

Cleveland Harbor-Interstate 90 Maritime and Freight Dominance

Benefit-Cost Analysis Narrative

Executive Summary

The Cleveland Harbor - Interstate 90 Maritime and Freight Fortification (CH-I90) is a 6.3-acre critical infrastructure initiative that will strengthen the long-term viability of maritime operations within Cleveland Harbor. The project provides an urgently needed and locally preferred facility for the beneficial use of dredged material, ensuring that sediment from the Cuyahoga River Federal Navigation Channel can be responsibly managed in compliance with federal and state requirements.

The foremost objective of the CH-I90 Project is to protect the economic integrity of the Port of Cleveland and the regional maritime industry it supports. Regular dredging of the Cleveland Harbor is essential to keeping this economic engine running, yet the region will exhaust its current dredge-material capacity by 2029 without the project. Without consistent dredging, vessels cannot reliably access the Cuyahoga River, placing at risk more than 13 million tons of annual cargo and over 23,000 jobs tied to the maritime economy. Due to the type of materials and essential American industries reliant on the Cuyahoga River, such as ship building and steel production, there is no holistic and viable alternative to maritime shipping.

Another major objective of the CH-I90 Project is to improve the physical resilience of I-90. The segment of I-90 protected by the CH-I90 Project is one of the most heavily traveled routes in Northeast Ohio, with an Average Annual Daily Traffic count (AADT) of 127,603 vehicles per day, including 5,105 trucks, providing access to 1,027,211 workers ([Ohio Department of Transportation Traffic Count Database – 2024 AADT](#)). It is designated as part of the National Truck Network and as part of the STRAHNET (Strategic Highway Corridor Network), designated by the US Department of Defense as essential to national defense. It is also a National Scenic Byway (Lake Erie Coastal Ohio Trail). U.S. Bike Route 30 (USBR30) is an existing separate facility parallel to I-90 directly adjacent to the north in this area.

As a nationally significant infrastructure investment aligned with BUILD program priorities, the CH-I90 Project ensures the Cuyahoga River remains navigable, maritime freight remains competitive, and the Port continues to function as a critical gateway for regional and national industry. By securing long-term dredge capacity, preserving reliable vessel access, and protecting adjacent Primary Highway Freight System (PHFS) routes, the project delivers essential resilience and continuity for the region's core freight network. By expanding long-term dredge capacity, preserving reliable vessel access, and protecting adjacent Primary Highway Freight System (PHFS) routes, the project delivers essential resilience and continuity for the region's core freight network.

Summary of Project Present Value of Costs and Benefits and BCR in Million \$2024

BCA Key Indicators	Unit	Results
Total Discounted Costs	2024 US\$	13.48
Total Discounted Benefits	2024 US\$	22.41
Net Present Value (NPV)	2024 US\$	8.93
Benefit/Cost Ratio (BCR)	-	1.66

Benefit-Cost Ratio: The **BCR for the Base Case is 1.66**. Given its substantial contribution to the overall project benefits, the preservation of maritime cargo transport through regular dredging stands as the primary economic justification for the CH-I90 Project. This conclusion underscores the argument that there is no viable alternative to river-based shipping for these materials. The cascading impacts of shifting to land-based shipping include cargo, job and revenue losses, increased infrastructure costs, and heightened pollution levels.

Net Present Value of the Project: NPV of the Project is estimated at **\$8,930,332**.

Total Discounted Benefits (discounted at 7.0%): The total discounted value of benefits was estimated at **\$22,409,752**.

Present Value of Benefits (discounted at 7.0%): The total present value of benefits was estimated at **\$24,842,078**. Modal diversion savings and prevented cargo losses are the predominant driver of these benefits, reflecting the significant transportation cost impacts that would arise if maritime freight were forced onto trucks. This analysis treats modal diversion as an appropriate and justified project benefit, as the No Build scenario would render the port nonoperational, and no viable transportation alternatives exist to absorb or preserve this economic activity.

Total Discounted Costs (discounted at 7.0%): The total discounted value of costs was estimated at **\$13,479,420**.

Present Value of Costs (discounted at 7.0%): The total present value of costs for the project is estimated at **\$15,918,790**.

Benefit-Cost Analysis Structure & Methodology

This benefit-cost analysis (BCA) was conducted for the Cleveland Harbor - Interstate 90 Maritime and Freight Fortification (CH-I90) to quantify the benefits of the CH-I90 Project as compared to the no-action (No Build) alternative. The objective of this BCA is to provide an assessment of the benefits of the CH-I90 Project (modal diversion, cargo loss, and resilience) when compared to Project's costs (capital, operation and maintenance expenditures) over the 30-year analysis period from 2026 to 2058.

This analysis has been prepared in accordance with U.S. Department of Transportation (DOT) guidance for BUILD grant benefit-cost analyses and follows standard economic BCA methodology for large infrastructure projects. It incorporates relevant guidance and data from USDOT, the U.S. Army Corps of Engineers, and studies and datasets from the Port of Cleveland, Cuyahoga County, and prior technical work completed for the broader CHEERS Project. For FY 2026, USDOT recommends that applicants present all cost and benefit values in 2024 dollars. Therefore, all values have been adjusted to this baseline accordingly.

This BCA framework includes:

- **Definition of the Base Case and the Project Scenario.**
 - a. The Base Case represents conditions without implementing the Project (i.e., "No Action").
 - i. The Base Case represents the reference point against which the incremental benefits and costs of the investment alternative will be measured.
 - b. The Project Scenario reflects the evaluation of impacts if the Project were implemented.

- **Identification and Quantification of Benefits and Costs.**

Benefits: A range of benefits was identified and quantified to the extent possible, adhering to the Department of Transportation's "Benefit-Cost Analysis Guidance for Discretionary Programs," released in December 2025. Benefits that could not be quantified were categorized as "non-quantifiable."

Costs: Regarding CH-I90's costs, the study adheres to standard practices and requirements, encompassing costs incurred during both the construction (Capital expenses) and operational (Operation and maintenance expenses) phases of the CH-I90 Project over the 2026-2056 analysis period.

 - All monetary values are expressed in constant 2024 dollars.
 - The time horizon for the BCA is 2026-2058, reflecting:
 - Planning & 100% Design early 2027;
 - Construction Period from 2027 to 2028;
 - Dredge Placement from 2028 to 2030;
 - Operation and Maintenance Covering 2030 to 2056; and
 - Benefit Accrual Period from 2028 to 2058.

- **Estimation of the Present Value of Benefits and Costs.** A real discount rate of 7.0% is applied to express future costs and benefits to present value terms per USDOT guidelines. Because all costs and benefits are expressed in constant dollars, no

escalation for general inflation or sector-specific cost growth is included, avoiding double-counting of price changes already embedded in the real discount rate.

- **Estimation of Net Present Value (NPV) and Benefit-Cost Ratio (BCR).** The Project's NPV and BCR are calculated by comparing the difference between the Base Case and the Project Scenario over the 2026-2058 analysis period. A BCR greater than 1 indicates that project benefits exceed costs, supporting economic viability.

Assumptions and Disclaimer

- This assessment is intended to illustrate the benefits of the CH-I90 Project over its implementation timeframe against the holistic cost estimate of the project.
- This assessment uses best available information, methods, and assumptions as of 2026.
- All costs and benefits are presented in constant 2024 US dollars and discounted to present value using a 7% discount rate in accordance with the national-level monetization value provided in the December 2025 USDOT BCA Guidance.
- This analysis quantifies and monetizes benefits where methodologies and data are available. Additional benefits are described qualitatively and not included in the BCR calculation.
- This assessment cannot account for future uncertainty. This report projects benefits into the future and inherently cannot guarantee the benefits described herein are actualized as described.
- Changes or delays to the phasing schedule utilized for this assessment will change the projected benefits accrued as outlined in this assessment.

1. Definition of the Base Case and Project Scenario

1.1 Base Case “No Action Scenario”

In the No Action scenario, dredging of Cleveland Harbor ceases in 2029 when existing confined disposal facilities reach their legal and physical limits. With no ability to place sediment—and with open-lake disposal prohibited under Ohio law (ORC 6111.32)—annual maintenance dredging stops entirely, triggering immediate and escalating navigational constraints throughout the Cuyahoga River Federal Navigation Channel.

Light-Loading and Modal Diversion Impacts

Reliable dredging is fundamental to the Port’s commercial operations. Each year, the Port removes over 225,000 cubic yards of sediment from the 5.9-mile channel, and since 2021 has generated more than 775,000 tons of dredged material for beneficial use.

This analysis assumes that once sediment begins accumulating in 2029, vessels will be forced to light load, reducing cargo efficiency and increasing transportation costs. According to the USACE *Economic Analysis for the Cleveland Harbor Dredged Material Management Plan* (2022), the average shoaling rate is approximately 1.3 feet per year. With the channel’s authorized depth at roughly 23 feet and its natural equilibrium depth at 16.8 feet, four years of shoaling would sharply reduce navigability. By 2032, the channel is expected to reach equilibrium depth, at which point large commercial vessels would no longer be able to enter or operate on the river—effectively ending deep draft maritime service.

As dredging halts in 2029 and channel depth declines, shippers would first experience light-loading, reducing cargo capacity and increasing port on transportation costs. According to USACE, each 1–2 feet of lost navigable depth imposes \$1.5 million to \$4.9 million in increased regional transportation costs driven by higher truck vehicle miles traveled, accelerated pavement wear, congestion, and increased crash risk ([United States Army Corps of Engineers Cleveland Harbor Fact Sheet](#)). Using the upper-bound estimate of \$4.965 million applied to the shoaling rate, this analysis assumes that from 2029–2031, maritime shipping remains operational but incurs annual inefficiency-related costs consistent with constrained navigation.

However, the region lacks the handling, storage, and roadway infrastructure necessary to absorb a largescale shift from maritime to truck freight. Accommodating this diversion would require major capital investments, potentially hundreds of millions of dollars, that are not currently feasible. In practical terms, the loss of dredging would lead not only to higher transportation costs but also to a breakdown in the region’s ability to move freight efficiently at all.

Loss of Navigability and Economic Disruption

The Port of Cleveland is one of the largest and most economically important ports on the Great Lakes, moving more than 13 million tons of cargo each year, supporting more than 23,000 jobs, and generating over 7 billion dollars in total economic value for Northeast Ohio (Ohio Maritime Plan).

Under the No Action Scenario, the Cuyahoga River reaches its equilibrium depth in 2032, rendering it inaccessible to large commercial vessels. This loss of navigability would produce direct cargo losses, with maritime-dependent industries unable to receive raw materials or

ship finished goods. This would result in direct job and revenue losses within the shipping industry and threaten land-based businesses reliant on maritime shipping.

The Port's maritime activities underpin a wide range of regional economic sectors that depend on reliable shipping access through Cleveland Harbor, including numerous manufacturing, commercial, and industrial operations, particularly the regional steel industry such as Cleveland-Cliffs and ArcelorMittal steel plants.

In 2022, critical minerals and other materials essential to the steel industry, such as iron ore and primary iron & steel products, made up nearly half of all inbound commodities and more than 96% of all outbound commodities at the Port of Cleveland.

Since steel and other heavy materials cannot be transported by truck or rail in Cleveland, these mills may be forced to close resulting in thousands of lost jobs and material. Given federal commitments to domestically produced steel, the inability to ship steel would severely disadvantage Cleveland-based mills and other businesses that rely on the port for both inputs and exports. This loss would have long-term regional impacts and put the Cleveland region behind for decades to come.

Health Impacts

This catastrophic impact on the maritime shipping industry and transition to land-based shipping would also have cascading environmental and health consequences. According to the International Transport Forum, ship-based freight movement is the most efficient form of commercial transport in terms of CO2 emissions. Road freight can produce over 100 times more CO2 to transport the same amount of goods over the same distance. In 2024, the USACE estimated that a shift to land-based transportation would increase emission rates by over 50,400 tons of particulate matter annually ([US Army Corps of Engineers](#)).

Increased CO2 and particulate matter emissions are direct contributors to air pollution and related health disorders such as asthma. This impact is already felt in Cleveland, which was ranked the 9th worst area in the nation for year-round particle pollution in 2025, and would worsen with higher truck traffic from modal diversion ([American Lung Association](#)).

Shoreline Vulnerability and Continued I-90 Damage

Beginning in the early 1900s, the location of the CH-I90 Project was filled and hardened to support the former Lake Shore Power Plant, constructed in 1910. The plant's warm water discharge and cold-water intake channels remain as structural remnants and are now outdated and deteriorated.

I-90 was later constructed along this same shoreline during the mid twentieth century, placing a major regional freight corridor immediately adjacent to Lake Erie. Its location exposes the highway to regular wave action, wind driven spray, icing, and salt intrusion during storm events. The 2015 I-90 Safety Study documented recurring visibility and pavement hazards along this segment, including episodes of wave overtopping and storm driven water crossing the roadway. These conditions create operational challenges for one of the highest volume traffic roadways in the region (2025 Ohio Department of Transportation Facts Book).

Without the CH-I90 Project, the shoreline remains exposed to storm-driven wave action. Frequent overtopping, icing, and roadway flooding expose this section of I-90, a roadway that carries over 140,000 vehicles per day, to a persistent and costly cycle of damage and

repair ([Ohio Department of Transportation, 2025](#)). Under current conditions, storm waves over 10 ft. from the north-northeast reach the existing 0.25-mile I-90 segment adjacent to the project. These hazards degrade roadway safety and reliability for one of the highest volume traffic corridors in the region, compounding the economic and operational consequences of losing dredge capacity. Recognizing the critical nature of these risks, the Ohio Department of Transportation highlights the CHEERS Breakwater as a key project for transportation resilience in the state ([ODOT Resilience Improvement Plan, 2024](#)). Investing in the CH-I90 Project will deliver long-term resilience, dramatically reduce recurring maintenance costs, and secure the safe, reliable operation of one of Ohio's most vital transportation assets.

1.2 Project Scenario

The CH-I90 Project is a construction-ready, federally deployable component of the broader CHEERS initiative. With 90% design complete and active coordination underway with the U.S. Army Corps of Engineers and Ohio EPA, the CH-I90 Project is positioned to enter final permitting immediately upon award. Construction is assumed to begin in 2027 and continue through 2028 (2027-2028), with the containment structure fully operational for the 2029 dredging season. Compounding this vulnerability, the U.S. Army Corps of Engineers is already limiting dredge quantities to minimum levels due to insufficient capacity, creating a heightened risk of operationally significant sediment accumulation.

The CH-I90 Project provides two years of new dredge-material capacity, allowing dredging to continue uninterrupted. This near-term capacity is strategically critical: it prevents the immediate dredging shortfall that would occur in 2029 under the No Action scenario. By sustaining dredging during this period, the CH-I90 Project maintains federally authorized channel depth, thereby preserving navigability and averting the onset of draft restrictions, light-loading, and freight diversion.

In other words, the CH-I90 Project allows:

- The Cuyahoga River to remain fully navigable.
- Commercial vessels to maintain full cargo throughput.
- The Port to sustain its annual movement of 13 million tons.
- Maritime-dependent supply chains—especially steelmaking—to remain uninterrupted.
- The region to avoid immediate modal diversion costs, environmental impacts, and roadway burdens.

Beyond dredging continuity, the CH-I90 Project delivers coastal resilience and state-of-good-repair benefits. The project repurposes deteriorated structures from the former Lake Shore Power Plant into a modern containment system that stabilizes the shoreline and reduces storm-driven wave energy. By reshaping the nearshore environment, the CH-I90 Project directly reduces wave overtopping, icing, and spray along the exposed segment of I-90, improving safety and reducing long-term maintenance needs for one of the region's highest-volume freight corridors.

The CH-I90 Project also reflects a decade of coordinated regional planning—including ecological restoration, transportation planning, and community-driven design processes—and is supported by the Port of Cleveland, Cleveland Metroparks, the City of Cleveland, ODNR, ODOT, and the Black Environmental Leaders network. More than 2,000 residents and 50 organizations have participated in public engagement, ensuring the project aligns with community priorities and BUILD program criteria for Quality of Life and Partnership.

2. Project Costs

2.1 Capital Costs

Costs estimated for this Project were developed as part of Schematic Design Cost Estimate dated January 29th, 2026. Estimates were developed as Class 5 estimates, following the Association for the Advancement of Cost Engineering (AACE) estimate classification matrix. At this stage, the estimate has an expected accuracy range of -30% to 50%, reflecting the variability in likely bid prices if the project were issued to tender in its current phase. Cost estimates represent probable construction costs based on current market conditions and assumes competitive bidding, with about four to five subcontractor bids per work category.

The total project cost utilized for this study comprises:

- Direct Costs – cover physical construction activities required for project implementation, including marine breakwater infrastructure, site preparation and demolition, hardscape elements like pathways and parking, boardwalks and shoreline enhancements, creation of habitat areas and native planting, nature-based stormwater management, installation of utilities, site buildings, installation of park program elements, and bridges and piers;
- Indirect Costs – represent non-physical project components, including project management and administration, safety measures and equipment, general construction requirements (e.g., temporary site access, construction offices and facilities, mobilization and demobilization), and permitting and regulatory compliance costs (i.e., licensing fees, obligatory government fees, and regulatory inspections). Indirect costs were estimated as 18% of direct costs.
- Contractor Markups (Overhead and Profit) – overhead represents general business expenses, including office administration, insurance, legal and accounting services, and other general expenses incurred to manage the project. Profit represents the margin added by the contractor to compensate for risks and provide financial returns. Overhead and profit were estimated as 10% of the combined direct costs and indirect costs.
- Contingency Costs – given the early-stage design of the project, a contingency of 15% was applied to both direct costs, indirect costs, and overhead and profit. As the design evolves, the contingency amount may be adjusted based on further detailed engineering and strategic site investigations.

The CH-I90 Project is planned for construction over a 2-year period, covering 2027 to 2028. Table 2 provides the estimated annual direct, indirect, overhead and profit, contingency, and total capital cost for the CH-I90 Project. The nominal total capital cost is estimated at \$13,060,000, adjusted to a present value of \$11,770,900 when a discount rate of 7% is applied.

CH-I90 Project Capital Cost in Constant 2024\$

Cost Summary	Nominal Costs (Millions, 2024 US\$)	Present Value of Costs (Millions, 2024 US\$)
Construction Year 1	\$7,811,000	\$6,376,103
Construction Year 2	\$9,311,000	\$7,103,317
Total Direct Cost Without Additional Costs	\$17,122,000.00	\$13,479,420

2.2 Operations and Maintenance Costs (O&M)

Annual O&M estimates were assumed to be 1.5% of Capital Cost values. This assumption provides a high-level approximation of costs for ongoing operational needs of infrastructure assets. Annual O&M costs are incurred over the CH-I90 Project’s lifespan. A discount rate of 7% is applied to calculate present value of costs.

CH-I90 O&M Cost

	Nominal	Present Value
Year	O&M	O&M
2026	\$-	\$-
2027	\$-	\$-
2028	\$-	\$-
2029	\$256,830	\$183,120
2030	\$256,830	\$171,049
2031	\$256,830	\$160,005
2032	\$256,830	\$149,475
2033	\$256,830	\$139,716
2034	\$256,830	\$130,470
2035	\$256,830	\$121,994
2036	\$256,830	\$114,033
2037	\$256,830	\$106,584
2038	\$256,830	\$99,650
2039	\$256,830	\$92,972
2040	\$256,830	\$87,065
2041	\$256,830	\$81,415
2042	\$256,830	\$76,022
2043	\$256,830	\$71,142
2044	\$256,830	\$66,262
2045	\$256,830	\$62,153
2046	\$256,830	\$58,044
2047	\$256,830	\$54,191
2048	\$256,830	\$50,596
2049	\$256,830	\$47,257
2050	\$256,830	\$44,175
2051	\$256,830	\$41,350
2052	\$256,830	\$38,525
2053	\$256,830	\$36,213
2054	\$256,830	\$33,645
2055	\$256,830	\$31,590
2056	\$256,830	\$29,535
2057	\$256,830	\$27,481
2058	\$256,830	\$25,683
TOTAL	\$7,704,900	\$2,431,358

3. Project Benefits

The CH-I90 Project's benefits are categorized into quantifiable and non-quantifiable benefits. Quantifiable benefits are assigned standardized monetary values, allowing for a more direct assessment. Non-quantifiable benefits rely on broader, interrelated urban dynamics or individual and collective perceptions, and lack direct monetary equivalents, making it challenging to isolate their full economic value. This section evaluates the CH-I90 Project's anticipated quantifiable and non-quantifiable outcomes, recognizing the importance of their collective contribution to the CH-I90 Project's overall value and impact.

3.1 Light Loading & Modal Diversion

Under the No Action scenario, maintenance dredging ceases after 2028. Progressive shoaling subsequently reduces navigable depth, constraining vessel maneuverability and increasing grounding risk. While commercial shipping could technically continue during the early years of shoaling, increasing draft limitations would undermine safe, reliable navigation. During this transitional period, shippers would begin adopting light-loading, whereby vessels must reduce payloads to remain within available draft.

As maritime capacity declines, shippers must divert displaced freight to alternate modes. In the near term, trucking represents the only viable substitute for the bulk and breakbulk commodities historically served by the Port of Cleveland.

According to USACE, each 1–2 feet of lost navigable depth imposes \$1.5 million to \$4.9 million in increased regional transportation costs ([United States Army Corps of Engineers Cleveland Harbor Fact Sheet](#)). According to the USACE Economic Analysis for the Cleveland Harbor Dredged Material Management Plan 2022, the average shoaling rate is 1.3 ft. per year. Using the upper-bound estimate of \$4.965 million applied to the shoaling rate, this analysis assumes that from 2029–2032, maritime shipping remains operational but incurs annual inefficiency-related costs consistent with constrained navigation.

To maintain analytical conservatism, the analysis does not assume cargo loss during this transitional period. Instead, the only quantified impact is the increasing cost of maintaining maritime operations as depth decreases.

However, if displaced freight were shifted to trucks, the 130,000 tons of cargo (1 percent of the Port's total estimated annual cargo volume) would require 4,727 additional truck trips per year, or 117 additional heavy-truck trips per day, based on the federal maximum legal truckload of 27.5 tons.

The Northeast Ohio Areawide Coordinating Agency (NOACA) has indicated that this level of added heavy-truck activity is not feasible on the existing roadway network. Such diversion would result in substantial negative externalities, including accelerated pavement wear, higher crash exposure, increased congestion, and elevated emissions. A full marine-to-truck shift would likely require significant new highway infrastructure, potentially costing hundreds of millions of dollars.

Again, to remain conservative, the analysis assumes that a meaningful share of displaced maritime cargo would divert to trucking, even though this outcome would be operationally difficult. Additional non-quantified externalities generated by this modal shift are discussed in Non-Quantifiable Benefits.

3.2 Cargo Loss

This analysis assumes that by 2033, shoaling reduces available depth to a point at which fully loaded commercial vessels can no longer safely operate.

At this depth, the Port of Cleveland can no longer move its normal throughput. This is conservatively assumed to generate a one-time structural loss equal to 1 percent of annual cargo. Based on the Port's baseline movement of 13 million tons per year, a 1 percent reduction results in approximately 130,000 tons of displaced maritime cargo.

Using the revenue baseline from the Ohio Maritime Plan (2023)—which reports \$1.6 billion in annual logistics revenue (2024 dollars) for 13 million tons, or roughly \$123 per ton—this 1 percent loss corresponds to \$15,998,822 in lost annual logistics revenue.

When combined with the estimated \$4.9 million in modal diversion costs, total conservative one-time annual losses equals approximately \$21 million in 2032.

To maintain a conservative and defensible analytical approach, the BCA limits quantified modal diversion and cargo loss impacts to the period ending in 2032, when navigation becomes infeasible under the No Build scenario. Beyond this point, shipper behavior and regional freight patterns become too speculative to monetize without overstating benefits. Restricting the analysis to verifiable, causally linked impacts aims to align with USDOT expectations for transparent and conservative baseline assessment.

3.3 Avoided Direct Physical Damages

The CH-I90 project is also designed to safeguard critical shoreline infrastructure—most notably the segment of I-90 adjacent to the project area—from severe wave action and storm-driven overtopping. To estimate the avoided damages to this corridor, the assessment evaluates how existing wave conditions interact with the interstate and then determines the scale of losses that would occur during a typical 1-percent annual-chance storm event. These losses are then annualized to represent the average yearly physical damages the Project would prevent.

To assess wave action in the Project area in 2025, KS Associates modeled wave conditions through a statistical analysis of offshore waves using the Simulating Waves Nearshore Model (SWAN 40.72ABCDE, Delft University of Technology, 2008, 2003). Wave conditions 4.8 miles offshore were developed using historical wave hindcast data (1960-2019) from Wave Information Studies Station 92068 (81.68°N, 41.60°W, 520' IGLD 1985) (USACE, 2020). Design wave conditions at the Project site were modeled based on a 1% annual chance storm event, with waves offshore reaching 18.4 feet at a 9.6 second-period. The SWAN model was used to estimate how offshore waves transform as they approach the nearshore zones through refraction, diffraction, breaking, dissipation, and wind growth. Model inputs included the offshore wave spectra, the existing shoreline and harbor protection structures along the Cleveland waterfront, the existing and proposed bathymetry and topography based on surveys between 1948 and 2022, and the proposed design. Nearshore wave heights and directions given the present and proposed conditions appear in the figure below (KS Associates, January 20, 2026).

Present Day 1% Annual Chance Nearshore Waves Given the Existing and Proposed Conditions.

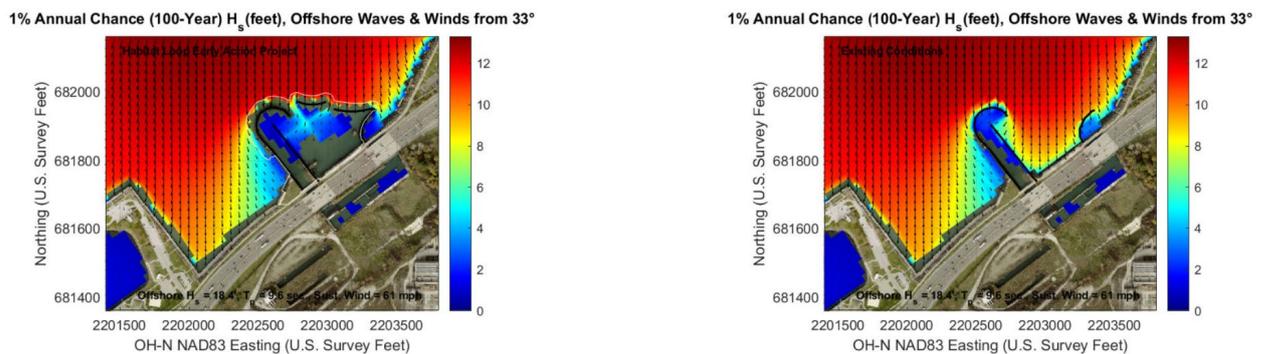


Figure 1: Modeled reduction in 100-year storm waves (1% annual chance) under the proposed project.

Based on the modeling illustrated above, storm events could drive 10 to 12-foot waves, overtopping the shoreline and pushing water across multiple travel lanes. Cleveland Metroparks reports that this level of overtopping has, in past storm events, extended into the westbound lanes of I90, causing damage severe enough to require full replacement of at least one travel lane.

Because this study focuses specifically on wave driven impacts, broader flood depth modeling—particularly forward-looking storm surge or inundation analyses—was not conducted. As a result, the damage estimates presented here reflect a conservative approach that captures only the portion of physical losses directly attributable to wave overtopping. Storm-driven impacts, broader flood depth modeling—particularly forward-looking storm surge or inundation analyses—was not conducted.

Under the No Build scenario, the analysis therefore assumes that storm generated wave action would continue to overtop the shoreline and force replacement of one lane of I90, representing the baseline level of recurring physical damage the CH-I90 Project is designed to avoid. In the Build scenario, the analysis therefore assumes that storm generated wave action would continue to overtop the shoreline and force replacement of one lane of I90, representing the baseline level of recurring physical damage the CH-I90 Project is designed to avoid.

For the I-90 corridor, the Federal Highway Administration (FHWA) reports a per-lane-mile reconstruction cost of \$7.6 million (2014\$), which was adjusted to 2024 values, resulting in a per-lane-mile cost of \$9.9 million (2024\$). Given historical reports of wave overtopping, this assessment assumes overtopping damaging up to 1 lane over a $\frac{1}{4}$ mile segment.

Total Anticipated Losses from a 100-Year Storm Event

I-90		Avoided Losses
I-90 segment length (miles)	0.25	
I-90 segment number of lanes (both directions)	7	
Major Urbanized Interstate Lane reconstruction cost (2014\$/lane mile) ⁵	7,675,000	
Lane reconstruction cost (2024\$/lane mile)	9,977,500	
Assumed Percent Damage ⁶	1 lane	\$2,494,375
⁵ Appendix A: Highway Investment Analysis Methodology - Policy Federal Highway Administration; ⁶ Assumption based on KS Associates report of wave overtopping and extending into westbound lanes, January 20, 2026.		

The Total Anticipated Loss from the present-day 100-year Storm Event was then converted into an Annualized Average Losses (AAL) to reflect expected losses on an annual basis, considering the likelihood of storm events with different return periods. The AAL accounts for probability-weighted losses from storms of varying severity, rather than on a single event. This approach considers storm events that occur more frequently (i.e., 10-year and 20-year storms), and less frequent but higher-damage events (i.e., 50-year and 100-year storms).

For the calculation of Annualized Average Loss (AAL), both the trapezoidal integration method and the incremental probability method are valid approaches. For this study, we have opted for the incremental probability method, which calculates AAL by breaking the exceedance probability-loss curve into discrete probability bands based on return periods. Each segment's probability is determined as the difference between successive exceedance probabilities, and the expected loss for that segment is weighted accordingly. This approach provides clear insight into how different hazard return periods contribute to the overall expected annual loss.

For this analysis, the present-day 100-year storm event was used as the base reference, with losses from other storm return periods adjusted using Annual Exceedance Probabilities (AEPs). By adding the probability-weighted avoided losses across all return periods, the total AAL for the CH-I90 Project is at \$64,853.75.

Avoided Annual Physical and Contents Losses for the CH-I90 Project (Nominal Values)

Return Period	Anticipated Loss	Annual Exceedance Probability (AEP)	Incremental Probability	Annual Avoided Losses by Storm
10	\$249,437.50	0.1	0.05	\$12,471.88
20	\$498,875.00	0.05	0.03	\$14,966.25
50	\$1,247,187.50	0.02	0.01	\$12,471.88
100	\$2,494,375.00	0.01	0.01	\$24,943.75
			AAL	\$64,853.75

This assessment assumes that resilience benefits will start after the completion of the CH-I90 Project’s breakwater, in 2029.

Avoided Direct Physical Damages Benefits (2024\$)

	Nominal	Present Value
Year	Resilience	Resilience
2026	\$-	\$-
2027	\$-	\$-
2028	\$-	\$-
2029	\$64,853.00	\$46,240.19
2030	\$64,853.00	\$43,192.10
2031	\$64,853.00	\$40,403.42
2032	\$64,853.00	\$37,744.45
2033	\$64,853.00	\$35,280.03
2034	\$64,853.00	\$32,945.32
2035	\$64,853.00	\$30,805.18
2036	\$64,853.00	\$28,794.73
2037	\$64,853.00	\$26,914.00
2038	\$64,853.00	\$25,162.96
2039	\$64,853.00	\$23,476.79
2040	\$64,853.00	\$21,985.17
2041	\$64,853.00	\$20,558.40
2042	\$64,853.00	\$19,196.49
2043	\$64,853.00	\$17,964.28
2044	\$64,853.00	\$16,732.07
2045	\$64,853.00	\$15,694.43
2046	\$64,853.00	\$14,656.78
2047	\$64,853.00	\$13,683.98
2048	\$64,853.00	\$12,776.04
2049	\$64,853.00	\$11,932.95
2050	\$64,853.00	\$11,154.72

2051	\$64,853.00	\$10,441.33
2052	\$64,853.00	\$9,727.95
2053	\$64,853.00	\$9,144.27
2054	\$64,853.00	\$8,495.74
2055	\$64,853.00	\$7,976.92
2056	\$64,853.00	\$7,458.10
2057	\$64,853.00	\$6,939.27
2058	\$64,853.00	\$6,485.30
TOTAL	\$1,945,590	\$613,963

3.4 Non-Quantifiable Benefits

While the CH-I90 Project provides significant quantifiable economic benefits, the project advances several outcomes identified in the U.S. Department of Transportation (DOT) guidance for BUILD grant benefit-cost analyses, including long-term resilience, improved safety, and enhanced environmental quality. These benefits stem from reimagining the Lake shoreline, reconnecting Cleveland neighborhoods to the lake, shifting to co-beneficial ways of handling dredge material, and developing an equitable and resilient future for the region now and in the future. Below are specific benefits that were not quantified within this assessment either due to methodological limitations or data constraints. However, they remain critical to understanding the full impact of the project.

Critical Industry Impacts: Cleveland Harbor supports several nationally significant maritime industries, including iron and steel production, critical minerals handling and processing, and shipbuilding. Waterfront facilities, such as ore docks, steel manufacturing operations, and vessel construction and repair facilities, rely on maritime navigability in Cleveland Harbor and form an important link in the Great Lakes maritime supply chain. Dredge capacity losses and cessation that will result if the CH-I90 Project is not implemented will take a significant toll on these critical American industries.

CO2 Emissions and Air Quality Impacts from Increased Truck Traffic: Should road infrastructure be expanded to meet the needs of the Port, increased truck traffic would lead to higher emissions of pollutants such as nitrogen oxides and particulate matter, deteriorating air quality. Poor air quality can exacerbate respiratory conditions and negatively impact public health, particularly for vulnerable populations. This analysis projects that without the ability to dredge, maritime shipping would be reduced which could lead to approximately 117 daily trucks added to the roads, resulting in hundreds of tons of additional pollutants.

Respiratory illnesses that result from exposure to poor air quality also have a significant economic impact. While Cleveland-specific data is not yet available, researchers from the Centers for Disease Control estimate that the annual per-person incremental medical cost of asthma (measured in 2015 USD) to be \$3,266, in addition to the \$3 billion in losses due to missed work and school days, \$29 billion due to asthma-related mortality, and \$50.3 billion in medical costs (Annals of the American Thoracic Society). Based on Downtown Cleveland's population of 21,000 and the most recent CDC data estimating the age adjusted-prevalence of asthma in Cleveland at 11.5%, building the CH-I90 Project would translate to over \$10 million in healthcare savings in 2024 dollars from reduced asthma-triggering pollution (Crain's Cleveland Business, 2024; CDC 500 Cities: City-Level Data, 2019).

Ultimately, without dredging, the resulting surge in truck traffic and associated emissions would impose substantial environmental, public health, and economic burdens on the surrounding neighborhoods, highlighting how maintaining maritime capacity is essential to safeguarding community wellbeing.

Reduced Safety and Increased Accidents Due to Land-Based Travel: The addition of freight traffic brings additional safety risks. While this analysis did not use USDOT methodology to quantify safety benefits in order to remain conservative, the USACE estimated a shift to

land-based travel and subsequent increase in annual accidents could result in \$18,448,000 annually for trucking and \$25,971,000 for railroad-related accidents (<https://re-ops.usace.army.mil/OandM/factsheets/ClevelandHarbor.pdf>). The methods used in this analysis are unknown and thus the benefits were not included in the BCR reflected herein. However, they illustrate how increased land-based based travel would negatively impact adjacent communities by introducing more land-based travel-related accidents.

Increased Maintenance Costs from Wave Overtopping on I-90: Frequent wave overtopping necessitates additional maintenance and plowing on I-90, leading to higher operational costs and added chemicals treatments for road safety.

Workforce Development: Construction of the CH-I90 Project will provide valuable employment opportunities for Cleveland. The Project has completed a Workforce Development Plan, that identifies 12 categories of ongoing, permanent jobs that will be supported by the Project. Construction activities for the CH-I90 Project are expected to create approximately 30-38 jobs each year. Jobs created range from roles that require specialized education to roles that are accessible to workers without post-secondary education. Construction jobs are identified by the Ohio Department of Jobs and Family Services as in high demand ([Ohio Department of Jobs and Family Services](#)). The CH-I90 Project offers not only a path to upward mobility for individuals, but also broader economic development for the regional Northeast Ohio workforce.

4. Summary of Results

This analysis quantifies net benefits by comparing the Base Case with the Project Case over the 2026-2056 evaluation period, applying a real discount rate of 7.0% to estimate present value of costs and benefits. The analysis yields the following results outlined below.

Total Discounted Benefits (discounted at 7.0%): The total discounted value of benefits was estimated at **\$22,409,752**.

Present Value of Benefits (discounted at 7.0%): The total present value of benefits was estimated at **\$24,842,078**.

This BCA analysis indicates that modal diversion savings is the predominant driver of Project benefits, representing the majority of all quantifiable benefits in this analysis. This outcome is expected given that logistics business revenue is valued at about \$1.6 billion (2024\$), and any disruption to navigability that renders vessels inoperable directly translates into cargo loss and increased transportation costs. As the CH-I90 Project supports regular dredging, thereby maintaining channel depth, the CH-I90 Project is expected to sustain logistics operations and preserve cargo throughput via existing logistics pathways.

This assessment follows the assumption that the inclusion of modal diversion as a project benefit is justifiable and appropriately accounts for potential economic displacement effects of the no-project scenario as it has been demonstrated that in the no-project scenario, the port would become non-operational and that there are no viable alternatives that could sustain some portion of the revenue.

Total Discounted Costs (discounted at 7.0%): The total discounted value of costs was estimated at **\$13,479,420**.

Present Value of Costs (discounted at 7.0%): The total present value of costs for the project is estimated at **\$15,918,790**.

Net Present Value of the Project: NPV of the Project is estimated at **\$8,930,332**.

Benefit-Cost Ratio: The **BCR for the Base Case is 1.66**. Given its substantial contribution to the overall project benefits, the preservation of maritime cargo transport through regular dredging stands as the primary economic justification for the CH-I90 Project. This conclusion underscores the argument that there is no viable alternative to river-based shipping for these materials. The cascading impacts of shifting to land-based shipping include job and revenue losses, increased infrastructure costs, and heightened pollution levels.

Summary of Project Present Value of Costs and Benefits and BCR in Million \$2024

BCA Key Indicators	Unit	Results
Total Discounted Costs	2024 US\$	13.48
Total Discounted Benefits	2024 US\$	22.41
Net Present Value (NPV)	2024 US\$	8.93
Benefit/Cost Ratio (BCR)	-	1.66

Summary of Project Present Value of Costs and Benefits for the Base Case Scenario in \$2024

Year	Discount Multiplier	Present Value Costs	Total Discounted Costs	Present Value Benefits	Total Discounted Benefits
2026	0.873	-\$	-\$	-\$	-\$
2027	0.816	\$6,373,776	\$6,376,103	-\$	-\$
2028	0.764	\$7,113,604	\$7,103,317	-\$	-\$
2029	0.713	\$183,120	-\$	\$3,586,285	\$3,403,099
2030	0.666	\$171,049	-\$	\$3,349,882	\$3,180,467
2031	0.623	\$160,005	-\$	\$3,133,598	\$2,972,399
2032	0.582	\$149,475	-\$	\$2,927,374	\$2,777,943
2033	0.544	\$139,716	-\$	\$11,433,834	\$11,292,743
2034	0.508	\$130,470	-\$	\$32,945	(\$97,591)
2035	0.475	\$121,994	-\$	\$30,805	(\$91,207)
2036	0.444	\$114,033	-\$	\$28,795	(\$85,240)
2037	0.415	\$106,584	-\$	\$26,914	(\$79,664)
2038	0.388	\$99,650	-\$	\$25,163	(\$74,452)
2039	0.362	\$92,972	-\$	\$23,477	(\$69,581)
2040	0.339	\$87,065	-\$	\$21,985	(\$65,029)
2041	0.317	\$81,415	-\$	\$20,558	(\$60,775)
2042	0.296	\$76,022	-\$	\$19,196	(\$56,799)
2043	0.277	\$71,142	-\$	\$17,964	(\$53,083)
2044	0.258	\$66,262	-\$	\$16,732	(\$49,611)
2045	0.242	\$62,153	-\$	\$15,694	(\$46,365)
2046	0.226	\$58,044	-\$	\$14,657	(\$43,332)
2047	0.211	\$54,191	-\$	\$13,684	(\$40,497)
2048	0.197	\$50,596	-\$	\$12,776	(\$37,848)
2049	0.184	\$47,257	-\$	\$11,933	(\$35,372)
2050	0.172	\$44,175	-\$	\$11,155	(\$33,058)
2051	0.161	\$41,350	-\$	\$10,441	(\$30,895)
2052	0.150	\$38,525	-\$	\$9,728	(\$28,874)
2053	0.141	\$36,213	-\$	\$9,144	(\$26,985)
2054	0.131	\$33,645	-\$	\$8,496	(\$25,219)
2055	0.123	\$31,590	-\$	\$7,977	(\$23,570)
2056	0.115	\$29,535	-\$	\$7,458	(\$22,028)
2057	0.107	\$27,481	-\$	\$6,939	(\$20,587)
2058	0.100	\$25,683	-\$	\$6,485	(\$19,240)
	Sum (in millions 2024 US\$)	\$15.91	\$13.48	\$24.84	\$22.41