Equitable Land Use Alliance
300 Carlsbad Village Dr, PMB 108A-79
Carlsbad, CA 92008

June 30, 2026

The Honorable Robert Rivas
Speaker of the California State Assembly
California State Assembly
The State Capitol, Rm 3164
Sacramento, California 94249

Re: **SB-569 (Blakespear) - OPPOSE**

Dear Mr. Speaker and Members of the State Assembly:

While mayor of Encinitas, bill author Sen. Blakespear championed the installation of multiple so-called “protected” Class IV bikeways that include “physical separation” from regular travel lanes. (via parked cars, flexible plastic posts/bollards, and/or curbs). The separators have been the direct causes of two bicyclist deaths, one on Leucadia Boulevard and another on Coast Highway. These separated bikeways also have led to numerous injuries to many other bicyclists on Coast Highway and Santa Fe Drive, several requiring emergency transport to hospitals.

Further, according to first responders, the bikeway design on Santa Fe Drive also causes delays for emergency response vehicles. Removal of refuge areas for other vehicles to pull over slows fire trucks from getting to fires and ambulances from getting patients to the hospital. The problems described above are not limited to Encinitas, as detailed in the two attached manuscripts.

Encinitas is now seeking to remove some of the dangerous Class IV infrastructure, but instead of simply acknowledging the problem, Sen. Blakespear submitted a series of last-minute gut-and-amends to an unrelated bill in hopes of statutorily forcing the city to retain the separators. A large number of opposition letters and “oppose” positions from cities and other groups and individuals, including ours, were excluded from the Bill Analysis for the June 29th hearing of the Assembly Transportation Committee, presumably based on another last-minute amendment submitted as the public portal was closing.

Proponents have argued that it is reasonable to prohibit removal of separation that is funded by the state (somehow consistent with ATP grants), and that the bill is really only designed to require public hearings and prevent “reduction in safety” for bicyclists. However, Sen. Blakespear made it clear during her June 29th testimony to the Assembly Transportation Committee that the legislative intent of her bill is still to prevent any removal of separation, because, in her mind, any alternative would be a reduction in bicyclist safety—apparently no matter how many cyclists are killed and injured by a bikeway, or whether it delays emergency responses.

In concept, separated bikeways “sound” safer and probably make some bicyclists “feel” safer, but the safety issues described above show how that can be a dangerous illusion. Sen. Blakespear’s Fact Sheet[1] references an approximately 50% crash reduction prediction based on the highly flawed Dixon et al. study that is published on the Federal Highway Administration’s website[2] and is widely cited by “protected bikeway” enthusiasts. However, the authors of that study acknowledged that they had to remove from their analysis all crashes with vehicles that occurred within 250 feet of intersections in order to make their crash reduction predictions reach statistical significance.

Among many other flaws, the Dixon et al. study also did not include any bicycle crashes with the physical separators themselves, other fixed objects, debris (which accumulates due to the inability of conventional street sweepers to clean Class IV bikeways), other bicyclists, pedestrians, and related hazards. Notably, all of these excluded crash types are the exact ones that led to the above-described fatalities and injuries in Encinitas’s Class IV bikeways, as detailed in the attached manuscripts.

In response to FOIA requests, the Dixon et al. authors, their institution, and the Federal Highway Administration have ignored or denied the existence of any data available to conduct an independent analysis. Nearly all safety studies of protected bikeways share these flaws, and it provides no solace to crash victims (or their families and friends) that the oft-cited safety studies do not include their particular crash types, so their crashes do not count or matter, even if fatal or life-changing.

Presumably to help establish that removal of bikeway separation is a matter of statewide concern, Sen. Blakespear also cited the neighboring City of Vista, which has already removed some segments of their Class IV bikeways. However, as summarized in this Coast News Group article,[3] this was done due to safety concerns and because the separators were interfering with the ability of buses to operate and trash collection to occur. The Democratic Councilmember who requested removal of some segments went through a highly deliberative process in consultation with public safety officials, the trash contractor (EDCO), the San Diego Bike Coalition, and traffic engineers to inform his recommendation for removal. Under SB-569, these safety and operational problems would have had to remain in place, because removal of segments of separators would lead to the *perception* of “reduced safety” by some bicyclists.

[1] Senator Catherine Blakespear Fact Sheet: “SB 569: Preserving Safe Bikeways” (https://www.calbike.org/wp-content/uploads/2026/06/SB-569-2.0-Blakespear-Factsheet.pdf)
[2] “Developing Crash Modification Factors for Separated Bicycle Lanes,” Dixon et al., 9/2023 (https://highways.dot.gov/media/33856)
[3] “Vista rolls back even more protected bike lane infrastructure,” The Coast News Group, 7/3/2025 (https://thecoastnews.com/vista-rolls-back-even-more-protected-bike-lane-infrastructure/)

In order to be safe, Class IV facilities should be quite wide (to allow cleaning and maneuverability to avoid crashes) and typically not be located on evacuation/emergency response routes, areas with high intersection/driveway densities, areas with large numbers of higher-speed cyclists, etc. These points are seemingly largely ignored by many bikeway designers, and many separated bikeway enthusiasts dangerously assume that such bikeways are always safer in all contexts.

Unfortunately, the above-described Class IV safety and operational problems often seem to become evident only after installation. Given limitations of individual streets (right-of-way width, intersection density, etc.), the only safe and viable fix, in some cases, may be to remove the separation. However, SB-569 would prevent that—no matter how bad the situation—because the bill is based on the short-sighted claim that Class IVs are always the safest option and the bill’s sole requirement that the *perception of safety* must be maintained for bicyclists—not their actual safety or the safety and operations for the overall community.

Finally, given the effect of making any physical separation an irreversible decision, despite any unintended consequences, this bill will dampen enthusiasm for cities to improve their bikeways.

Improvements/modifications to bikeways should be left to local professionals based on local data and policies established by the elected officials who are familiar with the specific streets and local context—not state mandates. **PLEASE VOTE TO OPPOSE THIS BILL.**

Sincerely,

Equitable Land Use Alliance Board of Directors

Steven Linke, PhD
Kris Wright
Diane Bedrosian, MD

Attachments:

“Case report showing elevated bicycle crashes and injuries in a separated bikeway in Encinitas, California,” Steven P. Linke, PhD, Ron Medak, MD, and Serge Issakov

“Unproven separated bicycle lane safety: Overreaching conclusions and marketing by transportation agencies,” Steven P. Linke, PhD

Case report showing elevated bicycle crashes and injuries in a separated bikeway in Encinitas, California

Steven P. Linke, PhD (splinke.traffic@gmail.com), Ron Medak, MD, and Serge Issakov

ABSTRACT

There is substantial inconclusive and contradictory information published on the alleged safety of separated bikeways. This report is an investigation of crashes on a South Coast Highway 101 corridor in the southern part of Encinitas, California. A “before-after” analysis of police report and emergency medical services data showed that crashes increased by 59% after conversion of a portion of the roadway to a separated bikeway configuration, seemingly due mainly to the vertical components and reduced space to maneuver. In contrast, no meaningful change in crash numbers occurred in an adjacent control corridor during the same time periods. Although no bicycle counts were collected by the city to assess crash rates, data from adjacent areas indicated that the increased crashes were largely not attributable to increased volumes. Additional crash data collected using crowdsourcing during the “after” time period further highlighted separated bikeway hazards. The combined police report, emergency medical services, and crowdsourced crash data included a fatality and numerous severe injuries attributable to the separated bikeway infrastructure. In addition, the crash data showed that reliance on police report data alone is likely to miss a majority of crashes, particularly in separated bikeways. Although this report addresses only one separated bikeway and control corridor, when considered in combination with other published observations, it raises serious concerns about the actual safety of separated bikeways.

INTRODUCTION

Over the past couple of decades, there has been an accelerating movement in transportation planning to separate bicyclists from motorists by creating bikeways with vertical components, such as flexible post delineators, wheel stops, curbs/medians, parked cars, etc. In California, these are legally called “Class IV separated bikeways,” but they also are known as “separated bicycle lanes,” “cycle tracks,” or “protected bicycle lanes.” The rationale is that they may increase ridership due to an increased perception of safety, and that they also may increase actual safety.[1]

Based largely on a 2023 self-published report,[2,3] the Federal Highway Administration (FHWA) is now claiming that such separated bikeways are established as “proven safety countermeasures” that “reduce crashes by up to 53%.”[4,5] In addition, the National Association of City Transportation Officials (NACTO) is now claiming that separated bikeways are “appropriate for all streets in all contexts.”[6] However, there is substantial countervailing evidence that crashes are likely to increase with vehicles at intersections on separated bikeway corridors and with fixed objects, debris, other bicyclists, pedestrians, etc. throughout such corridors, which could lead to net increases in crashes and injury severity.[7]

The 2023 FHWA report and other studies reporting separated bikeway safety tend to exhibit remarkable limitations, including weak study designs, small sample sizes/lack of statistical significance, unreliable bicycle counts, insufficient accounting for confounding variables, exclusion of a majority of crashes (e.g., those that occur at and around intersections and those not involving moving motor vehicles), etc. The findings have been largely inconclusive or contradictory between studies.[7]

Over the past few years in the north coastal region of San Diego County, California, there have been at least three widely reported fatal crashes in separated bikeways, and evidence indicates that the separated bikeway components themselves (plastic post delineators and wheel stops) were primary causes.

1. On November 28, 2020, a bicyclist was killed in the westbound separated bikeway on Leucadia Boulevard at Moonstone Court in Encinitas, when he struck the side of a right-turning truck (right hook crash).[8] The City of Encinitas eventually removed some of the plastic posts in the area and settled a lawsuit that alleged[9]:

    > [These] dangerous conditions created a trap that a reasonably careful person would not notice or anticipate as being dangerous, since the lack of dashed lines, and presence of bollards/stanchions created a false sense of safety while operating a bicycle in the bikeway while at the same time, depriving automobiles adequate opportunity to merge into the bikeway to turn right onto Moonstone Court.

2. On March 17, 2024, a bicyclist was killed in the northbound separated bikeway near the 2800 block of South Coast Highway 101 in Encinitas.[10,11] Official police records indicate that there was no vehicle involvement, but that the bicyclist had collided with a fixed object (California Crash Reporting System[12] Collision ID 4622805). Images of the crash site show that it was adjacent to plastic post delineators and wheel stops.

3. On October 12, 2024, a bicyclist was killed in the northbound separated bikeway near the 1900 block of Jimmy Durante Parkway in Del Mar.[13,14] The City of Del Mar eventually removed some of the plastic posts in the area, presumably because they were suspected of causing the crash.

Just since 2024, there have been several other reports of bicyclist fatalities and severe injuries in separated bikeways across North America, for example, two fatalities in Cambridge, Massachusetts,[15] a life-altering traumatic brain injury in Seattle, Washington,[16] and a hospitalization in Montreal, Canada.[17] In each of these cases, the vertical components (plastic posts, curbs, and/or parked vehicles) appear to have contributed to the vehicle drivers (typically in larger SUVs or trucks) being unaware of the bicyclists traveling in the same direction (blind spot), and to the bicyclists being unaware that the right turns were happening until it was too late—virtually identical to the “right hook crash” on Leucadia Boulevard in

Encinitas. The Seattle crash also led to a lawsuit against the city for the dangerous separated bikeway design,[16] and the legal status is unknown in the other cities.

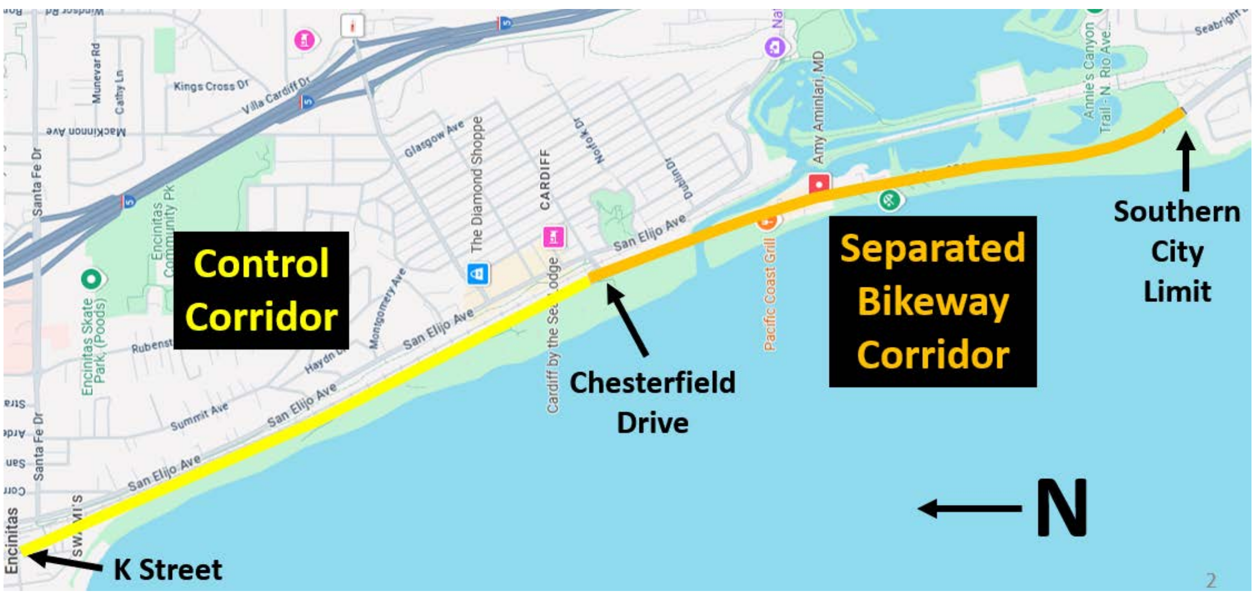
In the South Coast Highway 101 bikeway, along with the fatality described above, bicyclists have been reporting many other crashes, which were either directly or indirectly caused by the vertical components, and several have resulted in serious injuries. The intent of this case report is to assess the crash history of this bikeway.

RESULTS

Street corridors

The "separated bikeway corridor," which is the subject of this report is the approximately 1.3-mile portion of South Coast Highway 101 stretching from the southern city limit of Encinitas (at its border with Solana Beach) up to and including the Chesterfield Drive intersection (Figure 1, orange line). The vertical components include plastic delineator posts and wheel stops. In addition, an approximately 1.4-mile "control corridor" includes the portion of South Coast Highway immediately north of the separated bikeway corridor, stretching from north of Chesterfield Drive up to and including the K Street intersection (Figure 1, yellow line).

Figure 1. Study corridors: Separated Bikeway Corridor (orange) and Control Corridor (yellow).



Official crash data

Official crash data were first collected from the online California Highway Patrol's "California Crash Reporting System" (CCRS) database, which compiles local police reports.[12] However, it is well-known that this under-reports bicycle crashes, particularly those that do not involve motor vehicles and/or that occur off-roadway (separated bikeways are legally off-roadway).[7] Therefore, additional official crash data were obtained from the Encinitas Fire & Marine Safety Department's emergency medical service (EMS) dispatch logs.

All crash data were filtered for location on the corridors and to include only bicycle-involved incidents. Some crashes were only present in the CCRS database, some were only present in the EMS database, and some appeared in both. Table 1 demonstrates this in a subset of the analyzed crashes that occurred in 2021 through 2022.

Table 1. Official crash data sample (2021 through 2022).

Approximate Collision Date/Time	CCRS Collision_Id	EMS Incident Number
1/17/2021 16:56		2021-004912
4/21/2021 11:28		2021-030639
8/14/2021 0:44		2021-064176
9/6/2021 15:46		2021-071020
10/5/2021 16:08	2873756	
10/9/2021 13:45	2873754	2021-080645
1/14/2022 17:06	2627295	
8/12/2022 17:32		2022-064746
8/27/2022 7:52	2686951	
9/1/2022 18:03	2694444	2022-070711
11/16/2022 11:56		2022-092716

Longitudinal (before-after) approach

The wheel stops creating the separated bikeway were installed by April 2020, and CCRS data was available through December 2024. Therefore, equal 57-month analysis periods before (July 2015 through March 2020) and after (April 2020 through December 2024) conversion to the separated bikeway were compared. This "longitudinal" approach (crashes before and after on the same roadway) minimizes contamination with potentially confounding variables relative to a "cross-sectional" approach (crashes on different roadways compared during the same time period). Confounding variables in this context are differences in roadways other than the bikeway separation that could contribute to crashes.

Large increase in crashes after separated bikeway conversion

Table 2 shows the "before" and "after" bicycle-involved crash numbers for both the separated bikeway and control corridors. When only the police report-based crashes (CCRS database) are considered for the separated bikeway corridor, there were only 7 crashes before conversion and 10 crashes after (little meaningful difference). However, the EMS dispatch logs add an additional 27 crashes that did not generate police reports. In total, there were 17 crashes in the separated bikeway corridor reported in these official records before conversion, and 27 after conversion, representing a 59% increase.

In contrast, the control segment had 14 total crashes before and 13 after (no meaningful difference). Unfortunately, the City of Encinitas did not collect any bicycle counts in these corridors either before or after conversion of the bikeway. Therefore, it is impossible to compare crash “rates” that could have accounted for possible changes in volume. However, the inclusion of the control corridor data helps control for bicycle volumes and other factors that may have changed between the “before” and “after” time periods.

Table 2. Crash numbers before and after separated bikeway conversion. The numbers are split into crashes that appeared only in the CCRS database, only in the EMS dispatch logs, or both.

	Only CCRS	Both	Only EMS	Total	Change
Separated Bikeway Corridor (Southern City Limit to Chesterfield Drive)					
Before	2	5	10	**17**	
After	5	5	17	**27**	**59% increase**
Control Corridor (North of Chesterfield Drive to K Street)					
Before	3	3	8	**14**	
After	2	1	10	**13**	

EMS data demonstrates significant under-reporting of bicycle crashes in police reports

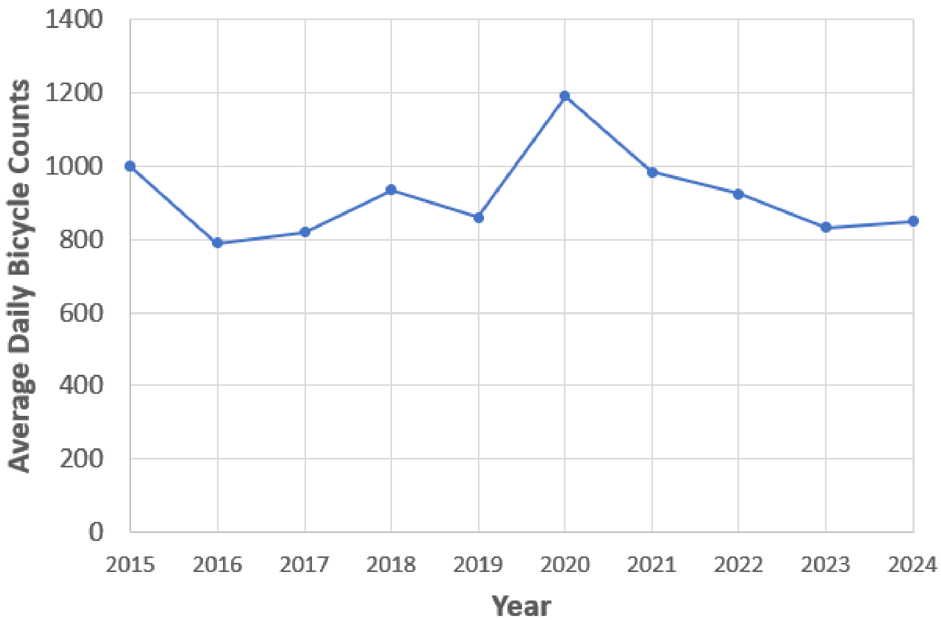
It is remarkable that 63% (45 of 72) of the total crashes in both corridors were recorded only in the EMS dispatch logs—no police reports generated for them to appear in the CCRS database, despite the fact that the injuries were severe enough to call for emergency assistance.

Bicycle volume data

Although the City of Encinitas has collected no bicycle counts in the separated bikeway corridor itself, the San Diego County Association of Governments (SANDAG) has a continuous automated bicycle counter located in Solana Beach at the intersection of South Coast Highway 101 and Lomas Santa Fe Drive (about 0.7 miles south of the separated bikeway).

Apart from a modest temporary increase in 2020 during the pandemic, bicycle counts remained relatively stable on South Coast Highway 101 over the course of the analysis period (Figure 2). Cumulative bicycle traffic was about 7% higher in the after period relative to the before period at the SANDAG counter, which would not account for the 59% increase in crashes in the separated bikeway corridor.

Figure 2. Average daily bicycle counts: Counts obtained from the SANDAG "Coast Highway & Coastal Rail Trail" continuous bicycle counter.



Exploratory analysis of crowdsourced crash data (101 Crash List)

Since conversion of the South Coast Highway 101 corridor to a separated bikeway, Serge Issakov has maintained a "crowdsourced" crash list (101 Crash List) compiled from reports from victims, family members or friends of the victims, or eyewitnesses.[18] From April 2020 through May 2025, there were 37 crashes added to the list, 10 of which also appeared in the CCRS database and/or EMS dispatch logs. Table 3 includes a sampling of the crashes from 2021 through 2022 side-by-side with the CCRS and EMS crashes, giving credence to the crowdsourcing approach.

Table 3. Crowdsourced “101 Crash List” sample (2021 through 2022).

Approximate Collision Date/Time	CCRS Collision_Id	EMS Incident Number	101 Crash List
1/17/2021 16:56		2021-004912	
4/21/2021 11:28		2021-030639	
7/13/2021			✓
8/14/2021 0:44		2021-064176	
9/6/2021 15:46		2021-071020	✓
10/5/2021 16:08	2873756		✓
10/9/2021 13:45	2873754	2021-080645	
1/14/2022 17:06	2627295		
3/23/2022			✓
7/16/2022			✓
8/12/2022 17:32		2022-064746	
8/27/2022 7:52	2686951		✓
9/1/2022 18:03	2694444	2022-070711	
11/16/2022 11:56		2022-092716	

101 Crash List crashes directly attributable to the bikeway

Through review of the 101 Crash List reports, it was determined that a minimum of 19 of the crashes on the list could be directly attributed to the existence of the vertical components of the bikeway (e.g., solo crashes from directly hitting a plastic post or wheel stop, or as a result of the inability to conduct an avoidance maneuver). Among these 19 crashes, 16 did not appear in either the CCRS or EMS crash lists, and 10 of those resulted in visible or worse injuries, further demonstrating that even the combined CCRS and EMS crash data does not fully capture all bicyclist injuries, let alone all bicyclist crashes.

Recent individual case reports (supplemental data)

It is also important to note that the crashes and injuries are happening to both experienced/vehicular bicyclists, as well as more casual/recreational bicyclists. Below are 8 example individual case reports.

On May 3rd, 2020, two different children under the age of 16 hit wheel stops, and one of them was thrown into the #2 vehicle lane.

On May 26th, 2020, experienced randonneur “Len” hit a wheel stop trying to avoid surfers and suffered fractures.

On March 13th, 2025, bicycle commuter “Annie” was forced to ride in the #2 vehicle lane, because there were pedestrians in the cycle track. She was crowded by a close-passing car and attempted to re-enter the cycle track, struck a wheel stop, and damaged her bike.

On May 11th, 2025, casual e-bicyclist “Priscilla” lost control in sand, swerved left, and fell, hitting her head on a wheel stop. She suffered a concussion, multiple scrapes, and EMS was dispatched and took her to the hospital.

On August 14th, 2023, experienced bicyclist “Fred” collided with a wheel stop, fell, and hit his head.

On October 5th, 2024, experienced bicyclist "Ken," acting as sweeper for a local recreational cycle club ride, hit a plastic post, crashed, and broke his clavicle and five ribs. He also had a concussion and brain bleed and was taken to the hospital unconscious.

On April 29th, 2025, experienced bicyclist "Herb" hit a plastic post and wheel stop, crashed, and suffered a concussion. EMS was dispatched and took him to the hospital.

On March 17, 2024, USMC Captain "Ryan" was killed at the location shown below near the northbound entrance at the southern city limit.[10] The police report determined the cause to be a collision with a fixed object, presumably a wheel stop, a plastic post, or the curb.[12]

DISCUSSION

The primary finding in this report was the 59% increase in crashes in the South Coast Highway 101 separated bikeway corridor in the 57-month period after its conversion compared to the 57-month period before. This longitudinal (before-after) approach is superior to a cross-sectional approach to minimize potential confounders. Another strength of this report is the inclusion of before-after data from the contiguous, very similar, control corridor.

The main limitation is the fact that this is a case report of a single separated bikeway corridor, so it is not possible to make any broad statistical conclusions, although that was not a goal. Another limitation is the fact that the City of Encinitas did not collect any bicycle count (exposure) data to account for possible changes in ridership. However, the stable bicycle counts observed directly south of the studied bikeway, as well as the stable crash numbers observed in the control corridor directly north, are strongly indicative that bicycle counts did not change considerably in the separated bikeway corridor in the before vs. after time periods—at least not enough to account for the 59% increase in crashes. In addition, there is substantial evidence that many of the crashes were directly or indirectly caused by the vertical components themselves, which could not have occurred but for the conversion to a separated bikeway.

Although the crowdsourced data was not available in the before time period, and because it could not be collected in a uniform manner for all crashes, it is considered exploratory. However, the data was thoroughly documented and corroborated, and it provides valuable, complementary information, as described below.

A potential minor limitation of this report is the fact that the construction of the separated bikeway occurred over a few months, so a few crashes with vertical components occurred before all vertical components had been installed. Also, a two-way cycle track was added to part of the control corridor in 2023, but the main roadway with its standard bicycle lanes, remained in operation, and there is not enough data yet to assess the safety of the cycle track.

This report highlights the fact that police report crash data, while critically important in any crash report/study, is far from comprehensive. When considered in the context of EMS dispatch logs, the police report data missed a majority of the crashes (63% of officially reported crashes appeared only in the EMS data). Even the combination of these two official data sources was far from complete, though. Crashes compiled through crowdsourcing overlapped to an extent with the official sources but also included many unique crashes, typically solo incidents.

It is not surprising that solo bicycle crashes would not appear in police reports, because police reports are heavily focused on motor vehicle-involved crashes. However, several of the solo events led to injuries and did not appear in the EMS logs either. While minor (visible) injuries would not necessarily lead to an EMS call, some were more severe, but the victims used alternative means to get medical attention, so these injury crashes did not appear in either official source. Researchers in other studies have analyzed records for emergency department visits and hospitalizations, which could help capture these additional crashes without relying on crowdsourcing. That was beyond the scope of this report, but studies likely need to include all of these sources to be comprehensive.

In conclusion, despite substantial marketing on the alleged safety of separated bikeways, there seem to be many contexts in which their installation makes conditions more hazardous for bicyclists, as demonstrated in this report and discussed in detail elsewhere.[7] Further, this report confirms the need to assess crashes more comprehensively to reach safety conclusions. Police report data alone and data that fails to account for solo bicyclist, off-road, or intersection crashes is not sufficient to make definitive conclusions on safety. Future separated bikeway studies should focus on before-after results with accurate and complete bicycle exposure and crash data, and local decision-makers should proceed with extreme caution when considering installations.

DETAILED METHODS

Street corridor characteristics

Separated bikeway corridor. Generally, there are two vehicle drive-lanes going in each direction (outside lane 11 feet wide, inside lane 10 feet wide) with single one-way bikeways on each side (7 feet of rideable width with 3-foot buffers from vehicles), along with a 5-foot sidewalk on the far west side. In areas with parking, there is also an 8-foot parking lane on the west side with a 2-foot buffer from the drive lane. Black wheel stops with white strips and green plastic delineator posts were installed in the 3-foot bicycle buffer between about February and May 2020. The wheel stops are generally about 10 feet long with 10-foot gaps between, and the plastic delineators are generally installed in every other wheel stop gap. Prior to conversion, generally, there were 5-foot unbuffered bicycle lanes.

Control corridor. Generally, there are one or two vehicle drive lanes going in each direction with 5-foot unbuffered bicycle lanes. In 2023, a two-way cycle track was installed on the west side, but the main configuration remained. Insufficient time has elapsed to assess its safety impacts.

Intersections. All intersections within the corridors were included, and areas within 250 feet of the bounding Chesterfield Drive and K Street intersections were included, consistent with industry standards.

Bicycle counts

Bicycle counts were obtained from the SANDAG Open Data Portal,[19] based on an automated in-pavement Eco Counter Zelt Evo at the “Coast Highway & Coastal Rail Trail” location (near the intersection of Coast Highway and Lomas Santa Fe Drive), about 0.7 miles south of the Cardiff cycle track.

Crash data

California Crash Reporting System (CCRS) database. The most recent ten years of crash records in the State of California are publicly available from the California Highway Patrol’s California Crash Reporting System (CCRS) through the California Open Data Portal.[12] This database was formerly known as the Statewide Integrated Traffic Records System (SWITRS). The years 2015 through 2024 were available for download at the time this study was conducted (March 2025), and there are three comma-separated value (CSV) files for each year that can be linked with a “CollisionId” field common to each file: Crashes (crash details), Parties (parties involved in the crashes), and InjuredWitnessPassengers (numbers and severities of injuries). Note that data from 2023 and 2024 are considered “provisional.”

The Crash files were first filtered for “City Name” = “Encinitas” and combined into one master database for all years. Second, the database was filtered for all collisions that occurred on Coast Highway 101 as the “PrimaryRoad” (this was a manual process, because there were several spelling variations. Third, the specific locations of the collisions along Coast Highway 101 were determined by using the block numbers, or by using distance (“SecondaryDistance”) and direction (“SecondaryDistance”) from the listed cross-streets (“SecondaryRoad”).

Emergency Medical Services (EMS) dispatch logs. EMS dispatch logs, filtered for location and bicycle involvement, were obtained from the Encinitas Fire & Marine Safety Department for both the main study area and the control area for 2015 through 2024. Injuries for dispatches that resulted in transport to a hospital were assumed to be severe, and all others were assumed to be non-severe. Note that one crash was excluded, because a police report definitively established that it was a solo motor vehicle incident.

101 Crash List

The 101 Crash List is crowdsourced in chronological order based on information about crashes provided to Mr. Issakov by the victims themselves, family members or friends of the victims, or eyewitnesses. The information was transmitted in person; via email, text or phone; or on social media (e.g,, Facebook). Social media posts that could not be independently corroborated were excluded. Injury severity was assessed by Dr. Medak based on the accounts as complaint of pain/probable, visible/minor, or severe/serious.

ABOUT THE AUTHORS

Dr. Steven Linke, PhD (corresponding author is a retired scientist and former traffic commissioner for the City of Carlsbad, California.

Dr. Ron Medak, MD, is a physician and traffic commissioner for the City of Encinitas, California.

Serge Issakov is a lifelong cyclist who has been actively advocating for more and safer cycling for more than 20 years. He is a board member of the San Diego Bicycle Club, the San Diego County Bicycle Coalition and the California Association of Bicycling Organizations. He is also a League (of American Bicyclists) Certified Instructor, a ride leader, and a former member of the San Diego Mobility Board.

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Unproven separated bicycle lane safety: Overreaching conclusions and marketing by transportation agencies

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A. Introduction/Purpose

In 2023, the Federal Highway Administration (FHWA) published a report on separated bicycle lane (SBL) safety,[1–3] leading to a claim that SBLs are "proven safety countermeasures" that "reduce bicycle/vehicle crashes by up to 53%" (Figures 1 and 2),[4,5] and, as of 2025, the National Association of City Transportation Officials (NACTO) is claiming that SBLs are "appropriate for all streets in all contexts."[6] However, closer scrutiny the 2023 FHWA report and previous SBL safety studies reveal that the "up to 53% crash reduction" claim should, at a minimum, be accompanied by the following qualifications and warnings:

- The claim applies only to crashes with moving vehicles in mid-block locations more than 250 feet away from intersections. Crashes with moving vehicles at and within 250 feet of intersections had to be excluded from the study in order to make the crash reduction estimate statistically significant, and other crash types (e.g., those with parked vehicles/fixed objects, debris, other bicyclists, pedestrians, and related hazards) were not studied.[2,7]
- Other studies indicate that crashes with moving vehicles at intersections and with parked vehicles/fixed objects, debris, other bicyclists, pedestrians, and related hazards are likely to increase in SBL corridors, which could actually lead to net increases in injuries and fatalities in SBLs.
- The claim was established for SBL designs with flexible post delineators only. Inclusion of other physical separation (e.g., wheel stops, curbs, or parked cars) degraded safety relative to the posts alone, and removal of these other physical separations is expected to decrease crashes by 40%.
- The claim may not generalize to cities other than San Francisco, California.

The FHWA and NACTO marketing of the SBL safety claims without disclosing these qualifications and warnings is irresponsible and possibly dangerous. The marketing is frequently cited by state, regional, and local policy-/decision-makers and their transportation staffs, as well as many bicycle advocacy groups and enthusiastic constituents. This has led to a veritable movement in some communities, including several in San Diego County, to install plastic posts, wheel stops, and other vertical elements under the assumption that they will increase safety. Unfortunately, SBL projects seem too often done in a rushed and indiscriminate manner, without assessing the appropriateness of either sites or designs, and without collecting detailed before-after data on usage and crashes, as recommended in professional guidance documents.

Safety studies on the addition of conventional (painted) bicycle lanes on US roadways have been relatively sparse–some showing reductions in crashes or injury severity, and many others showing no reduction or an increase.[8–17] US-based research has been even sparser for SBLs and has generated similarly contradictory or inconclusive findings.[2,11,15,18–23] The studies suffer from weak study designs, small sample sizes/lack of statistical significance, unreliable bicycle counts, insufficient accounting for confounding variables, exclusion of large numbers of crashes, ignorance of the crash types relevant to the safety interventions, and other problems. There is stronger evidence in some European cities, particularly in the Netherlands and Denmark, that SBLs may improve safety, but the cultural, topographic, and overall infrastructural contexts are very different there, including the fact that about one-third of trips are done by bicycle,[22] as opposed to about 1% in the US.[24]

Experience over the last five years in the north coastal region of San Diego County has included at least three fatalities in SBLs (representing most of the bicyclist fatalities in the affected communities, which had no fatalities in the prior five-year period), as well as large increases in crashes and injuries in SBLs on South Coast Highway in the Cardiff area of Encinitas.[25] These fatalities and many of the injuries can be directly attributed to the SBLs themselves. Also, the family of a San Diego city staffer, who has been a longtime advocate of SBLs, is now suing the city alleging an SBL led to the injury and emotional traumatization of their son.[26] While anecdotal, these observations also beg caution.

One purpose of this paper is to detail the substantial limitations of the 2023 FHWA report conducted by the Texas A&M Transportation Institute to those who may only be familiar with select headlines, conclusions, and marketing statements. While the 2023 FHWA study seemingly set out to be (and is being promoted as) a definitive safety model "development" and "validation" study, it was beset by similar limitations described above for past bicycle lane studies. It also has substantial data transparency issues. For example, the report does not reveal the identities of any of the streets studied or any crash numbers/details, and the FHWA and authors' institution have thus far refused to provide the study data for independent analysis. Like the SBL safety studies that came before it, the 2023 FHWA report contributes to a growing body of research, but it remains, at best, "exploratory," and the level of evidence it provides is not sufficient to set broad policy.

A second purpose of this paper is to highlight several factors that can make SBLs even more hazardous than conventional bicycle lanes. These factors should be considered when designing future SBL studies and when considering installation of SBLs.[14] While carefully designed SBLs on some roadways may provide enhanced safety, installation should be considered experimental and only done with caution. The aggressive "every street in every context" marketing, and the resulting well-intentioned but indiscriminate installations endorsed by SBL enthusiasts can have dangerous, even lethal, unintended consequences.

B. Executive summary (critique of the 2023 FHWA study)

- **Key study design limitations:**
  - Very basic, but essential, information was inexplicably not disclosed in the 2023 FHWA SBL study, including the numbers and locations of the studied street corridors, as well as the numbers, types, and severity of the crashes.
  - The authors stated that they were unable to determine the dates of installation of the SBLs in their study, so, instead of using the typically more robust before-after study design (comparing crashes on the same streets before and after SBL conversion), they were forced to employ a cross-sectional study design (comparing crashes on different SBL and non-SBL streets).
  - Cross-sectional studies are more subject to contamination with "confounders" (characteristics other than the SBLs that may account for observed differences in crashes), and several potentially powerful confounders were not examined in the study, including prevailing vehicle and bicycle speeds and driveway/alley density.
  - The authors acknowledge that the number of crashes in the study was "very small," that many statistical safety models were explored, and that the safety model should only be applied with caution to at least one other city (Denver), suggesting that the model may be "overfit," and that the safety claims may not apply generally to other cities.
  - No evidence of independent peer review has been provided, and no records have been produced in response to a 5/29/2025 Freedom of Information Act (FOIA) request for the underlying datasets, so no independent assessment of the data can be done.
- **Crash reporting gaps:**
  - Unfortunately, the 2023 FHWA study only appears to have included the subset of on-road vehicle-bicycle crashes present in police reports, even though it is widely acknowledged (including by the FHWA itself) that this approach vastly under-reports bicycle crashes. The excluded crashes are ones that do not involve moving motor vehicles (e.g., crashes with fixed objects, opened vehicle doors, debris, other bicyclists, pedestrians, etc.) and/or that occur off legally defined roadways–the very types of crashes that are amplified by SBLs. Large proportions of these unreported crashes result in injuries leading to hospital visits/stays.
  - This limited subset of crashes was then further constrained to only crashes that occurred in the portions of mid-block street segments greater than 250 feet from all intersections along the SBL corridors, because exclusion of intersection crashes was necessary to achieve statistical significance to support the safety conclusion. This,

despite the fact that SBLs can reduce visibility of and increase crashes with bicyclists around intersections.

- Bicyclists cannot avoid intersections when traveling on SBL corridors, meaning that any alleged reduction in crashes could be largely or entirely the result of reduced reporting and shifts to other crash types and locations that were excluded from analysis.

- **Extrapolated bicycle volume data:**
    - Bicycle volume data (critical to calculate crash rates) was not collected as originally planned due to the pandemic. Instead, statistical model-based extrapolation of limited historical data was used, with inconsistent and sometimes counter-intuitive results.
    - 2020–2021 volume data were excluded without showing the effects or providing a detailed justification, undermining the reliability and transparency of the findings.
- **Safety model inconsistencies/Lack of generalizability:**
    - Study results varied widely between cities; statistically significant improvements were only found in one city (San Francisco), and the main finding of the study (that plastic posts alone resulted in the largest crash reduction) was not supported in the city with the largest number of studied segments (Seattle).
    - Crash data from 2020–2021 and from segments with alleged zero traffic was excluded from the study without showing the effects or providing a detailed justification.
    - Validation of the model with data from Austin and Denver was only an assessment of statistical equivalency, not evidence that SBLs actually reduced crashes in those cities, and the authors cautioned about the applicability (generalizability) of the results to Denver.
    - The model may not be generalizable to cities beyond San Francisco and, perhaps, Cambridge.
    - The primary proposed safety benefit of SBLs is reduction of overtaking-type crashes with vehicles. However, no data on crash types or injury severities is presented to assess this alleged benefit.
- **Policy implications:**
    - Bodies like FHWA and NACTO are using inconclusive/contradictory studies to promote SBLs, which, given current evidence, should still be treated as experimental and used with caution–not mandated as universal safety solutions in all contexts.
    - Future studies of SBL safety intended to set national policy should: (1) focus on before-after study designs that fully account for confounders, (2) be powered with sufficient

crash sample sizes to make statistical conclusions without model overfitting, (3) make the underlying data available for independent confirmation, (4) more fully account for bicycle crashes and injuries (e.g., by combining emergency/hospital data with police reports), (5) account for safety through entire SBL corridors, including intersections, and (6) accurately account for changes in bicycle counts.

C. Summary of hazards created by SBLs, plus design guidance

- For a good literature review of many of the following issues, see the Discussion in Cicchino et al., 2020,[18] and for examples of SBL design guidance, see the San Diego County Bicycle Coalition's Cycle Track Toolkit.[27]

- Rideable lane width is a key component that affects many of the risks described below, including maneuverability within an SBL. NACTO "recommends" at least 7.5 feet.[6] If that cannot be achieved, painted bicycle lanes should be considered instead of SBLs. The safety of NACTO's 5-foot "minimum" rideable width is unproven.

- SBLs increase solo bicyclist crash risk due to the large number of fixed vertical objects introduced into a constrained space, like plastic posts/bollards and wheel stops. Many of the crashes in the South Coast Highway SBLs have involved such objects.[25]

- Unexpected transitions into SBLs can lead to solo bicyclist crashes with the vertical elements, so they should be well-marked. At least one of the SBL-involved bicyclist fatalities in north coastal San Diego County can be attributed to this.[25]

- SBLs can increase solo bicyclist crash risk due to debris accumulation arising from less cleaning, combined with reduced maneuverability to avoid the debris.

- SBLs increase bicycle-bicycle crash risk due to speed differentials (e.g., recreational bicyclists, experienced cyclists, and e-bicyclists) in the same constrained space.

- SBLs can increase bicyclist-pedestrian crashes due to pedestrians improperly using the SBL for walking/jogging.

- SBLs tend to reduce visibility/awareness between vehicle operators, bicyclists, and pedestrians at intersections, driveways, and alleys, leading to increased crash risk during vehicle right turns (right hooks), particularly for trucks and other vehicles with larger blind spots. Numerous serious injuries and fatalities related to right hooks have been reported across the US at SBL intersections, including a fatality in Encinitas.[25] If vehicle deceleration or mixing areas are not possible or practical, consider painted bicycle lanes instead of SBLs.

- Two-way SBLs are even more dangerous than one-way at intersections/driveways/alleys, because pedestrians and turning motorists may not be aware of bicyclists traveling in both directions (i.e., oncoming bicyclists are coming from an unexpected direction).

- Steep downhill grades that increase bicyclist speeds can further increase the risks described here due to the lack of space/time for maneuvering in the constrained space.

- SBL vertical barriers can hinder emergency vehicle access and maneuvering of disabled vehicles.

D. Conventional vs. separated bicycle lanes

Conventional bicycle lanes are typically delineated only by painted lines, sometimes with striped buffers between them and travel and/or parking lanes. There is currently a movement to promote construction of SBLs, which add vertical elements in the boundaries between bicycle and vehicle lanes to "separate" them (known in California as "Class IV separated bikeways," and sometimes called "cycle tracks" or "protected bicycle lanes"). The vertical elements can include:

- Flexible post delineators (sometimes called "plastic bollards" or "flexposts")
- Wheel stops that create a non-continuous "curb" (similar to those in parking lots)
- Continuous curbs, medians, planters, parking lanes, or other barriers

The rationale for SBLs is that they may increase *perceived* safety and ridership due to "separation" from vehicles.[28] However, despite substantial marketing claims that they also increase *actual* safety, they may only create the *appearance* of safety while making streets more hazardous.

E. FHWA and related SBL safety research

2015 FHWA SBL crash analysis report. In May 2015, the FHWA published a *Separated Bicycle Lane Planning and Design Guide*,[23] which included a "Crash Analysis Report" on 17 street corridors in 9 different cities. The report considered the SBL safety findings to be inconclusive:

> An in-depth analysis of crash and ridership data from implemented separated bike lanes in the U.S was completed to evaluate safety outcomes and inform the recommendations of this guide. While the bicycle collision and volume data that exist for most implemented projects is not yet sufficient to draw broad-based conclusions concerning the overall safety of separated bike lanes, the analysis did uncover useful insights to build upon in future analyses.

Crash Modification Factors. The 2015 FHWA report went on to call for additional safety studies, including the establishment of Crash Modification Factors (CMFs) for SBLs, emphasizing how it was imperative that future studies use more robust data collection and study design methods, which were outlined in an evaluation checklist and data collection section. Recommended methods for the development of CMFs have been published by multiple transportation organizations, as well.[29,30]

Note that a CMF is a number that, when multiplied by expected crashes under current conditions (typically derived from historical crashes), is intended to estimate a change in future crashes when a certain modification is made to a roadway. A CMF less than 1.0 predicts a reduction in crashes, while a CMF greater than 1.0 predicts an increase. For example, a CMF of 0.47 would theoretically predict a 53% reduction in crashes.

2023 FHWA study. The study includes the 0.47 CMF for conversion of a generic bicycle lane into an SBL with plastic delineator posts. It includes data from an unspecified number of street corridors in five different cities, although the statistical model that produced the CMFs only included three of the cities (San Francisco, CA, Cambridge, MA, and Seattle, WA) due to limited sample sizes in the other two (Austin, TX and Denver, CO).

It is evident from the published material that the study did not go as originally planned due to profound challenges in collecting the data, as well as inconsistencies in the data. The authors clearly did a lot of work (in fact, a lot more creative statistical work than they likely originally planned), and they seemingly did the best they could under the circumstances to support their premise that SBLs improve safety. However, as detailed below, this new study has many limitations and failed to meet the more robust data collection and evaluation standards considered imperative in the 2015 report.

SANDAG on SBLs. The San Diego Association of Governments (SANDAG), the Metropolitan Planning Organization for San Diego County, has apparently partnered with FHWA and NACTO to some extent on SBLs (based on webinar comments). SANDAG recently released its draft 2025 Regional Plan,[31] which says they will follow the “NACTO Contextual Guidance for Selecting All Ages & Abilities Bikeways" that includes SBLs or other separated paths on all streets with speed limits >25 mph (Figure 3). This appears to create an inappropriate mandate for local jurisdictions to construct SBLs on all streets other than local neighborhood streets in order to receive or compete for SANDAG funding, which could unintentionally make conditions more hazardous for people of all ages and abilities.

F. Challenges to design reliable safety studies

Study basics and confounding factors. It is beyond the scope of this paper to delve deeply into the designs of roadway safety studies. Generally, though, safety “outcome” data (e.g., numbers or rates of crashes, injuries, and/or injury severities) is compared for streets based upon the presence or absence of a safety “countermeasure” (in this case SBLs). Most studies will either compare the same streets before and after SBLs were installed (before-after/longitudinal study), or they will compare different streets with and without SBLs during a single time period (cross-sectional study).

Every comparison will include some potential “confounding factors”—differences between the streets other than the absence or presence of SBLs—which could explain part or all of any differences in safety outcomes independent of the SBLs. Therefore, to establish a clear cause-effect of the SBLs, it is critical to control for potential confounders, such as:

- Traffic volumes (vehicle, transit, bicycle, and pedestrian)
- Different types of vertical SBL elements
- Bicycle lane/buffer widths, presence of green paint, etc.
- Population density/land use
- Vehicle speeds
- Bicycle speeds
- Corridor length
- Grades
- Intersection/driveway/alley numbers and spacing
- Length of vehicle/bicycle mixing zones at intersections
- Vehicle turning frequency
- Intersection control types
- One-way vs. two-way vehicle lanes
- Through- and turn-lane numbers and configurations
- Parking lanes and/or medians
- Lighting
- Crash reporting method changes

Before-after (longitudinal) studies. Studies that compare the *same streets* before and after installation of an SBL are the strongly preferred and most robust study type to estimate CMFs, because there tend to be far fewer known or potentially unknown confounding variables.[30,32,33] The physical characteristics tend to stay the same, except the ones that arise from the SBL installation under study. Factors that vary over time, such as traffic volumes, and perhaps changes in crash reporting, might be examples of the limited variables that need to be controlled.

Cross-sectional studies. Before-after studies typically require several years of data both before and after SBL installation, which requires the existence and collection of more data. A less data-intensive design is a cross-sectional study, in which several different streets are analyzed during the same time period—some with SBLs and some without. However, it is difficult to identify sets of comparable control streets to assess whether differences in crashes are due solely to the SBLs, or whether they are due to one or more of the numerous other confounding variable differences, such as those listed above and, for example, why SBLs were installed on certain streets and not others.

Examples of weak study designs. A 2013 study of 19 US SBLs (**Lusk et al., *Bicycle Guidelines and Crash Rates on Cycle Tracks in the United States***) concluded that SBLs have lower vehicle/bicycle crash rates than a national average crash rate.[34] However, comparing crash rates to an alleged national average is an extremely weak cross-sectional study design that does not account for any confounding variables. In fact, it was subsequently pointed out that the observed crash rate differences were more correlated to intersection density than the presence of SBLs, among other weaknesses. The streets with higher intersection densities had crash rates much higher than the national average and the streets with lower densities had lower crash rates—all independent of the presence of SBLs.[35]

Another widely publicized 2019 study of crashes in 12 large US cities over a 13-year period (**Marshall and Ferenchak, *Why cities with high bicycling rates are safer for all road users***) proclaimed that the presence of SBLs in the cities was associated with better safety outcomes.[21] Although this study was presented as having a very large sample size, its conclusions are specious due to several methodological flaws. For example, the study appears to have included 1,300 miles of off-street trails in its definition of SBLs with only 12.5 miles of actual SBLs, and it failed to account for key confounding variables including population densities and traffic volumes/speeds, among several other statistical problems.[36]

Selection bias. Another factor that affects all studies is potential "selection bias." This arises from the fact that interventions, such as SBL conversions, that do not perform well (and perhaps even removed) are less likely to be included in safety studies, biasing results to locations where they tend to work better.

FHWA study critique:

Study design. The 2015 FHWA report used the more robust and preferred before-after study design on a limited set of sites, but, given an inconsistent mix of findings, the SBL safety results were ultimately considered inconclusive. The report stated:

> …[I]t is imperative…to collect bicycle and motor vehicle crash and volume data for a sufficient period of time before and after separated bike lane installation. This will improve understanding of safety benefits and design considerations…

The 2023 FHWA study was an opportunity to conduct a before-after analysis on a larger set of sites with more robust data. However, the authors used the less robust cross-sectional approach, because, as they describe in the study, they were unable to determine the dates of conversion to SBLs for the sites they were studying.

As described above, cross-sectional studies are more subject to bias from confounding variables when comparing SBL and non-SBL facilities. Adding to that concern, the authors lamented that the 2020 pandemic limited their data collection to pre-existing databases. Further, the authors did not identify any of the specific streets studied as SBL vs. non-SBL. They only identified the cities, preventing any independent comparison.

Confounders. The 2023 study employed a statistical method called "propensity score weighting" (PSW) to help reduce potential confounding variable bias, but PSW can only estimate the effects of variables that are chosen to be included. For example, the authors do not appear to have included vehicle speeds, bicycle speeds, and driveway/alley density, among other variables, in their modeling, all of which have been shown to affect crash frequencies.[22,35,37] And there could be other unknown differences between the undisclosed streets that bias the results.

The study also does not account for variations in the individual SBLs beyond the presence of flexible posts or “other” elements. These potential confounders include variations in lane widths or the types of other elements (e.g., wheel stops vs. planters vs. parking lanes), which are likely to have very different effects on safety.

Lack of transparency. Beyond just the design, the study has a noteworthy lack of transparency in that very basic, but absolutely essential information, like the numbers and identities of the studied street corridors, as well as the numbers, types, and severity of the crashes, are not disclosed. In addition, bicycle volume and crash data from 2020–2021 and street segments with alleged zero traffic were excluded from the study without showing the effects or providing a detailed justification.

Lack of peer review and inability to confirm results independently. In addition, there is no evidence that the study has undergone any sort of formal peer review (particularly from a statistical modeling standpoint); instead, it was just published directly by the FHWA. FOIA requests were submitted to the FHWA for the raw study data (Control Number 2025-0509) and CMF Clearinghouse reviews (Control Number 2025-0559), and a Public Information Request was submitted to the Texas A&M Transportation Institute for the raw study data (Reference Number K002829-080125). However, no responsive records or information has been provided. Without peer review or the ability to independently assess the data, any findings should be treated with great skepticism.

While cross-sectional studies *can* be acceptable to help establish CMFs, several other limitations in the 2023 FHWA study further compromised it, as described below.

G. Challenges in measuring overall safety throughout street corridors

The ultimate goal of decision-makers should be to improve *overall* safety *throughout* a bicycling corridor. Safety is typically measured by the number or rate of bicycle crashes and injury severity types. However, these measurements are challenging for any bicycle study, particularly for SBLs.

G.1. Under-reporting of bicycle crashes and injuries in police reports

State motor vehicle department crash data is derived from police reports, and a crash is generally defined as "an accident that involved a motor vehicle that occurred on a public highway or road in the U.S. and that resulted in property damage or personal injury."[38] Ironically, while the vast majority of bicycle crash studies have relied almost exclusively on such data, most bicycle crashes and injuries do not involve motor vehicles and/or occur off the legal “roadway.” This includes crashes caused by fixed objects like vertical components adjacent to the bikeway, opened vehicle doors, debris, other bicyclists, pedestrians, animals, etc.--the very types of crashes that are amplified by SBLs–and the SBLs themselves are typically legally considered to be “off-roadway.”

- **Fixed objects.** SBLs add significant numbers of new vertical elements to the roadway, such as the flexible posts and curbs, and concurrently reduce the space to maneuver. This factor directly increases the likelihood that bicyclists will crash into fixed objects.
- **Debris.** Vehicles tend to push road debris to the edges of streets, where SBLs are usually located. The vertical elements of SBLs often amplify debris-related crash risk, because they tend to create lanes that are not accessible by conventional street cleaning equipment. Rain and snow also can differentially affect SBLs due to drainage and plowing issues.
- **Other bicyclists.** The limited widths of most SBLs prevents safe passing. So, with the speed differentials of recreational cyclists, experienced cyclists, and ebikes, there is a higher likelihood of crashes with other bicyclists, or with SBL infrastructure in attempts to leave the SBL to pass.
- **Pedestrians.** Walkers and/or joggers often end up in bikeways for a variety of reasons. For example, some joggers prefer the asphalt of a bikeway to the concrete of a sidewalk. In addition, lack of right-of-way width may mean that an SBL installation reduces or eliminates pedestrian areas. These increase the likelihood of bicycle/pedestrian conflicts and crashes.

References demonstrating crash under-reporting

- 1999: The FHWA published a comprehensive literature review of studies comparing police report-based crashes with emergency department (ED) visits and hospitalizations.[39] Their conclusion was that police reports/crash statistics fail to include about 40-50% of ED visits (up to 82% in one jurisdiction) and 25-40% of hospitalizations of injured bicyclists.
- 2016: Based on data from the Massachusetts Department of Public Health, Boston police reports miss 76% of bicyclist ED visits and 60% of hospital admissions.[40]
- 2018: A University of California, Berkeley SafeTREC group published a more recent literature review, concluding that 54-93% of hospital visits were not linked to police reports.[41]
- 2021: A study in Orlando, Florida showed that 73% of ED visits and 57% of hospital admissions of bicyclists arose from crashes that did not involve motor vehicles, and, thereby, likely would not be reflected in police reports.[37]
- 2024: A study of bicyclist crashes/injuries in Toronto showed that 92% of bicyclist visits to EDs were not reflected in police reports.[42]
- 2025: In a report on the Cardiff-area Coast Highway SBL in Encinitas, CA, over 60% of emergency vehicle dispatches for bicycle-related crashes did not have a corresponding police report.[25]

The references cited above also discuss under-reporting of bicycle crashes from other studies too numerous to cite or detail here. The discordances in crash numbers between police reports and other sources varied greatly among the studies, but the common themes are: (1) most bicycle crashes do not appear in police reports or motor vehicle department statistics, because they do not involve moving motor vehicles and/or occur off-roadway, and (2) substantial percentages of these crashes result in ED visits and hospitalizations. Accordingly, the authors emphasize the need to assess records related to hospital visits, in addition to police reports, to avoid under-reporting of bicycle crashes and to avoid erroneous conclusions about the benefits of proposed safety countermeasures.

FHWA study critique:

The 2015 FHWA report acknowledged that their "[c]rash data includes only reported crashes involving a bicycle and a motor vehicle." In its call for development of CMFs for SBLs and other future studies, it went on to recommend comprehensive collection of crash and injury severity data. Unfortunately, the 2023 FHWA study provides very little information on the source of its crash data, but it, too, included only moving vehicle-bicycle crashes, with the authors stating:

> Possibly, other bicycle crashes may have occurred and were not reported. The research team was unable to incorporate these unreported crashes into the scope of this study.

A study comparing bicyclist visits to San Francisco General Hospital (SFGH) and police crash reports showed that: (1) 41.5% of injuries were bicyclist-only (did not involve a motor vehicle), (2) bicyclist-only injuries were four times more likely to require hospital admission than vehicle-bicycle injuries, and (3) there was no police report associated with 54.5% of all bicyclist injuries.[43] SFGH is the only Level I trauma center serving San Francisco, which is the primary city contributing crash data in the 2023 FHWA study. This under-reporting raises direct questions about the conclusion that SBLs reduce crashes, including those leading to severe injuries.

In summary, the 2023 FHWA study and the vast majority of other SBL safety studies do not account for any of the above-described non-vehicle-involved crashes or vehicle-involved crashes at intersections, which tend to be the majority of bicycle-involved crashes, particularly in SBLs. Therefore, any alleged reduction in crashes could be largely or entirely the result of reduced reporting and shifts to other crash types and locations that were excluded from analyses.

G.2. Unreliability of bicycle exposure data/aggregation bias

When assessing bicycle safety, absolute numbers of crashes can be misleading, because a change to a street such as installation of an SBL may change "exposure" (usage), as defined, for example, by trip numbers or mileage. The previous section described how systematic under-reporting of bicycle crash numbers, particularly in SBLs, has the potential to skew safety results. Using guesses at bicycle exposure rather than actual measurements can further skew the results.

FHWA study critique:

The 2015 FHWA report emphasizes the importance of collecting accurate bicycle exposure data when developing CMFs.[23] For the 2023 FHWA study, the original intent was to collect such data at the study sites in the Spring of 2020 to produce the SBL CMFs, but the authors apparently canceled that due to travel restrictions arising from the pandemic. Instead, they had to rely on limited historical bicycle counts from various areas in the cities from which they attempted to develop predictive statistical models to extrapolate counts at the actual sites. Also, many of the bicycle counts appear to be based primarily on extrapolation from vehicle traffic adjusted for variables like the presence of bicycle lanes, population density, land use, etc., which is an even wilder guess. AASHTO/FHWA guidance on CMF-development protocols points out the likelihood of bias due to data aggregation, averaging, and/or incompleteness.[30]

For the three cities used to produce the SBL CMFs, two of them used different methods, and multiple variables had opposite (and sometimes counter-intuitive) effects, while a statistical model could not even be developed for the third. For San Francisco, a Poisson mixed–effect model was produced to predict the bicycle counts, with higher counts being predicted for streets with more bicycle lanes and higher population density (Table 34). In contrast, for Seattle, a Gaussian mixed-effect model was produced, with *lower* counts counter-intuitively being predicted for streets with bicycle lanes and higher population density (Table 42). For Cambridge, the authors stated: "Although the research team made several attempts to statistically develop a nested mixed-effect negative binomial model, they were unable to identify any models that converged."

The San Francisco model also had the seemingly counter-intuitive observation that bicycle counts were *higher* in commercial and industrial areas relative to residential, public, and mixed-use areas. Also, essentially two different models had to be produced for Seattle (one for data from 2016-2018, and another for data from 2014-2015 plus 2019), because the results were so different in these sets of years.

Further, the authors excluded all bicycle exposure data from 2020 and 2021 for all cities, which they justified by citing the different travel patterns in those years due to the pandemic. However, no quantitative assessments were presented, so it is impossible to determine the impacts on the conclusions, or whether the exclusion was justified.

The authors stated:

> Ideally, this assessment should have included known bicycle exposure volumes…However, the implementation of SBLs in the United States is in its infancy, and multiyear bicycle counts are limited. In addition, the recent COVID-19 pandemic created challenges for research team members to travel to locations and conduct additional counts. Ultimately, the bicycle exposure variable…was estimated based on a variety of bicycle count types that included short-term bicycle counts, periodic counts that occurred regularly (usually every 2 yr), and a few permanent bicycle count stations.
>
> …[T]he team allowed some variability for how much bicycle count data could be used and potentially extrapolated to surrounding facilities.

In summary, despite the critical importance of accurate bicycle exposure data to determine crash rates, the authors of the 2023 FHWA study were unable to collect such data and, instead, had to rely upon guesses from statistical models that included multiple counter-intuitive variables and were different for each city and different time periods. This was not consistent with standards called for by AASHTO/FHWA.

G.3. Crashes at and within 250 feet of intersections had to be excluded to achieve statistical significance

SBLs are typically installed on street "corridors" that are comprised of "intersections" linked by the street "segments" between them (as opposed to being installed on single, isolated segments with no intersections). Even setting aside the crash number and bicycle exposure data limitations described above, most SBL safety studies, including the 2023 FHWA study, only report safety improvements within individual segments—not when intersections or complete corridors are included in the analyses.

Obviously, though, it is not possible for bicyclists to skip the intersections, where a majority of vehicle/bicycle crashes occur.[22,44] Ironically, the vertical elements of SBLs, particularly parked cars or large vegetation, tend to make motorists and bicyclists less aware of and/or less visible to each other, which increases vehicle/bicycle crash risks during turning movements at intersections.

In many cases, the vertical elements of an SBL are installed right up to the turning area, so right-turning vehicles must remain in the through lane (often with through-traveling vehicles behind them) until the last second, then suddenly turn right—across the SBL with potentially less visible cyclists. This is in contrast to the more traditional dashed mixing areas, where the bicycle lane becomes a shared right-turn lane for vehicles, or where vehicles move right across the bike lane into a dedicated right-turn lane. Although these mixing areas are potential vehicle/bicycle conflict points, they are designed to be long enough to allow safe mixing, rather than last-second, potentially unexpected turns across the bike area.

Several fatalities and serious injuries have been reported arising from vehicles making right turns across SBLs. For example, in 2020, a bicyclist was killed in the westbound SBL on Leucadia Boulevard at Moonstone Court in Encinitas, CA when he struck the side of a right-turning truck.[45] Plastic post delineators had been installed all the way up to the turning area at the intersection, eliminating any mixing zone. The City of Encinitas eventually settled a lawsuit[46] that alleged: "[These] dangerous conditions created a trap that a reasonably careful person would not notice or anticipate as being dangerous, since the lack of dashed lines, and presence of bollards/stanchions created a false sense of safety while operating a bicycle in the bikeway while at the same time, depriving automobiles adequate opportunity to merge into the bikeway to turn right onto Moonstone Court." Several of the SBL plastic posts leading up to the intersection were removed after the fatality to create a mixing area.

In 2024, two bicyclist fatalities occurred at intersections in SBLs in Cambridge, Massachusetts under virtually identical circumstances to the fatality in Encinitas.[47] Also in 2024, a life-altering traumatic brain injury occurred in Seattle when an SUV made a right turn across an SBL at a driveway (neighbors have reported frequent yelling there due to other close calls).[48] That incident also led to a lawsuit against the city for its dangerous design and insufficient sight distance. In July 2025, a bicyclist riding in an SBL in Montreal struck the side of a right-turning truck (dashcam video available in the linked news story).[49] In each of these cases, the vertical elements (plastic posts or curbs) were installed right up to the intersections, the motorists appear to have been unaware of the bicyclists traveling in the same direction (blind spot), and the bicyclists were unaware that the right turns were happening until it was too late.

In San Francisco, the Market Street/Octavia Boulevard intersection has been considered one of the most dangerous to bicyclists due to vehicles turning right across an SBL there.[50]. Note that this is not an exhaustive list of right hook crashes in SBLs–just a few recent incidents that include the cities in the 2023 FHWA study (San Francisco, Cambridge, and Seattle).

FHWA study critique:

The 2015 FHWA report observed:

> Increases in bicycle crashes after separated bike lanes were built were especially pronounced at intersections…
>
> It appears that the introduction of separated bike lanes may result in increased challenges at intersections, relative to separated or protected midblock locations. All six of the sites where the analysis included consideration of intersection vs. midblock crashes saw an increase in the percentage of crashes that occurred at an intersection relative to crashes at midblock. This was true for bicycle crashes as well as those not involving a bicycle.

The 2023 FHWA study reported:

> Initially, the research team hoped to develop CMFs for segments and intersections, but their attempts to model intersections and/or entire corridors were unsuccessful. Consequently, the team focused on developing robust CMFs for segments. Future work may be to conduct research that estimates the safety effect of the various types of SBL-to-intersection transitions…
>
> The research team assessed the prospect of using intersection-only and corridor-type models but found that for the available dataset, these two options did not yield statistically viable results.

First, it is particularly bizarre that none of the actual street names/locations of the SBLs were ever revealed for any of the cities in the 2023 FHWA study. Second, the fact that intersection crashes had to be excluded in order to achieve statistical significance is a critical flaw in the safety claim. In fact, all of the SBL intersection-based fatalities and serious injuries described above would have been excluded from the crash analysis.

In addition to excluding all crashes at the intersections themselves, the 2023 FHWA study also excluded crashes that occurred within 200 to 250 feet on both sides, which was not disclosed in the report itself but was described by the primary author in a webinar describing the results.[7] Although those distances are commonly accepted as being within an intersection's "area of influence," it means that the entire study was based only on crashes that happened in the middles of the “blocks” extracted from the full SBL corridors.

Also, block lengths can vary significantly between cities and different parts of the same city, which is not addressed in the study. There is no indication of what proportions of the corridors were actually included in the analysis.

In summary, while the 2023 FHWA study sought to demonstrate the corridor-level safety of SBLs, the inclusion of crashes that happened within 250 feet of both sides of intersections clearly caused the statistical models to fail. In the absence of quantitative assessments of all of the excluded data, or shared access to the underlying datasets to allow independent analysis, it is impossible to determine the overall safety impacts of the SBLs.

G.4. Vehicle safety, emergency vehicle response times

There also are safety concerns with SBLs independent of bicycle crashes. The barriers do not allow disabled vehicles to go to the edge of the street, and they reduce the ability of vehicles to yield to the edge when emergency response vehicles need to pass—requiring them to remain in active through-lanes. This is particularly true of streets with few through-lanes. This could negatively affect emergency vehicle response times and/or put drivers of disabled vehicles at risk.

H. Crash modification factor modeling

FHWA study critique:

The statistical modeling of the crash data to produce the CMFs also was quite muddled in the 2023 FHWA study. Table 1 (below) contains a summary of segment numbers and CMFs for “flexible posts” compared to “traditional or flush buffered bicycle lanes.” Although numerous other comparisons were described in the study, this was the main reported finding, so this critique will focus on that area (although it applies to the other comparisons as well).

Table 1

Safety model development sites	Total Segments	Non-SBL Segments	SBLs both directions*	SBLs single direction	CMF	Estimate	Standard Error	*p* -Value	Table[1]
San Francisco (SF)	384	320	28	36	0.338	-1.0849	0.3602	0.0026	47
Cambridge	179	155	24	0	0.592	-0.5244	0.7486	0.4836	50
SF + Cambridge	563	475	52	36	0.316	-1.1507	0.3366	0.0006	52
Seattle	660	541	71	48	1.178	0.164	0.883	0.853	58
All three	1223	1016	123	84	0.468	-0.758	0.267	0.005	60
"Validation" sites									
Austin	68	40	24	4					
Denver	384	368	13	3					

*Either one-way SBLs on both sides of a roadway or a two-way SBL on one side.

Statistical model overfitting. In statistical modeling, when sample/event (in this case, crash) numbers are small, but large numbers of variables and possible models are explored, there is a high risk of something called "overfitting." This could mean that, while an apparently very good model can describe crashes in the specific data being analyzed, the model does not reflect reality and will not "generalize" to accurately predict crashes in other data/cities.[30] In this regard, the authors stated:

> The research team found the number of bicycle crashes [events] to be very small…
>
> The research team developed several regression models for Cambridge, San Francisco, and Seattle (both independently and with a merged dataset).

The actual numbers of crashes in each city/corridor are never revealed in the study, and many variables (some counter-intuitive) and models seem to have been tested in many different combinations, raising concerns about potential overfitting.

Lack of statistical significance in individual cities. San Francisco was the only individual city for which a statistically significant CMF could be developed (0.338, p = 0.0026). It is curious that the addition of Cambridge, which had a worse and not statistically significant CMF as its best model (0.592, p = 0.4836), to San Francisco produced a better CMF than San Francisco alone (0.316, p = 0.0006). And although Seattle had the largest sample sizes (by far) of both non-SBL and SBL segments, the authors also were unable to develop a statistically significant CMF, and the best case model there showed an *increase* in crashes in SBLs vs. non-SBL segments (CMF = 1.178, p = 0.853). Note that Austin and Denver were completely excluded from CMF development, presumably due to low sample sizes of segments and/or crashes.

Disparate Seattle safety element results. The optimal statistical model developed on the Seattle data (although not statistically significant) suggested that SBLs with only flexible posts essentially imparted no safety improvement, while SBLs with flexible posts plus other vertical elements imparted a small safety improvement. This is in contradiction with the overall finding in the model developed from the combined Seattle/San Francisco/Cambridge data that flexible posts alone impart a large safety improvement that is degraded when combined with other vertical elements.

Significant differences between cities. In the final model developed from the combined Seattle/San Francisco/Cambridge data, the city locations themselves showed up as the most impactful coefficients, indicating that the crash rates were substantially different in each city and raising questions about the generalizability of the calculated CMFs to cities other than San Francisco and, perhaps, Cambridge.

Insufficiently characterized data exclusions. For the three-city final model, it appears that the authors removed all segments for which their estimate of average daily vehicle traffic (ADT) or annual average daily bicycles (AADB) was zero. It is unclear why some street segments would have had zero traffic. More importantly, it is unclear how many segments were removed, because the table with the results (Table 59[2]) claims that all 1,223 segments from the three cities were analyzed.

The authors discounted this as a "housekeeping issue." However, there was no explanation of what effect inclusion of those segments would have had on the model, and there was no mention of excluding segments with zero estimated traffic in the separate statistical modeling done on the San Francisco and Cambridge data.

On a related matter, similar to the situation described above for bicycle exposure data, the authors excluded crash data from 2020 and 2021 for all cities, stating in the Tech Brief (and not the main paper):

> Note that data for 2020 and 2021 were excluded from the CMF development efforts because those data were atypical.

However, no further justification was made for the exclusion of this data, beyond the claim that it was "atypical." In the absence of quantitative assessments of all of the excluded data, or shared access to the underlying datasets to allow independent analysis, it is impossible to determine the overall safety impacts of the SBLs.

Inconclusive validations. The so-called "exploratory validation" of the model with the Austin and Denver data was only an assessment of statistical equivalency—without any evidence that SBLs actually reduced crashes in those cities. In addition, while the equivalency test appeared to work for Austin, the Denver findings were quite different, and the authors rationalized this as follows in the Tech Brief with no further justification:

> …[T]he CMF for Denver conditions should be applied cautiously. The team was not completely sure about why these data differed, but Colorado has different weather patterns (particularly in the winter) and has a greater elevation than the other study sites.

This further amplifies the concern that the model may not be generalizable to cities beyond San Francisco and, perhaps, Cambridge.

Lack of crash type or injury severity data. The primary proposed safety benefit of SBLs is reduction of overtaking-type crashes with vehicles, which are the ones that occur mid-block.[2] However, the study includes no data on crash types or injury severities to assess this alleged benefit, which could have helped support the safety conclusions. Further, mid-block vehicle overtaking crashes tend to be a small minority (<10%) of overall bicycle crashes,[37] so the study and its crash reduction conclusion ignore the vast majority of bicycle crashes, including the many bicycle crash types that can increase substantially in

SBLs (e.g., intersection hooks, crosses, and T-bones, as well as fixed objects, debris, other bicyclists/pedestrians, etc.).

I. Inconsistencies in findings between studies

Flexible posts (bollards) alone vs. bollards plus other elements. It is not uncommon for different studies by different researchers to reach somewhat different conclusions or, for example, suggest some differences in the *magnitude* of safety benefits. However, when it comes to research on SBL safety, the inconsistencies in the findings within individual studies and between studies tends to be quite large. This indicates the need for larger, better-controlled studies.

One example is the alleged impact of different vertical elements on crashes. The 2015 FHWA report concluded:

> Plastic bollards applied in conjunction with other characteristics…were associated with a decrease in average annual total crashes while plastic bollards applied on their own were associated with an increase.

In stark contrast, the main finding of the 2023 FHWA study is that plastic bollards (flexible posts) alone had a CMF of 0.468 relative to conventional bicycle lanes (predicting a 53.2% reduction in crashes[51])--see the red box in Table 60 of the study below. However, when other vertical elements were added to the bollards, crashes increased relative to the bollards alone, and the results were no longer statistically significant (orange box in the table).

In fact, the FHWA CMF Clearinghouse reports a CMF of 0.605 for “Convert Blended vertical element Bike Lane to Flexible Delineator Post Bike Lane” based on the 2023 FHWA study.[52] In other words, for an SBL that includes both plastic posts and wheel stop curbs, *removal* of the wheel stops (leaving only the plastic posts) would be expected to nonsensically reduce vehicle-bicycle crashes by 39.5%.

Table 60. CMFs for bicycle crashes in San Francisco, Seattle, and Cambridge.

Condition	CMF	Estimate	Standard Error	*p*-Value	Significance
Flush buffer[a]	1.128	0.121	0.173	0.484	—
Flexible posts[a]	0.498	−0.698	0.264	0.008	**
Flexible posts[b]	0.441	−0.819	0.297	0.006	**
Flexible posts[c]	0.468	−0.758	0.267	0.005	**
Blended[a]	0.822	−0.196	0.252	0.437	—
Blended[b]	0.729	−0.316	0.300	0.292	—
Blended[c]	0.774	−0.256	0.263	0.331	—
Flexible posts[d]	0.605	−0.502	0.318	0.114	—
Flexible posts or blended[a]	0.640	−0.447	0.203	0.028	*
Flexible posts or blended[b]	0.567	−0.568	0.253	0.025	*
Flexible posts or blended[c]	0.602	−0.507	0.212	0.017	*

—Not statistically significant.
*Statistically significant at the 0.05 level.
**Statistically significant at the 0.01 level.
aBase condition: traditional bicycle lane.
bBase condition: flush buffered bicycle lane.
cBase condition: traditional or flush buffered bicycle lane.
dBase condition: blended vertical element.

Mixing zones. Another area of controversy is the safety of so-called “mixing zones,” where vehicles and bicycles conflict at intersections. The 2015 FHWA report stated:

> Mixing zones in combination with other treatments was associated with a decrease in average annual total crashes.

However, FHWA and NACTO guidance recommend minimizing the use of mixing zones, because they allegedly increase the lengths of conflict areas.[1,6]

Glossary of abbreviations and terms in the context of transportation safety

AASHTO (American Association of State Highway and Transportation Officials): A national transportation standards-setting organization that publishes guidelines for highway design.

Bollard: A vertical pillar-like object used for traffic control. In the context of SBLs, they are typically flexible plastic posts. In other cases, they can be rigid/crash-resistant for security.

Before-after (longitudinal) study: A study comparing data collected from the same set of sites both before and after safety modifications like SBLs are installed. Less subject to confounders than cross-section studies.

Class I, II, II, and IV bikeways: California classifications. Class I “bike paths” are off-roadway. Class II “conventional bike lanes” are on-roadway with only paint striping. Class III “bike routes” are on-roadway lanes shared with vehicles (sharrows). Class IV “separated bikeways” are on-roadway but separated from vehicle lanes with vertical elements (same as cycle tracks, separated bike lanes, or protected bike lanes).

CMF (Crash Modification Factor): A number that is multiplied by the future estimated crashes without treatment to estimate expected future crashes with a modification is made to a roadway. A CMF less than 1.0 predicts a reduction in crashes, while a CMF >1.0 predicts an increase. For example, a CMF of 0.47 would theoretically predict a 53% reduction in crashes.

Confounder (confounding factor): When assessing cause and effect of a safety modification, confounders may prevent accurate assessment of the actual effect of the modification, because the confounder(s) are responsible for part or all of the effect.

Cross-sectional study: A study comparing data collected from different sites during the same period of time—more subject to confounding factors than a longitudinal (before-after) study.

Cycle track: Same as Class IV bikeways, separated bike lanes, or protected bike lanes.

FHWA (Federal Highway Administration): US Department of Transportation division that sponsors roadway safety programs, among many other functions.

Flex post: A type of flexible plastic bollard frequently used for SBLs.

Longitudinal study: Same as before-after study.

NACTO (National Association of City Transportation Officials): Coalition of Departments of Transportation in North American cities that publishes roadway design standards.

Overfitting: While an overfit statistical model can predict safety outcomes in the data from which it was created, it fails to generalize to predict outcomes in other data, because it was based on ”noise.” Overfitting is a particular problem when many complex models are explored in small datasets.

Rideable width: The usable width of a bikeway for riding, excluding any shy distance, gutter pans, vertical SBL elements, or other unrideable areas.

SBL (separated bike lane): Same as Class IV bikeway, cycle track, or protected bike lane (PBL).

SANDAG (San Diego Association of Governments): An association of local governments that serves as the Metropolitan Planning Organization for San Diego County.

Selection bias: Failure to analyze a truly random sample for statistical analysis. For example, in SBL research, unsafe SBLs that have been removed cannot be analyzed, and SBLs that have better safety records may be more likely to be selected for analysis, thereby exaggerating their overall safety.

Wheel stop: Short section of “curb” or “berm” similar to those in individual stalls in parking lots that can serve as vertical elements in SBLs. They can be made of concrete, asphalt, or other materials, and glued or poured in-place.

Figure 1. Images from the FHWA website regarding SBLs.

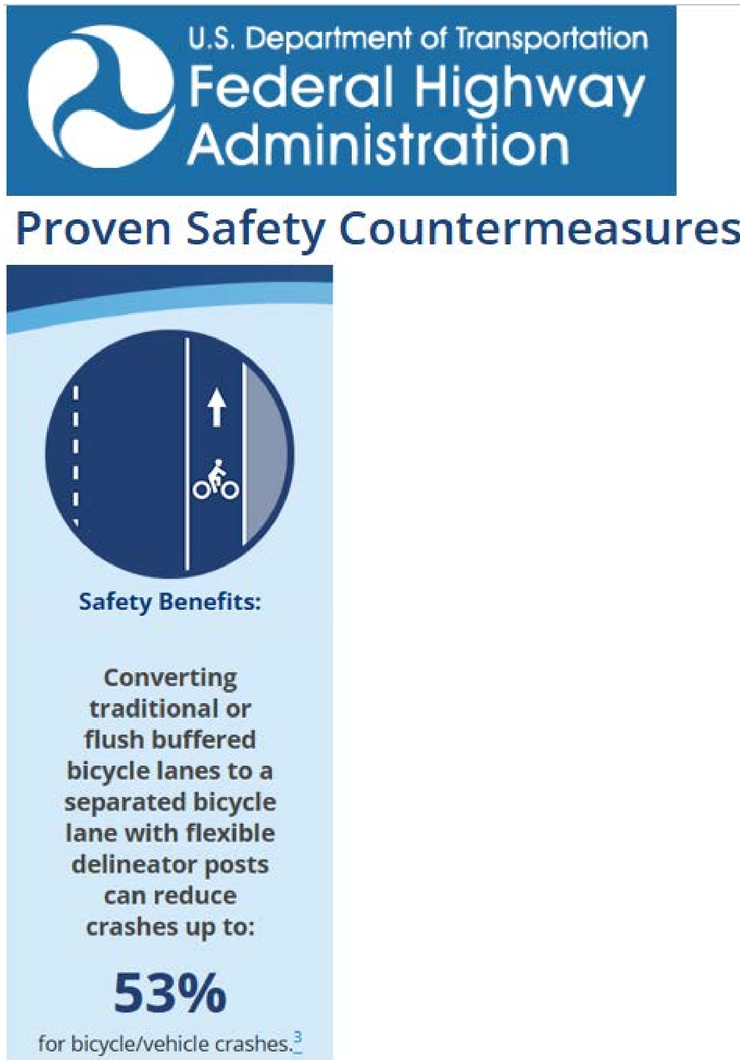

Figure 2. Additional FHWA marketing regarding SBLs posted on Facebook and elsewhere.

Figure 3. Figure K.4 from the SANDAG draft 2025 Regional Plan.

Roadway Context				All Ages & Abilities Bicycle Facility
Target Motor Vehicle Speed*	Target Motor Vehicle Volume (ADT)	Motor Vehicle Lanes	Key Operational Considerations	
Any		*Any*	*Any of the following:* high curbside activity, frequent buses, motor vehicle congestion, or turning conflicts‡	**Protected Bicycle Lane**
< 10 mph	Less relevant	No centerline, or single lane one-way	Pedestrians share the roadway	**Shared Street**
≤ 20 mph	≤ 1,000 – 2,000		< 50 motor vehicles per hour in the peak direction at peak hour	**Bicycle Boulevard**
≤ 25 mph	≤ 500 – 1,500			
	≤ 1,500 – 3,000	Single lane each direction, or single lane one-way	Low curbside activity, or low congestion pressure	**Conventional or Buffered Bicycle Lane, or Protected Bicycle Lane**
	≤ 3,000 – 6,000			**Buffered or Protected Bicycle Lane**
	Greater than 6,000			**Protected Bicycle Lane**
	Any	Multiple lanes per direction		
Greater than 26 mph†	≤ 6,000	Single lane each direction	Low curbside activity, or low congestion pressure	**Protected Bicycle Lane, or Reduce Speed**
		Multiple lanes per direction		**Protected Bicycle Lane, or Reduce to Single Lane & Reduce Speed**
	Greater than 6,000	*Any*	*Any*	**Protected Bicycle Lane**
High-speed limited access roadways, natural corridors, or geographic edge conditions with limited conflicts		*Any*	High pedestrian volume	**Bike Path with Separate Walkway or Protected Bicycle Lane**
			Low pedestrian volume	**Shared-Use Path or Protected Bicycle Lane**

Source: NACTO

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Acknowledgments

Thanks to John Allen, Karl Rudnick, Mighk Wilson, and Ron Medak for critical review of the manuscript.

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