

**Cost-Benefit Analysis and Scenario Modeling
Capital, Environmental, and Stakeholder Perspectives
on the Vancouver Island Rail Corridor**

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CBA - Vancouver Island Rail

A robust CBA for the Vancouver Island rail corridor should follow these key steps, derived from proven infrastructure analysis frameworks:

1. Define Scope and Stakeholder Perspective

- Clarifying the corridor's functional goals (commuter, intercity, freight, recreational use).
- Incorporating First Nations' legal rights and land use priorities, ensuring all impacted parties are engaged early in planning (e.g., land reversion, cultural and social objectives).

2. Compiling Cost Data

- Applying detailed cost breakdowns for capital upgrades (track, bridges, rolling stock) and operations, using granular estimates from local sources
- Rail Only: \$901M (base), rises substantially when including soil remediation.
- Trail Only: \$55M (base), but \$131M+ if environmental clean-up is required.
- Rail + Trail: \$129M (base), escalating to \$205M with full remediation.

3. Monetize and Quantify Benefits

- Economic: Model direct, indirect, and induced impacts (e.g., \$95M for certain corridor scenarios).
- Social: Assess value of mode shift (reduced congestion), access for remote and Indigenous communities, new tourism flows, opportunity for densification, and improved emergency routing.
- Environmental: Estimate reduction in GHG emissions from mode shift to rail, quantify wildlife corridor preservation, and assess benefit of restoring land function or habitat.
- User: Calculate time savings, fare reductions, producer and consumer surplus with examples from Channel Tunnel CBA (see prior detailed formulas for travel time and revenue benefits).

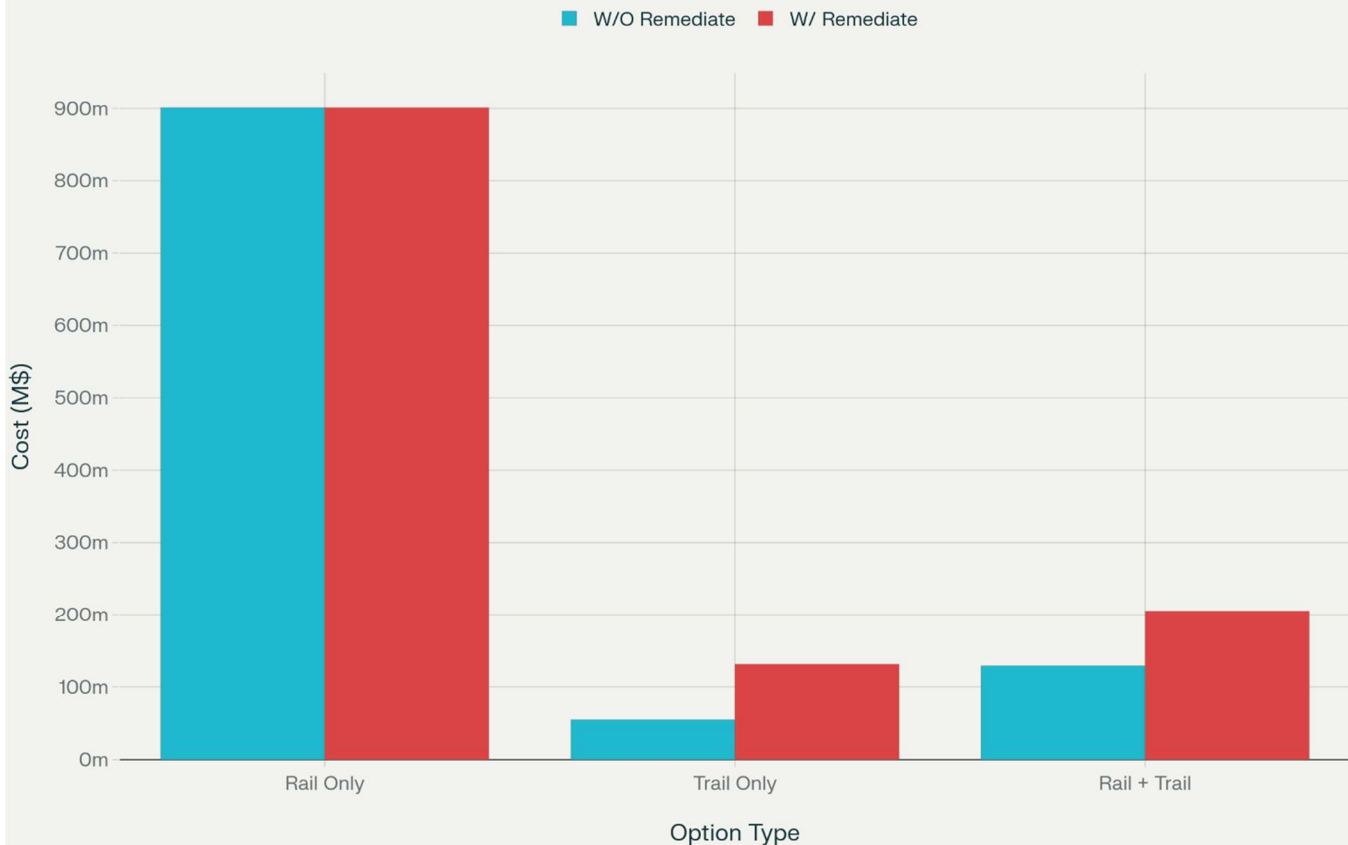
Updated Corridor Cost Comparison

Below is a bar chart visualizing the main capital cost scenarios for Vancouver Island corridor upgrades, both with and without soil/environmental remediation:

Upgrade Option	Base Cost (M\$)	With Remediation (M\$)
Rail Only	901	901
Trail Only	55	131
Rail + Trail	55	205

This chart demonstrates how environmental remediation is a critical cost factor, especially important given regulatory constraints and local laws regarding contaminated land and habitat conservation.

Vancouver Island Rail Costs



Time Savings and Modal Shift

- **User Time Savings:** Past studies (Channel Tunnel) calculate millions in value per annum from reduced travel time, using segment-specific actual trip data. For Vancouver Island, scenario-specific trip time and frequency estimates should be applied to each option (per attached reports).
- **GHG Reduction:** Potential GHG reductions should be monetized using local carbon pricing; mode shift away from road transport can improve island-wide climate resilience.
- **Producer and Consumer Surplus:** Use demand curves and fare/usage data to estimate both 'producer loss' (e.g., transition from existing modes) and 'consumer surplus' gained.
- **Stakeholder and Social Perspective- First Nations Engagement:** All project alternatives must ensure protected consultation and possible co-management, as legal/ownership rights critically shape which corridor uses are possible.
- **Community and Economic Effects:** The economic development enabled by corridor upgrades is substantial but must be benchmarked against both alternative uses and opportunity costs (e.g., housing, parks, utility corridors).

Key CBA Metrics

- Net Present Value (NPV) is the project viable when future costs and benefits are discounted to present-day values? Use multi-decade project timelines.
- Internal Rate of Return (IRR) what is the effective annualized return for the capital invested?
- Benefit-Cost Ratio (BCR) does the ratio of benefits to costs exceed 1 over the lifecycle, indicating value creation?

Current Recommendations

- Use cost modeling with full environmental contingencies built in, not just base estimates.
- Adopt adaptive scenario analysis: review population forecasts, potential modal uptake, and alternative uses regularly as conditions evolve.
- Maintaining corridors use flexibility to accommodate future mode shifts, changes in community priorities, and evolving environmental standards.
- Integrate stakeholder consultation and legal review at each CBA iteration; project legitimacy and long-term sustainability depend on this.

Capital Cost Breakdown by Segment

A detailed estimate of initial capital restoration (Class 2 Track Standard) for Victoria-Courtenay mainline shows the following segment costs (rounded for clarity):

Segment	Track Length (km)	Total Estimate (M\$) [supply + install]
Victoria-Langford	56.3	6.2
Langford-Duncan	158.3	16.9
Duncan-Nanaimo	175.9	19.4
Nanaimo-Parksville	125.1	14.1
Parksville-Courtenay	238.7	26.7
Parksville-Port Alb.	207.1	20.7
Wellcox Yard	64.6	6.5
Port Alberni Yard	32.7	3.3
Victoria Yard	8.1	0.8

Total base track cost, rolling stock, signals, and stations bring the corridor upgrade to approximately \$901M, in line with headline cost summaries. Trail-only options are estimated at \$55M but rise to \$131M+ if soil remediation requirements come into play. The Rail + Trail scenario is estimated at \$129M initially and \$205M with remediation requirements.

Operating and Fare Revenue Analysis

- Annual operating cost for full corridor rail: \$32M.
- Projected fare revenue (using average fare of \$15): \$26M per year.

- Annual operating shortfall: \$6M, requiring public subsidy. For comparison, continuous trail maintenance cost is much lower at ~\$0.3M/year for the CVRD segment.

Environmental Remediation Numerical

For 72 km of CVRD corridor (assuming 100 m sections), physical remediation estimates range:

- Physical remediation (low): \$175,000/section x 720 = \$126M
- Physical remediation (high): \$300,000/section x 720 = \$216M
- Risk Assessment (low): \$95,000/section x 720 = \$68.4M
- Risk Assessment (high): \$170,000/section x 720 = \$122.4M

Total remediation could exceed \$200M for sensitive land use conversion. Remediation for Reserve lands can be \$8.75M - \$15M, with additional risk assessment costs of \$4.75M - \$8.5M.

Rolling Stock and Fleet Capital Cost- Required trains for high-frequency peak service: Between 13 and 22 DMUs (self-propelled, 3-car sets).

- Fleet capital cost range: \$264M–\$432M, depending on schedule, fleet sizing, redundancy, and peak/off-peak planning.
- Station upgrades and new stations (Victoria-Langford alone): \$27.2M
- Maintenance facility: \$75.5M

Economic and Social Impact- Direct, indirect, and induced regional economic impact estimate for rail: \$95M for specific scenarios.

- Improved access to remote and Indigenous communities, tourism, and regional resilience not fully monetized in current BCR/NPV but recognized in qualitative model reviews.
- User time savings: Similar past studies (Channel Tunnel) use values between \$4.8/hr. (leisure) and \$38/hr. (business). Journey time reductions of 21–40 minutes are achievable. These could result in annualized savings of several million for commuters but must be calculated from local origin-destination travel demand.

Benefit-Cost Ratio (BCR), NPV, IRR- BCR: For a project to be justified,

“ $BCR = \{\text{Present Value of Benefits}\} / \{\text{Present Value of Costs}\} > 1$ ”.

Current fare revenue and operating costs, even before capital amortization, suggest strong need for mode shift, external funding, or population/popular support to achieve reasonable BCR.

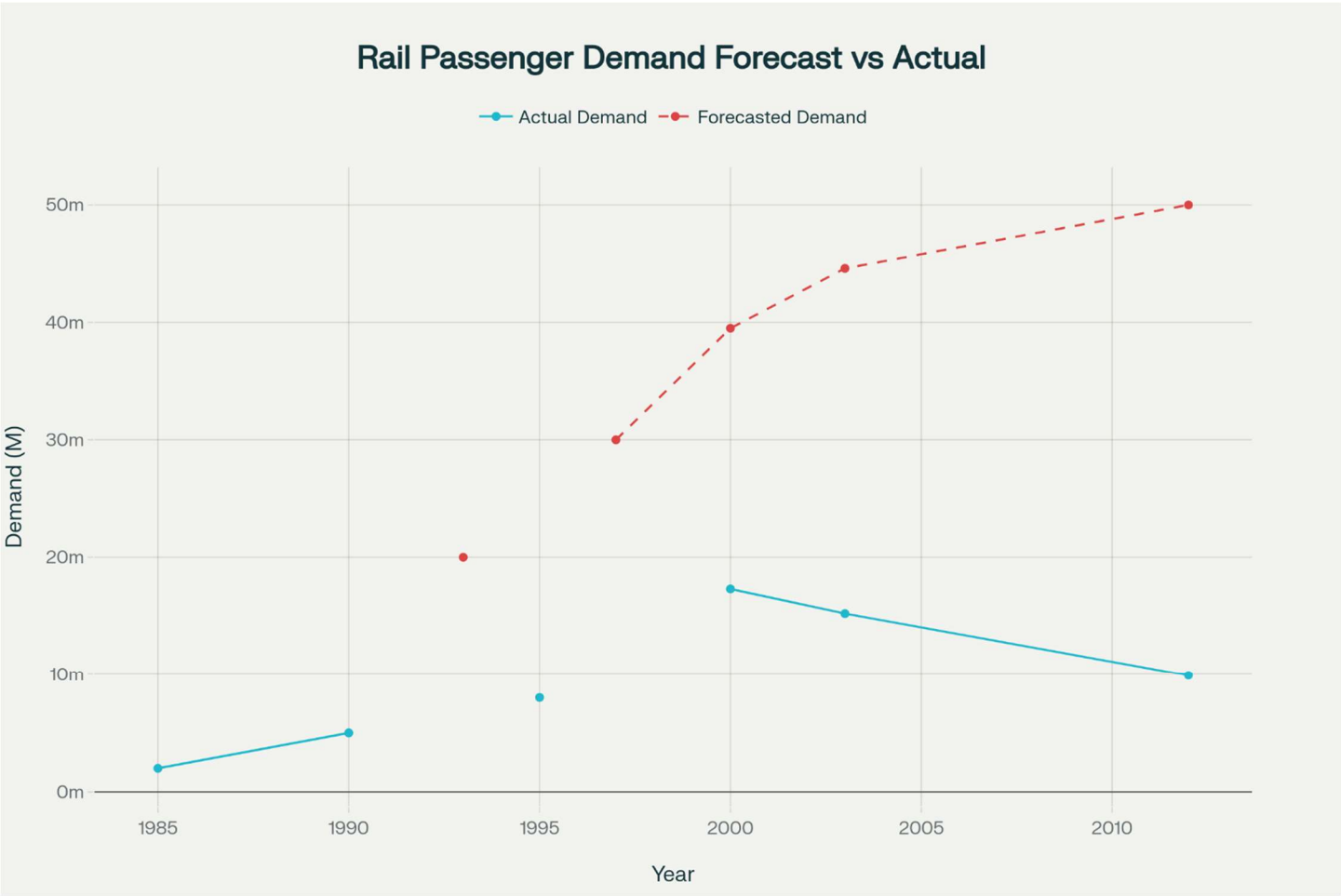
- NPV: Formula $NPV = \sum_{t=0}^T \{B_t - C_t\} / \{(1+r)^t\}$,

where “T” is analysis period, “B_t, C_t” are benefits and costs, and “r” is discount rate. NPV is highly sensitive to ridership, externalities, and chosen discount rate.

- IRR: Rate where “NPV=0”. Historical rail projects target IRR > 5% but often underperform due to demand overestimation or cost overrun.

Mode Shift and Demand

- Ridership scenarios developed for existing, forecast, and best-case densification (Scenario 3) require trains every 15 minutes peak, 13–22 units, supporting higher economic justification if realized.
- Previous project models (Channel Tunnel) showed constructed capacity may be like forecast, but demand can lag prediction by >50% for decades.



Summary Table (Selected Numeric)

Option	Capital Cost (M\$)	Op Cost (M\$/yr)	Fare Rev (M\$/yr)	Economic Impact (M\$)	Remediation (M\$)	Fleet Cost (M\$)
Rail Only	901	32	26	95	126 - 216	264 - 432
Trail Only	55	0,3	N/A	-	68 - 200+	-
Rail + Trail	129	36 - 50	varies	-	140 - 205	-

Conclusions

- Decision-makers must scrutinize demand and fare revenue forecasts using scenario modeling and independent external validation.
- Implementation success relies on partnership with First Nations and stakeholders, addressing reversion, remediation, and land use goals.
- Benefit realization strongly depends on regional transit integration, policy support, population density, and climate resilience strategy.
- Cost-benefit metrics (BCR, NPV, IRR) remain highly sensitive to remediation needs, operational funding, and actual ridership uptake.