Engineering Transformations of the New York Canal System

Long-Term Environmental and Public Health Implications

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Rivers, floodplains and engineered waterways

The Hudson, Mohawk and Passaic rivers drain much of the northeastern United States.

Their low-lying floodplains were once subject to seasonal flooding without engineered constraints.

Canals, channels, levees, locks, dams, floodwalls and reservoirs transformed these river systems into an economic engine.

The Hudson–Mohawk River basin

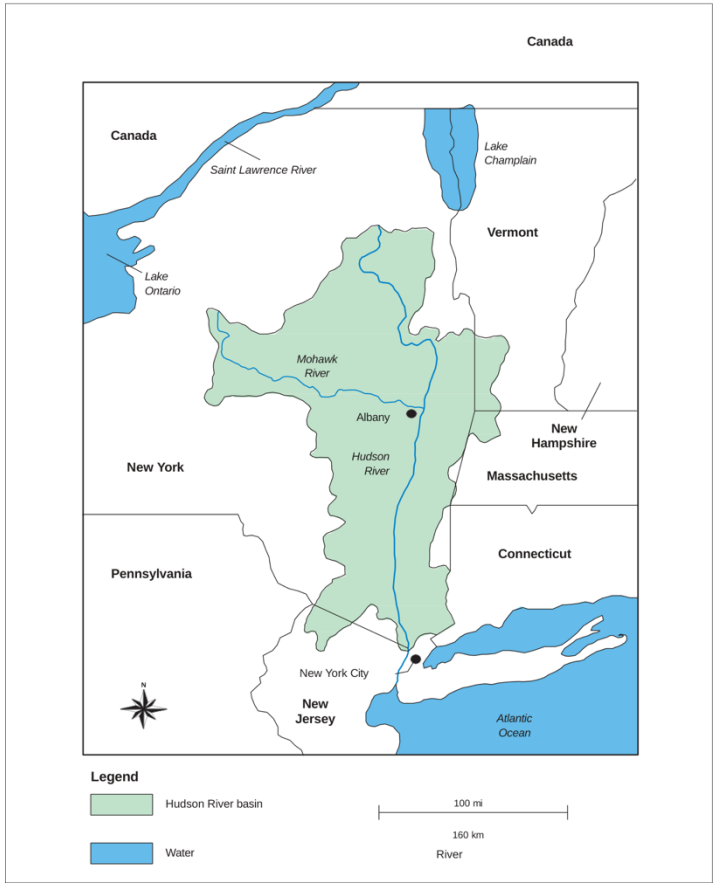

Figure 1. The Hudson and Mohawk River basin in New York State.

Objectives of the study

Examine the changing Hudson, Mohawk and Passaic river landscapes and systems.

Review the impacts of climate, manufacturing, channel construction, economic and population growth, and pollution.

Assess engineering interventions and recommend management that protects soil and water while balancing social, economic and ecosystem needs.

Case study 1 / The Hudson River

Water supply and transport capacity helped the Hudson River fuel the Industrial Revolution of the 1800s.

The river carried raw materials and finished goods.

Settlements and industries flourished, creating jobs, expanding communities and supporting regional and national prosperity.

Rivers and canals meet near Troy



Figure 2. Hudson River (background), Mohawk River (far right) and Erie Canal (front and centre), near Troy, New York.

PCB manufacturing on the Hudson

Two General Electric capacitor plants operated at Fort Edward and Hudson Falls, north of Albany.

PCBs were used in their production processes from 1947 to 1977.

Industrial pollution left a lasting mark on a river celebrated for its beauty and pristine waters.

Polychlorinated biphenyls (PCBs)

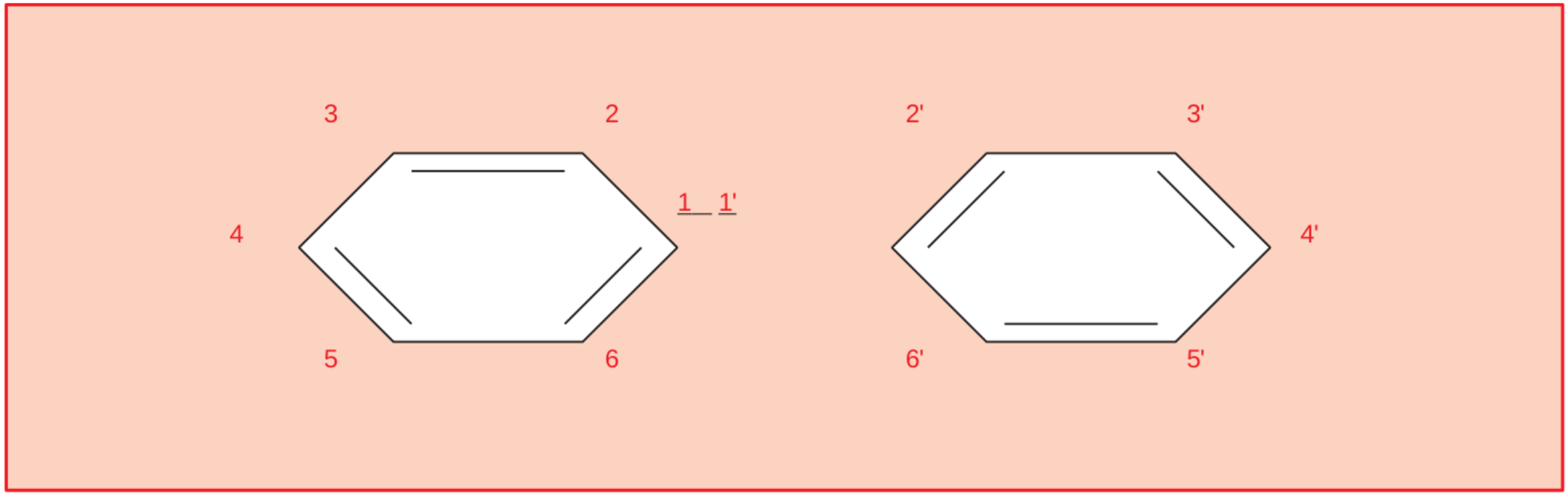

Figure 3. Biphenyl numbering system. Replacing some or all of the ten hydrogens at positions 2–6 and 2′–6′ with chlorine creates PCB congeners.

The Passaic River and Newark Bay

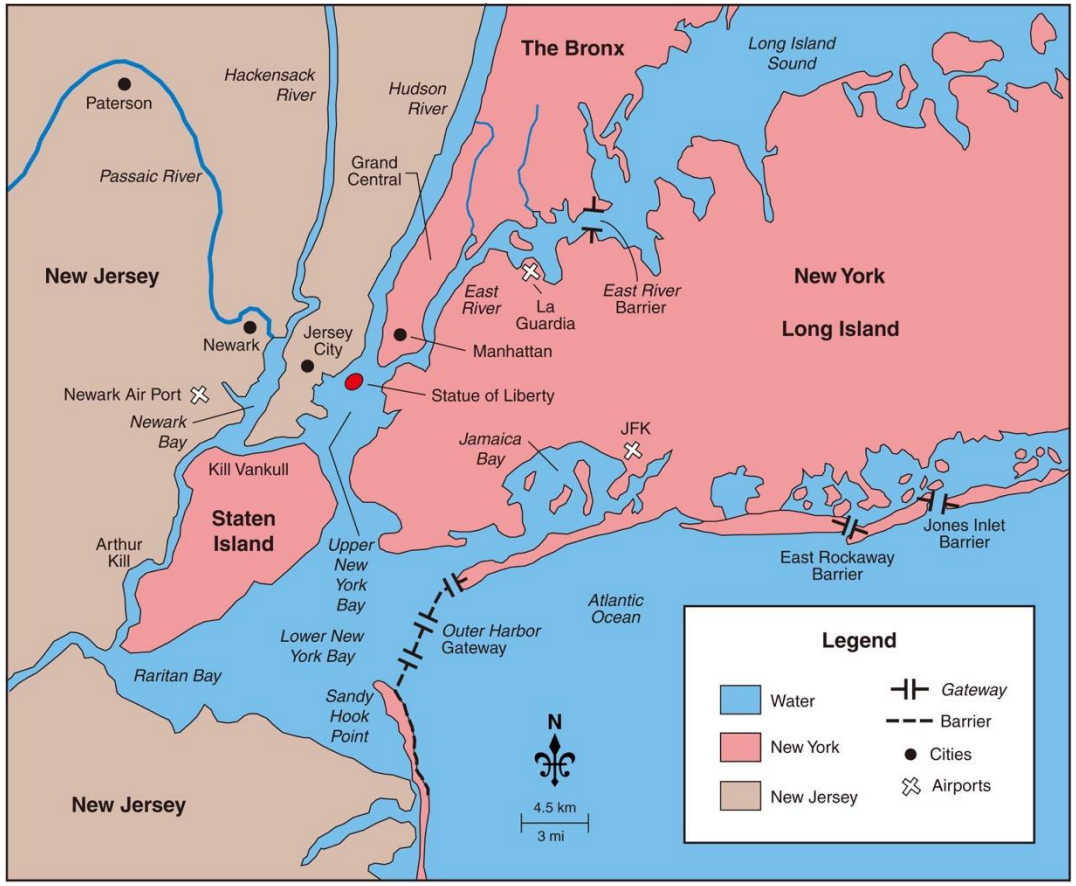

Figure 4. The 27 km Passaic River dioxin hotspot and its connection to Newark Bay and the Atlantic Ocean. Map: Mic Greenberg. Reproduced with permission from the Editor, Open Journal of Soil Science.

PCBs: ecological and public health impacts

Recreational fishing was banned from 1976 to 1995; a fish consumption advisory remains in the contaminated reach.

Over 90% of ducks tested in 2008 downstream of the GE plants exceeded the reported FDA tolerance for PCBs in fatty tissues.

In 1984, the USEPA designated 322 km of the Hudson River a PCB Superfund site.

Fishing on the lower Hudson



Figure 5. Recreational fishing boats south of the Troy Federal Dam. A fish advisory cautions against consuming fish from the contaminated reach.

The Hudson River PCBs Superfund site

Industrial PCB pollution created a lasting environmental legacy.

In 1984, 321 km of the Hudson River was classified as the Hudson River PCBs Superfund site—one of the largest in the country.

Under USEPA oversight, industry and government have spent billions of dollars cleaning up waste sites and the river.

Case study 2 / New York State Canal System

Reengineered waterways became an economic engine for New York State.

Canals and channels were combined with levees, locks, dams, floodwalls and reservoirs.

The canal system was dug through uplands from the Mohawk River to Lake Erie and Lake Ontario.

The New York State Canal System

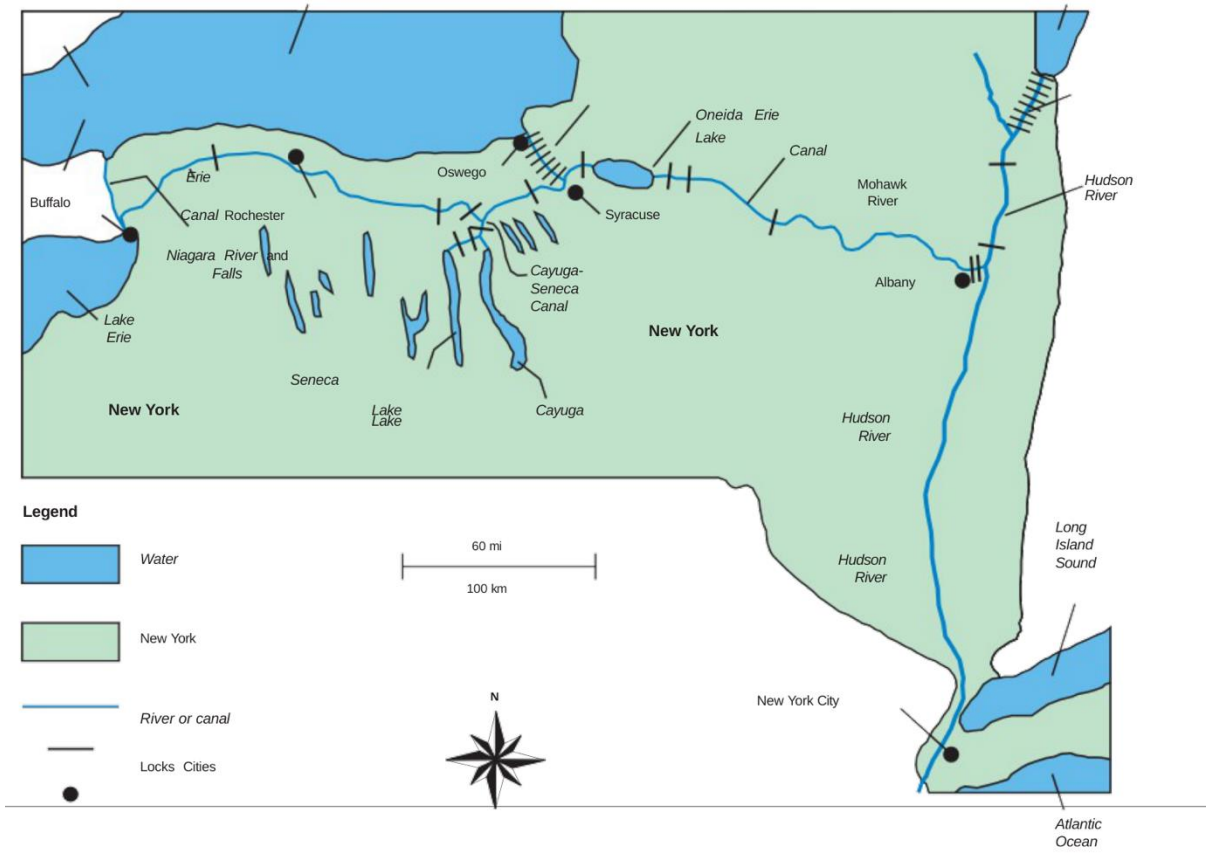

Figure 6. Built and enlarged from 1817 to 1880, the system links Buffalo and Lake Erie to Albany, the Hudson River, Lake Champlain and the Atlantic port of New York.

Connecting inland and coastal waterways

Upland canals connected the Mohawk River with Lake Erie and Lake Ontario.

The Kill Van Kull channel was dredged and deepened between Newark Bay and New York Bay.

This coastal route connected the Passaic and Hudson river systems.

Palmyra Lock 29



Figure 7. Closed gates at Palmyra Lock 29 create slack water as canal boats approach from the east.

East Kill Van Kull

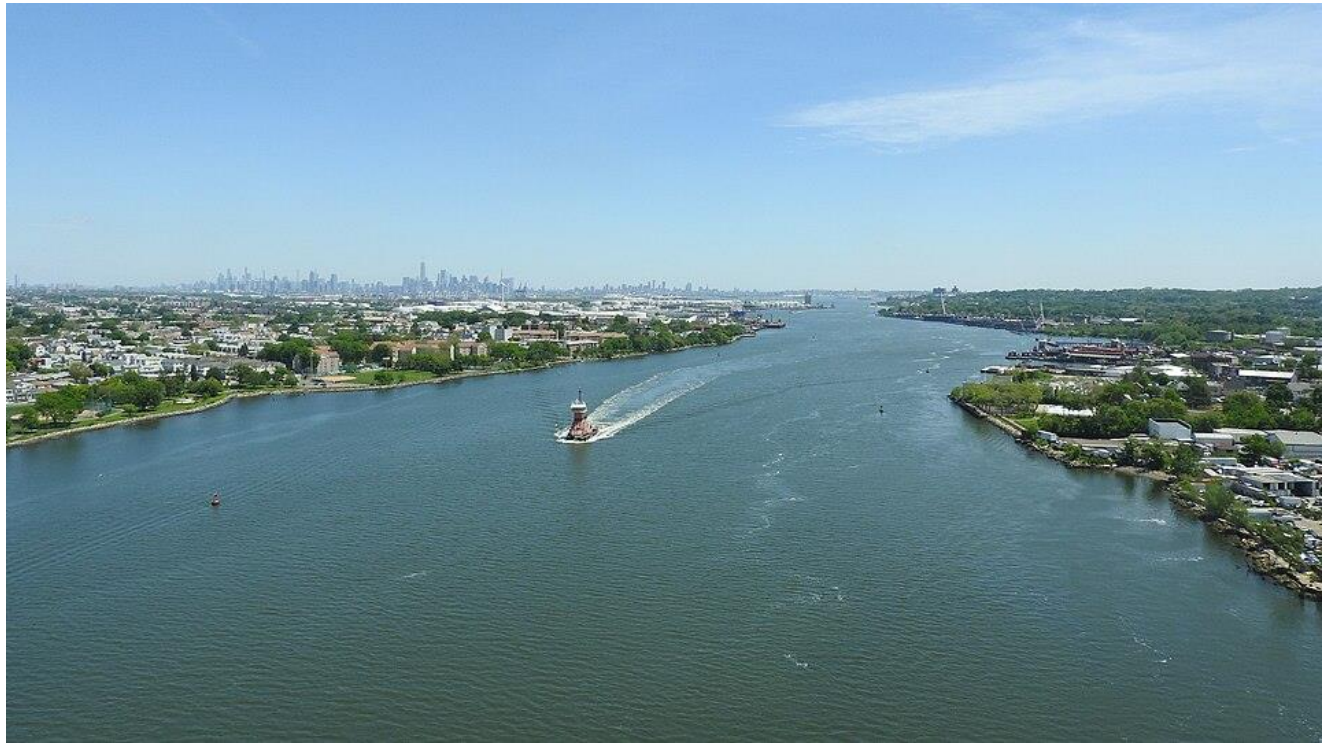

Figure 9. East Kill Van Kull. Photo: Jim Henderson.

Shipping through New York Bay



Figure 8. Ships waiting in New York Bay to enter Kill Van Kull. Photo: Jasmile.

Diamond Alkali: occupational exposure

Diamond Alkali began manufacturing Agent Orange in the 1950s.

Workers testified in court that they were exposed to the manufacturing by-product dioxin TCDD.

They described factory floors in the 1950s and 1960s as dangerously slick with spills and leaks of Agent Orange and TCDD.

Contamination identified in 1983

New Jersey and USEPA sampling found high TCDD levels near 80 Lister Avenue, Newark, and in Passaic River sediments.

The investigation identified contaminated soils as well as river sediments.

High levels of PCBs and mercury were also associated with the manufacture of other chemical products.

Cleanup of the Lister Avenue site

In 2001, the USEPA worked with New Jersey and other federal agencies to clean up the manufacturing site.

The building was demolished and its materials taken to a landfill.

Dioxin-contaminated soil was removed and incinerated; the site became a gravel parking lot.

The former Diamond Alkali site



Figure 10. The former Diamond Alkali site on the Passaic River. Building materials went to landfill; contaminated soil was incinerated. Reproduced with permission from the Editor, Open Journal of Soil Science.

A 27-kilometre dioxin hotspot

Chemical pollution left a 27-kilometre dioxin hotspot in the Passaic River.

Dioxin attached to sediments moving toward the Atlantic Ocean through Arthur Kill and Kill Van Kull.

Diamond Alkali's Newark facility manufactured Agent Orange for use as a defoliant during the Vietnam War.

Manufacturing workers and their families

Agent Orange was manufactured at seven locations in the United States and one in Canada.

Plant workers were exposed to dioxin TCDD during the manufacturing process.

Workers and their families continue to live with the consequences of the early 1960s decision to use tactical herbicides in Vietnam.

Tactical herbicide production in North America



Figure 12. Eight Agent Orange plants, the primary Agent Blue manufacturing site and two Gulf of Mexico shipping ports. Map: Cruz Dragosavac.

Health effects and sediment remediation

Doctors linked dioxin TCDD exposure to chloracne and cancers in chemical plant workers.

A remedy for contaminated lower Passaic River sediments was selected in March 2016.

Removed dredge material was dewatered and transported by barge to a permitted sediment-processing facility for disposal.

Deepening the Kill Van Kull channel



Figure 15. Deepening the channel to 17 m. A USACE dredge removes debris from bedrock broken by dynamite. Photo: Bob King.

The long-term cost of remediation

The estimated cost of the selected remedy was US$1.38 billion.

Cleanup plans were still being developed for the remainder of Newark Bay and the lower Passaic River.

The USEPA estimated US$12 billion for cleanup and natural resource restoration of the lower 27 km of the Passaic River and Newark Bay.

Newark Bay / Bayonne Bridge

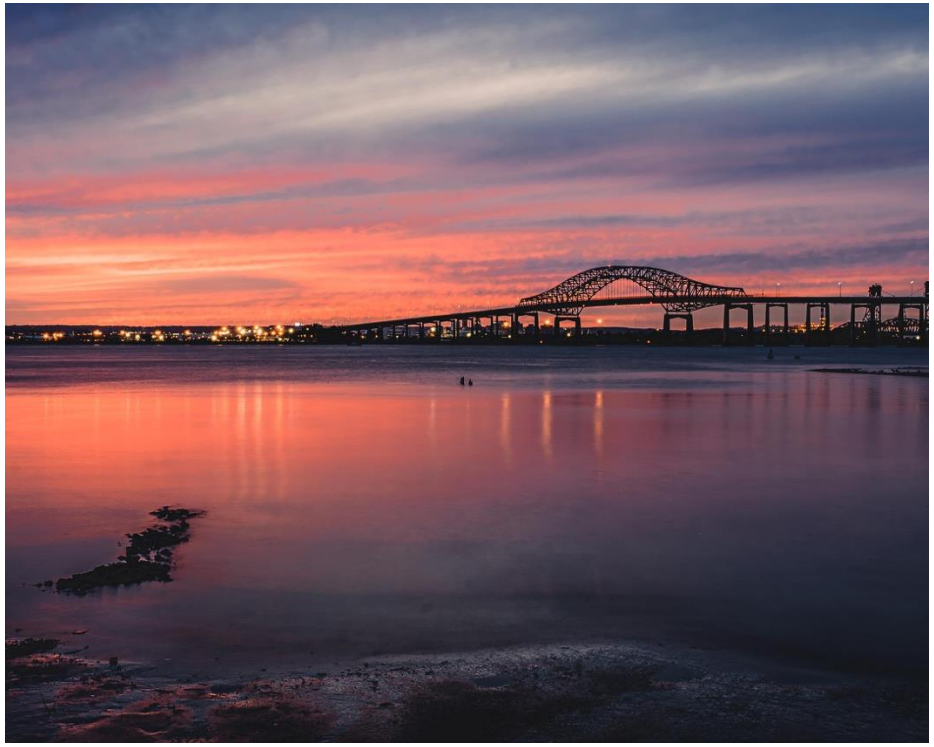

Figure 11. Bayonne Bridge viewed from Newark Bay at sunset. Photo: iStock.