PUBLIC SAMPLE | DECISION-SUPPORT ANALYSIS

QUANTIL

Contingency Business Case

Risk-based contingency reserve and allocation

This document is a decision-support analysis. It is not investment, legal or financial advice.

AACE RP 40R-08 / 42R-08 | PMI Practice Standard | ISO 31000:2018

Prepared for

Eastport Transit Authority (fictitious) | Project sponsor / steering committee

Project manager: Project manager (demo)

Project: Harbor Crossing Rail Tunnel | Region: Western Europe

Prepared by

Generated with the Quantil Risk Contingency Allocation Tool

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This document contains commercially sensitive analysis. Distribution is limited to the intended recipients and their advisers. Phase: Construction.

Contents

This Business Case quantifies the cost risk exposure of Harbor Crossing Rail Tunnel and recommends a financial reserve structure based on the weighted three-method contingency, with the Monte Carlo P80 confidence level as the reference budgeting level. The analysis was carried out with the Risk Contingency Allocation Tool (RCAT v4.0); the tests of its calculation core are documented in the RCAT validation note.

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Project information

Parameter	Value
Project name	Harbor Crossing Rail Tunnel
Project type	Infrastructure (Rail)
Contract form	NEC4 Option C
Phase	Construction
Delivery model	Design-Build
Region	Western Europe
Currency	EUR
Base estimate (budgeting anchor)	EUR 340.00M
Number of risk events	30
Analysis tool	Quantil RCAT v4.0, 10,000 iterations, seed 42

Basis for the assessment

This Business Case was prepared with the Quantil Risk Contingency Allocation Tool to support the project sponsor's decision on Harbor Crossing Rail Tunnel. The findings rely on the accuracy of the project input supplied by the client. The tool does not independently verify the underlying risk register.

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1. Summary and budgeting decision

Harbor Crossing Rail Tunnel is a project of type infrastructure (rail) in the Construction phase, with a deterministic base estimate of EUR 340.00M. Taken on its own as the budgeting anchor, the deterministic estimate provides adequate cover in fewer than 1% of the simulated scenarios. A well-founded contingency is therefore not a margin but a calculated necessity.

1.1 Decision required

The budgeting decision concerns the size and structure of the reserve to be included in the committed budget envelope. The recommended reserve is the weighted three-method contingency, set against the Monte Carlo P80 confidence level as the reference.

➤ **Decision required.** Include a risk-weighted contingency of EUR 42.21M (12.4% of the base) in the budget envelope, structured as EUR 29.55M PM-managed contingency plus EUR 12.66M sponsor-funded management reserve. This reserve covers approximately 63% of the simulated outcomes; the Monte Carlo P80 confidence level is EUR 52.96M (15.6% of the base), which is EUR 10.75M above the recommended reserve. P85/P90/P95 are presented separately as sensitivity and stress levels.

1.2 Key figures

Base estimate	Expected exposure (EMV)	Recommended reserve	Reserve % of base
EUR 340.00M	**EUR 38.67M**	**EUR 42.21M**	**12.4%**

Figure 1. Key figures: base estimate, deterministic expected risk exposure (EMV, sum of probability × PERT-EV), recommended reserve and reserve percentage. Simulated mean: EUR 38.59M.

1.3 Risk-weighted budget structure

The recommended structure separates risks the project has specifically prepared for (PM-managed contingency) from risks that were not foreseen at the time of budget sanction (sponsor-funded management reserve).

Tranche	Amount	Authority	Purpose
PM contingency	EUR 29.55M	Project manager	Identified risks
Management reserve	EUR 12.66M	Sponsor / steering committee	Unforeseen risks
Total reserve	EUR 42.21M	-	Weighted three-method reserve

Executive dashboard

The dashboard summarizes the full analysis at a glance: the key figures, the EMV split by risk category, the three methods, the top-5 risk drivers and the recommendation. A direct reflection of the Executive Dashboard in the RCAT tool.

Key figures

Base estimate	Total risk EMV	Recommended reserve	Contingency %	Total budget
EUR 340.00M	**EUR 38.67M**	**EUR 42.21M**	**12.4%**	**EUR 382.21M**

Risks	High risks	Medium risks	Complexity	Monte Carlo P80
30	**1**	**6**	**3.6**	**EUR 52.96M**

EMV by risk category and method comparison

Category	EMV	% share
Technical	EUR 11.54M	30%
Commercial	EUR 2.13M	6%
Schedule	EUR 3.30M	9%
Cost	EUR 2.43M	6%
External	EUR 14.23M	37%
Resource	EUR 1.42M	4%
Supply Chain	EUR 0.85M	2%
HSE	EUR 1.06M	3%
Interface	EUR 2.92M	8%
Opportunity	EUR -1.21M	-3%

Top-5 risk drivers

#	Risk	Category	Probability	EMV	% total
1	Regulator mandates an additional platform and evacuation shaft	External	40%	EUR 7.33M	18.4%
2	TBM main bearing failure requiring hyperbaric intervention	Technical	15%	EUR 4.88M	12.2%
3	Delay caused by restricted rail possession windows	Schedule	40%	EUR 2.63M	6.6%
4	Tunnel boring machine (TBM) stalls in an unforeseen ground layer	Technical	30%	EUR 2.00M	5.0%
5	Contractor claim over scope ambiguity at package interfaces	Commercial	35%	EUR 1.93M	4.8%

Recommendation and overall risk rating

Recommended contingency reserve	EUR 42.21M
Monte Carlo P80	EUR 52.96M
Overall risk rating	MEDIUM: Moderate risk profile. Approve the weighted reserve and monitor the top drivers monthly.

2. Project context and analysis scope

2.1 Project profile

Harbor Crossing Rail Tunnel is a project of type infrastructure (rail), delivered as Design-Build under a NEC4 Option C contract. The project is in the Construction phase with a duration of 54 months. Its weighted complexity score is 3.60 on a scale of 1 to 5 (01_PROJECT_PROFILE).

2.2 Scope of the cost risk analysis

The scope is limited to cost risk, modeled across a register of 30 risk events. The analysis answers three questions for the budgeting decision:

- What contingency reserve reflects the recommended weighted reserve, referenced against the Monte Carlo P80 confidence level?
- How should the reserve be structured between the PM buffer and the management reserve?
- Where is the risk concentrated, and which mitigation delivers the greatest reduction?

2.3 Standards and basis for the assessment

The methodology aligns with four standards for project cost risk analysis:

- **AACE RP 40R-08.** Contingency Estimating: General Principles.
- **AACE RP 42R-08.** Risk Analysis and Contingency Determination Using Parametric Estimating.
- **PMI Practice Standard.** Discrete risk-event modeling framework (probability × impact).
- **ISO 31000:2018 / IEC 31010:2019.** Risk management framework and assessment techniques.

3. Cost exposure under risk-weighted scenarios

3.1 The deterministic base understates the exposure

The deterministic base estimate of EUR 340.00M reflects the sum of point estimates. In probabilistic terms it sits at the low end of the cost distribution: budgeting at this level provides adequate cover in fewer than 1% of scenarios.

- **Expected cost overrun (EMV).** The deterministic expected exposure above the base is EUR 38.67M (+11.4%); the simulated mean across all 10,000 scenarios is EUR 38.59M (-0.20% against the EMV of the included risks).
- **Right tail (P95).** At the 95th percentile, exposure rises to EUR 74.19M (+21.8%), driven by low-probability but high-impact risks.

These figures are not a judgment on the quality of the cost estimate; they reflect the inherent uncertainty of the work, which a point estimate cannot by definition capture.

3.2 Cost outcomes by percentile

The Monte Carlo simulation (10,000 iterations, seed 42, correlation: Cholesky (12 x 12), Beta-PERT) produces a smooth cost distribution. For budgeting purposes, the weighted reserve (recommended), P80 (reference confidence level) and P95 (stress) are most relevant.

Confidence level	Reserve above base	% of base	Probability of adequacy
P10	EUR 17.61M	5.2%	10%
P50 (median)	EUR 35.66M	10.5%	50%
P80 (reference)	EUR 52.96M	15.6%	80%
P85 (sensitivity)	EUR 57.26M	16.8%	85%
P90 (sensitivity)	EUR 63.51M	18.7%	90%

P95 (stress)	EUR 74.19M	21.8%	95%

Table. Cost outcomes by confidence level, EUR, above the deterministic base.

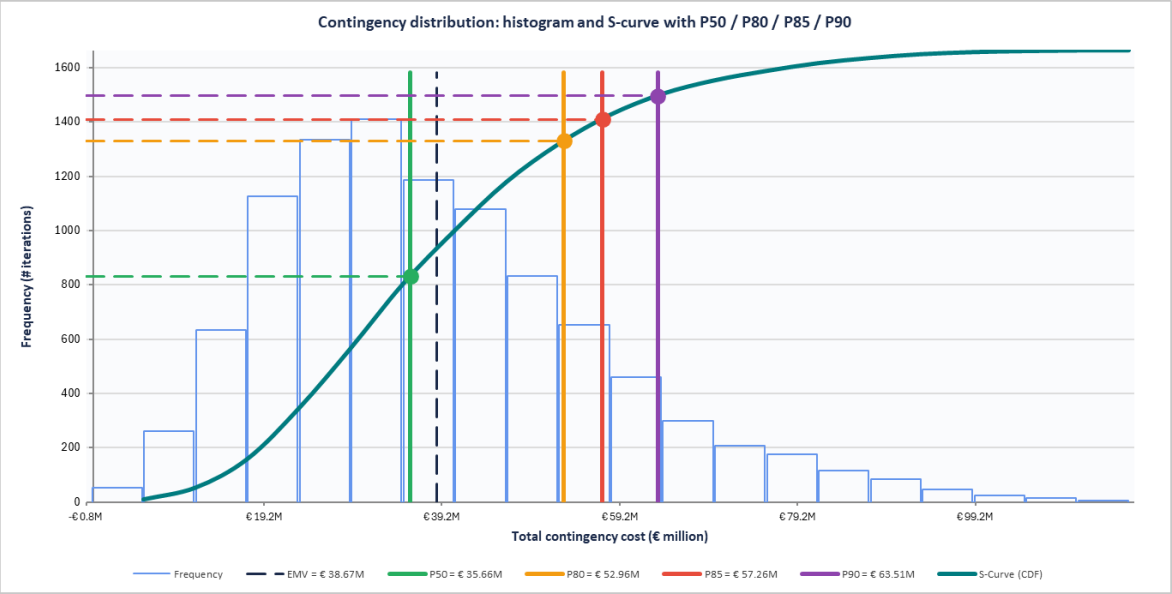


Figure 2. Cost risk distribution with S-curve and P50/P80/P85/P90. Source: RCAT 06_MONTE_CARLO.

3.3 Three-method reconciliation supports the figure

The recommended contingency is reconciled across three independent methods and weighted as set on 05_CONTINGENCY_CALC.

Method	Result	% of base	Weight
Method 1: Bottom-Up EMV	EUR 32.87M	9.7%	35.0%
Method 2: Factor-Based AACE	EUR 38.08M	11.2%	25.0%
Method 3: Monte Carlo P80	EUR 52.96M	15.6%	40.0%
Weighted recommendation	EUR 42.21M	12.4%	100%

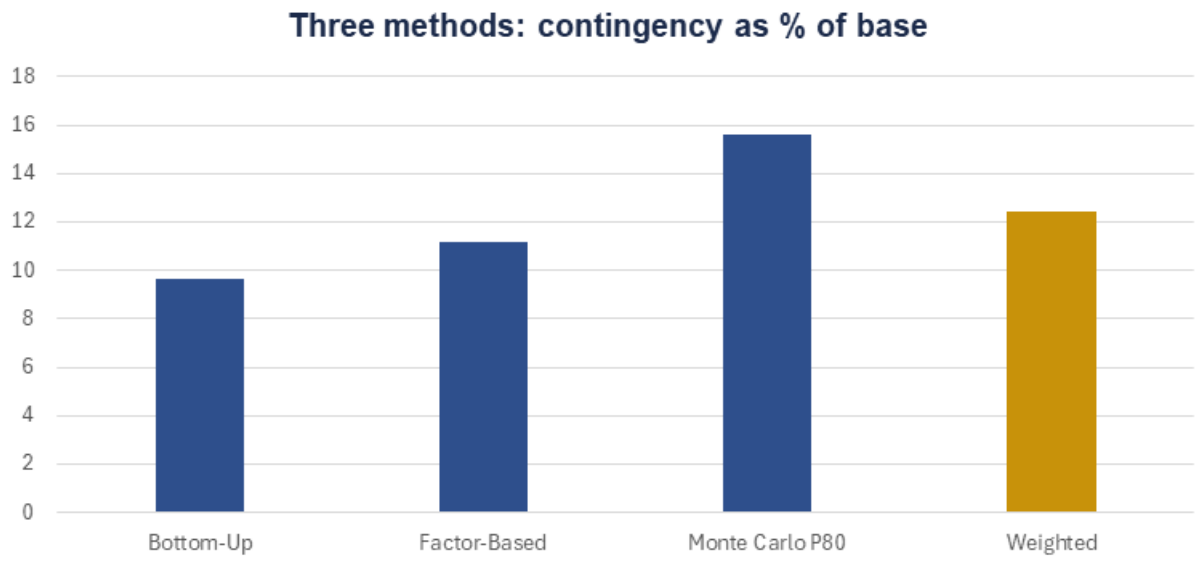


Figure 3. The three methods side by side; the weighted recommendation in gold.

The three methods span a range of 9.7% to 15.6% of the base. The weighted recommendation of 12.4% lies within that range.

4. Recommended reserve structure

4.1 Two-tier reserve architecture

The recommended EUR 42.21M contingency is structured into two tranches: 70% PM-managed contingency and 30% sponsor-funded management reserve, in line with common project governance practice.

Tranche	Amount	Authority	Purpose
PM contingency (70%)	EUR 29.55M	Project manager	Identified risks (register)
Management reserve (30%)	EUR 12.66M	Sponsor / steering committee	Unforeseen risks

4.2 PM-managed contingency reserve

The PM tranche of EUR 29.55M funds drawdown against risks from the register:

- **Authority.** Project manager, within delegated authority limits.
- **Drawdown trigger.** Materialization of a risk event on 03_RISK_REGISTER.
- **Audit trail.** Every drawdown recorded on 15_AUDIT_TRAIL with the risk number.
- **Replenishment.** Not automatic from sponsor equity; escalation on depletion.

4.3 Sponsor-funded management reserve

The sponsor tranche of EUR 12.66M funds unforeseen risks:

- **Authority.** Investment committee, without PM delegation.
- **Drawdown trigger.** Event outside the scope of the register at budget sanction.
- **Sponsor notification.** Material drawdowns (above EUR 1.27M) are reported to the sponsor / steering committee.
- **Replenishment.** Via equity injection by the client as a condition precedent.

5. Defensibility under external scrutiny

Risk committees, technical advisers and reviewers will challenge the figure. The analysis is set up to withstand that scrutiny.

5.1 Phase benchmark

For the Construction phase (Class 1), 01_PROJECT_PROFILE gives an indicative contingency range of 3% to 10% of the base. The recommended contingency of 12.4% lies above that range. The figure is driven by the project-specific risk register (Bottom-Up and Monte Carlo methods), so reviewers should see the difference explained by the risk profile of the project. The sector benchmark on 08_BENCHMARKS, which looks at the project type instead of the phase (8% to 18%), rates it within range.

5.2 Methodological defensibility

- **Three-method reconciliation.** Bottom-Up EMV (9.7%), Factor-Based (11.2%) and Monte Carlo P80 (15.6%) reconcile to a weighted figure of 12.4% (weights 35% / 25% / 40%).
- **Mean check of this run.** The simulated mean (EUR 38.59M) deviates -0.20% from the deterministic EMV of the included risks (EUR 38.67M).
- **Reproducibility.** The simulation uses a fixed seed (42) and 10,000 iterations, so a re-run with the same input reproduces the same percentiles.
- **Standards alignment.** AACE RP 40R-08, RP 42R-08, PMI Practice Standard and ISO 31000:2018.
- **Audit trail.** All inputs and formulas are transparent; the RCAT validation note documents the engine tests.

Calculation core. Engine: RCAT v4.0 engine 1.0 (MRG32k3a, exact Beta inverse). This report re-runs the simulation before reading the results, so every figure reflects the current register. The engine tests (random number generator, Beta inverse, Beta-PERT parametrization, correlation, reproducibility) are documented in the RCAT validation note.

Conclusion of section 5

The recommended figure rests on three axes: reconciliation across three methods, a documented and reproducible calculation core, and alignment with recognized standards.

6. Risk concentration and mitigation upside

6.1 A limited number of risks drive the exposure

The five largest of the 30 risks carry 47% of the total Expected Monetary Value and the ten largest carry 67%. That focuses the mitigation effort.

ID	Risk	Probability	EMV
R-029	Regulator mandates an additional platform and	40%	EUR 7.33M
R-028	TBM main bearing failure requiring hyperbaric	15%	EUR 4.88M
R-004	Delay caused by restricted rail possession win	40%	EUR 2.63M
R-001	Tunnel boring machine (TBM) stalls in an unfor	30%	EUR 2.00M
R-011	Contractor claim over scope ambiguity at packa	35%	EUR 1.93M
R-002	Settlement damage to adjacent buildings along	35%	EUR 1.84M
R-006	Concrete and steel price escalation above cont	45%	EUR 1.73M
R-030	Cross-passage ground freezing takes longer tha	35%	EUR 1.55M

Appendix summary. Top-8 risks by EMV (cumulative EUR 23.88M). Full register in the tool.

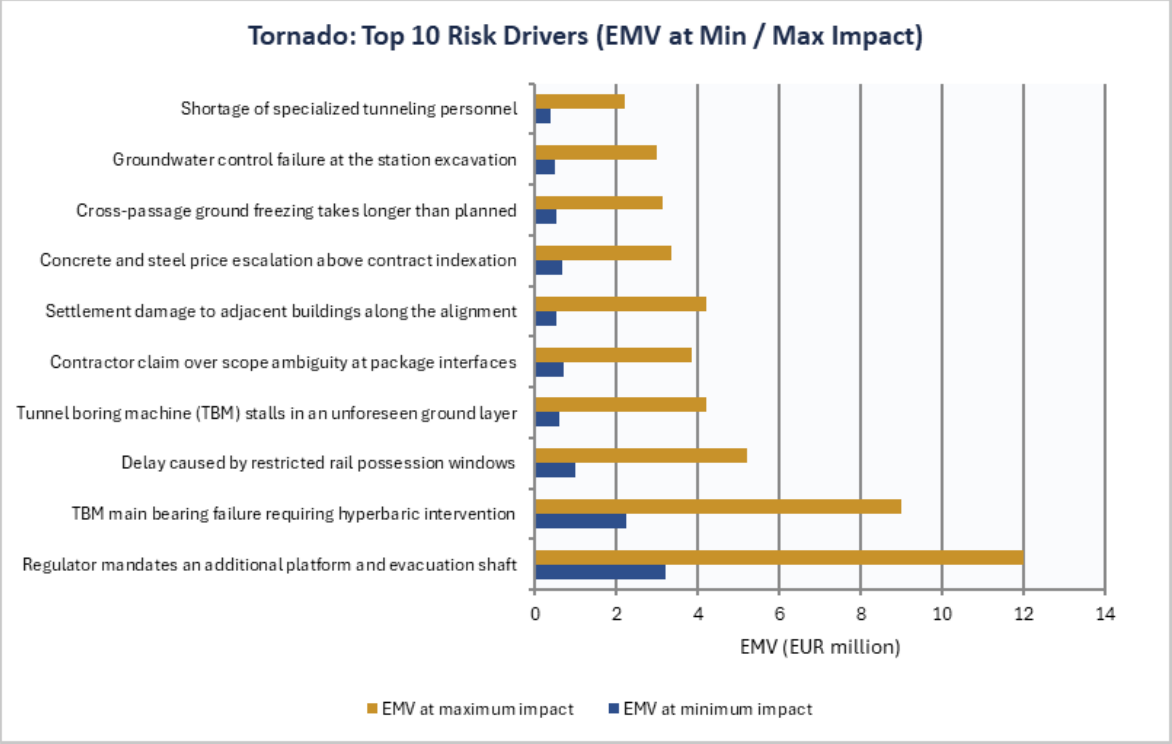


Figure 4. Tornado diagram: the ten largest risk drivers, ranked by their EMV range.

Reading the tornado: each bar shows the range of the Expected Monetary Value (EMV) of a risk between the optimistic and pessimistic scenario. The gold bar (High EMV) is the EMV at the maximum impact estimate; the blue bar (Low EMV) at the minimum estimate. The longer the bar, the greater the uncertainty the risk adds to the total cost position. The risks at the top carry the widest spread and therefore warrant the most attention in mitigation.

6.2 Probability × Impact matrix

The matrix splits the register across probability classes (vertical) and impact classes (horizontal). Each number is the count of risks in that quadrant. Risks toward the bottom right (high probability × high impact) are where exposure accumulates and where mitigation has the most effect.

Probability \ Impact	Very low	Low	Medium	High	Very high
Very low (0-10%)	0	0	0	0	0
Low (10-30%)	0	0	4	4	1
Medium (30-50%)	0	0	8	8	1
High (50-70%)	0	0	1	0	0
Very high (70-100%)	0	0	0	0	0

Figure 5. Probability × Impact matrix (5×5, number of risks per quadrant). Source: RCAT 09_SENSITIVITY.

6.3 Mitigation program cost-benefit analysis

The table below summarizes the mitigation program recorded on the 11_MITIGATION sheet for Harbor Crossing Rail Tunnel: the exposure before and after the planned responses, the cost of the responses and the resulting return.

Metric	Amount	Source (11_MITIGATION)
Pre-mitigation exposure (EMV)	EUR 38.67M	total pre-mitigation EMV
Residual exposure (EMV)	EUR 17.65M	total post-mitigation EMV

Expected reduction	EUR 21.02M	total mitigation value
Mitigation cost	EUR 12.60M	total cost of the planned responses
Net benefit	EUR 8.42M	reduction minus cost
Return (value / cost)	1.7×	mitigation efficiency ratio

For a planned mitigation cost of EUR 12.60M, the expected exposure falls by EUR 21.02M (from EUR 38.67M to EUR 17.65M), a return of 1.7× and a net benefit of EUR 8.42M. The individual measures and costs are detailed on the 11_MITIGATION sheet of the tool.

7. Conditions, controls and drawdown gates

This section documents the conditions that the project sponsor may include in the project governance framework.

7.1 Conditions precedent to first drawdown

- **Risk register baseline.** The client provides the completed 03_RISK_REGISTER at budget sanction.
- **Mitigation commitment.** The client confirms commitment to the mitigation program.
- **Reserve segregation.** PM contingency and management reserve held separately.
- **Quarterly re-simulation.** The client commits to a quarterly RCAT re-simulation.

7.2 Reporting and monitoring covenants

The sponsor / steering committee should require quarterly reporting on the adequacy of the contingency, based on a freshly re-run RCAT simulation with the updated register.

7.3 Governance of reserve drawdown

- **PM reserve ceiling.** Cumulative drawdown of 50% of EUR 29.55M triggers a review.
- **Management reserve.** Any drawdown from the EUR 12.66M management reserve triggers notification to the sponsor / steering committee.
- **Depletion threshold.** Combined depletion below 30% triggers a formal reassessment.

8. Conclusions and recommendations

The cost risk analysis of Harbor Crossing Rail Tunnel leads to five conclusions and a concrete set of recommendations for the budgeting decision. Together they form the basis for the size, structure and governance of the contingency reserve to be included.

8.1 Conclusions

8.1.1 A risk-weighted contingency is necessary

Budgeting on the deterministic base of EUR 340.00M protects the project in fewer than 1% of the simulated outcomes. The expected cost overrun (EMV) is EUR 38.67M (+11.4%; simulated mean EUR 38.59M), and at the 95th percentile exposure rises to EUR 74.19M (+21.8%). A well-founded contingency is therefore not a margin, but a calculated condition for a robust budget. The recommended reserve of EUR 42.21M covers approximately 63% of the simulated outcomes; the Monte Carlo P80 confidence level is EUR 52.96M, which is EUR 10.75M above the recommended reserve.

8.1.2 The figure is traceable

Three independent methods, Bottom-Up EMV (9.7%), Factor-Based AACE (11.2%) and Monte Carlo P80 (15.6%), reconcile to a weighted recommendation of 12.4%, within the span of 9.7% to 15.6% of the base.

Every input, weight and result can be traced in the tool, and the tests of the calculation core are documented in the RCAT validation note.

8.1.3 The two-tier structure protects the sponsor

By splitting the reserve into 70% PM-managed contingency (EUR 29.55M) and 30% sponsor-funded management reserve (EUR 12.66M), drawdown authority is aligned with the nature of the risk. Identified risks are managed within the project; unforeseen risks require explicit sponsor approval. This prevents uncontrolled depletion of the reserve.

8.1.4 The risk is concentrated

The five largest risks carry 47% and the ten largest 67% of the total Expected Monetary Value (09_SENSITIVITY). This concentration makes targeted mitigation effective: a limited number of control measures addresses a large part of the exposure. The mitigation program on 11_MITIGATION reduces the expected exposure by EUR 21.02M for a cost of EUR 12.60M (return 1.7×, net benefit EUR 8.42M).

8.1.5 Monitoring provides early visibility

Quarterly re-simulation with the updated register provides ongoing visibility of the remaining cost exposure. Deviations between the planned and actual risk position become visible early, so corrective action remains possible before the reserve comes under pressure.

8.2 Recommendations

Based on the above, the following concrete steps are recommended to the sponsor and the client:

- **Include the reserve.** Include EUR 42.21M (12.4% of the base) as contingency in the committed budget envelope, structured as EUR 29.55M PM contingency plus EUR 12.66M management reserve.
- **Formalize governance.** Attach an explicit approval route via the investment committee to the management reserve, with notification to the sponsor / steering committee on material drawdown.
- **Commit to mitigation.** Make the mitigation program on the top risks part of the conditions precedent, with measurable milestones per risk.
- **Set up monitoring.** Establish quarterly RCAT re-simulation as a reporting covenant throughout the Construction phase.
- **Maintain the register.** Keep the risk register current as a living document; new risks and revised estimates are incorporated at each re-simulation.

With these measures, the cost exposure of Harbor Crossing Rail Tunnel is managed within a traceable and transparently structured reserve. The decision remains with the sponsor.

9. Appendices

Appendix A: Full risk register

The full risk register of Harbor Crossing Rail Tunnel as used in the analysis. For each risk, the probability, the three-point estimate (minimum, most likely, maximum) and the Expected Monetary Value (probability × PERT-EV, 06_MONTE_CARLO column I) are shown. Amounts in EUR.

ID	Risk	Probability	Min	Most likely	Max	EMV	% total
R-001	Tunnel boring machine (TBM) stalls in an unforeseen ground layer	30%	EUR 2.00M	EUR 6.00M	EUR 14.00M	EUR 2.00M	5.2%
R-002	Settlement damage to adjacent buildings along the alignment	35%	EUR 1.50M	EUR 4.50M	EUR 12.00M	EUR 1.84M	4.8%
R-003	Unidentified utilities encountered during excavation	50%	EUR 0.50M	EUR 1.80M	EUR 4.50M	EUR 1.02M	2.6%
R-004	Delay caused by restricted rail possession windows	40%	EUR 2.50M	EUR 6.00M	EUR 13.00M	EUR 2.63M	6.8%
R-005	Archaeological find halts excavation	20%	EUR 0.80M	EUR 2.50M	EUR 6.00M	EUR 0.56M	1.4%
R-006	Concrete and steel price escalation above contract indexation	45%	EUR 1.50M	EUR 3.50M	EUR 7.50M	EUR 1.73M	4.5%
R-007	Groundwater control failure at the station excavation	25%	EUR 2.00M	EUR 5.50M	EUR 12.00M	EUR 1.50M	3.9%
R-008	Shortage of specialized tunneling personnel	40%	EUR 1.00M	EUR 2.80M	EUR 5.50M	EUR 1.18M	3.1%
R-009	Noise and vibration complaints lead to working-hour restrictions	45%	EUR 0.60M	EUR 1.80M	EUR 4.00M	EUR 0.89M	2.3%
R-010	Interface conflict between tunnel M&E system packages	30%	EUR 1.20M	EUR 3.50M	EUR 8.00M	EUR 1.16M	3.0%
R-011	Contractor claim over scope ambiguity at package interfaces	35%	EUR 2.00M	EUR 5.00M	EUR 11.00M	EUR 1.93M	5.0%
R-012	Permit amendment for contaminated spoil depot (nitrogen/PFAS)	30%	EUR 1.00M	EUR 3.00M	EUR 7.00M	EUR 1.00M	2.6%
R-013	Safety incident in the excavation (collapse or flooding)	12%	EUR 3.00M	EUR 8.00M	EUR 18.00M	EUR 1.06M	2.7%
R-014	Optimized bore profile saves segment concrete	30%	EUR -2.50M	EUR -1.20M	EUR -0.40M	EUR -0.39M	-1.0%
R-015	Station design change following public consultation	30%	EUR 1.00M	EUR 3.00M	EUR 7.00M	EUR 1.00M	2.6%
R-016	Late delivery of precast tunnel segments	35%	EUR 0.80M	EUR 2.20M	EUR 5.00M	EUR 0.85M	2.2%
R-017	Winter stoppage or extreme rainfall delays earthworks	40%	EUR 0.50M	EUR 1.50M	EUR 3.50M	EUR 0.67M	1.7%
R-018	Rail authority changes train protection (ETCS) requirements	25%	EUR 1.50M	EUR 4.00M	EUR 9.00M	EUR 1.10M	2.9%
R-019	Insurance claim settlement delays project cash flow	20%	EUR 0.30M	EUR 0.90M	EUR 2.20M	EUR 0.20M	0.5%
R-020	Key tunnel safety officer leaves the project	18%	EUR 0.40M	EUR 1.20M	EUR 2.80M	EUR 0.24M	0.6%

ID	Risk	Probability	Min	Most likely	Max	EMV	% total
R-021	Unexpected contaminated soil requires off-site disposal	30%	EUR 1.20M	EUR 3.20M	EUR 7.50M	EUR 1.08M	2.8%
R-022	Accelerated delivery through modular station construction	25%	EUR -3.00M	EUR -1.50M	EUR -0.50M	EUR -0.40M	-1.0%
R-023	Coordination conflict with the parallel highway project	30%	EUR 0.70M	EUR 2.00M	EUR 4.50M	EUR 0.66M	1.7%
R-024	Damage to a listed bridge during heavy transport	15%	EUR 1.00M	EUR 3.00M	EUR 8.00M	EUR 0.53M	1.4%
R-025	Additional cost of 24/7 dewatering running longer than planned	35%	EUR 0.60M	EUR 1.80M	EUR 4.20M	EUR 0.70M	1.8%
R-026	Early-opening bonus scheme for the tunnel	20%	EUR -4.00M	EUR -2.00M	EUR -0.80M	EUR -0.43M	-1.1%
R-027	Fire safety certification of the tunnel delays handover	22%	EUR 0.80M	EUR 2.50M	EUR 6.00M	EUR 0.62M	1.6%
R-028	TBM main bearing failure requiring hyperbaric intervention	15%	EUR 15.00M	EUR 30.00M	EUR 60.00M	EUR 4.88M	12.6%
R-029	Regulator mandates an additional platform and evacuation shaft	40%	EUR 8.00M	EUR 18.00M	EUR 30.00M	EUR 7.33M	19.0%
R-030	Cross-passage ground freezing takes longer than planned	35%	EUR 1.50M	EUR 4.00M	EUR 9.00M	EUR 1.55M	4.0%

Appendix A. Full risk register (30 risks). Amounts in EUR.

Appendix B: Methodology summary

RCAT applies three orthogonal contingency methods to the same input and reconciles them through weighting:

- **Method 1 (Bottom-Up EMV).** Sum of probability × PERT-EV per risk, adjusted for the portfolio effect (0.85).
- **Method 2 (Factor-Based AACE).** Base × (phase 6.0% + complexity 2.2% + contract 3.0% = 11.2%).
- **Method 3 (Monte Carlo P80).** 10,000-iteration Beta-PERT simulation (correlation: Cholesky (12 x 12), seed 42); P80 as reference.

Appendix C: Run information and validation

- **Engine** RCAT v4.0 engine 1.0 (MRG32k3a, exact Beta inverse).
- **This run** 10,000 iterations, 30 risks, seed 42; simulated mean EUR 38.59M against a deterministic EMV of EUR 38.67M (-0.20%).
- **Reproducibility** a fixed seed gives identical percentiles on a re-run with the same input.
- **Engine tests** random number generator, Beta inverse, Beta-PERT parametrization, correlation and percentile definition are tested in the RCAT validation note (08. Validation).

Appendix D: Disclaimer

This Business Case was prepared with the Quantil Risk Contingency Allocation Tool. The accuracy of the recommended contingency depends on the quality of the input supplied by the client. This document is a decision-support analysis. It is not investment, legal or financial advice.

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