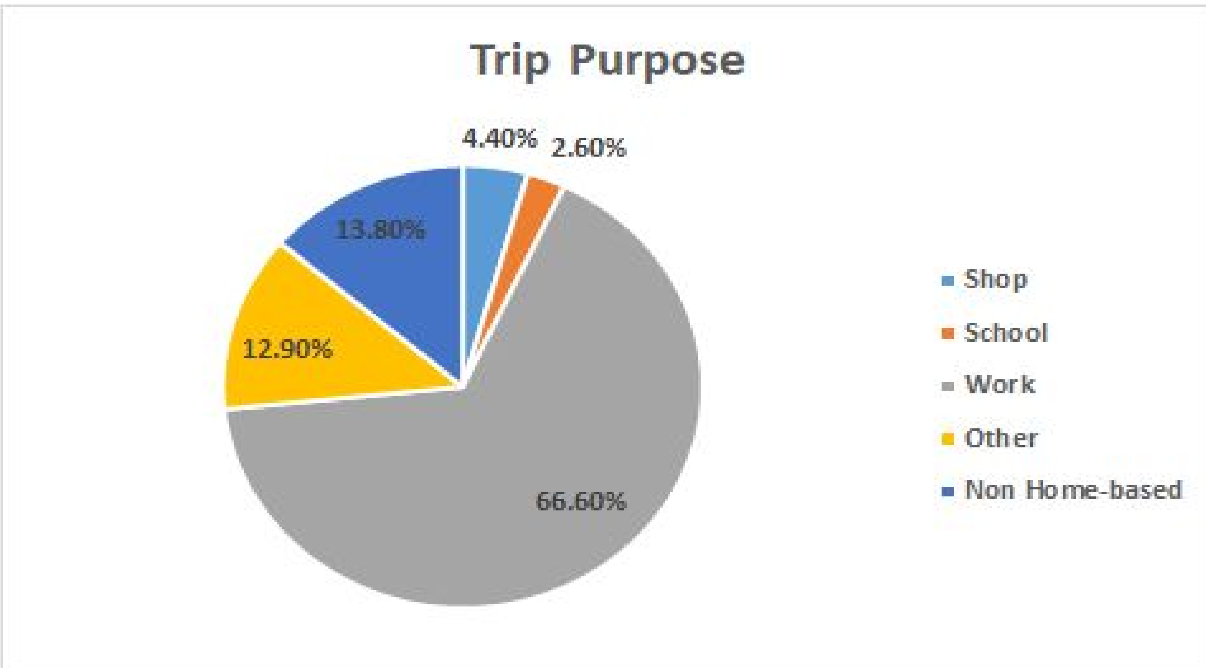
Figure 3: CTrans Lines and Share of Low Income Households (Bottom Quintile Households / Total Households):



ANALYSIS

Current CTrans Ridership (Base Case)

The analysis below uses Cube to model four scenarios. In the base case, ridership is modeled based on peak-hour headways as they currently exist. In this case, work dominates as the major trip purpose for CubeTown's transit riders accounting for around 67% (770,461 trips) of the total transit trips. School trips were the lowest and only accounted for 2.6% (27,298 trips) of the total transit trips. The other trip purposes data collected were for shopping, non-home based and others. The total trip purpose percentages were 4.4%, 12.9%, and 13.8% respectively.



In Scenario 1, Measure T fails and headways are modified to improve service on certain lines. In Scenario 2.1, Measure T passes and the resulting funds are used to improve headways only on CTrans' bus lines. Finally, in Scenario 2.2, Measure T passes and the resulting funds are used to improve headways both on CTrans' bus lines and on its rail line. Table 2 summarizes these scenarios.

Table 2: Scenarios Considered:

Scenario 1: Measure T Fails	**Scenario 2: Measure T Passes**	
Move one bus/driver from the Red line to the Flash line.	Scenario 2.1: Add 6 buses to the Red line.	Scenario 2.2: Add 2 buses to the Flash line and 1 rail car to the rail line.

Scenario 1: Measure T Fails

In Scenario 1, Measure T fails and CTrans is faced with the need to reallocate resources among its lines. We choose to model a scenario in which one bus and driver are moved from the local Red line to the commuter Flash line. In terms of trip attractions, CubeTown's job density is highest in the downtown and near-downtown. In terms of trip generation, the Flash line begins in CubeTown's low/moderate density suburbs, which might not suggest it as a candidate for increased service. However, the Flash line currently has by far the highest ridership of CTrans' bus lines. There seems to be a large, pre-existing flow of commuters using the Flash line to reach downtown attractions.

Given the Flash line's already high use, even a small decrease in headways might increase usage by meeting currently unmet demand. Although increasing headways by adding an additional bus does not directly reduce travel times along the route, it could reduce overall travel times for commuters by reducing the lag between when a commuter arrives at a Flash station and when a bus departs the station. By reducing the disparity that national data have shown in overall commute time between public transit and the car, this could make the Flash line slightly more competitive option for accessing downtown and near-downtown jobs (McKenzie and Rapino, p. 14). Moreover, commuting trips make up the majority (67%) of CTrans trips, and commuting plays a decisive role in determining flows of peak-hour traffic (McKenzie and Rapino 2011, p. 1). Adding a vehicle to the Flash line reduces headways from 10 minutes to 8 minutes - while a small improvement, it could nonetheless make the Flash more competitive with the car than it currently is.

Overall, Cube suggests that moving a vehicle from the Red line to the Flash line increases Flash and rail ridership while decreasing Red and Blue line ridership. The decreases are unsurprising. By the same logic that predicts reducing Flash line headways will increase its ridership, increasing Red line headways should decrease its ridership. Interpreting the Blue line's decrease requires more speculation, but the likeliest explanation is that travelers who had used the Blue line to get between the suburbs and downtown shift to the Flash line, which makes the same route significantly faster and more frequently.

The increases are also fairly straightforward. Matching expectations, moderately decreasing headways moderately increases Flash ridership. The increasing rail ridership, on roughly the same scale as the decreasing Red line ridership, suggests that some riders switch from the less-frequent Red line to take advantage of the rail line's relatively better frequencies.

Scenario 2.1: Measure T Passes and CTrans Adds 6 Buses

In this scenario, CTrans is assumed to use the additional funding from Measure T to add 6 buses and drivers to the red line, reducing headways on that line from 15 minutes to 5 minutes. Both the Red line and the Blue line run through densely populated areas and sparsely populated areas. But upon further examination in comparison to the Blue line, the majority of the Red line seems to run through some of the most densely populated areas of CubeTown. The Blue line also runs along the Flash line, the bus route with the highest ridership, for 40% of its route. This duplication of service, often in parts of the city that are only moderately dense in terms of population in jobs, probably makes the slower Blue line a poor competitor relative to the Flash line. Using the additional funds from Measure T to improve service on the Blue line would probably not do much to address this relative disadvantage. Therefore, investing the additional buses on the Red line would be the most cost-efficient in terms of improving job accessibility and serving the most riders.

As expected, ridership increases on the Red line, to a remarkable degree. Previously, the Red line's ridership of 283 had been roughly on par with the Blue line's 315. After decreasing Red line headways to 5 minutes, this value increases by roughly 400% to 1140, while ridership decreases by roughly ⅓ on the Blue line and by a little more than 5% on the Flash line. Rail ridership remains roughly the same, which runs against the conclusion from Scenario 1 that Red line and rail line cannibalize each other's rider base. Overall, the huge increase in Red line ridership seems to bear out the rationale behind this use of Measure T funding. The relative strength of this approach should probably be weighed against the results of using Measure T funding to improve service on each of the other bus lines, alone. This memo does not model these scenarios.

Scenario 2.2: Measure T Passes and CTrans Adds 2 Buses and 1 Rail Vehicle

In the final scenario, CTrans decides to use Measure T's passage to add two vehicles to its bus lines and one vehicle to its rail line. We model the effect of adding the two buses to the Flash line, reducing headways from 10 minutes to 7 minutes. The additional rail vehicle improved the rail headways from 8 to 7 minutes. The Flash has the highest ridership in the bus system and likely connects some lower-income residents to their employers downtown, so investing the additional buses on this line would be the most cost-efficient in terms of improving job accessibility and serving the most riders. Increasing service on the Red and Blue lines could be good options, but the lower ridership and the Blue line's relatively long route are judged not to justify investing two buses on one line. Alternatively, one bus could be added to each line, but this would not reduce headways in any meaningful way. In addition, although Scenario 2.1 suggests higher frequencies on the Red line do not cause lower ridership on the rail line, this might not hold in a scenario where the Red line's headways remain relatively high and the rail line's headways decrease somewhat. Since the rail route overlaps largely with the Red line, increasing capacity on rail and the Red line simultaneously could cause competition and dilute ridership on both routes.

The resulting ridership changes from the base case are roughly as expected, and unlike in Scenario 2.1 do not involve decreasing ridership on any line. Rail ridership increases by roughly 10% and Flash ridership increases by roughly 15%, suggesting that the decreased headways and increased accessibility represent real enticements for significant numbers of travelers. Red and Blue line ridership remain virtually unchanged from the base case.

CONCLUSION

The scenarios outlined above represent significant changes to CTrans' current service patterns. A summary of the headway changes can be found in Table 3, below:

Table 3: CTrans Lines and Changes to Headways (minutes) under Scenarios

Line	Current headway	Headway under Scenario 1	Headway under Scenario 2.1	Headway under Scenario 2.2
Red	15	20	5	15
Blue	15	15	15	15
Flash	10	8	10	7
Rail	8	8	8	7

The biggest overall increase in transit ridership, a roughly 12% increase, occurs as a result of drastically decreasing headways on the Red line (in Scenario 2.1). The next-highest increase occurs in the scenario in which Measure T funds are split to add 2 vehicles to the Flash line and 1 vehicle to the rail line. Scenario 1, modeling one potential response to Measure T's failure, shows the lowest ridership increase.

Scenarios 2.1 and 2.2 present two rather different ways to take advantage of potential Measure T funding. In the former, all funding is used to improve headways on the local Red line, with expected but still drastic effects: ridership is projected to boom on the Red line under this scenario while stagnating or decreasing on CTrans' other lines. In the latter scenario, funding is split between the Flash commuter bus line and CTrans' rail line. This represents a safe, "no lose" scenario: headways either remain the same or improve on all lines, and the same is roughly true of ridership numbers.

Scenario 1, on the other hand, presents a scenario in which CTrans responds to Measure T's failure by increasing its already significant ridership on the Flash and rail lines, which primarily serve commuters. By increasing headways on these lines, CTrans improves its ability to connect workers to CubeTown's very job-dense downtown. This comes at a moderate tradeoff in the form of decreased ridership on both of CTrans' local bus lines. Scenario 1 suggests that, even if Measure T fails, CTrans has options to increase overall transit ridership in CubeTown. However, the only scenario that allows increased ridership on all lines seems to depend on Measure T's passage.

Table 4: CTrans Ridership (Boardings) in the AM Peak under Base and Alternative Scenarios:

	Red Line	Blue Line	Flash	Rail	Total
No Change:					
Base	283	315	1117	3444	5159
Measure T Fails:					
Scenario 1	187	189	1299	3597	5272
Measure T Passes:					
Scenario 2.1	1140	189	1045	3421	5795
Scenario 2.2	288	331	1287	3786	5692

WORKS CITED

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McKenzie, Brian and Rapino, Melanie. 2011. "Commuting in the United States: 2009" The American Community Survey Reports ACS-15. Washington, DC: Bureau of the Census. Pages 1-19.