



Linea Laird as project manager for the new Tacoma Narrows Bridge. *Washington State Department of Transportation (WSDOT)*

LINEA LAIRD

ENGINEERING HISTORY

Linea Laird's eyes light up when she recalls traversing catwalks and cables, the wind tugging at her hard hat and goggles, as the new Tacoma Narrows Bridge took shape next to its older fraternal twin. As graceful as the Golden Gate, the fifth longest suspension bridge in the U.S. was completed in 2007, under budget and only a few months late despite unforeseen challenges and assorted surprises.

Laird was the project manager for the Washington State Department of Transportation. The bridge was her baby. "It was just a whale of a lot of fun doing it," she says with a grin. What's more, as every structural engineer knows, nothing beats the realization that what you've built likely will be standing long after you're six feet under. Failure, on the other hand, has an unlimited shelf life. The engineers for the ill-fated original Tacoma Narrows Bridge, which oscillated into oblivion in a 1940 windstorm, were haunted by its collapse. Laird's team had to work around the barnacled remains of "Galloping Gertie."

Chances are you've never heard of Linea Laird, despite the fact that she is one of the most accomplished highway engineers in the history of the Washington State Department of Transportation. The limelight isn't her style. Simultaneously self-effacing and self-confident, she likes talking about collaboration, not herself. "I had amazing mentors and great colleagues in my 38 years at WSDOT," she says. "A lot of them were women, but there were also remarkably supportive men."

Up front, in a sort of for-the-record moment, Laird volunteers that she doesn't have a college degree. But neither does Bill Gates. A summer job with WSDOT in 1979 led to the offer of a fulltime job. She decided to forgo her final year of engineering school. Her husband, Mike, whom she met at Montana State University, had already graduated and landed an engineering job at the Puget Sound Naval Shipyard in Bremerton. She decided she wanted to move up the WSDOT career path. The Lairds had a 3½-year-old and another child on the way when, after countless hours of studying, Laird passed the rigorous tests to become a licensed engineer. "I work hard," she says. "I don't like not being on top of a situation."

Laird's career at WSDOT was punctuated by calm oversight of costly, complicated projects, including the Narrows Bridge, the Alaskan Way Viaduct replacement and Highway 99 tunnel. In 2018, when Mayor Jenny Durkan needed

an interim director for the beleaguered Seattle Department of Transportation she summoned Laird, who had just retired from WSDOT. A long-planned vacation was postponed.



Laird as administrator of the Alaskan Way Viaduct Replacement Program in 2011. *WSDOT*

“The people at SDOT couldn’t believe Linea,” says Doug MacDonald, the plain-talking former state Secretary of Transportation. “She came in with a no-nonsense attitude and a sense of collaboration. Engineers who had been horrendously stifled were hugely gratified to find somebody in the corner office who could speak their language and produce answers on an asked-for accountability.”

Laird was not among the first women who broke through in the engineering ranks at WSDOT, MacDonald says, but she emerged early on as someone with major potential. Notably, she was preceded by Paula Hammond, who in 2007 succeeded MacDonald as secretary of transportation, and Lorena Eng, the former Northwest Region administrator. As the final financing plans for the Narrows Bridge took shape, Laird also found an ally and friend in Amy Arnis, WSDOT’s highly regarded chief financial officer. “Those bright women were among Linea’s role models in highways management,” MacDonald says. “It’s unsurprising that Governor Chris Gregoire became an admirer. . . . Linea has a steel-trap grasp of what she’s doing—about how to mobilize a team to complete a project. She’s a problem solver with a low tolerance for BS. Linea Laird cannot be shined.”

“WOMAN NAMED HIGHWAY ENGINEER.” The 1993 headline in the *Sun*, Bremerton’s daily newspaper, announced Laird’s promotion to Kitsap County project engineer for the Washington State Department of Transportation. Twenty years later when Laird became WSDOT’s first female chief engineer, that milestone was barely mentioned. To Laird, that’s a clear sign of progress, but she emphasizes that she experienced no significant gender discrimination during her years at WSDOT. That may say as much about her competence and confidence as the evolving culture of the Washington State Department of Transportation. Nationally, however, despite the growing demand for science-technology-engineering-math graduates, female engineers still routinely face gender bias in addition to the challenges of achieving work-life balance as working moms, according to recent studies. Stephanie Slocum,

an East Coast structural engineer with three young daughters, explores the issue in a 2018 book called *She Engineers*. Slocum stresses the importance of female role models and mentors.

Today, the 26 female licensed engineers at WSDOT represent 24 percent of the total, according to the agency’s human resources department. That’s on par with the numbers of women receiving engineering degrees nationally, yet in 2018 only 14 percent of the civil engineering workforce in America was composed of women. The good news is that some of the nation’s top engineering firms are now aggressively recruiting women. Still, the myth that women are too “fragile” or otherwise temperamentally unsuited to the construction industry lingers.*

John Conrad, Laird’s boss when he was an assistant secretary of WSDOT, remembers an incident that occurred a few years ago: “I think Linea may have been the only woman state maintenance engineer in the country—or at least at the national meeting we were attending together. One night at a dinner gathering, the chief engineer from Missouri made reference to me ‘and my wife.’ I said, ‘She’s not my wife—she’s our maintenance engineer.’”

LAIRD HAS UNDERSTOOD the importance of maintenance since childhood. Born in 1957, she grew up in the heart of Alaska, one of five kids in a close-knit Fairbanks family that loved camping and fishing. Linea, her sister and three brothers were expected to be resourceful—to have after-school jobs but still do well in school. She worked at a movie theater before landing a job at a grocery store, working before school, after school and weekends. She excelled in math and science.



Lathrop High School, Fairbanks, Alaska, 1973

Her dad was a carpenter. Maybe that’s why she likes to build things. Her first car was a second-hand, red ’64 Ford Mustang. She learned to drive a stick-shift, change the oil and fix flats. She’s feminine and not very tall, 5-3 to be exact, but when she graduated from high school in 1975 and set out to raise money for college, she and a chum went to the laborer’s union hall to apply for a job on the Trans-Alaska Pipeline. “We goofed around for a couple of weeks, but when we went back they called our numbers. We looked at each other and thought, ‘Oh my!’”

Laird discovered that about 10 percent of the pipeline workers were can-do women. Some may have been the grandchildren of “Rosies” who riveted ships and

* Between 2017 and 2018 the number of women working in construction trades—well-paying jobs—increased by nearly 18 percent, “but women remain strongly underrepresented in the trades: fewer than one in 20 (3.4 percent) of construction trades workers in 2018 were women,” according to the Institute for Women’s Policy Research.

bombers during World War II. “None of the work I did was very technical,” Laird remembers. “It might be power washing vehicles. It might be shoveling gravel to leveling out platforms. There was graded area, like a big graving dock, where we tied rebar for metal forms that got set over the pipeline in areas where they crossed rivers. ... We were up in the camps eight weeks or more at a time, working 10 to 12 hours a day, seven days a week before we’d get a break. My take home pay was about \$750 a week, so I was very lucky to pay my way through college without being a burden on my parents.”

Without ever visiting the campus, she chose Montana State University at Bozeman, a compact little city in a picture-perfect valley rimmed by craggy mountains. “I looked at some of the pictures and said, ‘Wow, this kind of looks like Alaska! I think I’d be comfortable there.’ And I was.” Montana State’s engineering school was first-rate. One of her fellow students was her future husband.

Her timing was also right when she joined the Washington State Department of Transportation in Kitsap County. It was the 1980s “and there was a big push for women to be hired,” she remembers. “It came with a little bit of curiosity and a little bit of angst about whether women were going to be disruptive to an all-male engineering office. But we proved we were capable professionals—good teammates.”

Laird loved construction engineering technology, largely a man’s world at the time. “I liked the outdoor side of things. I liked the *building* side of things—the surveying and fieldwork. I think it was because of my trades work up on the Alaska pipeline.”

For Laird, being state maintenance engineer, was “so much fun.” It was—still is—a male-dominated niche, but here and there across America female engineers were demonstrating they understood potholes and expansion joints—or as Doug MacDonald puts it, “She cut her teeth doing the old-fashioned go-get-the-asphalt-laid-on-the-ground deal.” Laird smiles when she hears that line. “As a state maintenance engineer, you divvy out the budget to get stuff done. But the people in the regions don’t report to you. So you have to use all of your collaborative tools to create the right policy and bring people along. I was not uncomfortable in that world because of the trade work I had done.”

IN 1999, as WSDOT’s Olympic Region engineering manager for the proposed new Tacoma Narrows Bridge, Laird helped sort out the contract language and plans for the \$800 million project. The new bridge generated substantial local opposition. “There were many public meetings during the environmental and design phase—crowds of unhappy people,” Laird remembers. “Some did not believe it would solve the traffic issues. Besides, they didn’t want to pay a toll. They felt that was unfair. It wasn’t about improving the safety of the route with a beautiful new bridge to expedite traffic. It was about disruption. It was about being tolled. Some of the locals felt we were just jamming it down their throats.”



Linea and Lloyd Brown, WSDOT's Communication Director, high atop the new Tacoma Narrows Bridge. Catwalks and cables are under construction in the background. *WSDOT*

The project started out as a public-private partnership, with WSDOT as a stakeholder. Then things got complicated in a hurry. After a legislative U-turn, tedious number-crunching and environmental impact statements, the job finally moved forward. It had become, in the parlance of WSDOT, a negotiated “Design-Build” project where the state executes a contract with one firm for design and construction services. But someone from the state still has to be the big boss on site to work with the design-build contractor.

“We executed a contract in the fall of 2002, relying on permits that had already been procured,” Laird remembers. “The project amounted to cross walking two worlds between the public-private developer agreements and the negotiated design-build contract. Then Doug MacDonald said, ‘By the way, I want you to be the project manager and run this thing.’”

Laird has nothing but praise for Tacoma Narrows Constructors, a Bechtel-Kiewit joint venture, and her WSDOT team.

BRIDGING THE NARROWS for the third time in 60 years involved reviewing historic engineering mistakes to ensure they weren't repeated. In 2017, Craig Holstine, an historian with WSDOT's Cultural Resources Program, wrote an award-winning article on the history of the first span. Here's the genesis of “Galloping Gertie”:

Residents on both sides of Puget Sound's narrowest point between Tacoma and the Kitsap Peninsula had long dreamed of replacing the outdated ferries that crossed the rushing tides there with a bridge. Automobile popularity in the 1920s, along with advancements in suspension bridge technology, fueled interest in a bridge. ... As war loomed overseas, defense facilities around Puget Sound grew in size and importance, and a highway connecting Fort Lewis with the Bremerton Naval Shipyards became a national defense priority. But federal funding remained elusive, despite New Deal stimulus.

On August 14, 1937, however, U.S. Senator Homer T. Bone, a Democrat from Tacoma, wrote to Lacey Murrow, the dashing young director of the State Highways Department: “If there is any possible way that we can secure funds for the Narrows Bridge we are going to try to do it.” The announcement by the Washington Toll Bridge Authority that Murrow was heading to the other Washington to apply for federal funding prompted “the biggest celebration in Tacoma’s history.” Funds secured, the bridge was completed in record



The original Tacoma Narrows Bridge opens on July 1, 1940.
Washington State Archives

time—“barely 19 months, about half the normal construction time for a bridge of its size and type,” Holstine notes. An estimated 10,000 people gathered at the span the day it opened, July 1, 1940. Unfortunately, the federal Public Works Administration had rejected as too costly the plan proposed by Murrow’s lead engineer, opting instead for “a sleeker, lighter, cheaper design by one of the nation’s leading suspension bridge engineers,” Leon Moisseiff of New York City. Almost immediately the suspended center span began to vibrate whenever the wind whipping through the Narrows kicked up, which is to say often. New anchoring cables helped a bit. But the clock was ticking

on catastrophe. No one has summed it up better than Holstine:

“On November 7, 1940, at 11:02 in the morning, after a half-hour of severe movement in winds over 42 miles per hour, much of Galloping Gertie’s main span fell into Puget Sound. A victim not of unforeseen gale-force winds but of design flaws, Gertie became the most infamous failure in bridge history. Its plate-girder deck, acting as a sail in moderate breezes, created a vortex of swirling wind force contributing to a ‘torsional flutter’—or twisting motion—that became self-generating. The bridge’s



“Galloping Gertie” collapses on November 7, 1940. *James Bashford/The Olympian*

extremely light, flexible construction offered little resistance to the torsional forces that a more conventional stiffening deck truss would have provided.”

Wartime necessities delayed construction of a replacement span. The new bridge finally opened in the fall of 1950. Though its stability is a testament to the lessons learned from the first span’s death spiral, Laird says the designers of the \$849 million third span revisited the issue of suspension bridge structural aerodynamics: “We went with the TNC team to Ottawa and put a model of the new bridge in a wind tunnel. The collapse of ‘Galloping Gertie’ created a whole new segment of engineering.”

A stable span was Job One. Aesthetics were also hugely important, Laird says. In constructing a parallel landmark, “we had to have a bridge that could not be an exact replica, because then you diminish the historic significance of the original span. Being a half century newer, it had to meet modern standards but also complement what was already there. That was a darn big deal.”

While Gertie’s ghost haunts the Narrows, her earthly remains, some 260 feet below the surface, also represented a challenge. The debris field from the 1940 disaster was added to the National Register of Historic Places in 1992. It’s now home to “a wide variety of sealife, ranging from giant octopi and wolf eels, to sea bass and salmon sharks.”

“We had to take great care to ensure that the caissons (piers) for the bridge towers did not disturb the remains of the original bridge. I had some interesting meetings with the state archeology and preservation director,” Laird says.

Meanwhile, each day some 90,000 sidewalk-superintendents in the form of



The second Tacoma Narrows Bridge was built in 1950. *Michael W. Siegrist, State Library Photo Collection, Washington State Archives*

motorists were driving past the project. MacDonald gave the media wide access to the undertaking. “I told her it would be an incredible opportunity to showcase the project,” he remembers with a chuckle. “But if something goes wrong there’s no curtain to hide behind.”

The cables from which the bridge span is suspended are fashioned from strands of wire, each about the thickness of a No. 2 pencil. That facet of suspension bridge technology hasn’t changed much from the process invented in the 1870s by John and Washington A. Roebling for the construction of the Brooklyn Bridge.

In 2005, “when they unwrapped the paper on some of the spools from South Korea, they discovered the wire was corroded,” MacDonald says. “What do we do now? The public is watching. And you’ve invited them to watch everything you’re doing. You can’t say ‘Go away for about six months. We have this little problem to deal with!’ Linea and her team worked through the problem with Tacoma Narrows Constructors. The long and short of it was that the integrity of the bridge was not compromised. The way she handled that scrutiny was a big evolution in the development of a seasoned project engineer. And when she ended up in Seattle to rescue the tunnel and viaduct program, she brought that experience to a very public project. She played a hugely positive role in those three landmark projects.”

Amy Arnis, whom MacDonald describes as “the smartest person in Olympia you’ve never heard of,” was WSDOT’s chief financial officer when the tricky financing for the new bridge was being ironed out. “One of the things I came to appreciate about Linea is her attention to detail,” Arnis says. “I had so much confidence that she knew that contract inside and out, chapter and verse. I was fielding lots of questions about the project from the State Treasurer and various financial institutions. On

the mornings of the bond sales I could call Linea at 6:30 a.m. on my way to the Treasurer’s Office and be confident I’d get the answers to the questions I knew I’d be asked. There’s another thing, too: Working in the finance end of WSDOT, I didn’t get many chances to watch what happened in the engineering office or at a construction site. She invited me to team breakfasts. I got to see how she built her team. I thought that was so cool. And it speaks volumes about what kind of leader she is.”

On July 15, 2007, 60,000 people turned out for the dedication of the new bridge. It was the



Cutting the ribbon to open the new Narrows Bridge in 2007. Doug MacDonald at right. WSDOT

culmination of years of effort from the design-builder and WSDOT. “I was so proud of the teamwork that created a beautiful landmark bridge that will be in place years beyond my lifespan,” Laird says.

LAIRD NEXT BECAME WSDOT’s state construction engineer, representing the state on national committees for highway planning research and construction. In 2009 she became “intricately involved” in the design-build contract for the controversial Highway 99 tunnel designed to replace Seattle’s Alaskan Way Viaduct. The landmark elevated roadway was judged to be vulnerable to a major earthquake.

Some said a tunnel could crack in a quake or become a big-bore inferno if a multiple-vehicle collision ignited gas tanks. Others worried that structures above the route could be damaged by the boring. One study warned that if toll rates were set high enough to foot the bill, thousands of motorists would “avoid the tunnel and cram into downtown streets.”

In other words, it was a high-profile political and engineering environment.

“I knew almost as little about tunnels as I’d known about suspension bridges when I started on the Tacoma Narrows project,” Laird says, with a sort of here-we-go-again smile. “I mean, it’s not like the state digs a complicated, landmark tunnel every few years. And this project is right in *downtown* Seattle. It’s incredibly complicated. There is very little room for staging construction equipment, and the project goes right through the heart of the city under an array of complicated buildings. The route included very poor soils. What’s more, we didn’t own the property underground where this huge tunnel was going to be created, so we had to develop agreements with all the property owners along the way. Meanwhile, the City of Seattle also has a vested interest in the work you’re doing and protecting all of its interests. It saw itself as a regulatory oversight body. While projects come and go, the city remains and lives with the results.”

While navigating a thicket of contracts, Laird’s team worked with the city, King County, worried state legislators, impacted business owners and numerous other stakeholders, including the conflicted public. “Paula Hammond, my boss and mentor for years, was WSDOT’s secretary of transportation when the project started, so I knew her door was always open,” Laird says. “She’s whip smart and so on top of things. She



With “Big Bertha,” the gigantic machine boring the tunnel to replace the viaduct. WSDOT



FHWA Administrator Victor Mendez, WSDOT Secretary Paula Hammond and Governor Chris Gregoire chat at the Aug. 10, 2010, opening event for the Smarter Highways system on I-5 in Seattle. *WSDOT*

not only understands the engineering side of things, she understands the political side of things. And she has devoted her career to paving the way for women in professional careers. The tunnel wouldn't have happened without Paula's leadership, but it was really Governor Gregoire who pushed it through. Her persistence and skillset for problem solving are something else."

In the fall of 2011, when Ron Paananen, WSDOT's project manager for the \$3.1 billion viaduct replacement project, departed for the private sector,

Laird was handed full oversight for the biggest assignment of her career.

On Laird's watch, contracts were awarded, the southern mile of the viaduct was demolished and work began in Japan on construction of the world's largest tunnel-borer. The mammoth machine—57½ feet in diameter and more than 300 feet long—was dubbed "Bertha" in honor of Seattle's first female mayor, the redoubtable Bertha Knight Landes. Two schoolchildren won a WSDOT contest to come up with the best name. At the time, Laird conceded that "Bertha" might not be the prettiest name, but she said it conjured up something that was big, solid and had a "down-home" quality. She had no inkling that "Bertha" was going to conjure up big down-home trouble.

The delays and controversies that dogged the project for more than two years, including Bertha's litigious big breakdown, unfolded after Laird had moved on. She was named WSDOT's chief engineer in 2013 by the new secretary of transportation, Lynn Peterson, who was similarly dedicated to providing career opportunities for women.

The viaduct replacement project was back on track in 2017 when Laird interrupted her short stint as a retiree to answer Mayor Durkan's call to serve as interim director of the Seattle Department of Transportation. The job came with a mandate to help provide modal pathways during the next several years of intense citywide construction. Completion of the tunnel was just one phase of the transition. Viaduct demolition and waterfront construction would come next, as well as an expanded Convention Center, the major renovation of Key Arena, the City Center Street Car and several Sound Transit projects. Laird's mandate was to keep the "Move Seattle" levy projects moving.

"It was four intense months. I appreciated getting to work with the SDOT team and feeling like I could contribute to problem-solving, even in such a short



Linea, left, and other key players pose for a “Women in transportation” photo at the tunnel breakthrough event in 2017. The others, from left are state Representative Judy Clibborn; Patty Rubstello WSDOT’s assistant secretary for Urban Mobility & Access; Paula Hammond, former Secretary of Transportation; Megan Cotton, WSDOT Tribal and Federal Relations Director, and Allison Camden, WSDOT Intergovernmental & Tribal Relations Director. *WSDOT*

timeframe. I learned that Jenny Durkan is intensely focused on making good decisions for the city while still maintaining a sense of humor. That’s a tall order. I came away with the conclusion that she is an amazing leader.”

It was time to retire—again.

Linea and Mike Laird, currently working on a bigger boat-shed, have three children—two daughters and a son. Daughter No. 1 is an accountant; Daughter No. 2 a nurse. Their brother is a mechanical engineer. “I have very independent and greatly balanced children,” Laird says with pride. “My career required a lot of travel—and many days with long hours. My husband bore a lot of the brunt of the day-to-day stuff. That allowed me to have the career I had. It was incredibly fulfilling. I do miss being part of a great team and playing a role in supporting transportation. The future holds many opportunities, especially for women in STEM careers.”

John C. Hughes
Legacy Washington

LINEA LAIRD SOURCE NOTES

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