ConnectSF

Active Transportation Study: Network Builds Memo

SUMMARY

The purpose of this memo is to document the development process for three "Network Build" concepts for the Active Transportation Study. These Network Builds present three different versions of citywide bike networks, organized along different themes, metrics, and priorities. Each of these three Network Builds were developed to be comparable in scale, cost, and impact with corresponding concepts for the Transit Corridors Study and the Streets & Freeways Study. Due to the comparatively low cost and limited impact of individual active transportation projects, the Active Transportation Study pursued a model of citywide bicycle networks. This allows for the citywide network to be modeled on a cumulative basis. The Three Network Builds themes are as follows:

- **Maximum Mode Shift**: bike network investments focused on high job/population areas or areas with high projected growth. Bike network investments prioritize fast and direct commute trips.
- **Vision Zero**: bike network investments focused on the High Injury Network. Bike network investments prioritize car-free streets, encouraging more short trips and street transformation.
- **Communities of Concern Access**: bike network investments prioritize access to mobility, especially Muni Rapid lines and regional transit, for low-income communities.

All three Network Build concepts were assembled using ATS corridors identified in the Corridor Suitability Assessment Memo (visualized in the Corridor Segment maps). All of the corridor segments in each Network Build are assigned one of three bicycle facility typologies, first identified in the ATS Typologies Memo. Each Network Build pursues a specific set of goals, the metrics for which determine the corridors selected for inclusion and the mix of typologies applied across the network. This results in three appreciably different Network Builds, for the purpose of clearer differentiation in modeling outputs and comparison against TCS and SFS concepts.

The project team started with a "Core Network" concept, identified with metrics in the Data Profiles Memo. The Core Network exercise identified a subset of ATS corridors and applied a set of typologies across the network, weighting all metrics equally.

The three Network Builds, preliminarily identified in the ATS scope of work, were adjusted and updated to better conform with the metrics identified in the Data Profiles Memo. By utilizing those metrics to assess both corridors and corridor segments, the study team created a uniform process for network and typological adjustments. The Core Network was used as the starting point for all three Network Builds, with each Network Build's key metrics determining changes to both corridors and typological assignments.

CORRIDOR & ZONE PROFILE SUMMARY

The corridors and zones were developed as part of Task 3 and resulted in:

- 20 corridors
- 49 corridor segments (subset geographies of the corridors)
- 14 zones

The culmination of Task 4 was the development of Corridor Profiles and Zone Profiles, where key metrics were analyzed and documented to create a clearer picture of active transportation trips taking place across the 20 ATS corridors. The purpose of the profiles was to identify active transportation opportunities and needs in different parts of San Francisco, using corridor profile summaries to understand longer and cross-town trips and using zone profiles to understand neighborhood and local trips.

For more information about how these geographies were developed, please see the Corridor Suitability Assessment memo and Corridor Segmentation and TAZ Allocation memo.

The ATS's goals, objectives and initial metrics were developed as part of Task 4 (Network Analytical Framework) and documented in the Data Framework memo. For the purpose of informing the network development process, ATS staff updated and refined metrics the data framework metrics. More details about the profiles and a table comparing initial data framework metrics to the final profile metrics are included in the Data Profiles memo.

ESTABLISHING CORE NETWORK

The first step in establishing the core network was to identify gaps in the existing bikeway network, looking only at network segments scored as 1 (suitable for children) or 2 (comfortable for most adults) as part of the Level of Traffic Stress (LTS) bikeway classification system[1]. This was done by overlaying the existing LTS 1 and 2 bikeway network on top of the 20 ATS corridors. If an ATS corridor covered or ran through an existing gap in the network, then that corridor remained as a candidate for the core network. This was a visual assessment carried out in ArcGIS. After this process, 15 out of the 20 ATS corridors remained, and those are the 15 corridors that were evaluated for inclusion in the core network.

In Task 4 of this study, the project team identified metrics (aligned with the Goal Areas of Connect SF – outlined in the Data Framework Memo) that would inform opportunities for the development of a core network. The team used the following metrics (a subset of the metrics identified in the Data Profiles memo) to evaluate the appropriateness of each corridor for the core network. The metrics selected were those that had highest correlation with potential positive outcomes for current best-practice bike network infrastructure:

- High percentage of Communities of Concern (CoC) population
- High bike mode share

[1] Level of Traffic Stress system developed at the Mineta Transportation Institue to measure the quality and connectivity of bicycle networks (http://transweb.sjsu.edu/PDFs/research/1005-low-stress-bicycling-network-connectivity.pdf). SFMTA uses a modified version of LTS labeled the Bicycle Network Comfort Index (https://www.sfmta.com/sites/default/files/projects/2017/ComfortIndexCIP_011317_0.pdf).

- Low percent of population with access within ¼-mile of a Muni Rapid stop
- High population and job density
- High transit crowding
- High percent of streets within corridor that are part of Vision Zero's High Injury Network
- High percent of trips that are two miles or less (bike trips most competitive with driving)
- Low percent of streets within corridor that are part of the LTS 1 and 2 network

Methodology

As a result of the Data Profiles established in Task 4, a series of metrics was available for all of the ATS corridors; this corridor-level data was joined to corridor boundaries in ArcGIS, allowing evaluation against each metric.

For inclusion in the core network, the project team looked at metrics by quartiles (top 25%) and by the top two quintiles (top 40%). Because there are only 15 corridors to be evaluated, the study team felt that only including corridors in the top quartile (top 25%) of corridors would yield a limited network with few corridors. Therefore, the team also assessed the top two quintiles (40%) of corridors that performed high based on the metrics. For each corridor that fell within either the top quartile or the top two quintiles, 1 point would be allocated to the corridor. Inclusion in the core network was based on which corridors had the highest scores across all metrics.

Figure 1. Core Network if including only top quartile

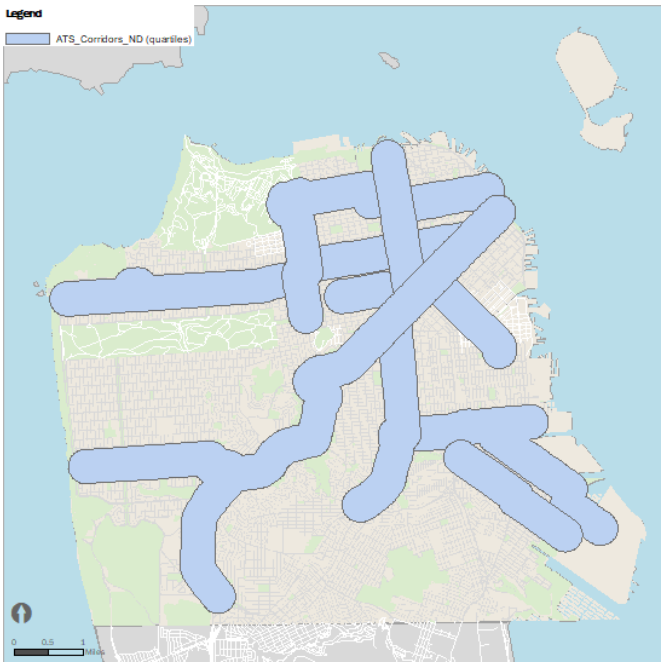

Figure 2. Core Network if including corridors in top 2 quintiles

If only the highest scoring corridors by quartile were included in the core network, then it will result in a lack of coverage in certain parts of the city, as shown in Figure 1. Because the other network builds are meant to use the core network as a base, the project team felt that it would be more appropriate to have more corridors in the core network to allow for greater coverage throughout the city. Therefore, the team decided to include the corridors that scored the highest by top two quintiles of metrics (see Figure 2).

Figure 3. Top two quintiles with ATS Zones Overlay

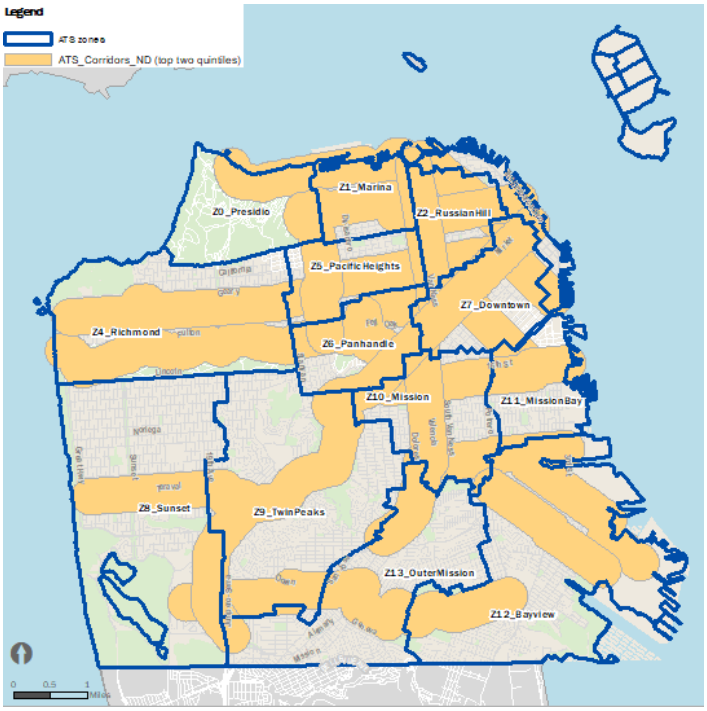

Figure 4. Revised Core Network

A final step in the development of the core network was ensuring that there was coverage in each ATS Zone. As shown in Figure 3, there was little coverage in Zone 8 (Sunset), Zone 11 (Mission Bay), and Zone 3 (Embarcadero). The team decided to include the corridor segment that runs through 19th Avenue in the Sunset and to include the entire ATS corridor that runs north-south from the Embarcadero to Bayview Hunters Point. The final core network is shown in Figure 4.

Figure 4 shows the final core network, which includes 10 ATS corridors and 1 ATS corridor segment (the portion of ATS corridor 9 that runs north-south through the Sunset district).

Inclusion of existing car-free streets: Upon review of the core network, the project team discussed whether existing car-free streets in San Francisco should be considered in the core network. Because there is a desire to be consistent and to reflect the strong public support for existing car-free streets, the project team decided to include the Great Highway corridor into the final ATS core network (see Figure 5). Other existing car-free streets, which are Market Street and John F. Kennedy Drive, were already reflected in the core network.

Figure 5. Final Core Network

METRICS SELECTION FOR TYPOLOGIES

Following the establishment of a Core Network, the ATS team developed a system to apply typologies to all of the segments of this new network. This system sought to leverage the data collected and analyzed as part of the Corridor & Zone Profiles in order to assign typologies to their most suitable corridor segments. Because the Core Network acted as a baseline, and not any of the three final Network Builds, the ATS team could use it as a testing model for a system of assigning typologies across the network.

The ATS team started by identifying Profiles metrics that most closely aligned with each of the three typologies. Because the metrics used to identify the Core Network completely overlap with key metrics for the Best Practices Bike Network, all corridor segments of the Core Network were assigned Best Practices Bike Network typology as a network baseline. The ATS team then assessed corridor segments in the Core Network for Profile metrics that best correlate with the other two typologies: Car Free Streets and Mobility Hubs. These metrics were:

> Car Free Streets (9 metrics): CoC coverage (high), walk mode share (high), bike mode share (high), short trips of two miles or less share (high), trip purpose (high percent of bike trips for personal/social trips), percentage of destinations within 500 feet of high quality bike network (low), population and job density (high), percent of streets on high injury network (high), percent of streets on LTS 1 or 2 network (low)

For the Car Free Streets typology, the ATS team sought indicators which would suggest strong interventions to restrict or divert car trips would lead to positive outcomes. This meant identifying areas with high walking & biking trips, areas with many short trips (especially for non-commute reasons), high densities of activity (suggesting a need for open space), areas with many bike/ped collisions, and areas with low current access to high-quality bike networks.

> Mobility Hubs (7 metrics): CoC coverage (high), transit mode share (high), regional trip share (high), short trips of two miles or less share (high), percent of streets with 5% slope or greater (high), access to Muni Rapid Network (high)

For the Mobility Hubs typology, the ATS sought indicators which would suggest the introduction of a mobility hub (which increases electric mobility availability and facilitates trip-chaining with transit) would lead to positive outcomes. This meant identifying areas with high transit ridership, many regional trips, many short trips (which could be easily replaced by electric mobility devices), areas with substantial topographic barriers (hills being easier to climb with electric mobility devices), and areas with high access to the Muni Rapid Network lines (increased potential for trip-chaining).

Some metrics were available at the Corridor Segment level and some metrics were only available at the Zone level. These were:

> Zone-level data (13 zones): percentage of destinations within 500 feet of high quality bike network (low); population and job density (high); percent of streets on high injury network (high); percent of streets on LTS 1 or 2 network (low); percent of streets with 5% slope or greater (high); access to Muni Rapid Network (high)

Corridor Segment-level data (49 segments): CoC coverage (high); walk mode share (high); bike mode share (high); short trips of two miles or less share (high); trip purpose (high percent of bike trips for personal/social trips); transit mode share (high); regional trip share (high)

APPLYING TYPOLOGIES TO THE CORE NETWORK

Starting with a baseline assumption of Best Practices Bike Network across the Core Network, the ATS team analyzed segment and zone level data for segments to assign either the Car Free Street or Mobility Hub typology. The rationale for this approach is that corridor segments not suited to Car Free Street or Mobility Hub typologies would remain as the Best Practices Bike Network typology. Because the Core Network was identified using metrics associated with the Best Practices Bike Network, all segments already express some level of suitability with this typology.

For the key metrics for Car Free Streets and for Mobility Hubs typologies, the ATS team identified the top performing segments or zones for each of the metrics identified above. The ATS team established a cutoff of the top 38% performing corridor segments or zones for each metric. That meant identifying the top 19 performers for segment-level data and the top performers 5 for zone-level data for each key metric associated with a given typology. Corridor segments falling within this cutoff range for a majority of the metrics for a typology (5 of 9 for Car Free Streets; 4 of 7 for Mobility Hubs) were flagged for typological assignment.

This analysis identified 19 corridor segments for Car Free Streets application and 14 corridor segments for Mobility Hub application; 12 corridor segments qualified for assignment with both typologies. In order to assign one typology over another, the ATS team compared corridor segment ranking for Short Trips (2 miles or less) versus corridor segment ranking for Regional Trips. Where the Short Trip ranking was higher, the segment was assigned to Car Free Street typology. Where the Regional Trip ranking was higher, the segment was assigned to Mobility Hubs typology.

Figure 6. Core Network Typologies

This resulted in a Core Network with 49 corridor segments:

- 28 segments (57%) as Best Practice Bike Network
- 15 segments (31%) as Car Free Street
- 6 segments (12%) as Mobility Hubs

NETWORK BUILD DEVELOPMENT

Following the development of the Core Network, the ATS team built off of this model to develop three differentiated Network Builds. The ATS team developed three Network Build themes, originally identified in the ATS scope of work, to pursue distinctly different outcome goals. By optimizing the Core Network around these distinct thematic goals, the ATS team was able to develop three

distinctively different Network Builds with network segment assignment based on alignment with key metrics.

The three Network Build themes are:

> Communities of Concern Access (Equity): This Network Build prioritizes access to sustainable modes for low-income residents and residents of color. This Network Build focuses on facilitating transit trip-chaining in areas far from downtown and creating fast & direct routes to jobs closer to downtown.
>
> Vision Zero: This Network Build prioritizes safety for vulnerable road users, focusing on reducing vehicle interactions with people walking and biking on the High Injury Network. This theme also prioritizes the replacement of longer vehicle trips with shorter local trips made by walking and biking.
>
> Mode Shift: This Network Build prioritizes cross-city networks of protected bikeways, creating direct and fast routes by bike to areas of the highest job and residential densities. In areas where direct bike trips to high-density locations are less competitive with other modes, this the prioritized trip-chaining to Muni-rapid and regional transit.

Corridor Modifications

The first step taken by the ATS team was to revisit the corridor selection in the Core Network. By applying theme-specific metrics to all corridors, the team hoped to identify new corridors for inclusion in each Network Build, creating more differentiation for analysis & comparison. The metrics used to identify corridor additions were:

> Equity: CoC coverage (high). Corridors in the top quintile rank for this metric were added.
>
> Vision Zero: Percentage of streets on HIN (high). Corridors in the top quintile rank for this metric were added.
>
> Mode Shift: Walk and bike mode shares (low), 2050 jobs/population (high), increase in jobs and population from 2015 to 2050 (high), transit crowding (high), percent of short trips two miles or less (high). Corridors in the top quintile rank for three or more of these metrics were added.

This resulted in the inclusion of the following corridors:

> Equity: ATS 3 – Alemany-Bayshore; ATS 20 – Geneva-Harney; and ATS 7 – Folsom
>
> Vision Zero: ATS 7 – Folsom
>
> Mode Shift: ATS 7 – Folsom

Typology Assignment

Following the establishment of modified networks for each build, the team assigned typologies to corridor segments. The method for establishing typologies in the Core Network was modified for each theme, emphasizing increased application of Mobility Hubs, Car Free Streets, or both. Emphasis or de-emphasis was expressed by increasing or decreasing the cutoff for the number of top-ranked metrics needed to qualify for assignment to that typology.

The changes in emphasis from the Core Network methodology is as follows:

Equity: De-emphasize Car Free Streets, emphasize Mobility Hubs

Vision Zero: Emphasize Car Free Streets, no change to Mobility Hubs

Mode Shift: De-emphasize Car Free Streets (as a proxy for emphasizing Best Practice Bike Networks), emphasize Mobility Hubs

The three resulting Network Builds are shown below.

Equity:

g


Legend
CoC Access Scenario
BPBN
Car Free Street
Mobility Hub

ConnectSF

Vision Zero:

ConnectSF

Mode Shift:

COST ESTIMATE DEVELOPMENT

The ATS team identified units to associate with each typology then researched potential costs of those units.

- For the Best Practice Bike Network typology, mileage was identified unit, and unit costs were based on protected bike lane projects.
- For the Car-Free Street typology, intersections was the unit used. Costs considered infrastructure needed at intersections such as traffic diverters and signage.
- For the Mobility Hub typology, the ATS team set the units to one hub per mile of network. This method was only used to approximate the number of mobility hubs in a network build for cost estimation purposes only. In implementation, the siting and distance between mobility hubs would be based on other planning factors. The mobility hub unit costs were informed by initial project costs of the 19th Street BART bike station.

The team then summed the number of units of each typology within the three network builds to calculate high-level cost estimates.

	Unit Costs		**Equity**		**Mode Shift**		**Vision Zero**	
	Units	Cost/unit	Units	Costs	Units	Costs	Units	Costs
BPBN	mile	$4M	31	$ 124M	32	$128M	18	$72M
Car-free Street	intersections	$250K	193	$48M	183	$46M	495	$124M
Mobility Hub	1 hub per mile	$500K	29	$15M	20	$10M	9	$5M
Total Cost			$187M		$184M		$201M	

The Equity and Mode Shift network build concepts are closer in cost estimates. The Vision Zero network build has higher costs compared to the other two due to the emphasis on the Car-Free Street typologies and associated costs per unit.