METROPOLITAN TRANSPORTATION COMMISSION
ASSOCIATION OF BAY AREA GOVERNMENTS

MEMORANDUM

HORIZON

Agenda Item 2

TO: Regional Advisory Working Group DATE: July 31, 2018

FR: Anup Tapase, Adam Noelting and Dave Vautin

RE: Horizon and Plan Bay Area 2050: Project Performance Assessment Methodology

Background

This memorandum presents the draft methodology for evaluating transportation project performance for Horizon and Plan Bay Area 2050. The methodology leverages the framework used in Plan Bay Area and Plan Bay Area 2040, and has been updated to reflect feedback received last cycle as well as the latest best practices for project evaluation.

Project Performance Methodology Overview

The project performance assessment for Horizon and Plan Bay Area 2050 will evaluate three primary types of transportation projects: capacity-increasing investments, operational strategies, and resilience projects to address sea level rise and seismic hazards. Committed projects – those that have full funding and environmental clearance – are exempt from project performance and will be included in the baseline network. Uncommitted projects previously evaluated during Plan Bay Area 2040 – with total costs greater than $250 million[1] – and new project submissions from CMAs, public agencies, NGOs and the public with total costs greater than $1 billion[1], will be evaluated during Horizon. Other new project submissions with total costs greater than $250 million will be evaluated during Plan Bay Area 2050, following the Call for Projects, using the same evaluation methodology.

Projects will be evaluated through the following assessments:

1. **Benefit-Cost Assessment** – primary assessment
    - Compares societal benefits against anticipated project costs
    - Explores project performance against all three futures ("what if" scenarios)
    - Includes supplemental analyses of confidence & sensitivity (similar to Plan Bay Area 2040)
2. **Guiding Principles Assessment** – secondary assessment
    - Evaluates alignment with the five Guiding Principles using specific project-focused criteria
3. **Equity Assessment** – secondary assessment
    - Determines if transportation investments have the potential to benefit residents in Communities of Concern (geographic assessment)
    - Exploring methods to quantify equity benefits; seeking input on best practices

Ultimately, each project will be rated as high-, medium-, or low-performing based on the assessment results. This helps to ensure that the Plan Bay Area 2050 investment strategy prioritizes higher-performing projects in a fiscally-constrained context.

1. Benefit-Cost Assessment Methodology

The Benefit-Cost Assessment will leverage Travel Model Two to quantify benefits of transportation projects. Travel Model Two is an activity-based model that simulates travel decisions over a typical workday for the entire Bay Area in the horizon year of 2050. Benefits (or disbenefits) of the project relative to a baseline no-project scenario will be determined for each of the three futures, reflecting different external forces, control totals, and land use patterns. The costs of each project reflect the

upfront investment cost, lifecycle costs and O&M costs through 2050. Staff is proposing making several enhancements to the methodology this cycle given its primary role in the assessment.

*Proposed Major Enhancements (refer to **Attachment A**)*

- **Safety:** Benefits of operational improvements (such as grade-separated interchanges) could be better captured in Travel Model Two through post-processing, contingent on project sponsors providing sufficient design detail to do so. National crash modification factors, along with updated fatality/injury valuations, would be used to implement this enhancement.
- **Natural Lands:** Conversion of natural lands (e.g. wetlands, agricultural land) to infrastructure could be estimated as an annual loss of goods, such as farm products and wood, and services, such as climate regulation and habitat provision, based on a per-acre value.
- **Transit Crowding:** The incorporation of transit crowding in Travel Model Two now allows the accessibility element of project benefits to reflect the disbenefit of crowding in transit.

*Benefit Valuation Updates (refer to **Attachment B**)*

- **Accessibility:** Similar to Plan Bay Area 2040, the project performance assessment will utilize the travel model's logsum outputs. Logsum is a metric that measures utility or consumer surplus, and captures mobility benefits (i.e., travel time savings, in-vehicle or out-of-vehicle), travel costs (i.e., tolls, fares, parking, vehicle operating), and transit crowding. These benefits collectively will be termed as "accessibility benefits" this cycle, consistent with the estimation methodology. Logsums can be directly converted to hours and monetized using a consistent value of time for all income classes, acknowledging the implicit judgment that the accessibility is valued the same for all people.
- **Updates to Reflect Future-Specific Income Distributions:** Valuation of time is proposed to continue following USDOT guidance at 50% of median wage rate. However, wages differ in the three futures. Percentage changes in the median wage rate for each future is estimated based on the output of different income distributions from the regional economic model. As a result, the three Futures have different values of time, ranging from $12.10 to $17.90 per hour (2018$). Similarly, auto operating costs also vary by future, ranging from $0.10 to $0.40 per mile.
- **Travel Time Reliability:** The proposed valuation this cycle incorporates the latest research which indicates a slightly lower ratio against value of time is appropriate for motorists and a higher ratio is appropriate for freight, when compared to Plan Bay Area 2040 valuations.
- **All Other Benefits:** Minor updates are proposed to valuations for all other benefits from Plan Bay Area 2040; no benefits are proposed for removal.

*Calculation Methodology (refer to **Attachment C**)*

- **Present Value Approach:** Staff is proposing to use present values of a stream of benefits and costs to calculate a benefit-cost ratio, rather than using benefits and costs in the horizon year as in Plan Bay Area 2040. This approach can capture advantages of quicker construction and implementation timelines, and long-term benefits of large investments. Forecasting streams of benefits and costs and discounting will present challenges; however, staff believes there are strong merits to this approach. Assumptions are being developed based on best practices.

*Supplemental Assessments (refer to **Attachment D**)*

- **Minor Updates:** Confidence and sensitivity analyses will be conducted, as in Plan Bay Area 2040, with updates to the criteria that are used. The present value approach will eliminate the

need for confidence assessment of timeframe inclusiveness, but calls for new criteria in the sensitivity analysis based on construction timelines, analysis period, and discount rate.

2. **Guiding Principles Assessment** *(refer to **Attachment E**)*

The Guiding Principles Assessment relies solely on qualitative criteria and seeks to ensure that projects align with five Guiding Principles that reflect core aspirations for the Bay Area – to create a region that is **Affordable**, **Connected**, **Diverse**, **Healthy**, and **Vibrant**. Specific questions were defined to evaluate projects against each principle, focusing on significant negative impacts associated with the project itself, rather than the performance of the jurisdiction(s) where the project may be located. Staff integrated feedback that was received during June RAWG, including additional clarity on evaluation questions, and refinements on how the Principles might be used to flag projects. For example, an exception would be made for projects increasing travel times if they have significant safety benefits.

3. **Equity Assessment** *(refer to **Attachment F**)*

While the geographical analysis of the supplemental equity assessment will be maintained, methods to quantify the equity effects at a project level are being explored, taking into account that marginal accessibility benefits may be more valuable to some than others. The viability of this assessment will depend on precision of model outputs for population subgroups. We are seeking input to learn about the best practices in the region and beyond. Please refer to Attachment F for the assessment framework from last cycle, noting that the Equity Targets Assessment will not be done this cycle given elimination of the Targets Assessment.

Next Steps

MTC/ABAG welcomes your input on the draft methodology for project performance for Horizon and Plan Bay Area 2050; please submit comments to Anup Tapase (atapase@bayareametro.gov) by **Tuesday, August 21st**. The final methodology will be circulated by late September to RAWG stakeholders. Next steps for the evaluation process include:

- **August 2018**: code and run baseline network (committed projects) in Travel Model Two; address outstanding issues with updates to major projects from Plan Bay Area 2040
- **September 2018:** convene jury to review projects submitted by public, NGOs, and private sector to select finalists for further analysis; begin coding projects submitted for evaluation
- **October 2018:** begin Travel Model Two model runs

Attachments

- **Presentation**
- **Attachment A: Proposed Benefit and Cost Assessment Methodology**
- **Attachment B: Benefit Valuations**
- **Attachment C: Proposed Benefit-Cost Ratio Calculation Methodology**
- **Attachment D: Supplemental Assessments to Benefit-Cost Assessment**
- **Attachment E: Guiding Principles Assessment**
- **Attachment F: Project-Level Equity Assessment from Plan Bay Area 2040**

1. Cost figures refer to capital investment (initial and rehabilitation costs) as well as operations and maintenance costs, in year of expenditure dollars, up to the horizon year 2050.

Attachment A – Proposed Benefit and Cost Estimation Methodology

Benefits Estimation

Benefit estimation will leverage Travel Model Two, an activity-based model that simulates travel decisions over a typical workday for the entire Bay Area in the horizon year of 2050. Benefits (or disbenefits) of the project relative to a baseline no-project scenario will be determined for each of the three futures, reflecting different external forces, control totals, and land use patterns. Table A.1 captures all the benefits/disbenefits that are estimated and the methodology for doing so.

Table A.1 Proposed Project Benefits Methodology

Benefits / Disbenefits	Includes	Methodology	Data sources
Accessibility[1,2] (logsums, expressed in hours)	• Travel time savings o Across all modes (auto, truck, transit, TNC, bike, ped) o Includes in-vehicle and out-of-vehicle time (waiting, transfer) • Travel costs o Tolls o Parking o Vehicle operating costs (fuel, maintenance, repair) • Transit crowding[3]	Change in accessibility at the individual level is measured using the logsum methodology in Travel Model Two. The aggregate of logsum measures across individuals measures the total change in accessibility, equivalent to the consumer surplus due to the project. Logsum measures are converted to hours based on a coefficient that relates it to time.	Travel Model Two
Travel Time Reliability (hours)	• Auto travel time reliability • Freight travel time reliability	Number of hours lost due to unreliable travel time is measured as the sum of incident delay across all roadways. Incident delay is calculated as a function of volume-to-capacity ratio and number of lanes on a roadway.	Travel Model Two
Collisions (number of victims for fatality / injury, number of incidents for PDO)	• Fatalities due to collisions • Injuries due to collisions • Property damage only (PDO) collisions	Change in the number of incidents due to a project is the product of change in VMT due to the project and an estimate of incidents per VMT, by area type (urban/rural), facility type, and number of lanes. This will be adjusted in the Futures to account for safety benefits of AVs, based on AV penetration in the fleet mix. Estimation of reduction in number of incidents due to a specific safety improvement is calculated separately, since the model cannot account for this. This is calculated using historical number of incidents at the site obtained from SWITRS, and a crash reduction factor for the specific safety improvement, obtained from FHWA[3, 4].	Travel Model Two, SWITRS, CMF Clearinghouse (FHWA)

Benefits / Disbenefits	Includes	Methodology	Data sources
Emissions (metric tons)	• CO_2 (global social effects) • Air pollutants (negative health effects) o $PM_{2.5}$ o Other volatile organic compounds (e.g. NO_x, SO_2, Acetaldehyde, Benzene)	Change in emissions is measured as the sum of VMT, multiplied by an estimate of future emission levels per VMT forecasted by EMFAC. These estimates depend on time period of the day, vehicle class and speed. The emission level would be zero in the case of electric vehicles, and hence futures with higher levels of EV adoption will have significantly lower levels of emissions benefits.	Travel Model Two, EMFAC
Loss of Natural Land (acres)	• Loss of natural land that is converted to transportation infrastructure, by land type: o Wetland o Forestland o Pastureland o Farmland	Area of land will be estimated based on lane or track miles including a buffer area, or a facility area, or equivalent. *Tools to determine the type of land that would be converted are being explored (e.g., Greenprint).*	*TBD*
Benefits from Physical Activity (active individuals)	• Morbidity benefits from increased walking/cycling • Mortality benefits from increased walking/cycling	*The methodology is being updated at this time.* In Plan Bay Area 2040, an active individual was considered to be one that walked (including to/from transit) and/or biked for 30 minutes a day, based on research. The Travel Model is able to determine the change in the number of such individuals as a result of a project.	*TBD*
Noise (VMT)	• Impact of change in noise levels due to change in auto/truck VMT	Change in VMT due to the project, by auto and truck	Travel Model Two
Auto Ownership (vehicles)	• Change in number of vehicles induced by project	Predicted change in the number of vehicles owned by households, based on VMT and household demographics	Travel Model Two

1. A small number of trips are not captured by accessibility logsums – interregional trips (i.e. trips between the Bay Area and other surrounding regions), trips to/from the airports, and freight trips. Impacts of projects on these trips are measured using value of time saved and operating cost savings per VMT.

2. Accessibility is a measure of the ease with which transportation users are able to reach destinations. Improving accessibility is generally accepted as the core objective of transportation investments, since users do not use transportation for the sake of the transportation itself (except in rare cases), but to reach destinations. It represents more than just mobility improvements in terms of travel time. Users, in making travel decisions, take into account not only travel time, but also mode choices available, land use patterns (i.e., destination locations), travel costs, congestion and crowding when making travel decisions. Their decisions are also dependent on their personal characteristics such as age, household income, number of workers/dependents in the household, etc.

3. The disbenefit experienced due to transit crowding is taken into account within the logsum measure, based on coefficients (or weights) of in-vehicle travel time developed by a study on crowding in the LA Metro (Los Angeles Metro Crowding, Capacity, and Unreliability Summary Report, 2014). The coefficients are available for crowding on a 1 to 7 scale, by trip mode, purpose and demographic factors. Overall, the coefficient is 1.00 when the transit vehicle is not crowded, and 1.378 when it is extremely crowded, and 1.629 when unable to board. The current Travel Model Two structure does not permit a simulation or dynamic assignment of transit ridership, and hence no hard capacity constraints can be set on transit.

4. A project may have one or more safety improvements, as provided by project sponsors. For each of those improvements, the following method is applied. First, a ratio of the number of incidents at the site of the safety improvement to the total number of incidents in the Bay Area, over the period from 2013-17, is calculated using data from SWITRS. This ratio is multiplied with the change in the number of collisions due to the project, as estimated using VMT output from the travel model, to determine number of collisions at safety improvement site location without the safety improvement. This number is then diminished by a crash reduction factor for the specific safety improvement (obtained from FHWA), to determine the collisions avoided due to the safety improvement.

5. Sample Crash Reduction Factors (CRF) from CMF Clearinghouse for specific countermeasures are shown in the Table A.2 below. CRF denotes the percentage reduction in crashes that may be expected as a result of the countermeasure. CRFs can be negative as well, i.e. crashes would increase as a result of the countermeasure.

Table A.2 Crash Reduction Factors (CRF) by Countermeasure
(Source: CMF Clearinghouse)

Countermeasure	CRF
Install median barrier	86
Improve horizontal/vertical alignments	58
Divided vs. undivided cross road at diamond interchange ramp	47
Straight ramp instead of cloverleaf ramp	45
Long ramp instead of short ramp	38
Provide bike lanes	36
Install ramp meter (on-ramp)	36
4 to 3 lanes w/ TWLTL	30
Provide an auxiliary lane between entrance ramp and exit ramp	20
4 to 5 lanes	-11

Costs Estimation

Table A.3 – Proposed Methodology for Project Costs

Costs	Includes	Methodology
Upfront Capital Investment	Planning, design, environmental, right of way and rolling stock acquisition, and construction	Project sponsors will submit cost estimates through the Call for Projects. Before conducting the assessment, MTC will review costs for accuracy and inclusiveness.

Costs	Includes	Methodology
Net Operating and Maintenance Cost	Ongoing costs of operations and maintenance	For road projects, lane-mile maintenance costs are estimated using typical lane-mile costs by facility type. This costs are determined internally by MTC staff. For transit projects, sponsors submit gross operating and maintenance costs. These are converted to net annual operating costs by subtracting the fare revenue estimated by the Travel Model, thus rewarding projects that recoup more of their operating costs through new farebox revenue. The fare revenue may vary dramatically between futures. Project sponsors will submit O&M estimates through the Call for Projects. MTC will review these estimates and calculate *net* O&M, or the additional O&M that is not recouped by the project. MTC might also add O&M costs to roadway or transit projects that do not submit O&M costs through the Call.
Lifecycle Costs	Rehabilitation and replacement cost of assets above and beyond regular O&M costs	Calculated based on lifetime of asset. For example, bus assets have lifetimes of 14 years, and hence we assume there would be a same level of initial capital investment at the 14 year mark. However, this may vary by future, for example, in the case that electric buses must be procured instead of diesel buses. Staff acknowledges the complexity of these assumptions, and will seek to clarify them as they are updated. Asset lifetimes are shown in Table A.4.
Residual Value	Value of assets in horizon year	Since the analysis year ends in 2050, any remaining value of assets is essentially a negative cost. This is calculated based on straight-line depreciation of major asset components based on lifetime of assets. Real estate assets do not depreciate.

Table A.4: Proposed Useful Lives for Asset Classes *(more asset classes may be added)*
(Source: MTC)

Costs	Expected Useful Life (in years)
Local Bus	14
Express Bus	18
BRT system	20
Diesel Multiple Unit (DMU) rail vehicles	25
Heavy Rail Cars	40
Rail infrastructure (majority of ROW in tunnel)	80
Rail infrastructure (all other)	20
Roadway (majority of ROW in tunnel)	80
Roadway (highway)	20
Ferry	20
Technology / Operations	20

Attachment B – Benefit Valuations

This attachment summarizes recommended benefit valuations for the benefit-cost assessment for Horizon and Plan Bay Area 2050, based on a review of recent research and best practices for monetizing benefits from transportation projects. Table B.1 presents the recommended valuations for each benefit category, including a comparison to the Plan Bay Area 2040 valuation and a description of the basis of the valuation. Benefit valuations that would differ by Future are indicated using CG for Clean and Green, RT for Rising Tides, Falling Fortunes, and BF for Back to the Future.

Table B.1 – Proposed Benefit Valuations of Benefits - PBA 2040 vs. Horizon/PBA 2050

Category	Benefit	PBA 2040 Valuation (2017$)	Horizon Valuation (2018$)	Type of update	What does this valuation include?
Accessibility benefits	*For trips captured in logsums (majority of trips)*				
	Accessibility benefits (per hour)	$12.66	No major external forces $12.71 CG $17.90* RT $12.10 BF $17.50	Update to reflect multiple futures	Accessibility benefits are interpreted using Value of Time, after converting logsums to hours. This is set at 50% of the median regional wage rate ($25.43), based on USDOT guidance. This wage rate would vary by future, due to external forces. Based on a preliminary household income distribution forecasted by the REMI model (*subject to change), ratios were calculated for multiplying with the wage rate in the case of no major external forces, to obtain the wage rate in the three Futures. *Sources: US Department of Transportation; Bureau of Labor Statistics Occupational Employment and Wage, 2017*
	For trips not captured in logsums (only interregional and airport auto trips, freight)				
	Auto In-Vehicle Travel Time (per hour)	$12.66	(same as above row)		Same as above row *Sources: US Department of Transportation; Bureau of Labor Statistics Occupational Employment and Wage, 2017*
	Truck In-Vehicle Travel Time (per vehicle hour of travel)	$33.69	No major external forces $31.18 CG $43.80 RT $29.60 BF $43.00	Updated to reflect multiple futures	The valuation is the total hourly compensation paid to truck drivers. This valuation represents the labor cost of transporting goods on the roadway network, including benefits. The calculation method for the three Futures is identical to that for Accessibility Benefits. *Source: FHWA Highway Economic Requirements System; Bureau of Labor Statistics Occupational Employment and Wage, 2017*

Category	Benefit	PBA 2040 Valuation (2017$)	Horizon Valuation (2018$)	Type of update	What does this valuation include?
	Auto operating costs (per mile)	$0.3072	No major external forces $31.18 CG $0.40 RT $0.20 BF $0.10		The baseline operating cost is $0.20 per mile, which represents the cost users experience in making daily travel decisions, following USDOT guidance. It includes cost of fuel, maintenance and repair, based on forecasted fuel costs and efficiencies in 2050. This cost varies by future based on external forces. *Source: USDOT, EIA Energy Outlook 2018, AAA Your Driving Costs 2017 Edition*
	Truck operating costs (per mile)	$0.8795	No major external forces $1.00 CG $1.55 RT $1.00 BF $0.70	Updated to reflect multiple futures	The baseline operating cost is $1.00 per mile, which represents the cost carriers experience in making daily travel decisions, following USDOT guidance. It includes cost of fuel, maintenance and repair, and depreciation, based on forecasted fuel costs and efficiencies in 2050. This cost varies by future based on external forces, similar to auto operating costs (depreciation component is held constant). *Source: USDOT, EIA Energy Outlook 2018, AAA Your Driving Costs 2017 Edition*
Travel Time Reliability	**Auto** (per person hour of non-recurring delay)	$12.66	No major external forces $10.17 CG $14.30 RT $9.70 BF $14.00	Major Update	This represents the value placed by an auto driver on the consistency of travel times, and measured as a Reliability Ratio * Value of Time. Recent SHRP research has indicated values of 0.3-0.8. The upper limit of 0.8 is used as a conservative estimate, and this is in line with agencies abroad. This is multiplied by the Value of Time calculated above ($12.71). *Source: SHRP 2 L35 Projects A and B – Value of Travel Time Reliability in Transportation Decision Making*
	Freight/Truck (per vehicle hour of non-recurring delay)	$33.69	No major external forces $46.77 CG $65.70 RT $44.50 BF $64.50	Major Update	This value represents the value placed by carriers and shippers on unreliable travel times, due to increased costs from driver compensation, handling costs at origin and destination, inventory management, depreciation of commodity value. The Reliability Ratio was found to be in the range of 1.5. This is multiplied by the Value of Time calculated above ($31.18). *Source: Examining the Value of Travel Time Reliability for Freight Transportation to Support Freight Planning and Decision-Making", FDOT, 2016*

Category	Benefit	PBA 2040 Valuation (2017$)	Horizon Valuation (2018$)	Type of update	What does this valuation include?
Collisions	**Fatality Collisions** (per fatality)	$10.8 million	$10.1 million	Data source version update	The valuation includes the internal costs to a fatality collision victim (and their family) resulting from the loss of life, as well as the external societal costs. It represents: • Loss of life for the victims • Medical costs incurred in attempts to revive victims • Loss of enjoyment of family member to other members of the family • Loss of productivity to the family unit (e.g., loss of earnings) • Loss of productivity to society • Loss of societal investment in the victim (e.g., educational costs) *Source: USDOT, 2017, SWITRS database*
	Injury Collisions (per injury)	$124,000	$109,200	Data source version update	The valuation includes the internal costs to an individual (and their family) resulting from the injury, as well as the external societal costs. It represents: • Pain and inconvenience for the individuals. • Pain and inconvenience for the other family members • Medical costs for injury treatment • Loss of productivity to the family unit (e.g., loss of earnings) • Loss of productivity to society *Source: USDOT, 2017, SWITRS database*
	Property Damage Only Collision (per incident)	$4,590	$3,360	Data source version update	The valuation includes the internal costs to a property damage collision victim (and their family) resulting from the time required to deal with the collision, as well as the external societal costs from this loss of time. It represents: • Inconvenience to the individual and to other members of the family • Loss of productivity to the family unit • Loss of productivity to society *Source: USDOT, 2017, SWITRS database*
Physical Inactivity	**Morbidity and productivity** (per active adult)	**$1,341**	***$1,368****	Inflation only	**Morbidity and productivity* (per active adult) **The methodology is being updated at this time.* The current valuation from PBA2040 represents the savings achieved by influencing an insufficiently active adult to engage in moderate physical activity

Category	Benefit	PBA 2040 Valuation (2017$)	Horizon Valuation (2018$)	Type of update	What does this valuation include?
	Mortality (per life saved)	**$10.8 million**	**$10.1 million***		five or more days per week for at least 30 minutes. It reflects annual Bay Area health care cost savings of $326 (2006 dollars), as well as productivity savings of $717 (2006 dollars). *Source: California Center for Public Health Advocacy/Chenoweth & Associates 2006, "The Economic Costs of Overweight, Obesity, and Physical Inactivity Among California Adults"*
Emissions (per metric ton)	**CO_2**	$100	$118	Value Update	This valuation represents the full global social cost of an incremental unit (metric ton) of CO_2 emission from the time of production to the damage it imposes over the whole of its time in the atmosphere. *Source: Federal Interagency Working Group on the Social Cost of Carbon, Revised 2016*
	Diesel $PM_{2.5}$	$665,400	**$596,360**	Value Updates	These valuations represent the negative health effects of increased emissions including: • Loss of productive time (work & school) • Direct medical costs from avoiding or responding to adverse health effects (illness or death) • Pain, inconvenience, and anxiety that results from adverse effects (illness or death), or efforts to avoid or treat these effects • Loss of enjoyment and leisure time • Adverse effects on others resulting from their own adverse health effects *Source: BAAQMD, 2017*
	Direct $PM_{2.5}$	$658,800	**$591,900**		
	NO_x	$6,000	**$6,360**		
	Acetaldehyde	$5,100	**$4,240**		
	Benzene	$15,200	**$13,360**		
	1,3-Butadiene	$42,600	**$37,840**		
	Formaldehyde	$5,900	**$4,980**		
	All Other ROG	$4,300	**$3,600**		
	SO_2	$22,200	**$19,820**		
Natural Land (per acre, per year)	**Wetland**	-	**$33,495**	New benefits	Represents the benefits of ecosystem goods (e.g. farm products, fish, minerals, water, wood) and services (e.g. disturbance regulation, climate regulation, habitat, nutrient cycling, pollination, recreation), based on comprehensive database of published, peer-reviewed primary valuation studies. *Source: Nature's Value in Santa Clara and Sonoma Counties, Earth Economics (2014/16)*
	Forestland	-	**$5,229**		
	Pasture	-	**$4,677**		
	Agricultural land	-	**$1,438**		
Noise (per mile traveled)	**Auto**	$0.0013	$0.0014	Inflation only	This valuation represents the property value decreases and societal cost of noise abatement. *Source: FHWA Federal Cost Allocation Report*
	Truck	$0.0170	$0.0170		
Auto Ownership	**Costs per Vehicle**	$3,920	$5,124	Change in data source	This valuation represents the annual ownership costs of vehicles, beyond the per mile operating costs. It includes insurance, depreciation (15K miles annually) and financing charges. *Source: AAA, as recommended by USDOT*

Attachment C – Proposed Benefit-Cost Ratio Calculation Methodology

Methodology Used in Plan Bay Area 2040

The methodology to calculate the benefit-cost ratio (BCR) in Horizon reflects a significant update from the last plan cycle. In Plan Bay Area 2040, costs for the horizon year were calculated by annualizing the construction costs over the useful life of the asset and adding the annual O&M costs. The benefit in the horizon year, as calculated by the Travel Model, was then divided by the costs to determine a BCR. While this methodology has advantages of easier calculation and simplifying the inputs, it does not capture the time value of money. Specifically, it does not capture the advantages of quick/easy implementation, long-term benefits of a large capital investment and overall trends of benefits by infrastructure type.

Proposed Methodology for Horizon

In Horizon, BCR will be calculated as the ratio of the present value of the stream of benefits of the project, to the present value (PV) of the stream of costs, including capital costs, O&M costs, lifecycle costs of rehabilitation and replacement, and a reduction in costs based on residual value. The following formula illustrates this calculation:

$$BCR = \frac{PV(Benefits)}{PV(Capital\ Investment) + PV(Net\ O\&M\ costs) + PV(Lifecycle\ Costs) - PV(Residual\ Value)}$$

In this methodology, various assertions and assumptions will need to be made with respect to discounting, the period of analysis, and forecasting the stream of costs and benefits until the end of the analysis period.

Discount Rate

The real discount rate (discount rate net of the inflation rate) used to calculate the present values of forecasted benefits and costs is 7% per year, based on USDOT guidance for TIGER grant applications. The exception to this is the value of natural resources – air and land (dis)benefits – for which a lowered discount rate of 3.5% is used. This reflects the nature of natural capital assets over built capital assets, since they do not depreciate. Reports on natural capital assets generally show present values using two discount rates – 0%, which recognizes the renewable nature of natural capital and also assumes the people even 100 years from now will enjoy the same level of benefits we enjoy today, and 3.5%, which federal agencies such as the Army Corps of Engineers use.

Analysis Period

Since the assessment is primarily concerned in comparing the BCR of projects, similar timelines should be considered to appropriately compare the present values. Staff proposes to calculate BCRs for a 30-year period of all projects, including construction time, discounting all benefits and costs to the first year of construction of the project. For most projects, with exceptions such as tunnel or bridge based infrastructure, this analysis period should cover the useful life of the assets. For convenience, the 30-year analysis period starts period in 2021 and ends in the horizon year 2050. A residual value of the

investment at the end of the 30-year analysis period is added as a negative cost, to reflect the fact that the assets with long lifespans would have remaining value beyond the analysis period.

We also propose to calculate a second BCR as part of the supplementary sensitivity analysis, using an analysis period that spans the entire lifetime of the major asset in each project, considering that some project assets can have much longer lifetimes of 60-80 years. In effect, this measures the present value of the remaining benefits and costs of the project beyond the horizon year. However, this metric will be used only as a secondary guidance, since predictions of benefits 20-30 years post the horizon year lose reliability.

Costs and Benefits Streams

Methodology for calculating lifecycle costs of rehabilitation and replacement over the analysis period and residual value is briefly described in Table A.3 in Attachment A. These costs would be based on the lifetime of assets and simplifying assumptions will be made to estimate these costs relative to the initial investment cost, based on the asset class. The general practice followed in benefit-cost analyses of transportation infrastructure is to assume that benefits are constant or consistently rising with metrics such as ridership over the lifetime of the asset, depending on the type of benefit. However, such assumptions may not hold strong in the case of divergent futures, and hence more elaborate assumptions need to be developed. For instance, in a future where there are no major external shifts, benefits from lowered emissions due to a major transit investment could be assumed to grow in a straight line over 20 years to the Horizon year value, if maximum ridership is assumed to be reached in the 20th year. However, if the electric vehicles are a high percentage of the fleet mix in the Future scenario, then benefits from emissions may rise for the first ten years when the fleet is largely fossil-fuel powered, but eventually drop to a much lower value, as the Horizon year benefits would be represented in the output of the Travel Model Two. Capturing the benefit that the transit investment provides in the interim period is critical to evaluate the benefit-cost ratio. The assumption for the stream of these benefits from reduced emissions may be tied to the penetration of electric vehicles into the fleet and other related factors.

Table C.1: Methodology by Benefit/Cost Category to calculate Present Values
(methodology and assumptions in process of being developed)

Category		Discount Rate	Methodology to calculate stream over analysis period
Benefits	Accessibility	7.0%	Options are being explored – assuming constant benefits for all years or making specific assumptions by future, depending on the benefit.
	Travel Time reliability	7.0%	
	Collisions	7.0%	
	Emissions	3.5%	
	Loss of Natural Land	3.5%	
	Benefits from physical activity	7.0%	
	Noise	7.0%	
	Auto ownership	7.0%	
Costs	Capital costs	7.0%	Methodology described in Table A.3 in Attachment A.
	O&M costs	7.0%	
	Lifecycle costs	7.0%	
	Residual value	7.0%	

Acknowledging that such assumptions may take some time to be developed, and that calculations would be more complex, staff believes that this is a move in the right direction to evaluate the performance of projects, and that the rigor of the benefit-cost analysis would be enhanced. For illustrative purposes, rough BCRs were calculated for two projects from Plan Bay Area 2040 using the proposed streamed benefits and costs approach. The BCRs from both approaches are compared against each other for both projects, shown in Table C.2. Project 2 scored higher than Project 1 during the last plan cycle. However, when Project 2's longer construction time and Project 1's higher magnitude of annual benefit are taken into account by the proposed BCR approach, Project 1 scores higher.

Table C.2: Comparison of BCR calculation methods

BCR Calculation Line Item	**Project 1** (higher magnitude of annual benefit)	**Project 2** (longer implementation time)
Upfront Capital Costs ($m)	$820	$737
Annual O&M cost, less farebox recovery ($m)	$62	$0
Annual Benefit (as estimated in Travel Model One) ($m)	$248	$95
BC Ratio calculation using annualized benefits and costs, as in PBA2040		
Annualized Cost (= annualized construction cost + annual O&M cost less farebox recovery) ($m)	$121	$37
BC Ratio (as calculated in PBA 2040)	**2.1**	**2.6**
BC Ratio calculation using proposed present values methodology		
Construction start year assumption	2021	2021
Construction / implementation duration	1 year	5 years
Useful life of asset	14 years	20 years
Lifecycle cost ($m)	$820 in year 15	Assumed 0
BC Ratio (as calculated using PVs)	**2.4**	**1.3**

Attachment D – Supplemental Assessments to Benefit-Cost Assessment

Plan Bay Area 2040 evaluated the limitations of the project performance results, to document the known shortcomings of the approach and better inform policy makers of the strengths and weaknesses of the analysis outcomes. Two assessments were conducted in this regard: the Confidence Assessment, and Sensitivity Testing. Staff proposes to retain these supplemental assessments, with some modifications given the changes to the analysis framework itself.

Confidence Assessment

In Plan Bay Area 2040, the Confidence Assessment addressed three main limitations of the Benefit-Cost Assessment:

1. Travel Model Accuracy
    a. Does the travel model have limitations in understanding a particular type of travel behavior (e.g. merging and weaving at interchanges)?
    b. Does the travel model lack an understanding of smaller-scale project travel changes relative to the region (e.g. single infill station, expressway improvements)?
2. Framework Completeness
    a. Does the travel model output capture all of the primary benefits of the project (e.g. the value of relieving transit crowding or primarily recreational or tourism benefits)?
3. Timeframe Inclusiveness
    a. Is the project an "early winner" (i.e. can be implemented quickly and provides key benefits in the short term)?
    b. Is the project a "late bloomer" (i.e. benefits will not be realized until the final years of the planning horizon)

The proposal to calculate benefit-cost ratios (BCRs) with present values eliminates the need for the Timeframe Inclusiveness assessment. The former two assessments continue to be relevant. While some of the commonly stated shortcomings in PBA2040's Confidence Assessment have been addressed – such as transit crowding, benefit from safety improvements, and small size of projects (potentially addressed by increasing the project cost minimum threshold to $250 million) – various other limitations continue to persist. Travel Model Two does not have the ability to forecast weekend travel or freight travel. The model also has limitations in considering some modes of travel separately, such as shared TNC, or bicycling to transit. External forces in the futures such as penetration of automated technologies or natural disasters are represented by sweeping assumptions and hence travel model accuracy may be compromised.

For the above reasons, staff proposes to conduct a confidence assessment of the Travel Model Accuracy and Framework Completeness.

Sensitivity Assessment

The Sensitivity Assessment evaluates how the Benefit-Cost Assessment outcomes change as a result of modifying some key assumptions. In contrast to the Confidence Assessment, this is a quantitative evaluation and determines if BCR rankings would change with different assumptions. In Plan Bay Area 2040, staff assessed the sensitivity by changing project capital cost estimates based on project type, valuation of travel time, and valuation of life. Of these, only the former two had substantial effects on the BCR.

Given that Horizon will assess project performance in three different futures, that each have different income distributions and hence different average valuations of time (which is used to interpret accessibility benefits), staff proposes eliminating sensitivity testing based on changes to valuation of travel time. The new approach to calculating the BCR introduces new variables over which sensitivity could be tested.

Staff proposes to evaluate the sensitivity of the benefit-cost assessment to the following:

1. Increasing capital cost estimates
2. Extending the duration of the construction timeline
3. Considering a longer stream of benefits and costs that spans 50 years, or the lifetime of the assets, whichever is longer
4. Lowering the discount rate

Attachment E - Guiding Principles Assessment

The Guiding Principles reflect the core aspirations for the Bay Area through 2050 – to create a region that is **Affordable**, **Connected**, **Diverse**, **Healthy**, and **Vibrant**. The Principles are intended to inform each of the key elements of *Horizon*, including analysis of projects in the Project Performance Assessment, the prioritization of policies in the Perspective Papers, and the selection of metrics & strategies for each future evaluated through the process.

Within the Project Performance Assessment, the Guiding Principles Assessment will be integrated as a secondary, qualitative assessment alongside the benefit-cost assessment. Unlike past long-range planning cycles, the assessment will be used solely to flag projects that do not support one or more of the Principles. As such, the criteria for the proposed Guiding Principles Assessment are narrowly defined to focus on significant negative impacts associated with the project itself, rather than the performance of the jurisdiction(s) where the project may be located. **Table E.1** below shows the criteria for each of the Guiding Principles.

Table E.1: Framework for Guiding Principles Assessment

Guiding Principle	**Evaluation Question** *If yes, the project is not supportive of the Guiding Principle*	**Application of Evaluation Question** *For a project to be flagged as not supportive of the Guiding Principle…*
Affordable	**Does the project increase travel costs for lower-income residents?**	• The project would have to actively eliminate a lower-cost travel alternative, rather than just offering a new travel option.
Connected	**Does the project increase travel times or eliminate travel options?**	• The project would have to increase travel time for one mode without decreasing it for another mode; exceptions would be made for projects with significant safety benefits that justify increased travel times, or… • … the project would have to eliminate a modal option from a travel corridor.
Diverse	**Does the project displace lower-income residents or divide communities?**	• The project would have to directly displace lower-income households through site acquisition, or… • …the project would have to build an elevated structure through an existing neighborhood.
Healthy	**Does the project increase emissions?**	• The project would have to yield a long-term net increase in emissions
Vibrant	**Does the project eliminate jobs?**	• The project would have to directly result in a net reduction of jobs.

Each project will receive one of two potential scores: **Supports Guiding Principles** or **Does Not Support ___ Guiding Principle(s)**.

While the thresholds for the Guiding Principles will ultimately be set by the MTC Planning Committee, a potential staff recommendation next spring could rely on the following framework:

- If a project **Supports Guiding Principles**, its designation as a **high-, medium-, or low-performer** would be entirely based on the benefit-cost assessment results.
- If a project **Does Not Support 1 Guiding Principle**, it would not be eligible for high-performer status. Determination of whether it is a **medium- or low-performer** would be based on the benefit-cost assessment results.
- If a project **Does Not Support 2 or more Guiding Principles**, it would be designated as a **low-performer**, regardless of its benefit-cost assessment results.

Attachment F – Project-Level Equity Assessment from Plan Bay Area 2040

Memorandum

TO: Kristen Carnarius and Dave Vautin, MTC

FROM: Casey Osborn and Krista Jeannotte, Cambridge Systematics, Inc

DATE: May 11, 2016

RE: Plan Bay Area 2040 Project Performance Support – Task 5.1 Equity Assessment

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This memorandum and accompanying spreadsheet represent the Plan Bay Area 2040 Project Performance Support deliverable for Task 5.1. It contains a summary of the equity assessment methodology and results.

Equity Assessment Methodology

As part of the performance assessment for the Plan Bay Area 2040 update, a separate equity assessment was conducted focused exclusively on a project's ability to support the equity issue areas of Plan Bay Area 2040 and to serve vulnerable populations. This equity assessment first isolated each project's scores on the equity related targets in the performance assessment. Next, the assessment considered how each project would increase access for vulnerable populations, also known as "Communities of Concern." Projects that did not increase access for these populations did not receive a score in the equity assessment. Projects that did increase access were ranked according to their score on the equity targets.

The equity-related targets taken from the overall performance assessment were:

- Reduce adverse health impacts associated with air quality, road safety, and physical activity by 10% (Target 3);
- Decrease by 10% the share of lower-income residents' household income consumed by transportation and housing (Target 5);
- Increase the share of affordable housing in PDAs, TPAs, or other high-opportunity areas by 15% (Target 6);
- Reduce the share of low-and moderate-income renter households in PDAs, TPAs, or high-opportunity areas that are at an increased risk of displacement to 0% (Target 7);
- Increase the share of jobs accessible within 30 minutes by auto or within 45 minutes by transit by 20% in congested conditions (Target 8); and
- Increase by 35% the number of jobs in predominantly middle-wage industries (Target 9).

The same scoring methods from the targets assessment were used for the equity analysis: strong support (1); moderate support (0.5); minimal impact (0); moderate adverse (-0.5); and strong adverse (-1). The six equity related target scores were summed to calculate an overall equity targets score ranging from +6 to -6, strong support to strong adverse impact.

To identify whether a project served a vulnerable population, each project was mapped against census tracts identified by MTC as "Communities of Concern," an index that takes into account multiple disadvantage factors[1] including percent of residents that are low-income, members of a minority group, zero-household vehicles, to name a few. At first, service areas were defined broadly, consistent with the service areas used in the overall performance assessment. A service area includes not only the cities within and adjacent to a project and its access points (bus stop, freeway on ramps, etc.), but also any cities that connect or meet up with the project area (e.g., one stop away on a BART train or along a commute path).

By this definition service areas cast a wide net, and under the service area geography nearly all projects served a Community of Concern.[2] Such a high performance rate made it clear that the Communities of Concern "service area" methodology was not subtle enough to capture variations in project locations and types.

As such, the process was refined, and projects were evaluated on whether or not they *increased access* for a Community of Concern. Using GIS, the projects that actually ran within Communities of Concern, and/or contained access points within those Communities of Concern, were identified.

This more detailed increased access consideration resulted in 16 projects that *do not* increase access for a Community of Concern. Examples to illustrate how the criteria of access points affected projects that formerly contained service areas with Communities of Concern include:

- While several ferry projects had service areas that included communities of concern such as Berkeley and San Francisco, access points along the Bay and the project scope itself were not within Communities of Concern.

- Many of the light rail transit projects in the South Bay appeared to primarily increase access for wealthier outlying areas, not necessarily for Communities of Concern. Under the service area methodology, Communities of Concern within the City of San Jose resulted in these projects initially "serving" a Communities of Concern, when in actuality no part of the project area fell within a Community of Concern.

[1] For Plan Bay Area 2040, the definition of communities of concern include all census tracts that have a concentration of BOTH minority AND low-income households at specified thresholds of significance, or that have a concentration of low-income households AND a concentration of three or more of six additional factors. These additional factors include: limited English proficiency population, zero-vehicle households, seniors 75 and older, and people with a disability, single-parent families, and severely cost-burdened renters.

[2] The exceptions were two projects, an ITS and freeway project in the Tri-Valley.

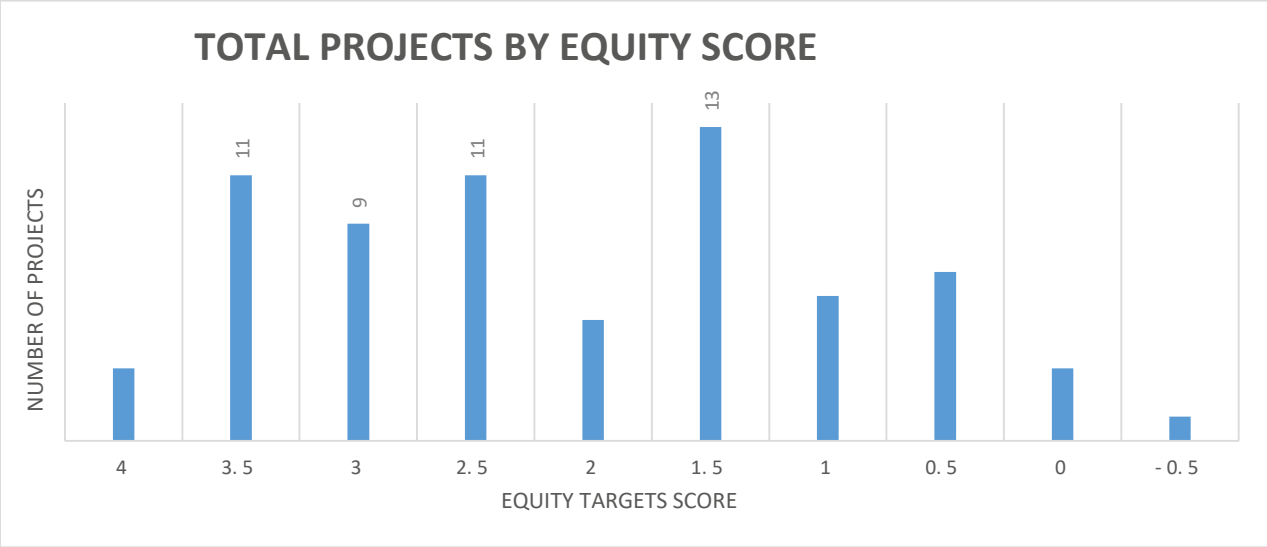
Results

Of the projects, 53 provided access to a Community of Concern, while 16 did not. The projects that increased access for a Community of Concern were then ranked according to their total equity targets score. Table 1 presents the equity analysis results.

The projects that performed highest on the equity assessment were large scale transit projects serving primarily inner urban areas, including San Pablo and Geary BRT, BART Metro, Muni Forward and AC Transit Frequency Improvements, and BART to Silicon Valley. Rounding out the top ten were VTA's Steven Creek LRT, El Camino Real BRT, and Downtown San Jose Subway. The highest scoring non-transit project was the Columbus Day Initiative. While the highest possible equity score possible was six, the three highest-performers only received a score of four. This is in part due to the many "Moderate Adverse" scores on the displacement target. The same inner urban areas that have the potential to increase access for a number of Communities of Concern, are also the areas with some of the highest risks for displacement.

In general, roadway projects did not score as high on equity targets as transit projects. This is partially attributable to roadway project's overall lower performance on targets promoting healthy and safe communities, and decreasing household and transportation costs. Figure 1 below provides a break down of number of projects by equity score.

Figure 1: Number of Projects by Equity Score



Projects that scored high on the equity targets (with scores of 3 or greater), but failed to increase access for a Community of Concern included eBART, and two VTA LRT projects: Vasona and Tasman West LRT. There were more transit projects (9) than roadway projects (6) that did not serve Communities of Concern. The only other project that failed to serve a Community of Concern was the Santa Cruz tollway and LRT project, which is both a transit and roadway project.

Lastly, only four projects received a zero or negative score on equity targets. Of these four, two – US-101 Express Lane Network in San Mateo and San Francisco, and SR-152 Tollway – increased access for Communities of Concern. However, given their equity score of 0, the project's increase in access does not advance the six equity-related targets for Plan Bay Area 2040.

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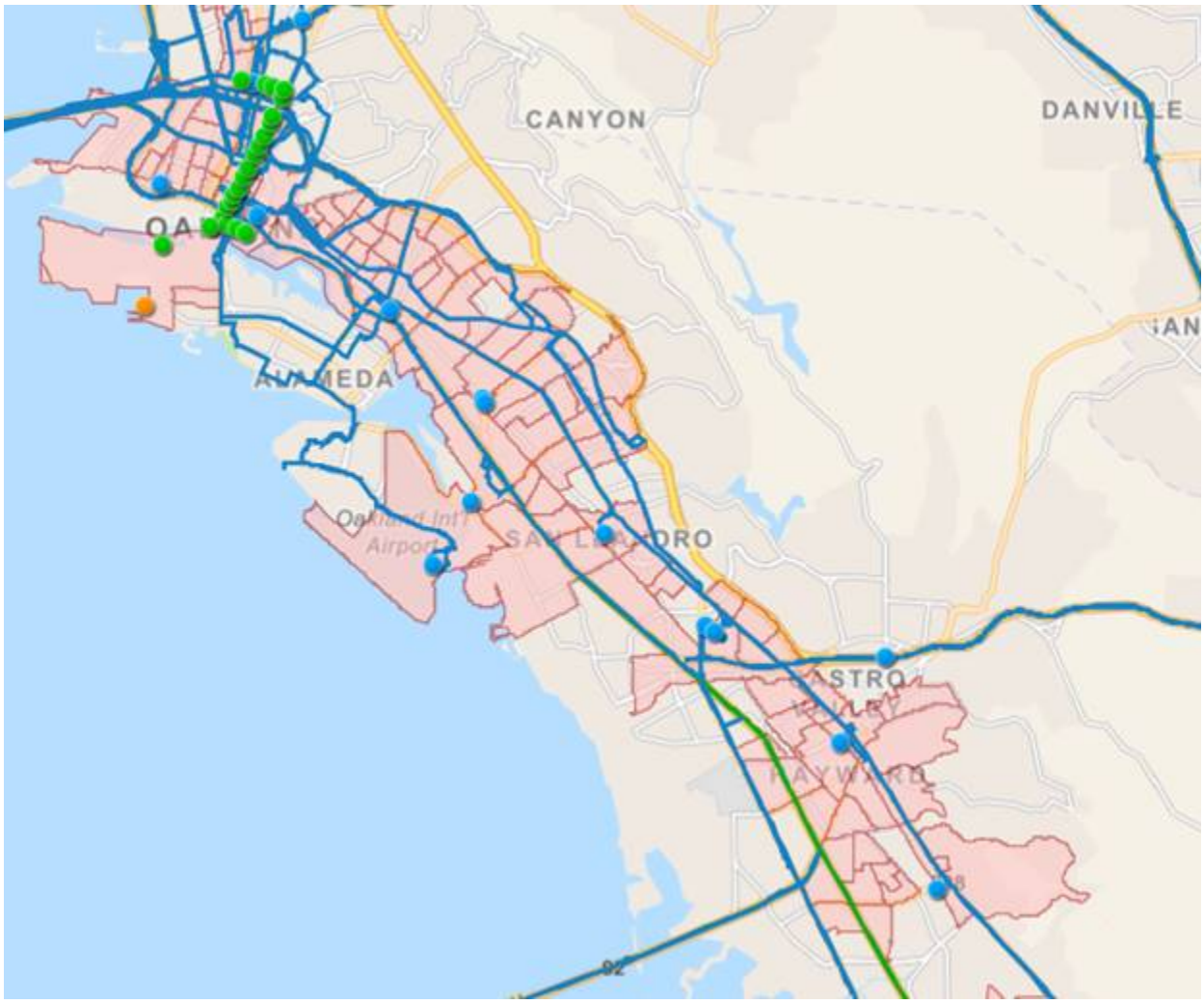
Table 1: Equity Analysis Scoring

PROJECT ID	PROJECT NAME	3 - HEALTHY + SAFE COMMUNITIES	5 - HOUSING + TRANSPORTATION COSTS	6 - AFFORDABLE HOUSING	7 - DISPLACEMENT RISK	8 - ACCESS TO JOBS	9 - JOBS CREATION	EQUITY TARGET SCORE	SERVES COMMUNITY OF CONCERN
207	San Pablo BRT (San Pablo to Oakland)	STRONG SUPPORT	STRONG SUPPORT	STRONG SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	4	Yes
501	BART to Silicon Valley – Phase 2 (Berryessa to Santa Clara)	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	4	Yes
1001	BART Metro Program (Service Frequency Increase + Bay Fair Operational Improvements + SFO Airport Express Train)	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	4	Yes
206	AC Transit Service Frequency Improvements	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	3.5	Yes
301	Geary BRT	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	STRONG SUPPORT	STRONG SUPPORT	3.5	Yes
311	Muni Forward Program	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	STRONG SUPPORT	STRONG SUPPORT	3.5	Yes
402	eBART – Phase 2 (Antioch to Brentwood)	MINIMAL IMPACT	STRONG SUPPORT	STRONG SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG SUPPORT	3.5	No
504	Stevens Creek LRT	STRONG SUPPORT	STRONG SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	3.5	Yes
506	El Camino Real BRT (Palo Alto to San Jose)	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	3.5	Yes
507	Vasona LRT – Phase 2 (Winchester to Vasona Junction)	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG SUPPORT	3.5	No
510	Downtown San Jose Subway (Japantown to Convention Center)	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	3.5	Yes
522	VTA Service Frequency Improvements (10-Minute Frequencies)	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	3.5	Yes
1650	Public Transit Maintenance - Bus	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	3.5	Yes
1651	Public Transit Maintenance - Rail	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	3.5	Yes
304	Southeast Waterfront Transportation Improvements (Hunters Point Transit Center + New Express Bus Services)	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	3	Yes
307	Caltrain Modernization - Phase 1 (Electrification + Service Frequency Increase) + Caltrain to Transbay Transit Center	STRONG SUPPORT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	3	Yes
312	19th Avenue Subway (West Portal to Parkmerced)	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	3	Yes
313	Muni Service Frequency Improvements	STRONG SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	3	Yes
505	Capitol Expressway LRT – Phase 2 (Alum Rock to Eastridge)	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	3	Yes
515	Tasman West LRT Realignment (Fair Oaks to Mountain View)	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	3	No
517	Stevens Creek BRT	STRONG SUPPORT	STRONG SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	3	Yes
801	Golden Gate Transit Frequency Improvements	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG SUPPORT	3	Yes
903	Sonoma County Service Frequency Improvements	MODERATE SUPPORT	STRONG SUPPORT	STRONG SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	3	Yes
104	Geneva-Harney BRT + Corridor Improvements	STRONG SUPPORT	STRONG SUPPORT	MINIMAL IMPACT	STRONG ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	2.5	Yes
306	Downtown San Francisco Congestion Pricing (Toll + Transit Improvements)	STRONG SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG ADVERSE	STRONG SUPPORT	STRONG SUPPORT	2.5	Yes
513	North Bayshore LRT (NASA/Bayshore to Google)	MODERATE SUPPORT	STRONG SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	2.5	No
516	VTA Express Bus Frequency Improvements	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	2.5	Yes
523	VTA Service Frequency Improvements (15-Minute Frequencies)	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	2.5	Yes
1101	Caltrain Modernization - Phase 1 (Electrification + Service Frequency Increase)	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	2.5	Yes
1102	Caltrain Modernization - Phase 1 + Phase 2 (Electrification + Service Frequency Increase + Capacity Expansion)	STRONG SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	2.5	Yes
1203	Vallejo-San Francisco + Richmond-San Francisco Ferry Frequency Improvements	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	STRONG SUPPORT	MODERATE SUPPORT	2.5	Yes
1204	Berkeley-San Francisco Ferry	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG SUPPORT	2.5	No
1301	Columbus Day Initiative	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	2.5	Yes
205_15	Express Bus Bay Bridge Contraflow Lane	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	2.5	Yes
203	Irvington BART Infill Station	MODERATE SUPPORT	STRONG SUPPORT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	2	No
331	Better Market Street	MODERATE SUPPORT	STRONG SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	2	Yes

PROJECT ID	PROJECT NAME	3 - HEALTHY + SAFE COMMUNITIES	5 - HOUSING + TRANSPORTATION COSTS	6 - AFFORDABLE HOUSING	7 - DISPLACEMENT RISK	8 - ACCESS TO JOBS	9 - JOBS CREATION	EQUITY TARGET SCORE	SERVES COMMUNITY OF CONCERN
905	SMART – Phase 3 (Santa Rosa Airport to Cloverdale)	MINIMAL IMPACT	MINIMAL IMPACT	STRONG SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	2	No
1403	Local Streets and Roads Maintenance (Preserve Conditions vs. No Funding)	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MINIMAL IMPACT	STRONG SUPPORT	2	Yes
1413	Local Streets and Roads Maintenance (Preserve Conditions vs. Local Funding)	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MINIMAL IMPACT	STRONG SUPPORT	2	Yes
302	Treasure Island Congestion Pricing (Toll + Transit Improvements)	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	1.5	Yes
403	I-680 Express Bus Frequency Improvements	MODERATE SUPPORT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	1.5	Yes
409	I-680/SR-4 Interchange Improvements + HOV Direct Connector	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	1.5	No
410	Antioch-Martinez-Hercules-San Francisco Ferry	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	1.5	Yes
502	Express Lane Network (Silicon Valley)	MODERATE ADVERSE	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	1.5	Yes
508	SR-17 Tollway + Santa Cruz LRT (Los Gatos to Santa Cruz)	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	MINIMAL IMPACT	STRONG SUPPORT	1.5	No
519	Lawrence Freeway	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	1.5	Yes
601	I-80/I-680/SR-12 Interchange Improvements	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	1.5	Yes
604	Solano County Express Bus Network	MODERATE SUPPORT	MINIMAL IMPACT	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	1.5	Yes
901	US-101 Marin-Sonoma Narrows HOV Lanes – Phase 2	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	1.5	No
1302	Express Lane Network (East and North Bay)	MODERATE ADVERSE	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE ADVERSE	STRONG SUPPORT	STRONG SUPPORT	1.5	Yes
1502	Highway Maintenance (Preserve Conditions vs. No Funding)	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MINIMAL IMPACT	STRONG SUPPORT	1.5	Yes
1502	Highway Maintenance (Ideal Conditions vs. Preserve Conditions)	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MINIMAL IMPACT	STRONG SUPPORT	1.5	Yes
103	El Camino Real Rapid Bus (Daly City to Palo Alto)	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	1	Yes
401	TriLink Tollway + Expressways (Brentwood to Tracy/Altamont Pass)	MODERATE ADVERSE	MINIMAL IMPACT	STRONG SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	1	No
605	Jepson Parkway (Fairfield to Vacaville)	MINIMAL IMPACT	MINIMAL IMPACT	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE SUPPORT	1	Yes
1201	San Francisco-Redwood City + Oakland-Redwood City Ferry	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	STRONG ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	1	No
1206	Alameda Point-San Francisco Ferry	MODERATE SUPPORT	MINIMAL IMPACT	MINIMAL IMPACT	STRONG ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	1	Yes
1304	Bay Bridge West Span Bike Path	MODERATE SUPPORT	MODERATE SUPPORT	MODERATE SUPPORT	STRONG ADVERSE	MINIMAL IMPACT	MODERATE SUPPORT	1	Yes
102	US-101 HOV Lanes (San Francisco + San Mateo Counties)	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	0.5	Yes
202	East-West Connector (Fremont to Union City)	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	0.5	Yes
210	I-580 ITS Improvements	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	0.5	No
404	SR-4 Widening (Antioch to Discovery Bay)	STRONG ADVERSE	MINIMAL IMPACT	STRONG SUPPORT	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	0.5	Yes
411	SR-4 Auxiliary Lanes - Phases 1 + 2 (Concord to Pittsburg)	MODERATE ADVERSE	MINIMAL IMPACT	MODERATE SUPPORT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	0.5	Yes
518	ACE Alviso Double-Tracking	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	0.5	No
1202	Oakland-Alameda-San Francisco Ferry Frequency Improvements	MODERATE SUPPORT	MINIMAL IMPACT	MODERATE ADVERSE	STRONG ADVERSE	STRONG SUPPORT	MODERATE SUPPORT	0.5	Yes
101	Express Lane Network (US-101 San Mateo/San Francisco)	MODERATE ADVERSE	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	STRONG SUPPORT	0	Yes
209	SR-84 Widening + I-680/SR-84 Interchange Improvements (Livermore to I-680)	MODERATE ADVERSE	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	0	No
503	SR-152 Tollway (Gilroy to Los Banos)	MODERATE ADVERSE	MINIMAL IMPACT	MINIMAL IMPACT	MINIMAL IMPACT	MINIMAL IMPACT	MODERATE SUPPORT	0	Yes
211	SR-262 Connector (I-680 to I-880)	MODERATE ADVERSE	MINIMAL IMPACT	MODERATE ADVERSE	MODERATE ADVERSE	MODERATE SUPPORT	MODERATE SUPPORT	-0.5	No

Project-Level Equity Map – Screenshot
(Source: Plan Bay Area 2040 Performance Assessment Online Dashboard)



CAMBRIDGE SYSTEMATICS

HORIZON

Project Performance Assessment – Draft Methodology

Horizon & Plan Bay Area 2050

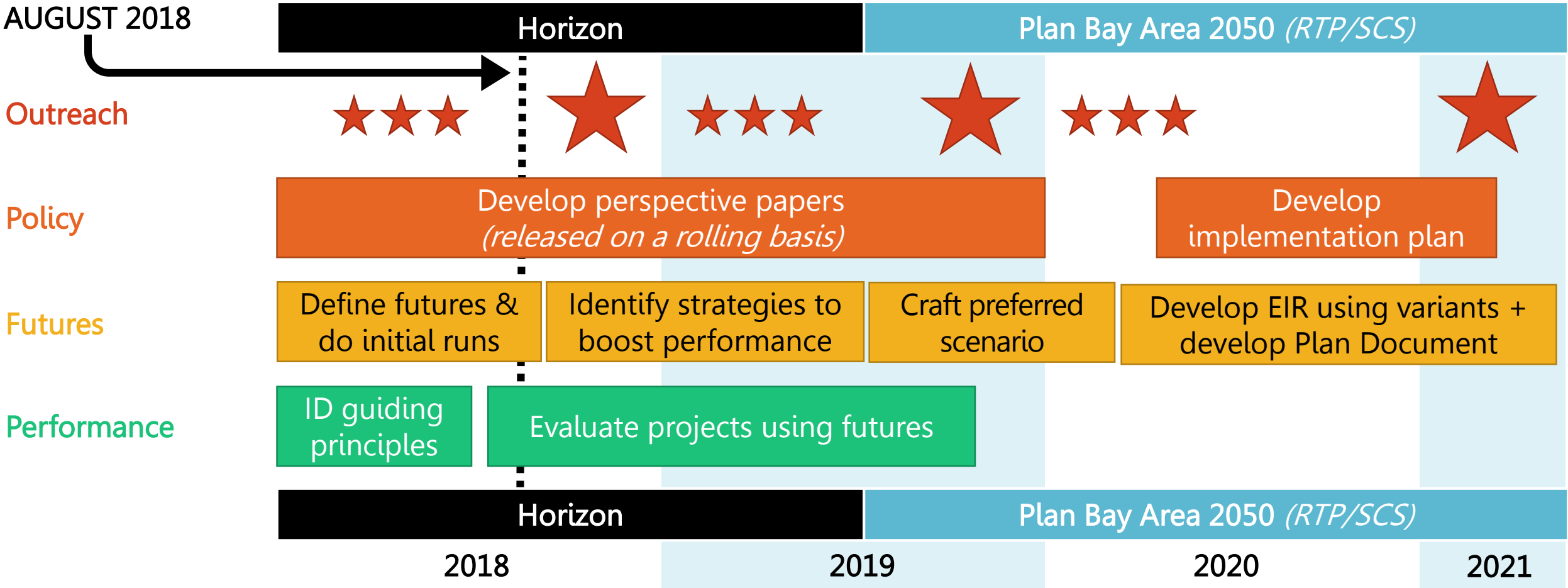
Regional Advisory Working Group

Anup Tapase, MTC/ABAG – August 7, 2018

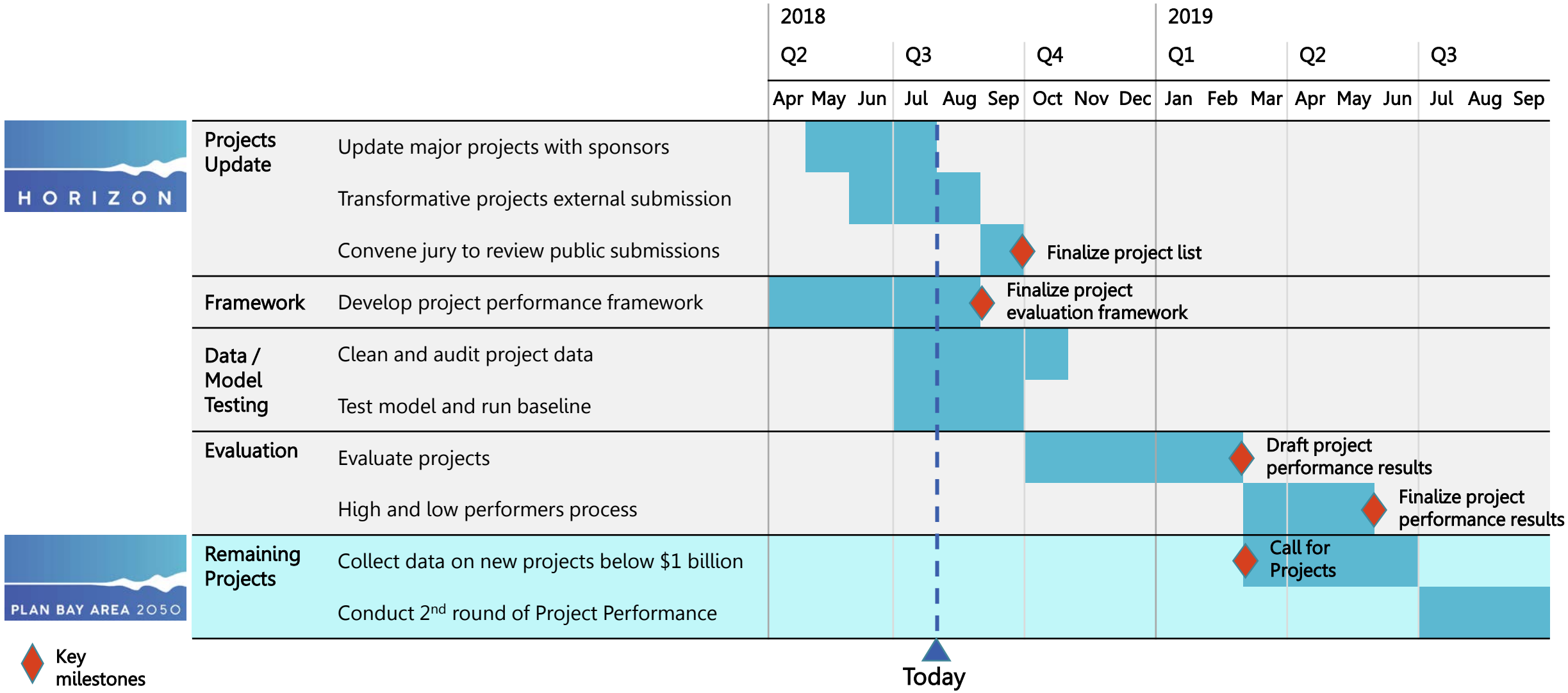
Agenda

- **Project Performance Assessment Overview**
- Benefit-Cost Assessment
- Guiding Principles Assessment
- Equity Assessment
- Next Steps

Horizon + Plan Bay Area 2050 Overview



Project Performance Timeline



Project Performance Scope

	Cost Threshold for Evaluation	Project Types to be Evaluated	Opportunities for Project Submission
Plan Bay Area 2040	>$100 million	Uncommitted Capacity-Increasing Projects **Only**	CMA & Major Operator Submissions **Only**
HORIZON / PLAN BAY AREA 2050	>$1 billion for Horizon >$250 million for Plan Bay Area 2050	Uncommitted Projects: • Capacity-Increasing • Operations • Resilience	Submissions from: • CMAs & Operators • Other Public Agencies • NGOs • Public at Large

Project Performance Framework

Plan BayArea 2040

- Benefit-Cost Assessment
  - Confidence
  - Sensitivity
- Targets Assessment
  - Equity

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- Benefit-Cost Assessment
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Benefit-Cost Assessment Overview

Benefits – for travelers & society

Accessibility

- Travel time - in vehicle
- Travel time - out of vehicle
- Vehicle operating costs
- Travel costs
- Mode choice availability
- Transit crowding

- Travel time reliability
- Emissions
- Natural land loss
- Health
- Safety
- Noise

Costs – for public sector

Capital Costs

- Initial investment
- Residual value

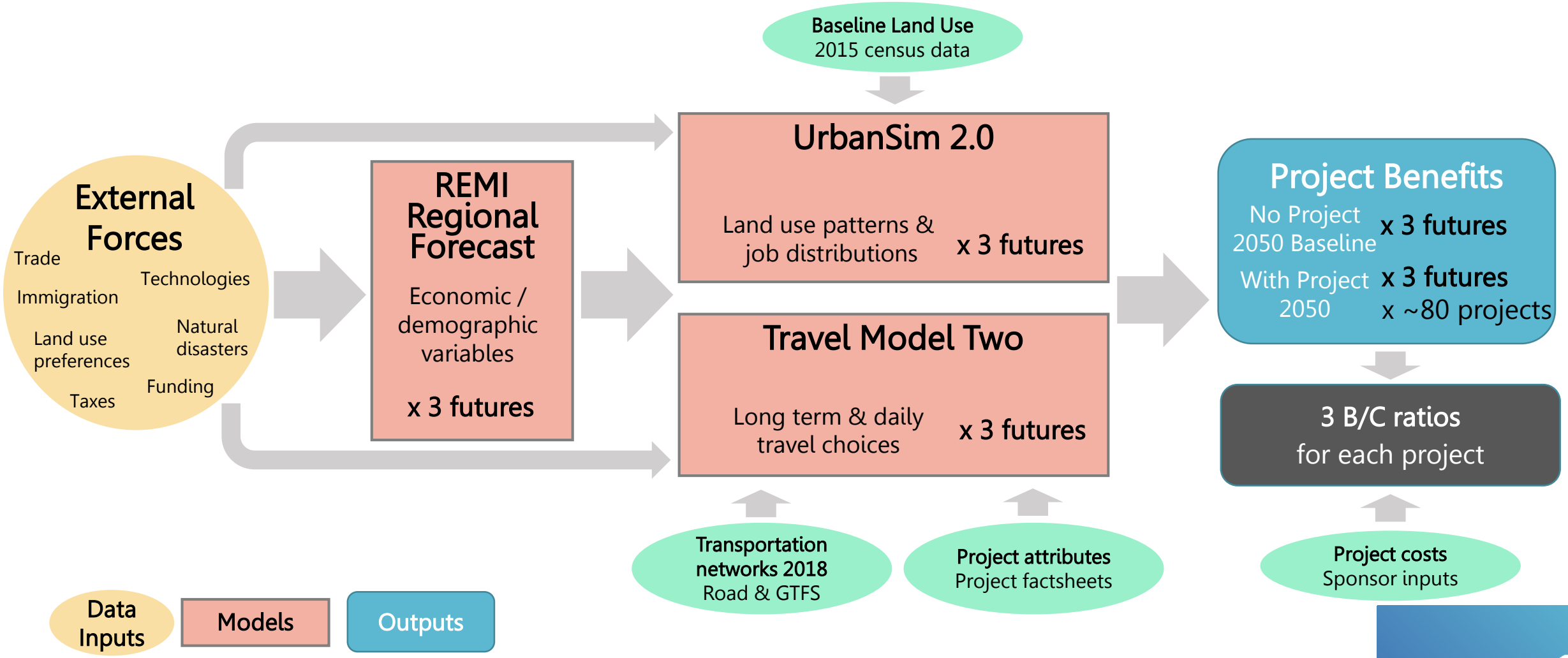
Net Operating & Maintenance Costs

$$\text{Benefit-Cost Ratio} = \frac{\text{Benefits}}{\text{Costs}}$$

Major Enhancements from PBA 2040

Refer to Attachment A-D for details on proposed Benefit-Cost Assessment methodology

Process Flowchart for Calculating Benefit-Cost



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- Project Performance Assessment Overview
- **Benefit-Cost Assessment**
  - **Proposed Major Enhancements** (Table A.1)
  - Benefit Valuation Updates
  - Calculation Methodology
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Safety: Capturing impacts of safety improvements

Proposed Methodology to Estimate Impact of a Project on Number of Collisions

Change in number of collisions due to a project

Change in VMT
x
Historical crash rates

+

Historical crashes at safety improvement site
x
Crash reduction factor (CRFs)

- Already part of PBA 2040
- Does not capture benefits of safety improvements such as elimination of weaving lanes
- Would incorporate AV safety benefit estimates by future

- Newly considered in Horizon / PBA 2050
- Examines number of collisions specific to location of targeted safety improvement
- CRFs sourced from FHWA's CMF Clearinghouse (Table A.2 in Attachment A)
  - E.g.: Median barrier: 86%, 4 to 5 lanes: -11%

Contingent on project sponsors providing sufficient design detail

(could be collected in fall 2018)

Natural Lands: Loss in value due to conversion

Methodology to Estimate Value of Loss of Natural Land

1. **Estimate area of land being converted**
   - Using lane or track miles (plus buffer), facility area

2. **Determine land typology**
   - Wetland, forestland, pastureland, farmland
   - Tools to determine are being explored, such as Greenprint

3. **Multiply area by annual value of natural land**
   - Valuation includes
     - goods (e.g. farm products, wood)
     - services (e.g. climate regulation, habitat)
   - Disbenefit experienced every year for life of project

Transit Crowding: Part of accessibility benefits

Methodology to Estimate Impact of Transit Crowding

- Crowded transit influences transit mode-choice decisions at the individual level
- Effect is modeled within logsum measure of accessibility, as a coefficient of travel time
  - Coefficients (weights) obtained from a study of consumer preferences with respect to crowding in Los Angeles transit (2014)
  - Crowding on a 1 to 7 scale, by trip mode, purpose and demographic factors
  - Coefficient is 1.00 when the transit vehicle is not crowded, and 1.378 when it is extremely crowded, and 1.629 when unable to board

Model testing has determined that this is the most viable approach to incorporate transit crowding

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Questions? Comments?

- Are project sponsors able and willing to submit specific safety improvement details?
- Are there any additional project benefits that should be included in our framework?

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Benefit Valuations: Key changes

Valuations based on wage rates vary by Futures

- Value of time (50% of wage rate) is impacted by shifts in income distribution
  - $12.10 - $17.90 per hour ($12.70 baseline) (2018$)
- Vehicle operating costs vary due to external forces (fuel prices, taxes)
  - $0.10 - $0.40 per mile ($0.20 baseline) (2018$)

Some valuations are updated based on latest research

- Value of Travel Time Reliability (1 * Value of Time in PBA2040)
  - Decreased for Auto (0.8 * Value of Time)
  - Increased for Freight (1.5 * Value of Time)
- Physical Activity – *being updated*

All other valuations have only minor updates

- Based on new guidance, revised data source, and/or adjusted for inflation

Refer to Attachment B for details on proposed valuations of benefits

Accessibility: Updating terminology

Plan BayArea 2040

"Travel time and cost savings"

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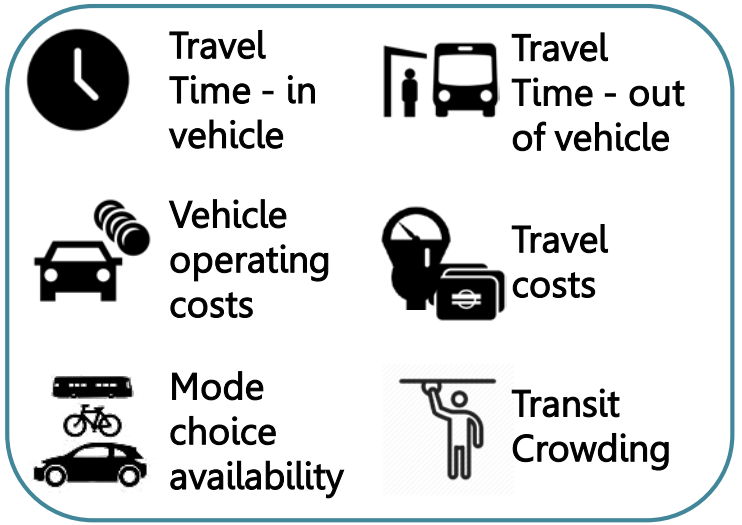
"Accessibility benefits"

- No change in methodology
  - Uses same logsum measure
  - Logsum approach has improved further: includes crowding, new modes (TNCs, AVs)
- "Accessibility benefits" more accurately describes model outputs as well as human behavior – represented by logsum metric
  - Mobility is large part of accessibility
  - Accessibility measures the ease with which people are able to reach their destinations
  - Change in accessibility measures change in utility, or consumer surplus

Accessibility benefits include:



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B/C Calculation: Accounting for time value of benefits and costs

Proposal to improve methodology to calculate BC ratio

Plan BayArea 2040

$$\text{B/C Ratio} = \frac{\text{Horizon year annual benefits}}{\text{Horizon year "annualized" cost}}$$

- **Annual Benefits:** Estimated by Travel Model
- **Annualized Costs:** $\frac{\text{Construction cost}}{\text{Useful life of asset}}$ + Annual O&M

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$$\text{B/C Ratio} = \frac{\text{Present value (Benefits)}}{\text{Present value (Costs)}}$$

- **Horizon Year Benefits:** Estimated by Travel Model
- **Stream of Benefits:** *Assumptions being developed*
- **Stream of Costs:** Initial capital investment + Annual O&M + Lifecycle costs – Residual value

Pros of approach

- Captures advantages of projects that are quick/easy to construct/implement[1]
- Captures long-term benefits of a large capital investment
- Identifies projects with high absolute value of annual benefits relative to costs
- Follows USDOT guidance for B/C analysis

Cons of approach

- Complex calculation
- Requires various simplifying assumptions

1. PBA2040's Confidence Assessment identified some projects as "early winners and late bloomers" to capture this

B/C Calculation: Preliminary Assumptions

Discount rate

- 7%, following USDOT guidance for B/C analysis of infrastructure projects
- 3.5% for natural resource benefits/disbenefits, i.e. water, air

Analysis period

- Propose to calculate a B/C ratio for a 30 year period of the project, including construction time, discounting benefits/costs to the first year of construction of the project
- 30 years is generally sufficient to capture benefits and costs for most asset classes at 7% discount rate
- For convenience, assume this period to start in 2021, end in Horizon year 2050
- Longer analysis period of 50 years or lifetime of asset (whichever is longer) to be considered in sensitivity analysis

Costs

- Investment costs spread evenly over construction period
- Lifecycle costs incurred when useful life of asset expires (refer to Table A.4)
- Residual value of investment calculated at Horizon year and added as a negative cost

Benefits

- Assumptions for growth of benefits over analysis period need to be defined by benefit category and Future; options are being considered
  - Horizon year benefits assumed for all years
  - Specific assumptions by future

Assumptions are being updated to reflect best practices

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Questions? Comments?

- Are there any concerns about this approach?

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Supplemental Assessments: Proposed updates

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Confidence Assessment Criteria

- Model accuracy
- Completeness of framework
  - Some limitations in PBA 2040 addressed – transit crowding, safety benefits
- Timeframe inclusiveness
  - Addressed by present value approach

Sensitivity Assessment Criteria

- Capital cost
- Value of travel time
- Valuation of life

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Confidence Assessment Criteria

- Model accuracy
- Completeness of framework
  - Other limitations persist – weekend travel, freight

Sensitivity Assessment Criteria

- Capital cost
- Timeline of project construction
- Longer B/C stream that spans lifetime of project assets
- Discount rate

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Questions? Comments?

- Are there any other key limitations of the B/C assessment framework that should be assessed for confidence or tested for sensitivity?

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Guiding Principles Assessment *(revised)*

Potential Approach to Flag Projects

If a project **does not support one** Guiding Principle, it would not be eligible for high performer status.
If it **does not support more than one** Principle, it would be designated as a low performer.

Guiding Principles and Evaluation Questions

Changed based on feedback in June RAWG

Principle	Evaluation Question	Application of the Evaluation Question
AFFORDABLE	Does the project increase travel costs for lower-income residents?	• The project would have to actively eliminate a lower-cost travel alternative, rather than just offering a new travel option.
CONNECTED	Does the project increase travel times or eliminate travel options?	• The project would have to increase travel time for one mode, without decreasing it for another mode; exceptions would be made for projects with significant safety benefits that justify increased travel times, or… • …the project would have to eliminate a modal option from a travel corridor.
DIVERSE	Does the project displace lower-income residents or divide communities?	• The project would have to directly displace lower-income households through site acquisition, or… • …the project would have to build an elevated structure through an existing neighborhood.
HEALTHY	Does the project increase emissions ~~or consume open space~~?	• The project would have to yield a long-term net increase in emissions. • ~~The project would have to directly acquire and develop open space or agricultural lands.~~
VIBRANT	Does the project eliminate jobs?	• The project would have to directly result in a net reduction of jobs.

Refer to Attachment E for details on Guiding Principles Assessment

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Equity Assessment: Exploring options

Vision for Improved Project-Level Equity Assessment:

- Compare project impacts across different population groups (e.g. income, vehicle ownership)
- Quantify equity impacts of projects in monetary values
- Provide an alternative equity lens to visualize the benefits/cost ratio

Methodology to measure equity impacts of projects

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- **Geographic Analysis:**
  - Determines whether projects provided more transportation access points to residents in Communities of Concern
  - Does not measure whether residents' accessibility was actually impacted
- **Equity Targets Assessment:** no targets analysis in Horizon

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- **Baseline: Maintain Geographic Analysis**
- Precision of Travel Model Two outputs for small population subgroups at the project level needs to be determined
- *Methods to quantify equity effects at the project level are being explored – seeking input to learn about best practices in the region and beyond*

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Next Steps

- **Major Projects Update**
  - **CMAs and Major Transit Operators:** please submit as soon as possible
  - Due date was July 31
- **Transformative Projects Submission**
  - **All:** deadline is September 6
- **Feedback on Project Performance Framework**
  - Comment period open for two weeks
  - Send comments to atapase@bayareametro.gov by **August 21**
- **Revised Project Performance Framework**
  - To be sent out in late September
- **Modeling**
  - Baseline modeling begins in August
  - Project evaluation continues through Spring 2019

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Questions? Comments?