

BAY AREA MONITOR

 A Publication of the League of Women Voters of the Bay Area

August/September 2017 • Volume 43, Number 1



Layering Landscapes with Bay Area Greenprint

Urban Heat Islands
Nutrient Pollution
Transportation Incentives

Welcome to Year 43

August can be a quiet time around the Bay Area, but this month marks the start of the *Bay Area Monitor's* new publication year — our 43rd, this time around. As always, we're excited to offer a fresh slate of in-depth articles.

First off, we examine Bay Area Greenprint, an online mapping tool that allows planners to analyze open spaces — such as the Coyote Valley, which serves as both our cover image for this edition as well as the centerpiece for our brief tutorial on how to use the tool.

Deeper into the edition, we consider the phenomenon of urban heat islands, and take a look at innovative strategies for counteracting this public health threat. Then we explore how transportation agencies are deploying incentives to influence rider behavior and ease commute headaches. And finally, we investigate the issue of nutrient pollution and find out what actions wastewater dischargers are contemplating to confront the problem.

We hope you find these articles enlightening and useful.

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Thank You for Your Support

The *Monitor* would like to acknowledge recent donations from Alex Starr and Sherry Smith in memory of Yvonne Koshland, and from Terry Grant and Carole Woods. Such generous financial contributions are greatly appreciated, and help this publication continue to fulfill its mission. Donations to the League of Women Voters of the Bay Area, a 501(c)3 organization, are tax deductible.

Published in August, October, December, February, April, and June, the Monitor appears both in print and online at www.bayareamonitor.org. Distributed in the nine-county San Francisco Bay Area and other parts of California, the Monitor's readership consists mainly of elected and appointed officials, government staff, business and community leaders, nonprofit affiliates, library patrons, engaged residents, and League members. Subscriptions to the publication are free.

The Monitor's primary financial support comes from the Metropolitan Transportation Commission and the Bay Area Air Quality Management District. The publication also receives funding from other public government agencies and through reader donations.

Expanding Public Ferry Service

- WETA began passenger ferry operations in 2011
- WETA has invested \$465 million to support ferry service expansion
- Since 2012 ridership has increased 74%; up 29% since 2015
- 2.7 million ferry riders annually from nine terminals

WETA's Long Range Strategic Plan: 44 Vessels and 16 Terminals by 2035



Fleet Expansion

- Seven new vessels by 2019 bringing the WETA fleet to 16

Route and Terminal Expansion

- Richmond ferry service in September 2018
- SF Ferry Terminal expansion in 2019
- Treasure Island Ferry, Mission Bay, Redwood City, Berkeley and more

Operations and Maintenance Expansion

- North Bay Operations and Maintenance Facility – Opened 2016
- Central Bay Operations and Maintenance Facility – Opens 2018

Emergency Response Preparedness

- Coordinate water transportation response
- Support evacuation and first responder transportation
- Provide emergency water transit service and expertise

Layering Landscapes with Bay Area Greenprint

By Aleta George

There's a new tool in town.

The Bay Area Greenprint is designed to help transportation agencies, water districts, and the conservation community in their work. It is an online mapping tool and data cruncher that measures natural and agricultural resources, and quantifies the importance of those resources in our lives. Planners and policymakers can use this information to better understand the costs and benefits of possible land use decisions.

A team of conservation, data, and mapping experts from The Nature Conservancy, Greenbelt Alliance, American Farmland Trust, the Bay Area Open Space Council, and GreenInfo Network designed and developed the Bay Area Greenprint. The team launched the tool in June 2017 after working on it for two years with science and method advisors from several other regional organizations.

The need for such a tool is evident for those who work in land conservation, said Tom Robinson, director of conservation, science, and innovation at the Bay Area Open Space Council and co-lead on this project. Prior to working with the Open Space Council, Robinson worked for years at the Sonoma County Agricultural Preservation and Open Space District. He knows how difficult it is to get data into a communicable shape necessary to make decisions, obtain permits, and submit in grant proposals.

"There is a giant gap between getting data and pulling it into a form at the desktop level," said Robinson. "The amount of information that [planners and conservation managers] are supposed to be conversant in expands every year, and Greenprint is designed to help those folks get quick access to interpreted data for their world."

The Nature Conservancy's Liz O'Donoghue served as the project lead. "In the Bay Area, we have a wealth of natural and agricultural resources and a wealth of information about those resources," she said. "We wanted to find a way to accumulate data and present it to planners in a straightforward and easy way so that they can make smart planning decisions grounded in science and the latest, up-to-date data."

The Greenprint team's first step was to identify potential users and ask them how the tool might make their lives

easier. The team then identified natural and agricultural values and benefits, and funneled them down into simplified terms. They matched those with existing data, and worked with the target users on scenarios for useful applications.

One important goal of the project was to integrate the topic of natural resources into planning processes earlier. For example, transportation agencies design upgrades like lane additions or new interchanges based on need. The environmental review, however, comes late in the process and can introduce challenges — such as an endangered species hotspot or a flood zone — after plans are well underway. Greenprint reveals such complications ahead of time by providing a quick snapshot of the area in question. Planners can identify a proposed project area and learn early on if they need to consider prime farmland, an important wildlife corridor, or a groundwater recharge zone.

For those who navigate maps and data daily, using the Bay Area Greenprint tool for the first time may come easy. For those who don't, it may not feel so intuitive. "Like any new technology, you need to give yourself time to understand it," said O'Donoghue. "Then it becomes second nature."

Average Bay Area residents who learn how to use Greenprint may find themselves better prepared to participate



Bay Area Greenprint project lead Liz O'Donoghue talks about the online tool at its official launch event in Berkeley on June 21, 2017.

photo by Alec MacDonald

Layering Landscapes with Bay Area Greenprint (from page 3)

in the planning of their own communities. For example, a supporter of urban limit lines could create a map and bring it to a city council meeting as a visual aid for persuading elected officials. “Greenprint empowers activists,” said Carrie Schloss, a data scientist at The Nature Conservancy. “It democratizes the process when an activist can bring talking points, statistics, and maps to community meetings.”

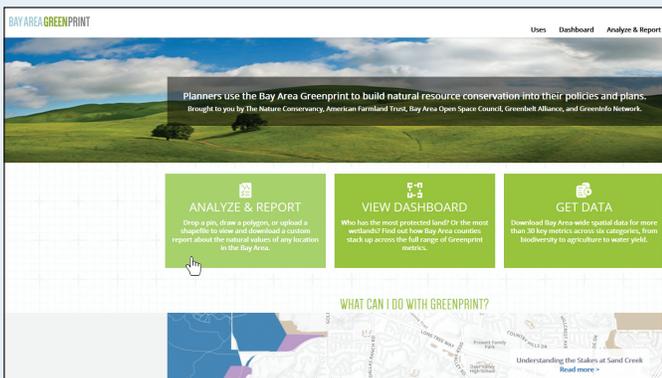
The Bay Area Greenprint does not yet have long-term funding or a permanent home, but the organizations that launched it are committed to seeing it solidly implemented in the Bay Area. For the next three years, their focus is on outreach, education, and training. 

Aleta George covers open space for the Monitor.

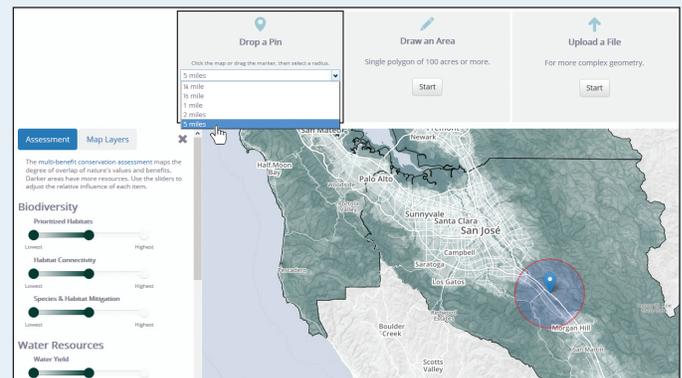
A Quick Bay Area Greenprint Tutorial - Exploring Linkages in the Coyote Valley

Matt Freeman, assistant general manager of the Santa Clara Valley Open Space Authority, is a project advisor for Bay Area Greenprint. He called the tool “a great starting place to get a quick, high-level understanding of open space values and planning issues,” and walked the *Monitor* through an example of how to use it to analyze the Coyote Valley. This priority natural landscape provides the last remaining undeveloped linkages between the Santa Cruz Mountains and the Diablo Range. These natural lanes are used by wildlife such as mountain lions and tule elk to migrate, find mates, and survive. The corridor between the mountainous wilds is vital for species to adapt to climate change and maintain genetic diversity. Here are step-by-step instructions given by Freeman for how to create a map to show the linkages:

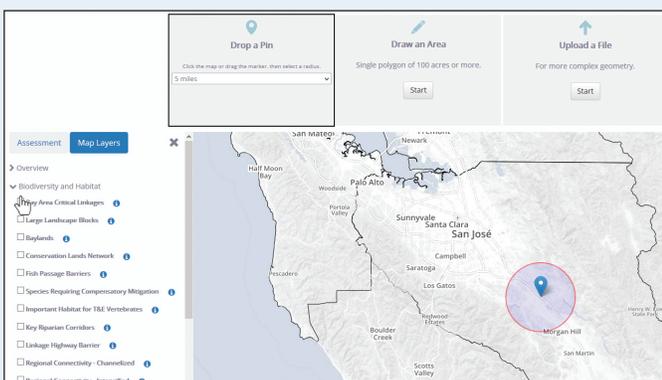
1) Go to bayareagreenprint.org and click “Analyze & Report.” A map will appear; zoom in by clicking the “+” sign; click-and-hold the map to drag it around so that Morgan Hill is in the frame.



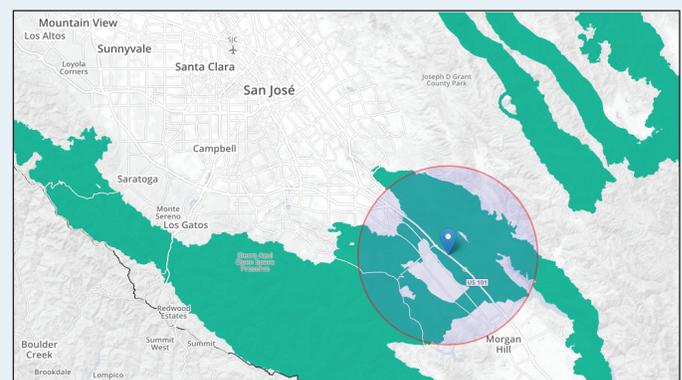
2) Click “Start” in the “Drop a Pin” box and select a 5-mile radius in the drop-down menu. Click-and-hold the pin to drag it onto US 101 between San José and Morgan Hill.



3) Click “Map Layers” in the box to the left of the map (next to the “Assessment” box). Click on “Biodiversity and Habitat” and select “Bay Area Critical Linkages” from the drop-down menu.



4) The resulting map shows the wildlife corridors that connect the mountain ranges in the Coyote Valley, bringing the concept of linkages to life with a visual representation.



Experiment with the map to learn more about what Bay Area Greenprint can do. Try viewing new map layers, like “Agriculture,” where clicking “Agricultural Land” reveals five types of farmland. Instead of using a pin, select other top boxes to draw an area, upload a GIS shapefile, or choose a predefined area such as a city, county, or watershed. Click on “Get a Report” for detailed data about the selected area.

Summer in the City: Seeking Relief from Urban Heat Islands

By Leslie Stewart

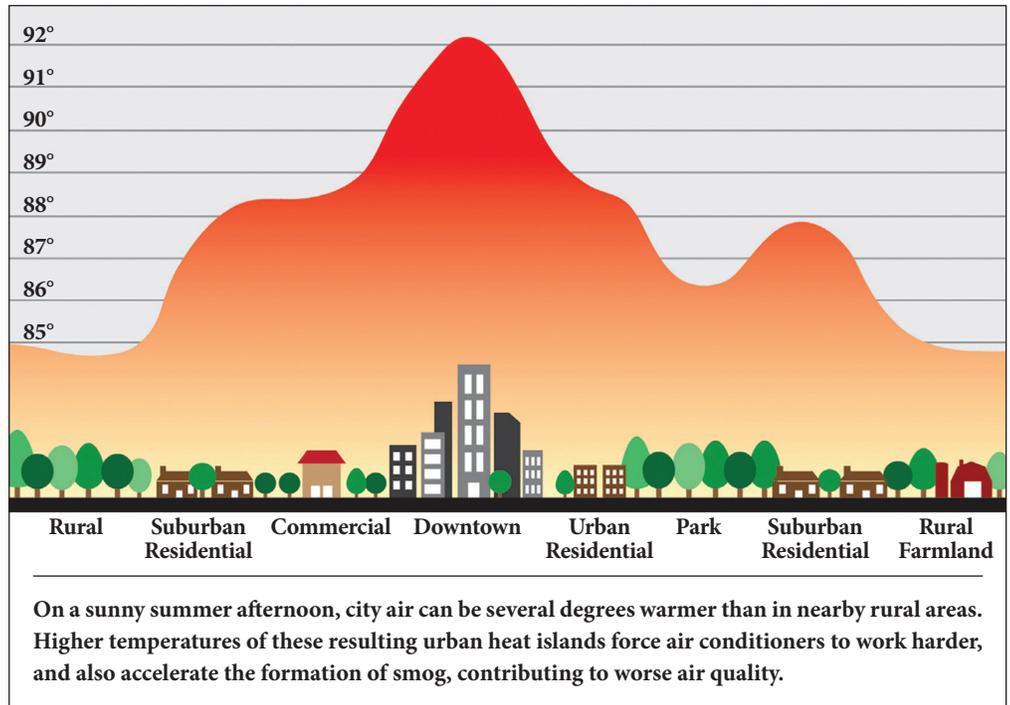
Hot enough to fry an egg on the pavement? The pavement itself may be partially to blame — and the buildings around it as well.

In a phenomenon known as the urban heat island effect, the roofs, streets, and sidewalks in a built-up area absorb heat during the day and re-radiate it, sometimes well into the night, so that heat lingers and accumulates. Building patterns that reduce wind flow, while beneficial during colder seasons, can trap hot air in urban “canyons” and add to the problem.

Excessive heat can have many adverse effects on people and the environment, as evident around the Bay Area during the recent June heat wave. Air quality suffers, as sunlight and radiated heat quickly cook car exhaust into smog. According to the Environmental Protection Agency’s website, “Increased daytime temperatures, reduced nighttime cooling, and higher air pollution levels associated with urban heat islands can affect human health by contributing to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality.” In short, all that heat is more than uncomfortable — it’s dangerous. And once it starts to build, it’s difficult and expensive to counteract. Air conditioning helps only inside buildings, while adding to the outdoor temperatures and gobbling electricity.

Climate change may bring even hotter summers to the Bay Area, adding urgency to reducing the heat island effect for the region. Rather than using energy on cooling, more climate-sensitive options look at diminishing the amount of heat that is absorbed in the first place. Experts around the region have been pushing for innovative solutions such as “cool roofs” that reflect sunlight and radiate heat efficiently, “green roofs” planted with vegetation, and parking lots that feature reflective coatings or plenty of shade.

For example, in the recently adopted Clean Air Plan, the Bay Area Air Quality Management District included a proposal to develop and promote a model “cool parking” ordinance to encourage the use of reflective coatings and shade trees when parking lots get built or resurfaced. The



plan also includes developing model building codes for cool roofs. These models for parking lots and roofs will also be included as recommended mitigation measures in CEQA comments and guidance to local jurisdictions.

The current version of the state’s CalGreen building codes already includes cool roofs as a voluntary “reach code.” Rachel DiFranco, sustainability coordinator for the City of Fremont, explained that reach codes can be adopted by

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Summer in the City (from page 5)

local jurisdictions to strengthen their building codes. She recounted that when Fremont's Sustainability Commission considered new reach codes, it chose to add requirements for mandatory solar installations and electric vehicle readiness, rather than cool roofs. "The city really wanted to encourage more solar, and felt that combining solar with cool roof requirements might have been too complex and difficult for some developments," DiFranco said. However, developers still have the option of cool roofs to achieve additional energy savings for a project.

It's anticipated that the next CalGreen iteration, due in 2019, will include the cool roof requirements as mandatory code. In San Mateo County, the cities of San Mateo and Brisbane have recently passed ordinances requiring reflective roof materials on low-slope roofs (which have the greatest potential for heat absorption) in both residential and non-residential construction projects. A model cost-effectiveness study has been prepared for various roof types and climate zones by the California Energy Commission's Codes and Standards Program for cities considering this reach code.

Although green roofs are also included in the CalGreen building codes as a reach code, they are less common than reflective roofs. However, as of January 1, 2017, San Francisco became the first US city to require 15 to 30 percent of roof space to have solar panels and/or vegetation on most new construction. In addition to the landmark domed living roof at the California Academy of Sciences, the city already has a number of smaller green roofs, including the EcoCenter at Heron's Head Park and the new UCSF Medical Center at Mission Bay. A city-commissioned cost-benefit study concluded that these roofs provide a net benefit to owners; the initial cost is offset by stormwater management savings, while the increased real estate value creates a long-term benefit.

In other parts of the Bay Area where they are not mandated, green roofs can be found on buildings that are constructed according to LEED environmental certification standards or have been designed to generate as much energy as they use. Such projects often also incorporate special pavement types, as at San José's Environmental Innovation Center, which also includes a cool roof and many other sustainable features.

CalGreen includes voluntary reach codes for both residential and non-residential projects that specify pavement options to reduce the heat island effect of sidewalks, patios, driveways, and parking lots. In addition to permeable (or pervious) pavement, which allows water to pass through or to evaporate slowly from internal pockets, cool pavement

options include reflective materials and coatings, grid pavers which allow plants to grow through the spaces, and pavement that is shaded by trees or structures.

A new Pavement Life Cycle Assessment tool for cities to determine the overall life-cycle environmental costs and benefits of various cool pavement options has just been developed for the California Air Resources Board by a team at Lawrence Berkeley National Laboratory's Heat Island Group. Users can weigh the potential for adding to global warming

or smog production, generating more particulates, or increasing or reducing energy demands. Co-author Haley Gilbert expects the greatest interest in cool pavement will be in hotter areas like Fresno and Los Angeles, where the study's tests were run, although that could change in the future as climate change affects northern California. "Some future scenarios were considered, but not future climate," she explained.

While some reflective materials did not compare well with conventional ones when considering overall life cycle, there are other reasons to require cool pavements.



The EcoCenter at Heron's Head Park in San Francisco has both vegetation and solar panels on its roof.

photos by Alec MacDonald



The San José Environmental Innovation Center showcases numerous sustainable features, including parking canopies topped with solar panels (left) and electric vehicle charging stations shaded by trees (right).

photos by Alec MacDonald

The Heat Island Group research did not include the health benefits of local heat reduction from cooler pavements, which Gilbert observed could be an important component of deciding which options to implement. She also cautioned that the research was focused on how pavement choice would affect average air temperatures city-wide. “We measured at building height, not at street level. The benefit is sometimes downwind, so you could have different effects within individual neighborhoods,” she noted.

Although denser development is often associated with a greater heat island effect, absorbent surfaces in a high-rise area may be smaller than in a suburban business area with many flat roofs and parking lots. Both can benefit from requirements for passive cooling mechanisms, such as reflective or living green surfaces to offset heat build-up and even lower urban temperatures.

Other city ordinances that call for tree planting or parking lot shading may also apply to individual projects. For example, Sacramento has an ordinance that specifies the number of shade trees required for parking lots. Many city and county climate action plans incorporate urban tree planting and other measures to reduce heat islands. At the neighborhood level, parks and other green spaces can also help to offset the impact of heat-absorbing roofs and pavements.

Cities can model best practices to reduce heat, as Menlo

Park has done by adding cool roofs to some city buildings. Also, much of the pavement area in cities is publicly owned in the form of streets and sidewalks, so local governments can make their own contribution to reducing heat islands through their public works programs. As Gilbert observed, “Tackling urban heat islands is one local thing that cities can do to offset overall climate change.” 

Leslie Stewart covers air quality and energy for the Monitor.

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Travel Rewards: Incentives Aim to Shift Commute Behavior

Cecily O'Connor

When it comes to commuting, what would prompt you to change your routine?

To nudge commuters toward new options, a few public transit providers are experimenting with pricing strategies like cash rewards and free rides. Such incentives allow agencies to manage transportation demand while addressing bemoaned issues like crowding on trains or roadway congestion.

“Incentives do work — some better than others,” said Dr. Elliot Martin, assistant research engineer at UC Berkeley’s Transportation Sustainability Research Center. The key for transit operators is that incentives should encourage behavioral shifts among riders without the need for “overt” infrastructure changes, he said.

They also can complement larger policy goals for safety, reliability, and convenience, as well as minimizing environmental impacts.

While commuting is a habitual pattern that most people re-evaluate when experiencing a job change, incentives “can be structured to do a variety of things,” Martin said. “It really depends on what the operator is interested in.”

Having counseled a variety of operators, Selena Barlow reported that “most of the incentives my clients do tend to be short-term, like an incentive around Earth Day, or free rides for a day or week.” As owner and manager of Transit Marketing, LLC, she provides marketing and planning support for small to medium-sized rail and bus systems. Barlow has advised clients such as the Redding Area Bus Authority, helping the agency form a transit pass partnership with Shasta College that enables students to ride buses to class for free.

In the Bay Area, a rush-hour “Perks” program from BART and the San Francisco County Transportation Authority is a recent example of using cash rewards. The six-month trial program sought to shift riders onto trains departing before or after the 7:30 a.m. to 8:30 a.m. rush hour.

Touted as “the first of its kind” in North America, Perks is modeled after a similar rewards program in Singapore

introduced in 2012 by the Land Transport Authority to ease peak-hour rail ridership. Perks participants signed up at BARTperks.com with an e-mail address and Clipper card number. They earned one point for every mile traveled via BART, and up to six times the points when starting a trip in the 60 minutes before and after rush hour.

Points earned via Perks could be bartered for cash rewards or applied to a PayPal account, amounting to nearly \$3 a month on average. Or, riders could apply points and play “Spin to Win” on the Perks’ site game boards to pick up more points or snare cash prizes of \$1 to \$100. In general, riders that trekked via BART more often earned a higher game status and subsequent rewards. They could share results on social media.

Results of the trial, which concluded February 28, are mixed: the program experienced greater-than-expected participant sign-ups, but only a small number commuted outside of BART’s busiest 60 minutes.

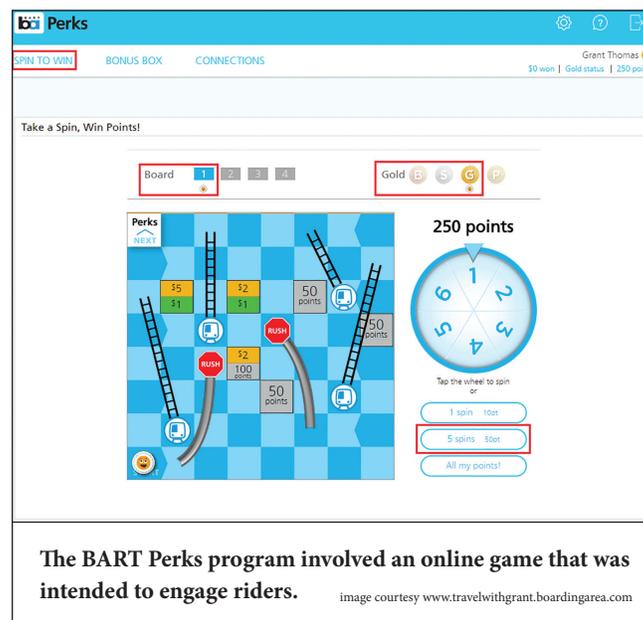
As a result, BART is learning important lessons about the nature of incentivizing and connecting with transit riders. BART riders enjoyed Perks’ so-called gamification aspects, but the program needs to better

target people for whom commute changes make long-term sense, said BART spokesperson Alicia Trost.

“We were surprised that a huge portion of those that signed up or were playing were never traveling in the peak,” Trost said. “They liked the idea of gamification of the commute and getting a small incentive for riding.”

Meanwhile, Sonoma-Marín Area Rail Transit (SMART) is using incentives to build a base of riders for its newly launched train service. SMART, an alternative to commuters who depend on Highway 101 to move between Marin and Sonoma counties, began offering free preview rides during a soft launch in late June. Once the system is officially open, it will extend free introductory rides “for a limited period, then move into a half-price fare period until after Labor Day,” said SMART spokesperson Jeanne Mariani-Belding in an e-mail.

“This will give the community the opportunity to try





Passengers boarded a SMART train at the Rohnert Park Station this summer as part of free preview rides offered by the rail agency in hopes of encouraging more people to use the system.

photo courtesy of SMART

our new service and experience what SMART has to offer,” Mariani-Belding said.

Yet free rides and cash rewards are only as good as riders’ desire to commit to incentive programs.

“It’s not as simple as saying, ‘I’m going to give you some financial reward to travel outside of peak hours,’” said Dr. Michael Visser, chair of the economics department at Sonoma State University. “You have to make sure that it works for people.”

For example, a well-designed “game” in which it’s easy to sign up and includes both virtual and physical rewards is a good first step toward making an incentives program successful for riders and transit operators, said Craig Nelson, a consultant at Steer Davies Gleave in Los Angeles, where he specializes in digital information solutions for transportation and gamification sites.

Nudging transit riders toward new options works best when “using online gamification or commuter challenge websites, supported by good old human contact and encouragement,” Nelson said. “If you just have a fancy website, without the engagement and outreach, you’ll get low participation rates.”

BART enlisted 15 employer partners to help support flexible work schedules and promote Perks to their employees. However, certain factors like BART’s decision to allow any rider to join Perks actually diluted the intended impact of the program.

Diny Huang was one of the 18,000 riders who signed up, although she didn’t alter her schedule because it “conveniently worked” with Perks.

“I was on a later schedule ... and rolled into the office around 9:30 a.m., sometimes even 10 a.m.,” she said.

In the end, the Perks program incentivized 250 participants to travel away from the peak rush hour. About 2,600 participants traveled in the peak before the program began, meaning

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Travel Rewards (from page 9)

10 percent of riders targeted by Perks actually shifted.

Since BART communicated these preliminary results in March, several transit agencies have asked to see the full evaluation summary when it's released this fall, Trost said. That summary will help inform the approach to a second Perks testing phase next year, for which BART received a \$500,000 Federal Transit Administration grant to conduct.

While incentive programs aren't necessarily common practice among transit providers, "more are getting interested" and doing things like running regular commuter challenges for reducing car trips, Nelson said.

Commuter challenges are increasingly employed to encourage residents to find alternatives to driving alone, incentivized by prize-driven competitions. They also dovetail with other important goals — such as reducing congestion and improving air quality — shared by initiatives like the Bay Area Commuter Benefits Program. Overseen by the Metropolitan Transportation Commission and the Bay Area Air Quality Management District, it requires employers with 50 or more full-time employees to offer benefits such as public transit subsidies, free transit service, or the ability to deduct transit fares from pre-tax income.

Commute.org, San Mateo County's transportation demand management agency, ran a commuter challenge this spring. Between April 1 and May 31, 1,480 participants logged more than 53,000 "alternative" trips via bike, walking, shuttles, and public transit on the Commute.org website, contributing to the elimination of 275 tons of carbon dioxide. The organization handed out \$6,200 worth of prizes and giveaways.

"The participants in the commuter challenges we help to deliver really respond well to messages that focus on saving money, working as a team to solve congestion problems, and contribute to the happiness of commuters," Nelson said.

When it comes down to it, riders just want a good reason to switch their commute habits. Otherwise, they are likely to stick with what they know.

"We work a lot with the face-to-face element of this, often knocking on doors and using 'motivational interviewing' to help commuters understand how giving up their car once or twice a week could improve their quality of life," Nelson said.

For BART riders, quality of the ride is important, too. While congestion is frustrating, "the bigger issue is delays," Huang said. "That's driving people crazy." 

Cecily O'Connor covers transportation for the Monitor.

Neutralizing Nutrient Pollution



Algal blooms deplete oxygen levels in water and can result in "dead zones" such as this one in Annapolis, Maryland along the Chesapeake Bay, an estuary like the San Francisco Bay.

photo courtesy John Surrick/Chesapeake Bay Foundation (cbf.org)

By Robin Meadows

Nutrients — such as nitrogen — are essential to life, but an overabundance can mean trouble for waterways. Take Chesapeake Bay and the Gulf of Mexico, which are infamous for "dead zones" where closely-packed bodies of fish float to the surface or wash ashore by the thousands. These dead zones are caused by nutrient pollution, which makes algae grow too fast. The resulting algal blooms ultimately kill fish and other aquatic creatures by using up the oxygen they breathe.

Nitrogen is high in the San Francisco Bay as well, but so far it has escaped the catastrophic effects of nutrient pollution. That may be about to change, however.

"Nutrients are one of the more substantial problems the San Francisco Bay may face over the long-term," said the San Francisco Estuary Institute's David Senn, lead scientist for the Bay Area Nutrient Management Program.

Besides causing dead zones, some algae produce toxins that kill fish and other aquatic life directly. These harmful algal blooms can also cause health problems in people — including rashes, respiratory issues, and liver illness — who swim in or accidentally swallow the water.

Why has the Bay been immune to nutrient pollution? "There's inherent protection in the system," Senn said, explaining that "one of the things keeping a lid on algae is

sediment suspended in the water.” Algae need both nutrients and sunlight to grow, and sediment makes water cloudy, blocking the light.

But this protection may not last much longer. “The Bay is changing,” Senn said. Notably, sediment has decreased by as much as half in recent decades. Since the Gold Rush, sediment from pulverized rock has come down from the Sierra Nevada foothills and into the Bay. And now the last of that sediment is washing away. As the water in the Bay becomes clearer, algae get more light and can use the extra nitrogen in the water to grow more.

Most of this excess nitrogen comes from the 37 major wastewater treatment plants that discharge into the Bay. Sewage is full of ammonia — which contains nitrogen — and it goes straight through most treatment plants here. “The plants are treating waste from more than seven million people, and most do not treat nutrients,” Senn said, adding that “nutrient concentrations here can be two or more times higher than in areas where they are a problem.”

Nutrients are challenging to regulate, however. This is partly because, unlike toxicants, nutrients are needed and too little is as dangerous as too much. “They fuel the base of the food web,” said Naomi Feger, a planner with the San Francisco Bay Regional Water Quality Control Board. Another complication is that the impact of nutrients varies with environmental factors such as water depth and tidal mixing, which in turn vary across the Bay. “It’s not just the concentration, it’s also the conditions — the science will identify the parts of the Bay that are more vulnerable,” she said.

For now, rather than setting a cap on nitrogen, the Water Board wants to help keep anthropogenic sources out of the Bay. Some wastewater treatment plants are using or testing natural approaches for removing nitrogen. “Marshes process nutrients,” Feger explained, adding that “the Petaluma treatment plant has a created wetland and gets good nitrogen reduction.” Another example is the Oro Loma wastewater treatment plant in San Lorenzo, where effluent irrigates a “living levee” that slopes gradually from wetlands to uplands and is planted with native vegetation. Baykeeper, a nonprofit dedicated to stopping pollution in the Bay, is looking to see where else these approaches could be implemented, said Feger.

In addition, under a nutrient permit established by the Water Board in 2014, water agencies are required to explore ways of reducing the nitrogen in wastewater treatment plant effluent. The Bay Area Clean Water Agencies (BACWA) expects to submit a report detailing options and costs in the fall, said BACWA Executive Director David Williams.

According to the upcoming report, nitrogen could be reduced about 10 percent by optimizing current wastewater treatment plants. “They can use existing tanks to convert ammonia to nitrate, which is a form of lesser concern,” said Williams, who formerly was the director of wastewater of the East Bay Municipal Utility District. Then bacteria would convert nitrate to nitrogen gas, which would go “back into the atmosphere where it belongs,” he said, noting that the air we breathe is 80 percent nitrogen. Altogether, this would cost upwards of \$220 million total.

Alternatively, nitrogen could be reduced about 17 percent by concentrating the nitrogen-containing organic material — such as feces and food scraps — and then treating this sidestream separately from the rest of the wastewater. The first step would be coarse screening to remove things like diapers, rags, and two-by-fours, Williams said, adding, “You’d be surprised what gets into wastewater.” The resulting organic sludge would then go into a tank with microbes, yielding methane that would be burned for energy, as well as biosolids that could be used as fertilizer. The sidestream approach would cost about \$660 million total.

The most effective nitrogen reduction method is also the most expensive. Upgrading wastewater treatment plants would lower nitrogen 65 percent to 85 percent, depending on the type of upgrade, at a cost of \$8 to \$10 billion total, respectively. As in the first option, microbes would convert ammonia into nitrate, which would then be converted to nitrogen gas. The difference is that the upgrades would treat the nitrogen in organic sludge more completely.

Williams likes the local, collaborative approach to keeping nutrient pollution at bay. “The rest of the country has reverted to litigation to solve these issues, but we have a good process here,” he said. He also recognizes the need to regulate nutrients in the Bay: “It’s common sense — we can’t continue to have ever-increasing nitrogen. We will need to limit it.” 

Robin Meadows covers water for the Monitor.



Want to learn more about the issues covered in this edition of the *Monitor*, as well as other regional policy matters? Follow us at facebook.com/bayareamonitor for article updates, related news from reliable media outlets, League announcements, agency meetings, nonprofit events, planning documents, and public comment opportunities.

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