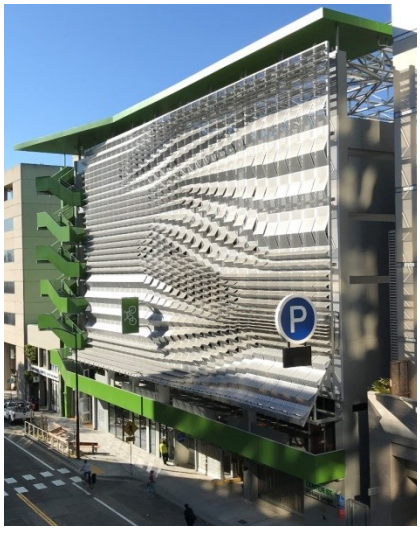
Sustainable and Resilient Infrastructure

Creating a Better Future for our City

Presented by the
Vision 2050 Task Force
November 2019



Infrastructure investment will be crucial. The world should adopt a simple rule: if big infrastructure projects are not green, they should not be given the green light. Otherwise, we will be locked into bad choices for decades to come.

-- UN Secretary General Antonio Guterres, 2017

Table of Contents

Foreword by Mayor Jesse Arreguin

Acknowledgements

Mayor's Office

Jesse Arreguin, Mayor
Brandi Campbell, Former Chief of Staff
Tano Trachtenberg, Legislative Aide

Task Force Leadership

Ray Yep, Chair
Margo Schueler, Co-chair

Steering Committee

Karen Parolek, Quality of Life Work Group lead
Debbie Sanderson, Quality of Life Work Group co-lead
Margo Scheuler, Environment Work Group lead
Kristina Hill, Environment Work Group, co-lead
Sachu Constantine, Technology Work Group lead
John Elliott, Technology Work Group co-lead
Gordon Wozniak, Finance/management Work Group lead
Victoria Legg, Finance/management Work Group co-lead
Jim McGrath, Technology Work Group member
Bruce Riordan, Environment Work Group member
Ray Yep, Task Force chair

Task Force Members

Jesse Arreguin	Max Gomberg	Rigel Robinson
Amanda Bornstein	Kate Harrison	Bruce Riordan
Tony Bruzzone	Larry Henry	Debbie Sanderson
Brandi Campbell	Kristina Hill	Margo Schueler
Sachu Constantine	Victoria Legg	Sophia Skoda
Nate Dahl	Jaimie Levin	Kira Stoll
Paul Degenkolb	Jose Lopez	Sam Trachtenberg
Erin Diehm	Monika Mann	Tano Trachtenberg
John Elliott	Emily Marthinsen	Alfred Twu
Scott Ferris	Jim McGrath	Susan Wengraf
Lucy Flood	Toni Mester	Anna Whitney
Abigail Franklin	Nicholas Oxley	Gordon Wozniak
John Gage	Karen Parolek	Ray Yep
Ben Gerhardstein	Lauren Randall	

For more information, please contact **Ray Yep**: rayyep1@gmail.com

Executive Summary

Section 1
The Vision 2050 Initiative

Vision 2050 is a citizen-led planning effort, convened by Mayor Jesse Arreguin, to create a common vision to guide physical infrastructure planning. The vision extends over 30 years to encourage long-term planning that will begin to meet the serious challenges of the 21st century — including climate change, inequality, population changes and aging infrastructure— and improve the quality of life for the next generation of Berkeley residents. Vision 2050 proposes to move beyond business-as-usual to accelerate the building of climate-smart, technologically advanced, integrated, and efficient infrastructure.

What is Infrastructure?

Miles of infrastructure work to keep our city functioning beneath our feet, under our tires, and all around us as we go from home to school and work, shop and eat in town, or just enjoy the company of neighbors. Some parts of this critical infrastructure are controlled by the City of Berkeley while other important components are controlled by our partners—EBMUD, PG&E, AC Transit, BART and others. Figure 1 shows the components above the ground, on the street surface and below ground. We call this the public commons.

Infrastructure on the surface is the most familiar feature – streets, sidewalks and bikeways that support cars, trucks, bikes an poles support electric and communications l down and enjoy life, providing habitat for our w

Beneath our feet is another ex ts that we rarely think about until something br mes and businesses, brings natural ga ewage. It is also part of the electric and commu ound BART system.

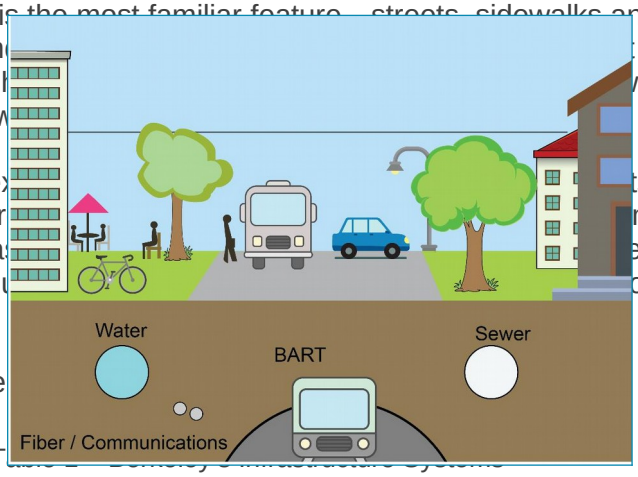


Table 1 shows the magnitude

T s

Berkeley Infrastructure Systems		
Infrastructure System	**Controlled by City**	**Controlled by Others**
Streets, Sidewalks, Paths, Bikeways, and Tunnels	216 miles of streets 300 miles of sidewalks 50 miles of paths and bikeways	AC Transit buses BART system Lyft and Uber ZipCar, Gig, etc.
Power and Communication Systems	7,000 street lights	PG&E electricity and natural gas delivery systems Private telecommunications and Internet services
Parks and Street Trees and public plantings	38,000 street trees 52 parks	
Water Supply System	11 creek watersheds	EBMUD potable and recycled Water
Sewers	380 miles of sewers	EBMUD sewage treatment
Storm Water System	220 miles of storm drains	

Berkeley Infrastructure Systems		
Infrastructure System	**Controlled by City**	**Controlled by Others**
	6,000 storm drain facilities	
Solid Waste Management	7 acre transfer and recycling station Curbside collection services for over 23,000 homes and businesses Commercial food waste collection	Alameda County landfill Alameda County household hazardous waste services Alameda County construction & demolition debris services

What is the Problem?

Street repairs needed

Berkeley, along with much of the United States, is faced with infrastructure that was built 80+ years ago. Many facilities in Berkeley were built as part of the Works Progress Administration (WPA) in the late 1930's. Those projects included Aquatic Park, the Berkeley yacht harbor, Rose Garden, Civic Center, the Community Theater on the Berkeley High campus, and many other facilities. The City's streets, storm drains, sewers, and EBMUD's water lines are also of similar age, if not older. The problem with aging infrastructure is that they are susceptible to unplanned failure, cause service interruptions, cost more to maintain and don't meet current requirements.

Aging piping systems

Our infrastructure systems are old, much of it is at the end of its useful life. How we got to this situation is also a problem. We have not planned for all of the needed repairs and provided the necessary funding to keep the systems in good working condition. We do not have a life cycle approach to managing our infrastructure. As we rebuild, the infrastructure must change in response to population changes, environmental demands and technology innovations.

To meet these complex challenges, we need to transform our infrastructure management to include:

Safety concerns with overhead wires

- A longer term view
- New technologies and solutions to develop intelligent adaptable infrastructure
- Inter-department and inter-disciplinary planning
- Additional funding

w Was This Report Developed?

ayor Arreguin announced in his 2017 State of the City address his intention to develop Vision 2050 – a long–term infrastructure plan to create a City that is resilient and sustainable for future generations. The initiative began in April 2018 and concluded in November 2019. A task force was formed that included over 40 people from across our community. The work was organized into four work groups – quality of life, environment, technology, and finance/management. Involving the community was very important in the process and that involvement included a series of information sessions in Fall 2018 and community workshops in Summer 2019. Our community voiced their support for this Plan with the passage of Measure R in the November 2018 election, which asked our Berkeley voters the following:

Shall the measure, advising the Mayor to engage citizens and experts in the development of Vision 2050, a 30-year plan to identify and guide implementation of climate-smart, technologically-advanced, integrated and efficient infrastructure to support a safe, vibrant and resilient future for Berkeley, be adopted?

Our community's overwhelming response was "yes."

Section 2
Street Corner View of Berkeley in 2050

If you are standing on a street corner in Berkeley in 2050, what will our city look like? Will our infrastructure adapt to make our lives more productive and enjoyable or will we feel the stress of too much change? The Vision 2050 task force attempted to transport ourselves to the future and imagined a Berkeley in 2050.

A Vision for Berkeley in 2050

What might a typical day look like in Berkeley in 2050? Our cool wet and warm dry seasons will give way to a much warmer and drier climate. With neighborhoods and supporting infrastructure specific to its place, there is no one vision of Berkeley in 2050. We chose to imagine a fall day to create a hypothetical story of what Berkeley could feel like as we adapt our infrastructure and ourselves to a different climate.

A Fall Day in Berkeley in 2050

Hi, I'm Maria! It's already a warm morning as I cycle down the bike path, calling out to n who are walking their kids to school and getting ready for work. I continue down t str thankful for the protected bike lanes and the pothole free streets. What a difference has made to bike and pedestrian safety! I am on my way to the South Berkeley co-op great aunt Lizzie lives. She's 85 but still learning, so we are going to a habitat restorat workshop at the updated Berkeley Marina.

My watch pings to let us know that the accessible shuttle, now celebrating its 20th year of electrified operation, will pick us up in five minutes. After we board, I take a moment to check my phone and see that my home's smart energy system correctly rotated our solar panels to maximize their output and shaded the windows on the sunny south side.

When we arrive at the workshop, we learn that Berkeley High students trained in many kinds of habitat restoration are running the workshop. Aunt Lizzie is pleased to find out these services are now subsidized for low-income city residents. She sets up an appointment to have two experts come evaluate landscape opportunities at her co-op.

As we stroll down the waterfront, we see people coming and going from the bustling ferry terminal. Aunt Lizzie stops for a moment to remember what this area was like before Berkeley restored the wetlands to help protect the waterfront from sea-level rise and storm surges. It's thrilling to see the snowy egrets hunting in the restored, climate-buffering wetlands.

On the way to lunch, we spot solar panels now producing a significant portion of the city's power needs, and I particularly enjoy easy access to the strong secure Wi-Fi now available throughout the city. I'm still trying to convince Aunt Lizzie to get an Easy Access watch, but she prefers the old method of text messages on her phone.

After lunch, I return home and see the Berkeley fire department hard at work. They are inspecting homes in the neighborhood to be sure that debris is cleared away from our houses and that we are doing everything we can to prevent an urban wildland fire. It's the time of year that the Diablo winds kick up. We are thankful for the Public Works Department who has

undergrounded the overhead wires on Ashby and other evacuation routes. Aunt Lizzie takes a shuttle home to rest.

Hi, I'm Aunt Lizzie! The mid-afternoon heat is unbearable, so we seniors limit our outdoor activity then. Not long ago, the Home Helpers with an HCD grant, helped our co-op retrofit for this new climate – put white shingles on the roof, installed an attic fan, added insulation, installed an evaporative air cooling system, and raised the building to avoid the basement flooding. What a relief! And with all the new trees, our home is now comfortable and we didn't have to move!

At around 4 pm my friend Annie knocks on the door – time for our outdoor concert at the plaza! Fortunately, the plaza has lots of benches and tables in the shade or we certainly wouldn't be here! We pick our favorite spot under a leafy oak tree and close to the Mist Maker and watch children playing in the interactive fountain. It's all recycled water, so we don't worry about wasting water in this perpetual drought.

After the concert, Annie and I cross the street to the nearby park for our Tai Chi class. At the corner, we press the button for the "Extra Time to Walk" light; it gives us plenty of time to cross the street and we feel much safer. It's time for home and dinner, so we walk to the shuttle stop in the soft down-glow of LED lights, mounted hip-level on the pathway's stanchions. Life at 85 in 2050 is different from what we expected, but enjoyable nonetheless. New rain gardens now prevent those awful flooded intersections of 2020 and provide a little green oasis at every other corner! Annie and I look forward to the days of cooling sea breezes, but we feel so fortunate to live in Berkeley where 30 years ago someone thought to plan ahead! Berkeley is still an amazing and charming city.

Establishing Our Core Values

Berkeley's deteriorating infrastructure requires allocating financial resources and resident support to remedy it. Although improvement opportunities exist, fixing infrastructure is expensive, is technical, and it is often met with inconsistent responses from residents and policymakers alike. The inadequate and inequitable repairs to infrastructure make people reluctant to finance it because people in poorer neighborhoods experience longer response to their infrastructures needs. Vision 2050 focuses on developing a resilient infrastructure that will not only withstand shocks, but also provides an opportunity to develop socioeconomic resilience to bring about employment opportunities to Berkeley residents, address issues of equity, and build a healthy city with the end goal of improving the overall quality of life of current and future residents.

Connecting the Dots

We have imagined a healthy and resilient city, with a booming local economy and less segregated in the year 2050. The vision has shown us how far we can go as a city. Climate resilience and hazard risks are relevant to Berkeley, instead of coming together during a time of disaster and crisis, it is better to unite in preparation before disaster strikes. Vision 2050 is the opportunity we have as residents to start a transformative change to help us adapt and cope with disasters and its impacts in a practical manner. Moving forward, an equitable approach to

infrastructure should, every year, strengthen Berkeley's equity and inclusion metrics through improvements in health equity that address all social determinants of health.

Place matters. Residents continue to experience growing health disparities across different neighborhoods. Life expectancy is not balanced across the city, population continues to grow, increasing demand for more and better infrastructure and services. Inequitable trends can be reversed as more affordable housing, accessible economic opportunities, and stronger tenant protections emerge in the city; therefore, providing a more stable living situation to vulnerable residents.

Repairing our infrastructure translates to establishing a local green economy, primarily driven by renewable energy, sustainable capital improvement projects, and responsible technology achievements. Getting there will take a lot of work and a significant financial lift. Financing a resilient Berkeley is a central question in our minds. Fortunately, the city is in good financial shape and confidently can prepare to take the step forward, allowing the city to formulate the long-range infrastructure plan for the next thirty years. The significant feature of Vision 2050 is planning for a more integrative built environment through technology, protecting the environment, having a sound financing structure to pay for the vision, and improving residents' quality of life.

Vision 2050 will establish a sense of resilience, strengthen social networks, maintain a sustainable physical structure, and improve the quality of life for thousands of residents. Vision 2050 can help us achieve significant physical outcomes, yet disparities in equity and inclusion across income, race, ethnicity, ability, and gender has not been resolved, but we are on the right path to achieving it.

As we anticipate a future that is changing, our planning to meet those challenges should be thoughtful and guided by the principles of what we want Berkeley to be like. We call these core values. These values must be built into our efforts to build infrastructure for the future. The Vision 2050 task force developed the following four core values:

- **Equity** – – Ensure benefits are equitably distributed and available and that they consider health status and school outcomes as well as access to jobs, housing, food and upward mobility
- **Public health and safety** – Enhance public health, well-being and safety
- **Strong local economy** – Develop local skills and capacity to keep jobs and economic benefits close to home
- **Resiliency and sustainability** – Enhance abilities to withstand challenges and support future needs

These core values, applied to our infrastructure, results in:

- Clean water and air
- Shared and safe community spaces such as streets, sidewalks, public parks and other people-centered places
- Transportation that connects us, improving mobility for all while reducing pollution and energy-use
- Local and clean energy that is efficient, electrified, low-carbon and equitably provided
- Natural habitats that are biodiverse and thrive in an urban environment

- Fast and widely-accessible communications bringing all residents and businesses into the 21st century.
- Resilient systems that make our schools, homes and businesses ready for fire, earthquakes, and floods

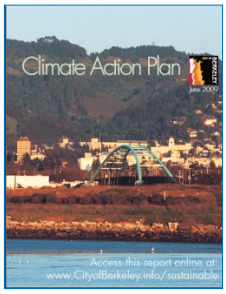
Section 3
Building on Current Infrastructure Planning

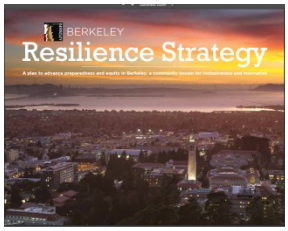
The City has prepared plans for many infrastructure systems. Some of the plans were done many years ago and some are recent. The Vision 2050 task force used the existing plans as the starting point. We want to build on what has been done and to add recommendations where it is needed. This section describes the City's current plans and infrastructure improvement programs.

Building on the City's Planning

The Vision 2050 task force created a database of the City's relevant infrastructure plans. The plans were reviewed and information was summarized in several ways, including their connection to:

- Infrastructure systems
- Core values
- Criteria from the Institute for Sustainable Infrastructure's Envision program
- Date of preparation and current applicability





Over 20 plans were reviewed. The plans that provide the key guidance for our future include the:

- Climate Action Plan
- Resilience Strategy
- Capital Improvement Program

A summary of the current plans and their recommended actions are show on Appendix 2.

Our review found that the plans were prepared for specific purposes and often lacked integration. This is improving with the City Manager's Strategic Plan and the recent Resilience Strategy. We also found no regular schedule for preparing or updating the plans. Some plans are current and applicable while others are out of date, incomplete, or have not been started. Many plans have been only partially implemented.

Case Studies

It is valuable to learn from projects and programs implemented in Berkeley. We can glean from these what has worked well and what attributes to carry to our future work. Positive case studies include the Climate Action Plan, Measure T1, and the Center Street Parking Garage. The attributes that have worked well include the following.

- Have an executive level "champion" for the project. This provides the vision and imperative for the project team.

- Involve the appropriate commissions early in the project. This will provide valuable input and buy in.
- Involve community organizations and the community, in general, to gain input and to educate them on the project.
- Develop options for the project based on the input. Screen the options based on multiple criteria and make recommendations.
- Provide status reports, including cost and schedule, on a regular basis to the public. This can be in reports to City Council, updates on websites, or in community meetings.

Current Infrastructure Investments

Berkeley's most recent Comprehensive Annual Financial Report (CAFR) for the fiscal year ending on June 30, 2018, listed the City's total capital assets at about $850 million. In a March 19, 2019 report on Projections of Future Liabilities, the City Manager stated that the City's largest unfunded liability of $786 million is infrastructure that has exceeded its useful lifespan. The available funding to address this failing infrastructure is about $33 million, which is about 4.2% of the total need. As a result, failing infrastructure is kept in service beyond its useful lifespan and the cost of replacement increases substantially due to inflation and construction cost escalation as shown in Figure 4.

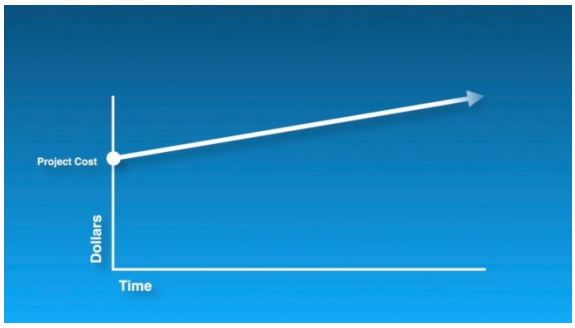


Figure 4 – Cost escalation

Berkeley prepares a 5-year Capital Improvement Plan (CIP) and it is updated every two years. The CIP outlines the specific projects, schedule and the funding needs for the following infrastructure systems:

- City facilities
- Information systems
- Parks and marina
- Sanitary sewer
- Storm drains
- Sidewalk repairs
- Street repairs
- Transportation
- Other infrastructure
- Equipment

Projects shown in the CIP are typically systems that have been studied, are known to be deficient and improvements are needed to bring them back to acceptable use. There many

Table 2 – CIP project categories

infrastructure needs that have not yet made it into the CIP. The following table attempts to organize the needs into three categories.

Category	Definition	Examples	Funding Needs, $millions
CIP projects	Projects that have conceptual planning completed and order of magnitude cost estimates prepared. These projects are ready to move to design and implementation once the funding is in place.	• Sewer system improvements • Short term street improvements • Short term storm drain improvements • Building maintenance	200 - 300
Known program needs	Projects where planning studies have been done but funding and implementation have not been approved. These projects are not in the CIP.	• Watershed management plan projects • Marina improvements • Utility undergrounding • Sidewalk improvements • Municipal pier improvements • Green infrastructure program to comply with stormwater permit	300 - 400
Undefined program needs	Projects where planning studies have not been done yet but there is a known need for them in the future. These projects are not in the CIP.	• Long term street improvements • Response to sea level rise • Civic center improvements • Waterfront improvements	200 - 300
Total			**700 – 1,000**

The CIP, along with special revenue funds, bonds, enterprise funds, transfer taxes, and state and federal funding, provide the funds to maintain and construct our capital assets and infrastructure. Several recent actions by the voters have provided an important boost to the resources available for meeting these challenges:

Measure T1, authorizing the City to sell $100 million of General Obligation Bonds to repair, renovate, replace, or reconstruct the City's aging infrastructure and facilities, including sidewalks, storm drains, parks, streets, senior and recreation centers, and other important City facilities and buildings.

Measure F (a countywide vehicle registration fee), increasing the Parks Tax revenues approximately 16.7% to support parks, playgrounds, city trees and landscaping operations and maintenance. Measure F provided an additional $750,000 per year to Berkeley for major

maintenance projects, raising annual funding for parks capital and major maintenance projects from $250,000 to $1 million.

Measure BB (a property tax assessment), which implements a 30 year Transportation Expenditure Plan. Berkeley's allocation is approximately $2.6 million annually and is applied to improving the pavement condition and specific street/transportation improvement projects and increasing funding for local transportation enhancements. Measure BB will benefit the City's streets and roads, pedestrian and bicycle infrastructure. Measure M (a general obligation bond), to provide an additional $30 million which is being used to significantly accelerate the implementation of the 5-Year Street Plan and install green infrastructure where appropriate, improving the condition of city streets and Green Infrastructure projects as defined in the Watershed Master Plan.

Current Financial Challenges

The City has two major unfunded liabilities: Pension/Benefits and Infrastructure, both of which are increasing rapidly. From Fy2012 to FY2019, the unfunded liability for Pensions/Benefits almost doubled from $363 million to $665 million, whereas the Infrastructure unfunded liability almost tripled from $325 million to $882 million. See Table ___.

Table ____

Unfunded Liabilities

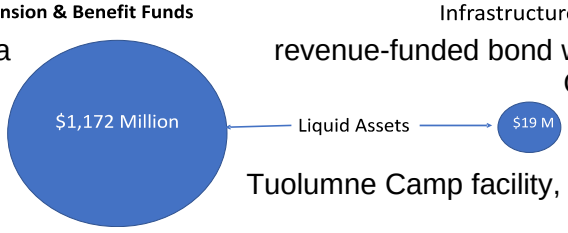
Fiscal Year	Pension/Benefits	Infrastructure
2012	$362 million	$325 million
2019	$665 million	$882 million

From FY2012 to FY2020, the City increased its annual funding of pension/benefits from $76.5 million to 115.6 million, which increased its total Pension/Benefits liquid reserves to $1,172 million.

Over the same time period, the City funding for infrastructure decreased $53.5 million to $39.8 million, while infrastructure unfunded liabilities tripled, which is clearly inadequate to maintain the City's aging infrastructure, let alone modernize it.

Furthermore, most of the City's capital assets do not have reserve funds associated with them, with the exception of vehicle, building maintenance and computer/servers, which total only $19 million, or fifty times smaller than the Pension/Benefits reserves.

Fig. 5 Liquid Assets & Reserves



While there are many fiscal challenges, the City has some opportunities as well. First, the public has shown its wiliness to support bond funding for infrastructure modernization by passing Measures M and T1. Second, the City demonstrated the benefits of a revenue-funded bond when it replaced the Center Street Parking Garage with a climate smart facility, using its cash flow from parking revenues. Third, in FY2020 the City will replace the destroyed Tuolumne Camp facility, funded primarily with insurance funds,

with a modern facility. Fourth, the proposed 5-yearcapital budget for FYs2020 – 2024, increases capital spending to ~$67 million/year, which is a substantial increase over the previous plan.

Section 4
Future Challenges for Our Infrastructure

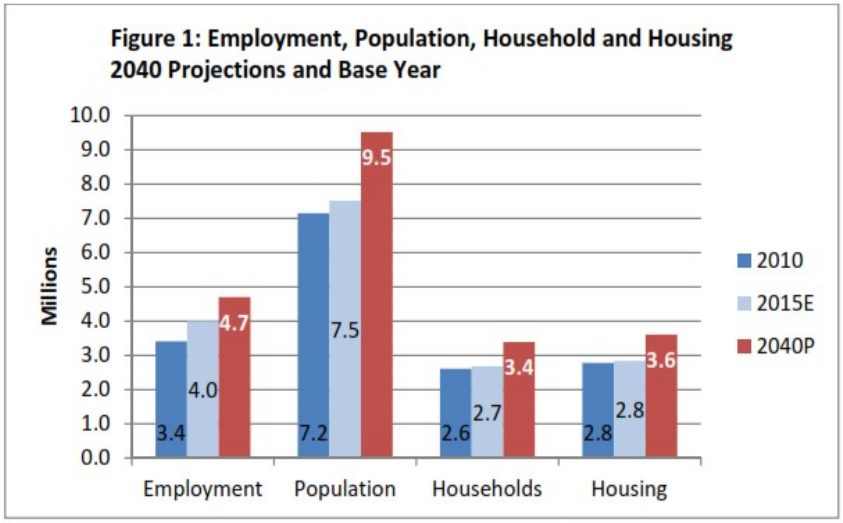
As we look to replace or upgrade our current infrastructure, we must address many challenges, such as decreasing fossil fuels, increases in population, drought, wildfires and flooding, and information privacy and security threats, while also taking advantage of various opportunities, such as local energy generation, electrification, micro-grids, access to real-time information, and the re-design of our public commons. Following are summaries of those challenges.

Demographic Trends in Berkeley

The Vision 2050 initiative, which covers 2018 through 2050, focuses on how to provide what infrastructure to best serve the current and future population of Berkeley. Plan Bay Area (PBA) projects regional changes in employment, population, numbers of households, and housing units for the years 2010 through 2040. We've taken the 2040 projections and extrapolated them to 2050 for Berkeley. The PBA considered 3 different scenarios for projecting changes in employment and population, and chose the "modest growth" scenario, which follows national trends. The region's number of jobs and population surged from 2010 to 2015.

More People are Projected

Figure ____ summarizes the expected changes in population, jobs, households, and housing units from 2010 through 2040 for the Bay region. Both population and jobs experienced rapid growth from 2010 to 2015. One-fourth of the projected population growth and half of the job growth occurred in that 5-year period and the growth of both are expected to slow significantly from 2015 through 2040. The number of households increased by only 13% of that 5-year period and numbers of housing units by only 8%.



Source: ABAG from California Department of Finance, California Employment Development Department, US Bureau of the Census, and in-house analysis.

Figure

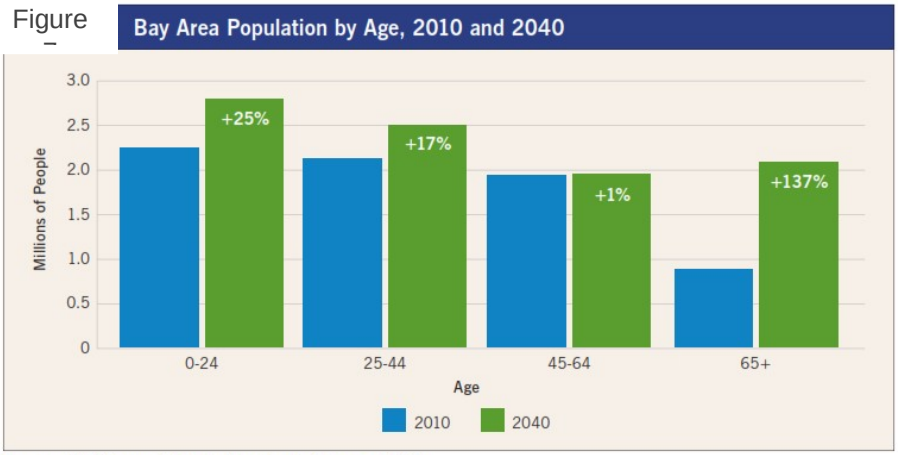
More Diverse, but Lower Percentage of Working-Age Adults

We assume that demographic changes in Berkeley in the coming 35 years will be like that of Alameda County and the region.

- Racial and ethnic balance will become less white and more Latino and Asian.

- Household incomes at the moderate and above-moderate levels will decrease somewhat and those at the low and very low levels will increase a little bit.
- Like the rest of the country the number of working age adults will decrease from 3.5 per retirement age adult to 2.5 per retirement age person.
- The number of people over 65 will double, from 12% to 22% of the population.

Figure



Sources: 2010 Census, California Department of Finance, ABAG

Applying regional percentages to estimate 2015 and 2050 levels for the City of Berkeley:

- Berkeley's growth in households, housing units, jobs and population are slightly below that expected for the County of Alameda and the region.
- Between 2015 and 2050 the population, the number of households and the number of housing units in Berkeley are estimated to increase about 26-27%. Growth in jobs for that time is expected to increase by only 20%. As in the rest of the region, a great deal of job growth has already occurred, and the numbers of people, households, and housing units will catch up.

For planning future infrastructure, about 2/3 of the increase in households is expected to occur along the major transit corridors.

Quality of Life Challenges

The quality-of-life challenges fall into two categories – impacts resulting from infrastructure decisions and the need to improve quality of life by prioritizing some infrastructure expenditures over others. To date, most Berkeley plans fall into the first category and the current decision-making process makes it difficult to address challenges in the second category.

Current Long-term Planning

Long-term plans in Berkeley historically have focused on:

- Geographic location (i.e., Downtown Area Plan, West Berkeley Plan) that address land use issues, including limited infrastructure goals
- Type of infrastructure (i.e., Parks Plan, Marina Plan, Bicycle Plan); they address improvements to existing infrastructure, but are bound by the size and location of existing infrastructure
- Meeting statewide mandates (i.e., the Climate Action Plan, the Resilience Plan) to reduce the city-wide impacts of climate warming and to ensure a fast and efficient recovery from major disasters

Many of these plans seek to minimize infrastructure impacts on quality of life (add example) or to improve quality of life (by improving parks, pathways, etc.), either directly or indirectly. The third category of plans take a new approach – to preserve city-wide quality of life through more far reaching plans and interdepartmental coordination.

Why are there Challenges?

With such good plans, why do we face "quality of life" challenges? First, how well these long-term plans protect or enhance quality of life depends entirely on how they are implemented and monitored. The current process assigns departments to implement each plan, or a portion of a plan, as the City Council makes funds available. As would be expected, the Council prioritizes capital funding to mitigate current crises and current needs, which tend to be near-term not long-term.

Second, the departmental decision-making process includes little involvement from other departments, no feedback loop, and no way to measure impacts on quality of life or evaluate how to plan better the next time. Even though many of these plans mention ways to mitigate or enhance quality of life, without a feedback loop or performance measures, we don't know if these are just words intended to "sell" the plans.

Third, despite everyone's best intentions, the current process of implementing and funding infrastructure makes it almost impossible for the City of Berkeley to use quality of life as a decision-making tool. For example, important tradeoffs cannot be considered. Should neighborhoods with a high percentage of seniors have priority in sidewalk repairs over other neighborhoods? Should repairing sidewalks near senior facilities be a higher priority than repairing streets used primarily by non-seniors? Should small neighborhood parks take priority over wetland rehabilitation needed to mitigate impacts of rising sea level? The piecemeal process for making infrastructure decisions in Berkeley removes any opportunity to improve quality of life by coordinating infrastructure development more broadly and over a longer time horizon.

Responding to Future Challenges

In the coming 30 years, physical environmental crisis that we face will become more frequent, making it even more important that we coordinate planning and funding procedures for developing infrastructure, over a longer time horizon. Increased heat will have a disproportionate impact on the health and comfort of seniors and young children, especially those unable to afford air conditioning. And demographic projections indicate that the percentage of seniors will continue to increase! Wildland fires will increase making evacuation for disabled individuals more critical. Air quality will decrease due to increased smoke from nearby fires and changes in wind direction due to warmer land. Homes in lower-income neighborhoods are most vulnerable to flooding related to sea level rise and the least able financially to bear the burden.

To meet these challenges, we need a new decision-making process that includes social equity as a key decision-making criterion, as well as a measure of impacts. [more to come . . .]

Environmental Challenges

In the past 50 years, we've planned for "suitability" by trying to match land uses to the capacity of a site. We've also planned for "sustainability" by trying to minimize our impacts on the environment, while supporting biodiversity and other ecosystem services. And we've planned for

Environmental trends will influence the livability of Berkeley. By seeing the connections and the differences, we can make smarter investments in our

“resilience” by seeking to increase our capacity to recover quickly from events like earthquakes, fires and temporary flooding. But this new era of infrastructure planning will have to contend with changes in the environments that have seemed relatively stable in the past.

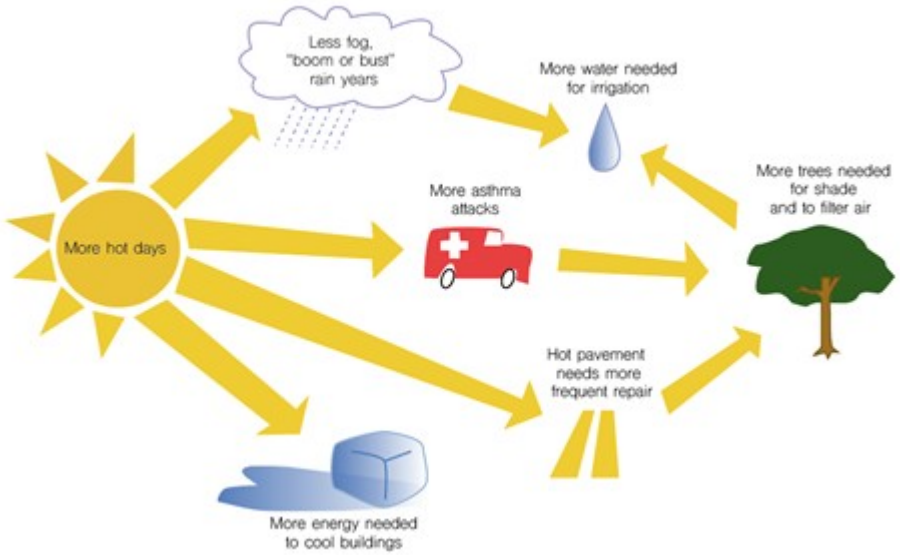
Our City has declared a Climate Emergency. According to the 4th California Climate Assessment, new climate conditions will lead to more frequent major fires and intense precipitation events, reduce our air quality and regional biodiversity, and gradually flood the coastal highways, parks and neighborhoods of cities around the Bay Area. With all the things we’ve planned in the past – road systems, sewer systems, new towns, new airports, etc. -- we haven’t planned for an environment that is changing so much that it will require us to adapt.

The big changes that will affect Berkeley are increasing heat, rainfall extremes and rising sea levels. These will affect many other critical trends, like maintenance costs and health. The City needs a vision that reflects how these trends are connected. Our shared public investments and policies need to help us mitigate fossil fuel emissions and adapt to long-term changes like rising seas, as well as build our resilience to short-term events, such as a heat wave or an extreme rainstorm.

Increasing Heat

Hotter air leads to more intense rainfall, drier vegetation, and air quality problems that impact people’s health. Research shows the links between increased air temperature and people’s health, the health of urban trees that could cool our homes, and the maintenance costs for our infrastructure. More heat means higher maintenance costs and lower performance for conventional “gray” infrastructure. California’s 4th Climate Assessment is the best science-based prediction of our future local climate. It says Berkeley can expect an increase in air temperature, along with boom-and-bust rainfall years.

Observations since 1950 show a decrease in the number of foggy days. In dry years, we’ll have less fog and less humidity. That could cause an increase in the mortality of park and street trees, as well as on private property. If we water more, we’ll increase water demand and would need to be ready for that. If the trees die, they can’t provide shade, leading to even higher air temperatures and energy demand in buildings. Dead and dry vegetation is more dangerous as a fuel for fire in the hills of Berkeley. Increased air temperatures can lead to asthma attacks and other respiratory problems – particularly if the air doesn’t cool off quickly at night, and trees aren’t around to filter the air. More frequent fires will lead to losses of property, reduce air quality, and potentially risk people’s lives. There is evidence that hotter streets need more frequent



maintenance, and that hotter streets are associated with breaks in underground water pipes. That's a lot to plan for, and it means we need to know how these things are connected when we plan.

Significant Changes in Precipitation

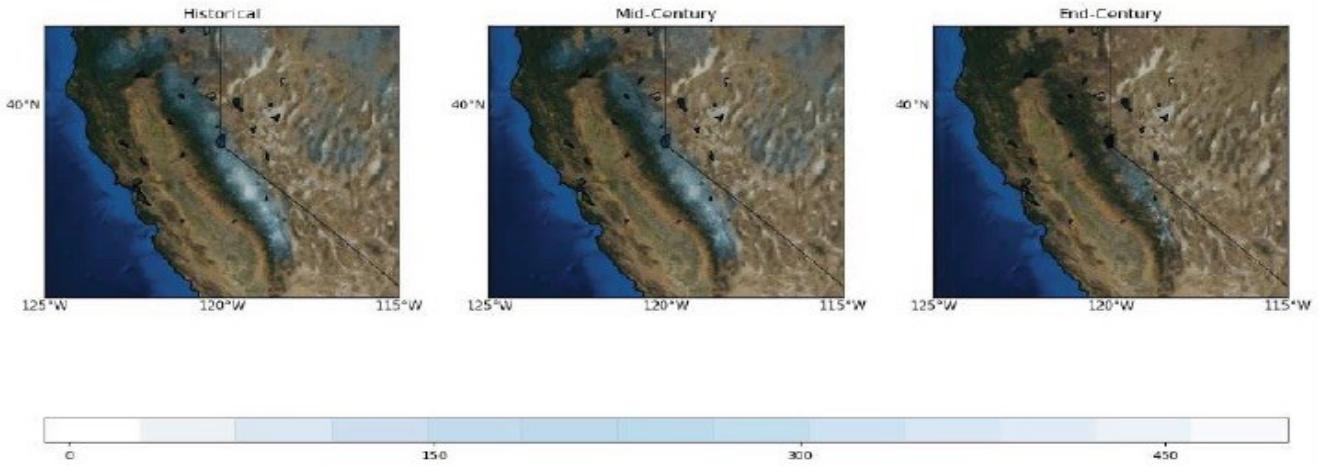
California's 4th Climate Assessment projects that the Bay Area will experience more "boom and bust" years — both very wet and very dry conditions — in the coming decades. Our largest winter storms, called "atmospheric rivers," will likely become more intense, bringing challenges to Berkeley's stormwater system, making potholes more ubiquitous and deeper, and flooding key facilities. At the same time, longer and deeper droughts — like the 2012-16 drought which led to the most severe moisture deficits in the last 1,200 years — will parch our precious parks and open spaces. Even if rainfall totals don't increase, higher temperatures and longer heatwaves will dry out vegetation significantly, increasing fire danger and degrading streetscapes and green areas.

Warmer temperatures are also predicted to make a substantial change in the Sierra snowpack, source of the vast proportion of EBMUD's water supply. Under a high emissions scenario in California's 4th Climate Assessment, the average Sierra snowpack will decline by 20% in the next few decades, 30%-60% in mid-century, and over 80% in the late 21st century. Consecutive years of low or no snowpack are especially worrisome. In addition, warmer temperatures are producing a shift to earlier snowmelt in the Sierra, posing storage and supply problems for high water demand periods that occur in hot summers and falls.

Fire Risk

2017 was the hottest year on record, following 5 years of drought that killed 129 million trees in California. Five of the most destructive wildfires in the state's history burned between October and December 2017. There were 7,117 wildfires that year, compared to the historic average of 4,835. The carnage continued in 2018 with 5,847 fires before the traditional "fire season" even began, destroying over 1 million acres, thousands of homes, and taking dozens of lives. The entire town of Paradise burned to the ground in less than two hours, taking close to 90 lives with it.

Climate change has increased temperatures and drought, which will inevitably lead to even more severe fires. Diablo wind-driven fires are impossible to stop while these strong winds are blowing. But taking steps to reverse climate change can minimize the severity of wildfires. This can be done by utilizing more solar and wind-generated power instead of burning coal and natural gas, better insulating homes and businesses to conserve energy, shutting down utilities



in high wind conditions, providing more public transportation, planting more climate-moderating trees, creating viable escape routes in high hazard fire areas, improving emergency warning systems and taking other significant steps needed to lower emissions and stabilize climate.

Many large wildland/urban interface fires duplicate the destruction similar fires caused years before. The Tubbs Fire that burned through Santa Rosa followed the same path as a 1964 fire. Our local 1991 Tunnel Fire followed the same path as the 1970 one. As of yet, no fire has followed the path of Berkeley's 1923 one. But one inevitably will. Each fire destroyed way more homes and took more lives than the earlier fires, due to the increase in population density. Despite that, Berkeley is encouraging even denser housing by facilitating ADUs (accessory dwelling units), even in the dangerous hills high fire hazard zone. This is a recipe for disaster, especially considering the narrow winding streets that must serve as evacuation routes. Many streets in the hills, hardly any of which lead directly downhill, don't come anywhere close to meeting current State standards for street width. The majority of these streets cause traffic backups even under normal conditions. And a significant percentage of Berkeley's population lives in the hills. And those who don't live there are not out of danger considering the destruction of the Coffey Park flatlands of Santa Rosa that burned to the ground during the Tubbs Fire.

Fires will burn following an earthquake that could destroy much of the city and its infrastructure within the next 20 years. Some predictions include destruction of hundreds of buildings, loss of power for weeks and destruction of 5,000 water lines, most of which will not be repaired for months. Multiple fires will burn out of control as well. Thousands of people will either move out of town or need to live in shelters post-earthquake. School will close. Businesses will fail. Plans must be developed and action taken soon to make the city as resilient as possible in the face of these threats.

Both the City and its residents must take immediate action to strengthen and improve the fire resistance of our homes and businesses in the face of catastrophic climate change and the inevitable fires, floods, droughts and landslides it will cause. This can include undergrounding utilities along the main evacuation routes, requiring Class A fire-resistant roofing and double pane windows, removal of flammable trees and hedges, ensuring that home fire alarms are functioning, expanding fire safety inspection capabilities, imposing reasonable limits on street parking on excessively narrow hill streets, construction of turnouts to take parked cars off streets, increasing public education programs about fire safety, installing redundant emergency warning systems, encouraging more citizens to take CERT classes, and more.

Native plants have adapted to the fire ecology of our state, and re-sprout from the roots or from dormant seeds after fires. Unfortunately, this isn't possible for homes or people. We need an effective plan of action to minimize the impacts of future disasters. Then we need to implement it.

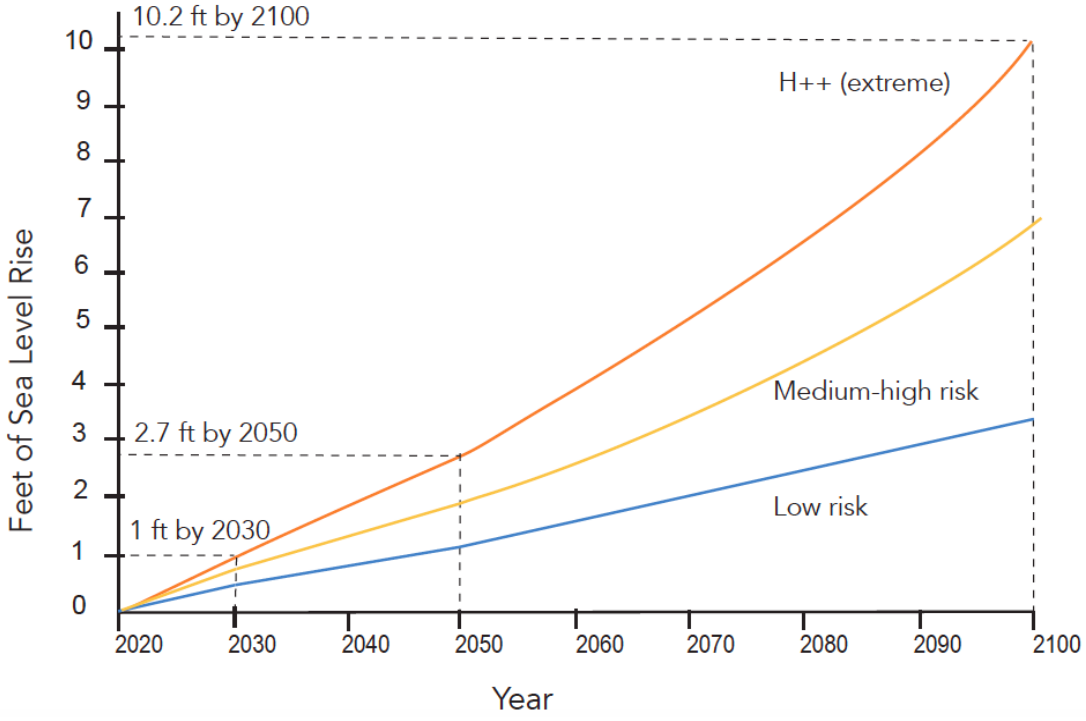
Earthquakes and Landslides

Berkeley's Local Hazard Mitigation Plan identifies earthquake and rainfall triggered landslides as likely hazards with catastrophic severity of impact. Most of our thinking about acute land changes centers on building structures but the impacts to our infrastructure range from rupture and blockage of water, sewer and gas pipelines to toppling of power and communication poles and overhead structures. Streets and sidewalk buckling and failure will impede emergency responders and evacuation routes. Any failures in these critical infrastructure systems will disrupt service. (LHMP 2019 B-13)

Sea Level Rise

Both California's 4th Climate Assessment and the State of California's recent guidance to public agencies on sea level rise tell us that Berkeley can expect to see significant sea level rise over the next 20-80 years, and long after that. Although no one knows exactly how much the Bay will rise and by when, the State has provided a range of estimates to show the low risk, medium-high risk, and extreme risk scenarios.

For 2050, the State has identified a range of likely sea level rises of between 1.1 to 2.7 feet. By 2100 the projections indicate increases from 3.5 to over 10 feet above today's sea level. As scientists have learned more about the dynamics of ice sheet melting, they have developed scenarios for even greater sea level rise. Many scientists now believe that the amount of carbon and methane in the atmosphere today has committed us to an eventual rise in sea level of about 10 feet. No matter what the sea level is in 2100, it will continue to rise until some equilibrium is reached between the elevated levels of CO2 present and the amount of heat already trapped in the ocean. Figure __ shows the estimated range of sea level rise in the Berkeley area.



California's science-based guidance to public agencies recommends that local jurisdictions consider "medium-high risk" predictions when planning long-term facilities (i.e., facilities meant to last 20-50 years). For investments meant to last beyond 50 years, the State recommends that we consider the potential for an extreme sea level rise scenario

Figure – Sea level rise estimates from California State Guidance for public agency planning, 2018

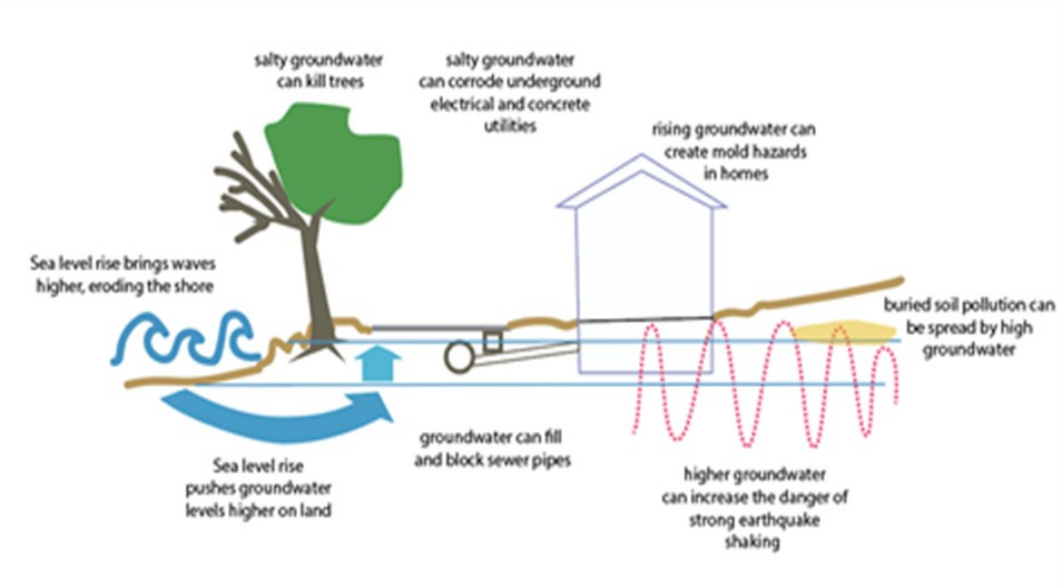
No matt 0 and beyond. That's how accelerating trends work, they change faster over time. But there's no point in building things for a sea level rise that won't see long term use. We need to consider the expected lifetime of the things we build, as well as the rate of sea level change. Many scientists think that we'll know a lot more about which sea level trend is actually occurring in the next decade or two. If so, there may be reasonable moral arguments that current generations should do and pay for more adaptation, since we are causing the change. However we decide to respond to that challenge, it's as critical not to waste money preparing infrastructure investments for sea level rise if those structures are not intended to last more than a few

decades as it will be to ensure longer lived assets are prepared to withstand potential extreme sea level rise.

Coastal parks and bike trails will be affected – both by sea level rise directly, and by increased erosion from wave action that reaches higher areas of the land. This will push us to decide where public access (and private facilities that pay fees to the City) will continue, and where these will be lost or reconfigured. Intertidal wetlands will be lost unless investments are made to raise the surface elevation of the wetlands, or they are allowed to migrate inland onto lands that are now roads, parking, or other uses.

Combined Effects

Sea level rise is a trend that is very likely to produce unexpected effects through networks of causes and effects. The US Geological Survey has shown that rising sea levels will cause groundwater – the water that rises and falls in the soil as rain and tides influence it - to also rise within a few miles of the shoreline. This could flood sewer pipes and basements. It could also move soil pollution around, creating serious health threats. It can cause corrosion of pipes and problems with underground electrical utilities. Street pavement is more prone to cracking in a high-groundwater environment. High groundwater can increase the risk of extreme shaking in an earthquake, risking damage to property and loss of life. We can adapt to this challenge, but we need to see the cause-and-effect network connections in order to choose the right investment and design strategies. Loss of marshes will devastate biodiversity historically hosted in vegetated bayshores.



While other lower lying communities around the Bay will experience serious impacts from sea level rise before Berkeley, we will all be impacted within the life span of many of our infrastructure investments. Our regional wastewater, transportation, refineries and pipelines, will require significant adaptation investment. Many regional facilities will need to be relocated. Our bay shoreline, roadways and western neighborhoods already suffer flooding impacts of rising sea and groundwater levels when combined with severe storms and king tides. Long term infrastructure investments should be evaluated frequently against evolving sea level rise data and projections.

There is not one answer for Berkeley

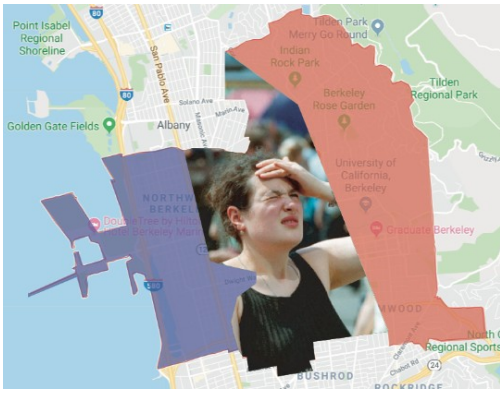
Our city grew in the 19th century along the shipping corridors on the bay with the pier and the railroads moving goods and people north and south from the farms and factories. With the establishment of the University, the center of town shifted east from old Oceanview and Berkeley spread developing our 20th century grid of water, sewer, and gas underground and telephone and power overhead along the street right of ways from bay to the hills.

Our infrastructure corridors connect us, providing transportation, water, waste, power and communication networks. But from an infrastructure and climate point of view, Berkeley has three different "zones" with different challenges.

The hills have the highest risk of fires, seismic shaking and landslides. Steep slopes and narrow, winding roads make evacuation difficult. Adaptation will require careful management of vegetation, and finding opportunities to shelter in place when evacuation is impractical. Water pressure needs to be high for fire-fighting, and electric utilities should probably be placed underground.

Flooding risks are most important in the flats, as climate change and development increase runoff from higher elevations. Rising sea levels and groundwater will keep water from seeping into the soil and flowing into the Bay. The flats also have worse air quality, thanks to heavy traffic on Interstate 880, University, Ashby and San Pablo Avenues. Buried infrastructure will need to be waterproof, and the risks of extreme shaking may increase as groundwater rises. The neighborhoods need more trees and less gas-powered traffic to improve air quality.

Downtown Berkeley is particularly vulnerable to heat, as density increases along with traffic. South Berkeley also has high traffic flows and needs safer streets and sidewalks for bikes and pedestrians. These neighborhoods need greener infrastructure (trees and rain gardens) to help manage both storm water and air quality. Since they sit at the base of the hills, storm water and groundwater can emerge as springs and flood basements. Infrastructure and sidewalks need to be enlarged and re-designed to handle growth and development, making the sidewalks into more people-friendly public space. South Berkeley has provided affordable housing and community space for diverse families. Future development should prioritize their housing and public space needs, and not displace people who are part of Berkeley's community.



These different parts of Berkeley have different needs. Planning needs to recognize historic and present inequalities, and avoid using "equality" (i.e., giving everyone the same thing) as a substitute for "equity" (which is making sure people have access to what they need). Funding for some very local needs should come from the people who benefit the most, and for other issues, funding may come from a broad base.

Technology Pathways

Technology trends are changing the way we use the city's infrastructure and existing infrastructure does not meet future needs. Furthermore, new technology needs to be energy efficient, electrified, decentralized, low-carbon, integrated with our buildings and public infrastructure, and widely and equitably accessible. We note particularly that the benefits of technology change are not likely to be shared widely without some intervention by the city. And finally, proactive steps are needed to protect quality of life and mediate the potential negative impacts of technology.

But it is impossible to predict exactly what technologies will be available 5 years from now, let alone 30 years from now when we reach 2050. Rather, we seek to define general principles to guide City procurement and plan implementation, and to inform customer-facing policies and practices. Staying in the context of City procurement, and the responsibility for the Public Right of Way, we identified 6 technology pathways - Building, Energy, Transportation, IT, Water and Waste Management - that will impact the services that the City must provide. Each of these technology pathways has seen dramatic changes and many more are expected. Without knowing the specific evolution of each technology pathway, we can set up the general principles that a technology should satisfy (and the levers that the City has to encourage compliance):

1. Energy Efficient (Reach Codes, etc.)
2. Electrified (Fuel switching, rebates, etc.)
3. Decentralized (Resilient and promoting consumer choice)
4. Low Carbon (Increased reliance on solar and wind, walkable City)
5. Integrated (i.e. with City Plans, as in undergrounding and paving; also with private buildings)
6. Equitably distributed (Rebates, Incentives, wide area coverage, geographically distributed, low barriers to entry)

So for example, our roads and Public Right of Way should prioritize safe access for pedestrians, bikers, low cost widely available zero carbon public transit fleets, EV charging, and on-demand services for Seniors and Youth.

Technology Services

Services refer to the core functions of the City of Berkeley in 2050. We have listed 7 functions described briefly below:

1. Building Services: Buildings support basic residential services like comfort and shelter, commercial activities, City services, information and communications hubs, and they define the "grid edge" with respect to energy services from PG&E and East Bay Community Energy.
2. Transportation Services: Transportation networks, including roadways, sidewalks, bicycle and pedestrian bike paths, public transit systems, fleets, and shared and private vehicles/private automobiles move people, goods and services around the City.
3. Energy Services: Energy services in the City of Berkeley refers to the production, distribution and consumption of energy used to provide basic residential and commercial needs, including end-use appliances and self-generation.
4. Communications/Information Services: Physical and logical communications infrastructure, and overlapping security and identity infrastructure support the safe and timely flow of information and data between individuals, equipment and infrastructure in the City of Berkeley.

5. Water and Waste-water Services: Refers to complete hydrological cycle: rain and storm water, surface flows and containment, subsurface groundwater flows, clean water and wastewater distribution and treatment, and quality assurance for all end uses.
6. Waste Management Services: Waste management begins with how and what we consume, and then include diversion to re-use, recycling and compost before any solid waste is generated.
7. Emergency Services: Fire, Police, Medical and Mental Health assets must be deployed to resolve inevitable conflicts, disasters and disruptions to City life.

Technology Trends

Buildings

By 2050, buildings in Berkeley will be significantly more energy and water efficient, electrified, and connected. They will also host increasing capacity for local energy generation and storage. They will be increasingly efficient in water use and waste water treatment. To accommodate these changes, buildings will need efficiency improvements, electrical service upgrades, IT infrastructure improvements, and water use improvements. Berkeley has direct control over municipal buildings and infrastructure, and can use City Ordinances and financial incentive programs to effect change in the private building stock.

Transportation

Certainly the City will have to grapple with the electrification of transportation, including private Electric Vehicles (EVs), and our Public Right of Way must make some accommodations to EV charging for light, medium and heavy duty transport. There may also be an increase in autonomous vehicle traffic, but that remains to be seen. The more important trend will be move people out of private vehicles entirely onto streets that are bicycle and pedestrian friendly, public transit oriented, environmentally durable, and more accessible for public utility upgrades.

Energy

By 2050, Berkeley seeks an energy system that delivers carbon free electricity across a highly distributed system, capable of providing reliability and resilience while serving the needs of fully electrified building and transportation sectors. California has established a policy framework that will achieve a carbon free grid within that time frame, but Berkeley has the ability to accelerate the progress towards that goal within the City limits.[1] In any case, Berkeley has significant control and influence over local energy infrastructure and technology choices, particularly for public and city assets. Multiple and multifaceted changes to that infrastructure and its uses will be required to achieve the Vision 2050 carbon goals, as well as other values prioritized in the plan. In general, these changes can be summarized as: 1) maximize energy efficiency, 2) electrify everything possible, 3) decarbonize and clean up the grid, and 4) squeeze fossil fuels out. Other changes, like undergrounding of utilities, while not strictly required for decarbonization, may be necessary to achieve resilience, reliability, access and equity (democratic). Incentives for home electrification, including heat pump technology and induction cooking are an important tool for the City, particularly targeted at low income households.

Information

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1 SB 100 (de León) was signed by the Governor in September, 2018. It mandates 60% renewable energy for electricity generation by 2030 and 100% carbon free by 2045, which could include nuclear, large hydro and other clean energy technologies. It does not speak to the penetration of distributed technologies or specifically address local resilience.

By 2050, information flows in Berkeley will change fundamentally, in quantity, in quality, and in granularity. Common objects will communicate with each other. Data will be stored and retrieved at molecular and atomic level. In short, where electrons flow, there will be information exchange. All electrical and electronic devices-- automobiles, trucks, appliances, communication devices, entertainment devices, information infrastructure components, lighting devices--will be able to communicate. Major infrastructure components--road surfaces, beams and column elements of buildings, load-bearing components of bridges and towers, all piping and pumping infrastructure for water, wastewater, airflow and air conditioning, all cabling and energy transport infrastructure--will gradually incorporate sensing and communication of real-time state information. The City must make plans to manage this flow of information, as well as to address any issues that arise from the inevitable risk to privacy. Communications protocols are not the domain of the City, but rather must be thought of as a compliance objective. Particular care must be taken to ensure that Emergency Services has full access to the flow of information.

Water
With climate change, increasing variations in water supply, and extremes in drought conditions and periods of intense rainfall, Berkeley's infrastructure must be prepared for these conditions and work closely with EBMUD and regional agencies. Storm water capture, ground water recharge, grey water treatment, reclamation and reuse all have technological innovations we need to incorporate in our local infrastructure.

Waste
By 2050, Berkeley will have made significant reductions in disposal of single-use products, and also expanded the range of materials that can be reused, recycled, or composted. To accommodate these changes, new businesses or government services will need to exist, and changes will need to be made at the Transfer Station and other facilities.

Our Opportunities

Economic Growth and Job Creation
Investments in our infrastructure have historically created economic opportunities, and it can now, too. Investments made through the WPA transformed Berkeley, creating jobs and significant community resources such as our beloved Rose Garden. Investments made in undergrounding BART through our city enabled us to have a vibrant downtown that is not under the shadow of or divided by BART tracks, as well as the Ohlone Greenway. We have an opportunity as we replace our end-of-life infrastructure to create significant economic opportunity.

Re-thinking the Public Commons
As we dig up our streets to upgrade the infrastructure, as well as consider how transportation changes will be incorporated, we have an opportunity to re-consider and re-prioritize how we use our publicly-owned land, designing them to balance the needs of all those using the spaces. Berkeley's streets cover more than 12% of the entire city, a total of about 800 acres. We generally see the streets as a means for transportation – walking, cycling and driving, although they are also a place for community gathering and transaction—meeting neighbors on the sidewalk to chat, having lunch at a sidewalk café, window shopping, or just enjoying a stroll. They are spaces that we spend a significant amount of our time, whether sitting in a car or on a bus, walking to the office or school, or meeting a friend for lunch.

Since Roman times, cities have used the public rights-of-way to convey people and goods on the ground plane, and water, wastewater and stormwater below the ground plane. In the last 100 years, natural gas has been added to the below ground utilities and some neighborhoods have underground power and telecommunications systems. Most neighborhoods, however, obtain these "wired" services from above ground utilities. All of these conveyances – transportation, water, wastewater, power, communications – use the right-of-way.

Unfortunately, while there is a single city-owned right-of-way, we've designed, financed and maintained these infrastructure systems separately and created separate City department, regional agencies, and private entities to build and maintain them. This is understandable, as power and gas is provided by a regulated private corporate monopoly, potable water is provided by a public regional utility, telecommunications is provided by multiple competing privately owned systems while the city is responsible for stormwater and wastewater conveyance.

Our opportunities to improve our city in the public right-of-way include:

- Financial Responsibility – Non-city owned entities are responsible for maintaining their assets in the public right-of-way. They are also responsible for repairing damage to the surface when they access their underground assets.
- Coordination – The city is responsible for coordinating right-of-way access by all users – including drivers, pedestrians and utilities – but that coordination is often lacking, resulting in uncoordinated street projects and increased expenses for all utility and right-of-way providers.
- Right of Way Beneficiaries – A city's public right-of-way provides significant, even essential benefits to the owners of the adjacent property. Without street access – for transportation or utilities – property would have little value. Accordingly, property owners should be expected to provide some level of support for maintenance of the public right-of-way. The actual users of the right-of-way – motorists, utility users, etc. – should also pay for a share of the right-of-way.
- Rigid Definitions of Enterprise Funds – A key aspect in the lack of coordination is overly rigid and legalistic allocation of enterprise funds. Staff often balk at coordination efforts because the funding source is, for example, sewers, and a more coordinated effort could result in some sewer funds being used for paving or green infrastructure. While well intentioned, this results in overall sub-optimal outcomes for the city's overall infrastructure. All users – the ultimate funders of these enterprise funds – benefit from comprehensive first-class infrastructure and the current rigid definitions should be relaxed to achieve the overall goal.
- Street Maintenance, Funding and Trends – Berkeley underspends on its street paving by about $10 million annually. Funding for the street rehabilitation program is from many sources, but the on-going program is funded from revenues generated by motor vehicle fuel taxes (about $2.5 million annually) and recently the county transportation sales tax has also funded about $2.5 million. The on-going program funding is about $7 million annually, well below the required spending levels to ensure high-quality street pavement. Even this funding level is likely to diminish in future years. While the State Legislature passed a 12-cent fuel tax increase (which was upheld by the voters in November 2018) and indexed the tax to inflation, motor vehicle fuel taxes are a diminishing resource. As transportation electrification accelerates, fuel tax revenue will decrease. As vehicle autonomy is perfected, shared-ride costs could drop significantly, access to services could increase dramatically and more shared-ride trips could occur, and curb management will become paramount.

- Quality of Life – Viewing our public commons as exactly that–the “commons” where we meet, transact and facilitate transportation. The coming changes provide an opportunity to make the time we spend in these spaces more enjoyable and more conducive to community strength and resilience by strengthening our physical health and social connections.

Ecosystem Preservation and Restoration

More sustainable infill growth will concentrate people in urban environments where green space is a critical component to quality of life. Protecting existing canopy while reducing fire risk and finding adequate space for new trees in densely engineered developments is a challenge, as is achieving a more equitable distribution of tree canopy across the socio-economic landscape.

Healthy urban forests can produce ecosystem functions, goods and services that benefit humans and the environment. Ecosystem services include energy conservation, air quality improvement, carbon storage, storm water runoff reduction and wildlife and pollinator habitat. Wildland-urban interface zone fire landscaping and dense development on private property underscores the need to ensure tree canopy in the public right of way.

With marshland being the current most effective living carbon capture system, our infrastructure investment for carbon sequestration should include marsh restoration and development in addition to conventional grey infrastructure hardening along our shoreline.

Section 5
Our Recommendations

The City of Berkeley has an infrastructure system that has allowed us to thrive and grow for over 100 years. The Vision 2050 team commends the City for the planning it has done and the programs underway to keep our systems working. Now is the time to incorporate new technologies and to adapt to environmental trends that will allow the systems to support us for another 100 years. The Vision 2050 task force has reviewed the City's work to date and has drawn on the expertise of our members. With careful thought, we provide the following recommendations for your consideration.

The task force recommends that any future infrastructure project prioritize quality of life. Every project should be vetted and meet all the quality of life core value metrics that were presented in Chapter 2 and in the table below. Just like every infrastructure project should be sustainable, and through its implementation provide an easier movement of people and goods, it should also provide an opportunity to improve the lives of all Berkeley residents. The infrastructure projects must provide upward mobility, resilience, safety, and access to healthier and equitable urban environment in which everyone can have the opportunity to thrive.

The task force recommends that the quality of life core values serve as the guiding standard to inform, rank, and approve future infrastructure projects.
Furthermore, the task force recommends this tool be used as a metric to gauge how quality of life is improved at a community and individual level for disadvantaged residents. The task force recommends disadvantaged residents to be, but not limited to, communities of color, children, elderly, low-income, disabled, homeless, immigrants. Projects that do not meet all criteria shall be revised and properly address before receiving final approval. Additionally, the responsible department for infrastructure projects should create a scoring mechanism to give priority to areas and infrastructure projects with highest urgency, these projects and areas will be prioritized using the core values matrix and be highly weighted on equity values.

Quality of Life Core values				
	Equity	**Public Health and Safety**	**Strong Local Economy**	**Resiliency and Sustainability**
	Ensure benefits are equitably distributed and available and that they consider health status and school outcomes as well as access to jobs, housing, food and upward mobility	Enhance public health, well-being and safety	Develop local skills and capacity to keep jobs and economic benefits close to home	Enhance abilities to withstand challenges and support future needs
Meets core			##	

Quality of Life Core values				
values criteria?				

Equity is an important part that each infrastructure project must address. The following equity considerations must be incorporated: health status outcomes, school outcomes, access to jobs and housing, access to upward mobility, access to food, with an eye towards creating opportunities for young people, include health equity.

Policies to Move Us Forward

Policies are the principles adopted by the City Council that guides staff on how to carry out its work. The Vision 2050 task force recommends the following new policies for our City. The policies were formulated to address the following challenges.

Recommended Policy	Addresses these Challenges	Target Outcomes
Life cycle infrastructure management policy	• Systems reach the end of its useful life and failures occur • Inadequate funding to maintain systems • Systems become obsolete	• Systems are repaired or replaced during the life cycle • Service levels are maintained • Long term cost projections help with financing plan • New technologies are incorporated
Multi-criteria evaluation policy	• Decisions are made in silos • Lack of criteria for decision making • Inadequate consideration of environment and equity issues	• Balanced and comprehensive approach to decision making • Decisions are documented and transparent
One dig policy	• Inconsistent planning in our public right-of-way • Frequent impacts from construction	• Coordinated use of our public right-of-way • Reduced construction impacts to neighborhoods • Reduced long term cost of construction
Right-of-way management and financing policy	• Lack of organizational clarity for planning in our public right-of-way • Inadequate funding for infrastructure improvements	• Create a Bureau of Right-of-Way to coordinate work. • Consolidate and create new sources of infrastructure funding.

Life Cycle Infrastructure Management Policy

Life Cycle Infrastructure Management is a process that Berkeley can use to make sure that planned maintenance can be conducted and capital assets (pipes, streets, equipment, etc.) can be repaired, replaced, or upgraded on time and that there is enough money to pay for it.

Life cycle management is the practice of managing infrastructure capital assets to minimize the total cost of owning and operating these assets while delivering the desired service levels. Many cities use this practice to pursue and achieve sustainable infrastructure. A high-performing life cycle management program includes detailed asset inventories, operation and maintenance tasks, and long-range financial planning. Cities are responsible for making sure that its system stays in good working order, regardless of the age of its components. Life cycle management programs with good data—including asset attributes (e.g., age, condition, and criticality), life-cycle costing, proactive operations and maintenance, and capital replacement plans based on cost-benefit analyses—can be the most efficient method of meeting this challenge. The benefits that can be realized through life cycle management include:

- Prolonging asset life and improving decisions about asset rehabilitation, repair, and replacement
- Meeting consumer demands with a focus on system sustainability
- Setting rates based on sound operational and financial planning
- Budgeting focused on critical activities for sustained performance
- Meeting service expectations and regulatory requirements
- Improving responses to emergencies
- Improving the security and safety of assets
- Reducing overall costs for both operations and capital expenditures

Life cycle management principles have been used by the private industries for a long time. In the public sector, the major infrastructure systems (highways, water systems, airports, ports, etc.) built after World War II have deteriorated over time and asset management principles were called in to help. Over the past 40+ years, the U.K., Australia, and the United States have implemented life cycle management programs in the highway, water, airport, and other infrastructure systems.

We recommend that Berkeley adopt a life cycle infrastructure management policy that includes the following.

- Define the purpose and outcome objectives of having a life cycle infrastructure management program
- Define the infrastructure systems that will be involved with the program
- Define the components of the program
- Define the part of the organization responsible for the program
- Define the reporting and oversight requirements

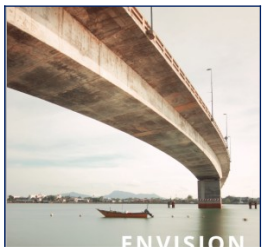
Multi-criteria Evaluation Policy

Berkeley has many policies and written plans that guide the evaluation of infrastructure decisions. However, the City does not have a set of clear consistent criteria on how to conduct the evaluations. Knowing that our city has a limit on its financial resources, a limit on its staff resources, and an engaged informed community, it would be helpful to have a balanced and transparent approach to decision making.

TBL concept image by REAL consultants

The Vision 2050 task force recommends the use of multi-criteria evaluation for decision making. An example of this the Triple Bottom Line (TBL) concept. TBL analysis seeks to quantify financial, environmental and social impacts and value them to the extent practical, while retaining all significant non-quantified or non-valued impacts as part of a structure economic summary description of decision alternatives. Leading public agencies, such as Seattle Public Utilities, and many private companies are using TBL.

Another example is the Envision program, organized by the Institute for Sustainable Infrastructure. Envision is an objective framework of criteria designed to help identify ways in which sustainable approaches can be used to plan, design, construct and operate infrastructure projects. Envision not only asks, “Are we doing the project right?” but also, “Are we doing the right project? Envision is a framework that includes 64 sustainability and resilience indicators, called ‘credits’, organized around five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Resilience. These collectively address areas of human wellbeing, mobility, community development, collaboration, planning, economy, materials, energy, water, sitting, conservation, ecology, emissions, and resilience. These indicators collectively become the foundation of what constitutes sustainability in infrastructure.



Envision manual with 64 indicators

Each of the 64 credits has multiple levels of achievement representing the spectrum of possible performance goals from slightly improving beyond conventional practice, to conserving and restoring communities and environments. By assessing achievement in each of the 64 credits, project teams establish how well the project addresses the full range of sustainability indicators, and are challenged to pursue higher performance.

We recommend that Berkeley adopt a multi-criteria evaluation policy that includes the following.

- Define the purpose and outcome objectives of having multi-criteria evaluation
- Define the infrastructure systems that will be involved with the program
- Define the components of the program and the optional tools
- Define the part of the organization responsible for the program
- Define the reporting and oversight requirements

One Dig Policy

The City coordinates repair and rehabilitation work in the public right of way with other agencies. The work can involve street paving, sewer work, storm drain work and other projects. The coordination is done regularly with EBMUD, PG&E, ATT, Comcast, and other agencies to determine if they have planned work in the same area in the future. Berkeley also imposes a five year moratorium to not have work that requires pavement cuts after a street has been rehabilitated. All of these efforts help to ensure that construction work in one area is coordinated and that impacts to service and the public is minimized.

Trenching for sewer work

Berkeley has been conducting studies to expand broadband internet service to more parts of Berkeley and is preparing a Broadband Infrastructure Master Plan. Many other cities h similar goals. One issue that many cities are addressing is whether to require the insta conduits for telecom cables whenever other utility work is constructed. The purpose tc internet service in cities and to minimize the cost and impacts of installing conduits separately. This is often called a “one dig” or “dig once” policy.

The Vision 2050 task force recommends the adoption of a One Dig policy to formalize the coordination being done and to facilitate the expansion of internet service in the City. The policy should include the following.

- Define the purpose and outcome objectives of having a One Dig policy
- Define the infrastructure systems that will be involved with the policy
- Define the agencies where coordination is required
- Define the part of the organization responsible for the program
- Define the reporting and oversight requirements

Right-of-Way Management and Financing Policy

The City must consider the 800 acres and 200 miles of city right-of-way as a holistic asset that must be managed comprehensively over 30 years. Key goals of the policy include the following:

Management

The city's Transportation Division should be expanded into the Right-of-Way Bureau and be responsible for all the coordination of all aspects of the public right-of-way (i.e., construction coordination with utilities, street openings, etc.) and primary jurisdiction over all aspects of the ground plane (traffic management, curb management, green infrastructure, sidewalk repair, and street pavement). A key need is for a 3D map of all the utilities in the city right-of-way, which does not currently exist. The Bureau should make this an essential and required baseline project. Other city divisions and services (sewer, etc.) will be treated by the Bureau in the same manner as the city currently coordinates with private utilities.

Financing

The Right-of-Way Bureau must become an enterprise department with dedicated funding sources. These sources should fully fund the required pavement program, sidewalk repair program, green infrastructure, implementation of the bicycle and pedestrian plans, as well as the on-going coordination efforts (requiring more staff). In addition to the subventions from the State and the county sales tax, (about $5 million annually), the city should do the following with city-controlled revenue:

- Redirect two-thirds of the utility users fees (about $10 million annually) to the Right-of-Way Enterprise Fund.
- Redirect all of the parking meter revenue and the parking fines (about $16 million annually) into the Right-of-Way Enterprise Fund.
- Merge and reauthorize the separate street-lighting, stormwater, green infrastructure and sewer funding programs into one fund, specifically authorizing the use of these funds for associated projects within the public right-of-way.
- Ad Valorem Tax: Berkeley has an assessed valuation of about $20 billion. This generates about $200 million in 1% tax revenue, of which Berkeley receives 32.57%%, or about $65 million annually. Up to 10% of the ad valorem revenues (initially about $6.5 million annually) should be allocated to the Right-of-Way Enterprise Fund.

In addition, the city should also institute the following new taxes to prepare for the gradual decline of the fuel tax and the likely increase in shared-ride vehicles:

- A TNC tax, patterned on San Francisco's proposed tax of 3.26% on regular single-passenger trips and 1.5% on shared rides. Trips made by fully electric vehicles will be

tax-free for the first two years, and then gradually increasing to the full rate within five additional years.

- A trip charge on all vehicles operating on city streets when TNC rates increase to 45%, replacing the TNC charge. An additional curb access charge for TNCs when they drop passengers on curbs on city streets.
- Based on San Francisco's TNC calculations, the Berkeley tax could generate about $5 million annually. These funds would be allocated to the Right-of-Way Enterprise Fund.
- Street Damage Restoration Fees – Los Angeles and other cities levy a street damage fee on local utilities for the pavement damage caused by underground utilities who do not adequately patch the street after projects. Based on Los Angeles calculations, in Berkeley this fee could provide an additional $3 million annually into the Right-of-Way Enterprise Fund (this fee may be substantially reduced if the city coordinates paving and other projects well).

Planning for the Future

It is often said that the largest influence on a project are the decisions made during planning. Planning is a process to consider the community needs, the options to provide the project, the cost and schedule implications, and other factors. The City excels in planning in many departments. The following are recommendations to add to the planning work being done.

Develop an Asset Management Program

Currently, the City has three modest Asset Management Programs for vehicle maintenance & replacement, building maintenance and computer/servers which total about $19 million. Since these programs represent a small fraction of the total infrastructure assets, we make the following recommendations.

We recommend that an Asset Management Program (AMP) be developed to properly maintain Berkeley's infrastructure and to forecast the future improvement needs. The background on the concept is discussed in the policy recommendations above.

We previously mentioned that much of the City's infrastructure systems are 100 years old and have deteriorated. We can't change that, but we can change the future. An AMP is a forward looking process. It forecasts maintenance needs to keep systems in proper working order and predicts the timing to perform repairs or replacement. It also forecasts the costs, which helps with budgeting and rate setting.

Components of an AMP include:

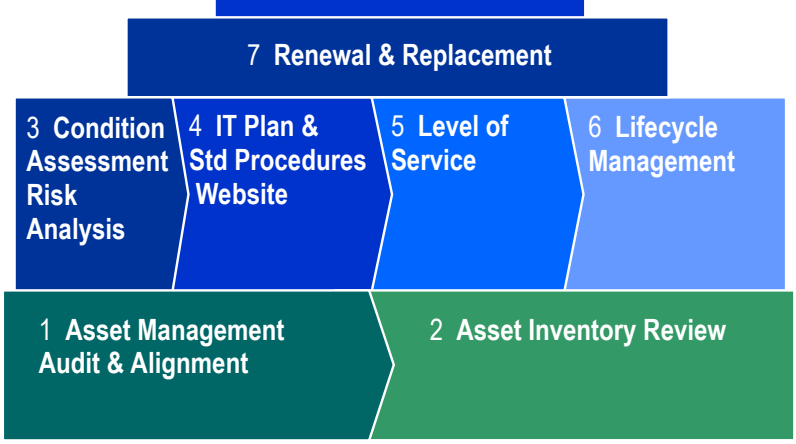


Figure 11 – Asset management program

Summary of recommendations:

1. Conduct research to understand the concept and benefits of asset management.
2. Evaluate the organizational structure, staffing requirements, and budget to develop an asset management program.
3. Prepare an Asset Management Plan.

Move to Integrated and Adaptive Planning

The planning and implementation of infrastructure projects typically involves the Planning, Public Works, Parks and Recreation, and Budget and Finance Departments. It appears to us that some departments have planning capability while others do not. Some departments operate according to functional programs. Our experience is that planning is a separate discipline that requires specialized training, tools, and experience. We recommend that each department review its organizational structure and evaluate ways to have a planning capability.

Once planning capability is in place, we recommend that the planning be integrated across City departments. There are different ways to do this and the following is one suggestion.

- Organize an oversight committee of department heads or their designees to review and ensure integration of planning
- Hold quarterly oversight review meetings
- Use an adaptive planning process

The new era of urban planning will have to contend with changes in the environments that have seemed relatively stable in the past. With all the things we've planned in the past – road systems, sewer systems, new towns, and new airports, etc. -- we haven't planned for an environment that is changing so much that it will require us to adapt.

"Adaptation" refers to altering our systems and structures to adjust to permanent changes. Resilience refers to altering systems and structures so that we can recover more quickly from

temporary events. Both resilience and adaptation will be needed in a changing climate, because we will experience many of the gradual, permanent trends that we now face as a series of events (for example, extra high tides, or extra hot days). We will also continue to grapple with the risk of major earthquake events, which will require an ability to recover quickly. But adaptation is a special planning problem because it's new, and it will require strategic investments by multiple generations of Berkeley citizens in order to succeed.

The adaptation pathways approach is to array options against a future trend that is known, although the magnitude of that trend is unknown for any given year (as with sea level rise, for example). This planning method is best for situations where there is a known trend and direction, but the timing of the trend is uncertain. For example, we know that sea levels are rising, and that they will continue to rise until they reach at least 10 feet above present levels. But we don't know what the relative sea level rise will be in any given year. We also know that both the likelihood and intensity of fires are increasing in California as a result of drying vegetation, but we don't know when the Berkeley Hills will burn.

The adaptation pathways approach would require us to lay out the different things we can do to reduce our losses and maintain our resources over a period of time, and identify sequences of things we can do as the environmental changes occur. Each sequence or "pathway" can be compared to the others in terms of costs and benefits, allowing planners to choose the one that maintains the most flexibility while conserving the value of key assets over time.

As noted in the California SGC infrastructure planning guidance (CSIWG 2018), local governments need to track these environmental trends for at least two critical reasons. Berkeley should use tools like network diagrams and predicted climate trends to plan and communicate adaptation pathways that will avoid wasting public funds on assets that will be unsustainable. These adaptation pathways should be used to develop and critique existing Local Hazard Management Plans (LHMPs), plans to protect public health, watershed and street tree plans, park plans, capital planning for sewers, road maintenance plans, revenue expectations for coastal facilities, and water supply system capital planning.

Summary of recommendations:

1. Review and develop planning capability in the departments involved with infrastructure management
2. Develop an organizational structure, such as an oversight committee, to integrate planning across City departments
3. Use adaptive planning processes

Prepare Infrastructure Master Plans

Whether projects are in the CIP or need further studies to be in the CIP, we recommend preparing infrastructure master plans. Master Planning is a process to develop long term plans for infrastructure systems. The process incorporates the following components:

- Evaluate the condition of the infrastructure assets and their remaining useful life.
- Evaluate the drivers that will affect the future use of the systems, including regulatory requirements, climate change conditions, technology advancements, and other factors.
- Evaluate alternatives for making the improvements.
- Develop a plan for the improvements, including the priority, schedule and funding requirements.

A Master Plan should be prepared for each infrastructure system. The Plan should project infrastructure needs for 20 or more years and the Plan should be updated on an approximate 5 year schedule.

Summary of recommendations:

1. Staff to review the status of existing infrastructure planning and to develop a program to prepare the needed infrastructure master plans.
2. Staff to prepare a process, criteria, and schedule to prepare the infrastructure master plans. The plans shall be updated on a regular schedule as required, such as every 5 years.
3. The master plans shall be the primary resource for input to the CIP and for capital financing.

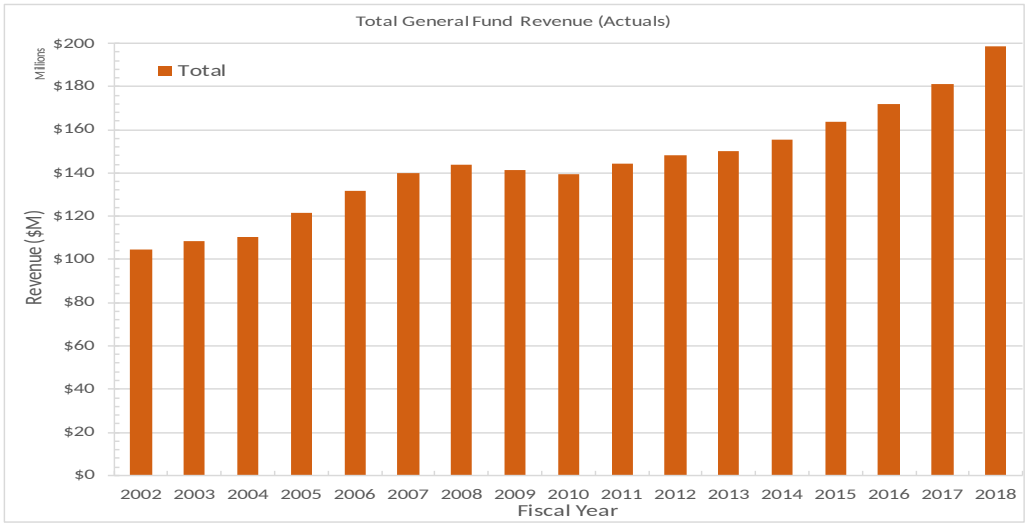
Finance for the Future

City of Berkeley has $851 million of Capital Assets[1] of which 44% have exceeded ~~it~~ their useful lifespans.

City currently spends only about $34 million/year on capital and maintenance needs. At this level of funding, Berkeley's infrastructure is deteriorating faster than it is being repaired/replaced and construction cost escalation (~5%/yr) is significantly increasing replacement costs. For example, currently, the City spends $1.3 million/year maintaining storm drains. After five years, the unfunded liability for the storm drain system is projected to increase from $241 million to $259 million.

- To modernize its old decaying physical structures with resilient, durable, and climate-smart infrastructure will require substantial investments.
- Does Berkeley have the financial resources to modernize its old decaying physical structures that provide vital services with a climate-smart infrastructure that will be resilient, technically advanced, and durable?

Berkeley's finances are in good shape. In the last decade and a half, General Fund revenues have increased from $108 to $198 Million, or ~90%, as shown in Fig. 1. The Total City Budget, which was $446 million in FY2017 has increased by a similar percentage. Revenues are exceeding expenses and the City's Investment Portfolio, which holds unspent funds, has increased by 300%.



Capital expenditures are typically funded through a combination of debt financing (pay-as-you use) and cash (pay-as-you-go). Paying in cash avoids the cost of interest payments, but requires the City to accumulate sufficient cash to fund the project, while

Figure 12 – Berkeley general fund revenues

construction costs escalate. Using debt to finance capital projects, incurs interest expense, but allows the project to start earlier avoiding escalation costs. Finally, there is the option of using both cash and debt to finance infrastructure as the City did with the Center Street Parking Garage project.

GO Bonds

General Obligation Bonds (GO) are backed by the "full faith and credit" of the issuer. Typically, GO bonds are based on the assessed value of the property within the jurisdiction, and require voter approval by a two-thirds majority.

The cost of borrowing capital funds depends on the City's credit rating. In FY2018 the Berkeley Unified School District (BUSD), which has annual revenues of ~$175 million, has borrowed $275 million and has received a credit rating on its GO bond debt from Standard & Poor of AA+. The COB Berkeley, which has annual revenues of ~$415 million, has borrowed $91 million, and also has a credit rating of AA+.

If the COB increased its GO debt/revenue ratio to match BUSD's, the COB could issue several hundred million of additional debt and presumably keeps it AA+ rating.

Table 4 – Bond credit ratings

FY 2018	Revenues ($Millions)	GO Bonds ($Millions)	Debt/Revenue	Bond Rating Standard & Poor
COB	$415	$91.5	22%	AA+
BUSD	$175	$274.8	157%	AA+

Table 1 shows a comparison of the revenues, GO debt, the debt/revenue ratio, and the Ratings by Standard & Poor for the COB and the BUSD.

Future GO Bond Debt Capacity

How much debt that a municipality can issue depends of the total assessed value of property in the City. Over the last quarter century, Fig-14 shows that the total assessed value of property in Berkeley has increased from $4.7 billion to $20 billion, or over 300%.

General Obligation (GO) Bonds

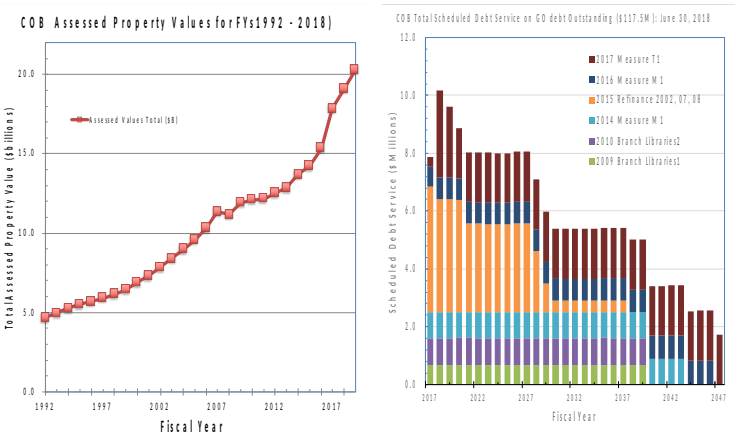


Fig. 14 shows the total assessed property values for the FYs 1992 – 2017.

If property values continue to increase at a similar rate over the next 30 years, the total value of Berkeley property could be three times larger in 2050 than in 2018. This means that Berkeley could issue three times as much debt than currently outstanding, without raising its debt-service-tax-rate, if interest rates remain constant. Furthermore, as old bonds are paid off as shown in the right-hand portion of Fig. 14, there is an opportunity to issue additional debt, without raising the debt-service-tax rate.

Revenue Bonds

Revenue bonds are defined as municipal bonds that finance projects that have a revenue stream to support them. The income generated by the revenue stream pays the interest and principal on the bonds. Recently, the City of Berkeley issued a $34 million revenue bond backed by Parking Meter revenue with a coverage ratio of 2.55. See Fig. 15.

In contrast to Berkeley, which issues mostly GO-bonds, EBMUD issues all of its debt as revenue bonds. With a revenue stream of ~$100 million, EBMUD's Wastewater (WW) system supports ~$400 million in bond debt, while maintaining a AAA bond rating from Standard & Poors.

Berkeley has a number of Enterprise Funds that provide services that generate revenue streams (~$100 million) comparable to EBMUD's WW system. If the cash generated by all of the COB's Enterprise funds could generate a similar coverage ratio to the Center Street Garage, then Berkeley may be able to carry ~$350 million in revenue bond debt, compared to the current $60 million.

Revenue Bonds

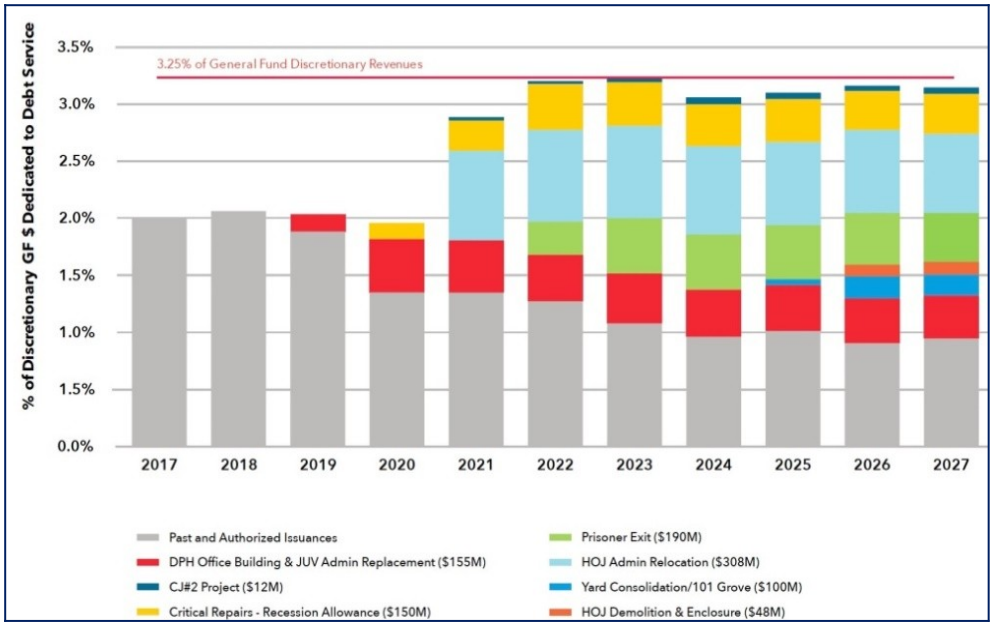
Category FY2017	EBMUD Waste Water	COB Enterprise Funds
Revenue Bonds (% Total)	99%	32%
Revenue	$119 M	$105M
Bond Debt	$390 M	~$59 M

Fig. 15 shows a comparison of the revenues and bond debt for the COB and EBMUD's WW system.

Major Maintenance and Annual Capital Needs

The majority of the San Francisco's ongoing annual capital needs are funded with General Fund dollars. These are typically smaller investments to maintain facilities and infrastructure in a good state. The two largest categories are Street Resurfacing and Facility Renewal.

Fig. 16 San Francisco's Capital Plan General Fund Debt Program: FYs2017-27.



As Fig. 4 shows, SF dedicates 3.25% of GF revenues to its Pay-As-You-Go Program. Over time as the GF increases, the capital contributions increase, which allows staff to plan on a 10-year timescale. Berkeley has a similar program that assigns the "excess revenue"

from the Transfer Tax over $12.5 Million to its Capital Improvement Fund. Because the Transfer Tax is volatile, long range planning is difficult.

Unfunded Liabilities and the General Fund Surpluses

The City's two major unfunded liabilities are tied to infrastructure, $882 million, and benefits, $665 million.

In response to the $665 million benefits unfunded liability, in the City plans to dramatically increase its spending on benefits to almost $116 million in 2020.

To adequately address the $882 million in infrastructure unfunded liabilities, the City needs to double its projected spending from $33 million to $66 million in 2020. Some possible sources of this new funding are:

- Develop a 10-Year Capital Funding Plan & Major Project Queue.
- Increase capital funding from General Fund
    - Lower the one-time revenue cap from $12.5 million to $8.5 million which would provide an increase in Capital funding of $4 million annually.
    - Replace the Transfer Tax funding of capital/maintenance with a 5% tax of Total GF revenue.
- Assigning up to 50% of the annual salary savings to fund capital and maintenance needs.
- Designate "unclaimed" Seismic/Resilience Rebates to an Infrastructure Reserve Fund.
- Designate GF surpluses to the two major City Unfunded Liabilities – split 50/50.
- Put a measure on the 2022 ballot to issue a new infrastructure bond.

Recently, Berkeley voters have demostrated that they strong support increasing infrastrucutre spending, by approving $130 million of General Obligation bonds (Measure M & T1) by overwhelming margins. To better align its priorities with the mandate from the voters, the City needs to dedicate more of its existing revenue streams to address this major unfunded liability. Failure to provide funding to maintain and modernize existing infrastructure will greatly increase the future cost due inflation and the increase in construction costs, which is currently running at 5% per annum.

New Development as a Source of Infrastructure Funding During the next quarter century, new development will continue across the City. All of these developments increase the city's tax base, but some may lead to the need for infrastructure upgrades.

A key tool used in San Francisco was the imposition of a Community Services District only for upzoned properties and only imposed on the increment of additional density granted. As an example, if the city were to provide further upzoning in downtown or in the southside, that additional development envelope would be allowed only if the property owners agreed to create a districtwide Community Services District. The CSD could then fund additional infrastructure needs or other public benefits to accrued to the district – these can include green infrastructure, wider sidewalks, better streetlights, or even new parks. In addition, the district can fund the maintenance of some of these assets, providing a source of both capital and operating funds. The CSD requires a study and nexus of benefits to the district and creates a rate (based on the ad valorem value) of the development subject to the tax.

Other funding tools include a financing successor to redevelopment – the Enhanced Infrastructure Financing District. In this district, tax increment from some of the taxing agencies is pledged to the district, which then issues bonds for infrastructure improvements. Berkeley could pledge its own tax increments under this arrangement to provide another financing mechanism.

Hazards of Greatest Concern

Earthquake

We do not know when the next major earthquake will strike Berkeley. The United States Geological Survey states that there is a 72% probability of one or more M 6.7 or greater earthquakes from 2014 to 2043 in the San Francisco Bay Region. There is a 33% chance that a 6.7 or greater will occur on the Hayward fault system between 2014 and 2043. This means that many Berkeley residents are likely to experience a severe earthquake in their lifetime.

A catastrophic earthquake on the Hayward Fault would cause severe and violent shaking and three types of ground failure in Berkeley. Surface fault rupture could occur in the Berkeley hills along the fault, damaging utilities and gas lines that cross the fault. Landslides are expected in the Berkeley hills during the next earthquake, particularly if the earthquake occurs during the rainy winter months. Landslide movement could range from a few inches to tens of feet. Ground surface displacements as small as a few inches are enough to break typical foundations. Liquefaction is very likely in the westernmost parts of the city and could occur in much of the Berkeley flats. Liquefaction can destroy pavements and dislodge foundations.

Shaking and ground failure is likely to create impacts that ignite post-earthquake fires. Firefighting will be simultaneously challenged due to broken water mains and damage to electrical, transportation, and communication infrastructure.

In a 6.9 magnitude earthquake on the Hayward Fault, the City estimates that over 600 buildings in Berkeley will be completely destroyed and over 20,000 more will be damaged. One thousand to 4,000 families may need temporary shelter. Depending on the disaster scenario, one hundred people could be killed in Berkeley alone, and many more would be injured. Commercial buildings, utilities, and public roads will be disabled or destroyed. This plan estimates that building damage in Berkeley alone could exceed $2 billion, out of a multi-billion dollar regional loss, with losses to business activities and infrastructure adding to this figure.

Low-income housing units are expected to be damaged at a higher rate than other residences. Other types of housing, such as condominiums, may replace them when land owners rebuild. This could lead to profound demographic shifts in Berkeley.

Wildland-Urban Interface Fire

Berkeley is vulnerable to a wind-driven fire starting along the city's eastern border. The fire risk facing the people and properties in the eastern hills is compounded by the area's mountainous topography, limited water supply, minimal access and egress routes, and location, overlaid upon the Hayward Fault. Berkeley's flatlands are also exposed to a fire that spreads west from the hills. The flatlands are densely-covered with old wooden buildings housing low-income and vulnerable populations, including isolated seniors, people with disabilities, and students.

The high risk of wildland-urban interface (WUI) fire in Berkeley was clearly demonstrated in the 1991 Tunnel Fire, which destroyed 62 homes in Berkeley and more than 3,000 in Oakland. In 1923, an even more devastating fire burned through Berkeley. It began in the open lands of

Wildcat Canyon to the northeast and, swept by a hot September wind, penetrated residential north Berkeley and destroyed nearly 600 structures, including homes, apartments, fraternities and sororities, a church, a fire station and a library. The fire burned downhill all the way to Shattuck
Avenue in central Berkeley.

If a fire occurred today that burned the same area, the loss to structures would be in the billions of dollars. Destruction of contents in all of the homes and businesses burned would add hundreds of millions of dollars to fire losses. Efforts to stabilize hillsides after the fire to prevent massive landslides would also add costs. Depending on the speed of the fire spread, lives of Berkeley residents could also be lost. Many established small businesses, homes, and multi-family apartment buildings, particularly student housing, would be completely destroyed, changing the character of Berkeley forever.

Catastrophic Reserve
Berkeley Catastrophic Reserve was established to sustain General Fund Operations in the case of a public emergency such as a natural disaster. Currently, this reserve fund totals $13 million. Since the City's monthly expenditures are ~$39 million, $13 million is clearly inadequate to fund the City's response to a major earthquake or wildfire.

The City does have a large pool of liquid funds in its Investment Portfolio, which as of December 31, 2018 contained at $446 million in Total Cash and Investments. Several employee trust funds contain ~$45 million and the balance of $401 million consists of unspent fund balances, bond proceeds, additional reserves, and operating cash. While ~$80 million originated from the General Fund and presumably could be redirected to funding the City's emergency response to a major disaster, the $320 million balance originated from the City's numerous other funds which have legal strictures on allowable expenditures.

To secure more adequate liquid funds to address a major disaster, we recommend that the City

- Consider designating its Investment Portfolio as a Major Disaster Reserve.

Implement for the Future

When the proper approvals have been made, Berkeley will embark on a large and long-term process to plan, design, build, and maintain improvements to our infrastructure. This will go far beyond the magnitude of our current CIP and of the Measure T1 program. How to implement to program will require careful evaluation and discussions. The following suggestions are provided to get the discussion started.

Use a Program Approach

With an infrastructure program that will approach $1 billion, it will be necessary to prioritize the work in phases. Phase 1 is the current Measure T1 program. Subsequent phases will depend on the priority of the work, whether planning has been started, community input, and the overall ability to implement the work. Table 5 is a suggested five phase program.

Table 5 – Program approach

Program Phase	Funding Level	Priority Projects

1	$100 million	• Public buildings including the north Berkeley senior center, mental health facility, Live Oak community center, Frances Albrier community center, etc. • Selected street improvements • Visioning for Civic Center • Planning for the municipal pier and Aquatic Park tide tubes • Other
2	$200 – 250 million	• Marina improvements • Street improvements to bring condition to "good" level • Emergency preparedness, including undergrounding on arterial and collector evacuation routes • Transfer station
3	$200 – 250 million	• Watershed and storm drain improvements • Green infrastructure improvements • Park improvements
4	$150 million	• Waterfront improvements • Civic Center improvements • IT improvements
5	$150 million	• Facilities improvements • Other infrastructure
Total	$800 – 1,000 million	

A Program Plan should be written and available to City staff and the community.

Develop organizational capacity and structure

Capital infrastructure work is primarily carried out by the Planning, Public Works, Parks and Recreation, and Budget and Finance departments. The work involves planners, engineers, construction managers, procurement specialists, contracts, and other people. All of these capabilities are in place to carry out the City's CIP. When the Measure T1 program was initiated, a special program team was organized. They have dedicated staff and utilize support from other parts of the City.

The proposed infrastructure program is much larger than can be handled by the current staff or organization. We suggest that the City consider the following topics.

- **Organizational structure** – We recommend that an infrastructure program department be created in the City's organization. This would be separate from the day-to-day operations of public works and parks and recreation. There should be core competencies in the department, such as planning, design, construction management, and schedule and cost management. Other departments, such as procurement, legal, field operations, etc. shall provide support. To ensure that work is coordinated throughout the City, there should be a management oversight committee.
- **Staff capabilities** – We recommend that additional staff be hired. The number of staff and their expertise needs further evaluation. Staff will be required in the current public works and parks and recreation departments to prepare master plans and to create an asset management program. Staff will be required in the new infrastructure program department.
- **Use of consultants** – We recommend that the program team be a blend of City staff and consultants. It is a cost-effective way to retain knowledge while gaining expertise. This blended approach has been used effectively in San Francisco, San Jose, and other major infrastructure programs.

Develop program management tools and processes

We recommend that a Program Plan be written. The Plan should include the following:

- Outcome objectives
- Breakdown structure of work activities
- Project team and responsibilities
- Cost and schedule tracking
- Change management and approval process
- Reporting

To effectively carry out the program, the project team will need many tools, including the following.

- A cost accounting system that will be able to track and report on labor, materials, and consultant costs according to a work breakdown structure.
- A website to communicate with the public.
- Document management
- Risk management
- Cost estimating
- Scheduling
- Procurement

Utilize independent oversight and reporting

We talk a lot about having transparency and accountability with City programs and good way to ensure that is to have independent oversight and reporting. The concept is to appoint a citizen's oversight committee comprised of people with relevant experience. The committee would meet quarterly and prepare an annual report of progress compared to the Program Plan. The concept has been used effectively by the Berkeley Unified School District and other agencies in the Bay Area.

Exciting Projects Ahead

The environmental trends and technology advances are opportunities to create exciting projects for our future. How will these apply to Berkeley? The following suggests new solutions to old problems.

Table 3 – New solutions to old problems

Systems and Projects	New Solutions
City facilities • Measure T-1 improvements • Civic center	• Better maintenance with asset management program • Seismic improvements allow some facilities to be shelters in emergencies • Deep green initiative • Electrification
Information systems • Broadband internet	• One Dig policy helps with internet expansion • Work with utility undergrounding routes • Wireless technologies are improving
Parks and marina • Marina improvements • Municipal pier	• Better maintenance with asset management program • Better knowledge of adaptation to sea level rise • Better knowledge of climate variability for plant

Systems and Projects	New Solutions
• Aquatic park	management • Restore and maintain habitat for shoreline protection, heat and water management
Sanitary sewers	• Implement the consent decree program • Continue using HDPE pipe, pipe bursting and other cost effective technologies
Storm drains	• Implement the Green Infrastructure Plan • Better knowledge of climate variability for hydrologic analysis • Better maintenance with asset management program • Prioritize natural infrastructure solutions
Sidewalk repairs	• Continue existing program and complete backlog • Use green technologies • Expand the urban canopy
Street repairs	• Better maintenance with asset management program • Use multi-criteria evaluation to make better decisions • Use life cycle cost analysis to select durable and sustainable technologies • Incorporate green technologies • One Dig policy
Transportation	• Vision Zero • Complete streets • Adeline corridor plan • San Pablo Avenue plan
Other infrastructure • Transfer station	• Zero waste policy • Consider sea level rise implications
Equipment	• Better maintenance with asset management program
Emergency preparedness • Hazard mitigation plan	• Underground overhead wires on evacuation routes

The following illustrates how the new solutions can be applied.

- **Develop micro-grids** -- Develop a micro-grid network connecting both public and private facilities. In order to accommodate more distributed renewable generation, and to foster more resilience and reliability, the City's electricity distribution grid infrastructure will need to identify and increase "hosting capacity" for distributed energy resources and allow for two-way flows of energy.

Resilience Strategy 2A

- **Safe and sustainable transportation** -- The City has direct control over its vehicle fleets, including emergency services vehicles and charging facilities on Municipal Property. Through a "safe streets" lens and its plan implementation (Paving Plan, BeST Plan, Vision Zero, etc.) it can switch to more durable permeable pavement, add protected bicycle and pedestrian pathways, create more public transportation hubs and services and generally deprioritize private traffic and parking.

Resilience Strategy 2D

- **Electrify buildings** -- Along with transportation, buildings account for the bulk of energy consumption in Berkeley, historically both gas and electricity. Vision 2050 requires that all building loads be electrified. These electrified buildings have the potential to provide critical services to the distribution system, including demand response, peak load shifting and management, and even voltage and frequency regulation. Most of these opportunities will be determined at the state or market level by the CPUC and utility providers, but the actual conversion of the building systems and end-uses are subject to City oversight and influence.

  Resilience Strategy 2E

  Title 24 already encourages conversion to heat pump technology for water heating and HVAC, as well as encouraging efficient appliances, lighting and building envelope requirements. Berkeley should consider additional incentives or streamlining to encourage more rapid adoption.

  Title 24 also requires solar on all new construction and major retrofits. Berkeley can further ensure that all buildings have sufficient and appropriate solar generation through its zoning and permitting ordinances and through targeted incentives, tax exemptions and application streamlining.

- **Use electric vehicles** -- To meet climate targets by 2050, personal transport will need to be electrified - move off of fuel to decarbonized electricity. Much of the capital investment will be market driven as consumers decide to purchase or procure electric vehicles. From an Energy Services perspective, this shift requires that multiple charging modes are available to facilitate efficient “fueling” of the vehicles. In addition, vehicle fleets and services, like buses, TNCs, police, fire and emergency vehicles subject to approval by the City must be converted to all-electric in a timely and orderly manner.

  City plans must identify and develop locations for publicly accessible grid-connected and powered Level I, Level II and DC-fast charge facilities, with sufficient geographic diversity and capacity to serve Berkeley residents regardless of income or neighborhood. This means that curbside charging may be necessary in many dense multifamily neighborhoods. Heavy duty charging facilities for public transit and city fleets, as well as facilities for electric bikes, scooters and other mobility options must be incorporated into planning. This will require enhanced permitting guidelines, standards and possibly incentives, as well as allowances for new business models.

  Prioritize safe access for pedestrians, bikers, low cost widely available zero carbon public transit fleets, EV charging, and on-demand services for seniors and youth. The City must continue to encourage and support (for example, through streamlined permitting processes) at-home vehicle charging. A clarified policy on single-family homes without access to off-street parking must be developed so that charging stanchions and plugs can be properly and safely installed at or near the public-right-of-way. Incentives will also play a part, particularly for disadvantaged communities in Berkeley. Leveraging its permitting authority, the City can encourage more widespread deployment of both public and private charging infrastructure, not just for cars, but for buses, bikes and scooters as well. Tapping into the use of vehicle transponders and street sensors is also recommended.

- **Use green infrastructure** -- Integrate multi-benefit Green Infrastructure as an element in all Public Works projects. As noted, Green Infrastructure is one of the best examples of

Resilience Strategy 3A

resilience in practice. Move beyond compliance in implementation of the Green Infrastructure Plan.

- **Dig once**-- Perform all street rehabilitation in coordination with utility, sewer, water runoff, and undergrounding projects. Use the underlying infrastructure condition as a factor in paving project selection and prioritization.

- **Consider material life cycle** -- Incorporate material life cycle with waste reduction and material reuse. Utilize recycling as a last resort in all project specifications. Address external benefits and costs in project design.

- **Diversify water supply** -- Innovate to diversify Berkeley's water supply. Examine the use of groundwater for landscape or backup water supply. Participate in the EBMUD/Hayward Sustainable Groundwater Plan development process. Investments in cisterns installed in street storm water management projects should include water retention and use. Work with EBMUD and UCB to bring reclaimed water distribution to Berkeley.

Resilience Strategy 3B

- **Restore Nature as infrastructure** – Nature can be the first line of defense integrated into engineered solutions within the urban landscape. Natural systems can provide protection, adaptation and mitigation to climate impacts. In addition to the recommendations in the Resilience Strategy, the City must increase tree canopy in the mid and low lands to address air quality, heat impacts and quality of life as we continue to build. Trees and marshes should be factored into carbon capture calculations as we move to 2045 carbon neutrality. Use of native trees and plants will improve urban habitat. Plantings along transportation corridors in coordination with adjacent cities will ensure migration paths for birds and pollinators. As elements of all Marina projects, develop, enhance and continue restoration of marshland along the Bayfront to stabilize the shoreline against sea level rise, capture sediment runoff and provide habitat. Marsh vegetation is the most effective vegetative carbon sequestration planting.

Resilience Strategy 3C

- **Preserve permeability** -- Incorporate climate impacts into all public infrastructure projects. With increasing private property development much of the City's remaining permeability is being paved over with hardscape and buildings. An assessment of the current level of impermeability should be made to ensure that the storm water infiltration levels do not further degrade with continued development. To maintain current levels of infiltration, the City should ensure that equivalent land areas within the public commons are made permeable to offset all private property development of impermeable surfaces and specific GI. Future GI and Watershed Management Plans should move the City to restoration of infiltration in keeping with future Sustainable Groundwater Management Plans.

Resilience Strategy 3D

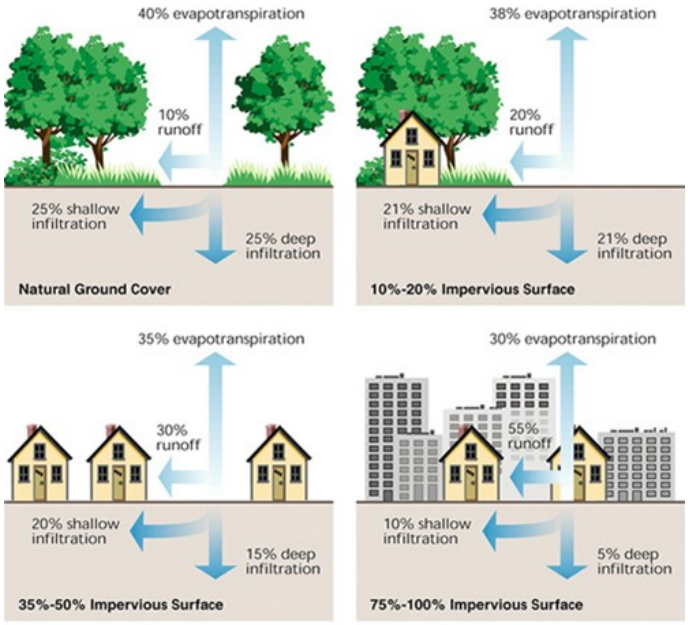


Fig. 3.21 -- Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
By the Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the U.S.)

Figure 10 – Preserve permeable areas

Section 6
Engaging Our Community

Section 7

Actions to Move Us Forward

Appendix A
Glossary of Terms

Appendix B
Review of City Plans for Infrastructure Action

Infrastructure System	PLANS	PLAN ACTIONS	FUTURE NEEDS
Streets & Sidewalks	• Bicycle Plan • Climate Action Plan • Five Year Paving Plan • Hazard Mitigation Plan • Watershed Management Plan • Strategic Transportation Plan • Five Year Paving Plan • Pedestrian Master Plan	• Expand and improve pedestrian & cyclist infrastructure (BP, CAP, FYPP, PMP, STP) • Design streets for stormwater capture and filtration (CAP, FYPP, STP) • Manage parking to minimize driving demand (CAP, STP) • Improve pavement conditions (FYPP) • Reduce greenhouse gas emissions of pavement rehabilitation (FYPP) • Improve pedestrian evacuation routes in Fire Zones 2 and 3 (HMP)	• Collaboration between stormwater capture and multi-modal street infrastructure improvements • Transition from grey to green infrastructure • Implement life cycle cost analysis and closed loop environmental impact reviews • Allow transit-centered housing to reduce dependency on single occupancy vehicles
Sanitary Sewer	• Sanitary Sewer Program	• Minimize frequency and severity of sanitary sewer overflows	• Coordinate planning for sewer improvements with street and other underground construction • Manage rising water table impacts • Build water reclamation infrastructure
Storm Drains	• Resilience Strategy • Climate Action Plan • Five Year Pavement Plan • Hazard Mitigation Plan • Resilience Plan • Strategic Transportation Plan • Watershed Management Plan	• Permeable surfaces and greenspace for filtration (CAP, STP) • Rainwater capture with below-street cisterns (RP) • Improve storm drain pipes and general infrastructure (FYPP, WMP) • Reduce flooding caused by inadequate drainage & expand capacity (HMP) • Improve pollutant removal (WMP)	• Collaboration between stormwater capture and multi-modal street infrastructure improvements • Transition from grey to green infrastructure
Solid Waste Management	• Climate Action Plan • Solid Waste Management Plan	• Expand local capacity to process recycled materials (CAP)	• Consideration of solid waste management after disaster • Revise zero waste goals to reflect current global recycling markets • Prioritization of waste reduction goals and elimination of single use plastics
Parks and Vegetation	• Climate Action Plan	• Consider vegetation plan for fire hazard areas	• Increase urban forestry efforts

Infrastructure System	PLANS	PLAN ACTIONS	FUTURE NEEDS
Management	• General Plan • Hazard Mitigation Plan • Resilience Plan • Strategic Transportation Plan • Watershed Management Plan	(CAP, HMP) • Support urban forestry efforts (CAP, GP) • Habitat connectivity (CAP, WMP) • Create and maintain tree planting efforts (CAP, STP) • Drought-tolerant landscaping (STP, GP, HMP, RP) • Design greenscapes for stormwater capture and filtration (CAP) • Reduce fire fuel (HMP, GP)	• Restore ecosystem services
Marina	• Marina Master Plan • Hazard Mitigation Plan	• Enhance open space and recreation (MMP) • Enhance wildlife habitat (MMP) • Mitigate sea level rise (HMP)	• More consideration of where to invest considering flooding projections • Implement marshland carbon capture
Power (PG&E, Solar)	• Climate Action Plan • General Plan • Hazard Mitigation Plan • Resilience Plan	• Reduce fossil fuels and increase renewables (CAP, GP, RP) • Improve disaster resistance of natural gas (HMP) • Underground electric grid	• Integrate renewable energy goals with undergrounding and fire safety • Eliminate fossil fuels
Transportation (AC Transit, BART, AMTRAK)	• Bicycle Plan • Climate Action Plan • Five Year Pavement Plan • Hazard Mitigation Plan • Strategic Transportation Plan	• Coordinate bicycle lane improvements with AC Transit for multi-modal use of streets (BP, CAP, FYPP) • □ Encourage improved transit service (CAP, BTP)	• Electrify vehicles and provide electrification infrastructure • Simplify permitting for regional agency transportation projects
Water (EBMUD)	• Climate Action Plan • Hazard Mitigation Plan • Resilience Plan • Watershed Management Plan	• Partner with local, regional, and state agencies for water conservation and diversifying water sources (CAP, HMP) • Use groundwater as backup water supply (CAP, RP) • Encourage water conservation (CAP, HMP) • Reduce use of potable water for non-potable use and diversify reclaimed water	• Simplify permitting for regional agency water projects

Infrastructure System	PLANS	PLAN ACTIONS	FUTURE NEEDS
		supply (CAP, RP, WMP) • Coordinate backup water supplies in case of disaster (HMP)	